Roadway Watercourse Crossing Inspection Manual

March 13, 2015

Revision History

Version Date	Description
May 10, 2012	Manual Released
April 8, 2013	Fish passage evaluation flowchart on page 11: 'Outlet Score' clarified as units in cm.
October 14, 2014	Minor adjustments to enhance clarity with respect to application in low gradient systems.
March 13, 2015	Modified field inspection form in Appendix 'A' to better align with fish passage decision flowchart in 10.1

Acknowledgements

This manual incorporates information and images from the Foothills Research Institute (FRI). Particular thanks go to Ngaio Baril of FRI and Rich McCleary.

Thanks go also to the participants of the watercourse crossing assessment workshops and ESRD field staff, many of whom provided recommendations for improvement.

Roadway Watercourse Inspection Manual
ISBN 978-1-4601-2038-5

Table of Contents

1.0 Purpose and Format

The intent of this manual is to provide stream crossing assessors with a good understanding of information and issues related to the management of stream crossings in Alberta and the means to gather relevant information quickly and consistently, in a manner that will satisfy basic inspection requirements of Alberta Environment and Sustainable Resource Development (ESRD).

This manual is an expanded version of a guide developed as part of the Foothills Watershed Remediation Pilot Project—a joint project between ESRD and the federal Department of Fisheries and Oceans (DFO). It is intended for use by both government and industry. Following the pilot phase, a program of enhanced watercourse crossing management for roads covered under the Public Lands Act has been endorsed for implementation within ESRD. Other regulatory agencies may use this protocol at their discretion.

Data collection to satisfy basic inspection requirements as they appear on the Watercourse Crossing Inspection Form are not to be confused with conditions contained within a Fisheries Act Authorization that may have been issued for the crossing project.

This manual is a work-in-progress. New information and improvements suggested by users will be incorporated in future versions.

2.0 Definition of a Crossing

For the purposes of this manual and the protocol, “crossing” refers to road crossings of watercourses identified as per the classification scheme described herein.

- Bridges
- Open or closed-bottom culverts
- Fords or low-level crossings
- Temporary road crossings, such as ice or snow bridges
- Suspended
- Reclaimed

Reclaimed crossings are within the scope of the inspection protocol to assist in the audit of reclamation certificates.

3.0 Environmental Risk

Roads pose one of the biggest human-related risks to fish populations. Research in Alberta and elsewhere in the world has found a strong correlation between increasing roads and decreasing fish populations. In Alberta, the number of roads, particularly in forested areas, has dramatically increased in the past 20 years. In some areas, road density exceeds 5 km/km2. To put this into perspective, a density of 0.8 km /km2 has been correlated to collapsed bull trout populations. Where roads intersect watercourses, the risk level is most acute. Increased focus is being placed on access management planning to make the road network more efficient and to reduce environmental risk.

Road-stream crossings are common trouble spots for high erosion and sedimentation. Where roads are built over streams, the natural flow of water in the channel is sometimes altered (e.g. constricted), water is trained to flow along ditches and land is disturbed. Naturally, some sedimentation occurs, but native fish are well-adapted to deal with this. Unnaturally high sediment loads reduce fish habitat quality and fish health, and may cause some fish populations to be lost. High sediment loads cause clean gravels to be buried, reduce visibility and sunlight penetration, and may reduce the ability of fish to breathe.

Road-stream crossings in which culverts are installed often impair or completely block the passage of fish, particularly upstream movement, and thereby fragment fish habitat. Fish vary in their swimming ability. Not all fish have the speed and jumping ability of trout and salmon. Sculpins, burbot, stickleback, minnows and fry of all species are weak swimmers. As a consequence of impaired fish passage, the fish community upstream of a culvert is often quite different than it is downstream. In many cases, there are no fish found above culverts in small streams where freezing or drought has occurred and fish have been killed. The ecology of entire watersheds is greatly altered by culvert fish barriers. Fish are prevented from accessing habitats, such as spawning areas, and populations may be separated from each other for long periods of time, reducing genetic mixing. In Alberta, culvert fish barriers are generally considered as having the most detrimental overall affect on fish habitat.

To better manage the road-related risks to fish in Alberta, a program is in place to assess stream crossings and remediate problems. A key part of this program is the development and application of a standardized protocol to assess crossing sites for erosion / sedimentation concerns and for fish passage.

4.0 Legislation and Regulators

The purpose of legislation is to permit an approved activity to cross a watercourse with as little impact as possible to the overall function and health of the watershed from a hydrological and biological perspective.

Activities in and around watercourses are controlled by federal and provincial legislation:

- Federal Fisheries Act: Fisheries and Oceans (DFO)
- Provincial:
    - AB *Water Act* – ESRD
    - AB *Public Lands Act* - ESRD

The regulators have overlapping, yet independent roles, with a shared mandate to manage environmental risks relative to stream crossings.

5.0 Data Parameters for Stream Crossing Inspection

The stream crossing inspection process is designed to be conducted by one person. The data collection requirements are a reflection of this basic constraint.

The following instructions relate to the form found at the back of the manual. Essential data parameters will be highlighted in **red**.

5.1 Site Reference Data

- Water Crossing ID – Not essential. If a number is painted (orange) on or near the crossing, record it.
- Watercourse Name – If named, if known. Not essential.
- Disposition Number – Entered by inspector, but not necessarily in the field.
- **Co-ordinates – Essential**. From your GPS unit. Record for each visit. UTM preferred (vs. Lat. /Long.) per NAD 83 datum. Allow a few minutes for satellite lock-on to ensure good accuracy (i.e. +/- 20m). Specify Easting and Northing (e.g. E:0XXXXXX N:XXXXXXX).

5.2 Watercourse Classification Data

- **Stream Classification – Essential**. The requirements for stream crossing inspection are based on stream and crossing type. Streams are classified primarily on channel development, based on an assessment in the vicinity of the crossing location (within 100m upstream and downstream).

Note: This stream classification approach is similar to that applied as part of the ASRD Forest Management Operating Ground Rules, with the addition of a fluvial vs. non-fluvial distinction.

Note: in the event of an apparent difference in stream features between the upstream and downstream sides of the crossing, the classification will be based on the upstream features.

- The identification of a defined watercourse channel is the first step. A channel is indicated by at least 50 meters of visible bed and defined banks (may be grass covered). No channel = no further assessment for fish passage required.
- The distinction between fluvial and non-fluvial streams is the second step. Use the following photo examples and flow chart to classify.
- Fluvial = stream power great enough to transport and arrange bed materials and create a sequence of pools and riffles. High probability of fish occurrence.

Note: a stream channel need not meet all of the criteria shown to be fluvial, but will meet most, with emphasis placed on key criteria (marked with a red asterisk *)

- Much effort has gone to making the classification process as definite as possible; however, streams don't always fit neatly into categories. View stream classification as a best-fit judgment based on the weight of evidence.
- In low-gradient, peat-based systems, the emphasis should be placed on channel continuity and uniformity, rather than composition of bed materials.

Note: the observed presence of fish (i.e., probability of fish occurrence = 100%) at or near the crossing site, particularly upstream, trumps all criteria for stream classification, resulting in a need to do an assessment for fish passage.

5.3 Watercourse Classification Examples

Figure 1: Non-fluvial channel (Images courtesy of Forest Research Institute)

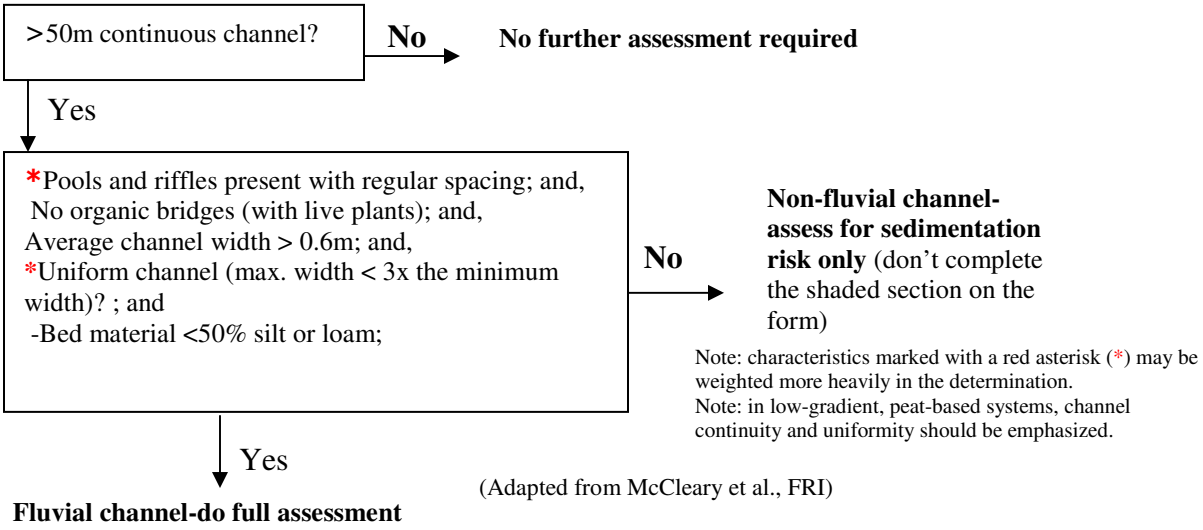
Note: no pool/riffle sequence; highly variable channel width; organic bridges (live plants); mostly organic bed material

Figure 2: Fluvial channel (Images courtesy of Forest Research Institute)

Note: pool/riffle sequence established; channel width relatively uniform; no organic bridges; cobbles, sand and gravels in bed

Note: pool/riffle sequence forming; channel width becoming relatively uniform; no organic bridges are dead logs; bed largely inorganic (cobbles, sand)

5.4 Watercourse Classification Flow Chart



(Adapted from McCleary et al., FRI)

For fluvial watercourses, use the following criteria to select intermittent or large vs. small permanent:

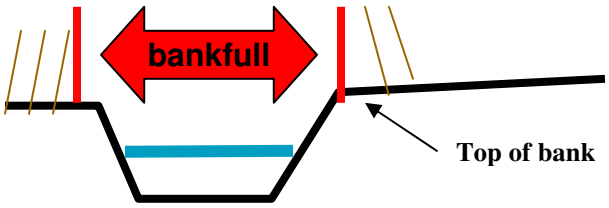
Intermittent - Channel usually has no terrestrial vegetation; Channel width often less than 0.4m. Usually some bank development.

Permanent-small - Banks well-defined. Channel well-defined and not vegetated. Channel width from greater than 0.7m to 5m. *Transitional streams channel widths are generally between 0.4 and 0.7 meters.*

Permanent -large - Non-vegetated channel width exceeds 5m

6.0 Bankfull Width (BFW) – Essential

"…described as the point at which the water breaches its banks and flows onto the floodplain."
-Foothills Stream Crossing Inspections Manual



It is sometimes also roughly equated to "rooted width," the point on a bank where the rooted, non-grass, vegetation begins.

- Unless the channel is very small (less than 1.5m wide), BFW is to be measured to the nearest 0.5m using a measuring tape or a laser range finding device or visually estimated to the nearest meter. Very small channels can be measured to the nearest 0.01m using a tape. Specify if measured or estimated.
- Measure BFW in a straight section, clearly outside of the zone of influence of the crossing itself. E.g. below the outfall pool, or above any ponding upstream of the crossing.
- Take a measurement both upstream and downstream of the crossing site and record the average.
- Measure BFW from top of bank to top of opposite bank. If bank is not physically well-defined, estimate the bounds using the cross-channel distance between the roots of bank side trees or shrubs.

7.0 Crossing Classification

Crossing Type – Essential. Only road crossings are within scope of this program.

- Bridges- temporary bridges are single span, typically lack revetments, wing walls or bank armoring, and are modular steel, or timber construction. Permanent bridges usually incorporate concrete abutments and bank armoring.
- Culverts – for multiple culverts, only consider those pipes that are within the stream channel. Identify the primary culvert (which conveys the majority of flow). Distinguish traditional closed vs. open-bottom culverts.
- Fords – shallow water crossings, often at riffles; well-graveled sites. Rare along maintained roads.
- Suspended – crossing structure removed temporarily.
- Reclaimed – crossing structure removed permanently. Associated with reclaimed roads

8.0 Erosion / Sedimentation Assessment

Sedimentation / erosion risk is to be assessed for crossings of all streams with at least 50m of continuous visible channel development. For such cases, Erosion evidence, Source and Extent are essential.

- Assess the condition of ground and vegetation at the site for evidence of active or potential erosion, the cause and relative severity of impact to the stream.
- Erosion = Yes if there are signs of earth movement (e.g. gullying, slumping, uprooted or displaced plants) at the crossing site, indicating active erosion.
- Erosion = Potential if there no evidence of movement, but there is exposed earth on fill slopes and ditches leading to the stream.
- Indicate (circle appropriate word) whether erosion is evident at the inlet or outlet side, or both
- Source- check all that apply
- Extent = High if the movement of eroding materials to the channel is unimpeded, being in direct or imminent contact. Estimate the total area (m2) of the erosion zone(s).
- Extent = Low if the movement of eroding materials is not in imminent contact with stream channel or is at least temporarily impeded from contact by erosion control.

Figure 4: Erosion Example (Photo courtesy of Forest Research Institute)

This site would be assessed as follows:

- Erosion = Yes
- Extent = High
- Source= Fill Slope

Active erosion zone, characterized by exposed earth and indications of earth movement, such as displaced vegetation, slumping and gully formation.

Figure 5: No Erosion Example (Photo courtesy of Forest Research Institute)

This site would be assessed as follows:

- Erosion= No

No exposed earth or evidence of earth movement. Rock armoring. Vegetation intact and well-established.

Figure 6: Exposed Earth Example (Photo courtesy of D.Park)

This site would be assessed as follows:

- Erosion= Potential
- Extent = High
- Source= Road Surface & Fill Slope

Exposed earth, but with no evidence of movement. Minimal grassy and weedy vegetation.

Figure 7: Eroding Material Example (Photo courtesy of D.Park)

This site would be assessed as follows:

- Erosion= Yes
- Extent = High
- Source = Ditch (note failed silt fence)

Eroding materials in direct contact with stream channel.

Figure 8: Slumping Example (Photo courtesy of D.Park)

This site would be assessed as follows:

- Erosion= Potential
- Extent = Low
- Source= Fill Slope

Evidence of past slumping and movement of fill material. Patches of exposed earth. Vegetation is impeding the contact of the eroding material on the channel.

9.0 Culvert Status Assessment

In the event of multiple culvert sites, the assessment is focused on the primary (i.e., largest, most water moved) culvert. If a culvert is not clearly primary, then designate one as primary focus of assessment.

9.1 Culvert(s) Diameter- Essential

Measure the diameter (to the nearest hundredth of a meter, e.g. 0.83m) of any or all culverts within the stream channel. If more than one culvert, ensure the diameter of the designated primary culvert (see above) is recorded in the appropriate space on the form.

Note: Most metal pipe culverts are round. If the culvert is not round (i.e., oval), record the horizontal width.

9.2 Debris Blockage- Essential

Indicate if at least 10% of the diameter of the culvert is obstructed. Indicate the cause of the blockage in the comments section at the bottom of the form.

9.3 Substrate in culvert- Essential

Choose the category that best describes the dominant substrate type. Choose the % category that best reports how far back into the culvert (from the outlet) substrate can be found. Under conditions of low water transparency, substrate info may be unavailable (indicate "unknown").

9.4 Backwater in culvert- Essential

Backwater is the **upstream extension of the outlet pool into the culvert**. Choose the % category that best reports how far up into the culvert (from the outlet) backwater can be found.

9.5 Culvert slope – Essential

Looking through the culvert, do a visual assessment. Is the culvert roughly level with a uniform grade (straight tube), or does it have a visible slope or a bent tube? Does the movement of the water (velocity and depth changes) through the culvert indicate high or changing slope?

- Backwater and culvert slope are often related. A lack of backwater through the culvert is an indication of culvert slope exceeding the natural grade of the stream channel.

9.6 Outlet Gap and Pool Depth – Essential

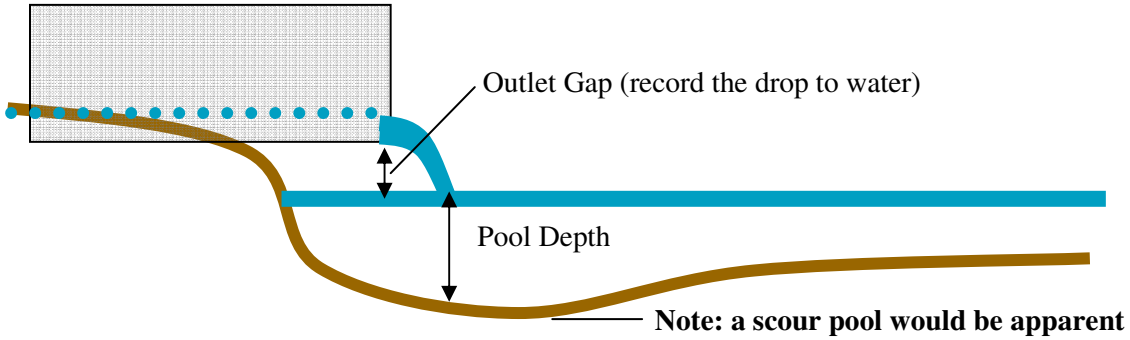
See the following diagrams. For a multiple culvert site, record Outlet Gap and Pool Depth for the **lowest** functioning culvert. Using a marked staff or meter stick, record these measures to the nearest hundredth of a meter (e.g. 0.52m).

Outlet Gap is the vertical difference between the lower lip of culvert (the invert) and the water surface. If outlet is submerged, record the drop as a negative value (e.g. -0.15m). Record "null" if the invert is embedded in substrate and check the embedded box.

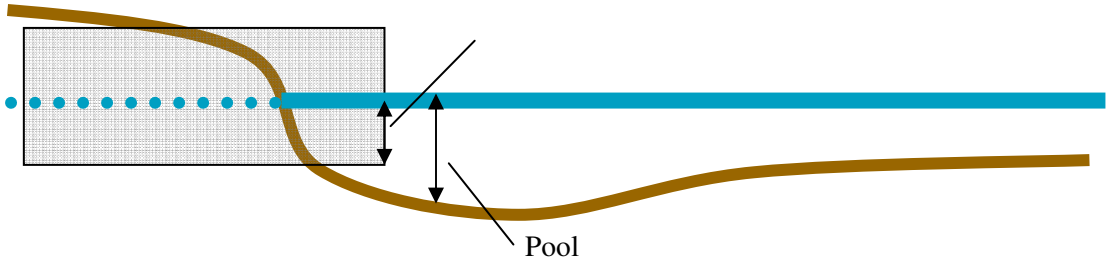
Pool Depth is measured from the water surface to the substrate, just downstream of the culvert outlet. If the substrate is coarse and the depth quite variable, take 3-4 measures and record an average. Indicate in the **scour pool** check box if an obvious scour pool has been formed below the culvert. Add the Outlet Gap and Pool Depth to obtain the **Outlet Score**

9.7 Diagrams of Culvert Outlet Measures

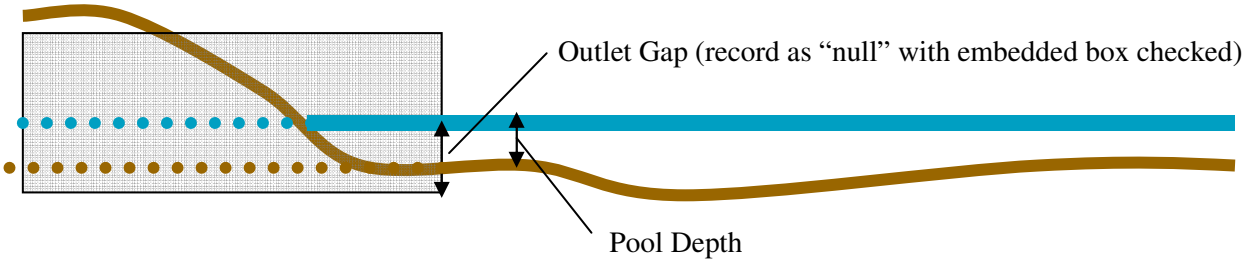
Perched outlet condition



Submerged outlet condition



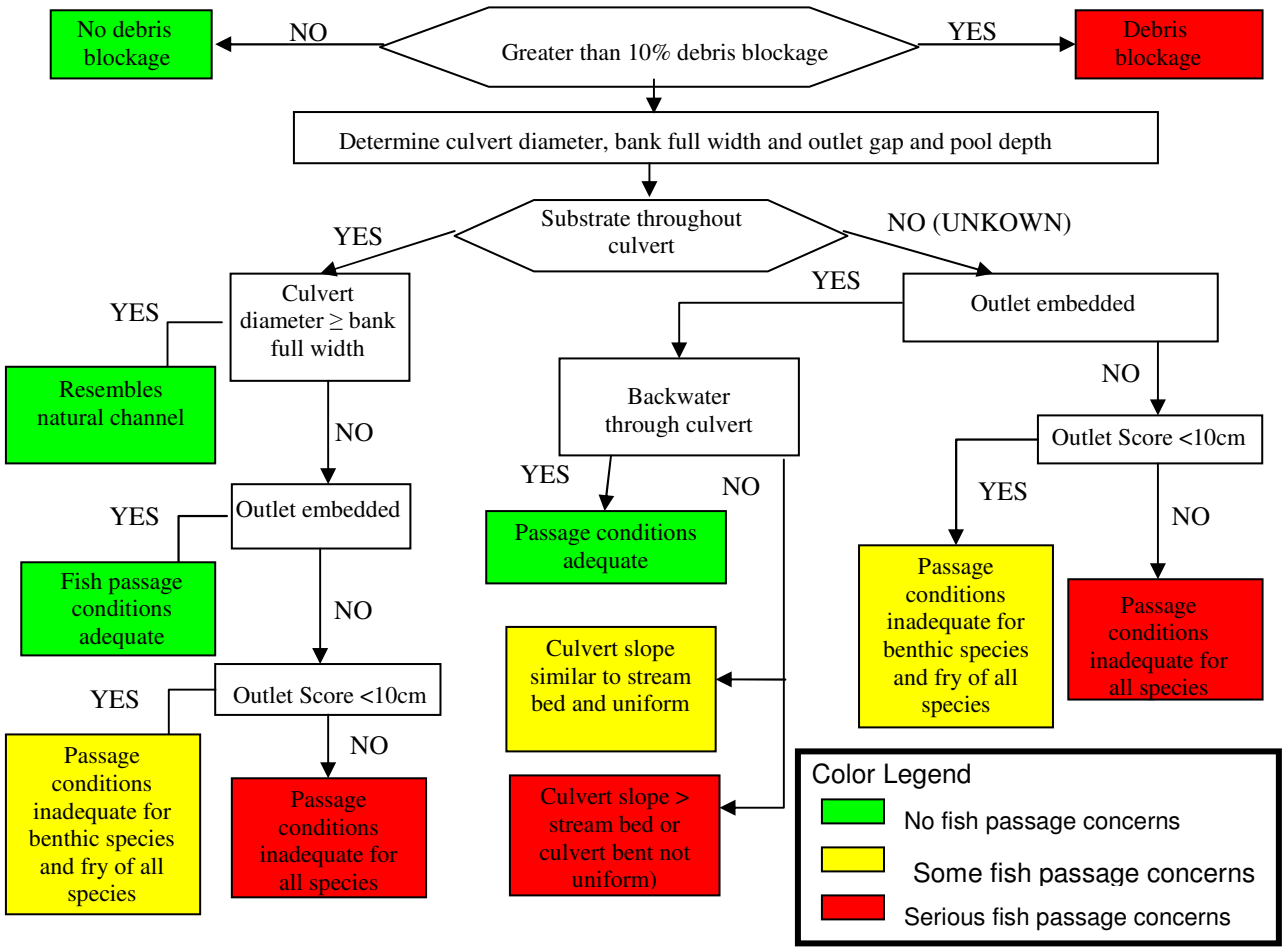
Embedded outlet condition



10.0 Fish Passage Assessment

- Applicable only to culvert crossings of fluvial streams. This assessment is optional in the field.
- Passage assessment is considered for 2 categories of fish, generally based on their size and swimming ability.
- Weak swimmers – benthic (bottom-dwelling, e.g. sculpins) fish and small-bodied fish (<10cm overall length, including fry and fingerlings of trout, grayling, whitefish and suckers, etc.).
- Strong swimmers – larger-bodied fish (>10cm overall length)
- Record the fish passage assessment as per the flowchart provided. If passage is inadequate for strong swimmers, it will be deemed inadequate for weak swimmers as well (check "all" box).

10.1 Fish Passage Evaluation Criteria for Culvert Stream Crossings



10.2 Comments and Photos

Add in any notable comments, particularly:

- Culvert damage (e.g. crushed)
- Observations of fish at site (note size and fish type or species if possible)
- Causes of any blockage
- Hazards to road users
- Any recommended remediation actions
- Estimated area of active erosion zone (m2)

If possible, take digital photos showing the relevant crossing features, particularly problems. If it is a culvert crossing, show the culvert outlet and inlet in relation to the stream. Use a wide angle to include as much of site as possible. Record numbers of images, by view (so inlet and outlet can be ID'd) in the comments space.

10.3 Safety

This assessment protocol is designed to be performed by a single worker. Safety procedures for working alone should be followed as needed.

Specific relevant hazards and suggested responses:

- Traffic – wear high visibility clothing and look before crossing roadways. Park vehicle to not restrict roadways.
- Slipping & Falling – steel culverts and stream rocks are slippery. Wear boots with grip soles and step carefully. The use of a staff when walking in or near water is recommended if footing is insecure.
- Bears – bears often follow watercourses and water noise can mask the sounds. Be bear aware and carry bear spray or a firearm for protection (if allowed by employer policy).

10.4 Gear List

The following items are considered mandatory:

- GPS device
- Measuring rod or staff – at least 2 meters long, capable of measuring to the nearest centimeter.
- Rubber boots or hip-waders

The following items are recommended:

- Fiber measuring tape (suggest at least 20m long)
- Hi-visibility vest
- Laser rangefinder
- Polarized sunglasses
- Digital camera
- Bear spray (or 12 gauge shotgun, loaded with slugs)

11.0 For More Information

Contact Dani Walker, Provincial Aquatic Habitat Specialist, Fisheries Habitat Policy, Alberta Environment and Sustainable Resources Development, Edmonton for questions or comments on this user's guide.

Email: Dani.Walker@gov.ab.ca
Phone: (780) – 644-5353

Contact Dave Hugelschaffer, Approvals Manager, South District, Upper Athabasca Region, Alberta Environment and Sustainable Resource Development, Edson, for more information about the Foothills Watershed Remediation Pilot Program.

Email: Dave.Hugelschaffer@gov.ab.ca
Phone: (780) - 723-8531

Appendix A
Field Inspection Form

Alberta Government — Environment and Sustainable Resource Development

Watercourse Crossing Inspection Form

Roadway Watercourse Crossing Inspection Manual

Water Crossing Name of ID (ex. # spray painted on or around culvert)		
Watercourse Name:		Disposition No.
GPS Co-ordinates (UTM):	Easting:	Northing:

Stream Classification: ☐ Ephemeral ☐ Non-Fluvial (in non-fluvial, omit shaded section)
☐ Fluvial & either: ☐ Intermittent, or ☐ Permanent – Small, or ☐ Permanent - Large
Bankfull width: ____.__m (☐ measured or ☐ estimated to nearest metre)

Crossing Type:	☐ Bridge – Permanent ☐ Bridge – Temporary ☐ Culvert - Single
	☐ Culvert - Multiple ☐ Culvert – Open Bottom
	☐ Fill - Log ☐ Ford ☐ Suspended ☐ Reclaimed

Erosion at site? ☐ Yes ☐ Potential ☐ No	☐ Inlet ☐ Outlet ☐ Both
If Yes or Potential, identify source (check all that apply): ☐ Ditch Gully ☐ Bank Slump ☐ Fill Slope ☐ Road Surface ☐ Bridge Deck ☐ Other	
Extent: ☐ Low ☐ High-unsatisfactory	Total Erosion Area (m^2) _____

Culvert(s) diameter: _____m _____m _____m _____m (primary)

Greater than 10 % of diameter blocked by debris? ☐ Yes ☐ No (note cause in comments)
Substrate in the culvert? ☐ Yes ☐ No ☐ Unknown
If yes, what type? ☐ Sand ☐ Gravel ☐ Cobble ☐ Boulder ☐ Other:
For what length of culvert? ☐ 25% or less ☐ 50% ☐ 75% ☐ 100%
What proportion has backwater? ☐ 0% ☐ 25% ☐ 50% ☐ 75% ☐ 100%
Culvert slope: ☐ Level and Uniform ☐ Slope > or Vertically Bent
Outlet Gap: _____m (for lowest, if more than one culvert) ☐ Embedded
+Pool Depth: _____m = Score: _____ Scour pool apparent? ☐ Yes ☐ No

Fish Passage Assessment (use 10.1: Fish Passage Evaluation Criteria for Culvert Stream Crossings)

☐ No Concerns ☐ Some Concerns ☐ Serious Concerns

Inspector's Name:	Inspection Date:

Comments: (if photos taken of inlet and outlet, please record image numbers)

March 13, 2015 — Watercourse Crossing Inspection Form — Page 1 of 1