Statewide Asset Data Exchange System (SADES)

New Hampshire Stream Crossing Initiative

Field Manual

In Partnership With the New Hampshire:

Department of Environmental Services
Department of Transportation
Fish and Game Department
Division of Homeland Security and Emergency Management
Association of NH Regional Planning Commissions
UNH Technology Transfer Center

Version: 7.0

The New Hampshire Stream Crossing Initiative— A multiagency effort

The State of New Hampshire has formed an interagency workgroup to collaboratively manage the state's stream crossing assessment efforts, comprised of representatives from the Departments of Environmental Services (NHDES) and Transportation (NHDOT), Fish and Game Department, and The Division of Homeland Security and Emergency Management. 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 their compatibility with local stream processes, as well as Aquatic Organism Passage. The multiagency approach of the NH Stream Crossing Initiative enables towns and agencies to more efficiently address the problem of undersized stream crossings, infrastructure safety, and flood risk management by working collaboratively.

Project Background

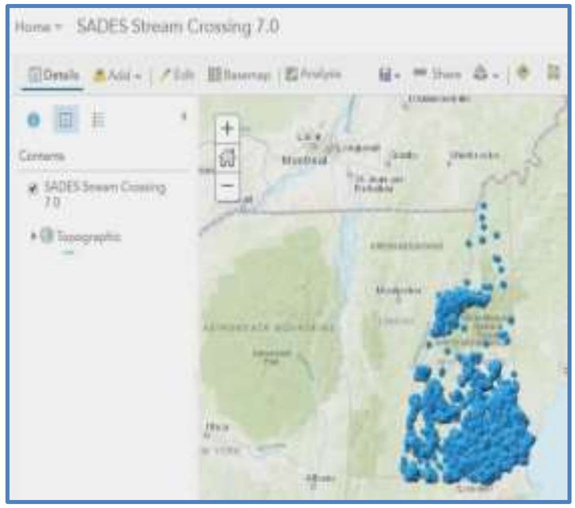
Stream crossings are structures (i.e. culverts, bridges, arches) that carry a road over a river, lake, wetland, or small stream. In a state that has a vast diversity of waterbodies, stream crossings are a critical component of New Hampshire's road network and infrastructure. Undersized culverts and bridges may restrict streamflow moving through the crossing, thereby increasing water velocity through the culvert. The force of this fast-moving water exiting the culvert can cause downstream bank erosion and streambed scour, bank destabilization, and a perched culvert condition. During floods, the 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 which can act as a wall of water 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, the state of New Hampshire Department of Environmental Services (DES), working with partners, is striving to address flood risks and make our infrastructure more resilient through a proactive approach by identifying problem culverts for replacement before they can fail and cause damage.

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 data for a crossing assessment is complete and undergone Quality Assurance and Control 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** (DOT asset condition score), and 4) **Hydraulic Capacity** of the structure to transport predicted flows under storm events. For these screening tools to produce accurate results accurate data collection and following the instructions outlined in this manual, is *essential*. Stream crossing data collected through this protocol **must** be quality-controlled (QAQC) by the NHDES New Hampshire Geological Survey **before** it can be run through the scoring models and distributed to the public. It is critical that data collectors participate in the QAQC process to ensure high-quality data that accurately represents the conditions of the stream crossing and river environment. Contact Thomas Taggart (Thomas.taggart@des.nh.gov) for questions regarding the QAQC process.

This protocol is designed for surveys on freshwater stream crossings and is **NOT** applicable for tidally-influenced crossings. For information on tidal crossings contact Kevin Lucey at (603) 559-0026 at the NH DES Coastal Program.

The Statewide Asset Data Exchange System (SADES)

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 is hosted by Arc GIS Online, and managed by The University of New Hampshire Technology Transfer Center (T^2) as part of the NH DOT'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 that would like access to such equipment to collect this 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.



Because this data is collected by multiple agencies, it is subject to a rigorous quality assurance and control (QA/QC) process at several levels before it is ready for use and distribution by agencies, towns, and other groups working on stream crossing efforts. The initial data compilation and management onto the webserver is done by T^2 and QA/QC is performed by New Hampshire Geological Survey scientists. The QA/QC process ensures consistency across agencies performing the data collection and reduces incorrect scoring of stream crossings due to errors made in the field.

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
Cell: (603) 397-7745

Questions about survey coordination, field training, and Data Quality Control contact:

New Hampshire Geological Survey, Department of Environmental Services
Thomas Taggart
(603) 271-5762
Thomas.Taggart@des.nh.gov

or
Cheryl Bondi
(603) 271-0587
Cheryl.Bondi@des.nh.gov

Equipment

Rangefinder	To measure bankfull widths, crossing dimensions and 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 app; Cellular capacity for ArcGIS geographic positioning.
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.
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

These surveys must be done by at least two people for safety reasons. Because these surveys take place around roads, it is recommended that each person wears highly visible clothing and a safety vest in bright colors with reflective material. 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 and uploading data and accessing SADES are provide by Chris Dowd at UNH ^{T2} and is available at (603) 862-5489. The field manual training includes a short, classroom session, followed by a field portion on Punch Brook in Franklin, NH. Please contact NHGS to schedule a training session (603) 271-5762. During the course of field assessments, NHGS and NHDOT staff is available to answer questions and provide technical guidance at any time.

Identifying Possible Assessment Locations

Data collectors must identify and plan what stream crossings your team will assess. To identify survey locations using spatial data:

1. Identify ***possible*** crossing locations.
    a. NHDES conducts an intersection analysis of NHDOT's road layer and the National Hydrography Dataset flowline.

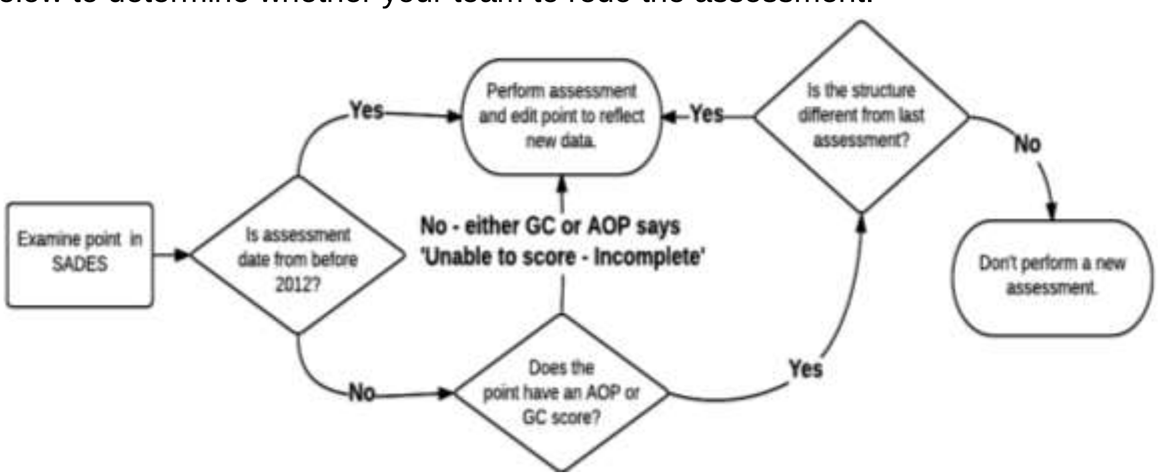
2. Compare the list of ***possible*** crossing locations versus ***completed*** assessments.
    a. Check the SADES layer to determine which ***possible*** crossing locations have already been assessed.
    b. If a ***possible*** crossing locations has already been assessed, it can be further categorized into one of two categories:
        i. **Re-assess**- Locations with an AOP/GC score of "Unable to Score-Incomplete" or assessment date earlier than 2012 must be surveyed again.
        ii. **DO NOT re-assess**- Locations with an AOP/GC score.

3. Coordinate with NHGS staff for ***confirmation*** on survey plans.
    a. NHGS can assist with survey planning by confirming the locations you plan to assess, because the agency is informed on the survey plans of all other groups and has access to current layer updates.

Proper planning is essential to a successful field season! Be sure to Coordinate your survey plans with the NH Geological Survey to avoid duplicating the efforts of other teams!

Protocol for Re-assessing Stream Crossing Locations

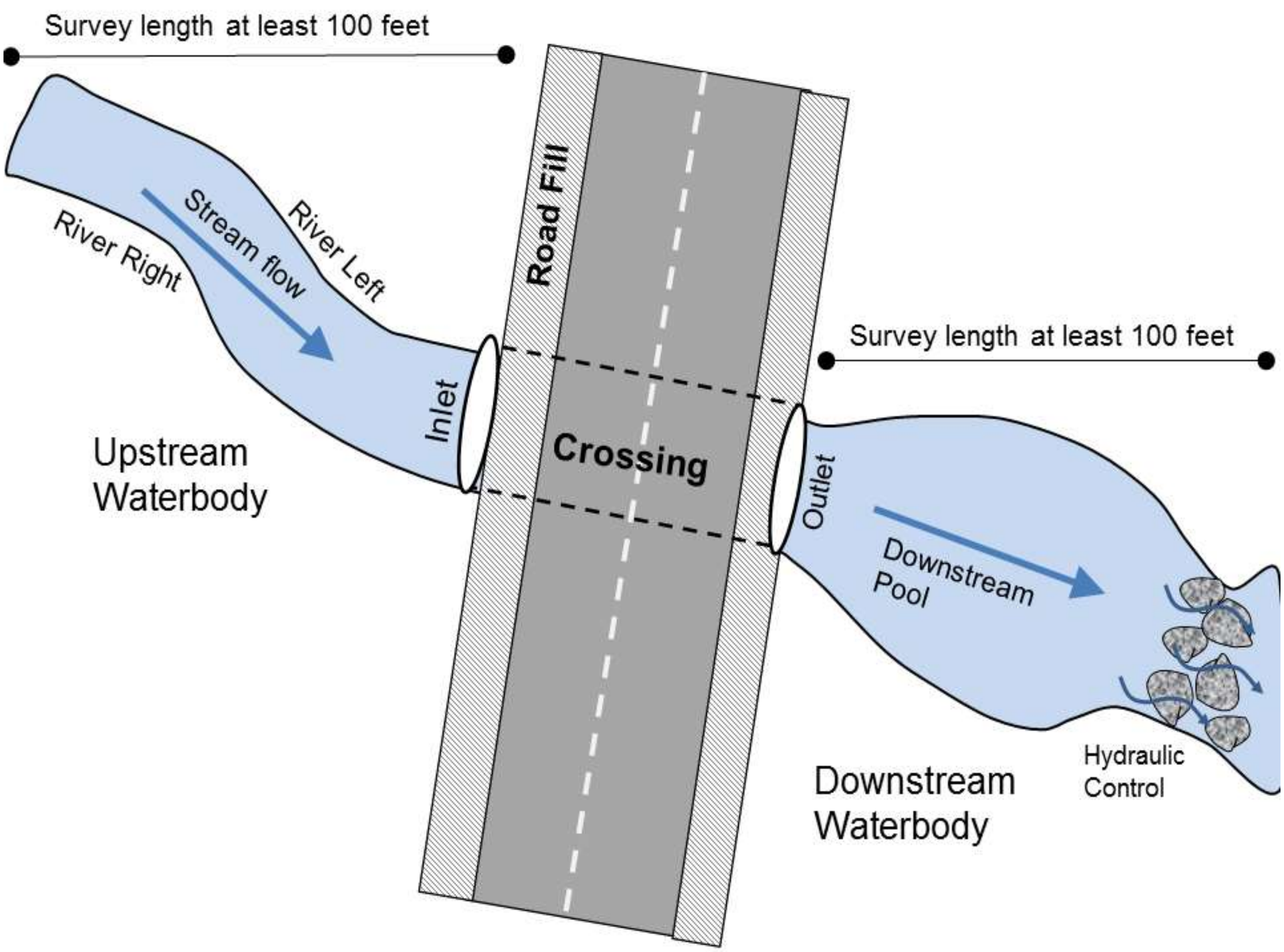
What if another team has already assessed a stream crossing? Follow the flow chart below to determine whether your team to redo the assessment.



Assessment Overview

Stream crossing assessments should be done at low flow, during the summer or early fall. When data collectors first visit a new survey location they **must** first identify the upstream and downstream waterbody types from the road viewpoint- these important variables determine the subsequent workflow of the parameters that need to be collected and the appropriate ESRI Collector App to select.

The upstream assessment should be done first, starting at the inlet and working upstream to gather information on the river environment- you should walk at least 100 feet upstream OR the length it takes to collect 3 channel bankfull measurements to understand the stream environment. For in-structure parameters, data collectors must stand at the inlet and visually scanning the inside of the crossing— **do not enter the enclosed area of the structure**! The downstream survey is conducted last and observers should walk at least 100 feet downstream of the crossing for a thorough assessment of the river.



