

*State of Maine Aquatic Resources
Management Strategy Forum*

STREAM SMART ROAD CROSSING

Pocket Guide



MaineDOT

ACKNOWLEDGEMENTS

This guide was developed to provide basic explanations for installing and replacing crossings in an effective and cost-efficient manner while meeting goals of restoring and maintaining stream habitat connectivity and enhancing the stability of roads and culvert crossings. The Aquatic Resource Management Strategy (ARMS) forum consisted of over seventy state and federal agencies, town representatives, commercial entities, non-profit organizations, and non-governmental advocates for environmental, landowner and industry interests. ARMS members met over three years to share information and establish a unified strategy that incorporates the latest scientific and technical knowledge related to maintaining and restoring stream connectivity while considering financial and infrastructure constraints. This guide was produced through the sustained efforts of the following:

- Maine Department of Transportation
- Maine Department of Agriculture, Conservation, and Forestry
- Maine Department of Marine Resources
- Maine Department of Environmental Protection
- Maine Department of Inland Fisheries and Wildlife
- Federal Highway Administration
- US Army Corps of Engineers
- Wells National Estuarine Research Reserve
- Casco Bay Estuary Partnership
- Maine Coast Heritage Trust
- Maine Municipal Association
- Maine Rivers
- American Concrete
- Penobscot Indian Nation
- Houlton Band of Maliseet Indians
- Aroostook Band of Micmacs
- University of Maine System
- Cumberland County Soil & Water Conservation District
- Kennebec Estuary Land Trust
- Natural Resource Conservation Service
- Trout Unlimited
- Sustainable Forestry Initiative
- The Nature Conservancy
- Maine Audubon
- Associated General Contractors
- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- Project SHARE
- Sargent Corporation
- Sewall Company
- Maine Association of Realtors
- U.S. Geological Survey
- Towns of Sanford, Yarmouth

The contributing authors of this document make no representation or warranty, either expressed or implied, concerning the completeness or suitability of this information and whether it will comply with all regulatory requirements.

TABLE OF CONTENTS

Overview

- Purpose and scope of this guide
- What is aquatic organism passage?
- Common barriers for aquatic organisms

Stream Smart Design (The 4 S's)

- Span the stream
- Set the elevation right
- Slope and skew match the stream
- Substrate in the crossing

Site Assessment & Measurement

- Indicators of problems at replacement crossings
- Field Measurements
 - Measure bankfull width to span the stream
 - Measure stream profile to determine elevation and slope
 - Measure stream profile to set elevation and slope to match stream
 - Measure streambed material to determine substrate in the crossing

Adhering to the content of this guide is not required by state and federal agencies charged with natural resource management. Recommendations are based on proven practices that limit the road-damaging flows from extreme weather and practices that allow for passage of fish and other organisms. Crossings that are constructed using these principles are likely to comply with permitting requirements.

Implementation

- Culvert length
- Inlet and outlet armoring
- Hydrologic methods
- Other design issues
 - Road construction concerns
 - Stream ecology concerns
- Tips for installing Stream Smart road crossings
- Stream diversion, dewatering and cofferdams
- Culvert installation and construction
 - Sediment control
 - Culvert excavation and backfill
 - Culvert installation
 - Embankment stabilization
 - Riprap installation
 - Substrate in the crossing
 - Long-term maintenance
- Permitting considerations

Appendices

Appendix A – Stream Smart crossing site examination and culvert sizing worksheets

Appendix B - Sources of technical assistance

Appendix C - Excerpts of laws/regulations pertaining to new and replacement crossings

Contacts

OVERVIEW

Purpose and Scope of this Guide

Road crossings that meet “Stream Smart” performance goals promote the natural movements of fish and wildlife and normal stream processes that support healthy habitat in a diversity of flow conditions. Aquatic organism passage and habitat connectivity are key elements for freshwater and coastal waterway stream crossings. Appropriately sized and well-installed crossings also reduce the likelihood of flooding, minimize safety risks to the road and surrounding infrastructure, and protect users. To improve aquatic organism passage, installing a replacement crossing is encouraged over rehabilitation of an existing crossing when possible.

- ! Allow the stream to act like a stream by passing fish and wildlife as well as the higher flows that come with large infrequent storms while protecting the stability of the road and public safety.

The Scope of this Guide

- **The design descriptions and examples presented in this guide are limited to small stream crossings that are 6 feet or less in stream bankfull width and less than 2 percent slope** constructed by municipalities, contractors, and other road owners who are replacing a crossing without the benefit of professional design and technical expertise. Note that this size stream often has a drainage area of approximately a half square mile or less.
- While fish passage associated with crossing structures can be straightforward for these smaller culverts, ensuring their structural stability is more complex. **The details of designing structures in streams larger than 6 feet are beyond the scope of this booklet.** Though the same principles should be used for the installation of larger culverts, with these more complex situations, civil engineering and/or geotechnical expertise is recommended.

This guide is intended for sites having the following characteristics:

- Channel is well-defined or flows are backwatered through the crossing.
- Proposed culvert has a diameter of 8 feet or less that can fully span the stream channel and the overall stream slope is less than 2 percent.
- Local soils allow digging to embed the pipe or for open-bottom culvert footings (i.e. not ledge beneath).
- Stream is not tidal (i.e. there is no tidal marsh upstream).

What is aquatic Organism Passage?

Aquatic organism passage occurs when a road-stream crossing acts like a natural stream without fragmenting upstream habitats from those downstream, allowing fish, insects, animals, and natural river flows, sediments, and nutrients to move freely. Aquatic organisms are species that depend for at least some part of their life on rivers, intermittent or perennial streams, and adjacent areas to live, feed, reproduce, and move between habitats. These include:



Fish



Invertebrates
(mussels, snails, crabs, crayfish, insects)



Herptiles
(frogs, turtles, snakes, salamanders)



Mammals

In almost all cases, designing and installing a new or replacement crossing is required to provide aquatic organism passage. In addition to regulatory mandates, state and federal agencies encourage the design and construction of aquatic organism passage even on projects that are exempt or not regulated. A crossing that provides aquatic organism movement will usually be sized for the passage of erosive flows from large storms. It will increase stability of the road and safety for the public. The life expectancy of an appropriately sized structure is significantly longer and over the long-term will likely realize cost savings.

OVERVIEW

Common Barriers for Aquatic Organisms



Velocity Barriers: Undersized culverts are narrower than the stream, constrict flow at the inlet, create high velocities through the culvert, and have limited roughness and variation to mimic the natural stream bed. Higher velocities create turbulence at the outlet. Turbulence and high velocity make it difficult for fish and other aquatic organisms to move upstream through the crossing. They erode the downstream stream bed which can create a Jump Barrier and cause downstream bars or barriers from the dislocated sediment. Note: Swimming abilities of fish differ considerably among species and age classes; just because one species can get through fast water does not mean that all species can.



Low Flow Barriers: This refers to inadequate water depth for fish to swim through the crossing during low flows. Water becomes too spread out in a pipe, especially with a flat bottom, making passage harmful or impossible. This often occurs in crossings with multiple pipes, and in many situations is the result of a culvert being set too high.



Jump Barriers: High-velocity water can create a pipe ‘hung’ or ‘perched’ above the water at the outlet. Over time, downstream scour can deepen the stream bed to create a significant drop at the outlet (hanging or perched outlet). This is also created by setting the pipe too high during installation. Fish and aquatic organisms have to jump into the culvert to get through. Even if a strong-swimming species like trout or salmon is able to jump high enough to get in the pipe, it may be swept back out by high-velocity flow and lack of resting areas within the crossing.



Exhaustion Barriers: Some culverts are too long, too steep, or lack resting areas or instream eddies. These may exhaust fish and aquatic organisms and prevent them from swimming the length of the culvert.



The goal is to make the crossing invisible to the stream so that the stream can do what it should do: regulate the flow of water, move organisms and material, and provide habitat connectivity.

STREAM SMART DESIGN

The 4 S's

1. Span the Stream
2. Set the Elevation Right
3. Slope and Skew Match the Stream
4. Substrate in the Crossing

1. Span the Stream



Don't Pinch

A Stream Smart solution lets the stream be a stream and avoids “pinching” or “constricting” the channel. In this photo, the stream is much wider than the culvert.

Terms such as “channel width,” “bankfull width,” or “normal high water” are measures of the natural width of a stream. In general, streams have an identifiable channel width that is most stable when completely spanned or exceeded by a crossing. Water flows vary over time, so the natural widths noted above may not be evident the day you are assessing the stream.



