DFW GS 24-01

New York State Department of Environmental Conservation

Division of Fish and Wildlife Technical Guidance

Issuing Authority: Jacqueline Lendrum Director, Division of Fish and Wildlife Signature:_____________________	**Title:** Draft Guidance for the Review of Bridge and Culvert Projects in Nontidal Waters Requiring a Protection of Waters Permit and a Water Quality Certificate
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***** N O T I C E *****

This document has been developed to provide Department staff with guidance on how to ensure compliance with the statutory and regulatory requirements, including case law and administrative interpretations, and to provide consistent treatment of similar situations. This document will also inform the public and provide insight on the Department's technical considerations of particular facts and circumstances. This guidance document is not a fixed rule under the State Administrative Procedures Act subsection 102(2)(a)(I). Furthermore, nothing set forth herein prevents staff from varying from this guidance as the specific facts and circumstances may dictate, provided staff's actions comply with applicable statutory and regulatory requirements. This document does not create any enforceable rights for the benefit of any party.

I. Purpose: This guidance provides an overview of design requirements, guidelines, and other considerations used by the New York State Department of Environmental Conservation (NYSDEC or "the Department"), Division of Fish and Wildlife (DFW) during the review of stream crossing (bridge and culvert) projects requiring a permit from NYSDEC. As described in greater detail below this guidance is intended to clarify NYSDEC's established stream crossing guidelines for fish and wildlife passage; to incorporate climate change considerations into issuance of NYSDEC permits as required by recent state legislation and policy; to clarify permit issuance standards used by staff;

and to promote and encourage statewide consistency and efficiency among Department staff and the regulated community.

II. Regulatory Authority:

The following statutes and policies are applicable to stream crossing projects in New York State and are those most commonly considered by NYSDEC when reviewing project proposals and permit applications. These statutes and policies pertain to the protection of streams and other waterbodies as well as requirements to consider climate change during project permitting. This guidance brings together various stream crossing requirements and other considerations consistent with these statutes and policies.

1. Protection of Streams and Other Waterbodies

Protection of Waters permits and Water Quality Certificates (WQC) are issued under the authority of New York State Environmental Conservation Law (ECL) Article 15 and the implementing regulations under Title 6 of the Official Compilation of the New York Codes, Rules, and Regulations (NYCRR) Part 608. A permit from the NYSDEC is required for activities that involve the disturbance of protected streams, the placement or excavation of fill within navigable waters of New York State (NYS), or for projects requiring a WQC for the discharge of dredged or fill material into waters of the United States. The installation of new or replacement stream crossings (bridges and culverts) usually involves stream disturbance of some type or the placement of materials within the stream channel.[1] Routine maintenance and repairs can also involve activities that would require a permit under ECL Article 15. Exceptions to these permit requirements exist for local public corporations and state agencies (e.g., NYS Department of Transportation (NYSDOT)) that have a written memoranda of understanding with the Department and for specific emergency work and agricultural activities.[2] Whereas these local and state public entities do not always need a Protection of Waters permit, they must still meet permit issuance standards through a consultation process with NYSDEC. Further, this permit exemption does not apply more broadly to WQCs and public entities must ensure they are covered under either a blanket WQC or apply for an individual, project-specific WQC.

Stream crossing projects on non-jurisdictional waters may also require a permit from NYSDEC.[3] For example, bridge or culvert installation or maintenance that could result in the taking of an endangered or threatened species or its habitat will likely require an

[1] See 6 NYCRR § 608.1 for definitions pertaining to relevant NYSDEC jurisdictions, including “banks,” “bed” and “mean high water.”

[2] ECL § 15-0501 subdivisions 4, 5, 6, and 7.

[3] For the purposes of this guidance document, the phrase “non-jurisdictional waters” refers to streams that do not meet the definitions of “protected stream” or “navigable water” under 6 NYCRR § 608.1.

endangered species permit under 6 NYCRR Part 182.[4] Therefore, NYSDEC strongly encourages anyone planning a stream crossing project in NYS to consider a pre-application meeting with their regional NYSDEC permits office to discuss permitting requirements before beginning the project.

2. Climate Change Policy

In 2014, New York State enacted the Community Risk and Resiliency Act (CRRA). It is the policy of NYS, in accordance with CRRA, to consider sea-level rise, storm surge, and flooding in permit issuance decisions for some major projects under the Uniform Procedures Act (UPA), including ECL Article 15 Title 5. In 2019, the Climate Leadership and Community Protection Act (Climate Act) amended CRRA to promote adaptation and resilience, including actions for state agencies to assess reasonably foreseeable risks of climate change on any proposed projects and require mitigation measures. CRRA was also expanded to consider additional risks, such as tropical and extra-tropical cyclones, wind, changes in average and peak temperatures, changes in average and peak precipitation, public health impacts, and impacts on species and other natural resources. Additionally, CRRA was amended to require that future physical climate risk be considered in issuance of permits for major projects for programs subject to the UPA.[5] The Department may require mitigation of significant risk to public infrastructure and services, private property, natural resources, and disadvantaged communities.[6] In 2020, pursuant to CRRA, the Department released its approved guidance documents for consideration of flood risk in permit decisions. [7]

In December 2022, the Department issued Revised Commissioner's Policy-49 (CP-49), Climate Change and DEC Action.[8] CP-49 directs the Department to incorporate climate change considerations and adaptation strategies into aspects of its decisions and actions in which climate or weather is a relevant factor, and to comply with the requirements of the Climate Act and CRRA. Programs are required to identify climate hazards and vulnerabilities in regulatory and funding programs by reviewing and amending, as necessary, regulations, policies, and guidance documents to ensure climate risks are adequately considered. To fulfill the combined requirements of CRRA, the Climate Act,

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[4] See ECL § 11-0103 and 6 NYCRR § 182.2.
[5] ECL § 70-0107(3).
[6] ECL §75-0101(5).; Climate Justice Working Group (CJWG) Draft Disadvantaged Communities Criteria is available at: https://climate.ny.gov/resources/disadvantaged-communities-criteria/. The CJWG is expected to vote on final criteria in February 2023
[7] CRRA Flood Risk Management, Natural Measures, Estimating Guidelines for Elevation, and Smart Growth, available at: https://dec.ny.gov/environmental-protection/climate-change/new-york-response/crra.
[8] Revised CP-49, Climate Change and DEC Action, December 14, 2022.
https://www.dec.ny.gov/docs/administration_pdf/cp492022.pdf

and CP-49, this guidance applies to all road-stream crossings regardless of UPA major or minor designations.

