Culvert Inspection and Rating

Introduction

• Many different types of culverts – refer to Table 1.1 in Manual

• Vast majority are CSP or SPCSP in various shapes - round, arch pipe, horizontal ellipse

• Three culvert forms (Cul1, CulE, CulM)

• Same forms used for all types of culverts

• Timber pipe (TP) culverts exception
  – Use TT form

Form Types

• CUL1
  – Single culvert or single culvert extended with same material and size

• CULM
  – Two or more culverts (MP, SP or BP etc.)
  – Includes 1 Upstream & 1 Downstream End section for each Barrel section
  – Exception is Concrete Boxes (BP) where single U/S and single D/S sections for all barrel sections
  – Includes 2 cell box extended with single steel

• CULE
  – Single culvert extended with different material and/or size
  – One Upstream & Downstream section, Barrel sections for all cells and/or pipes

Introduction

• Bridge sized culverts have an equivalent diameter of 1500mm or greater

• Bridge site that requires a 1500 mm pipe due to hydraulic discharge

• Will routinely inspect smaller culverts if there are several (low level crossing)

• May also inspect if multiple small culverts are equivalent in hydraulic capacity to bridge-sized (2-1200mm)

• May inspect certain other non-bridge sized culverts (3 - 900mm)
Culvert Inspection and Ratings

Inventory Information

- Extracted from BIS
- Span/rise is original design shape
- If round then only rise is recorded
- Span types – refer to Table 1.1 and Sec. 13.2.3
- Corrugation Profile and Plate Thickness selected from Table 13.1 and 13.2 (p.13.5 in manual)
- Specific information is provided for all pipes
  - a culvert extended with same material and size is considered to be one culvert (Cul1)

Culvert Inspection and Ratings

Culvert Span Types

Numbering and Identification

- Where the culvert does not carry flow determine “upstream” and “downstream”
  - Look in direction of increasing chainage
    - (to north or east)
  - Left is “upstream” (end 1)
  - Right is “downstream” (end 2)
  - Keep same choice for each subsequent inspection
Numbering and Identification

- Primary span is the largest span at the site
- Secondary span is the smaller span
- Multiple culverts of same dimension are numbered in order of increasing chainage (from south to north or west to east)
- Multiple culverts also have same Ring numbering system (R1, R2, R3, etc.)

Ends - General

- Individual rating sections for the Upstream and Downstream ends
- Single upstream and downstream end sections for the CUL1, CULE forms
- Separate Upstream and Downstream ends for each Barrel section on CULM forms - except Concrete Boxes
- Upstream and Downstream sections are identical
- Items are inspected and rated the same way for both ends

Ends - General

- Purpose:
  - Improve aesthetics
  - Improve hydraulic performance
  - Prevent undermining due to scour
  - Prevent scour of the embankment
  - Reduce piping along or under the culvert
  - Resist uplift due to buoyancy forces
  - Shorten the culvert
  - Stiffen the ends
End Treatment - Types

- **Steel**:  
  - Most common  
  - Bevel end with no concrete treatment

- **Concrete**:  
  - Presence of any or all of: Headwall, Collar, Wingwall, Cutoff Wall

- **Other**:  
  - Timber Culvert with Timber End Treatment

- **None**:  
  - Square end – no Bevel present

Bevel Ends – End Treatment Type is “Steel”

Bevel Ends with Full Concrete End Treatment - Type is “Concrete”

Bevel End with Full Concrete End Treatment - Type is “Concrete”
End Treatment - Headwall

- Located over the crown
- Usually attached to the barrel
- Purpose:
  - Aesthetics
  - Strengthen end
  - Resist buoyancy force
  - Retaining walls

End Treatment - Collar / Slope Protection

- Located along the beveled slopes of flexible culverts between headwall and cutoff wall
- Usually constructed from concrete
- Usually used with and connected to headwall and cutoff walls
  - May be used alone

