TOWN OF WEYMOUTH
WATER AND SEWER CAPACITY ANALYSIS

Prepared for:
Town of Weymouth, Massachusetts
and
Southfield Redevelopment Authority

ENVIRONMENTAL PARTNERS
— An Apex Company —

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ADD	Average Day Demand
ADF	Average Daily Flow
AFF	Available Fire Flow
AJBWTP	Arthur J Bilodeau Water Treatment Plant
ARJWW	Abington Rockland Joint Water Works
ASR	Annual Statistical Report
AWWA	American Water Works Association
BAC	Biological Activated Carbon
BPS	Booster Pumping Station
CCOD	Commercial Corridor Overlay District
CEMU	Confidently Estimated Municipal Use
CI	Cast Iron
CIP	Capital Improvements Program
DAF	Dissolved Air Flotation
DI	Ductile Iron
DWF	Dry Weather Flow
EP	Environmental Partners
EPS	Extended Period Simulation
FAR	Floor Area Ratio
GAC	Granular Activated Carbon
gpd	Gallons per Day
gpm	Gallons per Minute
GPWTP	Great Pond Water Treatment Plant
HGL	Hydraulic Grade Line
hp	Horsepower
HSZ	High Service Zone
idm	Inch-Diameter Mile

I/I	Inflow/Infiltration
ISO	Insurance Services Office
ISZ	Intermediate Service Zone
LSZ	Low Service Zone
MAPC	Metropolitan Area Planning Council
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MBTA	Massachusetts Bay Transit Authority
MDD	Maximum Day Demand
MG	Million Gallons
MGD	Million Gallons per Day
MGY	Million Gallons per Year
MOA	Memorandum of Agreement
MR	Mill River
MWRA	Massachusetts Water Resources Authority
NGVD29	National Geodetic Vertical Datum of 1929
OIT	Operator Interface Terminal
OPC	Opinion of Probable Cost
OSR	Old Swamp River
OWR	Office of Water Resources
PFAS	Per-and Polyfluoroalkyl Substances
PLC	Programmable Logic Controller
PRV	Pressure Reducing Valve
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
RGPCD	Residential Gallons per Capita per Day
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SDA	Sanitary Drainage Area

SRA	Southfield Redevelopment Authority
SSO	Sanitary Sewer Overflow
SWNAS	South Weymouth Naval Air Station
UAW	Unaccounted-for Water
UMass	University of Massachusetts
UPS	Uninterruptible Power Supply
USGS	United States Geological Survey
VCOD	Village Center Overlay District
VOC	Volatile Organic Compound
WMA	Water Management Act
WRC	Water Resources Commission
WTP	Water Treatment Plant

EXECUTIVE SUMMARY

Environmental Partners Group, LLC (EP) contracted with the Southfield Redevelopment Authority (SRA) in conjunction with the Town of Weymouth to prepare this Water and Sewer Capacity Analysis, with the primary goal of assisting the Town with maintaining a high level of water and sewer service to its residents through the 2040 planning year.

EP's scope of services included the following tasks:

- Review water system infrastructure and ability to provide water in compliance with existing Drinking Water Regulations.
- Review water system efficiency, redundancy and resiliency.
- Collect water production and consumption records and develop current water system statistics.
- Develop a list of existing and future proposed developments that are projected to require water and sewer service from Weymouth, including the build-out of the former South Weymouth Naval Air Station (SWNAS).
- Project population growth and water and sewer demand within the existing service areas.
- Review any mechanical and operational factors that may impose limitations to the Town's water supply.
- Evaluate the adequacy of the Town's existing water supply sources to meet existing and future water demands through 2040.
- Develop potential alternatives for Massachusetts Water Resource Authority (MWRA) supply to mitigate projected water supply shortfalls.
- Determine Weymouth water system improvements required for each MWRA supply alternative using the Town's existing hydraulic model of the water system and asset inventory developed as part of this report.
- Using the Town-wide sewer metering results from spring 2021, recalibrate the sewer model for dry weather and wet weather flows.
- Incorporate additional sewer flows from proposed developments into the Town's sewer hydraulic model.
- Using the calibrated model, evaluate the capacity of the existing sewer system.
- Identify improvements necessary for the system to accept flows from proposed developments including SWNAS.

EP has provided a complete and detailed explanation of our findings, conclusions, and recommendations in the following Water and Sewer Capacity Analysis Report.

REPORT CONTENTS

EP has prepared and organized the report in sections as described below.

- Section 1 describes and assesses the Town's water supply system, including the water supply wells and raw water piping, treatment facilities, storage facilities, finished water piping, emergency supply interconnections, and supervisory control and data acquisition (SCADA) system.
- Section 2 addresses supply and demand, including present water use, potential future development, projected demands, water conservation, and water supply availability.
- Section 3 identifies alternatives to utilize MWRA supply in Weymouth, evaluates water system hydraulics and recommends improvements to maintain the Town's existing level of water service over the 2040 planning horizon.
- Section 4 summarizes the MWRA supply alternatives including preliminary findings from the MWRA for extension of their system to Weymouth.
- Section 5 summarizes the sewer model recalibration results, evaluates sewer system hydraulics under various projected flow conditions and recommends improvements to reduce the risk of surcharging and sanitary sewer overflows in the system.

Existing Water Infrastructure Assessment

The Weymouth Water Department, under the Department of Public Works, serves approximately 55,000 residents and commercial and industrial facilities with over 16,000 service connection. The water system consists of five groundwater supply wells, a surface water supply system, two water treatment facilities, a booster pump station, four storage facilities, several pressure reducing valve stations to support three main service zones, and approximately 240 miles of distribution system water mains ranging in diameter from 2-inch through 18-inch.

In 2020, the Town of Weymouth produced approximately 1,671 million gallons (MG), or 4.58 million gpd. This includes a supply of approximately 100,000 gallons per day (gpd) to residents and businesses in the Weymouth portion of the former SWNAS.

To improve water system resiliency and redundancy, EP recommends the Town pursue infrastructure improvements to mitigate supply and distribution failures including:

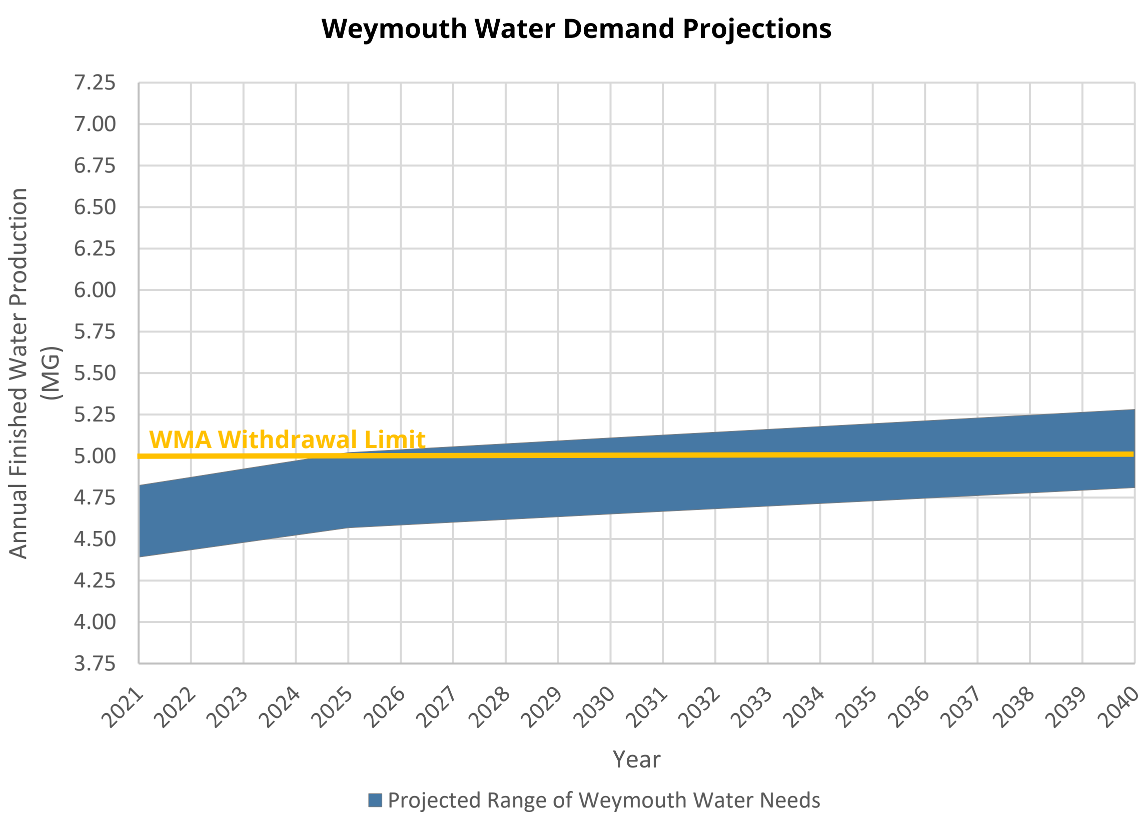
- Addition of standby power at the water supply well pump stations
- Replacement of Winter Street Well No. 1 and the Circuit Ave Well
- Replacement of cast iron pipe
- PRV vault improvements
- Replacement of the Park Avenue tank

- Development of standard operating procedures and regular emergency interconnection planning with neighboring communities.

Evaluation of Water Supply and Demand

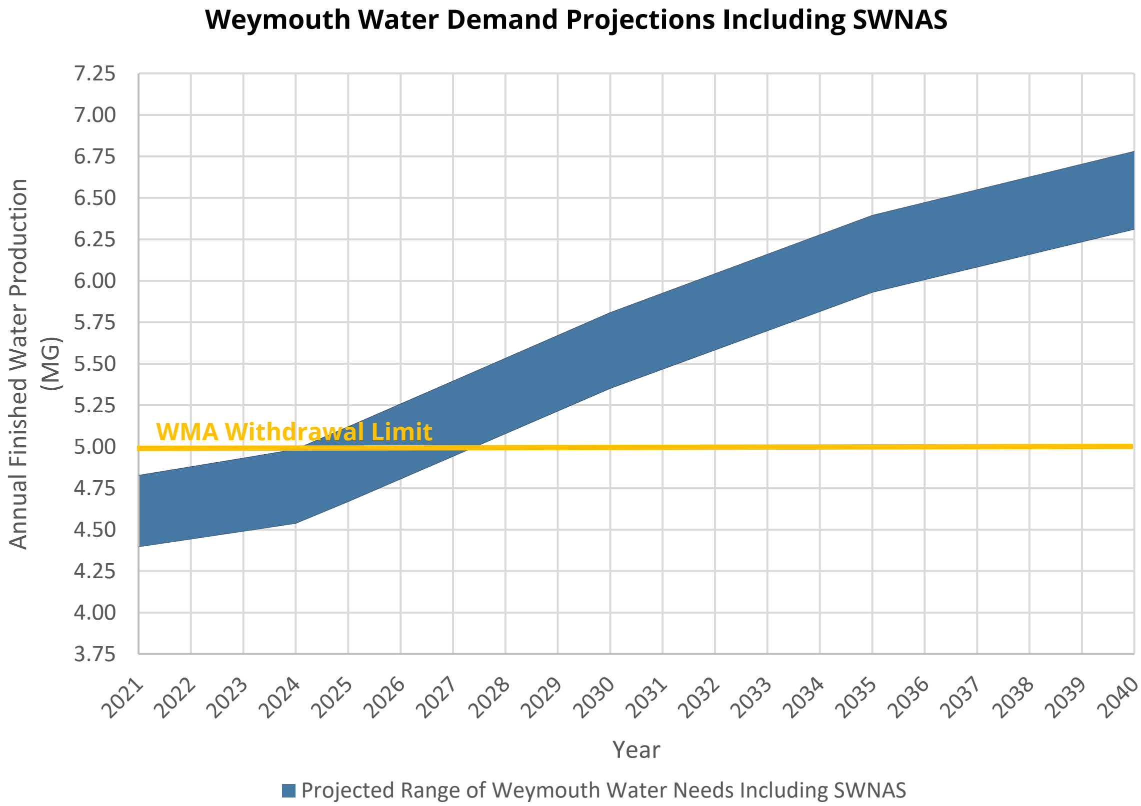
The Town's average day demand (ADD) from 2016 to 2020 was approximately 4.25 million gallons per day (MGD) which equates to 1,552 million gallons per year (MGY). The average finished water maximum day demand (MDD) was 5.26 MGD and the average ratio of finished water MDD to ADD is 1.23. Within the Town of Weymouth, the majority of water use is residential consumption (83 percent). Residential per-capita consumption between 2016 and 2020 was approximately 49 residential gallons per capita per day (RGPCD), well below the Massachusetts Department of Environmental Protection's (MassDEP) benchmark of 65 RGPCD. From 2016 to 2020, the Town had an average of 22.3 percent unaccounted-for water (UAW), which exceeds the MassDEP allowable UAW threshold of 10 percent for sources permitted under the Water Management Act (WMA).

Recent zoning regulation changes are anticipated to slow the pace of growth from 2025 through the end of the study period. However, Weymouth's water demand could surpass the Town's WMA withdrawal limit within approximately the next 5 years, without any additional demand from the SWNAS development, as shown in the Weymouth Water Demand Projections Figure below.



The water demand projection above does not include provisions for any new high volume industrial or commercial users in Weymouth.

The long awaited development in SWNAS will further increase required production and is projected to exceed WMA limits within the next decade, as shown in the figure below.



Water demand for full buildout of SWNAS, including the areas within Abington and Rockland, is currently estimated at approximately 2.4 MGD by 2040, which when combined with Weymouth's town-wide demand would exceed Weymouth's water supply safe yield of 6.27 MGD..
The MWRA regional water supply is the only viable choice for long term supply of the projected water demands in Weymouth with the ultimate ability to provide redundancy and replace the Town's current supplies. EP recommends that Weymouth begin investigating options for supply from the MWRA to accommodate the future water needs of the Town.

MWRA Supply Alternatives Analysis

EP developed several scenarios for MWRA supply to the Town of Weymouth's water system, including the following connection points:

- On Bridge Street at the Quincy town line, in the Low Service Zone (LSZ)
- On Washington Street at the Braintree Town Line, in the Intermediate Service Zone (ISZ)
- On Columbian Street at the Braintree town line, in the High Service Zone (HSZ)
- Near Summer Street at the Braintree town line (via Route 3), in the HSZ
- At the Great Pond Water Treatment Plant, in the HSZ

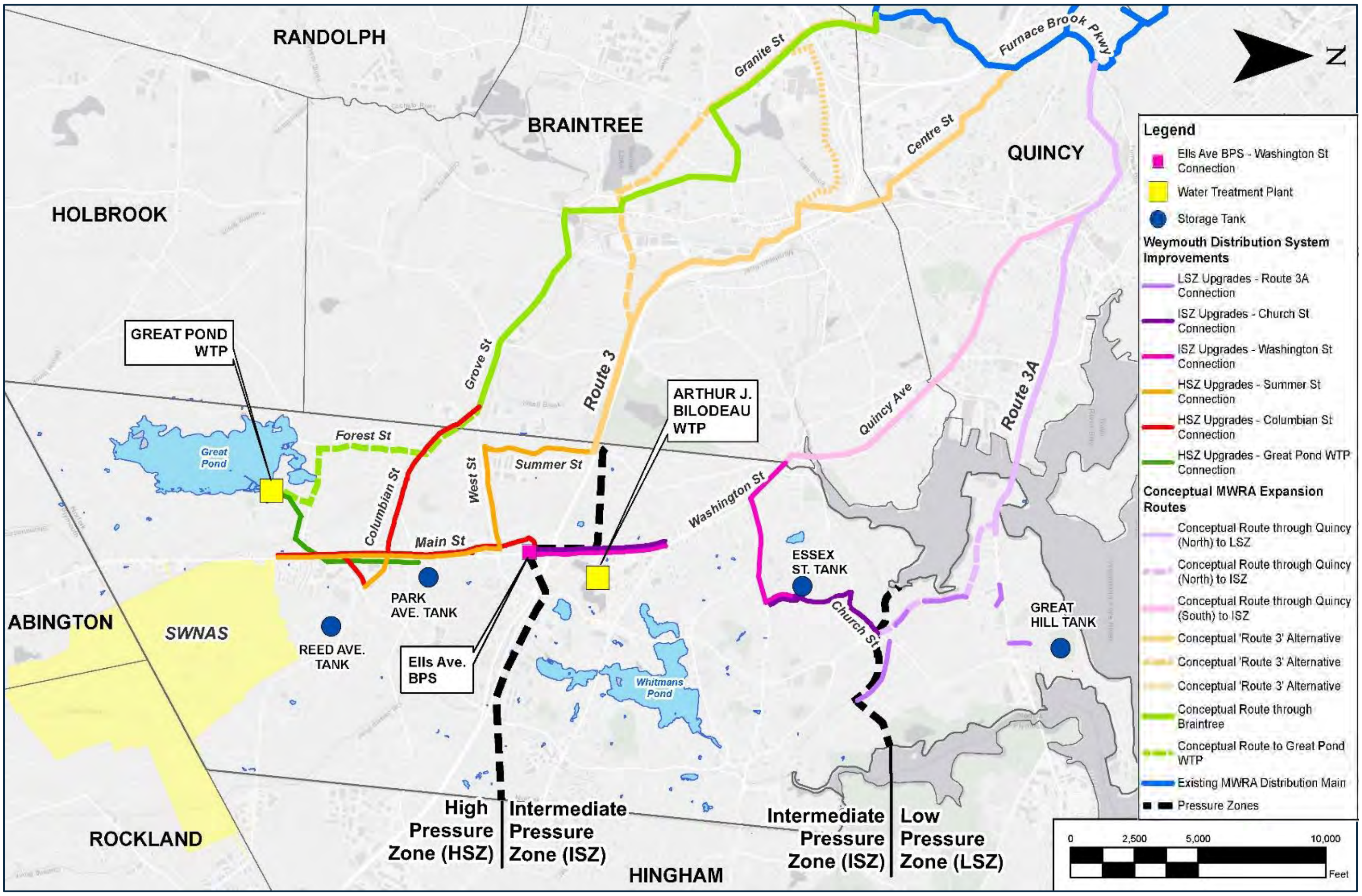
Based on the hydraulic analysis, the two most advantageous alternatives are the ISZ connection at Washington Street and the HSZ connection at the Great Pond WTP. These two alternatives could supply water to the Town of Weymouth through 2040 projected demands as well as the full buildout of SWNAS. Both options would require the Great Pond WTP to remain active and serve as a backup water supply to the Town until a redundant MWRA supply is available in the future. The HSZ connection provides more flexibility to transform Great Pond to a setting that is open for public use.

The preferred alternative is the ISZ connection as the capital costs are lower and long term hydraulic performance of the system is stronger compared the HSZ connection. The HSZ connection provides an immediate transition from Weymouth supply to MWRA supply for the entire Town but has the highest community impacts and capital costs due to the extents of water main upgrades required in Weymouth.

Summary of Weymouth Supply Alternatives

The MWRA provided four primary conceptual routes to supply Weymouth with MWRA water, all of which involve connecting a new 36-inch pipeline to MWRA's Section 22 in Quincy. Conceptual routes that connect to Weymouth's HSZ also include sub-alternatives resulting in a total of eight (8) conceptual routes to extend the MWRA system to Weymouth.

Conceptual Pipelines for MWRA Supply to Weymouth



Note: The colored routes and system improvements shown on the figure above are linked to the cost table below. This allows readers to match costs for transmission main route and Weymouth system improvements for each alternative.

All proposed alternatives possess unique design, permitting, and operational challenges. Estimated capital costs of the MWRA extension and required Weymouth system improvements are summarized below.

Conceptual Infrastructure Costs for MWRA Supply to Weymouth

MWRA Supply Scenario & Weymouth Improvements	Weymouth System Improvement Costs	MWRA Extension Costs	Total
Quincy (North) + LSZ Water Main Upgrades	$3,650,000	$51,850,000	$55,500,000
Quincy (North) to ISZ+ ISZ Water Main Upgrades	$11,360,000	$70,788,000	$82,148,000
Quincy (South) + ISZ Water Main Upgrades & BPS	$12,590,000	$56,871,000	$69,341,000
Rt. 3 Alt. 1 + HSZ Upgrades - Summer Street	$30,328,000	$63,357,000	$93,685,000
Rt. 3 Alt. 2 + HSZ Upgrades - Summer Street	$30,328,000	$50,876,000	$81,204,000
Rt. 3 Alt. 3 + HSZ Upgrades - Summer Street	$30,328,000	$60,515,000	$90,843,000
Braintree Alt. 1 + HSZ Upgrades -Columbian Street	$26,599,000	$58,205,000	$84,804,000
Braintree Alt.2 + HSZ Upgrades - Great Pond WTP Connection	$16,190,000	$71,300,000	$87,490,000

EP recommends that the Town pursue the Quincy North to ISZ Connection alignment, Quincy South alignment and the Braintree alignment alternatives. The Quincy South alignment and connection to the ISZ at Washington Street meets the Town of Weymouth's water supply goals at the lowest projected cost and provides added flexibility by allowing a phased approach to water system modifications. The Quincy North to ISZ alignment provides similar benefits to the Quincy South alignment but could avoid mitigation costs in Braintree that outweigh the costs of the additional transmission main. The Braintree alignment alternatives also meet the Town's supply goals at lower cost and lower risk than the Route 3 alternatives. EP recommends additional analysis to determine the modifications required to convert the Great Pond WTP to a pump station for the MWRA supply.

In addition to the capital cost considerations described above, EP's recommended alternatives are more compatible with Weymouth's long term goals of replacing aging infrastructure and improving the Town's environmental resources. MWRA supply would provide the Town flexibility to deactivate groundwater supplies, transition Great Pond to a backup supply and transform the pond itself to a setting that is open for public use.

Sewer Capacity Analysis

The Weymouth sewer system contains approximately 200 miles of sewer mains, approximately 4,880 manholes, 11 flooded suction pump stations, 1 suction lift pump station and 18 submersible pump stations. Wastewater flows are discharged into the MWRA system. In 2020, the average daily flow (ADF) was approximately 7.41 MGD.

The 2020 average wastewater flow of 7.41 MGD compared to the same year water consumption of 4.58 MGD demonstrates the amount of infiltration/inflow (I/) that enters the sewer collection system annually. These extraneous flows that enter the sewer system from groundwater and rainfall runoff can reduce the useful life of a sanitary network and lead to sanitary sewer overflows. Weymouth has an ongoing I/I reduction program that includes prioritized rehabilitation and replacement of aging and defective sewer infrastructure. A comprehensive flow metering and I/I study was completed in 2021.

EP used the data from The Town's 2021 system-wide flow metering program to update and recalibrate the hydraulic model for the sewer collection system and simulate hydraulic conditions. MassDEP guidelines require that the Sanitary Sewer Overflows (SSOs) do not occur during the 5-yr, 24-hr storm event. The Town has additionally instituted the requirement that gravity sewer pipes and pump stations maintain 20% reserve hydraulic capacity during a 1-Yr, 6-Hr storm event. Simulations show that the Weymouth collection system currently meets the MassDEP recommendation to transport the 5-yr, 24-hr storm without the occurrence of an SSO, however, three gravity sewer areas totaling 7,500 linear feet (LF) exceed the 20% reserve capacity threshold during a 1-Yr, 6-Hr storm event. The incremental proposed flow increases from SWNAS result in additional pipe segments crossing the 20% reserve capacity threshold and at full buildout of the SWNAS development, approximately 11,950 LF of sewer needs to be upgraded in addition to the upgrades required under existing conditions. Upgrades and estimated costs are summarized in the table below.

Required Sewer Upgrades Summary

SWNAS ADF (MGD)	Incremental Required Sewer Upgrade Length (LF)	Cumulative Required Sewer Upgrade Length (LF)	Location	Sewer Upgrade Cost per LF (Upgrade Dia.)	Total Sewer Upgrade Cost	Incremental Sewer Upgrade Cost Opinion	Cumulative Sewer Upgrade Cost Opinion
0.540	1,150	1,150	Tide Mill Brook Marsh	$5,500 (42”)	$8.00M	$27.93M	$28.68M
	2,600	3,750	Essex Street	$5,500 (42”)	$14.30M		
	3,750	7,500[1]	Liberty and Union Streets	$1,700 (15”)	$6.38M		
0.810	500	8,000	Main Street Easement	$2,500 (24”)	$1.25M	$1.25M	$29.93M
1.440	5,850	13,850	Mill Street / Easement to Columbian	$4,500 (30”)	$26.33M	$26.33M	$56.26M
	5,600	19,450	Easement - Columbian Street Main Street	$4,500 (30”) $2,500 (24”)	$26.65M	$26.65M	$82.91M

1. The 7,500 LF upgrades are required under existing conditions (no additional SWNAS flow)

Simulations show that the sewer upgrades associated with the various SWNAS buildout phases will provide the minimum required 20% reserve capacity during a 1-Yr, 6-Hr storm event and will prevent SSOs during a 5-Yr, 24-Hr storm. Additionally, the Libbey Parkway Pump Station (PS) has sufficient capacity to handle SWNAS flows from the proposed buildout scenario which allocates an additional ADF of 0.54 MGD to the PS.

SECTION 1 WATER INFRASTRUCTURE ASSESSMENT

EP has prepared this section to describe the Town of Weymouth's existing water infrastructure and identify potential improvements to system efficiency, redundancy, and resiliency. System efficiency, redundancy, and resiliency will be critical to maintaining adequate water service during the anticipated water demand increases over the next 20 years.

SECTION 1.1 BACKGROUND

The Town of Weymouth (the Town) is a primarily residential community, situated approximately 12 miles southeast of Boston in Norfolk County. Spanning 22 square miles, it borders the communities of Abington, Braintree, Hingham, Holbrook, Rockland, Quincy, and the Hingham Bay. The Weymouth Water Department, under the Department of Public Works, serves approximately 55,000 residential customers and various commercial and industrial facilities.

The Weymouth water system consists of five groundwater supply wells, a surface water supply system, two water treatment facilities, a booster pump station, four storage facilities, several pressure reducing valve stations to support three main service zones, and approximately 240 miles of distribution system water mains ranging in diameter from 2-inch through 18-inch. A map of the Weymouth water system, showing the groundwater wells, surface supply system, treatment facilities, water main piping, storage tanks, and service zones is included in Figure 1-1.
In 2020, the Town of Weymouth produced approximately 1,671 million gallons (MG), or 4.58 million gpd. Town water demand in 2020 by consumer type is shown in Table 1-1 below.

Table 1-1: Metered Finished Water Service Connection Types

Service Connection Type	Total No. of Connections	Total 2020 Water Consumption (MG)
Residential	15,819	1,042.5
Commercial	782	149.2
Industrial	16	5.2
Municipal, Institutional, and Non-Profit	109	8.1
Other	2	1.2
Total	**16,728**	**1,206.2**

SECTION 1.2 WATER SOURCES

The Town pumps raw water from five groundwater wells within the Mill River aquifer and the Great Pond surface water system. Drinking water is produced at two water treatment facilities: the Arthur J. Bilodeau Water Treatment Plant (AJBWTP), which treats raw water from the groundwater wells (Winter Street Well No. 1, Winter Street Well No. 2, Main Street Well, Circuit Avenue Well and Libbey Park Well), and the Great Pond Water Treatment Plant (GPWTP), which treats water from the Great Pond surface water supply system. The Great Pond surface supply system includes Great Pond, Whitman's Pond, and the impounded South Cove. The total authorized withdrawal under the Water Management Act from Town sources is 5.00 million gallons per day (MGD). Table 1-2 below provides general production information from each water supply source in 2020.

Table 1-2: 2020 Water Sources Usage Details

Source Name	Total Withdrawal (MG)	Total Days Operated	Max Day Withdrawal (MG)
Great Pond Surface Water System	1,595.4	365	5.712
Circuit Avenue Well	47.5	320	0.334
Main Street Well	29.2	171	0.326
Libbey Park Well	0.0	0	0
Winter Street Well No. 1	1.4	11	0.281
Winter Street Well No. 2	115.3	310	0.753
Total	**1,789**	**--**	**--**

As shown, the Great Pond surface water system produces significantly more water than any other source, accounting for nearly 90% of the Town's supply. In 2020, the amount drawn from Great Pond was ten times the amount of the next largest source, Winter Street Well No. 2, which was operated for most of the year. The remaining wells run less than a quarter of the year. Winter Street Well No. 1 is subject to significant pumping restrictions, related to the time of year and flow readings in the Mill River and Whitman's Pond.

Section 1.2.1 Surface Water Supply

The Great Pond surface water supply system has been used as a source of raw drinking water for the Town of Weymouth since the public water system was established in 1885 and remains the largest source to this day. The Great Pond Reservoir is a 0.80 square mile pond located southwest of South Weymouth in the Weymouth Back River Watershed, with a usable volume of 1,000 MG. To maintain adequate levels within Great Pond, the Town pumps water from South Cove, an impoundment upstream of Whitman's Pond separated by a sluice gate, using the Washington Street Pump Station. Raw water is pumped on an annual basis in coordination with the Herring Warden. In emergencies, the Town is also permitted to pump raw water from Whitman's Pond proper by opening the sluice gate to South Cove. The Massachusetts Department of Environmental Protection (MassDEP) approved safe yield of the surface supply system is 3.63 MGD. Surface water from Great Pond is treated at the Great Pond Water Treatment Plant.

Washington Street Raw Water Pump Station

In response to the severe drought conditions between 1964 and 1966, the Town constructed the Washington Street Pump Station at 929 Washington Street and a 20-inch diameter transmission to supplement Great Pond with water from South Cove. The pump station typically operates during the fall and winter months and is vital to maintain sufficient water levels in Great Pond. The pump station houses two vertical turbine pumps with 75 hp motors that pump raw water into a 20-inch diameter raw water transmission main that travels approximately 3.5 miles before discharging into Great Pond. The pump house has a maximum aggregate capacity of about 4,800 gallons per minute (gpm). Currently, the Washington Street Pump Station is not equipped with backup power capabilities.

Section 1.2.2 Groundwater Supply

The Town supplements their surface water supply using five groundwater wells, located in the Mill River aquifer: Winter Street Well No. 1, Winter Street Well No. 2, Main Street Well, Circuit Avenue Well and Libbey Park Well. A summary of the groundwater wells is shown in Table 1-3.

Table 1-3: Groundwater Supply Sources

Source Name	Location	Installation Year	Depth (ft)	Pump Motor (hp)
Circuit Avenue Well	180 Circuit Avenue	1944	66	20
Main Street Well	360 Main Street	1951	55	25
Libbey Park Well	150 Libbey Parkway	2018	42	30
Winter Street Well No. 1	155 Winter Street	1963	49	20
Winter Street Well No. 2	101 Winter Street	1973	48	15

All sources except the Libbey Park Well are active gravel-packed wells with vertical turbine pumps, housed in pump buildings. The Libbey Park Well was replaced in 2018 with a new well outside the pump station building. A submersible well pump that will discharge through the building is scheduled for installation in 2022. There are no existing emergency backup power capabilities at any of the well buildings. Each well pump discharges into an 8-inch diameter transmission main, which conveys raw water to the Arthur J. Bilodeau Water Treatment Plant.

Four of the wells have been rehabilitated within the last decade, three of which were performed in the last two years. The results of each rehabilitation on the well capacities are shown in Table 1-4.

Table 1-4: Groundwater Well Rehabilitation

Source Name	Date of Rehabilitation	Specific Capacity before Rehabilitation	Specific Capacity After Rehabilitation	1999 Specific Capacity[1]
Circuit Avenue Well	January 2021	32 gpm/ft at 250 gpm	98 gpm/ft at 500 gpm	84 gpm/ft at 486 gpm
Main Street Well	January 2021	10.9 gpm/ft at 380 gpm	29.8 gpm/ft at 400 gpm	48 gpm/ft at 549 gpm
Libbey Park Well[2]	N/A	21.9 gpm/ft at 275 gpm	N/A	N/A
Winter Street Well No. 1	May 2020	45 gpm/ft at 300 gpm	214 gpm/ft at 385 gpm	427 gpm/ft at 710 gpm
Winter Street Well No. 2	June 2004	71 gpm/ft at 608 gpm	134 gpm/ft at 580 gpm	53 gpm/ft at 313 gpm

1. The Mill River wells were tested in 1999 as part of the safe yield study.
2. The Libbey Park Well was replaced in 2018.

Section 1.2.3 Emergency Interconnections

The distribution system is also connected to adjacent communities through several interconnections. Direct interconnections between neighboring communities are normally closed but can be opened via isolation valves to deliver water as needed during an emergency situation. The Weymouth water distribution system maintains direct piping interconnections with the following neighboring water systems: Braintree, Abington-Rockland Joint Water Works (ARJWW), the Weir River Water System (serving Hingham and Hull), and Quincy (supplied by the MWRA). A summary of Weymouth water distribution system interconnections is provided in Table 1-5.

Table 1-5: Hydraulic Information of Adjacent Communities via Interconnection

Community System	Interconnection Location / Service Zone	Size of Interconnection	Weymouth Hydraulic Grade Line[1]	Community Hydraulic Grade Line[2,3,4]
Weir River Water System	High Street / Intermediate	8-inch	288	282
Weir River Water System	Commercial Street / Intermediate	8-inch	288	282
Abington-Rockland Joint Water Works	Main Street / High	8-inch	296	290
Abington-Rockland Joint Water Works	Liberty Street / High	6-inch	296	290
Abington-Rockland Joint Water Works	Pine Street / High	12-inch	296	290
Braintree	Columbian Street / High	10-inch	330	330
Braintree	Sterling Street / Intermediate	6-inch	261	261
Braintree	Washington Street / Intermediate	10-inch	261	261
Quincy	Bridge Street / Low	12-inch	230	230

1. Weymouth Datum (NGVD 1929 + 5.82 feet)
2. WRWS Datum (USGS – Mean Sea Level 1929)
3. Braintree Datum (NGVD 1929 + 5.78 feet)
4. Quincy Datum (Boston City Base Datum: NGVD 1929 + 5.65 feet)

SECTION 1.3 GREAT POND WATER TREATMENT PLANT

Water pumped from the surface water supply system is treated at the GPWTP, an 8.0 MGD capacity treatment facility located at 239 Pond Street. The GPWTP produced an average of 3.53 MGD over the last 5 years.

The original GPWTP was constructed in 1936 with an initial capacity of 4.0 MGD, but the Town expanded the GPWTP capacity to 6.0 MGD in 1967, when the South Cove supplemental supply line was brought online. However, in 2009, the original plant was demolished and replaced by a new facility equipped with coagulation/flocculation, dissolved air filtration, and media filtration processes, which is in operation today. Four vertical turbine pumps draw raw water from Great Pond into the raw water pump station, adjacent to Great Pond, via two 24-inch ductile iron pipes and then to the treatment plant through one 20-inch ductile iron pipe. Treated water is then pumped into the high-pressure service zone.

Water Treatment Processes

The treatment system at the GPWTP includes a number of unit processes, operated in parallel where possible. Raw water pumped into the GPWTP from Great Pond is screened for chlorine and pH parameters, after which it is dosed with potassium permanganate (for precipitation of iron and manganese) and sodium hydroxide (for pH control). To remove organics, water is treated with polyaluminum chloride and passed through rapid mixers and coagulation/flocculation basins, then treated with dissolved air filtration (DAF) for supplemental solids removal. After clarification, the water is ozonated for multiple purposes: the enhancement for removal of organics and reduction of disinfection by-product precursors; the control of tastes and odors; and for primary disinfection. Water is then passed through deep bed biologically active granular activated carbon (BAC) media, which removes biological degradable organic compounds and those that can cause additional taste and odor concerns. After filtration, the remaining treatment processes consist of chemical additions: gaseous chlorination for secondary disinfection; sodium bicarbonate for alkalinity adjustment; phosphoric acid for corrosion control; and hydrofluorosilicic acid (fluoride) for dental hygiene. Finished water is passed through the underground clearwell before it is pumped into the distribution system.

Residuals Management

The residuals management system at the GPWTP includes physical and chemical dewatering and lagoons for residuals management. Residuals generated from filter backwashing are discharged into holding tanks, equipped with mechanical mixers to maintain steady sludge consistency, then treated with a polymer and passed through a plate settling system, with the supernatant discharging to the permitted discharge outfall. Process waste from preoxidation, rapid mix, DAF, and sludge from the plate settler are discharged into the sanitary sewer. Three lagoons adjacent to the facility can also be used for residuals discharge and settling if sanitary sewer discharge is restricted by the MWRA. Sludge from the lagoons is periodically excavated and transported to an approved disposal facility.

Additional GPWTP Facilities

Treatment is managed within the GPWTP through a supervisory control and data acquisition (SCADA) system. The SCADA system allows operators to observe and adjust chemical addition, pump operations, tank levels, pressures, and other key components of the GPWTP. The GPWTP's control room houses the monitoring and control infrastructure for the entire WTP. The control room is staffed 24/7 with certified operators who monitor the treatment process. The SCADA system includes SCADA computer workstations, remote terminal units (RTUs), Operator Interface Terminals (OIT), SCADA communication panels, control panels, and an assortment of associated instrumentation and control devices. Communication between the GPWTP and remote field facilities is via telephone and radio. Connection between the GPWTP and the AJBWTP is via a dedicated 56k baud leased line.

The GPWTP is equipped with two diesel stand-by generators for backup power, sized to meet the demand of the entire facility. The generators are housed in separate individual enclosures, located southeast of the ozone contactor basin. During power failures, the generators provide power to the

facility via automatic transfer switches. The SCADA system control panels, programmable logic controllers (PLCs), and human machine interface (HMI) computers are supplied with uninterruptible power supplies (UPS) to remain in service during an outage and during power transfer.
The facility includes a standard WTP laboratory with a fume hood, sample sink, benchtop spectrophotometer, pH probes, and a benchtop turbidimeter. Sample lines from throughout the plant discharge to the sample sink. Operators conduct routine analyses every shift in this laboratory. The treatment plant also has the following facilities:

- Restroom and locker room facilities
- Meeting room
- Staff offices
- Storage room
- Electrical room
- Maintenance and utilities rooms

SECTION 1.4 ARTHUR J. BILODEAU WATER TREATMENT PLANT

Water pumped from the five groundwater wells is treated at the Arthur J. Bilodeau Water Treatment Plant, a 4.0 MGD capacity water treatment facility located at 95 Winter Street. The AJBWTP was originally constructed in 1973 to mitigate taste, odor, and color complaints from the groundwater supply. The plant produces an average of 0.72 MGD of finished water, which is pumped from the facility's clearwell into the intermediate service zone via a 12-inch diameter pipe.

The well pumps can be operated automatically based on the water elevation within the facility's clearwell, but may be individually operated by the WTP Operator using a manual switch or a remote-start SCADA system command. The AJBWTP is equipped with a SCADA system similar to that of the GPWTP for data collection, process control and communications with remote locations, including wells, storage tanks, and the GPWTP. The SCADA system control panel and main computer are located in the facility control room. The treatment plant can be operated as a satellite facility, controlled entirely from the GPWTP, but is staffed for at least one full 8-hour shift each day during operation.

In the event of a power failure, a natural gas-fired generator will power the AJBWTP via an automatic transfer switch. Control logic programmed into the generator automatically starts the generator system, and, upon power transfer, all WTP equipment and components can be operated normally. The SCADA system is supplied with a UPS to remain in service during an outage and during power transfer.

Water Treatment Processes

Raw water from each well merges into a single pipe that serves as the intake for the AJBWTP. Physical treatment at the plant is performed in two parallel treatment trains, which can operate independently or in parallel: packed tower aeration for the removal of trace volatile organic compounds (VOCs), dissolved carbon dioxide (for pH adjustment), and partial oxidation of dissolved iron and manganese; coagulation/flocculation using walking beam flocculators; clarification using tube settlers for the removal of solids; and granular activated carbon (GAC) media filters for enhanced removal of trace VOCs, PFAS, natural organic matter, and particles not removed during sedimentation. Complimentary chemical addition and treatment consists of potassium permanganate for oxidation of source water iron and manganese, polyaluminum chloride for coagulation, and potassium hydroxide for pH adjustment. Following filtration, water travels to the facility's clearwell where it is fluoridated for dental health. Just before the piping exits the plant, the finished water is injected with sodium hypochlorite for residual disinfection and phosphoric acid for corrosion control in the distribution system.

Residuals Management

Two lagoons provide settling time for sludge from the sedimentation basins and filter backwash. The lagoons are each five feet deep and have a combined storage volume of approximately 300,000 gallons. Each lagoon is equipped with an outlet structure containing a recycle pump. Settled water is pumped from each lagoon through a 4-inch line to a common metering vault. The 4-inch line discharges to the 10-inch raw water line from Winter Street Well #1. This line carries the settled water to the head of the AJBWTP.

Additional AJBWTP Facilities

The facility includes a standard WTP laboratory with a fume hood, sample sink, benchtop spectrophotometer, pH probes, and a benchtop turbidimeter. Sample lines from throughout the plant discharge to the sample sink. Operators conduct routine analyses every shift in this laboratory.

SECTION 1.5 WATER STORAGE TANKS

Background

Water storage facilities serve several functions within the water distribution system, including system pressure equalization, fire suppression volume and emergency storage, and operational flexibility. The volume of water within a storage tank is immediately available for fire protection and can supplement the system so the Town may perform routine maintenance on its treatment facilities, groundwater wells, pump stations, and distribution piping.

The Town of Weymouth maintains four water storage facilities within the three service zones: Reed Avenue, Park Avenue, Essex Street, and Great Hill. Two of the tanks (Reed Avenue and Park Avenue) are located in the high-service zone, and one tank each is located in the intermediate- and low-service zones (Essex Avenue is located in the intermediate zone; Great Hill is located in the low zone). Combined, the storage facilities provide approximately 4.9 MG of storage. A summary of the Weymouth water distribution system storage facilities is presented in Table 1-6.

Table 1-6: Distribution System Storage Facilities

Storage Tank	Volume (MG)	Overflow Elevation[1] (ft)	Base Elevation[1] (ft)	Type	Material
Park Avenue	1.25	300	211	Standpipe	Welded Steel
Reed Avenue	2.00	300	203	Standpipe	Welded Steel
Essex Street	1.00	265	226	Elevated Spheroid	Welded Steel
Great Hill	0.65	165	149	Reservoir	Welded Steel

1. All elevations are Weymouth Datum (NGVD 1929 + 5.82 feet)

The high service zone is serviced by the Reed Avenue tank and the Park Avenue tank. The Reed Avenue tank is a 2 MG capacity standpipe, constructed in 1969. The tank was last painted in 2010. The welded steel tank is located at approximately 33 Reed Avenue. The Park Avenue standpipe, located near Lockewoods Drive, is a welded steel tank constructed in 1957, with a capacity of 1.25 MG. It was last painted in 2003. The overflow elevation of both tanks is approximately 300 feet (Weymouth Datum).

The Essex Street storage tank, located in the intermediate-service zone near Calnan Circle, is an elevated steel hydrosphere with a capacity of 1 MG, constructed in 1990. It was last painted in 2011. The overflow elevation of the Essex Street storage tank is approximately 265 feet (Weymouth Datum). There are provisions on-site to introduce sodium hypochlorite into the system to boost the distribution system chlorine residual. Sodium hypochlorite is delivered in a 55-gallon drum by truck, where it is transferred to the day tank using a portable drum pump. A chemical feed pump, with automatic and manual control options, meters the sodium hypochlorite from the day tank to the 16-inch riser pipe into the water storage tank. Under automatic control, the chemical feed pump is activated when the altitude valve is open and the tank is filling. Under the manual control, the chemical feed pump is controlled by a local on/off hand switch. The supplemental addition of chlorine is typically only operational from May through September. A second feed pump is located on site for emergency use.

The Great Hill storage tank is 0.65 MG capacity reservoir located in the low-service zone on Bradley Road in Great Hill Park. After its construction in 2002, the Great Hill tank coating system was rehabilitated in 2015. The storage tank is comprised of welded steel and has an overflow elevation of 166 feet. The Great Hill tank also has a booster chlorine chemical addition facility. The system consists of a liquid storage tank, chemical metering pumps, and associated flow sensors. Chemical addition is triggered when the tank begins filling: flow into the tank signals the system to energize and dose sodium hypochlorite into the 12-inch inlet/outlet main. Once flow into the tank stops or flow reverses into the system, the booster chemical system shuts off. Similar to the chlorine booster system at the Essex Street tank, this system is typically operational from May through September.

A summary of pertinent engineering data associated with Weymouth's four water distribution storage tanks is provided in Table 1-7.

Table 1-7: Summary of Storage Tank Design Criteria

Storage Tank	Service Zone	Base Elevation[1] (ft)	Overflow Elevation[1] (ft)	Height (ft)	Diameter (ft)	Nominal Volume (MG)	Incremental Volume (gal/ft)
Park Avenue	High	211	300	90	49	1.25	14,045
Reed Avenue	High	203	300	98	59	2.00	20,620
Essex Street	Intermediate	226	265	128	72	1.00	25,640
Great Hill	Low	149	166	18	80	0.65	38,235

1. Weymouth Datum (NVGD 1929 + 5.82 feet)

All four tanks were most recently fully inspected (including interior and exterior) in May 2020. Table 1-8 summarizes the major recommendations from the 2020 inspection.

Table 1-8: Storage Tank Maintenance Recommendations Summary

Storage Tank	Service Zone	Interior Recommendations	Exterior Recommendations
Park Avenue	High	Cleaning and spot coating of all interior components	Complete re-coat walls, roof and overflow, repair concrete foundation,
Reed Avenue	High	Cleaning and spot coating of ceiling	Cleaning of walls and spot coating of roof
Essex Street	Intermediate	Cleaning and spot coating of pedestal and tank walls	Cleaning and spot coating of pedestal, tank walls, roof and overflow
Great Hill	Low	Spot coat rigging holes	Cleaning and spot coating of tank walls and roof

EP advises that the Town follow all maintenance recommendations made during these inspections, which included comprehensive re-coating of key tank components to hinder corrosion, steel fatigue and deterioration, and protect the tank components along with other structural improvements.

Usable Storage

Useable storage is typically divided into two components:

- **Useable Storage for Equalization of Peak Hourly Demand:** The volume of storage in the tanks above the elevation required to provide a minimum of 35 pounds per square inch (psi) static pressure (81.2 feet) throughout each service zone.

- **Usable Storage for Fire Protection:** The volume of storage in the tanks above the elevation required to provide a minimum of 20 psi static pressure (46.2 feet) throughout each service zone.

In the high service zone, the tanks' overflow elevation is approximately 300 feet, and the highest customer is located at an elevation of approximately 204 feet. Therefore, the usable storage for peak hour demand for the Park Avenue tank and the Reed Avenue tank is approximately 213,000 gallons and 312,000 gallons, respectively (a total of approximately 525,000 gallons). In the intermediate service zone, the overflow elevation is approximately 265 feet, and the highest customer is located at an elevation of approximately 162 feet. The usable storage for the Essex tank is therefore approximately 568,000 gallons. In the low service zone, the overflow elevation is approximately 166 feet, and the highest customer is located at an elevation of approximately 89 feet. Thus, at this elevation, there is no usable volume for the Great Hill tank. When the Great Hill tank is full, the highest customer in the low service zone (not included in the Prospect Hill boosted zone) has a static water pressure of less than 35 psi.

Table 1-9: Weymouth System Storage Capacity

Storage Tank	Service Zone	Incremental Volume (gal/ft)	Overflow Elevation[1] (ft)	Highest Customer Elevation (ft)	Usable Volume for PHD[2]	Usable Volume for Fire Flow (MG)	Nominal Volume (MG)
Park Avenue	High	14,045	300	204	0.21	0.70	1.25
Reed Avenue	High	20,620	300	204	0.31	1.03	2.00
Essex Street	Intermediate	25,640	265	162	0.57	1.00	1.00
Great Hill	Low	38,235	166	89	0.00	0.65	0.65

1. Weymouth Datum (NVGD 1929 + 5.82 feet)
2. Peak Hourly Demand

Peak Hourly Demand

The volume of distribution storage required to meet peak hourly demands is a function of both the maximum daily demand and the available pumping capacity. If pumping capacity is equal to or greater than the maximum day demand, the storage required to meet peak hourly demands is estimated as 30 percent of the maximum day demand, as referenced in the American Water Works

Association Manual of Water Supply Practices. Assuming the Town's pumping capacity will remain equal to or greater than the maximum daily demand, the required storage to meet projected 2040 peak hourly demands is shown in Table 1-10.

Table 1-10: Peak Hourly Demand Storage Requirements

Service Zone	MDD[1] (MGD)	Required Peak Hourly Demand Storage (30% MDD)	Total Usable Storage Available (MG)	Useable Storage Surplus or (Deficit) (MG)
High	4.13	1.24	0.53	-0.71
Intermediate	2.60	0.78	0.57	-0.21
Low	1.04	0.31	0.00	-0.31
System Wide	7.76	2.33	1.09	-1.24

1. Maximum Day Demand

This analysis indicates that there is a system-wide projected deficit of approximately 1.24 million gallons for peak hourly demand storage.

Fire Protection

The volume of distribution storage necessary for fire protection is based in part on the fire flow requirements established by the Insurance Services Office (ISO). Criteria established by ISO are used by insurance companies to set fire insurance rates for the municipality. Based on the most recent ISO report released in November 2006, the highest fire flow requirement in Weymouth is 6,000 gpm at the Lowe's Home Improvement Center on Bridge Street (low service zone). Additionally, the Weymouth high school (high service zone) and the Chapman middle school (intermediate service zone) both require a 5,000 gpm fire flow.

The usable storage for fire protection is the storage volume needed at each tank to maintain 20 psi at the highest customer elevation minus the storage volume required to meet peak hourly demand. The results of the available fire protection storage analysis are presented in Table 1-11.

Table 1-11: Fire Protection Storage Requirements

Service Zone	Required Fire Flow Storage (MG)	Zone Fire Storage Available (MG)	Total Fire Storage Available (MG)	Useable Storage Surplus or Deficit (MG)
High	1.20	0.49	0.49	-0.71
Intermediate	1.20	0.22	0.71	-0.49
Low	1.44	0.34	1.05	-0.39

This analysis indicates a projected deficit for fire protection storage in all of the service zones. The high service zone has the largest deficit of 0.71 MG.

SECTION 1.6 BOOSTER PUMP STATIONS

The Weymouth water system has one booster pump station in the distribution system: the Prospect Hill Booster Pump Station (BPS) located at 160 Prospect Hill Drive. The BPS serves a small residential neighborhood in the low service zone around Prospect Hill Drive and Hilltop Drive. The pump station equipment is housed in a subsurface vault and consists of four centrifugal pumps designed to satisfy a wide range of domestic flow and fire demands if necessary. The pump station is not equipped with standby/emergency power capabilities.

SECTION 1.7 PRESSURE REDUCING VALVE VAULTS

There are five pressure reducing valves (PRVs) within the distribution system to regulate and control pressure across the Town. The PRVs maintain adequate pressure within each of three zones and alleviate excess system pressure resulting from significant changes in topography in the community. Recommended static water pressures for consumer use in public water supply systems range from a minimum of 35 psi to a maximum of 100 psi (MassDEP Guidelines and Policies for Public Water Systems). Normal working pressures are typically in the range of 60 psi. Pressures greater than 100 psi can result in increased leakage throughout the distribution system and rapid discharge of water from household plumbing fixtures.

Three PRVs delineate the high service zone from the intermediate service zone, and two PRVs delineate between the intermediate and low service zones. Pressure reducing valves located at the intersection of Pleasant Street and Libbey Industrial Park, Ells Avenue, and Summer Street regulate the approximately 20 psi pressure differential between the high service and intermediate service zones. The PRVs are installed on 12-inch, 8-inch, and 12-inch diameter water mains, respectively. The Pleasant Street valve is located at an approximate elevation of 109 feet, with a pressure set point of 61 psi. The Ells Avenue valve has a pressure set point of 67 psi and is located at an approximate elevation of 105 feet. The Summer Street PRV has a pressure set point 58 psi, located at an approximate elevation of 116 feet.

The two PRVs that reduce pressure from the intermediate service zone to the low service zone operate on 12-inch and 8-inch diameter mains, located at Church Street and Hanian Drive, respectively. The hydraulic gradient between the intermediate and low service zones is approximately 40 psi. The Church Street valve is located at an approximate elevation of 39 feet, and the pressure set point is 56 psi. The Hanian Drive valve is located at an approximate elevation of 81 feet and has a pressure set point of 38 psi.

Upstream and downstream pressures at each PRV are monitored remotely via the SCADA system. The PRVs are inspected and maintained by the valve manufacturer (Flowrite) as needed. Control settings are adjusted to reflect seasonal changes in water system demand.

SECTION 1.8 DISTRIBUTION PIPING

The Weymouth water system consists of approximately 240 miles of distribution water mains (not including raw water piping), ranging in diameter from 2-inch to 18-inch. Records indicate that distribution pipes are of the following materials: asbestos cement, cast iron, copper, ductile iron, polyvinyl chloride (PVC), and galvanized steel. A summary of the water mains by diameter is presented in Table 1-12, and Figure 1-2 shows the distribution piping by size. The majority of the pipes (69.7%) are 8-inches and smaller in diameter.

Table 1-12: Finished Water Distribution Piping by Diameter

Pipe Diameter	Quantity (ft)	Percent of Total
4-inch or less	37,042	2.8%
6-inch	522,727	39.9%
8-inch	353,429	27.0%
10-inch	87,821	6.7%
12-inch	278,753	21.3%
14-inch or larger	28,247	2.2%
Unknown	873	0.1%

A summary of Weymouth's distribution piping by material is presented in Table 1-13 and displayed in Figure 1-3. The most common pipe material within the distribution system is cast iron (47.6%), and the second most common pipe material is ductile iron (40.2%).

Table 1-13: Finished Water Distribution Piping by Material

Pipe Material	Quantity (ft)	Percent of Total
Cast Iron	623,477	47.6%
Ductile Iron	526,730	40.2%
Asbestos Cement	84,313	6.4%
PVC	10,260	0.8%
Galvanized Steel	6,362	0.5%
Copper	4,510	0.3%
Unknown	53,240	4.1%

Cast iron (CI) pipe has significant risk of failure, given its tendency toward corrosion, and indicates that a pipe has aged past its useful life, as cast iron pipe was rarely installed after the 1980s. As shown in Table 1-14 below, almost 20% of the total amount of CI pipe are pipes 12-inches and larger, indicating a potential for significant impacts to service from pipe failure.

Table 1-14: Cast Iron Pipe by Diameter

Pipe Diameter	Quantity (ft)	Percent of Total
4-inch or less	8,204	1.32%
6-inch	314,714	50.48%
8-inch	109,523	17.57%
10-inch	68,251	10.95%
12-inch	110,000	17.64%
14-inch or larger	12,317	1.98%
Unknown	468	0.08%

SECTION 1.9 SYSTEM EFFICIENCY, REDUNDANCY, AND RESILIENCY

Based on the assessment of the Weymouth water system, EP has identified several areas that may increase system efficiency, redundancy, and resiliency to improve and maintain adequate service.

An important step to improve the system is reducing the amount of unaccounted-for water. In 2020, the Town of Weymouth produced 1,671 MG of finished water available for distribution. Of this total, 399 MG (23.9%) was estimated as unaccounted-for water, much higher than the MassDEP recommended limit of 10%. The Town performed a successful leak detection program in 2020, during which a total of 24 leaks were identified and repaired, and resulted in an estimated leak reduction of 34.6 MG. EP recommends that the Town continue to conduct surveys like these to find and repair leaks, as this can improve water system efficiency, reduce costs associated with water production (e.g., electricity costs, chemical costs, and purchased water costs), and prolong system service life by reducing equipment run times.

Emergency power is an important part of a water system’s resiliency. Although the AJBWTP is equipped with standby power, the five groundwater supply wells do not have standby power. EP recommends that the Town equip each of the well buildings with an on-site standby generator that can be used in a power outage to maintain well service.

The Town should also focus on infrastructure improvements to mitigate supply and distribution failures. Well rehabilitation reports noted that well screens at Winter Street Well No. 1 and Circuit Ave Well have begun to fail and should be programmed for replacement. Additionally, the Main Street Well’s specific capacity after the 2020 rehabilitation was only 60% of the specific capacity in 1999, signifying that the well is nearing the end of its useful life. A significant portion of the distribution system piping is of cast iron (47.6%), and nearly a quarter of the cast iron pipe comprises of 12-inch or larger mains. A failure of larger mains can result in a significant loss of service, which can impact many customers and require an expensive and time-consuming repair. EP recommends that the Town replace all cast iron pipe of 12-inch or larger within the next decade and continue to replace smaller cast iron pipes as possible. Service reports on the pressure reducing valves indicated that several vaults were flooded and inaccessible unless fully drained. The Town can maintain reliable operation of the PRVs by replacing the vault sump pumps, equipping the stations with flood alarms, and installing dehumidifiers.

The low service zone does not currently have any useable storage for peak hour demand. The Great Hill tank overflow would need to be raised by a minimum of 12 feet (assuming the tank's current diameter) to gain the required 0.31 MG of peak hour demand storage.

Water supply systems also need to establish sources of emergency supply should their traditional sources or treatment fail. The Town of Weymouth has provisions to supplement their own supply through emergency interconnections with Braintree, ARJWW, Hingham and Quincy during minor production losses from the GPWTP. During an event that causes a total loss of supply, several factors may impact the capacity to fully supply Weymouth:

- Seasonal availability of water: EP estimates that the combined supply availability of Braintree, WRWS and ARJWW is approximately 2.5 MGD during periods of off-peak seasonal demand. Seasonal peak demand periods could reduce the supply availability significantly, based on weather conditions. The MWRA interconnection with Quincy has the highest supply reliability but can only serve the low service zone (approximately 20% of total system demand) without supplemental pumping.
- Location of Interconnection: the ideal location for interconnection is in the high service zone as water can flow to the other service zones without the need for pumping. Connections within the intermediate or low service zones require pumping to the high service zone which currently contains approximately 40% of total system demand. The percentage of total system demand within the high service zone is projected to increase to 55% by 2040.

In the event of a major loss of supply, the Town would need to rely on all available neighboring communities and provide supplemental pumping to satisfy demands in the high service zone. EP recommends standard operating procedure development and regular emergency interconnection planning with neighboring communities. EP recommends increasing available storage volume in the high service zone to meet forecasted peak hour demands and fire protection requirements. Surplus storage in the high service zone can also supplement fire storage deficiencies in the intermediate and low service zones. The Park Avenue tank, located in the high service zone, is the next scheduled for a major rehabilitation, and EP recommends that the Town consider replacing this tank to increase usable volume in anticipation of the projected growth..

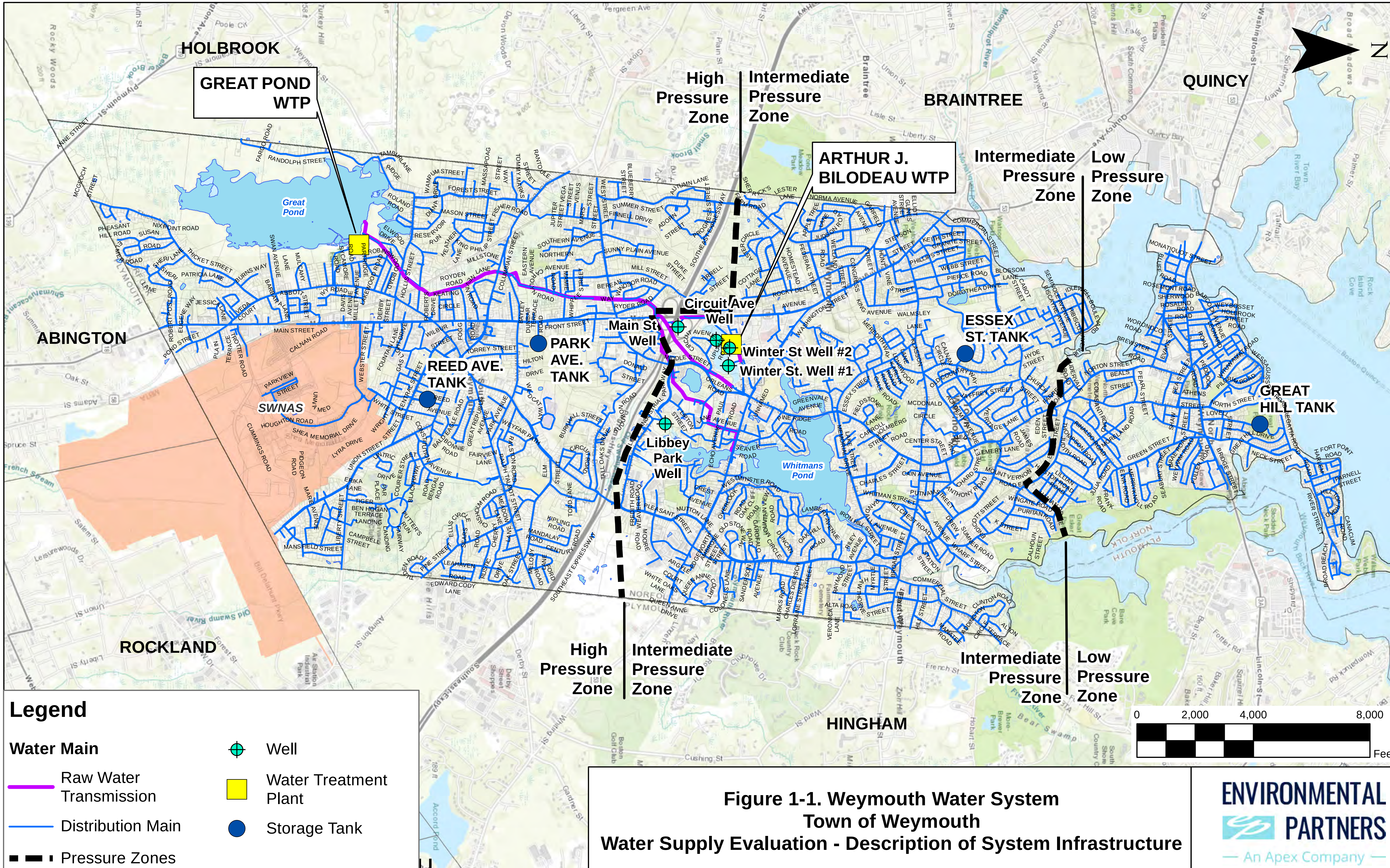


Figure 1-1. Weymouth Water System
Town of Weymouth
Water Supply Evaluation - Description of System Infrastructure

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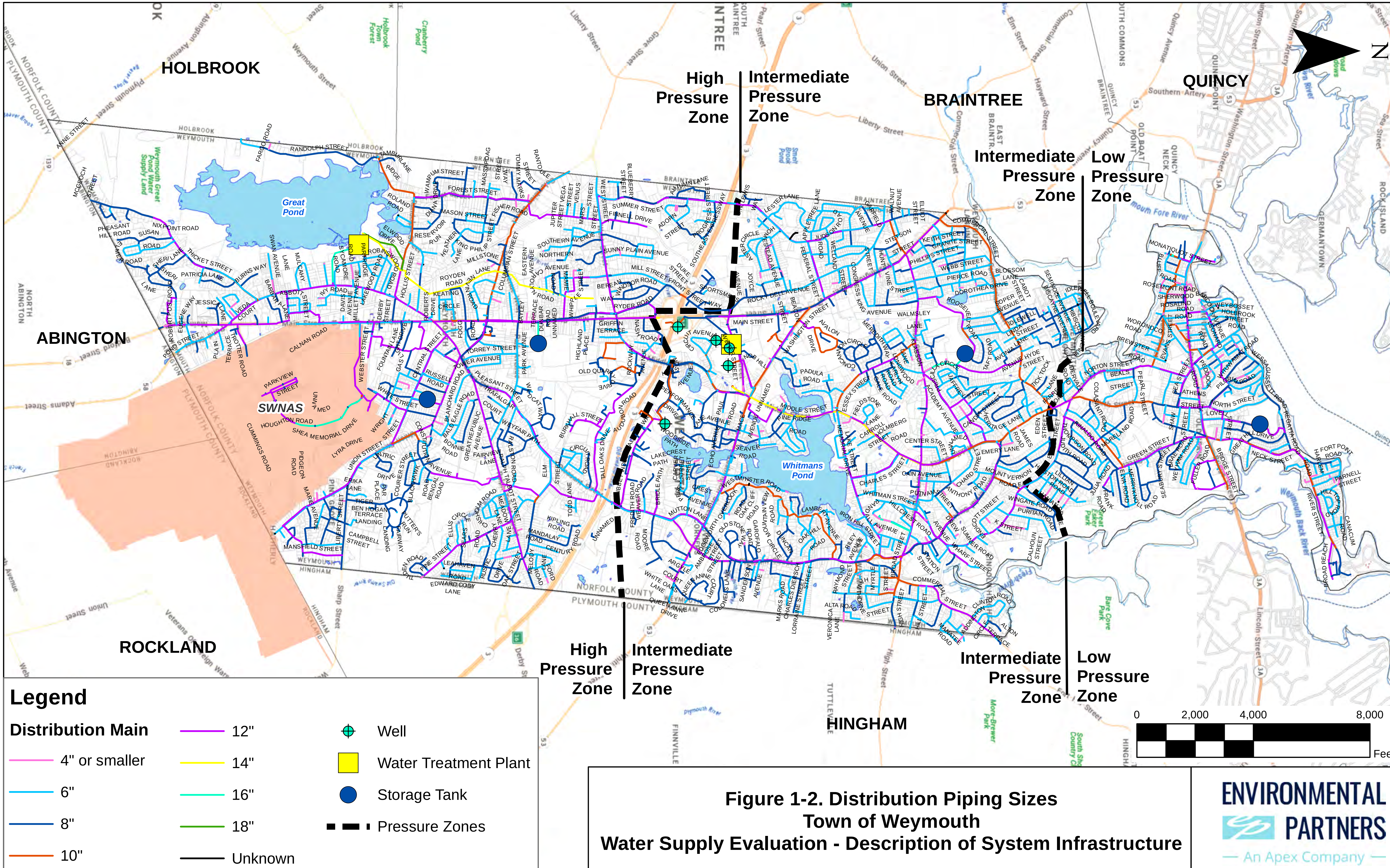

Figure 1-2. Distribution Piping Sizes
Town of Weymouth
Water Supply Evaluation - Description of System Infrastructure

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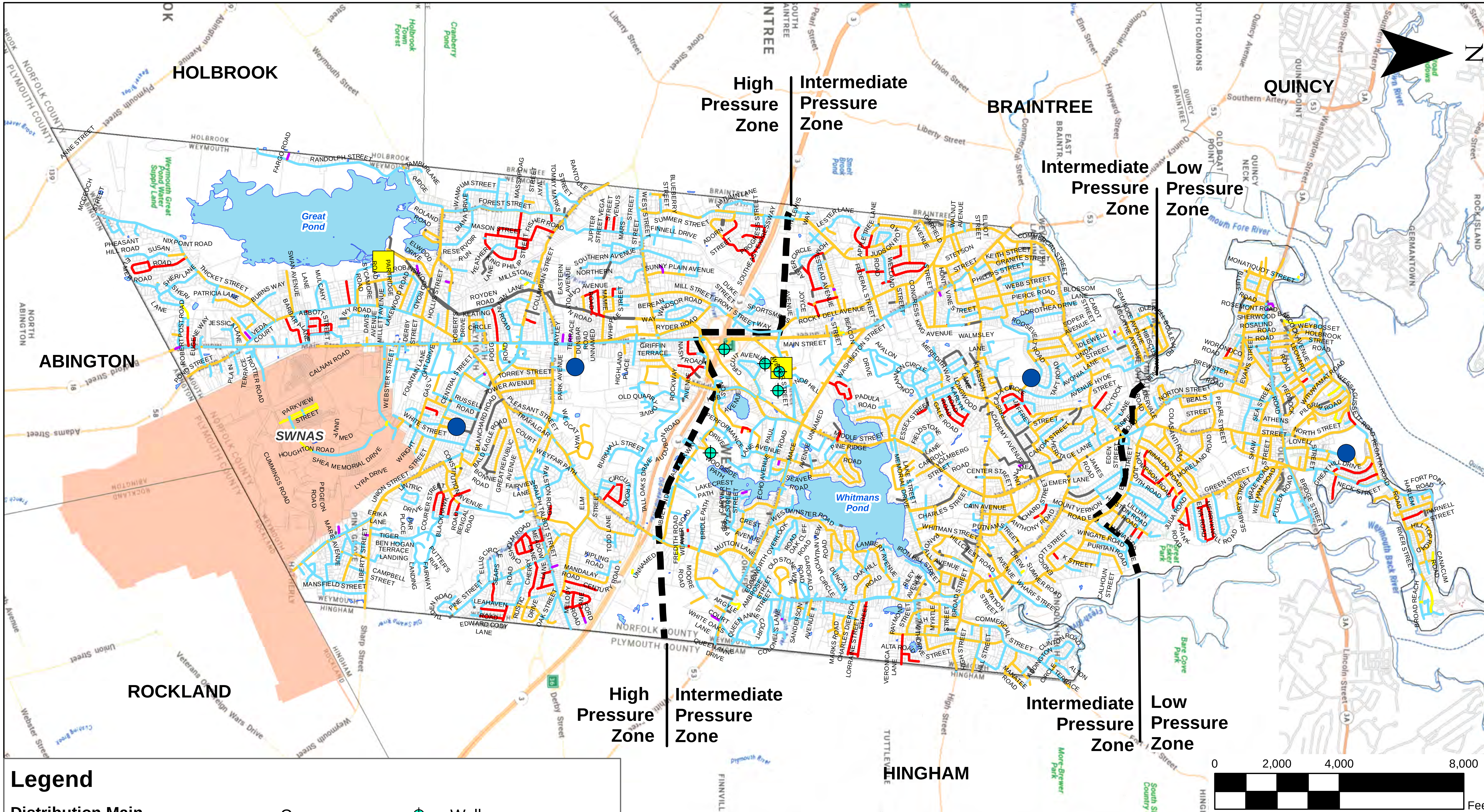

Legend

Distribution Main

- Unknown
- Asbestos Cement
- Cast Iron
- Copper
- Ductile Iron
- PVC
- Steel/TYT
- Well
- Water Treatment Plant
- Storage Tank
- Pressure Zones

Figure 1-3. Distribution Piping Material
Town of Weymouth
Water Supply Evaluation - Description of System Infrastructure

ENVIRONMENTAL PARTNERS
— An Apex Company —

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SECTION 2 EVALUATION OF SUPPLY AND DEMAND

EP has prepared this section to review the Town's existing water supply and its ability to meet current and future water demands. The Massachusetts Department of Environmental Protection (MassDEP) manages registrations and permits for all withdrawals of water for public water consumption greater than 100,000 gallons per day (gpd) under the requirements of the Water Management Act (WMA). EP compiled and analyzed current registered and permitted capacities and observed pumping capacities at all water supply sources, historic water use trends, and future average and maximum-day water projections to assess the ability of the Town to meet consumer needs through the 2040 planning term.

