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

Western States Water Council
2022 National Water Use Data Workshop

August 18, 2022

Michael Thompson, P.E. and Chad Pindar, P.E.

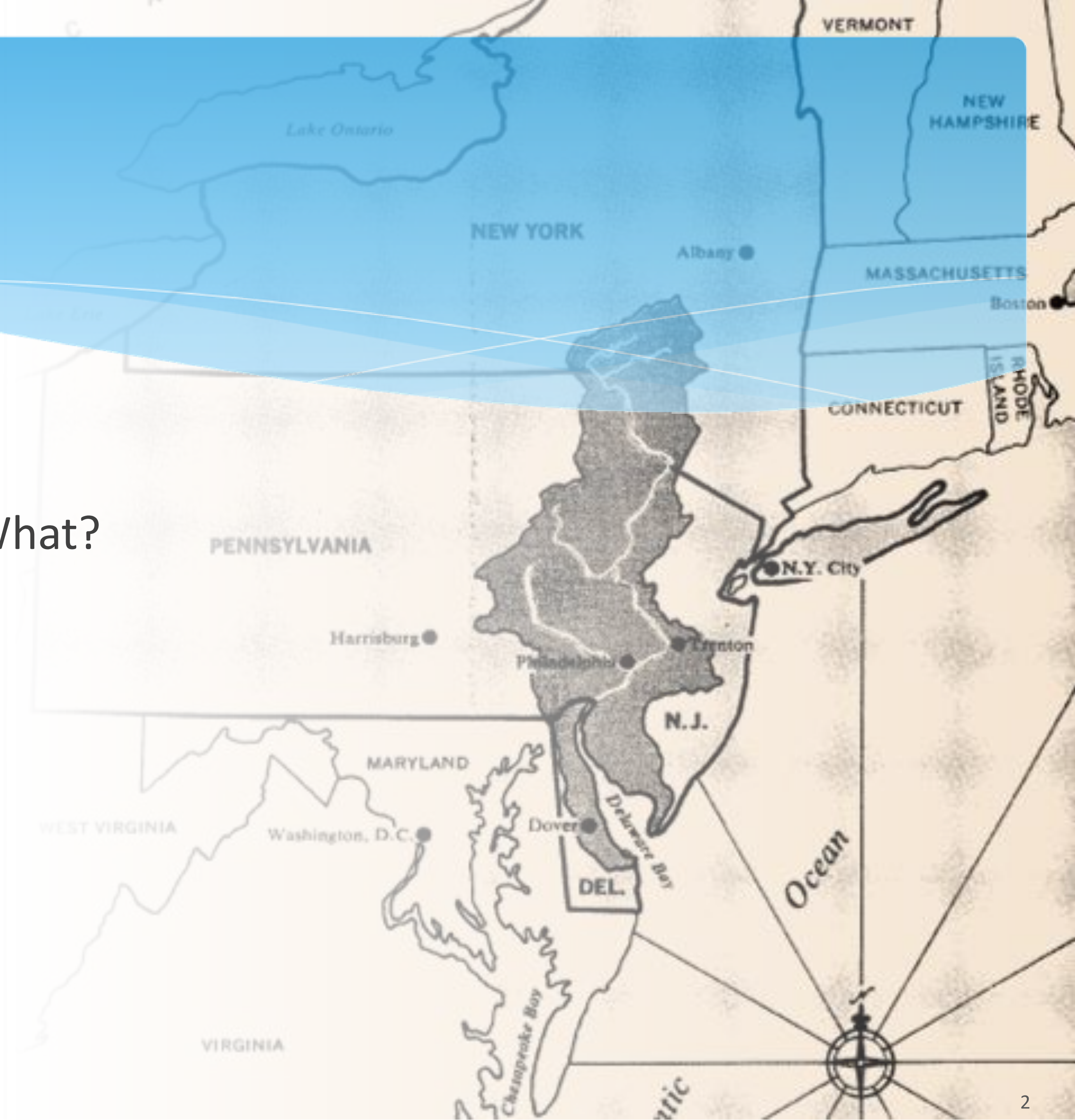
DRBC Water Resource Planning Section
Water Resource Engineer

DRBC Water Resource Planning Section
Manager

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Outline

1. Setting and Background
2. Water Supply Planning – Why and What?
3. Methodology
4. Results
5. Publication and data deliverables
6. Questions

