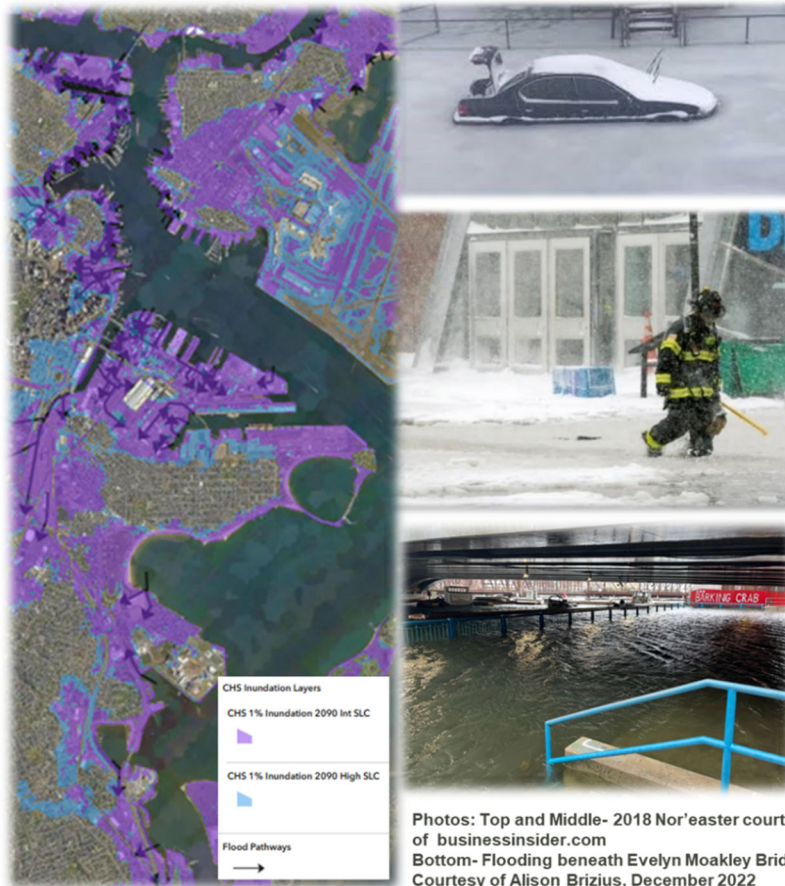


Boston Coastal Storm Risk Management Study

Draft Integrated Feasibility Report and Programmatic Environmental Assessment



NEPA ID: PEAX-202-00-E6R-1776854417

USACE New England District | City of Boston





Boston Water and
Sewer Commission

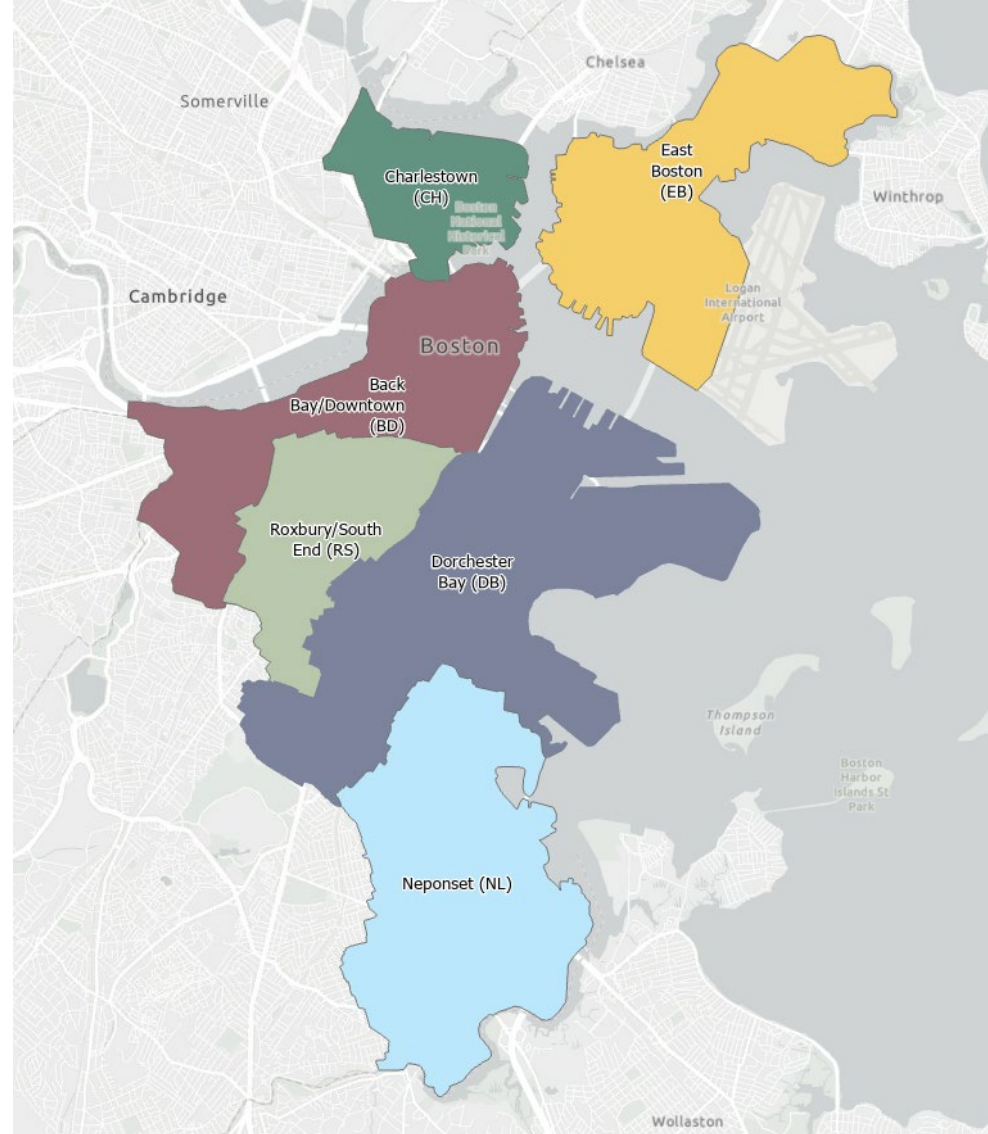
Inundation Model Update Draft USACE Model Runs

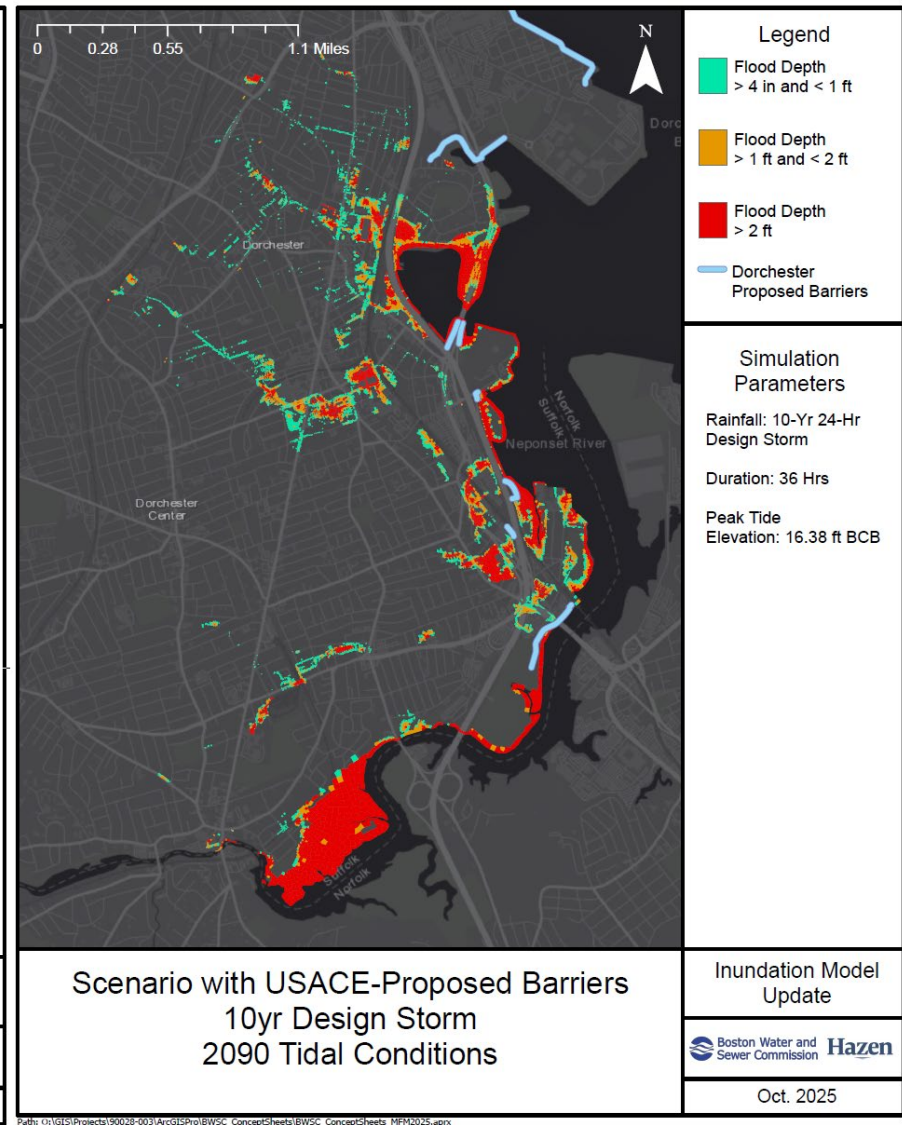
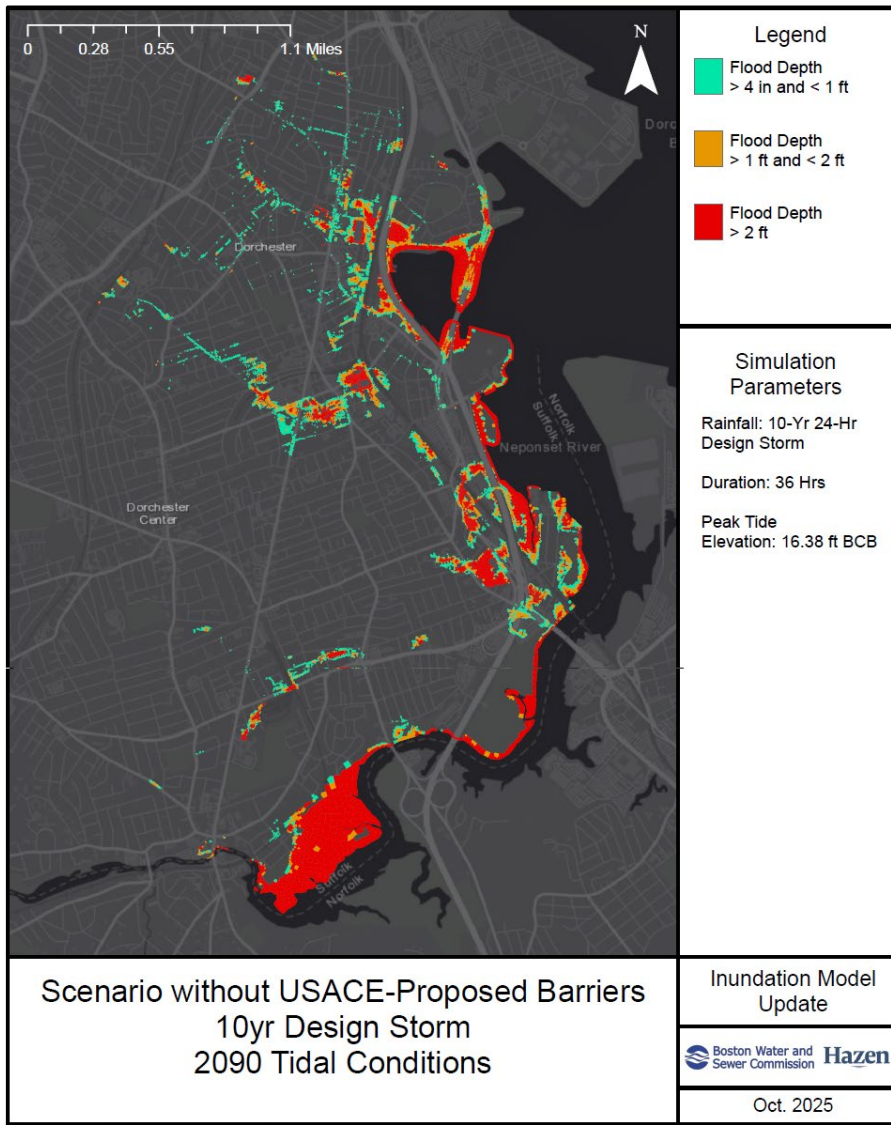
November 24, 2025

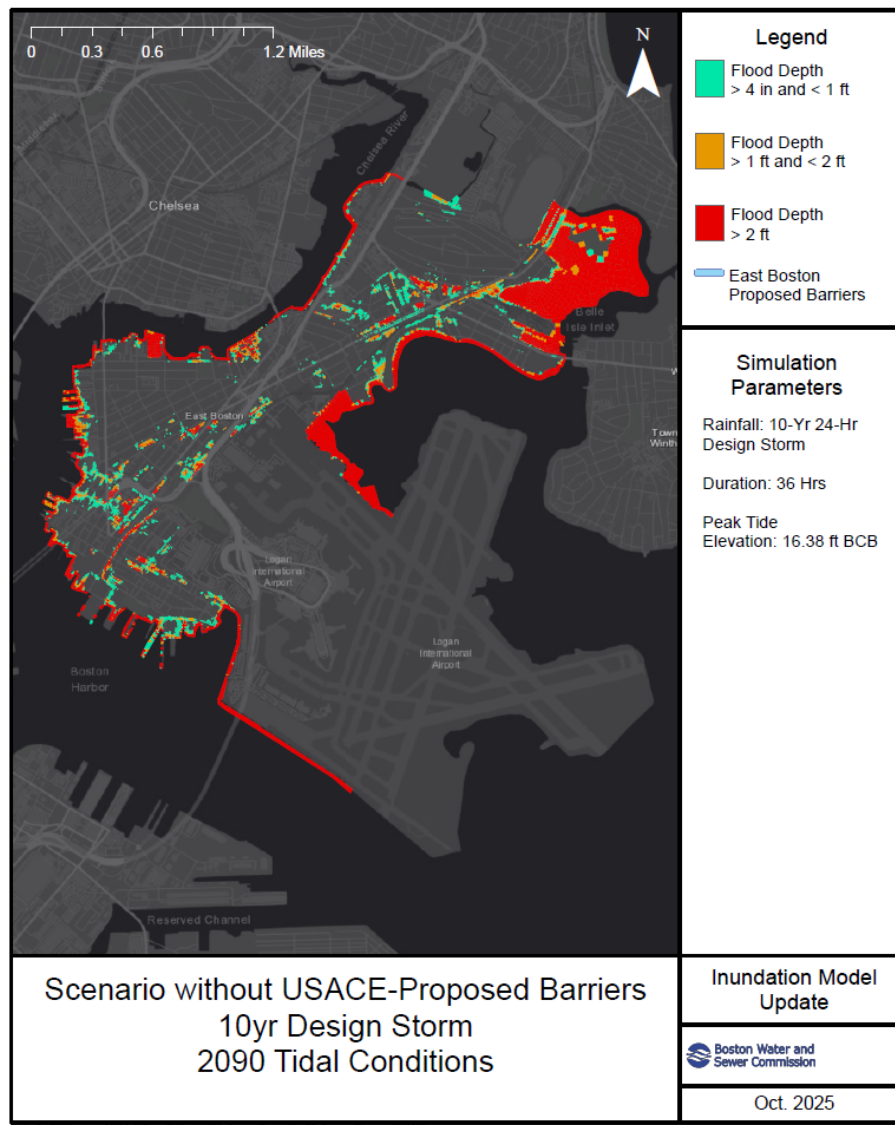
USACE Model Run Assumptions

- Assumptions:
 - Tidal Conditions: 2090 projected conditions from USACE, Peak Elevation: 16.382 BCB
 - Rain: Present-day 10-year design storm (SCS Type III), Depth: 5.15 Inches
 - Outfalls were modeled to have tide gates only where the existing model includes them
 - Coastal barrier alignments were taken directly from USACE and used to raise the elevation of 2D cells along the alignment
 - The 1D model from the previous inundation model project was used in conjunction with Hazen's new mesh produced from a high-resolution DEM from 2021
- Goals:
 - Evaluate if USACE alignments increase flooding under specified conditions (e.g., if “minimum facilities” may be needed)
- Outcome:
 - Model predictions did not show increased flooding (indicating that minimum facilities are not required)

