BOARD OF WATER COMMISSIONERS

Regular Meeting Agenda

Tuesday, July 16, 2024 6:15 p.m.

Meeting will be held at the Bristol Water & Sewer Department, Water Filtration Plant, 1080 Terryville Ave., Bristol, CT. or join via Zoom: Meeting ID:845 169 6140, Passcode: 123456; Dial in: 1-929-205-6099.

1. Call to Order
2. Pledge of Allegiance
3. Moment of Silence
4. Approval of the minutes of the June 18, 2024 Regular Board Meeting
5. Approval of the Department Reports for the Month of June 2024
6. Public Participation
7. Customer Correspondence
    1. 49 South Street Ext.
    2. 81 Geary Avenue
    3. 32 Elm Street
8. GIS
9. Safe Yield and MOS Final Report - Hazen
10. Committee Reports
11. Investments
12. Superintendent's Report
13. Chairperson's Report
14. Old Business
15. New Business
16. Adjournment

Next Meeting: Tuesday, August 20, 2024 6:15 p.m.

BOARD OF WATER COMMISSION
JUNE 18, 2024 – REGULAR MEETING

PRESENT: Chairperson Phelan; Commissioners Porrini and Cunningham; Council Liaison Jacqueline Olsen.

Absent: Commissioners Dunn and Ferrier.

STAFF PRESENT: Superintendent Robert Longo; Assistant Superintendents Bolduc, Keegan and Dawn LaBella, Office Manager.

1) **CALL TO ORDER.**

   Chairperson Phelan called the meeting of the Board of Water Commission to order at 6:10 p.m.

2) **PLEDGE OF ALLEGIANCE.**

3) **MOMENT OF SILENCE.**

4) **APPROVAL OF THE MINUTES OF THE APRIL 16, 2024 PUBLIC HEARING.**

   On motion of Commissioner Porrini and seconded, it was unanimously voted to approve the April 16, 2024 Public Hearing minutes as presented.
   Motion passed.

5) **APPROVAL OF THE MINUTES OF THE APRIL 16, 2024 REGULAR MEETING.**

   On motion of Commissioner Porrini and seconded, it was unanimously voted to approve the April 16, 2024 regular meeting minutes as presented.
   Motion passed.

6) **APPROVAL OF THE DEPARTMENT REPORTS FOR THE MONTH OF APRIL 2024.**

   On motion of Commissioner Porrini and seconded, it was unanimously voted to approve the April 2024 Department Reports as presented.
   Motion passed.

7) **APPROVAL OF THE DEPARTMENT REPORTS FOR THE MONTH OF MAY 2024.**

   On motion of Commissioner Porrini and seconded, it was unanimously voted to approve the May 2024 Department Reports as presented.
   Motion passed.

8) **PUBLIC PARTICIPATION.**

None.

9) **CUSTOMER CORRESPONDENCE.**

1. 457 Woodland Street: Requesting to have penalties waived.

   On motion of Commissioner Porrini and seconded, it was unanimously voted that no recourse be given.
   Motion passed.

2. 399 Redstone Hill Road: Requesting to have $7.50 penalty fees waived.

   On motion of Commissioner Porrini and seconded, it was unanimously voted that no recourse be given.
   Motion passed.

3. 33 Manross Road: Requesting a reduction on excessive water charges due to a leak.

   On motion of Commissioner Porrini and seconded, it was unanimously voted that no recourse be given.
   Motion passed.

10) **COMMITTEE REPORTS.**

None.

11) **INVESTMENTS.**

None.

12) **SUPERINTENDENTS REPORT.**

No action taken.

13) **CHAIRPERSONS REPORT.**

No action taken.

14) **OLD BUSINESS.**

None.

15) **NEW BUSINESS.**

None.

16) ADJOURNMENT.

At 6:45 p.m., on motion of Commissioner Porrini and seconded, it was unanimously voted to adjourn.

ATTEST: _____

Renee M. LaMarre
Water & Sewer Administrative Assistant

BRISTOL WATER DEPARTMENT
JUNE 2024

WATER BILLING

Water Bills rendered June 2024	$830,648.06
Water Bills remaining unpaid as of June 2024	$307,359.07

PRECIPITATION

For the Month	5.60 "	Normal	4.28 "	Departure from Normal	1.32 "
For the Year	35.27 "	Normal	22.17 "	Departure from Normal	13.10 "

RESERVOIR CAPACITY

Total Available Capacity - June 2024	1,183,690,000	Gallons	92.594%

PRODUCTION

Monthly Production - June 2024	193,074,260	Gallons
Monthly Production - June 2023	190,137,200	Gallons

