NEW HAMPSHIRE

STREAM CROSSING INITIATIVE

FIELD MANUAL

for the Statewide Asset Data Exchange System (SADES)

Cover image: Newly replaced stream crossing, Groton NH. Credit: Kyle Hacker

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STREAM CROSSING INITIATIVE
FIELD MANUAL
for the Statewide Asset Data Exchange System (SADES)

Prepared in partnership with:

New Hampshire Department of Environmental Services
New Hampshire Geological Survey
New Hampshire Department of Transportation
New Hampshire Fish and Game Department
New Hampshire Department of Safety – Division of Homeland Security and Emergency Management
Association of New Hampshire Regional Planning Commissions
Univeristy of New Hampshire Technology Transfer Center

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The New Hampshire Stream Crossing Initiative— A multiagency collaboration

The NH Stream Crossing Initiative is an interagency workgroup to collaboratively manage the state's stream crossing assessment efforts. The initiative is comprised of representatives from the New Hampshire Departments of Environmental Services (NHDES; New Hampshire Geological Survey and Wetlands Bureau), Transportation (NHDOT), and Fish and Game Department (NHFG), The Division of Homeland Security and Emergency Management (HSEM), and the University of New Hampshire Technology Transfer Center (UNH T^2). This initiative has become possible due to the expertise of many people who have contributed their time and effort to develop and refine the stream crossing survey protocols, data management and methods for scoring stream crossings for geomorphic compatibility,, aquatic organism passage, and hydraulic vulnerability to flooding. The multiagency approach of the Initiative enables towns,state and federal agencies, and conservation groups to more efficiently address the problem of undersized stream crossings, infrastructure safety, and flood risk management by working collaboratively.

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ACRONYMS

ACRONYM	DEFINITION
AOP	Aquatic Organism Passage
BFW	Bankfull width
CCDS	Closed culvert drainage system
DS	Downstream
DOS	New Hampshire Department of Safety
GC	Geomorphic Compatibility
HSEM	(DOS) Homeland Security and Emergency Management
HC	Hydraulic Capacity
NHDES	New Hampshire Department of Environmental Services
NHFG	New Hampshire Fish and Game Department
NHGS	(NHDES) New Hampshire Geological Survey
NHDOT	New Hampshire Department of Transportation
NHDESWB	New Hampshire Department of Environmental Services Wetlands Buruea
NHSCI	New Hampshire Stream Crossing Initiative
SADES	Statewide Asset Data Exchange System
T^2	(UNH) Technology Transfer Center
QA/QC	Quality Assurance and Quality Control
UNH	University of New Hampshire
US	Upstream

PROJECT BACKGROUND

Stream crossings are structures (for instance, culverts, bridges, arches) that carry a road over a river, lake, wetland or small stream. As a state that has a vast diversity of waterbodies, stream crossings are a critical component of New Hampshire's road network and infrastructure. Undersized culverts and bridges may restrict streamflow moving through the crossing, thereby increasing water velocity through the conduit. The force of this fast-moving water exiting the conduit can cause downstream bank erosion and streambed scour, bank destabilization, and a perched culvert condition. During floods, fast moving water entering the pipe can overwhelm the roadway fill and banks and lead to a road washout. In addition, small culverts are prone to obstructions, which can cause water to pond upstream. During flood situations, that water can create a wall of water that is washed downstream, eroding stream banks and damaging infrastructure in its path. Improperly designed crossings can also be a barrier to fish and other aquatic animal passage, prohibiting upstream movements to important spawning areas and fragmenting the stream network. Learning from past experiences, NHDES, working with partners, is striving to proactively address flood risks and make our infrastructure more resilient by identifying problem culverts for replacement before they can fail and cause damage.

PURPOSE

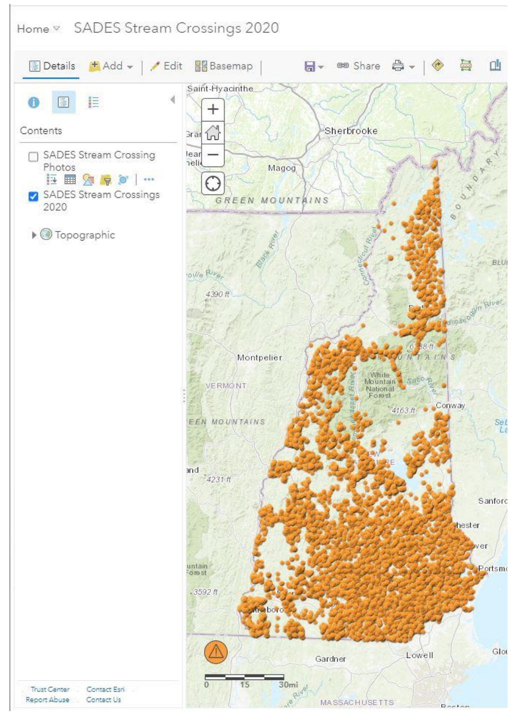
The purpose of stream crossing surveys is to **collect coarse-screening level** information to support data-driven decisions on prioritizing stream crossing replacement projects within a town, watershed, or region. The data collected in this protocol will be sufficient to rank culverts according to their risk of overtopping and failure, degree of aquatic organism passage, and impacts to stream geomorphology and general river environment. Once a crossing assessment is complete and has undergone quality assurance and quality control (QA/QC), it is screened for:

1) Geomorphic Compatibility (GC) — structure fit with river form and processes.
2) Aquatic Organism Passage (AOP) — ranking of whether the structure is a barrier to animal passage.
3) Condition – New Hampshire Department of Transportation (NHDOT) asset condition score.
4) Hydraulic Capacity (HC) — of the structure to transport predicted flows under storm events.

For these screening tools to produce accurate results, accurate data collection (and therefore, following the instructions outlined in this manual) is essential. Stream crossing data collected through this protocol **must** be QA/QC'd by the New Hampshire Department of Environmental Services (NHDES) New Hampshire Geological Survey (NHGS) and Wetlands Mitigiation Program **before** it can be run through the scoring models and distributed to the public. It is critical that data collectors participate in the QA/QC process to ensure high-quality data that accurately represent the conditions of the stream crossing and river environment. Contact Brian Hauschild in NHGS or Cheryl Bondi in the NHDES Wetlands Bureau for questions regarding the QA/QC process.

This protocol is for surveys on freshwater stream crossings and is **NOT** applicable for tidally-influenced crossings. For information on tidal crossings, contact Kevin Lucey at the NHDES Coastal Program at (603) 559-0026. To view more information on tidal crossing assessments, read the "Resilient Tidal Crossing Report."

THE STATEWIDE ASSET DATA EXCHANGE SYSTEM



The Statewide Asset Data Exchange System (SADES) is an online geodatabase that stores stream crossing data and is displayed on a web mapping service. The online database and map are hosted by ArcGIS Online, and managed by The University of New Hampshire (UNH) Technology Transfer Center (T^2) as part of the NHDOT's asset management program. Data is collected using the ESRI Collector Application for ArcGIS and uploaded to ArcGIS Online. UNH T^2 has an equipment loan program available to agencies to collect these data. This equipment is available on a first-come-first-served basis and an outline of the loan program is distributed by T^2 to all stake holding parties.

All data submitted to SADES undergoes a rigorous Quality Assurance and Quality Control (QA/QC) process before it is available for use and distribution by agencies, towns, and the public. The initial data compilation and management onto the webserver is done by T^2 and QA/QC is performed by NHDES environmental scientists. The QA/QC process ensures consistency across data collection groups and reduces incorrect scoring of stream crossings due to errors made in the field. After data passes the QA/QC process, it can be viewed using the NH Aquatic Restoration Mapper or the NH SADES Stream Crossing Viewer.

Questions regarding the ESRI Collector app, SADES geodatabase and equipment loan program:
UNH Technology Transfer Center
Chris Dowd
SADES Manager
chris@nhsades.com
Office: (603) 862-5489

Questions about survey coordination, field training, and Data Quality Control contact:
NHDES New Hampshire Geological Survey
Brian Hauschild
brian.k.hauschild@des.nh.gov
Office: (603) 271-0587

NHDES Wetlands Mitigation Program
Cheryl Bondi
Cheryl.A.Bondi@des.nh.gov
Office: (603) 271-0727

EQUIPMENT

Rangefinder	**To measure bankfull widths, crossing dimensions, crossing length, and pool length. This is an essential piece of equipment!**
Measuring Tape	To measure in cases where the rangefinder will not work.
Depth Rod	To measure water and pool depth, and roadway and culvert elevations in tenths of a foot.
Electronic Field Tablet	Equipped with the Arc Collector application.
GPS Receiver	To use if the data collection device is not GPS equipped
Safety Vests	Brightly colored, reflective vests so data collectors are visible on the road.
Waders or Hip Boots	These allow observers to survey tailwater pools and deeper portions of the stream and also protect data collector's legs from abrasions and poison ivy.
Hand-held Level	For reading the vertical distance on the depth rod when measuring the inelt and outlet elevations.
Sun Protection	Hat, sunglasses and sunscreen.
Insect Repellant	To protect from mosquitoes and ticks.
First Aid Kit	To deal with any minor injuries, cuts, scrapes, etc.
Cell Phone	In case of emergency, to coordinate surveys, or to contact your coordinator
Flashlight	To inspect the inside condition and substrate of the crossing.
Hard ruler	To measure sediment within structure for embedded culverts.

SAFETY

Surveys must be done by at least two people for safety reasons. Because these surveys take place around roads, it is highly recommended each person wears highly visible clothing and a safety vest. Surveyors should avoid wading into areas of high flows, pools of unknown depths, or scaling steep and rocky embankments. Using an accurate laser rangefinder is one way to measure long distances without having to wade across the stream or climb up the banks. People should never enter or cross through a culvert as part of this protocol.

There may be situations when a parameter cannot be collected due to safety and land access issues. In these cases, leave the field blank and explain in the comments. Each collector should also follow their own agency safety protocols.

TRAINING

Training is ***required*** of any individuals, agencies or organizations that plan to assess stream crossings using the New Hampshire Stream Crossing Assessment Protocol. Instructions on electronic data collection, uploading data, and accessing SADES are provide by Chris Dowd at UNH T^2, who is available at (603) 862-5489. The field manual training includes a full-day classroom session accompanied by a half-day field portion. Please contact NHGS to find out the dates of planned trainings at (603) 271-2876. During the course of field assessments, NHDES and NHDOT staff are available to answer questions and provide technical guidance. All training materials including presentations, demonstration videos, handouts, and the most current version of the field manual are located on the [Stream Crossing Initiative Webpage] under the "Training" menu.

HOW TO DETERMINE SURVEY LOCATIONS

The location of all potential road-waterbody intersections (i.e. stream, lake, pond, and wetland) are prepopulated in the SADES Stream Crossings databse. There are three tiers of potential survey locations, each represented by a different symbol:

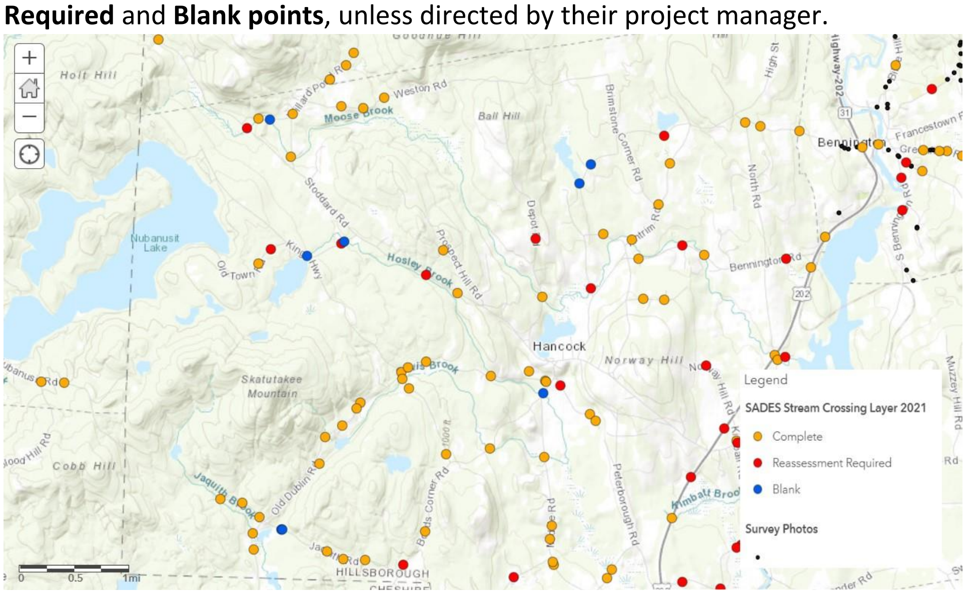
1) "**Complete**" points (orange circles) are stream crossings where a recent survey (within 5 years) has been done, the data has passed QA/QC, and it is scored for AOP, GC, HC, and Condition.

2) "**Reassessment Required**" points (red circles) are those that need to be revisited for either:

- A complete survey to replace data older than 5 years or replace incompltete and/or incorrect data, or
- A partial survey to fill in data gaps to score for AOP, GC, and HC.

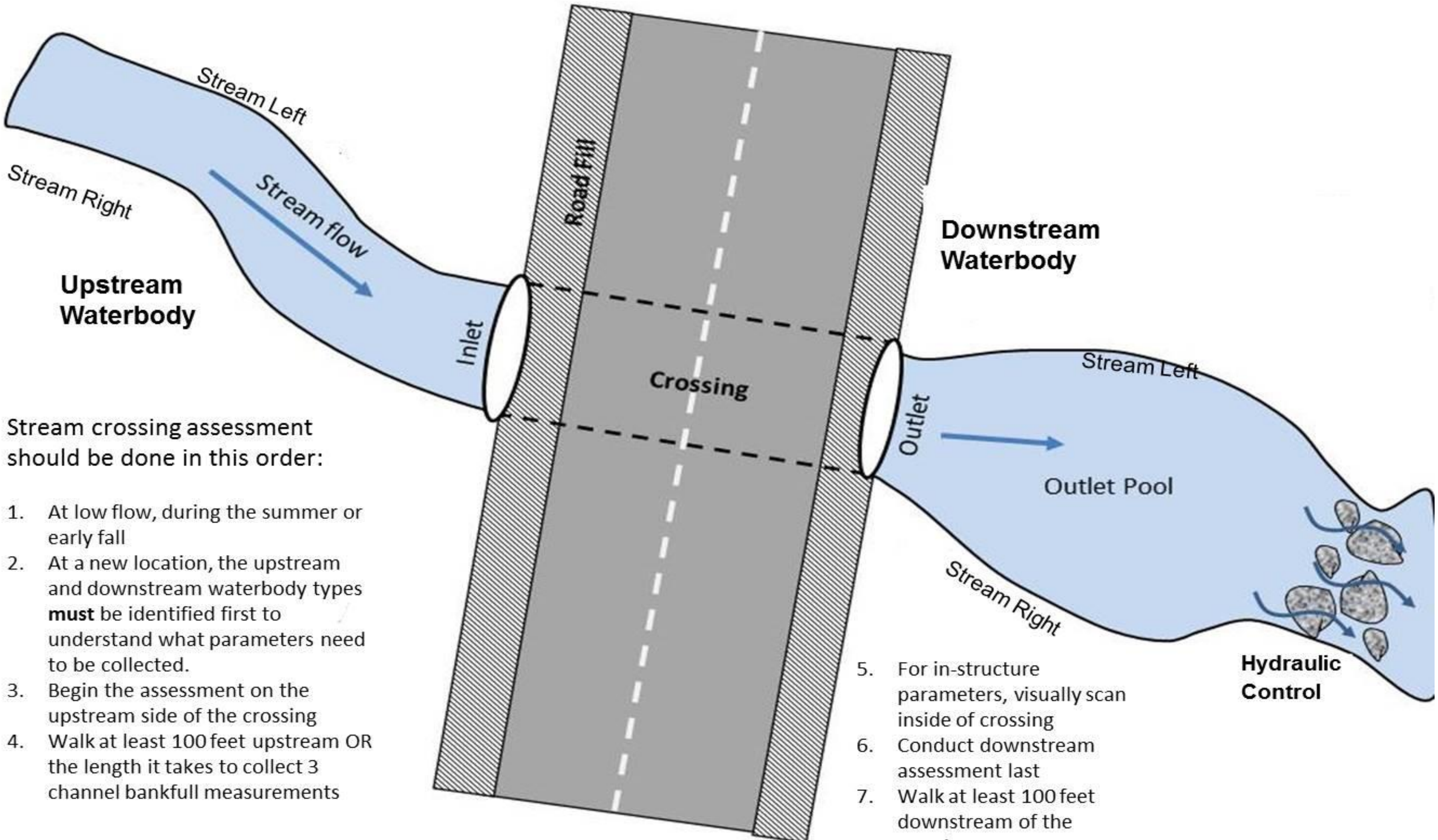
3) "**Blank**" points (blue circles) are potential stream crossing locations where no survey has ever been done and a full survey is needed.

Data collectors will download their project area of interest in the Arc Collector App and the SADES Stream Crossing layer will display the three tiers of data classification. Teams should focus their survey efforts on the **Reassessment Required** and **Blank points**, unless directed by their project manager.



What if your stream crossing location is not included in the prepopulated database?
New points can still be created in SADES for any stream crossings that may not be located on the map. Once data collection is complete, assessors will still need to create a photo point to be placed on top of the data point.