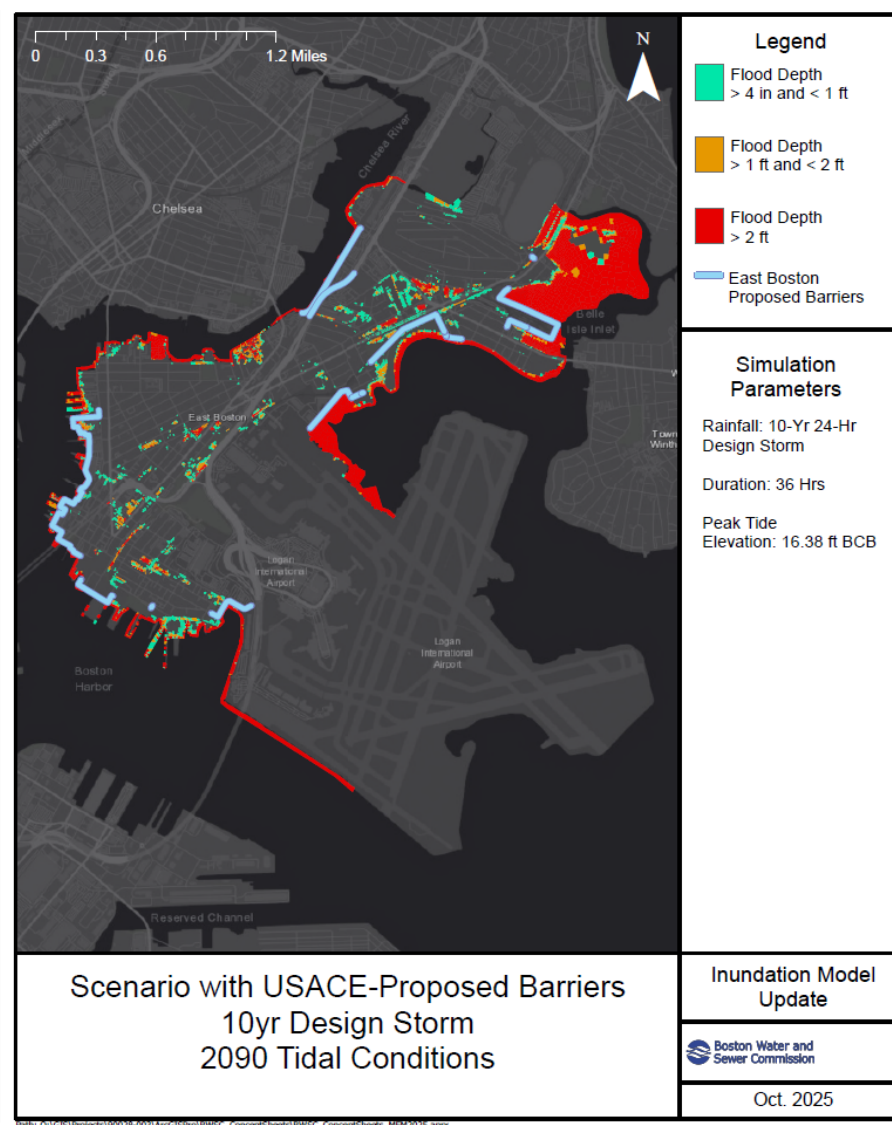
2D Model Zone Overview



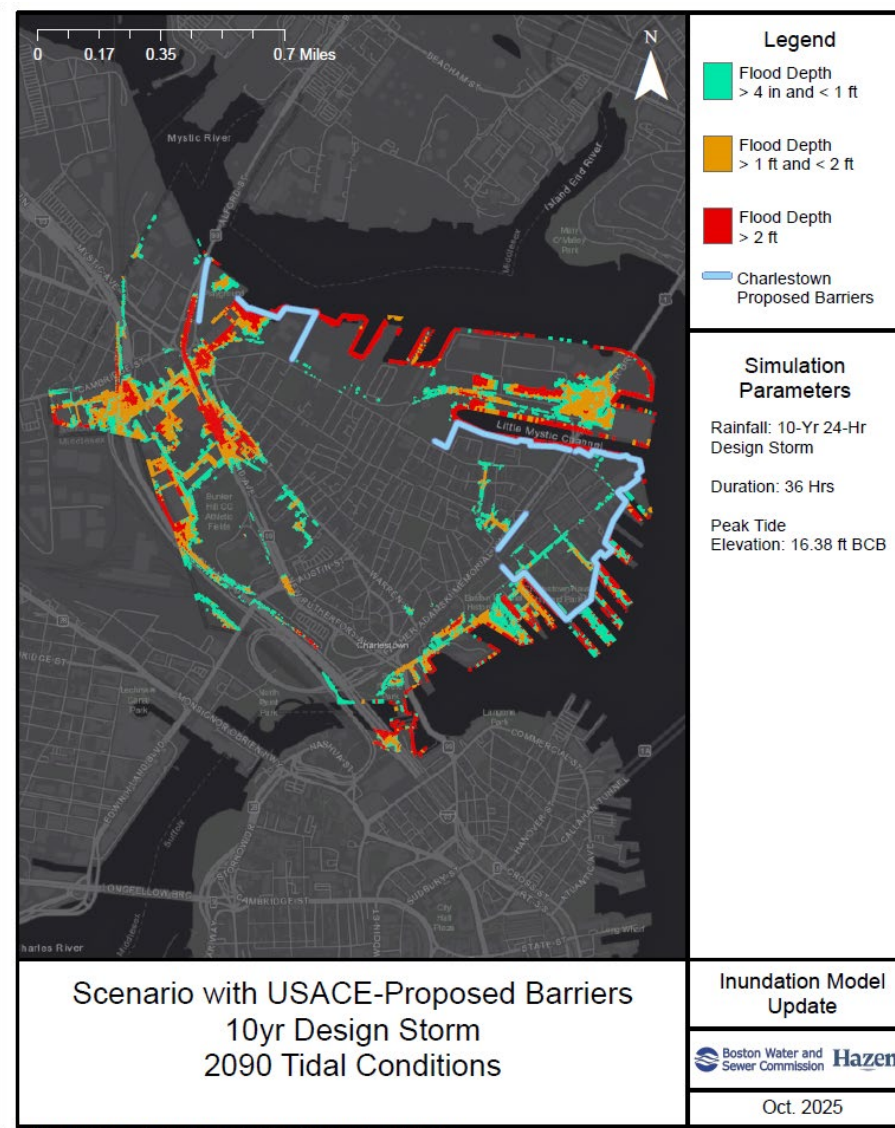
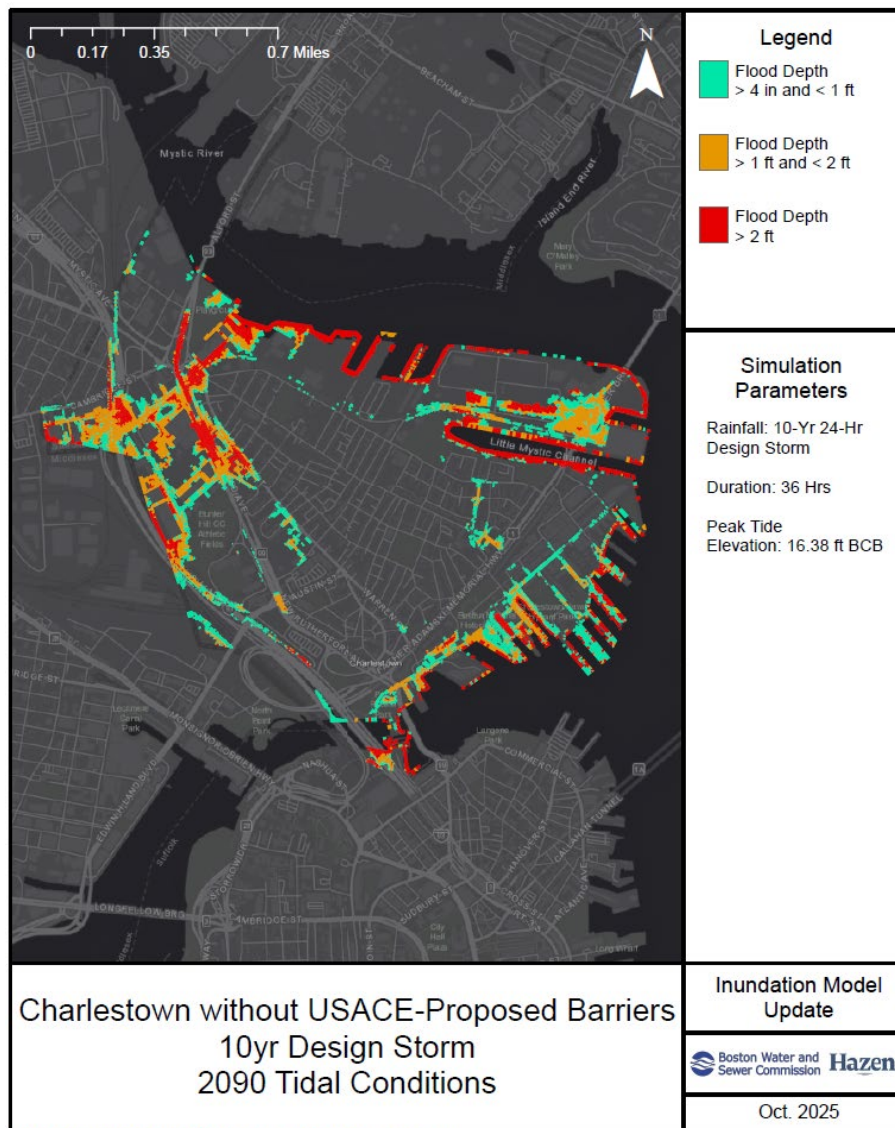


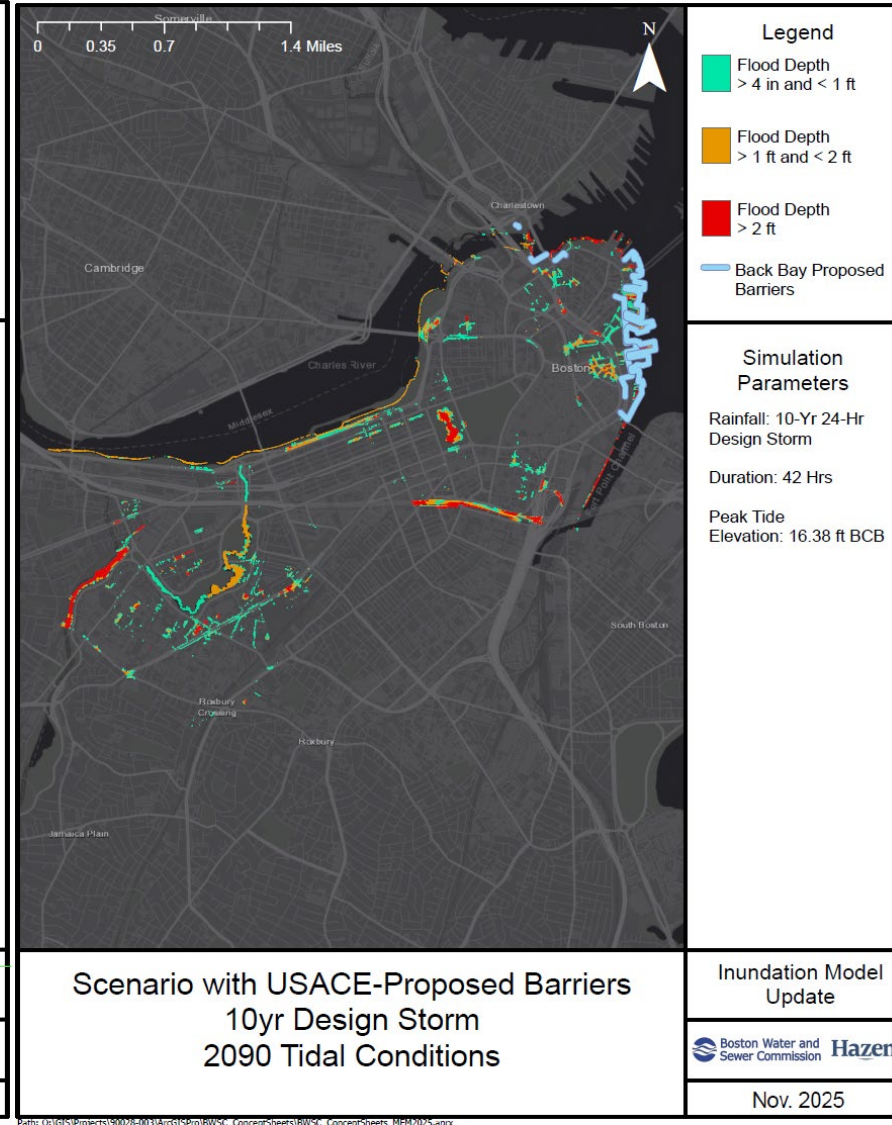
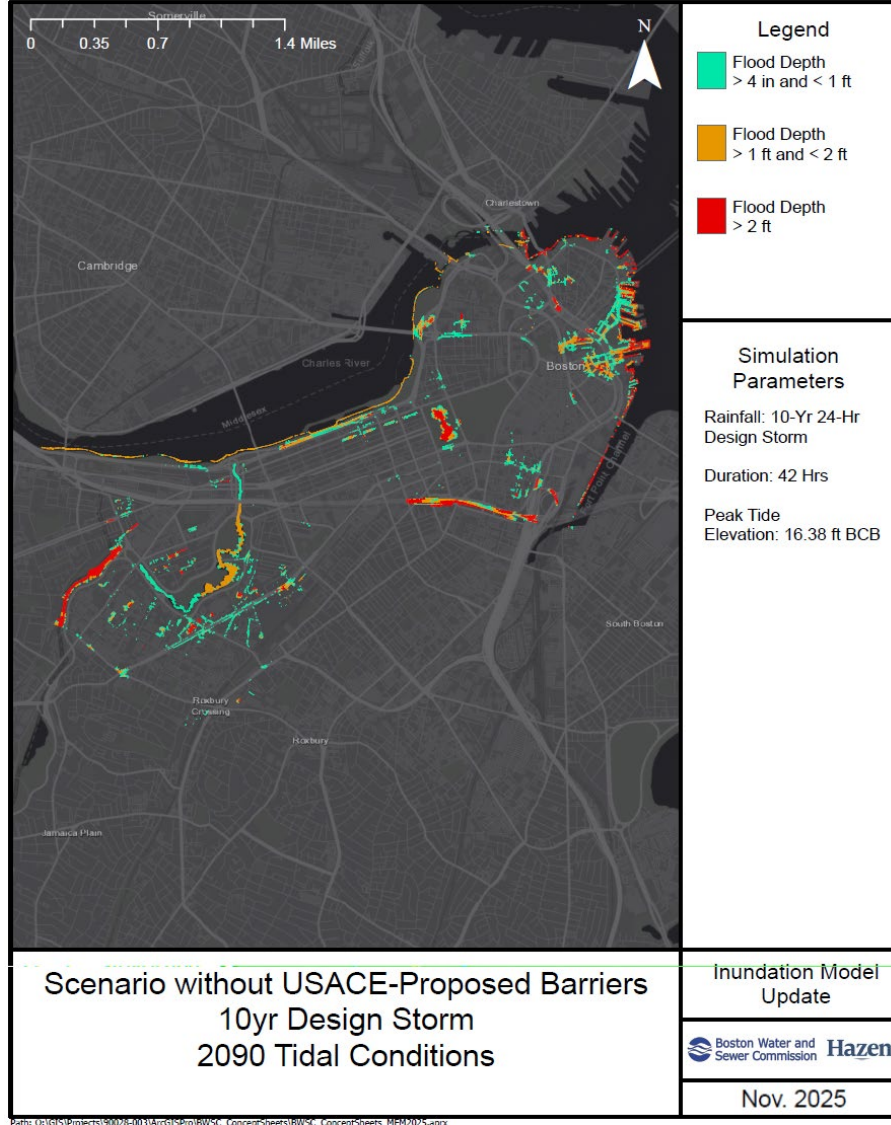


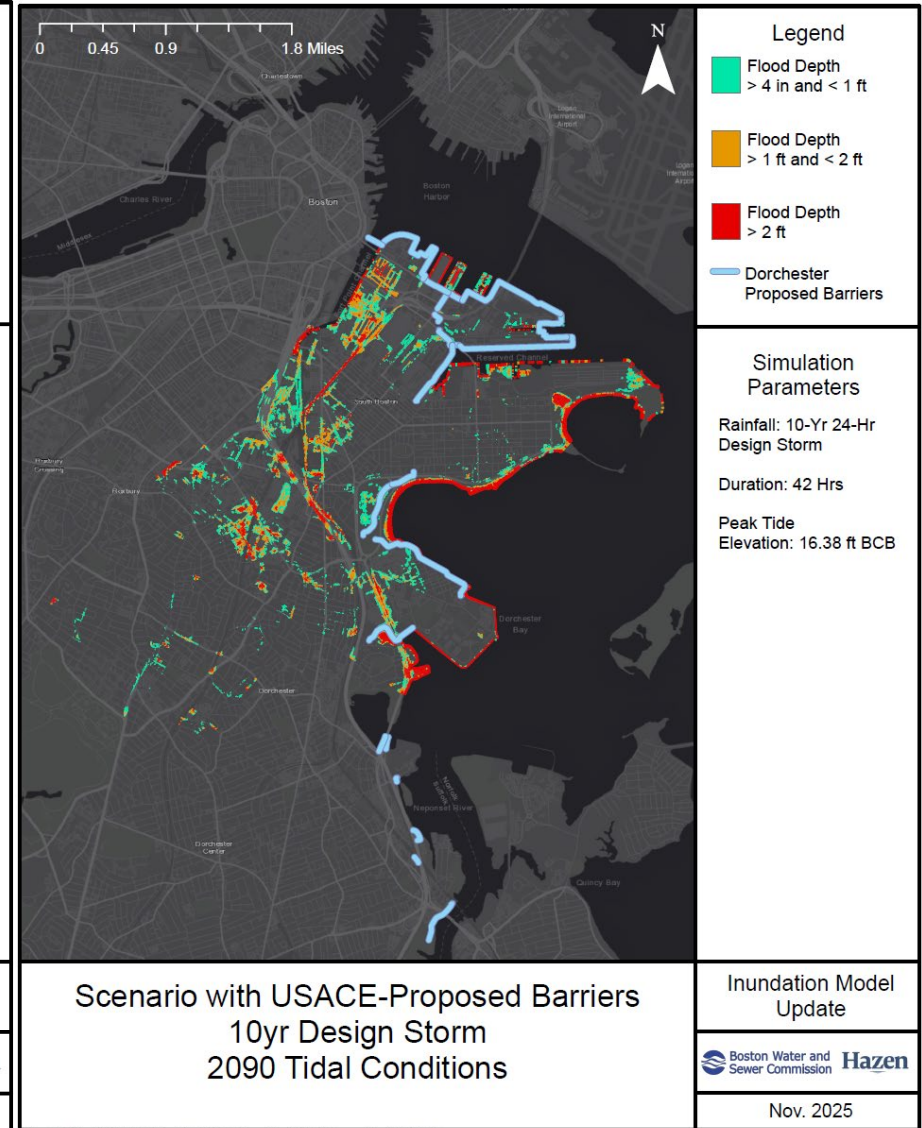
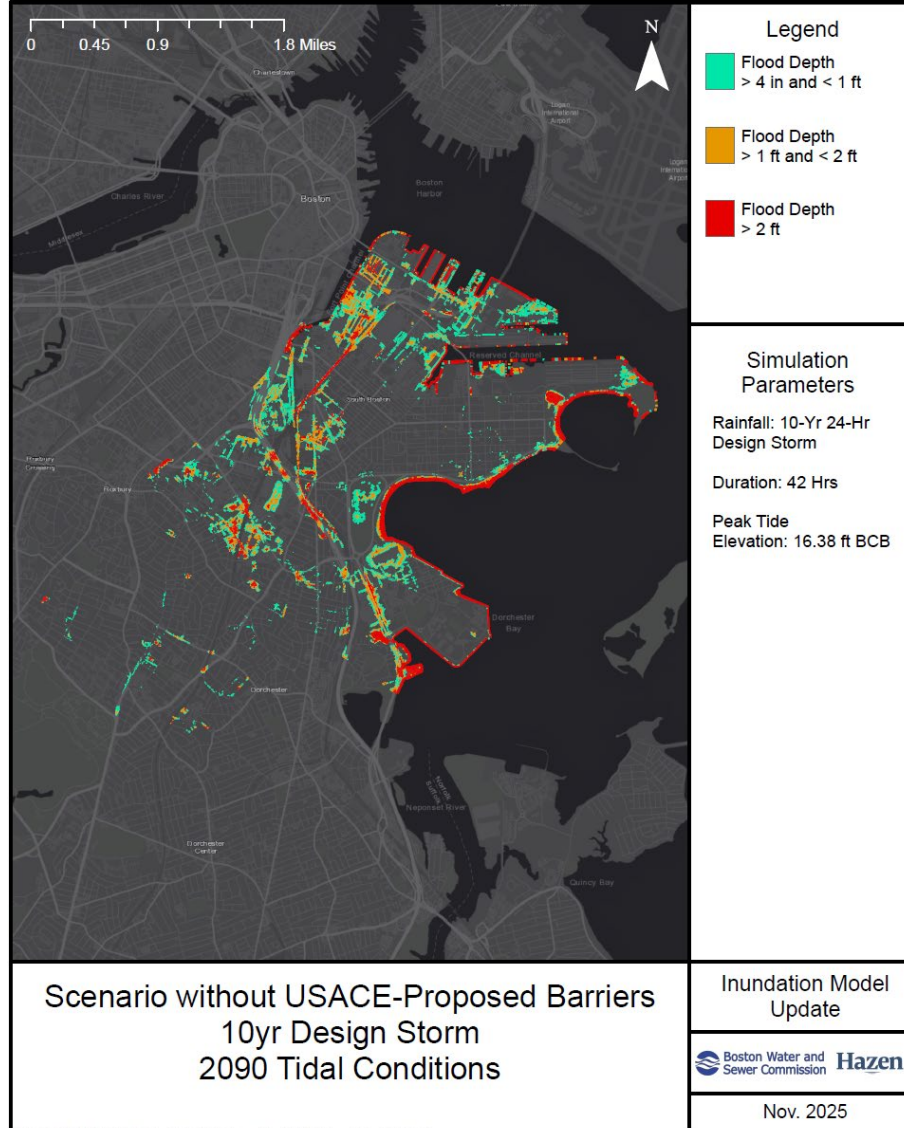
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Hazen *Technical Memorandum*