III. Responsibility: To be permitted under ECL Article 15, any proposed project must be evaluated by NYSDEC using permit issuance standards described in 6 NYCRR § 608.8. Additionally, NYSDEC must follow an application review process to determine whether a permit can be issued based on such considerations as the environmental impacts of the proposed project, adequacy of design, and current natural resource management objectives.[9] DFW ensures that permittees adhere to the requirements of ECL Article 15 through review of designs and other permit application materials submitted to the NYSDEC's Regional Division of Environmental Permits (DEP) Regional Permit Administrator. DEP also coordinates review of projects requiring federal permits with the U.S. Army Corps of Engineers (USACE) as part of the joint application review process.[10]

IV. General

Definitions, Applicability, and Limitations

1. Definitions

Banks – That land area immediately adjacent to, and which slopes toward, the bed of a watercourse, and which is necessary to maintain the integrity of a watercourse. For purposes of this guidance, a bank will not be considered to extend more than 50 feet horizontally from the mean highwater line; with the following exception: where a generally uniform slope of 45 degrees (100 percent) or greater adjoins the bed of the watercourse, the bank is extended to the crest of the slope or the first definable break in slope, either a natural or constructed (i.e., road or railroad grade) feature, lying generally parallel to the watercourse.

Bankfull – The elevation of a streambank, or the width between the same elevation of both banks, that connects the stream channel with its floodplain, where water that has filled the channel would begin to spill onto the floodplain. This elevation usually corresponds with an abrupt change in slope.

Bridge – A structure constructed over a stream, river or other depression that carries a road or other crossing (e.g., railway, driveway) from one side to the other. Bridges are most often distinguished from culverts in that bridges utilize a deck, and do not require additional substrate or fill material placed between the structure and the road. For the purposes of this document and for consistency with other New York State guidance, some

[9] See 6 NYCRR § 608.7 for additional explanation of NYSDEC's permit application review process and the issues that must be considered.

[10] NYSDEC environmental permits forms and requirements, including the Joint Application Form and instructions, are found at: https://dec.ny.gov/regulatory/permits-licenses/environmental-permits/forms-requirements.

design standards and recommendations are based on internal structure width or distance between abutments.[11] Generally, standards for bridges apply to structures spanning at least 20 feet.

Critical Transportation Infrastructure – Infrastructure, including roadways, bridges, and culverts, that provides primary access to a critical facility (e.g., designated emergency shelter, police, hospital, firehouse, ambulance, wastewater treatment plant, water treatment facility, power generation facility, schools, communication centers) or is part of a designated evacuation route. Hereafter critical transportation infrastructure may be more specifically referred to as “critical roadway”, “critical bridge”, or “critical culvert”.

Critical Facilities – Systems, facilities, and assets so vital that if destroyed or incapacitated it would disrupt the security, economy, health, safety, or welfare of the public.

Culvert – A structure that carries water below a roadway or other crossing type (e.g., railway, driveway) and usually requires the addition of fill material between the structure and the road. Culverts can vary in shape and may be constructed from various materials including metal, plastic, and concrete. For the purposes of this document and for consistency with other New York State guidance, some design standards and recommendations are based on internal structure width or distance between abutments. Generally, standards for culverts apply to structures spanning less than 20 feet.

Freeboard (bridge) – Vertical distance, usually expressed in feet, between the design flood elevation and the lowest chord of the bridge. See *New York State Flood Risk Management Guidance*.

Freeboard (roadway) – Vertical distance, usually expressed in feet, between the design flood elevation and the outside edge of the roadway shoulder. See *New York State Flood Risk Management Guidance*.

High Risk Area – A location that is near improved property that has been subject to repetitive flooding, and current infrastructure directly contributes to this flooding situation; or a location within an area that has been identified as vulnerable through flood studies, within a FEMA Special Flood Hazard Area, or in NYSDOT’s statewide flooding vulnerability assessment; or provides primary ingress/egress for a community.

Hydraulic Sizing/Hydraulic Opening – The capacity of a structure to pass a certain flow, usually in cubic feet per second (cfs).

[11] Note that NYSDOT includes some large (>20 ft) culverts, including multiple culvert pipe configurations, within their definition of “bridge” and readers of this Guidance should be aware of any implications of that definition.

Hydrologic – Refers more broadly to considerations of local hydrology that are factored into stream crossing design(s).

Mean High Water - Approximate average high-water level for a given body of water at a given location that distinguishes between predominantly aquatic and predominantly terrestrial habitat. (See 6 NYCRR § 608.1 for the full regulatory definition.)

Navigable Water - All lakes, rivers, streams and other bodies of water in the State that are navigable in fact or upon which vessels with a capacity of one or more persons can be operated notwithstanding interruptions to navigation by artificial structures, shallows, rapids or other obstructions, or by seasonal variations in capacity to support navigation. Navigable waters do not include waters that are surrounded by land held in single private ownership at every point in their total area. (See also 6 NYCRR § 608.1.)

Pressure Flow – Water pressure created by a structure filling at the inlet at or near the point of submersion. This situation is sometimes referred to as the structure being in “inlet control.”

Protected Stream - Any stream or particular portion of a stream for which the Department or any of its predecessors has adopted any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t), or C(t). Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Any continuous flowing natural stream that is not shown on reference maps shall have the same classification and assigned standards as the waters to which it is directly tributary. (See also 6 NYCRR § 608.1 and 6 NYCRR § 800 through § 941.)

Streambed/Active Channel – The land area of a watercourse covered by water at mean high water.

2. Applicability and Limitations

The hydraulic sizing of bridges and culverts is well established, and many current design guidelines also incorporate geomorphic principles to both naturalize stream crossings and make them less prone to flood damages and erosion. The sizing of bridges and culverts (herein after, “structures”) cannot rely solely upon designing to a set flow interval. To best protect against flooding risks and to preserve ecological quality, structure design must incorporate consideration of the stream type and important stream functions including sediment and debris transport, water velocities and depths, and aquatic organism and wildlife passage. Structures commonly fail when stream functions are not considered, and problems arise from geomorphic incompatibility, resulting in stream instability/erosion and clogging with sediment and debris.

V. Pre-design Considerations

The ideal stream crossing is often described using terms such as “optimized” or “right-sized”. In general, these terms refer to crossings that are designed and constructed to minimize any interaction with the stream channel being crossed or by recreating the natural stream channel dimensions within the crossing along with seamless reconnection to the upstream and downstream channel. To accomplish this, stream crossing projects should account for; the characteristics or “geomorphology” of the stream being crossed; the various flows or hydrology of the stream being crossed; and any current or future infrastructure considerations. These three categories are described in greater detail below as they may relate to stream crossing projects.

