Building Resilience at the Watershed Scale

2023 Battelle Conference on Innovations in Climate Resilience

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Charles River Watershed Association

Weston & Sampson

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Presentation Outline

- Our Team
- Our Approach
- Public Engagement
- Model Development
- Flood Risk Results
- Flood Mitigation Solutions
- Next Steps





Our Team

Charles River Watershed Association: Project Lead, management, facilitation, secure funding
Weston & Sampson: Technical Lead, author of the Charles River Flood Model (CRFM)
Communities Responding to Extreme Weather (C.R.E.W): Engagement Lead
Charles River Climate Compact: Municipal participants (15-20 communities), provide data and input, utilize project output

Charles River Climate Compact

The CRCC is a **coalition of communitie**s in the Charles River watershed, convened by the Charles River Watershed Association (CRWA) that work on climate adaptation by sharing information and experiences and taking a watershed view of climate adaptation and mitigation strategies. The CRCC addresses challenges such as **precipitation-based flooding, sea level rise, extreme heat, and ecosystem health through regional collaboration and information sharing**, and addresses how actions and policies of individual communities impact neighboring or downstream communities.

Julie Wood, she/her
Climate Compact Director
Charles River Watershed Association

Indrani Ghosh, PhD
Resiliency Senior Technical Leader
Weston & Sampson

Our Approach

How do we plan for what's coming if we don't know what's coming?

- In Massachusetts, land use decisions are almost exclusively made at the local level.
- The Charles River watershed, just 308 square miles, includes 35 different municipalities, that is 35 different decision making processes
- The **watershed scale is the most appropriate** geographic scale to consider when investigating precipitation-based flooding impacts.
- Taking a watershed view provides the **opportunity to equitably address flooding** concerns by considering upstream impacts on downstream communities.

Our Approach

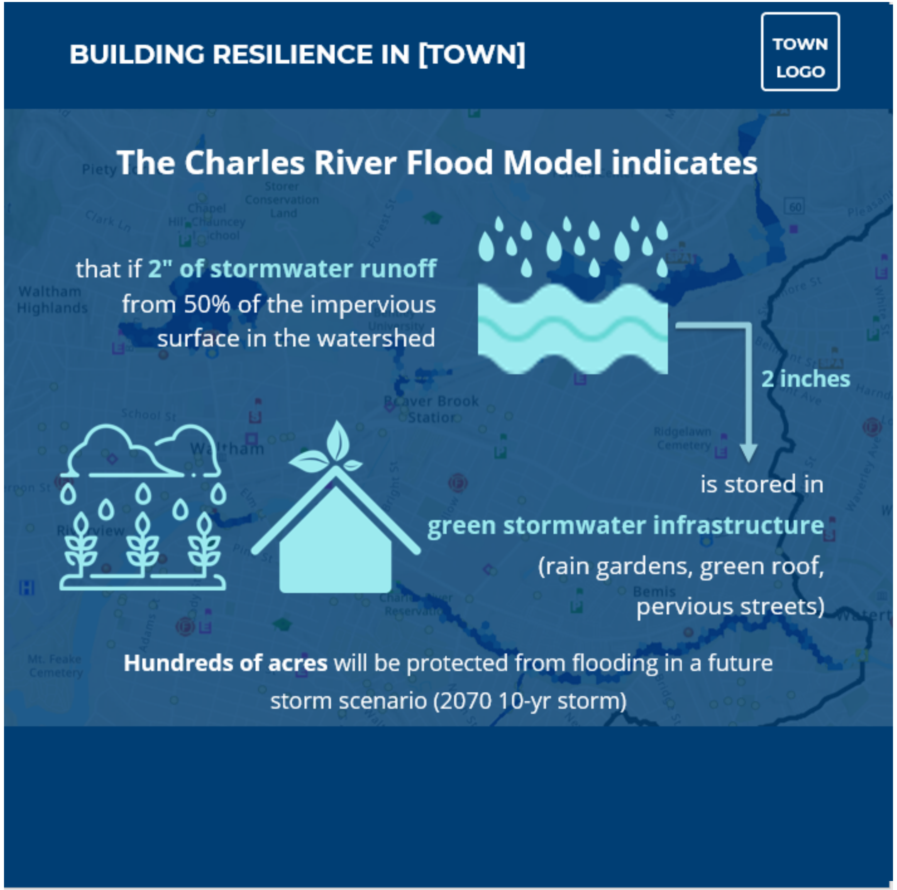
Working across municipal boundaries can be challenging!

- CRWA served as convener, project leader, and secured funding
- The goal of developing a stormwater flooding model was identified through **collaborative "listening"** and working sessions with the Climate Compact
- Funding source is primarily the State of Massachusetts **Municipal Vulnerability Grant Program** (climate adaptation grants)
- One community stepped up to serve as primary fiscal agent
- All participating communities contributed either in kind time or cash match

Public Engagement

Goals:

- **Build trust** in the Charles River Flood Model as a useful planning and governing tool
- Begin to **build support for solutions** the Flood Model demonstrates as effective
- **Get input** at some key decision points such as modeling time horizons and possible solutions



