CHARLES RIVER WATERSHED MODEL

Appendix A.0:
Compilation of Existing Data and Gaps
Identified from Review of Existing Resources

MEMORANDUM

TO: Charles River Watershed Association

FROM: Indrani Ghosh, Resiliency Technical Leader, Weston & Sampson

DATE: April 16, 2021

SUBJECT: Compilation of existing data and gaps identified from review of existing resources

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Project Background

Weston & Sampson is working in collaboration with the Charles River Watershed Association (CRWA) as part of the Technical Team for the FY21 MVP Action Grant awarded to Natick to develop a Charles River watershed regional model. Existing models, data, and reports from watershed communities, Massachusetts Water Resources Authority (MWRA), and the Department of Conservation and Recreation (DCR) were utilized as a baseline for the model. The Technical Team implemented previous efforts by engaging project partners to the maximum extent practicable to compensate for the tight project timeline and budget restraints, and to not duplicate prior work.

Methods for Collecting Data

Weston & Sampson as part of the Technical Team engaged project communities by requesting submittal of the following data:

- Municipal MVP Plan or Hazard Mitigation Plan maps showing key community resources (GIS format preferred)
- Historic flood reports/complaints database with dates (GIS format preferred)
- Relevant past stormwater modeling/flooding reports from projects over last 5-10 years
- Stormwater infrastructure GIS shapefiles of pipes, manholes, outfalls, and any other critical inlet/outlet flow control structures
- Recent topographic or LiDAR data from past/ongoing projects
- Recent bathymetry data of major water bodies from past/ongoing projects
- Plans/as-builts of dams, bridges, and culvert crossings along the Charles River
- Dam inspection reports for dams along the Charles River
- Dredging or other reports on maintenance activities
- Lists of any major proposed roadway improvements, public housing and/or park/open space projects in 5-year capital plans
- Lists of any major proposed private development projects or vacant lots where the communities would like to propose potential green infrastructure opportunities

A SharePoint site was set up and used as a platform for participating project communities to submit existing data on the aforementioned topics. All data was reviewed as it was submitted and tracked in a spreadsheet to identify data gaps. The spreadsheet is shown in Figure 1, below. GIS files of stormwater infrastructure were determined by Weston & Sampson to be most important in the creation of this model. After allowing time for project communities to upload the requested data, Weston & Sampson sent personalized emails to individual communities requesting specific missing key data to ensure that any existing, relevant data was considered in the creation of the model.

Document	Municipality														
	Arlington	Dedham	Frankin	Holliston	Medway	Millis	Natick	Needham	Newton	Norfolk	Sherborn	Watertown	Wellesley	Weston	Wrentham
Municipal MVP Plan or Hazard Mitigation Plan maps showing key community resources (preferably GIS format)	1) need GIS files 2) map shows key locations but data isn't provided (through MAPC?)		need original GIS files	need original GIS files		need original GIS files		need original GIS files	need original GIS files	Need GIS files		need original GIS files		need original GIS files	need GIS files, Hot spot from MAPC
Historic flood reports/complaints database with dates (preferably GIS format)	Prefer GIS files (submitted files were excels)							Submitted map from BETA with environmental toxicity and watershed features, missing original GIS data							Historic storms listed in HMP report, no further details
Relevant past stormwater modeling/flooding reports from projects over last 5-10 years	included the Spy Pond Study					Updated storm drain system maps (PDF)				Business District Drainage Evaluation, Northside Interceptor Drainage Improvement, Union St Drainage Improvements	The fields at Sherborn				
**Stormwater infrastructure GIS shapefiles of pipes	Provide Gravity drain information. Missing many elevations and diameters, but many are provided as well.	Missing many elevations but provide many as well.	Missing elevations	Missing	Location only - missing critical features about elevations, material, and diameter	Provided some diameters and materials but not all, still missing elevations.	Provided elevations and materials	Provided all details needed.	Location Only - missing crtical invert elevations and materials	Received	Give no spatial reference - relative to each other but not a basemap.	Diameters and location provided, still missing elevations and materials	GDB file does not contain drainage structures. Layer files unreadable, must be in .shp or .gdb.	Some diameters available but not all, still missing elevations and material.	Location only - missing critical diameters and elevations
**Stormwater infrastructure GIS shapefiles of manholes	missing most invert / rim elevations		Missing elevations	Missing	Location only - missing critical features about elevations, material, and diameter	Provided some diameters and materials but not all, still missing elevations.		Provided all details needed.	Location Only - missing crtical features	Received	Give no spatial reference - relative to each other but not a basemap.	Missing	GDB file does not contain drainage structures. Layer files unreadable, must be in .shp or .gdb.	Some materials available but not all, still missing elevations and diameter.	Location only - missing critical elevations and materials
**Stormwater infrastructure GIS shapefiles of outfalls	Missing most elevations	missing some of the elevations but provides many	Missing elevations	Missing	Location only - missing critical features about elevations	Provided some diameters and materials but not all, still missing elevations.		Provided all details needed.	Missing critical features like invert elevations	Received	Give no spatial reference - relative to each other but not a basemap.	Location only - missing critical elevations	GDB file does not contain drainage structures. Layer files unreadable, must be in .shp or .gdb.	Some materials available but not all, still missing elevations and diameter.	Missing critical elevations
**Stormwater infrastructure GIS shapefiles of any other critical inlet/outlet flow control structures	Provide culverts , control valves, fittings, pumps, etc. but most are missing elevations.	Provide gravity main & inlets	Provide leaching pits, rain gardens, overflow structures, etc but no elevations	Missing	Location only - missing critical information	Provided some diameters and materials but not all, still missing elevations.		Provided all details needed.	Missing critical features	Provide catch basins, swales, drain bridges, water quality structures	Give no spatial reference - relative to each other but not a basemap.	Missing	GDB file does not contain drainage structures. Layer files unreadable, must be in .shp or	Missing	Location only
Recent topographic or LiDAR data from past/ongoing projects	stated to refer to MassGIS for most recent	stated to refer to MassGIS for most recent											Unreadable as .lyr files		
Recent bathymetry data of major water bodies from past/ongoing projects															
Plans/as-builts of dams along the Charles River															
Plans/as-builts of bridges along the Charles River															
Plans/as-builts of culvert crossings along the Charles River	provides GIS files		Cooks Farm		Chicken Brook & Hopping Brook				CentralAve/Elliot St Bridge, South Meadow St culvert,	Holbrook Street	Indian Brook				
Dam inspection reports for dams along the Charles River				Included Factory pond dam, houghton pond dam, lake winthrop dam	Included Sanford Mill, Choate Park Dam					City Mills Pond Dam					
Dredging or other reports on maintenance activities			Beaver St Drainage Improvements				Stated there is no history of / plans to dredge			Town Pond Improvements, Lawrence St Improvements			Included list of contracts, with no details		
List any major proposed roadway improvements, public housing and/or park/open space projects in 5-year capital plans							Included roadways only		Included CCVA, Climate Action public infra plan, Commonwealth Ave Bridge,						
List any major proposed private development projects or vacant lots where the communities would like to propose potential green infrastructure opportunities															

Figure 1. Tracking sheet for existing data submittal from project communities

Summary of Existing Data

The first step in developing the model was to determine a watershed boundary of the Charles River watershed. A shapefile of this boundary was created and uploaded into a GIS mapfile. Then, all data submitted by the participating project communities was analyzed by employees of Weston & Sampson as part of the Technical Team to determine their importance in the creation of the model. The GIS shapefiles of stormwater infrastructure were determined to be critically important and were uploaded to a GIS geodatabase then organized by type of infrastructure. The stormwater infrastructure most critical to the model included drainpipes, manholes, outfalls, and catch basins located within the watershed area.

For the purposes of this model, only drainpipes within the watershed boundary with a diameter greater than or equal to 24-inches were included in the mapfile. These drainpipes were sorted into three (3) categories: pipe diameters greater than or equal to 24-inches and less than 36-inches, pipes greater than or equal to 36-inches and less than 48-inches, and pipes greater than or equal to 48-inches. Each of these categories was represented in the mapfile accordingly. From there, only the manholes, outfalls, and catch basins located along these select drainpipes were included in the mapfile. An example of the mapfile is shown in Figure 2, below.

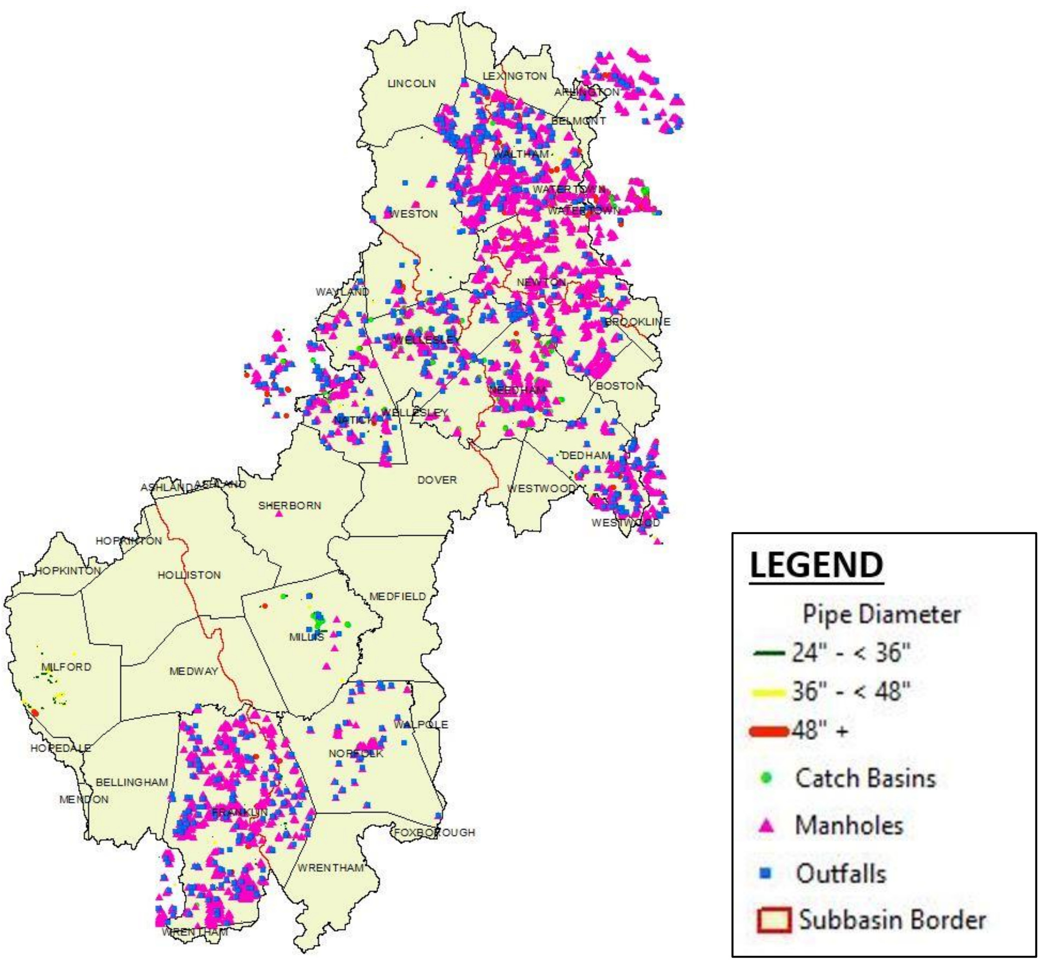


Figure 2. Mapfile of stormwater infrastructure from project communities' existing data.

Data Gaps

Utilizing existing data provides the advantage of generating a model in a shorter timeline, but it has limitations in that it creates data gaps where accurate existing data cannot be found. Key data gaps that have been identified in the creation of this model are summarized as follows:

- Many of the GIS shapefiles from all Towns were missing elevation data for the stormwater infrastructure.
- The Towns of Arlington, Dedham, and Newton submitted no existing GIS shapefiles for catch basins.
- The Towns of Medway and Wrentham had no diameter data for the GIS shapefiles of drainpipes that were submitted. This omitted GIS shapefiles for any other stormwater infrastructure within these towns, as the stormwater infrastructure selected for the model was based on proximity to drainpipes greater than or equal to 24-inches.
- The Town of Sherborn submitted GIS shapefiles for culverts but no other drainpipes, and limited stormwater infrastructure was located along these culverts.
- The Towns of Medway, Milford, and Watertown submitted GIS shapefiles for various types of stormwater infrastructure that show up in the Atlantic Ocean in the mapfile, suggesting an error in the data.
- The Town of Holliston was unable to submit any GIS files related to stormwater infrastructure due to health-related staffing challenges during the pandemic.

CHARLES RIVER WATERSHED MODEL

Appendix A.1:
Project Team Workshop 2 Presentations (workshop held in three parts: May 5th, May 12th, May 26th)

Charles River Watershed Association

Building Resilience Across the Charles River Watershed

Workshop #2 Part 1: Nature Based Solutions
May 5, 2021

Agenda

1:00-1:10: Welcome & Introductions

1:10-1:30: Present Results of Municipal & Public Feedback

1:30-1:45: Present NBS Solutions to be voted on to include in the model

1:45-2:00: Discussion/Survey

Meeting Goal

- Present nature-based solutions that could be modeled
- Discuss prioritization of nature-based solutions
- Take a survey to select strategies to model

We'll review survey results at the end of next Wednesday's training

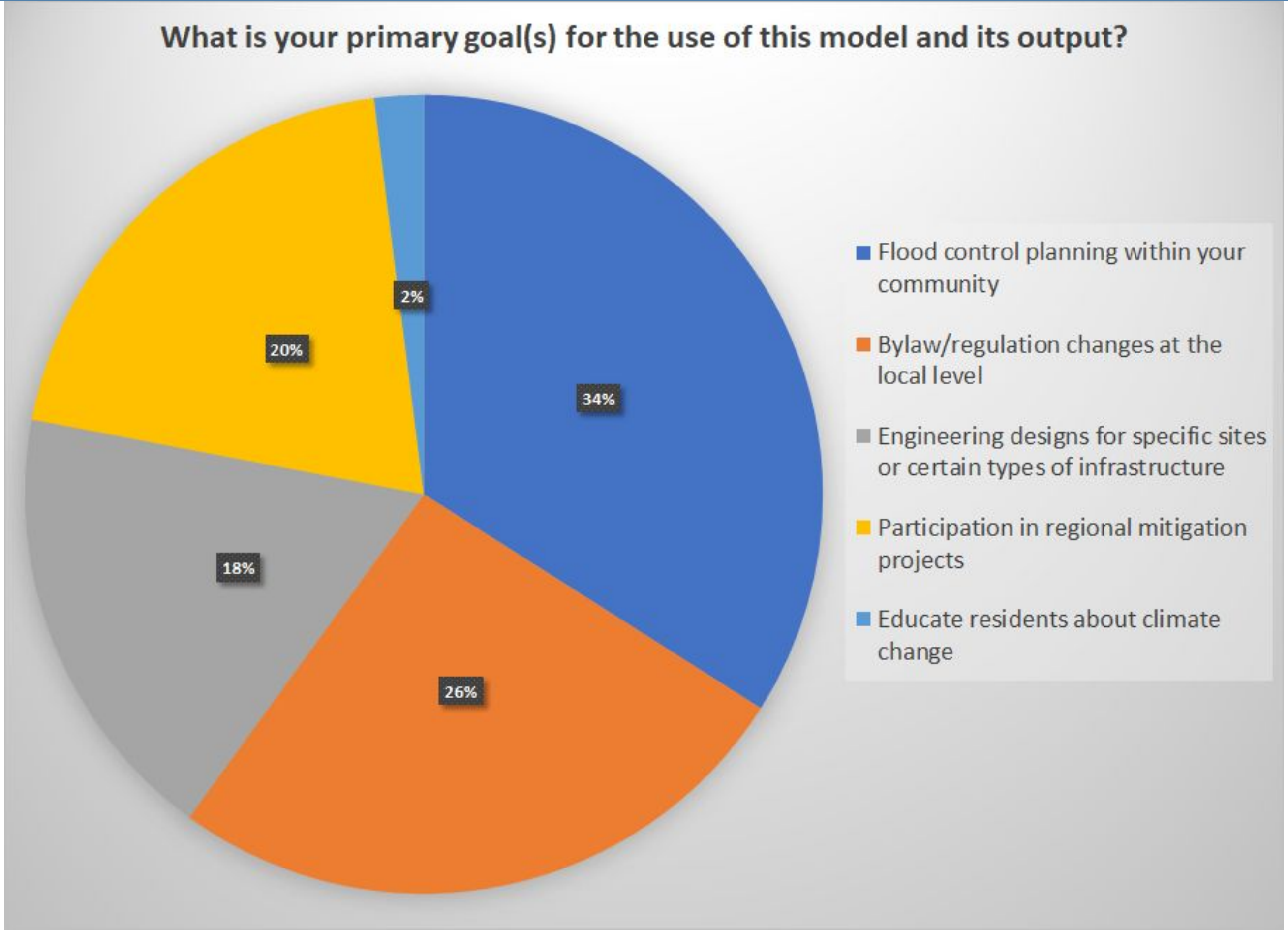
Project Update

- May 12th: Engaging Climate Vulnerability Communities Training
- Update: model results for existing conditions and from the nature-based solutions runs will be presented on **May 26th**
- Model progress update from Indrani
- Don’t forget to document your match hours (spreadsheet now includes a list of project meetings)
- Project end date is June 30th!

Project Team Feedback

Building Resilience Across the Charles River Watershed

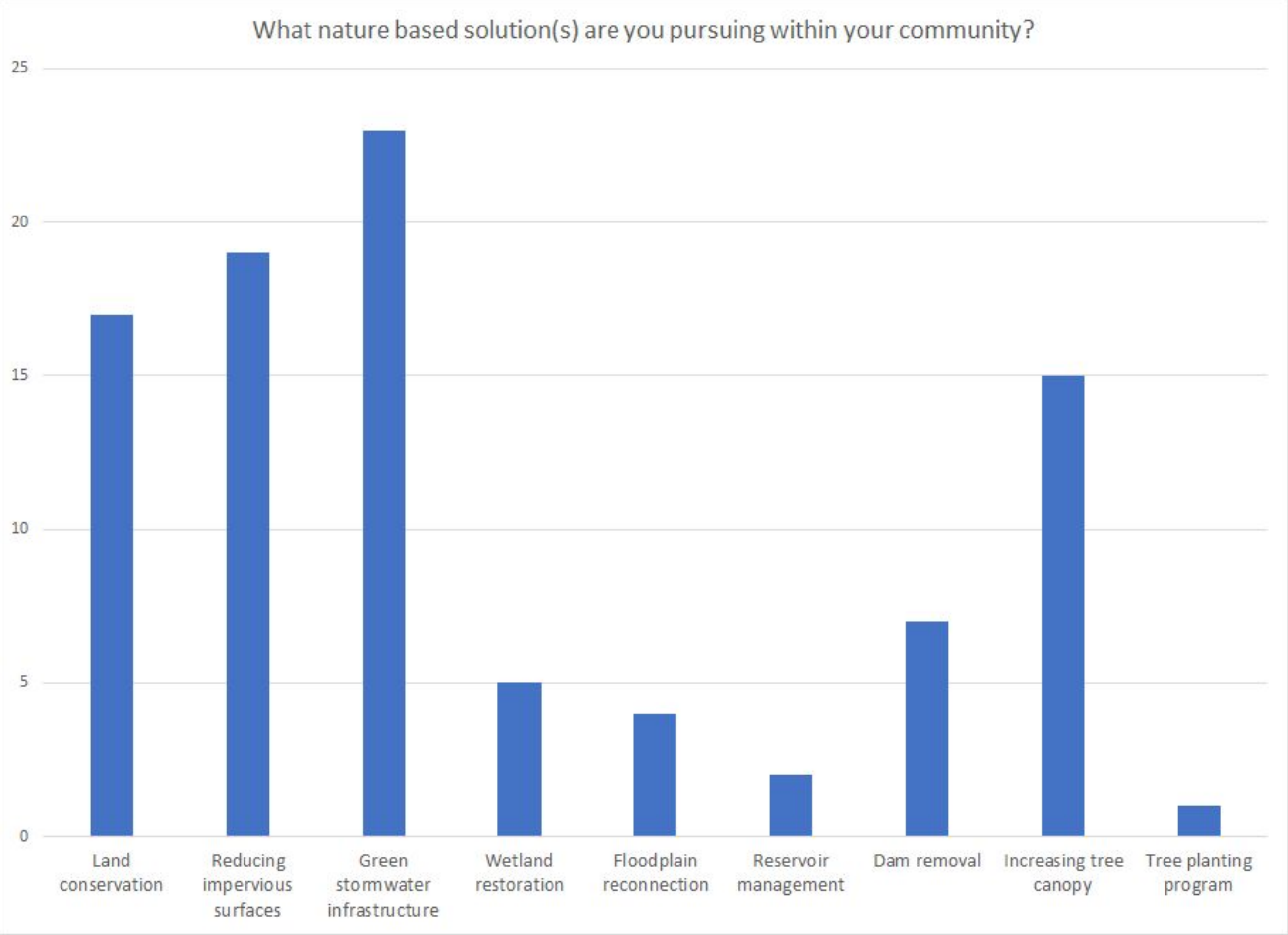
Charles River Watershed Association



Building Resilience Across the Charles River Watershed

Charles River Watershed Association

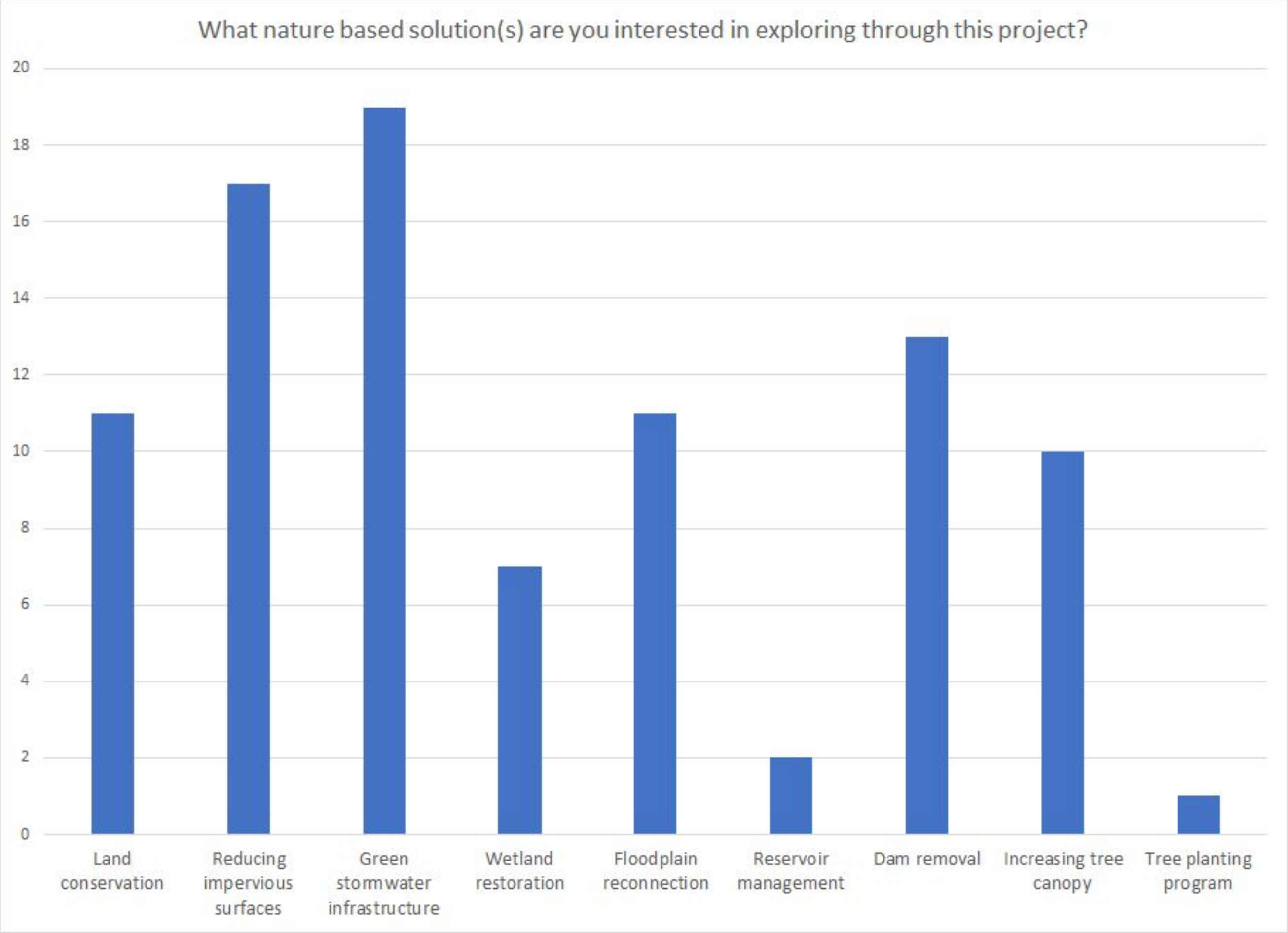
1. GSI
2. < IC
3. Conservation
4. Tree canopy



Building Resilience Across the Charles River Watershed

Charles River Watershed Association

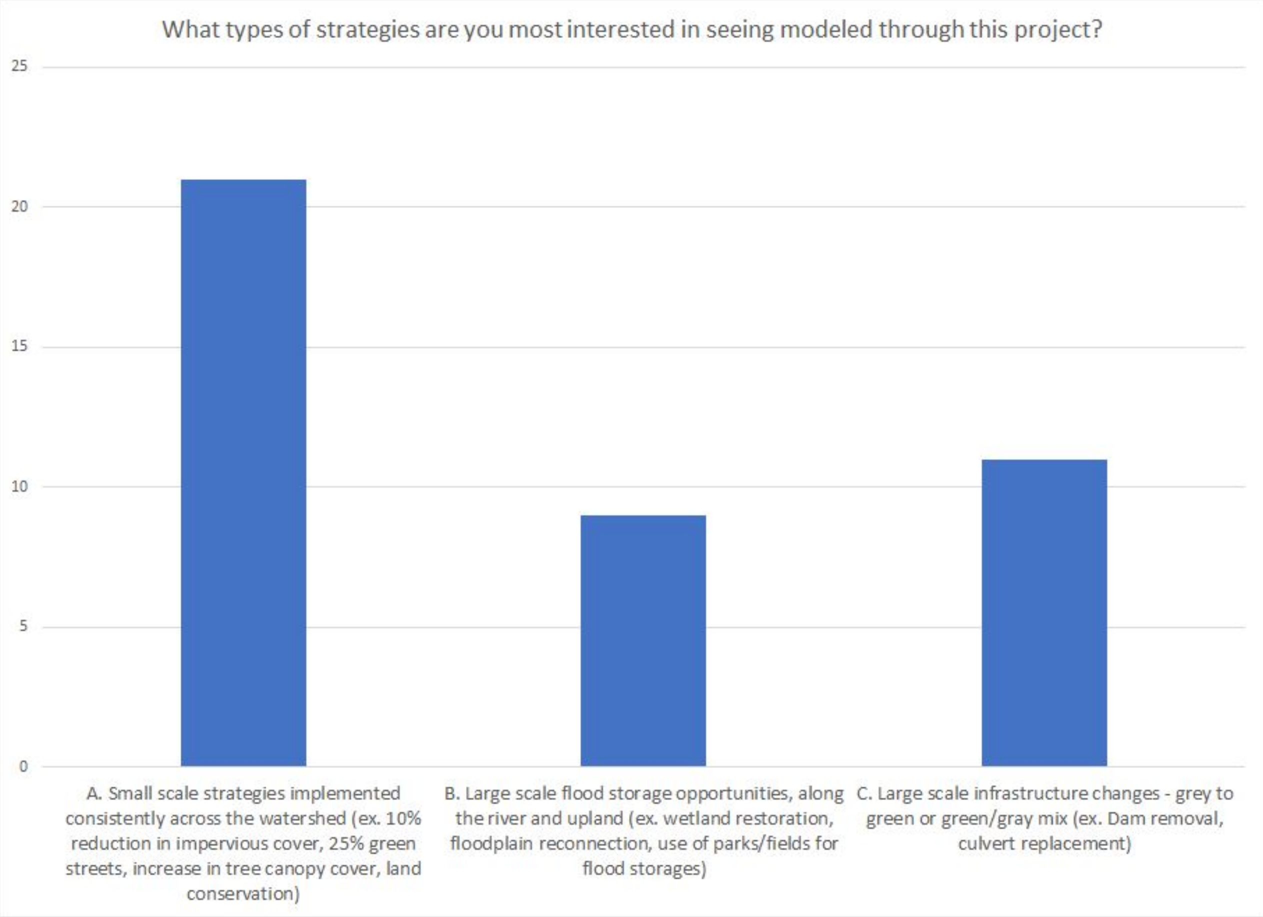
1. GSI
2. < IC
3. Dam Removal
4. Floodplain reconnection
5. Conservation
6. > Tree canopy
7. Wetland restoration



Building Resilience Across the Charles River Watershed

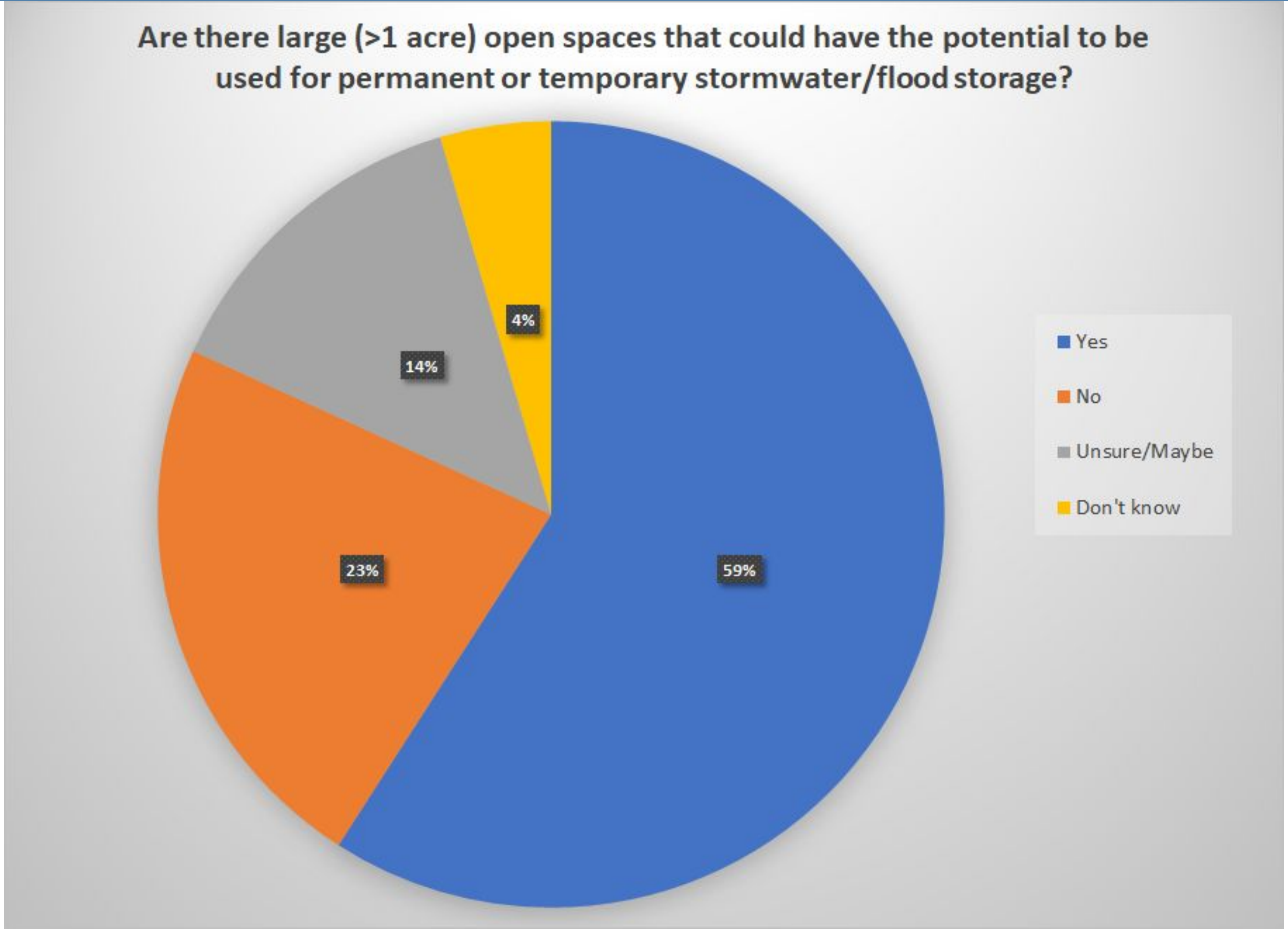
Charles River Watershed Association

1. Small scale strategies (GSI, < IC)
2. Infrastructure changes (dam removal, culvert changes)
3. Large scale flood storage



Building Resilience Across the Charles River Watershed

Charles River Watershed Association



Which of the following, if any, do you think are NOT feasible for your community even if funding for implementation was available?

1. None (all are feasible with funding and public support) (9)
2. Move development out of flood plain (8)
3. All undeveloped lots >2 acres available to provide flood storage (6)
4. Permanently protect >50% of available open space (4)
5. Dam removal (4)
6. Increase tree canopy by up to 25% (4)
7. Wetland construction (river adjacent and upland) (3)
8. Green infrastructure stores 1.5” storm runoff from 50% of all impervious cover town-wide (3)
9. Dam management changes (2)
10. Decrease directly connected / effective impervious cover by 10-25% (2)
11. Restore culverted streams (1)

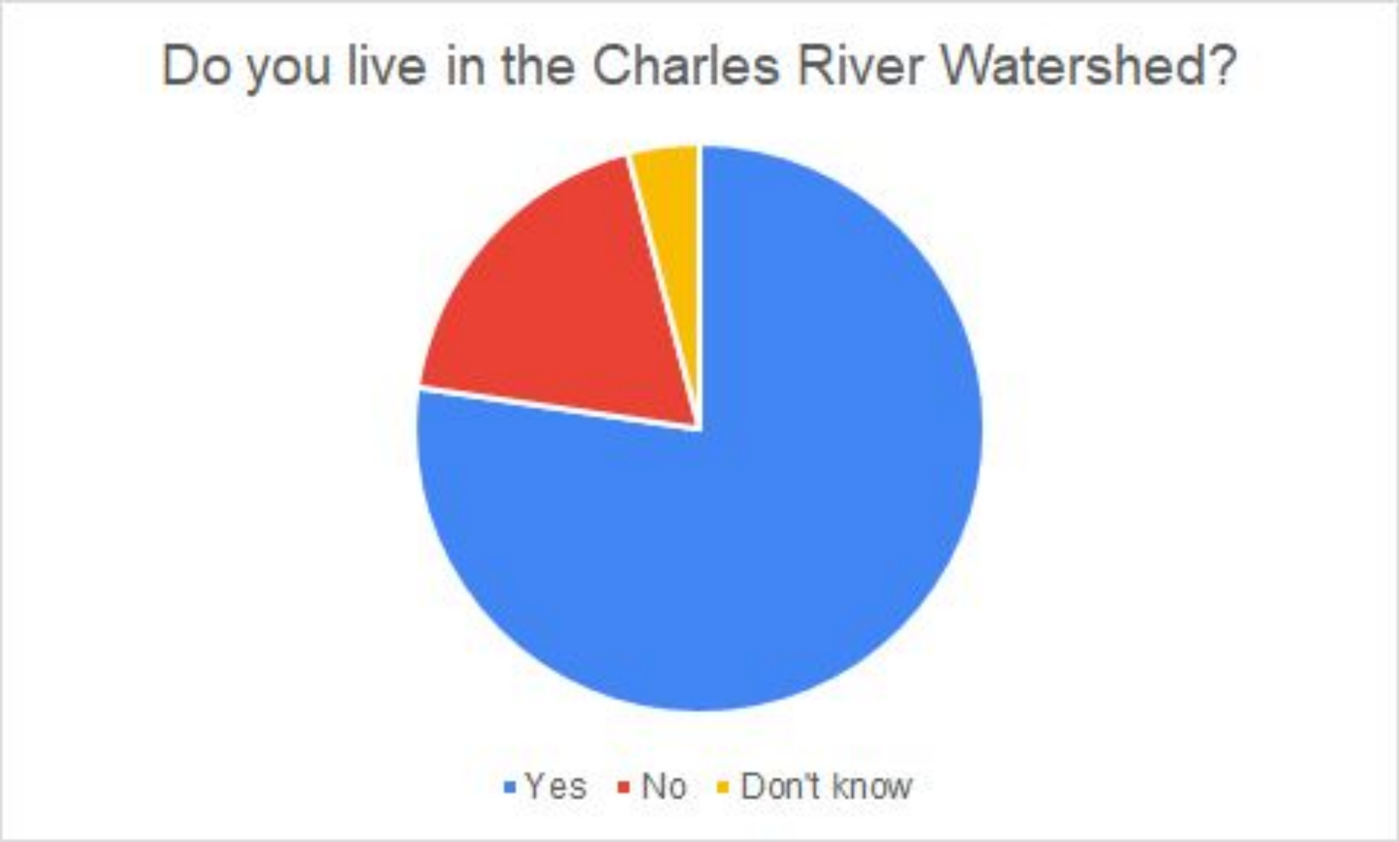
Public Feedback

Public Survey Results

Two Surveys:

- one issued to virtual event attendees (69 responses)
- one issued to general public (103 responses)

Also had three non-English surveys but did not get any responses: learning opportunity


Do you live in the Charles River Watershed?
Yes
No
Don't know

Building Resilience Across the Charles River Watershed

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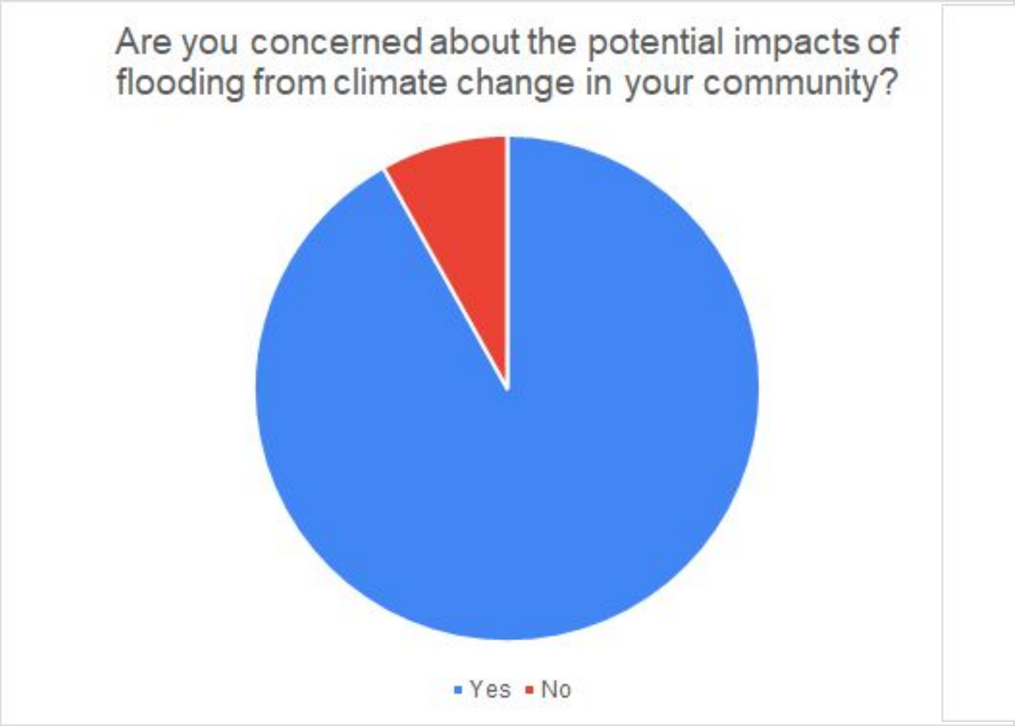
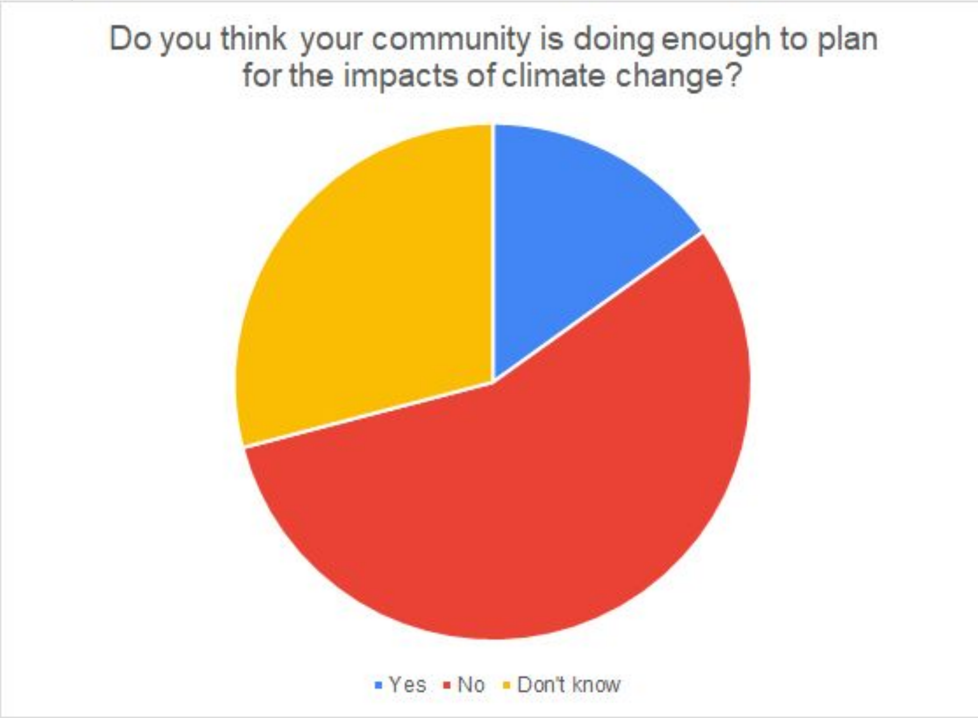
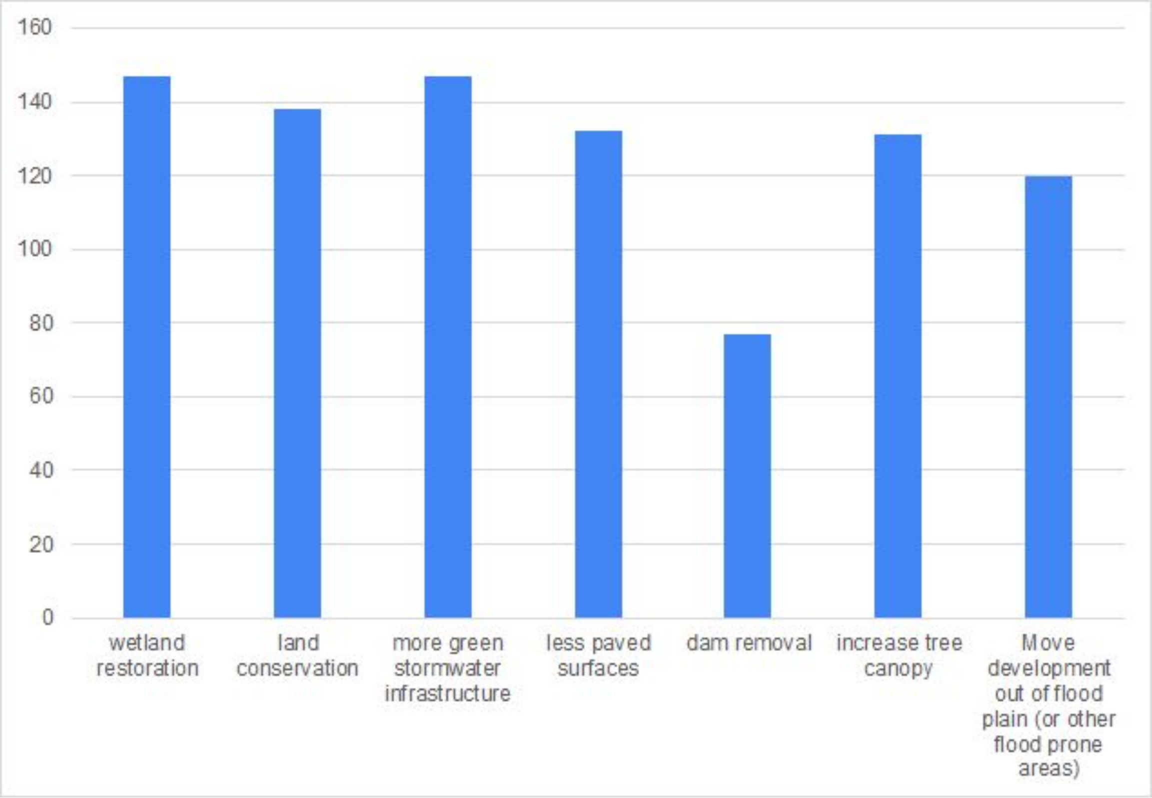




Which of these would you like to see explored as possible nature-based solutions to help mitigate potential flooding impacts of climate change?



Building Resilience Across the Charles River Watershed

Charles River Watershed Association

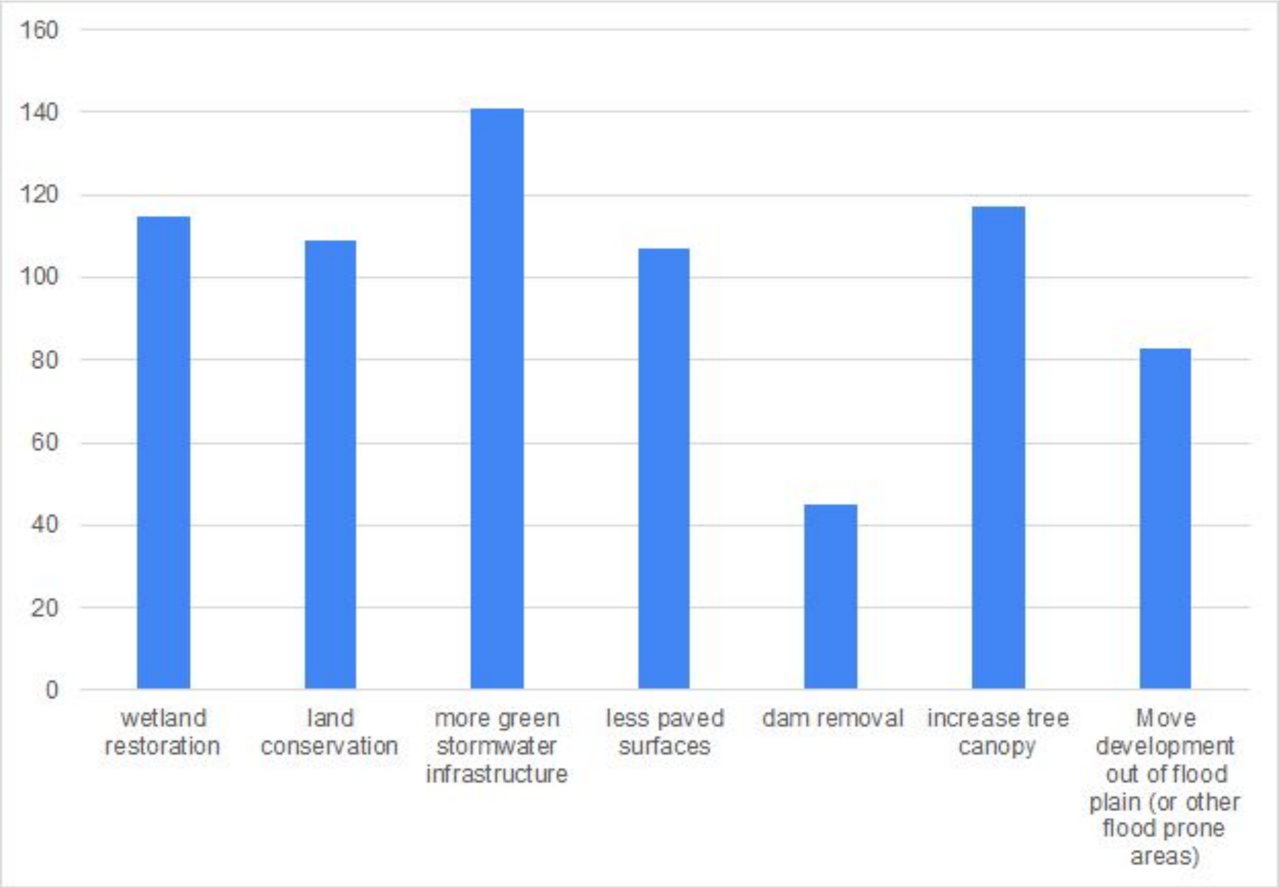
Additional Suggestions

- Undersized culvert replacement
- Enhancing local sources of water supply vs MWRA
- have city, state and federal plans include these solutions
- No asphalt driveways
- Stricter land use controls; incentives for clustered density
- Man made wetlands with elevated boardwalks where it makes sense
- Daylight buried streams
- Parks created in wetlands/ floodplains
- Preserve existing tree canopy
- All of the above

Building Resilience Across the Charles River Watershed

Charles River Watershed Association

Which of these nature based solutions do you thir would be ***possible*** i your community?



Do you have any concerns about the changes nature-based solutions could bring to your community?

- Inequitable benefits
- Inter-community cooperation
- Cost
- Further gentrification
- Raising rents/housing cost
- Maintenance
- Private land
- Dam removal would require significant study
- Cost of maintaining newly-created wetlands so they don't get full of rubbish and invasive species
- Buy in from residents
- Beaver activity might impact nature based solutions
- Getting community buy-in
- Mosquitos

Summary

Top Nature Based Solutions to Model:

Project Team

1. GSI
2. < IC
3. Dam Removal
4. Floodplain reconnection*
5. Conservation*
6. > Tree canopy
7. Wetland restoration

*some reservation/concerns

Preference for modeling small scale system across the watershed

Top Nature Based Solutions to Model: Public

1. Wetland restoration (147)
2. More green stormwater infrastructure (147)
3. Land conservation (138)
4. Less paved surfaces (132)
5. Increase tree canopy (131)
6. Move development out of flood plain (or other flood prone areas) (120)
7. Dam removal (77)

Summary

Most Feasible: Public

1. More green stormwater infrastructure (141)
2. Increase tree canopy (117)
3. Wetland restoration (115)
4. Land conservation (109)
5. Less paved surfaces (107)
6. Move development out of flood plain (or other flood prone areas) (83)
7. Dam removal (45)

*Public also has some concerns over moving development out of the floodplain

Summary

- **Land conservation**, **More green stormwater infrastructure** and **Less paved surfaces** appear in the top five responses for both surveys/all questions
- Wetland Restoration was popular very with public, least popular with municipal team
- Dam Removal not very popular with the public
- Both groups had some concerns about the feasibility of floodplain reconnection

Modeling Nature Based Solutions Scope Review

Charles River Watershed Association

Task 4. Select Priority Watershed Scale Climate Adaptation Strategies

Sub-Task 4.1 Identify Priority Actions

Sub-Task Task 4.2 Select Priority Actions

Task 5. Watershed Scale Adaptation Recommendations

Sub-Task 5.1 Assess Priority Mitigation Measures using H/H model

Sub-Task 5.2 Evaluate Co-Benefits of Nature Based Solutions

Sub-Task 5.3 Prioritization of flood mitigation alternatives

Modeling Nature Based Solutions

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Sub-Task 4.1 Identify Priority Actions

Concurrent with Tasks 2 and 3, the Technical Team, working with **a few community partners who are able to dedicate more time to the project will identify specific mitigation strategies** within the broad categories already identified by the group:

1. Upstream flood storage assessment for priority areas
2. Green infrastructure interventions for priority areas
3. Land conservation / land use change strategies
4. Floodplain restoration strategies

The flood mitigation strategies that will be evaluated can be a **combination of watershed wide strategies and site-specific strategies.**

Nature-based solutions subcommittee met on April 1st

Modeling Nature Based Solutions

Sub-Task Task 4.2 Select Priority Actions

A **second full project team workshop will be held to identify and prioritize watershed scale flood mitigation strategies to assess in Phase I.** The project team will also review responses from the community survey administered in Task 1 which include some input on residents' preferences or concerns for flood mitigation approaches. The project team will select the priority actions through discussion and voting.

Deliverables:

- Workshop 2 with project team communities
- Selection of prioritized list of flood mitigation strategies with maximum potential of flood reduction at the watershed scale

Nature-based solutions subcommittee feedback

Constructed wetlands can be expensive and face permitting challenges

Support for looking at impervious cover reduction

“Reducing” impervious cover could also mean disconnecting it (in practice)

Support modeling strategies that Cities/Towns can implement in ways that work for them (i.e. green stormwater infrastructure), implementation might look different in Medway vs. Newton need to allow for flexibility

Supporting for identifying strategies that each community can work toward because we know it’s effective

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Please complete the survey by noon on Monday, May 10th

Welcome more than one response per community.

Hope to get AT LEAST one response per community.

