2022 CO-OP Drought Exercise Guide

November 15-17, 2022

ICPRB Section for Cooperative Water Supply Operations on the Potomac (CO-OP)

2022 DREX schedule

- Day 1, Tuesday, November 15, 2022
  - 7:30 AM – 10:00 AM
    - Exercise overview
    - Discussion: Little Seneca release/Occoquan load shift
    - Morning email
  - 10:00 AM – 10:30 AM: Break
  - 10:30 AM – 11:30 AM: Special topic: System Overview/MWCOG Drought Stages (Sarah/Cherie)
  - 11:30 AM – 12:30 PM: Break
  - 12:30 PM – 2:00 PM: Afternoon email
  - 4:00 PM – 5:00 PM: Practice Drought Coordination Technical Committee MS Teams Call
- Day 2, Wednesday, November 16, 2022
  - 7:30 AM – 10:00 AM
    - Discussion: Patuxent Load Shift
    - Morning email
  - 10:00 AM – 10:30 AM: Break
  - 10:30 AM – 11:30 AM: Special topic: Data Portal/Withdrawal Forecasts/LFAA Thresholds (Luke/Sarah/Cherie)
  - 11:30 AM – 12:30 PM: Break
  - 12:30 PM – 2:00 PM: Afternoon email
- Day 3, Thursday, November 17, 2022
  - 7:30 AM – 10:00 AM
    - Discussion: Jennings Randolph release/Luke target and the storage buffer
    - Morning email
  - 10:00 AM – 10:30 AM: Break
  - 10:30 AM – 11:30 AM: Special topic: Great Falls Flow-by/Loudoun Water Protocol (Sarah/Cherie)
  - 11:30 AM – 12:30 PM: Break
  - 12:30 PM – 1:30 PM: Afternoon email

Exercise overview – basics

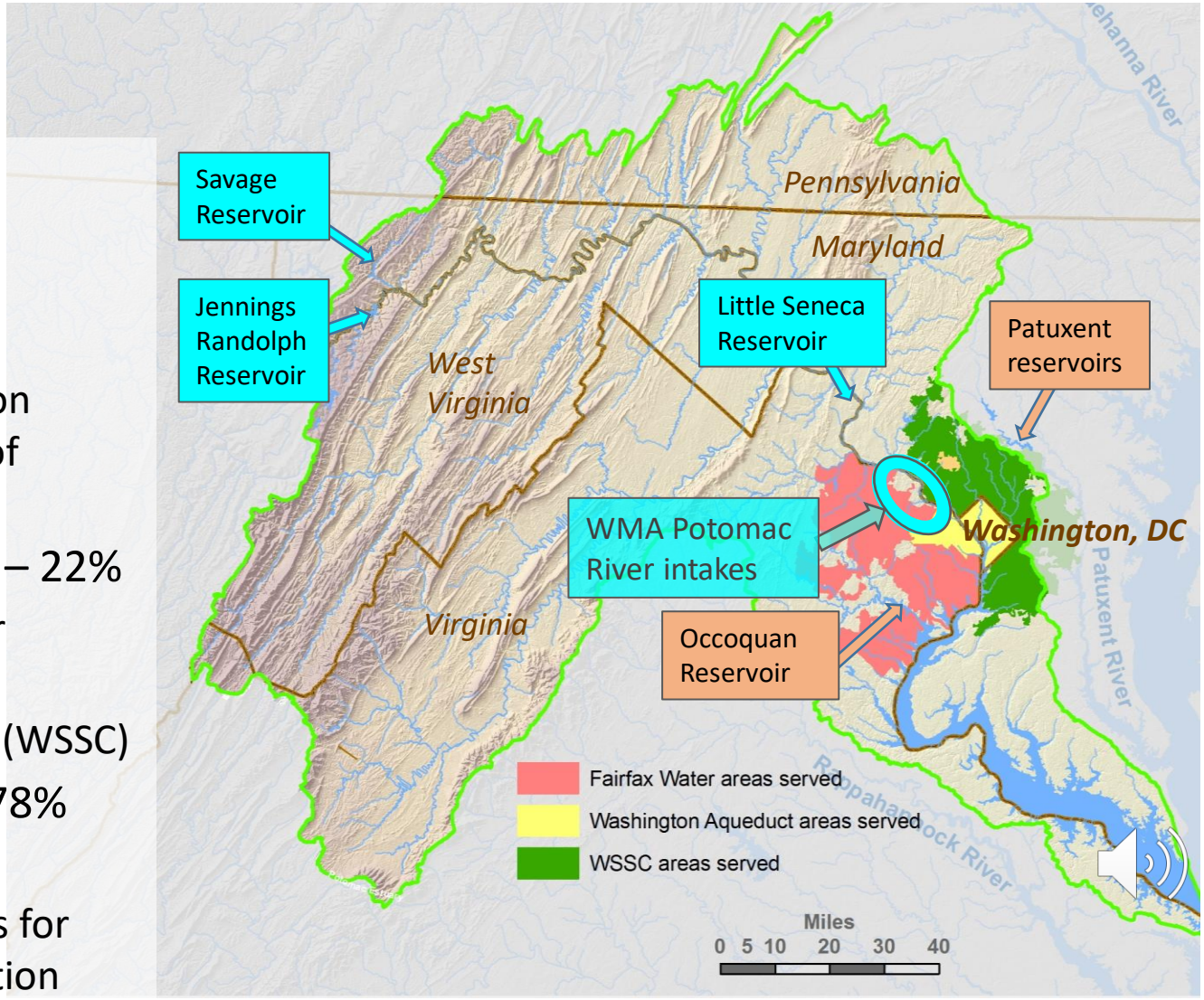
- Using updated "DroughtOps" Shiny app for decision support
  - Automated data retrieval
  - Drought operations version now available "in the cloud" at https://icprb.shinyapps.io/DroughtOps/
  - Exercise version needs to be run from your desktop
  - This week is an opportunity for debugging/suggesting improvements!
- Simulation of drought
  - Based on 2022 data for Aug 25,
  - Flows are scaled by a factor of 0.29,
  - Demands are scaled by a factor of 1.1,
- Draft report in on SharePoint site – document activities and problems there!
  2022 WMA Drought Exercise report, with Appendices A-C.docx
- Scenario

