Water Withdrawal and Consumptive Use Estimates for the Delaware River Basin (1990-2017) With Projections Through 2060

Lower Delaware River Wild and Scenic Council Meeting

June 30, 2022

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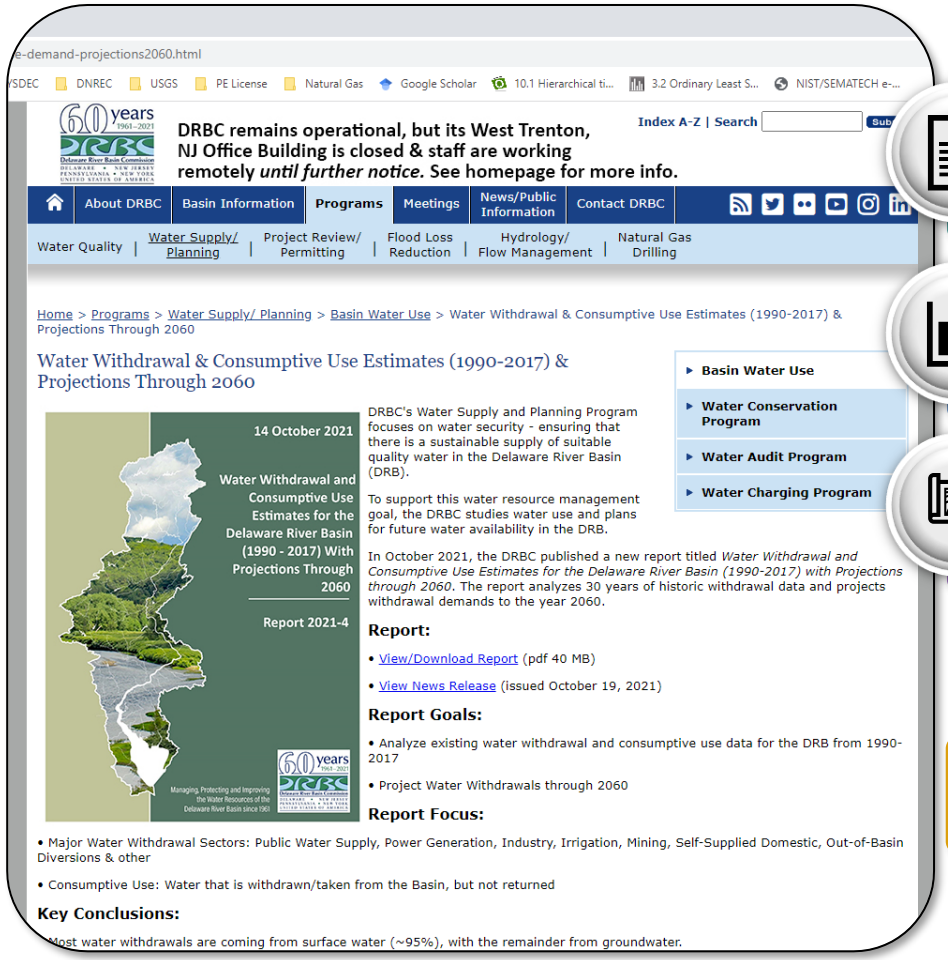
Outline

1. Publication and data deliverables
2. Water Supply Planning – Why and What?
3. Methodology
4. Results
5. Relationship to LDRWS program
6. Questions

1. Publication & Data Deliverable

Report webpage:

https://www.nj.gov/drbc/programs/supply/use-demand-projections2060.html



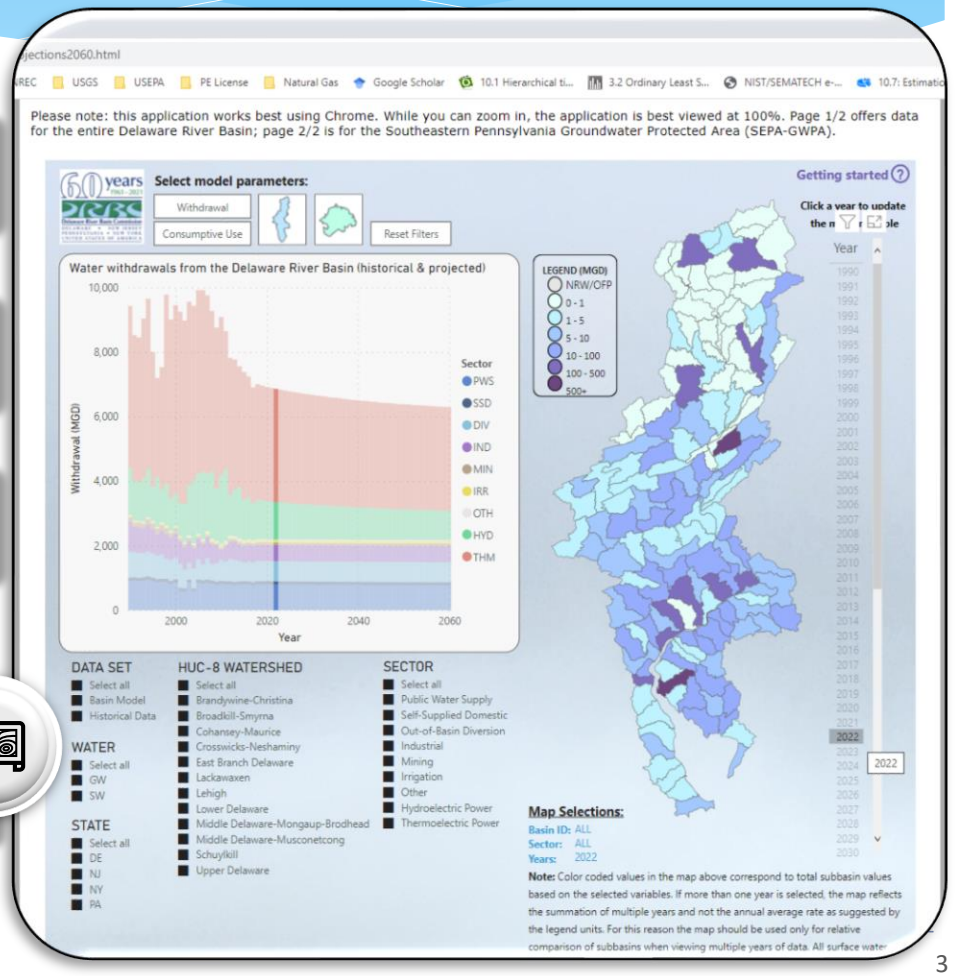
You can:

Download the report (~40 MB)
(Best viewed with Adobe)

Download the dataset (~10 MB)
MS Excel File (no macros)

Download high resolution maps from the report

Interact with the Power BI data visualization tool



2. Water Supply Planning – Why and What?

Ontelaunee Reservoir Dam
near Reading, Pennsylvania.
Credit: © Melissa Kopf
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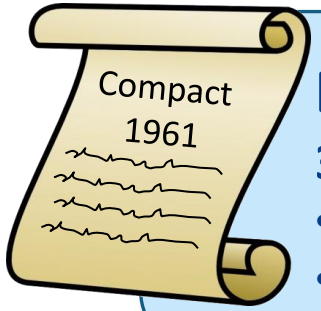
2. Water Supply Planning: Why are we projecting withdrawal data?

Is there enough water to meet future demands?

1. What are the current/future demands?
2. How does it compare against current allocations?
3. What about a repeat of the Drought of Record?
4. What about climate change?



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3.6 General Powers.

- Conduct and sponsor research on water resources
- Collect, compile, correlate, analyze, report and interpret data on water resources and uses in the basin

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2. Water Supply Planning: What are the planning objectives?

Provide projections of future average annual water use in the Delaware River Basin, through the year 2060, to be used in future planning assessments.

