2022 WASHINGTON METROPOLITAN AREA DROUGHT EXERCISE

S. Ahmed, C. Davis, H. Moltz, S. Nummer, C. Schultz, and L. Vawter

Section for Cooperative Water Supply Operations on the Potomac
Interstate Commission on the Potomac River Basin
30 West Gude Drive, Suite 450, Rockville, Maryland 20850

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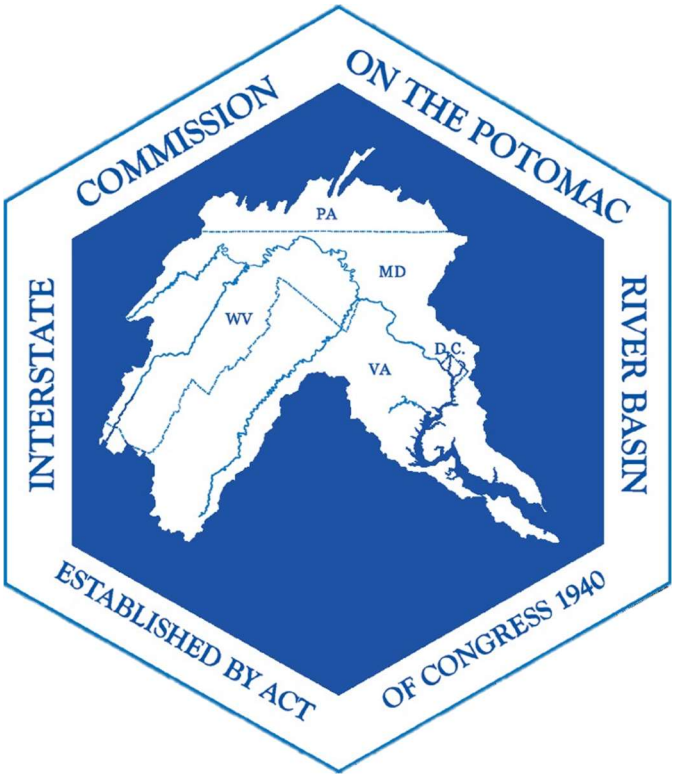
Abbreviations

BG	Billion gallons
cfs	Cubic feet per second
CO-OP	Section for Cooperative Water Supply Operations on the Potomac
CO-OP suppliers	Fairfax Water, WSSC Water, and Washington Aqueduct
CPC	Climate Prediction Center
CU	Consumptive use
Data Portal	CO-OP website for drought data submissions
D.C.	District of Columbia
DCC	Drought Coordination Committee
DCTC	Drought Coordination Technical Committee
DC Water	District of Columbia Water and Sewer Authority
DOEE	Department of Energy & Environment
DroughtOps Shiny App	Drought Operations Shiny Application
FEWS	Flood Early Warning System
FW or Fairfax Water	Fairfax County Water Authority
ICPRB	Interstate Commission on the Potomac River Basin
JRR	Jennings Randolph Reservoir
LFAA	Low Flow Allocation Agreement
LFFS	Low Flow Forecast System
LS	Little Seneca Reservoir
LW	Loudoun Water
MAE	Mean absolute error
MARFC	NWS Middle Atlantic River Forecast Center
MDE	Maryland Department of Environment
MG	Million gallons
MGD	Million gallons per day
M-NCPPC	Maryland-National Capital Park and Planning Commission
MWCOG	Metropolitan Washington Council of Governments
NOAA	National Oceanographic and Atmospheric Administration
NWS	National Weather Service
PRRISM	Potomac River and Reservoir Simulation Model
U.S.	United States
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
VADEQ	Virginia Department of Environmental Quality
VDH	Virginia Department of Health
VWP	Virginia Water Protection
WA	Washington Aqueduct
WMA	Washington Metropolitan Area, or Washington, DC., metropolitan area
WMA suppliers	CO-OP suppliers, Loudoun Water, and the City of Rockville
WSCA	Water Supply Coordination Agreement
WSSC Water	Washington Suburban Sanitary Commission
WTP	Water treatment plant
WTF	Water treatment facility



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The report is available online at www.PotomacRiver.org as ICP23-3_Ahmed.pdf.

2022 Washington Metropolitan Area Drought Exercise

The Washington, D.C., metropolitan area (WMA) relies on the Potomac River for over three-quarters of its water supply. The area's three major water suppliers ("CO-OP suppliers"), Fairfax County Water Authority (Fairfax Water), Washington Suburban Sanitary Commission (WSSC Water), and Washington Aqueduct (a Division of the U.S. Army Corps of Engineers) participate in a cooperative system of water supply planning and management. This participation includes joint funding of water supply storage in reservoirs located upstream of the suppliers' Potomac River intakes and coordinated operations during droughts.

During times of drought, the Section for Cooperative Water Supply Operations on the Potomac (CO-OP) of the Interstate Commission on the Potomac River Basin (ICPRB) plays a crucial role in coordinating water supply operations. By coordinating withdrawals from the Potomac River, Patuxent, and Occoquan reservoirs, the CO-OP staff help ensure that water resources are being utilized efficiently and effectively for the benefit of the system. When the forecasted flow in the river is not sufficient to meet expected demands, the CO-OP staff make requests for releases from upstream reservoirs. These demands include the water supply needs of the WMA and an environmental flow-by of 100 million gallons per day (MGD), or 155 cubic feet per second (cfs), on the Potomac River below the Little Falls Dam near Washington, D.C.

The ICPRB CO-OP section conducts an annual drought exercise to maintain readiness for drought conditions. These exercises serve as a platform for CO-OP staff to evaluate and discuss water management strategies with relevant stakeholders, prior to a real drought scenario. The activities aid in training CO-OP staff on regional agreements, tools, and decision-making processes. Moreover, they offer participants the chance to refine their communication processes and enhance organizational efficiency.

This report describes activities conducted during the 2022 Drought Exercise. The virtual training took place on Tuesday, Wednesday, and Thursday, November 15-17, from 7:30 A.M. to 2:00 P.M. Communications during the exercise were via telephone, email, and Microsoft Teams, and all operations were "simulated." Stakeholders received twice-daily email reports on “actual” precipitation, river flow, water withdrawals, and “simulated” operations and reservoir storages. This year's exercise included the following elements:

- A regional Drought Coordination Technical Committee (DCTC) conference call to discuss potential water use restrictions associated with the Metropolitan Washington Council of Governments (MWCOG) "Warning" stage,[1]
- Communication with Washington Aqueduct on the Low Flow Allocation Agreement (LFAA) thresholds,[2] and

[1] MWCOG, “Metropolitan Washington Water Supply and Drought Awareness Response Plan: Potomac River System,” MWCOG, 20 Jun 2000, https://www.mwcog.org/documents/2000/6/20/metropolitan-washington-water-supply-and-drought-awareness-response-plan-potomac-river-system/

[2] https://www.potomacriver.org/wp-content/uploads/2018/01/LFAA-Annotated_2_22_2018.pdf and https://www.potomacriver.org/wp-content/uploads/2018/01/LFAA_Memo_of_Intent_071978.pdf

- Data collection and operational forecasts through CO-OP's Data Portal and daily flow forecast tool to determine the need for "simulated" releases from Little Seneca and North Branch reservoirs (Jennings Randolph and Savage).

Participants in this year's exercise included staff from:

- ICPRB, which coordinates planning and operations between suppliers;
- Washington Aqueduct, which supplies water to the District of Columbia via DC Water and specific areas in Virginia, including Arlington County;
- WSSC Water, which supplies water to Montgomery and Prince George's counties in Maryland and, on a limited basis, to other parts of Maryland;
- Fairfax Water, which supplies water to Fairfax County, Virginia, and provides wholesale water to other suppliers in northern Virginia;
- Loudoun Water, which supplies its retail customers in Loudoun County in part with water withdrawn from the Potomac River and treated at its Trap Rock Water Treatment Facility (WTF) and in part with water purchased wholesale from Fairfax Water;
- The U.S. Army Corps of Engineers (USACE), Baltimore District Office, which manages the North Branch reservoirs water quality and water supply releases; and the
- MWCOG, which coordinates communications regarding drought restrictions in the WMA.

This year, there was no “actual” Little Seneca release due to the impact of Hurricane Nicole, a late-season Category 1 hurricane that brought heavy rainfall to the U.S. East Coast and affected Potomac River flow. As a result, the excess flow from the hurricane would have masked any test release. Nevertheless, in order to keep their information up-to-date for future Little Seneca releases, the Maryland-National Capital Park and Planning Commission (M-NCPPC) was contacted. The Montgomery County Executive, County Council members, and the M-NCPPC are informed of any periods when “actual” releases may occur.

Drought Operations for the CO-OP System

System Organization

The CO-OP suppliers rely on the Potomac River as their primary source of raw water, with each supplier having one or more intakes located upstream of Little Falls dam near Washington, D.C. Figure 1, taken from the 2020 Washington Metropolitan Area Water Supply Study, [3] provides an overview of the service areas and resources along the Potomac River. The Washington Aqueduct has two intakes on the Potomac River, one at Little Falls dam and another at Great Falls, situated several miles upstream. Fairfax Water and WSSC Water also have intakes on the Potomac, in conjunction with two off-Potomac sources. Fairfax Water partially relies on stored water from the Occoquan Reservoir, while WSSC Water depends on water stored in two reservoirs in the Patuxent River watershed, namely T. Howard Duckett (Rocky Gorge) and Triadelphia. Furthermore, these three suppliers jointly own storage in two reservoirs located upstream of their Potomac River intakes: Jennings Randolph Reservoir, located on the North Branch of the Potomac River adjacent to Garrett County, Maryland and Mineral County, West Virginia, and Little Seneca Reservoir located in Montgomery County, Maryland. Jennings Randolph Reservoir is

[3] https://www.potomacriver.org/wp-content/uploads/2020/12/2020-WMA-Water-Supply-study-FINAL-September-2020.pdf

operated by the USACE Baltimore District Office, while WSSC Water operates the dam at Little Seneca. The water suppliers have shared the capital costs as well as the operations and maintenance costs for both Jennings Randolph and Little Seneca reservoirs. In addition, they share the operations and maintenance cost of a third upstream reservoir, Savage, located on the North Branch of the Potomac, which operates in conjunction with Jennings Randolph Reservoir. This network of reservoirs on the Potomac are available to augment river flow during low flow periods.

The cooperative system that governs water allocation among the suppliers was established more than 40 years ago through two agreements. The Low Flow Allocation Agreement (LFAA) of 1978 defines a formula for water allocation during shortages, including the City of Rockville.[4] The Water Supply Coordination Agreement (WSCA) of 1982 commits the three suppliers to operate "in a coordinated manner" during droughts to optimize available resources.[5] Recently, Loudoun Water installed an intake on the Potomac River just upstream of the LFAA's limits. All these suppliers' intakes are affected by low flows in the Potomac River, either under the LFAA and or under their water withdrawal permits.

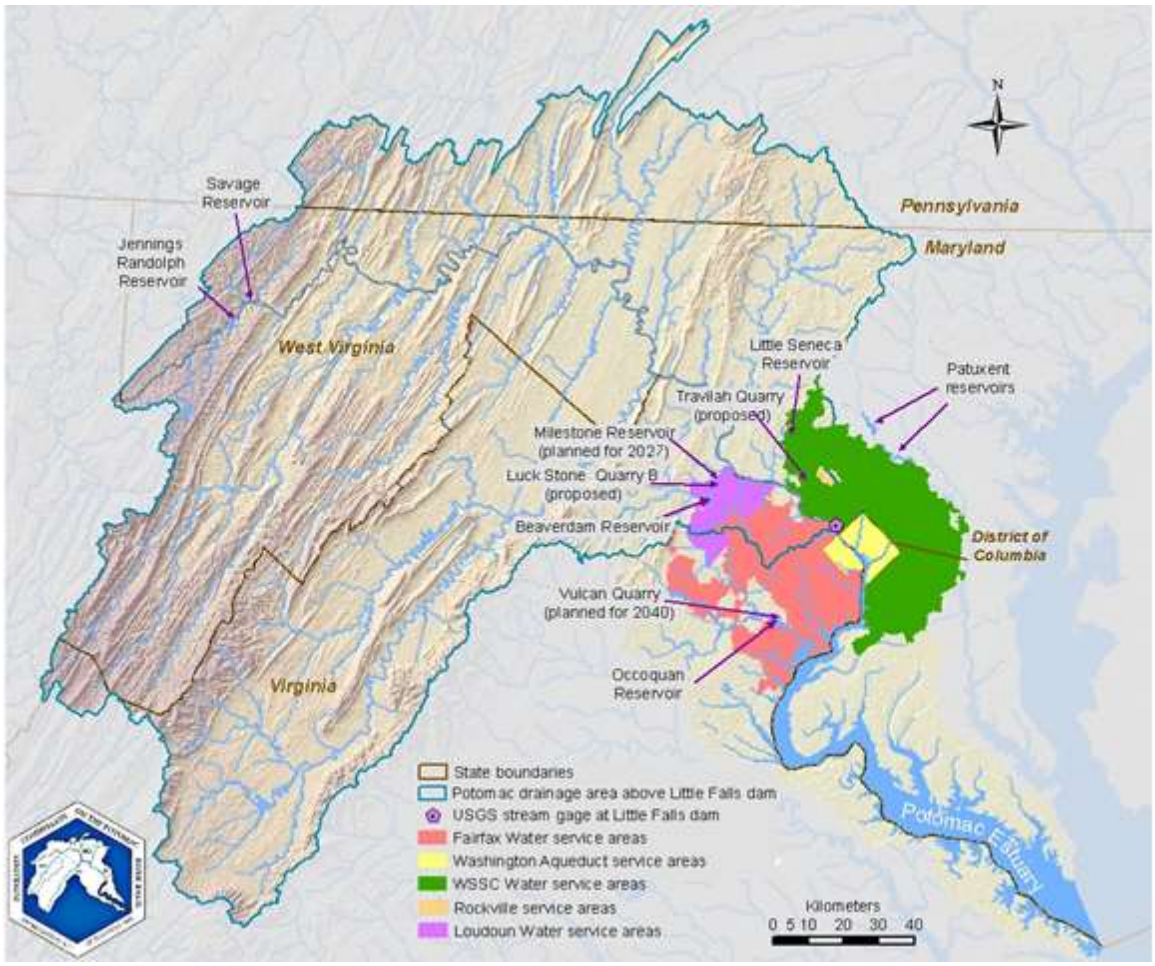


Figure 1: WMA current, planned, and proposed water supply resources, and supplier service areas.

[4] https://www.potomacriver.org/wp-content/uploads/2018/01/LFAA-Annotated_2_22_2018.pdf and https://www.potomacriver.org/wp-content/uploads/2018/01/LFAA_Memo_of_Intent_071978.pdf
[5] https://www.potomacriver.org/wp-content/uploads/2014/12/WSCA-Scanned-Feb-4-2009.pdf

Drought Operations

Key CO-OP goals for drought operations are:

- Maintain Potomac River flow at Little Falls dam (U.S. Geological Survey (USGS) Gage ID 01646500) at or above the environmental flow-by of 100 MGD (155 cfs).[6]
- Shift Washington Aqueduct withdrawals from Great Falls to Little Falls when Great Falls flow reaches 500 MGD (774 cfs).
- Balance the use of storage in system reservoirs to ensure that adequate volumes are maintained in each reservoir to sustain withdrawals throughout a severe drought and to provide a 95% probability of refill to 90% capacity by June 1 of the following year.

Given the travel times between upstream water storages and CO-OP supplier Potomac River intakes, predicting future river flows and WMA demands is necessary. CO-OP staff uses flow and demand forecasts to meet operational goals during drought to develop scenarios for release rates from upstream reservoirs and withdrawal rates from water supplier intakes. During low flow conditions, travel times to the last supplier intake are approximately nine days from Jennings Randolph Reservoir and one day from the Little Seneca Reservoir. These travel times are also used to plan Little Falls flow augmentations.

Operations scenarios may require "load shifts" by the water suppliers between intakes, shifting some portion of a supplier's withdrawal from one intake to another. Fairfax Water and WSSC Water load shift to their off-Potomac reservoir intakes to maintain the Potomac River flow at Little Falls above the environmental flow-by. Alternatively, these suppliers may load shift to the Potomac River to preserve storage in their off-Potomac reservoirs. Washington Aqueduct may shift a portion of its withdrawal from its Great Falls to its Little Falls intake to help increase flow in the stretch of the Potomac River between Great Falls and Little Falls. Load shifting requires close communication between ICPRB CO-OP and water supplier staff to ensure that the proposed scenarios are feasible.

Communications

Communications are a critical part of drought operations. During the exercise, the water suppliers reported "actual" data and system constraints because they have established protocols to automate communications that were practiced during the exercise to help build routines into staff schedules. Meanwhile, CO-OP staff made coordinated system management decisions based on "simulated" flows and demands. This data difference causes a disconnect between "actual" and "simulated" actions; however, it exercises the essential communication skills needed to be practiced by the water supplier and CO-OP staff teams.

This report section details the drought exercise pre-meeting, authorization for reservoir releases, Data Portal website, and daily email reports. In addition to the exercise activities, this section describes the MWCOG-hosted conference call of the DCTC to discuss the "Warning" stage triggered by the "simulated" drought conditions.

[6] MDNR. 1981. Potomac River Environmental Flow-by Study. Prepared by Maryland Department of Natural Resources, Water Resource Administration, Water Supply Division, Water Supply Planning Section. Annapolis, Maryland.

Drought Exercise Pre-Meeting.

In advance of the drought exercise, a virtual meeting of the CO-OP staff and the WMA water suppliers took place on November 7, 2022, from 11:00 A.M. to 12:30 P.M. The meeting served to:

- Review and update physical and operational constraints of the supplier systems;
- Meet utility operational personnel;
- Discuss the drought exercise procedures; and
- Update drought-related contact information.

Information on the participants and the WMA system appear in Table 1 and Table 2, respectively.

