Rt. 47/Hadley Street and Titan Pier Road at Dry Brook
Culvert Replacement Concept
South Hadley, MA

Site Description

Rt. 47/Hadley Street and Titan Pier Road cross Dry Brook approximately 300 feet west of the intersection of Rt. 47/Hadley Street and Sullivan Lane. The existing structure is a round pipe constructed of concrete at the inlet and corrugated metal at the outlet, and there appears to be a larger chamber in the structure between the inlet and outlet pipes. The culvert appears to change direction under South Hadley Road or Titan Pier Road. The culvert diameter is 4 feet at the inlet, resulting in a severe constriction of the stream's approximately 16-foot bankfull width. The crossing is undersized for all peak flows assessed under existing and future climate conditions. Noted structural deficiencies include embankment piping and damage to the culvert joints, headwalls and wingwalls, and armor.

Proposed Concept

- Replace the existing metal pipe culvert with an open-bottom arch with a span of approximately 22 feet to accommodate a future estimated bankfull width of approximately 17.4 feet associated with an estimated 20% increase in bankfull flows due to climate change,
  - This will result in a crossing that meets the Massachusetts River and Stream Crossing Standards, which require a span of 1.2 times the stream's bankfull width.
- The proposed culvert replacement design concept will:
  - Provide increased hydraulic capacity to reduce flooding risk and to allow water and debris associated with larger storms to pass.
  - Decrease potential for road overtopping during heavy precipitation.
  - Reduce geomorphic risk by realigning the culvert and eliminating changes in structure material and dimensions.
  - Improve the passability of the structure

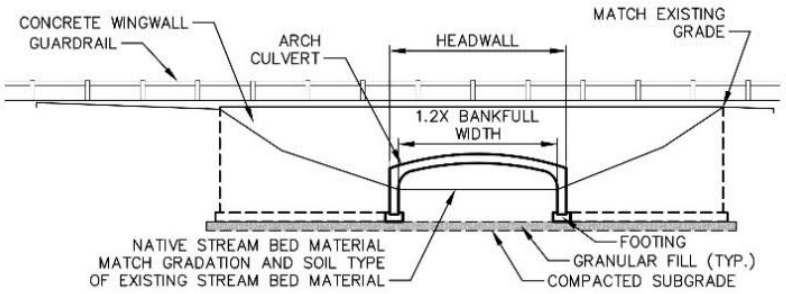


Image 3: Typical detail of an open arch culvert designed to meet MA Stream Crossing Standards

Image 1: Existing structure inlet during field visit on November 24, 2020.

Image 2: Existing structure outlet during field visit on November 24, 2020. Note the large scour pool, eroded banks, and perched outlet. Also note the change from concrete at the inlet to corrugated metal at the outlet.

Image 4: Interior of the existing culvert during November 24, 2020 field visit. Note the change in culvert alignment at the chamber in the background.

Site Prioritization Summary

Scaled Crossing Priority Score (0-1): 0.75
Impact Score (1-5): 4
Hydraulic Risk Score (1-25) (Existing/Future): 20/20
Geomorphic Risk Score (1-25): 16
Structural Risk Score (1-25): 12
AOP Benefit Score (1-25): 15

Existing Crossing Characteristics

Material: Corrugated metal pipe, concrete
Structure Width: 4 feet (inlet), 5 feet (outlet)
Structure Height: 4 feet (inlet), 5 feet (outlet)
Structure Length: Approximately 107 feet
Bankfull Width: Approximately 16 feet

Hydraulic Capacity Summary

Total Drainage Area: 0.71 miles^2
Existing Structure Capacity: 87.5 cfs
Estimated Peak Flows:

Recurrence Interval	Existing	Future
10-year	88.4 cfs	106 cfs
25-year	121 cfs	145 cfs
50-year	149 cfs	179 cfs
100-year	178 cfs	214 cfs

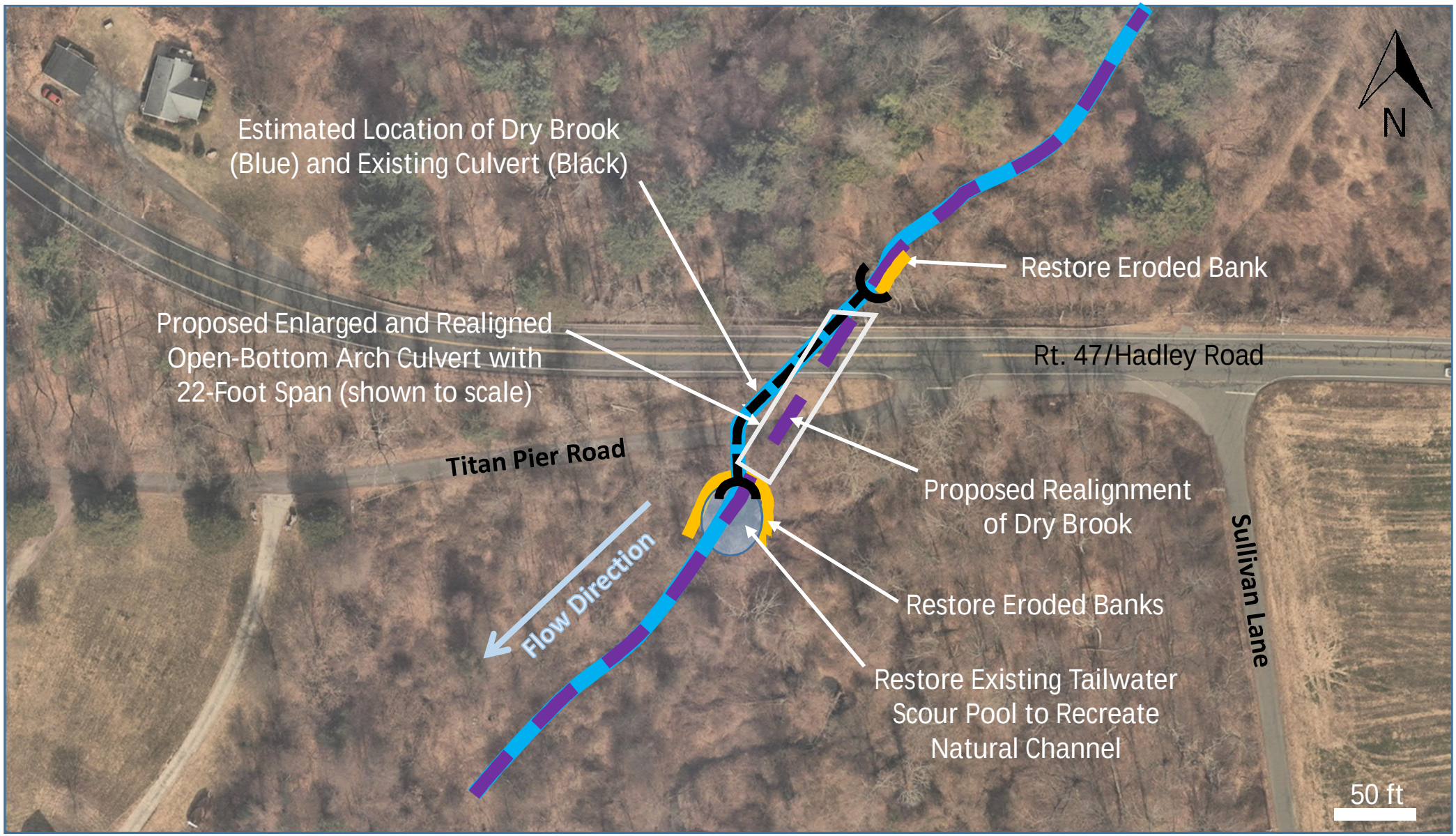
Notable Assessment Findings

- High potential for transportation disruption and flood impact potential
- Severe constriction
- Structure changes material, size, and direction between inlet and outlet

Preliminary Opinion of Cost[1]

Total project cost: $1,600,000

[1]Actual project cost may range from -30% to +50% of the quoted cost.



