



Mayo Mill Dam Feasibility Study Selected Alternative Report Piscataquis River Dover-Foxcroft, ME

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Executive Summary

Introduction

Mayo Mill Dam is located on the Piscataquis River in downtown Dover-Foxcroft, Maine. Mayo Mill Dam powered mills and factories at the site for generations, yet neither the dam nor the impoundment serves the purpose for which they were originally intended. The Piscataquis River is an important resource due to its high historical, recreational, and ecological value. As a tributary to the Penobscot River, the Piscataquis River provides significant potential for recovery of Atlantic salmon and other native sea-run fish in the watershed.

This Selected Alternative Report was adapted from the Mayo Mill Dam Feasibility Study Alternatives Analysis Report (Inter-Fluve 2023c) which detailed the feasibility analysis of several alternatives for Mayo Mill Dam. Atlantic Salmon Federation and the Town of Dover-Foxcroft undertook the alternatives analysis to assemble information to help inform decision-makers regarding the future of the dam and evaluate potential alternatives. This Feasibility Study was prepared under contract to the Atlantic Salmon Federation (ASF) in partnership with the Town, The Nature Conservancy in Maine (TNC), and the National Oceanic and Atmospheric Administration (NOAA Restoration Center). The Study Team includes Inter-Fluve, Alden Labs, Gomez & Sullivan, VHB, and Viewshed to evaluate various project components. A steering committee was formed by the Town to provide local consultation.

Following review of the Alternatives Analysis Report, the Steering Committee selected dam removal (Alternative R1/R2) as the alternative to recommend to the Select Board. Dam removal was judged to best meet the project goals compared to the other alternatives evaluated. This report details the considerations associated with the selected alternative. Detailed analysis of the alternatives considered can be found in the project's Feasibility Study and Alternatives Analysis report (Inter-Fluve 2023c).

Goal and Objectives of the Initiative

The project goal is to resolve the long-term management of the Mayo Mill Dam, while contributing to the revitalization of the historic downtown, bolstering community, economic, and flooding resiliency, and embracing the ecological recovery of the Piscataquis River, with emphasis on endangered Atlantic Salmon. In response to the project goal, several specific objectives were identified. The objectives involve three core themes: reduce the burden of long-term management of the dam; restore river connectivity to benefit fish, wildlife, and ecological processes; and enhance the role that the site and adjoining areas play in the community experience.

Potential Project Constraints

To identify sensitive ecological and cultural resources in the project area, Inter-Fluve reviewed previous consultations and submitted initial inquiries to various state and federal agencies. A federal threatened and endangered species review indicated that there are potentially federal threatened and endangered species in the project area, including Atlantic salmon. The project area is

within the mapped area of two Maine Threatened species of freshwater mussels and two rare plant species have been documented downstream of the dam. The MHPC determined that the project will likely be determined to have an Adverse Effect on the local historic district due to the potential impacts to the existing powerhouse structure.

The regulatory compliance pathways were identified for various general alternatives to provide fish passage. To implement the selected alternative, compliance will generally involve surrendering the FERC exemption, and obtaining necessary federal, state, and local regulatory authorizations. These Federal actions will require formal consultation under Section 7 of the Endangered Species Act, which will set specific conditions and performance requirements.

To evaluate potential physical site constraints related to the selected alternative, features and infrastructure within the resource area, buildings, roadways, homes, and other infrastructure within the regulated 100-year floodway were identified.

Preliminary Design Considerations

Prior to evaluating specific project alternatives, several overarching design considerations were evaluated, including potential for power generation, dam rehabilitation recommendations, flood resilience impacts, fish passage, sediment management, and landscape enhancements, and riparian vegetation restoration.

Power Generation: The Study Team reviewed the potential to restore power generation at the site. The study indicated that the long-term economic viability of a profitable hydropower development is low. This finding is consistent with previous evaluations of the feasibility of redeveloping the site for hydroelectric power generation. A limiting factor is the capital expenditure necessary for the structural rehabilitation at the dam and powerhouse. The baseline conditions evaluation further indicated that the spillway does not meet FERC's current required factors of safety for stability. The spillway would require structural alterations to meet the necessary stability factors of safety if it were to remain under a proposed action.

Flood Resiliency Benefits: The flood hazard evaluation determined that the dam increases the flood hazard along the Piscataquis River, and selected areas of downtown Dover-Foxcroft are vulnerable to flooding as a result. The dam does not attenuate flooding as a run-of-the river dam. However, the dam elevates the water surface level in the river upstream of the dam and during extreme flood events, the banks of the river are likely to overtop, resulting in potential property and public infrastructure damage. Flooding on South Street may pose public safety concerns.

The 100-year flood mitigation benefits were evaluated with several potential permanent pond levels ranging from 2 feet to 8 feet lower than the current pond level. These reduced impoundment levels could be implemented through strategies which retain the dam spillway and install a technical fishway or replace the dam with a nature-like fishway that extends upstream from the dam location. The resilience benefits of these strategies were contrasted with the resilience benefits associated with dam removal.

The results indicated that the 100-year flood resilience benefits of the strategy which retains the dam are marginal. The results indicated that the nature-like fishway strategy may provide meaningful 100-year flood resilience benefits in the downtown area, but more marginal benefits in the vulnerable South Street-Pine Street area. Finally, the results indicated that the dam removal strategy will provide the greatest 100-year flood resilience benefit in the both the downtown and South Street-Pine Street areas. With this strategy, the model results indicate 100-year flood water surface elevations may be reduced to the extent that the buildings in these vulnerable areas would no longer be in zone of inundation.

Fish Passage Strategies: The alternatives analysis identified and evaluated four general potential fish passage restoration approaches for the Mayo Mill Dam, including Technical Fish Passages, Nature-like Fishways, dam removal, and a no-action alternative. Based on the Mayo Mill dam site characteristics, target fish species, and population estimates, the optimal fish passage approach would entail dam removal.

Landscape Enhancement: Conceptual public landscape enhancement designs were developed to support the downtown revitalization objectives. The conceptual enhancement designs were developed considering the potential opportunities for public space creation within the current upland area and within the current impoundment area that is subject to be dewatered under the selected alternative. The landscape enhancement designs were developed within a framework of short-term goals for near-term implementation and long-term goals for potential longer-term transformational strategies. The proposed enhancements in the short-term goals framework include circulation improvements, river access, walking paths, benches, docks, and enhanced vegetation. Potential long term transformational strategies include enhanced public amenities such as pedestrian bridges, a boardwalk, additional open spaces, an amphitheater, and a public parking lot.

Alternative Selection:

Following articulation of the primary project goals and associated objectives and preliminary design considerations, the Steering Committee and the Study Team narrowed a broad range of potential alternatives to a short list of five action alternatives for more detailed study, along with a no action alternative (Table 1).

Table 1. Summary of alternatives identified for detailed study.

ID	Alternative
0	No Action
M1	Retain Spillway and Impoundment, New Vertical Slot Fishway on River Left, FERC Exemption Surrendered
L1	Retain Spillway, Lower Impoundment 5 Feet, New Vertical Slot Fishway on River Left, FERC Exemption Surrendered
N6	Replace Dam with 3% Bank to Bank Nature-Like Fishway, Retain Upstream Impoundment, FERC Exemption Surrendered
N7	Replace Dam with 2% Bank to Bank Nature-Like Fishway, Lower Upstream Impoundment 5 Feet, FERC Exemption Surrendered
R1/R2	Dam Removal, FERC Exemption Surrendered

The five action alternatives were developed schematically and described with reference to a series of key considerations. These considerations included dam modifications, fish passage restoration, flood management and resilience, changes to the impoundment, sediment management, existing features and low-lying infrastructure, landscape enhancement and revitalization, ecological restoration, and operation and maintenance considerations. The alternatives were then evaluated for their relative benefits according to six key criteria that were the dominant considerations that the Steering Committee cited in developing the short list of alternatives for detailed study from the broader range of options. The alternatives are qualitatively contrasted according to these criteria in Table 2. Dam removal, the selected alternative, was judged to best meet the project goals for all of the key criteria evaluated.

Table 2. Qualitative relative benefits of five action alternatives in addressing six key criteria.

Criteria	Dam Removal (R1/R2)	2% Nature-Like Fishway (N7)	3% Nature-Like Fishway (N7)	Vertical Slot Fishway with 5' Lower Pond (L1)	Vertical Slot Fishway with Current Pond (M1)
Fish Passage	Best	Good	Favorable	Moderate	Moderate
Flooding Resiliency	Best	Favorable	Moderate	Limited	Limited
Landscape Amenities	Most Opportunity	Good Opportunity	Moderate Opportunity	Moderate Opportunity	Least Opportunity
Dam & Fish Passage Construction Costs	Lowest	High	Highest	Moderate	Moderate
Grant Funding	Best	Favorable	Moderate	Low	Low
Operation & Maintenance	Least	Low	Moderate	Greatest	Greatest

Conceptual Cost Estimate Analysis:

Opinions of probable construction costs were developed for the selected alternative. Life span costs for each of were also estimated. Dam removal was associated with the lowest construction cost, lowest life cycle cost, and greatest potential for grant funding of all alternatives evaluated. Dam removal projects are most likely to draw support from external funding sources associated with ecological recovery and infrastructure resiliency initiatives. In terms of the landscape enhancement costs, the dam removal alternative has the greatest estimated costs which correlate with the greatest degree of opportunity, although the actual degree of landscape enhancement could be scaled to the level determined to be the best fit for the community. See Section 7 for detailed information.

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1. Introduction

Flowing through downtown Dover-Foxcroft, the Piscataquis River has long been a cultural and economic focal point of the region. The river powered multiple generations of mills and factories at the Mayo Mill Dam site, playing a role in elevating the village as an industrial hub within Piscataquis County since the 19th century. Though the last factory at the site closed in 2007, the river remains an important resource due to its high historical, recreational, and ecological value.

Presently, the Town of Dover-Foxcroft (Town) is considering a range of actions at the Mayo Mill Dam, aligned with its Downtown Revitalization Plan (2003) and Town Comprehensive Plan (2016) objectives. Additionally, time-sensitive compliance requirements related to the regulatory obligations for the dam accentuate the need to develop a plan of action. The site occupies a unique position at the heart of Dover-Foxcroft (Figure 1). The Town would like to resolve the long-term management of this Town-owned infrastructure, while contributing to the revitalization of the historic downtown, and enhancing the community experience through improved public safety, increased access to the river, and enhanced recreational opportunities.

At the same time, the Piscataquis River has great regional ecological value. The Piscataquis is a tributary to the Penobscot River, the largest watershed in Maine with the greatest potential for recovery of Atlantic salmon and other native sea-run fish. The Piscataquis River is a key to recovery in the Penobscot and in Maine, having more viable Atlantic salmon habitat than the other areas of the watershed. Restoration of fish passage at the site is seen as a potential major step in the watershed for the ecological benefits it would provide, a conservation priority shared by the Town.

Based on the above range of factors, the Town and the Atlantic Salmon Federation (ASF), along with The Nature Conservancy in Maine (TNC) and the National Oceanic and Atmospheric Administration (NOAA Restoration Center), partnered in fall 2022 to conduct a feasibility study to examine three core themes: long-term management of the dam; restoration of safe, timely and effective fish passage; and enhancement of the role that the site and adjoining areas play in the community experience.

The feasibility study plan was formalized through a Town-approved agreement with ASF, who in turn contracted Inter-Fluve to lead the technical work. Inter-Fluve assembled a consulting team of subject matter experts (Study Team) to evaluate various project components, whose roles are summarized in Table 3. A six-member Steering Committee (Committee) appointed by the Town provides essential local guidance and review of the feasibility study efforts through monthly meetings and ad hoc consultations.

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Table 3. Study Team Roles and Responsibilities

Firm	Project Role / Responsibility
Inter-Fluve	Lead technical consultant, river science and engineering, river ecology and restoration, project coordination, stakeholder engagement support
Alden Labs	Technical Fish Passage Design
Gomez & Sullivan	Dam safety engineering, hydropower evaluation
VHB	Civil and transportation infrastructure coordination
Viewshed	Landscape Design

This Selected Alternative Report documents the selection of the dam removal alternative by the Steering Committee as the preferred project in late 2023. Three study deliverables precede this report and provide essential context for selected alternative analysis reported herein. The Baseline Conditions Report (Inter-Fluve et al. 2023a) documents the historical and existing conditions context for infrastructure, dam condition, watershed, river flow, ecological, recreational, land use and community planning frameworks. The Preliminary Project Options Summary & Screening Matrix Memorandum (Inter-Fluve et al. 2023b) facilitated an initial screening of potential project options to identify the selected project alternatives to be studied in detail, which are summarized in this report. The Feasibility and Alternatives Analysis report details technical aspects of five dam removal and fish passage alternatives evaluated (Inter-Fluve et al. 2023c).

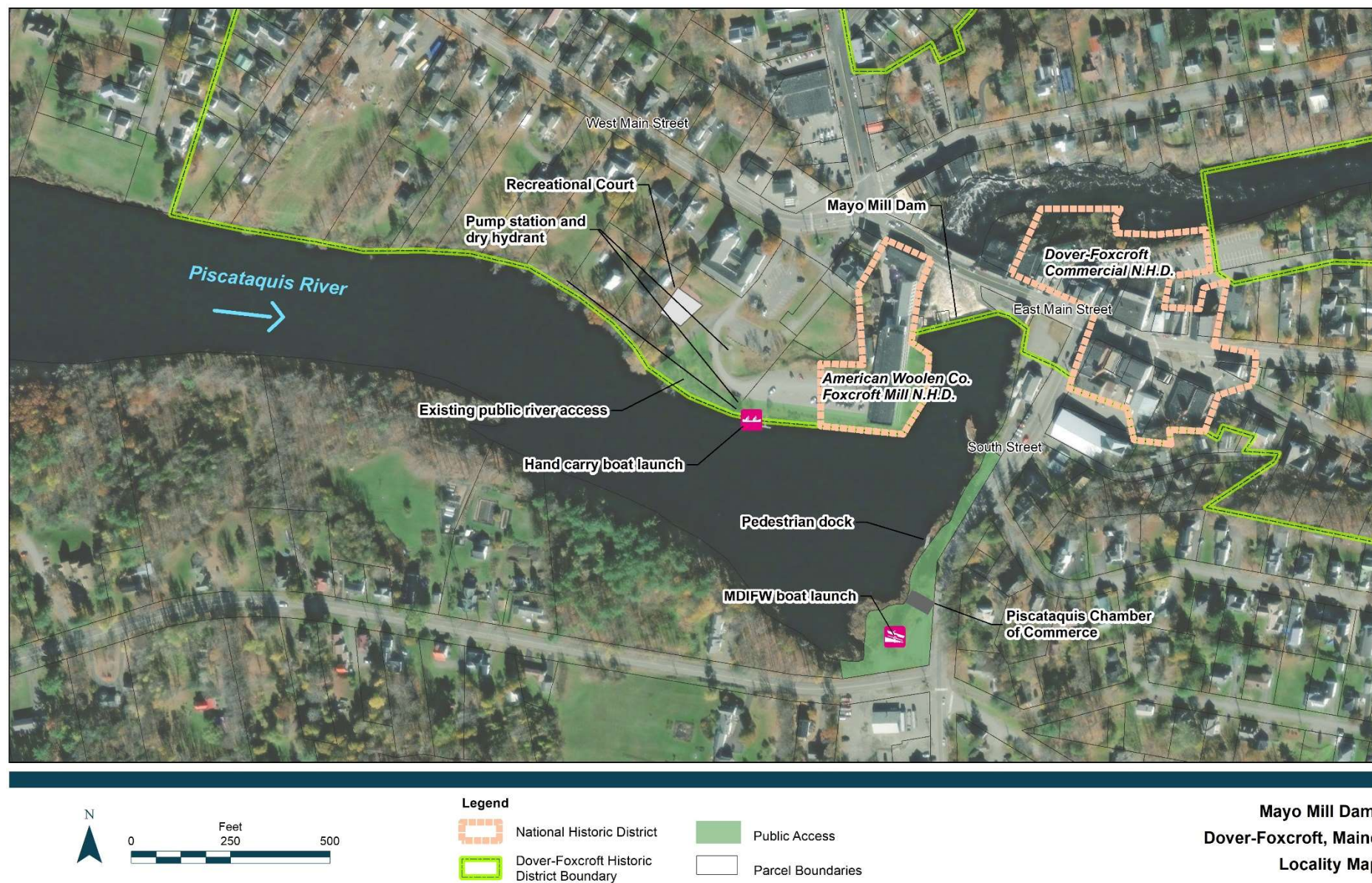


Figure 1. Overview map of Mayo Mill Dam and vicinity.

2. Goals & Objectives

Through collaborative discussions, the Committee established a goal and associated objectives to guide the project initiative. The overarching *Goal* for the effort is the following:

- Resolve the long-term management of the Mayo Mill Dam, while contributing to the revitalization of the historic downtown, bolstering community, economic, and flooding resiliency, and embracing the ecological recovery of the Piscataquis River, with emphasis on endangered Atlantic Salmon.

In response to this goal, specific *Objectives* include the following:

- Resolve outstanding obligations to and compliance requirements for the existing Federal Energy Regulatory Commission Moosehead Manufacturing hydropower generation license exemption (FERC P-5912).
- Limit the Town's financial obligations for management of the dam.
- Limit the Town's operation requirements for management of the dam.
- Reduce flood risk and enhance resilience to climate change.
- Contribute to ongoing downtown revitalization efforts.
- Avoid or mitigate impacts to infrastructure and buildings that exist along the river corridor.
- Restore safe, timely, and effective passage potential for native sea-run and resident fish, with specific emphasis on Atlantic Salmon.
- Restore river connectivity to benefit fish and wildlife, water quality and ecological processes.
- Enhance public access and use of the river corridor by facilitating educational opportunities and interface with other access initiatives.
- Enhance the acknowledgement of the historical role of the river in Town history through research, interpretation and dissemination of knowledge.
- Enhance the community landscape aesthetic through integration of the restored natural river corridor with the surrounding built environment.

3. Potential Constraints

3.1 ENVIRONMENTAL AND HISTORICAL CONSTRAINTS

All of the alternatives considered can impose short-term and long-term impacts on the environment during the construction phase of a project and disrupt species that had adapted to presence of the dam. Any proposed construction project can also have cultural impacts if the dam or impoundment is adjacent to historically significant features. To identify potential environmental and historical constraints, including sensitive ecological and cultural resources in the project area, Inter-Fluve reviewed previous consultations and submitted initial inquiries to various state and federal agencies. The results of the reviews and inquiries are discussed below.

3.1.1 State of Maine

Maine Department of Marine Resources (MDMR)

Based on previous comments in past consultations during FERC amendment proceedings, MDMR indicates that the project area is within State management plans to protect and restore self-sustaining populations of native sea-run fish to their historic habitat. The Piscataquis River is one of the primary tributaries to the Penobscot River, containing important habitat for Atlantic salmon, alewife, blueback herring, American shad, American eel, and sea lamprey. MDMR will be further consulted in subsequent phases regarding coordination of any terms and conditions required in managing habitat and resources for sea-run fish.

Maine Natural Areas Program (MNAP)

MNAP searched its data system and inquired with local experts for documentation of state-listed rare or unique botanical features in the vicinity of the project area. The results of the search indicate that two rare plant species have been documented on the river right ledge downstream of the Dover-Foxcroft Bridge. The species are Garber's Sedge (*Carex garberi*) and Shining Ladies'-tresses (*Spiranthes lucida*). MNAP requests the opportunity to conduct a site visit to update the status of these two state-listed rare plant populations and can provide further comments after such a survey.

Maine Department of Inland Fisheries and Wildlife (MDIFW)

The MDIFW review indicated that yellow lamp mussel and brook floater, two Maine Threatened species of freshwater mussels, may be present in the project area. Both species are covered by the Maine Endangered Species Act. MDIFW will be further consulted in subsequent phases regarding coordination of managing habitat and resources for resident and sea-run fish. Consultation with MDIFW will continue throughout the project.

Maine Historic Preservation Commission (MHPC)

Based on their review of the sites and potential project actions, the MHPC determined that the project will likely be determined to have an Adverse Effect on the Mayo Mill historic district. This would be triggered by the removal of the powerhouse, which was a part of all of the project alternatives evaluated. This structure is listed on the national historic register as contributing to the

American Woolen Company Foxcroft Mill/Mayo & Son Woolen Mill Historical District. The dam has been rebuilt and repaired over the years and is not considered part of the historic district. In their consultation for this study, the MHPC also suggested that the any alternative that would lower the impoundment level would expose land that should be assessed by an archaeological firm.

Depending on the selected proposed projects that emerge from this feasibility study, formal consultation with the MHPC would be initiated through either the FERC surrender process, U.S. Army Corps of Engineers (USACE) permitting process, or other federal action such as use of federal funds for project construction. Because the permitting is at the federal level, any selected project would be reviewed for historic impacts under Section 106 of the National Historic Preservation Act, ultimately leading to development of a memorandum of understanding between the federal action agency (FERC, USACE, NOAA or USFWS) and MHPC.

A range of actions could likely be required, from documentation of potentially affected structures or resources for the Maine Historic Engineering Record, to avoidance and preservation in the extreme case. Based on prior project experience on fish passage restoration projects at historical dams in Maine and elsewhere in New England, these are not considered to be a hard project constraint. However, these considerations should be carefully integrated into ongoing project planning.

MHPC ultimately requested to be kept abreast of project developments pertaining to which alternative will be selected and the specific design elements of that alternative so that they can conduct a complete review. Consultation with MHPC will continue throughout the project.

3.1.2 Federal

USFWS

A federal threatened and endangered species review was conducted using the USFWS “Information for Planning and Consultation” system. The inquiry produced a potentially-present list that included four species: Canada Lynx (*Lynx canadensis*), Monarch Butterfly (*Danaus plexippus*), Northern long-eared bat (*Myotis septentrionalis*), and the Atlantic salmon (*Salmo salar*).