Public Engagement

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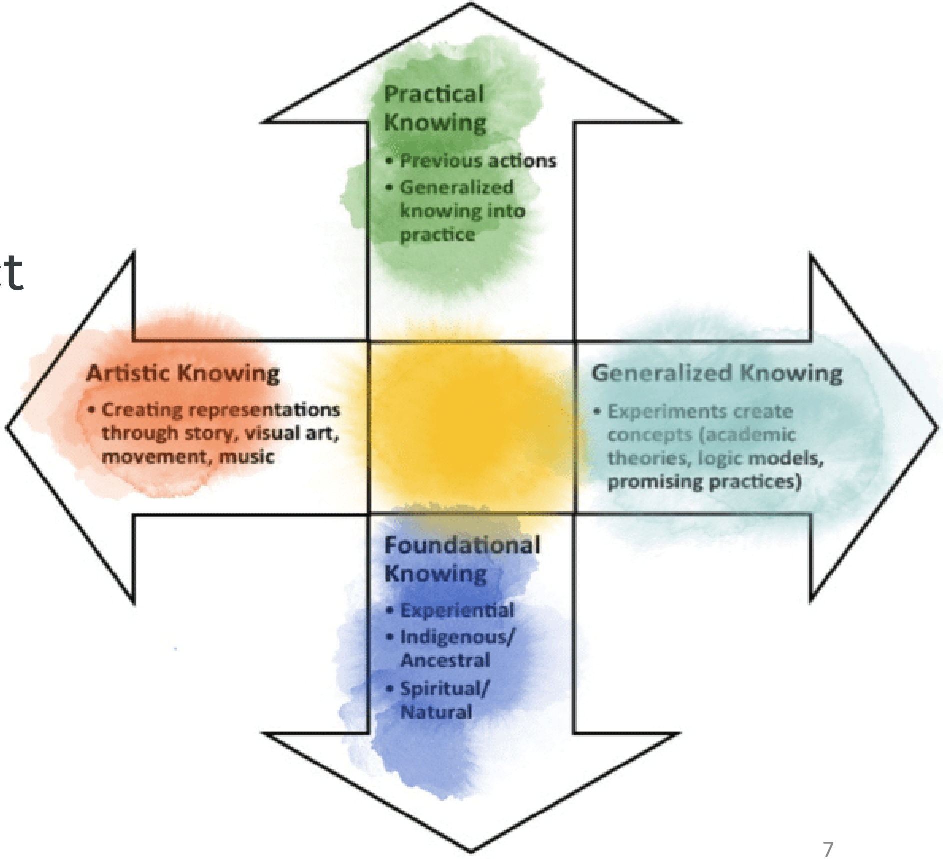
Challenges:

- Pandemic
- Technical nature of the project
- Busy schedules
- Language barriers



Public Engagement

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Our Approach:

- Dedicated engagement lead: Communities Responding to Extreme Weather (C.R.E.W.)
- Use existing avenues:
  - Libraries
  - YMCA
  - Town "pride" days/events & festivals
- Online: webinars, videos & online surveys; good opportunities for communicating in multiple languages
- All results available online

VIDEO *Building Resilience in the Watershed Initiative with the Charles River Flood Model.*

OUR WORK — Charles River Watershed Association

www.crwa.org

1 Dimensional Framework

Generate **runoff**; convey non-flood **flows**

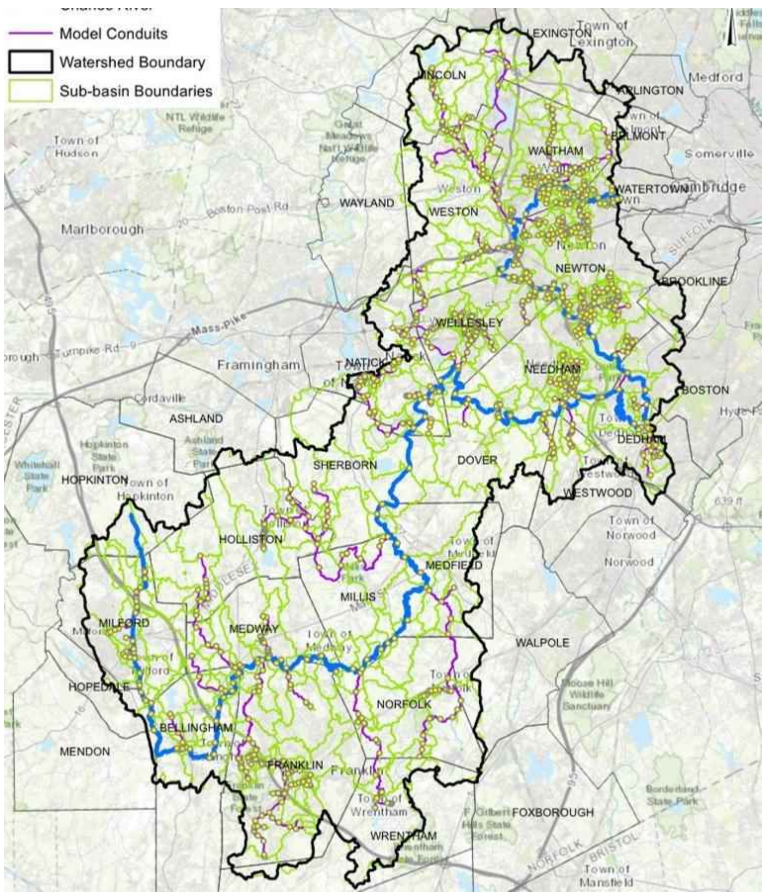
272 square miles of the watershed

Over **1400** junctions

1,279,838 LF of dams, culverts, bridges, crossings, drains, overtopping conduits modeled

