Photo courtesy of Greg Coyle, Lowell Wastewater

A Predictive CSO Alert System for the Merrimack River at Newburyport

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June 9, 2021

Brown AND Caldwell | Merrimack Valley Planning Commission | MRWC MERRIMACK RIVER WATERSHED COUNCIL | City of Newburyport Massachusetts

Outline of Discussion

- Merrimack Watershed Background
  - Watershed Characteristics
  - CSO Communities and Efforts
  - Current Status of CSO Alerts
- A Predictive Tool for CSO Impacts at Newburyport
- Collaborative Testing and Validation
- Evolution of Bacteria Monitoring in the Merrimack

The Merrimack Watershed

Brown AND Caldwell

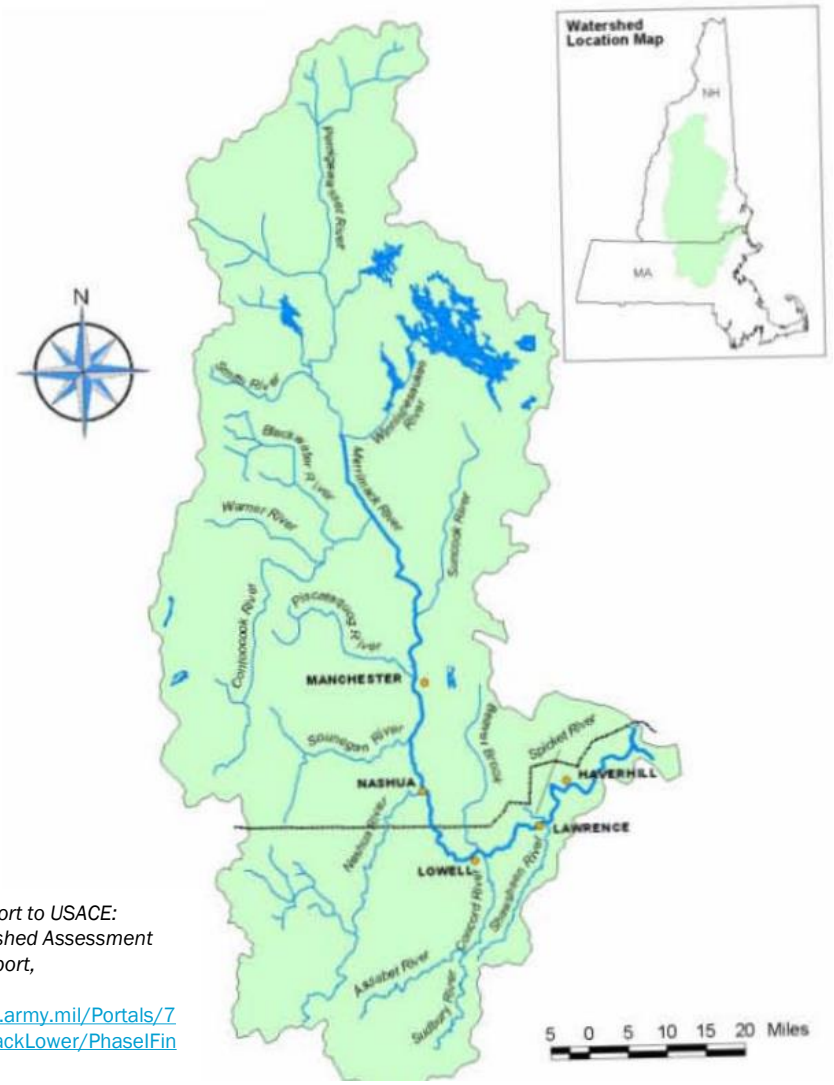
History of Water Uses in the Merrimack

Approximately 5,000 square miles

- MA
- NH

Significant Regional Resource

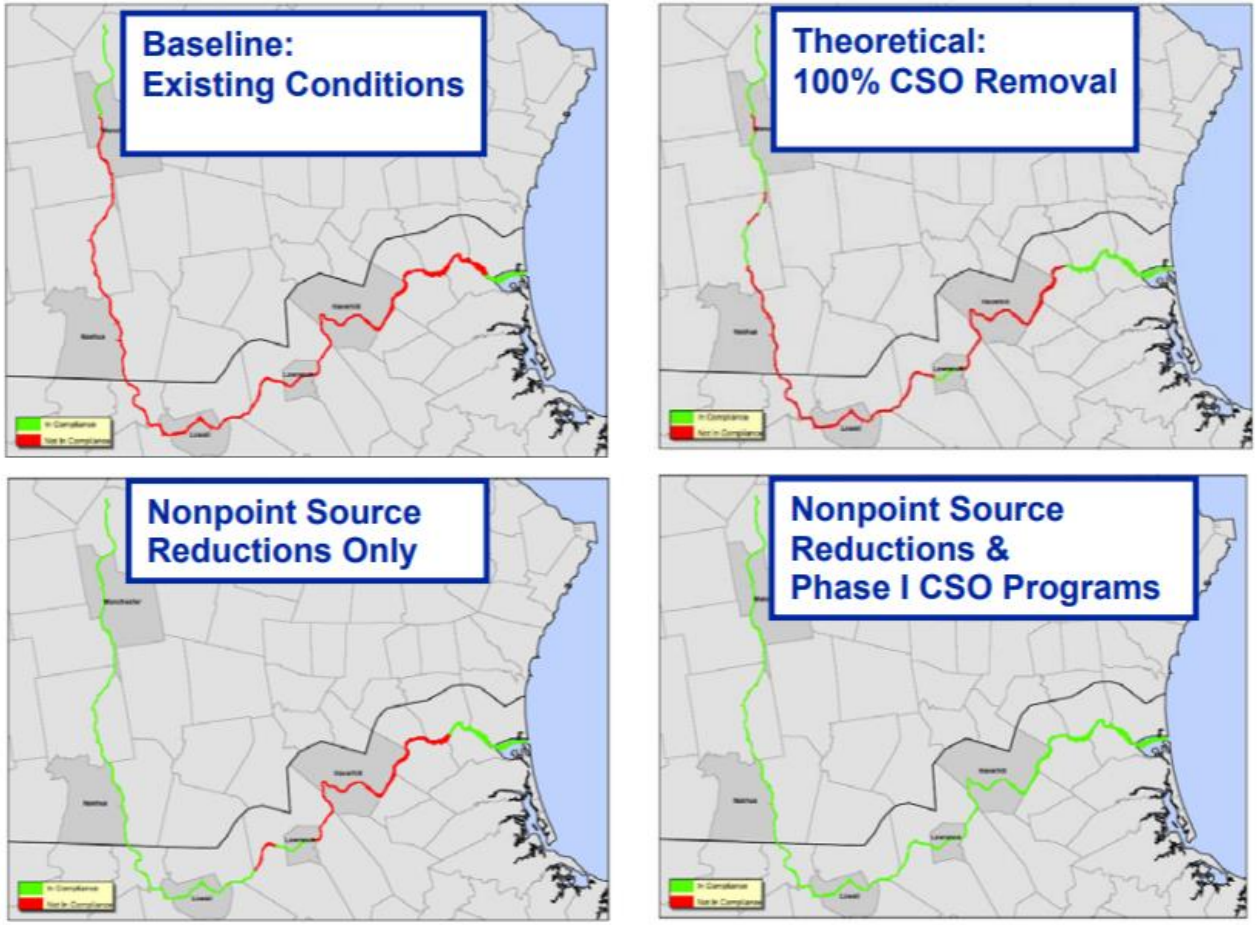
- Recreation
- Aesthetics
- Aquatic habitat
- Shell-fishing
- Drinking Water
- Treated wastewater disposal
- Hydropower
- Urban revitalization



Source: CDM Smith report to USACE: Merrimack River Watershed Assessment Study, Final Phase I Report, September 2006
https://www.nae.usace.army.mil/Portals/74/docs/Topics/MerrimackLower/PhaseIFinal.pdf

Summary of Bacteria in the River (2006)

1. Standards have changed, but bacterial contamination persists
2. Multiple Sources
   a) CSOs
   b) Stormwater
   c) Illicit Connections



Source:
CDM Smith Report to USACE: Merrimack River Assessment Study
US Army Corps of Engineers / Merrimack River Basin Community Coalition
Phase I Report, Figure 6-6, September, 2006
https://www.nae.usace.army.mil/Portals/74/docs/Topics/MerrimackLower/PhaseIFinal.pdf

Example of Recent CSO Improvements (Lowell)

Genesis of Collaboration

- CSOs are a common priority
- Need a better understanding of the river as a system
- Funding made available through Merrimack River District Commission

Photo courtesy of Merrimack River District Commission & Massachusetts Smart Growth Alliance

Photo courtesy of Greg Coyle, Lowell Wastewater

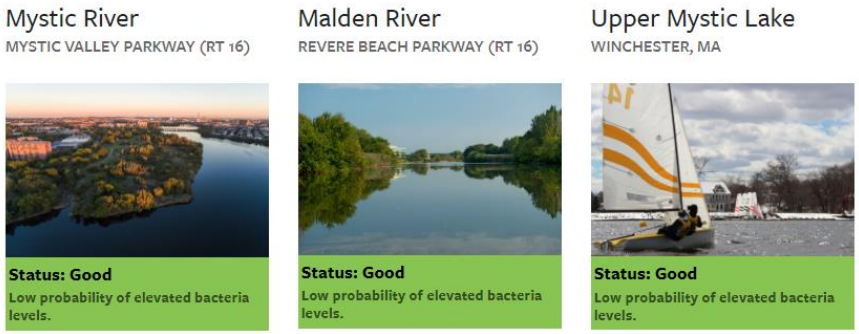
Motivation for a Predictive Bacteria Tool