SECTION 2.1 BACKGROUND

Located approximately 12 miles southeast of Boston and 42 miles north of Providence, the Town of Weymouth (the Town) is comprised primarily of residential neighborhoods but also sustains various goods & services storefronts and some commercial and light industrial facilities. Convenient access to Route 3 has fostered rapid growth of the commuter community.

The Town produces drinking water at two water treatment facilities: the Arthur J. Bilodeau Water Treatment Plant (AJBWTP), which treats raw water from five groundwater wells (Winter Street Well # 1, Winter Street Well # 2, Main Street Well, Circuit Avenue Well and Libbey Park Well), and the Great Pond Water Treatment Plant (GPWTP), which treats water from the Great Pond surface water supply system. Supplies are located in the Mill River aquifer and the Great Pond surface water supply system. Great Pond can also be supplemented by Whitman's Pond and Old Swamp River. Whitman's Pond is reserved for solely an emergency use, but water is pumped from the Old Swamp River (also known as the South Cove of Whitman's Pond) on an annual basis in coordination with the Herring Warden to maintain water levels within Great Pond. The total authorized withdrawal under the Water Management Act from Town sources is 5.00 million gallons per day (MGD).

Weymouth's water distribution system consists of approximately 240 miles of pipe, ranging in diameter from 2-inch through 16-inch. Water distribution storage is maintained between four tanks, with a total storage capacity of 4.9 million gallons.

The Town supplies drinking water to customers within Weymouth including approximately 100,000 gallons per day (gpd) to the region of the SWNAS development within Weymouth. The former Naval Air Station is located in the tri-town area between Abington, Rockland, and Weymouth. Upon the closure of the naval station, the land was transferred to the SRA for residential and commercial use.

SECTION 2.2 CURRENT DEMANDS

Section 2.2.1 Average Day Demand

Average-day demand (ADD) is the average daily volume of water pumped over the course of one year. This metric is used as a baseline to determine the adequacy of existing water supply sources. Table 2-1 summarizes the Town's finished water production, which includes metered use, confidently estimated municipal use (CEMU), and unaccounted for water (UAW) (further discussed below), for the five-year period from 2016 through 2020. The Town's average finished water withdrawal from 2016 to 2020 was approximately 4.25 MGD or 1,552 million gallons per year (MGY).

Table 2-1: Annual Water Demand, 2016-2020

Year	Total Annual Production (MGY)[1]	Average-Day Demand (MGD)[1]
2016	1,519	4.16
2017	1,531	4.19
2018	1,537	4.21
2019	1,502	4.12
2020	1,671	4.58
5-Year Average	**1,552**	**4.25**

1. Includes water sold to SWNAS.

Section 2.2.2 Maximum-Day Demand

Maximum-day demand (MDD), the largest 24-hour demand during a calendar year, is a metric that can be used to evaluate adequacy of treatment and pumping facilities. Capabilities of production must meet periods of maximum demand to ensure storage tank levels remain adequate and system pressures are consistently within acceptable ranges. MDD is typically expressed as a ratio of ADD. This ratio varies based on the characteristics of the individual community. Table 2-2 below shows finished water MDD relative to finished water ADD between the years of 2016 and 2020. The average finished water MDD is 5.26 MGD and the average ratio of finished water MDD to finished water ADD is 1.23.

Table 2-2: Maximum versus Average Day Water Demand, 2016-2020

Year	Average-Day Demand (MGD)	Maximum Day Demand (MGD)	MDD/ADD Ratio
2016	4.16	5.33	1.28
2017	4.19	4.28	1.02
2018	4.21	5.37	1.28
2019	4.12	4.81	1.17
2020	4.58	6.49	1.42
5-Year Average	**4.25**	**5.26**	**1.23**

Section 2.2.3 Analysis of Metered Water Use

The Town's Annual Statistical Report (ASR) lists the annual metered water use by customers. This total does not include water lost to treatment processes, CEMU, or UAW. Table 2-3 summarizes the Town's total water consumption by customer classification from 2016 to 2020. Within the Town of Weymouth, the majority of water use is residential consumption (83 percent).

Table 2-3: Annual Water Consumption by Customer Classification in MGY

Customer Classification	2016	2017	2018	2019	2020	Average	Percent Total Consumption
Residential	933.9	946.7	967.0	950.8	1042.5	968.2	83.2%
Commercial	168.3	172.6	172.0	167.0	149.2	165.8	14.3%
Municipal/ Institution/ Non-Profit	7.3	12.0	6.4	5.6	5.2	7.8	0.7%
Industrial	11.5	14.3	11.2	10.8	8.1	10.7	0.9%
Other	16.8	34.3	1.7	0.0	1.2	10.8	0.9%
Total Metered Use	**1,137.7**	**1,179.9**	**1,158.2**	**1,134.1**	**1,206.2**		

Residential Per-Capita Finished Water Use

Public water systems permitted under the Water Management Act (WMA) are subject to a residential per-capita consumption limit of 65 RGPCD (residential gallons per-capita per-day of finished water). Residential per-capita consumption is reported to MassDEP annually. Between 2016 and 2020, the Town's average finished water use was approximately 49 RGPCD, well below MassDEP's benchmark of 65 RGPCD. As demands are predominantly residential (83 percent), the RGPCD is an important metric that can be used to analyze demand. Table 2-4 shows residential finished water use from 2016 to 2020.

Table 2-4: Annual Residential Finished Water Use, 2016-2020

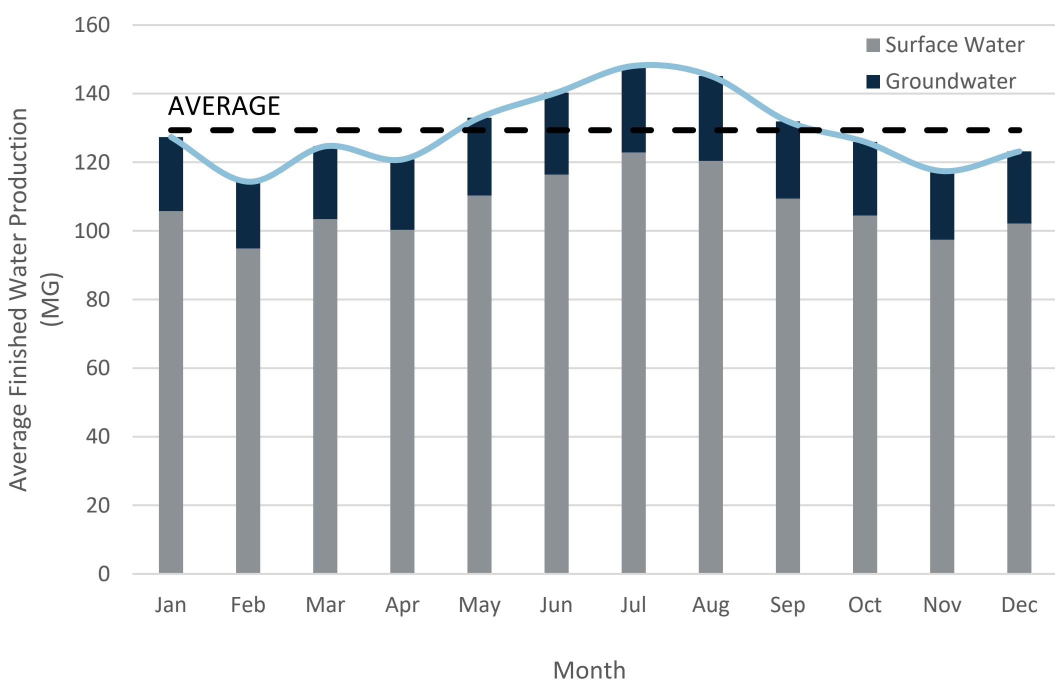
Year	Residential Metered Water Sales (MG)	Percent of Total Water Sales	Residential Population Served[1]	Residential Per-Capita Water Use (RGPCD)
2016	933.9	82.1%	52,216	49
2017	946.7	80.2%	53,549	48
2018	967.0	83.5%	53,925	49
2019	950.8	83.8%	54,012	48
2020	1042.5	86.4%	55,544	51
5-Year Average	**968.2**	**83.2%**	**53,849**	**49**

1. Based on ASR Reporting

Monthly Finished Water Production

The monthly fluctuation in finished water production is demonstrated below, by comparing the total annual finished water production spread equally across all 12 months to the actual finished water production each month. Figure 2-1 shows the average monthly finished water production based on data from 2016 to 2020.

Figure 2-1: Average Finished Water Production by Month, 2016 to 2020



Unaccounted-For Water

Unaccounted-for Water (UAW) encompasses any finished water that is produced or purchased but is not metered or included in the CEMU. UAW can be caused by distribution system leaks, metering inaccuracies, and similar untallied losses. From 2016 to 2020, the ASRs report an average of 22.3 percent UAW, as shown in Table 2-5, which exceeds the MassDEP allowable UAW threshold of 10 percent for sources permitted under the WMA. EP recommends the Town continue to implement monitoring practices to identify and address causes of UAW.

Table 2-5: Annual Unaccounted-for Water (UAW), 2016-2020

Year	Total Finished Water (MGY)	Total Metered Water Use (MGY)	Confidently Estimated Municipal Use (MG)	Unaccounted-for Water Loss (MG)	Percent UAW
2016	1,519.2[1]	1,137.7	27.2	337.5	22.5%
2017	1,530.5[1]	1,179.9	33.0	317.7	21.2%
2018	1,537.1	1,158.2	12.9	365.9	23.8%
2019	1,502.3	1,134.1	69.6	298.6	19.9%
2020	1,671.5	1,206.2	66.3	399	23.9%
5-Year Average	**1,552.1**	**1,163.2**	**41.8**	**343.7**	**22.3%**

1. Water sold to the SRA in 2016 was not included in the UAW calculation for 2016 and 2017.

SECTION 2.3 CURRENT WATER SUPPLY

Section 2.3.1 Water Supply Sources

The Town of Weymouth treats raw water from the Great Pond surface water system and five groundwater sources at the Great Pond Water Treatment Plant and Arthur J. Bilodeau WTP, respectively. A summary of the water supply sources is shown in Table 2-6 below. As shown, the Great Pond surface water system produces significantly more water than any other source. In 2020, the amount drawn from Great Pond was ten times the amount of the next largest source, Winter Street Well #2.

Table 2-6: Weymouth Water System Supply Sources

Source Name	Source Type	2020 Total Raw Water Withdrawal (MG)
Great Pond System	Raw Surface Water	1,595.4
Circuit Avenue Well	Raw Groundwater	47.5
Main Street Well	Raw Groundwater	29.2
Libbey Park Well	Raw Groundwater	0.0
Winter Street Well No. 1	Raw Groundwater	1.4
Winter Street Well No. 2	Raw Groundwater	115.3
	Total	**1,789**

Section 2.3.2 MassDEP Withdrawal Limits

All the Weymouth water sources are currently registered under the WMA, except Winter Street Well No. 1, which is a permitted withdrawal. Under the WMA, Weymouth is authorized to withdraw a total annual volume of 1,825 MG, or an average of 5.00 MGD throughout the year. This authorization includes an average of 4.51 MGD from registered sources and 0.49 MGD from the permitted source (Winter Street Well No. 1). Weymouth's registered withdrawals are based on finished water volume while the Winter Street Well No. 1 permitted withdrawal is based on raw water. Table 2-7 below summarizes the raw and finished total annual withdrawals over the past decade.

Table 2-7: Weymouth Water System Historic Water Withdrawal

Year	Total Raw Water Withdrawal (MG)	Total Finished Water Volume (MG)
2010	1,589.8	1,479.7
2011	1,585.9	1,468.4
2012	1,596.1	1,492.4
2013	1,579.7	1,468.1
2014	1,669.9	1,559.2
2015	1,664.3	1,545.7
2016	1,623.6	1,519.2
2017	1,645.6	1,530.5
2018	1,665.8	1,537.1
2019	1,642.8	1,502.3
2020	1,800.0	1,671.5

Table 2-7 shows that, historically, Weymouth withdraws approximately 80 to 90 percent of their annual system withdrawal limit. In 2020, the Town withdrew approximately 92% of the permitted annual volume. Because of operational issues at Winter Street Well No. 1, the Town narrowly exceeded their registered withdrawal in 2020 (4.57 MGD withdrawal vs. 4.51 MGD registration limit) In addition to the total system annual withdrawal limit, each groundwater well is subject to a maximum daily withdrawal limit, which is based on Zone II approvals. Table 2-8 summarizes the Zone II maximum daily approved pumping rates for water sources in MGD and gpm. Some of the sources are approved under combined pumping rates.

Table 2-8: Weymouth Water System Supply Sources

Source Name	Max Day Approved Pumping Rate (MGD)	Max Day Approved Pumping Rate (gpm)
Circuit Avenue	1.23 Combined	853 Combined
Main Street		
Winter Street No. 2		
Libbey Park	0.39	269
Winter Street No. 1	1.03	715

The Table above does not include the Great Pond System, which has an approved firm yield of 3.63 MGD (2,520 gpm). The Great Pond firm yield was established using the drought of the early 1960s as the critical drought. The pumping capacity and typical summertime flow rates from Great Pond (e.g., 5.71 MG maximum day in 2020) are significantly greater than the firm yield. Table 2-9 below incorporates the Great Pond firm yield and summarizes the safe yield for the Weymouth water supply.

Table 2-9: Weymouth Water Supply Safe Yield

Source Name	Approved Safe Yield (MGD)	Approved Safe Yield (gpm)
Great Pond System	3.63	2,520
Mill River Wells	2.26	1,570
Libbey Park Well	0.39	269
Total	**6.27**	**4,359**

The Town of Weymouth must operate within the limits of its maximum daily approved pumping rates and the annual WMA registered volume. MassDEP has issued draft changes to the WMA regulations (310 CMR 36), which may impose additional conditions on registered water suppliers, such as mandatory drought restrictions. EP recommends the Town continue to track any changes to the WMA that may levy additional restrictions on registered water suppliers.

Weymouth is operating under an interim WMA permit that MassDEP has administratively continued since 2010. Current withdrawal limits are based on DCR projections that do not include water use from the SWNAS.

Section 2.3.3 Maximum-Day Water Supply Assessment

The Town currently operates five of their six water supply sources. They routinely maintain and redevelop the wells as needed to improve production of raw water volume and quality. The Libbey Park Well is not operated because of declining well capacity and is scheduled for replacement in 2022. Table 2-10 lists the sources alongside their Zone II maximum daily limits, operational capacities, and supply capacities. Operational capacity is the amount of water the source is capable of providing when considering hydraulic and well recharge limitations. The supply capacity is the lesser of the Zone II maximum daily limit and the operational capacity. The Great Pond WTP has a maximum treatment capacity of 8.4 MGD.

Table 2-10: Withdrawal Capacities

Source	Zone II Maximum Daily Limit (MGD)	Current Operational Capacity (MGD)	Supply Capacity (MGD)
Great Pond	N/A[1]	8.00	8.00[1]
Circuit Avenue	1.23 Combined	1.45 Combined	1.23 Combined
Main Street			
Winter Street No. 2			
Libbey Park	0.39	0.39	0.39
Winter Street No. 1	1.03	0.72	0.72
Total	**2.64**	**10.18**	**10.34**

1. Great Pond is not subject to a Zone II maximum daily limit but has a firm yield of 3.63 MGD as discussed above. This yield is typically exceeded during summer months; however, pumping in excess of the safe yield can reduce the reliability of a surface water supply during a drought.

In order to provide an adequate supply of water during periods of peak water usage, the Town's firm capacity, the system capacity without its largest source, should match or exceed the MDD. The loss of the Town's largest source, Great Pond, would reduce supply by 8.0 MGD, leaving a firm capacity of approximately 2.3 MGD. Additionally, the AJBWTP has an operational capacity that would further limit the water system's firm capacity to approximately 2.0 MGD. With an average MDD of 5.26 MGD, the Town has insufficient capacity to meet current peak demands without the Great Pond supply system. However, it is common for communities with a primary surface water supply to provide redundancies within WTP raw water and finished water processes, rather than maintain 100% redundancy of the supply itself. The GPWTP was designed to incorporate 100% redundancy for all critical components, such that any individual component failure would not result in a loss of production capacity.

SECTION 2.4 WATER SYSTEM DEMANDS FORECAST

While evaluating future water demands, EP reviewed historic water-use patterns, anticipated population and employment projections, approved development projects, and projected development in the Town's commercial corridors. The Massachusetts Water Resources Commission (WRC) published the "Policy for Developing Water Needs Forecasts for Public Water Suppliers and Communities and Methodology for Implementation" (last revised March 9, 2017), which outlines their methodology for demand forecasting. EP followed this methodology to forecast the Town's customer water demands through the 2040 planning year.

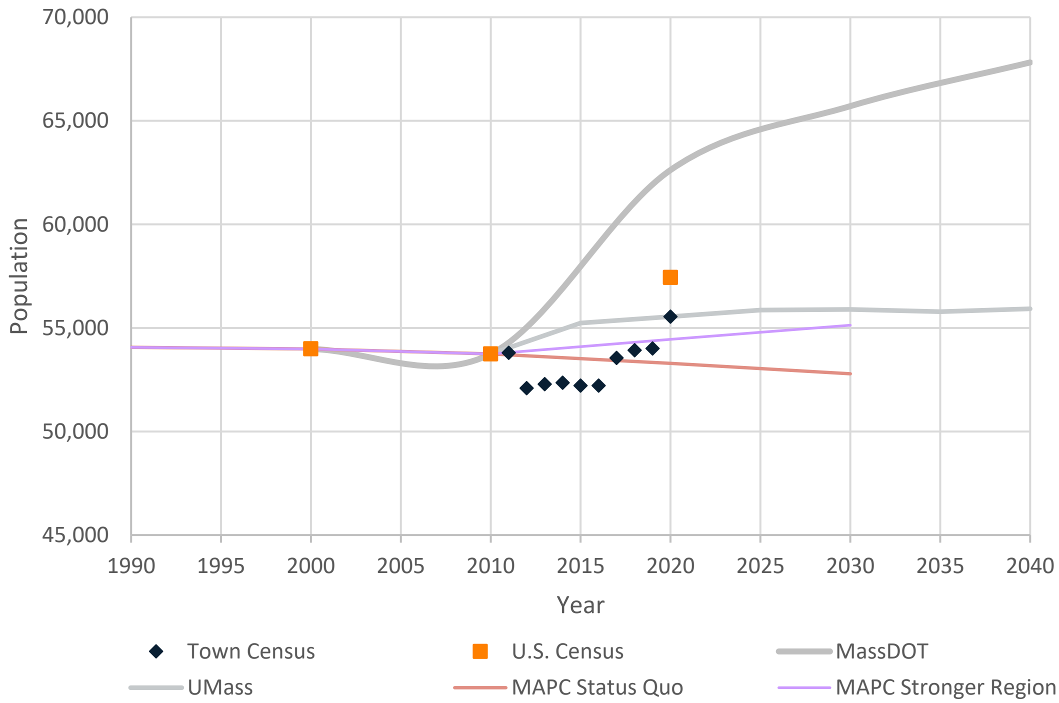
A water needs forecast estimates the volume of water that a public water supplier will need to provide to meet its customers' needs for the future. The WRC approved a methodology for forecasting the estimated volume of water a population will need at a specific date in the future. EP used the following data from the past five years to develop a demand forecast:

- Water supply information including metered volumes of water pumped, water purchased, and water sold;
- Water-use information based on actual metering;
- A breakdown of water use into residential, non-residential, unaccounted-for, and treatment loss categories; and
- Service population.

Section 2.4.1 Population Served Forecasts

With the high percentage of residential usage for the water system (83 percent), population changes will likely be the most significant factor in future water needs. EP reviewed historic population data from Weymouth's Annual Town Reports and federal census data and consulted published population forecasts through the year 2040 from the Massachusetts Department of Transportation (MassDOT), University of Massachusetts Donahue Institute (UMass) and Metropolitan Area Planning Council (MAPC). MassDOT released future population forecasts through 2040 in September 2018, while UMass produces annual estimates of town populations between US Census years. The MAPC looks at two population projection scenarios: "status quo" assuming a continuation of existing trends and "stronger region" assuming a higher population growth model. Historic Town Population & Population Projections 2-2 compares these population projections to historic data.

Figure 2-2: Historic Town Population & Population Projections



The MassDOT model projects significant growth from 2020 to 2040. The UMass and MAPC models both indicate flat population growth over next two decades.

Employment Forecast

Following residential use, commercial use is the second largest user classification in Weymouth. Similar to their population forecasts, MassDOT provides employment forecasts estimating the number of people that will be working within the Town. Table 2-11 summarizes US Census employment data from 2000, 2010, and 2020 as well as the MassDOT employment forecasts through 2040.

Table 2-11: Historic and Forecasted Employment

US Census 2000	US Census 2010	US Census 2020	MassDOT 2030 Projection	MassDOT 2040 Projection
16,572	22,147	24,992	26,576	27,960

Weymouth Approved Developments

Recent sharp increases in development and population in Weymouth were primarily stimulated by adoption of the Village Center Overlay District (adopted in 2010) and Commercial Corridor Overlay District (adopted in 2018). A total of 18 developments have been approved since 2013 in these targeted growth areas including the Route 18 corridor, Route 3A corridor, Weymouth Landing, and Columbian Square. Approved developments are summarized in Table 2-12. Based on construction estimates, all the developments were assumed completely unoccupied as of 2020.

Table 2-12: Weymouth Approved Developments

Address	Approval Date	Units	Commercial (sf)
The Gradient - 1 Gradient Court	6/24/2013	158	-
Seascape at Broad Beach	3/22/2017	50	-
660 Broad Street	2/6/2018	20	1,500
1055 Main Street	3/20/2019	24	7,000
1400 Main Street	6/27/2018	153	7,000
1500 Main Street	2/13/2019	237	6,000
0-48 Washington	2/13/2019	87	7,500
122 Washington	12/9/2020	28	1,500
15-17 Front	3/24/2021	24	1,000
143-145 Washington Street	4/26/2017	43	4,000
165 Washington Street	7/26/2017	12	-
44 Wharf Street	9/30/2020	86	-
655 Washington Street	3/24/2021	160	6,000
1325 Washington Street	6/16/2021	270	4,200
1431-39 Main	2/24/2021	165	-
88 Pleasant Street	4/14/2021	30	2,000
46 Union Street	12/11/2019	14	-
10 Front Street	3/16/2017	23	Preserved Existing
Total		**1,584**	**47,700**

Weymouth Future Development

The Town of Weymouth recently revised the Commercial Corridor Overlay District (CCOD) by reducing floor area ratios (FARs) and maximum building heights in order to slow the current pace of development. A summary of the undeveloped lots that are proposed to be incorporated into the revised Commercial Corridor Medium Density and Low Density Overlay Districts is provided in Table 2-13, along with the estimated potential commercial area and residential units. Table 2-13 also includes potential future growth in the Village Center Overlay District (VCOD), based on existing zoning regulations.

Table 2-13: Potential Future Development in Weymouth

Overlay District	Total Development (sf)	Commercial (sf)	Residential (sf)	No. Residential Units
CCOD Low Density	2,319,629	193,302	2,126,326	1,800
CCOD Medium Density	1,207,263	75,454	1,131,809	962
Weymouth Landing	1,026,392	342,131	684,261	601
Total	**4,553,284**	**610,887**	**3,942,397**	**3,363**

EP assumed the following to develop future development estimates in Table 2-13:

- FAR of 0.5 for development within the CCOD (Low Density and Medium Density).
- Structure heights of three stories and four stories for CCOC Low Density and Medium Density, respectively.
- Commercial SF for CCOD and VCOD equal to 25% of the ground floor area with balance residential at 1,200 SF per unit.
- Lot coverage of 50% for VCOD with structure height of 3 stories
- Commercial SF for VCOD equal to 100% of the ground floor area with balance residential at 1,200 SF per unit.

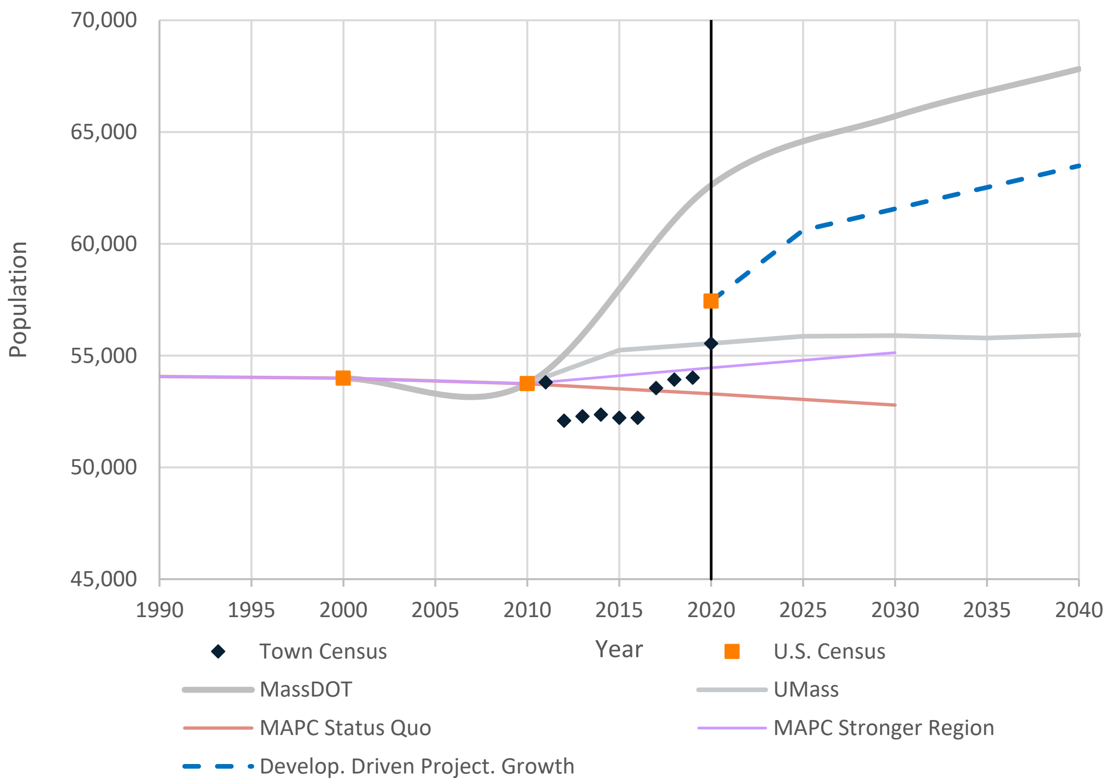
Development Driven Growth Forecast

EP incorporated approved development projects and future development in the Town as outlined in Table 2-12 and Table 2-13 into population projections. Outside of these targeted growth areas, the Town is projected to incur minimal population growth, as the MAPC and UMass projections suggest. EP established a development-driven projection as shown in Figure 2-3 below as a blue dashed line named "Develop. Driven Proj. Growth". This projection was selected as a representative population projection for the demand analysis.

EP assumed the following to develop population projections in Figure 2-3:

- 100% Occupancy of approved developments (Table 2-12) by 2025
- 50% Build-out of the VCOD and CCOD within the study period (Full Build Out in 2060)
- 2 People per Residential Unit

Figure 2-3: Historic Town Population & Population Projections



SWNAS Development

The SWNAS development is expected to grow significantly in the coming decades. The development plan for the area will transform SWNAS into a community hub, made up of a combination of residential, commercial, and public spaces. As of the end of 2020, the following approved residential developments included in Table 2-14 were unoccupied in the Weymouth region of the development.

Table 2-14: SWNAS Unoccupied Developments

Name	Units	Beds/Unit
Fairing Way	24	2 beds
Stonebridge	43	3 beds

These developments were assumed to be completely occupied by 2024. The rate and total amount of growth in SWNAS over the next two decades is under consideration. The following section includes approximate projected water demands for the Weymouth region of the development, as provided by the developer.

Section 2.4.2 Demand Forecasts

The Massachusetts Water Resources Commission (WRC) forecasting methodology recommends demand estimates are calculated using a value of 65 RGPCD and a UAW of 10 percent of annual usage, in accordance with state Water Conservation Standards. Non-residential ADD is estimated at 21 gpd per work force capita based on the 2016 to 2019 average non-residential use. Table 2-15 provides a summary of the demand forecast for the years 2020 to 2040 using the WRC forecasting methodology.

Table 2-15: Projected Demands in Million Gallons per Day, 2020-2040 (WRC Methodology)

Year	Projected Residential ADD	Projected Non-Residential ADD	Projected Estimated Municipal Use	Projected UAW, 10%	Weymouth Projected Finished Water Demand	SWNAS Additional Projected Finished Water Demand	Total Projected Finished Water Demand
2025	3.94	0.47	0.11	0.50	5.02	0.10	5.12
2030	4.00	0.48	0.11	0.51	5.11	0.70	5.81
2035	4.06	0.50	0.11	0.52	5.20	1.20	6.40
2040	4.13	0.51	0.11	0.53	5.28	1.50	6.78

When forecasting estimated water needs as discussed above, Weymouth will experience an average increase in demand of approximately 0.11 MGD every five years for the next two decades. SWNAS will expect an average increase in demand of 0.38 MGD every five years. Over the twenty-year forecast, the total finished water ADD will increase by approximately 2.0 MGD to 6.78 MGD. Similarly, the total projected MDD will increase to 8.34 MGD.

Because the WRC methodology is based on a residential per-capita consumption of 65 RGCPD, and the Town of Weymouth's average RGPCD was significantly lower, EP repeated the analysis using the observed average residential demand of 49 RGPCD and the observed average UAW of 22.3%. Over the twenty-year forecast, the total finished water ADD is projected to increase to 6.31 MGD. Similarly, the projected MDD is projected to increase to 7.76 MGD. Table 2-16 provides a summary of the demand forecast using historical Weymouth water usage values.

Table 2-16: Projected Demands in Million Gallons per Day, 2020-2040 (49 RGPCD, 22.3% UAW)

Year	Projected Residential ADD	Projected Non-Residential ADD	Projected Estimated Municipal Use	Projected UAW, 22.3%	Weymouth Projected Finished Water Demand	SWNAS Projected Finished Water Demand	Total Projected Total Finished Water Demand
2025	2.97	0.47	0.11	1.02	4.57	0.10	4.67
2030	3.02	0.48	0.11	1.04	4.65	0.70	5.35
2035	3.06	0.50	0.11	1.05	4.73	1.20	5.93
2040	3.11	0.51	0.11	1.07	4.81	1.50	6.31

Figure 2-4: Water Demand Projections

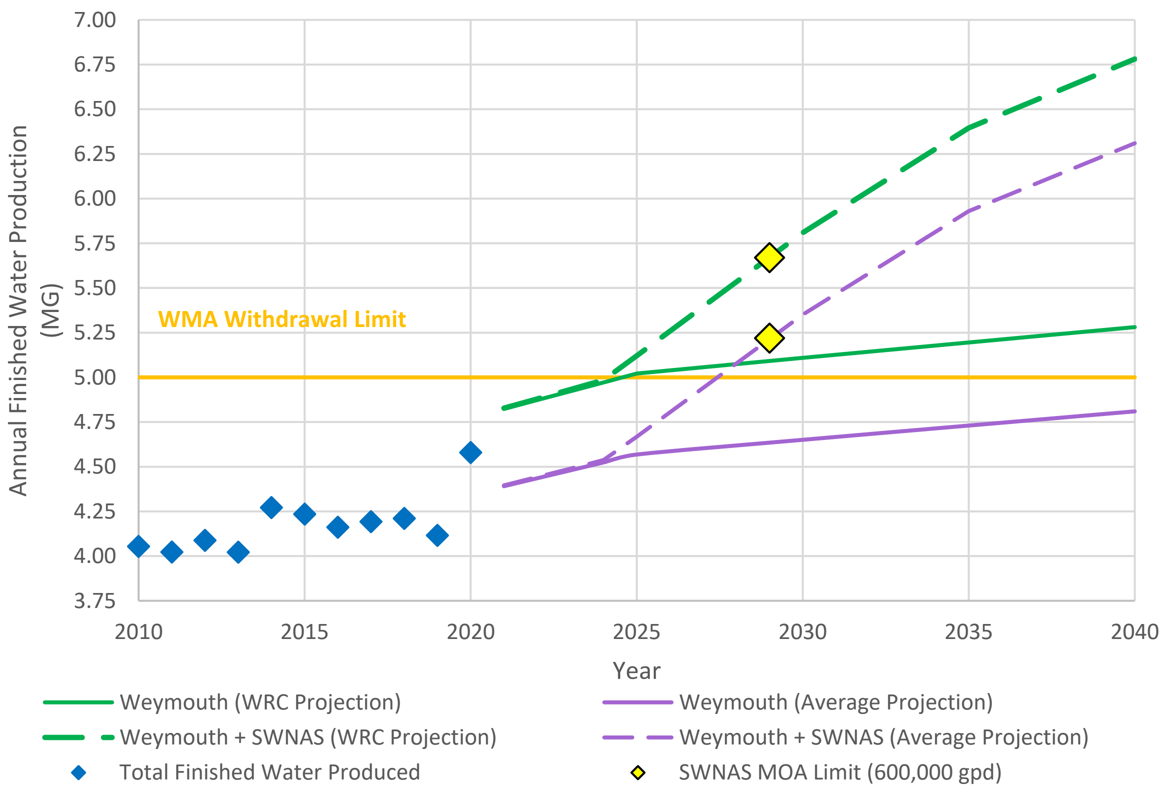


Figure 2-4 demonstrates that Weymouth has little capacity to supply the SWNAS development with its scheduled development. Finished water production to supply solely Weymouth is projected to surpass the WMA annual withdrawal limit in the next 5 years, if demand increases according to the WRC projection method. Although the projection is based on estimated population growth rates, it is important to compare these projections with historic data. Actual water demand varies annually based on weather conditions and the intensity of development over the next 20 years will depend on economic factors in addition to any further changes to zoning regulations. Additionally, water demand in 2020 was likely an anomaly because of conditions caused by the global pandemic, which drastically increased water demand for residential usage. However, remote and flexible work schedules may persist after the pandemic subsides and permanently alter baseline demands for Weymouth.

SECTION 2.5 CONCLUSIONS AND RECOMMENDATIONS

Water Management Act

Based on the current pace of development in Weymouth, water demand could surpass the Town's WMA withdrawal limit within approximately the next 5 years, without any additional demand from the SWNAS development. The anticipated development in SWNAS will further increase required production and exceed WMA limits within the next decade in even the most conservative estimates. MassDEP anticipates that the renewal process for Weymouth's WMA permit will begin in 2023. An additional 0.25 MG of average daily permitted withdrawal should be requested in addition to projected additional water demands from SWNAS. The most recent memorandum of agreement (MOA) between the SRA and the Town of Weymouth that includes the provision to supply up to 600,000 gpd of water to SWNAS should be incorporated into the permit renewal's request for additional permitted withdrawal. EP also recommends the Town of Weymouth continue to track any changes to the WMA regarding additional restrictions on registered water suppliers.

Unaccounted-for Water

The Town of Weymouth reported UAW of at least 20 percent for the past 7 years, which is double the standard for Massachusetts water suppliers. This elevated UAW increases the amount of water that the Town must produce and limits the amount of water available for customer use. The American Water Works Association (AWWA) recommends conducting periodic water audits to minimize system losses. In addition to the steps that Town has alrady taken to reduce UAW, including extensive leak detection, EP recommends the Town conduct a water audit to identify and ultimately reduce sources of UAW.

Firm Capacity

To provide an adequate supply of water during future periods of peak water usage, the firm capacity of the system should match or exceed the projected MDD. As previously discussed, with the Great Pond Water Treatment Plant out of service, the remaining water suppies can only provide approximately 2.0 MGD which is 38 percent of the Town's average MDD from 2016 to 2020. It is not practical for Weymouth to increase supply redundancy to mitigate for loss of Great Pond and the Town must rely on redundancies within the GPWTP and emergency interconnections with neighboring communities. EP recommends the following approach to improve water system reliability:

- **Implement Water Loss Controls** – If the recommended water audit identifies opportunities for water loss control, implementation of these water loss control practices could reduce demands and improve Weymouth's firm capacity. For example, the water audit may identify outdated and potentially underregistering service meters.

- **Increase the Reliability of Great Pond** – The Town should continue to invest in preventative maintenance for all components of the GPWTP. Improving the reliability of the GPWTP reduces the risk of losing partial capacity of the Town's primary supply.

- **Continue Well Maintenance and Redevelopment Work** – Ongoing well maintenance, redevelopment and replacement over the past decade has been critical to maintaining maximum water supply during peak summertime demand periods. EP recommends this effort continue to maximize the operational capacity of the wells.

- **Maintain Reliable Interconnections with Neighboring Water Systems** – Previous research has been conducted about the logistics of purchasing water via interconnections with neighboring systems to mitigate the loss of the GPWTP. In order to meet off-peak demands, a combination of emergency interconnections would need to be activated including from Braintree, the Weir River Water System (Hingham), and Abington-Rockland. During peak summer demands, loss of the GPWTP would also likely require activation of the MWRA interconnection with Quincy in North Weymouth. EP recommends that Weymouth continue to coordinate with neighboring water systems and develop standard operating procedures for interconnections on a seasonal basis.

- **Water Conservation Practices** – Weymouth has a drought triggered seasonal demand management plan that restricts outdoor water use. The Town could consider options for stricter implementation of the regulation or tightening the regulation to further reduce water usage and MDD. In addition, the Town could provide incentives and rebates for existing residential customers to utilize high efficiency irrigation systems and water fixtures. (Weymouth already has a mandatory conservation program for new customers.)

South Weymouth Naval Air Station

The Town of Weymouth currently has a memorandum of agreement (MOA) with the SRA that agrees to supply up to 600,000 gpd to SWNAS. Existing usage from the development is currently approximately 100,000 gpd which is incorporated into the historical usage in this memorandum.

Demand projections presented in Table 2-15 and Table 2-16 estimate that Weymouth's existing withdrawal surplus could be eliminated over the next 5-7 years.. EP projects that the Town will exceed the existing WMA limit by at least 0.25 MGD if SWNAS is supplied with 600,000 gpd within the projected development time frame of approximately 2029. EP recommends the Town complete renewal of their WMA permit before committing to further water supply for SWNAS.

Massachusetts Water Resource Authority Supply

Water demand for full buildout of SWNAS (within Weymouth) is currently estimated at approximately 1.6 MGD by 2040 which would exceed Weymouth's water supply safe yield of 6.27 MGD and require supply from a regional supplier (Massachusetts Water Resource Authority). Beyond the 2040 study period, EP estimates an additional annual withdrawal of approximately 0.25

MGD within Weymouth (outside SWNAS), including full buildout of the Town's commercial overlay districts. Including the existing commitment of 600,000 gpd to SWNAS, this would result in an average demand of approximately 6.0 MGD (using WRC methodology) or 96 percent of the water supply safe yield.

EP recommends that Weymouth begin investigating options for supply from the Massachusetts Water Resource Authority (MWRA) to accommodate the future water needs of the Town and SWNAS. Projected SWNAS water demands outside of Weymouth (Abington and Rockland) add an additional average daily demand of 0.8 MGD which could also potentially be accomodated by MWRA supply. A singular SWNAS water system fed by Weymouth would allow for hydraulic continuity througout SWNAS and provide mutual hydraulic benefit to the Weymouth distribution system.

SECTION 3 MWRA SUPPLY ALTERNATIVES ANALYSIS

EP has developed potential MWRA supply alternatives to mitigate projected water supply shortfalls in Weymouth. This analysis is necessary now because EP estimates that Weymouth's existing withdrawal surplus could be eliminated in the next 5-7 years with the Town's projected growth.

SECTION 3.1 BACKGROUND

Projected system demands over the 2040 planning horizon are as follows:

Table 3-1: Average Day Demand Projections with SWNAS

Year	Weymouth Projected Finished Water Demand (MGD)[1]	SWNAS Projected Finished Water Demand (MGD)	Total Projected Finished Water Demand (MGD)
2025	5.02	0.10	5.12
2030	5.11	0.70	5.81
2035	5.20	1.20	6.40
2040	5.28	2.30[2]	7.58

1. Based on WRC methodology, using 65 RGPCD and 10% UAW as inputs
2. Includes 1.5 MGD in Weymouth and 0.8 MGD in Abington and Rockland

Using the WRC methodolgy, projected demands will exceed the WMA authorized withdrawal of 5.0 MGD by 2025. Even if the Town is able to keep residential per-capita demands closer to the historic 49 RGPCD, projected demands would still surpass authorized withdrawals by the year 2029.

Massachusetts Water Resource Authority (MWRA) Supply

To offset this supply deficit, the Town of Weymouth is considering supplementing or replacing the Town's current supplies with water purchased from the regional supplier, the Massachusetts Water Resources Authority (MWRA). EP assessed the feasibility and hydraulic performance of a variety of supply scenarios based on potential extensions of the existing MWRA system limits in Braintree and Quincy.

Existing Water System

The water system is divided into three service zones: the High Service Zone (HSZ), Intermediate Service Zone (ISZ), and Low Service Zone (LSZ) as shown in Figure 3-1.

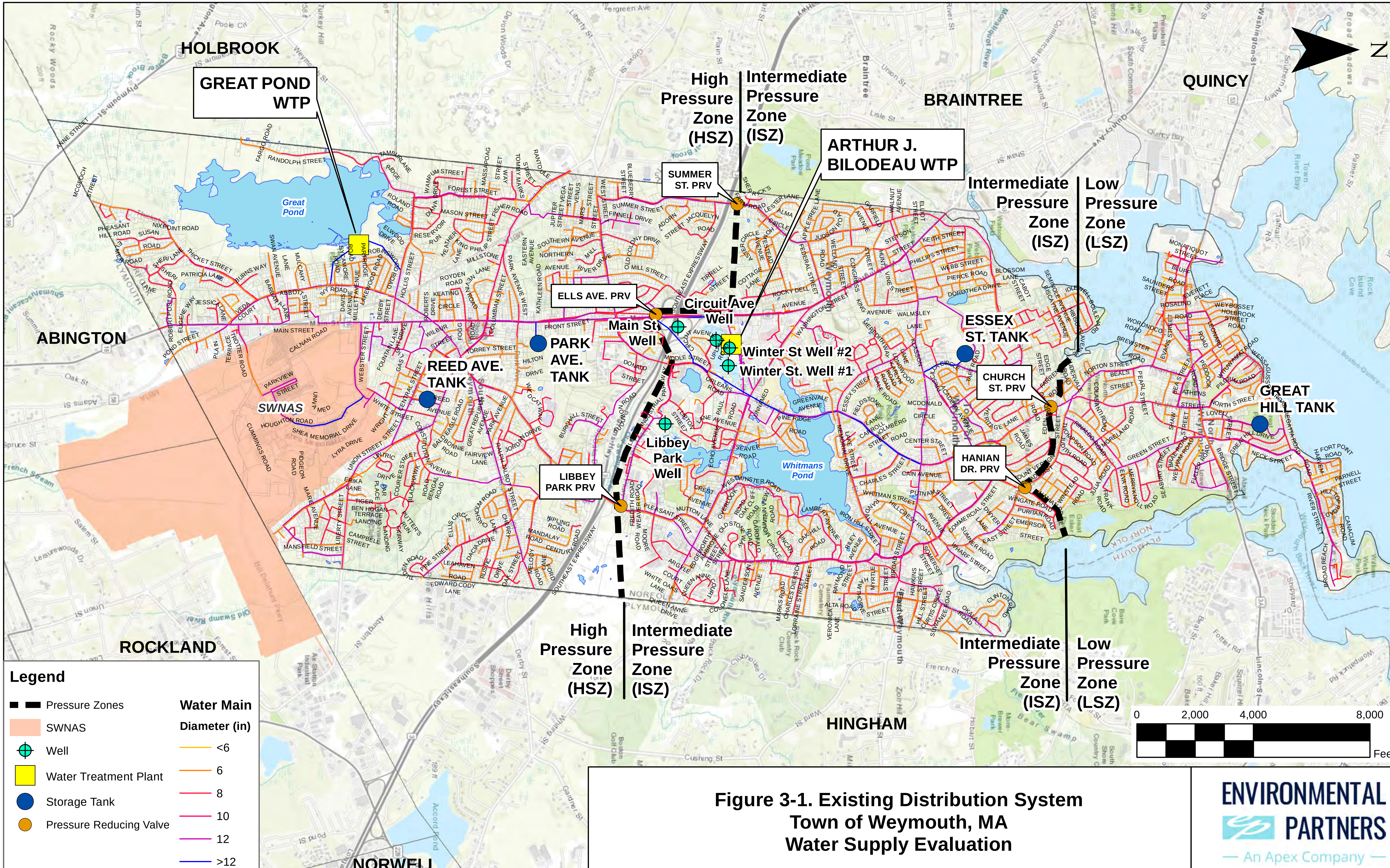


Figure 3-1. Existing Distribution System
Town of Weymouth, MA
Water Supply Evaluation

SECTION 3.2 HYDRAULIC ANALYSIS

EP utilized the hydraulic model in the most recent version of WaterGEMS V8i to perform a hydraulic analysis of the Town's water system under both current conditions with current supply scenarios, and future conditions with a variety of MWRA supply scenarios. Performance metrics included available fire flows (AFF), system pressures, and storage tank operating levels.

Procedure

Fire flows were examined under steady state conditions using maximum day demands. The modeling software incrementally increases the flow at a given point in the model until a local or system pressure drops to 20 psi, and reports that flow as the available fire flow.

When examining system pressures, EP ran a 72-hour extended period simulation and identified the maximum and minimum pressures at each point in the model over that time period. Based on MassDEP Guidelines and Policies for Public Water Systems, the normal working pressure in the distribution system should range from 60 to 80 pounds per square inch (psi) and not less than 35 psi. Additionally, pressure-reducing valves are required for static pressures over 80 psi per the plumbing code (248 CMR 10.14(4)(g)1). As such, system pressures below 35 psi and above 80 psi were flagged as concerns. System pressures below 20 psi and above 100 psi were flagged as extreme.

EP also reviewed tank levels over the 72-hr extended simulation period. The primary metric for tank levels is the volumetric turnover on a daily basis, which is used as a proxy for average water age. EP additionally evaluated operating ranges of the tanks under the various scenarios to confirm that available storage for peak hour demand equalization and fire protection would remain at current levels.

The system performance under current conditions was used as a comparative baseline for future improvement recommendations. Recommended improvements for future system performance are intended to meet or exceed the performance of the current system. There are currently pressures outside MassDEP recommended limits at select locations throughout the system, as well as areas with fire flow deficiencies. Future improvements are intended to avoid exacerbating existing deficiencies and to avoid creating new deficiencies. Additional water system improvements that could mitigate existing deficiencies are outside of the scope of this study.

EP also noted whether system pressures at a given point deviated by greater than 10 psi under future improvements scenarios, as significant deviations could create the perception of decreased level of service for customers. For example, while a pressure of 40 psi is acceptable by MassDEP guidelines and Massachusetts Plumbing Code, a pressure drop from 75 psi to 40 psi may be perceived as a decreased level of service by the water user.

Assumptions

For fire flow scenarios, EP reviewed the tank level fluctuations over the extended period simulation, and used the average tank level as the input level during fire flow analyses. Pumps/sources were active during fire flow scenarios, as it is assumed they would be called to run during an extended fire event. During extended period simulations, the Great Pond WTP is set to run with a flow target of 2,400 gpm. During maximum day demand scenarios, peak discharge is increased up to 3,800 gpm. The AJBWTP runs at approximately 1,000 gpm.

The Church Street and Hanian Drive Pressure Reducing Valves (PRVs), which allow flow into the LSZ, are set to open when the Great Hill Tank level drops to 10 ft, and close when it reaches 17.5 ft.

As outlined in Section 2, 2020 average day demands are 4.25 MGD, and the ratio of maximum demand to average day demand is 1.23, yielding a maximum day demand of 5.23 MGD. Projected 2040 average day demand is 5.28 MGD, plus an additional 2.3 MGD from SWNAS. EP assumed the same ratio of 1.23 for 2040 modeling scenarios, yielding a projected maximum day demand of 9.38 MGD. All simulations include water demand allocations for known proposed developments.

Table 3-2: Summary of Modeled Demands (MGD)

		Weymouth Demand	SWNAS	Total
2020 Demand	Average Day Demand (ADD)	4.15	0.10	4.25
	Maximum Day Demand (MDD)	5.11	0.12	5.23
2040 Demand	Average Day Demand (ADD)	5.28	2.30	7.58
	Maximum Day Demand (MDD)	6.49	2.85	9.34

MWRA Supply Scenarios Considered

Based on input from the MWRA and Town, EP developed several scenarios for MWRA supply to the Town of Weymouth's water system. These included the following connection points:

- On Bridge Street at the Quincy town line, in the LSZ
- On Washington Street at the Braintree Town Line, in the ISZ
- On Columbian Street at the Braintree town line, in the HSZ
- Near Summer Street at the Braintree town line (via Route 3), in the HSZ
- At the Great Pond WTP, in the HSZ

For the LSZ Bridge Street connection, the entirety of the LSZ would be transferred to the MWRA, the PRVs supplying the LSZ would be closed (except for emergency use), and the resulting supply capacity would be used to offset projected demand increases in the HSZ and ISZ. The Great Pond and AJB treatment plants would remain active. An extension of this alternative includes extending the LSZ boundary to incorporate some ISZ customers, further increasing the supply capacity of the HSZ and ISZ.

For the ISZ Washington Street connection, both the LSZ and ISZ would be transferred to the MWRA, the PRVs supplying the ISZ would be closed (except for emergency use), and the resulting supply capacity would be used to offset the SWNAS demands. The AJB WTP would be decommissioned in this scenario, but the Great Pond WTP would remain active to serve the HSZ. Projected 2040 average day demands would exceed the Great Pond safe yield, so a booster pumping station would need to be installed to supplement the HSZ with supply from the MWRA connection at Washington Street.

For all three HSZ connection scenarios, the MWRA would supply the entirety of the Town's water demands. Both treatment plants were deactivated in the hydraulic model during these scenarios, except in the Great Pond connection scenario, where it was converted to a pumping station.

It is important to note that a "baseline" 2040 model run is not possible, because current supplies are insufficient to meet projected demands. Without an MWRA connection, the tanks would drain over time and not recover. Thus, all 2040 model scenarios included an MWRA supplemental connection.

HSZ and ISZ MWRA supply scenarios also require water system upgrades to generate a stable model run, as the current system hydraulics and supplies cannot support 2040 maximum day demands, particularly with the change in the supply point. In other words, simply connecting to MWRA water at these locations would still result in a supply deficit, because the current pipe configuration would not allow distribution of water throughout the Town.

Low Service Zone hydraulics do allow for a simple connection without hydraulic upgrades, as discussed in detail later in this analysis. However, expanding the LSZ boundary would require pipeline improvements, including water main upgrades and service transfers.

For all MWRA supply scenarios, EP assumed an optimal hydraulic grade line (HGL) at the connection point to the Weymouth distribution system as noted in the sections below. HGLs for connections were assumed to be constant.

Section 3.2.1 Existing System Analysis

Existing Pressure Analysis

EP utilized the hydraulic model to simulate maximum and minimum pressures throughout the system during a 72-hr extended period simulation of both average day demand and maximum day demand conditions. This analysis focuses on maximum day demands, where the higher flows tend to create a more varied pressure distribution.

The low water elevation in the HSZ tanks during a typical maximum day demand scenario is approximately 270 feet. As a result, pressures below 35 psi are experienced for customers above approximately 185 feet in elevation, which occurs along the western and southern edges of the HSZ and near the two tanks. Low pressures also occur at the high elevations in the LSZ, near the Great Hill Tank and the Hanian Drive PRV. Model simulations do not show any pressures below 20 psi under normal operating conditions.

Similarly, the high tank level in the ISZ is approximately 266 feet, so pressures above 80 psi are experienced by customers below an elevation of approximately 81 feet, which occurs primarily along the northeast and northwest edge of the ISZ (near the LSZ PRVs). Closest to the LSZ boundary, some pressures in the ISZ climb as high as 109 psi. High and low pressure areas are shown in Figure 3-2.

Existing Fire Flow Analysis

EP simulated available fire flows throughout the Town to set a base line level of service under 2020 maximum day demand conditions. Fire flows were evaluated using ISO requirements for one and two family dwellings based on the distance between dwellings. That data set was supplemented with the 2006 ISO fire flow requirements, which included 34 separate test sites for commercial and industrial properties. ISO sites that exhibited fire flow deficiencies are presented below in Table 3-3, and are shown in Figure 3-3. Existing fire flow deficiencies found in residential areas are also presented in Figure 3-3.

Table 3-3: ISO Fire Flow Deficiencies

Test No.	Location	Model Junction ID	Needed FF	Modeled 2020 FF
7	Union Street at Hamilton School	2283	3,000	2,940
9	Bridge Street at Lowes	746	6,000[1]	2,210
10	Finnell Drive at West Street	2892	3,000	2,780
17	Bridge Street at Bluff Road	4511	3,000	1,960
21	Pilgrim Road at Wadaga Road	4248	2,250	2,030
22	Broad Street at School House Road	5652	4,500[1]	2,020
23	Main Street at Henderson Street	6020	4,500[1]	3,440
31	Green Street at Merryknoll	530	2,000	1,200

*Municipal system fire flow obligations are limited to 3,500 gpm.

These deficiencies are due to a number of factors, including distance from the storage tanks, surrounding pipe diameters and materials, and elevation of the areas. As stated above, mitigating existing deficiencies is not within the scope of this analysis. The goal of the recommended improvements during MWRA supply scenarios is avoid exacerbating existing deficiencies and to avoid creating new deficiencies. For all scenarios discussed below, EP compared 2040 available fire flows to existing 2020 fire flows and modeled water main improvements as necessary such that no new deficiencies were created.

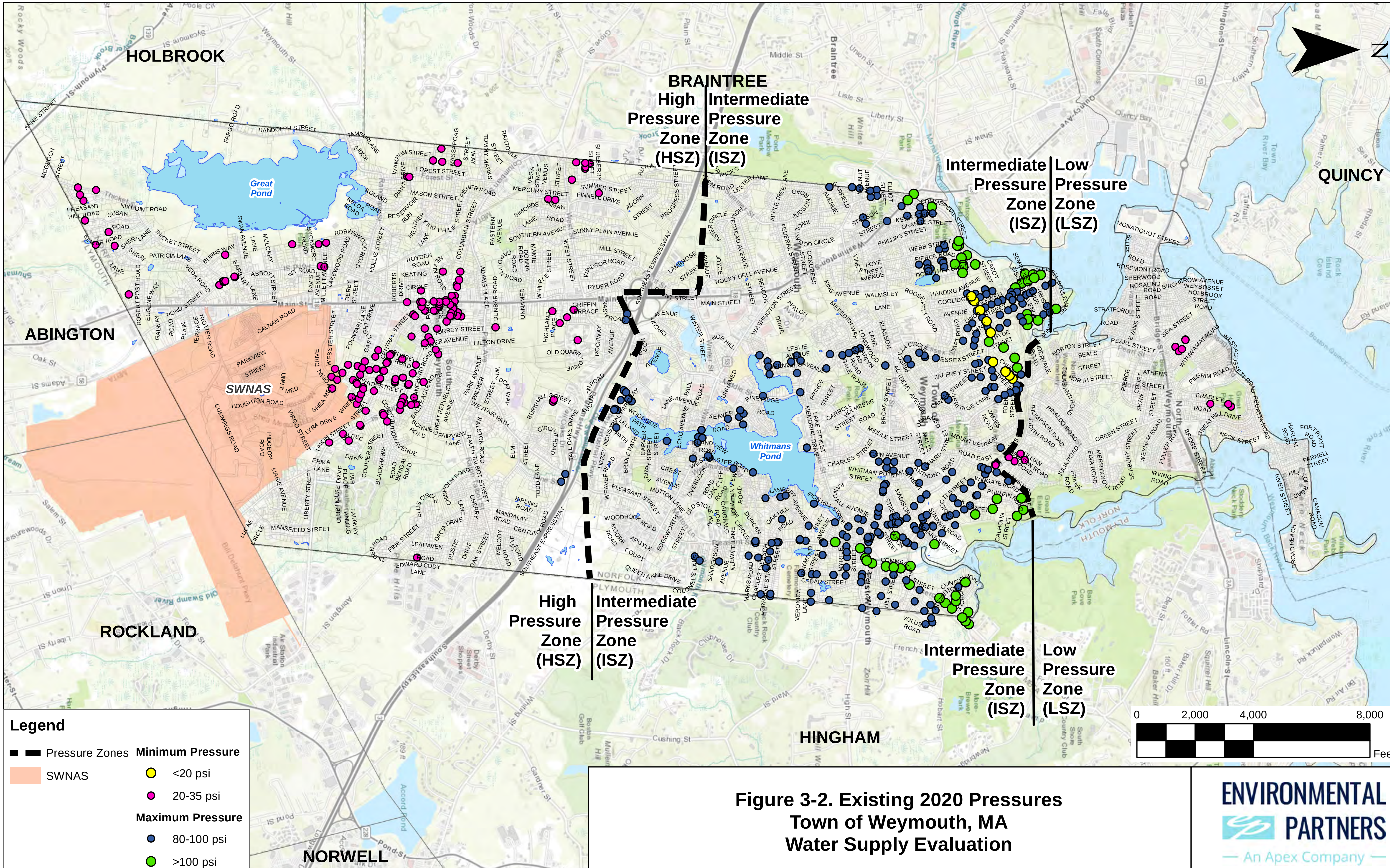


Figure 3-2. Existing 2020 Pressures
Town of Weymouth, MA
Water Supply Evaluation

I:\SSTTDC.290\290-2104 Weymouth Water Supply Eval\04 GIS\Memo 3\Figure 2 - Existing 2020 Pressures.mxd

I:\SSTTDC.290\290-2104 Weymouth Water Supply Eval\04 GIS\Memo 3\Figure 3 - Fire Flow Deficiencies.mxd

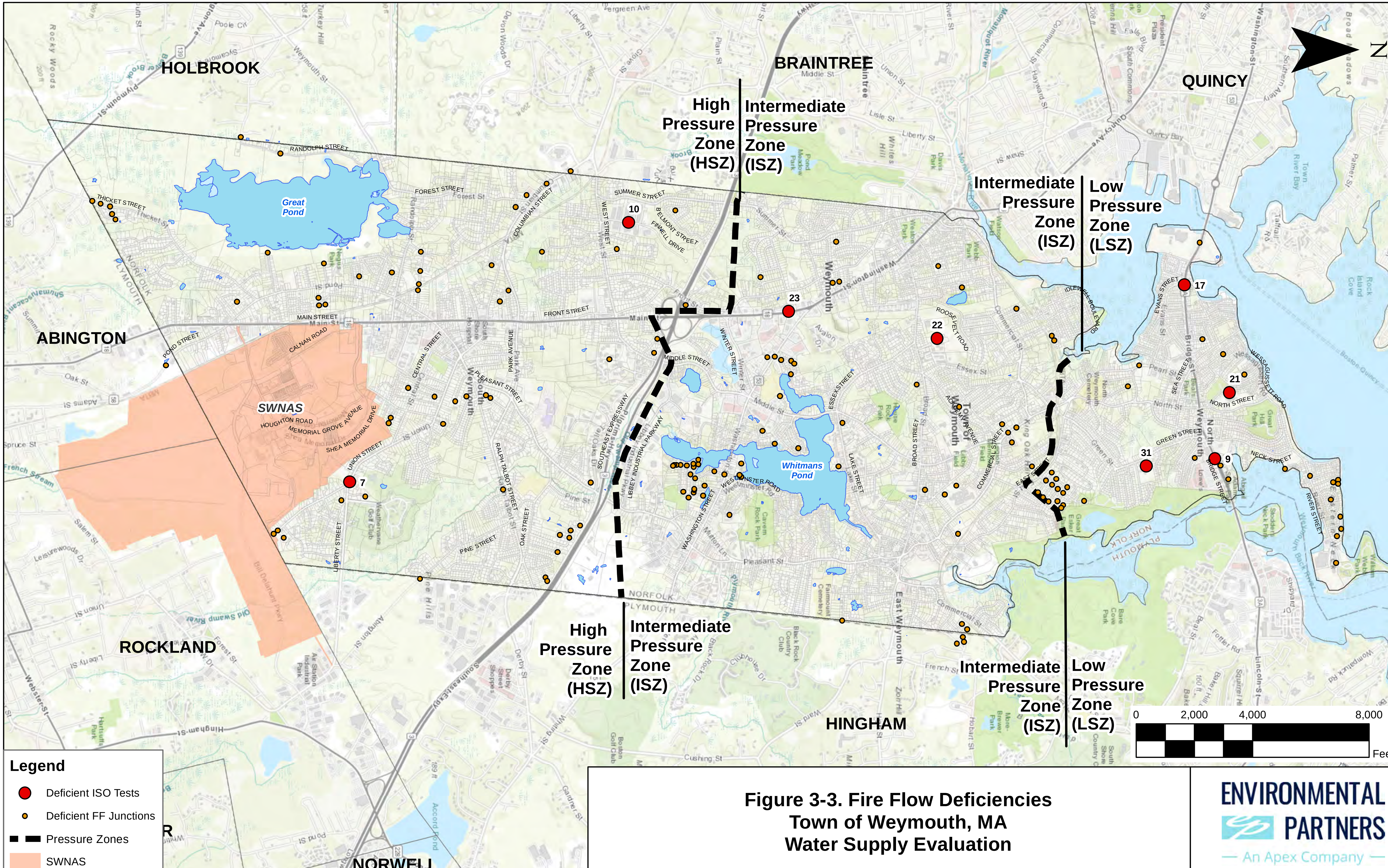


Figure 3-3. Fire Flow Deficiencies
Town of Weymouth, MA
Water Supply Evaluation

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Section 3.2.2 MWRA Supply Scenarios

MWRA Supply via the Low Service Zone (Quincy)

Transferring the LSZ to MWRA supply would remove some system demands and thus create additional capacity for the Town as well as the SWNAS development. Per Table 3-1 above, the 2040 projected system demands are 5.28 MGD, plus 2.30 MGD for SWNAS, for a total of 7.58 MGD. The WMA permitted withdrawal is 5.0 MGD.

The 2020 LSZ demands are approximately 0.78 MGD, and the projected 2040 LSZ demands are approximately 0.93 MGD. Therefore, transferring the LSZ to the MWRA system is insufficient to offset the entirety of the SWNAS demands. However, based on the projections shown in Table 3-1, it could afford the Town of Weymouth additional years of capacity, as shown below in Table 3-4.

Table 3-4: Projected System Capacity with LSZ on MWRA Supply

Year	Projected Base ADD (MGD)	Projected SWNAS ADD (MGD)	Total Projected System Demand (MGD)	LSZ Demands (MGD)	System Demands without LSZ (MGD)	Projected Surplus/(Shorfall) (MGD)
2025	5.02	0.10	5.12	0.78	4.34	0.66
2030	5.11	0.70	5.81	0.83	4.98	0.02
2035	5.20	1.20	6.40	0.88	5.52	(0.52)
2040	5.28	2.30	7.58	0.93	6.65	(1.65)

While not sufficient to offset the entirety of the SWNAS demands, converting the LSZ to MWRA supply extends the existing 5.0 MGD capacity until approximately 2030, as opposed to the current timeline of approximately 2024.

Assuming an incoming MWRA HGL of approximately 171 feet, fire flows and available pressures were comparable to baseline levels and the transfer to MWRA supply could be completed without significant water main improvements. However, there is approximately 7,000 linear feet of unlined cast iron water mains along critical transmission pathways between the point of connection, the Great Hill tank, and the furthest reaches of the zone. Older, unlined cast iron mains usually experience accelerated material degradation and represent a higher risk for breaks and ruptures. Should the Town wish to proceed with the LSZ Conversion, EP recommends the Town consider replacing these cast iron mains as part of that alternative, as shown in Figure 3-4 and summarized in Table 3-5 below:

Table 3-5: LSZ Cast Iron Water Main Replacements

DI Pipe Diameter	Upgrade Length (ft)
6”	1,300
8”	100
12”	5,600
Total	**7,000**

In addition, as shown in Figure 3-2, there is a collection of ISZ customers near the LSZ boundary who currently experience pressures above 80 psi. These customers could be incorporated into the LSZ, thus expanding the LSZ and further increasing the additional capacity for the SWNAS development following the transfer to MWRA supply. These potential additional demands amount to approximately 0.154 MGD in 2040, which would approximately offer an additional 1-2 years of capacity.

