Conceptual Evaluation for Culvert Replacement:

Stage Road Stream Crossing

Stage Road Stream Crossing,
North Branch of the Swift River,
Cummington, Massachusetts

Prepared for
Massachusetts Division of Ecological Restoration
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CONCEPTUAL EVALUATION FOR CULVERT REPLACEMENT:

STAGE ROAD STREAM CROSSING

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CONCEPTUAL EVALUATION FOR CULVERT REPLACEMENT:

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1.0 Introduction

This report was prepared by Stantec Consulting Services Inc. (Stantec) under contract to the Commonwealth of Massachusetts Department of Fish and Game Division of Ecological Restoration (DER) with funding provided by DER. The objective of this report is to present information on the Stage Road stream crossing in Cummington, Massachusetts, including information to inform the design of a culvert replacement with a structure that meets the Massachusetts River and Stream Crossing Standards (Standards)[1].

Section 1 of this report summarizes the Standards and the primary design criteria that were used in the development of the conceptual design presented in this report. Section 2 of this report presents observed existing conditions at the Stage Road stream crossing and specific site characteristics relative to selection of a replacement crossing that meets the Standards. Section 3 of this report identifies a conceptual replacement crossing design, discusses environmental permitting requirements, and provides an opinion of probable cost for installation of the suggested replacement crossing.

This report is intended solely to present general, preliminary guidance for replacement of the existing culvert to meet criteria in the Standards. The conceptual replacement crossing design presented in this report was developed based on site observations and Stantec's understanding of the Standards. Apparent constraints, based on observations during a single site visit and discussions with attendees at the site visit, are noted in the subsequent sections of this report, but there may be other site constraints that are not identified in this report. Additional evaluation of site-specific conditions, engineering design, and permitting would be required prior to replacement of the existing culvert.

1.1 MASSACHUSETTS RIVER AND STREAM CROSSING STANDARDS

This section presents brief descriptions of goals and design standards described in the Massachusetts River and Stream Crossing Standards.

The overall goals that the Standards seek to achieve include:

1. Fish and Aquatic Organism Passage;
2. River/Stream Continuity; and
3. Wildlife Passage.

The potential to achieve these goals at a given site is dependent upon multiple site-specific constraints, and it may not be possible to achieve all of these goals at a given site. Primary, relevant design criteria that were used in the development of the conceptual design geometries presented in this report include:

1. A minimum span of 1.2 times the identified bankfull channel width;
2. The use of open-bottom or embedded structures to allow for placement or natural accretion of native substrates; and
3. An openness ratio appropriate to landscape and habitat context.

The Standards were developed with the objective of facilitating movement of fish and wildlife and preservation or restoration of continuity of riverine processes; the Standards explicitly note that

[1] Jackson, S., A. Bowden, B. Lambert, and A. Singler. 2011. Massachusetts river and stream crossing standards. University of Massachusetts, Amherst, The Nature Conservancy, Boston, Massachusetts Division of Ecological Restoration, Boston, and American Rivers, Northampton, Massachusetts. 1 March.

compliance with the design criteria may not address drainage and/or flood control needs. While it may be presumed that compliance with design criteria presented in the Standards will provide for a replacement structure with an open area equal to or greater than that of the existing culvert system, it is contingent upon the designer to verify that a replacement structure has appropriate hydraulic conveyance as part of project design.

The Standards include specific criteria for "general" and "optimum" standards for new stream crossings, with the "optimum" standards applicable to stream crossings in areas of particular statewide or regional significance for their contribution to landscape-level connectedness. Both the "general" and "optimum" criteria are considered to be desirable where applicable but may not be reasonably achievable based on identified site-specific constraints.

2.0 Project Site

This section presents information based on observations by Stantec and discussions with other stakeholders during a site visit on June 15, 2012, information provided to Stantec by DER, and review of aerial photographs.