Bald and/or Golden Eagles are known to be in the project area, and are protected by the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Eleven migratory birds protected by the Migratory Birds Treaty Act were also identified as being present in the project area at various times of year. The National Wetlands Inventory indicates that the project area will overlap with Freshwater Forested/Shrub wetlands and Riverine aquatic habitat.

The Monarch Butterfly is a recently-listed candidate species and the typical considerations are not yet provided. The next steps would entail coordination with the USFWS Maine Field Office to determine if the candidate species or suitable habitat is present in the action area, and then develop measures to avoid effects as needed.

Typical considerations for the Bald and/or Golden Eagles are focused on impacts within 660 feet of an active nest during the breeding season which in northern Maine is March 1 – August 30. An

initial review of the ‘Maine - Bald Eagle Nest Locations and Buffer Zones Map’ concluded that likely action area of this proposed project is not within 660 feet of a bald eagle nest.

Typical considerations for the Northern long-eared bat center around removal of trees greater than 3 inches in diameter. In Maine, the typical implication is simply that USFWS is notified if trees of this size must be removed as a result of project actions and may require the trees to be removed before the start of the regional nesting season (prior to April 1).

The project area falls within the designated critical habitat for Atlantic salmon. The Gulf of Maine Distinct Population Segment (DPS) of Atlantic salmon was first listed as endangered under the Endangered Species Act (ESA) on November 17, 2000 jointly by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service NMFS)¹. On June 19, 2009 the critical habitat designation for this population was finalized and includes the Piscataquis River within the project area. Safe, timely, and effective upstream and downstream passage is federally required to be provided for Atlantic salmon at this site.

All life stages of Atlantic salmon are present in the Piscataquis watershed and impacts to them, and their critical spawning and rearing habitat will be carefully considered during all stages of the project. Any Federal action at the site, which may include the FERC license exemption surrender process, or permitting for a potential project, will require a formal Section 7 consultation with USFWS or NOAA, and terms and conditions will be determined throughout that process.

Based on previous comments filed in past consultations during FERC amendment proceedings, USFWS would also be concerned with providing safe, timely, and effective upstream and downstream passage for alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) (collectively, river herring) and American eel and sea lamprey.

Consultation with USFWS regarding all federal threatened and endangered species will continue throughout the project.

NMFS

Based on previous comments in past consultations during FERC amendment deliberations, NMFS indicated that the project area is within the Gulf of Maine distinct population segment (DPS) of Atlantic salmon. The recovery of Atlantic salmon and their habitat is a priority for NMFS under the ESA and is highlighted by the agency as one of nine “Species in the Spotlight”. NMFS will be concerned with all temporary and permanent impacts to Atlantic salmon critical habitat as well as all temporary and permanent impacts to safe, timely, and effective upstream and downstream passage for Atlantic salmon.

Formal consultation with the NMFS would likely be initiated through either the FERC surrender process, the U.S. Army Corps of Engineers (USACE) permitting process, or other federal action such as use of federal funds for project construction. Because the permitting is at the federal level, any

¹ Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmo salar*). 65 FR 223 (November 17, 2000).

selected project would be reviewed for impacts under Section 7 of the ESA, likely leading to specific terms and conditions to satisfactorily surrender the license exemption.

In addition to any terms or conditions set during a potential surrender, a Section 7 consultation will also require a Biological Assessment that analyzes the total effects of the proposed action including all temporary and permanent impacts to all life stages of Atlantic salmon, as well as all temporary and permanent impacts to spawning and rearing habitat. Upon acceptance and review, the lead federal agency (likely NMFS) will issue a Biological Opinion that will include required terms and conditions for construction and potentially long-term operations.

3.2 PROJECT PERMITTING

Prior to considering regulatory compliance for construction, the first compliance step under any of the alternatives identified by the Committee and discussed in detail in Section 5 would be to surrender the FERC license exemption. The license exemption surrender administered by FERC would itself be considered a Federal action, subject to all Federal laws. During the surrender process, FERC, state agencies, and federal agencies may prescribe terms and conditions that must be fulfilled prior to the surrender becoming effective.

For construction of the likely range of project actions considered, regulatory permits that may be required include the following:

- National Environmental Policy Act
- Maine Department of Environmental Protection (DEP), Maine Waterway Development and Conservation Act (MWDCA) Permit (most likely), or Natural Resources Protection Act (NRPA) Permit with associated state agency consultations including MDMR and MDIFW
- Maine Department of Environmental Protection (DEP), Maine Stormwater Management Law Permit By Rule (most likely), or Site Location of Development Act Permit
- US Army Corps of Engineers Clean Water Act Individual Permit, with associated Section 7 of the Endangered Species Act (ESA) with federal agencies including USFWS and NOAA/NMFS
- Consultation with Tribal Historic Preservation Offices (THPO) of all federally-recognized Native American tribes in Maine
- Maine Historic Preservation Commission (Section 106 of the National Historic Preservation Act) Memorandum of Agreement
- Town of Dover-Foxcroft permits may include Demolition, Shoreland Zoning, and Flood Hazard Development Permits

For post-construction, any modifications to the FEMA-mapped 100-year floodway would require a revision to the FEMA flood hazard maps. The revision would be based on as-built conditions, executed through one of two methods: Physical Map Revision or Letter of Map Revision (more common).

3.3 INFRASTRUCTURE CONSIDERATIONS AND POTENTIAL CONSTRAINTS

The Baseline Conditions Report (Inter-Fluve et al. 2023a) details adjacent features and infrastructure potentially influenced by project alternatives (Figure 2). The detailed review of project alternatives in Section 5 identifies potential impacts to these features by each project alternative. Consultation with relevant owners of infrastructure will continue throughout the subsequent planning, detailed design and construction phases of the project. Additional consideration was given to buildings, roadways, homes, and other infrastructure located within the existing 100-year floodway that is directly influenced by the existing Mayo Mill Dam (see Section 4.3).

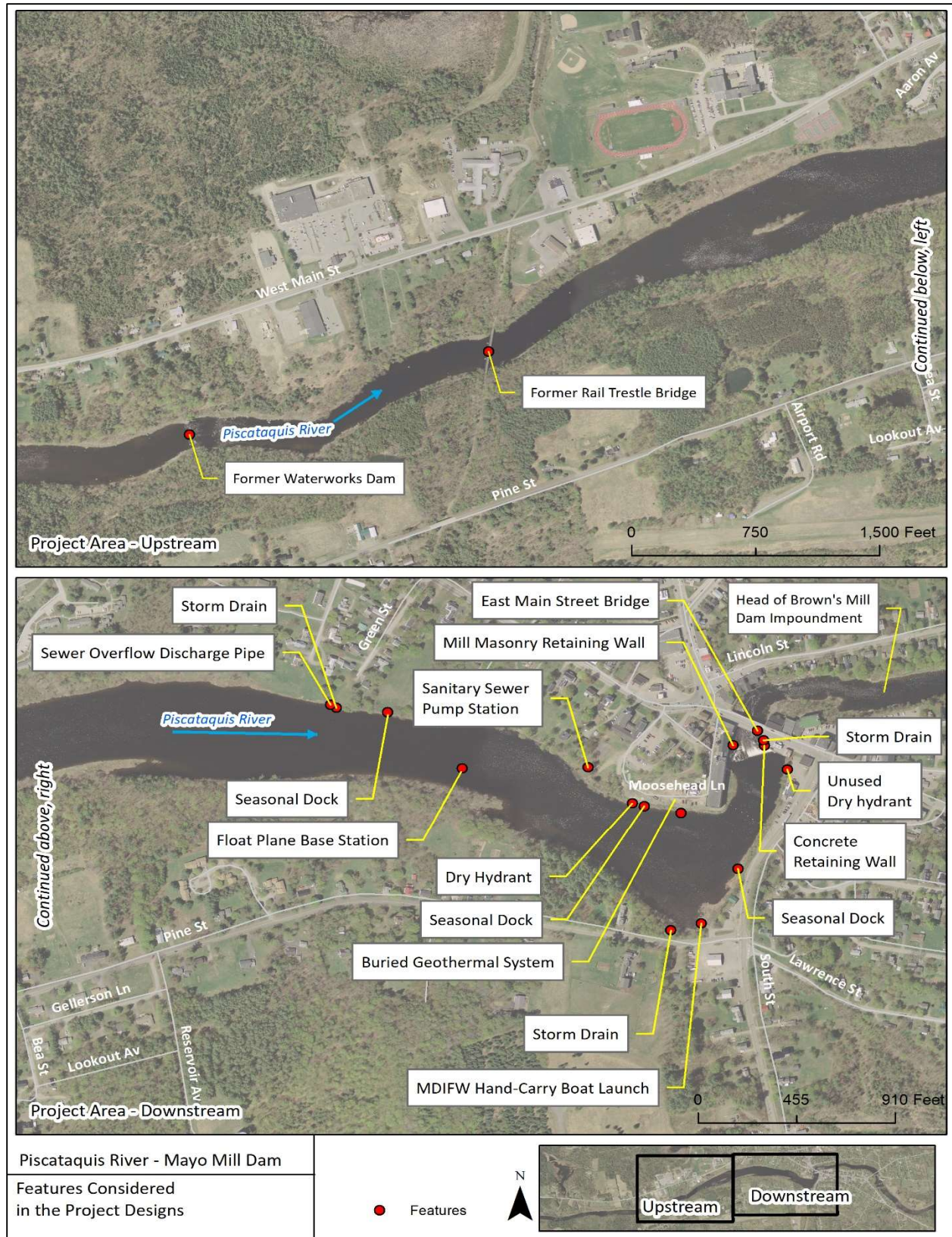


Figure 2. Locations of adjacent features and low-lying infrastructure.

4. Preliminary Design Considerations

To address the goals and objectives established for the project, we evaluated the feasibility of potential management approaches for the site. Prior to detailing the specific project alternatives that were evaluated, several overarching design considerations were evaluated that apply to the range of alternatives. These considerations are summarized in this Section of the report.

4.1 POWER GENERATION

As detailed in the Baseline Conditions Report (Inter-Fluve 2023a), power has not been generated at the site since 2008. Multiple parties have reviewed the potential to restore power generation since that time, but none of the evaluations has led to restoration of power generation. To support the Committee in review of project options for the site, a new hydropower development pre-feasibility study was conducted by the Study Team (Gomez & Sullivan Engineers 2023b) to review the potential for regeneration at the present time. The hydropower study report is included as Appendix A in the Feasibility and Alternatives Analysis Report (Inter-Fluve 2023c).

The study first developed estimates of annual energy production for the facility operating under the auspices of the existing FERC license exemption. The study then evaluated the costs to redevelop the hydropower generation capacity, which included the costs of necessary repairs to the dam and powerhouse. The total budget estimates ranged from \$4.3 million to \$4.8 million.

A preliminary economic analysis was then completed utilizing a simple payback method that compares the initial capital investment (only) to the projected revenue. Using this economic model, the study estimated that the capital investment necessary to restore power generation would require approximately 50 to 100 years to pay back, based on projected generation revenue.

It should be noted that the simple payback method utilized does not explicitly account for lifecycle costs including ongoing operation (including personnel), maintenance, periodic repairs, and necessary compliance measures (including monitoring of fishway effectiveness and the cost to potentially replace the fishway if that was required based on the ESA consultation). Other long-term costs such as insurance and property taxes (unless voided by Town) were not explicitly accounted for in the estimates.

When these economic factors are added to the consideration of the capital investment payback analysis, the projected timeframes to overcome the required investment would be substantially longer. Based on these considerations, the long-term economic viability for a profit-seeking concern such as a hydropower developer is extremely low. Anecdotally, the typical capital investment payback period targeted by hydropower developers ranges from 5 to 10 years.

4.2 DAM CONDITION AND STABILITY

FERC conducted a periodic dam safety inspection in early August 2023, and issued a dam safety inspection report in late August, requiring the Town to address several specific areas of concern and develop selected updates to required administrative plans. As part of the Baseline Conditions assessment (Inter-Fluve 2023a), the Study Team subsequently conducted a detailed dam condition

assessment and stability analysis (Gomez & Sullivan Engineers 2023a) to inform alternatives which may retain the dam in place. While the spillway was found to be of generally sound condition, several areas of notable degradation were indicated.

In addition, the stability analysis found that FERC-required stability factors of safety were not met under certain loading conditions. For each of the project alternatives that retain the dam or spillway in place, applicable repairs or stability mitigation countermeasures identified by Gomez & Sullivan (2023a; Table 4) were included in the alternative definition and estimated cost.

Conventional contemporary dam safety requirements by FERC and other typical jurisdictions require the spillway to pass the FEMA Base (100-year) Flood, without overtopping the abutments. The dam presently does not have this capacity, but will be assumed to be required to prepare the dam to be maintained in perpetuity, if selected.

Table 4. Summary of structural deficiencies reported by dam condition assessment.

Deficiency Area	Recommended Repair
Dam	
Left Abutment Wall	Shore up existing building structure from building interior as necessary
Left Abutment Wall	Fill voids with reinforced concrete
Right Abutment Seepage	Place new concrete to fill voids, and pressure grout, as required
Concrete Apron	Drill and grout rebar into existing concrete and place new concrete to the original lines
Erosion of Bedrock below Dam	Place concrete and/or heavy riprap to fill void
Concrete Deterioration of Log Sluice Left and Right Walls	Remove all soft and deteriorated concrete. Drill and grout rebars into existing concrete. Place new concrete to the original lines
Spillway Stability	Installation of approximately 17 post-tensioned anchors, installed on the downstream face of the spillway
Powerhouse	
Roof	Shore structure as required. Make roof watertight with tarps or similar to prevent additional damage.
Roof	Repair roof structure and install new roofing system
Generator Floor	Provide positive support for timber floor beam on upstream end of powerhouse
Turbine Floor Deck	Replace missing and damaged floor planks, or close-off area to prevent access
Stone Wall Foundations	Pressure grout areas of walls with seepage, or place concrete on exterior face of walls. Repoint the walls.
Corroded Structural Steel Framing	Reinforce existing framing if possible or replace individual members
Spalled Concrete Roof Deck and Beams	Remove deteriorated concrete. Splice-in new reinforcing to make up lost area of steel due to corrosion. Patch with structural epoxy with minimum compressive strength of 4,500 psi

4.3 FLOOD MANAGEMENT AND RESILIENCE

The Baseline Conditions Report (Inter-Fluve 2023a) demonstrated the influence of Mayo Mill Dam on flooding patterns along the Piscataquis River and the vulnerability of selected areas of downtown Dover-Foxcroft to major floods such as the FEMA Base Flood (100-year event; Figure 3). The dam is a run-of-river dam that does not store flood waters, but does increase the elevation of flood waters in the upstream river. Flood risk is a detriment to properties, roadways, infrastructure, and buildings within the floodplain or near the river, which will continue to increase with time. The December 2023 flood (a 50-year recurrence interval peak flood event) which occurred shortly following the vote of the Steering Committee which selected dam removal as the preferred project to recommend to the select board underscored the influence of the dam on upstream water levels during floods.

With increasing precipitation and changing flooding patterns as a result of climate change, there is opportunity to enhance flood management and resilience in the downtown area. There is a plethora of benefits to be realized by bolstering the resiliency of the downtown area against major floods. First, by reducing flood depths to the extent that selected businesses, homes, and other structures would no longer be within the FEMA Special Flood Hazard Zone, requirements for mandatory flood insurance may be alleviated. Furthermore, by reducing flood depths in areas that are still expected to be inundated, including roads, the degree of damages may be substantially reduced. This consideration is particularly relevant along South Street (Route 7), where inundation constitutes not only a nuisance but a public safety concern. Substantial inundation of this road could also lead to repair costs required of the Town, unless damage assistance could be secured.

General considerations of flood damage avoidance suggest that on average for every dollar spent on damage avoidance approximately 6 to 12 dollars of voided repair costs are realized (e.g., Multi-Hazard Mitigation Council 2019). Recognizing that the areas of downtown Dover-Foxcroft within the FEMA base flood zone include businesses, homes, and a significant transportation corridor², removing these areas from flooding impacts would result in a significant long-term benefit to the Town. At the same time, eliminating or modifying aging structures which no longer serve their intended purpose alleviates maintenance requirements and the risk associated with damage to under-maintained structures, and associated damages to surrounding buildings and infrastructure if they become compromised.

The following paragraphs provide a general representation of potential flood management benefits to inform the Committee review of project alternatives. In evaluating the potential alternatives to study in more detail at the August 15 meeting, the Committee pondered the potential resiliency benefits of lowering the impoundment level in varying increments of feet. The analysis reported below first systematically represents the potential benefits from an incremental lowering strategy. The potential flood management benefits associated with incremental lowering, nature-like

² Annual average daily traffic estimates for South Street and the Main Street bridge are approximately 5,000 and 10,000 cars per day, per the Maine DOT public map viewer (<https://www.maine.gov/mdot/mapviewer/>).

fishways, and dam removal alternatives are compared in the subsequent paragraphs and considerations for the selected alternative are discussed in more detail in Section 5.

In the incremental flood resilience impacts assessment, three general strategies are represented (Table 5), which bracket the alternatives that were selected for detailed study by the Committee. To simulate the incremental effects of the Modify Dam and NLF strategies, the existing conditions hydraulic model developed for the study (Inter-Fluve 2023a) was modified to represent the strategies, first by simulating the case where the existing impoundment elevation would be maintained, followed by a series of iterations to progressively lower the impoundment level. For the Dam Removal strategy, the existing conditions model was modified to represent the post-structure removal condition. To represent the results, the potential benefits of each increment of each strategy were referenced at five landmark points of reference (Figure 3). Note that several of these landmarks are connected by Route 7, a major route to and from Dover-Foxcroft, where potential flooding constitutes a public safety issue.

The simulated benefits of each strategy are represented with calculated changes in inundation depth at the landmark locations, aerial depiction of the resulting change in inundation extent, and longitudinal profiles depicting the differences in flood water surface elevations.

Table 5. General strategies considered for flood resilience impacts assessment.

Strategy	Description
Modify Dam	Retain dam spillway in current location but modify the dam with a secondary spillway that replaces the portion of the dam to the left of the log sluice with a new spillway that controls the impoundment at a lower elevation.
Replace Dam with Nature-like Fishway (NLF)	Remove the dam and replace the impoundment water level control function with a bank-to-bank nature-like fishway that extends upstream of the dam location approximately 430 feet.
Dam Removal	Remove the dam without replacing the impoundment water level control function.

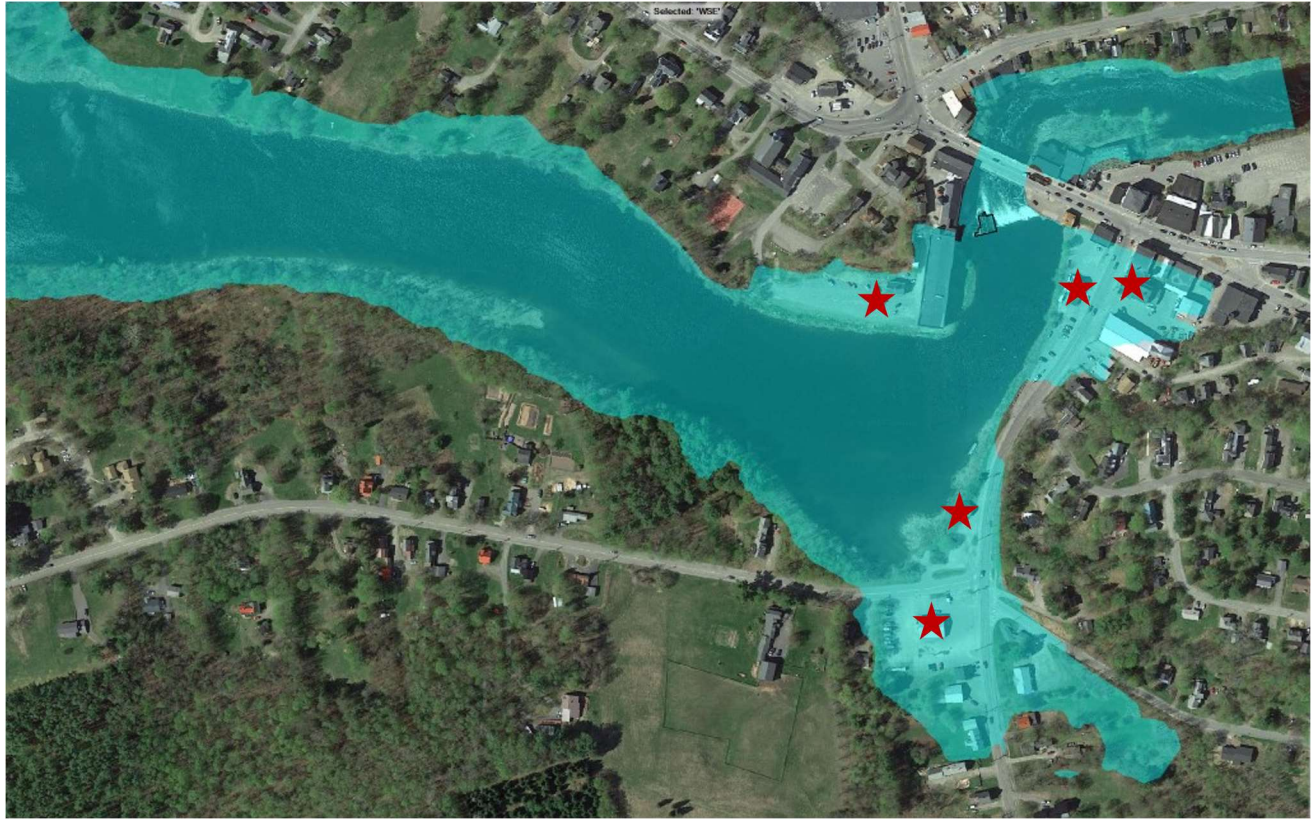


Figure 3. Aerial view of simulated FEMA Base Flood (100-year) inundation extent. Red stars indicate five locations of interest.