Top Priorities from a Multi-State Visioning Process in 2020 on the Merrimack (Funded by the Merrimack River District Commission)

FUNDING	REGULATIONS	REGIONAL WATER MANAGEMENT	PUBLIC EDUCATION	DATA	LAND MANAGEMENT
Secure funding for infrastructure to enhance ability to comply with regulations.	Establish more collaborative check-ins with EPA	Designate one interstate entity to establish common goals, coordinate planning, help prioritize investments	Develop a "toolbox" to equitably help public understand ALL river uses and how they impact the river as individuals	Develop standards for data collection	Highlight the attractions of the river to encourage economic growth
Prompt legislative / congressional funding for infrastructure and explore restrictions	Must consider basin as a holistic system from a regulatory point of view - Integrated Management		Work with young people to educate early	Provide better access to data relevant to all uses	Emphasize LID & Stormwater management for new development
Seek long term commitments from elected officials for interstate funding and incremental benefits	Develop uniform standards for WWTPS and CSOs	Develop a process for consistent prioritization of investments: "The river unifies but also divides."	Support/fund real-time dissemination of water quality data to communties downstream	Develop means of tracking future data against baseline	Work with land trusts and towns to acquire open space abutting the river (flood mgt, ecosystems, recreation, access)
Incentivise more creative and diversified funding streams: P3, Impact Investing	Require more regulatory control, enforcement based in law	Rebrand the river as a valueable resource for all uses: Share succes stories and financial commitments, Connect the river and citizens with regional recreational opportunities (walking trails, bike trails, boat access, fishing, wildlife viewing, etc.)		Involve more science-based organizations in river mgt & decisions	Consider environmental justice populations with respect to open space preservation, river access, and benefits of use

Similar Public-Facing Alert Systems

MYSTIC RIVER WATERSHED ASSOCIATION



What do the categories mean?