Nature Based Solutions

Green Stormwater Infrastructure (GSI): Which strategies would you like to see modeled? (SELECT TWO)

- [ ] Green infrastructure stores 2" storm runoff from up to 50% of all impervious cover town-wide
- [ ] 10% of feasible/priority land area is GSI
- [ ] Storage on large (>5 acres) public properties (GSI, underground storage, "blue roofs")
- [ ] Attenuate peak flow from 25-yr to 2-yr on larger parcels
- [ ] Storage on large private properties
- [ ] Other:

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Strategy: Green Stormwater Infrastructure

- Green infrastructure stores 2” storm runoff from up to 50% of all impervious cover town-wide

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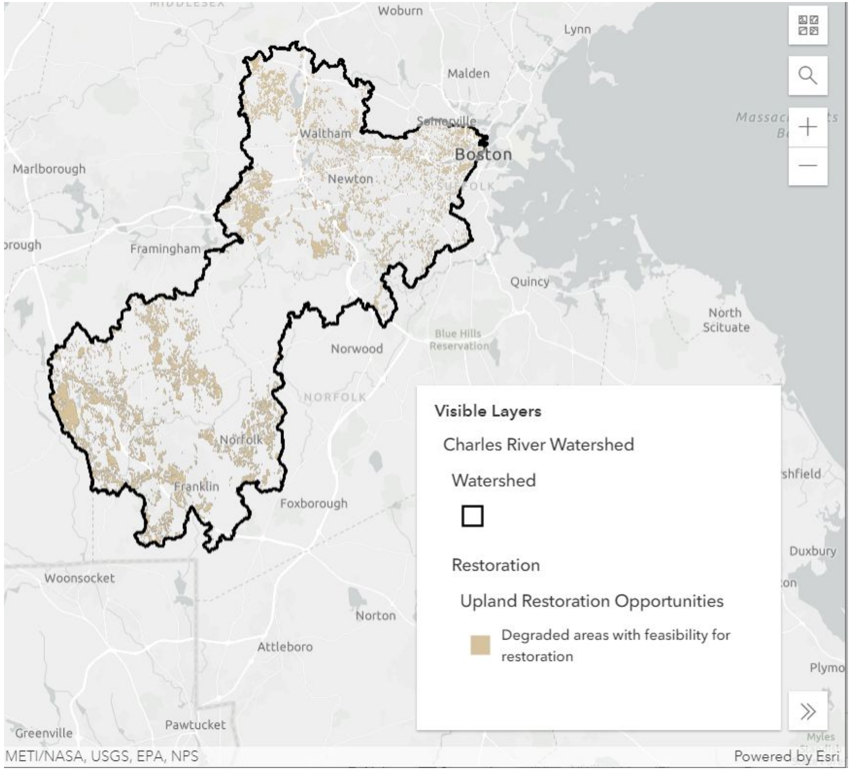
Strategy: Green Stormwater Infrastructure

- 10% of feasible/priority land area is GSI (based on CRWA/TNC Nature Based Solutions Mapping Tool)



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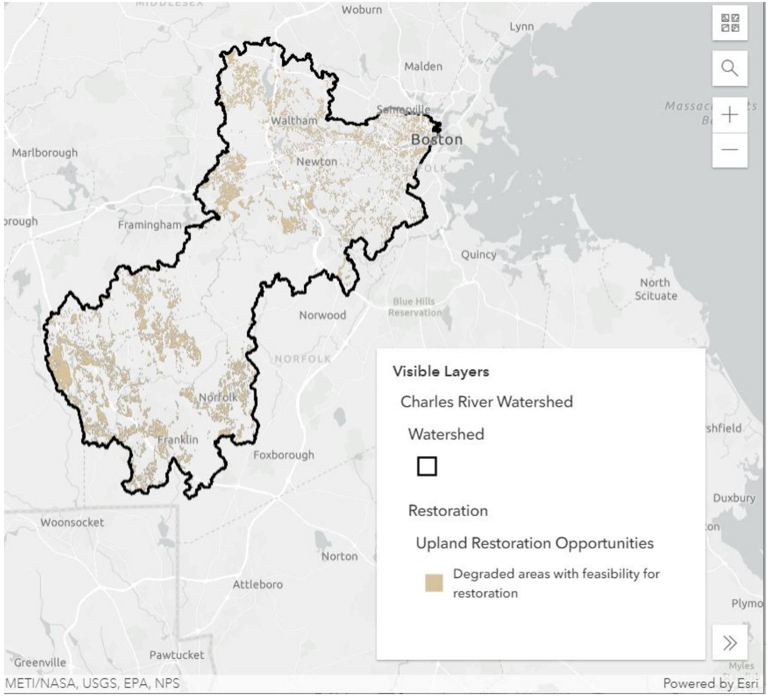
Watershed-wide example: Small / Medium Scale Green Stormwater Infrastructure Across the Watershed



Based on Charles River Watershed Conservation and Restoration Prioritization Tool

- Degradation: groundwater depletion, high impervious cover, high pollutant load
- Feasibility: well drained soils, open space
- Excluded: activity use limitations, forested areas, wellhead protection zones

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Small / Medium Scale Green Stormwater Infrastructure Across the Watershed

Criteria Subcategory	Degradation			Feasibility	
Criterion Overview	Indicates need for restoration			Indicates high feasibility areas to implementing effective green infrastructure	
Criteria Shorthand	Areas with groundwater depletion	Properties with high impervious cover	Areas with high pollution loading	Areas with well draining soils	Areas with space availability
Layer Details (GIS file)	MassDEP Sustainable Water Management Initiative (SWMI) net groundwater depletion	Building Structures, MassGIS	• Impervious cover, MA Land Use/Land cover 2016 • MA Land Use 2005	NRCS Hydrological Soil Groups	Existing parks and open spaces, MassGIS 2017
Analysis	Categories 4 or 5	Building Structure Footprints >1 acre	Commercial, Industrial, High-Density Residential land Land cover = impervious	Soil groups A and B, and unknown	Publicly owned parks and open space
Analysis Detail	Basins whose unaffected August median flow is more than 25% depleted after accounting for groundwater and groundwater discharges	Buildings with large footprints often have large parking lots	High pollutant, impervious areas are ideal areas to target large pollutant loads	A and B soils have high infiltration capacity, making them ideal areas to implement green infrastructure. Unknown soils were included to not exclude urban areas with little information.	Upland restoration projects can often be implemented in existing, publicly owned parks and open spaces
Co-benefits	• Environmental Justice Communities (MA_CharlesRiver_EnvJustice) • Greenspace Deserts (MA_CharlesRiver_GreenspaceDeserts)				
Excluded	• Activity/Use Limitation (AUL) sites, 21(e) sites, and underground storage tanks (MassGIS 2016 with 200' buffer) • Forested areas (MA Land Use 2005) • Wellhead Protection Zone I and Zone II areas (MassGIS 2016)				

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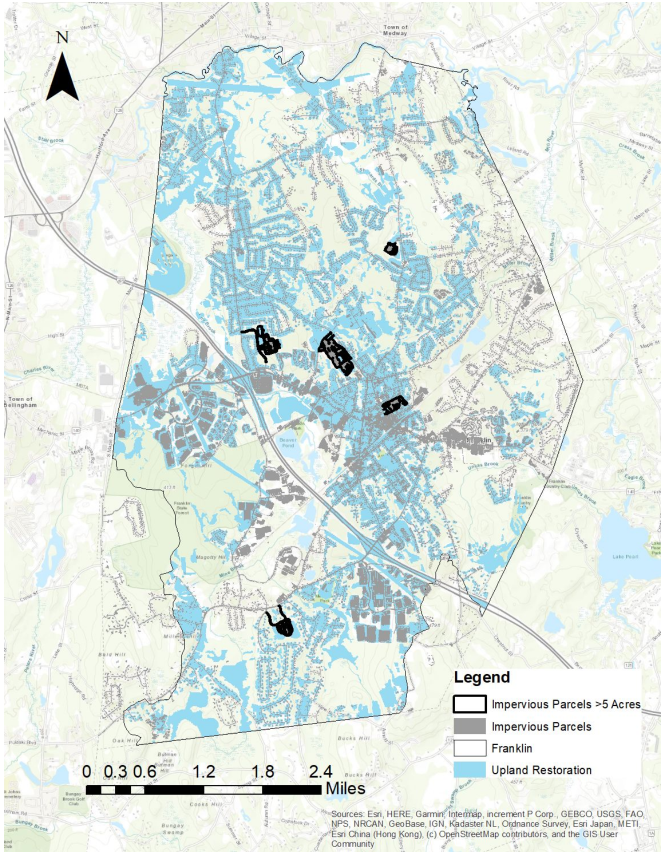
Strategy: Green Stormwater Infrastructure

- Storage on large (>5 acres) public properties (GI, underground storage, “blue roofs”)
- Storage on large private properties



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Site-Specific Example: Large scale GI or storage at publicly owned sites

Methods

- Used 2016 GIS Land Use Layer to identify”
    - Parcels > 5 acres
    - Impervious
    - Tax exempt
- Further narrowed by identifying parcels >40% impervious cover (eliminate town forests, conservation land, etc.)
- Manual review to exclude private schools, cemeteries, roads, universities, etc.

Results: Primarily public schools (K-12) and municipal buildings/DPWs (~65 sites)

Medway

Medway High School

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Natick

Natick High School

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Wellesley

Wellesley Department of Public Works

Wellesley Recycling and Disposal Facility

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Strategy: Green Stormwater Infrastructure

- Attenuate peak flow from 25-yr to 2-yr on larger parcels
- Other?

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Strategy: Reduce Impervious Cover

- Reduce effective impervious cover watershed wide by 10% (for subbasins over 10%)
- Reduce impervious cover in the upper and middle watershed by 25%
- Reduce IC down to 30%, for communities already below 30%, reduce by 5-10%
- Other?

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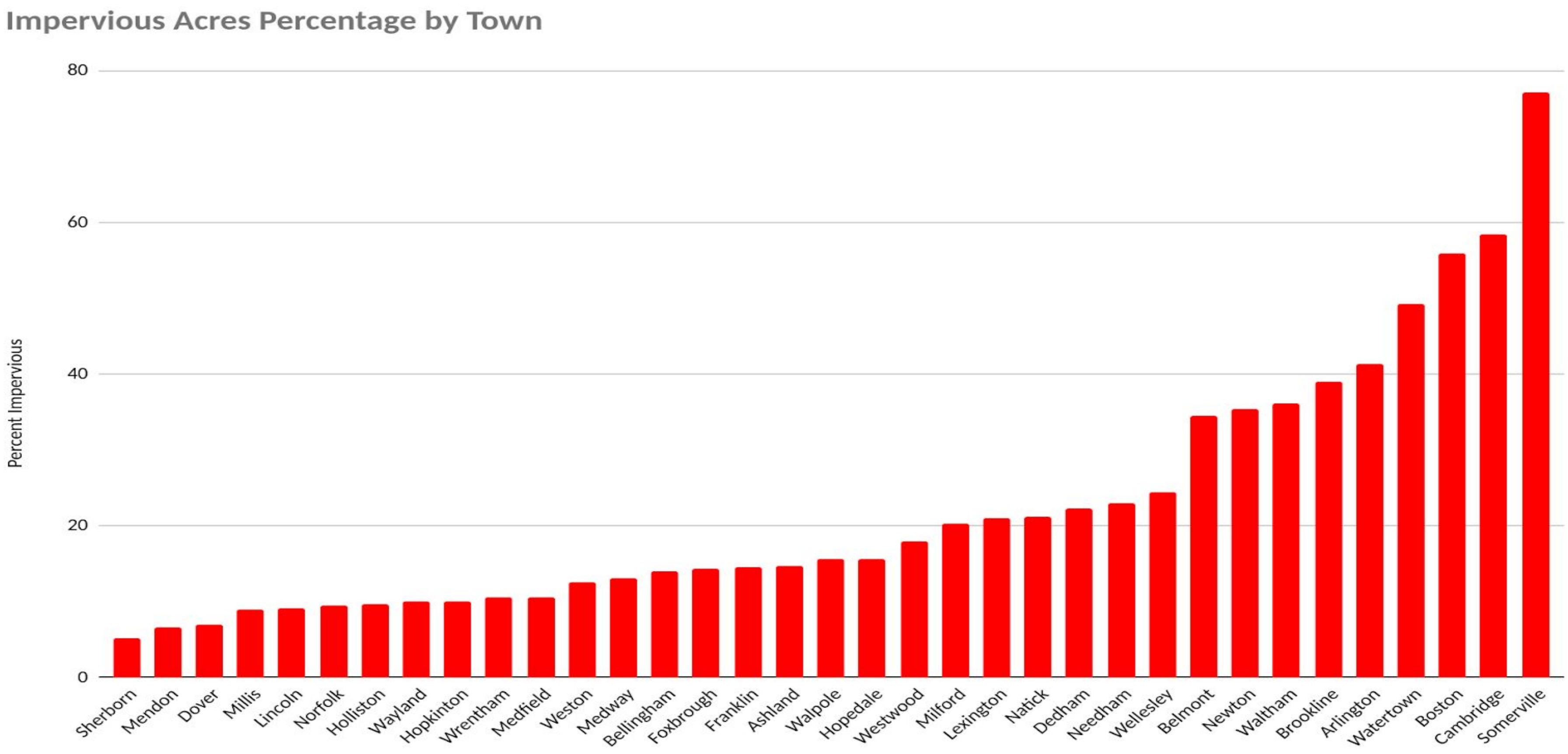

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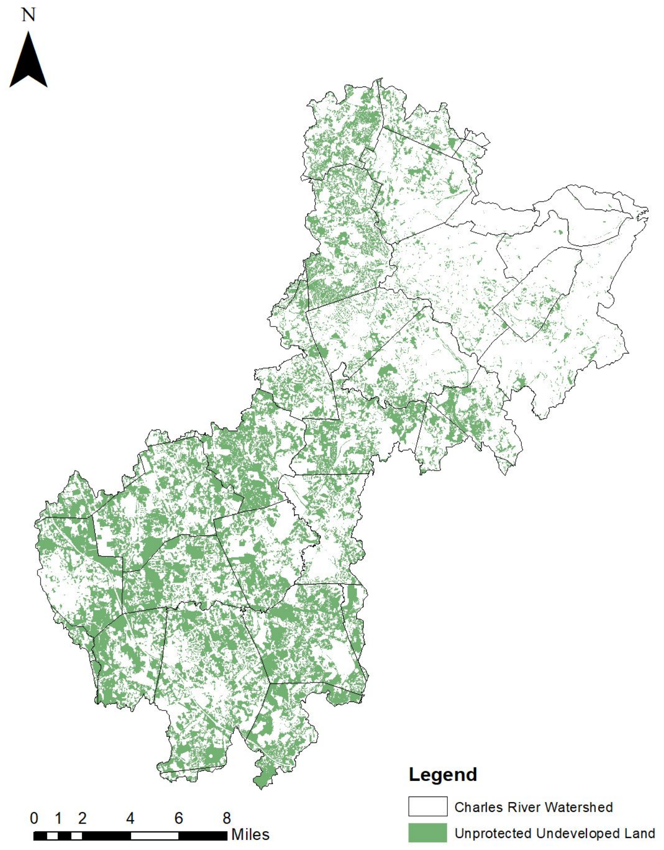
Strategy: Land Conservation

- Allow 50% of remaining undeveloped / unprotected land to become impervious
- Allow 75% of remaining undeveloped / unprotected land to become impervious
- Others?



Modeling Nature Based Solutions

Strategy: Land Conservation

- Allow 50% of remaining undeveloped / unprotected land to become impervious
- Allow 75% of remaining undeveloped / unprotected land to become impervious
- Others?

TOWN	AREA (acres)
ARLINGTON	10.09
DEDHAM	2582.72
FRANKLIN	11950.95
HOLLISTON	9951.62
MEDWAY	7046.44
MILLIS	5530.99
NATICK	3726.76
NEEDHAM	2572.94
NEWTON	1549.63
NORFOLK	8961.31
SHERBORN	7930.48
WATERTOWN	32.71
WELLESLEY	2305.52
WESTON	6984.85
WRENTHAM	5887.51

Modeling Nature Based Solutions

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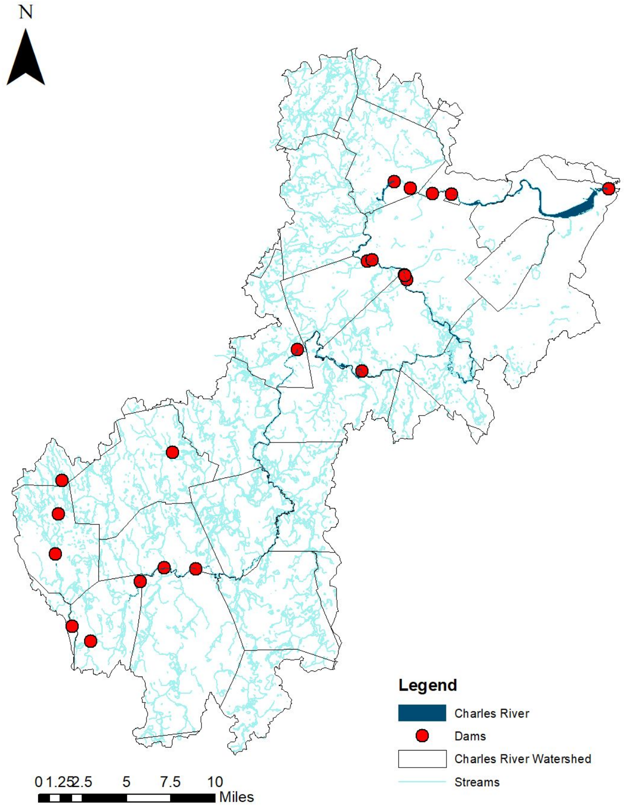
Strategy: Dam Removal / Reservoir Management

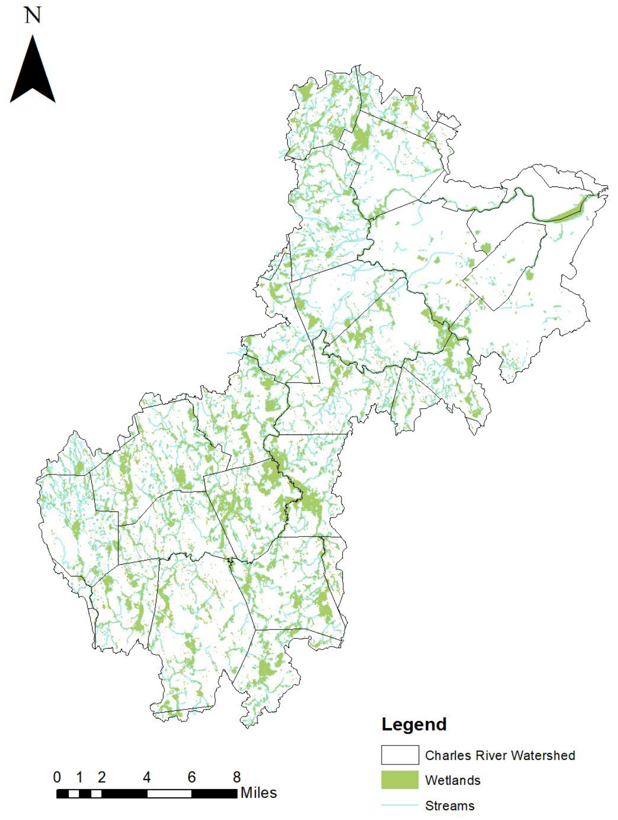
- Remove all dams other than active flood control (New Charles & Moody St.)



Modeling Nature Based Solutions

Strategy: Floodplain reconnection

- Augment riparian wetland areas by 10%
- Remove select culverts
- Eliminate all impervious cover within 200 ft. of rivers/streams



Modeling Nature Based Solutions

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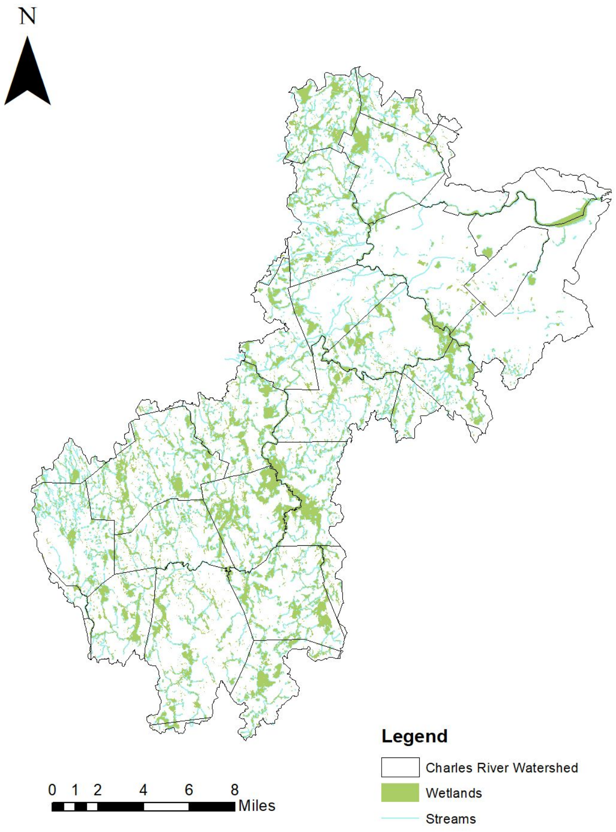
Strategy: Wetland Restoration

- All wetland areas 10% larger
- All wetland areas 20% larger
- Constructed wetlands on large public parcels (overlap with GSI category)



Modeling Nature Based Solutions

Strategy: Increase Tree Canopy

- 25% public ROWs become green streets: tree box filters /bioswales connected to leaching catch basins
- 50% public ROWs become green streets: tree box filters /bioswales connected to leaching catch basins
- Others?

Questions and Discussion

Guide to making your selections:

- Consider what is feasible in "near-term" (<5 years)
- Consider public input
- CRCC/CRWA can help with implementation (i.e. grant requests, building public support, policy tools, etc. - you won't be on your own!)

Next Steps:

- Complete the survey by Monday, May 10th at noon
- Come to *Engaging Climate Vulnerable Communities Training* on May 12th @9am to see the results
- Modeling results will be presented on May 26th

Engaging Climate Vulnerable Communities

May 12, 2021

Engaging Climate Vulnerable Communities

Charles River Watershed Association

Agenda

9:00-9:10: Introductions

9:10-9:40: Dr. Atyia Martin, All Aces

9:40-10:00: Cate Mingoya, Groundwork USA

10:00-10:25: Ethan McDonough, CREW

5 *minute break*

10:30 - 11:00: Workshop #2 - Review survey results

CREW Communities Responding to Extreme Weather

Addressing Community Vulnerability in Climate Planning

CREW has put together this toolkit for municipal climate planners to explain why different communities are vulnerable to climate change and to help craft potential solutions. We also want this toolkit to provide resources and advice on how to address these issues of social vulnerability. We have broken this document into three parts:

1) The reasons specific communities are vulnerable to climate change.
2) Tools to identify socially vulnerable groups in your own community.
3) Advice on the best ways to include these groups in climate planning and to ensure collective resilience. Here, we will also include specific advice about using the results of the Charles River Flood Model (CRFM) in your community.

www.com

CONTACT CREW TODAY

VISIT CREW'S WEBPAGE

Today's Speakers

Dr. Atyia Martin
CEO and Founder
All Aces, Inc.

Cate Mingoya
Director of Capacity Building
Groundwork USA

Ethan Parker McDonough
Special Project Coordinator
CREW

Modeling Nature Based Solutions

Charles River Watershed Association

Thank you for filling out the survey;
23 responses!

Nature Based Solutions

Green Stormwater Infrastructure (GSI): Which strategies would you like to see modeled? (SELECT TWO)

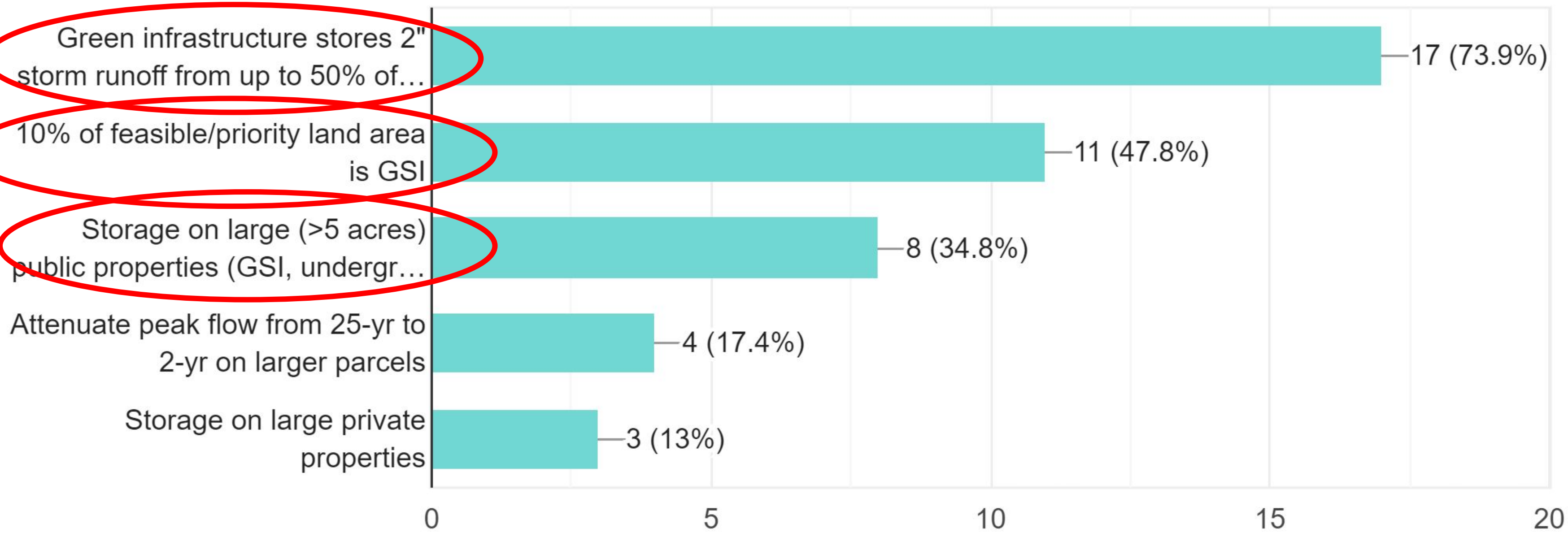
- [ ] Green infrastructure stores 2" storm runoff from up to 50% of all impervious cover town-wide
- [ ] 10% of feasible/priority land area is GSI
- [ ] Storage on large (>5 acres) public properties (GSI, underground storage, "blue roofs")
- [ ] Attenuate peak flow from 25-yr to 2-yr on larger parcels
- [ ] Storage on large private properties
- [ ] Other:

Modeling Nature Based Solutions

Charles River Watershed Association

Green Stormwater Infrastructure (GSI): Which strategies would you like to see modeled? (SELECT TWO)

23 responses

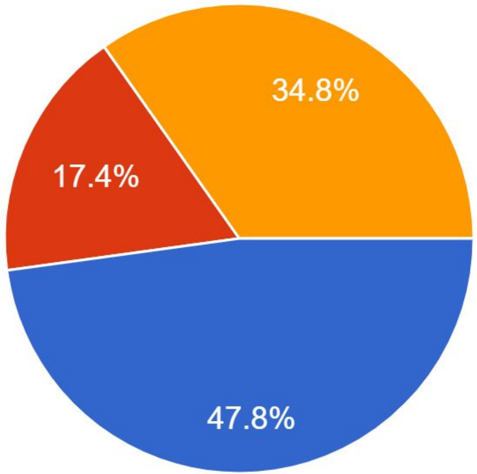


Modeling Nature Based Solutions

Charles River Watershed Association

Reducing Impervious Cover: Which strategy would you like to see modeled? (SELECT ONE)

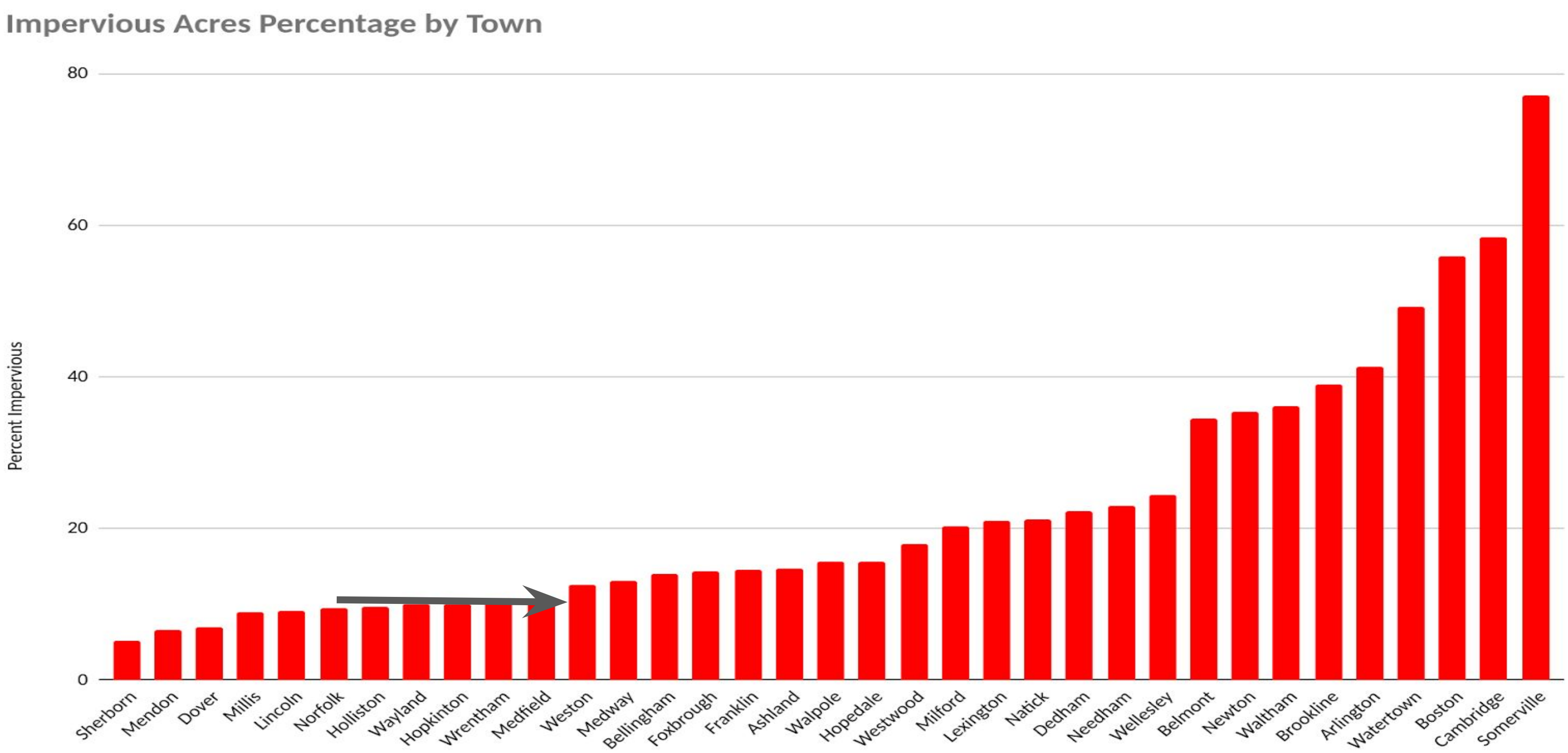
23 responses



- Reduce effective impervious cover watershed wide by 10% (for subbasins over 10%)
- Reduce impervious cover in the upper and middle watershed by 25%
- Reduce impervious cover to 30%, for communities already below 30%, reduce by 5-10%

Modeling Nature Based Solutions

Charles River Watershed Association

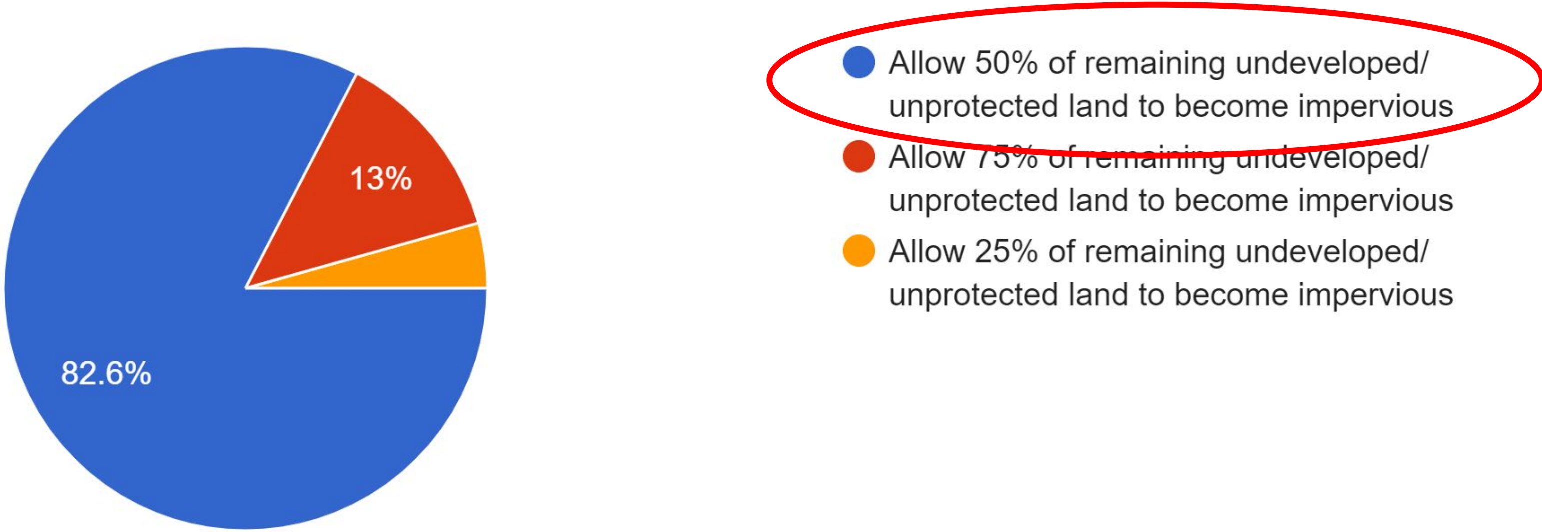


Modeling Nature Based Solutions

Charles River Watershed Association

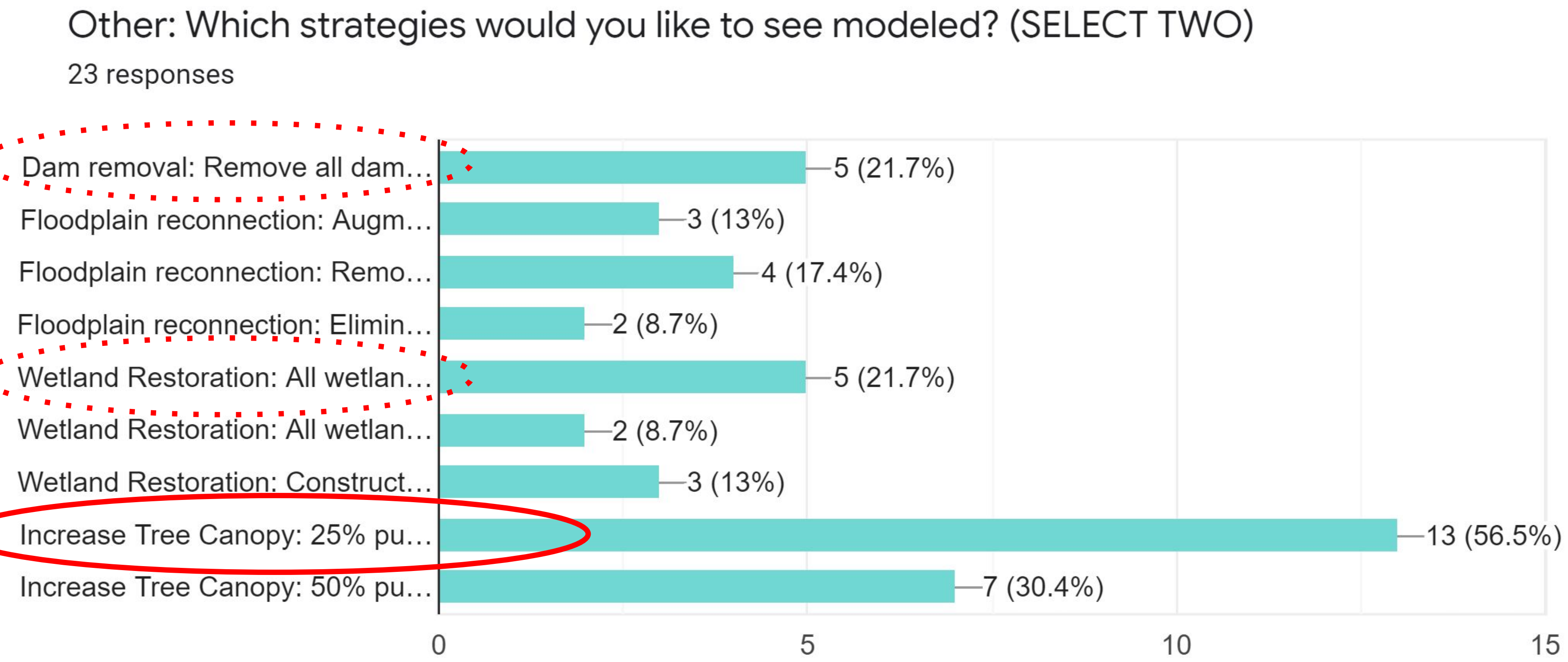
Land Conservation: which strategy would you like to see modeled? (SELECT ONE)

23 responses



Modeling Nature Based Solutions

Charles River Watershed Association



Modeling Nature Based Solutions

Charles River Watershed Association

Results

Green Stormwater Infrastructure
1. Green infrastructure stores 2" storm runoff from up to 50% of all impervious cover town-wide
2. 10% of feasible/priority land area is GSI*
3. Storage on large (>5 acres) public properties (GSI, underground storage, "blue roofs") (site specific strategy)

Reduce Impervious Cover
4. Reduce effective impervious cover watershed wide by 10% (for subbasins over 10%)

Land Conservation
5. Allow 50% of remaining undeveloped/unprotected land to become impervious

Other
6. Increase Tree Canopy: 25% public ROWS become green streets: tree box filters/bioswales connected to leaching catch basins

Alternates:
Wetland Restoration: All wetland areas 10% larger
Dam removal: Remove all dams other than active flood control dams

Details from May 5th presentation found here.

*Later changed to 20%

Upcoming Meetings

Charles River Watershed Association

May 26th, 1-2:30pm: Modeling Results!

June 2nd, 1-2pm: Climate Compact Meeting (bi-monthly meeting rescheduled from May)

TBD:

1. **Final project team meeting**

   -Communication's kit

   -Discuss next steps

2. **Final Public Presentation (virtual event)**

Charles River Watershed Flood Modeling – Initial Model Results Presentation

05.26.2021

Weston & Sampson

Charles River Watershed Association

Presentation Outline

- Recap future rainfall scenarios
- Model development
- Model calibration
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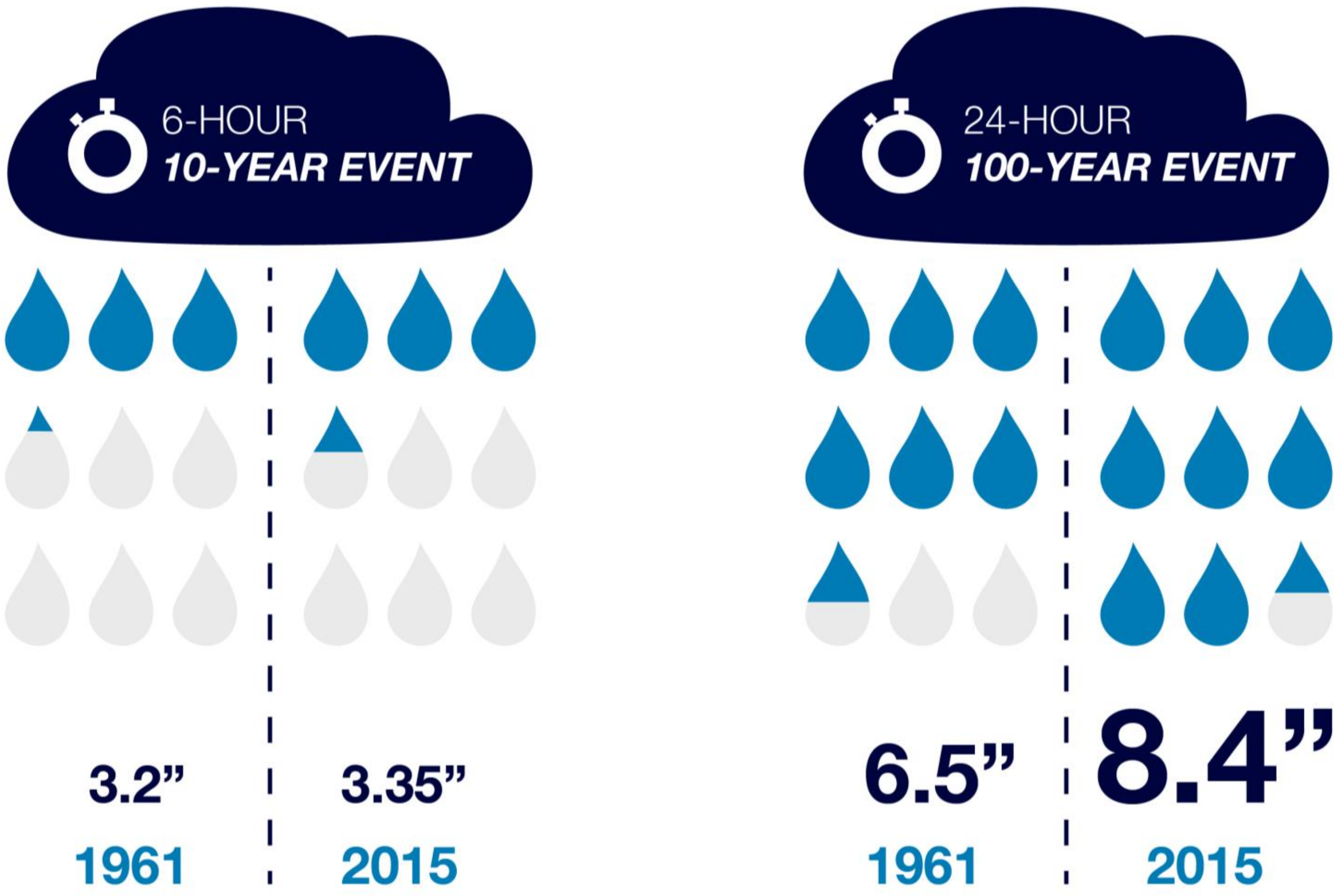
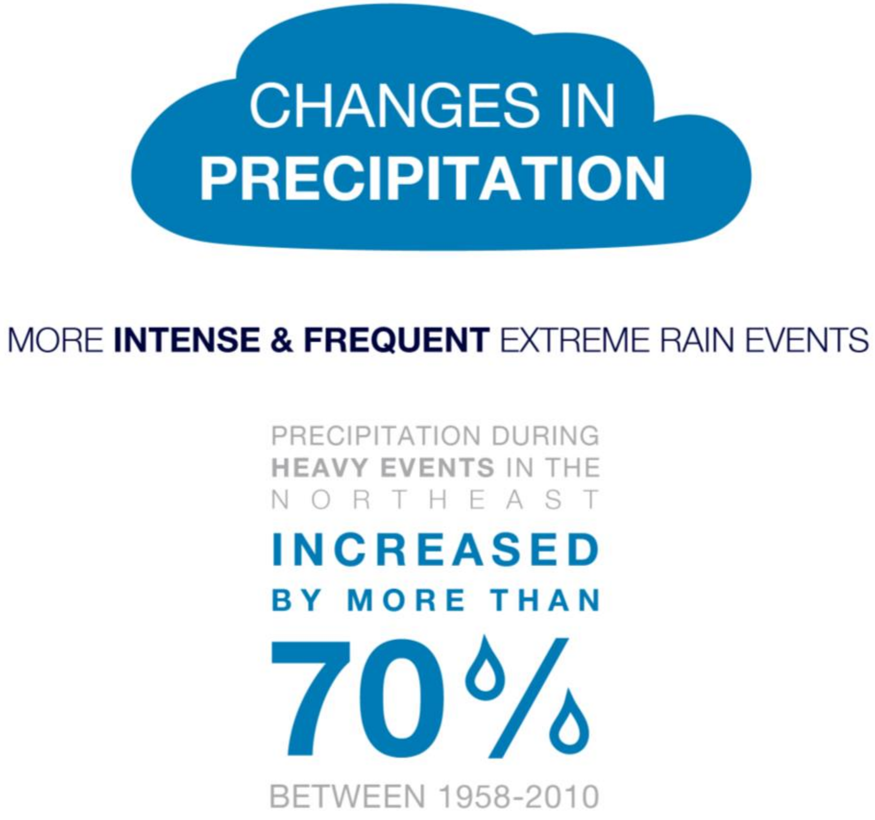
Historic Change in Precipitation

Charles River Watershed Association





Weston & Sampson

Sources: NOAA TP-40 (1961) and NOAA Atlas Volume 10 (2015)

ergy & Environmental Affairs. 2019. “Changes in Precipitation.” Massachusetts Climate Change Clearinghouse. Resilientma.org/changes/

Expected Future Increase in Precipitation

Charles River Watershed Association

Recommended Percent Increase Estimates from RMAT (to be applied to NOAA Atlas 14 baseline values)

Location	Design Storm	Mid-Century (2030/2050)	Late Century (2070/2090)
Massachusetts (all counties except Hampden)	More Frequent Design Storm*	8%	20%
	100-yr Design Storm	11%	27%
	Extreme Design Storm**	15%	36%
Hampden County	More Frequent Design Storm*	15%	36%
	100-yr Design Storm	*Perform Detailed Precipitation Analysis*	
	Extreme Design Storm**	*Perform Detailed Precipitation Analysis*	

* More Frequent Design Storms include 2-year, 5-year, 10-year, 25-year, and 50-year return periods

** Extreme Design Storms include 200-year and 500-year return periods

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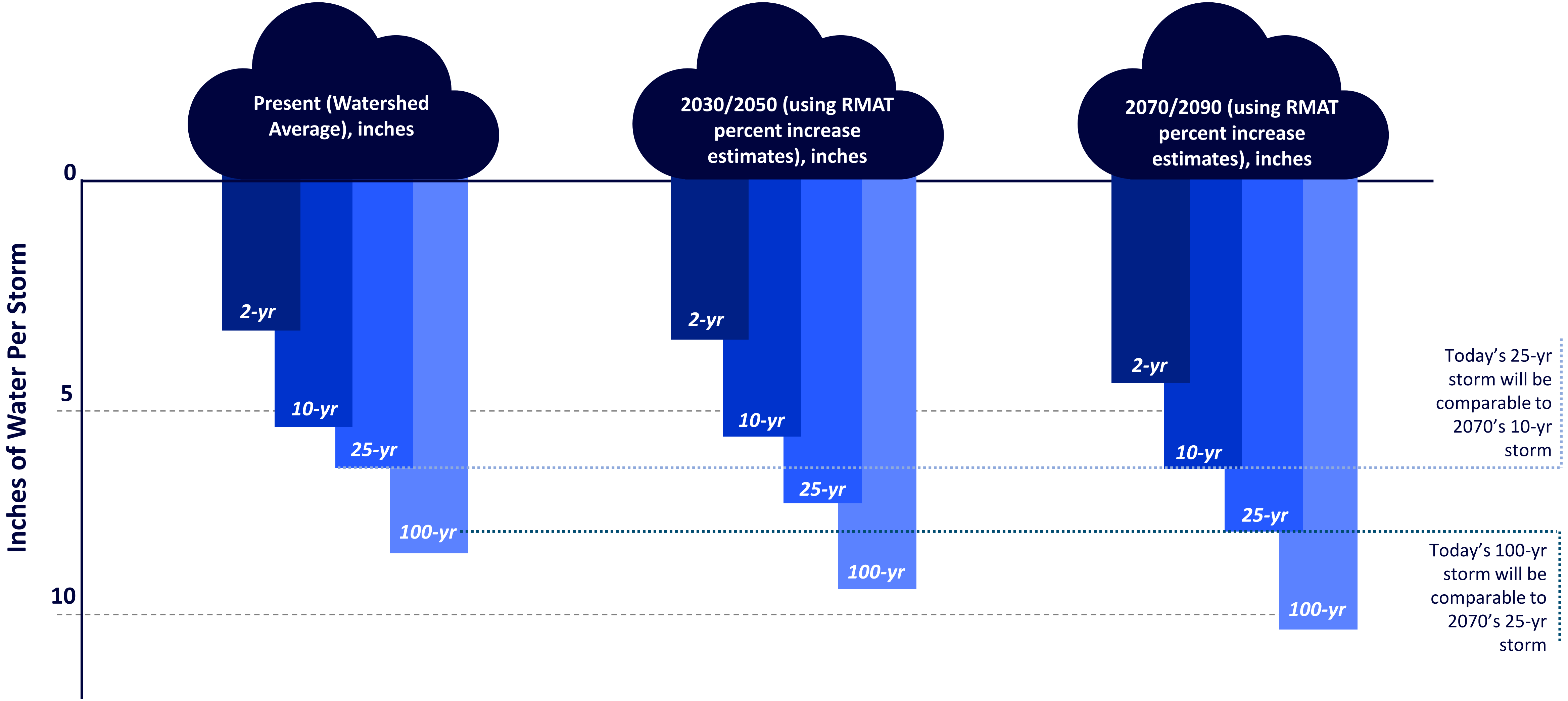
Expected Future Increase in Precipitation



Proposed Future Storm Scenarios

Charles River Watershed Association

Proposed Design Rainfall Depths for Future Storm Scenarios in the Charles River Watershed Model

Recurrence Interval	Present (Watershed Average), inches	2030/2050 (using RMAT percent increase estimates), inches	2070/2090 (using RMAT percent increase estimates), inches
2-yr	3.34	3.60	4.00
10-yr	5.20	5.62	6.25
25-yr	6.37	6.88	7.64
100-yr	8.17	9.07	10.37
500-yr	11.12	12.79	15.12

Summary of potential model runs:

- Calibrate the model to March 2010 event
- Validate model to May 2006 event (Mother's Day storm)

Future scenarios model runs for consideration:

- Present and 2070 2 yr storms (2)
- Present, 2030 and 2070 10 yr storms (3)
- Present, 2030 and 2070 100-yr storms (3)
- More extreme event: 2070 100-yr storm of 11.7 inches (from Mystic River Watershed project) or 500-yr storm of future 12.8 inches (1)

Model Development

Charles River Watershed Association

Presentation Outline

- Recap future rainfall scenarios
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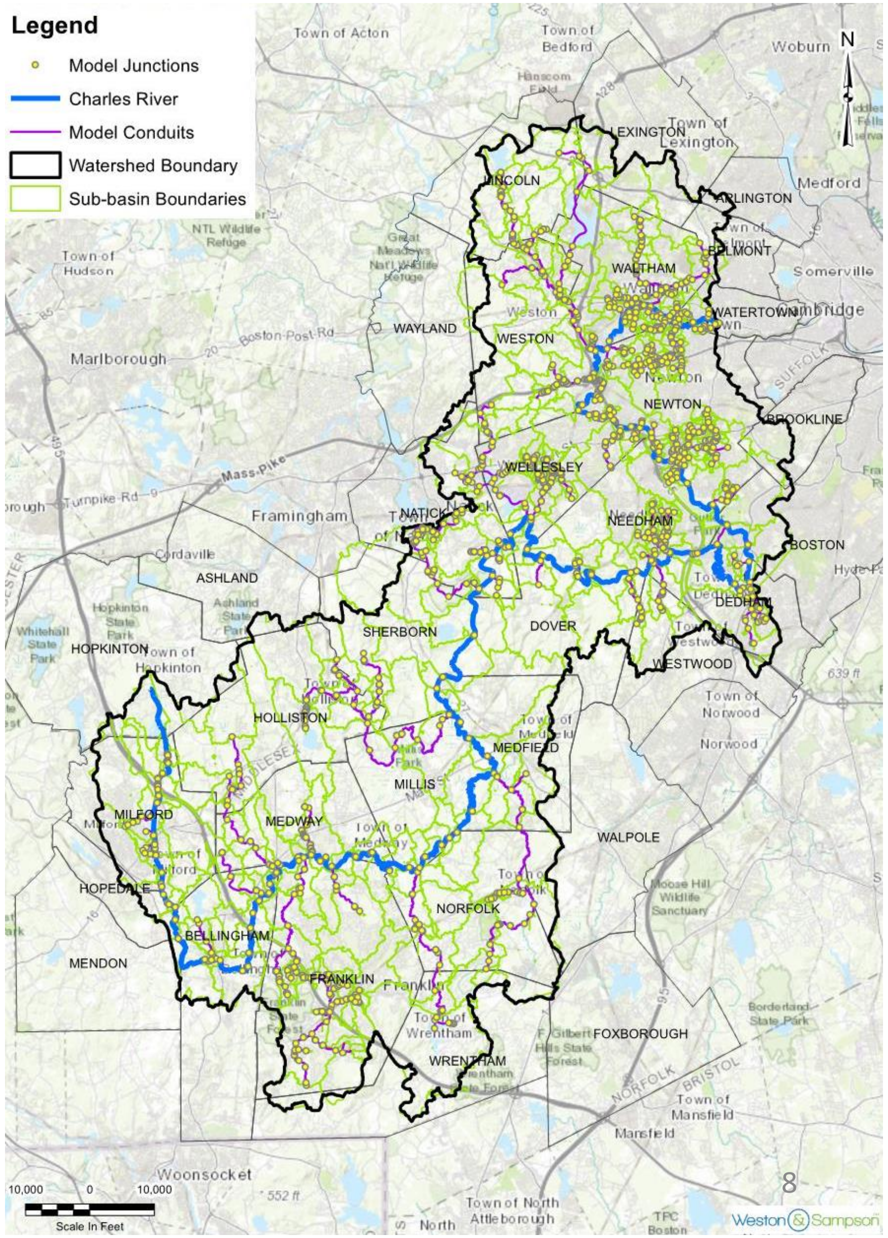
Weston & Sampson

Model Development

Charles River Watershed Association

1D Framework

- Generate runoff; convey non-flood flows
- 272 square miles of the watershed
- Over 1400 junctions
- Over 1500 conduits (including dams, culverts, bridge crossings, etc.)
- Over 700 sub-catchments
- Over 30 storage volumes



