Aquatic Habitat Connectivity Survey

Mill Brook
West Tisbury and Chilmark, Massachusetts

August 2012

Upstream Face of culvert on Witch Brook at North Road

Prepared for
Town of West Tisbury

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1.0 SUMMARY

The Division of Ecological Restoration (DER) performed a site visit to evaluate aquatic habitat connectivity at four road-stream crossing locations in West Tisbury and Chilmark, Massachusetts. There are two main watersheds in the town of West Tisbury: the Tiasquam River and Mill Brook. Both streams originate in the terminal moraine and flow generally south to Tisbury Great Pond. Both streams are fragmented by numerous low-head dams established variously for agricultural, manufacturing, and aesthetic reasons. In addition, the two streams and their tributaries flow through numerous road crossings of various vintages and configurations.

Certain land use practices have resulted in degradation of aquatic and riparian habitat in and along the Tiasquam and Mill Brook. For example, Mill Brook supports a small population of sea-run, or “salter,” brook trout (*Salvelinus fontinalis*); this species was nearly extirpated from the brook in the latter half of the 20th century due to factors including destruction of suitable habit and installation of instream barriers that prevent upstream migration of all fish except American eel (*Anguilla rostrata*) into the Brook upstream of Mill Pond. Mill Brook still has a population of Eastern brook trout; however, those fish are unable to move back and forth to the estuary.

This report presents preliminary information on the four road crossings- three associated with Mill brook and one at the head of Tiah’s Cove. None of the crossings currently meet the Massachusetts Stream Crossing Guidelines for fish and wildlife passage. Each location provides an opportunity to enhance fish and wildlife passage to a different degree. This report can be used to help prioritize which locations to focus on first for the purpose of aquatic habitat restoration

Because it impounds much more water than the other crossings assessed here, options for the Old Farm Road Dam should be considered independently based on ecological and engineering input. Depending on the Town of West Tisbury’s goals, it might prioritize addressing the crossings that it owns in a manner similar to one of the following:

1. Upgrading each culvert when it needs maintenance but not before;
2. Replace culverts when the road needs re-surfacing;
3. Prioritizing the replacement of one or more culverts based on ecological characteristics of that reach (e.g. in accordance with findings from an updated MassWildlife fish population survey);
4. Partner with private and non-governmental organizations to raise funds for replacement of one or more culverts;
5. Proactively replace one crossing on a recurring basis, regardless of maintenance needs.

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DISCLAIMER: This report was prepared by Division of Ecological Restoration staff with input from others as cited. This report is not an engineering study.

1.0 INTRODUCTION

This report was prepared by the Commonwealth of Massachusetts Department of Fish and Game Division of Ecological Restoration (DER). The mission of DER is to restore and protect the Commonwealth of Massachusetts's rivers, wetlands, and watersheds for the benefit of people and the environment. The objective of this report is to provide a preliminary evaluation of aquatic habitat connectivity at four road-stream crossing sites in West Tisbury and Chilmark, Massachusetts.

Project work included review of information prepared by others and provided to DER, observations made during a preliminary site visit on August 6, 2012, and a review of readily available information. The site visit was attended by West Tisbury Conservation Commissioner Prudy Burt, Civil Engineer Kent Healy, Highway Superintendent Richard Olson, and Kristen Fauteux representing the Sheriff's Meadow Foundation. Photographs taken by DER during the site visit are included in the noted Appendices.

Each of the four locations visited features similar opportunities and constraints for restoration. At each location, the Road-Crossing Inventory developed by the River and Stream Continuity Partnership (www.streamcontinuity.org) was performed to collect data regarding the crossing and the observed effect on stream continuity. A summary of the observations made at each site, along with recommendations for further consideration are included in subsequent sections of this report. Ballpark cost estimates are offered for each site based on DER's professional opinion and familiarity with costs from similar projects in southeastern Massachusetts. Competitive bid solicitations have resulted in considerable cost savings for restoration project in Massachusetts over the recent years.

2.0 OVERVIEW OF THE MA STREAM CROSSING STANDARDS

The Massachusetts River Continuity Partnership compiled information for fish and wildlife passage requirements, culvert design standards and methodologies for evaluating barriers[1] to fish and wildlife passage. The information was used to develop performance standards for culverts and other stream crossing structures. The Massachusetts River and Stream Crossing Standards[2] are intended for new permanent crossings (highways, railways, roads, driveways, bike paths, etc.) and, when possible, for replacing existing crossings.

The overall goals the Standards seek to achieve include:

- Fish and Aquatic Organism Passage;
- River/Stream Continuity; and
- Wildlife Passage.

The stream crossing guidelines are based on two sets of standards: General and Optimum. Optimum standards should be used in areas of statewide or regional significance for their contribution to landscape connectedness or in streams that provide critical habitat for rare or endangered species. Based on review of existing information provided and accessible to DER, the West Tisbury crossings would likely strive to meet the General standards.

The standards include six important variables:

1. **Type of Crossing:** Spans (bridges, 3-sided box culverts, open-bottom culverts or arches) are strongly preferred.
2. **Embedment:**
   a. All culverts should be embedded (sunk into stream) a minimum of 2 feet, and round pipe culverts at least 25%.
   b. If pipe culverts cannot be embedded this deep, then they should not be used.

[1] Instruction Guide for Field Data Form: Road–Stream Crossing Inventory (http://streamcontinuity.org/pdf_files/Instructions%20for%20Field%20Data%20Form%205-14-12.pdf) and Field Data Form: Road-Stream Crossing Inventory (http://streamcontinuity.org/pdf_files/Continuity%20Project%20Road-Stream%20Crossing%20Data%20Form%205-14-12.pdf)

[2] River and Stream Continuity Partnership. Massachusetts River and Stream Crossing Standards. March 1, 2006 (revised March 1, 2011) (web-based document) http://streamcontinuity.org/pdf_files/MA%20Crossing%20Stds%203-1-11%20corrected%203-8-12.pdf

c. When embedment material includes elements >15 inches in diameter, embedment depths should be at least twice the D84 (particle width larger than 84% of particles) of the embedment **material.**

3. **Crossing Span:**
   - General: Spans channel width (a minimum of 1.2 times the bankfull width of the stream).
4. **Openness:**
   - General: Openness ratio (cross-sectional area/crossing length) of at least 0.82 feet (0.25 meters). The crossing should be wide and high relative to its length.
5. **Substrate:**
   - Natural bottom substrate should be used within the crossing and it should match the upstream and downstream substrates. The substrate and design should resist displacement during floods and maintain an appropriate bottom during normal flows.
6. **Water Depth and Velocity:**
   - Water depths and velocities are comparable to those found in the natural channel at a variety of flows

The crossing standards establish minimum criteria generally necessary to facilitate fish and wildlife movement and maintain stream continuity. Use of these standards alone will not satisfy the need for proper engineering and design.

2.1 Crossing Replacements

Given the number of existing crossing structures, it is important to assess what impact these crossings are having and what opportunities exist to mitigate ecosystem impacts. Culvert upgrading requires careful planning and is not simply the replacement of a culvert with a larger structure. Even as undersized structures block the movement of organisms and materials, over time, rivers and streams adjust to the hydraulic and hydrological changes caused by these structures. Increasing the size of the crossing structure can destabilize the stream and cause head cutting – the progressive downcutting of the stream channel – upstream of the crossing. There may also be downstream effects such as increased sedimentation. Crossing replacements can result in the loss or degradation of wetlands that formed above the culvert as a consequence of constricted flow.

Before replacing a culvert or other crossing structure with a larger structure it is essential that the replacement be evaluated for its impacts on:

- downstream flooding,
- upstream and downstream habitat (in-stream habitat, wetlands),
- potential for erosion and head cutting, and
- stream stability.

In most cases, it is necessary to conduct engineering analyses including long profiles of sufficient length to understand potential changes in channel characteristics. A "long profile" is a surveyed longitudinal profile along the thalweg (deepest portion of the channel) of the stream extending well upstream and downstream of the crossing.

2.1 Site Evaluation and Considerations

The Massachusetts Road-Stream Crossing Inventory establishes protocols for volunteers and technicians to conduct a rapid assessment of river and stream road crossings. The information is used to determine if crossings are barriers to fish and wildlife movement, and cause habitat fragmentation. The survey protocols assist indentifying key problems and consequences of poorly designed stream crossings, and can be used to identify how improvements can be made during replacements and upgrade of structures.

Typical problems include undersized crossings, shallow crossings and perched crossings. Common consequences include low flow depths insufficient to facilitate movement of fish and other aquatic organisms, unnatural bed material and/or lack of natural substrates, scouring and erosion, high flow velocities, clogging and ponding of water.

3.0 UN-NAMED TRIBUTARY TO PRIESTER'S POND

The Road-Stream Crossing Inventory Data Form for this site can be found in Appendix B.

3.1 Existing Conditions

This section describes the current conditions at this location as observed in the field and from other sources.

Priester's Pond is the fourth dammed impoundment on Mill Brook upstream from its outlet in Town Cove of Tisbury Great Pond. The Pond is approximately 4.7 acres in area and is formed by an earthen dam with a concrete and masonry spillway at its western end. In addition to its source from Mill Brook, Priester's Pond receives surface inflow from an unnamed tributary (UNT) that flows in from the glacial moraine to the north, passing under North Road. The contributing subwatershed of this UNT at North Road is approximately 420 acres[3] of mostly agricultural, forest, and residential land uses.

