Enhancing Spill Response through Modeling and Automation

DRBC Water Management Advisory Committee
Subcommittee on Source Water Protection (SSWP)
Held Hybrid: NJ American Water Treatment Plant in Delran, NJ and via Zoom Webinar for the public

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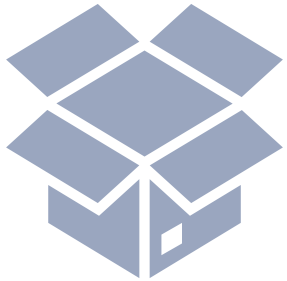
Motivation for Spill Modeling



DRBC Spill Modeling “Toolbox”

Ongoing Developments

Spills Happen in the Delaware River

- The EWS has reported over 460 events since its formation in 2005[1]
- November 2004:
  - *Athos I* Oil Spill – 263,000 gallons of crude oil released
  - Original spill model procedure created by Namsoo Suk and John Yagecic[2]

Photo Credit: *NOAA*

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[1]Schuylkill Action Network, *www.schuylkillwaters.org* (2024)
[2]Yagecic & Suk, *JAWRA* (2014)

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- August 2018:
  - Train derailment in Hancock, NY
  - Motivation for upper basin spill modeling

Photo Credit: *National Park Service, Upper Delaware Scenic & Recreational River*