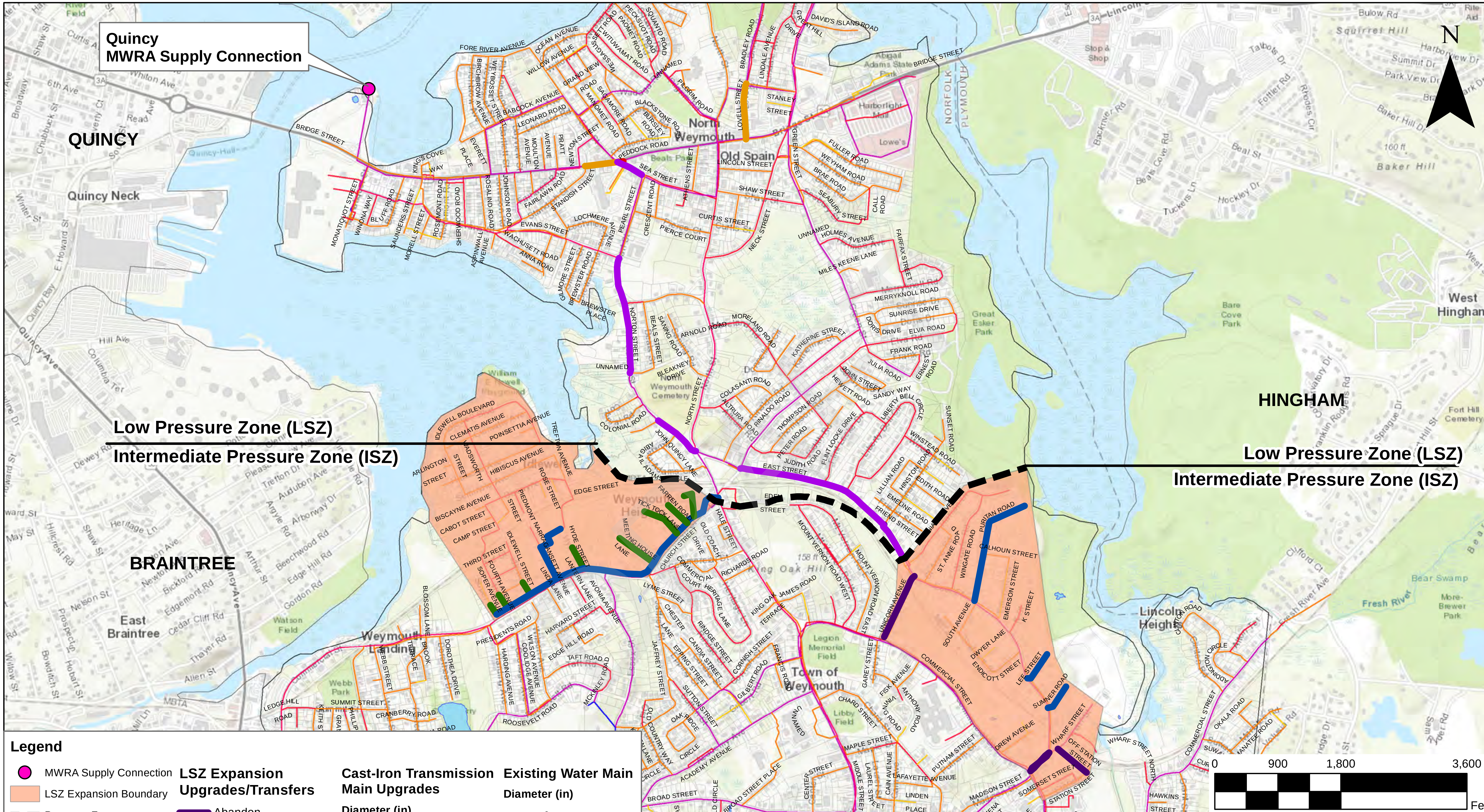
Converting these customers would involve the installation of new water mains, cutting several water main connections to the ISZ, and converting a number of customers to the new water mains. A summary of the required water main upgrades is presented in Figure 3-4 and outlined in Table 3-6 below:

Table 3-6: Water Main Improvements for LSZ Expansion

DI Pipe Diameter	Upgrade Length (ft)
8”	4,800
12”	3,900
Total	**8,700**

These converted customers would also see pressure drops of 40 psi unless the Great Hill Tank was raised/replaced with a higher overflow elevation. Therefore, while EP does recommend the Town consider this LSZ Expansion as part of a future water system master plan update, the modest capacity increase is likely not worth the expense as part of the effort to source additional capacity for the SWNAS development.

In summary, while converting the LSZ to MWRA and expanding the LSZ boundary extends the Town’s supply surplus until approximately 2030-2032, it is insufficient to fully offset the entirety of the SWNAS demands. This scenario would also require the LSZ be split from the rest of distribution system in order to reserve capacity of the Town’s supplies for future growth.



Legend

- MWRA Supply Connection
- LSZ Expansion Boundary
- Pressure Zones

LSZ Expansion Upgrades/Transfers

- Abandon
- New/Replacement WM
- WM Conversion

Cast-Iron Transmission Main Upgrades

Diameter (in)

- 6
- 8
- 12

Existing Water Main

Diameter (in)

- <6
- 6
- 8
- 10
- 12
- >12

Figure 3-4. LSZ Pipeline Improvements for MWRA Connection

Town of Weymouth, MA
Water Supply Evaluation

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I:\SSTTDC.290\290-2104 Weymouth Water Supply Eval\04 GIS\For memo\Figure 4 - LSZ Pipeline Improvements for Quincy MWRA Connection.mxd

MWRA Supply via the Intermediate Service Zone (Washington Street)

Transferring the ISZ and LSZ to MWRA supply via Washington Street would remove additional system demands and reserve additional capacity for the SWNAS development. Per Table 3-1 above, the 2040 projected system demands are 5.28 MGD, plus 2.30 MGD for SWNAS, for a total of 7.58 MGD. Without the AJBWTP, the Town's supply would be limited to the Great Pond WTP safe yield of 3.63 MGD.

The 2020 combined ISZ and LSZ demands are approximately 2.75 MGD, and the projected 2040 demands are approximately 3.27 MGD. Therefore, transferring the ISZ and LSZ to the MWRA system is sufficient to offset the projected HSZ zone demand including up to 1.62 MGD from SWNAS. Full buildout of SWNAS cannot be supplied, as shown below in Table 3-7.

Table 3-7: Projected System Capacity with ISZ and LSZ on MWRA Supply

Year	Projected Base ADD (MGD)	Projected SWNAS ADD (MGD)	Total Projected System Demand (MGD)	ISZ+LSZ Demands (MGD)	System Demands without ISZ/LSZ (MGD)	Projected Surplus/(Shorfall) (MGD)
2025	5.02	0.10	5.12	2.75	2.37	1.26
2030	5.11	0.70	5.81	2.92	2.89	0.74
2035	5.20	1.20	6.40	3.10	3.30	0.33
2040	5.28	2.30	7.58	3.27	4.31	(0.68)

EP assumed an incoming MWRA HGL of approximately 169 feet, slightly above the Essex Street tank overflow elevation. To adequately fill the Essex Street tank, approximately 3,600 feet of existing 10" and 12" cast iron water mains on Washington Street and Broad Street would need to be upgraded to 16" ductile iron up to Roosevelt Road. From Roosevelt Road, the transmission mains to the Essex Street tank are unlined cast iron. Older, unlined cast iron mains usually experience accelerated material degradation and represent a higher risk for breaks and ruptures. Should the Town wish to proceed with the ISZ Conversion, EP recommends the Town consider replacing 4,300 feet of 12" and 16" cast iron mains with 16" ductile iron water mains as part of that alternative, as shown in Figure 3-5 below.

Under this alternative, EP recommends continuing to utilize the existing PRVs at the HSZ/ISZ border for emergency fire supply. The extent and magnitude of the upgrades required to maintain existing fire flow service to the furthest reaches of the ISZ (near the PRVs) would likely result in excess water age, and would be cost prohibitive. Further analysis is needed to compare these two approaches.

Meeting the entirety of the projected 2040 demands in the HSZ would require a booster pumping station to provide water from the MWRA supplied ISZ to the HSZ. EP assumed the BPS would be located at the HSZ/ISZ boundary at Ells Avenue. Ells Avenue is centrally located and close to the HSZ tanks, and as a result would optimize the hydraulic profile in both the HSZ and the ISZ under the BPS conditions. EP identified a preliminary pumping rate of approximately 1,200 gpm would be required during peak demands. Exact sizing will need to be determined as part of the preliminary design of the BPS.

EP recommends the Town replace the unlined cast iron on the suction side of the proposed BPS with 16" ductile iron water main, providing a more reliable transmission pathway between the Washington Street connection and the Ells Avenue site. This would amount to an additional 5,400 feet of 16" DI water main, bringing the total to 9,700 feet for this alternative. The extent of the unlined cast iron water main replacements is shown on Figure 3-5 below.

Should a future preliminary design effort determine a higher required flow rate than the 1,200 gpm used in this analysis (e.g. if the Town wishes to provide full redundancy to the HSZ), the size and extent of the water main upgrades is likely to increase, and will need to be reassessed.
This alternative will result in the future blending of incoming MWRA water with the existing Great Pond source in the HSZ when the BPS is implemented. This will likely require treatment modifications to the Great Pond WTP to accommodate the different chemical constituents in both supplies and to maintain acceptable water quality standards.

MWRA Supply via the Intermediate Service Zone (Church Street)

An alternate connection point for the ISZ is near the Church Street PRV. This would involve a transmission main that passes through the LSZ and connects on the upstream side of the Church St PRV. Hydraulic performance would be comparable to the Washington Street connection point discussed above.

To adequately fill the Essex Street tank, approximately 4,500 feet of existing 10" cast iron and 12" ductile iron water mains on Church Street, Commercial Street, and Essex Street would need to be upgraded to 16" ductile iron up to the Essex Street Tank. Additionally, older, unlined cast iron mains usually experience accelerated material degradation and represent a higher risk for breaks and ruptures. Should the Town wish to proceed with the ISZ Conversion, EP recommends the Town consider replacing 7,100 feet of 12", 14", and 16" cast iron mains with 16" ductile iron water mains as part of that alternative (including the suction side of the Ells Ave BPS), as shown in Figure 3-6 below.

As with the Washington Street connection alternative, EP recommends continuing to utilize the existing PRVs at the HSZ/ISZ border for emergency fire supply. This alternative would also warrant the same potential Great Pond treatment modifications discussed under the Washington Street alternative.

EP has not included the additional length of transmission main through the LSZ in the capital cost estimates. The transmission main would pass through the LSZ and would not connect to the Weymouth water system until it reaches the ISZ, resulting in an additional 9,900 feet of large-diameter transmission main in comparison the LSZ connection scenario.

I:\SSTTDC.290\290-2104 Weymouth Water Supply Eval\04 GIS\Memo 3\Figure 5 - ISZ Improvements for Washington St Connection.mxd

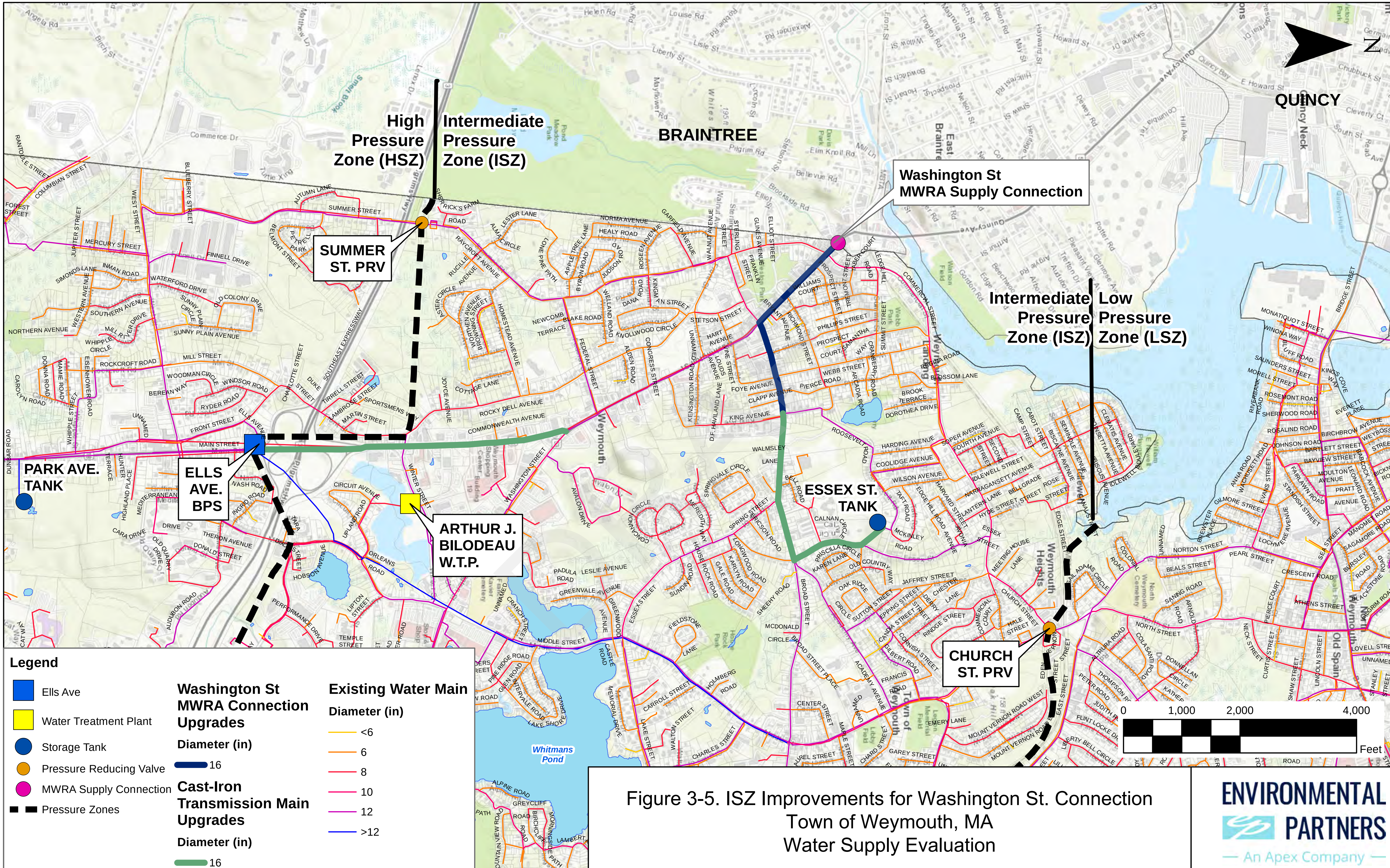

Figure 3-5. ISZ Improvements for Washington St. Connection
Town of Weymouth, MA
Water Supply Evaluation

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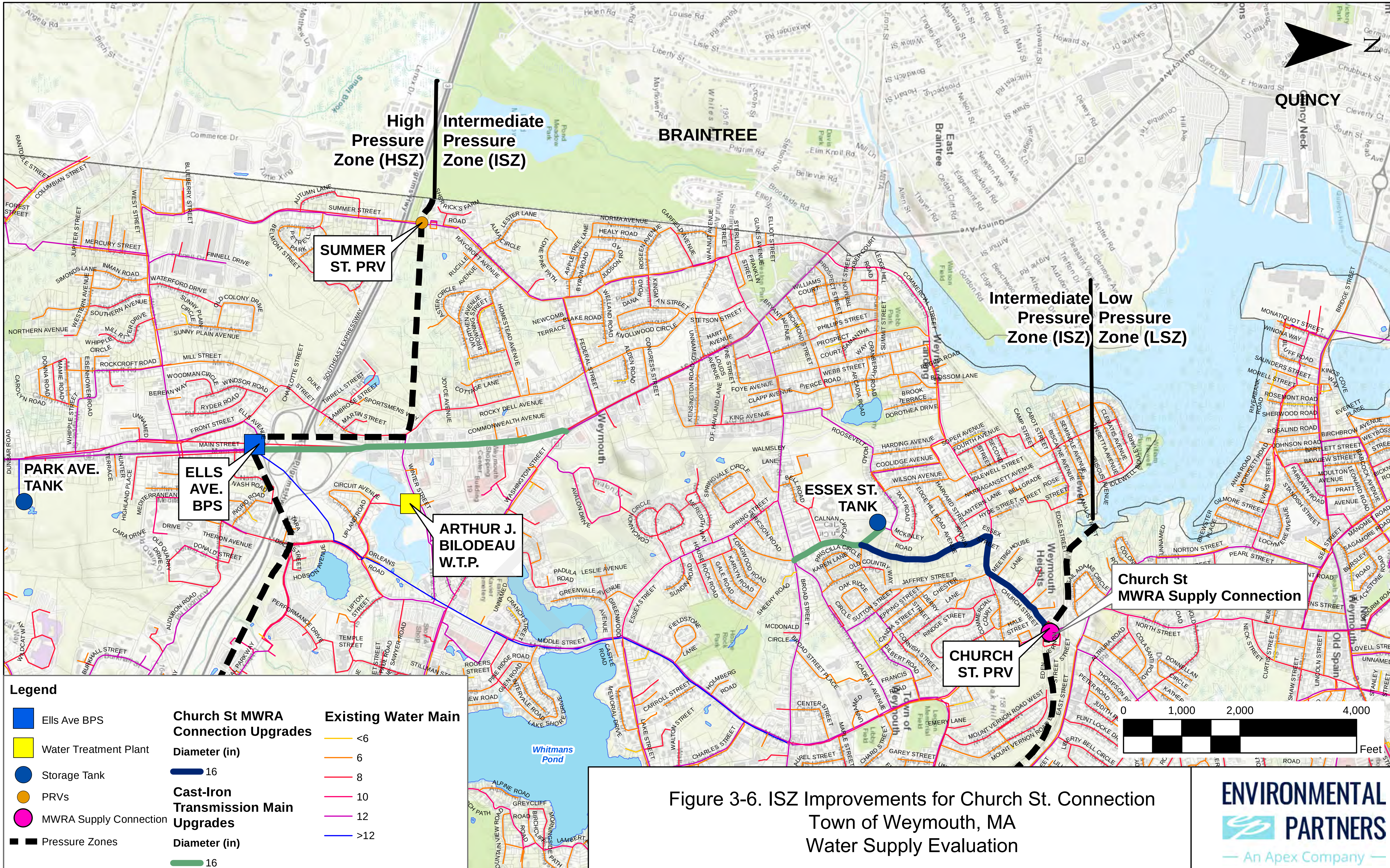

Figure 3-6. ISZ Improvements for Church St. Connection
Town of Weymouth, MA
Water Supply Evaluation

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I:\SSTTDC.290\290-2104 Weymouth Water Supply Eval\04 GIS\Memo 3\Figure 6 - ISZ Improvements for Church St Connection.mxd

MWRA Supply via the High Service Zone (Columbian Street)

Another alternative is to supply the entirety of the Town's water system demands via a new connection to the MWRA system in the High Service Zone at Columbian Street. It is assumed in this alternative that the Town's existing supplies would be deactivated under normal operating conditions.

This alternative largely mimics existing system operations, except that the point of entry is shifted, and the ISZ now gets all of its supply via the PRVs. For this alternative to perform similarly to the current system, a large volume of water needs to be transmitted along Columbian Street, to the HSZ tanks, and to the PRVs. The HGL of the MWRA supply line in this scenario would need to be approximately 305 feet.

As shown in Figure 3-7, a 30" ductile iron water main would need to extend from the point of connection on Columbian Street to Main Street. This serves to convey water toward the HSZ tanks and into the heart of the service zone. This transmission pathway along Columbian Street includes an MBTA railroad crossing.

From there, a 16" DI main needs to extend north until the Ells Avenue PRV and south until Shea Drive. Upgrading the water main north to the Ells Avenue PRV helps convey that water toward the ISZ with sufficient HGL, as the ISZ would need to draw all its water from the PRVs without the AJBWTP online. Extending south to Shea Drive serves to decrease headlosses to the southern extents of the system; the Great Pond WTP currently increases pressures in that region, and deactivating the plant would result in additional customers with low pressures unless this water main upgrade is completed.

Lastly, a 16" DI main is required to be extended along Pleasant Street to increase the hydraulic carrying capacity between Main Street and Union Street. This encourages water to move toward the Reed Avenue Tank, which helps both tanks maintain adequate turnover. Without such an extension, water would preferentially fill the Park Avenue Tank (which is closer to the MWRA connection), and the tank would remain full for significant periods of time while the Reed Avenue Tank continues to fill. EP also recommends the Town consider installing an altitude valve at the Park Avenue Tank for this alternative. In total, this alternative would require approximately 18,500 feet of water main upgrades in the HSZ, as shown below in Table 3-8.

Table 3-8: Water Main Upgrades for MWRA Supply at Columbian Street

DI Pipe Diameter	Upgrade Length (ft)
12"	250
16"	12,000
30"	6,250
Total	**18,500**

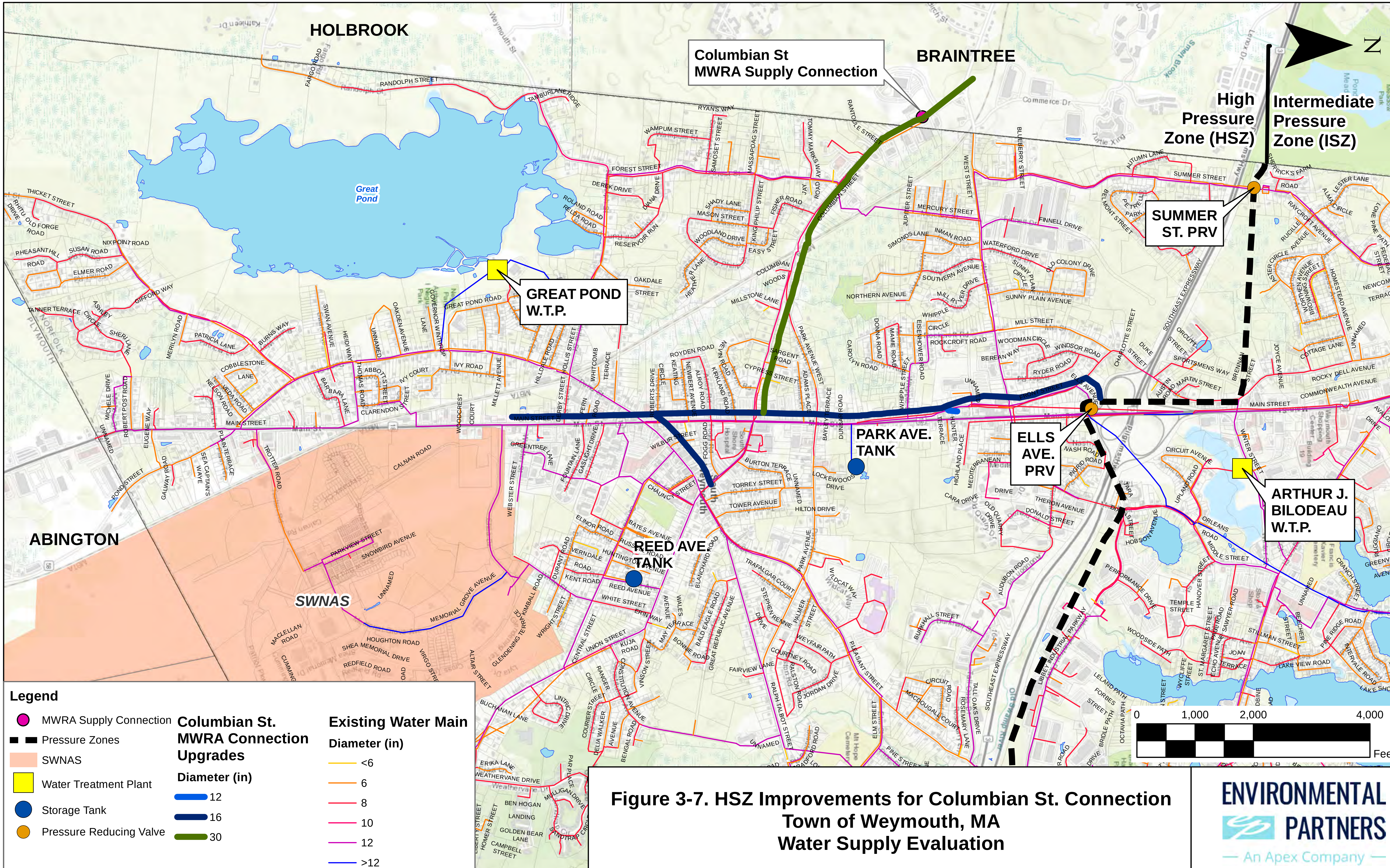

Figure 3-7. HSZ Improvements for Columbian St. Connection
Town of Weymouth, MA
Water Supply Evaluation

I:\SSTTDC.290\290-2104 Weymouth Water Supply Eval\04 GIS\Memo 3\Figure 7 - HSZ MWRA Improvements for Columbian St Connection.mxd

MWRA Supply via the High Service Zone (Summer Street)

An alternative location for the HSZ MWRA supply is near Summer Street at the Braintree town line. This location allows MWRA supply to be brought to the area via Route 3. As with the previous HSZ supply alternative, EP assumed that the Town's existing supplies would be deactivated under normal operating conditions. The HGL of the MWRA supply line in this scenario would need to be approximately 305 feet.

While the principles of the water main upgrades are largely the same as the Columbian Street connection, this supply point is considerably further from the HSZ tanks. It also further exacerbates the sequential filling of the tanks, and would likely necessitate the addition of an altitude valve on the Park Avenue Tank. It is also further from the higher elevation customers in the southwestern extent of the pressure zone, and thus requires larger diameter water mains to provide adequate HGL to those customers.

Facilitating a connection at Summer Street while preserving system performance would necessitate the installation of a 30" water main from the connection to West Street and from West Street to Main Street. A 20" water main would extend along Main Street to Columbian Street/Union Street. Similar to the Columbian Street alternative, a 16" water main would extend further along Main Street to Shea Memorial Drive, and a 16" water main would also extend to Union Street.

The required water main upgrades are summarized in Table 3-9 and Figure 3-8 below:

Table 3-9: Water Main Upgrades for MWRA Supply at Summer Street

DI Pipe Diameter	Upgrade Length (ft)
16"	6,000
20"	4,500
30"	8,300
Total	**18,800**

The overall length of upgrades required would be larger than the Columbian Street alternative, and the diameters would be larger. This results in a higher cost than the Columbian Street alternative and poorer overall hydraulic performance for the system. From this information alone, this is not the preferred alternative. However, the Summer Street alternative should not be eliminated as this may be the most advantageous location from the perspective of MWRA expansion. Selection of a preferred supply location should include the results of this analysis in conjunction with evaluation of the potential route for MWRA expansion.

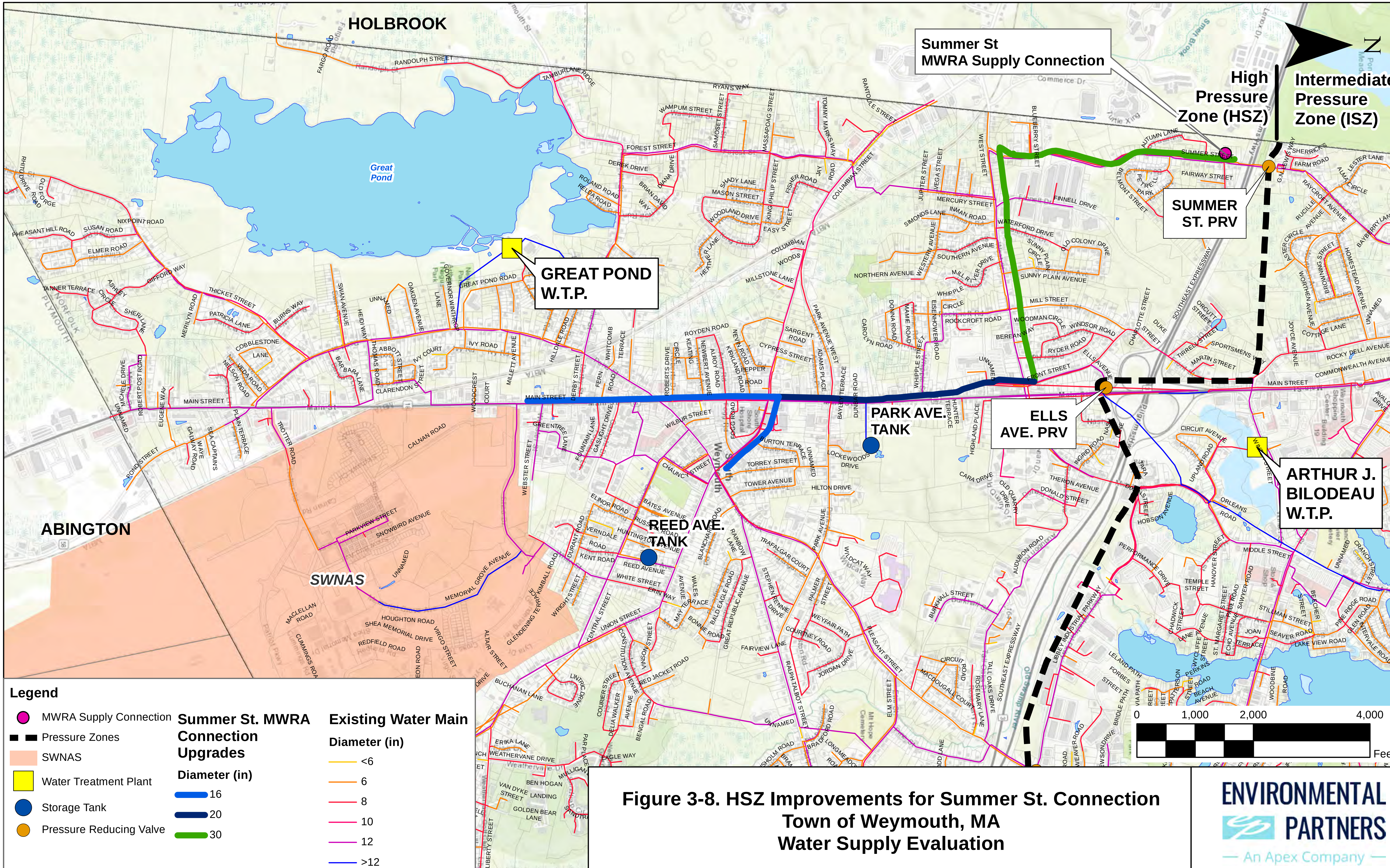

Figure 3-8. HSZ Improvements for Summer St. Connection
Town of Weymouth, MA
Water Supply Evaluation

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I:\SSTTDC.290\290-2104 Weymouth Water Supply Eval\04 GIS\Memo 3\Figure 8 - HSZ MWRA Improvements for Summer St Connection.mxd

MWRA Supply via the High Service Zone (Great Pond WTP)

A third HSZ alternative is to supply the entirety of the Town's water system demands via a new connection to the MWRA system connected into the headworks of the Great Pond WTP. EP assumed in this alternative that the Town's existing supplies would be inactive under normal operating conditions.

The HGL of the MWRA supply line in this scenario would need to be greater than 180 ft to fill the Great Pond clearwell upstream of the distribution pumps. Downstream of the clearwell, this alternative largely mimics existing system operations, except that the ISZ now gets all of its supply via the PRVs. This puts additional demand on the Park Avenue tank, which is closer to the ISZ, and water from the new MWRA connection would preferentially fill the Reed Avenue Tank, which is closer to the WTP. For this alternative to perform similarly to the current system, water main upgrades would need to be implemented that would reduce headlosses to the Park Avenue tank.

As shown in Figure 3-9, a 24" ductile iron water main would need to extend from the WTP, and along parts of Derby Street and Pond Street to Main Street. From there, a 16" DI main needs to extend north until the Park Avenue Tank. This transmission pathway along Hollis Street includes an MBTA railroad crossing.

In total, this alternative would require approximately 8,000 feet of water main upgrades in the HSZ, as shown below in Table 3-10.

Table 3-10: Water Main Upgrades for MWRA Supply at Columbian Street

DI Pipe Diameter	Upgrade Length (ft)
16"	3,600
24"	4,400
Total	**8,000**

It is important to note that while this HSZ option requires fewer upgrades to the Weymouth distribution system, it requires an approximately 10,000 linear foot extension of the proposed 36-inch MWRA supply line beyond the Town line to the Great Pond WTP. As a result, the overall length of pipe required for the three HSZ connection options is comparable. In addition, the WTP's three finished water distribution pumps would require upgrades to accommodate future maximum day demand.

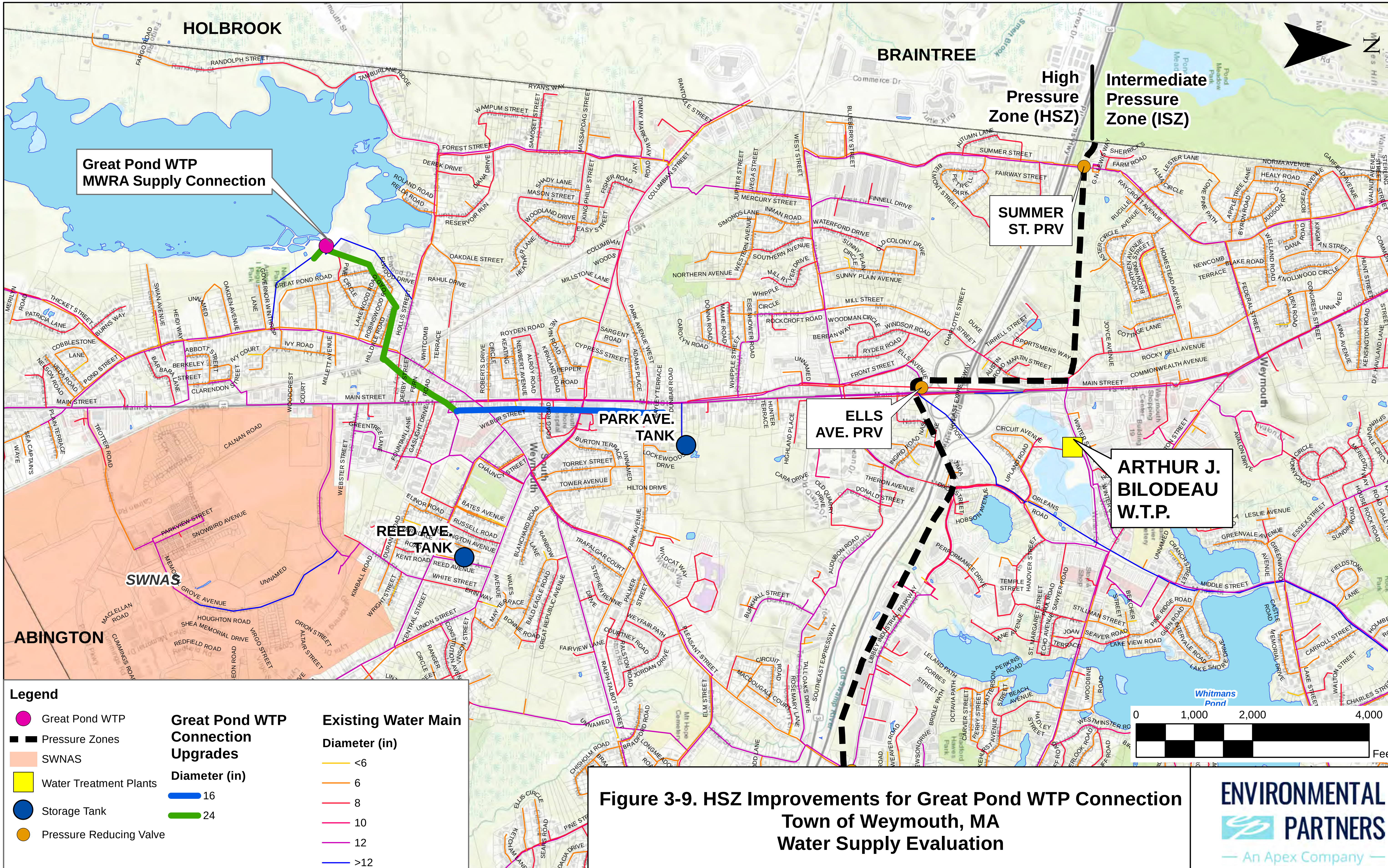


Figure 3-9. HSZ Improvements for Great Pond WTP Connection
Town of Weymouth, MA
Water Supply Evaluation

I:\SSTTDC.290\290-2104 Weymouth Water Supply Eval\04 GIS\Memo 3\Figure 9 - HSZ Improvements for Great Pond WTP Connection.mxd

SECTION 3.3 CAPITAL COSTS

Budget level opinions of probable project cost for distribution system improvements under the various MWRA supply scenarios are presented in Table 3-11. Costs are presented in January 2022 dollars and include 20% engineering and 25% contingency factors.

Table 3-11: Water Main Upgrades – Opinion of Probable Cost

LSZ Cast Iron Replacements with Ductile Iron						
Diameter (in)	Length (LF)	Cost/LF	Construction Cost	Engineering	Contingency	Total
8	1,400	$300	$420,000	$90,000	$110,000	$620,000
12	5,600	$375	$2,100,000	$420,000	$510,000	$3,030,000
		Total	**$2,520,000**	**$510,000**	**$620,000**	**$3,650,000**
LSZ Expansion Transfers						
Transfer	Qty	Unit Cost	Construction Cost	Engineering	Contingency	Total
Customer	30	$3,000	$90,000	$20,000	$30,000	$140,000
Main Connection	13	$10,000	$130,000	$30,000	$40,000	$200,000
		Total	**$220,000**	**$50,000**	**$70,000**	**$340,000**
LSZ Expansion Water Main Upgrades						
Diameter (in)	Length (LF)	Cost/LF	Construction Cost	Engineering	Contingency	Total
8	4,800	$300	$1,440,000	$290,000	$350,000	$2,080,000
12	3,900	$375	$1,462,500	$300,000	$360,000	$2,122,500
		Total	**$2,902,500**	**$590,000**	**$710,000**	**$4,202,500**
ISZ Water Main Upgrades – Washington Street Connection						
Diameter (in)	Length (LF)	Cost/LF	Construction Cost	Engineering	Contingency	Total
16 (Upgrade)	3,600	$500	$1,800,000	$360,000	$440,000	$2,600,000
16 (CI Replace)	9,700	$500	$4,850,000	$970,000	$1,170,000	$6,990,000
					Ells Ave BPS	$3,000,000
Total			**$6,650,000**	**$1,330,000**	**$1,610,000**	**$12,590,000**
ISZ Water Main Upgrades – Church Street Connection						
Diameter (in)	Length (LF)	Cost/LF	Construction Cost	Engineering	Contingency	Total
16 (Upgrade)	4,500	$500	$2,250,000	$450,000	$540,000	$3,240,000
16 (CI Replace)	7,100	$500	$3,550,000	$710,000	$860,000	$5,120,000
					Ells Ave BPS	$3,000,000
Total			**$5,800,000**	**$1,160,000**	**$1,400,000**	**$11,360,000**

Table 3-11: Water Main Upgrades – Opinion of Probable Cost (continued)

HSZ WM Upgrades – Columbian Street Connection						
Diameter (in)	Length (LF)	Cost/LF	Construction Cost	Engineering	Contingency	Total
12	250	$375	$93,750	$20,000	$30,000	$143,750
16	12,000	$500	$6,000,000	$1,200,000	$1,440,000	$8,640,000
30	6,250	$1,700	$10,625,000	$2,130,000	$2,560,000	$15,315,000
					Railroad Crossing	$2,500,000
		Total	**$16,718,750**	**$3,350,000**	**$4,030,000**	**$26,598,750**
HSZ WM Upgrades – Summer Street Connection						
Diameter (in)	Length (LF)	Cost/LF	Construction Cost	Engineering	Contingency	Total
16	6,000	$500	$3,000,000	$600,000	$720,000	$4,320,000
20	4,500	$875	$3,937,500	$790,000	$950,000	$5,677,500
30	8,300	$1,700	$14,110,000	$2,830,000	$3,390,000	$20,330,000
		Total	**$21,047,500**	**$4,220,000**	**$5,060,000**	**$30,327,500**
HSZ WM Upgrades – Great Pond WTP Connection						
Diameter (in)	Length (LF)	Cost/LF	Construction Cost	Engineering	Contingency	Total
16	3,600	$500	$1,800,000	$360,000	$440,000	$2,600,000
24	4,400	$1,275	$5,610,000	$1,130,000	$1,350,000	$8,090,000
					Railroad Crossing	$2,500,000
					Great Pond WTP Modifications	$3,000,000
		Total	**$7,410,000**	**$1,490,000**	**$1,790,000**	**$16,190,000**

SECTION 3.4 CONCLUSIONS

Based on the data reviewed as part of this analysis, the two most viable alternatives are the ISZ connection at Washington Street and the HSZ connection at the Great Pond WTP. These two alternatives could supply water to the Town of Weymouth through 2040 projected demands as well as the full buildout of SWNAS. Both options would require the Great Pond WTP to remain active and serve as a backup water supply to the Town until a redundant MWRA supply is available in the future. The preferred alternative is the ISZ connection as the capital costs are lower and long term hydraulic performance of the system is stronger compared the HSZ connection.

While the LSZ conversion to MWRA supply could occur with the lowest capital cost, the LSZ conversion only offers a temporary solution, as it would likely extend the Town's supply capacity only until approximately 2030 given the current WMA withdrawal limit of 5.0 MGD. The LSZ Expansion would further extend the supply capacity 1-2 years, but would necessitate considerable capital investment for a relatively small gain, and would still not fully offset the projected SWNAS development demands.

Connecting the MWRA supply to the ISZ at Washington Street would effectively divide the water system into two separate systems in the near term, and would require the continued operation of the Great Pond WTP to supply the HSZ. The total demands that would be transferred to the MWRA supply offset the project HSZ zone demands and result in an immediate 1.26 MGD supply surplus. As demands increase over time, including the full buildout of the SWNAS development, the HSZ would eventually experience a deficit based on current demand projections. Future SWNAS demands in Abington and Rockland (0.8 MGD) would require the redundant HSZ supply from the MWRA or a pump station from the ISZ to HSZ.

To facilitate the ISZ connection, the Town of Weymouth would need to install approximately 3,600 feet of 16” ductile iron water main along Washington Street and Broad Street. EP also recommends the Town replace additional cast iron water mains between the connection point and the Essex Street tank, and upstream of the Ells Ave BPS, amounting to an additional 9,700 feet of 16” ductile iron water main. The incoming HGL of the MWRA system would need to be approximately 169 feet.

The Route 3 alignment alternatives have the highest capital cost and highest level of construction and permitting risk but provide an immediate transition from Weymouth supply to MWRA supply for the entire Town. The Summer Street connection in Weymouth requires the highest level of hydraulic improvements within the Town to maintain the current level of service, including almost 9,000 feet of water main upgrades on Main Street (Route 18).

The HSZ connection alternatives provide an immediate transition from Weymouth supply to MWRA supply for the entire Town but have higher community impacts and capital costs due to the extents of water main upgrades required in Weymouth. In the long term, the HSZ alternatives allow the Town’s three service zones to remain connected and provide more flexibility to transform Great Pond to a setting that is open for public use.

SECTION 3.5 RECOMMENDATIONS

EP recommends the Town further investigate the feasibility of extending the MWRA supply to the potential HSZ connection points and to the ISZ at either Washington Street or Church Street.

ISZ Connection Alternatives

Further hydraulic modeling and analysis will be required to develop seasonal control strategies for the water system under this new configuration. In addition to potential revisions to Great Pond WTP operations, the Town will need to identify emergency ISZ fire flow supply protocols at the PRVs. EP also recommends the Town review its emergency response protocols under the new system configuration, as the resulting surplus in the HSZ will likely result in increased ability to supply neighboring water systems in the near term, and the change of water source in the ISZ and LSZ may impact emergency protocols in these zones. Additionally, the Town will need to reassess long-term supply redundancy as the SWNAS development progresses and the HSZ approaches the projected supply deficit.

While both ISZ connection points are viable and capital costs within Weymouth are anticipated to be comparable, the Church Street connection point would require an additional 9,900 linear feet of MWRA transmission main. EP recommends the Town compare the additional transmission main cost against mitigation costs required by Braintree for routing the transmission main through East Braintree to Washington Street in Weymouth. The Church Street connection does not require any commitment from Braintree. An additional consideration for the Church Street connection is the future MWRA expansion to Hingham and other neighboring communities. The transmission route through the LSZ would narrow the distance between the MWRA system and Hingham's distribution system by approximately 1 – 1.5 miles in comparison to the Washington Street connection.

HSZ Connection

The HSZ connection scenarios all meet the Town's goal of providing water supply to meet demands through the 2040 projections. The HSZ connections require more improvements in Weymouth but provide water that is immediately usable to the entire Town. Similar to the ISZ connection, the resulting water supply surplus will result in increased ability to supply neighboring water systems in the near term, and may impact emergency protocols.

SECTION 4 SUMMARY OF WEYMOUTH SUPPLY ALTERNATIVES

EP has prepared this section to summarize the conceptual system expansion routes provided by Massachusetts Water Resources Authority (MWRA) and the recommended improvements in Weymouth that correspond with the various potential MWRA connection locations.

SECTION 4.1 BACKGROUND

Projected demands in Weymouth will exceed the WMA authorized withdrawal of 5.0 MGD within the next 5 – 7 years. To offset this supply deficit, the Town of Weymouth is considering supplementing or replacing the Town's current supplies with water purchased from the MWRA. In Section 3, EP assessed the feasibility and hydraulic performance of a variety of supply scenarios based on potential extensions of the existing MWRA system limits.

SECTION 4.2 MWRA SUPPLY SCENARIOS

The MWRA provided four primary conceptual routes to supply Weymouth with MWRA water, all of which involve connecting a new 36-inch pipeline to MWRA's Section 22 in Quincy. Conceptual routes that connect to Weymouth's High Service Zone (HSZ) also include sub-alternatives resulting in a total of eight (8) conceptual routes as shown in Figure 4-1.

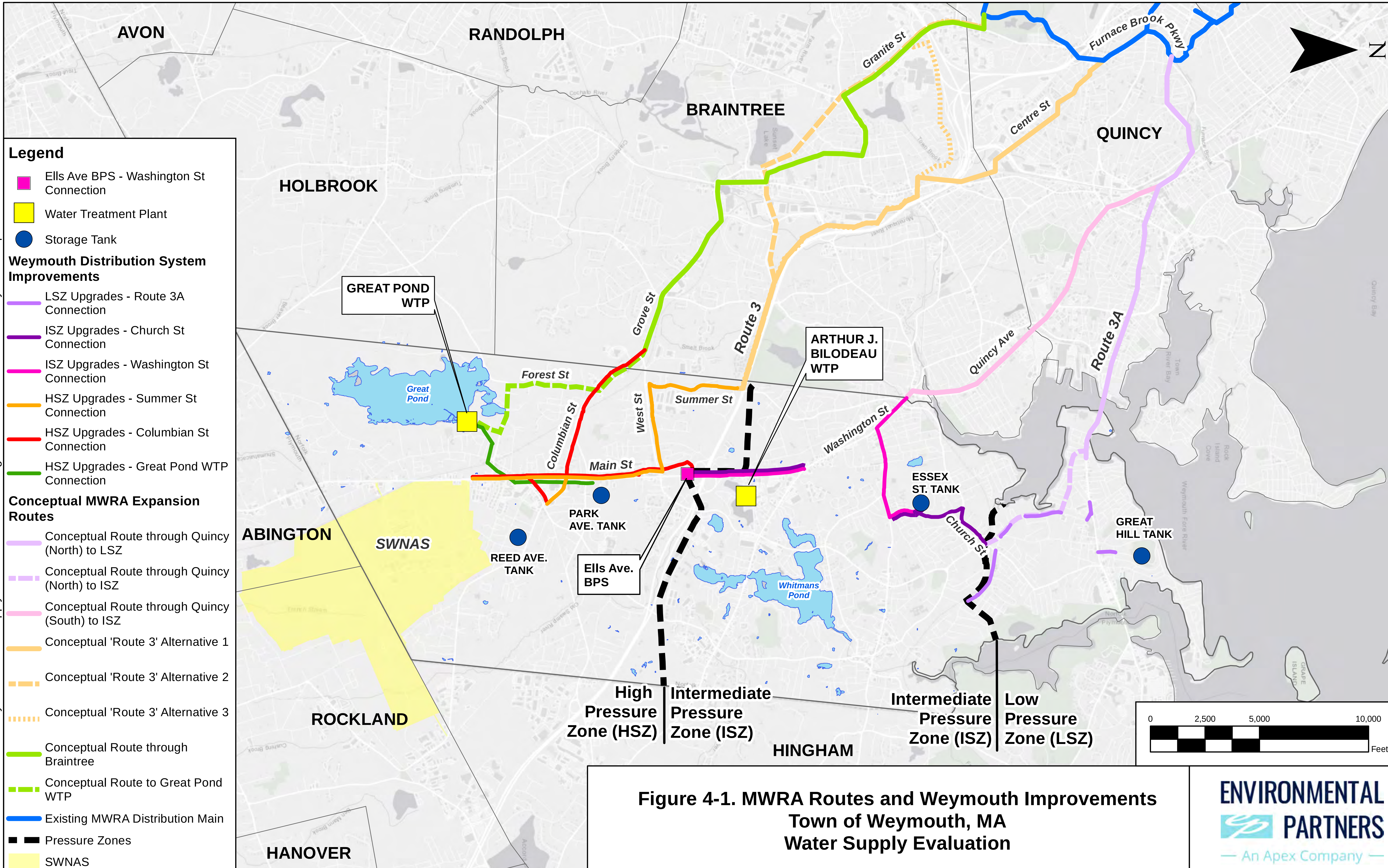


Figure 4-1. MWRA Routes and Weymouth Improvements
Town of Weymouth, MA
Water Supply Evaluation

I:\SSTTDC.290\290-2104 Weymouth Water Supply Eval\04 GIS\Memo 4\Figure 1 - MWRA Routes and Weymouth Improvements.mxd

Section 4.2.1 Conceptual Route through Quincy (North) to Weymouth Low Service Zone

MWRA Conceptual Route

This route ties into MWRA Section 22 at Adams Street and Furnace Brook Parkway in Quincy. It includes approximately 20,000 feet of main traveling south through Quincy along Adams Street and Washington Street (Route 3A) and crossing the Fore River to connect to Weymouth in the Low Service Zone. This alternative will require construction of two MWRA pump stations along the route to maintain the required hydraulic grade line for servicing Weymouth. Connection to Weymouth's LSZ will require operation of a pressure reducing valve.

Weymouth System Improvements

There are significant lengths of unlined cast iron water mains along critical transmission pathways between the point of connection, the Great Hill tank, and the furthest reaches of the zone. EP recommends the Town consider replacing approximately 7,000 feet cast iron mains in the LSZ as part of the alternative.

Transferring the LSZ to the MWRA system under this alternative is insufficient to offset the entirety of the projected increased demands in Weymouth. EP estimates that this alternative would extend the existing 5.0 MGD allowable withdrawal until approximately 2030.

Section 4.2.2 Conceptual Route through Quincy (North) to Weymouth Intermediate Service Zone

MWRA Conceptual Route

This route ties into MWRA Section 22 at Adams Street and Furnace Brook Parkway in Quincy. It includes approximately 20,000 feet of main traveling south through Quincy along Adams Street and Washington Street (Route 3A) and crossing the Fore River to enter Weymouth. Once in Weymouth, the main would extend an additional 10,000 feet along Bridge Street, Evans Street and Norton Street to connect to the ISZ at the Church Street PRV. This alternative will require construction of two MWRA pump stations along the route to maintain the required hydraulic grade line for servicing Weymouth.

Weymouth System Improvements

In order to maintain the existing level of service, EP recommends the Town replace 6,200 feet of 10-inch, 12-inch and 16-inch cast iron mains on Church Street, Commercial Street and Essex Street with 16-inch ductile iron water mains. To maintain existing available fire flows in the ISZ, the Town would continue to utilize the existing PRVs at the HSZ/ISZ boundary.

Additionally, meeting the entirety of the projected 2040 demands in the HSZ would require a booster pumping station (BPS) at Ells Avenue to provide water from the MWRA-supplied ISZ to the HSZ. EP recommends the Town replace the unlined cast iron upstream of this proposed BPS on

Washington Street and Main Street with 16-inch ductile iron water main. This approach would require an additional 5,400 feet of 16-inch DI water main, bringing the total pipe replacement length to 11,600 feet for this alternative.

Section 4.2.3 Conceptual Route through Quincy (South) to Weymouth Intermediate Service Zone

MWRA Conceptual Route

This route begins at MWRA Section 22 at Adams Street and Furnace Brook Parkway in Quincy. It traverses approximately 23,100 feet through Quincy, heading south along Adams Street and Quincy Avenue, passing through a small portion of northern Braintree, and connects to Weymouth in the ISZ on Washington Street. To meet the Town of Weymouth's hydraulic grade line requirements, this route requires construction of two MWRA pump stations.

Weymouth System Improvements

In order to maintain the existing level of service, EP recommends the Town replace 4,300 feet of 12-inch and 16-inch cast iron mains on Washington Street, Broad Street and Essex Street with 16-inch ductile iron water mains. To maintain existing available fire flows in the ISZ, the Town would continue to utilize the existing PRVs at the HSZ/ISZ boundary.

Additionally, meeting the entirety of the projected 2040 demands in the HSZ would require a booster pumping station (BPS) at Ells Avenue to provide water from the MWRA-supplied ISZ to the HSZ. EP recommends the Town replace the unlined cast iron upstream of this proposed BPS on Washington Street and Main Street with 16-inch ductile iron water main. This approach would require an additional 5,400 feet of 16-inch DI water main, bringing the total pipe replacement length to 9,700 feet for this alternative.

Section 4.2.4 Conceptual Route 3 Alternative Routes to High Service Zone

MWRA Conceptual Route

The MWRA proposed three alternative routes to connect Weymouth utilizing the Route 3 corridor. All three alternatives will connect to Weymouth in the High Service Zone at Summer Street.

'Route 3' Alternative 1

This route connects to MWRA's Section 22 at Furnace Brook Parkway and Copeland Street in Quincy and traverses approximately 25,000 feet to Weymouth's HSZ at Summer Street. It runs south along Centre Street to Burgin Parkway, crossing near the Adams MBTA Station. The main crosses the MBTA tracks toward Independence Avenue and then runs south to cross over either Route 3 MBTA tracks or under Washington Street, entering Braintree. Once within Braintree, the main runs along narrow streets adjacent to Route 3, before crossing the MBTA tracks and the Union Street rotary. South of Union Street, the main runs along the Route 3 abutment before connecting into

Weymouth's HSZ at Summer Street. This route requires one MWRA pump station to meet hydraulic requirements.

'Route 3' Alternative 2

This route connects to MWRA's Section 22 in the Blue Hills Reservation, adjacent to the Pine Hill Cemetery off of Granite Street, and traverses approximately 23,400 feet to Weymouth's HSZ at Summer Street. The route runs south through Braintree along Granite Street, under Route 93 to Braintree 5 corners. It then continues along Franklin Street to Pearl Street, following Pearl Street under the MBTA tracks until the abutment of Route 3, at which point it would follow the same alignment as Alternative 1, connecting into Weymouth's HSZ at Summer Street.

'Route 3' Alternative 3

This route connects to MWRA's Section 22 in the Blue Hills Reservation, adjacent to the Pine Hill Cemetery off of Granite Street, and traverses approximately 26,800 feet to Weymouth's HSZ at Summer Street. The route runs along Granite Street, under Route 93 and turns east to follow the road around South Shore Plaza to Washington Street in Braintree. Once the pipeline crosses Washington Street, it follows the same alignment as Alternative 1, connecting into Weymouth's HSZ at Summer Street.

Weymouth System Improvements

EP assumes in the three 'Route 3' alternatives that the Town's existing supplies would be deactivated under normal operating conditions. Facilitating a connection at Summer Street while preserving system performance would necessitate the installation of a 30-inch water main from the connection to West Street and from West Street to Main Street. A 20-inch water main would extend along Main Street to Columbian Street/Union Street. A 16-inch water main would also extend further south along Main Street to Shea Drive. The overall length of upgrades required is approximately 18,800 feet.

Section 4.2.5 Conceptual Route through Braintree to High Service Zone

MWRA Conceptual Route

This route connects to MWRA's Section 22 in the Blue Hills Reservation adjacent to the Pine Hill Cemetery on Granite Street. It runs through Braintree along Granite Street and other local roads before reaching Weymouth's HSZ at Columbian Street. At this location, there are two alternatives that EP considered: (1) connect to the Weymouth system at Columbian Street or (2) continue the MWRA pipeline to the Great Pond WTP and utilize the WTP as a pump station.

Braintree Alternative 1 – Terminating at Columbian Street

This alternative will supply the entirety of the Town's water system demands via a new connection to the MWRA system which terminates at Columbian Street in Weymouth's HSZ.

Braintree Alternative 2 – Extension to Weymouth's Great Pond WTP

This alternative will supply the entirety of the Town's water system demands via a new connection from the MWRA system into the Great Pond WTP clearwell. Once MWRA main reaches the HSZ at Columbian Street, it travels east to Forest Street, following local roads to reach Elwood Drive at the rear entrance of the Great Pond WTP. This route does not require any pump station as the Great Pond WTP finished water pumps will serve this function. Upgrades to the WTP Pumps and modifications to the WTP are required to provide full pumping redundancy for Weymouth buildout conditions and accommodate the MWRA pipeline.

Weymouth System Improvements

Braintree Alternative 1 – Terminating at Columbian Street

It is assumed in this alternative that the Town's existing supplies would be deactivated under normal operating conditions. To support this supply, this alternative would require approximately 18,500 feet of water main upgrades in the HSZ along Columbian Street and Main Street. This includes a 30-inch ductile iron water main from the point of connection on Columbian Street until Main Street; a 16-inch DI main on Main Street extending north to the Ells Avenue PRV and south to Shea Drive; and a 16-inch DI main along Pleasant Street to increase the hydraulic carrying capacity between Main Street and Union Street.

Braintree Alternative 2 – Extension to Weymouth's Great Pond WTP

It is assumed in this alternative that the Town's existing supplies would be deactivated under normal operating conditions. To meet the performance of the existing system, this alternative would require approximately 8,000 feet of water main upgrades in the HSZ. A 24-inch ductile iron water main would need to extend from the WTP, and along parts of Derby Street and Pond Street to Main Street. From there, a 16-inch DI main needs to extend north until the Park Avenue Tank.

SECTION 4.3 CAPITAL COSTS

Conceptual-level opinions of probable project cost for distribution system improvements under the various MWRA supply scenarios are presented in Table 4-1. Costs are presented in January 2022 dollars and include an allowance of 20% for engineering services and 25% for contingency.

The total projected costs for each connection scenario are presented in Table 4-1.

Table 4-1: Opinion of Probable Cost for MWRA Supply to Weymouth Alternatives

MWRA Supply Scenario & Weymouth Improvements	Weymouth System Improvement Costs	MWRA Extension Costs	Total
Quincy (North) + LSZ Water Main Upgrades	$3,650,000	$51,850,000	$55,500,000
Quincy (North) to ISZ+ ISZ Water Main Upgrades	$11,360,000	$70,788,000	$82,148,000
Quincy (South) + ISZ Water Main Upgrades & BPS	$12,590,000	$56,871,000	$69,341,000
Rt. 3 Alt. 1 + HSZ Upgrades - Summer Street	$30,328,000	$63,357,000	$93,685,000
Rt. 3 Alt. 2 + HSZ Upgrades - Summer Street	$30,328,000	$50,876,000	$81,204,000
Rt. 3 Alt. 3 + HSZ Upgrades - Summer Street	$30,328,000	$60,515,000	$90,843,000
Braintree Alt. 1 + HSZ Upgrades - Columbian Street	$26,599,000	$58,205,000	$84,804,000
Braintree Alt.2 + HSZ Upgrades - Great Pond WTP Connection	$16,190,000	$71,300,000	$87,490,000

SECTION 4.4 CONCLUSIONS & RECOMMENDATIONS

All proposed alternatives possess unique design, permitting, and operational challenges that must be considered. A summary of these challenges is presented in Table 4-2.

Table 4-2: Summary of MWRA Supply Alternatives to Weymouth

Alignment Alternative	Capacity Increase	Compatibility with Weymouth CIP Goals	Compatibility with Weymouth Environmental Goals	Design, Permitting and Construction Challenges	Resident / Business Impacts	Capital Cost
Quincy (North) + LSZ	1.65 MGD Shortfall	Medium – Compatible with Town's long term infrastructure goals to replace cast iron pipe.	Low – Does not allow phasing out Town's water supply sources.	Medium – Shortest MWRA route crossing single community; directional drilling of Fore River required.	Medium – MWRA extension is along commuter route; 7,000 LF pipe replacements in Weymouth.	$55.5M
Quincy (North) + ISZ	No Shortfall	Medium – Compatible with Town's long term infrastructure goals to replace cast iron pipe.	Medium – Allows phased approach to deactivation of Weymouth's supply.	Medium – Route crossing single community; directional drilling of Fore River required.	Medium – MWRA extension is along commuter route; > 20,000 LF pipe construction in Weymouth.	$82.1M
Quincy (South) + ISZ	No Shortfall	High – Incorporates high priority water main replacements on Washington Street.	Medium – Allows phased approach to deactivation of Weymouth's supply.	Medium – Second shortest MWRA route; crosses two communities.	Medium – MWRA extension is along commuter route; 9,700 LF pipe replacements in Weymouth.	$69.3M
Rt. 3 Alt. 1 - 3 + HSZ at Summer Street	No Shortfall	Medium – Compatible with Town's long term infrastructure goals to replace cast iron pipe.	High – Allows for immediate deactivation of Weymouth's supply.	High –Multiple highway and railroad crossings, high quantities of rock removal anticipated.	High – Approx. 8 mile long work zone in high traffic area and local streets.	$81.2 – $93.7M
Braintree Alternative 1 + HSZ at Columbian Street	No Shortfall	Medium – Compatible with Town's long term infrastructure goals to replace cast iron pipe.	High – Allows for immediate deactivation of Weymouth's supply.	Medium – Longest MWRA route; crosses single community; MBTA crossing in Weymouth.	High – Approx. 8 mile long work zone in high traffic area and local streets.	$84.8M
Braintree Alternative 2 + HSZ at GPWTP	No Shortfall	Medium – Compatible with Town's long term infrastructure goals to replace cast iron pipe.	High – Allows for immediate deactivation of Weymouth's supply.	Medium – Longest MWRA route; crosses single community.	High – Approx. 8 mile long work zone in high traffic area and local streets.	$87.5M

Although the Quincy North alignment and LSZ connection has the lowest overall cost and community impact, it does not offer any compatibility with Town's long-term goal to replace the existing water supply with MWRA supply. By implementing this alternative, the Town will only delay their supply deficit and face additional infrastructure improvements to supply water to the HSZ and ISZ.

The Quincy North alignment and ISZ connection allows for full buildout conditions at a comparable overall cost and with comparable impacts when compared to the HSZ connections but has the advantage of only crossing one neighboring community. This option allows for a phased approach as supplemental supply to the HSZ from the Ells Avenue BPS would not be required until projected flows in South Weymouth are realized. This alternative also allows a phased approach to meet the Town's goals of deactivating the WTPs.

The Quincy South alignment and ISZ connection allows for full buildout conditions at a lower overall cost and lower impacts to the surrounding communities compared to the HSZ connections. This option also allows for a phased approach as supplemental supply to the HSZ from the Ells Avenue BPS would not be required until projected flows in South Weymouth are realized. This alternative also allows a phased approach to meet the Town's goals of deactivating the WTPs.

The Route 3 alignment alternatives have the highest capital cost and highest level of construction and permitting risk but provide an immediate transition from Weymouth supply to MWRA supply for the entire Town. The Summer Street connection in Weymouth requires the greatest level of hydraulic improvements within the Town to maintain the current level of service, including almost 9,000 feet of water main upgrades on Main Street (Route 18).

Similar to the Route 3 alignments, the Braintree alternative alignments provide an immediate transition from Weymouth supply to MWRA supply for the entire Town but have a higher community impacts and capital cost because of the alignment length. Both Braintree alternatives utilize local roads and present less construction and permitting challenges than the Route 3 alternatives.

EP recommends that the Town pursue the Quincy North to ISZ Connection alignment, Quincy South alignment and the Braintree alignment alternatives. The Quincy South alignment and connection to the ISZ at Washington Street meets the Town of Weymouth's water supply goals at the lowest projected cost and provides added flexibility by allowing a phased approach to water system modifications. The Quincy North to ISZ alignment provides similar benefits to the Quincy South alignment but could avoid mitigation costs in Braintree that outweigh the costs of the additional transmission main. The Braintree alignment alternatives also meet the Town's supply goals at lower cost and lower risk than the Route 3 alternatives. EP recommends additional analysis to determine the modifications required to convert the Great Pond WTP to a pump station for the MWRA supply.

For all alternatives presented, MWRA supply redundancy cannot be achieved without a second MWRA pipeline constructed as part of a larger regional MWRA South Shore expansion. Interconnections with neighboring Towns cannot meet Weymouth's summer demands and are not sufficient as a redundant source of water for the constructed MWRA alignment from Quincy or Braintree. As a result, the Great Pond WTP cannot be decommissioned until a regional MWRA expansion is completed.

SECTION 5 WEYMOUTH SEWER MODEL UPDATES AND CAPACITY ANALYSIS

EP prepared this section to evaluate the hydraulic capacity of the Weymouth sewer collection system. This section presents the findings from the evaluation and provides improvement recommendations for capacity upgrades to accommodate the Town's projected growth.

SECTION 5.1 BACKGROUND

Section 5.1.1 Weymouth Sewer Collection System

The majority of the Weymouth sewer system was built between 1947 and 1980. This system contains approximately 200 miles of sewer mains and approximately 4,880 manholes that are operated and maintained by the Town of Weymouth's Sewer Division. Wastewater flows collected by the Town's system are discharged into the Massachusetts Water Resources Authority (MWRA) system. Once the flow enters into the MWRA system, it travels through either the Intermediate Pump Station or the Braintree-Weymouth Replacement Pump Station and continues to the Deer Island Wastewater Treatment Plant. The Weymouth sewer system contains 11 flooded suction pump stations, 1 suction lift pump station and 18 submersible pump stations. Average daily flow (ADF) of wastewater in Weymouth varies annually based on rainfall. In 2020, the ADF was approximately 7.41 million gallons per day (MGD).

The wastewater collection system is divided into six sub-basins as shown on Figure 5-1. These sub-basins converge flow into five main trunk lines (interceptors) that discharge directly into the MWRA. The MWRA designates the Weymouth interceptor connection points by Sanitary Drainage Areas (SDAs) as shown in Table 5-1.

Table 5-1: Weymouth Sanitary Drainage Areas

Interceptor Basin	Sanitary Drainage Area
Mill River	SDA 4
Old Swamp River	
Lower Central	
Landing	SDA 2 (2 discharge points)
North Weymouth	SDA 6, 8 & 9
Southeast	SDA 5

Section 5.1.2 SWNAS

The Town of Weymouth currently has a memorandum of agreement (MOA) with the SRA that agrees to provide up to 540,000 gpd of sewer capacity to SWNAS. Sewer meter data from September through December 2021 indicates an average flow of approximately 407,000 gpd. Existing water usage from the development is currently approximately 100,000 gpd. The difference between metered water and sewer flows indicates infiltration/inflow (I/I) of over 300,000 gpd in the SWNAS collection system.

Sewer service is critical to support SWNAS redevelopment. Wastewater demand projections are presented in Table 5-2 below, totaling 2.202 MGD by 2040. This flow assumes 0.24 MGD of water consumptive losses (10% of total water demand from research, development, and manufacturing). Typical I/I allowances for determining sewer flows of 500 gallons per day per inch-diameter mile (gpd/idm) for new pipes are also included in Table 5-2. EP assumed that the existing average infiltration rate from the SWNAS development of 0.31 MGD will be reduced to 0.016 MGD before any sanitary flow is added. Projected SWNAS I/I rates are based on an additional 52 inch-diameter miles of sewer being constructed within the development for full buildout (Total of 83 idm). The additional sewer I/I allowance was added proportionally relative to projected SWNAS sewer demand through 2040.