May 15, 2026

To: Boston Water and Sewer Commission

Emma Page, PE, Director of Planning and Sustainability

John Sullivan, PE, Chief Engineer

Peter Salvatore, PE, Deputy Chief Engineer

From: Hazen and Sawyer

Benjamin Agrawal, PE, Associate

Mitchell Martin, PE, Principal Engineer

Charles Wilson, PE, Associate Vice President

Re: Induced Flooding Analysis

Summary

The purpose of this memorandum is to summarize the results of analyses conducted to evaluate the potential for various coastal barriers being studied by United States Army Corps of Engineers (USACE) to “induce” interior flooding under specific rainfall and tidal conditions (100-year, 24-hour design storm and two tidal conditions – a representative present day tide cycle and a USACE-projected 2090 tide cycle). The memorandum contains a description of the analysis, methodology, conditions specified by the USACE, and a summary of results for each neighborhood analyzed. In general, model predictions indicate that the proposed barriers have a low potential to induce interior flooding during the conditions specified by the USACE.

Background

The Boston Water and Sewer Commission (BWSC) and its consultant, Hazen and Sawyer (Hazen), are currently executing a project that includes inundation modeling and development of conceptual designs to mitigate the impacts of extreme storms, sea level rise and storm surge on drainage system performance. This project builds on prior work that included development of BWSC’s original 2D inundation model (which uses PCSWMM software), which predicts the extent, duration and magnitude of surface flooding in the City of Boston (City), and also the Coastal Stormwater Discharge Analysis (CSDA) project, which developed stormwater management solutions to mitigate the model-predicted flooding.

In parallel to this work, the United States Army Corps of Engineers (USACE) and the City are undertaking the Boston Coastal Storm Risk Management (CSRM) project, which has the ultimate goal of identifying coastal flood protection measures for the City. Certain proposed structural measures (e.g., floodwalls, levees, tide gates) have the potential to induce additional surface flooding if they interfere with the natural discharge of overland flow or disrupt stormwater conveyance to outfalls.

In order to assist the USACE and City team, BWSC and its consultant performed an “Induced Flooding Analysis” in support of the CSRM project. The analysis utilized BWSC’s 2D inundation model, which is the only 2D model that includes both the sanitary and stormwater systems owned and operated by BWSC. As such, the following steps were completed using the BWSC’s “existing” inundation model:

1. Use the previously developed inundation model (due to schedule constraints, BWSC’s updated inundation model was not yet available for use on this analysis) to evaluate the potential for induced flooding as a result of the proposed shoreline elevation modifications identified associated with the CSRM project,
2. If induced flooding was predicted in Step 1, assess whether the stormwater management solutions developed previously by BWSC during the CSDA project (documented in a report entitled “Coastal Stormwater Discharge Analysis”, 2023) were sufficiently sized to manage the induced flooding. The solutions developed during CSDA were designed to a conceptual level with design conditions that differed from those proposed by the USACE for this analysis. The USACE specified conditions of 7.89 inches of rainfall over 24 hours and peak sea levels of 10.78 and 16.38 feet BCB, whereas the CSDA concepts were designed for 6.18 inches of rainfall over 24 hours and a peak sea level of 20.26 feet BCB.

The scope of this analysis was based on statement of work provided by the USACE (included in Appendix A). For each coastal neighborhood in the City, two or three of the following scenarios were modeled:

Scenario 1: Future Without Project (FWOP)

FWOP is an existing conditions model scenario, where BWSC infrastructure is modeled as-is, with no changes or additions of USACE-proposed seawalls or planned BWSC coastal stormwater resiliency / interior drainage projects.

Scenario 2: Future With Barriers (FWB)

FWB uses the existing BWSC infrastructure model with the addition of USACE-proposed barriers (floodwalls/levees) without any planned BWSC coastal stormwater resiliency / interior drainage projects.

Scenario 3: Future With Project (FWP)

FWP uses the existing BWSC infrastructure model with the addition of USACE-proposed barriers (floodwalls/levees) and planned BWSC coastal stormwater resiliency / interior drainage projects.

For each neighborhood, Scenarios 1 and 2 were compared, and if Scenario 2 exhibited an increase in flooding, Scenario 3 was also modeled.

Model Configuration and Data Sources

PCSWMM 2D model simulations provide a quantitative analysis of flood extent, depth, and duration at any given time for each modeled region of the ground surface. Each small region of the ground surface in the model is simulated using a "cell" with a representative base elevation. Figures within this report

showing maps of model simulation results show the peak depth of flooding for each model "cell" during the entire simulated time period. Model 2D conduits connect the 2D "cells" and therefore represent overland flow velocity (surface flooding speed and direction), which was also assessed for each simulation in each model zone.

For each model zone, each scenario was modeled using a present-day tidal cycle and a future condition tidal cycle. For some zones, small refinements (to improve model stability and reduce simulation time) were made between when the future tide cycle runs were performed and when the present-day tidal condition runs were performed. Therefore, the model for the same scenario in the same zone may have a different number of 2D cells and 2D conduits depending on which tidal condition was used in the simulation.

USACE provided rainfall data for the 0.01 AEP (100-year) design storm from NOAA Atlas 14 at Logan Airport with a 24-hour duration and five-minute time step. The initial coastal boundary condition evaluated is defined as the mean tidal cycle with mean sea level (MSL) at 11.13 ft BCB plus a USACE High Sea Level Change projection for the year 2090. The resulting peak tide elevation is approximately 16.38 feet BCB. The results for this tidal condition are presented in the figures titled "- USACE-Projected 2090 Tide Cycle".

In some areas, initial model predictions suggested the possibility that this high sea level limited the ability of the system to drain regardless of the presence of the proposed barriers, thus "masking" the walls' potential impacts on interior drainage. A second tidal condition was evaluated at a lower tide, with peak tide elevation at 10.78 ft BCB, which corresponds with mean high water (MHW) for the 1983-2001 National Tidal Datum Epoch (NTDE) for the National Oceanic and Atmospheric Administration (NOAA) buoy number 8443970, located in the Fort Point Channel in Boston. The results for this tidal condition are presented in the figures titled "- Present Day Tide Cycle". Evaluating USACE's proposed flood barriers during this lower tidal scenario helps determine whether the barriers obstruct overland flow that would normally exit the system without the walls in place. All simulations were configured conservatively by aligning peak runoff with peak tide conditions.

USACE provided shapefiles for Scenario 1: Future Without Project (FWOP), which includes the wall alignments and associated elevations resulting from projects which are already completed/under construction at Ryan Playground and Piers Park II. Scenarios 2 (Future with Barriers) and Scenario 3 (Future With Project / FWP) uses shapefiles also provided by USACE, reflecting closure structures in the open position. For all scenarios, outfalls were modeled to have tide gates only where the existing model includes them. Wall alignment files were provided for five (5) regions. The walls were simulated using five separate model zones. The five model zones did not align exactly with the wall regions provided by USACE, except for in East Boston. The model zones were delineated differently from the USACE barriers for reasons of hydraulic contiguity and model size limitations of the modeling software. A list of the model zones with a description of which wall sections were used in each model zone follows:

- Charlestown (Part of the USACE "Downtown" and all of "Charlestown" barrier alignments)
- East Boston (All of USACE "East Boston" barrier alignments)
- Back Bay/Downtown (Part of USACE "Downtown" barrier alignments)
- Dorchester Bay (Part of USACE "Dorchester" and all of "South Boston" barrier alignments)

- Neponset (Part of the USACE “Dorchester” barrier alignments)

QA/QC Procedure

Quality control checks were performed at several stages throughout the project, beginning with the setup of the first “template” model. Each member of the modeling team reviewed the template model. While producing the “template” model, a checklist was created for each subsequent model setup. The model setup checklist for this project was used by the modeler to create each subsequent model and was again used during QC when each model was reviewed for accuracy. Each model was reviewed by a subject matter expert, other than the modeler, to ensure that model parameters and model component attributes were properly configured, including:

- Time step
- Number of trials per time step
- Simulation dates
- Boundary conditions for 1D and 2D outfalls
- Rainfall time series applied to all subcatchments
- Number of 1D model components
- 1D and 2D outfall invert elevations
- Total rainfall depth
- Total routing error
- Simulation warnings and errors

Additionally, a second modeler reviewed each simulation after running and checked for anomalous results through a combination of numerical methods and visual inspection. This check was performed to ensure that model “noise” or instability did not significantly impact the conclusion of the modeling effort.

Model Predictions/Results

For each neighborhood, model predictions for Scenarios 1 and 2 were compared, and if Scenario 2 exhibited an increase in flooding, Scenario 3 was also simulated. Charlestown was the only neighborhood whose results demonstrated that under the conditions modeled, the USACE-proposed barriers induced flooding. Scenario 3 results demonstrated that for the specific rainfall and coastal scenarios modeled, BWSC’s proposed stormwater improvements have limited benefit in reducing the model-predicted induced flooding caused by USACE’s proposed barriers.

The following sections contain results for each neighborhood and include a brief summary of the intention of the analysis, model inputs, and results including figures illustrating predicted flood extent and depth, and statistics on flood duration and velocity.

Limitations

It should be noted that all modeling herein was performed using best available information at the time the work began (early 2026). As such, all simulations were performed using BWSC’s then-current version of the 1D sewer and drain model. Updated and recalibrated versions of the sewer and drain models were being developed in parallel, as well as updated versions of the 2D inundation model. As the BWSC’s Inundation Model Update project (and these models) continues to advance, improvements will continue to

be made to improve the accuracy of 2D model predictions; these improvements have the potential to impact the flood mapping included herein.

Organization

The remainder of the memorandum includes a summary of the modeling performed for each “zone”, as described previously.

East Boston Model Zone Results

USACE Induced Flooding Analysis – East Boston

The Boston Water and Sewer Commission (BWSC) is evaluating flooding conditions and designing stormwater improvements across Boston using PCSWMM modeling. At the same time, the United States Army Corps of Engineers (USACE) Coastal Storm Risk Management (CSRM) project may affect rainfall-driven flooding by altering overland flow paths and stormwater conveyance through new floodwalls and levees. For all scenarios, outfalls were modeled to have tide gates only where the existing model includes them. To understand these potential impacts, Hazen completed an initial analysis comparing three scenarios: (1) Future Without Project, (2) Future with USACE barriers only, and (3) Future With Project including both USACE measures and BWSC's proposed stormwater improvements. Scenario 3 was modeled only where Scenario 2 showed increased flooding, to determine whether the proposed stormwater improvements reduce induced flooding. This analysis also could help determine whether BWSC's planned improvements are adequately sized to address additional flooding that could result from the CSRM project. Note that the solutions previously developed by BWSC were designed (to a conceptual level) for a different tidal scenario and for a different design intent.

Summary of Model Inputs

The following are inputs to the PCSWMM model utilized in this analysis:

- Rainfall: 100-year, 24-hour design storm (rainfall depth = 7.89 inches)
- Representative Present Day Tide Cycle: Peak tide elevation = 10.78 ft BCB (Mean High Water from 1983-2001 NTDE)
- USACE-Projected 2090 Tide Cycle: 2090 mean tidal cycle (peak tide elevation = 16.38 feet BCB)
- Model Duration = 42 hours

Model Simulation Results

The East Boston neighborhood was evaluated through Scenario 1 and Scenario 2. When analyzed, there was no significant increase in model predicted flood extent, depth, duration and velocity in Scenario 2 versus Scenario 1. Results therefore indicate that the USACE proposed barriers within this neighborhood will not induce flooding in the region. Thus, Scenario 3 was not modeled.

Flood Extent and Depth

The model predicted extent and depth of flooding for present day MHW Scenario 1 and Scenario 2 are shown in figures EB-1 and EB-2. The extents for future mean high tide Scenario 1 and Scenario 2 are shown in figures EB-4 and EB-5. A comparison between Scenario 1 and 2 for present day MHW is shown in EB-3 and a comparison of Scenario 1 and 2 for future mean high tide is shown in EB-6. The comparison maps are generated by subtracting the model-predicted flood depths from Scenario 2 by Scenario 1, so the difference in flood depth for each cell (induced flooding) is shown. Due to the lack of induced flooding between Scenario 1 and Scenario 2, Scenario 3 was not simulated.



EB-1 - Scenario 1 (Future Without Project) Present Day Tide Cycle



EB-2 - Scenario 2 (Future with USACE-Proposed Barriers) Present Day Tide Cycle



EB-3 – Model-Predicted Induced Flooding (Present Day Tide Cycle)



EB-4 - Scenario 1 (Future Without Project) USACE-Projected 2090 Tide Cycle



EB-5 - Scenario 2 (Future with USACE-Proposed Barriers) USACE-Projected 2090 Tide Cycle



EB-6 – Model-Predicted Induced Flooding (USACE-Projected 2090 Tide Cycle)

Flood Duration

Flood duration was calculated for each 2D cell using a threshold of 4 inches, meaning a cell was considered “flooded” whenever water depth reached or exceeded this value. The East Boston future tidal conditions model includes a total of approximately 136,000 2D cells, while the current tidal conditions model includes about 86,000 2D cells. Comparing Scenario 1 and Scenario 2, the addition of the USACE-proposed flood barriers resulted in changes to flood duration in approximately 6% of cells under future tidal conditions and 1% of cells under current tidal conditions. Overall, the future-conditions model showed an increase in flood duration of roughly 20 minutes, while changes under current conditions were negligible.

Velocity

PCSWMM represents 2D overland flow through the use of conduits assembled as a mesh across the model area. Overland flow velocity was calculated for each 2D conduit in the model. The East Boston simulations include approximately 358,000 2D conduits under future tide conditions and 233,000 2D conduits under current tide conditions. Comparing Scenario 1 and Scenario 2, the addition of the USACE-proposed flood barriers resulted in velocity increases in approximately 12% of conduits for future tidal conditions and 11% for current tidal conditions. Among the conduits that experienced an increase in 2D conduit velocity, the average velocity increased by about 1.71 fps in the future tidal conditions model and 1.91 fps in the current tidal conditions model. Increases in 2D conduit velocity indicate that the USACE-proposed barriers induce higher overland flow velocities for some regions of the model zone, which in some cases could potentially negatively impact natural slopes and built infrastructure.

Charlestown Model Zone Results

USACE Induced Flooding Analysis – Charlestown

The Boston Water and Sewer Commission (BWSC) is evaluating flooding conditions and designing stormwater improvements across Boston using PCSWMM modeling. At the same time, the United States Army Corps of Engineers (USACE) Coastal Storm Risk Management (CSRM) project may affect rainfall-driven flooding by altering overland flow paths and stormwater conveyance through new floodwalls, levees, and tide gates. To understand these potential impacts, Hazen completed an initial analysis comparing three scenarios: (1) Future Without Project, (2) Future with USACE barriers only, and (3) Future With Project including both USACE measures and BWSC’s proposed stormwater improvements. Scenario 3 was modeled only where Scenario 2 showed increased flooding. This analysis helps determine whether BWSC’s planned improvements are effective at addressing any induced flooding in this region caused by the CSRM project. The solutions previously developed by BWSC were designed (to a conceptual level) for a different tidal scenario and for a different design intent.

Summary of Model Inputs

The following are inputs to the PCSWMM model utilized in this analysis:

- Rainfall: 100-year, 24-hour design storm (rainfall depth = 7.89 inches)
- Representative Present Day Tide Cycle: Peak tide elevation = 10.78 ft BCB (Mean High Water from 1983-2001 NTDE)
- USACE-Projected 2090 Tide Cycle: 2090 mean tidal cycle (peak tide elevation = 16.38 feet BCB)
- Model Duration = 42 hours

Model Simulation Results

The Charlestown neighborhood was initially evaluated through Scenario 1 and Scenario 2. When analyzed, induced flooding was present in Scenario 2, indicating that the USACE proposed barriers would induce flooding in the region. Thus, Scenario 3 was modeled to determine if BWSC’s previously proposed stormwater improvement project within Charlestown (Charlestown Pump Station concept, designed as a part of the Coastal Stormwater Discharge Analysis Project, 2023), was adequate to manage potential increases in flooding caused by the barriers.