Attendees at June 15, 2012 Site Visit:

- Monica Vandoloski, Town of Cummington Selectman
- Robert Dextraze, Town of Cummington Highway Superintendent
- Carrie Banks, DER
- Michael Chelminski, Stantec

2.1 STAGE ROAD STREAM CROSSING

2.1.1 Site Identification

Owner: Town of Cummington

Location: Stage Road, Cummington

Waterway: North Branch of the Swift River

Coordinates: North Latitude 42.468694; Longitude -072.870866

2.1.2 Existing Conditions

Stage Road crosses the North Branch of the Swift River in Cummington, Massachusetts. The Stage Road culvert is a corrugated metal pipe approximately 12 feet (ft) in diameter with beveled ends and an overall length of 85 ft. The actual culvert diameter varies between 11.5 ft and 12.5 ft due to pipe distortion and some vertical sag between the culvert inlet and outlet. The beveled ends of the inlet section of the culvert failed during the August 2011 high-flow event associated with Tropical Storm Irene and have been partially removed via torch cutting by the local highway department. The downstream invert of the culvert was perched approximately 2 ft above the downstream water surface during the site visit. The culvert invert slope is approximately 1.2 percent over the length of the culvert. The roadway crest elevation overlying the culvert is approximately 6 ft to 8 ft above the culvert top of pipe. Stage Road in the vicinity of the culvert is paved and has guardrails along both sides of the roadway. The asphalt pavement is cracked over the approximate alignment of the culvert, and discussions with Town of Cummington staff during the site visit suggest that the crack widened following overtopping of the roadway during Tropical Storm Irene in late-August of 2011.

Additional observations made during the site visit, and relevant to culvert replacement design, include the presence of a former bridge approximately 75 ft downstream from the outlet of the existing culvert, a beaver dam located approximately 20 ft upstream from the existing culvert inlet, and the presence of an approximately 10-acre wetland complex along the North Branch of the Swift River immediately upstream from the culvert.

This culvert does not meet criteria in the Standards due to the perched outlet of the culvert, which is an apparent barrier to upstream fish passage during most conditions.

Representative photographs from the site visit are included in Appendix A to this report.

2.1.3 Channel Characteristics Relevant to Replacement Crossing Design Criteria

This section presents identified stream channel and stream valley characteristics that are relevant to selection of a replacement crossing design that would generally meet the Standards at the Stage Road stream crossing. Information presented here was obtained from a single site visit and additional data collection would be necessary as part of the design of a replacement crossing.

Table 1 presents site characteristics of primary relevance to design standards described in the Standards.

Table 1: Channel Characteristics

Channel Characteristic	Approximate Value
Bankfull width	25 ft
Channel Slope	1%
Dominant Substrate	Cobble/Bedrock
Embankment Height	20 ft
Valley Width Upstream from Roadway Embankment	350 ft

3.0 Conceptual Replacement Crossing

This section presents brief descriptions of potentially suitable crossing types and identified site constraints, identifies a recommended replacement crossing type, discusses environmental permitting requirements, and provides an opinion of probable cost.

3.1 RECOMMENDED REPLACEMENT CROSSING GEOMETRY AND TYPE

A common constraint on the design of replacement culverts to meet criteria in the Standards is lack of overlying cover; the relatively high roadway embankment at this site provides an opportunity to install a relatively large culvert that could meet the criteria in the Standards and improve flood flow conveyance in the North Branch of the Swift River. Given that the roadway embankment at this culvert was overtopped during Tropical Storm Irene in late-August of 2011 and that water levels rose above the culvert inlet during another rain event the following week, replacement of this culvert with a larger structure is recommended. Another attribute of this site that appears to support installation of a larger stream crossing includes persistent beaver dams upstream from the culvert; it is expected that installation of a larger culvert would reduce the potential for debris jamming associated with upstream beaver dams and potentially reduce the incidence of beaver dam construction immediately upstream.

The approximate bankfull width of the North Branch of the Swift River in the vicinity of the culvert is 25 ft. An open-bottom, arch or three-sided box structure, with a width between 30 ft and approximately 35 ft, appears to be feasible and appropriate for this site. A minimum span of 30 ft meets the 1.2-times bankfull

requirement of the Standards and a 35 ft span is the approximate upper limit for a structure that would not require raising the road grade.