Over **700** sub-catchments

Over **30** storage volumes



Field Verification

Sampson

Charles River Watershed Association

6 days of site visits

119 junctions/nodes

25 dams

298 crossings

442 structures field verified

Used ArcGIS Collector App to record notes, measurements, and take photos

Legend

Junctions To Visit

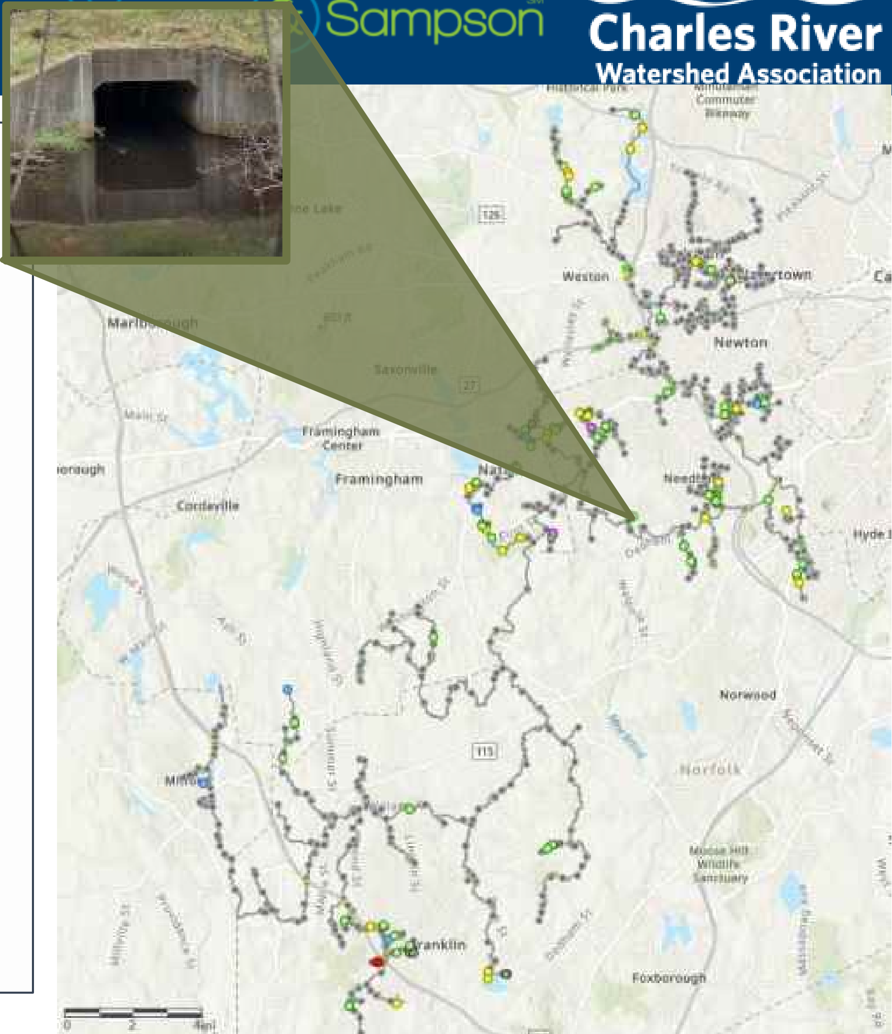
- Visited
- Could Not Access
- Could Not Locate
- Does Not Exist
- Not Yet Visited
- OTher Status
- Other

Conduits To Visit

- Visited
- Could Not Access
- Could Not Locate
- Does Not Exist
- Not Yet Visited
- Other Status
- Other

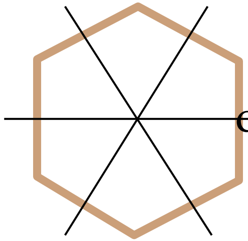
Junctions (No Gaps)

Conduits (No Gaps)



Model Development

2 Dimensional Cells



7,748 – 2D cells created from LiDAR

Identify appropriate resolution

Convey flood flows; provide floodplain storage

Define boundary areas

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Model Calibration

Calibrated to the March 2010 Storm

Based on 15-min data from the USGS gage on Stony Bro

8.99 inches

Peak intensity

Approximately a **65**-yr

58.5 hrs

0.68 in/ hr

48-hr event

*Flooding was close to **100-yr** or even worse in places due to the saturated ground, preceding rainfall, and snowmelt*

Model was calibrated at 5 locations for **3 parameters**

(runoff volume, peak flow, timing of peak)