4.3.1 Modify Dam Resilience Strategy

The potential flood resilience benefits of the Modify Dam strategy are summarized in Table 6 and are represented in Figure 4 to Figure 5. The model results indicate that the flood resilience benefits for the Modify Dam strategy for the 100-year return period flood are limited in reduction of peak flood water surface elevations. The flood zone continues to surround each of the five landmarks.

Table 6. Summary of flood resilience benefits from the Modify Dam strategy for the 100-year return period flood event, based on model simulations. Positive depth value indicates inundation, negative depth value indicates feature is outside inundation zone. WSE = water surface elevation.

Location	Existing Case		Lower Impoundment 2'		Lower Impoundment 5'		Lower Impoundment 8'	
	WSE (Ft*)	Depth (ft)	WSE Change** (ft)	Depth (ft)	WSE Change** (ft)	Depth (ft)	WSE Change** (ft)	Depth (ft)
Hardware Store	355.1	4.1	-1.4	2.7	-2.3	1.7	-3.2	0.9
Redemption Center	355.1	6.1	-1.4	4.7	-2.3	3.7	-3.2	2.9
Chamber of Commerce	355.5	4.5	-1.3	3.2	-2.2	2.3	-3.1	1.4
Oil Company	355.6	5.6	-1.3	4.3	-2.2	3.4	-3.0	2.6
Mill Parking Lot	355.6	7.6	-1.3	6.3	-2.2	5.4	-3.0	4.6

* NAVD88 **Compared to Existing



Figure 4. Aerial comparison of simulated flood resilience benefits for the 100-year return period flood for the Modify Dam strategy (Lower 2'-purple, Lower 5'-lavender, Lower 8'-gray) to existing conditions (cyan).

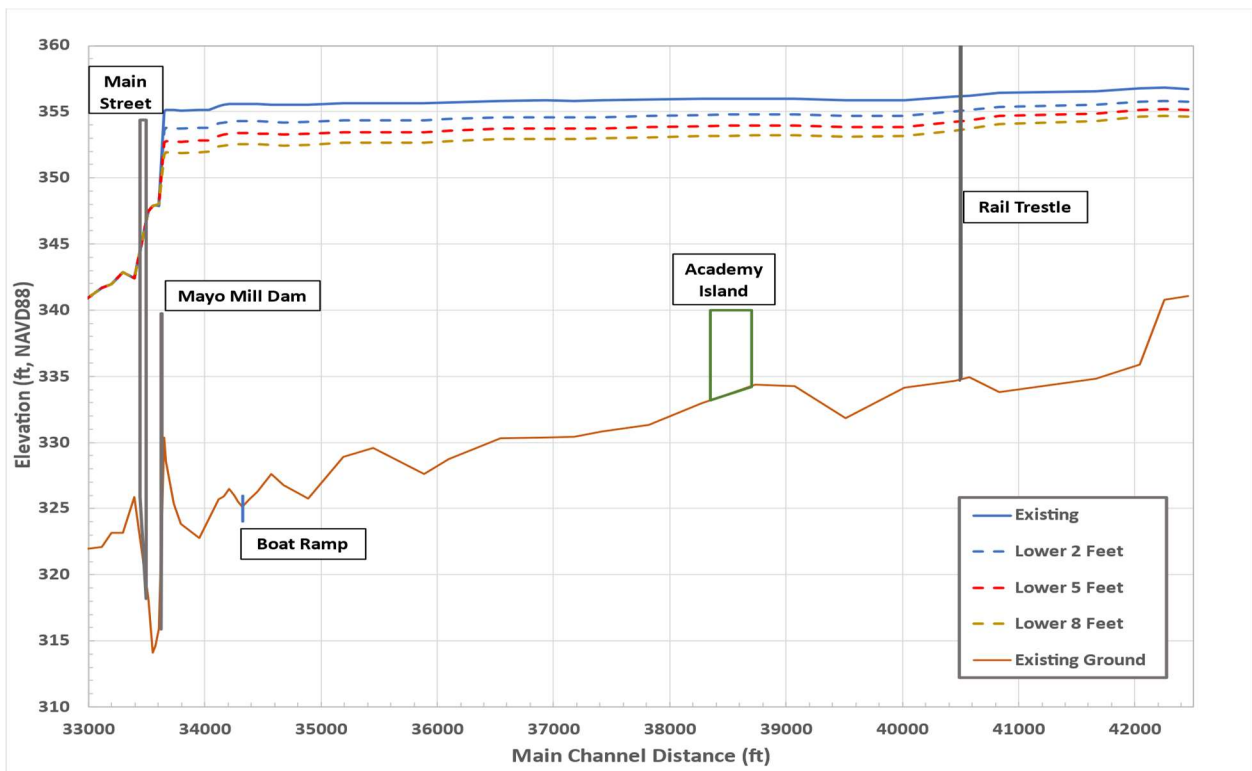


Figure 5. Profile comparison of simulated flood resilience benefits for the 100-year return period flood for the Modify Dam strategy.

4.3.2 Nature-Like Fishway Resilience Strategy

The potential flood resilience benefits of the NLF strategy are summarized in Table 7 and are represented in Figure 6 to Figure 7. The model results indicate that the flood resilience benefits for the NLF strategy for the 100-year return period flood substantially reduce peak water surface elevations in the downtown area (buildings no longer within the flood zone), but reduce elevations to lesser degree in the South Street-Pine Street area (buildings still in the flood zone).

Table 7. Summary of flood resilience benefits from the NLF strategy for the 100-year return period flood event, based on model simulations. Positive depth value indicates inundation, negative depth value indicates feature is outside inundation zone. WSE = water surface elevation.

Location	Existing Case		NLF Maintain		NLF Lower 2'		NLF Lower 5'	
	WSE (Ft*)	Depth (ft)	WSE Change** (ft)	Depth (ft)	WSE Change** (ft)	Depth (ft)	WSE Change** (ft)	Depth (ft)
Hardware Store	355.1	4.1	-7.1	-3.0	-6.9	-2.9	-6.8	-2.7
Redemption Center	355.1	6.1	-7.1	-1.0	-6.9	-0.9	-6.8	-0.7
Chamber of Commerce	355.5	4.5	-1.4	3.1	-2.9	1.6	-4.4	0.1
Oil Company	355.6	5.6	-1.4	4.2	-2.9	2.7	-4.3	1.3
Mill Parking Lot	355.6	7.6	-1.4	6.2	-2.9	4.7	-4.3	3.3

* NAVD88 **Compared to Existing

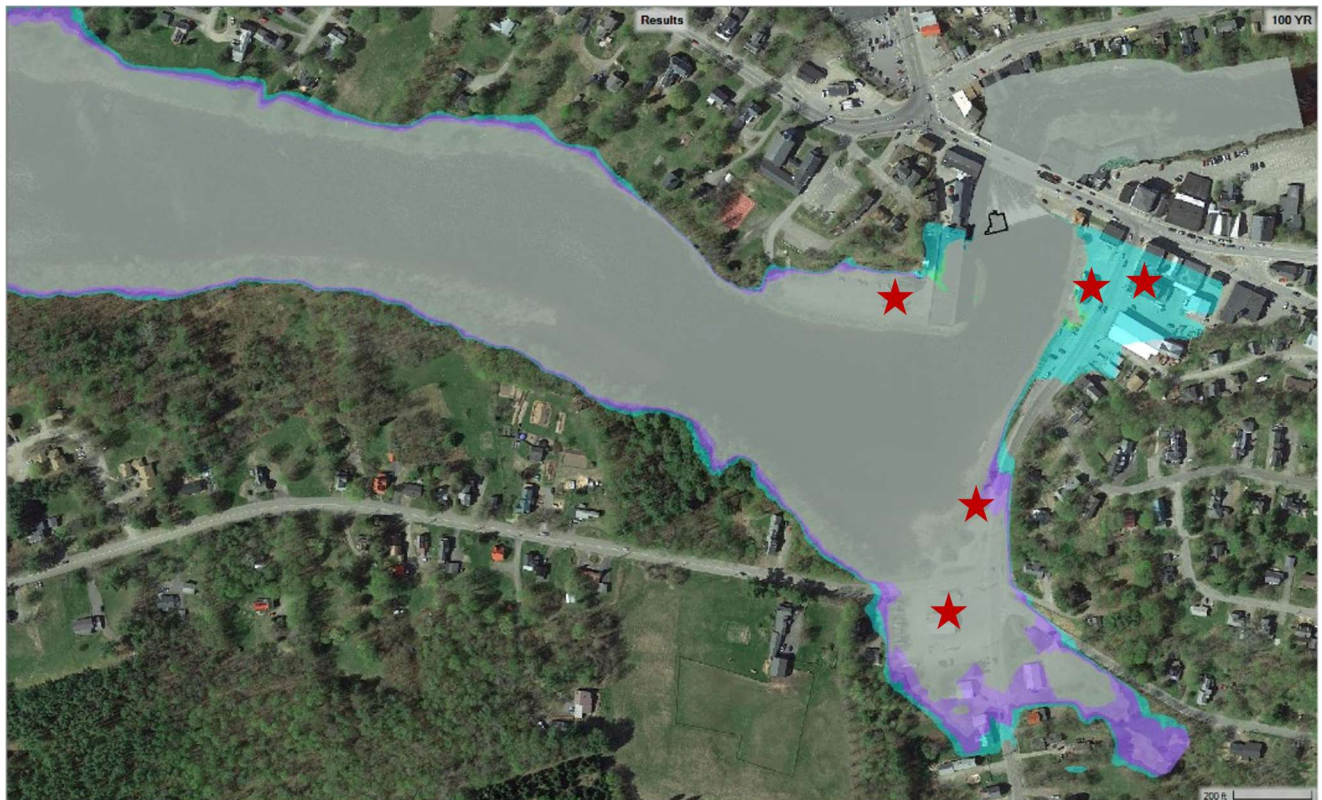


Figure 6. Aerial comparison of simulated flood resilience benefits for the 100-year return period flood for the NLF strategy (Maintain-purple, Lower 2'-lavender, Lower 5'-gray) to existing conditions (cyan).

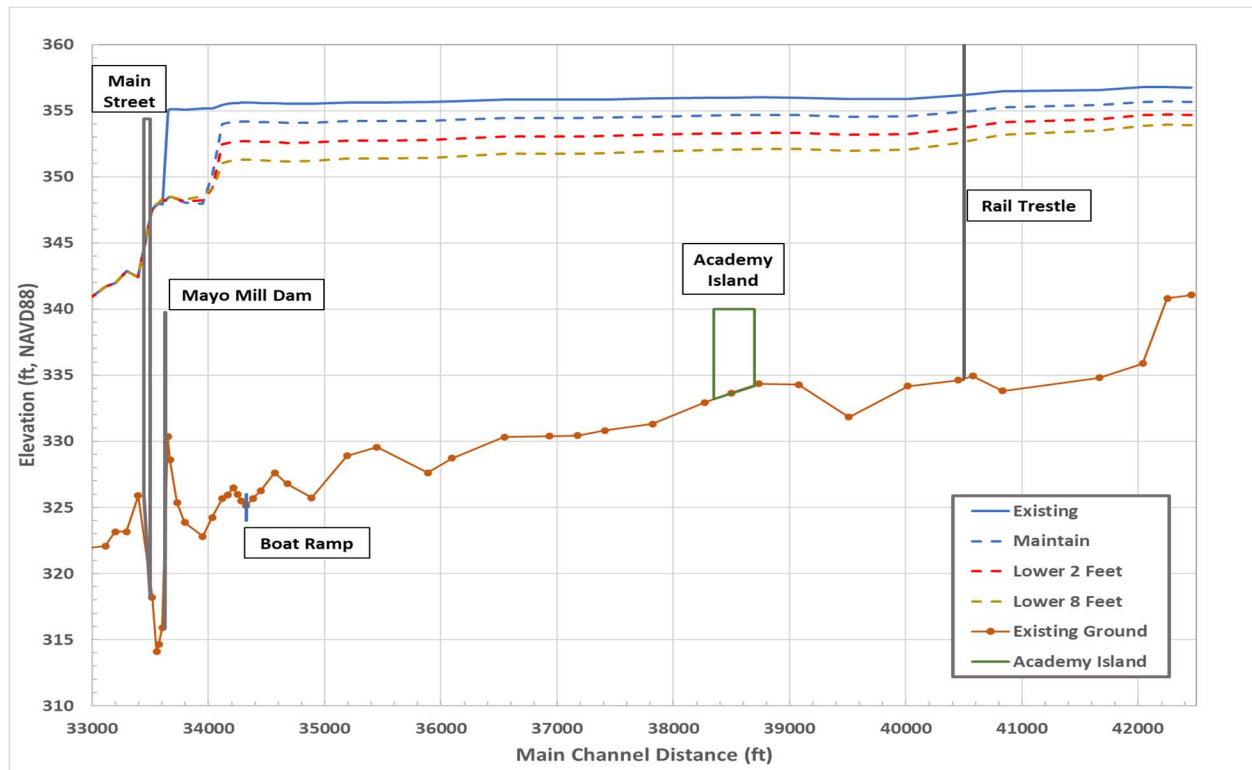


Figure 7. Profile comparison of simulated flood resilience benefits for the 100-year return period flood for the NLF strategy.

4.3.3 Dam Removal Resilience Strategy

The potential flood resilience benefits of the Dam Removal strategy are summarized in Table 8 and are represented in Figure 8 to Figure 9. The model results indicate that the flood resilience benefits for the Dam Removal strategy for the 100-year return period flood substantially reduce peak water surface elevations in both the downtown area and the South Street-Pine Street area (buildings no longer within the flood zone). This strategy provides the greatest flood risk reduction benefits of all of the alternatives.

Table 8. Summary of flood resilience benefits from the Dam Removal strategy for the 100-year return period flood event, based on model simulations. WSE = water surface elevation.

Location	Existing Case		Dam Removal	
	WSE (Ft*)	Depth (ft)	WSE Change** (ft)	Depth (ft)
Hardware Store	355.1	4.1	-6.6	-2.5
Redemption Center	355.1	6.1	-6.6	-0.5
Chamber of Commerce	355.5	4.5	-6.2	-1.6
Oil Company	355.6	5.6	-6.1	-0.5
Mill Parking Lot	355.6	7.6	-6.1	1.5

* NAVD88 **Compared to Existing



Figure 8. Aerial comparison of simulated flood resilience benefits for the 100-year return period flood for the Dam Removal strategy (Removal-gray) to existing conditions (cyan).

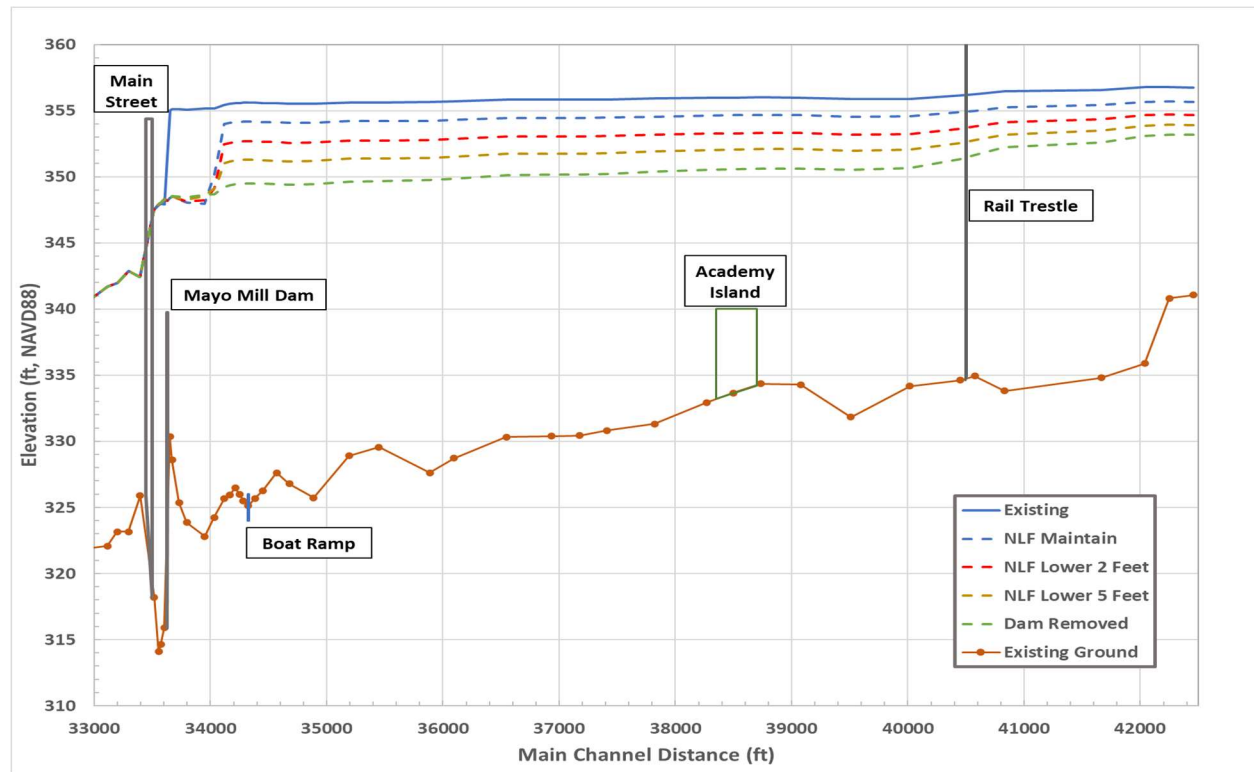


Figure 9. Profile comparison of simulated flood resilience benefits for the 100-year return period flood for the Dam Removal strategy.

4.3.4 Project Alternative Resilience Comparison

Lastly, Figure 10 to Figure 11 compare the flood resilience benefits of the selected alternative (dam removal) and the other alternatives presented in the project's Feasibility and Alternative Analysis Report (Inter-Fluve et al. 2023c). The model results indicate that the flood resilience benefits for the Dam Removal strategy for the 100-year return period flood exceed the benefits of the other strategies in both the downtown area and the South Street-Pine Street area (buildings no longer within the flood zone). The NLF strategy offers comparable resilience benefits in the downtown area, but more incremental benefits in the South Street-Pine Street area. The Modify Dam strategy offers the least benefit of the alternatives studied in detail.



Figure 10. Aerial comparison of simulated flood resilience benefits for the 100-year return period flood for the five alternatives detailed in Section 0. The alternatives (M1-purple, L1-lavender, N6-olive, N7-brown, N6-green, R1/R1-light green) are compared to existing conditions (cyan)

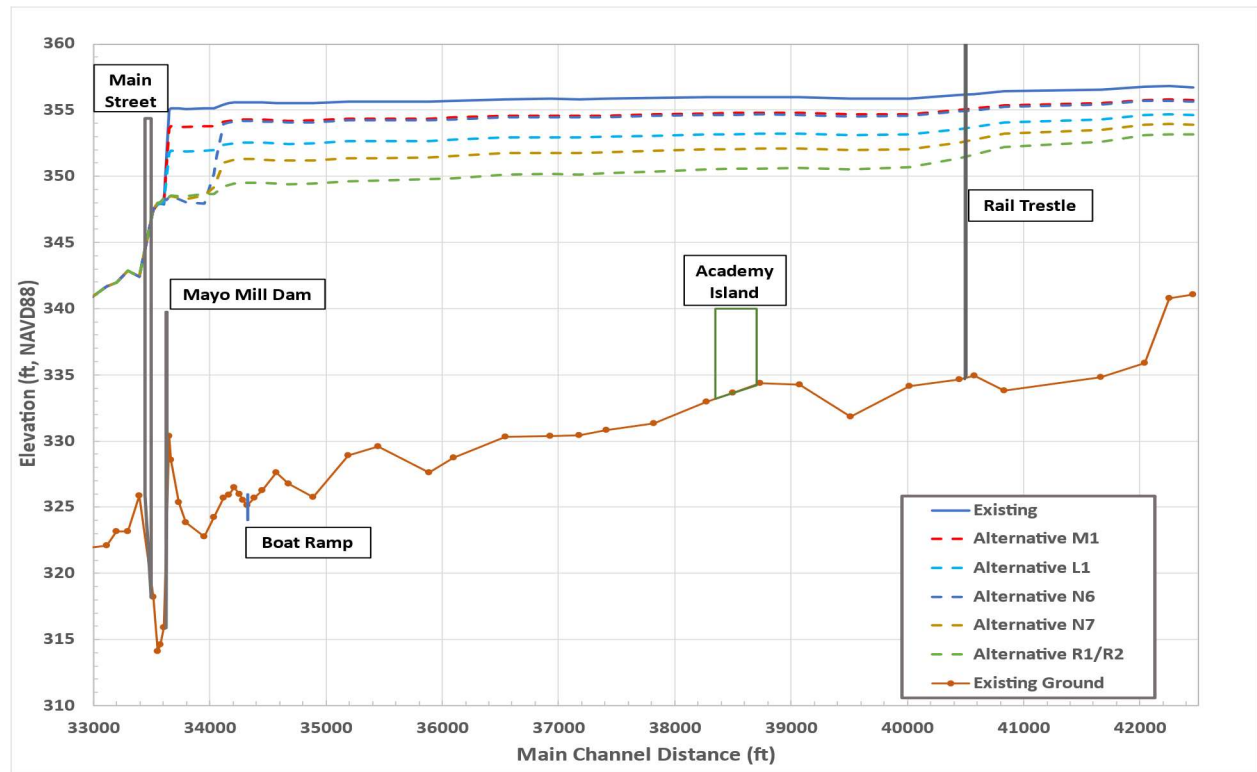


Figure 11. Profile of simulated flood resilience benefits for the 100-year return period flood for the five alternatives detailed in Section 0.