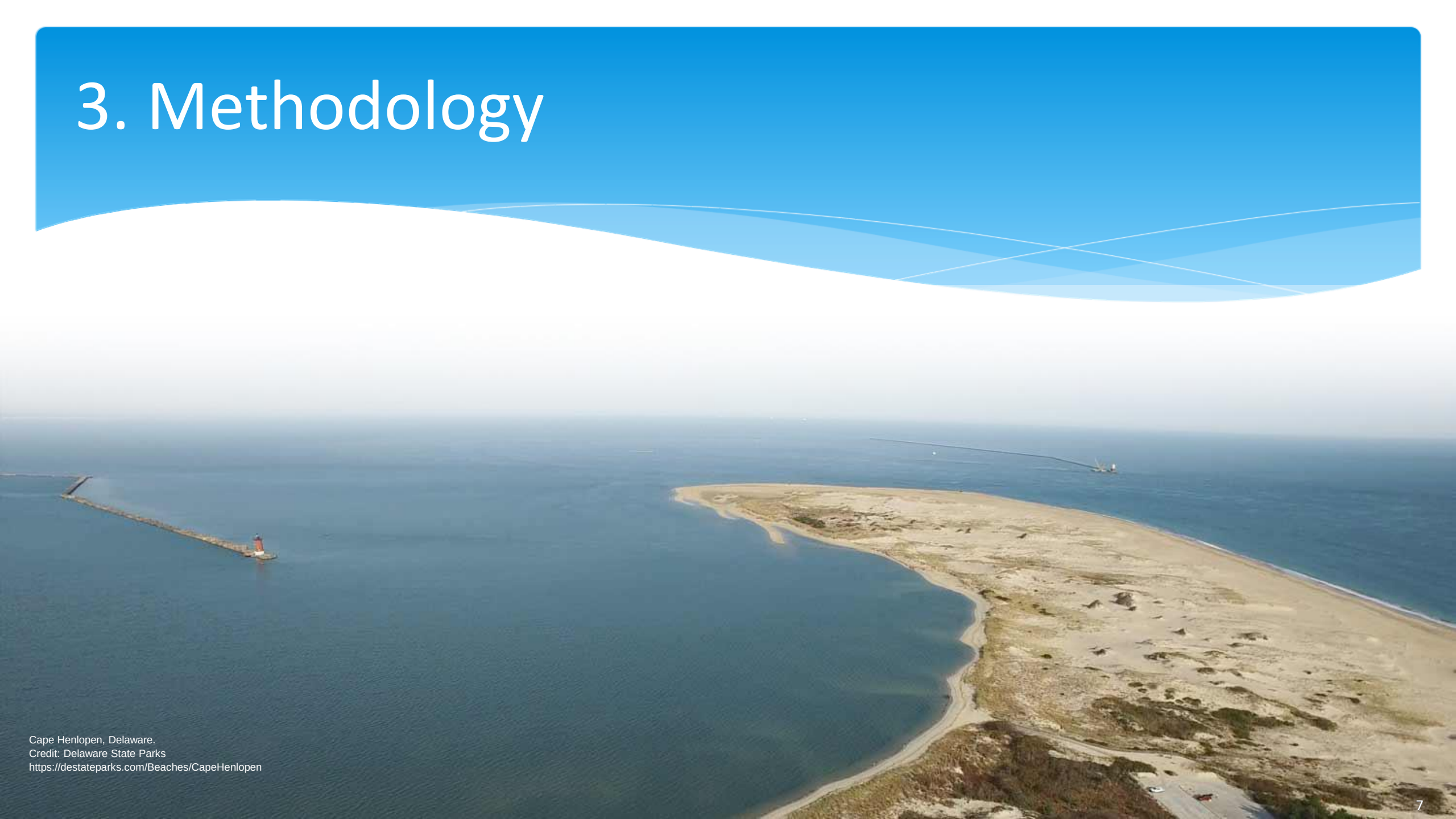
Represent each water use *sector* at the Basin-wide scale.

Apply GW results to the 147 sub-watersheds (Sloto & Buxton, 2006) and the sub-watersheds of SEPA-GWPA.

Apply SW results at the source level for future availability analyses.

Relate results to regulatory approvals.

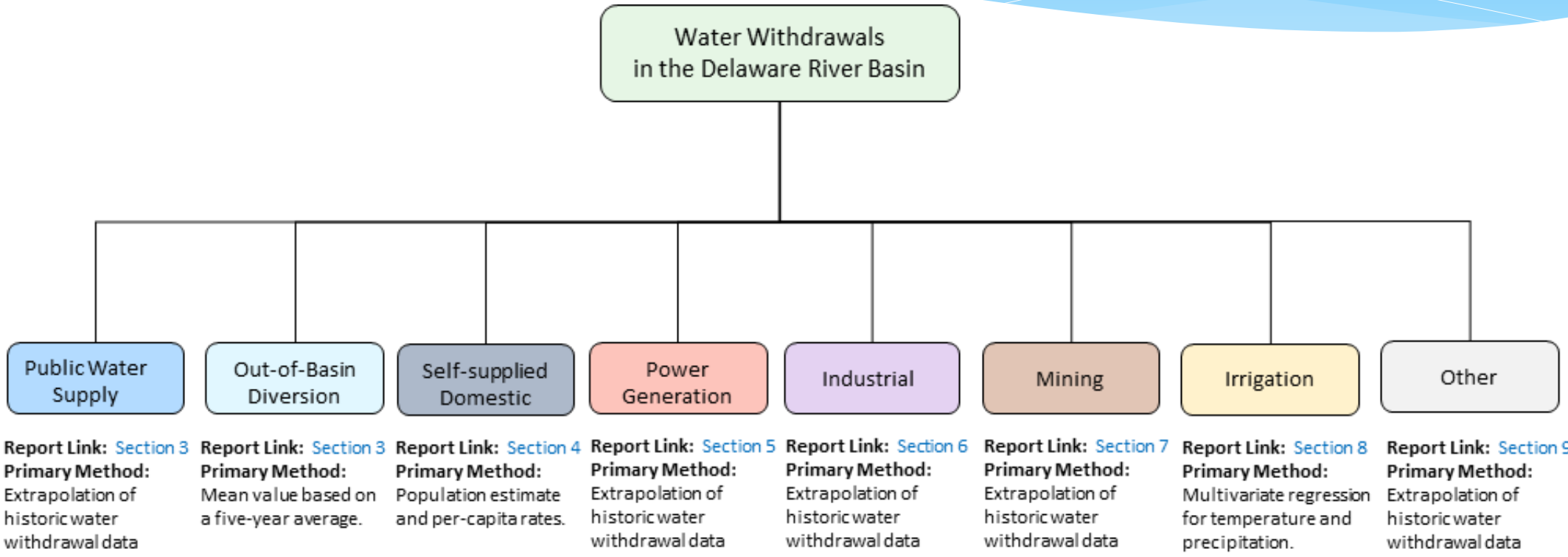
3. Methodology



Cape Henlopen, Delaware.
Credit: Delaware State Parks
https://destateparks.com/Beaches/CapeHenlopen

3. Methodology: Breakdown by sector

The primary method is extrapolation of historic reported withdrawal data



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3. Methodology: A plan for projecting data?

NOTE:
Not the method for self-supplied domestic withdrawals, and irrigation withdrawals

Where do we start?