The UNT passes through a round concrete culvert that appears in good condition. The culvert has an approximately 31-inch-diameter inlet and 27-inch-diameter outlet, both with concrete headwalls. The culvert's length is approximately 42 feet, 9 inches. There is no observable channel armoring at the outlet. The bottom invert of both ends of the culvert appear to be roughly consistent with the stream bed elevations, though an approximately 5-inch drop from the culvert outlet invert to the bed was measured. The culvert is not skewed with respect to the stream alignment and its slope appears to be roughly consistent with the slope of this reach.

This culvert does form a constriction on the UNT as evidenced by its smaller width relative to the approximately 6-foot-wide bankfull width observed in this reach. Further evidence of a hydraulic constriction is found in the large scour pool at the outlet. This pool exceeds 3.5 feet of depth in spots and scour has displaced a quantity of sand and gravel into a large bar, likely restricting flow at certain times (see Photo 1 in Appendix A). This bar appears to backwater the outlet of the culvert under certain conditions, which may be a positive effect on upstream fish passage. However, the relatively small opening of the culvert, likely excessive velocities during high flows, and lack of dry passage through the culvert make it a moderate[4] barrier to fish and wildlife passage. This culvert does not meet the Massachusetts Stream Crossing Standards for fish and wildlife passage

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[3] Kent Healy, personal communication.

[4] A Moderate Barrier is defined by the River Continuity Partnership as, "blocking passage for some species or individuals but not others".

3.2 Recommendations

The culvert appears to adequately handle a range of flows and certainly allows passage of most fish species under moderate to lower flows. However, because of its blockage of some fish and wildlife passage and apparent hydraulic inadequacy, this culvert would need to be replaced in order to fully meet the Massachusetts Stream Crossing Standards for fish and wildlife passage. In order for this crossing to achieve unimpeded passage of fish and wildlife, the crossing would need to be replaced, or at least modified, per the Standards. The size, alignment, geometry, and invert elevation of a replacement culvert would need to be determined based on engineering studies, consideration of beneficial and adverse environmental impacts, and fluvial processes in the downstream reach, including potential changes in downstream conditions that could occur following replacement of the North Road culvert. The selection and design of any replacement crossing should accommodate at least the “General” standards established by the Massachusetts River and Stream Crossing Partnership described under Section 2.0 above. The design of a new crossing would likely need to be performed in accordance with MassDOT standards. To the extent that the Town is interested in pursuing culvert replacement and has funds available, replacement of this culvert might be undertaken during upcoming road resurfacing work.

Replacement of this culvert with a larger, more wildlife-friendly crossing would require excavation of the North Road embankment, water management during construction, and installation of a new culvert or bridge. Vehicular traffic would have to be maintained during construction. Active restoration or the brook upstream or downstream from North Road (e.g., excavation of sediment) is not considered in the ballpark cost estimates presented here.

The decision on what crossing structure to install could be made based in part on the results of a brief alternatives analysis in which a qualified engineer evaluated each crossing type against the site conditions and constraints. Total costs for this project could range from $200,000 to $400,000. Typical costs for a study (including data collection, modeling, and a report with engineer’s estimate of cost) range from $25,000 to $40,000. The typical cost for permit application consultation, preparation, and submittal is from $10,000 to $20,000, with the actual level-of-effort being highly dependent on regulatory requests for information. The typical cost for development of design plans and specifications to support regulatory permitting and bid solicitation is $20,000, and the OPC for construction is $150,000 depending on the crossing structure chosen.

3.3 Regulated Resources

Management of impacts to regulated wetland resource areas must be considered in the design and installation of any new crossing. This section briefly addresses jurisdictional resources regulated by the Massachusetts Department of Environmental Protect (MADEP) and West Tisbury Conservation Commission under the Massachusetts Wetlands Protection Act (WPA) and the West Tisbury Wetlands

Protection Bylaw. Jurisdictional resource areas were not specifically identified or delineated by DER as part of this work; the intent of this section is solely to discuss potential regulated resources that may occur in and along the project reach of the UNT to Priester's Pond. It is presumed here that the UNT is a perennial stream according to the WPA.

Regulated resource features and areas that may occur in and along the UNT may include Bank, Land Under Waterbodies and Waterways (LUWW), Bordering Vegetated Wetland (BVW), Bordering Land Subject to Flooding (BLSF), and Riverfront Area. This list is not exhaustive.

In addition, portions of Priester's Pond are included as Priority Habitats for Rare Species by the MA Natural Heritage and Endangered Species Program (NHESP). Coordination with NHESP in the project planning stage is advisable.

4.0 WITCH BROOK CULVERT AT NORTH ROAD

The Road-Stream Crossing Inventory Data Form for this site can be found in Appendix C.

4.1 Existing Conditions

This section describes the current conditions at this location as observed in the field and from other sources.

Crocker Pond is the fifth dammed impoundment on Mill Brook upstream from its outlet in Town Cove of Tisbury Great Pond. The Pond is approximately 7.6 acres in area and is formed by an earthen dam with a concrete and masonry spillway at its western end. In addition to its source from Mill Brook, Crocker Pond receives surface inflow from Witch Brook, which flows in from the glacial moraine to the north, passing first under North Road. The contributing subwatershed of this UNT at North Road is approximately 450 acres[5] of mostly agricultural, forest, and residential land uses.

This area is listed as Priority Habitat for Eastern box turtle (*Terrapene carolina*)[6], a species of Special Concern. According to the Natural Heritage and Endangered Species Program, this species uses moist woodlands, swamps, fens, and stream banks for a variety of habitat needs.

Witch Brook passes through a 31-inch-diameter[7] round concrete culvert that appears in good condition. No internal culvert features were observable and both ends of the culvert feature concrete headwalls. The culvert's length is approximately 40 feet, 9 inches. There is no observable channel armoring at the outlet. The bottom invert of both ends of the culvert appear to be roughly consistent with the stream bed elevations; no drop was observed at either end's invert. The culvert is not skewed with respect to the stream alignment and its slope appears to be roughly consistent with the slope of this reach.

This culvert does not meet the MA Stream Crossing Standards for fish and wildlife passage. This culvert does form a constriction on Witch Brook as evidenced by its smaller width relative to the approximately 4-to-6-foot-wide bankfull width observed in this reach (see Photo 3). Further evidence of a hydraulic constriction is found in the small scour pool at the outlet. This pool is somewhat larger and deeper than representative areas of this reach of Witch Brook. However, the relatively small opening of the culvert,

[5] Kent Healy, personal communication.

[6] August 15, 2012 letter from MA Natural Heritage and Endangered Species Program.

[7] The notation of 42 inches on the attached field data form may be an error.

likely excessive velocities during high flows, and lack of dry passage through the culvert make it a moderate[8] barrier to fish and wildlife passage.

4.2 Recommendations

The culvert on Witch Brook at North Road appears to adequately handle a range of flows and certainly allows passage of most fish species under moderate to lower flows. However, because of its blockage of some fish and wildlife passage and apparent hydraulic inadequacy, it does not meet the Massachusetts Stream Crossing Standards for fish and wildlife passage. In order for this crossing to achieve unimpeded passage of fish and wildlife, the crossing would need to be replaced, or at least modified, per the Standards. The size, alignment, geometry, and invert elevation of a replacement culvert would need to be determined based on engineering studies, consideration of beneficial and adverse environmental impacts, and fluvial processes in the downstream reach, including potential changes in downstream conditions that could occur following replacement of the North Road culvert. The selection and design of any replacement crossing should accommodate the “General” standards established by the Massachusetts River and Stream Crossing Partnership described under Section 2.0 above. The design of a new crossing would likely need to be performed in accordance with MassDOT standards.

Because of the potential for Eastern box turtle to be using this site, attainment of the “Optimum” standards should be considered. These standards can be summarized as follows:

1. *Use a bridge*

Unless there are compelling reasons why a culvert would provide greater environmental benefits only bridges should be used. Bridges are preferred over open-bottom culverts because they can be installed with minimal impact to the stream channel and provide more headroom for wildlife.

2. *Span the streambed and banks*

The structure span should be at least 1.2 times the bankfull width and provide banks on one or both sides with sufficient headroom to provide dry passage for semi-aquatic and terrestrial wildlife. It is critical to avoid channel constriction during normal bankfull flows. A width of 1.2 times bankfull width is the minimum width needed to meet these standards. Bankfull width should be determined as the average of at least three typical widths, ideally measured at the proposed structure’s location, and then upstream and

[8] A Moderate Barrier is defined by the River Continuity Partnership as, “blocking passage for some species or individuals but not others”.

downstream of the proposed structure (except where stream sections are not representative of conditions where the structure will be located).

The stream width should be measured at straight sections of the channel outside the influence of existing structures and unusual channel characteristics. The structure should not be narrower than the bankfull width at the crossing location. For streams within floodplains 1.2 times bankfull may not be sufficient to ensure adequate water conveyance for large, infrequent flood events without destabilizing the stream channel. In these cases, wider structures or alternative means of conveying flood waters may be necessary. It is critically important that structure design on these streams be based on sound engineering and, to the extent possible, take into account the potential effects of climate change on future storm characteristics (e.g. storms are likely to be more severe) and how the hydrology of the stream could change due to development within the watershed.

For guidance on the technical issues associated with sizing crossing structures refer to the U.S. Forest Service publication “Stream Simulation: an Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings” available at http://www.streamcontinuity.org/online_docs.htm.