1. Natural Resources - Geomorphic Considerations

A structure designed to incorporate geomorphic considerations will support several important stream functions including fish and wildlife passage, sediment transport that allows naturalizing streambed morphological processes to continue downstream, stabilizing channel bed and habitat features, and providing for overbank flows near crossings.

The principle behind the geomorphic design approach is to optimize structure size, shape, and placement so that the stream channel form and processes can function more naturally. Structures that are properly embedded or use a natural stream bottom and are sized at the active channel width or larger are (1) able to convey more water, sediment, debris, and ice; (2) less prone to clogging; (3) less prone to scour and erosion; (4) more compatible with a stable channel; and (5) allow for the free movement of fish and wildlife through the structure. Conversely unembedded structures and those that do not span the active streambed channel width are prone to causing flood and erosion damage since they tend to create backwater flows, clog with accumulated materials, and increase exit velocities.

When properly installed, bridges and culverts spanning the stream’s entire bankfull width allow for small lateral and vertical stream adjustments, especially in high-gradient channels. Bankfull-spanning structures are less prone to non-uniform flow paths that lead to ponding, accumulation of wood and other debris, and structure clogging. Structures spanning the bankfull width of the stream also support hydrologic conditions that are more likely to accommodate aquatic and terrestrial organism passage.

Structures must be designed with an understanding of the geomorphic channel type to achieve geomorphic compatibility. For example, structures in high-power erosive settings (i.e., high gradient, riffle-pool) may have higher risk of vertical erosion (i.e., channel incision or downcutting); whereas those on low-power depositional settings would be more prone to horizontal channel migration and avulsion. It is important that designs account for the geomorphic stream type, width, and anticipated changes in width, such as when threshold channels or wandering channels move from single thread to multi-thread during a flood event.

Channel type and valley setting can be used to estimate or model the sediment regime at the crossing site. Sediment accumulation is common at bridges and culverts that cause backwatering (i.e., ponding at the inlet). This can lead to scour around the structure inlet by skewing the stream's angle of approach. Sediment accumulation at the structure inlet is often associated with faster exit flows, which can cause scour pool formation at the outlet end. Outlet scour pools tend to be associated with vertically offset streambeds or streambed disconnection, and when scour becomes severe the result is often a freefall onto a lower water surface. Vertically offset water surfaces at the structure outlet are referred to as either an outlet drop or "perched" culvert, a condition which disrupts aquatic connectivity and can even undermine the structure.

Proper structure design must account for the floodplain setting. For example, lower gradient channels with broad floodplains may benefit from much wider structures or flow relief culverts, whereas higher gradient channels with narrow floodplains may not see as much benefit from additional internal structure width. In other words, the flood-prone width and frequency of inundation are important to know to fine-tune the structure width to minimize flow constriction during floods.

Other, less obvious natural resource considerations include proper floodplain connection and riparian vegetation in the vicinity of the crossing. Roadways often interrupt floodplain connection, and some designs can even disconnect streams from their floodplain entirely (e.g., undersized structures combined with high roadway embankments). Similarly, stream crossings often interrupt vegetated riparian corridors, but greater impacts to streams occur when crossings are designed and maintained to be devoid of riparian vegetation on the upstream or downstream side of the crossing, usually to reduce maintenance or maintain lines of sight. Both practices can be detrimental to the stream's ecological functions, causing a disruption in the riparian corridor that prevents or inhibits terrestrial and semi-aquatic wildlife passage. Removal of woody vegetation can destabilize streambanks and lead to erosion. A lack of riparian vegetation can also eliminate shading, leading to higher-than-normal water temperatures and creating unfavorable conditions for native aquatic organisms such as trout. The cumulative effects of several crossings on a single stream can be significant. These impacts are exacerbated during higher temperatures including those associated with climate change.

The ability of fish and wildlife to pass freely through a stream crossing can be essential for their life history (biological requirements). Any structure that is restricting this movement can have negative impacts on the affected species' populations as well as the overall habitat. Structures often affect fish and wildlife passage when they cause an accumulation of debris, excessive flow velocities through the structure, and/or abrupt streambed elevation changes at the inlet or outlet. Additionally, a lack of substrate or adequate water depth within a structure can restrict aquatic organism passage for many species. Structure length can also influence fish and wildlife passage; therefore, road and shoulder widths should be the minimum necessary for the crossing while still meeting any design/safety standards. Often, side slopes can be reduced by using headwalls or the maximum steepness possible without compromising stability or safety to minimize the length of the culvert. In general, a side slope grade of 2:1 is typically the steepest grade that can be vegetated. In some cases, increasing steepness may lead to the need for guiderails or other safety measures which may add length to the culvert. Measuring and documenting a structure's impact on fish and wildlife passage can be done using the North Atlantic Aquatic Connectivity Collaborative (NAACC) assessment methodology.[12]

2. Resilience - Hydrologic Considerations

Bridges and culverts are usually designed and engineered to last a very long time, in many cases between 50 and 100 years and designs should account for the full range of flows that can be expected over the life of the structure. In addition to understanding both annual flows (e.g., spring high and summer low flows) and periodic flood events (e.g., 50-year, 100-year floods), design should also account for increasing frequency and higher volumes of extreme precipitation events and the likelihood of increased potential for flooding due to climate change. In New York State, flood flows are expected to increase by 10 to 20% or more over the next 65 to 85 years, and these adjustments must be factored into the design and construction of new bridges and culverts.[13] Adjusting for future conditions will help to ensure that siting and design sufficiently account for the effects of climate change and reduce future flooding risk while preserving ecological processes.

3. Bridge and Culvert Condition – Infrastructure Considerations

Bridge or culvert siting and design should anticipate potential future structure failures and maintenance. Structures that are designed with the aforementioned geomorphic and hydrologic considerations tend to perform much better over the long term, thereby reducing or eliminating premature repair and replacement costs.[14] Designs that do not consider the impact of the stream, stream functions, or future conditions on the structure itself are more likely to require maintenance for issues including deterioration (e.g.,

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[12] North Atlantic Aquatic Connectivity Collaborative webpage https://streamcontinuity.org/naacc.

[13] NYS Department of Environmental Conservation. 2020. New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act https://extapps.dec.ny.gov/docs/administration_pdf/crrafloodriskmgmtgdnc.pdf.

[14] Levine, J. 2013. An Economic Analysis of Improved Road-Stream Crossings. The Nature Conservancy. August 2013.

spalling, rusting), undermining, and footer scour. Properly designed structures also reduce or eliminate the need for ongoing stream intervention, including but not limited to debris removal and stream maintenance to address sediment aggradation and lateral erosion caused by ponding, outlet erosion and downcutting caused by increased exit velocities and altered sediment transport (i.e., sediment starving).