Parameter	Waterbody Type		
	Stream	Wetland or Pond	Drainage
03) Waterbody - Upstream	X	X	X
04) Crossing Type	X	X	X
05) Assessment Date	X	X	X
06) USER ID	X	X	X
07) Observers	X	X	X
08) Organization	X	X	X
09) Project Name	X	X	X
12) Road Name - Field	X	X	X
14) Structure Skewed to Roadway	X	X	
15) If Channel Avulses Stream Will	X	X	
16) Angle of Stream Flow Approach	X	X	
17) Number of Structures at Crossing	X	X	X
18) Overflow Structures Present	X	X	
19) Structure Type	X	X	X
20) Structure Material	X	X	X
22) Inlet Type	X	X	X
23) Inlet Wingwall Angle - Stream Left	X		
24) Inlet Wingwall Angle - Stream Right	X		
25) Upstream - Width (A) (ft)	X	X	X
26) Upstream - Open Height (B) (ft)	X	X	X
27) Upstream - Wetted Width-Wall Rise (C) (ft)	X	X	X
28) Upstream - Total Height (D) (ft)	X	X	X
29) Structure Opening Partially Obstructed	X	X	
30) Screening at Structure	X	X	
31) Inlet Headwall - Materials	X	X	
32) Inlet Headwall - Condition	X	X	
33) Scour Undermining Structure - Upstream	X	X	
34) Bank Armoring - Upstream	X		
35) Water Depth - Upstream channel (ft)	X		
36) Upstream - Bankfull Width 1 (ft)	X		
37) Upstream - Bankfull Width 2 (ft)	X		
38) Upstream - Bankfull Width 3 (ft)	X		
39) Dominant Substrate - Upstream	X		

Parameter	Waterbody Type		
	Stream	Wetland or Pond	Drainage
39) Dominant Substrate - Upstream	X		
40) Upstream Deposit Type	X		
41) US Deposit Taller than 0.5 Bankfull Height	X		
42) Bank Erosion - Upstream	X		
43) Bedrock Present - Upstream	X		
44) Channel - Bankfull Width 1 (ft)	X		
45) Channel - Bankfull Width 2 (ft)	X		
46) Channel - Bankfull Width 3 (ft)	X		
47) Dominant Substrate - Channel	X		
48) Steeper Segment within 1/3 mile Upstream	X		
49) Beaver Dam Near Structure - Upstream	X	X	
50) Distance to Beaver Dam - Upstream (ft)	X	X	
51) Structure Slope Compared to Channel Slope	X		
52) Inlet Invert Elevation (ft)	X		
53) Roadway Elevation (ft)	X		
55) Outlet Invert Elevation (ft)	X		
56) Waterbody - Downstream	X	X	X
57) Water Depth - Structure Outlet (ft)	X	X	
58) Structure Length (ft)	X	X	X
60) Downstream - Width (A) (ft)	X	X	X
61) Downstream - Open Height (B) (ft)	X	X	X
62) Downstream - Wetted Width-Wall Rise (C) (ft)	X	X	X
63) Downstream - Total Height (D) (ft)	X	X	X
`65) Structure Condition	X	X	X
66) Dominant Substrate - Throughout Structure	X	X	
67) Structure Clogged with Sediment	X	X	X
68) Outlet Headwall - Materials	X	X	
69) Outlet Headwall - Condition	X	X	
70) Scour Undermining Structure - Downstream	X	X	
71) Outlet Grade	X	X	
72) Outlet Invert Drop (ft)	X	X	
73) Outlet Invert Height	X	X	
74) Outfall Treatment	X	X	

Parameter	Waterbody Type		
	Stream	Wetland or Pond	Drainage
75) Scour of Streambed at the Outlet	X	X	
76) Bank Armoring - Downstream	X	X	
77) Downstream pool - Presence	X	X	
78) Downstream pool - Entrance Depth (ft)	X	X	
79) Downstream pool - Maximum Depth (ft)	X	X	
80) Water Depth - Downstream Channel (ft)	X	X	
81) Downstream - Bankful Width 1 (ft)	X		
82) Downstream - Bankful Width 2 (ft)	X		
83) Downstream - Bankful Width 3 (ft)	X		
84) Dominant Substrate - Downstream	X		
85) Bank Erosion - Downstream	X		
86) DS Bank Heights Taller than US Banks	X		
87) Bedrock Present - Downstream	X		
88) Downstream Hydraulic Control - Type	X		
89) Downstream Hydraulic Control - Distance (ft)	X		
90) Beaver Dam Near Structure - Downstream	X	X	
91) Distance to Beaver Dam - Downstream (ft)	X	X	
92) Wildlife observed - US, DS, Structure	X	X	
93) Comments	X	X	X
NA) Minimum 6 photos	X	X	X

Your particular crossing may have a combination of waterbody types between the upstream and downstream environment. Be sure to follow this key and the icons next to each parameter to understand what data needs to be collected at each waterbody type.

3.) Upstream Waterbody	S	W	D
Identify the inflow waterbody type form the viewpoint of the road.			

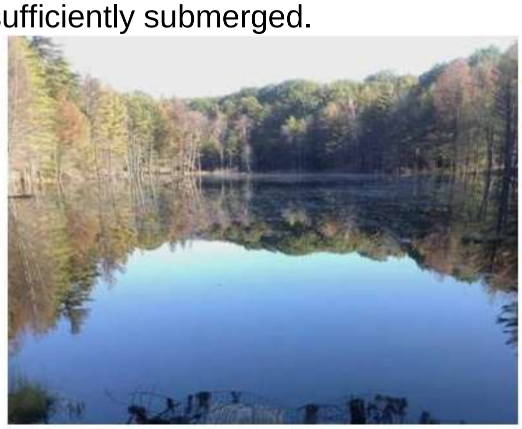
- **WETLAND**- a waterbody that does not have defined channel banks and is in an area where the water table is at or above the land surface throughout the year. The soil is saturated with water and vegetation and there is often standing or flowing water. If there is flowing water moving downstream through the crossing, but it is surrounded by wetland and you are unable to collect *at least* 3 bankfull widths due to lack of defined channel, then classify as a wetland.




- **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.



- **SURFACE**- a crossing at a depression in the land surface that stores water, such as a lake or pond, and does not have defined channel banks. An impounded water body, as created by a large dam downstream for example, could also meet this category, particularly if channel bank indicators are sufficiently submerged.

- **DRAINAGE**- a crossing at a depression or indentation in the landscape that conveys or stores water only during or directly following precipitation events. Engineered landforms such as storm water retention ponds and roadside ditches should be classified as drainages. If you are unsure whether the water body only conveys water for roadside drainage, use a topographic map to determine if the crossing is on a flowline, or walk upstream to assess whether bankfull indicators are present.


Parameter Name	**S**	**W**	**D**
Icons next to each parameter indicate the waterbody types where it is collected.			

S- parameter is collected at stream crossings.
W- parameter is collected at wetland or surface (pond, lake, impounded) crossings.
D- parameter is collected at drainage structures.

There are three ESRI Collector menus available for data collection based on the upstream waterbody types. Be sure to understand how to identify the four different waterbody types and select the appropriate Collector App menu for your survey situation.

4.) Crossing Type	**S**	**W**	**D**
Select the crossing type based upon the *upstream waterbody*. Refer to the table on pages **8-10**, and the white boxes next to each parameter, to ensure adequate data is collected for each crossing.			

- **WETLAND**- the upstream waterbody has been identified as a wetland.
- **STREAM-** the upstream water body has been identified as a stream.
- **SURFACE-** the upstream water body has been identified as a pond or lake.
- **DRAINAGE-** the upstream water body has been identified as a drainage.
- **NOT SURVEYABLE –** a crossing that cannot be surveyed due to safety or access issues, such as a crossing on a busy street or highway, or a culvert on private land. Write in the comments why the crossing is unsurveyable. Include pictures if 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 and include in the comments what is observed at the location and include pictures.

5.) Assessment Date	S	W	D
Record survey date.			

6.) User ID	S	W	D
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	D
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	D
Select the standard organization abbreviation.			

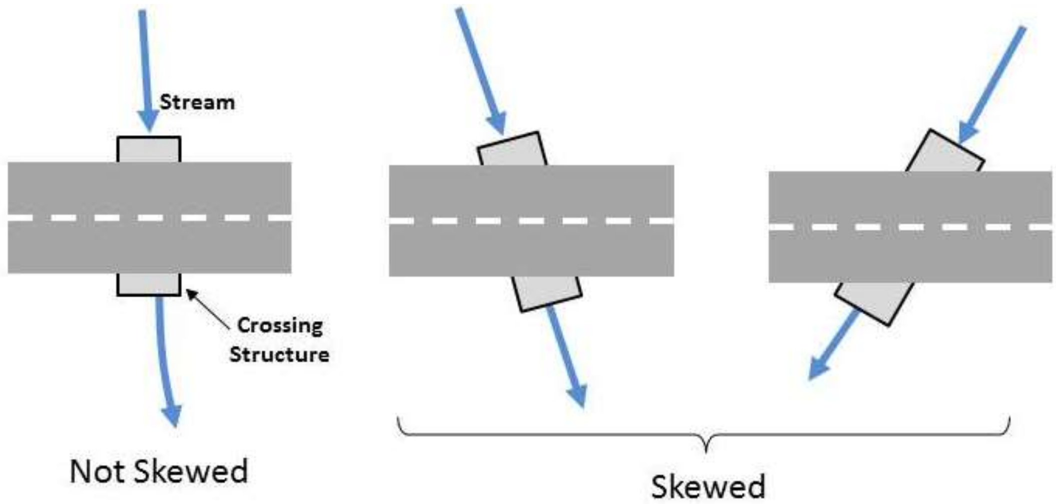
NHGS- NH Geological Survey
NHDES- all other units within the NH Department of Environmental Services
NHDOT- NH Department of Transportation
NHFG- Fish and Game Department
NCC- North Country Council
LRPC- Lakes Region Planning Commission
UVLSRPC- Upper Valley-Lake Sunapee Region Planning Commission
SWRPC-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

9.) Project Name	S	W	D
Name that has been agreed upon with your project collaborators to identify this work.			

12.) Road Name - Field	S	W	D
Type in the road that the structure is on using maps or street signs.			

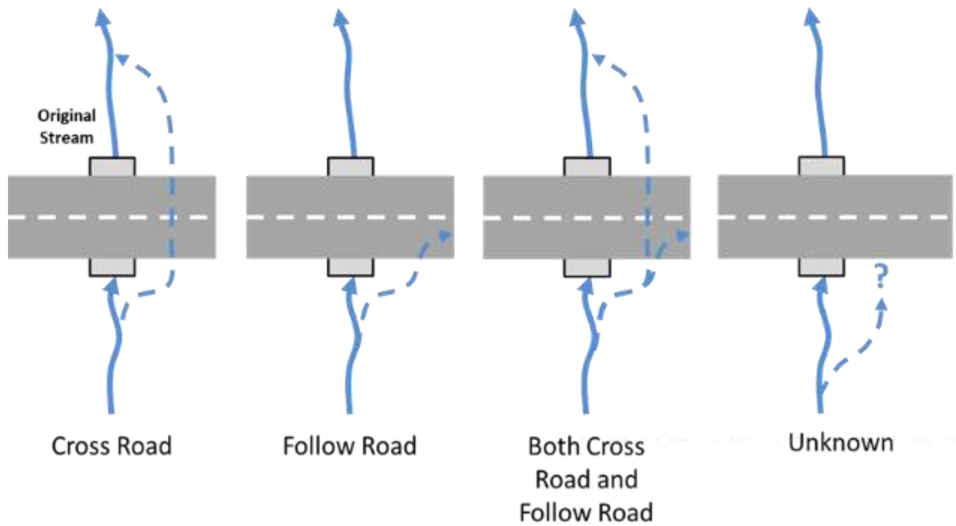
14.) Structure Skewed to Roadway	S	W	D
Indicate whether the structure is skewed (or angled) in comparison to the roadway.			

- **YES**- the structure is **not** perpendicular to the road (~90º angle).
- **NO-** the structure is positioned perpendicular (~90º angle).

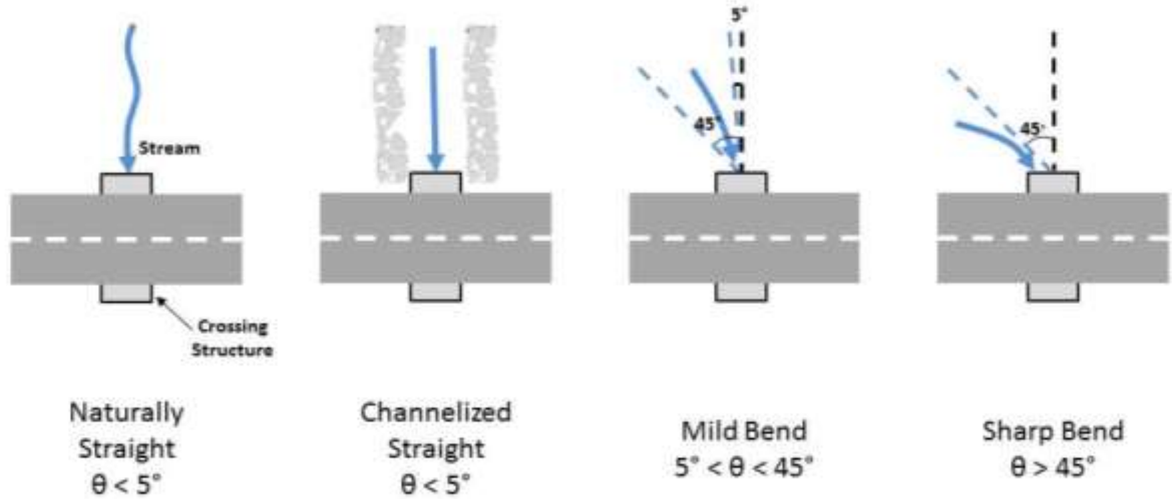


15.) If Channel Avulses Stream Will	S	W
Standing on the road above the crossing imagine the stream flowing up and out of the channel due to high flows. Before eventually re-entering the channel describe how the local land elevations would influence the direction of water flow.		

- **CROSS ROAD**- the water will overtop the road and then re-enter the channel downstream of the structure. This occurs where the road approaches on either side are higher in elevation than the road surface at the crossing.
- **FOLLOW ROAD**- flood waters would travel down a ditch or shoulder of the road for a distance *before* traveling overland to re-enter the stream channel.
- **CROSS AND FOLLOW ROAD-** The stream would cross over the road and *then* follow it for some distance before re-entering the stream channel.
- **UNSURE**- topography around the crossing is too subtle to identify a potential avulsion.



16.) Angle of Streamflow Approach	S	W	D
Record the angle that the stream enters the crossing structure.			



SHARP BEND –stream enters the structure at a severe angle; 45º to 90º bend.

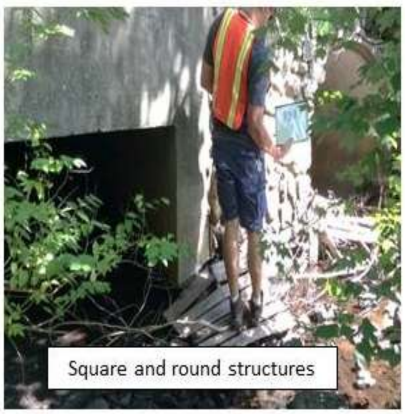
- MILD BEND - the stream enters the structure at a gentle angle; 5º to 45º bend.

