R.L. Harris Dam Relicensing - FERC No. 2628
Reservoir Operations on the APC Hydro System

Presented by:

Alan Peeples
Manager – Reservoir Management

January 31, 2018
Wedowee Marina South

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First Things First

Power

Power - Capacity

- Installed capacity is the maximum instantaneous power that a generating unit can produce, and is expressed in megawatts (mw)
  - the power the unit is generating at any one moment in time
  - Harris installed capacity is 66mw per unit

- Instantaneous Load (mw)
  - Electricity is a demand product
  - Instantaneous Load is the instantaneous demand for electricity on the system.
  - Harris' installed capacity supports the instantaneous demand (load) on the Southern Electric bulk power system

Power - Energy Generation

- the electricity generated over a period of time (one hour), expressed as megawatt hours.
  - 1 mwh = 1,000 kwh
  - Your power bill is based on electricity usage, measured in kwh

Hydroelectric Dams are both producers and consumers of energy

Production

- Generating electricity for consumer end use

Consumption

- Station service – measured in mwh
  - The local energy needed at the dam to run pumps, lights, compressors, etc. for operations
- “Motoring” – a big heat sink
  - Systemwide benefits for electric grid stabilization

Hydraulics

Hydraulic Capacity

There are 2 primary ways to pass water from the dam:

1. Hydroelectric Generating Unit Operation
   - Electricity is generated
2. Spill Gate Operation
   - No electricity is generated, only passing water

Under normal conditions, spill gates are not operated until all of the available generating units are at full gate flow

Hydraulics

Hydraulic Capacity - Hydroelectric Generating Unit Operation

- Hydraulic capacity is the flow, cubic feet per second (cfs), that a hydroelectric generating unit is designed to pass
  - Best Gate flow – the amount of flow from the unit at the most efficient wicket gate position
    - This is where the unit is operated under normal conditions
      - ~6500 cfs
      - Optimum balance between power and flow
      - Best MPG
  - Full Gate flow – the amount of flow from the unit with wicket gates in the 100% (wide open) position
    - ~8000 cfs
    - Moves the most water but not most efficient generating point, less energy production
      - i.e., non-optimal MPG
    - Operated when there is a greater need to move larger quantities of water
      - High flow situations

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Hydraulics

Hydraulic Capacity – Spill Gate Operation

- The spillway section where the spill (tainter) gates are located is 310 feet long and contains six tainter gates, each 40.5 feet wide and 40.0 feet high.
- The spillway crest is at elevation 753.0 msl
- The top of the tainter gates is elevation 793.5 msl, one-half foot above full summer pool
- At elevation 795.0 msl, the upper limits of the Induced Surcharge Curve, the spillway has a capacity of almost 270,000 cfs.

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Flow versus Volume

- **Flow** is a volume of water per unit of time
  - For example
    - Cubic feet per second, cfs
    - 1 cfs = 448.8 gallons per minute (gpm)

- **Volume** is the result of flow over time
  - For Hydro, it is calculated as day-second-feet or dsf
    - 1 cubic foot per second for one day
    - 1 dsf = 1 cfs x 86400 seconds/day = 86400 cubic feet
    - 1 dsf = 646,272 gallons
    - 1dsf = 1.983 acre-feet (1.983 feet deep over an acre)
    - also referred to as cfs-day

Example
- Harris Unit 1 operates for 12 hours of the 24 hour day
- Volume is 6500 cfs x 12 hours / 24 hours = 3250dsf
- Could also consider this 3250cfs average for day

Water:

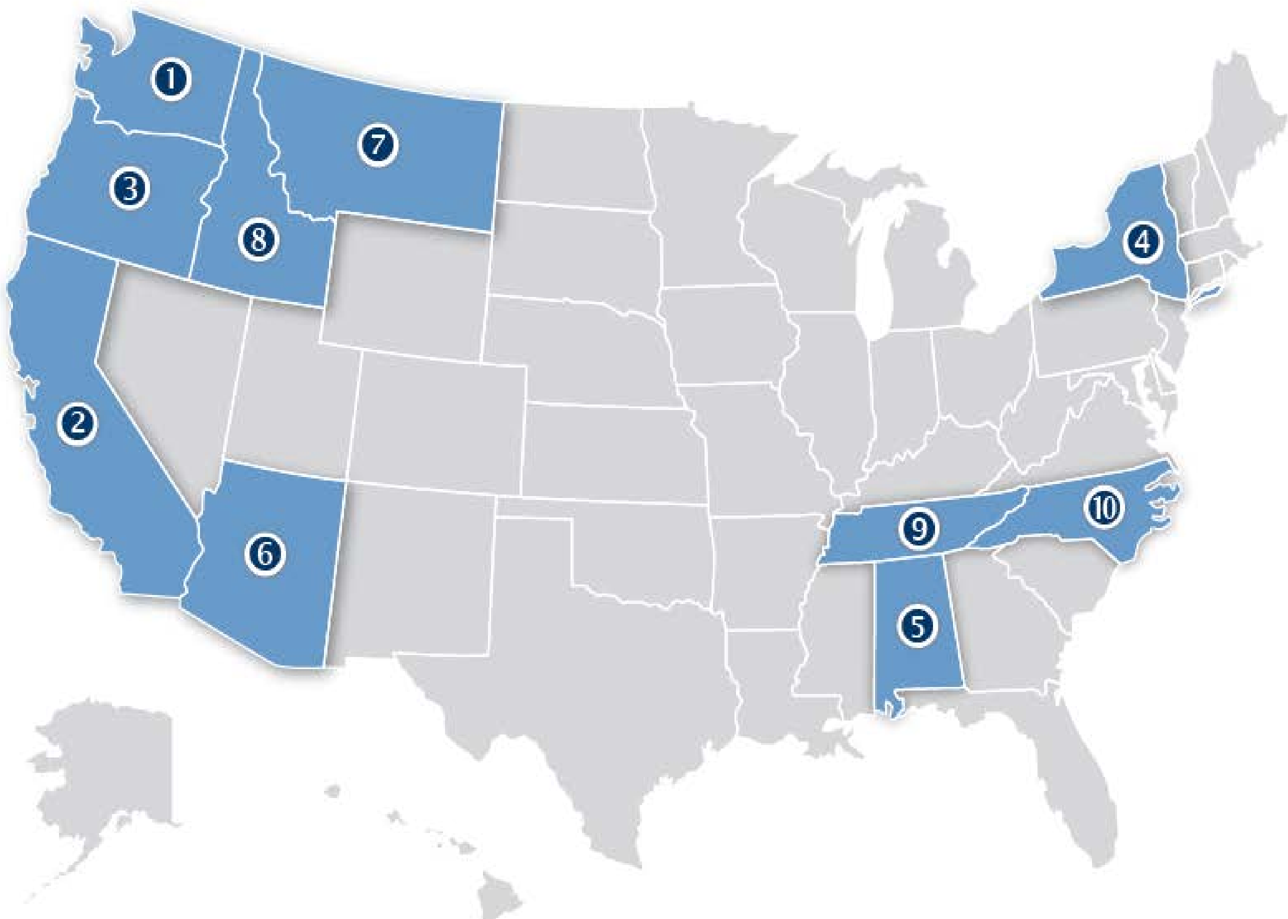
the Leading Renewable Energy Source

According to the U.S. Energy Information Administration (EIA):

- **Generation from Renewable Fuels**
  - "**Hydroelectric**. Water is currently the leading renewable energy source used by electric utilities to generate electric power".
  - Hydropower accounted for **6.5%** of total U.S. electricity generation and **44%** of generation from renewables in 2016.

Source: U.S. Department of Energy – Energy Information Administration

Hydropower Installed Capacity

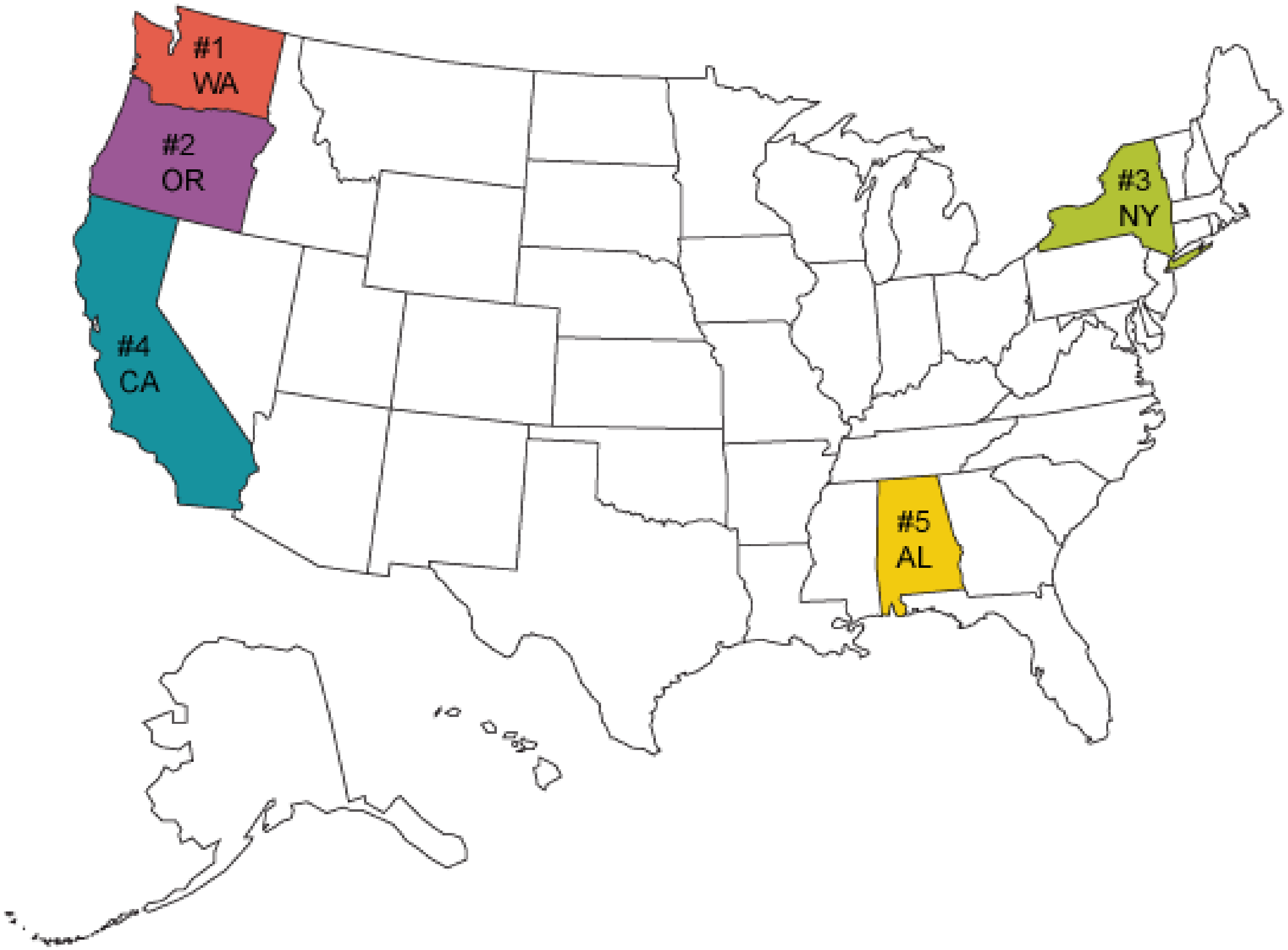


2012 Capacity (MW)	
1 Washington	21,112
2 California	10,057
3 Oregon	8,241
4 New York	4,657
5 Alabama	3,280
6 Arizona	2,718
7 Montana	2,655
8 Idaho	2,540
9 Tennessee	2,499
10 North Carolina	1,939

Source: EIA

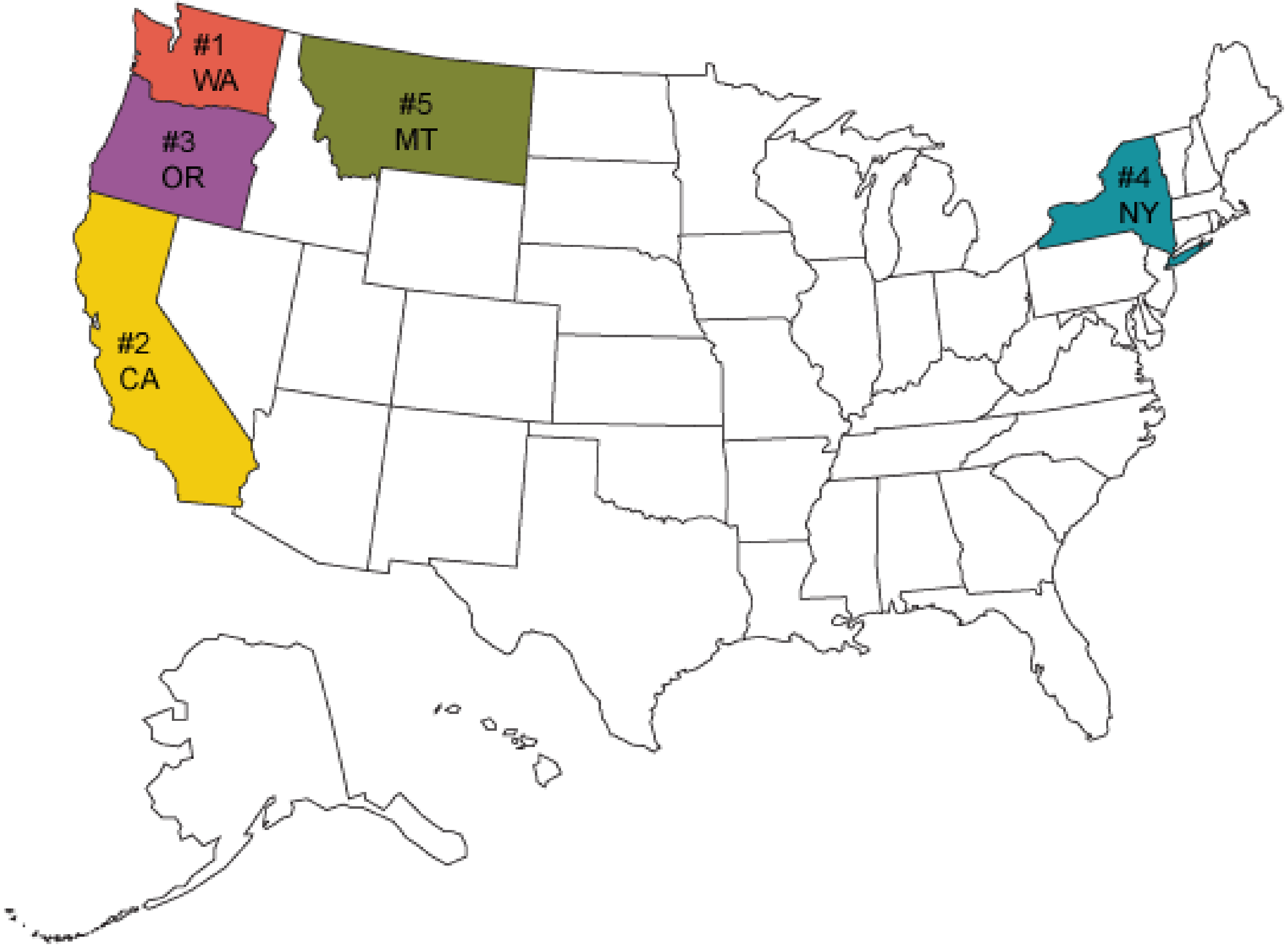
HARRIS DAM RELICENSING

Top Hydropower Producing States, 2009



Source: U.S. Energy Information Administration, *Renewable Energy Consumption and Electricity Preliminary 2009 Statistics* (August 2010).

Top Hydropower Producing States, 2010



Source: U.S. Energy Information Administration, *Electric Power Monthly,* Table 13.B (March 2011).

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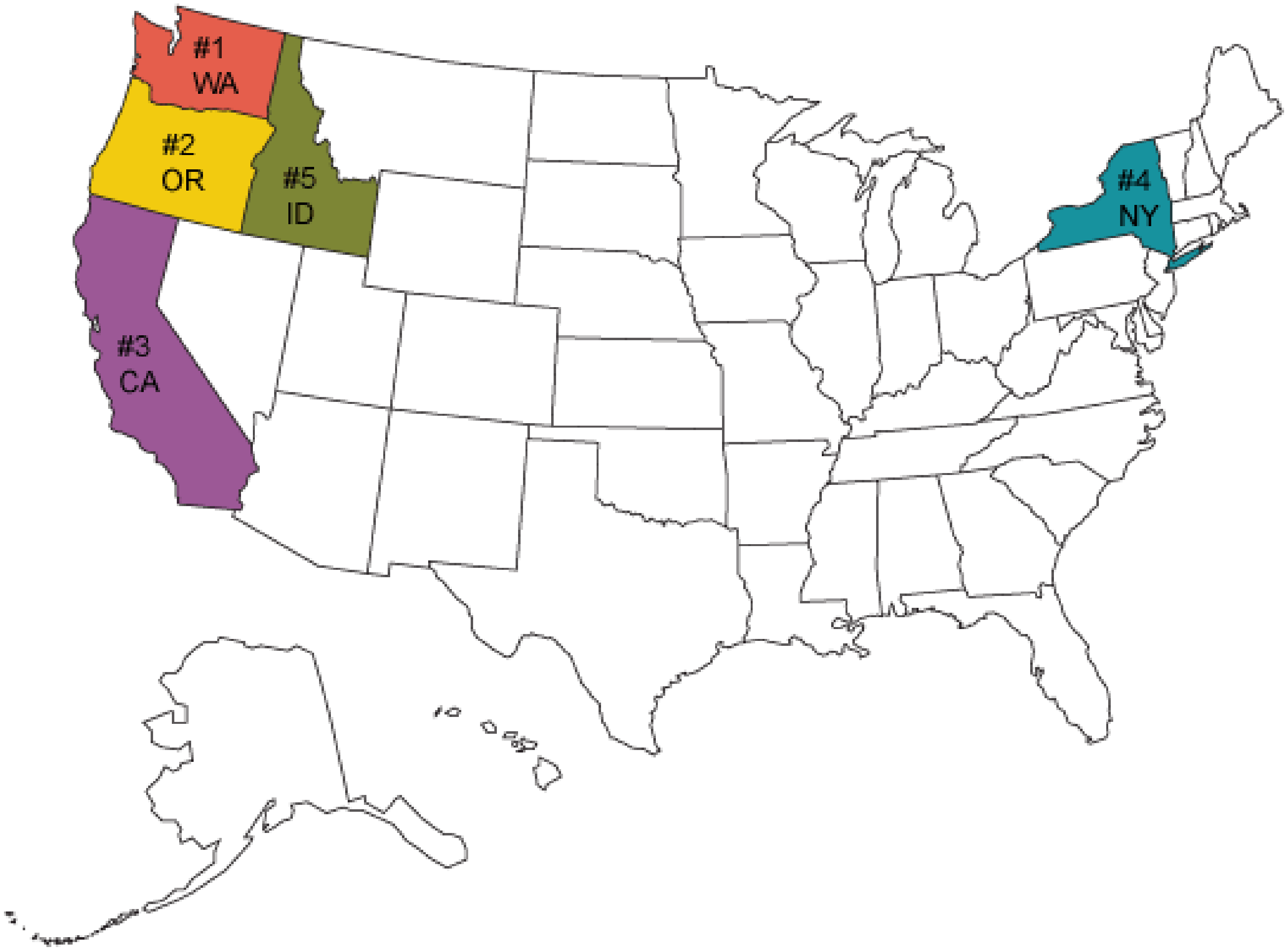
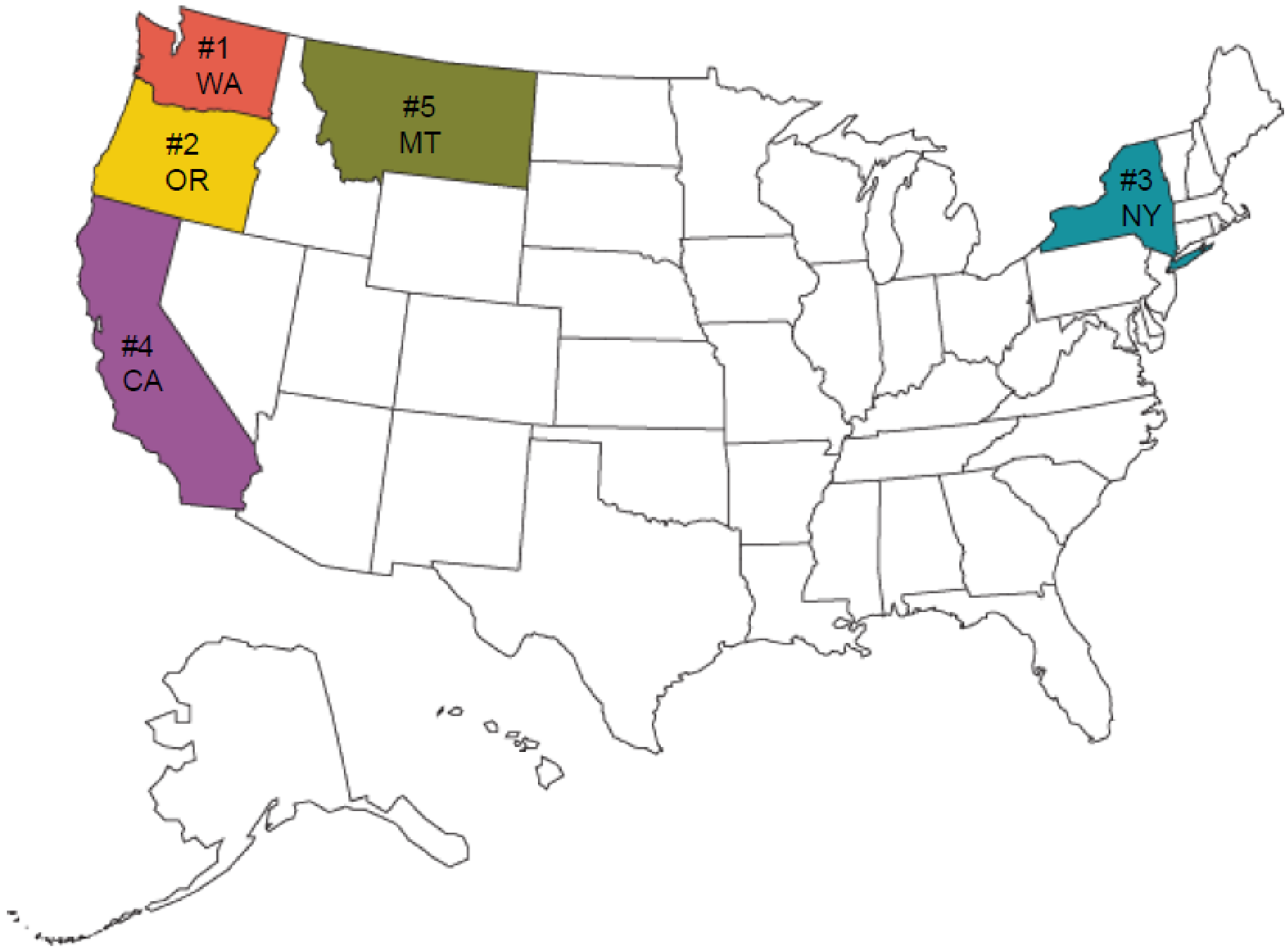
Top Hydropower Producing States, 2011



Source: U.S. Energy Information Administration, *Electric Power Monthly*, Table 1.13.B (February 2012).

Top Hydropower Producing States, 2012



Source: U.S. Energy Information Administration, *Electric Power Monthly*, Table 1.13.B (February 2014).