VI. Determining the Need for Rehabilitation, versus Replacement, of Existing Culverts and Bridges

The evaluation of existing culverts and bridges starts with an assessment of the needs or deficiencies at the crossing and whether to replace, versus rehabilitate, the structure. Project applicants should be encouraged to make this decision in consultation with NYSDEC. Consultations should not only consider cost and any site constraints but should also include discussions of natural resource impacts and benefits, geomorphic considerations, history of flooding, and geographic location. Keep in mind that some repair techniques may make matters worse by reducing internal structure dimensions, reducing flow capacity, or by adding new artificial structure bottoms or inverts that alter the streambed within the structure and cause disconnection from the adjoining streambed. Consulting early with NYSDEC will help to incorporate design requirements into the projects up front, avoiding the need for re-designs to meet permit issuance standards. Considering these complexities, permit issuance determinations must be made on a case-by-case basis.

If rehabilitation of an existing culvert or bridge can meet or exceed all the specific design requirements in Section VII of this guidance and is not in a “High Risk Area” or “Critical Transportation Infrastructure” as described further below, rehabilitation will usually meet issuance standards and can be authorized.

VII. Design Requirements for All New and Replacement Culverts and Bridges

This section describes the minimum design requirements for any new or replacement culvert or bridge. Later sections will describe situations necessitating more stringent (i.e., for “critical” bridges and culverts) or less stringent (special considerations) design requirements. A summary checklist highlighting many of these requirements is also provided in Appendix A.

1. Structure Type

Structures with natural streambeds and continuous streambanks are preferred in almost all instances. When selecting structure type, a number of options can be considered provided they are properly designed to minimize negative impacts on fish and wildlife and accommodate design flows. Structure types are listed in order of preference below:

1. Bridges and open-bottom box structures
2. Open-bottom arches
3. Four-sided box structures, arches with flat bottom (i.e., embedded floor)
4. Elliptical/squashed culverts
5. Round culvert pipes

Multiple (stacked or parallel) culverts should not be used to achieve sizing requirements. The addition of flow relief culverts set above the streambed elevation and outside of the active channel can be considered on a case-by-case basis.

2. Placement and Alignment

Wherever possible, the stream should be flow-aligned, meaning the location of the stream crossing is located on a relatively straight section of stream channel that is naturally perpendicular to the road. Avoid placing crossings at channel meanders, near the confluence with another stream or drainage, or where the stream channel would run closely parallel to a road before crossing below. Similarly, avoid creating an artificial stream meander or skew to accommodate a perpendicular stream crossing. In these cases, it is usually better to allow the stream to remain flow-aligned with a non-perpendicular crossing.

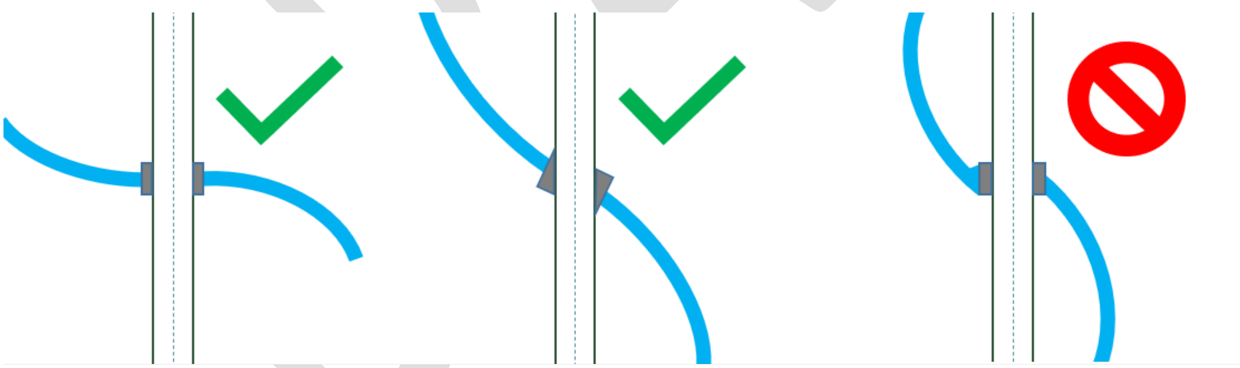

Figure 1: Examples of flow aligned (left and middle) and non-flow aligned (right) crossings.

For replacements, always consider whether the new structure placement or alignment can be improved to better accommodate the stream. Adjustments in placement can help account for the lateral stream adjustments that have occurred while the previous structure was in service. It is also important to assess the potential for future channel migration, also called the lateral adjustment potential (LAP), before deciding on final structure placement.[15]

3. Structure Width

Streambed / Active Channel – Determining the width of a stream crossing should be based on an internal structure width that will accommodate a minimum of 1.25 times (1.25x) the streambed or active channel width (figure 2). The streambed or active channel width is measured at the stream's mean high-water elevation, usually distinguishable by the edge of dense, terrestrial rooted vegetation[16] and the physical characteristics of an average high-water elevation (e.g., clear natural line at the top of scour, sediment, debris). The mean high-water level is generally the same, and may be expressed, as the ordinary highwater mark (OHW or OHWM) on Joint Application Forms for federal permits.

A structure designed to accommodate 1.25x the width of the streambed should contain a defined channel, including stream banks, within the structure such that water depths remain consistent with those of the upstream and downstream channel it is connecting. Stabilizing vegetation is difficult to maintain within stream crossing structures, therefore, properly sized material that will resist anticipated flows should be used, and then infilled with smaller material, such that stream bank dimensions are carried through the structure. Uniform streambanks throughout the structure are generally acceptable; however, use of the United States Forest Service's (USFS) Stream Simulation methodology[17] should be encouraged, such that the features of the reference reach (e.g., bank variations, pools, riffles, steps) are mimicked within the structure. In cases where the streambed or active channel width measurement is less than bankfull width, the 1.25x multiplier will usually allow the crossing to carry the full bankfull channel dimensions within the internal structure width (figure 2).

Bankfull - The bankfull width or bankfull stage of a stream corresponds with the elevation at which one or both banks connect to its floodplain. This generally occurs at the 1.5 to 2-year flood recurrence interval. The most reliable field indicator of bankfull elevation is an obvious and abrupt transition in slope from bank to floodplain. This transition may not always be obvious in the field, so supporting field indicators are used, including the tops of point bars and bank undercuts, changes in bank material (e.g., transition from large rocks to finer particle sizes) and change in vegetation (usually the low limit of woody vegetation).