Table 1 Participants in the Drought Exercise Pre-Meeting

Organization	Facility
ICPRB	Sarah Ahmed, Stephanie Nummer, Christina Davis, Heidi Moltz, Luke Vawter, Michael Nardolilli, Cherie Schultz
Fairfax Water	Niffy Saji, John Kingsbury, Gregory Prelewicz
WSSC Water	Jay Mabe, Karen Wright, Luis Maya, Kimberly Six
Washington Aqueduct	Anne Spiesman, Woody Peterson
Loudoun Water	Jessica Edwards-Brandt, Tom Barrack, Pam Kenel, Mark Peterson
MWCOG	Christine Howard, Steve Bieber
USACE Baltimore District	Julia Fritz, Laura Felter
USGS	Sarah Queen
National Weather Service	Jeremy Geiger, Bill Marosi, Kristin Kline

Table 2 WMA Water Supply System Information and Operational Constraints

Supplier	Facility	Type	Max. (MGD)	Min. (MGD)	Transfer Rate to Facility (MGD)[a]
Fairfax Water	Griffith	Production	120[b]	45	35[c]
Fairfax Water	Corbalis	Production	225	60[d]	50[e]
WSSC Water	Patuxent	Production	60[f]	40[g]	
WSSC Water	Potomac	Production	240	100	
WSSC Water	Little Seneca	Release	275[h]	0	
Washington Aqueduct	Dalecarlia	Production	225	50	
Washington Aqueduct	McMillan	Production	90	30	
Washington Aqueduct	Great Falls	Withdrawal	220[i, l]	0	
Washington Aqueduct	Little Falls	Withdrawal	525[j, l]	60[k]	
Loudoun Water	Trap Rock	Production	20[m]	0[n]	
Loudoun Water	Goose Creek	Withdrawal	15[o]	0[p]	
Loudoun Water	Potomac	Withdrawal	40[q]	0[r]	

a) Confirm load shift requests. Western (Potomac) service area demand is 60%, including Loudoun Water sales.
b) From November 9th to 18th, production limited to 70 MGD with no peaking capacity due to maintenance. This information was communicated personally by N. Sajji in November 2022.
c) A maximum East-to-West transfer to Griffith plant (to increase Potomac flow) requires 24-hour notice due to the Backlick Pump Station. Fairfax Water can swiftly transfer 10-15 MGD from Griffith to Corbalis plant per J. Thompson, Nov. 2019.
d) The Corbalis minimum production is lower in winter and higher in summer. Seasonal variation in production is a function of the Potomac service area demand, pump capacities, and the portion of Loudoun Water demand served by the plant.
e) The maximum West-to-East finished transfer rate to the Corbalis plant needs minimal notice to save Occoquan water.
f) A 76 MGD maximum depends on the reservoirs, as per personal communication with K. Wright in November 2020. The Patuxent plant (four raw pipelines) will have a typical maximum of 72 MGD and an emergency maximum of 120 MGD in May 2023.
g) If the emergency storage of the Patuxent reservoir falls below 1000 MG, a minimum production rate of 20 MGD may be possible through periodic plant shutdowns. This information was communicated personally by J.C. Langley.
h) The design maximum is 275 MGD according to K. Wright's personal communication in November 2020. The maximum release rate during the November 17, 2020, test was 280 MGD, as per personal communication from C. Hutchings.
i) Water from the Potomac River at Great Falls travels through two pipelines with 110 MGD capacity each, totaling 220 MGD, to the Dalecarlia Reservoir forebay. It's then pumped from the forebay to the main reservoir with a total capacity of 325 MGD (225 firm) by the Booster Pumping Station.
j) The main body of the Dalecarlia Reservoir can receive water from the Little Falls Pumping Station with a maximum capacity of 525 MGD (425 firm). The treated water from the Dalecarlia Reservoir is then distributed to the Dalecarlia and McMillan WTPs.
k) The flow rate of the 50 MGD pump at Little Falls has been measured to be 60 MGD.
l) Starting in summer 2023, the "old" conduit connecting Great Falls to the Dalecarlia Forebay will be temporarily unavailable for one year, increasing reliance on the Little Falls Pump Station (as communicated by A. Spiesman in November 2022).
m) The maximum production from Trap Rock WTF (which treats water from the Potomac River) is planned to increase to 32 MGD by 2027.
n) If the Trap Rock WTF is not operational, Loudoun Water will switch to purchasing its entire supply from Fairfax Water.
o) If the Potomac River is unavailable, Loudoun Water will transport up to 15 MGD of water from the Goose Creek Reservoir and Beaverdam release to the Trap Rock WTF via the Goose Creek Emergency Crossing pipeline.
p) The Goose Creek Reservoir serves as a backup water source.
q) Loudoun Water does not plan to expand the capacity of the Potomac River Pump Station.
r) If the Potomac River is unavailable, Loudoun Water has the capability to switch to the Goose Creek Reservoir and potential Beaverdam release, delivered through the Goose Creek Emergency Crossing.

As depicted in Figure 2, Washington Aqueduct has restrictions at the Little Falls Pumping Station in addition to what is stated in Table 2. When adjusting the Great Falls' load, it is crucial to consider the impact that Little Falls pumps can have on the USGS gage located near the station. Pump #6, which is closest to the USGS gage, can cause a temporary drop in water levels in the area around the gage. Pumps #4 and #5 may also result in a similar effect (as noted in a personal communication with W. Peterson in September 2017). The flow rates of the Little Falls pumps, compared to their design rates, are as follows: a 50 MGD design rate corresponds to an observed rate of 60 MGD, a 75 MGD design rate corresponds to 94 MGD, and a 100 MGD design rate corresponds to 125 MGD.

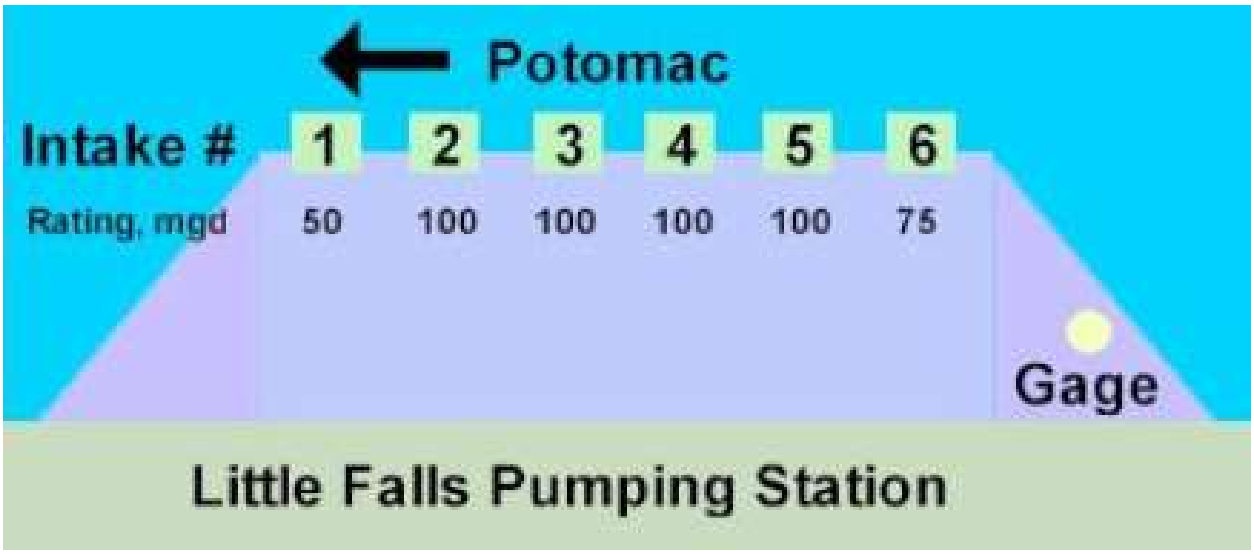


Figure 2: Schematic of pumps at Little Falls (provided by Washington Aqueduct).

Operations Committee

During droughts, CO-OP staff provide operational recommendations to the Operations Committee, which has oversight and authority to override the CO-OP staff recommendations per the WSCA (1982). In the fall of 2022, the Operations Committee consisted of the General Manager of Washington Aqueduct, the Chief of Production of WSSC Water, and the General Manager of Fairfax Water. Communications between the CO-OP Operations Committee and CO-OP staff take place regarding use of upstream reservoirs and concurrence is requested when water supply releases are initiated. In the past, CO-OP staff has contacted the Operations Committee to discuss test reservoir releases. For this exercise scenario, drought operations have occurred for some time; therefore, we assume the Committee members gave permission already.

Little Seneca Water Supply Release

This year's drought exercise assumes water supply releases from Jennings Randolph and Little Seneca reservoirs have reduced their combined storage to 60% capacity. Prior to initiating requests for a reservoir release, it is necessary to establish contact with the Operations Committee. The Little Seneca Reservoir release requires additional communication with the Montgomery County Executive and County Council members and the Maryland-National Capital Park and Planning Commission.

For each exercise, a letter is drafted for the Montgomery County Executive and County Council members (Appendix A) and contact is made with the Maryland-National Capital Park and Planning Commission.

The purpose of this communication is to inform these groups so that they can inform stakeholders that reservoir releases will likely occur in the coming weeks. The draft letter serves as a template for an "actual" drought event. Sometimes the letter is sent to its intended recipients, but not this year because 1) Little Seneca did not make a water supply or test release, and 2) there was a transition in elected official positions due to the recent election.

Data Exchange

The CO-OP Data Portal[7] is a password-protected website that collects, processes, and serves water supplier data used for drought operations. This website is based on the Drupal content management system and is hosted by GoDaddy (previously Media Temple). Emails are sent by water suppliers to coop@icprb.org with water withdrawal data and in some cases, reservoir storage data. These data are automatically ingested by the Data Portal, which uses the data to construct text files containing recent and forecasted WMA withdrawals. The Data Portal is also used to exchange data files between the DroughtOps Shiny App and the Low Flow forecast System (see the section on Tools). In summary, expectations for the water suppliers during the drought exercise are to:

- Submit morning hourly withdrawal data by 7:30 A.M. that include yesterday and as much of today as possible;
- Submit afternoon hourly withdrawal data by 1:00 P.M., extending data for as much of today as possible;
- Follow automated data protocol per each supplier preference, alternatively, follow the manual submission instructions using the hourly data file templates provided on the Data Portal Submission Page; and
- Be available for operations calls.

To simplify the data submission process, suppliers are encouraged to use their automated data files and data submission processes as much as possible, both morning and afternoon. If a data revision needs to be made, a new email using these same processes can be re-sent to the Data Portal. An example of an hourly A.M. and P.M. file submitted by each supplier during this exercise is provided in Appendix B.

The Data Portal optionally provides water suppliers opportunities to review and edit their submitted data by 1) generating graphs, tables, and comma separated value files of their submitted data, 2) modifying a submission, and 3) editing the demand forecast assumptions.

Email Reports

During operations, twice-daily updates are sent out to the distribution list shown in Table 3. These email reports are the primary way that the public views an ICPRB CO-OP drought exercise.

[7] www.icprbcoop.org

Table 3: Participants in the Drought Exercise Email Distribution

Organization	Facility
USACE Baltimore District	Amy Guise, Laura Felter, Julia Fritz
DC Water	Kishia Powell, Matt Ries, Maureen Schmelling, Salil Kharkar
DOEE	Jeff Seltzer*, Rafiq Jennings, David Pilat
Fairfax Water	Chad Coneway, Christopher Posey, Command Operations Center, Corbalis Plant Senior Operator, Doug Grimes, Gregory Prelewicz, Griffith Operators, Jamie Hedges, John Kingsbury, Marlee Franzen, Niffy Saji, Susan Miller, Traci Kammer Goldberg
ICPRB	Alimatou Seck, Christina Davis, CO-OP staff, Curtis Dalpra, Heidi Moltz, Mike Nardolilli, Renee Bourassa, Sarah Ahmed, Stephanie Nummer, Cherie Schultz
Loudoun Water	Alton Echols, Bradley Schmitz, Brandon Isenhart, Carla Burleson, Darrin Geldert, Eugene Wharton, Gerardo Casteneda, Jessica Edwards-Brandt, Kendra Sveum, Mark Peterson, Mike Rumke, Pam Kenel, Ray Kirkpatrick, Thom Lipinski, Thomas Barrack
MARFC	Peter Ahnert, Robert Shedd, Seann Reed
MDE	Alex McNamee, Greg Busch, Jason Zhao, Lainey Reed, Lee Currey*, Robert Peoples
M-NCPPC Black Hill Regional Park	Mike Little, Steve Root
MWCOG	Christine Howard, Lisa Ragain, Steve Bieber, Tom Gates
USGS	A.J. Greise, Charles Walker, Jeff Kvech, Jonathan Dillow, Matt Baker, Sarah Queen
VADEQ	Hannah Somers, Joey Kleiner, Rob Burgholzer, Scott Kudlas*
Washington Aqueduct	Anne Spiesman, Arthur White, John McLaughlin, Mel Tesema, Dalecarlia Control Room, McMillan Control Room, Rudy Chow, Woody Peterson
WSSC Water	Ajay Gupta, Anand Kanuri, Carla Reed, Charles Brown, Control Operations, David Mcdonough, Dinesh Bahadursingh, Hahns Hairston, J.C. Langley, James Price, Jerry Irvine, Jin Shin, Joel Caudill, John Kasprzak, Karen Wright, Kevin Harnish, Kimberly Six, Lyn Riggins, Matt Mirenzi, Mike Harmer, Robert Maloney, Tom Hilton, Todd Supple
National Weather Service	Jeremy Geiger
ICPRB Commissioners, including those above marked with *	Bob Sussman, Catherine McCabe, Mindy Neil, Susan Weaver, Willem Brakel

Updates were written with a short summary at the top of the page, so readers could quickly identify new information. The title included the drought exercise day, and a morning or afternoon tag. The main content consisted of:

- ACTUAL Recent basin-wide average precipitation (above Little Falls)
- ACTUAL Daily flows
- ACTUAL Yesterday's Washington Metropolitan Area Potomac River withdrawals and discharges
- ACTUAL Yesterday's Patuxent, Occoquan, and net total system withdrawal
- ACTUAL Yesterday's total system withdrawal
- ACTUAL Loudoun Water Potomac River flow values for drought operations protocol (based on yesterday's flows)
- ACTUAL Today's estimated withdrawals (labeled production during exercise but should be changed)
- ACTUAL Tomorrow's estimated withdrawals (labeled production during exercise but should be changed)
- SIMULATED Recommended operations for today
- SIMULATED Reservoirs - Usable storage

The email updates for the 2022 Drought Exercise are in Appendix C. A record of email reports is available on the Monitoring Reports page of the Data Portal website.[8]

In the email reports, staff assume that CO-OP's withdrawal forecast model reasonably estimates today's (same day) and tomorrow's (next day) demand. The 2022 fall season (Sep-Nov) has an estimated 8 MGD mean absolute error (MAE) for the three CO-OP suppliers and 2 MGD for Loudoun Water. During the 3-day exercise period, this MAE ranged from 1 to 14 MGD. The total withdrawal (Potomac plus secondary intake) forecasts and “actuals” are summarized below in Figure 3 and Table 4.

[8] www.icprbcoop.org/products/monitoring-reports

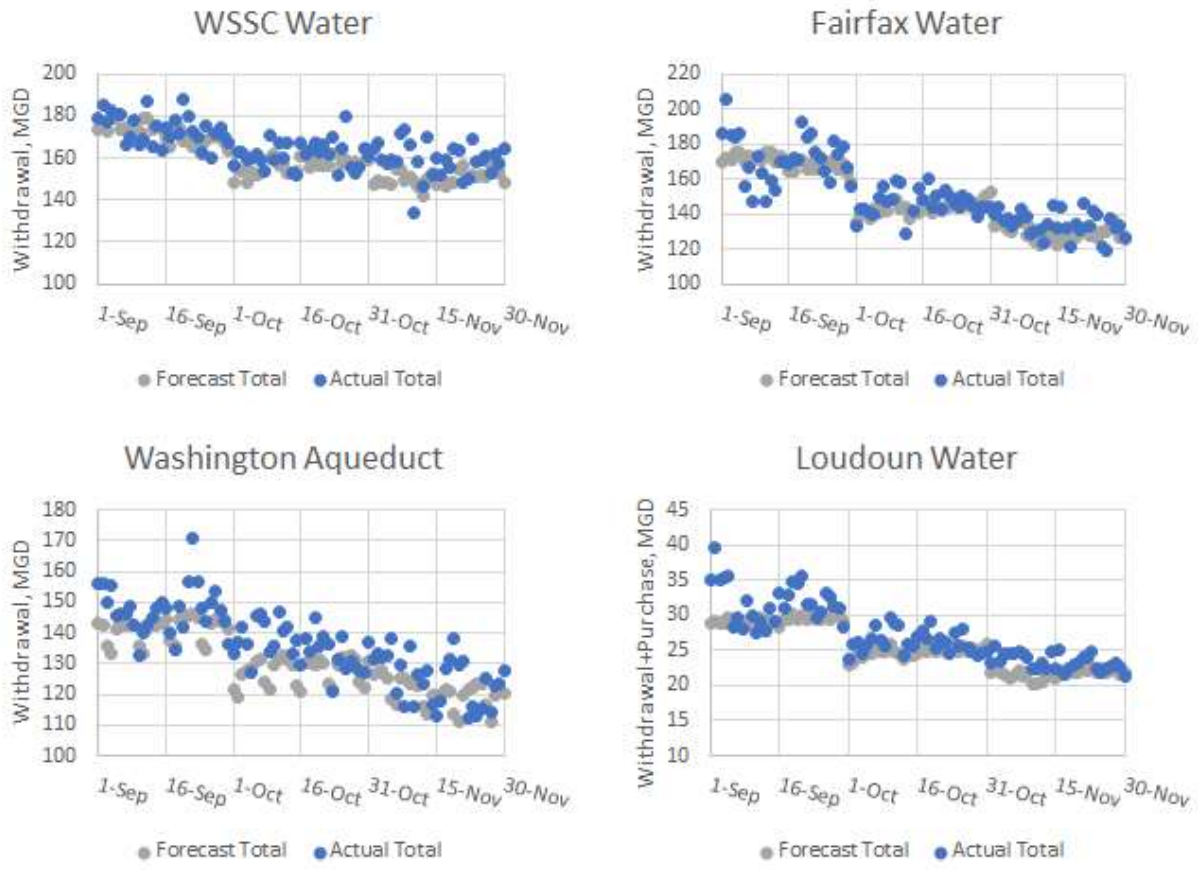


Figure 3: Withdrawal forecasts and "actuals" for the Sep-Nov fall season for year 2022.Total includes both Potomac and alternative sources for each supplier. These forecasts are currently in the development stage and require review.

