Is Groundwater Being Used Sustainably in the Delaware River Basin?

AWRA National Conference

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Credit: Sara Sayed

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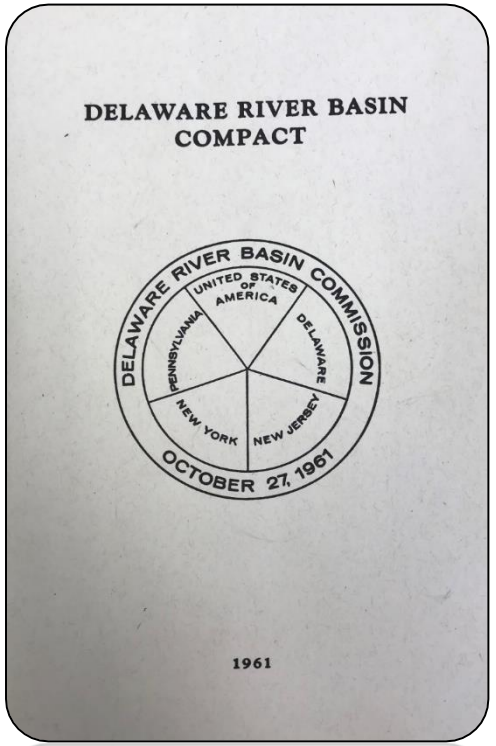
What is the Delaware River Basin Commission?

- Created by an Interstate Compact in **1961** due to
  - Water supply shortages and disputes
  - Flooding
  - Pollution in the Delaware and its tributaries
- Has **5** voting members: Delaware, Pennsylvania, New Jersey, New York and Federal Government [ACOE]
- Delaware River Basin Compact directs **regulatory**, **monitoring & assessment** and **planning** duties



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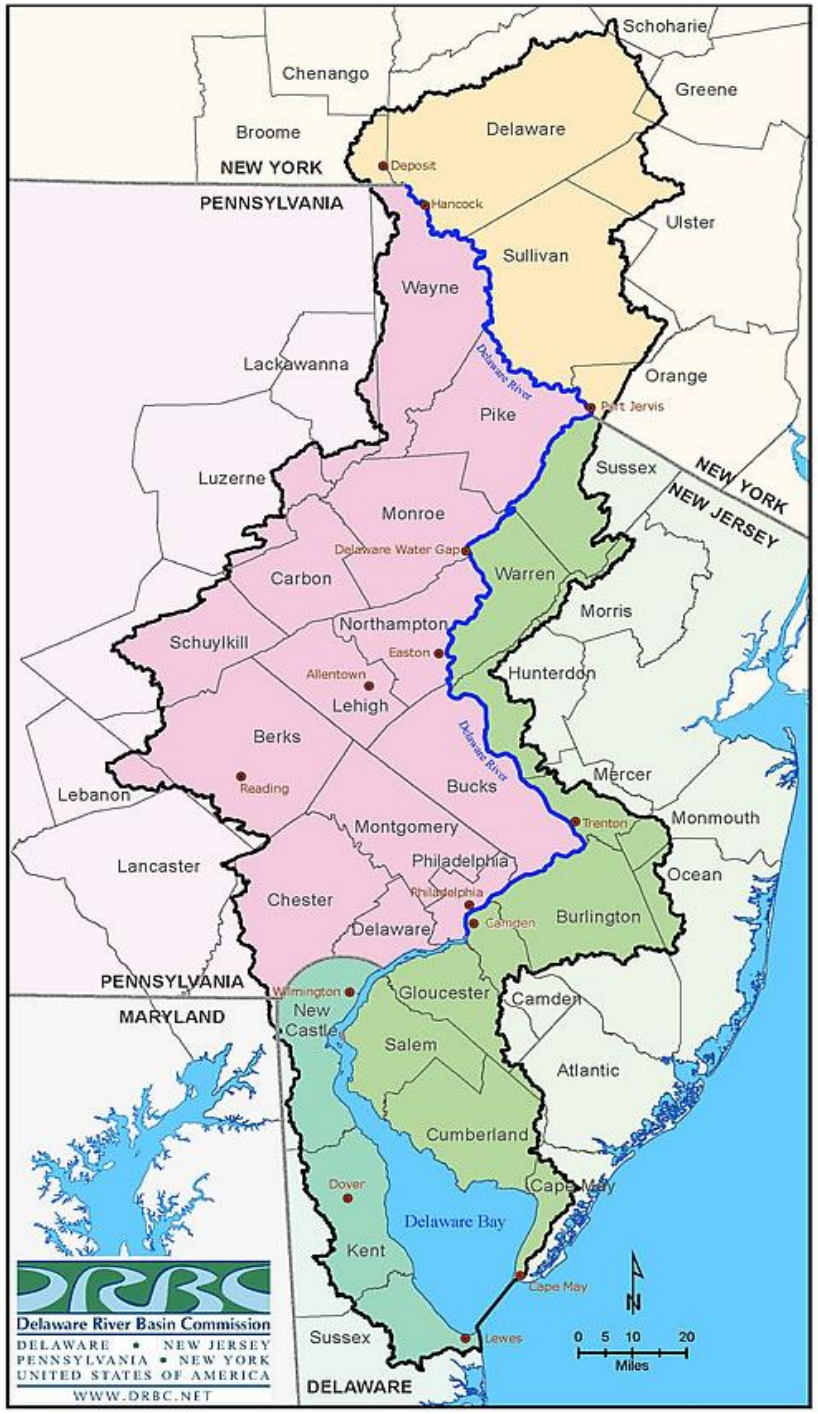

The Delaware River Basin (DRB)

- Main stem river is **330 miles long**
- Forms an interstate boundary over its entire length
- Longest, **un-dammed** U.S. river east of the Mississippi
- **Drains 13,539 square miles** in 4 states
  (0.4% USA land area)
- **13+ million people** (about 4% of the 2020 U.S. population) rely on the waters of the Delaware River Basin
- Water **withdrawal** in the Basin = **6.4 billion gallons/day**
- **0.45 billion gallons/day** of water comes from groundwater
  (1/2 of that used for public water supply)
- **Contributes over $21B in economic value** to the region