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[15] Lateral Adjustment Potential is more thoroughly described in U.S. Forest Service. 2008. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings.

[16] Field indicators for mean high-water level should be clear. Transient annual plants and water tolerant plants are common below mean high-water level and should not be used to lower mean high-water level determinations.

[17] U.S. Forest Service. 2008. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings

Any structure designed to span the bankfull width should contain a defined channel, including stream banks, within the structure, such that water depths remain consistent with those of the upstream and downstream channel it is connecting. To account for bankfull channel dimensions, new and replacement bridges should be designed at a vertical elevation that is above bankfull height (see Section 7 for freeboard requirements) and with angled banks or vertical abutments beyond bankfull width, such that channel dimensions, including streambanks, are maintained within the structure. Critical bridges should be designed to span at least 1.5x streambed/active channel as described in section 7 below.

Methods for Determining Structure Width - Considering the structure width requirements described above, it is important to know how to determine the stream's width to calculate internal structure width. Measurements collected in the field are critical for determining appropriate channel width at the point of the crossing. Regression tables and computer modeling, including use of the online application StreamStats,[18] can be helpful for generating predicted channel dimensions (e.g., width and depth), but these values should be used in conjunction with field measurements. A calculated channel width from any computer model must be confirmed or adjusted using field measurements before permit issuance is recommended.

Field measurements should be collected on an identified reference reach that is a relatively undisturbed section of the same stream. In the case of a replacement structure, stream channel dimensions should be collected away from the influence of the structure being replaced. The goal of these measurements is to ensure proper stream geomorphology (i.e., channel width, depth and velocity) can be maintained throughout the new structure. For small streams, representative width measurements are often found upstream or downstream of the existing crossing at a distance of 10 to 20x the stream channel width. For example, measurements on a stream channel with an approximate width of five feet would be collected at least 50 feet upstream of the existing crossing. If possible, do not use measurements collected above tributaries to the stream being measured as determination of the correct channel dimensions at the point of the crossing must account for these additional sources of water. When measuring stream channel dimensions, taking the average of several measurements from different locations within the reference reach will help account for variability and increase accuracy and confidence.

[18] USGS StreamStats https://streamstats.usgs.gov/ss/.

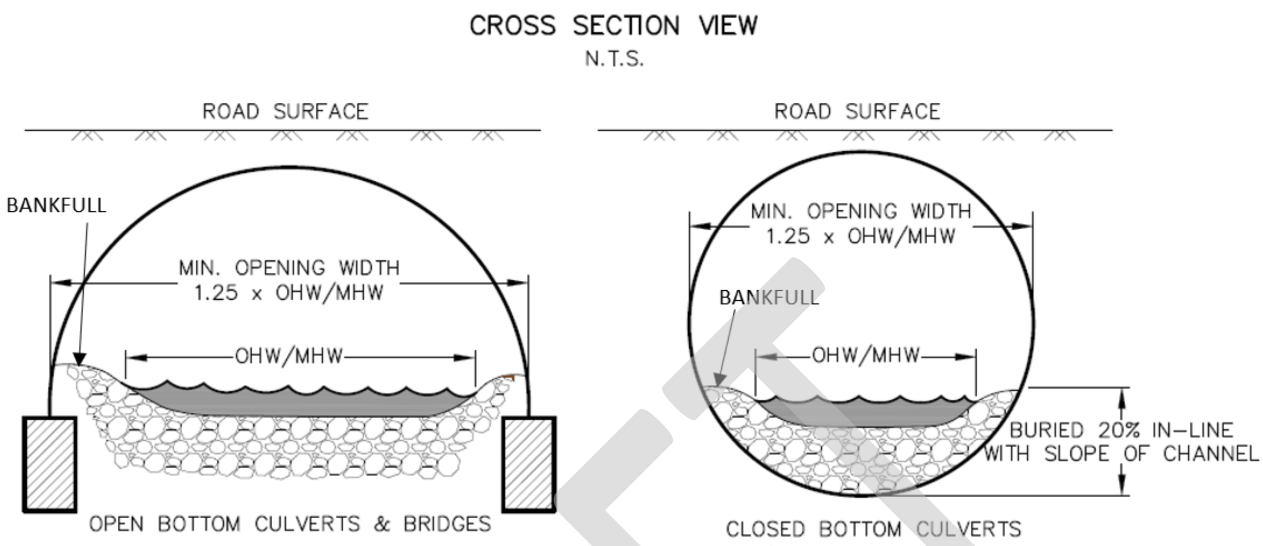

Figure 2: Example cross sections showing minimum internal structure width and embeddedness.

4. Embeddedness

Determining project-specific foundation depths for open bottom structures involves consideration of many factors that are beyond the scope of this Guidance.[19] It is important that designs communicate how foundation depths will be appropriate for the stream channel being crossed. For example, bridges and other open-bottom structures that cross stream channels should ensure the elevation(s) of footings are set in consideration of the potential for streambed scour and anticipated vertical movement of the streambed. One method for communicating appropriate design depths for scour is to include an estimate of the stream's vertical adjustment potential (VAP) at the point of the crossing. Estimating VAP is done using the streambed's longitudinal profile and then measuring the variations in bed elevation including scour pool depths throughout the stream reach being crossed. These variations are relative to the streambed slope over the same distance. Once the VAP has been established, the lower VAP line can be included on at least one drawing to indicate the structure depths relative to the lower VAP line, usually with an additional factor of safety.[20]

Structures with bottoms (e.g., elliptical and round pipes, four-sided box structures) must be embedded such that the streambed and channel within the structure matches the adjoining upstream and downstream channel in cross section to maintain water depth and flow velocity. Structure bottoms must be at least 20% embedded based on the

[19] Determining proper foundation depths is a complicated engineering task. This Guidance should not be used in place of appropriate engineering manuals including FHWA Publications HEC 18, HEC 20 and HEC 23.

[20] Vertical Adjustment Potential is more thoroughly described in U.S. Forest Service. 2008. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings.

structure's internal height at the downstream invert (figure 2). Deeper embedding may be needed where VAP estimates exceed 20% of the structure height. When site conditions prevent structure embedding, such as on bedrock, only open-bottom structures should be used. Exceptions to these criteria may be considered where it can be demonstrated that the new structure will maintain a natural stream bottom throughout in consideration of scour potential, sediment grain size, slope, and VAP. If internal sediment retention structures are proposed (e.g., sediment retention sills), those structures must be fully embedded during installation.

