Water Supply Assessment for the Kaskaskia Region

March 6, 2012 presentation

"Beyond Yield Analysis: Drought Impacts on the Kaskaskia Navigation Channel"

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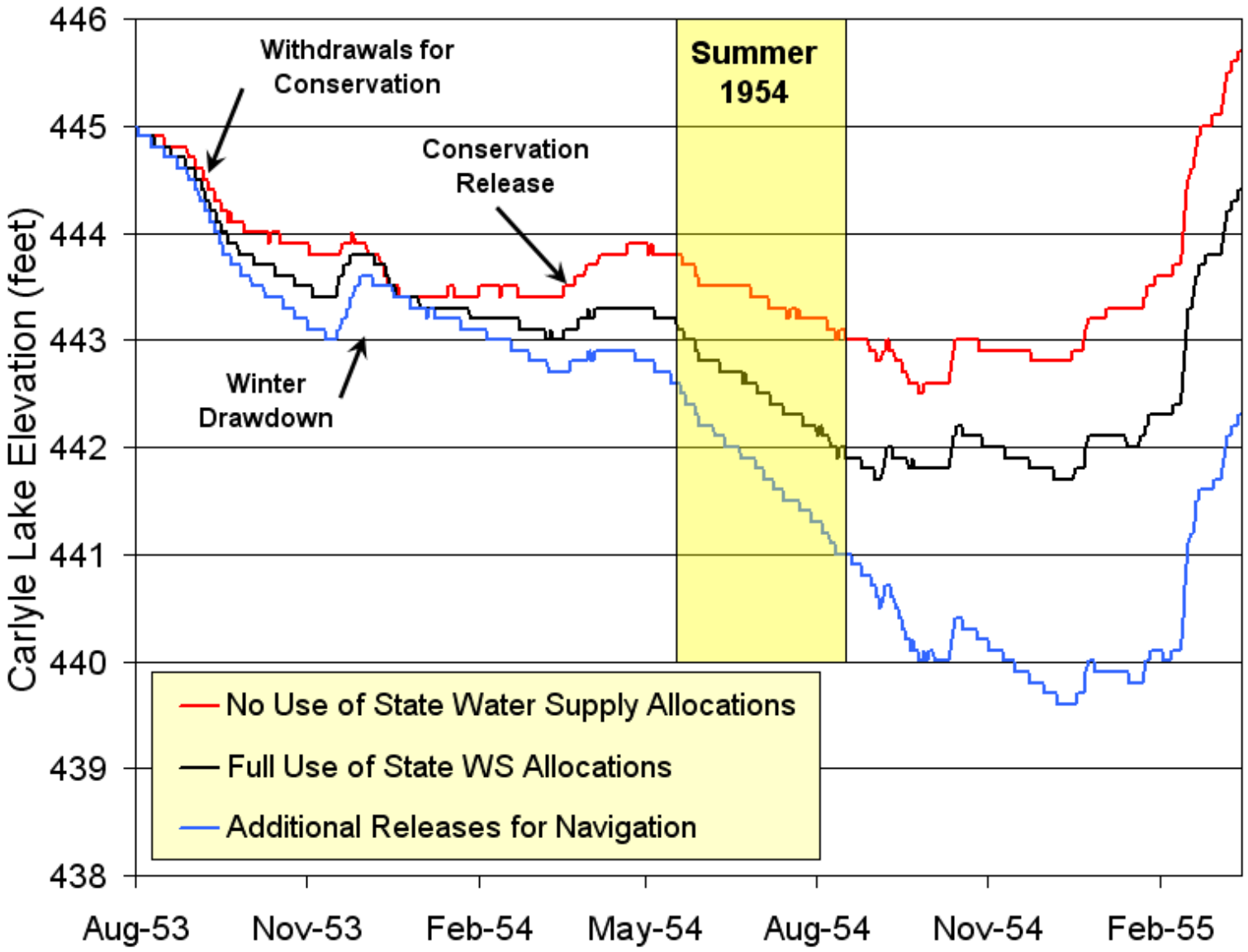
Note: Adjustments to water level simulations presented last month

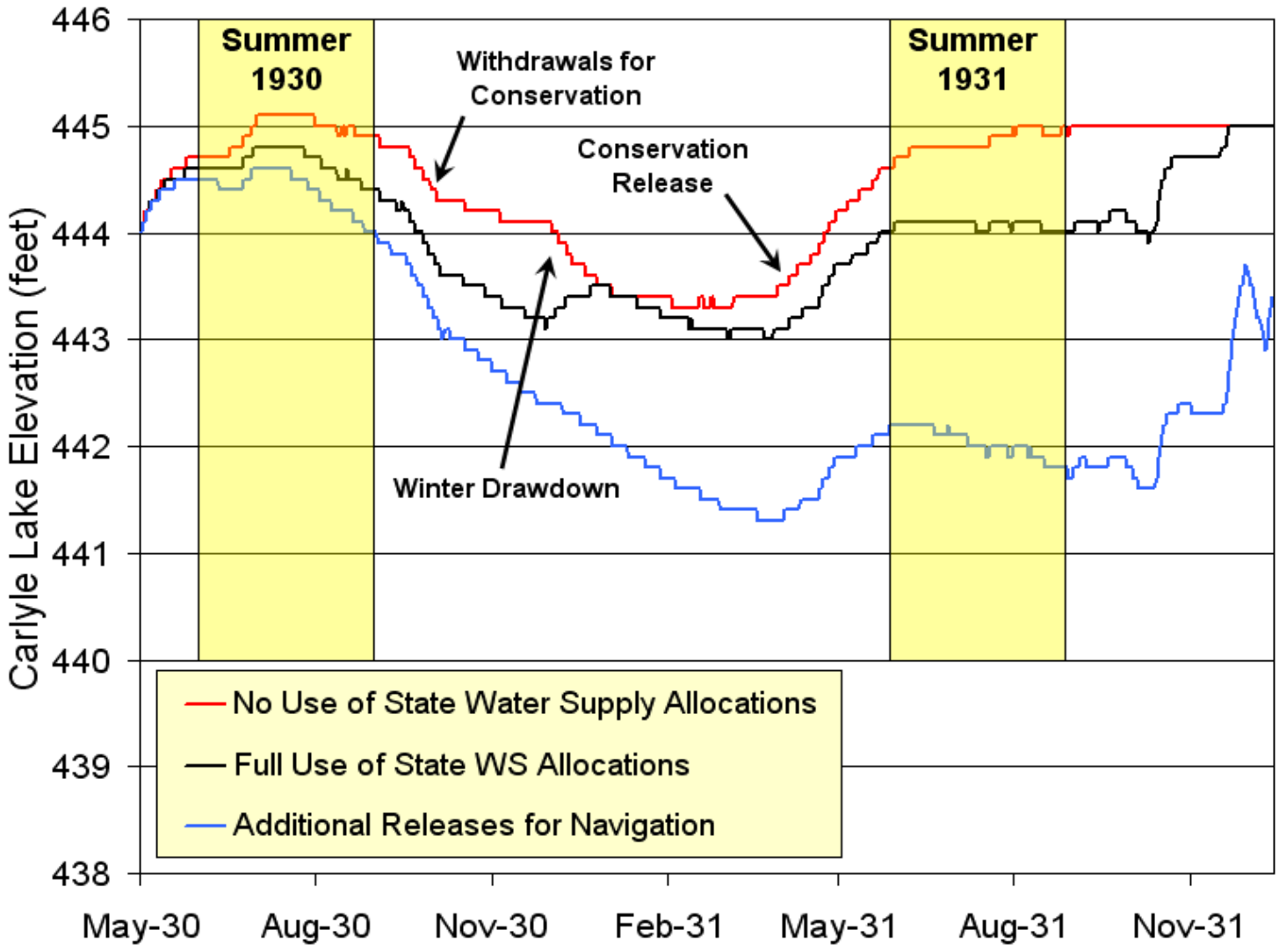
The simulations of Lake Shelbyville and Carlyle Lake water levels during severe drought were modified:

- In the third scenario, the additional releases for navigation were reduced from 50 mgd to 40 mgd
- For all scenarios, we assumed that the Corps would permit a 6" variance (increase) in the winter level during extremely dry conditions
- We also assumed that conservation withdrawals would be limited once Carlyle Lake falls below an elevation of 442'

The modified simulation results are the ones included in the meeting materials distributed by Allie.



Note: With the changes, the minimum elevation is around 440' instead of 439'



Also, these simulations are based on uniform (constant) use for water supply and navigation. If these uses varied – as based on time of need – it is likely that simulated Carlyle water levels would show the pool refilling at the beginning of the 1930 drought

Possible occurrence of an 'early' drought

- A number of comments have previously been made regarding the possibility that Lake Shelbyville and Carlyle Lakes might not start a drought at full pool during a drought with an early (May/June) onset
- This has been emphasized primarily because that is what was experienced during the 1988 drought
- As will be discussed, these early droughts can create elevated needs for flow releases to the Kaskaskia navigation pool.
- However, most droughts start later in the summer. A closer examination of simulated water levels shows that, while a greater likelihood exists for low starting elevations at Shelbyville, the 1936, 1976, 1988 years are the only historical droughts for which Carlyle Lake wouldn't fill (or get close to filling) by the end of June.

What Happened in 1988?

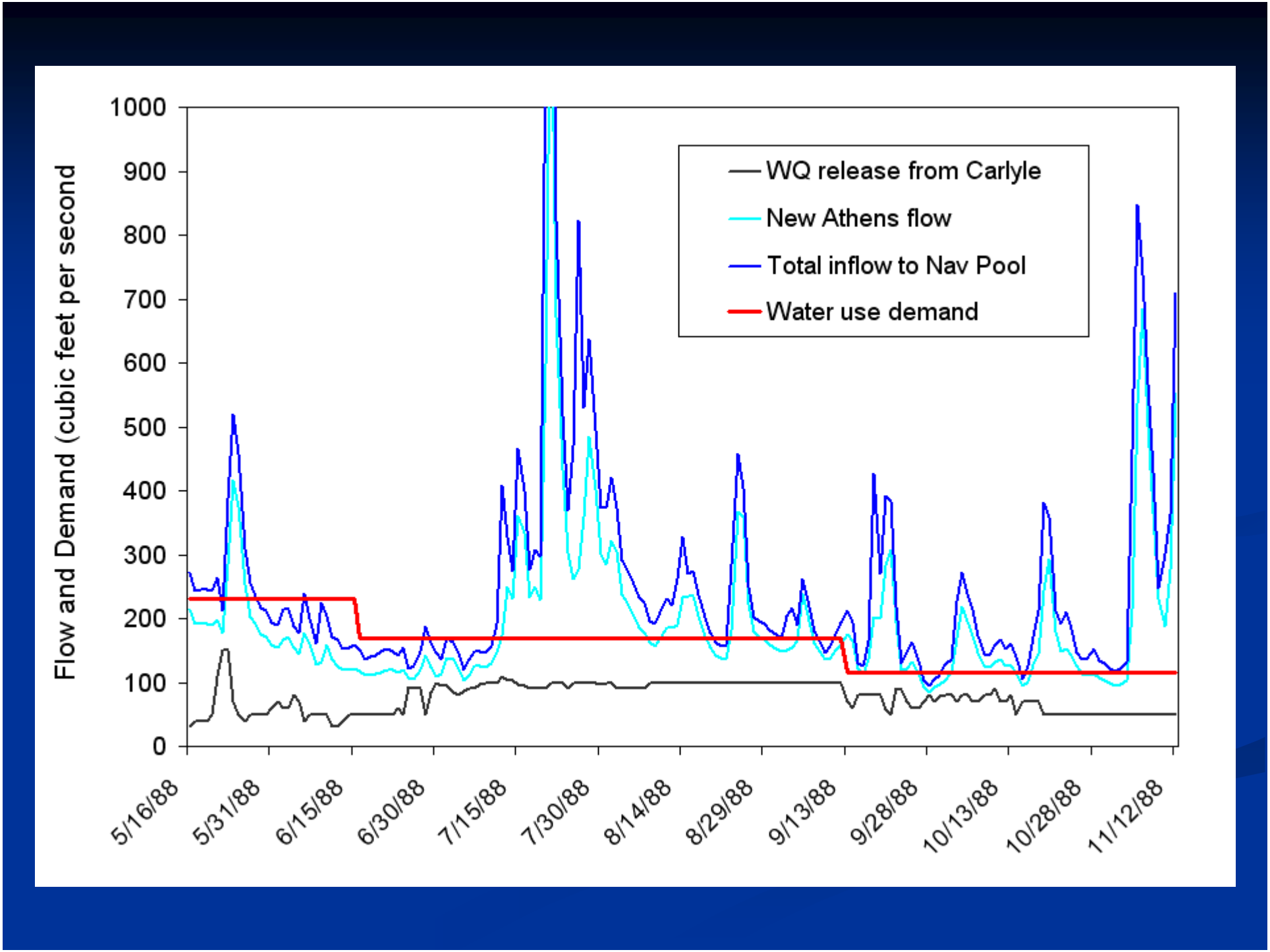
Rough Estimates of Average Daily Water Demand