Table 4: Withdrawal Forecasts and Results for the 2022 Drought Exercise

Day		15-Nov	16-Nov	17-Nov	Mean Absolute Error (MAE)
Fairfax Water Withdrawals, MGD					
Same Day	Forecast Total	117	126	122	
	Actual Potomac	73	84	72	
	Actual Occoquan	58	60	60	
	Error	-14	-18	-10	14[a]
Next Day	Forecast	125	122	125	
	Actual Potomac	84	72	62	
	Actual Occoquan	60	60	60	
	Error	-19	-10	3	11
WSSC Water Withdrawals, MGD					
Same Day	Forecast Total	145	147	146	
	Actual Potomac	119	112	120	
	Actual Patuxent	41	39	40	
	Error	-15	-4	-14	11[b]
Next Day	Forecast	146	147	147	
	Actual Potomac	112	120	116	
	Actual Patuxent	39	40	39	
	Error	-5	-13	-8	9
Washington Aqueduct Withdrawals, MGD					
Same Day	Forecast Total	120	119	121	
	Actual Great Falls	113	118	129	
	Actual Little Falls	0	0	0	
	Error	7	1	-8	5[c]
Next Day	Forecast	119	121	120	
	Actual Great Falls	118	129	131	
	Actual Little Falls	0	0	0	
	Error	1	-8	-11	7
Loudoun Water Withdrawals, MGD					
Same Day	Forecast	20	21	21	
	Actual Produced	0	8	13	
	Actual Purchased	22	17	8	
	Error	-2	-4	0	2[d]
Next Day	Forecast	21	21	21	
	Actual Produced	8	13	13	
	Actual Purchased	17	8	9	
	Error	-1	0	-1	1

[a] MAE for the past Sep-Nov fall season is 8 MGD
[b] MAE for the past Sep-Nov fall season is 8 MGD
[c] MAE for the past Sep-Nov fall season is 8 MGD
[d] MAE for the past Sep-Nov fall season is 2 MGD

Drought Coordination Technical Committee Conference Call

The WMA developed a coordinated drought response plan, the *Metropolitan Washington Water Supply and Drought Awareness Response Plan: Potomac River System* (MWCOG, 2000) following the 1999 drought.[9] During the 1999 drought, a lack of coordination in communication between states, local jurisdictions, and water suppliers resulted in widespread confusion among the public regarding the drought conditions and restrictions on water usage. The various jurisdictions and suppliers addressed this problem with a regional response plan that is coordinated by MWCOG. This plan details various triggers, actions, and messages for three water restriction stages ("Watch," "Warning," and "Emergency") to be implemented in the MWCOG region covering Washington, D.C., and its Maryland and Northern Virginia suburbs. Drought stages are declared by the Drought Coordination Committee (DCC), whose members consist of Chief Administrative Officers from MWCOG's 21 member governments, the general managers of area water utilities, water supply officials from the Maryland Department of the Environment (MDE) and the Virginia Department of Environmental Quality (VADEQ), and ICPRB CO-OP staff. The DCC is supported by staff from MWCOG, NOAA's Climate Prediction Center (CPC), and the USGS. Technical support for DCC decisions is provided by the Drought Coordination Technical Committee (DCTC), which consists of staff from the DCC member agencies. The stages as described in the plan are as follows:

- The "Watch" stage can be declared when the NOAA CPC indicates D1 drought intensity level (moderate drought) for most of the Potomac basin.
- The "Warning" stage can be declared when the combined water supply storage at Jennings Randolph and Little Seneca reservoirs has dropped to 60% of capacity for five consecutive days with 5% probability of not being able to meet unrestricted water supply demands over the next one to two months.
- The "Emergency" stage is declared when there is a 50% probability of not being able to meet water supply demands over the next month.

The drought response plan calls for voluntary reductions in water use during the "Watch" and "Warning" stages and mandatory restrictions in the "Emergency" stage. A table detailing each of the stages can be found in the drought response plan document on the MWCOG website.

A conference call of the regional DCTC coordinated by MWCOG took place on November 15, 2022. The conference call occurred as a special event for the 2022 Drought Exercise. The "simulated" drought conditions were such that the combined storage in Little Seneca and Jennings Randolph reservoirs had been at or below 60% for several days and therefore triggered a discussion on whether to go into the "Warning" stage of the MWCOG drought response plan. The DCTC unanimously "simulated" recommending to the MWCOG Chief Administrative Officers to implement the "Warning" stage and the associated voluntary water restrictions. The agenda, minutes, and people in attendance are provided in Appendix E.

Simulated System Management

This section provides a detailed description of the technical tools and practices used for daily drought operations and coordination, including operational procedures for Little Falls and Great Falls load

[9] http://www.mwcog.org/pdf/drought-plan-response_plan.pdf.

shifting, Potomac withdrawals and pumping, Patuxent and Occoquan reservoir operations, and Little Seneca and North Branch Reservoir operations.

Scenario

The scenario for this year's exercise, included in the morning email to stakeholders on November 15, was for a drought in 2022:

> *The day is Tuesday, August 15, 2022, and the basin is in moderate drought. Per the MWCOG regional plan, the drought stage is "Warning." A practice DCTC call is scheduled for 4-5 P.M. this afternoon to discuss current conditions and regional voluntary water use restrictions. During the past winter, the weather was unseasonably warm, with year-to-date precipitation departures from average equaling 2.2 inches below normal. On June 1, all system reservoirs exceeded CO-OP's target of 90% capacity. But in late June, flow in the Potomac River fell to a level requiring releases from the system's upstream reservoirs. Since then, periodic releases from Jennings Randolph and Little Seneca reservoirs have augmented river flow. Combined upstream water supply storage in Jennings Randolph and Little Seneca is 9.9 BG or 59% of the combined capacity. Because operations have been ongoing over the summer period, it is assumed that Washington Aqueduct shifted their river water withdrawals from Great Falls to Little Falls back in early July when flow at Little Falls dropped to 500 MGD. The reason for this shift in withdrawals is to maintain the 300 MGD flow-by at Great Falls.*

Tools

ICPRB staff practiced drought operations procedures and use of the following tools:

The DroughtOps Shiny App is a "Shiny" application built using R scripting language. It automatically downloads data and displays observed and forecasted flows, reservoir storage levels, WMA withdrawals, and drought management maps for Maryland and Virginia. The tool also shows WMA drought operation status levels, determined by numerical thresholds specified in the WSCA, LFAA, and MWCOG regional drought response plan. Furthermore, it computes reservoir release rates based on Potomac River flow forecasts to meet future WMA demands and environmental flow-by at Little Falls. This application is accessible to CO-OP staff via desktop computers or the cloud on a website.

The Data Portal includes a demand forecasting tool that predicts daily demand for each water supplier. The forecast equations, derived from the 2020 Washington Metropolitan Area Water Supply Study, incorporate a data-informed annual demand estimate. Independent variables used to estimate current and next day demand include the number of consecutive days with rainfall less than 0.15 inches, the day of the week, today's and tomorrow's estimated maximum temperature, and estimated and forecasted rainfall for both days. Additionally, the model uses maximum temperature and rainfall data from the previous two to five days, respectively. As noted in the Communications section, the Data Portal also serves as a communication tool and facilitates data exchange between water suppliers, the DroughtOps Shiny App, and the Low Flow Forecast System.

The Low Flow Forecast System (LFFS) is a real-time model that forecasts Potomac River flow at Little Falls. It uses the Deltares, Inc. Flood Early Warning System (FEWS) software to download and process streamflow and meteorological data, and the Chesapeake Bay Program Watershed Model, Phase 5.2, to generate 15-day forecasts of Potomac River flows.

Activities

During the 2022 Drought Exercise, and in the event of an "actual" drought, CO-OP staff are required to complete the activities outlined in Table 5 as part of an enhanced operations schedule. Staff convene at 7:30 A.M. each morning (in the exercise, staff met via Microsoft Teams). The first task involves verifying the completeness of withdrawal and reservoir level data from water suppliers using the Data Portal website. If necessary, staff request missing data from suppliers via email or phone. Next, staff review recent and forecasted Potomac River flows and WMA demands using the DroughtOps Shiny App. This step includes evaluating water availability projections for the current day, the next day, and the following nine days. Staff then discuss potential operational changes that can meet WMA demands, the 100 MGD environmental flow-by at Little Falls dam, and a 120 MGD margin of safety (MOS) based on these forecasts.

If CO-OP staff agree upon a water supply release from Jennings Randolph Reservoir, they contact the USACE's Baltimore District Office by phone using the Duty cellphone number. For operational changes by water suppliers, staff make phone contact to confirm the feasibility of the change given the supplier's physical system and demand constraints. Once all operational changes are confirmed feasible, staff send an email to stakeholders, reporting recent rainfall, current and previous day's "actual" Potomac River flows, CO-OP and Loudoun Water's "actual" withdrawals, current and forecasted demand, Loudoun Water's drought operations protocol, operational changes, and current reservoir storages. After sending the email, staff internally review information on special topics and discuss morning activities. Staff reconvene at 1:00 P.M. every afternoon and repeat the process to prepare and distribute a revised email to stakeholders.

The discussion on the drought exercise highlights various types of decisions, including those based on nine-day, one-day, and zero-day river flow forecasts, as well as stages outlined in the Low Flow Allocation Agreement and the Loudoun Water Protocol. Nine-day operations involve releasing water from Jennings Randolph and Savage reservoirs. Such releases are estimated to take approximately nine days to reach Little Falls during low flow conditions. One-day operations entail releasing water from Little Seneca and/or increasing Fairfax Water's Occoquan Reservoir withdrawal to shift demand away from their Potomac intake, with impacts taking approximately one day to reach Little Falls. Zero-day operations involve increasing WSSC Water's Patuxent withdrawal and reducing their Potomac River withdrawal, which increases flow at Little Falls in less than half a day. The Low Flow Allocation Agreement operations involve forecasting withdrawals over the next five days to determine if they meet flow triggers for Alert, Restriction, or Emergency stages, and assisting the Washington Aqueduct with corresponding tasks if they choose to declare an LFAA drought stage. The Loudoun Water Protocol involves CO-OP staff communication on expected impacts of upstream reservoir releases on Potomac River flow at Point of Rocks, as per their Virginia Water Protection permit (VWP Permit No. 10-2020).

Table 5: Daily Drought Operations Schedule

7:30 A.M.	Tasks
Water Suppliers	• Verify withdrawal and reservoir data has been sent to coop@icprb.org. If necessary, upload data manually. • Optionally, use Data Portal to revise demand forecast assumptions.
CO-OP Staff	• Review withdrawal and reservoir data in Data Portal and request missing data. • Review USGS flow data and LFFS data displayed by DroughtOps Shiny App. If data is missing, troubleshoot and make corrections.
8:00 A.M.	Tasks
CO-OP Staff	• Review forecasted flows and the need for water at Little Falls today, tomorrow, and nine days in the future. Draft operational requests to meet these needs. • If water is needed today, phone WSSC Water to request a Patuxent load shift. • If water is needed tomorrow, phone Fairfax Water to request an Occoquan load shift.
9:00 A.M.	Tasks
CO-OP Staff	• If a water supply release is needed in nine days, phone the USACE Baltimore District Office to request the desired flow target, in cfs, at the USGS gage at Luke, Maryland, located below the Jennings Randolph and Savage reservoirs. • If a water supply release is needed tomorrow, phone WSSC Water's control room to request the Little Seneca Reservoir release rate, in MGD, and call the M-NCPPC. • If a load shift is needed to increase flow below Great Falls, phone Washington Aqueduct's Dalecarlia control room with the desired pumping rate at Little Falls.
10:00 A.M.	Tasks
CO-OP Staff	• Revise draft operational requests based on phone verifications. • Send the morning email report to stakeholders, including yesterday and today's Potomac River flow, CO-OP supplier and Loudoun Water withdrawals, and a summary of operational changes.
11:00 A.M.	Tasks
CO-OP Staff	• Rerun LFFS to generate new data to input to Data Portal and DroughtOps Shiny App.
Water Suppliers	• Review the morning email report and verify that requested operational changes could be implemented in the event of actual drought.
12:30 P.M.	Tasks
Water Suppliers	• Verify withdrawal and reservoir data has been sent to coop@icprb.org. If necessary, upload data manually. • Optionally, use Data Portal to revise demand forecast assumptions.
CO-OP Staff	• Review withdrawal and reservoir data in Data Portal and request missing data. • Review forecasted flows and water need at Little Falls today, tomorrow, and nine days in the future. • If there have been significant changes in conditions, repeat steps listed above to make operational revisions.
2:00 P.M.	Tasks
CO-OP Staff	• Send the afternoon email report to stakeholders, including a summary of any revisions to the morning operations.
Water Suppliers	• Review the afternoon email report and verify that requested operational changes could be implemented in the event of actual drought.

The exercise was based on real-time data to practice use of CO-OP's real-time operational tools. To simulate low flow August conditions, the following scaling factors were applied: streamflow's were reduced by a multiplication factor, and demands were increased by a multiplication factor shown in Table 6. Details on each day's exercise activities are given in the following sections by day.

Table 6: Dates and Simulation Factors

Day	Exercise Date	Simulation Date	Flow Factor	Demand Factor
1	November 15, 2022	August 25, 2022	0.29	1.10
2	November 16, 2022	August 28, 2022	0.31	1.18
3	November 17, 2022	August 29, 2022	0.32 + flow edit	1.20

Day One

On Day 1 of the exercise, November 15, CO-OP staff first reviewed the morning's "actual" data submissions in the Data Portal. WSSC Water (Todd Supple) called to confirm the hourly data format, as their submissions only provided daily average data files. All morning data, except for WSSC Water and Fairfax Water,[10] came in automatically. Staff then reviewed "simulated" yesterday's Potomac River flow at Little Falls, which had significantly fallen to 266 MGD (412 cfs) according to the Situational Awareness tab of the DroughtOps Shiny App (Figure 6).[11] CO-OP staff discussed decision support information and made "simulated" operational requests, which are described below. Appendix B and Appendix C document data submission formats and email reports, respectively.

One-day Operations: On Day 1, CO-OP's Potomac River and Reservoir Simulation Model (PRRISM) algorithm predicted a "simulated" 24 MGD deficit for Little Falls based on previous flows and a constant lag. Figure 4 under the Local Ops tab shows this deficit as "Tomorrow's need from combined L Seneca release and Occoquan load shift." CO-OP staff initially thought that part of the deficit could be addressed by a 15 MGD load shift by Fairfax Water to their Occoquan intake. Due to an "actual" ongoing construction project at the Griffith plant, CO-OP staff learned from Dave Bolton that they could shift 15 MGD of "simulated" withdrawals for about eight hours, providing a 5 MGD "simulated" shift over the day. To accommodate the plant limitations, CO-OP staff requested the remaining 19 MGD deficit as a "simulated" Little Seneca release from WSSC Water Control Room. Although Little Seneca Reservoir could have supplied the full 25 MGD, its poorer refill characteristics compared to the Occoquan Reservoir made it a less ideal option.

During the internal CO-OP staff meeting on Day 1, two special topics were discussed: the system overview with a schematic of the system, and the MWCOG drought stages. The system overview provided more detailed information on the Drought Operations for the CO-OP System section presented in the report. The MWCOG drought stages were discussed prior to the DCTC conference call, with "simulated" combined water supply storage at Jennings Randolph and Little Seneca reservoirs reported as 58% of capacity in Table 7, marking the 5th consecutive day it had been below 60%. These storage numbers, produced using PRRISM, were adjusted to "simulate" the MWCOG "Warning" stage conditions, which later triggered the discussion of implementing "simulated" voluntary water

[10] FW reverted to an old data format.

[11] Day 1 flows and demands are "actual" conditions on August 25, 2022, with scaling factors applied to simulate drought conditions.

restrictions (see section on Drought Coordination Technical Committee Conference Call[12]). CO-OP staff discussed the possibility of ending restrictions when combined water storage at reservoirs remains above 60% for 15 days, or if the probability of not meeting unrestricted water supply demands over the next 1 to 2 months drops to 5%. However, accurately estimating this probability is more complicated than relying solely on reservoir storage.

Table 7: Day 1 Storage Summary

Facility	Percent Full	Current (BG)	Usable Capacity (BG)
WSSC's Patuxent Reservoirs	63%	6.39	10.2
Fairfax Water's Occoquan Reservoir**	70%	5.65	8.17
Little Seneca (LS) Reservoir*	56%	2.2	3.9
Jennings Randolph Reservoir (JRR) Total	65%	18.97	29.4
Jennings Randolph Reservoir Water Supply*	59%	7.7	13.1
Jennings Randolph Reservoir Water Quality	69%	11.27	16.3
Savage Reservoir	35%	2.21	6.3

*Combined JRR + LS Storage = (2.2 + 7.7)/(3.9 + 13.1) = 58%

**Usable capacity corrected post-exercise to match the 2019 bathymetric survey

Day Two

On Day 2, yesterday's "simulated" flow at Little Falls was 179 MGD (277 cfs) and the current observation for the day had decreased to 152 MGD (235 cfs).[13] Withdrawal and reservoir storage data on the Data Portal were reviewed, and all suppliers had submitted their morning data. CO-OP staff referred to the information displayed in the DroughtOps Shiny App (Figure 7) and made the following "simulated" operational requests.

Zero-day Operations: According to the PRRISM algorithm, the Local Ops tab showed a 7 MGD (11 cfs) deficit for "Today's need from the Patuxent load shift." CO-OP staff discussed that in an "actual" drought, WSSC Water might already be operating the Patuxent plant at a lower capacity from "actual" of around 40 MGD to conserve water, which would allow for a "simulated" load shift to increase production up to 60 MGD for the day. WSSC Water has the flexibility to make this kind of load change within the day. However, before contacting WSSC Water, the CO-OP staff reviewed the need for a Little Seneca release.

One-day Operations: The DroughtOps Shiny App on the Local Ops tab reported a forecasted one-day "simulated" deficit of 141 MGD (218 cfs) for "Tomorrow's need from the combined Little Seneca release and Occoquan load shift." Upon comparing the "simulated" demands, CO-OP staff discovered that the Occoquan plant was limited to a maximum production of 70 MGD due to the "actual" planned construction work, as confirmed by phone with the Fairfax Water's Distribution staff. This meant that the entire "simulated" 141 MGD deficit had to be met by the Little Seneca Reservoir, which was well below its max release limit of 275 MGD.

To confirm the "simulated" 7 MGD Patuxent load shift for the zero-day operations and the 141 MGD Little Seneca release for the one-day operations, a call was placed to WSSC Water's control room. As the

[12] This data triggered the discussion of the practice conference call, which resulted in a unanimous decision to implement voluntary water restrictions.

[13] Day 2 flows and demands were based on "actual" conditions on August 8, 2022, with scaling factors applied to simulate drought conditions.

requested load shift was on the Potomac River, the system would continue to function properly even with a different withdrawal for the Patuxent. Therefore, the request asked to reduce Potomac withdrawals by 7 MGD and increase Patuxent withdrawals based on operational preferences.

