



Additional and Updated Surface Water Analyses

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Agenda Item 5

Update on Synthetic/Extended Drought Analysis (Thurmond Releases)



USACE Plan for Emergency Drought Operations

- **Goal:** Provide a continuous water supply to the greatest population for as long as possible.
- Drops the lake pools below the bottom of their conservation zones in a predefined manner.
 - Due to the lower density of population around Lake Russell, USACE would sacrifice the volume of water in Russell while maintaining supplies to Hartwell and Thurmond.
 - Thurmond has the next lower population density and would be sacrificed second.
 - Lake Thurmond would continue to provide its minimum release requirement of 3,600 cfs measured at Augusta
 - Once Thurmond supply was depleted, USACE would begin to draw the Hartwell pool below the bottom of its conservation zone. At this point, most all the M&I intakes on the reservoirs would be unusable.
- USACE would work with their Emergency Management Team to establish alternate sources of water, trucking from the inactive storage zone of the reservoirs, or elsewhere.

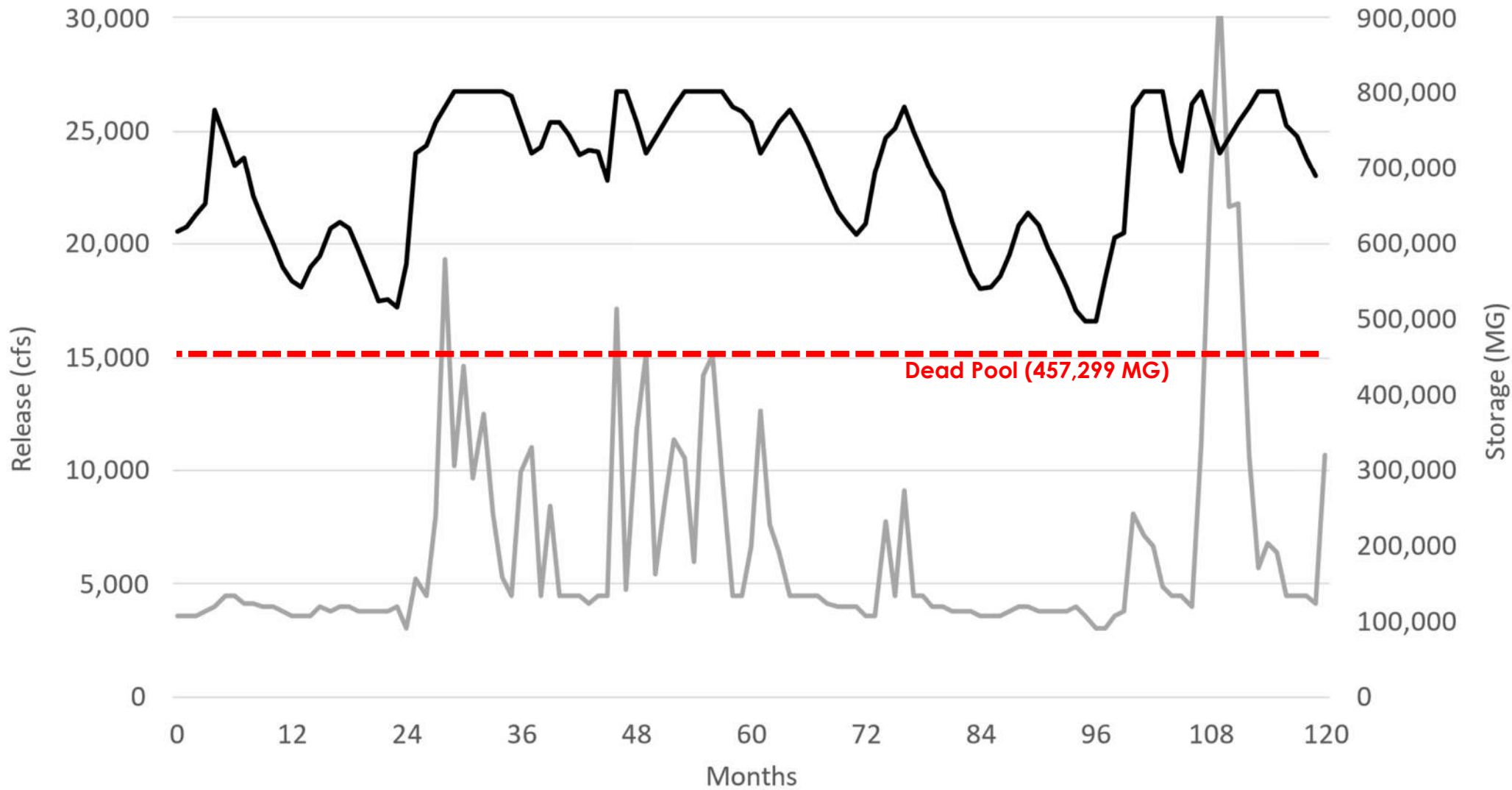
Resequencing Historical Flows to Investigate Potential Future Droughts

Methods

Three (3) constructed scenarios:

1. Repeating 5-year drought constructed by splicing together the **five driest water years** in the hydrologic period of record with respect to mainstem total annual flow. These were **2001, 2008, 1981, 1988, and 2017**.
2. **Repeating single year drought** corresponding to the **second driest water year (2008)** and identified as the critical single year drought with respect to Lake Thurmond water supply availability.
3. **Repeating synthetic drought year** constructed by splicing together the **twelve driest calendar month flows** in the hydrologic period of record.