Rt. 47/Hadley Road and Titan Pier Road

Culvert Replacement Concepts, South Hadley, MA

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Hillside Avenue at Buttery Brook
Culvert Replacement Concept
South Hadley, MA

Site Description

Hillside Avenue crosses Buttery Brook approximately 0.25 miles south of the intersection of Rt. 202/Granby Road and Hillside Avenue. The existing structure is a 3-foot round pipe constructed of concrete set in concrete headwalls at the inlet and outlet. A Contech manhole was observed near the crossing on the road surface and a created basin that appears to be associated with stormwater management is located in the woods adjacent to the inlet. The crossing has adequate capacity to pass most or all peak flows under existing and future climate conditions, however, the site is subject to elevated structural and geomorphic risk. Severe constriction of the stream's approximately 11-foot bankfull width has caused extensive scour at the outlet that has undermined the structure and an asphalt scour protection pad that was previously poured at the outlet. This asphalt now remains as a floating shelf over the scour hole. Sinkholes are also forming behind the headwall at the outlet.

Proposed Concept

- Realign the crossing and replace the existing culvert with an open-bottom arch or three-sided box culvert with a span of approximately 16 feet to accommodate a future estimated bankfull width of approximately 12.2 feet associated with an estimated 20% increase in bankfull flows due to climate change.
  - This will result in a crossing that meets the Massachusetts River and Stream Crossing Standards, which require a span of 1.2 times the stream's bankfull width.
- The proposed culvert replacement design concept will:
  - Relieve constriction and reduce potential for scour and erosion
  - Reduce geomorphic risk by realigning the culvert
  - Improve the passability of the structure

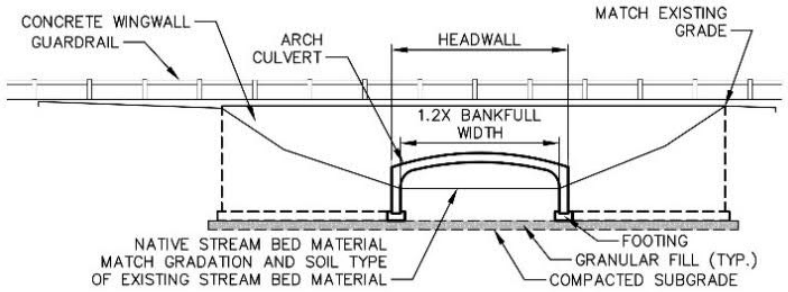


Image 3: Typical detail of an open arch culvert designed to meet MA Stream Crossing Standards

Image 1: Existing structure inlet during field visit on November 25, 2020. Note the inlet drop and misalignment of the stream with the inlet.

Image 2: Existing structure outlet during field visit on November 25, 2020. Note the large scour pool, severely eroded banks and undermined endwall, and perched outlet. Also note the two perched stormwater pipes (to the right of the outlet in this photo).

Image 4: View downstream of the culvert outlet during the November 25, 2020 field visit. Note the severe bank erosion.

Site Prioritization Summary

Scaled Crossing Priority Score (0-1): 0.75
Impact Score (1-5): 4
Hydraulic Risk Score (1-25) (Existing/Future): 4 / 8
Geomorphic Risk Score (1-25): 16
Structural Risk Score (1-25): 20
AOP Benefit Score (1-25): 15

Existing Crossing Characteristics

Material: Concrete
Structure Diameter: 3 feet
Structure Length: 166 feet
Bankfull Width: Approximately 11.3 feet

Hydraulic Capacity Summary

Total Drainage Area: 0.74 miles^2
Existing Structure Capacity: 170 cfs
Estimated Peak Flows:

Recurrence Interval	Existing	Future
10-year	78.0 cfs	93.6 cfs
25-year	106 cfs	127 cfs
50-year	129 cfs	155 cfs
100-year	154 cfs	185 cfs

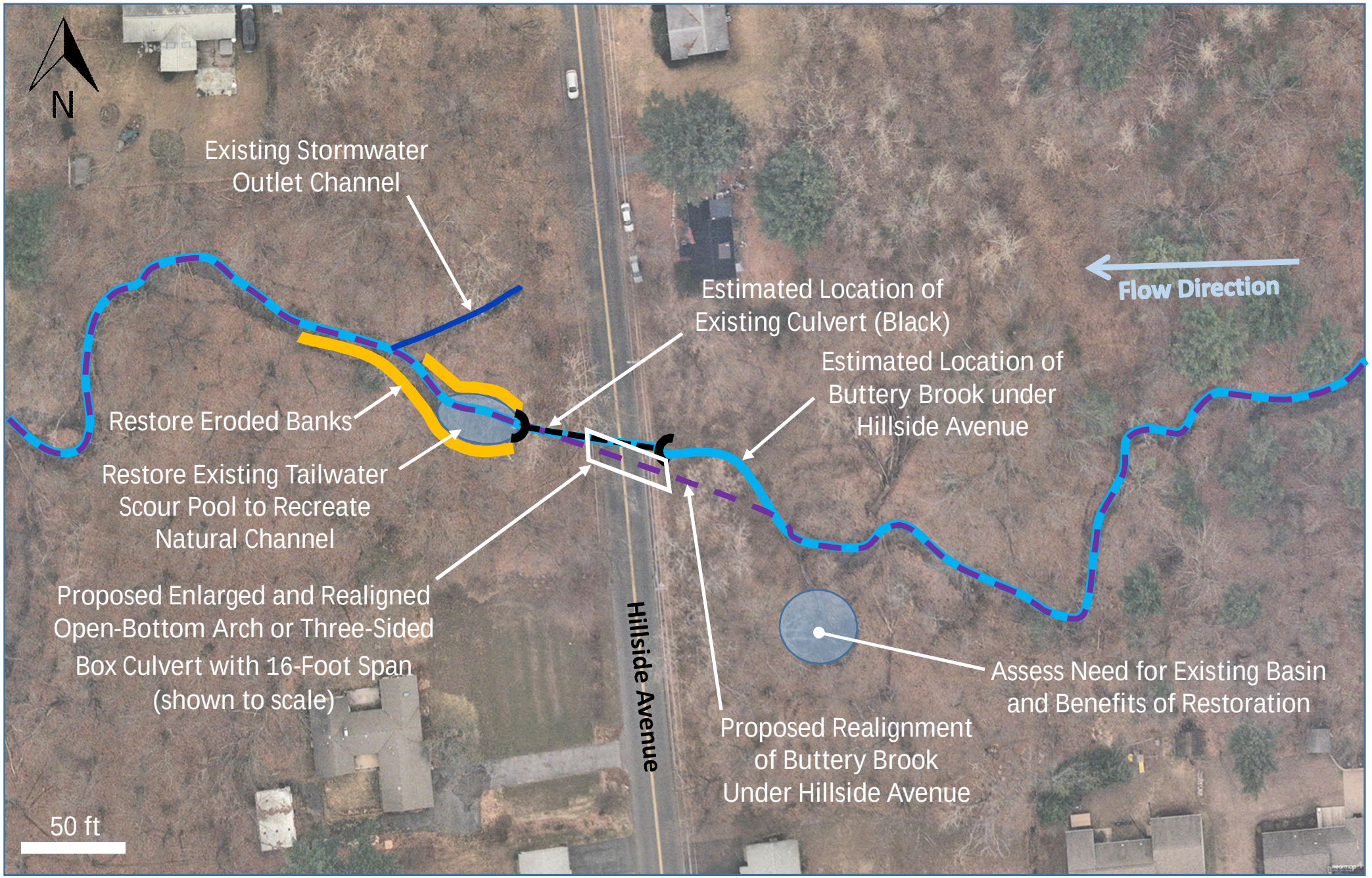
Notable Assessment Findings

- Severe scour at the outlet has undermined the endwall and caused the formation of sinkholes and a large scour pool
- High flood impact potential
- Critical structural deficiencies include culvert blockage, embankment piping, and poor structural integrity and alignment

Estimated Replacement Cost Range[1]

Total project cost: $900,000

[1]Actual project cost may range from -30% to +50% of the quoted cost.