  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 November 15, 4-5 PM, in response to simulated combined storage in Jennings Randolph and Little Seneca reservoirs dropping to 9.9 billion gallons (BG), or 60 percent 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 percent 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."[1]

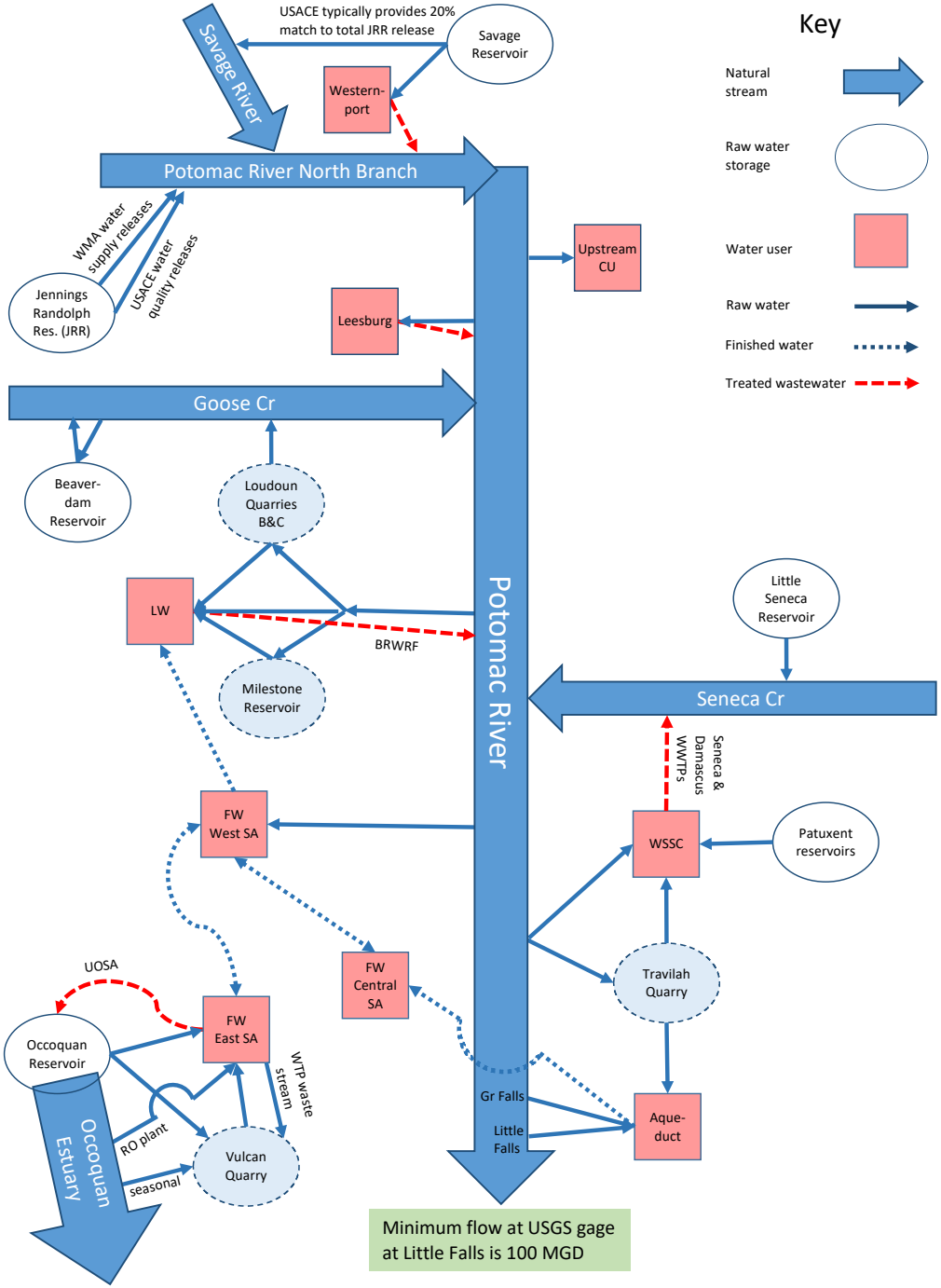
[1] Potomac River Environmental Flow-By Study (MD DNR, 1981)