Lake Thurmond Outflow (Regulated Release + Additional Outflow) and Storage



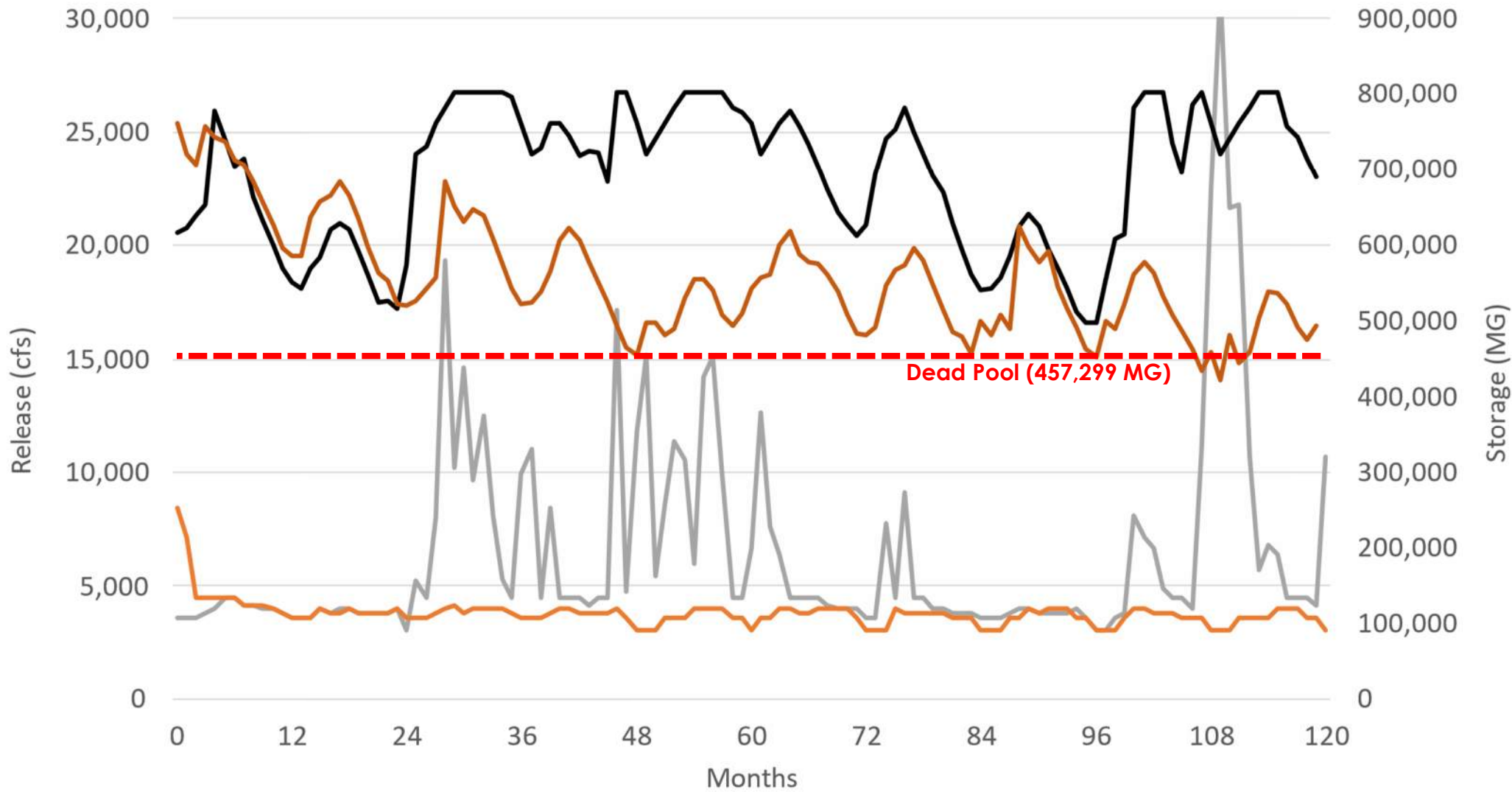
— 2070 High Demand Scenario (2001-2010) Release — High Demand Scenario (2001-2010) Lake Storage

Resequencing Historical Flows to Investigate Potential Future Droughts

This graph plots Lake Thurmond storage and releases (monthly timestep)

2070 High Demand Scenario For years 2001 – 2010

Lake Thurmond Outflow (Regulated Release + Additional Outflow) and Storage



— 2070 High Demand Scenario (2001-2010) Release — Scenario 1 Release
 — High Demand Scenario (2001-2010) Lake Storage — Scenario 1 Lake Storage

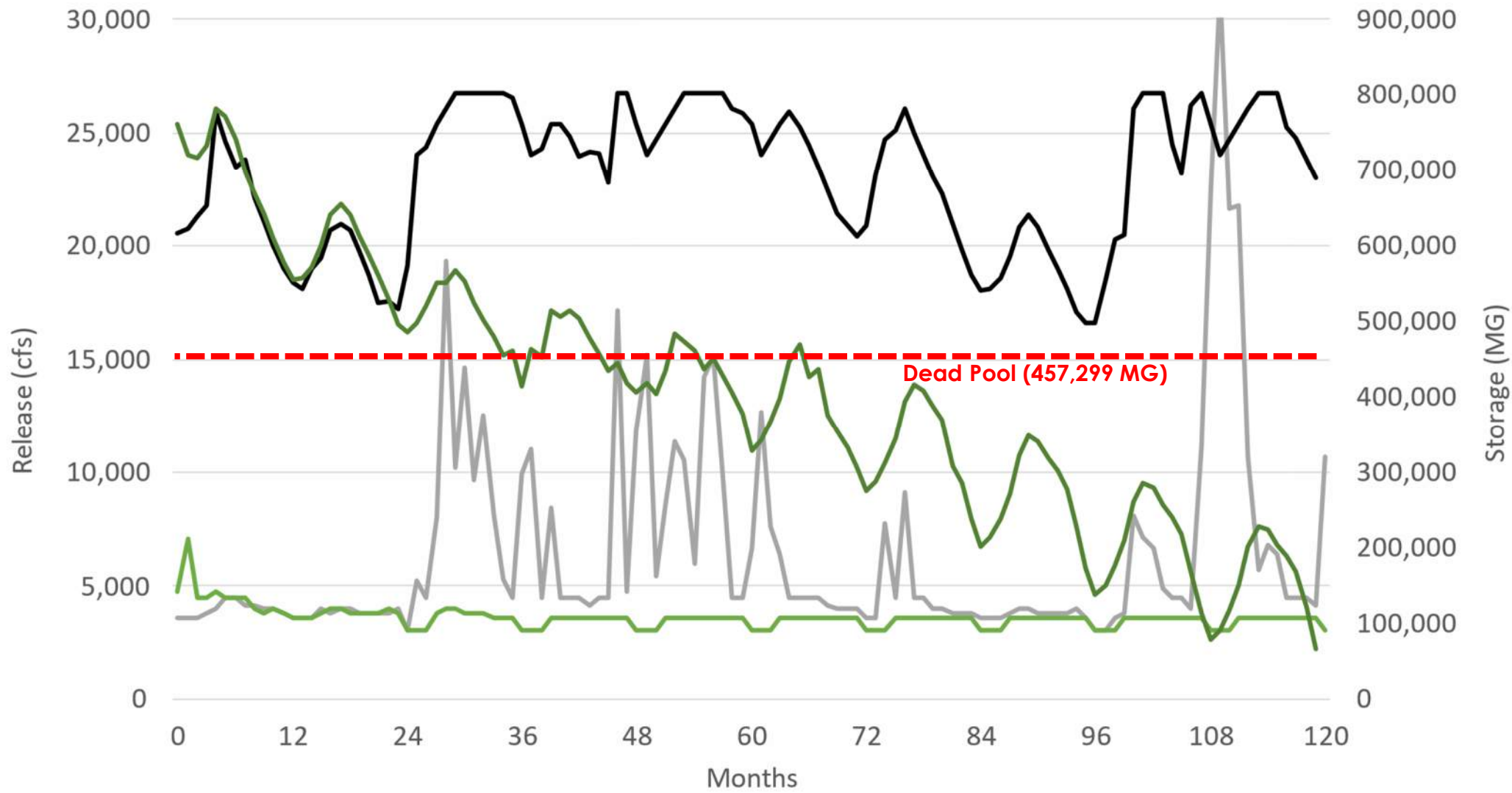
Resequencing Historical Flows to Investigate Potential Future Droughts

This graph plots Lake Thurmond storage and releases (monthly timestep)

2070 High Demand Scenario
 For years 2001 – 2010

Drought Scenario 1

Lake Thurmond Outflow (Regulated Release + Additional Outflow) and Storage



— 2070 High Demand Scenario (2001-2010) Release — Scenario 2 Release
 — High Demand Scenario (2001-2010) Lake Storage — Scenario 2 Lake Storage