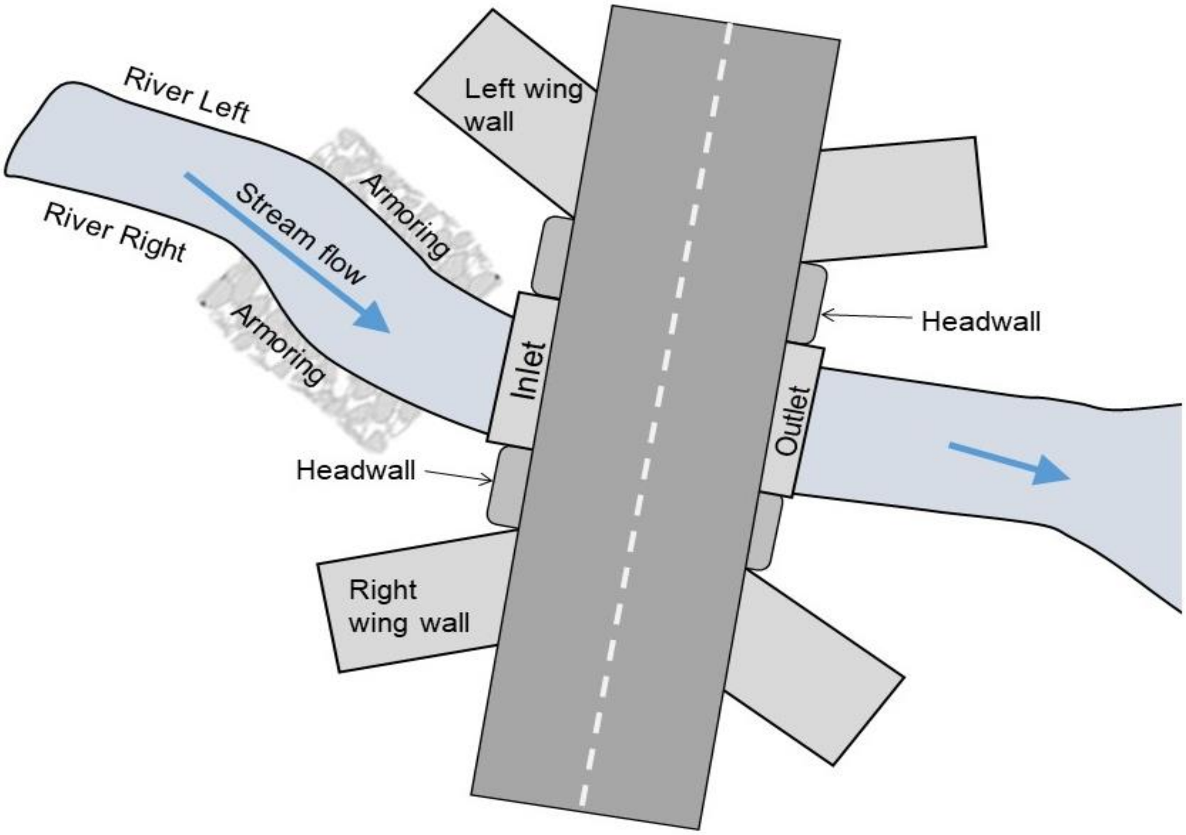
Assessment Overview



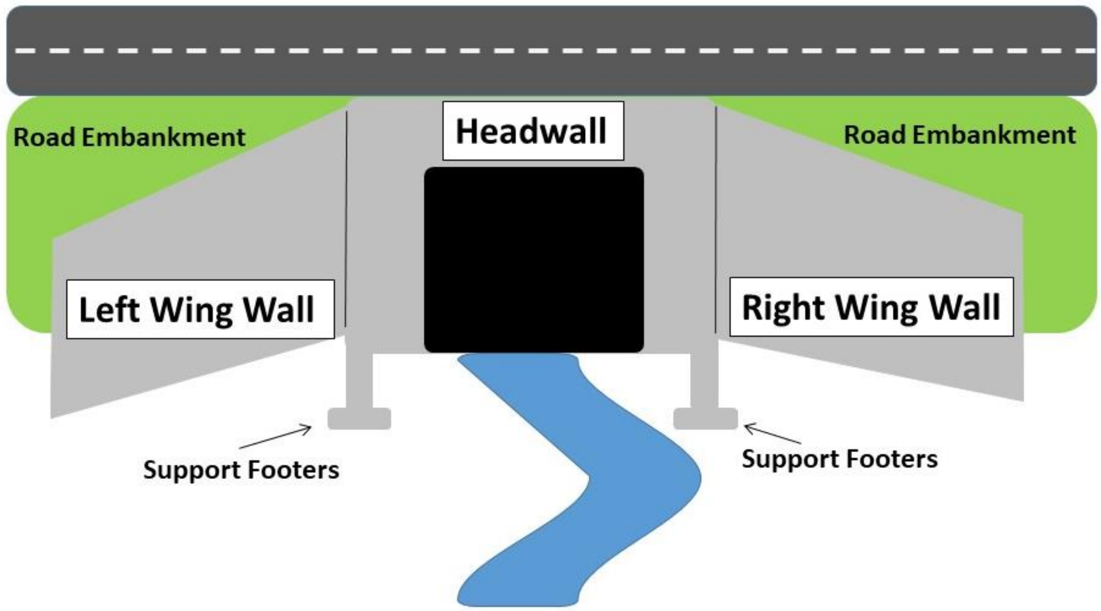
Stream crossing assessment should be done in this order:

1. At low flow, during the summer or early fall
2. At a new location, the upstream and downstream waterbody types **must** be identified first to understand what parameters need to be collected.
3. Begin the assessment on the upstream side of the crossing
4. Walk at least 100 feet upstream OR the length it takes to collect 3 channel bankfull measurements
5. For in-structure parameters, visually scan inside of crossing
6. Conduct downstream assessment last
7. Walk at least 100 feet downstream of the crossing
8. **Do not enter the enclosed area of the structure**

STRUCTURAL COMPONENTS OF A CROSSING



Structural Feature	Definition
Headwall	A solid structure surrounding the inlet that anchors the pipe or box and prevents erosion of roadfill material. Can be constructed from a variety of materials such as concrete, stone, or metal
Wing Wall	A solid structure installed on either side of the inlet that flare outward to direct water into the crossing and hold back the road embankment. These features come into direct contact with the inlet face and extend continuously outward. They are usually made of concrete or stone with masonry.
Armoring	Hard materials such as large rocks, concrete blocks, orsmaller-angualr stones (rip rap) that are installed along the stream banks to preventerosion.
Culvert (Structure or Conduit)	The main structure at the crossing that transports the water under the road.
Footer (abutments)	The concrete blocks at the base of a culvert, underneath the headwall or wing walls, that provide structural support.


Headwall
Road Embankment
Road Embankment
Left Wing Wall
Right Wing Wall
Support Footers
Support Footers


Headwall
Wing Wall
Headwall
Wing Wall
Wing Wall
Headwall
Wing Wall
Wing Wall
No Headwall
No Wing Wall

Parameters

The letters next to each parameter indicate the waterbody types where it is collected. All quantitative parameters are measured to the nearest tenth of a foot.

S – parameter is collected at stream crossings.
W – parameter is collected at wetland or surface (pond, lake, impoundment) crossings.

*Note: for crossings that run underground, create one data point at the inlet and use the upstream waterbody to determine what parameters are collected and indicate in the comments where the outlet is

3) Upstream Waterbody – S | W

Standing above the crossing and looking upstream, determine the the waterbody type that flows int the crossing.

STREAM – A channelized depression in the landscape that has defined channel banks and transports water either intermittently or perennially to lower elevations. If the stream is dry during the time of survey, use the presence of bankfull indicators to determine whether the waterbody is a stream.

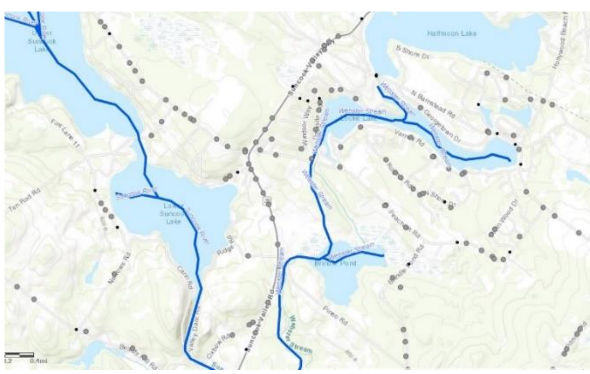


WETLAND – A waterbody that does not have defined channel banks and is in an area where the water table is at or above the land surface throughout the year. The soil is saturated with water and vegetation and there is often standing or slowly flowing water. If there is flowing water moving downstream through the crossing, but it is surrounded by wetland and you are unable to collect at least three bankfull widths due to lack of a defined channel, then classify as a wetland.




SURFACE – A crossing at a depression in the land that stores water at the surface, such as a lake or pond. An impounded water body that is created by either a large dam or a severly undersized crossing would qualify as a surface waterbody.

DRAINAGE – (NOT surveyed under this protocol) A structure at a depression or indentation in the landscape that holds water only during, or directly following, precipitation and is not located on the natural stream/waterbody network. Engineered landforms including storm water retention ponds, roadside ditches, and landscaped drainages do not have natural bankfull indicators because they are man-made and the banks are constructed. If a structure is not on a mapped stream line, walk upstream to see if there are natural bankfull indicators. If it is classified as a drainage create a data point, select the upstream waterbody and crossing type, and assess as part of NHDOT CCDS protocol or move to your next location.



4) Crossing Type – S | W

Select the crossing type based upon the upstream waterbody. Refer to letter-key next to each parameter, to ensure adequate data is collected for each crossing.

STREAM – the upstream water body has been identified as a stream.

WETLAND – the upstream waterbody has been identified as a wetland.

SURFACE – the upstream water body has been identified as a pond or lake.

DRAINAGE – the upstream water body has been identified as a drainage. Either assess the crossing as part of NHDOT CCDS protocol or move to next assessment location.

NOT SURVEYABLE – a crossing that cannot be surveyed at all due to safety or road access issues, such as a culvert on private land and/or an unsafe dirt road. Write in the comments why the crossing is unsurveyable and include pictures if possible. Often there are situations where only part of the survey can be done, and some parameters need to be skipped; in these cases mark the Crossing Type as the upstream waterbody and fill in as much of the data as possible and include in the comments why some parameters were skipped. For example, at a large bridge you may not be able to collect bankfull widths and water depths, but you can visually assess all the other parameters, so collect as much data as possible!

NO CROSSING PRESENT – No structure was present where one was predicted to occur. It is important to document these locations to avoid repetitive sampling. Create a data point in SADES, write in the comments what is observed at the location and include pictures.

5) Assessment Date – S | W

Record survey date.

6) User ID – S | W

User specific ID's may have been generated by the organization(s) performing the assessments. This ID could be based on an area (political or watershed), a specific project or the collecting organization.

7) Observers – S | W

Initials in all CAPS of the observer(s) collecting the field data, separated by a single space.
For example: "JH EM."

8) Organization – S | W

Select the standard organization abbreviation.

CNHRPC – Central New Hampshire Region Planning Commission
GMCG – Green Mountain Conservation Group
LRPC – Lakes Region Planning Commission
NCC – North Country Council
NHDES – all other units within the NH Department of Environmental Services
NHDOT – New Hampshire Department of Transportation
NHFG – New Hampshire Fish and Game Department
NHGS – New Hampshire Geological Survey
NRPC – Nashua Regional Planning Commission
RPC – Rockingham Planning Commission
SNHPC – Southern New Hampshire Region Planning Commission
SRPC – Strafford Regional Planning Commission
SWRPC – Southwest Region Planning Commission
TU – Trout Unlimited
TNC – The Nature Conservancy
UVLSRPC – Upper Valley-Lake Sunapee Region Planning Commission
UNH – The University of New Hampshire
OTHER – A group that is not listed above, include name in the comments section.

9) Project Name – S | W

Name that has been agreed upon with your project collaborators to identify this work.

12) Road Name – Field – S | W

Type in the road that the structure is on using maps or street signs.

14) Structure Skewed to Roadway – S | W

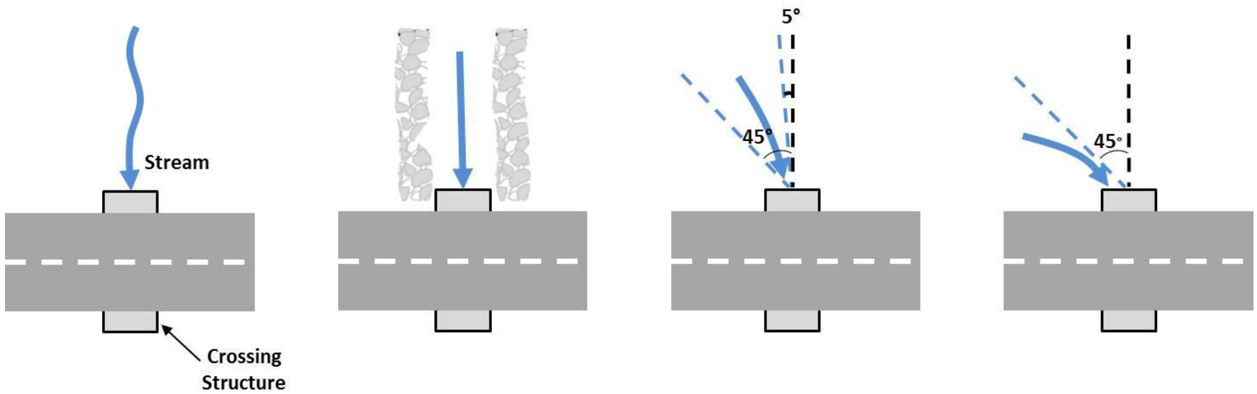
Indicate whether the structure is skewed (or angled) in comparison to the roadway.

YES – the structure is ***not*** perpendicular to the road (~90° angle).

NO – the structure is positioned perpendicular (~90° angle).

16) Angle of Streamflow Approach – S

Stand directly above the inlet and record the angle that the stream enters the crossing structure.



Naturally Straight $\theta < 5°$

Channelized Straight $\theta < 5°$

Mild Bend $5° < \theta < 45°$

Sharp Bend $\theta > 45°$

NATURALLY STRAIGHT – Stream enters the structure straight-on with no channelization.

CHANNELIZED STRAIGHT – Stream enters the inlet straight on due to alteration and straightening of the channel or banks. Indicators include landscaped banks (left), concrete banks (center), armored banks (right), or the channel just upstream of the straightened section is naturally sinuous (aerial photos below). The aerial images below show examples of **channelized straight** streams, including a reach that has been straightened compared to the natural channel form, based on historical meander bends in the surrounding landscape (below left), or a clearly straightened stream in a field (below right).

MILD BEND – The stream enters the inlet at a gentle angle; 5° to 45° bend.

SHARP BEND – Stream enters the inlet at a severe angle; 45° to 90° bend.

17) Number of structures at Crossing – S | W

Count all of the culverts that are at or below the bankfull elevation. Do not count overflow pipes. **Divides in a bridge span are not considered multiple structures.** If multiple structures are identical in size, shape, material and slope, collect data on one of the structures and enter the number of crossings (top photos). If the structures are not identical, collect data on the structure that transports most of the water and include data for the other structure(s) in the comments (example photos below).

Identical structures at a crossing

Different shaped pipes

Pipes are different sizes

One pipe is blocked

18) Overflow Structures Present – S | W

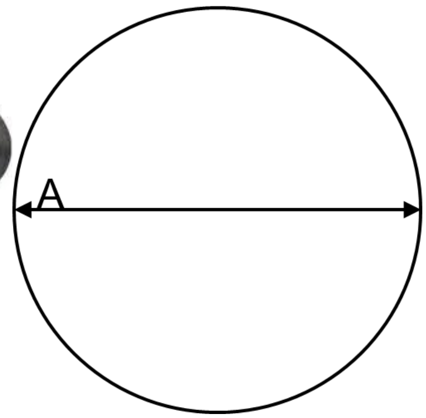
Overflow pipes are smaller than the primary crossing, and are installed at a higher elevation than the main structure.

YES – there are overflow pipes.
NO – there are no overflow pipes present.

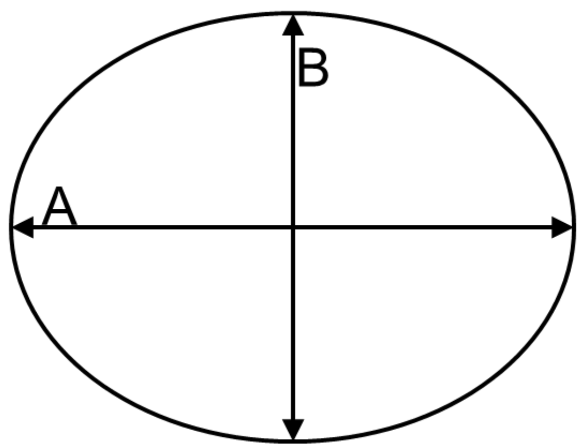
19) Structure Type – S | W

Select the type that describes the shape and dimensions of the main culvert or bridge that is carrying the water flow. The letter dimensions (A, B, C and D) are defined by parameters 26-29 and can be found on pages 31 and 32.

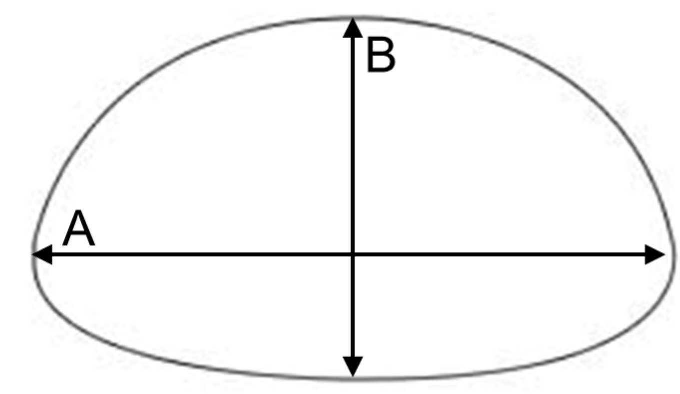
ROUND CULVERT – a circular structure with a closed bottom such as a metal, concrete, and plastic pipe.



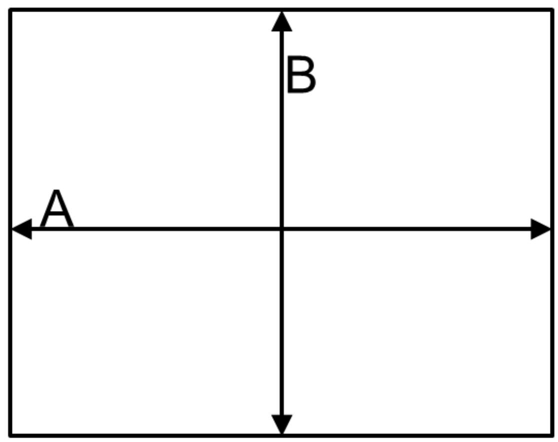
ELLIPTICAL CULVERT – an oval structure that has a closed, constructed bottom and is longer along one (A) of its axes, so it appears to be flattened.



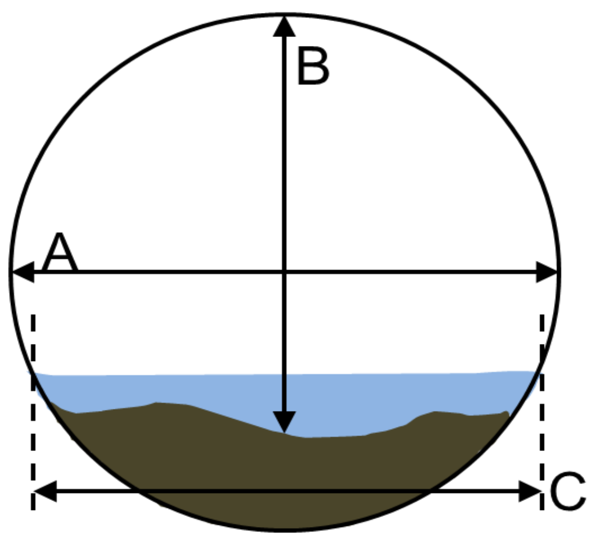
PIPE ARCH CULVERT – an oval structure that has a closed, constructed bottom, and is shaped somewhat like an egg (vertically), in that the bottom is wider and more rounded compared to the top.



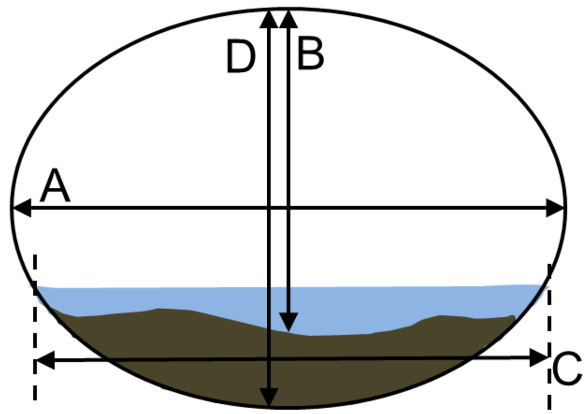
BOX CULVERT – a square or rectangular-shaped culvert with a closed bottom.



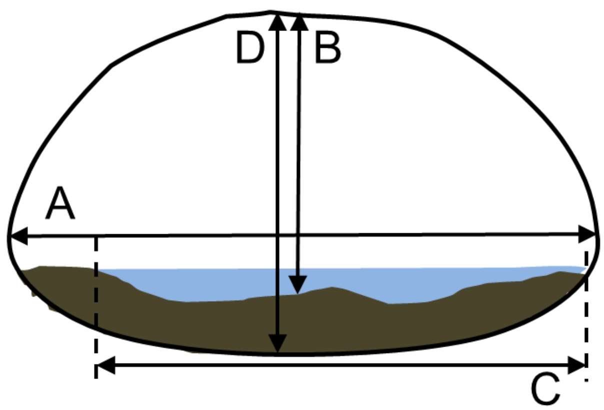
EMBEDDED ROUND CULVERT – a circular pipe that is partially buried below the stream bed so that natural sediment continues **throughout the** bottom of the structure.