CASH STATEMENT WATER	
BALANCE:JUNE 1 2024	2,673,404.59
REVENUE:	
ACCOUNTS RECEIVABLE	497,629.95
SERVICE ACCOUNTS	13,135.59
FINES	
SEWER ACCOUNTS	468,891.76
LIENS	(1.04)
PENALTIES	3,176.84
REMOVE METER	200.00
CLOSING COSTS	4,725.00
REINSTATE FEES	8,625.00
ASSESSMENTS	
ADMIN FEE/LIENS (WPC)	70.00
LAND LEASE	2,436.27
CELL TOWER LEASE	16,999.92
SCRAP METAL SALES	
TIMBER SALES	
STATE BOND TRANSFERS	49,390.50
TOTAL REVENUE:	1,065,279.79
TOTAL REVENUE SUPER NOW CHECKING ACCOUNT	1,065,279.79
DISBURSEMENTS (VOUCHERS):	791,440.20
TRANSFERS:	
SEWER TRANSFER (BWSD)	468,891.76
TRANSFER TO PROCUREMENT ACCOUNT	15,000.00
ACCOUNT BALANCES:	
SUPER NOW CHECKING ACCOUNT	
BALANCE: JUNE 30 , 2024	2,463,352.42
GOALS ENABLING FUND	
BALANCE: JUNE 30 , 2024	5,612,827.59
CONSTRUCTION ACCOUNT	
BALANCE: JUNE 1, 2024	122,836.94
DEPOSIT	13,022.00
DISBURSEMENTS	(8,351.49)
BALANCE: JUNE 30, 2024	127,507.45
PAYROLL CASH ACCOUNT	
BALANCE: JUNE 1, 2024	192,568.58
DEPOSIT	262,994.89
DISBURSEMENTS	(255,110.15)
BALANCE: JUNE 30, 2024	200,453.32

2023 2024 BRISTOL WATER DEPARTMENT BUDGET				
Jun-24				
	APPROVED BUDGET	EXPENDED JUNE	EXPENDED TO DATE	% TO DATE
CLASSIFICATION	2023 2024	2023 2024	2023 2024	2023 2024
SALARIES	$ 2,910,770.00	$ 239,291.15	$2,898,292.70	99.57%
FRINGE BENEFITS	$ 1,626,455.00	$ 98,839.53	$1,441,593.26	88.63%
OPERATING SERVICES	$ 2,515,492.00	$190,605.43	$2,143,015.20	85.19%
MATERIALS & SUPPLIES	$ 1,127,245.00	$163,196.53	$1,492,043.62	132.36%
CAPITAL OUTLAY	$ 1,181,141.00	$25,452.50	$302,481.61	25.61%
GRAND TOTAL	$ 9,361,103.00	$717,385.14	$8,277,426.39	88.42%
OPERATING SERVICES				
LIGHT & POWER	$ 410,505.00	$ 35,713.80	$406,256.74	98.97%
TELEPHONE	$ 24,240.00	$ 1,665.76	$19,996.53	82.49%
POSTAGE	$ 29,900.00		$18,018.52	60.26%
ADVERTISING	$ 1,000.00	$ 455.27	$3,916.07	391.61%
CLOTHING/UNIFORMS	$ 6,680.00	$ 1,818.44	$10,978.83	164.35%
MAINTENANCE/SERVICE	$ 75,720.00	$ 1,400.45	$41,754.14	55.14%
LEASE	$ 12,349.00	$ 1,271.10	$10,706.59	86.70%
CONFERENCE & MEMBERSHIP	$ 30,550.00	$ 3,165.90	$29,544.43	96.71%
TAXES	$ 605,783.00		$505,759.20	83.49%
PROFESSIONAL SERVICES	$ 264,220.00	$ 64,420.61	$341,233.82	129.15%
LIENS	$ 6,300.00	$ 100.00	$2,814.67	44.68%
MISCELLANEOUS	$ 6,570.00	$ 362.94	$10,521.17	160.14%
CONTRACTOR SERVICES	$ 616,600.00	$ 29,999.93	$388,122.05	62.95%
DEBT SERVICES	$ 134,275.00	$ 6,727.07	$134,274.84	100.00%
SEWER USE FEE	$ 10,800.00		$13,500.00	125.00%
NEW BRITAIN AGREEMENT	$ 280,000.00	$ 43,504.16	$205,617.60	73.43%
TOTAL OPERATING SERVICES	$ 2,515,492.00	$190,605.43	$2,143,015.20	85.19%
SUPPLIES AND MATERIALS				
MOTOR FUELS	$ 62,857.00	$ 6,452.11	$69,071.12	109.89%
OFFICE SUPPLIES	$ 33,285.00	$ 816.68	$26,179.92	78.65%
MAINTENANCE SUP & MATERIALS	$ 387,000.00	$ 136,477.12	$815,021.44	210.60%
MV PARTS & SUPPLIES	$ 15,150.00		$22,913.29	151.24%
MV SERVICE & REPAIRS	$ 44,000.00	$ 1,331.45	$40,180.81	91.32%
FUEL OIL	$ 41,250.00		$42,853.07	103.89%
CHEMICAL TREATMENT	$ 270,000.00	$ 18,119.17	$311,386.22	115.33%
INSURANCE	$ 273,703.00		$164,437.75	60.08%
TOTAL SUPPLIES & MATERAILS	$ 1,127,245.00	$163,196.53	$1,492,043.62	132.36%
CAPITAL OUTLAY				
CAPITAL EQUIPMENT	$ 200,000.00		$41,618.90	20.81%
CAPITAL OUTLAY	$ 585,000.00		$83,401.45	14.26%
MISC. UTILITY ASSETS	$ 396,141.00	$ 25,452.50	$177,461.26	44.80%
CAPITAL OUTLAY TOTAL	$ 1,181,141.00	$25,452.50	$302,481.61	25.61%
GRAND TOTAL	$ 9,361,103.00	$717,385.14	$8,277,426.39	88.42%