Prior to restrictions (late May to mid-June)

Recreational Navigation	64 mgd (8 lockages)
Commercial Navigation	32 mgd (4 lockages)
Pool Evaporation	25 mgd
Baldwin net withdrawal	30 mgd
	151 mgd (230 cfs)

Following Restrictions

Navigation	60 mgd (7 lockages)
Pool Evaporation	25 mgd
Baldwin net withdrawal	25 mgd
	110 mgd (170 cfs)


Flow and Demand (cubic feet per second
1000
900
800
700
600
500
400
300
200
100
0
5/16/88
5/31/88
6/15/88
6/30/88
7/15/88
7/30/88
8/14/88
8/29/88
9/13/88
9/28/88
10/13/88
10/28/88
11/12/88
WQ release from Carlyle
New Athens flow
Total inflow to Nav Pool
Water use demand

A look at water demand scenarios under various drought conditions

Scenario 1: Commercial navigation needs are assumed to be equal and constant to the KRPD's 2021 projections (9.9 M tons). Public and power water needs are equal to the 2050 CT projection by SIU.

Scenario 2: Commercial navigation needs are assumed to be equal and constant to the KRPD's 2016. projections (3.9 M tons). Public and power water needs are equal to the 2050 LRI projection by SIU.

Scenario 3: Commercial navigation tonnage is assumed to be 13 M tons. Public and power water needs are equal to the 2050 MRI projection by SIU.

Scenario 1A: Average Daily Demand during an Extreme Summer Drought

Recreational use is slightly higher than what occurred in 2002 & 2007

Commercial use remains roughly as projected for year 2020

Recreational Navigation	51 mgd (6 lockages)
Commercial Navigation	43 mgd (5 lockages)
Pool Evaporation	25 mgd
Baldwin net withdrawal	30 mgd
Prairie State withdrawal	26 mgd
	180 mgd (280 cfs)

* Mississippi River conditions similar to the 1988 drought are assumed (22.5 foot lift = 8.5 mgd). Roughly 60% of total summer use in this scenario is for navigation.

Scenario 1B: Average Daily Demand during an Extreme Fall-to-Spring Drought similar to 1953-54 drought

Recreational Navigation	0-9 mgd (0-1 lockages)
Commercial Navigation	45 mgd (5 lockages)
Pool Evap. + Precipitation	0 mgd
Baldwin net withdrawal	15-20 mgd
Prairie State withdrawal	18 mgd**
	78-92 mgd (120-145 cfs)

78 mgd applied to Nov-Mar; 92 mgd applied to Oct & Apr

* Conditions similar to the 1953-54 drought are assumed (24-foot lift)

** Prairie State's estimated winter use is greater than 18 mgd, however their drought withdrawals are projected to be limited by allocation agreement

Scenario 2A: Average Daily Demand during a Summer Drought

Recreational use is slightly higher than what occurred in 2002 & 2007
Commercial use remains roughly as projected for year 2020

Recreational Navigation	51 mgd (6 lockages)
Commercial Navigation	17 mgd (2 lockages)
Pool Evaporation	25 mgd
Baldwin net withdrawal	35 mgd
Prairie State withdrawal	26 mgd
	154 mgd (240 cfs)

* Mississippi River conditions similar to the 1988 drought are assumed (22.5 foot lift = 8.5 mgd). Roughly 60% of total summer use in this scenario is for navigation.

Scenario 2B: Average Daily Demand during an Extreme Fall-to-Spring Drought similar to 1953-54 drought