Table 5-2: SWNAS Projected Sewer Flow

Year	SWNAS Projected Finished Water Demand (MGD)	SWNAS Projected Sewer Demand (MGD)	SWNAS Estimated Infiltration Allowance (MGD)
2025	0.20	0.18	0.018
2030	0.80	0.72	0.024
2035	1.30	1.17	0.030
2040	2.40[2]	2.16	0.042

1. Includes 1.6 MGD in Weymouth and 0.8 MGD in Abington and Rockland

In addition, development within the Town of Weymouth (outside of SWNAS) is projected to increase sewer loading to the collection system by approximately 0.46 MGD by 2040.

SECTION 5.2 CAPACITY ASSESSMENT

The Town of Weymouth's sewer collection system model was originally created by EP in 2009 and calibrated using system-wide flow metering data from April through June 2008. The Town recently completed system-wide flow metering in April 2021 and EP used the data to update and recalibrate the hydraulic model for the sewer collection system and simulate hydraulic conditions during a 1-yr, 6-hr storm event and a 5-yr, 24-hr storm event. The hydraulic model was updated using SewerGEMS V8i by Bentley Systems Inc. DEP guidelines require that the Sanitary Sewer Overflows (SSOs) do not occur during the 5-yr, 24-hr storm event. The Town has additionally instituted the requirement that gravity sewer pipes and pump stations maintain 20% reserve hydraulic capacity during a 1-Yr, 6-Hr storm event.

Section 5.2.1 Model Update and Calibration

Physical Data

The model incorporates the following information:

- Gravity sewers – nominal diameters, length, materials, and Manning's roughness coefficients
- Sewer manholes – pipe invert elevations, rim elevations and structure diameter
- Sewer force mains – nominal diameters, materials, and Hazen-Williams roughness C-values
- Pumping Stations – pump discharge rates and operating ranges for 30 pump stations throughout the Town.

The gravity sewer, sewer manhole and force main physical data was initially based on the Towns GIS data and supplemented with available sewer record drawing information for improvements completed since 2009. All elevations were adjusted to match the Town of Weymouth's vertical datum.

Flow Metering

Weymouth installed 32 temporary sewer flow meters in March through June 2021 as part of the Town's ongoing infiltration and inflow (I/I) reduction program. These 32 temporary meters were supplemented by four permanent meters to analyze the flow from 31 sewer subareas. Excerpts from the Town's 2021 flow metering program are included as an attachment to this memorandum, including flow meter locations.

Model Stability

Continuity error is a measure of model stability and represents the balance error of total inflows into the system, outflows, flow losses due to overflows, and volume changes. A model that operates at a continuity error of 5% or less is typically considered stable. The model operates at a continuity error between 0.3% - 3.9% and is considered stable.

Dry Weather Calibration

The model was calibrated for dry weather conditions based on the dry weather flow (DWF) metering data. Dry weather days are defined as the days following at least three (3) consecutive days without rainfall. Dry weather calibration results are attached to this memorandum for the 36 flow meter locations. The average dry weather flow DWF during the metering period (March through June) was 9.07 MGD. The metering period occurred in the high groundwater season during which dry weather flows are generally at the highest levels, which should be the conditions considered in a capacity analysis.

In general, a proportional adjustment to the base flow (sanitary and infiltration) loads was made to all sewer wet wells and manholes that had an assigned base loading in the model. Using the 2021

DWF data, a base infiltration flow for each metered sub-area was calculated as 88% of nighttime flow between the hours of midnight and 5 AM. During these low flow hours, EP assumed 12% of the total flow to be legitimate sanitary flow. After subtracting infiltration, remaining sanitary flow was then averaged for each subarea and used to create hourly multipliers for input as daily flow patterns.

Wet Weather Calibration

The model was calibrated for wet weather conditions based on the flow metering data collected during the April 15-16, 2021 rainfall event. This storm event had total rainfall depth of 2.88 inches and was the best representation of a wet weather event during high groundwater conditions. Wet weather calibration consisted of establishing a tributary sewershed for each meter and assigning hydrographs using the RTK method to which mimics short-, medium- and long-term inflow responses. Figures comparing flow meter data to model output at each flow meter location during the wet weather storm event are included as an appendix to this report.

Section 5.2.2 Hydraulic Analysis

Baseline Information and Model Settings

EP used the following key model parameters as the baseline settings for this sewer model update:

- Numerical Solver – Implicit SewerGEMS Dynamic Wave Solver
- Routing Time Step - 1 minute
- Routing Method – Dynamic Wave
- Output Increment – 15 minutes
- SWMM Hydrologic time step – 30 minutes

Additional Baseline Model Settings

- MWRA outfall hydraulic conditions were simulated as a free discharge. The goal of this evaluation is to determine hydraulic restrictions in the Weymouth collection system prior to being discharged to the MWRA.
- Future SWNAS infiltration was modeled based on future sewer infrastructure buildout plans provided by the developer and a design I/I value of 500 gpd/idm. EP assumed that the existing 0.31 MGD average infiltration rate would be reduced to 0.016 MGD before any sanitary flow is added. Existing SWNAS sanitary flow was approximated at 0.10 MGD based on billed water usage.
- Future Weymouth flows (0.46 MGD) were included in all simulations including existing conditions.

Buildout Projections

The following scenarios were simulated to evaluate the hydraulic performance of the Weymouth Collection System during the 1-yr, 6-hr and 5-yr, 24-hr Storm Events.

Table 5-3: Projected Sewer Flow

Scenario	Additional Weymouth Sanitary Flow	Total SWNAS Flow	Total Additional Sanitary Flow
Existing Conditions	0.46 MGD	0.10 MGD	0.46 MGD
SWNAS 25% Buildout	0.46 MGD	0.540 MGD	0.90 MGD
SWNAS 38% Buildout	0.46 MGD	0.810 MGD	1.17 MGD
SWNAS 50% Buildout	0.46 MGD	1.080 MGD	1.44 MGD
SWNAS 67% Buildout	0.46 MGD	1.440 MGD	1.80 MGD
SWNAS 83% Buildout	0.46 MGD	1.800 MGD	2.16 MGD
SWNAS Full Buildout	0.46 MGD	2.160 MGD	2.52 MGD

For the SWNAS buildout simulations, all SWNAS flows were simulated as pump station discharges. EP assumed that all flow would be discharged to the existing force main discharge location on Liberty Street (Old Swamp River (OSR) Interceptor) up to the 25% buildout scenario. Additional modeled flow from subsequent buildout phases discharged to Main Street, approximately 800 feet south of Shea Drive (Mill River (MR) Interceptor). Table 5-4 summarizes SWNAS flows by Interceptor and the simulated pump station discharge rates based on TR-16 peak flow guidelines.

Table 5-4: SWNAS Discharge Summary

Scenario	Sewer ADF (MGD)	ADF to OSR Interceptor	ADF to MR Interceptor	Simulated OSR PS Capacity	MR PS Capacity
Existing Conditions	0.100	0.10	-	0.390[1]	-
5.4 - SWNAS 25% Buildout	0.540	0.54	-	2.28	-
8.1 - SWNAS 38% Buildout	0.810	0.54	0.270	2.28	0.98
10.8 - SWNAS 50% Buildout	1.080	0.54	0.540	2.28	1.84
14.4 - SWNAS 67% Buildout	1.440	0.54	0.900	2.28	2.91
18.0 - SWNAS 83% Buildout	1.800	0.54	1.260	2.28	3.86
21.6 - SWNAS Full Buildout	2.160	0.54	1.620	2.28	4.64

1. Existing PS Capacity

Hydraulic Analysis Results

A summary of pipe segments with less than 20% reserve capacity during a 1-yr, 6-hr storm for the scenarios above are presented in Figures 5-2 through 5-8.

Manhole Freeboard and SSO Risk

EP established the following criteria for evaluating the risk associated with the occurrence of a SSO at each surcharged manhole:

- High Risk: Less than 4' of available freeboard
- Medium Risk: 4' – 10' of available freeboard
- Low Risk: Greater than 10' of available freeboard

Figure 5-9 shows all simulated surcharged manholes under existing conditions during a 5-yr, 24-hr storm event. Surcharged manholes are categorized into high, medium and low SSO risk based on the criteria above.

Libbey Parkway Pump Station

Since the proposed flows entering the Old Swamp River Interceptor will collect at the Libbey Parkway Pump Station, the capacity of this station was assessed for the 25% SWNAS Buildout Scenario. The proposed flows tributary to the pump station are presented in Table 5-5.

Table 5-5: Libbey Parkway Pump Station Capacity

Scenario	Peak Instantaneous Flow	Pump Station Existing Capacity (with 20% reserve)[1]
5.4 - SWNAS 25% Buildout, Dry Weather	1.66 MGD	6.0 MGD[1]
5.4 - SWNAS 25% Buildout, 1-Yr, 6-Hr Storm	2.52 MGD	
5.4 - SWNAS 25% Buildout, 5-Yr, 24-Hr Storm	3.23 MGD	

1. 7.488 MGD Capacity X 80% = 6.0 MGD

SECTION 5.3 CONCLUSIONS AND RECOMMENDATIONS

Refinement of base flows, physical attribute data, wet weather storm response and pump station operation for the Weymouth sewer model has increased the accuracy of both the model's flow output and hydraulic performance analysis results.

Existing infiltration within the SWNAS development is approximately triple the rate at which MassDEP considers warranting further investigation. EP understands that the SRA suspects a single defect at the SWNAS Pump Station No. 1 wetwell is the source of the majority of infiltration. All recommendations in this analysis are dependent upon reducing the SWNAS infiltration to 0.016 MGD and maintaining infiltration levels at 500 gpd/idm.

Model simulation output shows that under existing conditions (assuming SWNAS I/I is reduced to 500 gpd/idm), three gravity sewer areas exceed the 20% reserve capacity threshold during a 1-Yr, 6-Hr storm event including:

- 30-inch Lower Central Interceptor between Commercial Street and the MBTA Crossing (1,150 lf)
- 30-inch Lower Central Interceptor on Essex Street between Longwood Road and Old Country Way (2,600 lf)
- 8-inch gravity sewer on Liberty and Union Streets at the existing SWNAS discharge (3,750 lf)

Sewer surcharging during a 5-yr, 24-hr storm event is generally minor to moderate. There are three primary areas of surcharging, including:

- Lower Central Interceptor along the Tide Mill Brook Marsh between Commercial Street and the MBTA Railroad crossing. The existing 30-inch pipe in this area is undersized as discussed above and as shown in Table 5-6.
- Lower Central Interceptor between Washington Street and Essex Street. The existing 30-inch pipe on Essex Street is undersized as discussed above and as shown in Table 5-6 and causes upstream surcharging.
- Seaver Street between the Washington Street and the Seaver Street Pump Station. Simulations show that the 5-yr, 24-hr storm event peak flow (approximately 630 gpm) exceeds the pump station capacity of 400 gpm.

Simulations show that the Weymouth collection system currently meets the MassDEP recommendation to transport the 5-yr, 24-hr storm without the occurrence of an SSO.

The Libbey Parkway PS has sufficient capacity to handle proposed flows from the 25% SWNAS buildout scenario. Under the 25% SWANAS buildout scenario, simulations show a nominal increase of peak flow to the PS to 3.23 MGD (54% capacity).

EP recommends further investigation of the Seaver Street pump station for evidence of surcharging during wet weather events. Sewer rehabilitation efforts in this subarea (Meter 2980) should be monitored for effectiveness and considered as part of further evaluation to determine if a pump station upgrade is warranted.

As shown in Figures 5-2 through 5-8, the incremental proposed flow increases from SWNAS result in additional pipe segments crossing the 20% reserve capacity threshold during a 1-Yr, 6-Hr storm. At full buildout of the SWNAS development (Figure 5-8), approximately 11,950 linear feet of 8-inch through 24-inch sewer needs to be upgraded in addition to the upgrades required under existing conditions. Undersized sewer pipes are summarized in Table 5-6.

Table 5-6: Sewers >80% Capacity with Proposed SWNAS Flows

Scenario	SWNAS Sewer ADF (MGD)	Upgrade Location	Upgrade Length (LF)	Existing Sewer Dia.
Existing Conditions	0.090	LCI – Tide Mill Brook Marsh (Commercial Street to MBTA)	1,150	30-inch
		LCI – Essex Street	2,600	30-inch
		Liberty & Union Streets	3,750	8-inch
5.4 - SWNAS 25% Buildout	0.540	-	-	-
8.1 - SWNAS 38% Buildout	0.810	Main Street Easement	500	8-inch
10.8 - SWNAS 50% Buildout	1.080	-	-	-
14.4 - SWNAS 67% Buildout	1.440	Mill Street / Easement to Columbian (3A)	5,850	21-inch
		Easement - Columbian Street Main Street (3B)	5,600	15 / 21 - inch
18.0 - SWNAS 83% Buildout	1.800	-	-	-
21.6 - SWNAS Full Buildout	2.160	-	-	-

Section 5.3.1 Hydraulic Analysis of Recommended Improvements

Improvement Scenarios

EP created scenarios in the model to evaluate the collection system for the 1-Yr, 6-Hr and 5-Yr, 24-Hr storm events at the various buildout stages shown in Table 5-4. The simulations included upgraded pipe diameters and pipe roughness values for pipe replacement sections. The collection system was evaluated based on maintaining 20% reserve capacity during a 1-Yr, 6-Hr storm and for SSOs during a 5-Yr, 24-Hr storm to determine the adequacy of the sewer improvements.

EP simulated improvements for the 100% SWNAS buildout scenario only, as the Town will require any upgrades to account for full buildout flows to avoid multiple improvements in the same location. The interim buildout simulations were used to determine sewer upgrade locations that correspond with proposed SWNAS flows. Table 5-7 and Figure 5-10 presents the model scenarios and assessment results. The Main Street Easement improvement under the 38% SWNAS buildout scenario will result in low velocities and will require more frequent maintenance by the Town prior to realization of the higher buildout scenarios.

Simulations show that the sewer improvements associated with the various SWNAS buildout phases do not result in any SSOs during a 5-Yr, 24-Hr storm, assuming the existing SWNAS I/I is reduced as described above.

Table 5-7: Required Sewer Upgrades for Proposed SWNAS Flows

Scenario	SWNAS Sewer ADF (MGD)	Upgrade Location	Upgrade Length (LF)	Existing Sewer Dia.	Proposed Sewer Dia.
Existing Conditions	0.090	LCI – Tide Mill Brook Marsh (Commercial Street to MBTA)	1,150	30-inch	42-inch
		LCI – Essex Street	2,600	30-inch	42-inch
		Liberty & Union Streets	3,750	8-inch	15-inch
5.4 - SWNAS 25% Buildout	0.540	-	-	-	-
8.1 - SWNAS 38% Buildout	0.810	Main Street Easement	500	8-inch	24-inch
10.8 - SWNAS 50% Buildout	1.080	-	-	-	-
14.4 - SWNAS 67% Buildout	1.440	Mill Street / Easement to Columbian (3A)	5,850	24-inch	30-inch
		Easement - Columbian Street Main Street (3B)	4,500	21-inch	30-inch
		Easement - Columbian Street Main Street (3B)	1,100	15-inch	24-inch
18.0 - SWNAS 83% Buildout	1.800	-	-	-	-
21.6 - SWNAS Full Buildout	2.160	-	-	-	-

A detailed summary of pipe capacities for Scenario 21.6 (SWNAS full buildout) under existing conditions and with proposed upgrades is shown in Table 5-9.

SECTION 5.4 CAPITAL COSTS

Budget level opinions of probable project cost for collection system improvements under the various SWNAS buildout scenarios are presented in Table 5-8. Costs are presented in July 2022 dollars and include 20% engineering and 30% contingency factors.

Table 5-8: Sewer Upgrades – Opinion of Probable Cost

SWNAS ADF (MGD)	Incremental Required Sewer Upgrade Length (LF)	Cumulative Required Sewer Upgrade Length (LF)	Location	Sewer Upgrade Cost per LF (Upgrade Dia.)	Total Sewer Upgrade Cost	Incremental Sewer Upgrade Cost Opinion	Cumulative Sewer Upgrade Cost Opinion
0.540	1,150	1,150	Tide Mill Brook Marsh (1A)	$5,500 (42")	$8.00M[2]	$27.93M	$28.68M
	2,600	3,750	Essex Street (1B)	$5,500 (42")	$14.30M		
	3,750	7,500[1]	Liberty and Union Streets (1C)	$1,700 (15")	$6.38M		
0.810	500	8,000	Main Street Easement (2)	$2,500 (24")	$1.25M	$1.25M	$29.93M
1.440	5,850	13,850	Mill Street / Easement to Columbian (3A)	$4,500 (30")	$26.33M	$26.33M	$56.26M
	5,600	19,450	Easement - Columbian Street Main Street (3B)	$4,500 (30") $2,500 (24")	$26.65M[3]	$26.65M	$82.91M

1. Improvements (7,500 LF) required under existing conditions.
2. Includes one (1) MBTA Railroad Crossing (150 LF) at $2.5M.
3. Includes two (2) MBTA Railroad Crossings (150 LF each) at $2.5M each.

SECTION 5.5 MWRA CONSIDERATIONS

As stated in the modeling assumptions, this analysis takes into account the capacity of Weymouth's collection system without regard for the hydraulic conditions at the Town's MWRA outfalls. Although the MWRA has recently completed a regional improvement project to the Weymouth-Braintree Interceptor System by adding the Intermediate Pump Station and replacing the Braintree-Weymouth pump station, elevated hydraulic grade line conditions at Weymouth's outfalls occur during wet weather events that may cause surcharging of the Weymouth system that is not shown in the results of this analysis. EP recommends that the Town and the SRA share the results of this analysis with the MWRA and consider further study using projected MWRA hydraulic grade line elevations from the MWRA's sewer model.

Table 5-9: Model Run #21.6 - 100% SWNAS Buildout

					A	B	= A / B		C	= A / C
Pipe Designation	Upstream Manhole	Downstream Manhole	Length (ft)	Dia. (in)	Modeled Peak Flow (gpm)	Existing Full Flow Capacity (gpm)	Modeled Peak Flow/Existing Full Capacity	Proposed Dia. (in)	Proposed Pipe Capacity (gpm)	Modeled Peak Flow/Proposed Pipe Capacity
P-1050	3087: 35-MH-4871	3112: 35-MH-4856	319.9	15	2,886	1,521	190%	21	**5,325**	54%
P-1049	3112: 35-MH-4856	3113: 35-MH-4830	317	15	2,865	1,746	164%	21	**6,115**	47%
P-1048	3113: 35-MH-4830	3114: 35-MH-4800	280.5	15	2,849	1,651	173%	21	**5,783**	49%
P-808	3114: 35-MH-4800	3115: MH-4779	168.8	15	2,837	2,612	109%	21	**9,147**	31%
P-647	3115: MH-4779	3144: MH-4775	171.5	15	2,936	1,213	242%	24	**7,700**	38%
P-646	3144: MH-4775	3147: MH-4776	53.3	22	2,941	3,120	94%	24	**7,134**	41%
P-645	3147: MH-4776	3148: MH-4772	192.2	22	2,915	2,903	100%	30	**6,453**	45%
P-644	3148: MH-4772	3149: MH-4757	154.6	22	2,870	2,822	102%	30	**6,288**	46%
P-643	3149: MH-4757	3150: MH-4732	265.7	22	2,900	2,750	105%	30	**8,076**	36%
P-2065	3150: MH-4732	3151: MH-4688	296.2	22	2,931	3,532	83%	30	**6,549**	45%
P-642	3151: MH-4688	3156: MH-4667	151.1	21	2,949	2,521	117%	30	**5,502**	54%
P-641	3196: MH-4660	3197: MH-4629	231.4	21	2,956	1,322	224%	30	**5,502**	54%
P-640	3197: MH-4629	3198: MH-4591	328.4	21	2,952	2,321	127%	30	**6,009**	49%
P-2064	3198: MH-4591	3199: MH-4551	328.4	21	2,950	2,387	124%	30	**6,179**	48%
P-639	3199: MH-4551	3209: MH-4506	320.2	21	2,940	2,351	125%	30	**6,087**	48%
P-638	3209: MH-4506	3245: MH-4466	197	21	3,087	2,430	127%	30	**6,289**	49%
P-637	3245: MH-4466	3246: MH-4444	125.1	21	3,071	2,621	117%	30	**6,786**	45%
P-2063	3246: MH-4444	3247: MH-4388	283	21	3,036	2,571	118%	30	**6,656**	46%
P-636	3247: MH-4388	3248: MH-4354	283.9	21	3,000	2,424	124%	30	**6,276**	48%
P-635	3248: MH-4354	3276: MH-4319	273	21	2,962	2,546	116%	30	**6,591**	45%

Weymouth Sewer Capacity Analysis
Table 5-9: Model Run #21.6 - 100% SWNAS Buildout

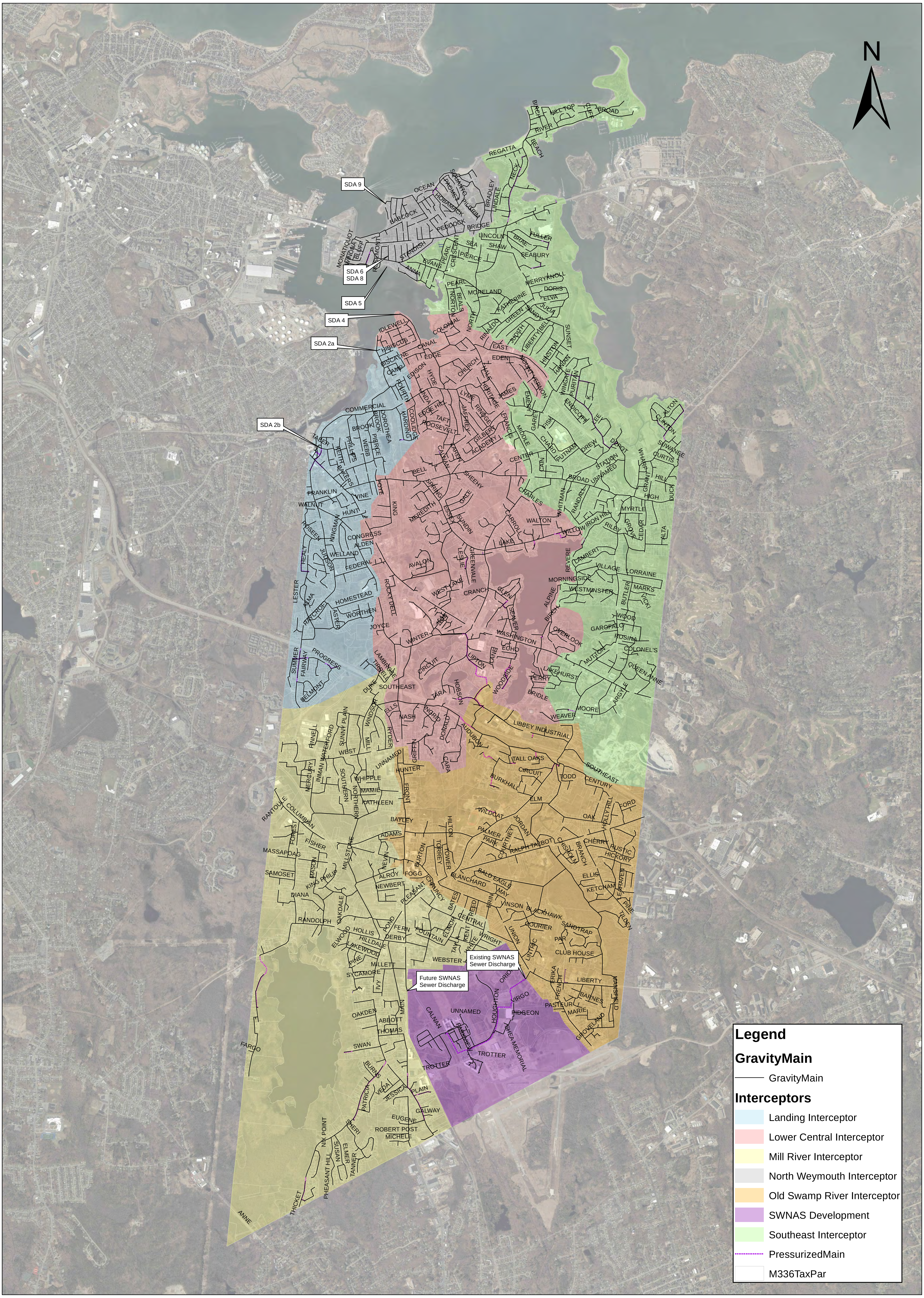
					A	B	= A / B		C	= A / C
Pipe Designation	Upstream Manhole	Downstream Manhole	Length (ft)	Dia. (in)	Modeled Peak Flow (gpm)	Existing Full Flow Capacity (gpm)	Modeled Peak Flow/Existing Full Capacity	Proposed Dia. (in)	Proposed Pipe Capacity (gpm)	Modeled Peak Flow/Proposed Pipe Capacity
P-634	3276: MH-4319	3278: MH-4274	242.6	21	2,925	2,283	128%	30	**5,909**	49%
P-2062	3278: MH-4274	3279: MH-4236	241.9	21	2,891	2,504	115%	30	**6,483**	45%
P-633	3279: MH-4236	3286: MH-4199	184.8	21	2,877	2,563	112%	30	**6,634**	43%
P-632	3286: MH-4199	3290: MH-4183	101.2	21	2,906	2,449	119%	30	**6,339**	46%
P-631	3290: MH-4183	3291: MH-4152	173.4	21	2,930	2,533	116%	30	**6,557**	45%
P-630	3291: MH-4152	3364: MH-4106	281.8	21	2,947	2,542	116%	30	**6,579**	45%
P-5852	3364: MH-4106	3365: MH-4074	288.7	21	2,962	2,330	127%	30	**6,032**	49%
P-5851	3365: MH-4074	3366: MH-4048	285.8	21	2,970	2,265	131%	30	**5,864**	51%
P-5850	3366: MH-4048	3367: MH-4037	220.3	21	3,079	2,443	126%	30	**6,323**	49%
P-5849	3367: MH-4037	3368: MH-4026	242.3	21	3,078	2,460	125%	30	**6,368**	48%
P-1965	3368: MH-4026	3374: MH-4006	265.6	21	3,078	3,086	100%	30	**7,988**	39%
P-1964	3374: MH-4006	3377: MH-3981	251	21	3,069	2,333	132%	30	**6,038**	51%
P-1963	3377: MH-3981	3380: MH-3963	282.1	21	3,059	2,432	126%	30	**6,296**	49%
P-1962	3380: MH-3963	3381: MH-3931	244	21	3,049	2,535	120%	30	**6,561**	46%
P-1961	3381: MH-3931	3384: MH-3900	268.7	21	3,037	2,603	117%	30	**6,738**	45%
P-1960	3384: MH-3900	3385: MH-3877	197.7	21	3,025	2,628	115%	30	**6,802**	44%
P-1959	3385: MH-3877	3406: MH-3861	134.4	21	3,015	2,453	123%	30	**6,351**	47%
P-1958	3406: MH-3861	3558: MH-3847	245.6	21	3,061	2,527	121%	30	**6,541**	47%
P-1957	3558: MH-3847	3562: MH-3836	81	21	3,071	2,499	123%	30	**6,469**	47%
P-1911	3562: MH-3836	3563: MH-3809	204.6	21	3,075	2,677	115%	30	**6,930**	44%

Table 5-9: Model Run #21.6 - 100% SWNAS Buildout

					A	B	= A / B		C	= A / C
Pipe Designation	Upstream Manhole	Downstream Manhole	Length (ft)	Dia. (in)	Modeled Peak Flow (gpm)	Existing Full Flow Capacity (gpm)	Modeled Peak Flow/Existing Full Capacity	Proposed Dia. (in)	Proposed Pipe Capacity (gpm)	Modeled Peak Flow/Proposed Pipe Capacity
P-1910	3563: MH-3809	3564: MH-3764	351.1	21	3,082	2,489	124%	30	**6,443**	48%
P-1908	3565: MH-3762	3566: MH-3725	273.4	21	3,088	2,581	120%	30	**4,555**	68%
P-1907	3566: MH-3725	3567: MH-3707	140.9	21	3,091	2,542	122%	30	**6,680**	46%
P-1906	3567: MH-3707	3583: MH-3683	164.3	21	3,092	2,661	116%	30	**6,887**	45%
P-1905	3583: MH-3683	3584: MH-3647	291.9	21	3,093	2,532	122%	30	**6,554**	47%
P-1902	3586: MH-3612	3587: MH-3588	182.8	21	3,093	2,522	123%	30	**16,416**	19%
P-1901	3587: MH-3588	3589: MH-3573	183.1	21	3,091	2,465	125%	30	**6,687**	46%
P-1900	3589: MH-3573	3601: MH-3580	207.8	21	3,090	2,563	121%	30	**6,530**	47%
P-6156	3737: 18-MH-5728	3738: 18-MH-5729	85.1	42	6,130.72	6,921.96	89%	Slope Adjusted	**6380.3**	96%
P-1692	3784: 18-MH-5716	3785: MH-5858	229.8	42	5,844.63	5,159.49	113%	Slope Adjusted	**6635.5**	88%
P-1663	2785: MH-5813	2786: MH-2111	330	30	6,170	4,753	130%	42	**11,658**	53%
P-6291	2786: MH-2111	2816: MH-2083	161.4	30	6,146	4,582	134%	42	**11,240**	55%
P-1662	2816: MH-2083	2817: MH-2002	387.4	30	6,102	4,677	130%	42	**11,471**	53%
P-1661	2817: MH-2002	2821: MH-1971	90	30	6,056	3,361	180%	42	**8,245**	73%
P-1660	2821: MH-1971	2822: MH-1929	174	30	6,022	4,413	136%	42	**10,825**	56%
P-1659	2822: MH-1929	2823: MH-1880	205.4	30	5,983	5,138	116%	42	**12,603**	47%
P-1658	2823: MH-1880	2824: MH-1816	330.8	30	5,901	5,161	114%	42	**12,659**	47%
P-8109	2824: MH-1816	3868: MH-1768	150.3	30	5,899	5,414	109%	42	**13,279**	44%
P-1656	3868: MH-1768	3869: MH-1717	293	30	5,897	6,178	95%	42	**15,153**	39%
P-3996	3869: MH-1717	3873: MH-1667	193.6	30	5,916	5,124	115%	42	**12,569**	47%

Table 5-9: Model Run #21.6 - 100% SWNAS Buildout

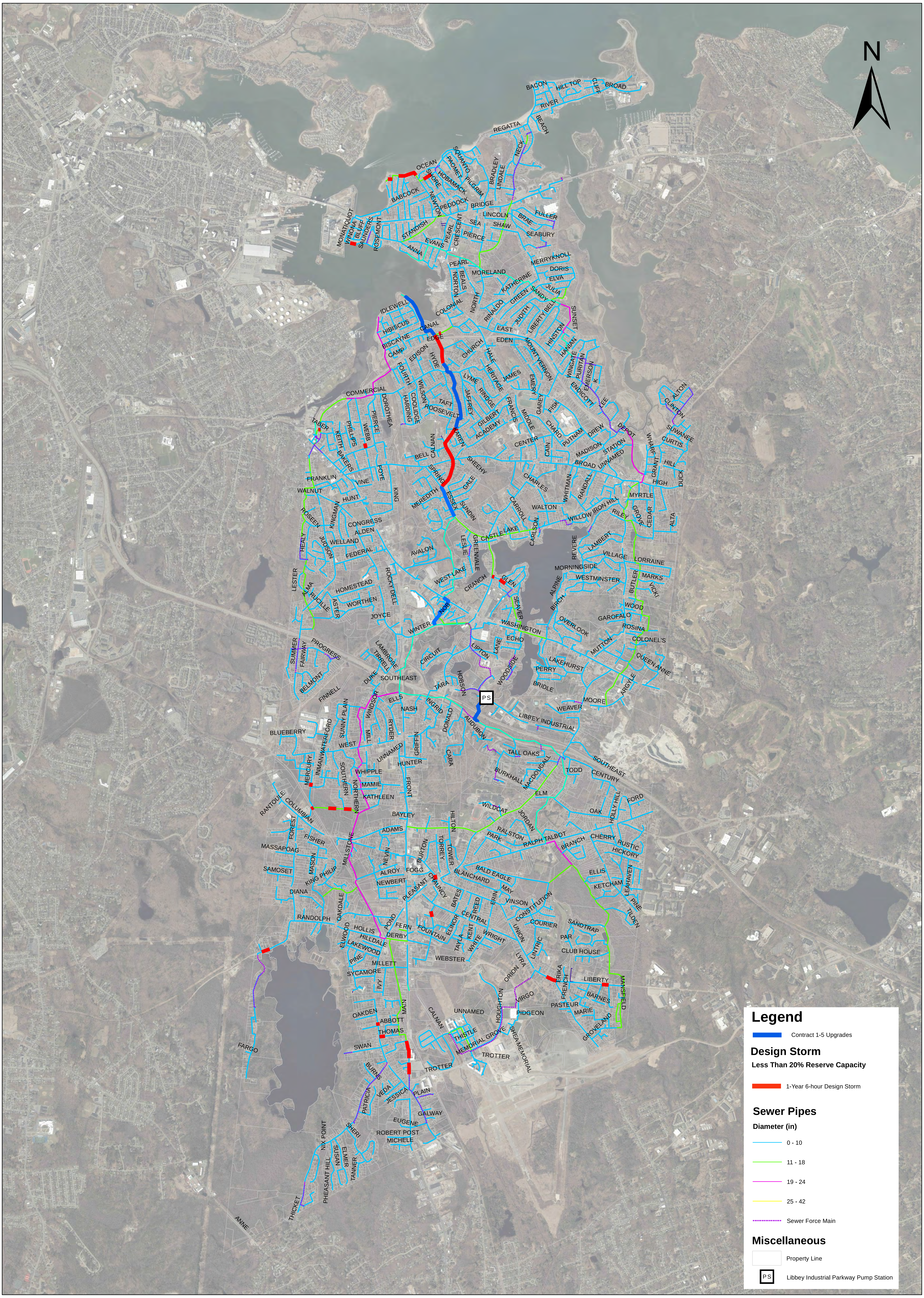
					A	B	= A / B		C	= A / C
Pipe Designation	Upstream Manhole	Downstream Manhole	Length (ft)	Dia. (in)	Modeled Peak Flow (gpm)	Existing Full Flow Capacity (gpm)	Modeled Peak Flow/Existing Full Capacity	Proposed Dia. (in)	Proposed Pipe Capacity (gpm)	Modeled Peak Flow/Proposed Pipe Capacity
P-3995	3873: MH-1667	3874: MH-1645	164	30	6,042	5,567	109%	42	**13,656**	44%
P-3994	3874: MH-1645	3875: MH-5735	83.6	30	6,042	4,027	150%	42	**9,877**	61%
P-6276	3875: MH-5735	3883: MH-5736	15.6	30	6,040	4,664	130%	42	**11,439**	53%
P-3980	4061: MH-1145	4062: MH-1107	264.3	30	6,224	5,547	112%	42	**13,606**	46%
P-3979	4062: MH-1107	4064: MH-1076	268	30	6,273	5,393	116%	42	**13,228**	47%
P-3978	4064: MH-1076	4065: MH-1039	327.2	30	6,318	5,574	113%	42	**16,153**	39%
P-3977	4065: MH-1039	4067: MH-1002	281.3	30	6,345	6,586	96%	42	**16,153**	39%
P-1256	1639: 32-MH-4897	1640: 32-MH-4881	312.5	10	813.62	862.88	94%	15	**1564.5**	52%
P-1559	1650: 32-MH-4906	1652: 32-MH-4907	250.7	8	795.03	665.98	119%	15	**1963.5**	40%
P-1560	1646: 32-MH-4902	1650: 32-MH-4906	247.6	8	794.94	652.47	122%	15	**1923.7**	41%
P-1561	1645: 32-MH-4901	1646: 32-MH-4902	148.8	8	816.03	684.00	119%	15	**2016.7**	40%
P-1562	1643: 32-MH-4894	1645: 32-MH-4901	270.5	8	791.44	632.75	125%	15	**1865.6**	42%
P-6024	1674: 32-MH-4914	1675: 32-MH-4916	208.4	8	795.32	770.72	103%	15	**2272.3**	35%
P-6025	1675: 32-MH-4916	1676: 32-MH-4919	257.5	8	794.82	554.86	143%	15	**1635.9**	49%
P-6026	1676: 32-MH-4919	1677: 32-MH-4920	283.1	8	794.46	720.52	110%	15	**2124.3**	37%
P-6027	1677: 32-MH-4920	1690: 32-MH-4922	284.2	8	794.26	967.26	82%	15	**2851.8**	28%



ENVIRONMENTAL PARTNERS
— An Apex Company —

Figure 5-1: Existing Sewer Conditions
Weymouth, Massachusetts
November 2022

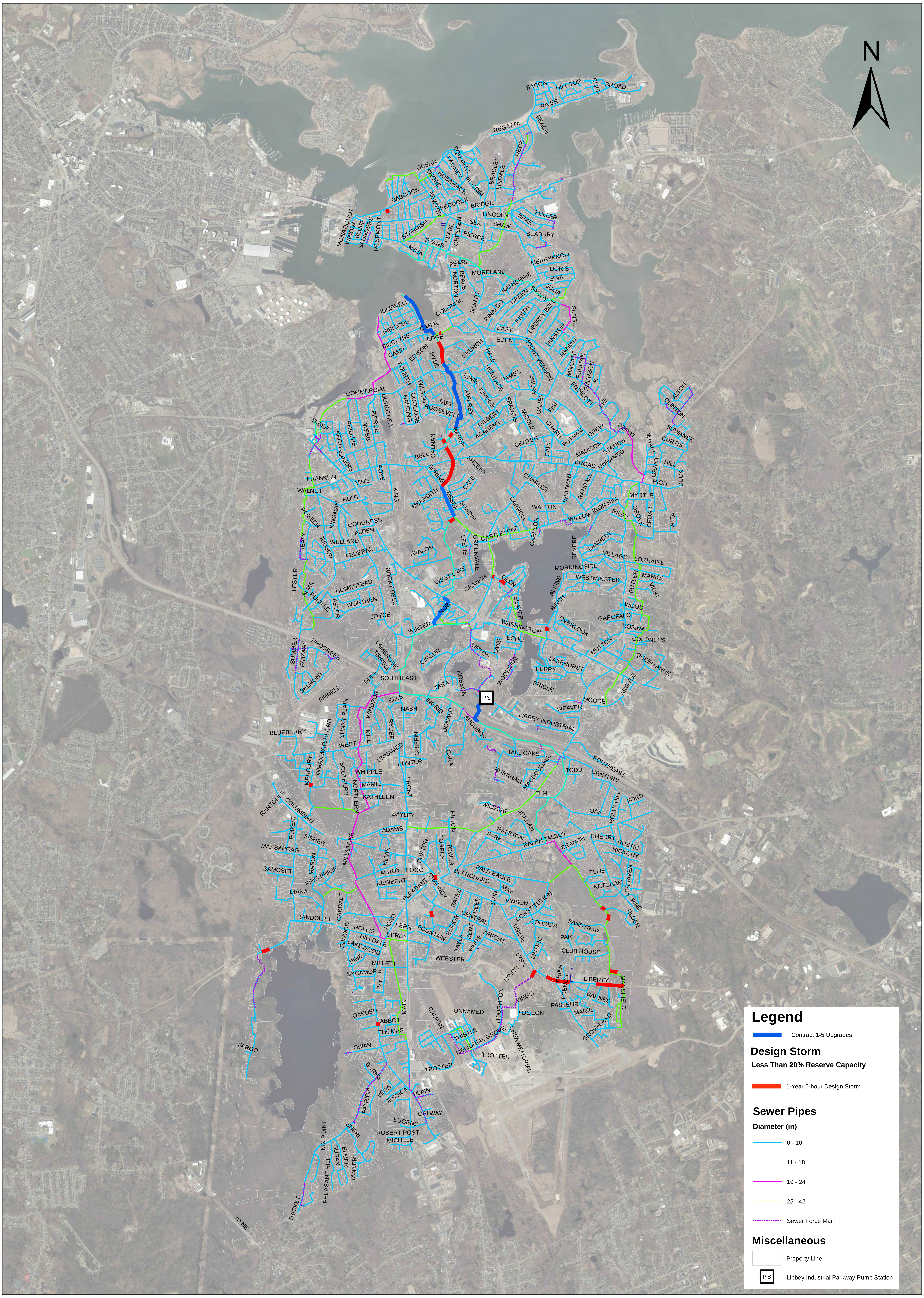
0 0.5 1 2 Miles



ENVIRONMENTAL PARTNERS
— An Apex Company —

Figure 5-2: Sewer System Existing Conditions
Weymouth, Massachusetts
November 2022

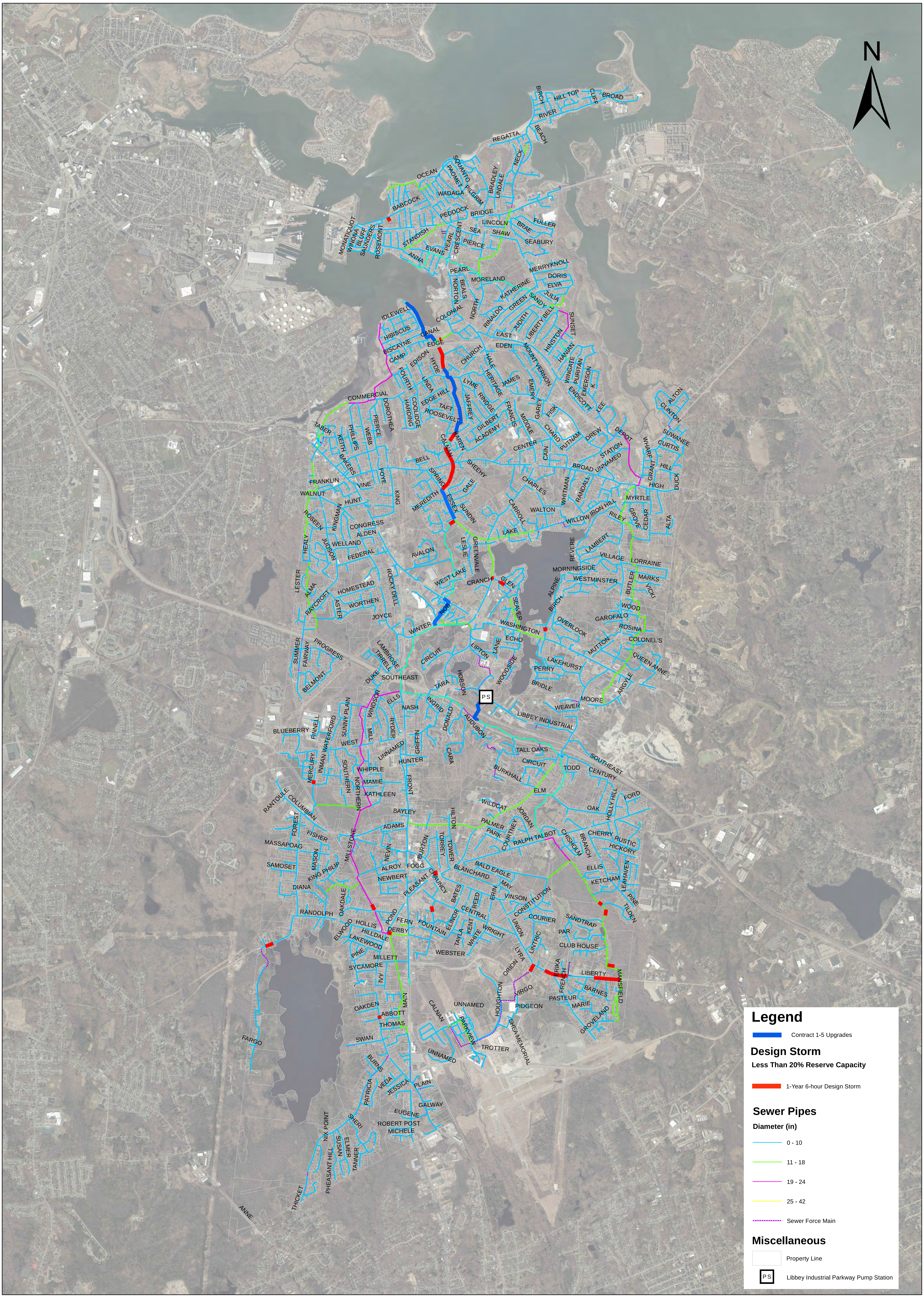
0 0.475 0.95 1.9 Miles



ENVIRONMENTAL PARTNERS
— An Apex Company —

Figure 5-3: Sewer System Scenario 5.4
Weymouth, Massachusetts
November 2022

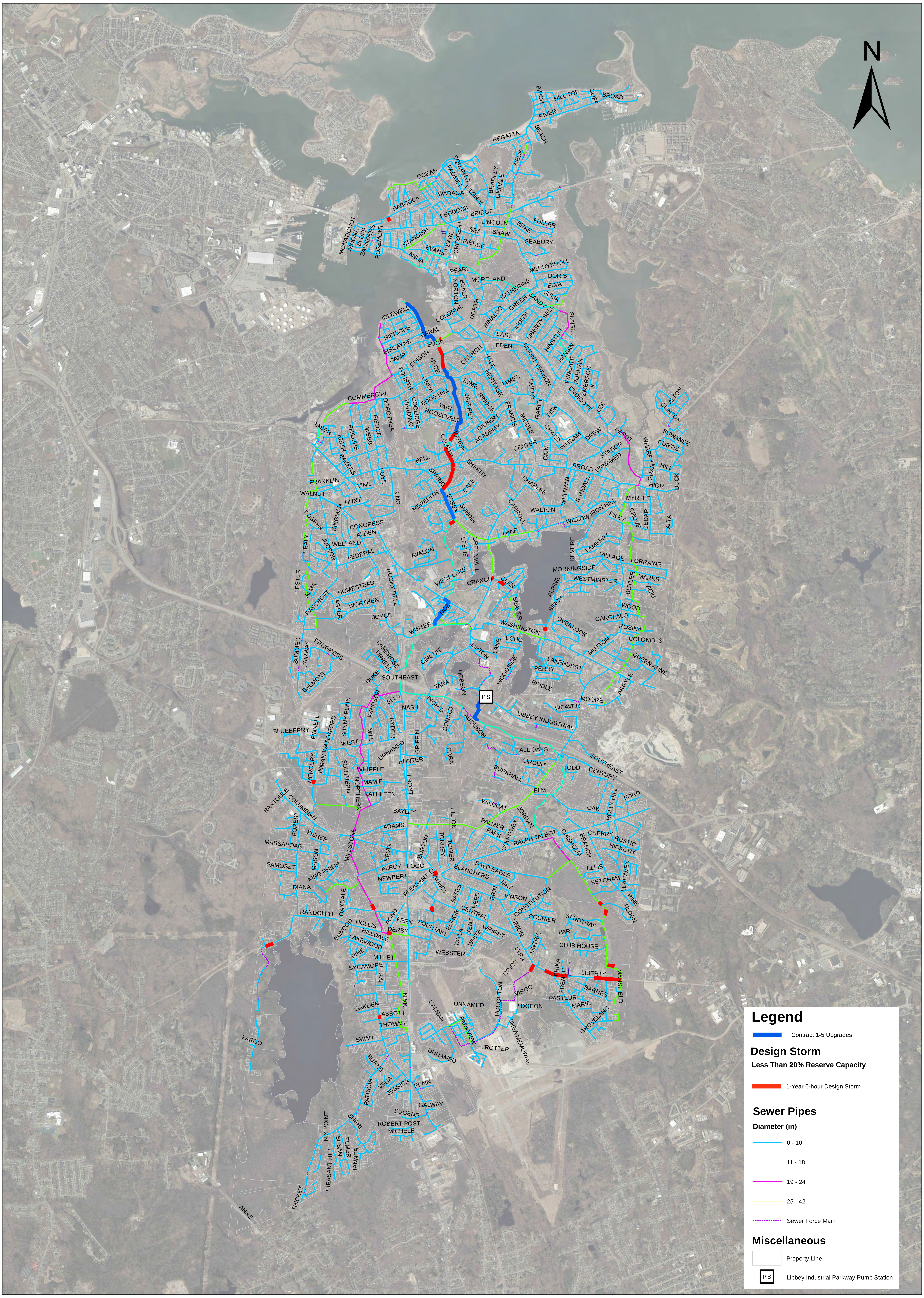
0 0.475 0.95 1.9 Miles



ENVIRONMENTAL PARTNERS
— An Apex Company —

Figure 5-4: Sewer System Scenario 8.1
Weymouth, Massachusetts
November 2022

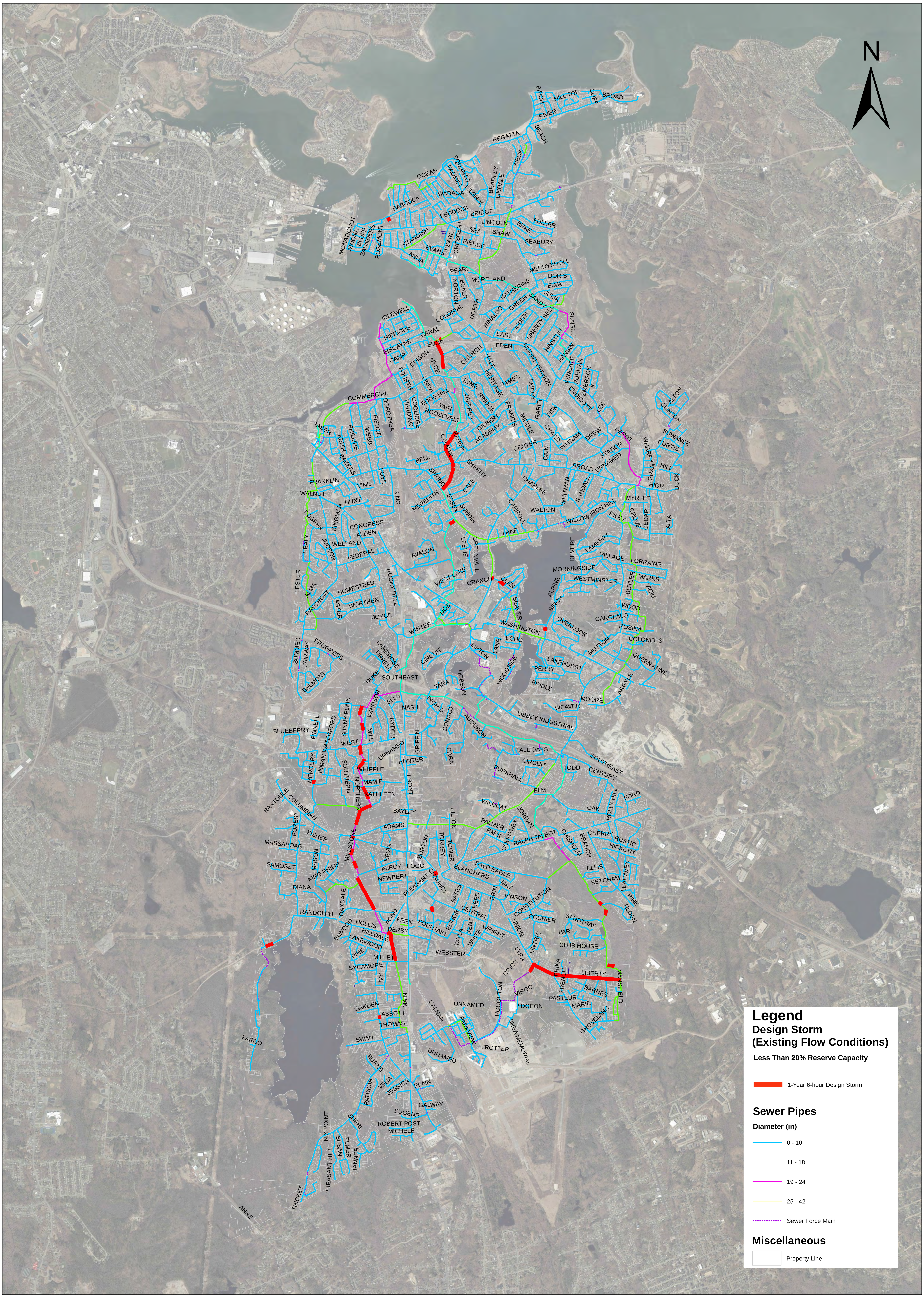
0 0.5 1 2 Miles



ENVIRONMENTAL PARTNERS
— An Apex Company —

Figure 5-5: Sewer System Scenario 10.8
Weymouth, Massachusetts
November 2022

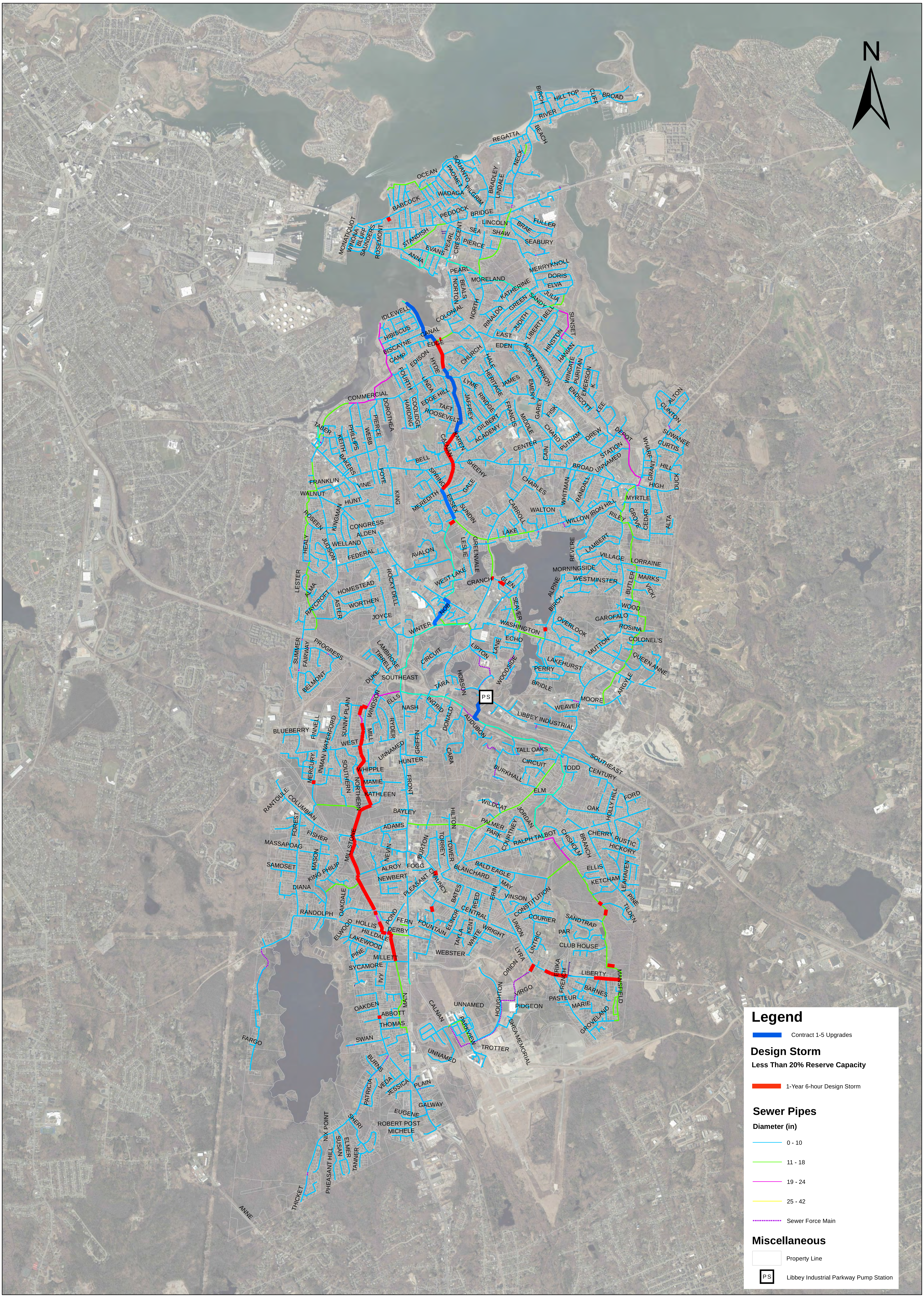
0 0.5 1 2 Miles



ENVIRONMENTAL PARTNERS
— An Apex Company —

Figure 5-6: Sewer System Scenario 14.4
Weymouth, Massachusetts
November 2022

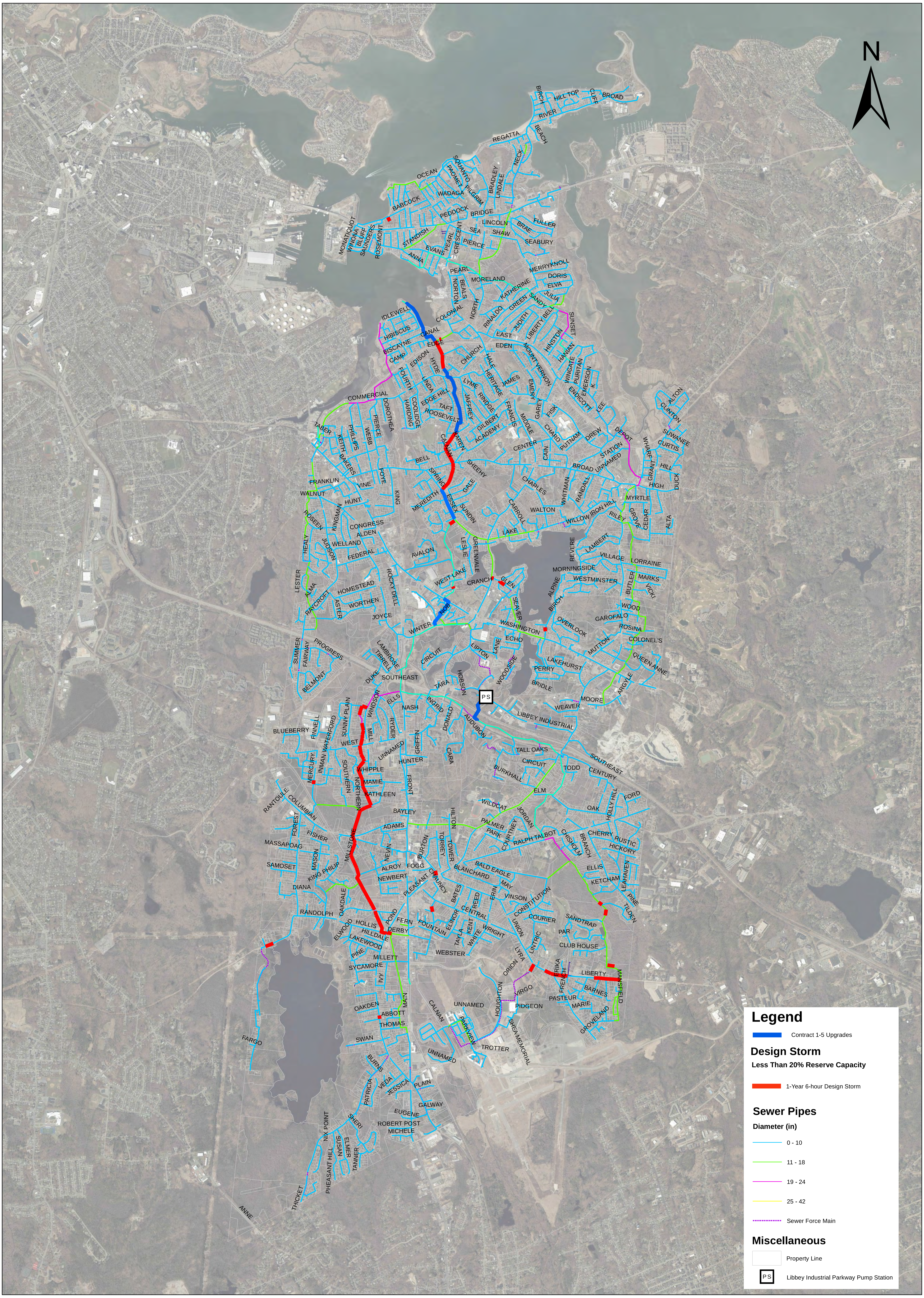
0 0.5 1 2 Miles



ENVIRONMENTAL PARTNERS
— An Apex Company —

Figure 5-7: Sewer System Scenario 18.0
Weymouth, Massachusetts
November 2022

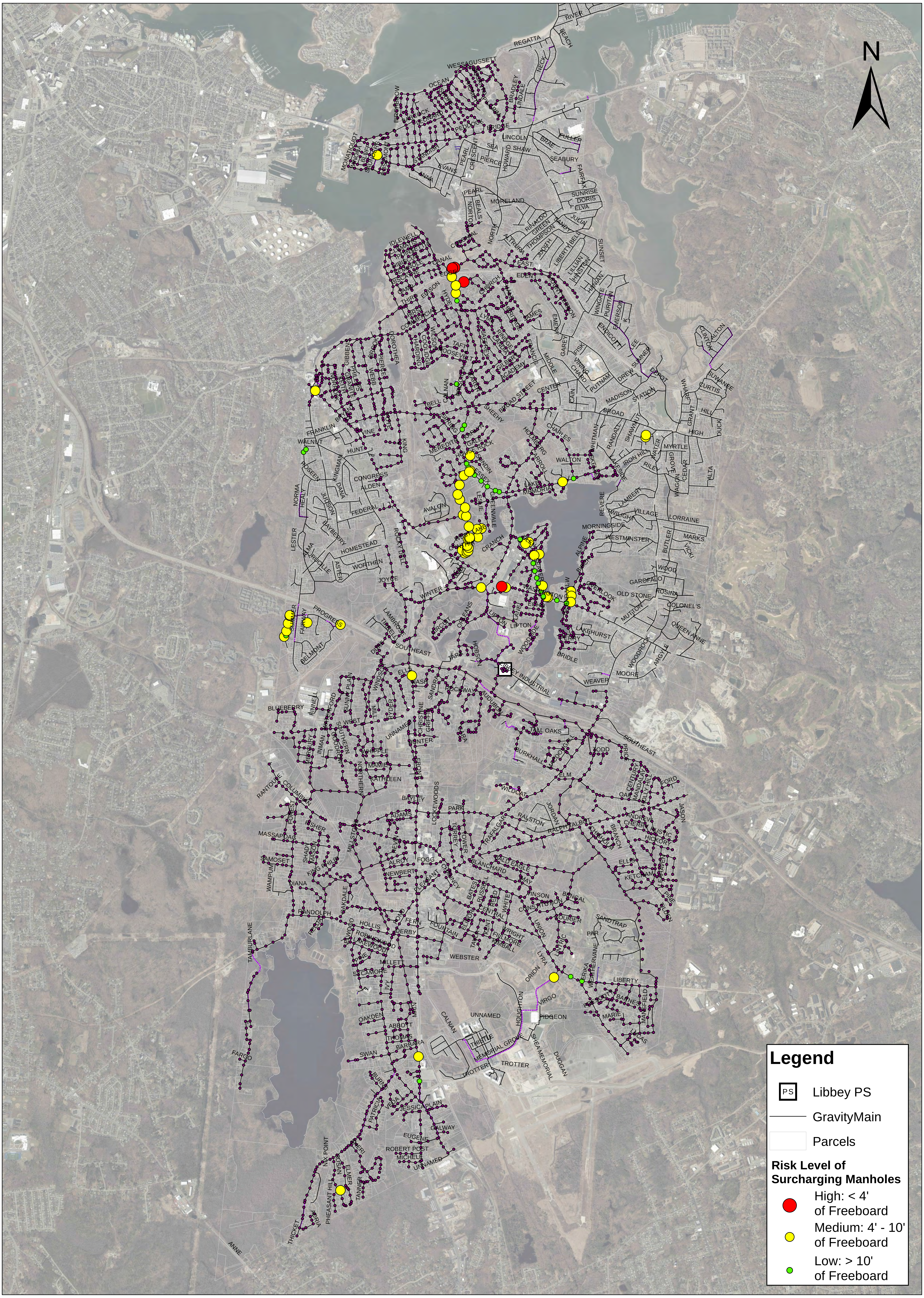
0 0.5 1 2 Miles



ENVIRONMENTAL PARTNERS
— An Apex Company —

Figure 5-8: Sewer System Scenario 21.6
Weymouth, Massachusetts
November 2022

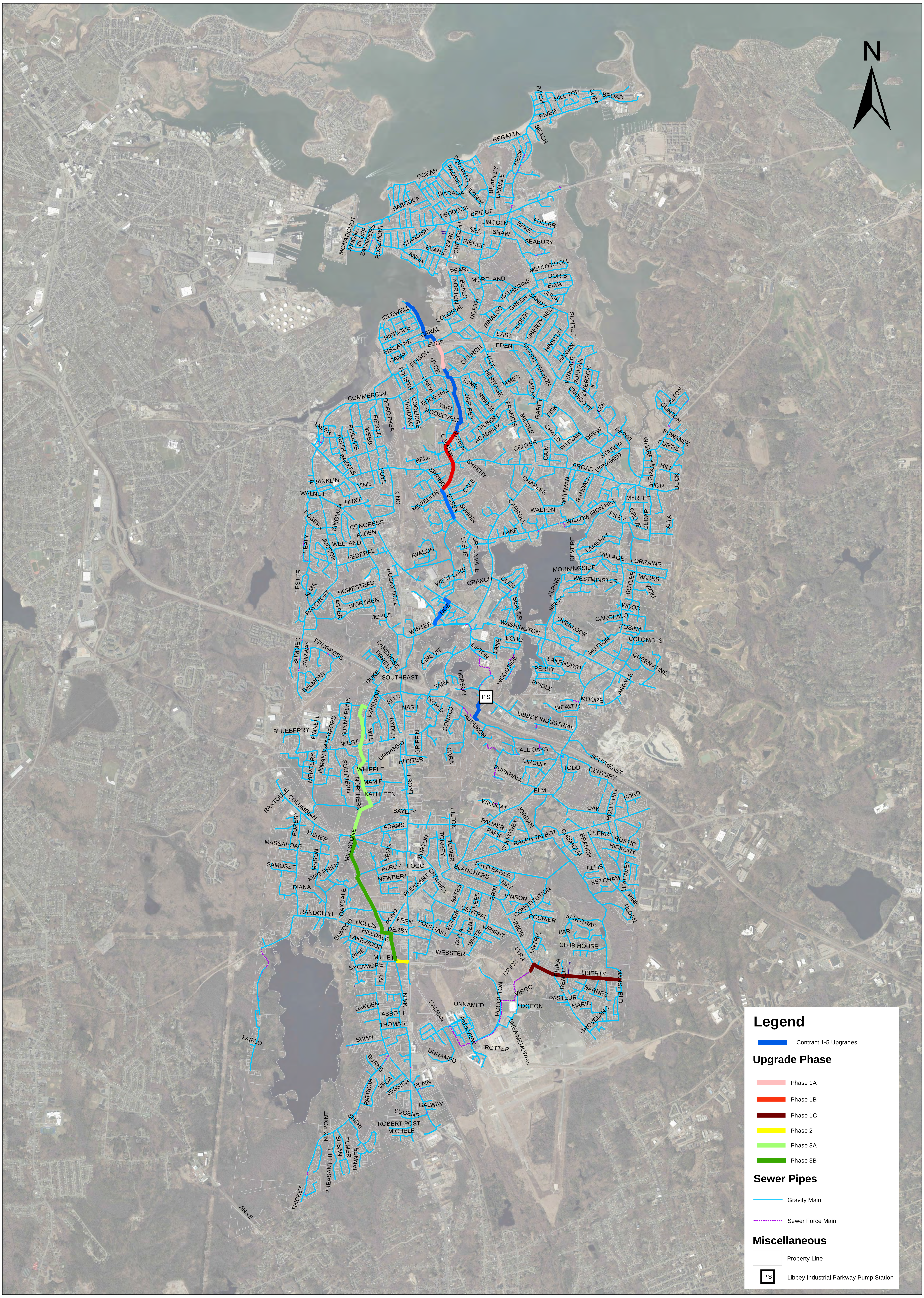
0 0.5 1 2 Miles



ENVIRONMENTAL PARTNERS
— An Apex Company —

Figure 5-9: Surcharging Manhole Risk - 5-Year Storm
Weymouth, Massachusetts
November 2022