4.4 FISH PASSAGE RESTORATION

There are numerous case studies around the region where sea-run fish populations are being restored. These efforts include a range of fish passage technologies, ranging from dam removal to nature-like bypass channels, and technical fish passages. The solution at each site is tailored to the particular opportunities and constraints present at each location. These projects all contribute to recovery of native sea-run fish populations within the Gulf of Maine. They also have innumerable collateral benefits to ecological health and environmental quality in each watershed and in the ocean, to management of aging infrastructure and flooding, and to community engagement and education.

Each dam presents a unique set of opportunities and constraints which must be addressed in order to re-establish sea-run fish populations and provide for passage of resident species throughout the watershed. These unique attributes were considered for the Mayo Mill dam in development of the options summarized in Section 5. The primary factors considered in the development of a successful fish passage facility are the overall height of the dam, the space available, the ability to attract fish to the fish passage, and the capacity to allow passage of the future restored fish population.

4.4.1 Target Native Fish Species and Population Sizes

Target fish species required to be considered and the associated population size assumptions are based on consultation with NOAA, US Fish and Wildlife Service (USFWS), Maine Department of Marine Resources (MDMR) and Maine Department of Inland Fisheries and Wildlife (MDIFW). Target fish species include Atlantic salmon, alewife, blueback herring, American shad, sea lamprey and American eel, along with eastern brook trout. Population sizes include 578,000 river herring (415,024 alewife, 163,139 blueback), 37,500 shad, and 1,200 Atlantic salmon.

As described in the Baseline Conditions Report (Inter-Fluve et al. 2023a), invasive fish species are present within Maine, and within the Penobscot and Piscataquis River systems, including smallmouth bass that currently occupy habitats above and below the Mayo Mill Dam. These invasive species act as both predators and competitors to native fish. Northern pike are an emerging threat in the Penobscot River as they have been documented above Milford Dam, though they have not been documented above Howland Dam. Impoundments create habitat conditions that are typically more favorable to invasive species like bass and pike, aiding their establishment and providing an advantage for them over native fish. Note that these fish are most often spread through both legal and illegal introductions.

MDIFW maintains concern that without control structures at one of more of the dams on the Piscataquis River (such as the existing pike control structure at Brown's Mill Dam), invasive pike could possibly spread within the drainage more quickly than with control structures in place. However, the control structures do not prevent people from moving them to new areas above the dams, and although the dams themselves may slow the spread of invasives, it is unlikely that they would prevent their spread. Regardless, the control structure at Brown's Mill Dam is important to the management of the fisheries in the Piscataquis River and will remain in place until the conditions laid out in the Penobscot River Invasive Species Barrier Agreement (MDIFW and MDMR 2009) are reached.

4.4.2 Site Characteristics

The overall height of the dam and the space available are characterized by the hydraulic height and effective gradient of the site. The hydraulic height and gradient are determined by the site characteristics, and dictate the types of fish passage technologies that can be considered at a site. In general, for a similarly constrained site, the level of difficulty and cost increases with increasing hydraulic height and effective gradient. In natural streams, sustained gradients that the anticipated fish species negotiate are typically less than approximately 3% to 5%, though there are instances where native sea-run fish are able to utilize steeper gradients for short distances in naturally functioning streams in Maine.

4.4.3 Fish Attraction

Fish attraction refers to the ability to enable ascending fish to find the entrance to the fish passage facility to allow the population to ascend the barrier without unnecessary delay due to overcrowding. Extended delay of fish in their upstream migration can lead to mortality due to energy expenditure and predation, and/or degraded condition when fish ultimately do reach spawning grounds, which in turn may lead to reduced reproductive success.

4.4.4 Biological Capacity

The capacity to allow passage of the future restored fish population, referred to as biological capacity, varies between fish passage approaches. The intent is to provide enough capacity for all of the individual fish to be able to ascend the passage barrier at the time and according to the rate they determine. Undersized facilities may create passage bottlenecks due to crowding at peak migration periods, causing delays that may increase stress and vulnerability to predation. MDMR (2023) provided a preliminary opinion of the potential restored native sea run fish populations: 578,000 river herring (415,024 alewife, 163,139 blueback), 37,500 shad, and 1,200 Atlantic salmon.

4.4.5 Passage Effectiveness

Effective passage is defined as the successful movement of target species through a zone of passage resulting from a favorable alignment of the fish passage and structural design, project operations, and environmental conditions during the key periods of passage activity. Effectiveness includes both qualitative assessments (e.g., integrity of fishway elements) and quantitative measurements. The term “efficiency” (with its subcategories “passage efficiency” and “attraction efficiency”) is reserved for the quantitative measurements of effectiveness. NMFS has not yet set a performance criteria standard for the Mayo Mill Dam site. It is anticipated that the criteria will likely be in the range of 90 percent to 95 percent for passage efficiency. The performance standard may also include percent efficiency targets required for entrance attraction and quantitative target for the number of days of delay. A site-specific analysis will be conducted by NOAA through the consultation process that will be initiated through subsequent Federal actions related to the site (see Section 3).

4.4.6 General Fish Passage Restoration Approaches

Four general potential fish passage restoration approaches were identified and evaluated for the Mayo Mill dam. Each of these approaches were initially considered and were screened for those most applicable based on the site characteristics. The four approaches are defined below, and technical information for each is provided in Table 9.

- **No Action:** No change from existing conditions.
- **Technical Fish Passage:** Sometimes referred to as a ‘technical fishway’ or fish ladder, this is a general descriptor of a range of fish passage designs which permit passage around a dam. Technical fish passage includes fishways constructed using concrete, metal, or wood materials to create an artificial channel. These passages are typically geometric in shape and engineered to dissipate flow energy using baffles and/ or weirs. They are able to be constructed at steeper effective gradients than natural stream channels and nature-like passages. The different technical designs are typically most effective for varying subsets of fish species. Technical fish passage technologies considered for this study include Vertical Slot, Pool and Weir, and Denil fishways.
- **Nature-like Fish Passage:** These fishways emulate natural flow patterns and the appearance of a naturalized stream channel, and incorporate the landscape and naturalized materials, to provide fish passage over or around an existing dam structure or barrier that is left in place. Nature-like fish passages require milder gradients than technical fish passage. By emulating natural flow patterns, it is reasoned that fish are able to more intuitively ascend the passage. These features are easily scaled for the available flow and biological needs. Nature-like fishways accommodate a broad range of fish species, including those considered in the Piscataquis River.

Nature-like fish passage includes both bypass channel and main channel approaches. With the bypass channel strategy, the fish passage is typically routed laterally around the passage barrier, requiring space outside the river channel for the construction. Often due to space constraints, the size of the allowable nature-like channel construction can be limited, limiting the amount of flow that they carry. In these instances, fishway entrance attraction can be a constraint. In contrast, main channel or bank-to-bank nature-like passages convey the full flow of the river, eliminating attraction constraints, but are typically much larger in size.

- **Dam Removal:** This refers to the removal or breaching of the dam and spillway, with a reversion to a flowing stream. Depending on the site characteristics, abutments or other appurtenant structures may be left in place following removal if required to ensure the stability of adjoining areas.

Table 9. Available fish passage technologies considered for this study.

Type	Maximum Gradient*	Recommended Gradient	Flow Capacity	Biological Capacity	Species Effectiveness (sea-run and native resident species such as brook trout considered)
Vertical Slot (Technical)	10% ³	5%	Scalable	Scalable**	Broadest effectiveness among technical fish passage
Pool & Weir (Technical)	10% ⁴	10%	Scalable	Scalable**	Possible limitation for American eel
Denil (Technical)	16% ²	12.5%	~10 to 30 cfs typical, 40 cfs max.	~200,000 ¹ river herring	Limitation for American eel and possibly sea lamprey. Capacity may be limited for river herring with fully restored fish population in watershed.
Steeppass (Technical)	20% ²	20%	< 8 cfs	~50,000 river herring	Limitation for American eel and possibly sea lamprey. Due to limited biological capacity for river herring not considered in project options.
Nature-like Fishway	5% ¹	3% (<2% is preferred)	Scalable	Scalable	All anticipated
Dam Removal	Natural channel gradient, 5% or less preferred ⁵		Full river flow, scalable	Unlimited	All anticipated

*Most applicable to Atlantic Salmon only **Greater than 1 million

Of the technologies listed, there is a general gradient of preference among resource agencies, regulators, and funders in the region based on monitored performance in passage of target species. Dam removal that does not require additional fish passage construction is by far the most preferred approach, followed by dam removal that requires proactive channel restoration. Dam removals also provide the ancillary benefit of relatively low or eliminated operation and maintenance costs compared to other fish passage strategies. The next preference is for nature-like approaches as the flatter gradients and naturalized flow patterns are considered to provide good fish potential passage conditions for the broadest range of fish.

Among the technical passage approaches, pool-type technologies (vertical slot, pool & weir) are generally favored on the basis of performance and reduced constraints relative to Denil fishways. However, pool-type fishways are more expensive than Denil ladders due to shallower required slopes. Lastly, Denil fishways are typically the least preferred approach. Although they can be very effective for river herring and salmonids including resident brook trout if sited and designed properly, they can be constrained by biological and flow capacity, possess greater sensitivity to operating conditions (head pond fluctuations), particularly flow conditions at the entrance and exit, can be susceptible to debris clogging, and the flow limitation may limit the attraction. This is

³ USFWS, 2019

⁴ USFWS, 2019

⁵ Turek et al., 2016

especially true at locations where competing flow signals may occur, such as dispersed flow over ledge outcrops or dam spillways. Operation and maintenance costs for Denil fishways are typically high, especially those that use wooden baffles. Denil fishway was considered for the Mayo Mill Dam, but was not advanced to the detailed alternatives analysis based on the above considerations, and due to species and biological capacity constraints.

Fish Passage Design Options for Mayo Mill Dam

Based on the Mayo Mill dam site characteristics, target fish species, and population estimates, the optimal fish passage approach would entail dam removal. Other fish passage improvement options were considered in the project's Feasibility and Alternatives Analysis given site characteristics and constraints, including bank-to-bank nature-like fishway, and vertical slot technical fishway, listed in the order of in order of likely fish passage effectiveness (Inter-Fluve et al. 2023c).



Figure 12. Example of constructed nature-like fish passage, Howland, Maine. This type of fishway is considered under Alternatives N6 and N7.



Figure 13. Examples of constructed nature-like fish passage. This type of fishway is considered under Alternatives N6 and N7.



Figure 14. Vertical slot fishway at West Enfield (photo credit: USFWS). This type of technical fishway is considered under Alternatives M1 and L1.

4.4.7 Fish Passage and Climate Resilience

Assessment of fish passage options considered the potential hydrologic effects associated with climate change. In general, dam removal strategies provide the greatest benefit to aquatic organism passage over wide flow ranges, while technical fishways are highly sensitive to the flow volume and hydraulic head, and may become impassible outside of prescribed conditions.

Dams with flow regulation means may be able to partially extend passable conditions of technical fishways in the face of increased precipitation and hydrologic extremes. Analysis of dam operations for optimal fish passage at the high and low flows of the fish migration period should be performed in subsequent design phases to ensure passage is possible over as wide a range of hydrologic conditions as possible.

4.5 SEDIMENT MANAGEMENT

Management of accumulated sediment behind a dam is a critical consideration when contemplating dam management activities. The sediment can potentially bear the legacy of contamination from past or present upstream land or industrial uses, including urban runoff. Release of this sediment in some instances could cause environmental harm to downstream areas due to its level of contamination. Release of accumulated sediment, if substantial in volume, could also cause downstream impacts through deposition in ecologically sensitive areas, or in locations that reduce flood conveyance. In some instances, removal of the accumulated sediment, if contaminated, is viewed beneficially by removing a potential contamination hazard from the aquatic system, as well as generally improving the ecological health of the habitat available to native flora and fauna.

At the same time, viewed from an ecological and sustainability perspective, the downstream transport of sediment is a natural process that is typically disrupted by the presence of a dam, which may have led to reduced habitat quality and stream integrity over time, both in the downstream river and in downstream coastal areas. Often, a stream reach downstream of a dam that is efficient at trapping sediment may be sediment ‘starved’, which may lead to channel instability or other impacts. In selected instances with limited downstream risks, accumulated sediment may be allowed to transport downstream to aid in recovery of the stream system.

These factors are weighed carefully along with potential project costs when determining the appropriate sediment management approach for each project. The range of options extends from proactive excavation or dredging of all of the accumulated sediment before a dam is breached at one end, to allowing the sediment to passively erode following dam removal at the other end of the spectrum. Between these two end points, there is a vast range of intermediate management options. This may include excavation of only that proportion of the accumulated sediment assessed to likely erode in the near-term following dam removal. Alternatively, this may include proactively restoring and stabilizing the river channel through the former impoundment in order to moderate erosion of the proportion of sediment that is left in place due to cost considerations, or other approaches.

The Baseline Conditions Report (Inter-Fluve 2023a) summarized the volumes of accumulated sediment across four zones, with the dominant volume of sediment found in Zone 2 which extends from the safety buoy upstream of the dam to the upstream end of Riverside Park, and Zone 3 which extends from that location to the upstream end of Academy Island. The overall estimate of accumulated sediment in the impoundment is 58,000 to 74,000 cubic yards, of which 18,000 to 23,000 cubic yards were estimated in Zone 2, while 39,000 to 50,000 cubic yards were estimated dispersed throughout Zone 3 (the largest zone at 68% of the total area). Sediment accumulation in Zone 1 (Mayo Mill Dam to the safety buoy) is negligible, limited to shoaled areas along the margins of the channel.

The Baseline Conditions Report (Inter-Fluve 2023a) also provides an overview of the tested accumulated sediment at the site. The sediment quality testing revealed that selected samples results exceeded the ecological criteria threshold (FTEC) and probable (FPEC) effects screening levels, predominantly for metals and semi-volatile organic compounds (SVOCs). The ecological criteria are

defined by the consensus-based sediment quality guidelines developed by NOAA (MacDonald et al. 2000), which set thresholds for concentrations of pollutants that might result in possible effects (FTEC) and probable effects (FPEC) to organisms living in freshwater ecosystems.

When the analyzed samples were compared to human health screening criteria from the Maine DEP's remedial action guidelines (ME-DEP-RAGs) for construction workers and park users, there were no exceedances. The human exposure criteria are part of the ME-DEP-RAGs for various levels of human exposure, in this case construction worker and park user (Maine DEP 2018a). These criteria are typically used to inform the determination of whether sediment is clean enough to allow it to pass downstream, to reuse the sediment on a project site, or whether it is advisable to remove the sediment from the project location and prevent further exposure.

In general, the highest concentrations were found in the sample collected adjacent to the Riverside Park (Mayo-1). Overall, the comparison samples taken from upstream and downstream of the impoundment are reasonably similar to the samples taken from the impoundment. However, in selected instances results for the samples in the impoundment are one- to two-times higher than the background samples, in particular for the sample near Riverside Park (Mayo-1) sample. In these instances, selected sample concentrations are still below the ecological criteria in some cases, whereas in other selected cases the increased concentrations cause the sample to exceed the next higher screening criteria.

While there are a range of compounds and constituents found in the accumulated sediment, the sediment quality is not unlike that found in many impoundments along rivers throughout New England. Sediment management will be a project component requiring coordination and project resources, yet successful sediment management is achievable while limiting impacts to local residents, river users, and fish and wildlife. There is an extensive track record of sediment management at many similar sites across the region that have resulted in highly successful river restoration.

Typically, reuse or release options for impounded sediment are discussed and confirmed at the beginning of a detailed design phase, through coordination with project stakeholders and regulatory agencies, and formalized through the permitting process. As a result, it is not presently known whether passive release of the accumulated sediment would be permitted, or whether it would be acceptable to project stakeholders.

In general, there is anticipated to be relatively modest tolerance for any notable passive sediment release of mobile sediment due to potential impacts to the downstream facilities, such as Brown's Mill hydroelectric station. Readily mobile fine sediment is present in the lower impoundment, but not all of the accumulated sediment is expected to be mobile in the dam management scenarios. Some deposits are already vegetated or would vegetate quickly under various project alternatives, making them unlikely to mobilize. Sediment within the post project channel alignment is the most likely to mobilize. The estimated volume of mobile sediment and associated preliminary management strategies are identified for each of the alternatives detailed in Section 5.

4.6 LANDSCAPE ENHANCEMENTS

In addition to the key objectives focused on management of the dam and restoration of safe, timely and effective fish passage, enhancement of the public landscape amenities and contribution to the downtown revitalization efforts are key objectives. Following a landscape enhancement design discussion with the Committee on September 21, 2023, conceptual enhancement designs were developed. The conceptual enhancement designs are stratified into two primary zones, which are the Upland Zone and the Impoundment Zone. Note that these conceptual designs represent a visioning of potential, but the final disposition of the landscape enhancement design that would be advanced to detailed planning and design would be refined based on subsequent discussion, coordination, and selection.

The conceptual enhancements in the Upland Zone were developed in reference to the existing condition (Figure 15) and consist of areas that would be unaffected by the final selection of the alternative selected for management of the dam and restoration of fish passage. The Upland Zone Enhancements were further developed according to potential near-term and long-term implementation timelines.

The conceptual near-term timeline is referred to as the Framework - Short-Term Goals enhancement strategy, with focus on areas that are located on public-owned and partner stakeholder-owned properties. This baseline is a recommendation in the short term as the bare minimum to meet the goals and embrace consistency with the existing revitalization plan and other initiatives.

The Framework - Short-Term Goals enhancement strategy is shown in Figure 16. In the short-term, the conceptual framework features modest upgrades to existing infrastructure along the river, including repairs to the two docks and boat ramp. The framework calls for improved riverfront circulation with the addition of walking paths connecting Memorial Park and Monument Square to the Mayo Mill and connecting the to-be-developed DOT parcel to the Chamber of Commerce/boat ramp area.

The long-term timeline is referred to as the Framework - Long-Term Goals enhancement strategy, which embraces additional broader-scale visions and strategies that optimize the long-term benefits to the Town in meeting the established objectives. The conceptual Framework - Long-Term Goals strategy is shown in Figure 17.

Long-term goals feature more substantial investments in riverfront infrastructure and connectivity. Within Memorial Park, the consolidation and reorientation of the existing parking area will support the development of a larger park space along the riverfront with expanded walking paths and additional park amenities. Moving east, a pedestrian bridge across the Piscataquis River and a boardwalk connecting the Mill to the Main Street Bridge will create a permanent pedestrian connection between the Memorial Park and the Chamber of Commerce. To reinforce these goals, Dover-Foxcroft would need to pursue parcel acquisitions for the existing A.E. Robinson & Redemption Center Lots, supporting a wider green space along the river with improved accessibility and gathering spaces.

However, the Framework - Long-Term Goals strategy includes enhancements on properties that are not presently publicly-owned or owned by partner-stakeholders, or may have more notable uncertainty associated with their implementation (such as a pedestrian bridge across the river). This strategy is considered similar to a long-term 'Master Plan' visioning of potential.

In contrast to the existing condition and Upland Zone (Framework - Short-Term Goals and Framework - Long-Term Goals) strategies, the Impoundment Zone enhancement strategies do vary directly for each project alternative. Concept plans integrating Upland Zone and Impoundment Zone enhancement strategies are included in Section 5 and in Appendix C for each alternative.

4.7 RIPARIAN VEGETATION RESTORATION

The landscape enhancement concept designs described above include restoration or enhancement of riparian vegetation in the areas depicted in the plans. These vegetative treatments would occur on both existing riverbank areas, and newly emergent areas. Vegetation management and restoration would also occur in the upstream impoundment areas, consistent with the changes and opportunities represented by the selected alternative.

It should be noted that some stands of invasive vegetation such as Japanese knotweed are already present along the river corridor in selected areas. Measures will be put in place in project design and construction to prevent the spread of these species to the newly emergent impoundment areas consistent with dam management options. Invasive vegetation management may consist of pre-treatment, along with selected seeding and planting of native riparian plants in an effort out-complete the noxious weeds.

