MICHIGAN DESIGN MANUAL
ROAD DESIGN

CHAPTER 4

INDEX

DRAINAGE

CHAPTER 4 DRAINAGE INDEX (continued)

MICHIGAN DESIGN MANUAL
ROAD DESIGN

Supplement to Chapter 4

Sections in MDOT Drainage Manual

The following list includes sections moved from the Road Design Manual to sections within the MDOT Drainage Manual. Some topics listed, remain in the Road Design Manual but are supplemented by discussions in the MDOT Drainage Manual.

TOPIC	LOCATION IN MDOT DRAINAGE MANUAL
GENERAL INFORMATION	Chapter 2 – Legal Policy and Procedures
Glossary	Glossary
General Procedures	Section 2.5.1
Legal Precedent to Discharge Surface Water	Section 2.5.2
Types of Right-of-Way Easements or Conveyance for Drainage	Section 2.5.3
Drainage Considerations	Section 2.5.4
Drainage Conditions and Participation with Local Agencies/Private Entities	Section 2.5.4.1
Participation Agreements & Costs	Section 2.5.4.2
Intracounty and Intercounty Drainage Systems for State Trunkline Storm Water	Section 2.5.5
Relocation of Existing Drainage Course	Section 2.5.6
Relocation of Field Tile Drains	Section 2.5.7
Design Procedures for Unknown Field Tile Locations	Section 2.5.8
STORM SEWER DESIGN	Chapter 7 – Road Storm Drainage Systems
General	Sections 7.1, 7.3.9, and 7.4.8.3
Storm Sewer Design Criteria and Procedure	
Roadways with Enclosed Drainage	Section 7.4.1
Depressed Roadways	Section 7.4.2
Design Velocity	Section 7.4.8.4
Hydraulic Grade Line	Sections 7.2, 7.4.9.1, and 7.4.8.4
Rational Method	Sections 7.4.9.7, 3.4.3, 3.4.1.4, and Table 3-1
Rainfall-Frequency Zones	Appendix 3-B
Rainfall-Intensity-Duration Tables	Appendix 3-B
Solving Manning's Formula	Section 7.4.8.2 and Table 7-5

TOPIC	LOCATION IN MDOT DRAINAGE MANUAL
Design Factors for Storm Sewers	Section 7.3.2
Steps in the Design of Storm Sewers using Rational Method	Sections 7.4.9.7 and 7.4.8.2
Tabulation Sheet for Computing Storm Sewers	Table 7-9
Hydraulic Elements of Channel Sections Chart	Section 7.4.8.2
Factors in Locating Catch Basins or Inlets	Section 7.4.5
Factors in Locating Manholes	Section 7.4.7.1
Numbering Drainage Structures	Section 7.4.7.3
Access Manholes to Storm Sewers	Section 7.4.7.2
Types	Section 7.4.7.2
Considerations	Section 7.4.7.3
Measurement and Payment	Section 7.4.7.3
Storm Sewer Pipe Classification and Usage Guidelines	Section 7.4.8.1
Jacked-in-Place Sewers	Section 7.4.8.1
Storm Sewer Soil Borings	Section 7.4.8.1
Storm Sewer Pipe - Curved	Section 7.4.8.5
DRAINAGE OUTLETS	Chapter 2 – Legal Policy and Procedures Chapter 8 – Stormwater Storage Facilities Chapter 9 – Stormwater Best Management Practices (BMP)
Acceptable Drainage Outlets	Sections 8.1.1 and 2.2.1
Unacceptable Drainage Outlets	Section 8.1.1
Retention/Detention Systems	Section 8.3.1
Design Guidelines to Reduce Impacts of Nonpoint Source Pollution on Receiving Waters	Sections 8.3.2 and 9.3.3
Detention Basins	Section 8.4.1
Infiltration Systems	Section 8.4.4
Storm Water Runoff Detention Basin Design Guides	Section 8.4.1
Design Considerations	Section 8.4.1.1
Design Procedures	Section 8.4.3
DITCHES	Chapter 4 – Natural Channels and Roadside Ditches
Roadway Drainage Ditches	Sections 4.4.3.2.1 and 4.4.3.2.3
Standard Ditches	Section 4.4.3.2.2