EMBEDDED ELLIPTICAL CULVERT – an elliptical pipe that has been intentionally installed so that natural sediment **continues throughout the bottom** of the structure.



EMBEDDED PIPE ARCH CULVERT – a closed-bottom pipe arch that has been installed below the streambed, so that natural sediment continues throughout the bottom.



EMBEDDED OR SEDIMENT BUILDUP?

Embedded

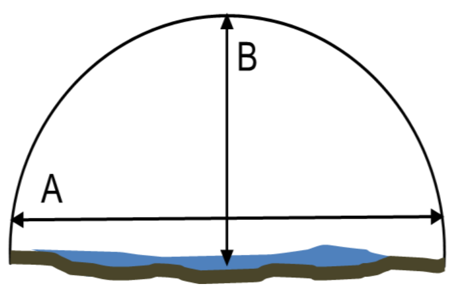
- Has sediment throughout the bottom thatmatches the size, shape, and distribution of the sediment of the natural upstream and downstream channel bottom.
- The substrate is usually at grade with the inlet.

Clogged

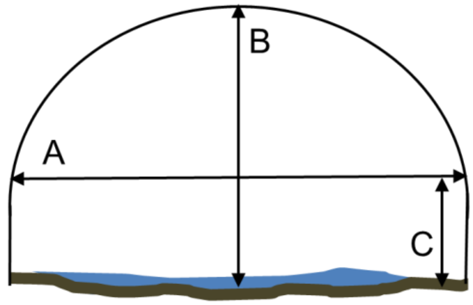
- Buildup of sediment and/or material that is caused by the culvert being undersized, improper alignement with the stream channel, or the presence of an obstruction.
- The sediment and/or material depth is a significant percentage of the structure’s open height and is restricting water flow.
- Material is concentrated on one side of the crossing

Embedded Structure ***Clogged Structures with Sediment Buildup***

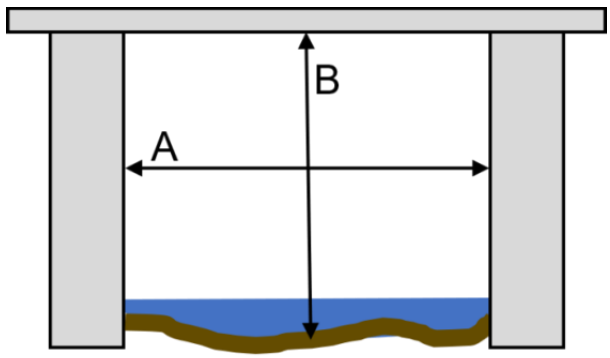
OPEN BOTTOM ARCH – an arc-shaped structure that does not have a bottom half, so the natural sediment continues throughout the crossing.



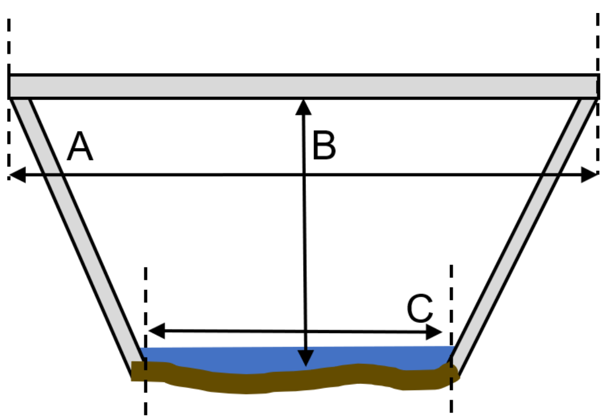
ARCH-BRIDGE – structure with a curved top under the road deck and sits on vertical abutments.



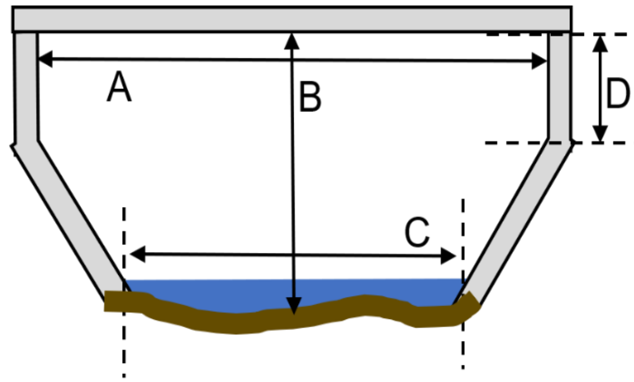
BRIDGE WITH ABUTMENTS – an open-bottom structure where the road deck bottom is also the top of the structure and the sides are at right angles.



BRIDGE WITH SIDE SLOPES – an open-bottom structure where the road deck bottom is also the top of the structure with angled sides. Side slopes may be rip rap covering the abutments for scour protection.



BRIDGE WITH SIDE SLOPES AND ABUTMENTS – an open-bottom structure where the road deck bottom is also the top of the structure, having both sloping sides and sides at right angles to give the bridge height over the stream. Side slopes can be rip rap that ties in with the abutments for scour protection.



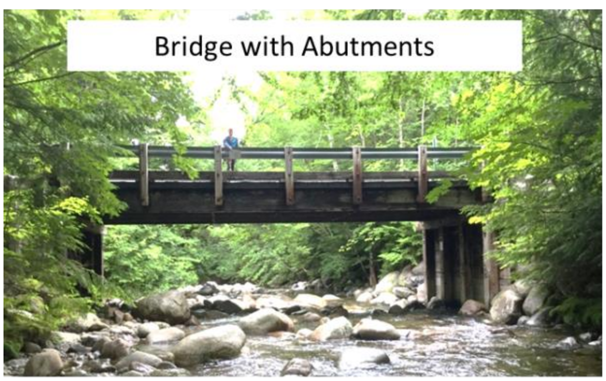
Comparison of a bridge with vertical abutments that are exposed (left) versus a bridge with rip rap tied into the abutments for scour protection (right).

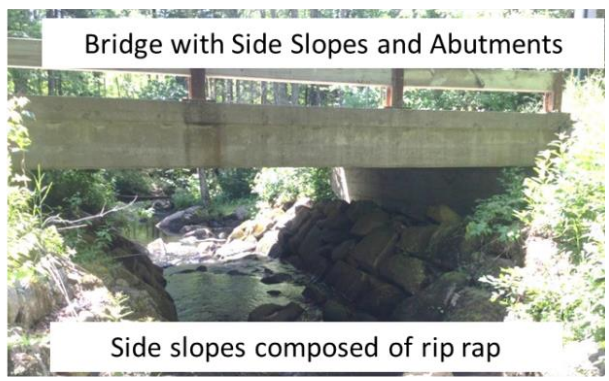
FORD – road crosses the river over material such as logs, stone or gravel laid on the streambed to stabilize the bottom. These are mostly found on dirt or gravel roads.

IDENTIFYING BOX CULVERTS VERSUS BRIDGES WITH ABUTMENTS

Culvert – A structure that supports a road over a water body by means of an enclosed pipe or box usually constructed within a masonry or concrete headwall, that typically has a constructed bottom and does not have abutments or piers.

Bridge – A structure that supports the roadway and *typically* spans the width of the channel encompassing both banks. The road deck bottom is almost always the top of the structure. Some structures that look like a bridge may actually be an embedded box culvert or an open bottom arch. Bridges have an open-bottom and the natural stream channel runs through the structure.





The definition for a bridge in this protocol is for stream crossing surveys only and differs from that used by NHDOT, which classifies all structures >10-foot width as a bridge. Please adhere to the definitions in this protocol for all stream crossing surveys!

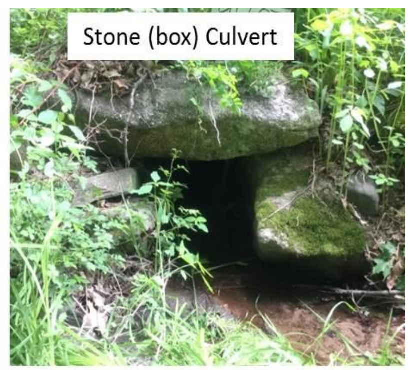
20) Structure Material – S | W

Identify the material that describes the dominant construct of the crossing. If structure material varies between the inlet and outlet, use the inlet material type and describe the outlet material in the comments. Bridges are often composed of several material types (e.g., a steel deck with concrete abutments); the primary (dominant) material of the overall structure should be selected.

CONCRETE – structure is made of pre-cast or cast-in-place concrete.
PLASTIC-CORRUGATED – both the outside and inside of the pipe have defined ridges.
PLASTIC-SMOOTH – inside surface of the pipe is smooth, regardless of whether the outside has ridges.
STONE – structure is made of rocks that are either bound together with mortar (masonry) or stacked tightly without mortar (dry fit stone).
STEEL-CORRUGATED – both the outside and inside of the metal pipe have ridges and grooves. A steel pipe will often have a dull metallic appearance and evidence of rusting.
STEEL-SMOOTH – the inside surface of the metal pipe is smooth, regardless of whether the outside of the pipe has ridges. A steel pipe will often have a dull metallic appearance and may have some rusting.
ALUMINUM-CORRUGATED – both the outside and inside of the metal pipe have ridges and grooves. An aluminum pipe will have a shiny-metallic appearance without any rust, but can have water stains.
WOOD – the structure is made of wood, not a common material for crossings.
OTHER – please note in the comments what material the crossing is made of.


Plastic-smooth


Concrete


Stone (box) Culvert


Steel-corrugated


Concrete Box


Aluminum- Corrugated

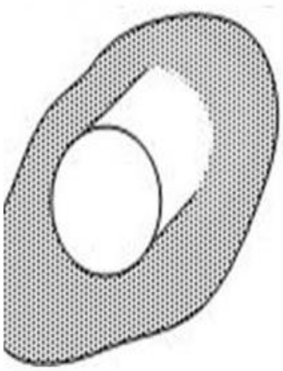

Plastic-Smooth


Plastic-Corrugated

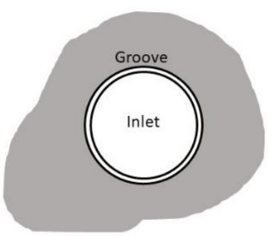
22) Inlet Type – S | W

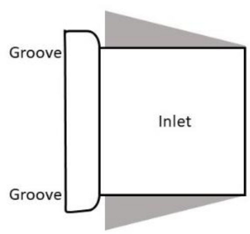
Select the option that best describes the shape and structure of the crossing inlet.

THIN PROJECTING – the end of the plastic or metal pipe extends outward from the headwall.

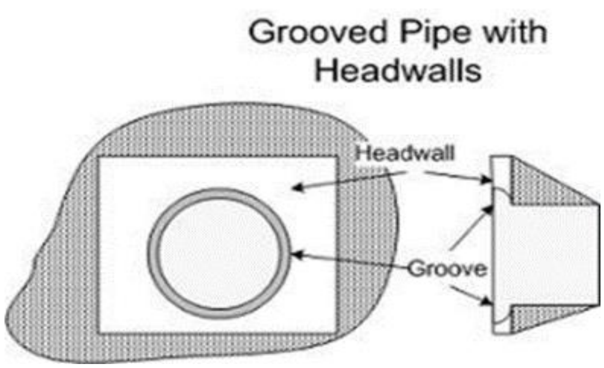



GROOVED CONCRETE PROJECTING – the end of the concrete pipe has a lip and extends outward from the headwall.

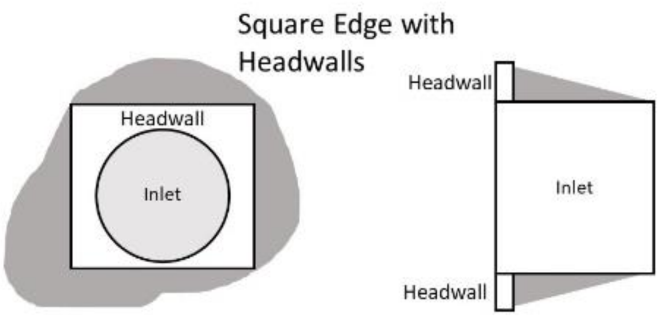




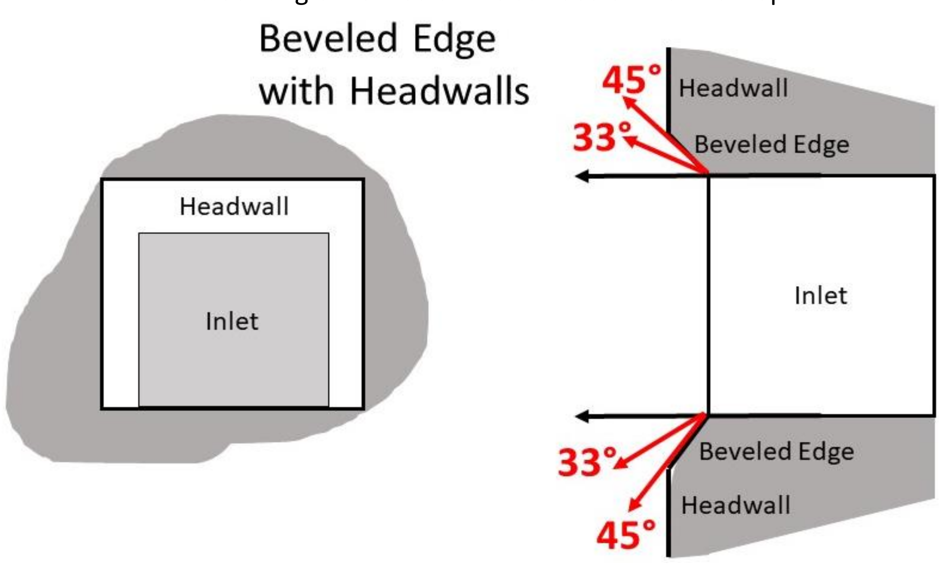
GROOVED CONCRETE WITH HEADWALL – the end edge of the concrete pipe has a lip and is flush with the headwall.



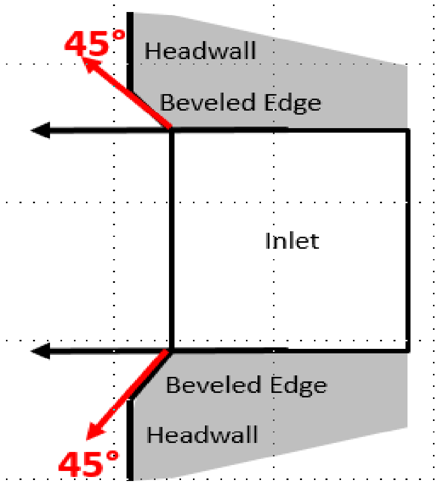
SQUARE EDGE WITH HEADWALL – the end edge of the pipe material (concrete, metal, plastic) is flush with the headwall.



1.5:1 BEVELED HEADWALL – a 33° angle inclined at the surface of the inlet top.



1:1 BEVELED HEADWALL– a 45° angle inclined at the surface of the inlet top.



ANY BEVEL WITH WING WALLS – the end edge of the inlet entrance is not perpendicular, but is angled.

NO BEVEL WITH WING WALLS – the end edge of the inlet entrance is perpendicular, and there are flared ***out walls.***

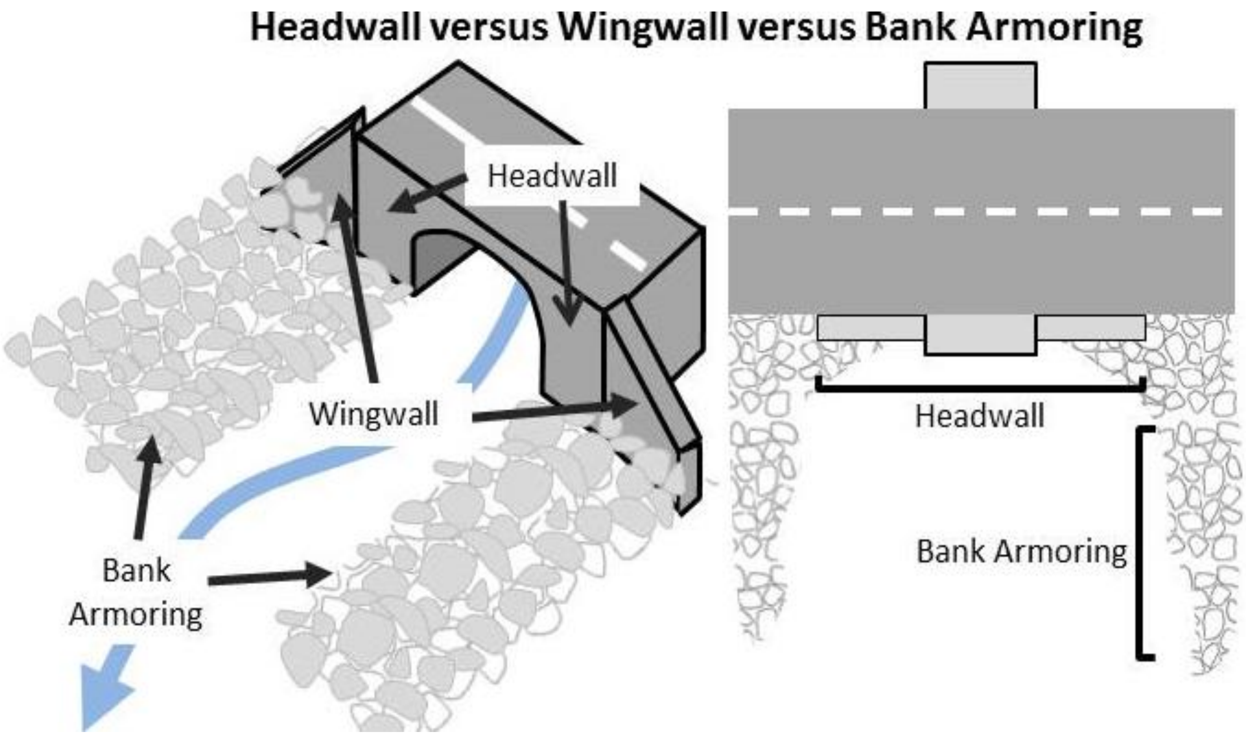
The inlet edge of this box culvert is flush with the headwall and does not have a beveled edge.

STANDARD END SECTION – the culvert inlet pipe and tapered wing walls are flush with the embankment, and both are connected with a structural floor that extends upstream from the pipe inlet to a point flush with the upstream extent of the flared wing walls.

MITERED – the end edge of the pipe has been cut at an angle that matches the slope of the road fill material. Mitered structures are most commonly made of corrugated metal.

On this mitered pipe arch, the inlet has been cut to have an angle is similar to the raod embankment.

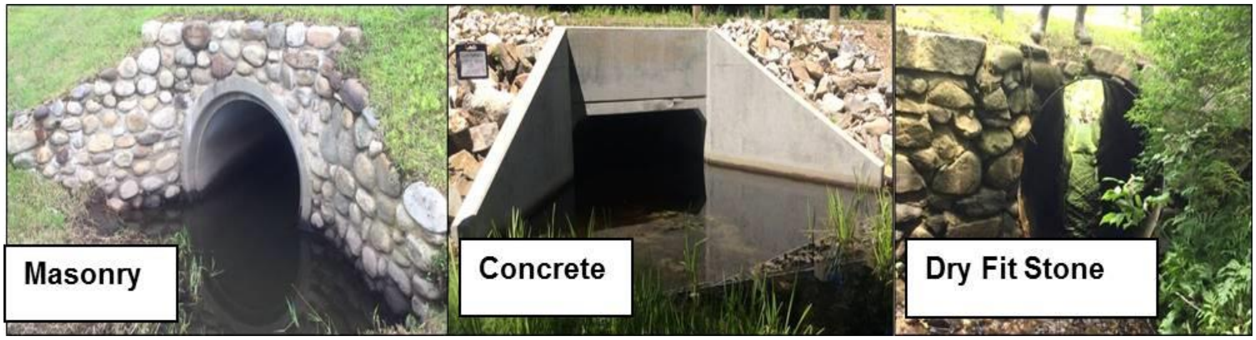
NONE OF THESE – the inlet type cannot be categorized into any of the types above.