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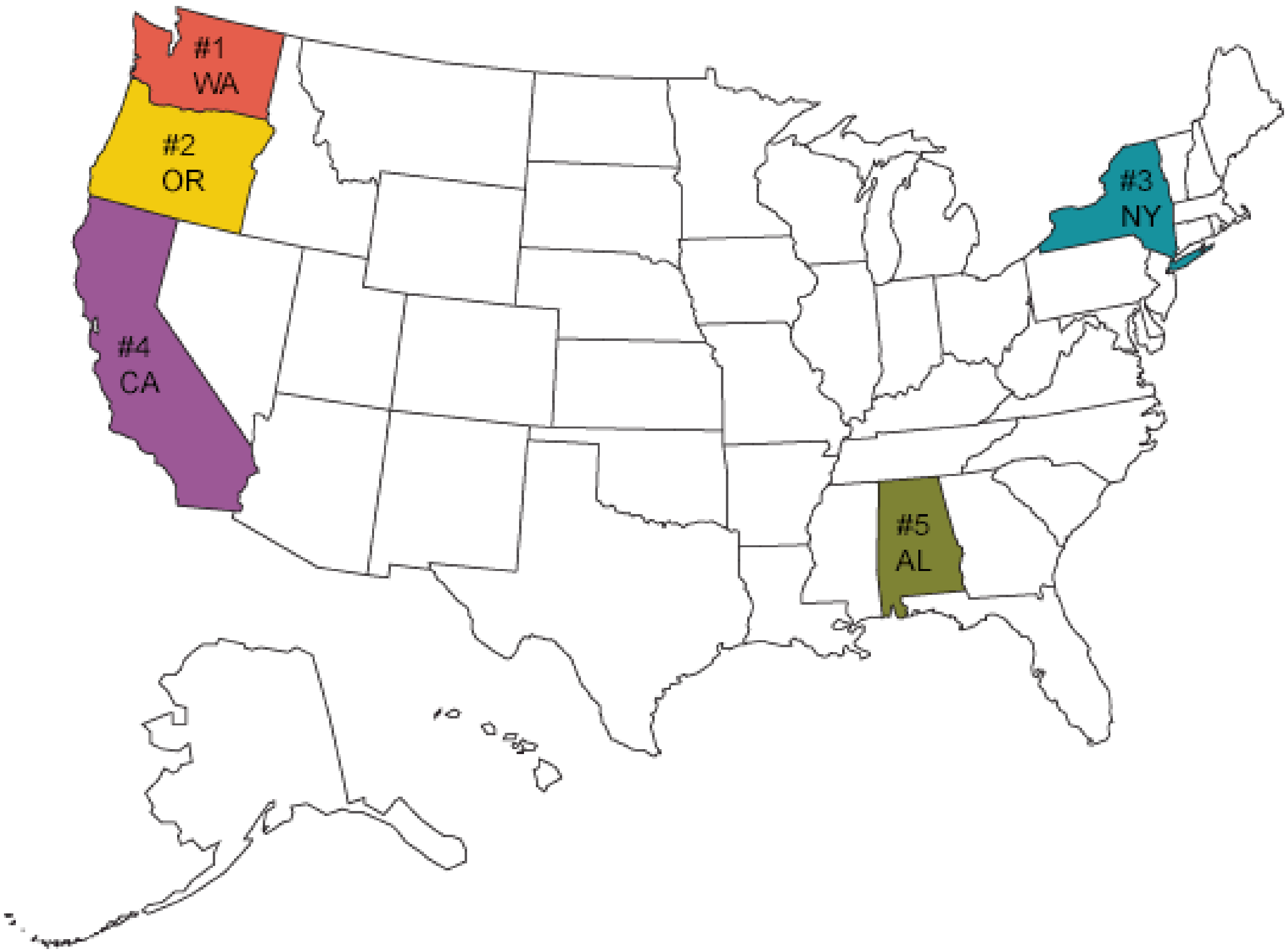
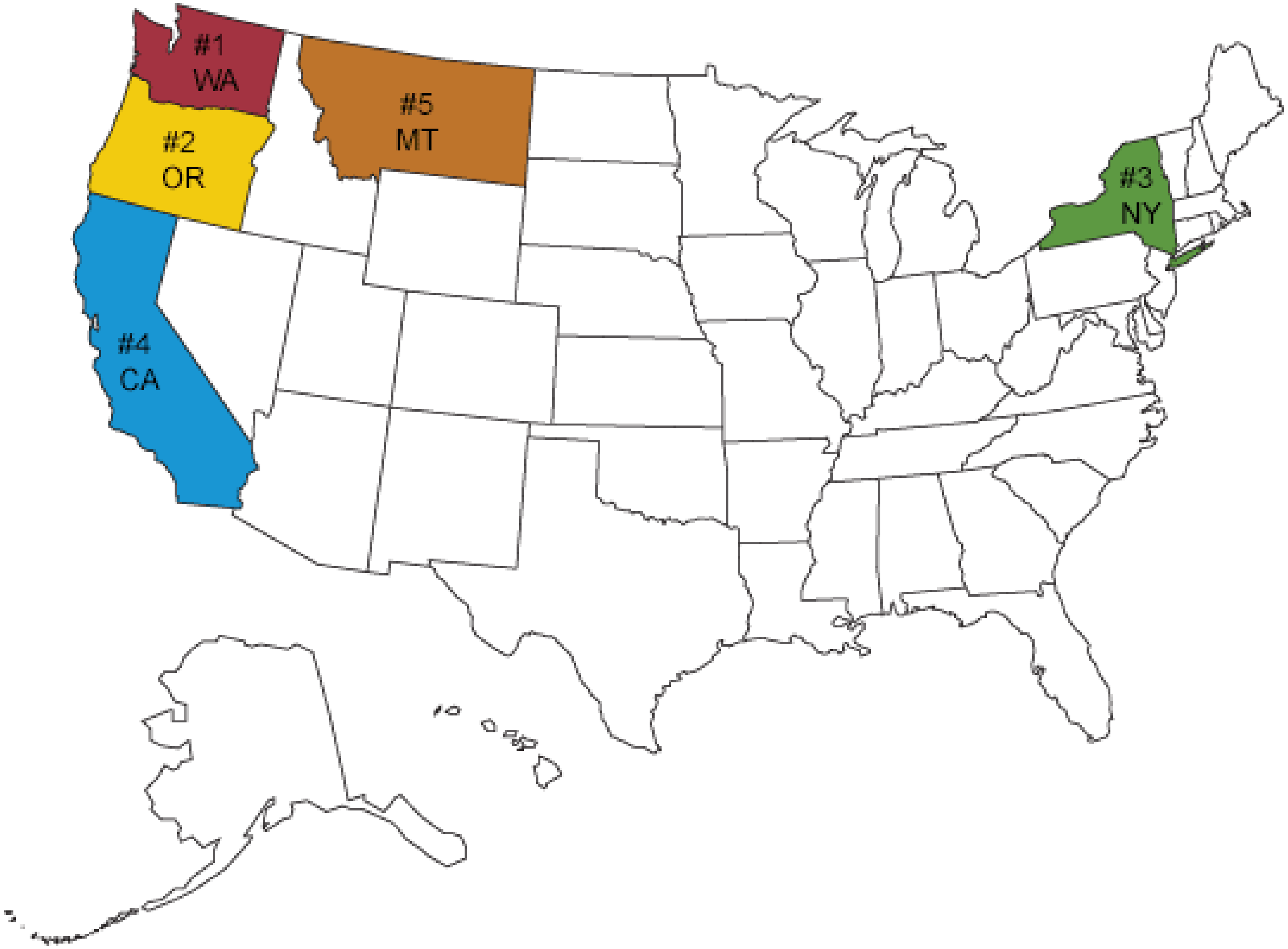
Top hydropower producing states, 2013



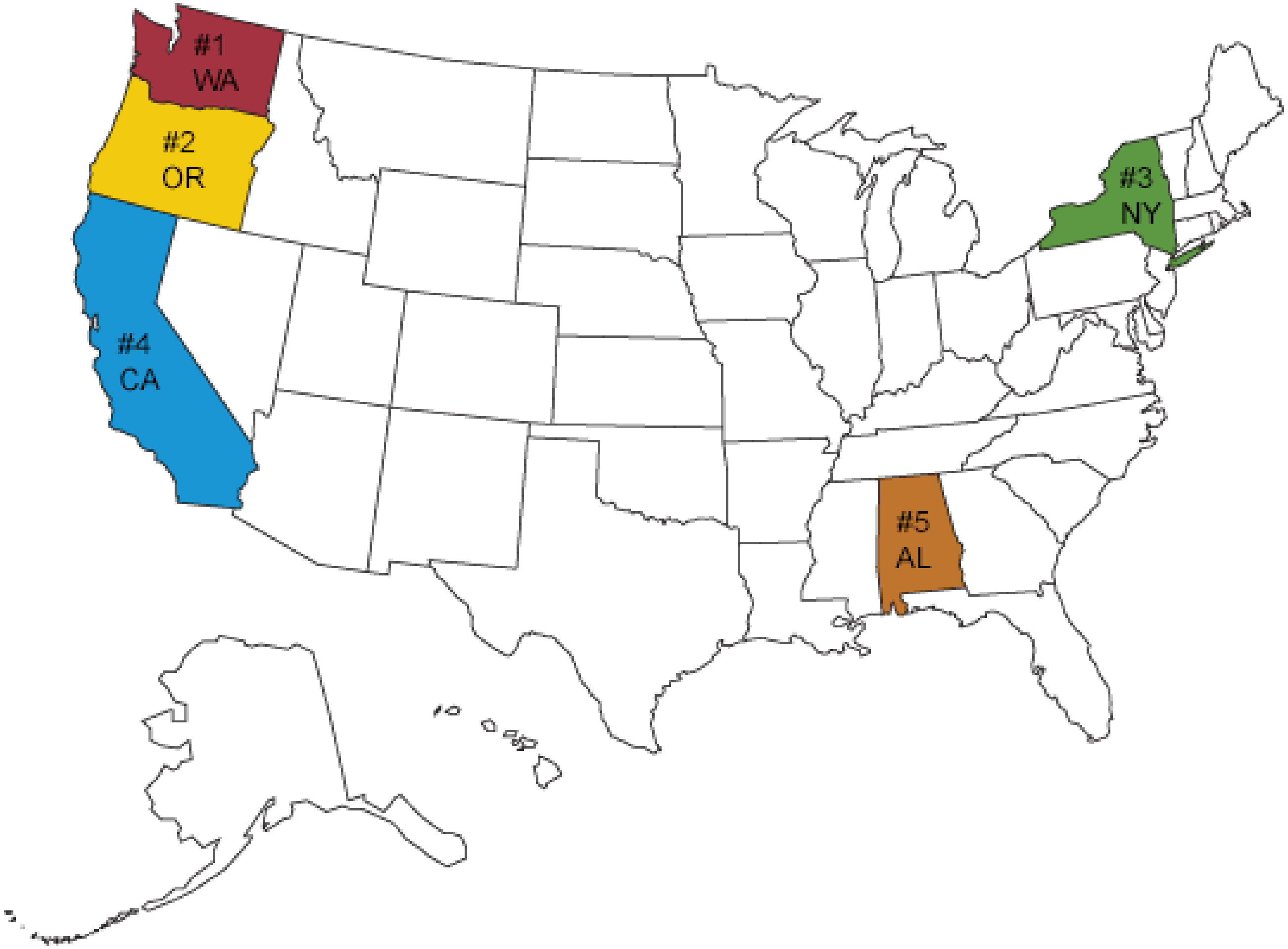
Source: U.S. Energy Information Administration, *Electric Power Monthly*, Table 1.13.B (February 2014).

Top hydropower producing states, 2014



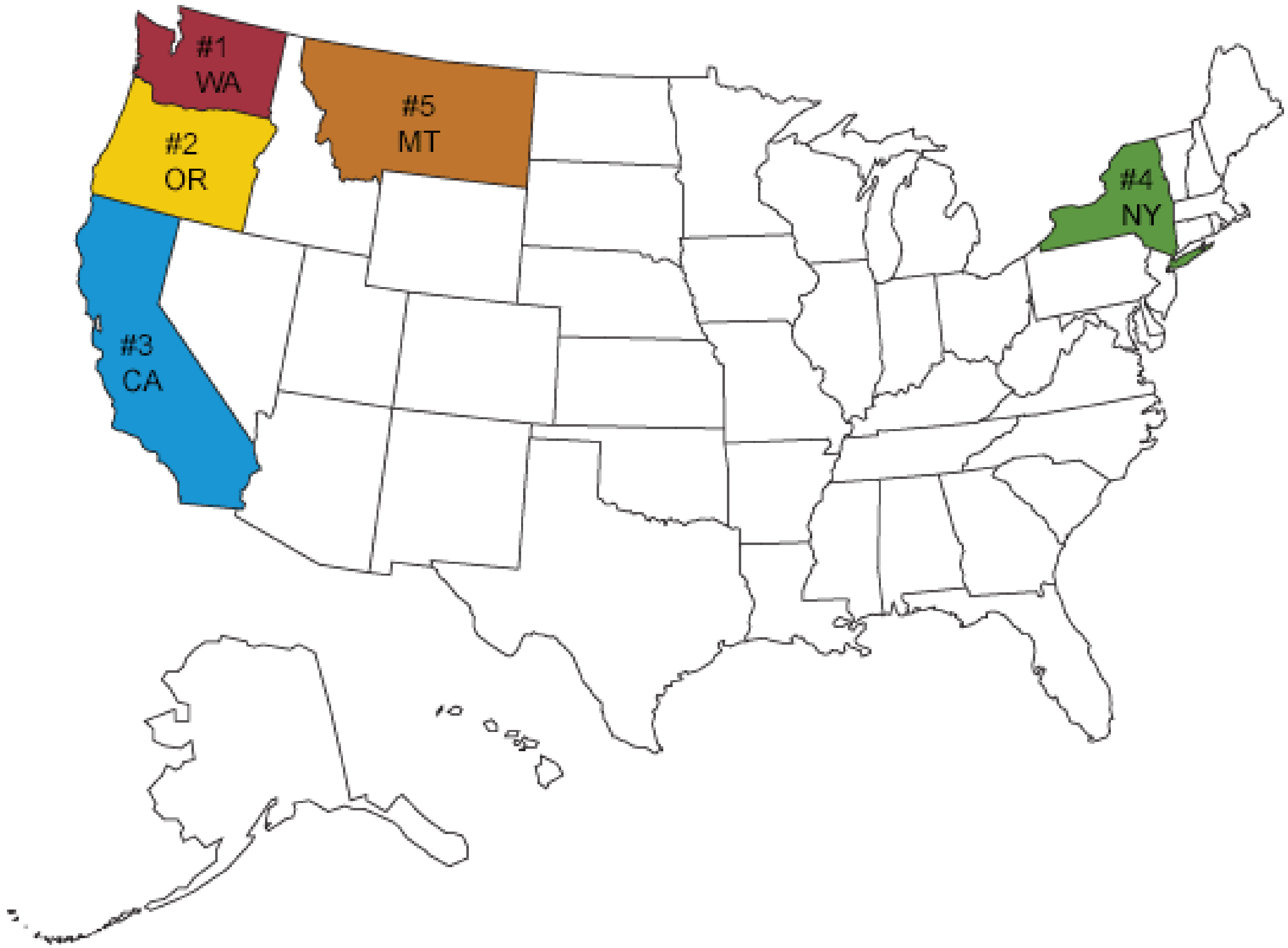
Source: U.S. Energy Information Administration, *Electric Power Monthly*, Table 1.13.B (February 2015)

Top hydropower producing states, 2015



Source: U.S. Energy Information Administration, *Electric Power Monthly*, Table 1.13.B, preliminary data, February 2016

Top hydropower producing states, 2016

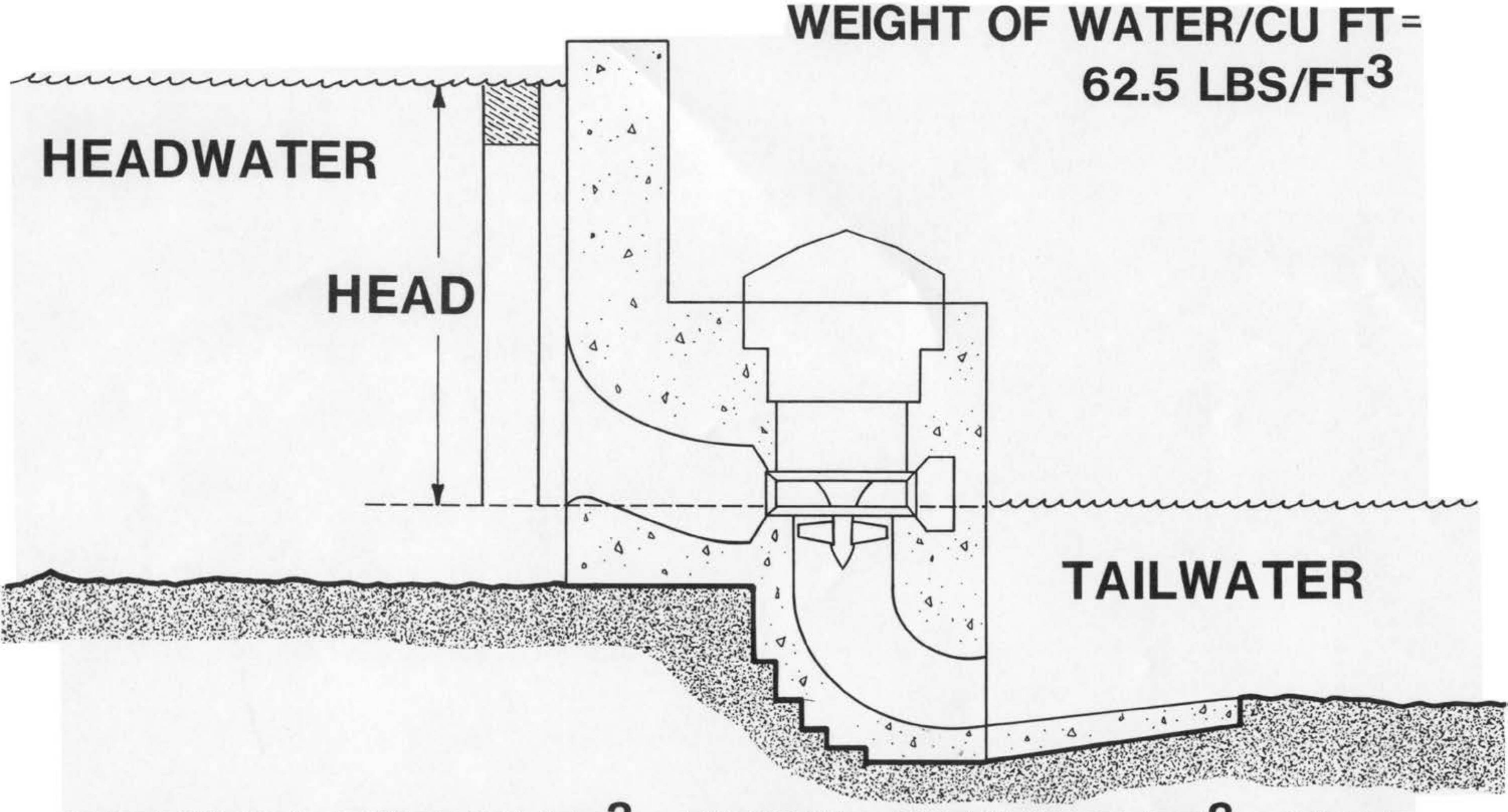


Source: U.S. Energy Information Administration, *Electric Power Monthly,* Table 1.10.B, February 2017, preliminary data

Alabama Power 2016 Energy Mix

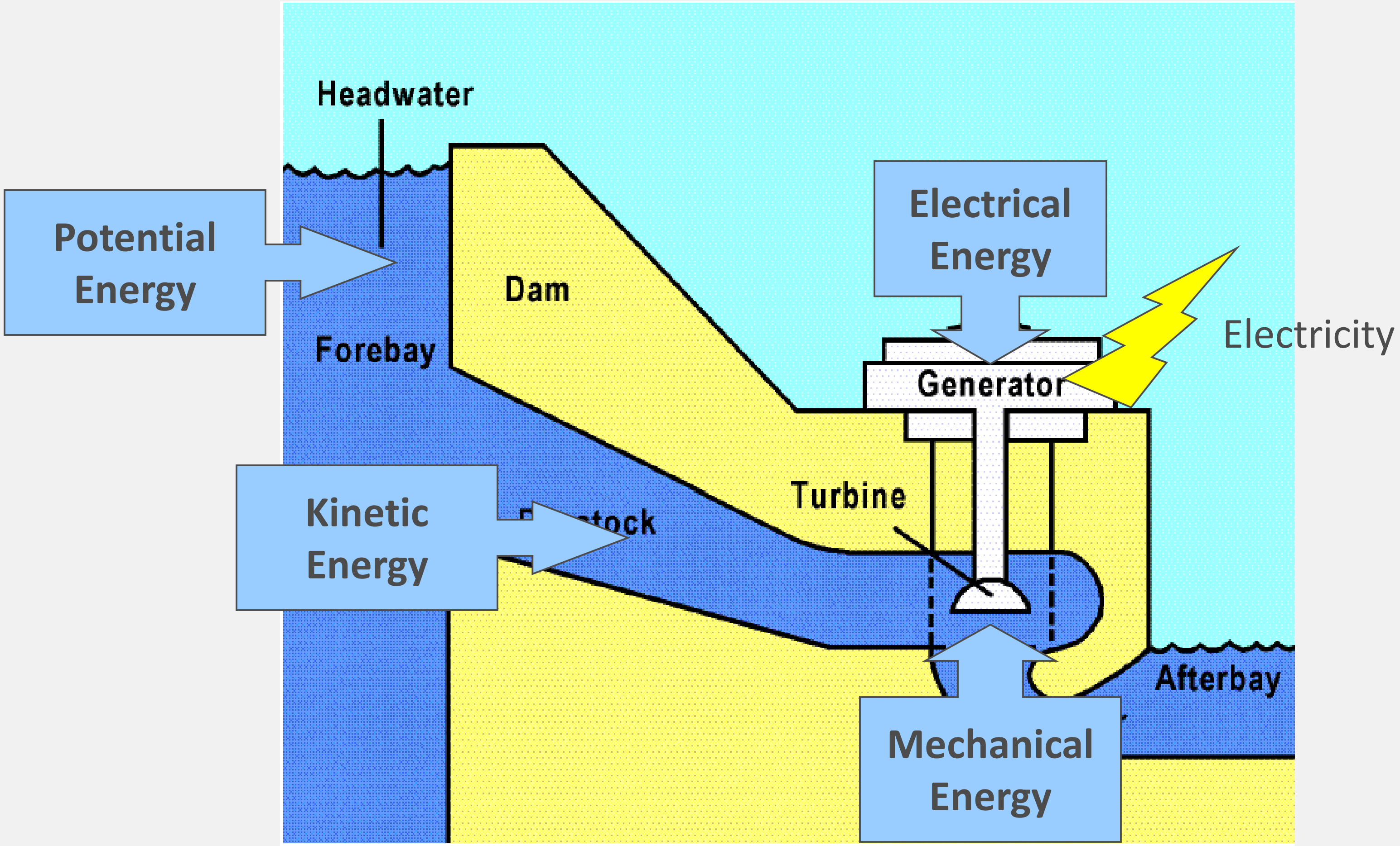
Generation (kilowatt-hours) percentages*	
Coal	52.50%
Nuclear	22.66%
Oil and Gas	19.54%
Hydro	5.30%

POTENTIAL ENERGY



POTENTIAL ENERGY/FT^3 = WEIGHT OF WATER/FT^3 x HEAD

From Water to Electric Power



Hydropower Calculations

$$P(kW) = (WxHxQxT)/737xT$$

$$P(kW) = (62.5xHxQxT)/737xT$$

$$P(kW) = (HxQ)/11.8$$

Two factors dictate
how much power is available for production:

H (Head) and Q (Flow)

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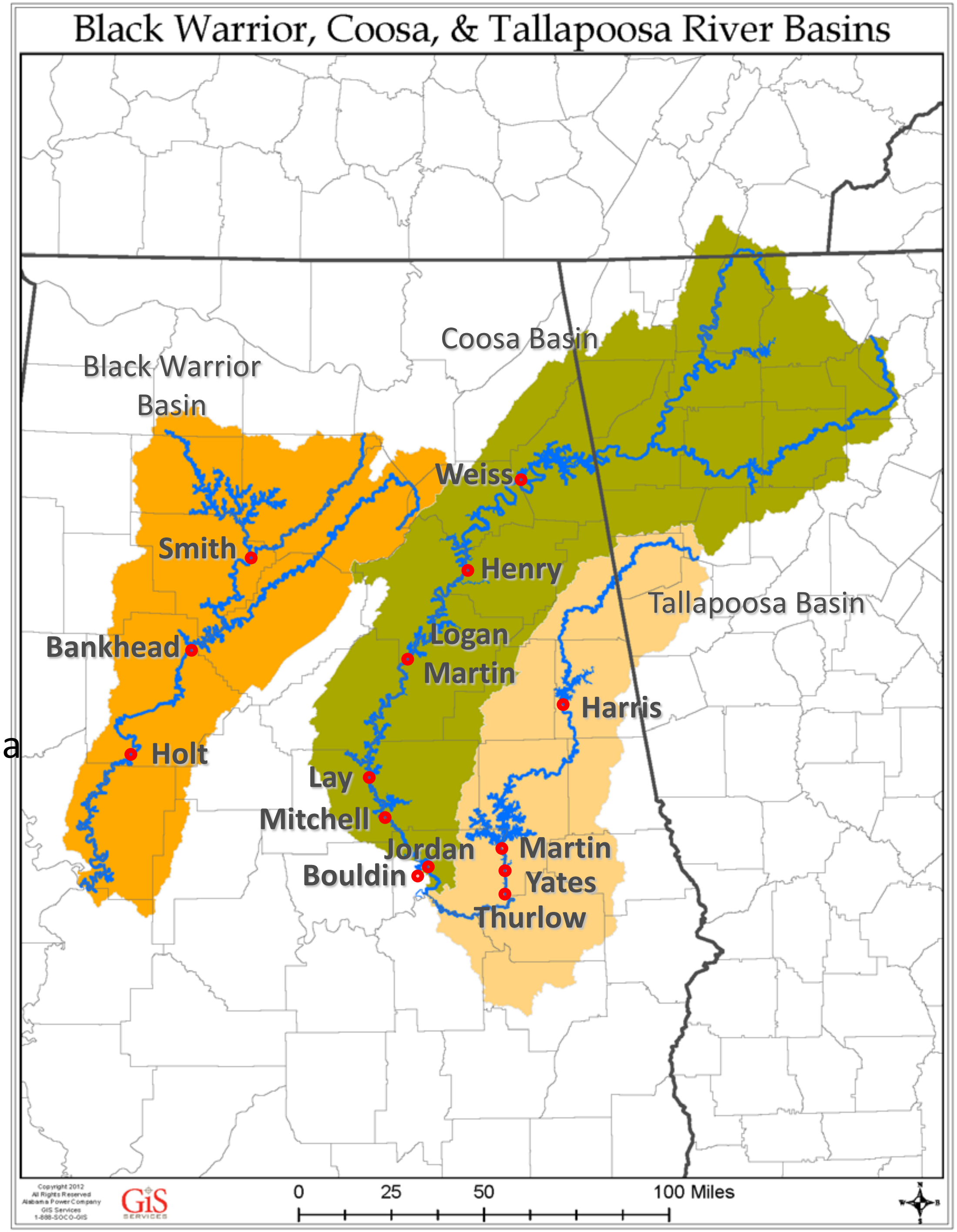
Alabama Power Company