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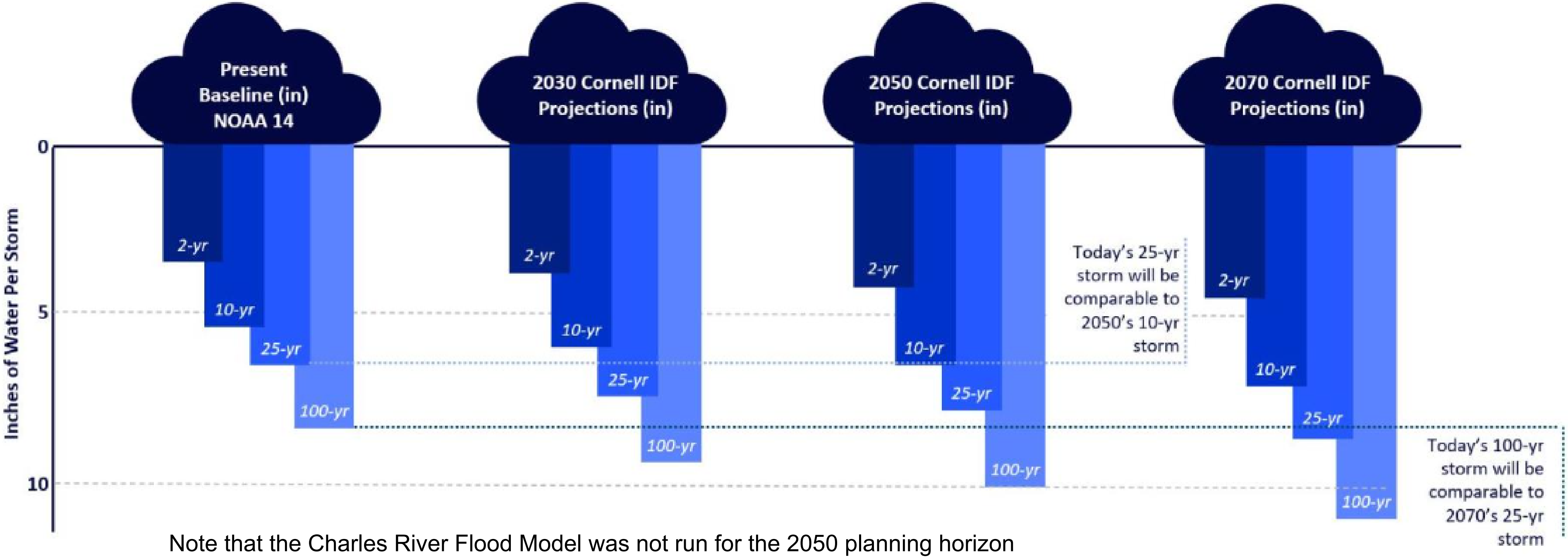
Model Calibration

2D Flood Model Results – William St, Wellesley

Results



Note that the Charles River Flood Model was not run for the 2050 planning horizon

Projections developed by Cornell University for EEA's Massachusetts Climate and Hydrologic Risk Project, integrated into EEA's Climate Resilience Design Standards Tool (version 1)

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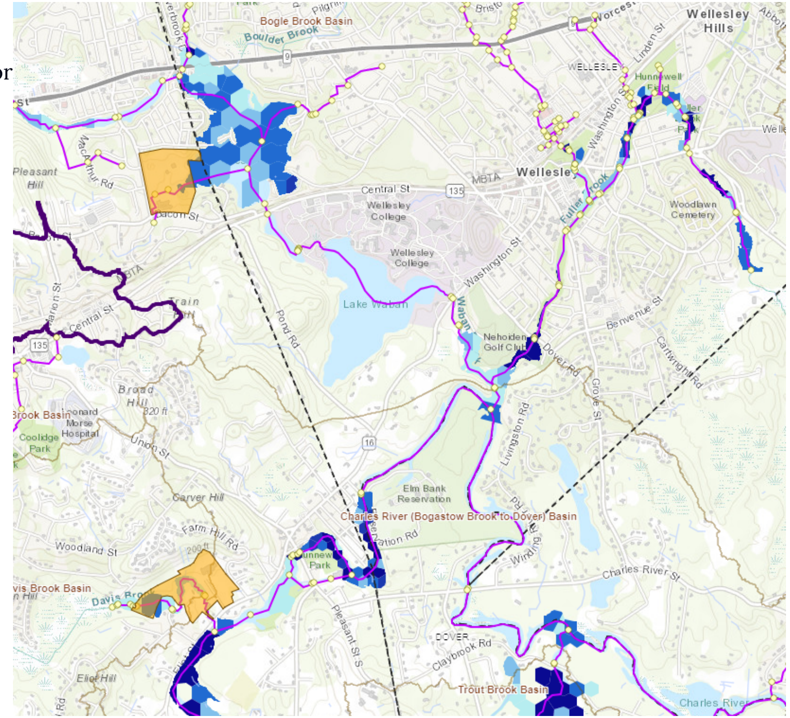
Model Results: 100-year Storm Comparison

Legend

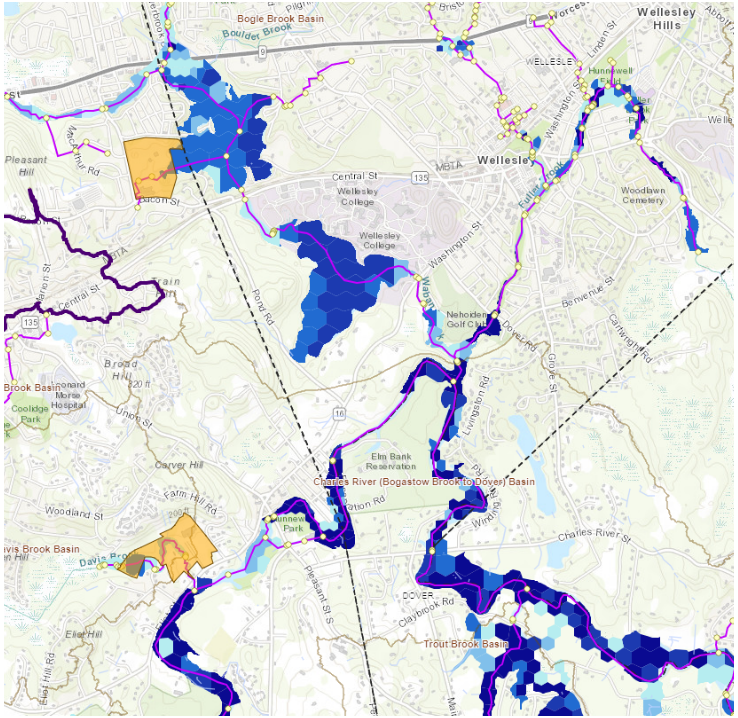
10-yr (10% AEP) 24-hr stor
Max Depth

- >3.0’
- >2.0’ – 3.0’
- >1.0’ – 2.0’
- >0.5’ – 1.0’
- >0’ – 0.5’
- No Flood

- Model Conduits
- Watershed
- Subbasins
- All Site Parcels



100-yr Storm Present
(8.2 inches in 24 hrs)