23) Inlet Wing wall: Material – S | W

Wing walls are structures installed on either side of the inlet to direct water into the crossing and hold back the road embankment. Structures should only be considered wing walls if there is continuous material installed to be in direct contact with the inlet face. Wing walls are solid structures lacking any large gaps and spaces within the structure material. They are most often made of concrete or stone masonry.

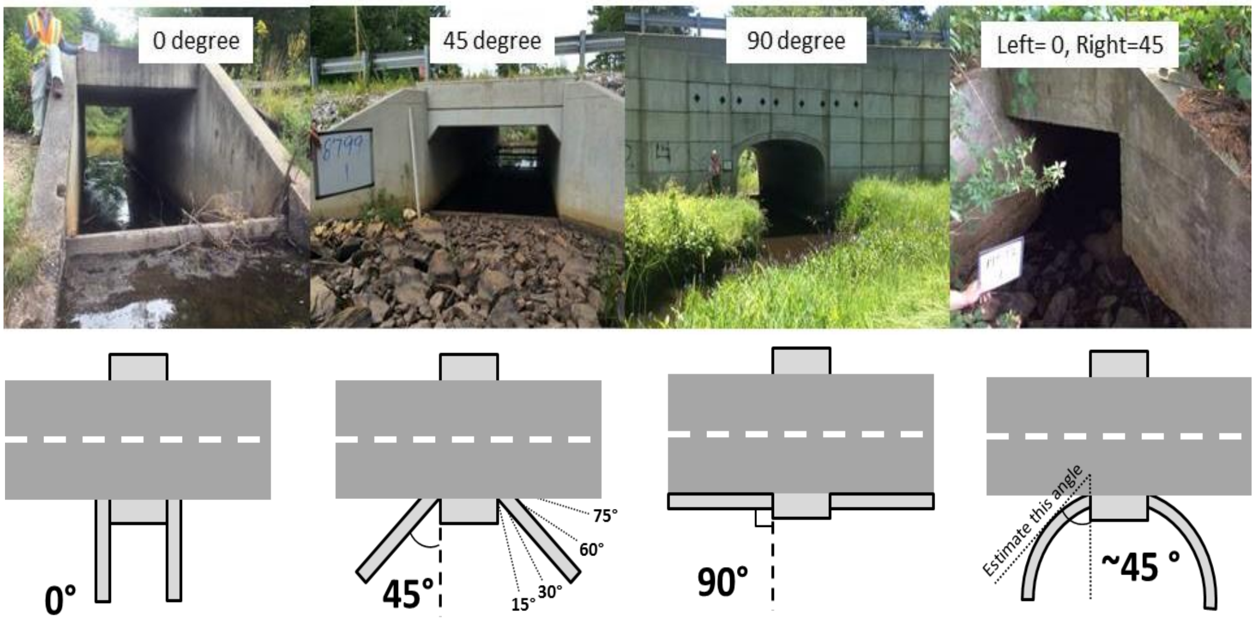
METAL – continuous metal walls, whether smooth or corrugated.
CONCRETE – preformed or cast-in-place concrete walls.
MASONRY – brick or stone structure bonded by mortar.
DRY FIT STONE – stone structure without mortar to bind the stones together.
PLASTIC – continuous plastic walls, whether smooth or corrugated.
GABION – wire cages filled with small stones that stack on one another to form a wall.
OTHER – a material not listed above.
NONE – no wing wall present.



24) INLET WING WALL ANGLE: STREAM LEFT – S

Stand in the middle of the channel facing the inlet and visually estimate the angle at which the wing walls project outwardfrom the structure opening, based on the diagram below. If no wing walls are present, leave this field blank.

ANGLE VALUE – 90, 75, 60, 45, 30, 15, 0



25) INLET WING WALL ANGLE: STREAM RIGHT – S

Stand in the middle of the channel facing the inlet and visually estimate the angle at which the wing walls project out from the structure opening, based on the diagram below. If no wing walls are present, leave this field blank

ANGLE VALUE – 90, 75, 60, 45, 30, 15, 0

Sometimes the wingwall may be curved shaped (yellow line) so you will need to estimate the overall angle of the wingwall projecting from the headwall.

26) Upstream: Width (A) (ft) – S | W

Measure the interior width of the crossing. Reference the structure diagrams for guidance.

27) Upstream: Open Height (B) (ft) – S | W

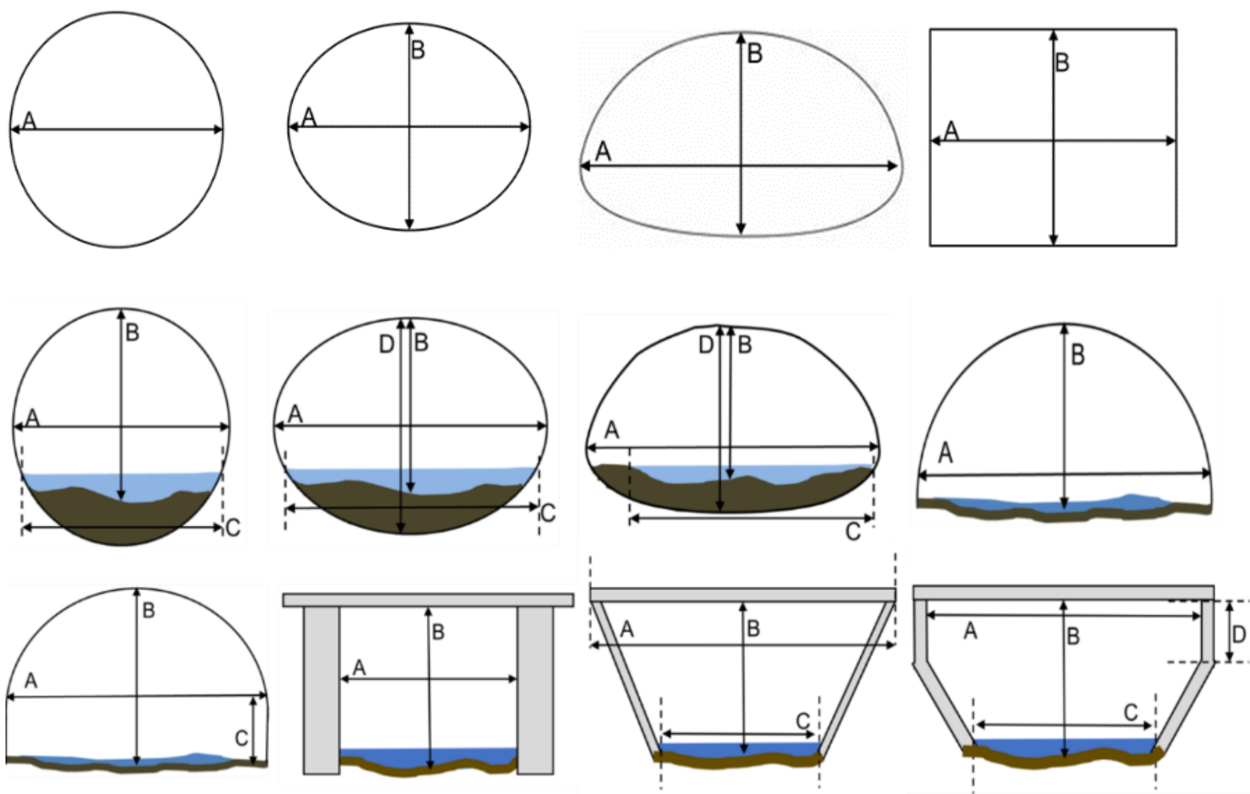
Measure the interior height from the inside top of the structure to the inside bottom of the structure. For ***embedded or clogged*** structures, this measurement should be located equal to the highest elevation of accumulated or embedded material in the crossing.

28) Upstream: Wetted Width/Wall Rise (C) (ft) – S | W

For ***embedded or clogged*** culverts, and open-bttom bridges, measure the width of stream channel (wetted width) that passes through the crossing. For an ***Arch Bridge***, measure the vertical wall rise as shown in the Arch Bridge diagram below.

29) Upstream: Total Height (D) (ft) – S | W

For ***embedded or clogged*** structures, measure the height from the interior top of the structure to the bottom of the structure. If you are unable to access the bottom of the structure because the sediment is to deep, then leave this field blank and leave a comment.For bridges with side slopes and abutments, measure the vertical height of the abutments beginning at the side slopes.



30) Structure Opening Mostly Obstructed By – S | W

Identify the type of material that is obstructing any part of the inlet that may reduce aquatic organism passage through the crossing. This implies that the obstruction is touching the stream bed and the wetted area is more than half blocked across the width of the culvert.

WOOD – wood material such as logs, branches, and trees.
SEDIMENT – sand and rocks transported and deposited by the stream in front of the inlet. Sediment is only considered an obstruction if it is blocking some of the inlet or water drops down into the culvert. If the entire culvert bottom is filled with sediment at an equal elevation to the natural streambed, this is not considered an obstruction.
STRUCTURAL DEBRIS – part of the headwall, wing wall, armoring or pieces of the crossing itself have detached and are blocking the inlet.
WOOD AND SEDIMENT – both wood and sediment are blocking the inlet.
DEFORMATION (CULVERT ONLY) – culvert pipe inlet is crushed, bent, or broken.
BEAVER DAM – logs and sticks from a beaver dam are blocking the inlet.
NONE – no part of structure opening is covered.
OTHER – none of the options apply and record the type of blockage in comments.


Wood

Sediment


Structural Debris


Wood and Sediment

31) Screening at Structure – S | W

Screens made of metal, plastic, wood or any another material may be installed across or around the inlet and outlet to prevent debris or wildlife from entering the pipe.

INLET – screening is present at the inlet.
OUTLET – screening is present at the outlet.
NONE – there is no screening present at this crossing.

32) Inlet Headwall: Material – S | W

A headwall provides anchoring support for the conduit and prevents surrounding soil and roadfill from washing away. Select the option that best describes the overall material surrounding the face of the inlet. If the headwall is made of more than one type of material, select the dominant type.

METAL – continuous metal walls, whether smooth or corrugated.
CONCRETE – preformed or cast in place concrete walls.
MASONRY – brick or stone structure bonded by mortar.
GABION – wire cages filled with small stones that stack on one another to form a wall.
DRY FIT STONE – stone structure without mortar to bind the stones together.
PLASTIC – continuous plastic walls, whether smooth or corrugated.
OTHER – a material not listed above.
NONE – no headwall present.

33) INLET CONDITION – S | W

Describe the condition of the external structural features (both the headwall and wing walls) surrounding the crossing inlet.

GOOD – Concrete: spalling of up to ¼-inch thickness is present, joints between headwall and wing walls are broken, or some mortar is missing from joints. Metal: Pitting or superficial rust is present.
FAIR – Concrete: spalling of more than ¼-inch thickness is present, but no reinforcement is present, joints between headwall and wing walls are beginning to separate, or joints between some stones are broken. Metal: flaking rust is present, wall thickness is lost, or a hole can be poked through the wall.
POOR – Concrete: reinforcement is visible, stones are loose, or large cracks run through the headwall. Metal: holes are present, full length cracks are present, joints are separated, or severe deformation
NO RATING – the headwall or wingwall is not evaluated or there is no headwall or wingwall at the inlet.

Box culvert with poor inlet condition due to significant spalling, cracks in concrete, and loose stones.

An example of severe concrete spalling.

34) Upstream: Scour Undermining Structure – S | W

Identify the part of the crossing that has deteriorated from the erosive action of moving water, that has excavated and carried away material from the streambed and banks. Indicators of scour are: exposed areas of the structure that should be covered by streambed material (e.g. footings or the bottm of abutments), leaning or hanging structures, water visibly flowing under or to the side of the inlet.

FOOTERS - A block of material at the base of a structure that provides structural support
CULVERT - The main structure at the crossing that allows water to pass through.
WING WALL - Angled walls on either side of the inlet that direct water into the crossing and provide support to the embankment.
CULVERT AND FOOTERS
CULVERT AND WING WALL
FOOTERS AND WING WALL
CULVERT, FOOTERS AND WING WALL
NONE – There is no evidence of scour around the structural features of the crossing.
UNKNOWN – Survey conditions prevent the ability to acuratey assess scour around the structure.

35) UPSTREAM: BANK ARMORING – S

Armoring is hard protective covering, such as rocks, angular stone (rip rap), gabion, wood, or other hard materials that are designed andinstalled to prevent bank erosion. It is common in mountainous terrain for the natural streambed and banks to consist of large bulders. In the situations when it is difficult to differentiate between armoring and natural substrate, look at the arrangement and gradient size of the rocks on the banks. Armoring will consist of rocks that are more uniform in shape and size, and their arrangement will be more ordered.

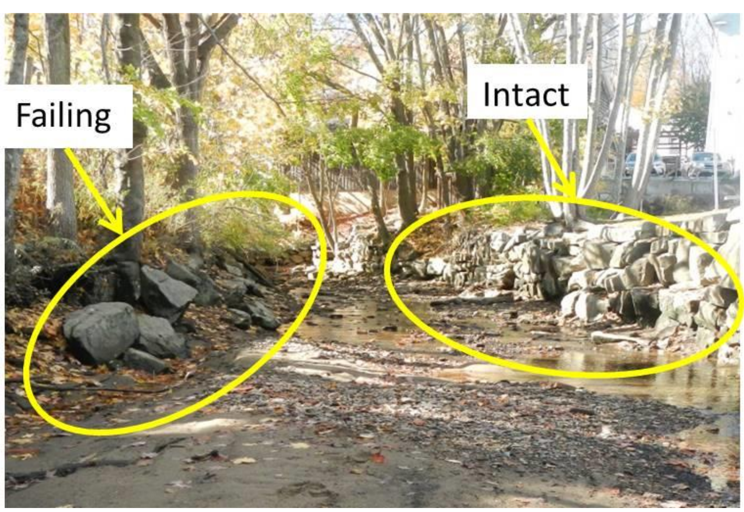
INTACT – not falling into stream, no missing or out-of-place pieces of armoring material
FAILING – parts are falling into the stream, missing or out of place.
NONE – no hard bank armoring present.
UNKNOWN – unable to assess the condition or presence of hard bank armoring.

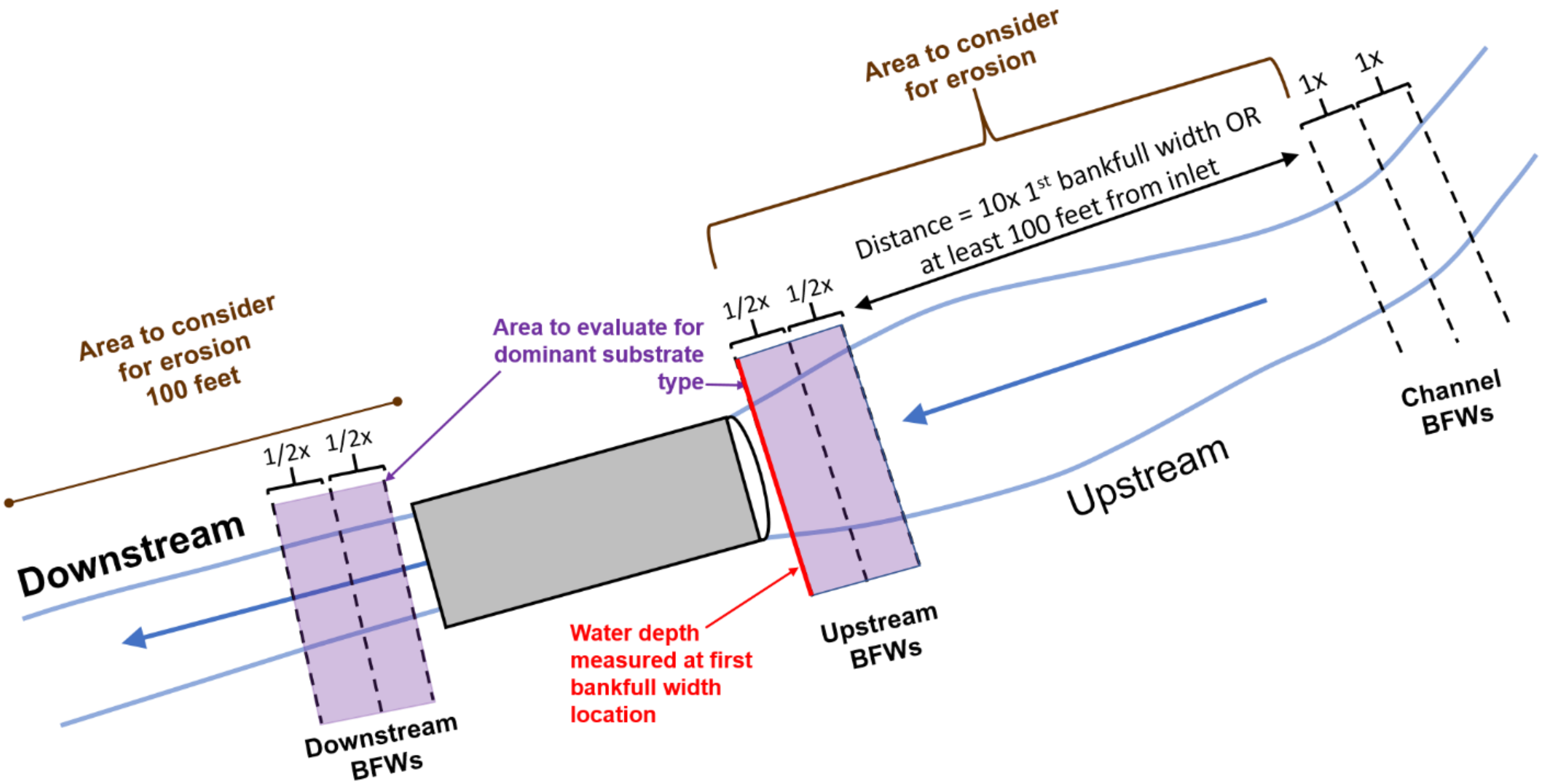
Natural Boulders | Intact Bank Armor | Failing Bank Armor