Hillside Avenue

Culvert Replacement Concepts, South Hadley, MA

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Brainerd Street at Unnamed Tributary to Stony Brook
Culvert Replacement Concept
South Hadley, MA

Site Description

Brainerd Street crosses an unnamed tributary to Stony Brook approximately 275 feet west of the intersection of Newton Street, College Street, and Brainerd Street and immediately to the east of a utility corridor. The existing structure is a round corrugated metal pipe that is partially buried in sediment at the inlet and perched at the outlet. This is partially due to the severe constriction formed by the 3-foot diameter of the culvert. The pipe also appears be poorly aligned and has a partial internal blockage near the outlet. The crossing is undersized for all peak flows assessed under existing and future climate conditions. Critical structural deficiencies include embankment piping, poor structure alignment, the blockage, deterioration of the invert, poor structural integrity of the barrel, and damaged or missing stone armor. The severe constriction and the placement of the culvert inlet at a sharp bend in the stream contribute to the high geomorphic risk associated with the crossing.

Proposed Concept

- Realign the crossing and replace the existing culvert with a three-sided box culvert with a span of approximately 12 feet to accommodate a future estimated bankfull width of approximately 9 feet associated with a 20% increase in bankfull flows due to climate change
  - This will result in a crossing that meets the Massachusetts River and Stream Crossing Standards, which require a span of 1.2 times the stream's bankfull width.
- The proposed culvert replacement design concept will:
  - Provide increased hydraulic capacity to reduce flooding risk and to allow water and debris associated with larger storms to pass.
  - Decrease potential for road overtopping during heavy precipitation.
  - Reduce geomorphic risk by realigning the culvert
  - Improve the passability of the structure

Image 1: Existing structure inlet during field visit on December 4, 2020, showing a blockage causing a drop into the inlet and erosion on the bank above the pipe.

Image 2: Existing structure outlet during field visit on December 4, 2020. Note the large scour pool, eroded banks, and perched outlet.

Image 3: Example of embedded box culvert (Maine Audubon).

Image 4: Interior of the existing culvert during December 4, 2020 field visit. The culvert is poorly aligned and rusted through, and a blockage has formed inside the barrel.

Site Prioritization Summary

Scaled Crossing Priority Score (0-1): 0.72
Impact Score (1-5): 4
Hydraulic Risk Score (1-25) (Existing/Future): 20/20
Geomorphic Risk Score (1-25): 20
Structural Risk Score (1-25): 20
AOP Benefit Score (1-25): 12

Existing Crossing Characteristics

Material: Corrugated metal pipe
Structure Diameter: 3 feet
Structure Length: Approximately 100 feet
Bankfull Width: Approximately 8.3 feet

Hydraulic Capacity Summary

Total Drainage Area: 0.32 miles^2
Existing Structure Capacity: 32.8 cfs
Estimated Peak Flows:

Recurrence Interval	Existing	Future
10-year	41.5 cfs	49.8 cfs
25-year	56.6 cfs	67.9 cfs
50-year	69.3 cfs	83.2 cfs
100-year	82.9 cfs	99.5 cfs

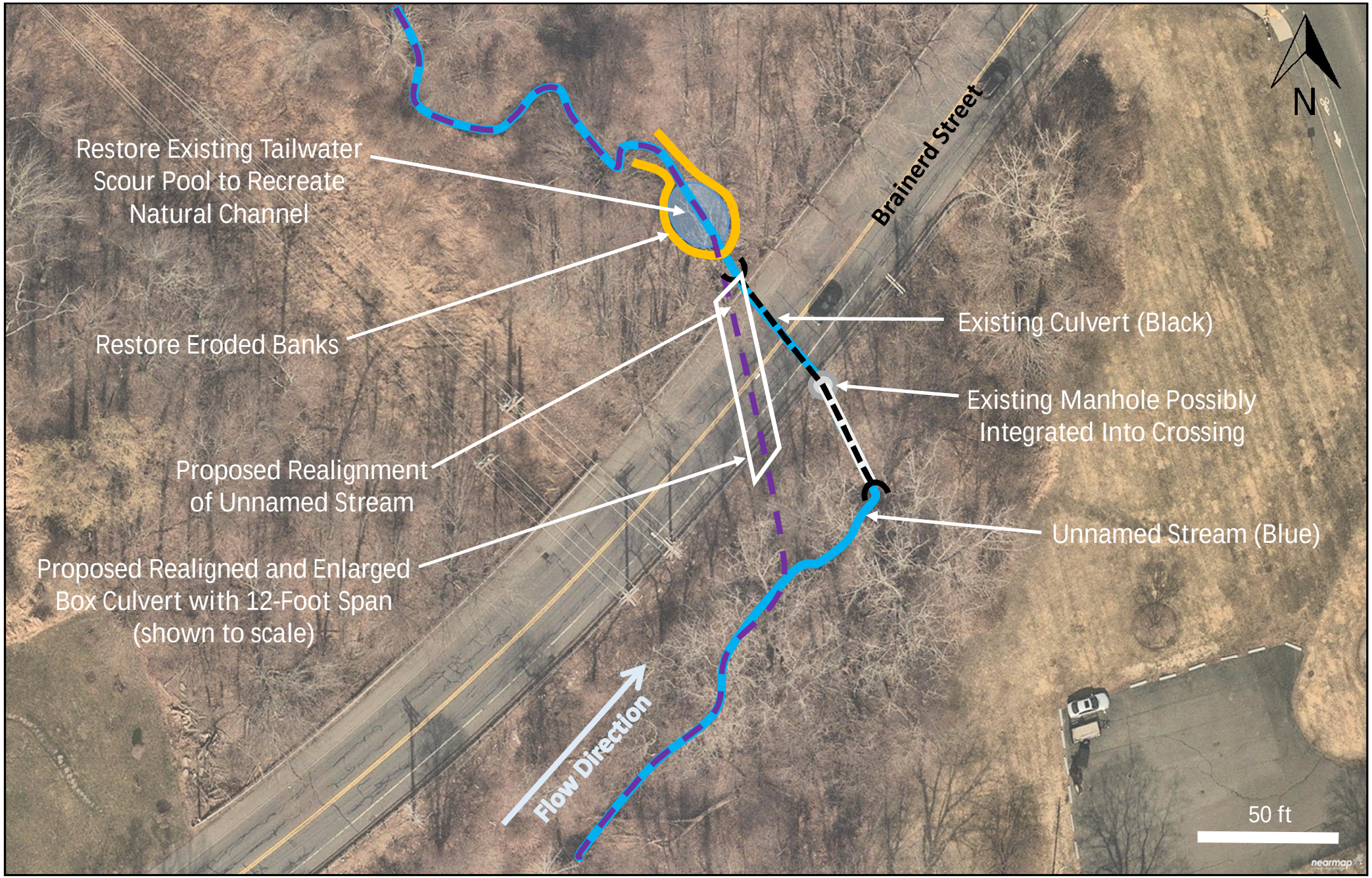
Notable Assessment Findings

- High flood impact potential
- Severe constriction
- Critical structural deficiencies include culvert blockage, embankment piping, and poor structural integrity and alignment

Preliminary Opinion of Cost[1]

Total project cost: $890,000

[1]Actual project cost may range from -30% to +50% of the quoted cost.



Brainerd Street

Culvert Replacement Concepts, South Hadley, MA

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Cedar Ridge, Lathrop Street, and Brainerd Street at Unnamed Tributary to Buttery Brook Culvert Replacement Concept

South Hadley, MA

Site Description

Cedar Ridge, Lathrop Street, and Brainerd Street cross an unnamed tributary to Buttery Brook approximately 0.8 miles west of the intersection of Brainerd Street and Rt. 116. The existing structures are all round concrete or corrugated metal pipes that are partially buried in sediment at the inlet. This is partially due to the severe constriction of the stream caused by each culvert. The Lathrop Street crossing is undersized for all peak flows assessed under existing and future climate conditions and the stream enters the inlet at a right angle, increasing geomorphic risk. Due to their close proximity to one another, the replacement of any one of these culverts may result in impacts that would impact the other two, and the crossings are very similar in scale and construction.