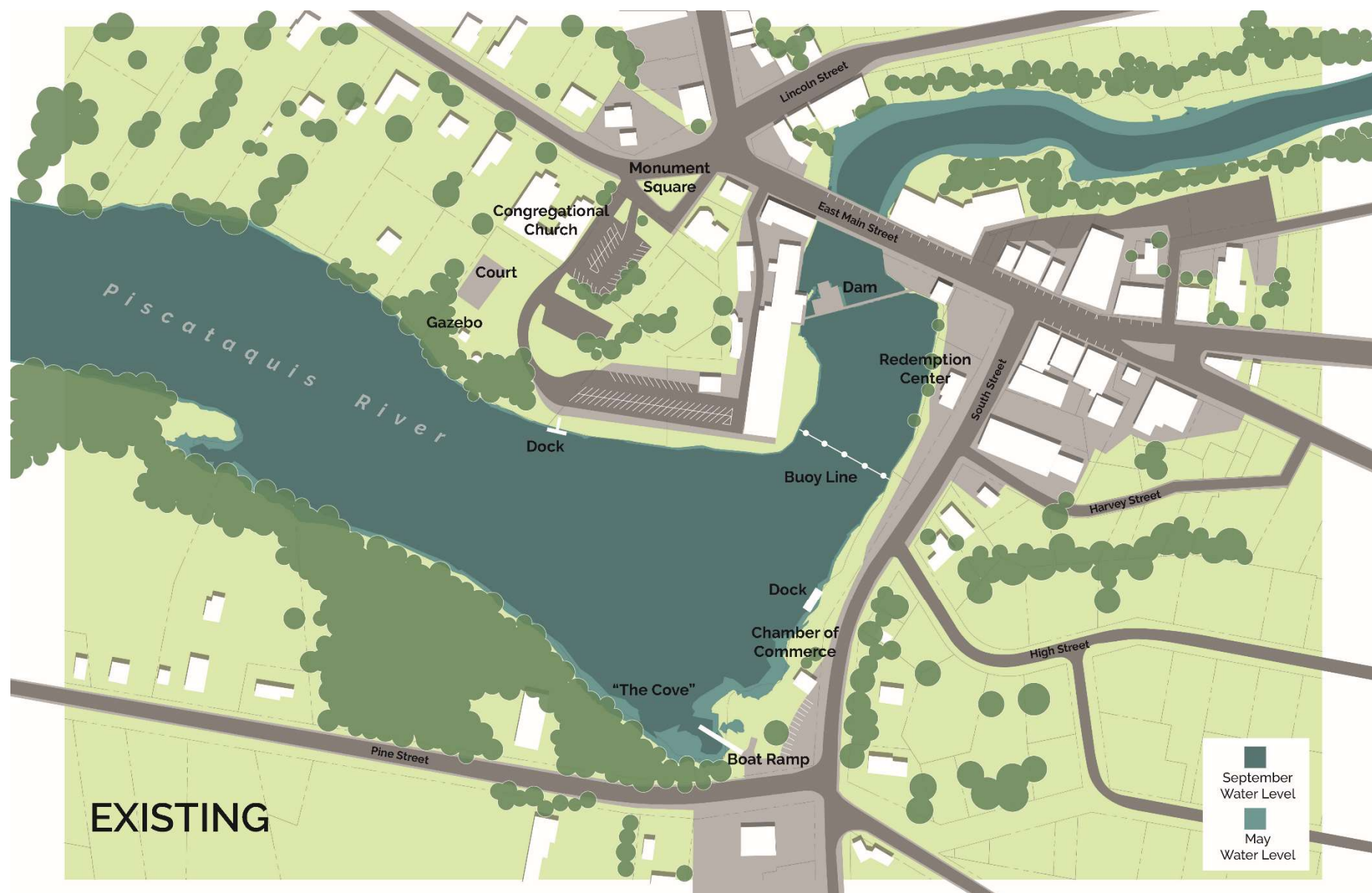


Figure 15. Existing Conditions Landscape Design Framework.

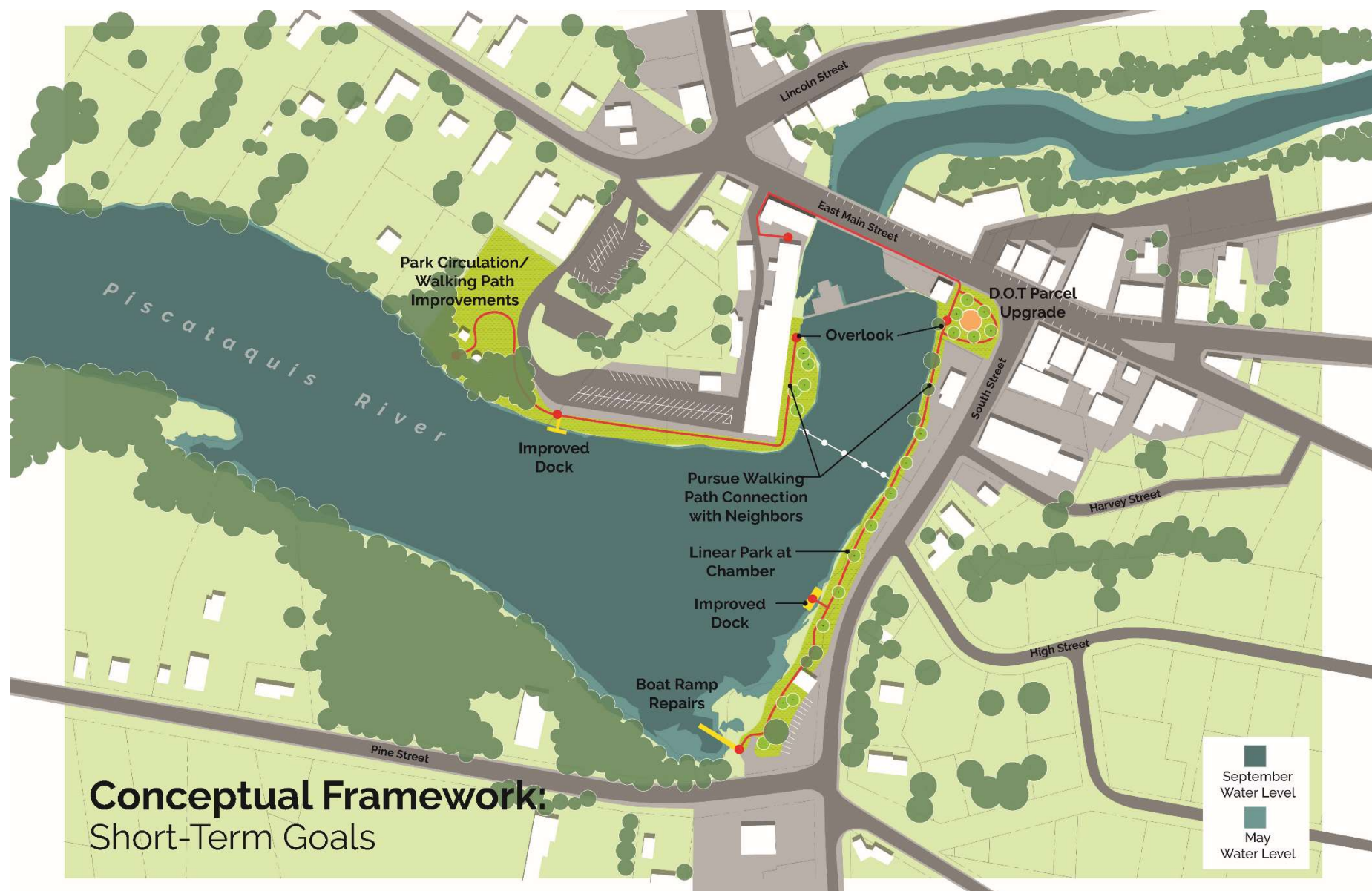


Figure 16. Conceptual Plan for Framework - Short-Term Goals enhancement strategy for the Upland Zone.

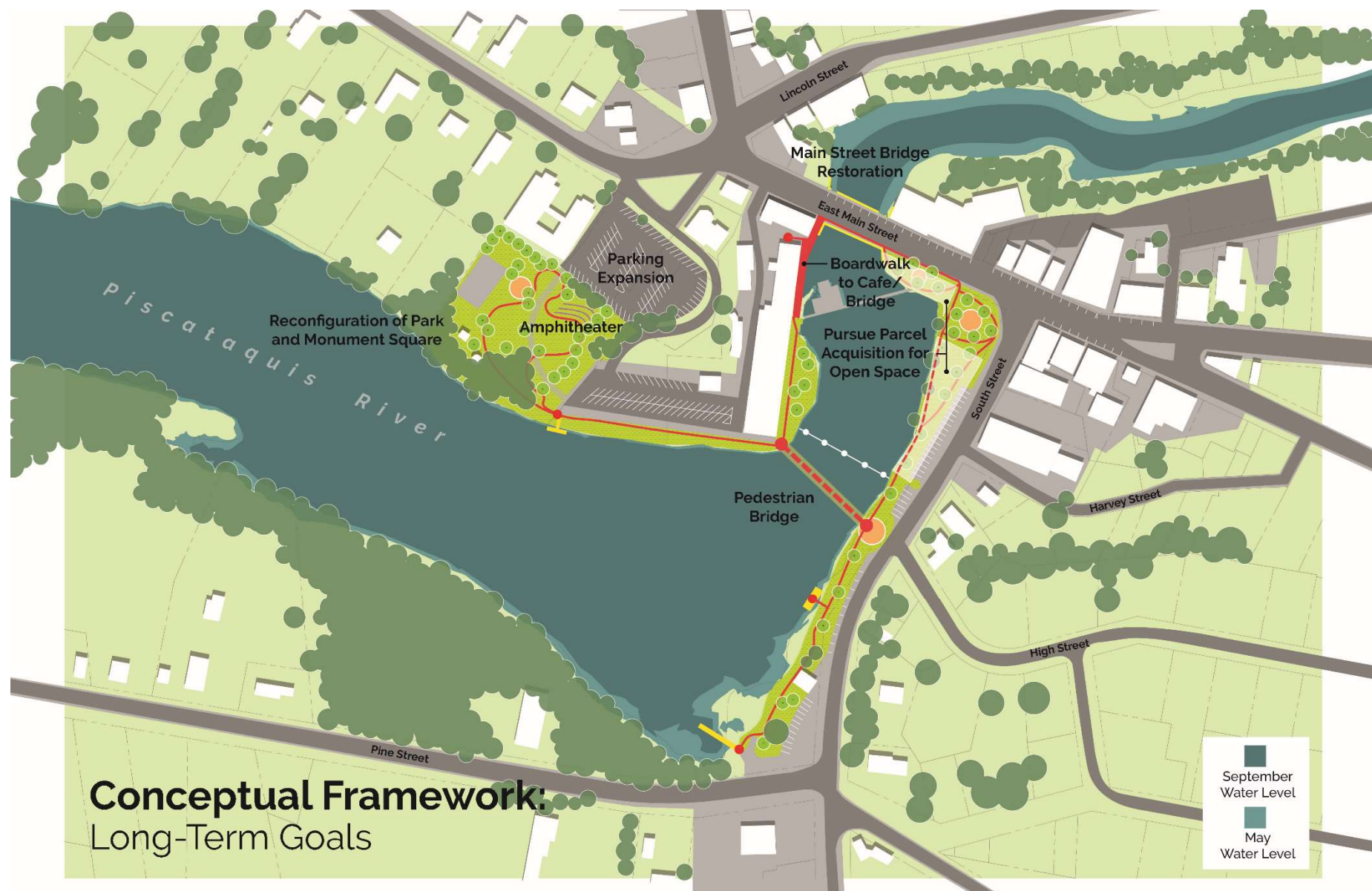


Figure 17. Conceptual Framework - Long-Term Goals enhancement strategy for the Upland Zone.

5. Mayo Mill Dam Selected Alternative

To address the goals and objectives established for the project, in this section we summarize the feasibility of the selected management approach for the site.

5.1 IDENTIFICATION OF PROJECT ALTERNATIVES

As noted earlier in this report, following articulation of the primary project goals and associated objectives (Section 2), the Committee and Study Team engaged a process to narrow a broad range of potential project options to a short list of three to five alternatives for detailed study. The broad range of potential project options was identified in the Preliminary Project Options Summary & Screening Matrix Memorandum (Inter-Fluve et al. 2023b), presented to the Committee at the July 18, 2023 meeting. Following review of the broad range of alternatives, the Committee selected five action alternatives to study in detail at the August 15, 2023 meeting. These five action alternatives, along with a no action alternative, are summarized in Table 10, and in the project's Feasibility and Alternative Analysis Report (Inter-Fluve et al. 2023c). Following review of the five action alternatives, the Committee and Study Team selected Alternative R1/R2, Dam Removal, as the preferred alternative. This alternative is detailed in the following section.

Table 10. Summary of Alternatives selected by the Committee for detailed study. Alternatives numbering scheme retained from preliminary screening matrix for consistency.

#	Alternative
0	No Action
M1	Retain Spillway and Impoundment, New Vertical Slot Fishway on River Left, FERC Exemption Surrendered
L1	Retain Spillway, Lower Impoundment 5 Feet, New Vertical Slot Fishway on River Left, FERC Exemption Surrendered
N6	Replace Dam with 3% Bank to Bank Nature-Like Fishway, Retain Upstream Impoundment, FERC Exemption Surrendered
N7	Replace Dam with 2% Bank to Bank Nature-Like Fishway, Lower Upstream Impoundment 5 Feet, FERC Exemption Surrendered
R1/R2	Dam Removal, FERC Exemption Surrendered

5.2 SELECTED ALTERNATIVE R1/R2 – DAM REMOVAL

Alternative R1/R2 comprises two variations of complete dam removal. Alternative R1 as originally defined included dam removal down to the existing ledge beneath the existing dam structures. Alternative R2 entailed incremental modification of the existing ledge if needed to optimize fish passage performance. Due to the limited nuanced difference between these two variations, Alternatives R1 and R2 were combined into a single alternative for the purposes of this report.

Alternative R1/R2 would remove the existing dam and power house and the existing legacy crib structure located immediately upstream of the existing concrete dam in their entirety. The riverbed and the upstream impoundment area would revert to a free-flowing condition. This alternative would result in surrender of the existing FERC license exemption.

The layout of the for Alternative R1/R2 is represented schematically in Figure 19. Lastly, landscape enhancements (Section 4.7) would be implemented to the extent facilitated by the project alternative. The following paragraphs describe the alternative in more detail.

5.2.1 Dam Modifications

This alternative would entail removing the existing dam and powerhouse structures and any existing legacy structures upstream of the concrete dam spillway. There would no longer be a dam structure at the site.

In addition to removal of the structures, Alternative R2 accounts for incremental ledge modifications which may also be required to optimize this alternative for fish passage restoration. An allowance for bedrock removal (1,380 cubic yards) was included in the conceptual cost estimate analysis for this sub-alternative. The final quantity will not be known until the dam is removed and the bedrock is examined. Therefore, to ensure adequate planning efforts, the quantity assumed for the allowance is conservatively high.

5.2.2 Fish Passage Restoration

Restoration of safe, timely and effective fish passage would be achieved by the complete dam removal, with the river reverting to free-flowing conditions. This alternative will provide the optimal upstream and downstream fish passage conditions among the evaluated action alternatives. Selected ledge modifications may be required after removal of the structures to optimize fish passage conditions for final agreed upon target species or for exclusion goals. The extent of supplemental ledge modification will not be known completely until the structures are removed. Compared to other alternatives assessed, alternative R1/R2 will offer the most complete restoration of safe, timely and effective fish passage past the site and through the impounded reach.

5.2.3 Flood Management and Resilience

The model results indicate that the flood resilience benefits for the Dam Removal strategy for the 100-year return period flood exceed the benefits of the other alternatives in both the downtown area and the South Street-Pine Street area (selected buildings no longer within the flood zone). The flood resilience benefit provided by Alternative R1/R2 offers notable advantages over nature-like fish passage and dam modification alternatives. There would be substantial flood level reduction is realized in the downtown area, enabling removal of buildings from the 100-year base flood inundation area. In addition, due to the incremental flood profile reductions offered by Alternative R1/R2, buildings in the South Street-Pine Street area are also able to be removed from the 100-year base flood inundation area.

Figure 20 displays the range in flood profile reduction for this alternative for a series of peak flow events. Section 4.3 of the report provides additional detail on the flood resilience benefits of this Alternative for the 100-year base flood case.

5.2.4 Impoundment

With Alternative R1/R2, the impoundment condition would transition from a ponded condition to a free-flowing river condition upstream of the dam location (Figure 21). This would include a variety of riffles and pools, with periodically spaced clusters of legacy glacial boulders and bedrock outcrops throughout. It is estimated that a moderately large residual pool area would remain in the reach between the dam location and The Cove. The impoundment area would narrow most substantially under Alternative R1/R2 and may be most notable in the cove area. Figure 22 and Figure 23 show the river inundation extents for a range of ambient flow conditions under Alternative R1/R2.

5.2.5 Sediment Management

Sediment management with Alternative R1/R2 would share similarities with the other alternatives. It would be required in the area adjacent to the facilities slated to be removed, such as the existing powerhouse structure. In addition, moderate sediment management may be included in selected areas of emergent riparian zones in conjunction with shoreline restoration activities along the lower impoundment area (Riverfront Park, along South Street). Lastly, more notable sediment management may be required in The Cove area. The removal of the impoundment will increase the proportion of the accumulated sediment that may be mobilized by high flow events. Incremental sediment management may also be considered to support landscape enhancement of that area.

The estimated quantity of sediment management is 16,500 tons. The cost analysis also includes a sediment removal contingency of 7,000 tons. The sediment management estimates are conservative pending further detailed evaluation and final design resolution. The actual final implemented quantity of sediment management may differ and may be less.

Sediment management and removal would be facilitated by carefully controlled impoundment drawdown to limit the amount of sediment mobilized during the drawdown period. Sediment to be managed would likely be removed by mechanical means. Additional trapping of sediment would be included in the control of water plan, enabling a portion of the sediment that is mobilized during the drawdown period to be trapped and removed from a location near the dam location.

5.2.6 Features and Low-Lying Infrastructure

With Alternative R1/R2, impacts to existing features and low-lying infrastructure would include the existing dry hydrant and the existing FAA-registered seaplane base.

Dry Hydrant

With the reduction in the impoundment water level, the function of existing dry hydrant (installed 2019) located along Riverfront Park may be impacted. The Study Team understands that this hydrant is a secondary fire protection facility, used primarily for training purposes. The

functionality of the dry hydrant would need to be mitigated if this secondary fire protection system were desired to be perpetuated in the future due to the removal of the impoundment in the area.

Seaplane Base

The second facility that could be impacted by lowering the impoundment is the private Federal Aviation Administration (FAA)-registered seaplane base (ME85). The Study Team understands the seaplane base is used periodically by selected private individuals during the summer months. Based on anecdotal accounts, the Study Team understands the typical aircraft utilizing the seaplane base range from Cessna 172 to Cessna 182 sizes (Brenenstuhl 2023). The seaplane base registration includes a defined water lane (water runway) that is 3,600 feet long and 300 feet wide.

The potential implications of impoundment lowering on the seaplane base were reviewed by the Study Team. As the seaplane base is a private base, it is not required to comply with FAA design guidelines that apply to public facilities, and in the event of changed conditions, the base owner is required to communicate the changes to the FAA. Because the changes discussed are not due to the actions of the seaplane base owner, early coordination with the owner is strongly encouraged.

The Study Team performed a preliminary review of the potential adaptation of the sea plane base functionality under the lowered impoundment conditions, based on the guidelines in FAA Advisory Circular 150/5395-1B (FAA 2018). Based on the capabilities of the Cessna 182, the minimum practical water lane length is 1,645 feet, and when there is a 50-foot obstacle it must clear, the requirement increases to 2,463 feet⁶. A width of 200 feet is considered a reasonable width for most sea plane bases, while a narrower width may be considered in constrained cases if the aircraft can operate safely under prevailing wind conditions. Water operating areas should be a minimum of 4 feet deep, while 6 feet is recommended.

Figure 18 provides a hypothetical comparison between the defined ME85 water lane dimensions to the minimum water lane dimensions for the Cessna 182 aircraft (with and without obstruction). This comparison suggests the required dimensions to serve the Cessna 182 could be notably less than the ME85-defined dimensions.

The functionality of the seaplane base would be substantially impaired by Alternative R1/R2. The seaplane base would likely need to be mitigated through relocation of the base to a new nearby location, conversion of the landing gear to amphibious gear, or some combination of these and other measures.

Sewer Overflow Pipe

In addition to the upstream features, a legacy combined sewer overflow pipe is located below the water line at the end of Green Street. Per Maine DEP records, this overflow is inactive at the present time. With Alternative R1/R2, this legacy outfall may need to be modified or decommissioned, pending further review and coordination.

⁶ Wipaire, 2023. Retrieved online at: [Cessna 182 Skylane Floats, Mods and Services | Wipaire](#)

Powerhouse and Buildings

Lastly, the alternative would remove the dam and powerhouse structures. In addition, supplemental scour protection would be provided along the building and retaining walls near the present location of the dam.

5.2.7 Landscape Restoration, Revitalization, and Recreation

Suggested conceptual landscape enhancement ideas specific to Alternative R1/R2 are shown in Figure 24 that add to the Short-Term and Long-Term goals as described in Section 4.6. The removal of the dam presents many opportunities for connectivity and restoration within the reclaimed impoundment. Walking paths and green spaces can extend further towards the river, creating more gathering spaces, meandering trail systems, and raised boardwalks/docks to access the water. The reduced water level could allow for moderate improvements to connectivity, including a 150' pedestrian bridge to span the Piscataquis River, as well as expanded walking paths and connections to regional trail systems upriver through partnerships with neighboring parcels.

These concepts also include additional walking paths along the river near the Mill building and expanding the vegetation restoration at the Cove area. Impoundment character would transition from flatwater to a free-flowing river. The river would generally be narrower with swifter currents, conducive to recreational paddling and canoeing, and other activities such as wading and fishing. One interesting accent would be to extend the finish line for the annual Piscataquis River Race from the present location in the Academy Island area to the area of Mayo Mill, at the water gateway to downtown Dover-Foxcroft. The water depths would be most conducive to non-motorized paddling. The degree of landscape enhancements with Alternative R1/R2 is the greatest among the five action alternatives.

5.2.8 Ecological Restoration Benefits

Aside from complete restoration of safe, timely and effective fish passage compared to the other action alternatives, a plethora of additional secondary ecological restoration benefits (water quality & temperature, invasive or non-native aquatic species habitat elimination, riparian habitat, freshwater mussel restoration, potential instream spawning and rearing habitat for Atlantic salmon) would be maximized by Alternative R1/R2. This is due to the conversion of the impounded reach to a free-flowing riverine condition.

5.2.9 Operation and Maintenance Considerations

Alternative R1/R2 would largely eliminate operation and maintenance requirements from the river corridor by eliminating structures from the river. Periodic maintenance of the vegetation along the river banks and new landscape amenities would be required over time.