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[1]Schuylkill Action Network, *www.schuylkillwaters.org* (2024)
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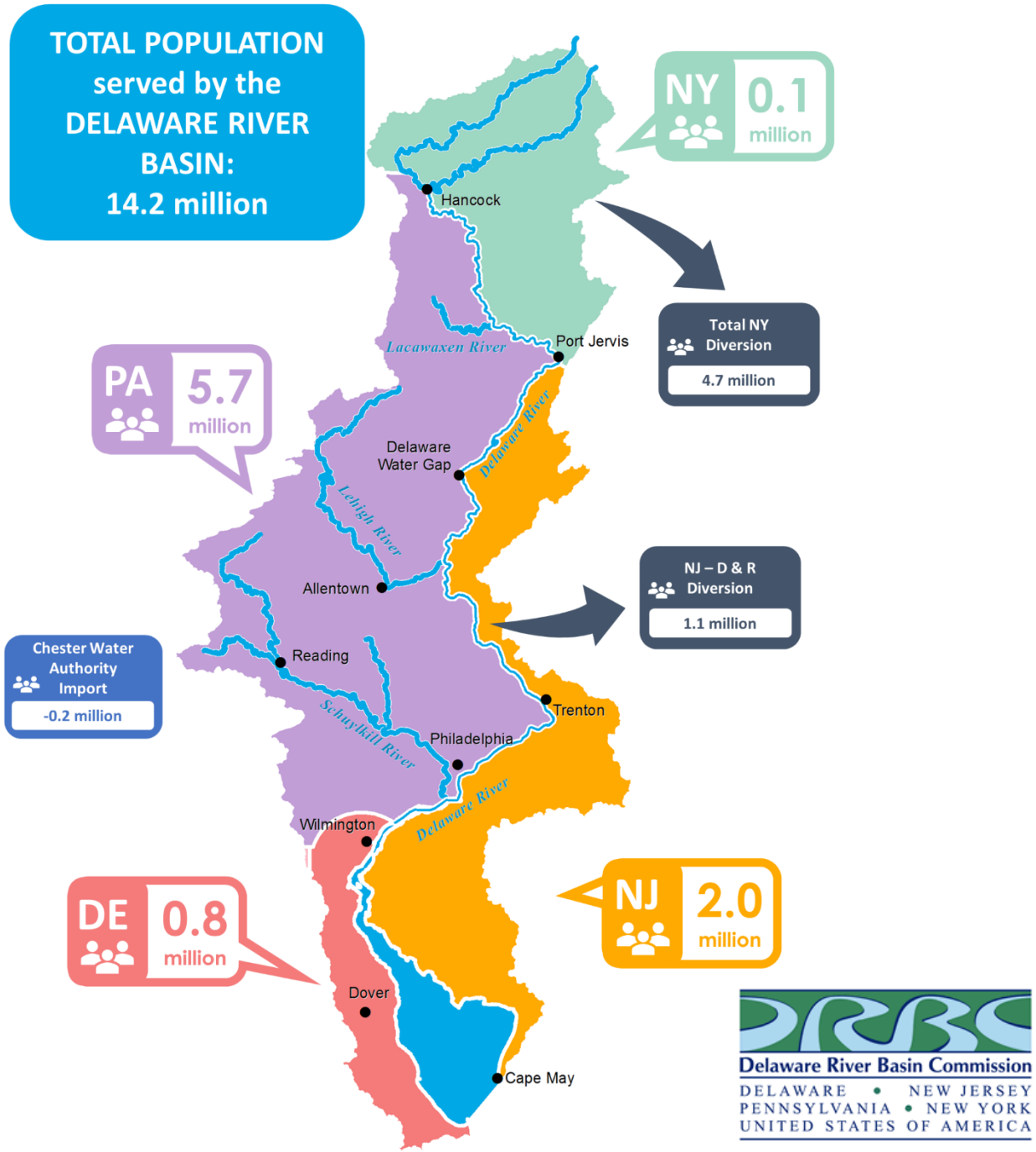
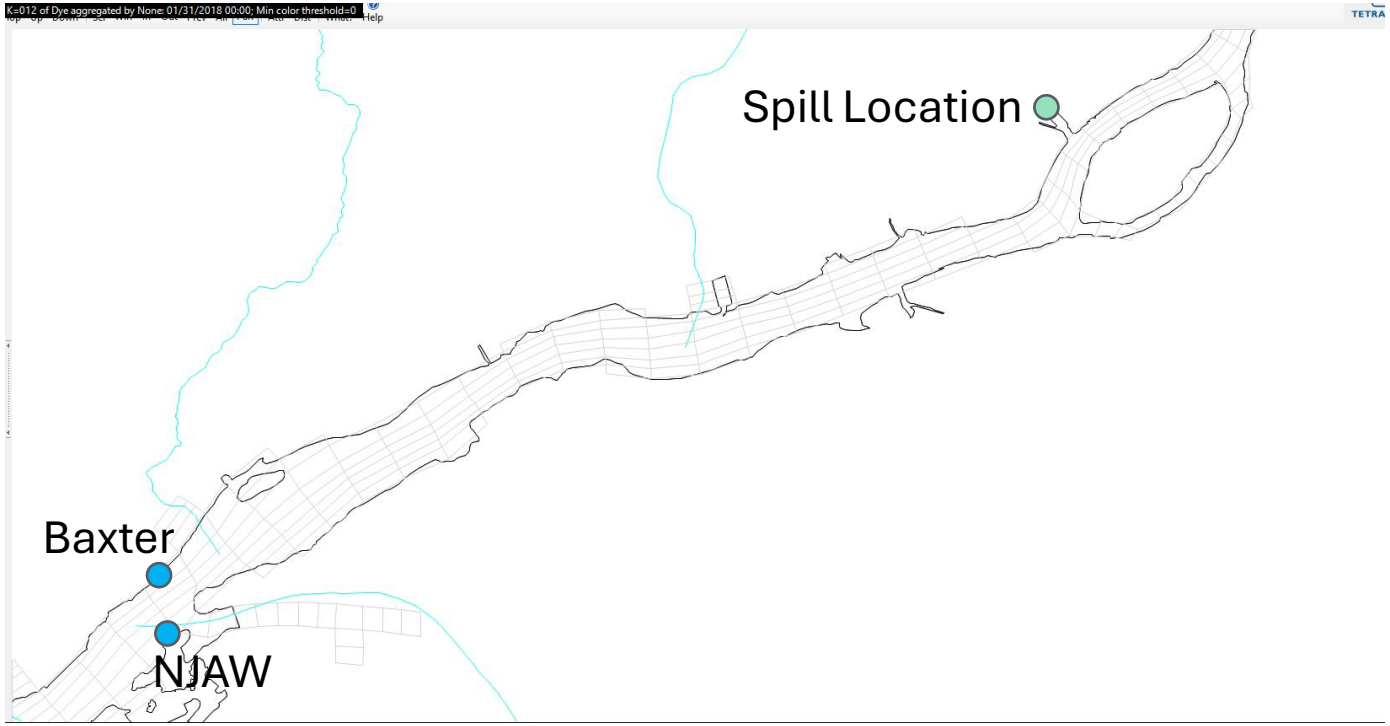
Over fourteen million people rely on drinking water from the Delaware River Basin[1]



[1]Water Resources Program FY 2025-2027 (DRBC Report No: 2024-3)