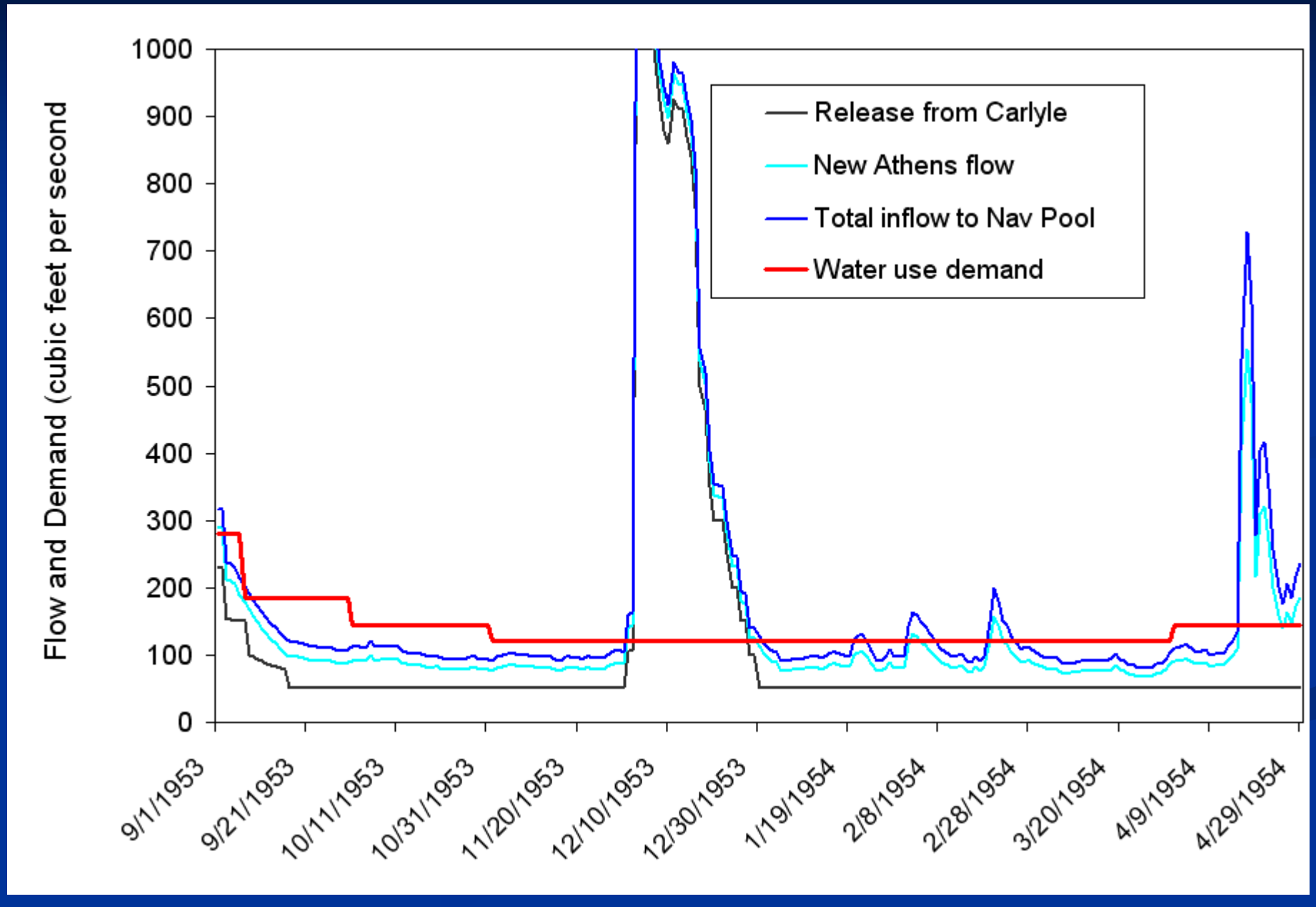
- Recreational Navigation 0-9 mgd (0-1 lockages)
- Commercial Navigation 18 mgd (2 lockages)
- Pool Evap. + Precipitation 0 mgd
- Baldwin net withdrawal 15-20 mgd
- Prairie State withdrawal 18 mgd

51-65 mgd (80-105 cfs)

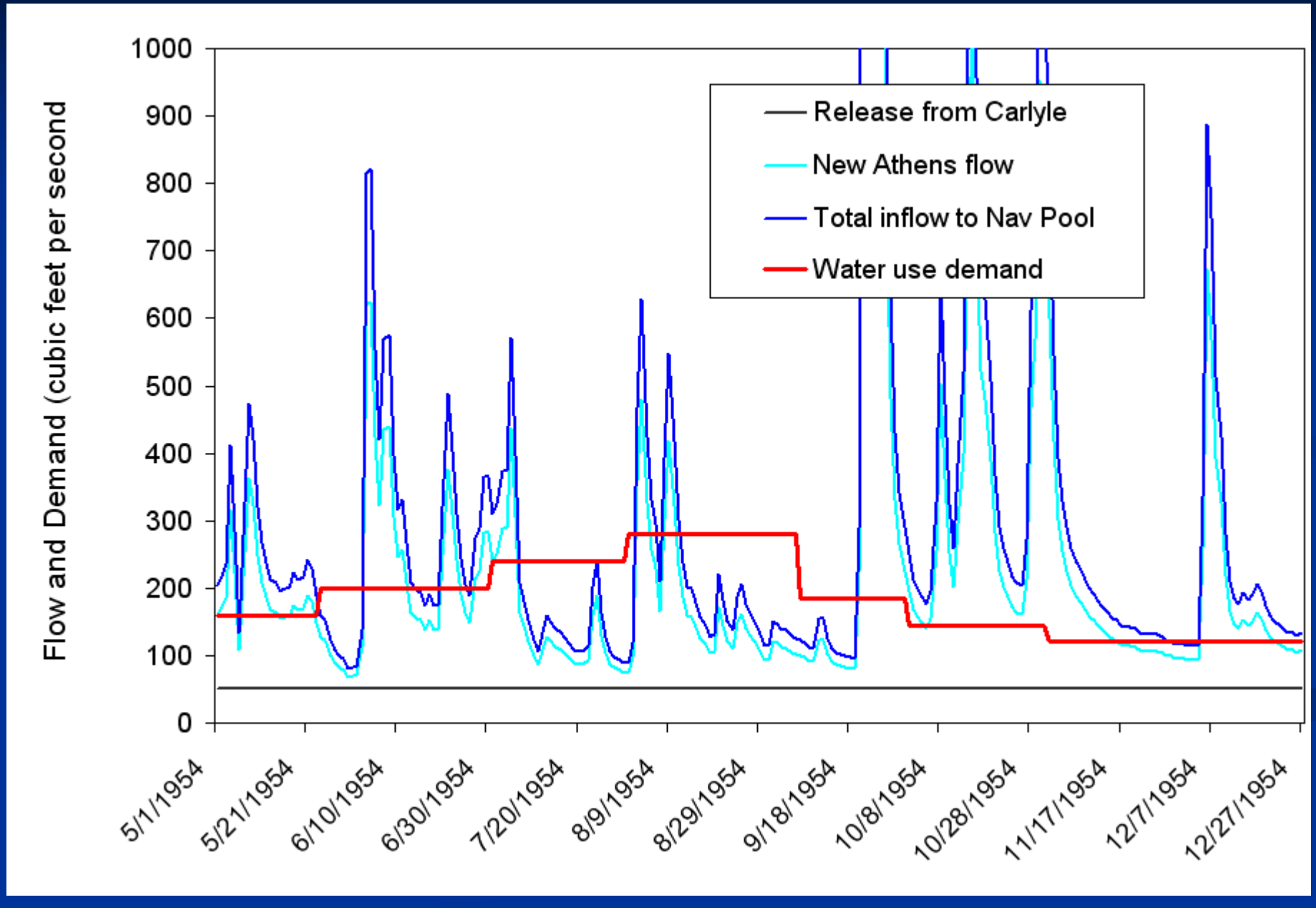
51 mgd applied to Nov-Mar; 65 mgd applied to Oct & Apr

