NY-NJ HARBOR ESTUARY PROGRAM RESTORATION STRATEGY TOOLKIT

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INTRODUCTION

This Restoration Strategy Toolkit developed by Princeton Hydro and the NY/NJ Harbor & Estuary Program helps its users to prioritize problematic road-stream crossings and identify possible solutions at potential project sites. This toolkit is meant to be used by a wide audience of professionals and volunteers, including those familiar with the North America Aquatic Connectivity Collaborative (NAACC) protocol for assessing road stream crossings. It builds on the data collected through the NAACC (or similar) field assessments to identify the least expensive & highest priority project sites (Prioritization Matrix) and provide solutions (Solution Matrix) ranging from low-tech solutions that can be implemented by volunteers at minor blockages, to detailed engineering and construction plans that would require qualified contractors to implement at severe blockages.

The Restoration Strategy Toolkit is a semi-quantitative rating system in a tabular matrix that compiles available metrics and data, linking site characteristics to a suite of potential restoration solutions for implementation at specific, problematic crossings. Recommended restoration approaches range in complexity from simpler strategies such as routine debris clearing, flow modification, or temporary measures during periods of fish movement or migration, to more complex strategies that consider the range of available replacement structure types (i.e., pipes, elliptical pipes, box culverts, open-bottom arch culverts, and bridges).

This narrative is aimed to guide users of the Restoration Strategy Toolkit by explaining the thought and ranking behind the toolkit, and some high-level guidance for its use.

PROJECT SITE PRIORITIZATION MATRIX

HEP uses the NAACC, the Dendritic Connectivity Index, and the Cornell WRI Hydrology Model in conjunction to prioritize potential road-stream crossings throughout the New York Harbor watershed. Princeton Hydro reviewed these protocols and models, and identified gaps in the existing data sources. Some of these data gaps can be addressed in an early prioritization phase, especially with data that can be collected initially with a relatively low cost. Additional data that requires more effort should be gathered as soon as feasible, whether it be at a phase useful for funding, determining feasibility, or a formal design phase.

Princeton Hydro developed a tool to refine the prioritization procedure currently used by HEP. This decision-making matrix considers previously omitted cost-drivers and complicating factors to provide additional guidance on the prioritization and feasibility of potential projects. Factors included in the Prioritization Tool include:

1. Span Width;
2. Utilities;
3. Road Classification;
4. Ownership;
5. Flooding;
6. Geomorphic Instability; and
7. Additional Restoration Opportunities.

SPAN WIDTH

USFS guidance indicates a designed span for a culvert replacement should be a minimum of 1.2 times the channel bankfull width. The NAACC considers bankfull width to be an optional measurement. However, Princeton Hydro recommends that bankfull width is considered the primary variable when designing a proposed culvert.

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Bankfull width is a measurement of the active stream channel width at bankfull flow, the 'channel shaping' flow which moves the most sediment over time and shapes the stream channel itself. In a natural stream setting, the bankfull water level begins to spill out of the channel into the floodplain. Estimates of the frequency of bankfull flows events vary, but they may commonly occur anywhere between twice a year to once every other year. There are various indicators of the bankfull water surface elevation, but generally they include:

- Abrupt transition from bank to floodplain;
- Top of point bars;
- Bank undercuts;
- Changes in bank material; and
- Change in vegetation.

The NAACC recommends the bankfull width be calculated using:

- An average of three measurements;
- Taken upstream, outside the influence of the structure;
- Taken at the top of a riffle before a pool; and
- Measured starting 10 times the width of the stream upstream of the culvert.

If a formal bankfull measurement cannot be taken (or if there is lack of confidence in the bankfull measurement), the user-friendly US Geological Survey StreamStats tool (USGS SteamStats) can approximate bankfull dimensions with regression curves based on physiographic region. The regression curves consider watershed size, watershed slope and geographic region among other variables.

UTILITIES

Utilities can often complicate road-stream crossing replacement projects. Utility lines are often accommodated below roads and therefore a common design constraint that must be considered.

Utilities are best observed during a site visit. Any evidence of the various types of utility lines should be noted, see Table 2 below for some standard evidence that there are nearby.

Table 2: Standard Evidence of Nearby Utilities

Utility	**Observable Evidence**
Stormwater	Manholes, Outfalls, Inlet Boxes, Inlet Catch Basins
Wastewater (Gravity Fed)	Manholes
Wastewater (Pressure)	Manholes, Pump Houses
Drinking water	Manholes, Cutoff Valves, Valves, Hydrants
Gas	Manholes, Marking Flags, Connection to Residences
Underground Electric	Manholes, Marking Flags, Connection to Residences
Overhead Utility	Utility Poles
Phone/Fiberoptic	Manholes, Marking Flags, Connection to Residences

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Accurate information regarding the locations and elevations of existing utility lines is uncommon during the early stages of a developing road-stream crossing project. Since utility mark-outs by NJ OneCall are for construction only and not in the planning phase, As-Built engineering plans obtained through communication with individual utility companies are the most likely method of procuring the elevations of a utility in the datum of NAVD88 (or a datum that can be converted to NAVD88).

