

# Ames Mill Dam Replacement

## *Phase I – Feasibility Study*

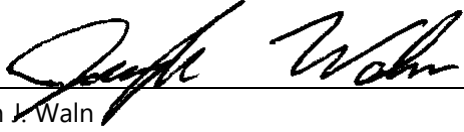
Prepared for  
City of Northfield, Minnesota

November 2023



## Certification

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of Minnesota.



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PE #: 46928

November 13, 2023

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Date

# Ames Mill Dam Replacement

## Phase I – Feasibility Study

November 2023

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## Abbreviations

AEP	annual exceedance probability
AOP	aquatic organism passage
APE	area of potential effects
BWSR	Minnesota Board of Water and Soil Resources
cfs	cubic feet per second
CWA	Clean Water Act
FEMA	Federal Emergency Management Agency
fps	feet per second
LGU	local government unit
MnDNR	Minnesota Department of Natural Resources
NHPA	National Historic Preservation Act
OSA	Office of the State Archaeologist
PWI	public waters inventory
SHPO	State Historic Preservation Office
SWPPP	Stormwater Pollution Prevention Plan
USACE	United States Army Corps of Engineers

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# 1 Executive Summary

## 1.1 Project Objectives

Post Consumer Brands owns and maintains the Ames Mill Dam in the City of Northfield, Minnesota, on the Cannon River.

The dam is a landmark to the local community and a popular feature in the middle of downtown Northfield between Ames Park on the west bank and Bridge Square Park on the east bank. The dam and adjacent features in downtown Northfield are shown in Figure 2-1.

Removal of the dam is being considered for the following safety, recreational, and ecological benefits:

- To improve public safety by removing the hydraulic roller (“drowning machine”) created by flow over the existing low-head dam structure
- To integrate the dam site with planned riverfront park improvements
- To allow for broad-based public recreation in, on, and along the river
- To allow for fish and aquatic organism passage between areas upstream and downstream of the dam

## 1.2 Options for Dam Removal

This feasibility study examines the viability of four options for dam replacement. These options are as follows:

- **Option 1:** Maintain the dam structure as is.
- **Option 2:** Remove the dam and replace it with rock rapids at a 3- to 5-percent slope using a compact footprint (Figure 4-1). The rock rapids would consist of 10 boulder weir structures spaced every 25–30 feet apart. This design would improve recreational and ecological benefits and minimize water level changes. The rapids would be around 250 feet long, extending from Ames Mill Park to the Fourth Street Bridge.
- **Option 3:** Remove the dam and replace it with rock rapids with a 2-percent slope using an expanded footprint. The rock rapids would consist of 10–15 boulder weir structures spaced every 45–55 feet (Figure 4-2). The larger footprint and flatter slope would allow additional recreational and ecological enhancement opportunities. The rock rapids would be around 550 feet long, extending from the Fifth Street Bridge to the Fourth Street Bridge.
- **Option 4:** The same as Option 3, except a portion of the dam structure adjacent to Ames Mill would remain as a visible reminder of the historic dam (Figure 4-3). The rapids area would be narrower because the dam remnant on the west bank would constrain it.

### 1.3 Evaluation of Options

In evaluating the options, the following factors were considered:

#### 1.3.1 River Hydrology and Hydraulics

A goal of the removal project is to maintain water surface elevations at a range of flows. The design elevation of the first rock riffle (899.4 feet) is close to the dam's existing crest elevation (900.2 feet). This would result in no rise for the 100-year water surface elevation. Water surface elevations drop about 1 foot for low flows and 0.6 feet for average flows.

For a comprehensive evaluation of river hydrology and hydraulics, see Section 5.1.

#### 1.3.2 Design and Construction

Construction considerations for the four options include the following:

- Project footprint: A smaller footprint will generally make Option 2 less complex and less costly.
- Water control: The three build options would require water in the Cannon River to be controlled.
- Dam removal: The dam would be entirely removed for Options 2 and 3, and a small portion of the dam would remain for Option 4.
- Sediment removal: Sediment deposition behind the dam must be removed to 1) get to solid foundation material for the rock riffles and 2) achieve the design subgrade. Options 3 and 4 would require more sediment removal.

The relative advantages/disadvantages of each option are outlined in Table 1-1.

**Table 1-1 Construction Considerations**

Construction Considerations	Option 1	Option 2	Option 3	Option 4
Project footprint	N/A	Medium	Large	Large
Water control during construction (relative difficulty)	N/A	Medium	High	High
Dam removal	N/A	All	All	Partial
Sediment removal amount	N/A	Small	Large	Large

For more information on construction considerations, see Section 5.2.

#### 1.3.3 Public Recreation

The drop over the existing dam prevents the public from safely kayaking, canoeing, or swimming through this reach of the river. The Minnesota Department of Natural Resources identified that the dam's submerged hydraulic jump could be a drowning hazard (reference [1]). Options 2, 3, and 4 all remove the hydraulic jump.

In addition to safety, recreational criteria include integrating the rock rapids with Ames Mill Park and possibilities for in-water recreation. Rankings of the options (poor, good, better, best) relative to these criteria are shown in Table 1-2.

**Table 1-2 Recreation Criteria and Rankings**

Recreation Criteria	Option 1	Option 2	Option 3	Option 4
Integration with Ames Mill Park	Poor	Good	Best	Best
In-Water Recreation	Poor	Better	Best	Best
Safety	Poor	Good	Best	Better

For more information on public recreation, see Section 5.3.

### 1.3.4 Aquatic Organism Passage

The Minnesota Department of Natural Resources identified that the existing dam does not provide for upstream aquatic organism passage (AOP, reference [2]). Option 1 maintains the existing condition with a complete barrier to AOP for all flow conditions. There are no identified benefits to this barrier; the dam does not appear to prevent the migration of aquatic invasive species to the upstream Cannon River (reference [3]).

The likelihood of aquatic organism passage under various flow conditions for Options 2, 3, and 4 is shown in Table 1-3. Removal of the barrier and providing for AOP would help to improve habitat and physical connectivity of habitat for fish and other aquatic species within the Cannon River watershed; these two “non-pollutant” stressors (among others) were identified in the Cannon River Comprehensive Watershed Management Plan (reference [4]) as currently impacting fish and macroinvertebrate communities in the watershed.

**Table 1-3 Likelihood of Aquatic Organism Passage under Various Flow Conditions**

Likelihood of AOP	Option 1	Option 2	Option 3	Option 4
Low Flow	Very Unlikely	Likely	Very Likely	Very Likely
Average Flow	Very Unlikely	Depends on Construction	Likely	Likely
Flood Flow	Very Unlikely	Unlikely	Unlikely	Unlikely

Barr recommends that a two-dimensional (2D) hydraulic model be constructed for the selected alternative during the final design to better characterize the complex flow conditions within the rock rapids and verify that the design allows for AOP.

For more information on AOP, see Section 5.4.

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### 1.3.5 Groundwater Drawdown and Subsidence

Based on a review of existing groundwater levels and local geology, a 1997 SEH report (reference [5]) concluded that full dam removal could cause groundwater lowering (drawdown) along the extent of the existing reservoir. A supplemental investigation (reference [6]) estimated that 3 to 9 inches of soil subsidence might occur with full dam removal—potentially affecting structures in the area. Subsidence could also affect sanitary, stormwater, and water main infrastructure, private utilities, and roadways. Another concern with proposed groundwater elevation changes is the potential for contaminated groundwater mobilization if flow directions change.

Replacing the dam with rock rapids (Options 2, 3, or 4) would minimize impacts on groundwater levels and likely avoid the anticipated soil subsidence issues that would be caused by a full removal.

### 1.3.6 Adjacent Infrastructure

The nearby infrastructure includes the historic Ames Mill, the river walk and the sculpture, Sesquicentennial Legacy Plaza, the Fifth Street Bridge, and the Fourth Street Bridge. State Highway 3 runs parallel to the river west of the project area. On the east side of the river, the nearest buildings to the project area are the US Post Office building and the commercial structure at 411 Water Street S.

Additional geotechnical investigation is recommended during the final design to better quantify impacts from residual groundwater drawdown. Depending on the investigation's findings, pre- or post-project foundation improvement can minimize foundation settlement for at-risk structures.

Other recommendations to mitigate impacts to adjacent structures are the following:

- Vibration monitoring
- Pre- and post-construction condition surveys
- Verify bridge foundations are on bedrock
- Verify the location and elevation of stormwater outfall(s)
- Check pre- and post-removal river velocity and erosion potential along river walls.

More information on adjacent infrastructure can be found in Section 5.6.

### 1.3.7 Cultural Resources

There are three historic properties within the project's area of potential effects (APE):

- The Northfield Commercial Historic District
- The Scriver Building
- The Ames Mill Dam

Options 2, 3, and 4 would adversely affect the Northfield Commercial Historic District and Ames Mill Dam by removing some or all of the dam structure. Option 4 would retain a portion of the dam structure to reduce the cultural resources impacts. The Scriver Building is not affected by the project.

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A March 2023 study of potential archaeological resources determined that the potential of intact archaeological resources in the area was low.

For more information on cultural resources, see Section 5.7.

### **1.3.8 Permitting and Environmental Review**

Environmental considerations will require permitting and oversight by various governmental entities. Permitting requirements will depend on several factors, including the dam removal methods, staging area location(s), sediment handling, and other factors depending on the full scope of the project.

Federal, state, and local agencies regulate projects impacting Minnesota’s water resources. Project activities must not be initiated until all applicable federal, state, and/or local approvals have been obtained. These include but are not limited to the following:

- State legislative approval of ownership transfer from Post to the City
- The state environmental review process
- State permits from the Minnesota Department of Natural Resources (MnDNR) regulating activities in the bed of public waters as defined in Minn. Stat. 105 and for dam safety and floodplains
- Federal permits from the USACE for dredged or fill material
- Local permits from the City of Northfield

Additional input will be needed from permitting agencies for design and to determine the scope of additional data necessary to meet environmental review and potential permit requirements, which are anticipated to be consistent among Options 2, 3, and 4.

More information on permitting is provided in Section 5.8.

### **1.3.9 Funding Sources**

Funding for this project is potentially available from the state of Minnesota, the federal government, private foundations, and stream mitigation credits. Table 1-4 outlines the requirements of three sources of funding: the MnDNR, Minnesota Trust Fund, and the U.S. Fish and Wildlife Service.

**Table 1-4 Potential Funding Sources**

	<b>Dam Safety Grant</b>	<b>Outdoor Heritage Fund/Conservation Partners Legacy</b>	<b>Minnesota Environment and Natural Resources Trust Fund</b>	<b>National Fish Passage Program</b>
Activities Funded	Removal of dams for the restoration of stream function, elimination of safety hazards, improvement of property values, fish and wildlife habitat, water quality, water availability, and recreational value	Activities that restore, protect, and enhance wetlands, prairies, forest and habitat for fish, game, and wildlife.	Activities that protect, conserve, preserve, and enhance Minnesota’s air, water, land, fish, wildlife, and other natural resources	Restoration of fish passage
Amount	\$25,000 to \$1 million	No minimum or maximum in general. The small grants Conservation Partners Legacy Program offers \$5,000 to \$500,000	No minimum or maximum	Up to \$2 million
Source	MnDNR	Outdoor Heritage Fund	MN Trust Fund	U.S. Fish and Wildlife Service
Favored Alternative	2, 3, or 4	3 and 4 (for aquatic organism passage)	3 and 4 (for aquatic organism passage)	3 and 4 (for aquatic organism passage)

More information on potential sources and their requirements is available in Section 5.9.

### 1.3.10 Stakeholder Input

Stakeholders include ownership (Post/DNR), City Council, City commissions, historical (SHPO), permitting (DNR/USACE), and funding/ecology (DNR) entities, as well as the public. Stakeholder meetings were held between July 27 and October 11, 2023, to inform option selection and design.

Post is generally supportive of options to remove the dam because the dam no longer serves a functional purpose to the company. Post requests that any alternative to remove the dam include detailed engineering analysis of the potential impacts to the Ames Mill building structural stability and mitigation of any issues identified.

Feedback from members of the public was generally supportive of replacing the Ames Mill dam, with comments focusing on the potential for improved river ecology, aquatic recreation (boating), and public safety (removal of drowning hazard). Some respondents referenced the historic nature of the dam structure and its importance as a symbol of Northfield’s founding as reasons to keep the dam in place.

### 1.3.11 Opinion of Probable Cost

Barr prepared an Engineer’s Opinion of Probable Cost estimates for constructing Options 2, 3, and 4. These concept-level estimates provide a cost range that is 25% below and 50% above the calculated cost value. Table 1-5 summarizes the estimated cost for Options 2, 3, and 4. Cost breakdowns for each option are in Appendix B. These concept-level costs are based on concept-level designs, quantities, and unit prices. Costs will change with further design.

**Table 1-5 Cost Estimation Summary**

	Option 2	Option 3	Option 4
Estimated Total Project Cost (Mid-Range Estimate)	\$3.5M	\$6.4M	\$6.4M
Cost Range (-25% to + 50%)	\$2.6M to \$5.3M	\$4.8M to \$9.6M	\$4.8M to \$9.6M

## 1.4 Summary of Options

Table 1-6 on the following page summarizes how the factors described above apply to the four options.

## 1.5 Recommendation

Based on a comparison of impacts and other factors associated with the alternatives, Barr recommends Option 3 as the alternative that best meets the project purpose.

**Table 1-6 Alternatives Evaluation Matrix**

<b>Criteria</b>	<b>Option 1: No Build</b>	<b>Option 2: Full Dam Removal, Compact Rapids</b>	<b>Option 3: Full Dam Removal, Expanded Rapids</b>	<b>Option 4: Partial Dam Removal, Expanded Rapids</b>
<b>Meets Purpose and Need</b>	No	Yes (partial; see notes)	Yes (partial; see notes)	Yes
<b>River Structures</b>	Existing dam	10 boulder weir structures spaced every 25–30 feet ~1 foot of drop across each structure	10–15 boulder weir structures every 45–55 feet ~0.8–1.0 feet of drop across each structure	10–15 boulder weir structures every 45–55 feet ~0.8–1.0 feet of drop across each structure 20-foot dam remnant
<b>Design and Construction</b>	No change	Compact footprint High velocity, large boulders and base rock	Expanded footprint Lower velocity, smaller boulders and base rock	Expanded footprint Lower velocity, smaller boulders and base rock
<b>Public Recreation</b>	No recreational improvements; hydraulic roller created by flow over the existing structure	Removal of hydraulic roller Boating under low- and average-flow conditions (higher velocity) <sup>(1)</sup> Does not integrate rapids with Ames Park <sup>(1)</sup>	Removal of hydraulic roller Boating under low- and average-flow conditions (lower velocity) Potential for Ames Park connections and river amenities	Removal of hydraulic roller Boating under low- and average-flow conditions (lower velocity) Potential for Ames Park connections and river amenities
<b>Aquatic Organism Passage (AOP)</b>	Complete barrier to fish and aquatic organism passage	Improvements to fish and aquatic organism passage (low flows likely, moderate possible) <sup>(1)</sup>	Improvements to fish and aquatic organism passage (low and moderate flows likely)	Improvements to fish and aquatic organism passage (low and moderate flows likely)
<b>Groundwater Drawdown and Subsidence</b>	No change	Limited potential for change at Ames Mill; limited study recommended	Limited potential for change in project footprint; further study recommended	Limited potential for change in project footprint; further study recommended
<b>Cultural Resources</b>	No change	Complete removal of contributing element to Historic District Will require mitigation <sup>(1)</sup>	Complete removal of contributing element to Historic District Will require mitigation <sup>(1)</sup>	Alteration of contributing element to Historic District May require additional mitigation
<b>Permitting and Environmental Review</b>	No change	Requires EAW, local/state/federal permits	Requires EAW, local/state/federal permits DNR permits more favorable due to AOP	Requires EAW, local/state/federal permits DNR permits more favorable due to AOP

Criteria	Option 1: No Build	Option 2: Full Dam Removal, Compact Rapids	Option 3: Full Dam Removal, Expanded Rapids	Option 4: Partial Dam Removal, Expanded Rapids
<b>Funding Sources</b>	No change	State/federal/private grants may be applicable AOP-focused grants less favorable	State/federal/private grants may be applicable AOP-focused grants more favorable	State/federal/private grants may be applicable AOP-focused grants more favorable
<b>Stakeholder Input</b>	Limited support due to historic structure	No specific comments received on Option 2, inferred lower support than Option 3 due to lower AOP and recreation potential	Public support for improvements to AOP, public recreation, and removal of drowning hazard	Similar to Option 3, no specific comments received on Option 4
<b>Cost</b>	\$0	\$2.6M to \$5.3M	\$4.8M to \$9.6M	\$4.8M to \$9.6M

(1) Evaluation indicates the option partially meets the project purpose and need for this category.

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## 2 Ames Mill Dam Description

### 2.1 General

Post Consumer Brands owns and maintains the Ames Mill Dam in the City of Northfield, Minnesota, on the Cannon River.

