Queensville Dam Removal Feasibility Study and Buttery Brook Watershed Enhancement

TOWN OF SOUTH HADLEY MASSACHUSETTS

FUSS & O'NEILL

MVP Municipal Vulnerability Preparedness

June 2022

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Financial assistance was provided by the Executive Office of Energy & Environmental Affairs (EEA) under the FY22 Municipal Vulnerability Preparedness (MVP) Grant Program. The MVP Action Grant offers financial resources to municipalities that are seeking to advance priority climate adaptation actions to address climate change impacts resulting from extreme weather, sea level rise, inland and coastal flooding, severe heat, and other climate impacts.

Introduction

A 2018 Phase 1 Dam Inspection showed Queensville Dam to be in poor condition and in need of roughly $175K in repairs to bring it to a safe condition. The impoundment, Titus Pond, is part of an underutilized conservation area (Titus Pond Conservation Area) that is impaired by significant algal blooms during much of the season—conditions which are expected to worsen as temperatures and precipitation-driven nutrient inputs increase with climate change. Rather than spend money on perpetual upkeep, the Town would prefer to remove the liability associated with the dam and restore the surrounding ecosystem for improved stormwater retention capacity to mitigate flooding, erosion, and other storm impacts in densely populated downstream neighborhoods and improve water quality/alleviate potential public health concerns associated with nutrient and bacteria impairments.

This report summarizes the first phase of a multi-phase project. The Town received an FY22 Municipal Vulnerability Preparedness Action Grant to complete a planning and assessment phase to evaluate options and develop a design concept to set the Town up to pursue design and implementation projects along Buttery Brook. The design concept developed during this phase and presented here will be advanced to design and permitting under the next project phase. Based on the feasibility study, attention and funds will be focused in the areas where projects are expected to have the greatest resilience benefits, as well as where projects have been deemed to be feasible (in terms of cost/benefit, property rights, topography, and community support). Ultimately, the specific design options being advanced through design and permitting during the FY23 phase will lead to constructed projects in future phases with benefits for downstream flooding, in addition to co-benefits of higher quality habitat, decreased nutrient loading, and benefits for climate vulnerable populations by providing better access to open space within the Buttery Brook watershed and potential positive impacts in reducing urban heat island effects and buffering extreme temperatures.

The Buttery Brook watershed is South Hadley's most heavily developed watershed, with a high degree of impervious area and several stretches where the stream runs through underground culverts. Titus Pond is the headwaters of the system, and therefore a natural place to begin work to improve conditions in the watershed and manage upstream stormwater contributions that ultimately make their way through the dense, low-income neighborhoods of the South Hadley Falls area before Buttery Brook converges with the Connecticut River.

Evaluation of options for Queensville Dam was specifically identified as a high priority action in the Town's MVP plan, in addition to a second high priority action to conduct dam assessments, identify privately-owned dams, and study feasibility of dam removals where

Algal bloom at Titus Pond – typical of summer conditions

aging dams may pose a threat of failure and flooding. The situation at Queensville Dam does not lend itself to a 'classic' dam removal because Route 116 is located on the dam embankment and cannot be relocated. This study therefore looked at two primary options with respect to dam removal: 1) open up the dam embankment, replacing the existing dam outlet structure with a small bridge to facilitate passage under Route 116, re-routing and re-constructing a stream channel through the impoundment and through the wooded area south of the adjacent 7-Eleven in order to daylight the portion of the stream currently buried under the 7-Eleven parking area; or 2) removing the outlet control structure which maintains the depth of the Titus Pond impoundment to drain the impoundment during normal conditions, restore the impounded area to wetland, and utilize the existing outlet pipe to convey the stream under Route 116 and the 7-Eleven.

Working concept graphic—Titus Pond Restoration Area

Project Goals

The Town's primary goals for the project are to:

1. **Eliminate the jurisdictional status and hazard threat associated with Queensville Dam by reducing the impounded area below jurisdictional thresholds**
2. **Address water quality issues in the existing impoundment**
3. **Create an improved Conservation Area with benefit to local residents, including the adjacent school, which is utilizing the area as a living laboratory, as well as adjacent neighborhood residents**
4. **Facilitate management of stormwater in the restored impoundment through the use of nature-based solutions (e.g., wetland step pools) and thereby reduce downstream flooding risk and erosion problems along Buttery Brook**

The small bridge option was ultimately found to be infeasible due to a number of factors, but most notably the fact that site topography (driven by fill to build Route 116 and surrounding development) would not allow for daylighting of the stream without substantial retaining walls, which would in turn channelize the stream and negate the potential ecological value of daylighting. The preferred alternative presented here is therefore to remove the existing outlet control structure while maintaining the existing culvert underneath 116 and restoring the impoundment to a series of natural wetland habitats.

Along with the preferred concept for restoration of the Titus Pond impoundment, the overall suite of conceptual improvements identified through the FY22 study includes a right-sized stream crossing at Mountain Avenue to provide better capacity for storm flows both now and under future precipitation conditions, address structural deficiencies, and meet the Massachusetts Stream Crossing Standards. Additional improvements north of the inlet to the buried stream section at Joffre Avenue will reduce nuisance flooding and further promote infiltration of stormwater by enhancing the existing wetlands.

This project is important for South Hadley right now for a variety of reasons. First, there is a legitimate need to address the structural condition of the dam, either through repair or removal in order to prevent the failure of a significant hazard dam which could have serious consequences. According to the 2018 Phase 1 Dam Inspection Report for Queensville Dam, either repair or removal of the dam is necessary to avoid a dam failure that would cause significant property damage to State Highway 116 and a 7-Eleven convenience store, both of which are located on the embankment. A gas line and other utilities in the right-of-way would also be expected to incur significant damage. Further downstream, there is potential for loss of life and property due to the presence of residential buildings and public streets. Similarly, the MVP plan identified as high priority the need to conduct education and outreach to residents living in flood-prone areas, and to specifically engage the community in exploration of stormwater management approaches for Titus Pond that consider the Town's future land use plans. Finally, the area around Titus Pond and Route 116/Newton Street is the focus of a MassWorks project titled "Newton Street Smart Growth District Improvements" which will be enacting a program of sidewalk, roadway, bikeway, utility, and pedestrian safety improvements as well as developing a new Senior Center and redeveloping the Woodlawn Plaza into affordable housing. Collectively, this Smart Growth initiative is expected to bring substantially increased foot traffic to the area, making this the ideal time and location to highlight resilience improvements at the Titus Pond Conservation Area and capitalize on public interest in the larger project to achieve focused public engagement around climate resilience in this part of the Town. The project will also incorporate additional engagement to continue developing community conversations around stormwater management and water quality, including a partnership with the local schools to build understanding about the connections between watershed health and climate resilience and engage students in ongoing observation of the positive ecosystem changes that are possible in their own community.