- Purpose:
  - Aesthetics
  - Stiffen the bevel
  - Resist buoyancy force
  - Improve hydraulic efficiency of end
  - Concrete slope protection
    - protect against scour / erosion
    - reduces piping potential

- Look for:
  - Signs of movement or tilting
  - Loose connections
- Rate according to condition of material and functionality of component
- Condition affecting functionality rate 4 or less
**End Treatment - Collar / Slope Protection**

- Look for:
  - Evidence of piping or scour / erosion
  - Loose connections
  - Voids underneath or settlement
- Rate according to condition of material and functionality of component
- If piping, rate 4 or less:
  - Also rated under bevel end and barrel

**End Treatment - Wingwalls**

- Generally found at culverts that do not have bevels
- Shape is either Parallel or Flared to culvert axis
- Main difference from Bevel is Wingwall is not attached to the barrel
- Usually constructed from concrete or steel
- Purpose
  - Improve hydraulic efficiency
  - Retain embankment fill

**End Treatment - Wingwalls**

- Record Shape as “Parallel”, “Flare”, or “Perpendicular” (to culvert axis)
  - Parallel wingwall
    - Req’ less scour protection between walls
  - Flared wingwalls
    - More hydraulic efficient
- May have a reinforced concrete slab between
  - Prevents undermining of wingwalls due to scour
  - Act as struts for greater stability
  - If present rate with wingwalls

- If wingwall is unstable rate 4 or less
- Separation losing fill rate 4 or less
- Includes rating of wingwall floor slab
End Treatment – Flared Wingwalls

- Located at the end of the culvert
- Vertical wall extending down below the bottom of the culvert
- Depth exceeds the depth of the riprap or concrete apron
- Usually constructed from concrete or steel
- Purpose:
  - Reduce potential for undermining of end of culvert
  - Minimize possibility of piping
  - Resist buoyancy force

End Treatment - Cutoff Wall

<table>
<thead>
<tr>
<th>Cutoff Component</th>
<th>Downstream End</th>
<th>New</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutoff Wall</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Look for evidence of:
  - Undermining
  - Piping
  - Uplift
  - Loose connections

- Usually not possible to inspect since they are submerged or covered with ice or debris
  - If not visible rate “N”
  - If certain not present rate “X”

- If piping, rate 4 or less
  - May also affect Bevel End and Barrel Rating
Culvert Inspection and Ratings

Ends - Bevel End

<table>
<thead>
<tr>
<th>Culvert Component</th>
<th>Land</th>
<th>Now</th>
<th>Explanation of Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bevel End</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insert Above/Below Stream Bed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above/Below (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

• Sloped section at the end of the culvert
• Permanently attached to the barrel
• Generally parallel to the culvert axis
• Bevel types
  – Full bevel
  – Step bevel

Ends - Bevel End

• Compared to projecting ends, bevel ends are more:
  – Aesthetic
  – Economical
  – Hydraulically efficient

• Compared to projecting ends, bevel ends on corrugated steel culverts are more flexible and susceptible to:
  – Deform due to lateral earth pressure
  – Uplift due to buoyancy
  – Heave due to frost action

Ends - Bevel End

• If possible, measure or estimate height above or depth below streambed and record amount in mm. (may not be able to measure or confirm measurements in high water or winter).

• Normally “Below” as designed to be buried ¼ diameter below streambed.

• If invert is “at streambed” record Above/Below as 0mm.