3. *Natural bottom substrate within the structure*

Careful attention must be paid to the composition of the substrate within the structure. The movement of benthic aquatic organisms could be obstructed or their necessary life-cycle movements could be substantially disrupted without a natural bottom forming a continuous medium through the structure. Substrate characteristics may be a more important determinant of passability than water depth or velocity for animals that tend to crawl (salamanders, crayfish) rather than swim in streams systems.

The substrate within the structure should match the characteristics of the substrate in the natural stream channel (mobility, slope, stability, confinement) at the time of construction and over time as the structure has had the opportunity to pass significant flood events. Substrate should be designed to meet desired characteristics after a period of adjustment likely to occur after construction.

The substrate should be designed to resist the complete loss of bed material during large, infrequent storms and to maintain appropriate channel characteristics through natural bed load transport. The goal is to achieve a dynamic equilibrium whereby substrate lost due to bed load transport is balanced by the movement of substrate into the structure from upstream.

Sometimes in order to ensure bed stability (stability is not the same as rigidity) at higher than bankfull flows it may be necessary to use larger substrate within the structure than is generally found in the natural stream channel. In these cases the substrate should approximate the natural stream substrate and when possible should fall within the range of variability seen in the natural channel upstream and downstream of the crossing.

4. *Designed with appropriate bed forms and streambed characteristics so that water depths and velocities are comparable to those found in the natural channel at a variety of flows*

In order to provide appropriate water depths and velocities at a variety of flows and especially low flows it is necessary to preserve or reconstruct the streambed within the structure. Otherwise, the width of the structure needed to accommodate higher flows will create conditions that are too shallow at low flows. The preference is to preserve the existing channel through the use of open-bottom spans wide enough to preserve the entire streambed. It is important that a continuous thalweg (deepest portion of the channel) be maintained through the structure. When constructing the streambed special attention should be paid to the sizing and arrangement of materials within the structure. If only large material is used, without smaller material filling the voids, there is a risk that flows could go subsurface within the structure.

For guidance on the technical issues associated with the design and construction of stream channels and bed forms refer to the U.S. Forest Service publication “Stream Simulation: an

Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings” available at http://www.streamcontinuity.org/online_docs.htm.

5. *Maintain a minimum height of 8 ft (2.4 meters) and openness of 2.46 feet (0.75 meters) if conditions are present that significantly inhibit wildlife passage (high traffic volumes, steep embankments, fencing, Jersey barriers or other physical obstructions. If conditions that significantly inhibit wildlife passage are not present, maintain a minimum height of 6 ft. (1.8 meters) and openness of 1.64 feet (0.5 meters).*

Attainment of this standard may not be practical or advisable given that it would likely require superelevation of the road. Doing this would likely have additional impacts that are not necessarily balanced by the gains as compared with a bridge or wide, open-bottom structure.

6. *Banks should be present on each side of the stream matching the horizontal profile of the existing stream and banks with sufficient headroom to provide dry passage for semi-aquatic and terrestrial wildlife*

To prevent failure, all constructed banks should have a height-to-width ratio no greater than 1:1.5 (vertical:horizontal) unless the stream is naturally incised. Banks within the structure should generally align with the profile and cross section of banks upstream and downstream of the structure and should be stable during a 100-year storm event. The banks should be designed and constructed so as not to hinder wildlife use of the streambed and banks for passage.

Replacement of this culvert with a larger, more wildlife-friendly crossing would require excavation of the North Road embankment, water management during construction, and installation of a new culvert. Vehicular traffic would have to be maintained during construction. Active restoration or the brook upstream or downstream from North Road (e.g., excavation of sediment) is not considered in the ballpark cost estimate presented here.

The decision on what crossing structure to install could be made based in part on the results of a brief alternatives analysis in which a qualified engineer evaluated each crossing type against the site conditions and constraints. Total project costs would likely range between $260,000 and $400,000. The cost for such a study (including data collection, modeling, and a report with engineer's estimate of cost) can range from $25,000 to $40,000. The costs for for permit application consultation, preparation, and submittal range from $10,000 to $20,000, with the actual level-of-effort being highly dependent on regulatory requests for information. Engineering design to develop plans and specs for permitting and contractor bid solicitation might be another $25,000, and construction might range from $150,000 to $250,000 depending on the crossing structure chosen.

4.3 Resource Areas

Management of impacts to regulated wetland resource areas must be considered in the design and installation of any new crossing. This section briefly addresses jurisdictional resources regulated by the Massachusetts Department of Environmental Protect (MADEP) and West Tisbury Conservation Commission under the Massachusetts Wetlands Protection Act (WPA) and the West Tisbury Wetlands Protection Bylaw. Jurisdictional resource were not specifically identified or delineated by DER as part of this work; the intent of this section is solely to discuss potential regulated resources that may occur in and along the project reach of Witch Brook.

Regulated resource features and areas that may occur in and along this portion of Witch Brook likely include Bank, Land Under Waterbodies and Waterways (LUWW), Bordering Vegetated Wetland (BVW), Bordering Land Subject to Flooding (BLSF), and Riverfront Area. This list is not exhaustive.

In addition, the culvert location is located within Priority Habitats for Rare Species by the MA Natural Heritage and Endangered Species Program (NHESP). Coordination with NHESP in the project planning stage is advisable.

5.0 OLD FARM ROAD DAM

The Road-Stream Crossing Inventory Data Form for this site can be found in Appendix D.

5.1 Existing Conditions

This section describes the current conditions at this location as observed in the field and from other sources.

The impoundment formed by the Old Farm Road Dam is the sixth dammed impoundment on Mill Brook upstream from its outlet in Town Cove of Tisbury Great Pond. The impoundment is approximately 0.75 acres in area and is formed by an earthen dam with two corrugated metal culverts forming the outlet near the dam’s midpoint. The property is owned and managed as part of the Roth Woodlands by the Sheriff’s Meadow Foundation.

The two twelve-inch-diameter corrugated metal culverts appear in adequate condition. Despite being nearly inundated at the upper end, flow at the outer end encompassed a depth of only one inch. This may indicate partial blockage with debris, a problem with the culverts’ horizontal alignment, or some compromise of the culverts’ internal integrity, though this could not be verified based on visual assessment. Given the densely vegetated nature of the impoundment, it is likely that debris may become stuck in the relatively small diameter pipes from time to time.

The two culverts are approximately 20 feet in length and discharge onto large boulders that form an approximately two-foot cascade down to where the stream resumes. Upstream fish passage is impossible for all but American eel at this point and wildlife passage is doubtful for most riparian species.

5.2 Recommendations

A certified dam inspector should be consulted to obtain recommendations regarding the advisable outlet dimensions and configuration for a dam of this size as well as any maintenance or repair recommendations that might serve to improve its safety. Reconfiguration of the dam’s outlet should also take into consideration potential improvements to fish and wildlife passage, however, due to its separation from potential diadromous fish passage, traditional fish ladders and the like are probably not necessary or appropriate at this time. Removal of the outlet structure and replacement with a properly-sized span would alleviate dam safety concerns and provide excellent fish and wildlife passage. This option would likely mean the loss of some of the impoundment and should be balanced against other goals. Depending on the extent of the dam chosen to remain, local hydrology, and the crossing type chosen, stabilization of the channel through the area of the crossing would be required.

5.3 Regulated Resources

Management of impacts to regulated wetland resource areas must be considered in the design and installation of any new crossing. This section briefly addresses jurisdictional resources regulated by the Massachusetts Department of Environmental Protection (MADEP) and Chilmark Conservation

Commission under the Massachusetts Wetlands Protection Act (WPA) and the Chilmark Wetlands Protection Bylaw. Jurisdictional resource were not specifically identified or delineated by DER as part of this work; the intent of this section is solely to discuss potential regulated resources that may occur in and along the project reach of the Mill Brook in the vicinity of this dam at Roth Woodlands.

Regulated resource features and areas that may occur in and along the UNT may include Bank, Land Under Waterbodies and Waterways (LUWW), Bordering Vegetated Wetland (BVW), Bordering Land Subject to Flooding (BLSF), and Riverfront Area. This list is not exhaustive.

In addition, portions of Roth Woodlands are included as Priority Habitats for Rare Species by the MA Natural Heritage and Endangered Species Program (NHESP). Coordination with NHESP in the project planning stage is advisable.

6.0 UN-NAMED TRIBUTARY TO TIAH'S COVE

The Road-Stream Crossing Inventory Data Form for this site can be found in Appendix E.

6.1 Existing Conditions

This section describes the current conditions at this location as observed in the field and from other sources.

Tiah's Cove forms a lobe of Tisbury Great Pond on the south shore of Martha's Vineyard. The Cove is fed in part by an un-named tributary (UNT) that flows in at the Cove's northernmost extent after crossing under Tiah's Cove Road. The site was examined very near low tide (low pond) in Tiah’s Cove. Based on the observed lack of localized scour or vegetation community discontinuity, it does not appear that the tide reaches as high as the road culvert, though the tide may cause back-up of the freshwater coming down the UNT. This assumption should be verified. The Stream Crossing Standards were developed specifically for freshwater, non-tidal rivers and streams and may not be appropriate for coastal waterways. Tidal crossing projects need to take into consideration:

- Daily fluctuating tides, bidirectional flows, tidal inundation and coastal storm surge,
- Flood protection of adjacent and upstream infrastructure,
- Saltwater channel morphology and potential impacts due to sea-level rises, and
- Hydraulic modeling to determine appropriate sizes of structures for desired degree of tidal restoration

Qualified personnel and consultants should carefully consider engineering design and construction techniques.