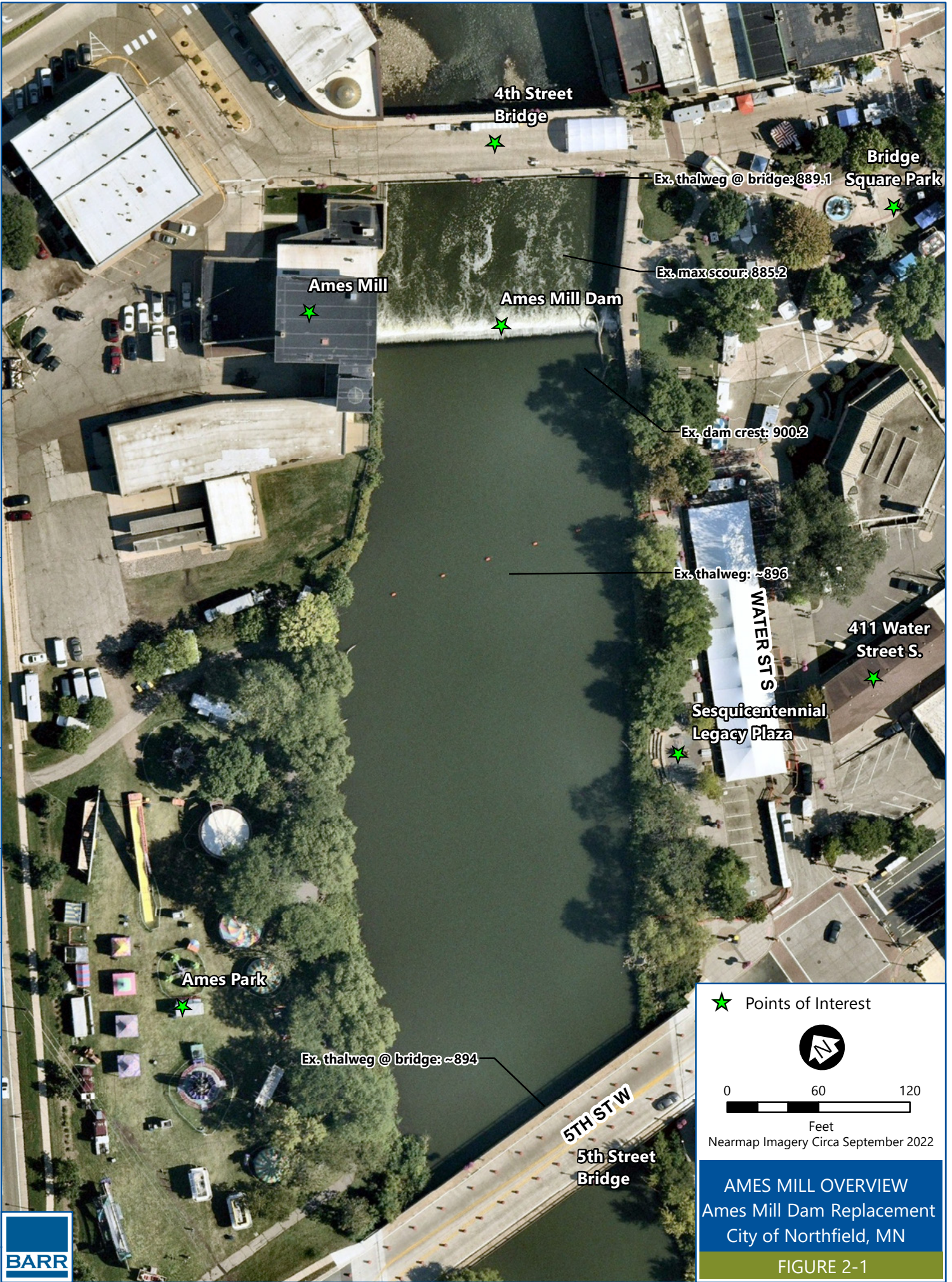
The dam is a landmark to the local community and a popular feature in the middle of downtown Northfield between Ames Park on the west bank (left looking downstream) and Bridge Square Park on the east (right) bank. The dam and adjacent features in downtown Northfield are shown in Figure 2-1.

### 2.2 Dam Description

The dam consists of a mass concrete fixed-crest spillway founded on bedrock. On the right side of the spillway (looking downstream), a 4-foot-square sluiceway and sluice gate provide a means for diverting river flows around the dam and drawing down the pool. The left side of the spillway previously included hydropower equipment which has been removed. The former equipment area has been filled with rock and concrete, and new walls have been constructed to close off this area. Immediately downstream of the dam, the river is enclosed by a concrete retaining wall on the right and the Post Consumer Brands historic Ames Mill building foundation wall on the left.

Pertinent project data is listed below:

- Height of the Spillway 12.5 feet
- Length of the Spillway 164.3 feet
- Drainage Area 934 square miles
- Location within the City of Northfield Section 1, T111N, R20W
- Minnesota Identification Inventory Number 356
- National Inventory of Dams Number MN00965
- State of Minnesota Hazard Classification 2 (Significant)
- Elevation of Spillway Crest 900.2 (1929 NGVD)



**AMES MILL OVERVIEW**  
Ames Mill Dam Replacement  
City of Northfield, MN

**FIGURE 2-1**

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## 2.3 Dam History

A brief history of the dam is presented below:

- 1855 The first dam was built at the site by John North, founder of Northfield. A grist mill was built on the east bank of the river and a sawmill on the west bank.
- 1869 The Ames family took over the dam and built a flour mill on the west bank of the river.
- 1884 A new timber dam was built to replace the original dam.
- 1890 A break in the dam occurred.
- 1895 Another break in the dam occurred.
- 1913 Another break in the dam occurred.
- 1918 The Campbell Milling Company constructed the existing concrete dam.
- 1942 A one-story warehouse addition to the Malt-O-Meal Building on the left bank was added.
- 1956 The Bin Farm addition was added to the Malt-O-Meal Building on the left bank.
- 1965 A record flood occurred at the dam. The depth of water over the spillway was estimated to be 5.5 feet.
- 1983 The dam was inspected by the Minnesota DNR Dam Safety Unit, and a formal engineering report was prepared. The report is dated March 1984. The report described several deficiencies and recommended repairs.
- 1984 The dam was inspected by the engineering firm of Indeco under a contract with the City of Northfield. The report is dated December 1984. The report described several deficiencies and recommended repairs.
- 1984 The right abutment area was repaired near the exit end of the 4-foot-square sluiceway, which had partially undermined. A washout near the downstream end of the sluiceway caused a loss of fill and undermining of the sidewalk above the sluiceway. Mass concrete was believed to be poured around the sluiceway as a repair.
- 1986 The left abutment area of the dam, which previously contained hydro equipment, was repaired and walled off with new reinforced concrete construction. Malt O-Meal Company completed the work.

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- 1997 The dam was inspected and evaluated for removal by SEH. The study showed:
- The dam needed repair.
  - There was scouring downstream of the dam.
  - The spillway concrete was below the desired minimum strength of 3,000 psi.
  - The dam may not be able to handle ice loads.
- The evaluation showed that dam removal would affect upstream channel elevations, potentially exposing sanitary sewer lines upstream of the Fifth Street Bridge and undermining piers for the TH 3 Bridge. Removal could also lower the upstream water table, potentially causing foundation settlement and damage to nearby buildings.
- 2007 Barr Engineering Co. conducted a dam replacement study evaluating seven options. One would repair the existing dam; six would replace the dam. Cost estimates ranged from \$1.1M to \$1.8M. Barr collected three sediment cores upstream of the dam; these showed a low likelihood of sediment contamination.
- 2014 The right (east) river wall footing downstream of the Water Street S. Bridge was repaired and stabilized to address undermining that had developed under the toe of the footing.
- 2015 Post Consumer Brands acquired Malt-O-Meal Company and, therefore, ownership of the Ames Mill Dam.

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## 3 Dam Replacement Project Background

### 3.1 Goals and Objectives

The City's long-term goals for the Ames Mill Dam replacement project include the following:

- To improve recreational opportunities for the broader community along and within the Cannon River
- To improve river ecology, including aquatic organism passage
- To honor the historic nature of the dam and adjacent structures

Project objectives to be considered in evaluating options include the following:

- Improve public safety by removing the hydraulic roller ("drowning machine") created by flow over the existing low-head dam structure
- Integrate the dam site with planned riverfront park improvements
- Allow for broad-based public recreation in, on, and along the river
- Improve fish and aquatic organism passage between areas upstream and downstream of the dam to help increase species diversity in the Cannon River watershed

Together these goals and objectives represent the purpose and need for the City's dam replacement project.

### 3.2 Previous Studies

The Ames Mill Dam and adjacent structures have been evaluated for various purposes over the last three decades. A comprehensive summary of previous studies and their relevance to this feasibility study is provided in Appendix A. Studies with particular findings referenced throughout this report include:

- SEH 1997 (reference [5]): Study for Malt-O-Meal on the state of the dam and the feasibility of full dam removal. The study and follow-up study recommended dam repair; potential subsidence was found with full dam removal.
- Barr 2007 (reference [1]): Project for Malt-O-Meal that evaluated the feasibility of dam removal. Seven options were evaluated; six would replace the dam. The study was expanded to evaluate modifications to address DNR requests for fish passage. Cost estimates ranged from \$1.1 to \$1.8 million.
- Barr 2023 (reference [7]): Hydrologic analysis for the City as part of a feasibility study for flood mitigation alternatives in the downtown area. The analysis recommended a discharge of 16,200 cubic feet per second (cfs) as the 1% annual-exceedance-probability (AEP) peak flood.

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### 3.3 Northfield Master Planning

The City of Northfield adopted the 2020 Riverfront Enhancement Action Plan, which sets a vision for Northfield's Cannon River regional park experience and defines key implementation steps for the next 5 years. This plan is available on the City's website (reference [8]). The five key actions in the plan are as follows:

- 1) Establish Northfield's Cannon River regional park
- 2) Enhance and activate Northfield's riverfront parks
- 3) Complete Northfield's local and regional trail system
- 4) Explore Ames Mill Dam reconstruction options
- 5) Promote economic development and a tourist destination

This dam replacement study is key action number four. The objective of the dam replacement study is to explore a range of concepts for the Ames Mill Dam (including leaving it in place) and assess the feasibility and efficacy of each option. The City will use the study to determine a path forward. According to the Riverfront Enhancement Action Plan, the study should consider an option for replacing the dam. The alternatives analysis should consider environmental, economic, recreational, design aesthetics, social, and cultural objectives. The options should range from repair of the existing dam to full replacement with a recreational whitewater feature. The options should connect and integrate with the broader uses of the river corridor, maintain or enhance the river's ecological health, and generally fit within the context of the watershed and Northfield's historic downtown area.

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## 4 Description of Options Evaluated

The City has identified the options described in the following sections. With the exception of Option 1, which involves no changes to the existing structures, Options 2, 3, and 4 are shown in Figure 4-1, Figure 4-2, and Figure 4-3, respectively.

### 4.1 Option 1—Maintain Existing Structure

Under this option, the Ames Mill Dam would be maintained in its current configuration. There would be no change to the surface or groundwater levels or structures adjacent to the dam. Post would retain ownership of the dam and conduct regular dam safety inspections and maintenance as required.

### 4.2 Option 2—Full Dam Removal, Rock Rapids (Compact Footprint)

With full dam removal, the Ames Mill Dam structure would be completely removed and replaced with rock rapids designed to maximize recreational and ecological benefits while minimizing water level changes. The project footprint would be kept as small as possible, using relatively steep rock rapids with a slope between 3 and 5 percent. The rapids would likely start near the downstream end of Ames Park, approximately 150 feet upstream of the existing dam, and extend to the Fourth Street Bridge—a total length of around 250 feet.

To minimize the impact of the dam removal on upstream water levels, the rock rapids would include a horseshoe-shaped upstream boulder weir. The elevation of this structure would be set near the existing dam crest elevation so that water levels around the structure's perimeter would be approximately equal to existing conditions. This upstream-most weir would be anchored to the concrete walls along the river banks near the existing dam; inner downstream weirs would blend into the upstream horseshoe weir at the outer edges. This arrangement would create the most gradual water surface slope in the center of the structure and much steeper slopes at the edges flowing towards the center.

Based on the total bed elevation change between the dam and the Fourth Street Bridge (11 feet), rock-arch rapids would require about 10 boulder weir structures with approximately 1.0 feet of drop across each structure, spaced every 25–30 feet. Fewer weirs with a slightly greater drop over each weir would allow for greater spacing between weirs, reducing construction complexity, but would be less effective at providing fish passage. As the weirs become longer, moving downstream and away from the horseshoe weir, the weir shape could become more varied and sinuous. For this feasibility study, the boulder weirs are depicted as distinct features with a defined drop over each weir. In the detailed design of the rapids, additional complexity could be added to create more varied flow conditions through boulder clusters or rock fields rather than distinct weirs. However, the available space to create flow complexity would be limited in this option.

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### 4.3 Option 3—Full Dam Removal, Rock Rapids (Expanded Footprint)

This option would be similar to the full removal option described above, except that the project footprint would be extended upstream toward the Fifth Street Bridge. This would allow for additional recreational and ecological enhancement opportunities. The rock rapids would extend from the Fourth Street Bridge to the Fifth Street Bridge (i.e., along the entire frontage of Ames Park plus additional length downstream), with a total length of approximately 550 feet and a slope of around 2 percent.

Because a horseshoe-shaped weir to control water levels would not be practical for the longer project footprint, each boulder weir would span the entire river channel and tie into the river banks on both sides. Depending on the bank material at a particular location, each weir would be either anchored to the existing concrete walls or extend into the soil of the river bank. Based on the total bed elevation change between the dam and the Fourth Street Bridge (11 feet), a rock-arch rapids would require 10–15 boulder weir structures with 0.8 to 1.0 feet of drop across each structure, spaced every 45–55 feet. Reducing the drop over each weir would require a larger number of weirs and closer weir spacing. Similar to Option 2, the boulder weirs for this study are depicted as sinuous, distinct features with a defined drop over each weir; additional complexity could be added in detailed design to create more varied flow conditions.

For this option, the change in water surface elevation from the upstream weir at Fifth Street to the downstream end of Ames Park would be approximately 5 feet.

### 4.4 Option 4—Partial Dam Removal, Rock Rapids (Expanded Footprint)

With this option, most of the dam structure would be removed to allow for the construction of rock rapids, but a portion of the existing dam would be left adjacent to Ames Mill to serve as a visible reminder of the historic dam. The upstream/downstream footprint of the rapids would be similar to Option 3, but the rapids would be narrower because the dam remnant on the west bank would constrain it.

Like Option 3, partial dam removal would require 10–15 boulder weir structures with approximately 0.8 to 1.0 feet of drop across each structure. Several weirs would be placed downstream of the dam structure (between the dam and Fourth Street), and the remainder would span the river channel upstream of the remaining dam structure. In contrast to the full removal options, the remnant dam structure would create a relatively tall obstacle protruding above the water surface during most flow conditions, which may be prone to debris accumulation and could be a hazard to recreational users under certain flow conditions.

### 4.5 Other Options Not Selected for Evaluation

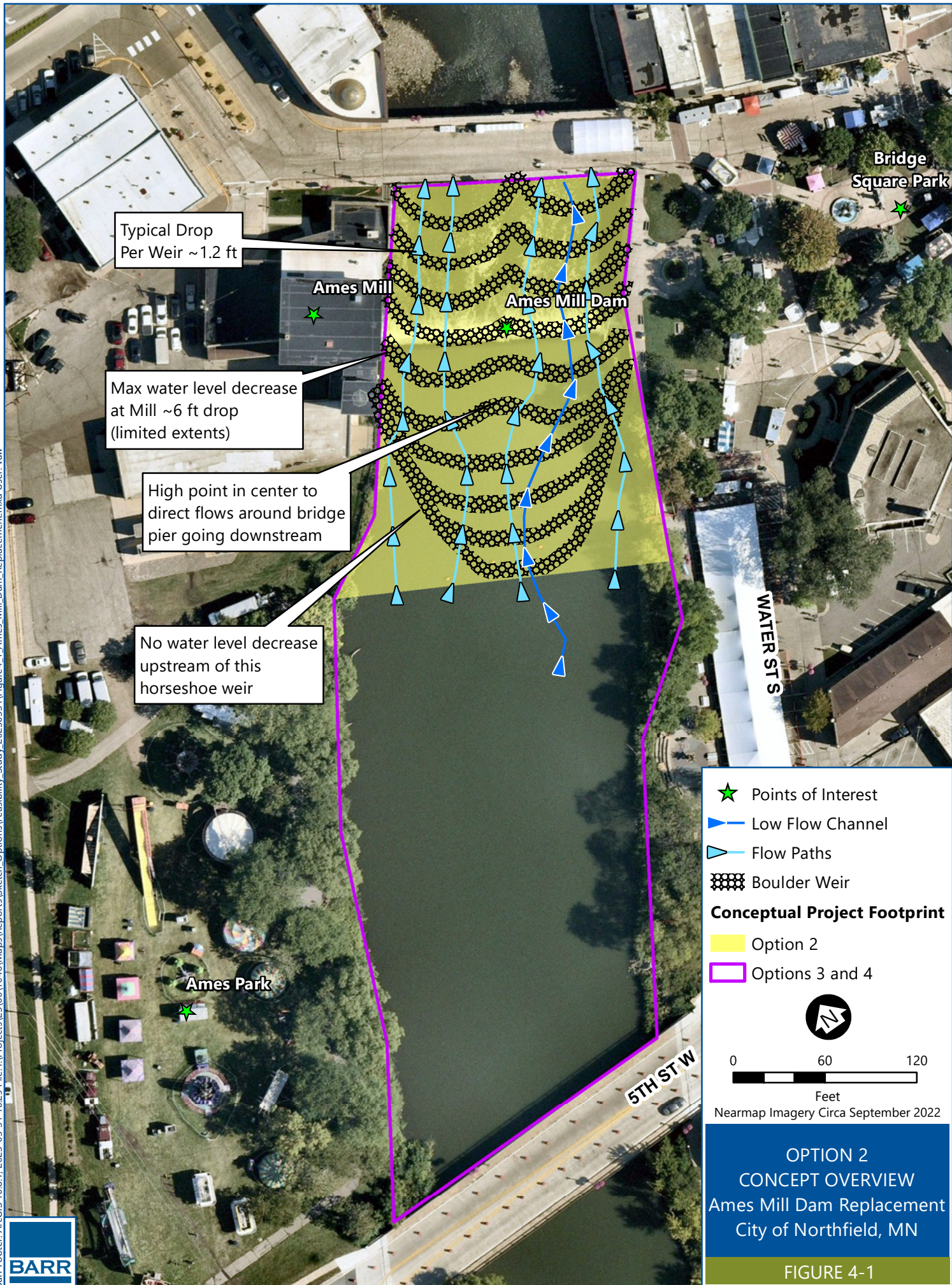
Other options considered in past studies were not selected for detailed evaluation in this study. The other options are described briefly below with the reasons they were not carried forward.