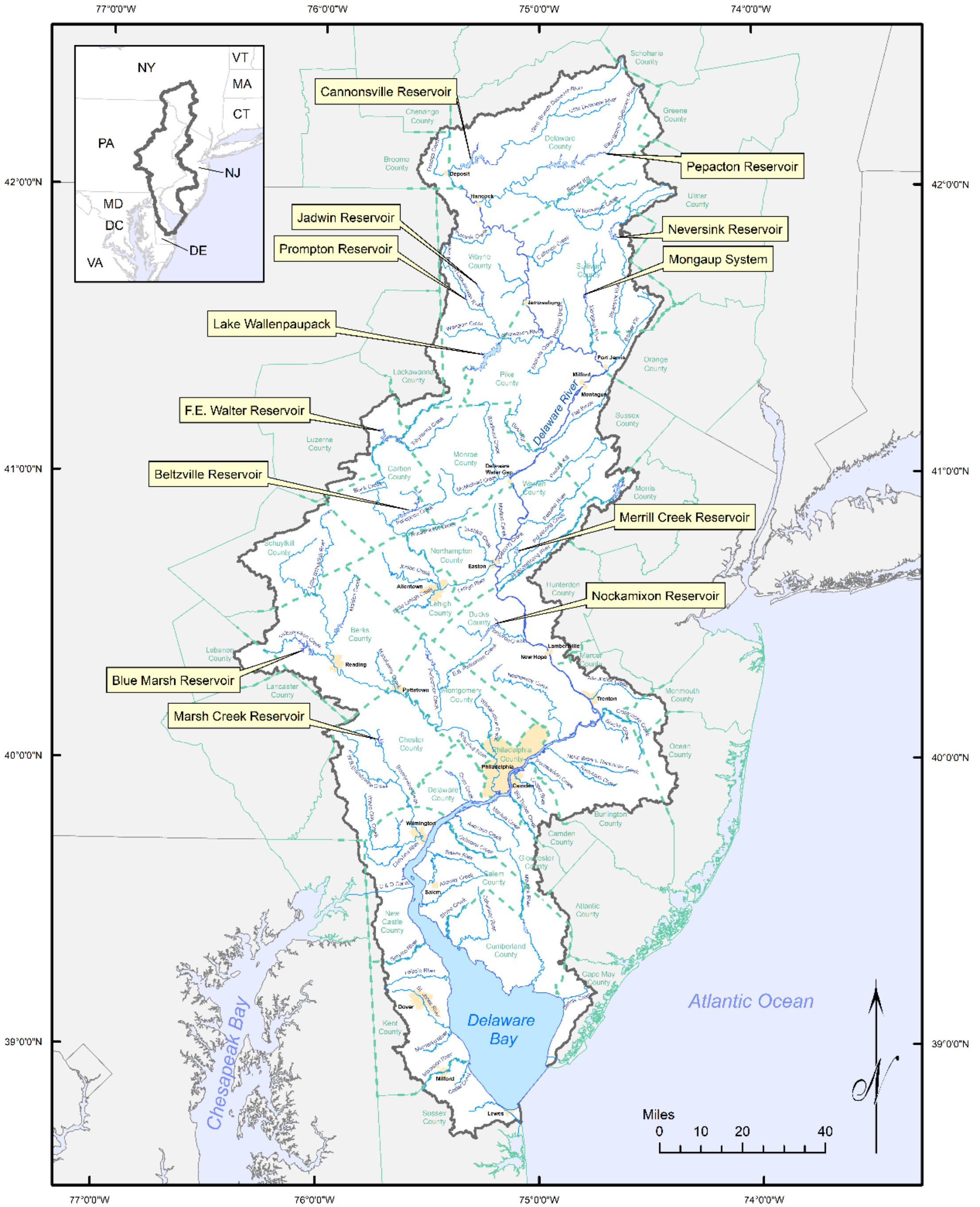


The Delaware River Basin

- Spans 4 states (DE, NJ, NY, PA)
- No mainstem dam – salt line (250 ppm chloride isochlor) repelled by freshwater flows
- Accounts for ~0.4% of total continental US land area
- Provides drinking water for an estimated 13.3 million people (about 4% of the US Population)
- Major exports to NYC and NJ under a 1954 Supreme Count Decree

Delaware River Basin Commission (DRBC)

- Federal Interstate Commission formed in 1961
- Five Commissioners (4 state governors & Federal Rep.)
- Regulations apply withdrawals > 100,000 gpd (or 10,000 gpd in the Southeastern Groundwater Protected Area)



2. Water Supply Planning – Why and What?

Ontelaunee Reservoir Dam
near Reading, Pennsylvania.
Credit: © Melissa Kopf
Used with permission

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?

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

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.

ommission
W JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

3. Methodology

The Delaware River viewed from Hawk's Nest
in Sullivan County, New York.
Credit: © Joseph Halliday

3. Methodology: What does the data look like?

State Agencies

DRBC normalizes state data into an integrated database

Bring in metadata as necessary *(+ millions of data)*

Metadata examples:
Names, Lat-Long, system categories, GW/SW, interconnections/transfers, regulatory approvals

A data point
System ID; Source ID;
Date (Year & Month); Volume

<u>1990-2017</u>
More than 1.6 million points describe withdrawals from the Delaware River Basin

<u>**For certain "sectors":**</u>
Link System IDs & Regulatory Approvals (~650 systems)
Generally, systems with withdrawals above review thresholds (100,000 gpd)

DRBC Project Review Section ->
Continually updating list of active approvals

Focus the projection work on these data…

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

3. Methodology: What data to focus on?

Sector of Data

Link System IDs & Regulatory Approvals

Public Water Supply

Power Generation

Industrial

Mining

Other

	Associated	Unassociated
Regulatory approvals:	664	*NA*
Sources:	2,612 (66%)	1,325 (34%)
Average withdrawal MGD:	6,566 (99%)	44 (1%)
Average cons. use MGD:	212 (98%)	4 (2%)

Create reports for assessing and projecting data

Irrigation

Regulatory approvals:	486
Sources:	2,547
Average withdrawal MGD:	48
Average cons. use MGD:	43

Aggregate multi-variate modelling at sub-watershed level.

Out-of-Basin Diversion

1954 U.S. Supreme Court Decree
4 sources (3 NYC reservoirs, 1 NJ diversion)

Simple average model based on historic records due to complexities.

