

## **Appendix A Culvert Inspection Guideline**

### **Routine Inspection:**

The inspection of the culverts and appurtenant features should follow the rating guideline outlined in Section Nos. 6.7.8 and 6.7.9 of the ConnDOT Bridge Inspection Manual (ConnDOT BIM). These ratings should be assigned and documented for existing culverts to remain in use, with recommendations provided. The procedure outlined in the ConnDOT BIM shall be used as the format for the inspection. A report documenting the results of the culvert inspection shall be provided. Two hard copies of this document and one disk containing the pertinent NBIS data in electronic format shall be provided.

### **Approach Roadway and Embankment:**

- Inspect the roadway for settlement due to culvert flattening, for evidence that the roadway has been patched or otherwise built-up, for cracks running parallel to the culvert centerline and for signs of erosion or failure of the embankment slope over the culvert. Look for signs of sink holes over the culvert that may be due to “piping” of the fill material through joints in the culvert.
- Evaluate the approach roadway for alignment, clearances, adequate shoulder profile, and safety features such as guide rails. These observations will not affect the condition code of the culvert, but should be included in the inspection report.
- Inspect the approach embankments for erosion protection such as slope paving or vegetation. Note the overall adequacy of this protection and note any vegetation near the culvert where root systems may damage the culvert.

### **Waterway:**

- Note any observed changes in stream/culvert horizontal or vertical alignment that might affect the hydraulic adequacy of the culvert or cause scour.
- Note any significant changes in the ground cover or land use within the tributary watershed that might change the volume of water the culvert must pass.
- Note whether or not the stream bed fluctuates between high and low flow volumes. Document any changes in the amount, type or location of any channel erosion and stream bed aggradation/degradation.
- Document any observable high water mark relative to the culvert barrel.
- Measure and document the volumetric flow rate and velocity of the water flow upstream, downstream and through the culvert (if possible).

- Document any debris buildup or other obstructions in the waterway upstream, downstream, or within the culvert and any effects the obstruction may have upon the hydraulic adequacy. Note any maintenance requirements for post inspection follow up.

#### **Culvert Barrel and End Treatments:**

- Check the culvert headwall, wingwalls, cutoff walls, and slope protection for any deficiencies or deterioration, undermining, scour, piping, tipping, settlement or slope failure.
- Check the culvert barrel for deformations, settlement (either a smooth slope over the length of the culvert or an abrupt change at a joint), leaking or distressed joints and other deficiencies or signs of deterioration. Check for evidence that lateral earth pressure is causing bulging, flattening, peaking, sliding or rotation in the barrel or barrel components as outlined in the ConnDOT BIM, Appendix 6.5 and Appendix 6.7.
- Document any debris or sediment build-up within the barrel.
- Verify the minimum required measurements of the culvert as outlined in ConnDOT BIM, Appendix 6.5. Dimensions should be taken at the inlet, outlet, mid-length and at 8 m (26 ft.) intervals (maximum) as applicable, if access to the interior of the culvert is possible. Locations of sagging, bulging, flattening or peaking should also be measured.
- Check the barrel footings for scour and undermining (typically found in culverts that pass the natural stream bed through the culvert) and around the inlet and outlet of closed barrel sections.
- Probe all areas of scour, undermining and joint mortar loss and note the average depth at each location and maximum depth overall.
- Check to see if the culvert barrel has separated from the headwalls or cutoff walls.
- Check to make sure headwalls and wingwalls are adequately retaining the embankment material and protecting it against erosion.
- Where practical, the floors of metal pipe culverts should be sounded with a metal rod in an attempt to locate voids due to undermining.

#### **Special Note About Corrugated Metal Culverts:**

- Culverts with mitered ends (ends cut to match the embankment slope) and ends of skewed culverts (where the end is cut parallel to the centerline of the roadway) have reduced strength in these areas and have increased susceptibility to buckling. Therefore, even minor deformations are significant.
- Projections of culvert ends beyond the embankment lead to increased probability of erosion and piping around the culvert barrel.

**Aprons, Energy Dissipaters and Flumes:**

- Check the apron, which reduces erosion at the inlet and outlet (typically a concrete slab or riprap), for deterioration, missing stones, undermining of slab, movement of stones due to scour and deterioration of the joint between the apron slab and headwall.
- Check the energy dissipaters, which reduce outflow velocity and downstream erosion (typically riprap or concrete basin), for missing stones, movement of stones, scour, undermining, deterioration and overall effectiveness.
- Check the flumes (typically concrete, bituminous material or riprap) for deterioration, erosion, debris and signs of water bypass.

