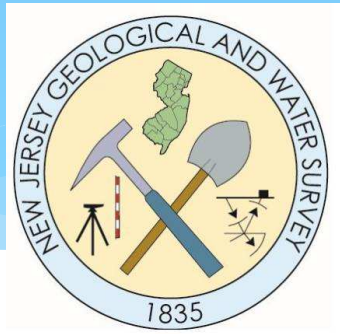
Opportunities to Meet Multiple Objectives in the Delaware River Basin

The Decree, GFA, FFMP and the need for a RiverWare Model: The New Jersey Perspective

December 3, 2015

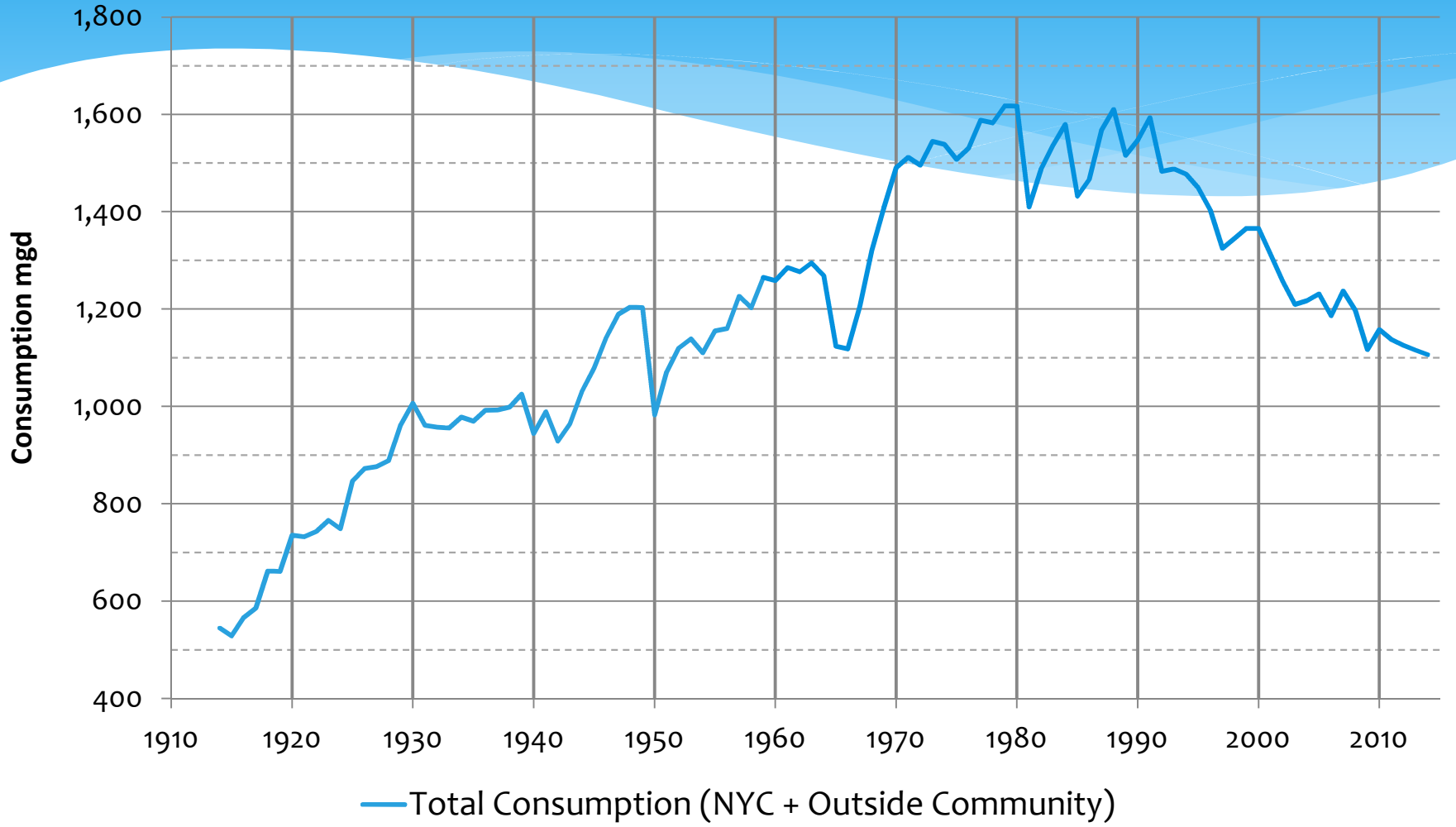


The views expressed here are solely those of the New Jersey Department of Environmental Protection