- NATURALLY STRAIGHT – stream enters 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.

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. 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 carrying most of the water flow and include data for the other structure(s) in the comments (bottom photos).		



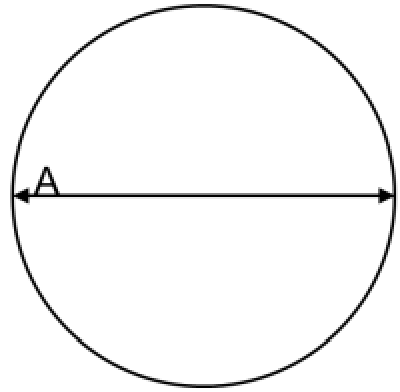
18.) Overflow Structures Present	S	W
Overflow pipes are *usually* smaller than the primary crossing, and are installed at a higher elevation than the main structure.		

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

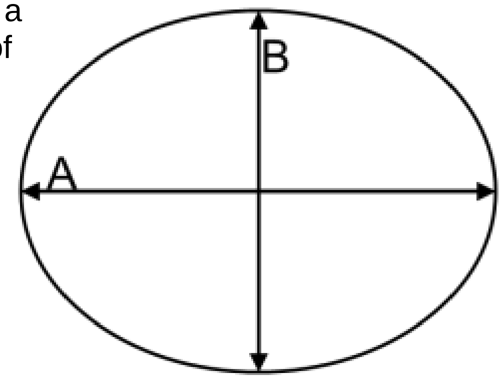


19.) Structure Type	S	W	D
Select the type that describes the shape and dimensions of the main structure.			

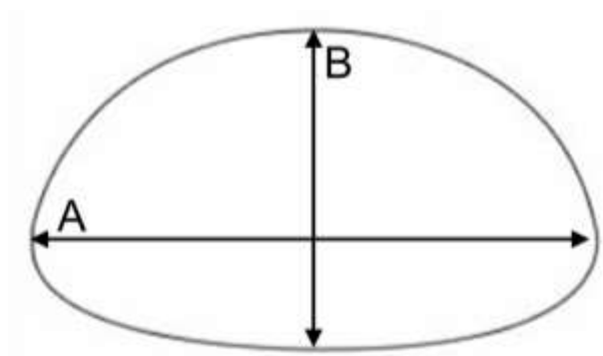
-ROUND CULVERT- a circular structure with a closed bottom such as metal, concrete, and plastic pipes.



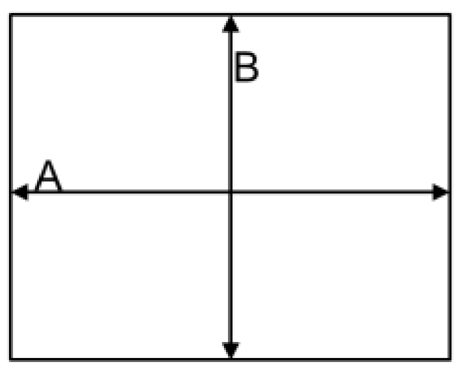
- ELLIPTICAL CULVERT- an oval structure that has a closed, constructed bottom and is longer along one of its axes, so it appears to be flattened.



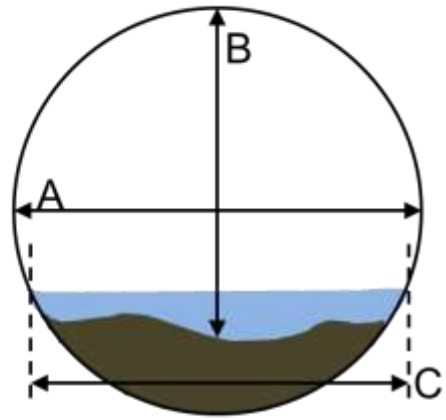
- PIPE ARCH CULVERT- an oval structure that has a closed, constructed bottom and is shaped somewhat like an egg (vertically), in that the bottom is wider and more rounded compared to the top.



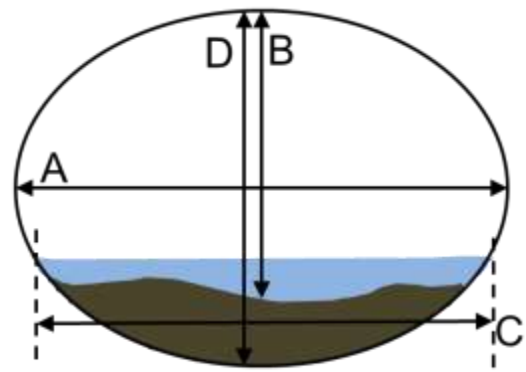
- BOX CULVERT- a square or rectangular-shaped culvert with a constructed bottom.



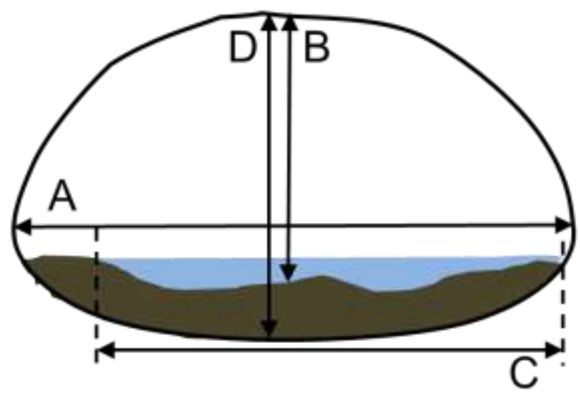
- **EMBEDDED ROUND CULVERT**- a circular pipe that is partially buried below the stream bed so that natural sediment continues throughout the bottom of the structure.



- **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 pipe arch (see above) that has been intentionally installed so that natural sediment continues throughout; you generally won't see the bottom of an embedded culvert.



<u>*EMBEDDED OR SEDIMENT BUILD-UP? *</u>

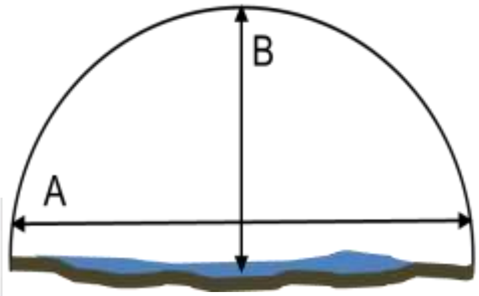
Embedded- a structure that has sediment throughout the bottom from being installed below the streambed or natural sediment transport. The substrate throughout the bottom is designed to match the natural variability in grain size of the stream.

Clogged- Sediment in the structure is from ongoing buildup of material due to being undersized, and the material depth is a significant percentage of the structure's height.

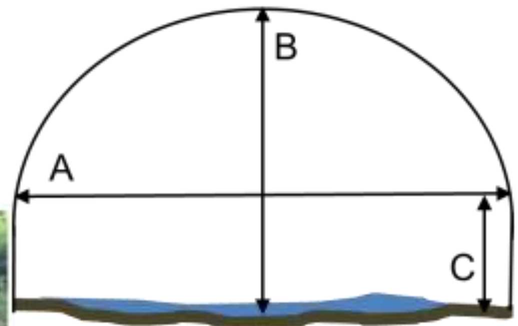

Embedded structure


Sediment build-up

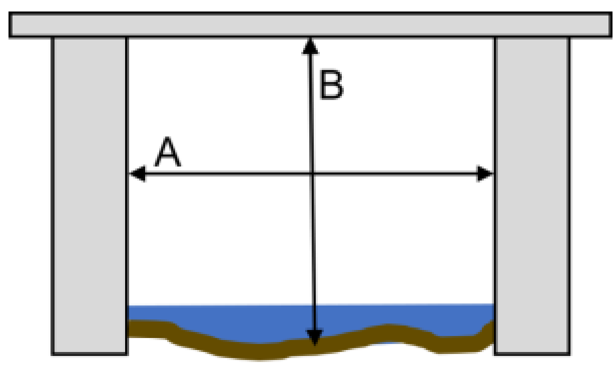
- **OPEN BOTTOM ARCH¬**- an arc-shaped structure that does not have a bottom half, so the natural sediment continues throughout the crossing.



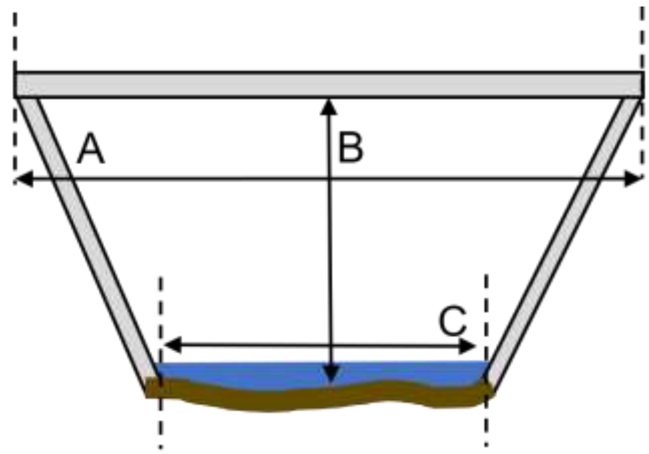
- **ARCH-BRIDGE**- structure with a curved top under the road deck and sits on vertical abutments.



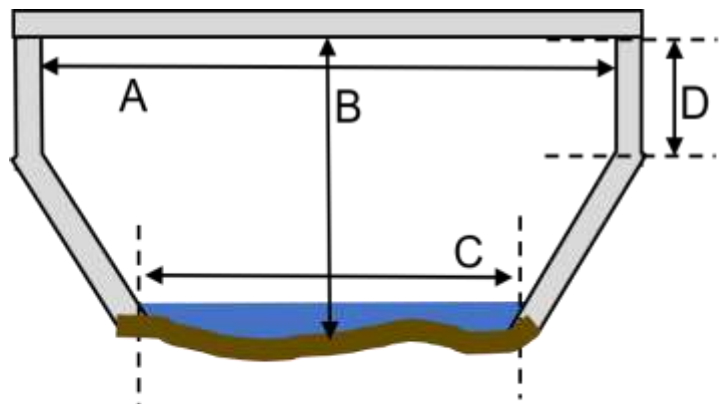
- **BRIDGE WITH ABUTMENTS**- a structure where the road deck bottom is consistent with the top of the structure and the sides are at right angles, and has an open bottom.



- BRIDGE WITH SIDE SLOPES- a structure where the road deck bottom is consistent with the top of the structure with angled sides, and an open bottom.



- BRIDGE WITH SIDE SLOPES AND ABUTMENTS- a structure where the road deck bottom is consistent with the top of the structure having both sloping sides and sides at right angles to give the bridge height over the stream.



- CATCH BASIN INLET- a structure designed to collect and transport roadside and storm water drainage. These structures can be varying shapes and sizes but are *usually* small round culverts or concrete box culverts.

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.

Notes about Identifying Box Culverts versus Bridge with Abutments:

Culvert- structure that supports a road over a water body by means of a complete pipe or box embedded in road fill, or constructed within a masonry or concrete headwall, that usually has a constructed bottom and does not have abutments or piers.

Bridge- structure that supports the roadway and *typically* spans the width of the channel, encompassing both banks, and the road deck bottom typically is the top of the structure. Some structures that look like a bridge may actually be an embedded box culvert or an open bottom arch (culvert).

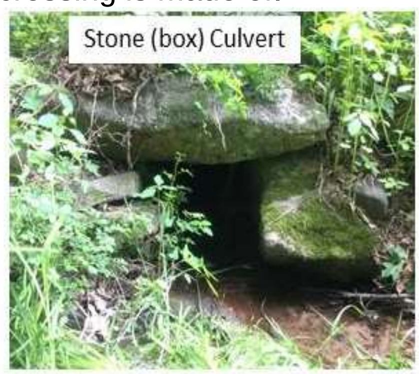
Characteristics to consider when evaluating whether a structure is a culvert or a bridge:

- A structure where the top of the inlet opening is the road deck is typically classified as a bridge, whereas a culvert has a headwall made of concrete, fill, or earthen material between the top of the inlet and the road surface.
- Culverts are usually enclosed structures, whereas bridges have an open bottom (natural sediment). Embedded culverts, arch culverts, and box culverts made of dry fit stone, will have or appear to have an open bottom and are an exception to this.
- Bridges usually span the width of the channel and encompass both channel banks.

The definition for a bridge in this protocol is for stream crossing surveys only and differs than that used by NH Department of Transportation that classifies all structures >10-foot width as a bridge. Please adhere to the definitions in this protocol for all stream crossing surveys!

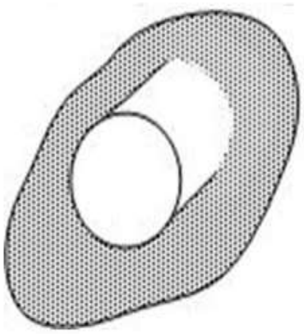
20.) Structure Material	S	W	D
Identify the material that describes the **dominant** construct of the crossing. If structure material varies between the inlet and outlet, use the inlet material type and mdescribe the outlet material in the comments. Bridges are often composed of several material types (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 has ridges.
- **PLASTIC-SMOOTH-** the **inside** surface of the plastic pipe is smooth and has no texture, regardless of whether the outside of the pipe has grooves.
- **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 and has no texture, regardless of whether the outside of the pipe has grooves and ridges. A steel pipe will often have a dull metallic appearance and may have evidence of 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 and will not have any rust, though 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.

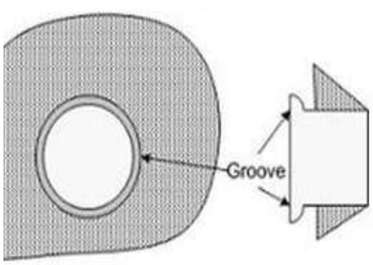


22.) Inlet Type	S
Select the option that best describes the shape and structure of the crossing inlet.	