Climate Change Connections and Considerations

Current climate science and data regarding temperature and precipitation rates for the Connecticut River Basin from the Northeast Climate Adaptation Center at UMASS, predict that in the next ten years, South Hadley could experience up to five more inches of annual precipitation, with much of that increase concentrated during more extreme precipitation events, and over eight more inches in the next seventy years. Even more alarming is the projected rise in the number of days above 90 degrees F - up to over 19 days in the next 10 years to up to 76 more days in 70 years. This data coupled with a decrease of 28 to 60 more days below freezing tells us that our transportation system is in big trouble. Localized flooding occurs several times per year at a number of road-stream crossings and stormwater infrastructure in many places offers no pretreatment prior to channelized discharge to the closest wetland or waterway, impairing the function and value of critical natural systems for both flood management and habitat.

Our proposed project seeks to incorporate improvements in the upper portion of the Buttery Brook watershed to provide enhanced stormwater management at Titus Pond Recreation Area, utilizing nature-based approaches to manage and infiltrate stormwater close to where it falls, thereby decreasing the risks of flooding in adjacent neighborhoods, reducing impacts to vulnerable neighborhoods downstream along Buttery Brook, and creating new and improved recreational and public amenities in the Town's Smart Growth District, within easy walking distance of the new Senior Center and coming affordable housing developments.

Feasibility Analyses: Existing Conditions

As a first step when considering dam removal or major modifications to an existing dam, a number of basic evaluations must be conducted to understand the existing conditions which will ultimately frame the permitting and engineering context for a future implementation project. Key elements of these feasibility analyses are presented here for wetlands, hydrology and hydraulics, and sediment management.

Wetlands

The project areas examined in this study are located within the local drainage basin of Buttery Brook, which flows through South Hadley Falls to join the Connecticut River approximately 1.4 stream miles further downstream. This project focused on Titus Pond and the reach of Buttery Brook extending approximately 1,800 feet downstream beyond the pond's outlet. Along this reach the brook flows in an established channel that is contained within most of the project area by low-lying forested or scrub-shrub wetlands. Occasionally, secondary (i.e., overflow) channels within an adjacent area of bordering vegetated wetlands were observed.

As part of the feasibility investigations, a full wetland delineation was performed to identify and map resource areas that are subject to jurisdiction under federal, state, and local wetlands permitting regulations.

In addition to the field delineation of resource areas, an inspection of Titus Pond, Buttery Brook and the surrounding habitats was conducted. Titus Pond is an impoundment of approximately 1.5 acres that was created by the construction of Queensville Dam, over which Newton Street (MA-116) passes. Titus Pond is relatively shallow around its perimeter and, based on a separate bathymetric inspection, is approximately 7 feet deep at its center. The pond is frequently impaired by significant algal blooms during the summer months. Wildlife observed in and around the pond includes: raccoon/*Procyon* lotor (tracks), woodland vole/*Microtus pennsylvanicus*, green frogs/*Lithobates clamitans*, American toad/*Anaxyrus amaericanus*, Canada geese/*Branta canadensis*, mallard ducks/*Anas platyrhynchos*, birds common to backyards and riparian areas, and an unknown fish species. Banks of the pond are well-vegetated, though most of the adjacent uplands consist of pavement, structures, or turfgrass.

Downstream of Titus Pond, Buttery Brook is mapped as an intermittent watercourse that flows in a south-southwesterly direction through the project area. Bankfull width of the brook ranges from 7 to 16 feet with moderately to steeply sloping banks. The banks of Buttery Brook are mostly well vegetated, and some undercutting was observed. While undercutting of the banks appears to be normal, a few locations of active erosion and bank/slope instability were observed in the project area. Composition of the brook substrate is primarily sand and silt with a minor fraction of gravel in areas where erosion/undercutting is proximate. Flow in Buttery Brook is moderate to slow with few grade-control structures or corresponding riffle-pool habitats. Buttery Brook is not mapped as a cold-water fishery by the Department of Fish and Wildlife; culverts in the project area are either perched, clogged, collapsing, or having such a steep gradient as to make aquatic passage impossible or very unlikely. Through most of the project area, the brook is bordered by freshwater forested and scrub-shrub wetlands. Wildlife observed near the brook includes: racoon (tracks observed), beaver/*Castor canadensis* (chewed stumps/branches and dam observed south of Joffre

Avenue), opossum/*Didelphis virginianus* (tracks), green frogs, and birds common to backyards and riparian areas.

The land use surrounding this reach of the brook is primarily developed for residential and commercial uses, and it is presumed that much of the local stormwater drainage from these built-up areas is discharged into Buttery Brook. Stormwater outfalls are visible at road crossings and south of Berwyn Street. Downstream of the segment of the brook that is culverted under Joffre Avenue (650± feet in length), a beaver dam was found that moderately impedes flow and has led to sediment accumulation at the outlet – and possibly within the culvert (the culvert was mostly submerged at the time of the inspection). The beaver dam, located approximately 200 feet downstream of the culvert's outlet, has an established spillway where the main channel for Buttery Brook re-forms.

In May 2022, the Town, Fuss & O'Neill, and a group of junior/senior level students from South Hadley High School installed water level loggers and pH/temperature loggers in Titus Pond and the upstream reach of stream that enters Titus Pond from the east. The students will be collecting data to monitor water quality conditions in the system under its existing configuration. These data will ultimately provide a baseline for comparison of post-restoration conditions to measure the impact of restoration interventions.

Students from South Hadley High School install water level and pH loggers in Titus Pond with the help of Fuss & O'Neill staff, May 2022

Sediment Management

When water is impounded behind a dam, decreased velocity causes sediment to drop out of the water column and accumulate within the impoundment. Whenever dam removal is considered, it is important to understand the quantity of accumulated sediment, how it will redistribute if the dam is removed or reconfigured, and whether the sediment contains any contaminants or hazardous materials that will need to be managed in order to prevent their mobilization during redistribution.

A field investigation of the pond sediment in Titus Pond was conducted on October 12, 2021, during which the sediment was measured, sampled, and observed within the context of the site. A transect location (Transect #1) through the center of Titus Pond was selected to provide a representative assessment of sediment quality as sediment in the pond could become mobilized as a result of increased flow velocity following dam removal. Three sediment borings (i.e. north, south, and center) were taken along the transect using a slide hammer method. Generally, the sediment cores were advanced through the presumed ponded sediment until the native substrate was identified based on material resistance. Field personnel logged sediment conditions, including recovery amount, texture, moisture content, color, odors, and observations of anthropogenic material. Samples at one foot intervals were field-screened for total organic vapors (TOV) using a photoionization detector (PID).