CO-OP basics – system map

- Suppliers
  - VA: Fairfax Water
  - MD: WSSC Water
  - DC & VA: Washington Aqueduct Division of USACE
- Individual resources – 22%
  - Occoquan Reservoir (Fairfax Water)
  - Patuxent reservoirs (WSSC)
- Shared resources – 78%
  - Potomac River
  - Upstream reservoirs for low flow augmentation



CO-OP basics – system schematic



Exercise overview – operational goals

- Meet system demands
- Keep daily average flow at Little Falls above 100 MGD (155 cfs)
- Keep daily average flow above 300 MGD (464 cfs) in the stretch of the river between Great Falls and Little Falls
- Operate to ensure that there is a 95% probability that system reservoirs are at least 90% full on June 1 of each year
- Operate the system in the most efficient manner we know how – by closely adhering to assumptions used in our planning model, PRRISM

Exercise overview – Shiny app tabs

- Situational Awareness
  - Meant to be what you want to see first thing in the morning
  - Complements Data Portal's "Self Briefing Conditions"
- Local Ops
  - Are flows so close to 100 MGD that we want an immediate load shift to the Patuxent? (MOS = 40 MGD in PRRISM)
  - Are flows at Great Falls getting close to 500 MGD so we want a load shift from Great Falls to Little Falls?
  - Are forecasted flows tomorrow low enough for a Little Seneca release and a load shift to the Occoquan? (MOS – 120 MGD in PRRISM)
- N Br Reservoir Ops
  - Are forecasts of flow in 9 days such that we want a Jennings Randolph release?

Great Falls flow-by overview

(simulation based on scaled Sep 15, 2020 flows)

- Flow at Great Falls is not measured – only estimated
- What is the required flow-by?
  - ICPRB/TNC/USACE Large River Flows study (Jim Cummins) recommended 300 MGD
  - Potomac River Environmental Flow-By Study (MD DNR, 1981) recommended 100 MGD plus Aqueduct withdrawal*
- What do we do to maintain this flow-by?
  - Ask Aqueduct to begin shifting from Great Falls intake to Little falls intake when flow at Little Falls nears 400 MGD

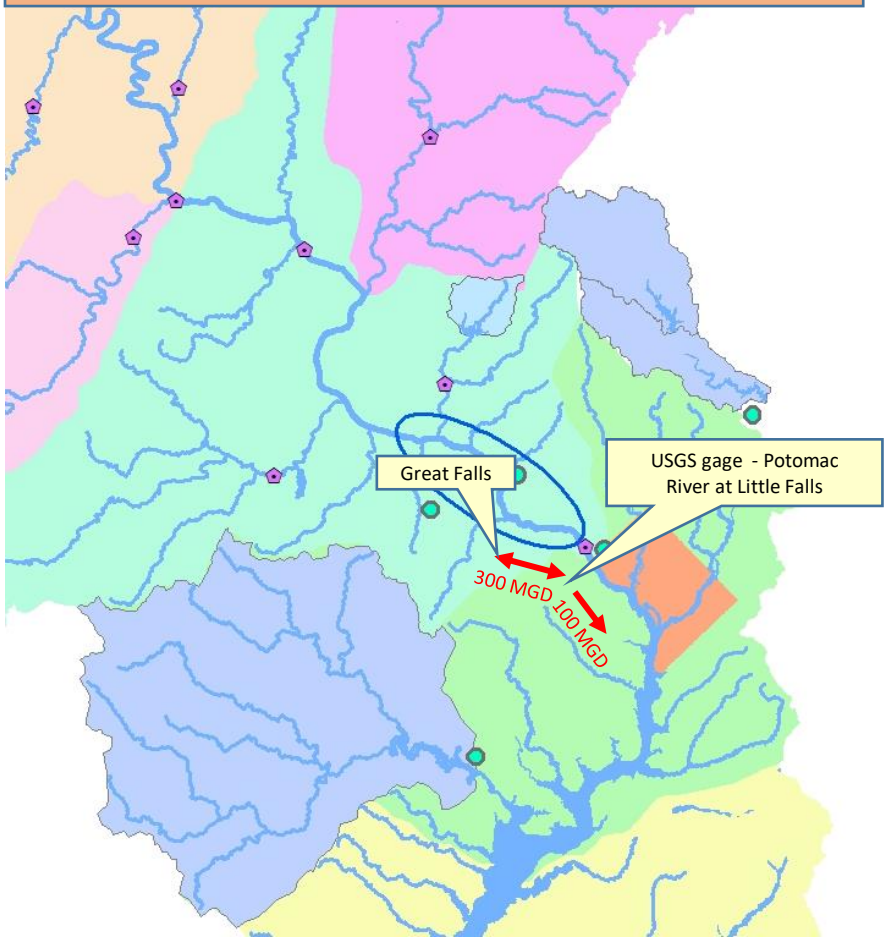
*RECOMMENDATION #2: At a calculated flow of 500 mgd just above the Great Falls intake, begin shifting Aqueduct withdrawals to the Little Falls dam intake to maintain at least 100 mgd plus the Washington Aqueduct's allocation up to 200 mgd between Great Falls and Little Falls dam. (Potomac River Environmental Flow-By Study, MD DNR, 1981)