ROAD CLASSIFICATION

Transportation and road classification provide critical information regarding the size and usage of the road which crosses the stream. Generally, the bigger and busier the road is, the more expensive the project will be as the project will entail:

1. A longer culvert
2. Increased difficulty and expense to close the road during construction
3. Alternative construction methods if the road cannot be closed down or can only be partially closed

Active roads also provide an opportunity to gain additional sources of funding by designating the culvert replacement as climate-ready infrastructure. Increasing the hydraulic capacity of undersized culverts reduces localized flood risk. If culvert replacement projects are not pursued, flooding, road washouts, property damage, and loss of human life are more statistically probable.

According to NJDOT, roads in New Jersey are classified from largest to smallest in the following order (9):

1. Interstate
2. Other Freeway/Expressway
3. Other principal Arterial
4. Minor Arterial
5. Major Collector
6. Minor Collector
7. Local

There are two additional types of roads to be considered: footpaths/fire access roads and railroads. Footpaths/fire access roads generally are used less frequently than local roads and may be used only for emergency purposes. These are potential relic roads where road decommissioning could allow for additional options.

In contrast, active railroad crossings can be very difficult projects to consider. Railroads are difficult owners to work with and can be expensive projects. See the ownership section below.

Table 3 exhibits how Princeton Hydro rated the aforementioned roads. The rating of 5 corresponds with the least expensive/highest priority and 1 with the most expensive/lower priority.

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Table 3: New Jersey Road Classification and Infrastructure and Complexity Ranking

New Jersey Road Classification	Infrastructure Benefits	Construction Complexity
Interstate	5	1
Other Freeway/Expressway	5	1
Other Principal Arterial	5	1
Minor Arterial	5	1
Major Collector	3	3
Minor Collector	3	3
Local	3	3
Footpath/Fire access	1	5
Railroad	1	1

OWNERSHIP

Ownership of the stream crossing has an important factor when prioritizing potential road stream crossing projects. The support of an owner can make a project go much smoother, while a difficult owner can halt a project. Ownership can often be looked up by address with the NJ-GeoWeb state database (10) or a GIS database of a specific county.

The Project Manager should reach out to the owner of the stream crossing at this stage in the project to understand whether they would be in support of a potential project.

There are challenges associated with public ownership (town or municipality, county, or state), including bureaucratic slowdown, conflicting decision-makers, risk aversion, and funding challenges. However, if road stream projects can be shown to only have beneficial impacts (aquatic organism passage, reduced flooding, more resilient infrastructure), they are more likely to be supported by public owners. Generally, Princeton Hydro considers town, municipality, or county to be easier project partners than the state or federal government.

Road-crossings owned by private citizens have their own constraints, as the decision is made by one individual. When supportive, this can be beneficial. However, the individual's mind can change or there can be a change in ownership. Therefore, Princeton Hydro considers engagement with the stakeholders of private property to be harder to navigate than stakeholders of public property.

Road-crossings owned by railroads are broken into a separate category because they are both common and especially difficult. There are many kinds of railroad crossings, since railroads are ubiquitous across New Jersey and the country. Additionally, railroad companies are especially risk-averse and disinclined to close an active trainline to construct a crossing. In addition to ownership of the road-crossing itself, upstream ownership, downstream ownership, and ownership of site access road(s) should also be considered. These can be determined through the same GIS database used to determine the ownership of the road-stream crossing. The best route for site access should be determined through field observations, when topography, infrastructure, and other possible considerations can be observed in person. Aerial imagery (google maps, google earth, etc.) can be used to as an alternative to determine site access paths.

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FLOODING

SITE FLOODING OBSERVATIONS

In lieu of a complex hydraulic model, the Prioritization Matrix includes qualitative observations related to existing flooding conditions at the project site.

If the culvert does not have sufficient hydraulic capacity, then the crossing likely attenuates flood flows. This can cause flooding upstream. Replacing the constricted road-stream crossing with one with more hydraulic capacity to reduce upstream flooding is beneficial, especially if there is infrastructure near the upstream floodplain (and even more so if the infrastructure is related to an Environmental Justice Community). However, the more flow is attenuated by the existing culvert, the more the important additional H&H modeling becomes during design for the purposes of the Flood Hazard Area Verification.

A simplified hydraulic model can be considered with the US Federal Highway Administration (US FHWA) HY-8 Culvert Hydraulic Analysis Program. However, for the purposes of permitting, a final design would require a detailed hydraulic analysis using the US Army Corps of Engineers HEC-RAS program.

