

Delaware River Basin Commission

Climate Change Considerations in Water Resource Management

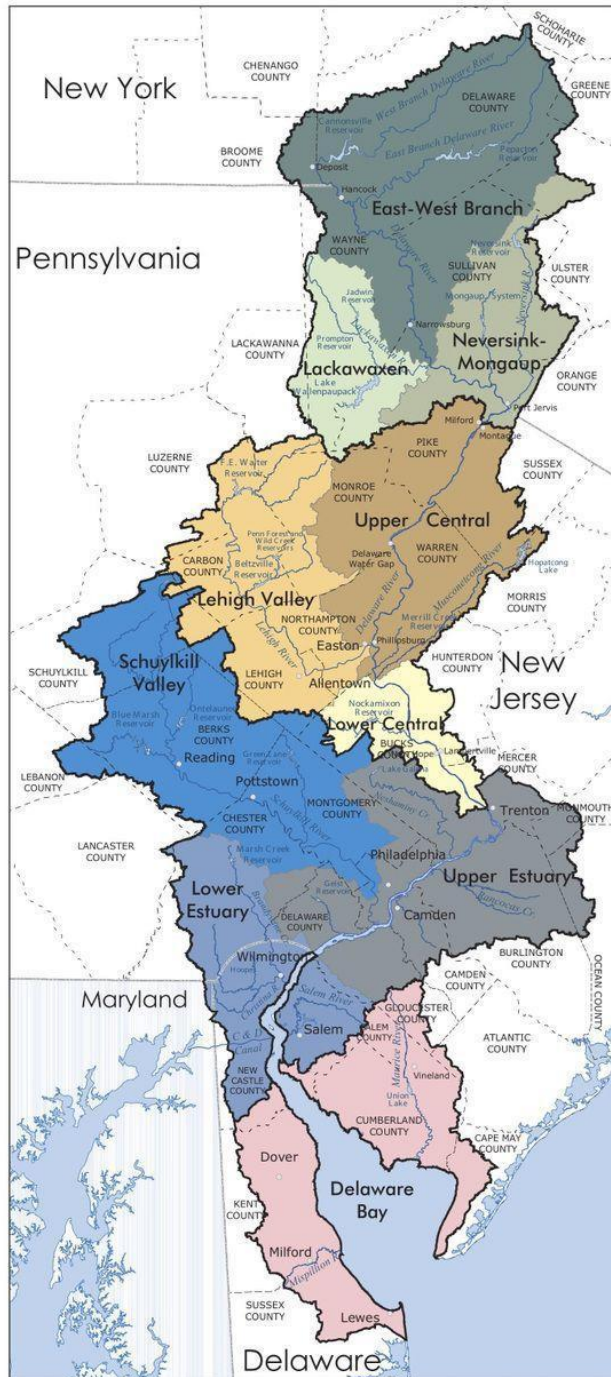
*Kristen Bowman Kavanagh, P.E.
Deputy Executive Director*

*2021 Annual Conference
Water Works Operators' Association of Pennsylvania
October 5, 2021*



Watersheds of the Delaware River Basin

- UPPER REGION**
- East-West Branch Watersheds
- Lackawaxen Watersheds
- Neversink-Mongaup Watersheds
- CENTRAL REGION**
- Upper Central Watersheds
- Lower Central Watersheds
- Lehigh Valley
- LOWER REGION**
- Schuylkill Valley
- Upper Estuary Watersheds
- Lower Estuary Watersheds
- BAY REGION**
- Delaware Bay Watersheds



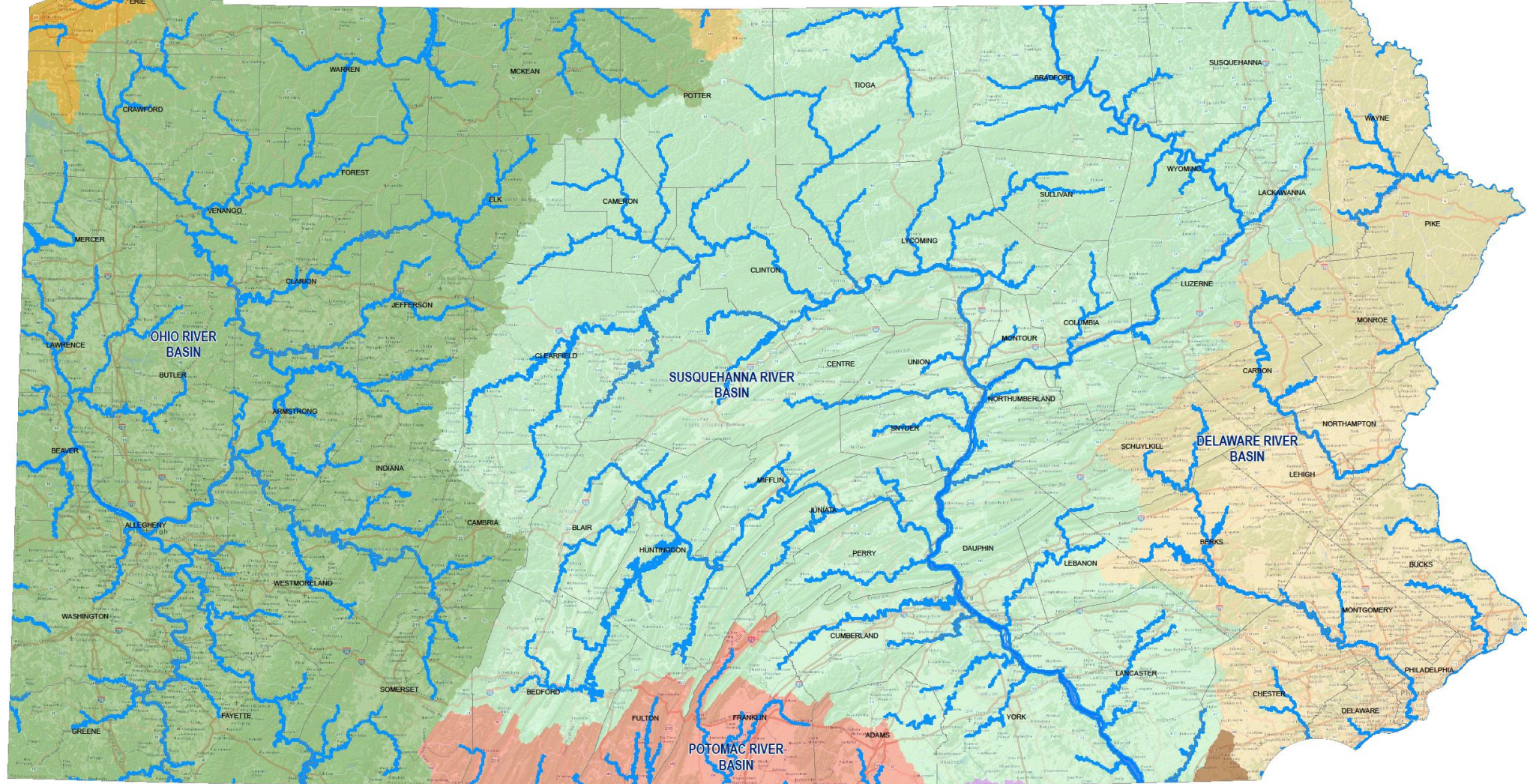
Watersheds of the Delaware River Basin

- “Watersheds” or “Drainage Basins”
- An area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel.

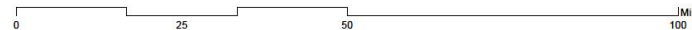
GREAT LAKES BASIN
(ERIE WATERSHED)

PENNSYLVANIA'S MAJOR RIVER BASINS

GREAT LAKES BASIN
(GENESEE WATERSHED)



- Gunpowder Watershed
- Erie Watershed / Great Lakes Basin
- Potomac River Basin
- Northeast / Elk River Watershed
- Genesee Watershed / Great Lakes Basin
- Susquehanna River Basin
- Ohio River Basin
- Delaware River Basin



Jack Hill, Resources Management Section, 9/17/2014



Source: PA DCNR

PADEP Compacts and Commissions Office to Coordinate Multiple Intra/Interstate Organizations



Interstate Commission on the Potomac River Basin (ICPRB) – an advisory, non-regulatory agency established to protect and enhance the waters and related resources of the basin through science, regional cooperation, and education



Great Lakes Commission (GLC) – interstate/international commission that recommends policies and practices to balance the use, development, and conservation of the water resources of the Great Lakes



Ohio River Valley Water Sanitation Commission (ORSANCO) – established to control and abate pollution – wastewater discharge standards and monitoring



Susquehanna River Basin Commission (SRBC) – enhance public welfare through comprehensive planning, water supply allocation, and management of the water resources of the basin – monitoring, planning, regulatory (allocation)



Delaware River Basin Commission (DRBC) – for the conservation, utilization, development, management, and control of the water and related resources of the basin to serve the public welfare – monitoring, planning, regulatory (allocation and discharge)

Watershed Law/Management in PA is Complex

- Common law – *based on previous court decisions or precedents, decided on a case-by-case basis*
- Surface water rules (riparian law) – *water rights are limited to land owners abutting a water body; “reasonable use” doctrine; right to use not own water*
- Groundwater rules (generally follow riparian law) – *the biggest pump/ deepest well wins*
- Lack of a statewide water permitting agency to regulate withdrawals – *handled in ~2/3 of state by DRBC and SRBC, common law elsewhere*
- State statutory law – *piecemeal regulations that target specific water topics*
- Interstate river basin commissions – *some with the force of law*



State Statutory Authorities Related to Watershed Management

- Regulation of pollution → *Clean Streams Law*
 - *Similar to federal CWA provisions: sediment management, erosion prevention, pollution standards, agricultural runoff, permits for discharging pollutants, stormwater permits, acid mine drainage (PADEP)*
 - *Oil and Gas Act (pollution of water supply systems resulting from energy development)*
- Dam operations → *Dam Safety and Encroachment Act*
 - Regulated by PADEP: construction, management, downstream minimum releases, wetlands
- Stormwater management → *Act 167*
 - *Enforced at county level: surface water runoff management plan for each watershed during extreme events*
- Public water supplies → *1939 Water Rights Act*
 - PUC regulates service areas of public water supply
 - Water quality regulated under state Safe Drinking Water Act (PADEP)

State Statutory Authorities Related to Watershed Management (cont)

- Water resources planning → Act 220
 - *Statewide water plan, updated every five years (currently being updated), six regions, regional committees and statewide committee*
 - *Planning and policy guidance document only – does not regulate water use*
 - *Requires registration and reporting of metered water use by certain categories/volumes water users*
 - *Identification of critical water planning areas require Critical Area Resource Plan (CARPs)*
- “Other”
 - *PA Environmental Rights Amendment*
 - *EPA’s Chesapeake Bay nitrogen/phosphorus/sediment TMDLs*
 - *Instream flow regulation & management (SRBC, DRBC, PA Fish & Boat Commission)*
 - *PEMA – drought and flood loss reduction*

Welcome to the Delaware River!