Great Falls Load Shift

- Recommended minimum flow between Great Falls and Little Falls is 300 MGD
- This can be achieved by shifting a portion of Washington Aqueduct's withdrawal from Great Falls intake to Little Falls intake
- Washington Aqueduct withdraws water from the Potomac at 2 locations
  - It prefers to withdraw from Great Falls, where gravity propels the water to the Dalecarlia Reservoir
  - It can withdraw at Little Falls just above the USGS gage; this water must be pumped up hill to their Dalecarlia Reservoir at a considerable cost
- Examples if flow above Gfalls is Q_{GF} = 350 MGD, using formula, $Q_{LF\ to\ GF} = Q_{LF} + W_{LF}$

  (where Q = flow; W = withdr):
  - If all withdrawal from G Falls then $Q_{LF\ to\ GF} = Q_{LF}$:
    - W_{GF} = 200 MGD
    - W_{LF} = 0 MGD
    - $Q_{GF\ to\ LF}$ = 150 + 0 = 150 MGD
    - Q_{LF} = 150 MGD
  - If all withdrawals from L Falls then Q_GF_to_LF = Q_GF:
    - W_{GF} = 0 MGD
    - W_{LF} = 200 MGD
    - $Q_{GF\ to\ LF}$ = 150 + 200 = 350 MGD
    - Q_{LF} = 150 MGD
  - Mixed withdrawals:
    - W_{GF} = 50 MGD
    - W_{LF} = 150 MGD
    - $Q_{GF\ to\ LF}$ = 150 + 150 = 300 MGD
    - Q_{LF} = 150 MGD
- The load shift from G Falls to L Falls should be done carefully before flow at Little Falls drops below 300 MGD
  - It takes ~ 9 hours for a hydrograph at Great Falls to arrive at Little Falls
  - L Falls pumps may artificially depress stage readings at the L Falls gage

If flow at Little Falls reaches 400 MGD, <u>START THINKING ABOUT</u> a Great Falls – Little Falls load shift



Great Falls flow-by – Little Falls pumping capacity

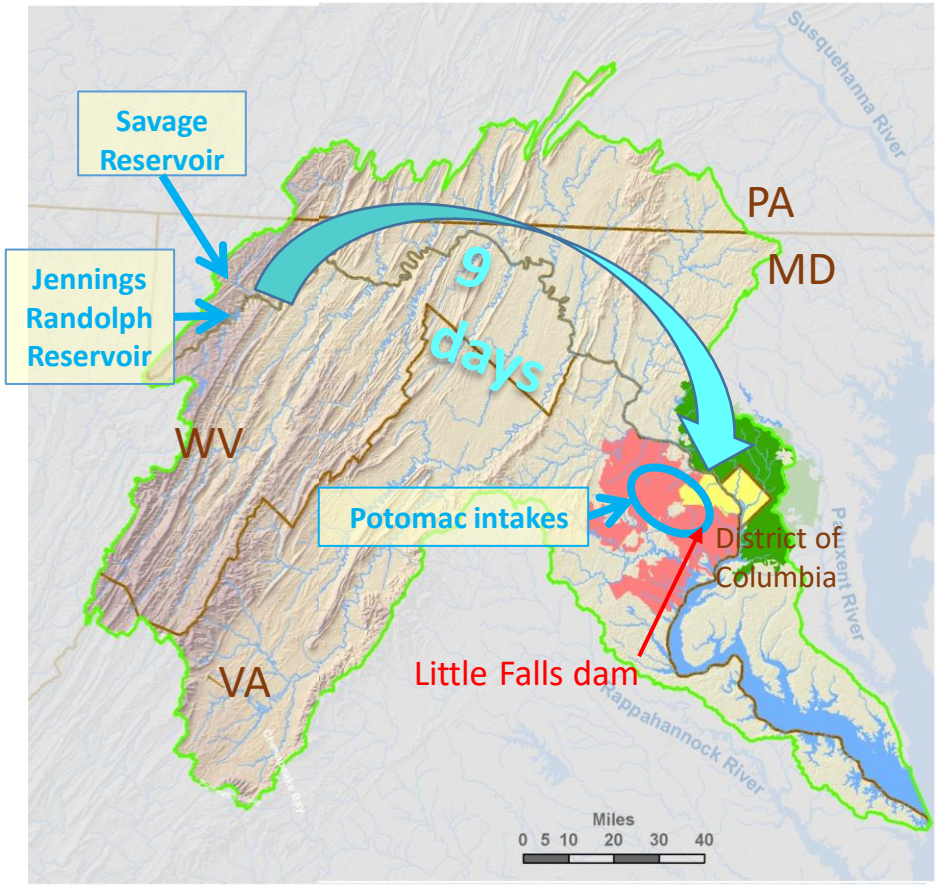
Pump design rate (MGD)	Pump observed rate (MGD)	Number of pumps
50	60	1
75	94	1
100	125	4