- THIN PROJECTING- the end of the pipe extends outward from the headwall.




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

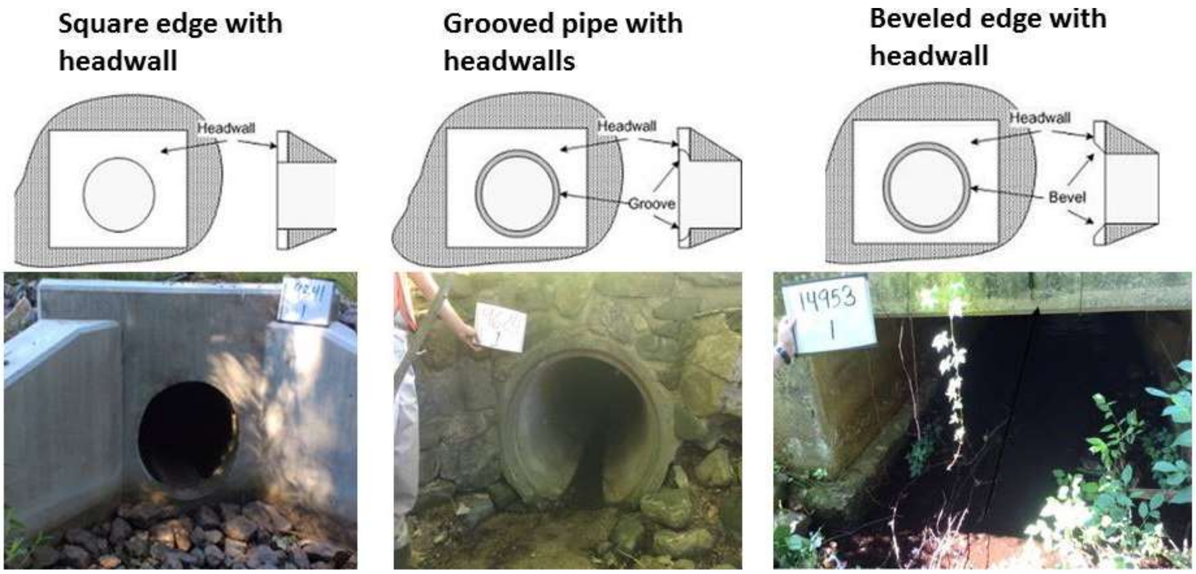



- GROOVED CONCRETE W/ HEADWALL- the end edge of the concrete pipe has a lip and is flush with the headwall.

- SQUARE EDGE W/ HEADWALL- the end edge of the concrete pipe is not grooved and is flush with the headwall.

- **1.5:1 BEVELED HEADWALL**- a 33º angle inclined surface at the inlet crown between the headwall and culvert top.

- 1:1 BEVELED HEADWALL- a 45º angle inclined surface at the inlet crown between the headwall and culvert top.



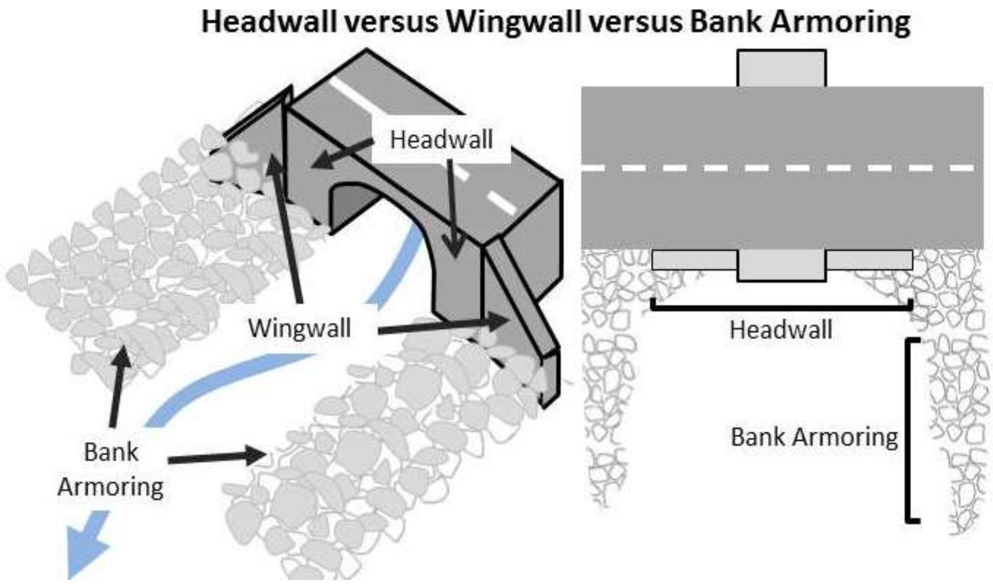
- STANDARD END SECTION- the culvert inlet pipe and tapered wingwalls are flush with the embankment, and both are connected with a structural floor that extends upstream from the pipe inlet to a point flush with the upstream extent of the flared wingwalls.

- **MITERED-** the end edge of the pipe has been cut at an angle that matches the slope of the road fill material.

- ANY BEVEL WITH WINGWALLS- the end edge of the inlet entrance is not perpendicular, but is angled.

- NO BEVEL WITH WINGWALLS- the end edge of the inlet entrance is perpendicular, and there are flared out walls.

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

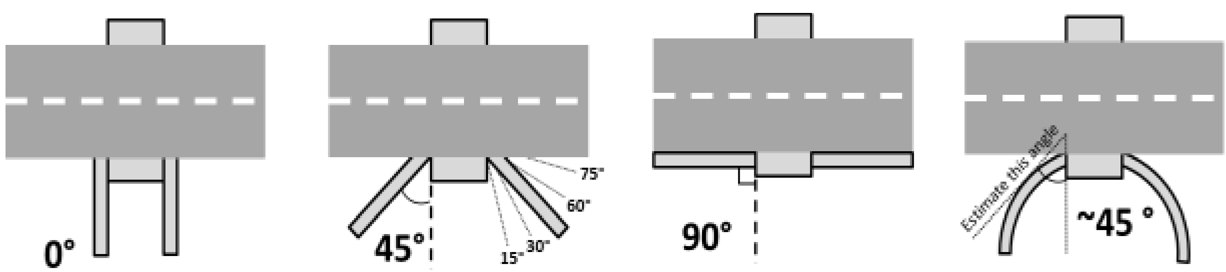


23.) Inlet Wingwall Angle- Stream Left	S
Record the angle between the stream and the wingwalls. If the shape of the wingwall extending form the headwall is not angular, and more of a gradual cup-shape, visually estimate the angle (lower right). If no wingwalls are present, leave this field blank.	

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

24.) Inlet Wingwall Angle- Stream Right	S
Record the angle between the stream and the wingwalls. If the shape of the wingwall extending form the headwall is not angular, and more of a gradual cup-shape, visually estimate the angle (lower right). If no wingwalls are present, leave this field blank.	

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

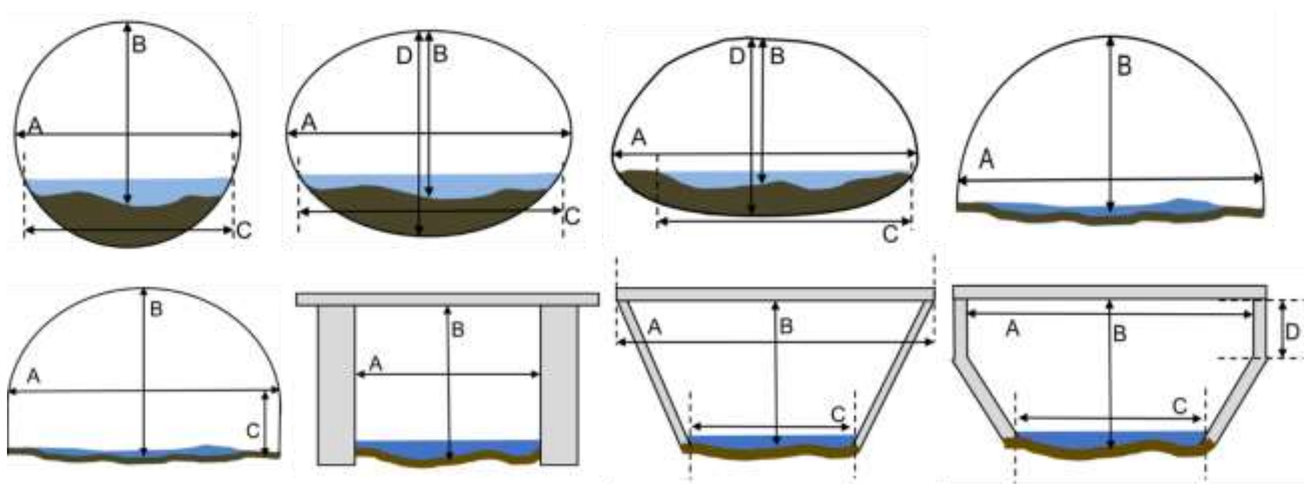


25.) Upstream –Width (A) (ft)	S	W	D
Measure interior width of crossing in decimal feet to the nearest tenth. Reference the structure diagrams for guidance.			

26.) Upstream – Open Height (B) (ft)	S	W	D
Measure the height from the interior side of the top of the structure to the bottom of the structure of the top extent of sediment or substrate. For *open* structures, i.e. structures that are not embedded or clogged with sediment, the bottom point on this measurement should be located at the bottom of the structure itself. For *embedded or clogged* structures, this measurement should be located equal to the highest elevation of accumulated or embedded material in the crossing.			

27.) Upstream – Wetted Width / Wall Rise I (ft)	S	W	D
If the structure is an *embedded or clogged* culvert, measure width of actual stream channel (wetted width) through crossing structure. **If the structure is an** *Arch Bridge*, measure the wall rise as shown in the Arch Bridge diagram.			

28.) Upstream – Total Height (D) (ft)	S	W	D
For *embedded or clogged* structures, measure the height from the interior side of the top of the structure to the bottom of the structure.			



29.) Structure Opening Partially 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.		

- **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, wingwall, 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.

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.




31.) Inlet Headwall – Materials	S	W
A headwall provides anchoring support for the pipe and prevents it from dislodging under high water pressure. Select the option that best describes the overall material of the inlet headwall.		

- **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.

32.) Inlet Headwall – Condition	S	W
Select the option that describes the condition of a concrete or stone inlet headwall.		

- **GOOD-** spalling of up to ¼” thickness is present, joints between headwall and wingwalls are broken, or some mortar is missing from joints. Metal: Pitting or superficial rust is present.
- **FAIR-** spalling of more than ¼” thickness is present, but no reinforcement is present, joints between headwall and wingwalls 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-** 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.
- **N/A-** the headwall is not evaluated or there is no headwall at the inlet.

33.) Scour Undermining Structure – Upstream	S

Identify the structure or part of structure that is affected by scour. Scour is the erosive action of running water in streams, which excavates and carries away material from the bed and banks. Indicators of scour are: exposed areas of structure that are typically covered by stream bed material (e.g., bridge footings), leaning or hanging structures, water visibly flowing under or to the side of the inlet of a culvert, and deep water along one or both sides of a bridge or arch when the bed feature through the structure is a riffle.

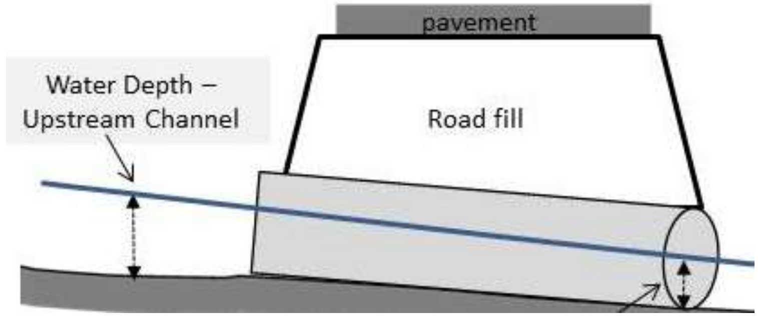
- FOOTERS
- CULVERT
- WING WALL
- CULVERT AND FOOTERS
- CULVERT AND WING WALL
- FOOTERS AND WING WALL
- CULVERT, FOOTERS AND WING WALL
- NONE
- UNKNOWN

34.) Bank Armoring – Upstream	S	W

Protective covering, such as rocks, vegetation or engineering materials this is installed to protect stream banks, or fill or cut slopes from flowing water.

- 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.

35.) Water Depth – Upstream Channel (ft)	S
Where the 1st Upstream Bankfull width is measured, record the deepest part of the channel by measuring from the water surface to the streambed.	

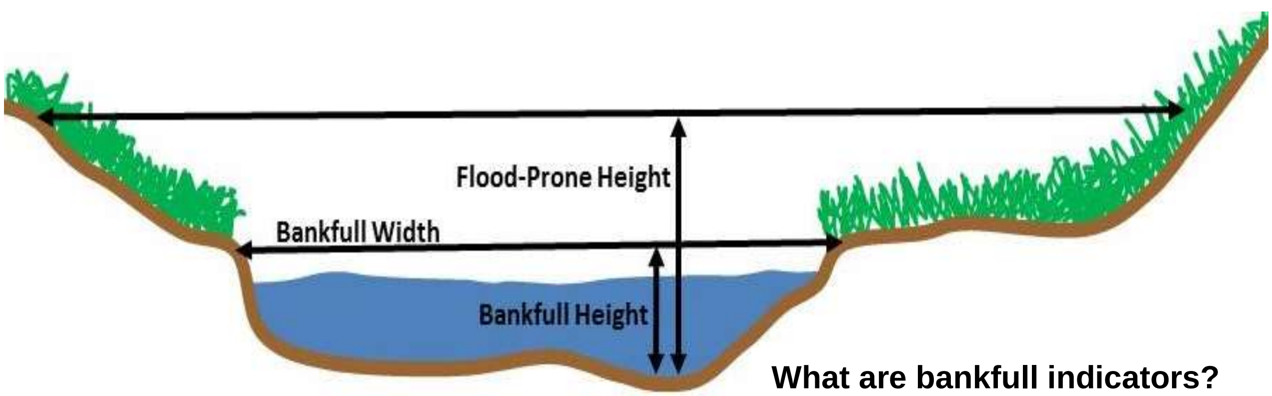


36.) Upstream – Bankfull Width 1 (ft)	S
Measure across the channel directly upstream of the crossing in the area that has the potential to be within the influence of the culvert.	