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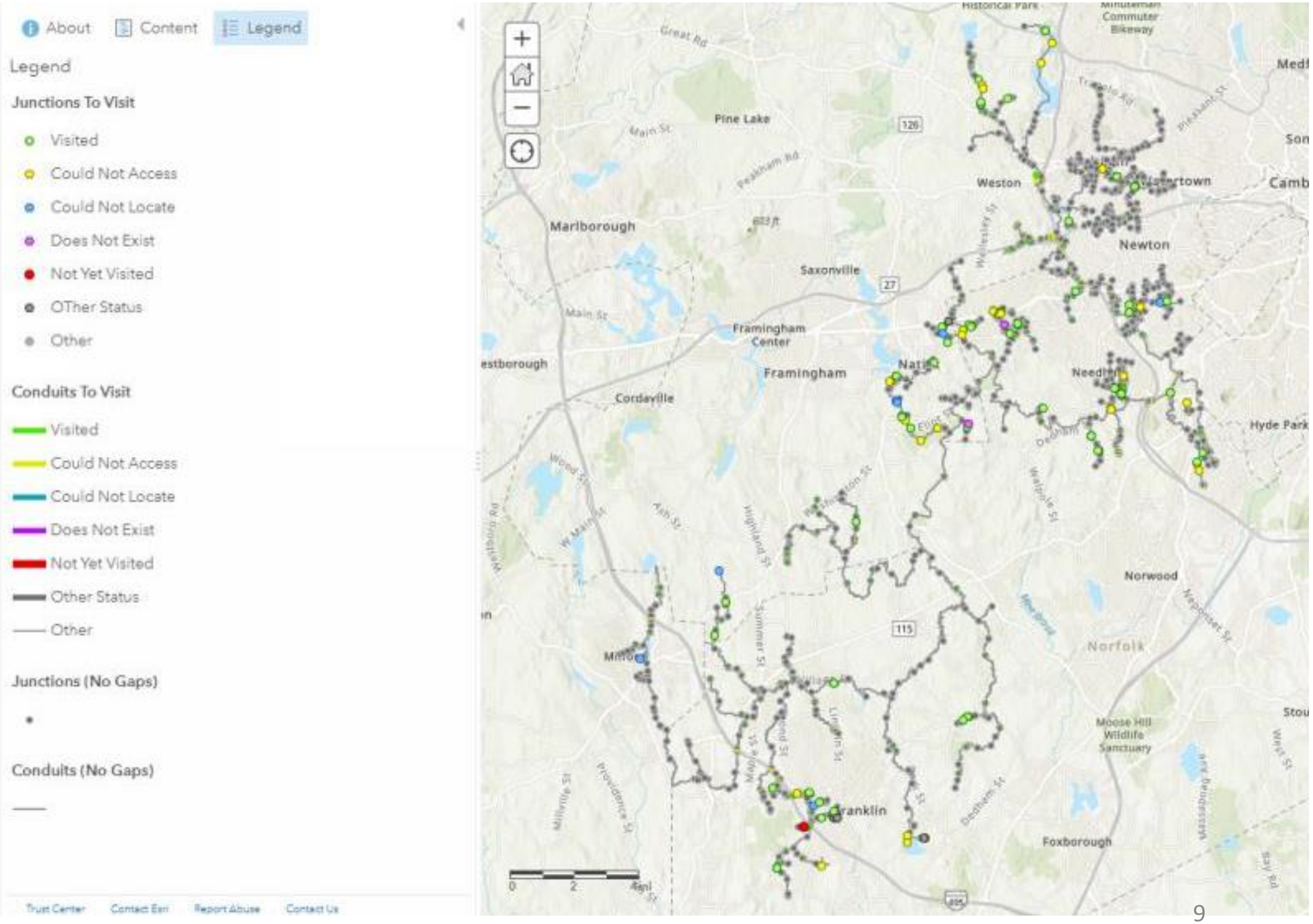
Field Verification

Charles River Watershed Association

- 6 days of site visits
- 119 junctions/nodes
- 25 dams
- 298 crossings
- 442 structures field verified



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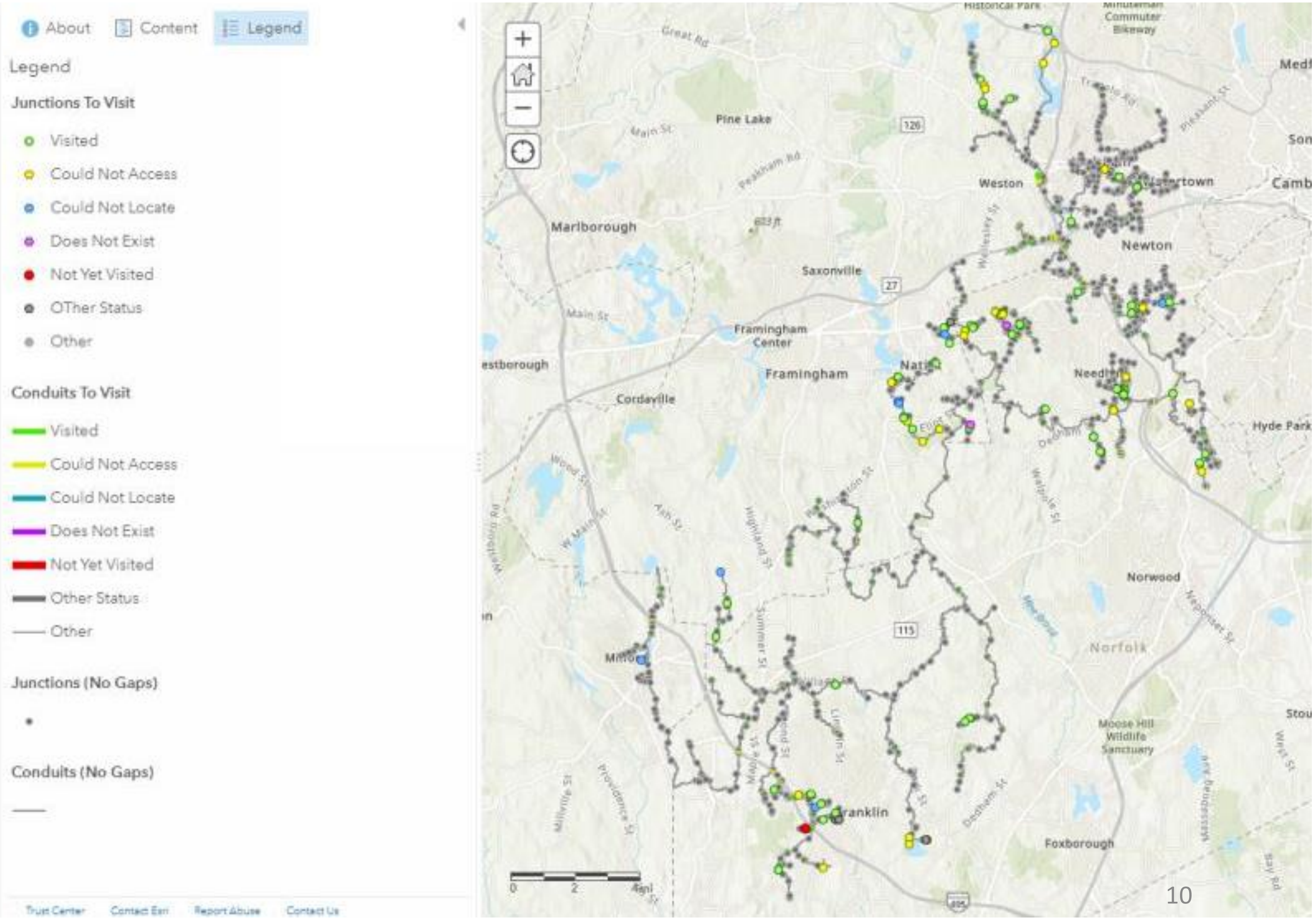
Field Verification

Charles River Watershed Association

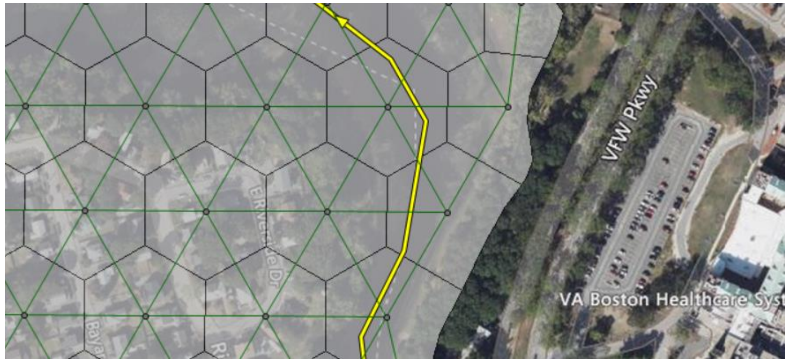
- Used ArcGIS Collector App to record notes, measurements, and take photos

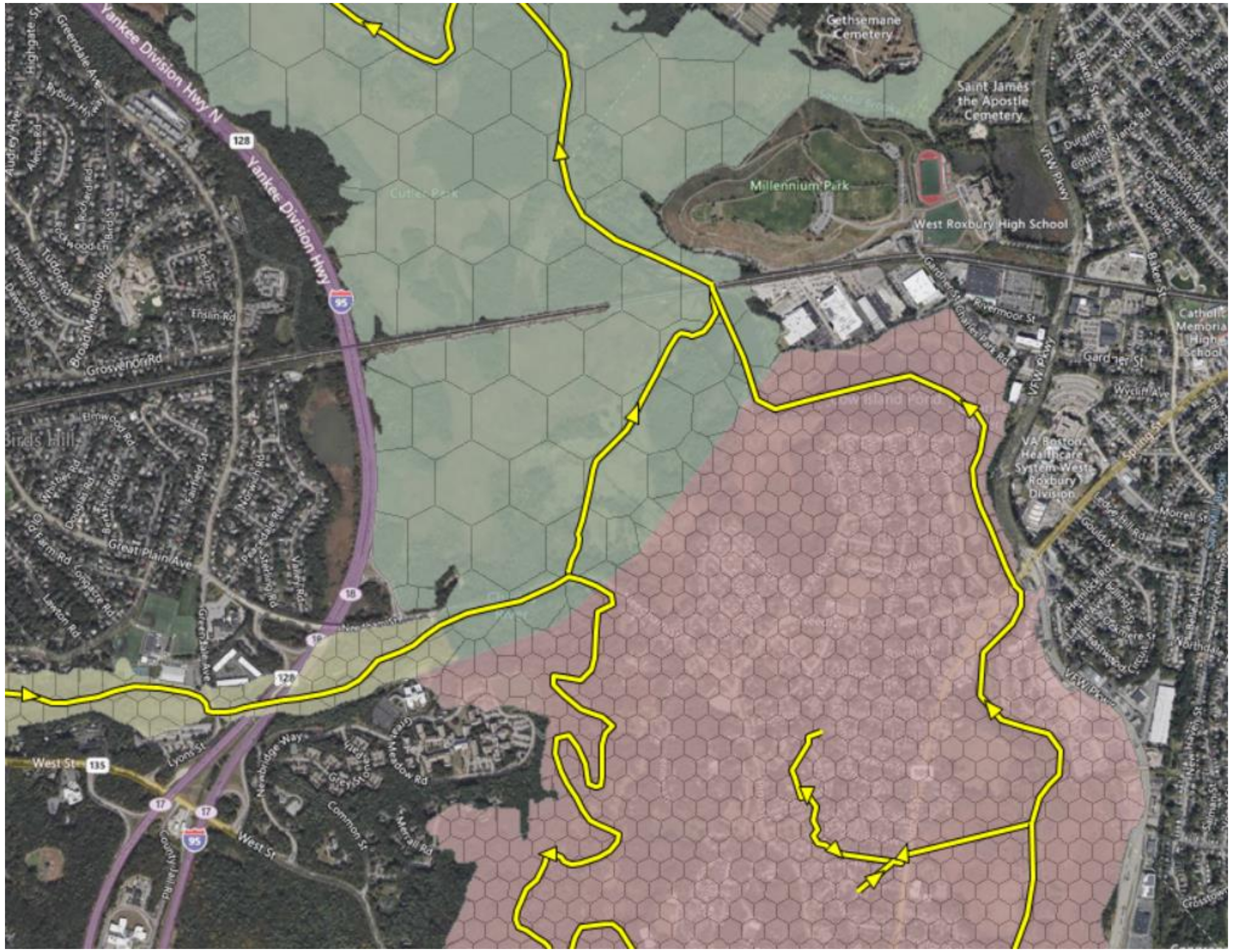


Charles River Watershed Association

2D Cells

- Convey flood flows; provide floodplain storage
- Define boundary areas
- Identify appropriate resolution
- Create 2D nodes from LiDAR
- Create 2D cells – 7,748!





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Model Calibration

Charles River Watershed Association

Presentation Outline

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Weston & Sampson

Model Calibration

- Calibrated to the March 2010 Storm

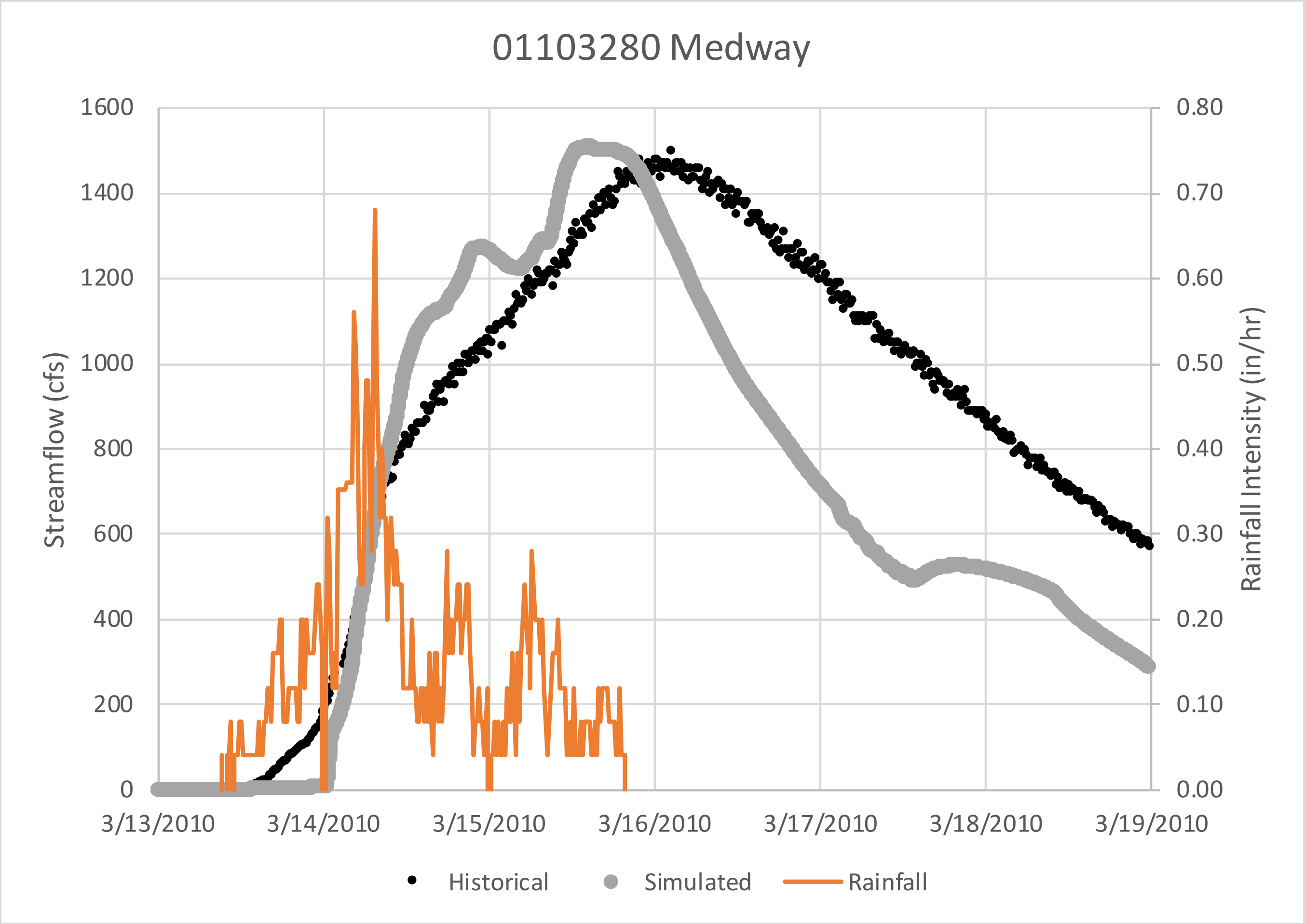
- Based on 15-min data from the USGS gage on Stony Brook:
  - 8.99 inches in 58.5 hrs
  - Peak rainfall intensity of 0.68 in/hr
  - Approximately the 65-yr 48-hour event
  - Flooding was close to 100-yr or even worse in places due to the saturated ground, preceding rainfall, and snowmelt

  - Model was calibrated at 5 gage locations (Medway, Dover, Wellesley, Waltham, Stony Brook Reservoir) for 3 parameters (runoff volume, peak flow, timing of peak)

Model Calibration

Charles River Watershed Association

Medway USGS Gage



Comparison	*Charles River* Medway 01103280
Sim Vol	362,590,258
Hist Vol	443,952,000
% difference	-22%
Sim Peak	1,509
Hist Peak	1,500
% difference	1%
Sim Time	3/15/10 14:32
Hist Time	3/16/10 2:30
Time Dev	-0.5

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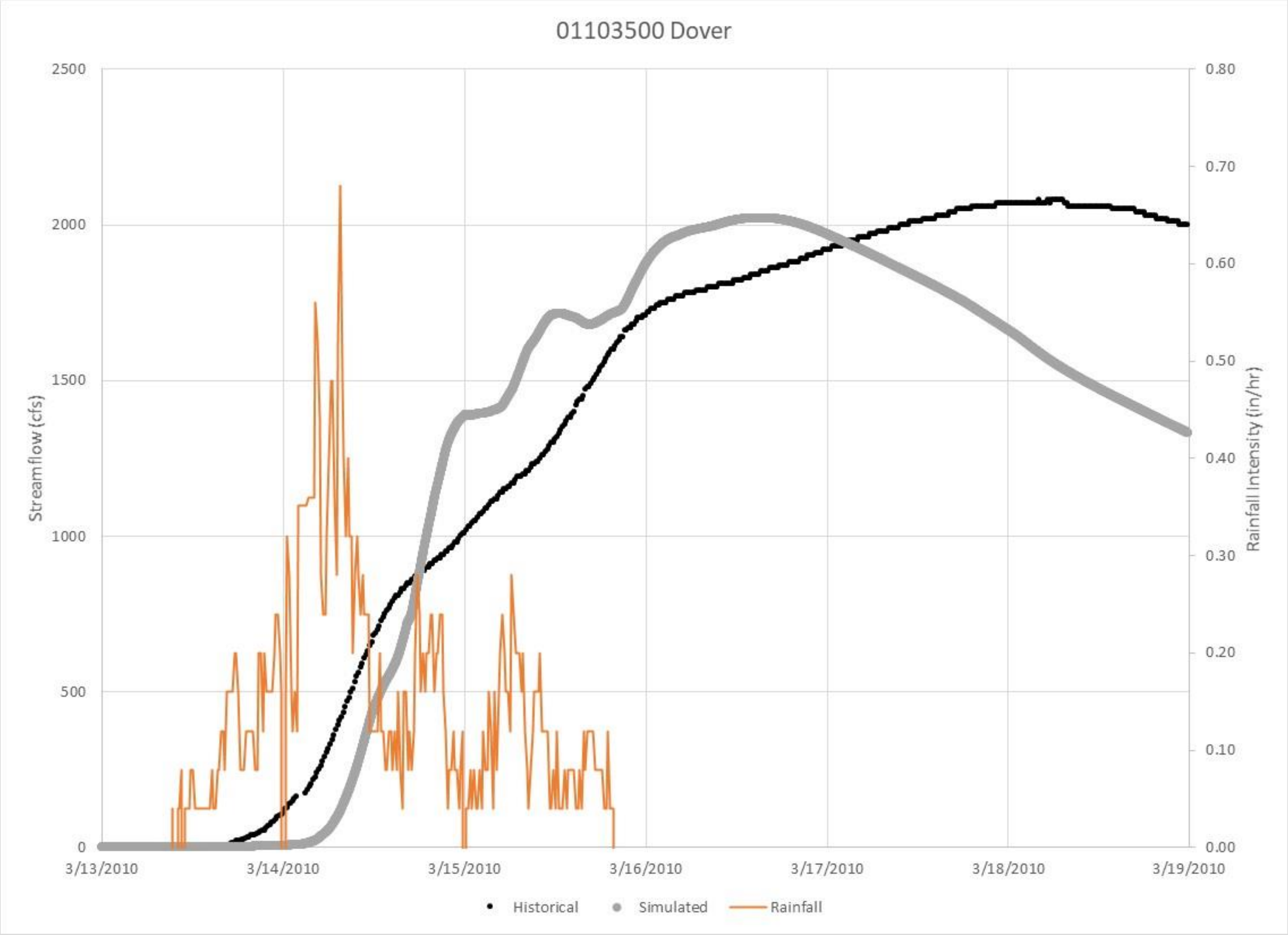
Model Calibration

Charles River Watershed Association

Dover USGS Gage



Comparison	*Charles River*
	Dover
	01103500
Sim Vol	640,644,430
Hist Vol	676,152,900
% difference	-6%
Sim Peak	2,022
Hist Peak	2,080
% difference	-3%
Sim Time	3/16/10 14:59
Hist Time	3/18/10 4:00
Time Dev	-1.5

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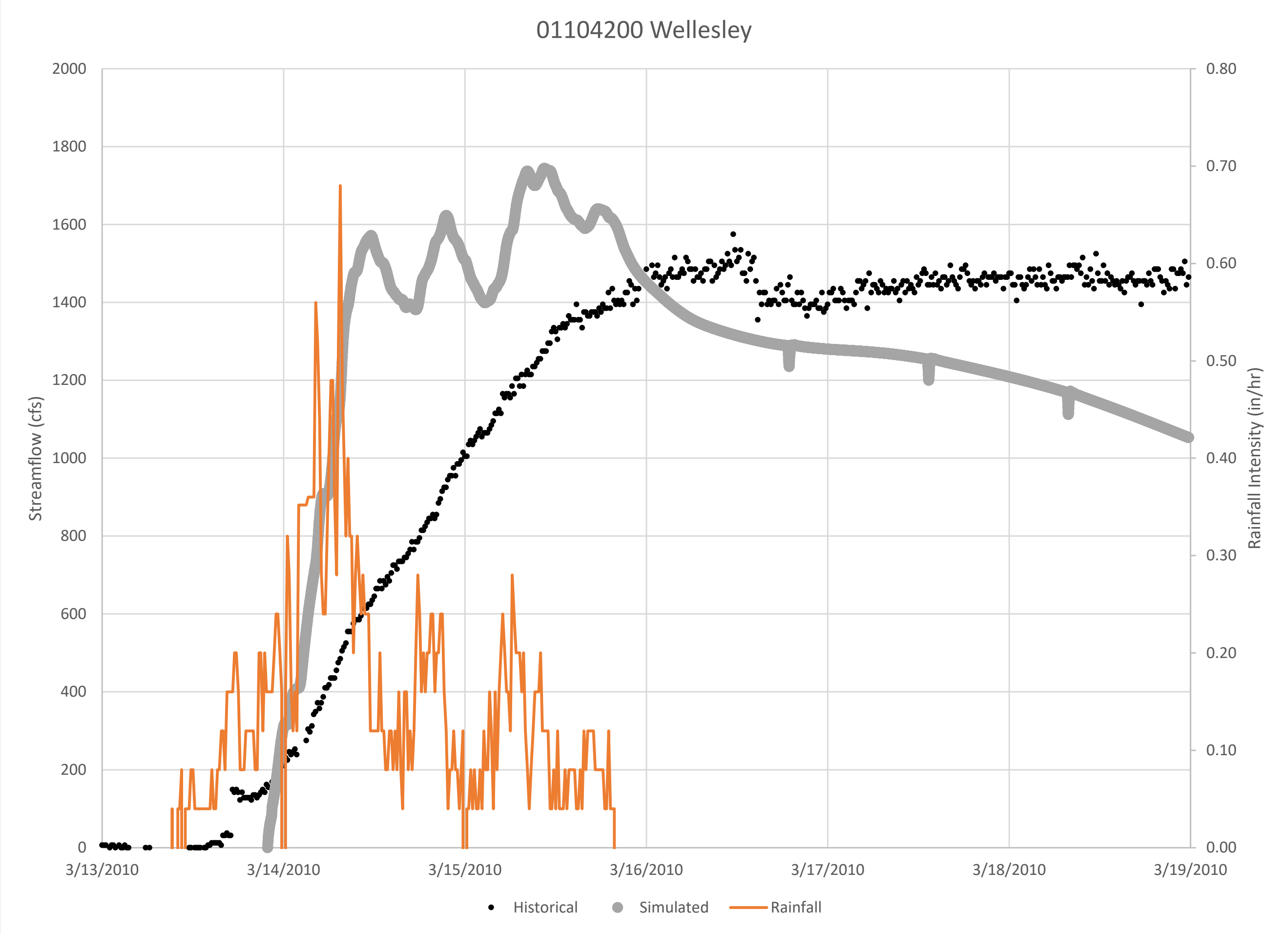
Model Calibration

Charles River Watershed Association

Wellesley USGS Gage



Comparison	*Charles River* Wellesley 01104200
Sim Vol	564,941,368
Hist Vol	542,532,600
% difference	4%
Sim Peak	1,744
Hist Peak	1,575
% difference	11%
Sim Time	3/15/10 10:31
Hist Time	3/16/10 11:30
Time Dev	-1.0

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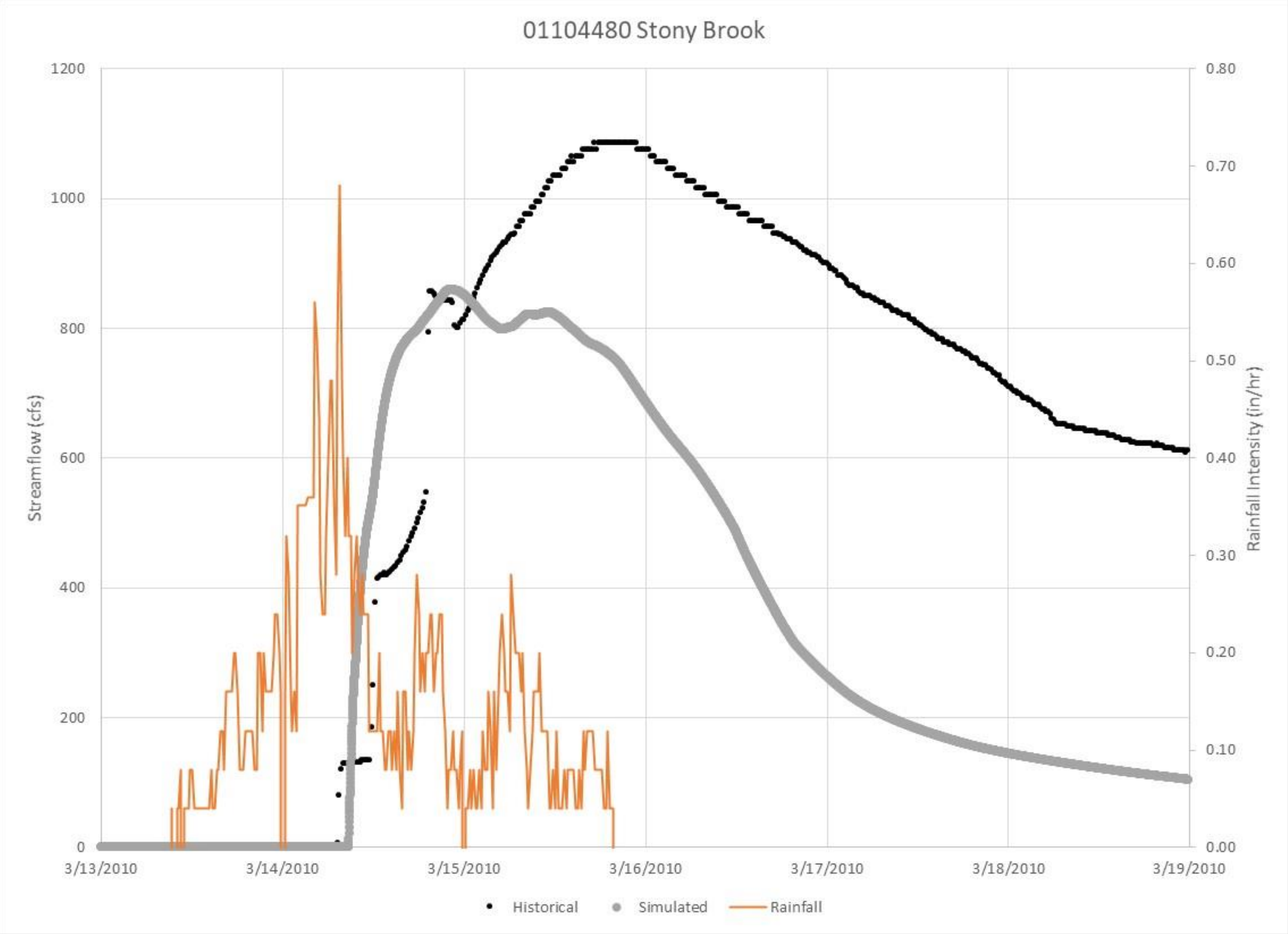
Model Calibration

Charles River Watershed Association

Stony Brook Reservoir USGS Gage



Comparison	*Stony Brook*
	Stony Brk
	01104480
Sim Vol	174,179,406
Hist Vol	325,443,690
% difference	-87%
Sim Peak	859
Hist Peak	1,086
% difference	-21%
Sim Time	3/14/10 22:15
Hist Time	3/15/10 17:15
Time Dev	-0.8

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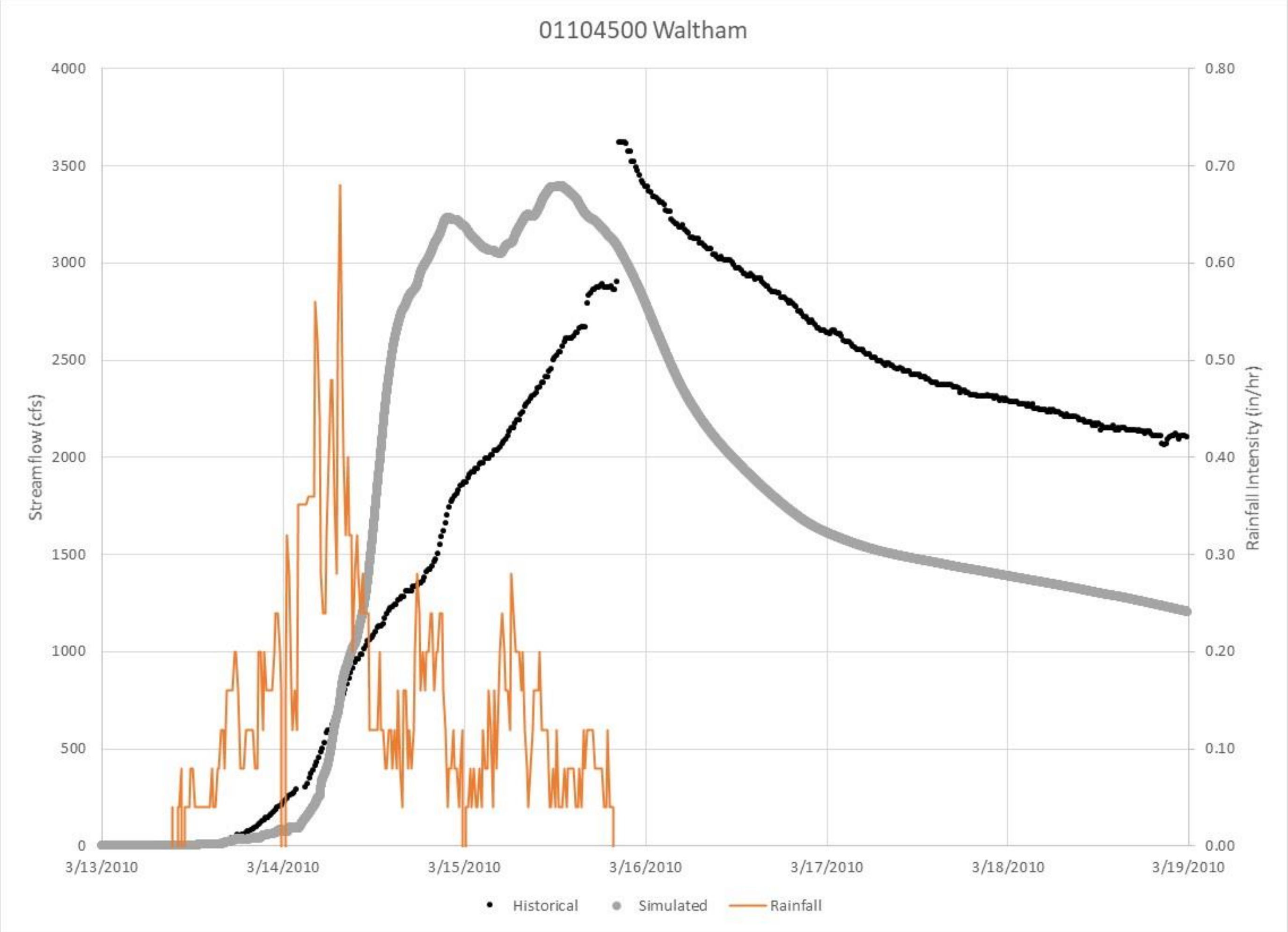
Model Calibration

Charles River Watershed Association

Waltham USGS Gage



Comparison	*Charles River*
	Waltham
	01104500
Sim Vol	838,246,510
Hist Vol	966,411,900
% difference	-15%
Sim Peak	3,397
Hist Peak	3,622
% difference	-6%
Sim Time	3/15/10 12:44
Hist Time	3/15/10 20:30
Time Dev	-0.3

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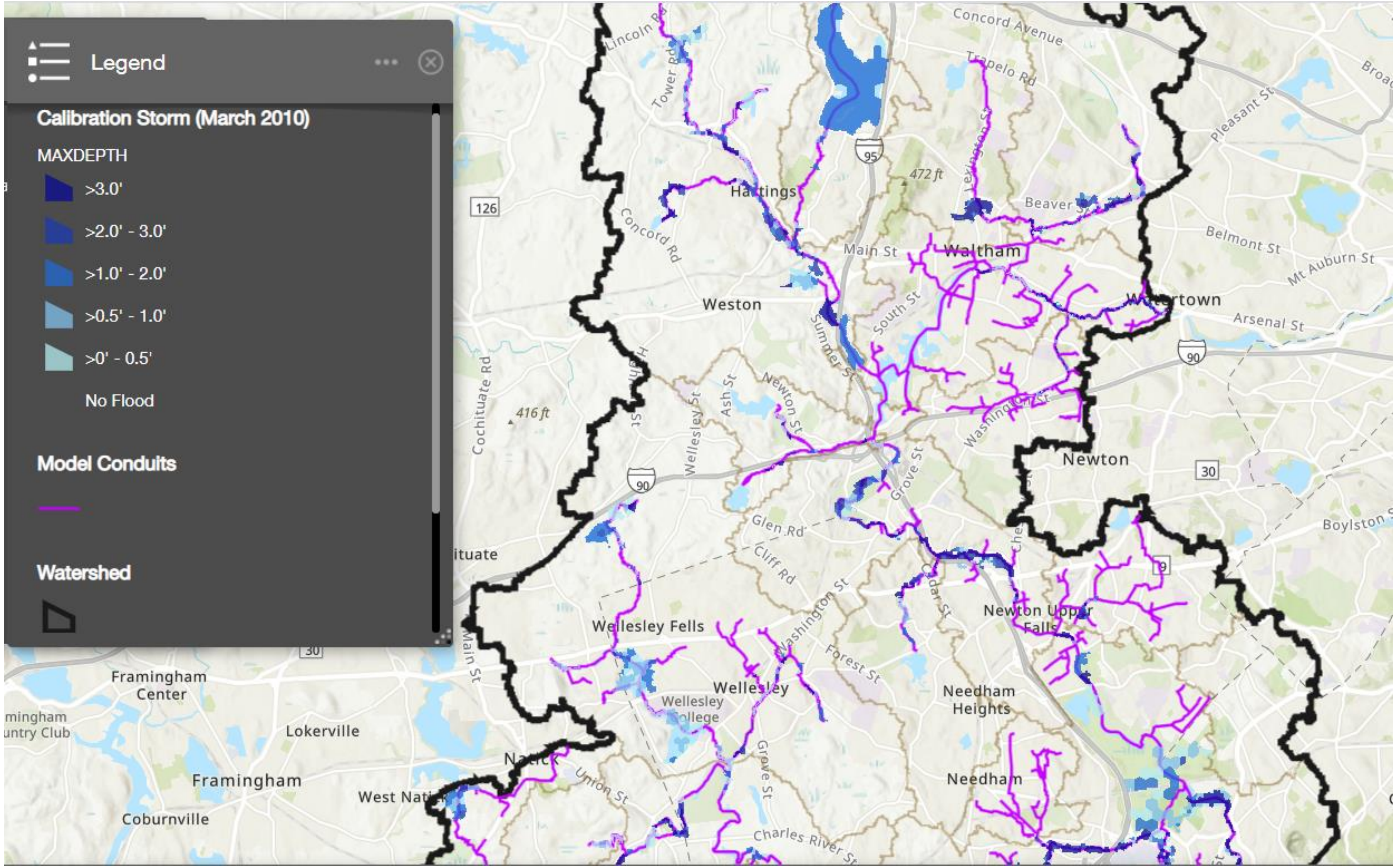
Model Calibration

Charles River Watershed Association

2D Flood Model Results for March 2010 Storm



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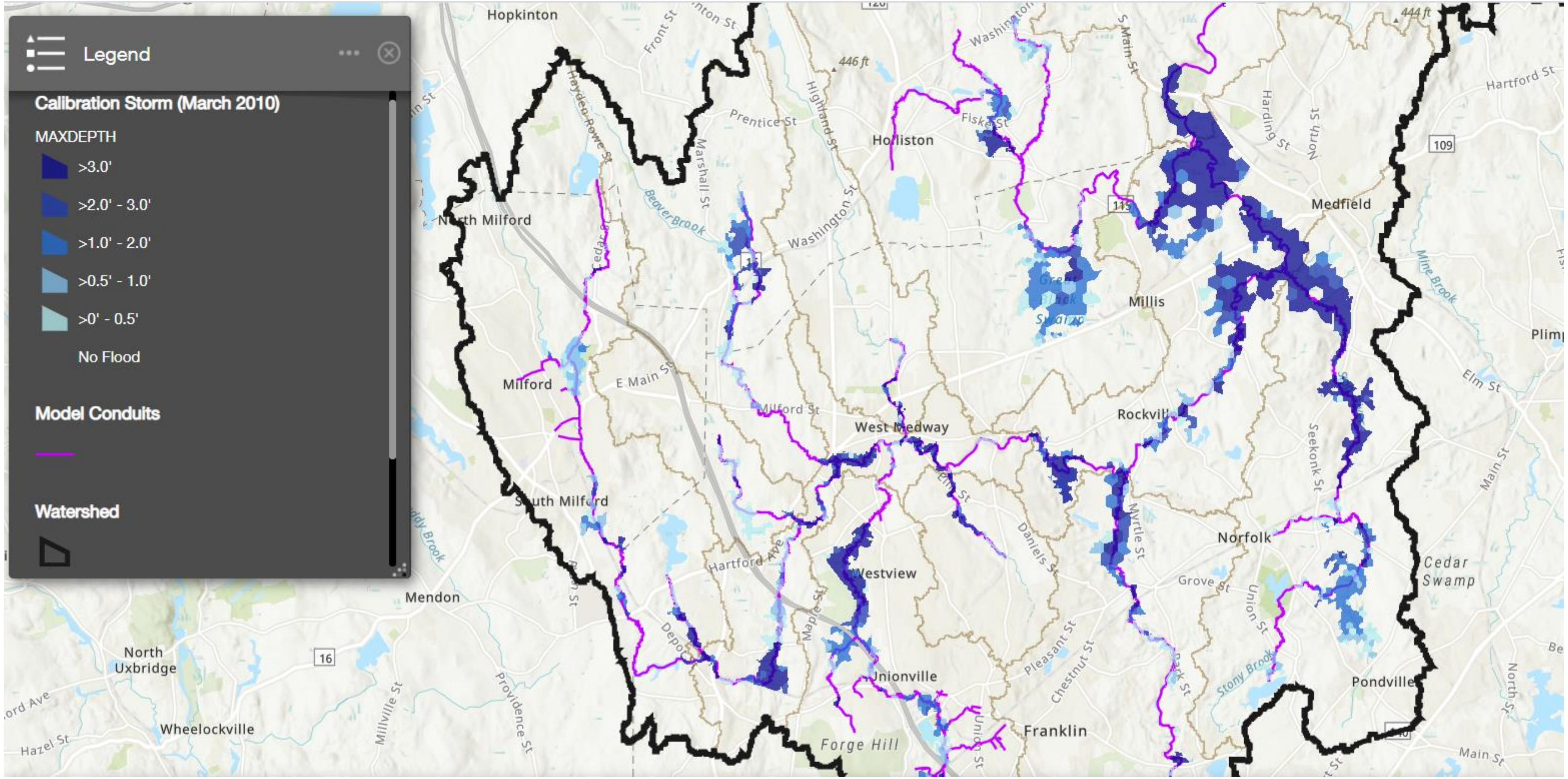
2D Model Results for March 2010 Storm



Model Calibration

Charles River Watershed Association

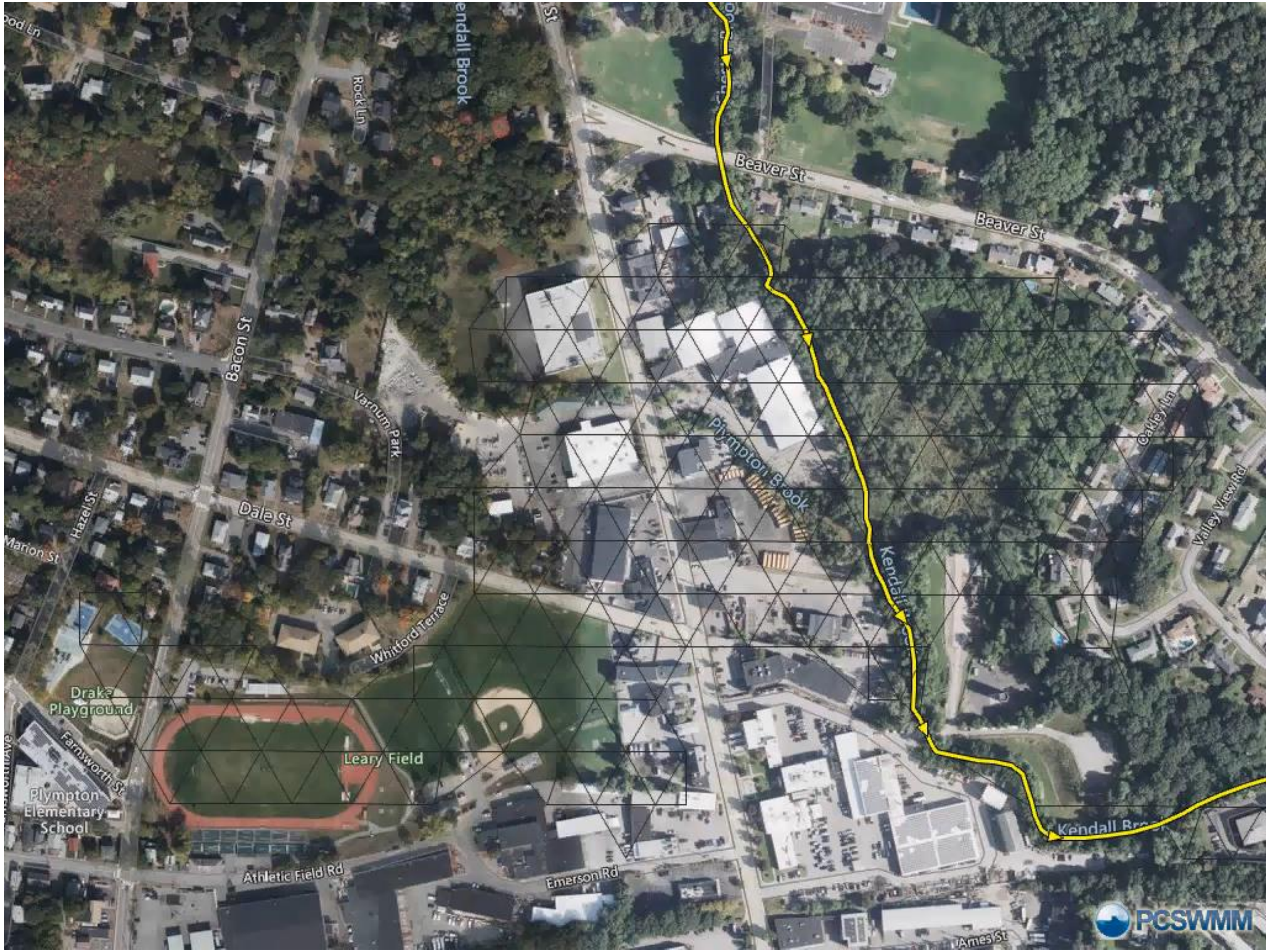
2D Flood Model Results – William St, Wellesley

Weston & Sampson

Model Calibration

Charles River Watershed Association

2D Flood Model Results –Plympton Brook Area, Waltham



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Future Storm Simulations

Charles River Watershed Association

Presentation Outline

- Recap future rainfall scenarios
- Model development
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- **Future storm simulations**
- Flooding impacts in the watershed
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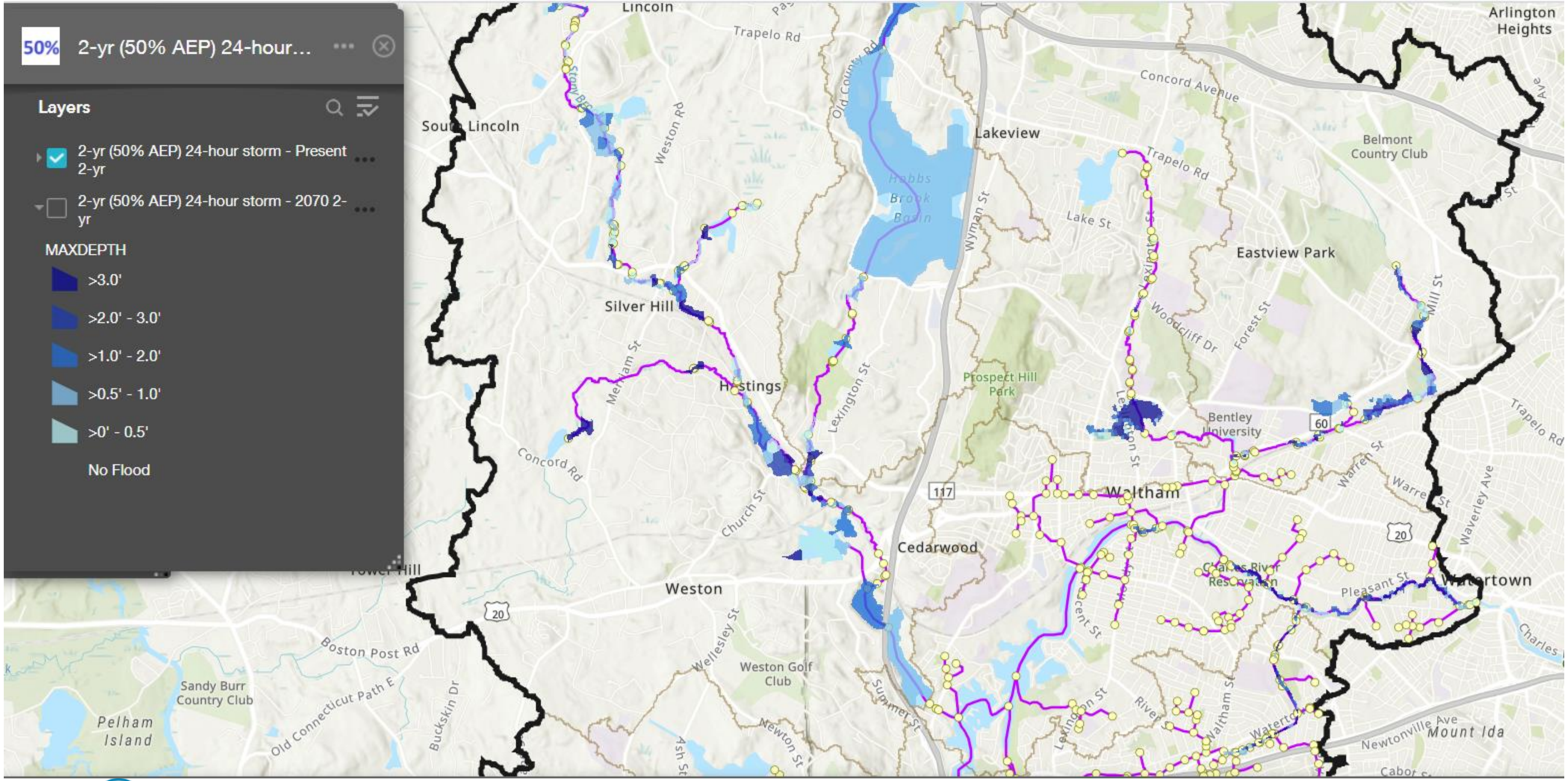
Weston & Sampson

Future Storm Simulations

Charles River Watershed Association

Design Storm Simulations – 2yr Storm Present (3.3 inches in 24 hrs)



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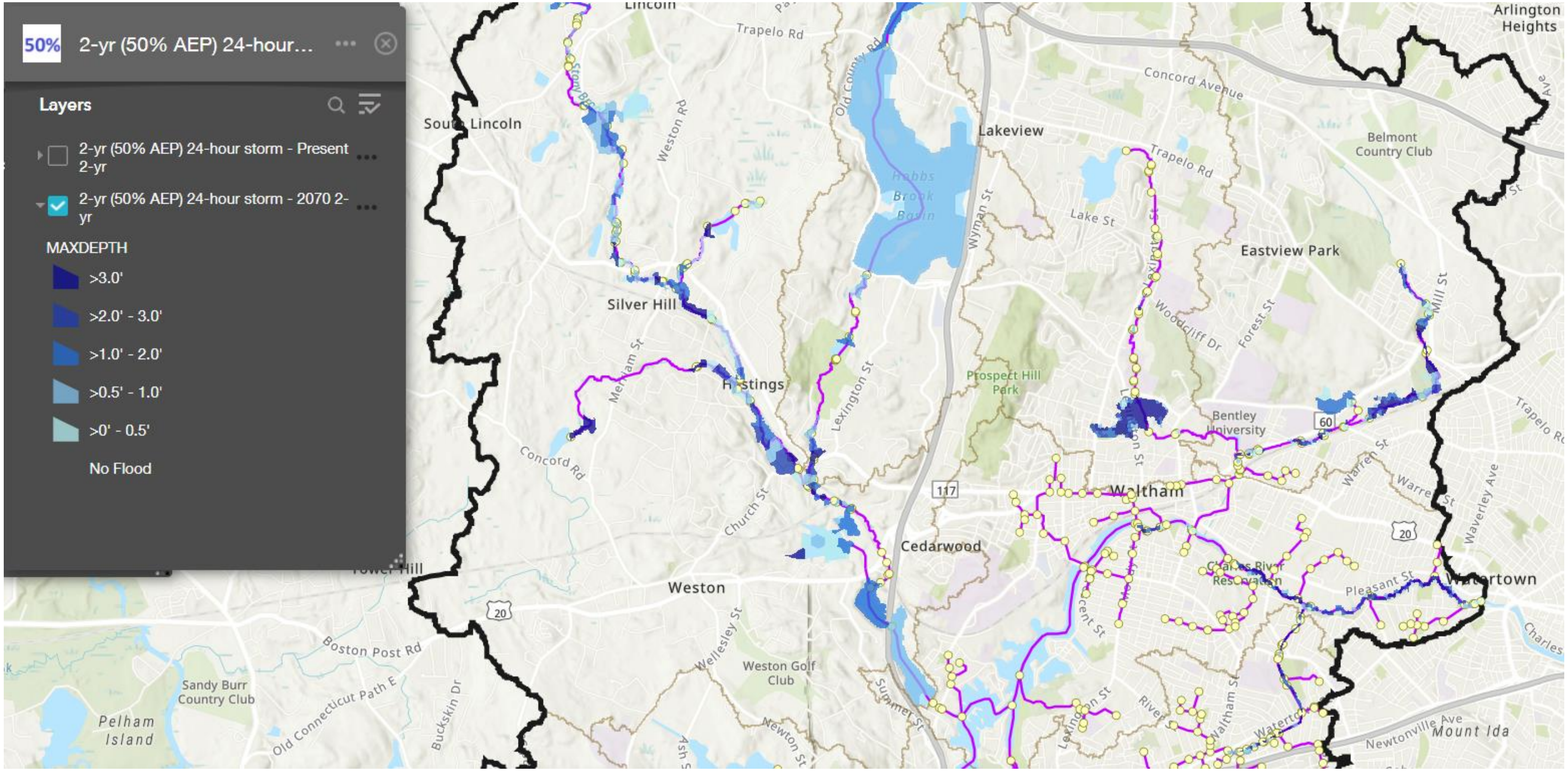
Future Storm Simulations

Charles River Watershed Association

Design Storm Simulations – 2yr Storm 2070 (4 inches in 24 hrs)