Loudoun Water Protocol: The Loudoun Water protocol section of the email report provides support for their Virginia Water Protection permit (VWP Permit No. 10-2020). In the "simulated" section of the Day 2 email report, the CO-OP staff estimated that 40 cfs (26 MGD) of the flow at Point of Rocks on the previous day was due to a Jennings Randolph release made seven days ago. Coincidentally, Loudoun Water had informed the CO-OP staff that the Trap Rock WTF had gone offline the previous day and had resumed operation at 9:00 A.M. on Day 2, which means they had "actually" followed the Loudoun Water protocol for part of the exercise. This operational change currently requires Loudoun Water to temporarily receive all their water from Fairfax Water.

Low Flow Allocation Agreement Stages: On Day 2 of the drought simulation, the LFAA threshold shifted from "Alert" to "Restriction" stage. This change was driven by the simulated previous day's adjusted flow at Little Falls and net Potomac withdrawals, which were 709 MGD and 462 MGD for Day 1, and 592 MGD and 413 MGD for Day 2, respectively. CO-OP staff spoke with Anne Spiesman from the Washington Aqueduct to discuss the LFAA process. CO-OP staff offered to remind Washington Aqueduct when to organize "actual" LFAA actions for the different stages since CO-OP is compiling the data.

Figure 4 provides a summary of Potomac River flow and net Potomac withdrawals for the exercise days, in relation to the "Alert" and "Restriction" stages of the LFAA. The exercise commenced with flows below the LFAA "Alert" stage threshold, which closely aligns with ICPRB CO-OP's trigger for implementing enhanced drought operations. Flows fall below the "Alert" stage threshold when the adjusted flow at Little Falls is less than twice the Potomac withdrawals. ICPRB CO-OP's enhanced operations commence when the same flow is less than twice the 5-day withdrawal forecast plus the 100 MGD environmental flow-by. Washington Aqueduct, with input from other LFAA signatory water suppliers (Fairfax Water and WSSC Water), may declare the LFAA stages. If the "Alert" stage is declared, the course of action is to notify the LFAA Moderator of flow conditions. If the position of Moderator is vacant, the Standby Moderator would be contacted.

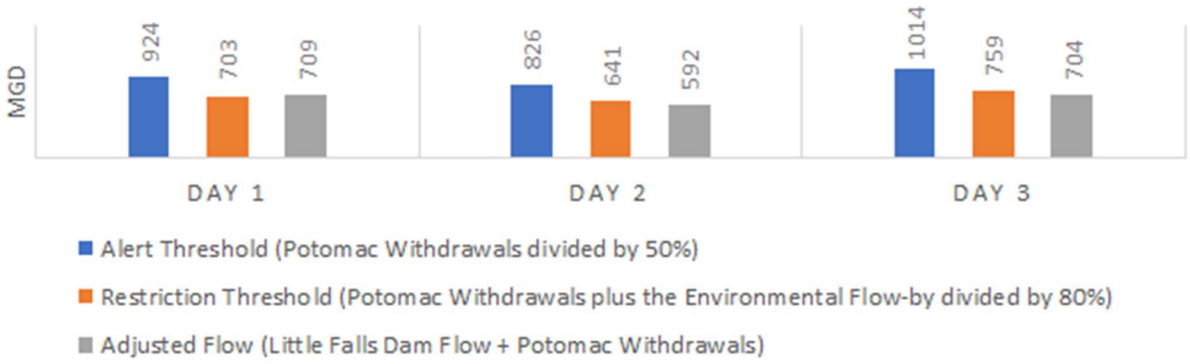


Figure 4: LFAA Stages of Flow in the Potomac River

Potomac River flow falls below the LFAA "Restriction" stage threshold when adjusted flow at Little Falls is less or equal 125% of the sum of the Potomac withdrawals and the environmental flow-by of 100

MGD (also shown in Figure 4). To protect the water supply in the WMA, Maryland and Virginia have implemented regulations to limit excessive upstream consumptive use (CU). In Maryland, non-residential surface water permits require low flow augmentation for CU above 1 MGD, and Maryland municipal residential users upstream of the WMA must reduce withdrawals to average winter use levels when the LFAA "Restriction" stage is declared. Virginia requires low flow protections for non-municipal permits for withdrawals from the Potomac River or its tributaries between West Virginia and Little Falls if CU is above 0.5 MGD. Virginia permits for Potomac River intakes between the Shenandoah River confluence and Little Falls require that withdrawals be reduced by an amount specified by VADEQ during the LFAA "Restriction" or "Emergency" stage. In conjunction, the Washington Aqueduct takes several steps to manage the water supply during the LFAA "Restriction stage," such as requesting the U.S. Park Service to discontinue putting Potomac River water into the C&O Canal. These measures help support effective management to protect the ecological health of the river and ensure long-term sustainability of the water supply in the WMA during times of low flow or drought conditions.

In a comment, Joel Caudill from WSSC Water brought up a question about whether Rockville, an independent water supplier located within a pocket of the WSSC Water service area, should be included in the email reports. WSSC Water had provided "actual" emergency water to Rockville a few days prior. Although Rockville's water demand is small, approximately 5 MGD, it was noted that the allocation formula under the LFAA includes Rockville's withdrawal, even though it is a relatively small amount, in an "actual" low flow event Rockville is allocated a share of the flow and therefore this exercise should reflect that to be consistent with the LFAA.

Day Three

On November 18, which was Day 3 of the exercise, CO-OP staff referred to information from the DroughtOps Shiny App (Figure 8).[14] Based on this information, they made "simulated" operational requests. A morning email report for Day 3 is included in Appendix C.

Nine-day Operations: On the DroughtOps N Br Ops tab, there were two conflicting flow forecasts due to an "actual" rain event that occurred on September 6th, as shown in the historical time series obtained from the USGS (solid blue line in Figure 5). According to the CO-OP's empirical Little Falls flow forecast (orange X in Figure 5), there would be a 9 MGD (14 cfs) flow deficit at Little Falls in nine days. However, the LFFS Little Falls flow forecast (blue dotted line in Figure 5) predicted a surplus flow of 2007 MGD. Although the LFFS forecast was likely more accurate at the time when the historical flows were being forecasted, the CO-OP staff ignored it for the purpose of simulating drought conditions conducive to a North Branch release request in the form of a Luke target flow.

[14] Day 3 flows and demands were based on "actual" conditions on August 29, 2022, with scaling factors applied to simulate drought conditions.

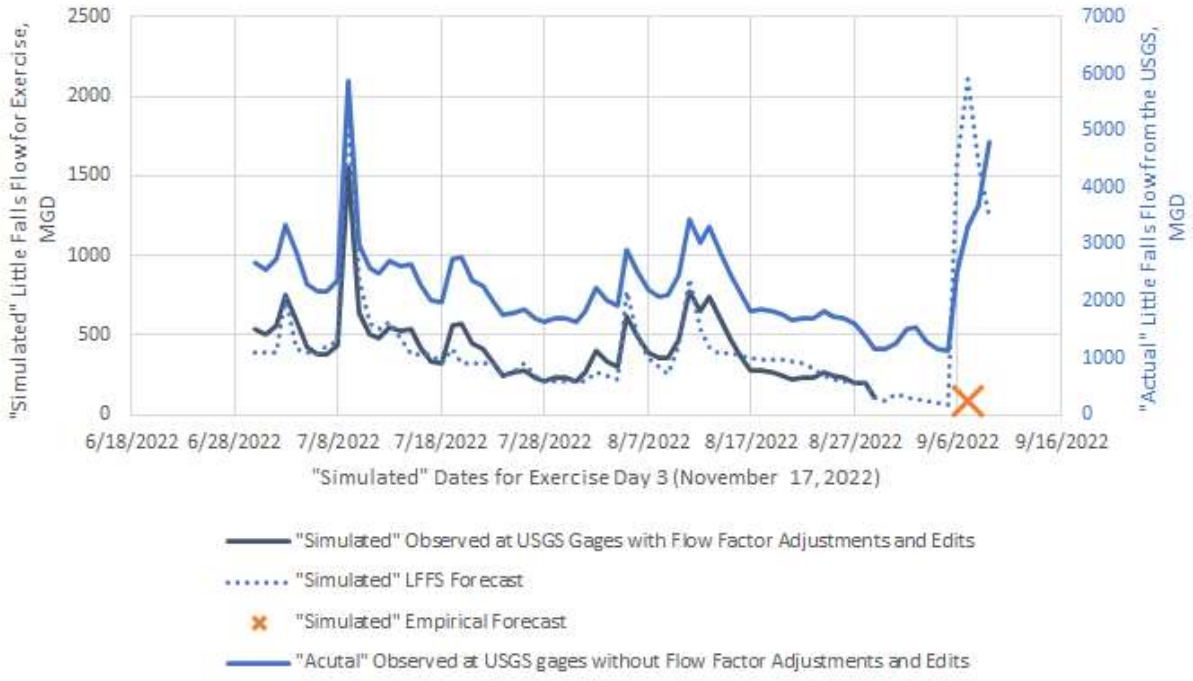


Figure 5 "Simulated" Little Falls flow and forecasts compared to "Actual" flow observed at the USGS Gage showing increase in flow due to a storm in the historical record of flows.

To calculate the target flow request at Luke, CO-OP staff took the USACE's planned release of 162 MGD (251 cfs) from water quality storage and added the 9 MGD needed to compensate for the estimated deficit from the empirical forecast. Additionally, a 21 MGD "buffer" was included to arrive at a final Luke target of (9 + 162 + 21) = 192 MGD (297 cfs). The buffer was calculated using the water supply storage balance equation for Jennings Randolph and Little Seneca reservoirs as a percentage of capacity, which is currently implemented in PRRISM. The goal of the buffer is to increase the Jennings Randolph release because the reservoir is high relative to Little Seneca storage availability.

At 9:00 A.M., the CO-OP staff requested a "simulated" water supply release from Jennings Randolph Reservoir with a Luke target of 297 cfs by calling the USACE's Baltimore District Office duty cell. A USACE Operations staff member confirmed that the request was acceptable. The reservoir accounting documentation for Jennings Randolph Reservoir was later provided by Laura Felter and is included in Appendix D, detailing the amount of water that was drawn from the water supply storage in the reservoir.

One-Day Operations: On the Local Ops tab (refer to Figure 10), CO-OP's "PRRISM algorithm" forecast for the tomorrow's flow at Little Falls, which was based on lagged observed flows at upstream gages, predicted that there would be a deficit of 118 MGD. Fairfax Water had already been operating the Griffith WTP at its maximum production capacity of 70 MGD due to “actual” ongoing improvements. With this information in mind, a phone call was made to the WSSC Water Control Room requesting a “simulated” Little Seneca release of 118 MGD (which was reduced from the previous day's release of 141 MGD).

Zero-Day Operations: On the Local Ops tab, the PRRISM algorithm forecast indicated that there would be no deficit in MGD, and this was the forecast that was followed during the exercise. However, CO-OP's LFFS forecast for the day's Patuxent load shift indicated a deficit of 36 MGD. It is important to note that the WSSC Water Patuxent demands for the day were "simulated" to be 60 MGD and that the Patuxent plant is currently limited to a maximum of 60 MGD. This constraint is due to the ongoing work to complete the raw water transmission main from Rocky Gorge to the plant. If the LFFS forecast had been used during this temporary work period, there would not have been enough flexibility to shift more demand off the Potomac due to this constraint.

Data Submission and Withdrawal Forecasting: On Day 3 of the drought simulation, CO-OP staff held discussions with Fairfax Water (Niffy Saji and Gregory Prelewicz) and WSSC Water (Todd Supple and Jay Mabe) regarding data submissions to the Data Portal. Anne Spiesman from Washington Aqueduct and Thomas Barrack from Loudoun Water had also made contact before the exercise. During the discussions, both suppliers were asked to adhere to a specific data format and submit their data to coop@icprb.org via email. Fairfax Water was reminded that their automated data submission system was ideal for the morning and only manual submissions were required in the afternoon. The format for the afternoon submission should be the same as the automated morning data, but with a preview of the next day's automated data. The automated format could be changed to include two tables, one for the previous day's data and another for a preview of the current day's data, to better serve all monitoring requirements. However, afternoon submission is not required all year round and can be generated only during enhanced monitoring periods. WSSC Water staff informed CO-OP that hourly data cannot be automated. Despite this limitation, an automated hourly data format was provided for the exercise. If they follow a consistent format, they can email data to coop@icprb.org with the specified subject line without logging into the Data Portal. Details on email data formats can be found in Appendix B.

Finally, both suppliers were encouraged to add notes and modifications to the off-Potomac portions of the demand forecast table on their supplier pages in the Data Portal. Notes can be used to highlight temporary considerations, such as a plant losing power, which would result in the forecast assumption for that plant being zeroed out.

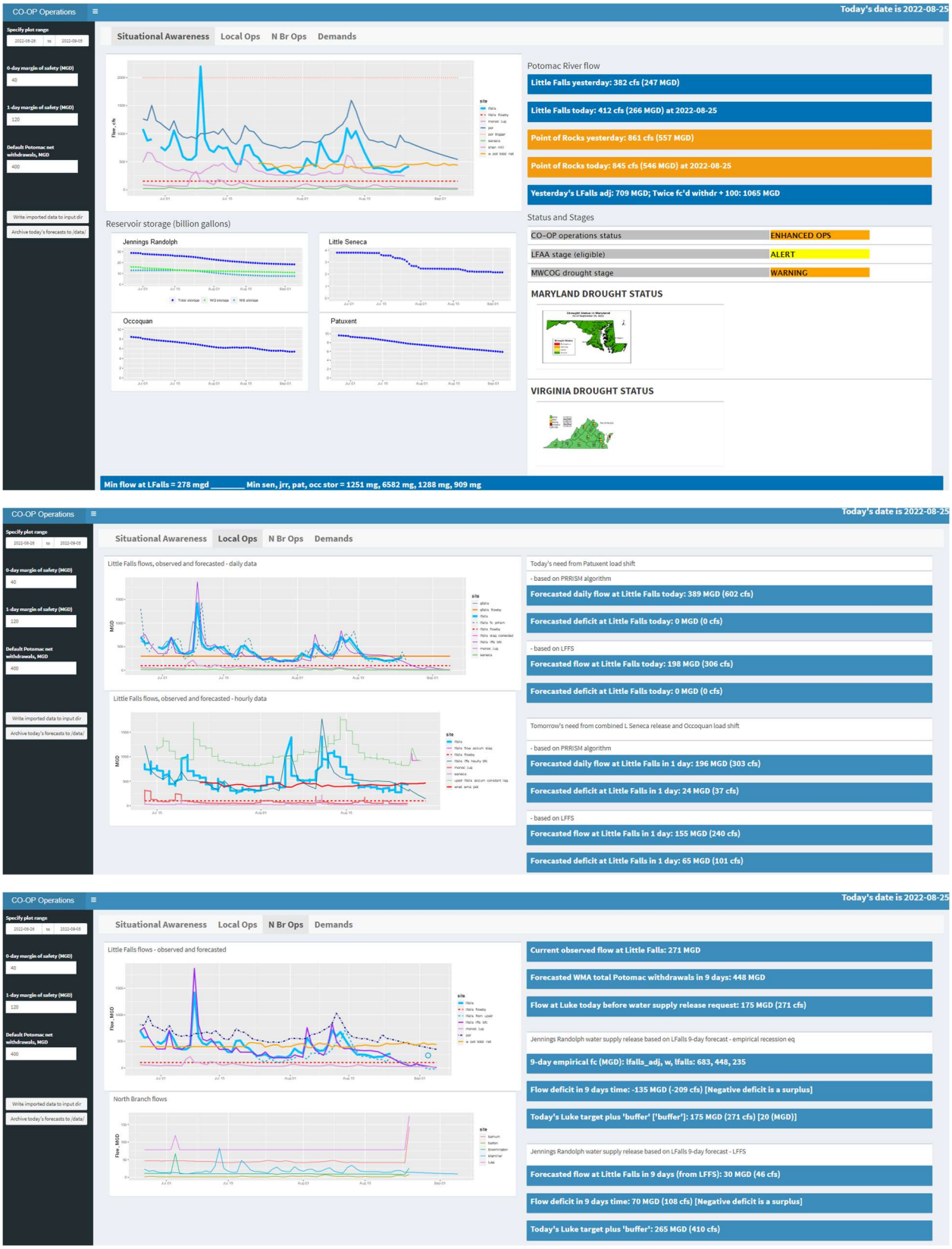


Figure 6: Day 1 Shiny App Display, LS Release/Occ Shift, NB Release.

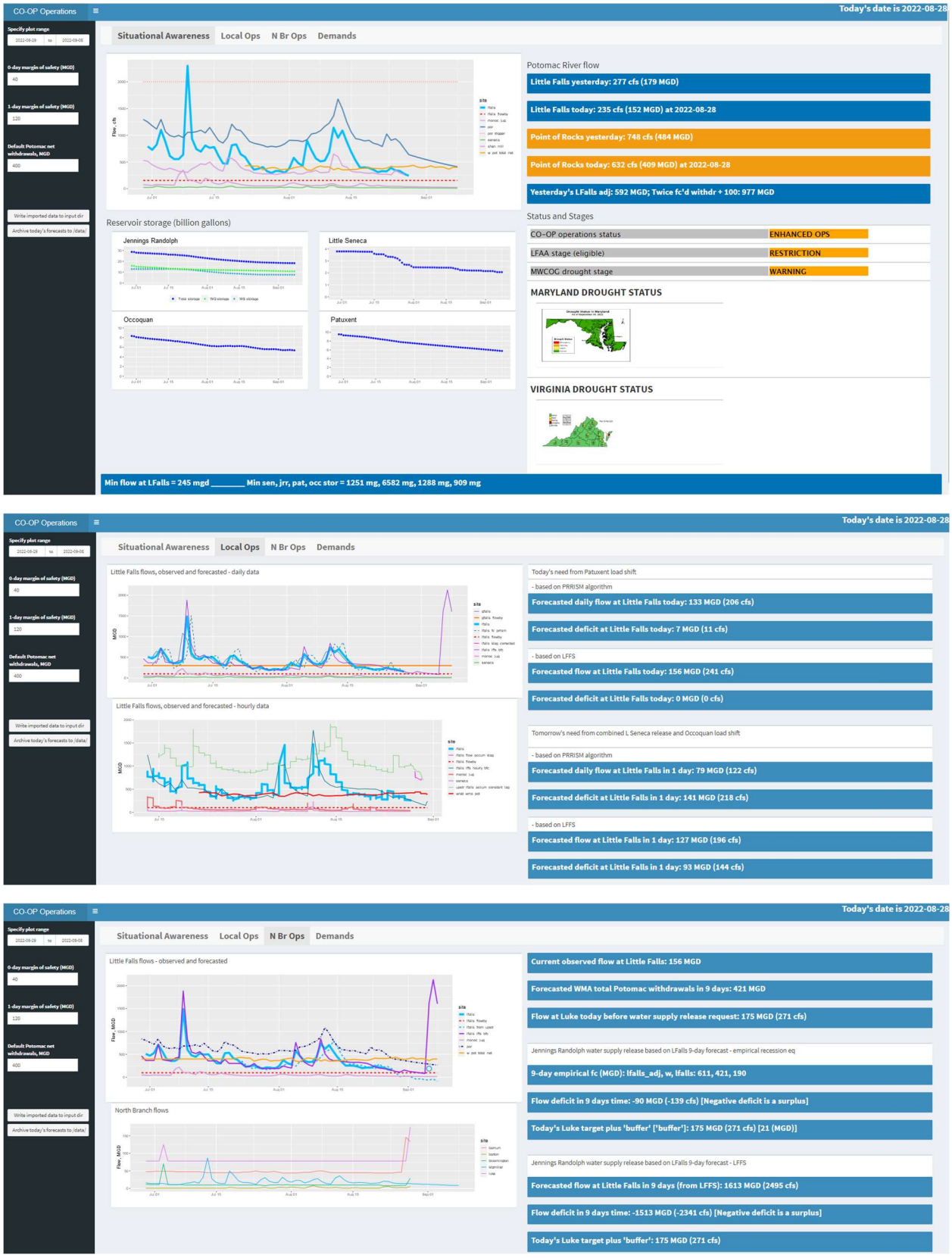


Figure 7: Day 2 Shiny App Display, LS Release/Occ Shift, NB Release.