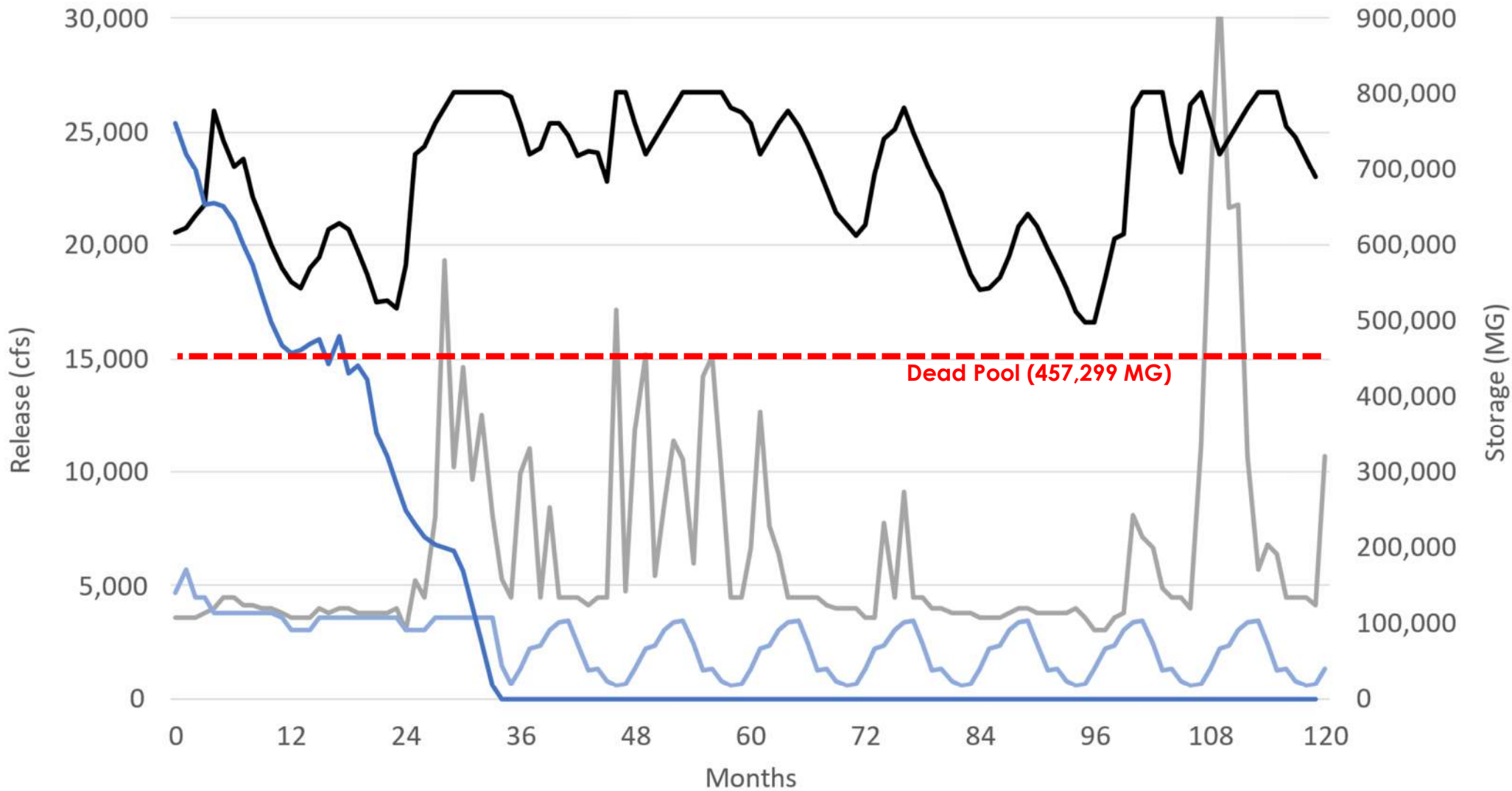
Resequencing Historical Flows to Investigate Potential Future Droughts

This graph plots Lake Thurmond storage and releases (monthly timestep)

2070 High Demand Scenario For years 2001 – 2010

Drought Scenario 2

Lake Thurmond Outflow (Regulated Release + Additional Outflow) and Storage



— 2070 High Demand Scenario (2001-2010) Release — Scenario 3 Release
 — High Demand Scenario (2001-2010) Lake Storage — Scenario 3 Lake Storage

Resequencing Historical Flows to Investigate Potential Future Droughts

This graph plots Lake Thurmond storage and releases (monthly timestep)

2070 High Demand Scenario For years 2001 – 2010

Drought Scenario 3

Update on Safe Yield of Major Reservoirs



Concepts and Purpose

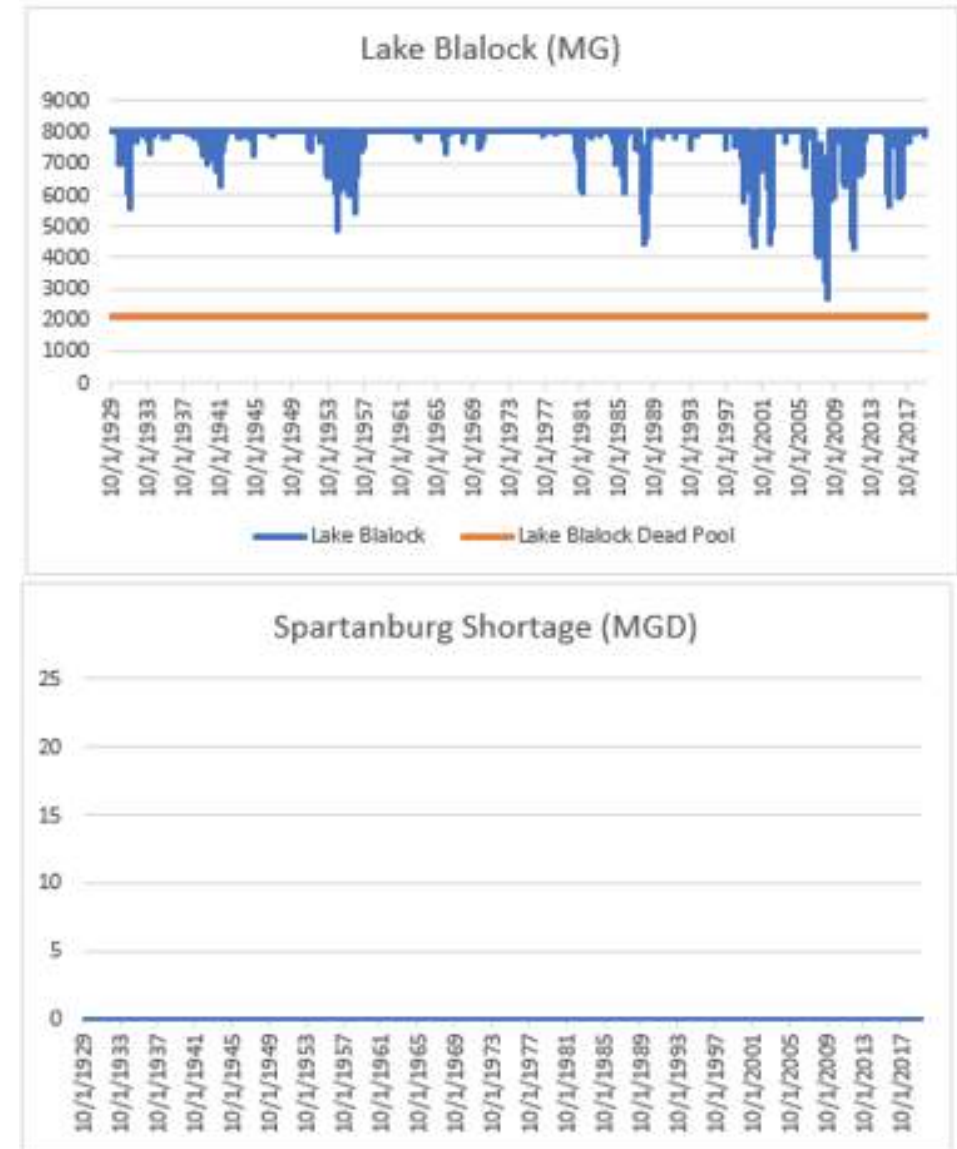
- **Safe Yield** = Maximum annual average demand that can be sustained through the period of record without depleting available storage (based on shallowest intake)
- **Reservoir Balancing:** In some cases, we can adjust rules so that reservoirs in a system draw down together at the same relative rate to avoid water in one but not others (for example)
- **Demand Assumptions:** Current / Permitted and Registered / **2070 High Demand**
- **Purpose:** Determine the amount of water that is physically/hydrologically available at a reservoir
- **Note:** Reservoir Safe Yield is DIFFERENT than basin safe yield used by SCDHEC for withdrawal permitting
 - **Reservoir Safe Yield:** Hypothetical maximum withdrawal volume used for planning
 - **Basin Safe Yield:** Statistical availability of free-flowing water in a river, used for permit evaluation