Proposed Concept

- Replace the existing culverts with three-sided box culverts with spans of approximately 9 feet to accommodate a future estimated bankfull width of approximately 6.9-7.5 feet associated with an estimated 20% increase in bankfull flows due to climate change,
  - This will result in crossings that meet the Massachusetts River and Stream Crossing Standards, which require a span of 1.2 times the stream's bankfull width.
- Realign the Lathrop Street crossing to the north of the existing crossing to eliminate the sharp bend in the stream at the inlet
- The proposed culvert replacement design concept will:
  - Provide increased hydraulic capacity to reduce flooding risk and to allow water and debris associated with larger storms to pass.
  - Decrease potential for road overtopping during heavy precipitation.
  - Reduce geomorphic risk by realigning the Lathrop Street culvert
  - Provide an economy of scale when designing, permitting, and constructing the culvert replacements, reducing overall costs.

Image 3: Example of a box culvert (Maine Audubon).

Image 1: Existing structure inlet during field visit on December 10, 2020. Note the sediment deposition blocking the projecting inlet.

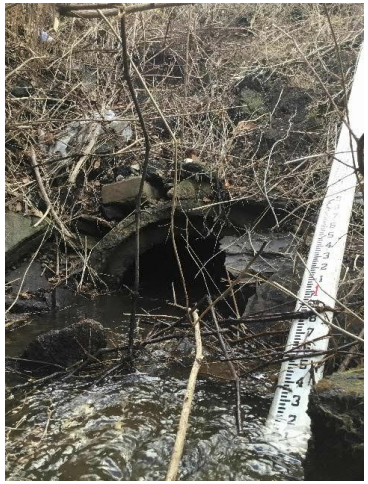


Image 2: Existing Brainerd Street culvert inlet during field visit on December 10, 2020.

Site Prioritization Summary (Cedar, Lathrop, Brainerd)

Scaled Crossing Priority Score (0-1): 0.66, 0.66, 0.54
Impact Score (1-5): 4, 4, 4
Hydraulic Risk Score (1-25) (Existing/Future): 8/12, 20/20, 8/12
Geomorphic Risk Score (1-25): 12, 16, 12
Structural Risk Score (1-25): 20, 0 (insufficient data), 16
AOP Benefit Score (1-25): 6, 6, 6

Existing Crossing Characteristics

Material: Concrete, Corrugated metal, Concrete
Structure Diameter: Unknown, 2 feet, 2 feet
Structure Length: Unknown, 88 feet, 54 feet
Bankfull Width: Approximately 6.5-6.9 feet

Hydraulic Capacity Summary

Total Drainage Area: 0.15 miles^2, 0.16 miles^2, 0.17 miles^2
Existing Structure Capacity: 43.6 cfs, 12.9 cfs, 45.0 cfs
Estimated Peak Flows (Brainerd Street):

Recurrence Interval	Existing	Future
10-year	24.8 cfs	29.8 cfs
25-year	34.1 cfs	40.9 cfs
50-year	41.8 cfs	50.2 cfs
100-year	50.2 cfs	60.2 cfs

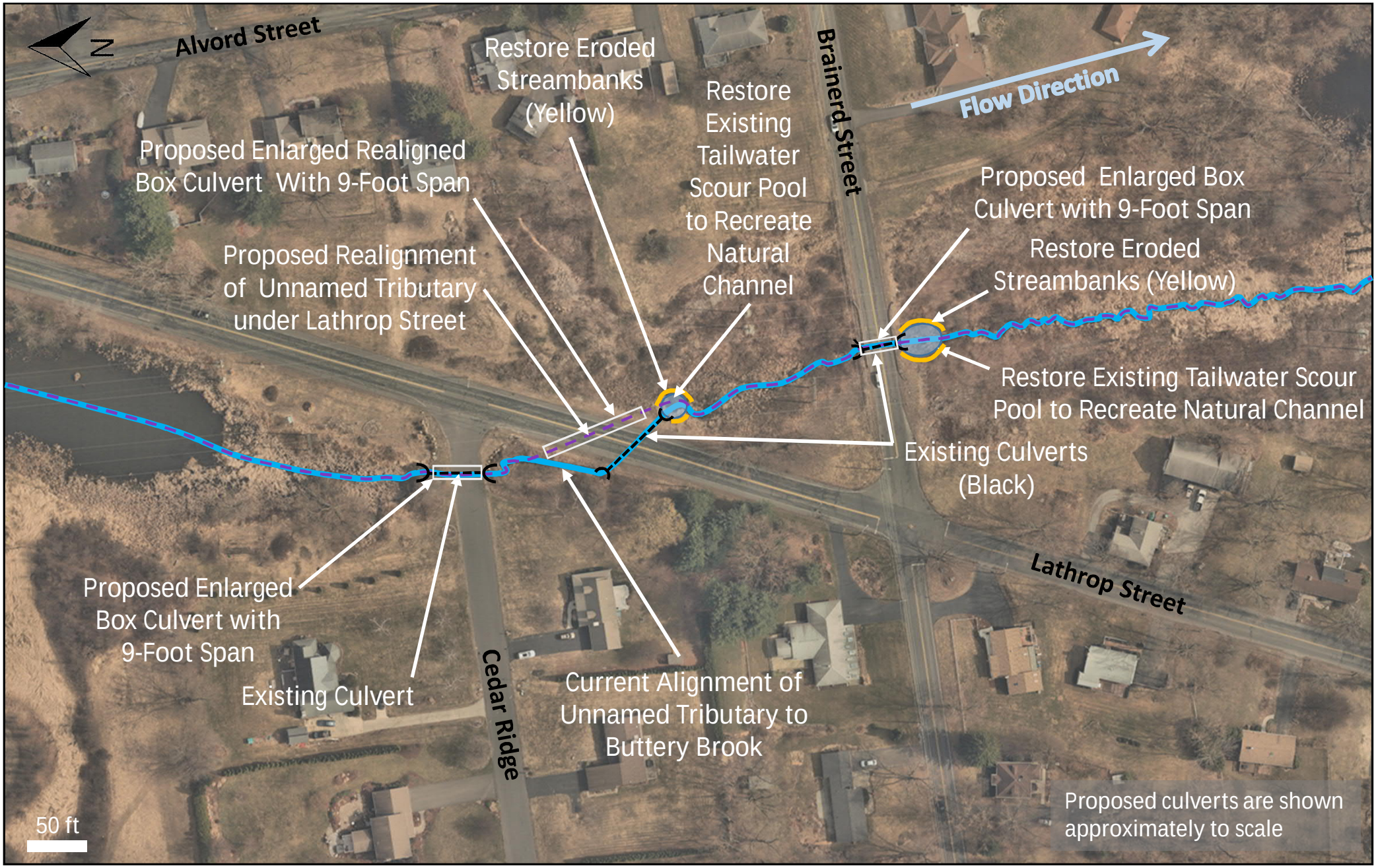
Notable Assessment Findings

- High flood impact potential
- High hydraulic and geomorphic risk at Lathrop Street culvert due to small diameter and angle of culvert to stream
- Cedar Ridge culvert integrated with stormwater drainage
- Sinkhole forming and outlet submerged at Brainerd St.

Preliminary Opinion of Cost[1]

Total project cost: $1,900,000

[1]Actual project cost may range from -30% to +50% of the quoted cost.