GOOD

Boating is probably safe! The chances that *E. coli* bacteria levels exceed state recreational standards are low, and there is no evidence of a cyanobacteria bloom.

ADVISORY

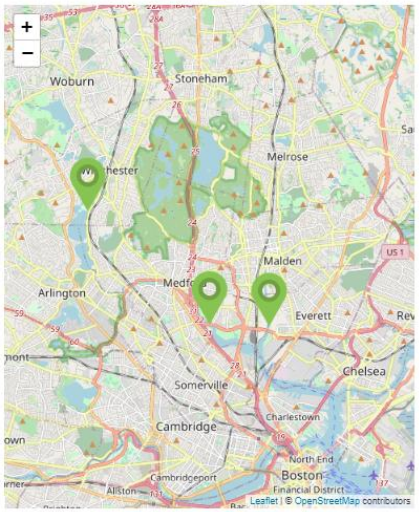
The chances that E. coli bacteria levels exceed state recreational standards are high, or there is evidence of a cyanobacteria bloom with concentrations exceeding state safety guidelines.

UNCERTAIN

There is no evidence of elevated bacteria levels, but screening values indicate a possible cyanobacteria bloom.

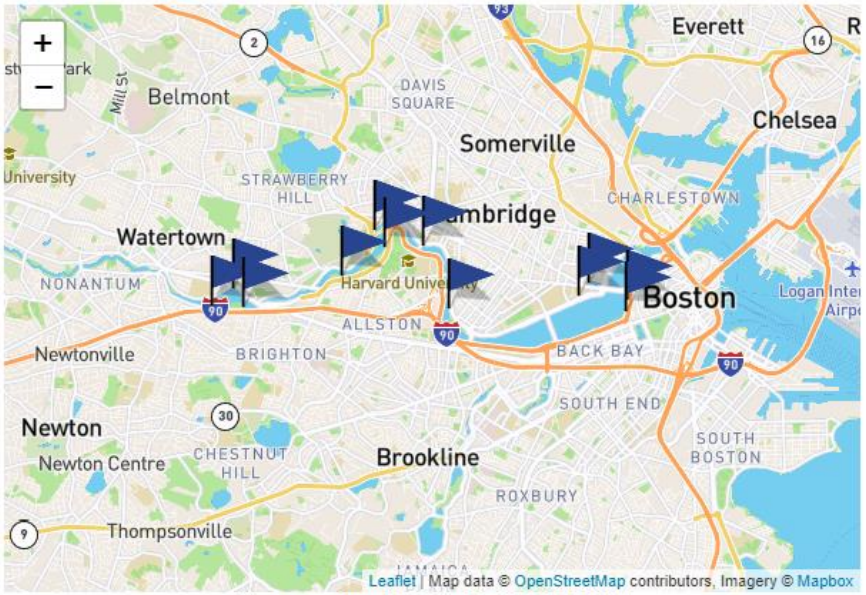
NOT AVAILABLE

Current predictions are not currently available due to missing data or other system error.



https://mysticriver.org/boatingadvisory

CHARLES RIVER WATERSHED ASSOCIATION



(Last updated: 2021-06-02 06:00:00)

Click here for more information.

https://www.crwa.org/flagging-program.html

Both very useful and easy to understand, but based on historic correlation between rain and bacteria levels

What is needed for the Merrimack

- Potential impacts from any or all of the 5 CSO communities, up to 80 miles away in Newburyport
- Science-based accounting of loading, travel time, decay, and dispersion
  - Too many variables to estimate with correlation
  - Need to account for periods of 1-7 days after each CSO event
  - Need to account for cumulative impacts of CSO discharges
- Predictions of when CSO-related bacteria may arrive at key recreational areas, and for how long

CSO Reporting Requirements

CURRENT REPORTING

- Public notification when a discharge begins
- Public notification when a discharge ends
- Volume estimates are included in year-end summaries
- Many communities are reporting earlier than required

Note that this reporting references the time and location of each discharge, but NOT the downstream impacts or duration of impacts

BY SUMMER 2022

- Issue advisory of overflow within 2 hours of detection
- Provide updates them 8 hours until it stops
- The advisory must include:
  - discharge location
  - date and duration
  - estimated volume
  - affected waters
  - any precautionary measures that must be taken to avoid health risks
  - and a statement on whether the discharge consists of untreated sewage
- Municipalities will be required to notify the two largest news organizations in the community as well.

A Predictive Tool for CSO Impacts

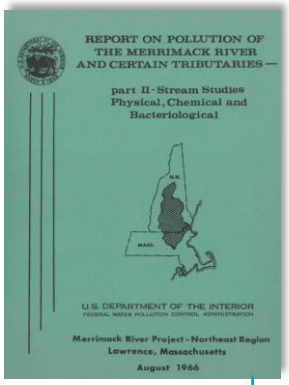
Brown AND Caldwell

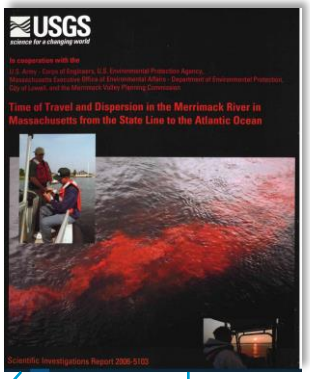
Utilization of Existing Information

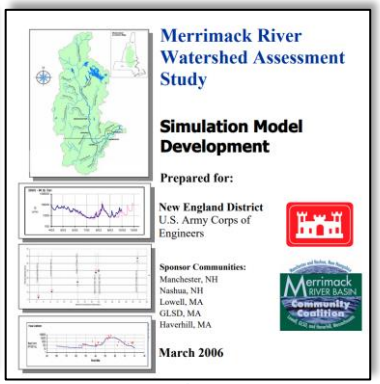
Electronic Notification of CSO Start/Stop