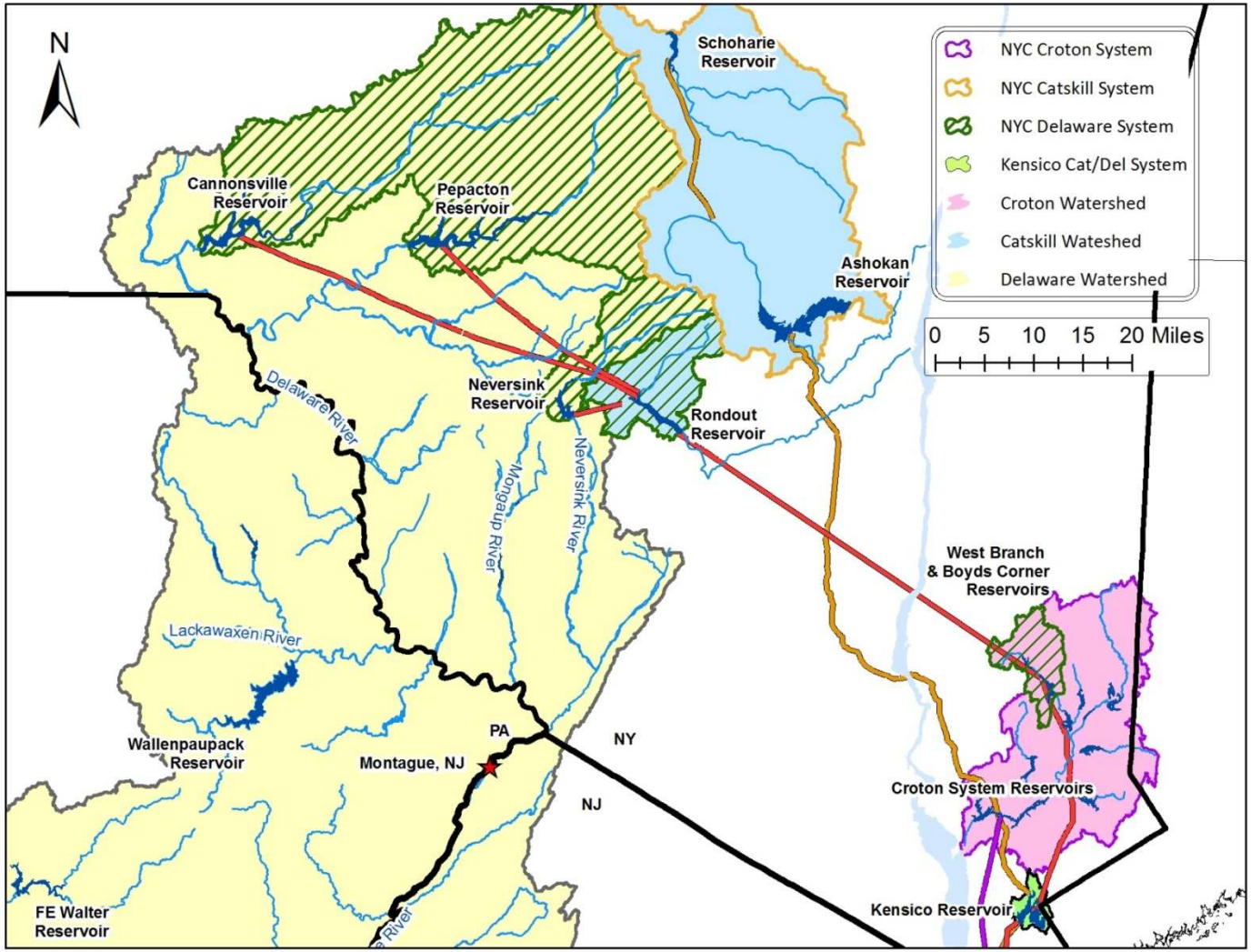
To be covered

* Decree/GFA/FFMP Background
* Justification for RiverWare model
* Preliminary RiverWare results
* Opportunities to meet multiple objectives

NYC Consumption 1914 - 2014



NYC and "all its sources of supply"



- Three distinct but interconnected systems:
- Delaware System
  - Pep, Can, & Nev
  - Rondout, W Branch & B Corner
- Catskill System
  - Schoharie & Ashokan
- Croton System
- Delaware/Catskill
  - Kensico

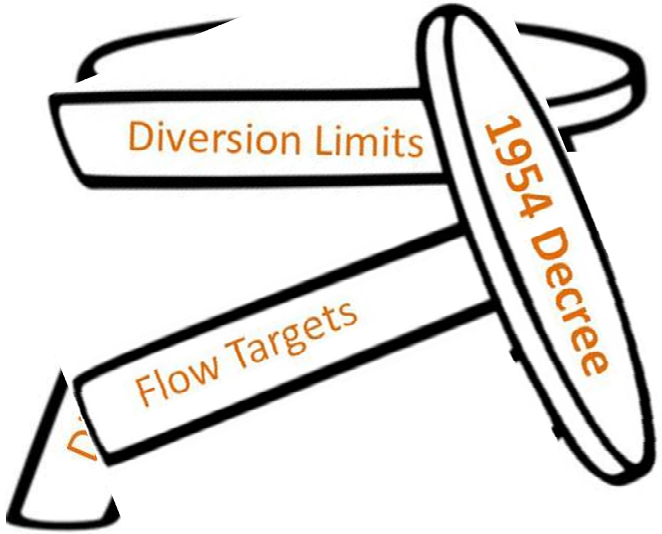
- Expansion into the Delaware triggered '31 and '54 Decrees

Principle of Equitable Apportionment as Applied in the 1954 Decree

1. Out-of-basin diversion limits
    1. NYC at 800 mgd
    2. NJ at 100 mgd

2. Instream flow maintenance
    1. Montague at 1,750 cfs all the time

3. Excess Quantity to prevent over-drafting by NYC
    1. now referred to as ERQ
    2. under appreciated, but key



Why the ERQ Is Important

* Defined as 83% of difference between **safe yield of all the city's sources** and its anticipated consumption (plus 7 ¼ BG)

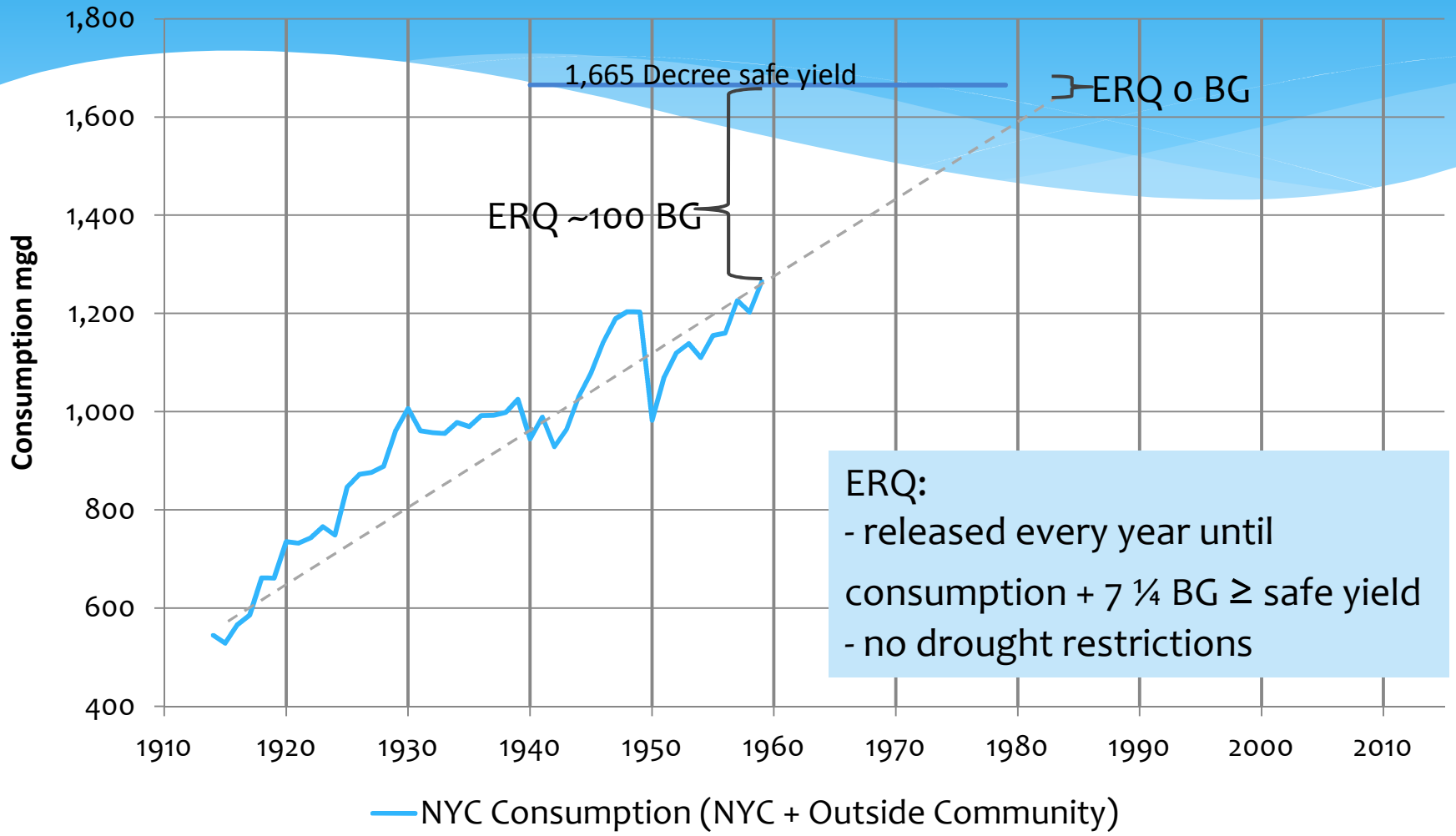
* Directly links the safe yield of **all of NYC's sources** (both inside and outside of the Delaware basin) to actions within the Delaware basin