The three cores of recovered pond sediment were composited into one sample for analytical testing by Pace Analytical Laboratory (Pace) in East Longmeadow, Massachusetts, and Thielsch Engineering in Braintree, Massachusetts, for the following parameters:

- Extractable petroleum hydrocarbons (EPHs) with Target Polycyclic Aromatic Hydrocarbons (PAHs)
- Total metals (Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, and Zinc)
- Polychlorinated biphenyls (PCBs)
- Herbicides and pesticides
- Volatile organic compounds (VOCs)
- Polycyclic aromatic hydrocarbons (PAHs)
- Total organic carbon (TOC)
- Toxicity Characteristic Leaching Procedure (TCLP) for lead

Sediment core sampling process, October 2021

The general subsurface conditions as observed in the borings included organic silt which was observed to be underlain by a native horizon consisting of sandy silt and/or fine sands. The borings observed at Transect #1, located in the central portion of Titus Pond, consisted of a shallow horizon of sediment of approximately a foot in thickness. All TOV readings were below the instrument detection limit (0.1 ppmv). No visible sheen or petroleum odor were observed at the transect location, however, the water surface was covered with green algae at the time of investigation.

Results of the analytical testing were compared to the MassDEP Maximum Allowable Contaminant Levels (MACLs) for Sediment Reuse at Lined Landfills (*Comm 94-007)* and the "Consensus-Based Probability Effect Concentration" (PEC). While not a regulatory criteria, the PEC are "intended to identify contaminant concentrations above which harmful effects on sediment-dwelling organisms were expected to occur frequently"[1]. All analytical data was below applicable PECs and MACLs.

Based upon these results, it is expected that any sediment that needs to be dredged and/or excavated as part of a restoration project could be reused as fill material in an upland portion of the site if it is suitable for restoration purposes. With the approval of permitting agencies, non-hazardous sediments can also often be allowed to redistribute naturally downstream. These alternatives greatly reduce any costs associated with transportation or disposal of the sediment and reduces the overall complexity of the dam removal process. Sediments could also be disposed of off-site, though additional analysis would likely be required by regulators prior to offsite transportation and disposal.

[1] MacDonald et al., *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*, 2000.

Hydrology and Hydraulic Analysis

The water level of Titus Pond is controlled by the outlet control structure of Queensville Dam-- a rectangular concrete box, approximately 5' wide x 5' long x 13' high. There is a 3'x 3' grated square inlet located at the normal pool of the pond that allows water to enter the outlet structure. At the bottom of the structure, approximately 8' down from the inlet there is a 24" reinforced concrete pipe (RCP) that runs from Titus Pond under Newton Street for approximately 210 feet. The culvert runs under commercial property (the 7-Eleven) and daylights into Buttery Brook southwest of Newton Street.

Further downstream, Buttery Brook crosses Mountain Avenue through a 24" corrugated metal pipe (CMP), measuring approximately 104 feet in length. The crossing was assessed as unable to safely pass the current 10-year storm due to its insufficient hydraulic capacity. The crossing also suffers from poor alignment causing erosion problems along the bank and allowing material to pile up at the inlet, causing blockages. Upon exiting Mountain Avenue, Buttery Brook continues approximately 315 feet through residential backyards. North of Joffre Avenue, the brook enters a storm sewer of unknown size for roughly 650 feet under several residential properties before daylighting south of Joffre Avenue. While the conditions of the buried pipe are unknown, residents report frequent flooding in the area and the headwall of the Joffre Avenue inlet may have collapsed. A standpipe at the inlet has been set as an emergency measure to maintain flows into the culvert.

A hydrologic model for Buttery Brook was developed using the U.S Army Corps of Engineers HEC-HMS version 4.8 software. The Soil Conservation Service (SCS) Curve Number (CN) methodology was used to represent the hydrologic losses for each sub-watershed. The Snyder Unit Hydrograph method was used to simulate the excess rainfall-runoff response of the watershed. Unit hydrographs for the 1-, 2-, 5-, 10-, 25-, 50-, and 100-year storm events were determined using HEC-HMS. The meteorological model in HEC-HMS was set up for a hypothetical storm using an SCS Type 3 distribution. Precipitation depth values were obtained from NOAA Atlas 14 for the 24-hour storm events and are shown at right. Both present and future climatic conditions were considered in this analysis. The crossing was classified as Tier 2 based on the RMAT Climate Resilience Design Standards Tool. Per Tier 2 RMAT methodology, present baseline precipitation depths from NOAA Atlas 14 were scaled by 27% for the 100-year design storm and 20% for more frequent design storms.

To analyze the impacts of the existing and proposed stream crossings at Newton Street, Mountain Avenue, and Joffre Avenue, a one-dimensional (1D) HEC-RAS model (version 6.1) was developed, and the peak unit hydrographs from the hydrologic analysis were input into the HEC-RAS hydraulic model. The HEC-RAS model was built using data from a January 2022 survey which includes twelve cross sections with detailed channel geometry, culvert inlet and outlet invert elevations for the Titus Pond impoundment and Mountain Avenue crossing, and detailed road survey data. Detailed cross sections for the 1D model were developed using survey data for main channel geometry and LiDAR data for overbank geometry. The LiDAR data set used was a 1-meter LiDAR based Digital Elevation Model (DEM) downloaded from NOAA Coastal Data Viewer (2015 USGS Lidar: Maine & Massachusetts QL1 & QL2). Manning's n values for the main channel and overbank areas were determined through site photographs. The model begins at the upstream end of Titus Pond and terminates approximately 270 feet downstream of the outlet of the conveyance pipe under Joffre Avenue. The alternatives considered are described and discussed below. Details of the hydraulic analysis for each alternative are presented in the separate Hydrologic and Hydraulic Report dated April 7, 2022.

NOAA Atlas 14 Precipitation Depths for Present and Late Century

24-Hour Design Storm	Present Baseline Precipitation Depth (in)	Late Century (2070/2090) Precipitation Depth (in)
1-year	2.46	2.95
10-year	4.98	5.98
25-year	6.17	7.40
50-year	7.03	8.44
100-year	7.99	10.15