Method

- Remove permit / intake / treatment constraints at the reservoir
- Suspend target elevation rules
- Maintain downstream release rules
- Apply appropriate demand scenarios upstream
- Consolidate withdrawals from the reservoir to a single hypothetical user at the reservoir
- Gradually increase continuous annual withdrawal (with seasonality) until:
 - lowest storage over period of record = dead pool / lowest allowable level
 - No Shortages

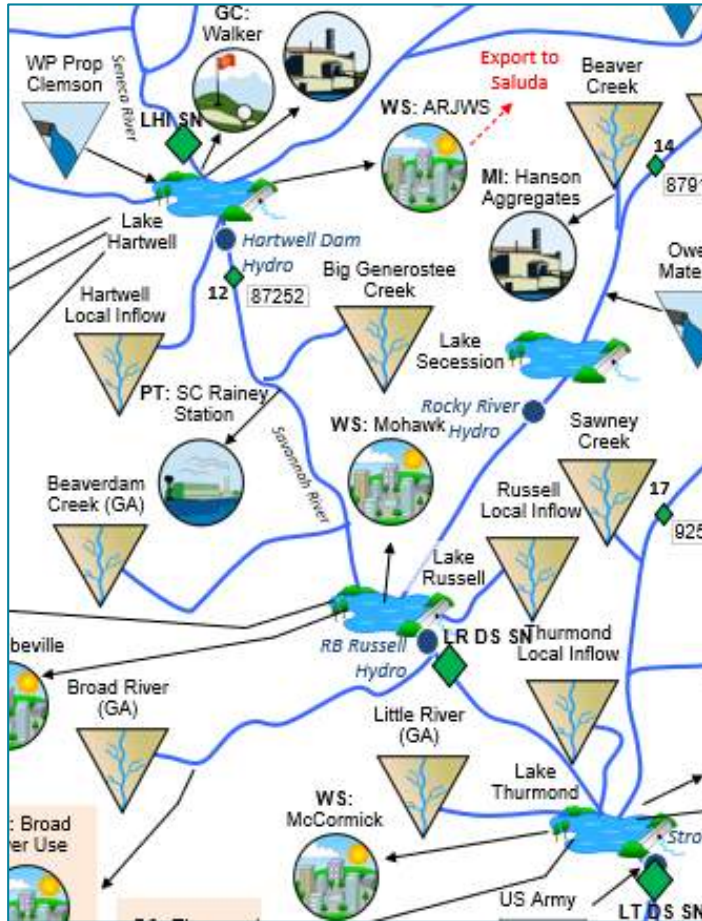
Graphs on the following slides now show lake elevations on the x-axis (not storage)

Example from Broad River Basin



Lower USACE Reservoirs

Lakes Hartwell, Russell, and Thurmond

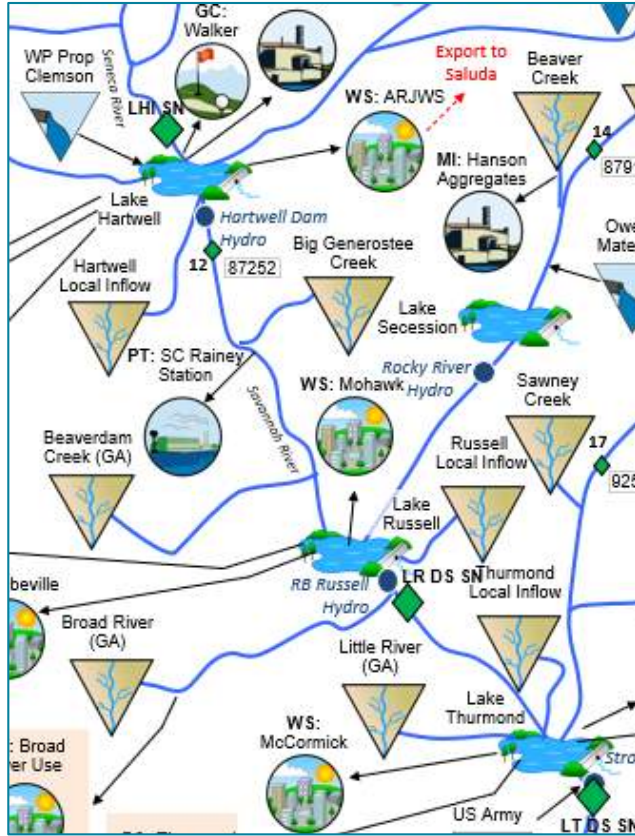


- Evaluated Individually
- Intake: highest critical intake
- Upstream rules unchanged
- Downstream rules unchanged
- Guide curves for Reservoir being tested suspended but downstream releases maintained
- Restricted the Reservoir being tested from going above the top of the flood pool