* Prevents NYC from **overdrafting** its Delaware basin reservoirs (NYC's selective use of one source of water over another) by releasing a portion of NYC unused safe yield (aka available water)

* From Notes of NYC Chief Engineer Kennison on Provisions of the Decree: (1955, DRBC files, unpublished, pg 4)

  *"We also agreed to the wording which in effect makes it **impossible** for **New York to overdraw** its Delaware account, since Pratt and I both concluded that it is merely a matter of New York's **adjustment of its storage drafts** between the different reservoirs in **all the City's systems**, and not only something which New York could easily regulate, but also something which **New York can do just as well as not, and without damage or inconvenience**."*

NYC Consumption and ERQ: 1954



What is NYC's Safe Yield

* Amount of **water available** to a water supply system during a repeat of the **drought-of-record** while meeting all other requirements, e.g. passing flows or reserve storages

* The 1,665 mgd safe yield defined in the 1954 Decree:
  * specifically included "all its sources of supply":
    * Croton, Catskill and Delaware Reservoir Surface Water Systems
  * based upon the 1930s drought
  * assumed a 25% reserve in Hudson basin and 0% reserve in Delaware basin
  * assumed no pumping in finished water distribution system
  * a negotiated number with actual hydraulic/hydrologic yield equal to 1,820 mgd
  * the 800 mgd diversion limit was the hydraulic limit of the Delaware Aqueduct and the hydrologic safe yield of the Delaware basin was slightly larger
  * no drought cutbacks or restrictions

* The 1960's drought reduced NYC's safe yield

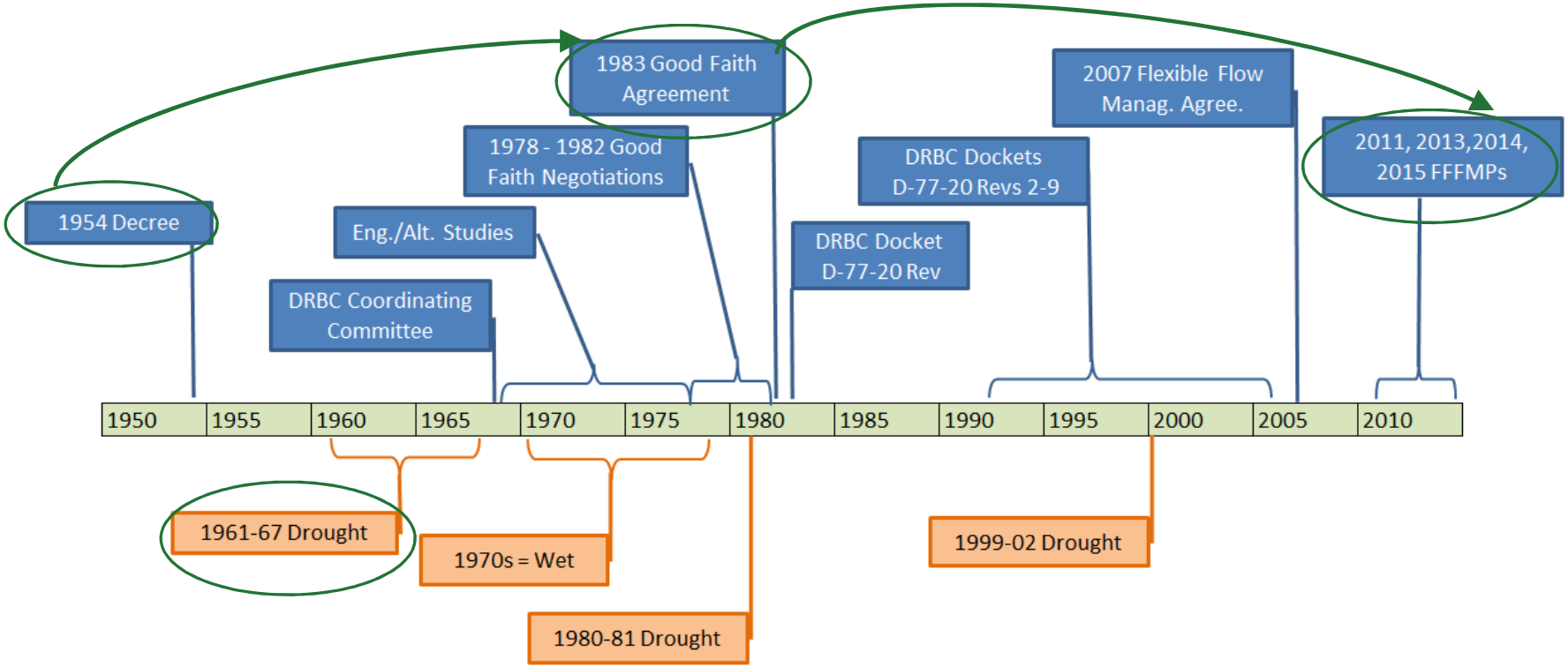
Conjunctive Safe Yield

"The whole is greater than the sum of its parts"

* *"The total firm yield from a group of reservoirs operated conjunctively to serve a large area* ***exceeds the sum of the individual firm yields*** *with each reservoir's serving its own smaller area."* Douglas and Lee, 1971, The Economics of Water Resources Planning

* *"The Catskill aqueduct has interlinked the earlier systems of water supply … since the Catskill, the Croton and the Ridgewood systems can now be* ***operated in conjunction****, the effective safe capacity of the combined systems is* ***greater than the sum*** *of the several capacities of the three if wholly disconnected."*
  NYC Board of Water Supply, 1917

Decree → FFMP Timeline



1961 – 1967 Drought-of-Record

U.S. Declares 4-State Drought Disaster; City Allowed to End Delaware Diversion

200 Million Gallons a Day to Be Put in 'Bank' for Use in an Emergency

By WARREN WEAVER, Jr.
Special to The New York Times

WASHINGTON, Aug. 18—New York City was relieved today of its obligation to pour 200 million gallons of water into the Delaware River system every day.

In an agreement to give the city that relief, President Johnson declared the Delaware Valley watershed and the communities it serves in four states a disaster area.

The agreement goes into effect Sept. 10, when the present drought emergency declared by the Delaware River Basin Com-

ENGINEER WARNS CITY CAN RUN OUT OF WATER IN 1966

Commission Told of Danger in Measures to Protect Philadelphia Supply

By McCANDLISH PHILLIPS
Special to The New York Times

What Drought Hath Wrought

This weekend's torrential rains brought only minor abatement in the metropolitan area's desperate shortage of water. The shortage both here and throughout the Northeast is compounded of nature's inconsistency and man's reckless profligacy, with man most to blame. Ten years ago the Board of Water Supply was saying here: "New York City is assured a plentiful supply of the finest water for the rest of this century." A four-year drought has upset all calculations.

Meanwhile, until the present scare, the city has been using water like a spendthrift. Even now, as the whole surrounding area is in dire emergency, Mayor Wagner is reported to have made the complacent comment—though he cannot really be complacent at this point—that "I don't think anyone will have to go without a bath."