Flood Extent and Depth

The model-predicted extent and depth of flooding for the present day representative tide cycle Scenario 1 and Scenario 2 are shown in figures CH-1 and CH-2. Figure CH-3 shows the model predicted flooding that is induced by the USACE-proposed barriers under present day MHW tide conditions. This comparison map was generated by subtracting the model-predicted flood depths from Scenario 2 by Scenario 1, so the difference in flood depth for each cell (induced flooding) is shown. This flooding is most significant around the Little Mystic Channel, with additional induced flooding nearby other sections of proposed barriers. Due to the presence of induced flooding between Scenario 1 and Scenario 2, Scenario 3 was simulated as well. Results for Scenario 3 are shown in CH-4. Figures CH-5, CH-6, CH-7 and CH-8 represent results for this neighborhood using the future mean high tide condition. Model

simulations indicate that there is more induced flooding for the present-day tidal condition as compared to the future USACE-projected tidal condition. This is likely because, under the USACE-projected future tidal condition, there are fewer opportunities for water to drain overland by gravity because of the high sea level, so the addition of the walls does not induce flooding in this scenario. Results demonstrated that for the specific rainfall and coastal scenarios modeled, BWSC's proposed stormwater improvements have limited benefit in reducing the model-predicted induced flooding caused by USACE's proposed barriers.



CH-1 - Scenario 1 (Future Without Project) Present Day Tide Cycle



CH-2 - Scenario 2 (Future with USACE-Proposed Barriers) Present Day Tide Cycle



CH-3 - Model-Predicted Induced Flooding Present Day Tide Cycle



CH-4 - Scenario 3 (Future with Project) Present Day Tide Cycle



CH-5 - Scenario 1 (Future Without Project) USACE-Projected 2090 Tide Cycle



CH-6 - Scenario 2 (Future with USACE-Proposed Barriers) USACE-Projected 2090 Tide Cycle



CH-7 - Model-Predicted Induced Flooding (USACE-Projected 2090 Tide Cycle)



CH-8 - Scenario 3 (Future with Project) USACE-Projected 2090 Tide Cycle

Flood Duration

Flood duration was calculated for each 2D cell using a threshold of 4 inches, meaning a cell was considered “flooded” whenever water depth reached or exceeded this value. The Charlestown future tidal conditions model includes a total of approximately 130,000 2D cells, while the current tidal conditions model includes about 70,000 2D cells. Comparing Scenario 1 and Scenario 2, the addition of the USACE-proposed flood barriers resulted in changes to flood duration in approximately 8% of cells under future tidal conditions and 3% of cells under current tidal conditions. Overall, the future-conditions model showed an increase in flood duration of roughly 3.1 hours for Scenario 2 versus Scenario 1, while changes under current conditions showed an increase of approximately 3 hours. In contrast, the change in flood duration between Scenario 2 and Scenario 3 is negligible for current tidal conditions, indicating that the BWSC stormwater improvements do not cause significant increase or decrease in flood duration for this condition.

Velocity

PCSWMM represents 2D overland flow through the use of conduits assembled as a mesh across the model area. Overland flow velocity was calculated for each 2D conduit in the model. The Charlestown simulations include approximately 240,000 2D conduits under future tide conditions and 190,000 2D conduits under current tide conditions. Comparing Scenario 1 and Scenario 2, the addition of the USACE-proposed flood barriers resulted in velocity increases in approximately 4.6% of conduits for future tidal conditions and 3% for current tidal conditions. Among the conduits that experienced increased velocity, the average velocity increased by about 0.4 fps in the future tidal conditions model and 0.47 fps in the current tidal conditions model. Increases in 2D conduit velocity indicate that the USACE-proposed barriers induce higher overland flow velocities for some regions of the model zone, which in some cases could potentially negatively impact natural slopes and built infrastructure.

Back Bay/Downtown Model Zone Results

USACE Induced Flooding Analysis – Back Bay / Downtown

The Boston Water and Sewer Commission (BWSC) is evaluating flooding conditions and designing stormwater improvements across Boston using PCSWMM modeling. At the same time, the United States Army Corps of Engineers (USACE) Coastal Storm Risk Management (CSRM) project may affect rainfall-driven flooding by altering overland flow paths and stormwater conveyance through new floodwalls, levees, and tide gates. To understand these potential impacts, Hazen completed an initial analysis comparing three scenarios: (1) Future Without Project, (2) Future with USACE barriers only, and (3) Future With Project including both USACE measures and BWSC's proposed stormwater improvements. Scenario 3 was modeled only where Scenario 2 showed increased flooding. This analysis helps determine whether BWSC's planned improvements are adequately sized to address additional flooding that could result from the CSRM project. The solutions previously developed by BWSC were designed (to a conceptual level) for a different tidal scenario and for a different design intent.

Summary of Model Inputs

The following are inputs to the PCSWMM model utilized in this analysis:

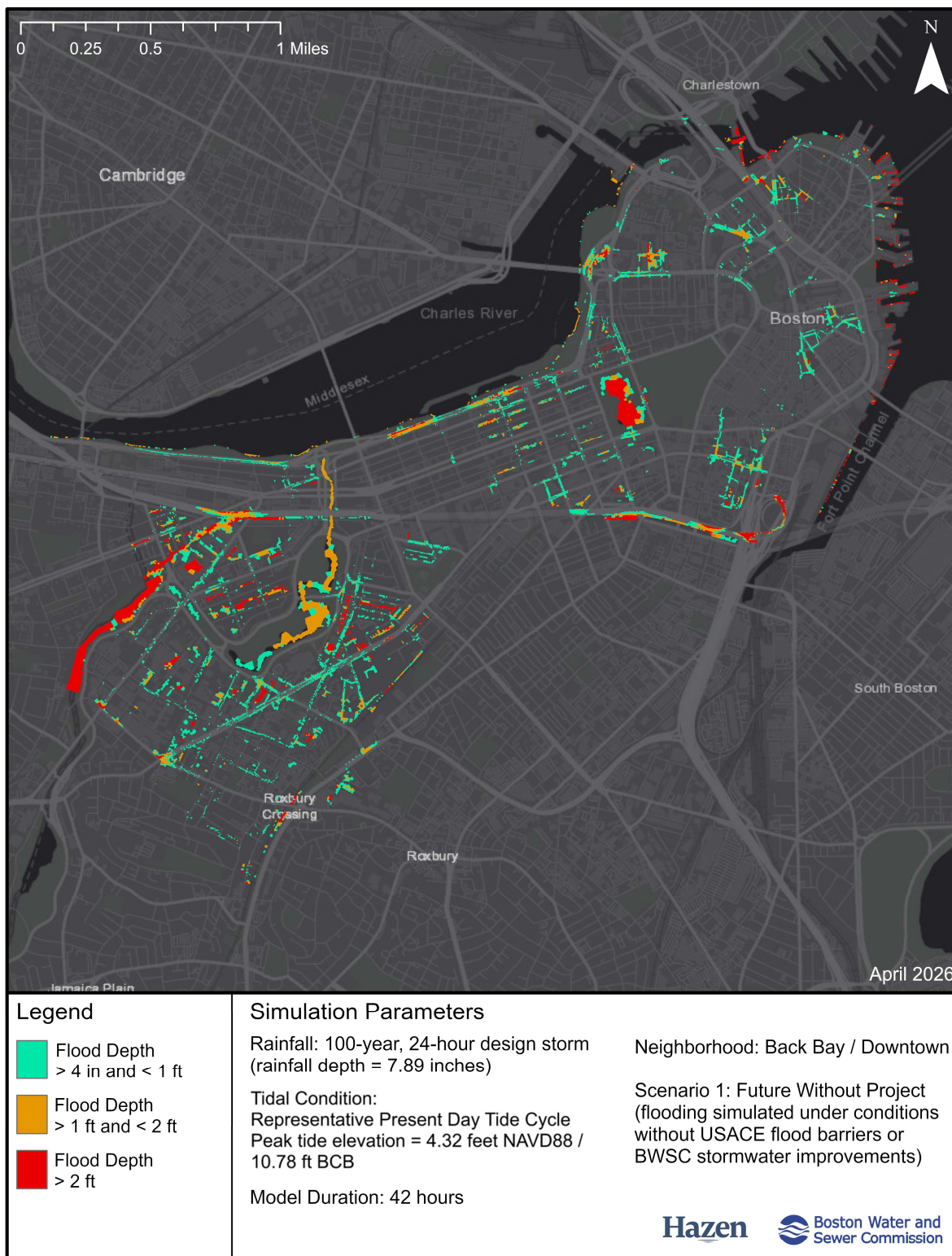
- Rainfall: 100-year, 24-hour design storm (rainfall depth = 7.89 inches)
- Representative Present Day Tide Cycle: Peak tide elevation = 10.78 ft BCB (Mean High Water from 1983-2001 NTDE)
- USACE-Projected 2090 Tide Cycle: 2090 mean tidal cycle (peak tide elevation = 16.38 feet BCB)
- Model Duration = 42 hours

Model Simulation Results

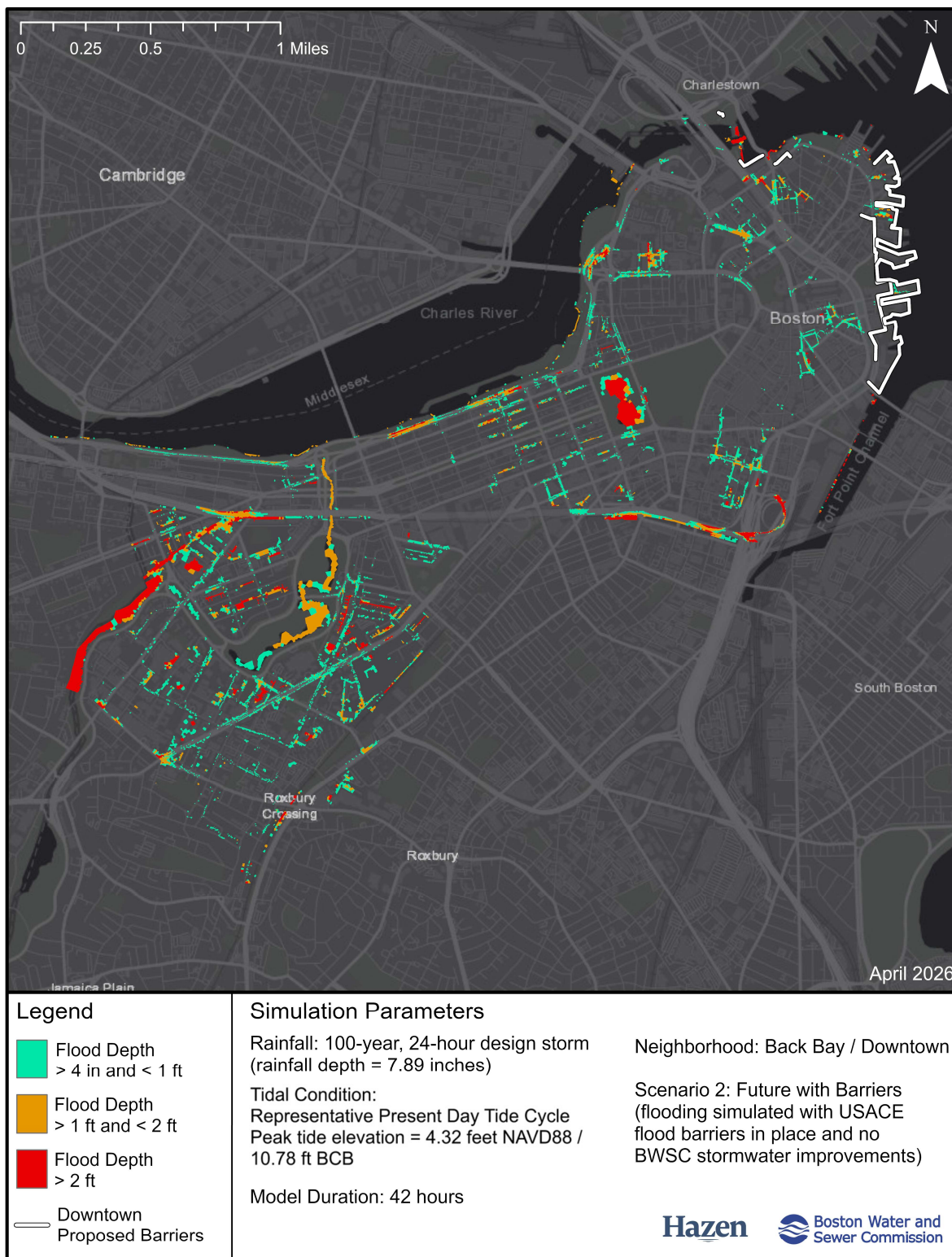
The Back Bay / Downtown neighborhood was evaluated through Scenario 1 and Scenario 2. When analyzed, there was no significant increase in model predicted flood extent, depth, duration and velocity in Scenario 2 versus Scenario 1. Results therefore indicate that the USACE proposed barriers within this neighborhood will not induce flooding in the region. Thus, Scenario 3 was not modeled.

Flood Extent and Depth

The model predicted extent and depth of flooding for present day MHW Scenario 1 and Scenario 2 are shown in figures BD-1 and BD-2. The extents for future mean high tide Scenario 1 and Scenario 2 are shown in figures BD-4 and BD-5. A comparison between Scenario 1 and 2 for present day MHW is shown in BD-3 and a comparison of Scenario 1 and 2 for future mean high tide is shown in BD-6CH-5. The comparison maps are generated by subtracting the model-predicted flood depths from Scenario 2 by Scenario 1, so the difference in flood depth for each cell (induced flooding) is shown. Due to the lack of induced flooding between Scenario 1 and Scenario 2, Scenario 3 was not simulated.



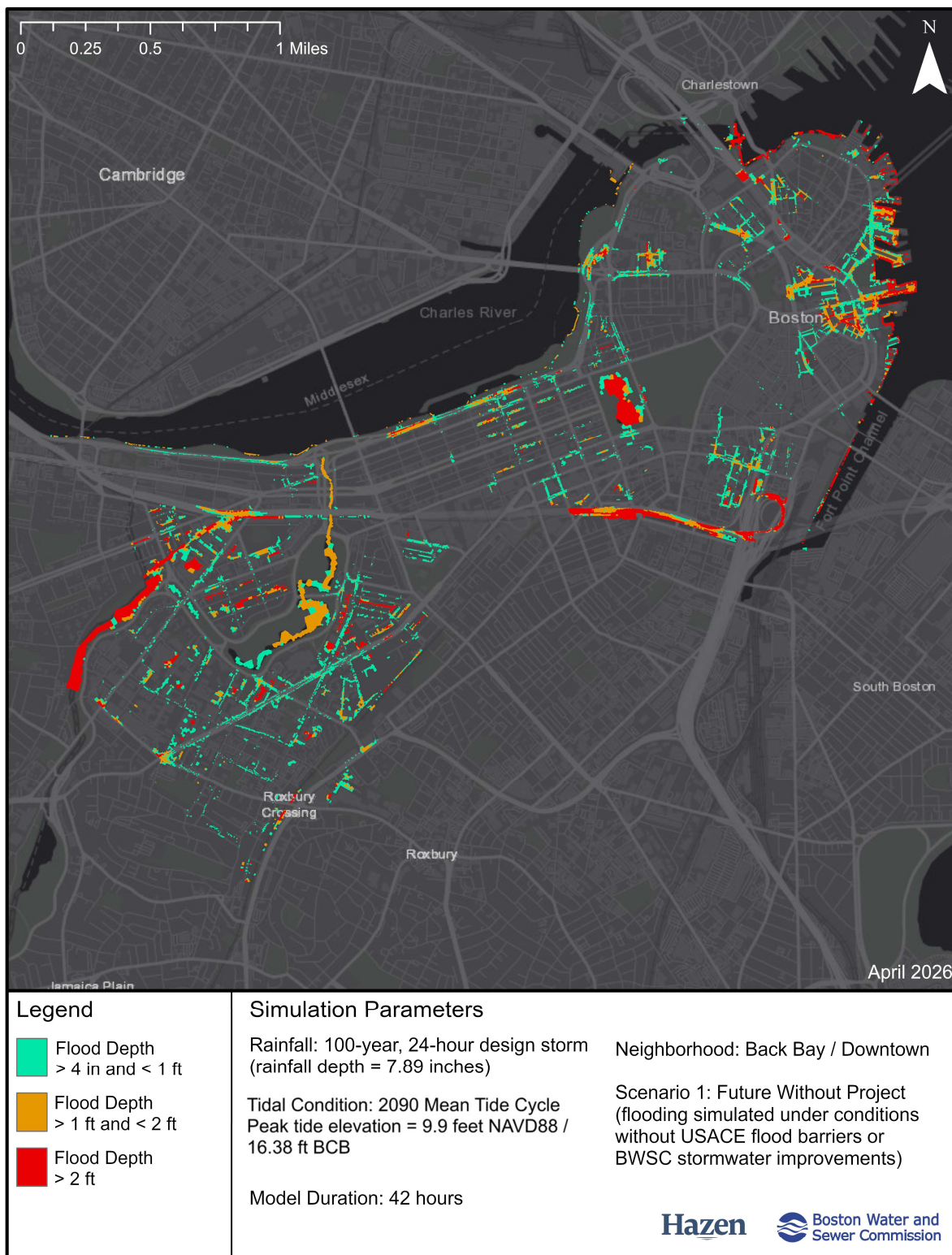
BD-1 - Scenario 1 (Future Without Project) Present Day Tide Cycle