Time-series hierarchy

Aggregate to results here

Perform projections here

Level 1
(Sector level)……

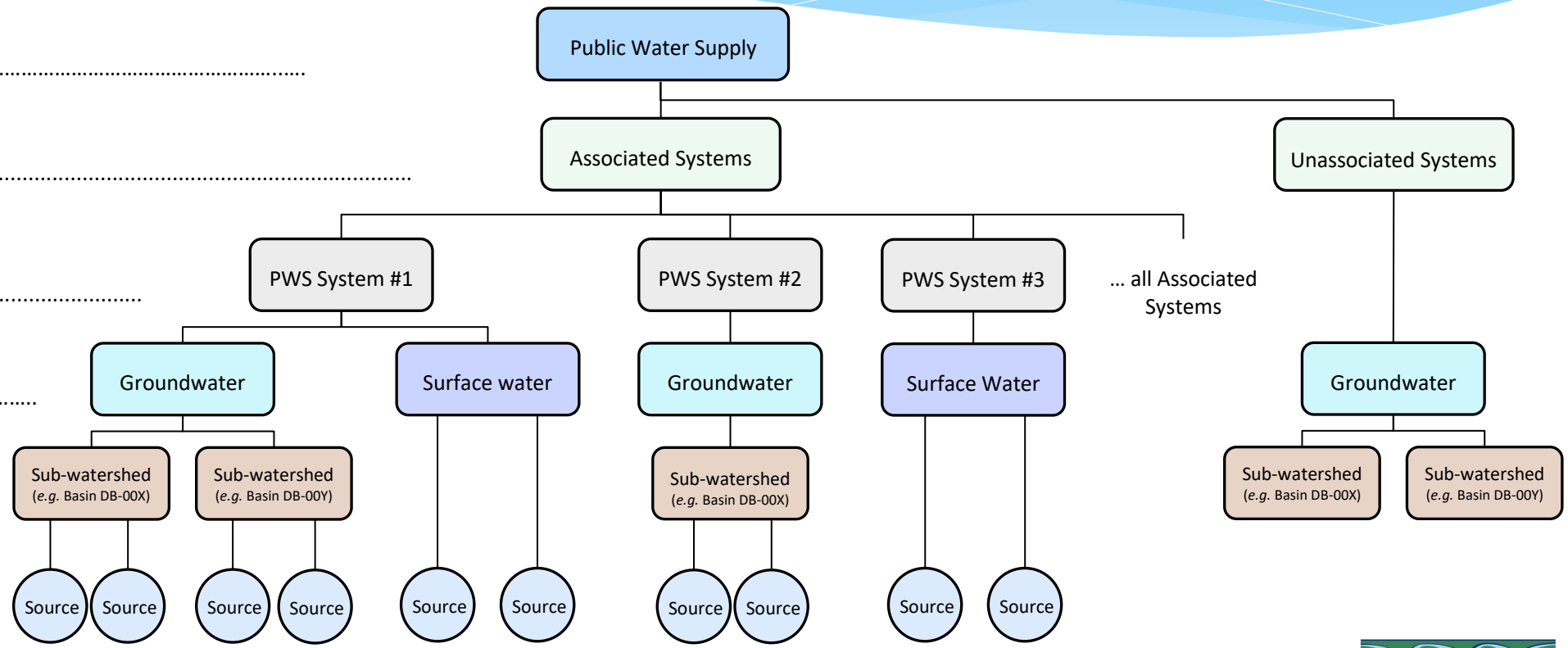
Level 2
(Regulatory level)……

Level 3
(System level)……

Level 4
(Source-type level)……

Level 5
(Sub-watershed level)……

Level 6
(Source level)……



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Hyndman, R., & Athanasopoulos, G. (2018). *Forecasting: principles and practice* (2nd ed.). Melbourne, Australia: OTexts. https://otexts.com/fpp2/

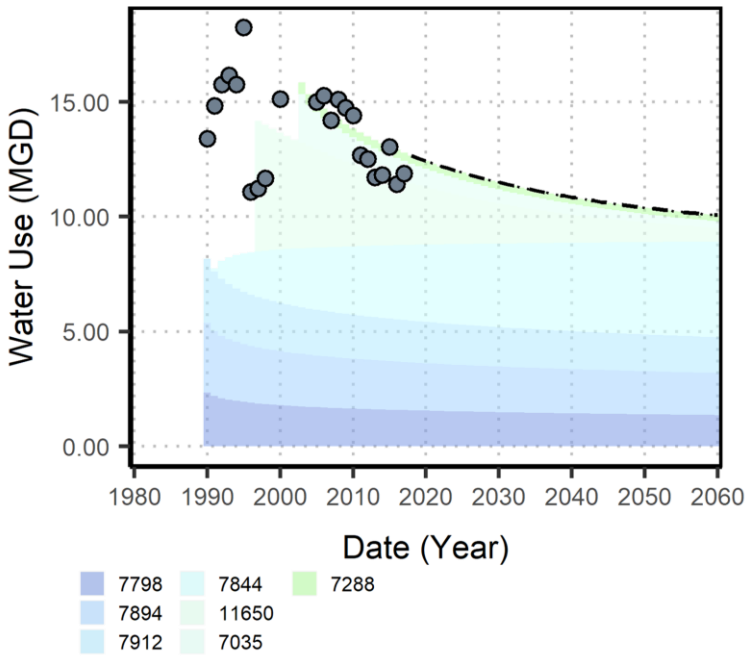
How to aggregate projections?

"Bottom-up approach"

PWS System #1 + PWS System #2 + PWS System #3 -

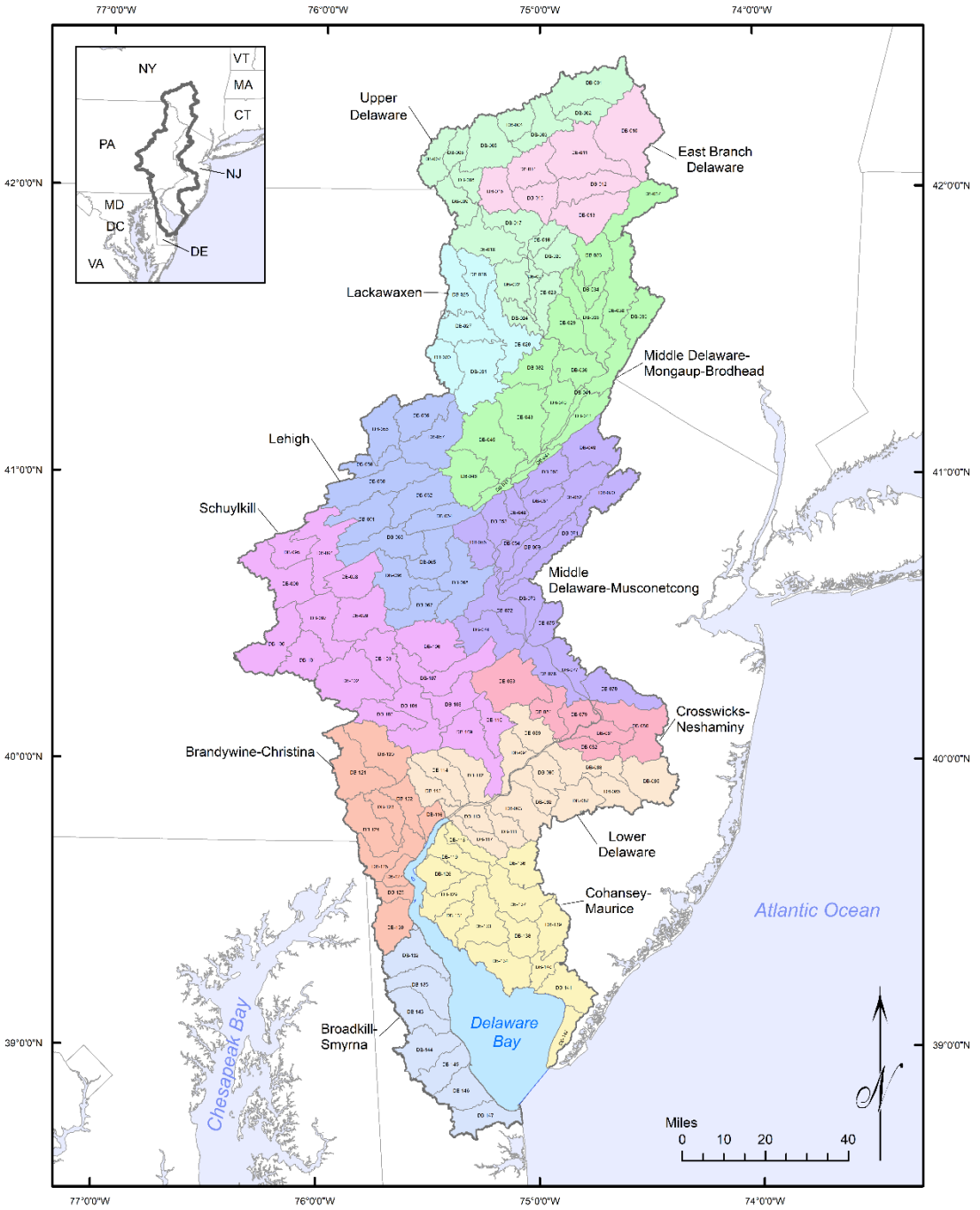
$$\boldsymbol{Total} = f_{1,1}(x) + f_{1,2}(x) + f_{1,3}(x) + f_{1,4}(x) + f_{2,1}(x) + f_{3,1}(x) + f_{3,2}(x)$$

DB-00X, DB-00Y, SW 1, SW 2 | DB-00X, "System Level" | SW 1, SW 2



Coherence

Do projections aggregate in a manner consistent with the time series?