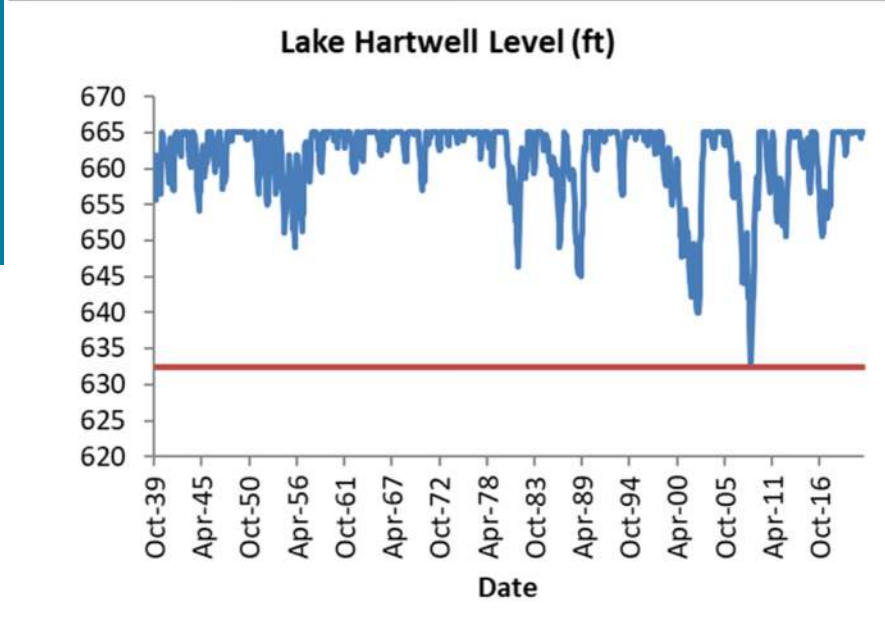
- Updated Stage-Storage relationships using recent survey data.
- Adjusted Lake Hartwell release targets to improve balance with Thurmond.
- Updated Thurmond model object to allow it to:
 - (1) Drop below the conservation pool
 - (2) Continue minimum release flows when below conservation pool

Lake Hartwell

Intake based on WS: Pioneer (632.37 ft)*



Hartwell Safe Yield:
 Baseline (Shown): 712 MGD
 2070 HD: TBD
 Permitted and Registered: 509 MGD



* Pioneer Rural Water District's intake is higher than the hydro operations limit of 625 ft used in the safe yield analysis presented previously.

Keowee-Toxaway Station Water Supply Study 2014, App H.

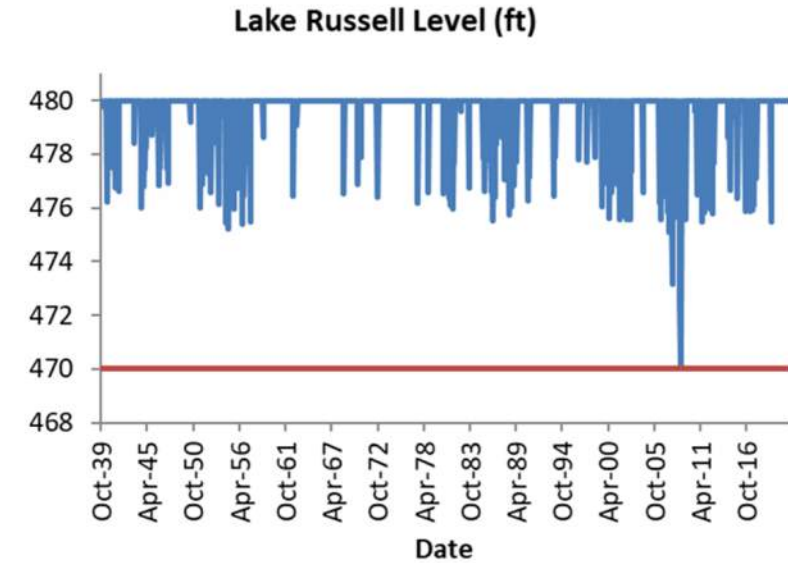
HARTWELL DAM ⁵					
Full Pond Elevation		Full Pond	660.00	Y	
Critical Boat Access Levels⁶		Public Access	652.00	Y	
Critical Swimming Access Levels		Public Access	654.00	Y	Level at which all USACE operated designated swimming areas are dry.
Anderson Regional Joint Water System	Hartwell Lake Filter Plant	Lake	Intake	615.00	Y
City of Hartwell	Hartwell WTP	Lake	Intake	612.00	Y
City of Lavonia	N/A	Lake	Intake	636.00	Y
Milliken & Company	Pendleton Finishing Plant	Lake	Intake	611.00	Y
J.P. Stevens	Westpoint Stevens Plant	Lake	Intake	610.00	Y
Clemson University	Central Energy Facility	Lake	Intake	638.00	Y
Clemson University Agriculture ⁷	Musser Fruit Farm	Lake	Intake	645.00	Y
Clemson Golf Course ⁸	Walker Golf Course	Lake	Intake	633.00	Y
		US Army	Intake	625.00	Y
Hydro Operations		Hydro	625.00	Y	

Lake Russell

Intake based on Hydro Ops (470 ft)



Russell Safe Yield:
 Baseline (Shown): 1,115 MGD
 2070 HD: TBD
 Permitted and Registered: 619 MGD

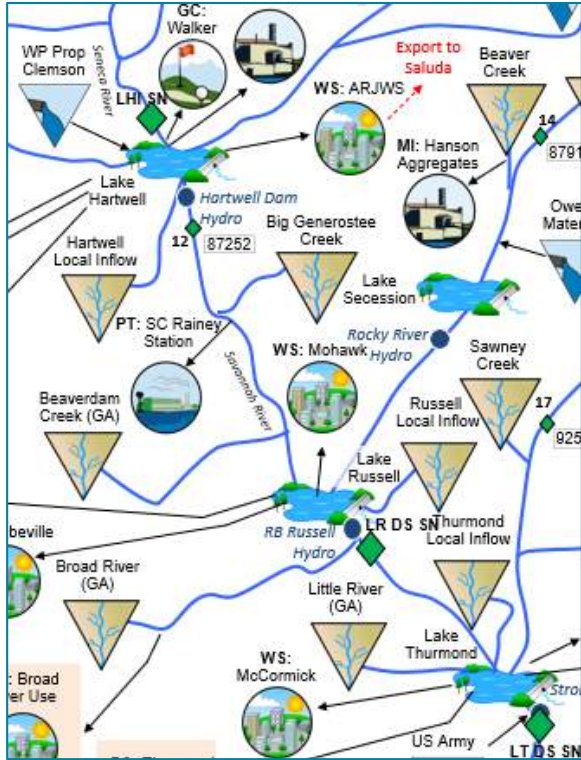


Keowee-Toxaway Water Supply Study 2014, App H.