In the photo on the bottom, the high water mark is shown in the line of discoloration on the pipe inside the culvert; outside the culvert it is indicated by the presence of upland vegetation

(grasses, trees). The ideal solution is to exceed the stream channel width with a larger pipe or an open bottom structure with banks inside the crossing. This allows wildlife to move along the banks and focuses low flows.

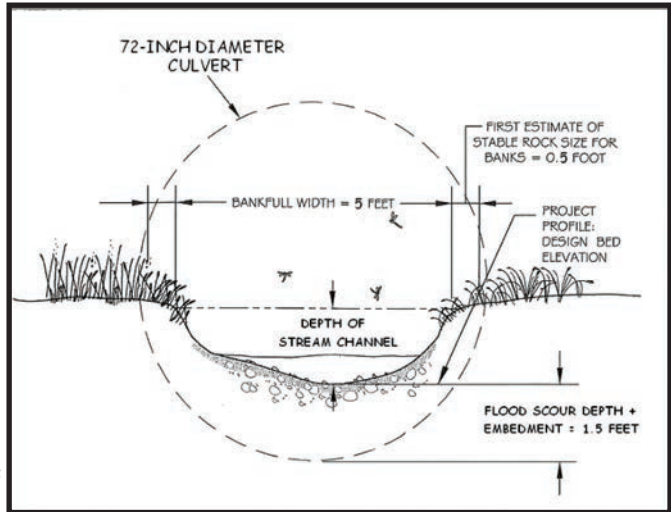
STREAM SMART DESIGN

1. Span the Stream *cont.*

Size it Right

Properly sizing and installing crossings is important to make roads more stable and safer, and to prevent expensive and ecologically damaging road washouts.

A properly sized culvert not only allows fish passage at normal water flows, but can also more likely handle large storm flow and floods.



Most existing culverts have been sized to pass runoff from 4 to 5 inches of rain, or the amount from a “25-year storm” (a powerful storm with a one in 25 chance that it will occur in any given year). This sizing can handle most normal stream flows, but generally structures need to be larger to handle storms the northeastern US has seen in recent decades. The Maine Department of Transportation recently began to use a 100-year storm (generally 6-8 inches of rain) as its sizing standard. Many large private landowners in Maine are also sizing significant crossings for larger 50 or 100-year storms for better durability of their structures over time, less likelihood of catastrophic failures, and to reduce the added expense that comes from road failures.

2. Set the Elevation Right

The bottom of the culvert should be set below the bottom of the deepest natural pool depth in the stream above and below the road crossing (not including the scour pool at the outlet). An appropriately sized structure set at an unnatural elevation can cause problems. Even when encountering ledge, an open-bottom structure should be considered, but may be difficult to install.



The existing outlet scour pool depth is usually unnaturally deep, and should not be used as a guide to setting the elevation of a replacement structure.

Incorrect culvert elevations

If you see impounded water upstream and fast flows downstream, the road and culvert are changing the hydrology. For instance, if 2 inches of water is in the culvert but 3 feet of water is ponded upstream of the structure, the culvert is most likely set too high. Dead trees also often indicate that the elevation of the original stream bed was lower before installation of the existing culvert.



Correct culvert elevations

If set at the correct elevation, there should not be water impounded or sediment accumulating upstream of the crossing. The stream and stream bed material immediately upstream and downstream of the crossing should look very similar.



There are two situations where upstream and downstream will not look similar, where the slope of the stream changes dramatically from upstream to downstream:

- 1. When bedrock at the crossing controls the stream so that upstream is much flatter than the downstream;*
- 2. When a crossing is at the bottom of a steep hill so that upstream is much steeper than downstream.*

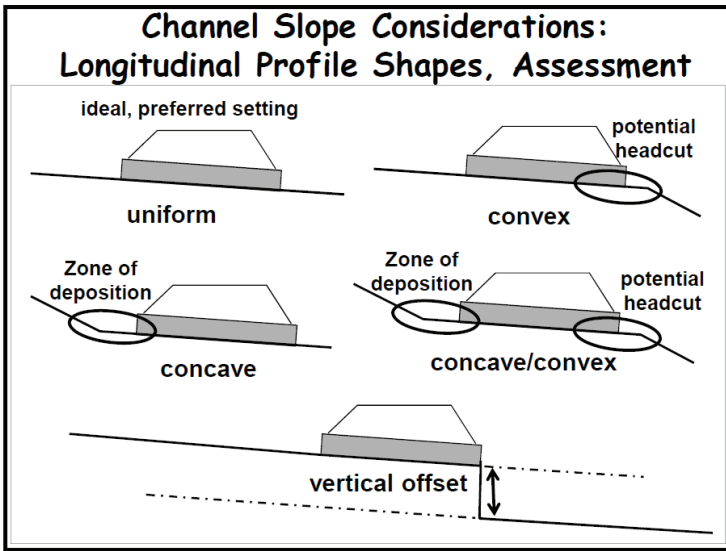


STREAM SMART DESIGN

3. Slope and Skew Match the Stream

Slope

It is important that the gradient or slope of the culvert (stream profile) matches the natural slope of the stream to avoid problems. Stream slopes below the culvert that are steeper than the slope of the culvert can cause headcuts which can cause culvert scour or hanging above the streambed. Steeper slopes above the culvert can cause zones of deposition at the inlet of the culvert which can block the culvert and increase the potential to blow out the culvert and the road.



Skew

The road crossing needs to be horizontally aligned with the stream rather than the road, and in many cases this may not be at a right angle with the road. When this occurs, the culvert will need to be longer to match the correct alignment of the stream to the road. Correct alignment minimizes scour at the inlet, and reduces the likelihood of failure.

4. Substrate in the Crossing



“Substrate” or “bed material” is the natural boulders, cobble, gravel, and other sediment that forms the stream bottom. Whether it is the existing bed material in the channel or material added inside an embedded structure, Stream Smart crossings include substrate that can move and be replaced by the natural flow of the stream for features like eddies, pools, and riffles. This material contributes to fish and aquatic organism passage by providing alternative flow paths and resting areas. Adding large, stable material as banks within the structure will help to ensure a natural flow path develops in the culvert sooner while focusing low flows into a smaller area to improve passage during drier times.

SITE ASSESSMENT and FIELD MEASUREMENTS



Use the Stream Smart Crossing Site Examination worksheets in Appendix A to gather site assessment information and collect the measurements needed for design calculations.

Step 1

A site assessment is required to achieve a “Stream Smart” crossing. Information to gather:

1. Site history and problems
2. Indicators or “clues” to stream performance
3. History of the existing culvert
4. Whether the culvert size, elevation, slope, and length are appropriate or could be corrected if the structure was replaced



Step 2

Take field measurements of the stream to determine the appropriate crossing size, elevation, slope, and substrate, including:

1. Bankfull Width for culvert sizing (See page 18 for instructions)
2. Stream Profile for culvert elevations and slope (See page 19 for instructions)
3. Bed Material for substrate in crossing (See page 21 for instructions)



Often, the stream channel in the zone around an existing culvert has been influenced by an undersized structure masking the natural stream elevation, shape, depth, and width near the crossing. Knowing the true stream elevations, width, depth, and path outside this “zone of influence” is critical to developing a Stream Smart design. **Bankfull width and stream elevation measurements must be determined using natural, undisturbed sections of the stream, 20-30 times the width of the stream upstream and downstream from the crossing.** For example, 60-90 feet for a 3-foot stream or 120-180 feet in each direction for a 6-foot stream. Be aware of significant tributaries that could influence or change the stream width.