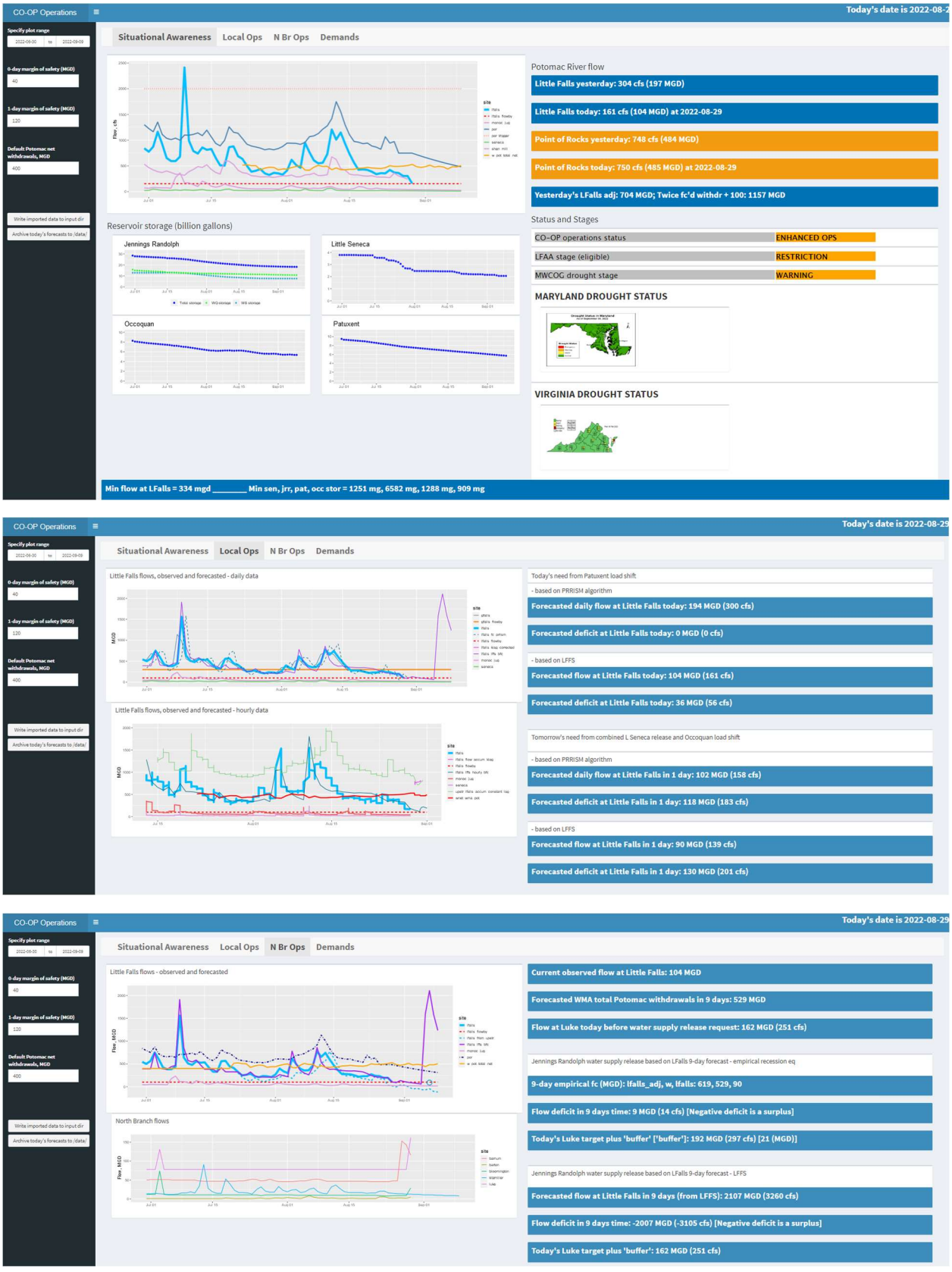


Figure 8: Day 3 Shiny App Display, LS Release/Occ Shift, NB Release.

Lessons Learned

Drought exercises provide CO-OP staff with insights on how to improve tools and procedures. Below is a list of lessons learned and action items for the coming year.

1. Data Submissions
    a. Maintain a goal of submitting data twice daily through automated means to avoid any changes during drought operations.
    b. Revise the submission forms to include two tables, one for the previous day's data and another for a preview of today's data, to accommodate morning and afternoon submissions. Consider using the Washington Aqueduct's submission format in Appendix B as a guide.
    c. Integrate the data submission process into the daily routines of operators as necessary.
2. Data Portal
    a. Improve version control for submissions to enable quick resolution by CO-OP staff.
    b. Streamline email communication with suppliers through automated updates and simplify manual submissions.
    c. Provide training on entering future off-Potomac withdrawals into demand forecast table for WSSC Water and Fairfax Water.
    d. Create reference resource for CO-OP staff to access consistent operational messages.
    e. Revise email reports on Loudoun Water production (net of Broad Run Discharge) to match other suppliers.
    f. Investigate limitations in automating WSSC Water hourly data reporting.
    g. Refine monitoring report publication process.
3. Low Flow Forecasting System
    a. Incorporate the re-running of the LFFS into the afternoon protocol to improve afternoon operations.
    b. Implement a reliable backup plan for withdrawal estimates in case data fails to arrive.
4. DroughtOps Shiny App
    a. Incorporate a value box displaying the Great Falls flow data on the Situational Awareness or Local Ops tabs.
    b. Improve the graphs of withdrawals and add today's and tomorrow's forecasted demands to ensure the automated calculations are functioning accurately on the Demands tab.
    c. Allow the input and preservation of water supply release data.
    d. Calculate reservoir inflows.
    e. Improve clarity and understanding of graphs.
5. Low Flow Allocation Agreement
    a. Provide Washington Aqueduct with access to the DroughtOps Shiny App, so they can have the option to monitor the LFAA relevant data.
    b. Conduct a future exercise to simulate the “Restriction Stage.”
    c. Determine the National Park Service representative responsible for temporarily stopping water input to the C&O Canal and assess the quantity of water being reserved for the Potomac River.
    d. Ask Rockville if they can provide withdrawal data during drought and decide whether a fifth user account in the Data Portal is necessary.
6. MWCOG Conference Call

   a. Update the Potomac Basin stakeholder list to ensure that all relevant staff members are included, as this list serves as an effective means of discussing upstream activities during severe drought events.
   b. Involve General Managers and members of the public in the use of this critical drought exercise communication tool.
   c. Include discussion on the status of the LFAA stages in the conversation.
7. Test Release
   a. Schedule a test release of water from either the North Branch or Little Seneca during a low flow period to gather travel time data and educate the public.

Appendix A: Little Seneca Water Supply Release Letter

INTERSTATE COMMISSION ON THE POTOMAC RIVER BASIN

30 W. Gude Drive, Suite 450
Rockville, MD 20850
(301) 984-1908
www.potomacriver.org

July 20, 2022

The Honorable Marc Elrich
Montgomery County Executive
Executive Office Building
101 Monroe Street, 2nd Floor
Rockville, MD 20850

Dear Mr. Elrich:

The Interstate Commission on the Potomac River Basin (ICPRB) coordinates drought-related water supply operations on behalf of the Washington, D.C., metropolitan area water suppliers (Washington Suburban Sanitary Commission (WSSC Water), Fairfax Water, and the Washington Aqueduct Division of the Army Corps of Engineers). **I am writing to notify you of our annual drought exercise occurring between November 15th and November 17th. The 2022 annual drought exercise will be solely simulation-based, and no actual test releases will be made.**

These exercises are conducted each year when an actual drought does not occur. The main goal is to practice decision making and communications within and between organizations. Periodically, a release from Little Seneca is included in the exercise to test coordination between ICPRB, WSSC Water staff operating the dam at Little Seneca, and staff at Black Hill Regional Park, where the reservoir is located. The 2022 ICPRB drought exercise does not include an actual test release but will allow us to ensure that communications between organizations, including the Montgomery County Executive Office, runs smoothly.

Little Seneca Reservoir was constructed with funds provided by the Washington area water suppliers in 1981. The reservoir is used to augment Potomac River flow during droughts to ensure a safe and reliable water supply for the over 4.8 million customers in the Washington metropolitan area, including the citizens of Montgomery County. It is an integral component of the cooperative system devised for the region. Releases are part of normal drought operations; drought-related releases were made in 1999, 2002, and 2010. Releases were also made during the annual drought exercises of 2003, 2004, 2005, 2013, 2015, and 2020.

The Maryland-National Capital Park and Planning Commission (M-NCPPC) has also been contacted about the plans for the 2022 ICPRB drought exercise.

The ICPRB is an interstate compact commission established by Congress in 1940. Its mission is to protect and enhance the waters and related resources of the Potomac River basin through science, regional cooperation, and education. Represented by appointed commissioners, the ICPRB includes the District of Columbia, Maryland, Pennsylvania, Virginia, West Virginia, and the federal government.

If you have any questions, contact me at mnardolilli@icprb.org or 301-274-8105.

Sincerely,

Michael A. Nardolilli, Executive Director
Interstate Commission on the Potomac River Basin

CC:
Council Member Gabe Albornoz
Council Member Andrew Friedson
Council Member Evan Glass
Council Member Tom Hucker
Council Member Will Jawando
Council Member Sidney Katz
Council Member Nancy Navarro
Council Member Craig Rice
Council Member Hans Riemer

Appendix B: Data Submission Process and Forms

Contact coop@icprb.org for exact email and subject requirements for data email submissions.

Figure 9 displays the morning (left table) and afternoon (right table) submissions for Washington Aqueduct, with both submissions adhering to a consistent format. The only difference is that the data for 11/15/22 is extended in the afternoon submission. During the afternoon submission, operators have the opportunity to revise earlier data. To initiate the automated data process, a staff member automatically generates or manually writes the data file according to the specified format. They then email the file to ICPRB CO-OP staff, using the same email address and subject line criteria as the automated process.

11/15/22 Hourly Potomac Raw Water Withdrawals - MGD

	Great Falls	Little Falls	Dale Flumes	Georgetown	Total
1	132.00	0.00	97.00	35.00	132.00
2	131.00	0.00	96.00	35.00	131.00
3	130.00	0.00	95.00	35.00	130.00
4	129.00	0.00	94.00	35.00	129.00
5	130.00	0.00	95.00	35.00	130.00
6	112.00	0.00	76.00	36.00	112.00
7	102.00	0.00	66.00	36.00	102.00
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
Avg	**123.71**	**0.00**	**88.43**	**35.29**	**123.71**
Max.	**132.00**	**0.00**	**97.00**	**36.00**	**132.00**
Min.	**102.00**	**0.00**	**66.00**	**35.00**	**102.00**

11/14/22 Hourly Potomac Raw Water Withdrawals - MGD

	Great Falls	Little Falls	Dale Flumes	Georgetown	Total
1	124.00	0.00	81.00	43.00	124.00
2	125.00	0.00	81.00	44.00	125.00
3	114.00	0.00	70.00	44.00	114.00
4	114.00	0.00	70.00	44.00	114.00
5	113.00	0.00	70.00	43.00	113.00
6	113.00	0.00	70.00	43.00	113.00
7	113.00	0.00	70.00	43.00	113.00
8	113.00	0.00	70.00	43.00	113.00
9	101.00	0.00	57.00	44.00	101.00
10	102.00	0.00	57.00	45.00	102.00
11	103.00	0.00	58.00	45.00	103.00
12	106.00	0.00	60.00	46.00	106.00
13	104.00	0.00	60.00	44.00	104.00
14	97.00	0.00	52.00	45.00	97.00
15	106.00	0.00	61.00	45.00	106.00
16	132.00	0.00	79.00	53.00	132.00
17	137.00	0.00	94.00	43.00	137.00
18	123.00	0.00	87.00	36.00	123.00
19	123.00	0.00	87.00	36.00	123.00
20	123.00	0.00	87.00	36.00	123.00
21	116.00	0.00	80.00	36.00	116.00
22	132.00	0.00	96.00	36.00	132.00
23	136.00	0.00	100.00	36.00	136.00
24	135.00	0.00	99.00	36.00	135.00
Avg	**116.88**	**0.00**	**74.83**	**42.04**	**116.88**
Max.	**137.00**	**0.00**	**100.00**	**53.00**	**137.00**
Min.	**97.00**	**0.00**	**52.00**	**36.00**	**97.00**

11/15/22 Hourly Potomac Raw Water Withdrawals - MGD

	Great Falls	Little Falls	Dale Flumes	Georgetown	Total
1	132.00	0.00	97.00	35.00	132.00
2	131.00	0.00	96.00	35.00	131.00
3	130.00	0.00	95.00	35.00	130.00
4	129.00	0.00	94.00	35.00	129.00
5	130.00	0.00	95.00	35.00	130.00
6	112.00	0.00	76.00	36.00	112.00
7	102.00	0.00	66.00	36.00	102.00
8	101.00	0.00	66.00	35.00	101.00
9	101.00	0.00	66.00	35.00	101.00
10	102.00	0.00	66.00	36.00	102.00
11	96.00		60.00	36.00	96.00
12	96.00		60.00	36.00	96.00
13	96.00		60.00	36.00	96.00
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
Avg	**112.15**	**0.00**	**76.69**	**35.46**	**112.15**
Max.	**132.00**	**0.00**	**97.00**	**36.00**	**132.00**
Min.	**96.00**	**0.00**	**60.00**	**35.00**	**96.00**

11/14/22 Hourly Potomac Raw Water Withdrawals - MGD

	Great Falls	Little Falls	Dale Flumes	Georgetown	Total
1	124.00	0.00	81.00	43.00	124.00
2	125.00	0.00	81.00	44.00	125.00
3	114.00	0.00	70.00	44.00	114.00
4	114.00	0.00	70.00	44.00	114.00
5	113.00	0.00	70.00	43.00	113.00
6	113.00	0.00	70.00	43.00	113.00
7	113.00	0.00	70.00	43.00	113.00
8	113.00	0.00	70.00	43.00	113.00
9	101.00	0.00	57.00	44.00	101.00
10	102.00	0.00	57.00	45.00	102.00
11	103.00	0.00	58.00	45.00	103.00
12	106.00	0.00	60.00	46.00	106.00
13	104.00	0.00	60.00	44.00	104.00
14	97.00	0.00	52.00	45.00	97.00
15	106.00	0.00	61.00	45.00	106.00
16	132.00	0.00	79.00	53.00	132.00
17	137.00	0.00	94.00	43.00	137.00
18	123.00	0.00	87.00	36.00	123.00
19	123.00	0.00	87.00	36.00	123.00
20	123.00	0.00	87.00	36.00	123.00
21	116.00	0.00	80.00	36.00	116.00
22	132.00	0.00	96.00	36.00	132.00
23	136.00	0.00	100.00	36.00	136.00
24	135.00	0.00	99.00	36.00	135.00
Avg	**116.88**	**0.00**	**74.83**	**42.04**	**116.88**
Max.	**137.00**	**0.00**	**100.00**	**53.00**	**137.00**
Min.	**97.00**	**0.00**	**52.00**	**36.00**	**97.00**

Figure 9: Washington Aqueduct automated submissions for the morning (left) and afternoon (right).

Figure 10 illustrates WSSC Water's morning submission format, which is sent daily during non-monitoring periods. Although this format accommodates daily average withdrawals and is useful for model development and testing, it needs to contain more detailed information for ICPRB staff during enhanced drought operations. In contrast, Figure 11 displays WSSC Water's morning (left) and afternoon (right) submissions during the exercise, which allows for hourly withdrawals and maintains consistency in both submissions. The only difference is that the data for 11/15/22 is extended in the afternoon submission, with an opportunity to provide revisions to earlier data. The hourly data, however, is not automated and operators must manually enter data in order to submit files to ICPRB staff during enhanced monitoring periods. By emailing the enhanced data file using the same address and subject

line criteria as the automated process, the file can automatically import to the Data Portal website, eliminating the need for operators to log in to the site.