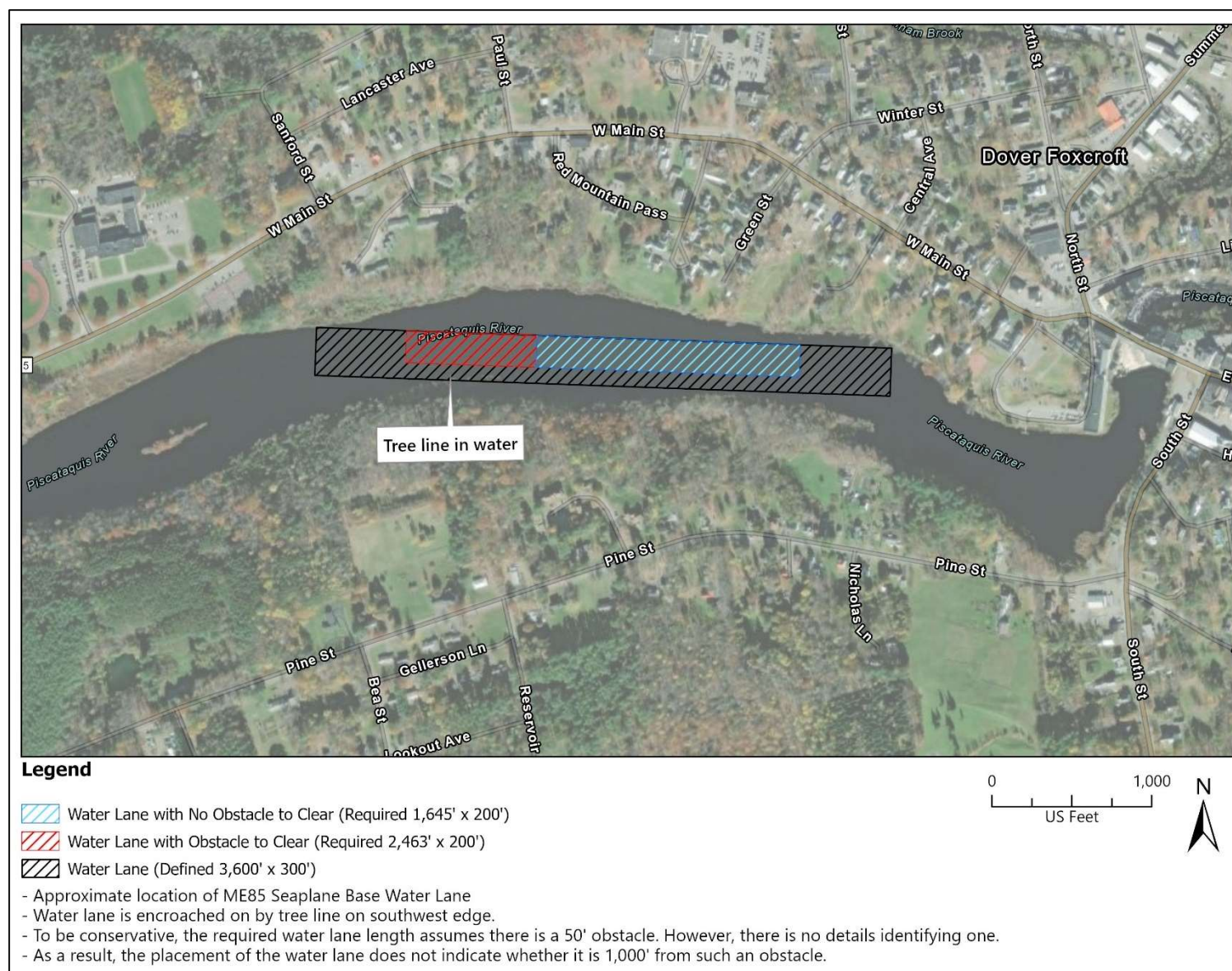


Figure 18. Hypothetical comparison of water lane dimensions defined for seaplane base ME85 to minimum requirements for Cessna 182 aircraft.

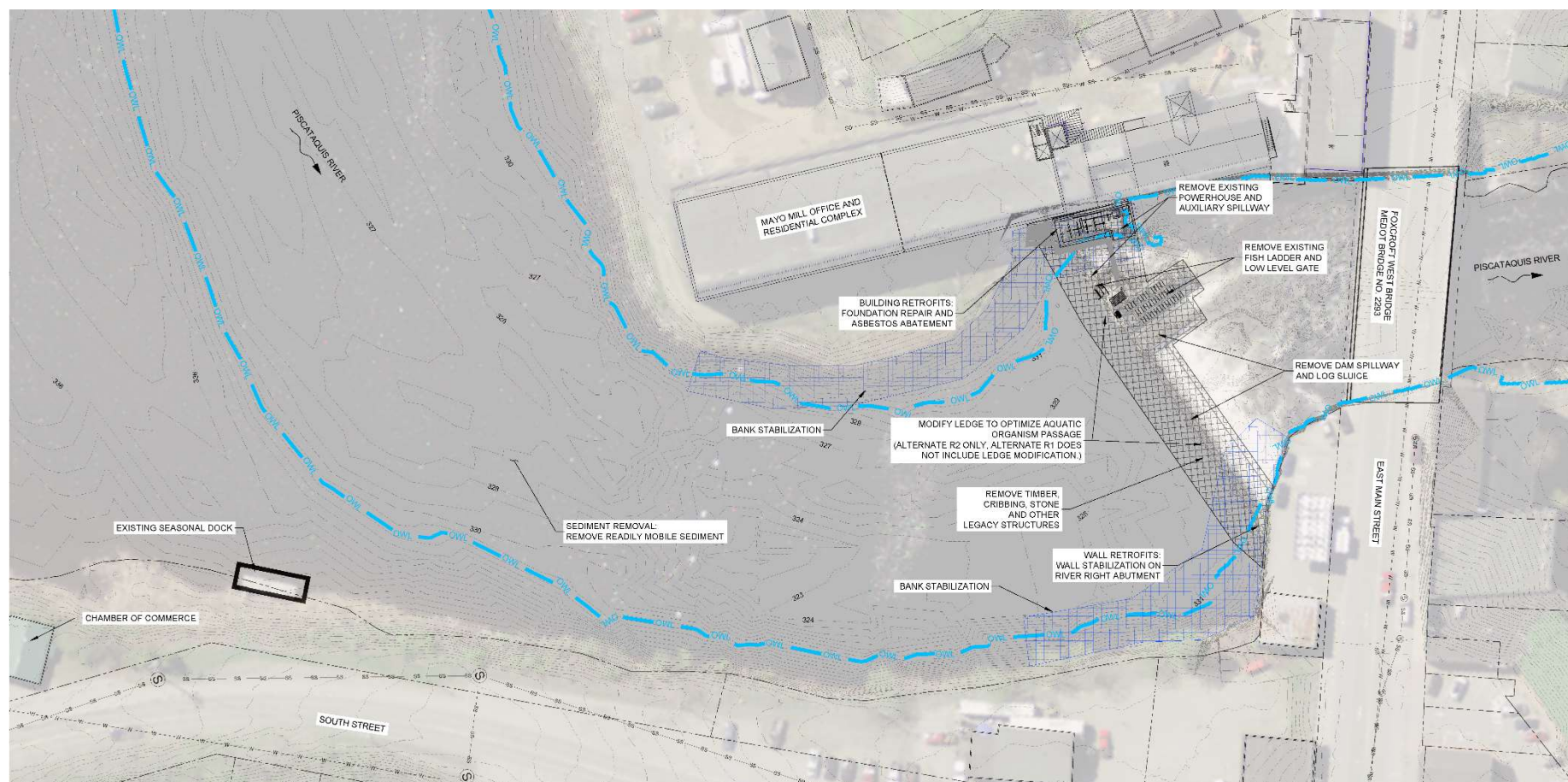


Figure 19. Schematic depiction of Alternative R1/R2.

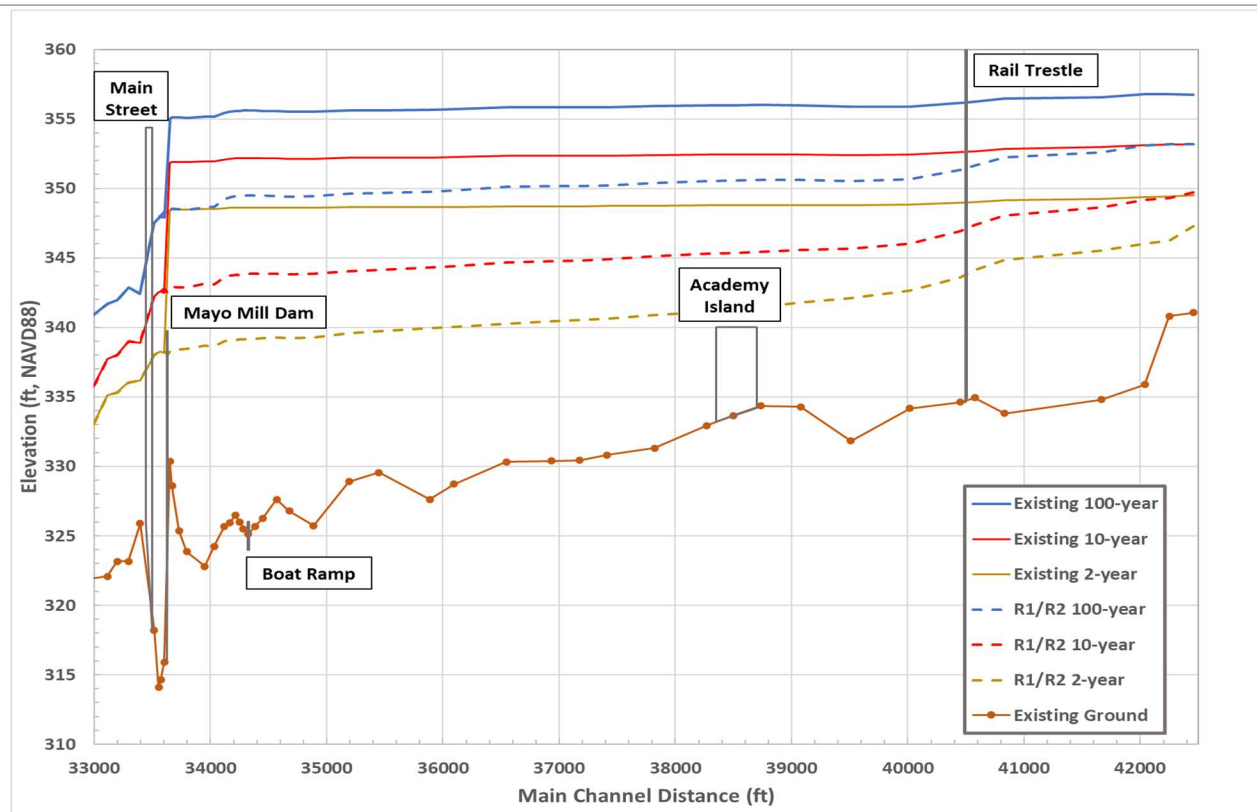


Figure 20. Longitudinal profile comparing the simulated water surface elevations for the existing condition and the estimated range provided by Alternative R1/R2.

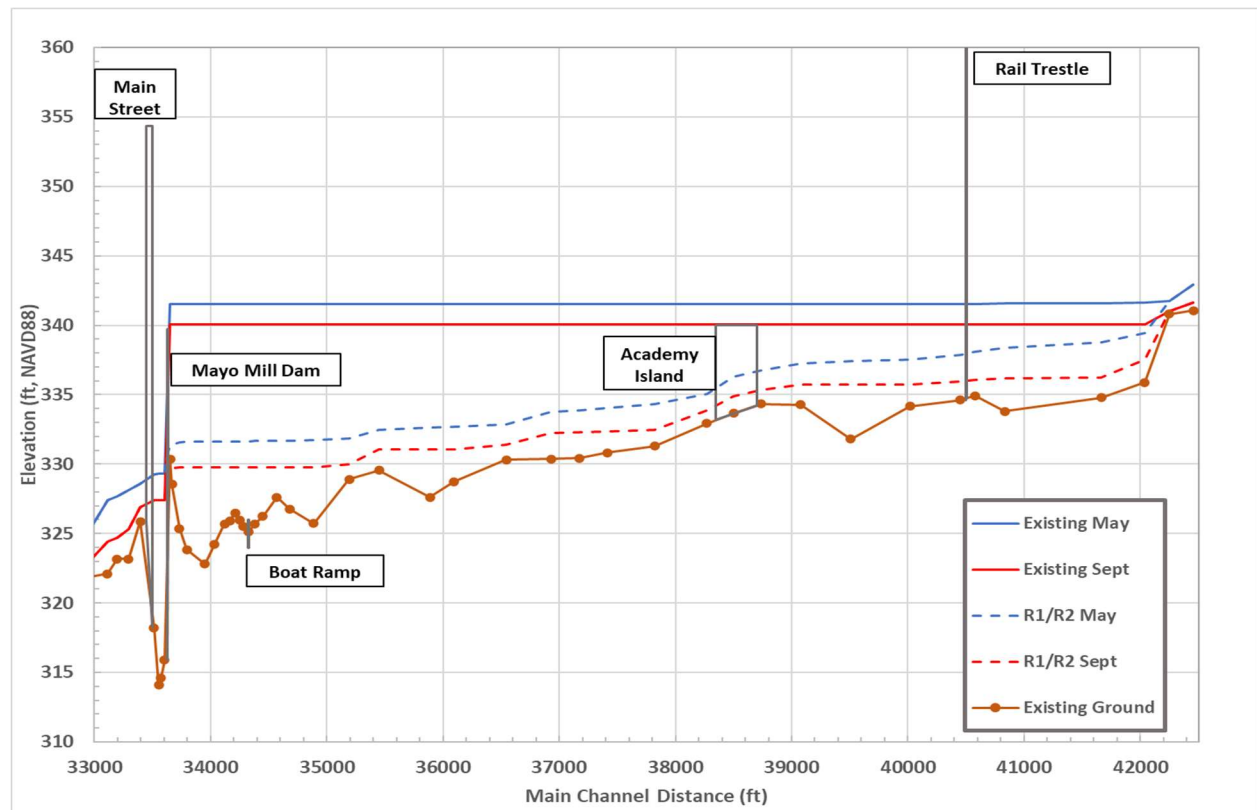


Figure 21. Longitudinal profile comparing the simulated typical water surface elevations for the existing condition and the estimated range provided by Alternative R1/R2.

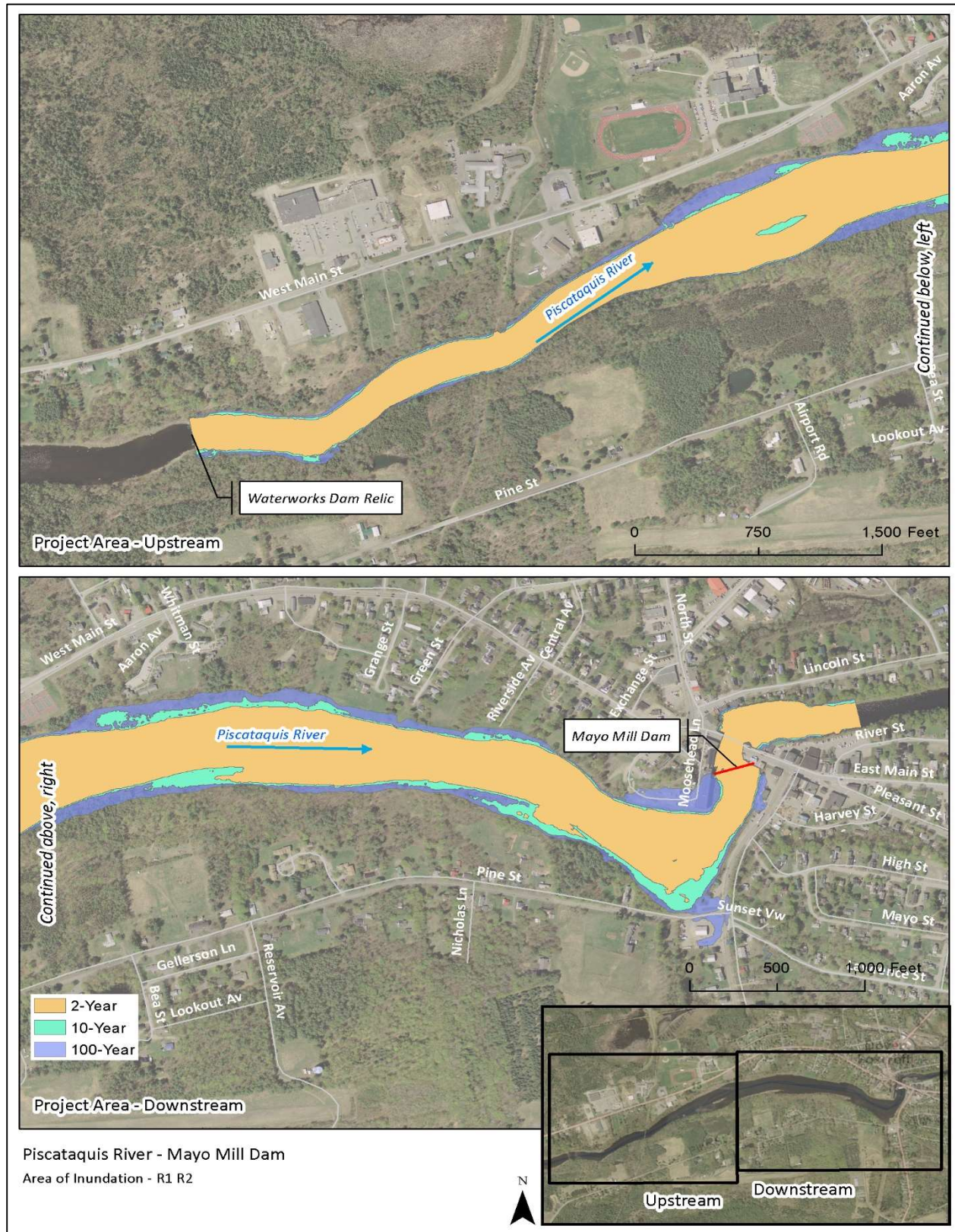


Figure 22. Inundation extents for 2-year (orange), 10-year (cyan), and 100-year (magenta) flow events with Alternative R1/R2.

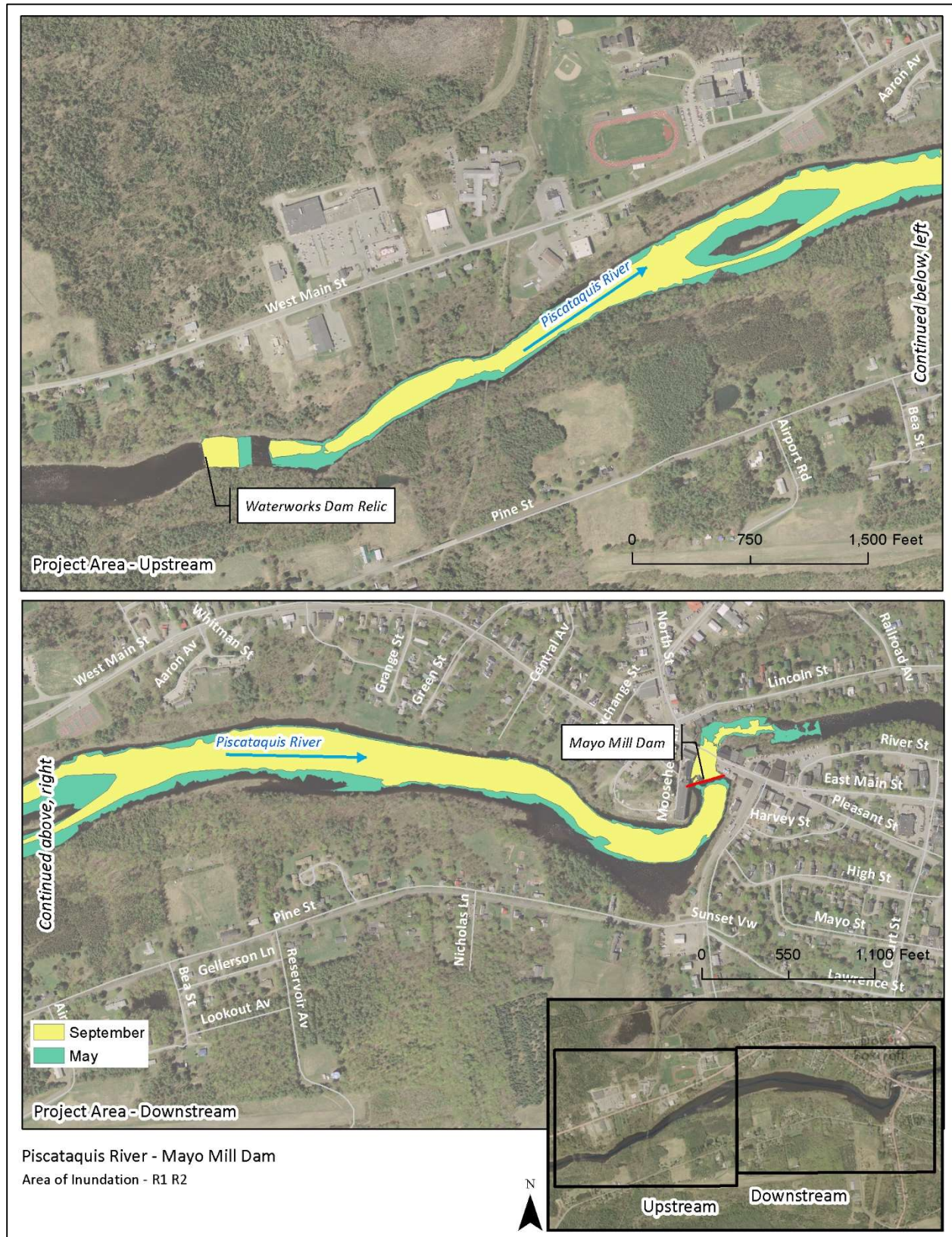


Figure 23. Inundation extents for May (green) and September (yellow) flow events with Alternative R1/R2.



Figure 24. Landscape Enhancement concept design for Alternative R1/R2, integrating alternative specific enhancements for the Impoundment Zone with the Short-Term and Long-Term goals for the Upland Zone.