SITE ASSESSMENT and FIELD MEASUREMENTS

Step One - Site Assessment

Indicators of Problems at Replacement Crossings

Many of the following indicators are from culverts that are too small for the stream. When a stream is “pinched” by an under-sized culvert, the water in the structure and immediately downstream moves faster than under natural conditions. The result can be seen at the outlet of a crossing by changes in erosion or sediment deposition. In addition to blocking fish passage, the water quality can be degraded, the crossing can become unstable, and streambed elevations altered. Some common signs of an undersized culvert include:



Sediment deposited in mounds upstream and/or downstream of the crossing – sometimes hundreds of feet downstream from past road washouts; see stream profile on page 20 showing aggraded areas upstream of undersized culvert; these deposits are not always obvious in the field;

Hung or perched culverts where the bottom of the outlet and/or inlet is higher in elevation than the surface of the water. Perched culverts have a variety of origins, including:

- Underlying or exposed bedrock that prevented embedding of the culvert
- Placement of the culvert on top of old crossing debris without consideration of the natural streambed elevation
- Inadequate size of the culvert that increases velocity, causing scour downstream.
- Frost-heaving caused by insufficient depth;

Scour pools downstream of the crossing;



Stream bed material that differs dramatically upstream and downstream of crossing and often none at all inside the structure; or

Upstream backwatering which can also happen when a culvert is installed above stream grade. The elevation of the streambed upstream may be lower than the elevation of the culvert bottom. This means that water is being dammed by the culvert and will not flow freely downstream except during periods of higher flows (e.g. spring flows, storms, etc.). Such impounded areas also tend to have higher temperatures than the natural stream, often preventing some fish and aquatic organisms from moving. In some cases, an upstream impoundment may put the long-term stability of the crossing in question as most road beds are not designed to act as dams.



SITE ASSESSMENT and FIELD MEASUREMENTS

Step Two - Field Measurements

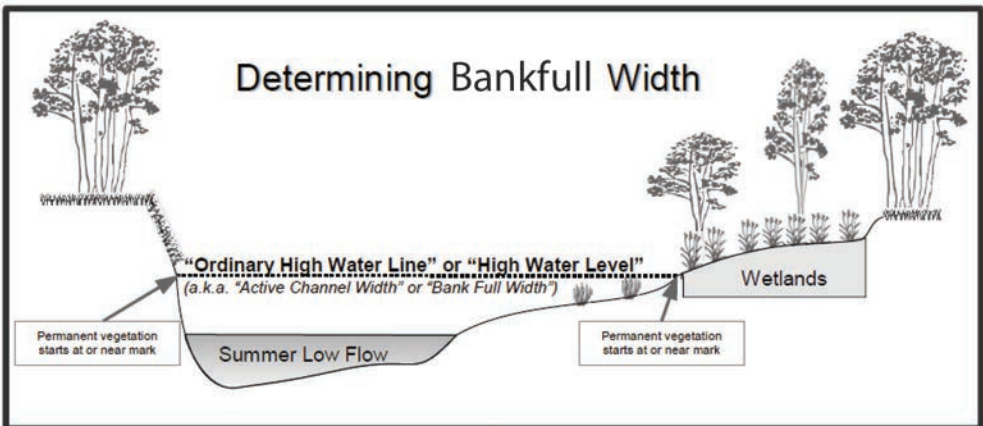
1. Measure Bankfull Width to Span the Stream

Bankfull width is easier to observe where the stream channel occurs within well-defined banks. Several measurements should be taken well outside of the zone of influence of the crossing to ensure a correct width. The distance of disturbance will vary with each stream and crossing, but generally you need to be at least a distance of 20-30 stream widths away from the crossing upstream or down to find an undisturbed area in which to take measurements (i.e. 60-90 feet for a 3-foot stream or 120-180 feet for a 6-foot stream).

At each measurement point, find the streamside elevation where:

- The tops of vegetated stream banks mark the top of the active floodplain;
- There is the lowermost extent of permanent woody vegetation; and
- Exposed soil or rock abruptly changes to vegetated soil.

Work with a helper to extend a measuring tape from that upper stream bank edge or bankfull height to the other bankfull elevation on the opposite side of the stream. Repeat at least 3 times or for as many locations as necessary until you get consistent repeated measurements outside the zone of influence.



2. Measure Stream Profile to Determine Elevation and Slope

- ! A stream profile survey provides all of the basic information needed to set the correct elevation of a stream bottom and slope of the stream for a stream crossing.



The stream profile (also called a longitudinal profile, see page 20) should be determined outside of the influence of an existing crossing structure. The stream profile is determined by measuring a series of elevations along the stream. It can be measured using a hand level or similar instrument, but on flat streams this method can be quite inaccurate. The use of a survey level mounted on a tripod greatly improves the quality of data for a stream with a flat slope.

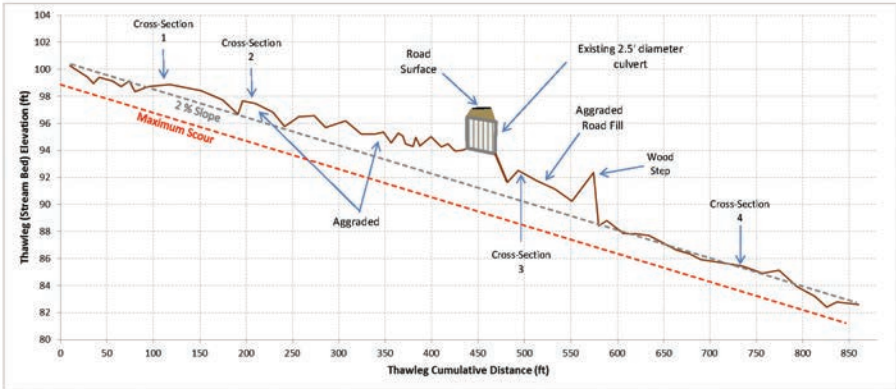
1. Starting at the inlet of the existing crossing, with a level and stadia (survey) rod 10-20 feet upstream, record the elevation.
2. Measure the distance over which the elevation measurements were taken (i.e. distance between the two rod readings).
3. Repeat this process upstream. Be sure to get the elevation difference between each point in the survey.
4. Continue taking measurements in this way until you have covered a distance of at least 20-30 times the width of the stream to get outside the influence of the existing road-stream crossing (i.e. 60-90 feet for a 3-foot stream or 120-180 feet for a 6-foot stream). Repeat downstream.
5. Repeat this process from the downstream outlet of the culvert 20-30 times the width of the stream.

Take measurements in shallow spots along the center, the deepest part of pools, the inlet and outlet of the culvert, and the proposed road center for the new culvert.

SITE ASSESSMENT and FIELD MEASUREMENTS

Step Two - Field Measurements *cont.*

Longitudinal Profile - Existing Conditions



Notes:
This view is vertically exaggerated, reflecting the different scales of units for elevation and distance.



3. Measure Streambed Material to Determine Substrate in the Crossing

It is important to quantify the amount of each type of bed material away from the influence of the existing crossing. For a Stream Smart crossing, the sediments within the culvert should be of equivalent size and quantity to what is found in the natural stream bed. Ideally, there is enough supply and diversity of sediment (i.e. fine and coarse gravel, small to large cobble) to place in the crossing.

Streambed material is generally quantified in 10% increments (e.g. “30% fines/sand; 50% gravel and cobble; 0% boulders; 20% bedrock”). A basic description of typical sizing categories of bed material is as follows:

- Bedrock: >13 feet diameter - Bigger than a car, or continuous.
- Boulders: >10 inches to 13 feet - Basketball to car size.
- Cobble: (small to large) >2.5 inches to 10 inches - Tennis ball to basketball.
- Gravel: (fine to coarse) >3/32nd inch to 2.5 inches - Ladybug to tennis ball.
- Sand: particles visible to the eye to 3/32nd inch and with a gritty feel.
- Fines: Silts and Clay. Particles not visible to the eye, clumpy and very soft when wet.

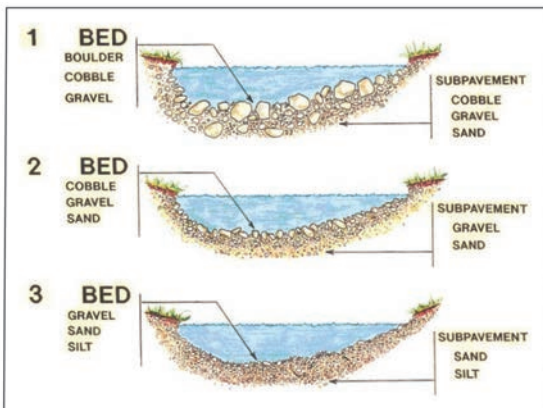


Image from *Applied River Morphology*, Dave Rosgen, 1996

A mixture of bed material size is very important, as the smaller particles will fill spaces among the larger ones, will consolidate to withstand higher velocities and flows and limit scour, and will allow stream flow to pass over the sediment (preventing flow from percolating only downward into the coarse sediment spaces).

IMPLEMENTATION

1. Span the Stream
2. Set the Elevation Right
3. Slope and Skew Match the Stream
4. Substrate in the Crossing



Use the worksheets provided in Appendix A to collect information and measurements and work through the calculations to identify the culvert size, slope, length, and embedment where appropriate. Enter the data into the forms found in Appendix A or draw on graph paper.