DRBC Spill Modeling

- Modeling capabilities
  - State-of-the-art models
  - Rapid future projections
  - Ongoing updates during event
- Model output
  - Concentration estimates
  - Time of travel
  - Lateral heterogeneity (e.g., PA vs. NJ differences)
- Support other models with hydrodynamics linkage files



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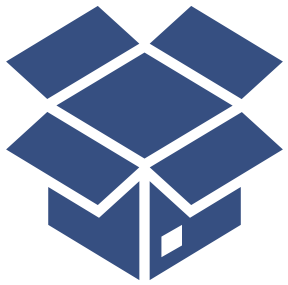


DRBC Spill Modeling “Toolbox”

Ongoing Developments

Non-Tidal Spills: Rapid Dilution Tool

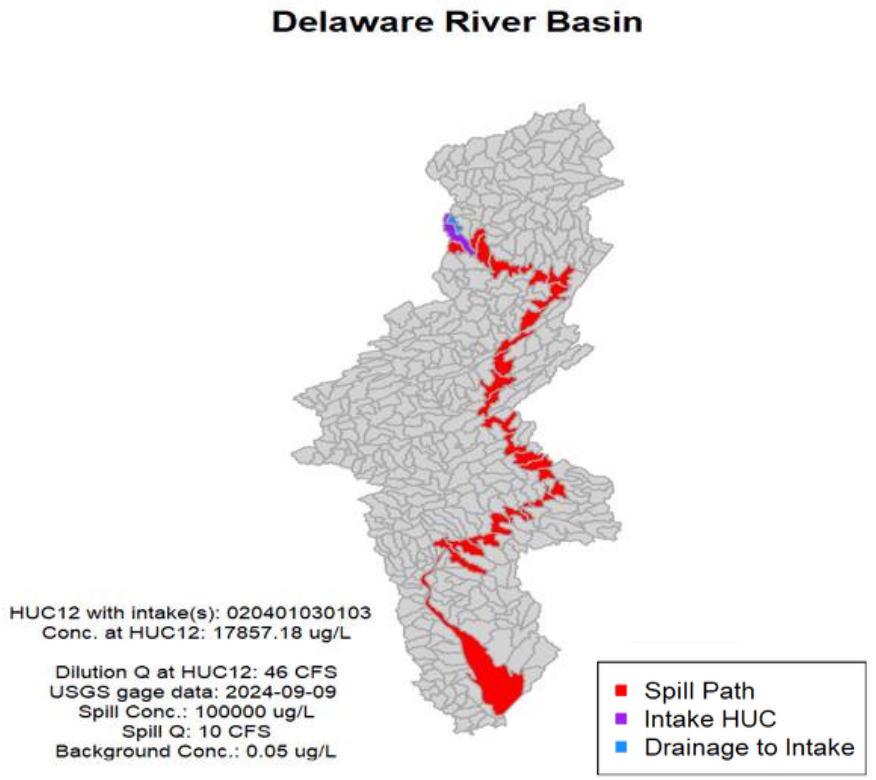
Daily Discharge from 300+ USGS Gages

Spill Data

Rapid Dilution Model[1] Runs

Computes:
- Downstream path of release
- Dilution at each subwatershed
- Predicted average water yield at each subbasin
- Estimated pollutant concentration at each node given dilution
- List of intakes at each node