Self-supplied Domestic

No reported data

Per-capita modelling by service areas and dasymetric population data

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

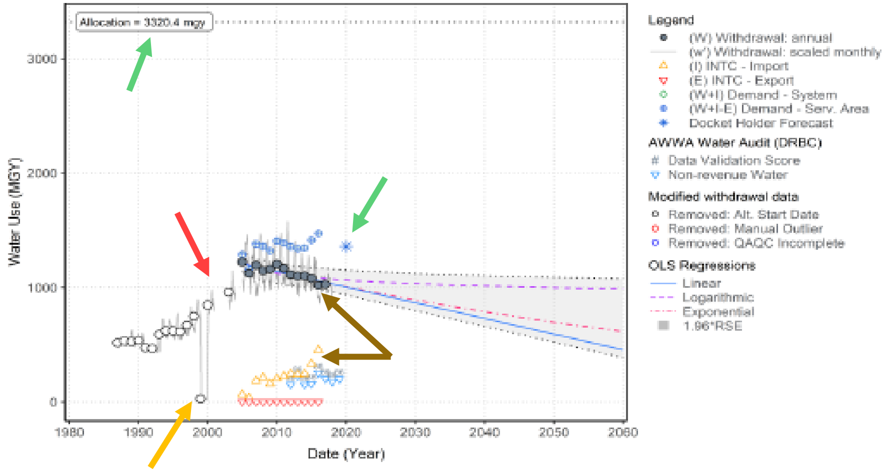
3. Methodology: Develop a report

- Each report has standardized analyses
- Visualizations greatly help QAQC

  For example:
  - Notice data gaps
  - Annual outlier
  - Dynamics between withdrawals and imports
  - Regulatory information such as allocations and self-reported projections
- Staff review to select period of record reflecting current withdrawal trends
- Verifying withdrawal sources against regulatory information to ensure completeness

Get the best possible picture of historic withdrawal.
Base projection on statistics and best professional judgement.

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:	1: System Level Analysis



Modeled data summary:

Param.	Value	Units
Mean:	1126.882	mgy
Mean(5yr)	1064.810	mgy
Median:	1121.777	mgy
Sigma:	63.287	mgy
CV:	0.056	---
x-start:	2005	(i.e. x=1)
NumPts:	13	---

System model thresholds:

Description	Threshold
Adj. R2 min:	0.2
p-value max:	0.05
2060_bottom:	0
2060_runaway:	10
2060_horiz:	0.75-1.25

Withdrawal QAQC thresholds:

QAQC Param.	Threshold
No. months (>=):	3
Low-limit (mgm,<=):	0.01
Bimodal Year:	2005
Outlier Year(s):	1999

System model results summary:

Model	Adj. R2	p-value	2060(mgy)	b-coef	c-coef	1.96_SE	P/F	
LIN	0.687	0.000	454.414	1222.949	-13.724	69.384	Pass	Equation: y = c*X + b
LOG	0.504	0.004	987.026	1232.804	-61.058	87.359	Pass	Equation: y = (c*Ln[X]) + b
EXP	0.690	0.000	615.421	1226.526	-0.012	70.586	Pass	Equation: y = b * e^(c*X)

WSID's included in the analysis:

WSID	No. OAID(s)	Desig.	WU-CatID	HUC-147	NoRecords <>(NA,0)	Start	End	Source Name
	1	GW	21	DB-104	314	1987	2017	Groundwater source #1
	1	GW	21	DB-105	332	1987	2017	Groundwater source #2
	1	SW	21	DB-104	324	1987	2017	Surface water intake #1
	1	GW	21	DB-104	320	1987	2017	Groundwater source #4
	1	GW	21	DB-104	319	1987	2017	Groundwater source #3

WSIDs not included in this analysis:

WSID	No. OAID(s)	Desig.	WU-CatID	In DRB?	Reason Excluded	Source Name

There are no other non-INTC sources for this OAID.

INTC's included in the analysis:

PWSID	Primary_WUDS	OAID	Imp_Exp	ToFrom_PWSID	ToFrom_WUDS	ToFrom_OAID	UseAmount	ToFrom_Name
			Import				2306.5	Name #1
			Import				258.1	Name #2
			Import				31.9	Name #3
			Export				0.3	Name #1
			Export				0.0	Name #2
			Export				0.0	Name #3