37.) Upstream – Bankfull Width 2 (ft)	S
Collected at ½ bankfull width upstream of the first bankfull width measurement.	

38.) Upstream – Bankfull Width 3 (ft)	S
Collected at ½ bankfull width upstream of the second bankfull width measurement	

Bankfull width is a measure of the wetted stream channel width at bankfull flow and is measured 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. First identify **bankfull indicators** and then measure the width from bank to bank at those locations.



What are bankfull indicators?

- Abrupt change in bank slope
- Line of vegetation growth
- Mineral stain marks on rocks
- Transition in sediment type

39.) Dominant Substrate- Upstream	S
In the area directly upstream from the crossing inlet, in the area where the 3 upstream bankfull widths were collected, visually determine the dominant substrate type based upon the grain size that takes up the greatest area.	

Type	Grain size(in.)	Relative size
BEDROCK	>160	bigger than a Volkswagen Bug
BOULDER	10.1-160	about the size of a basketball to a Volkswagen Bug
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.	

40.) Upstream Deposit Type	S
Indicate the type of sediment deposit within the channel directly upstream of structure.	

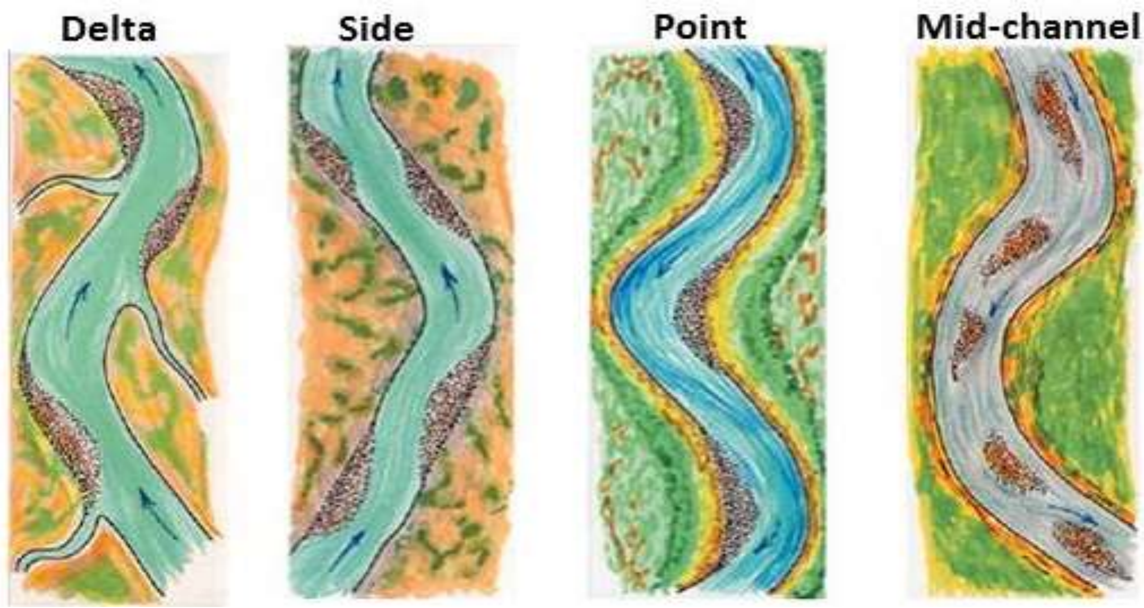
NONE- no sediment deposits observed.

DELTA- sediment deposits where a tributary enters a mainstem channel, often fan-shaped.

SIDE- sediment deposits located along the margins of the channel in locations other than the inside of channel meander bends (not point bars).

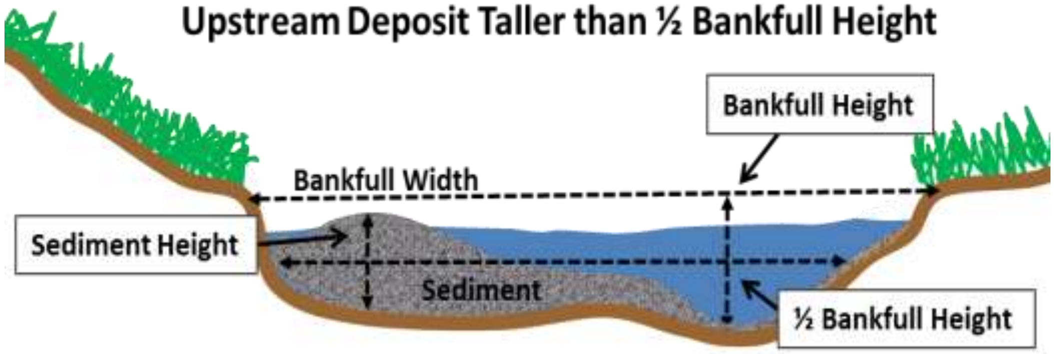
POINT BAR- a sediment deposit that is adjacent to the bank and occurs on the inside edge of a meander bend.

MID-CHANNEL- areas of sediment deposition (bars) built up above the streambed elevation of the nearby area, located in the channel away from the banks.



41.) Upstream Deposit Taller than 0.5 Bankfull Height	S
If a sediment deposit is present upstream of the structure, 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.

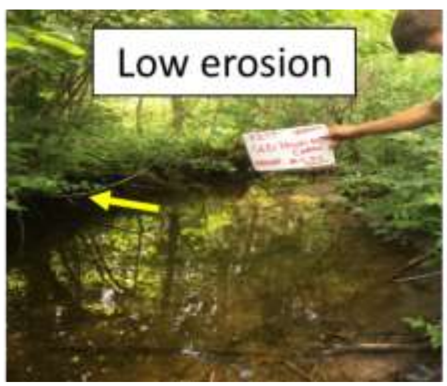


42.) Bank Erosion- Upstream	S
Identify the degree of bank erosion observed upstream of the structure. Indicators of bank erosion are steep and undercut banks, exposed roots, and unstable banks with sediment falling into the channel. Note that raw substrate occurring below the bankfull elevation (especially at low flow) is not considered erosion, unless associated with active bank failures or undercutting	

- **HIGH-** nearly continuous erosion along banks (left), especially on medium to steep banks (right) banks.

- LOW- discontinuous patches of erosion occur along the bank (left) or occasional areas of undercut banks with root exposure (right), typically found on streams with medium banks.

- NONE- no bank erosion evident.

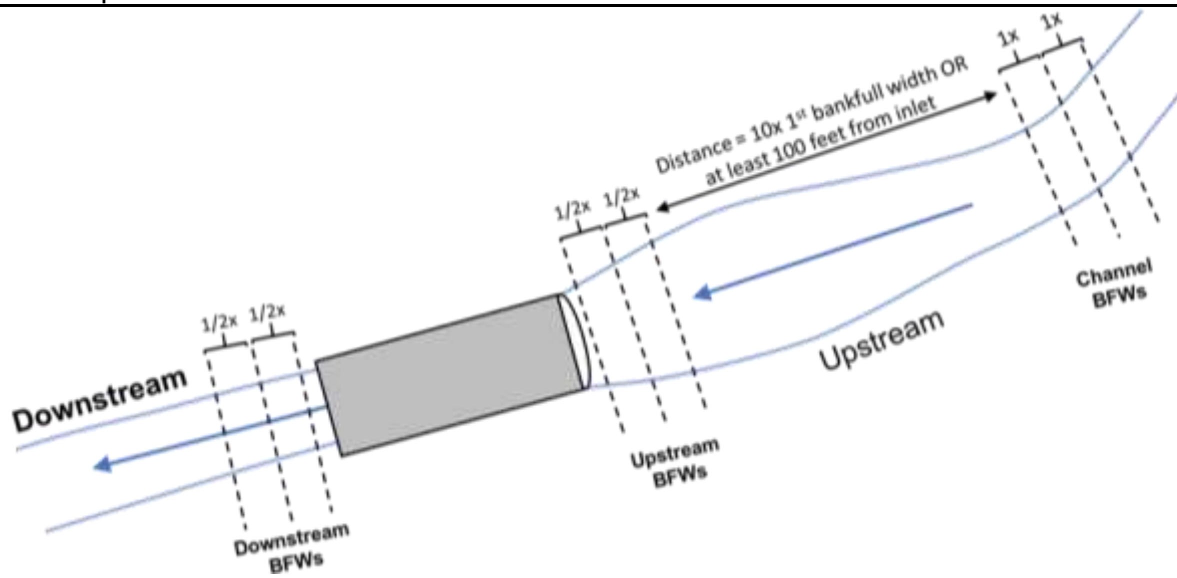


43.) Bedrock Present – Upstream	**S**
Indicate whether there is any bedrock visible in the channel upstream of the structure.	

- **YES**- bedrock is visible upstream of the structure and comprise part of the channel.

- NO- bedrock is NOT visible upstream of the structure and does not comprise part of the channel.

44.) Channel – Bankfull Width 1 (ft)	S
Record the bankfull width of the channel far enough upstream of the crossing such that the measurements are taken outside of the influence of the structure and represent a stable area of stream channel. Once the upstream bankfull widths are collected, proceed upstream **10x the length of the first bankfull width OR AT LEAST 100 feet** from the inlet. Space the remaining reference bankfull widths so that they are 1 bankfull width apart until a minimum of three have been collected.	



If the distance of 10x upstream from the 3rd bankfull measurement or 100 feet from the inlet brings you into the area of influence of another crossing, then **adjust** where you measure your channel bankfull widths and note the distance from the inlet in your comments.

45.) Channel – Bankfull Width 2 (ft)	S
Collected 1 bankfull width upstream of the first channel bankfull width measurement.	

46.) Channel – Bankfull Width 3 (ft)	S
Collected 1 bankfull width upstream of the second channel bankfull width measurement.	

47.) Dominant Substrate- Channel	S
In the area where the 3 channel bankfull widths were collected, visually determine the dominant substrate type based upon the grain size that takes up the greatest area. .	

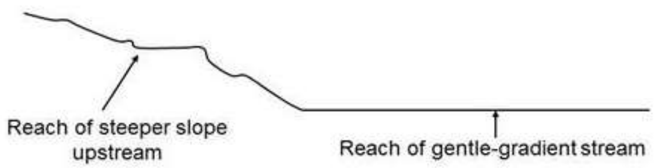
Type	Grain size(in.)	Relative size
BEDROCK	>160	bigger than a Volkswagen Bug
BOULDER	10.1-160	about the size of a basketball to a Volkswagen Bug
COBBLE	2.51-10	about the size of a tennis ball to basketball
GRAVEL	0.08-2.5	about size of peppercorn to a tennis ball
SAND	<0.08	the size of silt to the size 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.	

48.) Steeper Segment within 1/3 Mile Upstream	S
Walk upstream, 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.

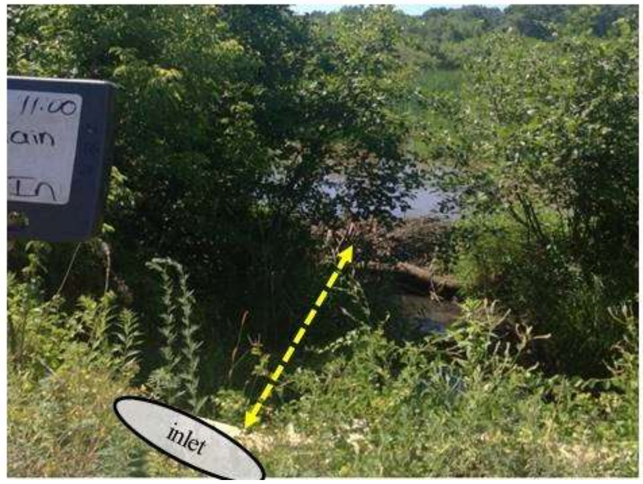


49.) Beaver Dam Near Structure – Upstream	S	W
Record whether a beaver dam is within 100 feet upstream from the structure or as far upstream as can be assessed visually. Beaver dams usually create a pond upstream. If unsure whether a dam was made by beavers, look at the ends of the branches to see if they have been gnawed.		

- **YES-** a beaver dam is located within 100 feet upstream of the structure.

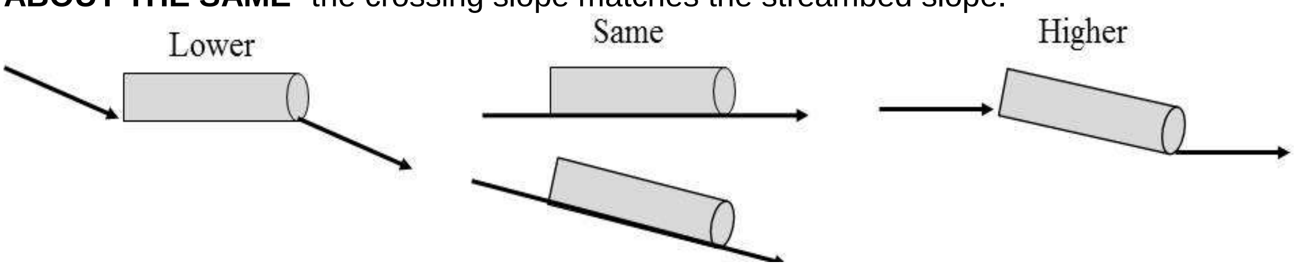
- NO- a beaver dam is NOT located within 100 feet upstream of the structure.

50.) Distance to Beaver Dam Upstream (ft)	S	W
Enter the estimated distance from the structure opening to the beaver dam.		



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.

