

CITY UTILITIES DESIGN STANDARDS MANUAL

**Book 2
Stormwater (SW)
SW8 Culverts**

June 2015

SW8.01 Purpose

A culvert is defined as a conduit for the conveyance of water under a roadway, railroad or other embankment. In addition to serving hydraulic functions, culverts must also carry overhead loads from traffic and other activities, thereby serving a structural function. Proper culvert design is essential because culverts often significantly influence upstream and downstream flood risks, floodplain management and public safety. The criteria presented in this Chapter shall be used in the design of culverts.

A culvert as distinguished from a bridge is usually covered with embankment and is composed of structural material around the entire perimeter although it can be supported on spread footings with the streambed serving as the bottom.

A bridge is a structure having an opening measured along the centerline of a roadway of more than 20 feet between faces of abutments or spring lines of arches. Multiple barrel box culverts or multiple pipe culverts having an opening of more than 20 feet between the limits of the extreme openings are sometimes classed as bridges. (*Bridge Inspection Manual Definitions*)

SW8.02 General Design

1. Federal Highway Administration

The design of culverts shall conform to the methodology described in the *Hydraulic Design of Highway Culverts* published by the U.S. Department of Transportation's Federal Highway Administration Publication No. FHWA-NHI-01-020, September 2001 (Revised May 2005 or current edition) Available online at <http://isddc.dot.gov/OLPFILES/FHWA/012545.pdf>

2. Indiana Department of Transportation

The *Indiana Department of Transportation Design Manual 2011* or current edition provides valuable culvert design information. The Design Manual is available online at <http://www.in.gov/dot/div/contracts/standards/dm>

SW8.03 Hydraulic Design

1. Design Program

The HY-8 program is the computerized implementation of FHWA culvert hydraulic approaches and protocols and shall be used for culvert design. Available online at <http://www.fhwa.dot.gov/engineering/hydraulics/software/hy8/>

2. Backwater

Culverts shall not increase backwater elevations on upstream properties. Backwater shall be contained within existing banks of the upstream open channel.

3. Overland Flow Routes

Emergency overland flow routes shall be checked to assure that backwater resulting from a potentially blocked culvert or intense storm does not flood or damage property. If an emergency overland flow route is not available, culvert flow capacity shall be increased. Sound engineering judgment shall be applied in determining the potential extent of backwater damage and the necessary increase in culvert flow capacity.

4. Minimum Diameter

The minimum diameter for culverts crossing a public roadway shall be 15 inches (15"). The minimum diameter for private driveway culverts within right-of-way shall be 12 inches (12").

5. Flow Velocity

Both minimum and maximum flow velocities should be considered when designing a culvert. A minimum velocity of 3.0 feet/second when the culvert is flowing partially full is recommended to ensure a self-cleaning condition during partial depth flow. The maximum velocity should not exceed culvert manufacturer recommendations. The maximum velocity should be consistent with channel stability requirements at the culvert outlet. The maximum allowable outlet velocity of culverts, which discharge to an earthen channel, shall be 6 feet/second. As outlet velocities increase, the need for channel stabilization at the culvert outlet increases. If velocities exceed permissible velocities for the various types of nonstructural outlet lining material available, the installation of structural energy dissipators are required.

SW8.04 Design Storm

1. Public Culverts

Publicly owned culverts crossing a roadway shall be designed to convey the peak flow resulting from a 100-year event. Driveway culverts within right-of-way shall convey the peak flow resulting from a 50-year event.

2. Private Culverts

Privately owned culverts located outside right-of-way and serving areas which do not require detention shall be designed to convey the peak flow resulting from a 50-year event and provisions shall be made to contain the runoff from a 100-year event. Lesser capacities may be considered provided that proper accommodations are provided for on-site storage of the 100-year event.

SW8.05 Sumped Culverts

Circular and elliptical pipes shall be installed with pipe inverts lower than adjacent channel flowline. Sound engineering judgment shall be applied to

determine the depth of sumping. Sumping increases the base flow capacity of circular and elliptical pipes, accommodates the future lowering of the channel, may increase the depth of pipe cover, and in environmentally sensitive areas allows for a natural stream bottom in the pipes.