The UNT passes under Tiah's Cove Road via a corrugated metal pipe. This crossing does not meet the Massachusetts Stream Crossing Guidelines for fish and wildlife. The culvert measured 18 inches in diameter at its upstream end and 28 inches in diameter at its downstream end. Both ends of the culvert are supported by concrete headwalls. Part of the upstream[9] headwall has dislodged and fallen into the stream forming a partial barrier to fish and wildlife movement through the culvert (see Photo 6). In addition, what appeared to be a coaxial cable was observed passing though the culvert on its eastern side. It is not clear what service, if any, this cable provides and to what adjoining properties.

It appears that stormwater draining from both directions on Tiah’s Cove Road does not have a ready path off of the roadway, except for discharging directly into the brook at the culvert location. During rain events,

[9] In general, the directionals “seaward” and “landward” are used here at sites that are tidally affected whereas the directionals “downstream” and “upstream” are used here at sites that are not tidally affected

water apparently collects at various points along the roadway in this area[10]. This condition is exacerbated by erosion of the soft shoulder by cars turning on the south side of the road, east of the culvert, and erosion of the dirt driveway opposite.

6.2 Recommendations

The culvert appears to adequately handle a range of flows and certainly allows passage of most fish species under moderate to lower flows. However, because of its blockage of some fish and wildlife passage and apparent hydraulic inadequacy, it does not meet the Massachusetts Stream Crossing Standards for fish and wildlife passage. In order for this crossing to achieve unimpeded passage of fish and wildlife, the crossing would need to be replaced, or at least modified, per the Standards. The size, alignment, geometry, and invert elevation of a replacement culvert would need to be determined based on engineering studies, consideration of beneficial and adverse environmental impacts, and fluvial processes in the downstream reach, including potential changes in downstream conditions that could occur following replacement of the Tiah’s Cove Road culvert.

Though not assessed as part of this study, the opportunity for installing stormwater BMPs within the upland right-of-way should be explored. Grass-lined swales might prove to be a feasible and effective measure to reduce direct road runoff, if space is available.

It is not immediately clear why this culvert has a smaller upstream opening as compared to its outlet. A professional engineer should be consulted relative to hydrologic and hydraulic changes that might result from replacing this culvert with a more wildlife-friendly crossing. In addition, before pursuing any replacement, the Town should make contact with the relevant utilities that might be responsible for the coaxial cable currently running through the culvert and develop a plan to terminate or relocate that service.

Replacement of this culvert with a larger, more wildlife-friendly crossing would require excavation of the Tiah’s Cove Road embankment, water management during construction, and installation of a new culvert. The design of a new crossing would likely need to be performed in accordance with MassDOT standards. Vehicular traffic would have to be maintained during construction. Active restoration of the brook landward or seaward from Tiah’s Cove Road (e.g., excavation of sediment) is not considered in the ballpark cost estimates presented here.

The decision on what crossing structure to install could be made based in part on the results of a brief alternatives analysis in which a qualified engineer evaluated each crossing type against the site conditions and constraints. Total costs for this project might range from $230,000 to $500,000. The cost for such a study (including data collection, modeling, and a report with engineer’s estimate of cost) might

[10] Richard Olson, personal communication.

range from $25,000 to $40,000. The range of cost for permit application consultation, preparation, and submittal is from $10,000 to $20,000, with the actual level-of-effort being highly dependent on regulatory requests for information. The development of design plans to support regulatory permitting and bid solicitation is potentially $20,000, and the cost for construction is likely to be at least $175,000 depending on the crossing structure chosen.

6.3 Regulated Resources

Management of impacts to regulated wetland resource areas must be considered in the design and installation of any new crossing. This section briefly addresses jurisdictional resources regulated by the Massachusetts Department of Environmental Protection (MADEP) and West Tisbury Conservation Commission under the Massachusetts Wetlands Protection Act (WPA) and the West Tisbury Wetlands Protection Bylaw. Jurisdictional resource areas were not specifically identified or delineated by DER as part of this work; the intent of this section is solely to discuss potential regulated resources that may occur in and along the project reach of the UNT to Tiah’s Cove. It is presumed here that the UNT is a perennial stream according to the WPA.

Regulated resource features and areas that may occur in and along the UNT may include Bank, Land Under Waterbodies and Waterways (LUWW), Bordering Vegetated Wetland (BVW), Bordering Land Subject to Flooding (BLSF), and Riverfront Area. This list is not exhaustive.

7.0 ADDITIONAL OBSERVATIONS

This section is intended to outline other observations of opportunities and constraints related to potential for improvement of the aquatic habitat of Mill Brook.

7.1 Stormwater at Scotchman's Lane

Scotchman's Lane crosses Mill Brook via a concrete culvert upstream of Mill Pond. While there are no curbs on the lane, the road does bank slightly on the edges. This precludes runoff into the adjacent upland except at a few locations which were observed to be in need of maintenance clearing during the site visit on August 6, 2012. The lack of any stormwater controls on the Lane means that during rainfall events, runoff drains downhill from both directions and empties into Mill Brook. This runoff likely carries with it sand and common roadway contaminants. It also has the potential to elevate the water temperature of Mill Brook, which is detrimental to the coldwater fishery. A 2000 survey by the MA Division of fisheries and Wildlife found tessellated darter, golden shiner, American eel, and American brook lamprey [state "threatened"] upstream of the crossing.

Several options for attenuating stormwater effects from Scotchman's Lane runoff have been discussed by the Conservation Commission and the Mill Pond Committee[11]. After reviewing the site conditions, it appears that roadway grading changes and installation of grassed channels (i.e. biofilter swales) at key locations in the upland would be a cost-effective solution to the problem. The limits of Bordering Vegetated Wetland adjacent to the Brook were delineated prior to DER's site visit and these extents show ample area for installation of BMPs in the uplands. Grass-lines swales have a high potential to remove suspended solids, some contaminants, and to encourage groundwater infiltration if installed and maintained correctly. Design and installation of these structures would need to take into account runoff quantities from representative storms and the space required to achieve the recommended 9 minutes residence time within the swale. Ideally, the swales could be designed to terminate at another stormwater BMP (e.g. an infiltration trench) thereby improving the water quality improvement through secondary treatment.

Such non-proprietary structures also obviate the need for high-cost in-line inlet treatment structures (e.g. Stormceptor systems). It may be possible for West Tisbury Highway or Public Works staff to create these structures with guidance and design from in-house engineers. The Town and other decision makers should consult the Massachusetts Stormwater Handbook for more information[12]. If work is confined to the upland on Scotchman's Lane, regulatory permitting may be less strenuous, however the hypothetical

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[11] Prudy Burt, personal communication.

[12] http://www.mass.gov/dep/water/laws/policies.htm#storm

work area is almost certainly within Riverfront Area at least, and so the West Tisbury Conservation Commission should be consulted early.

7.2 Stormwater at Mill Pond

As detailed in the Site Reconnaissance Report about Mill Pond Dam commissioned in 2011 by DER, stormwater inputs to Mill Brook at Edgartown/ West Tisbury Road may be deleterious to aquatic habitat in this reach. Runoff from the roadway enters the brook by flowing overland at a number of locations. This runoff is causing localized bank erosion on the downstream side, west of the dam spill way, and at other locations. This runoff likely carries with it sand and common roadway contaminants. It also has the potential to elevate the water temperature of Mill Brook, which is detrimental to the restoration of a coldwater fishery downstream of the dam. A 2000 survey by the MA Division of fisheries and Wildlife found brown bullhead, tessellated darter, golden shiner, American eel, and American brook lamprey [state “threatened”] downstream of the dam.

Because of the space constraints in the vicinity of the dam, this location may be best suited to an in-line system (e.g. Stormceptor) with additional curbing to control runoff where it enters the Brook. While this method would attenuate the discharge of solids into the brook, it would not have much, if any, effect on reducing runoff temperatures to the brook. The suitability of this approach as compared with other alternatives in terms of water quality and road safety (i.e. ability to handle the runoff so as to limit ponding on the road) should be analyzed by a qualified engineer. In addition to environmental regulatory compliance, the Town should consult with the Massachusetts Department of Transportation regarding any alteration to a jurisdictional road.

APPENDIX A
Site Photographs

Photo 1: Looking upstream at the sediment bar created at the outlet of the UNT to Priester's Pond Culvert.

Photo 2: The downstream outlet of the culvert passing the UNT to Priester's Pond showing expansion scour and scour pool.

Photo 3: Outlet of the Witch Brook culvert showing expansion scour.

Photo 4: The downstream side of the outlet of the Old Farm Road Dam

Photo 5: View looking upstream from the culvert on Tiah's Cove Road

Photo 6: Inlet of culvert at Tiah's Cove Road showing the broken piece of the headwall in the foreground and coaxial cable exiting on the left.