Drought in Northeast

When the statistics are all in, they may well indicate that this year's drought in the Northeast may be approaching a long-term record for regional dryness. A drought last year was broken in August, but the current dry spell persists, with no relief in sight.

The reason is a shift in the winds. Ordinarily they blow counterclockwise from the South, bringing moisture from the Gulf of Mexico. In the last few weeks they have been blowing clockwise from Canada, bringing little but dehydration. The dry Canadian winds are in turn associated with a high-pressure system that has been diverting any moist low-pressure systems from the West.

UDALL FINDS CITY FACES A DISASTER ON WATER SUPPLY

'We're Walking on Edge,' He Tells Session Here, Ending 2-Day Tour

EXCHANGES ARE SHARP

Secretary Promises to Act Rapidly—Mayor Defends Measures in Crisis

Suburbs Attempting To Counter Drought

By HOMER BIGART

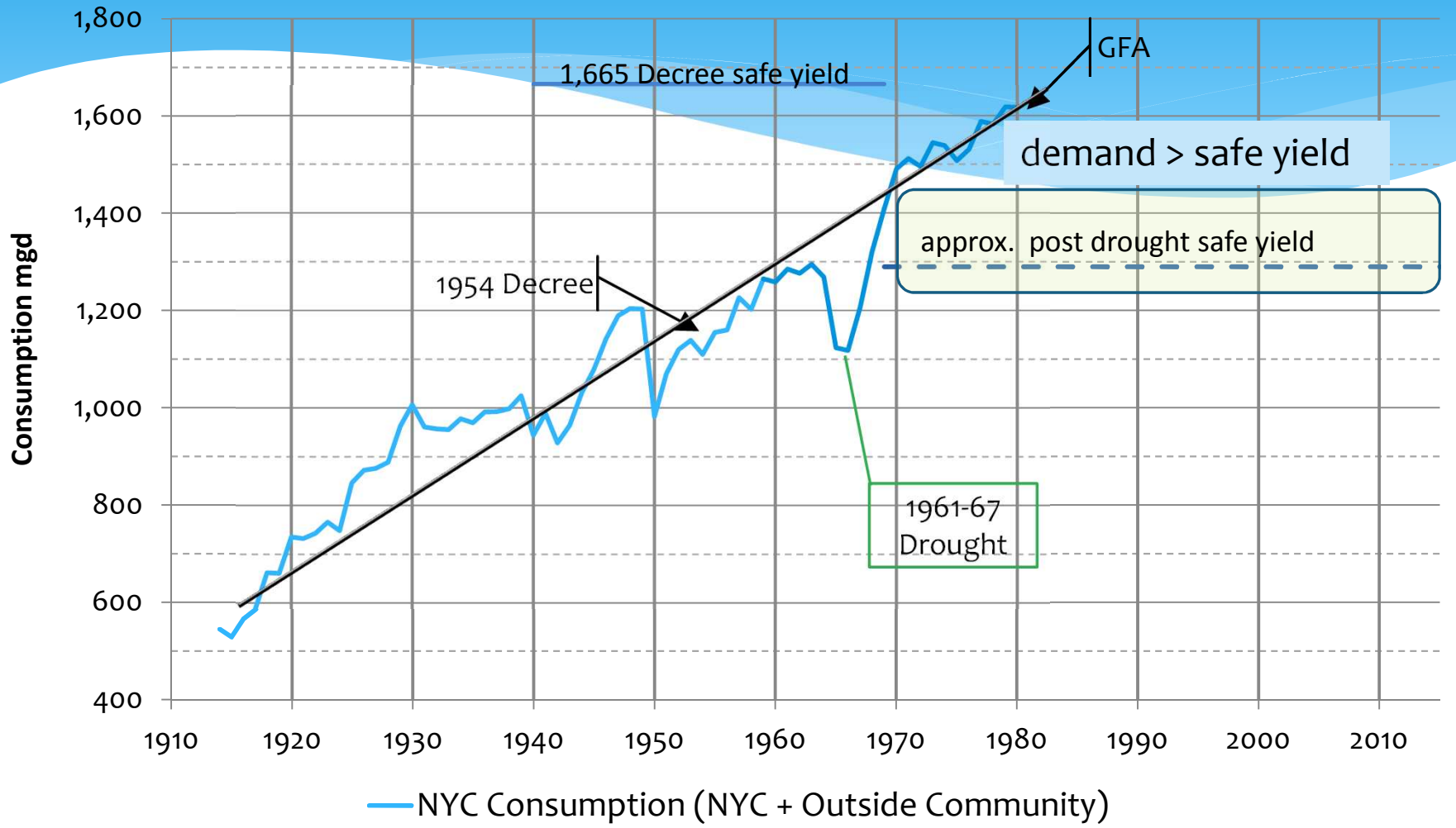
The forecast of continued drought drove some suburban communities to drastic attempts to conserve water yesterday.

Mayor Thomas J. Whelan of Jersey City proclaimed a "dire water emergency."

He threatened fines of up to $200 for persons who flush sidewalks, water lawns, wash autos or allow their household pipes to freeze. He acted as the city's reservoir at Boonton, N. J., fell to 36 per cent of storage capacity.