• Find a representative natural streambed location
  – Discount presence of localized scour hole or deposits (aggrading) at end of culvert

• Measure or estimate heaving of bevel and record amount

• Often best place to estimate is from inside barrel looking back to Bevel
• Use waterline as level
• Some heave is tolerable as long as water is entering Bevel
Culvert Inspection and Ratings

**Ends - Bevel End**

- Look for:
  - Piping
  - Deformation
  - Impact damage
  - Corrosion that affect strength
  - Abrasion
- If piping, rate 4 or less
  - Also rated under End Treatment if present
- Defects/deformations not affecting function rate 6 or less (un-supported bevel - no heave)
- Severe corrosion affecting strength (perforations) rate 4 or less – otherwise corruptions should not affect rating
- If no bevel, rate “X”
  - Underpasses often have square ends

**Ends - Scour Protection**

- Usually heavy rock riprap
- The current version of Std. Drawing S-1418-03 shows the minimum requirements for riprap
  - Coverage
  - Size
  - Minimum thickness
  - Gradation
- [http://www.transportation.alberta.ca/4860.htm](http://www.transportation.alberta.ca/4860.htm)
Ends - Scour Protection

- Purpose is to prevent scour and erosion at culvert ends which may:
  - Undermine the culvert
  - Undermine the sideslopes
  - Cause the formation of sand bars

Ends - Scour Protection

- Record the type of Scour Protection
  - If none exists and none is required, record type as “NATURAL”
  - If none exists and some is required, record type as “NONE”
- Estimate and record the average size (rock only)
- Look for:
  - Durability of riprap - e.g. sandstone is not acceptable
  - Shape - flat rocks not desirable
  - Displacement or movement
  - Scour
  - Current standards on S-1418

Ends - Scour Protection Ratings

- No scour/erosion or displacement rate 7 or more
- If none exists and none is required record type as “NATURAL” and rate 7 or more
- If none exists but is required record type as “NONE” and rate 4 or less (also make recommendation)
- Generally not rated higher than Scour rating – especially when Scour is 4 or less
- Protected area is smaller than required or rock gradation or quality is inadequate rate 4 or less
- Concrete protection with excessive settlement or undermining rate 4 or less
- Cattlepasses that handle drainage rate – otherwise X
- Removal of material from the streambed, banks or sideslopes by the action of flowing water and/or constrictions or obstructions (refer to Section 16.2 in manual).
- Effects:
  - Undermine the culvert
  - Undermine the sideslopes
  - Impede fish passage
  - Alter culvert hydraulics
Culvert Inspection and Ratings

**Ends - Scour / Erosion**

- Two types:
  - General – uniform lowering of original stream
  - Local – occurring at specific locations

- Look for:
  - Scour holes, especially at downstream ends
  - Undermining of culvert end or sideslopes
  - Slumping of sideslope or banks
  - Areas where flow impinges on banks, sideslopes or protection systems
  - Areas susceptible to high velocities and undermining
    - culvert footings
    - ends or bottoms of wingwalls and cutoff walls
    - sides of collars
    - ends or bottoms of ends of protection systems

- Rate the presence and extent of scour and adverse effects on culvert, embankment, streambed and banks

- If culvert and embankment are not affected, rate 5 or more

- Scour/erosion affecting culvert, rate 4 or less
Culvert Inspection and Ratings

Ends - Beaver Activity

- Beavers frequently construct dams at inlet or inside culverts
- Effects:
  - reduced flow capacity
  - Flooding upstream
  - Scour
  - Ponding of water inside culverts preventing inspection

Ends - General Rating

- Governing elements: (Refer to 1.10.7 & 13.5.10)
  - Headwall
  - Collar
  - Wingwall
  - Cutoff Wall
  - Bevel end
  - Scour protection
- If all are rated "X" then provide rating based on general condition of culvert end

Barrel - Rigid Types

- Made from concrete or timber
- Designed to carry loads without deflection (Rise and Span measurements normally not necessary).
- Culvert carries entire load with no reliance on surrounding fill for support.
- Generally more expensive but more durable, last longer and require less structural maintenance.
**Culvert Inspection and Ratings**

**Barrel - Flexible Types**

- Made from corrugated steel
- Low strength
- Dependent on surrounding backfill for support
- Culvert deflects under load until the backfill picks up the stress
- Entire load carrying system cannot be inspected directly (i.e. can inspect culvert but not backfill)
- Flexible culverts more susceptible to failure by:
  - Change in shape due to excessive deflection
  - Defective joints - cracks, open joints, cusped seams, etc.
  - Severe corrosion
  - Uplift of ends due to buoyancy forces