APPENDIX B

Field Data Form for
UNT to Priester's Pond Culvert

413-464-1527 Phil Dennis

5/12/2012

Data entry by NW	Date 8/6/12
Reviewed by ______	Date ______

Field Data Form: Road-Stream Crossing Inventory

Coordinator ______ **Crossing ID#** ______

Stream/River: UNT - Pritchers Pond **Road:** North Rd **Town:** W. Tis

Flow condition: ☒ Unusually low — ☒ Typical low-flow ☐ Average flow ☐ Higher than average

GPS Coordinates (lat/long):

☐ Decimal degrees N__ __ . __ __ __ __ __ W__ __ . __ __ __ __ __

OR ☒ Degrees, minutes, seconds North: D 41° M 24.246 S ______

West: D 70 M 40.828 S ______

Date: 8/6/12 **Location:** ______ **Observer:** NW

Photo IDs: #2-6 view d/s, d/s outlet, view u/s, u/s inlet

Road/Railway Characteristics

Road surface: ☒ Paved ☐ Unpaved ☐ Railroad

Road type: ☐ 1-Lane road ☒ 2-Lane road ☐ Multilane road ☐ Divided highway ☐ Railroad ☐ Buried stream

Crossing/Stream Characteristics *(during generally low-flow conditions)*

Crossing type: ☐ Ford ☐ Bridge ☐ Open bottom arch ☒ Single culvert ☐ Multiple culverts (# _____)
☐ Removed ☐ No crossing

Condition of crossing: ☐ New ☒ Excellent ☒ Fair ☐ Poor

Does the stream at the crossing support fish? ☒ Yes ☐ Not likely ☐ Don't know

Is the stream flowing? ☒ Yes ☐ No

Crossing span: ☐ Severe constriction ☒ Mild constriction ☐ Spans bank to bank ☐ Spans channel & banks

Tailwater Scour pool: ☐ None ☐ Small (wider or deeper than stream) ☒ Large (width or depth 2X stream)

Crossing alignment matches stream? ☒ Yes (flow aligned) ☐ No (skewed)

Culvert/Bridge Cell Characteristics *(Culvert/cell #1; use page 3 for additional culverts or cells)*

Structure embedded? ☒ Not embedded ☐ Partially embedded ☐ Fully embedded ☐ No Bottom

Structure substrate: ☐ None (smooth) ☒ None (rough/corrugated) ☐ Inappropriate ☐ Contrasting ☐ Comparable

Internal features ☒ None ☐ Slip lined ☐ Baffles/Sills ☐ Weir(s) ☐ Support structures

Physical Barriers to fish and wildlife passage: ☐ Severe ☒ Moderate ☐ Minor ☐ None

Describe any barriers: likely velocity barrier.

Is there a clear line of sight through the structure? ☒ Yes ☐ No

Does the structure provide dry passage suitable for use by terrestrial wildlife? plastic ☐ Yes ☒ No

If yes, what is the maximum structure height in the portion that offers dry passage? NA Feet

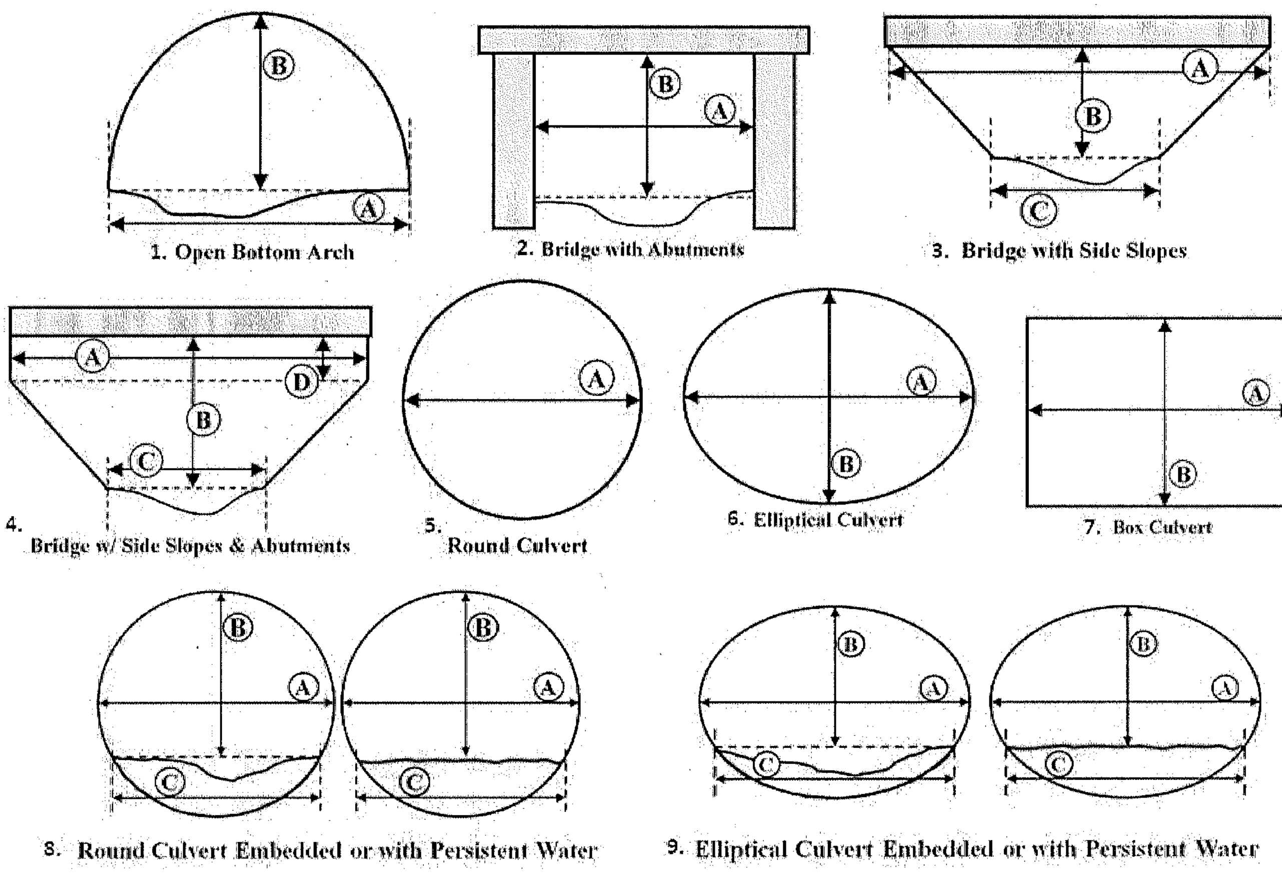
Comments 3/10" Rain last night. 3.5' scour pool, scour has left gravel bar D/s which is somewhat a control. Substrate sand-gravel.

For the following questions use as a reference a portion of the natural stream channel that is outside the influence of the crossing structure and not otherwise altered.

Water depth matches stream? ☐ Yes (comparable) ☒ No (deeper) ☐ No (shallower) ☐ Dry

Water velocity matches stream? ☒ Yes (comparable) ☐ No (slower) ☐ No (faster) ☐ Dry

Crossing Slope matches stream? ☒ Yes (comparable) ☐ No (flatter) ☐ No (steeper)



Length of stream through crossing: 42' 9" Feet

Inlet Structure Type (from above): ☐ **1.** ☐ **2.** ☐ **3.** ☐ **4.** ☒ **5.** ☐ **6.** ☐ **7.** ☐ **8.** ☐ **9.** ☐ **Ford**

Inlet Dimensions: A) 31 (ft.) B) ____ (ft.) C) ____ (ft.) D) ____ (ft.) ☐ Submerged

Inlet Water Depth (max depth inside the structure at the inlet): 15 Inches ☒ Measured ☐ Estimated

Inlet Drop ☒ None, or if present ____ Inches ☐ Measured ☐ Estimated

Outlet Structure Type (from above): ☐ **1.** ☐ **2.** ☐ **3.** ☐ **4.** ☒ **5.** ☐ **6.** ☐ **7.** ☐ **8.** ☐ **9.** ☐ **Ford**

Outlet Dimensions: A) 27" (ft.) B) ____ (ft.) C) ____ (ft.) D) ____ (ft.) ☐ Submerged

Outlet Water Depth (max depth inside the structure at the outlet): 13 Inches ☒ Measured ☐ Estimated

Outlet Drop

- **a. Culvert bottom to water surface** ☒ None, or if present ____ Inches ☐ Measured ☐ Estimated
- **b. Culvert bottom to stream bed** ☐ None, or if present 5 Inches ☐ Measured ☐ Estimated
- **c. With an outlet drop, check one:** ☐ Cascade ☐ Freefall ☐ Freefall onto cascade ☒ No drop

Armored streambed at outlet? ☐ Extensive ☐ Not extensive ☒ None

Comments u/s backfill = 6'

APPENDIX C

Field Data Form for Witch Brook culvert at North Road

5/12/2012

Data entry by MW	Date 8/6/12
Reviewed by	Date

Field Data Form: Road-Stream Crossing Inventory

Coordinator ____________ **Crossing ID#** ____________

Stream/River: Witch Brook **Road:** North Rd. **Town:** W. Tisbury

Flow condition: ☐ Unusually low ☒ Typical low-flow ☐ Average flow ☐ Higher than average

GPS Coordinates (lat/long):

☐ Decimal degrees N__ __ . __ __ __ __ __ W__ __ . __ __ __ __ __

OR ☒ Degrees, minutes, seconds North: D 41° M 24.203 S ______
West: D 70 M 41.152 S ______

Date: 8/6/12 **Location:** ____________ **Observer:** ____________

Photo IDs: # 7-10 view D/S, D/S face, view U/S, U/S face

Road/Railway Characteristics

Road surface: ☒ Paved ☐ Unpaved ☐ Railroad

Road type: ☐ 1-Lane road ☒ 2-Lane road ☐ Multilane road ☐ Divided highway ☐ Railroad ☐ Buried stream

Crossing/Stream Characteristics *(during generally low-flow conditions)*

Crossing type: ☐ Ford ☐ Bridge ☐ Open bottom arch ☒ Single culvert ☐ Multiple culverts (# _____)
☐ Removed ☐ No crossing