Headlines from NY Times Newspaper Archives

NYC Consumption and GFA: Post 1954



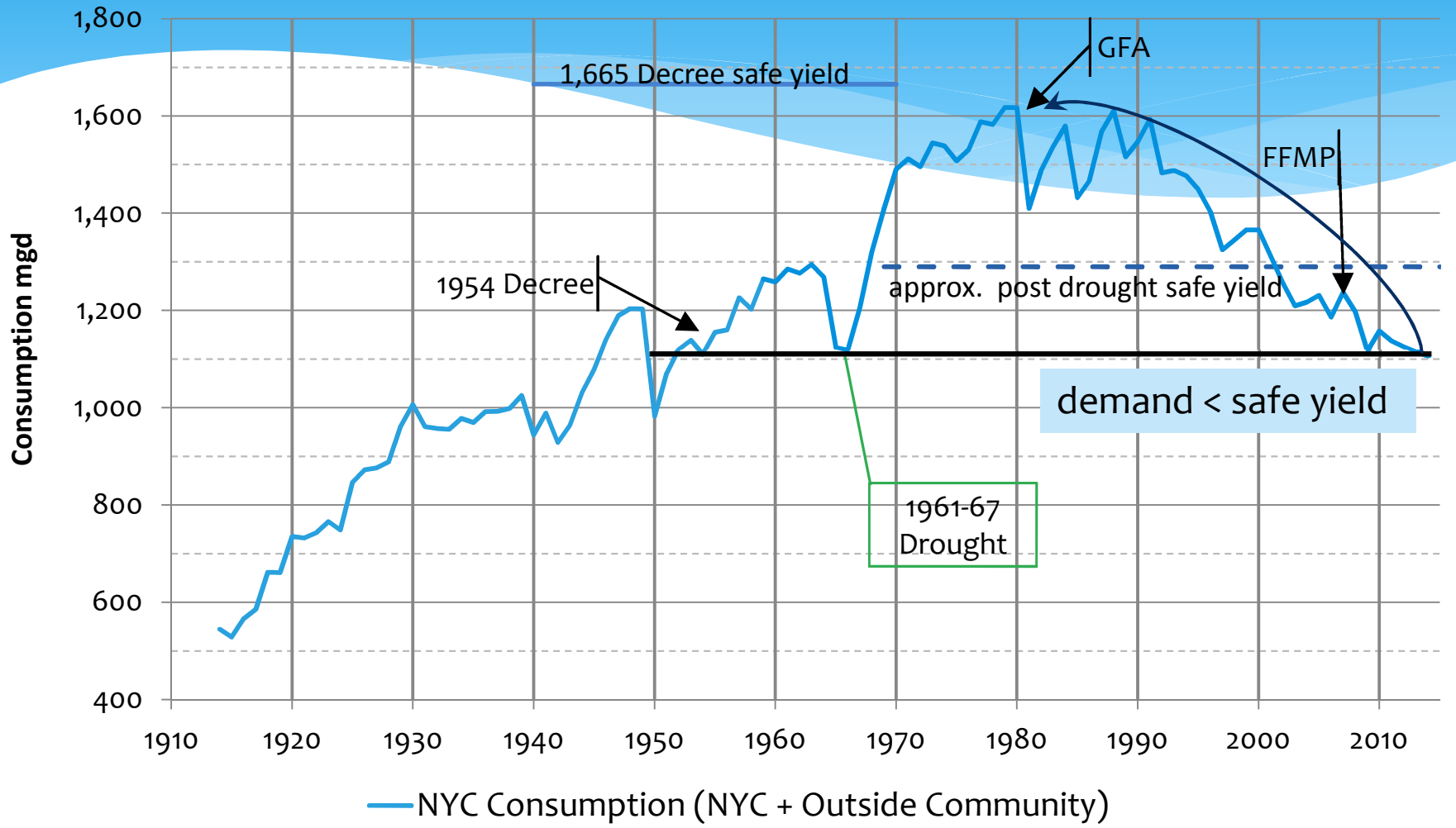
1983 Good Faith Agreement

* Established a post-drought operating plan that, at least partially, addressed NYC's supply problem, as well as added conservation releases, plus more…

* However the GFA also:
  * Removed protections afforded by the '54 Decree against overdrafting of the Delaware basin reservoirs by NYC
  * Loss of excess quantity (ERQ) when it matters; during drought
  * Provided benefits to NYC's water supply while placing negative consequences on lower basin; more drought days, more water use restrictions, and more ecologic risk
  * Imposes disproportionate reductions to New Jersey's diversion

* FFMP makes some improvements but continues GFA's fundamental flaws

NYC Consumption: 1983 - 2014



The Problem

* The GFA addressed some of the water supply problems created by the 1960's drought, but
  * NYC's safe yield never adequately recalculated after the 60's drought
  * Removed the balance of equity established by Decree
* The GFA has not been thoroughly reviewed in over 30 years despite the fact that:
  * Demands have substantially declined to 1950s levels
  * Significant infrastructure and regulatory changes have occurred inside and outside of the Delaware basin
  * The numerous incremental operational changes have not been adequately reviewed
  * Science, data and modeling have drastically improved
  * Current models available to all the Parties are inadequate; i.e. OASIS-PST
* The unanimous agreement requirement makes renegotiation extremely difficult

Models As Basis for Resolution

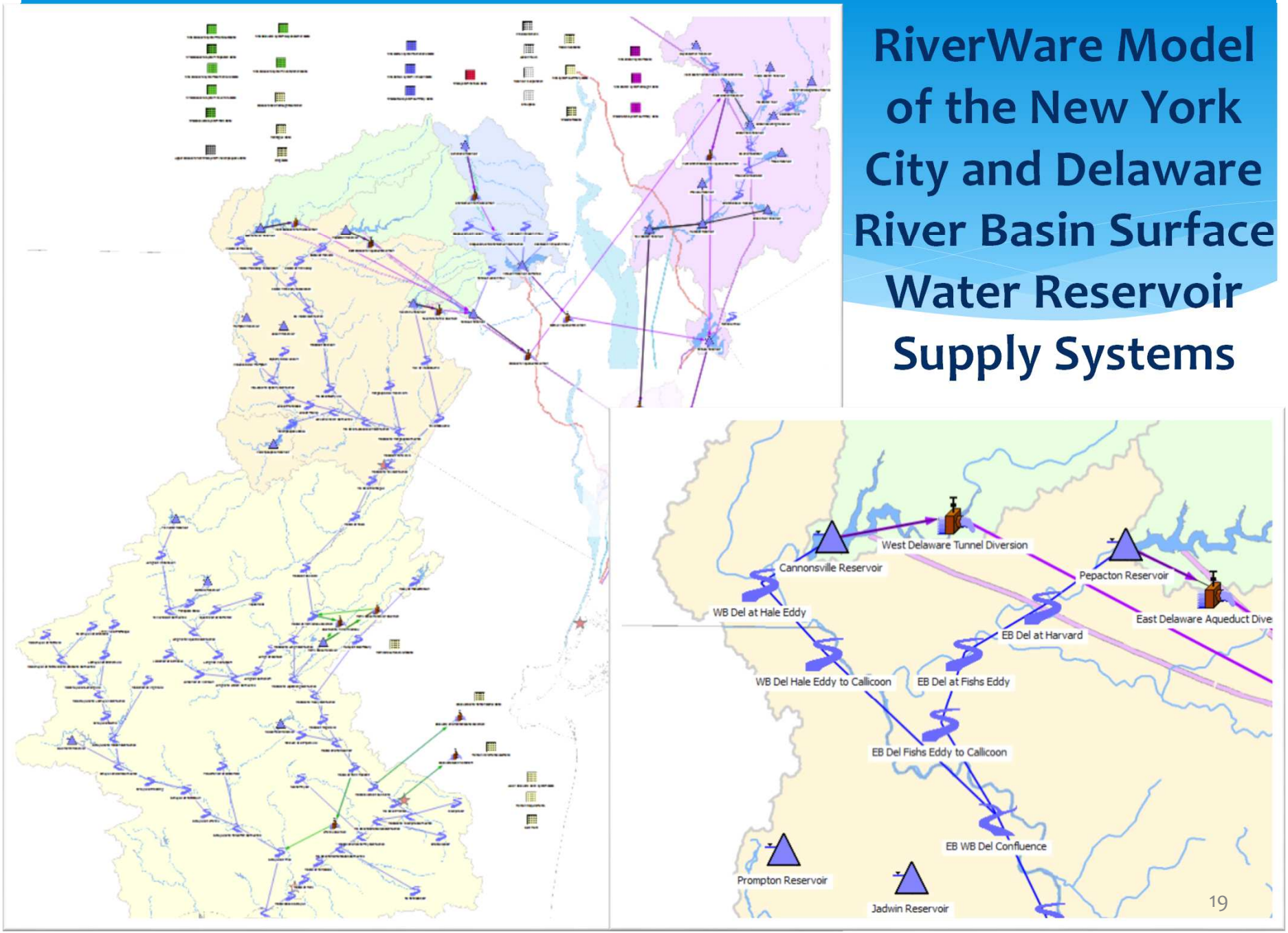
NJ determined that a new, appropriately scoped, river and reservoir model was the ideal tool to serve as the basis for the next agreement