Loudoun Water protocol

- Loudoun Water's permit "protects" CO-OP water supply releases from Loudoun Water withdrawals
  - See Virginia Water Protection permit # 10-2020, I. 2. f (p. 10), and Part I.J.10 (p. 14)
  - Also see letter to Sarah Marsala, Feb 19, 2014, to VADEQ
- Applies whenever streamflow at Point of Rocks (POR) is below 1400 cfs and we estimate that a Jennings Randolph release is passing by Point of Rocks (<u>until</u> Milestone Reservoir becomes operational)
- COOP will provide LW (in the morning email) with
  - $Q_{PR, obs}$: flow observed at POR
  - $Q_{PR, WS}$: flow at POR from water supply release
  - Q_{PR}: $Q_{PR, obs} - Q_{PR, WS}$
- Questions
  - Can we simply assume 7-day travel time for N Br releases to POR?
  - Does Savage release count?

North Branch Reservoir Operations

- The Corps operates Savage in coordination with Jennings Randolph (JRR) (usually provides 20% Savage "match")
- At full "conservation pool" (pool elevation = 1466") JRR storage is:
  - 13.1 BG water supply (WS) (44.56%)
  - 16.3 BG water quality (WQ) (55.44%)
- We request a "water supply" release by calling the Corps' Baltimore District Office by 9 AM
  - We calculate the deficit, or need, in 9 days based on the current flow at Luke (assuming no water supply release)
  - We add to the deficit a "buffer" used to keep JRR WS and L Seneca storage
  - We add our estimated need to the current Luke flow to get our requested "Luke target" flow, in cfs
  - Request the release by calling the Baltimore Central Office (weekdays) or Duty Cell (weekends)
  - The Corps' usual minimum Luke flow from WQ storage is 120 cfs (78 MGD)
  - If a WS release is requested, the Corps' WQ release drops to 100 cfs (65 MGD) (needs to be verified!)
- Use the Shiny app tab, N Br Reservoir Ops, to determine need for a North Br water supply release
  - Review default values for Patuxent and Occoquan withdrawals set by the Data Portal
  - The 9-day flow forecast is from CO-OP's "Little Falls recession" equation
  - The LFFS forecast is displayed for evaluation purposes, but may be considered, especially if rain is forecasted
  - In general, use NO MARGIN OF SAFETY, except see "buffer"