SW8.06 Structural Design

1. Loading

All culverts crossing a roadway shall be designed to withstand a minimum HS-20-44 loading as defined by the American Association of State Highway and Transportation Officials (AASHTO). Culverts crossing a railroad shall be designed to withstand an E-80 loading.

2. Installation Depth

Refer to manufacturer specifications or recommendations for installation depth requirements.

Minimum pipe diameters, classes and cover requirements are listed in [Chapter MA5 –Stormwater Materials and Testing Requirements](#).

3. Bedding and Backfill

Backfill classifications, materials, and methods of compaction shall be in accordance with City Utilities standards for projects inside of the City limits and in accordance with County Highway standards outside the City limits unless special circumstances warrant otherwise.

Bedding and Backfill standard details are located in [Chapter CADD8 – Standard Drawings and Details](#).

4. Floatation and Anchoring

Pipe floatation can occur when the uplift (buoyancy) forces outside the pipe are greater than the downward weight forces on the pipe. This uplift force can be great enough to cause the pipe to bend and dislodge from the embankment. Large diameter, flexible material culverts are more vulnerable to floatation. Anchoring may be achieved using concrete end sections, ties to a concrete footer, or other similar means.

SW8.07 Culvert Length Determination

Culvert length design shall consider embankment width, installation depth and embankment slopes. Culvert length shall be designed to comply with [Chapter SW10 – Crossing](#).

SW8.08 Inlet and Outlet Configuration

All culverts, public and private, shall have end treatments such as prefabricated end sections, wingwalls and aprons, or headwalls at the inlet and the outlet. The design of end treatments shall consider public safety and erosion control.

1. Roadside Safety

Roadside ditch culverts for commercial and residential drives shall have sloped prefabricated end sections. Headwalls and wingwalls are not permitted.

2. Trash Racks

Trash racks should be considered for inlet culvert end treatment where inlet clogging or downstream trash pollution is anticipated due to upstream land use activities. In general, trash racks shall not be used on culvert outlets. However, trash racks may be warranted on outlets in areas where public safety is a concern.

3. Erosion Control

Channel stabilization and erosion control measures shall be utilized at the inlet and outlet of a culvert.

SW8.09 Environmental Considerations

In channels with a base flow or normal pool, migration of aquatic species should be considered. Culverts should be sumped to maintain a base flow depth through the culvert equal to or greater than the adjacent channel base flow depth. Bottomless culverts may be considered to maintain a natural stream bottom.

Where fish migration is a concern, contact the Indiana Department of Natural Resources (IDNR), Division of Fish and Wildlife for culvert design assistance.

SW8.10 Permitting

Culvert installation may require approval and/or permitting from federal, state, or local agencies. Early coordination regarding permitting and approval is recommended. Each public agency may have design criteria which must be complied with for permitting.

1. Public Agencies

- City of Fort Wayne Street Engineering Department for work within City street or road right-of-way.
- Indiana Department of Transportation, Fort Wayne District for work within State, Federal, or Interstate Highway rights-of-way.
- Allen County Highway Department for work within County road right-of-way.
- Fort Wayne Parks and Recreation Department for work affecting the River Greenway or trail and bicycle system.
- Allen County Surveyor's Office for work affecting Allen County regulated drains or mutual drains.
- Allen County Department of Planning Services (DPS) for work within a flood zone.
- Indiana Department of Natural resources (IDNR) for:

- Early coordination for projects affecting stream channels or wetlands.
 - Stream crossings.
 - Work within a floodway or flood plain.
 - All culverts and bridges, public or private, with a drainage area equal to or greater than 1 square mile.
- Indiana Department of Environmental Management (IDEM) for Early Coordination for projects affecting stream channels, including regulated drains.
 - United States Army Corps of Engineers (USACE) for Early Coordination for projects affecting wetlands or stream channels including regulated drains.

After Early Coordination is submitted to IDNR, IDEM and USACE (It is advisable to copy affected local public agencies) a field check is scheduled. On the field check IDNR, IDEM and USACE will determine which agency/agencies have jurisdiction and what permitting will be required.

SW8.11 Culvert Materials

Culvert materials must be in accordance with [Chapter MA5 - Stormwater Materials and Testing Requirements](#).