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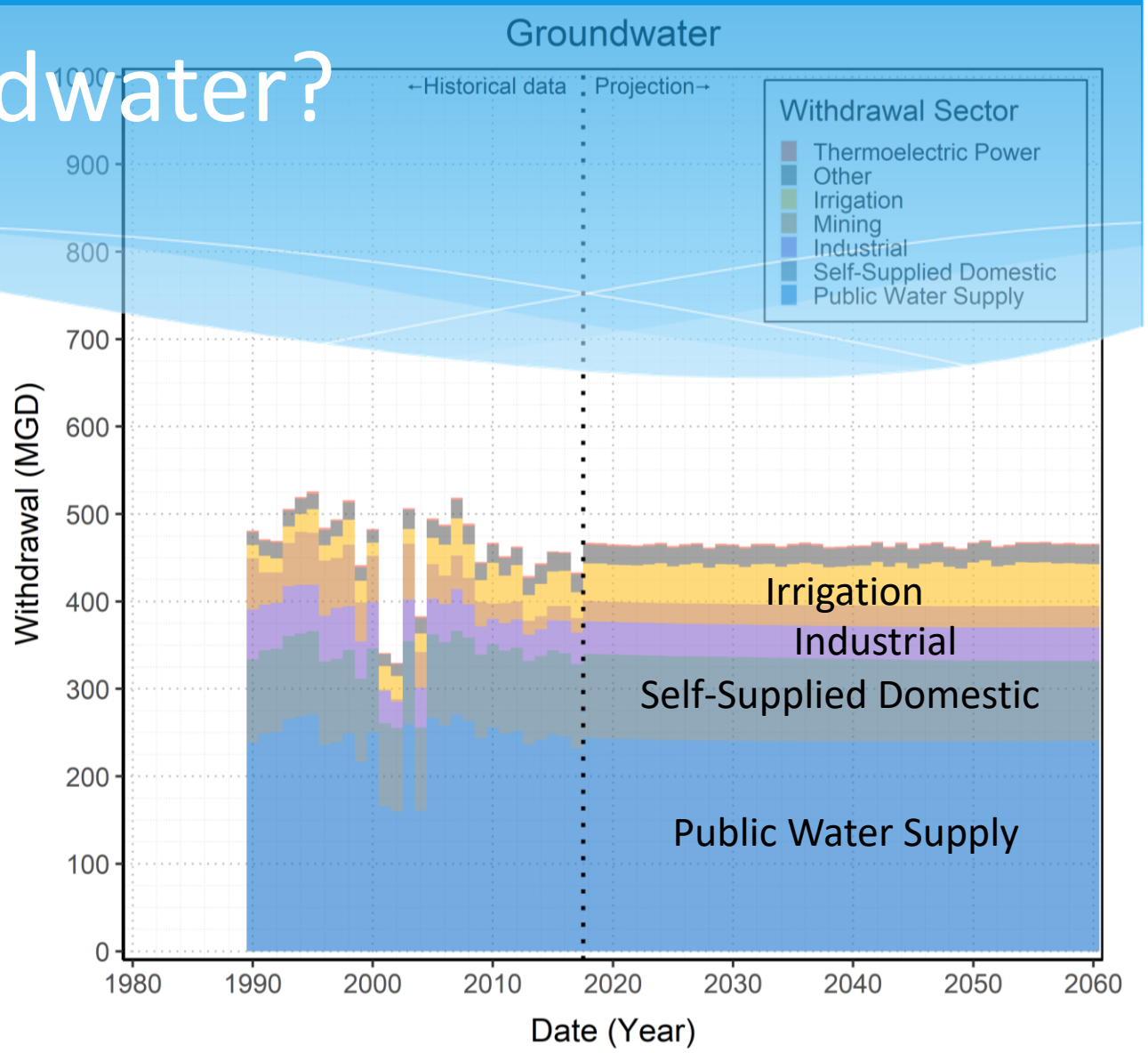
Is there enough groundwater?

- **The need**: Is there enough water available at the current withdrawal locations both at current and future demands?
- **Goals**:
  1. Analyze current groundwater availability for the Delaware River Basin.
  2. Provide projected availability estimates to the year 2060 in support of water supply planning.



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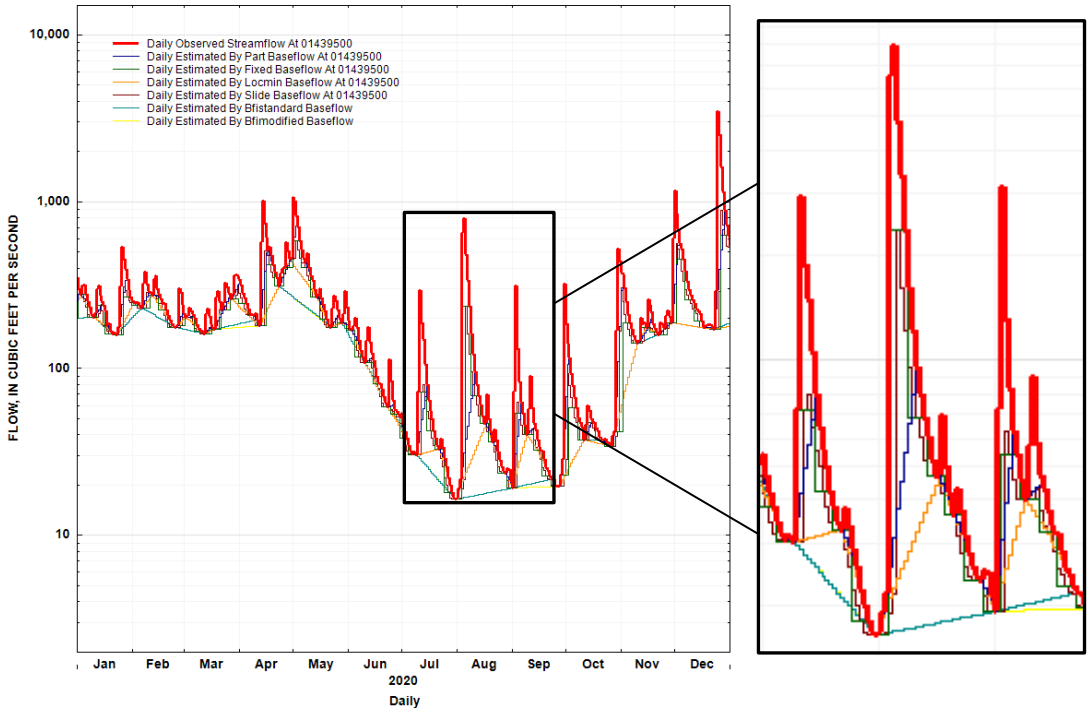
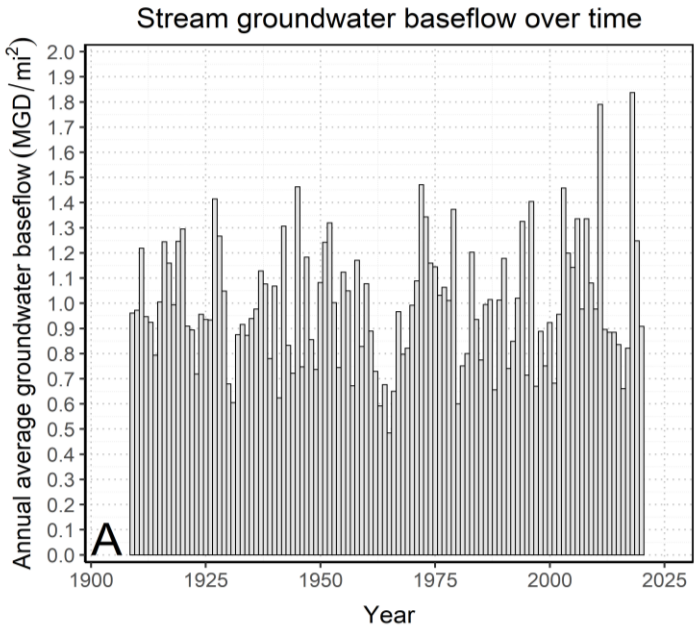
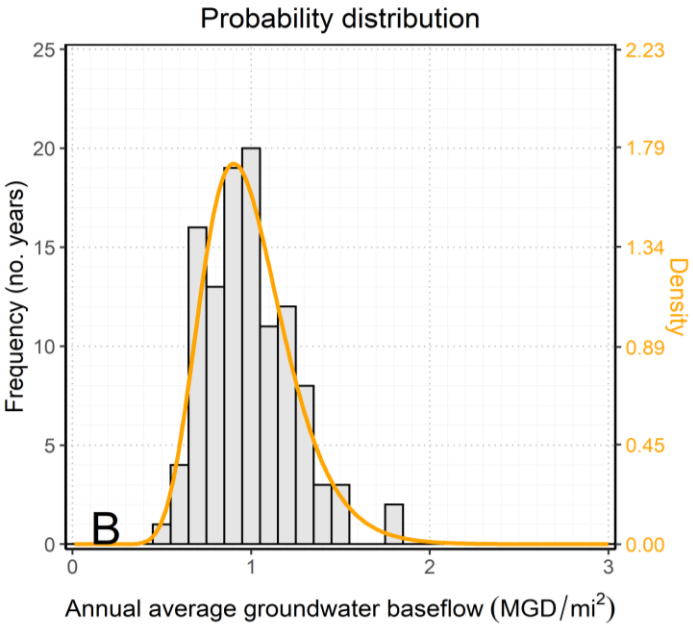
What is a groundwater baseflow recurrence interval?