STABILITY OF STREAM CHANNELS

Another common motivation for replacing a road stream crossing is the geomorphic instability of the river reach. Geomorphic instability has implications for both aquatic organism passage and the structural stability of the crossing itself.

A perched culvert at the downstream culvert face is a common limiting factor to aquatic organism passage through a road stream crossing. A perched culvert occurs when there is vertical offset between the water surface elevation through the road stream crossing and the downstream water surface elevation, creating a hydraulic drop and vertical distance that can be too much for species to overcome.

A perched culvert can be caused by the 'firehose' effect of an undersized culvert, causing high velocities at the downstream face of the culvert. This high velocity can create a scour hole in the downstream reach, eroding the channel bottom and causing the channel to downcut. Ultimately a headcut – a steep, upstream-eroding channel incision – can form at the downstream face. Headcuts migrate upstream and can undermine the existing culvert, requiring stabilization to ensure the culvert does not fail.

It is possible for undersized culverts to accumulate sediment at the upstream face. However, usually this accumulated sediment is a relatively small volume to excavate during the construction of the project and is not considered to be a potential deal-breaker. Increasing the hydraulic capacity of a culvert does restore natural stream channel morphology.

RESTORATION OPPORTUNITIES FOR HABITAT

HABITAT QUALITY

Habitat Quality and Water Quality can be included as considerations for which projects to prioritize. However, habitat quality of streams can be difficult to classify directly. Instead, there are various proxies that can be utilized, including the quality of the fisheries (in New Jersey the Classification of Trout Waters can be used as a proxy to fishery quality) or the importance of the site to Threatened and Endangered Species.

Princeton Hydro and HEP focused on the potential for the site to have a high-quality habitat value. Therefore, the toolkit is focused on three items related to habitat quality:

1) Whether the stream or crossing was identified in any habitat improvement plan;
2) Whether there is sufficient baseflow to support aquatic organism passage through the reach and culvert; and
3) Whether the road-stream crossing has been identified as the first barrier for migratory fish passage.

If the stream or crossing has been identified in a habitat improvement plan, then the potential project site has been identified by others as a priority. Therefore, it can be assumed that the project would provide an ecological uplift and is scored favorably.

Sufficient baseflow to support aquatic organism passage is an important consideration. There are many metrics to use to estimate baseflow, including field measurements. However, since hydrology may change conditions during a field assessment, this tool uses watershed area as a proxy to ensure sufficient water depths through the crossing. Watersheds with areas smaller than 1 square miles may not have sufficient flow, and watersheds with an area less than 2.5 square miles should have further investigation to verify there is enough baseflow to sustain a fishery in the reach.

Table 4: Small Watershed Area Rating

Watershed Area (Sq Mi)	Rating
1	1
2.5	2
5	4
20	5

WATER QUALITY

Water quality can play an impactful role in the aquatic organisms in a reach that would be impacted by a road-stream crossing projects, including:

- Temperature: Water temperature can affect the metabolism, growth, and reproduction of aquatic organisms.
- Dissolved Oxygen: Aquatic organisms require oxygen to survive, and levels of dissolved oxygen in water can affect their growth, reproduction, and survival. Low oxygen levels can also lead to the development of 'dead zones' in bodies of water, where fish and other aquatic organisms cannot survive.
- Bacteria Levels: Harmful bacteria can cause diseases and infections in fish and other aquatic organisms, which can lead to mass die-offs. High bacteria levels can also be an indication of other water quality problems, such as pollution.

Since these metrics of water quality require more effort to collect than data collected at a visual site investigation, these water quality metrics were not included in this toolkit.

ADDITIONAL RESTORATION OPPORTUNITIES

There are often multiple ecological restoration opportunities that can be pursued in conjunction with road-stream crossing replacement projects. These opportunities should be correctly weighted in the prioritization matrix in order to properly decide the project scope. Often times including additional restoration opportunities increases costs and may be outside the magnitude of the problems grant funding are meant to address.

AQUATIC HABITAT

Primarily, road-stream crossing replacements provide an opportunity to improve aquatic organism passage and connect upstream and downstream habitat for aquatic organisms. Redesigned road-stream crossings can remove anthropogenic barriers to aquatic organism passage created by outlet velocity barrier or low water depths.

TERRESTRIAL HABITAT

Road-stream crossings can also fragment habitat for terrestrial animals. Culverts that are too small to allow terrestrial animals to pass through them may force animals to traverse the dangerous roads above the crossing. Replacing undersized culverts with structures spanning at least 1.2 times the bankfull width allow a floodplain bench to continue through the length of the culvert, which can provide terrestrial animals (including reptiles and amphibians) with the opportunity to migrate upstream and downstream.

ADDITIONAL CONSIDERATIONS

The current HEP prioritization includes culvert condition as a metric in its methodology. Culvert conditions are currently based on site observations from the NAACC assessment. However, internal NJDOT and county lists of culvert conditions, while nonpublic, could be requested at this stage if it was found to be useful.