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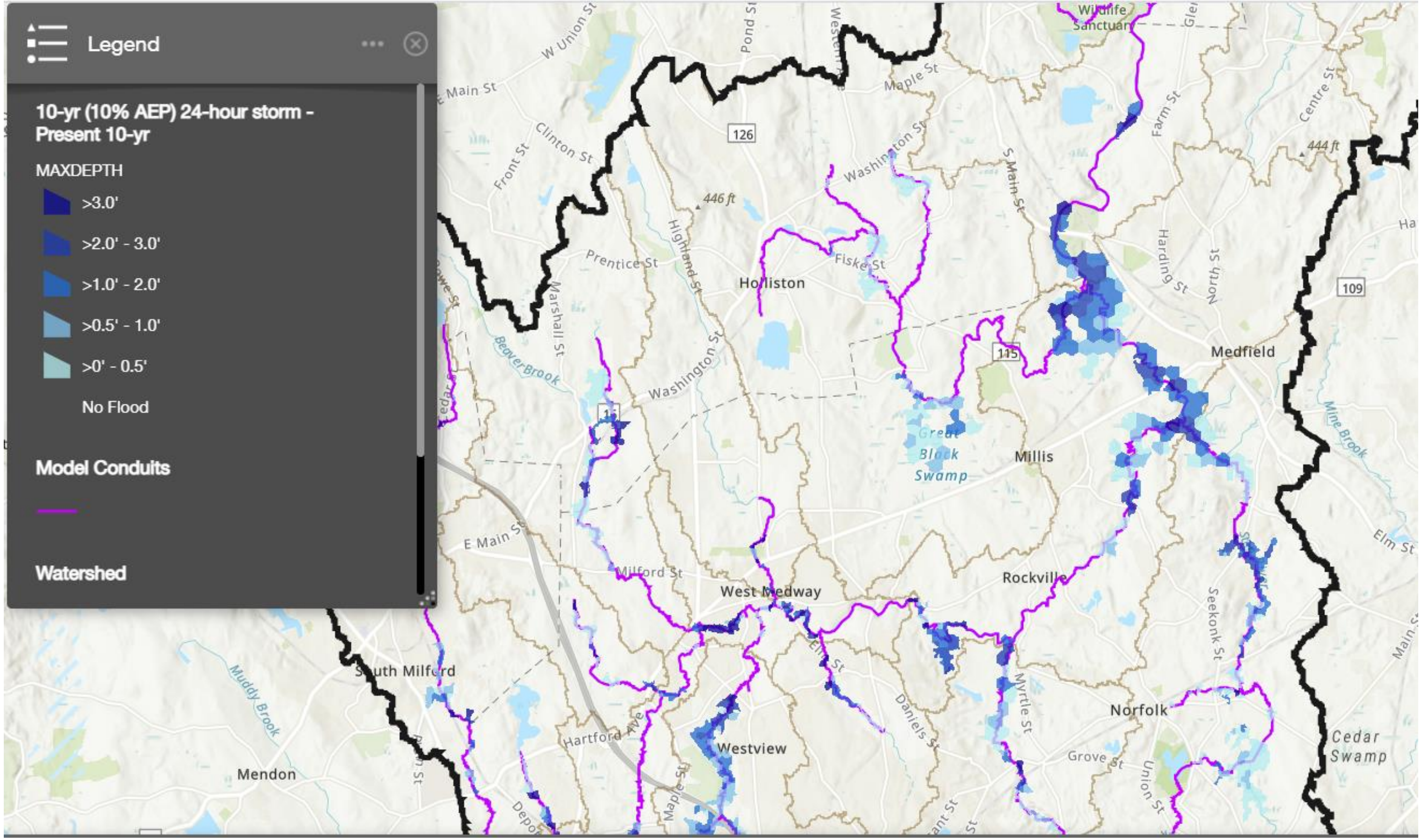
Future Storm Simulations

Charles River Watershed Association

Design Storm Simulations – 10 yr Storm Present (5.2 inches in 24 hrs)



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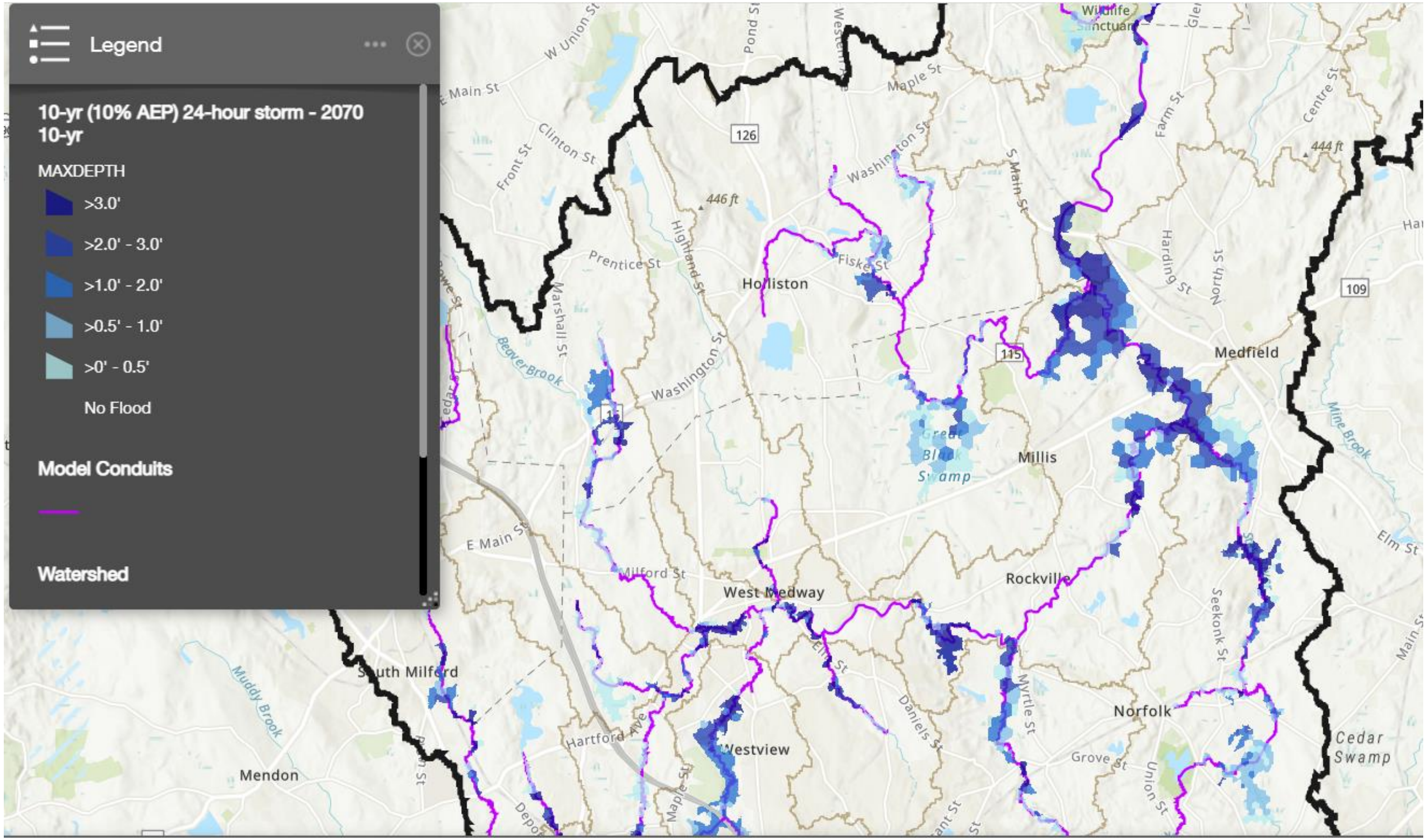
Charles River Watershed Association

Design Storm Simulations – 10 yr Storm 2070 (6.3 inches in 24 hrs)



Weston & Sampson

Presentation Outline

- Recap future rainfall scenarios
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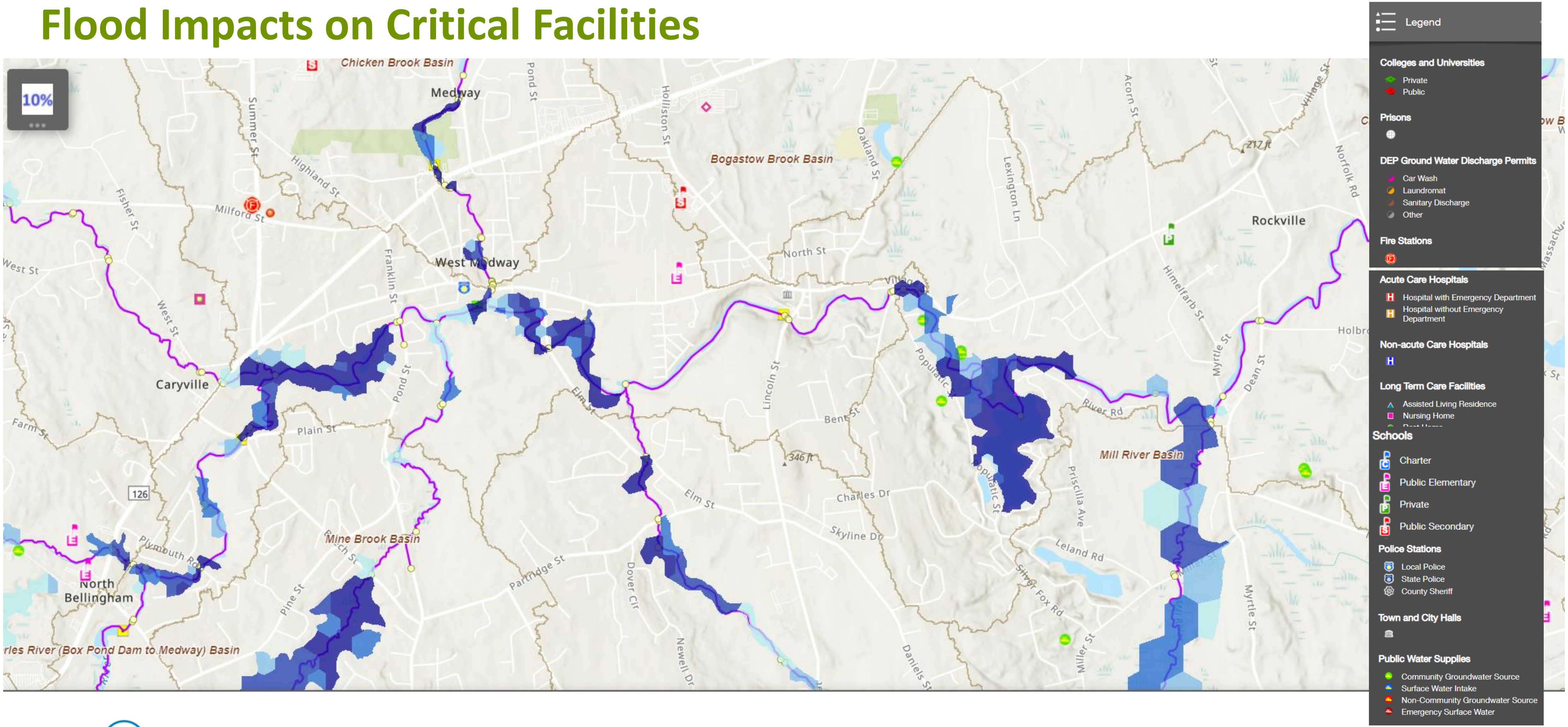
Flood Impacts

Charles River Watershed Association

Flood Impacts on Critical Facilities



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Flood Impacts

Charles River Watershed Association

Flood Impacts Across the Watershed

	# of Critical Facilities Impacted	Acres of flooding (ac)	Runoff Volume (MG)
Present 2-yr storm	33	3,186	3,053
2070 2-yr storm	42	4,389	4,264
Increase from Present	*+9*	*+1,203*	*+1,211*
Present 10-yr storm	53	6,909	7,368
2030 10-yr storm	56	7,630	8,642
Increase from Present	*+3*	*+721*	*+1,274*
2070 10-yr storm	56	8,579	10,651
Increase from Present	*+3*	*+1,670*	*+3,283*
March 2010 Storm (8.99 inches)	59	10,446	20,831

Flood Impacts

Charles River Watershed Association

Flood Impacts in Beaver Brook (Waltham)

	# of Critical Facilities Impacted	Acres of flooding (ac)	Runoff Volume (MG)
Present 2-yr storm	3	74.4	99
2070 2-yr storm	3	80.3	136
Increase from Present	---	*+5.9*	*+37*
Present 10-yr storm	4	95.8	225
2030 10-yr storm	4	112.1	259
Increase from Present	---	*+16.3*	*+34*
2070 10-yr storm	4	116.3	313
Increase from Present	---	*+20.5*	*+88*
March 2010 Storm (8.99 inches)	4	93.7*	573

*Timing of runoff from individual sub-basins for this historical event muted the peak discharge and flooding extents.

Weston & Sampson

Modeling Nature Based Solutions

Charles River Watershed Association

Presentation Outline

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- **Example results from a GI scenario**
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Weston & Sampson

Modeling Nature Based Solutions

Charles River Watershed Association

Scenarios Selected

Green Stormwater Infrastructure
1. Green infrastructure stores 2" storm runoff from up to 50% of all impervious cover town-wide
2. 10% of feasible/priority land area is GSI
3. Storage on large (>5 acres) public properties (GSI, underground storage, "blue roofs") (site specific strategy)

Reduce Impervious Cover
4. Reduce effective impervious cover watershed wide by 10% (for subbasins over 10%)

Land Conservation
5. Allow 50% of remaining undeveloped/unprotected land to become impervious

Other
6. Increase Tree Canopy: 25% public ROWS become green streets: tree box filters/bioswales connected to leaching catch basins

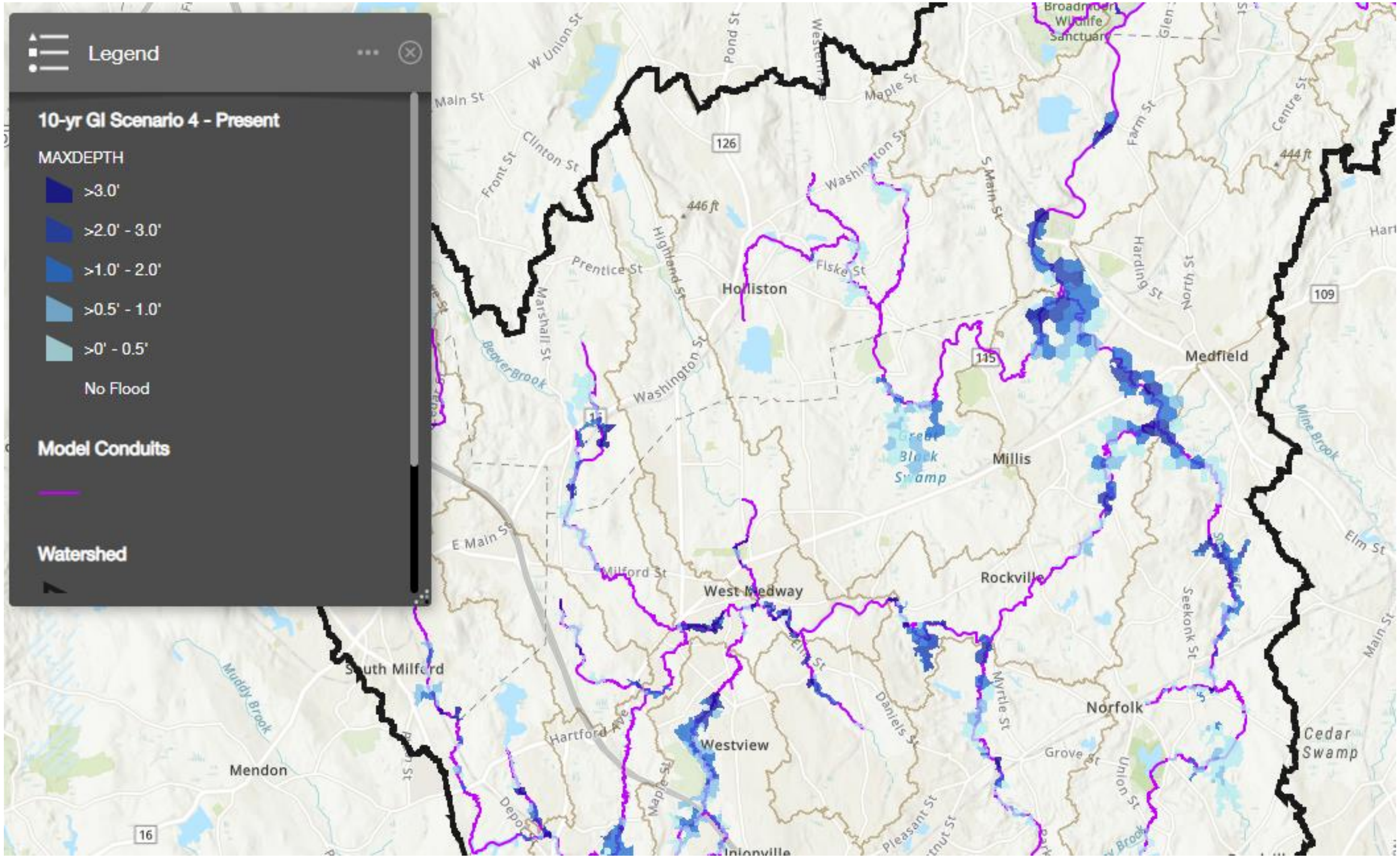
Alternates:
Wetland Restoration: All wetland areas 10% larger
Dam removal: Remove all dams other than active flood control dams

**Data details from May 5th presentation found here.

Nature Based Solution Model Runs

Charles River Watershed Association

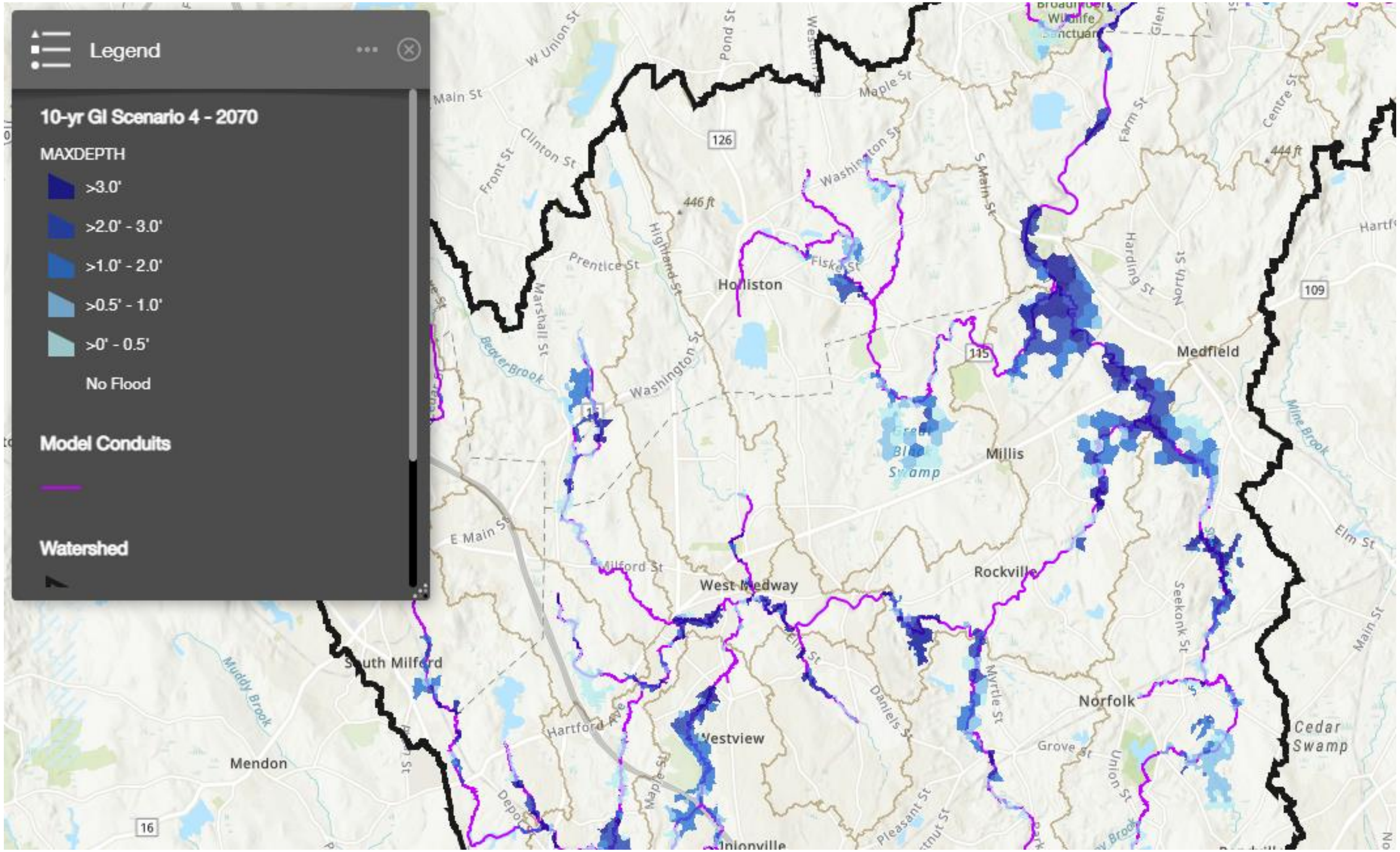
Green Infrastructure Sc 4 – 10 yr Storm Present (5.2 inches in 24 hrs)



Weston & Sampson

Nature Based Solution Model Runs

Green Infrastructure Sc 4 – 10 yr Storm 2070 (6.3 inches in 24 hrs)



Nature Based Solution Model Runs

Charles River Watershed Association

Flood Benefits Across the Watershed – Green Infrastructure Scenario 4

	# of Critical Facilities Impacted	Acres of flooding (ac)	Runoff Volume (MG)
Present 10-yr storm – No Action	53	6,909	7,368
Present 10-yr storm + GI Sc 4	50	6,790	7,142
Change from No Action	-3	-119	-226
2070 10-yr storm – No Action	56	8,579	10,651
2070 10-yr storm + GI Sc 4	56	7,906	10,401
Change from No Action	---	-673	-250

Weston & Sampson

Nature Based Solution Model Runs

Charles River Watershed Association

Flood Benefits in Beaver Brook – Green Infrastructure Scenario 4

	# of Critical Facilities Impacted	Acres of flooding (ac)	Runoff Volume (MG)
Present 10-yr storm – No Action	4	95.8	225
Present 10-yr storm + GI	4	88.0	212
Change from No Action	---	-7.8	-13
2070 10-yr storm – No Action	4	116.3	313
2070 10-yr storm + GI	4	106.2	298
Change from No Action	---	-10.1	-15

Weston & Sampson

Online Viewer Demo

Presentation Outline

Recap future rainfall scenarios

Model development

Model calibration

Future storm simulations

Flooding impacts in the watershed

Recap green infrastructure (GI) scenario runs

Example results from a GI scenario

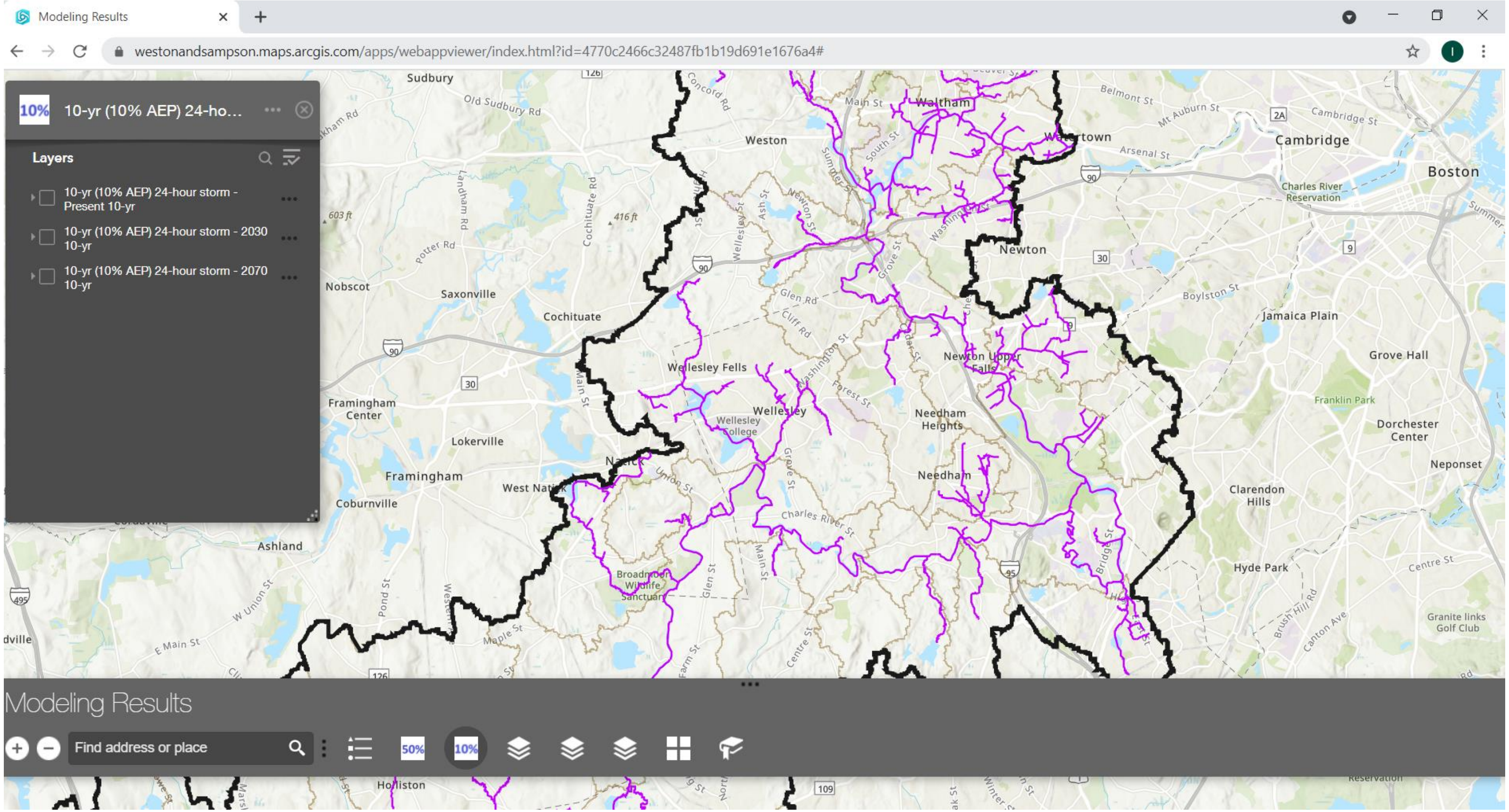
Online viewer demonstration

Questions and next steps

Online Viewer Demo

Charles River Watershed Association

[Online Viewer](#)



Question & Next Steps

Charles River Watershed Association

Presentation Outline

- Recap future rainfall scenarios
- Model development
- Model calibration
- Future storm simulations
- Flooding impacts in the watershed
- Recap green infrastructure (GI) scenario runs
- Example results from a GI scenario
- Online viewer demonstration
- **Questions and next steps**

Weston & Sampson

Upcoming Meetings

Charles River Watershed Association

June 2nd, 1-2 pm: Climate Compact Meeting (bi-monthly meeting rescheduled from May)

June 24th, 1-2 pm: Final project team meeting

-Communication's kit

-Discuss next steps

June 23rd, 7-8pm: Final Public Presentation (virtual event)

- Will be an updated and abbreviated version of what you saw today

CHARLES RIVER WATERSHED MODEL

Appendix A.2:
Project Team Workshop 3 Presentations
(and meeting photo)

Building Resilience Across the Charles River Watershed

Workshop #2 Part 1: Nature Based Solutions
May 5, 2021

Agenda

1:00-1:10: Welcome & Introductions

1:10-1:30: Present Results of Municipal & Public Feedback

1:30-1:45: Present NBS Solutions to be voted on to include in the model

1:45-2:00: Discussion/Survey

Meeting Goal

- Present nature-based solutions that could be modeled
- Discuss prioritization of nature-based solutions
- Take a survey to select strategies to model

We'll review survey results at the end of next Wednesday's training

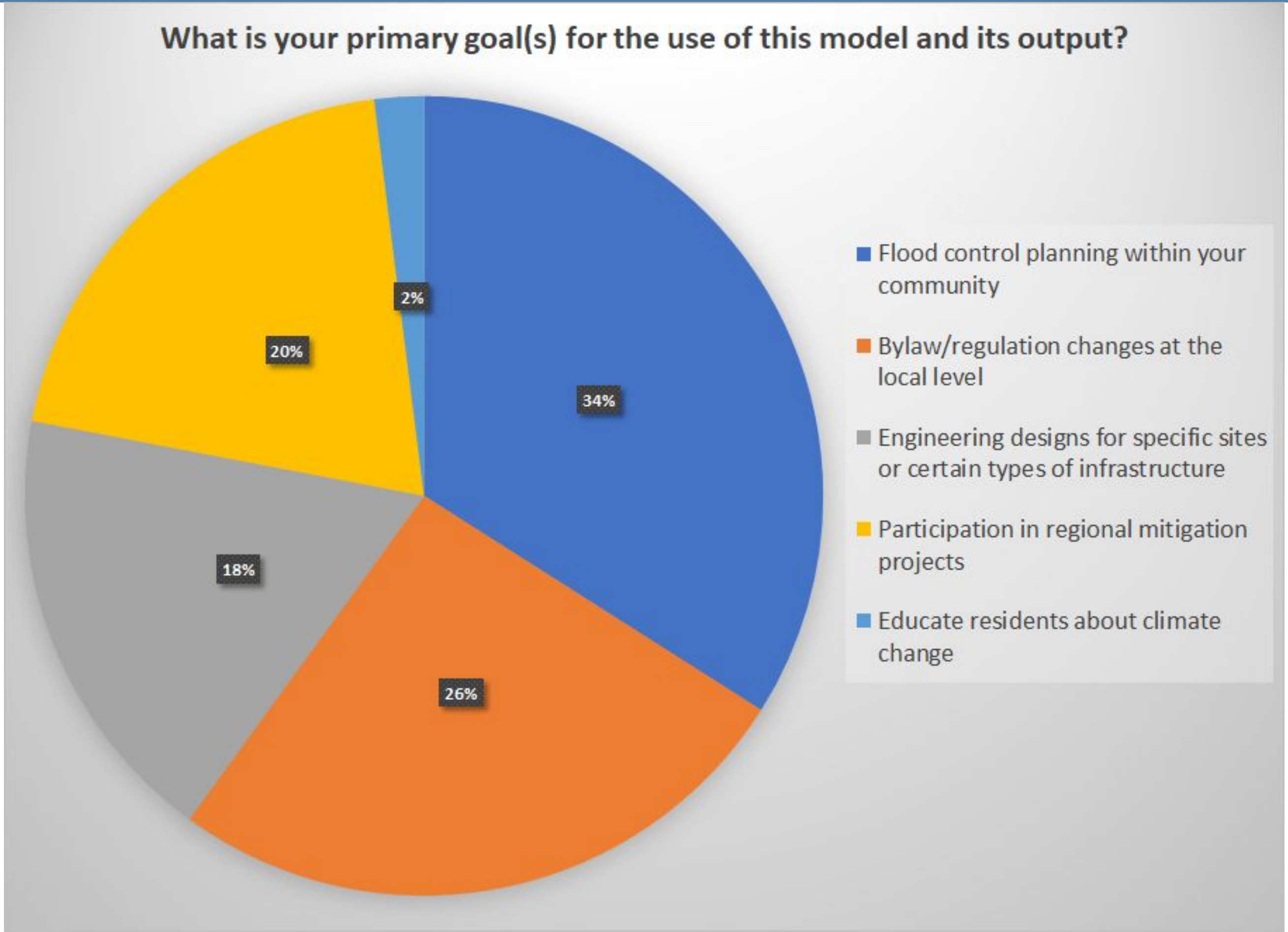
Project Update

- May 12th: Engaging Climate Vulnerability Communities Training
- Update: model results for existing conditions and from the nature-based solutions runs will be presented on **May 26th**
- Model progress update from Indrani
- Don’t forget to document your match hours (spreadsheet now includes a list of project meetings)
- Project end date is June 30th!

Project Team Feedback

Building Resilience Across the Charles River Watershed

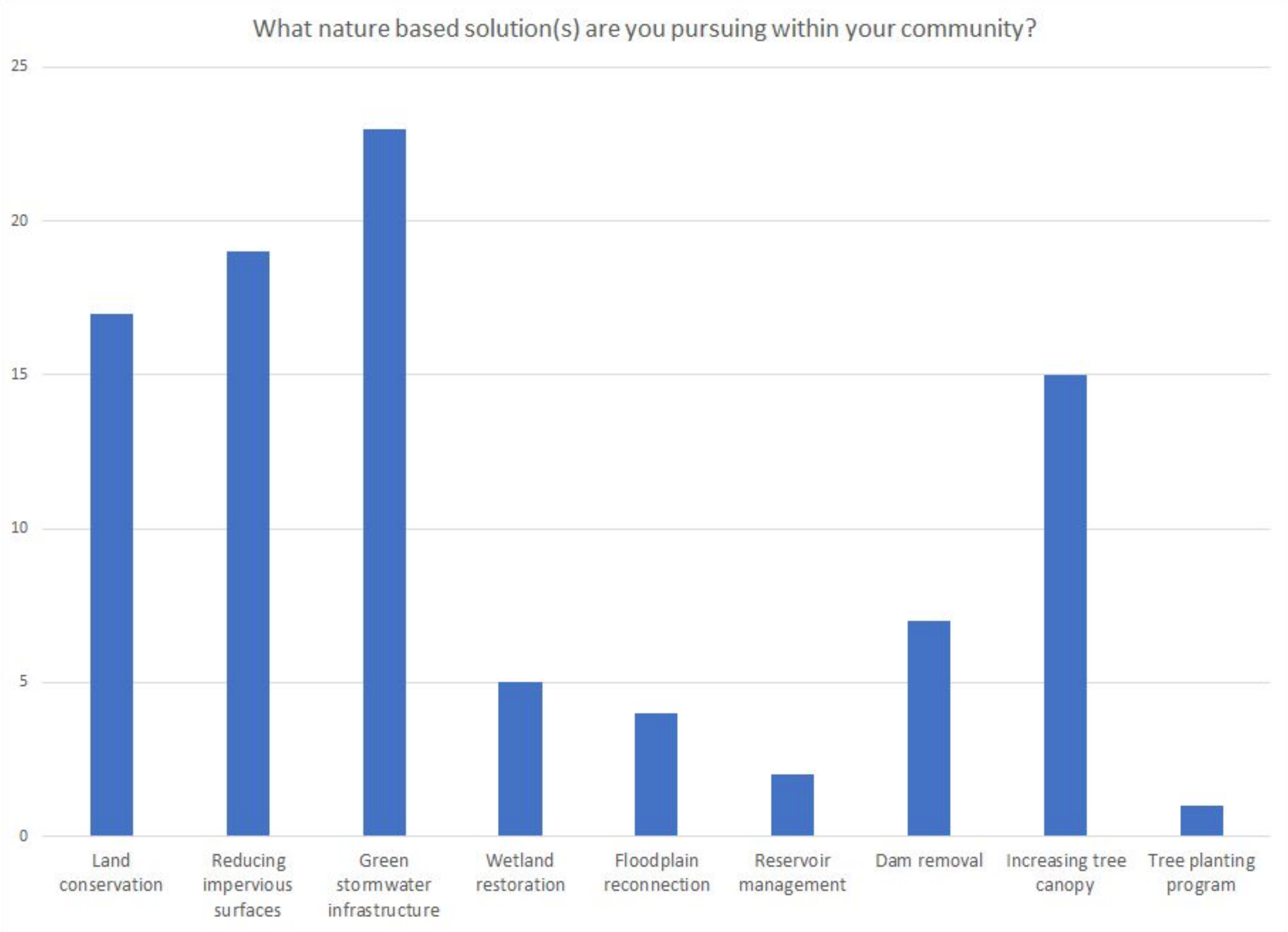
Charles River Watershed Association



Building Resilience Across the Charles River Watershed

Charles River Watershed Association

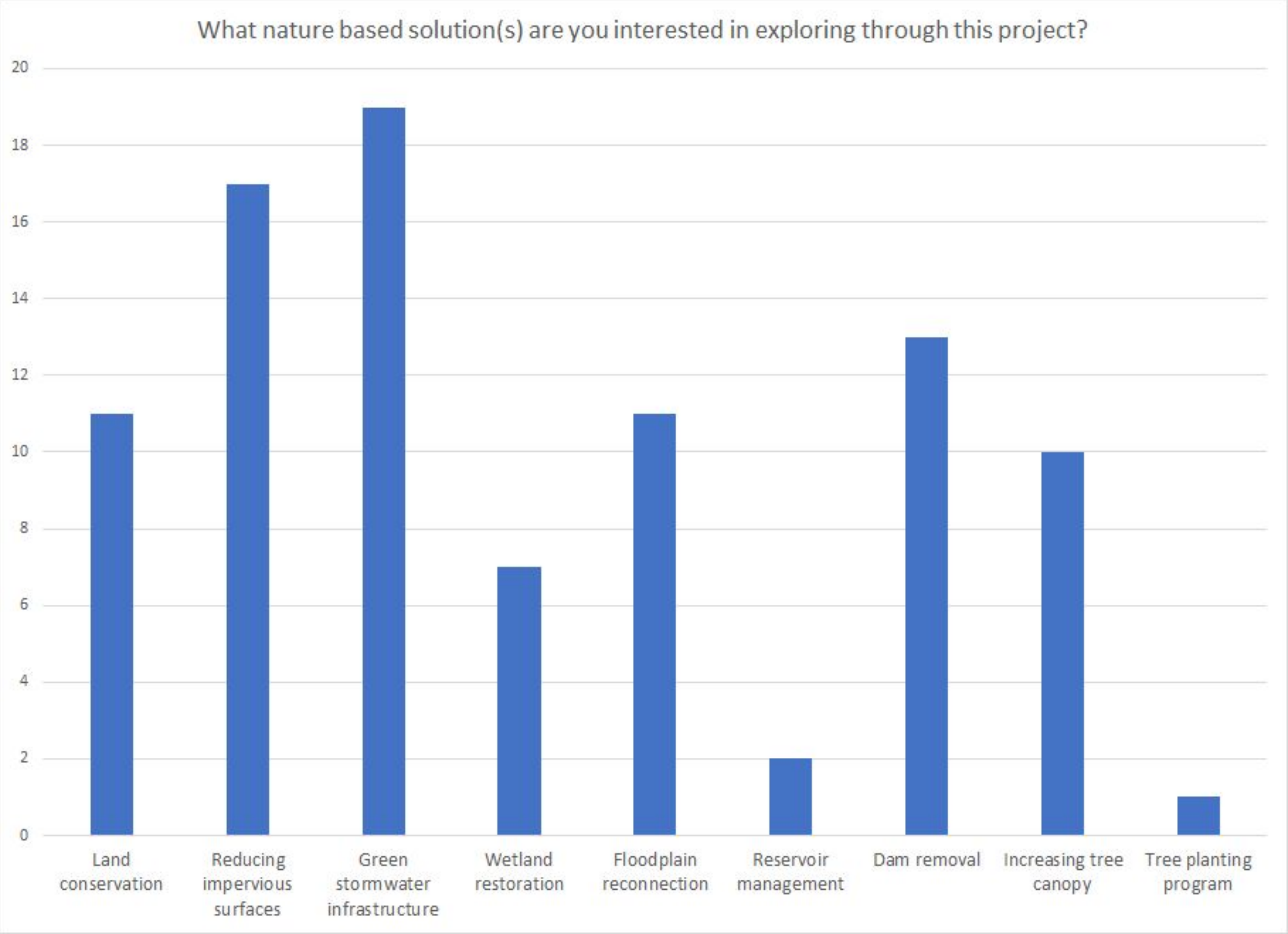
1. GSI
2. < IC
3. Conservation
4. Tree canopy



Building Resilience Across the Charles River Watershed

Charles River Watershed Association

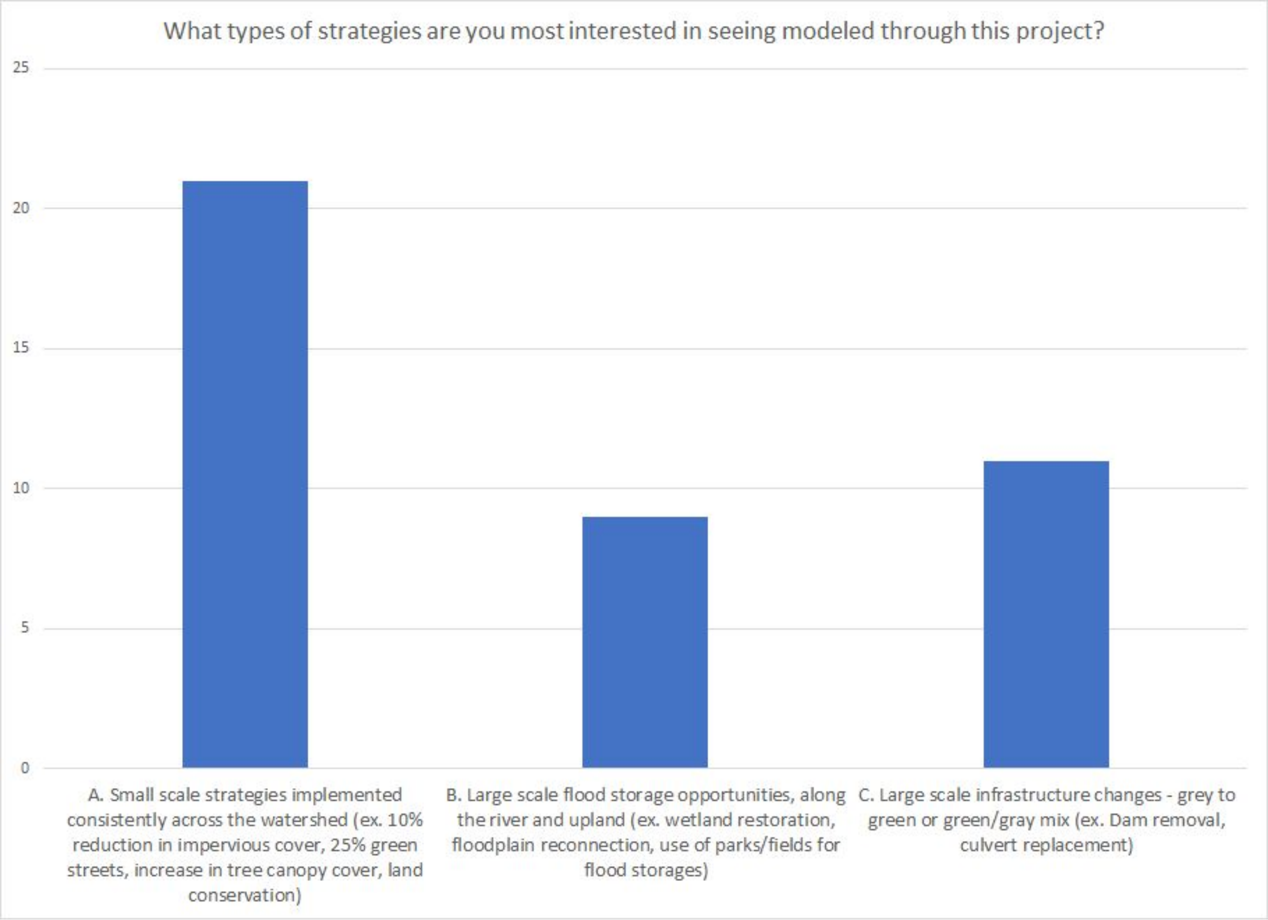
1. GSI
2. < IC
3. Dam Removal
4. Floodplain reconnection
5. Conservation
6. > Tree canopy
7. Wetland restoration



Building Resilience Across the Charles River Watershed

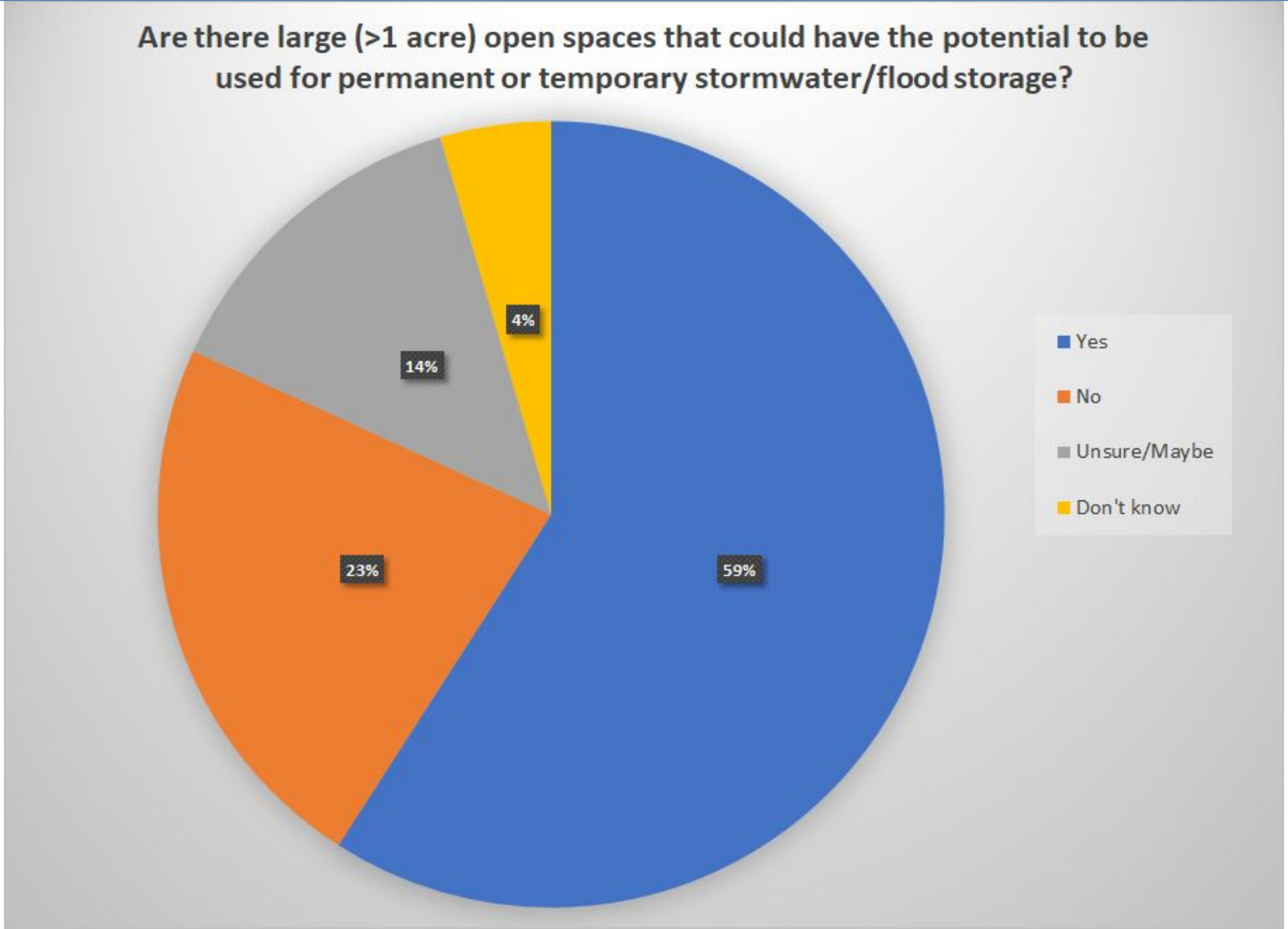
Charles River Watershed Association

1. Small scale strategies (GSI, < IC)
2. Infrastructure changes (dam removal, culvert changes)
3. Large scale flood storage



Building Resilience Across the Charles River Watershed

Charles River Watershed Association



Which of the following, if any, do you think are NOT feasible for your community even if funding for implementation was available?