1. SPAN the Stream - Size it Right



The scope of this guide is primarily for round, squashed/elliptical or concrete box culverts. For bridge spans or open bottom culverts, the sizing process is the same, however these structures should be very carefully designed and installed to ensure secure footing installation.

A simple way to size a culvert to meet Stream Smart principles is to choose a pipe or other structure that has a diameter 1.2 times the bankfull width as measured in an undisturbed location up or downstream of the crossing. This sized culvert would pass flows up to the bankfull width plus a 20% margin. When embedded to the recommended depth, it allows fish and wildlife movement during normal flows and should have adequate capacity for peak flows.

For culvert replacements, this basic sizing method may be difficult to apply with the following site conditions: high depth of fill, heavy traffic, bedrock, or buried utilities. Technical assistance may be required if any of these conditions is present.



IMPLEMENTATION

1. SPAN the Stream - Size it Right *cont.*



- Size the structure to 1.2 times the bankfull stream width or evaluate all alternatives and upsize the structure as practicable.
- Consider installing a bottomless structure.
- Using a culvert with a diameter 1.2 times the bankfull width takes into consideration the need to embed one quarter the diameter of the culvert



TIPS for CONSTRUCTION

Concrete culverts offer more flexibility with size and geometry of the opening. In a situation where the stream is very wide and shallow, a “low-height” concrete box structure can be used if practicable. It minimizes the amount of fill material where the road elevation does not allow for a high culvert and large amount of fill, but should be made wider than 1.2 times bankfull width if the vertical clearance is very low compared to the stream width (otherwise, the crossing will likely not have the capacity to handle large flows).

2. Set the Elevation Right

From the results of the spreadsheet in Appendix A or your graph paper drawing, note how the pools show the true bottom of the stream when connected by a line at the slope of the stream. This shows the natural tendency of the stream to scour to those elevations. If embedding a structure, set the new culvert bottom elevation $1/4$ the culvert diameter below these pool bottom elevations.

The Stream Smart principle of sizing the crossing by adding 20 percent to the bankfull width (1.2 times the bankfull width) takes into consideration the depth of embedment needed to provide stability under all flow conditions and to prevent erosion around the structure. But the elevation of the pipe and its embedment should be calculated to confirm this. Another good rule-of-thumb is to set all culverts 1-2 feet below the streambed elevation.

If there is no moveable streambed material, but only bedrock, then embedding the culvert becomes impractical. If there is uncertainty about the presence or absence of bedrock versus large rocks when attempting to embed a culvert into an existing streambed, consider the use of a bottomless arch structure such as modular pre-fabricated metal or concrete arches or small bridges. Given Maine's geology, it is relatively common to encounter unexpected bedrock during culvert installation.



Embedment should always be at least equal to one quarter of the culvert height (diameter for round culverts). Dewatering and stream diversion may be needed to set a pipe at the proper elevation. The recommended minimum embedment below the stream bottom elevation is:

*9 inches for culverts smaller than 3 feet
12 inches for culverts between 3 and 4 feet
15 inches for culverts between 4 and 5 feet
18 inches for culverts larger than 5 feet*

IMPLEMENTATION

3. Slope and Skew Match the Stream

From the results of the forms in Appendix A or your graph paper drawing, show the slope of the stream from the top to the bottom of the stream alignment. Match the grade of the installed pipe to the slope of the stream. To calculate the appropriate slope for a culvert installed using this guide (less than 2%), consider that there should be no more than one foot of drop on a 50-foot length of culvert (6 inches for 25 feet). Avoid “hanging” culverts where the bottom of the culvert outlet is above the low water level.

To prevent problematic skew, design the structure in line with the stream upstream and downstream, which may not be at a right angle to the road. This will require a longer structure than just the length required to directly cross the road.

4. Substrate in the Crossing

Riffles, pools, and eddies are important for fish and wildlife, slowing down the water velocity within a crossing structure, and providing alternative paths for organisms to move. The sizing of the substrate should be comparable to the existing bed of the stream. Use the percentages of the different size bed material that were identified during the field measurements in the natural section of the stream not influenced by the existing crossing to determine the mix and amounts of substrate needed for the stream bottom in the culvert.

If the stream bottom is silt, sand and fine gravel the embedment that was provided will allow material from upstream to colonize inside of the pipe. If the stream bottom consists of mostly coarse gravel, cobbles and boulders, then material needs to be placed inside the structure. When placing cobbles, match the size and pattern of rocks in the natural streambed above and below the crossing, but be sure to include a significant amount of finer material that will force the stream to flow across the new stream bed in the structure, and not only to percolate down into the spaces between the cobbles and boulders.



While multiple culverts aren't recommended due in part to their tendency to block the passage of natural materials like woody debris, it's possible to widen the crossing with more than one culvert. When done correctly, one structure is placed slightly lower than the other to maintain the stream channel during low flows and the second, slightly higher one, provides relief during higher flows. This is applicable when the road construction and fill does not provide sufficient coverage over a single large structure. Installing a crossing with multiple pipes may require technical assistance.

Culvert Length

Choose a structure that is long enough to extend beyond any roadside slopes so they and the shoulders will remain stable. Unless a vertical retaining structure is part of the design, the length of culvert must exceed both the upstream and downstream side slopes of the road. If the embankment is at a recommended slope of 1.5 to 1 (1.5 feet across for every foot of rise when riprapped), then the culvert needs to be as long as the width of the road, plus shoulder, plus three times the height of the embankment. In addition, the crossing must extend beyond the fill by at least 1/2 the pipe diameter on both sides. For grassed embankments, the embankment should be at a minimum slope of 2 to 1 (2 feet across for every foot of rise); thus the culvert will need to be longer by two full rises of the embankment on each side of the road.

Example: A road that is 20 feet wide with 4 foot shoulders, that will be 6 feet above the stream bottom, and that will need a 4 foot diameter culvert with riprapped embankments, will need a 50-foot long culvert:

$$[20\text{ft} + 2(4\text{ft}) + 3(6\text{ft}) + 2(4\text{ft})(1/2)] = 50$$

If the stream is somewhat skewed from a straight line across the road, measure along the stream to find the right length. (See directions for calculating culvert length on page 49.)

- ! Headwalls and wingwalls can be used to reduce the length of pipe. However, the armoring will need to be structurally sound. Proper selection of type and material for the retaining structure will be required and the construction and installation must follow immediately. Technical assistance may be required for design and construction of retaining walls.

IMPLEMENTATION

Inlet and Outlet Embankment Armoring

In Maine, rock is plentiful and adequately durable to be used as armoring stones. Never use rounded rocks as they will roll into the stream, leaving the embankment unstable and exposed to erosion.

RIPRAP SIZING

		CHANNEL SLOPE			
		1-2%	2-5%	5-10%	10-20%
MAXIMUM DEPTH OF FLOW (feet)	<0.5	3"	4"	4-6"	6-12"
	1.0	3"	6"	6-12"	12-18"
	2.0	4-6"	6-12"	12-18"	18-24"
	>3.0	6-12"	6-18"	18-24"	24"

- Riprap should be angular, durable and of a size and weight capable of withstanding the velocities at high flows. As a basic guideline, riprap should never be smaller than the largest rocks found naturally within the stream channel. Based on the channel's depth (maximum depth of flow) at bankfull width and the slope of the stream as calculated from the field measurement, the proper size riprap should be selected from the table above.
- Graded riprap consists of a variety of stone sizes with the average size of stone described as the D50. This is the diameter of stone of which 50 percent of the mixture by average diameter (width) is smaller and 50 percent is larger. This makes a well-graded mixture consisting of some large stones and many smaller rocks which progressively fill the voids between the stones.



- The minimum thickness of the riprap should never be less than 6 inches and preferably should be 2.2 times the D50 to ensure that there is sufficient rock coverage of the fill and filter fabric. One should not see the soil beneath the rock nor the filter fabric.

Hydrologic Methods

A hydrologic model is used to assess a more complex stream crossing, as it considers the entire watershed to estimate base and high stream flows. However, unless the land cover within the watershed is accurately evaluated, the model output may only be a rough estimate. These methods can also be useful when cross-checking the size of an existing or new culvert that appears to be undersized. A design engineer or a professional experienced in watershed modeling and flow assessment should be consulted to model and design a structure that requires accurate sizing.