RUSSELL DAM ⁵					
Full Pond Elevation		Full Pond	475.00	Y	
Critical Boat Access Levels ⁴		Public Access	466.00	Y	
Critical Swimming Access Levels		Public Access	N/A	Y	There are no USACE operated designated swimming areas on this reservoir.
City of Abbeville	Abbeville City WTP	Lake Intake	457.50	Y	
City of Elberton	Elberton WTP	Lake Intake	465.00	Y	
Town of Calhoun Falls ⁴	Calhoun Falls WTP	Lake Intake	457.00	Y	
Mohawk Industries, Inc.	Rocky River Plant	Lake Intake	464.75	Y	Highest intake elevation of 3
Santee Cooper	John Rainey Generating Station	Lake Intake	460.50	Y	
RBR State Park ³	RBR Golf Course	Lake Intake	468.80	Y	
Hydro Operations		Hydro	470.00	Y	

Lake Thurmond

Intake based on Hydro Ops (312 ft)

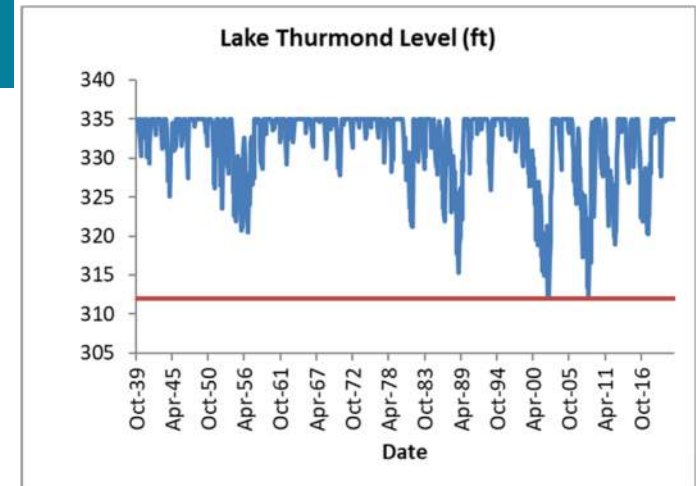
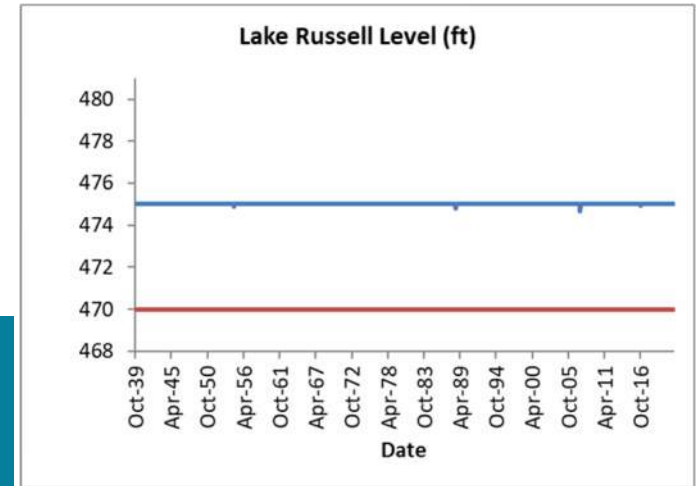
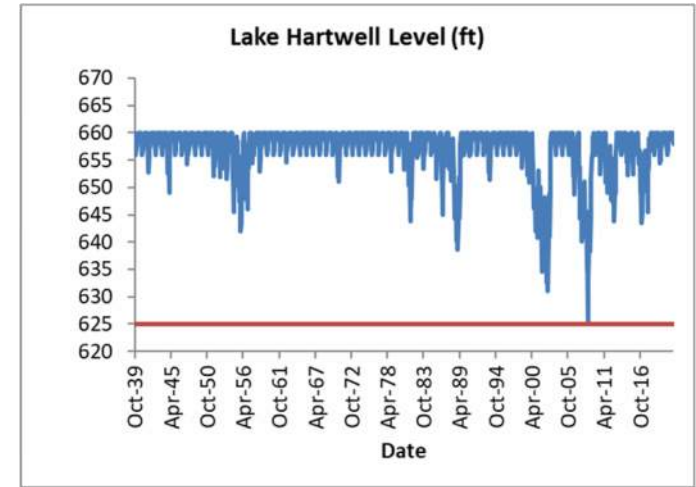


Average Regulated Releases (Baseline Safe Yield)

Lake Hartwell: 583 MGD
 Lake Thurmond: 2,861 MGD

Lake Thurmond's minimum release requirements result in a lower safe yield than Lake Hartwell.

Thurmond Safe Yield:
 Baseline (Shown): 465 MGD
 2070 HD: TBD
 Permitted and Registered: 301 MGD



Keowee-Toxaway Water Supply Study 2014, App H.

Lake System	Entity/Source Description	Facility	Lake/River Description	Elevation (FT MSL)	Study Verified	Comments
THURMOND DAM⁵						
	Full Pond Elevation		Full Pond	330.00	Y	
	Critical Boat Access Levels ⁶		Public Access	320.00	Y	
	Critical Swimming Access Levels		Public Access	324.00	Y	Level at which all USACE operated designated swimming areas are dry.
	McCormick Commission of Public Works	McCormick WTP	Lake Intake	304.00	Y	
	Columbia County Water Utility	Clarks Hill WTP	Lake Intake	312.00	Y	2nd highest of 3 intakes ²
	City of Lincolnton	James Allen Reed WTP	Lake Intake	311.00	Y	Physical limit of pumping operation for intake structure ⁷
	McDuffie County-City of Thomson	Big Creek	Lake Intake	312.00	Y	2nd highest of 3 intakes ²
	City of Washinton ⁴	Washington WTP	Lake Intake	307.00	Y	
	Savannah Lakes POA ³	Monticello Golf Course	Lake Intake	324.00	Y	
	Savannah Lakes POA ³	Tara Golf Course	Lake Intake	324.00	Y	
	Hickory Knob State Park ³	Hickory Knob Golf Course	Lake Intake	324.00	Y	
	Hydro Operations		Hydro	312.00	Y	