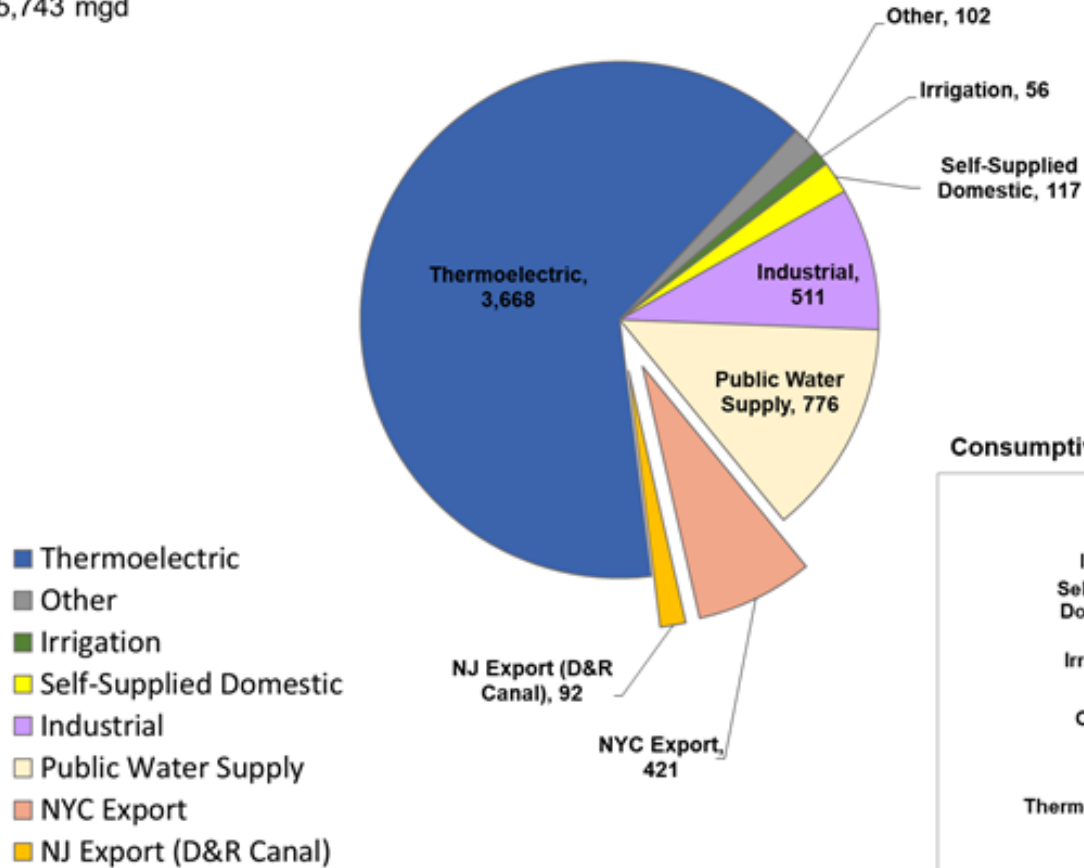
Fast Facts:

- Main stem is **330 miles long**
- Forms an interstate boundary over its entire length
- **Drains 13,539 square miles** in 4 states
- **13.3+ million people** (about 4% of the U.S. population) rely on the waters of the Delaware River Basin
- Water **withdrawal** in the Basin = **6.4 billion gallons/day**
- **Significant Exports:** NYC (up to 800 MGD) and NJ (up to 100 MGD)
- Longest, un-dammed U.S. river east of the Mississippi
- **Contributes over \$21B** in economic value

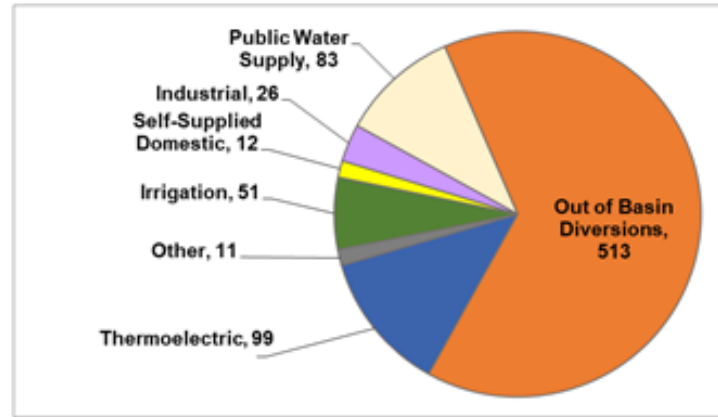


Delaware River Basin Water Use

Total Water Withdrawals
(ground and surface) from the
Delaware River Basin, 2018:
5,743 mgd



Consumptive Use and Major Basin Exports: 795 mgd



Consumptive Use:

Water that is withdrawn that is not returned to the surface waters of the basin undiminished

Figure 1. Total Water Withdrawals and Consumptive Use / Major Exports from the Basin in 2018. Note that self-supplied domestic estimates from other reporting years have been used as more recent data were not readily available. Additionally, data from the hydroelectric power sector is not presented as it is known to be incomplete.

What is the Delaware River Basin Commission?

■ Five Equal Members:

■ Delaware



■ New Jersey



■ Pennsylvania



■ New York



■ Federal Government



Note: New York City and Philadelphia are “advisors” and not members

Why was the DRBC created?

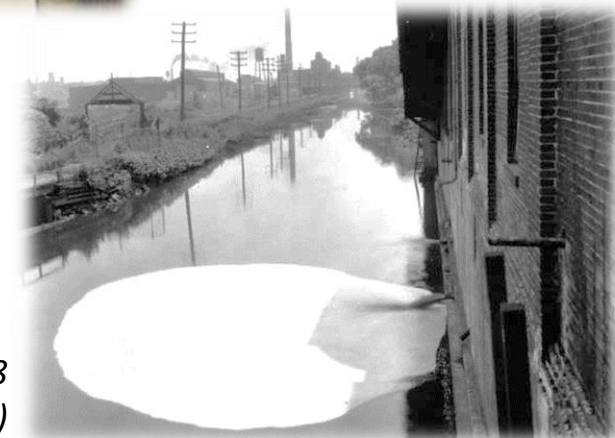
- Water supply shortages and disputes over the apportionment of the Basin's waters;
- Severe pollution in the Delaware River and its major tributaries;
- Serious flooding



*Easton-Phillipsburg free bridge in 1955
(lehighvalleylive.com file photo)*



*Fish kill on the Delaware from oil spill in 1929
(courtesy of Temple University Archives)*



*Slaughterhouses discharging in 1928
(courtesy of the Phila. Water Dept. Historic Collection)*

DRBC Core Responsibilities

Flood Damage Reduction

Development of **Recreational Facilities**

Conservation and **Development of ground and surface water supply**

Promotion of Related . . . **Watershed Projects**

Propagation of Fish and Game

*Improved
Navigation*

**Ensuring an adequate, equitable,
sustainable, and resilient flow of
clean and healthy water.**

**Protection
to Fisheries**

*Development of
Hydroelectric Power*

*Control of Movement
of Salt Water*

Abatement and control of stream pollution

And Regulation towards the attainment of these goals

Ensuring Water Security for Over 13 million People



CLIMATE CHANGE

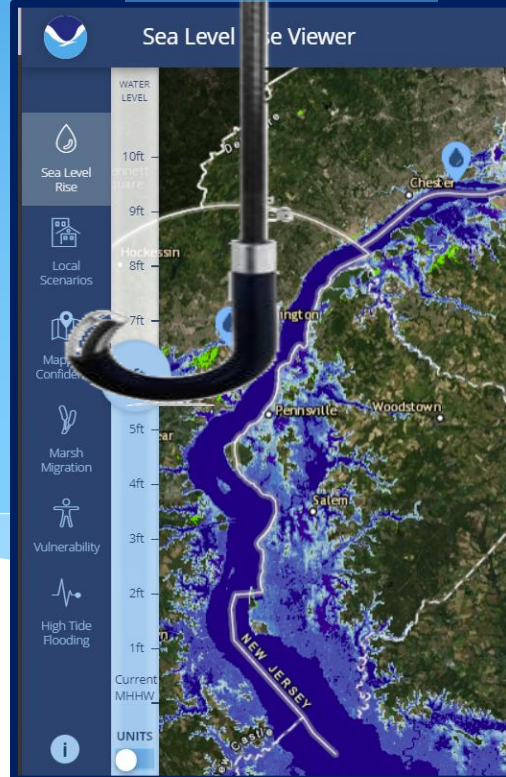
Habitat



High-Tide Flooding



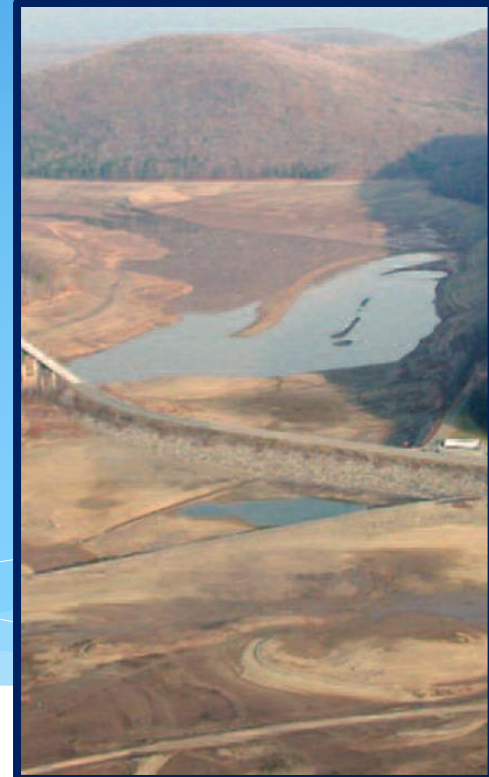
Sea Level Rise



Snowpack and Ice

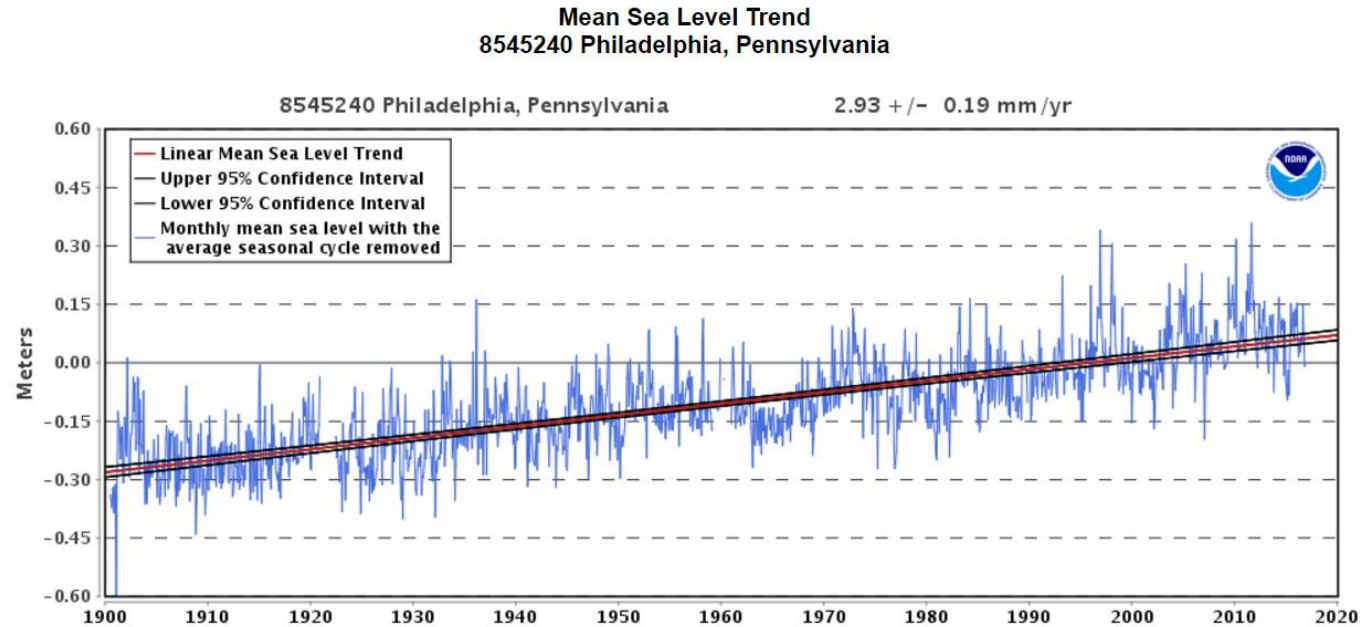


Drought



Climate Change Risks

- Sea Level Rise
- Increasing air temperatures
- More frequent dry periods (droughts)
- More intense heavy rains (flooding)
- Seasonal changes in hydrology, snow pack, and snow melt
- Instream flow and temperature changes on aquatic habitat