CITY OF BRISTOL WATER DEPARTMENT			
CAPITAL OUTLAY BUDGET YEAR 2023-24			
CAPITAL EQUIPMENT	**BUDGET REQUEST 2023-2024**	**EXPENDED JUNE 2024**	**EXPENDED TO-DATE**
FORD F550 4WD W/ UTILITY BODY (REPLACE TRUCK 6)	$110,000.00		$0.00
REPLACE WATERSHED VEHICLE	$90,000.00		$41,618.90
			$0.00
TOTAL CAPITAL EQUIPMENT	**$200,000.00**	**$0.00**	**$41,618.90**
UTILITY ASSETS			
DISTRIBUTION SECTION			
(2) Demo Saws	$1,200.00		$0.00
(2) Pipe Locators	$5,000.00		$0.00
Signage	$3,000.00		$0.00
Mueller Power Operator	$5,000.00		$5,400.00
(3) Pin Locators	$6,000.00		$0.00
(1) Jumping Jack Compressor	$4,500.00		$4,525.00
Insertion Valves	$40,000.00		$12,636.43
Regulator Repairs	$20,000.00		$0.00
(2) Automatic Flushers	$20,000.00		$0.00
			$0.00
TOTAL UTILITY ASSETS DISTRIBUTION SECTION	**$104,700.00**	**$0.00**	**$22,561.43**
METER SHOP SECTION			
5/8" Meters 650@149	$96,850.00	$7,900.00	$43,970.00
Transmitters 500 @135.00	$67,500.00	$16,800.00	$87,262.27
1 1/2" T-10 METER (10)	$7,335.00		$0.00
1" T-10 METER (10)	$3,427.00		$0.00
2" T-10 METER (10)	$9,405.00		$4,973.10
3" NEPTUNE TR/FLO COMPUND UME	$2,564.00		$0.00
3" NEPTUNE HP TURBINE UME	$1,283.00		$1,452.30
3/4" T-10 METER(20)	$4,935.00		$1,709.40
R900 Belt Clip Transceiver	$13,333.00		$0.00
Schonstedt Model GA-52Cx (2)	$2,109.00		$0.00
			$0.00
TOTAL UTILITY ASSETS METER SHOP SECTION	**$208,741.00**	**$24,700.00**	**$139,367.07**

CITY OF BRISTOL WATER DEPARTMENT			
CAPITAL OUTLAY BUDGET YEAR 2023-24			
WATER TREATMENT PLANT SECTION			
LMI Chemical Feed Pump	$10,000.00	$752.50	$6,501.73
PLC and Analyzer Equipment	$15,000.00		$0.00
Chemical Feed Maintenance Parts	$10,000.00		$3,729.57
Peristaltic Chemical Feed Pump	$10,000.00		$0.00
Turbidity Meter	$10,000.00		$0.00
Flow Meter	$12,000.00		$0.00
Chlorine Analyzer	$8,000.00		$0.00
TOTAL UTILITY ASSETS WATER TREATMENT PLANT	**$75,000.00**	**$752.50**	**$10,231.30**
WATERSHED SECTION			
			$0.00
Game Cameras	$1,500.00		$0.00
Chainsaw Chain Breaker and Spinner	$1,200.00		$0.00
			$0.00
			$0.00
TOTAL UTILITY ASSETS WATERSHED SECTION	**$2,700.00**	**$0.00**	**$0.00**
OFFICE SECTION			
Conference Table and Chairs	$5,000.00		$5,301.46
TOTAL UTILITY ASSETS OFFICE SECTION	**$5,000.00**	**$0.00**	**$5,301.46**
TOTAL UTILITY ASSETS	**$396,141.00**	**$25,452.50**	**$177,461.26**
	BUDGET REQUEST 2023-24	**EXPENDED JUNE 2024**	**EXPENDED TO-DATE**
CAPITAL IMPROVEMENTS			
WATER MAIN REPLACEMENTS	$350,000.00		$0.00
HYDRANT REPLACEMENTS	$100,000.00		$83,401.45
REPLACE STEEL DOORS IN WATERSHED GARAGE	$60,000.00		$0.00
UPGRADES TO FIRE ALARM SYSTEM	$75,000.00		$0.00
			$0.00
			$0.00
TOTAL CAPITAL IMPROVEMENTS	**$585,000.00**	**$0.00**	**$83,401.45**
TOTAL CAPITAL OUTLAY	**$1,181,141.00**	**$25,452.50**	**$302,481.61**
SCADA IN PROGRESS	$483,065.31	49,390.50	186,369.13
CARRY OVER FROM 2022-2023			
CAMERA PROJECT FP			175,051.21
2023 FORD F-150			42,791.30

2024 SHUT-OFFS BREAKDOWN Still off to date for non-pay: (38)

MONTH/ DISTRICT	*TERMINATION LETTERS SENT*	*DOOR HANGERS DELIVERED*	*# ACCTS. OUTSTANDING @ START OF SHUT-OFF DAY*	*# ACCTS. ACTUALLY SHUT-OFF THROUGHOUT SHUT-OFF DAY*	*# ACCTS. STILL OFF @ END OF SHUT-OFF DAY*	*# ACCTS. THAT REMAINED OFF @ END OF MONTH*
JANUARY 03	458	331	41	27	8	2
FEBRUARY 01	380	269	42	28	11	5
MARCH 02	432	N/A	77	63	14	3
APRIL 03	428	N/A	124	100	25	8
MAY 01	369	N/A	80	64	15	5
JUNE 02	338	N/A	89	69	19	7
JULY 03						
AUGUST 01						
SEPTEMBER 02						
OCTOBER 03						
NOVEMBER 01						
DECEMBER 02						

BEFORE RECEIVING A TERMINATION LETTER, THE CUSTOMER HAS RECEIVED THEIR ORIGINAL BILL PLUS A SECOND AND THIRD NOTICE. Example: Invoiced 8/1, 2nd Notice 9/1, 3rd Notice 10/1. THE TERMINATION LETTER IS SENT APPROX. 1 WEEK AFTER 3RD NOTICE. DOOR HANGERS FOLLOW IN 1-2 WEEKS WITH SHUT-OFF DAY 1 WEEK LATER.