**Barrel - General**

<table>
<thead>
<tr>
<th>Barrel Last Accessible Date</th>
<th>[ ]</th>
<th>[ ]</th>
</tr>
</thead>
</table>

- If barrel is accessible provide current date
- Not accessible explain why & retain previous date
- Rate elements N if not visible
- Previous comments are retained and dated
- If more than one barrel indicate location (west) or span number

**Barrel - Special Features**

- Cannot be rated under another component
- May be temporary or permanent
- Must be visible to inspect
  - Special design features not usually inspectable (ribs, thrust blocks, etc.)
Barrel - Special Features

- Examples
  - Struts
  - Shotcrete beams
  - Abrasion plates
  - Concrete Floor
  - Storm Drains

- Record type
- Provide additional information in Explanation of Condition
  - Description
  - Location
  - Dimensions
  - Inspection procedures
- Provide rating based on condition /functionality

Barrel - Special Features

- Shotcrete Beam

Barrel - Special Features

- Struts – Rated 3

Barrel - Deformation

- Rating due to collection
- Crack in both W & E walls on RD 6 and 10
- Crack in both W & E walls on RD 6 and 10
- Crack in both W & E walls on RD 6 and 10
- Crack in both W & E walls on RD 6 and 10
Barrel - Ring

- Different elements make up a complete ring:
  - Roof
  - Sidewall
  - Floor
  - Bolted or riveted seams
  - Circumferential seams (bolted (SPCSP) or external coupler (CSP))

- Purpose:
  - Carry water flow or traffic
  - Carry loads and transmit to surrounding soil
  - Prevent infiltration of fill

Barrel - Ring

- For round culverts, use approximate arcs shown
  - Use longitudinal seam if close

Barrel – Ring Defects

- Flexible Steel culverts look for:
  - Deformation (measure crest to crest)
  - Localized crimping or buckling
  - Longitudinal seam problems
  - Corrosion
  - Abrasion on floor

- Rigid Timber culverts look for:
  - Material defects – rot decay

- Rigid Concrete culverts look for:
  - Structural problems - cracking
  - Material defects - corrosion, scaling, freeze-thaw damage
Culvert Inspection and Ratings

**Barrel – Roof Ratings**

Flexible culverts - continued
- Presence of temporary repairs has no influence.
- Sag within 5%, no corrosion - rate 7
- Sag within 7%, no pitting - rate 5
- Sag within 10%, corrosion pitting – rate 4
- Sag 11-15%, isolated perforations – rate 3
- Sag >15%, roof flattening, reverse curvature, extensive perforations – rate 2.
- Reverse curvature in flat HE or round under low cover, severe perforations – rate 1.
- Consider Longitudinal Seam rating if in Roof.

Rigid Culverts:
- Rate Roof based on visual evidence, defects
- Measurements not required

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**Barrel – Sidewall Ratings**

Flexible Culverts:
- Record greatest measured Span in mm. (crest-crest). Mark in culvert for future reference.
- Record Ring number measurements taken.
- Calculate and record Deflection in mm (measured rise - design).
- Calculate and record % Deflection.
- Rate Sidewall based on % Deflection (Table 13.3) or other visual defects.
- If not able to measure Span due to size, ice, etc. a Sidewall rating is still required based on visual evidence and estimated deflection.

Rigid Culverts:
- Rate Sidewall based on visual evidence, defects
- Measurements are not required
Barrel Sidewall Severe Inward Movement

Barrel – Sidewall Buckling – Rated 3 or less

Barrel - Floor

• Note and record substrate type and %.
• Check timber floors for rot, missing sections.
• Check concrete floors for cracking, spalling, missing sections.
• Check steel floors for cracks, crimping/buckling, defective seams, corrosion, abrasion.
• Measure or estimate floor bulge and record ring number.
• For flexible culverts - If greatest floor bulge is occurring in same ring as worst roof deflection add bulge to measured Rise
• Indicate abrasion on floor by Yes or No. if yes provide comment.