* Conditions similar to the 1953-54 drought are assumed (24-foot lift)

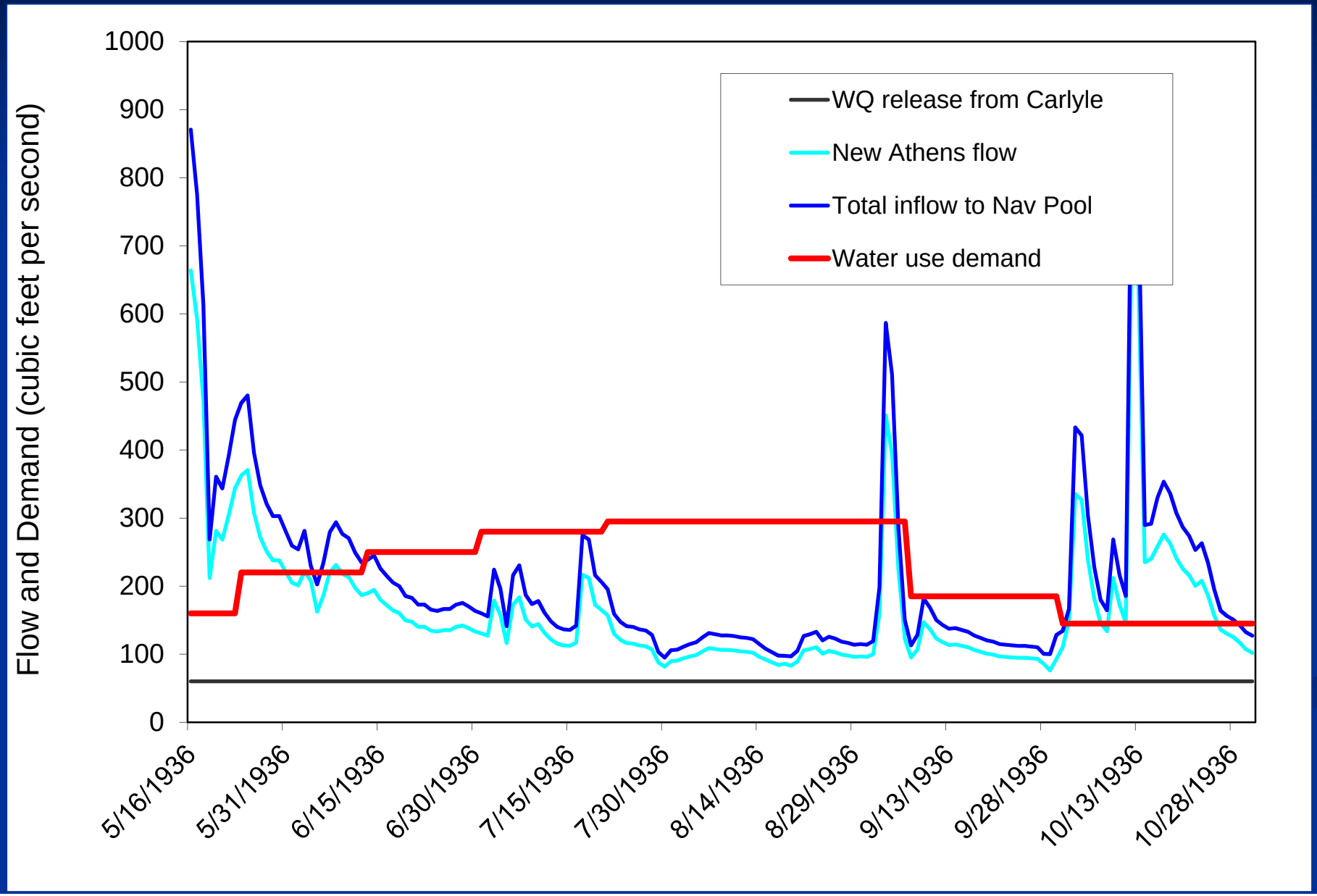
Simulation of 1953-54 Drought (Scenario 1) – 1/2



Simulation 1953-54 Drought (Scenario 1) – 2/2



Simulation of Severe Summer Drought (1936)



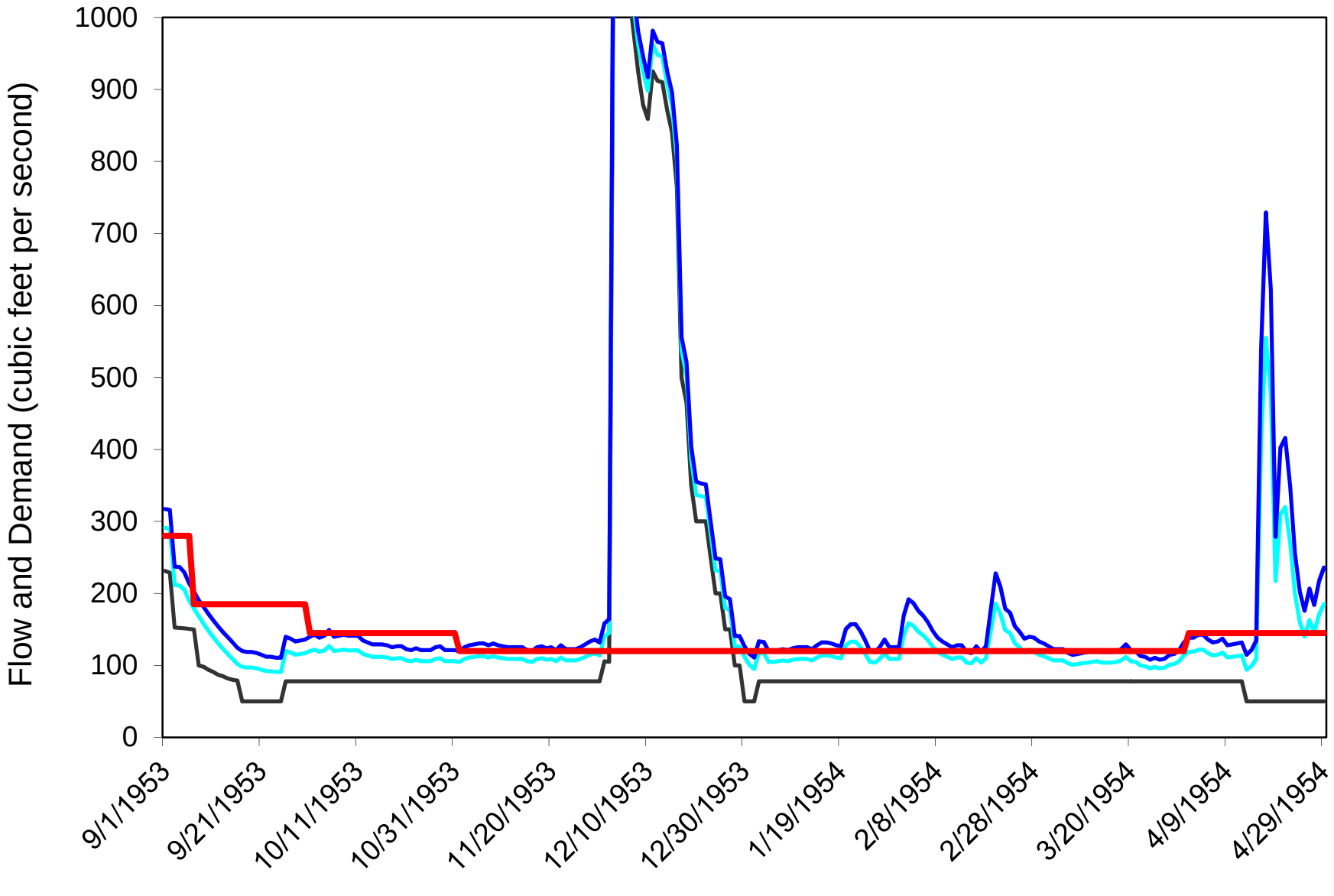
Conditions requiring a release from water supply storage