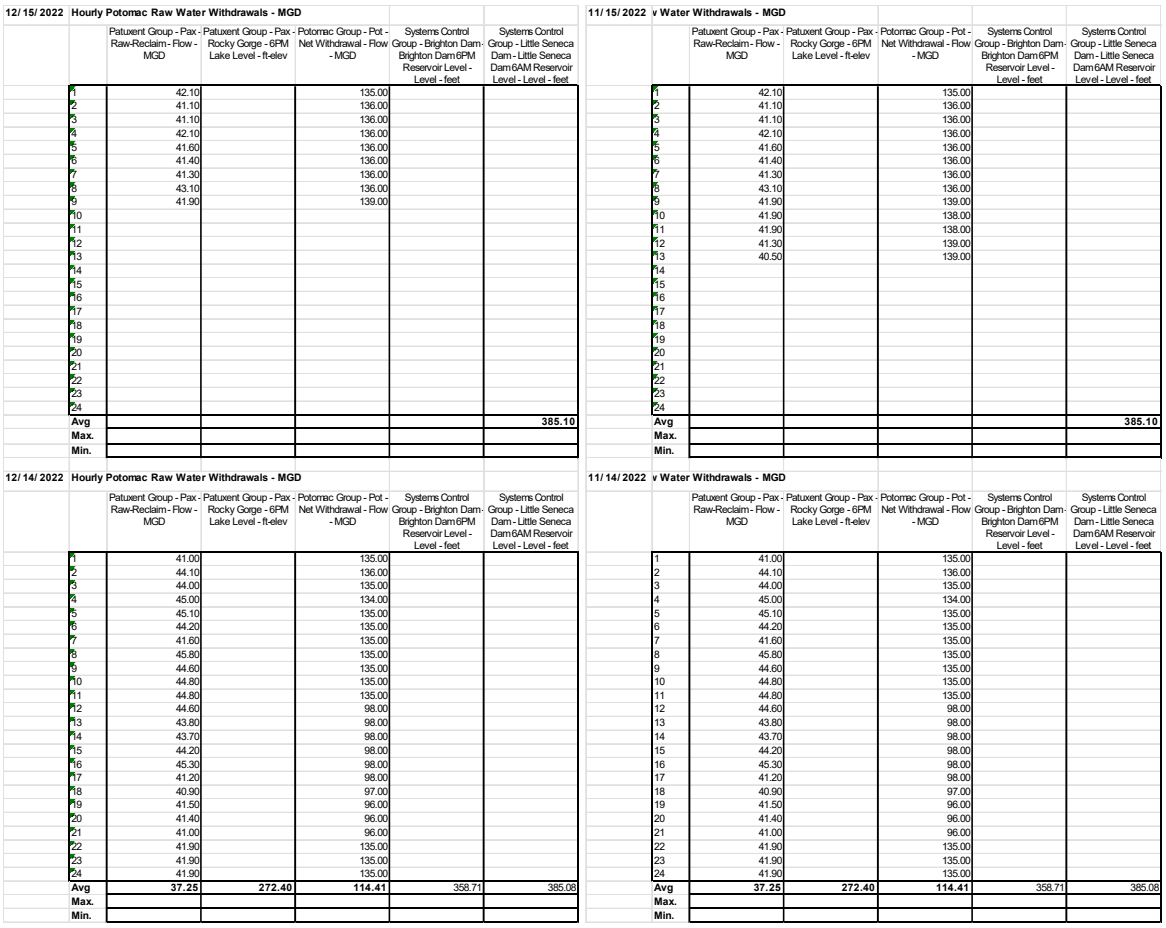
November - 2022

	Patuxent Group - Pax - Raw-Reclaim - Flow - MGD	Patuxent Group - Pax - Rocky Gorge - 6PM Lake Level - ft-elev	Potomac Group - Pot - Net Withdrawal - Flow - MGD	Systems Control Group - Brighton Dam - Brighton Dam 6PM Reservoir Level - Level - feet	Systems Control Group - Little Seneca Dam - Little Seneca Dam 6AM Reservoir Level - Level - feet
Date					
11/1/2022	73.08	273	91.6	358.91	384.92
11/2/2022	73.12	272.9	93.889	358.83	384.93
11/3/2022	64.49	272.7	94.371	358.76	384.93
11/4/2022	54.55	272.5	102.862	358.69	384.94
11/5/2022	37.75	272.5	121.121	358.62	384.94
11/6/2022	37.75	272.48	120.675	358.58	384.95
11/7/2022	39.49	272.5	132.707	358.52	384.97
11/8/2022	38.12	272.5	135.458	358.44	384.96
11/9/2022	40.73	272.6	125.827	358.37	384.95
11/10/2022	20.2	272.5	113.629	358.29	384.95
11/11/2022	37.95	272.6	120.124	358.41	384.95
11/12/2022	37.76	272.7	108.42	358.62	385.18
11/13/2022	37.89	272.6	131.881	358.71	385.15
11/14/2022			114.407	358.71	385.08
11/15/2022					
11/16/2022					
11/17/2022					
11/18/2022					
11/19/2022					
11/20/2022					
11/21/2022					
11/22/2022					
11/23/2022					
11/24/2022					
11/25/2022					
11/26/2022					
11/27/2022					
11/28/2022					
11/29/2022					
11/30/2022					

October - 2022

	Patuxent Group - Pax - Raw-Reclaim - Flow - MGD	Patuxent Group - Pax - Rocky Gorge - 6PM Lake Level - ft-elev	Potomac Group - Pot - Net Withdrawal - Flow - MGD	Systems Control Group - Brighton Dam - Brighton Dam 6PM Reservoir Level - Level - feet	Systems Control Group - Little Seneca Dam - Little Seneca Dam 6AM Reservoir Level - Level - feet
Date					
10/1/2022	57.77	276.98	98.848	359.71	384.71
10/2/2022	53.15	277	109.784	359.74	384.8
10/3/2022	47.34	277	115.331	359.72	384.86
10/4/2022	49.56	277.1	109.815	359.8	384.93
10/5/2022	53.42	277.1	106.455	359.9	384.92
10/6/2022	50.75	276.9	110.751	359.95	384.87
10/7/2022	49.68	276.7	109.366	360	384.82
10/8/2022	57.52	276.5	96.562	360	384.82
10/9/2022	54.01	276.9	117.051	360.03	384.83
10/10/2022	47.67	276.06	111.104	360.03	384.84
10/11/2022	51.16	275.36	115.817	360.06	384.84
10/12/2022	49.26	275.8	110.764	360.08	384.85
10/13/2022	48.64	275.7	118.648	360.15	384.87
10/14/2022	50.59	275.4	102.507	360.16	384.96
10/15/2022	52.04	275.3	100.018	360.11	384.98
10/16/2022	48.58	275.2	118.5	360.04	384.92
10/17/2022	47.97	275.2	113.736	359.99	384.84
10/18/2022	48.66	275.1	114.669	359.92	384.85
10/19/2022	50.16	275	117.187	359.83	384.84
10/20/2022	49.28	274.9	113.804	359.75	384.84
10/21/2022	52.19	274.8	114.394	359.67	384.84
10/22/2022	49.84	274.6	111.664	359.59	384.84
10/23/2022	48.96	274.6	120.633	359.52	384.85
10/24/2022	49	274.57	102.842	359.46	384.87
10/25/2022	70.33	274.39	94.321	359.4	384.87
10/26/2022	72.29	274.2	107.594	359.34	384.89
10/27/2022	56.09	274.01	99.231	359.27	384.9
10/28/2022	60.56	273.9	92.061	359.18	384.89
10/29/2022	63.63	273.7	92.195	359.1	384.9
10/30/2022	61.14	273.5	92.355	359.03	384.9
10/31/2022	68.66	273.3	91.962	358.97	384.9

Figure 10: WSSC automated data submission during non-drought periods.



12/15/2022	Hourly Potomac Raw Water Withdrawals - MGD				
	Patuxent Group - Pax - Raw-Reclaim - Flow - MGD	Patuxent Group - Pax - Rocky Gorge - 6PM Lake Level - ft-elev	Potomac Group - Pot - Net Withdrawal - Flow - MGD	Systems Control Group - Brighton Dam - Brighton Dam 6PM Reservoir Level - Level - feet	Systems Control Group - Little Seneca Dam - Little Seneca Dam 6AM Reservoir Level - Level - feet
1	42.10		135.00		
2	41.10		136.00		
3	41.10		136.00		
4	42.10		136.00		
5	41.60		136.00		
6	41.40		136.00		
7	41.30		136.00		
8	43.10		136.00		
9	41.90		139.00		
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
Avg					385.10
Max.					
Min.					

11/15/2022	v Water Withdrawals - MGD				
	Patuxent Group - Pax - Raw-Reclaim - Flow - MGD	Patuxent Group - Pax - Rocky Gorge - 6PM Lake Level - ft-elev	Potomac Group - Pot - Net Withdrawal - Flow - MGD	Systems Control Group - Brighton Dam - Brighton Dam 6PM Reservoir Level - Level - feet	Systems Control Group - Little Seneca Dam - Little Seneca Dam 6AM Reservoir Level - Level - feet
1	42.10		135.00		
2	41.10		136.00		
3	41.10		136.00		
4	42.10		136.00		
5	41.60		136.00		
6	41.40		136.00		
7	41.30		136.00		
8	43.10		136.00		
9	41.90		139.00		
10	41.90		138.00		
11	41.90		138.00		
12	41.30		139.00		
13	40.50		139.00		
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
Avg					385.10
Max.					
Min.					

12/14/2022	Hourly Potomac Raw Water Withdrawals - MGD				
	Patuxent Group - Pax - Raw-Reclaim - Flow - MGD	Patuxent Group - Pax - Rocky Gorge - 6PM Lake Level - ft-elev	Potomac Group - Pot - Net Withdrawal - Flow - MGD	Systems Control Group - Brighton Dam - Brighton Dam 6PM Reservoir Level - Level - feet	Systems Control Group - Little Seneca Dam - Little Seneca Dam 6AM Reservoir Level - Level - feet
1	41.00		135.00		
2	44.10		136.00		
3	44.00		135.00		
4	45.00		134.00		
5	45.10		135.00		
6	44.20		135.00		
7	41.60		135.00		
8	45.80		135.00		
9	44.60		135.00		
10	44.80		135.00		
11	44.80		135.00		
12	44.60		98.00		
13	43.80		98.00		
14	43.70		98.00		
15	44.20		98.00		
16	45.30		98.00		
17	41.20		98.00		
18	40.90		97.00		
19	41.50		96.00		
20	41.40		96.00		
21	41.00		96.00		
22	41.90		135.00		
23	41.90		135.00		
24	41.90		135.00		
Avg	37.25	272.40	114.41	358.71	385.08
Max.					
Min.					

11/14/2022	v Water Withdrawals - MGD				
	Patuxent Group - Pax - Raw-Reclaim - Flow - MGD	Patuxent Group - Pax - Rocky Gorge - 6PM Lake Level - ft-elev	Potomac Group - Pot - Net Withdrawal - Flow - MGD	Systems Control Group - Brighton Dam - Brighton Dam 6PM Reservoir Level - Level - feet	Systems Control Group - Little Seneca Dam - Little Seneca Dam 6AM Reservoir Level - Level - feet
1	41.00		135.00		
2	44.10		136.00		
3	44.00		135.00		
4	45.00		134.00		
5	45.10		135.00		
6	44.20		135.00		
7	41.60		135.00		
8	45.80		135.00		
9	44.60		135.00		
10	44.80		135.00		
11	44.80		135.00		
12	44.60		98.00		
13	43.80		98.00		
14	43.70		98.00		
15	44.20		98.00		
16	45.30		98.00		
17	41.20		98.00		
18	40.90		97.00		
19	41.50		96.00		
20	41.40		96.00		
21	41.00		96.00		
22	41.90		135.00		
23	41.90		135.00		
24	41.90		135.00		
Avg	37.25	272.40	114.41	358.71	385.08
Max.					
Min.					

Figure 11: WSSC Water's manual data submissions for the morning (left) and afternoon (right) during the drought exercise.

Figure 12 illustrates Fairfax Water's automated submission format, which is sent daily during non-monitoring periods and is ideal for average daily and hourly withdrawals. However, the format only provides space for yesterday's values and not for today's. During the exercise, Fairfax Water switched to an old data format (Figure 13 displays the morning and afternoon submissions on the left and right, respectively) to accommodate the additional data needs for enhanced operations. However, to do this, they had to log into the Data Portal and manually enter the values. By changing the expected format, ICPRB staff also had to manually interact with the data more frequently. Had the automated format been followed, even with a manual compilation of the data, water supply staff could have emailed the file to the same address and subject line criteria as the automated process, eliminating the need to interact with the Data Portal website.

Potomac Daily Withdrawal Report for:		Occoquan Daily Withdrawal Report for:	
11/14/22		11/14/22	
Time	Flow (MG)	Flow (MG)	Elevation (FT)
00:00	85.84	59.3	120.24
01:00	86.18	59.2	120.24
02:00	84.03	59.4	120.25
03:00	79.99	59.7	120.25
04:00	80.17	59.7	120.26
05:00	80.12	59.7	120.26
06:00	79.81	59.5	120.26
07:00	88.52	59.4	120.27
08:00	92.33	65.4	120.28
09:00	92.16	68.4	120.28
10:00	92.16	68.6	120.30
11:00	92.17	68.5	120.31
12:00	92.10	64.6	120.31
13:00	81.52	60.3	120.31
14:00	80.93	60.3	120.33
15:00	80.30	60.2	120.32
16:00	74.92	60.4	120.32
17:00	74.06	60.4	120.32
18:00	73.91	60.5	120.32
19:00	73.94	60.4	120.32
20:00	73.84	60.3	120.32
21:00	75.61	60.3	120.32
22:00	92.26	60.4	120.32
23:00	93.10	60.3	120.33
Average	83.33	61.47	120.29
Max	93.10	68.64	120.33
Minimum	73.84	59.23	120.24

Figure 12: Fairfax Water's automated data submission during non-drought periods and preferred during monitoring periods.

Date	11/15/2022
Time sent (7:30 or 1300)	7:30 AM
A.M. estimate of today's RAW WATER USE, MGD	155.00
P.M. estimate of today's RAW WATER USE, MGD	
Tomorrow's estimated RAW WATER USE, MGD	150.00
Usable Storage in Occoquan (bg)	7.48
Yesterday's Raw Water w/d from Corbalis (MGD)	83.33
Yesterday's Raw Water w/d from Occoquan (MGD)	61.47
Yesterday's TOTAL Withdrawal (MGD)	144.80

RATE MGD			Today's RAW WATER PUMP RATE MGD		
Time	Corbalis Withdrawal	Griffith Withdrawal	Time	Corbalis Withdrawal	Griffith Withdrawal
12:00 AM	85.84	59.3	12:00 AM	92.50	60
1:00 AM	86.18	59.2	1:00 AM	92.55	60
2:00 AM	84.03	59.4	2:00 AM	74.96	60
3:00 AM	79.99	59.7	3:00 AM	74.98	60
4:00 AM	80.17	59.7	4:00 AM	74.84	60
5:00 AM	80.12	59.7	5:00 AM	74.56	60
6:00 AM	79.81	59.5	6:00 AM	88.45	60
7:00 AM	88.52	59.4	7:00 AM		
8:00 AM	92.33	65.4	8:00 AM		
9:00 AM	92.16	68.4	9:00 AM		
10:00 AM	92.16	68.6	10:00 AM		
11:00 AM	92.17	68.5	11:00 AM		
12:00 PM	92.10	64.6	12:00 PM		
1:00 PM	81.52	60.3	1:00 PM		
2:00 PM	80.93	60.3	2:00 PM		
3:00 PM	80.30	60.2	3:00 PM		
4:00 PM	74.92	60.4	4:00 PM		
5:00 PM	74.06	60.4	5:00 PM		
6:00 PM	73.91	60.5	6:00 PM		
7:00 PM	73.94	60.4	7:00 PM		
8:00 PM	73.84	60.3	8:00 PM		
9:00 PM	75.61	60.3	9:00 PM		
10:00 PM	92.26	60.4	10:00 PM		
11:00 PM	93.10	60.3	11:00 PM		

Date	11/15/2022
Time sent (7:30 or 1300)	1:00 PM
A.M. estimate of today's RAW WATER USE, MGD	155.00
P.M. estimate of today's RAW WATER USE, MGD	145.00
Tomorrow's estimated RAW WATER USE, MGD	150.00
Storage in Occoquan (bg)	7.49
Yesterday's Raw Water w/d from Corbalis (MGD)	83.33
Yesterday's Raw Water w/d from Occoquan (MGD)	61.47
Yesterday's TOTAL Withdrawal (MGD)	144.80

Yesterday's RAW WATER PUMP			Today's RAW WATER PUMP RATE MGD		
Time	Corbalis Withdrawal	Griffith Withdrawal	Time	Corbalis Withdrawal	Griffith Withdrawal
12:00 AM	85.84	59.3	12:00 AM	92.50	60
1:00 AM	86.18	59.2	1:00 AM	92.55	60
2:00 AM	84.03	59.4	2:00 AM	74.96	60
3:00 AM	79.99	59.7	3:00 AM	74.98	60
4:00 AM	80.17	59.7	4:00 AM	74.84	60
5:00 AM	80.12	59.7	5:00 AM	74.56	60
6:00 AM	79.81	59.5	6:00 AM	88.45	60
7:00 AM	88.52	59.4	7:00 AM	92.08	60
8:00 AM	92.33	65.4	8:00 AM	84.05	60.00
9:00 AM	92.16	68.4	9:00 AM	83.31	60.00
10:00 AM	92.16	68.6	10:00 AM	83.98	60.00
11:00 AM	92.17	68.5	11:00 AM	63.93	60.00
12:00 PM	92.10	64.6	12:00 PM	64.26	60.00
1:00 PM	81.52	60.3	1:00 PM		
2:00 PM	80.93	60.3	2:00 PM		
3:00 PM	80.30	60.2	3:00 PM		
4:00 PM	74.92	60.4	4:00 PM		
5:00 PM	74.06	60.4	5:00 PM		
6:00 PM	73.91	60.5	6:00 PM		
7:00 PM	73.94	60.4	7:00 PM		
8:00 PM	73.84	60.3	8:00 PM		
9:00 PM	75.61	60.3	9:00 PM		
10:00 PM	92.26	60.4	10:00 PM		
11:00 PM	93.10	60.3	11:00 PM		

Figure 13 Fairfax Water's manual data submissions for the morning (left) and afternoon (right) during the drought exercise. This format altered the automated data format and should not be used in the future.

Figure 14 displays Loudoun Water's morning and afternoon submissions on the left and right, respectively. The morning submission followed the automated submission format, which is sent daily during non-monitoring periods and is ideal for average daily and hourly withdrawals. However, this format only provides space for yesterday's values and not for today's. Ideally, the morning data should include some of the current day's values. During the exercise, Loudoun Water manually compiled an afternoon report to include some of the current day's hourly withdrawals to accommodate additional data needs for enhanced operations. However, Loudoun Water modified the submission format, which prevented the emailed data from importing correctly into the Data Portal. As a result, ICPRB staff had to interact with the data more frequently. Had the automated format been followed, even with a manual compilation of the data, water supply staff could have emailed the file to the same address and subject line criteria as the automated process, reducing everyone's interactions with the Data Portal website.