1. None (all are feasible with funding and public support) (9)
2. Move development out of flood plain (8)
3. All undeveloped lots >2 acres available to provide flood storage (6)
4. Permanently protect >50% of available open space (4)
5. Dam removal (4)
6. Increase tree canopy by up to 25% (4)
7. Wetland construction (river adjacent and upland) (3)
8. Green infrastructure stores 1.5” storm runoff from 50% of all impervious cover town-wide (3)
9. Dam management changes (2)
10. Decrease directly connected / effective impervious cover by 10-25% (2)
11. Restore culverted streams (1)

Building Resilience Across the Charles River Watershed

Charles River Watershed Association

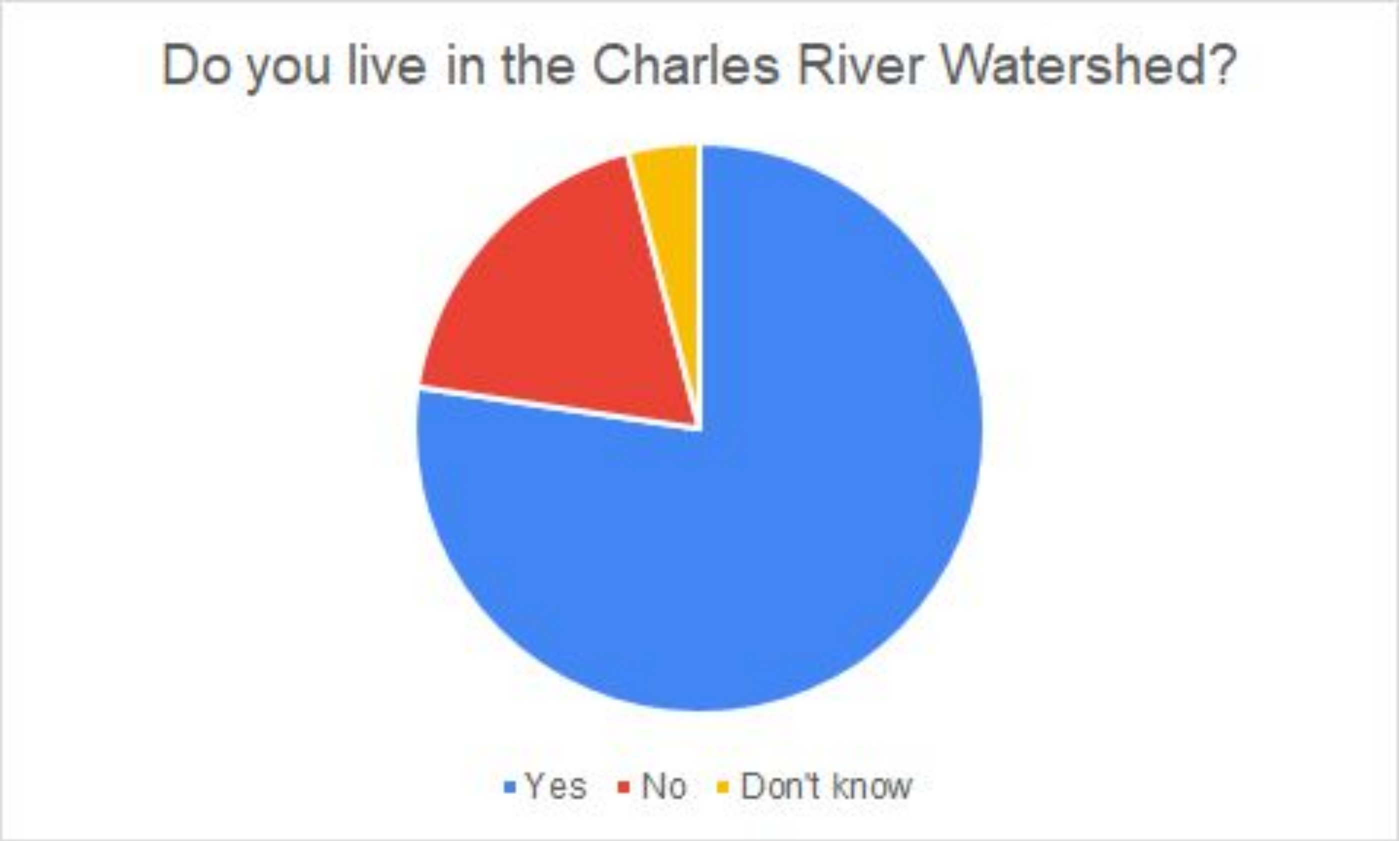
Public Feedback

Public Survey Results

Two Surveys:

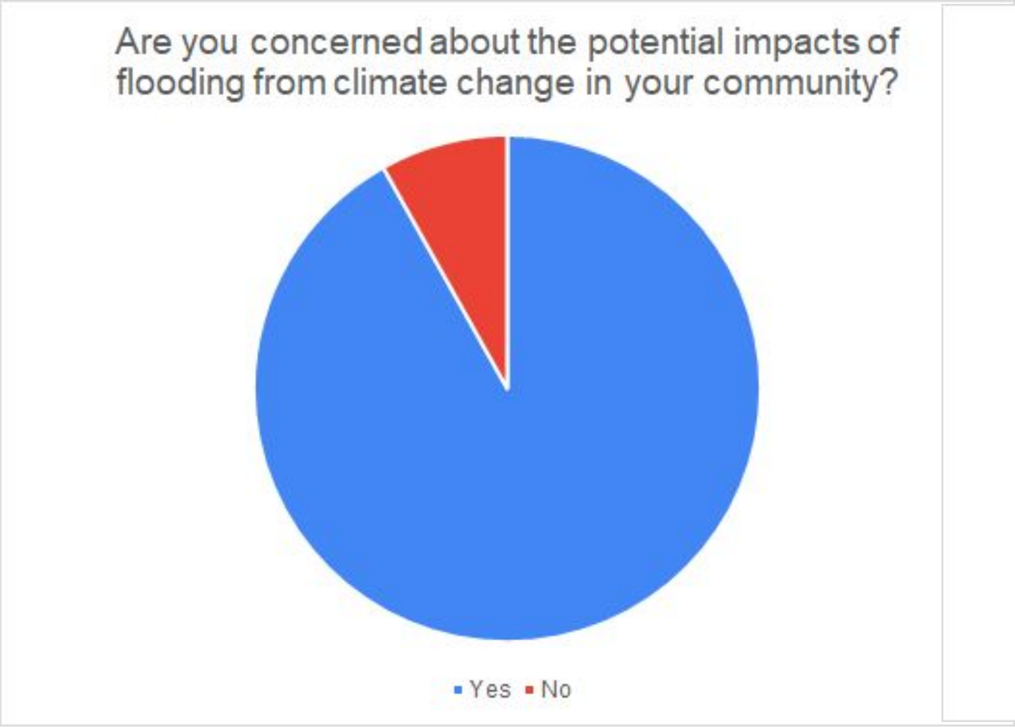
- one issued to virtual event attendees (69 responses)
- one issued to general public (103 responses)

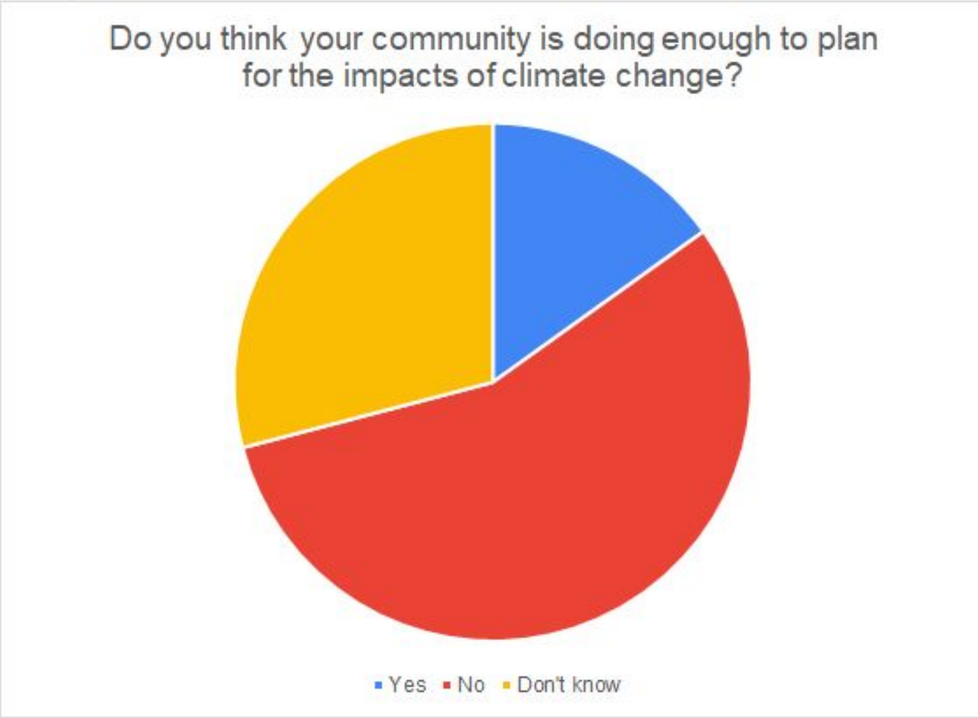
Also had three non-English surveys but did not get any responses: learning opportunity


Do you live in the Charles River Watershed?
Yes
No
Don't know

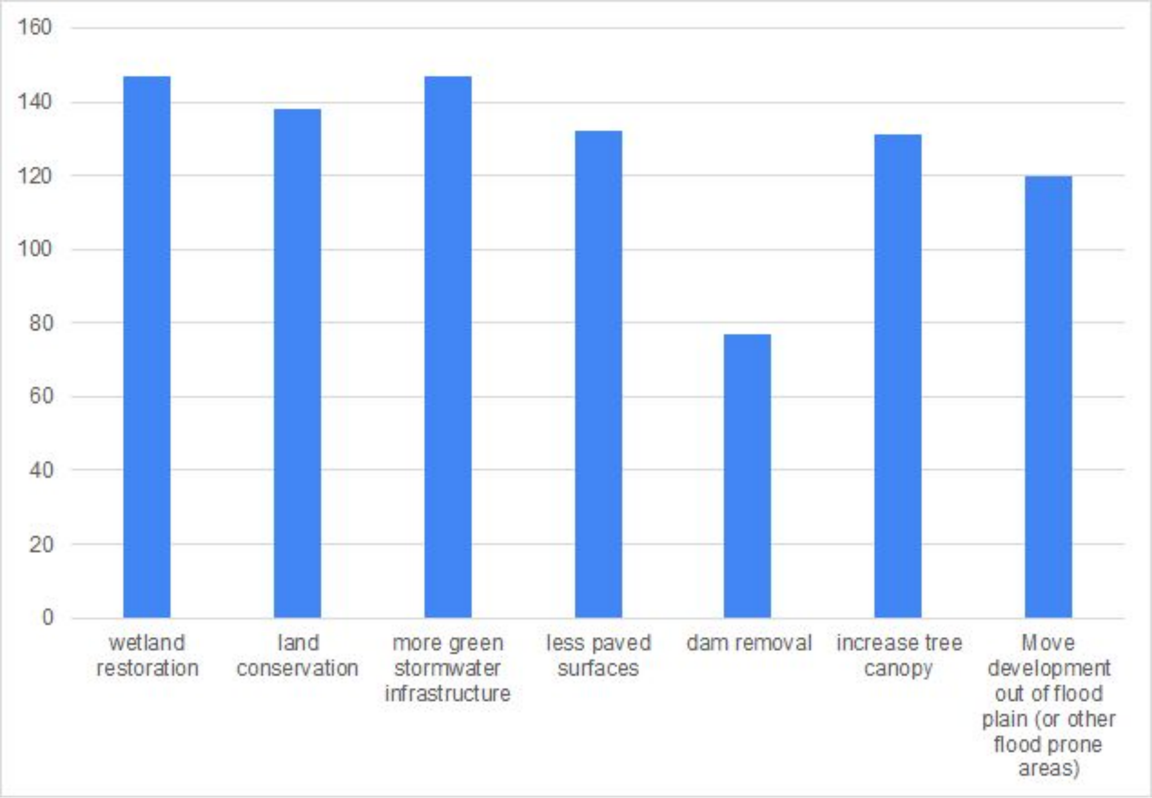
Building Resilience Across the Charles River Watershed

Charles River Watershed Association





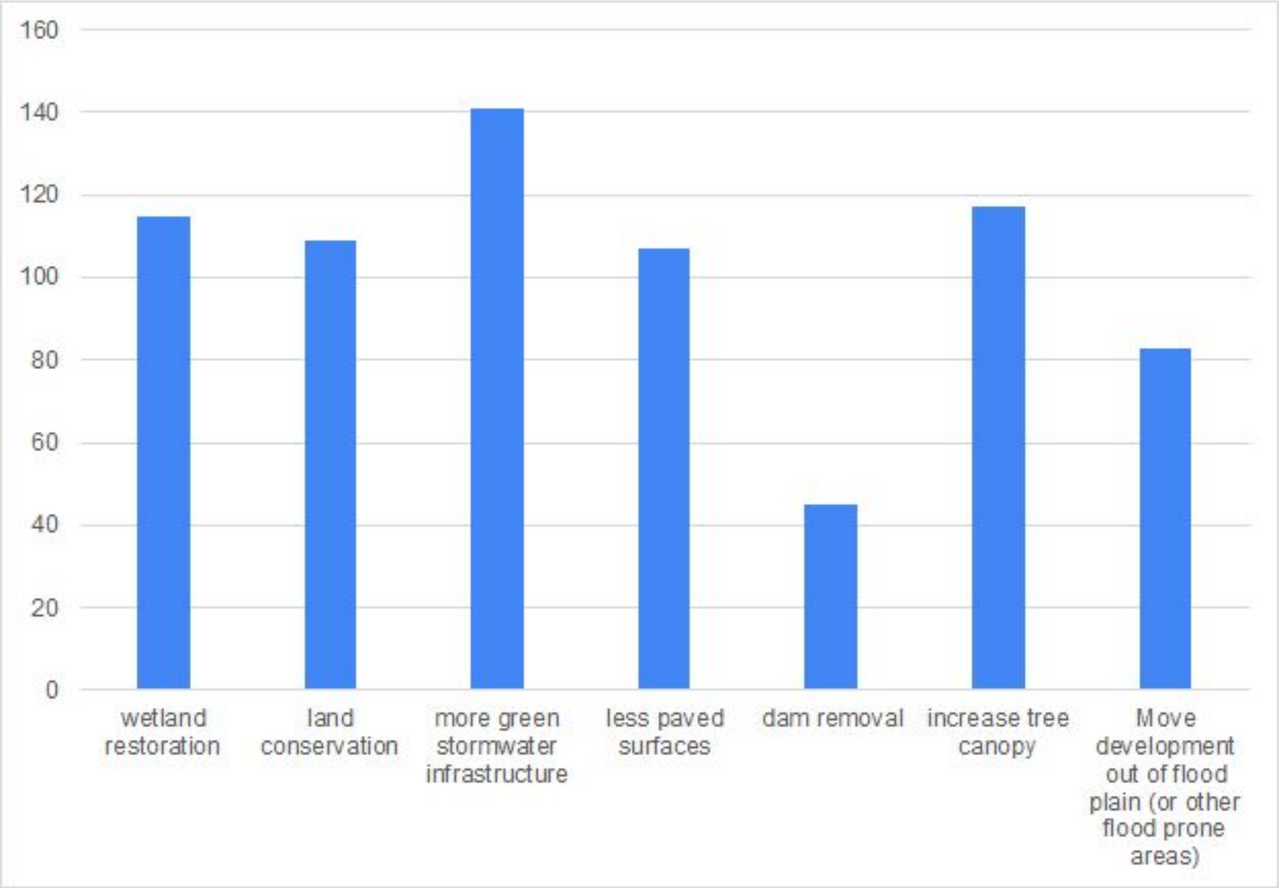
Which of these would you like to see explored as possible nature-based solutions to help mitigate potential flooding impacts of climate change?



Additional Suggestions

- Undersized culvert replacement
- Enhancing local sources of water supply vs MWRA
- have city, state and federal plans include these solutions
- No asphalt driveways
- Stricter land use controls; incentives for clustered density
- Man made wetlands with elevated boardwalks where it makes sense
- Daylight buried streams
- Parks created in wetlands/ floodplains
- Preserve existing tree canopy
- All of the above

Which of these nature based solutions do you thir would be ***possible*** i your community?



Do you have any concerns about the changes nature-based solutions could bring to your community?

- Inequitable benefits
- Inter-community cooperation
- Cost
- Further gentrification
- Raising rents/housing cost
- Maintenance
- Private land
- Dam removal would require significant study
- Cost of maintaining newly-created wetlands so they don't get full of rubbish and invasive species
- Buy in from residents
- Beaver activity might impact nature based solutions
- Getting community buy-in
- Mosquitos

Summary

Top Nature Based Solutions to Model:

Project Team

1. GSI
2. < IC
3. Dam Removal
4. Floodplain reconnection*
5. Conservation*
6. > Tree canopy
7. Wetland restoration

*some reservation/concerns

Preference for modeling small scale system across the watershed

Top Nature Based Solutions to Model: Public

1. Wetland restoration (147)
2. More green stormwater infrastructure (147)
3. Land conservation (138)
4. Less paved surfaces (132)
5. Increase tree canopy (131)
6. Move development out of flood plain (or other flood prone areas) (120)
7. Dam removal (77)

Summary

Most Feasible: Public

1. More green stormwater infrastructure (141)
2. Increase tree canopy (117)
3. Wetland restoration (115)
4. Land conservation (109)
5. Less paved surfaces (107)
6. Move development out of flood plain (or other flood prone areas) (83)
7. Dam removal (45)

*Public also has some concerns over moving development out of the floodplain

Summary

- **Land conservation**, **More green stormwater infrastructure** and **Less paved surfaces** appear in the top five responses for both surveys/all questions
- Wetland Restoration was popular very with public, least popular with municipal team
- Dam Removal not very popular with the public
- Both groups had some concerns about the feasibility of floodplain reconnection

Modeling Nature Based Solutions Scope Review

Charles River Watershed Association

Task 4. Select Priority Watershed Scale Climate Adaptation Strategies

Sub-Task 4.1 Identify Priority Actions

Sub-Task Task 4.2 Select Priority Actions

Task 5. Watershed Scale Adaptation Recommendations

Sub-Task 5.1 Assess Priority Mitigation Measures using H/H model

Sub-Task 5.2 Evaluate Co-Benefits of Nature Based Solutions

Sub-Task 5.3 Prioritization of flood mitigation alternatives

Modeling Nature Based Solutions

Charles River Watershed Association

Sub-Task 4.1 Identify Priority Actions

Concurrent with Tasks 2 and 3, the Technical Team, working with **a few community partners who are able to dedicate more time to the project will identify specific mitigation strategies** within the broad categories already identified by the group:

1. Upstream flood storage assessment for priority areas
2. Green infrastructure interventions for priority areas
3. Land conservation / land use change strategies
4. Floodplain restoration strategies

The flood mitigation strategies that will be evaluated can be a **combination of watershed wide strategies and site-specific strategies.**

Nature-based solutions subcommittee met on April 1st

Modeling Nature Based Solutions

Charles River Watershed Association

Sub-Task Task 4.2 Select Priority Actions

A **second full project team workshop will be held to identify and prioritize watershed scale flood mitigation strategies to assess in Phase I.** The project team will also review responses from the community survey administered in Task 1 which include some input on residents' preferences or concerns for flood mitigation approaches. The project team will select the priority actions through discussion and voting.

Deliverables:

- Workshop 2 with project team communities
- Selection of prioritized list of flood mitigation strategies with maximum potential of flood reduction at the watershed scale

Nature-based solutions subcommittee feedback

Constructed wetlands can be expensive and face permitting challenges

Support for looking at impervious cover reduction

“Reducing” impervious cover could also mean disconnecting it (in practice)

Support modeling strategies that Cities/Towns can implement in ways that work for them (i.e. green stormwater infrastructure), implementation might look different in Medway vs. Newton need to allow for flexibility

Supporting for identifying strategies that each community can work toward because we know it’s effective

Modeling Nature Based Solutions

Please complete the survey by noon on Monday, May 10th

Welcome more than one response per community.

Hope to get AT LEAST one response per community.

Nature Based Solutions

Green Stormwater Infrastructure (GSI): Which strategies would you like to see modeled? (SELECT TWO)

- ☐ Green infrastructure stores 2" storm runoff from up to 50% of all impervious cover town-wide
- ☐ 10% of feasible/priority land area is GSI
- ☐ Storage on large (>5 acres) public properties (GSI, underground storage, "blue roofs")
- ☐ Attenuate peak flow from 25-yr to 2-yr on larger parcels
- ☐ Storage on large private properties
- ☐ Other:

Modeling Nature Based Solutions

Charles River Watershed Association

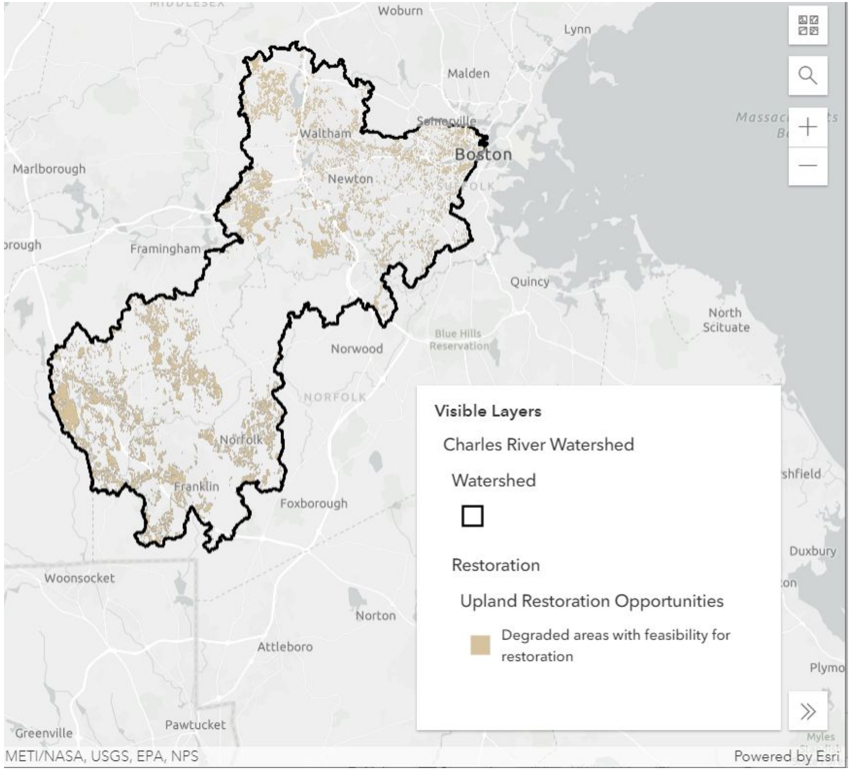
Strategy: Green Stormwater Infrastructure

- Green infrastructure stores 2” storm runoff from up to 50% of all impervious cover town-wide

Modeling Nature Based Solutions

Strategy: Green Stormwater Infrastructure

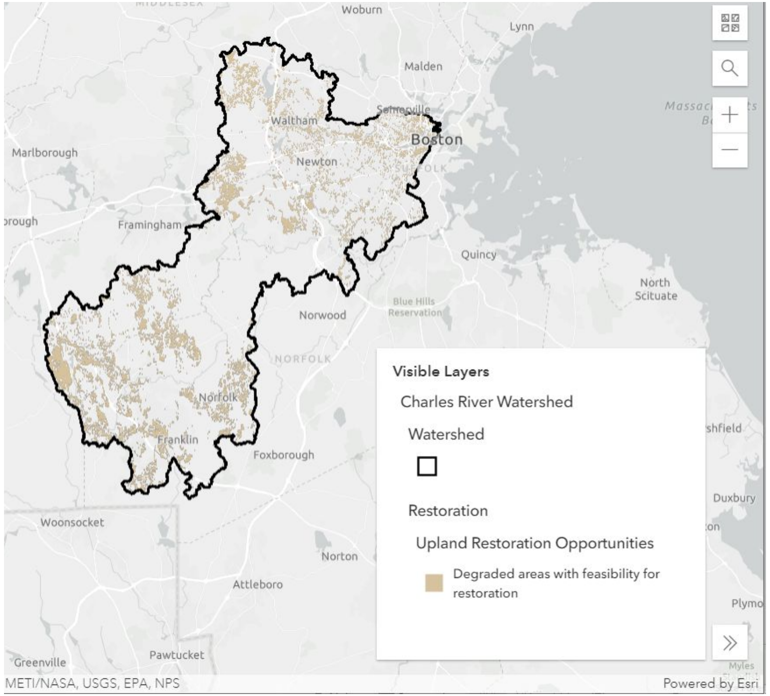
- 10% of feasible/priority land area is GSI (based on CRWA/TNC Nature Based Solutions Mapping Tool)



Modeling Nature Based Solutions

Charles River Watershed Association

Watershed-wide example: Small / Medium Scale Green Stormwater Infrastructure Across the Watershed



Based on Charles River Watershed Conservation and Restoration Prioritization Tool

- Degradation: groundwater depletion, high impervious cover, high pollutant load
- Feasibility: well drained soils, open space
- Excluded: activity use limitations, forested areas, wellhead protection zones

Small / Medium Scale Green Stormwater Infrastructure Across the Watershed

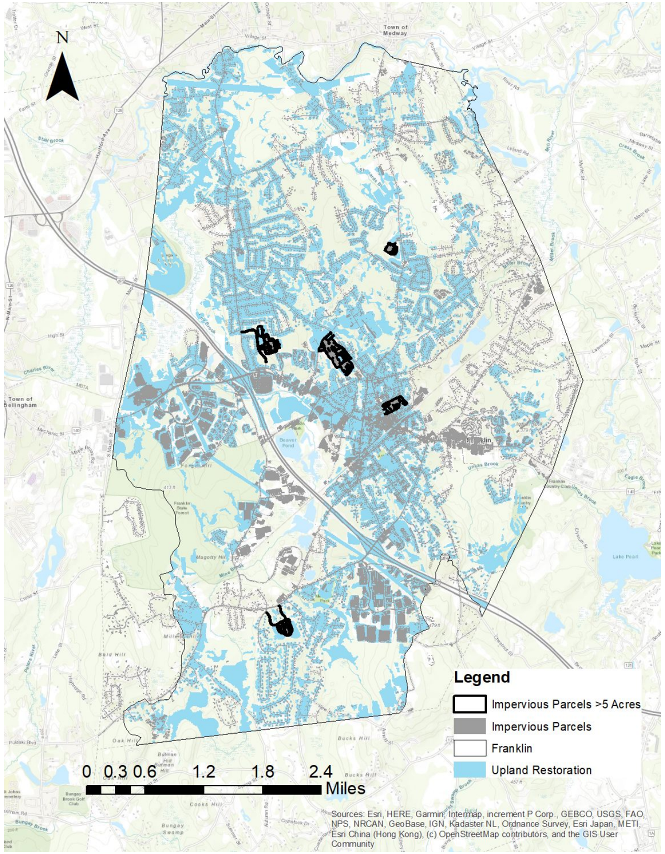
Criteria Subcategory	Degradation			Feasibility	
Criterion Overview	Indicates need for restoration			Indicates high feasibility areas to implementing effective green infrastructure	
Criteria Shorthand	Areas with groundwater depletion	Properties with high impervious cover	Areas with high pollution loading	Areas with well draining soils	Areas with space availability
Layer Details (GIS file)	MassDEP Sustainable Water Management Initiative (SWMI) net groundwater depletion	Building Structures, MassGIS	• Impervious cover, MA Land Use/Land cover 2016 • MA Land Use 2005	NRCS Hydrological Soil Groups	Existing parks and open spaces, MassGIS 2017
Analysis	Categories 4 or 5	Building Structure Footprints >1 acre	Commercial, Industrial, High-Density Residential land Land cover = impervious	Soil groups A and B, and unknown	Publicly owned parks and open space
Analysis Detail	Basins whose unaffected August median flow is more than 25% depleted after accounting for groundwater and groundwater discharges	Buildings with large footprints often have large parking lots	High pollutant, impervious areas are ideal areas to target large pollutant loads	A and B soils have high infiltration capacity, making them ideal areas to implement green infrastructure. Unknown soils were included to not exclude urban areas with little information.	Upland restoration projects can often be implemented in existing, publicly owned parks and open spaces
Co-benefits	• Environmental Justice Communities (MA_CharlesRiver_EnvJustice) • Greenspace Deserts (MA_CharlesRiver_GreenspaceDeserts)				
Excluded	• Activity/Use Limitation (AUL) sites, 21(e) sites, and underground storage tanks (MassGIS 2016 with 200' buffer) • Forested areas (MA Land Use 2005) • Wellhead Protection Zone I and Zone II areas (MassGIS 2016)				

Modeling Nature Based Solutions

Charles River Watershed Association

Strategy: Green Stormwater Infrastructure

- Storage on large (>5 acres) public properties (GI, underground storage, “blue roofs”)
- Storage on large private properties



Modeling Nature Based Solutions

Charles River Watershed Association

Site-Specific Example: Large scale GI or storage at publicly owned sites

Methods

- Used 2016 GIS Land Use Layer to identify"
  - Parcels > 5 acres
  - Impervious
  - Tax exempt
- Further narrowed by identifying parcels >40% impervious cover (eliminate town forests, conservation land, etc.)
- Manual review to exclude private schools, cemeteries, roads, universities, etc.

Results: Primarily public schools (K-12) and municipal buildings/DPWs (~65 sites)

Medway

Medway High School

Modeling Nature Based Solutions

Charles River Watershed Association

Natick

Natick High School

Modeling Nature Based Solutions

Charles River Watershed Association

Wellesley

Wellesley Department of Public Works

Wellesley Recycling and Disposal Facility

Modeling Nature Based Solutions

Charles River Watershed Association

Strategy: Green Stormwater Infrastructure

- Attenuate peak flow from 25-yr to 2-yr on larger parcels
- Other?

Modeling Nature Based Solutions

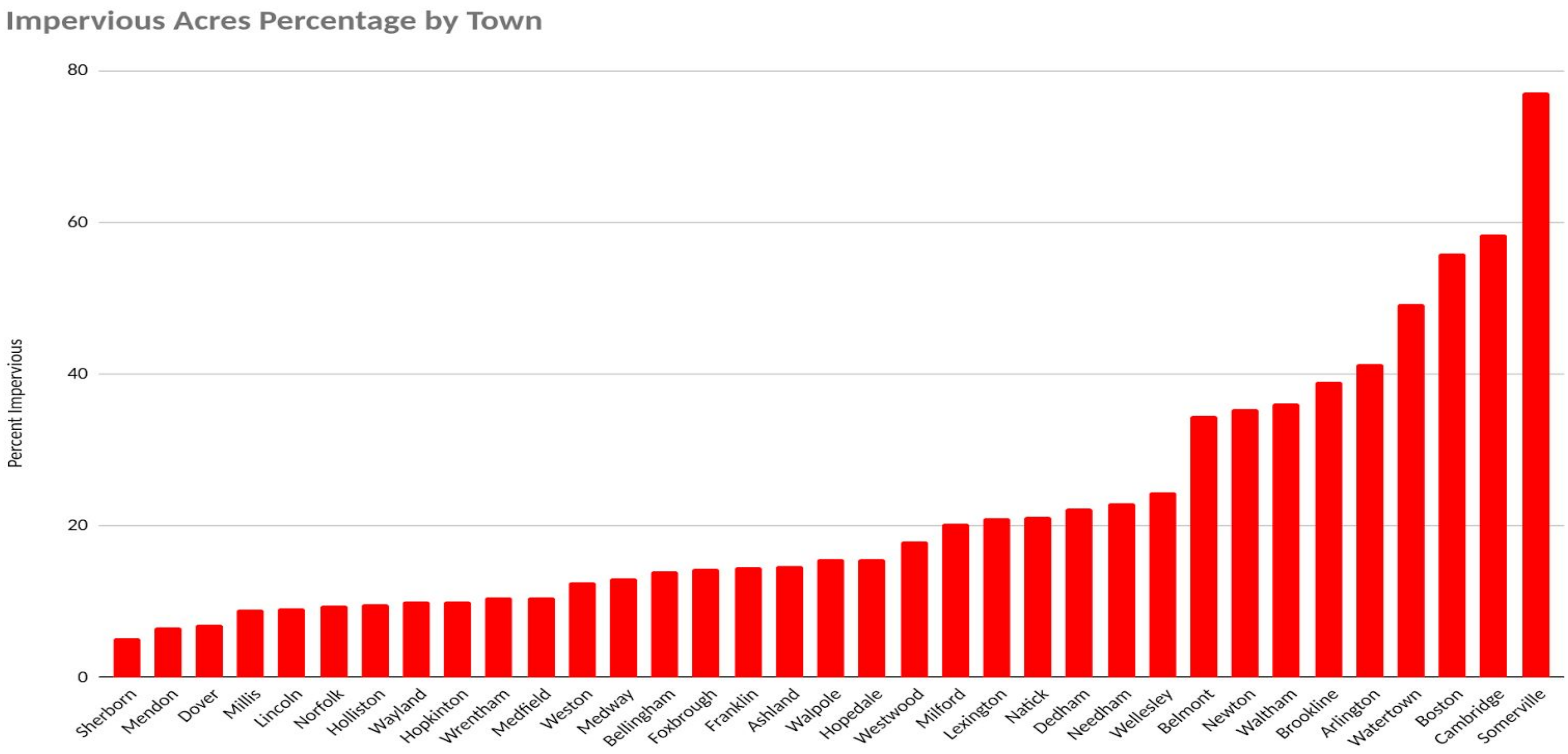
Charles River Watershed Association

Strategy: Reduce Impervious Cover

- Reduce effective impervious cover watershed wide by 10% (for subbasins over 10%)
- Reduce impervious cover in the upper and middle watershed by 25%
- Reduce IC down to 30%, for communities already below 30%, reduce by 5-10%
- Other?

Modeling Nature Based Solutions

Charles River Watershed Association

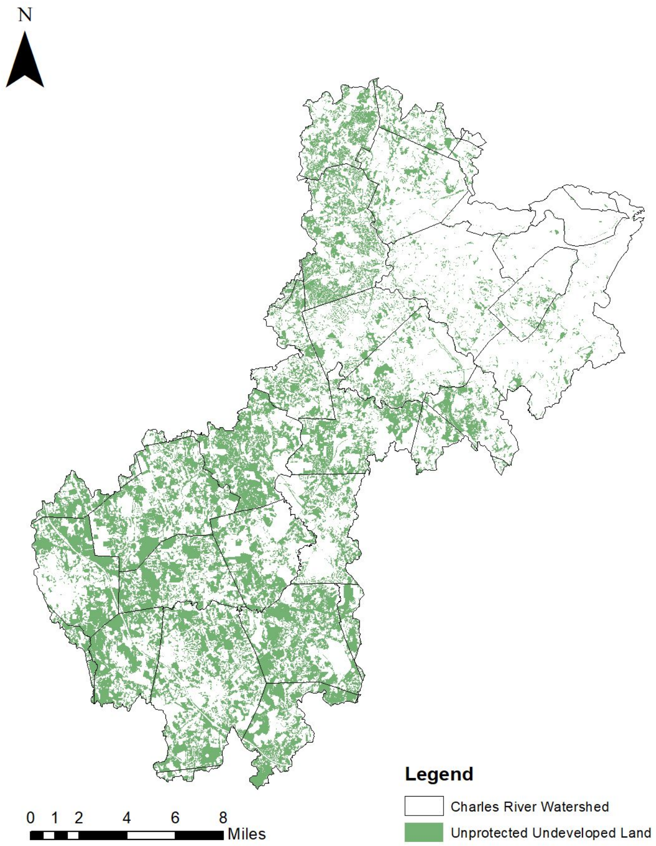


Modeling Nature Based Solutions

Charles River Watershed Association

Strategy: Land Conservation

- Allow 50% of remaining undeveloped / unprotected land to become impervious
- Allow 75% of remaining undeveloped / unprotected land to become impervious
- Others?



Modeling Nature Based Solutions

Charles River Watershed Association

Strategy: Land Conservation

- Allow 50% of remaining undeveloped / unprotected land to become impervious
- Allow 75% of remaining undeveloped / unprotected land to become impervious
- Others?

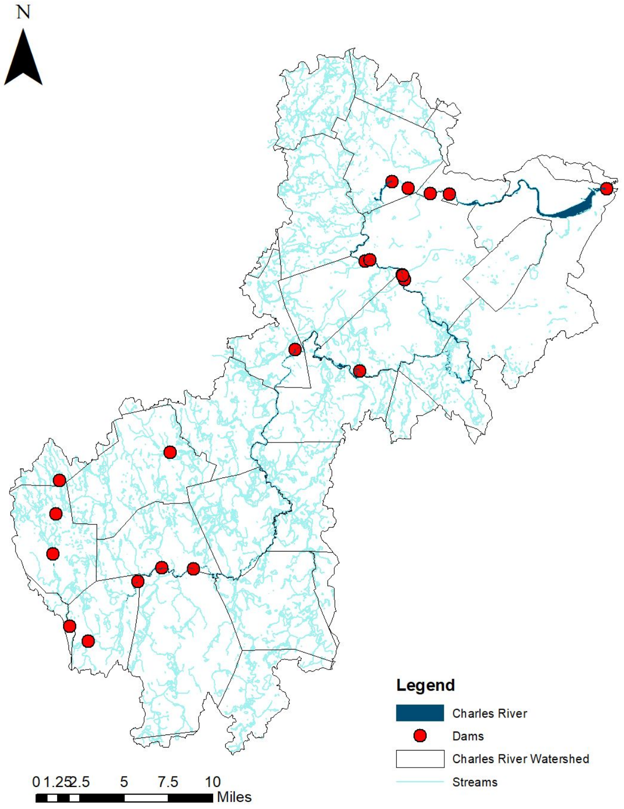
TOWN	AREA (acres)
ARLINGTON	10.09
DEDHAM	2582.72
FRANKLIN	11950.95
HOLLISTON	9951.62
MEDWAY	7046.44
MILLIS	5530.99
NATICK	3726.76
NEEDHAM	2572.94
NEWTON	1549.63
NORFOLK	8961.31
SHERBORN	7930.48
WATERTOWN	32.71
WELLESLEY	2305.52
WESTON	6984.85
WRENTHAM	5887.51

Modeling Nature Based Solutions

Charles River Watershed Association

Strategy: Dam Removal / Reservoir Management

- Remove all dams other than active flood control (New Charles & Moody St.)

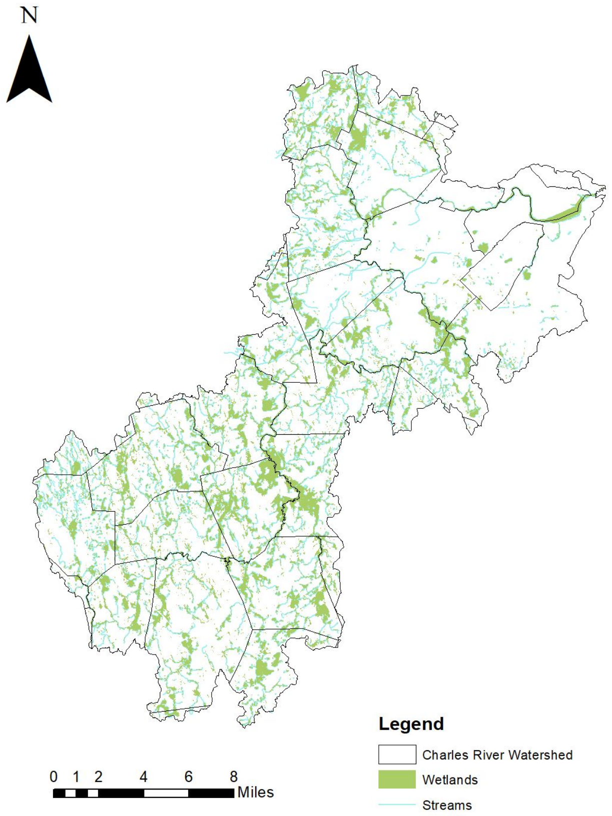


Modeling Nature Based Solutions

Charles River Watershed Association

Strategy: Floodplain reconnection

- Augment riparian wetland areas by 10%
- Remove select culverts
- Eliminate all impervious cover within 200 ft. of rivers/streams

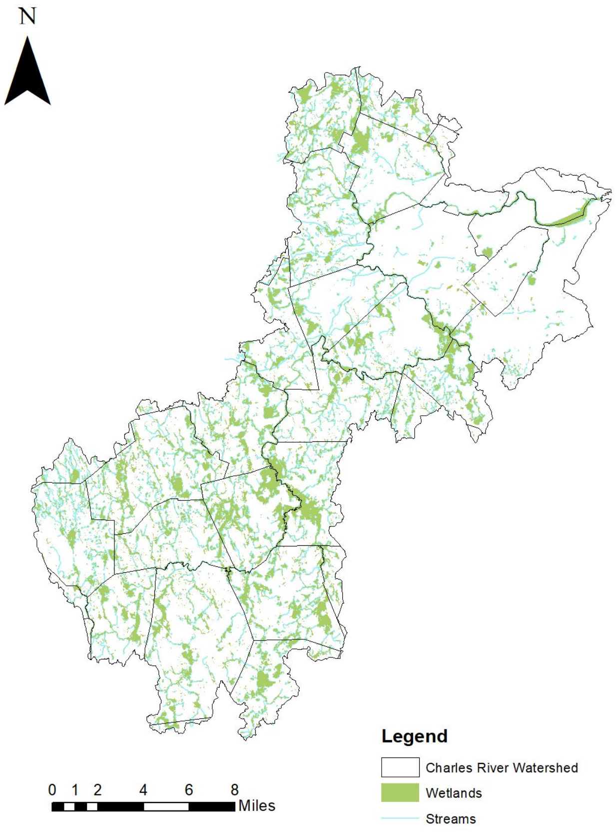


Modeling Nature Based Solutions

Charles River Watershed Association

Strategy: Wetland Restoration

- All wetland areas 10% larger
- All wetland areas 20% larger
- Constructed wetlands on large public parcels (overlap with GSI category)



Modeling Nature Based Solutions

Charles River Watershed Association

Strategy: Increase Tree Canopy

- 25% public ROWs become green streets: tree box filters /bioswales connected to leaching catch basins
- 50% public ROWs become green streets: tree box filters /bioswales connected to leaching catch basins
- Others?

Questions and Discussion

Guide to making your selections:

- Consider what is feasible in "near-term" (<5 years)
- Consider public input
- CRCC/CRWA can help with implementation (i.e. grant requests, building public support, policy tools, etc. - you won't be on your own!)

Next Steps:

- Complete the survey by Monday, May 10th at noon
- Come to *Engaging Climate Vulnerable Communities Training* on May 12th @9am to see the results
- Modeling results will be presented on May 26th

Engaging Climate Vulnerable Communities

May 12, 2021

Engaging Climate Vulnerable Communities

Charles River Watershed Association

Agenda

9:00-9:10: Introductions

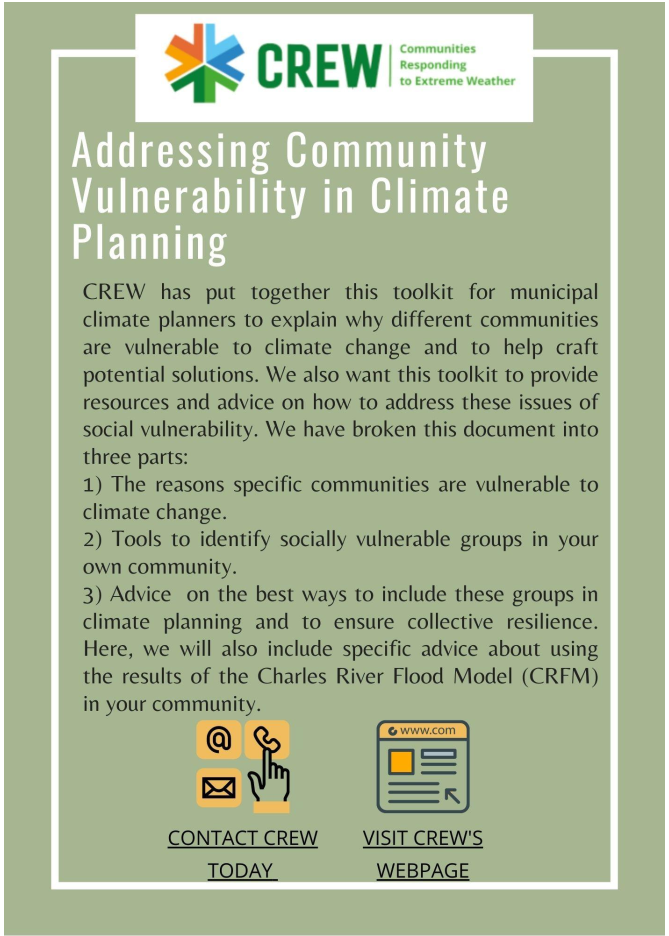
9:10-9:40: Dr. Atyia Martin, All Aces

9:40-10:00: Cate Mingoya, Groundwork USA

10:00-10:25: Ethan McDonough, CREW

5 *minute break*

10:30 - 11:00: Workshop #2 - Review survey results



Engaging Climate Vulnerable Communities

Charles River Watershed Association

Today's Speakers

Dr. Atyia Martin
CEO and Founder
All Aces, Inc.

Cate Mingoya
Director of Capacity Building
Groundwork USA

Ethan Parker McDonough
Special Project Coordinator
CREW

Modeling Nature Based Solutions

Charles River Watershed Association

Thank you for filling out the survey;
23 responses!

Nature Based Solutions

Green Stormwater Infrastructure (GSI): Which strategies would you like to see modeled? (SELECT TWO)

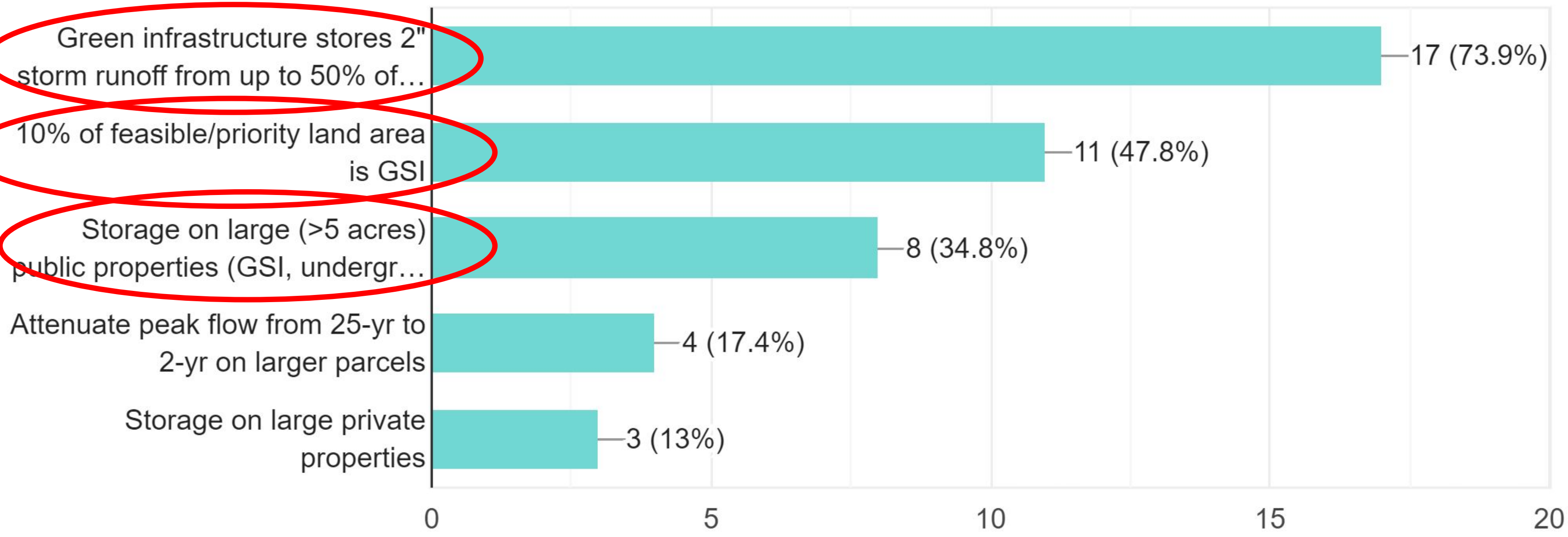
- ☐ Green infrastructure stores 2" storm runoff from up to 50% of all impervious cover town-wide
- ☐ 10% of feasible/priority land area is GSI
- ☐ Storage on large (>5 acres) public properties (GSI, underground storage, "blue roofs")
- ☐ Attenuate peak flow from 25-yr to 2-yr on larger parcels
- ☐ Storage on large private properties
- ☐ Other:

Modeling Nature Based Solutions

Charles River Watershed Association

Green Stormwater Infrastructure (GSI): Which strategies would you like to see modeled? (SELECT TWO)

23 responses

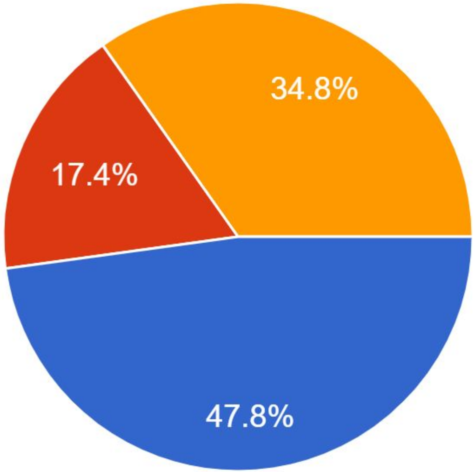


Modeling Nature Based Solutions

Charles River Watershed Association

Reducing Impervious Cover: Which strategy would you like to see modeled? (SELECT ONE)

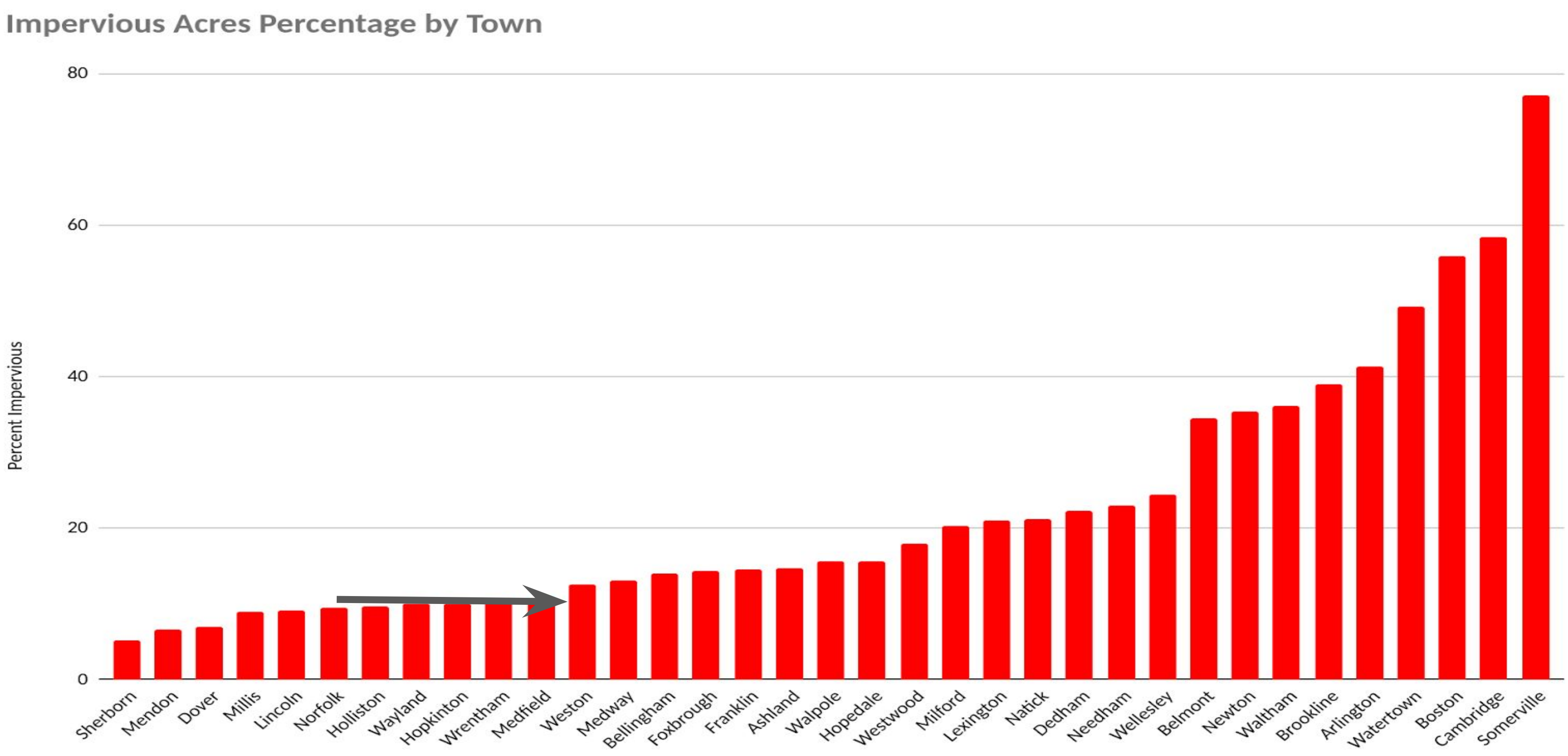
23 responses



- Reduce effective impervious cover watershed wide by 10% (for subbasins over 10%)
- Reduce impervious cover in the upper and middle watershed by 25%
- Reduce impervious cover to 30%, for communities already below 30%, reduce by 5-10%

Modeling Nature Based Solutions

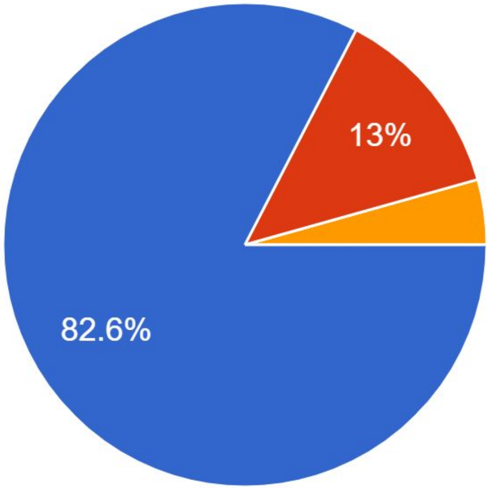
Charles River Watershed Association



Modeling Nature Based Solutions

Land Conservation: which strategy would you like to see modeled? (SELECT ONE)

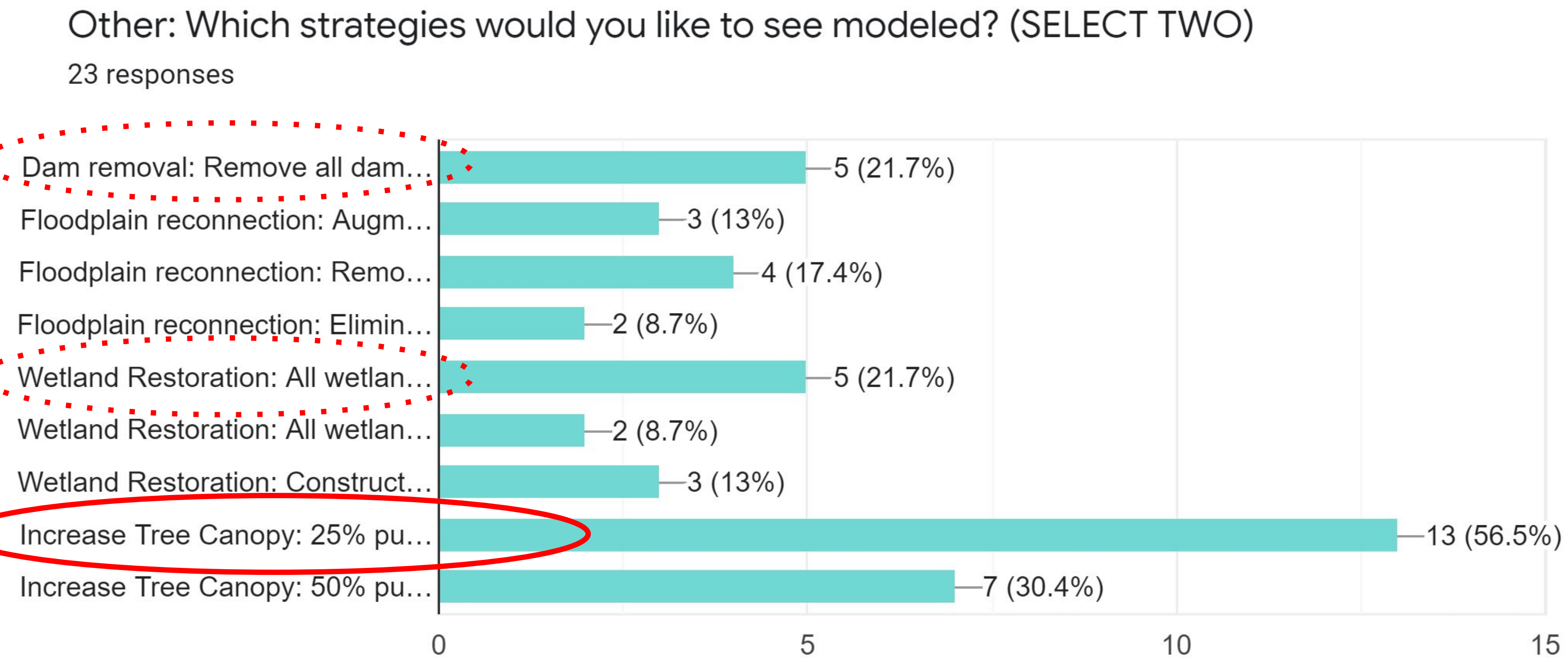
23 responses



- Allow 50% of remaining undeveloped/ unprotected land to become impervious
- Allow 75% of remaining undeveloped/ unprotected land to become impervious
- Allow 25% of remaining undeveloped/ unprotected land to become impervious

Modeling Nature Based Solutions

Charles River Watershed Association



Modeling Nature Based Solutions

Charles River Watershed Association

Results

Green Stormwater Infrastructure
1. Green infrastructure stores 2" storm runoff from up to 50% of all impervious cover town-wide
2. 10% of feasible/priority land area is GSI*
3. Storage on large (>5 acres) public properties (GSI, underground storage, "blue roofs") (site specific strategy)

Reduce Impervious Cover
4. Reduce effective impervious cover watershed wide by 10% (for subbasins over 10%)

Land Conservation
5. Allow 50% of remaining undeveloped/unprotected land to become impervious

Other
6. Increase Tree Canopy: 25% public ROWS become green streets: tree box filters/bioswales connected to leaching catch basins

Alternates:
Wetland Restoration: All wetland areas 10% larger
Dam removal: Remove all dams other than active flood control dams

Details from May 5th presentation found here.

*Later changed to 20%

Upcoming Meetings

Charles River Watershed Association

May 26th, 1-2:30pm: Modeling Results!

