CULVERT SIZING POLICY
Merril E. Dougherty, PE
Indiana Department of Transportation

The Goal for Policy is a Clear Understanding!

Suddenly, a heated exchange took place between the king and the most contractor.
Design Storm Frequency

INDOT Considers Four Criteria:

1. Downstream Channel Capacity
2. Backwater
3. Outlet Velocity
4. Roadway Serviceability

<table>
<thead>
<tr>
<th>Functional Classification</th>
<th>Allowable Backwater</th>
<th>Roadway Serviceability</th>
<th>Allowable Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeway</td>
<td>$Q_{30}$</td>
<td>$Q_{70}$</td>
<td>$Q_{50}$</td>
</tr>
<tr>
<td>Multilane Non-Freeways</td>
<td>$Q_{10}$</td>
<td>$Q_{10}$</td>
<td>$Q_{20}$</td>
</tr>
<tr>
<td>Two-Lane Facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AADT $\geq 3000$</td>
<td>$Q_{10}$</td>
<td>$Q_{20}$</td>
<td>$Q_{30}$</td>
</tr>
<tr>
<td>3000 $&gt; AADT \geq 1000$</td>
<td>$Q_{20}$</td>
<td>$Q_{25}$</td>
<td>$Q_{20}$</td>
</tr>
<tr>
<td>AADT $&lt; 1000$</td>
<td>$Q_{30}$</td>
<td>$Q_{20}$</td>
<td>$Q_{20}$</td>
</tr>
</tbody>
</table>

Note: The design storm frequency for culvert extension structures is identical to those for new culvert structures. Traffic volumes are for a 20-year projection.
Design Criteria

Downstream Channel Adequacy

Design Considerations:

• Check the stream for at least ¼ mile downstream
• Check the next three crossings, if within one mile
• Low lying structures within 300 feet upstream or ¼ mile downstream?
• Does the project add drainage area to the stream?
• Are overland flows concentrated?
• Is water brought to the stream more quickly than in the existing condition?

What to do if the Downstream Channel is inadequate?

First: Try to detain water!

But if not, perhaps improve the downstream channel...

In any case, contact INDOT Hydraulics!
Allowable Backwater
New Alignment

- 40mm Maximum Backwater
- Special Cases:
  - Backwater Dissipates 40mm or Less at R/W
  - Backwater is Contained in the Channel
    • Remember to Check Outlet Velocity!

Allowable Backwater
Replacing an Existing Culvert

- Match or Reduce Existing Backwater
- Exception:
  - Existing Backwater Exceeds 300mm
Allowable Backwater
Other Constraints

- Grade of Adjacent Driveways
- Finished Floor Elevation of Adjacent Buildings
- Elevation of Surrounding Crop Land

Jeff Foxworthy

You Might Be A Redneck If...

The flood history of your area can be seen on your living room walls.
Roadway Serviceability

- For a Q100 Design Storm
  - 0.6m Below Edge of Pavement

- For Design Storms Less Than Q100
  - Headwater Can Not Exceed Edge of Pavement

Maximum Outlet Velocity

- Revetment Riprap $\leq 2 \text{ m/s}$
- Class 1 Riprap $> 2 \text{ m/s} < 3 \text{ m/s}$
- Class 2 Riprap $\geq 3 \text{ m/s} \leq 4 \text{ m/s}$
- Energy Dissipator $> 4 \text{ m/s}$
  - See Chapter 34
Minimum Outlet Velocity

Typical Minimum Outlet Velocity
- 0.9 m/s

Do Not Consider Storage at the Culvert
Priority System

- Trial 1 - Single Circular Pipe
- Trial 2 - Single Deformed Pipe
- Trial 3 - Single Specialty Structure
- Trial 4 - Multiple Circular Pipes
- Trial 5 - Multiple Deformed Pipes
- Trial 6 - Multiple Specialty Structures

Pipe Culvert Interior Designation

- Smooth Interior - Manning’s n = 0.012
- Corrugated Interior - Manning’s n = 0.024
Minimum Culvert Size

<table>
<thead>
<tr>
<th>Structure Application</th>
<th>Minimum Circular Pipe Size</th>
<th>Minimum Deformed Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driveway Culvert</td>
<td>375 mm</td>
<td>0.10 m²</td>
</tr>
<tr>
<td>Mainline/Public Road Approach Culvert (2 lanes)</td>
<td>375 mm</td>
<td>0.10 m²</td>
</tr>
<tr>
<td>Mainline/Public Road Approach Culvert (3 + Lanes)</td>
<td>900 mm</td>
<td>0.60 m²</td>
</tr>
</tbody>
</table>

Culvert Extension Process

- Match Existing Culvert Size and Type
- Perform Appropriate Hydraulic Analysis
Approved Design Methods

- Computer Method
  - FHWA Program HY-8
- Hand Method
  - Nomographs From FHWA Publication HDS #5
    “Hydraulic Design of Highway Culverts”
  - Available as a Printed Manual and on CD ROM

Design Responsibility

- “Small Structure Replacement”
  - Consultant Will Furnish Plots and Documents
  - INDOT Hydraulics Will Size The Culvert
- All Other Types of Projects
  - Consultant Will Size the Culvert(s)
  - INDOT Hydraulics Will Review Computations
Where Do I Get More Information?

- INDOT Design Manual  
  Part IV  Hydrology and Hydraulics  
- FHWA Hydraulics Home Page  
  - Hydraulics Engineering Publication List  
  - Hydraulics Engineering Software Reference List  
  - www.fhwa.dot.gov/engineering/hydraulics

MAJOR MOVES!

- More Money Equals More Projects  
  - $150 Million Next Two Years for Local Transportation Projects  
  - INDOT Will Be Doubling the Current Construction Budget of $800 Million
- Proper Drainage is Essential  
  - Pavement Life  
  - Road Serviceability
Questions

www.fhwa.dot.gov/engineering/hydraulics