0 0.425 0.85 1.7 Miles

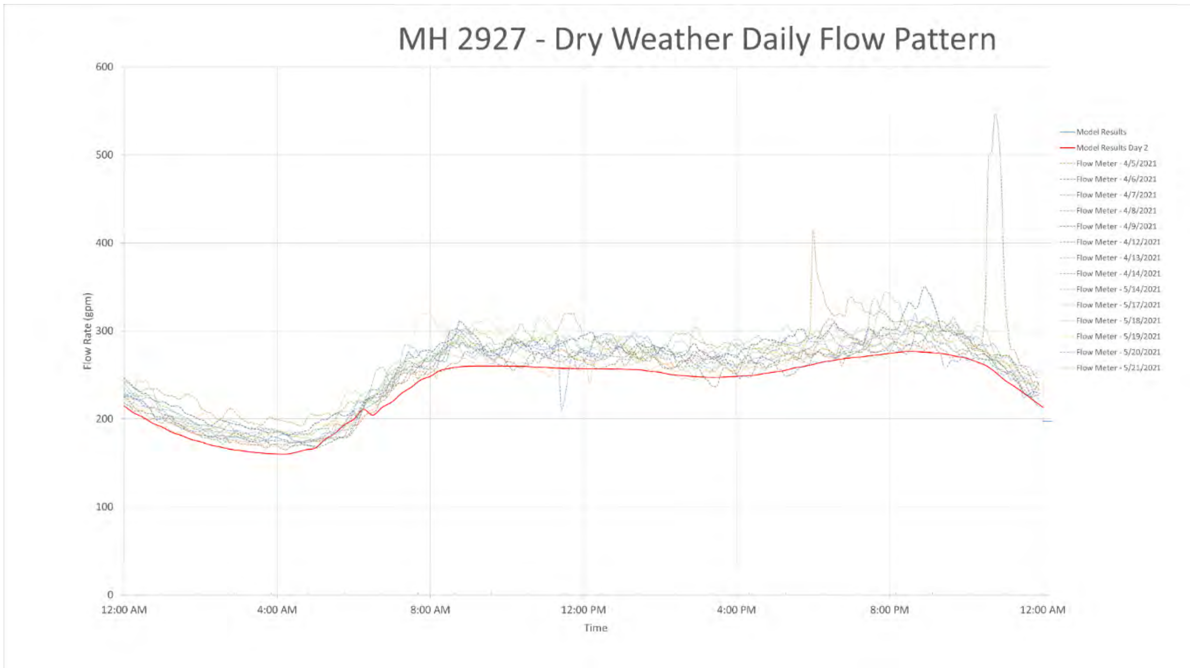


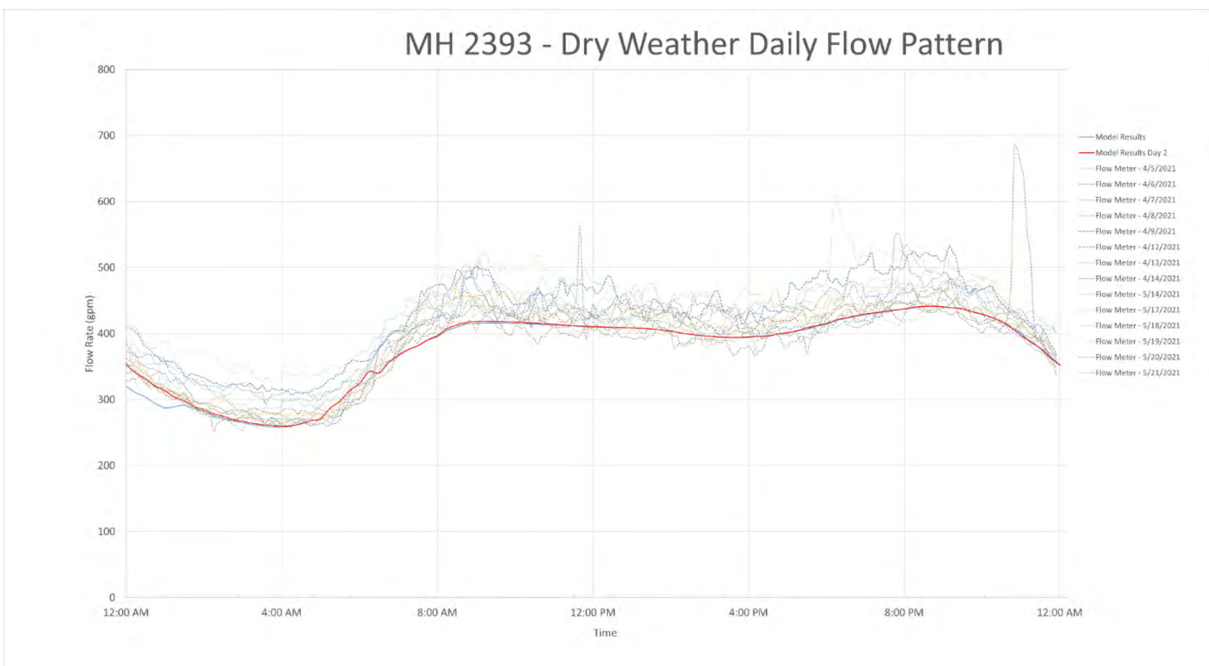
ENVIRONMENTAL PARTNERS
— An Apex Company —

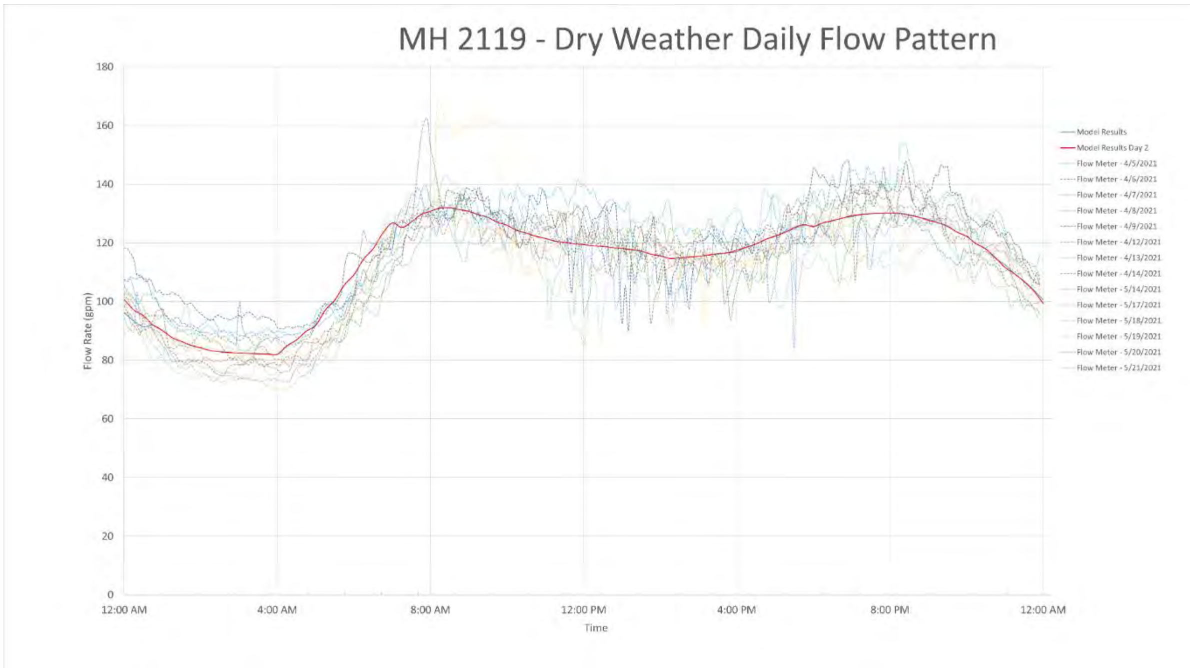
Figure 5-10 - Sewer Upgrade Phases
Weymouth, Massachusetts
November 2022

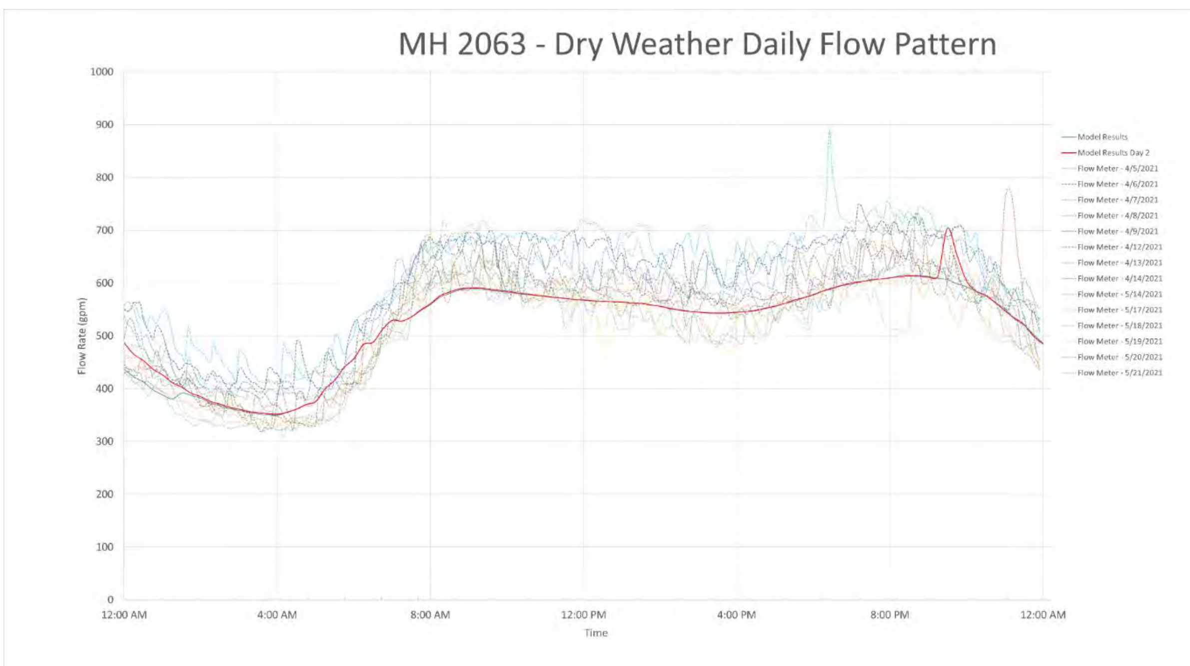
0 0.5 1 2 Miles

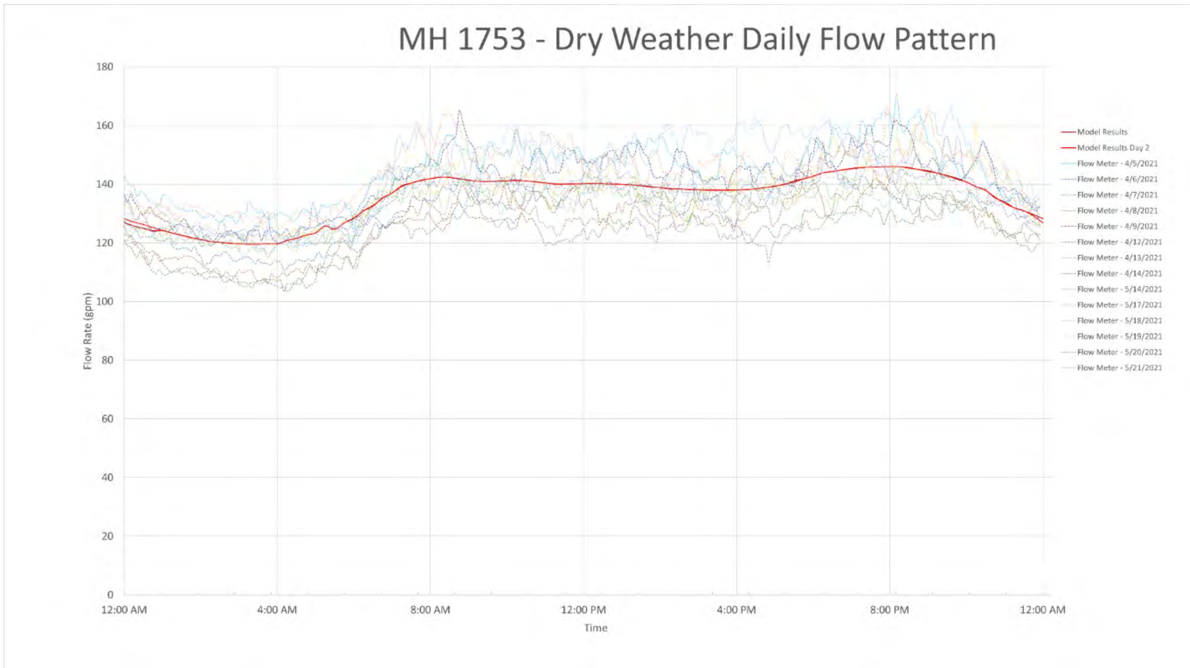
APPENDIX A - DRY WEATHER SEWER MODEL CALIBRATION RESULTS

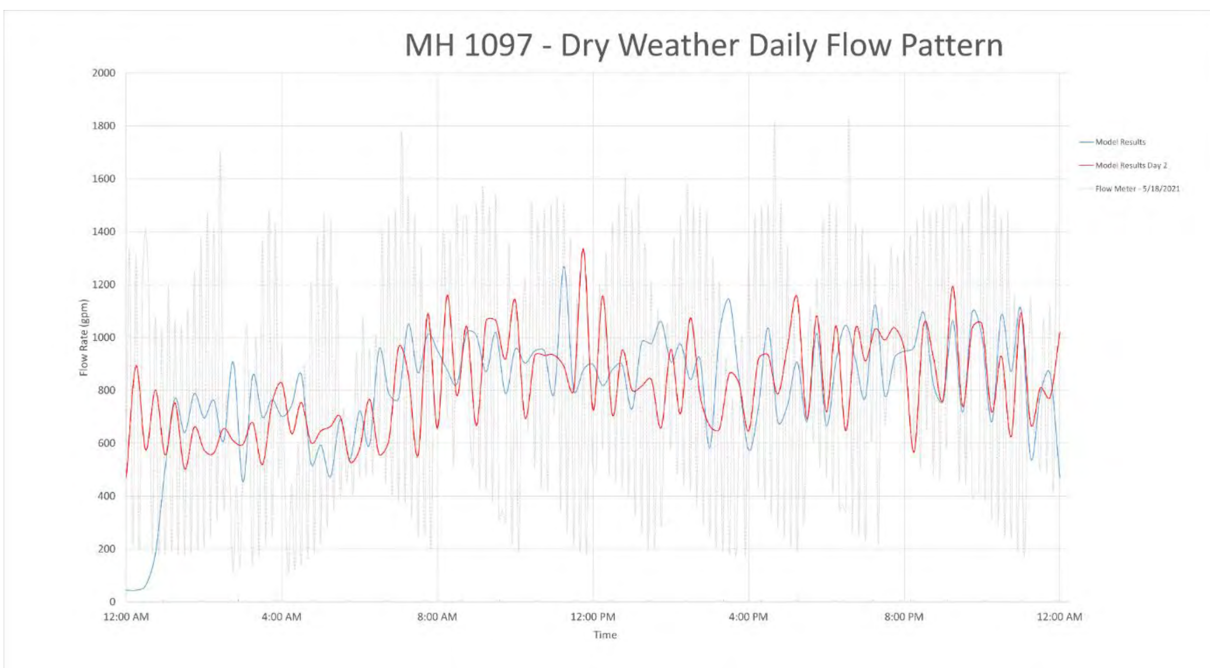

MH 2927 - Dry Weather Daily Flow Pattern
600
500
400
300
200
100
0
Flow Rate (gpm)
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

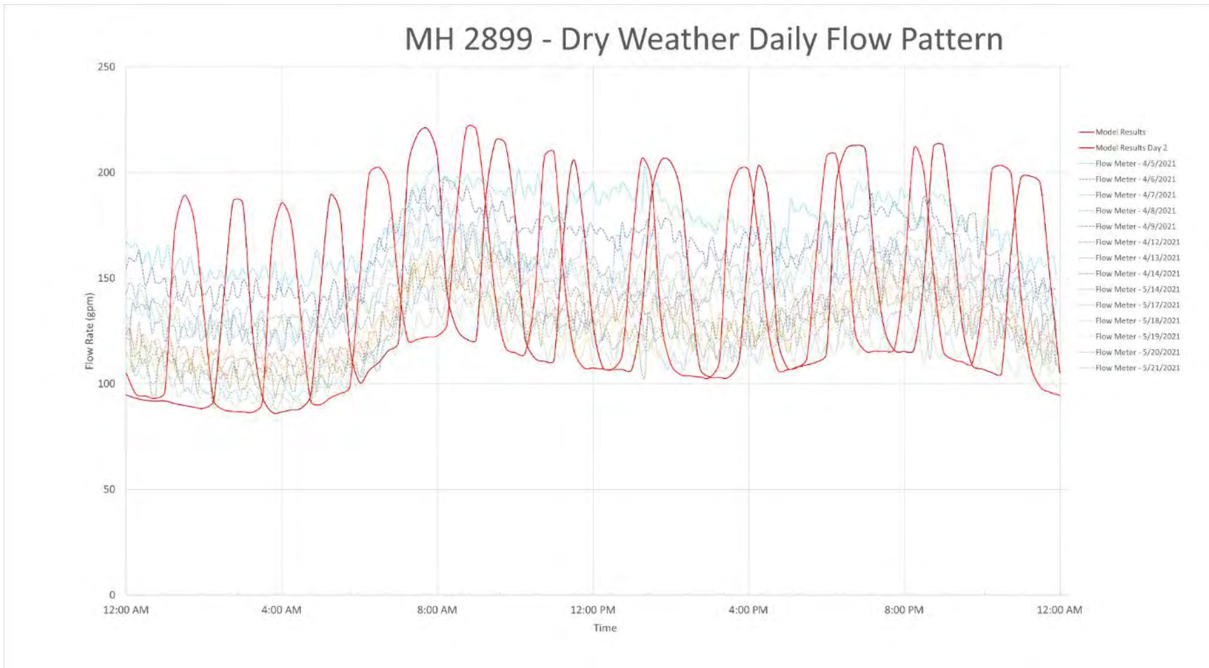

MH 2393 - Dry Weather Daily Flow Pattern
800
700
600
500
400
300
200
100
0
Flow Rate (gpm)
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

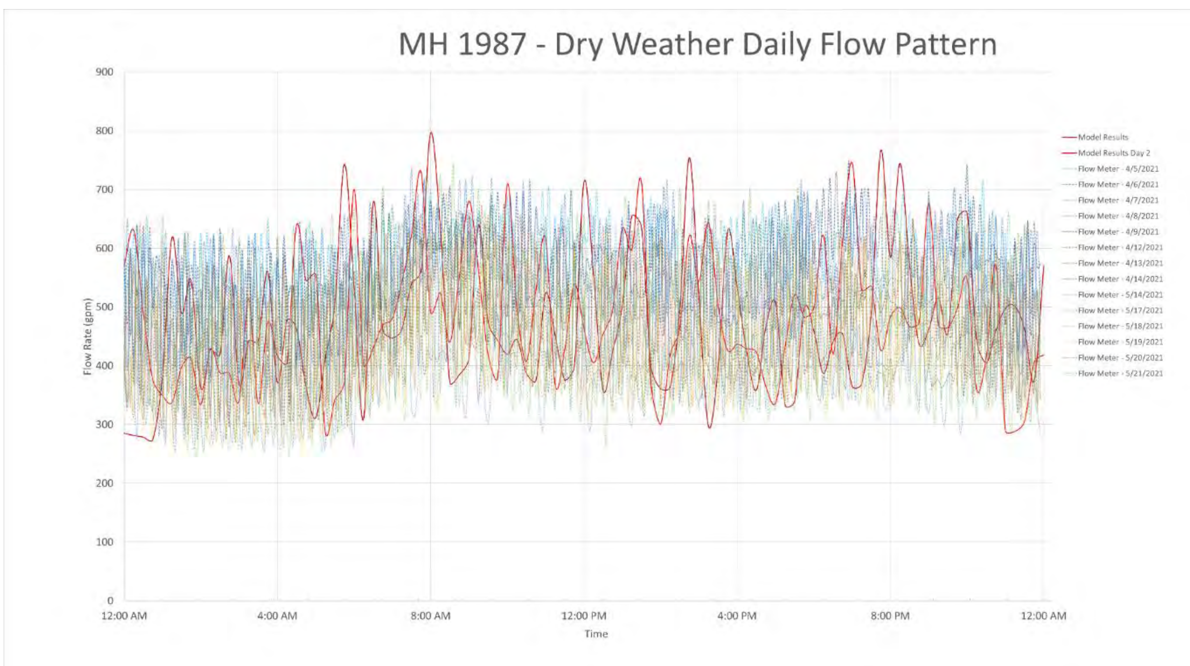

MH 2119 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
180
160
140
120
100
80
60
40
20
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

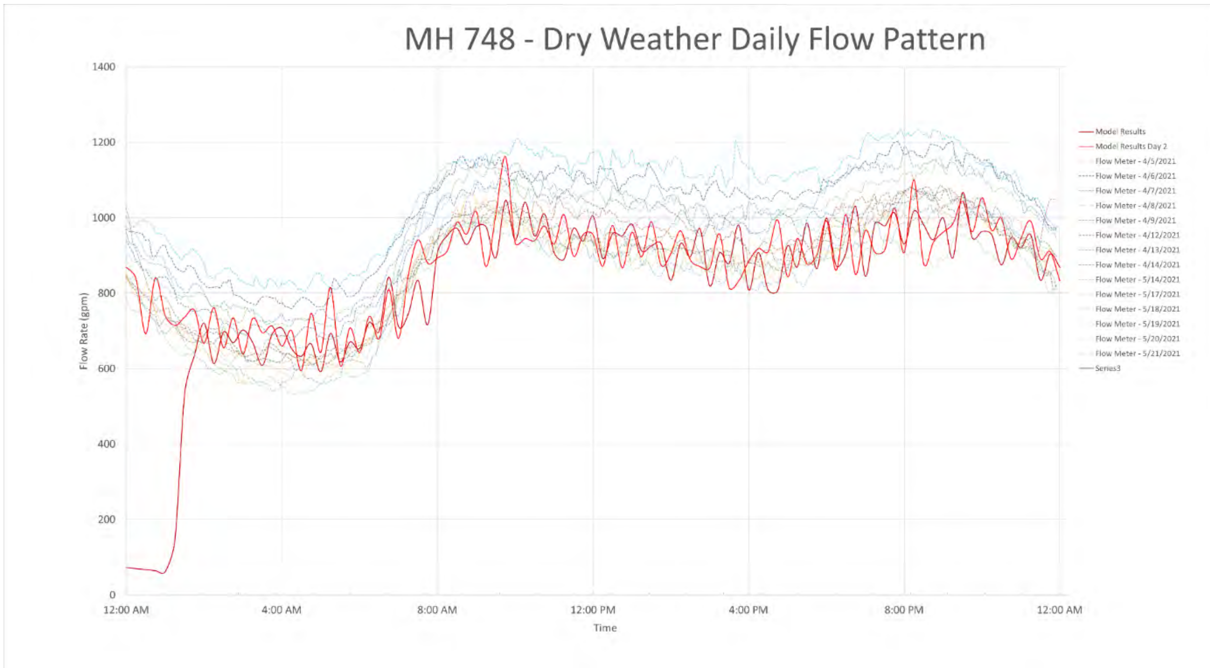

MH 2063 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
1000
900
800
700
600
500
400
300
200
100
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

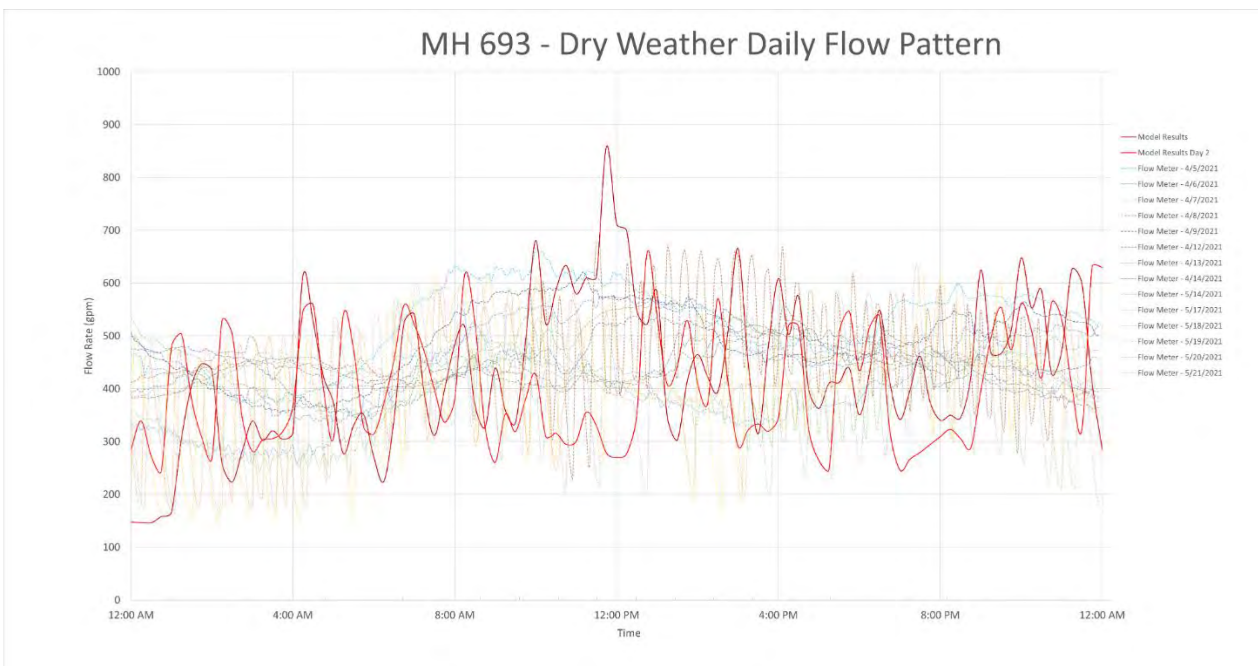

MH 1753 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
180
160
140
120
100
80
60
40
20
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

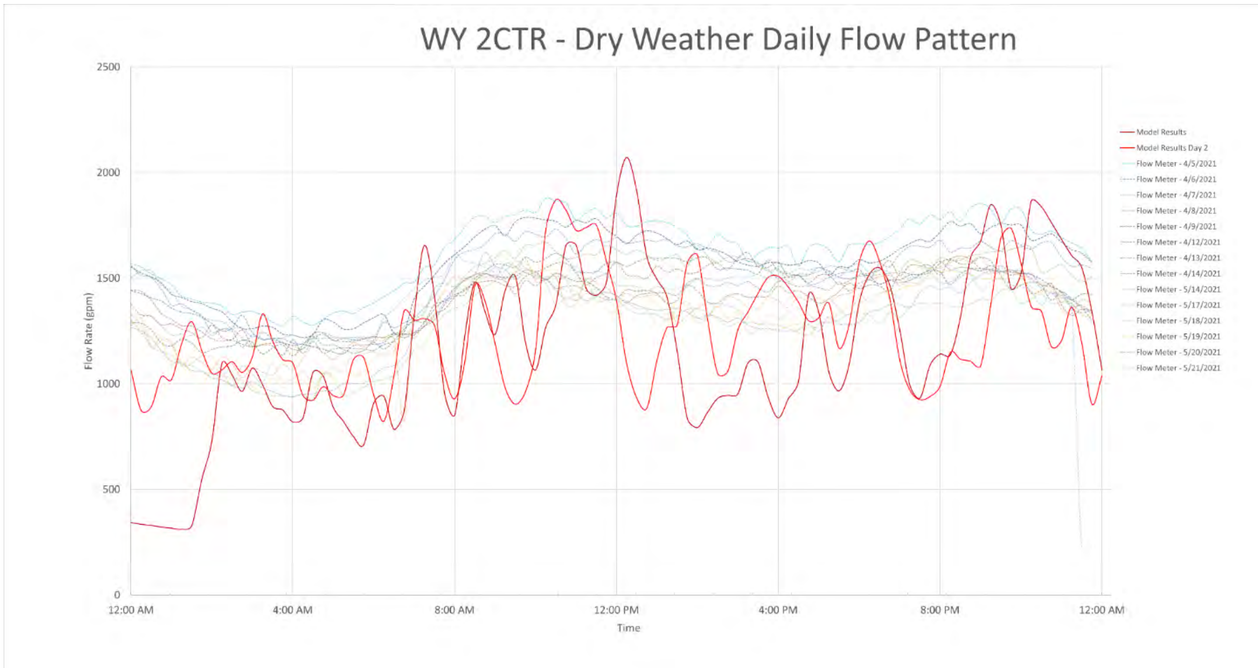

MH 1097 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 5/18/2021


MH 2899 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
0
50
100
150
200
250
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

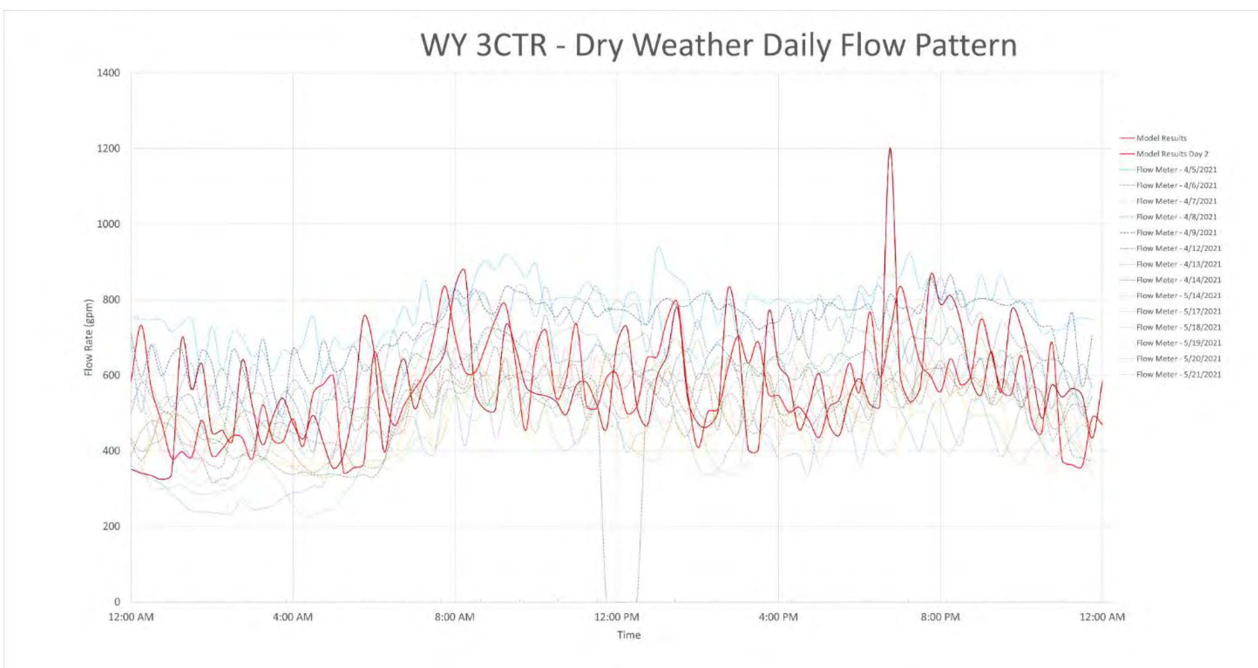

MH 1987 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
0
100
200
300
400
500
600
700
800
900
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021


MH 748 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021
Series3


MH 693 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021



WY 2CTR - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
2500
2000
1500
1000
500
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021



WY 3CTR - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
1400
1200
1000
800
600
400
200
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
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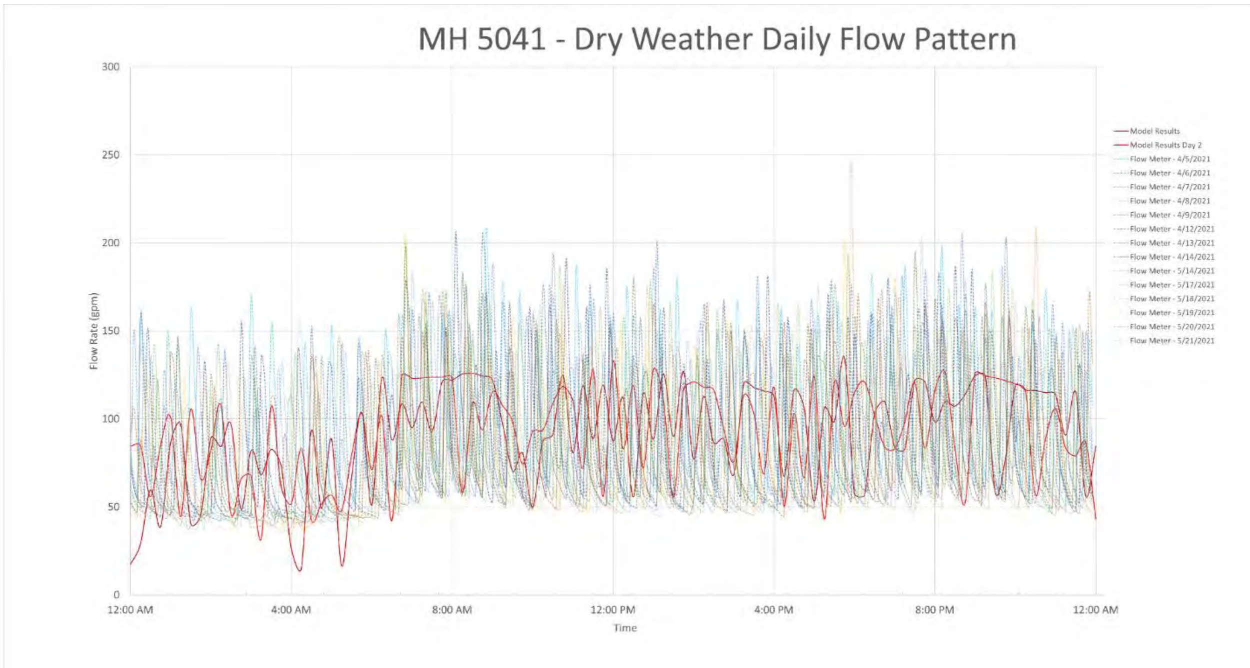
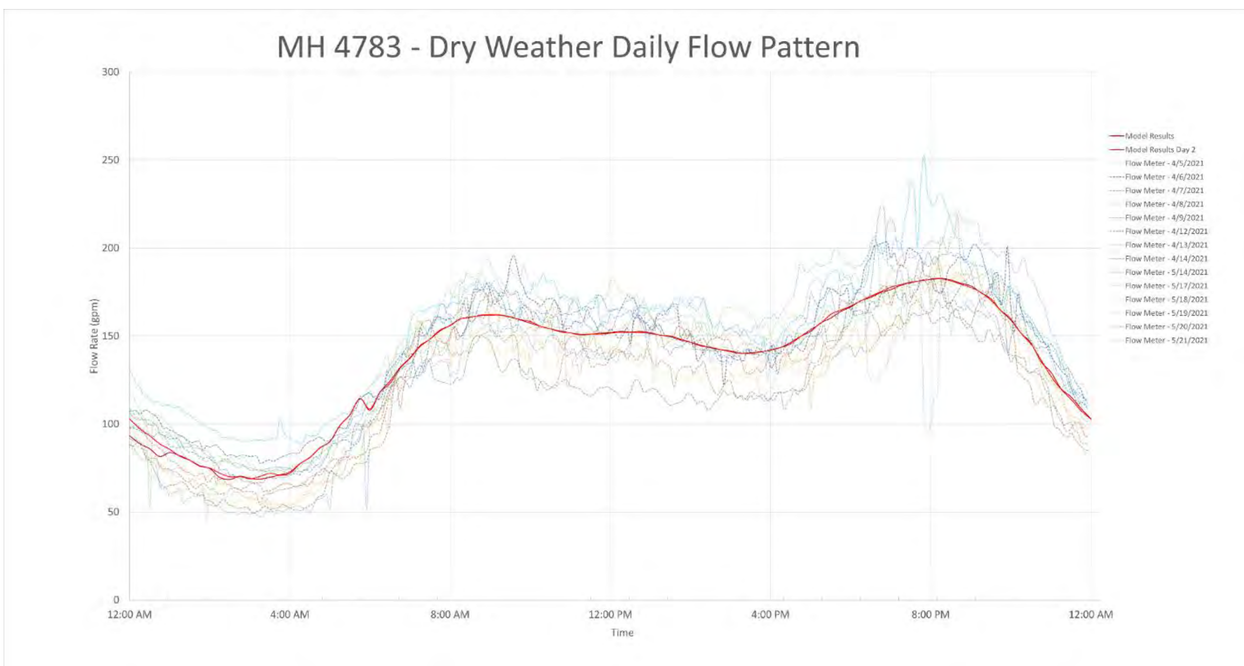
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021


MH 5041 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021
0
50
100
150
200
250
300
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM


MH 4783 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021
0
50
100
150
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250
300
12:00 AM
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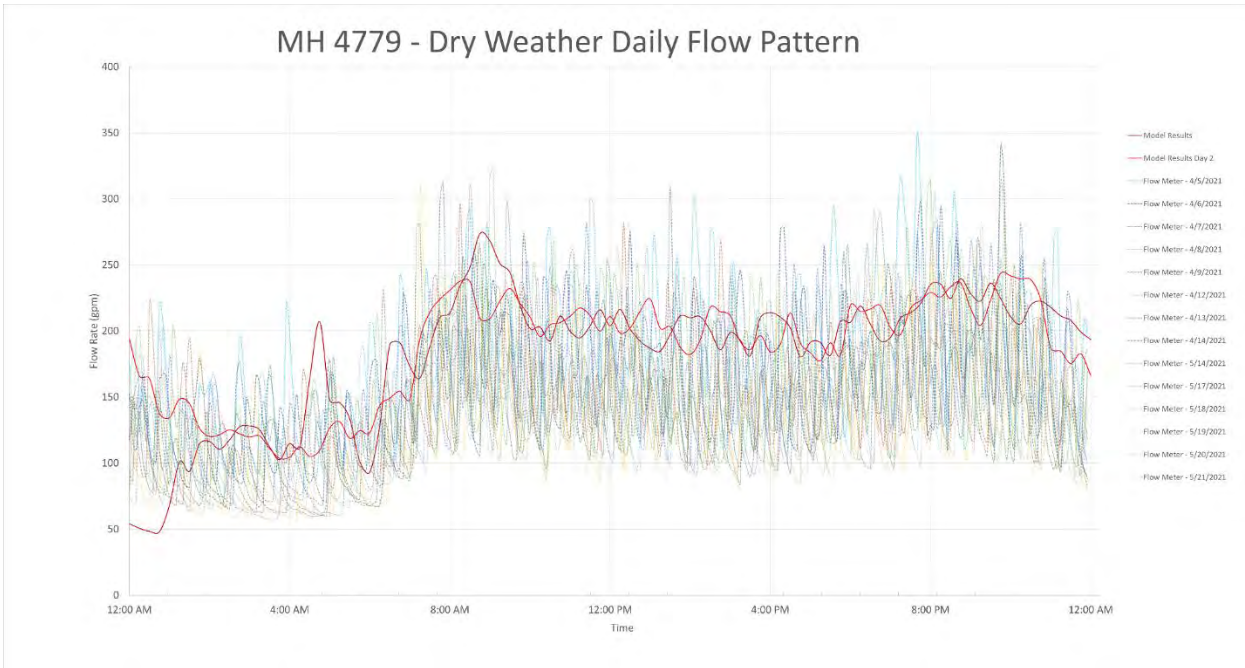
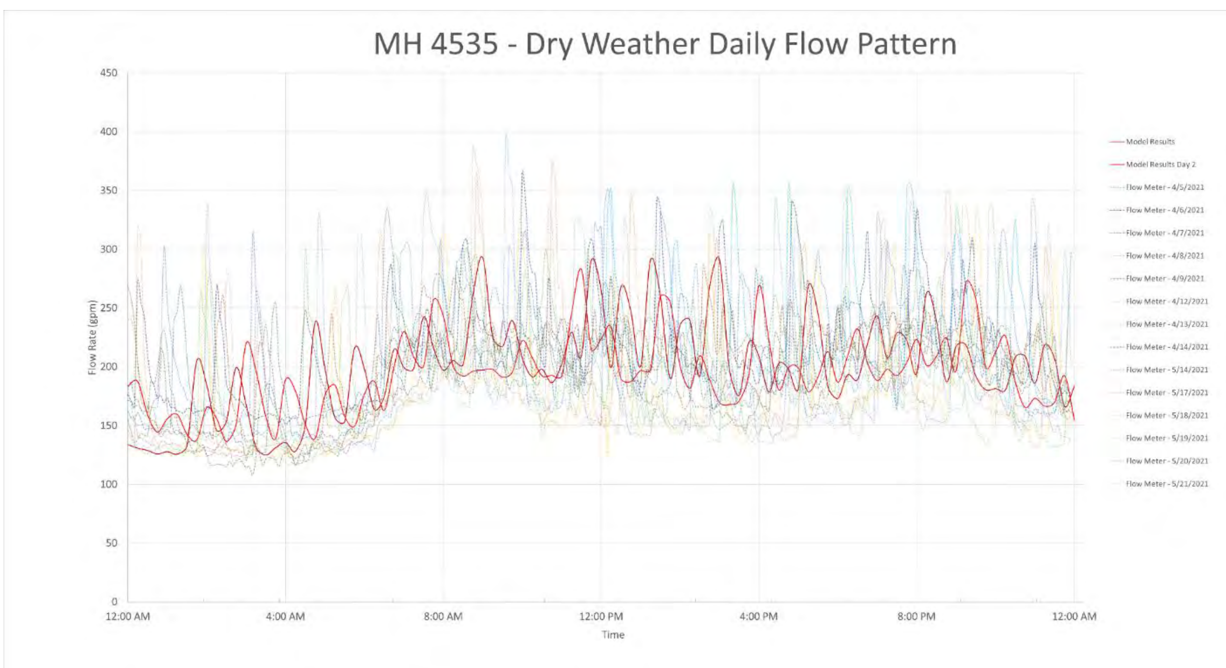
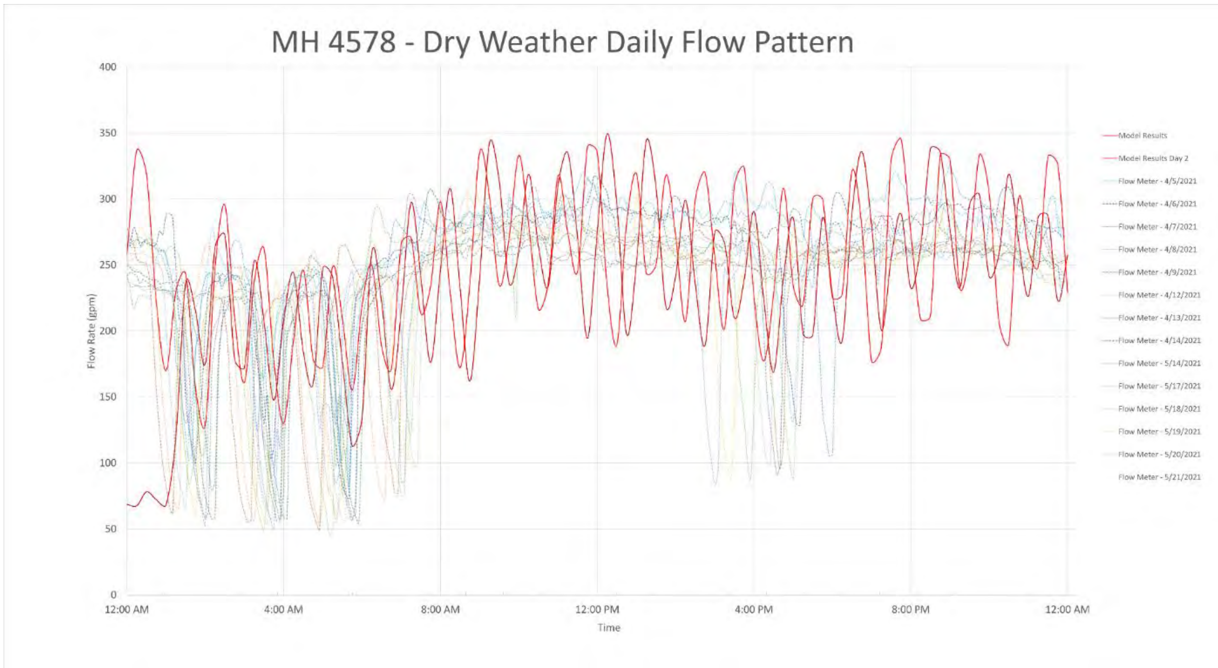
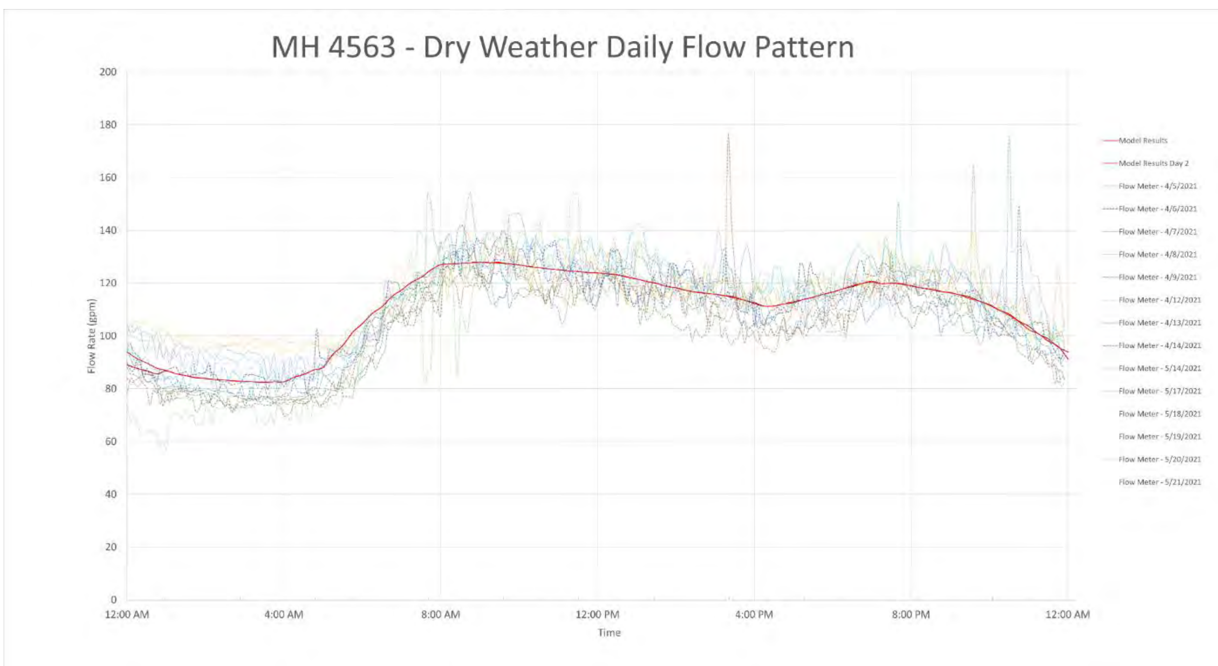
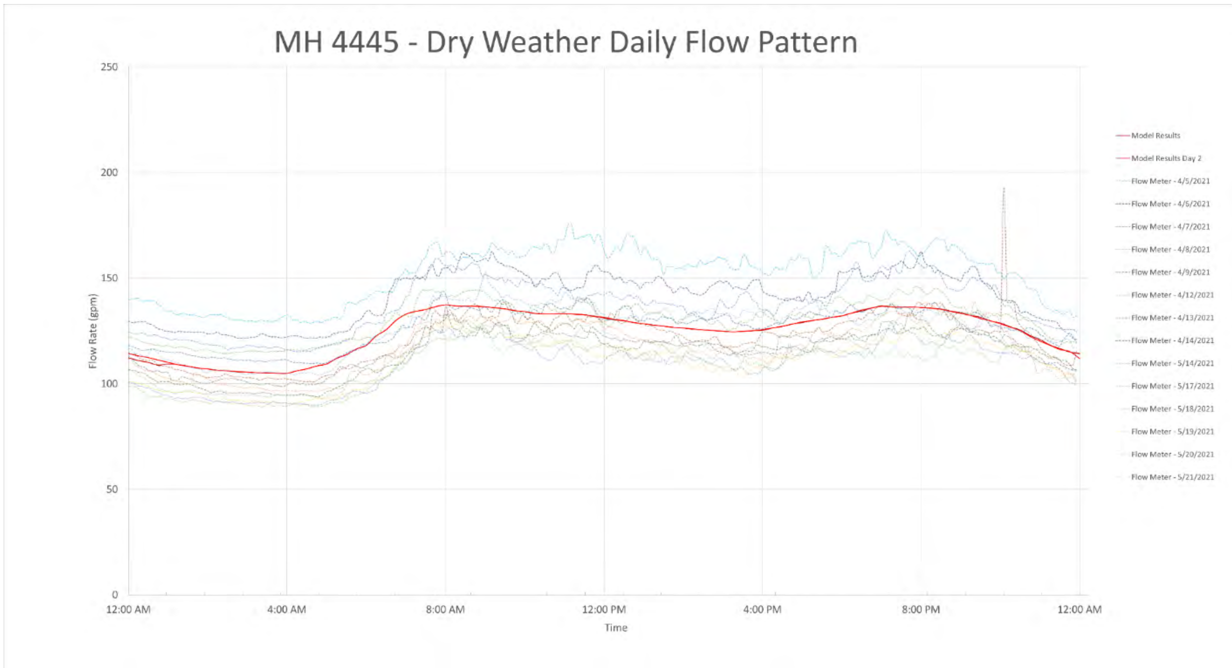
12:00 PM
4:00 PM
8:00 PM
12:00 AM

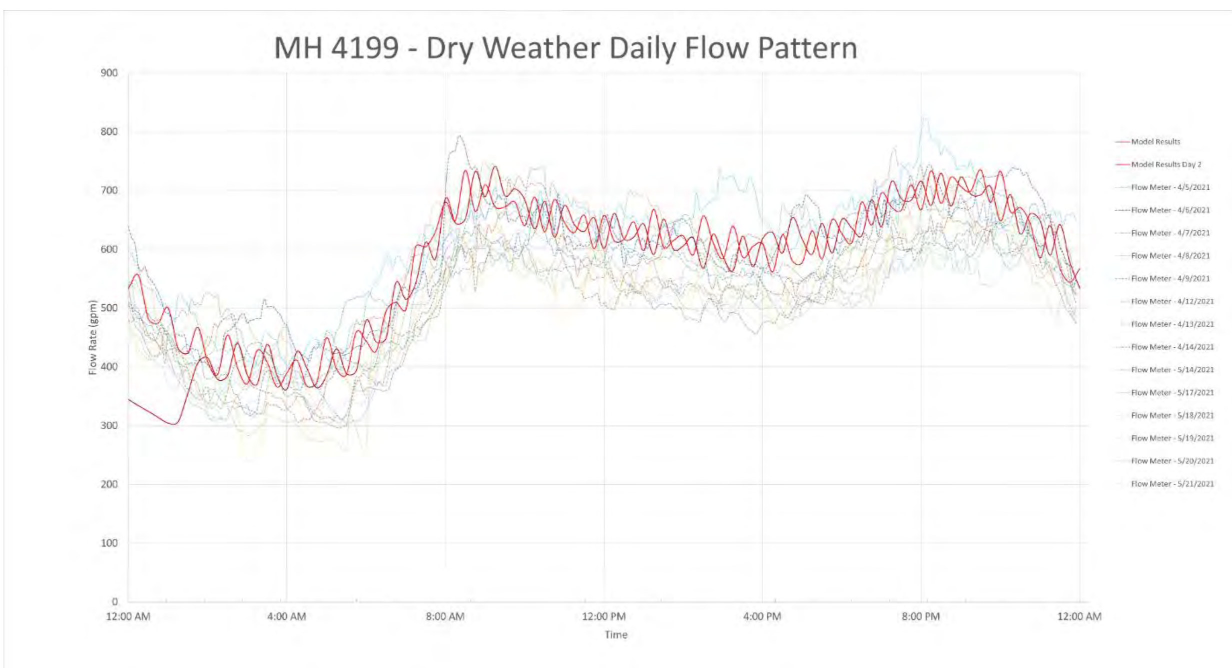

MH 4779 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
400
350
300
250
200
150
100
50
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

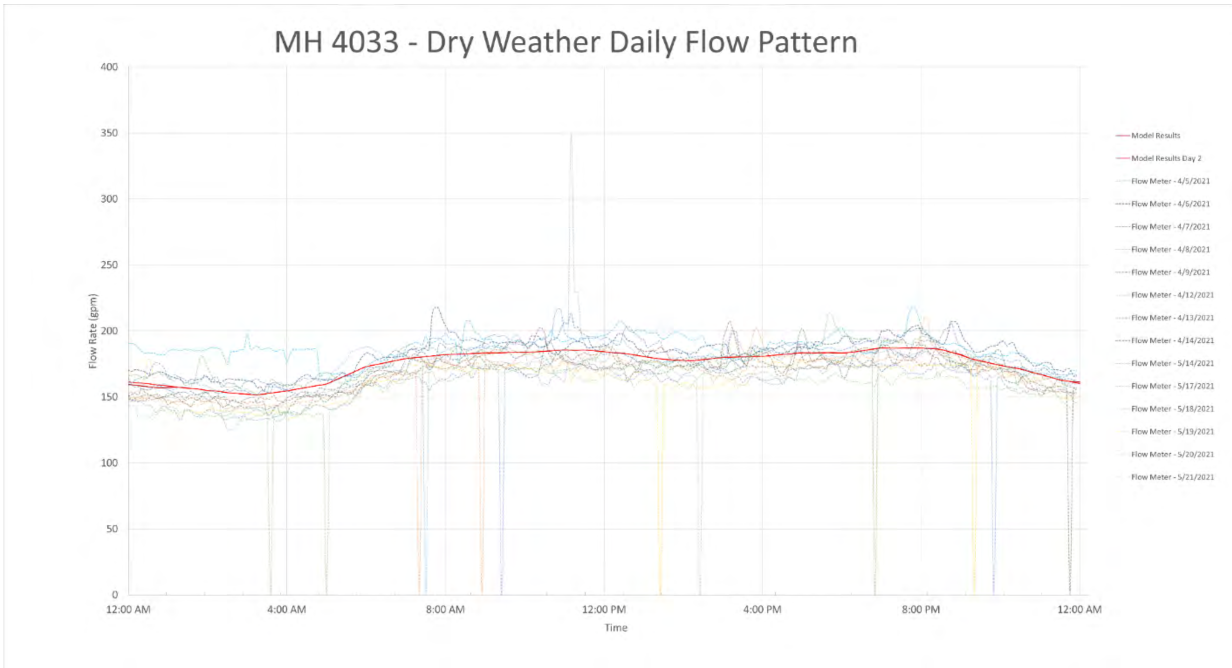

MH 4535 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
450
400
350
300
250
200
150
100
50
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

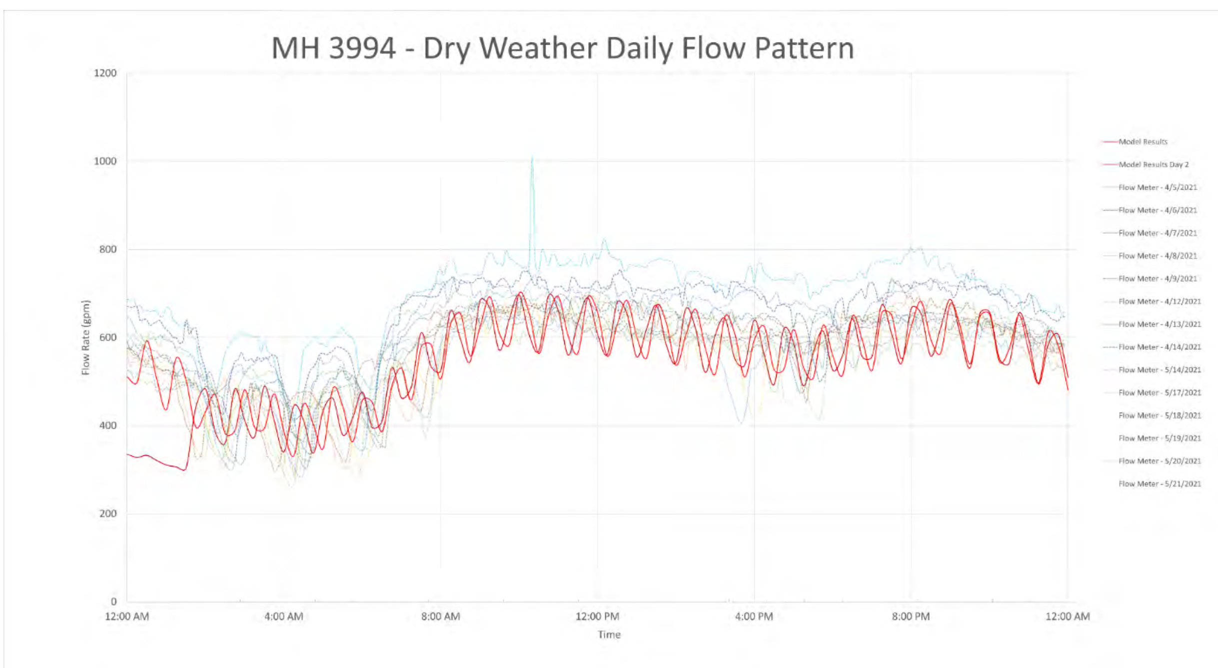

MH 4578 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
0
50
100
150
200
250
300
350
400

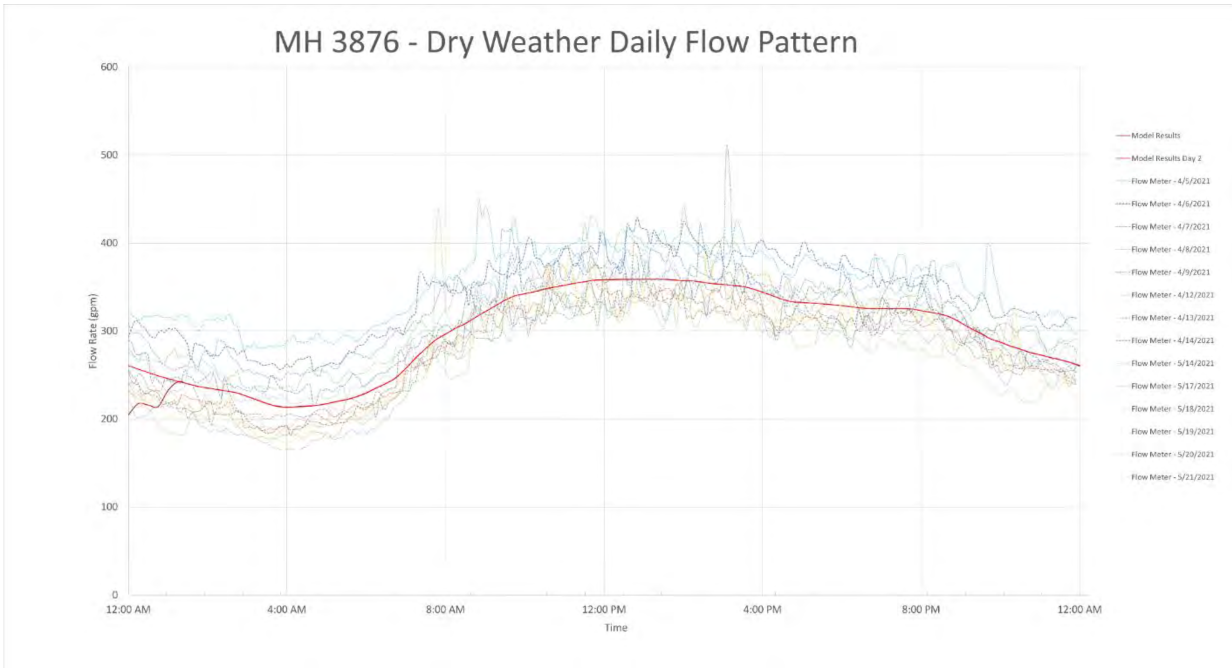

MH 4563 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
0
20
40
60
80
100
120
140
160
180
200


MH 4445 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
250
200
150
100
50
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

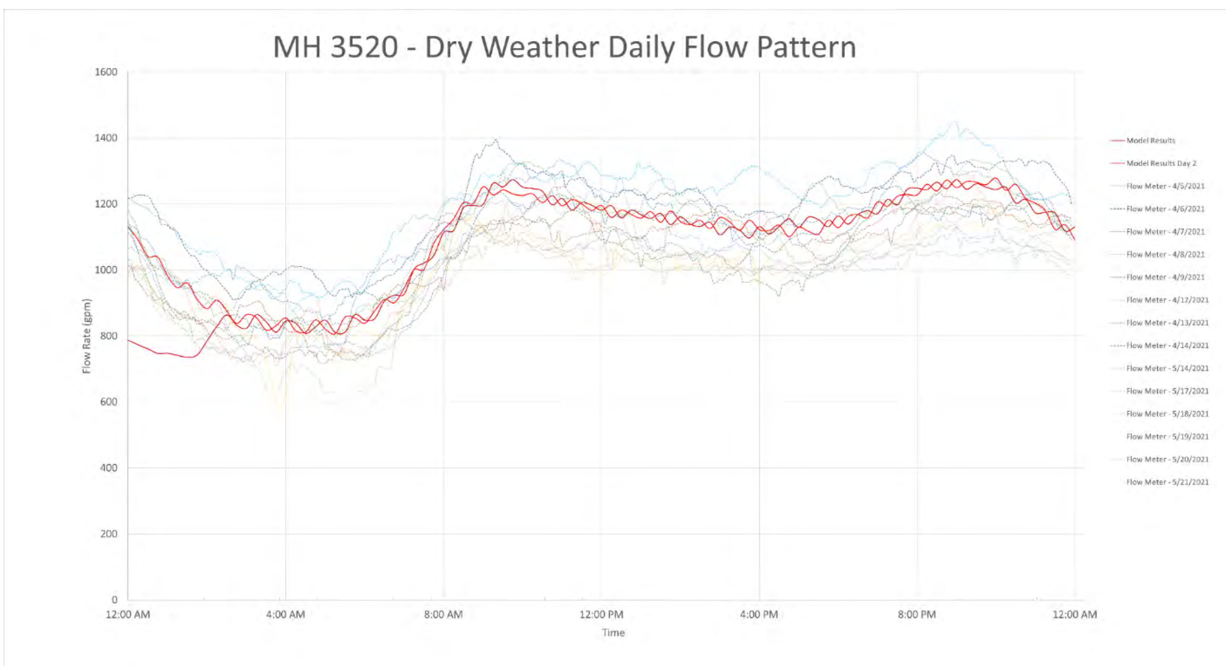

MH 4199 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
900
800
700
600
500
400
300
200
100
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021


MH 4033 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
400
350
300
250
200
150
100
50
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

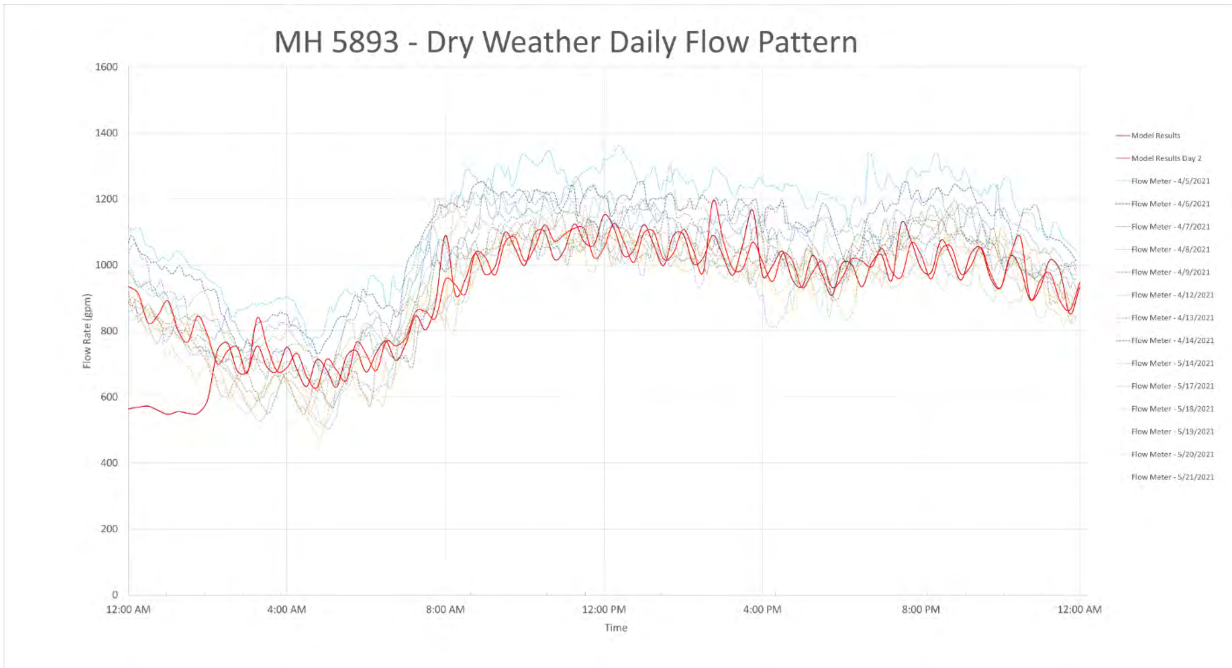

MH 3994 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
1200
1000
800
600
400
200
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