**Documentation Required for a Routine Inspection:**

- Document all observed deficiencies and deteriorations. Dimensions of deficient or damaged areas should include length, width, height, depth of material loss, orientation and location relative to a fixed, easily identifiable point.
- Estimate and record the depth of fill and pavement over the culvert.
- Draw a site plan that shows the orientation of all the culvert elements relative to the roadway. Sketch and dimension the boundaries of the waterway for the length necessary to show the alignment with the culvert (30 m (100 ft.) minimum). The sketch shall include both the inlet and outlet sides of the culvert, and dimension the typical width, depth, estimated velocity and direction of flow of the waterway, as well as all major changes in waterway cross section. All obstructions, deficiencies, changes in land use, changes in topography, sediment buildup, erosion, etc., shall be noted on the sketch (see Figure A-5-1 in ConnDOT BIM, Appendix 6.5 for an example sketch).
- Particular care shall be given to documenting any increase in quantity or size of deteriorations, erosion, sediment buildup, changes in waterway centerline, etc., that have changed since the last inspection. If the condition rating has changed since the last inspection, a photograph and detailed explanation of why the rating has changed shall be included in the report.
- Document any recent construction activity in the area that may affect the water flow through the culvert (i.e. changes in drainage area, land use, topography, etc.)
- Photographs taken shall include, but not be limited to the following:
  - View of the roadway above the culvert, taken from each roadway approach toward the culvert.
  - View looking at the culvert inlet and outlet taken from the waterway centerline or edge upstream and downstream of the culvert. The distance at which these photographs are taken shall be the distance sufficient to provide an overall view of the culvert and waterway at the culvert.

- View looking upstream from the culvert inlet and downstream from the culvert outlet.
- Typical views of all major components where deficiencies, erosion, sediment buildup, obstructions, etc., were noted. Include detailed photographs as necessary.

(Note: Pictures taken of the roadway from the approaches and detail photos of deficiencies, erosion, deterioration, etc., may be omitted if photos from previous inspections adequately reflect the current condition. However, all photos taken of the waterway approaches and culvert openings should be updated during each inspection so that lateral movement and changes in alignment over time can be documented.)

### **In-Depth Inspections:**

- In addition to the requirements for routine inspections, all exposed surfaces of concrete culverts should be tapped with a hammer to locate delaminations.

### **Documentation of In-Depth Inspection:**

- Same requirements as for routine inspection.

### **Report Review**

- Cross reference the inspection report, inspection field notes and photographs to ensure they are mutually supportive of their documentation.
- The inspection reviewer should determine if a pattern of deterioration or progressive deterioration is taking place. Progression will be determined by comparing present and past inspection reports.
- Special attention shall be given to field note documentation indicating changes in the culvert shape, the presence of scour, piping or other problem that may warrant further investigation.
- Culverts are usually designed to use the vertical and horizontal earth pressures to maintain their stability and increase their live load capacity. Therefore, any change in the “As-Built” condition of the soil surrounding the culvert (addition or removal) should be noted and possibly analyzed for effects on the stability and capacity of the culvert.
- Changes in drainage area, land use and topography that increase the depth or velocity of flow within the waterway should be assessed in terms of how they may effect the long term waterway stability (i.e. lateral movement, aggradation, degradation, etc.) and hydraulic adequacy of the culvert.

### **Maintenance Concerns**

- By the nature of their construction, culverts constrict the flow of water in the waterway. This constriction increases the potential for waterway blockage with debris and sediment, and increases the probability of scour around the culvert especially if high outlet velocities or turbulent flow conditions adjacent to the inlet are encountered. Therefore, any blockages noted should be removed as soon as possible (during the inspection if possible).

- Culverts typically have steep approach embankments, as well as large, abrupt drop-offs at the culvert crossings. Headwalls and wingwalls may be exposed to traffic presenting collision hazards to passable vehicles. Routine maintenance should include safety considerations (i.e. guide rails) as well as structural and hydraulic considerations.
- The addition of cut-off walls should be considered where “piping” or seepage around the outside of the culvert structure is found or suspected.
- Severely deteriorated culverts may be reviewed for repair by relining the culvert barrel.