6. Summary

A qualitative comparison of the five action alternatives detailed in the project's Feasibility and Alternatives Analysis Report (Inter-Fluve, 2023c) noted the relative merits and drawbacks of the alternatives relative to key criteria. Overall, the selected alternative of dam removal was judged to be favorable with respect to each evaluation criteria. These considerations included:

- Fish Passage: dam removal provides the greatest ecological and recovery benefits
- Flooding Resiliency: dam removal provides the greatest resiliency benefits
- Landscape amenities: dam removal provides the greatest opportunities
- Construction costs: dam removal would provide the lowest cost to the Town
- Grant funding: dam removal is associated with the most competitive grant funding potential
- Operations and maintenance: dam removal would entail the lowest O&M requirements and lowest lifecycle costs

7. Cost Analysis

Opinions of probable cost were developed for the selected alternative of dam removal. The cost opinion is intended at the present juncture primarily to enable relative comparison between options, with additional design development recommended to result in cost opinions that are suitable for advanced planning and fundraising.

According to the definitions developed by the American Association of Cost Engineering (AACE 2016), the goal for the cost analysis fits in the range of Class 4 estimates, with a published accuracy range of -30% to +50%. The cost analysis includes design, permitting, construction, and estimated operation and maintenance costs for a fifty-year planning horizon. The cost opinions were prepared in 2023 dollars, except as noted.

The cost opinions have been developed based on review of construction costs for similar items in past projects and applicable reference cost data. The actual costs of implementation of the project may vary from the 90% OPC estimate, based on heavy construction market fluctuations and other unforeseen factors, ongoing design development and possible optimization, and other considerations. In particular, recent bid results (2018-2022) have seen substantial escalation and volatility in bid pricing, experienced before, during and after the COVID-19 pandemic.

Conversations with construction contractors suggest costs may continue to escalate with increased stimulus and infrastructure spending, rising rates of inflation, rising material and fuel costs, and labor shortages. This cost opinions include a 30% construction cost contingency that includes considerations for the uncertainty due to the current level of design and these market factors. Refinement of designs, quantities and unit prices will continue in subsequent design phases.

7.1 ASSUMPTIONS

Several assumptions were required to facilitate preparation of the cost analysis, discussed below.

7.1.1 Sediment management

As noted in Section 4, accumulated sediment is present behind the Mayo Mill Dam. The estimates of sediment volumes requiring management will be refined in future design phases through additional sediment probing and coordination with stakeholders and regulatory agencies. Sediment management may constitute a primary cost factor at this site.

Due to the uncertainty associated with the sediment volume required to be managed for the dam removal alternative (R1/R2), conservatively high assumptions regarding sediment management were made. The cost estimates for Alternative R1/R2 assume sediment management of approximately 15,000 cubic yards (23,500 tons - base of 16,500 tons and contingency for 7,000 tons) of potentially mobile sediment, from impoundment zones 1 and 2. The cost estimates include an overall 30% contingency on top of the contingency line item specifically for sedimental removal. Supplemental sediment testing at the site in the next design phase would allow the sediment management options, and therefore costs, to be refined and optimized, if Alternative R1/R2 is advanced as the selected alternative.

7.1.2 Mitigation of Potential Feature and infrastructure impacts

Potential feature and low-lying infrastructure impacts associated with the project alternatives were reviewed generally in Section 3.3, and more specifically as directly relate to each alternative in Section 5. Preliminary costs for mitigation of impacts to these features, if any, were not included in the cost analysis. Follow-up analyses of potential project-related impacts and negotiation of associated mitigation will be required in future phases of project planning. Potential mitigations of flooding hazards that currently exist, which are not caused by the project alternatives, were also not considered in the cost analysis.

7.1.3 Analysis of Lifespan Costs

Annual operation and maintenance costs and periodic inspection and repair costs were included in the cost analysis. Dam removal was associated with the least lifespan cost, although some ongoing costs were assumed, especially at the sites in the town center area. Among the dam site, the upstream dams that will require more ongoing management during the fish passage season relative to maintaining lake levels were assigned higher lifespan costs than the options where the dam sites in the town center would be maintained, as those facilities would require less notable management.

Lifespan costs are presented in two ways. First, the estimated recurring costs in 2023 dollars were escalated for an assumed 4.2% rate of inflation over the 50-year period and aggregated to represent a total lifespan cost. Second, the total lifespan costs were discounted to estimate the sum in 2023 dollars that would be required to be invested (in 2023) at a 2% effective interest rate (actual interest minus inflation) to pay for the total aggregated cost.

The 4.2% rate of inflation was selected based on the RS Means Heavy Construction Index (RS Means 2023) over the from 1985 to 2023. The index is regionally adjusted to Lewiston, Maine.

7.2 ADDITIONAL CONSIDERATIONS

While not explicitly quantified in the cost analysis, additional factors bear consideration when evaluating the project options, discussed below.

7.2.1 Grant Funding

In addition to the raw costs for construction, it is important to consider the eligibility and competitiveness of the project to gain external funding, as these funding sources may dramatically reduce the net cost to the Town. Presently, there are unprecedented, once-in-a-generation levels of funding available, often with little local match requirement, for holistic, mutually beneficial projects with resilience, fish passage, and ecological restoration objectives, including multiple grant programs from NOAA, U.S. Fish and Wildlife Service, and the National Fish and Wildlife Foundation (NFWF). There is also significant potential funding available for proactive flood hazard abatement through FEMA’s Building Resilient Infrastructure and Communities (BRIC) and other programs. The requirements, complexities, and competition for funding through each of these programs varies.

There also appear to be potential funding opportunities for downtown revitalization and outdoor recreation opportunities, through partners such as Maine DOT, Maine Department of Conservation, and the Maine Downtown Center.

In contrast, even though there are some funds available that focus specifically on aging infrastructure, this funding is often reserved for high hazard dams or other essential infrastructure, especially if they are also able to in part contribute to climate resilience (e.g., viable hydropower facilities). Based on these factors, the highest likelihood of near complete funding for managing the dam and fish passage elements of the project rests with dam removal.

7.2.2 Collateral Economic Benefits

Studies conducted across New England have shown that dam removal results in improved economic value in the surrounding communities (Krasovskaia 2015; MassDER 2015, Stringer 2022, Leisher et al., 2022; Provencher et al., 2008). In many instances, proximity to an impounded river in Maine lowers a property’s value due to factors such as flooding (Krasovskaia 2015; Stringer 2022). Data from past dam removals in Maine show that dam removal resulted in increased property value for river proximity, making houses near undammed rivers more attractive for property owners (Krasovskaia, 2015; Lewis et al., 2008; Bohlen and Lewis, 2009; Lewis and Landry, 2017). Similarly, studies conducted on dam removals in Massachusetts have shown that dam removal resulted in increased economic activity and the creation of jobs (MassDER 2015).

With increasing precipitation and changing flooding patterns as a result of climate change, areas on the right riverbank are increasingly vulnerable to flooding. There is a plethora of benefits to be realized by bolstering the resiliency of the downtown area against major floods. First, by removing

built structures such as businesses and homes from the FEMA Special Flood Hazard Zone, requirements for mandatory flood insurance may be alleviated. By reducing flood depths in areas that are still expected to be inundated, the degree of damages may be substantially reduced.

Removing the dam also substantially reduces the potential for flooding on Route 7 (South Street), which constitutes not only a potential nuisance but a public safety issue. Inundation, especially for long periods of time, risks impact to public utilities on the road, road washouts and the replacement of fill, paving, striping, etc. following flooding. Removing the dam provides the opportunity to avoid the costs associated with loss of service and repairs to the road and impacts to public utilities.

General considerations of flood damage avoidance suggest that, on average, for every dollar spent on damage avoidance approximately 6 to 12 dollars of voided repair costs are realized (e.g., Multi-Hazard Mitigation Council 2019). Recognizing that the areas of downtown Dover-Foxcroft within the FEMA base flood zone include businesses, homes, and a significant transportation corridor, removing these areas from flooding impacts would result in a significant long-term benefit to the Town. At the same time, eliminating or modifying aging structures which no longer serve their intended purpose alleviates maintenance requirements and the risk associated with damage to under-maintained structures, and associated damages to surrounding buildings and infrastructure if they become compromised.

7.3 COST ANALYSIS SUMMARY

The results of the cost analysis are summarized in Table 11. In general, the initial construction costs for dam removal were lowest of all the alternatives evaluated during the alternatives analysis phase. Additionally, dam removal options were estimated to have the lowest life span costs of the options that were considered. Lastly, the full dam removal options are most likely to draw support from external funding sources associated with ecological recovery and infrastructure resiliency initiatives.

Table 11. Summary of estimated cost analysis for dam and fish passage project elements, rounded. Includes total initial costs and does not include landscape costs. See Appendix F for detailed cost analysis.

Alternatives	Total Estimated Initial Costs	Estimated Lifespan Cost
	Construction Costs* + Project Delivery Cost**	Total Aggregated Lifespan Cost*** (4.2% Inflation over 50 years)
	(\$)	(\$)
Alternative R1		
Dam Removal (No Ledge Removal) ++	\$5,979,700	\$0 - \$364,800
Alternative R2		
Dam Removal (With Ledge Removal) ++	\$6,308,500	\$0 - \$364,800

*Includes 30% design and construction contingency.

**Includes project management, permitting, design, construction management and construction observation.

***Includes annual and periodic repair costs escalated at 4.2%, estimated for relative comparison

†Likely limited potential for grant funding

++Likely greatest potential for grant funding

Table 12. Summary of estimated cost analysis for landscape enhancement project elements, rounded. Includes total costs and does not include dam or fish passage project element costs.. See Appendix G for detailed cost analysis.

Alternatives	Total Estimated Costs	Estimated Lifespan Cost
	Construction Costs* + Project Delivery Cost**	Total Aggregated Lifespan Cost*** (4.2% Inflation over 50 years)
	(\$)	(\$)
Alternative R1/R2		
Landscape Framework: Short-Term and Long-Term Goals	\$13,800,300	\$15,016,900

*Includes 30% design and construction contingency.

**Includes project management, permitting, design, construction management and construction observation.

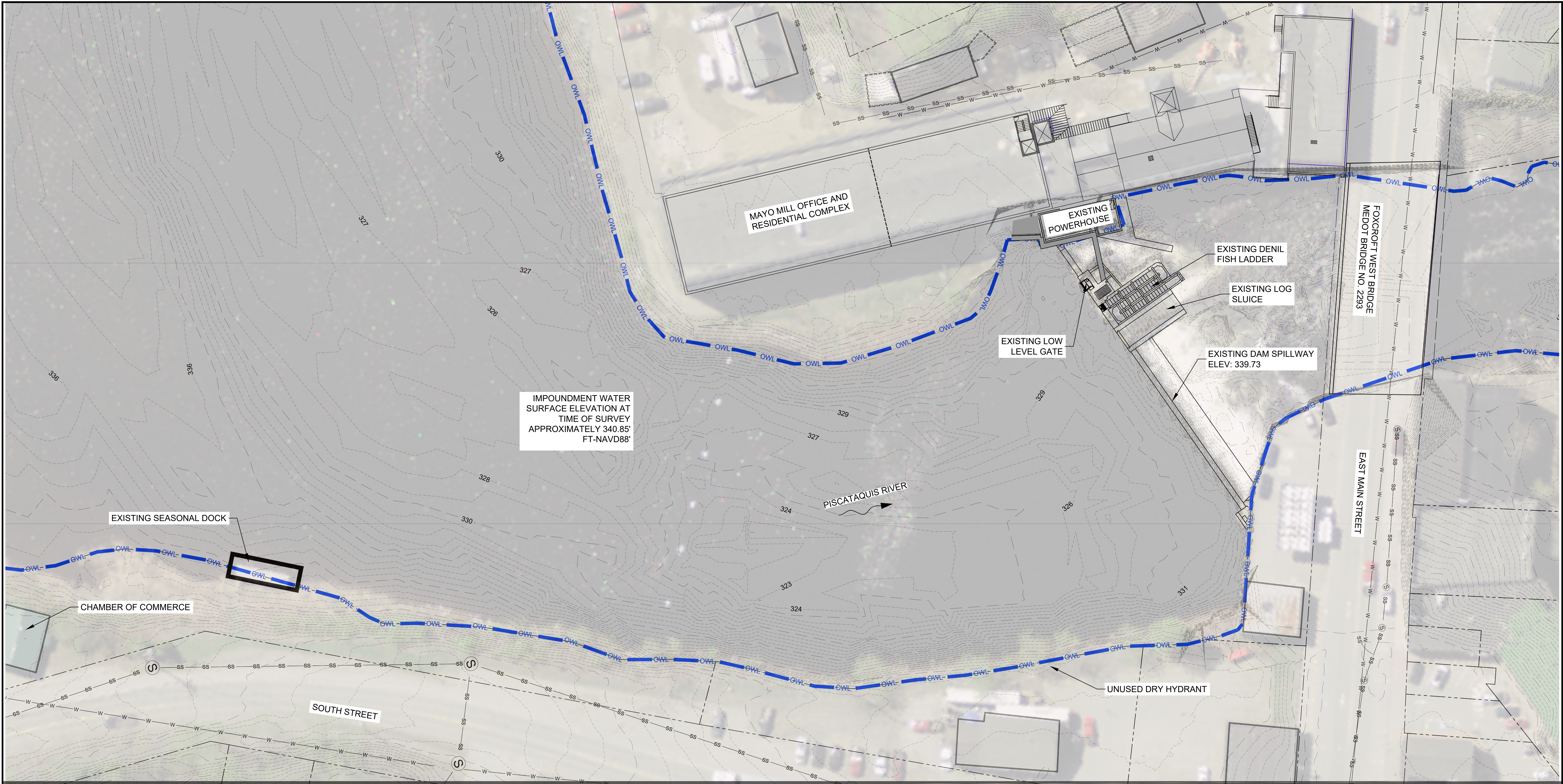
***Includes annual and periodic repair costs escalated at 4.2%, estimated for relative comparison

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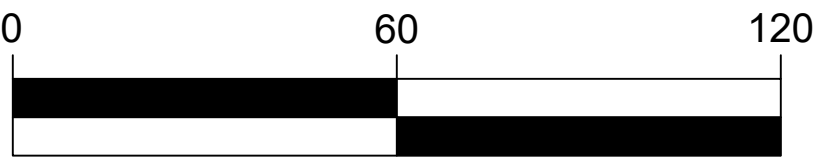
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Appendix A - Dam Removal Schematic Layout



LEGEND

- EXISTING 1 FT. CONTOUR
- EXISTING 5 FT. CONTOUR
- PARCELS
- Ⓢ-SS-SS SEWER LINE WITH MANHOLE
- W---W--- WATER LINE
- OWL — EXISTING SPRING WATER LEVEL



SCALE IN FEET
(AS SHOWN ON 22" X 34" SHEET)

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NO.	BY	DATE	REVISION DESCRIPTION

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DRAWN	DESIGNED	CHECKED
----	10-31-23	22-05-26
APPROVED	DATE	PROJECT

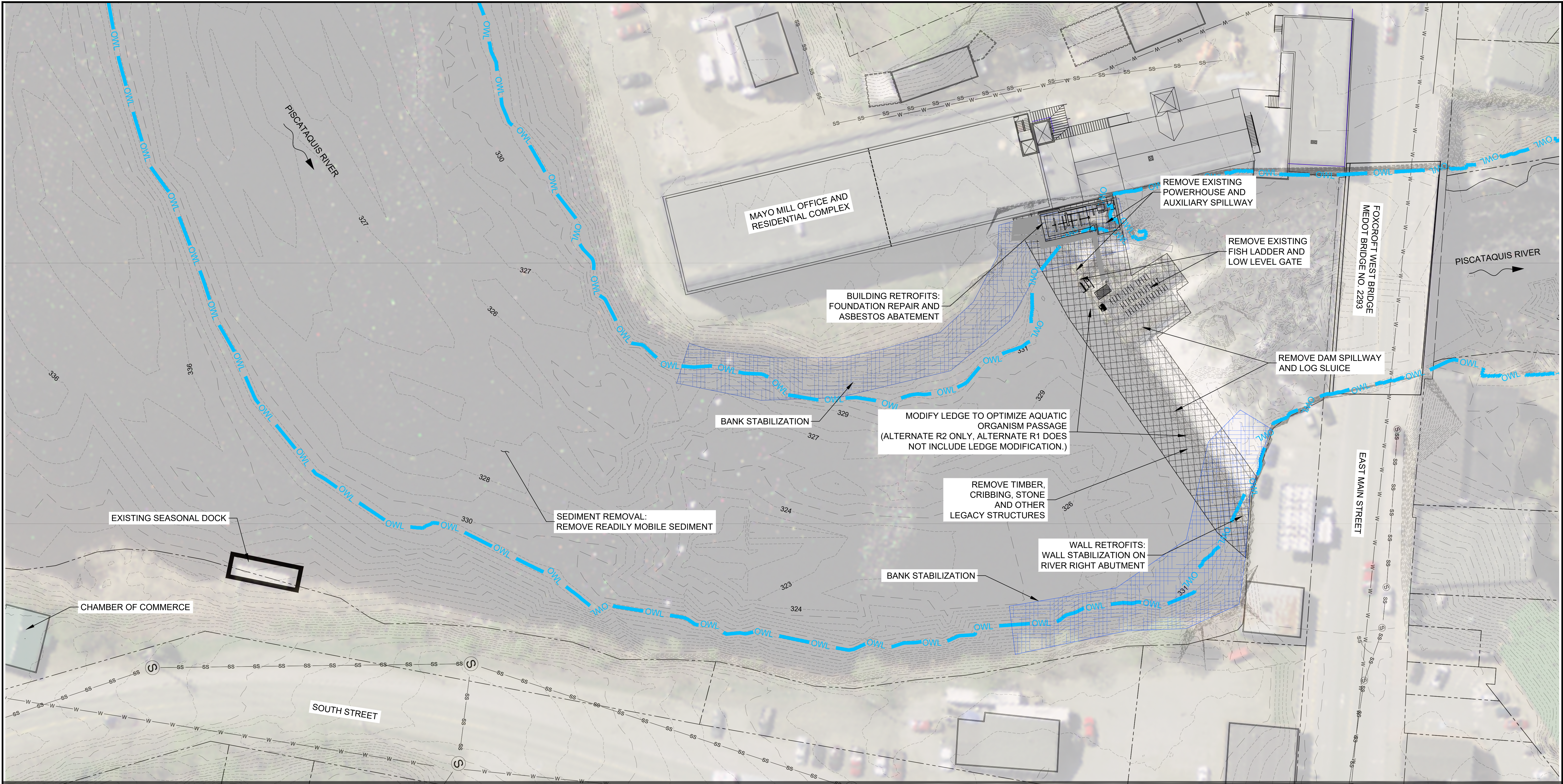
MAYO MILL FEASIBILITY STUDY
ATLANTIC SALMON FEDERATION
TOWN OF DOVER-FOXCROFT, ME



165 Main Street, Suite 2 B
PO Box 236
Damariscotta, ME 04543
207.315.7014
www.interfluve.com

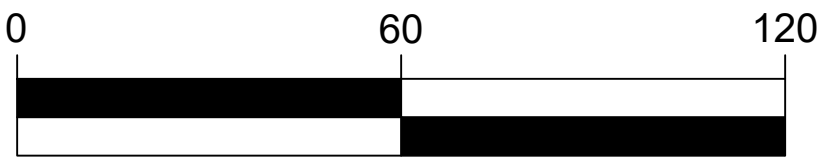
ALTERNATIVES ANALYSIS
EXISTING CONDITIONS

SHEET
EC



LEGEND

- EXISTING 1 FT. CONTOUR
- EXISTING 5 FT. CONTOUR
- PARCELS
- SS SS SS SEWER LINE WITH MANHOLE
- W W W WATER LINE
- OWL PROPOSED SPRING WATER LEVEL
- AREA OF BANK STABILIZATION
- AREA OF STRUCTURE REMOVAL



SCALE IN FEET
(AS SHOWN ON 22" X 34" SHEET)

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NO.	BY	DATE	REVISION DESCRIPTION

KD	MYS	MB
DRAWN	DESIGNED	CHECKED
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ALTERNATIVE ANALYSIS
DAM REMOVAL
(ALT. R1/R2)