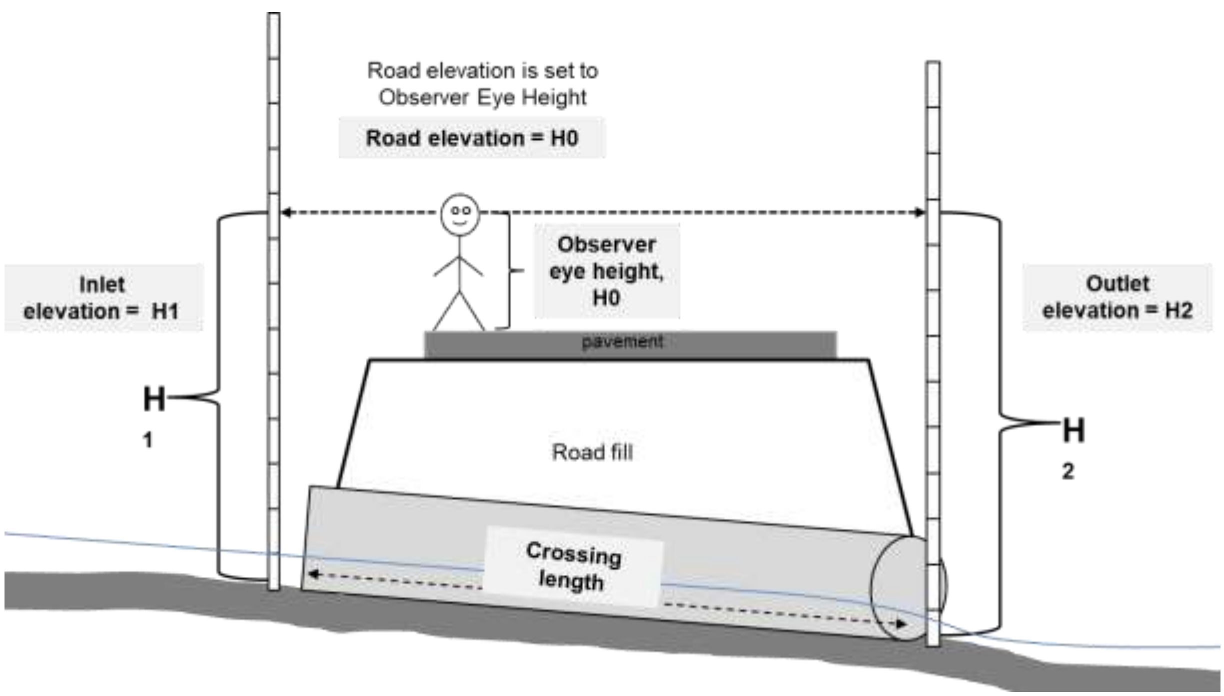


52.) Inlet Invert Elevation (ft)	S
Record the vertical distance between the inlet invert and the height of the roadway (which is set to the observers eye height). One observer stands in the stream at the inlet and holds the base of the depth rod on the inside edge of the inlet invert. The depth rod is 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. The second observer uses a pop level to measure the distance they are standing above the inlet and record this height (H_1).	

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.

53.) Roadway 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).	

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

- **WETLAND**
- **STREAM**
- **SURFACE**
- **DRAINAGE**

57.) Water Depth - Structure Outlet (ft)	S	W
Measure the depth of the water in the structure at the outlet.		

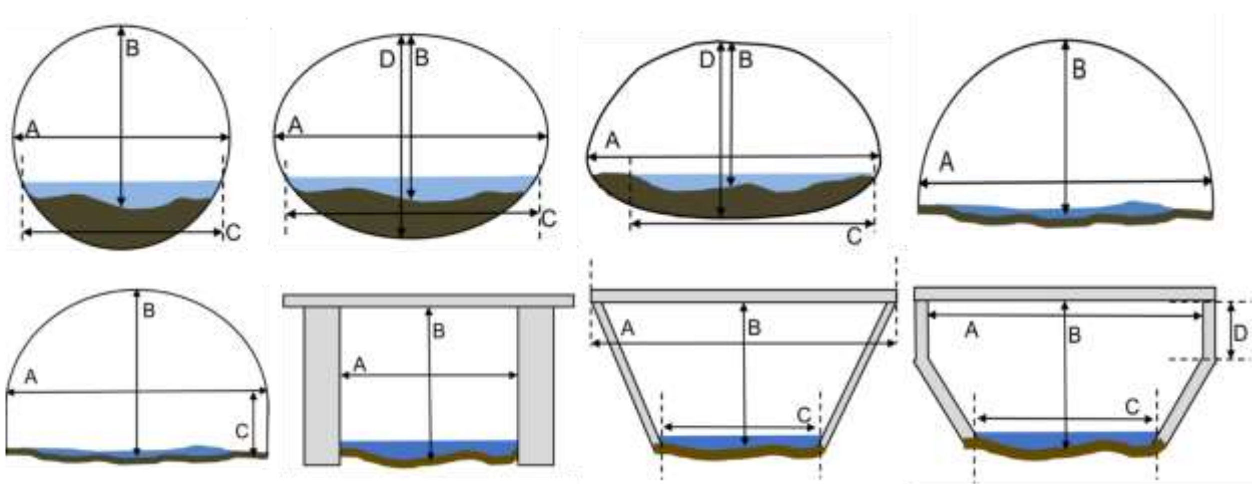
58.) Structure Length (ft)	S	W
Measure the crossing from inlet to outlet by using the rangefinder to shoot down the length of the crossing. If measurement through the crossing is not possible, is to stand on top of the inlet and measure over the road.		

60.) Downstream - Width (A) (ft)	S	W	D
Measure interior width of crossing in decimal feet to the nearest tenth. Reference the structure diagrams for guidance.			

61.) Downstream - Open Height (B) (ft)	S	W	D
Measure the height from the interior top of the structure to the bottom of the structure of the top extent of sediment or substrate. For *open* structures, i.e. structures that are not embedded or clogged with sediment, the bottom point on this measurement should be located at the bottom of the structure itself. 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	D
Measure width of actual stream channel (wetted width) through crossing structure if the structure is *embedded or clogged*. (This dimension is also the wall rise measurement on an Arch Bridge.)			

63.) Downstream - Total Height (D) (ft)	S	W	D
For *embedded or clogged* structures, measure the height from the underside of the top of the structure to the bottom of the structure.			



65.) Structure Condition | S | W | D

Identify the condition of the structure itself including the inlet, outlet, and inside of the pipe or box, based on the following rating criteria.

- **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.

66.) Dominant Substrate Throughout Structure | S | W

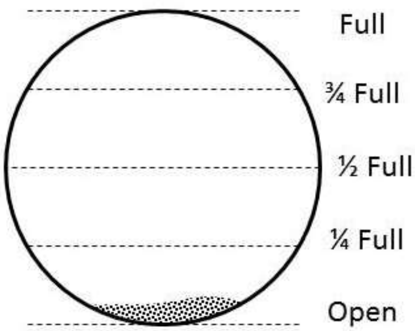
Select the type of substrate that is *continuously* distributed throughout the crossing. This is a key parameter for AOP that identifies whether substrate is throughout the structure to assist in fish passage. If substrate is not present throughout then select "NONE".

Type	Grain size(in.)	Relative size
BEDROCK	>160	bigger than a Volkswagen Bug
BOULDER	10.1-160	about the size of a basketball to a Volkswagen Bug
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 throughout the structure.	

67.) Structure Filled With Sediment | S | W | D

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 Headwall - Materials	S	W
A headwall provides anchoring support for the pipe and prevents it from dislodging under high water pressure. Select the option that best describes the overall material of the outlet headwall.		

- **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

69.) Outlet Headwall - Condition	S	W
A headwall provides anchoring support for the pipe and prevents it from dislodging under high water pressure. Select the option that best describes the overall condition of the outlet headwall.		

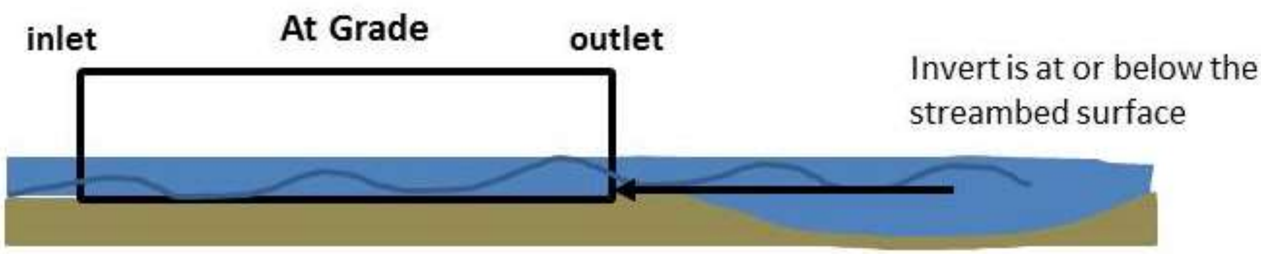
- **GOOD-** headwall is concrete or stone: spalling of up to ¼" thickness is present, joints between headwall and wingwalls are broken, or some mortar is missing from joints. Metal: Pitting or superficial rust is present.
- **FAIR-** headwall is concrete or stone: spalling of more than ¼" thickness is present but no reinforcement is present, joints between headwall and wingwalls 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-** head wall is concrete or stone: 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.
- **N/A (*default*)**- the headwall is not evaluated or there is no headwall at the outlet.

70.) Scour Undermining Structure - Downstream	S	W
Identify the part of structure that is affected by scour. Scour is the erosive action of running water, which erodes and carries away material from the bed and banks. Indicators of scour are: exposed areas of structure that are typically covered by stream bed material (e.g., bridge footings), leaning or hanging structures, water visibly flowing under or to the side of the outlet, and deep water along one or both sides of a bridge or arch when the bed feature through the structure is a riffle.		

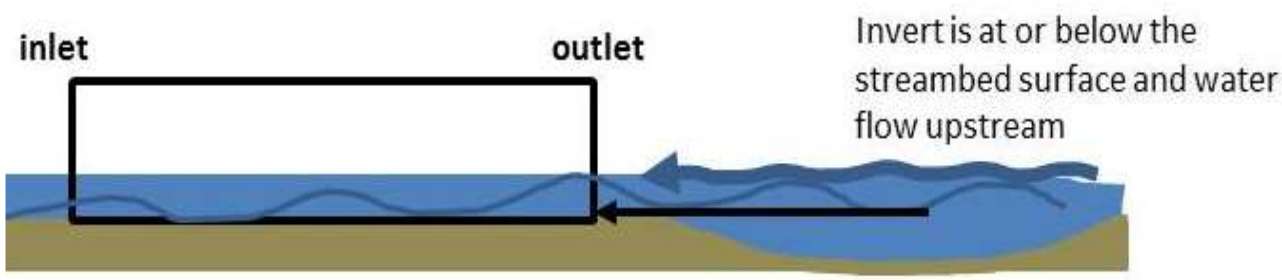
- **FOOTERS**
- **CULVERT**
- **WING WALL**
- **CULVERT AND FOOTERS**
- **CULVERT AND WING WALL**
- **FOOTERS AND WING WALL**
- **CULVERT, FOOTERS AND WING WALL**
- **NONE**
- **UNKNOWN**

71.) Outlet Grade	S	W
Description of the water surface profile as it leaves the outlet of the structure. This parameter evaluates the vertical distance a fish, or other aquatic organism would have to travel to get from the stream into the pipe, it is a key variable in the AOP screen.		

- **AT GRADE-** The invert of the outlet is at or below the streambed surface, and the streambed directly downstream of the culvert outlet is of a gradient typical to the channel at the structure site. If the channel directly downstream of the structure outlet is much steeper than the typical channel gradient at the site, then the outlet condition should be described as a cascade.



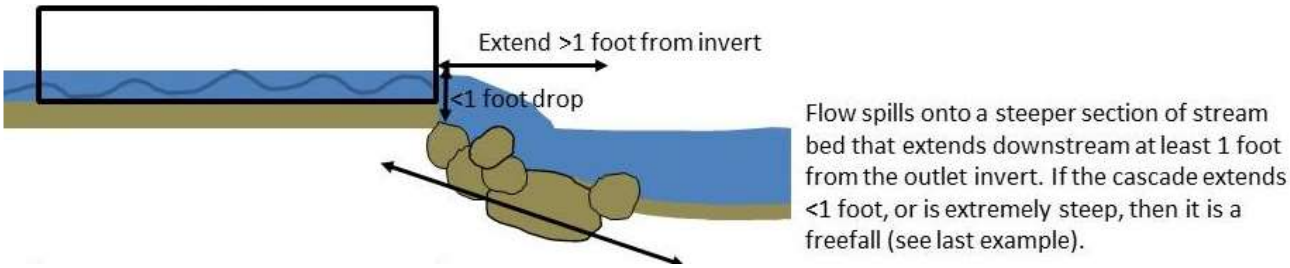
- **BACKWATERED-** Directly downstream of the outlet the water direction has reversed and is re-entering the outlet. Measure the distance (in feet) that the crossing outlet is backwatered.



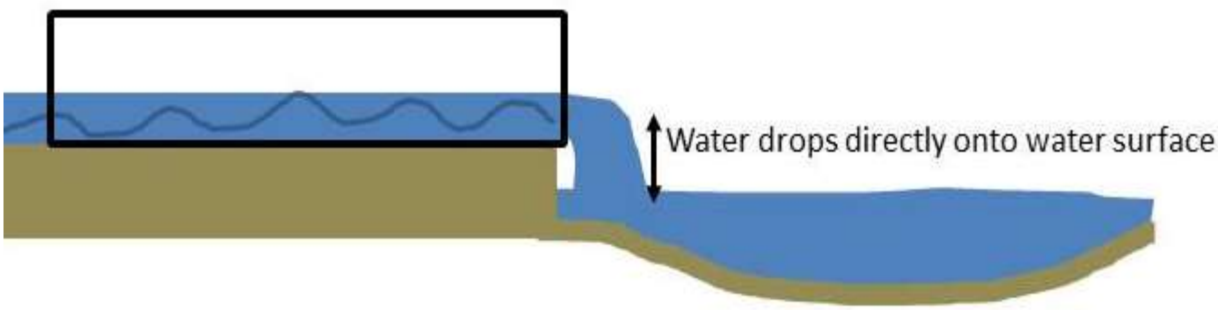
- CASCADE- The outlet is above the water surface and the flow spills out of the culvert onto a steep section of stream bed (typically bedrock or large boulders). To be considered a cascade, the streambed directly downstream of the culvert outlet should be steeper than the general stream gradient. Stream flow over the cascade may be sheet flow (as in over bedrock) or disperse flow (as in splashing off riprap or large boulders). The following must also be true:

- Cascade must extend > 1 foot beyond the culvert measured longitudinally.