Cedar Ridge, Lathrop Street, and Brainerd Street

Culvert Replacement Concepts, South Hadley, MA

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Willimansett Street at Buttery Brook
Culvert Replacement Concept
South Hadley, MA

Site Description

Willimansett Street crosses Buttery Brook approximately 240 feet north of its intersection with Hollywood Street and Memorial Drive. The existing structure is a round pipe constructed of concrete at the inlet and corrugated metal at the outlet with brick near the middle of the structure. The culvert diameter is approximately 3 feet at the inlet, resulting in a severe constriction of the stream's approximately 20-foot bankfull width. The crossing is undersized for all peak flows assessed under existing and future climate conditions. Noted structural deficiencies include embankment piping, poor structure alignment, loss of structural integrity, spreading of culvert joints, and damage flared end section.

Proposed Concept

- Realign the crossing to the north of the existing crossing to create a straight structure that avoids the manhole and the three wells at the structure outlet and eliminates the bends in the stream channel at the culvert inlet and outlet.
- Replace the existing culvert with a bridge, open-bottom arch, or three-sided box culvert with a span of approximately 26 feet, to accommodate a future estimated bankfull width of approximately 21.5 feet associated with a 20% increase in bankfull flows due to climate change
  - This will result in a crossing that meets the Massachusetts River and Stream Crossing Standards, which require a span of 1.2 times the stream's bankfull width.
- The proposed culvert replacement design concept will:
  - Provide increased hydraulic capacity to reduce flooding risk and to allow water and debris associated with larger storms to pass.
  - Decrease potential for road overtopping during heavy precipitation.
  - Reduce geomorphic risk by realigning the culvert and eliminating changes in structure material and dimensions.

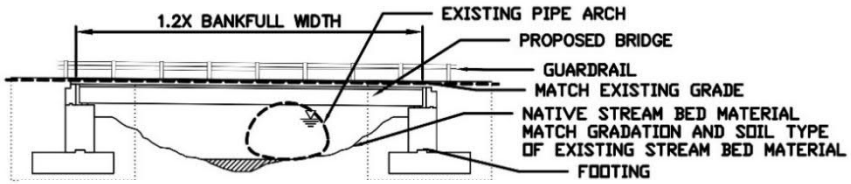


Image 3: Typical detail of a bridge designed to meet the MA River and Stream Crossing Standards.

Image 1: Existing structure inlet during field visit on November 25, 2020, showing a blockage causing a drop into the inlet and erosion of the banks to either side.

Image 2: Existing structure outlet during field visit on November 25, 2020. Note the gaps on either side of the culvert where erosion and piping may be occurring and the damage to the flared end section.

Image 4: Interior of the existing culvert during November 25, 2020 field visit. The culvert is poorly aligned and constructed of three different types of structural material.

Site Prioritization Summary

Scaled Crossing Priority Score (0-1): 0.66
Impact Score (1-5): 4
Hydraulic Risk Score (1-25) (Existing/Future): 20/20
Geomorphic Risk Score (1-25): 16
Structural Risk Score (1-25): 20
AOP Benefit Score (1-25): 6

Existing Crossing Characteristics

Material: Corrugated metal pipe, concrete, brick
Structure Diameter: 3 feet (inlet); 3.5-4 feet (outlet)
Structure Length: Approximately 156 feet
Bankfull Width: Approximately 20 feet

Hydraulic Capacity Summary

Total Drainage Area: 0.54 miles^2
Existing Structure Capacity: 35.2 cfs
Estimated Peak Flows:

Recurrence Interval	Existing	Future
10-year	59.8 cfs	71.8 cfs
25-year	84.5 cfs	97.8 cfs
50-year	99.7 cfs	120 cfs
100-year	119 cfs	143 cfs

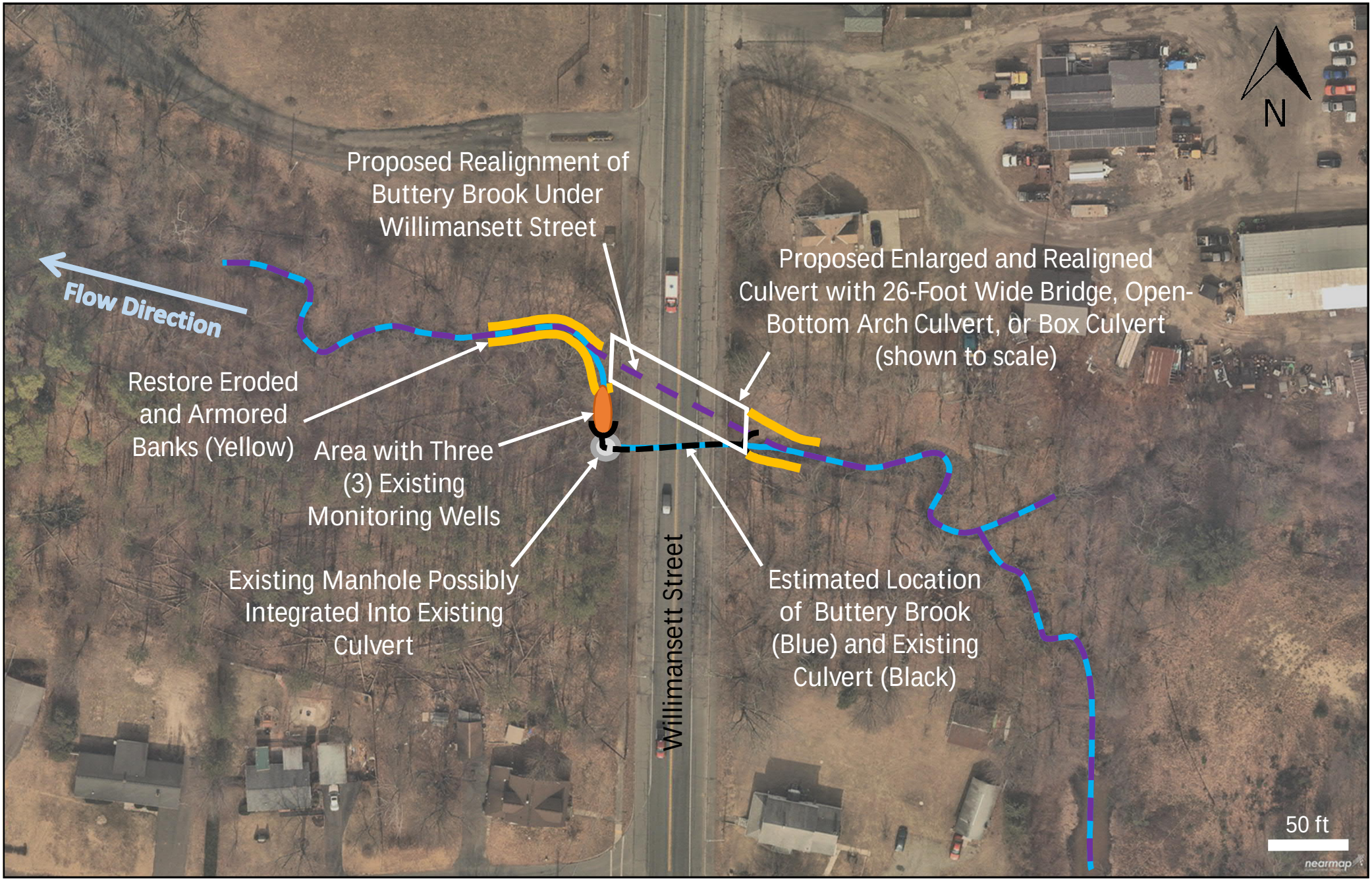
Notable Assessment Findings

- High flood impact potential and potential for transportation disruption and
- Structure changes material, size, and direction between inlet and outlet
- The structure outlet is located near three wells whose purpose is unknown

Preliminary Opinion of Cost[1]

Total project cost: $1,300,000

[1]Actual project cost may range from -30% to +50% of the quoted cost.