* Models are ideal tools to quantify water availability and impacts to safe yield of different assumptions or operating rules
* A model allows Parties to independently develop and evaluate any flow management proposal and its effect on water availability, the ecosystem, etc
* Transparent and fully vetted assessment of water availability is the critical first step to achieving a successful, equitable and long-term agreement

NJ's RiverWare Model

* Built using CADSWES's RiverWare software
* Simulates daily reservoir storages, flows and diversions
* Covers 1928 through 2006 time period
* Conjunctively models the Delaware River basin reservoirs, as well as the NYC's Delaware, Catskill, and Croton Systems
* Includes travel-time adjusted river flows and location of the salt-vernier
* Contains multiple rule sets to simulate both Decree and FFMP operating plans, as well as NYS regulations
* NJ's RiverWare ≈ NYC's OASIS-OST minus the bells and whistles

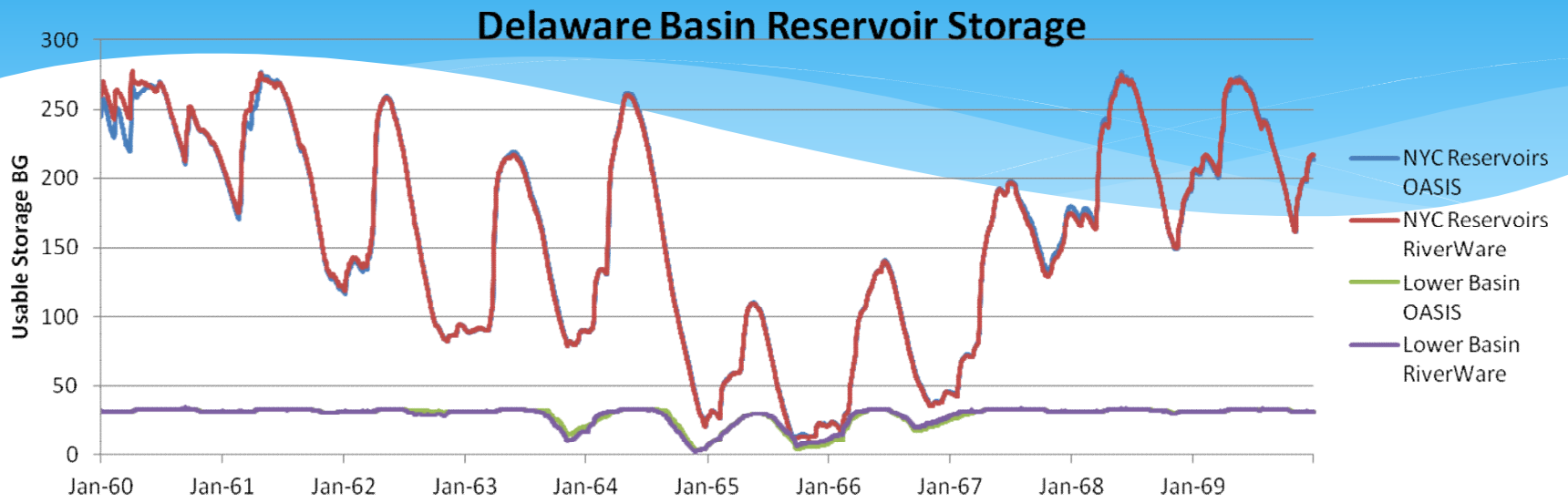
RiverWare Model of the New York City and Delaware River Basin Surface Water Reservoir Supply Systems

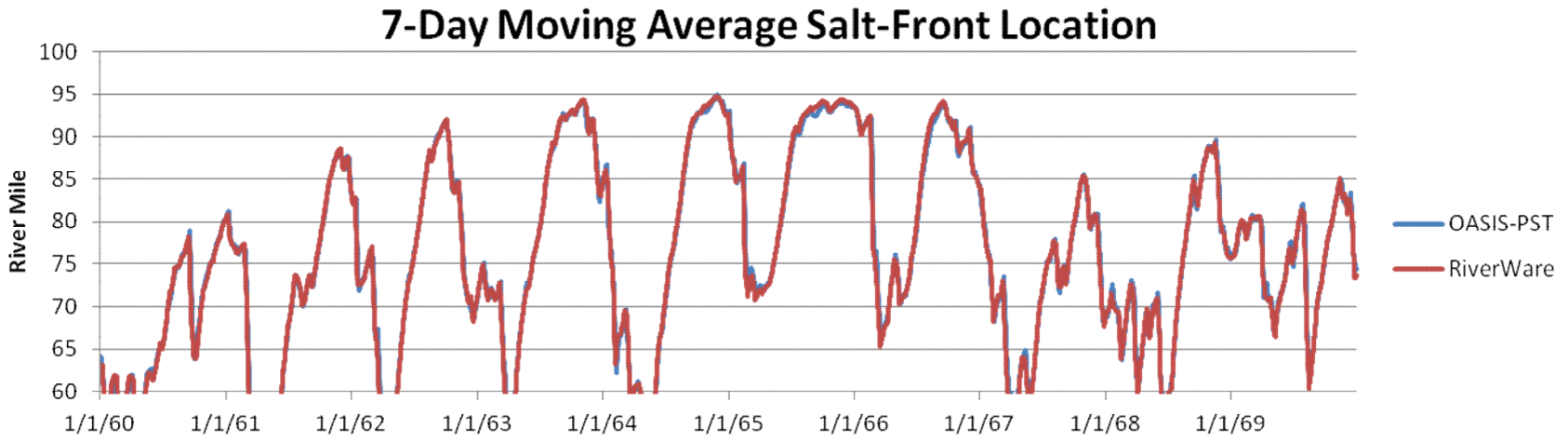


Preliminary Model Results

* Model is preliminary and still needs refining and further calibration
* Internal NJDEP and CADSWES reviews conclude that the model is reasonable
* Generally conservative assumptions so safe yield not overestimated; i.e. protective of water supplies
* Good correlation with DRBC's OASIS-PST
* RiverWare Scenarios
  * DRBC OASIS-PST calibration
    * Prove that NJ's model is capable of simulating the publically available, but limited OASIS-PST model
  * 1960s drought safe yield estimates
    * 1954 Decree Scenario
    * FFMP Scenario