Other Design Issues

Road Construction Concerns

- For new installations, if possible, site the crossing where natural soils will be the least disturbed and where the crossing will receive the least amount of surface runoff (i.e. a road stretch where the road can be flat versus descending toward the stream).
- For new installations, select a crossing location where there is no bend in the horizontal alignment of the stream. The crossing should be at a right angle with the stream instead of having the stream angle back into the culvert. The road centerline should be perpendicular to the stream for a minimum distance of 50 feet with the crossing alignment.
- Where practicable, roadside ditches should not terminate directly into the stream. They should be directed to a ditch turnout and level spreader above a buffer at least 20 feet from the stream.

Stream Ecology Concerns

- Construction should occur during times of low flow to minimize potential impacts to fish and aquatic organisms. The Maine Department of Inland Fisheries and Wildlife generally recommends that all in-stream work occur between July 15-September 30.
- Downstream flow in the stream must be maintained during construction. A cofferdam may be necessary to isolate the work area, but if there is flow in the stream during construction, bypass diversion is required to maintain normal stream flows. In preparation for a major storm, bigger pumps and bigger by-passes should be selected as they will be more effective.



IMPLEMENTATION

Tips for Installing Stream Smart Road Crossings

Construction of Stream Smart road crossings begins with good communication between the project manager and construction crew. Construction plans should be reviewed on site prior to construction.

There are many important items to discuss and identify at that time:

1. Review all details of the construction plans and permit requirements.
2. Determine if there is a need for state or federal fisheries biologists to be on site to assist with fish removal. This is particularly important if the site is located within the Gulf of Maine Distinct Population Segment (DPS) for endangered Atlantic salmon.
3. Determine the construction schedule.
4. Identify a staging area away from the stream for equipment and materials.
5. Identify the areas where construction debris (e.g. trees, old road material, old culvert) will be disposed.
6. Decide how vehicle loads, traffic patterns, and public use of crossing will be managed during construction.
7. Determine what will be necessary to maintain stream flow during construction. Controlling the water involves both a) estimating the pump capacity that will be required to pump clean water around the site and b) determining type and location of cofferdams. *Note: Fish entrainment on the screen of pump intake has been identified as a principle source of mortality. Screens should be sized to reduce currents at the intake and with a small enough mesh to prevent small fish from entering the intake.*
8. Work area will likely need to be dewatered during construction. Establish a location for a sedimentation basin to pump the dirty water to.
9. Identify a laydown area where the needed material and riprap can be stockpiled or where the culvert will be assembled, if necessary.



Stream Diversions, Dewatering, and Cofferdams

Projects that will be under construction while water is flowing in the stream will need cofferdams, stream diversion, and/or dewatering, to provide a dry working environment for construction activities and to maintain downstream normal flow.

Weather reports should be monitored and the structure adequately prepared for anticipated rain. Any flood flows can damage or destroy the cofferdam, and may contribute to the flooding of the upstream area.



Stream Diversions with Pumps

This practice should be limited to small streams, which drain less than one (1) square mile. Centrifugal pumps from 3 to 6 inch are commonly used, depending on the stream flow, height of the cofferdam and available area upstream for storage during construction.

Steps to be considered and implemented:

- Intake for the clean water hose is placed upstream of the cofferdam. Place a block net upstream of the intake hose to reduce the risk of lethal entrainment for fish and amphibians. Place in a pool, on a rock, or in a 5 gallon bucket to prevent erosion.
- If traffic is to be maintained on the road, a temporary pipe or culvert may be placed across the road to route the discharge hose around the construction site and allow construction traffic to move in and out of the site without affecting the hose.
- Diversion water should reenter the stream immediately downstream of the cofferdam to minimize the amount of stream channel that is dewatered. The discharge should be placed on a rock or with geotextile fabric under it to prevent scour within the stream.
- The constant force associated with pumping water will cause the discharge hoses to “migrate” over time. To prevent this, the end of the hose and the geotextile apron should be securely tied to an anchor (tree or other) to prevent movement.
- Assign someone to routinely check the pumps and hoses to ensure that no problems develop due to pumping or discharge. Do not leave unattended for any 24-period and remove all debris (rocks, sticks, etc.) daily.
- Secondary containment of fuel spills at the pump is required in Atlantic salmon watersheds and recommended at all sites. A kiddie pool works well for 3 and 4 inch pumps.

IMPLEMENTATION

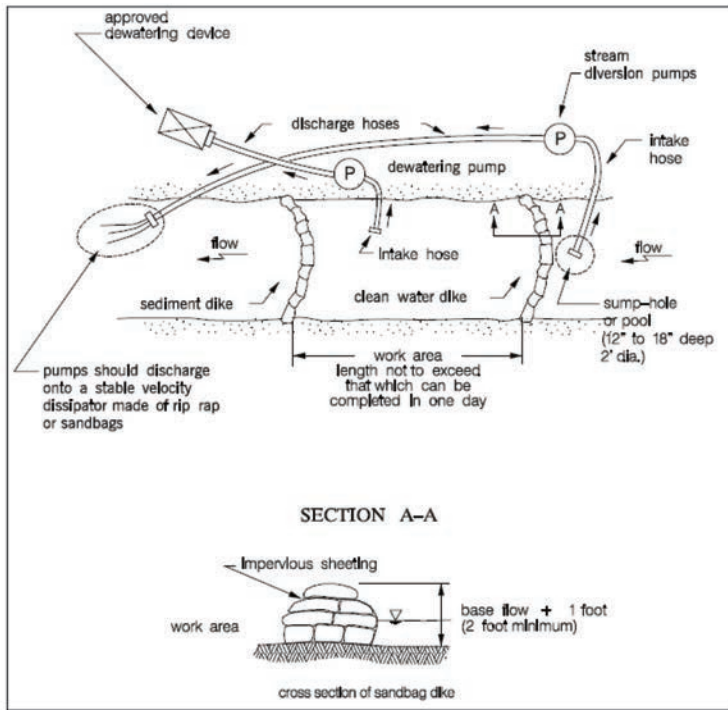
Stream Diversions, Dewatering, and Cofferdams *cont.*

Dewatering

Muddy water that accumulates within the construction dammed area is removed with a pump designed to handle dirty water. The sediment-laden water must be discharged well away from the stream and the clean water that is being pumped around the construction. There are several ways of filtering the discharge including creating a sediment basin by stacking hay bales, forming a box which is draped with geotextile fabric. A basin of this type filters sand and gravel from the water. The “duff” layer of the riparian buffer provides another means of filtering the silt fraction, provided the discharge is located a sufficient distance from the stream. Do not allow the outflow to channelize and cause erosion.

Cofferdams

Cofferdams are established a short distance upstream and downstream of the ends of the new culvert. On small streams, several layers of sand bags are generally sufficient. At larger sites, several options have been used including: commercial size sandbags (3'x3'x3'), sheet pile or plates set into the substrate, or concrete waste blocks. In each case, it is advisable to incorporate a sheet of plastic on the upstream side of the cofferdam to reduce leakage. The downstream cofferdam generally consists of a few smaller sandbags to contain dirty water or prevent downstream water from back-flushing into the construction site.



IMPLEMENTATION

Culvert Installation and Construction

Erosion and Sedimentation Control

Maine state and federal regulations require that all new and replacement crossings have erosion controls in place during construction and have measures to permanently stabilize any disturbed soil after the project is complete. Streams are highly sensitive and all construction work around waterways should have sedimentation control measures installed at the base of all disturbed slopes to protect the stream. A row of silt fence or erosion control mix are good options.

All construction-disturbed areas must be revegetated along streams. Grass seed and anchored mulching or erosion control mix should be applied as each area is completed. Where riprap is used to stabilize the crossing, the rocks need to be underlain by filter fabric. The rocks must be angular and durable. Where riprap is not used, stapled erosion control blankets are recommended.