- Full dam removal without rapids: This option, evaluated in 1997 (reference [5]), would return the river to its natural flow condition and elevation. The effect of significantly reduced upstream river

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levels and groundwater elevations would likely cause subsidence and damage to structures extending far upstream of the dam (reference [5]).

- Dam replacement in kind: Replacement in kind would not meet the City's goals for improved river recreation and ecology and would not improve public safety.
- Dam replacement with a concrete drop structure: Although a concrete drop structure could be designed to improve fish passage, this option would not meet the City's goals for improved river recreation and ecology (more broadly defined than fish passage). This option was evaluated in 2007 (reference [1]).
- Full dam removal with a very steep (20% slope) rock ramp: This option would be similar to Option 2 but with a steeper slope and a more limited footprint. This option was evaluated in 1997 (reference [5]) and again in 2007 (reference [1]). Such a steep slope would not improve river recreation or aquatic organism passage.
- Rock ramp placement on the dam's downstream face without dam removal: Similar to the dam removal with a very steep rock ramp, this option would not meet the City's goals for improved river recreation and ecology.



- Points of Interest
- Low Flow Channel
- Flow Paths
- Boulder Weir

**Conceptual Project Footprint**

- Option 2
- Options 3 and 4

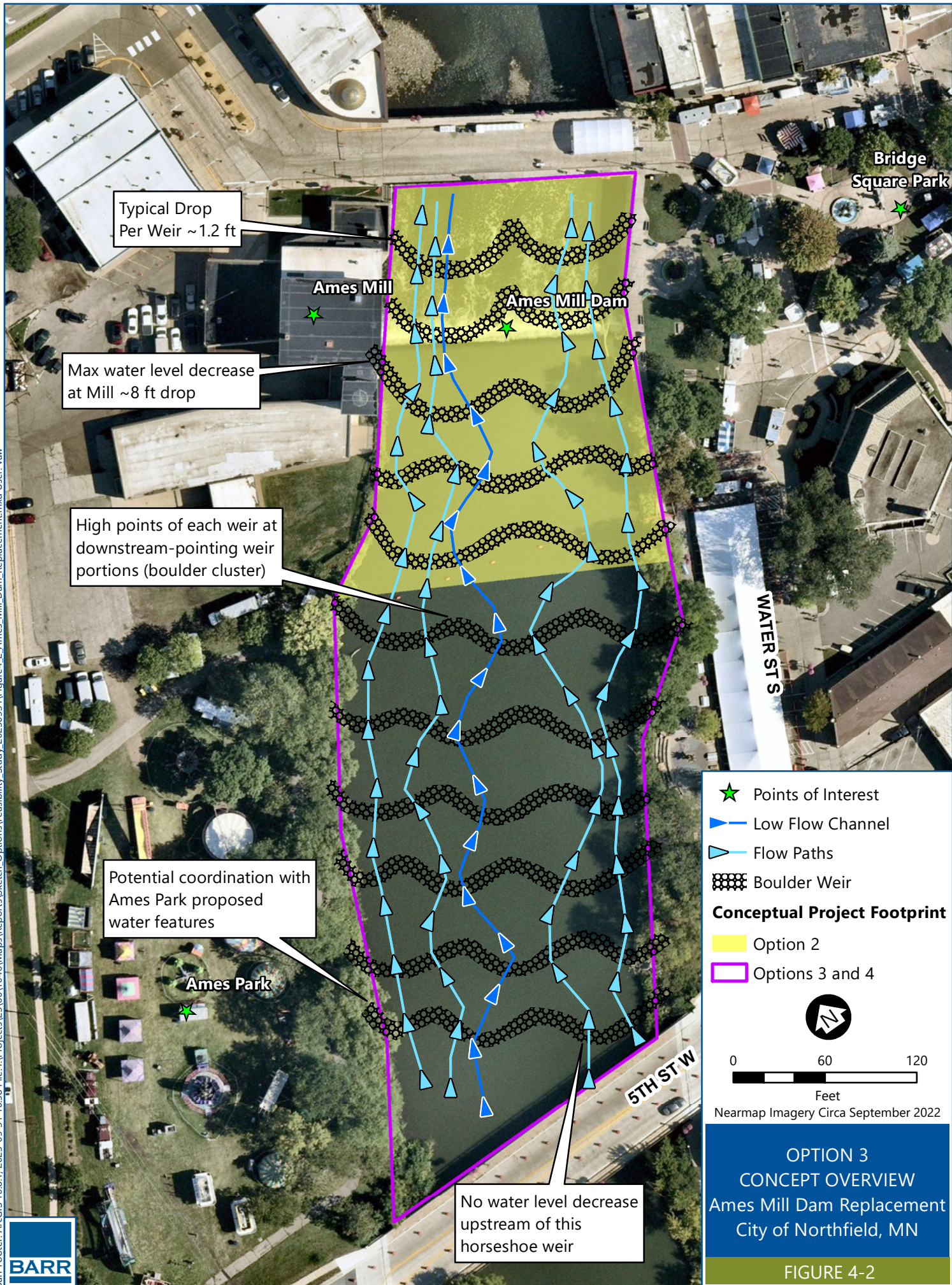
0 60 120  
Feet

Nearmap Imagery Circa September 2022

**OPTION 2**  
**CONCEPT OVERVIEW**  
 Ames Mill Dam Replacement  
 City of Northfield, MN

FIGURE 4-1





Typical Drop Per Weir ~1.2 ft

Max water level decrease at Mill ~8 ft drop

High points of each weir at downstream-pointing weir portions (boulder cluster)

Potential coordination with Ames Park proposed water features

No water level decrease upstream of this horseshoe weir

- ★ Points of Interest
- Low Flow Channel
- Flow Paths
- ⊗ Boulder Weir

**Conceptual Project Footprint**

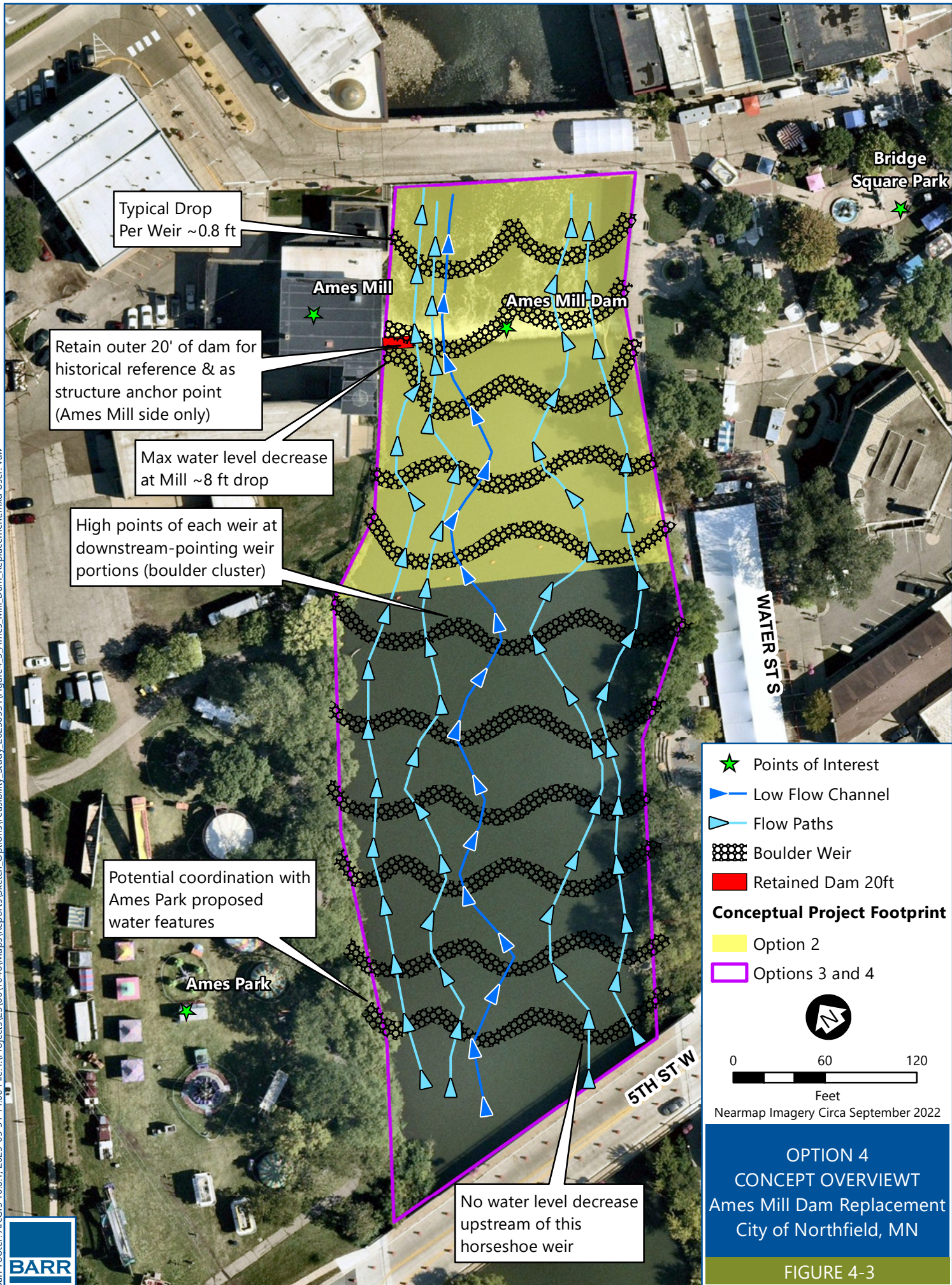
- Option 2
- Options 3 and 4

0 60 120  
Feet  
Nearmap Imagery Circa September 2022

**OPTION 3**  
**CONCEPT OVERVIEW**  
 Ames Mill Dam Replacement  
 City of Northfield, MN

FIGURE 4-2





Typical Drop Per Weir ~0.8 ft

Retain outer 20' of dam for historical reference & as structure anchor point (Ames Mill side only)

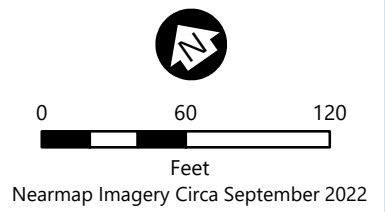
Max water level decrease at Mill ~8 ft drop

High points of each weir at downstream-pointing weir portions (boulder cluster)

Potential coordination with Ames Park proposed water features

No water level decrease upstream of this horseshoe weir

- ★ Points of Interest
  - ▶ Low Flow Channel
  - ▶ Flow Paths
  - ⊞ Boulder Weir
  - Retained Dam 20ft
- Conceptual Project Footprint**
- Option 2
  - Options 3 and 4



**OPTION 4  
CONCEPT OVERVIEW  
Ames Mill Dam Replacement  
City of Northfield, MN**

FIGURE 4-3



## 5 Evaluation of Options

The following sections present an evaluation of each of the four options with respect to their impacts on key characteristics of the Cannon River, the City of Northfield, and the dam replacement project itself:

- River hydrology and hydraulics (Section 5.1)
- Dam replacement design and construction (Section 5.2)
- Public recreation (Section 5.3)
- Aquatic organism passage (Section 5.4)
- Groundwater drawdown and subsidence (Section 5.5)
- Adjacent infrastructure (Section 5.6)
- Cultural resources (Section 5.7)
- Permitting and environmental review (Section 5.8)
- Funding sources (Section 5.9)
- Stakeholder input (Section 5.10)
- Project costs (Section 5.11).

The findings of this section are summarized in Section 6.

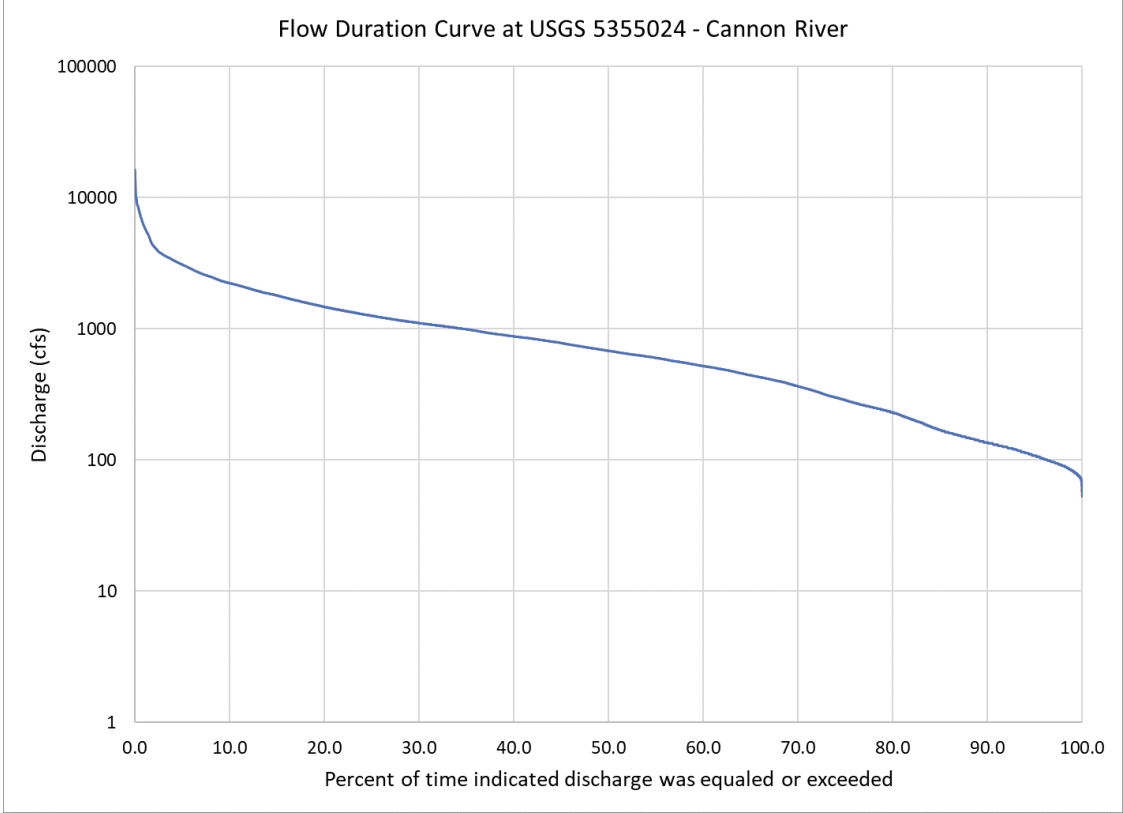
### 5.1 River Hydrology and Hydraulics

#### 5.1.1 Hydrology

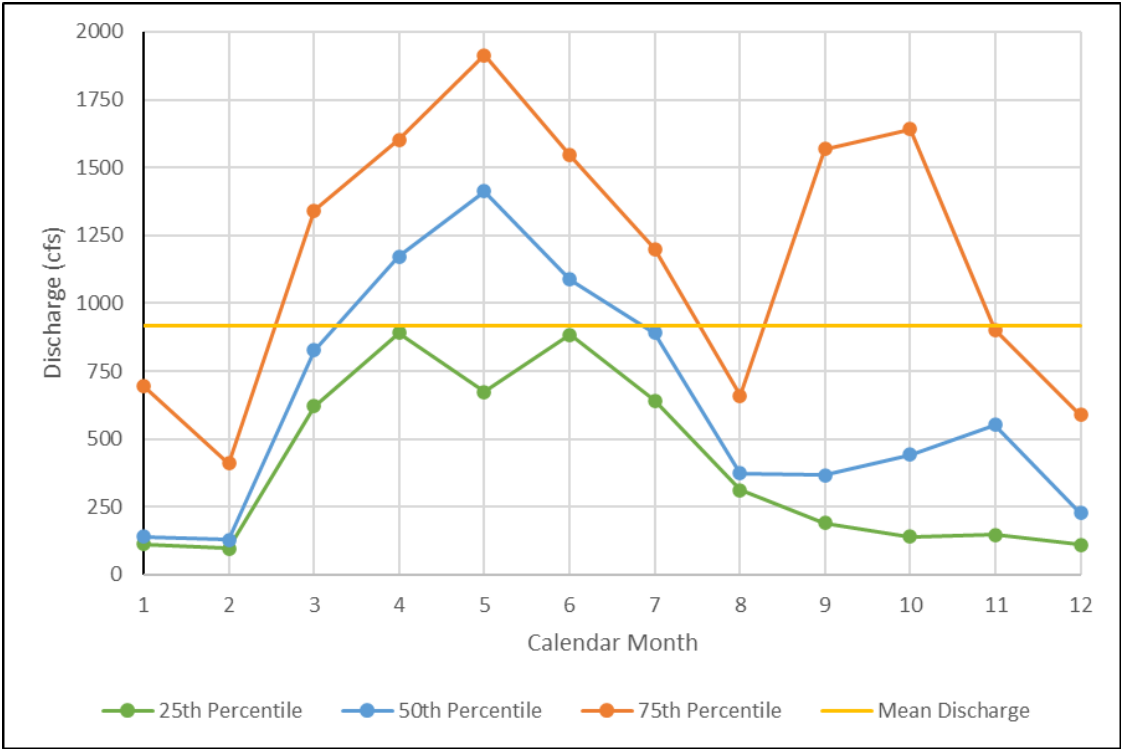
Data from USGS gage 05355024, located only 900 feet downstream of Ames Mill Dam on the Cannon River, was used to characterize the average and low flows passing the structure in a typical year. Figure 5-1 is a flow-duration curve for the period of record of daily data (2012 to present) showing the percent of time a given flow is equaled or exceeded. The daily river discharge rate has exceeded 135 cfs 90% of the time. This value was used as the low-flow discharge to evaluate how Options 2, 3, and 4 could potentially impact low water and groundwater levels.