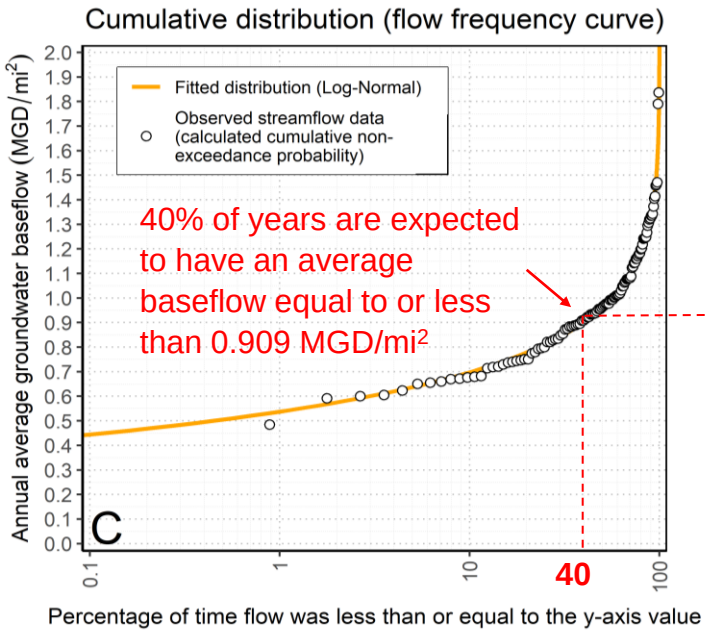


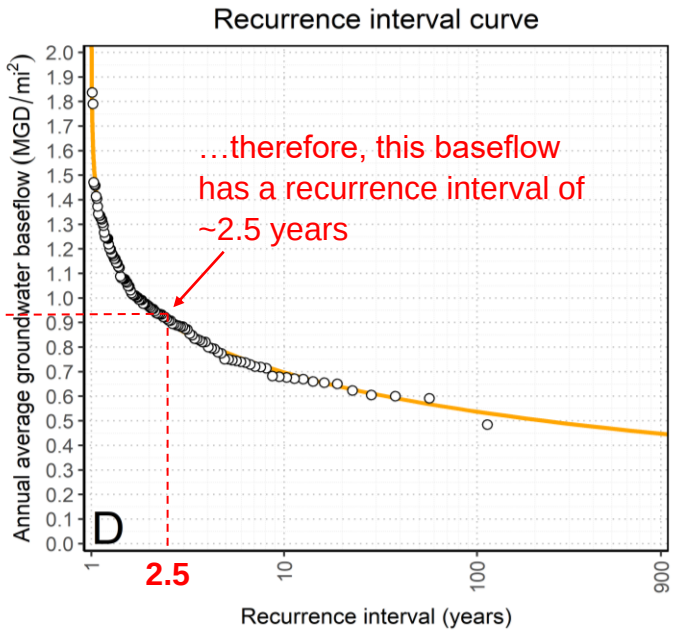
Baseflow Separation

Bush Kill at Shoemakers, PA









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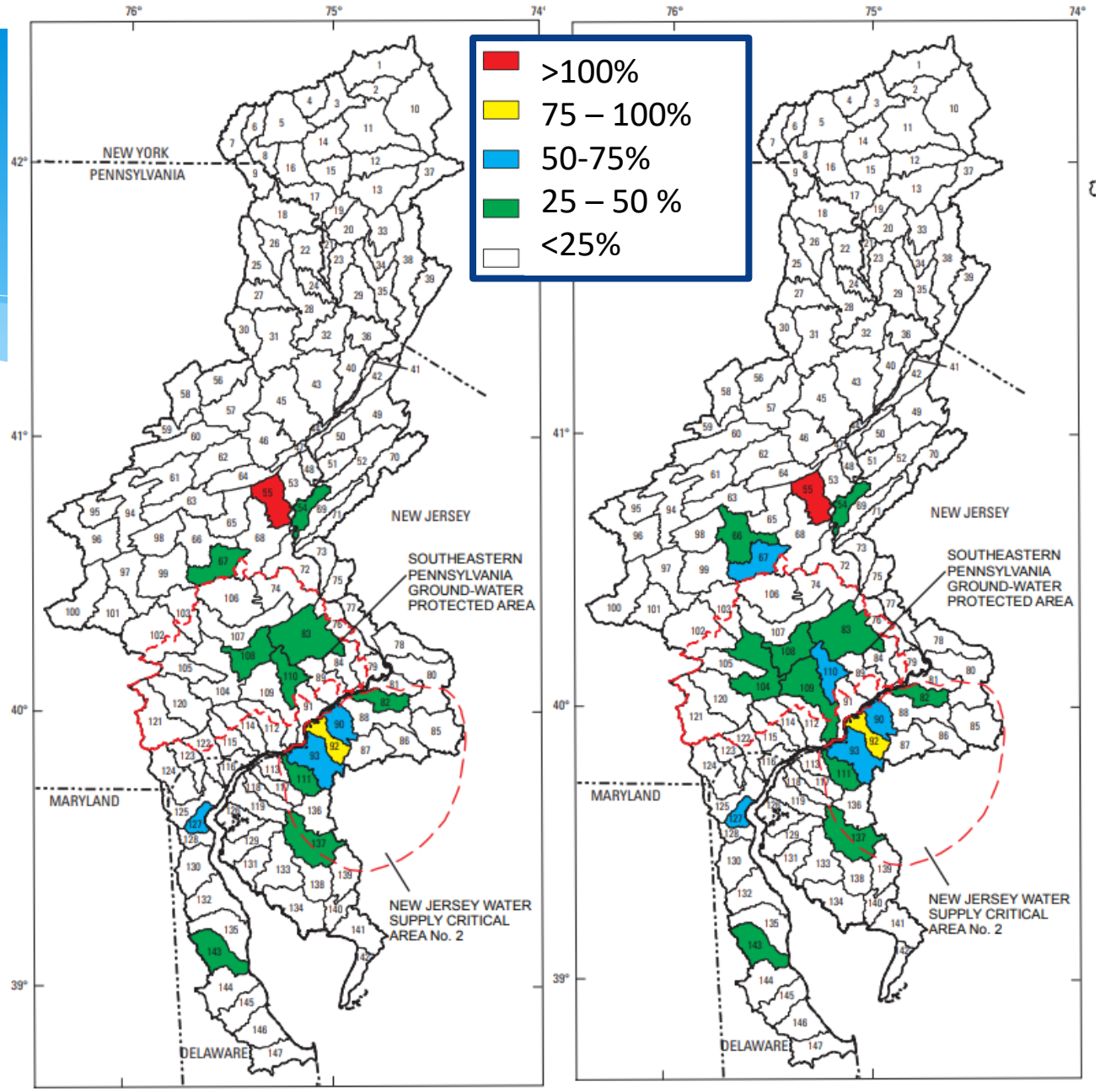
Basinwide baseflow analysis (Sloto & Buxton, 2006)