On rare occasions a road-stream crossing may have historic or cultural value. If deemed to have historic significance, additional consideration should be taken to engage stakeholders in the feasibility and design stage of the project. Two resources to help determine historic/cultural significance include:

- Bridgehunter, a database of historic or notable bridges in the United States (11).
- The National Parks Service National Register of Historic Places, the official list of the Nation's historic places worthy of preservation (12).

Ultimately for full design, a survey and stream morphology assessment should be performed. The survey should include the channel alignment, profile, and cross-sections upstream, through, and downstream of the crossing to capture thalweg profile, reach slope(s), bankfull width, bankfull depth, and in-channel bedforms (i.e. riffles, steps). The stream morphology assessment would include classification of the dominant (median and maximum) bed substrate grain size (via pebble count or visual estimate) as well as observation of in-channel bedforms.

SOLUTION MATRIX

The goal of the restoration strategy solutions matrix is a semi-quantitative ratings system that compiles the available metrics and data to provide potential restoration solutions for implementation at specific road-stream crossings. The recommended restoration approaches will range in complexity from simpler strategies (routine debris clearing, flow modification, or temporary measures during fish movement or migration) to more complex strategies that consider the range of available replacement structure types.

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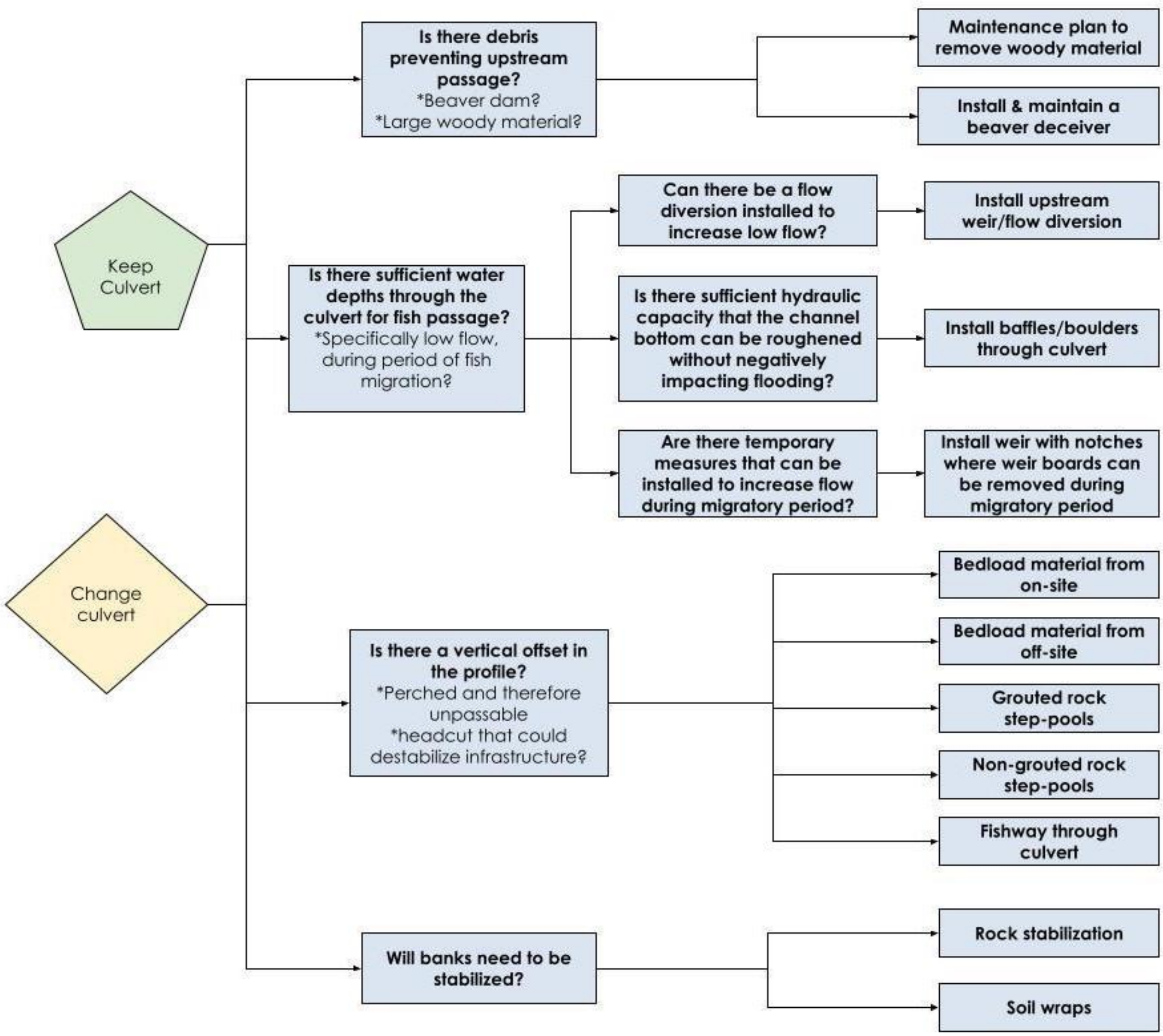
The matrix is organized from least complex options to more complex solutions. Regardless of whether the culvert span is going to be replaced as a part of the project, debris, water depths, outlet drop, and bank stabilization should be considered as a potential solution. Figure 4 displays the underlying Process-Flow Diagram (PFD) of the solution matrix.