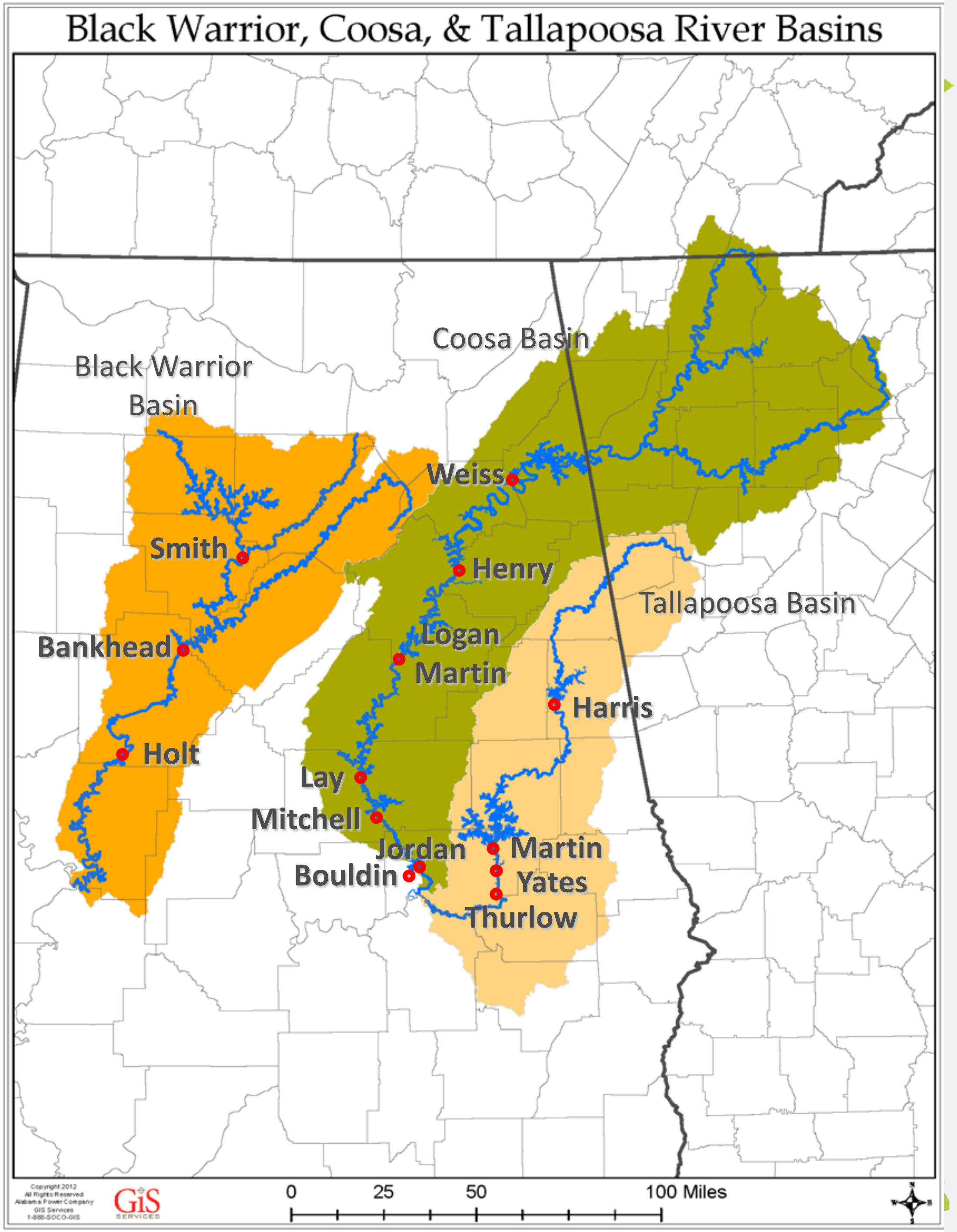
Hydroelectric Generation

- 14 Powerhouses
  - 41 Units
  - ~ 1600 megawatts of capacity
- 11 Reservoirs
  - 170,000 acres of pool area
  - 3,500 miles of shoreline
- Located in the Black Warrior, Coosa and Tallapoosa Basins



Competing Needs

- Power Generation
  - Energy
  - Bulk Power System Dynamic Benefits
- Flood Control
- Navigation
- Recreation
- Ecological / Water Quality
- Water Supply
  - Municipal
  - Industrial
  - Agricultural



Regulatory Flows

FERC

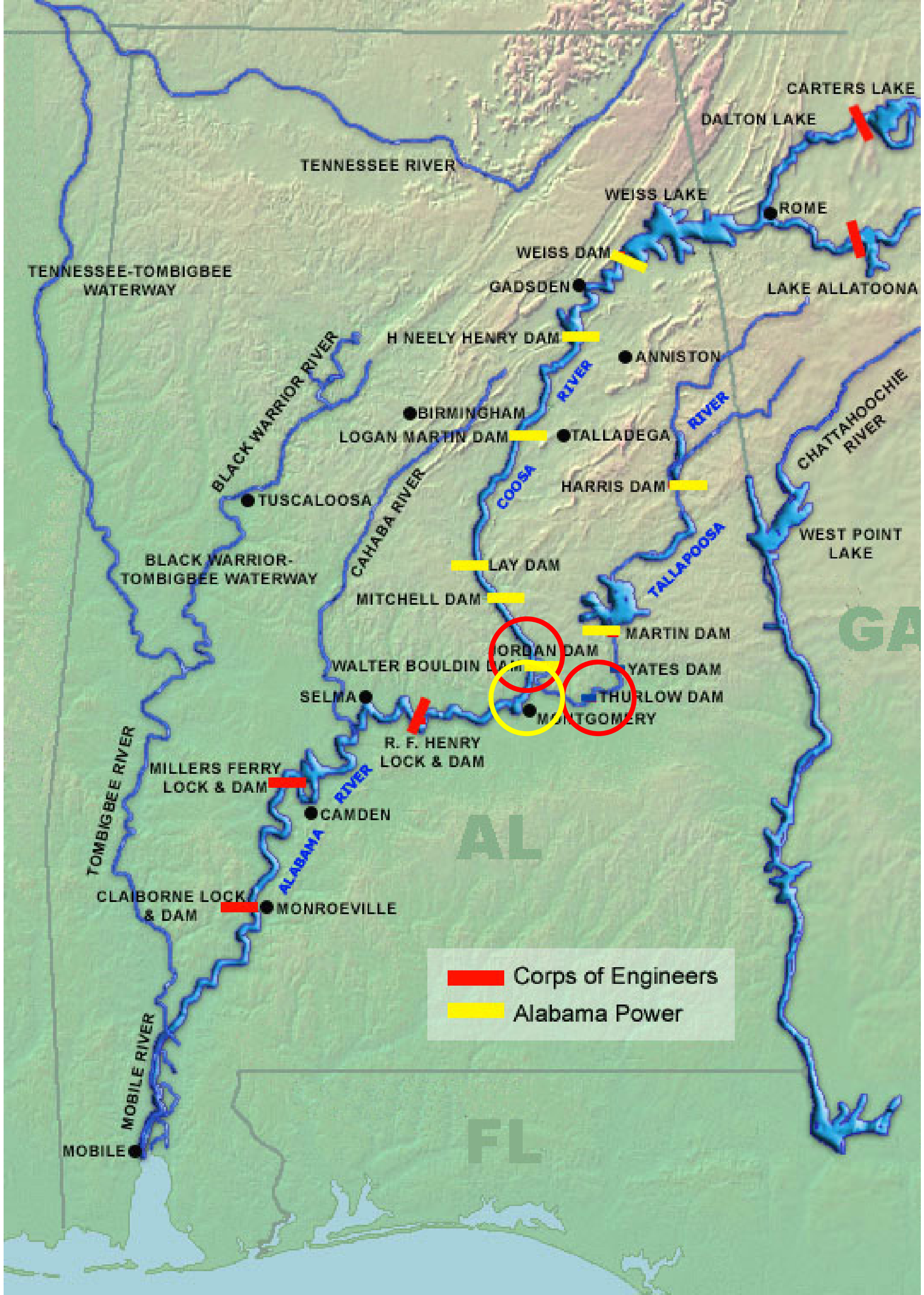
Project License

- Minimum Flows
  - *Coosa*
    - Jordan 2000+ cfs
    - Recreation Flows
  - *Tallapoosa*
    - Harris (Wadley) 45cfs
    - Thurlow 1200 cfs
  - *Warrior*
    - Smith 50cfs

U.S. Army Corps of Engineers

Reservoir Regulation Manuals

- Operate for Flood Control
- Provide for Navigation
  - Alabama River
    - 4,640 cfs
  - Warrior River
    - 245 cfs (Smith)



Flood Control License Articles

Coosa

- Article 402. *Flood Control Operations at Weiss, Neely Henry, and Logan Martin Developments*. The purpose of this article is to provide for flood control in accordance with rules and regulations prescribed by the Secretary of the Army pursuant to Public Law 83-436.

Warrior

- Article 403. *Flood Control Operations*. Upon issuance of this license, the licensee shall operate the Smith development in accordance with the U.S. Army Corps of Engineers (Corps) March 1965 Black Warrior-Tombigbee River Basin Reservoir Regulation Manual, Appendix A, for the Lewis M. Smith Reservoir (Manual), unless otherwise directed by the Corps

Harris

- Article 13(c) Operate the reservoir for flood control in accord with the agreement between the Chief of Engineers Department of the Army…

Martin

- Article 404. *Flood Control Operations.* The licensee must operate the project such that Lake Martin does not exceed elevation 491 feet mean sea level (msl) to assist in flood control. Flood control operation must be guided by the following: …

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…as Prescribed by Secretary of the Army

- U.S. Army Corps of Engineers, Mobile District
  - Basin-wide Master Reservoir Regulation Manuals
- Alabama–Coosa-Tallapoosa River Basin Reservoir Regulation Manual
  - Appendix B – Weiss
  - Appendix C – Logan Martin
  - Appendix D – Henry
  - Appendix I – Harris
- Black Warrior – Tombigbee River Basin Reservoir Regulation Manual
  - Appendix A - Smith

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Navigation Support Releases

Table 7-2. Basin Inflow above APC Projects Required to meet a 9.0-Foot Navigation Channel

Month	APC navigation Target (cfs)	Monthly historic storage usage (cfs)	Required basin inflow (cfs)
Jan	9,280	–994	10,274
Feb	9,280	–1,894	11,174
Mar	9,280	–3,028	12,308
Apr	9,280	–3,786	13,066
May	9,072	–499	9,571
Jun	8,648	412	8,236
Jul	8,232	749	7,483
Aug	7,808	1,441	6,367
Sep	7,600	[illegible]	[illegible]
Oct	7,600	[illegible]	[illegible]
Nov	8,024	[illegible]	[illegible]
Dec	8,864	1,789	[illegible]

4640

Table 7-3. Basin Inflow above APC Projects Required to meet a 7.5-Foot Navigation Channel

Month	APC navigation Target (cfs)	Monthly historic storage usage (cfs)	Required basin inflow (cfs)
Jan	7,960	–994	8,954
Feb	7,960	–1,894	9,854
Mar	7,960	–3,028	10,988
Apr	7,960	–3,786	11,746
May	7,856	–499	8,355
Jun	7,648	412	7,236
Jul	7,432	749	6,683
Aug	7,224	1,441	5,783
Sep	7,120	1,025	6,095
Oct	7,120	2,118	5,002
Nov	7,328	2,263	5,065
Dec	7,752	1,789	5,963

Reservoir Operations in a Bulk Power Electric System

What are the issues to be considered?

During certain storm trouble, hydro can quickly resolve associated line overloads

Provide “backup generation” during sudden loss of a generating unit

Provide “blackstart” capabilities to system

Provide “voltage stabilization” as system load changes throughout the day

Operating flexibility is important in APC’s ability to provide low cost , reliable electric service to its customers

All Energy Production Requires a Fuel Source

Our Fuel Procurement Contract…

The heat of the sun provides energy to make the water cycle work.

The sun evaporates water from the oceans into water vapor.

This invisible vapor rises into the atmosphere, where the air is colder.

The water vapor condenses into clouds.

Volcanoes emit steam, which forms clouds.

Air currents move clouds all around the Earth.

Water drops form in clouds, and the drops then fall to Earth as precipitation (rain and snow).

In cold climates, precipitation builds up as snow, ice, and glaciers.

Snow can melt and become runoff, which flows into rivers, the oceans, and into the ground.

Some ice evaporates directly into the air, skipping the melting phase (sublimation).

Rainfall on land flows downhill as runoff, providing water to lakes, rivers, and the oceans.

Some rain soaks into the ground, as infiltration, and if deep enough, recharges groundwater.

Water from lakes and rivers can also seep into the ground.

Water moves underground because of gravity and pressure.

Groundwater close to the land surface is taken up by plants.

Some groundwater seeps into rivers and lakes, and can flow to the surface as springs.

Plants take up groundwater and evapotranspire, or evaporate, it from their leaves.

Some groundwater goes very deep into the ground and stays there for a long time.

Groundwater flows into the oceans, keeping the water cycle going.

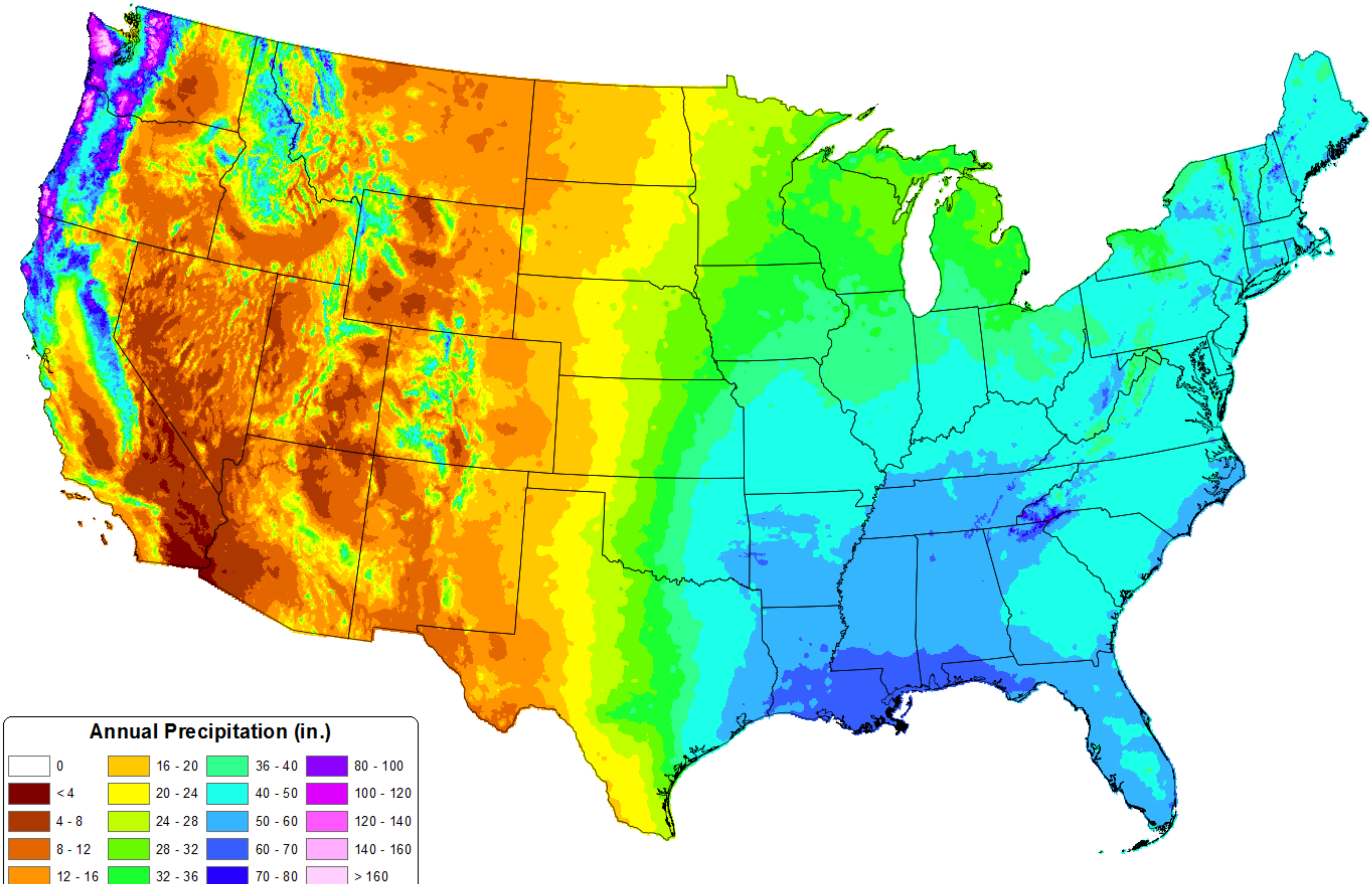
U.S. Department of the Interior
U.S. Geological Survey

Stefanie Neno, Jim Morgan, Gabriele Zanolli, Food and Agriculture Organization of the United Nations
Howard Perlman, Gerard Gonthier, U.S. Geological Survey

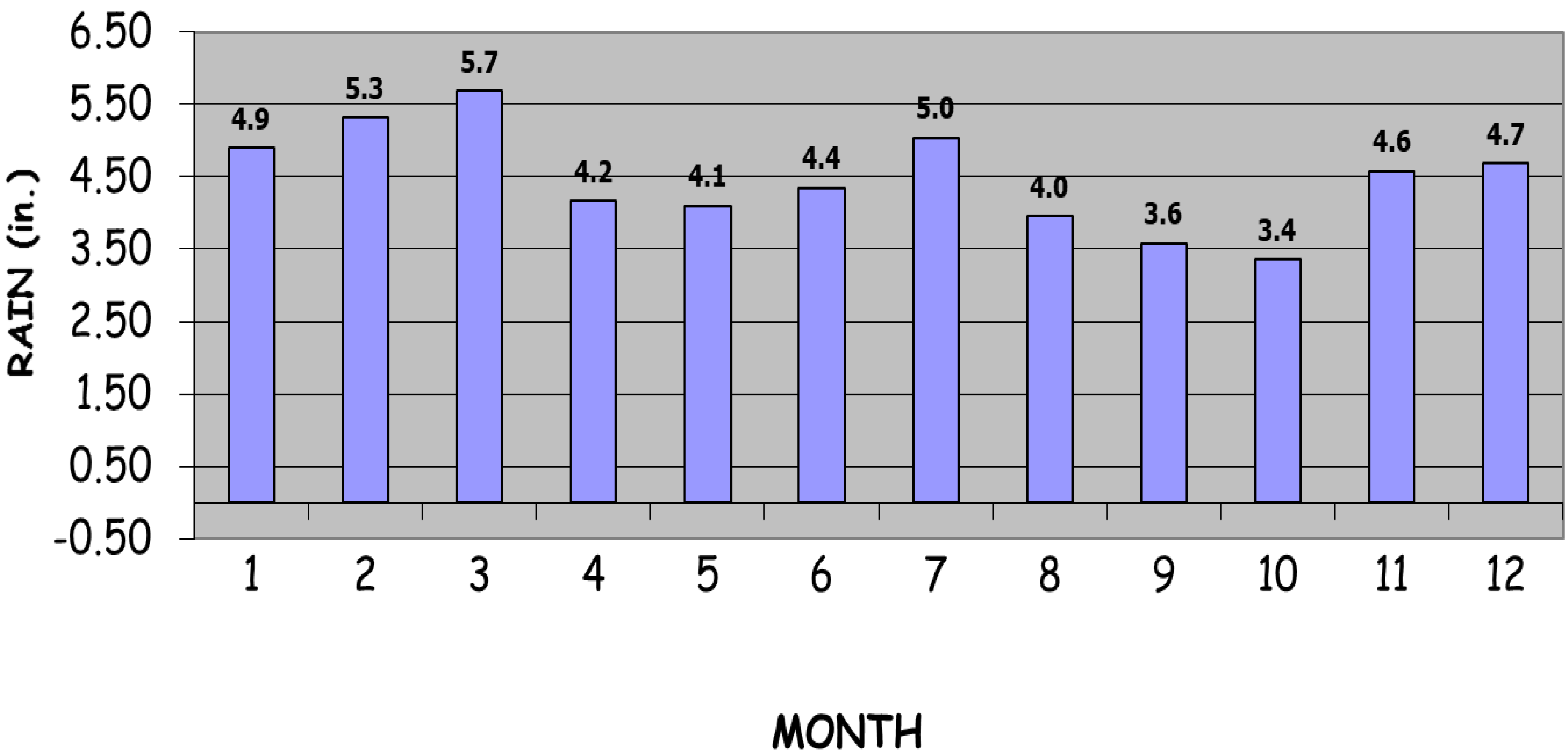
General Information Product 146
http://ga.water.usgs.gov/edu/watercycle-kids.html