Condition of crossing: ☐ New ☒ Excellent ☐ Fair ☐ Poor

Does the stream at the crossing support fish? ☒ Yes ☐ Not likely ☐ Don't know

Is the stream flowing? ☒ Yes ☐ No

Crossing span: ☐ Severe constriction ☒ Mild constriction ☐ Spans bank to bank ☐ Spans channel & banks

Tailwater Scour pool: ☐ None ☒ Small (wider or deeper than stream) ☐ Large (width or depth 2X stream)

Crossing alignment matches stream? ☒ Yes (flow aligned) ☐ No (skewed)

Culvert/Bridge Cell Characteristics *(Culvert/cell #1; use page 3 for additional culverts or cells)*

Structure embedded? ☒ Not embedded ☐ Partially embedded ☐ Fully embedded ☐ No Bottom

Structure substrate: ☐ None (smooth) ☒ None (rough/corrugated) ☐ Inappropriate ☐ Contrasting ☐ Comparable

Internal features ☒ None ☐ Slip lined ☐ Baffles/Sills ☐ Weir(s) ☐ Support structures

Physical Barriers to fish and wildlife passage: ☐ Severe ☒ Moderate ☐ Minor ☐ None

Describe any barriers: Likely velocity barrier @ sure flows. no dry passage

Is there a clear line of sight through the structure? ☒ Yes ☐ No

Does the structure provide dry passage suitable for use by terrestrial wildlife? ☐ Yes ☒ No

If yes, what is the maximum structure height in the portion that offers dry passage? NA Feet

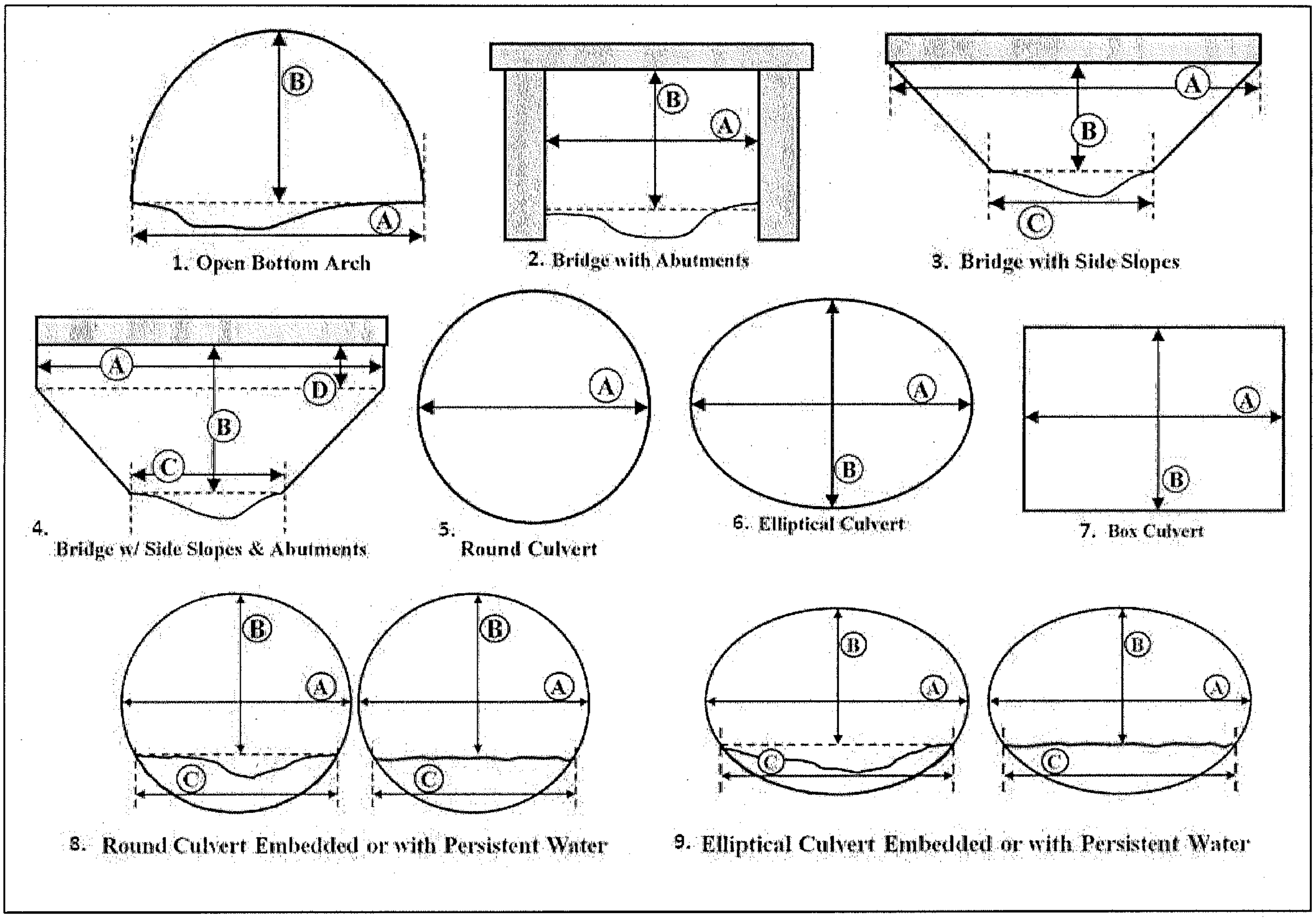
Comments ____________

For the following questions use as a reference a portion of the natural stream channel that is outside the influence of the crossing structure and not otherwise altered.

Water depth matches stream? ☒ Yes (comparable) ☐ No (deeper) ☐ No (shallower) ☐ Dry

Water velocity matches stream? ☒ Yes (comparable) ☐ No (slower) ☐ No (faster) ☐ Dry

Crossing Slope matches stream? ☒ Yes (comparable) ☐ No (flatter) ☐ No (steeper)



Length of stream through crossing: 40' 9" Feet

Inlet Structure Type (from above): ☐ **1.** ☐ **2.** ☐ **3.** ☐ **4.** ☒ **5.** ☐ **6.** ☐ **7.** ☐ **8.** ☐ **9.** ☐ **Ford**

Inlet Dimensions: A) 42" (ft.) B) ____ (ft.) C) ____ (ft.) D) ____ (ft.) ☐ Submerged

Inlet Water Depth (max depth inside the structure at the inlet): 3 Inches ☒ Measured ☐ Estimated

Inlet Drop ☒ None, or if present ____ Inches ☐ Measured ☐ Estimated

Outlet Structure Type (from above): ☐ **1.** ☐ **2.** ☐ **3.** ☐ **4.** ☒ **5.** ☐ **6.** ☐ **7.** ☐ **8.** ☐ **9.** ☐ **Ford**

Outlet Dimensions: A) 42" (ft.) B) ____ (ft.) C) ____ (ft.) D) ____ (ft.) ☐ Submerged

Outlet Water Depth (max depth inside the structure at the outlet): 5 Inches ☒ Measured ☐ Estimated

Outlet Drop

- **a. Culvert bottom to water surface** ☒ None, or if present ____ Inches ☐ Measured ☐ Estimated
- **b. Culvert bottom to stream bed** ☒ None, or if present ____ Inches ☐ Measured ☐ Estimated
- **c. With an outlet drop, check one:** ☐ Cascade ☐ Freefall ☐ Freefall onto cascade ☒ No drop

Armored streambed at outlet? ☐ Extensive ☐ Not extensive ☒ None

Comments washed out in 1944

APPENDIX D

Field Data Form for Old Farm Road Dam

American Brook Lamprey in all W. Tis. Brooks

5/12/2012

Data entry by AW	Date 8/4/12
Reviewed by ____	Date ____

Field Data Form: Road-Stream Crossing Inventory

Coordinator ____ **Crossing ID#** ____

Stream/River: Mill Brook **Road:** Private Sheriff's meadow **Town:** W Tisbury

Flow condition: ☐ Unusually low ☒ Typical low-flow ☐ Average flow ☐ Higher than average

GPS Coordinates (lat/long):

☐ Decimal degrees N__ __ . __ __ __ __ __ W__ __ . __ __ __ __ __

OR ☒ Degrees, minutes, seconds North: D 41° M 23.662 S ____

West: D 70° M 42.522 S ____

Date: 8/6/11 **Location:** ____ **Observer:** ____

Photo IDs: #11-15 u/s face from impoundment, u/s from culvert, view of outlet, view d/s (1), view d/s (2)

Road/Railway Characteristics

Road surface: ☐ Paved ☒ Unpaved ☐ Railroad

Road type: ☒ 1-Lane road ☐ 2-Lane road ☐ Multilane road ☐ Divided highway ☐ Railroad ☐ Buried stream

Crossing/Stream Characteristics *(during generally low-flow conditions)*

Crossing type: ☐ Ford ☐ Bridge ☐ Open bottom arch ☐ Single culvert ☒ Multiple culverts (# 2)

☐ Removed ☐ No crossing

Condition of crossing: ☐ New ☒ Excellent ☐ Fair ☐ Poor

Does the stream at the crossing support fish? ☐ Yes ☐ Not likely ☐ Don't know

Is the stream flowing? ☒ Yes ☐ No

Crossing span: ☒ Severe constriction ☐ Mild constriction ☐ Spans bank to bank ☐ Spans channel & banks

Tailwater Scour pool: ☒ None ☐ Small (wider or deeper than stream) ☐ Large (width or depth 2X stream)

Crossing alignment matches stream? ☒ Yes (flow aligned) ☐ No (skewed)