Estimate CSO Volumes and Bacteria Loads

Collect River Flow Data Automatically







Initial E. Coli Conc

Travel Time

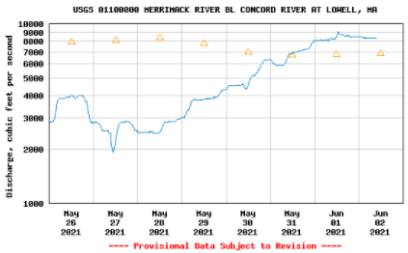
Dispersion

Decay

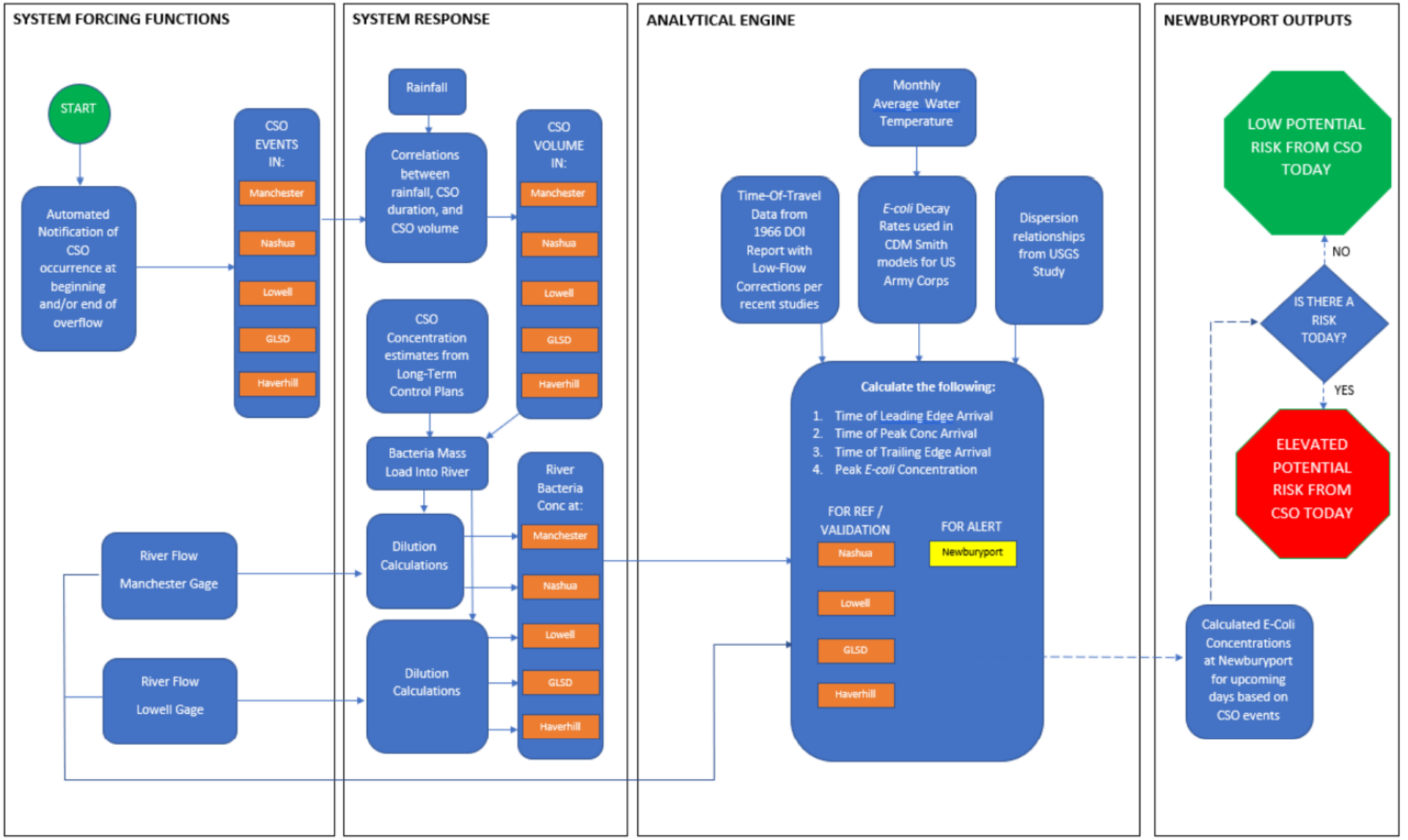
E.Coli from CSOs in Newburyport

Low Risk

Elevated Risk



Mechanistic Representation of the River



Planned Early Alert Web Portal

Merrimack River
Newburyport

Low Potential Risk
Status

**Note: This Merrimack River CSO Alert System notification of potential risk of elevated bacteria has been generated by an automated system that solely relies upon real-time river flow data published by the United States Geological Survey (USGS), previously published reports on the Merrimack River, and automated notifications that indicate the occurrence of a combined sewer overflow from one or more of the following upstream communities - Haverhill, the Greater Lawrence Sanitary District, Lowell, Nashua (NH), and/or Manchester (NH). The intent of this warning system is SOLELY focused on alerting the public to known upstream Combined Sewer Overflows that could potentially impact the river at Newburyport.*

The automated system considers real-time flow conditions along with published values for travel time, dispersion, and bacterial decay in the Merrimack River to roughly ESTIMATE potential bacteria levels in the river at Newburyport based on publicly documented combined sewer overflows upstream. The approach to identifying the risk level combines industry standard calculations typically used in water quality

Brown AND Caldwell

Merrimack River CSO Alert Status and Overview

What do the categories mean?