100-yr Storm 2070
(11.1 inches in 24 hrs)

Results

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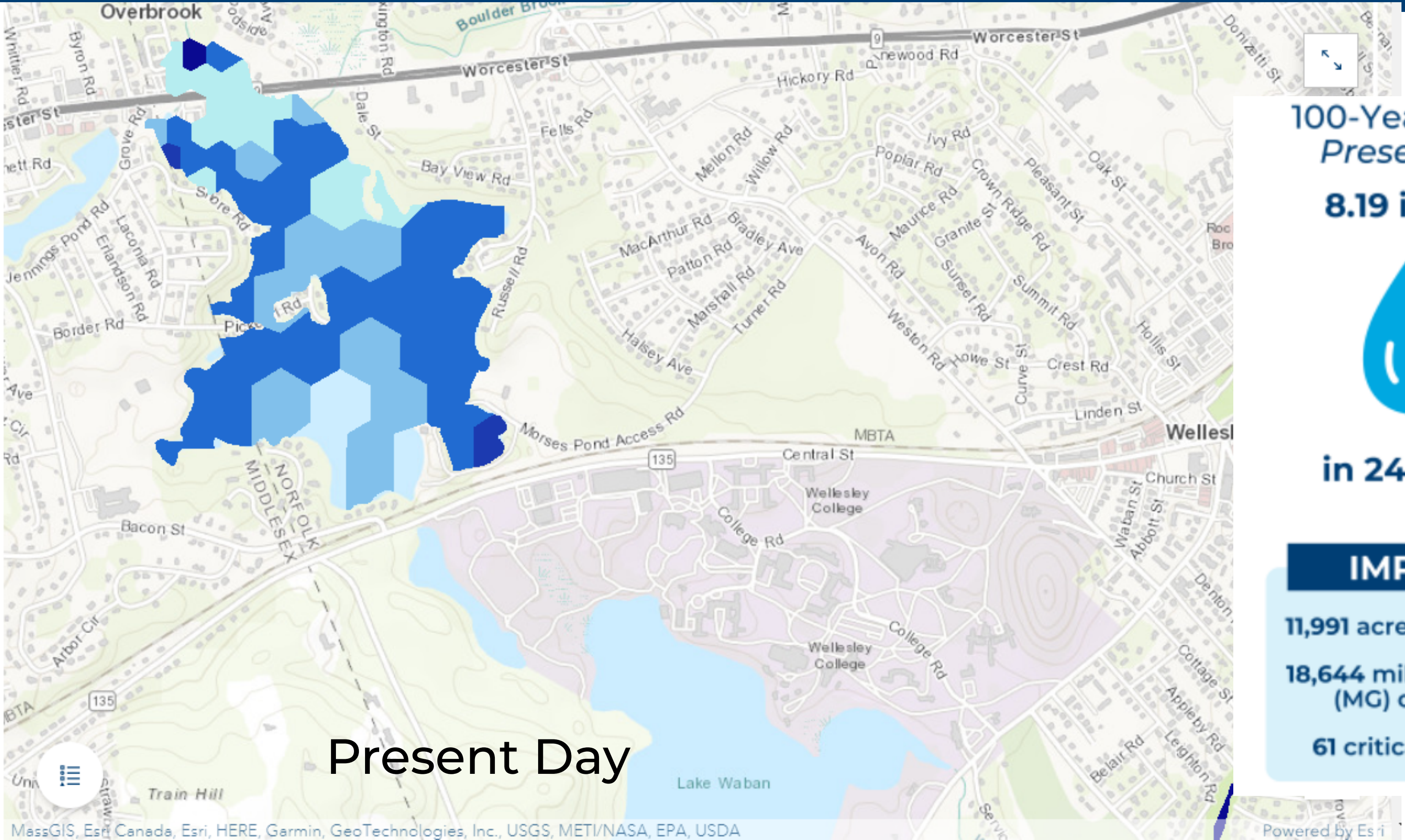