For replacement of an existing structure, do not assume the previous structure was properly embedded or set at an appropriate elevation. Also be mindful of the influences the previous structure may have had on streambed elevation(s). Except in extreme cases that are not conducive to elevation resetting, replacement structures must be designed to connect or reconnect upstream and downstream bed elevations, usually by embedding below the original stream profile. In-stream grade control should be considered in instances where streambed incision has occurred, or a downstream head cut has formed, and the original structure was controlling the streambed grade. In these cases, the design reach should extend to existing upstream and downstream grade control such as a rock riffle crests. In some cases, new streambed grade control such as a cross vane or rock riffle may be needed.

5. Slope

Structures with bottoms may be considered for horizontal placement or minor slopes less than 3%. Ensure that streambed slope within the structure matches natural channel slope and connects seamlessly with the adjoining upstream and downstream channel slopes. Bridges and open bottom structures should always be considered first where the natural channel slope exceeds 3%. Although less than ideal, consideration can be given to four-sided structures with built-in baffles or sills, which allow the structure to hold streambed substrate at slopes greater than 3%. In these instances, it is importance that the baffles are embedded during installation. New structures should never be installed with sills or baffles exposed to the water column if their purpose is solely to support culvert embedding.

6. Connectivity, Continuity, and Aquatic Organism Passage

Streams are important habitats and travel corridors for fish, as well as for many other aquatic, semi-aquatic, and terrestrial wildlife. The requirements described above are intended to minimize the negative impacts bridges and culverts can have on these organisms. In general, structures that meet all these requirements will ensure stream continuity is maintained and vital connections are not lost. Existing structures can be evaluated for their influence on stream connectivity using the standardized assessment methodology described by the North Atlantic Aquatic Connectivity Collaborative (NAACC).[21] An advantage of using NAACC is that once survey data are uploaded into the NAACC database, an Aquatic Organism Passage (AOP) score is automatically generated. This score can be used to quickly identify whether the structure is acting as a barrier and the severity of that barrier. The scoring criteria can then be compared to survey information to identify deficiencies to be corrected during project implementation. Examples of relevant survey data include the severity of stream constriction and the structure's outlet drop to the water surface. For replacement structures and structure repairs, it is a good idea to conduct "before" and "after" NAACC surveys to demonstrate that the work maintained or improved the AOP score.

7. Flood Flows and Water Surface Elevations[22]

Crossing designs must describe how the structure will accommodate design flows, including both low flows and flood flows. Structure widths are determined based on streambed width or bankfull width and may not always extend to the outer edge of inundation during a storm or flood (e.g., 50-year flood, 100-year flood). Bankfull flows should pass through a properly sized structure without narrowing or constriction of flow. Maximum design flows may narrow or constrict and usually require careful consideration of total structure capacity. Designs must ensure the structure opening can accommodate design flows (measured in cubic feet per second or cfs) by determining the inlet dimensions and cross-sectional area needed to pass peak flows while also considering the structure's influence on water surface elevation above the inlet.

Design Flows for New Bridge Projects – All new bridges and culverts with an internal opening greater than 20 feet should be designed to safely pass a flow that results from the 1% annual chance (100-year) flood event by gravity and without pressure flow. To account for projected increases in peak flows and flooding resulting from climate change, the calculated peak flows must account for the appropriate flow multiplier (110 or 120%) as described later in this section and depicted on Figure 3. Bridge design shall also provide sufficient bridge freeboard, not less than two feet, when passing flows from the 2% annual chance (50-year) flood event while accounting for the appropriate flow multiplier (for critical bridges see Section 8 below).

Design Flows for New Culvert Projects – New culvert pipes, four-sided boxes, and small bridges spanning less than 20 feet should be designed to safely pass a flow that results from increasing the 2% annual chance flow (50-year flood) by the specified flow multiplier (110 or 120%) (see Figure 3) by gravity and without pressure flow. Box and

[21] North Atlantic Aquatic Connectivity Collaborative https://streamcontinuity.org/naacc.

[22] Although tidal crossings are not the focus of this guidance, it should be noted that bridges and culverts in tidal areas should also be designed according to applicable coastal design criteria that incorporate a range of sea-level rise projections. See the NYS FRMG for additional details.

culvert pipe design shall also provide at least two feet of roadway freeboard above the 50-year flood elevation, and be able to pass the projected check flow (or 1% annual chance flow) without roadway overtopping. Again, flood flows must account for anticipated increases using the specified flow multiplier (110 or 120%).

Methods – Peak flow statistics are readily available for most of NYS from online sources including the StreamStats web application[23] or from FEMA Flood Insurance Studies (FIS) for structures in FEMA-designated Special Flood Hazard Areas. When using any reference, be sure to account for future increases in peak flows due to climate change by

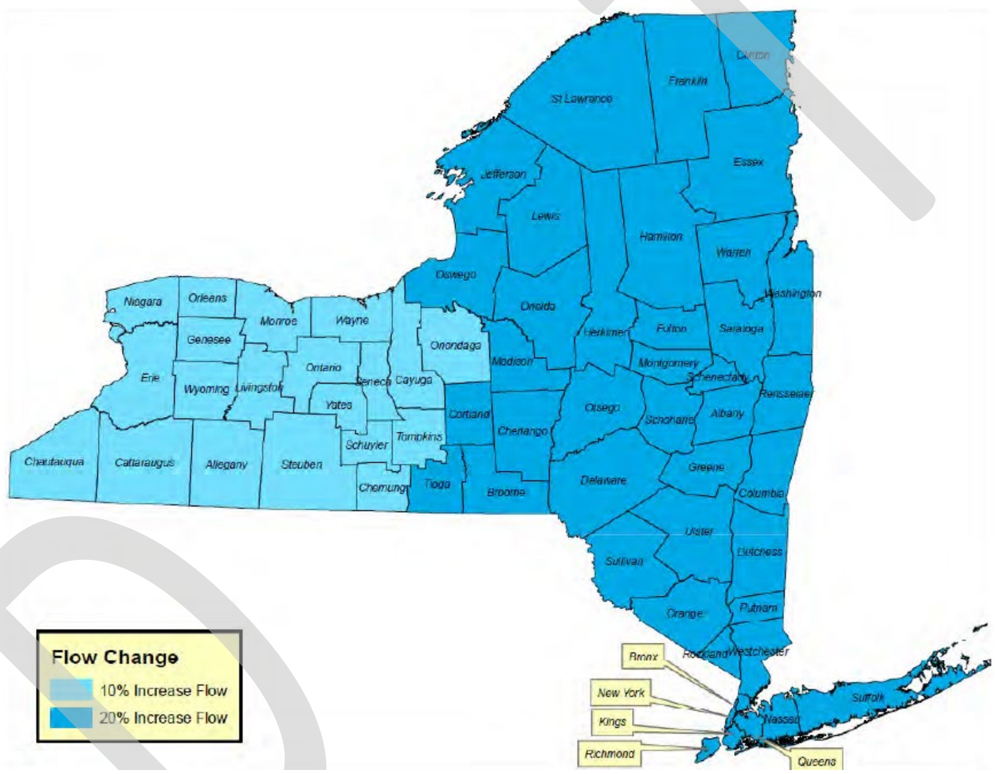

Figure 3:Design Flow Multipliers by County, taken from DEC Flood Risk Management Guidelines

applying the correct multiplier to account for predicted increases in flood flows (see figure 3).[24]