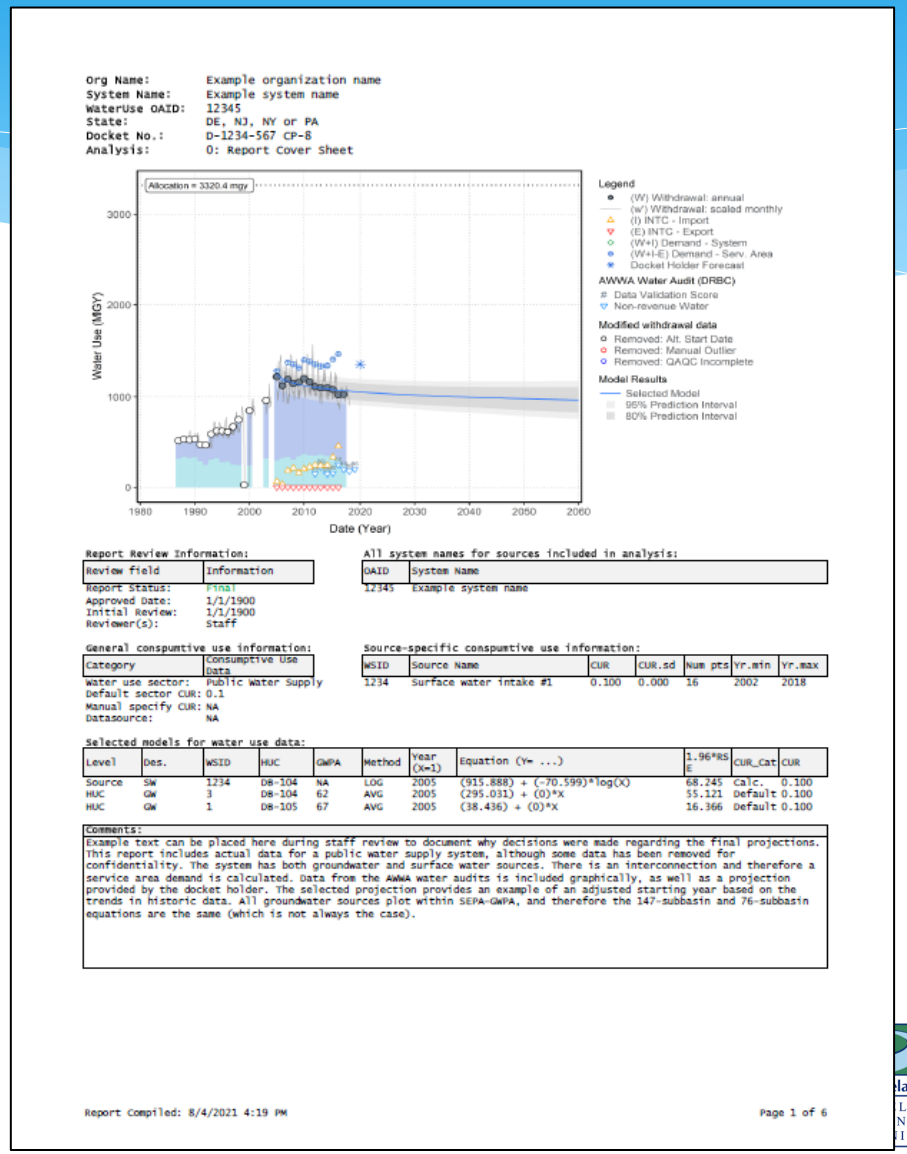
3. Methodology: A plan for projecting data?

The main model is based on extrapolating historic withdrawal data.

- Significant QAQC of historic data
- 600+ system reports
- 1,100+ equations

Method		Associated		Unassociated		Subtotal
		GW	SW	GW	SW	
Mean Value		218	71	147	0	436
OLS	Exponential	72	17	36	0	125
	Linear	83	11	11	0	105
	Logarithmic	250	74	69	0	393
Other		62	48	4	0	114
Subtotal		685	221	267	0	1,173

- OLS = Ordinary Least Squares
- Associated means system operate above review thresholds and has allocation regulatory approval.
- Does not include agriculture and self-supplied domestic analyses



Org Name: Example organization name
System Name: Example system name
WaterUse OAID: 12345
State: DE, NJ, NY or PA
Docket No.: D-1234-567 CP-8
Analysis: 0: Report Cover Sheet

Report Review Information:

Review field	Information
Report Status:	Final
Approved Date:	1/1/1900
Initial Review:	1/1/1900
Reviewer(s):	Staff

All system names for sources included in analysis:

OAID	System Name
12345	Example system name

General consumptive use information:

Category	Consumptive Use Data
Water use sector:	Public Water Supply
Default sector CUR:	0.1
Manual specify CUR:	NA
Datasource:	NA

Source-specific consumptive use information:

WSID	Source Name	CUR	CUR.sd	Num pts	Yr.min	Yr.max
1234	Surface water intake #1	0.100	0.000	16	2002	2018

Selected models for water use data:

Level	Des.	WSID	HUC	GWPA	Method	Year (X=1)	Equation (Y= ...)	1.96*RSE	CUR_Cat	CUR
Source	SW	1234	DB-104	NA	LOG	2005	(915.888) + (-70.599)*log(X)	68.245	Calc.	0.100
HUC	GW	3	DB-104	62	AVG	2005	(295.031) + (0)*X	55.121	Default	0.100
HUC	GW	1	DB-105	67	AVG	2005	(38.436) + (0)*X	16.366	Default	0.100

Comments:
Example text can be placed here during staff review to document why decisions were made regarding the final projections. This report includes actual data for a public water supply system, although some data has been removed for confidentiality. The system has both groundwater and surface water sources. There is an interconnection and therefore a service area demand is calculated. Data from the AWWA water audits is included graphically, as well as a projection provided by the docket holder. The selected projection provides an example of an adjusted starting year based on the trends in historic data. All groundwater sources plot within SEPA-GWPA, and therefore the 147-subbasin and 76-subbasin equations are the same (which is not always the case).

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4. Results

The Walt Whitman Bridge over the Delaware River.
Philadelphia in the background.
Credit: © Brian Kushner
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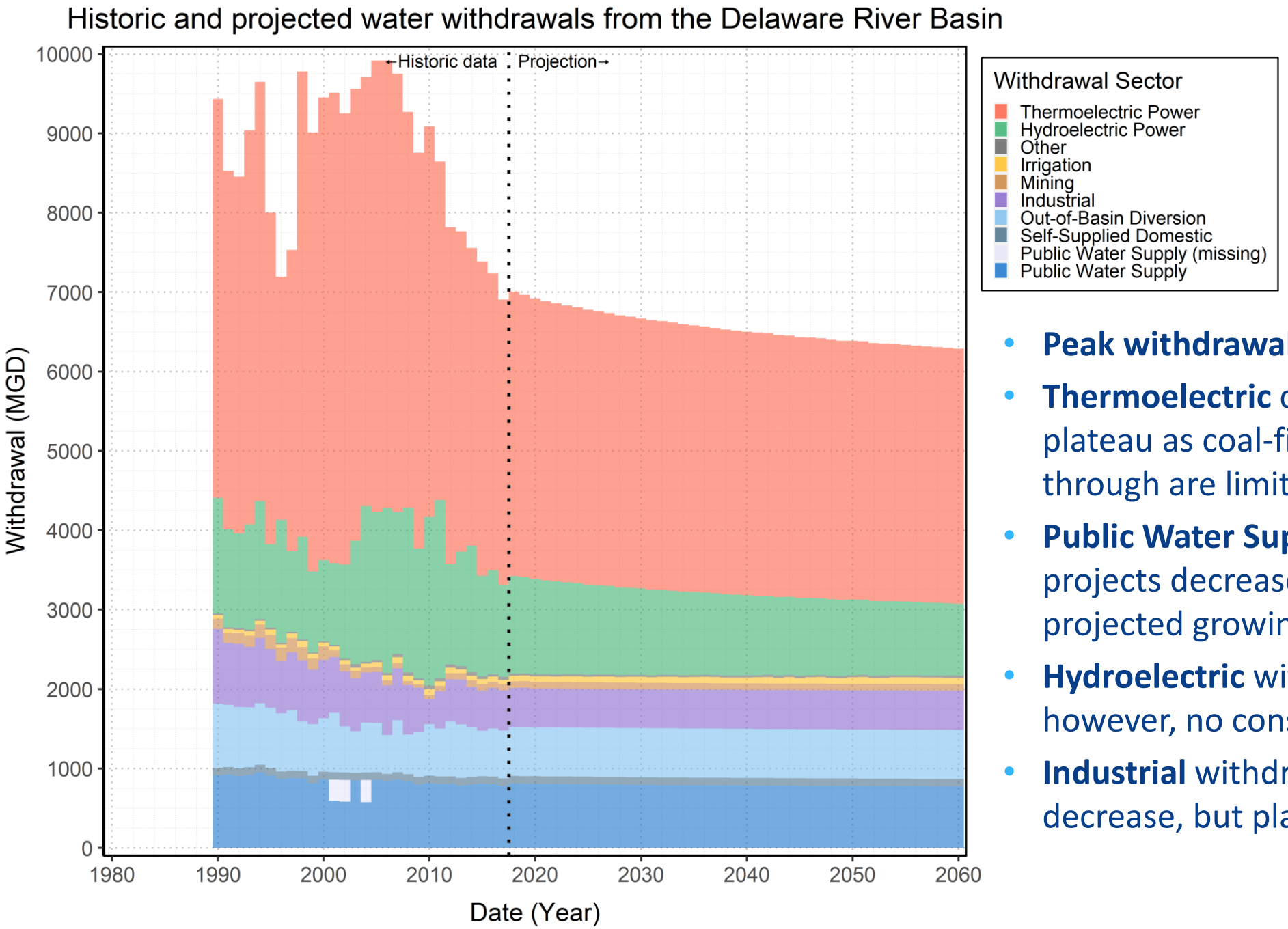