Additionally, a mean streamflow of 917 cfs was calculated from mean monthly discharges from 2012 through 2022. This discharge is exceeded approximately 40% of the time based on Figure 5-1. Figure 5-2 shows the mean and range of typical flows for January through December. Flow conditions are typically above the overall mean from April through June, near the mean in July, and often below the mean from August through the remainder of the year—although conditions can vary significantly year-to-year.

The discharge rates for higher recurrence-interval floods were determined using a HEC-SSP analysis of the historical observations at the gage adjacent to the dam from 1980 to 2020 and USGS gage 05353800 from 1966 to 1979 (reference [7]). Table 5-1 summarizes the discharges.



**Figure 5-1 Flow Duration Curve for Cannon River at USGS 05355024**



**Figure 5-2 Mean and Percentiles of Mean Monthly Discharges**

**Table 5-1 Cannon River Discharge Frequency**

Annual Exceedance Probability (AEP)	Return Frequency (years)	Discharge (cfs)
0.2%	500	21,600
0.5%	200	18,500
1%	100	16,200
2%	50	14,000
5%	20	11,200
10%	10	9,200
20%	5	7,200
50%	2	4,400
Low Flow	N/A	135
Mean Monthly	N/A	917

### 5.1.2 Hydraulics—Stream Geometry

Barr completed a preliminary hydraulic analysis of each option using HEC-RAS Version 6.3.1. Modeling for Option 1 used an existing conditions one-dimensional (1D) hydraulic model developed previously by Barr and calibrated for higher flow events to match recorded high-water marks. New hydraulic scenarios were created for Options 2, 3, and 4 by copying the existing conditions model and replacing the dam with the different rock riffle configurations. Table 5-2 presents a summary of the different modeled options. The number of rock weirs and elevation drop over each weir may be modified during the detailed design of each option within the ranges discussed in Section 4. The geometry presented in Table 5-2 represents a baseline configuration for each option for this feasibility study.

As discussed in Section 4, the primary goal of each design option was to maintain water surface elevations similar to the existing conditions. Maintaining water surface elevations involved setting the design elevation of the first rock riffle as close to the existing crest elevation of the dam as possible without impacting the 100-year flood elevation. The rock riffle is less hydraulically efficient than the existing dam spillway and therefore needs to be set slightly lower to pass flood flows without increasing the 100-year flood elevations. The existing crest elevation of the dam is approximately 900.2 feet; the design elevation of the first rock riffle was determined to be approximately 899.4 feet, with a low-flow channel established at 898.6 feet. A 60-foot-wide and 0.8-foot-deep low-flow channel was developed to help maintain flow depth during lower flow events for recreation and aquatic organism passage. For reference, the river is approximately 160 feet wide at the dam.

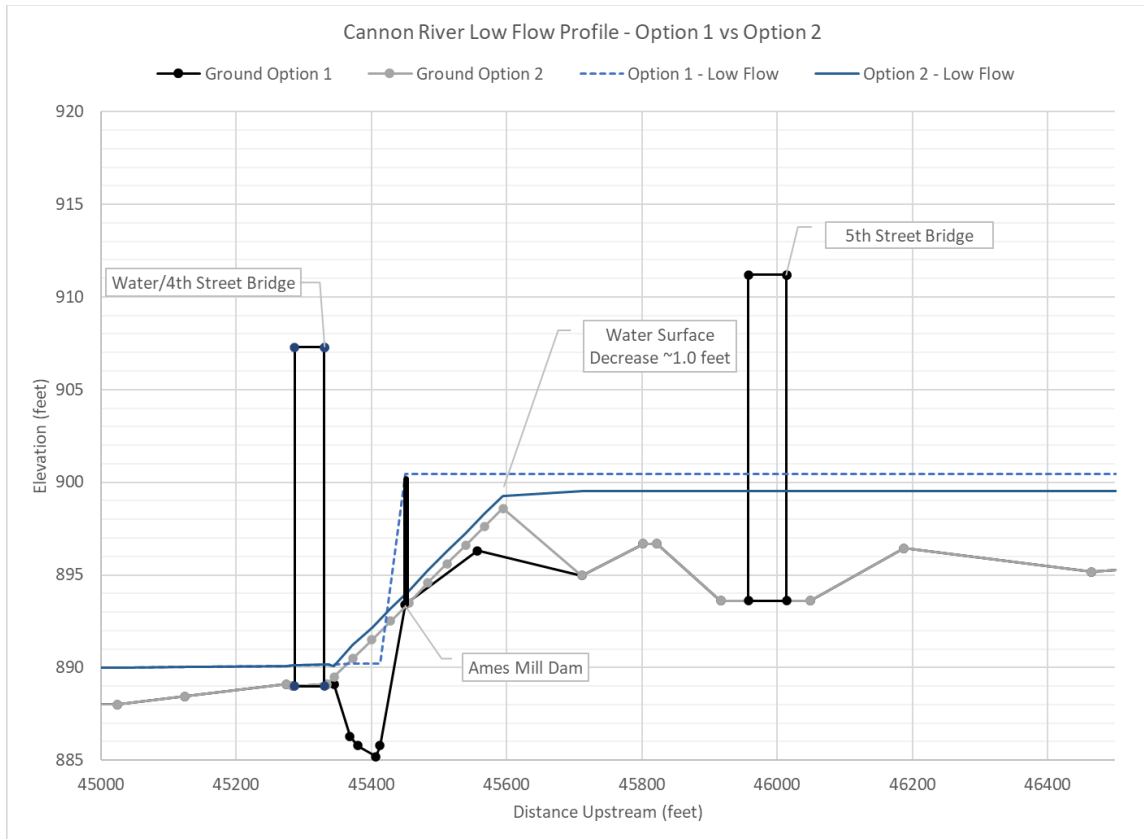
**Table 5-2 Summary of Modeled Options Geometry**

Feature	Option 2	Option 3	Option 4
Dam removal	Full	Full	Partial
Number of rock weirs <sup>(1)</sup>	10	11	11
Elevation drop over rock weirs (feet) <sup>(1)</sup>	1.0	0.9	0.9
Spacing of rock weirs (feet) <sup>(1)</sup>	28	49	49
Channel slope %	3.6	1.9	1.9
First rock riffle elevation (feet)	899.4	899.4	899.4
Last rock riffle elevation (feet)	890.3	890.1	890.1

(1) Geometry presented represents a baseline configuration for each option.

### 5.1.3 Hydraulics—Model Results

Hydraulic modeling results show that for each proposed option, there are no impacts to the 1% AEP flood levels upstream or downstream of the project area. Removing the dam and implementing the rock riffles reduced upstream water surface elevations for the mean monthly discharges by 0.7 feet and low-flow discharges by 1 foot for all three replacement options (Figure 5-3). The reduction in water surface elevation for low-flow discharges and mean monthly discharges (compared to existing conditions) continues for several miles upstream of the project. Options 2, 3, and 4 cause negligible changes in the flood water surface elevations upstream of the Fifth Street Bridge for events with an equal or lower probability than the 50% AEP. Reductions in flood elevations occur between the Fifth Street and Fourth Street Bridges due to the proposed dam removal and rock rapids construction. The low-flow water depth within the rock riffles (measured in the low-flow channel of each weir) for Option 2 is approximately 8 inches. For Options 3 and 4, it is approximately 9 inches.



**Figure 5-3 Water Surface Profile—Existing vs. Option 2—Low-Flow Discharge**

The rock riffles for Options 3 and 4 have a milder slope than for Option 2, so their mean velocities are lower. Maintaining the existing dam’s edge and reducing the river’s effective width by 20 feet in Option 4 caused minor differences between Options 3 and 4, most notably increasing the maximum velocity at mean monthly flows. Table 5-3 summarizes the maximum average velocities expected for each option at low, mean monthly, and the 1% AEP discharge. Velocities during the 1% AEP peak discharge are greater than 10 feet per second for all three build options. The build options do not affect velocities through the Fourth Street Bridge.

**Table 5-3 Maximum Average Velocity across Rock Riffles**

Discharge	Option 2 Velocity (fps)	Option 3 Velocity (fps)	Option 4 Velocity (fps)
Low flow	4.3	3.0	3.0
Mean monthly	6.0	4.9	5.3
1% AEP	13.2	11.0	10.9

Values shown are cross-sectional average velocity at the cross section with the highest average velocity.

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## 5.2 Design and Construction

This section presents design and construction considerations for Options 2, 3, and 4. Since Option 1 leaves the existing dam in place, no specific design or construction would be necessary. However, ongoing inspection, monitoring, and maintenance would be necessary over the structure's life.

### 5.2.1 Project Footprint

The footprint of Option 2 extends from the Fourth Street Bridge upstream, approximately 285 feet. Options 3 and 4 have a substantially larger project footprint: from the Fourth Street Bridge upstream, approximately 570 feet. In general, a smaller footprint will make Option 2 less complex and more desirable from a design and construction standpoint. The advantages of the smaller footprint associated with Option 2 include the following:

- Smaller rock volumes—less material imported and installed
- Less sediment removal—less material exported and disposed of
- Easier water control—less area to dewater and a shorter area around which to bypass flows
- Less likely to impact existing upstream features, such as underground utilities or intakes
- Less area disturbed by the project (thus less area to restore)

### 5.2.2 Water Control during Construction

To construct the proposed rock riffles in a generally dry condition, each of the three build options would require water in the Cannon River to be controlled. For all three options, the water control is expected to consist of three main components:

- An upstream cofferdam
- A downstream cofferdam
- A flow bypass around the site

The upstream and downstream cofferdams would be used to isolate the site, and water would be pumped from the area between the two cofferdams to create a dry working environment. The cofferdams could be constructed of earth, sheet pile, pre-manufactured water dams, jersey barriers, or other materials selected during detailed design or by the contractor.

For Option 2, the upstream cofferdam would be installed just upstream of the most upstream riffle. Options 3 and 4 terminate at the Fifth Street Bridge; it would need to be determined whether a cofferdam could be installed upstream of the first riffle and downstream of the bridge or, alternatively, if it would need to be installed upstream of the bridge.

Since all three design options end at the Fourth Street Bridge, fitting a cofferdam between the bridge and the last riffle could be difficult, and the cofferdam may need to be installed downstream of the bridge. Alternatively, shifting the riffles slightly upstream to make room for a cofferdam upstream of the bridge could be considered in future design stages.

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The flow bypass at this site could be challenging. On past similar projects, flows have typically been bypassed using one of the following approaches:

- Construct a bypass channel adjacent to the river—not practical at this site due to the adjacent infrastructure
- Install bypass gravity pipes—pipes would likely need to be installed within the river channel and inlets and outlets incorporated into the cofferdams
- Operate a pump bypass—may be feasible to bypass low flows
- Construct the riffles on one half of the channel while flow occupies the other half; after the first side is constructed, “flip” the flow to the first side and construct the remaining side

For all options, it would be desirable to maintain the water surface upstream of the cofferdams at an elevation similar to the dam’s crest throughout construction to avoid unintended impacts to adjacent infrastructure due to temporarily lowered water surface elevations.

The level of effort for water control would be largest for Options 3 and 4 because they require dewatering the largest area and bypassing flows a longer distance.

### **5.2.3 Dam Removal**

The dam would be entirely removed for Options 2 and 3, and a small portion of the dam would remain for Option 4. The existing dam would likely be removed using a pneumatic hammer mounted on an excavator. As further discussed in Section 5.6, it would be advisable to sawcut the outer edges of the dam in all removal options before demolishing the dam to prevent damage caused by vibration to the structures on the adjacent riverbanks. The existing dam primarily consists of reinforced concrete. The reinforced concrete could be removed and disposed of at a landfill; alternatively, the reinforcement material could be removed from the concrete, which could be broken down into smaller pieces (roughly 12-18 inches in diameter) and disposed of onsite as fill below or at the base of the proposed riffles. For Option 4, the sawcut would be performed farther from the Ames Mill structure, and the volume of concrete removed would be lower; otherwise, the options would be similar.

### **5.2.4 Sediment Removal**

Sediment deposition behind the dam will need to be removed to (1) get to solid foundation material for the rock riffles; and (2) achieve the design subgrade. At this time, it is assumed that excess sediment would be disposed of at an offsite location. Because Options 3 and 4 have a larger footprint than Option 2, they would require more sediment removal. Accumulated sediment extent, depth, and characteristics should be investigated further in the project’s next phase.

### **5.2.5 Rock Rapids Structures**

For all three build options, rock rapids structures would be installed in the river to control water levels, allow flows to step down gradually across the rapids, create diverse flow conditions, and allow for sediment and woody debris transport. The upstream-most boulder weir in each option must be designed

to maintain the upstream water levels without allowing excessive subsurface flow. Flow cutoff could be achieved by incorporating a soil barrier layer (clay) within the weir structure or by installing subsurface-driven sheet pile. However, due to the bedrock on the existing river bottom, sheet pile may not be feasible. This design consideration would be similar for all build options.

Boulder weir or other rock rapids structures must also be designed to be stable for the expected hydraulic conditions—specifically, the flow velocity and shear stress anticipated during peak flood events. Based on the hydraulic model results (Section 5.1.3), Option 2 would have a peak flood velocity (13.2 fps) 20 percent higher than Options 3 and 4 (11.0 and 10.9 fps, respectively). Peak shear stress in the rapids would also be 50 percent higher in Option 2 than in Options 3 and 4 (8.1 lb/ft<sup>2</sup> compared to 5.4 lb/ft<sup>2</sup>). The increase in velocity and shear stress in Option 2 would require significantly larger boulders for the weirs and base stone material between weirs as compared to Options 3 and 4. Based on preliminary material sizing calculations, the differences in boulder and base stone are shown in Table 5-4.

**Table 5-4 Preliminary Rock Rapids Material Sizing**

Material	Option 2	Option 3	Option 4
Boulders for weirs (average diameter)	Approximately 72 in	Approximately 48 in	Approximately 48 in
Base stone between weirs (average diameter)	22–29 in	16–20 in	16–20 in

Values based on 1% AEP velocity and shear stress at the cross section with the highest average velocity.

### 5.3 Public Recreation

The drop over the existing dam prevents the public from safely kayaking, canoeing, or swimming through this reach of the river. The Minnesota Department of Natural Resources identified that the dam’s submerged hydraulic jump (occurring downstream at certain flow conditions) could be a drowning hazard (reference [1]).

Ames Park provides an opportunity to bring visitors to the water in a way that contrasts with the walled channel through downtown. Options 3 and 4 are likely the easiest to integrate with park features, blurring the line between the park and the river’s edge and providing a more wide-ranging recreation area that might include casual fishing or splash play and up-close water viewing opportunities. While Option 2 condenses the energy dissipation footprint, Options 3 and 4 provide a gradual visual transition. The elevation change from upstream to downstream along the Ames Park frontage in these options would be approximately 5 feet, a degree of variation allowing for public entry to the river at multiple points and heights. Paths along the water could include steppingstones that fade into the energy dissipation drops created by the rock rapids.

Installing rock rapids in Options 3 and 4 can create an area for in-water recreation like kayaking. The rapids would likely be Class I and II, best for beginners and novices. Generally, a novice boater can navigate flowing water with wading factors (velocity times depth) up to 10 ft<sup>2</sup>/s (reference [9]). The depth

and velocity will vary across the cross-section, with lower wading factors associated with shallower depths and lower velocities on the channel edge and higher wading factors associated with deeper depths and higher velocities in the channel center. A summary of the wading factors across the rock riffles under mean monthly and low flow conditions is presented in Table 5-5. Option 2 has higher wading factors than Options 3 and 4, but all options have safe wading factors under these flow conditions.

**Table 5-5 Wading Factors Across Rock Riffles Under Different Flow Conditions**

Option	Mean Monthly Flow—Wading Factor (ft <sup>2</sup> /s)		Low Flow—Wading Factor (ft <sup>2</sup> /s)	
	Maximum (Channel Center)	Minimum (Channel Edge)	Maximum (Channel Center)	Minimum (Channel Edge)
Option 2	11.1	3.0	2.6	2.1
Option 3	9.2	2.7	2.0	1.6
Option 4	9.2	2.7	2.0	1.6

The proximity of Ames Park provides opportunities to integrate in-water recreation with the park. The park could provide river access for kayakers. The City could consider hosting a paddle share or provide rentals as done in the Twin Cities for the Mississippi River (<https://www.paddleshare.org/>). The dam remnant in Option 4 would present an obstacle that may restrict the potential paddling routes through the lower rapids and slightly increase flow velocities. Still, the effect on public safety will be limited because the remnant would only be on one side of the river. Option 2 would condense the rapids area and would be less conducive to connecting public recreation opportunities in the river with Ames Park because the park would be entirely upstream of the rapids.