Spill Event



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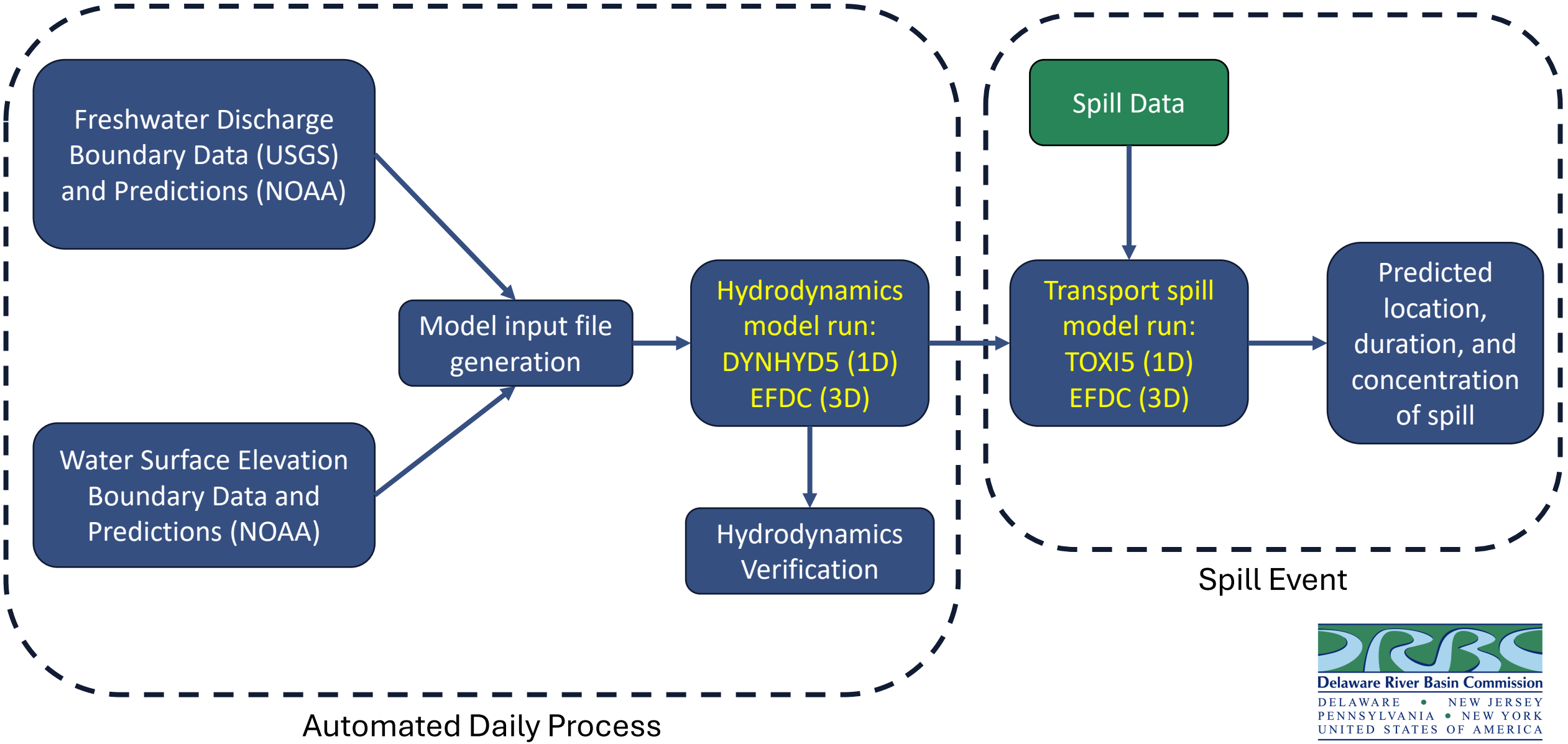
[1]Yagecic (2018)