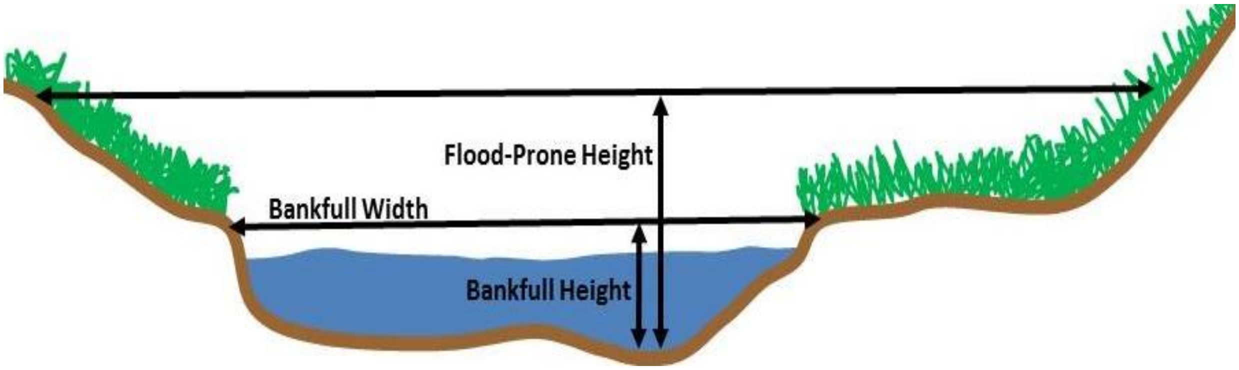






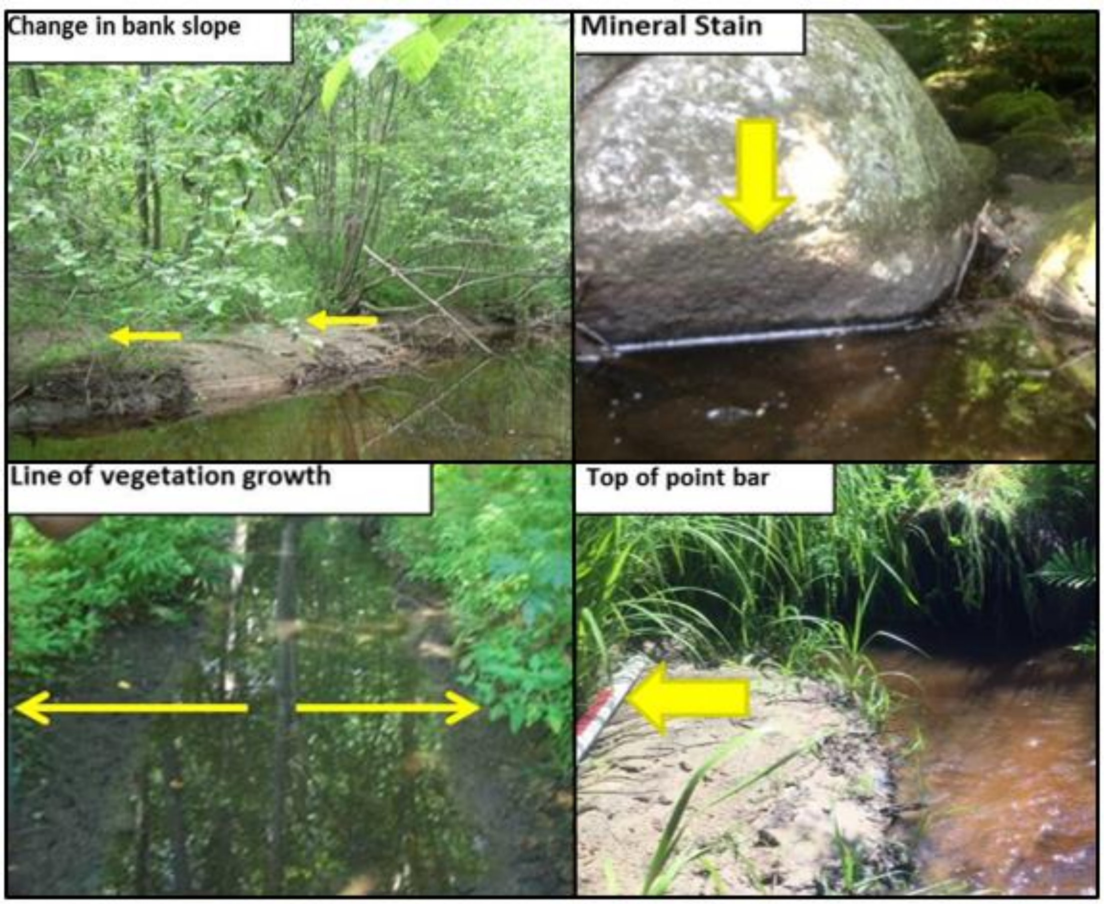
Overhead view of a stream crossing showing where upstream and downstream bankfull widths, channel bankfull widths, water depths, bank erosion, and substrate types are evaluated.

Bankfull width is a measure of the wetted stream channel at bankfull flow. Measure across the channel at the bankfull height. Bankfull height is the transitional point where water completely fills the stream channel and overflows onto the floodplain. Identify bankfull indicators first, then measure the width from bank to bank at those locations.



What to look for as bankfull indicators:

- Abrupt change in bank slope.
- Line of vegetation growth.
- Mineral stain marks on rocks.
- Transition in sediment type.
- Top of depositional feature (point bar).



36) WATER DEPTH: UPSTREAM CHANNEL – S

Measure the water depth directly upstream of the inlet, where the first upstream bankfull width (BFW) is collected. Record the water depth in the deepest part of the channel by measuring from the water surface to the streambed. If the channel is dry at the time of the survey, fill this field in with a value of zero.

37) UPSTREAM: BANKFULL WIDTH 1 (FT) – S

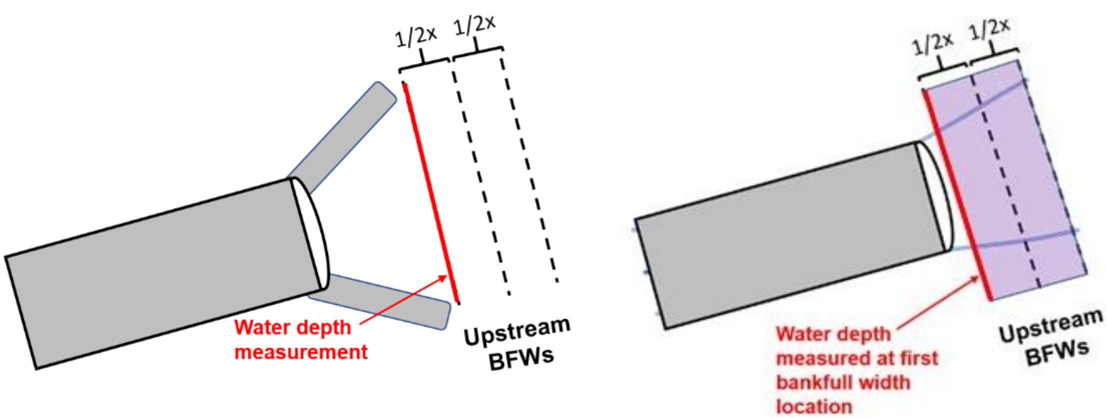
Measure across the channel directly upstream of the inlet in the area that is **within the influence** of the stream crossing. "Influence" refers to the area directly upstreamwhere water depths, velocities, sediment transport, and streambed features may be affected by the presence of the crossing, creating unnatural conditions. If there are wing walls that extend outward from the inlet, collect the bankfull widths at the end of those structures, not within the walls. If the channel splits upstream, measure the bankfull width of the stream that carries the majority of the flow.

38) UPSTREAM: BANKFULL WIDTH 2 (FT) – S

Measure across the channel at ½-bankfull width upstream of the first bankfull measurement.

39) UPSTREAM: BANKFULL WIDTH 3 (FT) – S

Measure across the channel at ½-bankfull width upstream of the second bankfullmeasurement.



Location to measure upstream water depth and bankfull widths at culverts with wing walls (left) and without wing walls (right).

40) UPSTREAM: DOMINANT SUBSTRATE: – S

In the area where the three upstream bankfull widths were collected (purple area highlighted in diagram above), visually determine the dominant substrate type that takes up the greatest area.

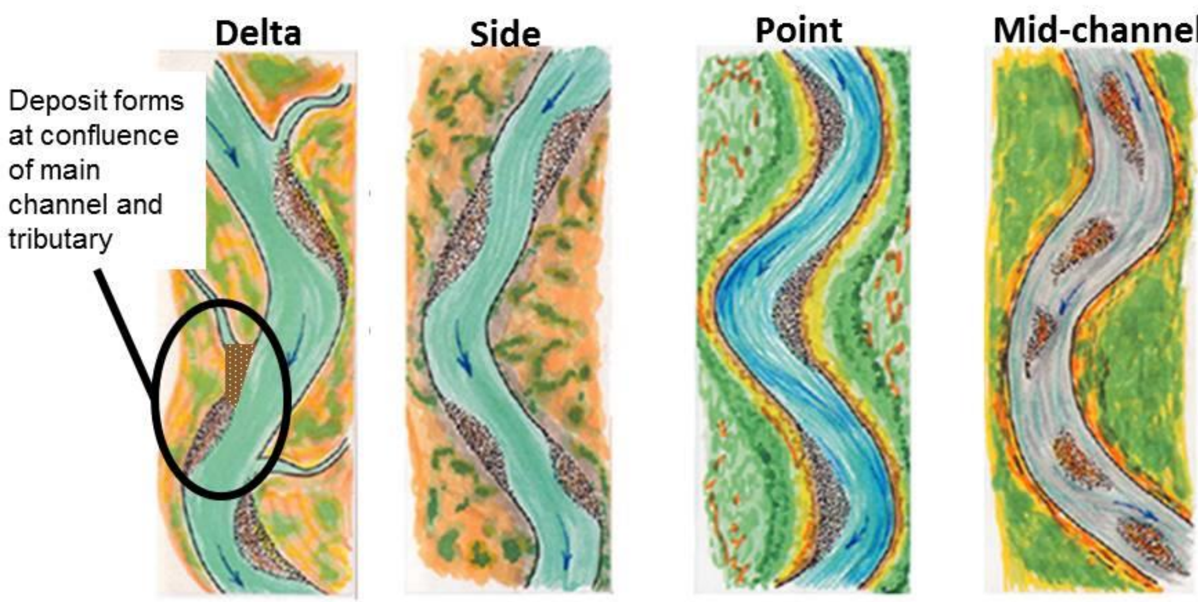
Type	**Grain size (in.)**	**Relative size**
BEDROCK		Immobile material anchored to Earth's surface
BOULDER	>10.1	bigger than a basketball
COBBLE	2.51-10	about the size of a tennis ball to basketball
GRAVEL	0.08-2.5	about size of peppercorn to a tennis ball
SAND	<0.08	the size of silt to the size of a peppercorn
SILT/CLAY	<0.002	grains are extremely fine and smaller than sand
UNKNOWN		Cannot assess due to turbid water or limited visibility
NONE		There is no substrate

Range of grain sizes for the sediment categories.

41) Upstream Deposit Type – S

Sediment in rivers gets deposited as water velocity slows down. Larger, heavier particles like pebbles and sand are deposited first, whilst the lighter silt and clay only settle if the water is almost still. Observe the streambed directly upstream of the inlet in the area of influence of the crossing and determine whether there is an area where sediment has accumulated.

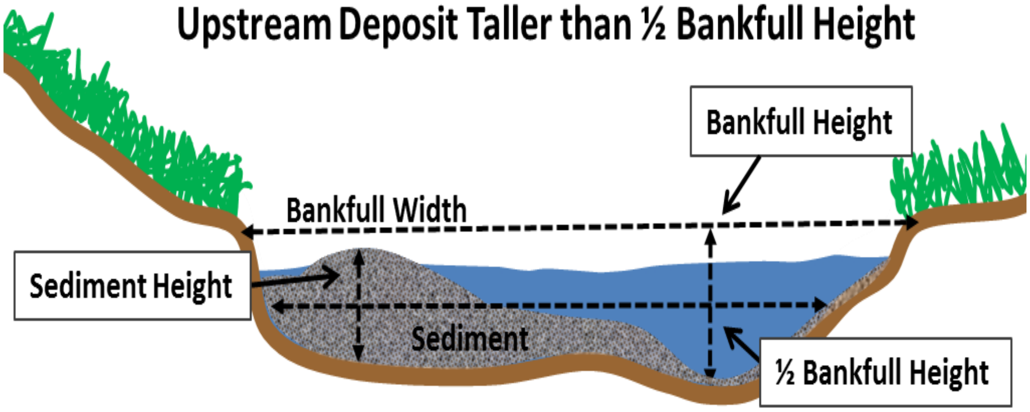
NONE – no sediment deposits observed.
DELTA – sediment deposits where a tributary enters a mainstem channel, often fan-shaped; these can be situated *either* at the mouth of the incoming tributary or directly downstream of a tributary (both diagrammed below).
SIDE – sediment deposits located along the margins of the channel in locations other than the inside of channel meander bends (not point bars).
POINT BAR – a sediment deposit that is adjacent to the bank and occurs on the inside edge of a meander bend.
MID-CHANNEL – areas of sediment deposition (point bars) built up above the streambed elevation of the nearby area, located in the channel away from the banks.



42) US DEPOSIT TALLER THAN 0.5 BANKFULL HEIGHT – S

If a sediment deposit is present upstream of the inlet, indicate whether the height of the deposit is equal to or higher than ½-bankfull elevation.

YES – upstream deposits fill the channel to an elevation greater than or equal to half of the bankfull elevation.
NO – upstream deposits DO NOT fill the channel to an elevation greater than or equal to half of the bankfull elevation.



43) UPSTREAM: BANK EROSION – S

Identify the degree of bank erosion observed in the area 10x the first bankfull width **OR** 100 feet upstream of the structure. Indicators of erosion are areas of bank that are undercut and have exposed roots, are raw and barren of soil, and/or soil have slumped or fallen into the stream. Keep in mind that streams can have natural background levels of erosion, especially in areas outside of meander bends and across from point bars, and that the degree is relative to stream size.

HIGH – nearly continuous areas of erosion (raw and barren soil) along banks (left), especially on medium to steep banks (right).


LOW – discontinuous patches of erosion (raw and barren soil) along the bank (left) or occasional areas of undercut banks with root exposure (right).

NONE – no bank erosion evident.

44) Channel: Bankfull Width 1 (ft) – S

Record the bankfull width of the channel 10x the length of the first bankfull width OR AT LEAST 100 feet upstream from the inlet. These measurements are taken in an area that is beyond the influence of the crossing and represents a natural area of the stream.

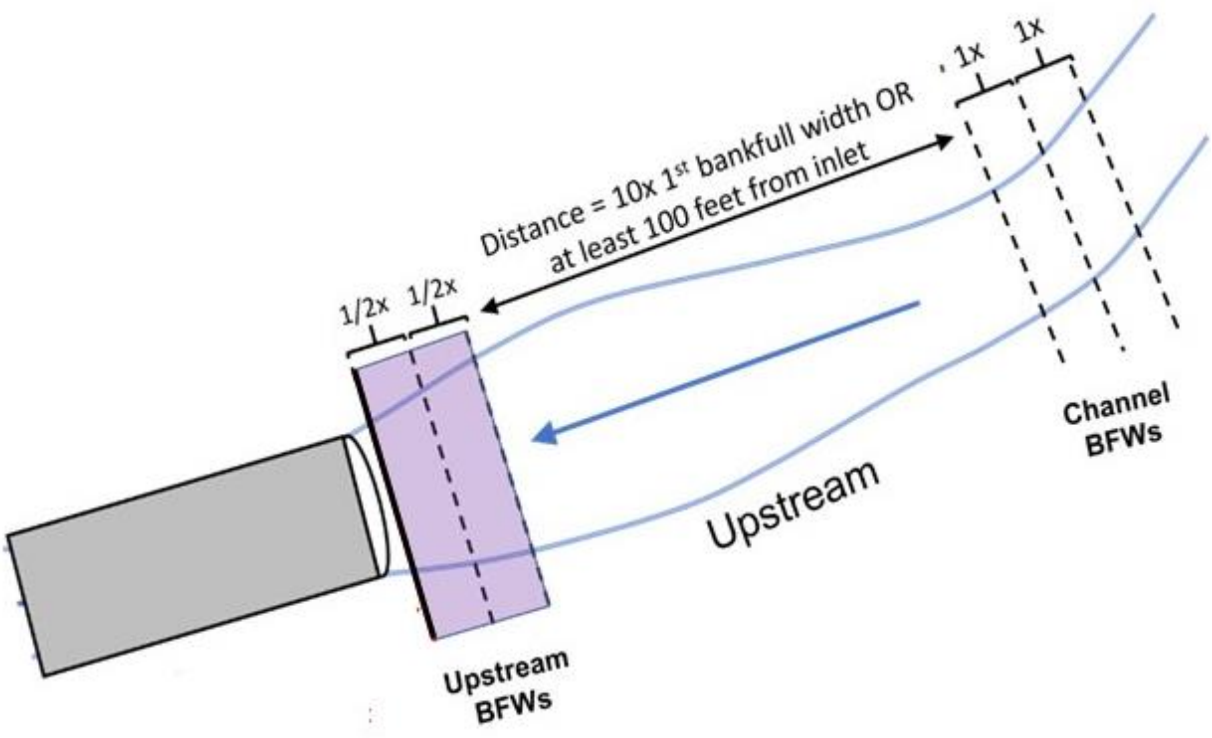
45) Channel: Bankfull Width 2 (ft) – S

Collected one bankfull width upstream of the first channel bankfull width measurement.

46) Channel: Bankfull Width 3 (ft) – S

Collected one bankfull width upstream of the second channel bankfull width measurement.

If the distance of 10x upstream from the 1st bankfull measurement or 100 feet from the inlet brings you into the area of influence of another crossing, then **adjust** where you measure channel bankfull widths and note the distance from the inlet in the comments.



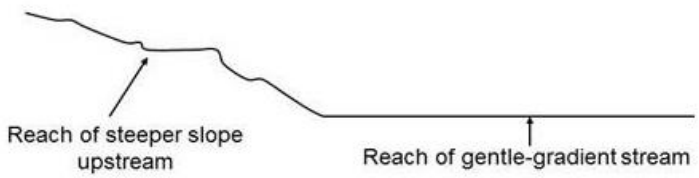
47) Channel: Dominant Substrate – S

In the upstream area where the three channel bankfull widths were collected, visually determine the dominant substrate type that takes up the greatest area.

48) Steeper Segment within $^{1}/_{3}$-mile Upstream – S

Walk upstream or use a topographic map or other digital elevation data to determine if there is a break in the channel slope farther upstream.

YES – structure is located on a stream segment of relatively gentle gradient that is within 1/3-mile downstream of a significantly steeper segment of stream.
NO – there is no dramatic increase in stream gradient upstream.
UNSURE – obscured view of upstream topography or topographic map not available.



An example of a section of river upstream of the culvert inlet that has a sudden steep gradient.

49) Upstream: Beaver Dam Near Structure – S | W

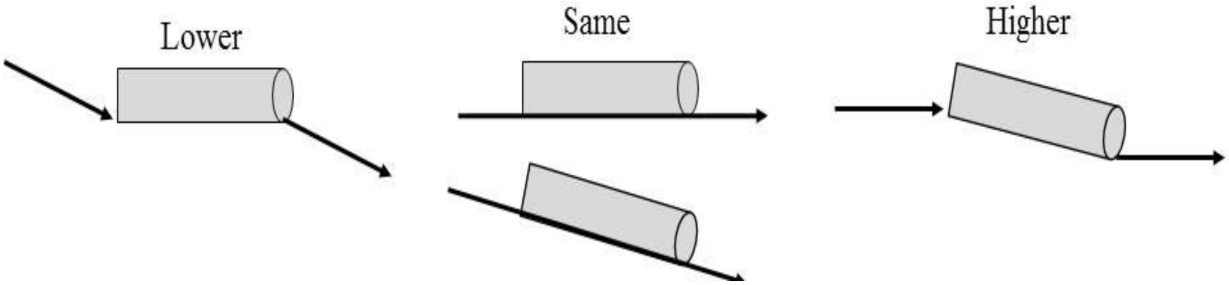
Record whether a beaver dam is within the survey area upstream from the structure. Beaver dams usually create a pond upstream. If unsure whether a dam was made by beavers, look at the ends of the branches to see if they have been gnawed.

YES – a beaver dam is located within the survey area upstream of the structure.
NO – a beaver dam is NOT located within the survey area upstream of the structure.

51) Structure Slope Compared to Channel Slope – S

This is a visual estimate to identify structures placed at a slope different than that of the channel.