- **Peak withdrawals have occurred**
- **Thermoelectric** decreases since 2007 will plateau as coal-fired facilities using once-through are limiting
- **Public Water Supply** has shown and projects decreases despite historic and projected growing in-Basin population
- **Hydroelectric** withdrawals are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

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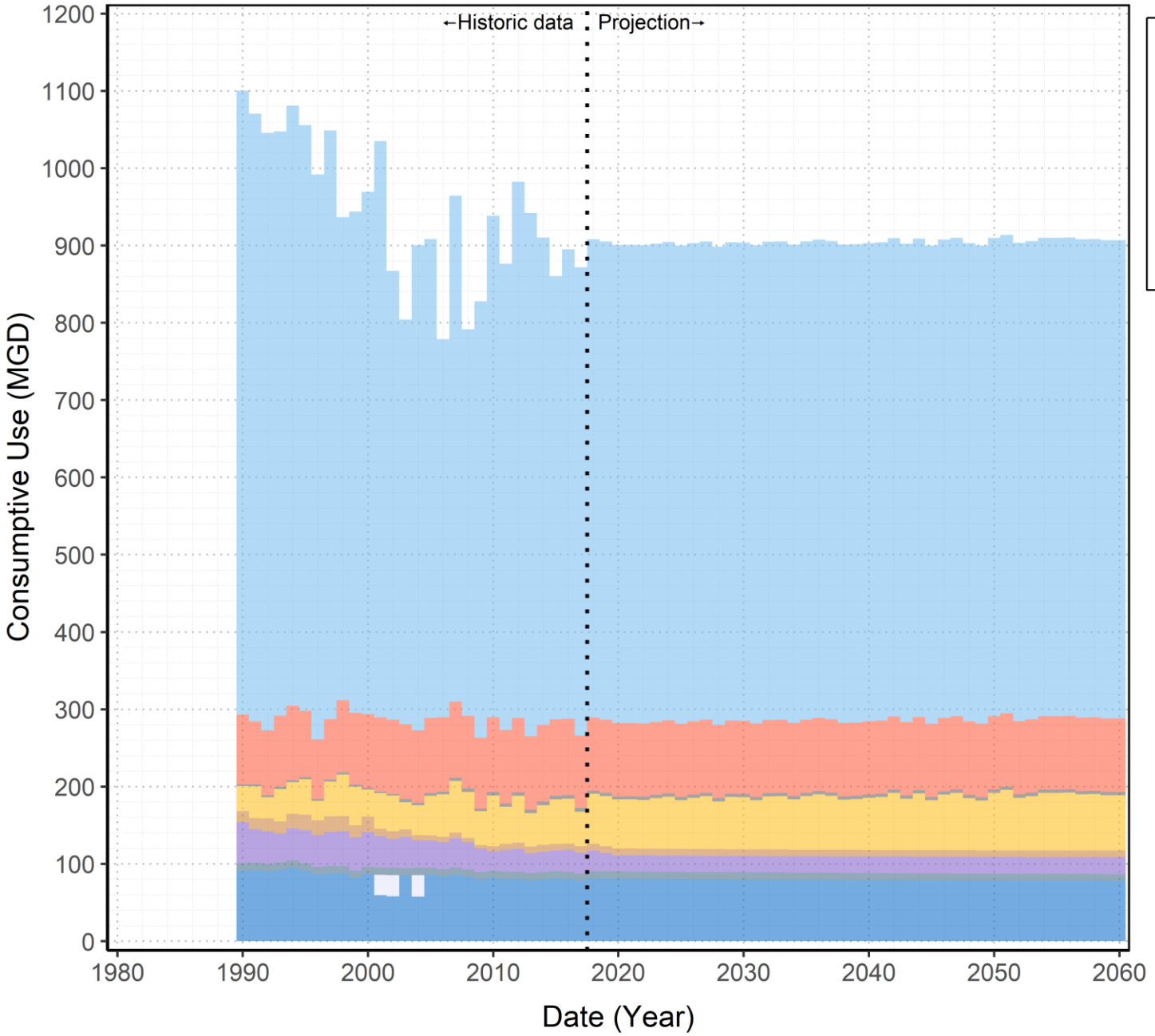
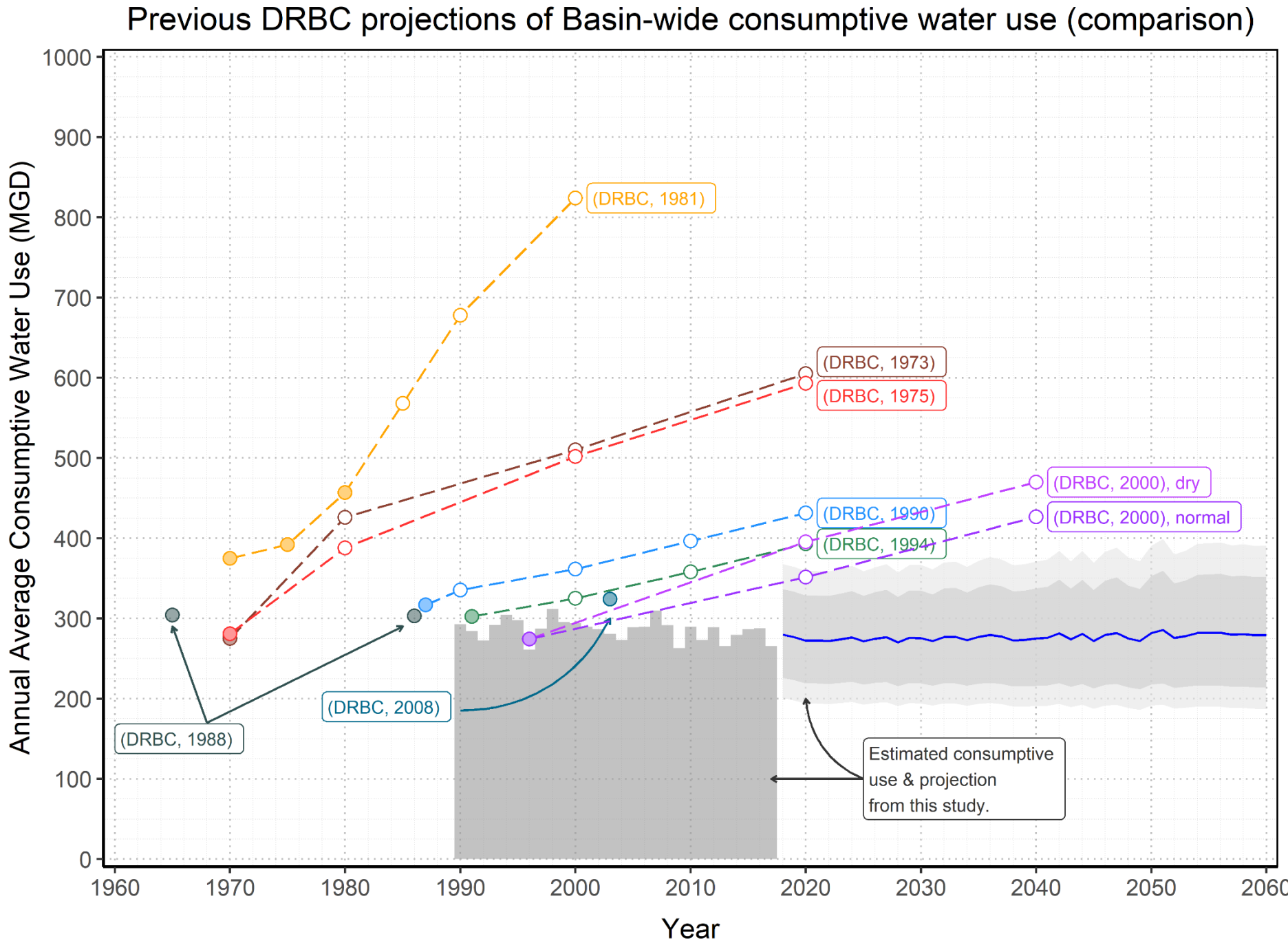
Historic and projected consumptive water use in the Delaware River Basin



- **Consumptive use projected to remain relatively constant**
- **Largest consumptive use is Out-of-Basin Exports under a U.S. Supreme Court Decree**
- **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



Prior projections often:

- Work from one estimated year of withdrawal data
- Are performed indirectly (e.g., applying population projections)
- May have considered/ accounted for planned facilities (e.g., power)

This study:

- Almost 30 years of data
- Aligns with previous *estimates*
- Most conservative projection

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5. Relationship to LDRWS program

The Delaware Water Gap
Credit: © Hop On Air LLC
(https://www.flyhopon.com/)
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5. Study relationship to LDRWS goals

SPECIFICALLY

LDRWS Management Plan Goals:

Goal 1: Maintain/improve water quality

Goal 2: Preserve and protect natural resources in the river corridor and along the tributaries

Goal 3: Preserve and protect historic & cultural resources in the river corridor

Goal 4: Encourage recreational use of the river corridor

Goal 5: Identify principles for minimizing the adverse impact of development within the river corridor

Goal 6: Preserve open space in the river corridor

A better understanding of the demands on that free flow (past, current and projected).