100-Year Storm, *Present Day*

8.19 inches

in 24 hours

IMPACT

11,991 acres of flooding

18,644 million gallons (MG) of runoff

61 critical facilities

Results

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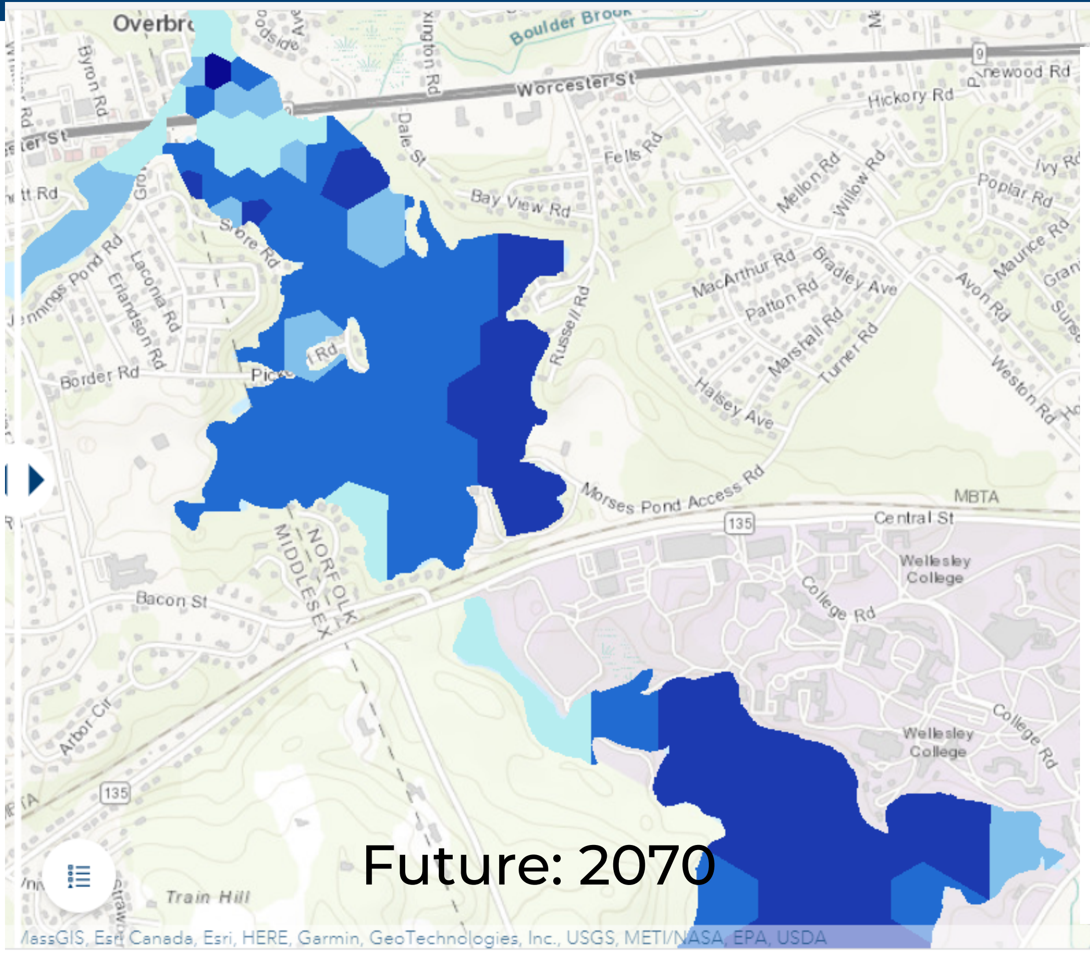

100-Year Storm, *Present Day*	100-Year Storm, *2070*
8.19 inches in 24 hours	**11.11 inches** in 24 hours

IMPACT (Present Day)

- 11,991 acres of flooding
- 18,644 million gallons (MG) of runoff
- 61 critical facilities

IMPACT (2070)

- 14,605 acres of flooding
- 29,925 million gallons (MG) of runoff
- 77 critical facilities

March 2010 Storm (8.99 in)	10,446 acres of flooding	20,831 MG of runoff

Watershed-Wide Nature Based Solutions

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Category	Scenario Number	Suggested: Phase 2
Green Stormwater Infrastructure	1A	GSI stores the 2-yr event (4.5 inches) from 50% of all impervious area
	1B	Target all large buildings & parking lots (public & private) for rooftop infiltration/disconnection (>5 acres) to store the difference between the (2070) 25-yr & 2-yr
Reduce Impervious Cover	2	25% reduction
Upland/Pond Storage	3	Add sites (14 sites, >20 ac.) & increase storage volume
Wetland Restoration	4	Increase wetland area around existing wetlands; increase of 20%
Land Conservation	5A	15% of remaining undeveloped/ unprotected land is developed
Regulatory	5B	Store the difference between (2070) 25-yr & 2-yr for 50% of assumed “new development”
Dam Removal	Alt B	Remove all dams other than active flood control (just remove recreation dams)

GSI = Green stormwater infrastructure

Watershed-Wide Nature Based Solutions

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Scenario 1A:

Nature-Based Solutions (NBS) used across the watershed to store runoff from the (2070) 2-yr rain event (4.5 inches) from half of all the impervious cover in the watershed

Climate Scenario	Percent Change in Watershed-wide Total Runoff Volume (MG) between Scenario 1A and No Action	
	2-year event	10-year event
Baseline (Present Day)	-47%	-20%
2070	-26%	-12%

This strategy is likely to mitigate:

- Approx 1,600 MG of flooding for the present day (baseline) 2-yr storm
- Approx 1,660 MG of flooding for the 2-yr storm by 2070