- Defined 147 subbasins in the DRB
- Recurrence interval (RI) baseflow values were determined for each subbasin based on its geology
  - 23 index stations characterized baseflow from 14 major rock types

$$\text{Groundwater availability} = \frac{\text{net groundwater withdrawal}}{\text{25- and 50-RI baseflow}}$$



25-RI baseflow (dry year)

50-RI baseflow (exceptionally dry year)

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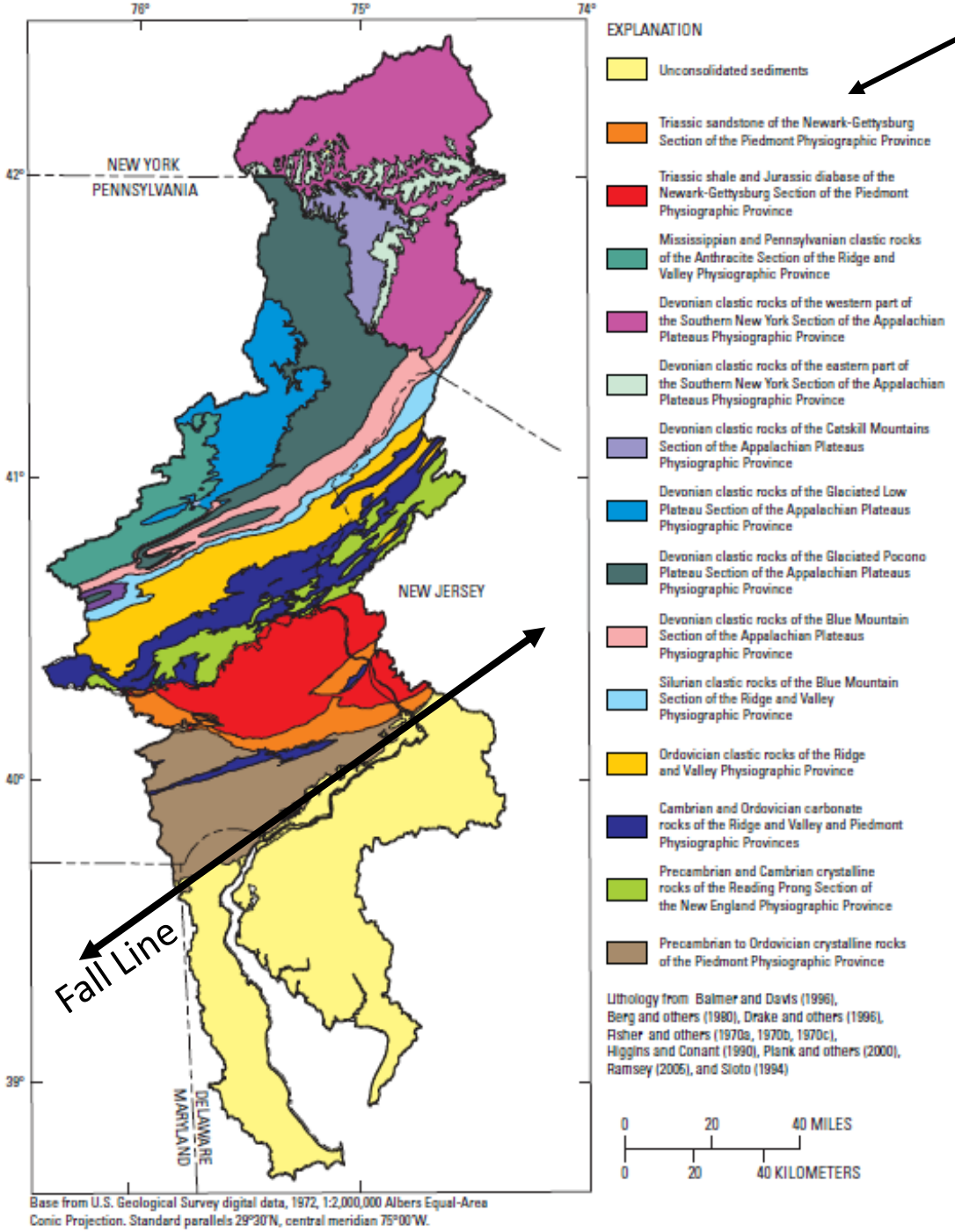

14 major rock types

Basic Basin Geology

- DRB: Appalachian Highlands & Atlantic Coastal Plain
- The Highlands are underlain by fractured bedrock and have high-energy streams and rivers
  - Sloto & Buxton Method #1: Calculate (empirical) recurrence intervals weighted by proportional areas of rock type
- The Coastal Plain is underlain by unconsolidated sediments made of sand, clay and gravel
  - Sloto & Buxton Method #2: Calculate (empirical) recurrence intervals weighted by proportional areas of surficial geology and land use

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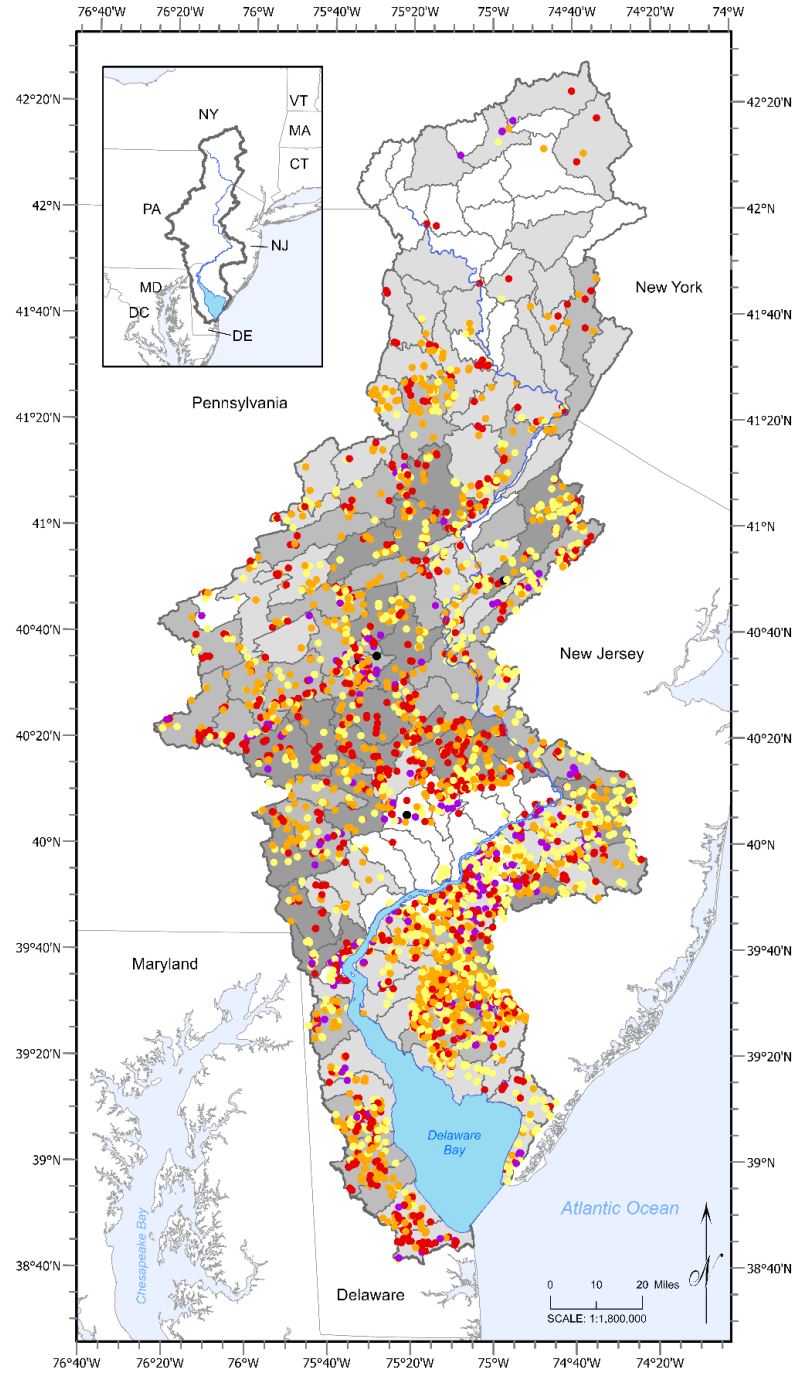