What are you looking for?

Current Monthly Summary ★

Current Month Payment Summary

Payment Type	Number Of Transactions	Total Paid
Credit/Debit Card	704	$117,491.23
EFT (Check)	197	$37,646.00
Online Bank Direct	190	$25,638.93
PayPal	62	$9,020.50
PayPal Credit	8	$1,388.38
Venmo	8	$1,266.21
Total	1169	$192,451.25

Monthly Invoice Summary

Invoice Count
No records to display.

Paperless Statistics

Invoice Type	Paperless
Water	6889

Auto-Pay Statistics

Invoice Type	AutoPay
Water	3436

Customer Registration Statistics

Customer Count	Registered Count	Registered %
22318	10662	47.77

Pay By Text Registration Statistics

Customer Count	Registered Count	Registered %
4616	3566	77.25

July 11, 2024

To: Rob Longo
Superintendent
Bristol Water and Sewer Department

From: Steven Nebiker
Meagan Heslin
Hazen and Sawyer

Safe Yield and Margin of Safety Analysis

Executive Summary

This report describes the methodology for, and results of, the calculation of safe yield (SY) for Bristol's reservoir system in accordance with the procedures in the Connecticut Regulations (RCSA 25-32d-4). The reservoir system is comprised of six reservoirs that are operated in a coordinated manner to deliver raw water to the surface water treatment plant.

The SY was analyzed using a daily timestep OASIS model developed by Hazen comprising Bristol's water supply sources, including both surface and ground water, plus interconnections with nearby utilities. The safe yield calculation applies to surface water only (from the reservoirs), so contributions from the other sources are ignored. The safe yield calculation involves increasing annual average surface water withdrawals (utilizing a monthly pattern) until the combined reservoir storage in the system is just depleted, subject to historical reservoir inflows of over 100 years and current reservoir operating policies. Details on the modeling inputs, assumptions and results for the critical period and 100-year return frequency analysis are described in subsequent sections.

The SY that would occur with a 1 in 100-year recurrence was found to be **4.8 mgd** under the upcoming release requirements of the DEEP streamflow standards to be implemented in 2027. Currently there are no minimum release requirements, but because of drought protection provisions in the standards, the impact on safe yield of adding in the new requirements is minimal (0.1 mgd).

Table of Contents

1. Model Components and Assumptions

1.1 Schematic

As shown on Figure 1, the model uses a schematic that includes nodes for reservoirs, river diversions and intakes, surface water treatment plant, along with finished water from groundwater supply and purchases from interconnections with nearby utilities. Arcs convey water between nodes in the direction of the arrows. The majority of the reservoirs are on the Poland River. Rules dictating the simulated movement of flow between the nodes are captured in the model's logic, using both a weighting scheme to prioritize operating goals as well as the model's operations control language. Additional detail is shown in the "Operating Rules" section of this report.

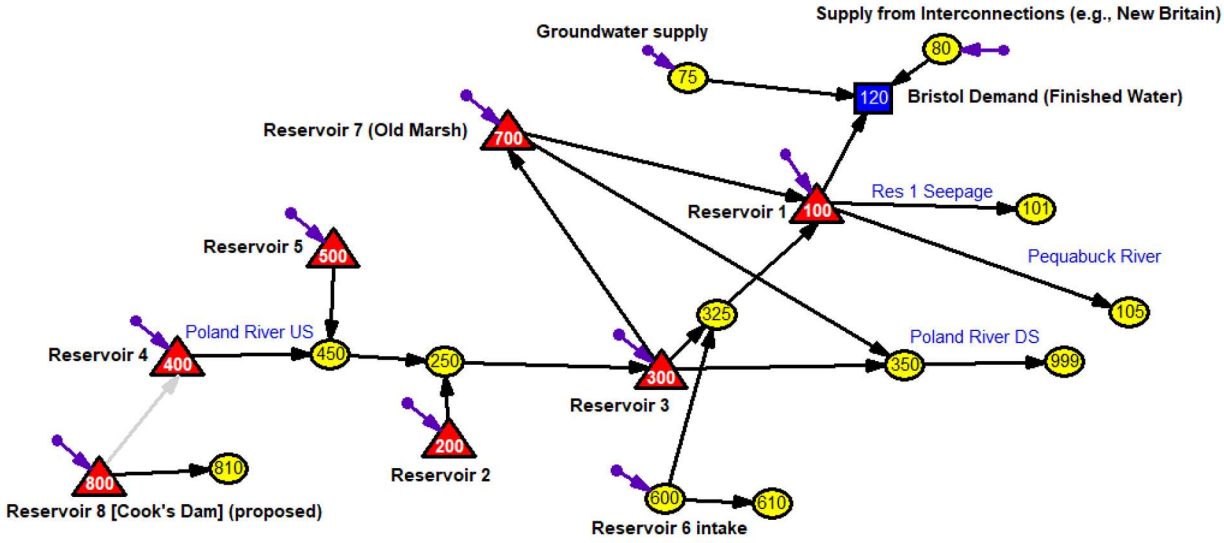

Figure 1. OASIS model schematic detail of the Bristol water supply system

1.2 Model Input

1.2.1 Reservoir and Diversion Information

A summary of Bristol's six reservoirs can be found in Table 1. Detailed stage-storage-area curves are used in the model to equate specific reservoir storage volumes to elevations/areas and are based on prior safe yield reports. Consistent with typical safe yield evaluations, all of the storage is assumed usable, with no reserve set aside. Usable storage in Reservoir 1 excludes any inaccessible storage below the lowest intake. In addition, additional storage from flashboards in Reservoir 7 is excluded since that storage is not allowed in SY analysis per Connecticut regulations.