Analysis of Alternatives

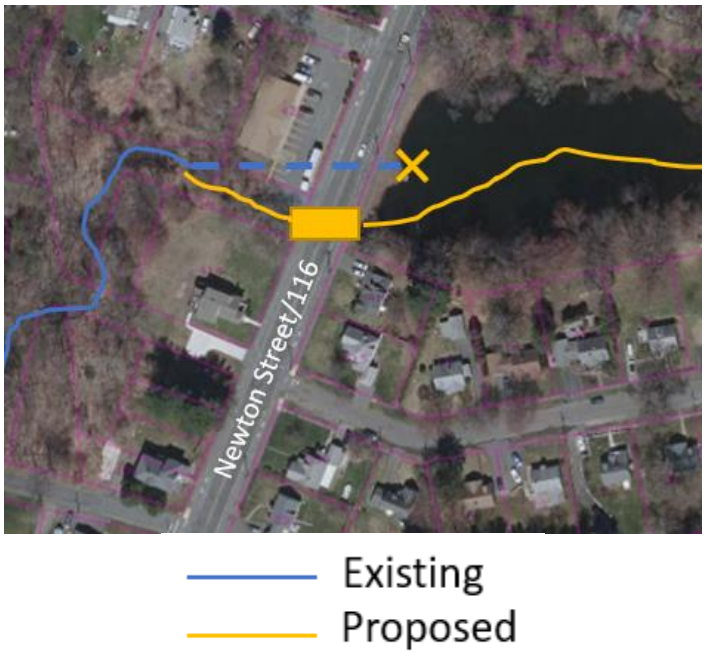
Titus Pond/ Queensville Dam

Three design alternatives were developed to evaluate the feasibility of removing the dam. In addition to the three design alternatives at the dam location, the road crossing at Mountain Avenue was assessed as well as the feasibility of daylighting the conveyance pipe under Joffre Avenue. Based on the level of criticality and an expected useful life of more than 50 years, it was determined that the proposed road crossings should be sized based on the Tier 2 RMAT rainfall recommendations. The 50-year storm was used for the design storm plus a 20% magnification for additional capacity to accommodate predicted climatic condition peak flows.

The situation at Queensville Dam does not lend itself to a 'classic' dam removal because Route 116 is located on the dam embankment and cannot be relocated. The study therefore looked at two primary options with respect to dam removal: 1) open up the dam embankment, replacing the existing dam outlet structure with a small bridge to facilitate passage under Route 116, re-routing and re-constructing a stream channel through the impoundment and through the wooded area south of the adjacent 7-Eleven in order to daylight the portion of the stream currently buried under the 7-Eleven parking area; or 2) removing the outlet control structure which maintains the depth of the Titus Pond impoundment to drain the impoundment during normal conditions, restore the impounded area to wetland, and utilize the existing outlet pipe to convey the stream under Route 116 and the 7-Eleven.

Under the first option, a 14-foot span x 5-foot high box culvert would be required to meet the Massachusetts Stream Crossing Standards and provide sufficient conveyance capacity for the 50-year storm event under future climate conditions. This alternative would also require the construction of a 10-foot high retaining wall on the downstream side of the box culvert where the channel would abut a 7-Eleven parking lot as well as purchasing property or easements from two separate landowners.

Two variations were explored for the second option—both of which center around removing the concrete outlet control structure and retaining the existing 24" RCP under Newton Street. These options would both permit water to enter the culvert at lower flood stages,



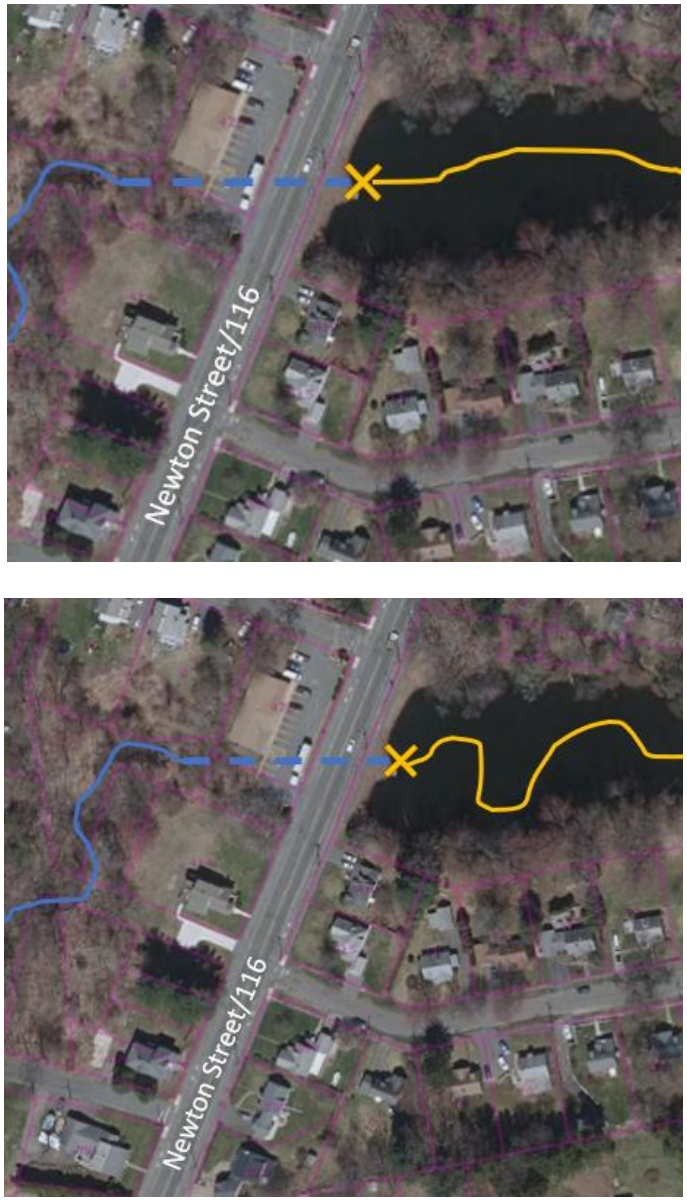
Dam Removal Concept Option 1: Replace dam outlet with small bridge to convey Buttery Brook under Route 116

allowing Titus Pond to drain. Under one version of this option, the channel would be allowed to reestablish naturally over time. Newton Street would still experience overtopping during the 50- and 100-year storm events, but the storage volume within Titus Pond would be less than 15 acre-ft, which would remove the jurisdictional status of Queensville Dam as a regulated dam under Office of Dam Safety regulation.

The third alternative includes active restoration of Buttery Brook through Titus Pond to a more defined meandering channel, which would increase floodwater and/or stormwater attenuation. The Titus Pond area would be graded with step-pool structures, meanders and riffles, native wetland vegetation would be planted, and green stormwater management techniques would be installed for runoff entering the area. Like Alternative 2, Newton Street would still experience overtopping during the 50- and 100-year storm events, but the dam classification could be removed as it would be less than 15 ac-ft of storage volume.

The first option was found to be infeasible due to a number of factors, but most notably the fact that site topography (driven by fill to build Route 116 and surrounding development) would not allow for daylighting of the stream without substantial retaining walls, which would in turn channelize the stream and negate the potential ecological value of daylighting.

The third alternative was found to best meet the project goals. An initial concept design and profiles were developed to demonstrate how a restored Titus Pond might appear (see following pages).