Figure 4: Solution Matrix PFD



DEBRIS

Debris blockage at the upstream face of culverts is a common issue as large woody debris and other organic and non-organic material can get caught. This is especially true of undersized culvert. Beavers may consider culverts to be an attractive place to construct dams, so they can be the source of debris blockage at a culvert if they are in the watershed.

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If the removal of debris is sufficient to meet the project goals, then the solution is relatively inexpensive. There will be a minimal upfront cost for an on-going maintenance plan and/or the construction of a diversion fence to protect a road culvert from beaver dams. Both solutions will require on-going maintenance. Maintenance should be performed in the spring before fish are most likely to migrate.

FLOW DEPTHS

Adequate water depths through road-stream crossings are critical for the passage of aquatic organisms. If flow depths through the road-stream crossings are shallower than upstream and downstream, the crossing can be as much of a barrier to aquatic organism passage as high velocities.

Th issue of inadequate flow depths may be addressed by a combination of the following:

- Installation of an upstream flow diversion to direct more baseflow through a single culvert opening. This is most feasible if the culvert has multiple openings, and the weir directs baseflow into one of the openings.
- Roughening the channel bottom with either boulders or baffles. Boulders and/or baffles can interrupt shallow, streaming flow through a road-stream crossing and increase the hydraulic roughness of the water, decreasing velocity and creating a more diverse flow pattern. However, care needs to be taken that the crossing has adequate flood capacity and that increasing the channel roughness will not negatively impact upstream flooding.
- Temporary measures, such as the installation of removable weir boards, may be implemented during specific times of the year to improve passability of the proposed structure. This solution can allow for a more "hands-off" approach to water surface elevation control. Weir boards can be added or removed as required to meet project goals.

The issue of inadequate flow depths can be solved independent of other solutions but should also be considered during the redesign of larger road-stream crossings. Costs of these solutions will range based on geotechnical conditions, channel depth, and required weir heights, but could be on the order of $50,000-$150,000.

OUTLET DROP

Drops at the outlet of a culvert can happen for several reasons. Primarily, this occurs at poorly-designed, undersized culverts. Undersized road-stream crossing will increase velocities during flood events. Resulting excess velocities and shear stresses can result in the stream downcutting at the downstream face of the culvert, as the invert of the culvert is perched higher than the downstream culvert.

An outlet drop can also occur if a headcut that was initiated downstream migrates to the crossing outlet. Headcuts are typically formed when there is a change that occurs to the river reach. The resulting 'knickpoints' create a steep, vertical drop in the channel bed that initiates more channel instability as it moves upstream. Large storm events or channel manipulation (channel straightening) are common causes of headcuts.

Typically, fixing a perched culvert involves a combination of lowering the culvert invert to be aligned with the stream channel and/or filling in the downstream channel to bring the invert of the channel up to the culvert.

If a road-stream crossing has a drop at the crossing's outlet, it is a solution that could be addressed on its own even if the crossing is not to be replaced. However, if the project addresses an outlet drop but not replacement of the full span, then care should be given that the original cause of downstream erosion is either addressed or considered in the solution.

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The elevation of the downstream culvert can be raised with correctly sized bedload (cobbles, gravels, sands, fine materials, etc.). These can be imported to the site or from material that's already on site. A good source of material can be any excavation from replacement of a larger culvert crossing. However, care should be taken that this bedload will stand up to the velocity and shear stress of the channel hydraulics.

If the longitudinal profile cannot be aligned with bedload material, then a step-pool design is required. Design guidance to ensure step-pools are passable by fish can be found in the *Federal Interagency Nature-like Fishway Passage Design Guidelines for Atlantic Coast Diadromous Fishes* (13). Depending on the velocities and shear stresses within the hydraulic models, the step-pool can be grouted.

The width of the stream and the height of the outlet drop influence the potential cost. A wider stream means more material is required to span the channel and update downstream grades. Additionally, the step-pool designs are often designed with a maximum of 5% slope. Therefore, the higher the outlet drop, the longer the step-pool is required to tie into the downstream existing grade (i.e., for every 1 foot of outlet drop, the length of the step-pool design increases by 20 feet).