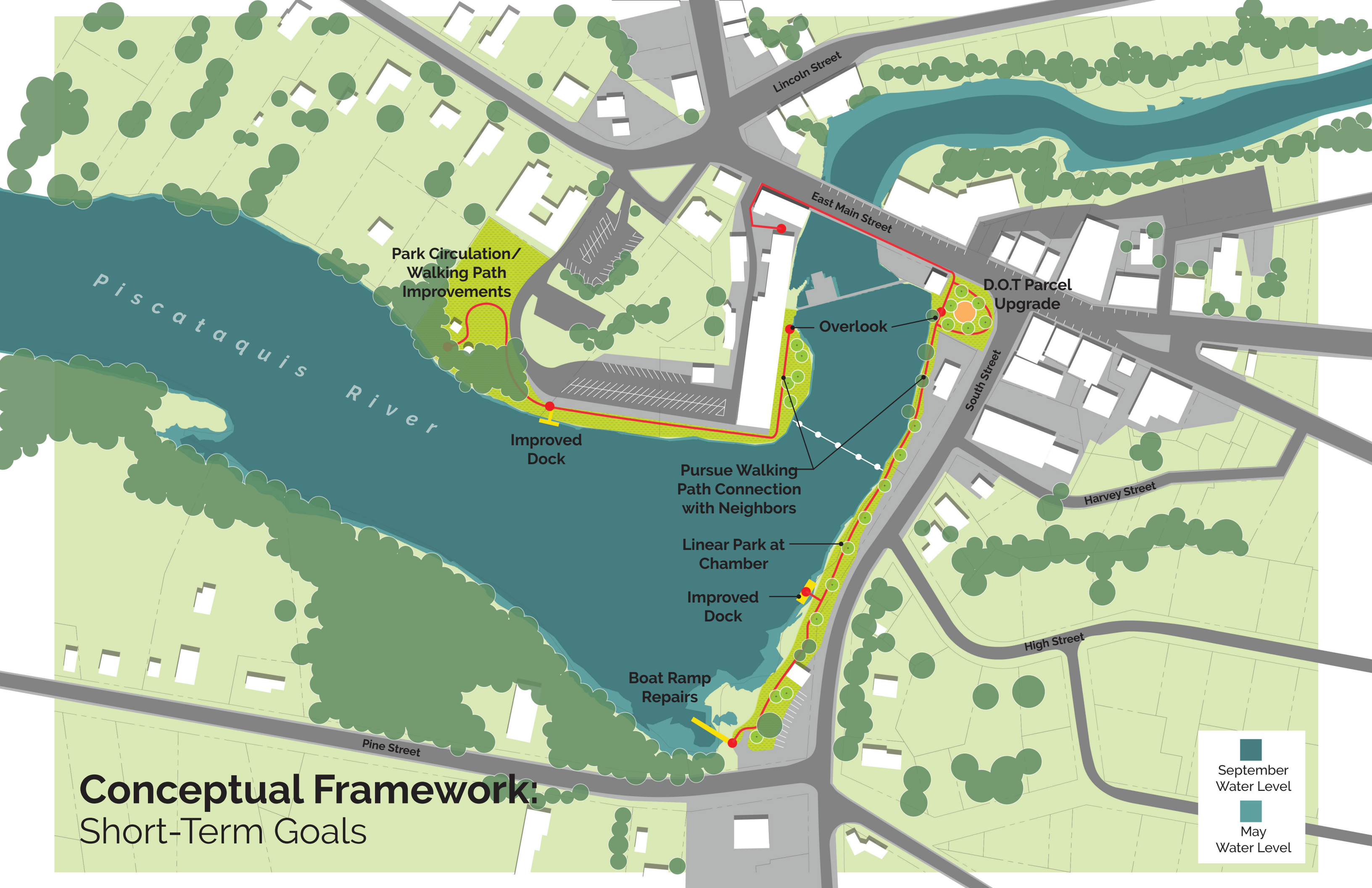
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R1/R2

Appendix B - Landscape Enhancement Concept Plan



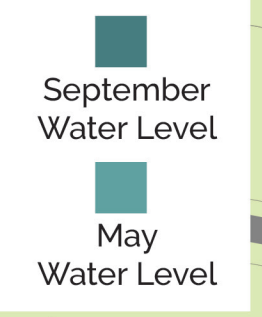
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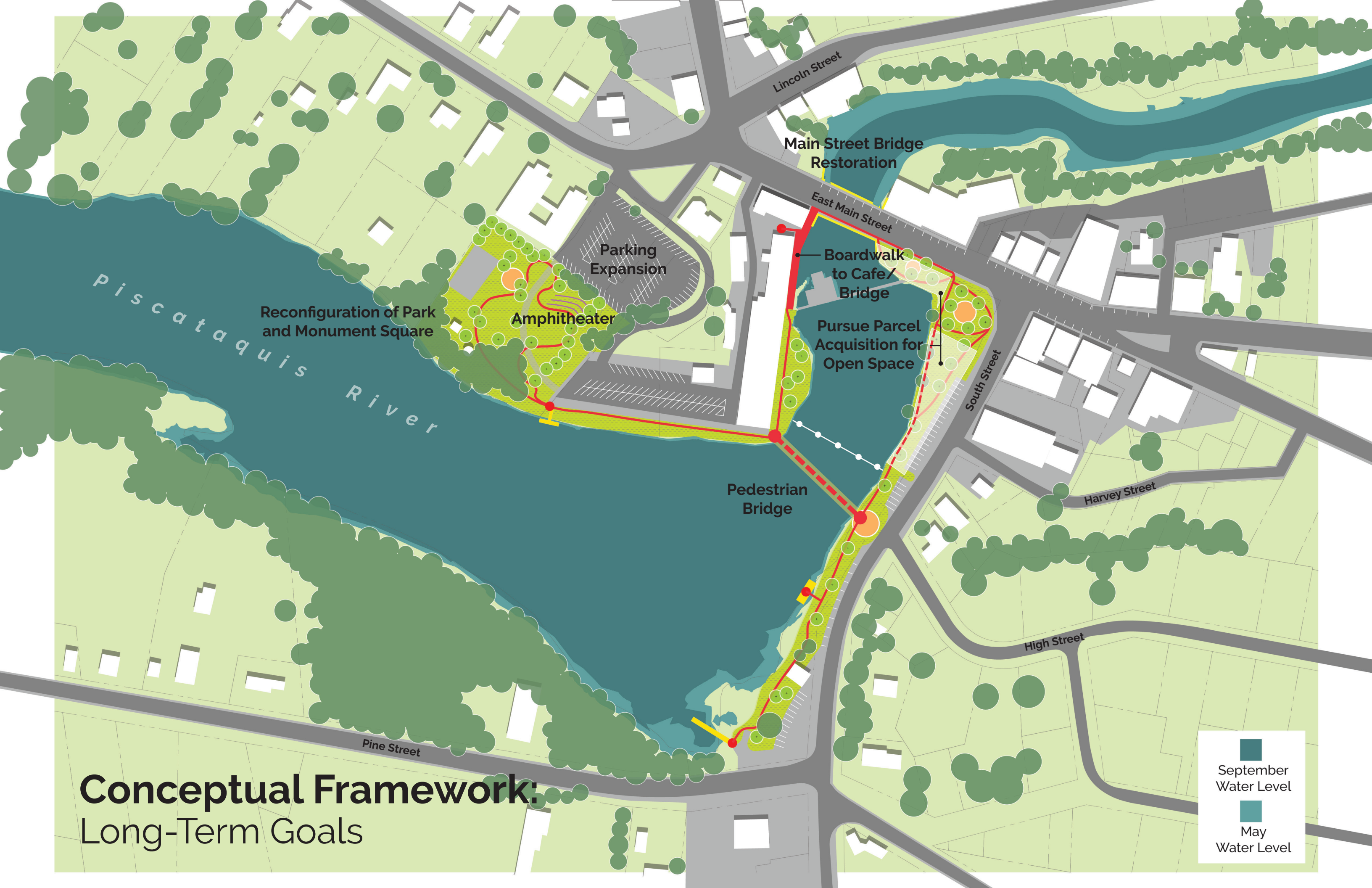




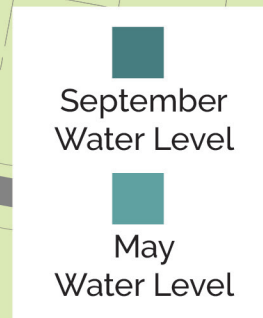
Conceptual Framework:

Short-Term Goals





Conceptual Framework: Long-Term Goals





Conceptual Goals: Dam Removal

Appendix C - Landscape Rendering



Figure C-1. Existing condition looking upstream at Mayo Mill Dam, June 20, 2022.



Figure C-2. Schematic depiction of Alternative R1/R2 with Long-Term Landscape Framework Goals indicated. Edge of existing impoundment indicated by break from yellowish vegetation to darker green vegetation.

Appendix D - Detailed Selected Alternative Summary Table

Table D1. Evaluation table comparing project options to identified evaluation criteria.

Option	Hydropower Generation	Impoundment Water Level	Flooding and Resiliency	Dam Structure & Facilities	Impacts to Facilities and Infrastructure	Fish Passage Effectiveness	Ecology & Water Quality	Public Access and Use	Historical & Educational Value	Community Plans & Aesthetic	Relative Construction Cost ¹	Long-Term Life Span Costs ²	Key Uncertainties & Focus Factors
R1/R2: Dam Removal, Dam Removal with Additional Ledge Modifications	Retired	Level reduced, some residual pool may persist	- Current: greatest reduction - Future: reduction - Enhancements: none	- Current: removed - Spillway capacity: N/A - O&M: N/A - O&M costs: N/A	- Bridge: no change - Hydrant: require adaptation - Sea plane: require adaptation - Docks: require adaptation	- Upstream effectiveness: high - Attraction: excellent - Species: All - Capacity limitation: no - Downstream: excellent - Compliance: not required	- Water quality: substantial improve - Habitat restoration: greatest improvement - Non-native species: habitat eliminated - Watershed connectivity: greatest improvement - Climate resilience: greatest improvement	- Current: adapt to lower level and river flow - Future: enhance, as consistent with lower level and river flow	- Historical: consistent, powerhouse repurpose potential - Educational: high, enhance interpretation	- Consistent with plans: yes - View: change from pond to flowing river with exposed boulders, riffles, and ledge	- Initial cost: \$4.9M-\$5.2M - Grant eligibility: best	- Costs: 360K to N/A - Revenue: no	- Sediment management - Ledge manipulation requirements - Optimize revegetation

¹ Includes estimated construction cost, plus 30% contingency. Rounded.

² Includes total aggregated lifespan cost over 50-year period, escalated for 4.2% inflation. Rounded.

Appendix E - Detailed Cost Table for Dam Removal

Table R1A. Conceptual Cost Estimate Analysis for Mayo Mills Dam, Dam Removal, No Bedrock Removal

Estimated Initial Project Costs						
Construction Cost Items						
No.	Item	Quantity	Unit	Unit Cost	Total Cost	Notes
Direct Costs						
1	Mobilization	1	LS	\$ 466,500	\$ 466,500	15% of other items; includes clearing and grubbing; traffic control as necessary
2	Water Control	1	LS	\$ 150,000	\$ 150,000	Recent bids, Engineer's Judgement
3	Erosion and Pollution Control	1	LS	\$ 75,000	\$ 75,000	Misc. Control Activities
Site Work						
4	Dam Removal	1	LS	\$ 175,000	\$ 175,000	Removal of Concrete, Log Sluice, Gatehouse, etc. to River Bed/Bedrock
5	Gatehouse Abatement	1	LS	\$ 50,000	\$ 50,000	Asbestos Abatement
6	Wall Retrofits	1	LS	\$ 20,000	\$ 20,000	Wall Stabilization at right retaining wall.
7	Building Retrofits	1	LS	\$ 40,000	\$ 40,000	Foundation Repair
8	Sediment Removal and Disposal	16,500	TON	\$ 70	\$ 1,155,000	Potential sediment management includes excavation and disposal to an in-state facility, large quantity pricing
9	Sediment Removal Contingency	7,000	TON	\$ 70	\$ 490,000	Potential sediment management includes excavation and disposal to an in-state facility, large quantity pricing, conservative contingency
10	Remove Timber Crib	1	LS	\$ 40,000	\$ 40,000	Remove legacy timber crib structure
11	Channel Work DS/at Dam	100	LF	\$ 500	\$ 50,000	Tailwater Riffle, Boulder Placement
12	Restore Passage at US Legacy Dam	1	LS	\$ 40,000	\$ 40,000	Shape Existing Boulders, Minor Supplements
13	Bank Stabilization	1,000	LF	\$ 1,000	\$ 1,000,000	May include fabric encapsulated soil lift, toe stone, fabric, other bank restoration in LA estimate
14	Fencing, Signage, and Appurtenances	1	LS	\$ 50,000	\$ 50,000	Estimated, Needs Advanced Design to Optimize
Site Landscape & Restoration						
15	Site Enhancement					See LA Opinion of Cost
			Construction Subtotal		\$ 3,801,500	
			Contingency (30%)		\$ 1,140,500	
Project Construction Total					\$ 4,942,000	
Initial Project Delivery Costs						
Item				Estimated % of Construction Cost	Total Cost	Notes
Project Management				2.0%	\$98,800	
Permitting				2.0%	\$98,800	
Engineering Design				10%	\$494,200	
Construction Contract Administration				2.0%	\$98,800	
Construction Observation				5.0%	\$247,100	
Initial Project Delivery Costs Total				21%	\$1,037,700	
Total Initial Project Costs					\$5,979,700	

Lifespan Costs - 50-year planning horizon

Item	Event Cost (2023 dollars)	Intervals	Total Cost (2023 dollars)	Total Aggregated Cost (Escalated for 4.2% Inflation over 50 years)	Total Capitalized Cost (2023 Investment to Finance Total Aggregated Cost, Assumes Interest Exceeds Inflation by 2%)
Annual Operation and Maintenance Estimated Cost (Every Year, On Average)	\$1,000	50	\$50,000	\$162,500	\$31,800
Repair and Rehabilitation Estimated Cost (Every 10 Years)	\$10,000	5	\$50,000	\$202,300	\$29,100
Total Lifespan Costs			\$100,000	\$364,800	\$60,900

Table R2A. Conceptual Cost Estimate Analysis for Mayo Mills Dam, Dam Removal, with Bedrock Removal

Estimated Initial Project Costs						
Construction Cost Items						
No.	Item	Quantity	Unit	Unit Cost	Total Cost	Notes
Direct Costs						
1	Mobilization	1	LS	\$ 499,600	\$ 499,600	15% of other items; includes clearing and grubbing; traffic control as necessary
2	Water Control	1	LS	\$ 150,000	\$ 150,000	Recent bids, Engineer's Judgement
3	Erosion and Pollution Control	1	LS	\$ 30,000	\$ 30,000	Misc. Control Activities
Site Work						
4	Dam Removal	1	LS	\$ 175,000	\$ 175,000	Removal of Concrete, Log Sluice, Gatehouse, etc. to River Bed/Bedrock
5	Gatehouse Abatement	1	LS	\$ 50,000	\$ 50,000	Asbestos Abatement
6	Wall Retrofits	1	LS	\$ 20,000	\$ 20,000	Wall Stabilization at right retaining wall.
7	Building Retrofits	1	LS	\$ 40,000	\$ 40,000	Foundation Repair
8	Bedrock Removal	1,380	CY	\$ 160	\$ 220,800	Potential bedrock excavation to promote connectivity
9	Sediment Removal and Disposal	16,500	TON	\$ 70	\$ 1,155,000	Potential sediment management includes excavation and disposal to an in-state facility, large quantity pricing
10	Sediment Removal Contingency	7,000	TON	\$ 70	\$ 490,000	Potential sediment management includes excavation and disposal to an in-state facility, large quantity pricing, conservative contingency
11	Remove Timber Crib	1	LS	\$ 40,000	\$ 40,000	Remove legacy timber crib structure
12	Channel Work DS/at Dam	100	LF	\$ 500	\$ 50,000	Tailwater Riffle, Boulder Placement
13	Restore Passage at US Legacy Dam	1	LS	\$ 40,000	\$ 40,000	Shape Existing Boulders, Minor Supplements
14	Bank Stabilization	1,000	LF	\$ 1,000	\$ 1,000,000	May include fabric encapsulated soil lift, toe stone, fabric, other bank restoration in LA estimate
15	Fencing, Signage, and Appurtenances	1	LS	\$ 50,000	\$ 50,000	Estimated, Needs Advanced Design to Optimize
Site Landscape & Restoration						
16	Site Enhancement					See LA Opinion of Cost
			Construction Subtotal		\$ 4,010,400	
			Contingency (30%)		\$ 1,203,100	
Project Construction Total					\$ 5,213,500	
Initial Project Delivery Costs						
Item	Estimated % of Construction Cost			Total Cost	Notes	
Project Management	2.0%			\$104,300		
Permitting	2.0%			\$104,300		
Engineering Design	10%			\$521,400		
Construction Contract Administration	2.0%			\$104,300		
Construction Observation	5.0%			\$260,700		
Initial Project Delivery Costs Total	21%			\$1,095,000		
Total Initial Project Costs				\$6,308,500		

Lifespan Costs - 50-year planning horizon					
Item	Event Cost (2023 dollars)	Intervals	Total Cost (2023 dollars)	Total Aggregated Cost (Escalated for 4.2% Inflation over 50 years)	Total Capitalized Cost (2023 Investment to Finance Total Aggregated Cost, Assumes Interest Exceeds Inflation by 2%)
Annual Operation and Maintenance Estimated Cost (Every Year, On Average)	\$1,000	50	\$50,000	\$162,500	\$31,800
Repair and Rehabilitation Estimated Cost (Every 10 Years)	\$10,000	5	\$50,000	\$202,300	\$29,100
Total Lifespan Costs			\$100,000	\$364,800	\$60,900

Appendix F - Detailed Cost Table for Landscape Enhancement

Table R1B/R2B. Conceptual Cost Estimate Analysis for Mayo Mill Dam, Landscape Site Enhancements, Dam Removal

Estimated Initial Project Costs						
Construction Cost Items						
No.	Item	Quantity	Unit	Unit Cost	Total Cost	Notes
Direct Costs (Near Term, Baseline)						
1	Demolition	1.95	AC	\$ 10,000	\$ 19,500	General demolition within the project area.
2	Erosion Control	2,000	LF	\$ 10	\$ 20,000	Temporary erosion control/silt fence. Includes construction entrance.
3	Rough Grading	1.95	AC	\$ 6,500	\$ 12,700	
Circulation (Near Term, Baseline)						
4	Walking Path	10,000	SF	\$ 8	\$ 80,000	Dense grade or gravel path, 5' wide
5	Furnishings	2,000	LF	\$ 30	\$ 60,000	Bench every 100', assumed waste can, bike rack
6	Signage	1	LS	\$ 60,000	\$ 60,000	four kiosks and small ped signs, potential for interpretive artwork, lighting, and/or parking signage.
Special Construction (Near Term, Baseline)						
7	Paved Plazas	1,200	SF	\$ 30	\$ 36,000	
8	Cantilevered Boardwalk	1,400	SF	\$ 500	\$ 700,000	175' long, 8' Wide, boardwalk to the café, contingent on agreement with the mill owner
9	Overlooks	6	EA	\$ 300	\$ 90,000	5'x10' with railing, benches and substructure, pressure treated wood, baseline item does not include alternative specific outlooks in line 16.
10	Docks	2	EA	\$ 75	\$ 22,500	5'X30', pressure treated wood
11	Boat Ramp	1,000	SF	\$ 15	\$ 15,000	100' long rebuild. Concrete. 10' wide.
Planting (Near Term, Baseline)						
12	Shade trees	30	EA	\$ 1,300	\$ 39,000	15 gal. potted trees
13	Riverbank Restoration	20,000	SF	\$ 18	\$ 360,000	10' wide zone at all river edges, erosion control mat with native seed
14	Lawn/Park	95,000	SF	\$ 3	\$ 285,000	Seeded with occasional groundcovers and ornamental planting
Additional Site Improvements For Alternative R1B/R2B, Near Term						
15	Boat Ramp	1,000	SF	\$ 15	\$ 15,000	100' of additional boat ramp, concrete, 10' wide
16	New Path at Chamber	250	LF	\$ 8	\$ 2,000	Dense grade, gravel path
17	Overlooks	1	EA	\$ 15,000	\$ 15,000	5'x10' with railing, benches and substructure, pressure treated wood, alternative specific overlooks are in addition to the baseline overlooks.
18	Riverbank Restoration	40,000	SF	\$ 18	\$ 720,000	Additional 40' wide zone at all river edges, erosion control mat with native seed.
19	Water Access at DOT	400	SF	\$ 200	\$ 80,000	
20	Restoration at the Cove	80,000	SF	\$ 18	\$ 1,440,000	Erosion control mat with native seed, occasional/strategically placed native plugs
21	Lawn/Park	60,000	SF	\$ 3	\$ 180,000	Seeded with occasional groundcovers and ornamental planting
22	Pedestrian Bridge	150	LF	\$ 22,000	\$ 3,300,000	
Long Term Additions, Baseline - Amphitheater, New Road, and Boardwalk						
23	Demolition	1.2	AC	\$ 10,000	\$ 12,000	For Monument Square improvements, amphitheater and parking expansion, general demolition.
24	Erosion Control	1,000	LF	\$ 10	\$ 10,000	Temporary erosion control/silt fence. Includes construction entrance.
25	Rough Grading	1.95	AC	\$ 6,500	\$ 12,700	Excavation playground area, paths/trails, and field (+/- 1.5 acres)
26	Amphitheater	25,000	SF	\$ 18	\$ 450,000	Monument Square
27	Parking Expansion	25,000	SF	\$ 13	\$ 325,000	Monument Square
28	New Road	8,600	SF	\$ 13	\$ 111,800	Monument Square
29	Cantilevered Boardwalk	600	SF	\$ 500	\$ 300,000	8' Wide, extend boardwalk 75' from the café to the bridge, contingent on near term boardwalk construction.
				Construction Subtotal	\$ 8,773,200	
				Contingency (30%)	\$ 2,632,000	
				Baseline Project Construction Total	\$ 11,405,200	
Initial Project Delivery Costs						
Item	Estimated % of Construction Cost			Total Cost	Notes	
Project Management	2.0%			\$228,100		
Permitting	2.0%			\$228,100		
Site Enhancement Design	10.0%			\$1,140,500		
Construction Contract Administration	2.0%			\$228,100		
Construction Observation	5%			\$570,300		
Initial Project Delivery Costs Total	21%			\$2,395,100		
Total Initial Project Costs					\$13,800,300	

Lifespan Costs - 50-year planning horizon					
Item	Event Cost (2023 dollars)	Intervals	Total Cost (2023 dollars)	Total Aggregated Cost (Escalated 4.2% Inflation over 50 years)	Total Capitalized Cost (2023 Investment to Finance Total Aggregated Cost, Assumes Interest Exceeds Inflation by 2%)
Annual Operation and Maintenance Estimated Cost (Every Year, On Average)	\$82,200	50	\$4,110,000	\$13,354,000	\$2,615,900
Repair and Rehabilitation Estimated Cost (Every 10 Years)	\$82,200	10	\$822,000	\$1,662,900	\$239,600
Total Lifespan Costs			\$4,932,000	\$15,016,900	\$2,855,500