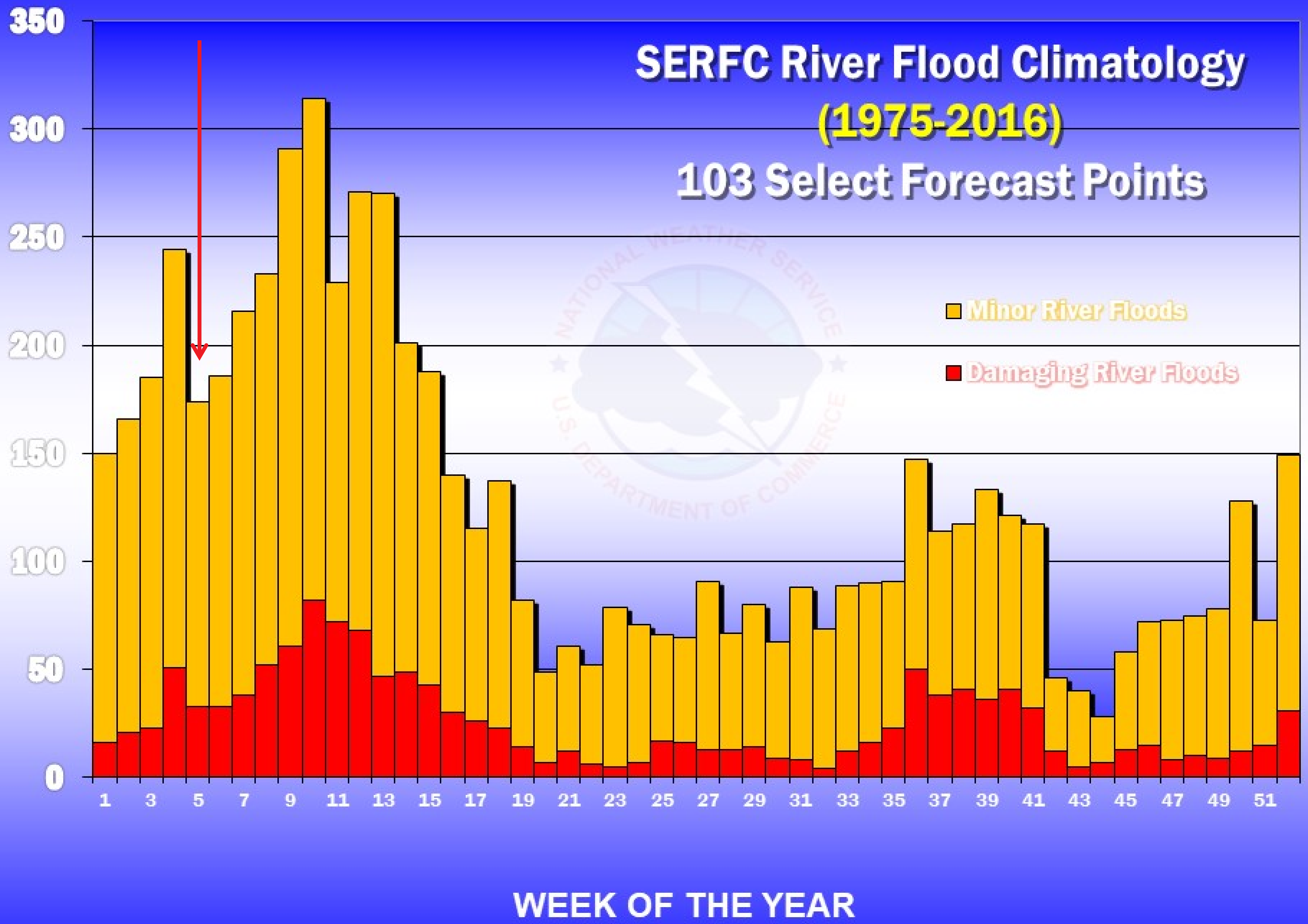
30-yr Normal Precipitation: Annual

Period: 1981-2010



Tallapoosa Basin Average Monthly Rainfall




SERFC River Flood Climatology
(1975-2016)
103 Select Forecast Points
Minor River Floods
Damaging River Floods
350
300
250
200
150
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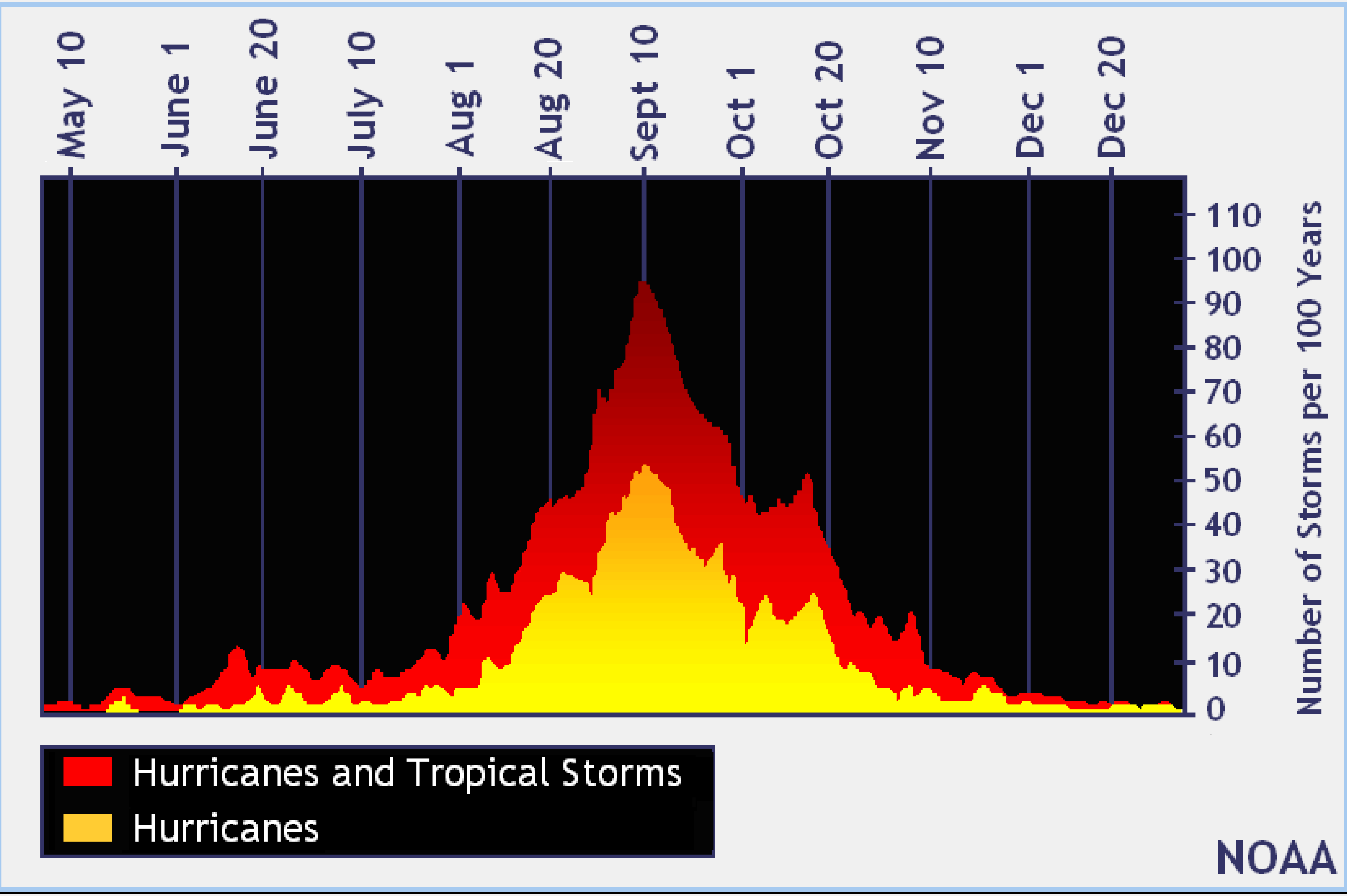
WEEK OF THE YEAR


May 10
June 1
June 20
July 10
Aug 1
Aug 20
Sept 10
Oct 1
Oct 20
Nov 10
Dec 1
Dec 20
110
100
90
80
70
60
50
40
30
20
10
0
Number of Storms per 100 Years
Hurricanes and Tropical Storms
Hurricanes
NOAA

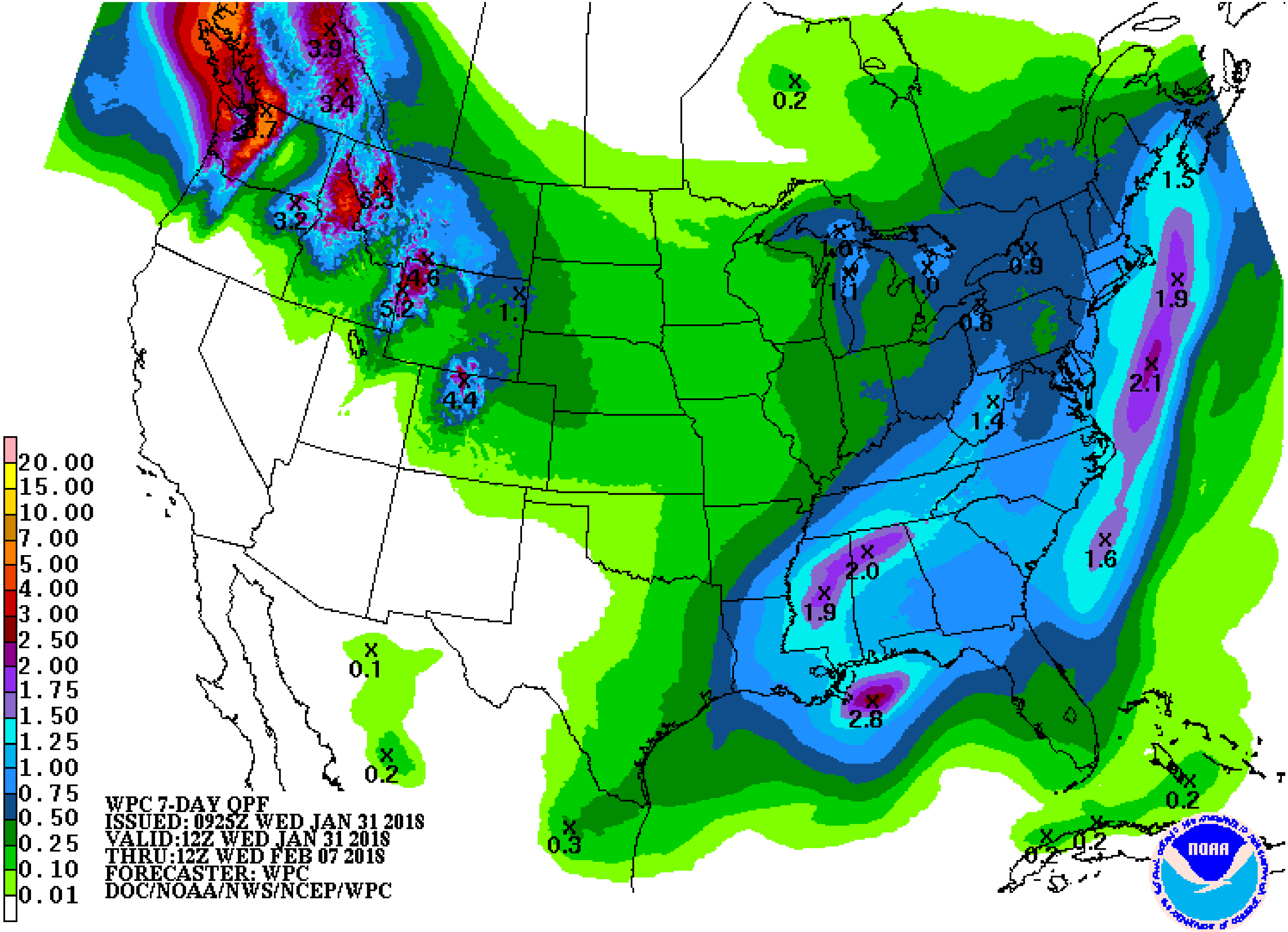
Informed Decision Making

How Do We Know What We Need to Know to Operate?

wil·ly-nil·ly

adverb
1. without direction or planning; haphazardly.

synonyms: haphazardly, at random, randomly, every which way, here and there, all over the place, in no apparent order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WPC 7-DAY QPF
ISSUED: 0925Z WED JAN 31 2018
VALID:12Z WED JAN 31 2018
THRU:12Z WED FEB 07 2018
FORECASTER: WPC
DOC/NOAA/NWS/NCEP/WPC
NOAA
3.9
3.4
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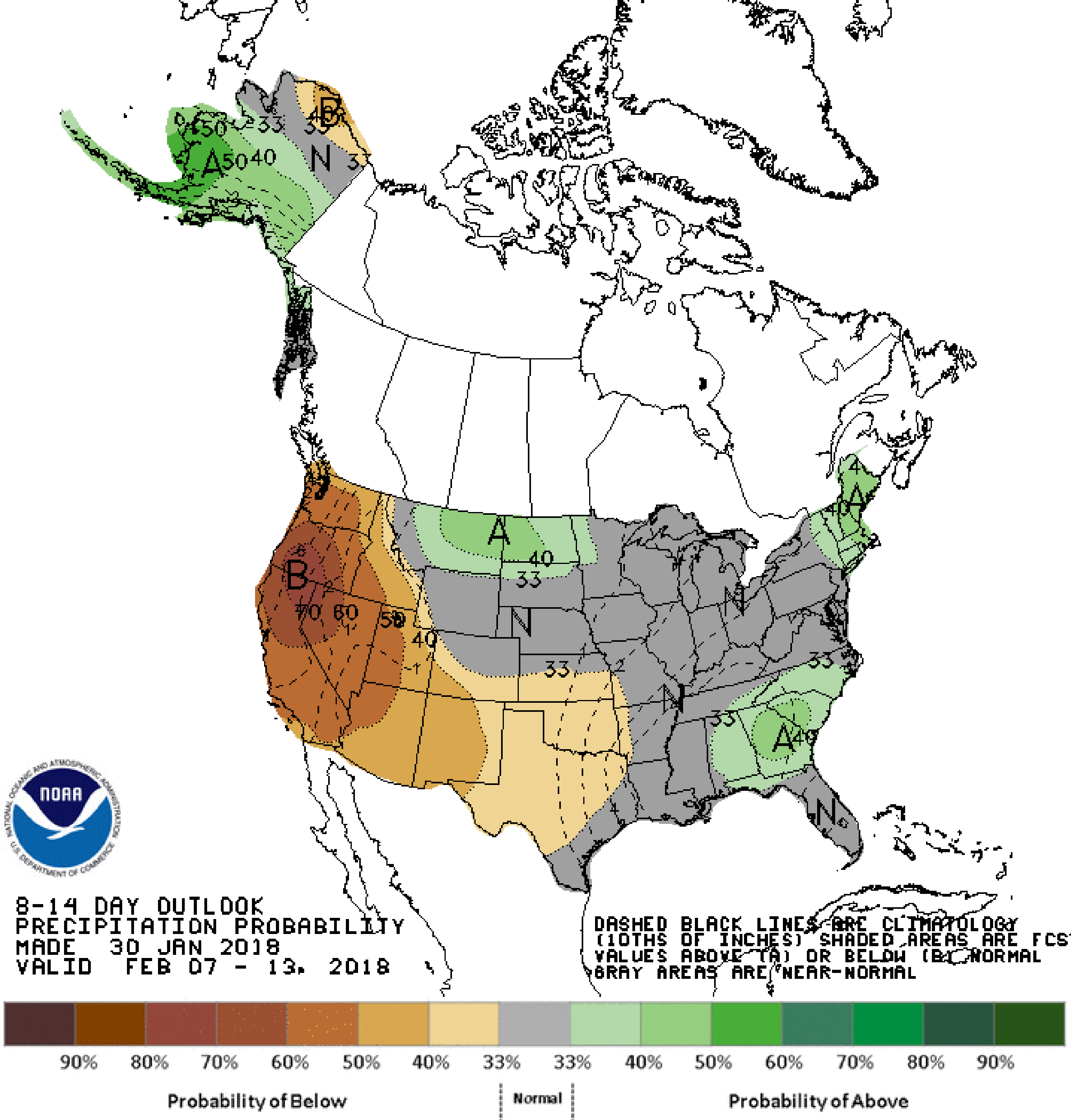

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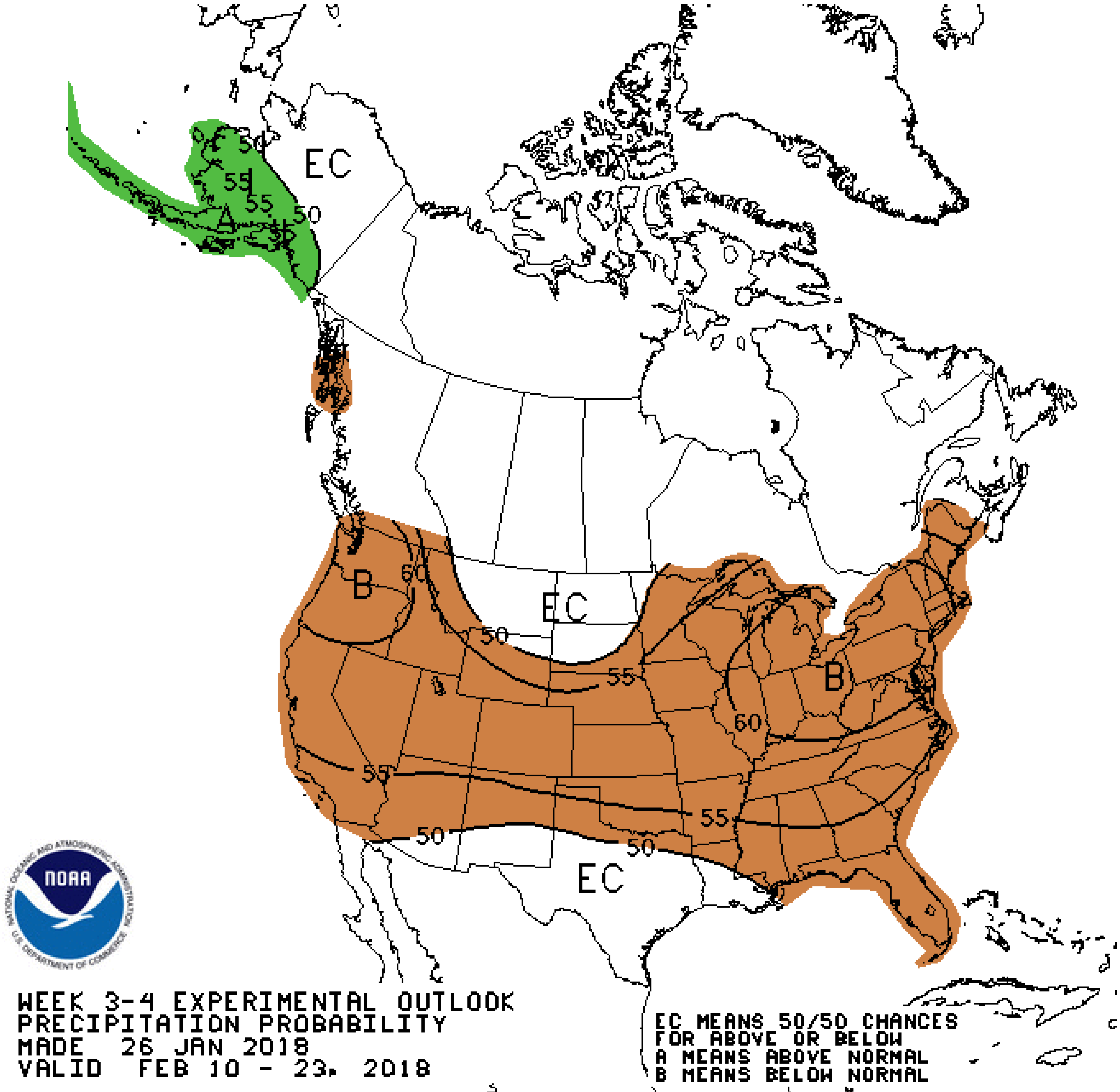
EC
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A
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B
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EC
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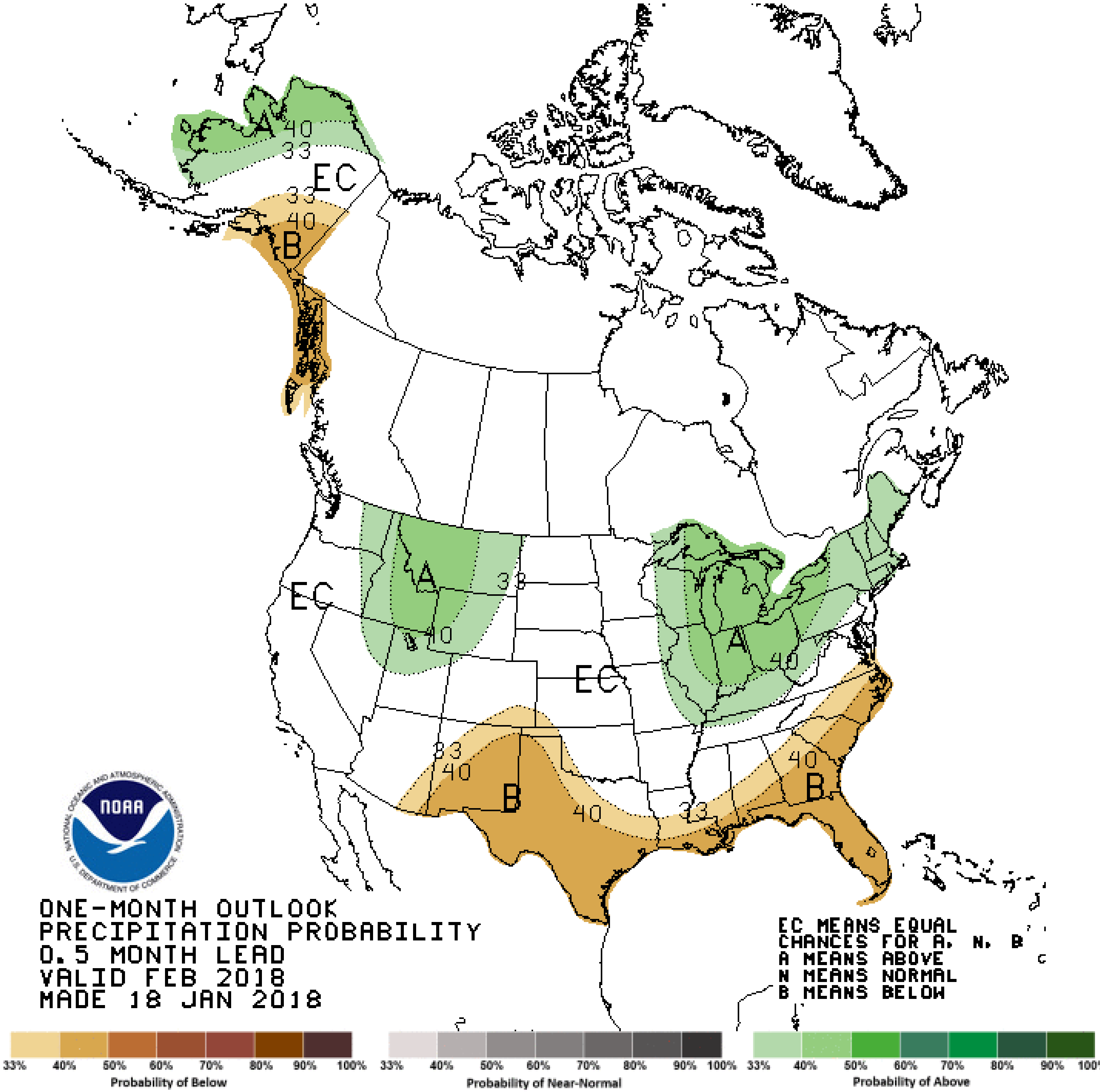
EC
WEEK 3-4 EXPERIMENTAL OUTLOOK
PRECIPITATION PROBABILITY
MADE 26 JAN 2018
VALID FEB 10 - 23, 2018
EC MEANS 50/50 CHANCES
FOR ABOVE OR BELOW
A MEANS ABOVE NORMAL
B MEANS BELOW NORMAL



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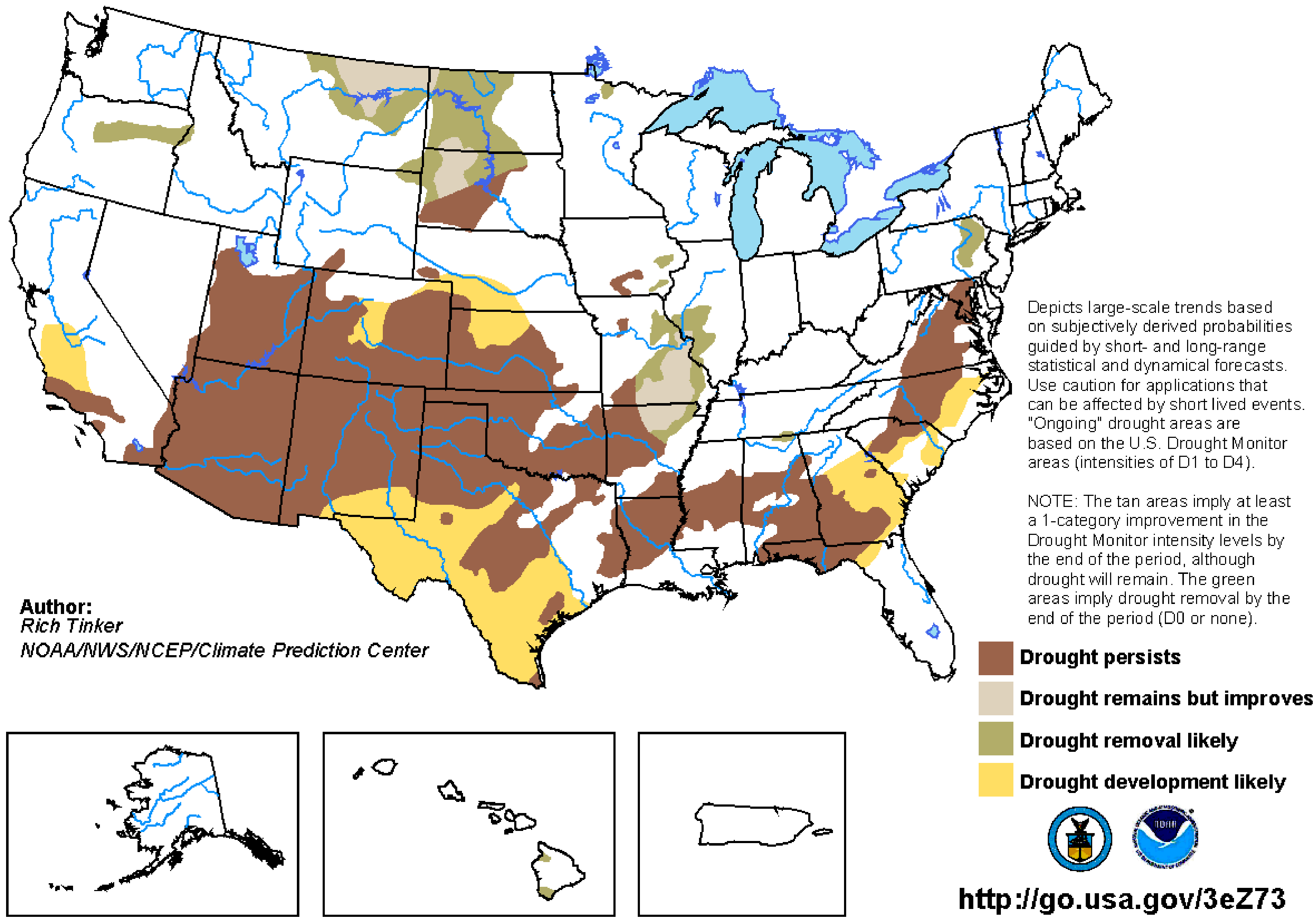
U.S. Seasonal Drought Outlook