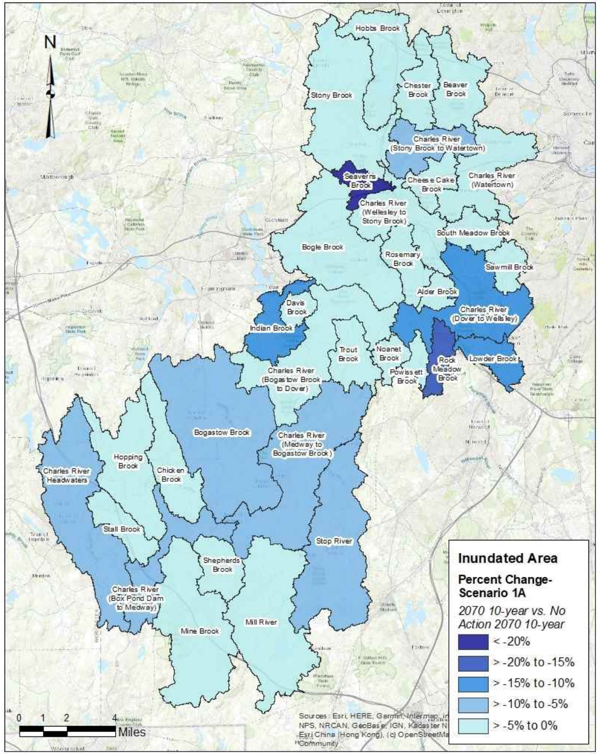
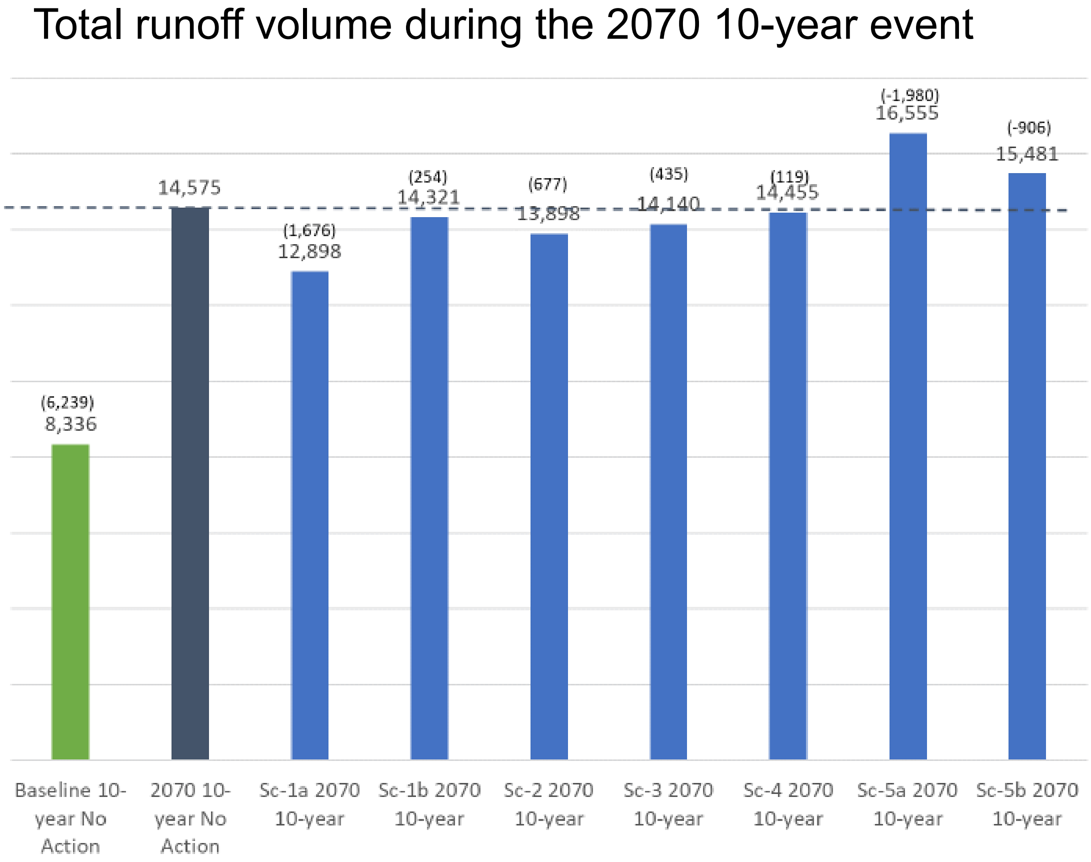


Figure: Map of the percent decrease in inundation area for Scenario 1A during the 2070 10-year event versus a No Action condition, by subbasin.

Results

Summary of Watershed-Wide Strategies



Priority Sites Selection

Site-scale Results

Tier 1
- Site Feasibility
- Flood Reduction
- Community Support

Tier 2
- Biodiversity
- Recreation
- Permitting Feasibility
- Regional co-benefits

40 Projects Submitted

Screened to 15 Projects

3 Projects Prioritized

Priority Site Selection

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Albemarle Field, Newton
Large athletic field/recreation complex for soccer, baseball, tennis and basketball.