- Flow exiting the culvert must drop less than 1 foot before hitting the cascade below. Flows dropping greater than 1 ft. before hitting a cascade are considered “free fall”.



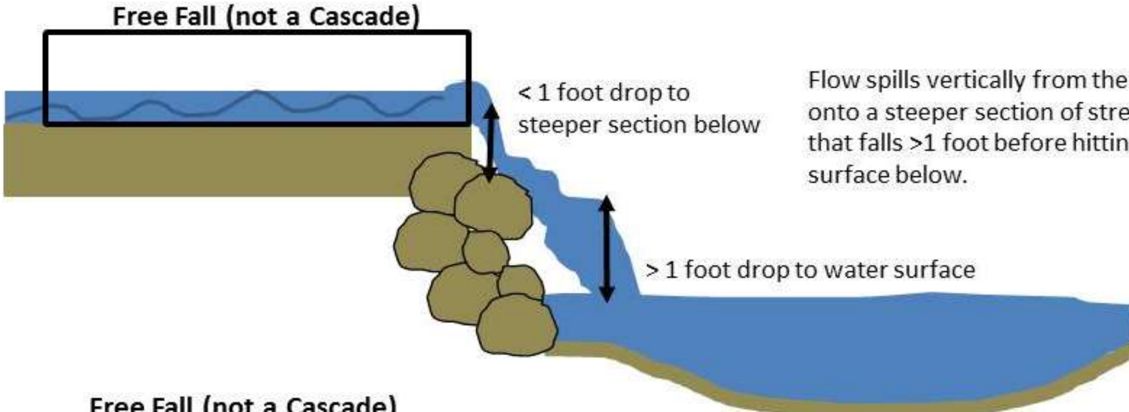
- FREE FALL- The invert is above the stream bed surface and the flow spills vertically out of the culvert onto the water surface (e.g. “perched” culvert). If the flow falls vertically from the culvert outlet and then hits a cascade, it is still considered “free fall” if the vertical drop from the outlet invert to cascade below is greater than 1 foot.



Freefall

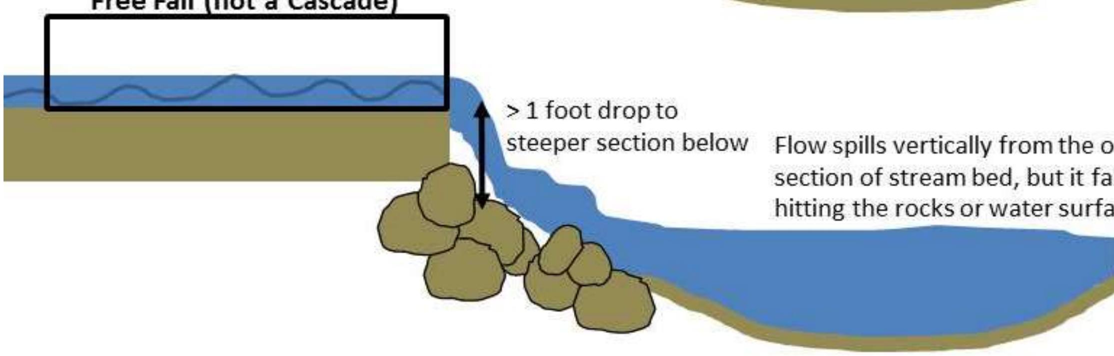
Cascade

Free Fall (not a Cascade)



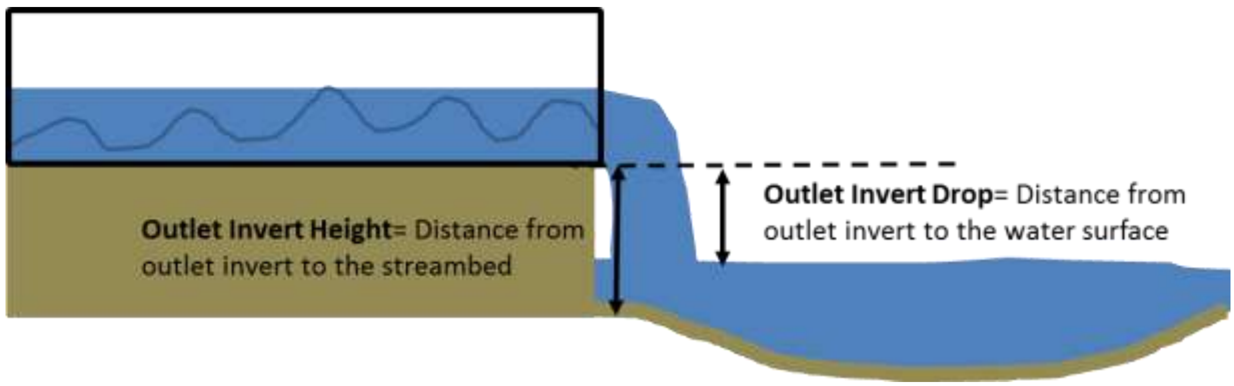
Flow spills vertically from the outlet <1 foot onto a steeper section of stream bed, but after that falls >1 foot before hitting the water surface below.

Free Fall (not a Cascade)

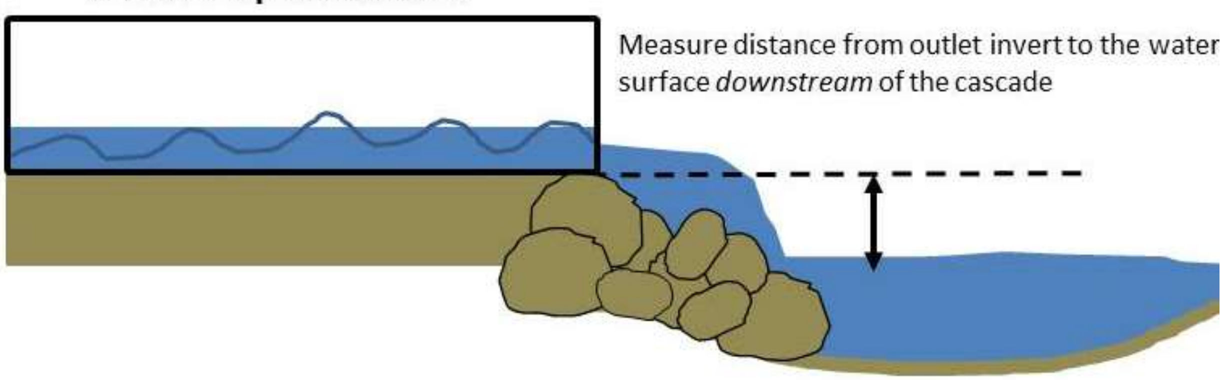


Flow spills vertically from the outlet onto a steeper section of stream bed, but it falls >1 foot before hitting the rocks or water surface below.

72.) Outlet Invert Drop (ft)	S	W
Measure the vertical distance (nearest tenth of a foot) from the outlet invert to the water surface. 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 outlet invert to the water's surface directly downstream of the cascade. If the structure is at grade this measurement must be zero.		



Outlet drop at cascades



73.) Outlet Invert Height	S	W
Measure with the wading rod, the vertical distance from the bottom of the structure outlet to the channel bottom. – See diagram above.		

- **EMBEDDED-** the bottom of the structure is below the streambed
- **AT GRADE –** the bottom of the structure is approximately at the same grade as the streambed or is embedded.
- **< 1 FOOT ABOVE CHANNEL –** the bottom of the structure is above the streambed but less than 1 foot.
- **1 – 2 FEET ABOVE CHANNEL –** the bottom of the structure is between 1 and 2 feet above the stream bed.
- **> 2 FEET ABOVE CHANNEL –** the bottom of the structure is more than 2 feet higher than the streambed.

74.) Outfall Treatment	S
Identify the type of treatment at the outfall of the structure.	

- **PLUNGE POOL -** deep depression in the stream bed at the base of the outlet.
- **FLOW DISSIPATER** - – a treatment at the outlet of the structure made of metal, concrete, or plastic that reduces the energy of the water and guides / disperses the water from the outlet into the stream bed. The dissipater can look like an apron or fan attached to the outlet, a concrete pad, or granite blocks at the outfall of the outlet.
- **RIP RAP -** stone 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.

75.) Scour of Streambed at the Outlet	S	W
Scour at Outlet of the crossing structure can cause visible erosion of the channel bed and can lead to the structure being perched above the channel.		

- **NONE-** no scour is observed at the outlet.
- **LOW-** finer material is no longer present after the outlet.
- **MEDIUM-** noticeable erosion is occurring at the outlet.
- **HIGH-** the outlet is perched due to erosion, high above the streambed.
- **UKNOWN-** the scour cannot be observed due to turbid or turbulent water.

76.) Bank Armoring - Downstream	S	W
Protective covering, such as rocks, vegetation or engineering materials used to protect stream banks, or fill or cut slopes from flowing water.		

- **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

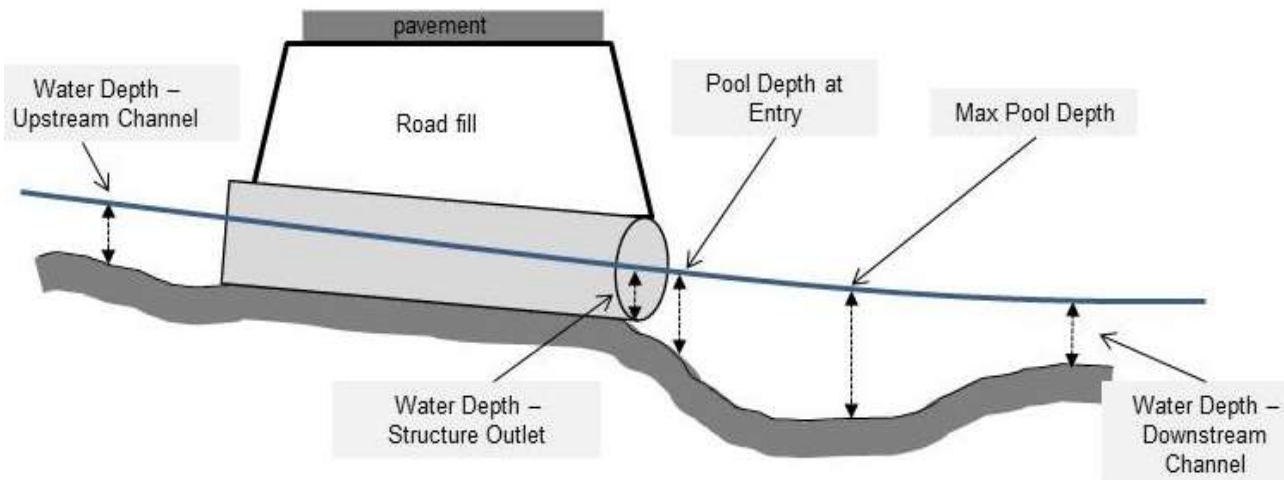
77.) Downstream Pool Present	S
Indicate if a pool is directly below the outlet of the structure. If the structure is a culvert that flows onto a cascade (as defined above) then answer “no” to this question.	

- YES- a pool is directly below the outlet of the structure.

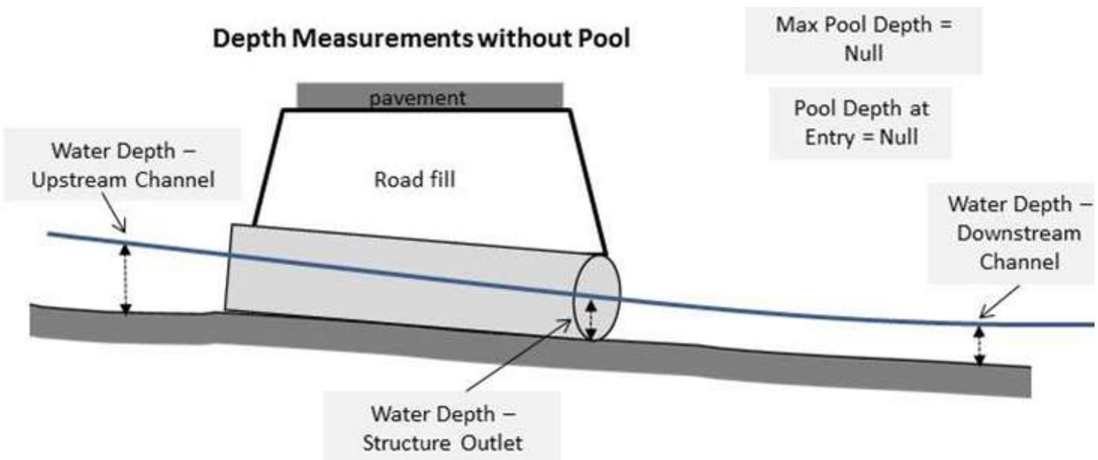
- NO- there is no pool or the culvert flows onto a cascade.

78.) Downstream Pool Depth at Entrance (ft)	S
Measure the depth from the water surface to the stream bed (nearest tenth of a foot) at the point where the streamflow enters the pool. Only applicable if there is a pool directly below the outlet. If there is no downstream pool, leave blank.	

79.) Downstream Pool Maximum Depth (ft)	S
At the point of maximum pool depth, estimate the pool depth. If the estimated depth is less than four feet measure the distance from the water surface to the stream bed to the nearest tenth of foot. 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.	