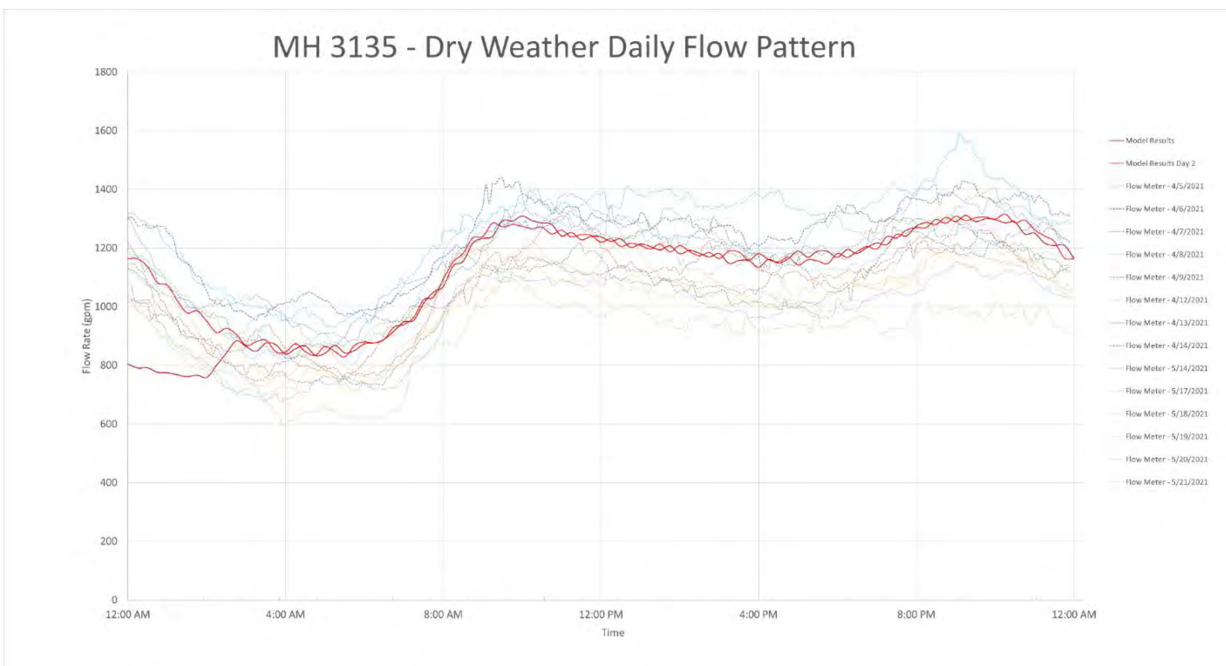


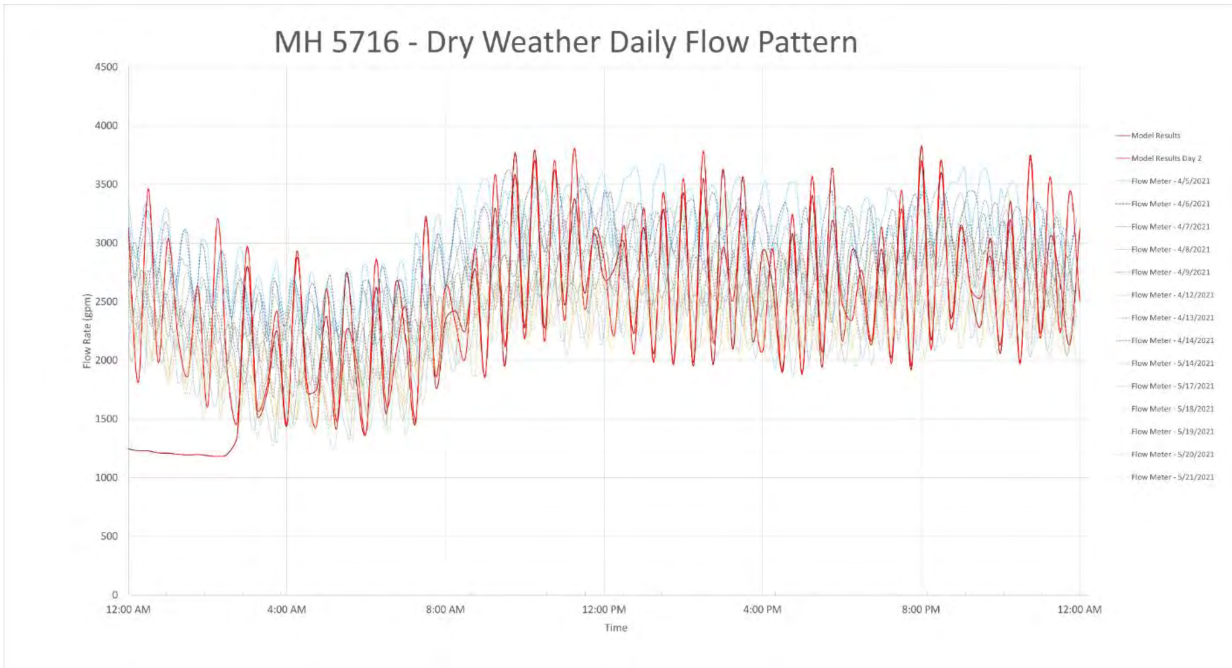
MH 3876 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
600
500
400
300
200
100
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

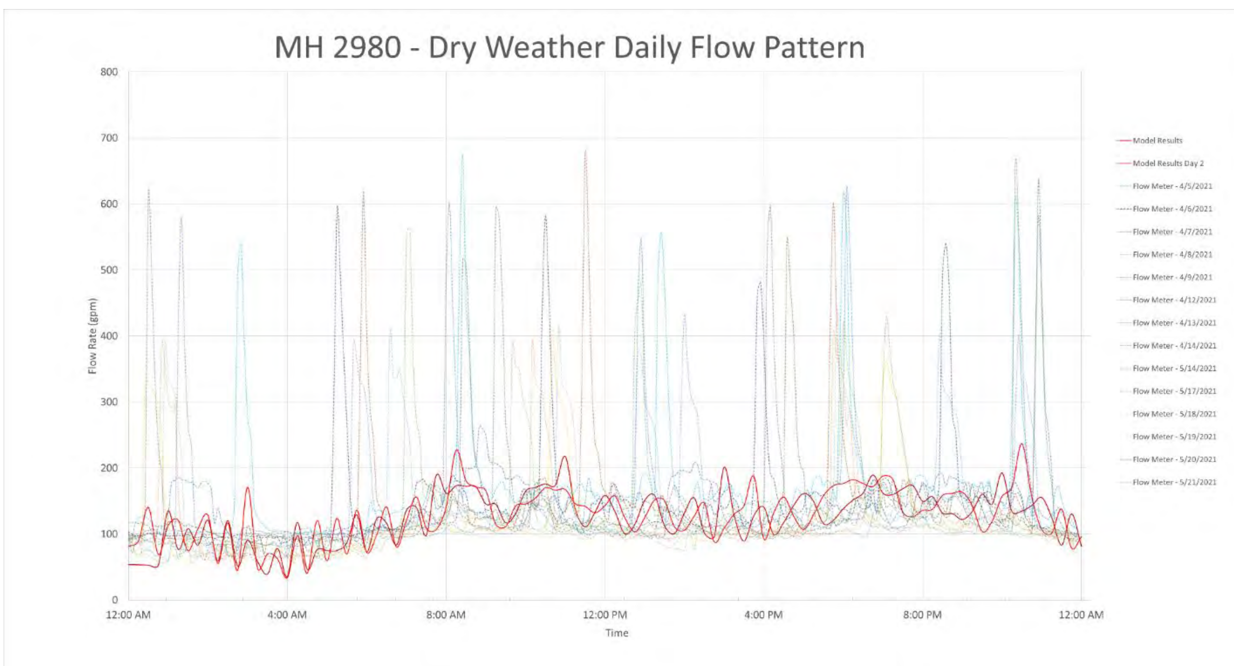


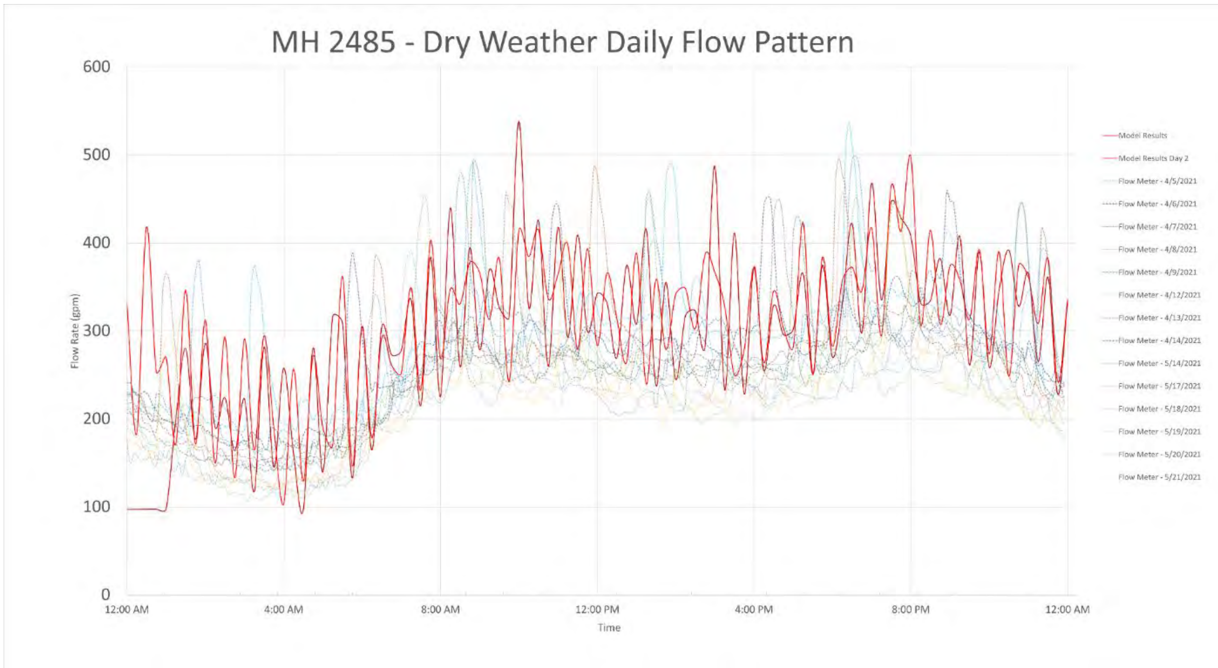
MH 3520 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
1600
1400
1200
1000
800
600
400
200
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

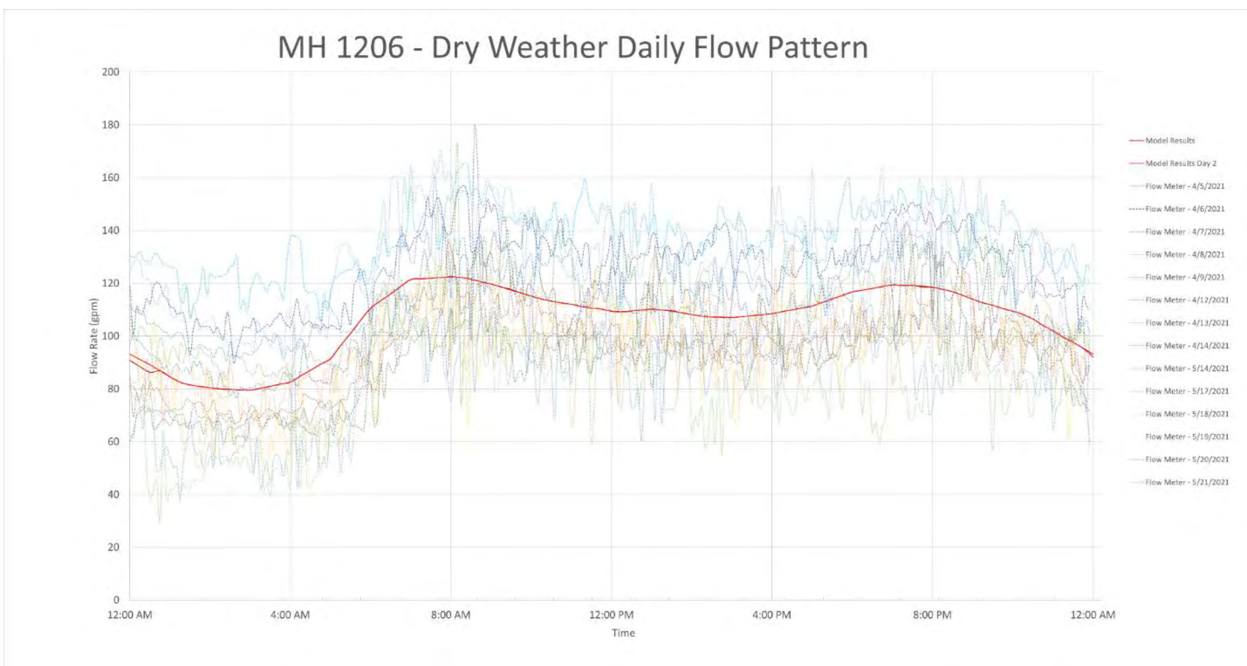

MH 5893 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
1600
1400
1200
1000
800
600
400
200
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

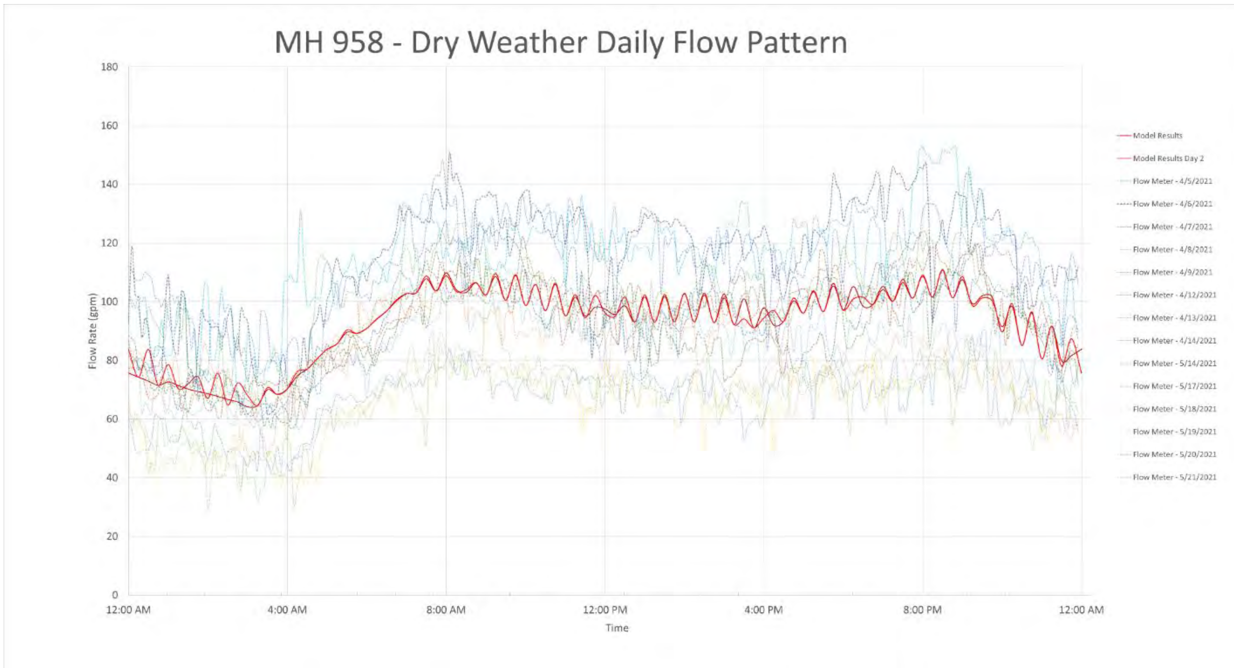

MH 3135 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
1800
1600
1400
1200
1000
800
600
400
200
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021


MH 5716 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

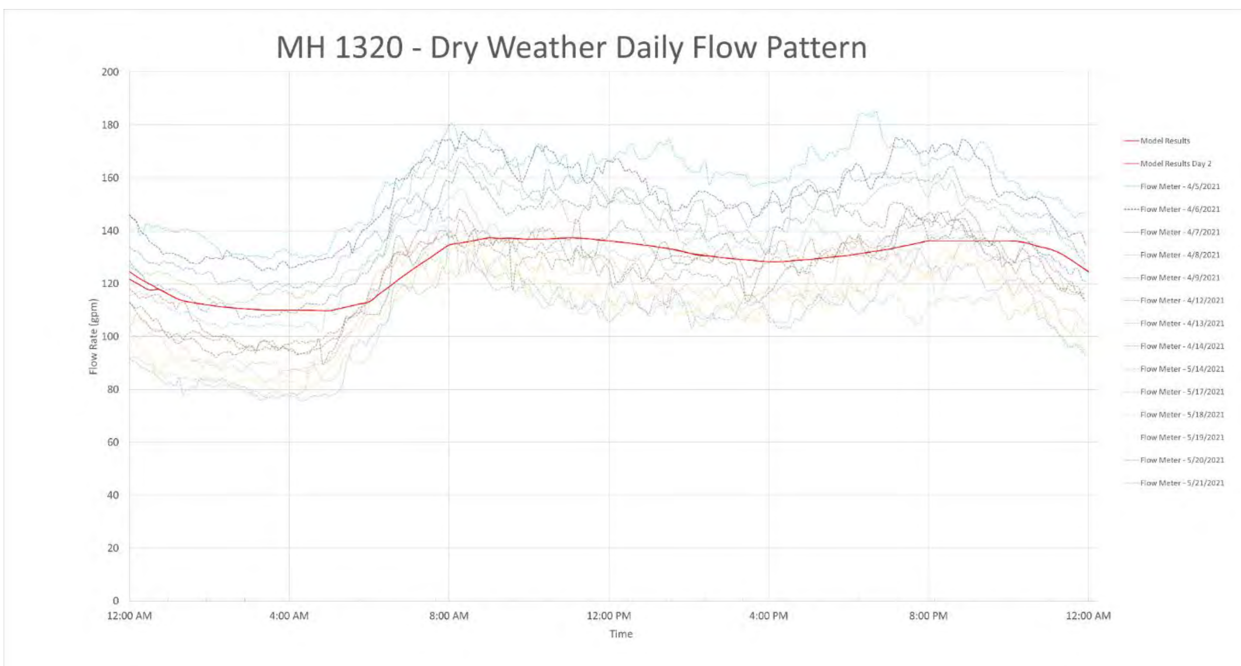

MH 2980 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021


MH 2485 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
600
500
400
300
200
100
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

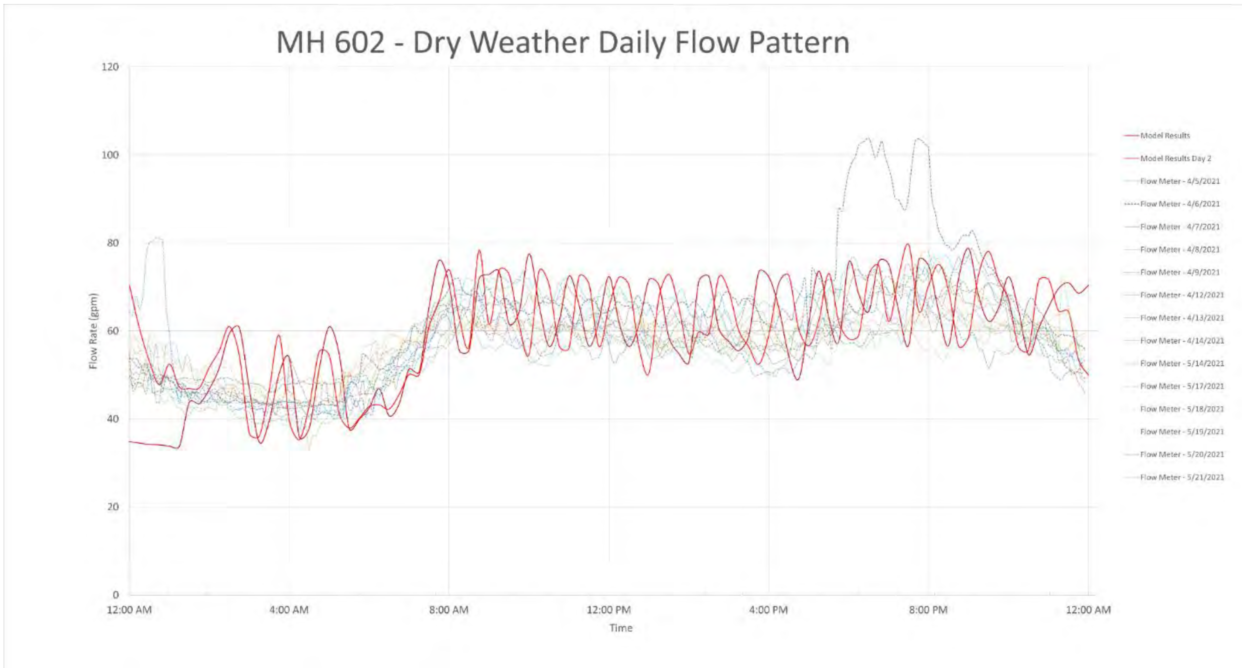

MH 1206 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
200
180
160
140
120
100
80
60
40
20
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

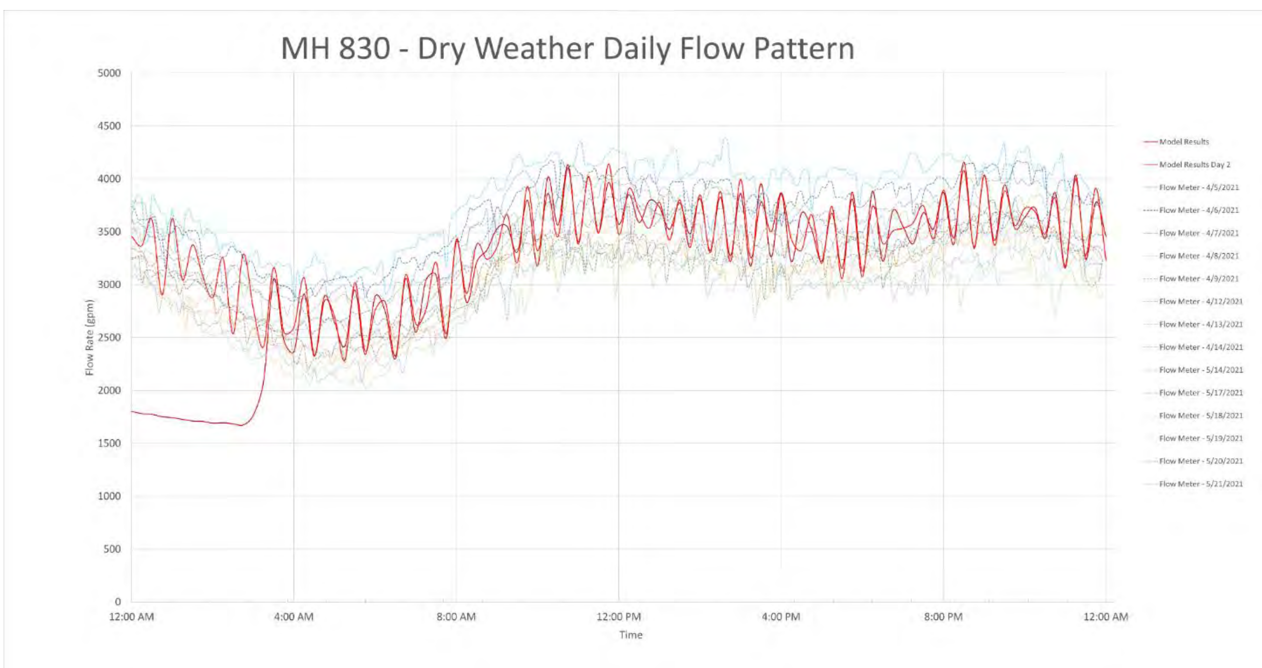


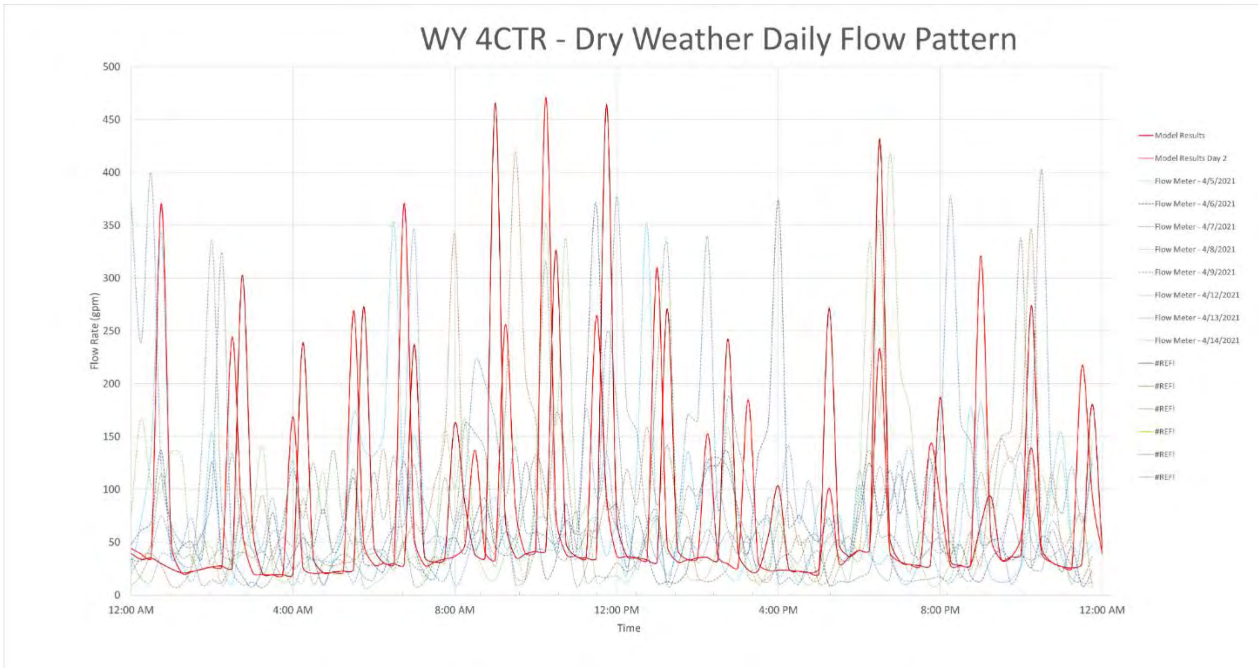
MH 958 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
0
20
40
60
80
100
120
140
160
180
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021



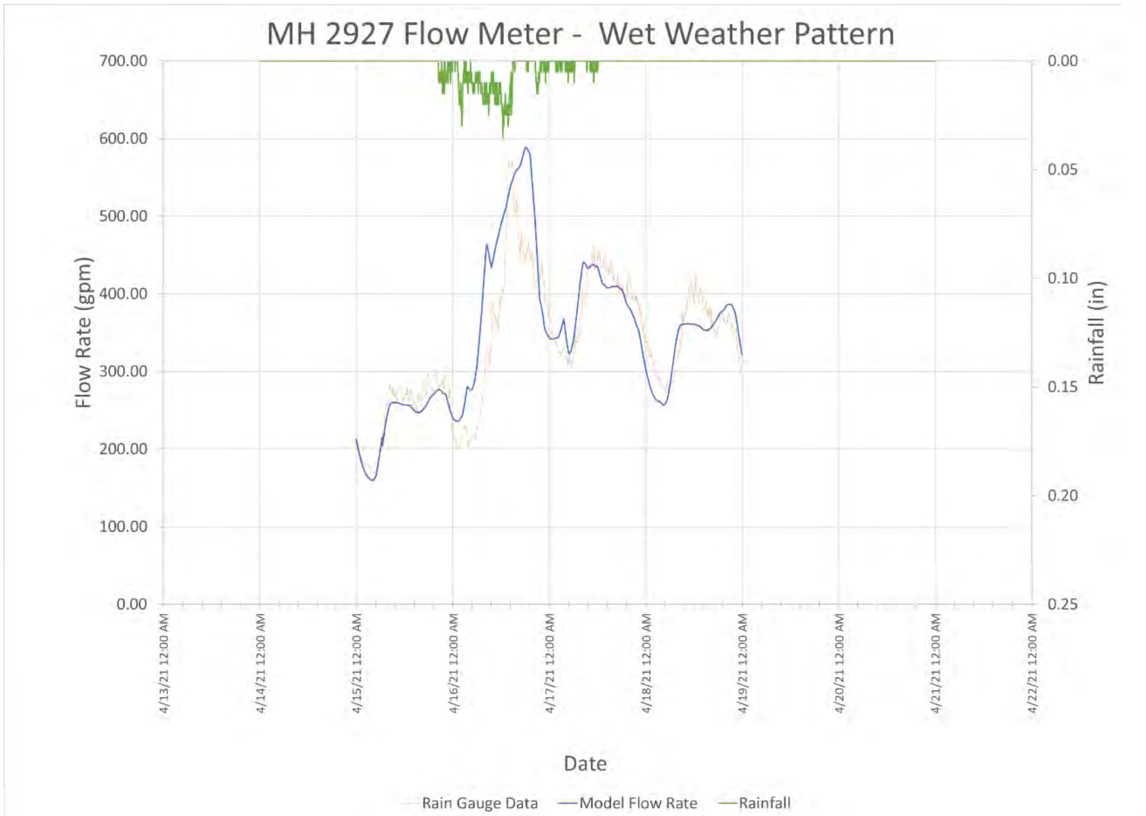
MH 1320 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
Time
0
20
40
60
80
100
120
140
160
180
200
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021


MH 602 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
120
100
80
60
40
20
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021

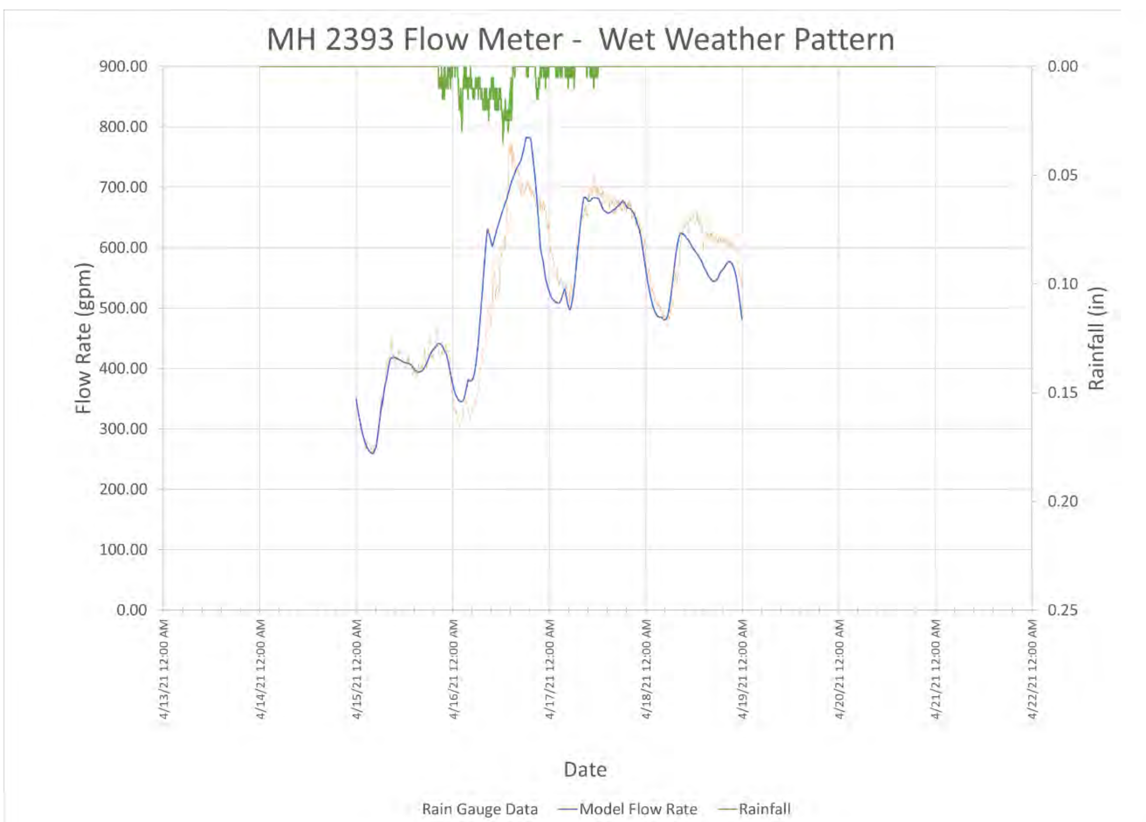

MH 830 - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
Flow Meter - 5/14/2021
Flow Meter - 5/17/2021
Flow Meter - 5/18/2021
Flow Meter - 5/19/2021
Flow Meter - 5/20/2021
Flow Meter - 5/21/2021


WY 4CTR - Dry Weather Daily Flow Pattern
Flow Rate (gpm)
500
450
400
350
300
250
200
150
100
50
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Time
Model Results
Model Results Day 2
Flow Meter - 4/5/2021
Flow Meter - 4/6/2021
Flow Meter - 4/7/2021
Flow Meter - 4/8/2021
Flow Meter - 4/9/2021
Flow Meter - 4/12/2021
Flow Meter - 4/13/2021
Flow Meter - 4/14/2021
#REF!
#REF!
#REF!
#REF!
#REF!
#REF!

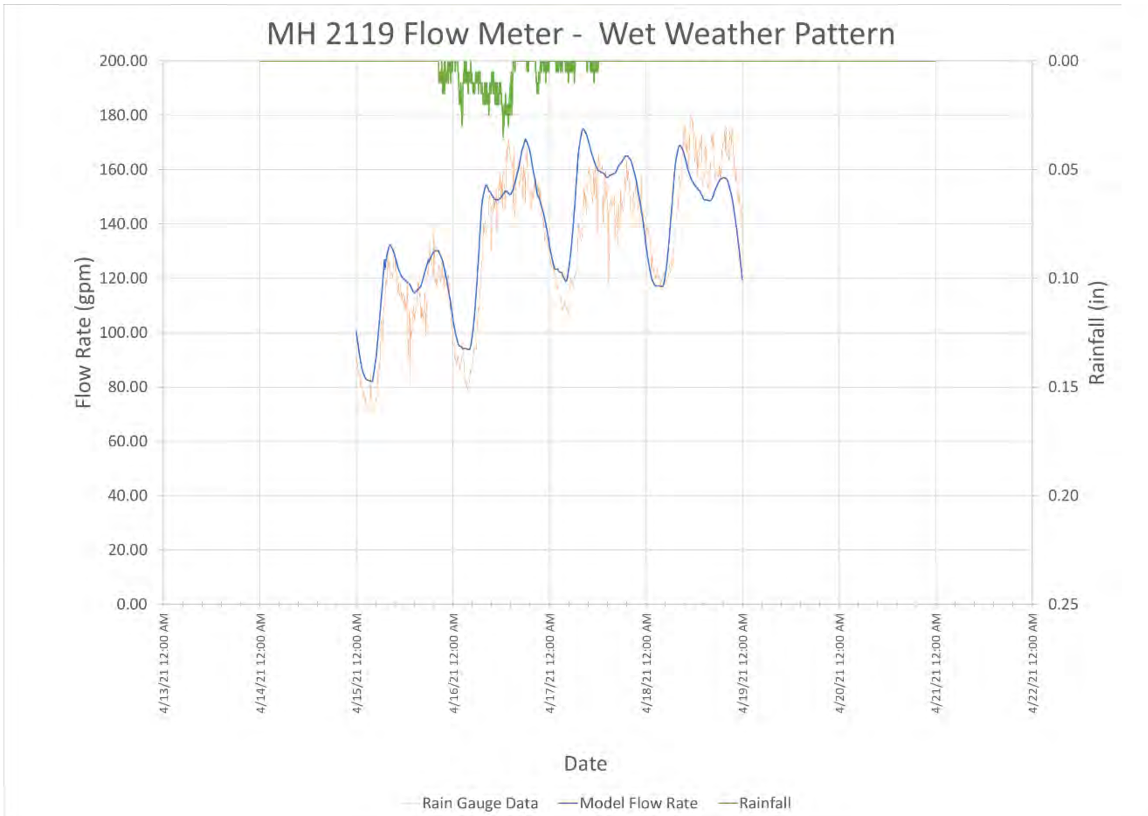
APPENDIX B - WET WEATHER SEWER MODEL CALIBRATION RESULTS



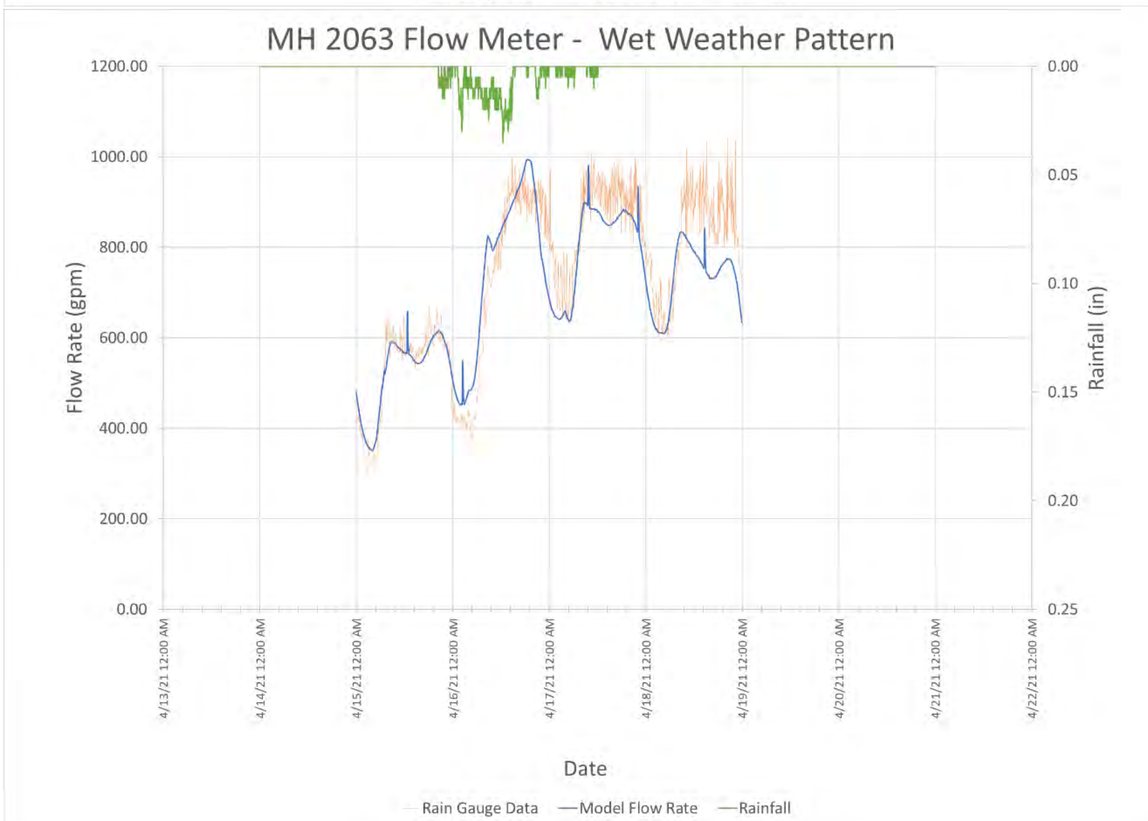
MH 2927 Flow Meter - Wet Weather Pattern
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Flow Rate (gpm)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall



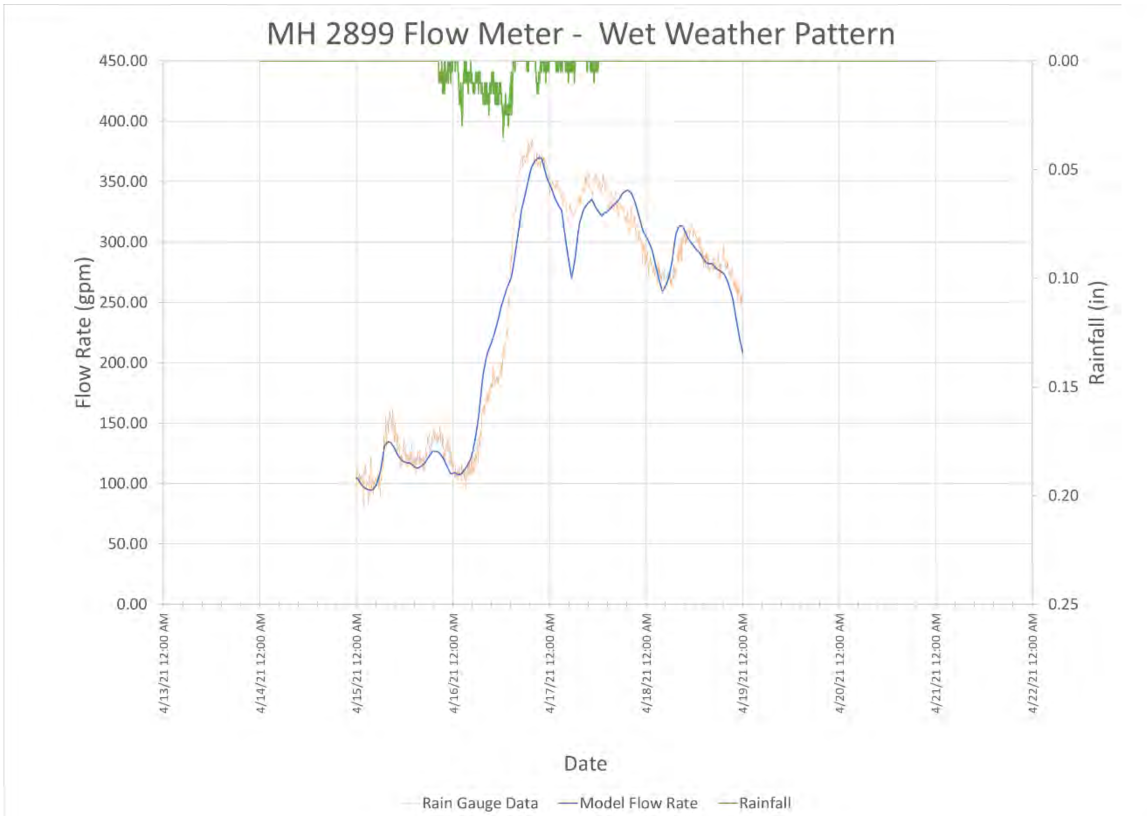
MH 2393 Flow Meter - Wet Weather Pattern
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Flow Rate (gpm)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall



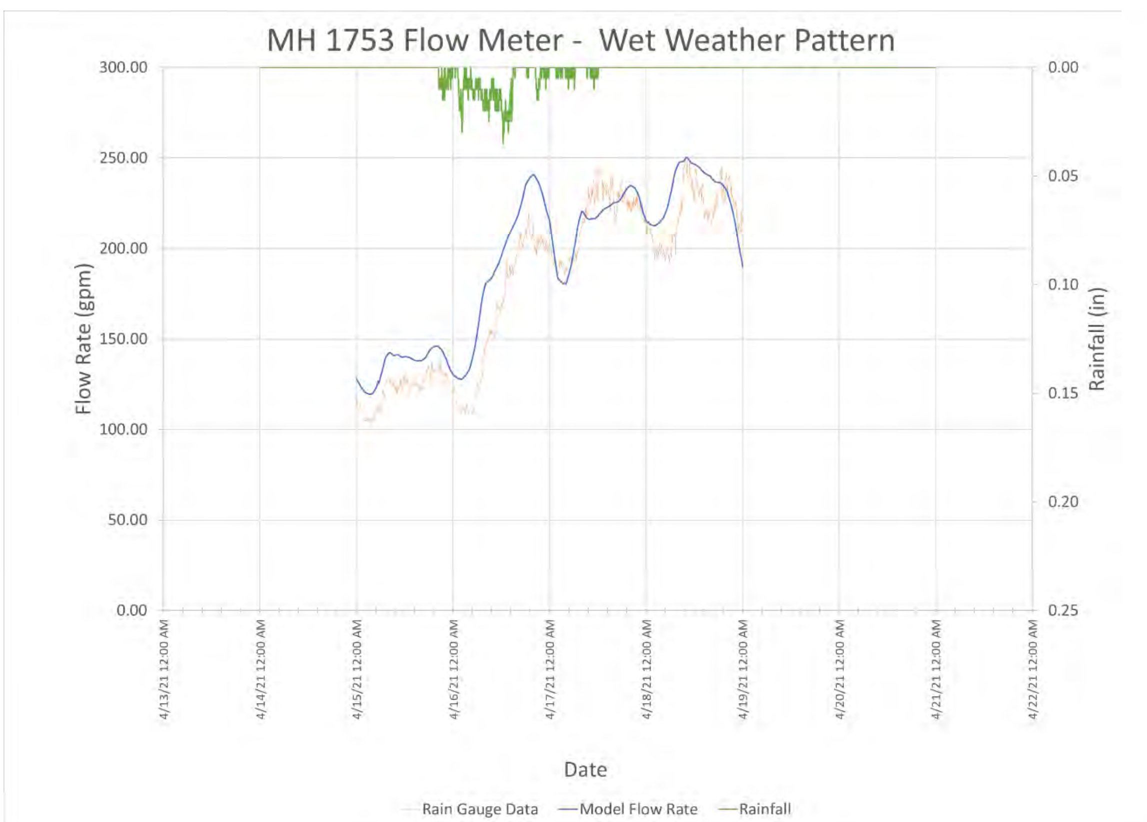
MH 2119 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Rainfall (in)
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall



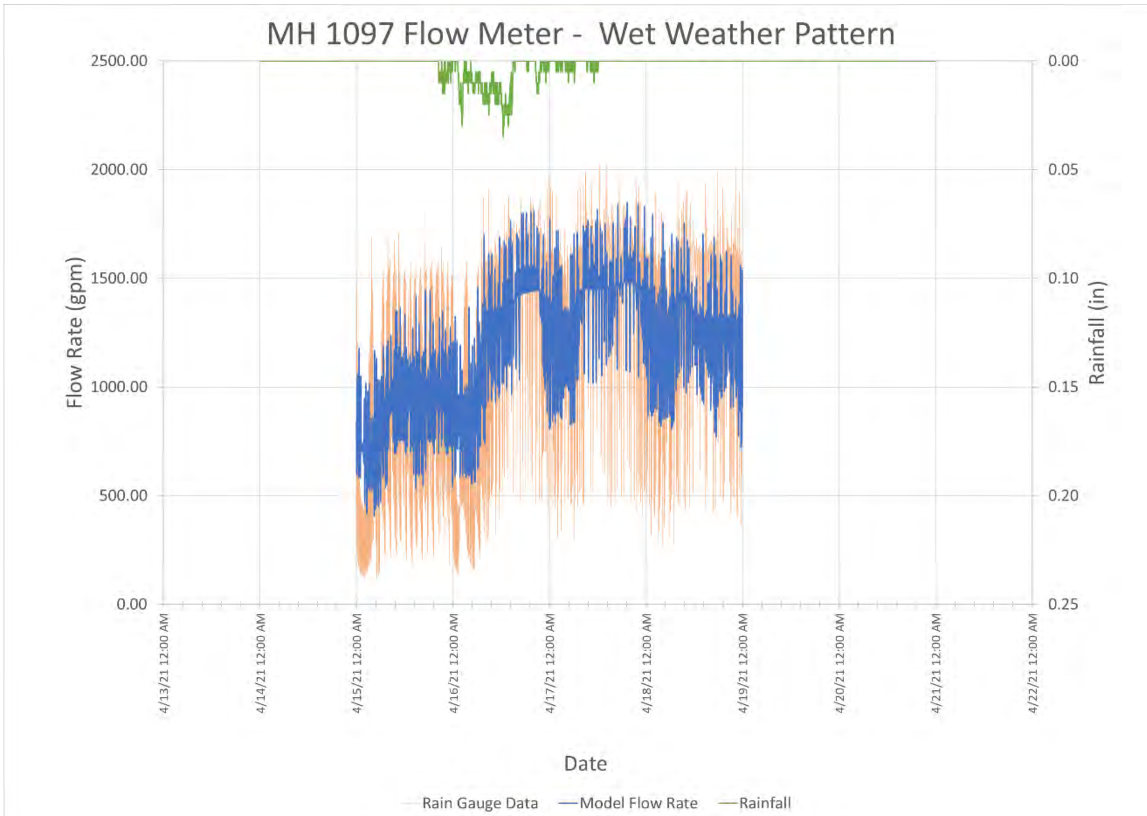
MH 2063 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Rainfall (in)
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall

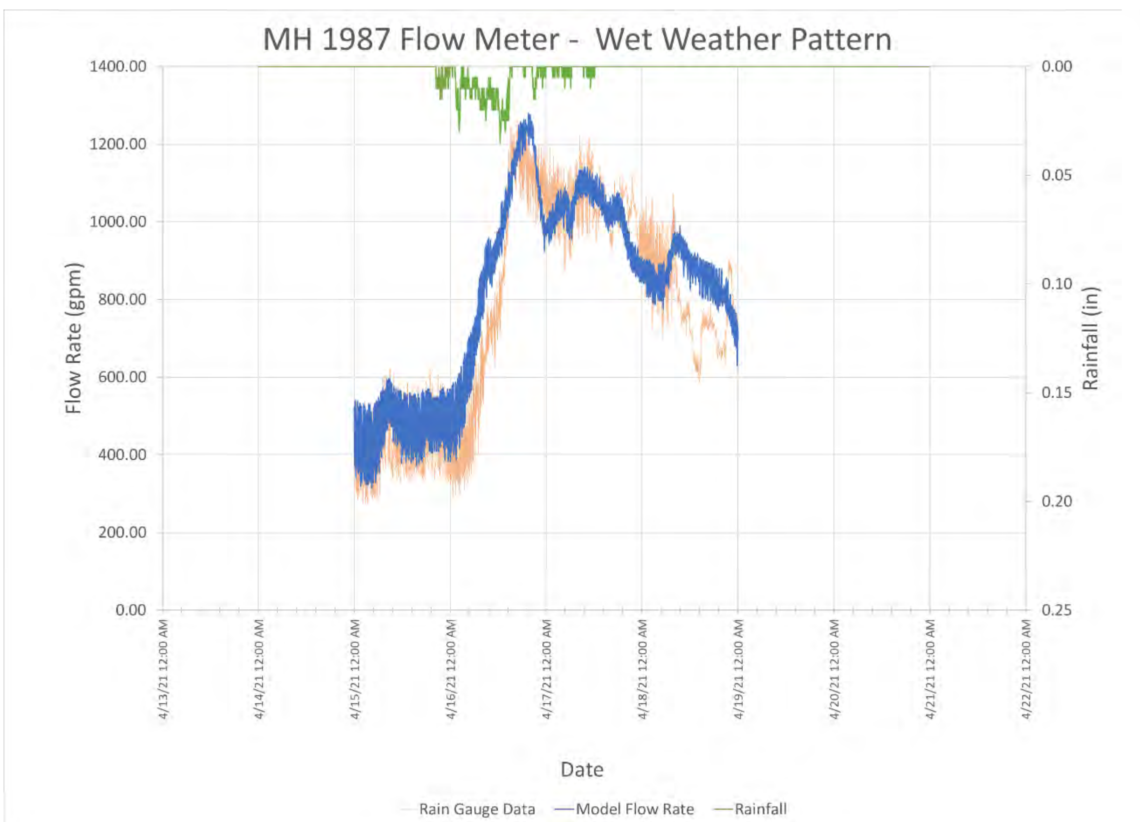


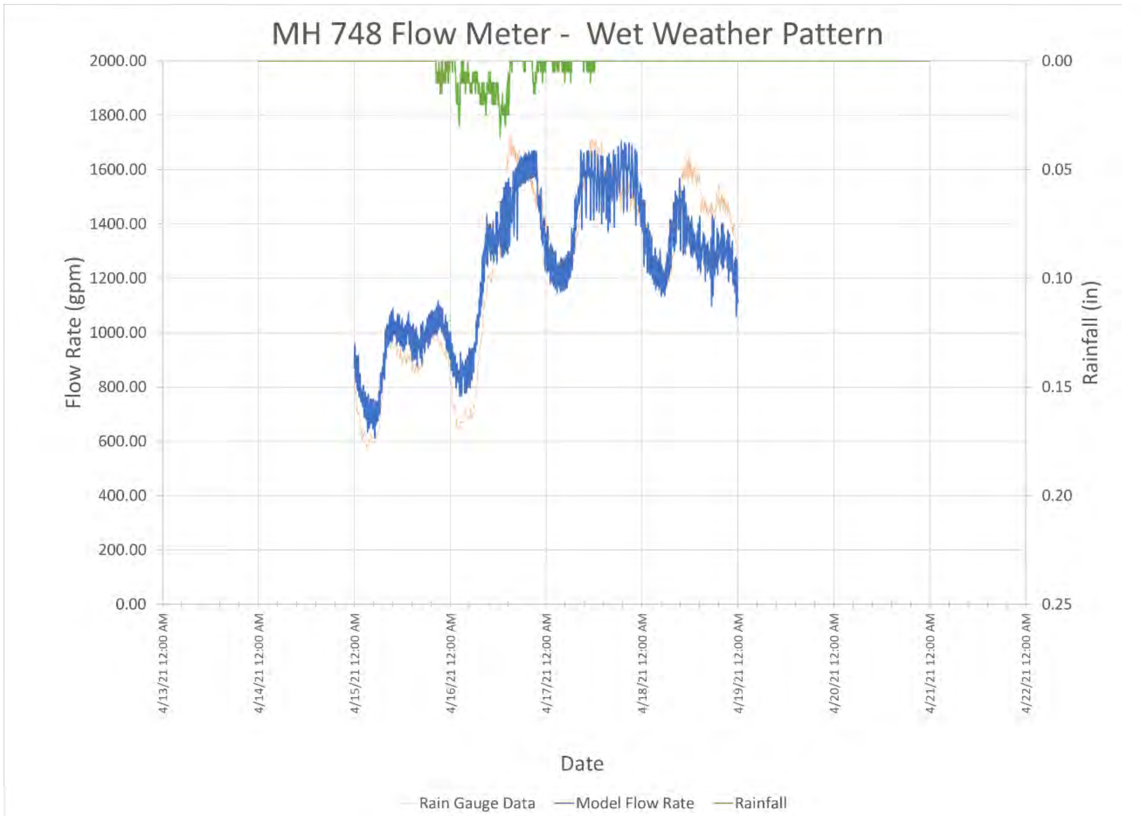
MH 2899 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall

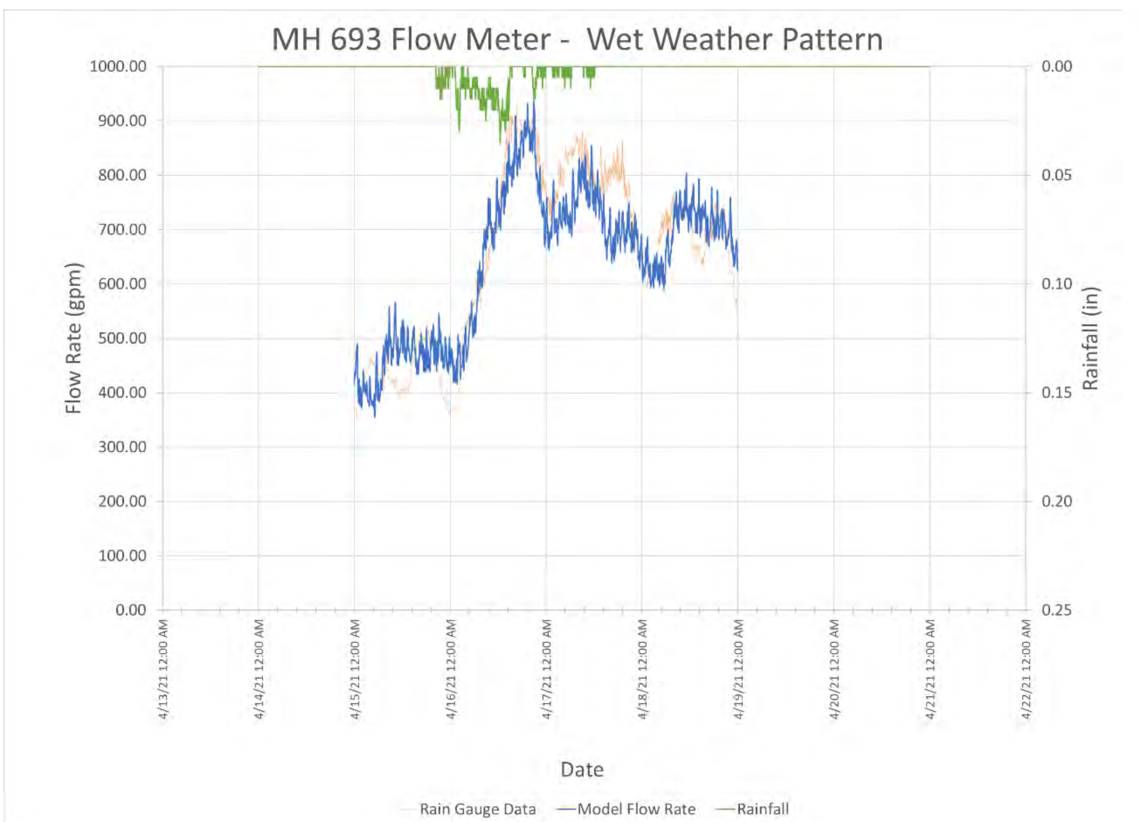


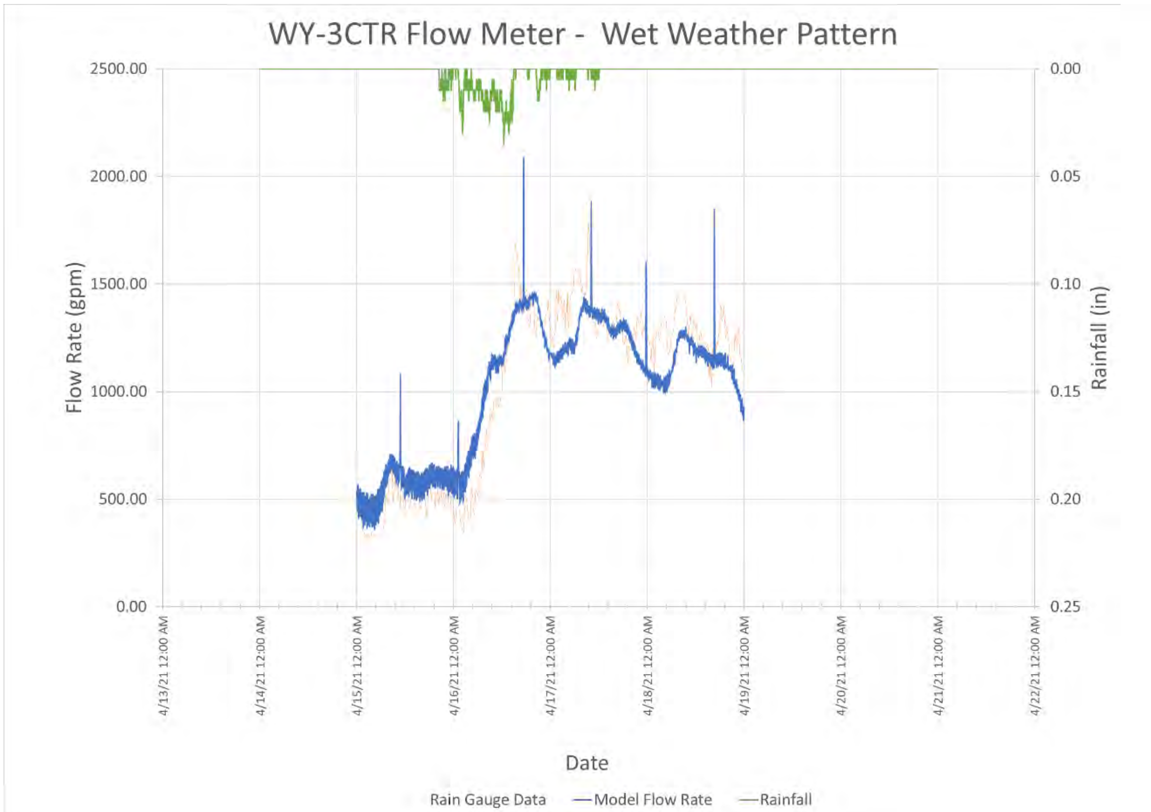
MH 1753 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall

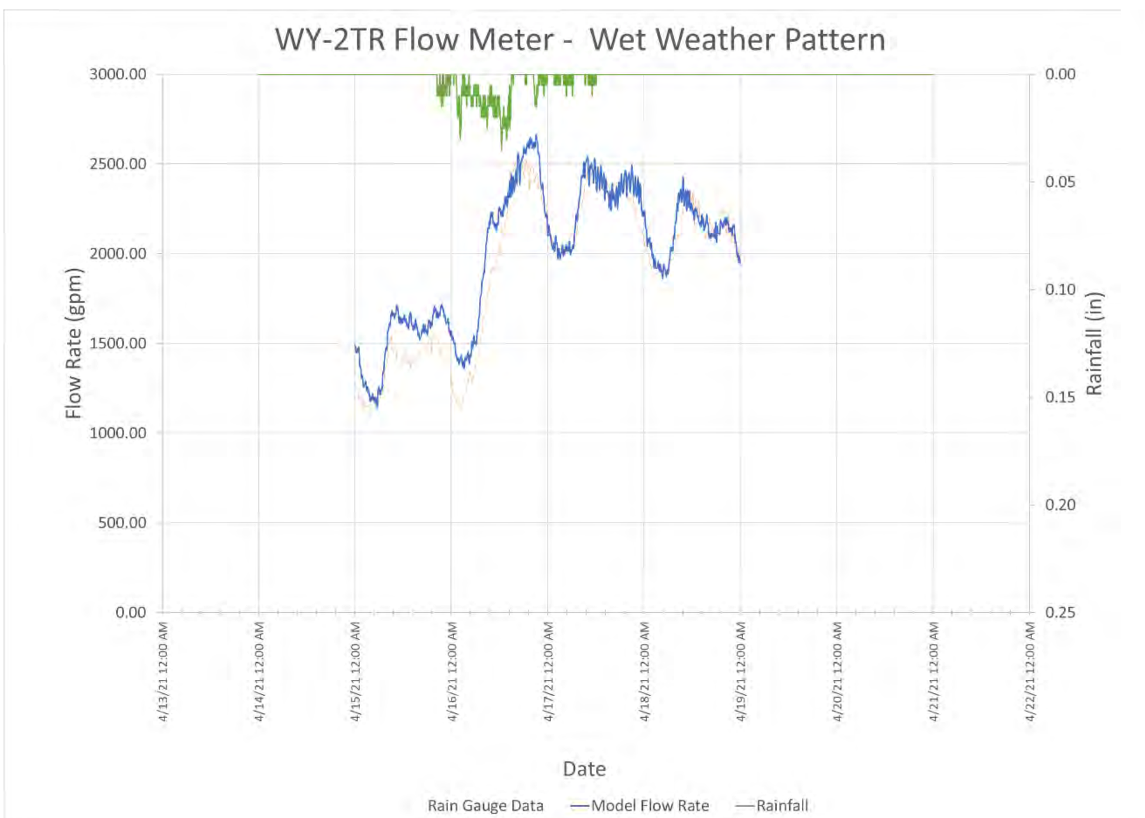

MH 1097 Flow Meter - Wet Weather Pattern
2500.00
2000.00
1500.00
1000.00
500.00
0.00
Flow Rate (gpm)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall

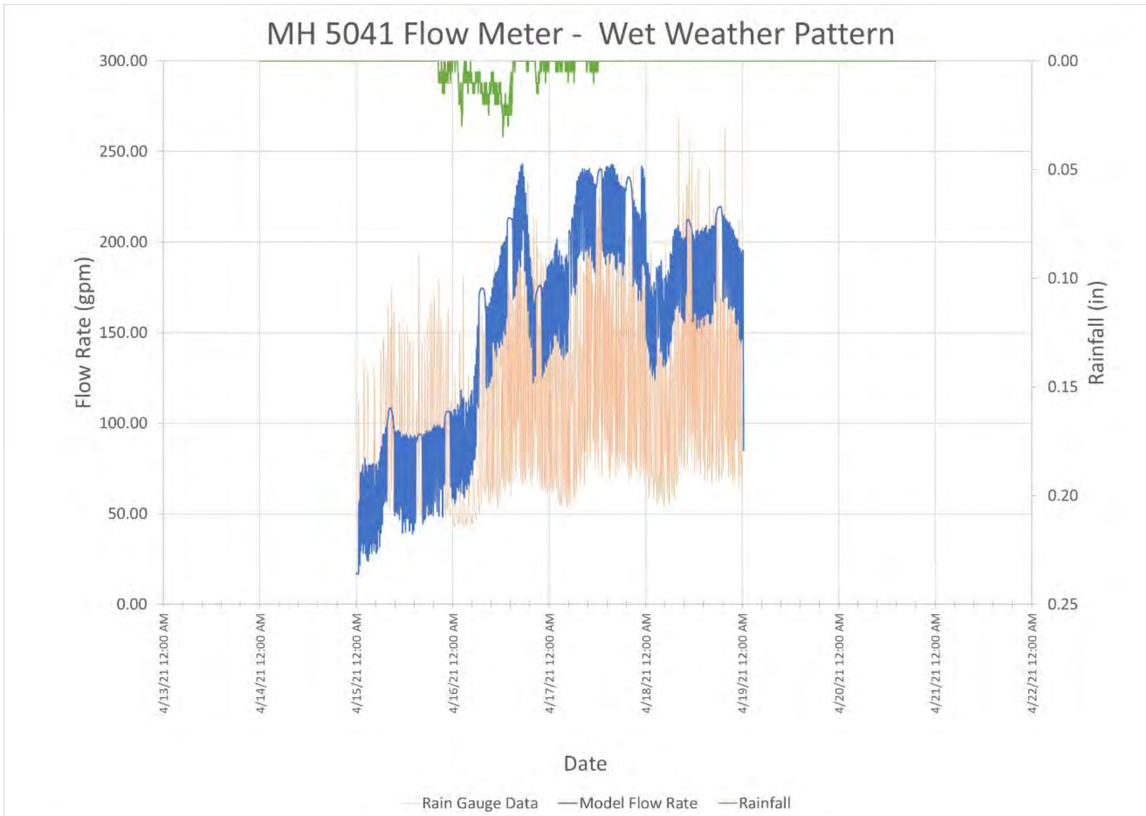

MH 1987 Flow Meter - Wet Weather Pattern
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Flow Rate (gpm)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall


MH 748 Flow Meter - Wet Weather Pattern
2000.00
1800.00
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Flow Rate (gpm)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall

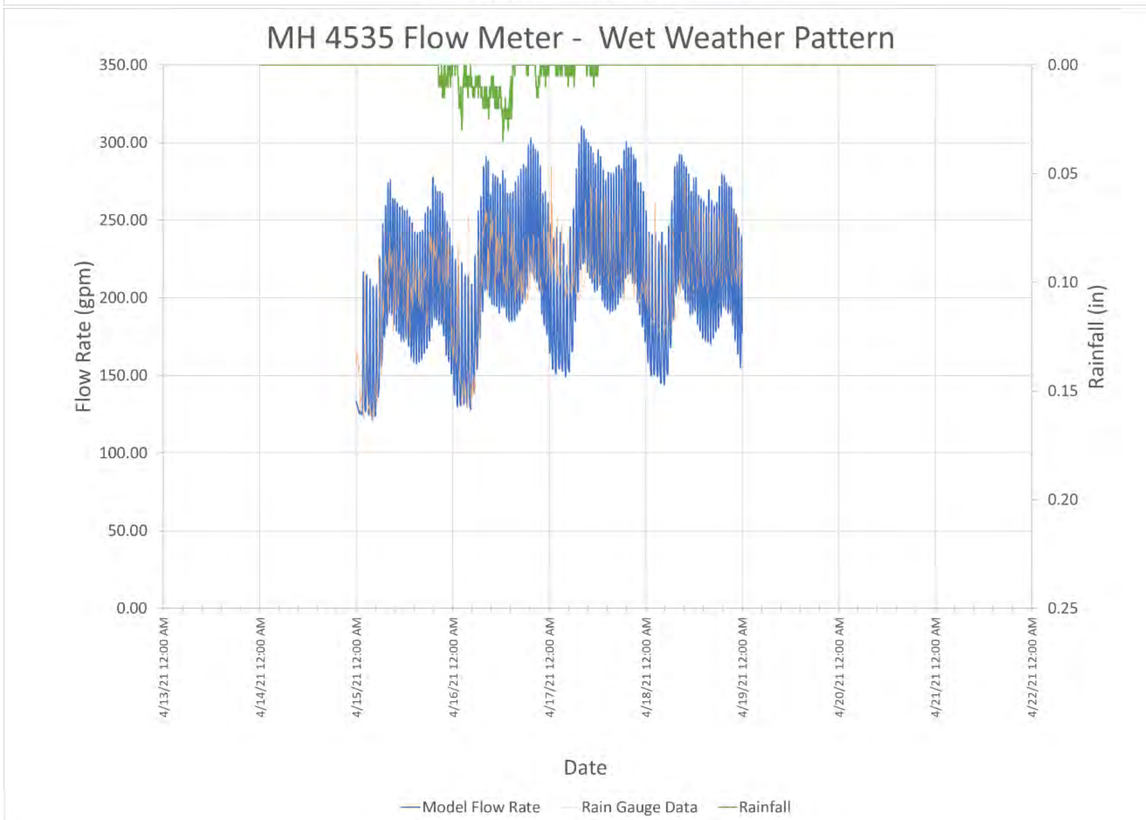

MH 693 Flow Meter - Wet Weather Pattern
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Flow Rate (gpm)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall


WY-3CTR Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
2500.00
2000.00
1500.00
1000.00
500.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall

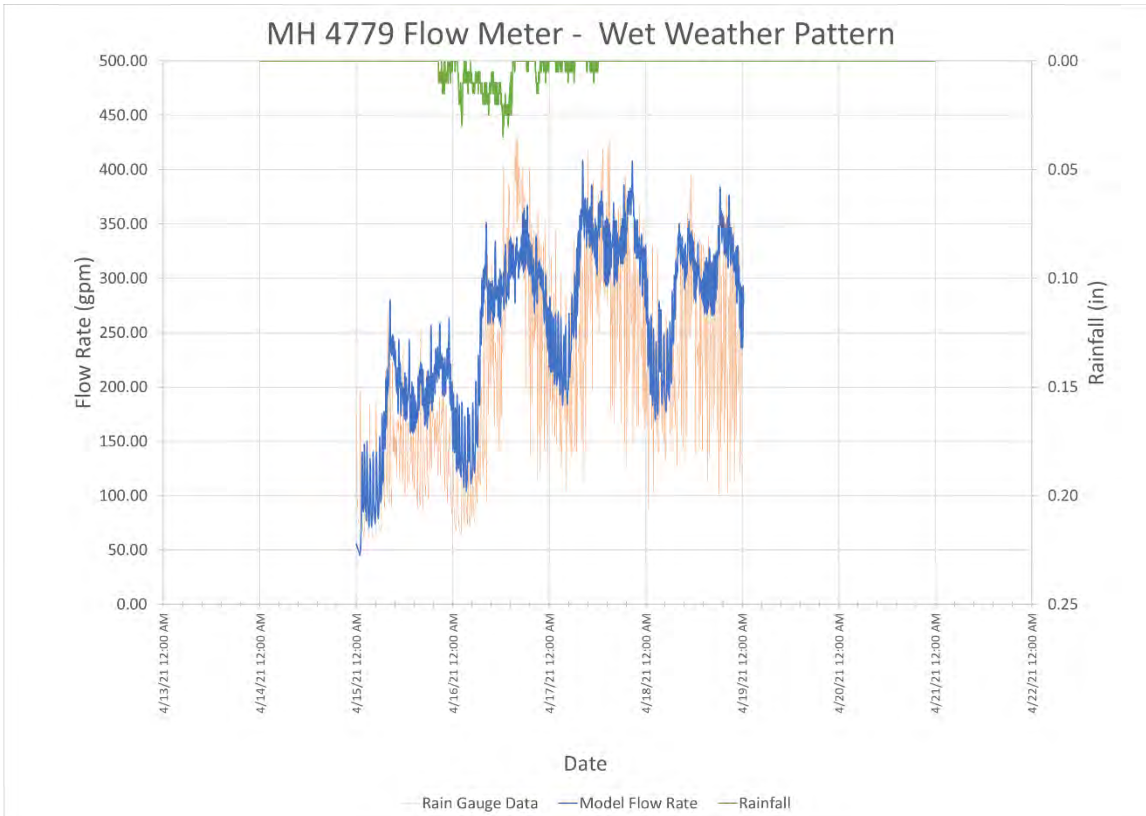

WY-2TR Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall



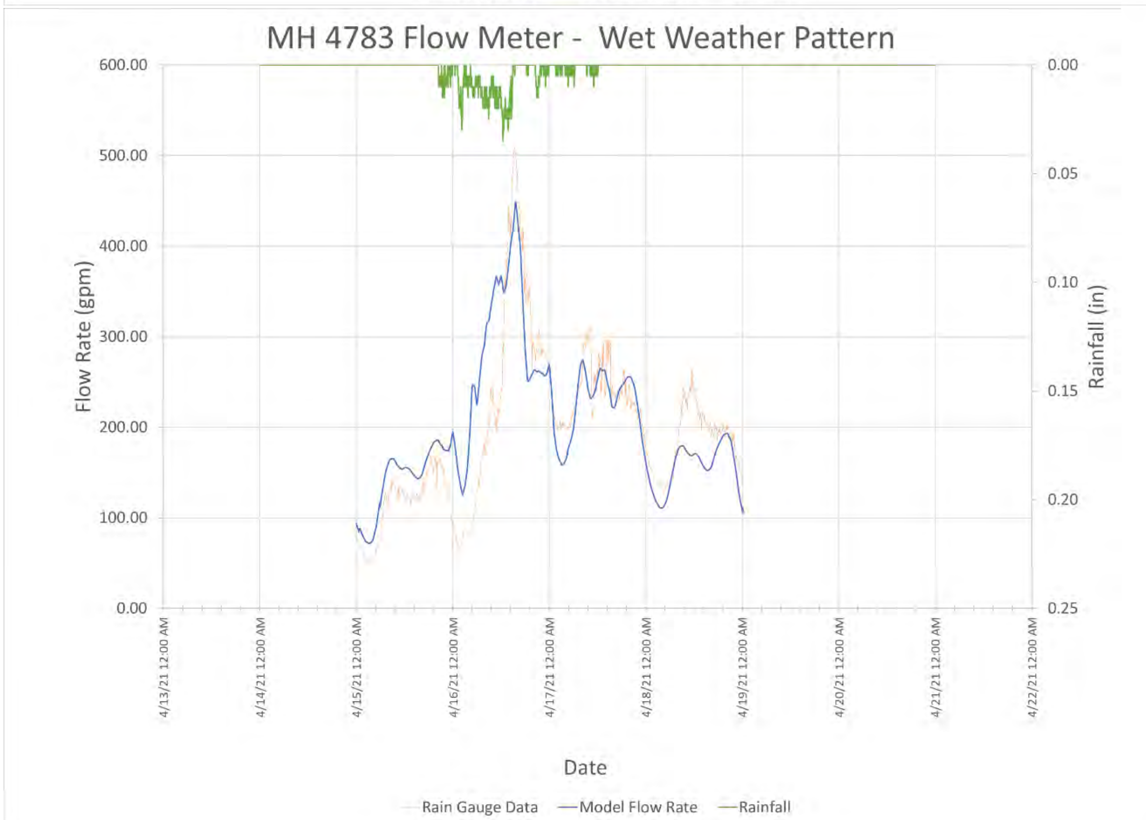
MH 5041 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall



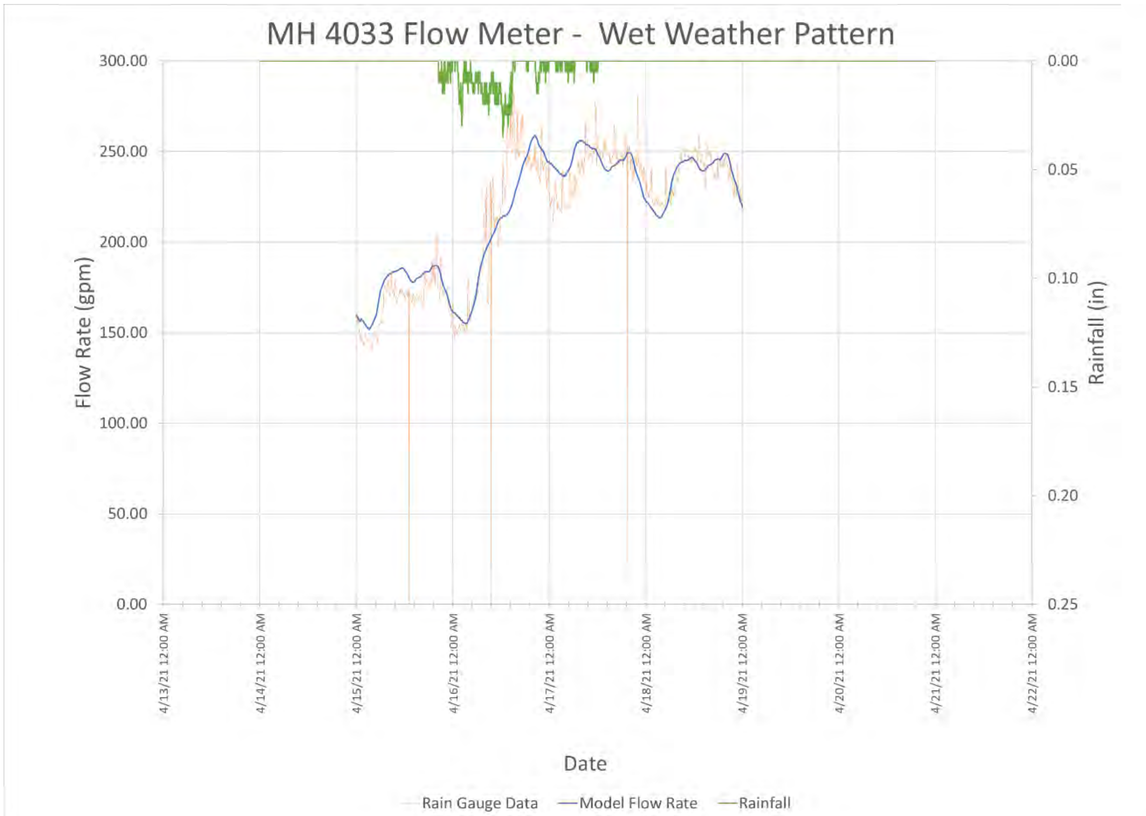
MH 4535 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Model Flow Rate
Rain Gauge Data
Rainfall

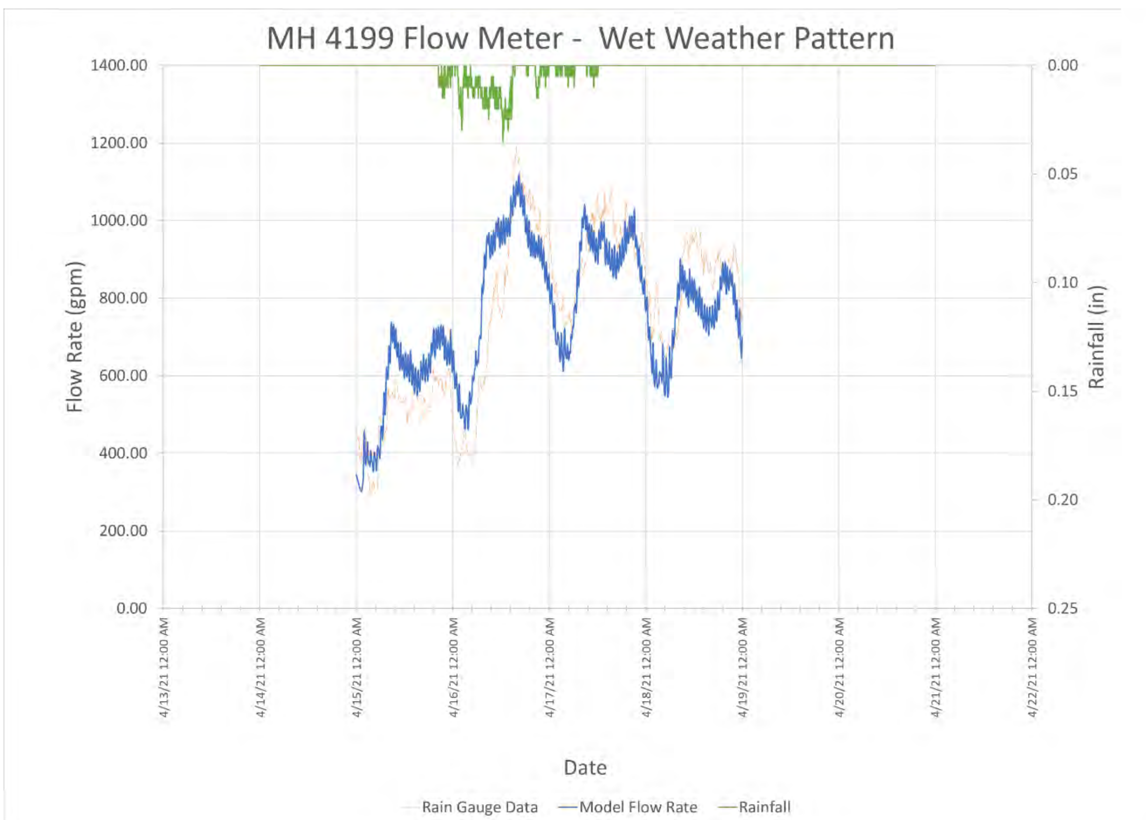


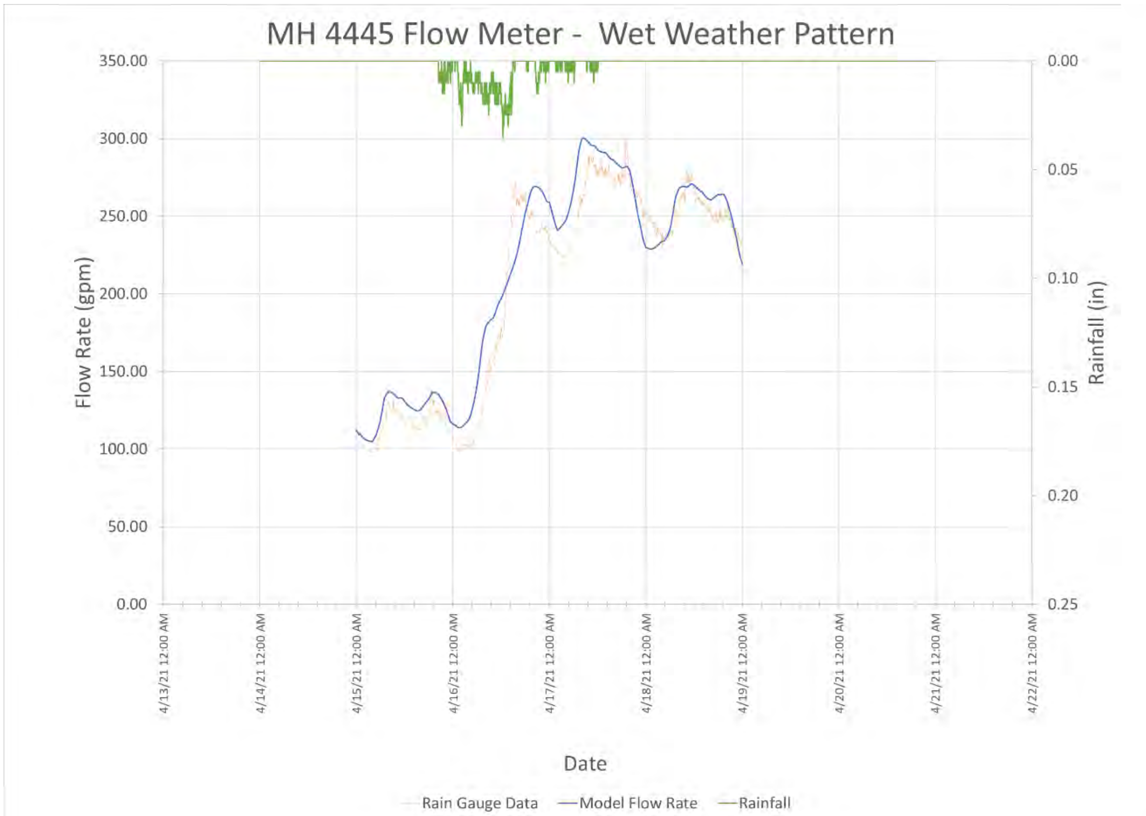
MH 4779 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall

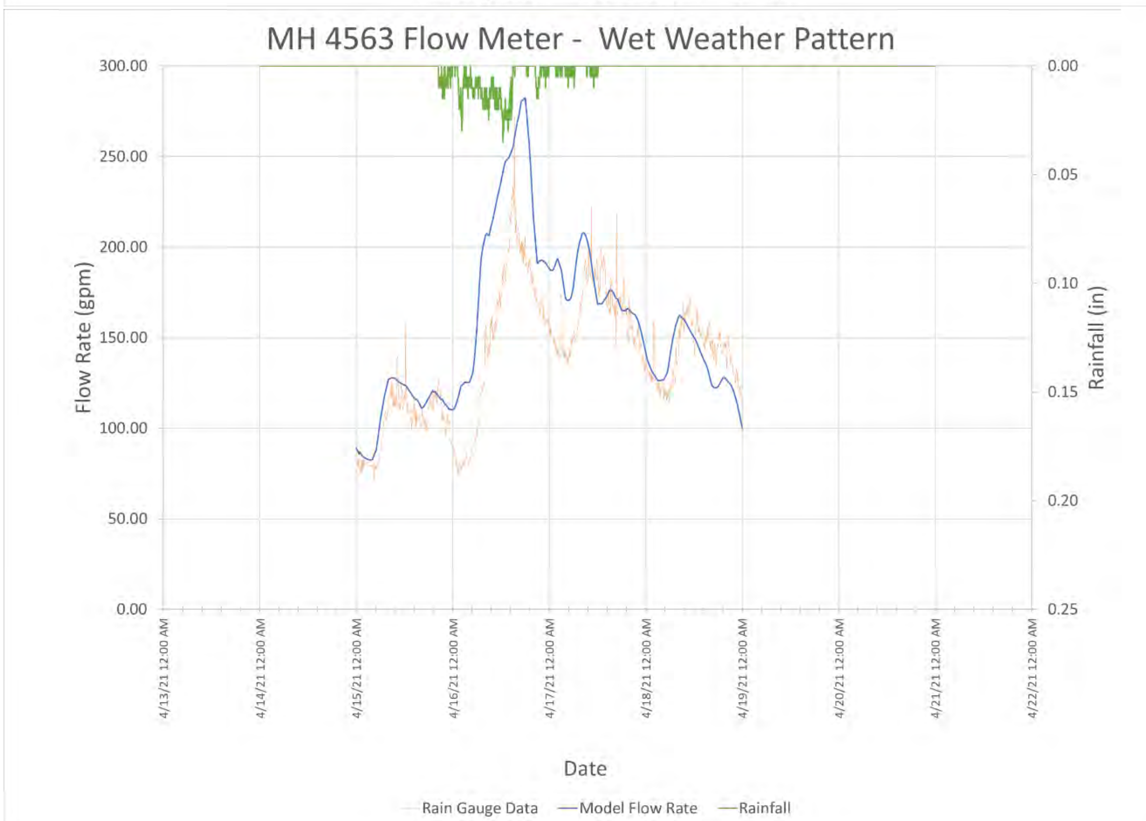


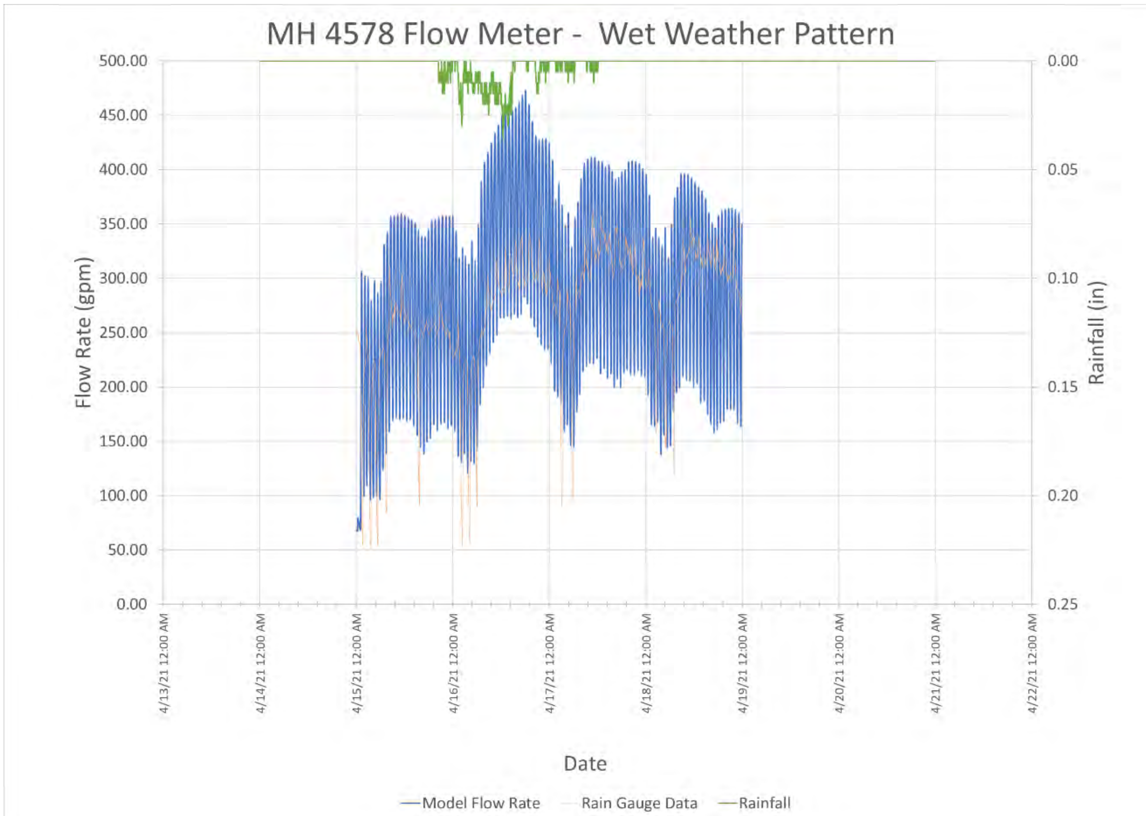
MH 4783 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall

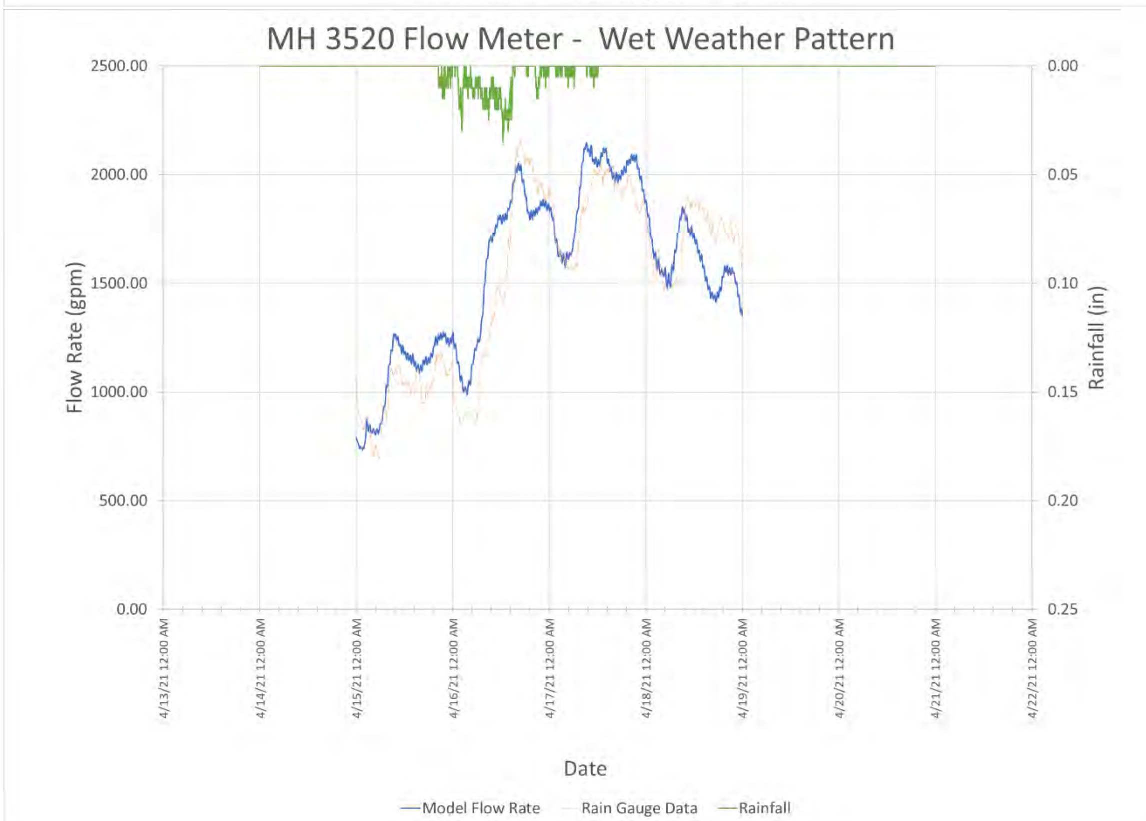

MH 4033 Flow Meter - Wet Weather Pattern
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Flow Rate (gpm)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall

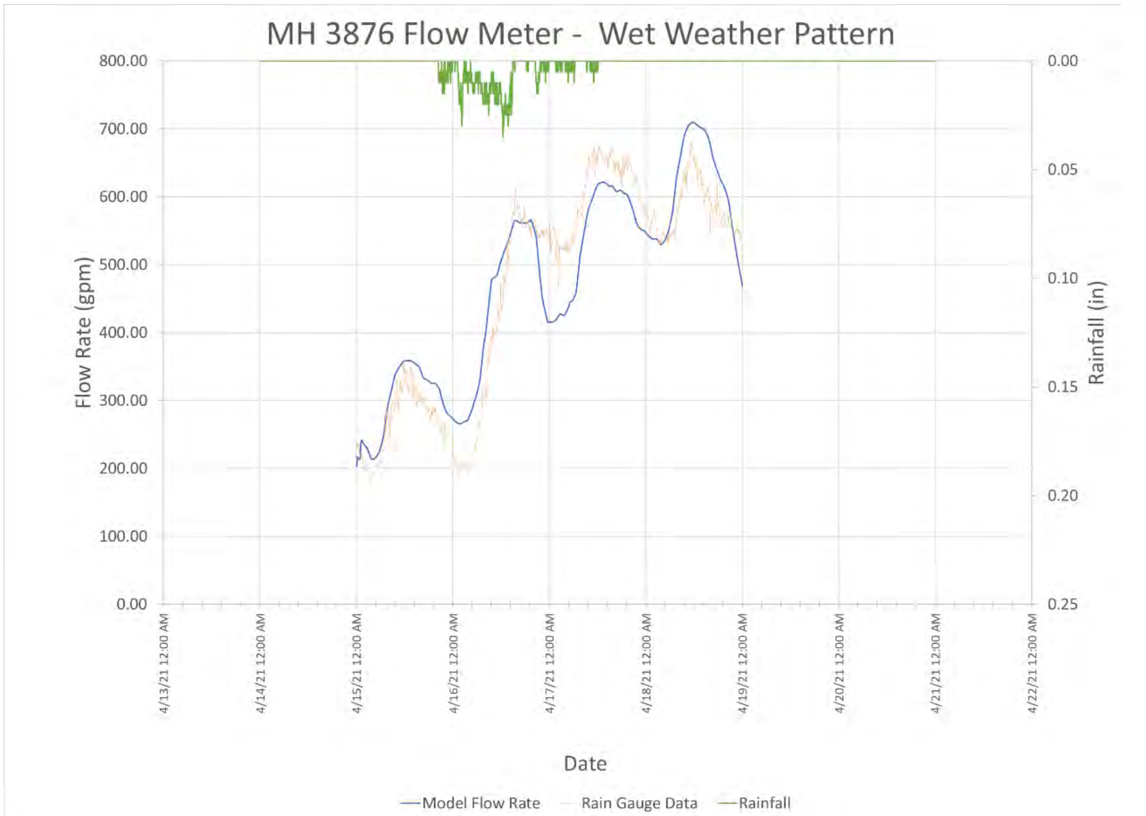

MH 4199 Flow Meter - Wet Weather Pattern
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Flow Rate (gpm)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall

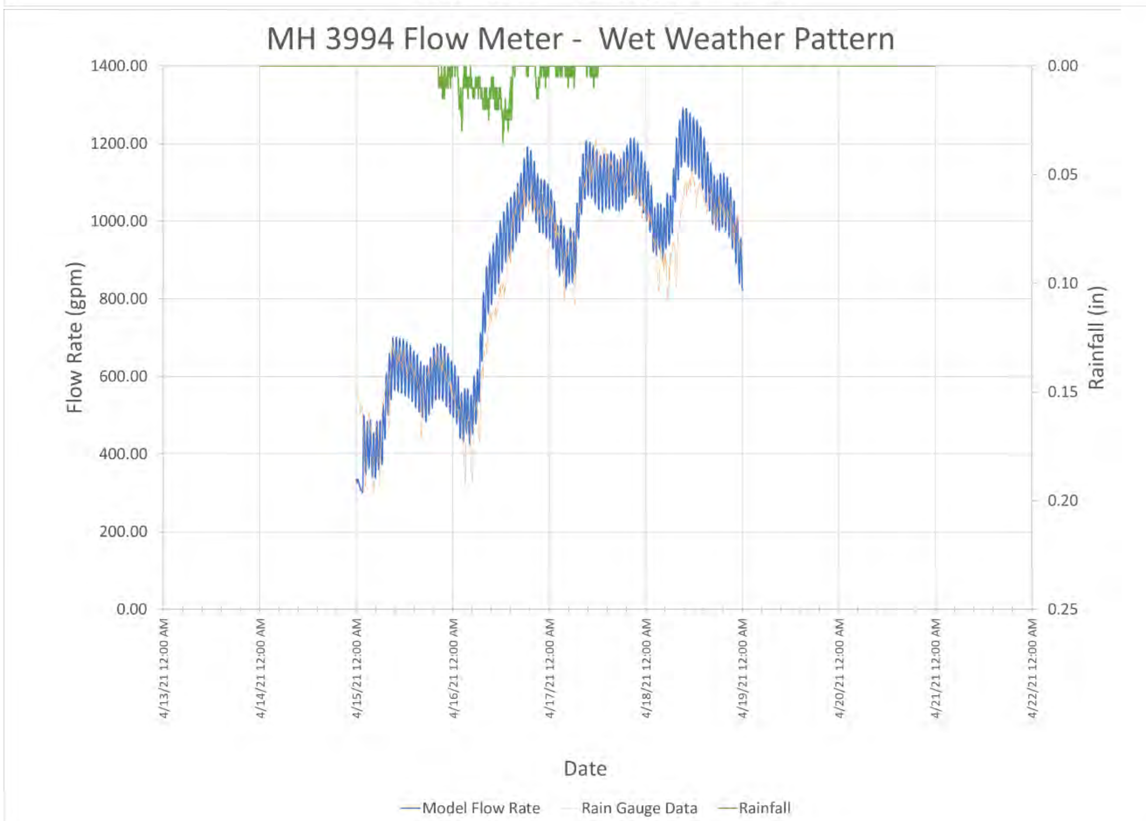

MH 4445 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall

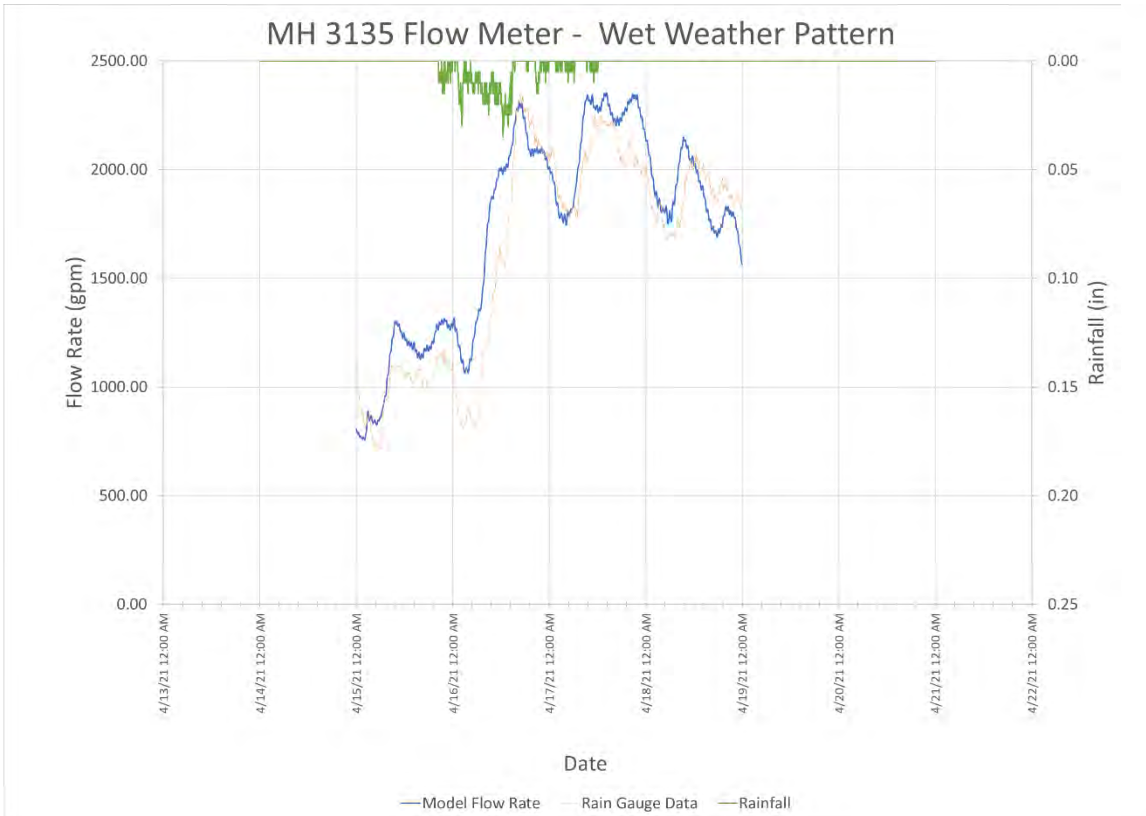

MH 4563 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Rain Gauge Data
Model Flow Rate
Rainfall

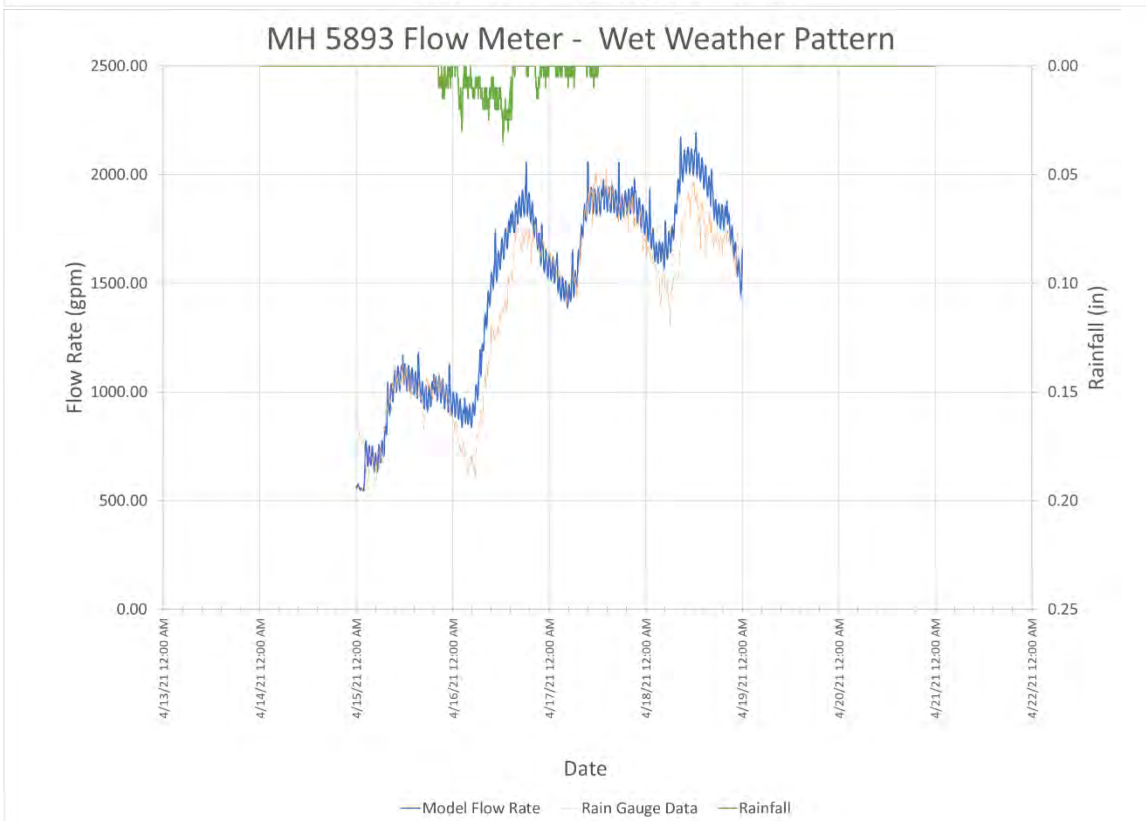

MH 4578 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Model Flow Rate
Rain Gauge Data
Rainfall

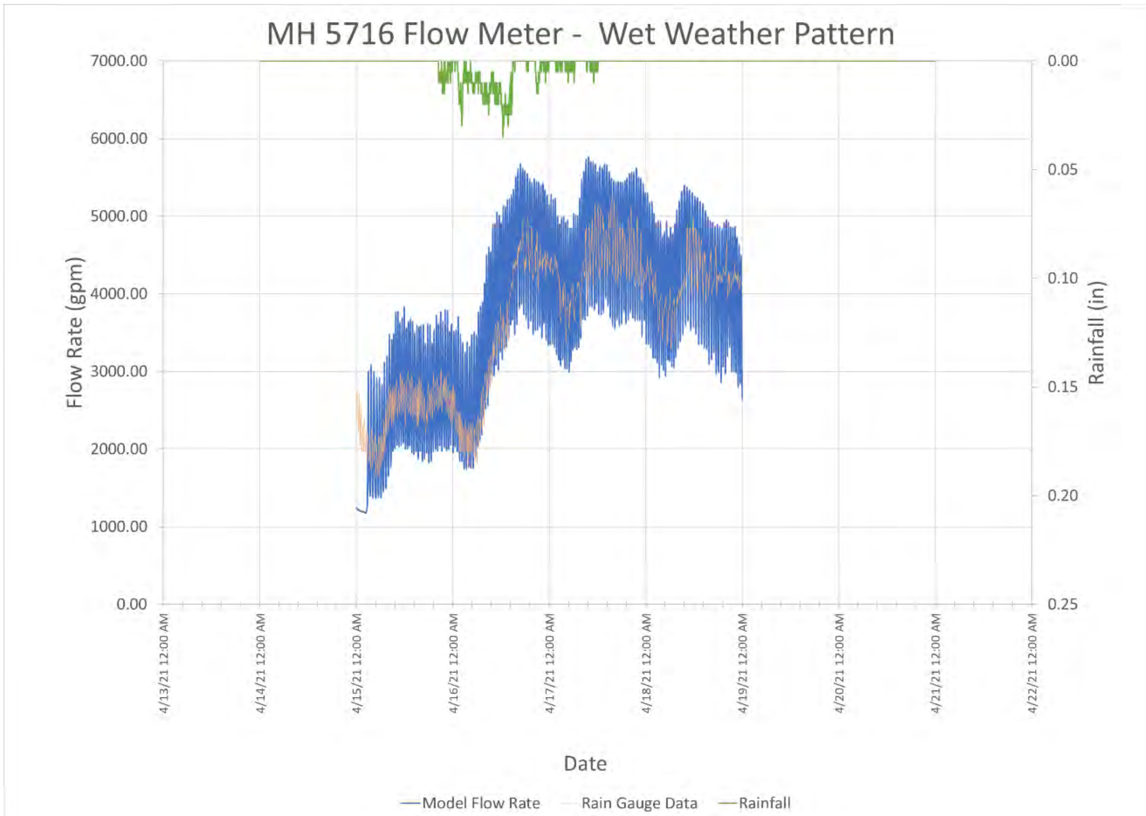

MH 3520 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
2500.00
2000.00
1500.00
1000.00
500.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Model Flow Rate
Rain Gauge Data
Rainfall


MH 3876 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Rainfall (in)
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Model Flow Rate
Rain Gauge Data
Rainfall

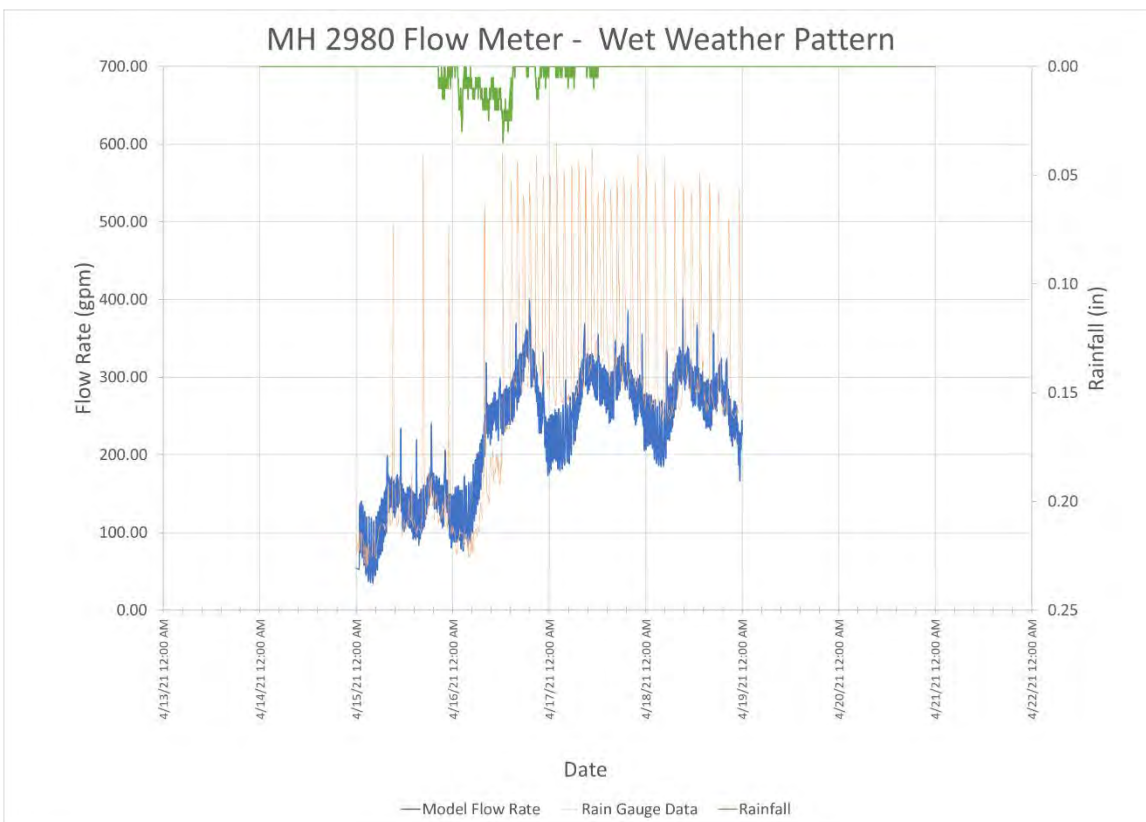

MH 3994 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Rainfall (in)
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Model Flow Rate
Rain Gauge Data
Rainfall


MH 3135 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
2500.00
2000.00
1500.00
1000.00
500.00
0.00
Rainfall (in)
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Model Flow Rate
Rain Gauge Data
Rainfall

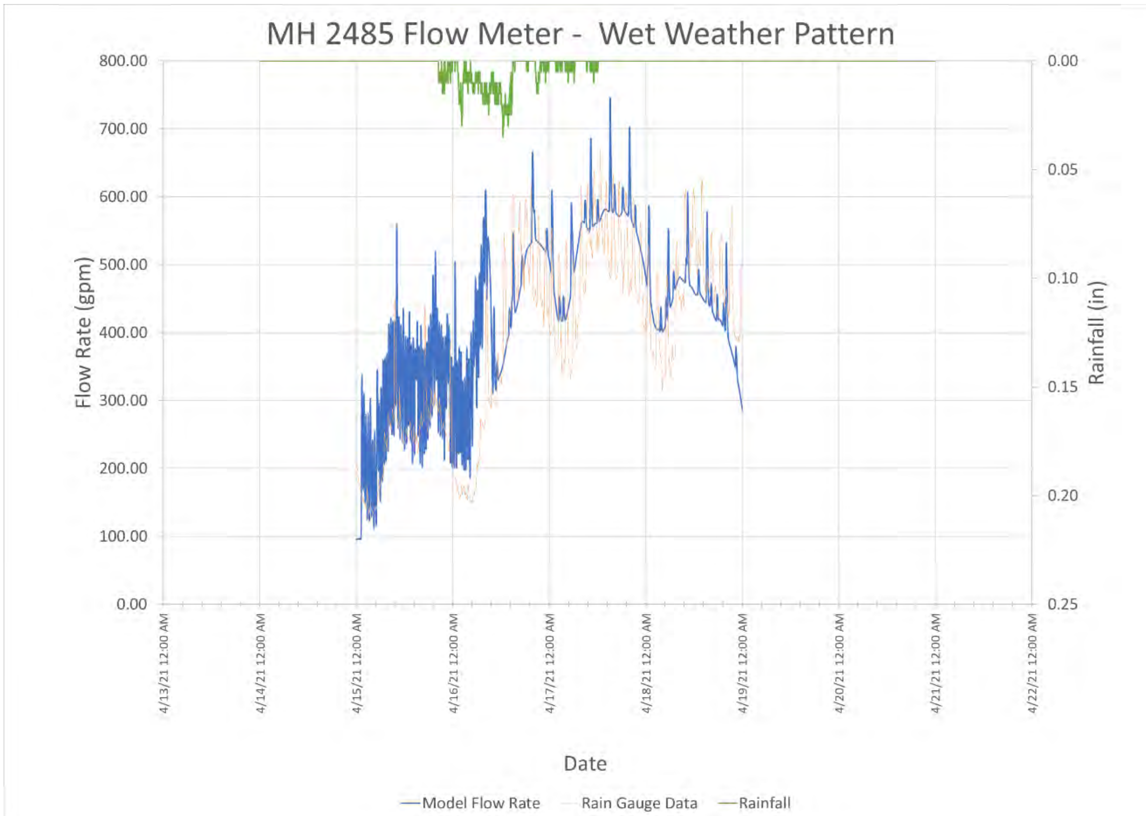

MH 5893 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
2500.00
2000.00
1500.00
1000.00
500.00
0.00
Rainfall (in)
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Model Flow Rate
Rain Gauge Data
Rainfall

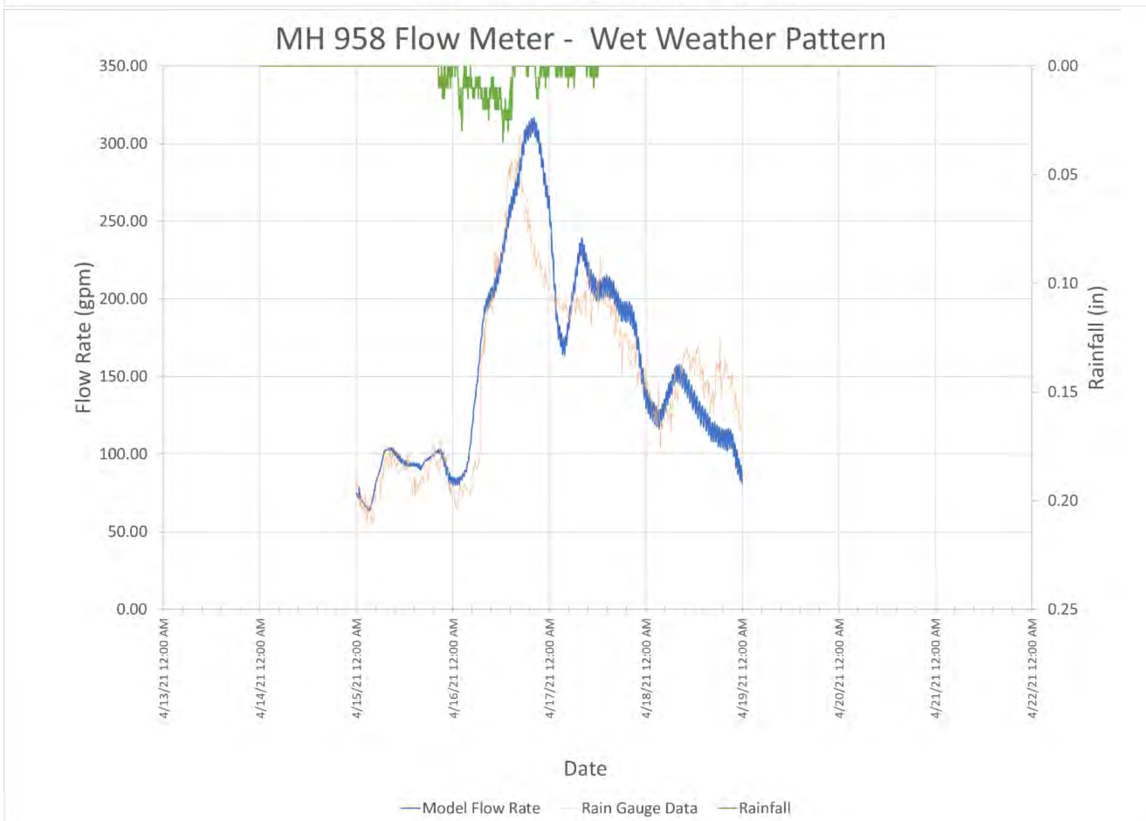


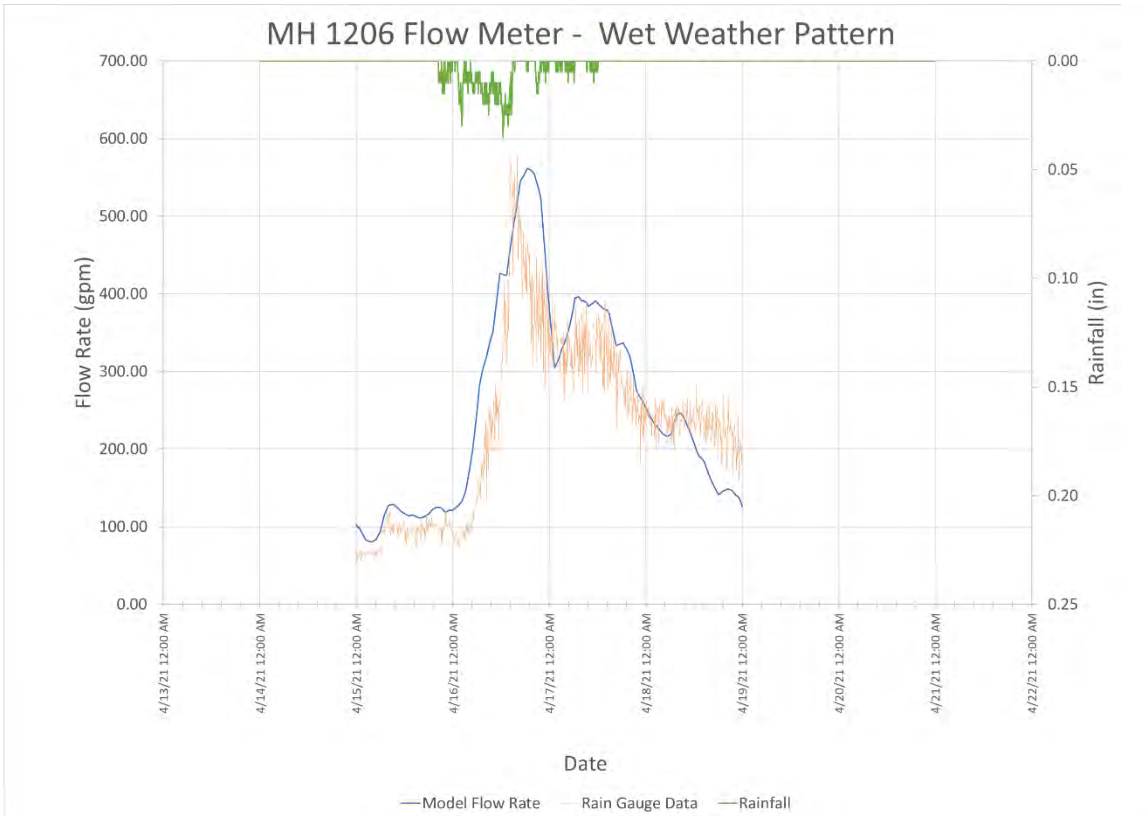
MH 5716 Flow Meter - Wet Weather Pattern
7000.00
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
Flow Rate (gpm)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Model Flow Rate
Rain Gauge Data
Rainfall



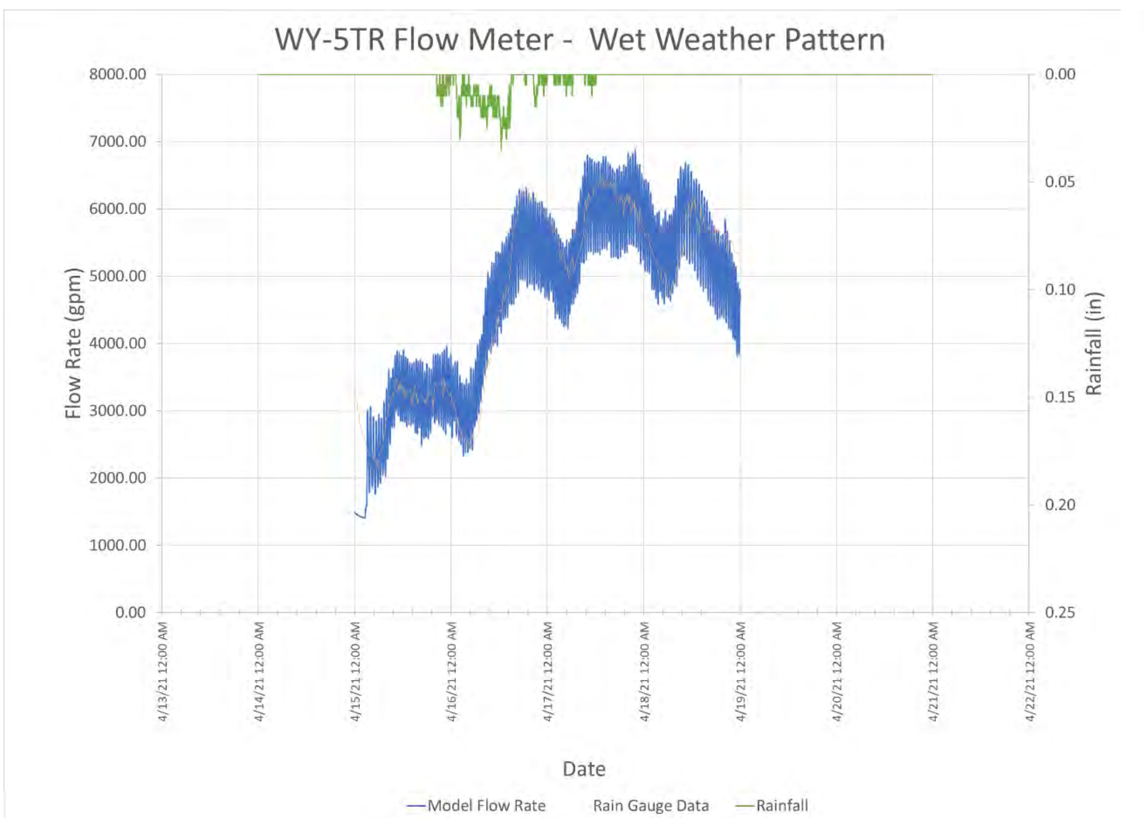
MH 2980 Flow Meter - Wet Weather Pattern
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Flow Rate (gpm)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Model Flow Rate
Rain Gauge Data
Rainfall


MH 2485 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
Date
Model Flow Rate
Rain Gauge Data
Rainfall


MH 958 Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
Rainfall (in)
Date
Model Flow Rate
Rain Gauge Data
Rainfall

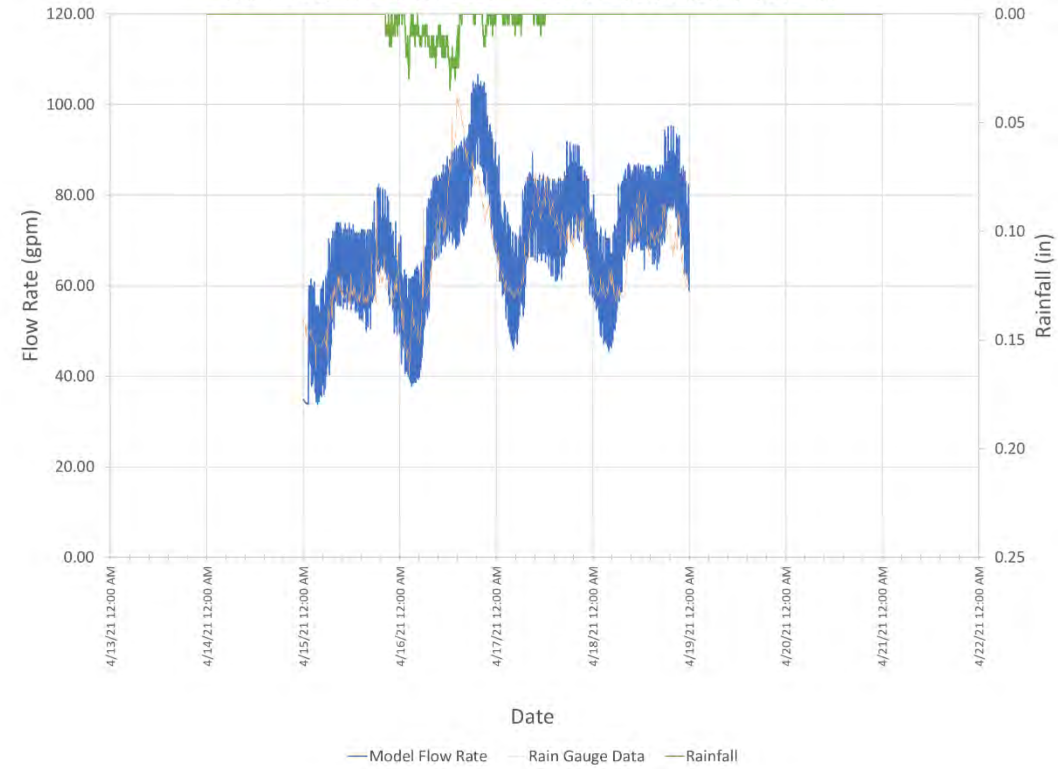


MH 1206 Flow Meter - Wet Weather Pattern
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Flow Rate (gpm)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Model Flow Rate
Rain Gauge Data
Rainfall

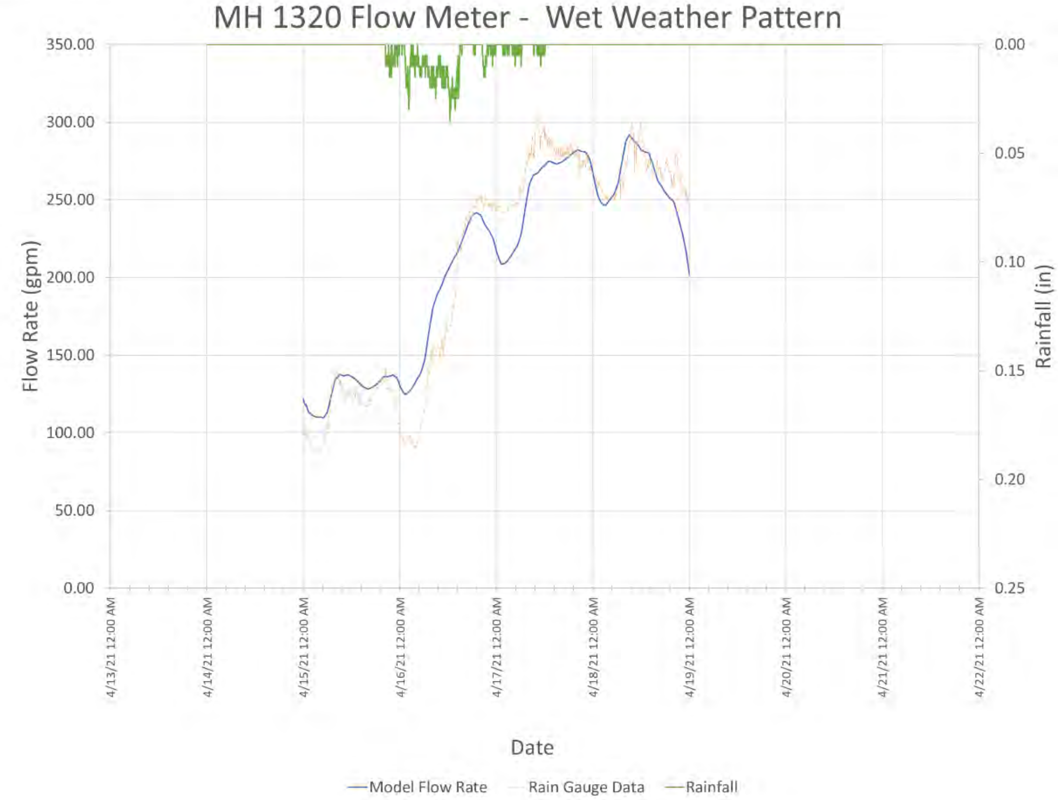


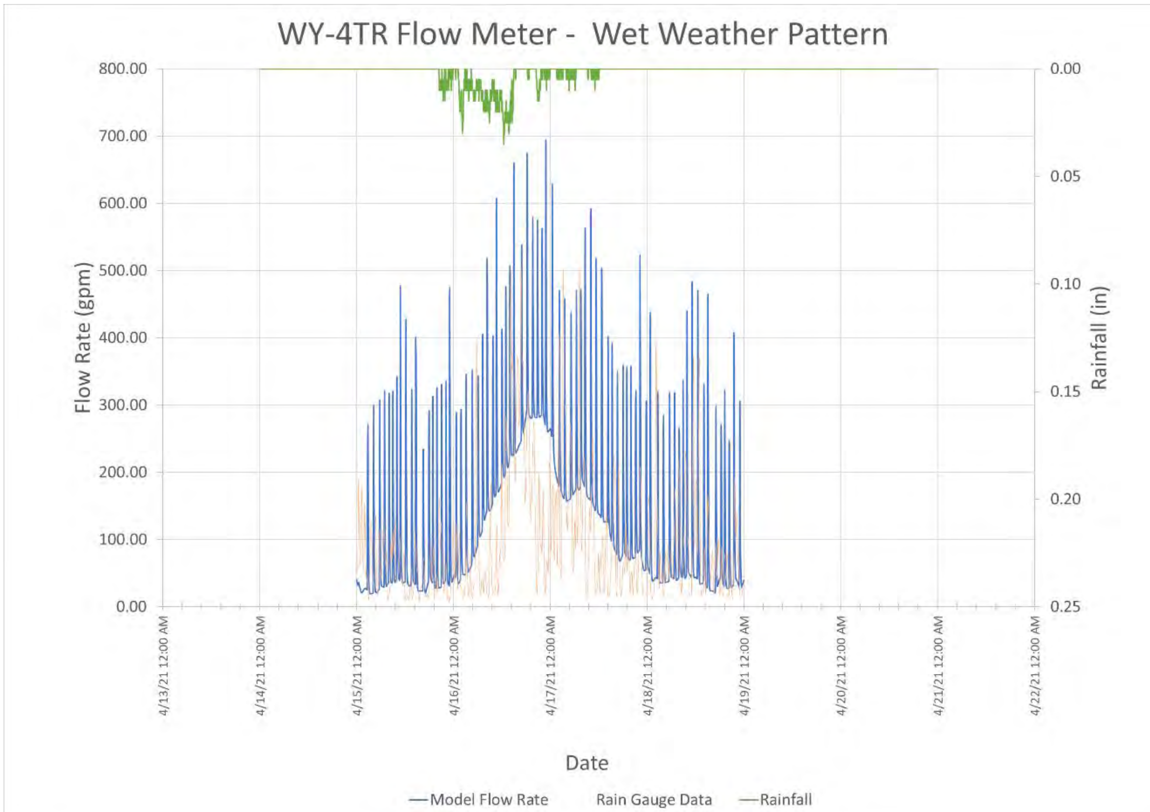
WY-5TR Flow Meter - Wet Weather Pattern
8000.00
7000.00
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
Flow Rate (gpm)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Model Flow Rate
Rain Gauge Data
Rainfall

MH 602 Flow Meter - Wet Weather Pattern



MH 1320 Flow Meter - Wet Weather Pattern





WY-4TR Flow Meter - Wet Weather Pattern
Flow Rate (gpm)
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Rainfall (in)
0.00
0.05
0.10
0.15
0.20
0.25
4/13/21 12:00 AM
4/14/21 12:00 AM
4/15/21 12:00 AM
4/16/21 12:00 AM
4/17/21 12:00 AM
4/18/21 12:00 AM
4/19/21 12:00 AM
4/20/21 12:00 AM
4/21/21 12:00 AM
4/22/21 12:00 AM
Date
Model Flow Rate
Rain Gauge Data
Rainfall

APPENDIX C – TOWNWIDE FLOW METERING DRAFT REPORT

Weston & Sampson

westonandsampson.com

55 Walkers Brook Drive, Suite 100
Reading, MA 01867
tel: 978.532.1900

DRAFT REPORT

January 2022

TOWN OF
Weymouth
MASSACHUSETTS

2021 Town-Wide Flow Metering

55 Walkers Brook Drive, Suite 100, Reading, MA 01867
Tel: 978.532.1900

Town of Weymouth, Massachusetts
Weston & Sampson Project No. ENG21-0225

January 11, 2022

Mr. Kenan J. Connell
Director of Public Works
120 Winter Street
Weymouth, Massachusetts 02188

Re: Draft Report
2021 Town-Wide Flow Metering

Dear Mr. Connell:

Weston & Sampson Engineers, Inc., is pleased to submit our draft report for the 2021 Town-Wide Flow Metering project. This report analyzes wastewater flow data for March through June 2021 and also includes review of existing available groundwater data and rainfall monitoring for that period.

This report presents our analysis of the flow metering results, identifies areas that appear to contribute excessive infiltration and inflow (I/I), and provides estimates of peak I/I. The May 2017 Department of Environmental Protection *Guidelines for Performing Infiltration/Inflow Analyses and Sewer System Evaluation Survey* (DEP Guidelines) were used as a guide for the flow data analysis.

System Description and Project Objectives

The municipal sewer system in the Town of Weymouth is comprised of approximately 180 miles of sewer ranging in size from 6-inches to 42-inches in diameter. In order to protect its substantial capital investment in sewer infrastructure, the Town of Weymouth has taken a proactive approach towards operating and maintaining the sewer system by implementing a comprehensive annual Town-Wide Sewer Investigation & Rehabilitation Program. This program was designed in 2006 to continue the Town's aggressive pursuit towards removal of I/I from the sewer system. The priority evaluation was ranked based on several criteria: areas not previously investigated, areas with excessive peak infiltration, and problem areas reported by the town. Years One through Ten of this program have been completed to assess I/I in Weymouth's sewer system.

This metering data is used to obtain current system flow information, to qualify and quantify I/I, and to assess the status of the Annual I/I Program. A full breakdown of meters by pipe diameter is included in Table 2*, Summary of Tributary Areas.* 32 temporary flow meters along with four permanent flow meters were utilized to analyze the flow from 31 subareas. MWRA data estimates a daily average of 7.41 million gallons per day (MGD) of wastewater flow during 2020.

Figure 1, *Metering Locations,* shows each sewer subarea, the limits of the wastewater collection system, and locations of the flow meters and rain gauges for this project. Figure 2, *Flow Schematic,* shows the flow schematic of Weymouth's sewer system.

Groundwater Data Review

According to the USGS groundwater gauge located in Duxbury, Massachusetts, groundwater levels during the metering program (March through June 2021) were at lower-than-average levels for the majority of the metering period. Lower-than-historical groundwater levels may decrease the baseline infiltration rates during the analysis because less groundwater may be entering the sewer system through pipe and manhole defects. Likewise, higher groundwater levels may result in increased infiltration and inflow rates.

Please note that the USGS site is located outside of Weymouth and the data only serves to indicate the general groundwater trends of the region, not the immediate study area. The following figure shows actual groundwater elevations (orange line) compared to the historical average comprised of median daily statistic levels recorded over the past 12 years (dotted blue line).