Report Compiled: 8/4/2021 4:19 PM

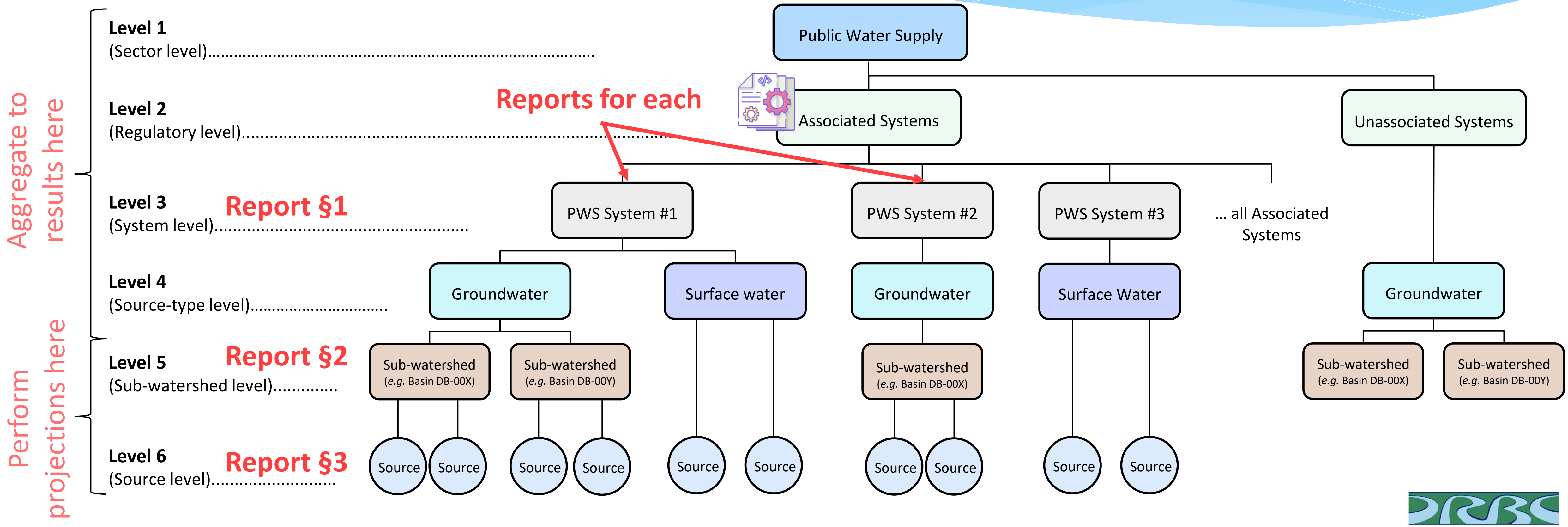
Page 3 of 6

3. Methodology: A plan for projecting data?

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

Where do we start?

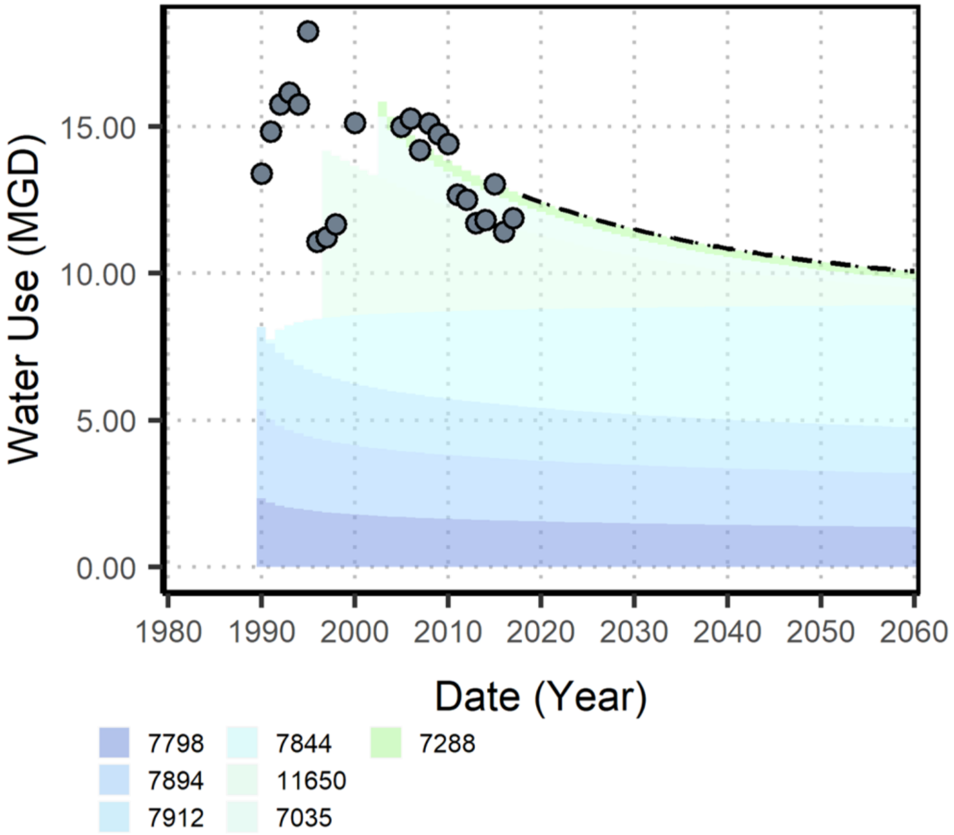
Time-series hierarchy



Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

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

3. Methodology: A plan for aggregating projections?



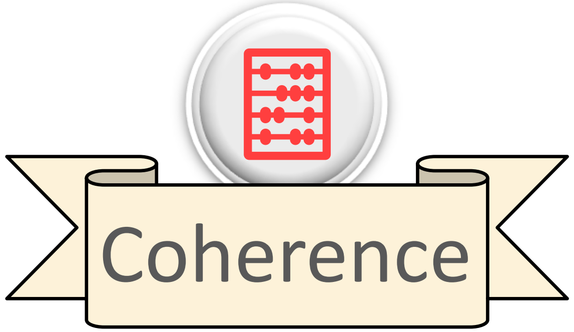
"Bottom-up approach"

$$\boldsymbol{Total} = \overbrace{f_{1,1}(x) + f_{1,2}(x) + f_{1,3}(x) + f_{1,4}(x)}^{\text{PWS System \#1}} + \overbrace{f_{2,1}(x)}^{\text{PWS System \#2}} + \overbrace{f_{3,1}(x) + f_{3,2}(x)}^{\text{PWS System \#3}} + \ldots$$