The other reservoirs shown on the schematic, Reservoir 6 and Reservoir 8 (Cook's Dam), are not active. Reservoir 6, with a drainage area of 0.77 square miles, cannot currently divert water into the system to Reservoir 1. Reservoir 8 has been proposed in prior studies but there are no plans now to build . The drainage area for this reservoir is 2.48 square miles. The incremental drainage areas listed in the table are used for drainage area adjustment of the gaged inflow described later.

Table 1. Reservoir information

Reservoir	Storage (MG)	Drainage Area (Incremental) (sq. mi.)
1	57	0.42
2	106	0.32
3	8	2.74
4	263	1.78
5	202	1.12
7	643	2.3
Total	***1,279***	**n/a**

1.2.2 Water Treatment Plant Production

To model withdrawals to the City's water treatment plant, an annual average production is multiplied by a monthly pattern (see Table 2) to account for seasonal variation in water use. Since the plant production is influenced by wellfield operations and the City's interconnections – which are not included in the reservoir safe yield analysis—the system demand was used to develop the monthly pattern. In addition, the monthly pattern relied on 2023 data rather than the typical prior five years since many of the years were influenced by the pandemic and not representative of historic operations. Finally, surface water withdrawals and production are assumed to be the same since production loss through the treatment process is not significant.

Table 2. Bristol system demand pattern

Month	Monthly Fraction of Annual Average
January	0.9
February	0.82
March	0.91
April	0.95
May	1.12
June	1.15
July	1.13
August	1.09
September	1.01
October	1.01
November	0.94
December	0.97

1.2.3 Inflows

Daily inflows to each reservoir are calculated by using a drainage area adjustment of the USGS Hubbard River near West Hartland, CT gage (#01187300). This gage is free of significant regulation upstream, thus providing a good estimate of natural inflow, and was used in past SY studies.

The formula used to compute the inflows is:

*Inflow = Gage flow * Reservoir incremental drainage area / Gage drainage area*

The gage is geographically close to the reservoir system and has a similar drainage area (19.9 square miles) to the combined drainage of the Bristol system. The gage also has a sufficient period of record to compute a 1 in 100-year safe yield, although as described later, the gage record was extended statistically to have an even longer record.

An inflow verification was conducted by forcing the model to match daily historic production from 2016 to 2023, and then comparing the resulting system storage to the actual observed storage (end of period, monthly) for the same period. Figure 2 shows matching the historical production during this period.

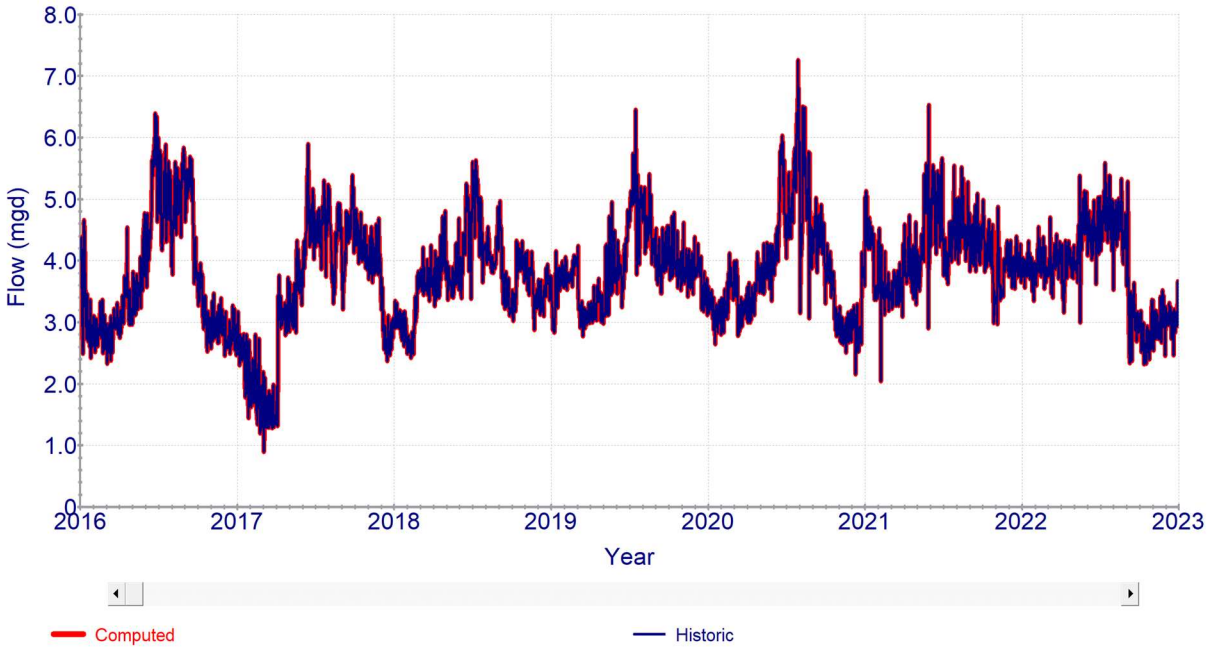

Figure 2. Historical and computed WTP production for model verification

Figure 3 shows the storage comparison, with overall good agreement between modeled and historic storage, suggesting that the Hubbard River gage is an appropriate gage for estimating inflows to the Bristol system. Additional confidence of this gage's applicability came from later verifying simulated drawdown in the historic drought of record (1960s).