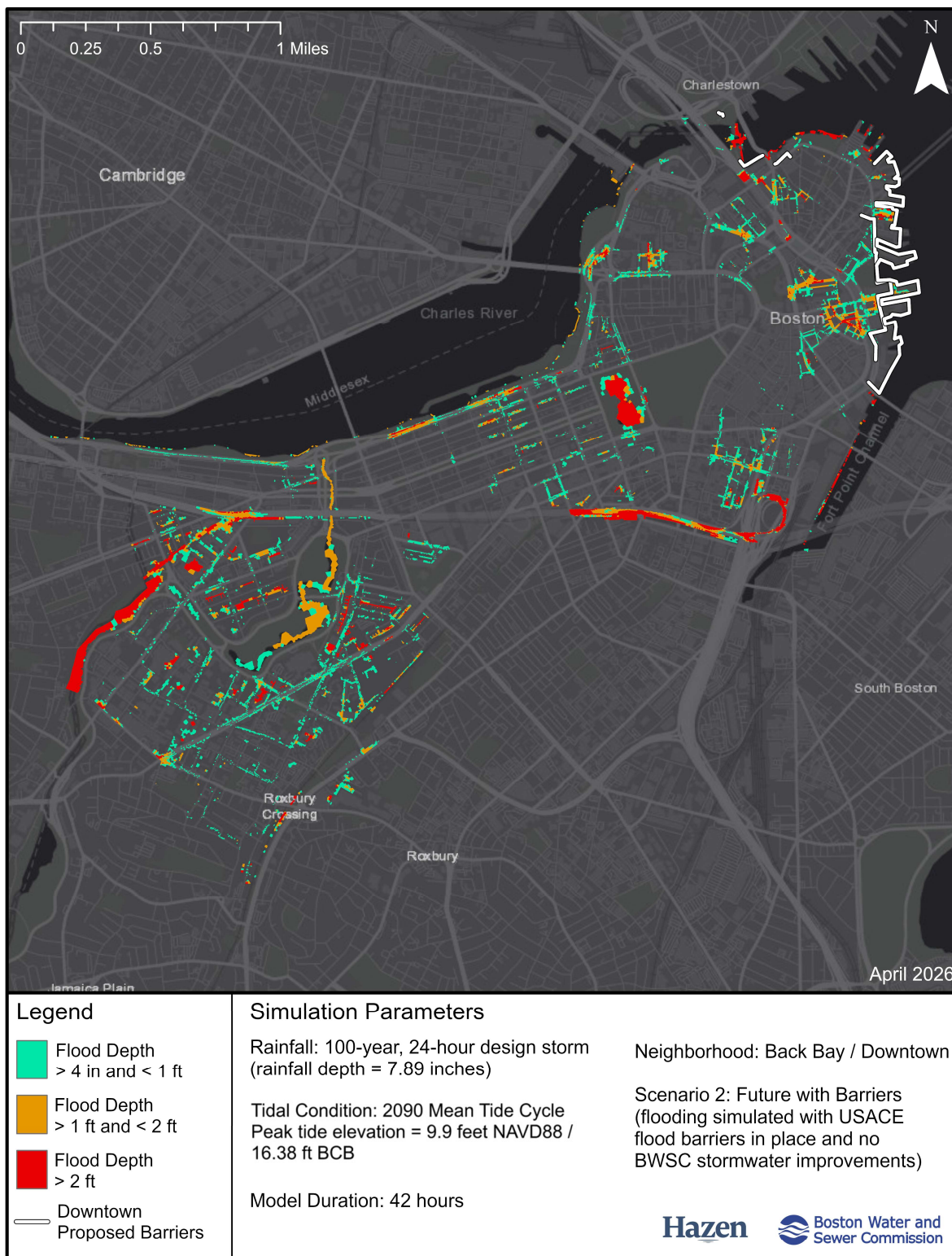
BD-2 - Scenario 2 (Future with USACE-Proposed Barriers) Present Day Tide Cycle



BD-3 - Model-Predicted Induced Flooding Present Day Tide Cycle



BD-4 - Scenario 1 (Future Without Project) USACE-Projected 2090 Tide Cycle



BD-5 - Scenario 2 (Future with USACE-Proposed Barriers) USACE-Projected 2090 Tide Cycle



BD-6 - Model-Predicted Induced Flooding (USACE-Projected 2090 Tide Cycle)

Flood Duration

Flood duration was calculated for each 2D cell using a threshold of 4 inches, meaning a cell was considered “flooded” whenever water depth reached or exceeded this value. The Back Bay / Downtown future tidal conditions and current tidal conditions models include a total of approximately 144,000 2D cells each. Comparing Scenario 1 and Scenario 2, the addition of the USACE-proposed flood barriers resulted in changes to flood duration in approximately 8% of cells under future tidal conditions and 19% of cells under current tidal conditions. Overall, the future tidal conditions model showed an increase in flood duration of roughly 5 minutes, while changes under current tidal conditions were roughly 10 minutes.

Velocity

PCSWMM represents 2D overland flow through the use of conduits assembled as a mesh across the model area. Overland flow velocity was calculated for each 2D conduit in the model. The Back Bay / Downtown simulations include approximately 358,000 2D conduits under future and current tidal conditions. Comparing Scenario 1 and Scenario 2, the addition of the USACE-proposed flood barriers resulted in velocity increases in approximately 3% of conduits for future tidal conditions and 1% for current tidal conditions. Among the conduits that experienced an increased velocity, the average velocity increased by about 0.2 fps in the future tidal conditions model and 0.07 fps in the current tidal conditions model. Increases in 2D conduit velocity indicate that the USACE-proposed barriers induce higher overland flow velocities for some regions of the model zone, which in some cases could potentially negatively impact natural slopes and built infrastructure.

Dorchester Bay Model Zone Results

USACE Induced Flooding Analysis – Dorchester Bay

The Boston Water and Sewer Commission (BWSC) is evaluating flooding conditions and designing stormwater improvements across Boston using PCSWMM modeling. At the same time, the United States Army Corps of Engineers (USACE) Coastal Storm Risk Management (CSRM) project may affect rainfall-driven flooding by altering overland flow paths and stormwater conveyance through new floodwalls, levees, and tide gates. To understand these potential impacts, Hazen completed an initial analysis comparing three scenarios: (1) Future Without Project, (2) Future with USACE barriers only, and (3) Future With Project including both USACE measures and BWSC's proposed stormwater improvements. Scenario 3 was modeled only where Scenario 2 showed increased flooding. This analysis helps determine whether BWSC's planned improvements are adequately sized to address additional flooding that could result from the CSRM project. The solutions previously developed by BWSC were designed (to a conceptual level) for a different tidal scenario and for a different design intent.

Summary of Model Inputs

The following are inputs to the PCSWMM model utilized in this analysis:

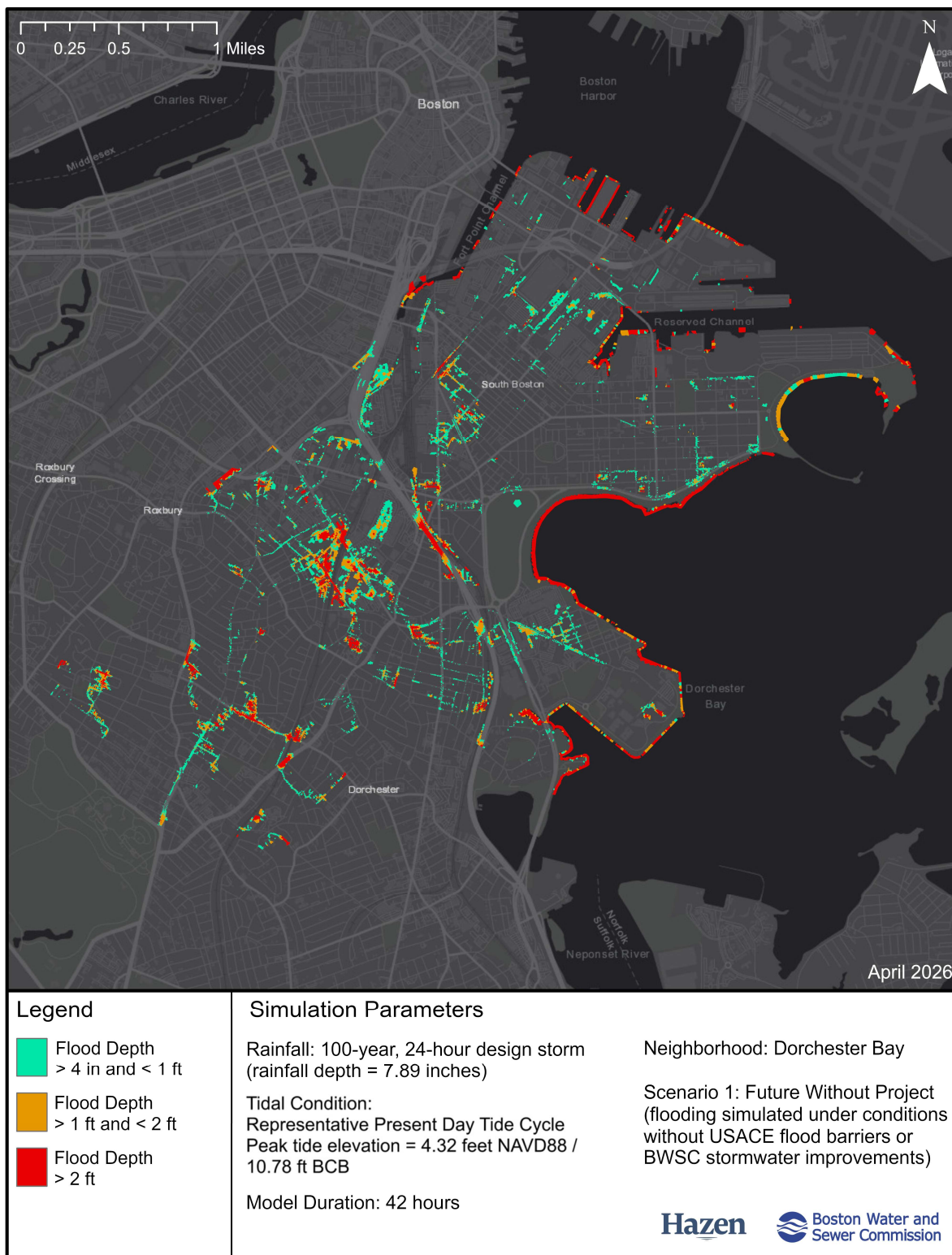
- Rainfall: 100-year, 24-hour design storm (rainfall depth = 7.89 inches)
- Representative Present Day Tide Cycle: Peak tide elevation = 10.78 ft BCB (Mean High Water from 1983-2001 NTDE)
- USACE-Projected 2090 Tide Cycle: 2090 mean tidal cycle (peak tide elevation = 16.38 feet BCB)
- Model Duration = 42 hours

Model Simulation Results

The Dorchester Bay neighborhood was evaluated through Scenario 1 and Scenario 2. When analyzed, there was no significant increase in model predicted flood extent, depth, duration and velocity in Scenario 2 versus Scenario 1. Results therefore indicate that the USACE proposed barriers within this neighborhood will not induce flooding in the region. Thus, Scenario 3 was not modeled.

Flood Extent and Depth

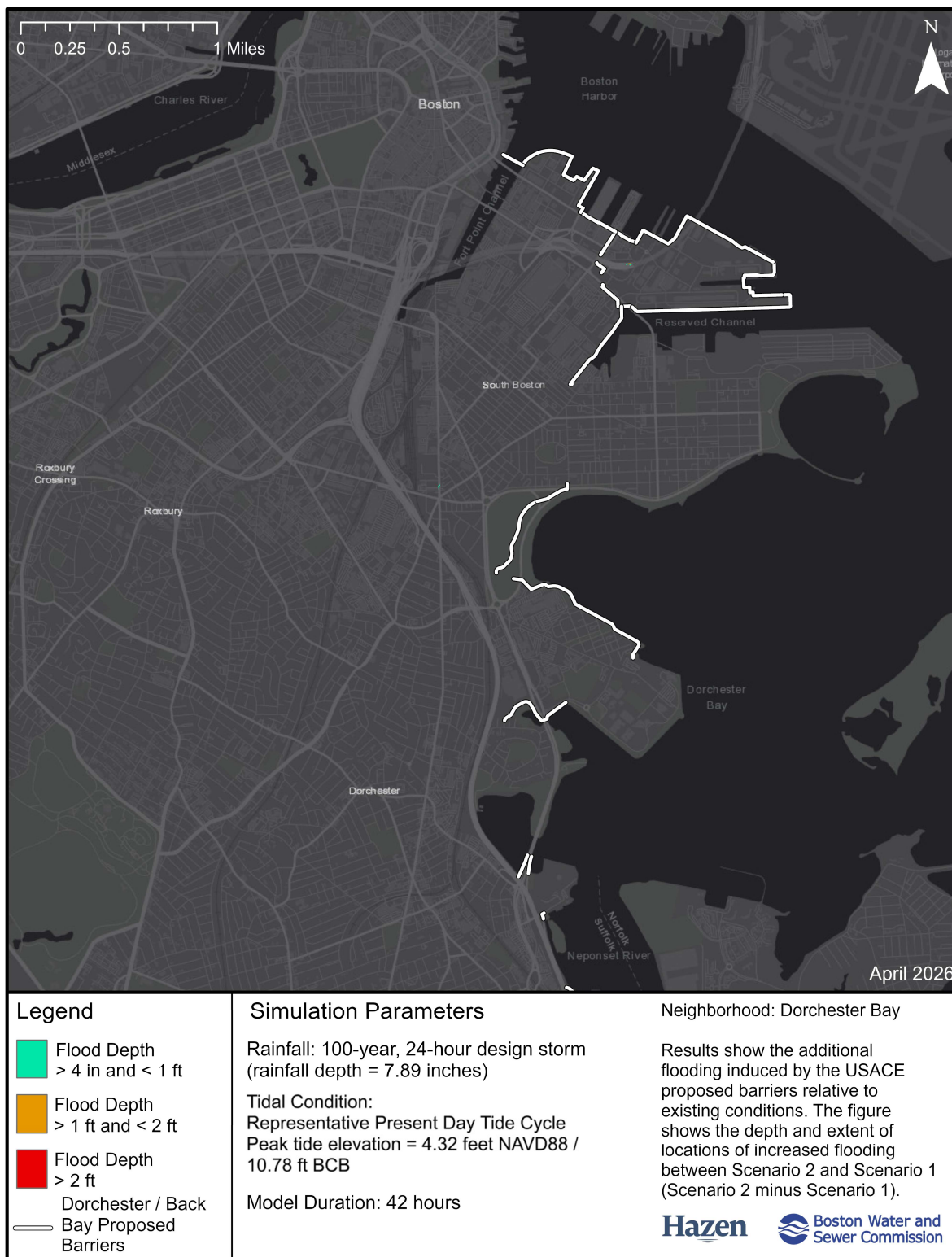
The model predicted extent and depth of flooding for present day MHW Scenario 1 and Scenario 2 are shown in figures DB-1 and DB-2. The extents for future mean high tide Scenario 1 and Scenario 2 are shown in figures DB-4 and DB-5. A comparison between Scenario 1 and 2 for present day MHW is shown in DB-3 and a comparison of Scenario 1 and 2 for future mean high tide is shown in DB-6. The comparison maps are generated by subtracting the model-predicted flood depths from Scenario 2 by Scenario 1, so the difference in flood depth for each cell (induced flooding) is shown. Due to the lack of induced flooding between Scenario 1 and Scenario 2, Scenario 3 was not simulated.



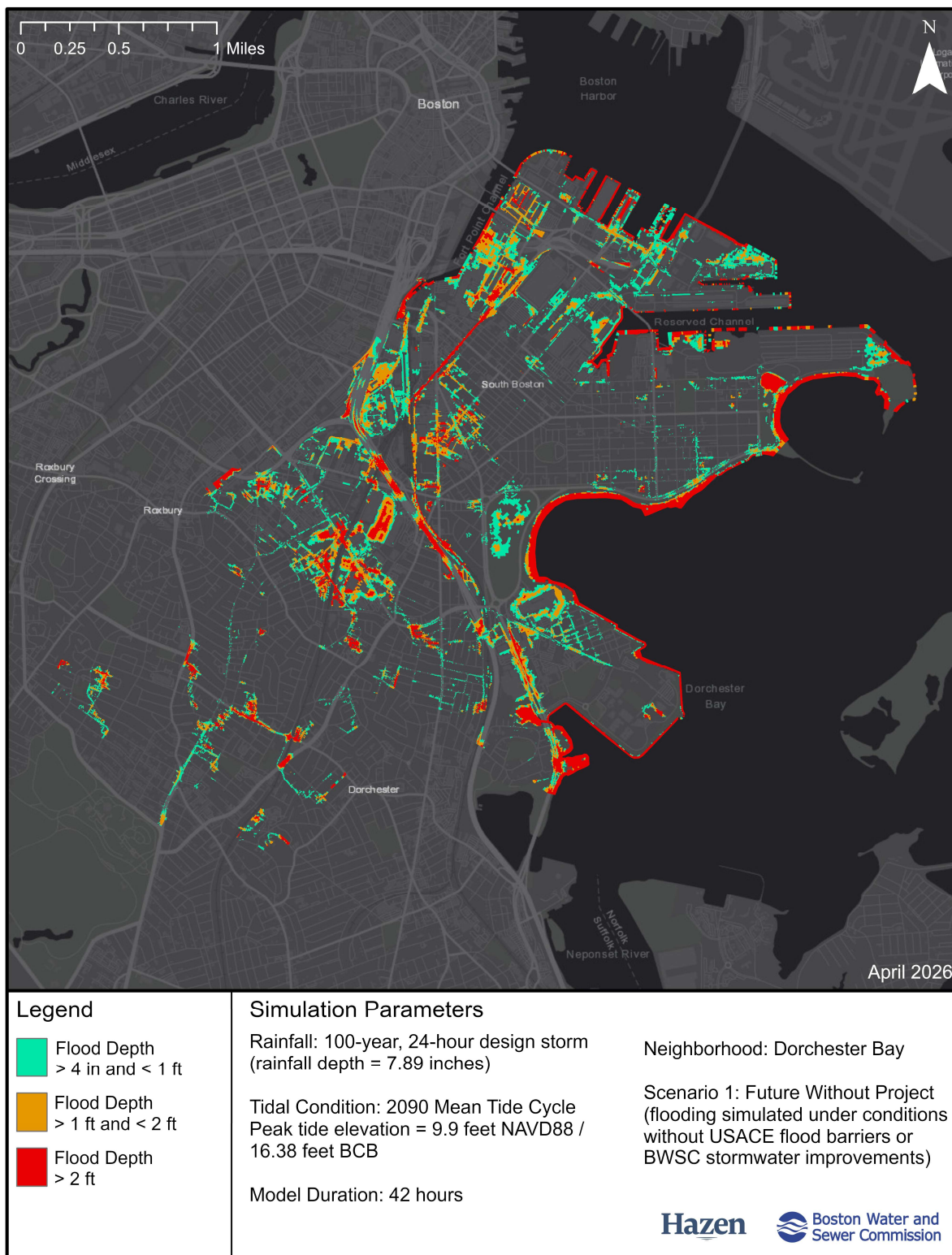
DB-1 - Scenario 1 (Future Without Project) Present Day Tide Cycle