Delaware Estuary Spills: Modeling Procedure



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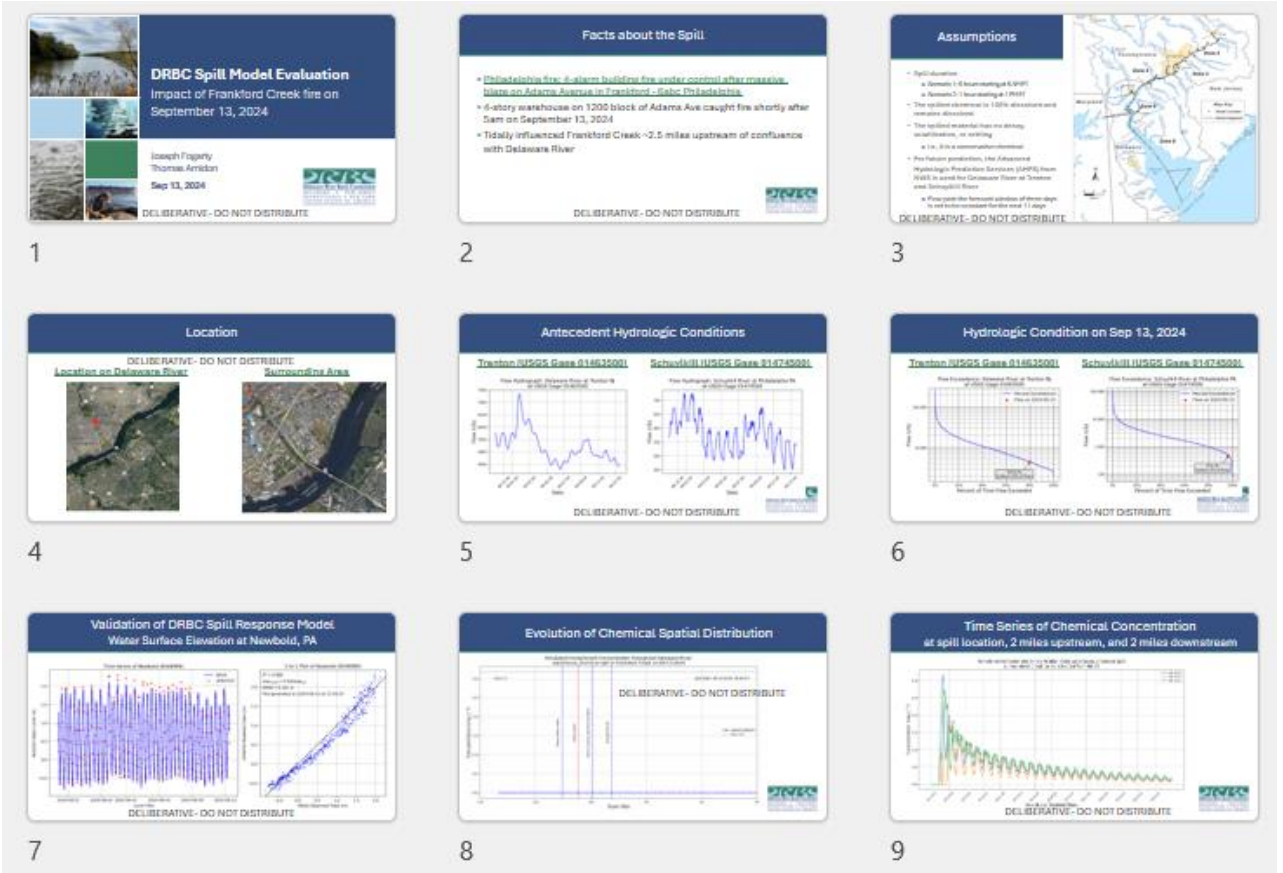
Yagecic & Suk, *JAWRA* (2014)

The DRBC is presentation-ready within a few hours after EWS first sends out alert of spill



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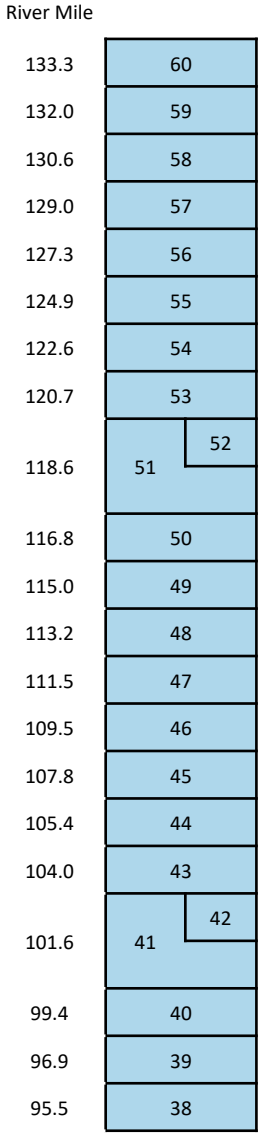
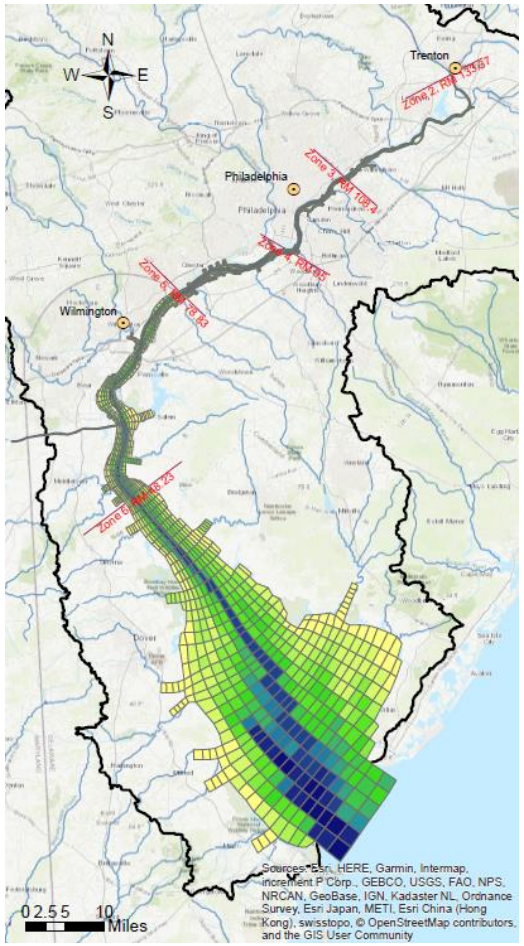
Delaware Estuary: 1D vs. 3D Modeling