Willimansett Street

Culvert Replacement Concepts, South Hadley, MA

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Westbrook Road at Unnamed Tributary to Stony Brook
Culvert Replacement Concept
South Hadley, MA

Site Description

Westbrook Road crosses an unnamed tributary to Stony Brook approximately 475 feet east of the intersection of Mosier Street and Westbrook Road. The existing structure is a round corrugated metal pipe that is mostly buried in sediment at the inlet and buried to about half the culvert diameter at the outlet. This is partially due to the severe constriction formed by the 2-foot diameter of the culvert. The crossing is undersized for all peak flows assessed under existing and future climate conditions. Critical structural deficiencies include embankment piping, poor structural integrity, and severe blockage of the barrel. The embankment piping has resulted in the collapse of the road embankment above the inlet.

Proposed Concept

- Realign the crossing and replace the existing culvert with an open-bottom arch with a span of approximately 8 feet to accommodate a future estimated bankfull width of approximately 6.5 feet associated with an estimated 20% increase in bankfull flows due to climate change,
  - This will result in a crossing that meets the Massachusetts River and Stream Crossing Standards, which require a span of 1.2 times the stream's bankfull width.
- The proposed culvert replacement design concept will:
  - Provide increased hydraulic capacity to reduce flooding risk and to allow water and debris associated with larger storms to pass.
  - Decrease potential for road overtopping during heavy precipitation.
  - Reduce geomorphic risk by alleviating the constriction.
  - Improve the passability of the structure.

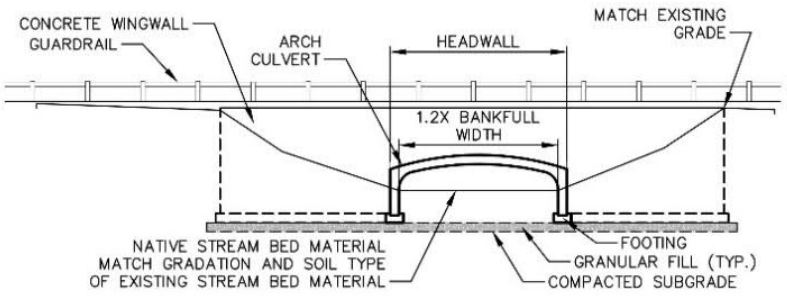


Image 3: Typical detail of an open arch culvert designed to meet MA Stream Crossing Standards

Image 1: Existing structure inlet during field visit on December 9, 2020, showing a blockage at the inlet and the collapsed bank above the pipe.

Image 2: Existing structure outlet during field visit on December 9, 2020. Note the severely eroded banks.

Image 4: The upstream channel during the December 9, 2020 field visit. A sediment bar has formed and split the channel upstream of the inlet.

Site Prioritization Summary

Scaled Crossing Priority Score (0-1): 0.66
Impact Score (1-5): 4
Hydraulic Risk Score (1-25) (Existing/Future): 20/20
Geomorphic Risk Score (1-25): 12
Structural Risk Score (1-25): 20
AOP Benefit Score (1-25): 6

Existing Crossing Characteristics

Material: Corrugated metal pipe
Structure Diameter: 2 feet
Structure Length: Approximately 107 feet
Bankfull Width: Approximately 6.1 feet

Hydraulic Capacity Summary

Total Drainage Area: 0.1 miles^2
Existing Structure Capacity: 0.71 cfs
Estimated Peak Flows:

Recurrence Interval	Existing	Future
10-year	17.1 cfs	20.5 cfs
25-year	23.6 cfs	28.3 cfs
50-year	29.1 cfs	34.9 cfs
100-year	34.9 cfs	41.9 cfs

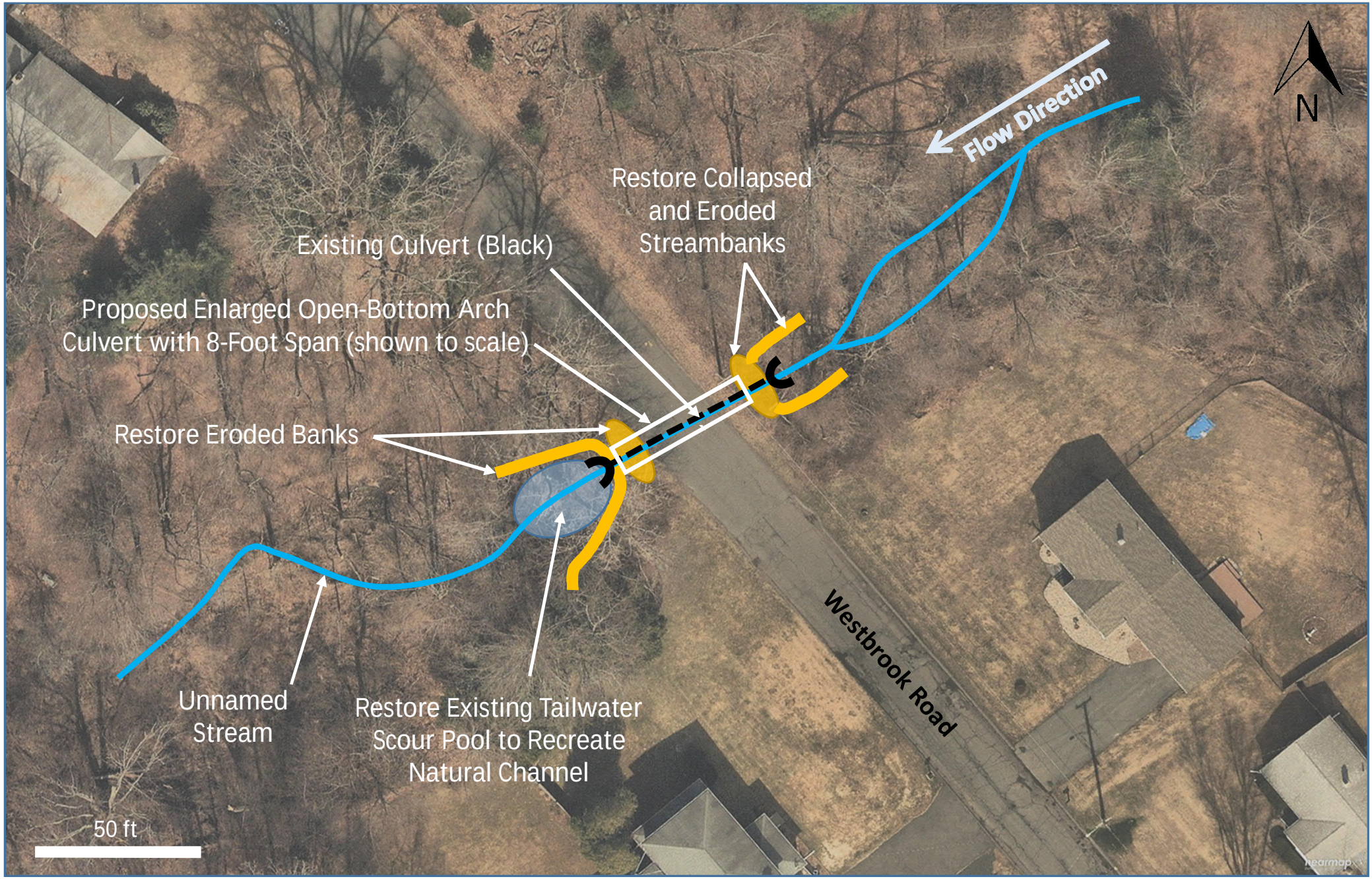
Notable Assessment Findings

- High flood impact potential
- Severe constriction
- Severe bank erosion and collapse at the inlet and outlet

Preliminary Opinion of Cost[1]

Total project cost: $560,000

[1]Actual project cost may range from -30% to +50% of the quoted cost.



Westbrook Road

Culvert Replacement Concepts, South Hadley, MA

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River Road at White Brook
Culvert Replacement Concept
South Hadley, MA

Site Description

River Road crosses White Brook approximately 1000 feet northeast of the intersection with Bayon Street. The location is known to have experienced flooding in the past. The existing structure is a round corrugated metal pipe that is almost fully buried in sediment and debris at the inlet and partially filled with sediment at the outlet. This is partially due to the severe constriction formed by the 5-foot diameter of the culvert. Due to the blockage, the crossing is undersized for all peak flows assessed under existing and future climate conditions. Sediment deposition at the culvert may be exacerbated by the presence of a beaver dam approximately 130 feet downstream of the culvert. At the time of assessment, water impounded by the beaver dam was backed up through the culvert.