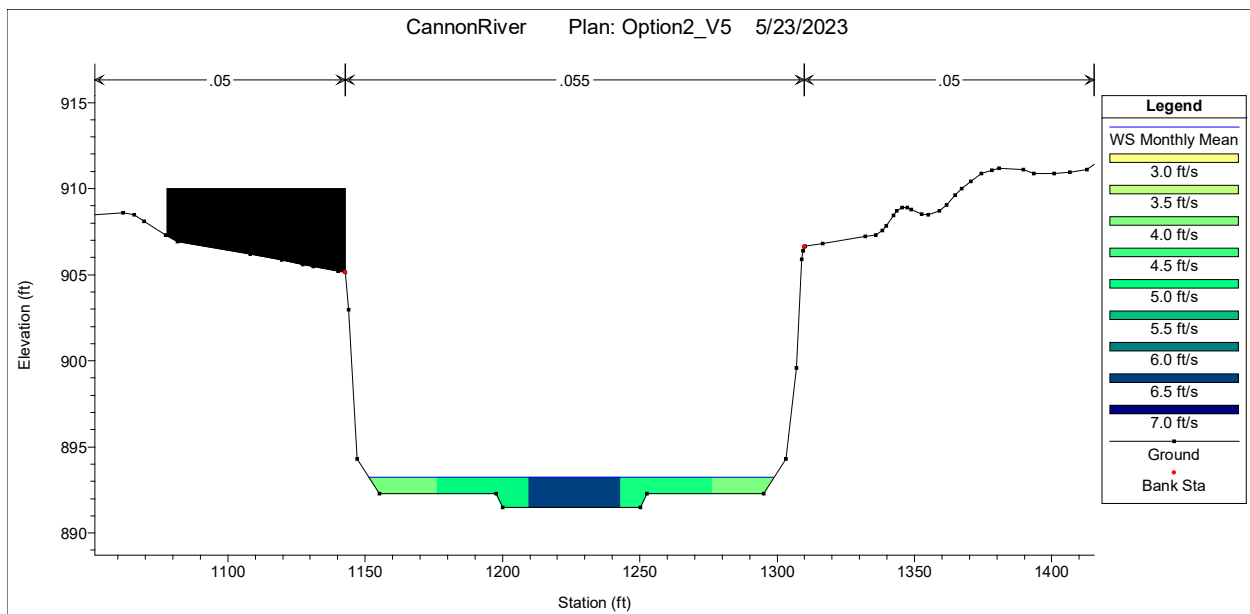
## 5.4 Aquatic Organism Passage

The Minnesota Department of Natural Resources (MnDNR) identified that the existing dam does not provide for upstream aquatic organism passage (AOP, reference [2]). Option 1 maintains the existing condition with a complete barrier to AOP for all flow conditions. There are currently no identified benefits to this barrier condition; for example, the dam does not appear to prevent the migration of any aquatic invasive species that would cause concern if introduced to the upstream Cannon River (reference [3]).

Removal of the barrier and providing for AOP would help to improve habitat and physical connectivity of habitat for fish and other aquatic species within the Cannon River watershed. These two “non-pollutant” stressors (among others) were identified in the Cannon River Comprehensive Watershed Management Plan (reference [4]) as currently impacting fish and macroinvertebrate communities in the watershed. The Cannon River through Northfield is listed as impaired for aquatic life and recreation. According to the watershed plan, specific goals to address this issue will be determined during the next generation of the watershed plan beginning in around 2030. Based on experience of the MnDNR at sites around Minnesota, (reference [10]), removing the Ames Mill dam as a barrier to AOP would be expected to allow most species currently prevented from moving through the area to return to upstream habitat.

While various aquatic species and even different life stages for a single species (such as juvenile vs. adult fish) can move upstream against flows of varying speed, a general rule of thumb is that AOP begins to become limited at flow velocities exceeding 3 feet per second or depth less than 6 inches (reference [11]). These limiting conditions do not necessarily apply to the entire river cross-section; many fish and other aquatic species typically move upstream along channel margins or in eddies protected by obstacles such as boulders or logs rather than in the center of the channel where the flow velocity is the highest. Many natural and constructed rapids structures include sufficiently diverse flow conditions so that AOP is possible in these protected areas even when the overall average channel velocity exceeds 3 feet per second.

The feasibility level hydraulic analysis performed for this study is based on the results from a 1D hydraulic model. A 1D hydraulic model can calculate the horizontal velocity distribution across the channel but cannot simulate the multi-directional flow that would occur through a rock riffle structure. Figure 5-4 shows the horizontal velocity distribution across a rock riffle under mean monthly and low flow conditions. Table 5-6 summarizes the average minimum and maximum velocities across the rock riffles at the channel center and edge. Under these flow conditions, the velocities for Option 2 are higher than 3 feet per second across the entire channel cross-section. For Options 3 and 4, the low flow velocities across the channel are less than 3 feet per second, and the mean monthly velocities are less than 3 feet per second at the channel edges, suggesting that they would not limit AOP.

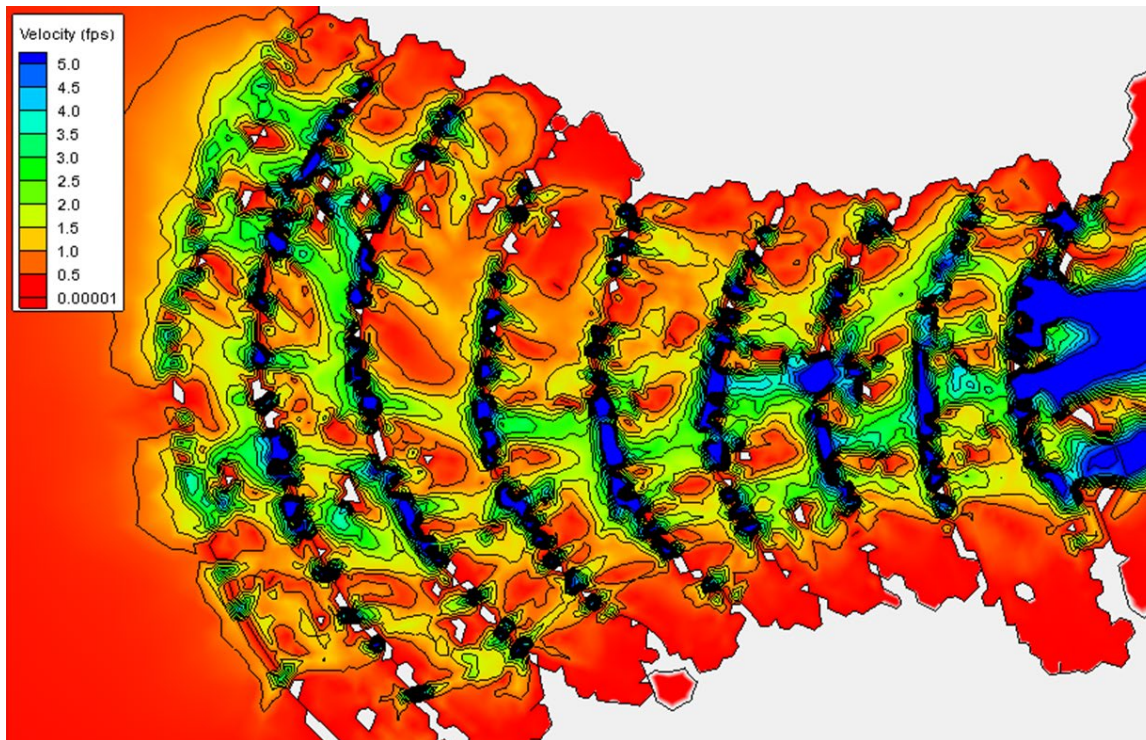


**Figure 5-4 Velocity Distribution at Rock Riffle—Option 2—Mean Monthly Flow**

**Table 5-6 Velocities Across Rock Riffles Under Different Flow Conditions**

Option	Mean Monthly Flow—Velocity (ft/s)		Low Flow—Velocity (ft/s)	
	Maximum (Channel Center)	Minimum (Channel Edge)	Maximum (Channel Center)	Minimum (Channel Edge)
Option 2	6.5	3.8	4.0	3.6
Option 3	5.2	2.9	2.9	2.5
Option 4	5.2	2.9	2.9	2.5

Barr recommends that a two-dimensional (2D) hydraulic model be constructed for the selected alternative during the final design to more fully characterize and design the complex flow conditions within the rock rapids and verify that the design allows for AOP. Figure 5-5 shows velocity results from a two-dimensional model Barr developed for a constructed rock-arch rapids structure in Hutchinson, Minnesota. The detailed results can be used to identify suitable routes through the rapids that meet depth and velocity criteria for AOP at different flows.



**Figure 5-5 Example Two-Dimensional Model Velocity Results for a Rock-Arch Rapids**

The preliminary hydraulic analysis results are adequate for comparing the design options.

- Low-flow conditions: Flow would be confined to the low-flow channel in all three build options, with flow depths of approximately 9 inches. The average flow velocity within the low-flow channel is estimated to be approximately 4 fps for Option 2 and approximately 3 fps for Options 3 and 4 due to the lower slope of the rapids. Therefore, AOP during low-flow conditions is very likely for

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Options 3 and 4 and may be achieved for Option 2, depending on the details of the boulder weir construction and flow diversity.

- Mean monthly flow conditions: During mean monthly flows, water would be above the main boulder weirs in all three build options (i.e., outside of the low-flow channel) at a depth of approximately 22 inches. Cross-sectional average flow velocity is estimated to be approximately 5.5-6.0 fps with channel center velocities of 6.5 fps for Option 2 and approximately 4.5–5.0 fps with channel center velocities of 5.2 fps for Options 3 and 4. Velocities at the edges of the channel ranged from 3.8 fps for Option 2 to 2.9 fps for Options 3 and 4. AOP during mean monthly flow conditions for all three options would be highly dependent on the details of the boulder weir construction and providing sufficient protected areas within the rapids. AOP may be difficult to achieve during mean monthly flows for Option 2 due to the tightly constrained nature of the proposed rapids footprint, but it is likely for Options 3 and 4 due to the lower velocity and greater design flexibility for the longer weir structures.
- Flood flow conditions: Due to the constricted nature of the Cannon River channel through Northfield, the average channel velocity away from the dam structure is often around 6 fps during flood flows. For the dam replacement options, velocities will be approximately 11 fps for Options 3 and 4 and 13 fps for Option 2. AOP under these conditions will be extremely limited through the entire City and nearly impossible to achieve across the rock rapids.

## 5.5 Groundwater Drawdown and Subsidence

The SEH report (reference [5]) and supplemental investigation (reference [6]) evaluated the effects of full dam removal with no constructed rapids, which would lower the water surface just upstream of the dam by approximately 9 feet. Based on a review of existing groundwater levels and the local geology, the 1997 study concluded that full dam removal could cause groundwater lowering (drawdown) along the extent of the existing reservoir (approximately 4,000 feet upstream of the dam) with greater drawdown near the dam and shorelines and lesser drawdown extending away from the reservoir, perpendicular to the shoreline. The water table drawdown is expected to be primarily within the Holocene alluvium sediments (“hal” sediments in reference [6]). Drawdown is expected to be of lesser magnitude outside of the alluvial sediments, where the water table resides within glacial till or bedrock. However, no numerical analysis was conducted to evaluate the extent of the potential drawdown.

Based on the magnitude of estimated groundwater drawdown and soil conditions observed in a boring 500 feet northwest of the river (Boring 18), the supplemental investigation (reference [6]) estimated that 3 to 9 inches of soil subsidence might occur for full dam removal, potentially affecting structures in the area of groundwater drawdown. The supplemental investigation (reference [6]) identified 14 nearby buildings within the potential zone of water table drawdown; eight of these buildings were potentially vulnerable to subsidence with a full dam removal. Subsidence could also affect sanitary, stormwater, and water main infrastructure, as well as private utilities. Roadways in the area of groundwater drawdown could have up to 9 inches of subsidence with full dam removal.

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The potential water table drawdown and associated subsidence for Options 2, 3, and 4 is expected to be less extensive both parallel to the river and laterally compared to the full dam removal as analyzed in the 1997 SEH study (references [5] and [6]). Options 2, 3, and 4 minimize the impact on river water levels compared to full dam removal. Option 2 (compact footprint) has the least impact on existing river water levels upstream of the dam. Options 3 and 4 would have a larger impact on river water levels than Option 2 but still significantly less impact than full dam removal. At a conceptual level, changes in river levels translate to a subsequent change in the water table. The more significant the change in the river water surface, the more laterally extensive the changes in groundwater levels. Hydraulic modeling showed that normal water surface elevation (WSE) upstream of the constructed riffles would drop no more than 1 foot under the proposed conditions—a much smaller change than the 9-foot drop evaluated in the 1997 study. It is expected that drawdown at the water table, and associated subsidence, would be limited to alluvial sediments between Fifth Street West and areas immediately downstream of the existing dam.

Additional geotechnical investigation is recommended during the final design to better quantify impacts from groundwater drawdown. This determination would likely involve performing soil borings and/or installing piezometers during the design process to measure the water depth in the soil adjacent to the river and particular structures of concern, ideally over an extended period, to evaluate the degree of variability under existing conditions. These measurements would be repeated after construction to confirm predictions about the post-construction groundwater surface. Such an investigation is recommended for all build options; the only difference is that the extent of the investigation would be greater under Options 3 and 4 due to the larger potentially impacted area. Depending on the investigation's findings, pre- or post-project foundation improvement can minimize foundation settlement for at-risk structures.

Another concern with proposed changes to groundwater elevations is the potential for contaminated groundwater mobilization if flow directions change. In 2007, sediment coring was performed at three locations upstream of the dam between the Fifth Street Bridge and the Fourth Street Bridge. Analysis showed no reasonable likelihood of contamination based on these cores or 1997 data collected by SEH. The Minnesota Pollution Control Agency's "What's in My Neighborhood" database indicates that seven sites within the potential area of groundwater drawdown for this project have undergone remedial investigation and/or cleanup. If groundwater contamination is present at these sites, the change in groundwater conditions may alter the movement of contaminants or affect existing remediation systems.

## **5.6 Adjacent Infrastructure**

The nearby infrastructure of interest includes the historic Ames Mill that forms the dam's left abutment, the river walk on the right abutment, and the sculpture and Sesquicentennial Legacy Plaza on the upstream/right side of the dam (see Figure 2-1). The Fifth Street Bridge on the upstream/south end and the Fourth Street Bridge on the downstream/north end confine all three options. There do not appear to be other significant structures directly abutting the river. State Highway 3 runs parallel to the river and approximately 200 feet to its left. On the right side of the river, the nearest building to the dam is a two-to-three-story architectural/decorative masonry US Post Office building slightly more than 100 feet from

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the river. Closer to the river (approximately 100 feet from the river bank) but farther upstream on the right side is a two-story masonry construction residential and commercial structure (411 Water Street South).

Based on the results of the geotechnical investigation discussed in Section 5.5, the design should determine if the phreatic surface (groundwater level) within the right and left river banks would change after the dam is removed. If the long-term water table adjacent to the river were to drop significantly, it could increase the effective stress within the soil along the river bank and increase the likelihood of bank failure and settlement of existing structures. A geotechnical engineer should assist with evaluating potential water table fluctuation due to dam removal. Information about the foundations of the structures adjacent to the river should be reviewed if water level fluctuation is anticipated. For Option 2, these concerns are localized to the areas immediately adjacent to the dam, including Ames Mill and the US Post Office building. For Options 3 and 4, this evaluation should also consider the plaza and 411 Water Street South on the right side of the river.

Vibration monitoring of the historic Ames Mill would be important with pre- and post-construction condition surveys. If the mill has an open basement, additional care and possibly reinforcements could be required since the additional fill in the river (e.g., boulders) could laterally load the basement wall. If the wall has soil behind it (i.e., if there is no basement below the existing dam elevation), the change in loading would be less concerning. Saw cutting of the dam would be important to mitigate vibrations during dam demolition. Protecting the abutments and historic Ames Mill could be less challenging if portions of the dam's ends are retained, such as in the case of Option 4 with the left-end dam remnant.

Fifth Street and Fourth Street bridges are reported to have piers founded on bedrock but not dowelled into the bedrock (reference [5]). The foundation designs for the bridges should be confirmed to be on bedrock, and any vulnerabilities associated with dam removal should be evaluated during detailed design. Based on a comparison of existing and proposed flow velocity at the bridges (Section 5.1.3), the potential for changes affecting bridge foundation scour is small for Options 2, 3, and 4. During detailed design and construction, care should be taken to align the downstream-most boulder weirs so that flow is directed around rather than toward the Fourth Street Bridge pier. This is especially true for Option 2, which has higher flow velocity and steeper rapids.

Stormwater outfalls exist in both the right and left retaining walls downstream of the dam and upstream of the Fourth Street Bridge. The elevation of these structures will need to be evaluated so that filling associated with the dam removal and rock rapids placement does not unintentionally block the outfalls. There is also a small tunnel bypass around the dam through the right abutment. This could potentially be used during construction but would need to be filled if the dam is replaced with constructed rapids.

A 2014 construction project stabilized a portion of the wall on the right side of the river downstream of the Fourth Street Bridge. The removal design should consider pre- and post-removal river velocity and erosion potential to confirm that there is minimal potential for undermining the wall. Based on the preliminary hydraulic model results, changes to the velocity downstream of the rock rapids are expected to be minimal.

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## 5.7 Cultural Resources

The City of Northfield has a long history of celebrating and preserving its history, beginning with the adoption of the Northfield Heritage Preservation Ordinance and the creation of the Heritage Preservation Commission in 1978. The following actions were taken to understand how the project may impact significant cultural resources (historic properties) under the Minnesota Historic Sites Act (MN State Statute 138.665) and to anticipate a potential federal undertaking for the project subject to Section 106 of the National Historic Preservation Act (NHPA).