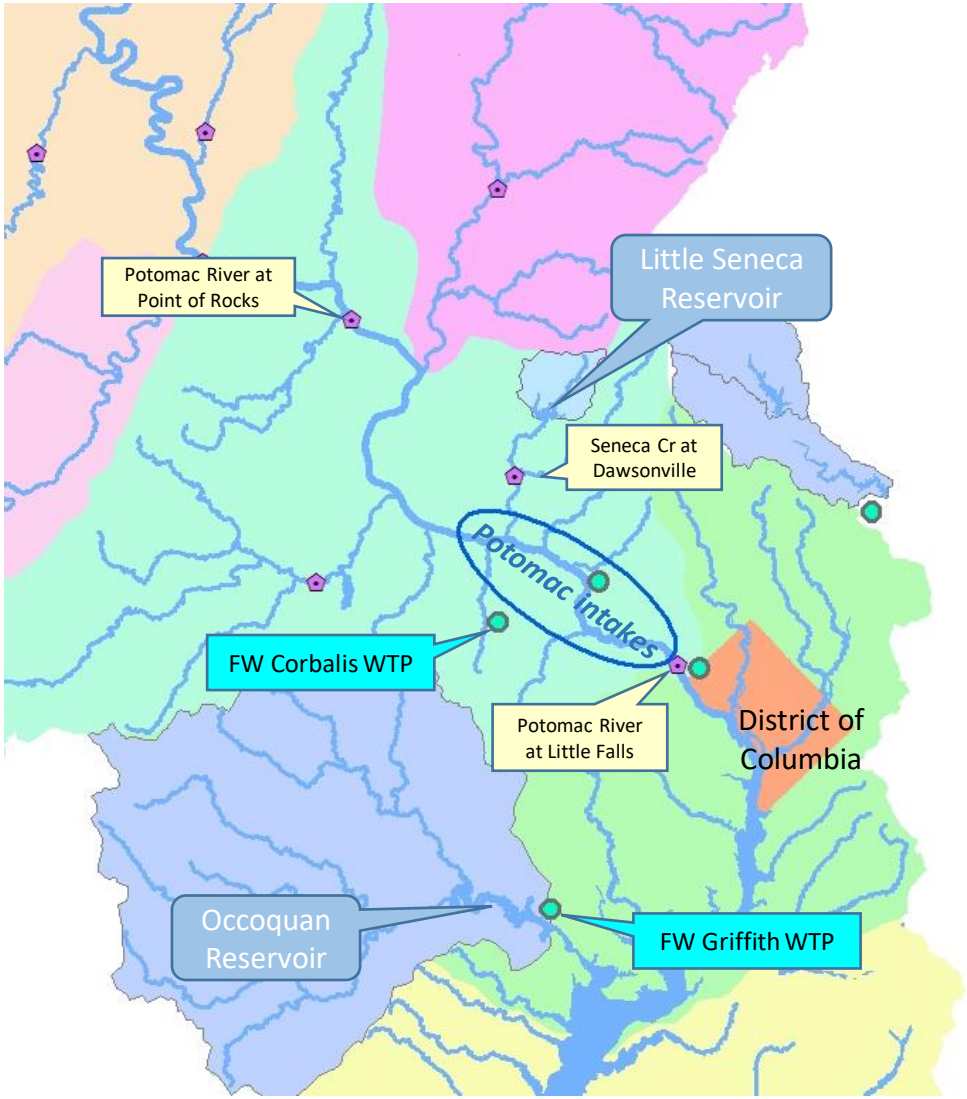


“Buffer” used to keep Little Seneca & JRR WS storage balanced

- Reduce JRR release if JRR is low relative to Little Seneca
- Increase JRR release if JRR is high relative to Little Seneca
- This is simulated in PRRISM by adding a “buffer” to the calculated release: buffer = (%JRWSStorage - %SenecaStorage) x 10 MGD (where percentages are based on usable capacities)
- Example: if %JRWSStorage = 50% and %SenecaStorage = 55% , then buffer = -5x10 = -50 MGD. So -50 MGD would be added to the calculated North Branch release target (i.e., 50 MGD would be subtracted).
- This buffer is being added to the Shiny app calculation

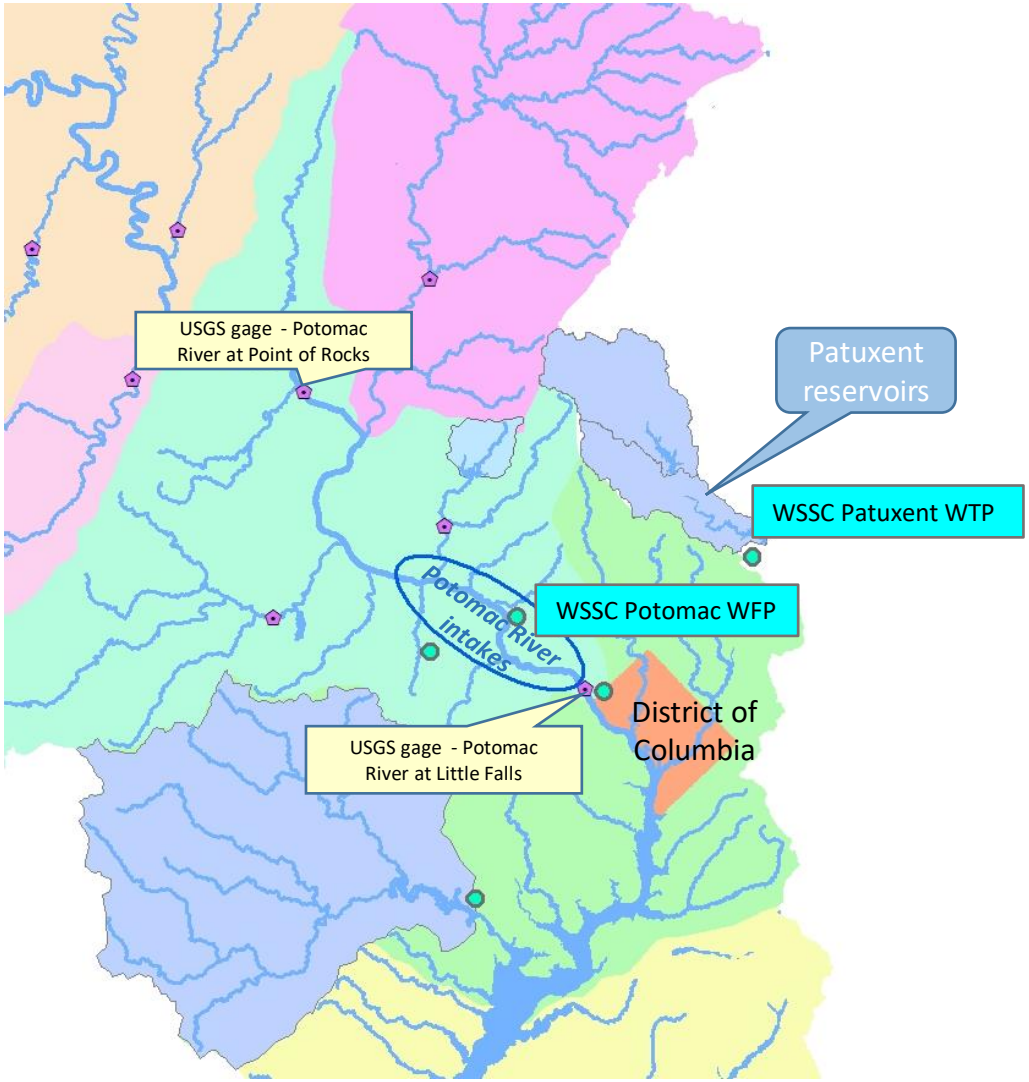
1-Day Ops – Little Seneca Release/Occ Load Shift