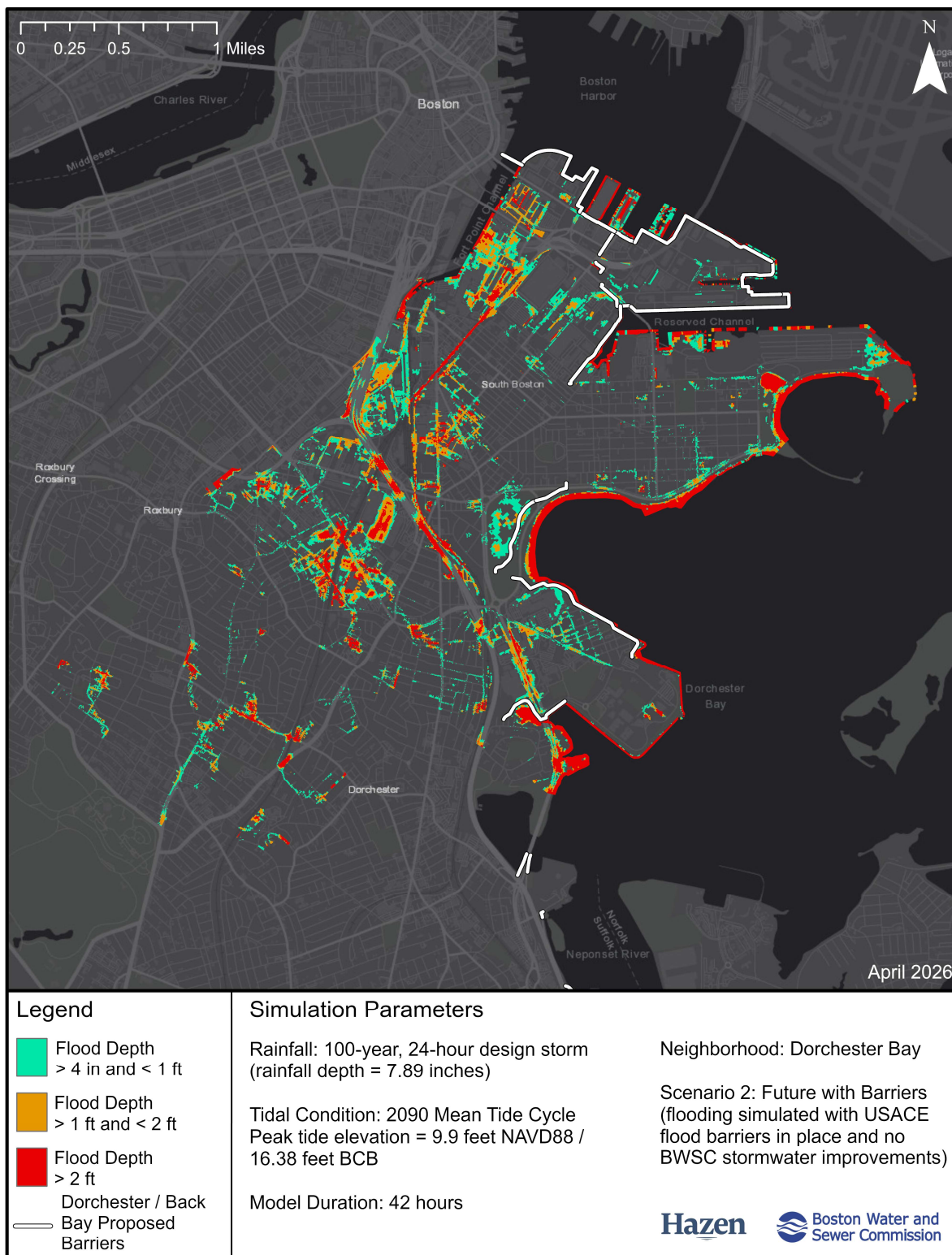
DB-2 - Scenario 2 (Future with USACE-Proposed Barriers) Present Day Tide Cycle



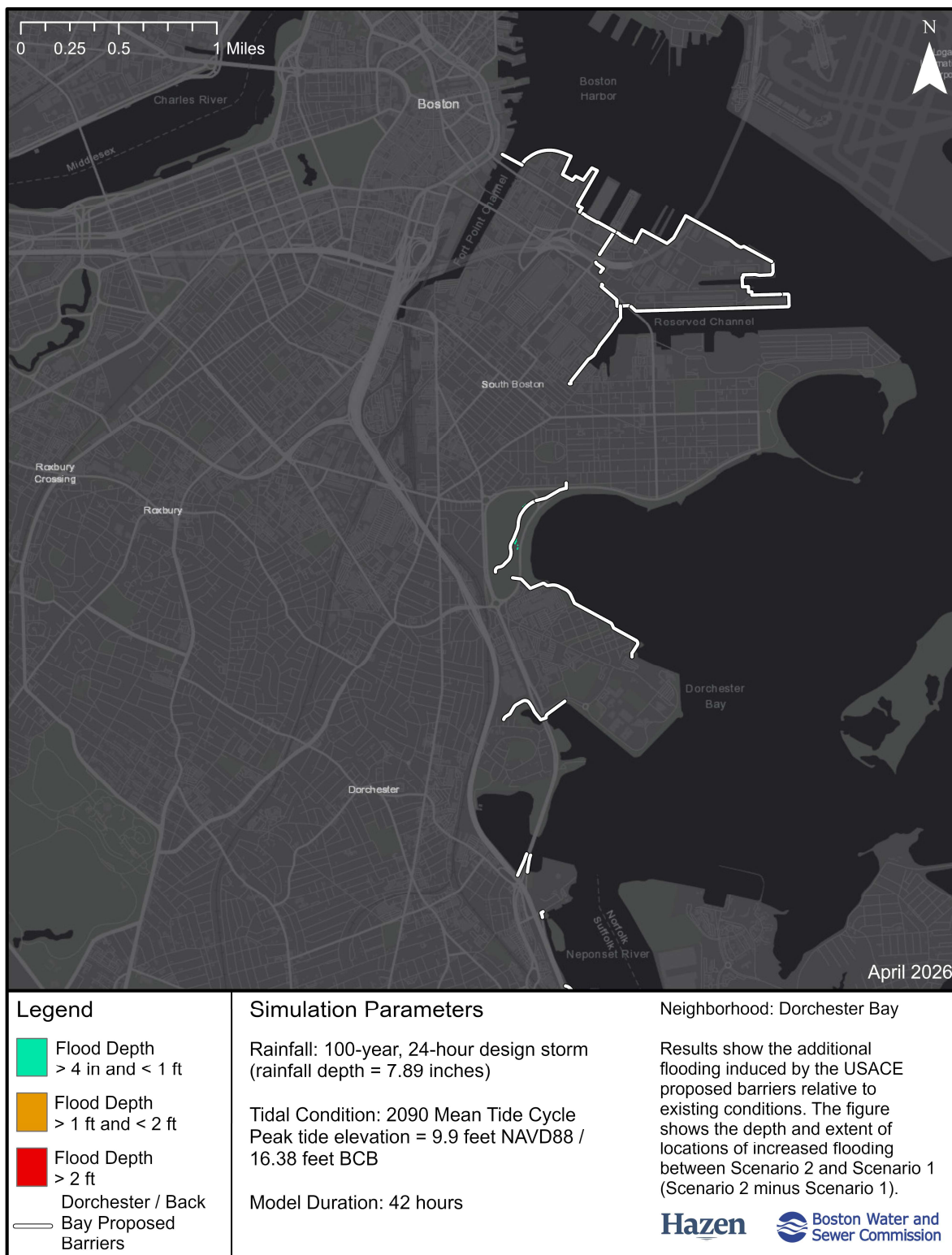
DB-3 - Model-Predicted Induced Flooding Present Day Tide Cycle



DB-4 - Scenario 1 (Future Without Project) USACE-Projected 2090 Tide Cycle



DB-5 - Scenario 2 (Future with USACE-Proposed Barriers) USACE-Projected 2090 Tide Cycle



DB-6 - Model-Predicted Induced Flooding (USACE-Projected 2090 Tide Cycle)

Flood Duration

Flood duration was calculated for each 2D cell using a threshold of 4 inches, meaning a cell was considered “flooded” whenever water depth reached or exceeded this value. The Dorchester Bay future tidal conditions model includes a total of approximately 367,000 2D cells, while the current tidal conditions model includes about 231,000 2D cells. Comparing Scenario 1 and Scenario 2, the addition of the USACE-proposed flood barriers resulted in changes to flood duration in approximately 11% of cells under future tidal conditions and 3% of cells under current tidal conditions. Overall, the future tidal conditions model showed an increase in flood duration of roughly 10 minutes, while changes under current tidal conditions were roughly 2 minutes.

Velocity

PCSWMM represents 2D overland flow through the use of conduits assembled as a mesh across the model area. Overland flow velocity was calculated for each 2D conduit in the model. The Dorchester Bay simulations include approximately 922,000 2D conduits under future tidal conditions and 574,000 2D conduits under current tidal conditions. Comparing Scenario 1 and Scenario 2, the addition of the USACE-proposed flood barriers resulted in velocity increases in approximately 2% of conduits for future tidal conditions and 1% for current tidal conditions. Among the conduits that experienced a change, the average velocity increased by about 0.13 fps in both future and current tidal condition models. Increases in 2D conduit velocity indicate that the USACE-proposed barriers induce higher overland flow velocities for some regions of the model zone, which in some cases could potentially negatively impact natural slopes and built infrastructure.

Neponset Model Zone Results

USACE Induced Flooding Analysis – Neponset

The Boston Water and Sewer Commission (BWSC) is evaluating flooding conditions and designing stormwater improvements across Boston using PCSWMM modeling. At the same time, the United States Army Corps of Engineers (USACE) Coastal Storm Risk Management (CSRM) project may affect rainfall-driven flooding by altering overland flow paths and stormwater conveyance through new floodwalls, levees, and tide gates. To understand these potential impacts, Hazen completed an initial analysis comparing three scenarios: (1) Future Without Project, (2) Future with USACE barriers only, and (3) Future With Project including both USACE measures and BWSC's proposed stormwater improvements. Scenario 3 was modeled only where Scenario 2 showed increased flooding. This analysis helps determine whether BWSC's planned improvements are adequately sized to address additional flooding that could result from the CSRM project. The solutions previously developed by BWSC were designed (to a conceptual level) for a different tidal scenario and for a different design intent.

Summary of Model Inputs

The following are inputs to the PCSWMM model utilized in this analysis:

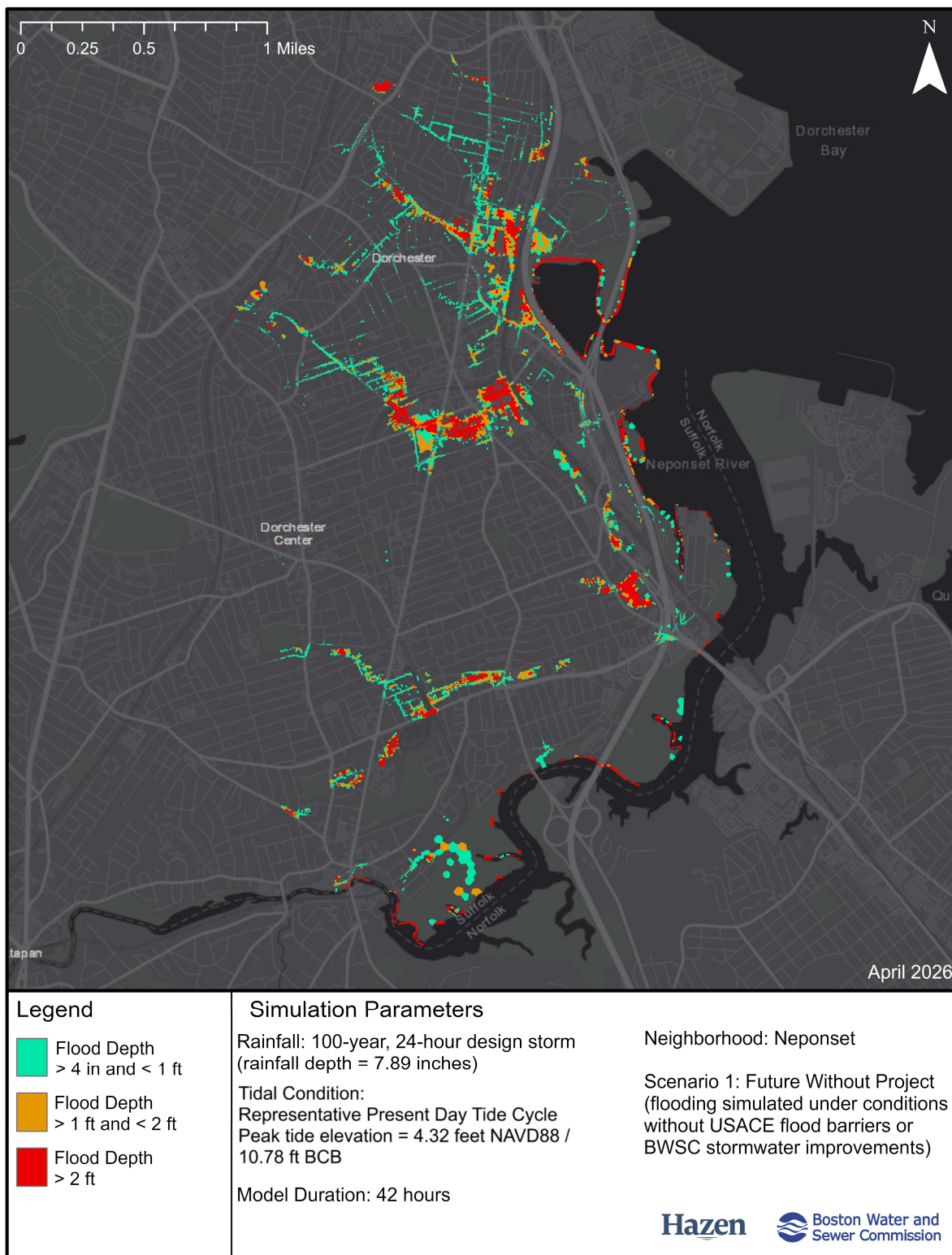
- Rainfall: 100-year, 24-hour design storm (rainfall depth = 7.89 inches)
- Representative Present Day Tide Cycle: Peak tide elevation = 10.78 ft BCB (Mean High Water from 1983-2001 NTDE)
- USACE-Projected 2090 Tide Cycle: 2090 mean tidal cycle (peak tide elevation = 16.38 feet BCB)
- Model Duration = 42 hours

Model Simulation Results

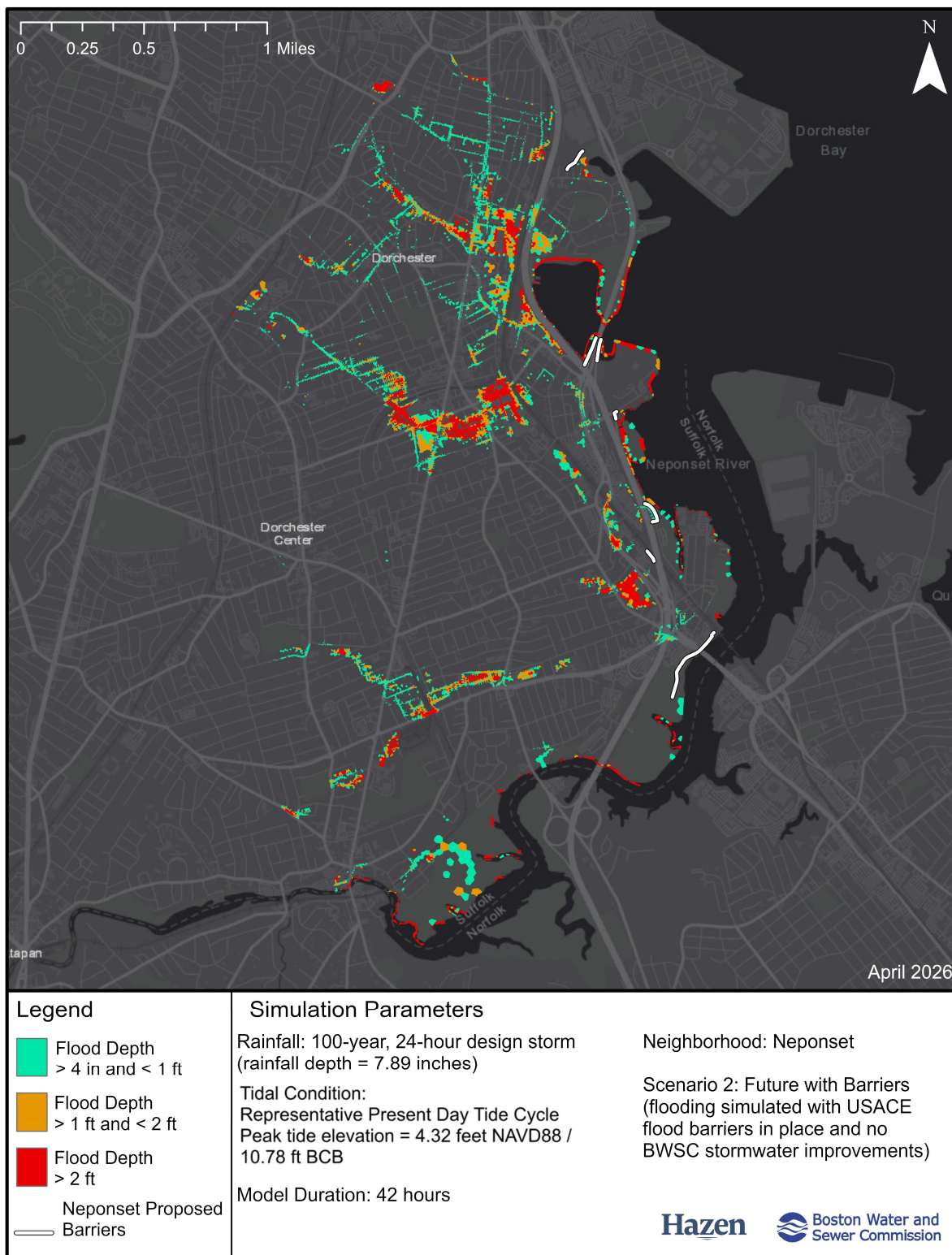
The Neponset neighborhood was evaluated through Scenario 1 and Scenario 2. When analyzed, there was no significant increase in model predicted flood extent, depth, duration and velocity in Scenario 2 versus Scenario 1. Results therefore indicate that the USACE proposed barriers within this neighborhood will not induce flooding in the region. Thus, Scenario 3 was not modeled.