Dam Removal Concept Option 2: Remove concrete outlet control structure and reuse existing 24" culvert under Route 116 (2 variations shown)

TITUS POND RESTORATION
CONCEPTUAL DESIGN AND PROFILES

FUSS & O'NEILL

PLACE Alliance NORTHEAST
Landscape Architecture, Urban and Ecological Design

PLAN LEGEND

1. NEW OUTLET CONFIGURATION
2. RESTORED LOW FLOW BUTTERY BROOK STREAM CHANNEL
3. EXISTING LOW FLOW BUTTERY BROOK STREAM CHANNEL
4. CREATED MARSH WETLAND COMPLEX
5. CREATED SCRUB/SHRUB WETLAND COMPLEX
6. CREATED FORESTED WETLAND COMPLEX
7. TRAIL HEAD OVERLOOK BOARDWALK CONNECTION TO SIDEWALK AT ROUTE 116
8. BOARDWALK OVERLOOK WITH SEATING AND EDUCATIONAL SIGNAGE
9. BOARDWALK STREAM CROSSING
10. QUEEN CIRCLE TRAIL HEAD
11. NATURAL SURFACE LOOP TRAIL EXTENSION
12. IN STREAM GRADE CONTROL STRUCTURES CONSTRUCTED WITH NATURAL MATERIALS - SUCH AS, NATIVE ROUNDED BOULDERS, LOGS, ROOTWADS, ETC.)
13. EXISTING RESIDENTIAL STRUCTURES

0 20 40 80

TITUS POND RESTORATION

WEST-FACING SECTION, LOW-WATER CONDITION

FUSS & O'NEILL

PLACE Alliance NORTHEAST
Landscape Architecture, Urban and Ecological Design

SECTION 1

REFORESTED UPLAND ZONE

PONDED AREA DURING LARGE STORM EVENT

CREATED MARSH WETLAND

MULTI-USE BOARDWALK

BERMED WETLAND BUFFER ZONE

BUTTERY BROOK STREAM PROFILE

ENHANCED MID BANK PLANTINGS

WETLAND PLANTING AREA

PONDED AREA DURING LARGE STORM EVENT

MULTI-USE BOARDWALK

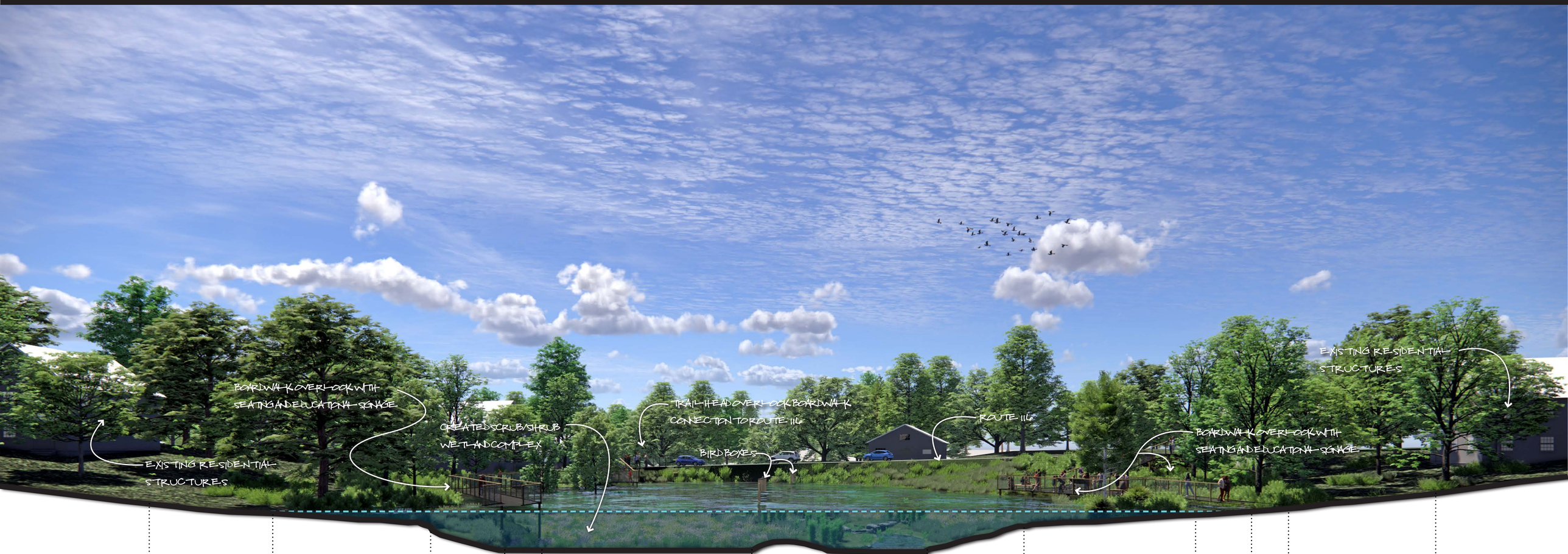
REFORESTED UPLAND ZONE

TITUS POND RESTORATION

WEST-FACING SECTION, DURING LARGE STORM EVENT

FUSS & O'NEILL

PLACE Alliance NORTHEAST
Landscape Architecture, Urban and Ecological Design



SECTION 1

REFORESTED UPLAND ZONE

PONDED AREA DURING LARGE STORM EVENT

CREATED MARSH WETLAND

MULTI-USE BOARDWALK

BERMED WETLAND BUFFER ZONE

BUTTERY BROOK STREAM PROFILE

ENHANCED MID BANK PLANTINGS

WETLAND PLANTING AREA

PONDED AREA DURING LARGE STORM EVENT

MULTI-USE BOARDWALK

REFORESTED UPLAND ZONE

TITUS POND RESTORATION

EAST-FACING SECTION, LOW-WATER CONDITION

FUSS & O'NEILL

PLACE Alliance NORTHEAST
Landscape Architecture, Urban and Ecological Design

SECTION 2

REFORESTED UPLAND ZONE
MULTI-USE BOARDWALK
PONDED AREA DURING LARGE STORM EVENT
ENHANCED MID BANK PLANTINGS
BUTTERY BROOK STREAM PROFILE
BERMED WETLAND BUFFER ZONE
WETLAND PLANTING AREA
MULTI-USE BOARDWALK
PONDED AREA DURING LARGE STORM EVENT
REFORESTED UPLAND ZONE

TITUS POND RESTORATION

EAST-FACING SECTION, DURING LARGE STORM EVENT

FUSS & O'NEILL

PLACE Alliance NORTHEAST
Landscape Architecture, Urban and Ecological Design

SECTION 2

REFORESTED UPLAND ZONE

MULTI-USE BOARDWALK

PONDED AREA DURING LARGE STORM EVENT

ENHANCED MID BANK PLANTINGS

BUTTERY BROOK STREAM PROFILE

BERMED WETLAND BUFFER ZONE

WETLAND PLANTING AREA

MULTI-USE BOARDWALK

PONDED AREA DURING LARGE STORM EVENT

REFORESTED UPLAND ZONE

TITUS POND RESTORATION

BIRDSEYE VIEW FACING SOUTHEAST, LOW-WATER CONDITION

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TITUS POND RESTORATION

BIRDSEYE VIEW FACING SOUTHEAST, POOLED WETLAND CONDITION

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PLACE Alliance NORTHEAST
Landscape Architecture, Urban and Ecological Design