An open-bottom arch was selected as the recommended alternative for general compliance with the Standards at this site due to the ability to reduce instream footprint of the stream crossing and meet the Standards within the identified site constraints. The recommended structure is substantially larger than 1.2-times bankfull width. A benefit of utilizing a structure that exceeds the minimum standard is the ability to provide for bank habitat on both sides of the channel within the culvert to aid terrestrial and semi-aquatic organism passage through what is otherwise a fairly high road fill across the surrounding floodplain.

Table 2 presents recommended conceptual culvert geometry and type based on information presented in the preceding sections of this report.

Table 2: Conceptual Replacement Crossing Design Criteria

Criteria	Value/Response
Length (stream-wise)	85 ft
Open-Bottom (Yes or No)	Yes
Width (span)	34.1 ft
Height (maximum)	13.25 ft

3.2 ENVIRONMENTAL REGULATORY COORDINATION AND PERMITTING

It is anticipated that environmental regulatory coordination and permitting requirements for the conceptual replacement crossing design described in this report would require local, state, and federal regulatory coordination and permitting. Regulated natural resources within the vicinity of the project site must be identified and anticipated project impacts to regulated resources must be quantified. This process will likely require field-based delineation of wetland resource in areas of direct disturbance and characterization of regulated natural resources in the surrounding area. Installation of the recommended replacement crossing may alter jurisdictional wetlands located adjacent to the project site; the potential for post-construction alteration of adjacent jurisdictional wetland resources was not assessed as a part of this study and appears to require further investigation.

A brief review of publicly available information suggests that the site is located within Estimated and Priority Habitat mapped by the Massachusetts Natural Heritage and Endangered Species Program (NHESP). Additional regulated resources may exist within or adjacent to the project site and coordination with environmental regulatory agencies is recommended to confirm the potential presence and nature of additional regulated resources.

It is anticipated that the conceptual replacement crossing design described in this report would require local, state, and federal regulatory coordination and permits including:

- **Order of Conditions from the Cummington Conservation Commission (or MassDEP) under the Wetlands Protection Act**[2]. This process is initiated by submitting a Notice of Intent (NOI) to the Cummington Conservation Commission and MassDEP. It is anticipated that the project may qualify as a Limited Project under 310 CMR 10.53(3) i and/or 310 CMR 10.53(4).

[2] A brief review of on-line resources suggests that the Town of Cummington does not have a municipal wetlands bylaw; this should be confirmed with the Cummington Conservation Commission.

- **Water Quality Certification from MassDEP**. Based on Stantec's understanding of the project and anticipated construction impacts, it appears that the project may involve greater than 100 cubic yards (CY) of dredge and/or may impact greater than 5,000 square-ft of bordering vegetated wetland and land under water; thus, it is likely that a Water Quality Certification will required. This should be confirmed following subsequent data collection and design development.

- **Authorization under General Permit from the U. S. Army Corp of Engineers**. To qualify for authorization under the General Permit, the project must comply with all the General Permit General Conditions, including General Condition #21 for Stream Crossings; these conditions should be reviewed to confirm compliance as the design and construction approach are developed. It is possible that the project may qualify for authorization under Category 1 of the General Permit, which would require submittal of a Category 1 Notification Form (Appendix C of the General Permit). If, following additional data collection, development of the project approach, and quantification of project impacts, it is determined that the project cannot comply with the Category 1 conditions, Stantec anticipates that the project will qualify for authorization under Category 2 of the General Permit (i.e., it will not require an Individual Permit). The appropriate Category (i.e., Category 1 or 2) of the General Permit for this project should be confirmed following subsequent data collection and design development.

- **Massachusetts Endangered Species Act (MESA) Review**. Because the project is apparently located within mapped Estimated and Priority Habitat, additional coordination with NHESP will be necessary to confirm what listed species' habitat(s) may be located in the vicinity of the project area and to identify opportunities to avoid or mitigate potential impacts to state-listed species and their habitat. A MESA Information Request can be submitted to NHESP to request information that may help inform the early design process. A formal MESA Review of the project will be required and can be initiated by submitting a copy of the project NOI to NHESP.