DB-00X DB-00Y SW 1 SW 2

DB-00X "System Level"

SW 1 SW 2



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

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

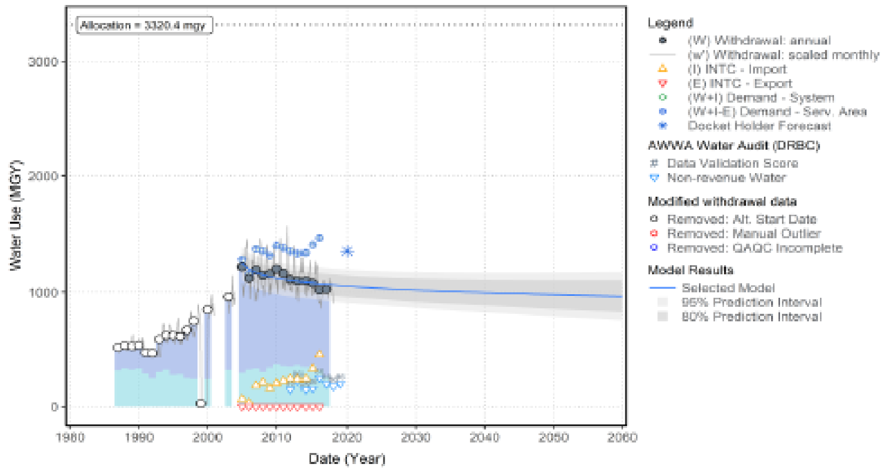
3. Methodology: Final reports

- Run report, review, select, re-run
- Significant QAQC of historical data
- 1,100+ equations
- Results aggregated to countless combinations

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).