Good Correlation with OASIS-PST

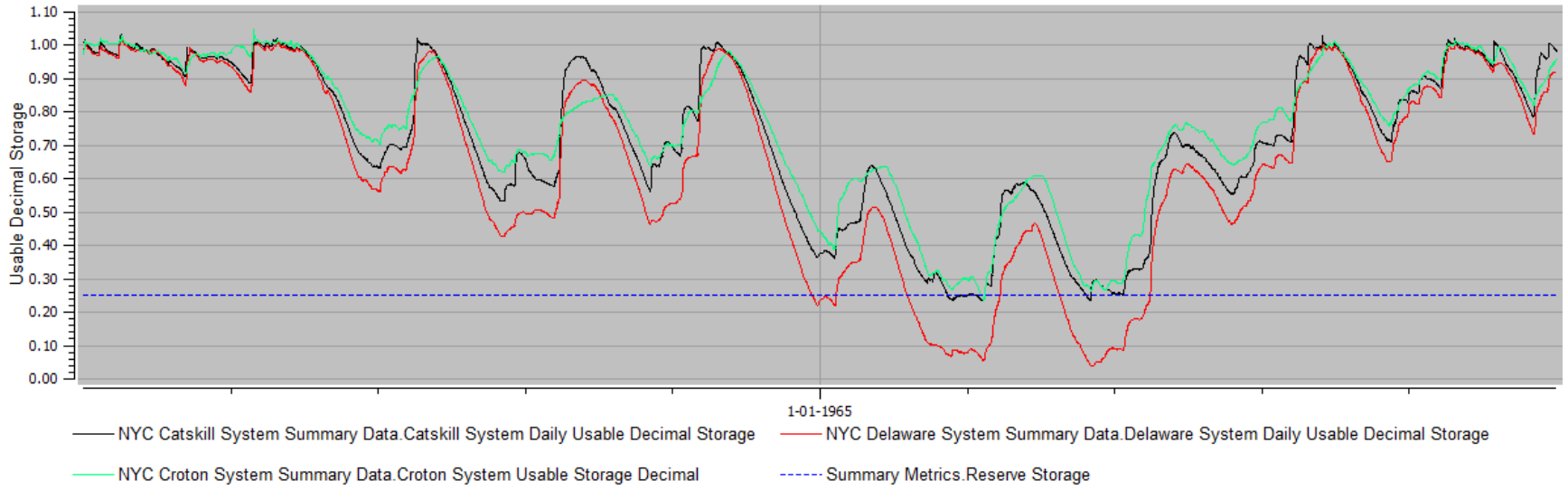




Safe Yield Scenario 1

* NYC Safe Yield with 1954 Decree conditions during '60s drought
  * 1,750 cfs at Montague all the time
  * Directed releases only, no conservation releases
  * How much water can be continuously supplied to NYC throughout the entire 1960's drought

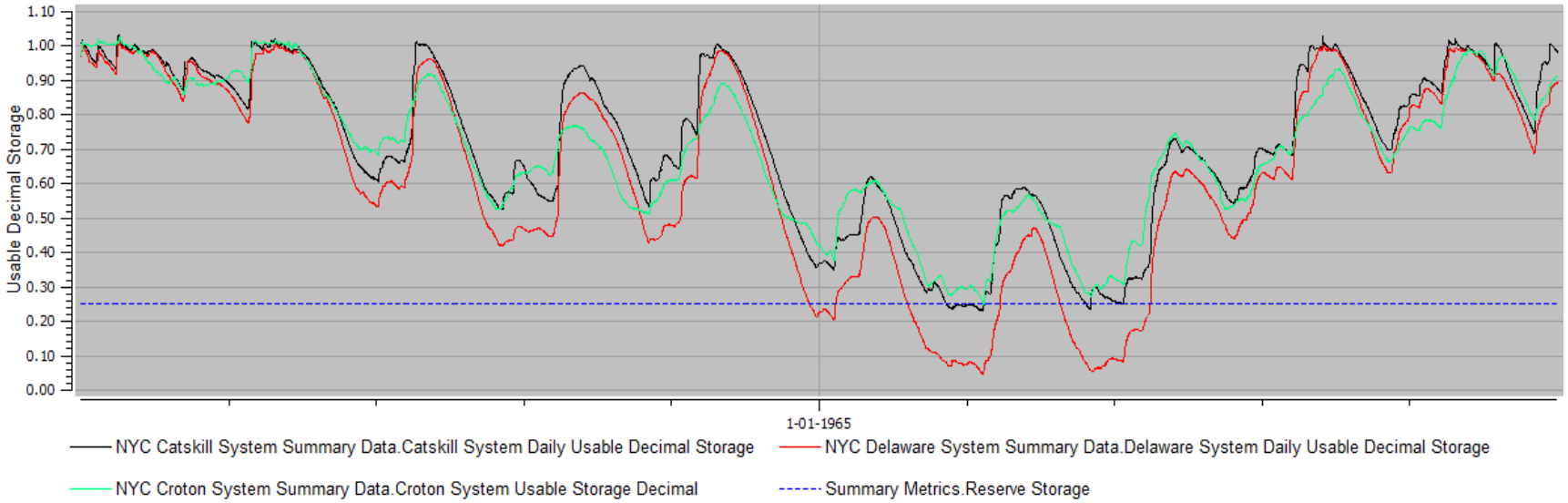
Decree Safe Yield = 1,320 mgd



Safe Yield Scenario 2

* NYC Safe Yield with FFMP conditions during ’60s drought
  * Variable flow target at Montague and Trenton
  * Directed releases with FFMP Tables 3 and 4a
  * How much water can be continuously supplied to NYC throughout the entire 1960’s drought

FFMP Safe Yield = 1,350 mgd



Scenario 2 ≈ 1993 NYC Study

The NYC Water Supply System, 1996, Hazen and Sawyer:

*"A 1993 NYCDEP safe yield study utilized a computer model that assumed **integrated and optimal use of the three water systems.** This methodology is known as Reservoir System Analysis (RSA) and produced a range of estimates depending upon the assumed operating constraints. The principal conclusions of the 1993 study were as follows:*

- *The **integrated system approach** produces a total **safe yield** of about **55 mgd higher** than the total* using the mass curve methodology for each watershed.*
- *The combined effect of the **more stringent 1970's NYSDEC release requirements** together with the **less stringent 1983 "Good Faith" Agreement** (relaxed the release requirements of the 1954 Supreme Court Decree) **increases** the total estimated **safe yield** by about 5 to 20 mgd."*