One-Dimensional Model Domain

Spilled material is laterally and vertically well-mixed in each river segment

Hydrodynamics and transport model are based on pre-2016 bathymetry



Three-Dimensional Model Domain

Spilled material is still well-mixed in each cell, but grid resolution is higher

Hydrodynamics and transport model are based on post-2016 bathymetry

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Case Study: March 2023 Acrylic Polymer Spill (near Bristol, PA)

- An estimated 8100 gallons of water-soluble acrylic polymer solution was released into Otter Creek from Trinseo PLC Plant

Simulation Case Study Parameters	
Spill Start:	March 24, 2023, 11:00 PM
Spill Location:	RM 118.87
Spill Duration:	2 hours
Chemical Mass:	65,000 lbs.
Assumptions:	100% dissolved, no decay, no settling, no volatilization

Photo Credit: *US EPA*

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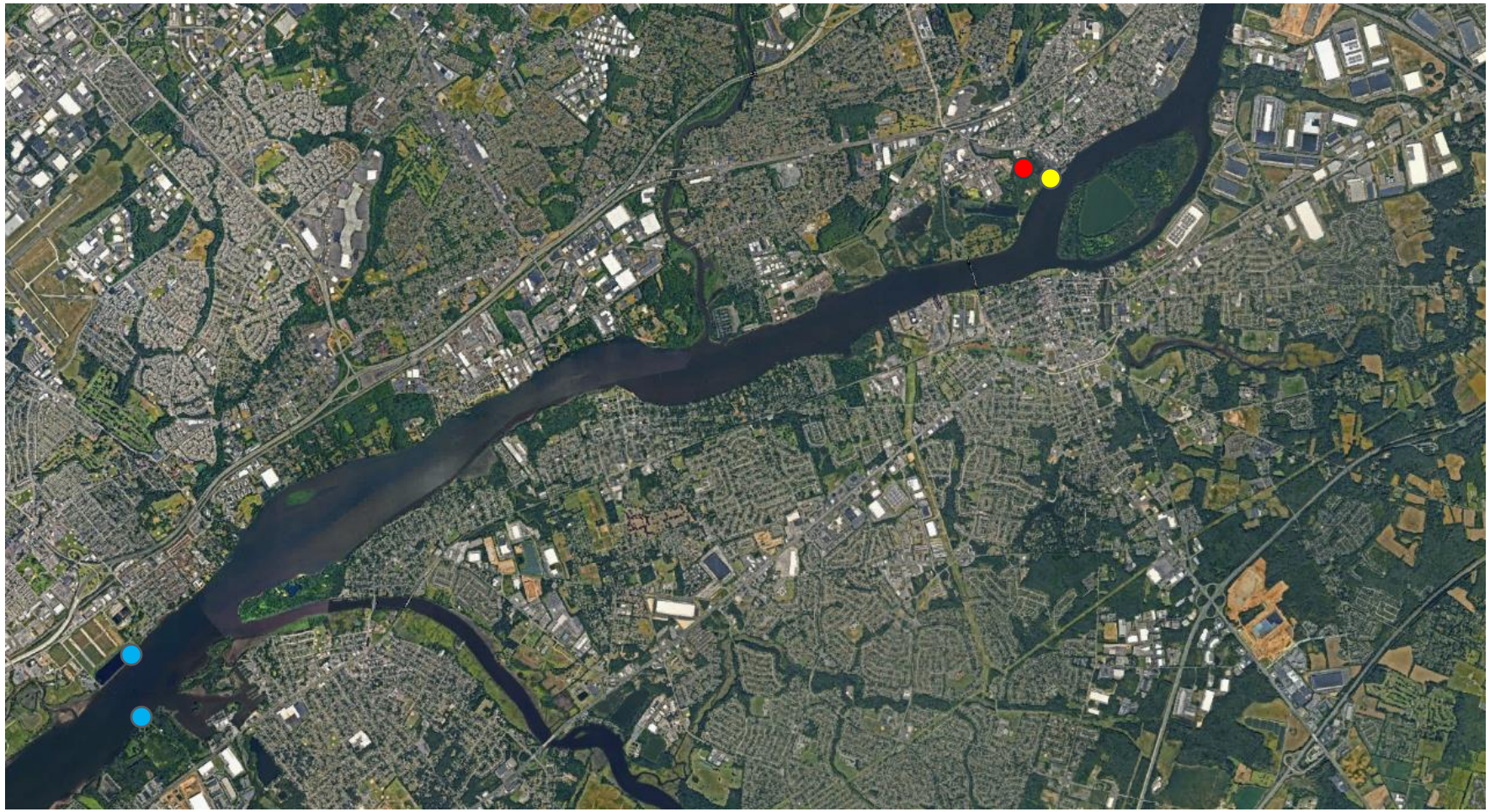