Flood Extent and Depth

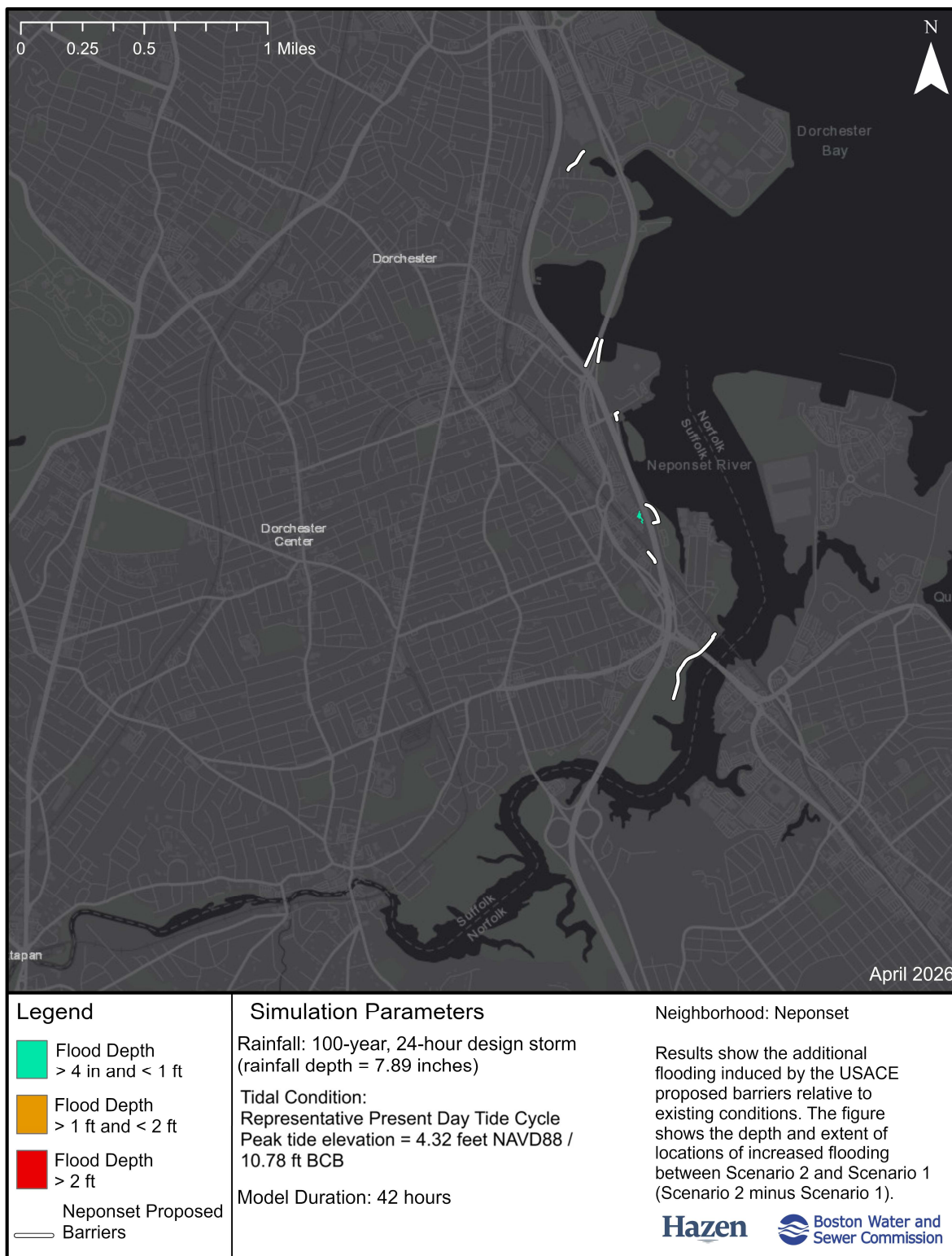
The model predicted extent and depth of flooding for present day MHW Scenario 1 and Scenario 2 are shown in NP-1 and NP-2. The extents for future mean high tide Scenario 1 and Scenario 2 are shown in NP-4 and NP-5. A comparison between Scenario 1 and 2 for present day MHW is shown in NP-3 and a comparison of Scenario 1 and 2 for future mean high tide is shown in NP-6. The comparison maps are generated by subtracting the model-predicted flood depths from Scenario 2 by Scenario 1, so the difference in flood depth for each cell (induced flooding) is shown. Due to the lack of induced flooding between Scenario 1 and Scenario 2, Scenario 3 was not simulated.



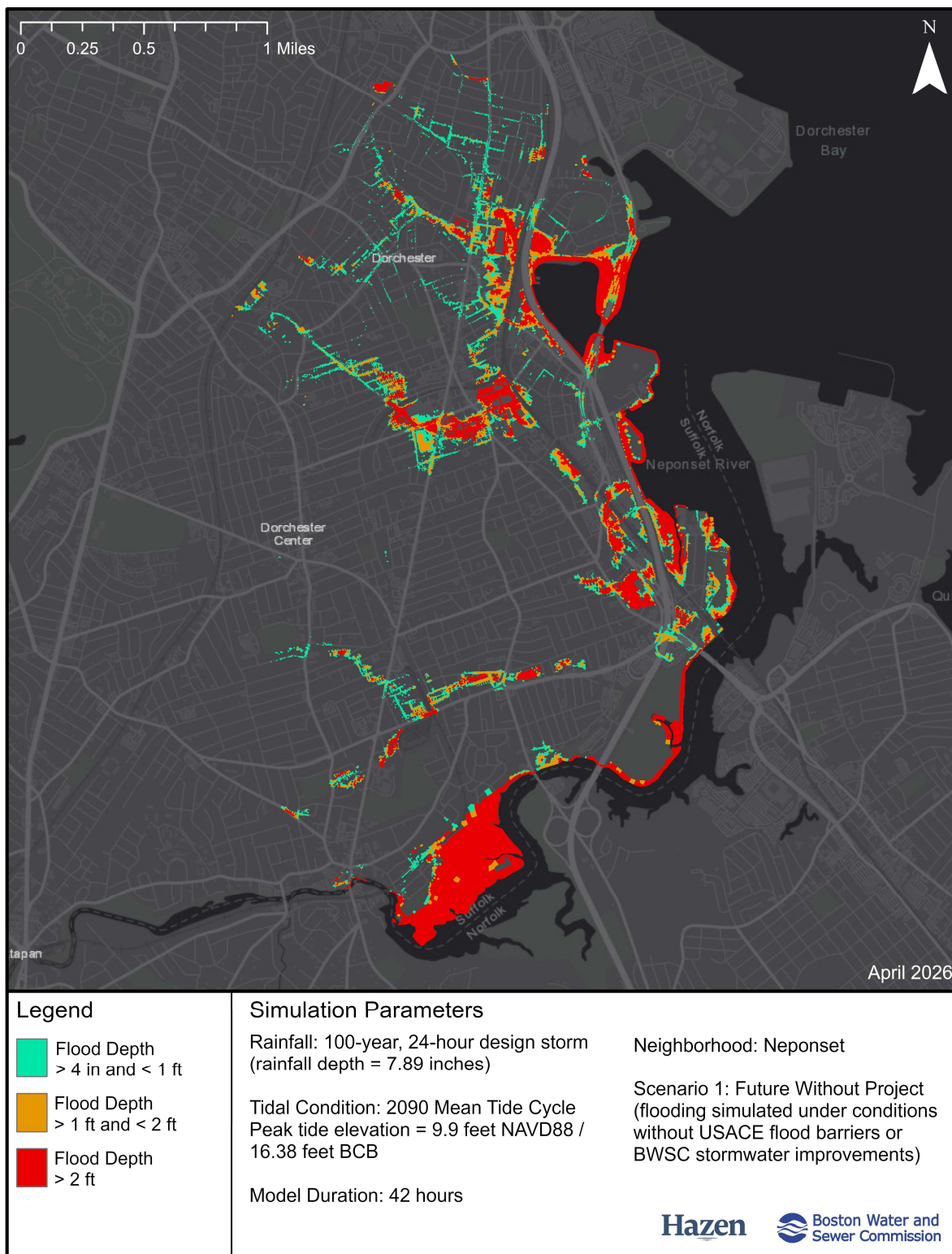
NP-1 - Scenario 1 (Future Without Project) Present Day Tide Cycle



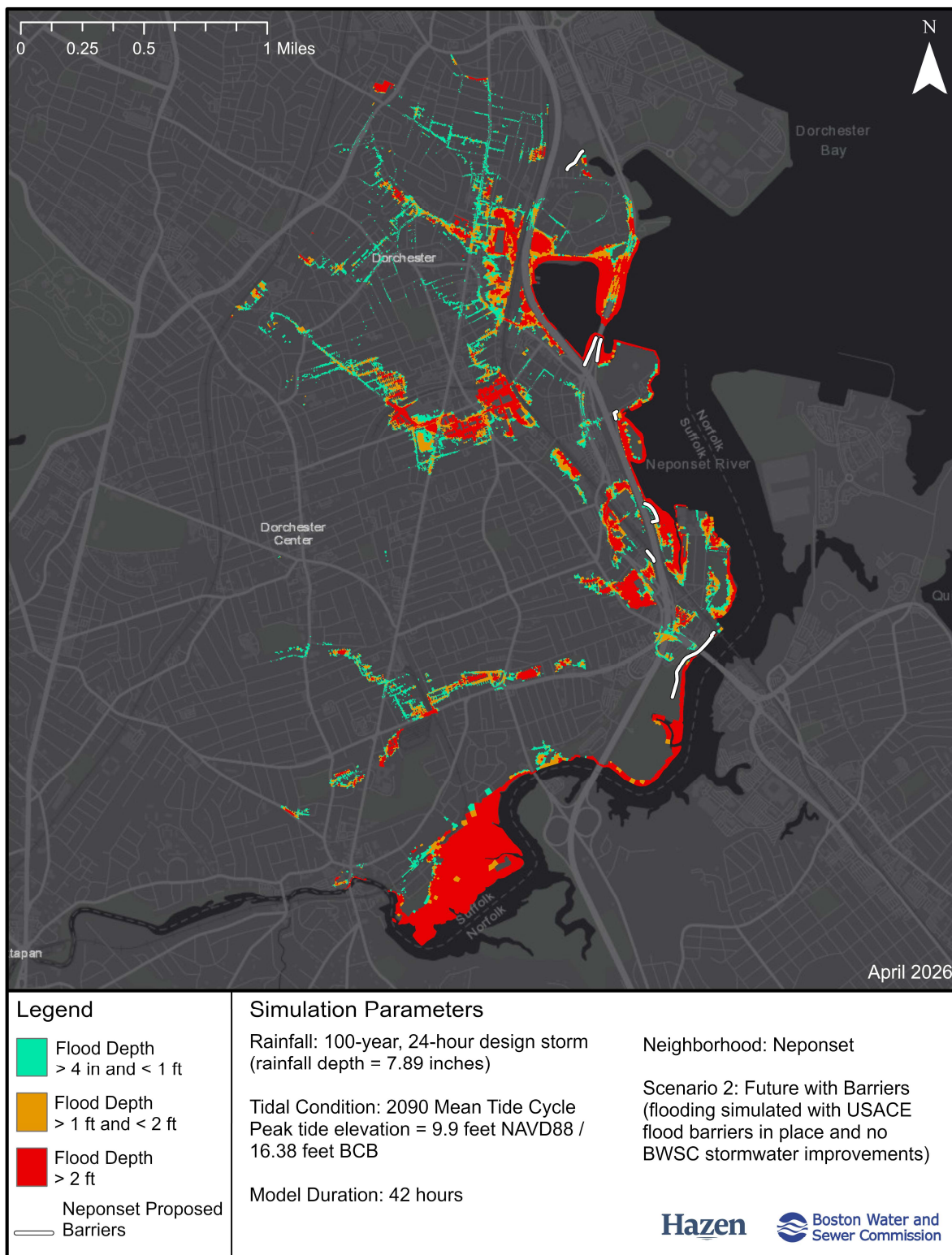
NP-2 - Scenario 2 (Future with USACE-Proposed Barriers) Present Day Tide Cycle



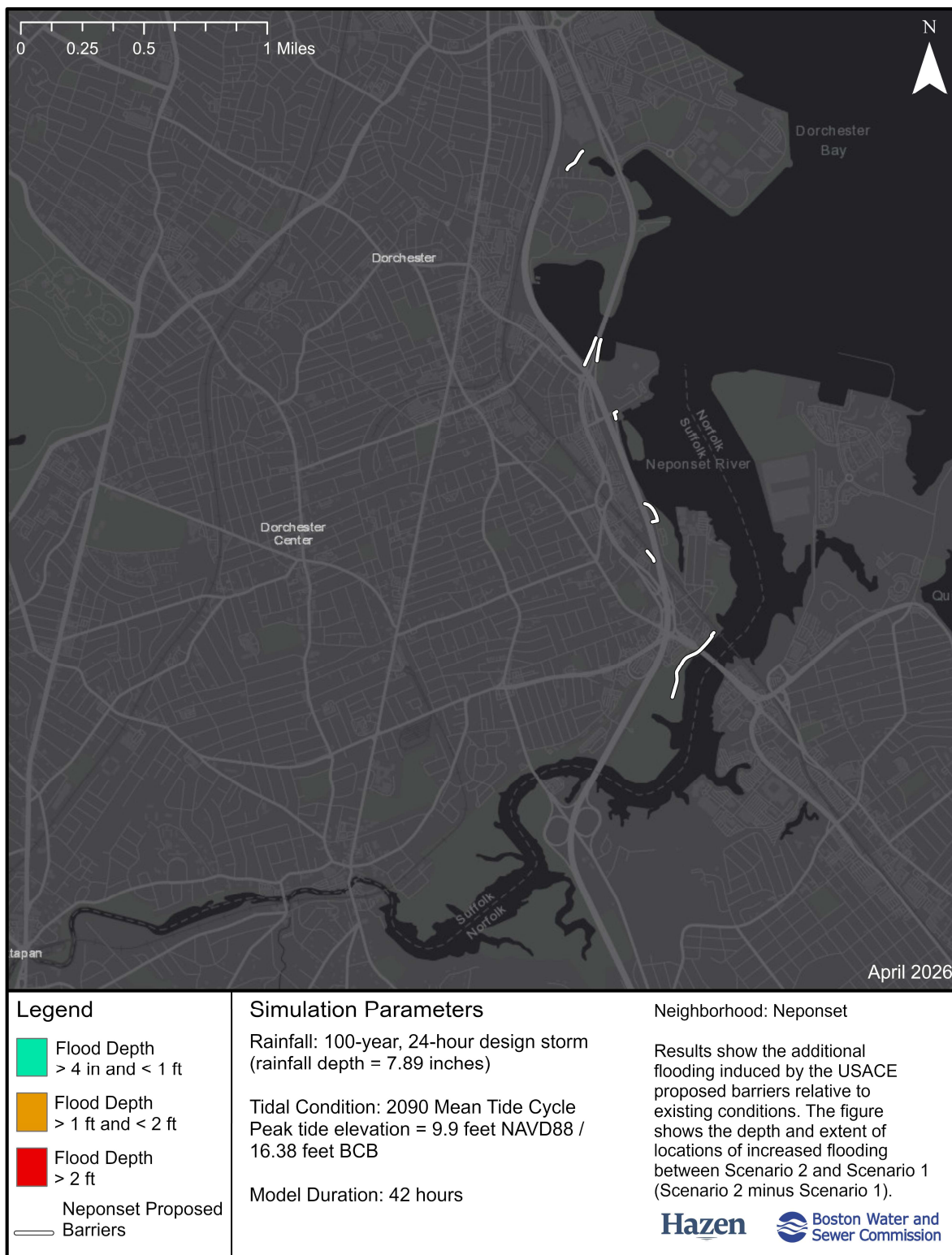
NP-3 - Model-Predicted Induced Flooding Present Day Tide Cycle



NP-4 - Scenario 1 (Future Without Project) USACE-Projected 2090 Tide Cycle



NP-5 - Scenario 2 (Future with USACE-Proposed Barriers) USACE-Projected 2090 Tide Cycle



NP-6 - Model-Predicted Induced Flooding (USACE-Projected 2090 Tide Cycle)

Flood Duration

Flood duration was calculated for each 2D cell using a threshold of 4 inches, meaning a cell was considered “flooded” whenever water depth reached or exceeded this value. The Neponset future tidal conditions model includes a total of approximately 277,000 2D cells, while the current tidal conditions model includes about 173,000 2D cells. Comparing Scenario 1 and Scenario 2, the addition of the USACE-proposed flood barriers resulted in changes to flood duration in approximately 4% of cells under future tidal conditions and 1% of cells under current tidal conditions. Overall, the future tidal conditions model showed an increase in flood duration of roughly 2 minutes, while changes under current tidal conditions were negligible.

Velocity

PCSWMM represents 2D overland flow through the use of conduits assembled as a mesh across the model area. Overland flow velocity was calculated for each 2D conduit in the model. The Neponset simulations include approximately 682,000 2D conduits under future tidal conditions and 462,000 conduits under current tidal conditions. Comparing Scenario 1 and Scenario 2, the addition of the USACE-proposed flood barriers resulted in velocity increases of approximately 1% of conduits for future tidal conditions and 0.05% for current tidal conditions. Among the conduits that experienced a change, the average velocity increased by about 0.14 fps in the future tidal conditions model and 0.34 fps in the current tidal conditions model. Increases in 2D conduit velocity indicate that the USACE-proposed barriers induce higher overland flow velocities for some regions of the model zone, which in some cases could potentially negatively impact natural slopes and built infrastructure.