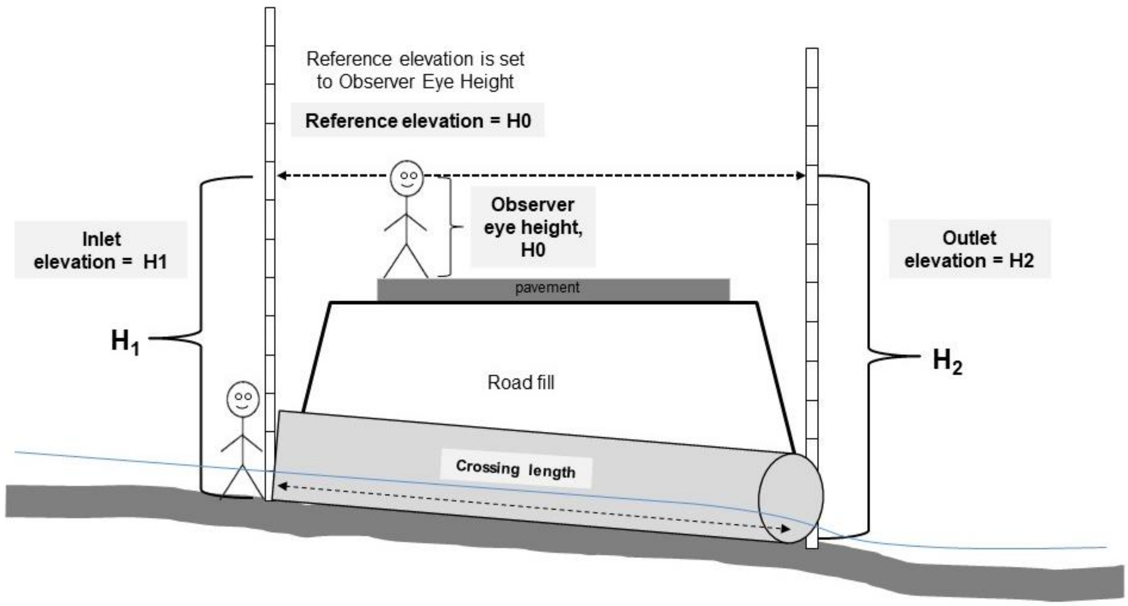
HIGHER – the crossing slope is higher than the natural slope of the streambed.
LOWER – the crossing slope is lower than the natural slope of the streambed
ABOUT THE SAME – the crossing slope matches the streambed slope.



You do **NOT** need to collect inlet and outlet elevations at stream crossings with **>20** feet width because these structures are too large to run through the Hydraulic Capacity model. STOP

52) Reference Elevation (ft) – S

One observer stands on the pavement at the location where flooding water would first touch asphalt—this is the lowest point along the road profile on the upstream side of the culvert. This location is used as a reference point for all elevation measurements and should be set to the observer's eye height (measure the distance from the road surface to the observer's eye).



54) Inlet Invert Elevation (ft) – S

Record the vertical distance between the inlet invert and the height of the roadway (which is set to the observers' eye height). One observer stands in the stream at the inlet and holds the base of the depth rod on the *inside edge* of the inlet. The depth rod is extended fully so that it surpasses the height of the road. A second observer stands on the road above the inlet, on top of the edge of the pavement, and uses a pop level to measure the distance they are standing above the inlet and record this height (H_1).

55) Outlet Invert Elevation (ft) – S

Record the vertical distance between the outlet invert and the reference height of the roadway (which is set to observer's eye height). One observer stands in the stream at the outlet and holds the base of the depth rod on the *inside edge* of the outlet invert. The depth rod is extended fully so that it surpasses the height of the road. A second observer stands on the road above the inlet, directly on top of the edge of the pavement and uses a pop level to measure their height above the inlet invert by shooting directly towards the extended depth rod. The second observer uses a pop level to measure the distance they are standing above the inlet and record this height (H_2).

56) DOWNSTREAM WATERBODY – S | W

Select the waterbody that describes the downstream type. Refer to the definitions and diagrams of waterbody types listed in the Upstream Waterbody parameter.

WETLAND
STREAM
SURFACE

57) WATER DEPTH: STRUCTURE OUTLET (FT) – S | W

Measure the depth of the water *within* the structure at the outlet.

58) STRUCTURE LENGTH (FT) – S | W

Measure the crossing from inlet to outlet by using the rangefinder to shoot through the length of the crossing. If measurement through the crossing is not possible, stand on top of the inlet and measure over the road. If measurement over the road is not possible, estimate the length in ArcGIS online using aerial imagery.

60) DOWNSTREAM: WIDTH (A) (FT) – S | W

Measure the interior width of the crossing. Reference the structure diagrams for guidance.

61) DOWNSTREAM: OPEN HEIGHT (B) (FT) – S | W

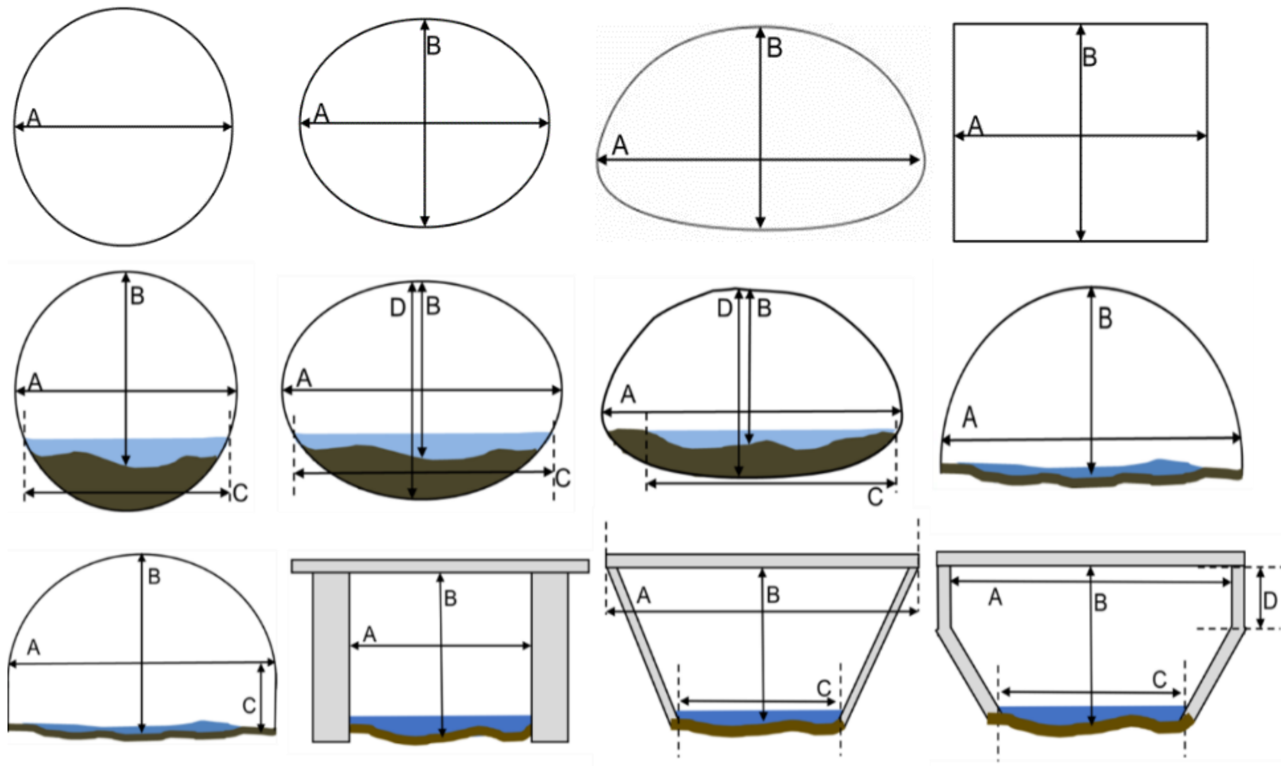
Measure the interior height from the inside top of the structure to the inside bottom of the structure. For ***embedded or clogged*** structures, this measurement should be located equal to the highest elevation of accumulated or embedded material in the crossing.

62) DOWNSTREAM: WETTED WIDTH/WALL RISE (C) (FT) – S | W

For ***embedded or clogged*** culverts, and open-bttom bridges, measure the width of stream channel (wetted width) that passes through the crossing. For an ***Arch Bridge***, measure the vertical wall rise as shown in the Arch Bridge diagram below.

63) DOWNSTREAM: TOTAL HEIGHT (D) (FT) – S | W

For ***embedded or clogged*** structures, measure the height from the interior top of the structure to the bottom of the structure. If you are unable to access the bottom of the structure because the sediment is to deep, then leave this field blank and leave a comment.For bridges with side slopes and abutments, measure the vertical height of the abutments beginning at the side slopes.



65) Structure Condition – S | W

Look inside the stream crossing and visually inspect the interior walls and surfaces of the structure. Identify the condition of the inside of the conduit based on the criteria below.

GOOD – like new, with little or no deterioration, consistent shape, minor joint misalignment, no movement, structurally sound and functionally adequate.
FAIR – some deterioration or cracking, joint separation with minor infiltration but structurally sound, localized distortion in shape, functionally adequate.
POOR – significant deterioration or extensive cracking and/or spalling, extreme deflection in shape, joint separation with potential to create voids, significant movement and/or functionally inadequate requiring maintenance or repair.
NO RATING – structure cannot be assessed due to blockage, unsafe conditions or other environmental circumstances.

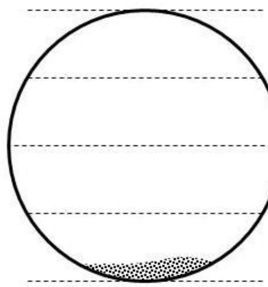
66) Dominant Substrate Throughout Structure – S | W

Select the type of substrate that is **continuously** distributed throughout the crossing. If substrate is not present throughout, then select "NONE."

67) Structure Filled With Sediment – S | W

Identify the amount of sediment buildup within the structure. This parameter should be evaluated for structures that are not considered "embedded" but are filled (or plugged) with sediment.

OPEN
¼ FULL
½ FULL
¾ FULL
ENTIRELY FULL



68) Outlet Wing wall: Material – S | W

Wing walls are structures installed on either side of the outlet to hold back the road embankment. Structures should only be considered wing walls if there is continuous material intentionally installed to be in direct contact with the with the outlet face.

METAL - continuous metal walls, whether smooth or corrugated.
CONCRETE - preformed or cast-in-place concrete walls.
MASONRY - brick or stone structure bonded by mortar.
DRY FIT STONE - stone structure without mortar to bind the stones together.
PLASTIC - continuous plastic walls, whether smooth or corrugated.
GABION - wire cages filled with small stones that stack on one another to form a wall.
OTHER - a material not listed above.
NONE - no wing wall present.

69) Outlet Headwall: Materials – S | W

A headwall provides anchoring support for the conduit and prevents surrounding soil and fill washing away. Select the option that best describes the overall material surrounding the face of the outlet.

METAL - continuous metal walls, whether smooth or corrugated.
CONCRETE - preformed or cast-in-place concrete walls.
MASONRY- brick or stone structure bonded by mortar.
DRY FIT STONE - stone structure without mortar to bind the stones together.
PLASTIC - continuous plastic walls, whether smooth or corrugated.
GABION - wire cages filled with small stones that stack on one another to form a wall.
OTHER - a material not listed above.
NONE - no wing wall present.

70) Outlet Condition – S | W

Describe the condition of the structural features (both the headwall and wing walls) at the crossing outlet. This parameter is assessing the structural features on the exterior of the outlet.

GOOD – Concrete: spalling of up to ¼-inch thickness is present, joints between headwall and wing walls are broken, or some mortar is missing from joints. Metal: Pitting or superficial rust is present.
FAIR – Concrete: spalling of more than ¼-inch thickness is present, but no reinforcement is present, joints between headwall and wing walls are beginning to separate, or joints between some stones are broken. Metal: flaking rust is present and some loss of wall thickness is present, or a hole can be poked through the wall with a sharp point.
POOR – Concrete: reinforcement is visible, stones are loose, or large cracks run through the headwall. Metal: holes due to corrosion are present, full length cracks or tears are present, joints are separated, or severe deformation is present.
NO RATING – the headwall or wingwall is not evaluated or there is no headwall or wingwall at the inlet.


These culverts are rated as "poor" outlet condition. The headwall is collapsing and there is scour inside the concrete pipe (left photo) and the metal pipe is rusted, bent, and the headwall is deterorating along the road embankment (right photo).

71) DOWNSTREAM: SCOUR UNDERMINING STRUCTURE S | W

Identify any parts of the structure that have been affected by the erosive action of running water, has carried material away from the bed and banks. Indications that scour is accuring at or around the structure are: exposed areas of the structure that should be covered by streambed material (e.g., bridge footings or abutments), and leaning or hanging structures. If a culvert outlet is submerged and this parameter cannot be visually assessed, assessors can use their wading rod to sense for any scour that may exist under the crossing.

FOOTERS
CULVERT
WING WALL
CULVERT AND FOOTERS
CULVERT AND WING WALL
FOOTERS AND WING WALL
CULVERT, FOOTERS AND WING WALL
NONE – There is no evidence of scour around the structural features of the crossing.
UNKNOWN – Survey conditions prevent the ability to acuratey assess scour around the structure.


Scour under culvert

Scour under the culvert and footers

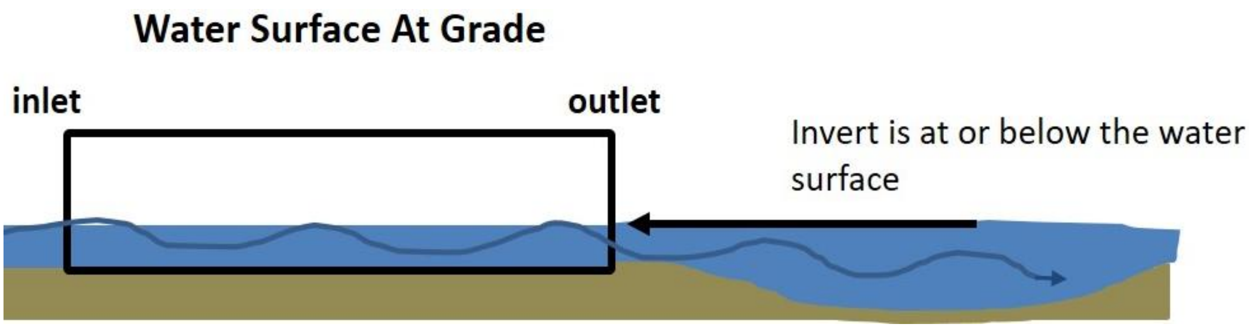

Scour under the footers

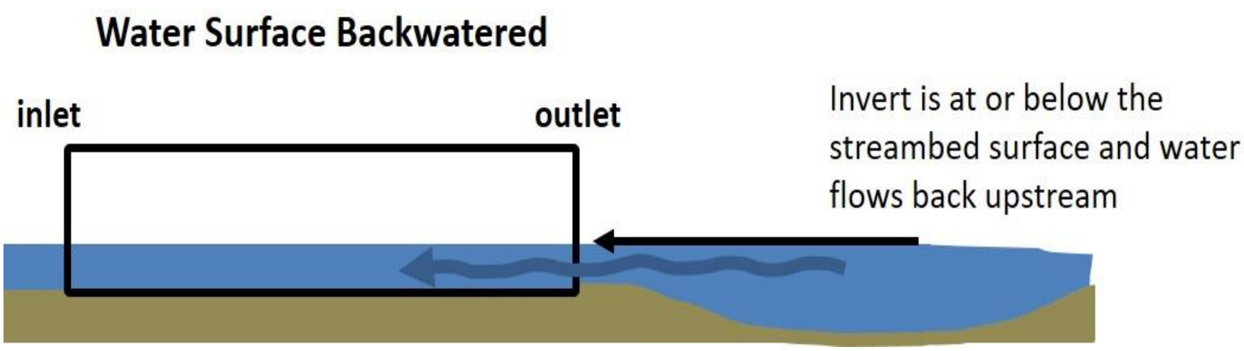
Scour under wing walls

72) OUTLET WATER PROFILE – S | W

Description of the water surface elevation as it leaves the outlet and enters downstream. This parameter evaluates the vertical distance an aquatic organism would have to travel to get from the stream into the pipe.

AT GRADE – the outlet invert is at or below the water surface and the water exiting the crossing is at the same elevation as downstream, with no drops as it exits the conduit.
BACKWATERED – directly downstream of the outlet, the water direction has reversed and is re-entering the crossing, flowing in an upstream direction..

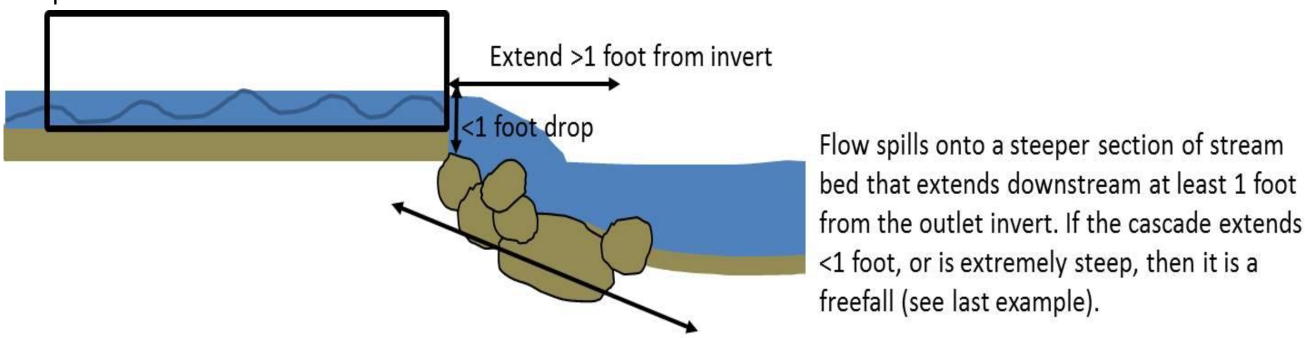




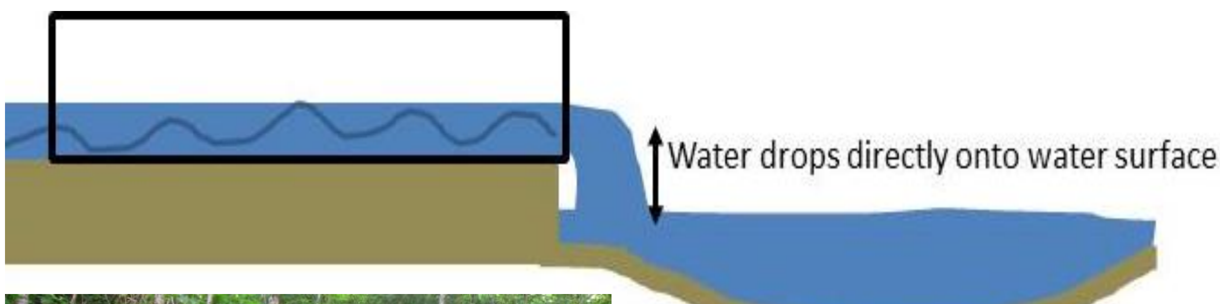
CASCADE – the outlet invert is above the downstream water surface and the flow spills out of the culvert onto a steeper section of streambed. Streamflow over the cascade may be sheet flow (as in over bedrock) or disperse flow (as in splashing off riprap or large boulders). To be classified as a cascade these two criteria must be met:

1) The steeper section of streambed must extend **more than one foot** beyond the outlet downstream. This can be done as a visual estimate and is not a parameter to be input to SADES.