- Spill Location
- Spill Model Cell
- Drinking Water Intake

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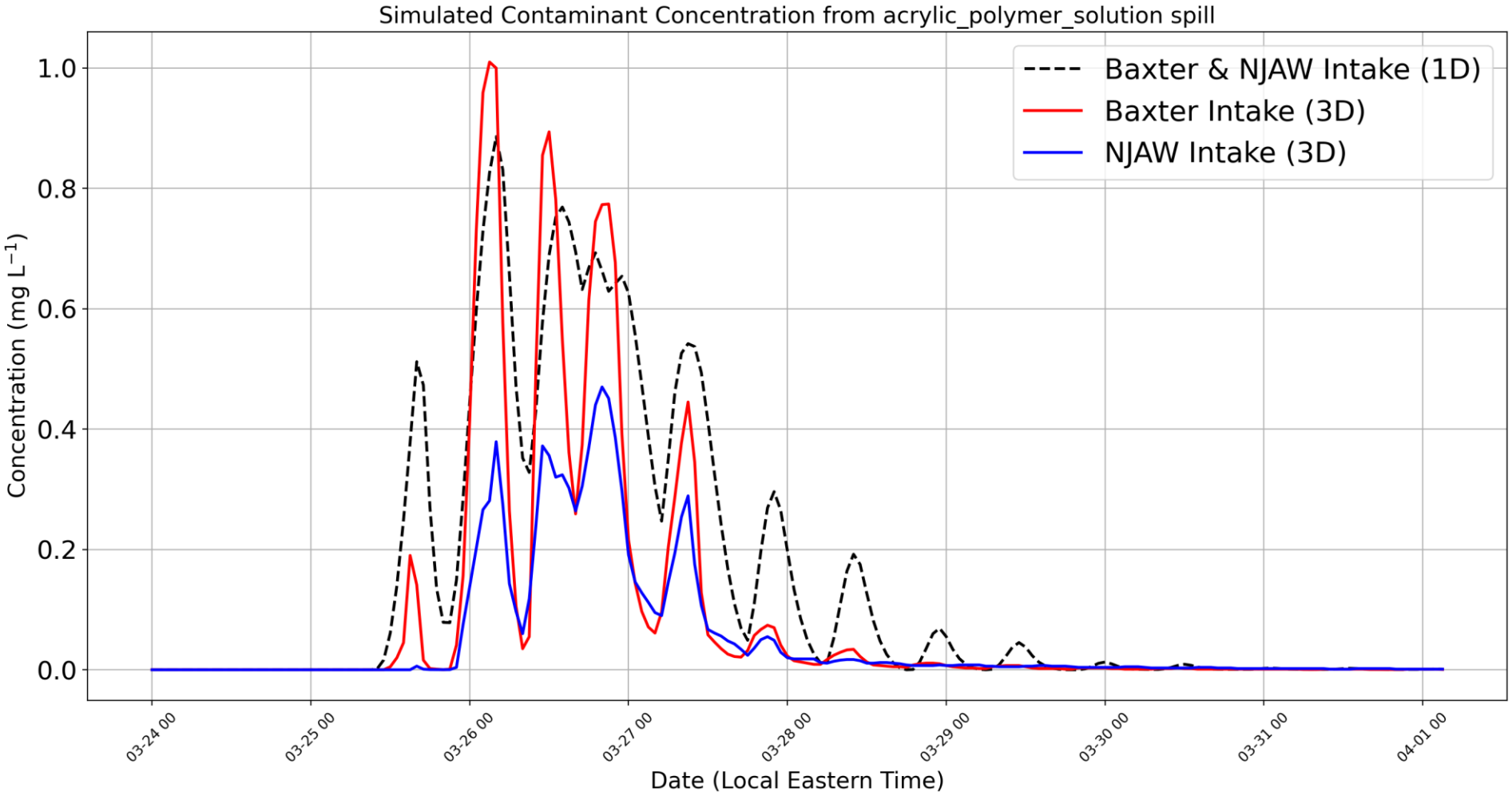
Case Study: Time Series