Barrel - Floor

• Rate flexible culvert floors as per Table 13.3:
  - Isolated perforations rate 4
  - Extensive perforations rate 3
  - Severe perforations rate 2
  - <5% bulging, minor abrasion and corrosion, no buckling or seam defects rate 6 or more
  - Seam rating may govern if located in floor
### Culvert Inspection and Ratings

#### Barrel - Ring

![Diagram of Barrel - Ring]

- **Design Shape**
- **Span**
- **Rise**

Deformed Shape

A = Roof Sag  
B1 + B2 = Sidewall Deflection  
c = Floor Bulge

### Culvert Inspection and Ratings

#### Barrel - Circumferential Seams

<table>
<thead>
<tr>
<th>Culvert Component</th>
<th>Last</th>
<th>Now</th>
<th>Explanation of Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Circumferential Seams</td>
</tr>
<tr>
<td>Separation (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Refers to seams joining individual rings or sections of culvert

- Found on most types of culverts
  - Bolted seams on SPCSP
  - Couplers on CSP or Riveted pipes
  - Joints in precast concrete
  - Construction joints in cast-in-place concrete

### Culvert Inspection and Ratings

#### Barrel - Circumferential Seams

- **Purpose**
  - Join rings  
  - Prevent infiltration of backfill

- Most common problems are separation caused by settlement or corrosion of couplers
  - Especially CSP and precast concrete (settlement)

- Potential for safety problem if void develops in fill

- **Look for:**
  - Separation
  - Loose or missing couplers (corrosion)
  - Bent or broken edges on the rings
  - Misalignment of rings
  - Infiltration of backfill
  - Voids in surrounding fill

- **Record width of worst separation.**

- **Gap but no soil infiltration - rate 4.**

- **Gap with minor soil infiltration - rate 3.**

- **Void from loss of material due to soil infiltration - rate 2.**

- **Severe loss of material due to soil infiltration - rate 1.**

- **Cracking from over torquing of bolts but no growth or problems – rate 5.**

- **Cracking due to roof sag rate 4 or less.**

- **May affect Roof, Sidewall or Floor rating if severe (2 or less).**
Barrel - Circumferential Seam Void Rated 2

Barrel - Circumferential Seam – Material Loss and Voids Rated 2

Barrel - Longitudinal Seams

- Applies to SPCSP and CSP riveted culverts
- All others, Rate "X"

Barrel - Longitudinal Seams

- Purpose
  - Join individual plates in ring
  - Transmit loads between plates
  - Approx. 75% bending strength of plates
- Indicate if all seams properly lapped by Yes or No
  - If No, provide comment
- Indicate if seams staggered by Yes or No
  - Within same arc only
  - At change of arc should not be staggered
  - If No provide comment
  - Most common problem is cracking
  - Especially on improperly lapped seams
Barrel - Longitudinal Seams

- Typical longitudinal seams

**INCORRECT LAP**

**CORRECT LAP**

Barrel - Longitudinal Seams

Cracked Seams

- Record and comment on number of rings with cracked seams
- Record and comment on number of rings with 2 or more cracked seams (may cause catastrophic failure)
- Record least remaining steel between cracks and record location in comments ("At R9")
- Mark and date ends of worst cracks – pencil is best
- Properly lapped seam has bolt in valley nearest visible edge of plate

Typical longitudinal seams

Cracked Seam

Barrel - Longitudinal Seams

Other Problems

- Poorly nested plates
  - Improper fabrication and/or poor assembly
- Cusping
  - Sharp break or discontinuity in curvature
  - Occurs most often at longitudinal seams
  - Improper fabrication, poor assembly/plate rotation during torqueing
  - Improper backfill
- Bolt tipping
  - High ring compression causing plate slippage and/or hole elongation
- Plate distortion
  - High ring compression, improper assembly and backfill
- Corrosion