If a nature-like fishway is not possible, a technical fishway (Alaskan steeppass, or similar) could be used as an option to assist in fish passage at a culvert. This is an atypical solution but can be considered in specific situations – typically when a weir or low head dam is constructed near the road-stream crossing. It should be noted that technical fishways can provide aquatic organism passage for a target species but does not allow for all organism passage.

BANK STABILIZATION

Bank stabilization is unlikely to be a primary driver for the cost of a project. However, it is included in this tool because bank stabilization is a relatively predictable expense.

If a project entails significant regrading that may include the construction of a bank, floodplain, and grade control structures —usually requiring the relocation or importation of fill —then bank stabilization in the form of a soil wrap or the planting of vegetation is typical in order to initially stabilize the newly-constructed bank. Hydraulic analysis may inform that newly constructed banks also require some rock stabilization. If the hydraulics show that a bank already prone to erosion remains in that hydraulic condition, rock stabilization is recommended. While rock stabilization is likely more expensive than a combination of soil wraps and planting of vegetation, it will likely only minorly increase the cost of a design and reduce maintenance costs in the future.

SIZE OF SPAN

A considerable cost consideration of a road-stream project is whether the span of the road-stream crossing will be replaced. For most situations, if a particular crossing has been prioritized as a potential project, it is likely that the crossing will be replaced with a larger structure. However, in some cases there is adequate hydraulic capacity to pass regular storm flows and the span is at least1.2x the channel's bankfull width.

Alternatively, some situations may arise wherein even if the crossing would benefit from a wider span, increasing the span of an undersized road-stream crossing is not possible. Culvert replacement may not be possible in the event that relocation of a conflicting utility is not feasible, or if the accommodation of nonnegotiable design constraints increase costs to the point that the project cannot be completed.

Figure 5 below shows a Process Flow Diagram (PFD) of whether a span should be replaced or not.

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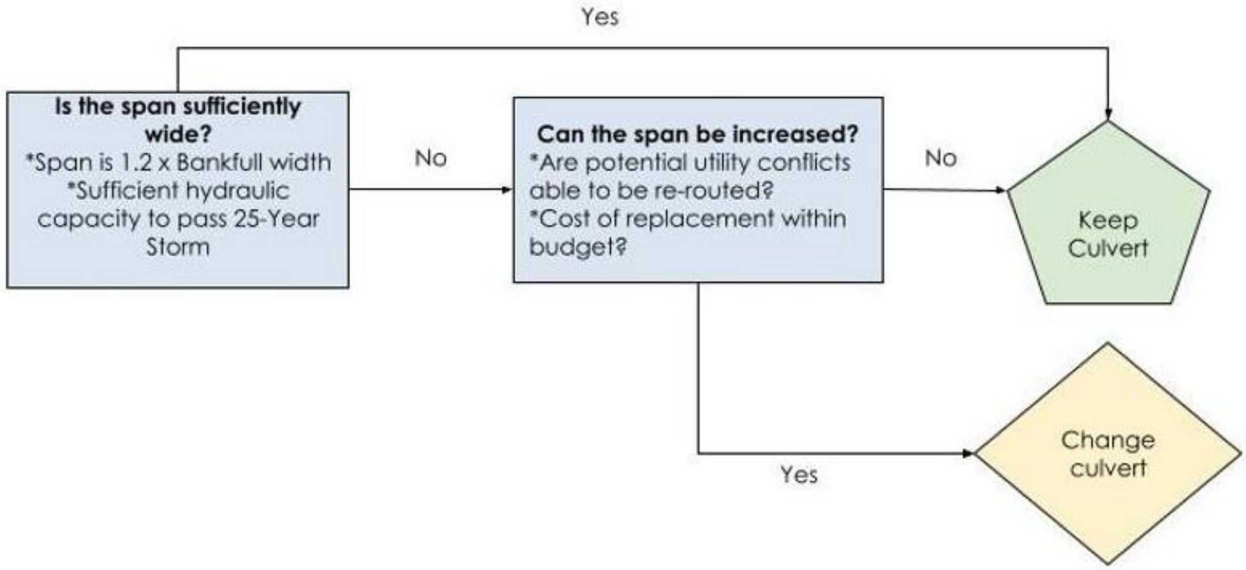
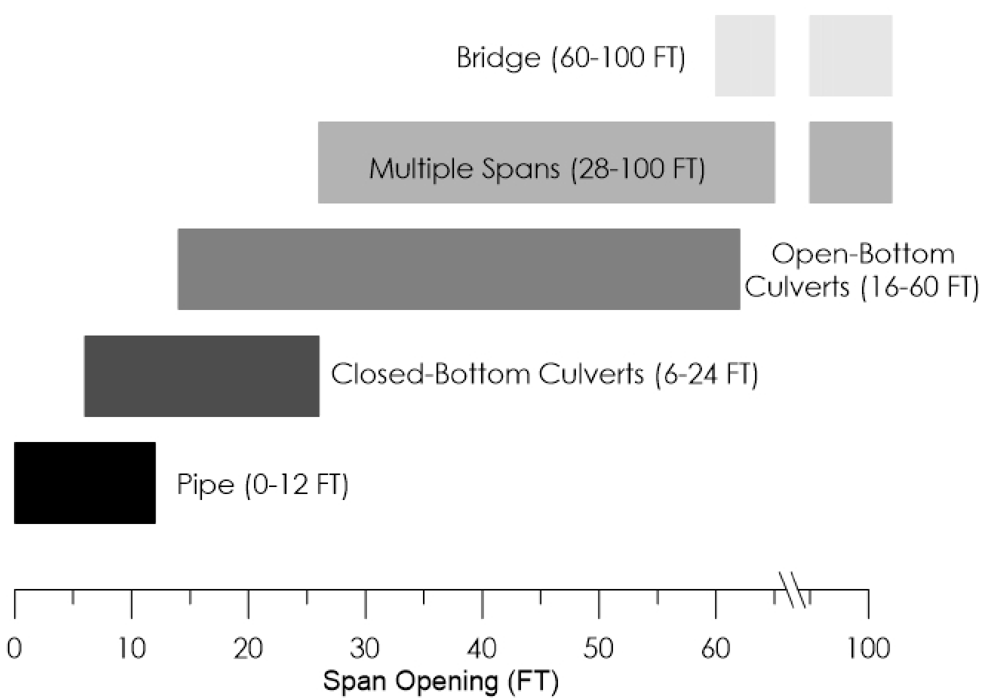
Figure 5: Culvert Replacement PFD