Groundwater sources net withdrawal for CY2017 (MGY)

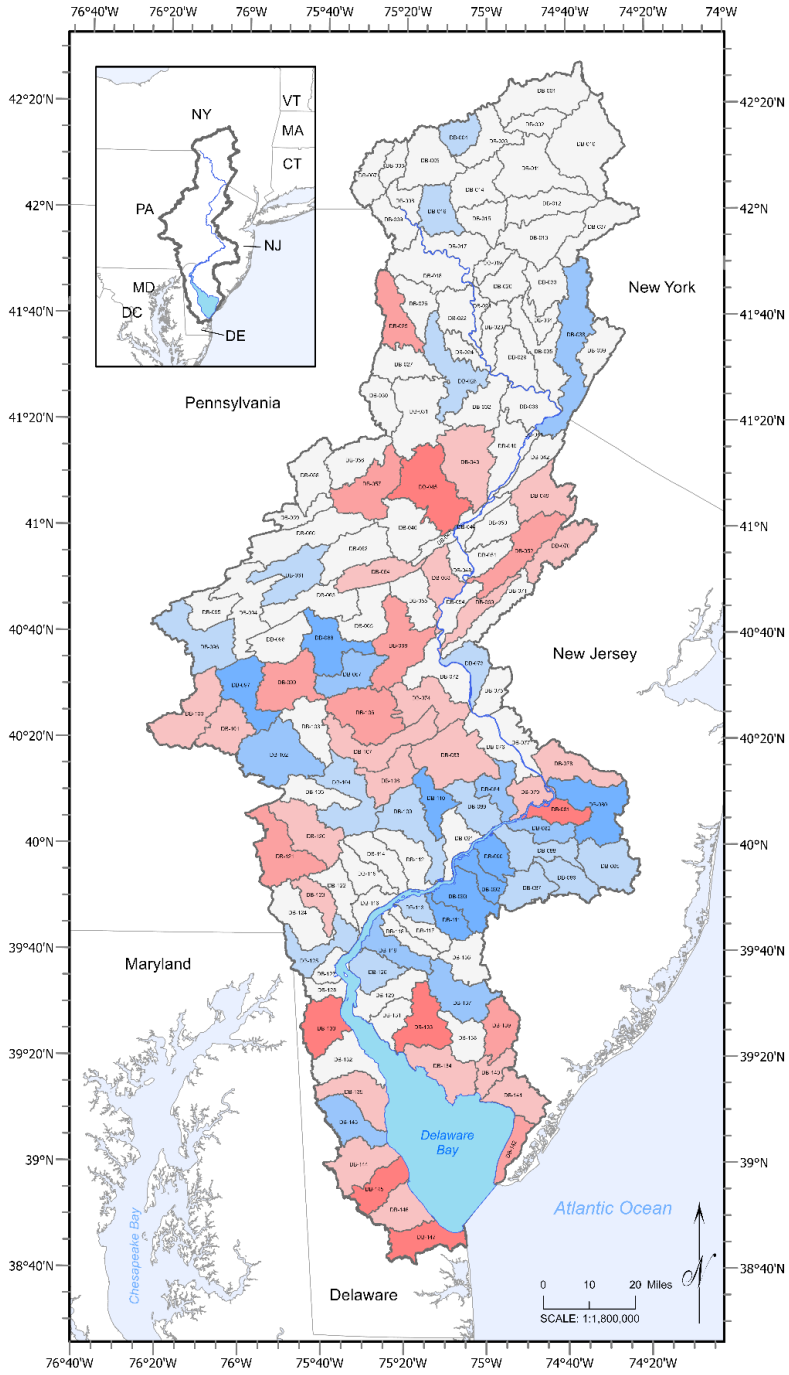
- ≤1
- (1, 10]
- (10, 100]
- (100, 1,000]
- ≥ 1,000

Estimated net groundwater withdrawal for self-supplied domestic (MGY)

- ≤5
- (5, 25]
- (25, 50]
- ≥ 50

5,416 points reported data.

2,111	(< 1 MGY)
1,702	(1, 10]
1,313	(10, 100]
286	(100, 1,000]
4	(> 1,000)



Modelled change in net groundwater withdrawal, 2018 to 2060 (MGD)

- ≥1.0
- (0.5, 1.0]
- (0.1, 0.5]
- (0.0, 0.1]
- (-0.1, 0.0]
- (-0.5, -0.1]
- (-1.0, -0.5]
- ≤-1.0

37 subbasins increasing (+23.5 MGD)

78 subbasins neutral (-0.10 < Δ < 0.10 MGD)

32 subbasins decreasing (-21.5 MGD)