June 2nd, 1-2pm: Climate Compact Meeting (bi-monthly meeting rescheduled from May)

TBD:

1. **Final project team meeting**

   -Communication's kit

   -Discuss next steps

2. **Final Public Presentation (virtual event)**

Charles River Watershed Flood Modeling – Initial Model Results Presentation

05.26.2021

Weston & Sampson

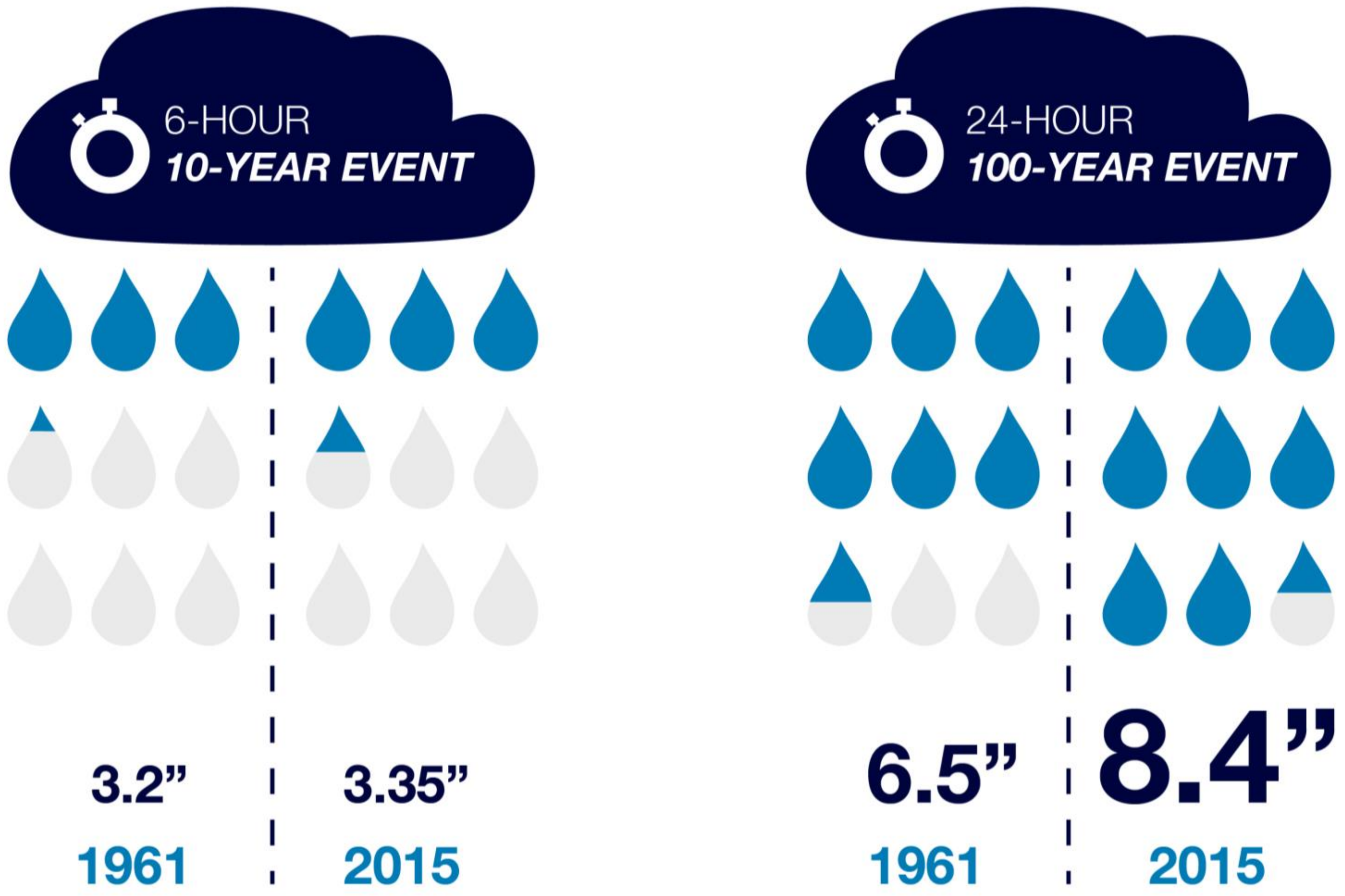
Charles River Watershed Association

Presentation Outline

- Recap future rainfall scenarios
- Model development
- Model calibration
- Future storm simulations
- Flooding impacts in the watershed
- Recap green infrastructure (GI) scenario runs
- Example results from a GI scenario
- Model demonstration
- Questions and next steps

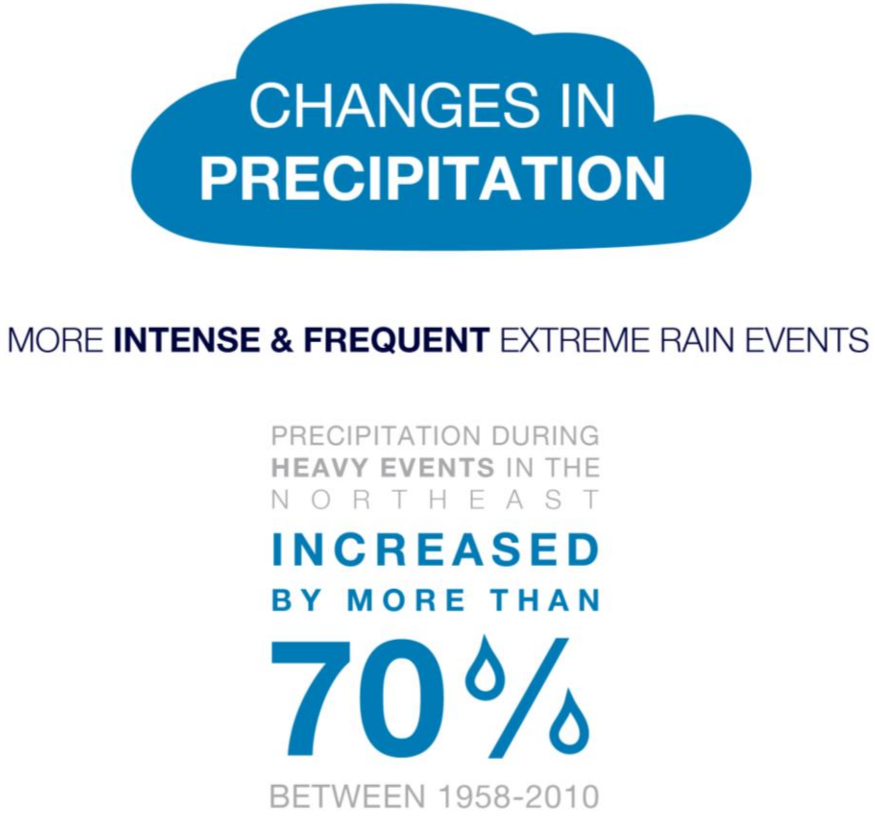
Historic Change in Precipitation

Charles River Watershed Association



Weston & Sampson

Sources: NOAA TP-40 (1961) and NOAA Atlas Volume 10 (2015)



ergy & Environmental Affairs. 2019. "Changes in Precipitation." Massachusetts Climate Change Clearinghouse. Resilientma.org/changes/

Expected Future Increase in Precipitation

Charles River Watershed Association

Recommended Percent Increase Estimates from RMAT (to be applied to NOAA Atlas 14 baseline values)

Location	Design Storm	Mid-Century (2030/2050)	Late Century (2070/2090)
Massachusetts (all counties except Hampden)	More Frequent Design Storm*	8%	20%
	100-yr Design Storm	11%	27%
	Extreme Design Storm**	15%	36%
Hampden County	More Frequent Design Storm*	15%	36%
	100-yr Design Storm	*Perform Detailed Precipitation Analysis*	
	Extreme Design Storm**	*Perform Detailed Precipitation Analysis*	

* More Frequent Design Storms include 2-year, 5-year, 10-year, 25-year, and 50-year return periods
** Extreme Design Storms include 200-year and 500-year return periods

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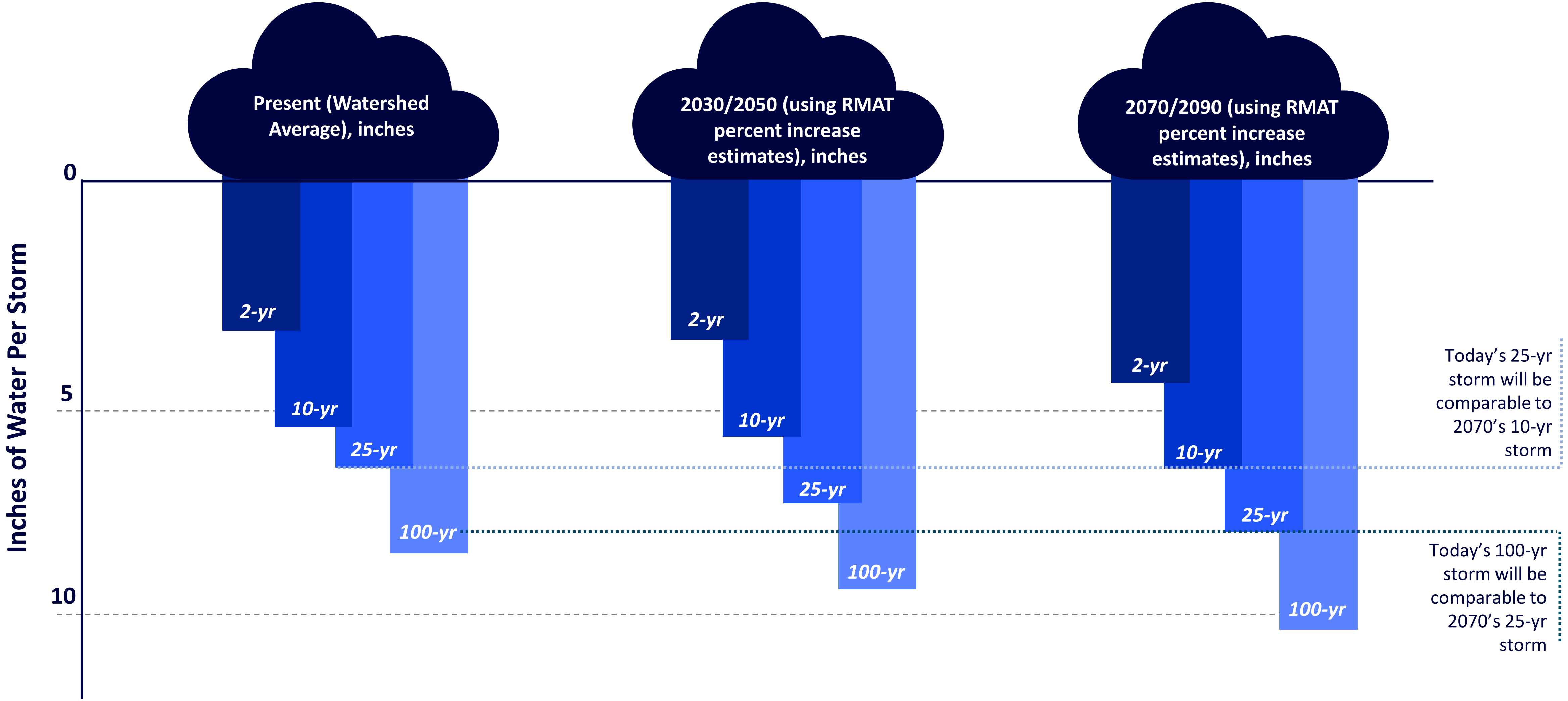
Expected Future Increase in Precipitation

Charles River Watershed Association



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Proposed Future Storm Scenarios

Charles River Watershed Association

Proposed Design Rainfall Depths for Future Storm Scenarios in the Charles River Watershed Model

Recurrence Interval	Present (Watershed Average), inches	2030/2050 (using RMAT percent increase estimates), inches	2070/2090 (using RMAT percent increase estimates), inches
2-yr	3.34	3.60	4.00
10-yr	5.20	5.62	6.25
25-yr	6.37	6.88	7.64
100-yr	8.17	9.07	10.37
500-yr	11.12	12.79	15.12

Summary of potential model runs:

- Calibrate the model to March 2010 event
- Validate model to May 2006 event (Mother's Day storm)

Future scenarios model runs for consideration:

- Present and 2070 2 yr storms (2)
- Present, 2030 and 2070 10 yr storms (3)
- Present, 2030 and 2070 100-yr storms (3)
- More extreme event: 2070 100-yr storm of 11.7 inches (from Mystic River Watershed project) or 500-yr storm of future 12.8 inches (1)

Model Development

Charles River Watershed Association

Presentation Outline

Recap future rainfall scenarios

Model development

Model calibration

Future storm simulations

Flooding impacts in the watershed

Recap green infrastructure (GI) scenario runs

Example results from a GI scenario

Online viewer demonstration

Questions and next steps

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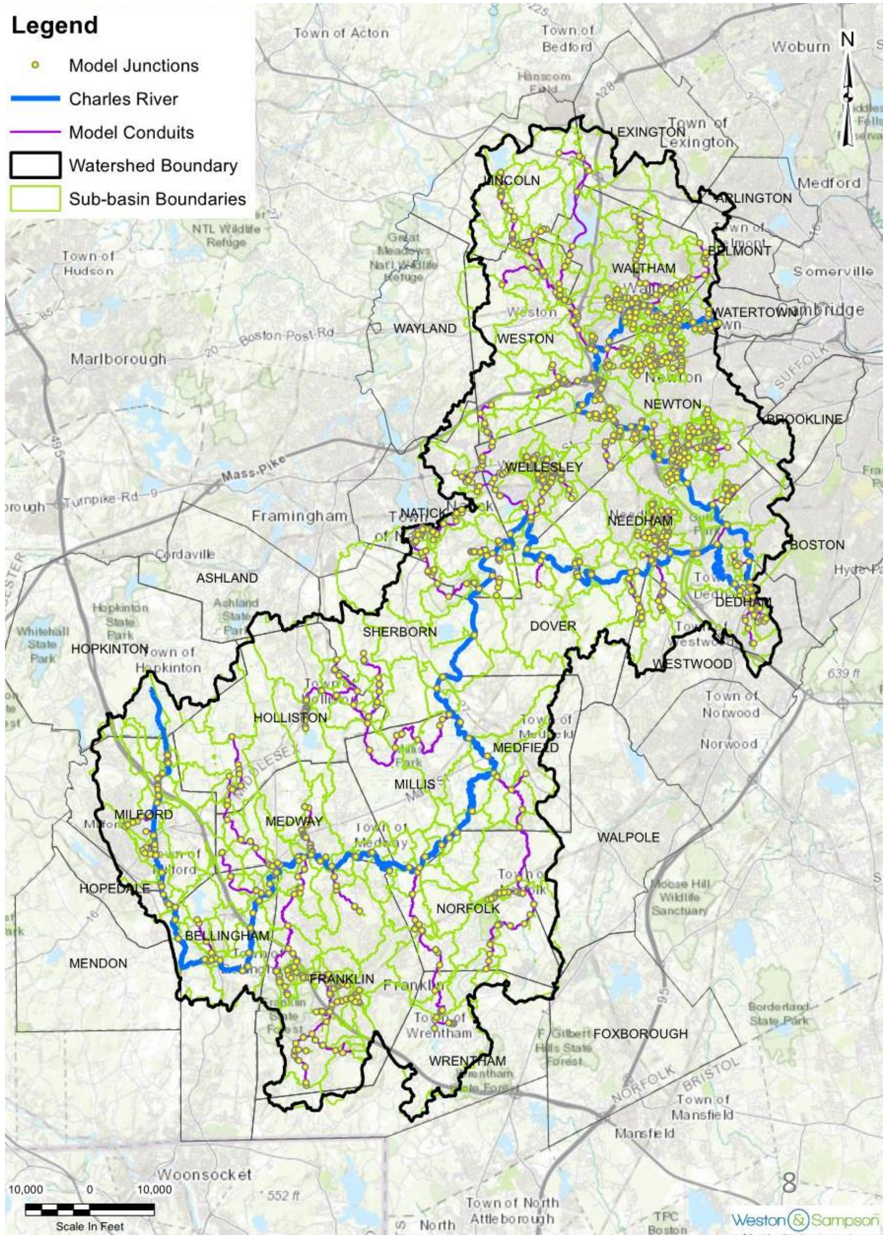
Model Development

Charles River Watershed Association

1D Framework

- Generate runoff; convey non-flood flows
- 272 square miles of the watershed
- Over 1400 junctions
- Over 1500 conduits (including dams, culverts, bridge crossings, etc.)
- Over 700 sub-catchments
- Over 30 storage volumes



8

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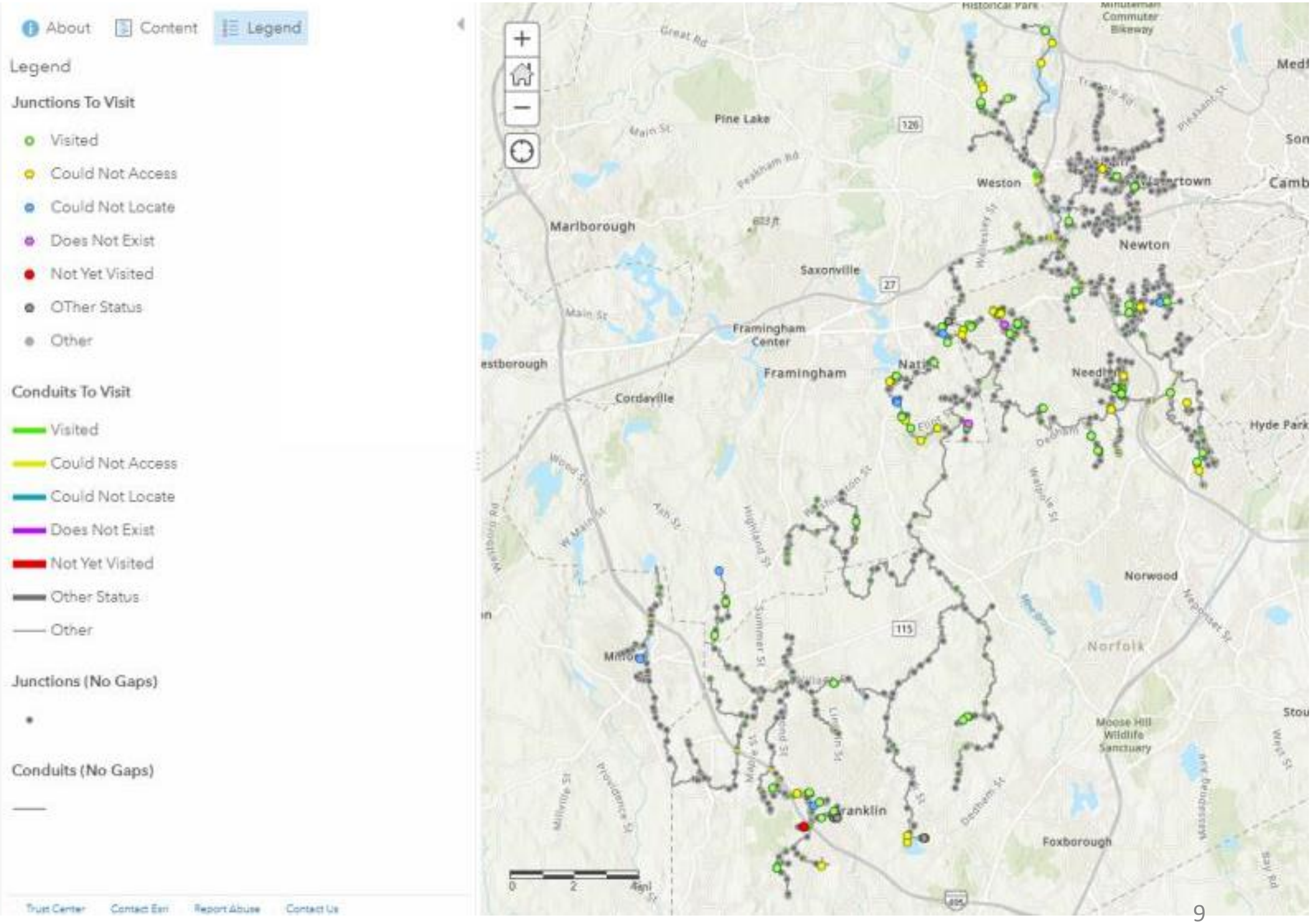
Field Verification

Charles River Watershed Association

- 6 days of site visits
- 119 junctions/nodes
- 25 dams
- 298 crossings
- 442 structures field verified



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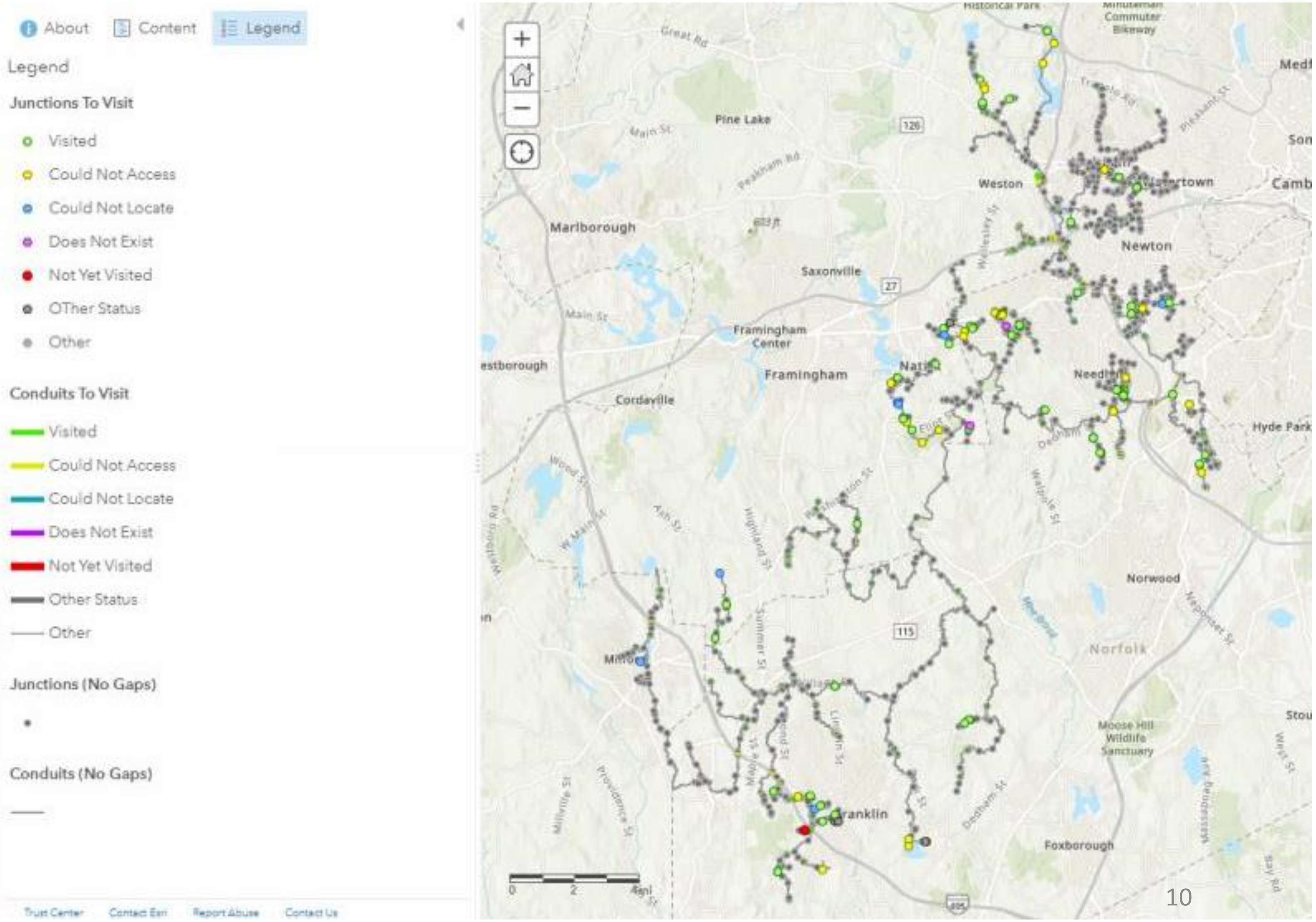
Field Verification

Charles River Watershed Association

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



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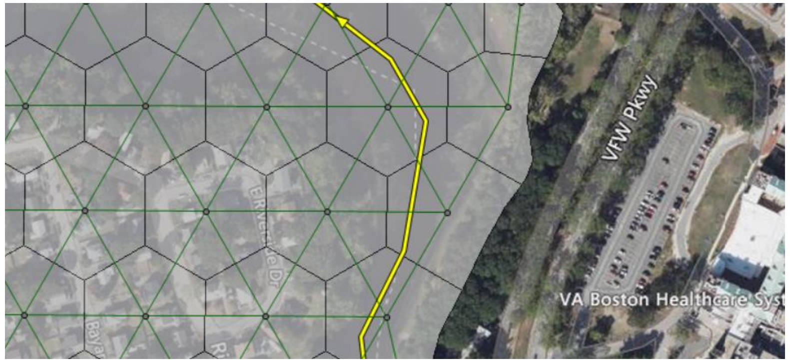
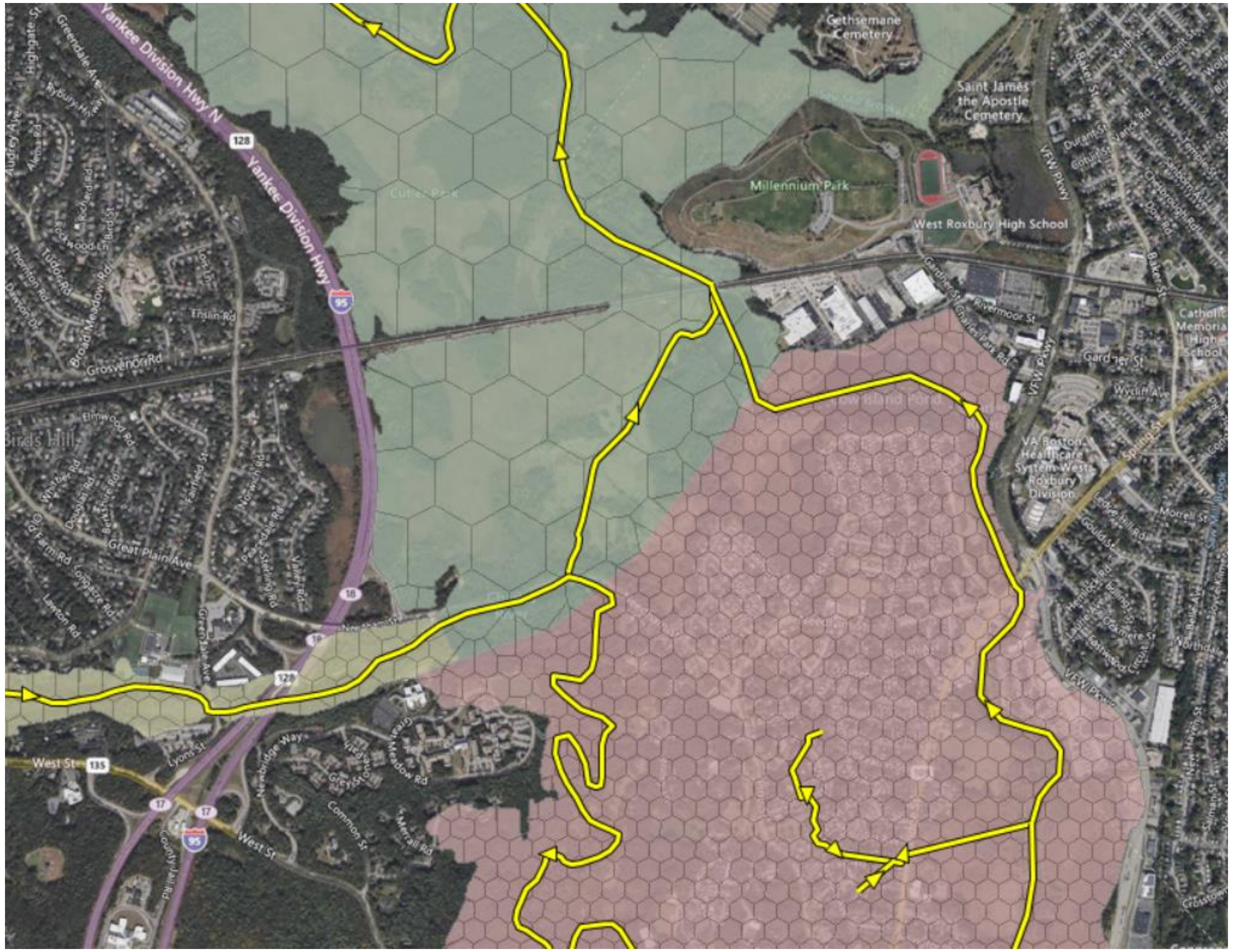
2D Cells

- Convey flood flows; provide floodplain storage
- Define boundary areas
- Identify appropriate resolution
- Create 2D nodes from LiDAR
- Create 2D cells – 7,748!





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Presentation Outline

Recap future rainfall scenarios

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Flooding impacts in the watershed

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Example results from a GI scenario

Online viewer demonstration

Questions and next steps

Model Calibration

Charles River Watershed Association

- Calibrated to the March 2010 Storm

- Based on 15-min data from the USGS gage on Stony Brook:
  - 8.99 inches in 58.5 hrs
  - Peak rainfall intensity of 0.68 in/hr
  - Approximately the 65-yr 48-hour 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 gage locations (Medway, Dover, Wellesley, Waltham, Stony Brook Reservoir) for 3 parameters (runoff volume, peak flow, timing of peak)

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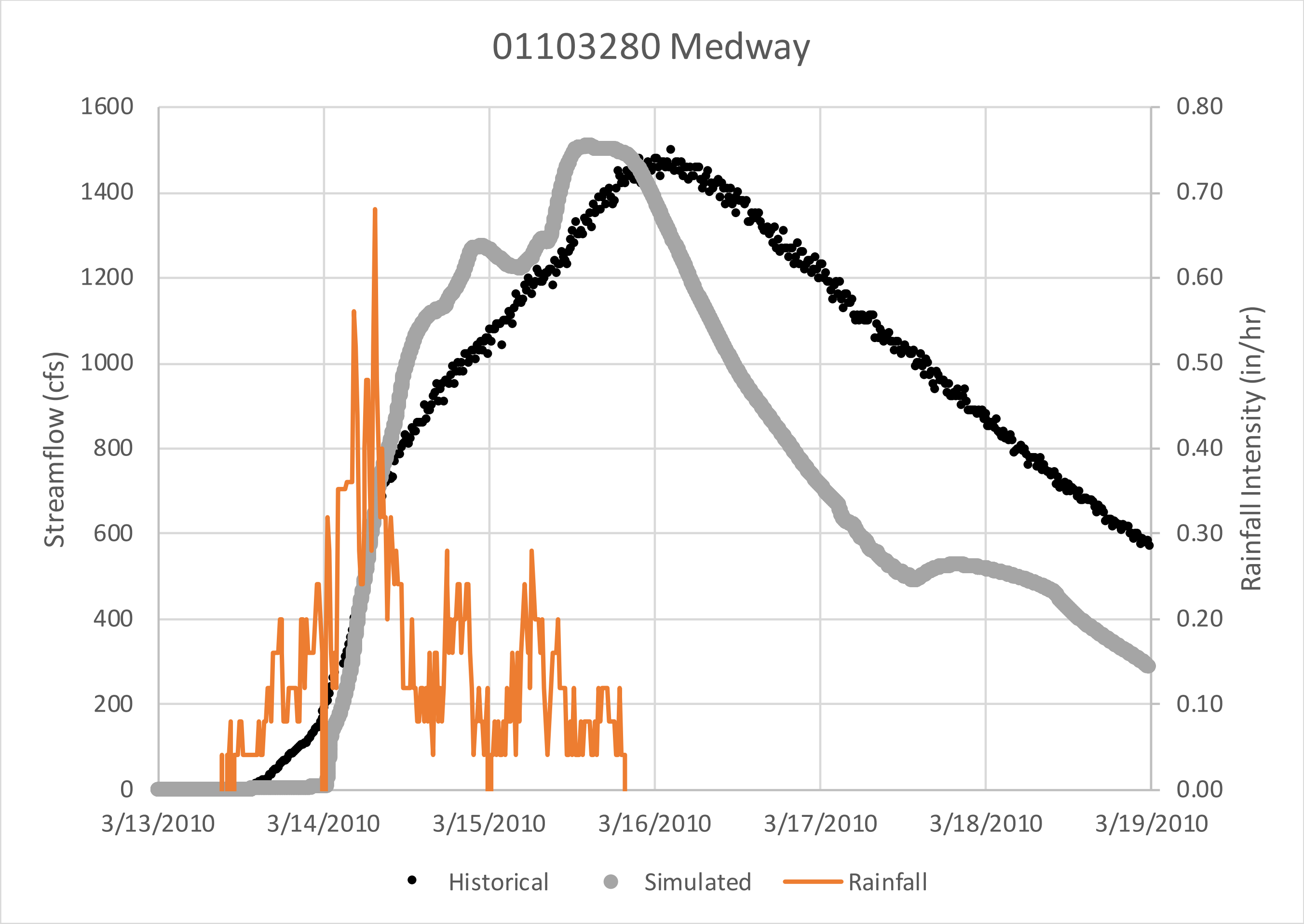
Model Calibration

Medway USGS Gage

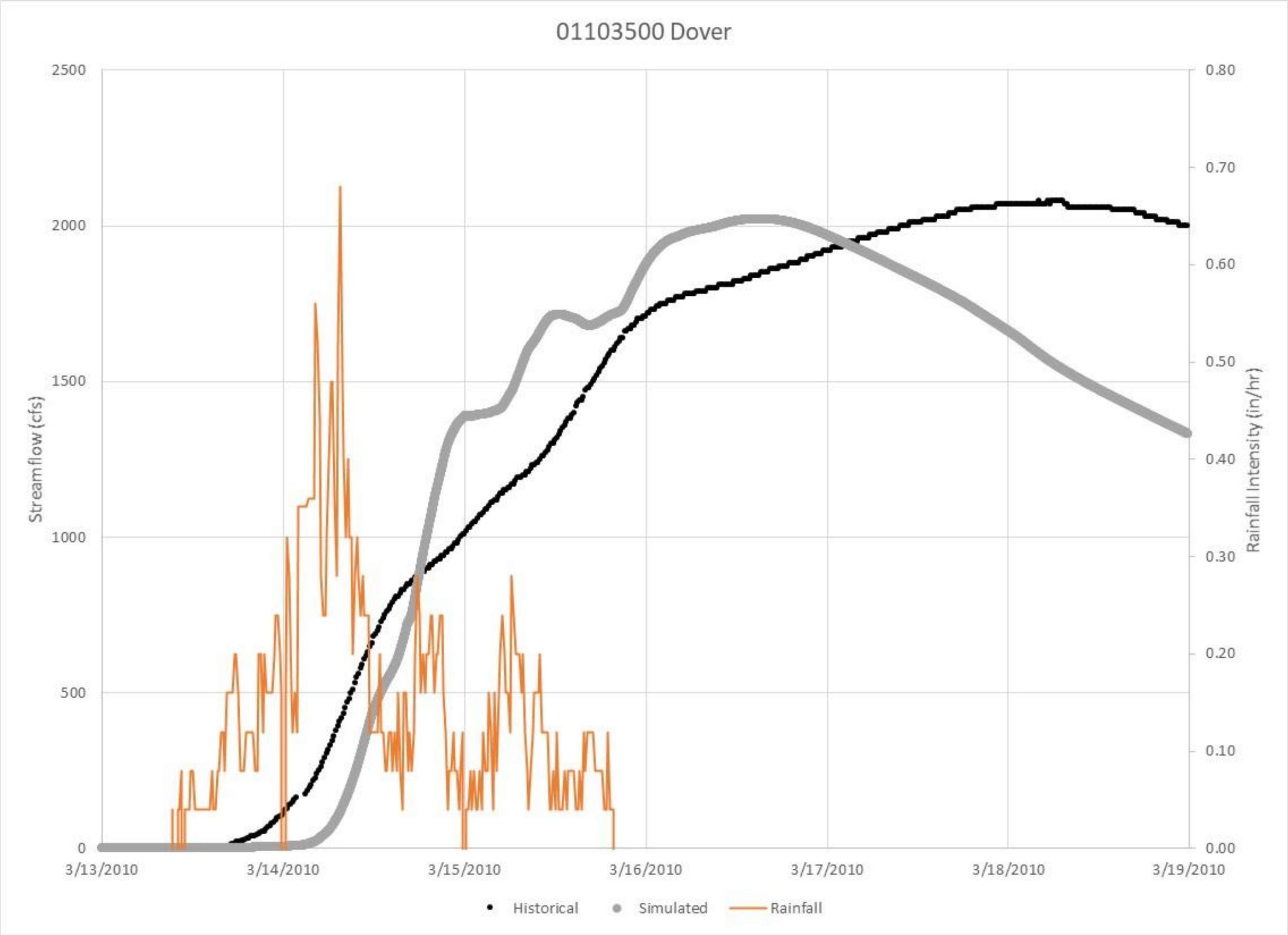


Comparison	*Charles River* Medway 01103280
Sim Vol	362,590,258
Hist Vol	443,952,000
% difference	-22%
Sim Peak	1,509
Hist Peak	1,500
% difference	1%
Sim Time	3/15/10 14:32
Hist Time	3/16/10 2:30
Time Dev	-0.5

Model Calibration

Charles River Watershed Association

Dover USGS Gage



Comparison	*Charles River*
	Dover
	01103500
Sim Vol	640,644,430
Hist Vol	676,152,900
% difference	-6%
Sim Peak	2,022
Hist Peak	2,080
% difference	-3%
Sim Time	3/16/10 14:59
Hist Time	3/18/10 4:00
Time Dev	-1.5

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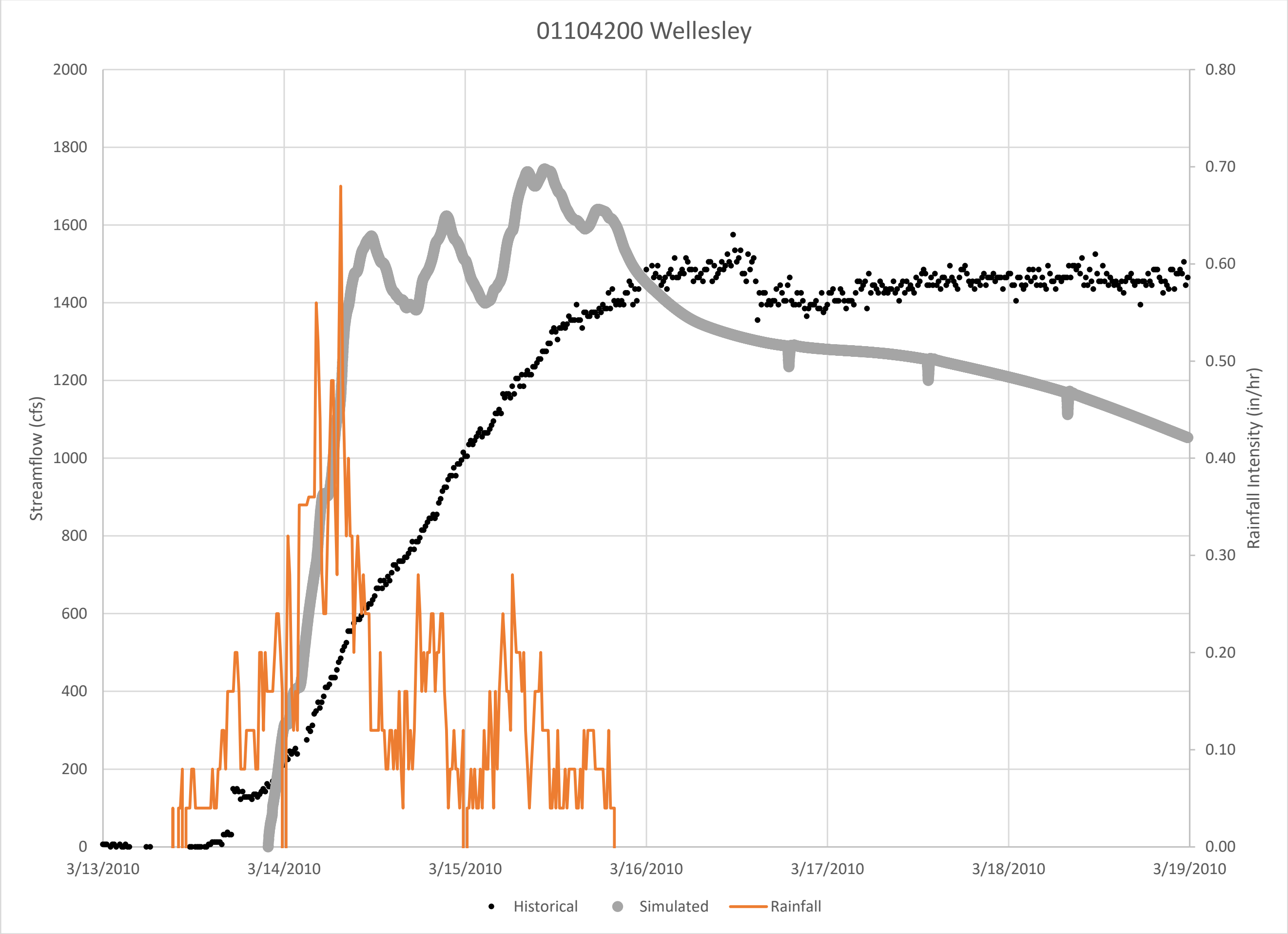
Model Calibration

Charles River Watershed Association

Wellesley USGS Gage



Comparison	*Charles River* Wellesley 01104200
Sim Vol	564,941,368
Hist Vol	542,532,600
% difference	4%
Sim Peak	1,744
Hist Peak	1,575
% difference	11%
Sim Time	3/15/10 10:31
Hist Time	3/16/10 11:30
Time Dev	-1.0

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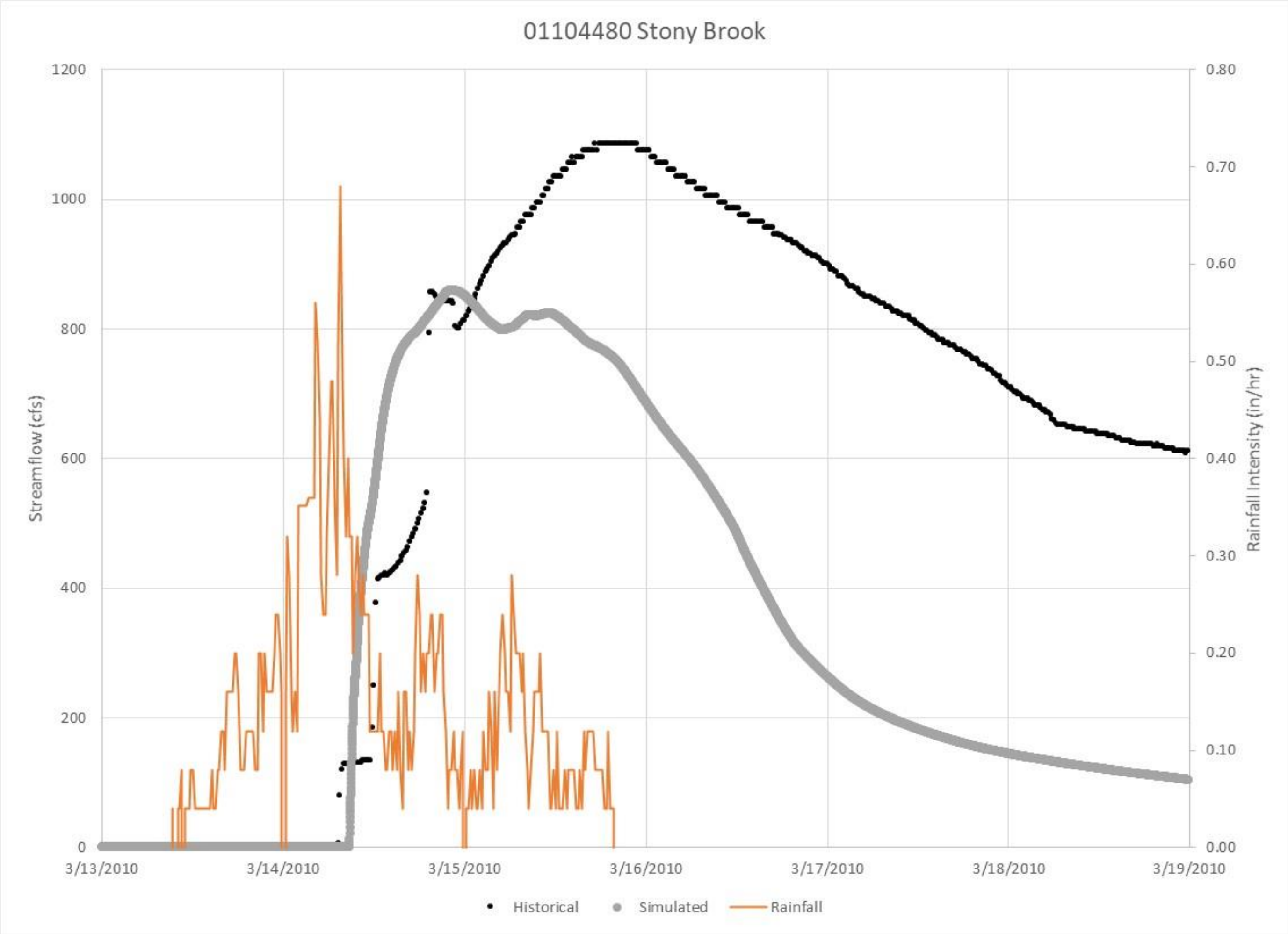
Model Calibration

Charles River Watershed Association

Stony Brook Reservoir USGS Gage



Comparison	*Stony Brook*
	Stony Brk
	01104480
Sim Vol	174,179,406
Hist Vol	325,443,690
% difference	-87%
Sim Peak	859
Hist Peak	1,086
% difference	-21%
Sim Time	3/14/10 22:15
Hist Time	3/15/10 17:15
Time Dev	-0.8

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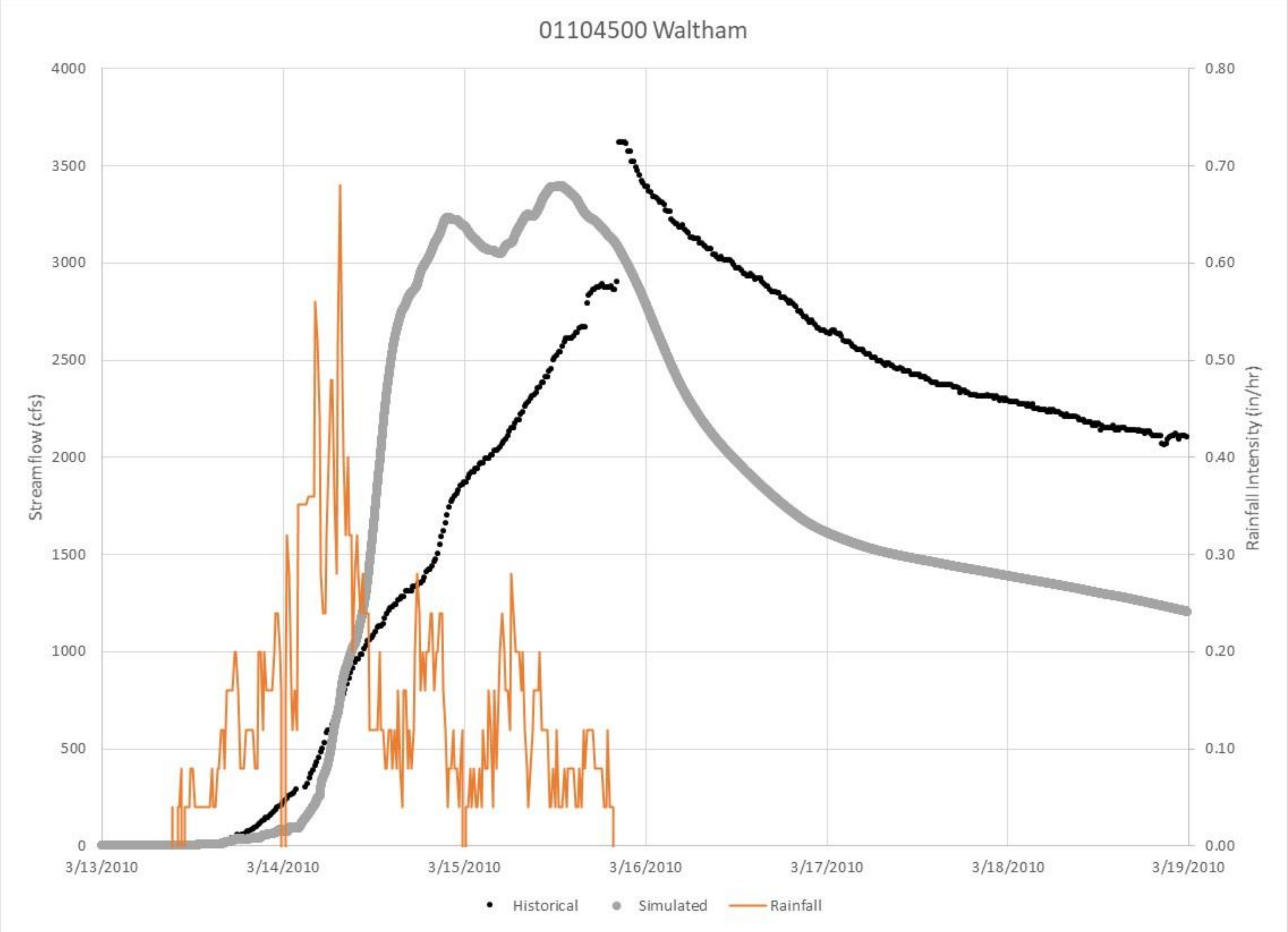
Model Calibration

Waltham USGS Gage

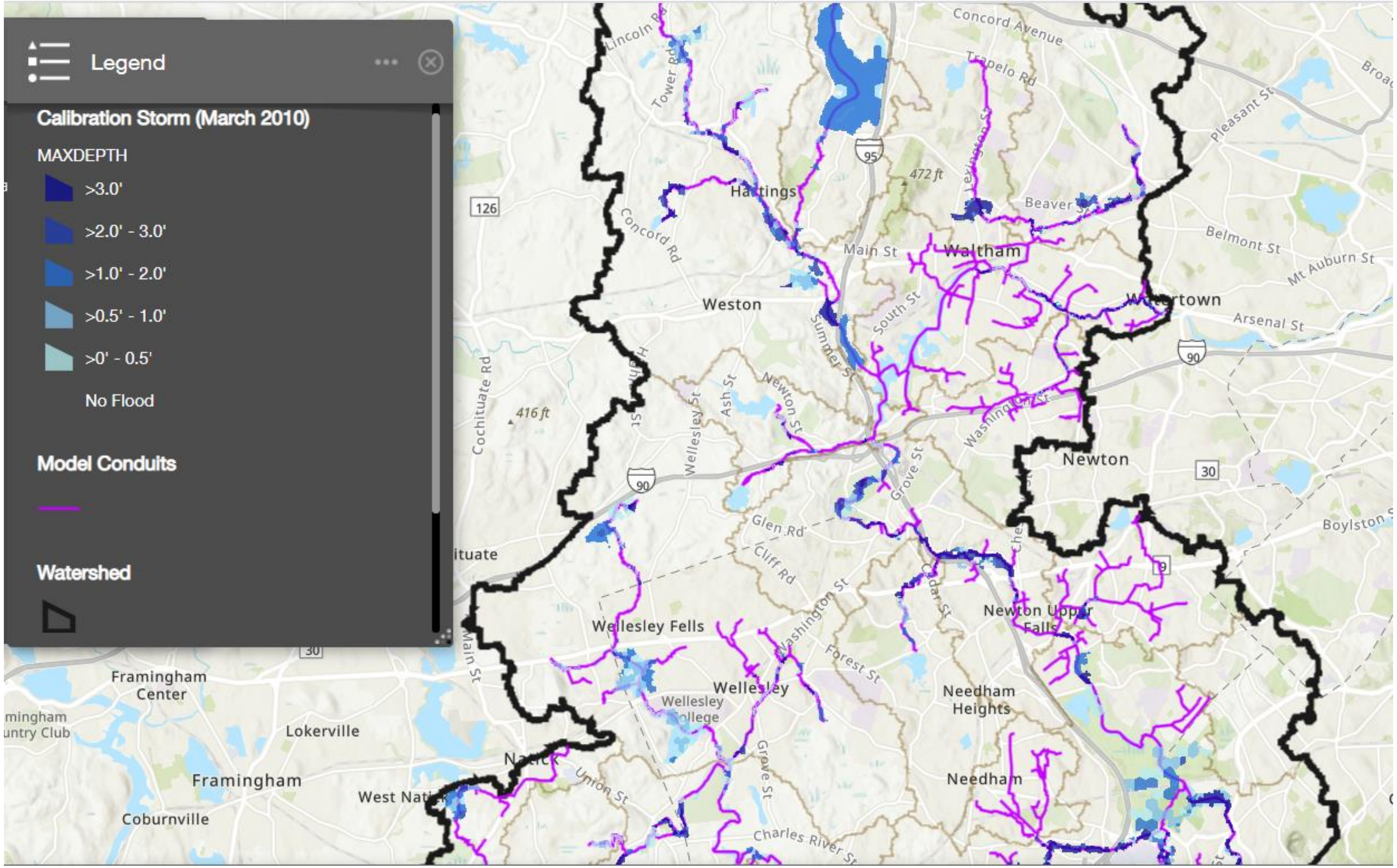


Comparison	*Charles River*
	Waltham
	01104500
Sim Vol	838,246,510
Hist Vol	966,411,900
% difference	-15%
Sim Peak	3,397
Hist Peak	3,622
% difference	-6%
Sim Time	3/15/10 12:44
Hist Time	3/15/10 20:30
Time Dev	-0.3