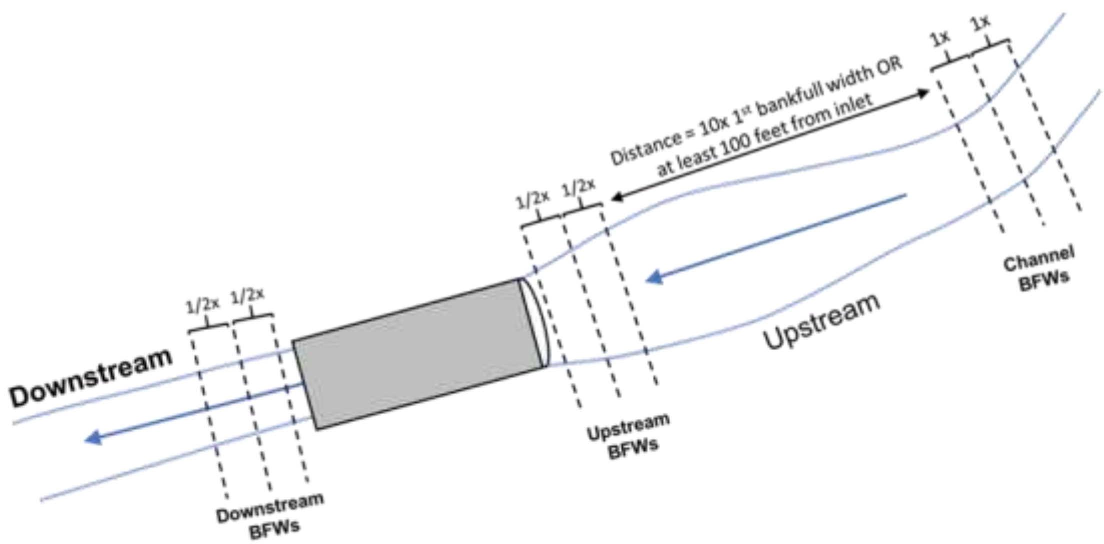
80.) Water Depth - Downstream Channel (ft)	S
Where the 1st Downstream Bankfull width is measured, record the deepest part of the channel by measuring from the water surface to the streambed.	



81.) 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 DS-1	

82.) Downstream- Bankfull Width 2 (ft)	S
Measured at ½ bankfull width upstream of the first bankfull width measurement.	

83.) Downstream- Bankfull Width 3 (ft)	S
Measured at ½ bankfull width upstream of the second bankfull width measurement.	



84.) Dominant Substrate - Downstream	S
In the area directly downstream from the crossing outlet, in the area where the 3 bankfull widths were collected, visually determine the dominant substrate type based on the grain size that takes up the greatest area.	

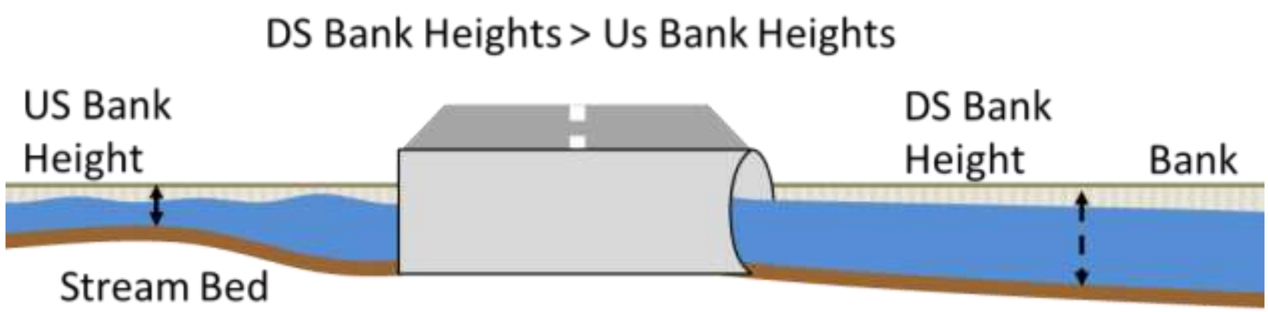
85.) Bank Erosion - Downstream	S
Identify the degree of bank erosion observed downstream of the structure. Refer to photo examples provided for upstream erosion.	

- **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.

86.) 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.



87.) Bedrock Present - Downstream	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.

88.) Hydraulic Control Type | **S**

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

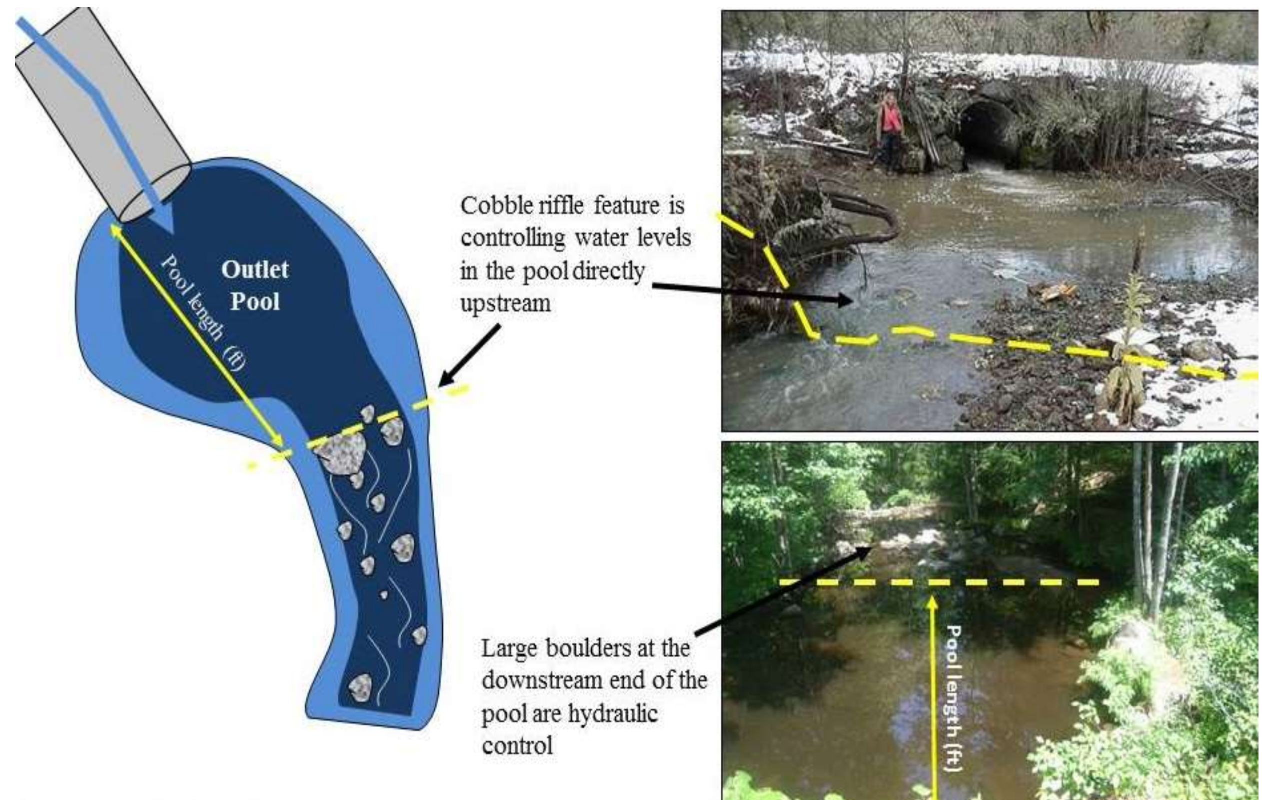


Diagram modified from Robert Gubernick R.G. (USFS) and Michael Love & Associates

89.) Downstream Hydraulic Control Distance From Structure (ft) | **S**

Measure the distance from the structure to the hydraulic control at the downstream end of the outlet pool (to the nearest tenth of a foot). If there is no downstream hydraulic control, leave blank.

90.) Beaver Dam Near Structure - Downstream | **S** | **W**

Record whether a beaver dam is present within 100 feet downstream from the structure or as far dowsntream as can be assessed visually.

- **YES-** a beaver dam is located within 100 feet upstream of the structure.

- NO- a beaver dam is NOT located within 100 feet upstream of the structure.

91.) Distance from Structure to Beaver Dam Downstream (ft) | **S** | **W**

Enter the estimated distance, in feet, from the structure opening to the beaver dam. If there is no beaver dam downstream, leave blank.

92.) Wildlife Observed - US, DS, 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.		

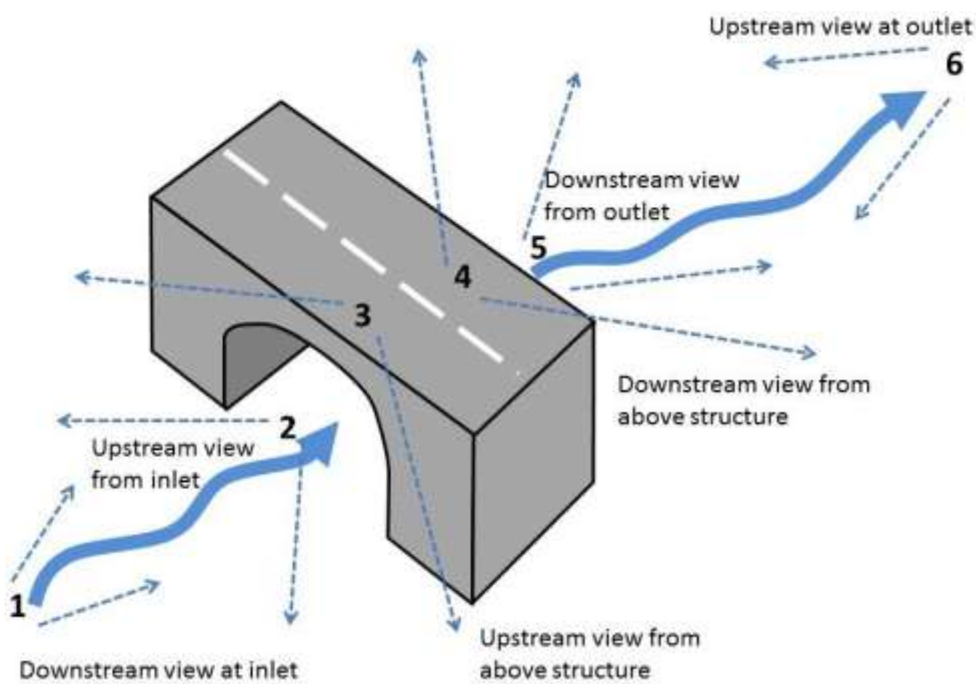
EXAMPLES OF POSSIBLE ANSWERS
- AMPHIBIAN- Frog or salamander
- FISH- if known indicate species
- TURTLE- if known indicate species
- LARGE MAMMALS- Moose, Bear, Coyote, Fisher, Deer, Beaver
- SMALL MAMMALS- Bobcat, Otter, mink, and any other small mammal
- WATER FOWL- ducks, geese, etc.

93.) Comments	S	W	D
Include notes on the structure not covered in the other fields. **1,000 character limit.**			

Minimum 6 photos	S	W	D
Photographs are required and stream crossings cannot go through Quality Control without them. Photographs should be sufficient to enable identification of river bed material, bank condition, and views capturing the entirety of the culvert inlet and outside. **Please take good pictures!!**			

- **PHOTO #1**- Downstream view toward structure inlet: This is meant to capture the structure inlet, roadway approaches, and if possible some of the land adjacent to the channel, armoring features (i.e., riprap, if present), and any other features of interest. 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: This is taken with the photographer standing in 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: This picture should capture the river environment and land adjacent to the channel upstream of the crossing.
- **PHOTO #4**- Downstream view of stream above structure: This picture should capture the environment and land adjacent to the channel downstream of the crossing.
- **PHOTO #5**- Downstream view from structure outlet: The photographer should be standing in 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: This is meant to capture the structure inlet, roadway approaches, and if possible some of the land adjacent to the channel, armoring features (i.e., riprap, if present), and any other features of interest. 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.



<u>Quality Assurance and Quality Control Review</u>

All data that is uploaded to SADES **must** undergo Quality Control by trained personnel at the NH Geological Survey. For data to be reviewed, the six required photos must be included with the data submission. Data collectors will receive their comments and the Review Status field will change to “Comments Ready”. It is the responsibility of the data collectors to make any changes to the raw data on SADES in order to address the concerns raised by NHGS during Quality Control. Once all of the QC comments have been addressed, NHGS will check whether appropriate edits are made, and change the Review Status to “Review Complete”, at which time the data is then ready to be run through the models and shared with the public. Once a crossing has been assigned its AOP and GC rank the Review Status will be changed to “Input Scored” by NHGS.

95.) Current QAQC Review Status
Current state in the review process.

- **NEW** - default field setting; generated when a new record is uploaded onto SADES.
- **COMMENTS READY** - NHGS has provided QC comments to the data collectors and is waiting for their responses.
- **COMMENT ADDRESSED** - the data collectors have made their data edits on SADES in response to the NHGS QC comments and engaged in a QC dialog with the QC manager
- **REVIEW ONGOING** - There are unresolved issues regarding the NHGS comments that the data collector still must address. This may involve a field revisit or some further investigation into the data or site photos. The data collector and NHGS QC manager are still in communication regarding the QC issues for this record.
- **REVIEW COMPLETE** - NHGS has reviewed the response comments from the data collectors and ensured all issues have been addressed.
- **SCORED** - The data has undergone 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 AOP or GC
- **MISSING PHOTOS** - NHGS is unable to perform QA/QC review because there are no photos for the crossing and this is a long-standing issue with the record.

96.) DES Review Comments
These are written comments that NHGS provides on issues, questions, and concerns, regarding environmental parameters, including those that are used specifically in the AOP, Geomorphic, Hydraulic Capacity, and Condition scores.

97.) Assessment Team Response Comments
These are the responses that the data collectors have to the NHGS QC comments.