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5. Results

Credit: Jake Bransky

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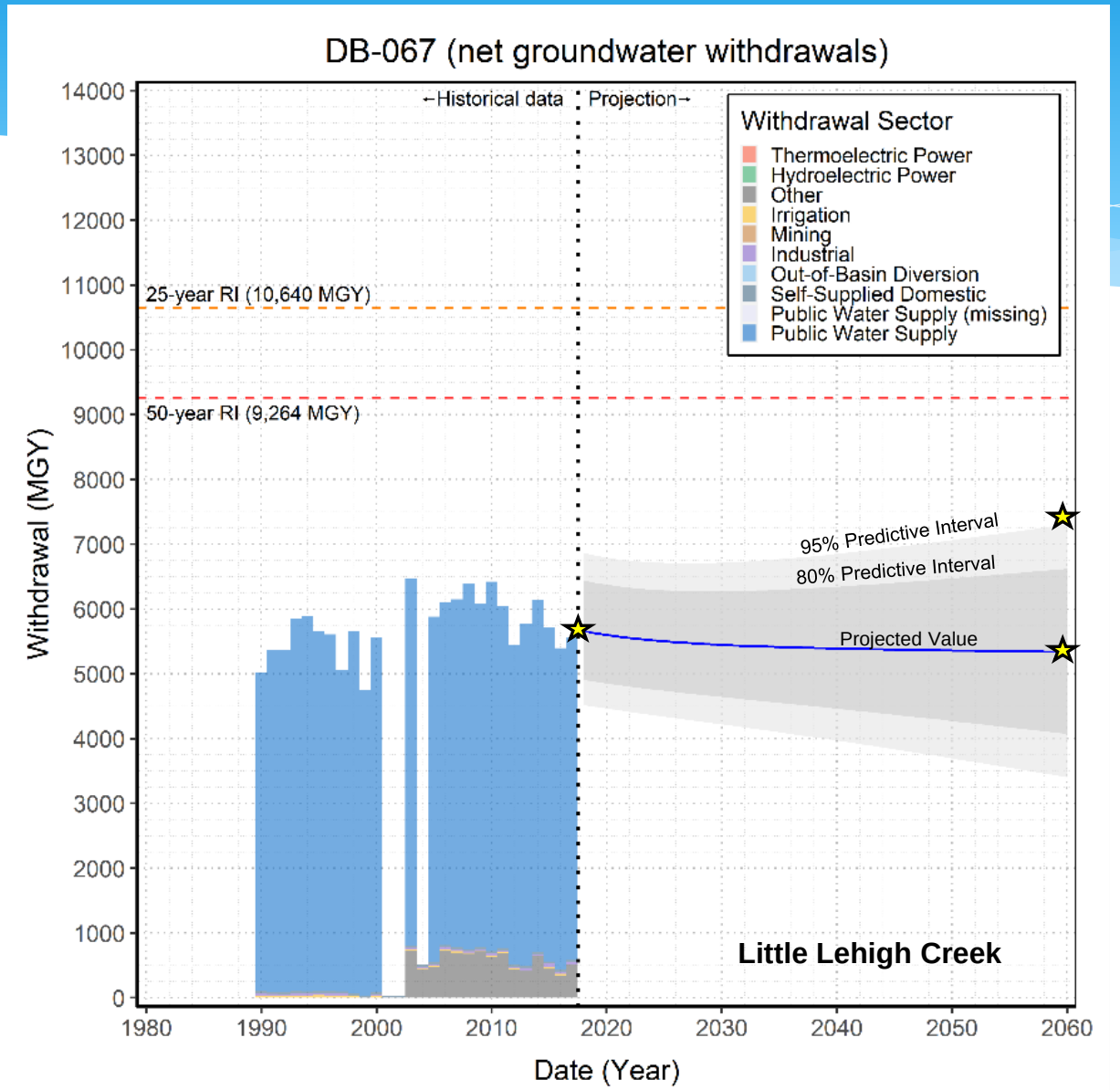
Screening tool assessment



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Projected Groundwater Use for **25-year** Annual Baseflow Recurrence

98 WATERSHED AND IDENTIFICATION NUMBER - Prefix DB is omitted

EQUAL TO OR GREATER THAN 100 PERCENT USE OF AVAILABLE GROUNDWATER

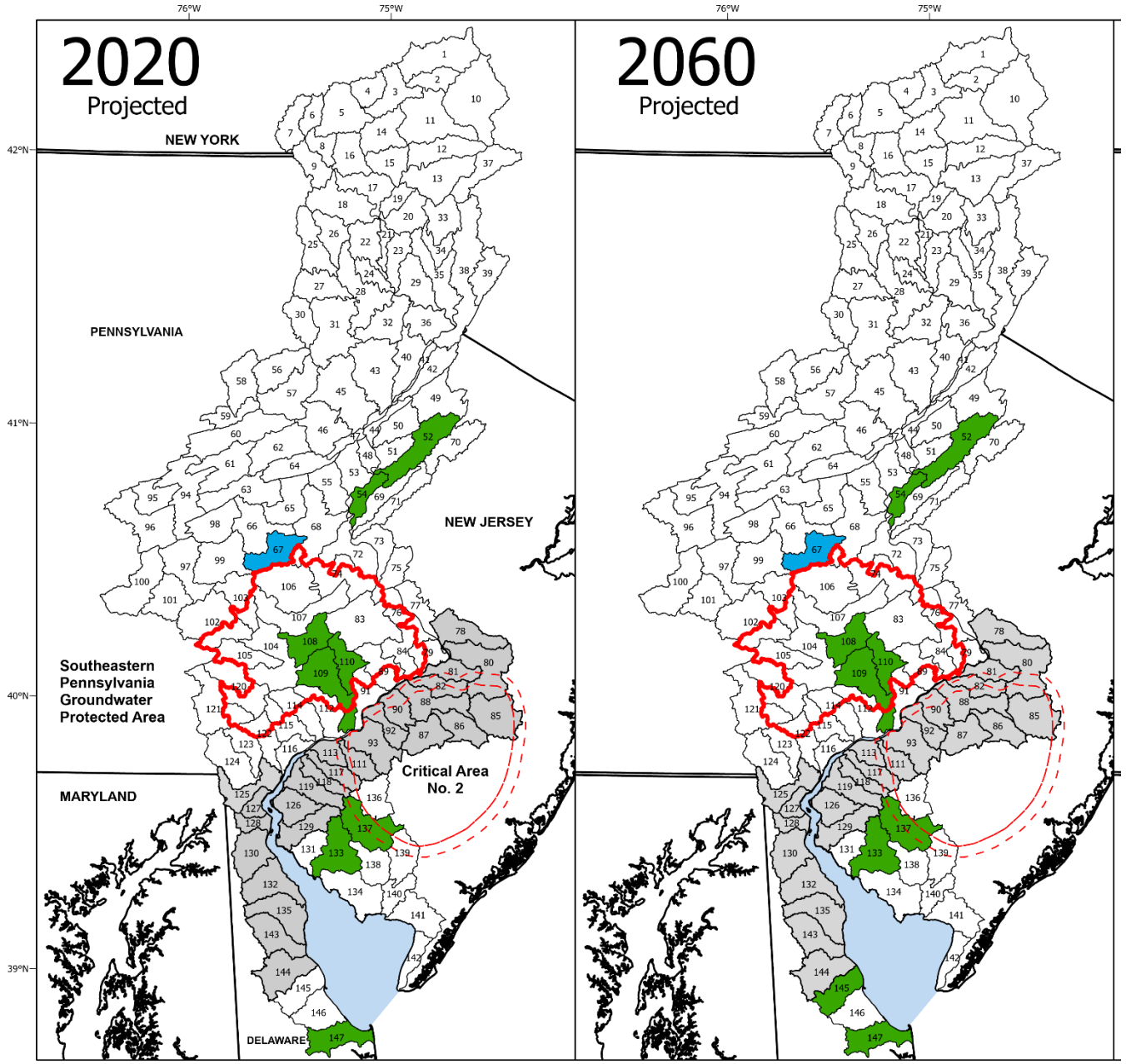
EQUAL TO OR GREATER THAN 75 AND LESS THAN 100 PERCENT USE OF AVAILABLE GROUNDWATER