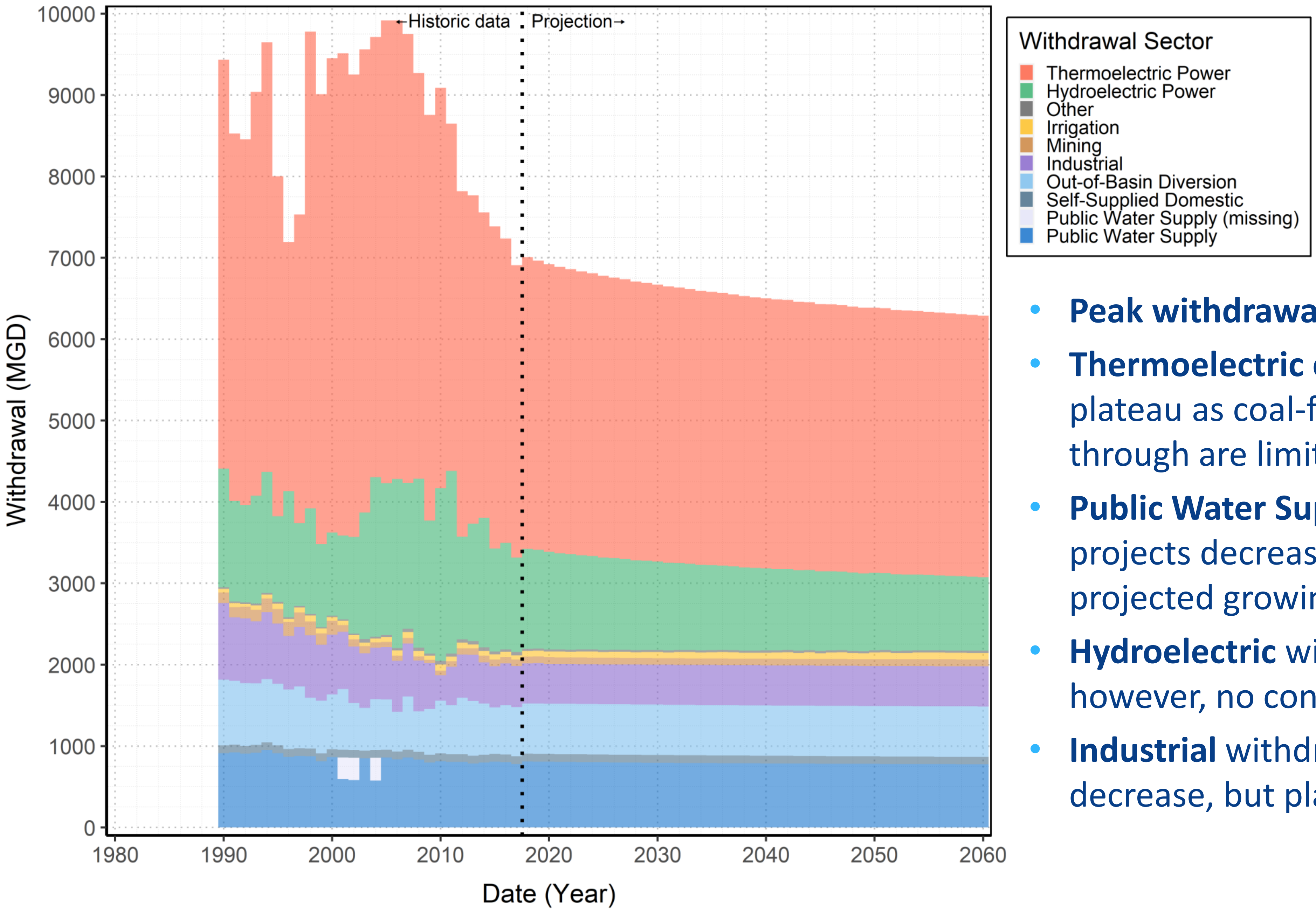
Report Compiled: 8/4/2021 4:19 PM

Page 1 of 6

4. Results

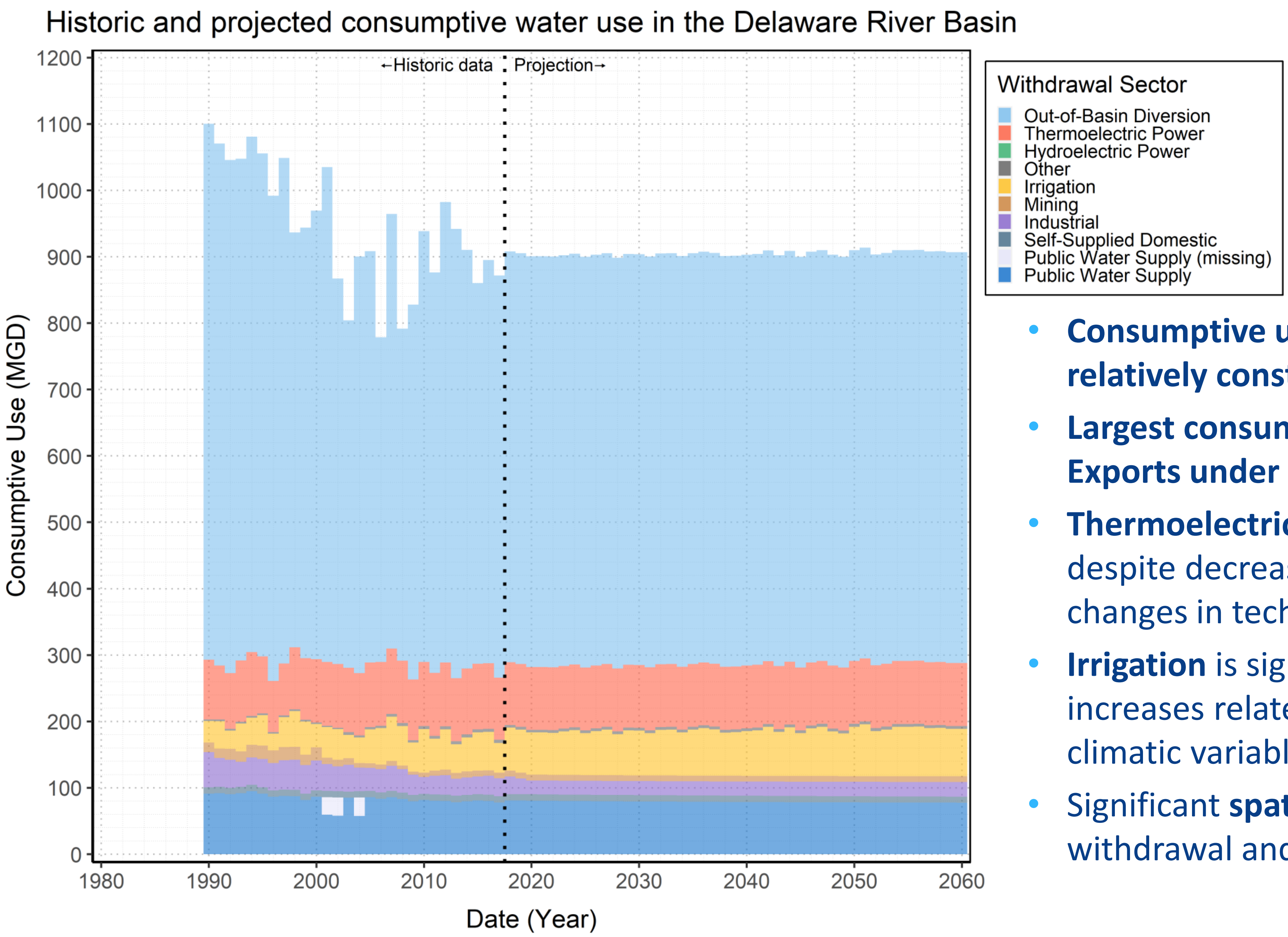
The Walt Whitman Bridge over the Delaware River.
Philadelphia in the background.
Credit: © Brian Kushner
Used in accordance with license