Drought Tendency During the Valid Period

Valid for January 18 - April 30, 2018
Released January 18, 2018



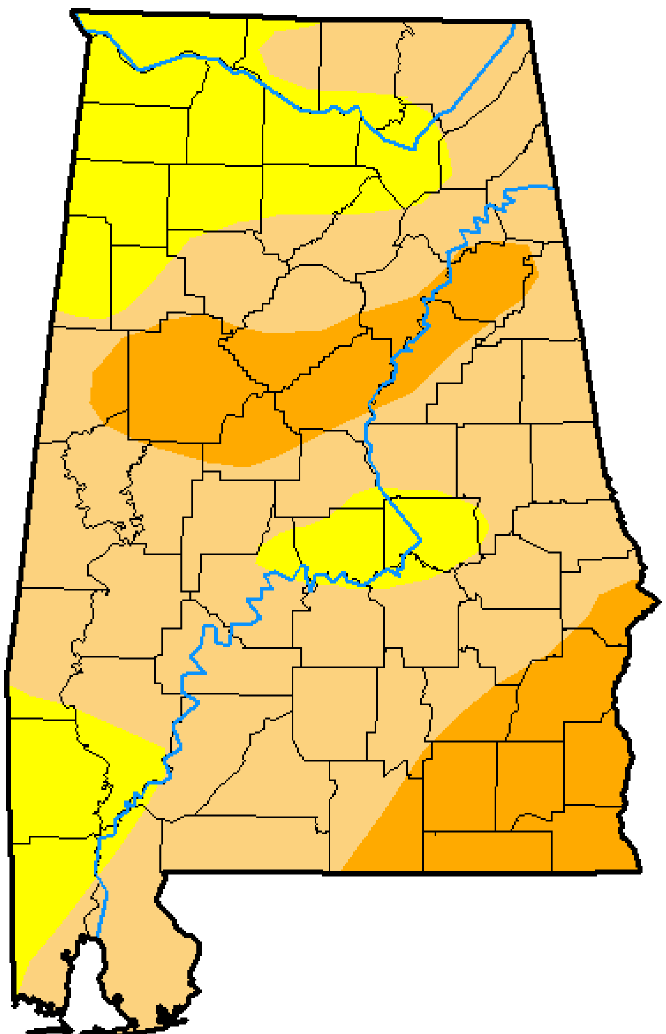
U.S. Drought Monitor

Alabama

January 23, 2018

(Released Thursday, Jan. 25, 2018)

Valid 7 a.m. EST



Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

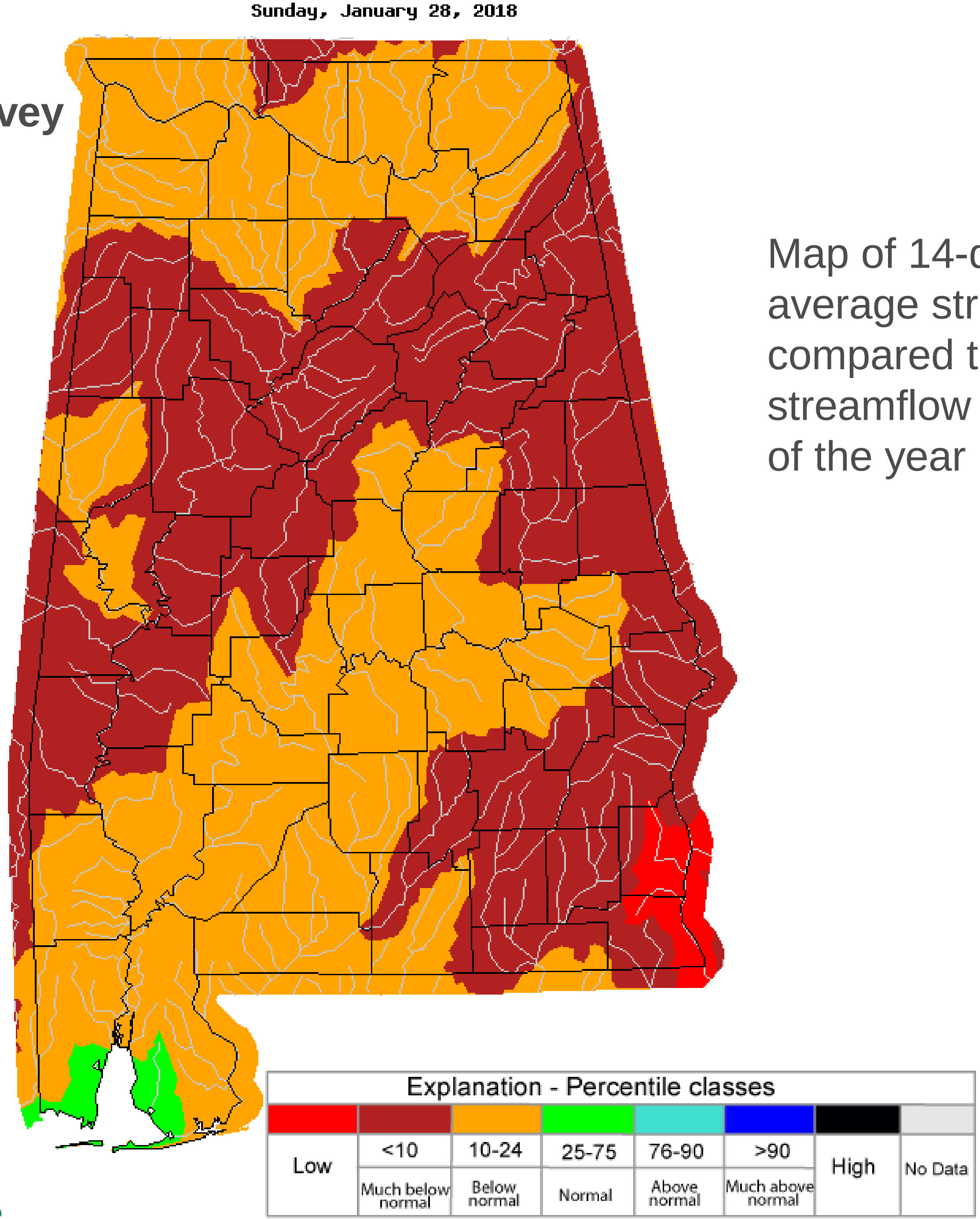
Author:

Richard Heim

NCEI/NOAA

http://droughtmonitor.unl.edu/

United States Geological Survey



Map of 14-day average streamflow compared to historical streamflow for the day of the year

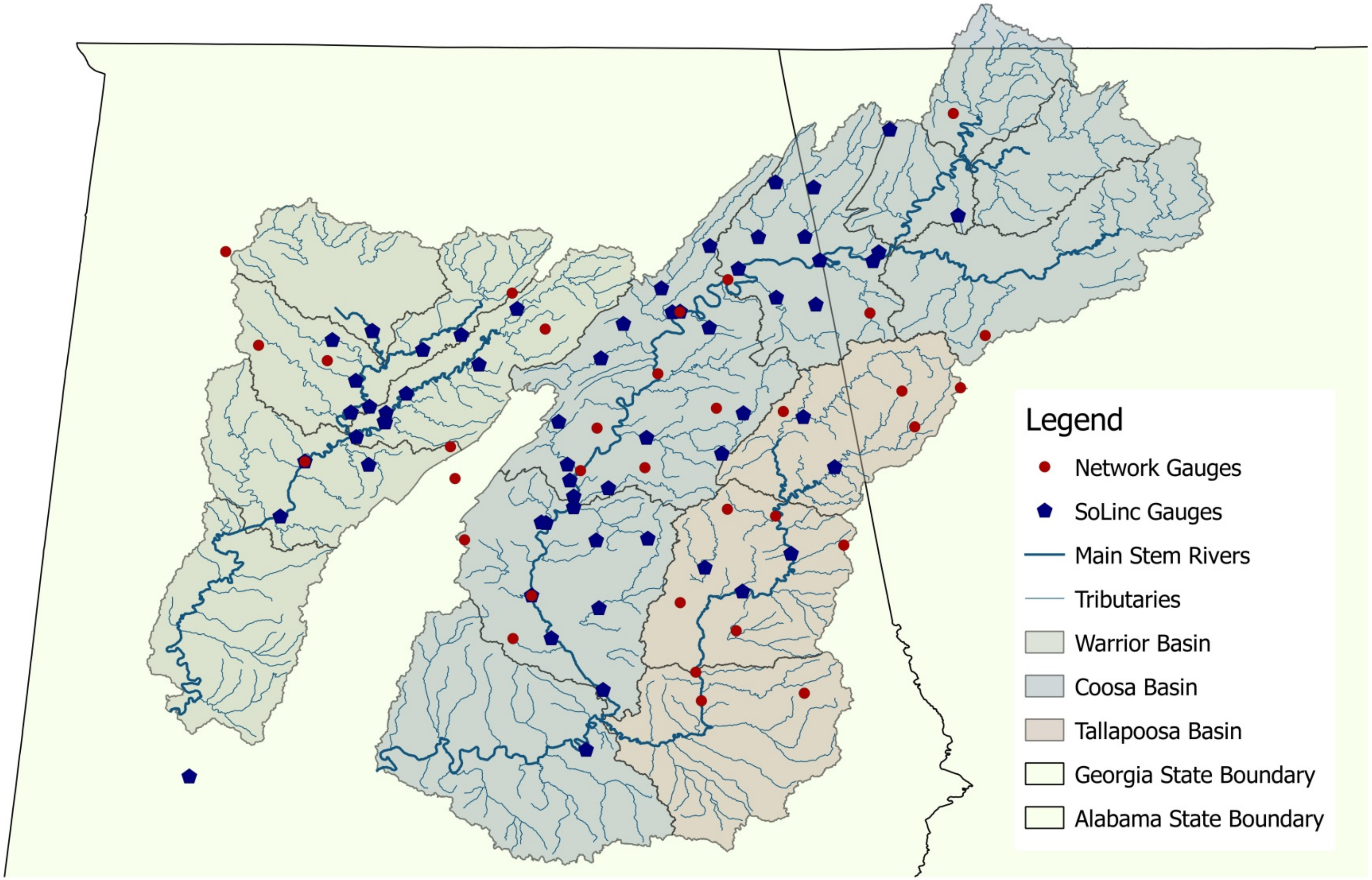
We are a Data Driven Function

How Do We Know What We Need to Know to Operate?

Real Time Systems

- HDAS – Hydro Data Acquisition System
- HOMS – Hydro Optimization Management System

HDAS Remote Gage Network



Hydro Optimization Management System HOMS

- Three Systems – Production, Backup and Development
- Twenty Three Servers
- Seven Database Servers and Twenty Databases
- Six Web Sites
- Six Desktop Applications

Gaging Program – Electronic Gages

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Two Types of Reservoirs:

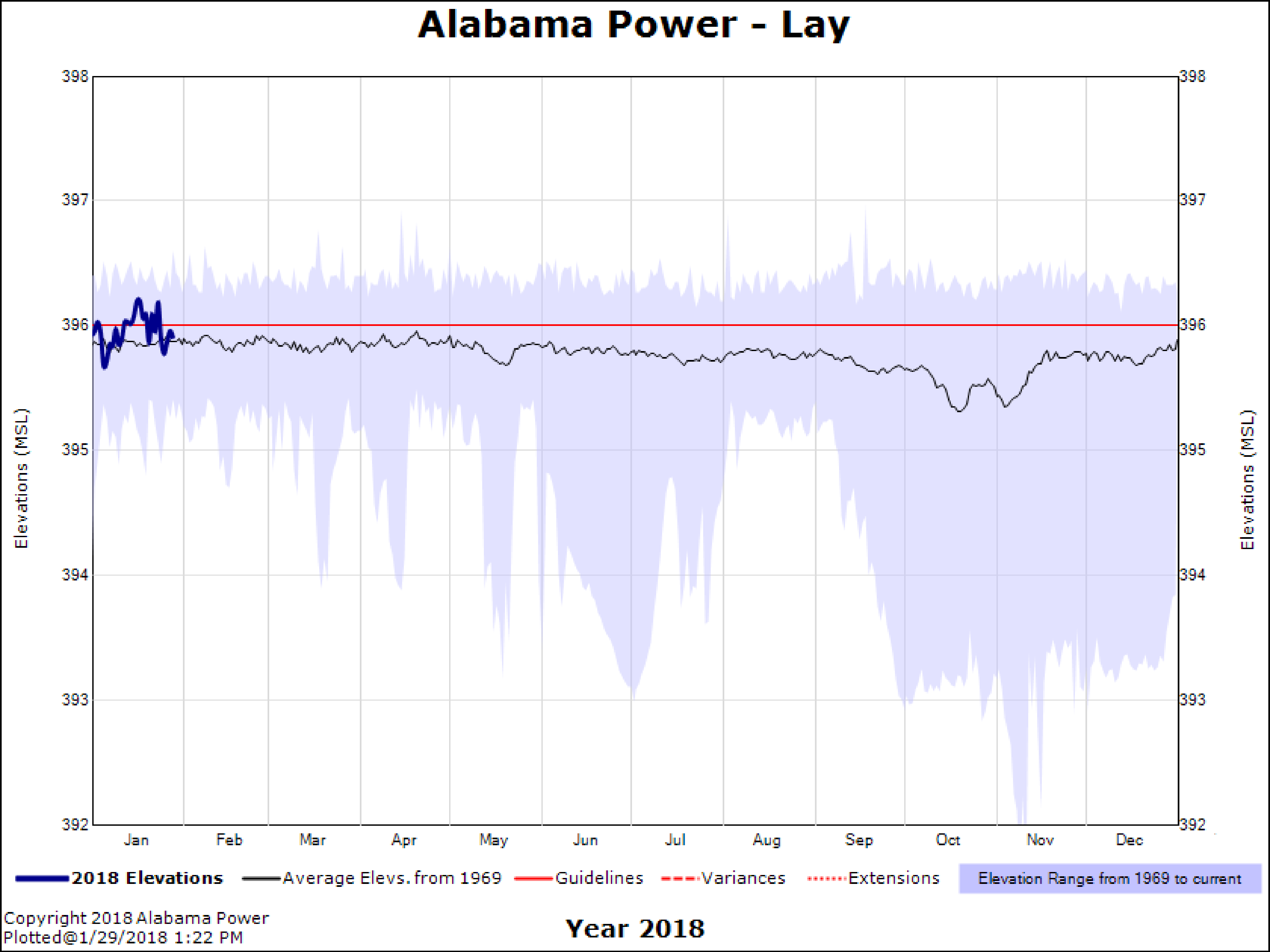
- Run of River
- Storage

Run of River:

- What flows in, also flows out
  - Inflow = Releases
  - Substantially consistent lake level year round

    Coosa
    - Lay
    - Mitchell
    - Jordan/Bouldin

    Tallapoosa
    - Yates/Thurlow



Alabama Power - Lay
398
397
396
395
394
393
392
Elevations (MSL)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2018 Elevations
Average Elevs. from 1969
Guidelines
Variances
Extensions
Elevation Range from 1969 to current
Copyright 2018 Alabama Power
Plotted@1/29/2018 1:22 PM
Year 2018

Storage Reservoirs

- What flows in, doesn't necessarily flow out or what doesn't flow in may actually flow out
  - Different Summer and Winter Elevations
    - *Coosa*
      - Weiss
      - H. Neely Henry
      - Logan Martin
    - *Tallapoosa*
      - Harris
      - Martin
    - *Warrior*
      - Smith
- Critical for Flood Control
- Critical for Drought Mitigation

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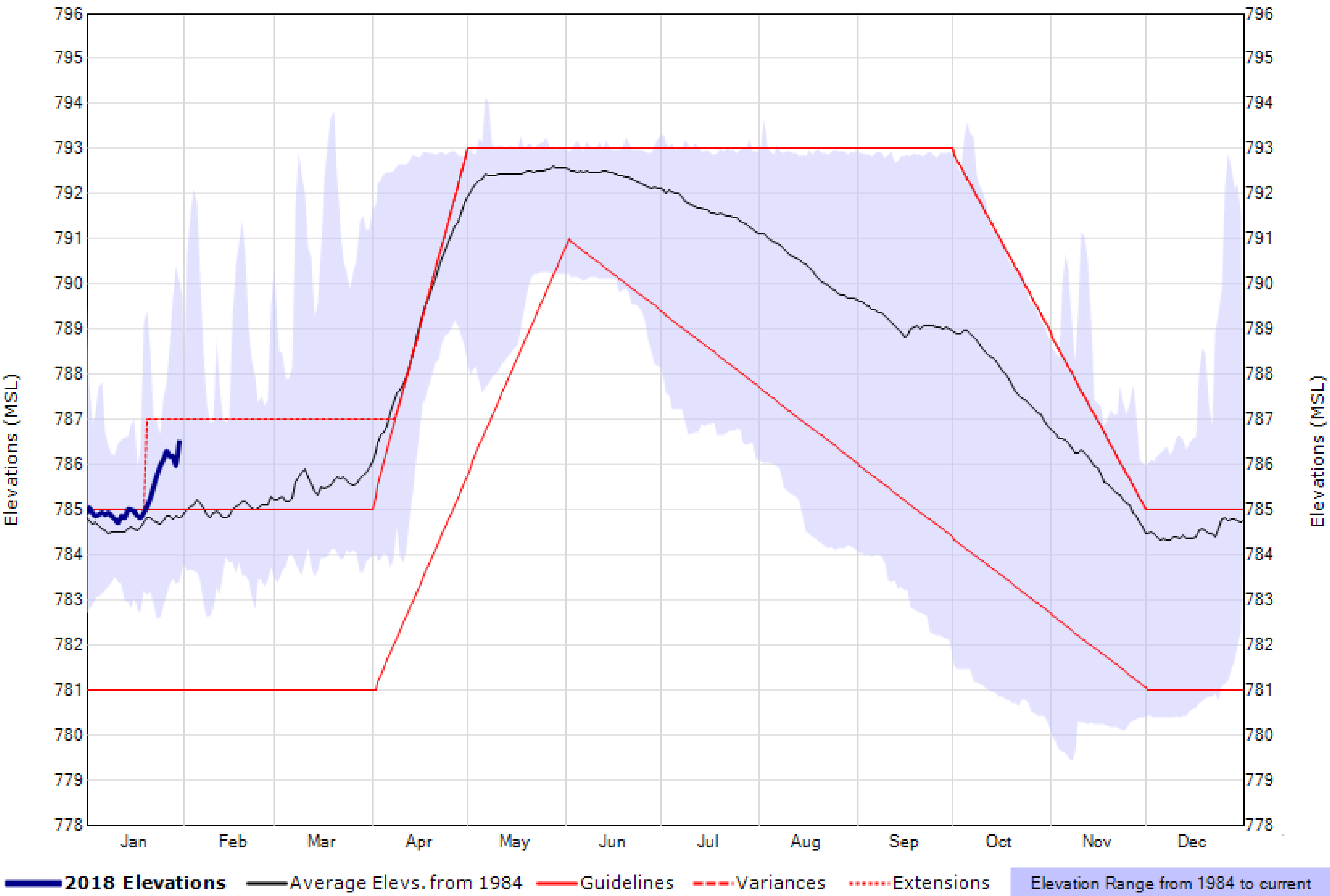
Alabama Power - Harris



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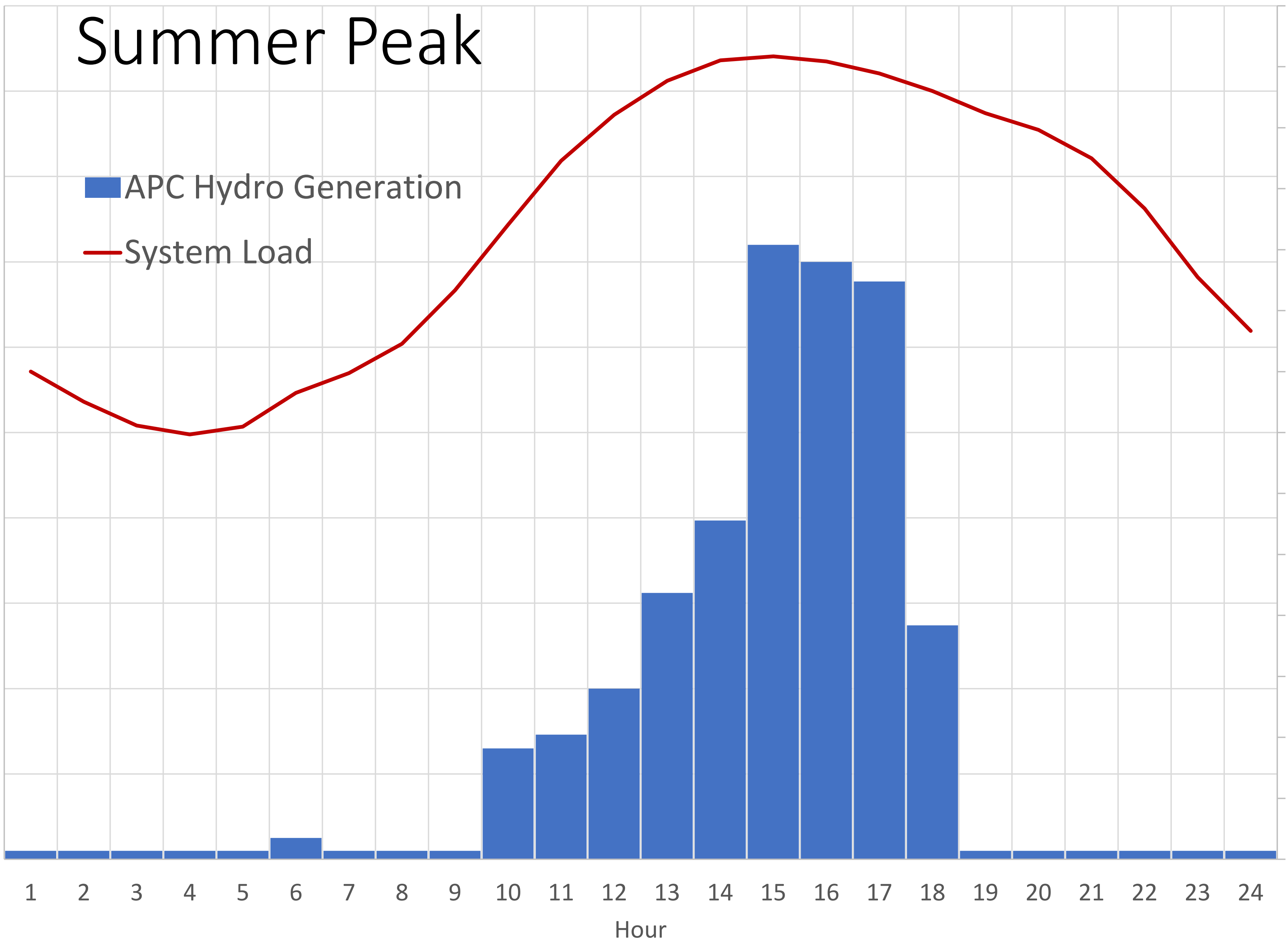
Year 2018

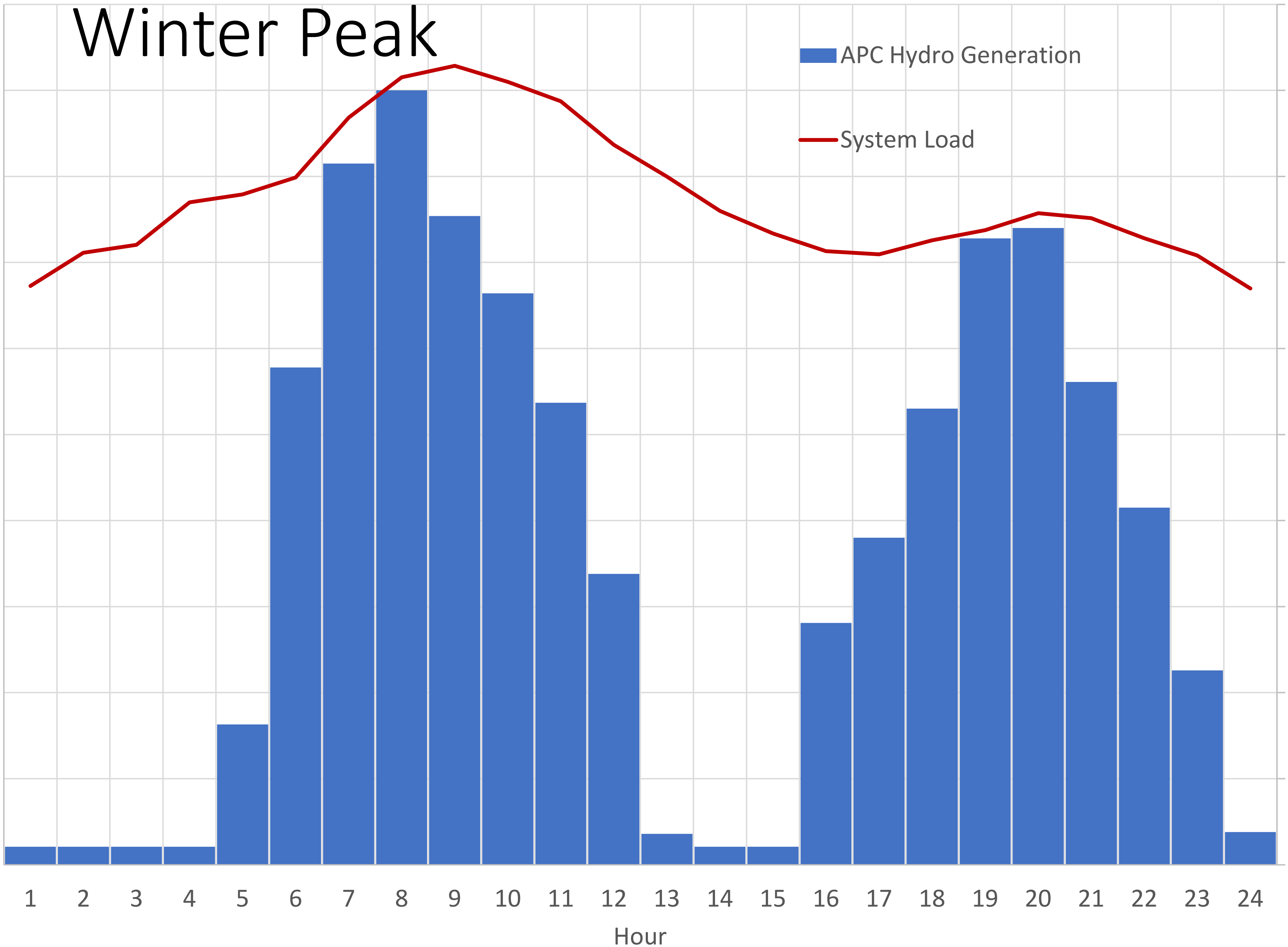
Hot Dogs and Energy Production

Peaking Generation

- Water available for generating electricity is limited
- Hydro is operated to fill in the peak load demand
  - Maximizes economics
- Summer has one peak
  - around 3 pm
- Winter has two peaks
  - Morning around 7 a.m.
  - Afternoon around 7 p.m.