Culvert/Bridge Cell Characteristics *(Culvert/cell #1; use page 3 for additional culverts or cells)*

Structure embedded? ☐ Not embedded ☒ Partially embedded ☐ Fully embedded ☐ No Bottom

Structure substrate: ☐ None (smooth) ☒ None (rough/corrugated) ☐ Inappropriate ☐ Contrasting ☐ Comparable

Internal features ☒ None ☐ Slip lined ☐ Baffles/Sills ☐ Weir(s) ☐ Support structures

Physical Barriers to fish and wildlife passage: ☒ Severe ☐ Moderate ☐ Minor ☐ None

Describe any barriers: Drop + Cascade on D/s end

Is there a clear line of sight through the structure? ☒ Yes ☐ No

Does the structure provide dry passage suitable for use by terrestrial wildlife? ☐ Yes ☒ No

If yes, what is the maximum structure height in the portion that offers dry passage? NA Feet

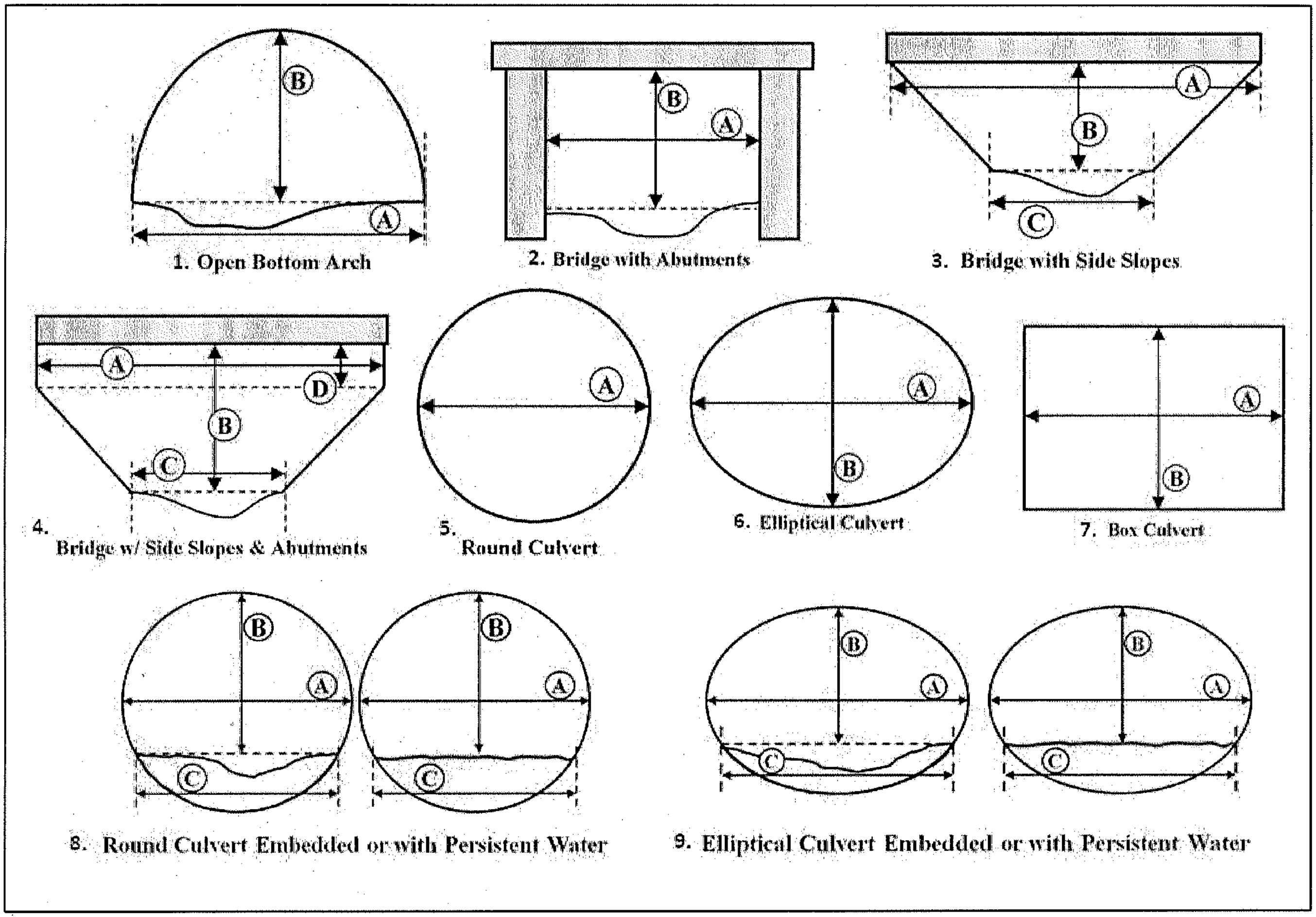
Comments Crossing is outlet of a Dam

For the following questions use as a reference a portion of the natural stream channel that is outside the influence of the crossing structure and not otherwise altered.

Water depth matches stream? ☐ Yes (comparable) ☐ No (deeper) ☒ No (shallower) ☐ Dry

Water velocity matches stream? ☒ Yes (comparable) ☐ No (slower) ☐ No (faster) ☐ Dry

Crossing Slope matches stream? ☐ Yes (comparable) ☒ No (flatter) ☐ No (steeper)



Length of stream through crossing: 20' Feet

Inlet Structure Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐ 6. ☐ 7. ☒ 8. ☐ 9. ☐ Ford

Inlet Dimensions: A) 12" (ft.) B) 1" (ft.) C) 0 (ft.) D) ____ (ft.) ☐ Submerged

Inlet Water Depth (max depth inside the structure at the inlet): 11 Inches ☒ Measured ☐ Estimated

Inlet Drop ☒ None, or if present ____ Inches ☐ Measured ☐ Estimated

Outlet Structure Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐ 6. ☐ 7. ☒ 8. ☐ 9. ☐ Ford

Outlet Dimensions: A) 12" (ft.) B) 11" (ft.) C) 1" (ft.) D) ____ (ft.) ☐ Submerged

Outlet Water Depth (max depth inside the structure at the outlet): 1 Inches ☒ Measured ☐ Estimated

Outlet Drop

- **a. Culvert bottom to water surface** ☐ None, or if present 7 Inches ☒ Measured ☐ Estimated
- **b. Culvert bottom to stream bed** ☐ None, or if present 9 Inches ☒ Measured ☐ Estimated
- **c. With an outlet drop, check one:** ☐ Cascade ☐ Freefall ☒ Freefall onto cascade ☐ No drop

Armored streambed at outlet? ☒ Extensive ☐ Not extensive ☐ None

Comments ____

____

____

STRUCTURE WORKSHEET FOR MULTIPLE CULVERT OR BRIDGE CELL CROSSINGS **Crossing ID#** ______

Note: *When inventorying multiple culverts or bridge cells, label left culvert/cell #1 and go in increasing order from left to right from downstream end (outlet) looking upstream.*

Culvert or Bridge Cell # Riv L

Culvert/Bridge Cell Characteristics

Structure embedded? ☐ Not embedded ☒ Partially embedded ☐ Fully embedded ☐ No Bottom

Structure substrate: ☐ None (smooth) ☒ None (rough/corrugated) ☐ Inappropriate ☐ Contrasting ☐ Comparable

Internal features ☒ None ☐ Slip lined ☐ Baffles/Sills ☐ Weir(s) ☐ Support structures

Physical Barriers to fish and wildlife passage: ☒ Severe ☐ Moderate ☐ Minor ☐ None

Describe any barriers: Drop + Cascade

Is there a clear line of sight through the structure? ☒ Yes ☐ No

Does the structure provide dry passage suitable for use by terrestrial wildlife? ☐ Yes ☒ No

If yes, what is the maximum structure height in the portion that offers dry passage? NA Feet

Comments ______

______

For the following questions use as a reference a portion of the natural stream channel that is outside the influence of the crossing structure and not otherwise altered.

Water depth matches stream? ☐ Yes (comparable) ☐ No (deeper) ☒ No (shallower) ☐ Dry

Water velocity matches stream? ☒ Yes (comparable) ☐ No (slower) ☐ No (faster) ☐ Dry

Crossing Slope matches stream? ☐ Yes (comparable) ☒ No (flatter) ☐ No (steeper)

Length of stream through crossing: 20' Feet

Inlet Structure Type: ☐ **1.** ☐ **2.** ☐ **3.** ☐ **4.** ☐ **5.** ☐ **6.** ☐ **7.** ☒ **8.** ☐ **9.** ☐ **Ford**

Inlet Dimensions: A) 12" (ft.) B) 1" (ft.) C) 0 (ft.) D) ______ (ft.) ☐ Submerged

Inlet Water Depth (max depth inside the structure at the inlet): 11" Inches ☐ Measured ☐ Estimated

Inlet Drop ☒ None, or if present ____ Inches ☐ Measured ☐ Estimated

Outlet Structure Type: ☐ **1.** ☐ **2.** ☐ **3.** ☐ **4.** ☐ **5.** ☐ **6.** ☐ **7.** ☒ **8.** ☐ **9.** ☐ **Ford**

Outlet Dimensions: A) 12 (ft.) B) 1" (ft.) C) 1" (ft.) D) ______ (ft.) ☐ Submerged

Outlet Water Depth (max depth inside the structure at the outlet): 1 Inches ☐ Measured ☐ Estimated

Outlet Drop

a. Culvert bottom to water surface ☐ None, or if present 7 Inches ☐ Measured ☐ Estimated

b. Culvert bottom to stream bed ☐ None, or if present 9 Inches ☐ Measured ☐ Estimated

c. With an outlet drop, check one: ☐ Cascade ☐ Freefall ☒ Freefall onto cascade ☐ No drop

Armored streambed at outlet? ☒ Extensive ☐ Not extensive ☐ None

APPENDIX E

Field Data Form for
Tiah's Cove Road Culvert

* Scottwaly La Swales - good idea.