- Little Seneca and Occoquan should be operated in conjunction during droughts
  - Releases from Little Seneca take 1+ days to arrive at Lfalls during low flow conditions
  - A FW load shift may take 1+ days to impact LFalls
    - ~15 hours for a change in their Potomac withdrawal (Corbalis plant) to be seen at Lfalls
    - 4-24 hours (?) to implement a transfer of water from their Occoquan (Griffith plant) to their Potomac (Corbalis plant) "service area"
- Constraints on the FW load shift:
  - The Griffith WTP min/max production is 45/120 MGD
  - The Corbalis WTP min/max production is 60/225 MGD
  - Note that FW planners say they can only increase Griffith (Occoquan) production by ~15 MGD per day
  - FW operators are constrained by energy costs, so pre-approval must be arranged during drought operations to operate Griffith at its maximum rate
- To request these releases
  - Call the WSSC control room for a Little Seneca release
  - Call the FW control room (and make sure Joel Thompson is kept informed) about FW load shifts
- Use a margin of safety (MOS) for tomorrow's flow at Little Falls
  - Used 120 MGD in alternatives study
  - Review of the recent performance of the forecast models may make you comfortable with a smaller MOS

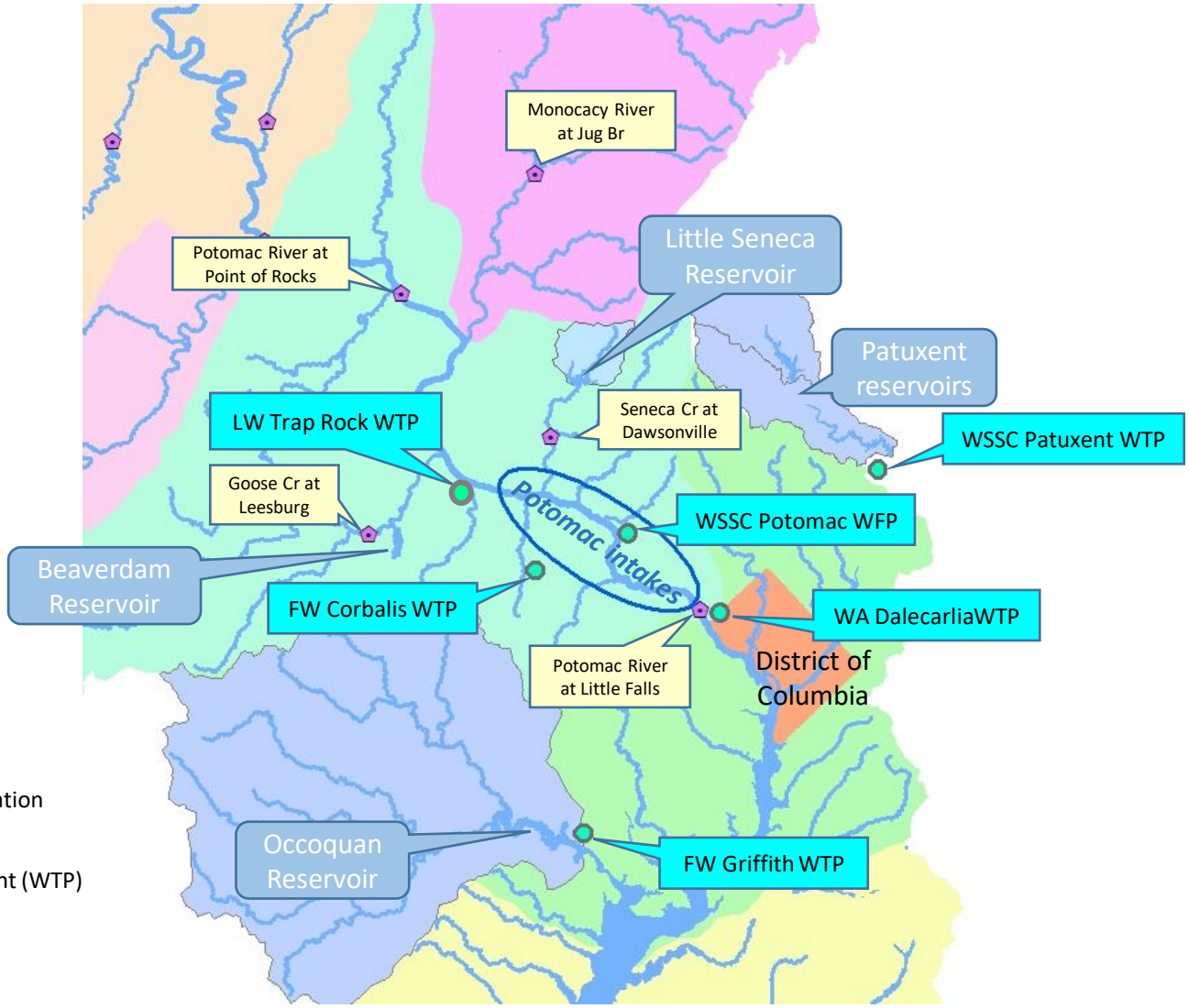


0-Day Operations – Patuxent Load Shift

- If observed flow at Little Falls is nearing 140 MGD (217 cfs), WSSC's Patuxent withdrawals can be increased to take some burden off of the Potomac
- Such a load-shift can have a reasonably fast impact on flow at Little Falls because
  - WSSC is usually able to implement such shifts very quickly and
  - We estimate that under low-flow conditions, a change in WSSC's Potomac withdrawal take 10 hours to impact flow at Little Falls
- Constraints on the load shift include the following:
  - WSSC's Potomac WFP's min/max production are 100 MGD/283 MGD
  - WSSC's Patuxent plant's min/max production are 33 MGD/62 MGD
- To request the load shift call WSSC's Control Room (but Karen Wright should be kept informed).



Map of Resources and Facilities Near the WMA



Reservoir Releases – a System Perspective

- Don't be "conservative" in the operations of Jennings Randolph (JR)
  - Don't add an extra margin of safety to the calculated JR release rate (except for balancing purposes – see below) "just to be safe" – it is Seneca's role to take care of any deficit that later develops
  - Even if it doesn't seem so, it will probably rain sometime in the next 9 days
- Keep storage in JR and Seneca reservoirs reasonably "balanced"
  - Reduce JR release if JR is low relative to Seneca
  - Increase JR release if JR is high relative to Seneca