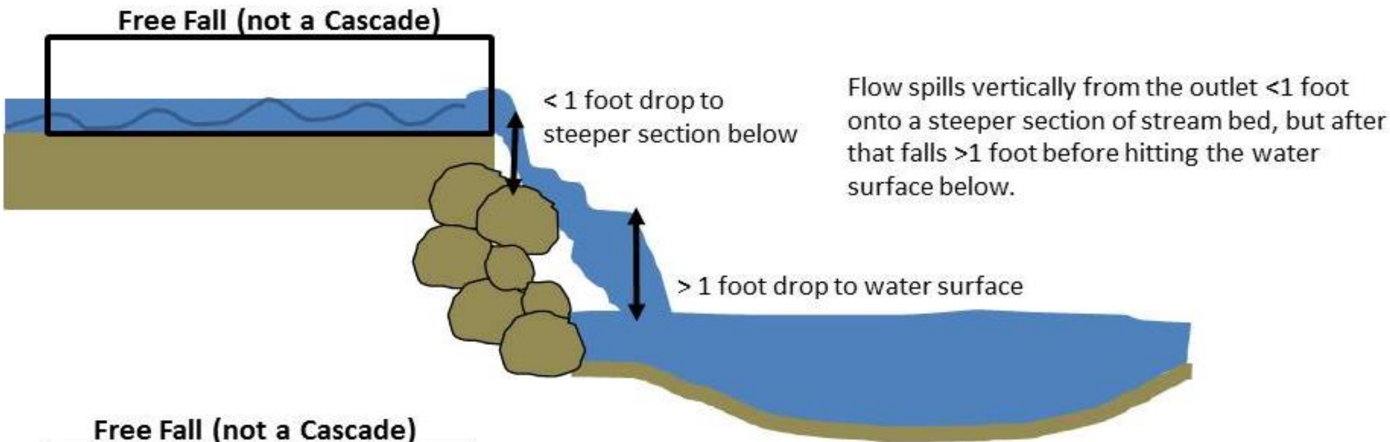
2) The flow exiting the culvert must drop less than one foot before hitting the steeper section of streambed below. If the flow drops greater than one foot before hitting a cascade than the water profile is classified as a "free fall."

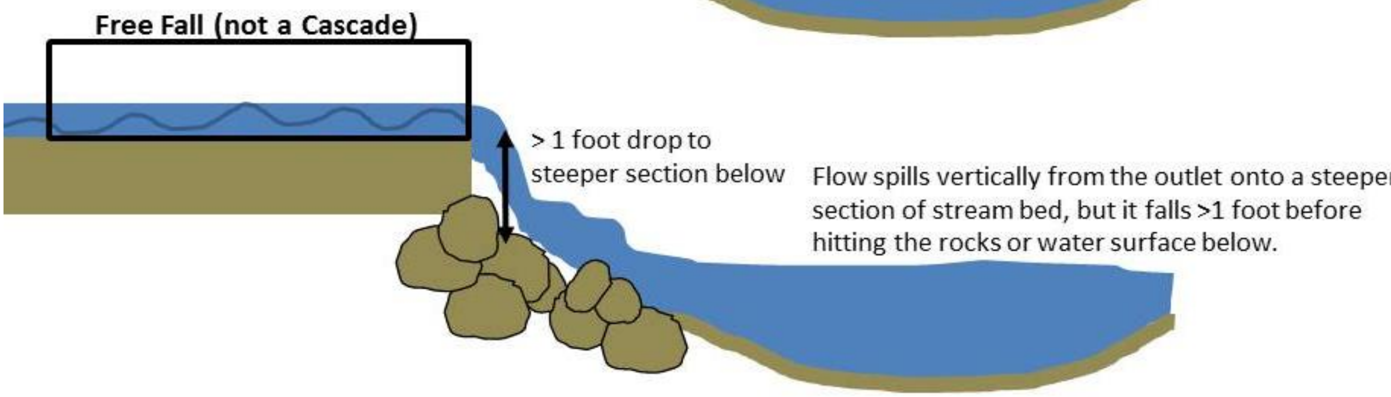


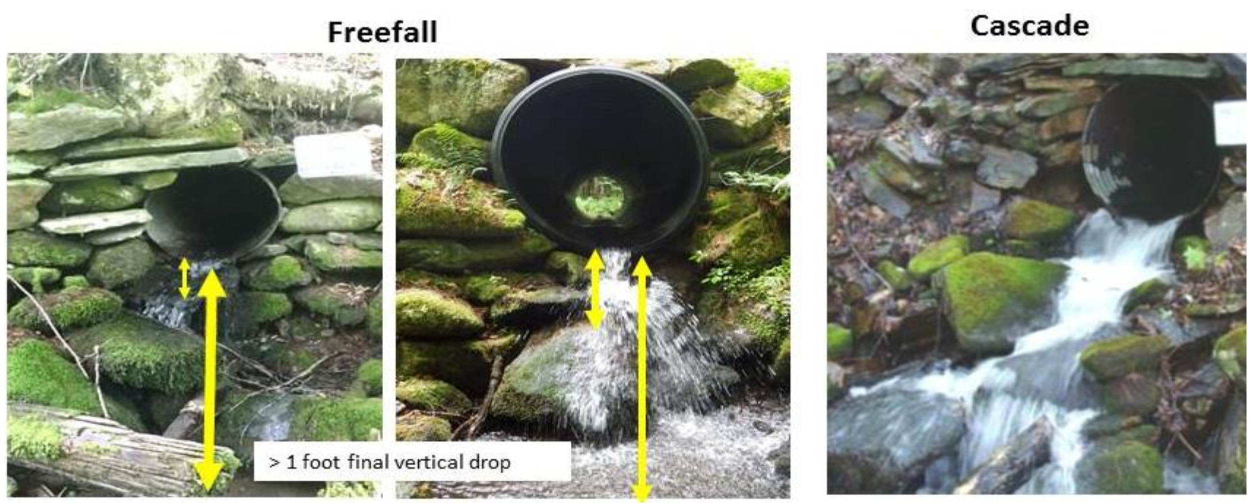
FREE FALL – The invert is above the streambed and the flow spills vertically out of the culvert onto the water surface (e.g., "perched" culvert). If the flow falls vertically from the outlet and then hits a cascade, but the vertical drop is greater than one foot, then it is still considered "free fall."



The outlet of this metal pipe is perched 2 feet above the downstream water surface, so is classified as a free fall.



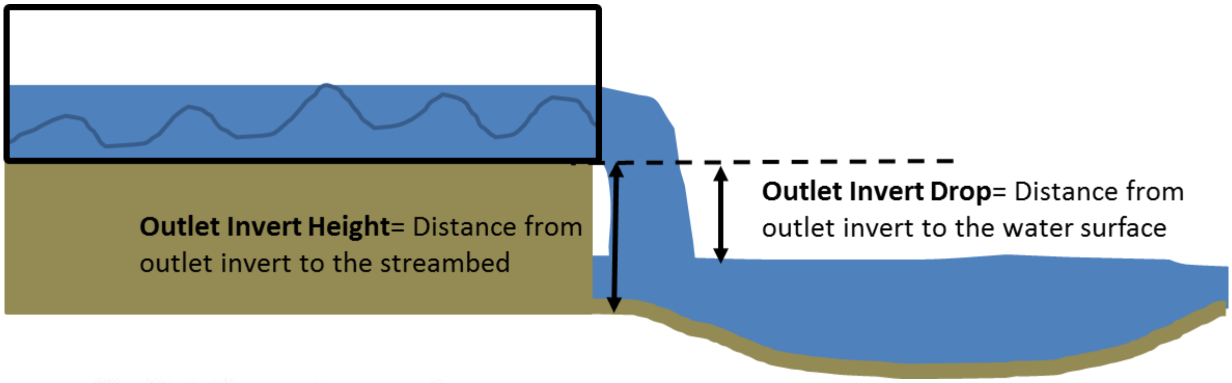




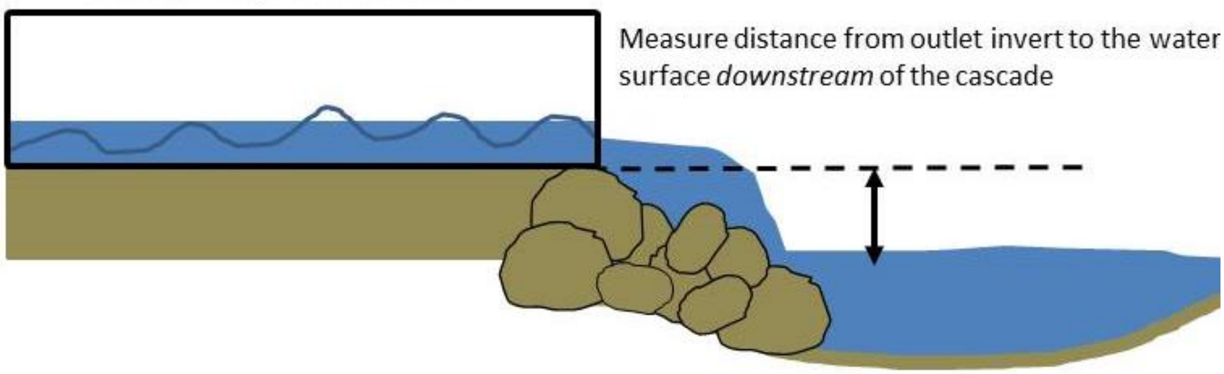
Because there is a greater than 1 foot vertical drop before the water hits the rocks below, these pipe culverts have a freefall (left photos). Whereas, a <1 foot drop onto a steeper section of rocks is a cascade (right photo).

73) Outlet Drop (ft) – S | W

Measure the vertical distance from the outlet invert to the water surface directly downstream. Take this measurement from the inside bottom surface of the structure (not the top of the water) down to the water surface below. If the culvert flow spills onto a cascade, or is a free fall onto a cascade, measure the vertical distance from the invert to the water surface directly downstream of the cascade. If the structure is at grade ***enter zero***.



Outlet drop at cascades

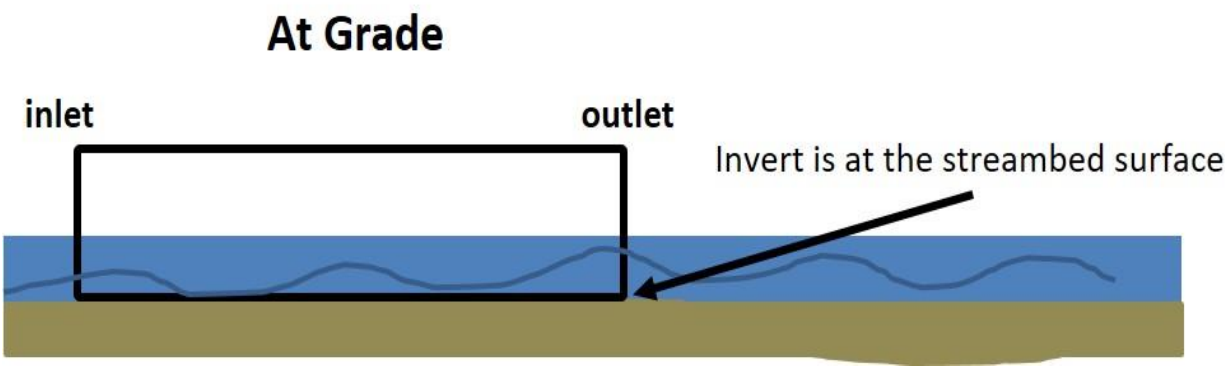


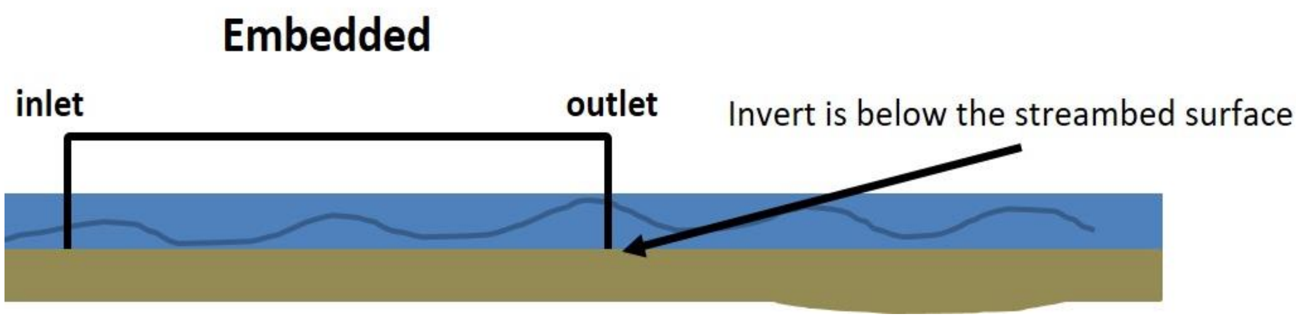
In situations where one pipe is "at grade" (left) and the other is a "freefall or cascade" (right), classify the pipe that carries the dominant flow and note the outlet grade for the drier pipe in the commnents.

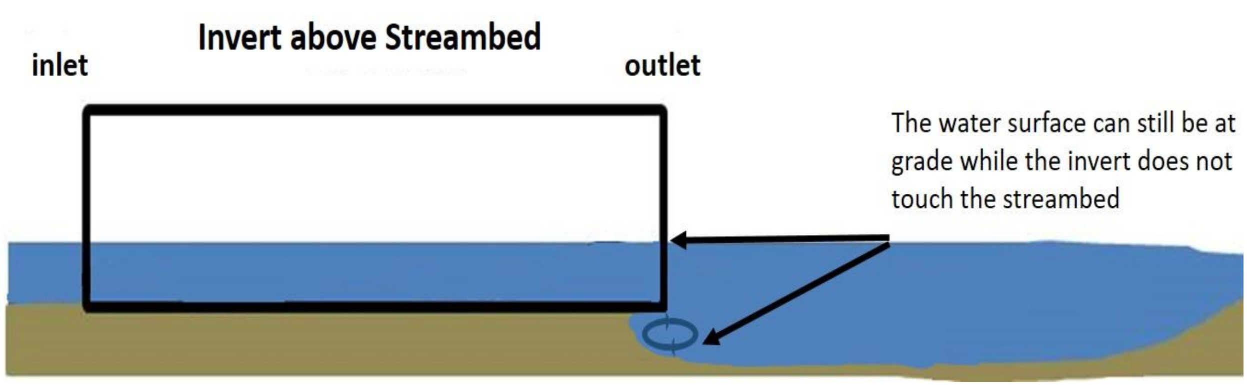
74) OUTLET HEIGHT FROM STREAMBED– S | W

Using the wading rod, measure the vertical distance from the bottom of the structure outlet to the streambed and classify according to the definitions below. This parameter describes whether the outlet invert (bottom of the culvert) is at the same elevation of the streambed, or if scour has occurred beneth the outlet.

EMBEDDED – the bottom of the structure is below the streambed.
AT GRADE – the bottom of the structure is the same grade as the streambed.
<1 FOOT ABOVE STREAMBED – bottom of the structure is above the streambed but less than one foot.
1-2 FEET ABOVE STREAMBED – bottom of the structure is between one and two feet above the streambed.
>2 FEET ABOVE STREAMBED– bottom of the structure is more than two feet higher than the streambed.







75) Outfall Treatment – S | W

Identify the type of structure installed at the outlet to reduce the energy of the water and guides/disperses the flow into the downstream.

FLOW DISSIPATER – metal, concrete or plastic installed at the outlet that is shaped like an apron or fan , a concrete pad, or granite blocks installed at the outfall.
RIP RAP – angular stones or rock bedding/ pad at base of the outlet.
OTHER – any other treatment that does not fit any of the descriptions include a note in the comments.
NONE – no treatment present.

76) Scour of the Streambed at the Outlet – S | W

Look for indications oferosion to the channel bed from high-velocity water exiting the outlet such as steep pools or the structure being perched above the channel. This parameter is relative to stream size so look at the degree of erosion within the context of the channel widths.

NONE – no scour is observed at the outlet.
LOW – finer material is no longer present below the outlet because it has been washed away, but an evident pool is not yet present
MEDIUM – noticeable erosion is occurring at the outlet; a pool is forming, but is not yet deep, and the conduit is in the process of becoming perched.
HIGH – the outlet is perched high above the streambed due to continuous erosion, and there is a deep pool present.
UNKNOWN – the scour cannot be observed due to turbid or turbulent water.

77) Downstream: Bank Armoring – S

Armoring is hard protective covering, such as rocks, angular stone (rip rap), gabion, wood, or other hard materials that are designed andinstalled to prevent bank erosion. It is common in mountainous terrain for the natural streambed and banks to consist of large bulders. In the situations when it is difficult to differentiate between armoring and natural substrate, look at the arrangement and gradient size of the rocks on the banks. Armoring will consist of rocks that are more uniform in shape and size, and their arrangement will be more ordered.

INTACT – not falling into stream, no missing or out of place pieces of armoring material.
FAILING – Parts are falling into the stream, missing or out of place.
NONE – No hard bank armoring present.
UNKNOWN – Unable to assess the condition or presence of hard bank armoring.

78) Downstream Pool Present – S | W

A pool is an area of the stream characterized by deeper depths and a slow current. Indicate if a pool is directly below the outlet. If there is a cascade (as defined above) at the outlet, then answer “no” to this question.

YES – a pool is directly below the outlet of the structure.
NO – there is no pool or the culvert flows onto a cascade.

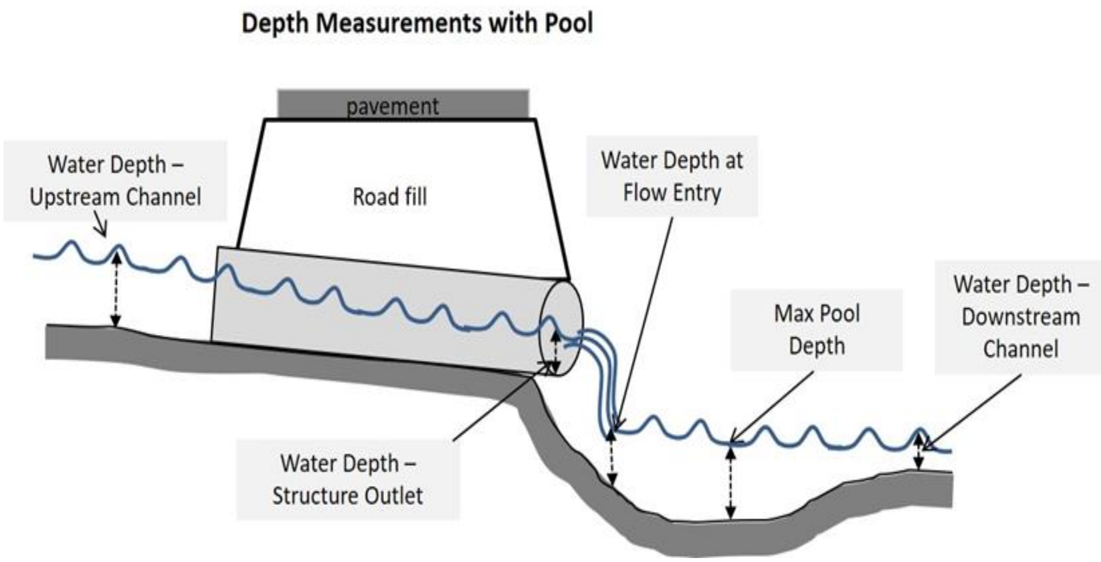
79) Downstream Water depth at flow entry (ft) – S | W

Measure the water depth from the water surface to the streambed at the point where the stream flow from the crossing enters the surface of the water (see diagrams below parameter #81).

The water depth is measured right at the point where water spills into the stream from the outlet.

80) Downstream Pool Maximum Depth (ft) – S | W

Estimate the pool depth at the point of maximum pool depth. If the estimated depth is greater than four feet, then record "greater than four feet." This data should be collected when the pool is present, and only if a pool is present directly below the outlet. If there is no downstream pool, leave blank.



81) Water Depth: Downstream Channel (ft) – S | W

At Downstream: Bankfull Width 1, record the deepest part of the channel by measuring from the water surface to the streambed. If there is a pool present, measure the depth immediately **after** the pool.