Alternative 2 Comparison

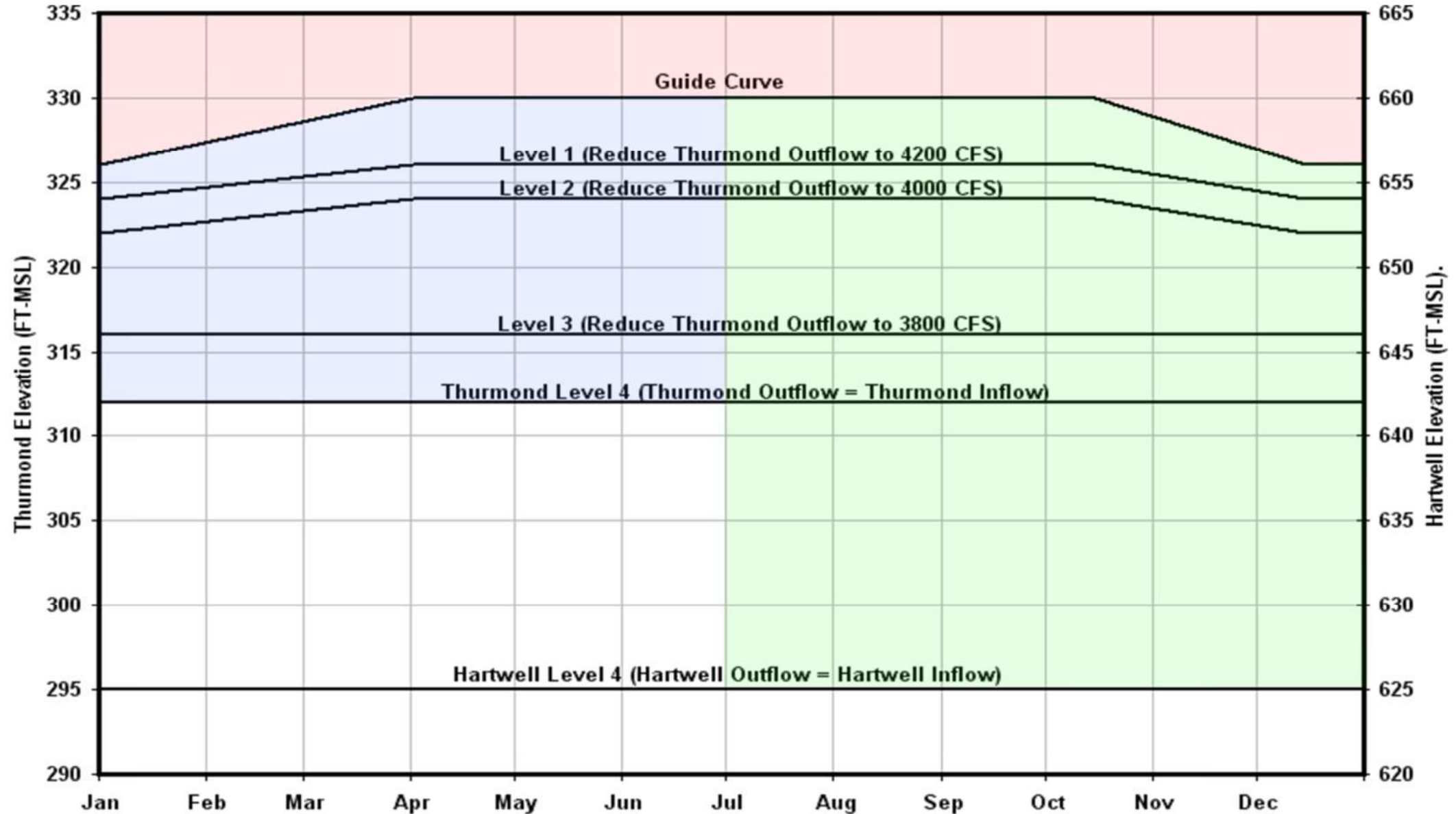


USACE 2012/14 Drought Contingency Plan

Trigger Level	Time of Year	Drought Response
1	Jan 1 - Dec 31	IF BR index >10%, Target 4200 cfs (daily average) release at Thurmond Dam IF BR index <10%, Target 4000 cfs (daily average) release at Thurmond Dam
2	Feb 1 - Oct 31	IF BR index >10%, Target 4000 cfs (daily average) release at Thurmond Dam IF BR index <10%, Target 3800 cfs (daily average) release at Thurmond Dam
	Nov 1 - Jan 31	Target 3600 cfs (daily average) release at Thurmond Dam
3	Feb 1 - Oct 31	Target 3800 cfs (daily average) release at Thurmond Dam
	Nov 1 - Jan 31 (Feb 1 – Feb 28 w/NMFS approval)	Target 3100 cfs (daily average) release at Thurmond Dam
4	Feb 1 - Oct 31	Target 3600 cfs (daily average) release at Thurmond Dam
	Nov 1 - Jan 31 (Feb 1 – Feb 28 w/NMFS approval)	Target 3100 cfs (daily average) release at Thurmond Dam

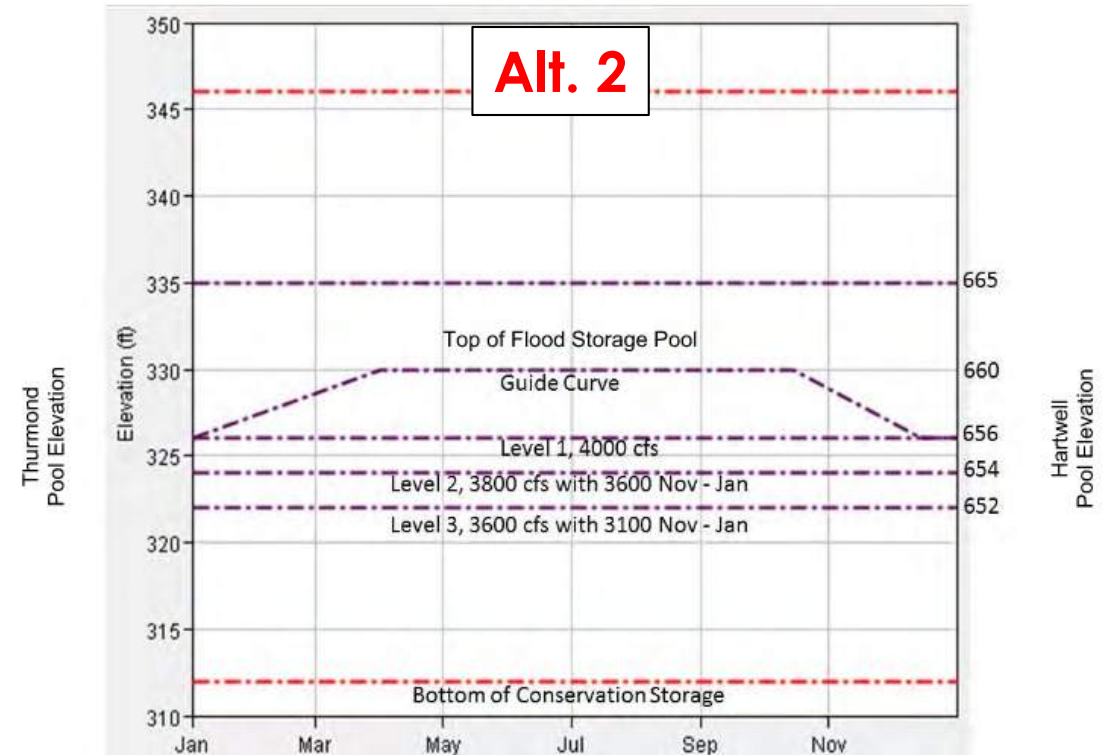
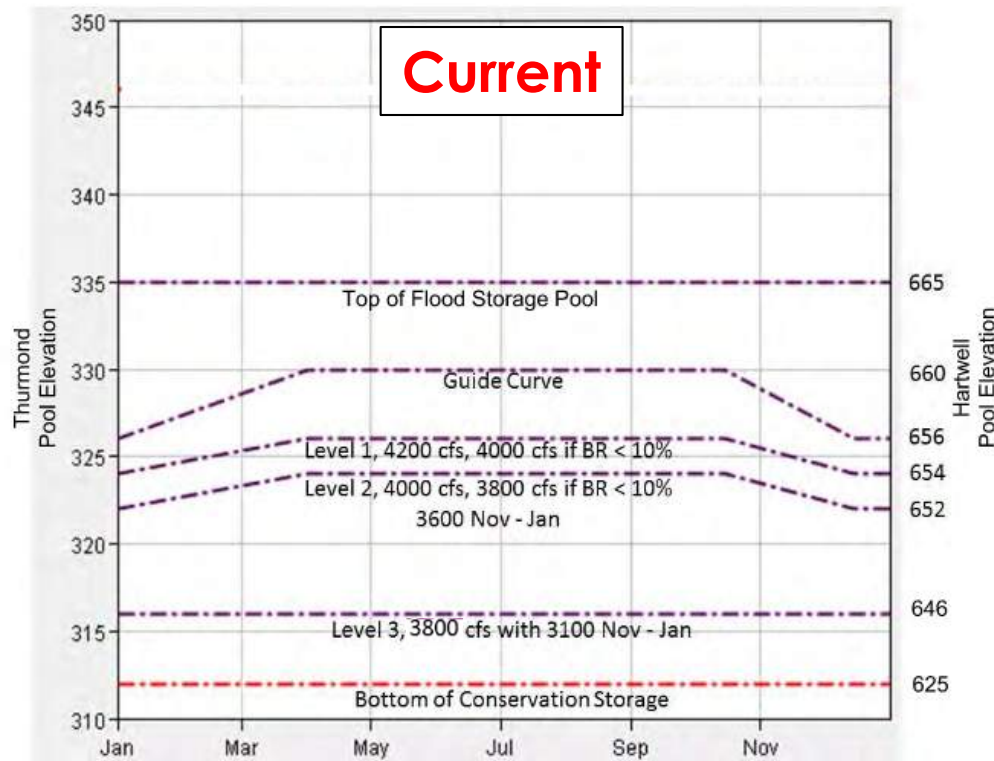
Dates in **red font** represent changes in the 2012 DCP