TITUS POND RESTORATION

BIRDSEYE VIEW FACING SOUTHEAST, DURING LARGE STORM EVENT

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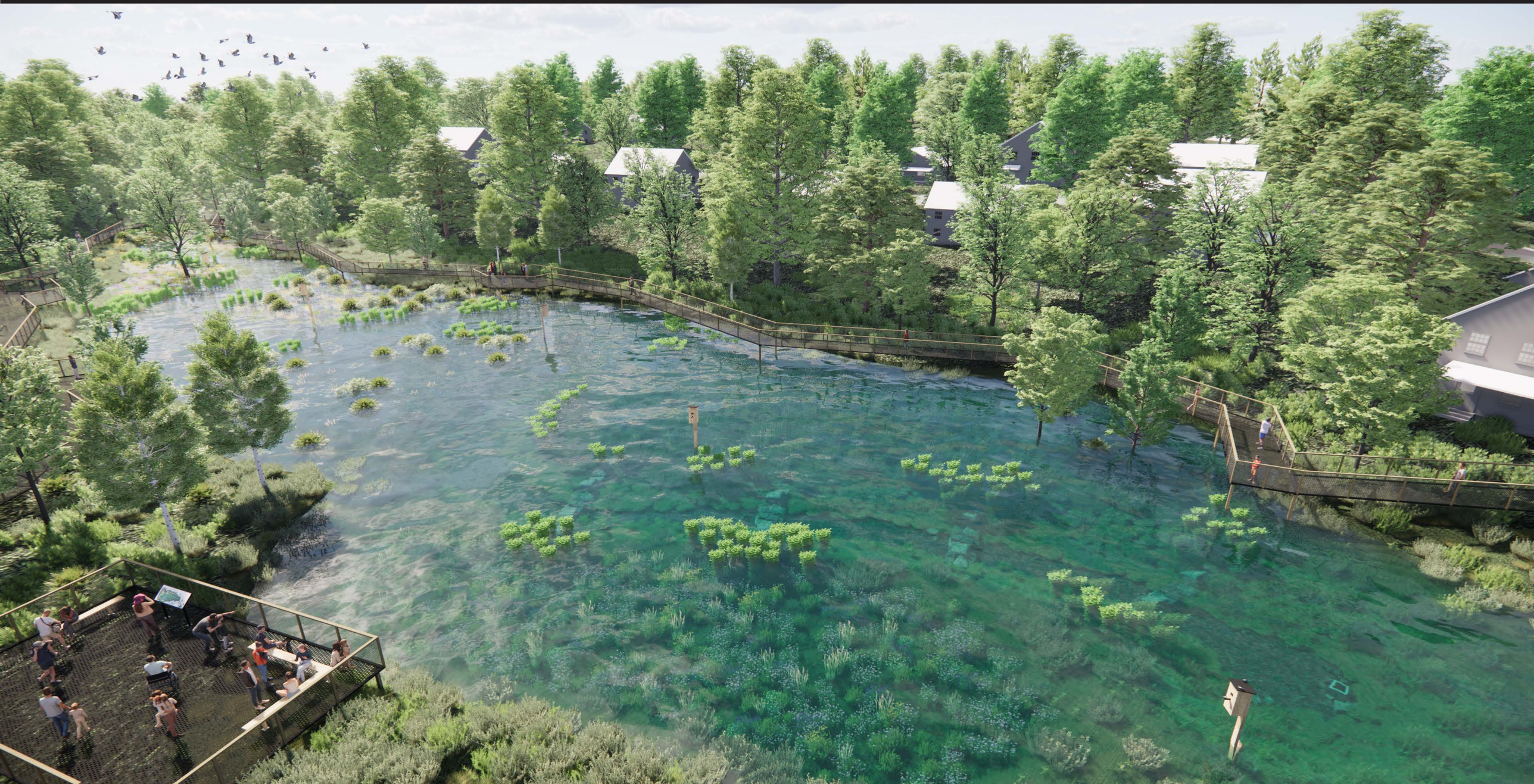
PLACE Alliance NORTHEAST
Landscape Architecture, Urban and Ecological Design



Downstream Improvements

The downstream road-stream crossings along Buttery Brook were first assessed through the Town's FY21 MVP Action Grant, and several of them were identified as high priority for redesign and replacement. This project further examined the viability of replacing and upgrading the two crossings at Mountain Avenue and Joffre Avenue. It was determined that replacing the Mountain Avenue stream crossing would be a viable and beneficial improvement. Daylighting of the buried stream section at Joffre Avenue was also considered but was found to be infeasible due to the proximity of adjacent residential structures along the buried stream alignment. In lieu of daylighting, it was determined that the next phase of the project should focus on improvements to the existing structure to improve stormwater handling, reduce flooding, and/or improve the ability to manage stormwater via enhancement of the existing wetland resource areas.

The Mountain Avenue crossing is proposed to be replaced to meet the requirements of the Massachusetts Stream Crossing Standards. The existing 24 inch corrugated metal pipe will be replaced with a 14-foot span x 5-foot rise three-sided frame with an open bottom that will be realigned to better match existing stream geometry. At present, the channel bends approximately 90 degrees to the west before flowing south under Mountain Avenue. The proposed design will realign the channel to reduce erosion and restore the natural stream function.

After reviewing parcel maps and easements, it was determined that it is not feasible to daylight the conveyance pipe under Joffre Avenue. The pipe runs under several constructed residential properties as well as across undeveloped private land which would need to be purchased to daylight Buttery Brook along this stretch. Due to the length of the buried pipe, meeting the openness ratio required by the Massachusetts Stream Crossing Standards would require a very wide and/or tall structure, which is not feasible in the already constrained space. Even construction of an in-kind replacement pipe in this location would likely be extremely disruptive to the adjacent structures and residential land use because of the proximity of built-up uses and the presumed depth of the existing culvert. Instead of removal and construction of a new structure, the Town will conduct closed circuit television investigation of the conveyance pipe to determine its condition and recommendations will be made to improve the culvert inlet and alleviate ongoing concerns around clogging and backups.