- If the flow at New Athens is 92 cfs or less, to withdraw water from the navigation pool Prairie State and Dynegy must request a release amount equal to or greater than their respective withdrawals.
- Each company must further "restrict their withdrawals … to the extent necessary which ensures the protection of the quantity of flow released for (other) purpose(s)." In essence, this means that if there is the need for a navigation release, then both companies would likely also need to request a release for their own withdrawals to avoid interference.

Required flow releases during the first half of the 1953-54 drought

- During the period from fall 1953 to spring 1954, it is estimated that the flow at New Athens would be near or below the Q7,10 (92 cfs) for roughly 170 days
- A water supply release would be necessary because of the protected flow restriction in the DNR allocation agreement.
- However, once one power company requests a release, that release would cause the low flow at New Athens to rise above 92 cfs – such that the second company would not necessarily be bound by the same protected flow restriction in their own agreement with DNR.

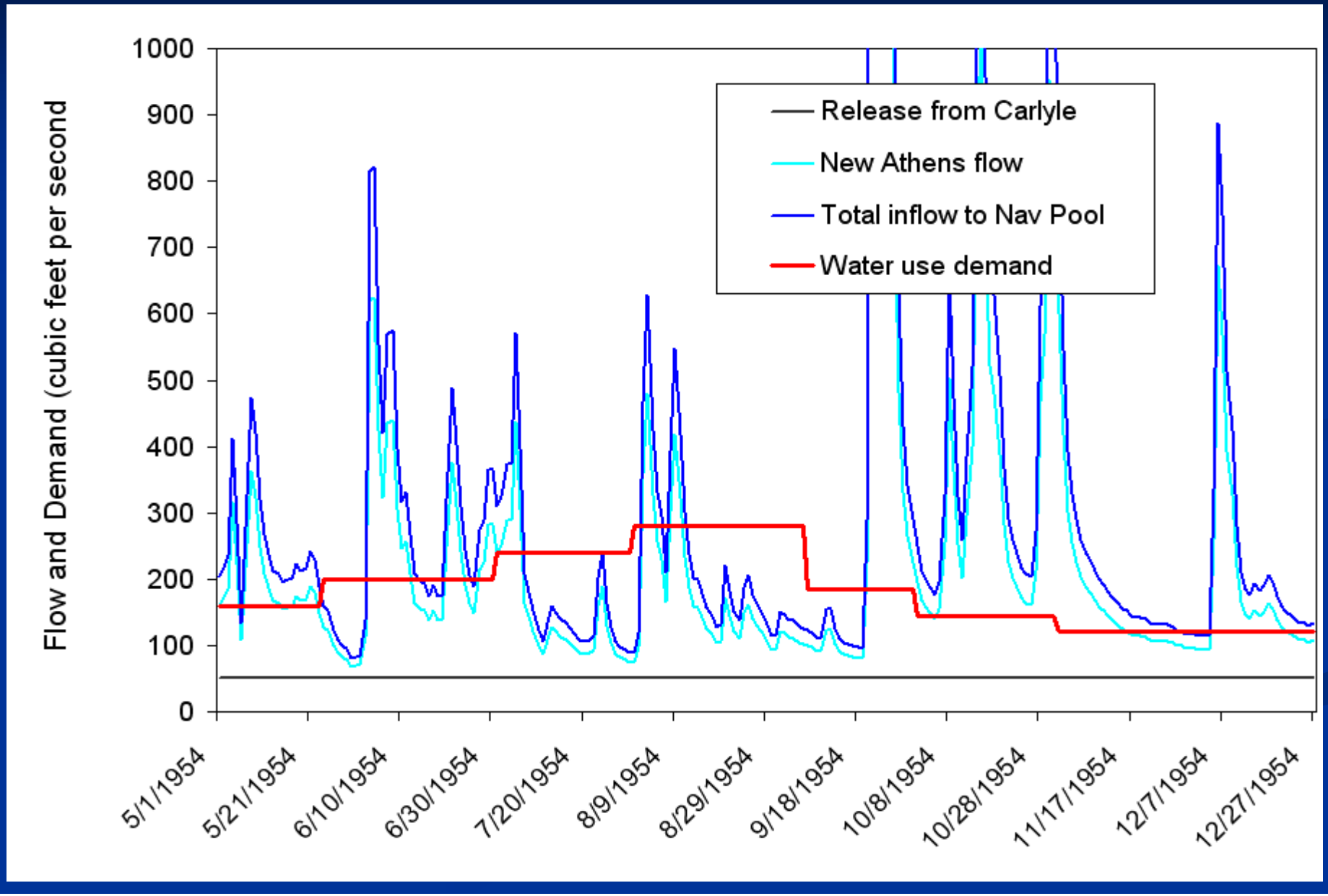
1953-54 flows with an additional 20 mgd release