Proposed Concept

- Replace the existing culvert with a bridge, open-bottom arch, or three-sided box culvert with a span of approximately 18 feet to accommodate an estimated future bankfull width of approximately 14 feet associated with an estimated 20% increase in bankfull flows due to climate change,
  - This will result in a crossing that meets the Massachusetts River and Stream Crossing Standards, which require a span of 1.2 times the stream's bankfull width.
- The proposed culvert replacement design concept will:
  - Provide increased hydraulic capacity to reduce flooding risk and to allow water and debris associated with larger storms to pass.
  - Decrease the potential for road overtopping during heavy precipitation.
  - Decrease the potential for blockage of the culvert
  - Improve the passability of the structure
  - Decrease sensory cues such as the sound of flowing water that trigger dam building behavior in beavers
- Install a flow-control device through the beaver dam to regulate the height of the impoundment of water at the culvert. Flow-control devices have been shown to be a cost-effective long-term solution to mitigating the impacts of beaver activity.

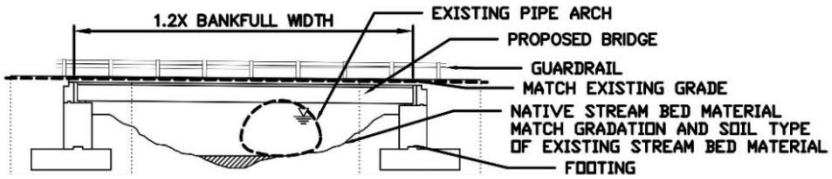


Image 3: Typical detail of a bridge designed to meet the MA River and Stream Crossing Standards.

Image 1: Existing structure inlet during field visit on December 10, 2020, showing only the top of the pipe. The rest of the inlet is buried under sediment and debris.

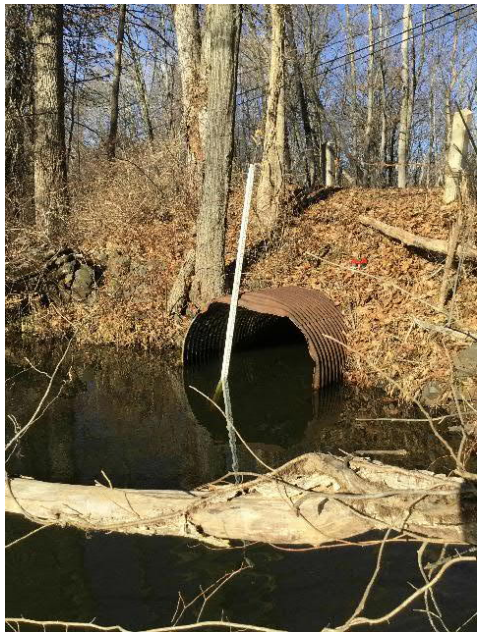


Image 2: Existing structure outlet during field visit on December 10, 2020.

Site Prioritization Summary

Scaled Crossing Priority Score (0-1): 0.39
Impact Score (1-5): 2
Hydraulic Risk Score (1-25) (Existing/Future): 10/10
Geomorphic Risk Score (1-25): 6
Structural Risk Score (1-25): 10
AOP Benefit Score (1-25): 9

Existing Crossing Characteristics

Material: Corrugated metal pipe
Structure Diameter: 5 feet
Structure Length: Approximately 47 feet
Bankfull Width: Approximately 13.1 feet

Hydraulic Capacity Summary

Total Drainage Area: 0.79 miles^2
Existing Structure Capacity: 3.74 cfs (due to blockage)
Estimated Peak Flows:

Recurrence Interval	Existing	Future
10-year	83.7 cfs	100 cfs
25-year	114 cfs	137 cfs
50-year	138 cfs	166 cfs
100-year	165 cfs	198 cfs

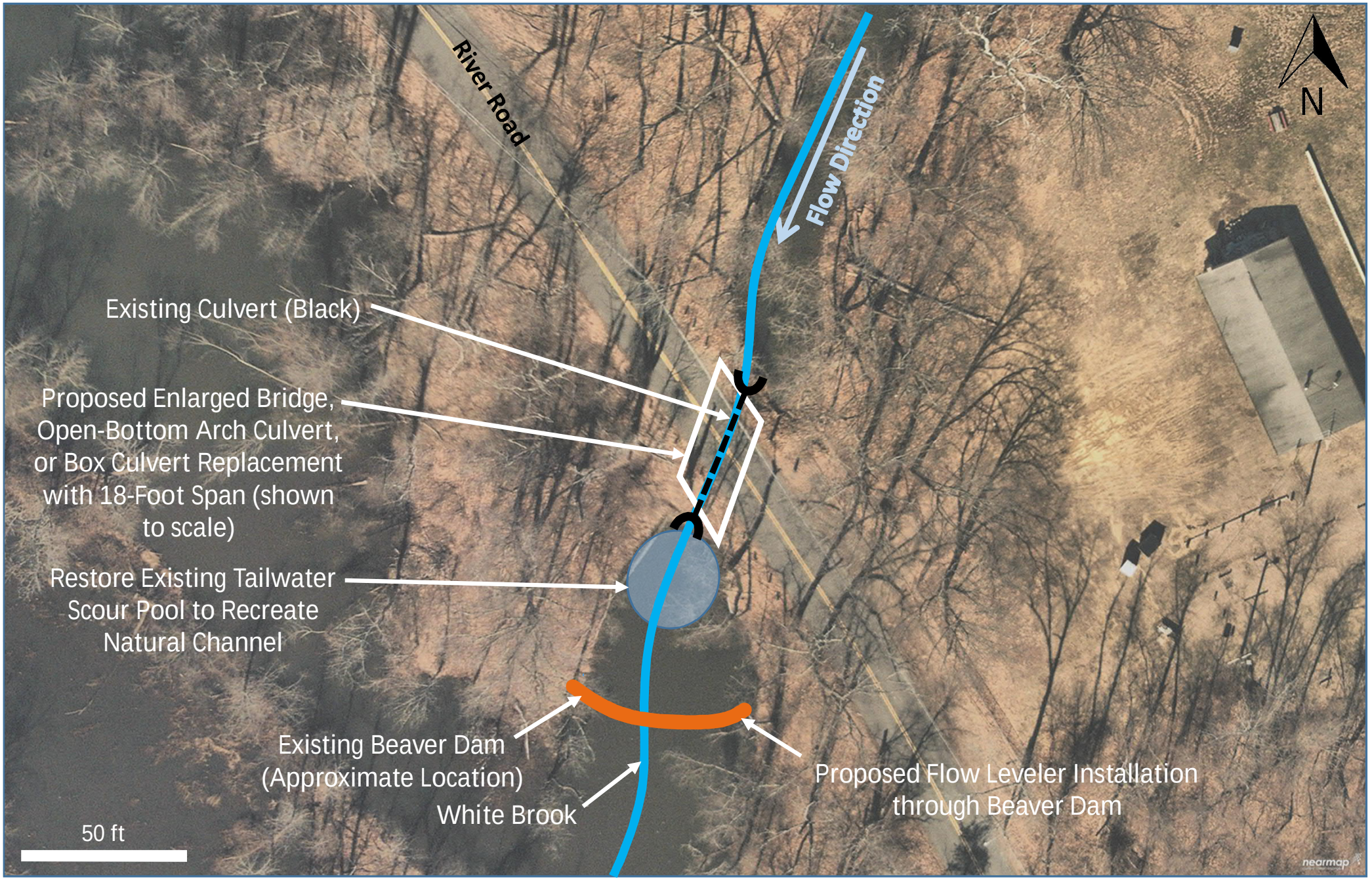
Notable Assessment Findings

- Severe constriction
- Severe blockage
- Severe lack of hydraulic capacity

Preliminary Opinion of Cost[1]

Total project cost: $950,000

[1]Actual project cost may range from -30% to +50% of the quoted cost



River Road

Culvert Replacement Concepts, South Hadley, MA

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Pearl Street at Elmer Brook
Culvert Replacement Concept
South Hadley, MA

Site Description

Pearl Street crosses Elmer Brook approximately 0.3 miles east of the intersection of Rt. 47/Hadley Street and Pearl Street. The location is known to have experienced flooding in the past. The existing structure is a round corrugated metal pipe perched at the outlet. This is partially due to the severe constriction formed by the 6-foot diameter of the culvert. The crossing is undersized for all peak flows assessed under existing and future climate conditions. A large tailwater scour pool has formed as a result of the constriction and the streambanks downstream of the crossing appear to be eroding toward farm fields. Based on aerial imagery it appears that severe erosion may also be occurring upstream of the crossing. The erosion that has occurred has resulted in mobilization of sediment that has been deposited as large sandbars farther downstream.