The proposed suite of improvements to Buttery Brook is presented on the next page and includes:

- Removal of the existing outlet control structure to Queensville Dam and associated draining of the impoundment
- Restoration of the Titus Pond impoundment
    - Creation of a meandering, low-flow channel
    - Grade controls and scour protection made from natural materials, including boulder or log vanes, rootwads, etc.
    - Native plantings to create a graduated series of wetland habitats, from emergent marsh to scrub shrub wetland to forested wetland
    - Inclusion of walking paths for public access, enjoyment, and educational use
- Replacement of the Mountain Avenue culvert with a 14 foot x 5 foot open bottom box culvert
- Realignment of the Mountain Avenue crossing with the stream channel to alleviate geomorphic risk factors associated with the current configuration
- CCTV investigation of Joffre Avenue culvert/buried section
- Replacement and/or upgrade of the Joffre Avenue inlet structure with improved headwall

BUTTERY BROOK RESTORATION

PROJECT MASTERPLAN AND PROPOSED ENHANCEMENTS DIAGRAM

FUSS & O'NEILL

PLACE Alliance NORTHEAST
Landscape Architecture, Urban and Ecological Design

PLAN LEGEND

1. RESTORED CHANNEL AND WETLANDS THROUGH TITUS POND IMPOUNDMENT
2. PEDESTRIAN CONNECTION FROM RTE. 116 AND ENHANCED TRAIL NETWORK
3. REMOVAL OF EXISTING OUTLET CONTROL STRUCTURE WITH INLET IMPROVEMENTS
4. WETLAND/RIPARIAN BUFFER ENHANCEMENT
5. PROPOSED CULVERT (14'X5') AND CHANNEL REALIGNMENT
6. WETLAND ENHANCEMENT AT JOFFRE AVENUE INLET
7. PROPOSED INLET IMPROVEMENTS

PLAN KEY

- PROJECT AREA/PROJECT LIMITS
- EXISTING STREAM CHANNEL
- RESTORED STREAM CHANNEL
- CHANNEL REALIGNMENT WITH RIGHT-SIZED CULVERT
- EXISTING CULVERT ALIGNMENT WITH INLET IMPROVEMENTS

0 40 80 160

Ecological Benefits

This project will not be a traditional dam removal, in that it will not remove a barrier to aquatic passage or fully restore natural hydrology. This is simply not feasible within the highly developed urban environment that surrounds Buttery Brook. Instead, Titus Pond represents an opportunity to mimic natural processes within the confines of the urbanized and highly impacted system and demonstrate the benefits of nature-based approaches even in the midst of intense development and built-up land use. The modifications proposed and the declassification of the Queensville Dam will allow for restoration of the headwaters of Buttery Brook to a natural wetland ecosystem, which will provide additional flood dampening and stormwater infiltration where the impoundment currently exists. Elimination of the impoundment and restoration to wetlands would also eliminate the warming effect that accompanies impounded water, providing for a cooler, healthier, better oxygenated stream and removing the risks to ecosystem and public health associated with the warm, stagnant water which currently characterizes the Titus Pond impoundment. The new wetland ecosystem will be a valuable recreational and educational resource for the community to learn about climate resiliency.

Right-sizing and increasing daylight through the Mountain Avenue culvert will remove barriers to aquatic and terrestrial passage and increase habitat connectivity, while also increasing the capacity of the structure to safely pass storm flows during large precipitation events and reduce the risk of the structure becoming clogged by debris or other material moving downstream. Re-alignment of the crossing to better match the stream channel path will also help to eliminate geomorphic risks due to the existing sharp bend at the culvert inlet and will simultaneously pull the culvert further from the adjacent residence, helping to protect private property from flood impacts.

Community Benefits

This project focuses on improving the Buttery Brook watershed, South Hadley's most heavily developed and most populated watershed, beginning at its headwaters. The project site is located just south of the Town's proposed Newton Street-Lyman Street Smart Growth District which is undergoing a program of sidewalk, roadway, bikeway, utility, and pedestrian safety improvements as part of an ongoing MassWorks grant. The site is 0.25 miles from the new South Hadley Senior Center and 0.1 miles from the proposed affordable housing complex being developed within the former Woodlawn Plaza. Restoration of the Titus Pond impoundment will not only help to reduce downstream flooding by improving stormwater management at the headwaters, but will also provide an improved public space for passive recreation and environmental education that will be easily accessible to climate vulnerable residents, including seniors and residents of the affordable housing complex. By focusing our efforts in and around an existing public conservation area at the Buttery Brook headwaters, we will be providing real benefits and engagement opportunities for the greatest number of people possible. Public input will drive the ultimate design through the focused feedback sessions to ensure that the space is welcoming and accessible for these residents. Representatives of key community groups in the EJ community will be invited to participate in the public design workshop.

Additionally, while the role of restoration of the Titus Pond impoundment in reducing conditions conducive to algal blooms was discussed above as an environmental co-benefit, the benefits of the project for reducing algal blooms extend to public health as well. In particular, the project will alleviate conditions that may ultimately foster cyanobacteria/harmful algal blooms which can be very dangerous for humans and animals. Restoration of the impoundment at Titus Pond to a natural wetland system is also

expected to provide opportunities to increase public utilization of the space (which is within easy walking distance of the Town's Smart Growth District) for additional public access and recreation, with these amenities being designed in collaboration with the community as a deliberate element of the design process. Trees and native plantings at the restored site will also provide additional canopy cover and help to provide a buffer against urban heat island effects.

The restoration site is being designed to incorporate a variety of wetland ecosystems, ranging from wetter/marsh systems to scrub-shrub wetlands, to a forested wetland. This design will have built in curricular value and will serve as an informal learning space for the community, as well as a more formal outdoor laboratory space for the high school.

Buttery Brook flows into the Connecticut River. Improvements to the stream therefore have larger water quality benefits that extend to the larger region's waterways. Both the improvements to water quality which will come from eliminating the impoundment and the upstream stormwater management made possible in and around the restored wetlands at the former impoundment will have water quality benefits for the downstream watershed and help to improve water quality in the Connecticut.

Next Steps

Detailed Design and Permitting

As the project moves forward to detailed design, public input and direction will be critical to shape the final design, particularly with respect to the Titus Pond restoration. Preliminary engagement of neighbors has been conducted to date, but the next project phase will feature more robust engagement and opportunities for the public to help shape the direction of the project, especially the access components. The Town has sought funding for a next MVP Action Grant which includes focused events with target audiences including neighbors to the impoundment, patrons of the Senior Center, and the high school AP science class. Collective input from these user groups will be incorporated along with additional technical and engineering data to refine the concept design.

Detailed design is expected to be oriented around the following key success criteria:

1) The project should ultimately result in reclassification of the Queensville Dam as non-jurisdictional, based on the removal of the impoundment and reduction of total storage space behind the dam embankment (which cannot be removed since it is coincident with the Route 116 road embankment) to below 15 acre-feet during the 100-year event. This will in turn achieve the Town's goal of reducing the liability of dam maintenance and reduce the associated flooding risks that would result from failure of the dam, which is currently classified as a significant hazard dam.

2) The project should alleviate risks associated with the undersized and poor-condition stream crossing at Mountain Avenue by replacing it with a crossing that meets the Massachusetts Stream Crossing Standards and will better protect the adjacent private property as well as the roadway and infrastructure from risk of flooding or damage.

3) The project should improve conditions at the inlet to the Joffre Avenue culvert to prevent future flooding backups due to clogging and reduce ongoing impacts to adjacent properties.

4) The project should result in improved water quality and habitat quality within Titus Pond Conservation Area and make this Town resource both more attractive and safer for South Hadley residents to access.