Historic and projected water withdrawals from the Delaware River Basin



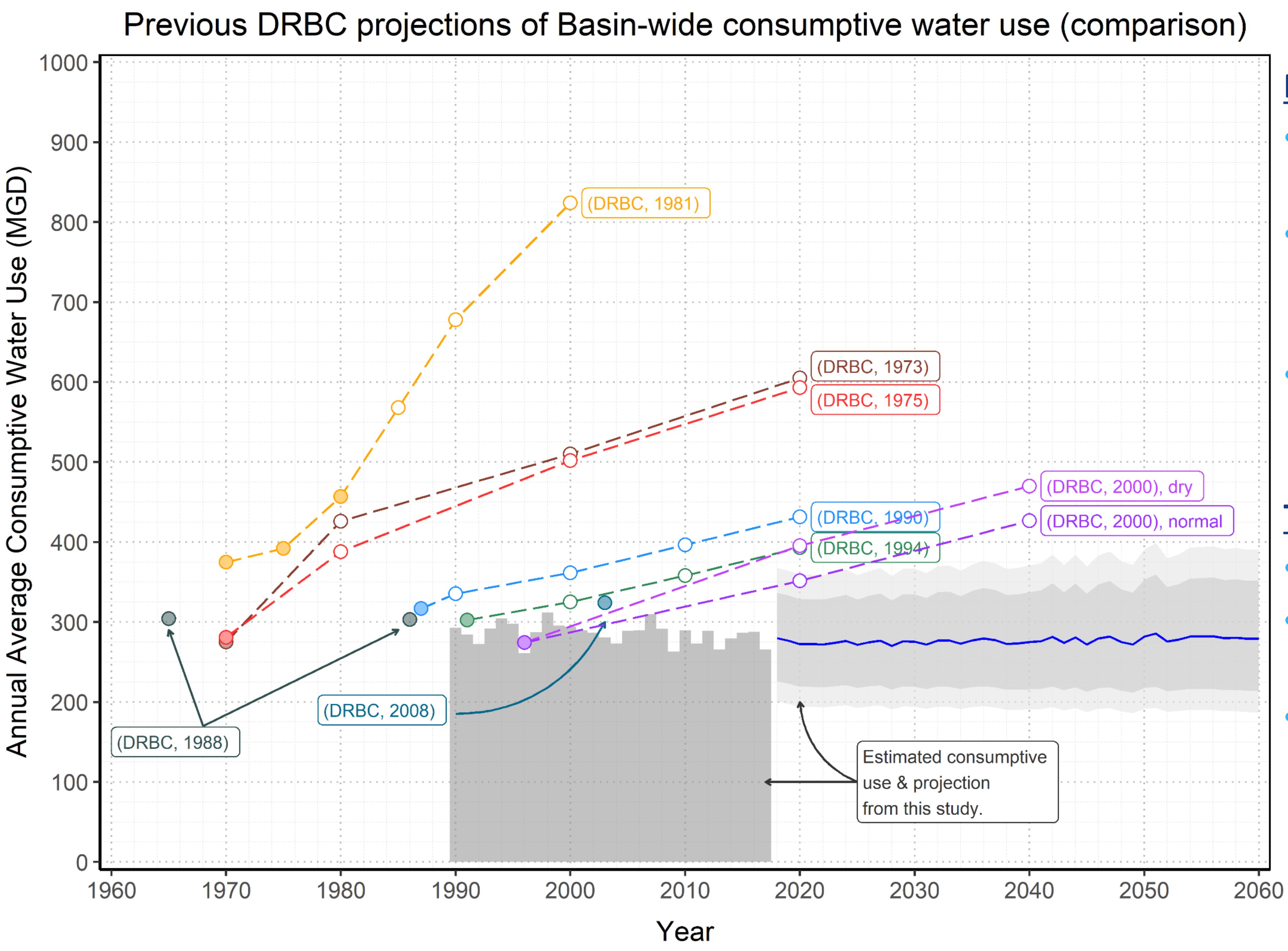
- **Peak withdrawals have occurred**
- **Thermoelectric** decreases since 2007 will plateau as coal-fired facilities using once-through are limiting
- **Public Water Supply** has shown and projects decreases despite historic and projected growing in-Basin population
- **Hydroelectric** withdrawals are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

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA



- **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

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA



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:

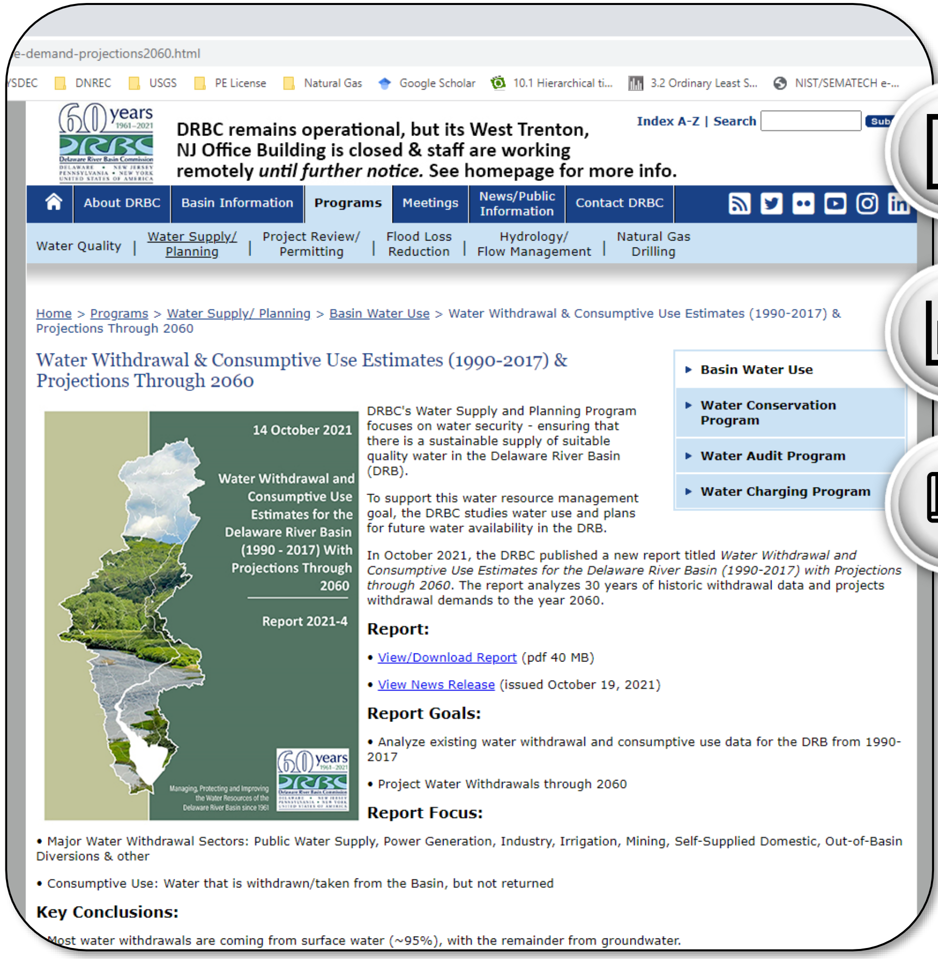
- Almost 30 years of data
- Aligns with previous *estimates*
- Most conservative projection