BROADLY

Wild & Scenic Rivers Act (October 2, 1968), Section I(b):

"It is hereby declared to be the policy of the United States that ***certain selected rivers of the Nation*** which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, ***shall be preserved in free-flowing condition, and*** that they and their immediate environments ***shall be protected*** for the benefit and enjoyment of present and future generations."

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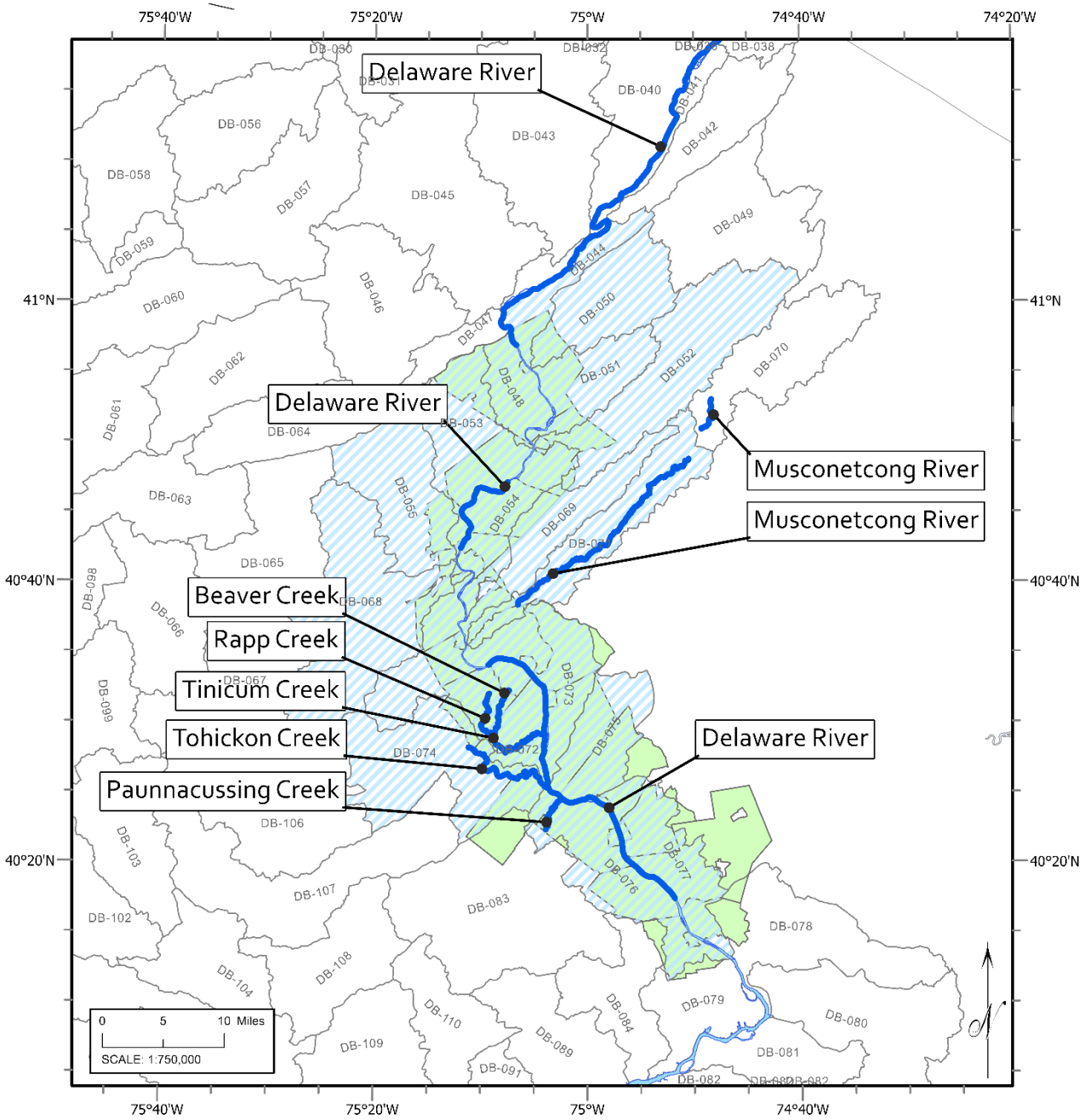


Legend

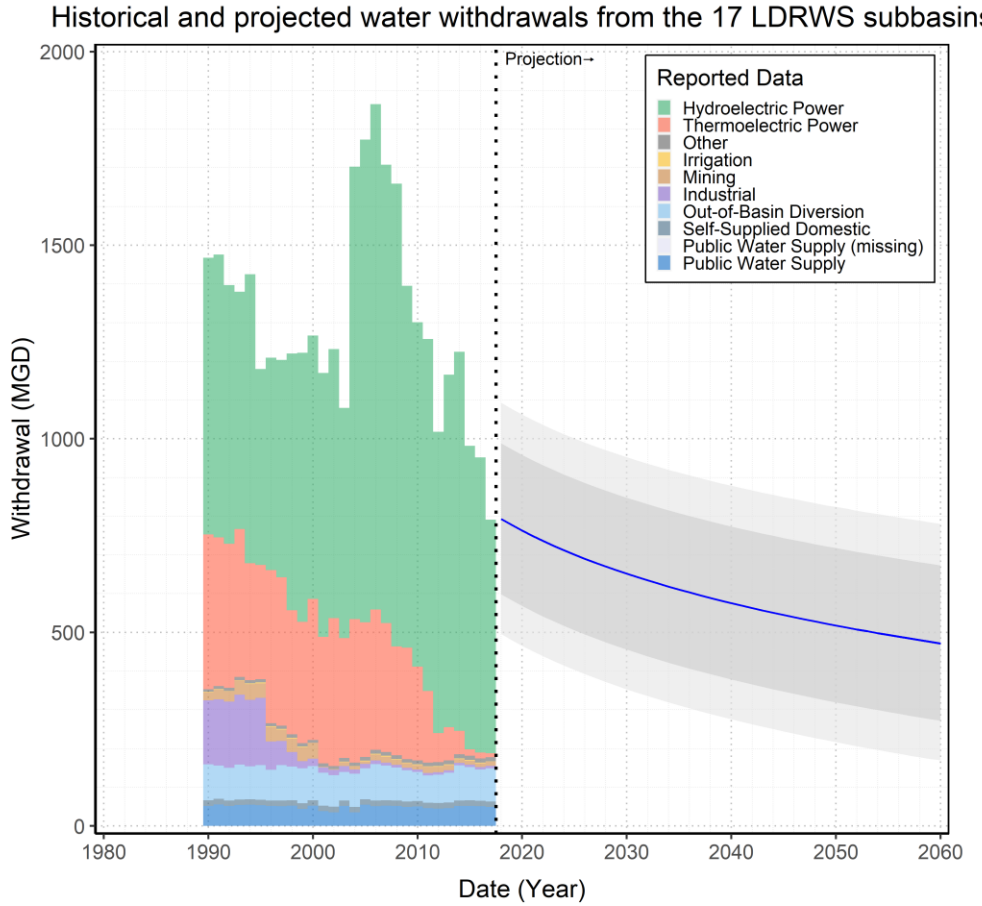
- National Wild and Scenic River Segments
- Municipal Boundaries (LDRWS Designation Map)