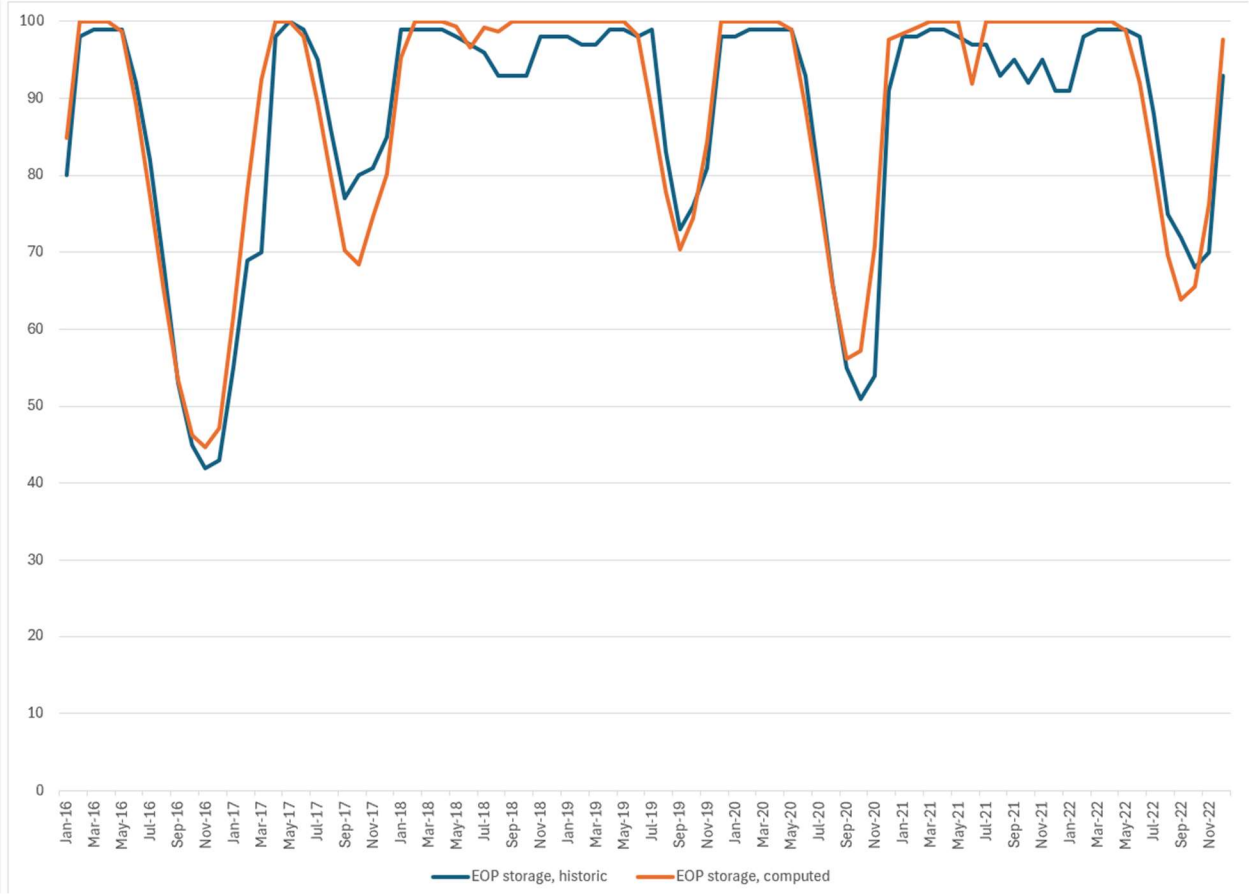

Figure 3. Verification results using the Hubbard River gage (showing end of period (EOP) % system storage on the y-axis))

The Hubbard River gage is active from 1938 to 1955 and 1956 to present. To capture as long a hydrologic record as possible, including the drought of the early 1930s, and to address gaps in the records, the gage data were "filled in" using statistical relationships with the other gages. This requires assembling a monthly record of the gage flows that are fed into a program named *Fillin* (developed by William Alley and Alan Burns of the USGS[1]). The program generates missing records using a log-transform and regression method and provides a complete monthly dataset from 1921 to 2023. Table 3 details the gages that were used by *Fillin.* The exact gage used to extend each record varies by month and year as the program uses the highest correlated available gage for each month.

After filling gaps in the records, the last step is to disaggregate the monthly filled-in flows into daily flows. This is done using flows for a daily, unregulated gage that is local or has similar drainage area (call it a "reference gage"). For this system, the Nepaug and Pomperaug gages were used as the reference gages. The disaggregation formula is:

[1] "Mixed-Station Extension of Monthly Streamflow Records," *Journal of Hydraulic Engineering*, ASCE, Vol. 109, No. 10, October 1983.