### 5.7.1 Proposed Area of Potential Effects

The area of potential effects (APE) for the project is where the project may cause alterations in the character or use of cultural resources. The APE includes the construction footprint, defined as the area in which the project may affect belowground (archaeological) resources and areas where visual, noise, or other effects caused by the project may occur outside the construction footprint. The APE was recently defined as part of a reconnaissance architectural history survey and a report prepared for the project by 106 Group (reference [12]) assessing effects. As defined in the 106 Group report, the APE's northern boundary includes the Fourth Street Bridge and all buildings one parcel north of East Fourth Street/Water Street South/Bridge Square on the east side of the river. The eastern boundary includes all properties that front Bridge Square parking areas along the east side of the Cannon River. The western boundary extends roughly one parcel beyond Trunk Highway 3. The western boundary does not include the rail corridor, which does not have viewsheds of the project area due to vegetation and intervening buildings. The APE's southern boundary includes properties one parcel south of Fifth Street East and West, including the Fifth Street Bridge. The APE generally includes parcels adjacent to the river (Figure 5-6, reference [12]).

The Minnesota State Historic Preservation Office (SHPO) has provided initial comments on the proposed APE and agrees that it is generally appropriate to consider potential direct and indirect effects of the project (reference [13]).

### 5.7.2 Identification of Historic Properties

The APE was subjected to a cultural resources literature review using data from the City of Northfield, SHPO, and the Minnesota Office of the State Archaeologist (OSA) in April 2023. The literature review determined that portions of the APE have previously been inventoried for historic architectural resources. OSA files indicate one possible historic archaeological site within the APE. No information indicated that the construction footprint had been surveyed for archaeological resources.

In addition, the City of Northfield recently commissioned 106 Group to complete a reconnaissance architectural history survey and assessment of effects on historic properties (reference [12]) and an archaeological literature review and assessment (reference [14]).

#### 5.7.2.1 Historic Architectural Resources

Downtown Northfield, including the APE, has been inventoried for historic architectural resources. An inventory and National Register of Historic Places (NRHP) nomination was completed by the City of Northfield for the Northfield Commercial Historic District in 1978, and the district was approved for listing

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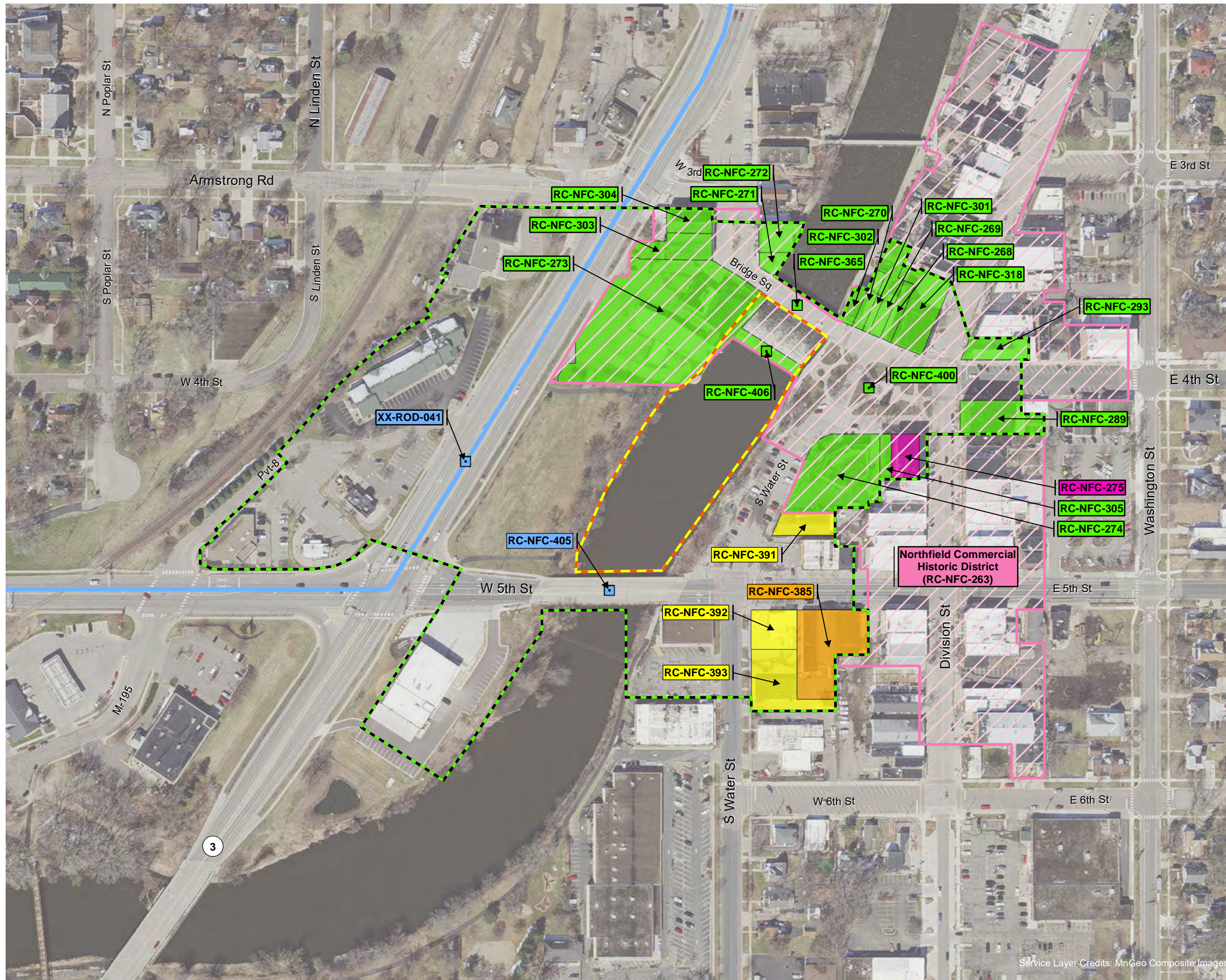
in the NRHP in 1979. This listing was updated in 1993 and 2021 (reference [15]). A portion of the APE is within the Northfield Commercial Historic District (Figure 5-6, reference [12]). Ames Mill Dam is listed as a contributing resource to the Northfield Commercial Historic District (reference [15]). The Scriver Building (RC-NFC-275), located within the APE and the boundaries of the Northfield Commercial Historic District, is individually listed in the NRHP.

The City completed a reconnaissance-level survey of historic architectural resources in 1990 and 1991, which resulted in the identification and documentation of 314 properties that included residential areas, the City's two college campuses, the 1979 Northfield Commercial District, and other City properties that appeared to be architecturally or historically significant (reference [16]).

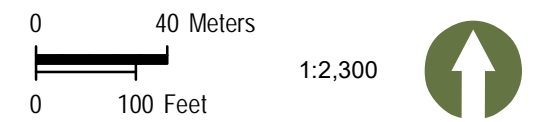
The City also commissioned 106 Group to complete a reconnaissance architectural history survey and assessment of effects study. Between January and April 2023, 106 Group investigated the project APE to identify properties 45 years or older that were not evaluated within the last 10 years. The investigation also evaluated these properties for potential listing in the NRHP. An assessment was also done to evaluate the project's potential effects on the three historic properties within the APE.

# Ames Mill Dam Reconstruction Project Reconnaissance Architectural History Survey and Assessment of Effects for Historic Properties

Northfield, Rice County, Minnesota



- Project Area
- Recommended APE
- NRHP-Listed District
- Individually NRHP Listed, Contributing to the Northfield Commercial Historic District
- Contributing to the Northfield Commercial Historic District
- Previously Assigned Inventory Number
- Previously Inventoried
- Previously Determined Not Eligible



Project Location, APE, and Literature Review Results

Figure 5-6

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### **Scriver Building**

The Scriver Building was listed on the NRHP in 1978. It is significant for its construction, as the location of First National Bank when it was robbed by the James-Younger gang in 1876, and for its association with Hiram Scriver, the first mayor of Northfield and founder of Carlton College. Although the Scriver Building is within the APE, it is approximately 250 feet southeast of Ames Mill Dam and has partially obscured views of the dam.

### **Northfield Commercial Historic District**

The Northfield Commercial Historic District was listed on the NRHP and designated as a local historic district in 1979. The district was nominated as an integrated town center composed of buildings and planned open space designed to consider the geography and natural features of the area, including the Cannon River. The district consists of a series of well-preserved buildings and represents a vital historic commercial center that continues to meet the needs of residents and visitors.

The Northfield Commercial Historic District was originally defined as a four-block expanse within the downtown business area of Northfield. Most buildings within the district are two stories tall and were constructed of local brick and quarried stone during the last quarter of the nineteenth century (reference [15]). French Second Empire, Queen Anne, Gothic, Italianate, and Romanesque styles are represented, as well as various commercial, vernacular, and contemporary designs. In 2021, the district's boundaries were altered to include the Northfield National Bank at 25 Bridge Square (1966) as a contributing property. The southeast and northwest corners of the district were also expanded to include the Northfield Armory (1915) and three twentieth-century commercial buildings. Two buildings were also removed from the district boundaries: the previously contributing Northfield Public Library (1910) due to exterior alterations and the Northstar Hotel at 512 Division Street (1900), which was razed in 2018.

The Cannon River flows diagonally through Northfield and is an anchoring element to the district. Bridge Square, the original town commons, is directly associated with the river. The "Mill Falls," formed by the Ames Mill Dam, is also noted as an element of both the river and the district in the NRHP nomination form (reference [15]).

Properties in the Northfield Commercial Historic District located within the APE include:

- 307 Water Street S
- 300 Water Street S
- 304 Water Street S
- 107 Third Street W
- 307 Water Street S
- 319 Water Street South (Ames Mill and the Ames Mill Dam)
- 19 Bridge Square
- 17 Bridge Square
- 13 Bridge Square
- 11 Bridge Square

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## **Ames Mill Dam**

John North constructed the first Ames Mill Dam on the Cannon River between 1855 and 1856 to power a flour and sawmill. In 1884, a new timber dam was constructed. The current dam was built in 1919 using concrete (reference [17]). The dam and associated flour mills were key to the settlement and growth of Northfield. Today, the dam is owned by Post Holdings but is no longer used for manufacturing, hydroelectric power, or any other functional purpose.

### **5.7.2.2 Archaeological Resources**

A review of the OSA portal for archaeological sites indicates that one site, 21Rcav, is within the APE. This site represents the possible location of Northfield Grist Mill. It is listed as an alpha site. Alpha sites have not been confirmed by a formal archaeological survey but generally represent locations where an archaeological site is anticipated based on some level of historical documentation. Two grist mills are depicted on an 1874 map of Northfield, Rice County, Minnesota, in the approximate location of site 21Rcav (reference [18]); both locations are in heavily developed areas, and no indication of these grist mills remains.

The City of Northfield commissioned an archaeological literature review and assessment for the project in January 2023. 106 Group completed a review of documentation regarding previously identified archaeological sites in the APE and within 1 mile of the APE and of archaeological surveys previously conducted within the APE (reference [14]). Historical maps, aerial photographs, and environmental data were also reviewed. The archaeological assessment identified whether the APE has the potential to contain unknown, intact archaeological resources that are potentially eligible for listing in the NRHP or contributing to existing NRHP-listed resources.

The literature review determined that with heavy disturbance from the construction and multiple reconstructions of the Ames Mill Dam and because the APE is inundated by the Cannon River or within flood zones, there is low potential for the APE to contain intact archaeological resources potentially eligible for listing in the NRHP or contributing to NRHP-listed resources. The 106 Group, therefore, recommended no further archaeological work within the APE for the project as currently planned (reference [14]).

SHPO provided initial comments 106 Group Report on archaeological resources. SHPO recommends that areas physically impacted by this work, as well as by water access, and storage and staging for equipment and dredging, should undergo a Phase I archaeological survey (reference [13]). If proposed construction activities take place near site 21CR0076, on the east bank of the current dam, SHPO recommends a Phase II evaluation of the site to determine its eligibility for listing in the NRHP. An official SHPO review would be triggered by the USACE review of a project permit.

### **5.7.3 Impacts on Historic Properties by Build Options**

Three historic properties, the Scriver Building, the Northfield Commercial Historic District, and Ames Mill Dam, were identified within the APE. However, the Scriver Building is not anticipated to be impacted by the project and is therefore not discussed further. Impacts associated with Options 2, 3, and 4 would

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adversely affect the Northfield Commercial Historic District and Ames Mill Dam. These impacts are discussed in the following sections. The impacts on these historic properties would be similar because each option would significantly alter the dam structure. Option 4, which would retain some components of the dam structure, is discussed further in Section 5.7.5.

### **Northfield Commercial Historic District**

Impacts to the Northfield Commercial Historic District would occur through the alteration or removal of the Ames Mill Dam, a contributing resource to the Northfield Commercial Historic District. The Ames Mill Dam, as an original feature and a foundational element of the district, contributes to the district's NRHP eligibility.

### **Ames Mill Dam**

Impacts on the Ames Mill Dam would occur through the alteration or removal of the dam, which would cause the dam to lose its NRHP eligibility due to a loss of integrity.

## **5.7.4 Interim Effects Analysis**

Although the project is not yet considered an undertaking subject to Section 106 of the NHPA, a federal agency undertaking is anticipated due to United States Army Corps of Engineers (USACE) permitting requirements. As a result, an interim effects analysis has been completed for the project according to 36 CFR 800.5.

According to 36 CFR 800.5(a)(1), "an adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association." Based on the current project information, the Ames Mill Dam, a contributing property to the Northfield Commercial Historic District, will be altered in a manner that destroys or diminishes the property's integrity. Therefore, our preliminary finding is that the project will have an "adverse effect" on the Ames Mill Dam. This recommendation is not the official effects finding, which would be submitted for review once the project is determined an undertaking subject to Section 106 of the NHPA. However, based on the current project plans, an analysis of the effects on the Ames Mill Dam follows. The analysis references the examples of adverse effects found in 36 CFR 800.5(a)(2).

Per 36 CFR 800.5(a)(2)(i), the undertaking may cause "physical destruction of or damage to all or part of the property." The Ames Mill Dam, a contributing element to the Northfield Commercial Historic District, may be removed in whole or in part.

Per 36 CFR 800.5(a)(2)(ii), the undertaking may cause "alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation and provision of handicapped access, that is not consistent with the Secretary's Standards for the Treatment of Historic Properties (36 CFR part 68) and applicable guidelines." The dam, a contributing element to the Northfield

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Commercial Historic District, may be altered in a manner inconsistent with the Secretary's Standards for the Treatment of Historic Properties.

Per 36 CFR 800.5(a)(2)(iii), the undertaking may cause "removal of the property from its historic location" as the dam, a contributing resource to the Northfield Commercial Historic District.

Per 36 CFR 800.5(a)(2)(iv), the undertaking may cause a "change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance." The Ames Mill Dam, a contributing resource to the Northfield Commercial Historic District, may be removed and replaced.

Per 36 CFR 800.5(a)(2)(v), the undertaking may cause the "introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features." The Ames Mill Dam, a contributing resource to the Northfield Commercial Historic District, may be removed, introducing a visual change to the district. Because the dam would be replaced with rock rapids, the audible elements of the sound of falling water will have minimal changes.

Per 36 CFR 800.5(a)(2)(vi), the undertaking will not cause "neglect of a property which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe or Native Hawaiian organization."

Per 36 CFR 800.5(a)(2)(vii), the undertaking will not cause "transfer, lease, or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance."

### **5.7.5 Potential Mitigation Measures**

Because an adverse effect is anticipated for the Ames Mill Dam and Northfield Commercial Historic District, the following options have been suggested as potential ways to mitigate the removal or partial removal of the dam. These mitigation measures could be implemented singly or combined as part of the City's overall strategy for the project.

- Historic American Engineering Record—level documentation (reference [19]) of the dam prior to its removal or partial removal
  - Provides a permanent record of the dam that would be printed for local libraries/historical societies for review and reference by the community and future generations following the dam's removal. The cost is estimated at \$30,000–\$45,000.
- Exhibits/Interpretive signage
  - An educational kiosk, a commemorative plaque, and/or interactive display near the dam's former location would provide information and visuals of the dam. The cost is estimated at \$20,000–\$30,000.

- Oral history project with interactive web map
  - A way to commemorate the history of the dam and its historic setting, incorporating an oral history project with members of the community who worked at Campbell Milling Company, Malt-O-Meal Company, or Post Holdings and remember specific stories about the dam/impoundment, or simply enjoyed its presence. These histories could be compiled with photographs/videos and incorporated into an interactive web map for the community and public at large to access/enjoy. An example can be found [here](#). The cost is estimated at \$30,000.
- Contribution to a local historic preservation effort
  - Instead of dam preservation, the City could fund other local preservation projects and/or provide additional monetary support for the Heritage Preservation Commission or other local preservation efforts.
- Creative mitigation with adjacent park efforts
  - Look for ways to incorporate salvaged portions of the dam into Ames Park. The cost would depend on how the City plans to improve the park.
- Retain dam remnants in the river
  - Option 4 represents a mitigative approach for the project, with a portion of the dam structure retained. Option 4 strikes a balance in recognizing the historical importance of the dam while allowing for the restoration of river ecology and increased recreational opportunities in Northfield.

## 5.8 Permitting and Environmental Review

Environmental considerations will require permitting and oversight by various governmental entities. Permitting requirements will depend on several factors, including the dam removal methods, staging area location(s), sediment handling, and other factors depending on the full scope of the project.