Sizing structures for desired design flows is done using some combination of reference tables, modeling the actual flood prone area above the structure and sizing the structure to accommodate flows, while also accounting for increased flood height caused by the structure narrowing flow. Remember also that structure embedding will reduce the cross-sectional area available to pass flows, and this reduced area must be used to determine

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[23] USGS StreamStats https://streamstats.usgs.gov/ss/.

[24] To determine the appropriate design flow multiplier, refer to NYS Department of Environmental Conservation. 2020. New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act.

structure size and minimum dimensions of the structure opening. For culverts on non-critical transportation infrastructure, sizing for flows is often done using the Federal Highway Administration's (FHWA) HY-8 Culvert Hydraulic Analysis Program, a free software available online.[25] Another helpful resource for estimating maximum flow through round and elliptical culvert pipes is the 2007 FHWA *Design for Fish Passage at Roadway-Stream Crossings* which includes a table (Table 7.3) with a range of pipe diameters and corresponding maximum flow in cfs.[26] In cases where designs are not engineer-stamped and the Department's evaluation of peak flow sizing is inconsistent with the submitted design, staff can offer to the applicant the option of submitting engineer-stamped plans that certify the proposed structure as capable of conveying the specific design flows.

Determination of structure size in consideration of flood flows must also include the potential for blockages. The potential input of large woody debris during a flood should be evaluated along the channel reach and watershed to determine if the structure is prone to clogging with debris. In these instances, the new design should evaluate the structure's flood capacity in a partially clogged condition (e.g., 25% to 50% blocked) in addition to clear flow. In northern climates, including New York State, ice can also clog structures. If past flood damages or overtopping have occurred due to clogging or are suspected due to a high probability of woody debris load during a flood, a number of considerations may be appropriate. For example, replacing multiple pipe configurations with a single opening may resolve clogging without increasing overall size or capacity. In most other cases, the bridge or culvert should be designed to fill to 80% of the opening height (i.e., headwater (Hw)/Depth (D) < 0.8) during clear flow to allow vertical space in the structure to pass sediment, woody debris, and ice. Post-flood evaluations of failed structures indicate that structures that were filled or overtopped during a flood were typically undersized or damaged due to debris accumulation and clogging.

Other design considerations include the geographic and geomorphic setting. For example, backwatering of a structure at the mouth of a stream entering a river or lake can reduce a structure's ability to pass flows. In these cases, backwater elevations should be a consideration to ensure that a properly sized structure is installed.

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[25] U.S. Department of Transportation, Federal Highway Administration, HY8 https://www.fhwa.dot.gov/engineering/hydraulics/software/hy8/.

[26] U.S. Department of Transportation, Publication No. FHWA-HIF-07-033, Design for Fish Passage at Roadway-Stream Crossings: Synthesis Report, 2007.

8. Requirements for Critical Bridges and Culverts[27]

A. Specific Design Requirements for New Critical Bridges – Critical and non-critical bridges have similar design requirements with two notable differences that may affect structure width, height, or cross-sectional area. As with non-critical bridges, critical bridges, as well as culverts with an internal opening greater than 20 feet, must be designed to safely pass the 1% annual chance flow (100-year flood), with the specified flow multiplier (110 or 120%) below the low chord of the bridge without going into pressure flow. However, critical bridge design must increase bridge freeboard to no less than three feet above flows from the 2% annual chance (50-year) flood event while accounting for the appropriate flow multiplier. Additionally, critical bridges should span a minimum of 1.5 times (1.5x) the active channel width.

B. Specific Design Requirements for New/Replacement Culverts on Critical Roadways – As with non-critical culvert projects, new culverts on critical roadways (culvert pipes, four-sided boxes, as well as small bridges spanning less than 20 feet) must be designed to safely pass a flow that results from increasing the 2% annual chance flow (50-year flood) by the specified flow multiplier (110 or 120%) without going into pressure flow. However, critical culvert design must increase roadway freeboard to no less than three feet, to pass the projected check flow without roadway overtopping. The projected check flow shall be the current 1% annual chance flow, increased by the specified flow multiplier (110 or 120%).

VIII. Special Considerations in Culvert and Bridge Sizing or Installation Geometrics

The minimum sizing and other design geometrics described in this guidance are generally applicable; however, unique situations should be evaluated on a case-by-case basis using special considerations such as those detailed below. Department staff may consider a best-fit alternative to account for these, and other, site-specific considerations.

<u>Conditions where a reduced internal structure width may be considered</u>

- Stream is confined or constrained by unmovable public infrastructure, and removal or relocation of such public infrastructure is not practicable.[28]

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[27] Although tidal crossings are not the focus of this guidance, it should be noted that critical bridges and culverts in tidal areas should also be designed according to applicable coastal design criteria that incorporate a range of sea-level rise projections. See the NYS FRMG for additional details.

[28] It is common practice for the New York State Department of Transportation and municipalities to acquire additional right of way to accommodate properly sized structures. This practice may include the acquisition, removal and relocation of buildings and other infrastructure with additional levels of review and justification. Under certain situations and circumstances, conditions may limit the ability to install a stream crossing that comports with these guidelines.

- Stream is confined or constrained by unmovable habitable structure(s), and removal or relocation of these structures is not practicable.
- Stream reach is functioning as a sediment transport reach due to pre-existing channelized conditions (i.e., moderately entrenched and having a steeper slope).
- Stream is confined or constrained by bedrock.
- Stream is on a low-gradient or similar situation where stream continuity will still be maintained and where flow relief culverts set above the streambed elevation and outside of the active channel are used.
- An alternative design approach has been evaluated and accepted by NYSDEC. For example, a full stream simulation assessment has been conducted and resulting design is consistent with USFS stream simulation methodology.