EQUAL TO OR GREATER THAN 50 AND LESS THAN 75 PERCENT USE OF AVAILABLE GROUNDWATER

EQUAL TO OR GREATER THAN 25 AND LESS THAN 50 PERCENT USE OF AVAILABLE GROUNDWATER

LESS THAN 25 PERCENT USE OF AVAILABLE GROUNDWATER

SCREENING TOOL NOT APPLIED



- Groundwater use is **expected to be sustainable** between 2020 and 2060
- Subbasin 67 is the only basin that uses more than 50 percent of its available groundwater
- Greyed area is where screening tool was not applied

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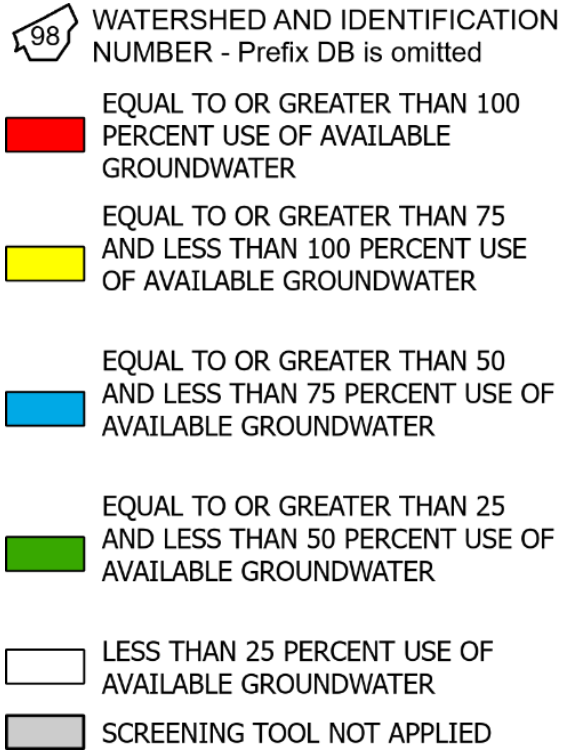
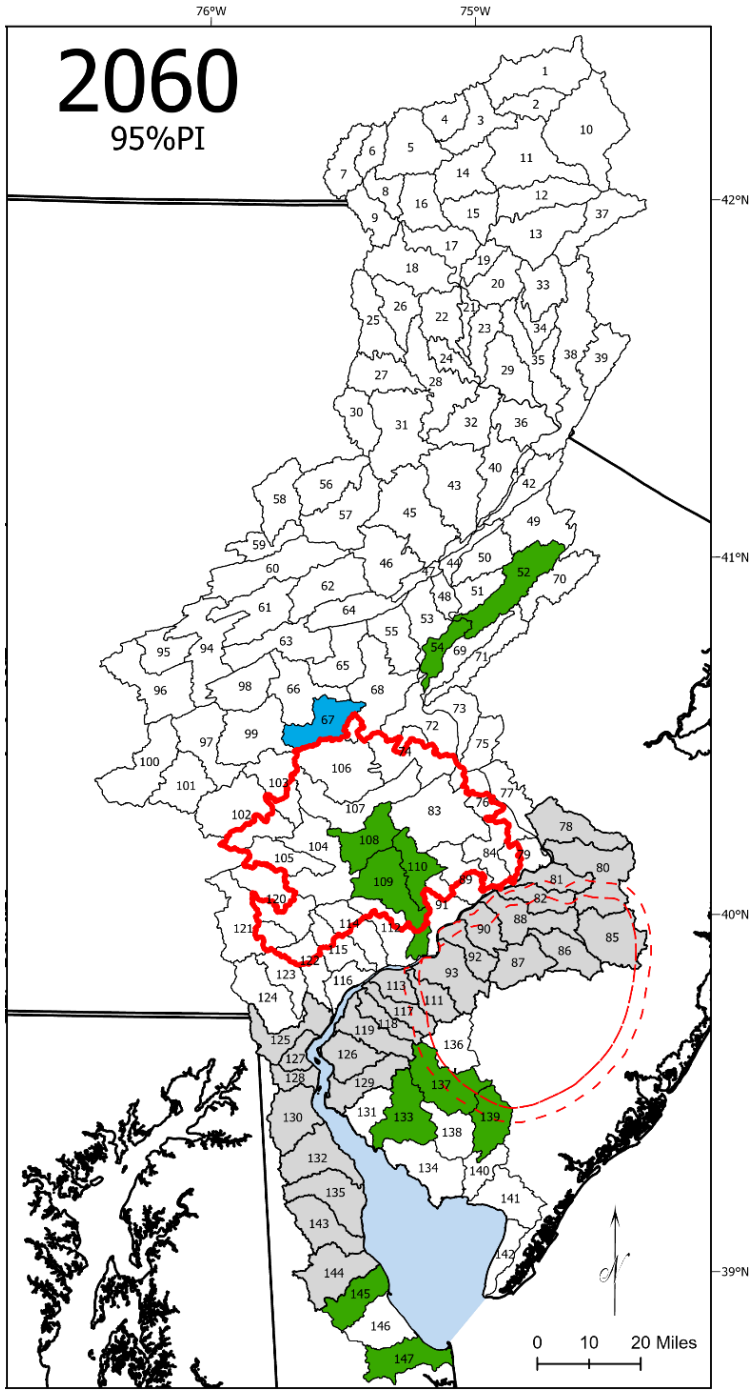
95% Predictive Interval Groundwater Use for **25-year** Annual Baseflow Recurrence





- Groundwater use is **expected to be sustainable** even at high end of withdrawals
- Subbasin 67 continues to be the only subbasin using than 50 percent of its available groundwater