Flows in MG		From Potomac
Date	Time	(Hourly total MG)
11/14/22	0:00	
11/14/22	1:00	0.00
11/14/22	2:00	0.00
11/14/22	3:00	0.00
11/14/22	4:00	0.00
11/14/22	5:00	0.00
11/14/22	6:00	0.00
11/14/22	7:00	0.00
11/14/22	8:00	0.00
11/14/22	9:00	0.00
11/14/22	10:00	0.00
11/14/22	11:00	0.00
11/14/22	12:00	0.03
11/14/22	13:00	0.03
11/14/22	14:00	0.43
11/14/22	15:00	0.56
11/14/22	16:00	0.54
11/14/22	17:00	0.54
11/14/22	18:00	0.42
11/14/22	19:00	0.41
11/14/22	20:00	0.37
11/14/22	21:00	0.38
11/14/22	22:00	0.39
11/14/22	23:00	0.05
11/15/22	0:00	0.00

BRWRF Effluent Total for	
11/13/22	6.42
11/14/22	6.48

From Fairfax Water Flow Total	
11/13/22	10.28
11/14/22	20.69

From Potomac Flow Total	
11/13/22	12.25
11/14/22	4.15

Flows in MGD		From Potomac on 11-15-22 Hourly total
Date	Time	
11/15/22	0:00	0.00
11/15/22	1:00	0.00
11/15/22	2:00	0.00
11/15/22	3:00	0.00
11/15/22	4:00	0.00
11/15/22	5:00	0.00
11/15/22	6:00	0.00
11/15/22	7:00	0.00
11/15/22	8:00	0.00
11/15/22	9:00	0.00
11/15/22	10:00	0.00
11/15/22	11:00	0.00
11/15/22	12:00	0.00
11/15/22	13:00	0.00
Avg		0.00
Max		0.00
Min		0.00

Figure 14: Loudoun Water's semi-automated data submissions for the morning (left) and afternoon (right) during the drought exercise. In the future the format should be revised to accommodate some hourly data into today and not just yesterday.

Appendix C: Email Reports

Day 1 (Tuesday, 2022-11-15)

2022 WMA Drought Exercise - Day 1: Morning Potomac flow and demand update (Tuesday, 2022-11-15)
Welcome to the first day of the 2022 WMA Drought Exercise. The simulation day is Thursday, August 25, 2022, and the basin conditions have reached the threshold of the "Warning" stage of the MWCOG drought regional plan. An “actual” practice Drought Coordination Technical Committee (DCTC) MS Teams meeting is scheduled for today (Tuesday, November 15, 2022) from 4:00 P.M. to 5:00 P.M., in response to “simulated” combined storage in Jennings Randolph and Little Seneca reservoirs dropping to 9.9 billion gallons (BG), or 60% of the combined capacity. The weather was unseasonably warm during the past winter, with year-to-date precipitation departures from average equaling 3.5 inches below normal. On June 1, all system reservoirs exceeded CO-OP's target of 90% capacity. But in late July, “simulated” flow in the Potomac River fell to a level requiring water supply releases from the system's upstream reservoirs. Since then, periodic releases from Jennings Randolph and Little Seneca reservoirs have augmented “simulated” river flow. Because operations have been ongoing over the summer period, the Washington Aqueduct shifted their river water withdrawals from Great Falls to Little Falls on August 16, 2022, when “simulated” flow at Great Falls above the Washington Aqueduct intakes dropped to 500 million gallons per day (MGD). This withdrawal shift is to maintain “at least 100 MGD plus Washington Aqueducts allocation up to 200 MGD between Great Falls and Little Falls dam” per the Potomac River Environmental Flow-By Study (MD DNR, 1981).

ACTUAL conditions, SIMULATED operations, and SIMULATED storages are reported below.

Best regards,

The ICPRB CO-OP Drought Team

ACTUAL Recent basin-wide average precipitation (above Little Falls): (based on CO-OP's Low Flow Forecast System analysis of Middle Atlantic River Forecast Center (MARFC) gridded multisensor precipitation estimates)
Yesterday's area-weighted average basin precipitation: 0 (inches)
Past 3-day cumulative area-weighted average basin precipitation: 0.7 (inches)
Past 7-day cumulative area-weighted average basin precipitation: 2.06 (inches)

ACTUAL Daily flows:
Little Falls gage flow 2022-11-14: 8725 MGD (13500 cfs)
Little Falls gage flow 2022-11-15: 9436 MGD (est., based on recently available real-time data) (14600 cfs)
Note: Gage flow at Little Falls is measured after water supply withdrawals.
Point of Rocks flow 2022-11-14: 10276 MGD (15900 cfs)
Point of Rocks flow 2022-11-15: 8467 MGD (est., based on recently available real-time data) (13100 cfs)

ACTUAL Yesterday's Washington Metropolitan Area Potomac River withdrawals and discharges (2022-11-14):
Fairfax Water Corbalis withdrawal (Potomac): 83 MGD
WSSC Water Potomac withdrawal: 114 MGD
Washington Aqueduct withdrawal: 117 MGD
Loudoun Water withdrawal: 4 MGD
Loudoun Water Broad Run discharge: 6 MGD
Total Potomac withdrawal: 319 MGD
Total net Potomac withdrawal: 312 MGD

ACTUAL Yesterday's Patuxent, Occoquan, and Net Total System Withdrawal (2022-11-14):
FW Occoquan withdrawal: 61 MGD
WSSC Patuxent withdrawal: 37 MGD

ACTUAL Yesterday's total system withdrawal (2022-11-14): 413 MGD

ACTUAL Loudoun Water Potomac River (PR) flow values for drought operations protocol (based on yesterday's flows):
QPR: 15900 cfs
QPR, obs: 15900 cfs
QPR, WS: 0 cfs
Note to Loudoun Water: See NWS ensemble flow forecasts (HEFS, GEFS, NAEFS) for Point of Rocks flow for the next 7 days – see https://www.weather.gov/erh/mmefs_marfc?id=PORM2&model=NAEFS.

ACTUAL Today's estimated production* (2022-11-15):
FW estimated production: 117 MGD
WSSC estimated production: 145 MGD
Washington Aqueduct estimated production: 120 MGD
LW total estimated consumption: 20 MGD
Total estimated production: 382 MGD
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church

ACTUAL Tomorrow's estimated production* (2022-11-16):
FW estimated production:125 MGD
WSSC estimated production:146 MGD
Washington Aqueduct estimated production:119 MGD
LW Total estimated consumption:21 MGD
Total estimated production:390 MGD
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church

SIMULATED Recommended operations for today (DREX Day 1 A.M.):

SIMULATED Fairfax Water: Reduce Potomac withdrawals by 5 MGD, keeping Potomac withdrawals steady. Griffith production per operational preference.

SIMULATED WSSC Water: Per operational preference, keeping Potomac withdrawals steady.

SIMULATED Little Seneca (release date, time, amount in MGD): Begin Little Seneca release of 19 MGD as soon as possible.

SIMULATED Washington Aqueduct: Meet all demands from Little Falls in order to maintain the Great Falls flowby.

SIMULATED North Branch Reservoirs A.M. Summary: No North Branch releases at the moment.

SIMULATED Reservoirs - Usable storage (DREX Day 1 A.M., BG):
Facility, %Full, Current, Capacity
WSSC's Patuxent reservoirs, 63%, 6.39, 10.2
Fairfax Water's Occoquan Reservoir, 70%, 5.65, 8.17
Little Seneca Reservoir, 56%, 2.2, 3.9
Jennings Randolph Total Reservoir, 65%, 18.97, 29.4
Jennings Randolph water supply**, 59%, 7.7, 13.1
Jennings Randolph water quality**, 69%, 11.27, 16.3
Savage Reservoir, 35%, 2.21, 6.3
** ICPRB's initial estimate. Final accounting of Jennings Randolph water supply versus water quality storage will be provided at a later date by the USACE.

Note (not repeated in every email to save space): Flow levels have dropped to a level that has triggered enhanced monitoring (SIMULATED), per the drought operations manual of the Water Supply Coordination Agreement. When adjusted flow at Little Falls (adjusted flow is gage flow plus upstream withdrawals) less the environmental flow is less than twice the Washington Metropolitan Area withdrawals, the water suppliers will begin reporting yesterday's and today's withdrawals and this morning's reservoir storage volumes. ICPRB asks that communications be sent by 7:30 A.M. and updates sent by 1:00 P.M. Reporting can be submitted through www.icprbcoop.org, by email to coop@icprb.org, or by telephone by leaving a message with the CO-OP operations number at 301-274-8132. Monitoring emails can be viewed at http://icprbcoop.org/products/monitoring-reports. Thank you for your contribution to the monitoring efforts.

2022 WMA Drought Exercise - Day 1: Afternoon Potomac flow and demand update (Tuesday, 2022-11-15)
Following this morning's operations request by ICPRB CO-OP, WSSC Water initiated a "simulated" water supply release from the Little Seneca Reservoir at 9:30 A.M. This reservoir is in the Black Hill Regional Park.

In talking with Fairfax Water distribution staff this morning, we learned that the maximum possible "simulated" load shift today from the Potomac to the Occoquan is 5 MGD due to "actual" installation work at the Griffith plant.

We look forward to hearing from those participating in the Drought Coordination Technical Committee Call hosted by MWCOG on MS Teams this afternoon at 4:00 P.M.

Best regards,

ICPRB CO-OP Drought Team

ACTUAL Daily flows:
Little Falls gage flow 2022-11-14: 8725 MGD (13500 cfs)
Little Falls gage flow 2022-11-15: 9113 MGD (est., based on recently available real-time data) (14100 cfs)
Note: Gage flow at Little Falls is measured after water supply withdrawals.
Point of Rocks flow 2022-11-14: 10276 MGD (15900 cfs)
Point of Rocks flow 2022-11-15: 7820 MGD (est., based on recently available real-time data) (12100 cfs)

ACTUAL Today's estimated production* (2022-11-15):
FW estimated production:117 MGD
WSSC estimated production:146 MGD
Washington Aqueduct estimated production:119 MGD
Total estimated production:382 MGD
LW total estimated consumption:20 MGD**
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church
**LW total estimated consumption includes purchase and production water and is not included in the total production estimate.

ACTUAL Tomorrow's estimated production* (2022-11-16):
FW estimated production:125 MGD
WSSC estimated production:147 MGD
Washington Aqueduct estimated production:119 MGD
Total estimated production:391 MGD
LW Total estimated consumption:21 MGD**
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church
**LW total estimated consumption includes purchase and production water and is not included in the total production estimate.

SIMULATED Recommended operations for today (DREX Day 1 P.M.):

SIMULATED Fairfax Water: Maintain the 5 MGD load shift from the Potomac to the Occoquan, keeping Potomac withdrawals steady. Griffith production per operational preference.

SIMULATED WSSC Water: Per operational preference, keeping Potomac withdrawals steady.

SIMULATED Little Seneca (release date, time, amount in MGD): Maintain the Little Seneca release of 19 MGD.

SIMULATED Washington Aqueduct: Meet all demands from Little Falls in order to maintain the Great Falls flowby.

SIMULATED North Branch Reservoirs P.M. Summary: No North Branch releases at the moment.

Day 2 (Wednesday, 2022-11-16)

2022 WMA Drought Exercise-Day 2: Morning Potomac flow and demand update (Wednesday, 2022-11-16)
Welcome to Day 2 of the 2022 WMA Drought Exercise. "Simulated" Potomac River flows are continuing to fall. We have asked WSSC Water to make a "simulated" reduction of their Potomac River withdrawals by 7 MGD to help maintain the Little Falls flow-by today. In addition, we have requested a "simulated" 141 MGD Little Seneca Reservoir release to help maintain the flow-by tomorrow. We estimate that 40 cfs of flow at Point of Rocks yesterday is due to a "simulated" past water supply release from Jennings Randolph Reservoir as noted in the "simulated" Loudoun Water drought operations protocol below.

ACTUAL Recent basin-wide average precipitation (above Little Falls):
(based on CO-OP's Low Flow Forecast System analysis of Middle Atlantic River Forecast Center (MARFC) gridded multisensor precipitation estimates)
Yesterday's area-weighted average basin precipitation: 0.65 (inches)
Past 3-day cumulative area-weighted average basin precipitation: 0.66 (inches)
Past 7-day cumulative area-weighted average basin precipitation: 2.71 (inches)

ACTUAL Daily flows:
Little Falls gage flow 2022-11-15: 9242 MGD (14300 cfs)
Little Falls gage flow 2022-11-16: 9372 MGD (est., based on recently available real-time data) (14500 cfs)
Note: Gage flow at Little Falls is measured after water supply withdrawals.
Point of Rocks flow 2022-11-15: 8014 MGD (12400 cfs)
Point of Rocks flow 2022-11-16: 6657 MGD (est., based on recently available real-time data) (10300 cfs)

ACTUAL Yesterday's Washington Metropolitan Area Potomac River withdrawals and discharges (2022-11-15):
Fairfax Water Corbalis withdrawal (Potomac): 73 MGD
WSSC Water Potomac withdrawal: 119 MGD
Washington Aqueduct withdrawal: 113 MGD
Loudoun Water withdrawal: 0 MGD
Loudoun Water Broad Run discharge: 7 MGD
Total Potomac withdrawal: 305 MGD
Total net Potomac withdrawal: 298 MGD

ACTUAL Yesterday's Patuxent, Occoquan, and Net Total System Withdrawal (2022-11-15):
FW Occoquan withdrawal:58 MGD
WSSC Patuxent withdrawal:39 MGD

ACTUAL Yesterday's total system withdrawal (2022-11-15): 403 MGD

ACTUAL Loudoun Water Potomac River (PR) flow values for drought operations protocol (based on yesterday's flows):
QPR: 12400 cfs
QPR, obs: 12400 cfs
QPR, WS: 0 cfs

ACTUAL Today's estimated production* (2022-11-16):
FW estimated production:126 MGD
WSSC estimated production:147 MGD
Washington Aqueduct estimated production:119 MGD
Total estimated production:392 MGD
LW total estimated consumption:21 MGD**
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church
**LW total estimated consumption includes purchase and production water and is not included in the total production estimate.

ACTUAL Tomorrow's estimated production* (2022-11-17):
FW estimated production:122 MGD
WSSC estimated production:147 MGD
Washington Aqueduct estimated production:121 MGD
Total estimated production:390 MGD
LW Total estimated consumption:21 MGD**

*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church
**LW total estimated consumption includes purchase and production water and is not included in the total production estimate.

SIMULATED Recommended operations for today (Day 2, A.M.):

SIMULATED Fairfax Water: Per operational preference, keep Potomac withdrawals steady. Maintain Griffith WTP at maximum production of 70 MGD.

SIMULATED WSSC Water: Reduce Potomac River withdrawal by 7 MGD and hold steady.

SIMULATED Seneca (release date, time, amount in MGD): Increase release from Little Seneca Reservoir to 141 MGD for Day 2 of Drought Exercise.

SIMULATED Washington Aqueduct: Meet all demands from Little Falls in order to maintain the Great Falls flow-by.

SIMULATED North Branch Reservoirs A.M. Summary: No North Branch releases for Day 2 of Drought Exercise.

SIMULATED Loudoun Water Potomac River (PR) flow values for drought operations protocol (based on yesterday's flows):
QPR: 708 cfs
QPR, obs: 748 cfs
QPR, WS: 40 cfs

SIMULATED Reservoirs - Usable storage (Day 2, A.M., BG):
Facility, %Full, Current, Capacity*
WSSC's Patuxent reservoirs, 61%, 6.26, 10.2
Fairfax Water's Occoquan Reservoir, 69%, 5.58, 8.17
Little Seneca Reservoir, 56%, 2.19, 3.9
Jennings Randolph Total Reservoir, 64%, 18.80, 29.4
Jennings Randolph water supply**, 59%, 7.7, 13.1
Jennings Randolph water quality**, 68%, 11.1, 16.3
Savage Reservoir, 33%, 2.1, 6.3
*Storage and capacities for Occoquan, Patuxent and Little Seneca reservoirs are provided by Washington Metropolitan Area water utilities, and based on best available information. Storage and capacities for Jennings Randolph and Savage reservoirs are based on observed water levels and available USACE water level/storage tables from 1998. ICPRB estimates that sedimentation has resulted in a loss of total available storage in Jennings Randolph Reservoir of 1.6 BG in recent years, and this loss is not reflected in the numbers above.
** ICPRB's initial estimate. Final accounting of Jennings Randolph water supply versus water quality storage will be provided at a later date by the USACE.

2022 WMA Drought Exercise-Day 2: Afternoon Potomac flow and demand update (Wednesday, 2022-11-16)
No additional operational changes are requested for this afternoon. "Simulated" flows at Little Falls are staying above 150 MGD.

During yesterday's practice call, the DCTC recommended entering the "simulated" Drought "Warning" stage of the MWCOG Drought Awareness Response Plan. This discussion occurred because the "simulated" combined water supply storage in Jennings Randolph and Little Seneca fell below 60%.

Best regards,

ICPRB CO-OP Drought Team

ACTUAL Daily flows:
Little Falls gage flow 2022-11-15: 9242 MGD (14300 cfs)
Little Falls gage flow 2022-11-16: 8919 MGD (est., based on recently available real-time data) (13800 cfs)
Note: Gage flow at Little Falls is measured after water supply withdrawals.
Point of Rocks flow 2022-11-15: 8014 MGD (12400 cfs)
Point of Rocks flow 2022-11-16: 6179 MGD (est., based on recently available real-time data) (9560 cfs)

ACTUAL Today's estimated production* (2022-11-16):
FW estimated production:126 MGD
WSSC estimated production:146 MGD
Washington Aqueduct estimated production:119 MGD
Total estimated production:391 MGD
LW total estimated consumption:21 MGD**
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church
**LW total estimated consumption includes purchase and production water and is not included in the total production estimate

ACTUAL Tomorrow's estimated production* (2022-11-17):
FW estimated production:122 MGD
WSSC estimated production:146 MGD
Washington Aqueduct estimated production:121 MGD
Total estimated production:389 MGD
LW Total estimated consumption:21 MGD**
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church
**LW total estimated consumption includes purchase and production water and is not included in the total production estimate

SIMULATED Recommended operations for today (DREX Day 2 - P.M.):

SIMULATED Fairfax Water: Maintain maximum Griffith production from this morning, keep Potomac withdrawals steady.

SIMULATED WSSC Water: Maintain morning reduction of Potomac River withdrawals of 7 MGD and hold steady.

SIMULATED Little Seneca Reservoir (release date, time, amount in MGD): Maintain the Little Seneca release of 141 MGD.

SIMULATED Washington Aqueduct: Meet all demands from Little Falls in order to maintain the Great Fall flow-by.

SIMULATED North Branch Reservoirs P.M. Summary: No North Branch release at the moment.