LOW POTENTIAL RISK*
Current recognized and calculated conditions **DO NOT INDICATE** a potentially elevated risk of unsafe bacteria (*E.coli*) levels in the Merrimack River in Newburyport today related to combined sewer overflows upstream, either today or in recent days. *See note below.

ELEVATED POTENTIAL RISK*
Current recognized and calculated conditions **DO INDICATE** an elevated potential risk of bacteria (*E.coli*) levels that exceed the MassDEP's limits for recreational water in the Merrimack River at Newburyport today. This elevated risk is solely reliant on automated alerts of recent overflow(s) of combined sewage from nearby communities into the

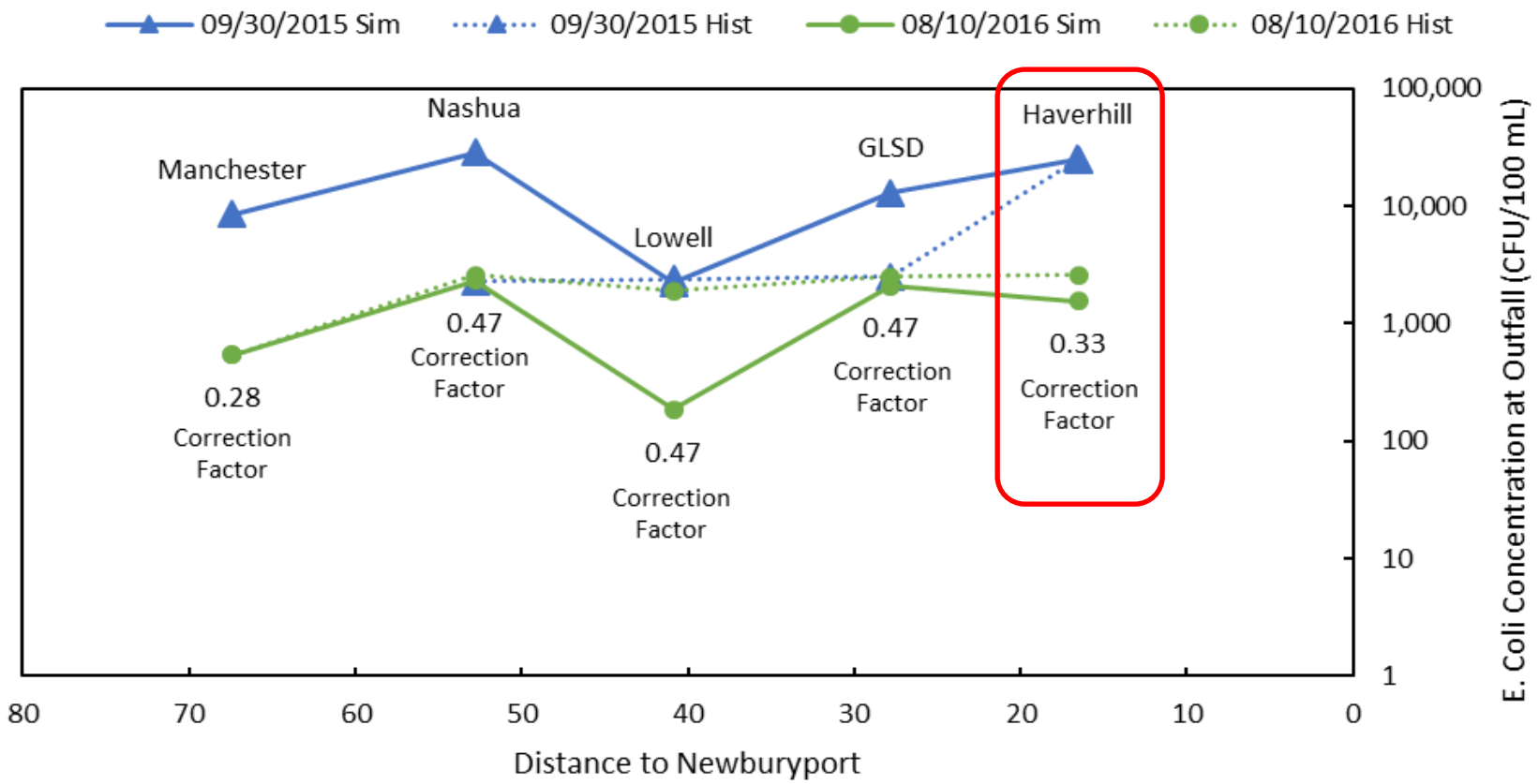
Status of the System

- The System was finished in June 2020
- It has been running live on Brown and Caldwell servers through the summer and into spring 2021
- Access to daily alerts has been provided to MVPC, City of Newburyport, and MRWC
- MRWC has coordinated field sampling events to help validate the system
  - 3 events which helped validate the “Low Potential Risk” status
  - 1 event which helped validate the “Elevated Potential Risk” status
- Collaborating with MRWC to finalize validation