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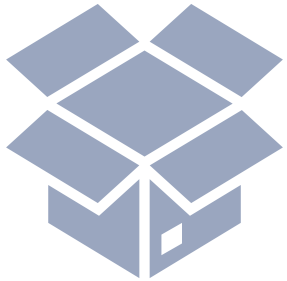

DRBC Spill Modeling “Toolbox”

Ongoing Developments

The Power of Automation and Scripted Processing

- What is automated?
  - Data retrieval
  - Pre-processing
  - Execution of hydrodynamic model
  - Plot generation
- What is used?
  - Estuary Spill Response: Python
  - Rapid Dilution: R
  - Cloud Computing
- More work up front – but *tremendous* return on investment

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Upcoming Work: Non-Tidal Main Stem

- The Hydrologic Engineering Center's River Analysis System (HEC-RAS) uses cross-sections to approximate the channel width of the Delaware River
- HEC-RAS computes:
  - Water surface elevation
  - Left, center, and right-channel velocity
- Ongoing development: extend current model down to Trenton to be used in combination with WASP[1] for a quick spill assessment
- This model would *supplement* the rapid dilution tool

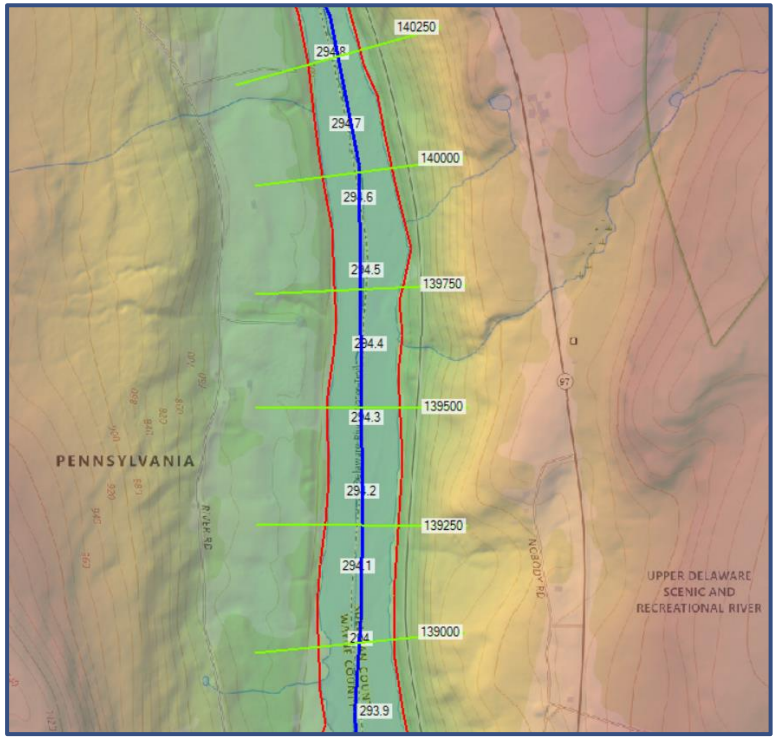

Photo Credit: *DRBC Memorandum for the Record,* "HEC-RAS based Habitat Model of the Delaware River from Hancock to the Delaware Water Gap"

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[1]Shabani et al., *J. Flood Risk Manag.* (2021)

Summary

- Spills will continue to happen
  - The DRBC's spill model is another available **"tool in the toolbox"** being developed and improved to support spill response in the Delaware River
  - **Modeling**, **automation** and **training** will best prepare us for quick and accurate dissemination to water purveyors, first responders, and remediation teams
- Current modeling capacities in estuary include
  - **Quick** one-dimensional spill model (DYNHYD, WASP)
  - **Higher resolution** three-dimensional spill model (EFDC)
- Ongoing developments include
  - **Automation** to reduce user error
  - Supplemental model for the **upper basin**
  - Continuation of **spill drills** to train DRBC staff

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"If you wait for the spill to begin modeling, you're too late" – John Y.

For additional information, contact the Spill Modeling Team @ DRBC:

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