Required flow releases during the first half of the 1953-54 drought

- The required flow release at roughly 18 mgd would amount to roughly 3 billion gallons over the 7-month period. When calculated over the accounting (water) year, this is 8.4 mgd.
- Since both companies would be benefiting from a single water supply release, they could share (switch off) in the responsibility of maintaining the protected flow; but more than likely that responsibility would fall on Prairie State (the upstream user, needs to pump more often).
- If Prairie State were to cease operations, however, Dynegy would then need to request the release.
- Alternatively, the Corps could potentially decide to increase the Carlyle WQ release during such a dry winter, removing the need for a water supply release

Flow releases during 2nd half of the 1953-54 drought



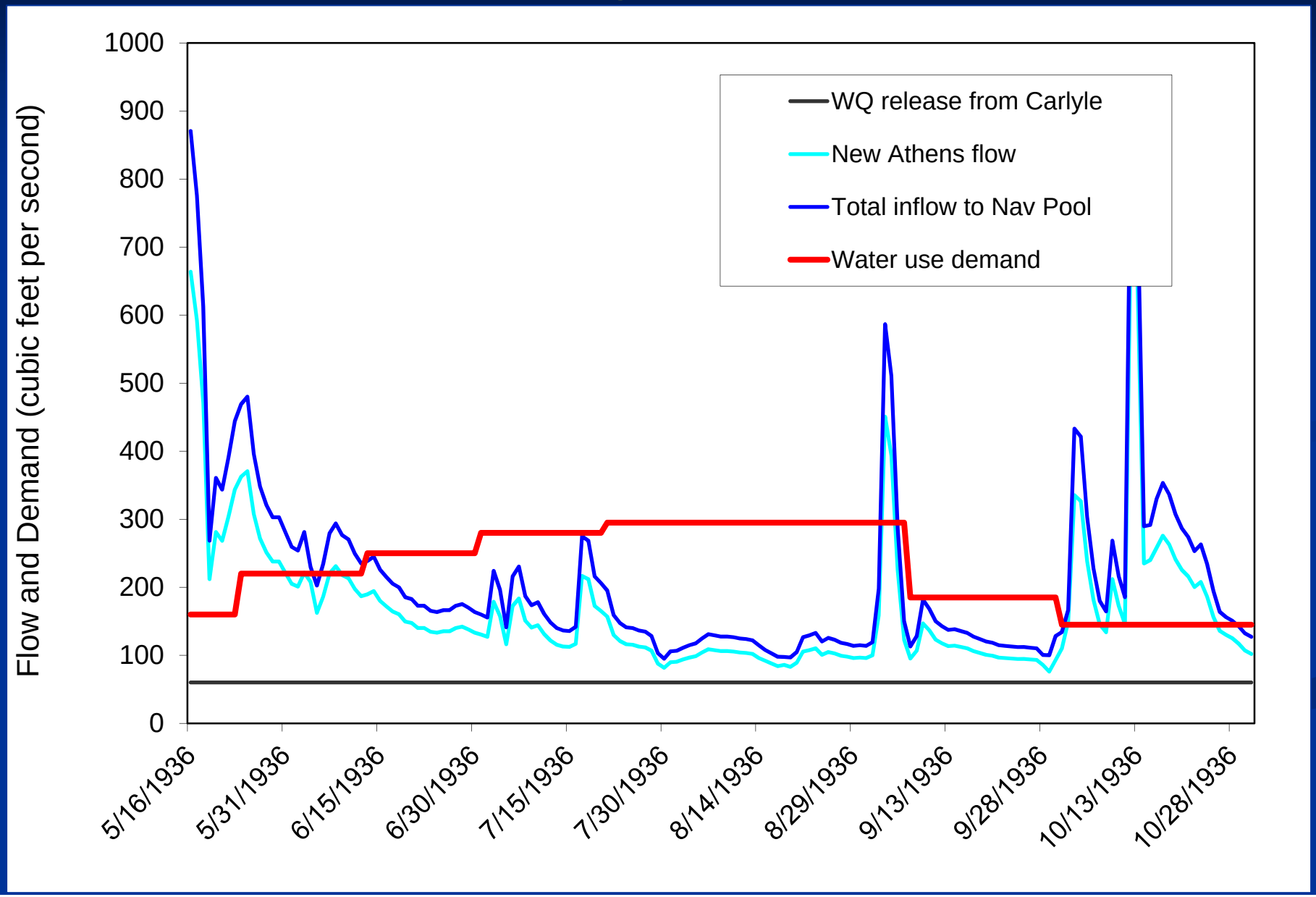
Flow releases during 2nd half of the 1953-54 drought

- Simulation results (demand scenario #1) indicate that a total of roughly 6.4 billion gallons (bg) would need to be released during the July-September 1954 period to meet navigation and water supply needs, maintaining pool levels in the nav channel between 368.0 and 368.8.
- Based on their uses, we have apportioned 4.0 bg to navigation and 2.4 bg to water supply.