Potential:
Underground and surface storage, with stream buffer improvements

Priority Site Concept

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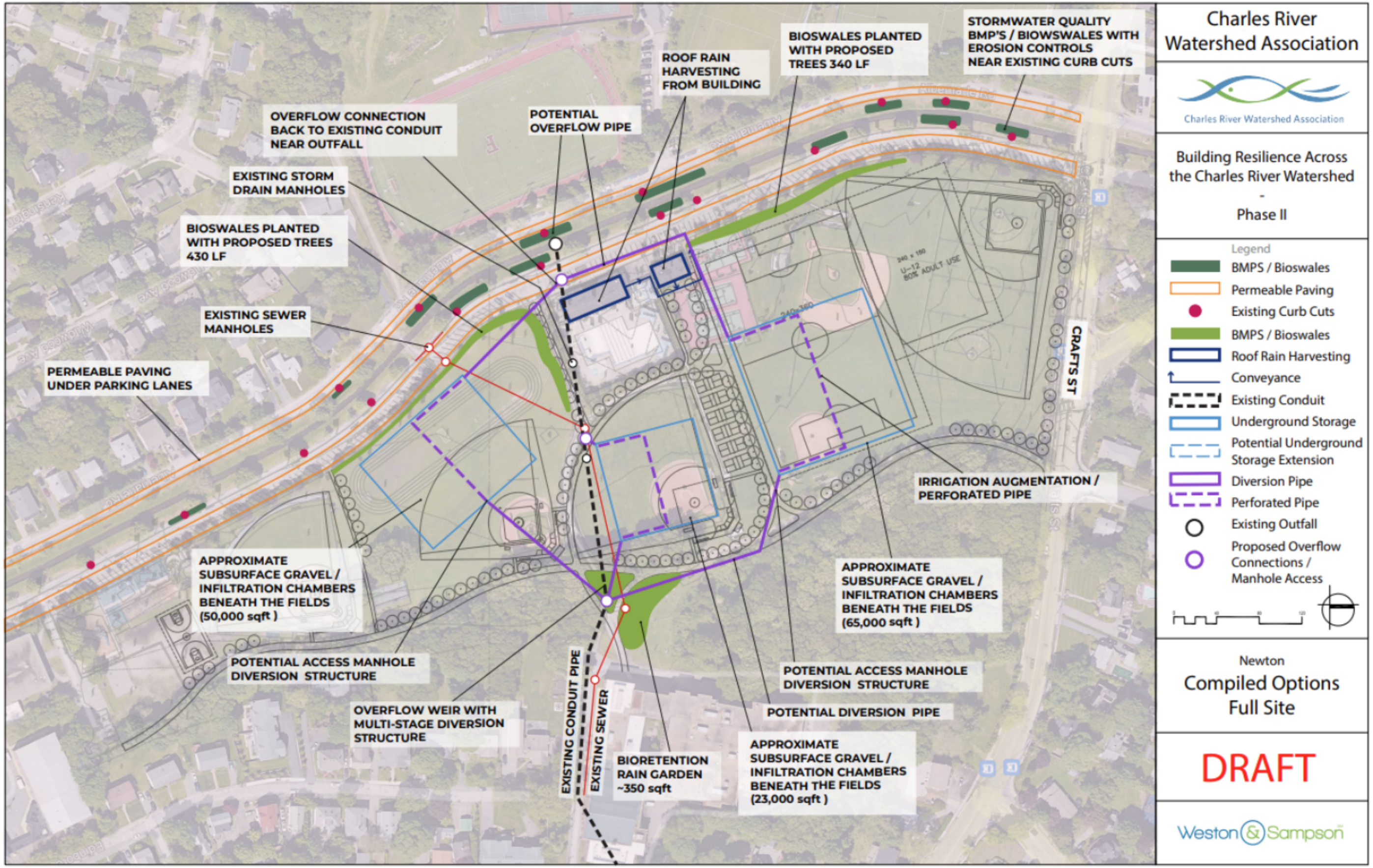
Diverting stormwater from an existing conduit

Sub-surface gravel infiltration chambers beneath the playing surfaces

Bioswales with trees

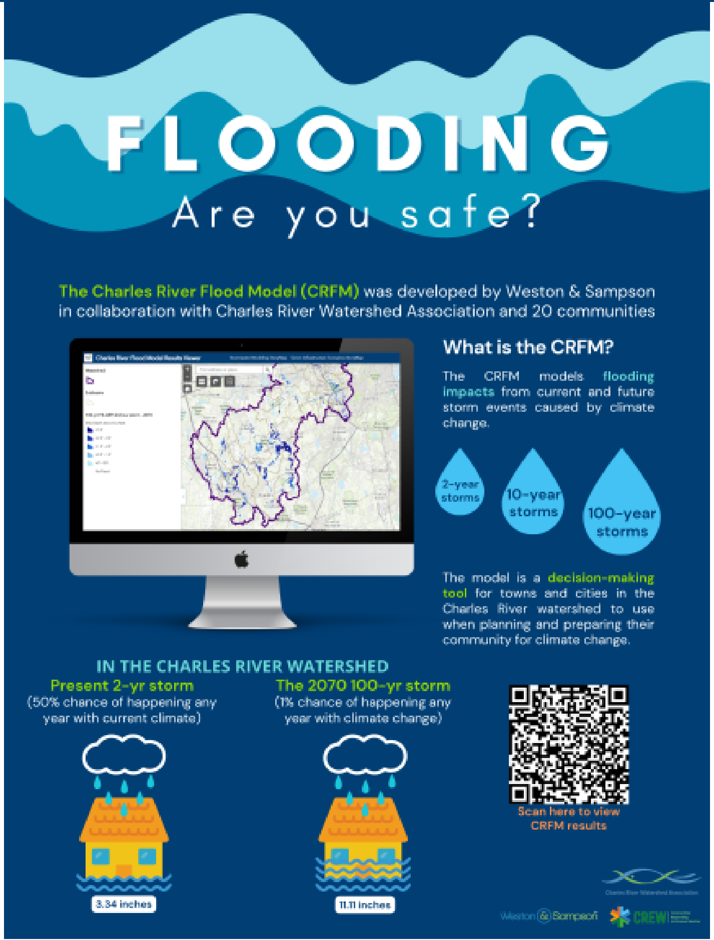


Concept plan for Albemarle Field, Newton created by Weston & Sampson

Next Steps

- Through June 2023
  - Focus on site scale opportunities with more site concept designs
  - Evaluate “neighborhood/ regional” scale opportunities (“impact areas”)
  - Engagement in EJ neighborhoods

- July 2023 – June 2024
  - Putting it all together!
  - Additional culvert assessments
  - Model updates
  - Watershed, neighborhood & site scale solutions
  - Updated Plan with considerable community engagement



Thank You!

Contact info: ghosh.indrani@wseinc.com; jwood@crwa.org
Website: https://www.crwa.org/watershed-model.html

OUR WORK — Charles River Watershed Association

www.crwa.org