SIMULATED Loudoun Water Potomac River (PR) flow values for drought operations protocol (based on yesterday's flows):
QPR: 708 cfs
QPR, obs: 748 cfs
QPR, WS: 40 cfs

Day 3 (Thursday, 2022-11-17)

2022 WMA Drought Exercise-Day 3: Morning Potomac flow and demand update (Thursday, 2022-11-17)
This is the final day of the three-day 2022 WMA Drought Exercise. "Simulated" Potomac River flows at Little Falls have fallen to 104 MGD. Forecasts for today indicate that "simulated" flows are expected to rise. We requested a "simulated" Jennings Randolph water supply release this morning of approximately 30 MGD with a Luke target of 297 cfs. Little Seneca continues to make a "simulated" water supply release to augment flows at Little Falls. There is hope for the basin, however, because the National Weather Service indicates the development of a "simulated" tropical storm off the coast of Florida in the coming week.

ACTUAL Recent basin-wide average precipitation (above Little Falls):
(based on CO-OP's Low Flow Forecast System analysis of Middle Atlantic River Forecast Center (MARFC) gridded 46ultisensory precipitation estimates)
Yesterday's area-weighted average basin precipitation: trace amount
Past 3-day cumulative area-weighted average basin precipitation: 0.66 (inches)
Past 7-day cumulative area-weighted average basin precipitation: 2.71 (inches)

ACTUAL Daily flows:
Little Falls gage flow 2022-11-16: 8855 MGD (13700 cfs)
Little Falls gage flow 2022-11-17: 6980 MGD (est., based on recently available real-time data) (10800 cfs)
Note: Gage flow at Little Falls is measured after water supply withdrawals.
Point of Rocks flow 2022-11-16: 6366 MGD (9850 cfs)
Point of Rocks flow 2022-11-17: 6528 MGD (est., based on recently available real-time data) (10100 cfs)

ACTUAL Yesterday's Washington Metropolitan Area Potomac River withdrawals and discharges (2022-11-16):
Fairfax Water Corbalis withdrawal (Potomac): 84 MGD
WSSC Water Potomac withdrawal: 112 MGD
Washington Aqueduct withdrawal: 118 MGD
Loudoun Water withdrawal: 8 MGD
Loudoun Water Broad Run discharge: 7 MGD
Total Potomac withdrawal: 322 MGD
Total net Potomac withdrawal: 315 MGD

ACTUAL Yesterday's Patuxent, Occoquan, and Net Total System Withdrawal (2022-11-16):
FW Occoquan withdrawal:60 MGD
WSSC Patuxent withdrawal:40 MGD
ACTUAL Yesterday's total system withdrawal (2022-11-16): 415 MGD

ACTUAL Loudoun Water Potomac River (PR) flow values for drought operations protocol (based on yesterday's flows):
QPR: 9850 cfs
QPR, obs: 9850 cfs
QPR, WS: 0 cfs
Note to Loudoun Water: See NWS ensemble flow forecasts (HEFS, GEFS, NAEFS) for Point of Rocks flow for the next 7 days – see https://www.weather.gov/erh/mmefs_marfc?id=PORM2&model=NAEFS.

ACTUAL Today's estimated production* (2022-11-17):
FW estimated production:122 MGD
WSSC estimated production:146 MGD
Washington Aqueduct estimated production:121 MGD
Total estimated production:389 MGD
LW total estimated consumption:21 MGD**
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church
**LW total estimated consumption includes purchase and production water and is not included in the total production estimate

ACTUAL Tomorrow's estimated production* (2022-11-18):
FW estimated production:125 MGD
WSSC estimated production:147 MGD
Washington Aqueduct estimated production:120 MGD

Total estimated production:392 MGD
LW Total estimated consumption:21 MGD**
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church

**LW total estimated consumption includes purchase and production water and is not included in the total production estimate

SIMULATED Recommended operations for today (DREX Day 3, A.M.):

SIMULATED Fairfax Water: Per operational preference, keep Potomac withdrawals steady. Maintain Griffith WTP at maximum production of 70 MGD.

SIMULATED WSSC Water: Maintain Patuxent at maximum production of 60 MGD. Potomac withdrawals per operational preference, keeping as steady as possible.

SIMULATED Little Seneca Reservoir (release date, time, amount in MGD): Reduce Little Seneca release to 118 MGD.

SIMULATED Washington Aqueduct: Meet all demands from Little Falls in order to maintain the Great Falls flow-by.

SIMULATED North Branch Reservoirs A.M. Summary: Initiate a North Branch Water Supply release; Luke target = 297 cfs (192 MGD). The assumed Luke flow without water supply releases is 251 cfs (162 MGD) (simulated).

SIMULATED Loudoun Water Potomac River (PR) flow values for drought operations protocol (based on yesterday's flows):
QPR: 723 cfs
QPR, obs: 748 cfs
QPR, WS: 25 cfs

SIMULATED Reservoirs – Usable storage (DREX Day 3, A.M., BG):
Facility, %Full, Current, Capacity*
WSSC's Patuxent reservoirs, 61%, 6.21, 10.2
Fairfax Water's Occoquan Reservoir, 70%, 5.6, 8.17
Little Seneca Reservoir, 56%, 2.19, 3.9
Jennings Randolph Total Reservoir, 64%, 18.73, 29.4
Jennings Randolph water supply**, 59%, 7.69, 13.1
Jennings Randolph water quality**, 68%, 11.04, 16.3
Savage Reservoir, 33%, 2.09, 6.3
*Storage and capacities for Occoquan, Patuxent and Little Seneca reservoirs are provided by Washington Metropolitan Area water utilities, and based on best available information. Storage and capacities for Jennings Randolph and Savage reservoirs are based on observed water levels and available USACE water level/storage tables from 1998. ICPRB estimates that sedimentation has resulted in a loss of total available storage in Jennings Randolph Reservoir of 1.6 BG in recent years, and this loss is not reflected in the numbers above.
** ICPRB's initial estimate. Final accounting of Jennings Randolph water supply versus water quality storage will be provided at a later date by the USACE.

2022 WMA Drought Exercise-Day 3: Afternoon Potomac flow and demand update (Thursday, 2022-11-17)
This email concludes the 2022 Washington Metropolitan Area (WMA) drought exercise. A summary report describing exercise assumptions, activities, and tools will be prepared and published on ICPRB's website (www.potomacriver.org).

Thank you for participating in the exercise and helping to maintain the reliability of the regional water supply system! We extend a special thanks to MWCOG for coordinating the practice Drought Coordination Technical Committee Call Tuesday afternoon. Given the high Potomac River flows during this year's exercises, we did not practice a Little Seneca test release, but we hope to continue this tradition for future events.

All the best,

The ICPRB CO-OP Drought Team

ACTUAL Daily flows:
Little Falls gage flow 2022-11-16: 8855 MGD (13700 cfs)
Little Falls gage flow 2022-11-17: 6980 MGD (est., based on recently available real-time data) (10800 cfs)
Note: Gage flow at Little Falls is measured after water supply withdrawals.
Point of Rocks flow 2022-11-16: 6366 MGD (9850 cfs)
Point of Rocks flow 2022-11-17: 6463 MGD (est., based on recently available real-time data) (10000 cfs)

ACTUAL Yesterday's Washington Metropolitan Area Potomac River withdrawals and discharges (2022-11-16):
Fairfax Water Corbalis withdrawal (Potomac): 84 MGD
WSSC Water Potomac withdrawal: 120 MGD*
Washington Aqueduct withdrawal: 118 MGD
Loudoun Water withdrawal: 8 MGD
Loudoun Water Broad Run discharge: 7 MGD
Total Potomac withdrawal: 330 MGD
Total net Potomac withdrawal: 323 MGD
*REVISED from Day 3, A.M. WSSC Water withdrawal report

ACTUAL Yesterday's Patuxent, Occoquan, and Net Total System Withdrawal (2022-11-16):
FW Occoquan withdrawal:60 MGD
WSSC Patuxent withdrawal:40 MGD

ACTUAL Yesterday's total system withdrawal (2022-11-16): 422 MGD*
*REVISED from Day 3, A.M. WSSC Water withdrawal report

ACTUAL Today's estimated production* (2022-11-17):
FW estimated production:122 MGD
WSSC estimated production:147 MGD
Washington Aqueduct estimated production:121 MGD
Total estimated production:390 MGD
LW total estimated consumption:21 MGD**
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church
**LW total estimated consumption includes purchase and production water and is not included in the total production estimate

ACTUAL Tomorrow's estimated production* (2022-11-18):
FW estimated production:125 MGD
WSSC estimated production:148 MGD
Washington Aqueduct estimated production:120 MGD
Total estimated production:394 MGD
LW Total estimated consumption:21 MGD**
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church

**LW total estimated consumption includes purchase and production water and is not included in the total production estimate

SIMULATED Recommended operations for today (DREX Day 3, P.M.):

SIMULATED Fairfax Water: Per operational preference, keep Potomac withdrawals steady. Maintain Griffith WTP at maximum production of 70 MGD.

SIMULATED WSSC Water: Maintain Patuxent at maximum production of 60 MGD. Potomac withdrawals per operational preference, keeping as steady as possible.

SIMULATED Little Seneca Reservoir (release date, time, amount in MGD): Maintain Little Seneca release at 118 MGD.

SIMULATED Washington Aqueduct: Meet all demands from Little Falls in order to maintain the Great Falls flow-by.

SIMULATED North Branch Reservoirs A.M. Summary: Maintain a minimum Luke target = 297 cfs (192 MGD). The assumed Luke flow without water supply releases is 251 cfs (162 MGD) (simulated).

SIMULATED Loudoun Water Potomac River (PR) flow values for drought operations protocol (based on yesterday's flows):
QPR: 723 cfs
QPR, obs: 748 cfs
QPR, WS: 25 cfs

Appendix D: Jennings Randolph Storage Accounting (Day 3, 2022-11-17)

The Jennings Randolph Lake storage accounting assumes current conditions on Day 3 of the drought exercise (November 17, 2022). USACE Baltimore District staff provided a post-exercise breakdown of the Luke target flow request using observed conditions at Jennings Randolph. On November 17, the lake elevation was 1424.0 feet (ft), which is full water supply storage, with 16,403 acre-feet (4.6 BG) of water quality storage. The ICPRB CO-OP staff requested a target of 297 cfs at Luke. The corresponding observed flow at Luke was 269 cfs, with an estimated 28 cfs local flow. To determine the required water quality release from Jennings Randolph Reservoir, USACE subtracted the local flow (28 cfs) from the 120 cfs requirement at Luke, resulting in 92 cfs. The release from Jennings Randolph Reservoir over the last 24 hours was 187 cfs, so subtracting the water quality release (92 cfs) left 95 cfs from water supply. The inflow to Jennings Randolph Lake was quite high that day (705 cfs) so all the water supply storage used was immediately replenished and no storage was taken from the water supply account. Additionally, 5 parts of the water supply release comes from Jennings Randolph Reservoir, and 1 part of the water supply release comes from Savage Reservoir.

CURRENT RESERVOIR STATUS							
ELEV @ 1000 HRS	WATER SUPPLY STORAGE @ 1000 HRS (40,194 ac-ft Total) *		WATER QUALITY STORAGE @ 1000 HRS (50,009 ac-ft Total)*		LUKE		
					ICPRB LUKE TARGET	EST. OBS.	EST. LOCAL
(FT NGVD)	(AC-FT)	(%)	(AC-FT)	(%)	(CFS)	(CFS)	(CFS)
1424.0	40,194	100.0%	16,403	32.8%	297		28
						269	

AVERAGE RELEASES FOR LAST 24 HOURS				
TOTAL SAVAGE	TOTAL J.RAND	J.RAND WQ	J.RAND WS	FLOW NEEDED TO REFILL WS STORAGE
(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
55	*200*	*= Damtender Instruction*		
54	187	92	95	95

J.RANDOLPH INFLOW DISTRIBUTION						CHANGE IN STORAGE DURING CURRENT DAY	
COMPUTED PROJECT INFLOW	BASE INFLOW CREDITED TO WQ (first 50)	EXCESS INFLOW Inflow>50)	MAXIMUM. INFLOW TO WS	USABLE INFLOW TO WS	BALANCE OF INFLOW TO WQ	WATER SUPPLY	WATER QUALITY
(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(AC-FT)	(AC-FT)
705	50	655	305	95	610	0	1026

DETERMINING RESERVOIR RELEASE TARGETS FOR INSTRUCTIONS TO DAMTENDERS

	FLOW (CFS)		
Luke target flow furnished by ICPRB	255	←	
Less local inflow			
Combined release needed from Randolph & Savage	11		
Less minimum flowby requirement at DC	244		
Combined release needed from Randolph WS & Savage	155 *		
	89		
Flowby requirement			
Assume 80% from Randolph WQ storage			
Assume 20% from Savage	124	say	125
Flowby	31	say	30
	155		
Combined release needed from Randolph WS & Savage			
Assume 80% from Randolph WS storage			
Assume 20% from Savage	71.2		
Water supply releases	17.8		
	89		
Jennings Randolph release target			
Water quality for flowby			
Water supply	125		
Total Randolph release	71.2		
	196.2		
Savage release target			
Release to match Randolph WQ release for flowby			
Release to match Randolph WS release	30		
Total Savage release	17.8		
	47.8		
Re-aggregated releases for Luke target			
Total Randolph release			
Total Savage release	196.2		
Local inflow	47.8		
Total flow at Luke	11		
	255	→	

* The 155 cfs dedicated to DC flowby may be reduced to 120 cfs (95 cfs from Randolph WQ storage and 25 from Savage) if there is insufficient Randolph WQ storage to maintain the higher flowby target. In such a case, releases in excess of 120 cfs would come from Randolph WS storage and Savage.

Appendix E: Drought Coordination Technical Committee Conference Call

Metropolitan Washington
Council of Governments

DROUGHT COORDINATION TECHNICAL COMMITTEE

2022 DROUGHT EXERCISE

November 15, 2022
4:00. – 5:00 P.M.
Webinar only via MS Teams

Join on your computer, mobile app or room device
Click here to join the meeting

Meeting ID: 215 395 220 084
Passcode: xwCHHT

DRAFT AGENDA

4:00 P.M. **1. WELCOME AND INTRODUCTIONS**
CAO Chair and/or COG Staff

4:10 P.M. **2. OVERVIEW OF AGENDA/GOALS FOR MEETING**
CAO Chair and/or COG Staff

4:15 P.M. **3. REPORTS ON REGIONAL CONDITIONS**

- Overview – COG Staff
- CO-OP System Report – ICPRB CO-OP staff
- Current Weather Conditions and Forecast – Rich Tinker, NOAA
- Streamflow and Groundwater – USGS
- Water Utility Status Reports
  - Fairfax Water
  - Washington Aqueduct
  - WSSC
  - Loudoun Water
  - Other Utilities
- State Reports
  - MDE – Lainey Reed
  - VADEQ

4:40 P.M. **4. POTENTIAL ACTIONS**

- Discus the possibility of entering the Drought WARNING Stage per COG's Regional Water Supply and Drought Awareness Response Plan
- Discuss contents of a Press Release and social media content
- Identify some common voluntary water restriction measures
- Identify need for another DCTC or DCC call

4:55 P.M. **5. NEXT STEPS**
COG Staff

5:00 P.M. **6. ADJOURN**

Steve Bieber opened the meeting by calling roll and introducing the purpose of the technical committee, which is to make recommendations to the Drought Coordination Committee, a smaller group of CAOs and Water Supply General Managers, on matters such as issuing a press release, declaring restrictions, and agreeing on messaging. While the Drought Coordination Committee generally follows the technical committee's recommendations, they have convened only three times in the past to issue a drought "Watch" stage. Bieber then proceeded to provide overviews of the CO-OP system condition, weather forecast, streamflow, and utility status reports.

- ICPRB CO-OP gave the exercise scenario summary.
- NOA presented a possible scenario that involved below-average precipitation starting at the end of the previous winter and continuing into the last fall, along with a mild and dry winter. D1 and D2 drought conditions were predicted to spread over the Piedmont area to the north and west, where the Potomac River receives its water, with the possibility of D3 or D4 drought conditions on the west side. The forecast indicated that the weather would be warmer and drier than usual, with occasional hot and humid thunderstorms. However, significant relief would likely require a tropical or extensive organized weather system.
- FW indicated that their ability to shift loads to Occoquan is currently limited due to ongoing work at the finished water pumping station. However, if this were an "actual" event, they may be able to delay the work and increase pumping capacity.
- WA has operated without constraints at Little Falls for over a week as per the scenario.
- Kimberly Six represented WSSC Water but was not able to provide an update.
- LW reported adhering to real-world low flow protocol since they were unable to bring in Potomac water due to intake restraints and were "actually" receiving all their water from FW.
- DC Water had no response.
- Frederick County asked if there is specific information valuable to the downstream users?
- Town of Leesburg would implement voluntary water restrictions as outlined in their drought assessment and water supply response plan, which corresponds to the "Warning" stage in the MWCOG plan.
- Virginia American Water reported one storage tank out of service, purchasing all water from FW in the real world.
- MDE would move to a "Warning" stage for the region, communicate with local governments, coordinate with our drought system, and impose voluntary water restrictions in the affected area, while increasing bi-weekly monitoring, as per their drought response plan.
- VDH reported working with impacted utilities on messaging and conservation measures.
- VDEQ will follow Virginia's drought response plan and monitor key indicators such as precipitation, streamflow, and reservoir storage in the Shenandoah and Northern Virginia regions. The committee includes partner agencies such as NOA, USGS, and Virginia state departments. Meetings will be held bi-weekly to assess conditions and make recommendations to the Governor, potentially leading to a "Warning" stage.

The group concluded that the scenario has entered the drought "Warning" stage, which requires the issuance of voluntary water restrictions, a recommended press release, and messaging around it. Table 8 lists the participants of the Technical Committee call.

Table 8: MWCOG Conference Call Participants

Organization	Facility
DC Water	John Lisle, Emanual D. Briggs
DOEE	David Pilat
Fairfax Water	Niffy Saji, Gregory Prelewicz
ICPRB	Cherie Schultz, Christina Davis, Stephanie Nummer, Heidi Moltz, Mike Nardolilli, Sarah Ahmed
Loudoun Water	Thomas Barrack
MDE	Lainey Reed
MWCOG	Christine Howard, Steve Bieber
Washington Aqueduct	Anne Spiesman
WSSC Water	Kimberly Six
National Weather Service	Jeremy Geiger, Rich Tinker
Frederick County	Mark Schweitzer
Virginia American Water	Barry Suits
VDH Office of Drinking Water	Jeremy Hull
VDEQ	Joey Kleiner
Charles County	Wilson Cochran
Town of Herndon	Robert Etris
Town of Leesburg	Amy Wyks