More erosion and sedimentation control measures and detailed instructions can be found in:

The DEP Erosion and Sedimentation Control manual:
maine.gov/dep/land/erosion/escbmps/index.html

The MaineDOT Best Management Practices for Erosion and Sedimentation Control manual: maine.gov/mdot/env/documents/pdf/bmp2008/BMP2008full.pdf

The Forestry Best Management Practices manual: maine.gov/doc/mfs/pubs/bmp_manual.htm

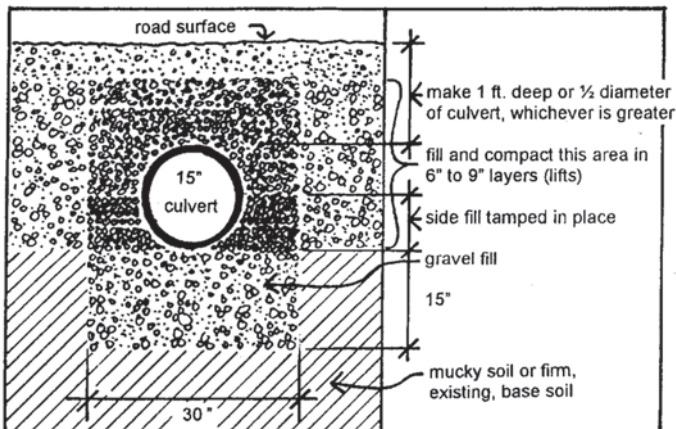
Culvert Excavation and Backfill

After determining the proper type, size, and placement of a culvert, the next steps are typically excavation and backfill. Excavation should begin after safety provisions and erosion and sedimentation controls are in place. At least 72 hours before starting the excavation, call Dig Safe and O.K. to Dig to locate any buried utilities, unless it is an emergency repair. Trenching practices must conform to OSHA regulations.

Excavation: The size and type of pipe will determine the depth of excavation and amount of embedment. It will also determine the backfill process. Depending on whether you are using a corrugated metal, plastic, or reinforced concrete pipe, the specific procedure could vary slightly. Manufacturers often provide guidance on installation. Other factors to consider are the size of the compactor and whether a box cut trench or a tapered trench will be used.

Foundation and Bedding: An unstable trench bottom should be compacted and stabilized with a stone or gravel bedding material to provide a uniform support to the base of the pipe.

Assembly of Pipe: Typically, concrete culvert is connected by inserting the spigot end into the bell end, from downstream to upstream. The joints must be clean and free of any soil or debris. Digging out below the connection area can help keep the pipe clean. Align the two pipes and either pull together with a strap and a come-along, or push them together with a crowbar or backhoe. If a backhoe is used, care must be taken to protect the end from being crushed or damaged. The first pipe can be partially backfilled to provide more stability. Corrugated metal and plastic pipes will have coupling bands. Follow the manufacturer's recommendations for joining pipes sections.



IMPLEMENTATION

Culvert Installation and Construction *cont.*

Culvert Installation

1. The culvert is bedded and backfilled with the native material if suitable (low fine content).
2. Backfill is installed in 6-inch lifts. Attention must be given to compaction beneath and halfway up the pipe.
3. Cover the culvert with a minimum of one foot of backfill. If multiple culverts are used, they shall be separated by at least 12 inches of compacted fill.
4. Sands, silts, clays, or organic materials should not be used for construction within the waterway channel.

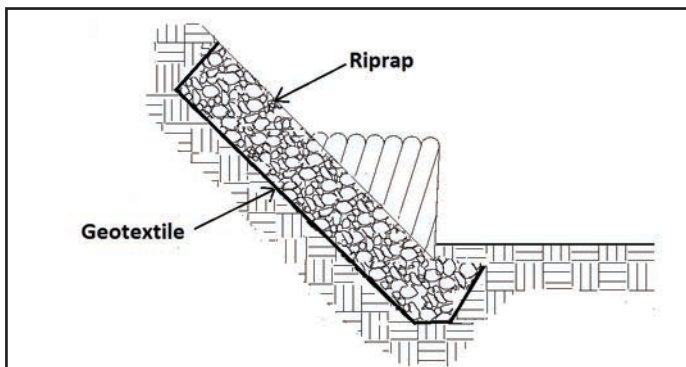


Embankment Stabilization

1. Make sure the culvert is embedded properly.
2. Once brought back to grade, all areas of disturbed soil are seeded within a week and protected by hay mulch or an erosion control blanket that is properly pinned.
3. The inlet and outlet is sufficiently stabilized for all anticipated flow conditions. The streambed is restored to the same slope as prior to the culvert installation.
4. Vegetation, riprap or other protective cover must be established promptly.

RipRap Installation

1. Prepare the subgrade for the riprap to the required elevation and grades. Any fill required in the subgrade is then compacted to a density approximating that of the surrounding undisturbed material. Fill should be compacted as required, typically to a density of 95 percent maximum as determined by Standard Proctor Density.
2. Nonwoven geotextile filter fabric should always be provided where seepage threatens the stability of the riprap.
3. Install the nonwoven geotextile filter fabric using proper construction methods for the material. Key in the filter fabric at the top of the riprap edge and extend the fabric into the toe trench.
4. Dig a trench at the toe of the slope to “key in” the bottom course of riprap. The key trench should be at least two thirds ($2/3$) as deep as the size of the largest riprap.
5. Place nonwoven geotextile cloth directly on the prepared slope. The edges of the sheets should overlap by at least 12 inches. Anchor according to the manufacturer’s recommendations and with the pins suggested by the manufacturer. If damage occurs, that sheet should be removed and replaced or repaired.
6. Place riprap immediately following filter fabric placement. Install riprap so that it produces a dense well-graded mass of stone with a minimum of voids and to its full thickness in one operation. Dumping large quantities of angular riprap stone onto geotextile fabric may result in tears. To avoid damaging fabric, do not drop stone from more than two feet above fabric.
7. Begin placing stones at the toe trench and work upwards, making sure the armor layer is at least two stones thick and completely covers the fabric or gravel filter.



IMPLEMENTATION

Culvert Installation and Construction *cont.*

Substrate in the Crossing

Adding substrate into a crossing is part of the Stream Smart design. Use caution when placing material into the pipe by following all training and procedures that apply to working in confined spaces. When a stream is stable, with a crossing sized and embedded properly, fine substrates such as sand and gravel may naturally move into and through the crossing.

However, if the culvert is greater than 4 feet in diameter and the stream's bed includes rocks that are greater than 2.5 inches, substrate should be added to the culvert with rocks that match those in the natural stream in size, shape and variety (do not use riprap). With larger culverts, such as those over 6 feet wide, larger rocks should be placed along the sides to act as banks within the culvert, and there should be a lower area, generally near the middle, where low flows will be concentrated.

Long-Term Maintenance

Establish a regular monitoring and maintenance schedule for each culvert. Check the structure following a major rain event, paying attention to the following:

1. Make sure that the road and ditches are not carrying sediment to the stream. Maintain and re-stabilize as needed.
2. See if the abutments, riprap armoring, and bank stabilization measures are being undermined or damaged, and if repair is needed.
3. Remove debris or other material that may block or constrict the culvert opening.
4. See that the river bed is stable. If erosion is occurring at the outlet, repair the apron as necessary.

Permitting Considerations

Many activities in, on, over, or adjacent to waterbodies, wetlands, and other natural resources require permits from federal and/or state agencies. You can find contact information and other helpful agencies in Appendix B. Local municipalities may also have permitting or notification requirements.

State Permits: Maine Department of Environmental Protection (DEP), Natural Resources Protection Act. DEP administers the Natural Resources Protection Act, which regulates activities in, on, over and adjacent to protected natural resources. The Natural Resources Protection Act (38 MRSA Section 480-B (9)) defines a river, stream, or brook. If you would like help identifying natural resources on your project site, contact your DEP Regional Office.

DEP has exemptions for maintenance and repair of existing structures and for the replacement of existing road culverts provided your project can meet certain criteria. They also have a Permit-by-Rule program that outlines design requirements for stream crossings for expedited review (Chapter 305, Section 10). Both the exemption and the Permit-by-Rule Standards require that the crossing allows fish passage and the use of erosion and sedimentation control measures.

Federal Permits: Army Corps of Engineers (ACOE) Maine Project Office, Clean Water Act. ACOE has the Maine General Permit that covers most waterway crossings. Your project may be a Category 1 (non-reporting) activity at the federal level if it meets specific standards, uses BMPs, new fill below the ordinary high waterline is less than 4,300 square feet, and the project is not in an Essential Fish Habitat (EFH).

Federal Permits: US Fish & Wildlife Service, Endangered Species Act. This applies to waterways that are designated as Atlantic Salmon, Gulf of Maine Distinct Population Segment (DPS), critical habitat (CH), and that are subject to the Endangered Species Act. Typical triggers are a federal action such as some component of federal funding of the project or if a permit is required from the Army Corps of Engineers. The same federal triggers may also require review of Atlantic Salmon Essential Fish Habitat (EFH) for Atlantic Salmon and select coastal species as designated by the Magnuson-Stevens Conservation and Management Act per 50 CFR. 600.