Collaborative Testing and Validation

Brown AND Caldwell

Desktop Comparison to Historic CSO Events

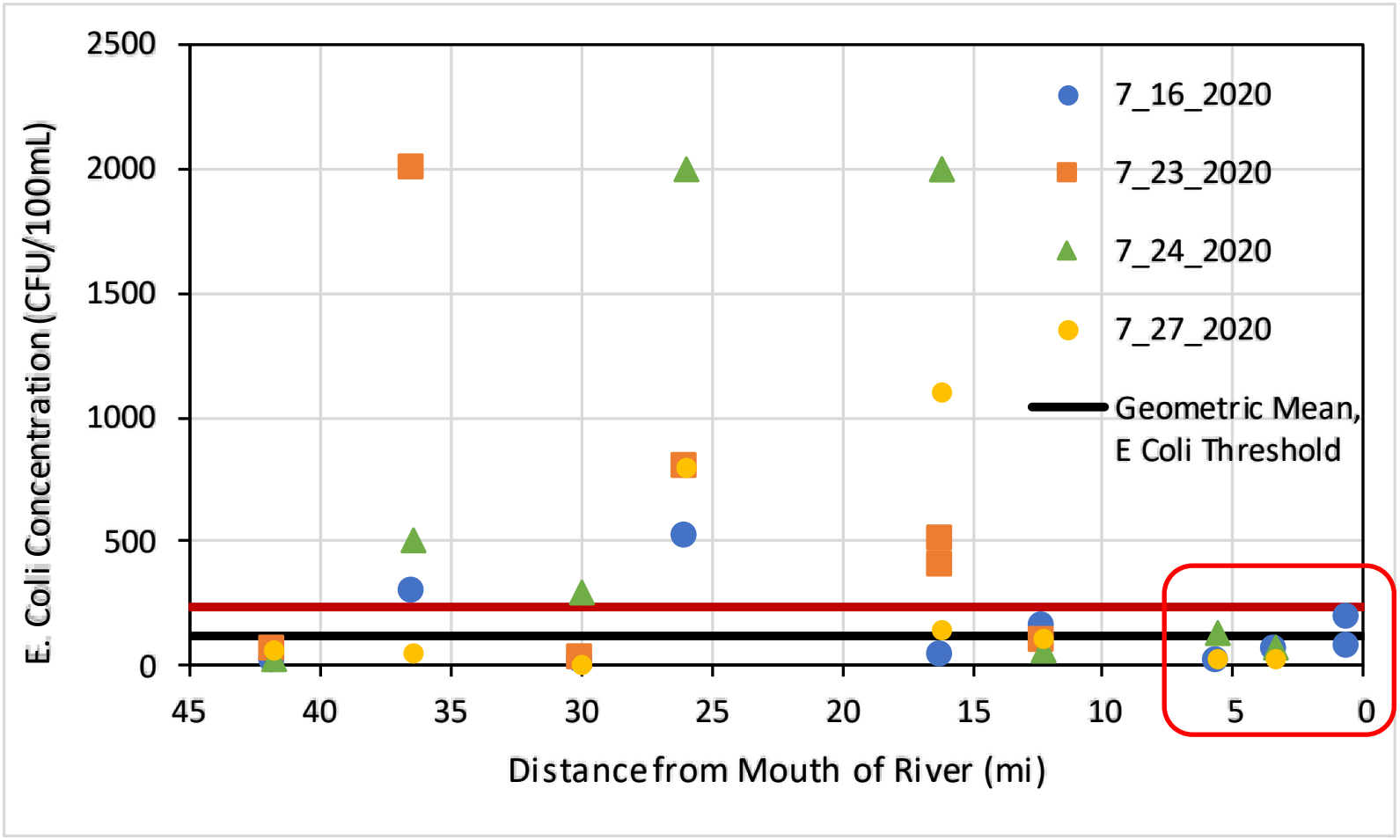


Field Validation: 4 Events

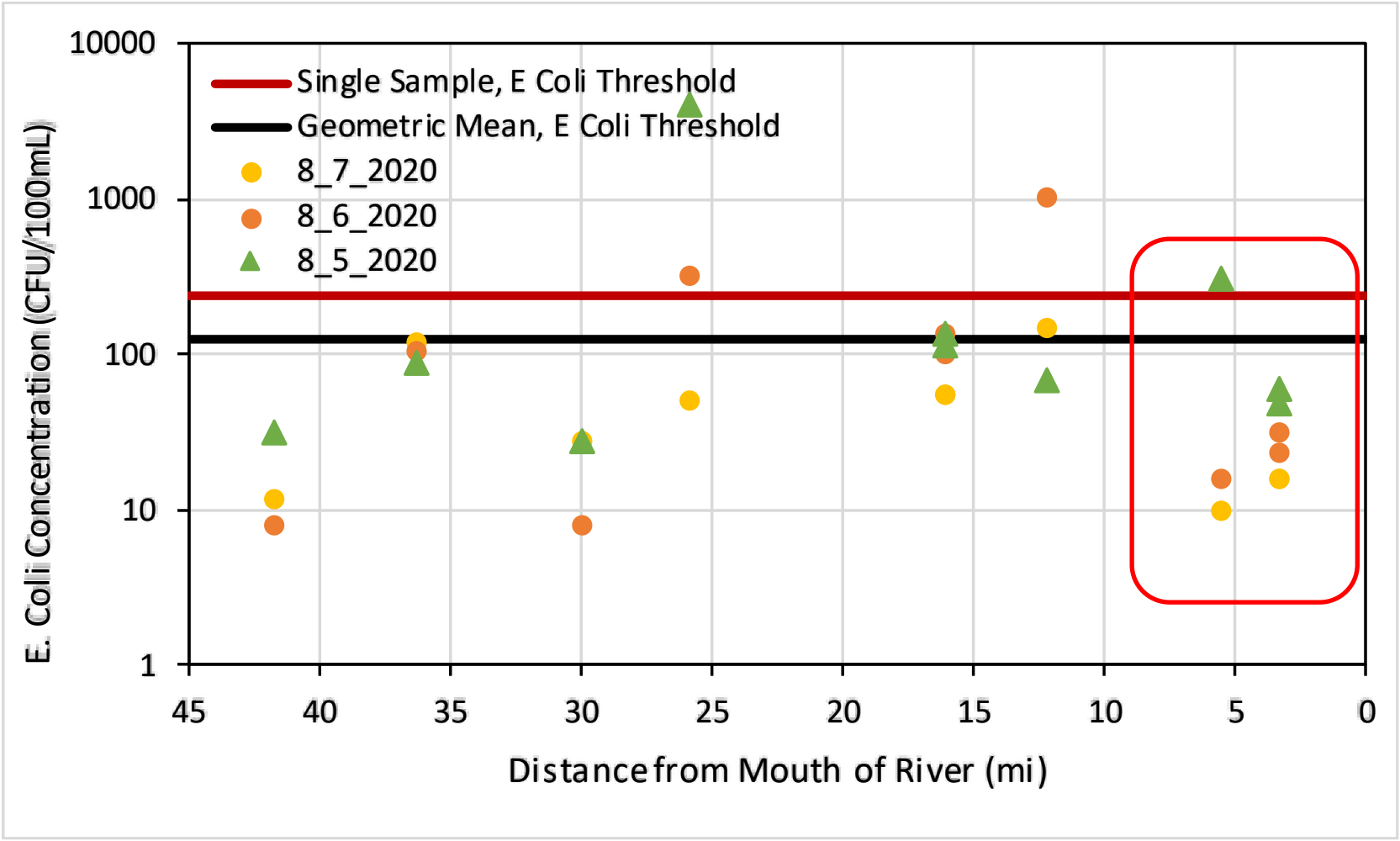
CSO Event Number	Date	River Flow (cfs)	Did Discharge Occur?				Status in Newburyport	
			Nashua	Lowell	Lawrence	Haverhill	Tool	Field
1	7/22/2020 to 7/23/2020	~2,500	Yes	Yes	Yes	Yes	●	●
2	8/4/2020	1,270	Not Yet Reported	No	No	Yes	●	●
3	9/10/2020	~2,500	Not Yet Reported	Yes	Yes	Yes	●	●
4	4/29 – 4/30 2021	~10,000		Yes	Yes	Yes	●	●