- **Historic and Archeological Resources Review**. Any project receiving state and/or federal funding, licenses or permits must be reviewed by the Massachusetts Historical Commission (MHC) for potential impacts to historic and archeological properties. This review can be initiated by submitted a Project Notification Form (PNF) to the MHC. A copy of this submittal should be provided to the local historical commission, applicable Tribal Historic Preservation Officers (THPOs) and the Bureau of Underwater Archeological Resources (BUAR) as required by state and federal regulations and applicable project permits. Based on Stantec's understanding of the project site, we anticipate that the project may be determined to result in no significant impact to historic or archeological resources and that further related coordination, research, and/or mitigation may not be required.

Additional permits or authorizations may be required based on project development and coordination with environmental regulators. Potential additional permits and coordination may include:

- **Massachusetts Environmental Policy Act (MEPA) review**. If the project is determined to involve an "Agency Action" (e.g., a Water Quality Certification from MassDEP), and it is determined that the project meets or exceeds a MEPA Review Threshold, MEPA review may be required. The MEPA review thresholds should be reviewed following additional site data collection and design planning to confirm whether MEPA review is required. If required, it is anticipated that such review could be accomplished through filing an Environmental Notification Form (ENF). Potentially applicable MEPA review thresholds may include alteration of bank and/or bordering vegetated wetlands (e.g., if future project studies and planning determine that culvert replacement may require or result in alteration or conversion of adjacent wetland resource areas exceeding the thresholds stated in the MEPA Regulations).

- **Chapter 91 Waterways License and/or Permit from MassDEP**. It is possible that the project may require a Chapter 91 Permit; this potential project requirement should be confirmed with MassDEP early in the project planning process.

3.3 OPINION OF PROBABLE COST

This section presents an opinion of probable cost for the recommended conceptual replacement crossing, including design, environmental permitting, construction administration[3] and observation, and construction.

Design and environmental permitting services for a replacement of the existing structure are anticipated to cost between $30,000 and $40,000. The level of effort associated with environmental permitting may vary based on the results of future data collection and design development. Construction-related administration services, such as bid package preparation, bid process support, administration of the construction contract, and observation during construction, are anticipated to cost between $15,000 and $35,000, depending on the required level-of-effort and duration of construction. Purchase and delivery of a corrugated metal arch structure is anticipated to cost approximately $120,000 (exclusive of installation). A pre-cast concrete arch structure with similar dimensions would cost more but may provide a longer service life; it is recommended that preliminary design of a replacement structure at this site evaluate the relative merits of such a structure based on initial and long-term costs. Installation of the corrugated metal arch structure (including excavation and disposal of the existing structure, installation, backfilling, repaving, and the installation of guardrails) is anticipated to cost approximately $160,000. The opinion of probable cost for replacement of the structure in aggregate is $325,000 to $355,000. Table 3 presents the opinion of probable cost for installation of a replacement culvert system.

Table 3: Opinion of Probable Cost

Work	Opinion of Probable Cost
Design & Permitting	$30,000 to $40,000
Construction Administration and Observation	$15,000 to $35,000
Cost of Culvert	$120,000
Installation of Replacement Structure	$160,000
Total	$325,000 to $355,000

3.4 ESTIMATED DURATION OF CONSTRUCTION

It is expected that installation of a replacement structure would require closure of Stage Road in the vicinity of the culvert for approximately 3 weeks, and that the total duration of project work, including repaving of the roadway and installation of guardrails, would take approximately 6 weeks. Given that the road would likely need to be closed for construction, it is expected that construction access would be from the existing roadway. In addition, there is a relatively clear area along the right side of the river immediately downstream from the roadway embankment that currently affords access to the culvert outlet and could also be used for construction access.

[3] Construction administration costs may vary substantially based on factors such as whether the work is performed by a municipal department, bidding procedures for private construction contractors, and other services during project construction.