Appendix A: USACE Induced Flooding Work Statement

Work Statement for Interior Drainage Induced Flooding Analysis for TSP

Background:

Construction of Boston Coastal Storm Risk Management (CSRM) project (the Project) has the potential to result in increases in the depth, duration and extent of rainfall-induced flooding because of structural measures implemented. The increases may result if the alignment of the floodwalls/levees prevents overland flow that would have otherwise occurred and/or tide-gates restrict the discharge of stormwater flows, diminishing the performance of the stormwater system. A complete assessment of increases in flooding will eventually include modeling a range of events. However, due to time constraints, a simplified approach is being taken with performing initial limited analysis prior the Tentatively Selected Plan Milestone (TSP). The more robust analysis will be performed later (post-TSP). A future work statement will better describe the robust effort based on the selected plan for TSP.

Conversations between BWSC, the City of Boston and USACE indicate they are actively investigating improvements to the stormwater system as a supplementary and complementary piece of the larger water resources resilience plan in the study area. The conversation included an understanding that complementary stormwater improvements would not be a part of the USACE plan because the USACE alignments likely won't increase risk across every area of the BWSC drainage area. But many pieces would be supplementary to the USACE plan where the recommended structures impact drainage and require management or mitigation measures. In these areas, the BWSC recommendations from the 2023 analysis would manage the risk reducing the impacts of potential increases.

It is believed that the BWSC interior drainage facilities would likely reduce or remove the need for real estate takings, either physical or regulatory for flowage easements. The current proposed facilities in the 2023 study are likely larger and more expensive than that needed to mitigate Project induced floodings. Although incorporating the facilities in their current larger state is more conservative and will increase project construction costs, it will reduce the scope and cost of a preliminary real estate takings analysis for induced flooding as required by HQ USACE Induced Flooding Guidance. In addition to the study efficiency, the public review of the USACE plan with BWSC facilities included will like to portray a more accurate depiction of what the whole of government plan will look like (combination of USACE and BWSC facilities).

Objective:

Perform initial interior drainage modeling to assess whether the proposed BWSC interior drainage facilities (as documented in the January 2023 Coastal Stormwater Discharge Analysis) are sufficiently sized to manage potential increases in flooding caused by the construction of the Project levees/ floodwalls and/or tide gates.

This means, modeling two or three scenarios:

- (1) Future Without Project (FWOP) which means not including the Project or proposed BWSC interior drainage features;

- (2) Future with barriers (e.g., floodwalls/levees) only, which means not including the proposed BWSC interior drainage features; and,
- (3) Future With Project (FWP) which means modeling the Project and the BWSC interior drainage features.

The results of the scenarios (1) and (2) should be compared, and if there is an increase in flooding in scenario (2), in either depth, duration or footprint, scenario (3) should be simulated to understand if, the rainfall-induced flooding in the FWP (scenario 3) is less than in the FWOP (scenario 1). If the FWP flooding is less than the FWOP flooding, then the facilities can be considered to be a sufficient mitigation for any potential induced flooding and that takings would not be needed.

Due to time constraints, the 100-yr rainfall amount will be used as a representative rainfall scenario to assess the sufficiency of the proposed BWSC interior drainage features. If BWSC or Hazen believes that a different event (either larger or smaller) would result in greater needs for mitigation (i.e. bigger pumps or ponds) to prevent increases in flooding associated with the construction of the project, the team should discuss using that rainfall event.

Induced Flooding Considerations:

“Induced Flooding” occurs when a constructed project (e.g., levee) causes an increase in flooding compared with the flooding conditions prior to the construction of the project. Increased flooding can be represented by increases in flood depths, flood frequency, flood duration, flood velocity, or acres flooded. Induced flooding represents a risk transference.

Induce flooding has the potential to occur for storms beyond the sewer design storm. The “minimum facilities” structures are only designed to address flooding up to the sewer design storm.

USACE Guidance (ER 110-2-103) indicates risk reduction should be investigated and recommended if cost effective and appropriate. Reduction of induced flooding may be appropriate when the benefits exceed the costs or there are overriding reasons of public safety, economic, or social concerns, or a determination of a real estate taking has been made.

Per recent guidance, a preliminary takings analysis should be completed no later than the TSP.

Sewer Design Storm: 10-year according to the 2023 Coastal Stormwater Discharge Analysis report.

Induced Flooding Guidance:

Memorandum For Headquarters And Major Subordinate Commands, Districts, And Field Operating Units, USACE, July 28, 2025.

Coastal Boundary Condition:

The coastal boundary conditions for this assessment are the same developed for the “minimum facilities” analysis included in the “Work Statement for Interior Drainage Analysis for TSP” submitted on July 31, 2025.

Rainfall Hyetograph:

The adopted frequency storm for this assessment is the 0.01 AEP (100-year) based on Atlas 14 at Logan Airport. The storm duration is 24 hours, and the time increment is five minutes. Use the precipitation data included in **Attachment 1** for the simulations.

Approach Assumption:

High tide assumed to occur concurrent with peak runoff as a conservative approach.

Alignment:

The shapefiles for the Future Without Project (FWOP) are included in **Attachment 2** and includes the Ryan Playground and the Piers Park II. Note that the Fort Point Channel project is not part of the FWOP anymore. The alignments for the Ryan Playground and the Piers Park II are the same included in the work statement submitted on July 31, 2025, for the minimum facilities runs.

The Future With Project (FWP) alignments are included in **Attachment 3**. These revised alignments account for the closure structures in the open position. Note that there have been some minor revisions along the barrier alignments. Use the most updated alignment files included in **Attachment 3** that are considered sufficient for analysis.

The shapefiles for Neighborhoods include:

- Charlestown.
- Dorchester.
- East Boston.
- South Boston.
- Downtown.

There are multiple alignments in some neighborhoods that will be discussed in future meetings.

Modeling Simulations:

Scenarios (1) and (2) should be simulated, and depending on the results, scenario (3) should also be simulated for each neighborhood:

- (1) Future Without Project (FWOP) which means not including the Project or proposed BWSC interior drainage features;
- (2) Future with barriers (e.g., floodwalls) only, which means not including the proposed BWSC interior drainage features; and,
- (3) Future With Project (FWP) which means modeling the Project and the BWSC interior drainage features.

The results of the scenarios (1) and (2) should be compared, and if there is an increase in flooding in scenario (2), scenario (3) should be simulated to understand if the rainfall-induced flooding in the FWP (scenario 3) is less than in the FWOP (scenario 1). If the FWP flooding is less than the FWOP flooding, then the facilities can be considered to be a sufficient mitigation for any potential induced flooding and that there would be no takings.

Some of the Project areas do not include proposed BWSC interior drainage features because they either have not been developed yet or the alignment from Climate Ready Boston is different. Therefore, conceptual designs will need to be developed for the areas lacking proposed interior drainage improvements prior to simulate this scenario. USACE will be engaging with BWSC on concepts for these areas.

Deliverables:

- H&H analysis to inform assessment of induced flooding and mitigation.
- Brief individual memos summarizing the results for each neighborhood and the following:
 - Comparison between scenarios (1) and (2) and between scenarios (1) (2) and (3) if scenario (3) is simulated. The comparisons should include flood extent, depth, and duration. (if there are apparent increases in velocity, those should be included as well).
 - Size of pipes, ponds, pumps modeled
 - Location of facilities.
 - General concept for operation if the solution includes pumping.
- Model output files that include flood extent, depth and duration of flooding.
- Quality control reviews performed by BWSC and/or their contractor.
- Summary report for all analyses.

Schedule:

USACE is using an assembly line type approach. This is the anticipated order for modeling. The deadlines will be provided soon.

- Charlestown - TBD
- Dorchester - TBD
- South Boston – TBD
- East Boston - TBD
- Downtown - TBD

Model Requirements:

We understand that BWSC has developed a 2D PCSWMM model for the analysis of Boston stormwater system. The development of this model is documented in the December 2020 Inundation Model report. This model was subsequently used in the January 2023 Coastal Stormwater Discharge Analysis report. Model improvements were made in advance of performing the minimum facilities analysis. Use of the same model used in the minimum facilities analysis is anticipated.

Hazen



Boston Water and
Sewer Commission

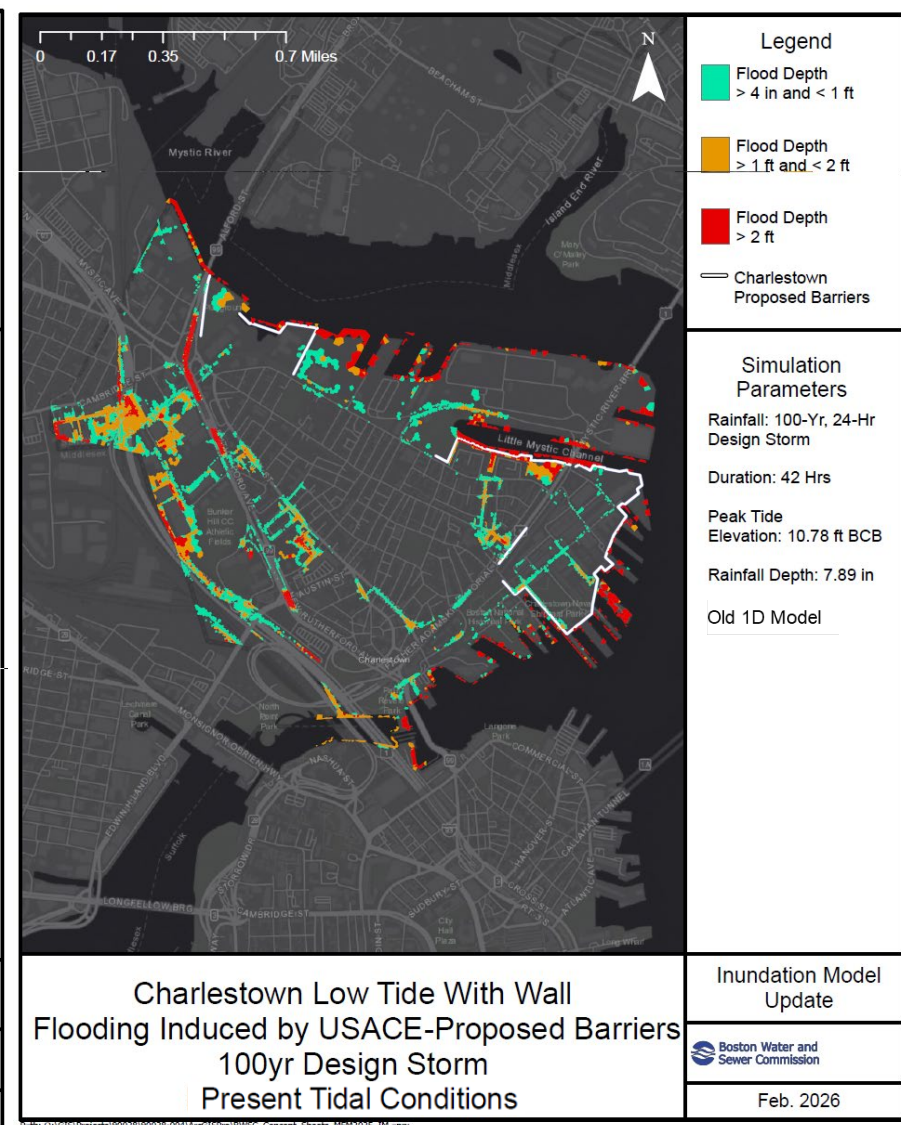
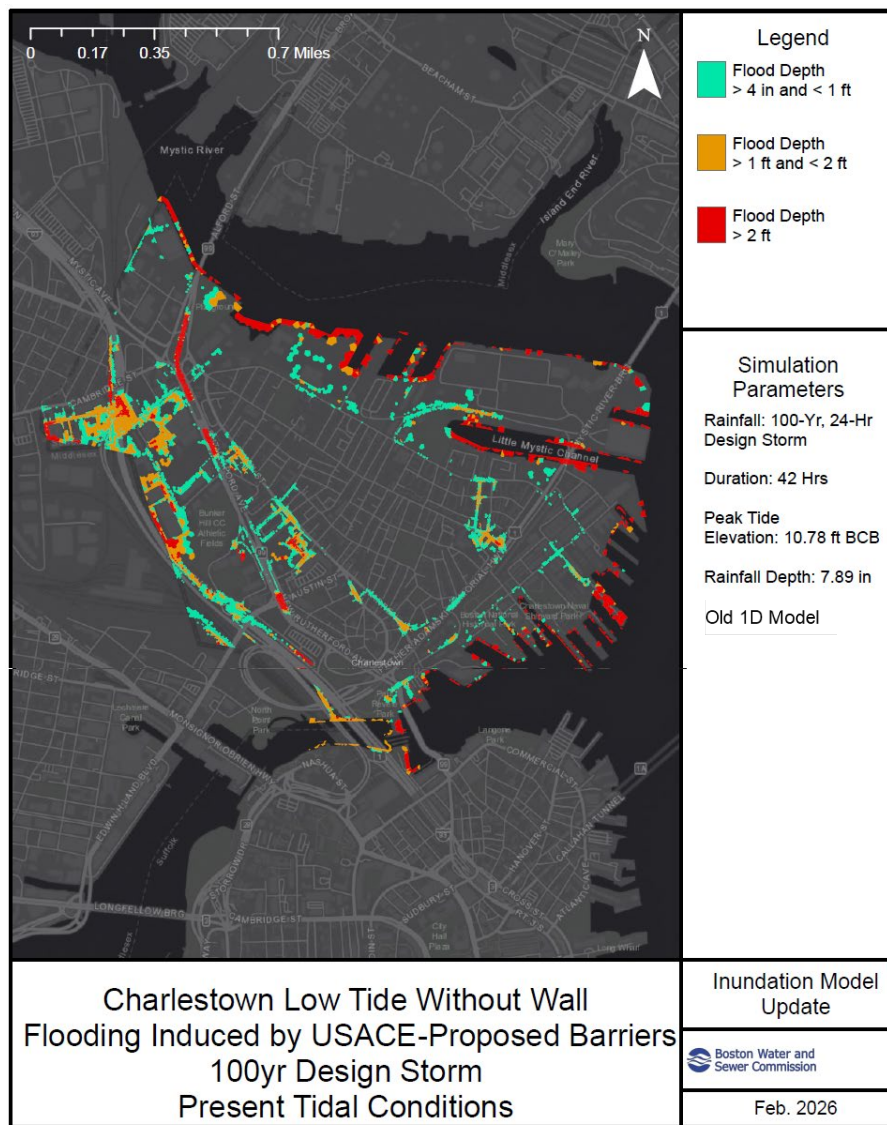
USACE Present Day Tide Model Simulations - Charlestown

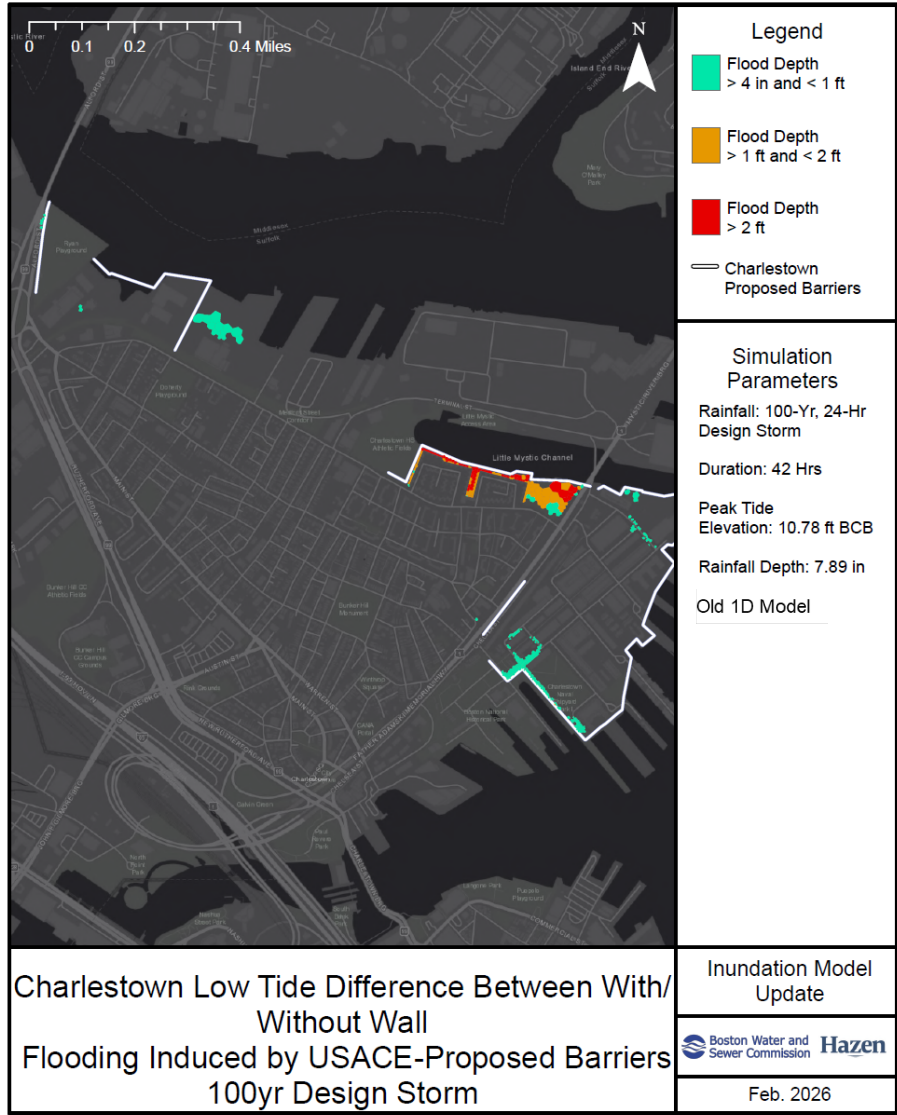
March 6th, 2026

Army Corps Induced Flooding Analysis – “Old 1D Model” Simulations

Modeled using new 1D model as well as old 1D model

Zone	100-year Design Storm, High Tidal Conditions			100-year Design Storm, Present-Day Tidal Conditions		
	Without Wall	With Wall	With Solutions	Without Wall	With Wall	With Solutions
Back Bay/Downtown	Complete	Complete	Not Needed	Complete	Complete	Not Needed
Charlestown	Complete	Complete	Complete	Complete	Complete	Complete
Dorchester	Complete	Complete	Not Needed	Complete	Complete	Not Needed
East Boston	Complete	Complete	Not Needed	Complete	Complete	Not Needed
Neponset	Complete	Complete	Not Needed	Complete	Complete	Not Needed





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