IMPLEMENTATION

Culvert Installation and Construction *cont.*



Review and permitting requirements can be complex. Consult with Special Issues. Pay special attention and consult with regulatory agencies early in the project's planning, especially if your project includes any of the following:

- *Retrofits (slip-lining, invert lining)*
- *Replacements of culverts associated with tidal conditions*
- *Replacing a pipe with one that is smaller in diameter than the original*
- *Will create more than 4,300 sq. ft. of fill in wetlands or below the ordinary high water-line*

It is likely that the agencies will require you to do at least one of the following:

- Demonstrate that fish or aquatic organism passage and habitat connectivity are provided to the extent practicable.
- Demonstrate that the project is going to be completed in the least environmentally damaging of all considered alternatives.
- Species-specific regulatory concerns may restrict in-stream work to several months a year.
- If the project has a particular species of concern to the regulatory agencies, you may also be asked to monitor your crossing to demonstrate that the structure passes the particular target species during the most crucial flows.

At stream crossings where there has been a history of maintenance issues (for example, crossing failures or chronic erosion), culvert replacement may include the removal of accumulated road material upstream and/or downstream of the site to restore the stream bed to its original elevation. Sites of this nature require further assessment and planning than is intended by this guide. It is highly recommended that you speak with fishery biologists, permitting agencies, and other technical advisors to ensure that the stream crossing is replaced in a manner that maximizes habitat rehabilitation and minimizes impact during construction.



Grand Lake Stream Arch

APPENDICES

Appendix A: Stream Smart Crossing Site Examination and Culvert Sizing Worksheets

STREAM-SMART CROSSING SITE EXAMINATION FORM			
Town:	Date:	Road, address:	Stream:
Description of location:			
Describe recent weather influencing stream flows:		Water elevation at time of visit:	
EXISTING STRUCTURE INFORMATION			
Type of existing structure:	Size:	Length:	Width of Road:
Height of fill:	What is the condition of the structure:		
Describe the outlet (hanging culvert, banks and pool, etc.):			
Describe the inlet (inlet pool, channel constriction, banks, etc.):			
What are the needed changes:			
CONSTRUCTION INFORMATION OR CRITERIA			
Duration of construction:	Traffic control issues:	Stream diversion, cofferdam or dewatering needs:	
Preferred time of construction (for traffic, fish passage, etc.):			

Appendix A: Stream Smart Crossing Site Examination and Culvert Sizing Worksheets *cont.*

STREAM CHARACTERISTICS AT TIME OF VISIT
The following information is not necessary to size and design an appropriate culvert for the crossing. However, it will provide important information later on to backup the decisions that were made during the site visit. Also, photos can be very useful.
Description of stream bed, material and banks within 50-100 feet of the crossing:
Describe bed load (stream channel rock size) and debris:
Describe how the stream reacts during high flood events:
Note evidence of bank instability and stream bottom scour:
Note stream flow angle to the culvert. If at an angle, a longer culvert may be needed:
Note channel stability (down cutting, lateral channel migration, accumulation of sediments, etc.):
Note upstream or downstream structures that may affect the site:
Note presence of bedrock depth and condition:
Note what other factors affect the site:
Note other special conditions needed to address issues at the site:

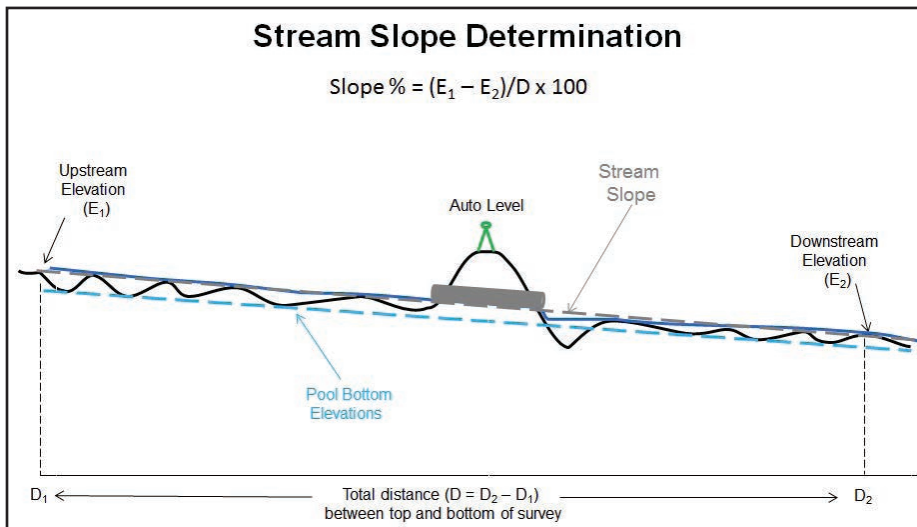
FIELD MEASUREMENTS	
(1) Width	Away from the influence of the crossing, take stream width measurements at 3-5 locations upstream and downstream that represent the width of the natural stream channel at the normal high water line. Do not measure at pools.
(2) Depth	At the same locations as the width measurements, measure the average depth from the high water line (not the current water level) down to the stream bottom across the channel. <i>Note: these measurements are generally not needed if sizing by the Stream Smart method of 1.2 times stream width.</i>
(3) Distance	Record the distance along a tape measure laid from upstream to downstream where each elevation measurement is taken, generally starting at zero, and continuing through the total distance surveyed.
(4) Elevation	Preferably sighted from one location on the road, record the elevation on the survey rod at representative high and low stream bed features upstream to downstream, and including existing crossing inlet and outlet, and road center, recording the distance for each elevation as described above.
CALCULATIONS	
(5) Width Averages	Average the width measurements (add measurements and divide by the number of locations) for both upstream and downstream portions of the survey, and for the overall stream reach.
(6) Slope	Calculate the overall slope of the stream by dividing the change in elevation from the top of survey (E_1) to bottom (E_2) by the total survey distance ($D_2 - D_1$), and multiply by 100 to get a percent.

Appendix A: Stream Smart Crossing Site Examination and Culvert Sizing Worksheets *cont.*

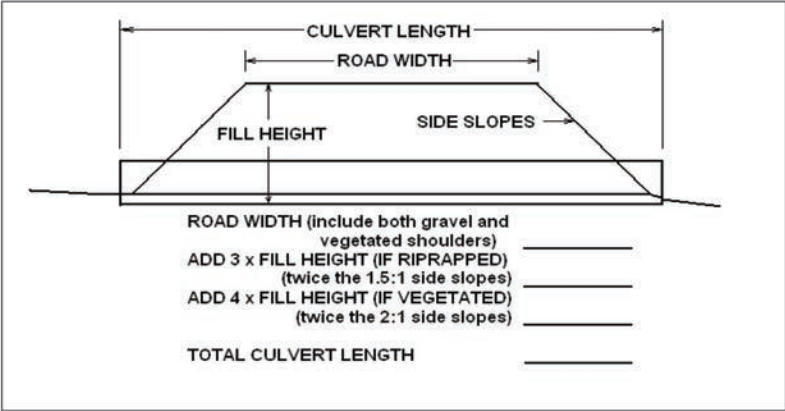
FIELD MEASUREMENTS - WIDTH		
Needed tools: measuring tape & survey rod		
	WIDTH (1)	DEPTH (2)
	Width (ft.) at high water mark	Average Depth (ft.) at high water mark
UPSTREAM FROM CROSSING		
Upstream Average (5)		
DOWNSTREAM FROM CROSSING		
Downstream Average (5)		
Overall Average (5)		

FIELD MEASUREMENTS - ELEVATIONS & SLOPE		
Needed tools: measuring tape, survey rod and level		
	SLOPE (3 & 4)	
	Distance (3) (ft.)	Elevation (4) (ft.)
UPSTREAM FROM CROSSING	(D ₁)	(E ₁)
Inlet Invert		
Road Center		
Outlet Invert		
DOWNSTREAM FROM CROSSING		
		(D ₂)
Slope % (6) = $(E_1 - E_2)/(D_2 - D_1) \times 100$		
* E ₂ should be taken at same feature type as E ₁ (pool bottom, top of riffle, etc.)		