Proposed Concept

- Realign the crossing and replace the existing culvert with a bridge, open-bottom arch, or three-sided box culvert with a span of approximately 24 feet to accommodate an estimated future bankfull width of associated with a 20% increase in bankfull flows due to climate change
  - This will result in a crossing that meets the Massachusetts River and Stream Crossing Standards, which require a span of 1.2 times the stream's bankfull width.
- The proposed culvert replacement design concept will:
  - Provide increased hydraulic capacity to reduce flooding risk and to allow water and debris associated with larger storms to pass.
  - Decrease potential for road overtopping during heavy precipitation.
  - Improve the passability of the structure
- Contact landowners upstream and downstream of the crossing to discuss implementation of nature-based bank stabilization solutions for bank erosion, including native riparian plantings:
  - Bank stabilization will limit the loss of existing farmland
  - Nature-based solutions are low cost and require little maintenance.
  - Nature-based solutions provide additional benefits, including improved in-stream and riparian habitat and improved water quality.

Image 1: Existing structure inlet during field visit on November 24, 2020.

Image 2: Existing structure outlet during field visit on November 24, 2020. Note the large scour pool, eroded banks, and perched outlet.

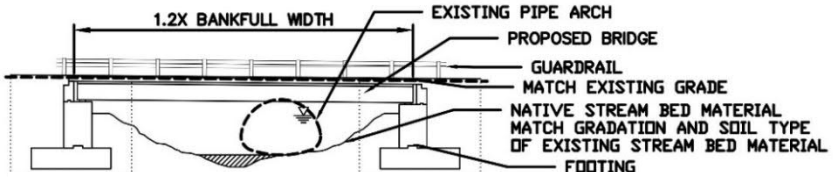

Image 3: Typical detail of a bridge designed to meet the MA River and Stream Crossing Standards.

Site Prioritization Summary

Scaled Crossing Priority Score (0-1): 0.35
Impact Score (1-5): 2
Hydraulic Risk Score (1-25) (Existing/Future): 10/10
Geomorphic Risk Score (1-25): 8
Structural Risk Score (1-25): 2
AOP Benefit Score (1-25): 5

Existing Crossing Characteristics

Material: Corrugated metal pipe
Structure Diameter: 6 feet
Structure Length: Approximately 45 feet
Bankfull Width: Approximately 19 feet

Hydraulic Capacity Summary

Total Drainage Area: 3.61 miles^2
Existing Structure Capacity: 231 cfs
Estimated Peak Flows:

Recurrence Interval	Existing	Future
10-year	296 cfs	355 cfs
25-year	400 cfs	480 cfs
50-year	486 cfs	583 cfs
100-year	578 cfs	694 cfs

Notable Assessment Findings

- Severe constriction
- Severe erosion downstream of the crossing, potentially threatening existing farmland
- Potential severe erosion upstream of the crossing
- Deposition of eroded sediment downstream of the crossing

Preliminary Opinion of Cost[1]

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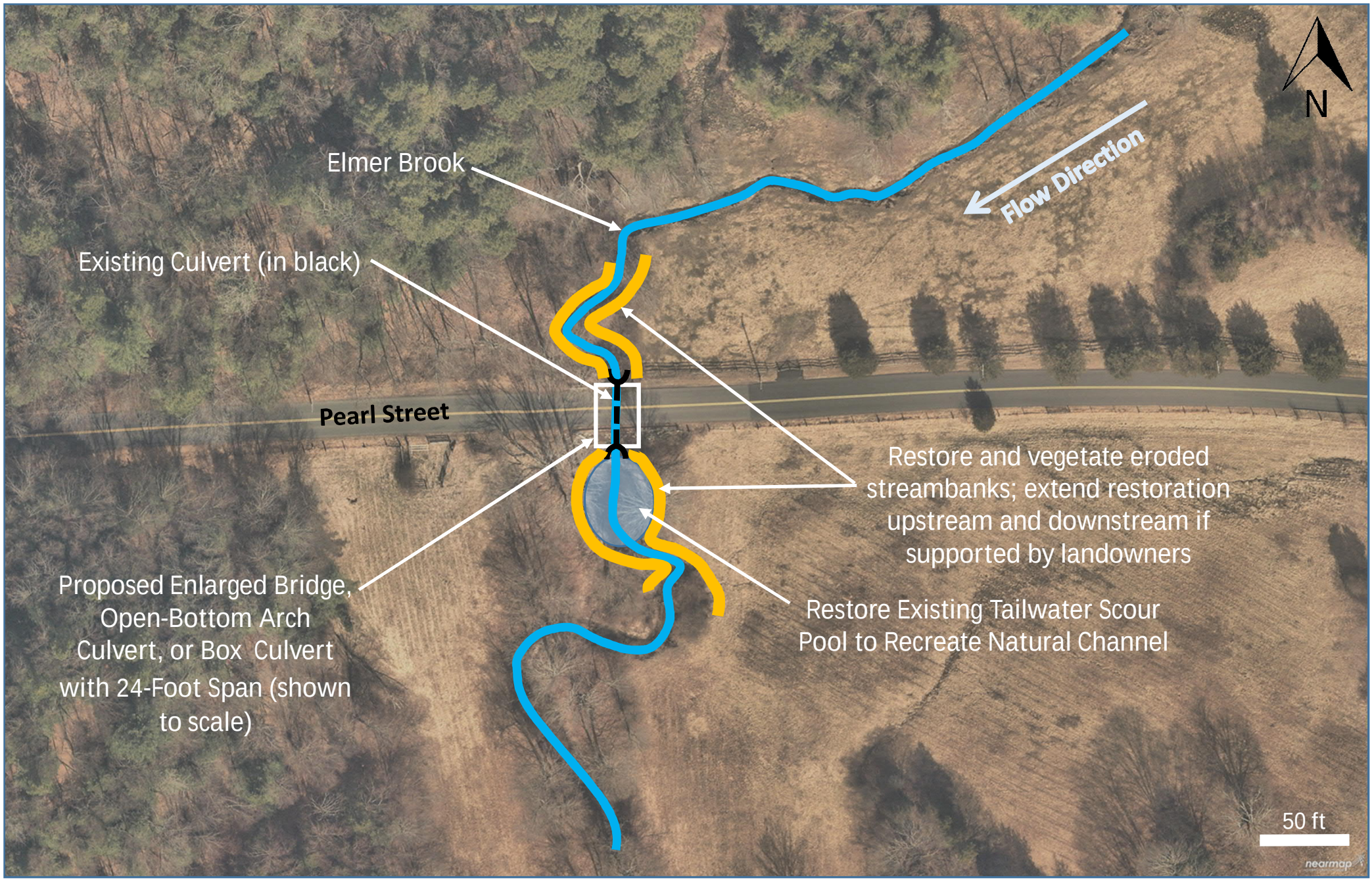

Pearl Street

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