Various federal, state, and local agencies regulate projects impacting Minnesota's water resources. Project activities must not be initiated until all applicable federal, state, and/or local approvals have been obtained. These include but are not limited to the following:

- A state permit from the MnDNR for transfer of ownership of the dam from Post to the City of Northfield
- The state environmental review process
- State permits from the MnDNR regulating activities in the bed of public waters as defined in Minn. Stat. 105
- Federal permits from the USACE for dredged or fill material
- Local permits from the City of Northfield

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The permit requirements are anticipated to be consistent across the three project options, including dam removal and replacement.

Additional input will be needed from permitting agencies for design and to determine the scope of additional data necessary to meet environmental review and potential permit requirements. The following sections summarize the anticipated environmental review and permits associated with this project.

### **5.8.1 Transfer of Ownership**

Transfer of dam ownership from a private to public entity in Minnesota requires legislative action. Either the current or future owner can initiate the process with a permit application submitted to the MnDNR. MnDNR will then prepare a report to the legislature on the current condition of the dam, the future owner's plans for the structure, and funding availability for removal or maintenance. If the legislature does not vote to object to the permit, the permit will be issued, and the transfer of ownership may proceed following the end of the legislative session.

### **5.8.2 Environmental Review**

The Minnesota Environmental Policy Act of 1973 (MEPA) established the Environmental Quality Board (EQB), which oversees the formal environmental review process for the state of Minnesota. An Environmental Assessment Worksheet (EAW) is a screening tool used to determine whether a full Environmental Impact Statement (EIS) is needed. Minnesota Rules 4410.4300 (Mandatory EAW Categories) identifies triggers requiring a project proposer to prepare an EAW. Minnesota Rules 4410.4300 Subp. 27A requires an EAW for projects that will change or diminish the course, current, or cross-section of 1 acre or more of any public water or public waters wetland. The total project footprint area is expected to be approximately 1 acre for Option 2 and up to 2.5 acres for Options 3 and 4; therefore, a mandatory EAW is anticipated for all options. For this mandatory EAW category, the responsible government unit (RGU) would be the City of Northfield as the local governing unit (LGU) for the project. A record of decision on the EAW must be issued before construction permits can be granted, and the EAW process typically takes at least six months to complete. Based on the current scope of the proposed project, no triggers have been identified that would require the project to move beyond an EAW to a full EIS.

### **5.8.3 Minnesota Pollution Control Agency**

Construction of the proposed project will require a National Pollutant Discharge Elimination System/State Disposal System Construction Stormwater (CSW) general permit issued by the MPCA. The CSW permit will require a stormwater pollution prevention plan (SWPPP) that explains how stormwater will be controlled within the project area during construction. Note that control of river flow below the ordinary high water level is under the jurisdiction of the MnDNR and would be covered in the public waters work permit (Section 5.8.5) rather than by the CSW permit.

### **5.8.4 Minnesota Wetland Conservation Act**

The Minnesota Wetland Conservation Act (WCA) regulates the filling and draining of wetlands and excavation within Type 3, 4, and 5 wetlands—and may regulate any other wetland type if fill is proposed. The WCA is administered by LGUs, which include cities, counties, watershed management organizations,

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soil and water conservation districts, and townships. The Rice County Soil and Water Conservation District (SWCD) is the LGU for the entire project area. The Minnesota Board of Water and Soil Resources (BWSR) oversees the administration of the WCA statewide.

As described in Minnesota Rules 8420, the WCA applies to the types of wetland impacts that could be a part of this project, and a permit related to wetland impacts may be required; however, the LGU will have the final determination. To assist with project permitting and design, a field wetland delineation is recommended to identify wetland boundaries.

### **5.8.5 Minnesota Department of Natural Resources**

The MnDNR regulates projects constructed below the ordinary high water level of public waters, watercourses, or wetlands that alter the waterbody's course, current, or cross-section. Public waters regulated by the MnDNR are identified on published public waters inventory (PWI) maps. The Cannon River is a public watercourse, so the proposed work would require an MnDNR public waters work permit for each option. Based on recent project experience, the MnDNR permit requirements give preference to projects that seek to closely emulate a river's natural flow conditions, provide enhanced opportunities for AOP, and use natural materials as much as possible. Therefore, based on the initial evaluation of AOP in Section 5.4, MnDNR permitting is more likely to be successful for Options 3 and 4 than for Option 2 based on the increased likelihood of AOP across a wider range of flows and the lower proposed slope of the rock rapids.

MnDNR also has jurisdiction over dam safety and floodplain permitting; all MnDNR permits would be consolidated into a single permit application. Because the project would involve work in the regulatory floodway of the Cannon River, a Conditional Letter of Map Revision would be required from the Federal Emergency Management Agency (FEMA).

### **5.8.6 United States Army Corps of Engineers**

Per Section 404 of the Clean Water Act (CWA), the USACE regulates the placement of fill into wetlands if they are connected to a Water of the United States. The MPCA may be involved in wetland mitigation requirements as part of the CWA Section 401 water quality certification process for the 404 permit.

The USACE 404 permit requires a Section 106 review for historic and cultural resources. The results of the archeological reconnaissance study are included in Section 5.7. If the SHPO requests more detailed information, a Phase I Archeological Survey may need to be completed. The USACE staff anticipates that the 404 permit review and approval process could require 120 days to complete. It is anticipated that the project options would be permitted under a nationwide or regional general permit. Coordination with the USACE would be required to confirm specific requirements related to the project.

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## 5.8.7 Local Permits

The City of Northfield would require the following permits/approvals to modify the dam:

- Construction grading, sediment and erosion-control permit: requires plans to ensure protection, repair, or replacement of any installed erosion and sediment-control measures disturbed by activity and monitor the current SWPPP during construction activity in the affected area.
- Right-of-way/obstruction permit: required to work within city property, right-of-way, or easements. Permits are issued by the City of Northfield Engineering Division.
- Stormwater management plan: required to be completed when a developer provides permanent stormwater management due to development within the city's shoreland overlay district; a stormwater management plan would not apply for the in-river work but may apply for adjacent park developments.
- Certificate of Appropriateness: required for exterior improvements to structures within the Downtown Historic District, including demolition and landscaping. Project plans are reviewed, and certificates are issued by the Heritage Preservation Commission.
- Building permit: required for demolition projects. Permits are issued by the City of Northfield Building Inspection Department.

## 5.9 Funding Sources

Removing the Ames Mill Dam will be costly. Various funding mechanisms were researched, ranging from federal sources to state grants and private foundations. Alternatives are presented below.

### 5.9.1 State of Minnesota

The state of Minnesota has several grant programs that may apply to the Ames Mill Dam project:

- The MnDNR Dam Safety unit may provide 50 to 100 percent funding for the removal of dams that are unsafe or in need of repairs. Dam safety grants are awarded for removing dams to restore stream function, eliminate safety hazards, and improve property values, fish and wildlife habitat, water quality, water availability, and recreational value. Preference is given to dams on the priority list of dams that are hazardous or abandoned and nonfunctional and for complete dam removals; the Ames Mill Dam was not on the most recent list completed in 2021 because it is privately owned and thus not currently eligible for MnDNR funding. Grant amounts have ranged from \$25,000 to \$1,000,000. Grants of over 50 percent of project costs are typically reserved for complete dam removal projects; the proposed alternatives would likely not qualify as complete removals based on feedback from MnDNR staff. Funding is subject to availability, and a legislative bonding initiative may be necessary to obtain funding to remove the Ames Mill Dam.
- Outdoor Heritage Fund (OHF)—The OHF has funded dam removal in the recent past. The City of Pine Rapids received an OHF grant in 2020 to remove a 13-foot-high dam on Norway Brook in northcentral Minnesota and construct rock-arch rapids for aquatic life passage and hydrologic and geomorphic continuity. The project, "Restoration of Norway Brook connectivity to the Pine

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River by removal of Norway Lake Dam and replacement with rock-arch rapids,” received \$2,300,000.

A sub-component of the OHF is the Conservation Partners Legacy (CPL) grant which funds smaller natural resources projects—less than \$400,000. For example, this or similar grants could be used to fund the ecological restoration of native plant communities and the creation of off-channel wetlands after dam removal and channel stabilization. OHF grant applications are typically due in May of each year.

- Funding may be available through Minnesota’s Environment and Natural Resources Trust Fund. The fund supports activities that “protect, conserve, preserve, and enhance Minnesota’s air, water, land, fish, wildlife, and other natural resources.” Projects that demonstrate ecological and other public benefits in various categories, including protecting or restoring land, water, and habitat, are eligible. There is no minimum or maximum funding amount, and funding allocation occurs annually, with applications due in March. Based on the initial evaluation of AOP in Section 5.4, an application for this funding is more likely to be successful for Options 3 and 4 than for Option 2 due to the increased likelihood of AOP across a wider range of flows for Options 3 and 4.
- The Legislative-Citizen Commission on Minnesota Resources ([LCCMR](#)) could be an option to fund further study and planning of the dam removal project. Partnering with the University of Minnesota or other organizations with expertise in dam removal may improve the odds of success. Proposals for the fiscal year 2024–2025 biennium (July 1, 2023, to June 30, 2025) were due in May 2022. Requirements for the next available round of funding have not been published, but proposals will likely be due in the spring of 2024.

### **5.9.2 Federal Government**

The National Fish Passage Program through the US Fish and Wildlife Service is offering funding to restore fish passage. The program offers assistance for removing instream barriers and restoring aquatic organism passage. Grants can be up to \$10 million, with 2024 applications due on December 31, 2024. Like the Environment and Natural Resources Trust Fund, an application for this funding is more likely to be successful for Options 3 and 4 than for Option 2.

### **5.9.3 Private Foundations**

The [Coca-Cola Foundation](#) funds some dam-removal projects, including a recent project in Columbus, Georgia, on the Chattahoochee River. Other nonprofit organizations like the McKnight Foundation or 3M’s charitable branch may be more likely to fund projects in Minnesota, although Coca-Cola has funded projects worldwide.

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## 5.10 Stakeholder Input

Barr and City staff presented the preliminary findings of this feasibility study to the following groups of stakeholders during the preparation of this report, with meetings held between July 27 and October 11, 2023:

- Permitting agencies
- Post Consumer Brands
- Northfield City Council
- Northfield public

Feedback received from the permitting agencies is summarized in Section 5.8.

Post is generally supportive of options to remove the dam because the dam no longer serves a functional purpose to the company. Post requests that any alternative to remove the dam include detailed engineering analysis of the potential impacts to the Ames Mill building structural stability and mitigation of any issues identified.

Public input was solicited at public meetings attended by Northfield residents, downtown property owners, and City Council members. Most attendees were generally supportive of replacing the Ames Mill Dam. Comments focused on the potential for improved river ecology, aquatic recreation (boating), and public safety (removal of drowning hazard). Some respondents referenced the historic nature of the dam structure and its importance as a symbol of why Northfield was founded as reasons to keep the dam in place.

## 5.11 Opinion of Probable Cost

Barr prepared Engineer's Opinion of Probable Cost estimates for the design, permitting, and construction of Options 2, 3, and 4. These concept-level estimates (Class 4, ASTM 2516-11) provide a cost range that is 25% below and 50% above the calculated cost value. Table 5-7 summarizes the estimated cost for Options 2, 3, and 4. Cost breakdowns for each option are in Appendix B.

The most substantial cost and the greatest reason for the difference among options is the construction of the rock riffles; the expanded footprint of Options 3 and 4 would require significantly more base rock material to line the river channel between boulder weirs. Other significant cost differences among options include water control and sediment removal, which are affected by the project footprint. The amount of sediment removal estimated for each option was based on the available bathymetry data from the Cannon River hydraulic model; the required removal amounts will need to be refined in detailed design based on updated bathymetry and sediment sampling.

**Table 5-7 Cost Estimation Summary of Options 2, 3, and 4.**

	Option 2	Option 3	Option 4
Estimated total project cost (mid-range estimate)	\$3.5M	\$6.4M	\$6.4M
Cost range (-25% to + 50%)	\$2.6M to \$5.3M	\$4.8M to \$9.6M	\$4.8M to \$9.6M

The total project costs presented in Table 5-7 include estimated costs for detailed design, geotechnical investigation, cultural resources mitigation, and permitting. Costs do not include the purchase of the dam from Post Consumer Brands. Estimated design costs are similar among options, with the estimated design costs for Options 3 and 4 somewhat higher due to the greater project footprint. Additional design costs were estimated for Option 4 to account for structural analysis of the stability of the dam remnant, which offset potential cost savings for demolition and cultural resources mitigation for that option.

These costs are based on concept-level designs, quantities, and unit prices. Costs will change with further design. Contingency is included in the estimates as an allowance for the net sum of costs that will be in the Final Total Project Cost at the time of design completion but is not included at this level of project definition. The estimated accuracy range for the Total Project Cost is defined as -25% to +50%. The accuracy range is based on professional judgment considering the level of design completed, the complexity of the project, and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Costs are in 2023 dollars.

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## 6 Summary and Recommendations

### 6.1 Summary of Options

The key differences among the four options are summarized in Table 6-1.

The “No-Build” Option 1 would not affect the Ames Mill Dam or the Northfield Commercial Historic District. Under this option, the dam would not be removed wholly or in part. This option would avoid impacts on historic properties; however, this option does not address the safety or ecological deficiencies of the dam, nor does it improve recreational opportunities for the Cannon River. As a result, this option does not meet the purpose and needs of the project and is not recommended for further consideration.

Option 2 would have a smaller construction footprint than Options 3 and 4, which would lead to some reduction in construction complexity and a significant reduction in project material costs. Concerning potential groundwater impacts, the smaller footprint of Option 2 would reduce the potential for subsidence and result in less need for geotechnical investigation in detailed design. Option 2 would have higher associated flow velocities than Options 3 and 4, making this option less effective for aquatic organism passage and less attractive for public recreation.

The longer rapids and flatter slope in Options 3 and 4 would decrease flow velocity compared to Option 2. This would reduce the size of the rock materials needed for the rock rapids, although the lower unit cost of materials would be more than offset by larger quantities of rock. Lower flow velocities in Options 3 and 4 would provide better opportunities for public river recreation and allow for easier aquatic organism passage over a wider range of flow conditions. In addition, the expanded footprint options would allow for integrating river recreational features with Ames Park.

Options 2, 3, and 4 would have similar considerations concerning the interaction with adjacent infrastructure, permitting and environmental review, and potential funding sources. Slight differences among the options may result in differences in permitability and applicability of individual funding sources, especially with respect to the preference of some agencies and funding sources for projects that enhance aquatic organism passage.

Option 2 and Option 3 would result in the same impacts to the Ames Mill Dam and similar impacts to the Northfield Commercial Historic District. Both options would result in the complete removal of Ames Mill Dam and will alter a portion of the Cannon River within historic district boundaries. Option 4 would result in the partial removal of Ames Mill Dam. Although the dam would no longer function under Option 4, the remaining portion of the dam structure would be a visible reminder of the historic dam. Mitigation for adverse effects under Section 106 would likely be similar for Options 2 and 3 due to the similar impacts these alternatives would have on the dam and historic district. Option 4 may require fewer mitigation measures than Options 2 and 3 since part of the dam would be preserved.

Due to the reduced construction footprint, material quantities, and construction duration, the estimated project cost for Option 2 is significantly less than for Options 3 and 4, which would have similar costs.

**Table 6-1 Alternatives Evaluation Matrix**

<b>Criteria</b>	<b>Option 1: No Build</b>	<b>Option 2: Full Dam Removal, Compact Rapids</b>	<b>Option 3: Full Dam Removal, Expanded Rapids</b>	<b>Option 4: Partial Dam Removal, Expanded Rapids</b>
<b>Meets Purpose and Need</b>	No	Yes (partial; see notes)	Yes (partial; see notes)	Yes
<b>River Structures</b>	Existing dam	10 boulder weir structures spaced every 25–30 feet Approximately 1 foot of drop across each structure	10–15 boulder weir structures every 45–55 feet Approximately 0.8–1.0 feet of drop across each structure	10–15 boulder weir structures every 45–55 feet Approximately 0.8–1.0 feet of drop across each structure 20-foot dam remnant
<b>Design and Construction</b>	No change	Compact footprint reduces construction costs and complexity High velocity requires very large boulders and base rock	Increased construction cost and complexity due to expanded footprint Lower velocity, smaller boulders and base rock	Increased construction cost and complexity due to expanded footprint Lower velocity, smaller boulders and base rock
<b>Public Recreation</b>	No recreational improvements; hydraulic roller (“drowning machine”) created by flow over the existing structure	Removal of hydraulic roller Boating under low and average flow conditions (higher velocity) <sup>(1)</sup> Does not integrate rapids with Ames Park <sup>(1)</sup>	Removal of hydraulic roller Boating under low and average flow conditions (lower velocity) Potential for Ames Park connections and river amenities	Removal of hydraulic roller Boating under low and average flow conditions (lower velocity) Potential for Ames Park connections and river amenities
<b>Aquatic Organism Passage (AOP)</b>	Complete barrier to fish and aquatic organism passage	Improvements to fish and aquatic organism passage (low flows likely, moderate possible) <sup>(1)</sup>	Improvements to fish and aquatic organism passage (low and moderate flows likely)	Improvements to fish and aquatic organism passage (low and moderate flows likely)
<b>Groundwater Drawdown and Subsidence</b>	No change	Limited potential for change at Ames Mill; limited study recommended	Limited potential for change in project footprint; further study recommended	Limited potential for change in project footprint; further study recommended
<b>Cultural Resources</b>	No change	Complete removal of contributing element to Historic District Will require mitigation <sup>(1)</sup>	Complete removal of contributing element to Historic District Will require mitigation <sup>(1)</sup>	Alteration of contributing element to Historic District May require additional mitigation

Criteria	Option 1: No Build	Option 2: Full Dam Removal, Compact Rapids	Option 3: Full Dam Removal, Expanded Rapids	Option 4: Partial Dam Removal, Expanded Rapids
<b>Permitting and Environmental Review</b>	No change	Requires EAW, local/state/federal permits	Requires EAW, local/state/federal permits DNR permits are more favorable due to AOP	Requires EAW, local/state/federal permits DNR permits are more favorable due to AOP
<b>Funding Sources</b>	No change	State/federal/private grants may be applicable AOP-focused grants are less favorable	State/federal/private grants may be applicable AOP-focused grants are more favorable	State/federal/private grants may be applicable AOP-focused grants are more favorable
Stakeholder Input	Limited support due to historic structure	No specific comments received on Option 2, inferred lower support than Option 3 due to lower AOP and recreation potential	Public support for improvements to AOP, public recreation, and removal of drowning hazard	Similar to Option 3, no specific comments received on Option 4
Cost	\$0	\$2.6M to \$5.3M	\$4.8M to \$9.6M	\$4.8M to \$9.6M

(1) Evaluation indicates the option partially meets the project purpose and need for this category.