Whether a span is to be replaced or not, there are various solutions that can be explored to create more aquatic organism passage. Debris, inadequate flow depths, and outlet drop are issues described above.

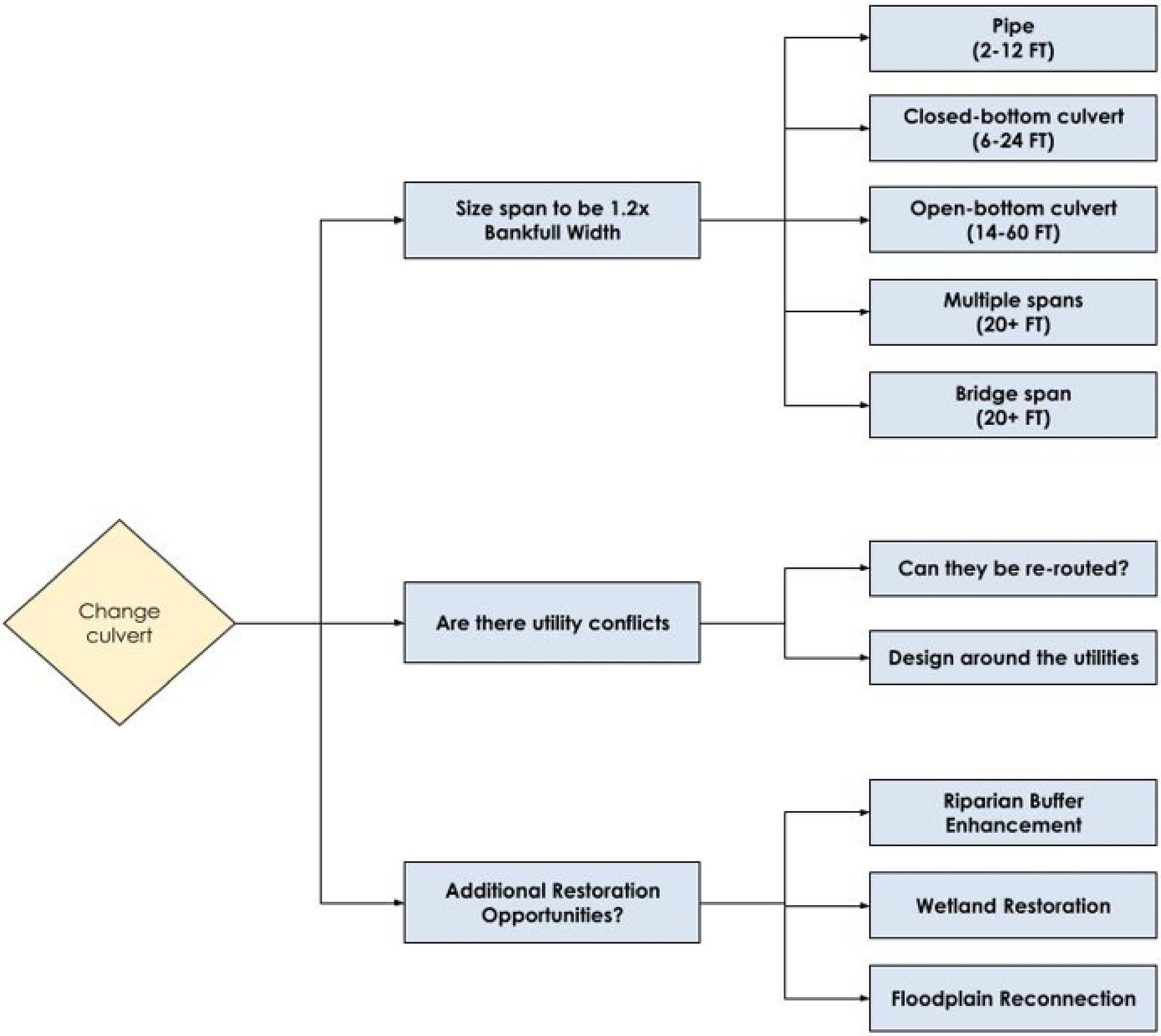
If a culvert replacement is being considered, various possible types of road-stream crossings could be proposed depending on the stream size. Figure 6 shows possible solutions, ranging from the smallest (and least expensive) pipes (up to 12 FT in diameter), to the larger (and more expensive) solutions such as open-bottom culverts or bridge spans (up to 100 feet or more).