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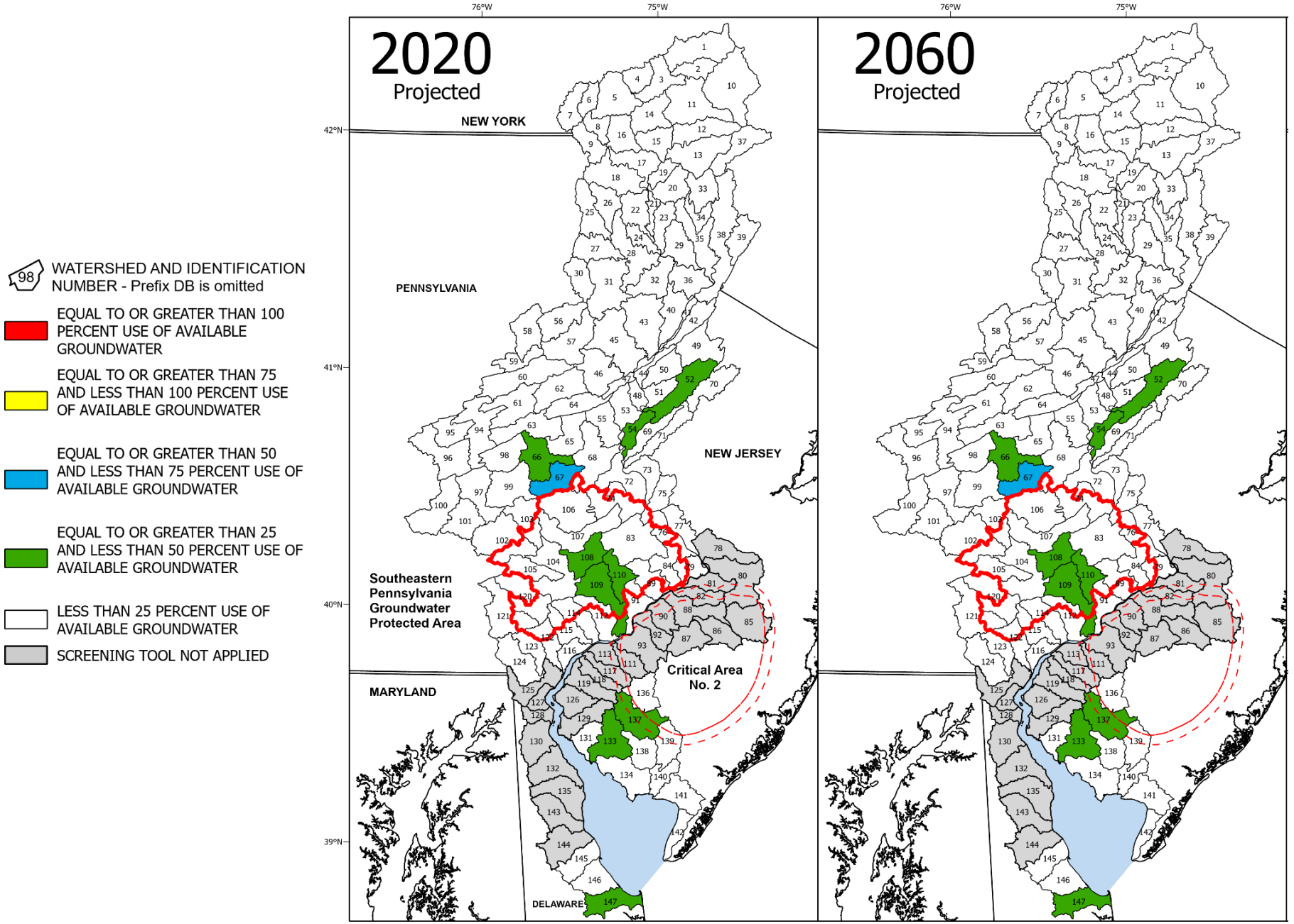
Projected Groundwater Use for **50-year** Annual Baseflow Recurrence



- In a drier scenario groundwater use **continues to be sustainable**

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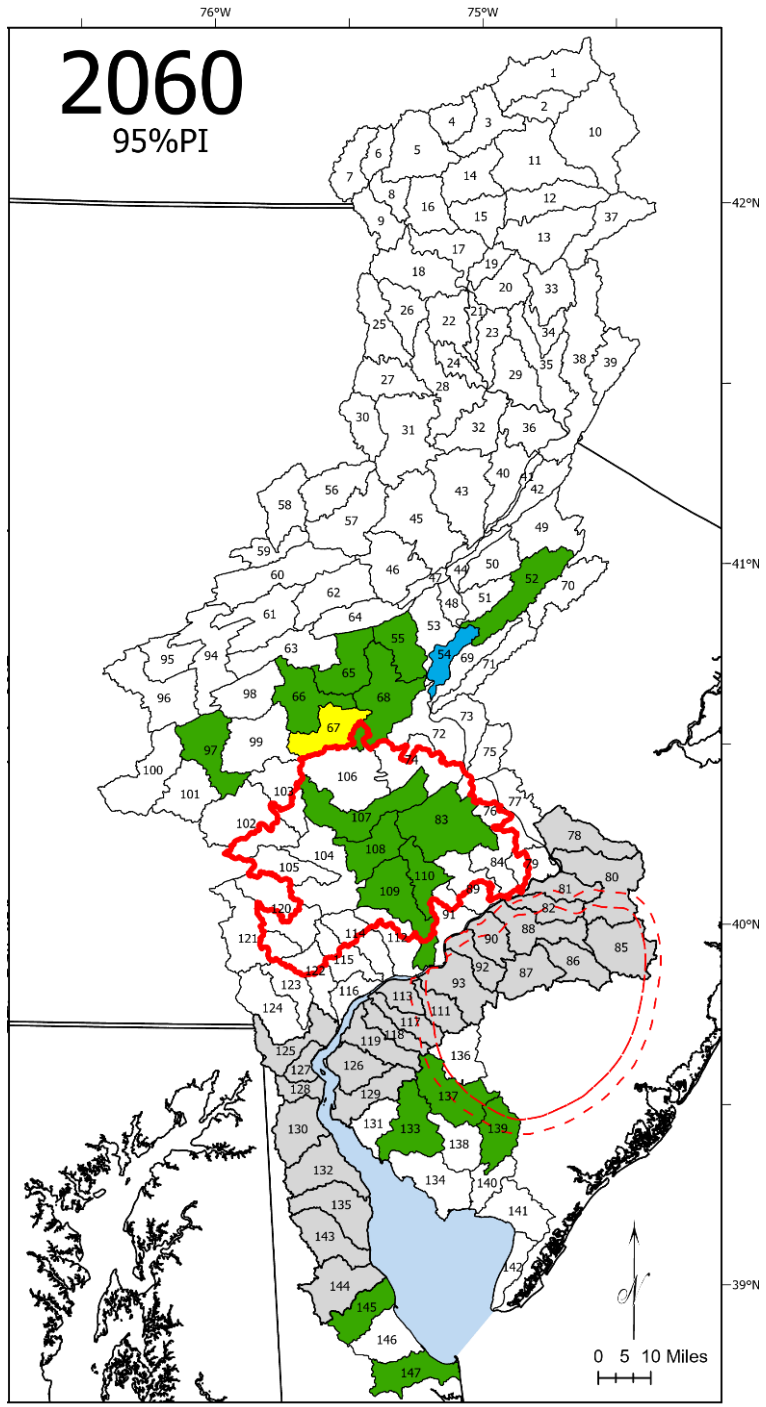
95% Predictive Interval Groundwater Use for **50-year** Annual Baseflow Recurrence



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EQUAL TO OR GREATER THAN 50 AND LESS THAN 75 PERCENT USE OF AVAILABLE GROUNDWATER

EQUAL TO OR GREATER THAN 25 AND LESS THAN 50 PERCENT USE OF AVAILABLE GROUNDWATER

LESS THAN 25 PERCENT USE OF AVAILABLE GROUNDWATER

SCREENING TOOL NOT APPLIED

- Groundwater use is **expected to be sustainable** in this drier scenario
- Subbasin 54 uses at least 50% of its available groundwater
- Subbasin 67 uses at least 75% of its available groundwater

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Conclusions - Summary

- Current and future groundwater use is sustainable in most areas of the Basin
  - Projected median and upper 95th percentile groundwater withdrawals
  - Net groundwater use projected to increase slightly: 356 mgd (2018) to 358 mgd (2060)
- Sloto & Buxton methodology not applicable in 26 Coastal Plain subbasins (8 in DE, 18 in NJ)
- Additional Information found in report:
  - Seasonality of baseflow
  - Natural resource assessment
  - Climate change impacts to groundwater availability


Credit: Michael Thompson

Next Steps

- Technical Report to be published in **late 2022**
- **Recommended areas for further exploration**:
  - Seasonality of use and availability
  - Coastal Plain geology & groundwater availability
  - Updating and improving the accuracy of recurrence interval baseflow values

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Questions?

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