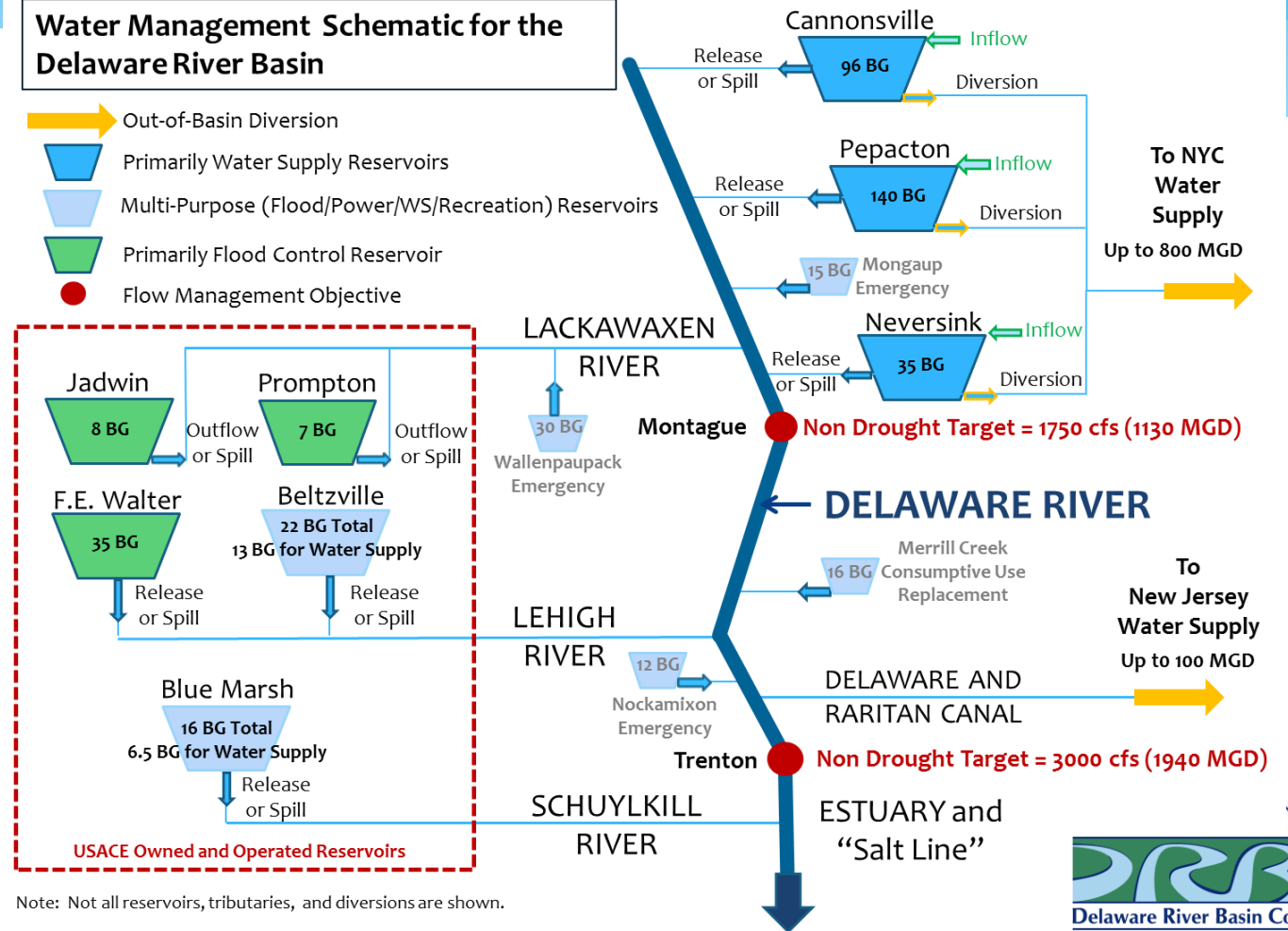
Philadelphia, PA
2.93 mm / year
0.96 ft. / 100 years

Flow & Salinity Management



Water Management Schematic for the Delaware River Basin

- Out-of-Basin Diversion
- Primarily Water Supply Reservoirs
- Multi-Purpose (Flood/Power/WS/Recreation) Reservoirs
- Primarily Flood Control Reservoir
- Flow Management Objective

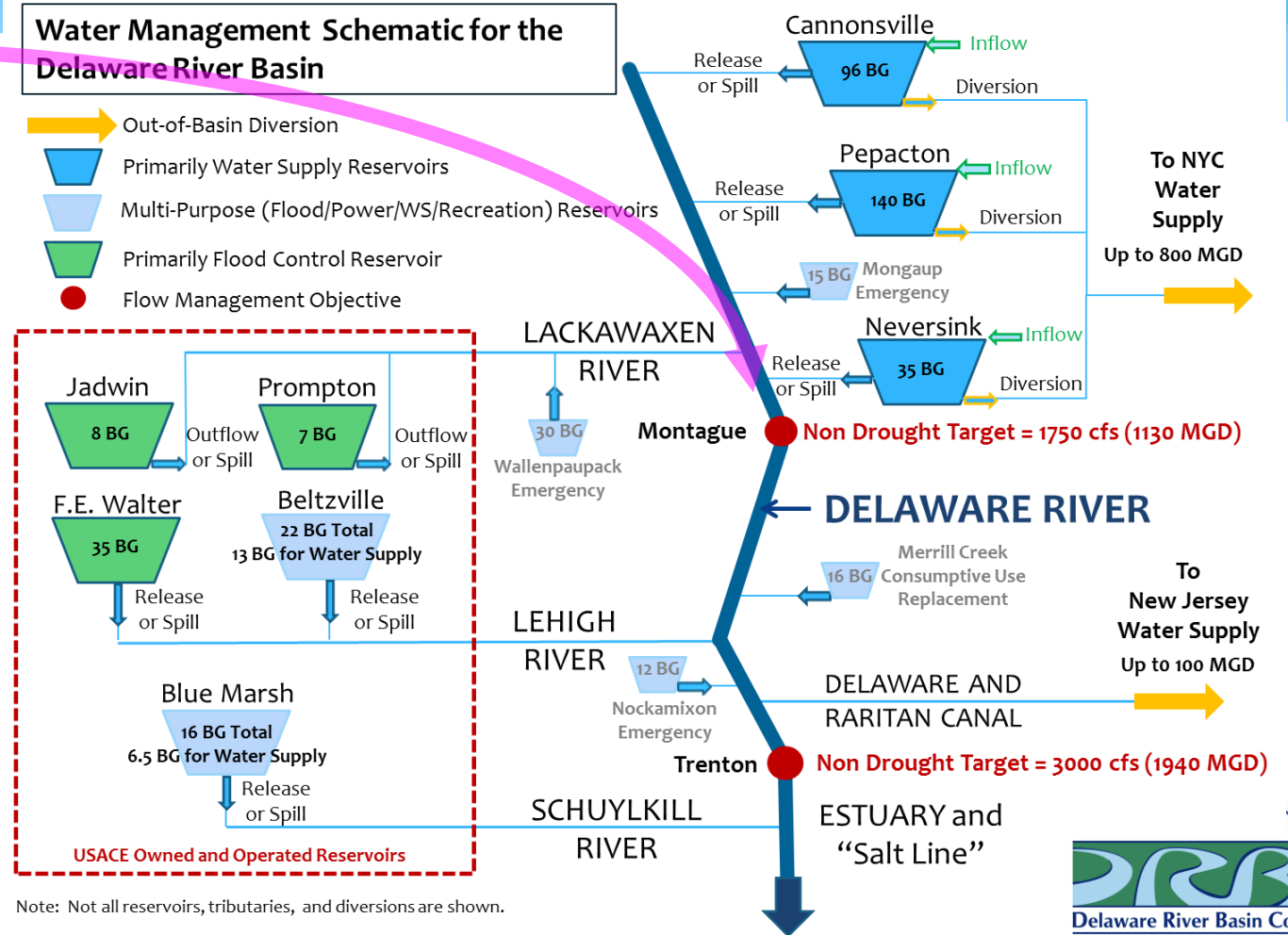


Flow & Salinity Management



Water Management Schematic for the Delaware River Basin

- Out-of-Basin Diversion
- Primarily Water Supply Reservoirs
- Multi-Purpose (Flood/Power/WS/Recreation) Reservoirs
- Primarily Flood Control Reservoir
- Flow Management Objective



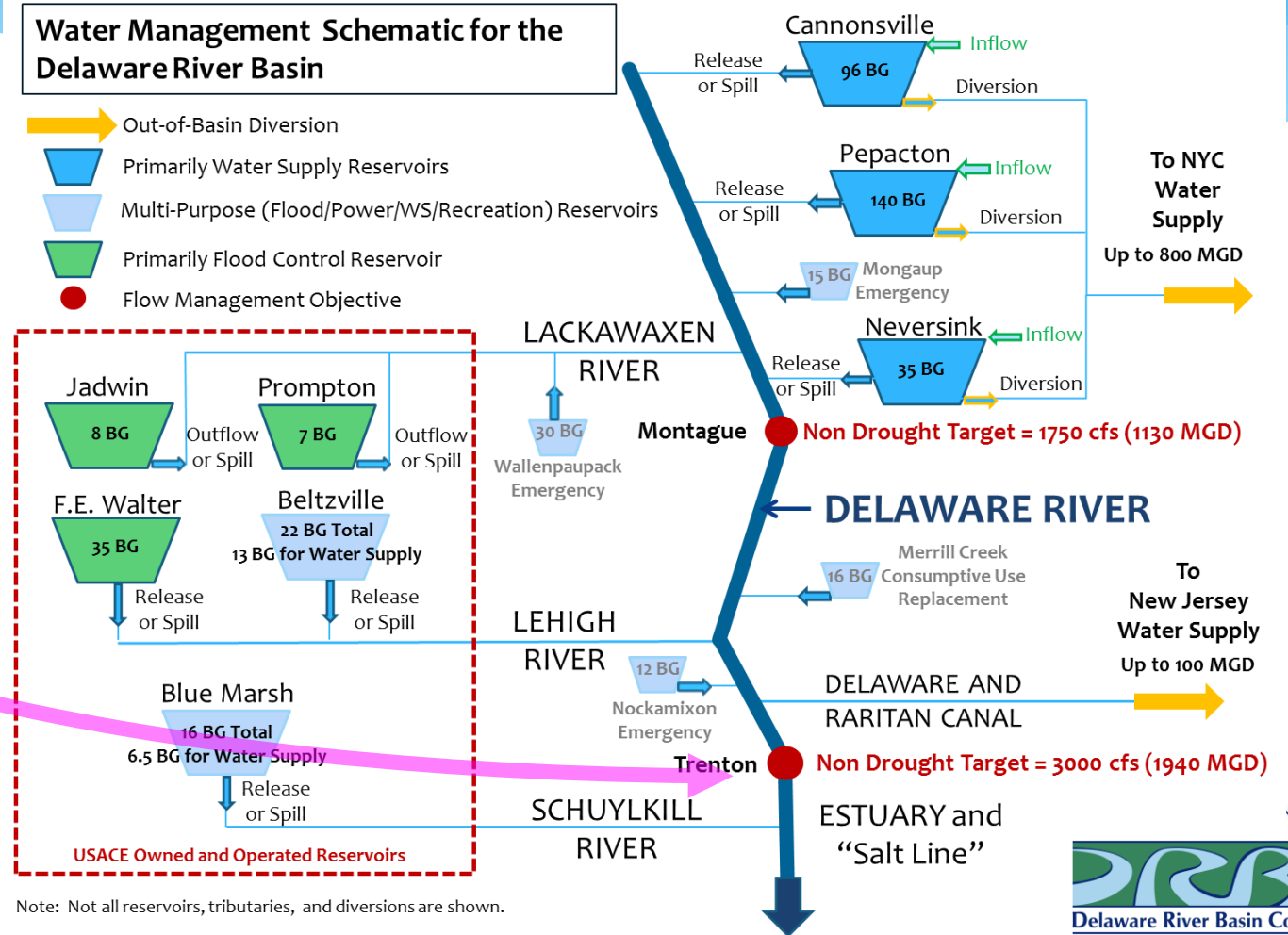
Note: Not all reservoirs, tributaries, and diversions are shown.

Flow & Salinity Management



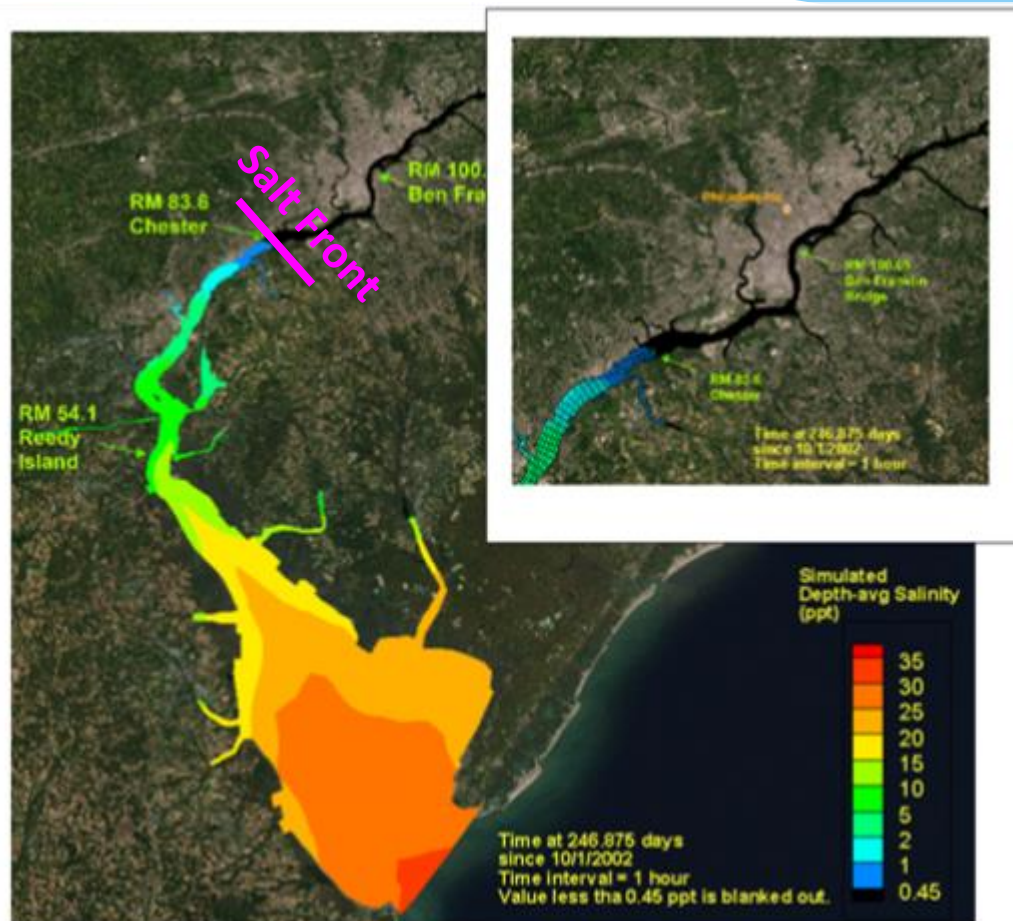
Water Management Schematic for the Delaware River Basin

- Out-of-Basin Diversion
- Primarily Water Supply Reservoirs
- Multi-Purpose (Flood/Power/WS/Recreation) Reservoirs
- Primarily Flood Control Reservoir
- Flow Management Objective



Note: Not all reservoirs, tributaries, and diversions are shown.

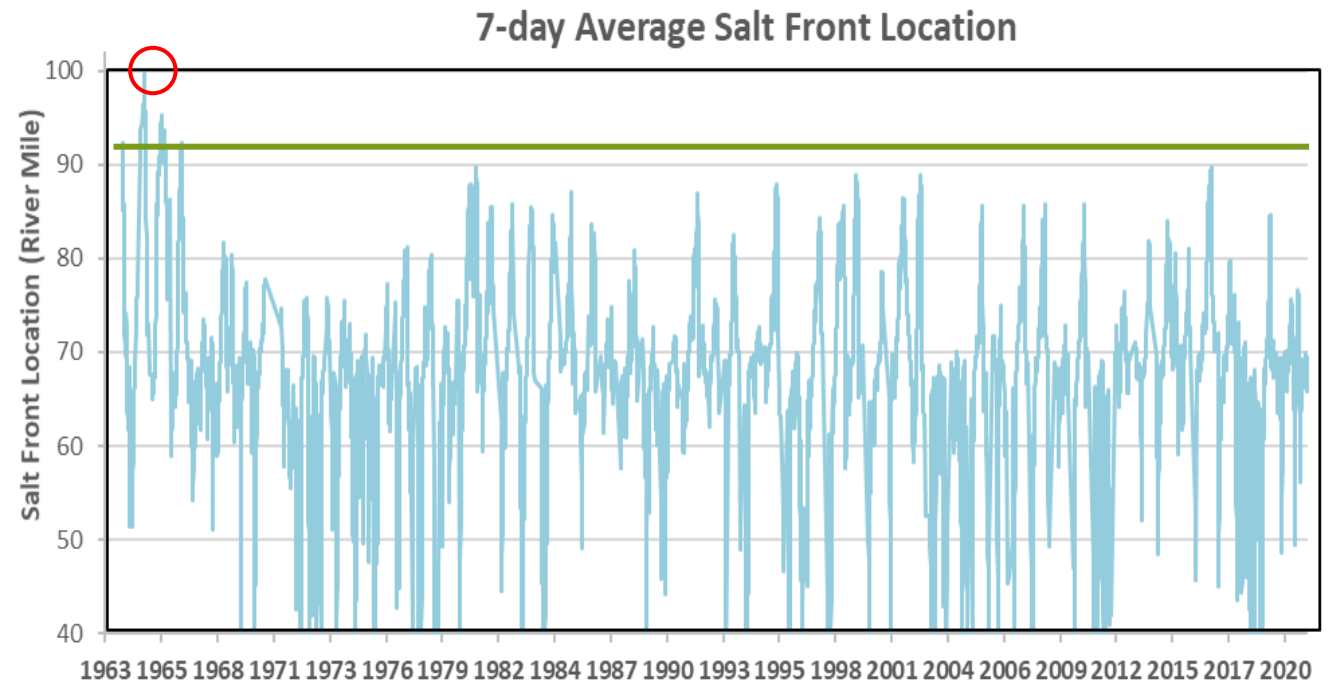
Managing the Salt Front in the Delaware Estuary

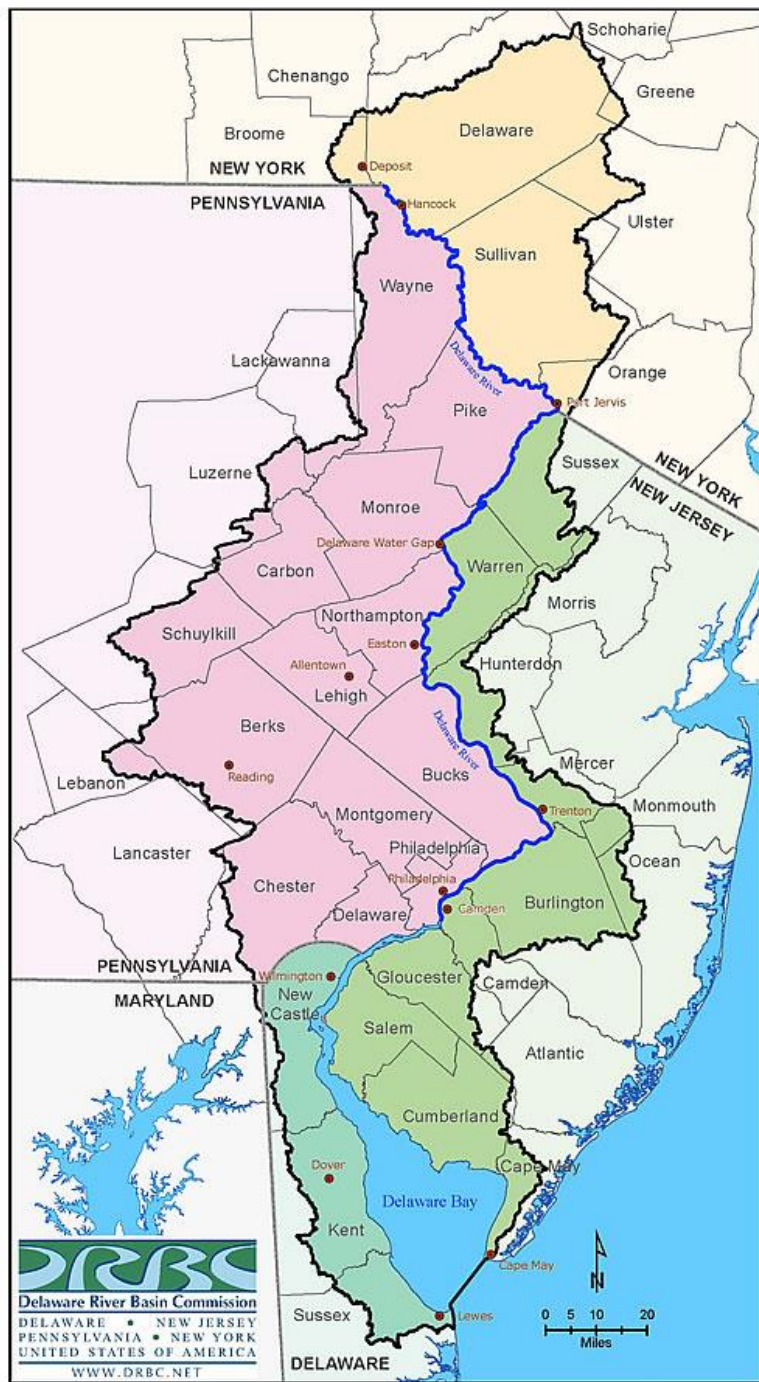


- The “Salt Front” represents where freshwater meets saltwater in the Estuary
 - 250 mg/L chloride
- Salt Front management protects drinking & industrial water intakes along urban corridor

Sea Level Rise Will be a Challenge for Future Salt Front Management

- During the 1960s, the salt front reached **RM 100**
- With drought management plan, flow targets, and water code: has not been above **RM 92**
- New planning efforts need to incorporate sea level rise





Freshwater Hydrologic
Climate Considerations:

- Precipitation
 - Flow

Temperature

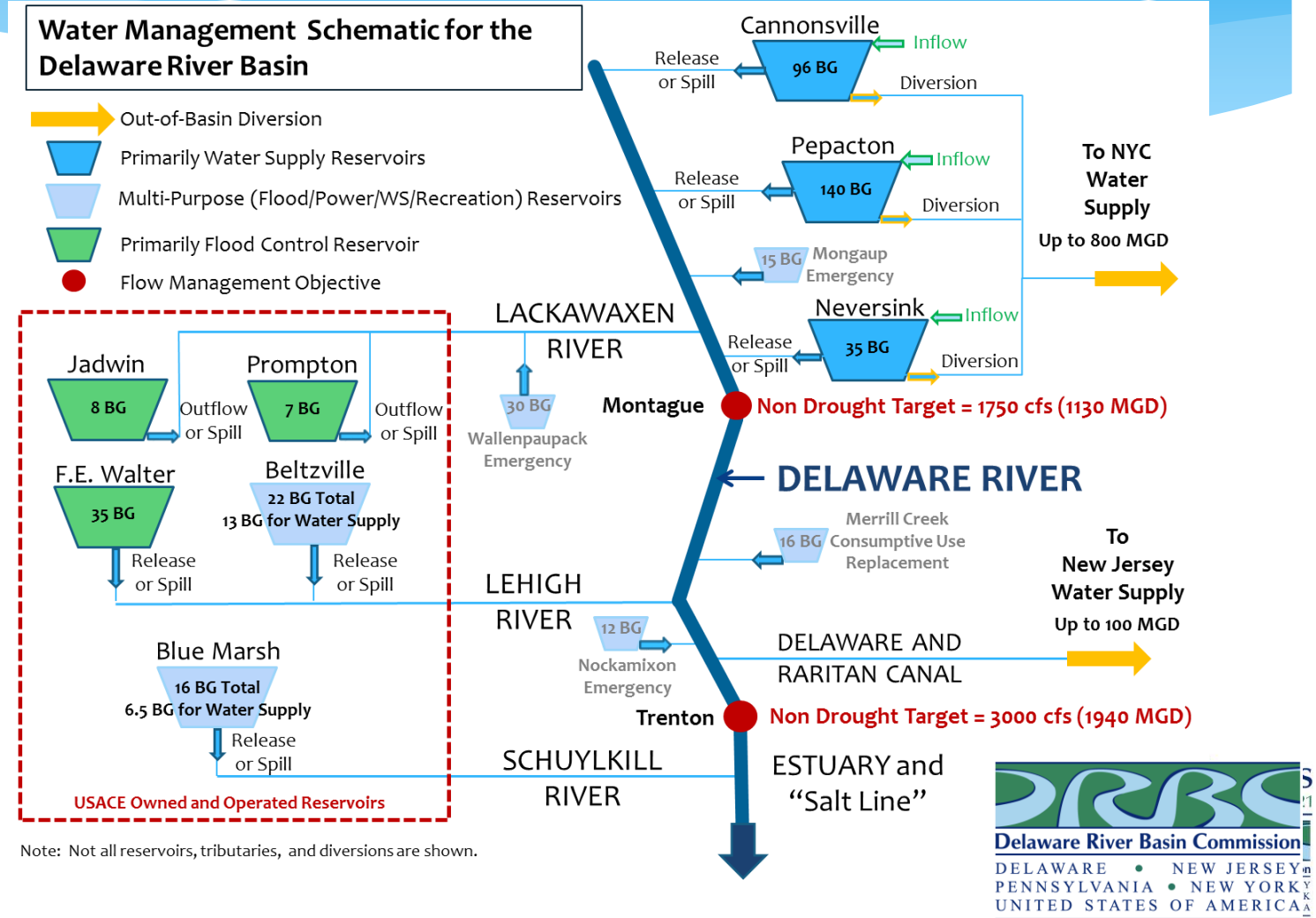
- Evapotranspiration
- Snowpack

Salt Water
Climate Considerations:

- Sea Level Rise

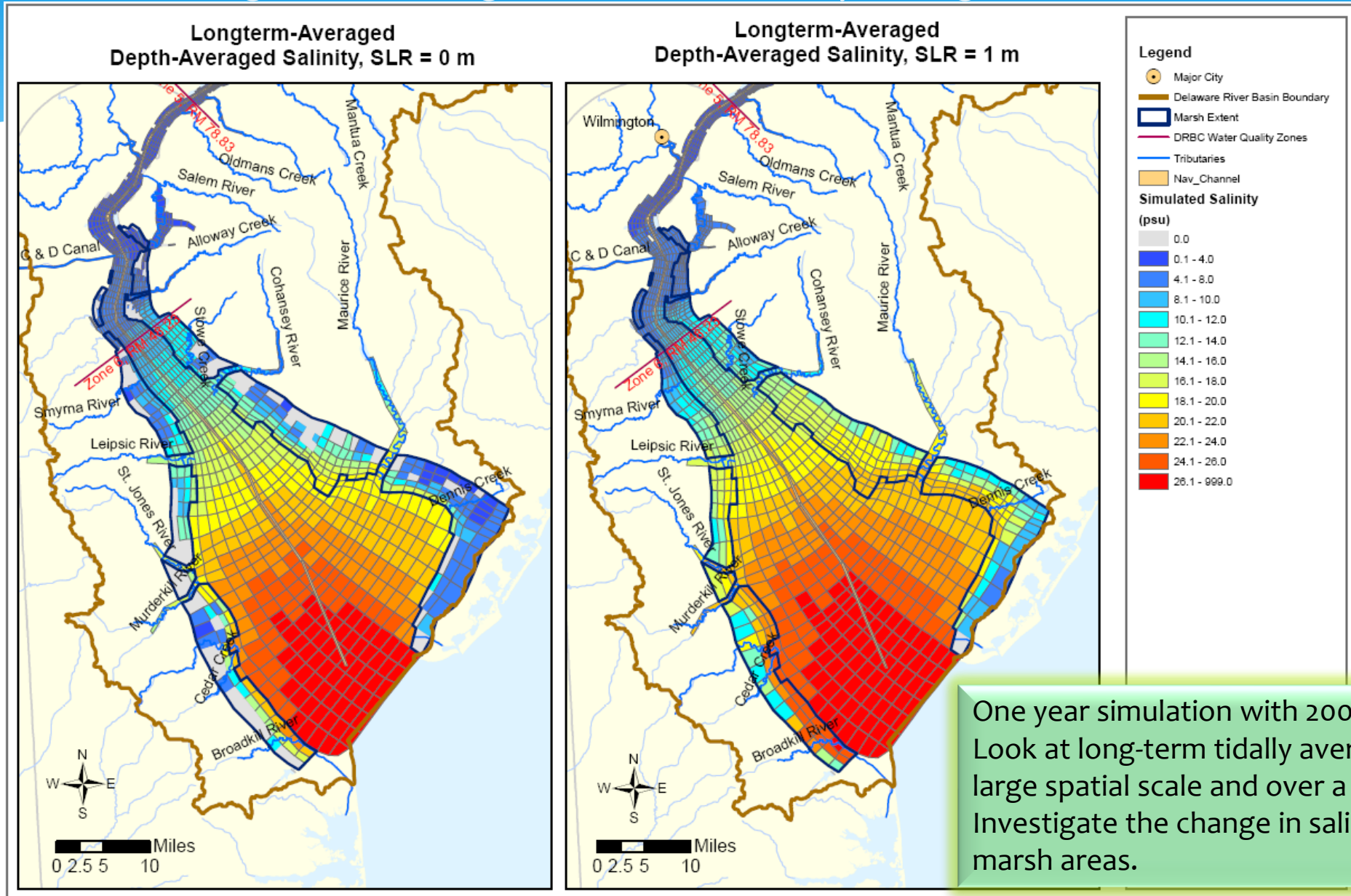
2060 Planning Questions - Water Availability

- Adequacy of available storage?
- Adequacy of emergency storage?
- Number of “drought days”?
- Adequacy of flow objectives?
- Water budget in major sub basins:
 - Will the available Water Supply meet the projected Water Demand?



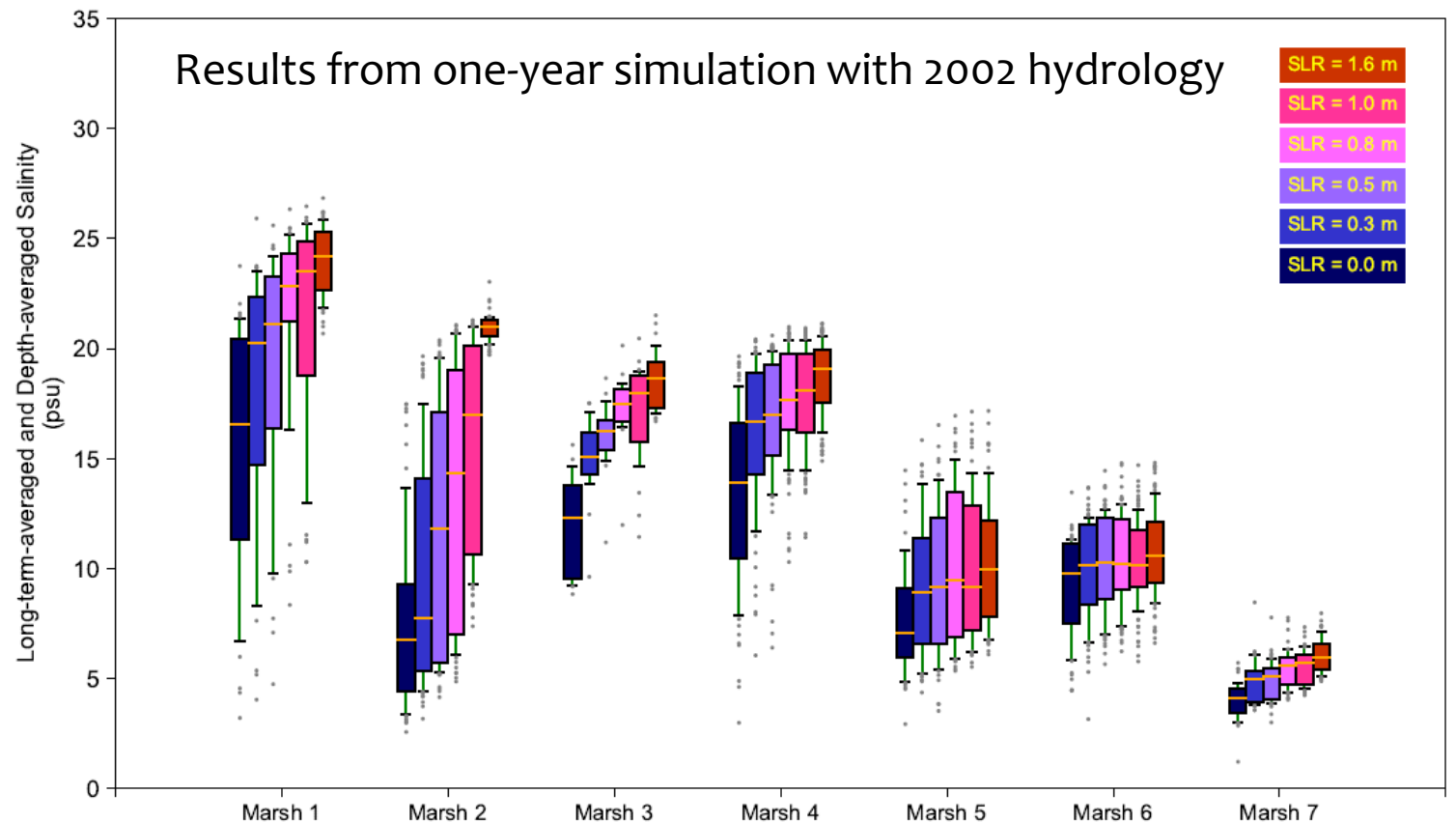
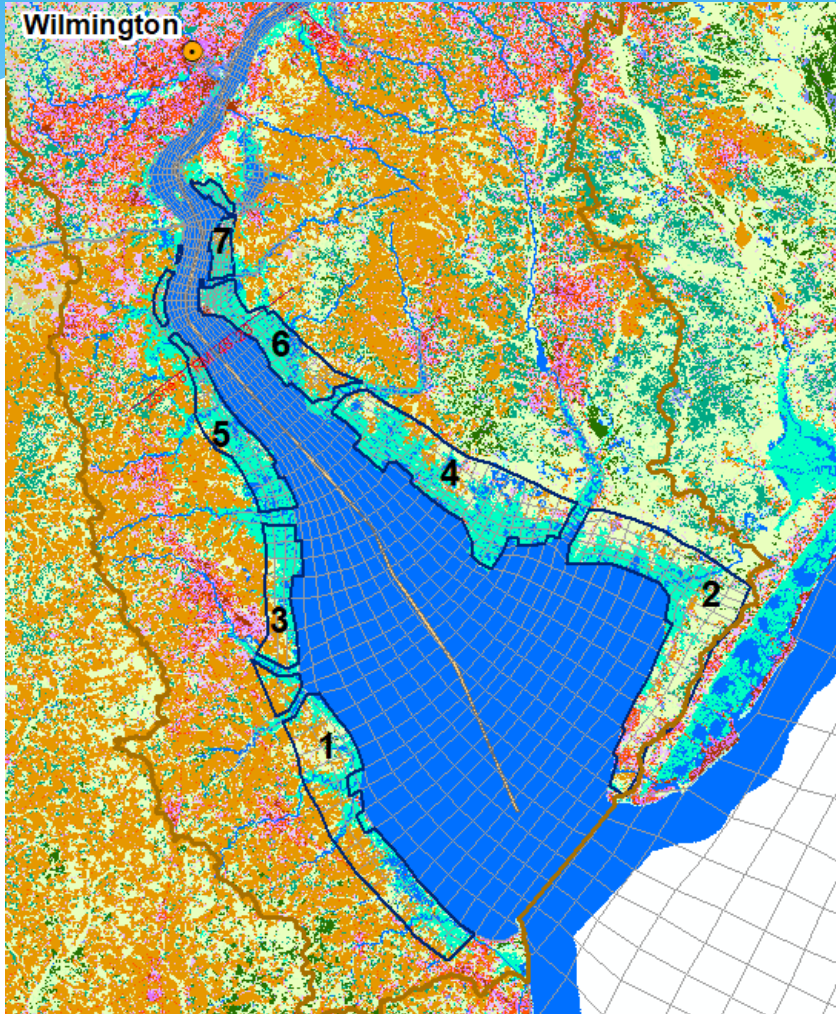
Predicted Salinity, 0 m vs. 1 m SLR

long-time averaged results, 2002 hydrologic conditions



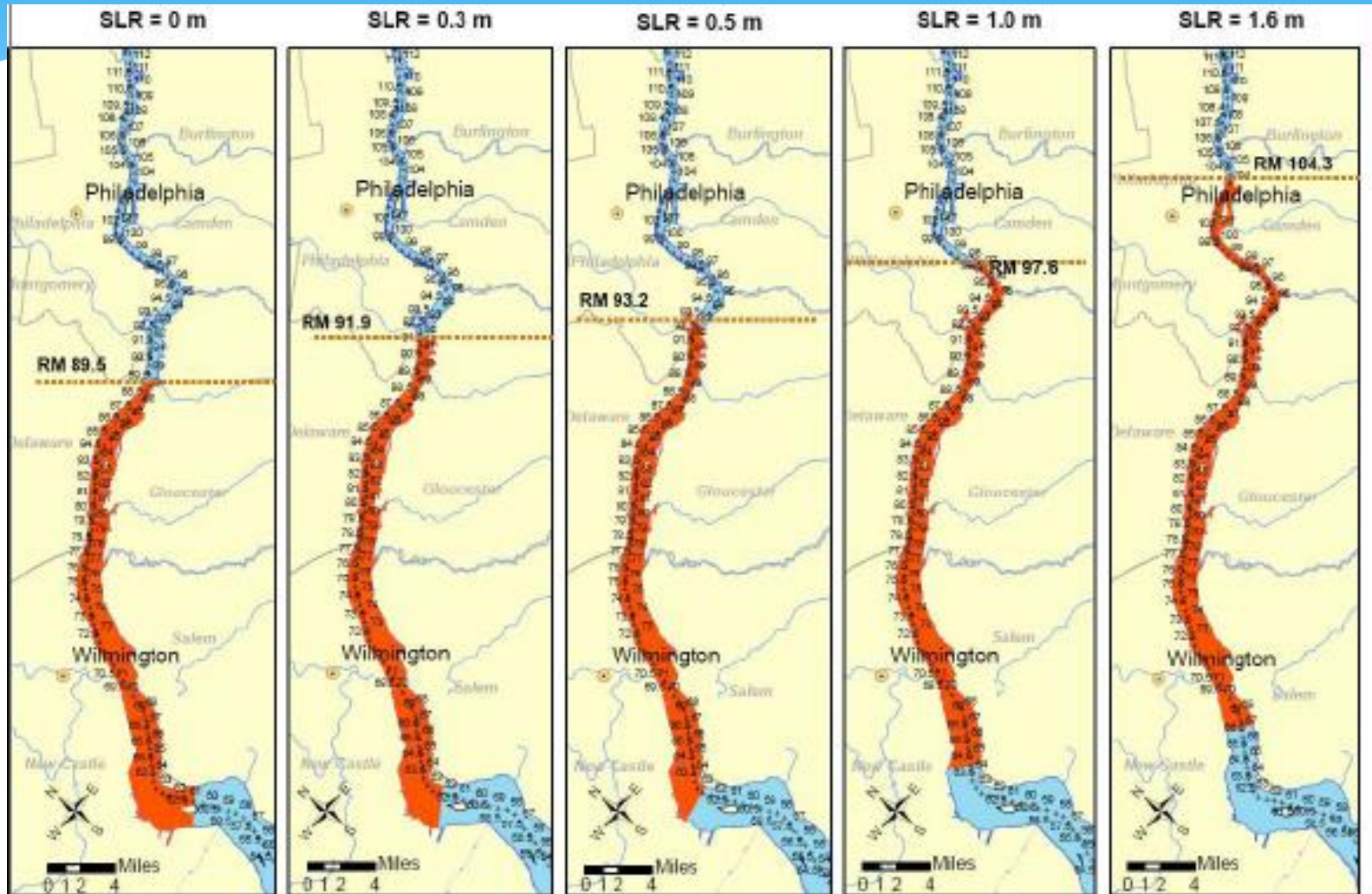
One year simulation with 2002 hydrology. Look at long-term tidally averaged salinity on a large spatial scale and over a long time period. Investigate the change in salinity regime over marsh areas.

Predicted Long-term-averaged and Depth-averaged Salinity In Marsh Areas



A clear gradient in salinity exists from the bay mouth towards upstream. For given marsh, tidally-averaged salinity increases as sea level rises.

Range of Salt Front Movement with SLR



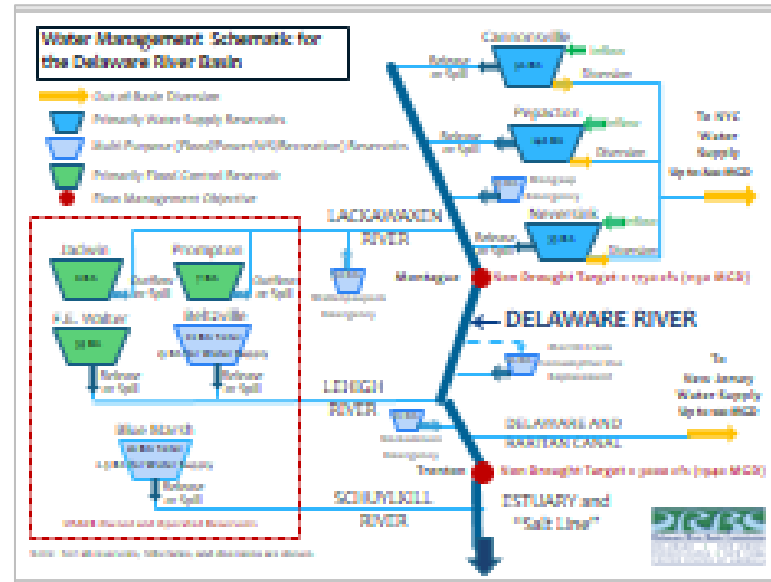
DRBC. EFDC Model - Preliminary Results

- Simulated salt front range during 4-months of low flow conditions
- Sea Level Rise (SLR) range 0 – 1.6 m

Evaluating Flow Management Scenarios Under Future Climate Change Hydrology

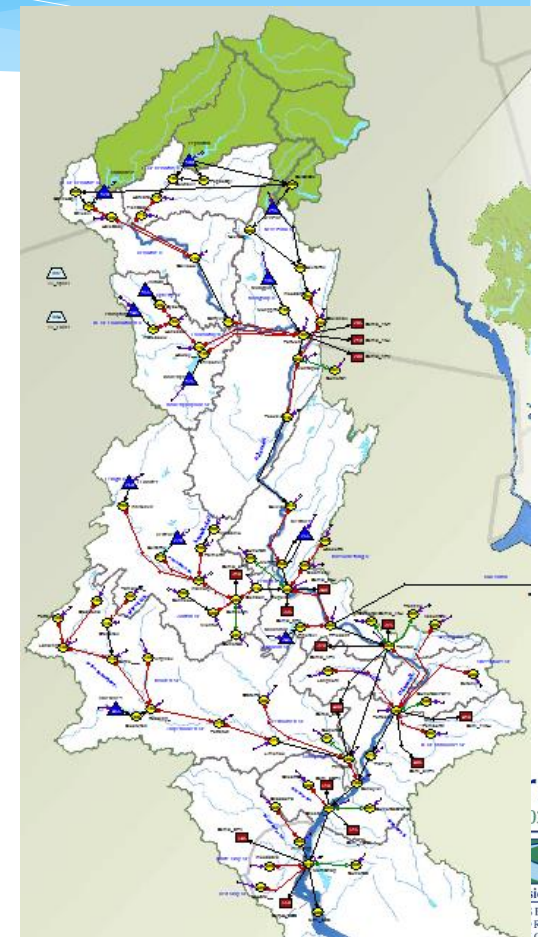
Step 1

Flow Management Rules



Water Code, FFMP, Dockets

DRB-PST



Evaluating Flow Management Scenarios Under Future Climate Change Hydrology (cont)

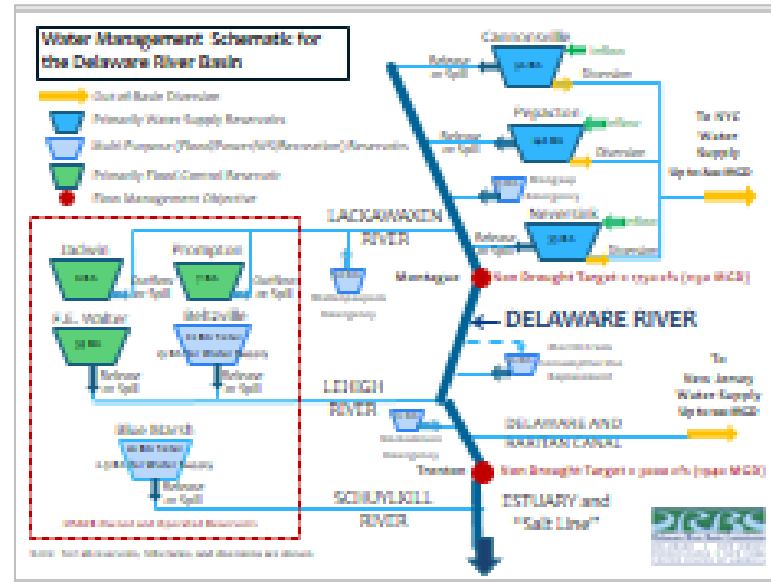
Step 2

Water Use Data



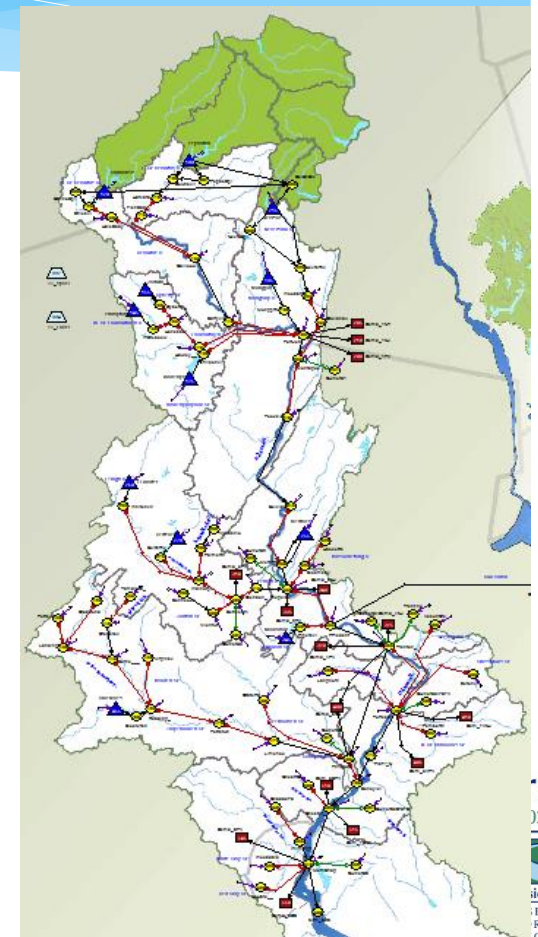
DRBC, States

Flow Management Rules



Water Code, FFMP, Dockets

DRB-PST



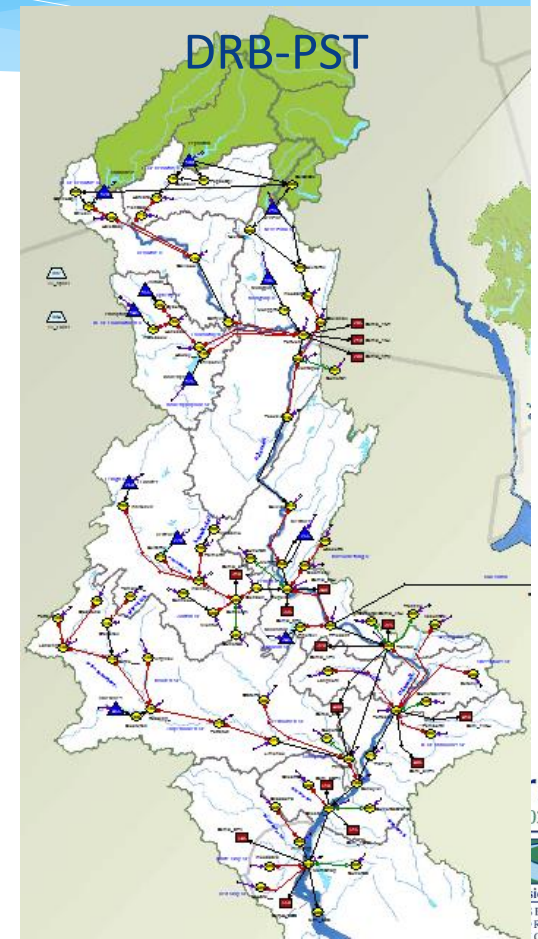
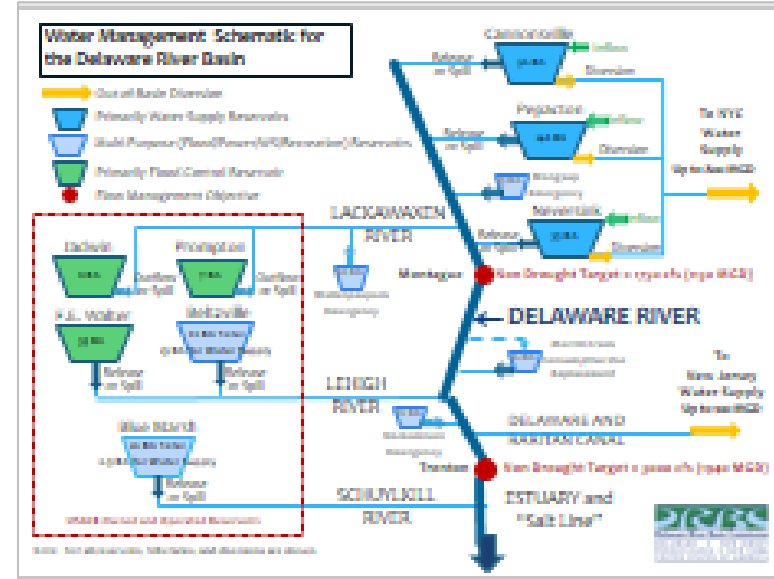
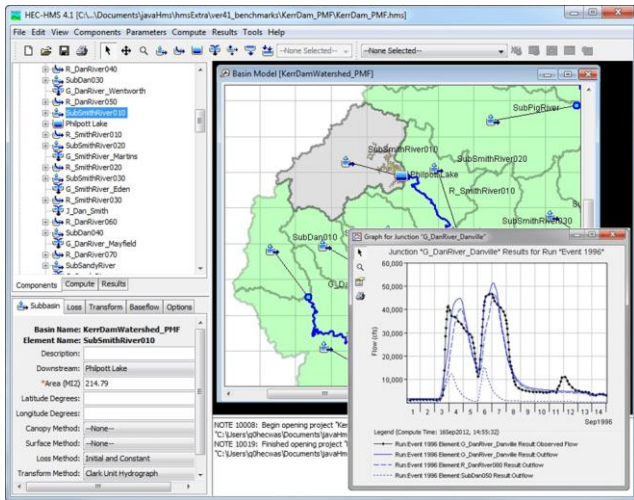
Evaluating Flow Management Scenarios Under Future Climate Change Hydrology (cont)

Inflows

Water Use Data

Flow Management Rules

DRB-PST



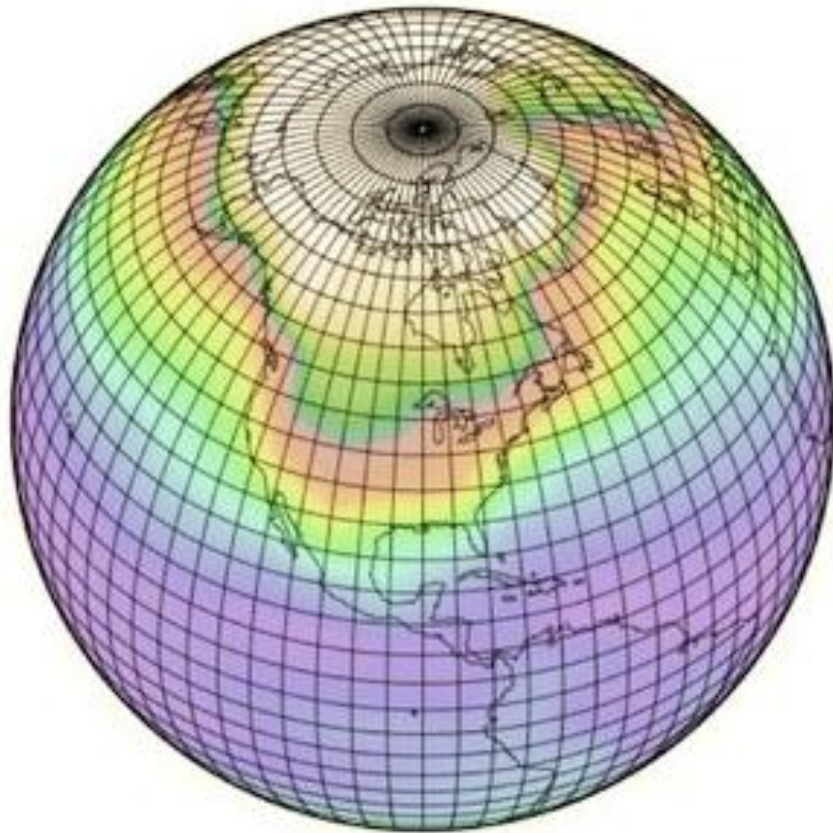
Future Hydrology

Water Code, FFMP, Dockets

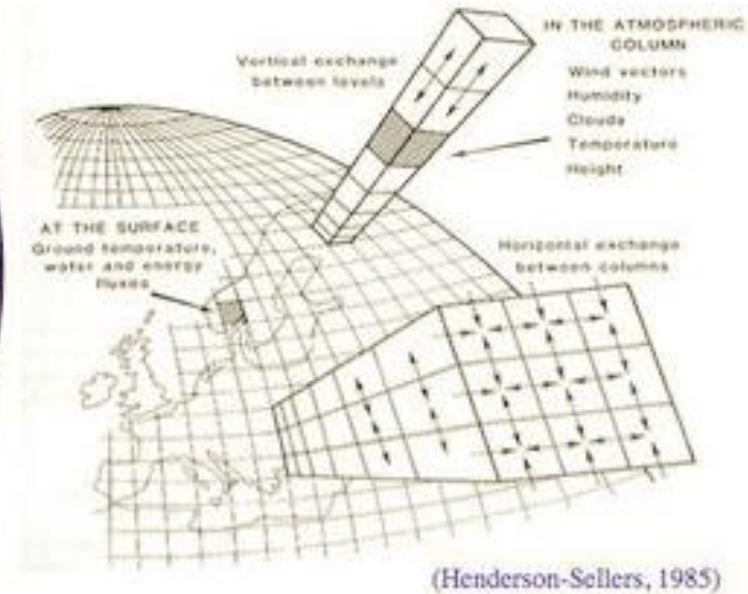
Step 3

DRBC, States

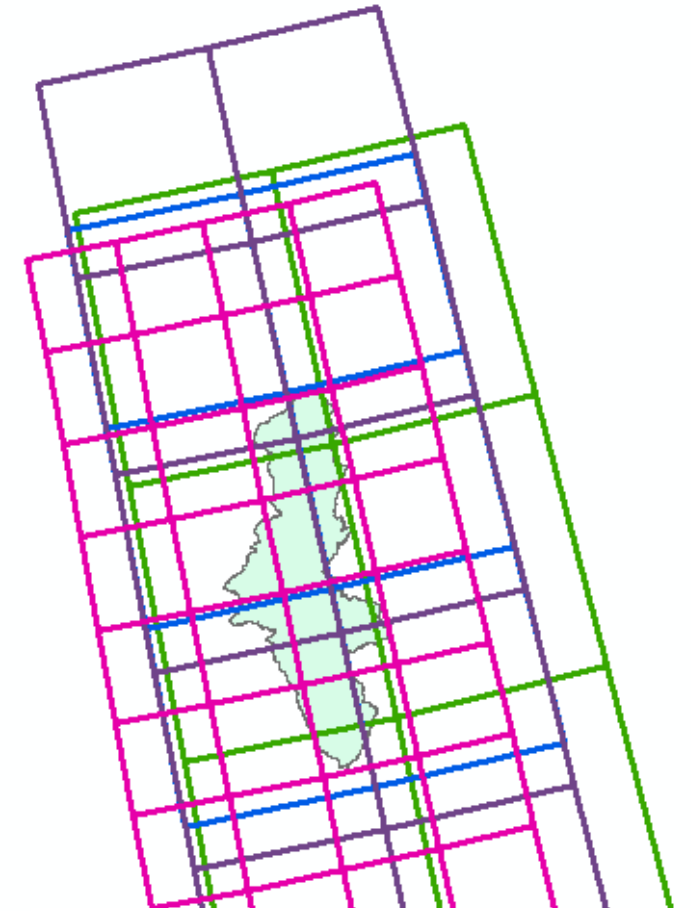
Future Hydrology (Inflows) Developed from Downscaling GCM Output



Global Circulation Model
(GCM) Tiles



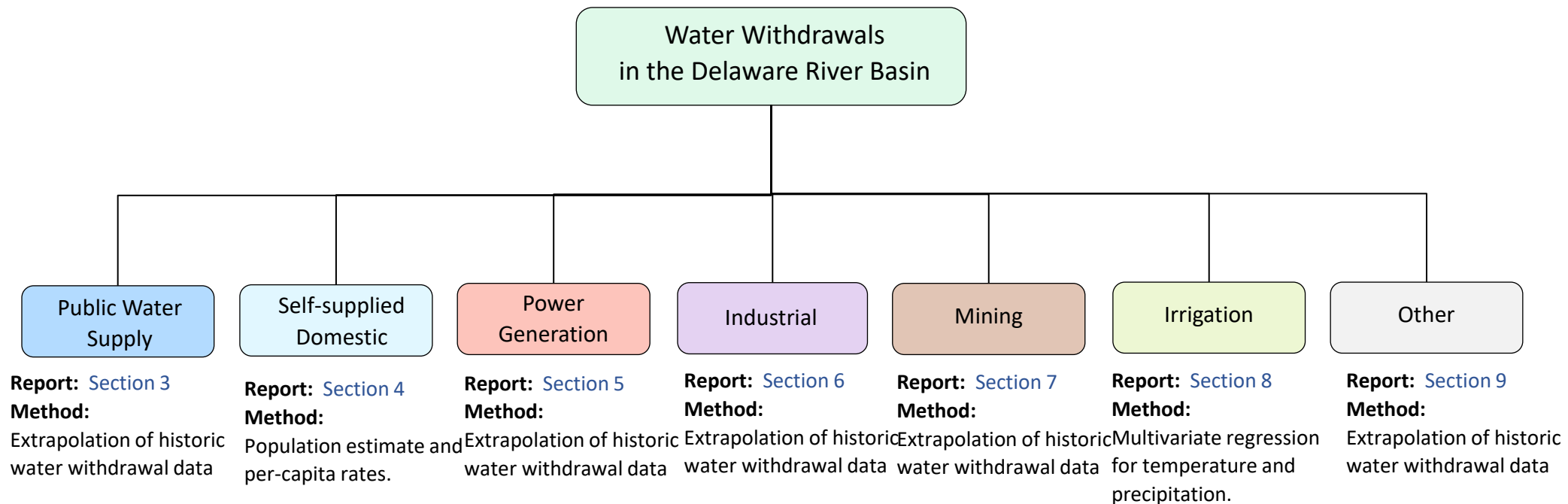
Finite Element Grid of
Atmospheric Layers



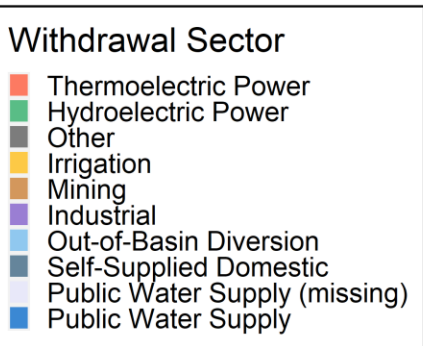
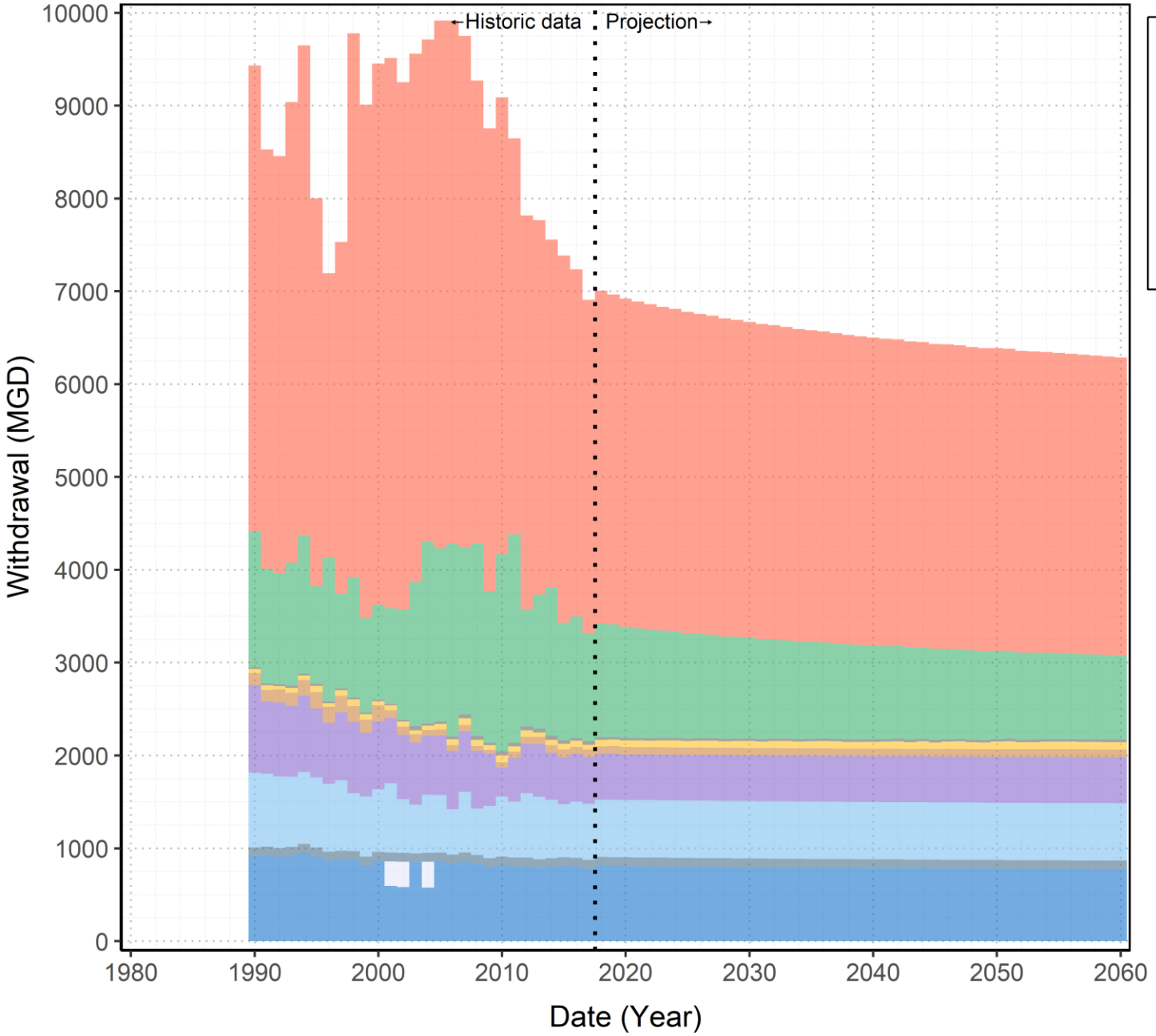
Tiles that Cover the DRB

Projected Water Withdrawal and Consumptive Use for the Delaware River Basin Through 2060

- Analyzed historic water withdrawal data (1990-2017) at the source level – for groundwater and surface water – to project future water withdrawals (to 2060).

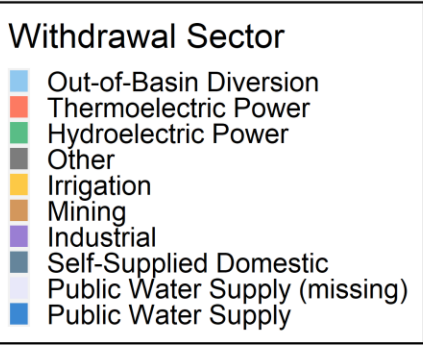
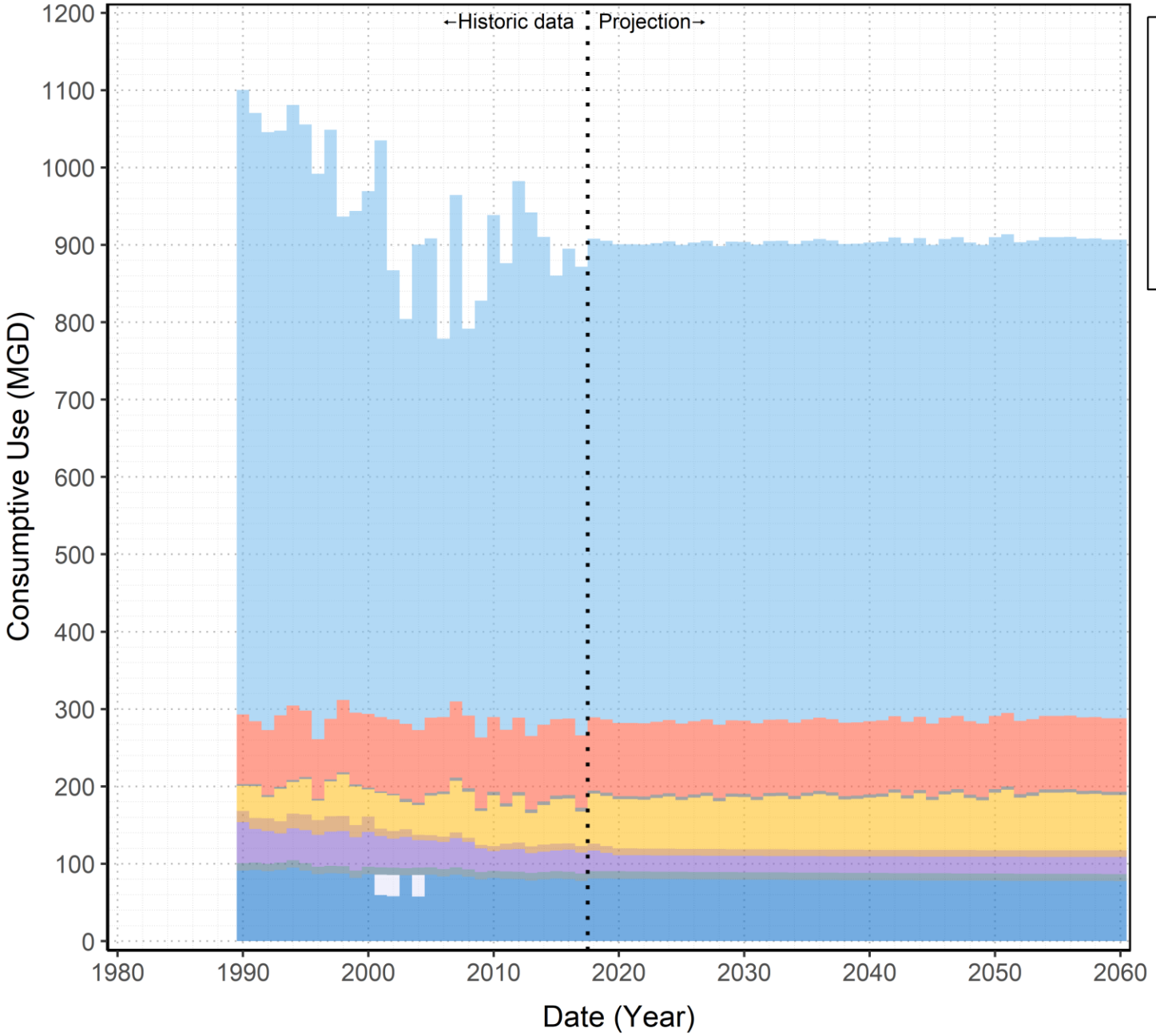


Historic and projected water withdrawals from the Delaware River Basin



- **Peak withdrawals have occurred**
- **Thermoelectric** decreases since 2007 will plateau as coal-fired facilities using once-through are limiting
- **Public Water Supply** has shown and projects decreases despite historic and projected growing in-Basin population
- **Hydroelectric** withdrawals are significant; however, no consumptive use
- **Industrial** withdrawals historically decrease, but plateau

Historic and projected consumptive water use in the Delaware River Basin



- **Consumptive use projected to remain relatively stable**
- **Thermoelectric** consumptive use constant despite decreased withdrawals due to changes in technology
- **Irrigation** is significant and shows slight increases related to projected changes in climatic variables
- Significant **spatial variation** in terms of both withdrawal and consumptive use

Projected Water Withdrawal and Consumptive Use for the Delaware River Basin Through 2060

■ Next Steps

➤ Groundwater availability

- 147 HUC scale
- SEPA GWPA scale

■ Surface Water availability

- Consider effects of climate change (future hydrology)
- Consider reservoir operations
- Consider the Drought of Record

Advisory Committee On Climate Change

- Composed of climate scientists, researchers, thought leaders, planners and experts on climate change adaptation and resiliency
- Representing government, academic and research institutions, environmental and watershed organizations, businesses/industries, and water/wastewater utilities
- Purpose & Charge
 - Identify and prioritize threats and vulnerabilities
 - Develop science-based future planning scenarios to inform DRBC planning and modeling studies
 - Coordinating body for climate related Basin water resource and watershed studies
 - Define scope and support development of a Basin wide climate impact study

Additional Information

- Interest Form (for listserv opt-in on variety of DRBC topics)

<https://www.state.nj.us/drbc/contact/interest/>

- Advisory Committee on Climate Change

https://www.nj.gov/drbc/about/advisory/ACCC_index.html

Kristen Bowman Kavanagh, P.E.
Deputy Executive Director

Kristen.B.Kavanagh@drbc.gov

www.drbc.gov



Delaware River Basin Commission

DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

***Managing, Protecting & Improving the Basin's
Water Resources Since 1961***