Model Calibration

Charles River Watershed Association

2D Flood Model Results for March 2010 Storm



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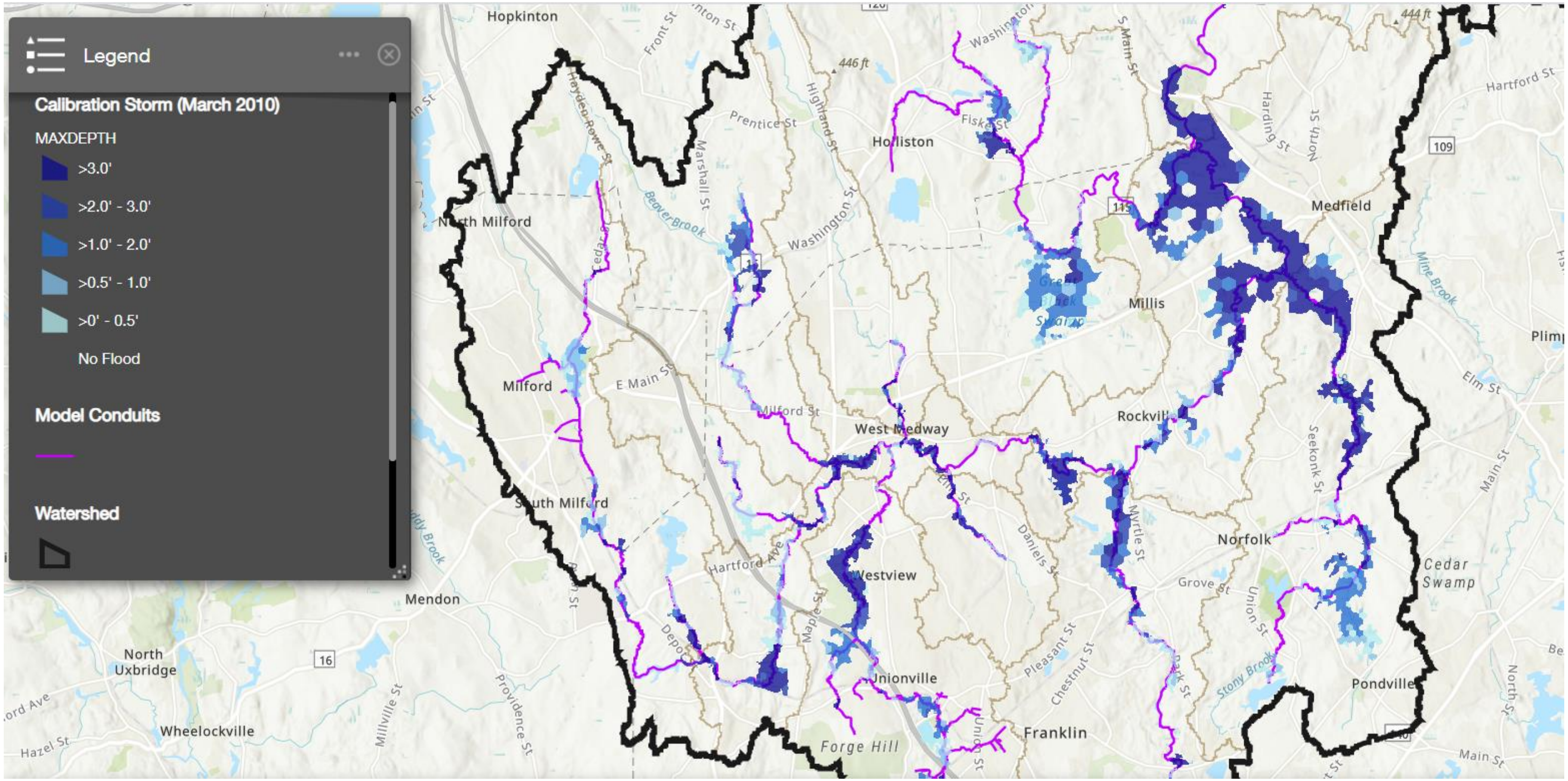
Model Calibration

Charles River Watershed Association

2D Model Results for March 2010 Storm



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Charles River Watershed Association

2D Flood Model Results – William St, Wellesley

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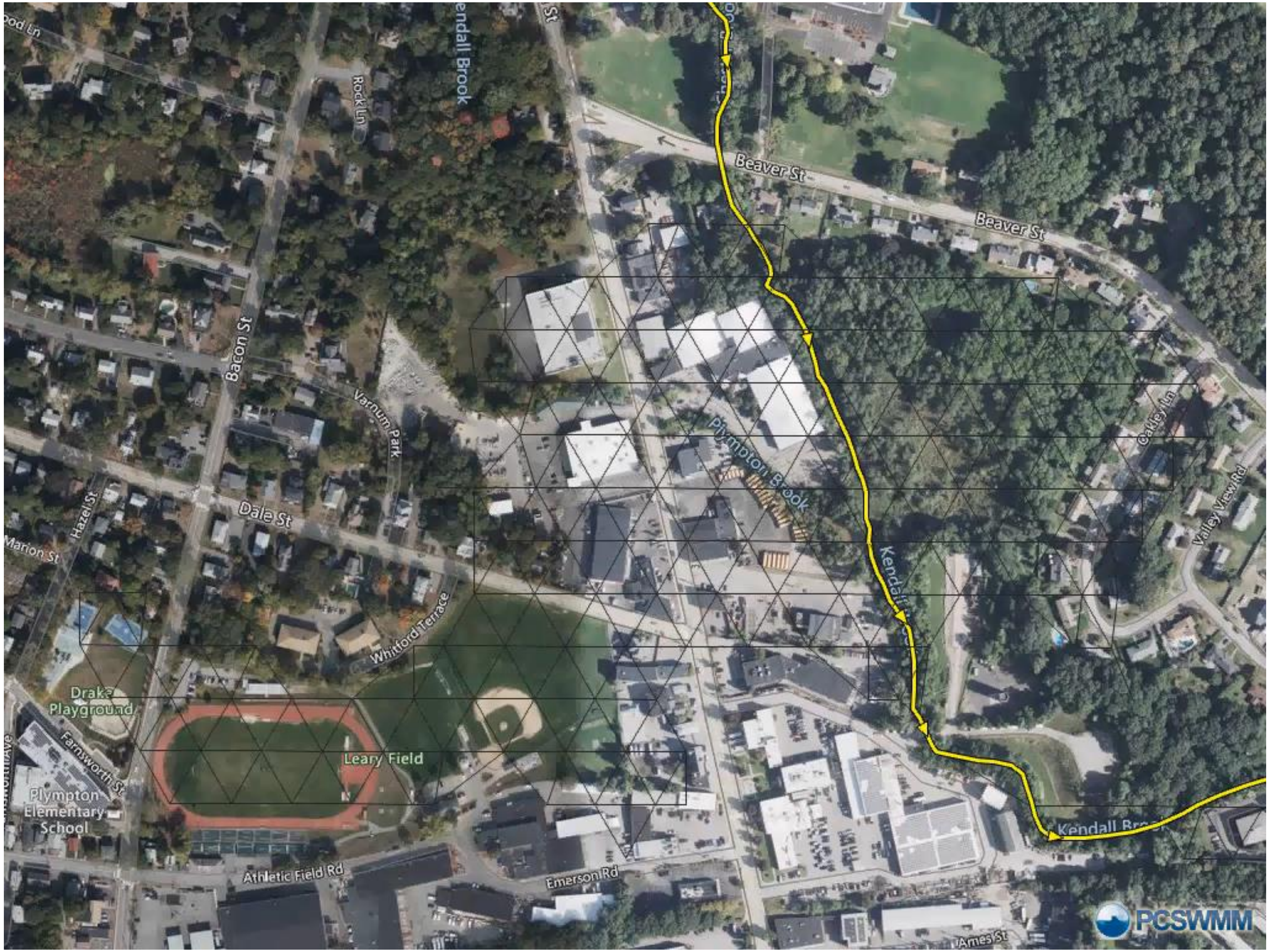
Model Calibration

Charles River Watershed Association

2D Flood Model Results –Plympton Brook Area, Waltham



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Presentation Outline

- Recap future rainfall scenarios
- Model development
- Model calibration
- **Future storm simulations**
- Flooding impacts in the watershed
- Recap green infrastructure (GI) scenario runs
- Example results from a GI scenario
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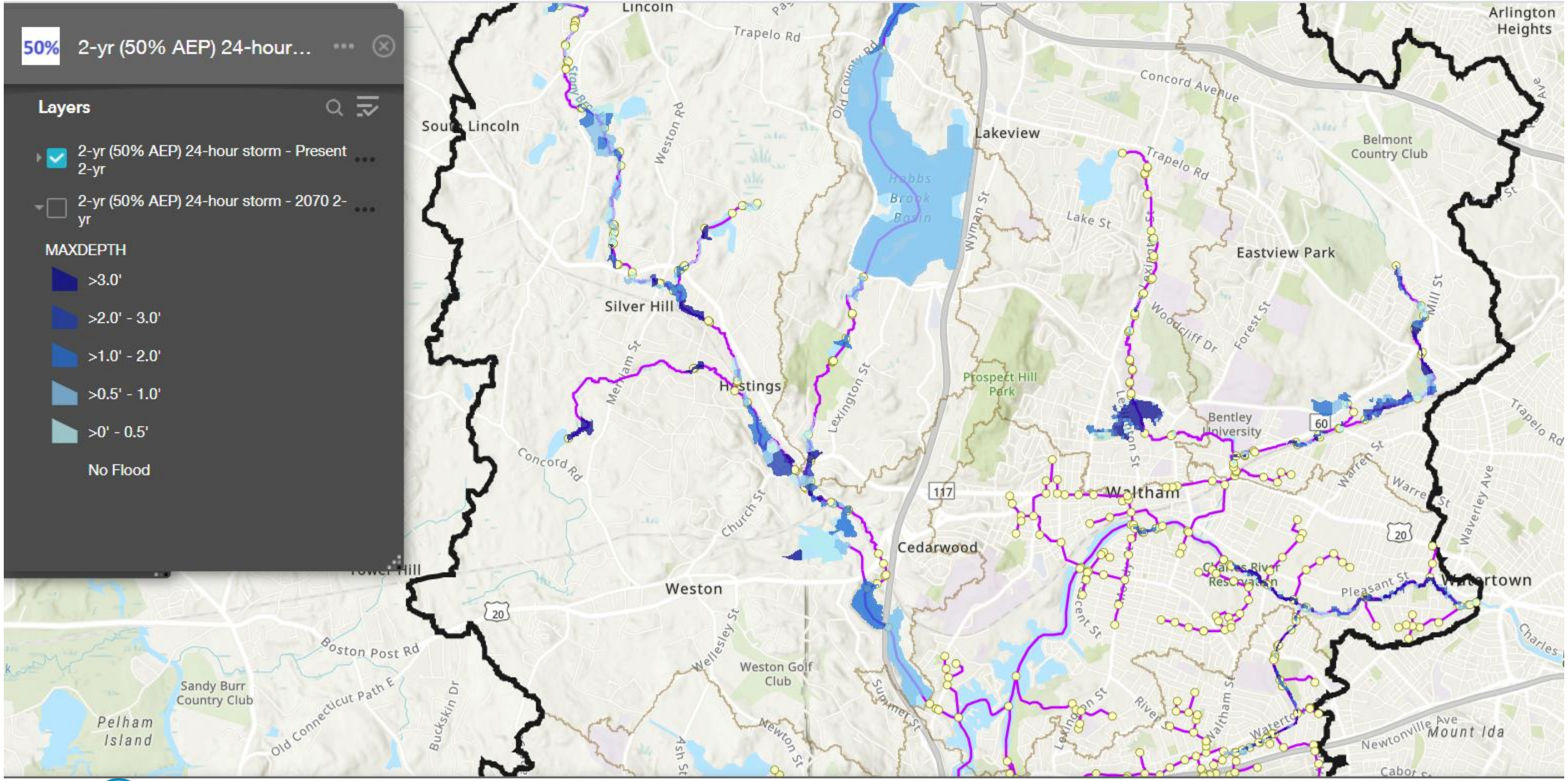
Future Storm Simulations

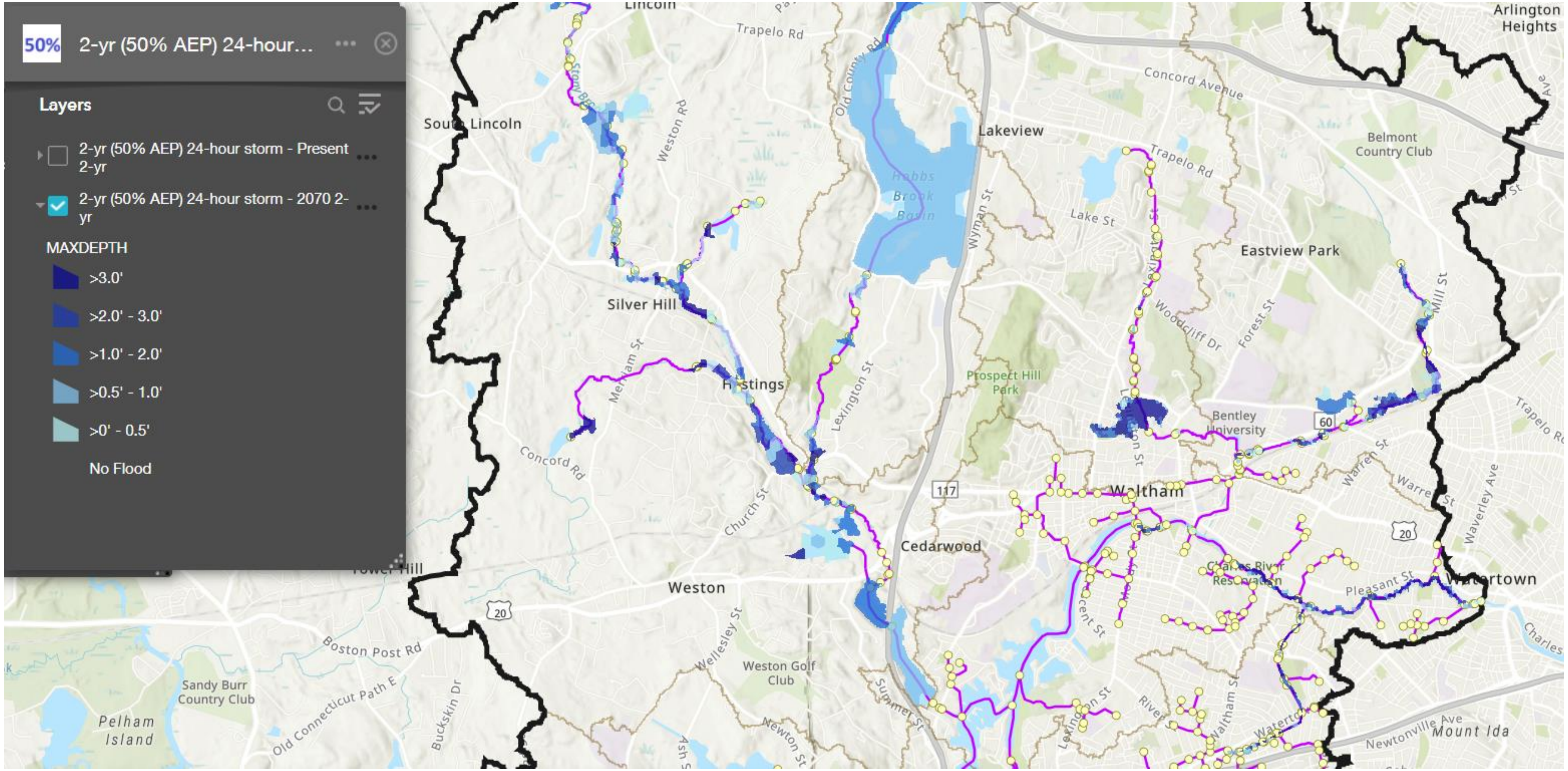
Charles River Watershed Association

Design Storm Simulations – 2yr Storm Present (3.3 inches in 24 hrs)



Charles River Watershed Association

Design Storm Simulations – 2yr Storm 2070 (4 inches in 24 hrs)



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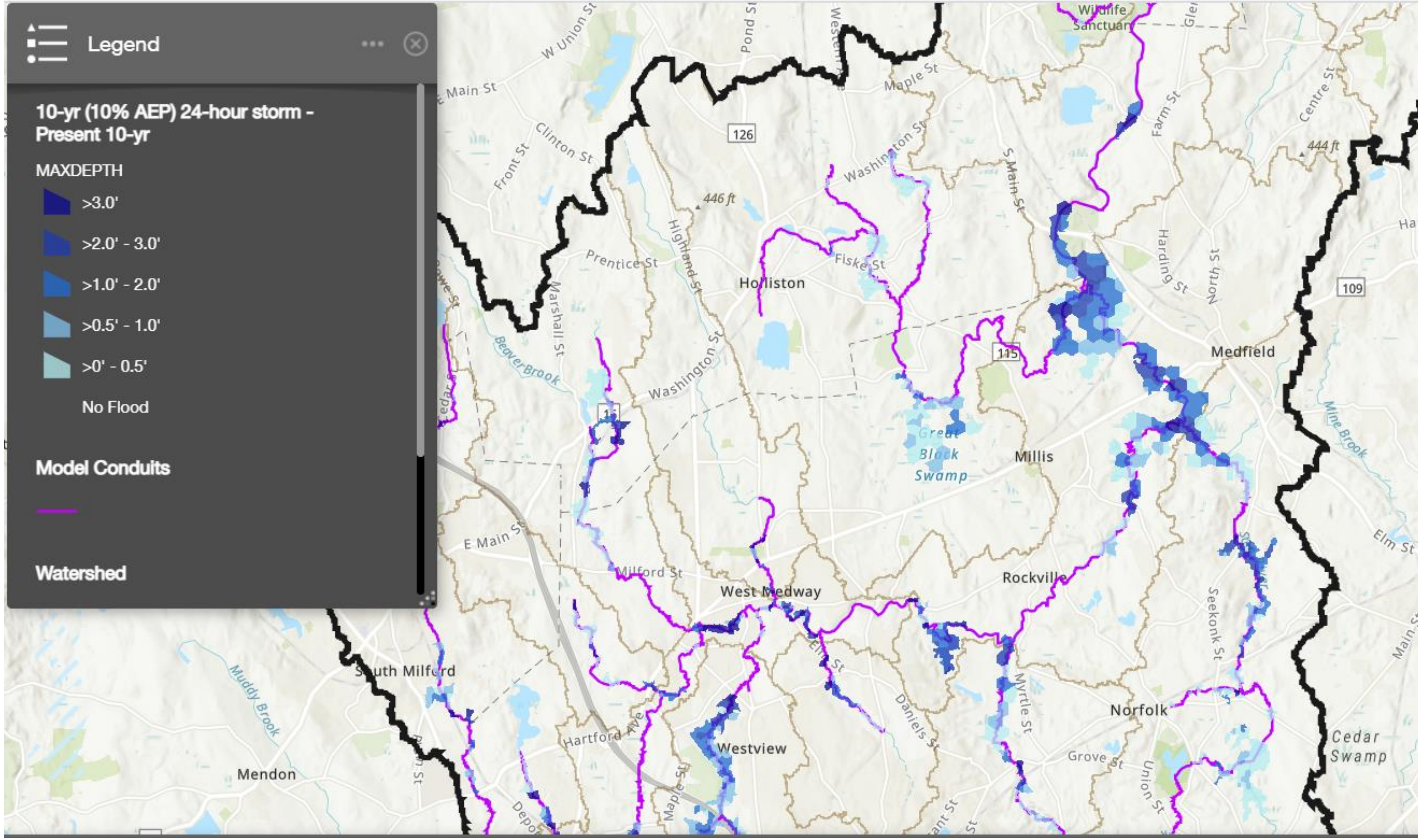
Future Storm Simulations

Charles River Watershed Association

Design Storm Simulations – 10 yr Storm Present (5.2 inches in 24 hrs)



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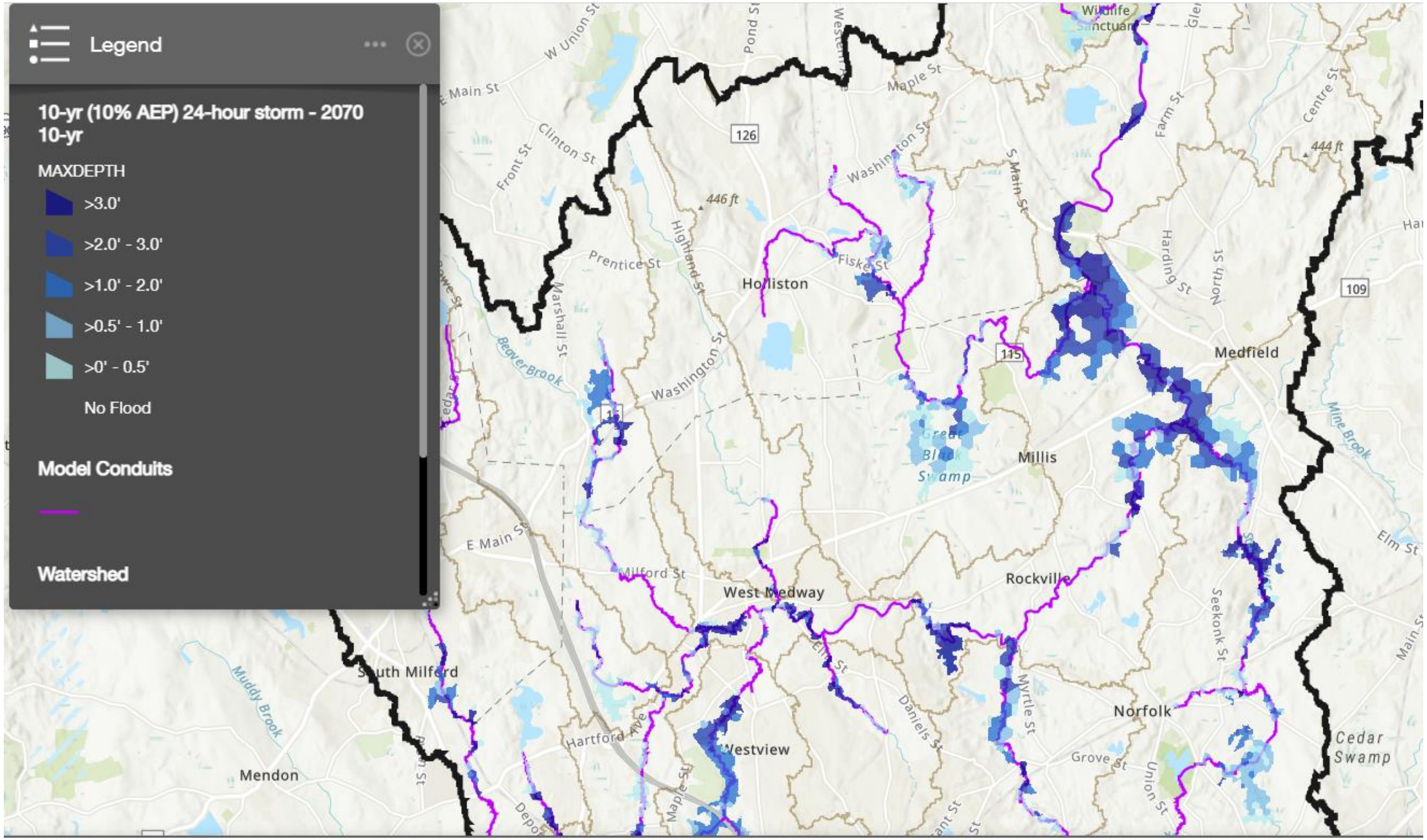
Future Storm Simulations

Charles River Watershed Association

Design Storm Simulations – 10 yr Storm 2070 (6.3 inches in 24 hrs)



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Presentation Outline

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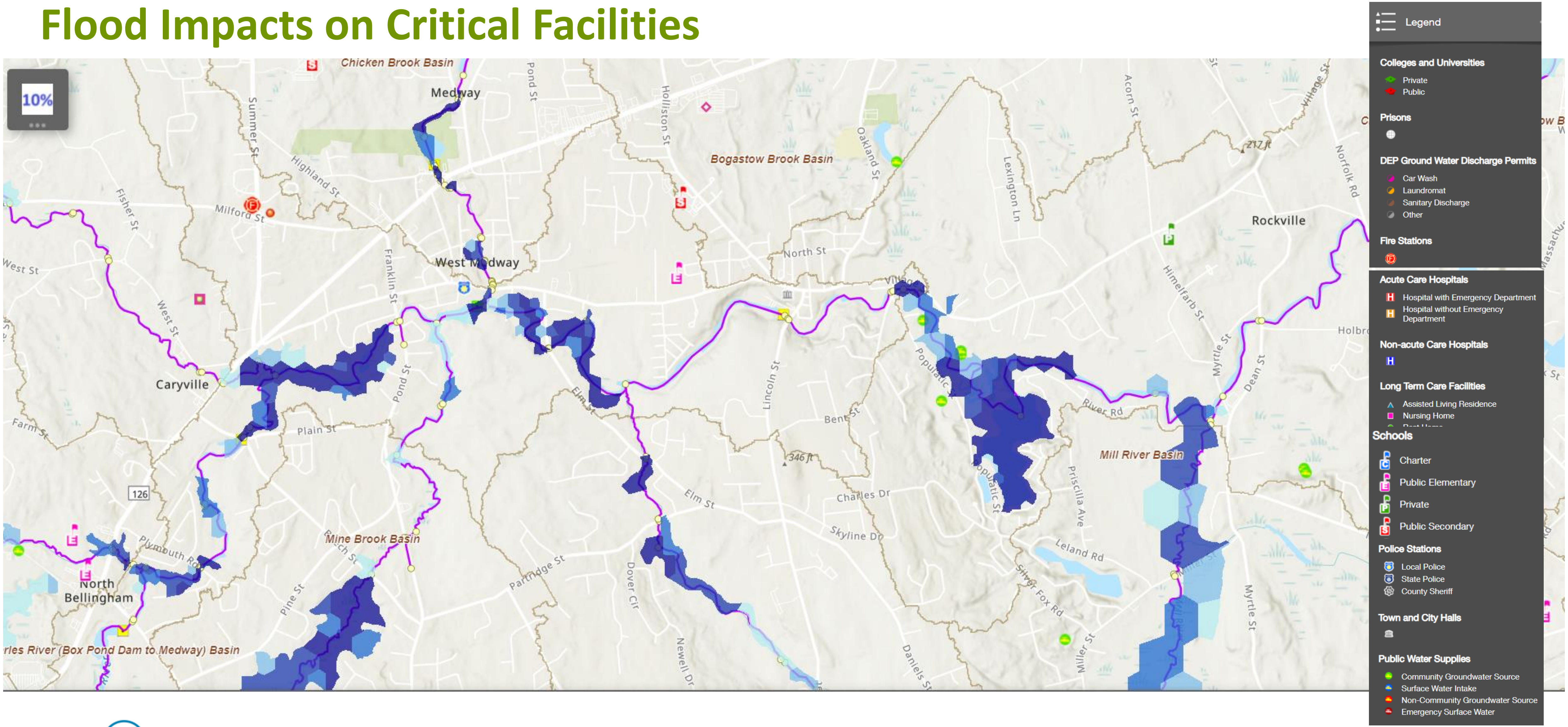
Questions and next steps

Flood Impacts

Charles River Watershed Association

Flood Impacts on Critical Facilities



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Flood Impacts Across the Watershed

	# of Critical Facilities Impacted	Acres of flooding (ac)	Runoff Volume (MG)
Present 2-yr storm	33	3,186	3,053
2070 2-yr storm	42	4,389	4,264
Increase from Present	*+9*	*+1,203*	*+1,211*
Present 10-yr storm	53	6,909	7,368
2030 10-yr storm	56	7,630	8,642
Increase from Present	*+3*	*+721*	*+1,274*
2070 10-yr storm	56	8,579	10,651
Increase from Present	*+3*	*+1,670*	*+3,283*
March 2010 Storm (8.99 inches)	59	10,446	20,831

Flood Impacts in Beaver Brook (Waltham)

	# of Critical Facilities Impacted	Acres of flooding (ac)	Runoff Volume (MG)
Present 2-yr storm	3	74.4	99
2070 2-yr storm	3	80.3	136
Increase from Present	---	*+5.9*	*+37*
Present 10-yr storm	4	95.8	225
2030 10-yr storm	4	112.1	259
Increase from Present	---	*+16.3*	*+34*
2070 10-yr storm	4	116.3	313
Increase from Present	---	*+20.5*	*+88*
March 2010 Storm (8.99 inches)	4	93.7*	573

*Timing of runoff from individual sub-basins for this historical event muted the peak discharge and flooding extents.

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- Recap future rainfall scenarios
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Modeling Nature Based Solutions

Charles River Watershed Association

Scenarios Selected

Green Stormwater Infrastructure
1. Green infrastructure stores 2" storm runoff from up to 50% of all impervious cover town-wide
2. 10% of feasible/priority land area is GSI
3. Storage on large (>5 acres) public properties (GSI, underground storage, "blue roofs") (site specific strategy)

Reduce Impervious Cover
4. Reduce effective impervious cover watershed wide by 10% (for subbasins over 10%)

Land Conservation
5. Allow 50% of remaining undeveloped/unprotected land to become impervious

Other
6. Increase Tree Canopy: 25% public ROWS become green streets: tree box filters/bioswales connected to leaching catch basins

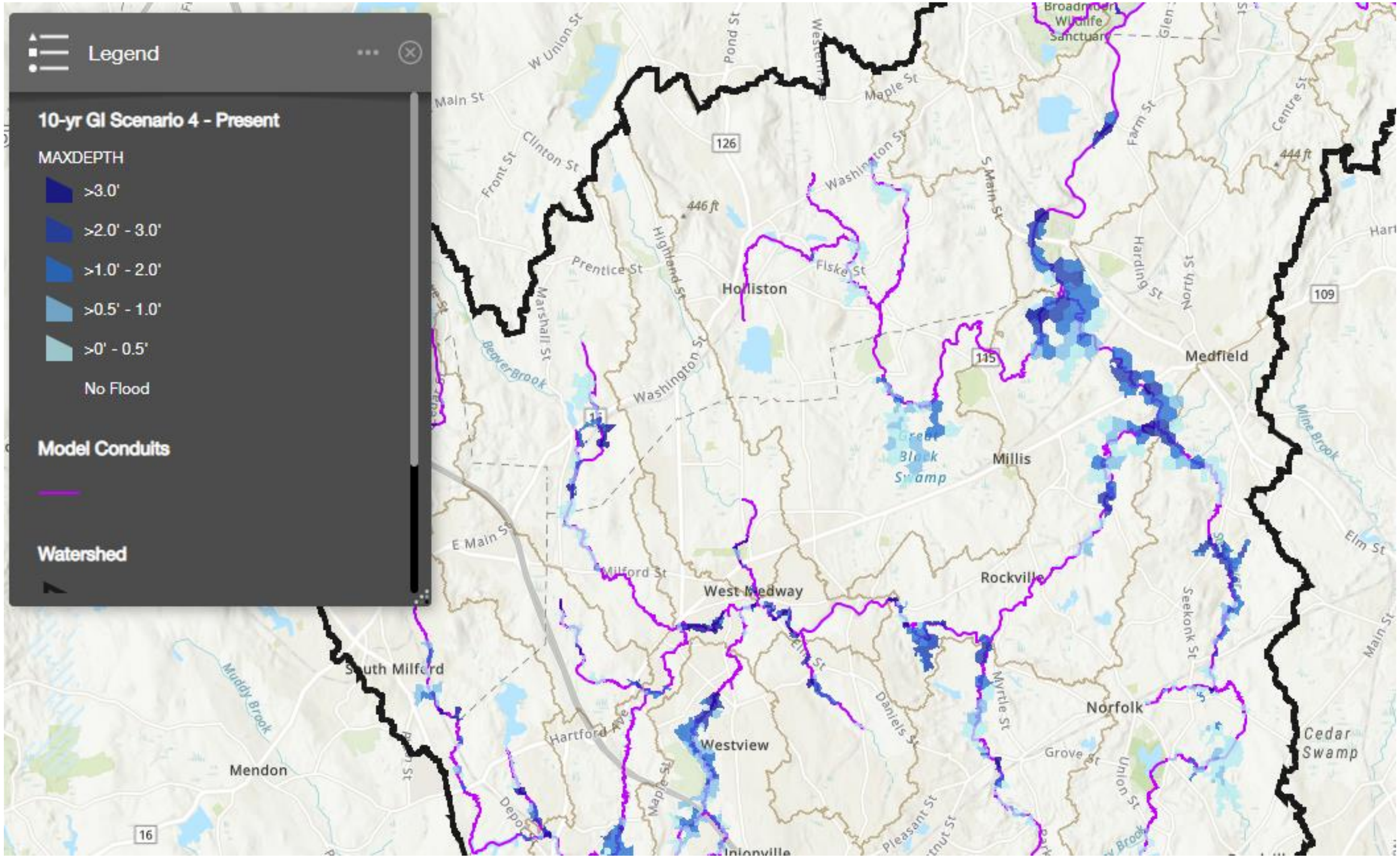
Alternates:
Wetland Restoration: All wetland areas 10% larger
Dam removal: Remove all dams other than active flood control dams

**Data details from May 5th presentation found here.

Nature Based Solution Model Runs

Charles River Watershed Association

Green Infrastructure Sc 4 – 10 yr Storm Present (5.2 inches in 24 hrs)



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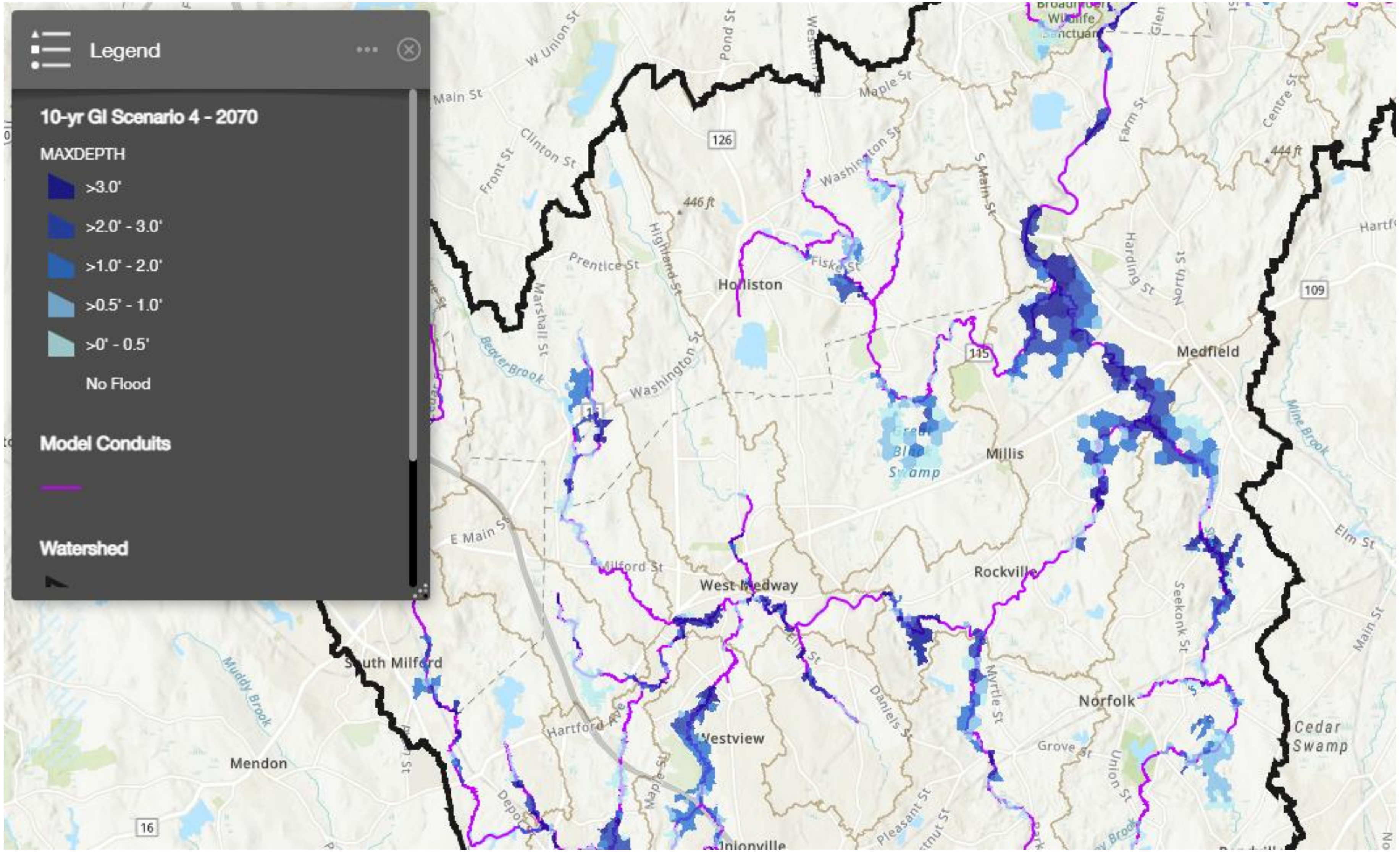
Nature Based Solution Model Runs

Charles River Watershed Association

Green Infrastructure Sc 4 – 10 yr Storm 2070 (6.3 inches in 24 hrs)



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Nature Based Solution Model Runs

Charles River Watershed Association

Flood Benefits Across the Watershed – Green Infrastructure Scenario 4

	# of Critical Facilities Impacted	Acres of flooding (ac)	Runoff Volume (MG)
Present 10-yr storm – No Action	53	6,909	7,368
Present 10-yr storm + GI Sc 4	50	6,790	7,142
Change from No Action	-3	-119	-226
2070 10-yr storm – No Action	56	8,579	10,651
2070 10-yr storm + GI Sc 4	56	7,906	10,401
Change from No Action	---	-673	-250

Nature Based Solution Model Runs

Charles River Watershed Association

Flood Benefits in Beaver Brook – Green Infrastructure Scenario 4

	# of Critical Facilities Impacted	Acres of flooding (ac)	Runoff Volume (MG)
Present 10-yr storm – No Action	4	95.8	225
Present 10-yr storm + GI	4	88.0	212
Change from No Action	---	-7.8	-13
2070 10-yr storm – No Action	4	116.3	313
2070 10-yr storm + GI	4	106.2	298
Change from No Action	---	-10.1	-15

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Online Viewer Demo

Charles River Watershed Association

Presentation Outline

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- Questions and next steps

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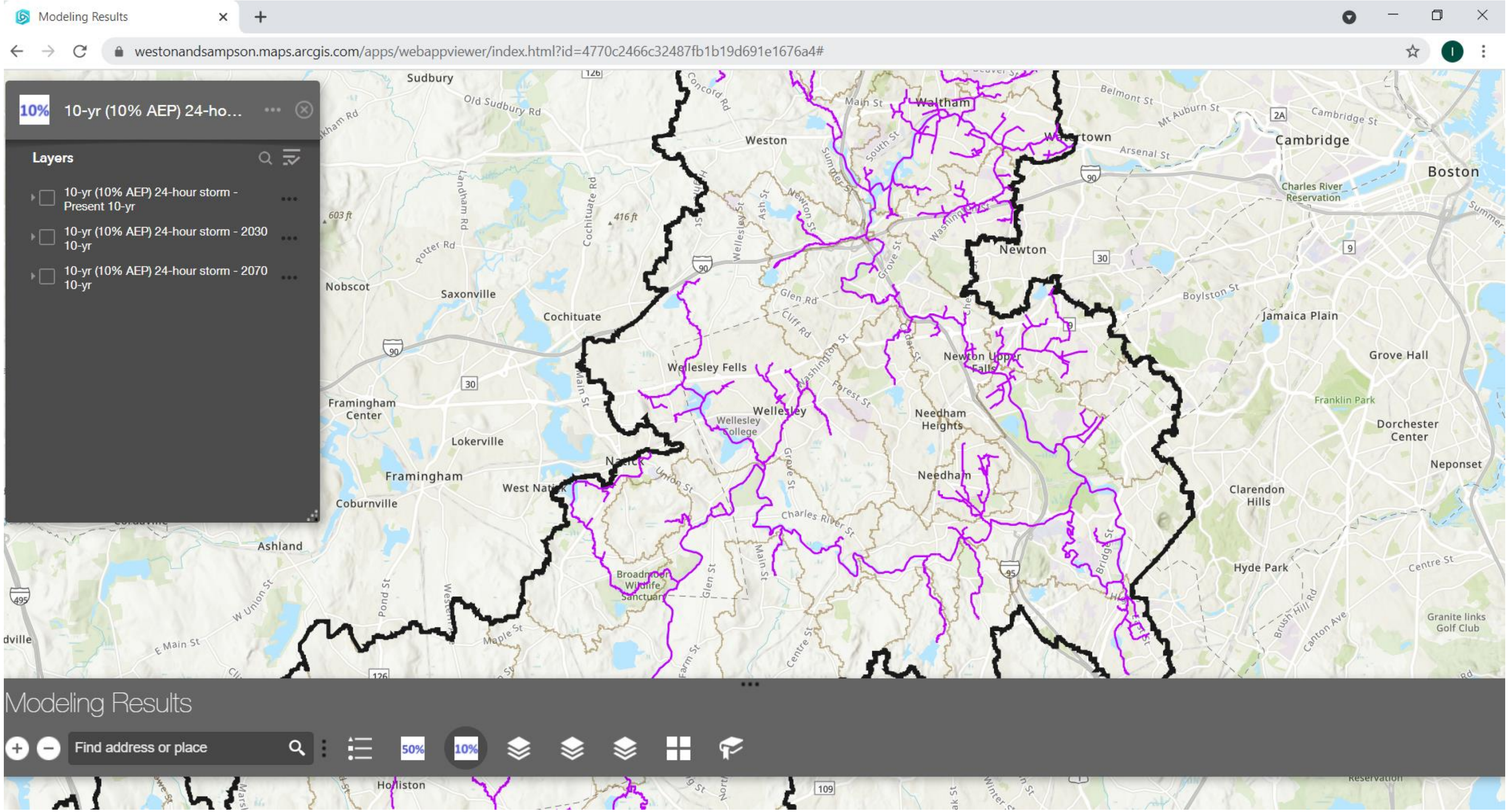
Online Viewer Demo

Charles River Watershed Association

Online Viewer



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Question & Next Steps

Charles River Watershed Association

Presentation Outline

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Upcoming Meetings

Charles River Watershed Association

June 2nd, 1-2 pm: Climate Compact Meeting (bi-monthly meeting rescheduled from May)

June 24th, 1-2 pm: Final project team meeting

-Communication's kit

-Discuss next steps

June 23rd, 7-8pm: Final Public Presentation (virtual event)

- Will be an updated and abbreviated version of what you saw today

CHARLES RIVER WATERSHED MODEL

Appendix A.3:
Summary Co-Benefits Table

Scenario 1	
Co-Benefit Type	Co-Benefit Description
Nature-Based Solutions Scenarios	Green infrastructure stores 2” storm runoff from up to 50% of all impervious cover town-wide (assume some infiltration on good quality soils).
Promotes Biodiversity	In this scenario, there is an additional 36,893 acres of green stormwater infrastructure providing additional greenery and habitat. GSI system typically function best with native or nativized vegetation which also provide habitat for local wildlife.
Restores or Remediates Sites	Careful site planning and selection of practices allow green infrastructure to work on contaminated sites and sites with poor soils.
Promotes Sustainable Development / Reduces Development in Climate Vulnerable Areas	GSI can provide green jobs and protection for surrounding properties, and amenities to surrounding residents. This scenario demonstrates where flooding impacts will occur with and without intervention.
Improved Water Quality	According the the EPA, if a stream’s watershed has greater than 25% impervious cover, the stream is a non-supporting, or unhealthy, stream. Treating and infiltrating stormwater runoff onsite will remove pollutants and reduce pollutant loading in the Charles River and the watershed. A biofiltration system similar to the FocalPoint has a 66% phosphorus removal rate. Bioretention systems and rain gardens have a removal efficiency of: • 90% TSS removal with adequate pretreatment • 30-50% total nitrogen • 30-90% total phosphorus • 40-90% metal pollutant A detention basin has pollutant removal efficiencies of: • 50% TSS removal with adequate pretreatment • 15-50% total nitrogen • 10-30% total phosphorus • 30-50% metal pollutant • Less than 10% pathogen removal
Annual Recharge	Using the Stormwater Recharge Calculator developed by Abt Associates with support from CRWA, it is estimated this scenario can recharge 16,288 million gallons per year (MGY).
Improved Air Quality	Improves air quality by filtering air pollutants and particulates. Larger impact if trees are incorporated into GSI systems.
Climate Mitigation	Increases in vegetation mean more direct carbon sequestration along with more shade and heat dissapation, lowering outdoor temperatures. Additionally, a reduction in impervious cover will lead to less heat absorbed, also helping reduce temperatures. Less energy spent on cooling purposes, will result in a decrease in carbon dioxide emissions.
Public Health	Infiltration practices will assist with groundwater recharge and restoring levels for drinking water. Provides flood management and reduces opportunity for combine sewer overflow events and associated hazards and displacement from flooding.
Reduce Long-term Maintenance	N/A
Raise Awareness of Nature-Based Solutions	Engages public in stormwater management issues with visual demonstration. Familiarizes public with GI practices

Scenario 2	
Co-Benefit Type	Co-Benefit Description
Nature-Based Solutions Scenarios	20% of feasible/priority land area is GSI (also assumed some infiltration on good quality soils and then filtration for the rest of the systems - can assume mostly systems with plants - i.e. not underground)
Promotes Biodiversity	In this scenario, there is an additional 32,242 acres of green stormwater infrastructure providing additional greenery and habitat. GSI system typically function best with native or nativized vegetation which also provide habitat for local wildlife.
Restores or Remediates Sites	Careful site planning and selection of practices allow green infrastructure to work on contaminated sites and sites with poor soils.
Promotes Sustainable Development / Reduces Development in Climate Vulnerable Areas	GSI can provide green jobs and protection for surrounding properties, and amenities to surrounding residents. This scenario demonstrates where flooding impacts will occur with and without intervention.
Improved Water Quality	According the the EPA, if a stream's watershed has greater than 25% impervious cover, the stream is a non-supporting, or unhealthy, stream. Treating and infiltrating stormwater runoff onsite will remove pollutants and reduce pollutant loading in the Charles River and the watershed. A biofiltration system similar to the FocalPoint has a 66% phosphorus removal rate. Bioretention systems and rain gardens have a removal efficiency of: • Total suspended solids (TSS): 90% with adequate pretreatment • Total nitrogen: 30-50% • Total phosphorus: 30-90% • Metals (copper, lead, zinc, cadmium): 40-90% metal pollutant A detention basin has pollutant removal efficiencies of: • TSS: 50% with adequate pretreatment • Total Nitrogen: 15-50% • Total phosphorus:10-30% • Metals (copper, lead, zinc, cadmium): 30-50% • Pathogens (coliform, E. Coli): Less than 10%
Annual Recharge	Using the Stormwater Recharge Calculator developed by Abt Associates with support from CRWA, it is estimated this scenario can recharge 87,923 MGY (area of GSI 10% of treatment)
Improved Air Quality	Improves air quality by filtering air pollutants and particulates. Larger impact if trees are incorporated. GI can also provide traffic and street noise abatement
Climate Mitigation	This scenario proposes treating an area of around 105,000 acres. Increases in vegetation mean more direct carbon sequestration along with more shade and heat dissapation. Additionally, a reduction in impervious cover means less heat absorbed, resulting in cooler temperatures. Less energy spent on cooling purposes, will result in a decrease in carbon dioxide emissions.
Public Health	Vegetation provides shade, dissipates ambient heat through evapotranspiration, and deflects radiation from the sun, which provide cooling (reduces heat island effect) and decrease opportunity for heat related deaths. Vegetation also releases moisture into the atmosphere. GSI improves aesthetics and increases exposure to greenness which can improve mental health and provide a possible reduction in the risk of crime. Mitigates the risk of flooding and combine sewer overflow events and associated hazards.
Reduce Long-term Maintenance	N/A
Raise Awareness of Nature-Based Solutions	Engages public in stormwater management issues with visual demonstration. Increases space and opportunity for social interaction. Familiarizes public with GSI practices.

Scenario 3	
Co-Benefit Type	Co-Benefit Description
Nature-Based Solutions Scenarios	Storage on large (>5 acres) public properties (assumes mix of underground and surface based systems)
Promotes Biodiversity	This scenario would include constructed wetlands or other large scale storage systems that create new habitat.
Restores or Remediates Sites	At certain sites green infrastructure solutions such as green roofs and cisterns that function without infiltrating stormwater into the soil can be assessed to add storage on sites not suitible for infiltration.
Promotes Sustainable Development / Reduces Development in Climate Vulnerable Areas	Provides amenities to surrounding communities. Increases property values and opportunity for green jobs. Provides large scale environmental protection. Wetlands play a crucial role in many state and tribal fishing economies.
Improved Water Quality	Constructed stormwater wetlands have a high pollutatant removal efficiency for soluble pollutants and particles. A constructed weltand has the following pollutant removal efficiencies: • TSS: 80% with pretreatment • Total nitrogen: 20% - 55% • Total phosphorus: 40% - 60% • Metal (copper, lead, zinc, cadmium): 20% - 85% • Pathogens (coliform, E. Coli): Up to 75%
Annual Recharge	Approximately 280 sites were identified as possibly “large scale” storage opportunities, if even a portion of these could provide infiltration for small rain events along with additional storage for large events this would result in considerable annual groundwater recharge.
Improved Air Quality	N/A
Climate Mitigation	Increases in vegetation mean more direct carbon sequestration along with more shade and heat dissapation.
Public Health	Increases opportunity for bird and wildlife viewing and physical activity. Improves aesthetics and increases exposure to greenness which can improve mental health and provide a possible reduction in the risk of crime. Mitigates the risk of flooding and combine sewer overflow events and associated hazards. Supports ecosystems, promotes biodiversity and provides cooling. Filters out pollutants and protects drinking water.
Reduce Long-term Maintenance	N/A
Raise Awareness of Nature-Based Solutions	Increases recreational opportunity and creates space for social interaction.

Scenario 4	
Co-Benefit Type	**Co-Benefit Description**
Nature-Based Solutions Scenarios	Reduce effective impervious cover watershed wide by 10%
Promotes Biodiversity	This scenario would transition over 7300 acres of impervious cover to more natural land covers, increasing habitat and promoting biodiversity.
Restores or Remediates Sites	N/A
Promotes Sustainable Development / Reduces Development in Climate Vulnerable Areas	Protects vulnerable communities through flood mitigation.
Improved Water Quality	According the the EPA, if a stream's watershed has greater than 25% impervious cover, the stream is a non-supporting, or unhealthy, stream. Treating and infiltrating stormwater runoff onsite will remove pollutants and reduce pollutant loading in the Charles River and the watershed.
Annual Recharge	By reducing 10% of effective imperivous cover, an additional estimated 4,536 million gallons of stormwater will be infiltrated annually.
Improved Air Quality	N/A
Climate Mitigation	This scenario proposes over 7,300 more acres of green space. A reduction in impervious cover means less heat absorbed, resulting in cooler temperatures. Less energy spent on cooling purposes, will result in a decrease in carbon dioxide emissions.
Public Health	Reduces stormwater runoff leading to improvements in water quaility. Reduces heat island effect, Creates additional open space.
Reduce Long-term Maintenance	N/A
Raise Awareness of Nature-Based Solutions	Increases visual demonstrations and opportunity of engagement with public. Opportunity for educational material to be built around GSI.

Scenario 5	
Co-Benefit Type	Co-Benefit Description
Nature-Based Solutions Scenarios	Allow 50% of remaining undeveloped/unprotected land to become impervious.
Promotes Biodiversity	Protecting the remaining undeveloped land in the watershed will prevent the further degradation of habitat and biodiversity loss.
Restores or Remediates Sites	N/A
Promotes Sustainable Development / Reduces Development in Climate Vulnerable Areas	Negative impacts for vulnerbale communties. Future development of open space is expected to make flooding worse by as much as 3,389 acres and 1,500 MG compared to present day conditions in a projected 2070 10-yr storm event.
Improved Water Quality	According the the EPA, if a stream's watershed has greater than 25% impervious cover, the stream is a non-supporting, or unhealthy, stream. Increasing impervious area in the watershed will reduce water quality.
Annual Recharge	N/A
Improved Air Quality	N/A
Climate Mitigation	N/A
Public Health	Increases opportunity for transportation of pollutants, degrades water quality, and increases surrounding temperatures all of which have negative effects on public health.
Reduce Long-term Maintenance	N/A
Raise Awareness of Nature-Based Solutions	N/A

Scenario 6	
Co-Benefit Type	Co-Benefit Description
Nature-Based Solutions Scenarios	Increase Tree Canopy: 25% public ROWS become green streets (would also probably be a mix of infiltration and filtration)
Promotes Biodiversity	Additional tree canopy cover, especially in areas where it is currently lacking will add biodiversity and habitat to developed areas of the watershed.
Restores or Remediates Sites	Careful site planning and selection of practices allow green infrastructure to work on contaminated sites and sites with poor soils.
Promotes Sustainable Development / Reduces Development in Climate Vulnerable Areas	Protects existing infrastructure and provides traffic and street noise abatement, strengthens soil. A healthy 100-foot-tall tree can absorb 11,000 gallons of water from the soil and release it into the air again, as oxygen and water vapor, in a single growing season.
Improved Water Quality	Vegetation plays a huge part in stormwater nutrient uptake. Installing tree box filters along ROWs can remove 80-90% TTS, 38-65% total nitrogen, 50-80% total phosphorus, and between 40-90% metals.
Annual Recharge	In a single subbasin (Lowder Brook), it is estimated this scenario can recharge 88.5 MGY. Due to the variety of soil types found within the subbasin, a conservative infiltration rate was used.
Improved Air Quality	Large scale improvements to air quality by filtering air pollutants and particulates. Reduction to air temperatures as well. A mature tree absorbs carbon dioxide at a rate of 48 pounds per year.
Climate Mitigation	Increases in tree canopy will reduce carbon dioxide emissions through direct carbon sequestration, and by providing more shade and therefore reducing the amount of energy needed for cooling purposes. Reduction in energy used will then lead to less output of atmospheric carbon dioxide emissions.
Public Health	Vegetation provides shade, dissipates ambient heat through evapotranspiration, and deflects radiation from the sun, which provide cooling (reduces heat island effect) and decrease opportunity for heat related deaths. Vegetation also releases moisture into the atmosphere. GI improves aesthetics and increases exposure to greenness which can improve mental health and provide a possible reduction in the risk of crime. Mitigates the risk of flooding and combine sewer overflow events and associated hazards.
Reduce Long-term Maintenance	N/A
Raise Awareness of Nature-Based Solutions	Increases visual demonstrations and opportunity of engagement with public. Opportunity for educational material to be built around GSI.