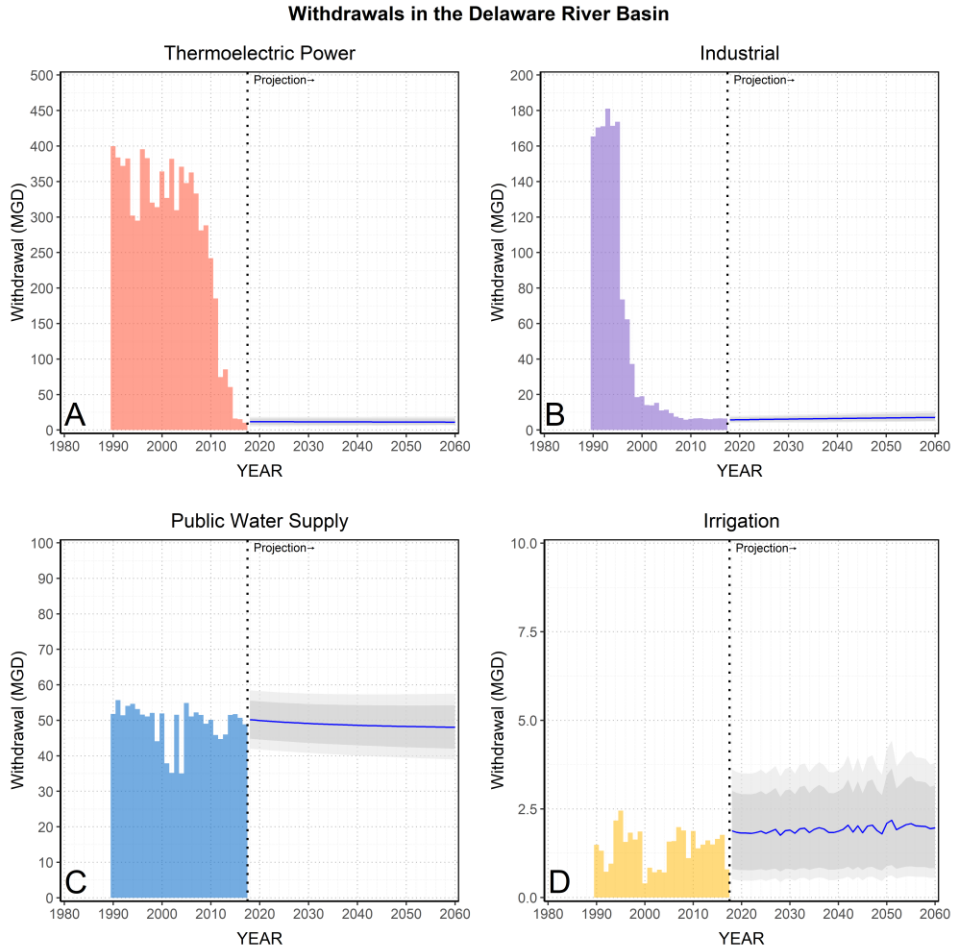
147 sub-watersheds (Sloto & Buxton, 2006)

- Overlies LDRWS Management Area
- Not included

Planning areas included in this analysis:

STATEID	BASIN_ID	STREAMS
NJ	DB-044	Van Campens Bk, Dunnfiled Cr & tribs to Delaware River
NJ	DB-050	Paulins Kill (below Stillwater Village)
NJ	DB-051	Stony Brook, Delawanna Creek, Beaver Brook
NJ	DB-052	Pequest River
NJ	DB-054	Pophandusing Bk, Buckhorn Cr, Lopatcong Cr &tribs to Delaware River
NJ	DB-069	Pohatcong Creek
NJ	DB-071	Musconetcong River below & including Trout Brook
NJ	DB-073	Hakihokake / Harihokake / Nishisakawick Creeks and tribs to Delaware River
NJ	DB-075	Lockatong Cr, Wickecheoke Cr & tribs to Delaware River
NJ	DB-077	Alexauken / Moore /Jacobs Creeks & tribs to Delaware Riv
PA	DB-048	Slateford Cr, Jacoby Cr, Allegheny Cr (tribs to Delaware River)
PA	DB-053	Martins Cr, Mud Run (tribs to Delaware River)
PA	DB-055	Bushkill Cr
PA	DB-068	Lower Lehigh River below Little Lehigh Creek
PA	DB-072	Frya Run, Cooks Cr, Tinicum Cr, & other tribs to Delaware River
PA	DB-074	Tohichon Cr
PA	DB-076	Geddes R, Hickory,Paunacussing,Aquetong,Pidock,Jericho,Houghs,Dyers,Buck Creeks,Hollow R





- Analysis includes six thermoelectric generation facilities. Four withdrawal from the Delaware River, one from the Lehigh, and one from groundwater. In 2017 they accounted for about 9.269 Twh (~8.97% of the Basin total) and a total withdrawal of 10.639 MGD (maximum in 2006 was 1,511 MGD).
- About 100 public water supply systems - 72% of volume from 3 systems which use the Delaware River. Almost all remainder is from groundwater. Does not include “the pump” (discussed later).
- Hydroelectric: Great Bear Hydropower on Paulins Kill (inactive 2016), and Yards Creek

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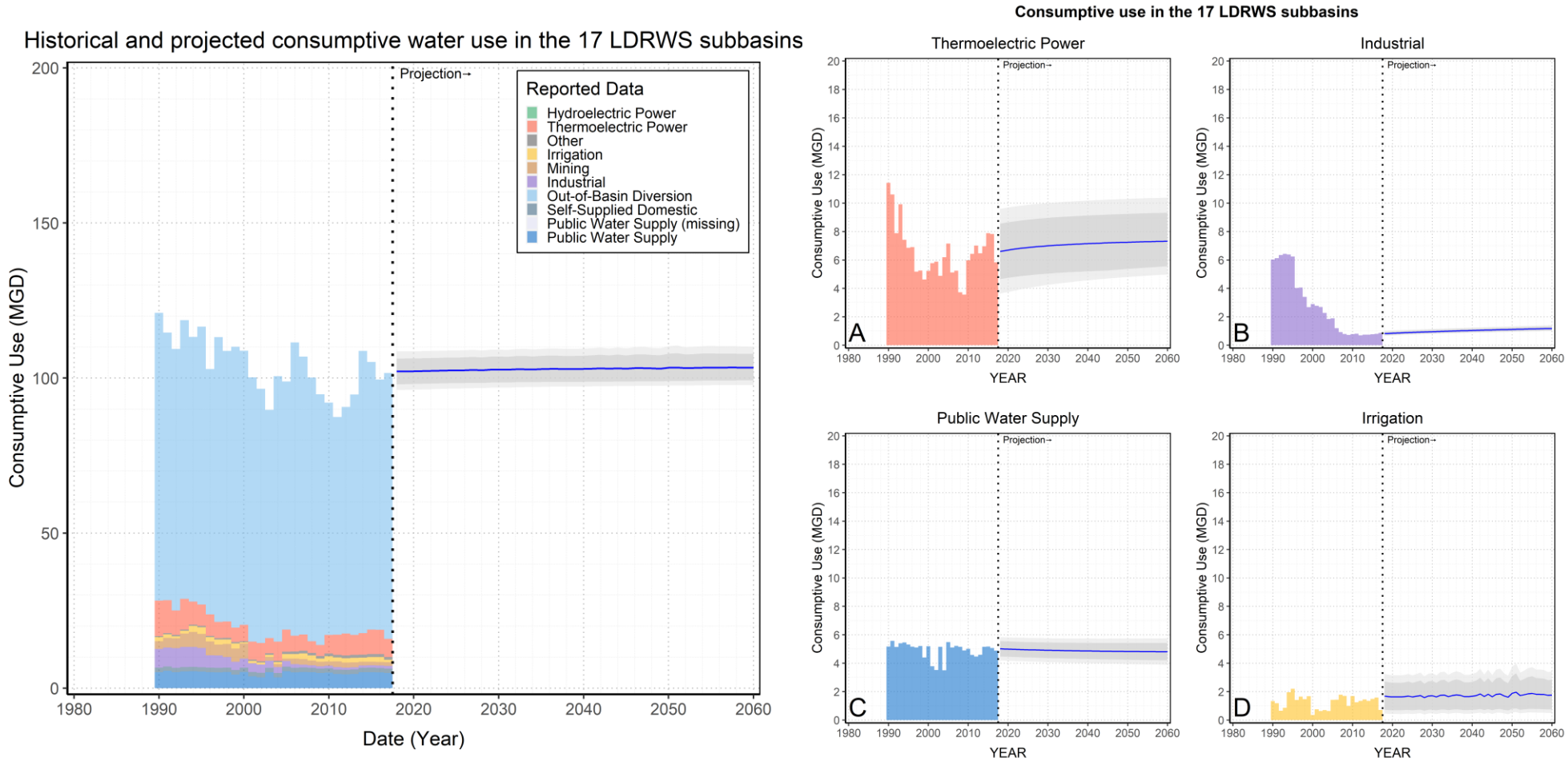

- Most consumptive use is Out-of-Basin diversion by NJ Water Supply Authority (Bulls Island, NJ)
- Public water supply mirrors withdrawal, standard rate of 10% applied.
- Thermoelectric based on site-specific consumptive use rates and therefore shows a different trend. In 2017 the value was about 5.837 MGD (annual average). Difference between OT cooling and recirculating cooling.