**INCORRECT LAP**

**CORRECT LAP**
Barrel - Longitudinal Seams Rating

- Rate as per Table 13.3
- All seams properly lapped and no defects rate 9
- If seams are not properly lapped but in otherwise excellent condition - rate 7
- >100mm remaining steel between cracks rate 4
- 50 – 100mm remaining steel between cracks - rate 3
- <50mm remaining steel between cracks rate 2
- Two cracked seams in same Ring – rate 2
- Rating for longitudinal seams may also affect Roof, Sidewall and Floor ratings
- Rate riveted longitudinal seams in CSP

Barrel – Wrong Lap - Cracked Longitudinal Seam - <50mm Remaining Steel-Rated 2

Barrel – Cracked Longitudinal Seam and Wrong Lap

Barrel – Failed Longitudinal Seam
Barrel - Coating

- Applicable to steel culverts only
- Applies mainly to zinc or aluminized coating
  - Can include other types - bituminous
- Purpose is to protect the steel from corrosion
  - Zinc & aluminum protect by sacrificial action

- Corrosion can occur on soil or water side of culvert
- Soil side corrosion is generally visible above waterline and most common at seams
  - Can lead to perforations
  - Difference in backfill resistivity
  - Corrosive chemicals in backfill or water in fill
- Water side corrosion usually occurs in lower areas
  - Abrasion can remove protective coating
  - Water may have low pH or contain corrosive chemicals
  - Anaerobic bacteria may live in stagnant water

Barrel - Coating – Sidewall Perforations and Separation

- Look for:
  - Fabrication or installation defects or damage
  - Loss of coating - Corrosion
  - Rust stains from bolt holes or seams
  - Perforations
- Record if corrosion is on SOIL and/or WATER side – provide comment if Yes
- Rate according to Table 13.3
- Superficial corrosion no pitting – rate 5 or 6
- Corrosion with pitting in roof or sidewall rate 4
- Isolated perforations in roof or sidewall, extensive perforations in floor - rate 3
- Extensive perforations in roof or sidewall, severe perforations in floor - rate 2
- Severe perforations in roof or sidewall - rate 1
- Rating of Coating may affect other elements ratings
Barrel Coating – Floor
Severe Perforations

Barrel - Camber

- Refers to longitudinal gradeline of invert
- No rating is required
- If water line is level can be used to determine camber
- Record whether camber is **POSITIVE**, Zero (0), or **NEGATIVE**
- If significantly **POSITIVE** or **NEGATIVE** provide Explanation

Barrel – Fish Passage Adequacy

- No Camber
- Positive Camber
- Negative Camber
- Roof Sag
Culvert Inspection and Ratings

Barrel – Fish Passage Adequacy

• Refer to BIM Bulletin #5

• Inspector should assume ALL culverts are fish bearing even when dry, and rate accordingly

• Refers to ability of culvert to accommodate fish passage U/S and D/S

• May have fish baffles to:
  ➢ provide rest areas
  ➢ reduce velocities
  ➢ provide minimum water levels

Culvert Inspection and Ratings

Barrel - Fish Passage Adequacy

Fish Baffles

Types of baffles
  – Spoilers
    • Concrete or steel projections
  – Large boulders
  – Weirs
    • Extend fully across floor
    • May have notches
  – Bolted to floor to prevent displacement

Record type of baffle or NONE

Condition and functionality of baffles including anchorages
Culvert Inspection and Ratings

Barrel - Fish Passage Adequacy

• Look for:
  – Excessive velocities
    • Scour
    • Silt deposition downstream
  – Steep gradient in culvert
  – Drops at ends of culvert
  – Anything which could block flow or affect water levels
    • Dirt
    • Beaver dams

Fish Passage Adequacy-Bulletin #5

• Additional information is recorded for Fish Passage Adequacy for all W/C culvert sites.
• Multiple culvert sites - record for primary culvert only, or for the worst case culvert (from a fish passage perspective) when no obvious primary exists.
• Note if fish are observed in stream or in culvert
• Record information under the following:
  Debris Blockage:
  - If obstructed by debris record % of culvert diameter and the cause of obstruction.
  Substrate in Culvert:
  - Note if present and dominate type (sand, gravel, cobble, boulder, silt, other).
  - Est. and note % of length that contains substrate.