Consider Elevated Risk for any prediction over 100 (correct order of magnitude)
Consider Elevated Risk for any prediction over 100 in West Newbury (tidal uncertainty)

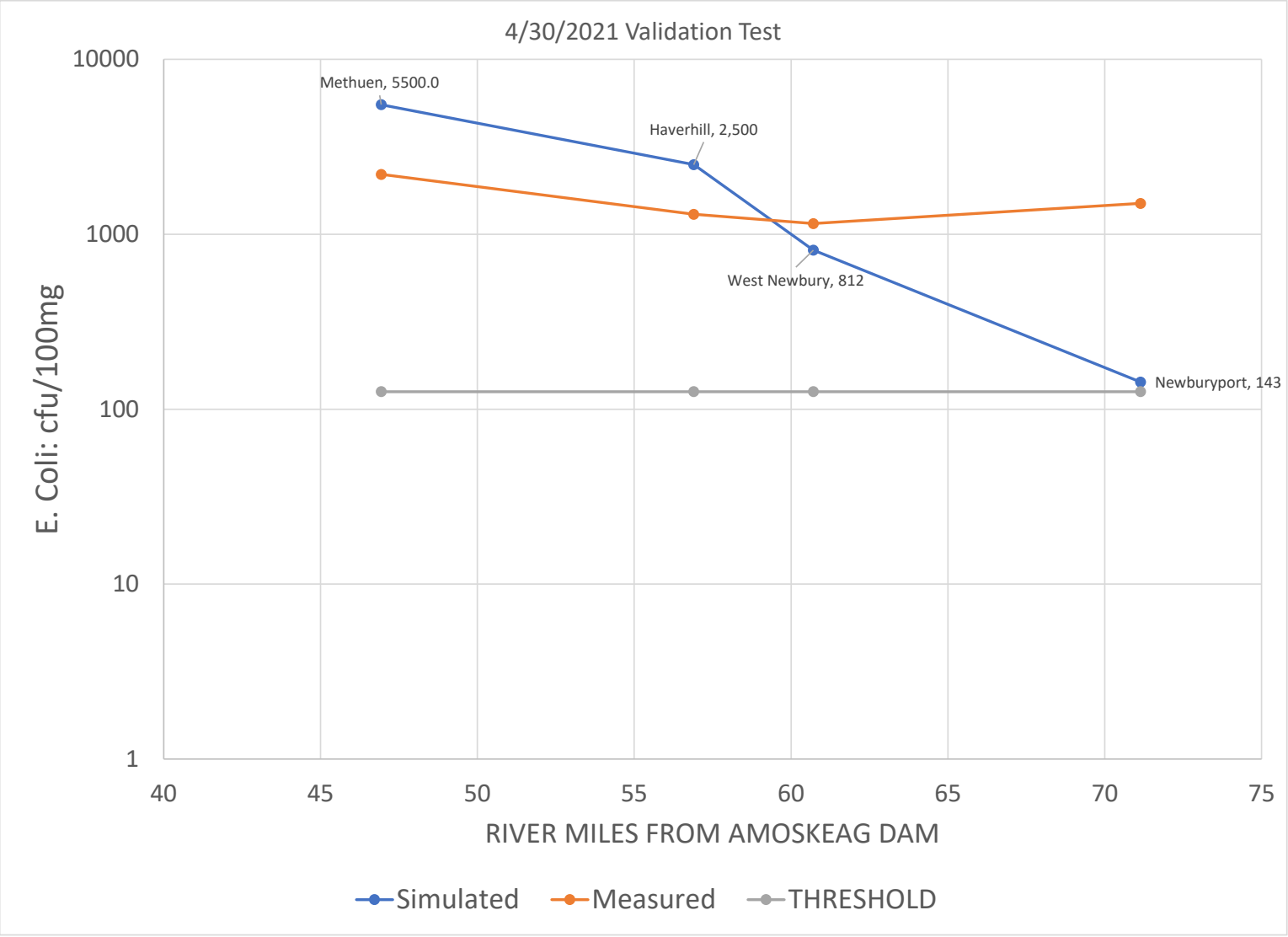
Field Validation: July 2020 (Low Flow)