USACE Reservoirs Drought Trigger Action Levels



Alternative 2 versus Current Operating Rules

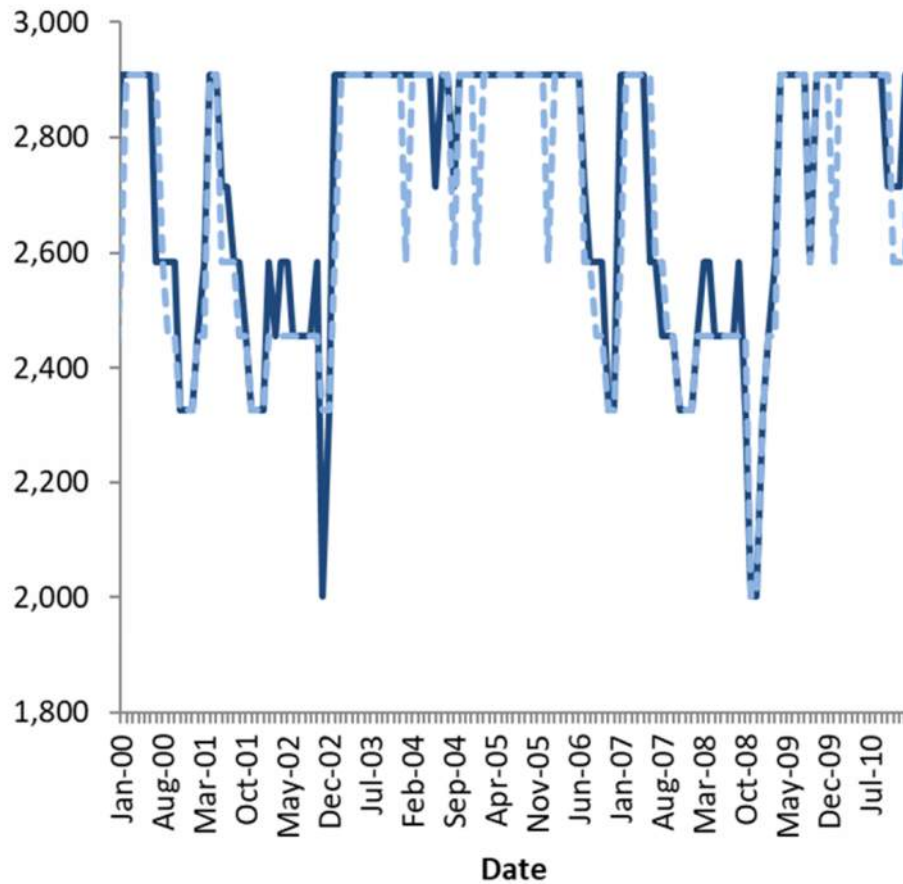
- Decrease in required flows from Thurmond for each trigger level
- No seasonal variation in trigger levels
- No dependency on Broad River inflows
- Raises trigger level 3 by 6 feet



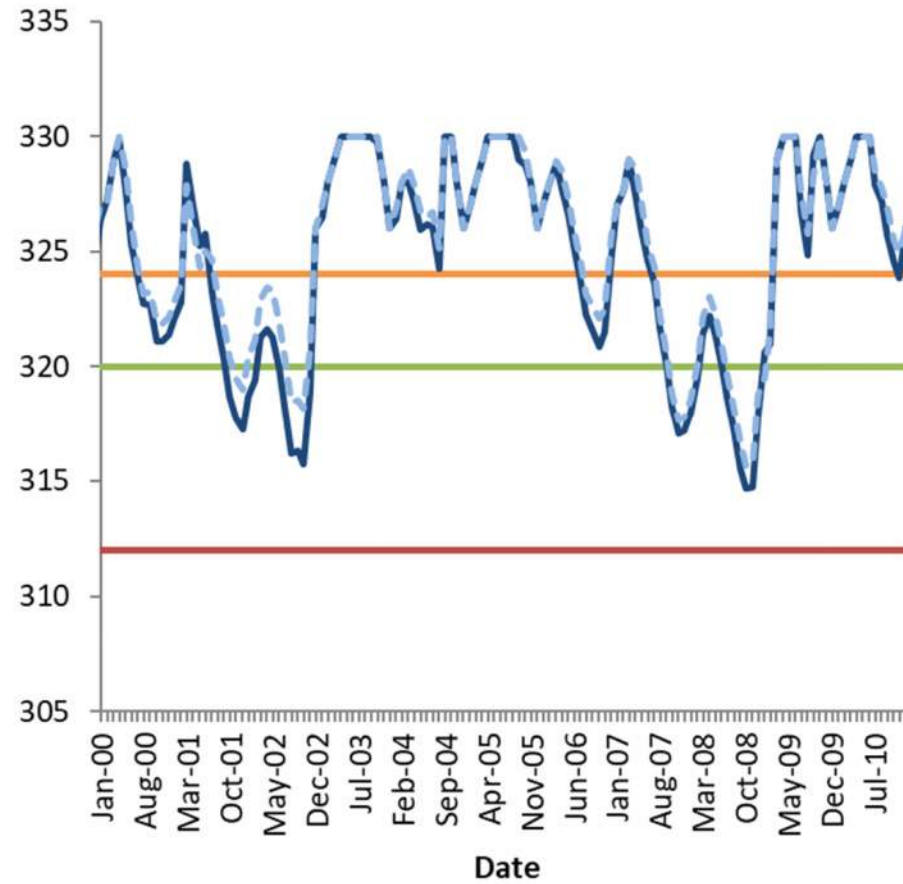
Lake Thurmond Response to Change in Release Rules

2070 HD Scenario, 2000-2010

Lake Thurmond Regulated Release (MGD)



Lake Thurmond Level (ft)



Current Rules

Alternative 2 Rules

Swimming Access =
Level at which all USACE operated swimming areas are dry.

Boating Access =
Level at which 70% of boat access points remain usable.

Bottom of Conservation Pool = 312 feet