Summer Peak
APC Hydro Generation
System Load
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Hour



Winter Peak
APC Hydro Generation
System Load
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Hour

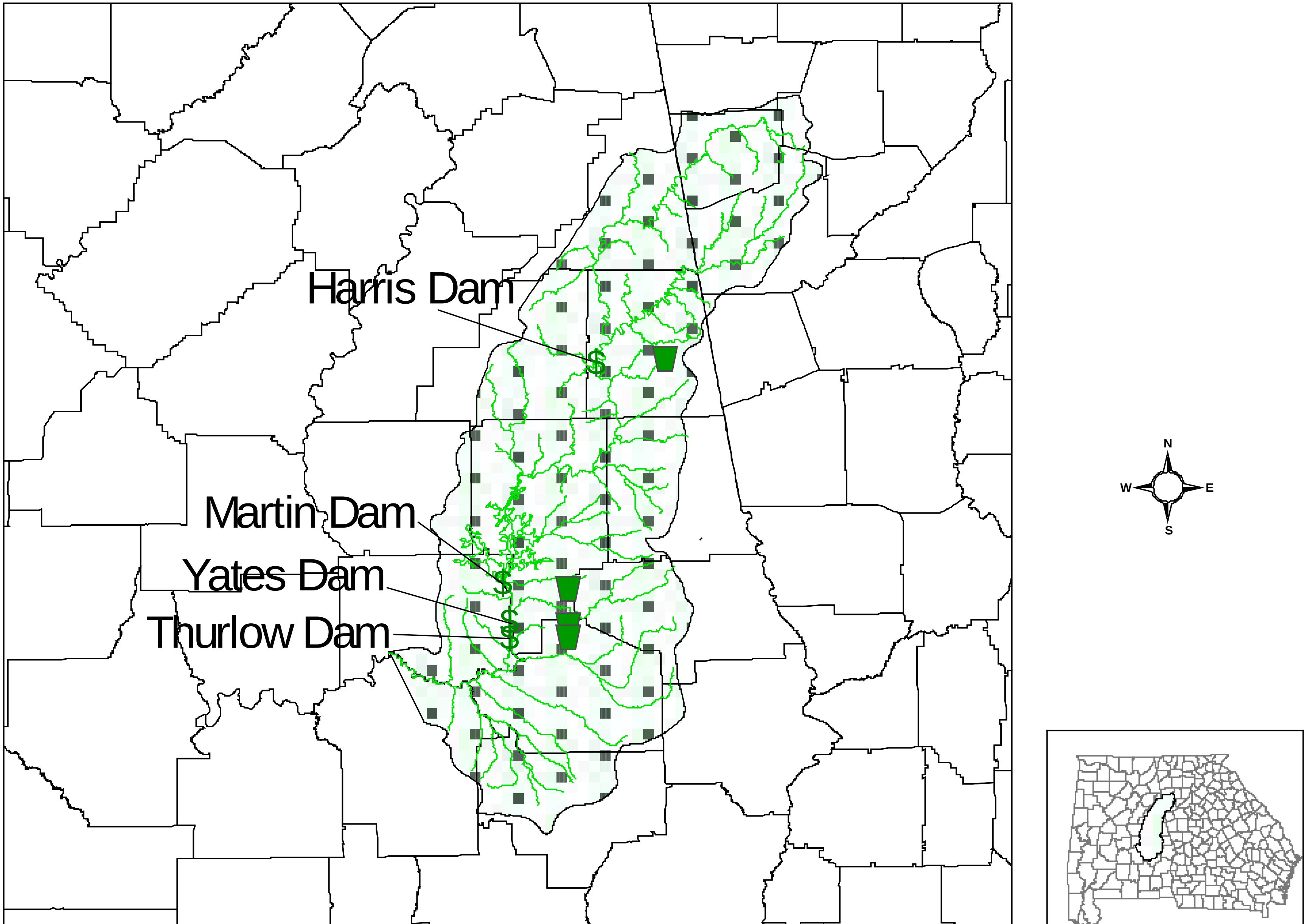
Harris Specific Operations

Routine Operations

Flood Operations

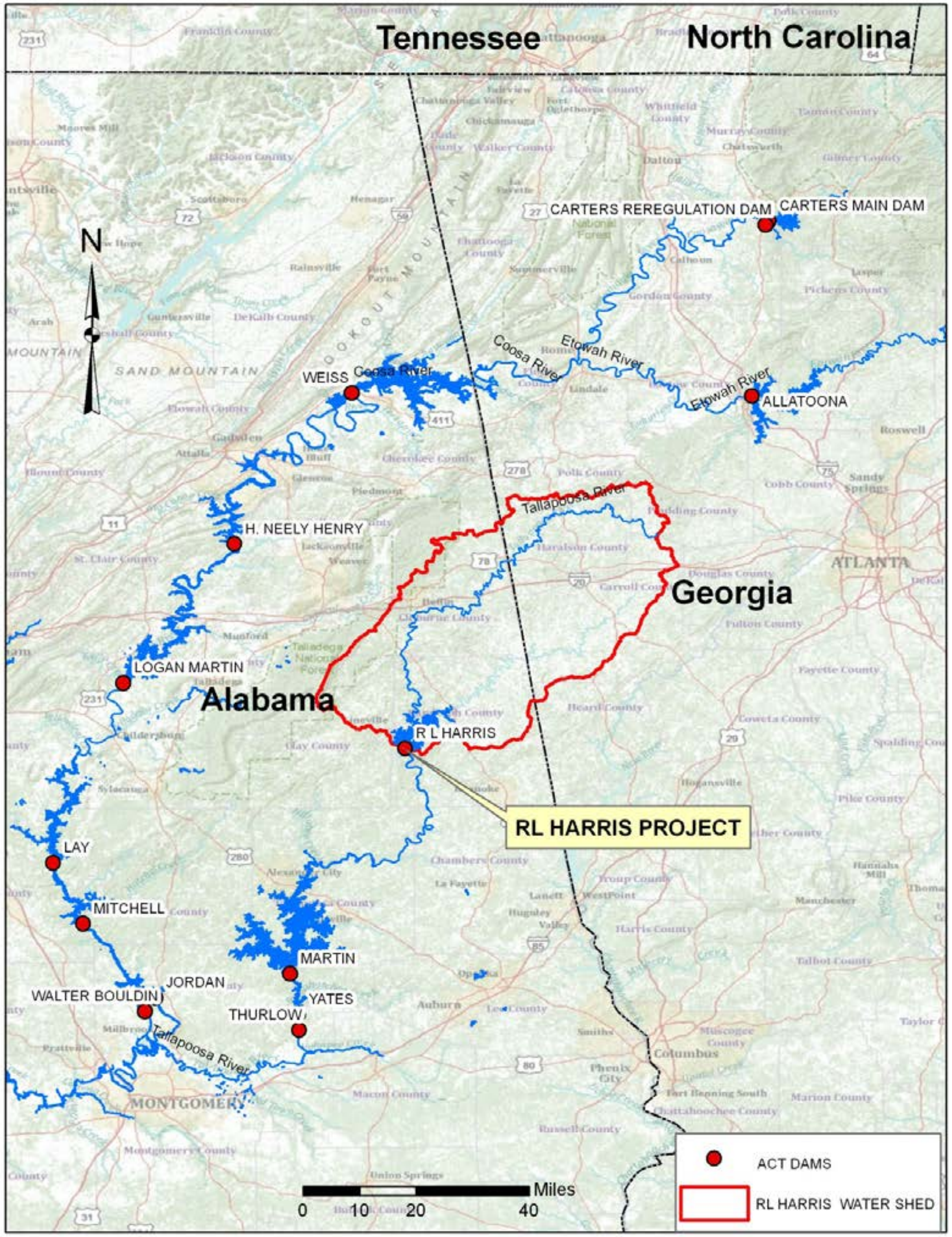
Drought Operations

Tallapoosa River Basin



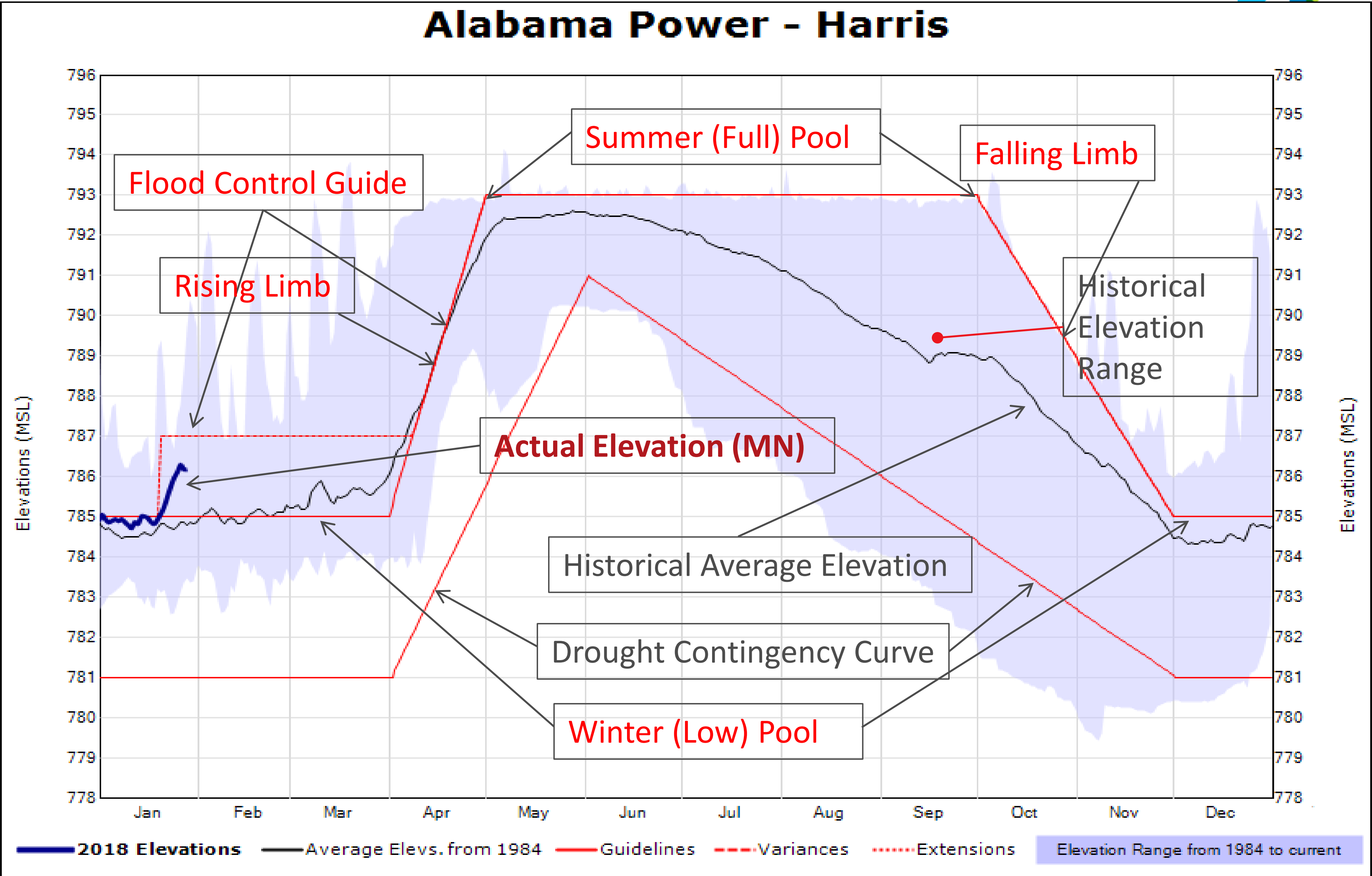
Tallapoosa River Basin

Approx. 1450 square miles of watershed draining into the reservoir



HARRIS DAM RELICENSING

Anatomy of a "Rule Curve Plot"



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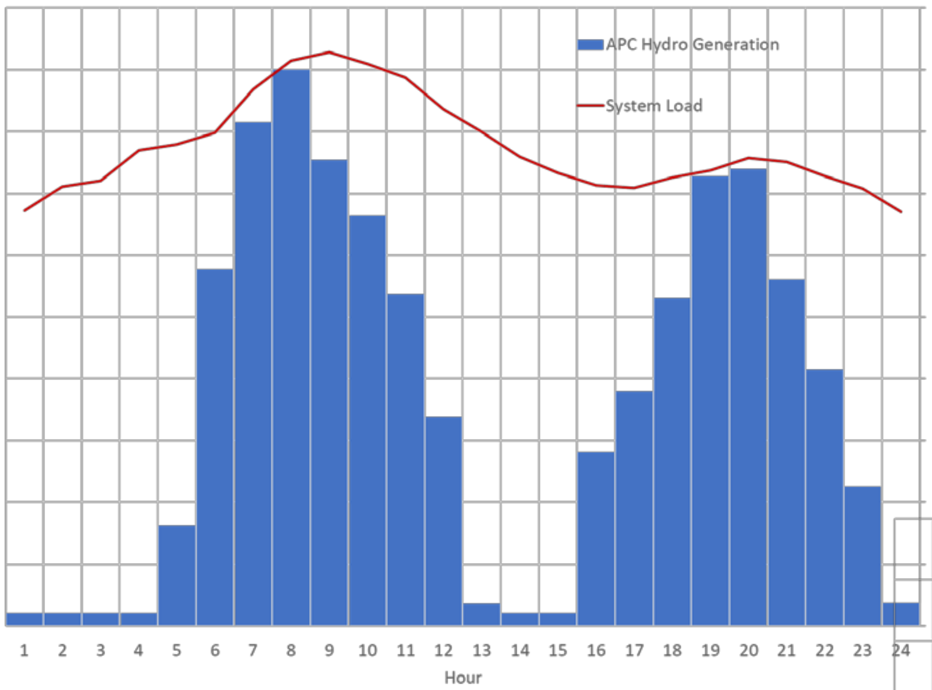
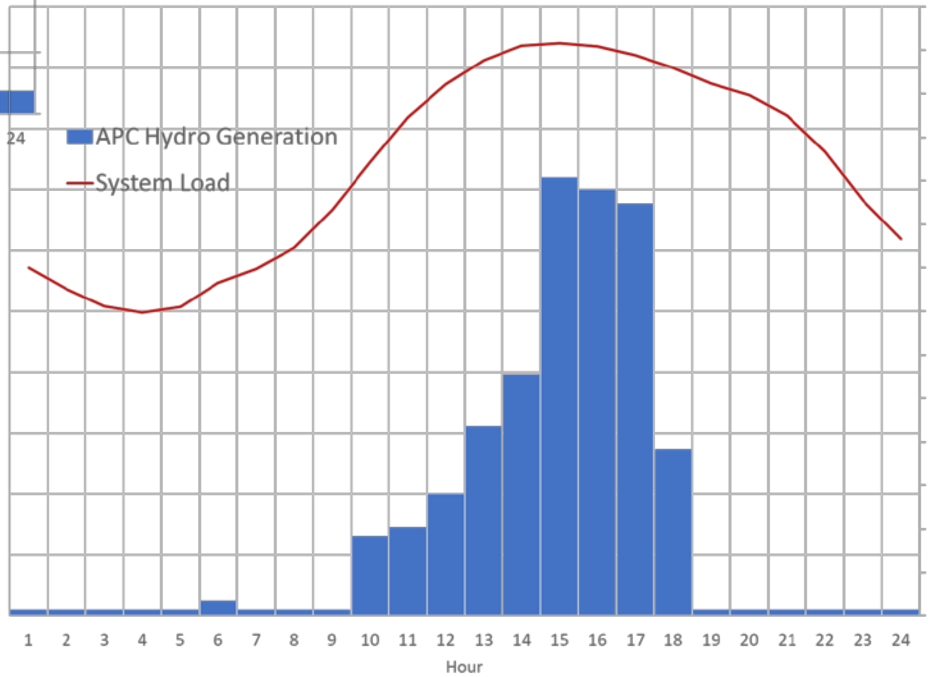
Designed for Peaking Operations





Harris Adaptive Flow – Green Plan - Main Unit Pulses

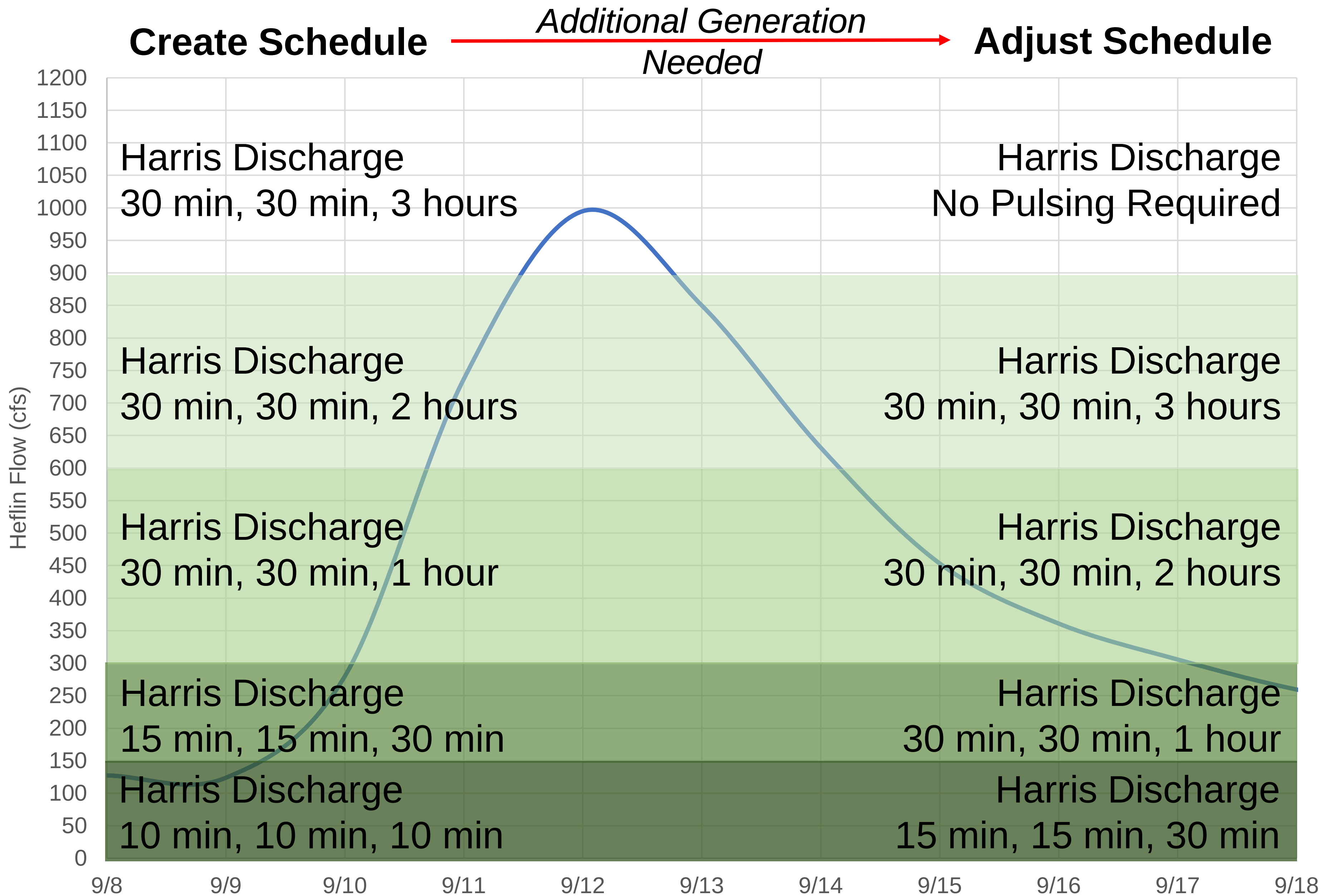
Create schedule based on prior day's Heflin flow

STEP	Prior Day's Heflin Flow (dsf)	Generation At 6 AM	Generation At 12 Noon	Generation As System Needs	Total Machine Time	Harris Total Discharge (dsf)
1A	0 < Heflin Q < 150	10 min	10 min	10 min	30 min	133
2A	150 < Heflin Q < 300	15 min	15 min	30 min	1 hour	267
3A	300 < Heflin Q < 600	30 min	30 min	1 hour	2 hours	533
4A	600 < Heflin Q < 900	30 min	30 min	2 hours	3 hours	800
5A	900 < Heflin Q	30 min	30 min	3 hours	4 hours	1,067

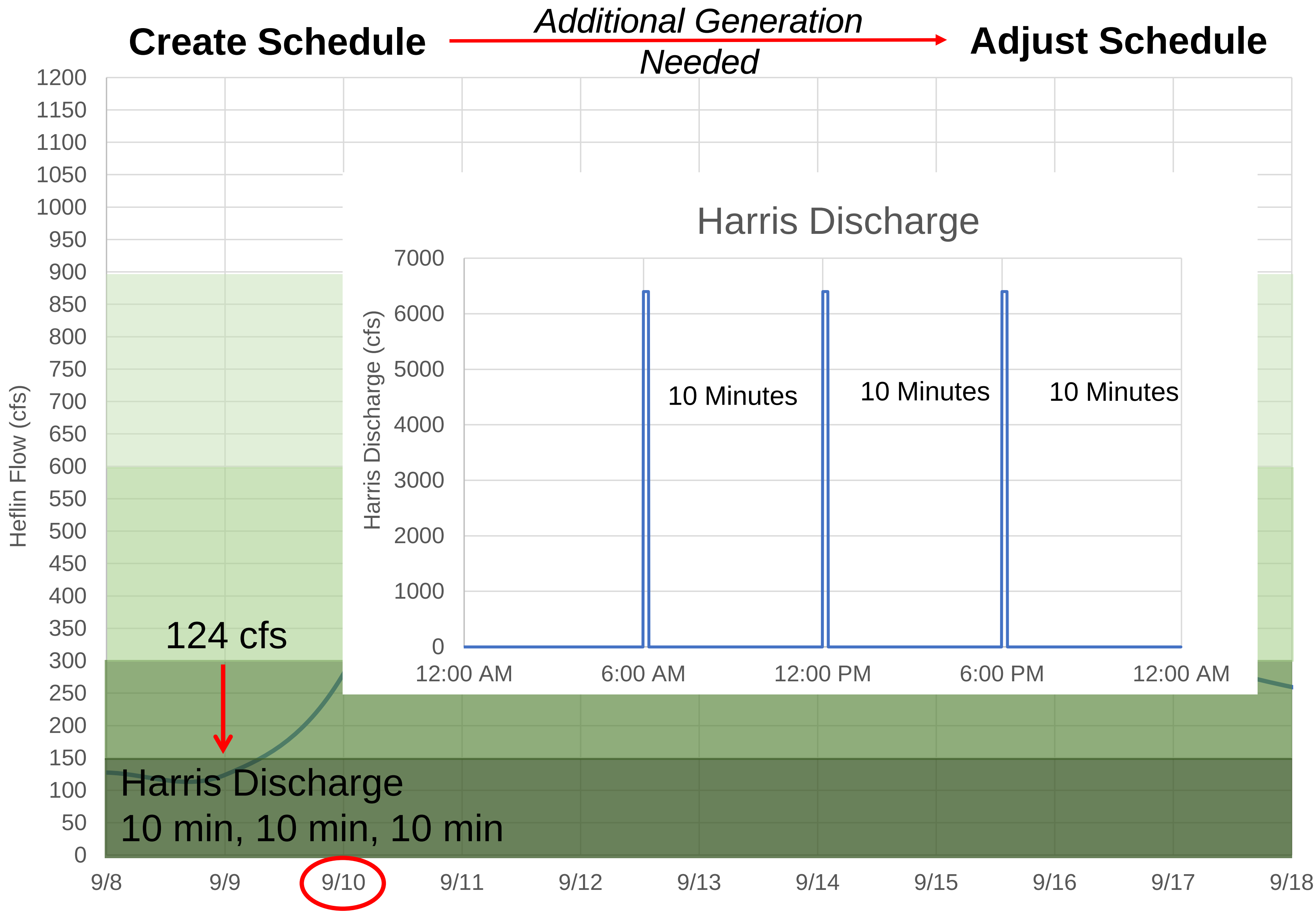
Adjust Schedule if Necessary

STEP	Total Schedule Generation	Generation At 6 AM	Generation At 12 Noon	Generation As System Needs	Total Machine Time	Harris Total Discharge (dsf)
1B	If generation = 1 machine hr	15 min	15 min	30 min	30 min	267
2B	If generation = 2 machine hr	30 min	30 min	1 hour	1 hour	533
3B	If generation = 3 machine hr	30 min	30 min	2 hours	2 hours	800
4B	If generation = 4 machine hr	30 min	30 min	3 hours	3 hours	1,067
5B	Generation > 4 machine hr	Not Required	Not Required	ALL		