Appendix A: Stream Smart Crossing Site Examination and Culvert Sizing Worksheets *cont.*



CULVERT WIDTH SIZING		
Copy the overall average width and depth measurements from the WIDTH worksheet	WIDTH	
	DEPTH (if needed)	
Stream Cross-Sectional Area (sq. ft.) = Width x Depth		
Stream Smart Culvert Width = 1.2 x WIDTH above		
Planned Culvert Shape (Round, Pipe Arch, Elliptical, Open Arch, Box)		
Planned Embedment (ft.)		
Planned Culvert Width (ft.) - available culvert size with width at least as wide as above Stream Smart Width (diameter for round culverts), and accounting for embedment		
Planned Culvert Height (ft.) - if not round		

SLOPE - LENGTH - EMBEDMENT											
Import the measurements recorded at the stream crossing	DEPTH										
	WIDTH										
	SLOPE										
Calculate the minimum length of the culvert needed by adding twice the height of the backfill over the bottom of the pipe plus the width of the road and shoulders. A longer pipe may be needed for shallower fill side slopes or for culverts that are angled to the road. Use the graphic provided below.			Culvert length:								
Enter the placement slope for the culvert, i.e., the slope of the culvert should be the same as the slope of the stream bottom.			Culvert slope:								
Embedment of the culvert is needed at 25% (one quarter) of the pipe size or use the provided embedment	≤ 3 feet	9"	Needed embedment:								
	3' - 4'	12"									
	4' - 5'	15"									
	> 5'	18"									
 <p>The diagram shows a cross-section of a culvert with a rectangular pipe. Above the pipe, a trapezoidal shape represents the road and its fill. The top horizontal line of the trapezoid is labeled 'ROAD WIDTH'. The vertical height from the top of the pipe to the top of the road is labeled 'FILL HEIGHT'. The sloped sides of the trapezoid are labeled 'SIDE SLOPES'. The total horizontal length of the culvert, including the pipe and the side slopes, is labeled 'CULVERT LENGTH'.</p> <p>Below the diagram is a calculation table:</p> <table border="0"> <tr> <td>ROAD WIDTH (include both gravel and vegetated shoulders)</td> <td>_____</td> </tr> <tr> <td>ADD 3 x FILL HEIGHT (IF RIPRAPPED) (twice the 1.5:1 side slopes)</td> <td>_____</td> </tr> <tr> <td>ADD 4 x FILL HEIGHT (IF VEGETATED) (twice the 2:1 side slopes)</td> <td>_____</td> </tr> <tr> <td>TOTAL CULVERT LENGTH</td> <td>_____</td> </tr> </table>				ROAD WIDTH (include both gravel and vegetated shoulders)	_____	ADD 3 x FILL HEIGHT (IF RIPRAPPED) (twice the 1.5:1 side slopes)	_____	ADD 4 x FILL HEIGHT (IF VEGETATED) (twice the 2:1 side slopes)	_____	TOTAL CULVERT LENGTH	_____
ROAD WIDTH (include both gravel and vegetated shoulders)	_____										
ADD 3 x FILL HEIGHT (IF RIPRAPPED) (twice the 1.5:1 side slopes)	_____										
ADD 4 x FILL HEIGHT (IF VEGETATED) (twice the 2:1 side slopes)	_____										
TOTAL CULVERT LENGTH	_____										

Note: The diagram only applies appropriately for Stream Smart crossings when the distance between x and y is between 40-60 stream widths (240'-360' for a 6' stream). In general, slope measurements taken close to the existing crossing will not reflect the natural stream slope.

Appendix B: - Sources of Technical Assistance

MaineDOT Local Roads Center: Municipal Departments of Public Works may contact Maine DOT's Local Roads Center for advice and guidance.

MaineDOT Local Roads Center
Community Services Division: Peter Coughlan
maine.gov/mdot/csd/mlrc
1-800-498-9133

Best Management Practices for Forestry: Protecting Maine's Water Quality Manual. Developed by the Maine Forest Service, Department of Agriculture, Conservation and Forestry, this manual provides detailed information on forest practices and offers culvert sizing and installation methods: maine.gov/doc/mfs/pubs/bmp_manual.htm

Complete MaineDOT Waterway and Wildlife Crossing Policy & Design Guide: This manual provides more detailed information on aquatic organism biology, engineering design considerations, and regulatory context for aquatic organism passage. It also describes alternative engineered solutions to retrofit existing pipes to provide aquatic organism passage: maine.gov/mdot/environmental-office-ho.php

MaineDEP: Bureau of Land and Water Quality, Division of Land Resource Regulation: maine.gov/dep/blwq/docstand/nrpapage.htm

- Augusta (Central Maine Regional Office): (207) 287-3901; (800) 452-1942
- Bangor (Eastern Maine Regional Office): (207) 941-4570; (888) 769-1137
- Portland (Southern Maine Regional Office): (207) 822-6300; (888) 769-1036
- Presque Isle (Northern Maine Regional Office): (207) 764-0477; (888) 769-1053

US Army Corps of Engineers: nae.usace.army.mil/reg/index.htm

Maine Project Office New England District US ACOE 675 Western Avenue #3, Manchester, Maine 04351. Phone: (207) 623-8124 Fax: (207) 623-8206

US Fish and Wildlife Service: <http://www.fws.gov/mainefieldoffice/>

To find out more about Atlantic Salmon Gulf of Maine Distinct Population Segment, contact the United States Fish and Wildlife Service: 306 Hatchery Road, East Orland, Maine 04431. Phone: (207) 469-7300 Fax: (207) 702-6000

National Marine Fisheries Service: To find out more about Atlantic Salmon Critical Habitat, contact the National Marine Fisheries Service (NOAA): nero.noaa.gov/prot_res/altsalmon/dpsmaps.html

Maine Department of Inland Fisheries & Wildlife: maine.gov/ifw/

Stream Smart: For additional Stream Smart resources including videos, powerpoint presentations, and workshops: StreamSmartMaine.org

Appendix C: Excerpts of Laws/Regulations Pertaining to New and Replacement Crossings

For full text of the Natural Resources Protection Act, including exemptions and definitions: mainelegislature.org/legis/statutes/38/title38sec4-80 A.html

For information on the presence or absence of endangered or threatened species, including Atlantic Salmon: fws.gov/mainefieldoffice/Endangered_and_Threatened_Species.html

For state Permit by Rule standards: maine.gov/sos/cec/rules/06/096/096c 305.doc

For the federal Maine General Permit: nae.usace.army.mil/Regulatory/SGP/me.htm

For information and assistance from the Maine Department of Inland Fisheries & Wildlife: maine.gov/ifw/wildlife/species/endangered_species/regional_offices.htm

Maine State, Natural Resources Protection Act. Title 38 MRSA § 480-Q.

Activities for which a permit is not required:

A permit is not required for the following activities if the activity takes place solely in the area specified below: [1987, c. 809, §2 (NEW).]

Existing crossings (Section 2-D). A permit is not required for the repair and maintenance of an existing crossing or for the replacement of an existing crossing, including ancillary crossing installation activities such as excavation and filling, in any protected natural resource area, as long as:

A. Erosion control measures are taken to prevent sedimentation of the water; [2011, c. 205, §3 (NEW).]

B. The crossing does not block passage for fish in the protected natural resource area; and [2011, c. 205, §3 (NEW).]

C. For replacement crossings of a river, stream or brook:

- * The replacement crossing is designed, installed and maintained to match the natural stream grade to avoid drop or perching; and
- * As site conditions allow, crossing structure that are not open bottomed are embedded in the stream bottom a minimum of one foot or at least 25% of the culvert or other structure's diameter, whichever is greater, except that a crossing structure does not have to be embedded more than 2 feet. [2011, c. 205, §3 (NEW).]

For the purpose of this subsection, "repair and maintenance" includes, but is not limited to, the riprapping of side slopes or culvert ends; removing debris and blockages within the crossing structure and at its inlet and outlet; and installing or replacing culvert ends if less than 50% of the crossing structure is being replaced.

Contacts

Maine Department of Environmental Protection

Portland	207-822-6300	888-769-1036
Augusta	207-287-3901	800-452-1942
Bangor	207-941-4570	888-769-1137
Presque Isle	207-764-0477	888-769-1053

Maine Department of Inland Fisheries and Wildlife: 207-287-8000

Maine Department of Marine Resources Division of Sea-Run Fisheries and Habitat

Hallowell	207-624-6352	(Central and Southern Maine)
Bangor	207-941-4454	(Penobscot and Northern Maine)
Jonesboro	207-434-5921	(Downeast Maine)

Maine Department of Transportation Environmental Office: 207-624-3100