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Office of the Delaware River Master

https://webapps.usgs.gov/odrm/

"In 1954, the U.S. Supreme Court issued a Decree … The Court directed that the River Master perform multiple duties and functions including administering the provisions of the Decree relating to:

- *yields, diversions, and releases;*
- *conserving the waters of the river;*
- *compiling data on the water needs of the parties;*
- *checking and correlating streamflow measurements and records;*
- *observing, recording, and studying the effect of developments in the watershed on water supply and other uses;*
- *and making periodic reports to the Court."*

Flexible Flow Management Program (2017)

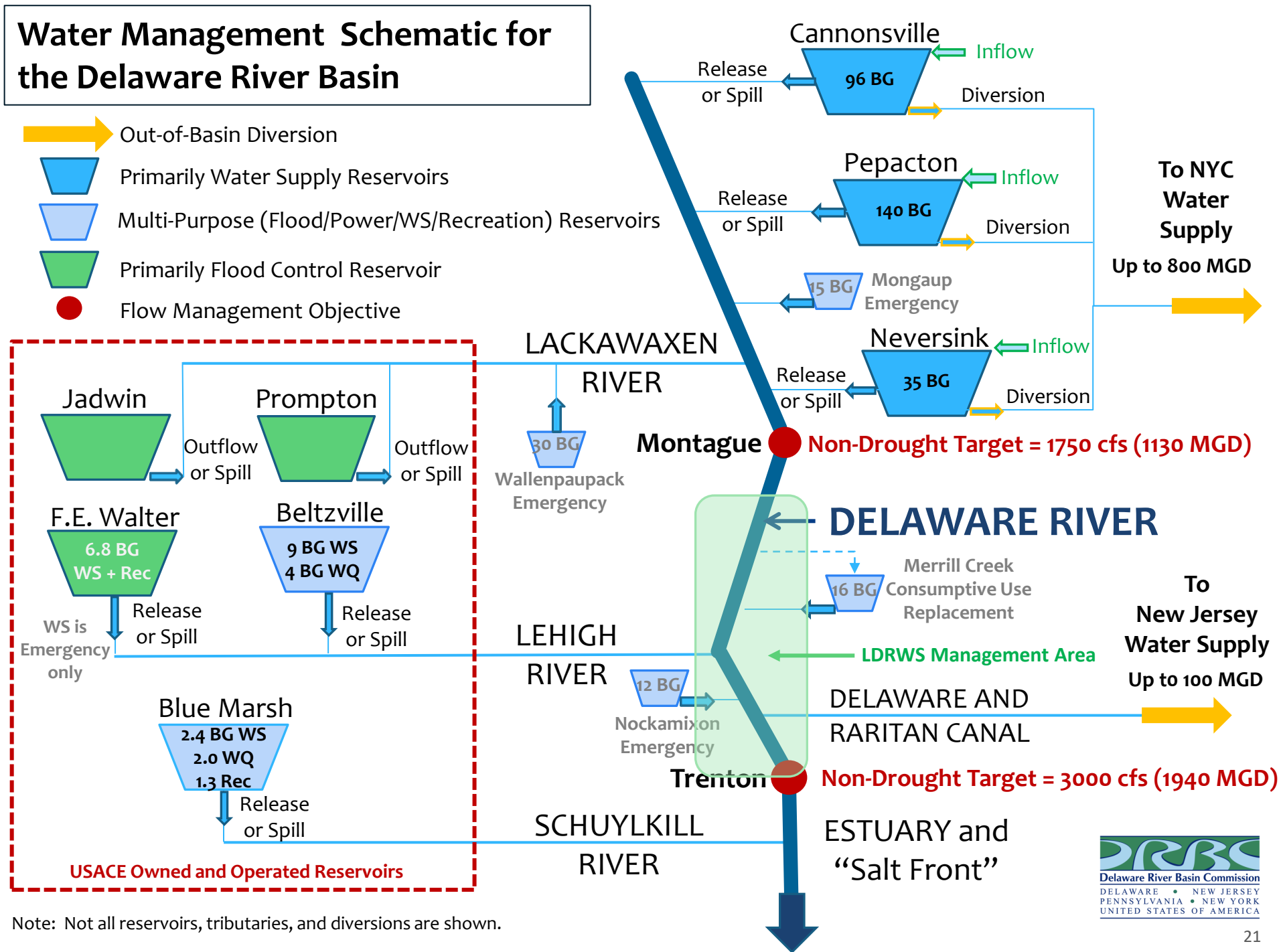
https://webapps.usgs.gov/odrm/ffmp/flexible-flow-management-program

DRBC Regulated Flow Advisory Committee (RFAC)

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

"Advising the Commission about the views of fishery, boating, and industrial interest groups and other resource management agencies, in addition to those of the Decree Party representatives, with respect to diversions and releases from and flows regulated by the Cannonsville, Pepacton, Neversink, Merrill Creek, Blue Marsh, F.E Walter, Beltzville and Nockamixon reservoirs, Lake Wallenpaupack and the hydropower reservoirs on the Mongaup River ("Regulated Flows");"

Water Management Schematic for the Delaware River Basin



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

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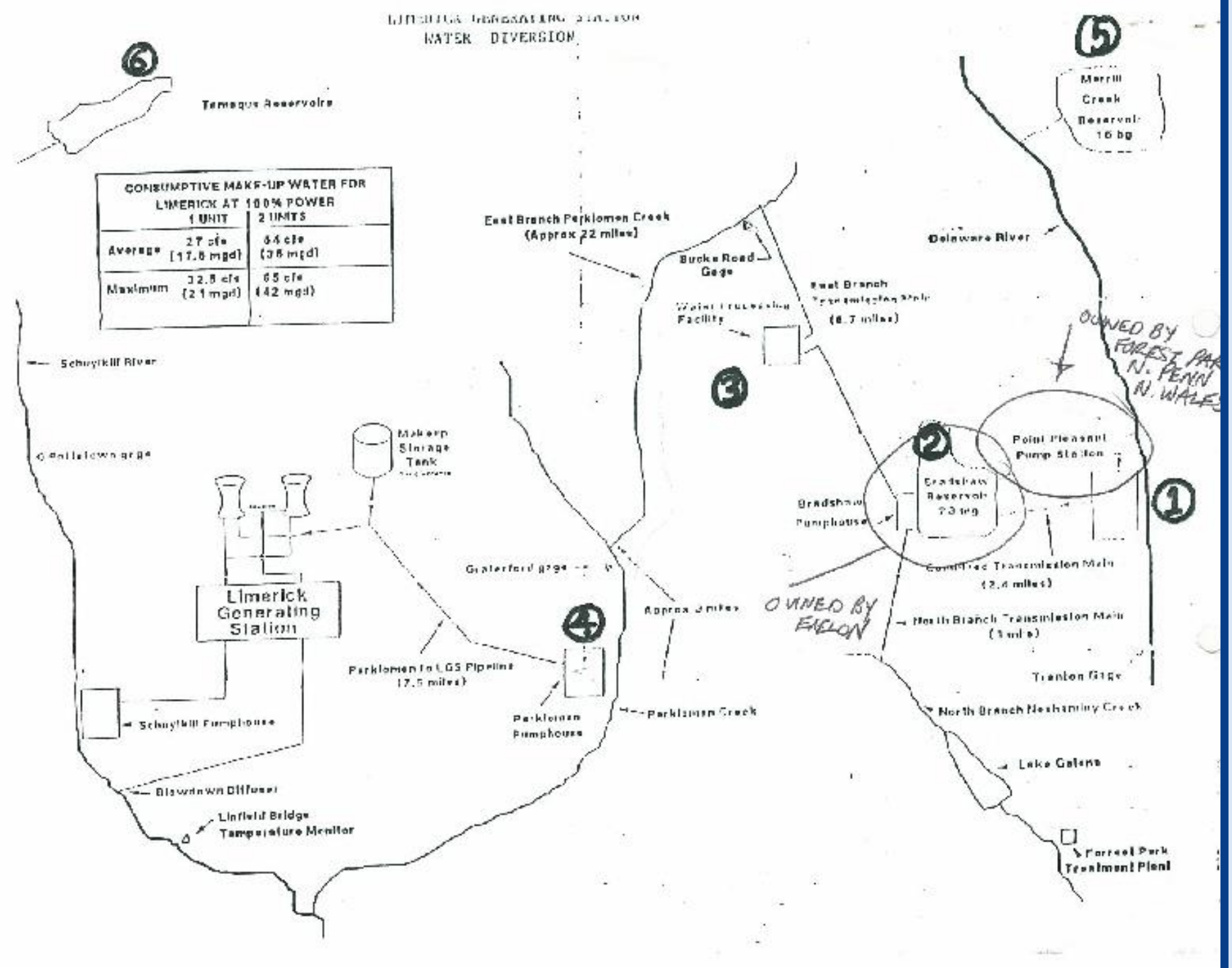

“The Pump” at Point Pleasant

- **Note:** Neshaminy Creek public water supply in take and the Exelon Limerick Perkiomen Creek intakes did not fall within the study area.

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8. Questions

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