CHARLES RIVER WATERSHED MODEL

Appendix A.4:
Project Team Communications Kit

Appendix A.4: Communications Kit
Provided to the project team as original files

- Template PowerPoint Presentation
- Social Media posts (available in multiple languages, video files also provided)
- Project flyer (available in multiple languages)
- Press release template
- User guide

Building Resilience Across the Charles River Watershed

Photo credit: Tim Rice

Weston & Sampson | CREW Communities Responding to Extreme Weather | Charles River Watershed Association

Town logo here

Building Resilience Across the Watershed

Charles River Watershed Association

Agenda

- Welcome and Introductions
- Background
- Charles River Flood Model Results
- [other agenda items]

Meeting etiquette *(suggestions for virtual)*
- Live captioning is available
- Use Q&A box/chat for questions
- Land acknowledgement (see suggestions in guide)

Meeting etiquette *(in-person)*
- Translators available (ASL, Spanish, Portuguese, Chinese)
- Land acknowledgement
- Provide compensation or incentives (free food/gift cards)

Charles River overflowing in Weston. Source credit: CRWA

Background

Charles River Watershed Association

Charles River Climate Compact

A convening of watershed communities to

- discuss shared and regional challenges to climate adaptation
- Identify solutions to both shared and regional challenges to climate adaptation
- investigate watershed scale flooding issues
- raise issues publicly or with the state together, as needed

Access to technical expertise from CRWA, and their network of environmental partners as needed, to address challenges in the following categories: flooding, stormwater, water quality and quantity, environmental justice, emergency preparedness, dam removal, wetlands protections, land use, and funding

Current Priorities (set in 2020):

- Develop a regional model of the watershed for analysis of regional adaptation strategies (done!)
- Develop a strategic plan for the CRCC
- Fund land conservation for the purpose of flood control
- Develop a regional tree planting plan

Background

Charles River Watershed Association

CLIMATE CHANGES	RELATED NATURAL HAZARDS
Changes in precipitation	– Inland flooding – Drought – Landslide
Sea level rise	– Coastal flooding – Coastal erosion – Tsunami
Rising temperatures	– Average/extreme temperatures – Wildfires – Invasive species
Extreme weather	– Hurricanes/tropical storms – Severe winter storms/nor'easters – Tornadoes – Other severe weather

Source: mass.gov

Climate Impacts in the Northeast

- Increased precipitation (together with impervious surfaces) can lead to flooding
- Rising temperatures can lead to droughts and heat-related deaths
- Increasing extreme weather events can cause damage to people and property

Climate impacts/threats to [town]

- [any impacts/threat identified in your town through MVP planning process or through citizen science]

Climate change will also lead to **significant social disruption** which will **not be felt equally** across the population.

Impacts include:

- Evacuation and displacement of vulnerable populations
- Loss of income/economic well being
- Public health issues including impacts on chronic health disparities, mental health, losing access to essential resources (clean air, water, soil)

Project Background

Charles River Watershed Association

Project Overview

- Regional collaboration to develop a flood model for the Charles River watershed
- Understand flooding under different climate change scenarios & assess benefits from mitigation measures
- Funded by MA Executive Office of Energy and Environmental Affairs FY21 MVP Action Grant Program

Project Goals

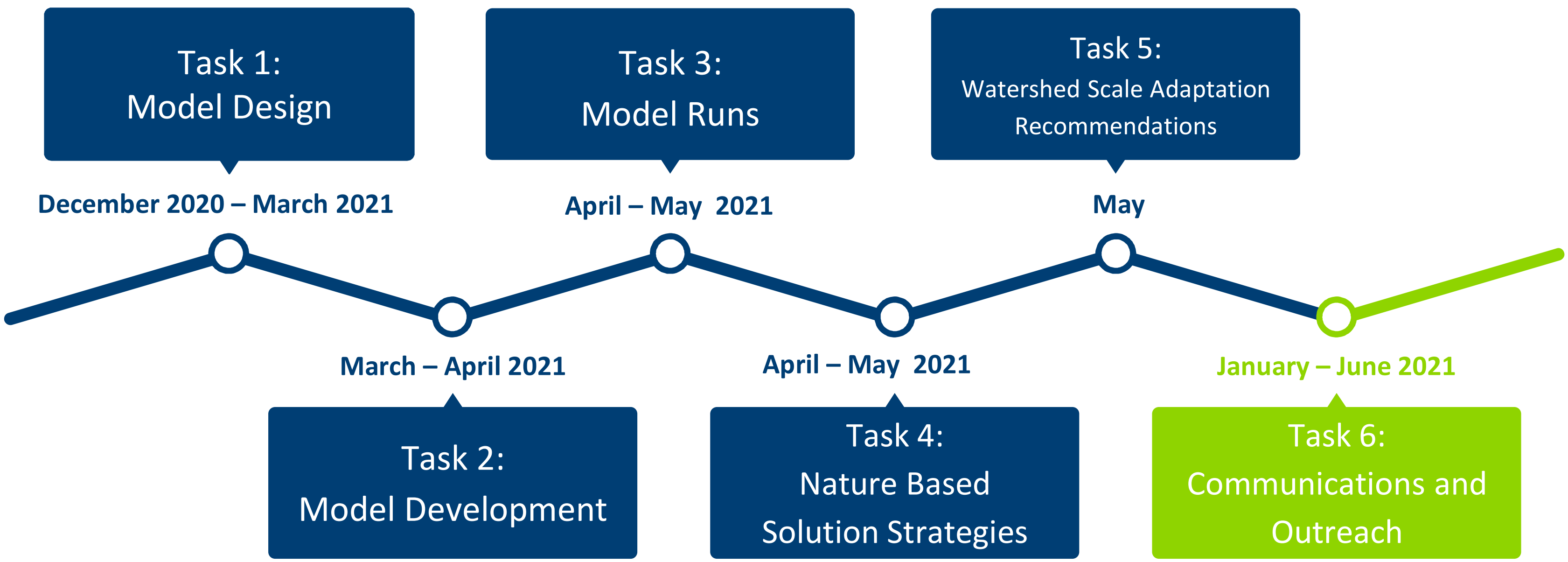
- Develop a useful and accessible climate planning tool for the region
- Use the flood model to understand the impacts of climate change to our Town/Community of [X]
- Engage watershed residents, particularly climate vulnerable residents, to build trust in this planning tool
- Build stronger regional ties





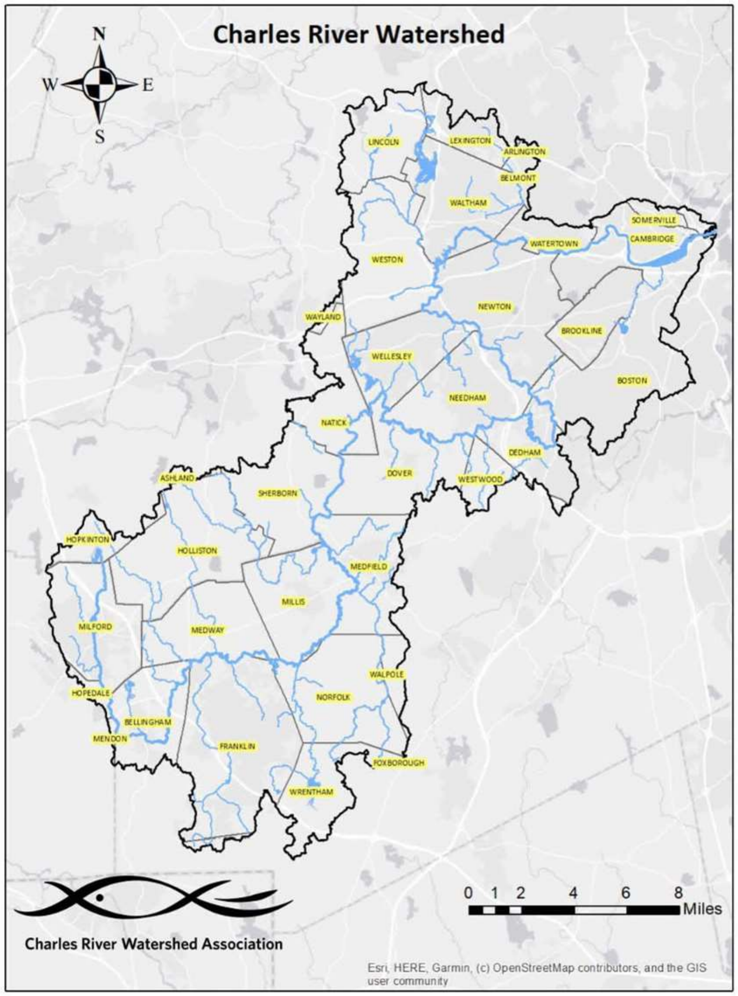
Project Timeline

Charles River Watershed Association



Model Development

Charles River Watershed Association

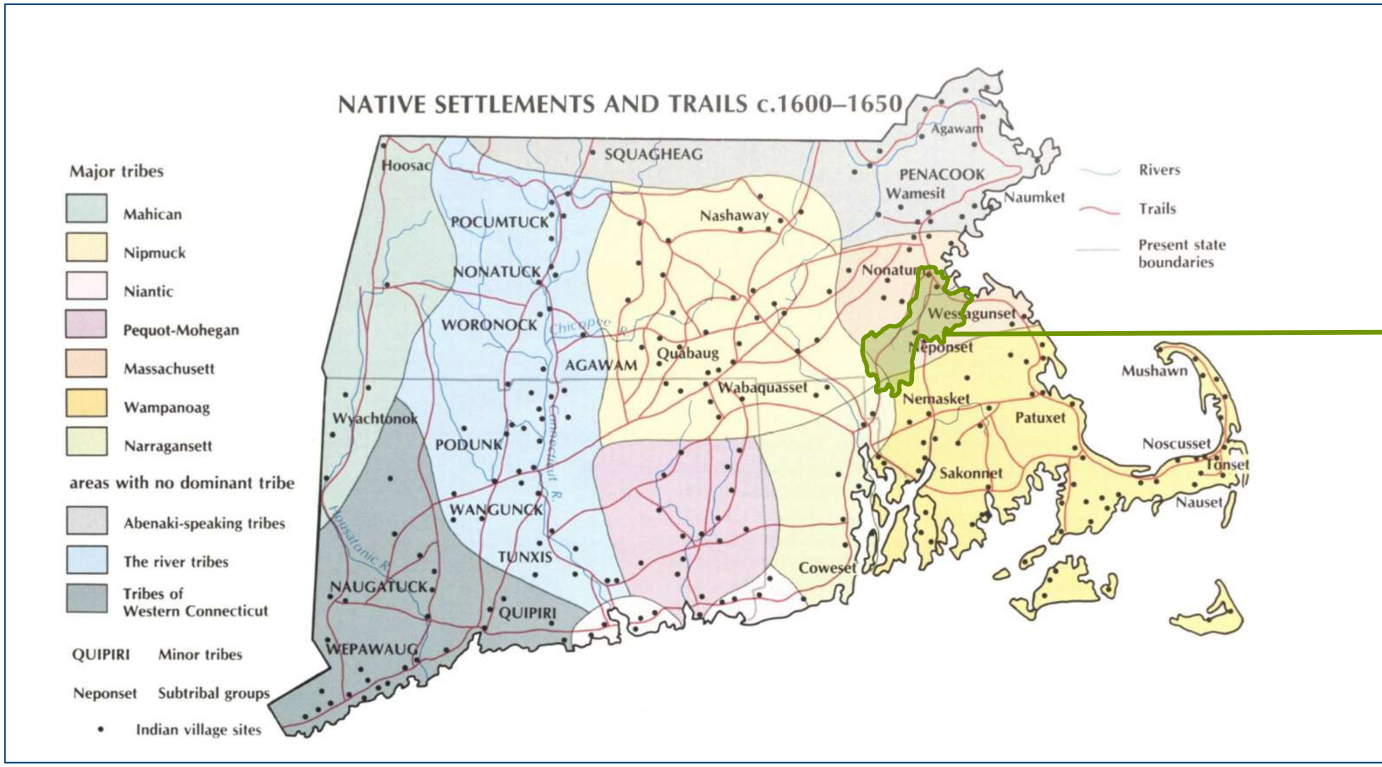


Participating Communities

Arlington	Needham
Dedham	Newton
Franklin	Norfolk
Holliston	Sherborn
Medway	Watertown
Millis	Wellesley
Natick	Weston
	Wrentham

Land Acknowledgement

Charles River Watershed Association



Map image of native settlements and trails c. 1600-1650 in Southern New England. Source credit: Harvard Map Collection

The Charles River Watershed resides within the **Massachusett**, **Nipmuck** and **Wampanaog** tribes

Model Development

Charles River Watershed Association

Model Overview: Charles River Flood Model v 1.0

- Computer model created using the PCSWMM software package
- Covers 272 sq miles of the watershed – most of the watershed outside of Cambridge and Boston which already have models

Data Collection →
- Land use and land cover
- Stormwater pipes from participating communities

Field Verifications →
- 6 days of site visits
- Use ArcGIS Collector App to record notes, measurements and photos

Build Model in PCSWMM →
- Define boundary areas (33 subbasins)
- Convey flood flows

Model Calibration
- Calibrate flood model to the March 2010 storm
- Resemble 100-yr flooding projections

Public Engagement

Charles River Watershed Association

Due to COVID-19 pandemic all project meetings and outreach were held online

Multiple Community Engagement Opportunities:

- Two webinars (available online):
  - Project introduction in January
  - Project results in June
- Three stakeholder meetings for additional discussion and feedback
- Resident input survey (available in 4 languages) close to 200 responses
- Project video
- Project website
- Communication's kit for project team outreach

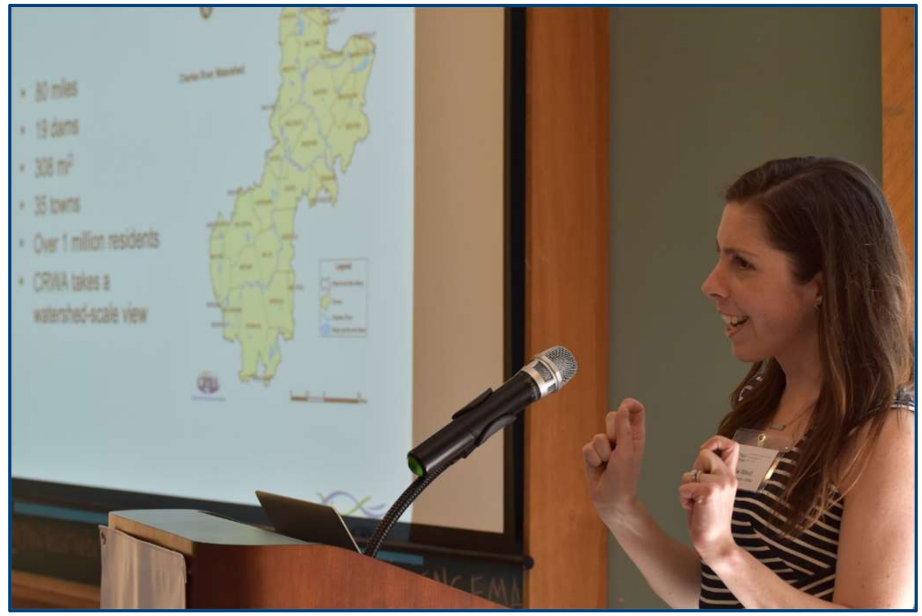


Photo taken pre-COVID

Received public input on two important factors: rain storms of concern and nature-based solutions for flood mitigation

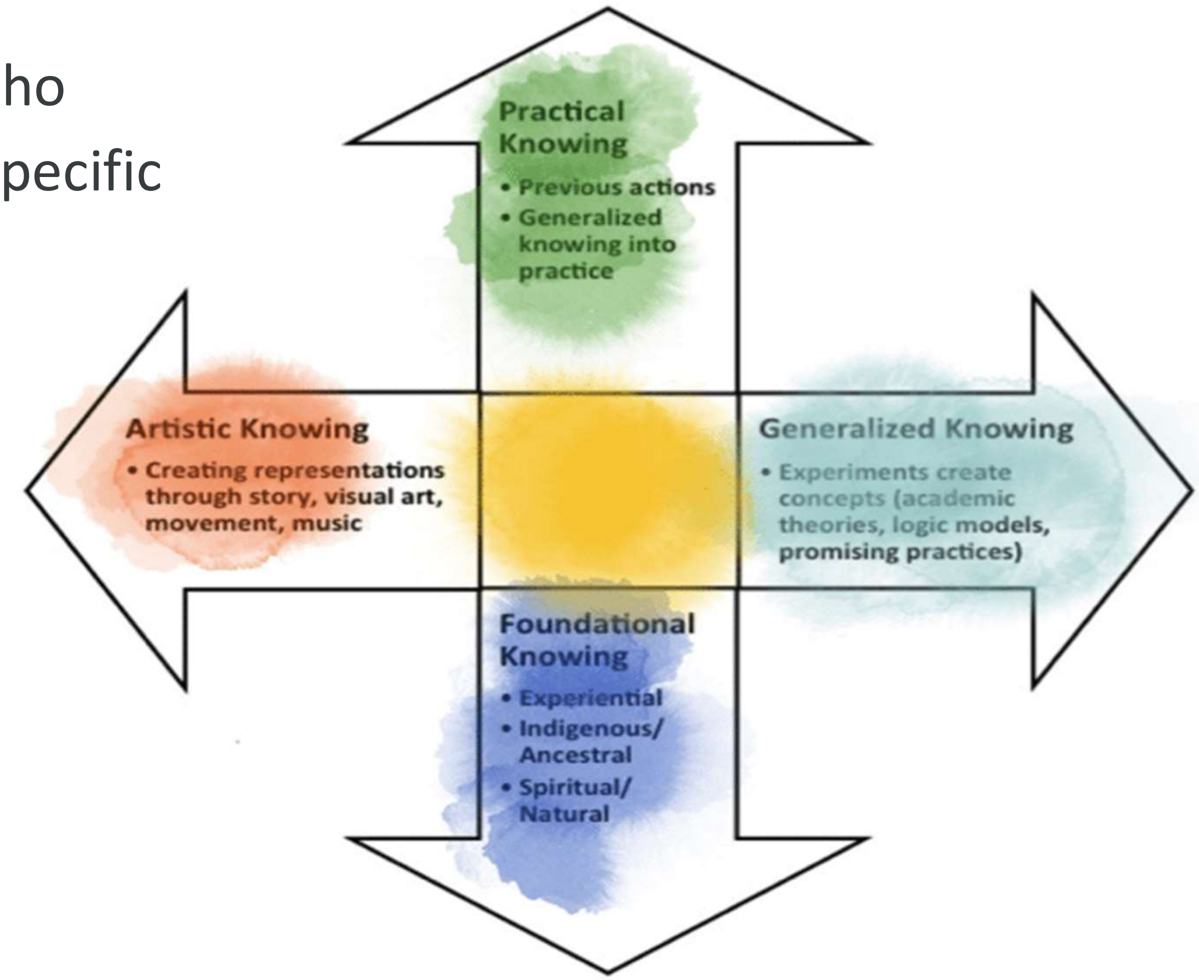
Importance of Stakeholder Engagement

Charles River Watershed Association

A **stakeholder** is an individual who shares interest or concern in a specific matter.

Different ways of knowing:

- foundational
- artistic
- general
- practical



Modeling Scenarios: Rainfall

Charles River Watershed Association

Rainfall Depths Based on Future Climate Change Scenarios

Recurrence Interval	Present (Watershed Average), inches	2030/2050 (using RMAT % increase estimates), inches	2070/2090 (using RMAT % increase estimates), inches
2-yr	3.34		4.00
10-yr	5.20	5.62	6.25
100-yr	8.17	9.07	10.37

*for 24-hour rainfall durations. RMAT = Resilient Massachusetts Action Team

Image of 2018 winter storm. Source credit:

Survey Results

Project Team: Top 3 storms of concern

1. Extended heavy rain events (12-36 hr storms)
2. Short intense rain events
3. Extended rainy seasons/rain on high groundwater conditions

Public: Future time frame you be interested in seeing flooding predictions for:

1. 2050 (146 votes)
2. 2030 (55 votes)
3. 2070/2100 (8 votes)*

*the project team was very interested in seeing the most extreme events modeled

Modeling Scenarios: Nature Based Solutions

Charles River Watershed Association

Asked what nature based solutions respondents would like to see modeled?

Project Team Survey Results

Top 5 nature-based solutions

1. Increase green stormwater infrastructure
2. Reduce impervious cover
3. Dam removal
4. Floodplain reconnection
5. Conservation

Public Survey Results

Top 5 nature-based solutions

1. Wetland restoration (147)
2. More green stormwater infrastructure (147)
3. Land conservation (138)
4. Less paved surfaces (132)
5. Increase tree canopy (131)

Project team voted wetland restoration very low, public voted dam removal very low.

Modeling Scenarios: Nature Based Solutions

Charles River Watershed Association

Modeling Nature Based Solutions

The flood mitigation strategies that the team modeled in this phase of the project were selected with input from the project team and watershed residents from seven categories.

Green Stormwater Infrastructure	Reduce Impervious Cover	Dam removal	Floodplain Reconnection	Land Conservation	Wetland Restoration	Increase Tree Canopy
• Store 2" storm runoff from up to 50% of all impervious cover town-wide with GI • 20% of priority land area designated for GSI • Storage on large (>5 acres) public properties	Reduce impervious cover in the watershed by 10%	Not selected in this phase	Not selected in this phase	Conserve only highest priority unprotected and undeveloped land, allow rest to be developed	Not selected in this phase	Increase tree canopy by 25%

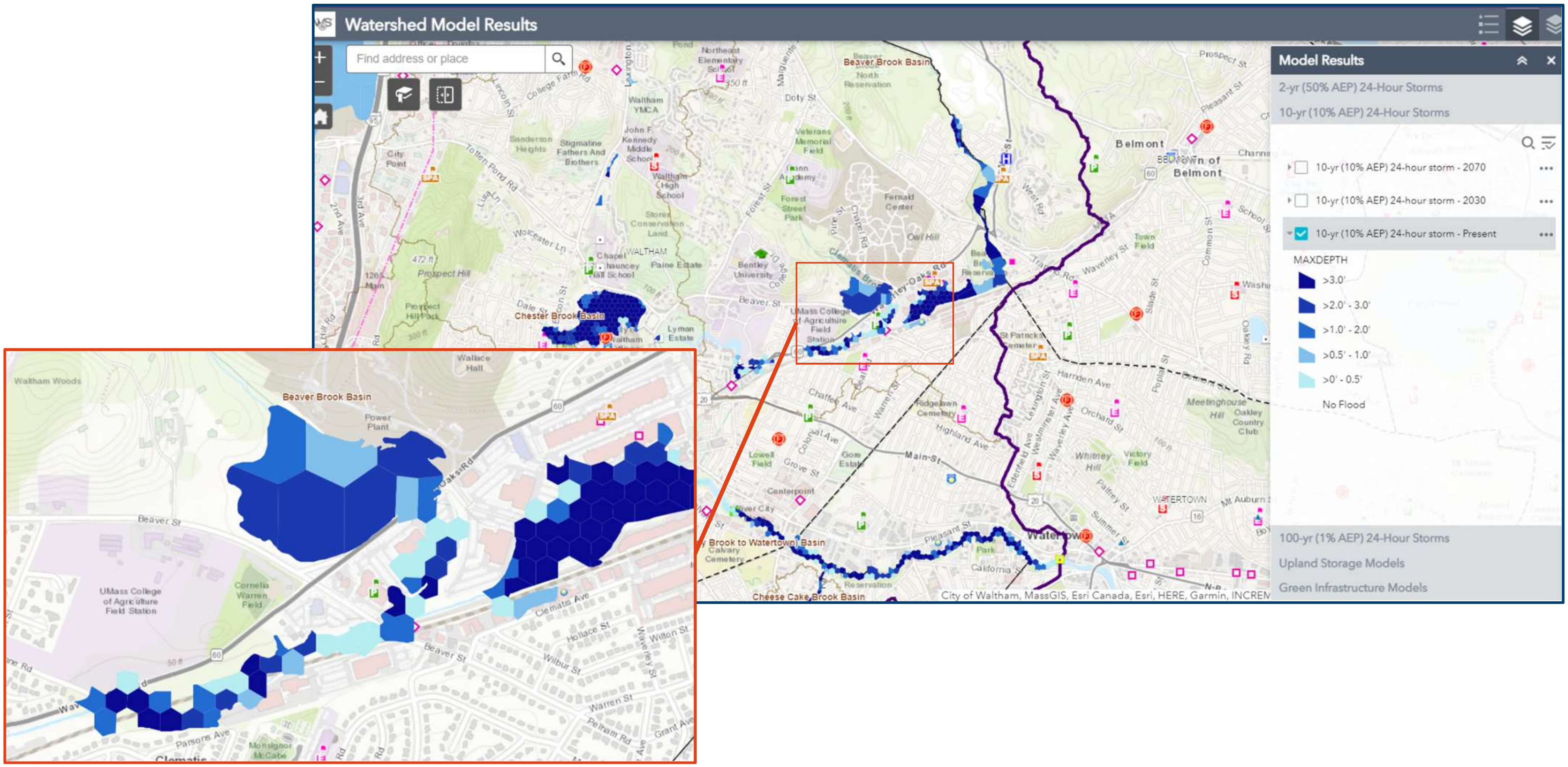
Watershed Scale Results

Charles River Watershed Association

	# of Critical Facilities Impacted	Acres of flooding (ac)	Runoff Volume (MG)
Present 2-yr storm	33	3,186	3,053
2070 2-yr storm	42	4,389	4,264
Increase from Present	*+9*	*+1,203*	*+1,211*
Present 10-yr storm	53	6,909	7,368
2030 10-yr storm	56	7,630	8,642
Increase from Present	*+3*	*+721*	*+1,274*
2070 10-yr storm	56	8,579	10,651
Increase from Present	*+3*	*+1,670*	*+3,283*
March 2010 Storm (8.99 inches)	59	10,446	20,831

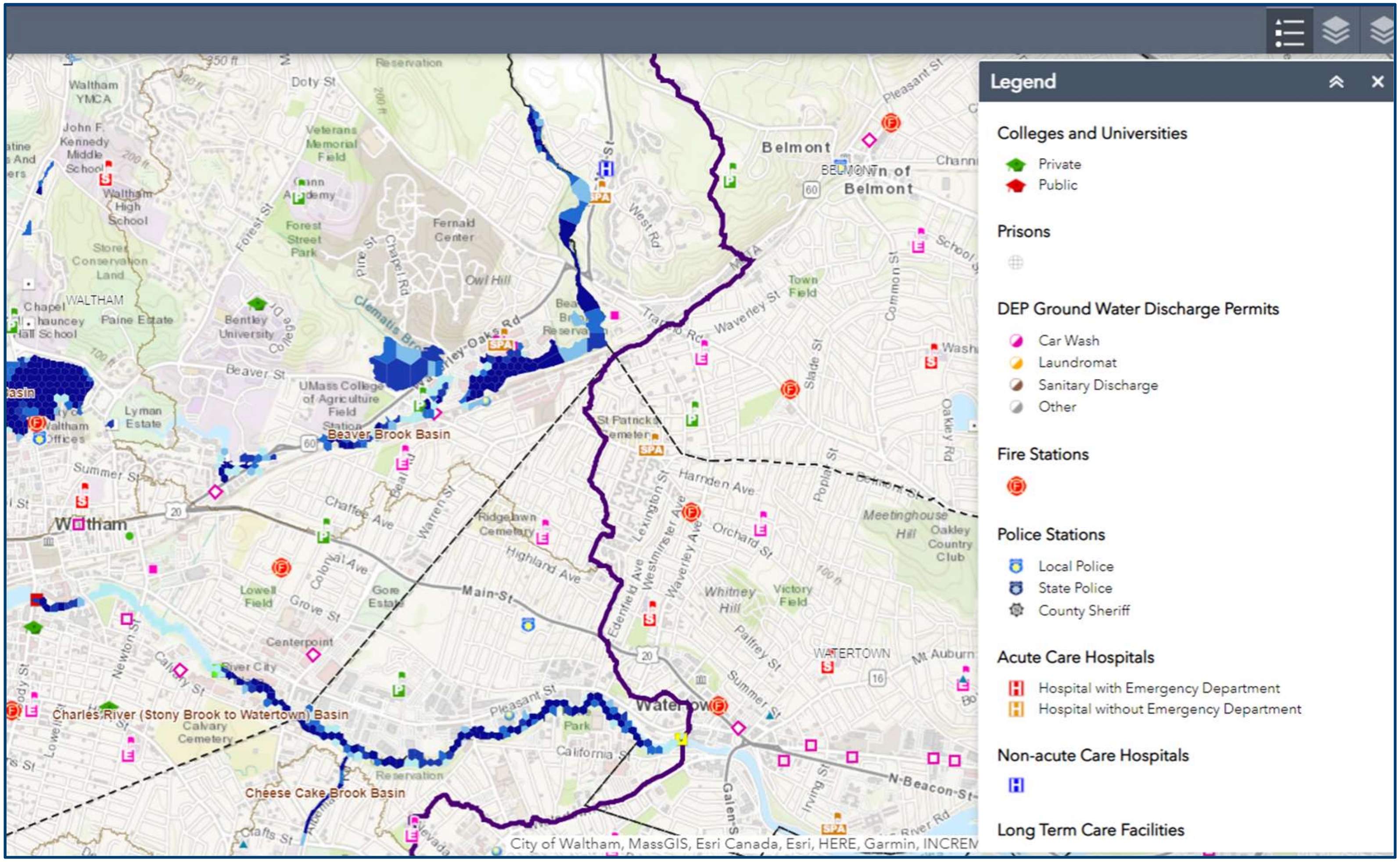
Flood Model for [Town Name]

Charles River Watershed Association



Flood Model Impacts for [Town Name]

Charles River Watershed Association

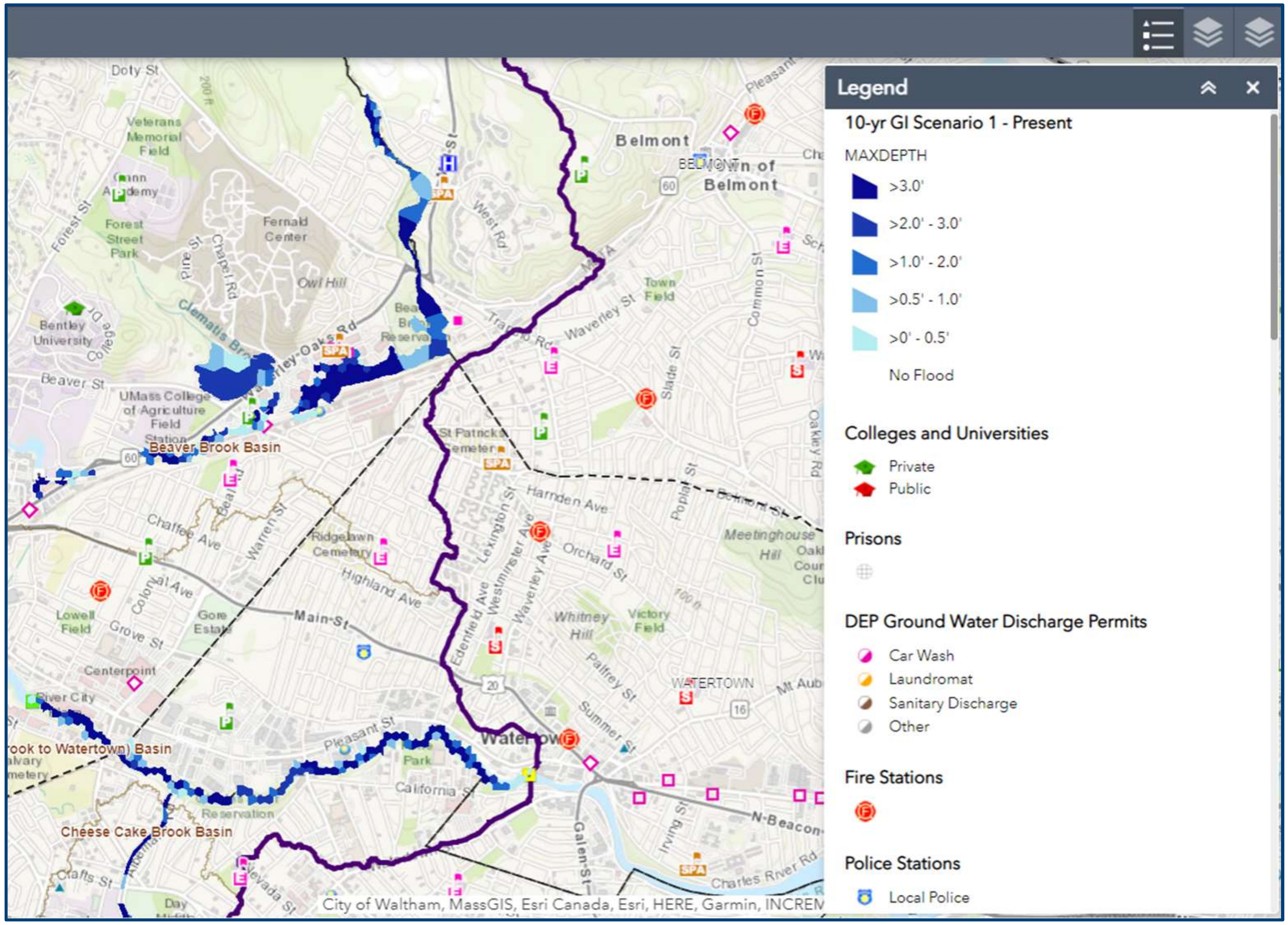


Flood Model Solutions

Charles River Watershed Association

Nature-Based Solutions

- Green Infrastructure (GI)
- Examples of GI: rain gardens, bioretention
- Potential impacts: help mitigate flooding impacts



Take a Look for Yourself!

Charles River Watershed Association

Website link here

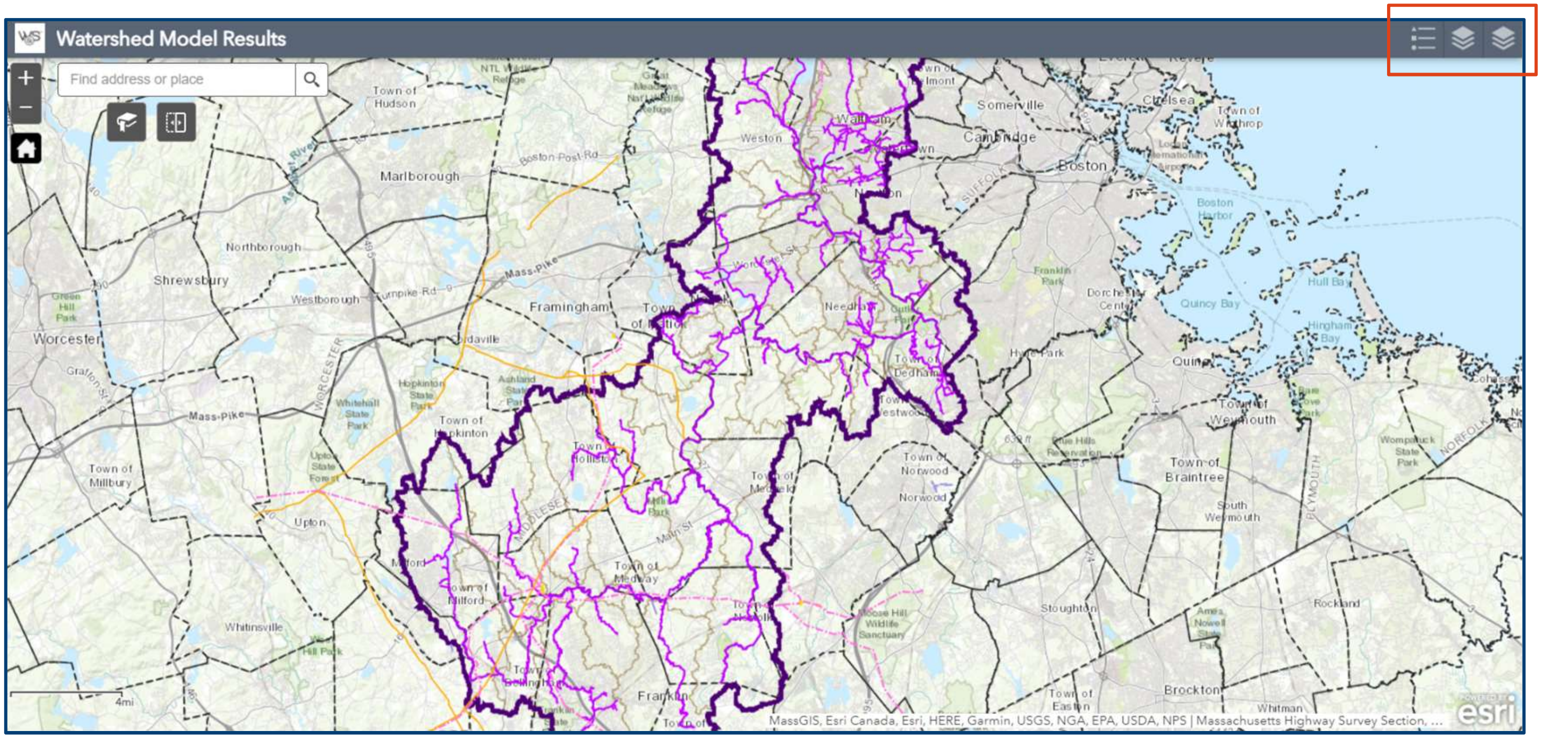
Step 1: Input your town location or select sub basin of interest or zoom in

Step 2: Select legend to see what is in view

Step 3: Select storm model (50%, 10% or 1% storms)

Step 4: Select critical facilities of interest

Step 6: Select nature based solutions impact to compare



Conclusion

Charles River Watershed Association

From the current day (baseline) 10-year event to the 2070 10-year event, we will see

- A 23% increase in flood-prone areas across the watershed
- Additional 1,600 acres (about twice the area of Central Park in New York City) that would not be flooded in today's storm but will be flooded in the future
- Many more homes, businesses, schools, roads, and potentially critical infrastructure that will be flooded

Model results demonstrate that nature-based solutions can mitigate the impacts of future flooding

However, it will take considerable investment and on the ground changes, beyond what may be considered "feasible" today to truly mitigate these impacts

Next steps

- Pursue more aggressive scenarios and test multiple strategies in concert to identify effective mechanisms to reduce flooding down to present-day levels and better
- Pursue funding to increase model detail, develop regional policy goals and tools, and identify large scale flood opportunities with significant local and regional benefits
- Develop the Charles River Watershed Climate Adaptation Implementation Plan that involves public input to document how model results will be used to put flood mitigation measures into practice

Lessons Learned

Charles River Watershed Association

Lessons Learned for [Town]

Resources

Charles River Watershed Association

Project website

- Building Resilience Across the Charles River Watershed

Climate Change Impacts

- Climate change in the watershed
- Climate action in Mass

Climate Resilience Toolkit

- Find the CRWA toolkit here

CRWA Climate Compact

- Learn more here

Modelling Workshops: Residents Meeting

- Building Resilience Across the Charles River Project Overview
- Middle Watershed Session
- Upper Watershed Session

Contact

Charles River Watershed Association

Contact info for CRWA

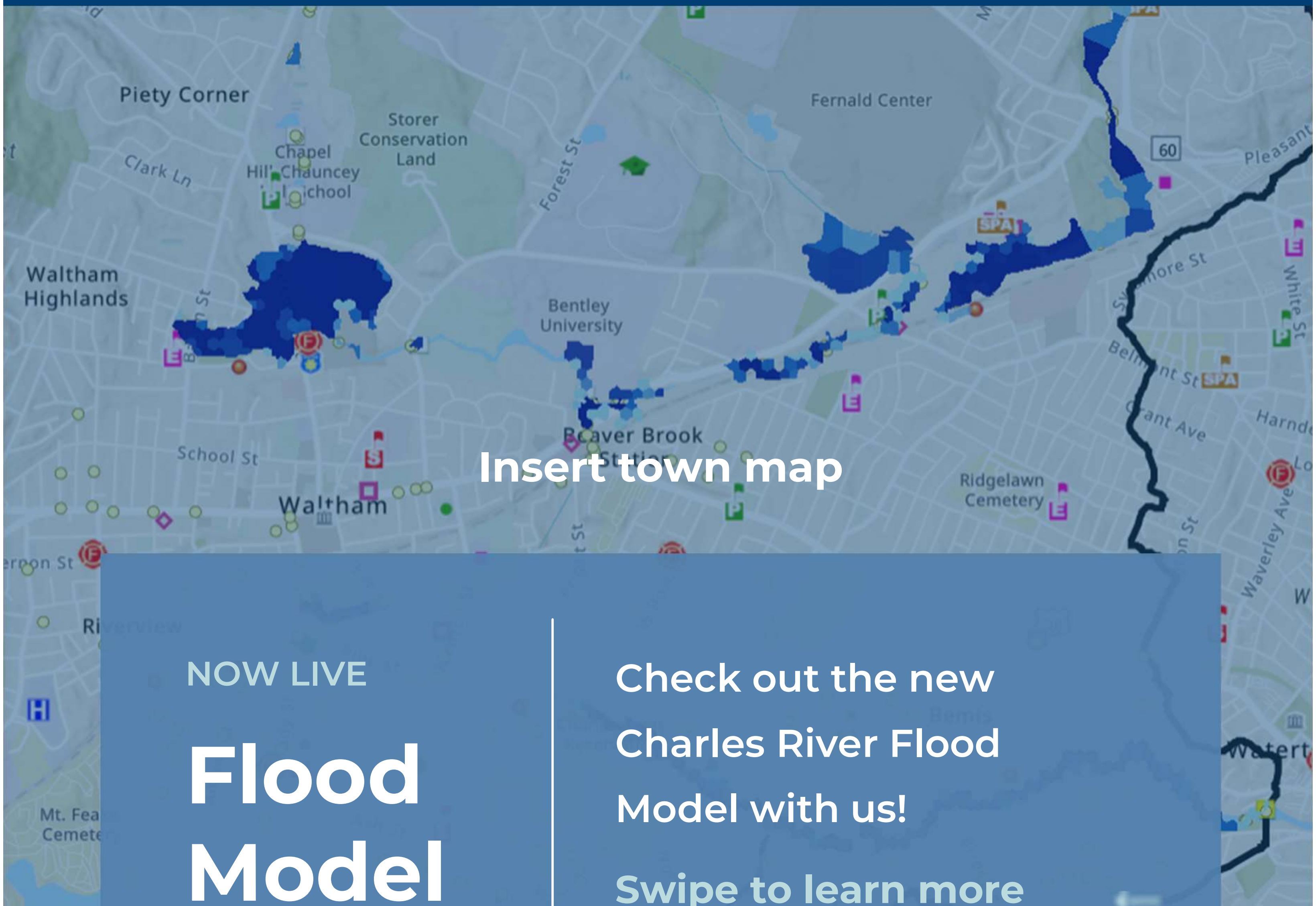
- www.crwa.org
- charles@crwa.org

Contact info for [town]

- phone
- email
- website

BUILDING RESILIENCE IN [TOWN]

TOWN LOGO



Insert town map

NOW LIVE

Flood Model

Check out the new Charles River Flood Model with us!

Swipe to learn more

Weston & Sampson

Charles River Watershed Association

CREW Communities Responding to Extreme Weather

BUILDING RESILIENCE IN [TOWN]

TOWN LOGO

Climate change will cause changes in precipitation

Heavy rainstorms and snowstorms can cause major flooding events

CLICK THE LINK BELOW TO MAP FUTURE FLOODS IN YOUR AREA

BUILDING RESILIENCE IN [TOWN]

TOWN LOGO

In the Charles River Watershed

Present 2-yr storm

(50% chance of happening any year with current climate)

3.34 inches

Flood **3,186** acres

Impact **33** critical facilities

3,054 million gallons of runoff

The 2070 100-yr storm

(1% chance of happening any year with climate change)

10.37 inches

Flood **12,500** acres

Impact **56** critical facilities

10,651 million gallons of runoff

BUILDING RESILIENCE IN [TOWN]

TOWN LOGO

The Charles River Flood Model indicates

that if **2" of stormwater runoff** from 50% of the impervious surface in the watershed

2 inches

is stored in **green stormwater infrastructure** (rain gardens, green roof, pervious streets)

Hundreds of acres will be protected from flooding in a future storm scenario (2070 10-yr storm)

BUILDING RESILIENCE IN [TOWN]

TOWN LOGO

The Charles River Flood Model indicates

that adding **32,000 acres** of new green stormwater infrastructure treatment systems in the watershed

(equivalent to 24,200 football fields!)

would protect **hundreds of acres from flooding** and **reduce flooding depths** in many areas of the watershed in a 2070 10-yr storm

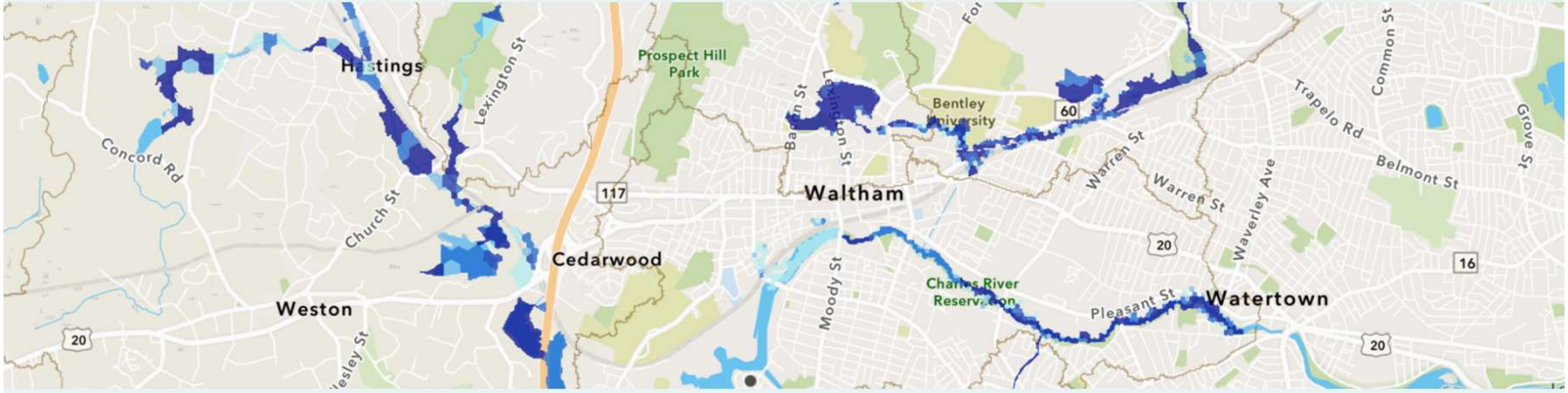
BUILDING RESILIENCE IN [TOWN]

TOWN LOGO

It is **important to protect the remaining natural land** that we have to keep downstream communities safe from flooding!

Many areas that are already developed can support more density to allow for **growth and land conservation**

To learn more, visit crwa.org



BUILDING RESILIENCE IN [TOWN NAME]

How will flooding impact our community?

The Town of [name] and 14 other communities in the Charles River watershed worked together to develop the Charles River Flood Model to identify areas vulnerable to flooding under future climate conditions.

This collaboration resulted in an interactive display of model results showing areas in the upper and middle Charles River watershed at risk from projected flooding events. Results also show the impact of possible flood mitigation measures.

This model will help [town name] take steps to protect the people, property and nature in our community. Learn more at: www.crwa.org/watershed-model.html

Scan QR code for complete model results

Insert sample model results from your town

Learn more about climate planning in [TOWN NAME] by visiting: [town website]

Charles River Watershed Association

Town seal here

CREW Communities Responding to Extreme Weather

Weston & Sampson

This project was funded by the Massachusetts Municipal Vulnerability Preparedness (MVP) grant program

NOTE: CRWA PLANS TO ISSUE PRESS AFTER JULY 12TH

Contacts:

[Insert Town Media Contacts]

Julie Wood
Deputy Director
Charles River Watershed Association
617-356-5060
jwood@crwa.org

The Charles River Flood Model is Now Live!

Date, 2021 - The Town of [X], in partnership with the Charles River Watershed Association (CRWA) and 14 other communities in the upper and middle Charles River watershed, is excited to announce the release of the Charles River Flood Model (CRFM). Funded by the MA Executive Office of Energy and Environmental Affairs FY21 MVP Action Grant Program, this flood model was developed by Weston & Sampson, and can be used as a planning tool to help communities, prepare for the impacts of climate change to protect vulnerable populations and property from flooding. As flooding does not follow political boundaries, this tool will help create stronger regional collaboration between communities in the watershed to understand and address flooding from climate change. The tool was used to model flooding from the types of storms that will become more common with climate change and to assess the flood reduction potential of various nature-based solutions such as land conservation, green stormwater infrastructure, and reducing impervious surfaces.

The model found that without intervention, a projected 2070 100-year storm will impact more than 50 critical facilities and flood up to 12,500 acres of land within the watershed. This is compared to about 10,400 acres of flooding during the severe rains of March 2010, the most recent significant flooding event caused by rainfall. This will put many residents, at risk, including climate vulnerable populations such as low-income residents, elderly, and those who suffer from physical or mental illness. [mention any specific vulnerabilities in your community]

The CRFM also demonstrates that incorporating nature-based solutions, like rain gardens and porous pavements, in the development of our towns will protect hundreds of acres from flooding and reduce flooding depths in certain areas. Residents can use the flood model to understand the impacts of climate change in their community and be part of the solution.

	# of Critical Facilities Impacted	Acres of flooding (ac)	Runoff Volume (MG)
Present 2-yr storm	33	3,186	3,053
2070 2-yr storm	42	4,389	4,264
Increase from Present	*+9*	*+1,203*	*+1,211*
Present 10-yr storm	53	6,909	7,368
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2070 10-yr storm	56	8,579	10,651
Increase from Present	*+3*	*+1,670*	*+3,283*
March 2010 Storm (8.99 inches)	59	10,446	20,831

Figure 1. Flood model results for the 10-yr 24 hour storm projections in the Charles River watershed

"CRWA is excited to have led this regional effort," said Julie Wood, deputy director with the Charles River Watershed Association. "This is a critical step to taking action as a region to effectively mitigate the expected flooding impacts of climate change. The model provides valuable information that will allow communities to make informed decisions about policy changes and on the ground interventions".

"Quote from Town"

The model was also used to test the impact of developing land that is currently undeveloped but vulnerable to future development. Developing half of the watershed's remaining undeveloped and unprotected land would result in an increase in 33% flooded area in the present day 10-yr storm and 20% increase in flooded area in the 2070 10-yr storm, compared to protecting the land from development. Allowing undeveloped land to be developed without considerable flood protection will cause downstream flooding and likely impact vulnerable residents.

###

Charles River Watershed Association uses science, advocacy, and law to promote resilient communities and a healthy river ecosystem. CRWA was formed in 1965 in response to public concern about the declining condition of the Charles River. Since its earliest days of advocacy, CRWA has figured prominently in major clean-up and watershed protection efforts that have dramatically improved the health of the Charles.

Communication Kit Guide

Purpose: This communications kit is designed to support municipal staff or other community leaders in informing residents about the Charles River Flood Model and the results of this study. An important goal of this project is to inform and engage watershed residents to build confidence and interest in the watershed flood model as a tool that can be used for local climate adaptation planning efforts.

PowerPoint Presentation

- Slide template can be modified to include specific town logos/name, photos, etc. You can download the presentation and make it your own.
- Recommended to use slides when presenting to large community groups either in person or virtually
- Script in the notes section can be used as template for presentation or resource guide
- Other recommendations from CREW to increase accessibility and community engagement
    1. Provide incentives for residents to engage this could include food and/or childcare at in person meetings
    2. Provide interpretation based on the community's language needs
    3. Invite and encourage attendees of diverse background and experiences
    4. Offer multiple meeting times and locations to accommodate different members of the community (low-income, seniors, people with disabilities, etc.) and make sure the events are accessible to these groups
    5. Create a community benefit agreement for development based around the flood model, using this website
    6. Release non-English and English versions of materials simultaneously
    7. The PowerPoint includes a slide to acknowledge the Indigenous Lands we are on. More information about land acknowledgement can be found here and here. Here is CREW's guide on land acknowledgements

Information Sheet/Flyer

- The information sheet can be modified to include town logo and local flood model maps
- Use the information sheet to promote the flood model by sharing printed sheets at local buildings and municipalities or as a pdf in outreach emails; CRWA will have hard copies available
- Increase accessibility by translating to commonly-used languages in your town; CRWA will have multi-lingual versions available
- Include a point contact person for any questions or feedback on the sheet

Social Media Package

- Social media package can be used to increase awareness of flood model and/or outreach events
- Social media posts are a great way to announce that the model is publicly available, CRWA is planning for a coordinated launch of the flood model viewer the week of July 12th, although it will be available as soon as June 30th
- Versions are available for Instagram, Facebook and LinkedIn
- Recommend using standard hashtags across all platform to increase reach (e.g. #ClimateChange #CommKit #FloodModel #CRCC #CRFM #BuildingResilienceinTownName)

Press Release

- Customize the press release and share it with local press contacts
- CRWA is planning for a coordinated press effort the week of July 12th