Figure 6: Culvert Replacement Solutions Based on length of span opening



Guidance for best aquatic and terrestrial organism passage is to size the span openings to be at least 1.2 times the bankfull width of the stream. Given that a road-stream crossing is going to be replaced with an opening with a correctly sized span, utilities and additional restoration opportunities are additional potential solutions that should be considered.

Figure 7: Culvert Replacement PFD



UTILITIES

Utility conflicts can make a road-stream crossing replacement project more complex and challenging, requiring additional design consideration and coordination with the utility companies. The design of a new culvert may conflict with existing utility infrastructure including sewer, water, or gas lines, electrical cables, or communication lines. Gravity-fed utilities (stormwater and gravity-fed sanitary sewer lines) are most difficult to relocate as they would require the installation of a siphon, while pressurized water lines, gas lines, and cable utilities typically can be replaced more easily.

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At this stage it is unlikely that the project partner has confidence in the elevations and exact locations of utility lines observed on site. This requires getting the information from utility companies directly. It is conservative to expect that projects with potential utility conflicts are going to incur a higher construction cost. To avoid utility conflicts, either the utility will need to be re-routed (some utilities are easier to re-route than others) or the road-stream crossing can be designed in a way to avoid the utilities that are on site.

ADDITIONAL RESTORATION OPPORTUNITIES

RIPARIAN BUFFER ENHANCEMENT

The riparian buffer is the vegetated area along the banks of a stream that helps filter pollutants, reduce erosion, and provide habitat for a variety of plants and animals. Enhancing the riparian buffer can provide several ecological benefits, including improved water quality, reduction in water temperatures, increased bank stabilization, and improved aquatic and terrestrial habitat. This restoration opportunity can be incorporated into a road-stream crossing replacement by extending the grading associated with the project upstream and/or upstream of the road-stream crossing itself.

WETLAND RESTORATION

Wetland restoration can be achieved by improving the hydrologic connection to the floodplain through the extension of grading associated with the road-stream crossing replacement further upstream and/or downstream of the road-stream crossing itself.

FLOODPLAIN RECONNECTION

Floodplain reconnection involves adjusting the grading of a channel to allow for lateral connectivity of water and sediment between the stream channel and its floodplain during high flows. There are many benefits of a connected floodplain, including improved water quality, habitat diversity, and increased flood storage. It is common for channels to become incised, especially channels heavily impacted by development and land use changes within the watershed. Reconnecting a channel's floodplain often includes updating the channel's longitudinal profile and/or creating a floodplain bench along the project reach.

The prioritization matrix breaks the floodplain reconnection opportunity info 'full' and 'partial' reconnection. Full reconnection is meant as an opportunity to restore the natural lateral connection along the entire project reach, often by repairing the incised channel and allowing for full floodplain reconnection. A partial floodplain reconnection is appropriate when the project will allow for the creation of a small floodplain bench, for example. Floodplain reconnection can be achieved by extending the grading associated with the road-stream crossing replacement further upstream and/or downstream of the road-stream crossing itself.

CONCLUSION

This narrative is aimed to guide users of the Restoration Strategy Toolkit by explaining the thought and ranking behind the toolkit, and some high-level guidance for its use. The Restoration Strategy Toolkit is a semi-quantitative rating system in a tabular matrix developed by Princeton Hydro and the NY/NJ Harbor & Estuary Program. It is meant to helps its users – professionals and volunteers familiar with road-stream crossing assessments – to prioritize problematic road-stream crossings and identify possible solutions at potential project sites. The toolkit builds on the data collected through the NAACC (or similar) field assessments to identify the least expensive & highest priority project sites (Prioritization Matrix) and provide various solutions (Solution Matrix) for potential road-stream crossing projects.

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