82) Downstream: Bankfull Width 1 (ft) – S

Measured directly downstream of the crossing in the area that has the potential to be within the influence of the culvert

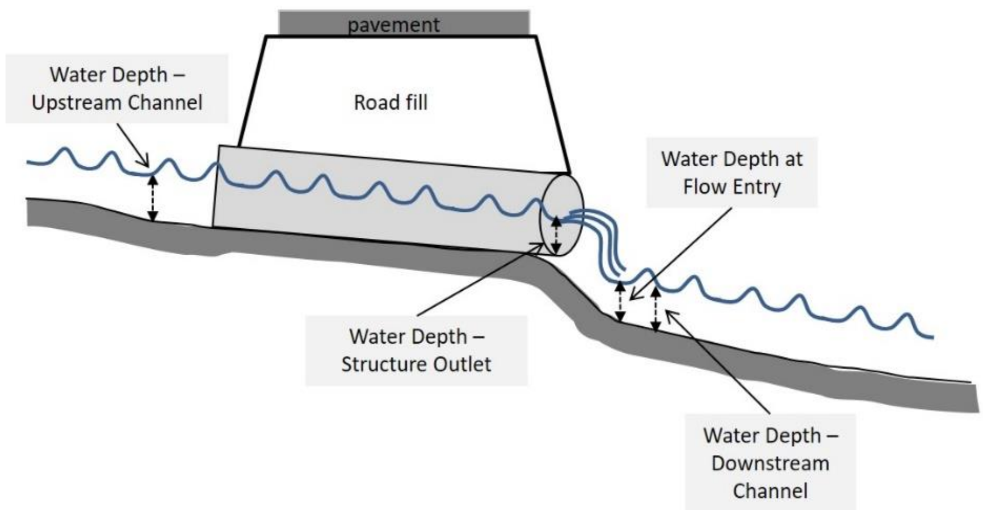
83) Downstream: Bankfull Width 2 (ft) – S

Measured at ½-bankfull width downstream of the first bankfull width measurement.

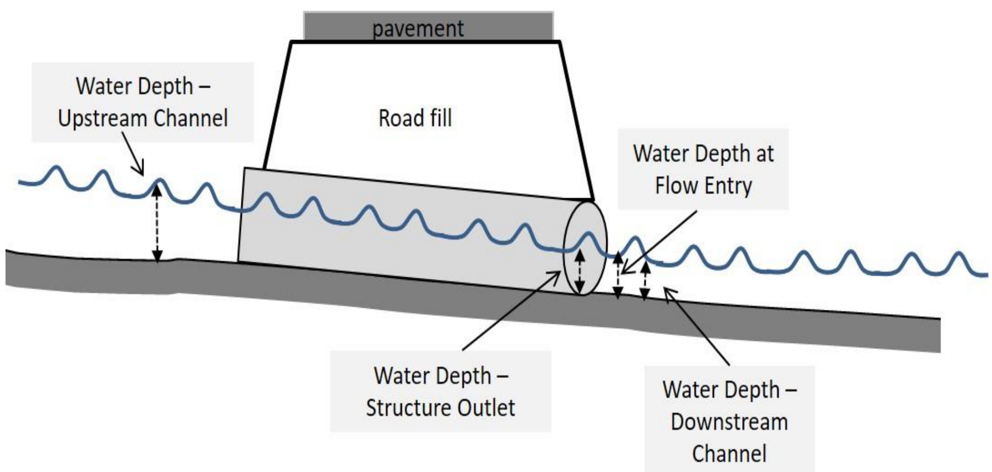
84) Downstream: Bankfull Width 3 (ft) – S

Measured at ½-bankfull width downstream of the second bankfull width measurement.

Depth Measurements perched with no pool

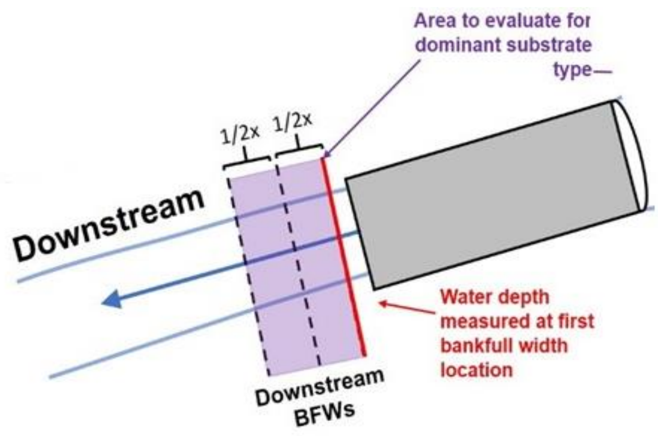


Depth Measurements without Pool (at grade)



85) DOWNSTREAM: DOMINANT SUBSTRATE – S

In the area directly downstream from the outlet, where the three downstream bankfull widths were collected, visually determine the dominant substrate type that takes up the greatest area.



86) DOWNSTREAM: BANK EROSION – S

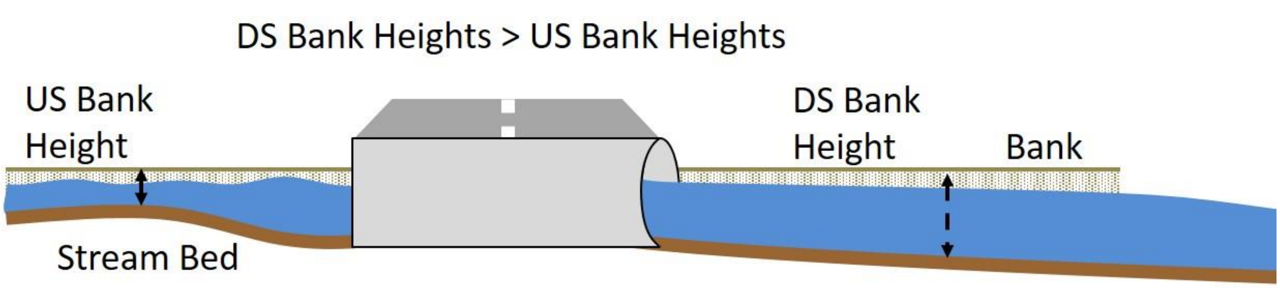
Identify the overall degree of bank erosion observed in the area 10x the first bankfull width or 100 feet downstream from the structure outlet. Refer to photo examples provided for upstream erosion. Keep in mind that streams can have natural background levels of erosion, especially in areas outside of meander bends and across from point bars, and that the degree is relative to stream size.

HIGH – nearly continuous erosion along banks, especially on medium to high banks.
LOW – occasional erosion along banks, mostly found on low banks.
NONE – no bank erosion evident.

87) DS BANK HEIGHTS TALLER THAN US BANKS – S

This parameter is designed to measure whether erosion has occurred downstream of the structure, and should be considered as relative to the streambed. If bank heights are higher downstream as compared to upstream, ensure that the form of the banks is similar to that observed upstream. For example, if a bank is high and comprised of a bedrock outcrop downstream that was not observed upstream, then it is possible that the difference in height may be caused by natural features as opposed to erosion caused by the culvert.

YES – bank heights downstream are substantially greater than bank heights upstream.
NO – upstream and downstream bank heights are similar.



88) DOWNSTREAM: BEDROCK PRESENT– S

Indicate whether there is any bedrock visible in the channel downstream of the structure.

- YES: bedrock is visible downstream of the structure and makes up part of the channel.
- NO: bedrock is NOT visible downstream of the structure; not present in channel.

89) HYDRAULIC CONTROL TYPE – S

If the water elevation directly downstream of the culvert is being controlled by a geomorphic feature, indicate the material.

BEDROCK
BOULDER
COBBLE
GRAVEL
SAND
SILT/CLAY
WOOD
UNKNOWN
NONE

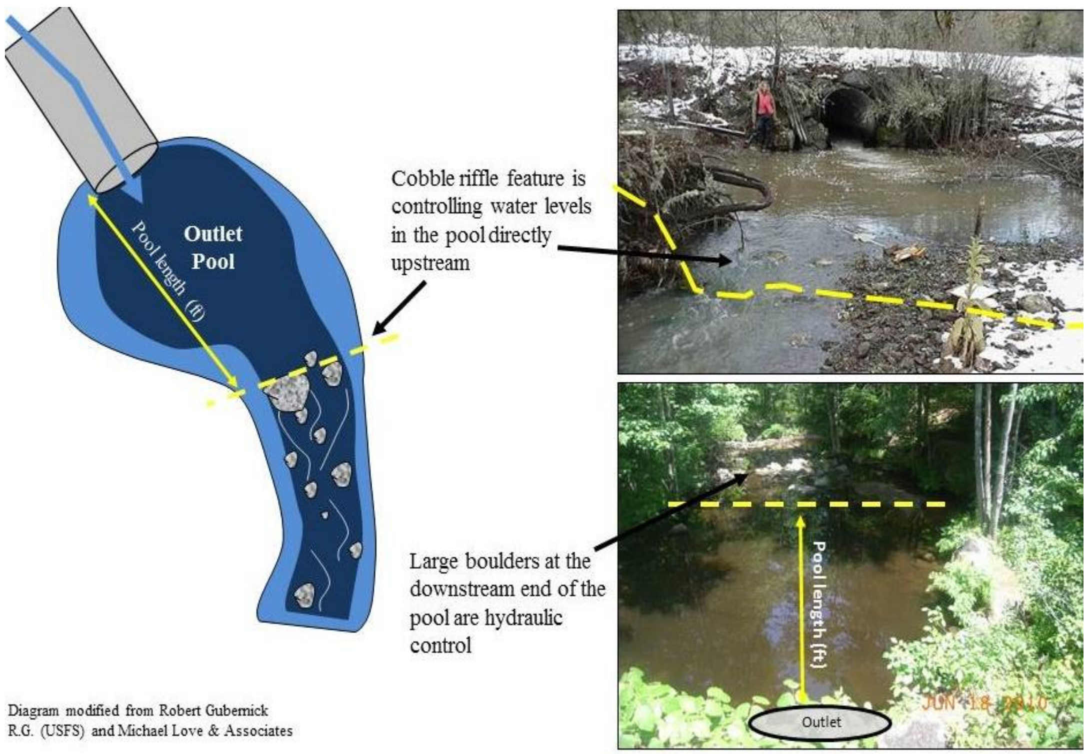
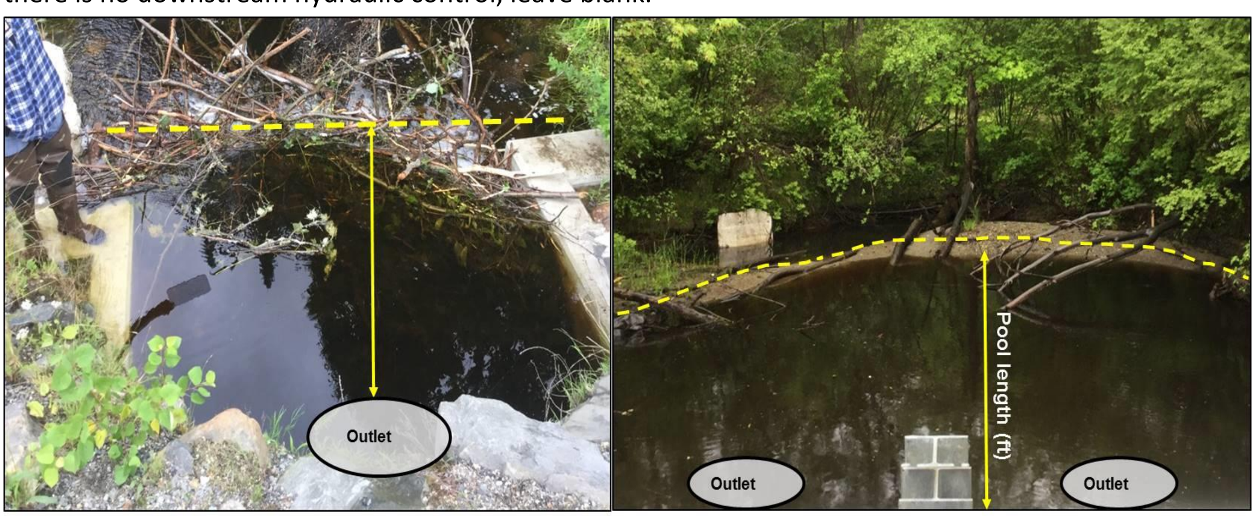


Diagram modified from Robert Gubernick R.G. (USFS) and Michael Love & Associates

90) HYDRAULIC CONTROL DISTANCE FROM STRUCTURE (FT) – S

Measure the distance from the outlet to the downstream hydraulic control. If there is a pool present just downstream of the outlet, then the hydraulic control will be located at the tail-end of the pool. If there is no downstream hydraulic control, leave blank.



91) Downstream: Beaver Dam Near Structure – S | W

Record whether a beaver dam is within the survey area downstream from the structure. Beaver dams usually create a pond upstream. If unsure whether a dam was made by beavers, look at the ends of the branches to see if they have been gnawed.

- **YES:** a beaver dam is located within the survey area downstream of the structure.
- **NO:** a beaver dam is NOT located within the survey area downstream of the structure.

92) Wildlife Observed US, DS, and Within the Structure – S | W

Consider the entire area that was surveyed upstream, downstream and within the structure, including the banks, water and channel bed, and indicate whether any wildlife was observed. Below is a list of examples of wildlife commonly seen around stream crossings, this is a text field (1,000-character limit) and multiple types may be entered. Note whether you see roadkill in the area.

EXAMPLES OF POSSIBLE ANSWERS
AMPHIBIAN – frog or salamander.
FISH – if known, indicate species.
TURTLE – if known, indicate species.
LARGE MAMMALS – moose, bear, coyote, fisher, deer, beaver.
SMALL MAMMALS – bobcat, otter, mink, and any other small mammal.
WATER FOWL – ducks, geese, etc.

93) Comments – S | W

Describe any sort of secondary information. Include notes on the structure not covered in the other fields. 1,000-character limit.

MINIMUM 6 PHOTOS – S | W

Photographs are required fr the data to undergo QA/QC review. Photos should be sufficient to enable identification of all the structural compnents of the crossing, the river bed material, bank condition, and views capturing the entirety of theinlet and outlet. Data collectors are required to take HIGH QUALITY photos because they are critical to the QA/QC process, so take extra care to collect sharp, clear images.

PHOTO 1 – **Downstream view toward structure inlet:** view must capture the structure inlet, headwall and wingwalls (if present), road embankment, and some of the adjacent land, bank, and armoring. This should be taken from a reasonable distance back from the structure with the widest angle setting so that the environment around the structure is captured.

PHOTO 2 – **Upstream view from structure inlet:** view from the streambed next to or in front of the structure. This picture is meant to focus on the bed and near-structure features. Bed substrate size and channel bars should be captured in this photograph.

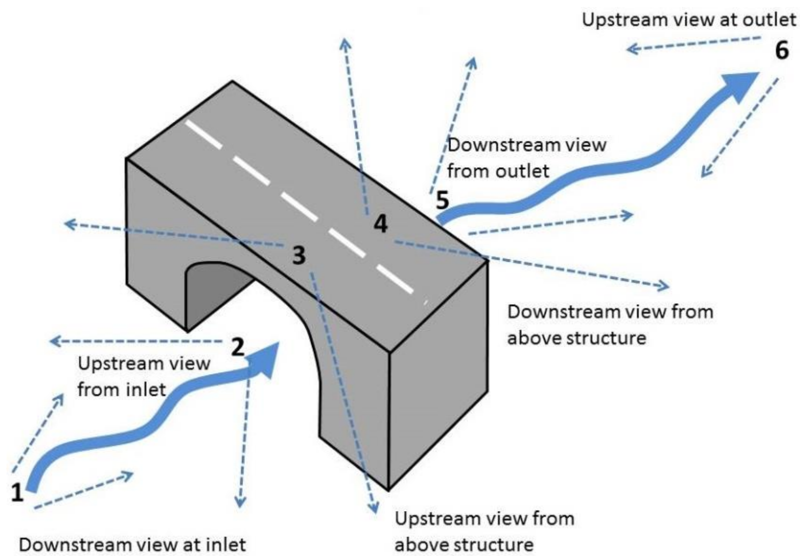
PHOTO 3 – **Upstream view of stream above structure:** capture the river environment and land adjacent to the channel upstream of the crossing. This photo is to be taken looking out at the channel and surrounding environment, not down at the streambed.

PHOTO 4 – **Downstream view of stream above structure:** capture the environment and land adjacent to the channel downstream of the crossing. This photo is to be taken looking out at the channel and surrounding environment, not down at the streambed.

PHOTO 5 – **Downstream view from structure outlet:** view from the streambed next to or in front of the structure. If dangerous conditions are present, take a photo standing as close as possible to the location where the downstream view will be maximized (please, take care not to fall into any scour pools).

PHOTO 6 – **Upstream view toward structure outlet:** view must capture the structure outlet, headwall and wingwalls (if present), road embankment, and some of the adjacent land, bank, and armoring This should be taken from a reasonable distance back from the structure with the widest angle setting so that the environment around the structure is captured.

ADDITIONAL PHOTOS: Any features that may need clarification. If you are at a stream crossing where thick vegetation blocks portions of the normal views, additional photos beyond the six required may be necessary and are encouraged.



QA/QC Review

All data uploaded to SADES **must** undergo Quality Control and Quality Assurance by trained personnel at NHGS and the NHDESWB. For data to be reviewed, the six required photos must be included with the data submission. Structure condition, Geomporphic Compatibility, and Hydarulic Vulnerability parameters will be reviewed by NHGS and the AOP paramters will be reviewed by NHDESWB. Data collectors will receive comments from the NHGS data reviewer and are expected to make changes to the data in SADES to address concerns raised by the data reviewer. The NHDESWB will review and make changes in SADES and provide the data collectors a summary of data collection issues and concerns. If a quantitative parameter needs to be re-measured in the field, the AOP reviewer will indicate so in the comments. There will be two fields to track the QA/QC review status, one for NHGS and one for AOP.

94) Current NHGS QA/QC Review Status

NEW – default field setting; generated when a new record is uploaded onto SADES.
COMMENTS READY – NHGS has provided QA/QC comments and is waiting for responses.
COMMENT ADDRESSED – the data collectors have made their data edits on SADES in response to the NHGS QC comments and engaged in a QA/QC dialog with the QC manager.
NHGS REVIEW COMPLETE – NHGS has reviewed the response comments from the data collectors and ensured all issues have been addressed.
SCORED: The data has undergone QA/QC process and scored for GC and AOP.
MISSING PARAMETERS – there are a long-term issues with this crossing that prevents it from being scored for GC, Hydraulic Vulnerability, or Condition.
MISSING PHOTOS – NHGS is unable to perform QA/QC review because there are no photos.

95) Current AOP QA/QC Review Status

NEW – default field setting; generated when a new record is uploaded onto SADES.
COMMENTS READY – NHDES Weltands reviewer recommends a quantitative parameter be remeasured.
COMMENT ADDRESSED – the data collectors have remeasured any necessary parameters
AOP REVIEW COMPLETE – NHDES Weltands reviewer has ensured issues have been addressed.
AOP SCORED: The data has undergone the QA/ QC process and scored for AOP.
Team Scored: NHDESWB reviewed the photos and assigned an AOP score.
MISSING PARAMETERS – there are long-term issues with the data that prevents it from being scored.
MISSING PHOTOS – NHDESWB is unable to perform QA/QC review because there are no photos.

96) NHDES Review Comments

Written comments that NHGS and NHDES Weltands provides on issues, questions and concerns, regarding the measured environmental parameters at each stream crossing location.

97) Assessment Team Response Comments

These are the responses that the data collectors have to the NHDES QA/QC comments.