*Daily flow = (monthly filled in flow) * (daily reference flow / monthly reference flow)*

Table 3. Gages used for extension of the Hubbard River gage record

Gage Number	Gage Name	Period of Record
01187800	NEPAUG R NR NEPAUG, CT	10/1921-09/1955, 10/1957-09/1972, 10/1998-09/2001, 06/2017-present
01204000	POMPERAUG RIVER AT SOUTHBURY, CT	10/1932-present

1.2.4 Evaporation and Precipitation

Net evaporation in the model is computed as evaporation minus precipitation, in inches. Evaporation is derived utilizing the monthly pattern required by DPH for Safe Yield Analysis (RCSA 25-32d-4) shown in Table 4, disaggregated to daily using the monthly average rate.

Table 4. Monthly Evaporation Rate

Month	Evaporation Rates (total inches/month)
January	0.85
February	0.93
March	1.51
April	2.15
May	4.15
June	5.10
July	5.61
August	5.25
September	3.64
October	2.60
November	1.66
December	1.34

Daily precipitation values are derived primarily from NWS CO-OP weather stations, including the long-term Bridgeport Sikorsky airport station, chosen as needed to fill in any gaps so the record can align with the inflows extending back to 1921. Net evaporation in the OASIS model is the daily difference between evaporation and precipitation, multiplied by the surface area of the reservoirs (as computed by the elevation-storage-area tables) and subtracted from, or added to, storage for each time step.

1.2.5 Minimum Releases

There are no current minimum release requirements. [It is assumed there is dam seepage, however, of 0.25 cfs from Reservoir 1 that flows into the stream below]. Under the Class 3 release requirements from the Connecticut Stream Flow Standards and Regulations (RCSA 26-141b) adopted in 2011, a minimum

release requirement will apply to Reservoir 3 starting in 2027, with the start date determined by the river basin the reservoir is located in, in this case the Connecticut River Basin. As shown in Table 5, this uses a fixed release year-round of 0.6 cfs based on the rearing and growth bioperiod (July through October), reduced to the reservoir inflow should that be less. The 0.6 cfs represents the BQ80, or bioperiod 80th percentile flow. In this case, the percentile represents the flow that is exceeded 80% of the time for that bioperiod. Since the reservoir is small, both in storage and drainage area, there is no requirement to release seasonally-varying bioperiod flows.

These streamflow requirements allow for reductions to the fixed release of 0.6 cfs as the system's drought triggers are activated. The reductions are 25%, 50%, 75%, and 100% in drought stages Advisory, Watch, Warning, and Emergency, respectively, with 15% cutback accommodation for spring drought avoidance from March to May. [Again, if inflow is less, then release only needs to be the inflow.] Bristol's drought triggers are shown in Appendix A. Note that demand reductions associated with drought stages are not included in the SY modeling.

Table 5: Future minimum release requirements

Reservoir	Required Minimum Release
3	Fixed at BQ80 flow of 0.6 cfs (but lowered upon drought trigger activation), or the natural inflow, whichever is less

1.3 Operating Rules

Reservoir operations in the model factor in the hydraulic limits associated with transferring water between reservoirs and the water treatment plant. These include limits on flows from Reservoir 7 and Reservoir 3 to the treatment plant, along with limits on how much water can be pumped from Reservoir 3 (which has large upstream drainage area but small storage) to Reservoir 7 (which has limited drainage area but significant storage) that contributes to maximizing system yield.

2. Safe Yield and Margin of Safety Results

2.1 Critical Period and 1 in 100-year Safe Yield Methodology

Using the model, the critical period is computed by determining the maximum annual average production that would draw the reservoir system down to zero percent usable storage once in the hydrologic record (1921 – 2023). For that critical period, an adjustment factor is calculated to adjust (if necessary) the inflows used to determine the safe yield with a 1 in 100-year recurrence interval in accordance with DPH regulations. The adjustment factor is calculated by dividing the 100-year recurrence average flow (see below) by the actual average gage flow for that period. If the adjustment factor is greater than 1.0, no adjustment to the inflows is applied, which will result in a more conservative estimate of yield.

The 100-year recurrence average flow is calculated in Excel using the following methodology:

1. Average the flows for the critical period duration on a rolling-average basis for the entire inflow record (1921 – 2023)
2. For each water year starting October 1, choose the minimum critical period average flow, and place the minimum for each year into a table sorted from lowest to highest
3. On the sorted minimum annual critical period flows, compute the 1 in 100-year recurrence value using a Log Pearson Type III distribution (computed in Excel).

2.2 Safe Yield Calculations

Using the inputs and operating rules described in the previous sections, the annual average withdrawal was increased incrementally until the usable reservoir storage in the system reached zero once in the hydrologic record. Table 6 summarizes the unadjusted safe yield, critical period dates and durations, and the 1 in 100-year adjustment flows and factors using the upcoming DEEP minimum release. The critical period begins when reservoir storage drops below full and ends when reservoir storage just reaches empty (before beginning to refill). Using the adjustment factor, the safe yield was re-computed to produce a final 1 in 100-year safe yield. Since the adjustment factor of 1.14 exceeds 1.0, no adjustment to the safe yield is applied.

Table 6. Critical period and 1 in 100-year adjustment factors

Unadj. SY (mgd)	Critical Period Start	Critical Period End	Critical Period Duration (days)	USGS Gage	Avg. Flow over Critical Period (cfs)	Avg. Crit. Period Flow with 1 in 100 ret. freq. (cfs)	1 in 100 year Adj. Factor*	1 in 100 year Safe Yield*
4.9	5/6/64	2/10/66	646	Hubbard River	12.0	13.7	1.14	4.8

** If the adjustment factor is greater than 1.0, no adjustment was made to the inflows and the resulting safe yield*

Figure 4 shows the simulated drawdown during the critical drought with the 1 in 100 safe yield production and upcoming minimum release requirement.