5/12/2012

Data entry by NW Date 8/6/12
Reviewed by ________ Date ________

Field Data Form: Road-Stream Crossing Inventory

Coordinator UNT to Tiahs Cove **Crossing ID#** ________
Stream/River: ~~Tiasquam Riv~~ **Road:** Tiahs Cove Rd. **Town:** W. Tisbury
Flow condition: ☐ Unusually low [x] Typical low-flow ☐ Average flow ☐ Higher than average

GPS Coordinates (lat/long):

☐ Decimal degrees N__ __ . __ __ __ __ __ W__ __ . __ __ __ __ __

OR [x] Degrees, minutes, seconds North: D 41° M 22.482 S ______
West: D 70° M 38.988 S ______

Date: 8/6/12 **Location:** ____________ **Observer:** ____________

Photo IDs: #16-21 view of d/s face (1), (2), view d/s, u/s face, Tiahs Cove looking u/s

Road/Railway Characteristics

Road surface: [x] Paved ☐ Unpaved ☐ Railroad

Road type: ☐ 1-Lane road [x] 2-Lane road ☐ Multilane road ☐ Divided highway ☐ Railroad ☐ Buried stream

Crossing/Stream Characteristics *(during generally low-flow conditions)*

Crossing type: ☐ Ford ☐ Bridge ☐ Open bottom arch [x] Single culvert ☐ Multiple culverts (# _____)
☐ Removed ☐ No crossing

Condition of crossing: ☐ New ☐ Excellent [x] Fair ☐ Poor

Does the stream at the crossing support fish? [x] Yes ☐ Not likely ☐ Don't know

Is the stream flowing? [x] Yes ☐ No

Crossing span: ☐ Severe constriction [x] Mild constriction ☐ Spans bank to bank ☐ Spans channel & banks

Tailwater Scour pool: ☐ None [x] Small (wider or deeper than stream) ☐ Large (width or depth 2X stream)

Crossing alignment matches stream? [x] Yes (flow aligned) ☐ No (skewed)

Culvert/Bridge Cell Characteristics *(Culvert/cell #1; use page 3 for additional culverts or cells)*

Structure embedded? [x] Not embedded ☐ Partially embedded ☐ Fully embedded ☐ No Bottom

Structure substrate: ☐ None (smooth) [x] None (rough/corrugated) ☐ Inappropriate ☐ Contrasting ☐ Comparable

Internal features [x] None ☐ Slip lined ☐ Baffles/Sills ☐ Weir(s) ☐ Support structures

Physical Barriers to fish and wildlife passage: ☐ Severe [x] Moderate ☐ Minor ☐ None

Describe any barriers: Likely velocity barrier

Is there a clear line of sight through the structure? [x] Yes ☐ No

Does the structure provide dry passage suitable for use by terrestrial wildlife? ☐ Yes [x] No

If yes, what is the maximum structure height in the portion that offers dry passage? N/A Feet

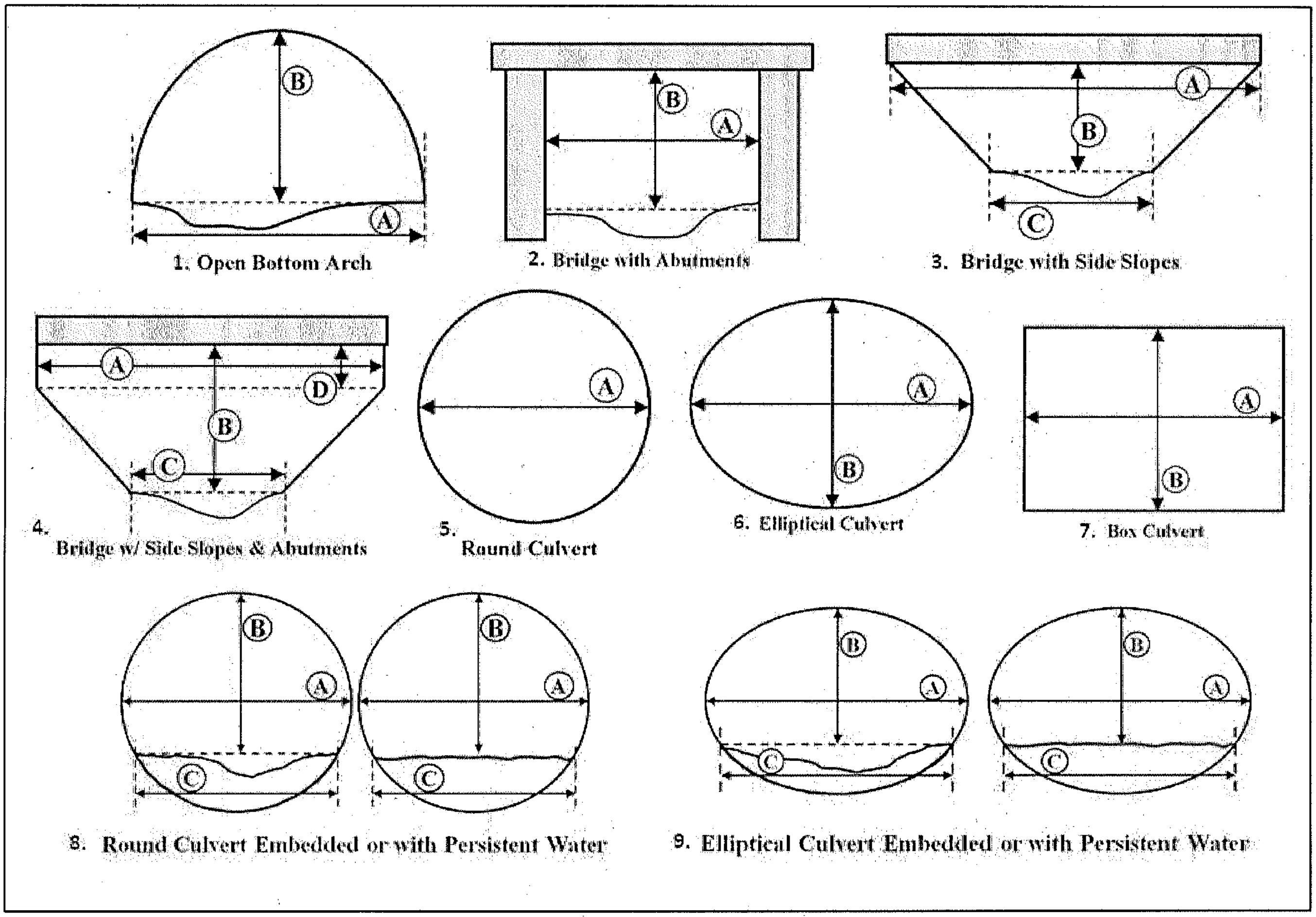
Comments ________________________________

For the following questions use as a reference a portion of the natural stream channel that is outside the influence of the crossing structure and not otherwise altered.

Water depth matches stream? [x] Yes (comparable) ☐ No (deeper) ☐ No (shallower) ☐ Dry

Water velocity matches stream? [x] Yes (comparable) ☐ No (slower) ☐ No (faster) ☐ Dry

Crossing Slope matches stream? [x] Yes (comparable) ☐ No (flatter) ☐ No (steeper)



1. Open Bottom Arch
2. Bridge with Abutments
3. Bridge with Side Slopes
4. Bridge w/ Side Slopes & Abutments
5. Round Culvert
6. Elliptical Culvert
7. Box Culvert
8. Round Culvert Embedded or with Persistent Water
9. Elliptical Culvert Embedded or with Persistent Water

Length of stream through crossing: 30 Feet

Inlet Structure Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☒ 5. ☐ 6. ☐ 7. ☐ 8. ☐ 9. ☐ Ford

Inlet Dimensions: A) ~~28~~ 18" (ft.) B) ______ (ft.) C) ______ (ft.) D) ______ (ft.) ☐ Submerged

Inlet Water Depth (max depth inside the structure at the inlet): 48 Inches ☒ Measured ☐ Estimated

Inlet Drop ☒ None, or if present ____ Inches ☐ Measured ☐ Estimated

Outlet Structure Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐ 6. ☐ 7. ☐ 8. ☐ 9. ☐ Ford

Outlet Dimensions: A) 28" (ft.) B) ______ (ft.) C) ______ (ft.) D) ______ (ft.) ☐ Submerged

Outlet Water Depth (max depth inside the structure at the outlet): 8" Inches ☐ Measured ☐ Estimated

Outlet Drop

a. Culvert bottom to water surface ☒ None, or if present ____ Inches ☐ Measured ☐ Estimated

b. Culvert bottom to stream bed ☒ None, or if present ____ Inches ☐ Measured ☐ Estimated

c. With an outlet drop, check one: ☐ Cascade ☐ Freefall ☐ Freefall onto cascade ☒ No drop

Armored streambed at outlet? ☐ Extensive ☐ Not extensive ☒ None

Comments Bankfull ~6' D/S U/S of inlet pool not accessible for wquant
Phone line (?) on LB culvert wall!
Left half of u/s head wall detached and partially blocking flow