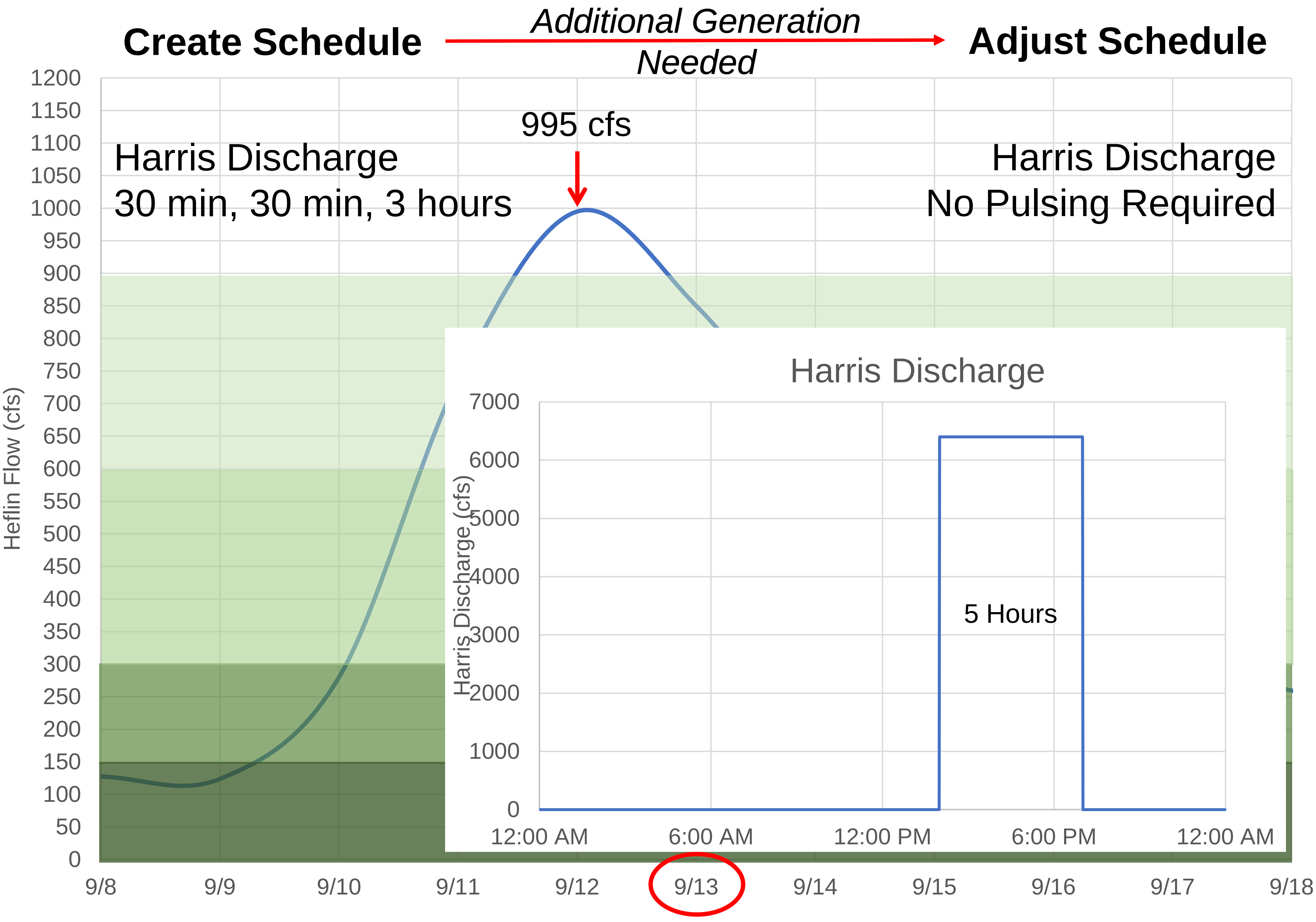
Harris Adaptive Management Scheduling



Harris Adaptive Management Scheduling

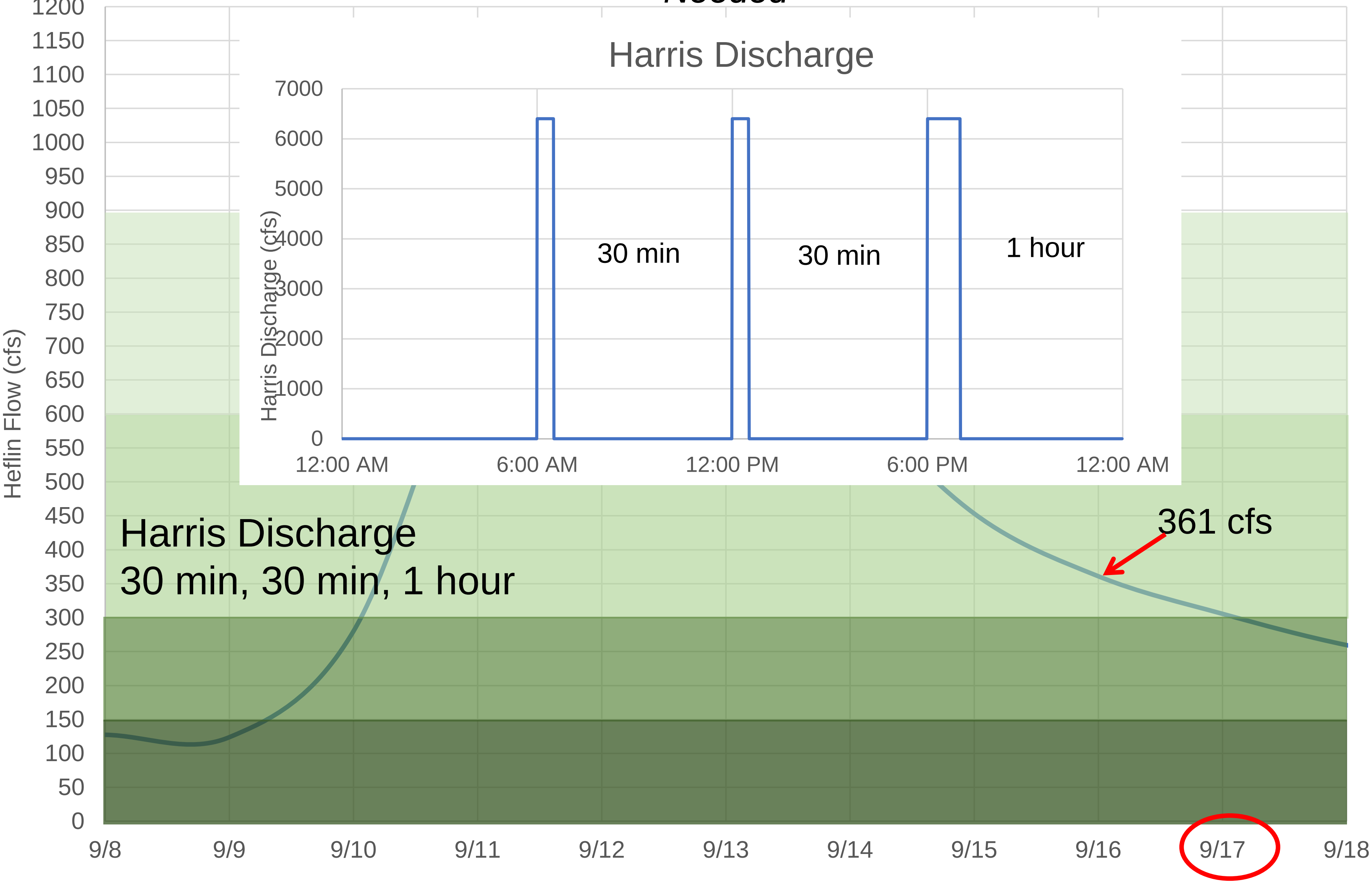


Harris Adaptive Management Scheduling



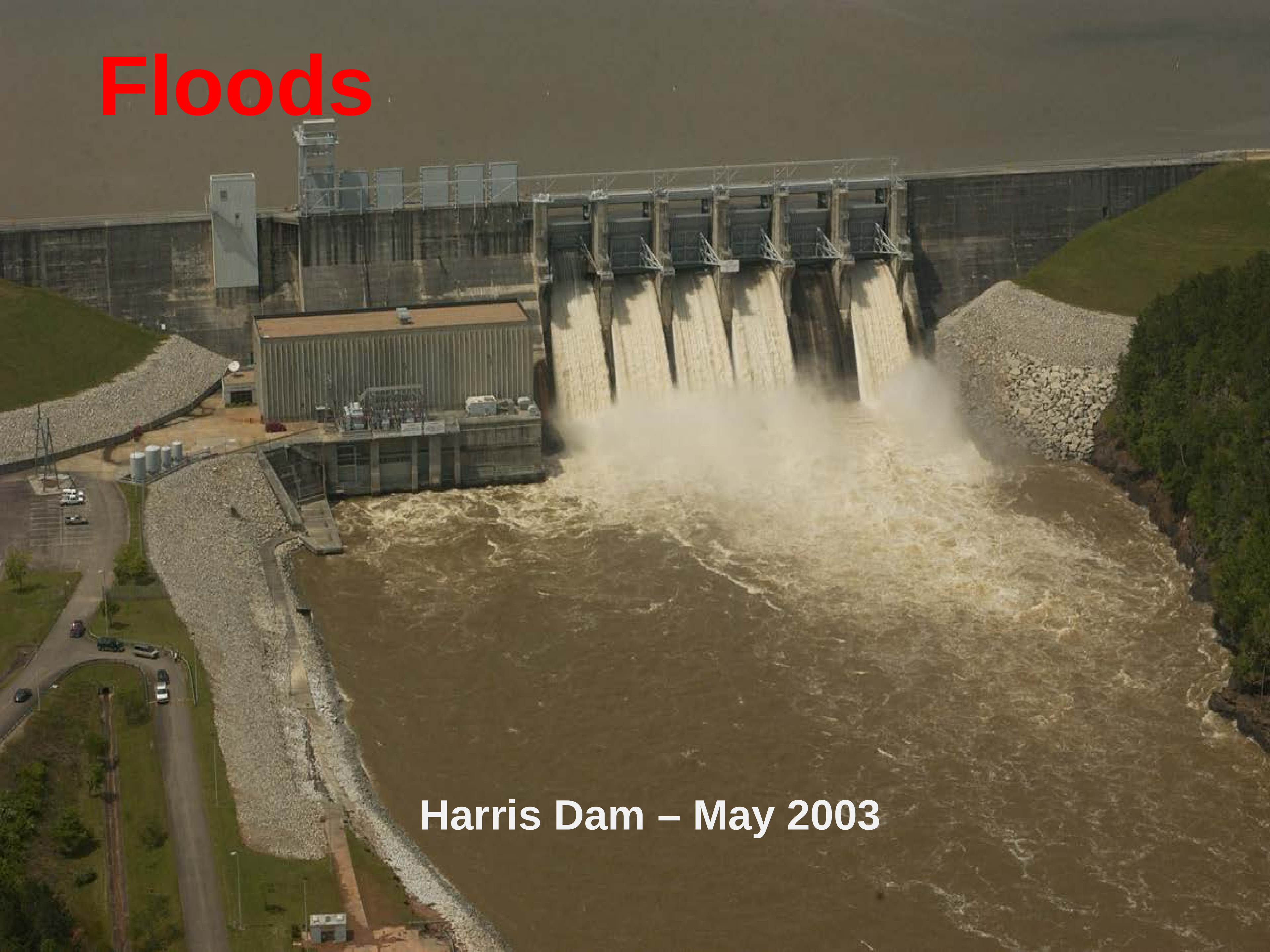
Harris Adaptive Management Scheduling

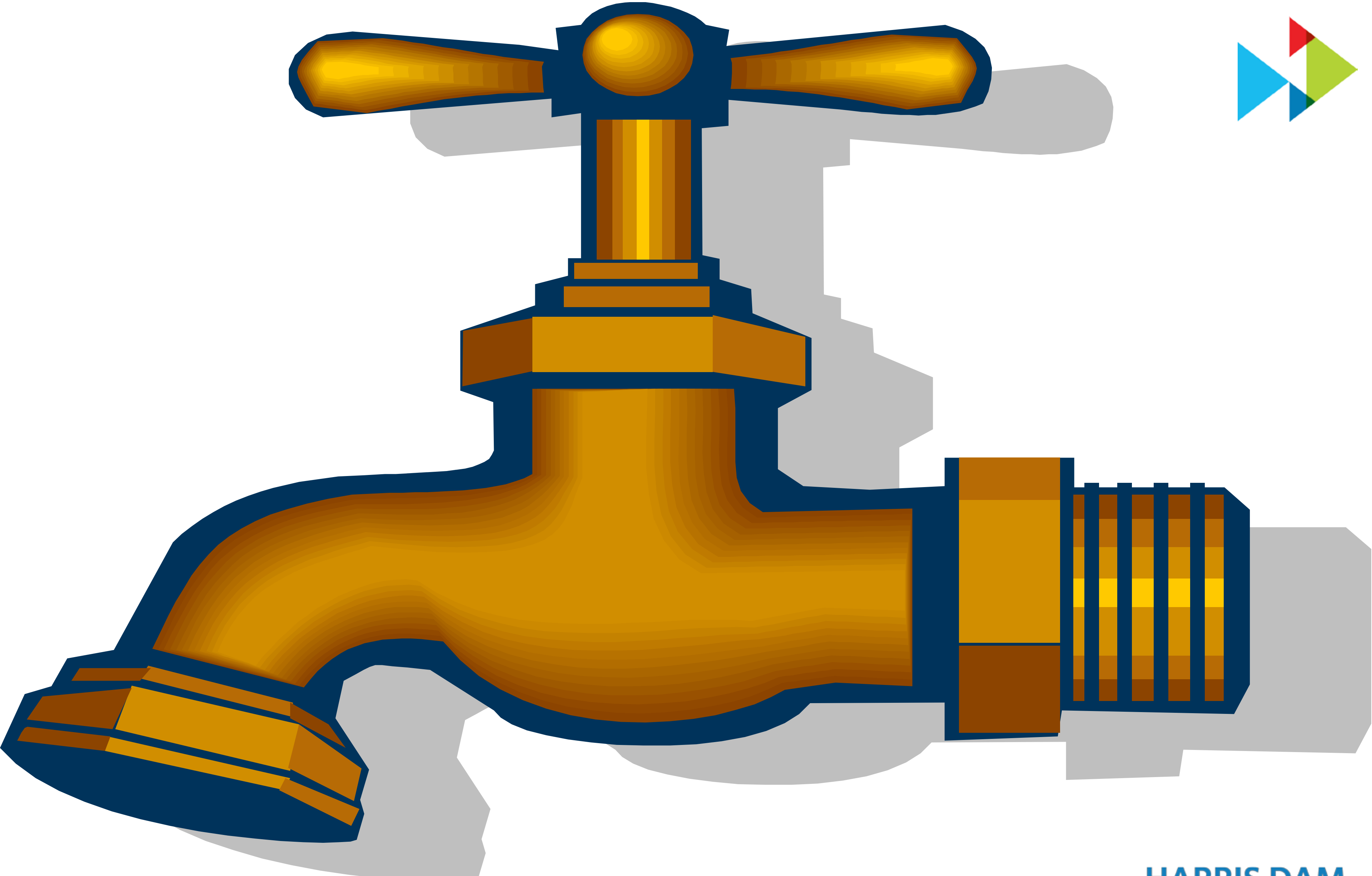
Create Schedule → *Additional Generation Needed* → **Adjust Schedule**



Weather Extremes!

Floods and Drought


Floods
Harris Dam – May 2003



HARRIS DAM
RELICENSING

Flood Control

- **Flood Control can be defined as minimizing river stages downstream of a dam**
  - Generally, the people and property located downstream benefit from flood control operations
- **Run-of-river reservoirs have no flood control capability**
  - they cannot provide this benefit to the public
- **Most flood control reservoirs have a control point that is used as a focus for the flood control operations:**
  - Harris uses Wadley

HARRIS DAM RELICENSING

How Are Floods Managed

- **Downstream flood peaks are minimized by discharging less water than is coming into the reservoir**

- **Studies of historic rainfall events result in a reasonable rules and regulations (flood control plan)**

- **Not every flood can be completely controlled**
  - each project has a particular amount of water that it can store
  - after all flood storage has been used, the project becomes run-of-river

License for FERC Project 2628

- Article 13. (c) Operate the reservoir for flood control in accord with the agreement between the Chief of Engineers, Department of the Army, and the Licensee ...

US Army Corps
of Engineers ®
Mobile District

ALABAMA-COOSA-TALLAPOOSA RIVER BASIN WATER CONTROL MANUAL

Final
APPENDIX I

R. L. HARRIS DAM AND LAKE (ALABAMA POWER COMPANY)

TALLAPOOSA RIVER, ALABAMA

U.S. ARMY CORPS OF ENGINEERS
SOUTH ATLANTIC DIVISION
MOBILE DISTRICT
MOBILE, ALABAMA

SEPTEMBER 1972
REVISED OCTOBER 1993; JUNE 2004; and MAY 2015

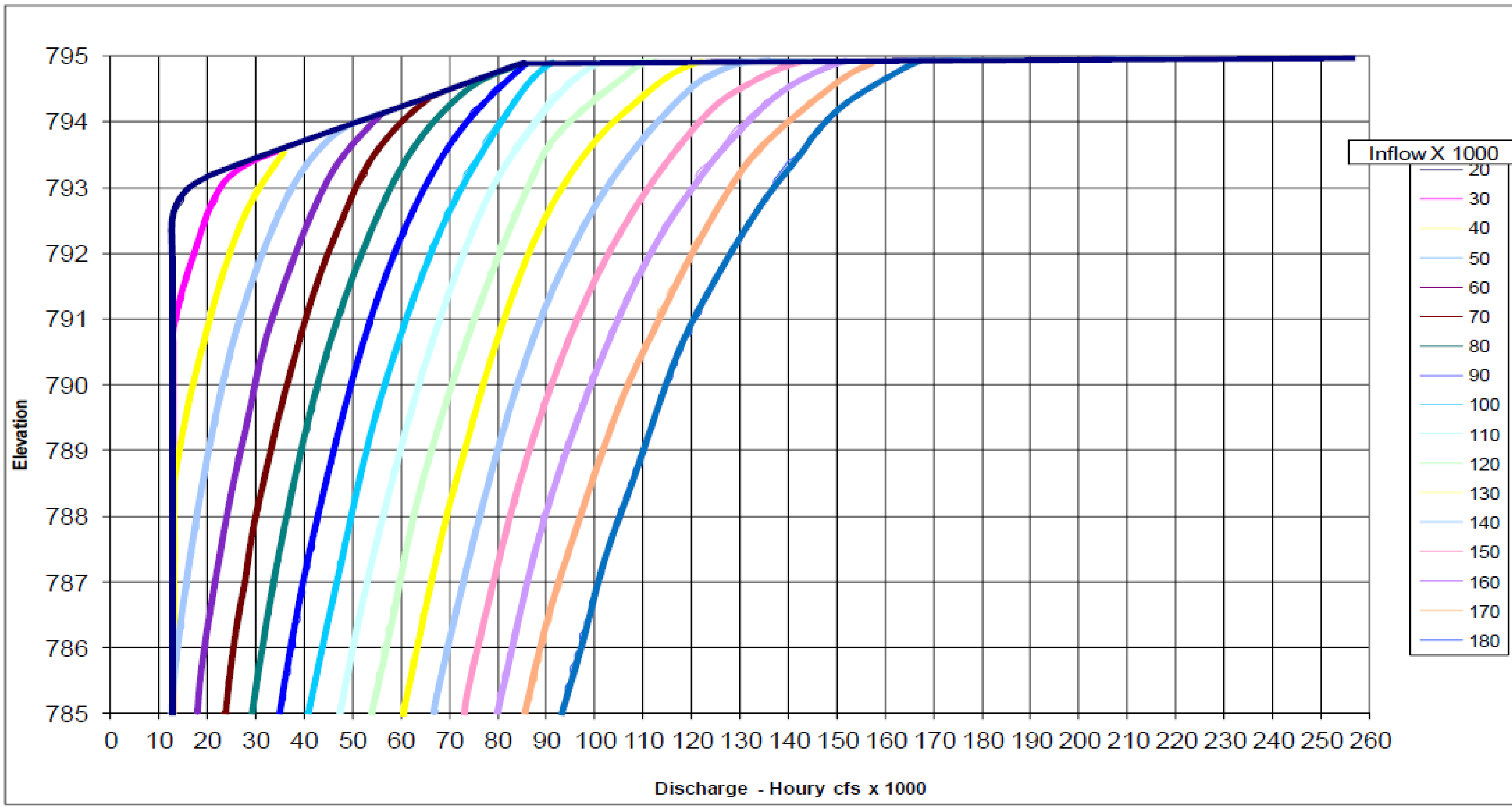
Harris Reservoir Flood Control Procedure

Rule	Condition	Outflow	Operation
1	Below Power Guide Curve (PGC)		Operate powerplant to satisfy system load requirements.
2	At or above PGC and below elevation 790	13,000 cfs or less depending on Wadley stage	Operate to discharge 13,000 cfs or an amount that will not cause the gage at Wadley to exceed 13.0 feet, unless greater discharge amounts are required by the Induced Surcharge Schedule. Discharge rates determined by the Harris real-time water control model may be substituted for those indicated by the Induced Surcharge Curves. If the model produces outflows in excess of those identified by the Induced Surcharge Schedule for six (6) consecutive periods, the operator shall notify the Water Management Section before making any further gate movements.
3	Above PGC and above 790 and rising	16,000 cfs or greater	Discharge 16,000 cfs or greater if required by the Induced Surcharge Curves Releases may be made through the spillway gates or powerhouse or a combination of both. Discharge rates determined by the Harris real-time water control model may be substituted for those indicated by the Induced Surcharge Curves. If the model produces outflows in excess of those identified by the Induced Surcharge Schedule for six (6) consecutive periods, the operator shall notify the Water Management Section before making any further gate movements.
4	Above PGC and falling		When the reservoir begins to fall, maintain current gate settings and power house discharge until the pool recedes to the PGC, then return to normal operation.

Induced Surcharge Curves

CORPS OF ENGINEERS

U. S. ARMY



Operating Instructions:

1. Follow regular flood control regulation as shown on Plate 7-3 until releases are required by this schedule.
2. Adjust the outflow hourly based on the average inflow for the preceding three hours and the current reservoir level as indicated by these curves.
3. When the reservoir level begins to fall maintain the current gate openings and power plant discharge in effect at that time until the reservoir recedes to the top of the Power Guide Curve, then follow regular flood regulations.
4. The Spillway Gate will be opened in accordance with the gate opening schedule to produce a discharge as near as practical to those prescribed under this schedule.