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

5. Publication & Data Deliverable

Report webpage:

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



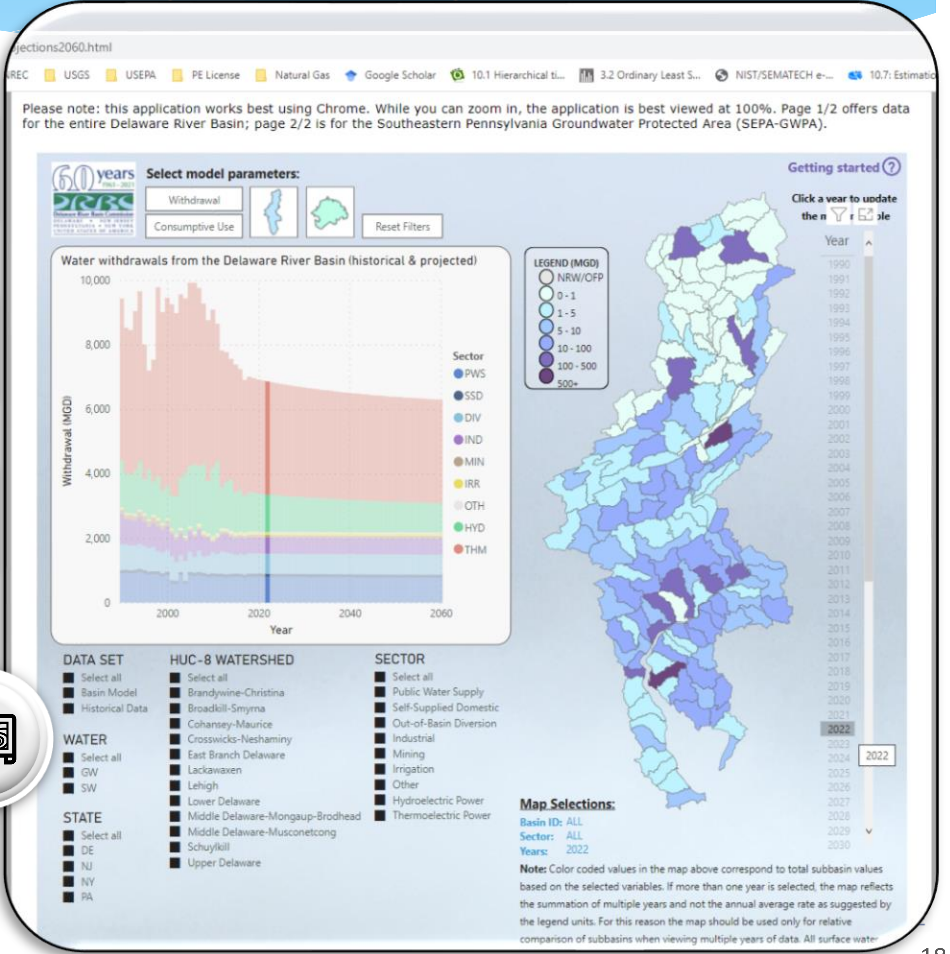
You can:

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

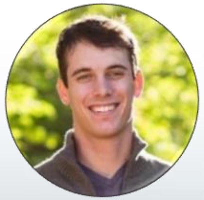
Download the dataset (~10 MB) MS Excel File (no macros)

Download high resolution maps from the report

Interact with the Power BI data visualization tool



6. Questions



Michael Thompson, P.E.
Water Resource Engineer

Delaware River Basin Commission
E: Michael.Thompson@drbc.gov
~~P: (609) 883-9500 ext. 226~~
~~F: (609) 883-9522~~

Chad Pindar, P.E.
Manager – Water Resource Planning Section

Delaware River Basin Commission
E: Chad.Pindar@drbc.gov
~~P: 609-883-9500 ext. 268~~
~~F: 609-883-9522~~

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

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA