Rating system for rural culvert crossing repair and maintenance.

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A statistical analysis of data collected by the MDT Maintenance Division was used to develop an Excel template that calculates a *condition index* for a given culvert. The condition index may be used to establish relative maintenance and replacement needs for culverts. The Excel template can be downloaded from:

http://www.coe.montana.edu/wti/Projects/culvert.htm

Complete details concerning the statistical analysis and the math that is used to arrive at the condition index can be found in:

Baker, D. 2001. Rating system for rural culvert crossing repair and maintenance. MS Thesis. Civil Engineering Department. Montana State university, Bozeman, MT.

Using the Software

To use the Excel template, a certain amount of field data must be collected to describe the culvert. The items that should be noted on the field visit, and the corresponding value that should be entered into the template are given in the tables below. In recording field data, look for the worst case (most conservative) scenario. For example, if you were assessing the degree of physical blockage to a culvert and the upstream end is completely covered, but the downstream end is open, rate the upstream end.

Item Observed and Entered	Actual Value to Enter in Template	Notes
Culvert Age	The number of years since the culvert was installed, as an integer (no decimals). Appropriate values are from 0 to 100 years.	Older culverts, in general, tend to have higher maintenance requirements than newer culverts.
Degree of Scour	An integer rating of 0, 1 or 2 indicating the degree of scour of channel material at outlet. 0 - No indication of scouring at outlet. 1 - Moderate scour. Limited amount has occurred but does not appear to continue. 2 - Major scour concerns, problem continues to wash away bed material.	High velocity water exiting a culvert may erode non-protected channel material. Scour holes at the outlet may impede fish passage.
Evidence of Major Failure	Indicate evidence of former major hydraulic failure by entering a 0 to indicate no evidence, or a 1 to indicate visual evidence of failure.	Failures may include: **Overtopping**: Backwater of culvert increases beyond height of roadbed. Water flows over road and may result in erosion of the road surface or shoulders. **Buoyancy Failure**: Uplift forces in culvert due to trapped air either bend ends of culvert up, or displace entire culvert. **Structural Collapse of Barrel**: Culvert barrels must support the weight of the above roadway. And major deformation can be considered collapse as the culvert's strength is primarily attributed to its shape. During major flow events drainage may overwhelm the capacity of the culvert and a hydraulic failure results. Typically one failure can lead to another.
Degree of Corrosion	Indicate the degree of corrosion on either the inside or outside of the culvert by entering a rating of 0, 1 or 2. soil side or water side corrosion according to: 0 - No indication of corrosion. 1 – Minor corrosion. 2 - Major corrosion.	Corrosion is the result of reactive soil, soil water, or water flowing in the culvert.
Invert Worn Away	Enter a rating of 0, 1, or 2 to indicate abrasive wear according to: 0 - No damage to the culvert lining. 1 - Minor damage to the culvert lining. 2 - Serious abrasion damage to the culvert lining.	Many culverts are lined with a protective material, including the galvanized coating on corrugated metal pipe. In some culverts this coating is worn away by the abrasion of rocks or sediment and this wear usually occurs in the bottom portion of the culvert. Note that if the culvert is worn completely through at the invert, enter a 2 here and be sure to enter a 1 under "Evidence of Major Failure".

Item Observed and Entered	Actual Value to Enter in Template	Notes
Sedimentation	Estimate the percentage of the cross sectional flow area this is blocked by sedimentation or sod, and enter this as a number between 0 (no sedimentation) and 100 (completely blocked by sediment or sod).	Sedimentation can include small debris or detritus, soil, gravel, cobble, or small pieces of organic matter. Sometimes there are plants growing in the sediments and should be included in the blockage estimate.
Physical Blockage	Estimate the percentage of the cross section that is blocked by large debris, with 0 meaning no blockage and 100 meaning completely blocked.	Large debris (debris that is too large to be easily removed during the inspection procedure) can indicate maintenance needs.
Joint Separation	Enter a 0 if no joint separation is observed, or enter 1 if joint separation is evident.	Some culverts are built by connecting short joints of pipe to form a long culvert. Differential settling can cause the joints to separate, leading to seepage or structural problems.
Physical Damage	Assess the severity of physical damage as follows: 0 - No physical damage. 1 - Minor physical damage, will not inhibit flow but may be a further maintenance hazard. 2 - Major physical damage, will decrease the ability to pass the design flow rate efficiently.	Physical damage to culvert is often he result of debris impact, cars leaving the roadway, or collision with maintenance equipment.
ADT Class	Enter an integer from 1 to 5 based on the number of vehicles crossing the culvert: 1 - 0 to 500 2 - 501 to 2000 3 - 2001 to 5000 4 - 5001 to 10,000 5 - Over 10,000	The average daily traffic (ADT) is used to show increased maintenance needs for culverts that are heavily used.
Detour Length Class	Enter a value from 1 to 5 based on the distance that motorists would have to travel in the event that the culvert is impassable: 1 - 0 to 1.0 miles 2 - 1.1 to 3.0 miles 3 - 3.1 to 10.0 miles 4 - 10.1 to 50.0 miles 5 - Over 50 miles	If the detour length around a culvert that fails is long, that culvert should be watched more closely to ensure that failure doesn't occur.

Immediately after each item is entered in the spreadsheet, the condition index automatically updates. When all the values are entered for a specific culvert the condition rating shown is the answer. If after entering any input value the word "no" appears in the far right column and the answer changes to "Check entries!", then you have entered a value incorrectly and should correct the mistake before moving on.

Interpreting Results

The condition index is an integer from 1 to 5. An index of 5 indicates a very healthy culvert with little or no repair/replacement needs. A condition index of 1 indicates a culvert that is in poor shape and is a likely candidate for immediate repair or replacement.

The condition indices are a valuable tool when assessing the maintenance or replacement needs of a large number of culverts. Also, the process of establishing the index for a small group of culverts may shed new light on the needs of those culverts simply because a systematic procedure has been used to assess all the culverts on a level playing field.

The rating system is not a substitute for common sense at any give culvert. For example, a culver that is 100% blocked by sediments but is healthy in all other regards would have, at worst, a condition index of 3. Common sense, however, tells us that if that culvert is not maintained soon, the next flow event will send water cascading over the road deck. This should be repaired. On the other hand, a culvert that may have minor concerns in all areas may have a lower condition index, but could withstand delayed maintenance.

Another important note is that the condition index does not differentiate between repair, maintenance, or replacement needs. Some problems can be fixed. Others indicate poor maintenance. Culverts in extremely poor condition may need complete replacement. These decisions should be made by qualified personnel with field experience.