4.0 Discussion and Comments

An open-bottom arch structure is suggested as an appropriate replacement structure for compliance with the Standards at the Stage Road stream crossing of the North Branch of the Swift River. While the existing culvert has apparently functioned well for its intended purpose (conveying the North Branch of the Swift River under Stage Road), overtopping of Stage Road occurred during Tropical Storm Irene due to factors including extreme high flows in the river and associated damage to the culvert inlet. Replacement of the culvert with a larger structure would reduce the potential for overtopping of the roadway and, with proper design and construction, restore fish and aquatic organism passage and continuity of riverine process, and enhance wildlife passage.

The upstream pool also rose above the top of the culvert inlet during a storm approximately one week after Tropical Storm Irene. The culvert inlet was damaged by the two storms, and Town of Cummington staff performed emergency repair work to remove some of the damaged ends of the culvert inlet, which had been bent into the culvert and resulted in some of the adjacent rock armoring falling into the culvert. Observations during the site visit suggest that the emergency repair work was done with reasonable care, but that further work is required to remove additional deformed sections of the culvert inlet and rock armor that currently lies in the throat of the culvert. It is recommended that, whether or not the existing crossing is replaced, the Town obtain necessary design materials and/or permits required to complete the emergency repair work that it previously initiated.

CONCEPTUAL EVALUATION FOR CULVERT REPLACEMENT:

STAGE ROAD STREAM CROSSING

Appendix A

Site Photographs

CONCEPTUAL EVALUATION FOR CULVERT REPLACEMENT:

STAGE ROAD STREAM CROSSING

Photo 1: Stage Road at Culvert (flow is from right to left)

Photo 2: Stage Road at Culvert (flow is from left to right)

Photo 3: North Branch of the Swift River and Wetland Complex Upstream from Stage Road (note beaver dam immediately upstream from culvert inlet)

Photo 4: North Branch of the Swift River and Old Bridge Downstream from Stage Road

Photo 5: Inlet to Stage Road Culvert (note damage to culvert and debris above culvert)

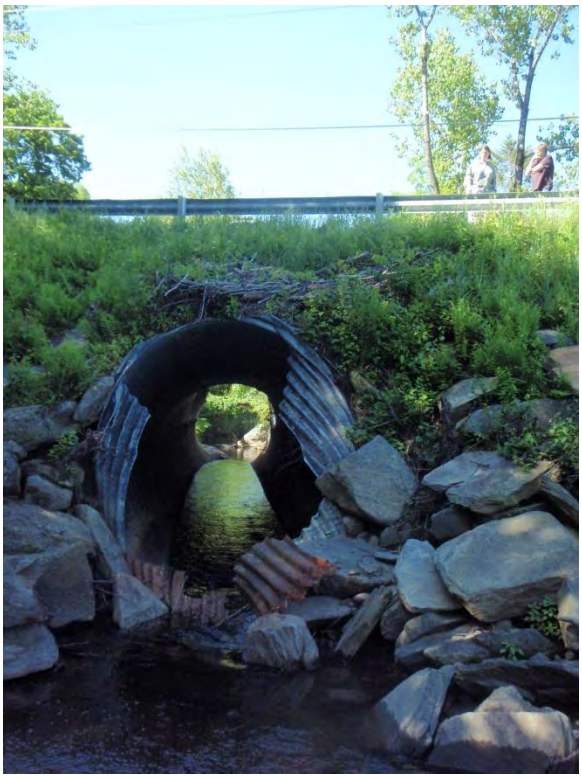

Photo 6: Beaver Dam Upstream from Culvert Inlet

Photo 7: Culvert Barrel with Damaged Inlet in Background

Photo 8: Culvert Outlet

Photo 9: Culvert Outlet and Old Bridge Downstream from Stage Road

Photo 10: Old Bridge Downstream from Stage Road

Photo 11: Section of Downstream Roadway Embankment to the right of the Culvert Overtopped during Tropical Storm Irene

Photo 12: Damaged Culvert Inlet