<u>Conditions where reduced embeddedness may be considered</u>

- Substantial consideration of aquatic organism passage (e.g., NAACC evaluation) provides assurance that new or repaired structure will allow organism passage without creating or worsening a barrier.
- Channel slope is less than 0.5%.
- Structure is under outlet control, or permanently backwatered.
- Sediment retention sills are not needed to keep bed in place.

<u>Conditions where a reduced design flow may be considered</u>

- The location has no history of flooding or damage.
- The location is not prone to deposition of bed material or structure clogging.
- There is no flooding risk to nearby infrastructure or resources.
- There has been an evaluation of acceptable levels of risk based on low traffic volume.[29]

IX. References

A. Law, Regulation, and Policy

<u>Environmental Conservation Law (ECL)</u>

- ECL Article 11 – Fish and Wildlife
- ECL Article 15 – Water Resources
- ECL Article 70 – Uniform Procedures
- ECL Article 75 – Climate Change

<u>Title 6 of the New York Codes, Rules and Regulations (NYCRR)</u>

[29] Cornell Local Roads Program, New York LTAP Center. (2009) *Highway Standards for Low-Volume Roads in New York State*. Ithaca, NY.

- 6 NYCRR Part 182 – Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern; Incidental Take Permits
- 6NYCRR Part 608 – Use and Protection of Waters

Policy - Department of Environmental Conservation (DEC)

- CP-49, Climate Change and DEC Action, revised December 14, 2022. https://extapps.dec.ny.gov/docs/administration_pdf/cp492022.pdf

General Permitting (DEC)

- NYSDEC General Permit for Stream Activities, GP-0-20-002 https://dec.ny.gov/regulatory/permits-licenses/general-permits/stream-activities-gp-0-20-002

B. Literature and Other References

Cornell Local Roads Program, New York LTAP Center. (2009) *Highway Standards for Low-Volume Roads in New York State*. Ithaca, NY.

Forest Service Stream Simulation Working Group. (August 2008). *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings*. San Dimas, CA: US Dept. of Agriculture.

Levine, J. (August 2013). *An Economic Analysis of Improved Road-Stream Crossings*. The Nature Conservancy.

New York State Department of Environmental Conservation. (August 2020). *New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act*. NYS DEC. https://www.dec.ny.gov/docs/administration_pdf/crrafloodriskmgmtgdnc.pdf

New York State Department of Environmental Conservation. *Community Risk and Resiliency Act (CRRA): Mainstreaming Considerations of Climate Change*. Webpage. https://dec.ny.gov/environmental-protection/climate-change/new-york-response/crra

New York State Department of Environmental Conservation. *Environmental Permits Forms and Requirements*. Webpage. https://dec.ny.gov/regulatory/permits-licenses/environmental-permits/forms-requirements

New York State Department of Environmental Conservation. *Stream Crossings: Protecting and Restoring Stream Continuity*. Webpage. https://dec.ny.gov/regulatory/permits-licenses/waterways-coastlines-wetlands/protection-of-waters-program/stream-crossings

New York State Department of Transportation. (2021). *Bridge Manual*. https://www.dot.ny.gov/divisions/engineering/structures/manuals/bridge-manual-usc

North Atlantic Aquatic Connectivity Collaborative. Webpage. https://streamcontinuity.org/naacc

Jackson, S., Abbot, A, (2019). *NAACC Stream Crossing Instruction Manual for Aquatic Passability Assessments in Non-tidal Stream and Rivers*. June 2, 2019. https://streamcontinuity.org/naacc/assessments/documents

U.S. Department of Transportation, Publication No. FHWA-HIF-07-033, *Design for Fish Passage at Roadway-Stream Crossings: Synthesis Report*, 2007.

U.S. Department of Transportation, Federal Highway Administration, *HY8 Software*. https://www.fhwa.dot.gov/engineering/hydraulics/software/hy8/

U.S. Geological Survey (USGS). *StreamStats Application*. https://streamstats.usgs.gov/ss/

Appendix A. Design Checklist

Design Checklist

- ✓ For structure replacements, the new structure type has been selected in consideration of site conditions and in accordance with structure preference list described in Section VIII 1. Structure Type**.**

- ✓ The stream crossing is aligned to accommodate the stream's natural flow path and accounts for any stream meandering. Alignment does not reduce the stream's hydraulic capacity.

- ✓ Structure internal width spans at least 1.25x the width of the streambed/active channel. Bridges are set above bankfull height such that abutments (if present) are outside of the bankfull channel. Critical bridges span at least 1.5x streambed/active channel.

- ✓ Proper stream geomorphology (i.e., channel width, depth, and velocity) will be maintained throughout the structure. These parameters can be measured from suitable reference cross sections within the riffle portion of the stream and checked using appropriate computer modeling or New York State's hydraulic geometry regression equations.

- ✓ Streambed material within the structure matches the natural stream channel
    - Structure has an open bottom, or
    - Structure with bottom is embedded at least 20% of the total internal height measured at the downstream invert.

- ✓ The stream crossing will retain sediment throughout its length and does not restrict natural sediment transport.

- ✓ Structure slope matches streambed slope and maintains uniform longitudinal transitions at the inlet and outlet.
    - Structures with bottoms, when used, are installed on less than 3% slopes.
    - Open bottom structures are used on streambed slopes greater than 3% and on non-embeddable surfaces (e.g., bedrock).

- ✓ The stream crossing will not result in hydraulic conditions that cause deposition (aggradation) or degradation (erosion, downcutting) of the stream channel at the structure itself or along the stream reach.

- ✓ Structure is designed and installed so that the natural stream flow is mimicked throughout the crossing and the structure does not constrict or fragment the stream.

- ✓ Replacement structures must not create a new inlet or outlet drop that restricts aquatic organism passage. Additional site modification (e.g., grade control or alignment) may be necessary to ensure the correct installation and long-term integrity of the structure.

- ✓ Design provides mathematical demonstration that culverts will pass 2% (50-year) chance peak flow, bridges will pass 1% (100-year) chance peak flow. Flows used in the design have been adjusted for future risk due to climate change (i.e., 10-20% multiplier) and bridge or roadway freeboard are accounted for in the design.

- ✓ Designs incorporate requirements for critical bridges and culverts where appropriate.

- ✓ The stream crossing will not cause backwatering at the inlet at annual and biennial high flows (1 and 2-yr flood events) and will accommodate the movement of anticipated woody debris and ice.

- ✓ Road and shoulder widths should be the minimum necessary for the crossing, and side slopes should be reduced using headwalls or as steep as possible without compromising stability to minimize the length of the culvert. A side slope grade of 2:1 is typically the steepest grade that can be vegetated.