Total water use over the 1953-54 drought

- The simulated total amount of the release during the accounting year (Oct 1953-Sept 1954) is 9.4 billion gallons (25.7 mgd):
  - 11.0 mgd for navigation
  - 14.7 mgd for water supply
- Using the 1953-54 simulation, Prairie State can show a need for much of its 13.35 mgd allocation
- Dynegy can show a need for much of its 14.35 mgd allocation if responsible for the winter flow release
- However, collectively the two companies would not need anything close to 27.7 mgd.
- Allocations were also assigned based on a 50-yr drought

Flow releases during a simulated severe Summer drought (1936)



Flow releases during a severe summer drought (patterned after 1936)

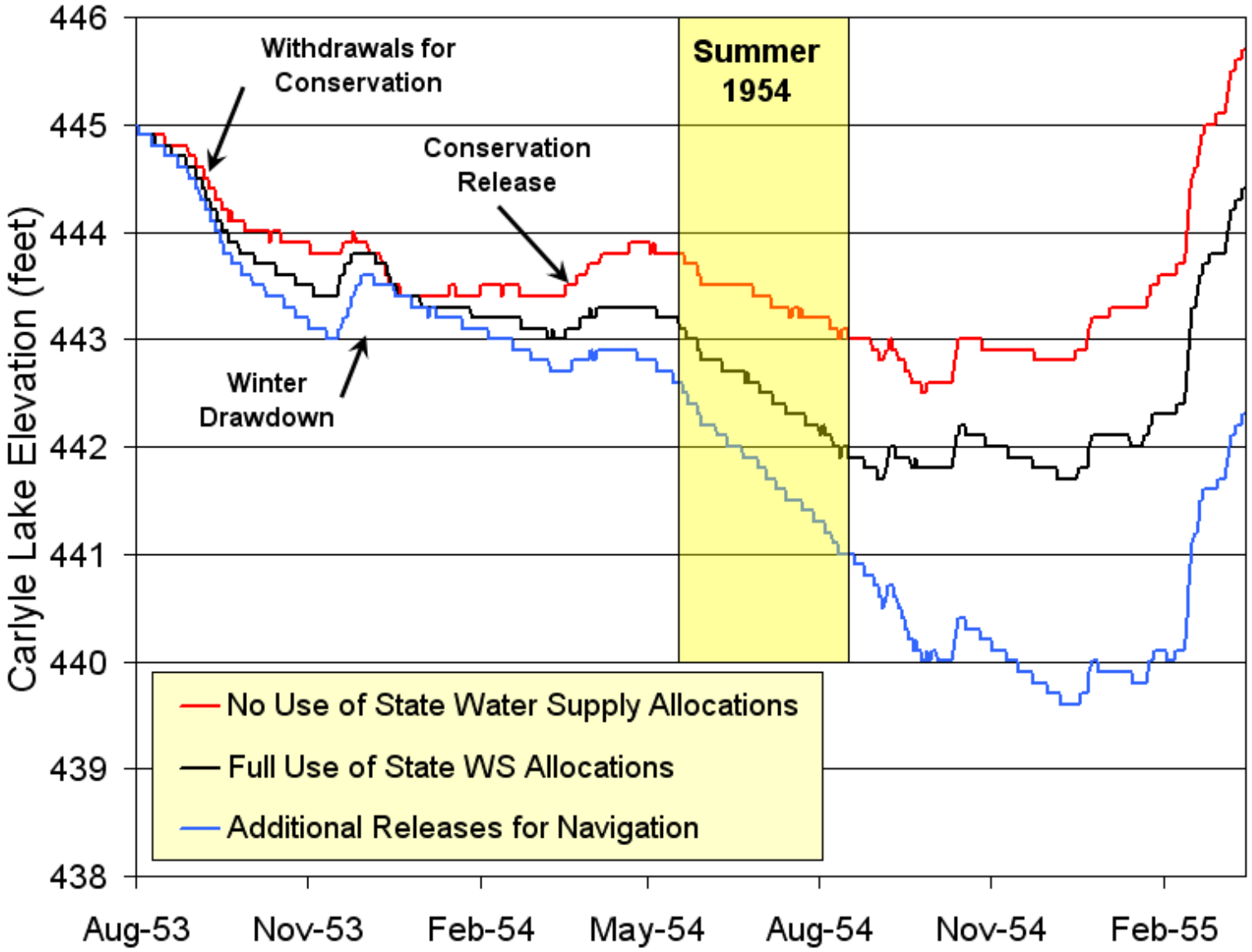
- Simulation results (demand scenario #1) indicate that navigation and water supply releases would be needed over 83 days, with a highest release rate of 240 cfs.
- A total of roughly 6.7 billion gallons (bg) would need to be released during the June-September 1936 period while maintaining pool levels in the nav channel between 368.0 and 368.8.
- This is equivalent to 18.5 mgd over the course of the Oct 1935 – Sept 1936 water year
- Based on their uses, we have apportioned 11.0 mgd to navigation and 7.5 mgd to water supply.

Flow releases during a severe summer drought (patterned after 1936)

- Although Prairie State's water supply use is estimated to be only about 1500 mg during such a summer (4 mgd when averaged over the accounting year), with a maximum release rate of only 18 mgd they would not be able to keep up with their use, and their raw water impoundment would fall below an operational level.
- They might want to amend their agreement with DNR to increase the maximum release rate without changing the average annual rate (developing additional storage or alternative supplies such as from the Mississippi River are other options).

Impact of Water Supply Releases to Shelbyville Carlyle Lake Levels

- The simulated lake levels during a 1953-54 drought condition (Scenario 1 demand) has not yet been estimated. However, the total amount of estimated navigation and water supply releases is noticeably less than the amount allocated for Dynegy and Prairie State
- Thus, the water levels would be higher than the "Full Use of State Water Supply Allocations" shown in the next slide.


Withdrawals for Conservation
Summer 1954
Conservation Release
Winter Drawdown
Carlyle Lake Elevation (feet)
446
445
444
443
442
441
440
439
438
No Use of State Water Supply Allocations
Full Use of State WS Allocations
Additional Releases for Navigation
Aug-53
Nov-53
Feb-54
May-54
Aug-54
Nov-54
Feb-55

Effect of raising the Navigation Pool operating level an additional ½ Foot

- The additional storage provided (600 mg) might be effective in avoiding releases during a moderate or short drought period, such as for the 1988 drought
- However, during a sustained drought, such as the 1953-1954 and 1936 droughts simulated here, the additional storage does not prevent the need for releases, and in fact would represent only a small percent of the total release needed

Conclusions

- The water supply allocations to Dynegy and Prairie State appear sufficient to provide for those companies' estimated water needs during not only a 50-year drought, but also for the drought of record.
- State allocations based on Shelbyville & Carlyle yield estimates do not consider additional available water from inflows downstream of Carlyle.
- Also, because there is some duplication of need during the 1953-54 drought-of-record condition, there may be unused water supply storage during such as drought. Given this, DNR may need to decide if additional allocations are appropriate.