Fish Passage Adequacy-Bulletin #5

Backwater in Culvert:
- U/S extension of standing water outlet pool into the culvert (Flowing water is not backwater).
- Estimate and record how far up into the culvert (% of culvert length from the outlet).

Outlet Pool Depth:
- Record depth of the pool to the nearest cm at the outlet.
- Take measurement within one culvert diameter of the end of the culvert.
- If outlet pool depth is highly variable, take several measurements and record the average.

Barrel - Fish Passage Adequacy

• Fish Passage Adequacy rated according to Section 13.6.12 of the BIM Inspection Manual.
• Culverts used as Cattlepass, Ped. Underpass or Grade Separation Rate X unless also designed to handle flows

  - Rate whether flowing or dry

  - If in line with or below streambed rate 5 or more

  - U/S or D/S ends above streambed rate 4 or less
Culvert Inspection and Ratings

**Barrel - Waterway Adequacy**

<table>
<thead>
<tr>
<th>Waterway Adequacy</th>
<th>Last</th>
<th>New</th>
<th>Explanation of Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Icing (Y/N)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silting (Y/N)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drift (Y/N)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Refers to the ability of the culvert to safely pass the design flow
  - Maintain Freeboard
  - Pass drift without damage
  - No damage from backwater created

**Barrel - Waterway Adequacy**

- Adequately sized culvert may be affected by:
  - Ice build up
  - Silt deposition
  - Drift accumulation
  - Beaver dams
  - Ponding
  - Repair or rehabilitation work
    - Shotcrete beams
    - Struts

- Indicate presence of ice build up (icing) by Yes or No if Yes explain
  - Not normal freezing of ponded water
  - Results from active springs which freeze and causes layers of ice to build up
  - If previously Yes - leave and retain comments adding date of previous inspection

- Indicate presence of silt build up (Siltting) by Yes or No, if Yes explain
  - Invert normally below streambed
  - Minor accumulation of silt expected

- Indicate presence of drift in Barrel by Yes or No
  - If “yes”, explain

- Look for:
  - High water marks (not normal flow lines)
  - Potential damage from backwater
  - Potential for drift
  - Evidence of high velocities
    - Scour
    - Silt deposition downstream

- Presence and effect of items which can affect adequacy
**Barrel - Waterway Adequacy**

- Rate “X” if not a drainage culvert
- Adequate opening rate 5
- HWM above crown, 4 or less
- Culvert blockage 50% or more rate 3 or less

**Barrel - Waterway Adequacy - 50% Blockage**

- Governed by the following element ratings:
  - Roof
  - Sidewalls
  - Longitudinal seams
  - Circumferential seam rating of 2 or less
  - Corrosion rating of 2 or less
- Barrel not accessible - rate barrel elements “N”
- If previous Barrel General Rating was 4 or less then carry over previous General Rating rating and provide Explanation of Condition (“carried forward”)
- If previous Barrel General Rating was 5 or more rate current General Rating “N”
Effects of Struts on Barrel General Rating

• Inspector may increase General Rating by 1 or 2 points but not exceed rating of 4.
• Rating Conditions
  – struts in place more than 2 years
  – struts rated 5 or more
  – 1 permanent reference for monitoring
  – struts inspected after any significant event
  – consider culvert size and depth of cover (failure of large diameter culvert under high fill may not be as serious as under low fill)
  – does not apply when deflections >30% or cracked seams with less than 25mm remaining steel
  – applied to general rating only, element ratings remain unchanged

Questions??