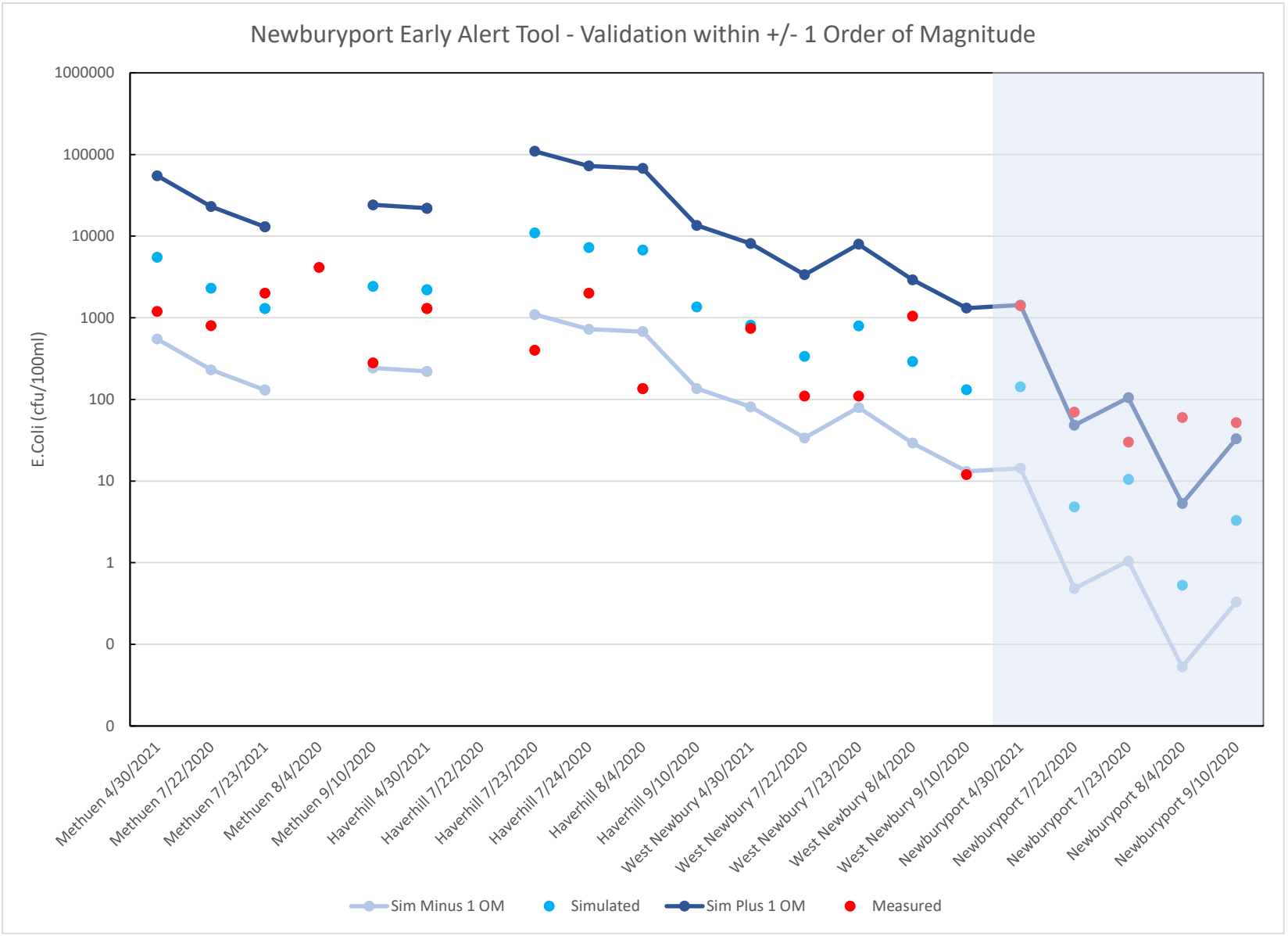
Field Validation: August 2020 (Low Flow)



Field Validation: April 2021 (High Flow)



Performance Summary



Evolution of Bacterial Monitoring

Brown AND Caldwell

Next Steps

BC Server

System will remain on BC Server until July 2021

Adjustments

Consider possible adjustments to threshold criteria

- Indicators at West Newbury (account for tidal uncertainty)
- Field monitoring for tidal influence and non-CSO sources

MRWC

System scheduled to transfer to MRWC in July 2021

Public Access

Public access will be granted upon mutual agreement between Newburyport, MVPC, MRWC, and BC after the transfer

Hopes for beyond this first phase:

- Include alerts for upstream communities?
- Migrate to real-time bacteria monitoring.

Thank you to those who enabled and supported this work:

MERRIMACK RIVER DISTRICT COMMISSION
- Senator Diana DiZoglio
- Representative James Kelcourse

MERRIMACK VALLEY PLANNING COMMISSION
- Lane Glenn
- Jennifer Hughes
- Theresa Park

MERRIMACK RIVER WATERSHED COUNCIL
- Matt Thorne
- Susie Bresney

City of Manchester, NH
City of Nashua, NH
Lowell Water
Greater Lawrence Sanitary District
City of Haverhill

Thank You