5) The project should provide for additional stormwater management at the former Titus Pond impoundment, using nature-based solutions and green infrastructure to promote filtration and infiltration of stormwater at the Buttery Brook headwaters, thereby reducing potential flood risks and erosion downstream.

6) The project will result in a design that integrates the above goals with development of a new natural resources education resource and public amenity in the heart of South Hadley's Smart Growth District.

Once the detailed design concept has been refined, additional calculations and modeling will be conducted as a check to quantify flood reduction benefits and confirm that the above goals are met. Water monitoring protocols have also been developed and initiated in collaboration with South Hadley High School students for ongoing

monitoring of the project site from existing conditions through post-restoration. The information gathered through this process will provide data to track water quality improvements and will also provide ongoing data on how stormwater moves through the system before and after restoration, to quantify the real benefits achieved after implementation.

An early coordination meeting with regulatory agencies was held February 24th, 2022 as part of the FY22 Action Grant scope. The meeting was attended by Town staff, the Town's consultant team, and 15 representatives of various state and federal agencies, including: MassDEP (Wetlands and 401 programs), MassDER, MassDCR Office of Dam Safety, MassDOT, MEPA, MVP, and U.S. Army Corps of Engineers. Discussion topics during that meeting included: routes for removing the jurisdictional status of the Queensville Dam, viability of/challenges with introducing a new bridge along Route 116 at Queensville Dam, management of sediment from the Titus Pond impoundment if the impoundment is drained, potential downstream impacts, private property concerns with certain alternatives, and potential permitting pathways and requirements. The discussions during this meeting helped inform the decision about which alternative to ultimately advance to design and permitting. No major hurdles or permitting barriers are anticipated with the preferred alternative. Necessary permitting processes are included in the scope for this phase of the project.

We intend to move forward with designs that enhance resiliency and utilize nature-based approaches, including full compliance with the Massachusetts Stream Crossing Standards for the replacement crossing at Mountain Avenue, and adherence to the Division of Ecological Restoration and Wetlands Protection Act guidance and requirements for ecological restoration projects, including consideration of downstream impacts, improvement on existing conditions, etc. There is no *a priori* reason to expect that this project would not be able to advance through permitting for a successful implementation project in future phases. Additional necessary due diligence information and field data already requested by the regulatory agencies during the early coordination meeting has been incorporated into the project scope and will be submitted with permitting applications.

The following permits are expected to be required:

- MassDEP Wetlands Protection Act Notice of Intent
- U.S. Army Corps of Engineers Pre-Construction Notification
    - Titus Pond Restoration will be filed under the "Aquatic Habitat Restoration, Enhancement, and Establishment Activities" category (General Permit 23)
    - Mountain Avenue culvert replacement will be filed under the "Linear Transportation Projects and Stream Crossings" category (General Permit 10)
    - Addition of a headwall and improvements to the inlet at Joffre Ave. will be filed under the "Maintenance" category (General Permit 1)
- Massachusetts Environmental Policy Act Review
    - Expanded Environmental Notification Form and Rollover EIR is expected under the streamlined ecological restoration project review process.
- MassDOT Chapter 85 Review (for Mountain Ave. culvert replacement)
- Massachusetts Chapter 253 Dam Safety Permit
- 401 Water Quality Certification

Funding and Costs

Order of magnitude cost estimates have been developed based on the initial project concepts. At the conceptual design stage, it is customary that project costs are provided with a -30% to +50% range, with the expectation that if the project scope does not change substantially, the final project cost should fall within this range once more detailed design information is available. Note that for the Titus Pond restoration, the initial estimate is based on preliminary grading information. Once detailed bathymetry data is collected for Titus Pond, grading will be updated, which will ultimately determine the quantity of soil to be excavated and any new wetland soil material which will need to be brought in to complete the restoration, with corresponding impacts to project costs.

To provide the Town the greatest degree of flexibility in bidding and funding the proposed Buttery Brook improvements, the project plans will be developed as two distinct plan sets for the two core elements of the Buttery Brook Watershed Improvements project: 1) Titus Pond Restoration Design and 2) Mountain Ave. Culvert Replacement and Joffre Ave. Inlet Improvements. The pond restoration in particular will require a specialty contractor with expertise in wetland restoration and will best be bid independently from the culvert work. The different project elements are also suited for and may ultimately be supported by different implementation funding sources. Having two distinct sets of plans will best position the Town to pursue these options.

It was initially assumed that future phases of the project would likely be eligible for funding under the EEA Dam and Seawall Grant program; however, the option identified through the feasibility study may not qualify under the Dam and Seawall program since it is not a traditional dam removal project. Unfortunately, due to the highly developed and degraded nature of the watershed, the Division of Ecological Restoration (DER) Culvert Replacement Municipal Assistance grants are not a good fit for the Buttery Brook watershed, as that program preferences more ecologically intact landscapes.

Project Element	Order of Magnitude Cost Estimate	-30% to +50% Cost Range
Titus Pond Restoration	$2.3M	$1.6M to $3.4M
Mountain Avenue Culvert Replacement	$1.7M	$1.2M to $2.6M
Joffre Avenue Inlet Improvements	$400K	$285K to $610K
TOTAL	**$4.4M**	**$3.0M to $6.6M**

Fortunately, however, as climate resilience and nature-based solutions continue to gain traction throughout Massachusetts and the United States, a variety of funding programs have become available or expanded their funding capacity to help facilitate these types of projects. Potential funding sources that may be accessible for the project elements include:

- Municipal Vulnerability Preparedness (MVP) Action Grant Program
  www.mass.gov/service-details/mvp-action-grant

- Division of Ecological Restoration (DER) Project Grants
  www.mass.gov/how-to/become-a-der-priority-project
  www.mass.gov/river-restoration-dam-removal

- Massachusetts Department of Transportation (MassDOT)
  Municipal Small Bridge Program
  www.mass.gov/municipal-small-bridge-program

- FEMA Hazard Mitigation Assistance Grant Programs
  - Building Resilient Infrastructure and Communities (BRIC)
  - Mitigation Grant Program (HMGP)

  www.fema.gov/hazard-mitigation-assistance

- American Rescue Plan Act

- Clean Water Act, Section 319
  Nonpoint Source Implementation Grants
  www.mass.gov/info-details/grants-financial-assistance-watersheds-water-quality

- Chapter 90 Program
  www.mass.gov/chapter-90-program

- MassWorks Infrastructure Program
  www.mass.gov/service-details/massworks-infrastructure-grants

- US Department of Housing and Urban Development (HUD)
  Community Development Block Grants (CDBG)
  www.mass.gov/service-details/community-development-block-grant-cdbg

- Healthy Watersheds Consortium Grant Program - U.S. Endowment for Forestry and Communities, USEPA, USDA NRCS
  www.epa.gov/hwp/healthy-watersheds-consortium-grants-hwcg

- Resilient Communities Program
  www.nfwf.org/resilientcommunities/Pages/home.aspx