ALABAMA-COOSA-TALLAPOOSA RIVER BASIN

WATER CONTROL MANUAL
R.L. HARRIS DAM AND LAKE

INDUCED SURCHARGE CURVES

HIGH WATER MARK

37.20 FEET (24.30 FEET ABOVE FLOOD STAGE)

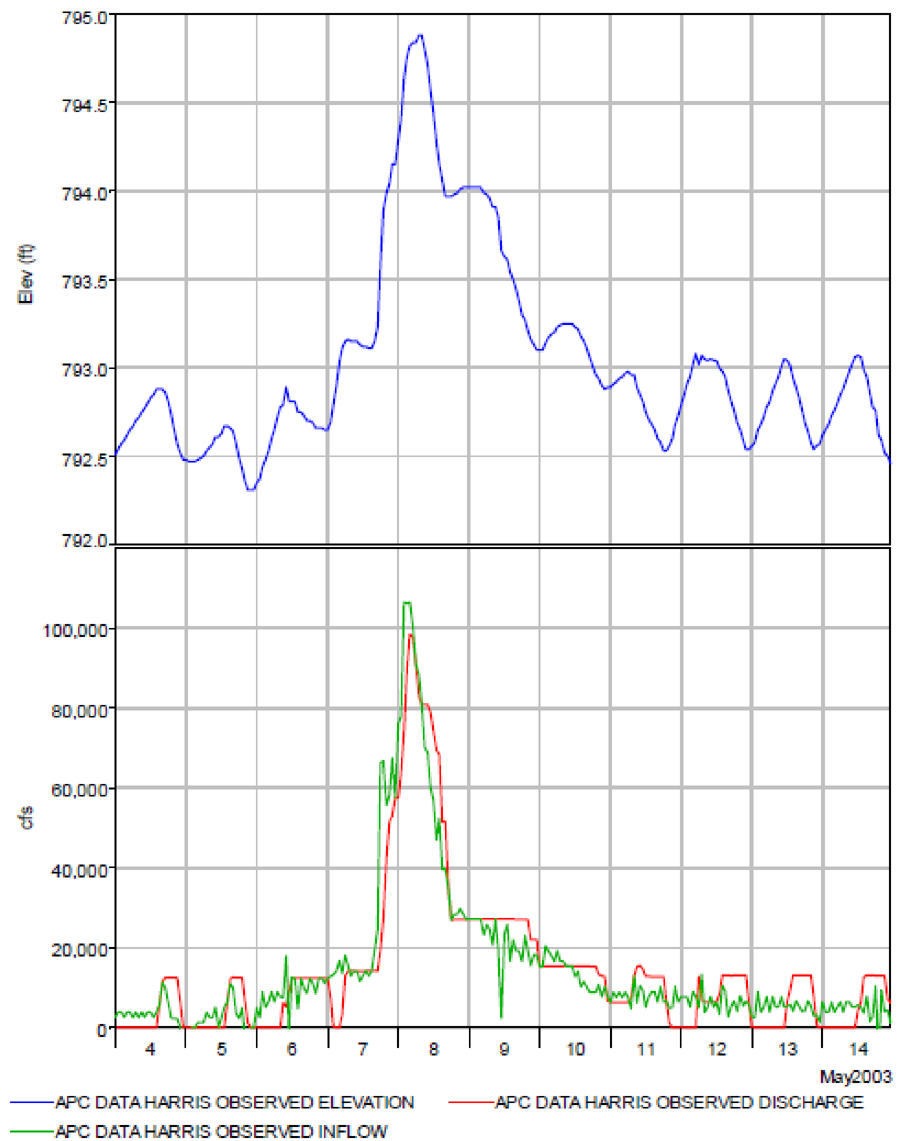
MAY 8, 2003

ON THIS DAY, WATER FROM THE TALLAPOOSA RIVER ROSE TO THIS LEVEL AT THIS LOCATION. FOR MORE INFORMATION, CONTACT:

NATIONAL WEATHER SERVICE BIRMINGHAM, AL
www.srh.noaa.gov/bmx

SOUTHEAST RIVER FORECAST CENTER
weather.gov/serfc

USGS ALABAMA WATER SCIENCE CENTER
al.water.usgs.gov



Data from APC hourly values

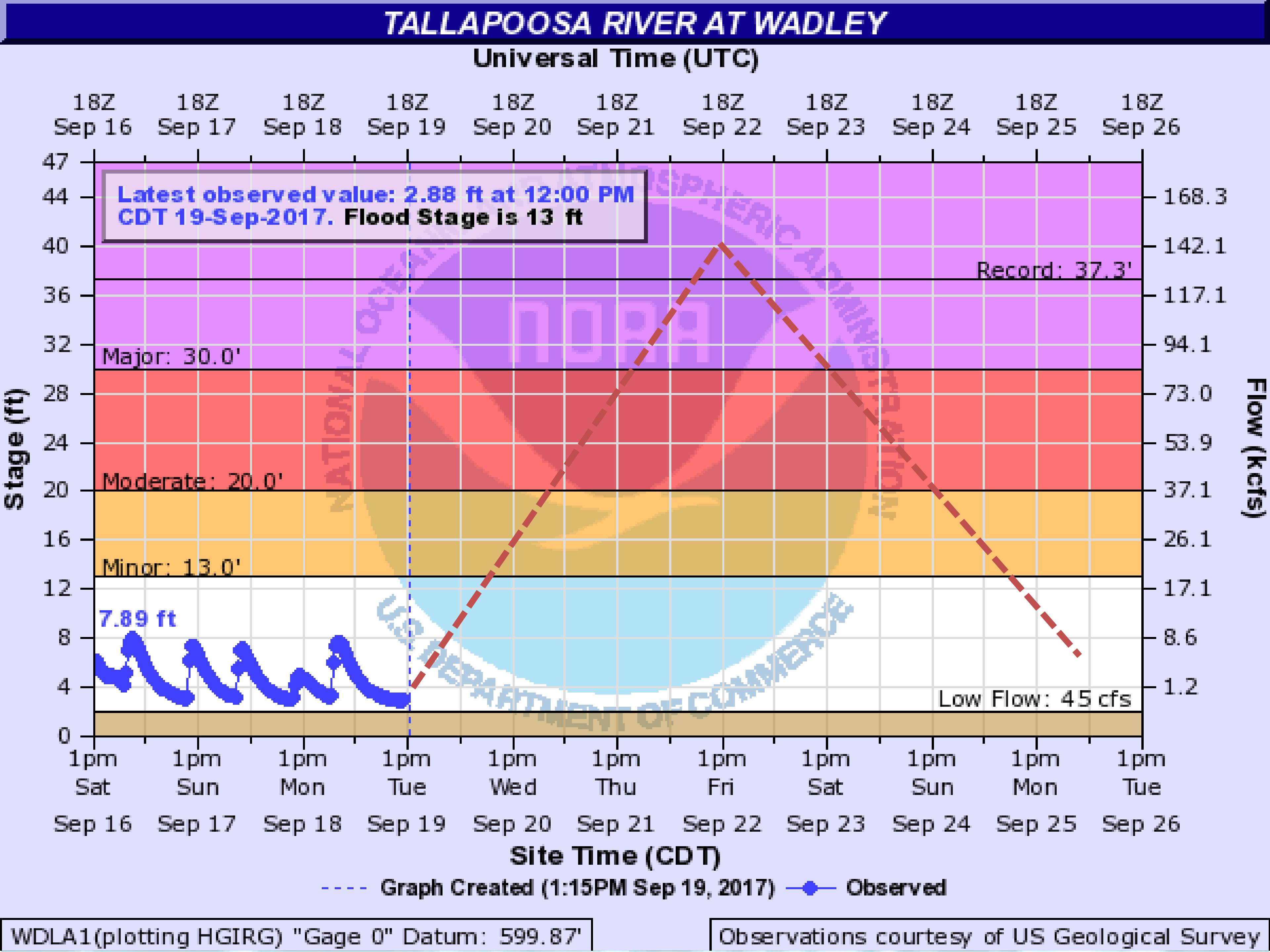
ALABAMA-COOSA-TALLAPOOSA RIVER BASIN

WATER CONTROL MANUAL
R.L. HARRIS DAM AND LAKE

FLOOD OF 2003
INDUCED SURCHARGE REGULATION
HOURLY VALUES

Responsibility for issuing stage forecasts to the public

- The issuing of stage forecasts to the general public is the legal responsibility of the National Weather Service. For the Alabama-Coosa-Tallapoosa and Black Warrior-Tombigbee river basins, forecasts are prepared by the National Weather Service's Southeast River Forecast Center in Peachtree City, Georgia. Flood warnings are issued by Birmingham's National Weather Service office in Calera.



TALLAPOOSA RIVER AT WADLEY
Universal Time (UTC)
18Z Sep 16
18Z Sep 17
18Z Sep 18
18Z Sep 19
18Z Sep 20
18Z Sep 21
18Z Sep 22
18Z Sep 23
18Z Sep 24
18Z Sep 25
18Z Sep 26
Latest observed value: 2.88 ft at 12:00 PM CDT 19-Sep-2017. Flood Stage is 13 ft
Record: 37.3'
Major: 30.0'
Moderate: 20.0'
Minor: 13.0'
7.89 ft
Low Flow: 45 cfs
Stage (ft)
47
44
40
36
32
28
24
20
16
12
8
4
0
Flow (kcfs)
168.3
142.1
117.1
94.1
73.0
53.9
37.1
26.1
17.1
8.6
1.2
1pm Sat Sep 16
1pm Sun Sep 17
1pm Mon Sep 18
1pm Tue Sep 19
1pm Wed Sep 20
1pm Thu Sep 21
1pm Fri Sep 22
1pm Sat Sep 23
1pm Sun Sep 24
1pm Mon Sep 25
1pm Tue Sep 26
Site Time (CDT)
Graph Created (1:15PM Sep 19, 2017)
Observed
WDLA1(plotting HGIRG) "Gage 0" Datum: 599.87'
Observations courtesy of US Geological Survey

Tallapoosa River at Wadley

Flood Impacts

- **35** - THE EAST END OF THE HIGHWAY 22 BRIDGE BEGINS TO FLOOD. WATER REACHES STORE/GAS STATION ON HIGHWAY 22 JUST WEST OF TOWN.
- **32** - PORTIONS OF HIGHWAY 22 SOUTHWEST OF WADLEY ARE FLOODED.
- **30** - SOME FLOODING OF BUSINESSES...INCLUDING PLANTATION PATTERNS...OCCURS IN THE WADLEY AREA.
- **20** - SOME FLOODING OCCURS IN THE WADLEY AREA. BETWEEN 22 AND 25 FEET THE BRIDGE OVER BEAVERDAM CREEK FLOODS.
- **13** - FLOODING OF PASTURELANDS IN THE AREA OCCURS AND CATTLE SHOULD BE MOVED TO HIGHER GROUND.

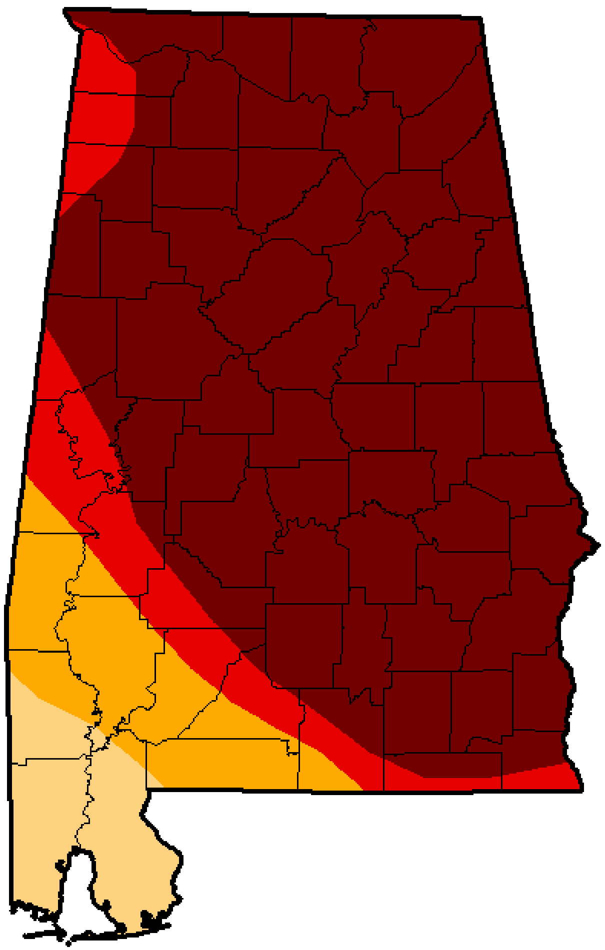
Low Water Impacts

- 45 CFS R.L. Harris dam (15 miles upstream) operated to provide a minimum flow of 45 cfs at Wadley.

Droughts

U.S. Drought Monitor

Alabama



October 16, 2007

(Released Thursday, Oct. 18, 2007)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	99.97	93.23	83.12	73.04
Last Week *10/9/2007*	0.00	100.00	99.97	91.01	78.18	58.82
3 Months Ago *7/17/2007*	0.00	100.00	90.28	71.55	41.56	24.33
Start of Calendar Year *1/2/2007*	51.87	48.13	0.00	0.00	0.00	0.00
Start of Water Year *9/25/2007*	1.40	98.60	90.18	81.92	71.11	48.72
One Year Ago *10/17/2006*	0.00	100.00	57.95	0.00	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Mark Svoboda
National Drought Mitigation Center

USDA National Drought Mitigation Center

http://droughtmonitor.unl.edu/

DAM LICENSING

Drought Management

- Droughts are very difficult to see coming
  - you don’t know you’re in a severe drought until you’ve been there for some time
- Droughts tend to take months to setup
  - And take months of wet weather to return flow conditions to normal
- APCo’s storage reservoirs can, to an extent, support some level of critical downstream flows during drought periods
  - this is done by releasing water from storage
- How does APCo determine how much and when and from where?
  - Alabama-ACT Drought Response Operating Plan (ADROP)
    - a low flow management plan, not a plan to keep the lakes full

Table 3: Drought Intensity Level Response Matrix [1]

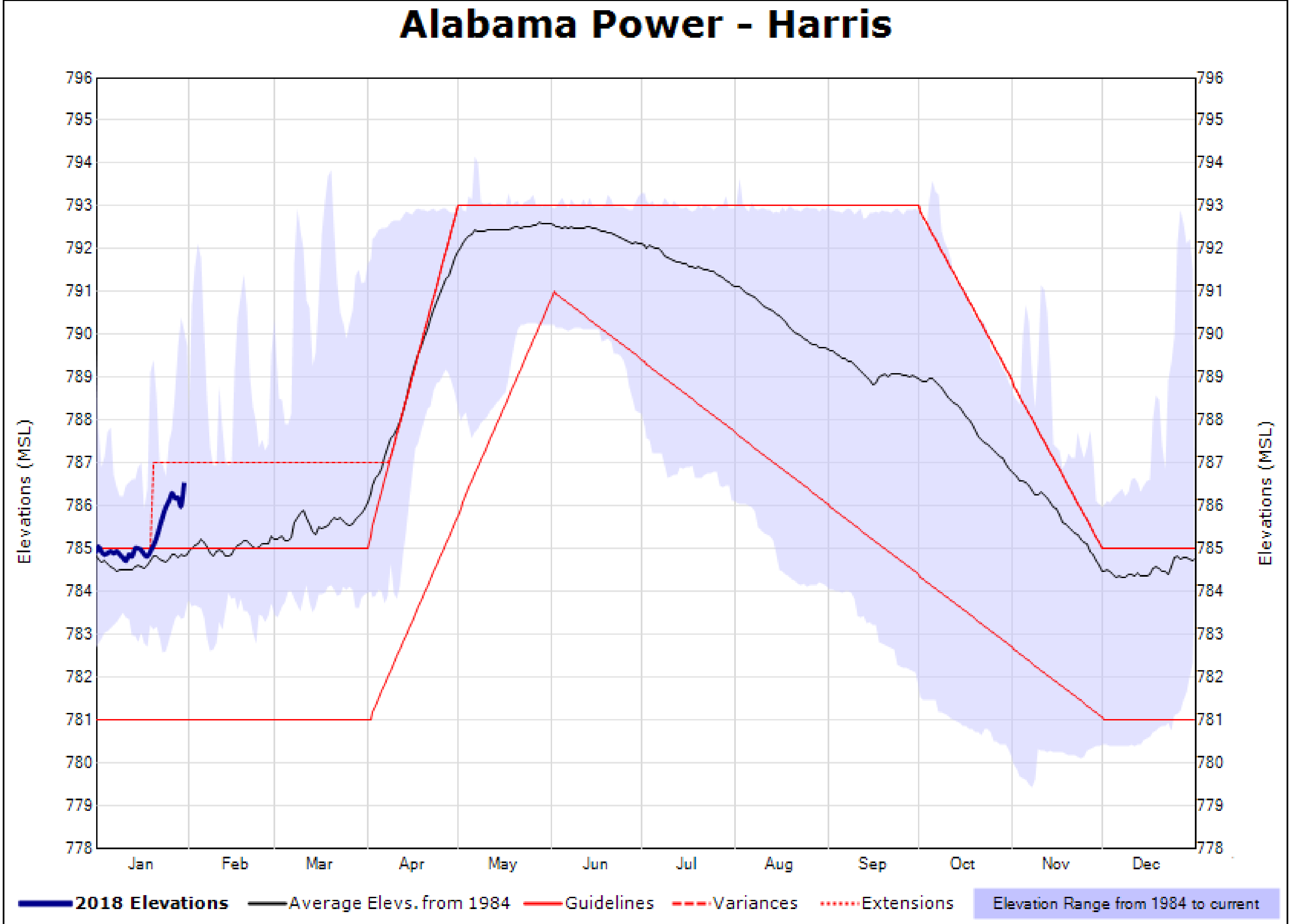
<table>
<tr><th></th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>June</th><th>July</th><th>Aug</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td rowspan="4">Drought Intensity Level Triggers</td><td colspan="12">Normal Operations</td></tr>
<tr><td colspan="12">DIL 1: Low Basin Inflows or Low Composite Storage or Low State Line Flow</td></tr>
<tr><td colspan="12">DIL 2: DIL 1 criteria + (Low Basin Inflows or Low Composite Storage or Low State Line Flow)</td></tr>
<tr><td colspan="12">DIL 3: Low Basin Flows + Low Composite Storage + Low State Line Flow</td></tr>
<tr><td rowspan="4">Coosa River Flow [2]</td><td colspan="3">Normal Operations 2000 cfs</td><td colspan="2">4000 (8000)</td><td>4000 - 2000</td><td colspan="6">Normal Operations 2000 cfs</td></tr>
<tr><td colspan="3">Jordan
2000 +/- cfs</td><td colspan="2">Jordan
4000 +/- cfs</td><td>6/15 Linear Ramp down</td><td colspan="3">Jordan
2000 +/- cfs</td><td colspan="3">Jordan
2000 +/- cfs</td></tr>
<tr><td colspan="3">Jordan
2000 +/- cfs</td><td colspan="2">Jordan
2500 +/- cfs</td><td>6/15 Linear Ramp down</td><td colspan="3">Jordan
2000 +/- cfs</td><td colspan="3">Jordan
2000 – 1600 +/- cfs</td></tr>
<tr><td colspan="3">Jordan
1600 +/- cfs</td><td colspan="3">Jordan
1600 - 2000 +/- cfs</td><td colspan="3">Jordan
2000 +/- cfs</td><td colspan="2">Jordan
1800 +/- cfs</td><td>Jordan
1600 +/- cfs</td></tr>
<tr><td rowspan="4">Tallapoosa River Flow [3]</td><td colspan="12">Normal Operations 1200 cfs</td></tr>
<tr><td colspan="4">Greater of: ½ Yates Inflow or
2 x Heflin Gage (Thurlow releases > 350 cfs)</td><td colspan="5">½ Yates Inflow</td><td colspan="3">½ Yates Inflow</td></tr>
<tr><td colspan="4">Thurlow 350 cfs</td><td colspan="5">½ Yates Inflow</td><td colspan="3">Thurlow 350 cfs</td></tr>
<tr><td colspan="6">Maintain 400 cfs at Montgomery WTP
(Thurlow release 350 cfs)</td><td colspan="3">Thurlow 350 cfs</td><td colspan="3">Maintain 400 cfs at Montgomery WTP
(Thurlow release 350 cfs)</td></tr>
<tr><td rowspan="4">Alabama River Flow [4]</td><td colspan="12">Normal Operations 4640 cfs</td></tr>
<tr><td colspan="4">4200 cfs (10% Cut) - Montgomery</td><td colspan="5">4640 cfs - Montgomery</td><td colspan="3">Reduce 4640 cfs – 4200 cfs Montgomery</td></tr>
<tr><td colspan="5">3700 cfs (20% Cut) - Montgomery</td><td colspan="4">4200 cfs (10% Cut) - Montgomery</td><td colspan="3">Reduce: 4200 cfs - 3700 cfs Montgomery
(1 Week ramp)</td></tr>
<tr><td colspan="4">2000 cfs Montgomery</td><td colspan="2">3700 cfs Montgomery</td><td colspan="3">4200 cfs (10% Cut) Montgomery</td><td colspan="3">Reduce 4200 cfs - 2000 cfs Montgomery
(1 Month ramp)</td></tr>
<tr><td rowspan="4">Guide Curve Elevation</td><td colspan="12">Normal Operations: Elevations follow Guide Curves as prescribed in License (Measured in Feet)</td></tr>
<tr><td colspan="12">USACE Variances: As Needed; FERC Variance for Martin</td></tr>
<tr><td colspan="12">USACE Variances: As Needed; FERC Variance for Martin</td></tr>
<tr><td colspan="12">USACE Variances: As Needed; FERC Variance for Martin</td></tr>
</table>

1. Note these are base flows that will be exceeded when possible
2. Jordan flows are based on a continuous +/- 5% of target flow
3. Thurlow flows are based on a continuous +/-5% of target flow; Flows are reset on noon each Tuesday based on the prior day's daily average at Heflin or Yates
4. Alabama River flows are 7-Day Average Flow

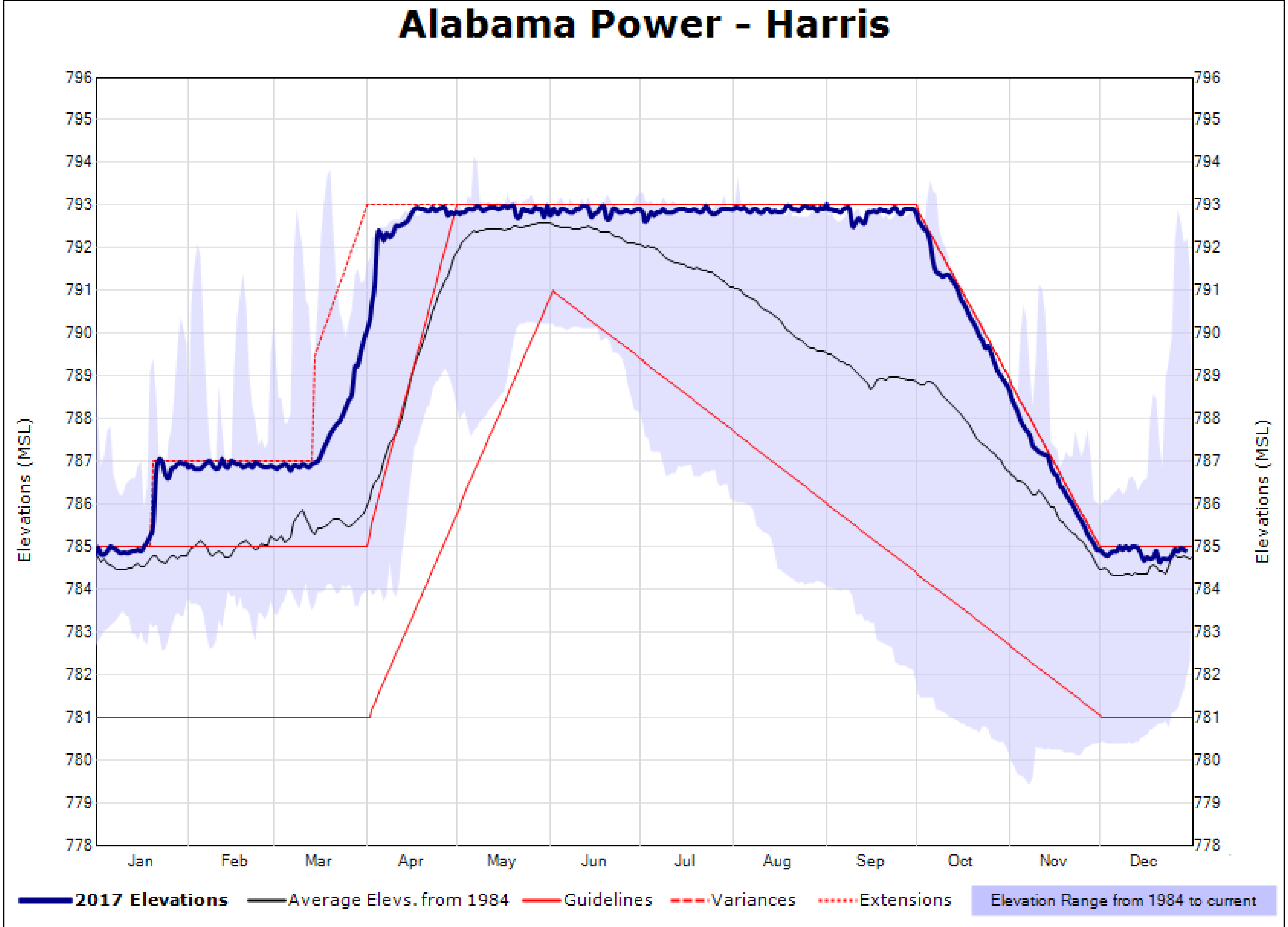
EVAPORATION

- Evaporative losses amounted to 1.5 feet of water from Alabama Power lakes in the summer months of 2007

- Enough water to supply Birmingham for one year



Plotted@1/31/2018 5:22 AM



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Year 2017

Our Agency Partners in Water Management

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

ADEM Alabama Department of Environmental Management

NATIONAL WEATHER SERVICE

USGS science for a changing world

U.S. FISH & WILDLIFE SERVICE

Outdoor Alabama
SHARE THE WONDER.

OWR The Office of Water Resources
A Division of ADECA

FERC FEDERAL ENERGY REGULATORY COMMISSION

HARRIS DAM RELICENSING

Questions?