  - This is simulated in PRRISM by adding a "buffer" to the calculated release: buffer = (%JRWSStorage - %SenecaStorage)x10 MGD (where percentages are based on usable capacities); so e.g. if %JRWSStorage = 50% and %SenecaStorage = 55% , then buffer = -5x10 = -50 MGD. So -50 MGD would be added to the calculated North Branch release target (ie 50 MGD would be subtracted).
- Operate Occoquan Reservoir in conjunction with Seneca during droughts
  - It takes approximately a day for any change in Seneca & Occoquan operations to impact flow at Little Falls (during low flow conditions)
  - If forecasts indicate that there is sufficient flow in the river tomorrow, operate both of these reservoirs to conserve storage
  - If a flow deficit is predicted for tomorrow, schedule a Seneca release, but reduce the burden on Seneca by "load-shifting" to the Occoquan (ie reduce FW's Potomac withdrawal and increase their Occoquan withdrawal)
  - Consult with FW about how much of a load-shift is possible in a day – 10 MGD? 20 MGD?
  - Do be "conservative" in these operations, ie add a comfortable margin of safety. PRRISM runs indicate that a margin of safety of 120-130 MGD ensures that the probability of missing the 100 MGD Little Falls flowby is minimal, and in 2002 operations a margin of safety of 100 MGD was used.
- Operate the Patuxent reservoirs to address near-term flow shortages
  - Changes in WSSC's operations can have a relatively quick impact at Little Falls (~ 10+ hours)
  - If it looks like there is a shortage developing today, ask WSSC to load-shift to the Patuxent ASAP (ie reduce their Potomac withdrawal and increase their Patuxent withdrawal).

Final Words – Importance of PRRISM

PRRISM is our best guide to the operational policies that achieve our goals

- Our current policies have been tested using PRRISM
- Our current policies were evaluated by Hydrologics in 2011 using OASIS – and they could not find improvements
- Any “new idea” should be evaluated in PRRISM to see if it leads to more reliable operations

Quick User Guide for Shiny App

1. App is now available via the Cloud at https://icprb.shinyapps.io/DroughtOps/
2. To run locally using Rstudio, first pull down app from GitHub, https://github.com/icprbcoop/DroughtOps
3. To open up app double-click on DroughtOps.Rproj
4. In order for app to work, need up-to-date data in /input/ts/current (for DREX days, folder is different)
   a. flows_daily_cfs.csv – daily flows beginning on January 1
   b. flows_hourly_cfs.csv – hourly flows
   c. wma_withdrawals.csv – hourly withdrawal file
   d. PM7_4820_0001.flow – LFFS simulated flows at Little Falls