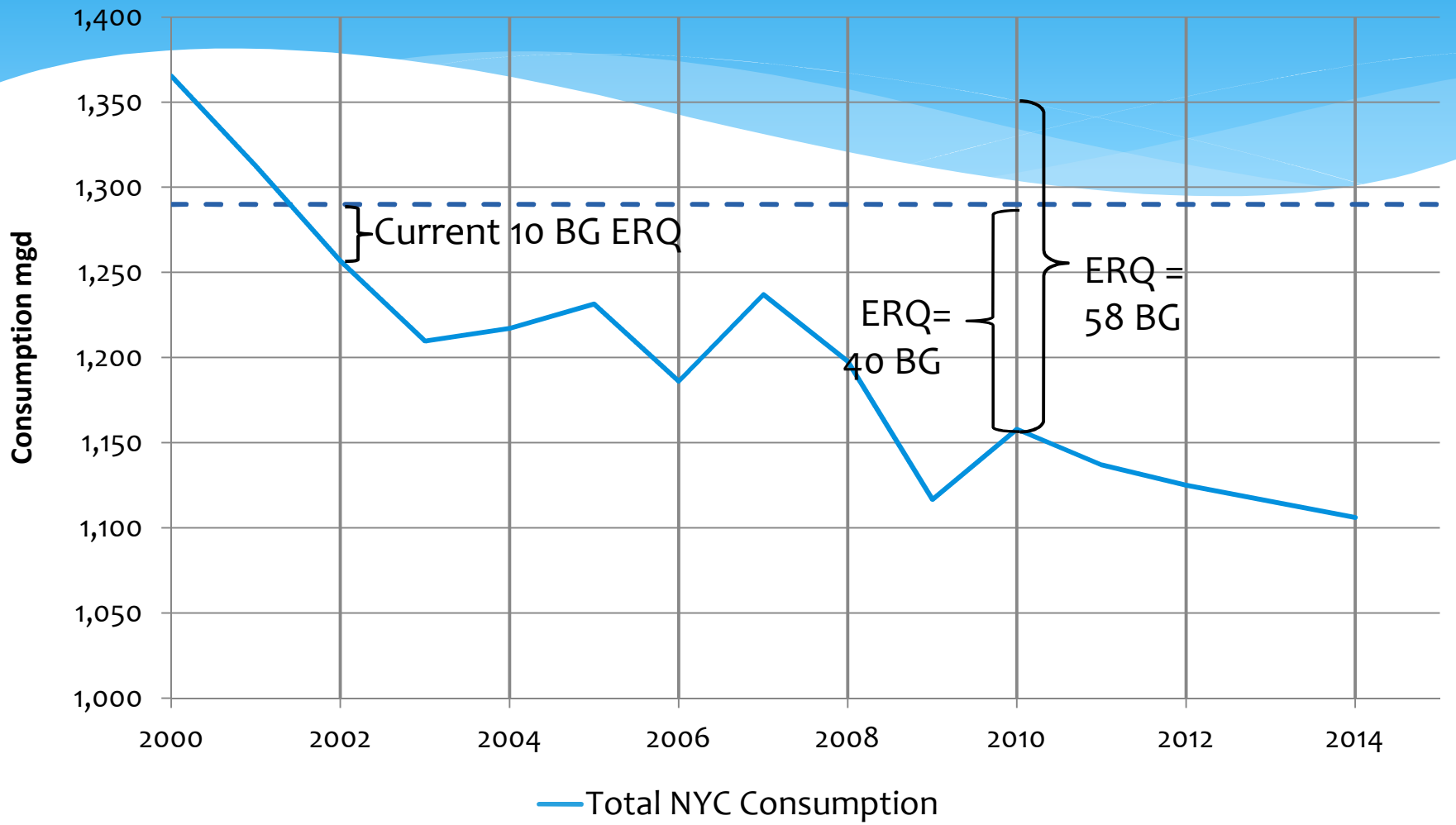
- 1,290 + 55 + (5 to 20) = 1,350 to 1,365 mgd NYC safe yield with GFA-type operations

*Refers to the 1,290 mgd safe yield used for planning purposes

Opportunities for Multiple Objectives

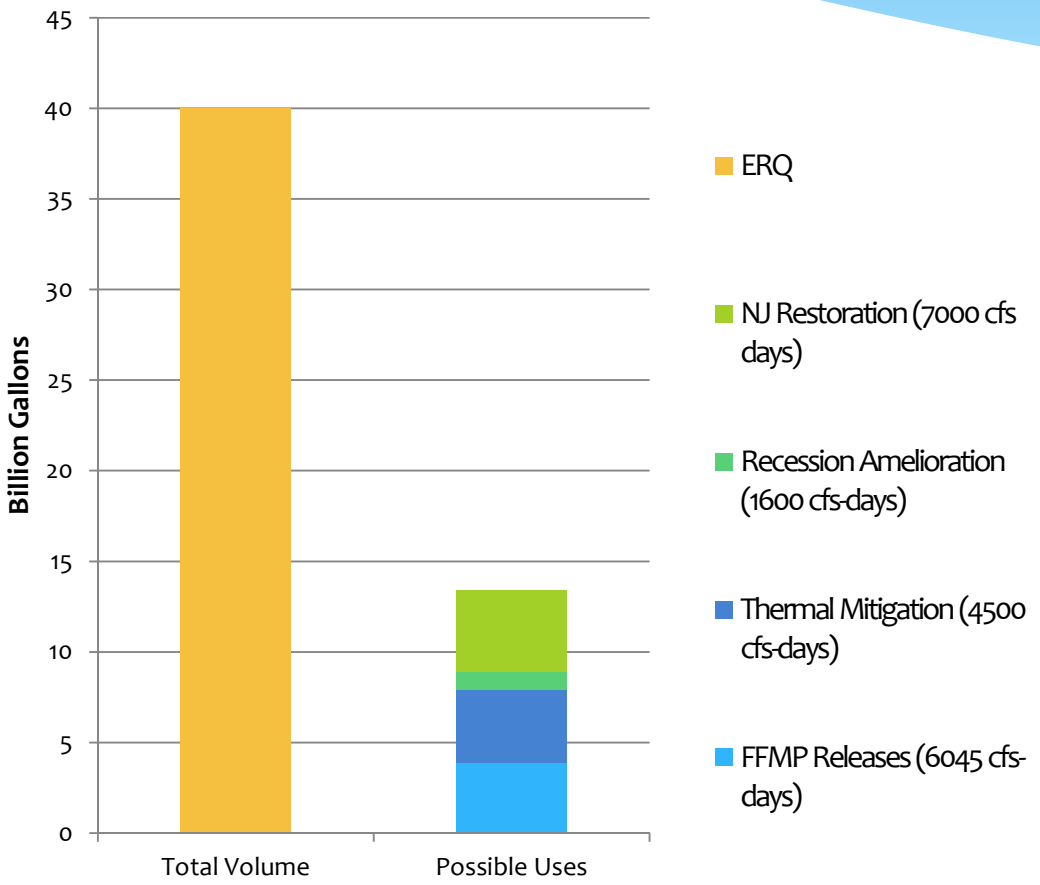
* Model allows independent and transparent evaluation of alternative rule curves, Montague objectives, overdraft protections, or Montague flexing/balancing and effects to the Delaware basin **and** all of NYC's sources
* ERQ: NYC safe yield at least as large as 1,350 mgd and available every year during a multiple-year drought; not interruptible
  * Creates "pool of water" that could be used for:
    * Enhanced ecologic releases
    * Thermal and release ramping mitigation
    * Downstream water supply augmentation, salt-water protection, and estuary enhancement
  * ERQ is only one way to resolve and may not be ideal for all objectives
* Ability to model alternative discharge mitigation procedures and impacts to NYC's water supply/safe yield
* Others…

NYC Consumption, Safe Yield & ERQ



Safe yield by definition means that the water is available every year, even during a multiple-year drought. Same for ERQ; i.e. not interruptible.

Comparison of ERQ and Multiple Objectives



* For comparative purposes the chart shows relative magnitude of objective water needs compared to ERQ
* ERQ may not be ideal or even preferred approach
* ERQ goes away when demand approaches safe yield
  * Demand increases from increased NYC use
  * Safe yield reduced due to future hydrologic changes

Conclusions

* Decree equity concepts can provide the basis for future agreements
* GFA 30+ years old:
  * GFA made fundamental changes to Decree
  * Conservation releases and flood mitigation have arisen as a significant ecologic and economic concerns for the upper Delaware
  * Significant infrastructure changes inside and outside of the basin
  * NYC's demand has declined to 1950s rates
  * The science, data and modeling capabilities have improved
* Appropriately designed models, such as RiverWare, are ideal tools to independently and transparently assess any proposal
* Preliminary model indicates that opportunities exist to meet multiple objectives
  * while maintaining water supply reliability and flexibility
* New agreements are needed and achievable

Thank You