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## 6.2 Recommendations

Based upon the comparison of impacts and other factors associated with the alternatives that would satisfy the project purpose and need, Option 3 is recommended as the alternative that best meets the project purpose and need with the “least remaining harm, after mitigation, to the protected activities, attributes, or features” that qualify the property for NRHP eligibility. Although the estimated cost of Option 3 is significantly higher than that for Option 2, Option 3 more fully meets the project purpose and need in every category except for cultural resources.

Options 3 and 4 have similar project benefits and costs, but the added design complexity of retaining a portion of the dam structure in Option 4 makes it less desirable for the following reasons:

- It is a potential safety hazard for recreational users.
- More-complex flow patterns and reduced river width could impede aquatic organism passage under some flow conditions.
- It is more complicated to design and construct rapids around the remnant.
- There is less room to isolate portions of the river to construct in the dry.
- If the remnant were to fail in a large flood, it could damage the adjacent mill building.
- It would concentrate flows through the east opening of the Fourth Street Bridge, which could create stability concerns.

Cultural resources mitigation permitting may require retaining some remnants of the dam structure even if the City elects to pursue Option 3, but the benefits of doing so can be more fully considered during the detailed design and permitting process.

Barr recommends that the City consider pursuing full removal of the Ames Mill Dam and replacement with an extended rock rapids structure (Option 3).

## 7 References

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- [16] C. Zellie, "Final Report: The Northfield Historic Sites Survey," Landscape Research, Saint Paul, 1991.

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## **Appendix A**

### **Data Summary Memo**

## Memorandum

**To:** David Bennett, City of Northfield  
**From:** Peter Hinck  
**Subject:** Data Gathering and Review  
**Date:** January 31, 2022  
**Project:** 23661046.00 Ames Mill Dam Replacement Phase 1

This memo documents the data collected and reviewed for Phase 1 of the Ames Mill Dam replacement feasibility study. Currently, we have no additional data needs for the study.

Document	Source	Summary
2020 Riverfront Enhancement Action Plan	City, 2020	<p>Planning Study for downtown area</p> <p>Study expectations from Council</p> <ul style="list-style-type: none"> <li>• prioritization to align with city's strategic plan</li> <li>• concept plans for strategic park improvements</li> <li>• identify short- and long-term projects and funding sources</li> <li>• preservation and conservation of the riverfront</li> <li>• identification of stormwater management project priorities</li> <li>• strategies for increased active use of the riverfront</li> <li>• opportunities for business expansion in the corridor</li> </ul> <p>Projects identified</p> <ul style="list-style-type: none"> <li>• Ames Park</li> <li>• Riverside Lions Park</li> <li>• Babcock Park</li> <li>• Trail System</li> <li>• Sechler Park</li> <li>• Ames Mill Dam</li> <li>• Downtown Riverwalk</li> </ul> <p>Plan Components</p> <ol style="list-style-type: none"> <li>1. Establish Northfield's Cannon River Regional Park</li> <li>2. Enhance + Activate Your Riverfront Parks</li> <li>3. Complete Your Local + Regional Trail System</li> <li>4. Explore Ames Mill Dam Reconstruction Options</li> <li>5. Promote Economic Development + Tourist Destination</li> </ol>
Flood Insurance Study for Rice County	FEMA	<p>100-year Discharge has changed over time</p> <p>2019 FIS 11,800 cfs (Preliminary)</p> <p>2012 FIS 11,800 cfs (Effective)</p> <p>2003 FIS 11,800 cfs</p> <p>1981 FIS 24,000 cfs</p>

Document	Source	Summary
Flow Frequency Analysis Memo	Barr, 2022	100-year Discharge = 16,200 cfs
Ames Mill and Cannon River Dam Inspection, Design, and Construction Documentation Report	Barr, 2020	<p>Report prepared for Post documenting inspections and repairs made to the Ames Mill structure adjacent to the Ames Mill Dam on the Cannon River. The study involved</p> <ul style="list-style-type: none"> <li>• sediment sampling upstream of the dam</li> <li>• bathymetric and land surveys</li> <li>• inspections of Ames Mill and the dam (dive inspection, core samples, visual inspection)               <ul style="list-style-type: none"> <li>○ scour and undermining observed</li> </ul> </li> <li>• stability analysis of the dam</li> <li>• construction documentation</li> <li>• agency coordination</li> </ul>
Ames Mill Dam Replacement Study -Report -Drawings -Cost Estimates	Barr, 2007	<p>Dam removal options study evaluated seven options. One would repair the existing dam. Six would replace the dam. Cost estimates were prepared for each option. The costs ranged from \$1.1M to \$1.8M. The study included renderings for the different options.</p> <p>Options considered:</p> <ol style="list-style-type: none"> <li>1. Repair/modify dam 1.17M</li> <li>2. Option 1 – Stepped rock rapids at 10% slope</li> <li>3. Option 2 – Stepped rock rapids at 20% slope</li> <li>4. Option 3 – Concrete steps at 20% slope</li> <li>5. Option 4 – Rock Rapids with Transverse shallow slope across river</li> <li>6. Option 5 – Stepped rock rapids at 5% Slope, starting downstream of the Water St. Bridge</li> <li>7. Option 6 – Move dam crest upstream, stepped rock rapids at 5% slope, entirely upstream of Water St. Bridge</li> </ol>
Sediment Sampling Report for the Cannon River Dam	Barr, 2007	<p>Barr collected 3 sediment cores upstream of the dam and had them chemically analyzed. Prior sediment sampling efforts did not meet new dredging guidance established by MPCA.</p> <ul style="list-style-type: none"> <li>• Sediment data did not show any reasonable likelihood of contamination</li> <li>• All tested sediments were below the SRV Tier II Criteria (industrial or recreational use).</li> <li>• Deeper clay layer slightly higher than Tier I criteria (residential or agricultural use) for arsenic, copper and mercury.</li> <li>• Upper sand layer passes all Tier I criteria.</li> </ul>
DNR Letter to Barr regarding dam removal options	DNR, 2007	<p>Comments on options being considered for the replacement of the Ames Mill Dam. Main points:</p> <ol style="list-style-type: none"> <li>1. The DNR encourages removal of existing structures that do not serve the public interest.</li> <li>2. The DNR would like to see removal plans to document the reduction in drowning potential and mitigation of the fish migration barrier caused by the existing dam.</li> <li>3. The DNR notes that Option 2 from the 2007 replacement study does not adequately mitigate the fish migration problem.</li> </ol>

Document	Source	Summary
Hydraulic Capacity and Dam Stability Investigations – Cannon River Dam	SEH, 1998	Report summarizing investigation Findings <ul style="list-style-type: none"> <li>• Dam is regulated by the MnDNR</li> <li>• Dam is classified as a "medium hazard" dam. Required to safely pass the 100-year flood and meet specified structural safety factors</li> <li>• Spillway has hydraulic capacity to pass 12,300 cfs</li> <li>• Stability analysis found the dam did not meet state dam safety criteria and provided recommendations to reinforce the dam.</li> <li>• Cost estimates for repairs/modifications</li> </ul>
Hydrologic Investigation of Dam Capacity	SEH, 1998	Report documenting the revision of the estimated peak discharge from the 1% annual exceedance probability (100-year) flood. <ul style="list-style-type: none"> <li>• The 1981 FIS uses 24,000 cfs</li> <li>• A 1994 USACE study estimated 13,000 cfs.</li> <li>• A 1997 USGS analysis estimated 14,000 cfs</li> <li>• SEH 1997 Bulletin 17B estimated 11,300 cfs</li> <li>• SEH 1997 Expected Probability 12,300 cfs</li> <li>• (subsequent 2003 FIS used 11,800 cfs)</li> </ul>
Inspection and Evaluation of Cannon River Dam Report for Malt-O-Meal	SEH, 1997	Report documents dam inspections, evaluation of options, and recommendations. Findings <ul style="list-style-type: none"> <li>• Dam needs repairs</li> <li>• Scouring observed downstream of dam</li> <li>• Some spillway concrete below desired minimum strength of 3000 psi</li> <li>• Dam required to safely pass the 100-year flood</li> <li>• Dam may not be able to handle ice loads</li> <li>• Provided opinion of cost range for dam repairs</li> <li>• No formal regularly scheduled inspection program</li> <li>• Additional signage is needed</li> <li>• Removal of the dam would affect upstream channel elevations. This could expose sanitary sewer line upstream of the 5th Street bridge. It could also undermine piers for the TH 3 bridge.</li> <li>• Removal of the dam would lower the upstream water table potentially causing foundation settlement and damage to nearby buildings.</li> </ul> Recommendations <ul style="list-style-type: none"> <li>• Set up formal inspection program.</li> <li>• Remove or repair the dam</li> <li>• Discuss silt removal requirements with State personnel.</li> <li>• Various recommendations if dam is removed, including additional studies on impacts to groundwater elevations.</li> </ul>

Document	Source	Summary
Inspection and Evaluation of Cannon River Dam Supplemental Investigation Report for Malt-O-Meal	SEH, 1997	<p>Follow-up study summarizing the results of additional investigations related to soil contamination and groundwater impacts from dam removal.</p> <p>Findings</p> <ul style="list-style-type: none"> <li>• Sediment sampling and testing program found high ammonia concentrations which can be toxic to fish. However, ammonia is unstable and quickly reacts with dissolved oxygen and converts to a non-toxic form. Release of sediments downstream should not pose a significant threat to fish.</li> <li>• Environmental file search (limited) found two contaminated sites near the dam. One at South Water and Fifth and the other at Fifth Street and Laurel Court.</li> <li>• Preliminary hydrologic and geotechnical evaluation of permanent reservoir drawdown.</li> <li>• Removal of the dam (with pool drawdown) could cause 3 to 9 inches of ground subsidence. Identified 14 buildings plus the mill in the zone of influence from groundwater table drawdown. Eight are potentially at risk from subsidence.</li> <li>• Subsidence could affect sanitary, stormwater and water main infrastructure, as well as private utilities.</li> <li>• Erosion protection measures for exposed riverbanks.</li> <li>• Armoring of TH 3 bridge piers may be needed.</li> <li>• Provided recommendations and planning level costs for mitigating issues related to a lower river profile and lower groundwater levels.</li> <li>• Copy of letters to MPCA discussing sediment removal and sediment contamination</li> </ul>
Ames Mill Dam Design Drawings	Power Engineering Co., 1917	PDF of pages from the original design drawings for the dam. Dam crest in drawings is 10.2 feet higher than the base of the spillway.

## **Appendix B**

### **Engineer's Opinion of Probable Costs**

**Option 2 - Compact Rock Rapids**

**10% Concept Design Level**

**ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS**

PROJECT: Ames Mill Dam Replacement Feasibility Study

CLIENT: City of Northfield

PROJECT #: 23661046.00

DATE: June 2023

**ESTIMATED COSTS**

Item No:	Item Description	Total Cost
1	Mobilization	\$ 220,000
2	Temporary Erosion Control	\$ 30,000
3	Water Control	\$ 300,000
4	Remove Existing Dam	\$ 90,000
5	Sediment Removal	\$ 115,000
6	Construct Rock Riffles	\$ 1,130,000
7	Sheetpile Cutoff	\$ 180,000
8	Riprap Bank Stabilization	\$ 35,000
9	Site Restoration	\$ 30,000
	Construction Cost Subtotal	\$ 2,130,000
10	30% Construction Cost Contingency	\$ 640,000
11	Design Engineering <sup>1</sup>	\$ 550,000
12	Geotechnical Investigation	\$ 50,000
13	Cultural Mitigation <sup>2</sup>	\$ 50,000
14	Permitting	\$ 80,000
	Total Project Cost (Mid Range Estimate) <sup>3,4</sup>	\$ 3,500,000
	Low Range Estimate (-25%)	\$ 2,630,000
	High Range Estimate (+50%)	\$ 5,250,000

**Notes:**

<sup>1</sup> Estimated as 20% of construction cost (including contingency).

<sup>2</sup> Cultural mitigation costs depend on the option chosen by the city. Costs for any one option are estimated to range from \$15,000 to \$45,000.

<sup>3</sup> Limited Design Work Completed (10% concept level).

<sup>4</sup> This concept-level (Class 4, 10% design completion per ASTM E 2516-11) cost estimate is based on concept-level designs, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. Contingency is an allowance for the net sum of costs that will be in the Final Total Project Cost at the time of the completion of design, but are not included at this level of project definition. The estimated accuracy range for the Total Project Cost as the project is defined is -25% to +50%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Operation and Maintenance and Construction Administration costs are not included.

**Option 3 - Expanded Rock Rapids**

**10% Concept Design Level**

**ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS**

PROJECT: Ames Mill Dam Replacement Feasibility Study

CLIENT: City of Northfield

PROJECT #: 23661046.00

DATE: June 2023

**ESTIMATED COSTS**

Item No:	Item Description	Total Cost
1	Mobilization	\$ 430,000
2	Temporary Erosion Control	\$ 30,000
3	Water Control	\$ 500,000
4	Remove Existing Dam	\$ 90,000
5	Sediment Removal	\$ 425,000
6	Construct Rock Riffles	\$ 2,430,000
7	Sheetpile Cutoff	\$ 110,000
8	Riprap Bank Stabilization	\$ 85,000
9	Site Restoration	\$ 30,000
	Construction Cost Subtotal	\$ 4,130,000
10	30% Construction Cost Contingency	\$ 1,240,000
11	Design Engineering <sup>1</sup>	\$ 800,000
12	Geotechnical Investigation	\$ 75,000
13	Cultural Mitigation <sup>2</sup>	\$ 50,000
14	Permitting	\$ 80,000
	Total Project Cost (Mid Range Estimate) <sup>3,4</sup>	\$ 6,375,000
	Low Range Estimate (-25%)	\$ 4,780,000
	High Range Estimate (+50%)	\$ 9,560,000

**Notes:**

<sup>1</sup> Estimated as 15% of construction cost (including contingency).

<sup>2</sup> Cultural mitigation costs depend on the option chosen by the city. Costs for any one option are estimated to range from \$15,000 to \$45,000.

<sup>3</sup> Limited Design Work Completed (10% concept level).

<sup>4</sup> This concept-level (Class 4, 10% design completion per ASTM E 2516-11) cost estimate is based on concept-level designs, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. Contingency is an allowance for the net sum of costs that will be in the Final Total Project Cost at the time of the completion of design, but are not included at this level of project definition. The estimated accuracy range for the Total Project Cost as the project is defined is -25% to +50%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Operation and Maintenance and Construction Administration costs are not included.

**Option 4 - Expanded Rock Rapids, Partial Dam Removal**

**10% Concept Design Level**

**ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS**

PROJECT: Ames Mill Dam Replacement Feasibility Study

CLIENT: City of Northfield

PROJECT #: 23661046.00

DATE: June 2023

**ESTIMATED COSTS**

Item No:	Item Description	Total Cost
1	Mobilization	\$ 430,000
2	Temporary Erosion Control	\$ 30,000
3	Water Control	\$ 500,000
4	Remove Existing Dam	\$ 80,000
5	Sediment Removal	\$ 425,000
6	Construct Rock Riffles	\$ 2,430,000
7	Sheetpile Cutoff	\$ 110,000
8	Riprap Bank Stabilization	\$ 85,000
9	Site Restoration	\$ 30,000
	Construction Cost Subtotal	\$ 4,120,000
10	30% Construction Cost Contingency	\$ 1,240,000
11	Design Engineering <sup>1</sup>	\$ 850,000
12	Geotechnical Investigation	\$ 75,000
13	Cultural Mitigation <sup>2</sup>	\$ 30,000
14	Permitting	\$ 80,000
	Total Project Cost (Mid Range Estimate) <sup>3,4</sup>	\$ 6,395,000
	Low Range Estimate (-25%)	\$ 4,800,000
	High Range Estimate (+50%)	\$ 9,590,000

**Notes:**

<sup>1</sup> Estimated as 16% of construction cost (including contingency).

<sup>2</sup> Cultural mitigation costs depend on the option chosen by the city. Costs for any one option are estimated to range from \$15,000 to \$45,000.

<sup>3</sup> Limited Design Work Completed (10% concept level).

<sup>4</sup> This concept-level (Class 4, 10% design completion per ASTM E 2516-11) cost estimate is based on concept-level designs, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. Contingency is an allowance for the net sum of costs that will be in the Final Total Project Cost at the time of the completion of design, but are not included at this level of project definition. The estimated accuracy range for the Total Project Cost as the project is defined is -25% to +50%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Operation and Maintenance and Construction Administration costs are not included.