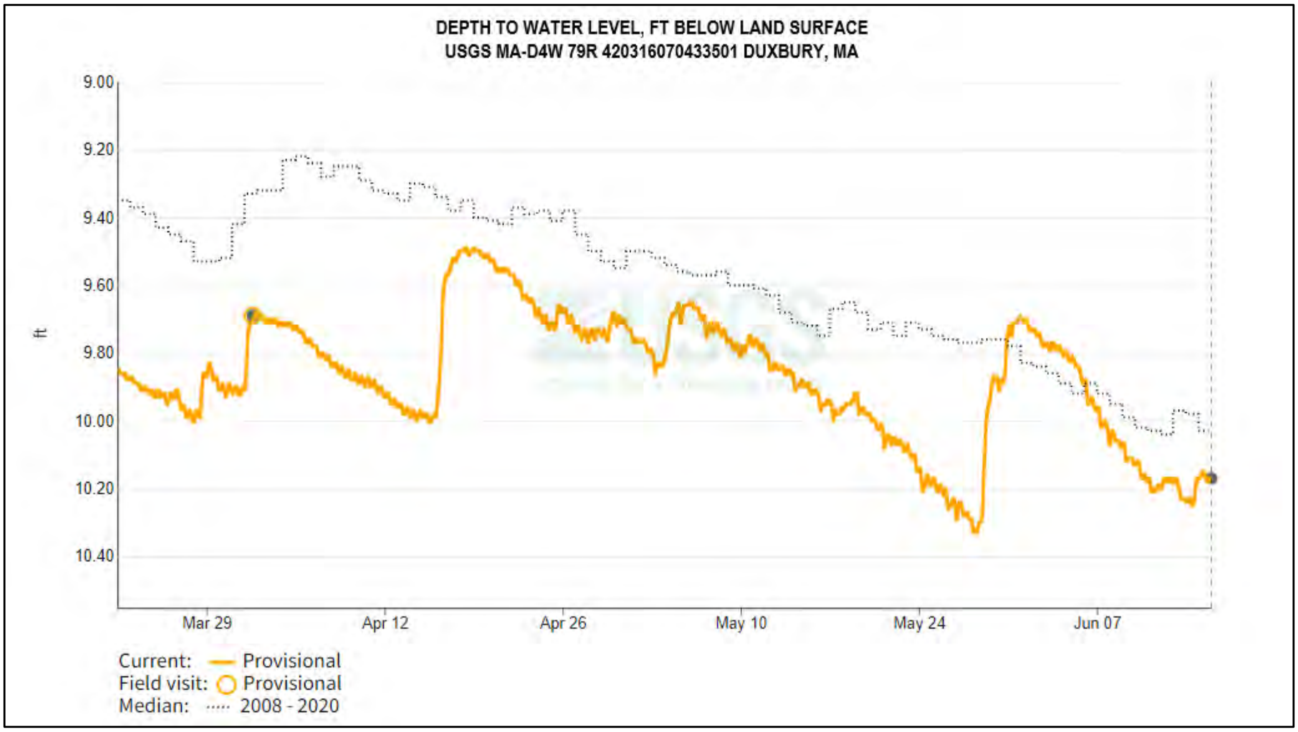


Figure 3, *USGS Groundwater Monitoring*

Four temporary ground water gauges were installed in manholes 602, 2927, 4033, and 5041 for the duration of the monitoring period. These gauges measured the depth to groundwater continuously in five-minute intervals. Three gauges, 2927, 4033, and 5041, showed approximately the same trend as the USGS groundwater gauge. Gauge 602 showed little change in groundwater levels throughout the monitoring period and will be considered unreliable.

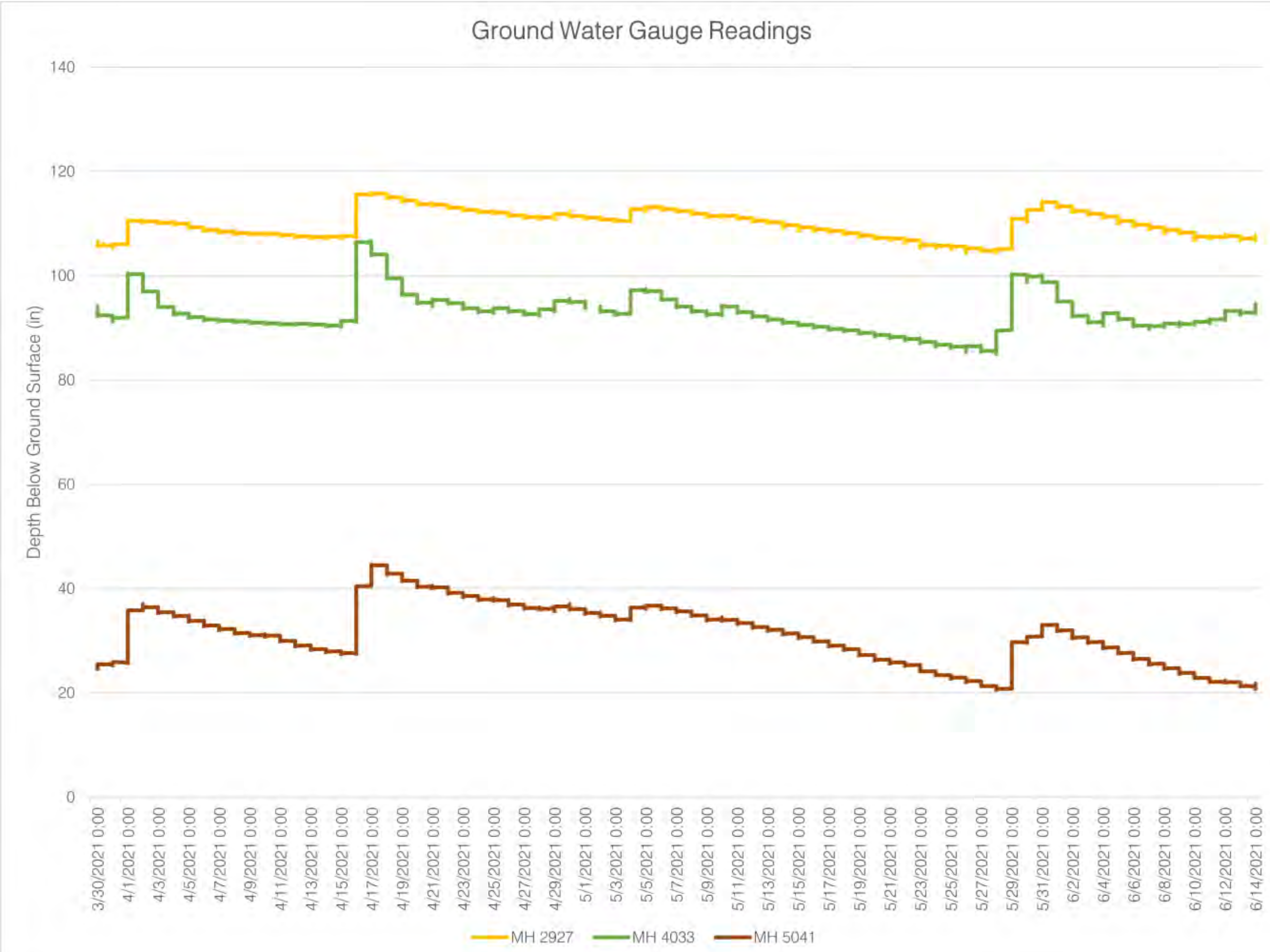


Figure 4, *Groundwater Gauge Readings*

Rainfall Monitoring

Rainfall information was collected by two tipping-bucket rainfall gauges installed and maintained by ADS Environmental Services (ADS) during the metering period. The rain gauges are located at the Wituwamat Pump Station and the Park Avenue Fire Station. The locations are identified in Figure 1, *Metering Locations*. The average daily rainfall from the two gauges is shown in Figure 5, *Average Daily Rainfall Summary*. The table below summarizes the monthly rainfall recorded within Weymouth during the monitoring period.

Month	Weymouth Average Rainfall Recorded (in)
April	4.83
May	5.60
June	1.37
TOTAL:	11.79

For the purpose of this report, a rainfall event is defined as more than 0.50 inches of rain in a period of time without a break of more than three hours. The five rainfall events that met these criteria during the metering period are summarized in the following table.

Rainfall Events

Storm #	Date	Total Time (hr)	Total Rainfall (in)	Peak Hour Intensity (in/hr)	Average Intensity (in/hr)
1	03/31/21	10	1.39	1.14	0.14
2	04/15/21	39	2.88	2.78	0.07
3	05/04/21	48	1.34	0.77	0.03
4	05/28/21	70	3.51	3.12	0.05
5	05/30/21	30	0.96	0.88	0.03

Flow Monitoring

Flow metering data was analyzed to obtain current information regarding sewer system flow in order to quantify I/I rates. Weston & Sampson retained the services of ADS to install, calibrate, and maintain 32 temporary flow meters. Flow data from four additional permanent flow meters was provided by the Massachusetts Water Resources Authority (MWRA) for use in this study. Flow from 31 subareas was directly monitored with 36 flow meters. Flows were monitored and data was accumulated from March 22 through June 16, 2021. Raw data for the metering period is available to the town upon request.

Each flow meter recorded flow volume, depth, and velocity in 15-minute intervals to calculate flow quantities. A meter was placed in a sewer pipe to measure flow from that area. Each meter was numbered according to the manhole in which it was installed. The location of each flow meter is shown in Figure 1, *Metering Locations*. A flow schematic is shown in Figure 2, *Flow Schematic*. Some meter data includes flow from meters in series or upstream, making it necessary to subtract data from upstream meter readings to obtain individual meter area data. Figure 2 illustrates how each subarea is hydraulically connected.

The meter locations, net tributary subareas, linear footage year, and average net daily flow are shown in the following table. A full breakdown of meters by pipe diameter is included in Table 2*, Summary of Tributary Areas.*

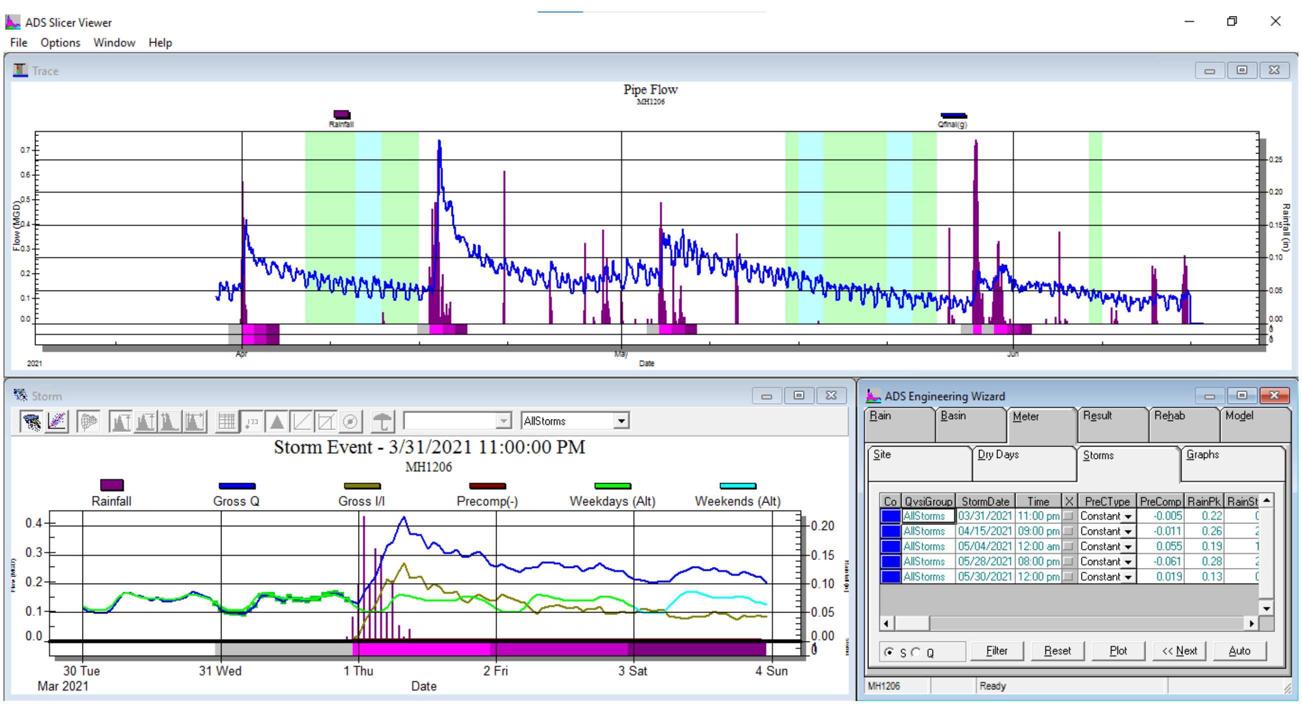
Meter	Net Tributary Subarea(s)	Total Linear Footage (lf)	Average Net Daily Flow (gpd)
602	N-2	11,671	90,000
693	B-1, B-2	49,212	710,000
748	B-3	35,263	70,000
830	N-12-1, C-2	39,808	740,000*
958	C-1	16,517	130,000
1097	B-3, B-4, B-5	29,276	290,000
1206	N-12-2	17,540	180,000
1320	D-11	17,658	200,000
1753	B-4	13,297	220,000
1987	D-2, D-3, D-12	35,288	540,000
2063	B-5	32,788	50,000
2119	B-5	15,272	170,000
2393	B-6	30,658	230,000
2485	C-4	31,269	170,000
2899	D-3	23,600	230,000
2927	B-6	36,841	390,000
2980	C-5	23,733	220,000
3135	C-7	28,923	70,000
3520	C-7, C-12	42,245	550,000
3876	C-9	33,717	470,000
3994	C-10	26,133	190,000
4033	C-12, C-13	25,621	260,000
4199	C-14	28,673	570,000
4445	C-10	25,068	200,000

4535	C-14	24,828	40,000
4563	C-10	26,524	170,000
4578	C-10, C-11	39,216	370,000
4779	C-15	29,164	120,000
4783	C-16	24,896	210,000
5041	C-15	27,036	120,000
5716	C-6, C-7, C-8	47,415	590,000
5893	C-8	31,514	140,000
WY-2TR	B-1	20,544	70,000
WY-3CTR	D-12	18,367	190,000
WY-4CTR	A-1, N-7	27,784	110,000
WY-5TR	C-3	35,209	--*

*Data for meter WY-5TR was not used, see paragraph four on page six. ADF for Meter 830 includes flow from WY-5TR.

Meter data was imported into ADS's SLiiCER flow analysis software for evaluation of base wastewater flow, groundwater infiltration and inflow. The data for each meter was analyzed to determine the quality of the data. A hydrograph depicts the diurnal curve for a subarea. Hydrographs of each meter were plotted to examine flow meter performance, data trends, and response to wet weather events. Hydrographs display the changes in average daily flow and total daily rainfall at each meter location, as well as the regular diurnal curve and the effect of I/I in each metered area. Infiltration that enters the sewer system will increase the baseline flow while inflow will cause large, temporary spikes in the sewer system during rain events. Hydrographs for each meter are included in Appendix A.

An example illustration of the SLiiCER interface is included below. The example includes a hydrograph (top) with rainfall (purple bars) and dry days (green and blue shade) and an example storm event analysis (bottom) used in the inflow analysis.



Meter data was further evaluated for accuracy by analyzing the shape of the scatter graph produced by plotting depth in inches versus velocity in feet per second. Scatter graphs for data representing uniform flow conditions should display a direct relationship between depth and velocity – where an increase in velocity occurs with an increase in depth. Scatter graphs for each meter are included in Appendix B.

Infiltration
Infiltration is extraneous groundwater that enters the sewer system through sources such as defective pipes, pipe joints, and manhole walls. Analysis of flow data for infiltration consists of selecting the lowest flow reading that occurs during dry weather conditions between the hours of 12:00 a.m. and 6:00 a.m. Nighttime flow represents a period of minimum sanitary flow, and therefore, has the highest percentage of flow attributed to infiltration. For this evaluation, the percentage of nighttime flow attributed to infiltration was assumed to be 88%.

Peak infiltration is defined as the average of the minimum flow rates (nighttime flow as described above) observed over a period of several dry days, during a period of high groundwater (i.e., during springtime). A "dry day" is defined as at least three days after the conclusion of a rain event. The estimated infiltration rates for each subarea may be found in Table 3, *Estimated Peak Infiltration*.

As shown in Table 3, an estimated 6,005,850 gpd of peak infiltration was calculated. In order to compare the infiltration rates in different sized metered areas, a gallon per day per inch diameter of sewer mile (gpdim) value is calculated by dividing gallons per day of infiltration by inch-diameter miles of sewer. According to the DEP Guidelines, subareas exhibiting an infiltration rate equal to or greater than 4,000 gpdim are considered excessive and should be prioritized for further investigation. As shown in Table 3, 11 metered areas are considered excessive. These 11 metered areas include 693, 748, 830, 1320, 1753, 1987, 2119, 3876, 4033, 4535, and WY-3CTR. Of these areas, meter 748 exhibited the highest infiltration rate of 7,195 gpdim.

Flow metering data obtained from the MWRA for meter WY-5TR was incomplete and only contained data from March 22 through May 5, 2021. The flow calculated by this meter was greater than the downstream meter (Meter 830) for a significant amount of time. This could be caused by debris at the bottom of the pipe giving the meter a greater flow depth than was actually present. This flow data was not used in the infiltration calculations, instead the area and flow data were combined with meter 830 to get a combined peak infiltration value.

The MWRA is currently in the process of replacing all meters in the MWRA system. Meter WY-5TR is planned to be relocated further downstream with a new meter. Therefore, it may not be necessary to contact MWRA about this meter regarding future billing and flow statistics.

Infiltration rates are considered to be at their peak during the spring months. However, infiltration is a year-round occurrence which decreases available wastewater system capacity. Removing infiltration increases available capacity and decreases sewer transportation and treatment costs, which is why the Annual Program has focused on infiltration sources to date. As noted above, rainfall and groundwater, which have a direct impact on infiltration rates, fluctuate year to year.

Inflow
Inflow is extraneous water that is discharged into the sanitary sewer system from sources such as catch basins, sump pumps, roof leaders, surface drains, holes in manhole covers, and other direct or indirect inlets. Inflow enters the sewer system through these sources during wet weather events. Inflow that enters the sewer can cause large increases in sewer flows over a short period of time. The main goal in removing inflow from the sewer system is to remove these short-but-voluminous increases in sewer flow that could potentially cause sewer system overflows and backups.

Rainfall data was collected throughout the monitoring period to identify storm events, total rainfall, and rainfall intensity. The data was used to relate variations in sewer flow during rainfall events to total storm rainfall for the purpose of identifying inflow and its components. Inflow is quantified by comparing metered flow during a rain event to flow metered during a dry weather period during the same day group (weekday or weekend) and time. This is necessary to ensure that observed flow variations are caused by inflow rather than normal diurnal fluctuations.

Peak design storm inflow is determined by estimating the inflow volume produced from a "design storm." The design storm is the five-year, twenty-four-hour storm event with a peak intensity of 0.182 inches/hour. (MassDEP Guidelines, 2017)

During the monitoring period, five Rainfall Events, shown on page 4 of this report, were used to quantify inflow. Wastewater flow during these storm events was compared to flow data during dry weather on a similar day of the week during the same time.

Flow meter data was analyzed to determine the inflow quantity corresponding to the five rainfall events and to obtain several data points for use in developing a linear regression analysis. The linear regression analysis plots peak inflow versus peak rainfall intensity for each storm and a best fit regression line is applied to the data points. The linear regression analysis is used to determine the peak design storm inflow relative to the rainfall intensity. Linear regression plots are attached in Appendix C.

The quantification of inflow includes some portion of rainfall induced or dependent infiltration, which is a direct result of stormwater percolation into the ground after significant rainfall events. As shown on Table 4, *Estimated Peak Inflow,* peak design storm inflow from the linear regression analysis is approximately 8,700,000 gpd.

In order to compare the inflow rates in different sized area, a gallon per day per linear foot of pipe (gpd/lf) value is calculated by dividing gallons per day of inflow by total linear feet of each metered area. This is useful information to determine the relative “concentration” of inflow across the sewer system and in prioritizing potential inflow investigations. One area had a significantly higher value when using this as a comparison. Metered area 4445 has a value over 33 gpd/lf.

Annual Program Prioritization

Based on the results of this study, Weston & Sampson recommends modifications to the existing prioritization of the ongoing Annual Program. Investigations have been completed through Year 10 of the existing prioritization, as shown in Table 5, of the current 20-year program. Year 11 is scheduled to include investigation of subarea B-3. This subarea has the highest concentration of infiltration of the remaining subareas and should remain as the next area of investigation.

For the remainder of the program beyond Year 11, subareas have been reprioritized based on the results of this study and grouped together so that approximately 55,000 lf of sewers are targeted for investigation each year. This reprioritization has resulted in the Annual Program being shortened from 20 years to 17 years. The updated prioritization is included as Table 6, *Updated Priority Evaluation*. At the conclusion of Year 17, the entire sewer system should be reprioritized based on this study and/or future flow information prior to implementing a new program.

Summary, Conclusions, and Recommendations

Peak infiltration for each area is presented in Table 3. An estimated 6,005,850 gpd of peak net infiltration exists in this metered portion of Weymouth’s sewer system. 11 metered areas exceeded the 4,000 gpdim threshold referenced in the DEP Guidelines as considered excessive. The table below shows systemwide I/I versus MWRA estimates.

	Average Daily Flow (mgd)	Peak Infiltration (mgd)	Average Annual Infiltration (mgd)	Peak Inflow (mgd)
2021 Flow Metering Results	9.07*	6.00	2.85	8.71
MWRA Estimates (2020)	7.41	6.84	3.25	N/A**

*2021 Flow Metering results only look at springtime values which are generally the highest throughout the entire year.
**MWRA does not calculate estimated inflow using a design storm methodology as used in this report.

Due to the unreliable data for meter WY-5TR, a separate infiltration analysis was run using the meters upstream of WY-5TR, thus combining the areas of meters 830 and WY-5TR. Dry day average infiltration was calculated to be 0.8 mgd or 4911 gpdim. Calculating the infiltration values using results from meter WY-5TR and meter 830 separately yielded 0.7 mgd or 4,235 gpdim.

The Annual Program has shown positive results for I/I removal according to this metering program. According to Table 5, *Priority Evaluation*, 12 of the 17 subareas with estimated infiltration have shown a decrease in infiltration post construction or remained approximately the same. The estimates for infiltration were prepared for the Priority

Evaluation report prepared in 2006. Infiltration values for all subareas are likely to increase year over year due to pipe and manhole degradation and also are highly dependent on annual weather and groundwater conditions.

Peak baseline design storm inflow rates for each area are presented in Table 4. Estimated peak baseline design storm inflow for a five-year, twenty-four-hour storm was approximately 8,712,000 gpd. The peak design storm inflow was derived by plotting the peak inflow versus peak hour rainfall intensity, creating a line-of-best-fit, then projecting the peak design storm inflow for the total baseline design storm rainfall intensity. This is shown in the linear regression analysis that can be found in Appendix C.

Inflow can be categorized as direct or delayed. Direct inflow is the result of direct connections from drain structures such as catch basins, driveway drains, roof leaders, or manhole vent holes. Delayed inflow is the result of rainfall induced infiltration and sump pumps connected to the sewer. The data indicates delayed inflow for most of the storm events and, therefore, it is recommended that a building inspection program be established to inspect individual buildings for sources of inflow, in addition to continuing the Annual Program. Weston & Sampson is available to discuss the establishment of building inspection at the towns request.

It is important to note that the wastewater collection infrastructure is a dynamic system that can degrade over time. Peak inflow could be significantly reduced, but overall inflow rates depend on variable annual rainfall and storm events. As system defects or I/I sources are repaired, other defects that were not as severe will continue to degrade. In addition, new connections may be permitted resulting in an increase in flows. Rainfall and groundwater, which have a direct impact on I/I rates, fluctuate year to year. Therefore, it is difficult to make an exact comparison for flow reductions and/or increases over time.

Continuing to pursue the removal of I/I through the Annual Program will serve to protect the Town of Weymouth's substantial investment in sewer infrastructure. The Annual Program provides benefits including I/I reduction, but also operation and maintenance of the sewer system regardless of excessive flow and have proven to locate backups and significant structural defects before they become emergency issues.

While metering results identified a few previously investigated subareas remain above the excessive infiltration threshold (4,000 gpdim), Weston & Sampson recommends the town continue investigating subareas not yet inspected through the ongoing Annual Program. Investigations have been completed through Year 10 of the Annual Program. All subareas scheduled for inspection after Year 10 have been reprioritized within the program based on the results of this study. Year 11 would include the investigation of Subarea B-3 in spring 2022.

We wish to thank you and members of the Department of Public Works and Engineering staff for their assistance while completing this project. We are available to meet with you at your earliest convenience to discuss this report. Please do not hesitate to contact me at (978) 532-1900 with any questions or comments you may have.

Sincerely,

WESTON & SAMPSON ENGINEERS, INC.

Hillary M. Lacirignola, PE
Vice President

cc: Frank Sheppard, Superintendent of Water & Sewer (via email)
Jerry Murphy, Assistant Superintendent (via email)
Braydon Marot, PE, Facilities Engineer (via email)
David Tower, DPW Business Manager
Jon Szarek, PE, MWRA

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Jon Szarek, MWRA

Attachments

\\wse03.local\WSE\Projects\MA\Weymouth MA\2210225 Town-Wide Flow Metering\Report\Weymouth - Town-Wide Flow Metering Report - draft.docx

FIGURES

FIGURE 1

TOWN OF WEYMOUTH, MA
2021 FLOW METERING

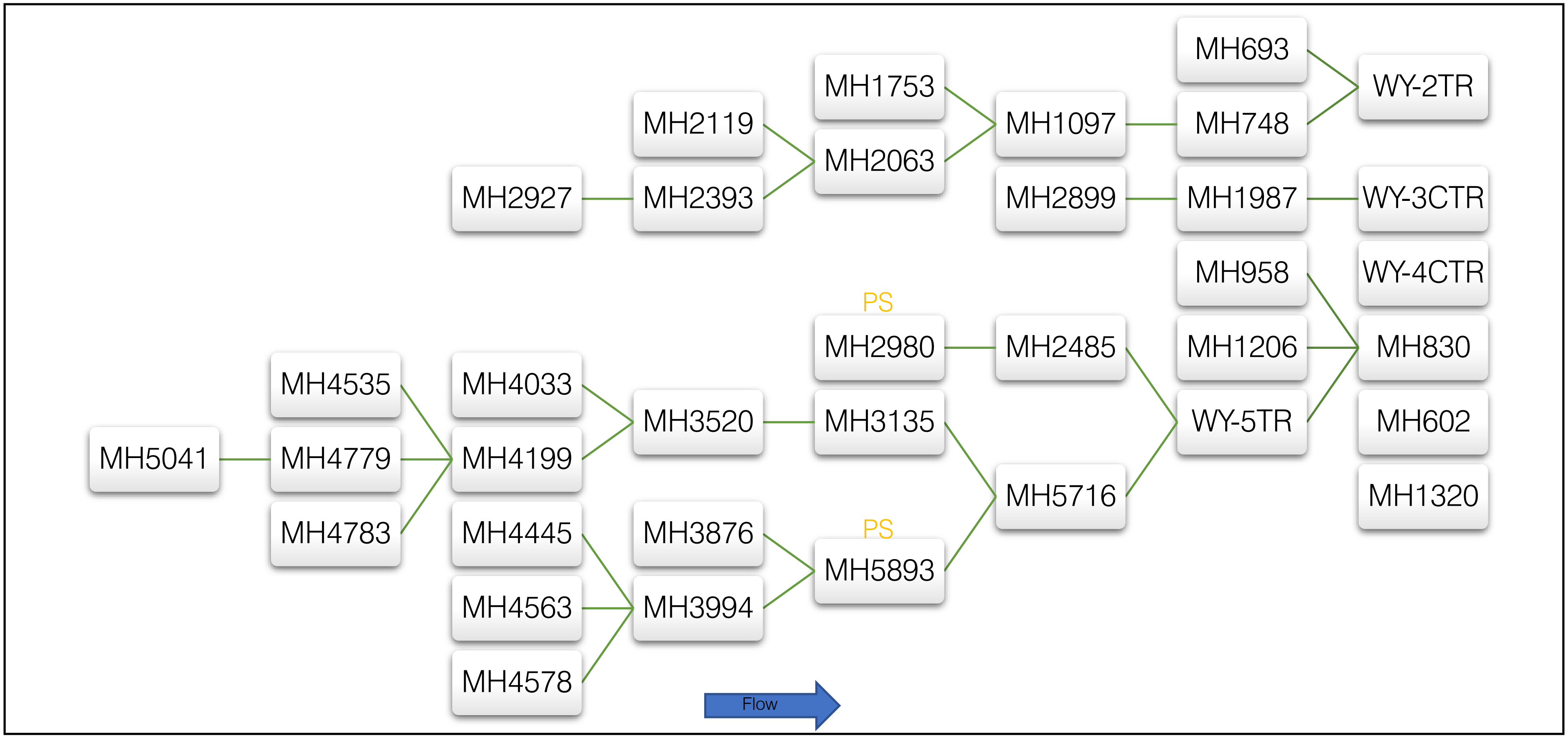
FLOW METERS

MARCH 2021 SCALE: NOTED

Weston & Sampson

FIGURE 2 – FLOW SCHEMATIC

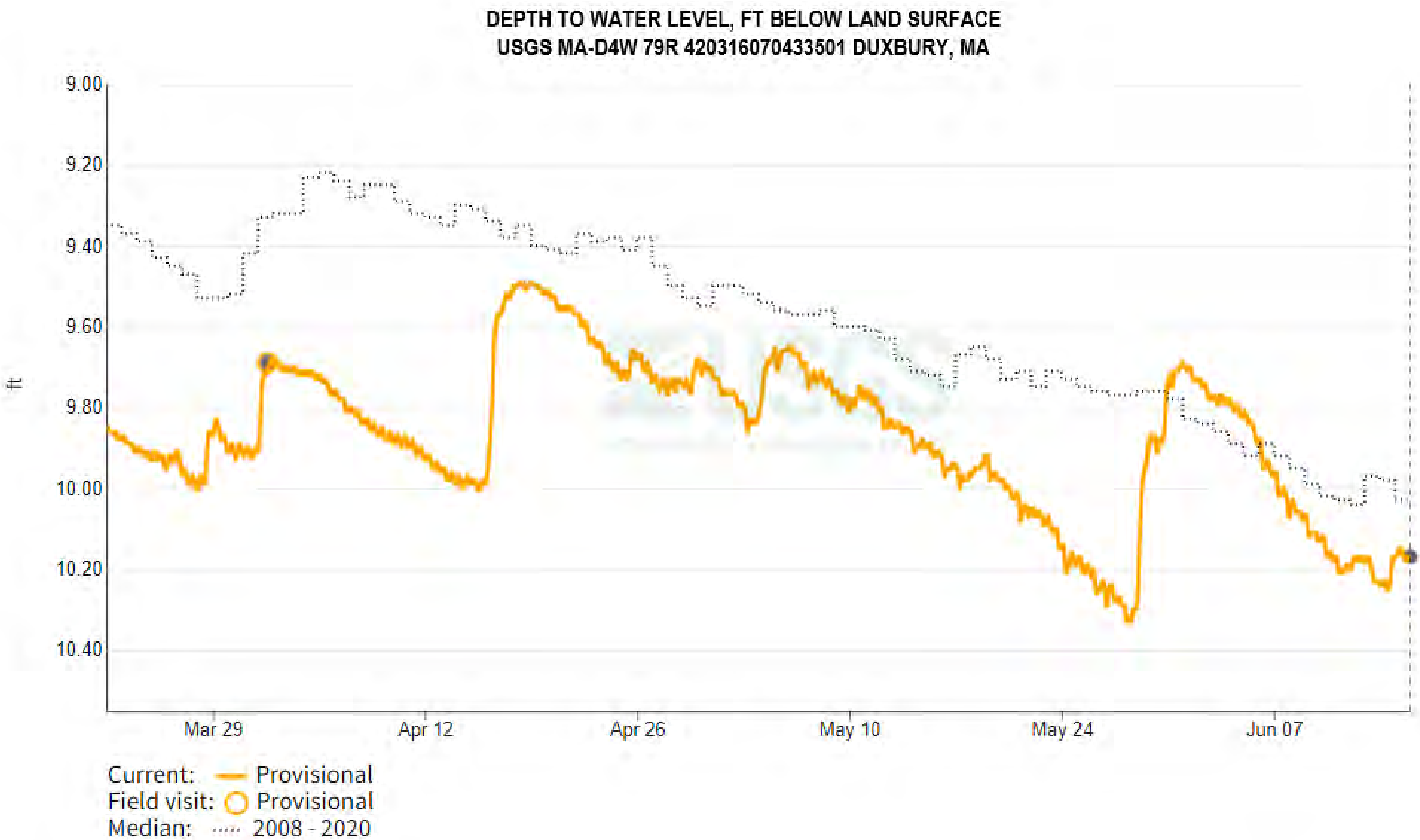
Town of Weymouth, MA
2021 Town-Wide Flow Metering



*WY- designates a permanent MWRA flow meter.
*PS designates the entire flow from a meter area enters a pump station to the next metered area.

FIGURE 3 - USGS GROUNDWATER GAUGE

Town of Weymouth, MA
2021 Town-Wide Flow Metering



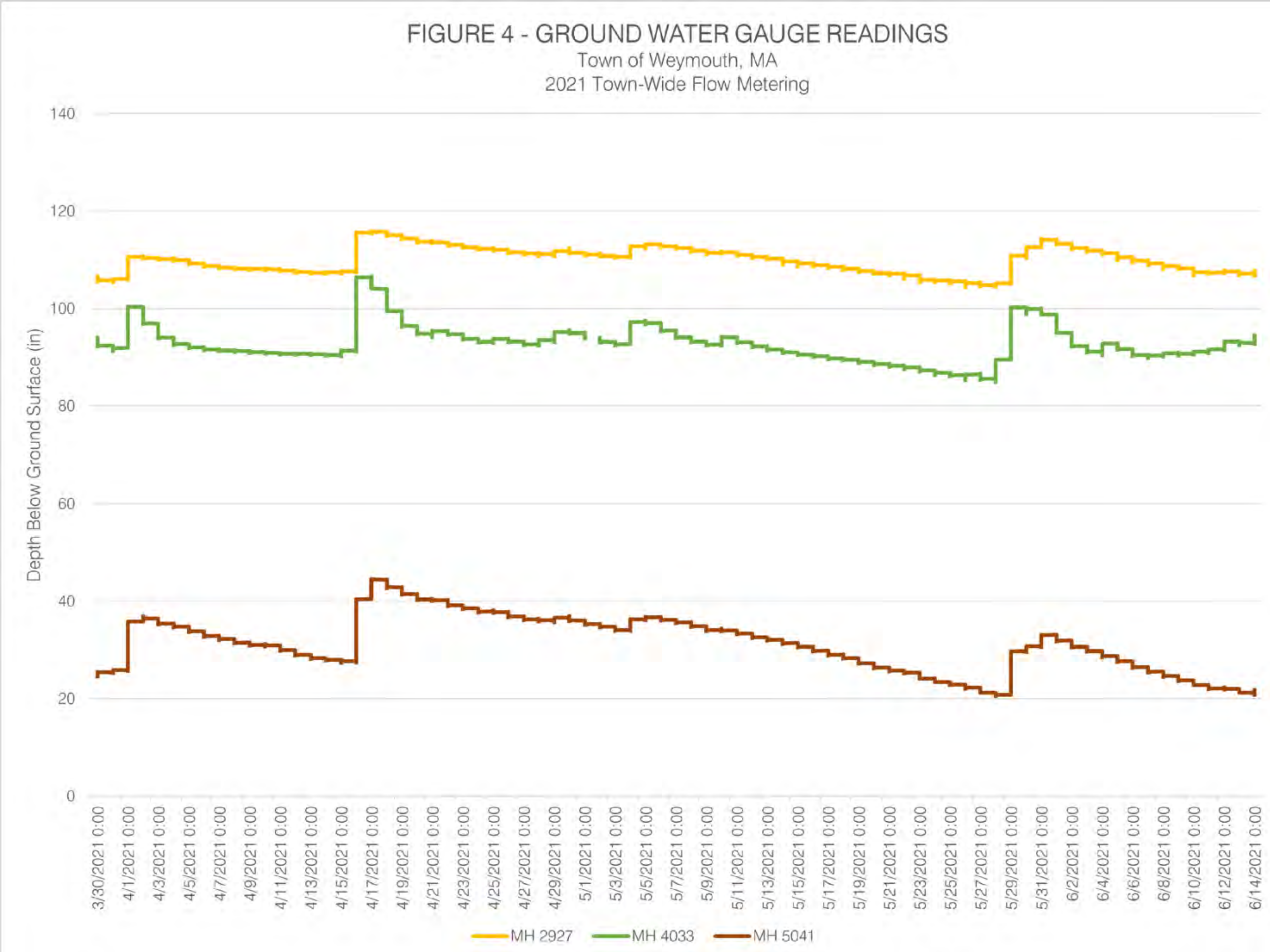


FIGURE 4 - GROUND WATER GAUGE READINGS
Town of Weymouth, MA
2021 Town-Wide Flow Metering
Depth Below Ground Surface (in)
140
120
100
80
60
40
20
0
3/30/2021 0:00
4/1/2021 0:00
4/3/2021 0:00
4/5/2021 0:00
4/7/2021 0:00
4/9/2021 0:00
4/11/2021 0:00
4/13/2021 0:00
4/15/2021 0:00
4/17/2021 0:00
4/19/2021 0:00
4/21/2021 0:00
4/23/2021 0:00
4/25/2021 0:00
4/27/2021 0:00
4/29/2021 0:00
5/1/2021 0:00
5/3/2021 0:00
5/5/2021 0:00
5/7/2021 0:00
5/9/2021 0:00
5/11/2021 0:00
5/13/2021 0:00
5/15/2021 0:00
5/17/2021 0:00
5/19/2021 0:00
5/21/2021 0:00
5/23/2021 0:00
5/25/2021 0:00
5/27/2021 0:00
5/29/2021 0:00
5/31/2021 0:00
6/2/2021 0:00
6/4/2021 0:00
6/6/2021 0:00
6/8/2021 0:00
6/10/2021 0:00
6/12/2021 0:00
6/14/2021 0:00
MH 2927
MH 4033
MH 5041

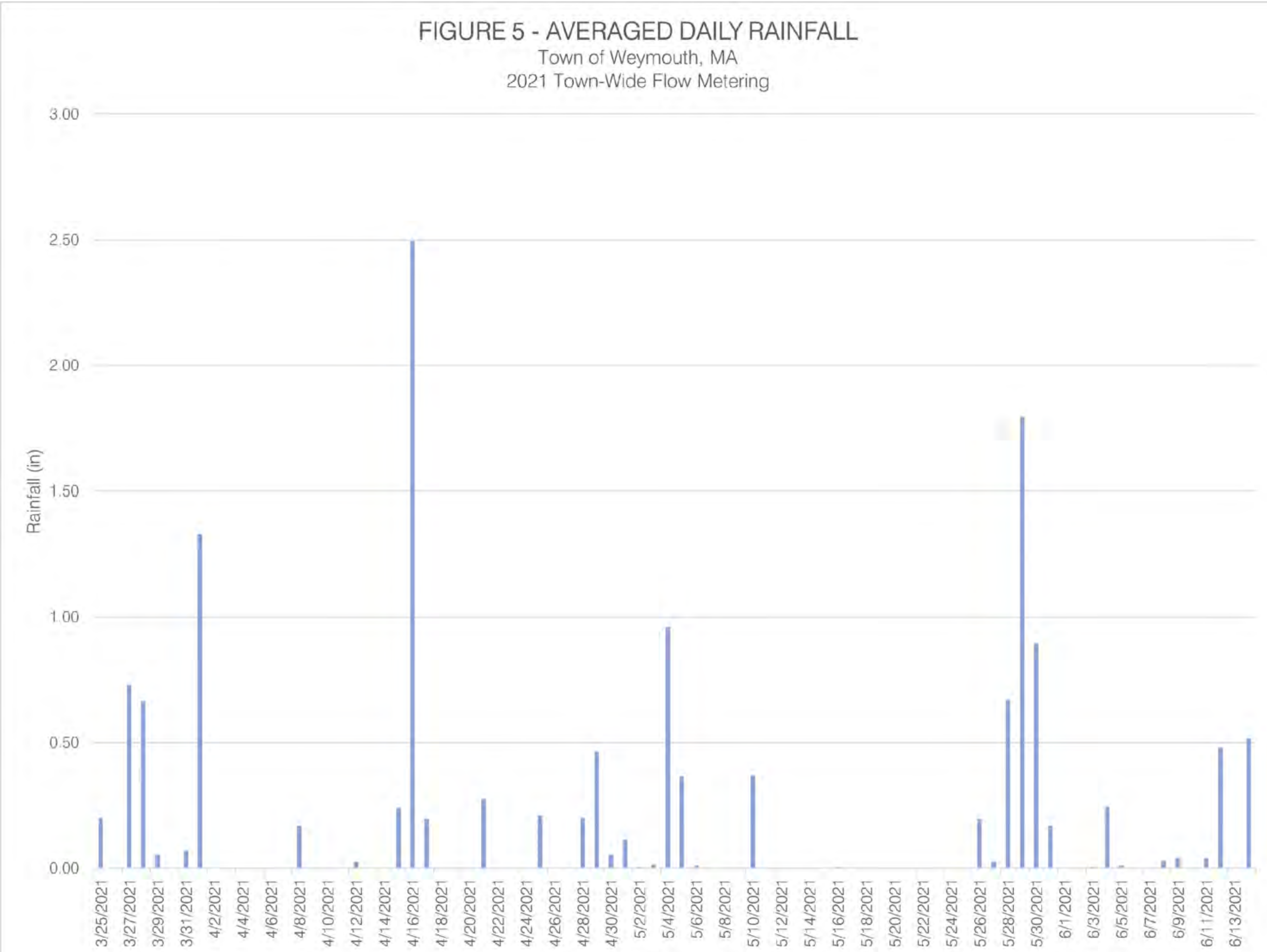


FIGURE 5 - AVERAGED DAILY RAINFALL
Town of Weymouth, MA
2021 Town-Wide Flow Metering
Rainfall (in)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
3/25/2021
3/27/2021
3/29/2021
3/31/2021
4/2/2021
4/4/2021
4/6/2021
4/8/2021
4/10/2021
4/12/2021
4/14/2021
4/16/2021
4/18/2021
4/20/2021
4/22/2021
4/24/2021
4/26/2021
4/28/2021
4/30/2021
5/2/2021
5/4/2021
5/6/2021
5/8/2021
5/10/2021
5/12/2021
5/14/2021
5/16/2021
5/18/2021
5/20/2021
5/22/2021
5/24/2021
5/26/2021
5/28/2021
5/30/2021
6/1/2021
6/3/2021
6/5/2021
6/7/2021
6/9/2021
6/11/2021
6/13/2021

TABLES

TABLE 1 - EXISTING SEWER SYSTEM SUMMARY TOWN OF WEYMOUTH, MA 2021 TOWN-WIDE FLOW METERING																
	Pipe Diameter (in)															
Subarea	4	5	6	8	10	12	15	18	21	22	24	27	30	42	Total Linear Footage (lf)	Total Inch-Diameter Miles (idm)
	Linear Footage (lf)															
A-1			237	21,679	450	630									22,996	35.40
B-1			130	21,032			1,475						4,529		27,166	61.94
B-2	66		382	33,359	9,892	475	1,544								45,718	75.23
B-3			335	50,217	3,126	902		2,236			1,499		1,983		60,298	110.14
B-4			209	11,212	3,520										14,941	23.89
B-5			181	43,595	6,410		1,483	1,755							53,424	88.59
B-6		96	574	57,325	849	1,542	7,355								67,741	113.61
C-1				15,708	808										16,516	25.33
C-2			1,105	6,625				201					3,422		11,353	31.42
C-3			225	20,757	10,973		508						1,568	1,364	35,395	73.69
C-4	43		198	21,531	2,207	2,021	2,499								28,499	48.75
C-5				16,975	4,415	2,343									23,733	39.41
C-6		2,652	963	18,217									26	4,067	25,925	63.71
C-7		77	1,131	25,025	2,579		1,557		964			4,356	1,154	540	37,383	85.54
C-8	12		608	42,511	663		304				2,564	4,958	1,205		52,825	111.08
C-9				23,115	4,169	3,820	2,613								33,717	59.02
C-10			425	88,224	6,078	3,215	5,592	1,116	345	1,798					106,793	181.53
C-12			51	28,958	2,227	590			6,645						38,471	75.92
C-13			102	20,538	2,755	1,157									24,552	39.08
C-14			329	41,330	6,097	1,573	171		3,241	962					53,703	95.50
C-15			547	44,385	6,576	169	4,204								55,881	92.65
C-16			338	23,066	804		1,005								25,213	39.71
C-16A				988	3,498	1,554									6,040	11.65
D-2			146	15,012	1,758	865	2,092								19,873	34.15
D-3		36	125	31,600	4,022	2,554									38,337	61.48
D-11		99	1,187	13,591	50	1,131	300	1,506							17,864	30.69
D-12	17		223	16,783	114	973	223				816				19,149	32.46
N-1				6,147	586										6,733	10.42
N-2				10,309	101	2,061									12,471	20.50
N-5				4,994	3,382										8,376	13.97
N-7			472	3,255		146	1,387								5,260	9.74
N-8			120	8,030				2,965							11,115	22.41
N-9				3,436											3,436	5.21
N-12-1			94	21,994	1,922	776							3,718		28,504	59.96
N-12-2				16,583	1,103										17,686	27.21
Total (lf)	138	2,960	10,437	828,106	91,134	28,497	34,312	9,779	11,195	2,760	4,879	9,314	17,605	5,971	1,057,087	1,911.01

*Unknown pipe diameters were assumed to be 8" diameter to calculate idm

TABLE 2 - SUMMARY OF METER TRIBUTARY AREAS
TOWN OF WEYMOUTH, MA
2021 TOWN-WIDE FLOW METERING

		Pipe Diameter (in)															
Meter Manhole	Subarea(s)	4	5	6	8	10	12	15	18	21	22	24	27	30	42	Total Linear Footage (lf)	Total Inch-Diameter Miles (idm)
		Linear Footage (lf)															
602	N-2				9,610		2,061									11,671	19.24
693	B-1, B-2	66		382	35,626	9,892	475	2,771								49,212	82.15
748	B-3			133	27,666	1,782	901		1,503			1,295		1,983		35,263	69.77
830	N-12-1, C-2			1,200	28,764	1,923	776		201					6,944		39,808	90.49
958	C-1				15,709	808										16,517	25.33
1097	B-3, B-4, B-5			203	24,930	1,996			1,943			204				29,276	49.33
1206	N-12-2				16,437	1,103										17,540	26.99
1320	D-11		99	1,188	13,591	50	1,130	300	1,300							17,658	29.98
1753	B-4			209	10,218	2,870										13,297	21.15
1987	D-2, D-3, D-12		36	272	28,639	1,927	2,099	2,315								35,288	58.73
2063	B-5			181	28,186	2,392		1,483	546							32,788	53.52
2119	B-5				11,254	4,018										15,272	24.66
2393	B-6				27,239		676	2,743								30,658	50.60
2485	C-4	43		198	24,301	2,207	2,021	2,499								31,269	52.95
2899	D-3				18,149	3,853	1,598									23,600	38.43
2927	B-6		96	574	30,084	849	866	4,372								36,841	62.32
2980	C-5				16,976	4,415	2,342									23,733	39.41
3135	C-7		77	656	22,157					547			5,486			28,923	64.62
3520	C-7, C-12			51	32,599	2,227	306			7,062						42,245	82.45
3876	C-9				23,115	4,169	3,820	2,613								33,717	59.02
3994	C-10				18,158	1,708	893	1,602	1,116	345		2,311				26,133	53.01
4033	C-12, C-13			102	21,323	2,755	1,441									25,621	40.92
4199	C-14			329	21,253	2,433	284	171		3,241	962					28,673	55.21
4445	C-10			287	24,018	531	232									25,068	38.25
4535	C-14				19,876	3,663	1,289									24,828	39.98
4563	C-10			138	20,549	5,837										26,524	42.35
4578	C-10, C-11				26,972	4,611	3,644	3,989								39,216	69.21
4779	C-15			547	21,774	2,152	169	4,522								29,164	50.92
4783	C-16			338	23,067	804		687								24,896	38.81
5041	C-15				22,612	4,424										27,036	42.64
5716	C-6, C-7, C-8		2,652	1,970	32,407	2,578		1,557					334	1,309	4,608	47,415	108.96
5893	C-8	12		75	24,045	458		304				2,051	3,493	1,076		31,514	71.56
WY-2CTR	B-1			130	16,635			248						3,531		20,544	46.12
WY-3CTR	D-12	17		222	16,503	114	695					816				18,367	30.77
WY-4CTR	A-1, N-7			237	24,934	450	776	1,387								27,784	44.60
WY-5CTR	C-3			225	20,759	10,972		508						1,568	1,177	35,209	72.20
Unmetered	N-1, N-5, N-8			592	25,418	4,070			3,171					999		34,250	63.38
Total (lf)		138	2,960	10,439	825,553	94,041	28,494	34,071	9,780	11,195	962	6,677	9,313	17,410	5,785	1,056,818	1,910.05

*Unknown pipe diameters were assumed to be 8" diameter to calculate idm

TABLE 3 - ESTIMATED PEAK INFILTRATION TOWN OF WEYMOUTH, MA 2021 TOWN-WIDE FLOW METERING					
Meter Manhole	Total Length (lf)	Inch-Miles	Net Peak Infiltration (gpd)	Net Peak Infiltration (mgd)	Net Peak Infiltration (gpdim)
602	11,671	19.24	58,000	0.058	3,013.8
693	49,212	82.15	444,500	0.445	5,410.9
748	35,263	69.77	502,000	0.502	7,195.1
830*	75,017	162.69	799,000	0.799	4,911.2
958	16,517	25.33	73,500	0.074	2,901.5
1097	29,276	49.33	69,550	0.070	1,409.8
1206	17,540	26.99	91,500	0.092	3,389.7
1320	17,658	29.98	121,000	0.121	4,035.6
1753	13,297	21.15	146,500	0.147	6,925.1
1987	35,288	58.73	374,500	0.375	6,376.4
2063	32,788	53.52	19,600	0.020	366.2
2119	15,272	24.66	99,500	0.100	4,034.7
2393	30,658	50.60	121,000	0.121	2,391.3
2485	31,269	52.95	67,500	0.068	1,274.8
2899	23,600	38.43	137,000	0.137	3,565.1
2927	36,841	62.32	228,000	0.228	3,658.4
2980	23,733	39.41	102,000	0.102	2,588.5
3135	28,923	64.62	82,000	0.082	1,269.0
3520	42,245	82.45	322,000	0.322	3,905.3
3876	33,717	59.02	259,500	0.260	4,396.5
3994	26,133	53.01	22,500	0.023	424.5
4033	25,621	40.92	181,500	0.182	4,435.9
4199	28,673	55.21	102,000	0.102	1,847.4
4445	25,068	38.25	132,500	0.133	3,464.1
4535	24,828	39.98	175,500	0.176	4,389.5
4563	26,524	42.35	109,500	0.110	2,585.8
4578	39,216	69.21	191,500	0.192	2,766.8
4779	29,164	50.92	37,500	0.038	736.5
4783	24,896	38.81	90,000	0.090	2,319.1
5041	27,036	42.64	70,000	0.070	1,641.7
5716	47,415	108.96	418,500	0.419	3,841.0
5893	31,514	71.56	10,700	0.011	149.5
WY-2CTR	20,544	46.12	113,000	0.113	2,450.2
WY-3CTR	18,367	30.77	186,000	0.186	6,044.0
WY-4CTR	27,784	44.60	47,000	0.047	1,053.7
Total	1,022,568	1,846.67	6,005,850	6.006	3,252.3

*Meter 830 includes pipe length and flow from MWRA Meter WY-5CTR

TABLE 4 - ESTIMATED PEAK INFLOW TOWN OF WEYMOUTH, MA 2021 TOWN-WIDE FLOW METERING								
Meter Manhole	Upstream Meters	Total Length (lf)	Regression Slope	Estimated Peak Design Storm Inflow (mgd)	Estimated Peak Design Storm Inflow (gpd)	Estimated Peak Design Storm Inflow (gpd/lf)	% of Total Design Storm Inflow	Cumulative % of Total Design Storm Inflow
4578		39,216	5.44	0.99	990,000	25.2	11.36%	11.36%
4445		25,068	4.67	0.85	850,000	33.9	9.76%	21.12%
WY-5CTR	2485, 5716	35,209	3.57	0.65	650,000	18.5	7.46%	28.58%
830	958, 1206, WY-5CTR	39,808	2.80	0.51	510,000	12.8	5.85%	34.44%
1097	1753, 2063	29,276	2.75	0.50	500,000	17.1	5.74%	40.17%
WY-3CTR	1987	18,367	2.36	0.43	430,000	23.4	4.94%	45.11%
693		49,212	2.09	0.38	380,000	7.7	4.36%	49.47%
3520	4033, 4199	42,245	1.92	0.35	350,000	8.3	4.02%	53.49%
1987	2899	35,288	1.54	0.28	280,000	7.9	3.21%	56.70%
748	1097	35,263	1.43	0.26	260,000	7.4	2.98%	59.69%
2980		23,733	1.37	0.25	250,000	10.5	2.87%	62.56%
WY-4CTR		27,784	1.37	0.25	250,000	9.0	2.87%	65.43%
1206		17,540	1.15	0.21	210,000	12.0	2.41%	67.84%
3876		33,717	1.15	0.21	210,000	6.2	2.41%	70.25%
4783		24,896	1.15	0.21	210,000	8.4	2.41%	72.66%
3994	4445, 4563, 4578	26,133	1.10	0.20	200,000	7.7	2.30%	74.95%
5716	3135, 5893	47,415	1.10	0.20	200,000	4.2	2.30%	77.25%
3135	3520	28,923	1.07	0.20	195,000	6.7	2.24%	79.49%
4199	4535, 4779, 4783	28,673	0.88	0.16	160,000	5.6	1.84%	81.32%
2927		36,841	0.85	0.16	155,000	4.2	1.78%	83.10%
2899		23,600	0.82	0.15	150,000	6.4	1.72%	84.83%
2393	2927	30,658	0.71	0.13	130,000	4.2	1.49%	86.32%
5893	3876, 3994	31,514	0.69	0.13	125,000	4.0	1.43%	87.75%
WY-2CTR	693, 748	20,544	0.69	0.13	125,000	6.1	1.43%	89.19%
958		16,517	0.66	0.12	120,000	7.3	1.38%	90.56%
4779	5041	29,164	0.66	0.12	120,000	4.1	1.38%	91.94%
2485	2980	31,269	0.63	0.12	115,000	3.7	1.32%	93.26%
1320		17,658	0.49	0.09	90,000	5.1	1.03%	94.30%
1753		13,297	0.47	0.09	85,000	6.4	0.98%	95.27%
2063	2119, 2393	32,788	0.44	0.08	80,000	2.4	0.92%	96.19%
4033		25,621	0.38	0.07	70,000	2.7	0.80%	96.99%
4535		24,828	0.38	0.07	70,000	2.8	0.80%	97.80%
4563		26,524	0.38	0.07	70,000	2.6	0.80%	98.60%
5041		27,036	0.27	0.05	50,000	1.8	0.57%	99.17%
2119		15,272	0.24	0.04	44,000	2.9	0.51%	99.68%
602		11,671	0.15	0.03	28,000	2.4	0.32%	100.00%
	TOTALS	1,022,568			8,712,000	9	100.00%	

TABLE 5 - 2006 PRIORITY EVALUATION

TOWN OF WEYMOUTH, MA

2021 TOWN-WIDE FLOW METERING

Subarea	Meter	If % of meter	Sub-Basin	Linear Footage (LF)	Inch-Miles	1999 Estimated Peak Infiltration		2021 Estimated Peak Infiltration		2021 Estimated Peak Inflow	
						GPD	GPDIM	GPD	GPDIM	GPD	GPD/LF
N-1	N/A	-	North Weymouth	6,733	10.42	N/A[2]	N/A				
N-2	602	100	North Weymouth	12,471	20.50	N/A	N/A	58,000	3,014	28,000	2.4
N-5	N/A	-	North Weymouth	8,376	13.97	N/A	N/A				
N-7	WY-4C	18.6	North Weymouth	5,260	9.74	N/A	N/A	8,742	1,054	46,500	9.0
N-9	N/A	-	Lower Central	3,436	5.21	N/A	N/A				
C-1	958	100	Lower Central	16,516	25.33	71,678	2,413	73,500	2,902	120,000	7.3
C-2	830	23.5	Lower Central	11,353	31.42	581,125	31,043	99,638	1,101	119,900	12.8
Year 1 Subtotal				64,145							
C-5[4]	2980	56.1	Lower Central	23,733	39.41	140,140	4,566	57,222	2,589	140,300	10.5
C-7[4]	N/A	-	Lower Central	37,383	85.54	536,984	8,060				
C-16	4783	100	Mill River	25,213	39.71	194,376	5,758	90,000	2,319	210,000	8.4
N-12-1	830	76.5	Lower Central	28,504	59.96	189,582	3,972	324,354	3,584	390,000	12.8
Year 2 Subtotal				114,833							
C-5[4]	2980	43.9	Lower Central	23,733	39.41	140,140	4,566	44,778	2,589	109,800	10.5
C-6	5716	100	Lower Central	25,925	63.71	690,569	22,284	418,500	3,841	200,000	4.2
C-7[4]	3135, 3520	100, 10	Lower Central	37,383	85.54	536,984	8,060	114,200	1,567	230,000	6.9
Year 3 Subtotal				63,308							
C-3	WY-5C	100	Lower Central	35,395	73.69	416,809	7,498	375,008	5,194	650,000	18.5
D-11	1320	100	Landing	17,864	30.69	149,917	5,479	121,000	4,036	90,000	5.1
Year 4 Subtotal				53,259							
B-1	693	40.6	Southeast	27,166	61.94	305,682	4,797	180,467	5,411	154,300	7.7
B-4	1753	100	Southeast	14,941	23.89	120,933	4,742	146,500	6,925	85,000	6.4
Year 5 Subtotal				42,107							
A-1	WY-4C	81.4	North Weymouth	22,996	35.40	193,183	5,476	38,258	1,054	203,500	9.0
C-8	5716	90	Old Swamp River	52,825	111.08	217,085	3,203	376,700	3,841	180,000	4.2
Year 6 Subtotal				75,821							
C-10	3994, 4445, 4563, 4578	100, 100, 100, 10	Old Swamp River	106,793	181.53	168,154	2,129	283,650	2,018	1,219,000	14.9
Year 7 Subtotal				106,793							
D-2	1987	47.4	Landing	19,873	34.15	80,000	2,189	177,513	6,376	132,700	7.9
D-3	1987, 2899	10, 90	Landing	38,337	61.48	157,366	3,054	160,750	3,973	163,000	6.6
Year 8 Subtotal				58,210							

TABLE 5 - 2006 PRIORITY EVALUATION

TOWN OF WEYMOUTH, MA

2021 TOWN-WIDE FLOW METERING

Subarea	Meter	If % of meter	Sub-Basin	Linear Footage (LF)	Inch-Miles	1999 Estimated Peak Infiltration		2021 Estimated Peak Infiltration		2021 Estimated Peak Inflow	
						GPD	GPDIM	GPD	GPDIM	GPD	GPD/LF
C-4	2485	100	Lower Central	28,499	48.75	61,000	1,738	67,500	1,275	115,000	3.7
C-9	3876	100	Old Swamp River	33,717	59.02	171,557	3,103	259,500	4,397	210,000	6.2
Year 9 Subtotal				62,216							
C-14	4199, 4535	100, 100	Mill River	53,703	95.50	104,684	1,298	277,500	2,915	230,000	4.3
Year 10 Subtotal				53,703							
B-3	748	100	Southeast	60,298	110.14	87,998	885	502,000	7,195	260,000	7.4
Year 11 Subtotal				60,298							
B-2	693	59.4	Southeast	45,718	75.23	185,741	2,976	264,033	5,419	225,700	7.7
Year 12 Subtotal				45,718							
C-12	3520	100	Mill River	38,471	75.92	133,612	2,653	322,000	3,905	350,000	8.3
N-8	N/A	-	Landing	11,115	22.41	59,000	2,648				
Year 13 Subtotal				49,586							
B-5	2119	100	Southeast	53,424	88.59	175,384	2,274	99,500	4,035	44,000	2.9
Year 14 Subtotal				53,424							
C-15	4779	100	Mill River	55,881	92.65	157,608	2,261	37,500	737	120,000	4.1
Year 15 Subtotal				55,881							
B-6	2927	50	Southeast	33,871	56.81	98,518	2,164	114,000	3,658	77,500	4.2
Year 16 Subtotal				33,871							
B-6	2927	50	Southeast	33,870	56.81	98,516	2,164	114,000	3,658	77,500	4.2
Year 17 Subtotal				33,870							
C-13	4033	100	Mill River	24,552	39.08	31,824	1,048	181,500	4,436	70,000	2.7
N-12-2	1206	100	Lower Central	17,686	27.21	31,826	1,202	91,500	3,390	210,000	12.0
Year 18 Subtotal				42,238							
C-11	4578	90	Old Swamp River	29,800	43.07	12,166	282	172,350	2,767	891,000	25.2
Year 19 Subtotal				29,800							
D-12	1987	43.3	Landing	19,149	32.46	1,985	72	162,159	6,376	121,200	7.9
Year 20 Subtotal				19,149							

1 "Estimated Peak Infiltration" is obtained by subtracting "Flow Removed" from "Peak 1999 Infiltration."

2 N/A - No flow data available

3 As Reported by town personnel.

4 Subareas C-5 and C-7 were investigated over two years of the program.

TABLE 6 - UPDATED PRIORITY EVALUATION

TOWN OF WEYMOUTH, MA

2021 TOWN-WIDE FLOW METERING

Subarea	Meter	If % of meter	Sub-Basin	Linear Footage (LF)	Inch-Miles	1999 Estimated Peak Infiltration		2021 Estimated Peak Infiltration		2021 Estimated Peak Inflow	
						GPD	GPDIM	GPD	GPDIM	GPD	GPD/LF
N-1	N/A	-	North Weymouth	6,733	10.42	N/A[2]	N/A				
N-2	602	100	North Weymouth	12,471	20.50	N/A	N/A	58,000	3,014	28,000	2.4
N-5	N/A	-	North Weymouth	8,376	13.97	N/A	N/A				
N-7	WY-4C	18.6	North Weymouth	5,260	9.74	N/A	N/A	8,742	1,054	46,500	9.0
N-9	N/A	-	Lower Central	3,436	5.21	N/A	N/A				
C-1	958	100	Lower Central	16,516	25.33	71,678	2,413	73,500	2,902	120,000	7.3
C-2	830	23.5	Lower Central	11,353	31.42	581,125	31,043	99,638	1,101	119,900	12.8
Year 1 Subtotal				64,145							
C-5[4]	2980	56.1	Lower Central	23,733	39.41	140,140	4,566	57,222	2,589	140,300	10.5
C-7[4]	N/A	-	Lower Central	37,383	85.54	536,984	8,060				
C-16	4783	100	Mill River	25,213	39.71	194,376	5,758	90,000	2,319	210,000	8.4
N-12-1	830	76.5	Lower Central	28,504	59.96	189,582	3,972	324,354	3,584	390,000	12.8
Year 2 Subtotal				114,833							
C-5[4]	2980	43.9	Lower Central	23,733	39.41	140,140	4,566	44,778	2,589	109,800	10.5
C-6	5716	100	Lower Central	25,925	63.71	690,569	22,284	418,500	3,841	200,000	4.2
C-7[4]	3135, 3520	100, 10	Lower Central	37,383	85.54	536,984	8,060	114,200	1,567	230,000	6.9
Year 3 Subtotal				63,308							
C-3	WY-5C	100	Lower Central	35,395	73.69	416,809	7,498	375,008	5,194	650,000	18.5
D-11	1320	100	Landing	17,864	30.69	149,917	5,479	121,000	4,036	90,000	5.1
Year 4 Subtotal				53,259							
B-1	693	40.6	Southeast	27,166	61.94	305,682	4,797	180,467	5,411	154,300	7.7
B-4	1753	100	Southeast	14,941	23.89	120,933	4,742	146,500	6,925	85,000	6.4
Year 5 Subtotal				42,107							
A-1	WY-4C	81.4	North Weymouth	22,996	35.40	193,183	5,476	38,258	1,054	203,500	9.0
C-8	5716	90	Old Swamp River	52,825	111.08	217,085	3,203	376,700	3,841	180,000	4.2
Year 6 Subtotal				75,821							
C-10	3994, 4445, 4563, 4578	100, 100, 100, 100	Old Swamp River	106,793	181.53	168,154	2,129	456,000	2,248	2,110,000	18.0
Year 7 Subtotal				106,793							
D-2	1987	47.4	Landing	19,873	34.15	80,000	2,189	177,513	6,376	132,700	7.9
D-3	1987, 2899	10, 90	Landing	38,337	61.48	157,366	3,054	160,750	3,973	163,000	6.6
Year 8 Subtotal				58,210							

TABLE 6 - UPDATED PRIORITY EVALUATION

TOWN OF WEYMOUTH, MA

2021 TOWN-WIDE FLOW METERING

Subarea	Meter	If % of meter	Sub-Basin	Linear Footage (LF)	Inch-Miles	1999 Estimated Peak Infiltration		2021 Estimated Peak Infiltration		2021 Estimated Peak Inflow	
						GPD	GPDIM	GPD	GPDIM	GPD	GPD/LF
C-4	2485	100	Lower Central	28,499	48.75	61,000	1,738	67,500	1,275	115,000	3.7
C-9	3876	100	Old Swamp River	33,717	59.02	171,557	3,103	259,500	4,397	210,000	6.2
Year 9 Subtotal				62,216							
C-14	4199, 4535	100, 100	Mill River	53,703	95.50	104,684	1,298	277,500	2,915	230,000	4.3
Year 10 Subtotal				53,703							
B-3	748	100	Southeast	60,298	110.14	87,998	885	502,000	7,195	260,000	7.4
Year 11 Subtotal				60,298							
B-2	693	59.4	Southeast	45,718	75.23	185,741	2,976	264,033	5,419	225,700	7.7
D-12	1987	43.3	Landing	19,149	32.46	1,985	72	162,159	6,376	121,200	7.9
Year 12 Subtotal				64,867							
C-12	3520	100	Mill River	38,471	75.92	133,612	2,653	322,000	3,905	350,000	8.3
Year 13 Subtotal				38,471							
B-5	2119	100	Southeast	53,424	88.59	175,384	2,274	99,500	4,035	44,000	2.9
Year 14 Subtotal				53,424							
B-6	2927	100	Southeast	67,742	113.61	98,516	2,164	228,000	3,658	155,000	4.2
Year 15 Subtotal				67,742							
C-13	4033	100	Mill River	24,552	39.08	31,824	1,048	181,500	4,436	70,000	2.7
N-12-2	1206	100	Lower Central	17,686	27.21	31,826	1,202	91,500	3,390	210,000	12.0
N-8	N/A	-	Landing	11,115	22.41	59,000	2,648				
Year 16 Subtotal				53,353							
C-15	4779	100	Mill River	55,881	92.65	157,608	2,261	37,500	737	120,000	4.1
Year 17 Subtotal				55,881							

1 "Estimated Peak Infiltration" is obtained by subtracting "Flow Removed" from "Peak 1999 Infiltration."

2 N/A - No flow data available

3 As Reported by town personnel.

4 Subareas C-5 and C-7 were investigated over two years of the program.

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