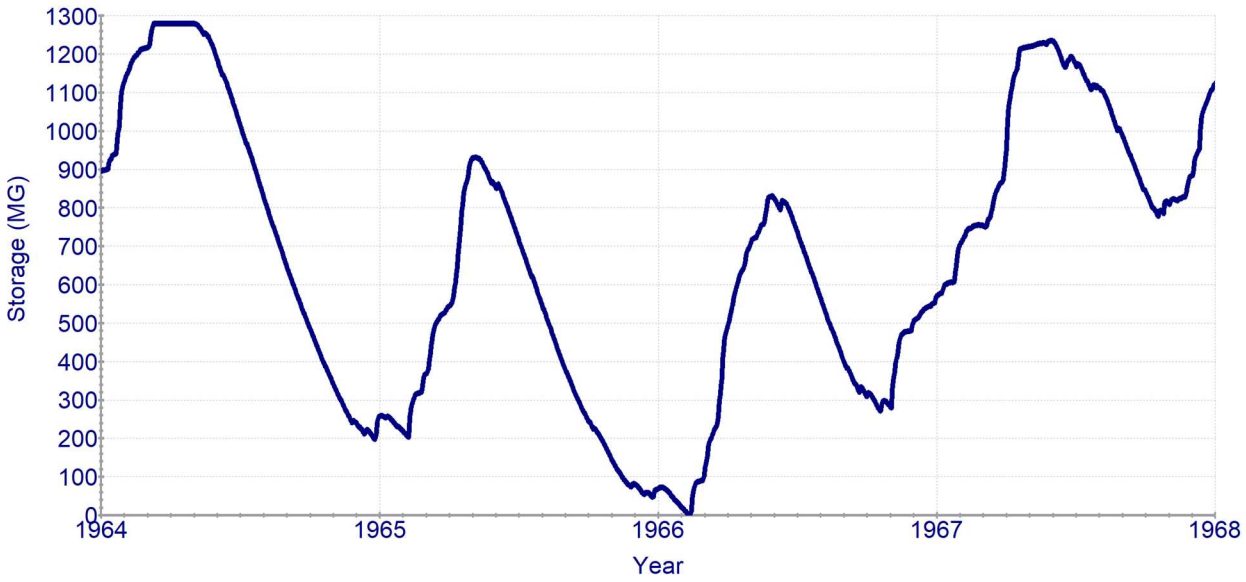

Figure 4. Bristol system storage over the drought of record, including critical period, using a safe yield withdrawal of 4.8 mgd and DEEP minimum streamflow requirement

2.3 Margin of Safety

Margin-of-Safety (MOS) is the unitless ratio of available water to demand. An MOS greater than 1.0 means that a system has more supply than demand, and an MOS less than 1.0 means a supply deficiency. There is no regulatory standard for MOS; however, DPH requires that MOS be calculated for annual average, maximum month, and maximum day demand conditions and sets a target MOS of 1.15 (15%) for each. For reservoirs, annual average supply is typically limited by safe yield and maximum month and maximum day supplies are limited by treatment capacity. This report therefore focuses on Bristol's average day MOS.

Table 7 provides calculations of the MOS over a 50-year planning horizon. The only variable changing over this time is the estimate of future demand. Prior reports (2010 Water Supply Plan Update, revised 2013 from Weston and Sampson), along with recent historical data and expected trends, were used to project demands through 2075.

The results indicate that with the current supply configuration, using the projected 0.25% annual growth rate in demand, the MOS target would be met over the 50-year planning horizon. It is important to note that even if the current purchase amount of 0.2 mgd were discontinued, the MOS would still remain above the minimum of 1.15 through 2075. [Instead of 1.20 shown in Table 7, it would be 1.17].

Table 7. Margin of Safety Calculations (all supply and demand in MGD)

Supply	**Current Year**	**2035**	**2045**	**2055**	**2065**	**2075**
Surface water	*4.8*	*4.8*	*4.8*	*4.8*	*4.8*	*4.8*
Groundwater from active wells (based on 2010 Water Supply Plan Update)	*2.2*	*2.2*	*2.2*	*2.2*	*2.2*	*2.2*
Purchases (average amount)	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
Total System Yield	7.2	7.2	7.2	7.2	7.2	7.2
Annual Average Demand (assuming 0.015 mgd annually or 0.25% annual growth)	5.3	5.4	5.6	5.7	5.9	6.0
Supply/Demand MOS	**1.36**	**1.33**	**1.29**	**1.26**	**1.22**	**1.20**

Appendix A: Drought Trigger Summary

For the calculation of safe yield under the future DEEP minimum release requirements, Bristol's system drought triggers, as detailed in its Drought Contingency Plan, are used to reduce the releases as allowed by the regulations. As presented in Table A1, the triggers for entering each drought phase are based on the monthly combined storage in all the reservoirs. The triggers have been aligned to the typical four suggested by DPH (advisory, watch, warning, and emergency). An assumed 7-day waiting period has been applied to entering each phase, and a 14-day waiting period for exiting each phase.

Table A1. Bristol Drought Triggers – Percent of Combined System Storage

Month	Advisory	Watch	Warning	Emergency
January	80	75	65	55
February	80	75	65	55
March	80	75	65	55
April	80	75	65	55
May	80	75	65	55
June	80	75	65	55
July	70	60	50	40
August	70	60	50	40
September	70	60	50	40
October	70	60	50	40
November	80	75	65	55
December	80	75	65	55