TOPIC	LOCATION IN MDOT DRAINAGE MANUAL
Round Bottom Ditch	Section 4.4.3.2.2
Berm or Swamp Ditch	Section 4.4.3.2.2
Independent Ditches	Section 4.4.3.2.2
Toe of Slope Ditch	Section 4.4.3.2.2
Valley and No-Ditch Sections	Section 4.4.3.2.2
DESIGN CRITERIA FOR ROADWAY CULVERTS	Chapter 3 – Hydrology Chapter 5 – Culverts
MDOT and FHWA Requirements	Section 5.3.2
Roadway Culvert Size Determination	Sections 5.3.3 and 5.3.4
Culvert Pipe Class Designations	Section 5.3.2.1
Culvert Usage Guidelines	Section 5.3.2.2
Permit Requirements for Roadway Culverts	Section 5.3.3
Culvert Drainage Areas Equal to or Greater Than Two Square Miles	Section 5.3.4
Culvert Drainage Areas Under Two Square Miles	Section 5.3.4
Determining Culvert Sizes	Section 5.3.4
Estimating Peak Flows for Culverts	Section 5.3.4
MDEGLE’s Soil Conservation Service (SCS) Method	Section 3.4.4 and Appendix 3C
The Rational Method for Estimating Peak Flows for Culverts	Section 3.4.1
Hydraulic Analysis Data and Soil Borings on Plans	Appendix 6-B
Culvert Extensions and Replacements	Section 5.3.6
Hydraulic Analysis Requirements	Section 5.3.4
Reinforced Circular Concrete Pipe Extensions	Section 5.3.6
Extending Existing Box and Slab Culverts	Section 5.3.6
Bedding and Filling Around Pipe Culverts	Section 5.3.7
Corrugated Structural Plate Pipe and Pipe Arches	Section 5.3.4
End Treatment for Culverts	Section 5.3.5
Culvert Sloped End Sections	Section 5.3.5.1
Guidelines for Usage	Section 5.3.5 and Table 5-1
C.S.P. to Concrete Culvert Adapter	Section 5.3.6
Outlet Headwalls	Section 5.3.5.1
Downspout Headers	Section 5.3.5.1
Concrete Slab Culverts	Section 5.3.5.2
Lining of Culverts	Section 5.5.3

CHAPTER 4

DRAINAGE

4.01

GENERAL INFORMATION

4.01.01 (revised 4-22-2019)

References

A. ***Computing Flood Discharges for Small Ungaged Watersheds***, MDEGLE, (rev. 2008)

B. ***Concrete Pipe Design Manual***, American Concrete Pipe Association, (June 2000)

C. ***Concrete Pipe Handbook***, American Concrete Pipe Association, (January 1988)

D. ***Hydrology,*** Section 4, National Engineering Handbook, Soil Conservation Service

E. ***MDOT Drainage Manual,*** Current Edition

4.01.03 (revised 8-26-2019)

General Procedures

See Drainage Manual Section 2.5.1.

At the time the line and grade of new roadways (including pathways and sidewalks) or the extent and limits of a widening or reconstruction project are determined, a careful engineering study and design must be made concurrently for surface and subsurface drainage. Highway drainage design involves two basic operations: estimating peak flows of runoff and designing a conveyance system.

Detailed hydrologic and hydraulic design guidelines are presented in the ***MDOT Drainage Manual***. For specific information contact the Design Engineer - Hydraulics.

4.02

STORM SEWER DESIGN

4.02.15 (revised 7-10-2006)

Sewer Bulkheads

Only sewer bulkheads larger than 12" in diameter will be measured for payment. The cost of placing sewer bulkheads 12" in diameter and less will not be paid for separately but payment for the work will be considered as having been included in the contract unit prices bid for other contract items. The sewer bulkhead location should be shown on the plans

4.02.18 (revised 11-28-2011)

Storm Sewer Under Structures

Storm sewers within the stress influence of the footings shall be protected by concrete encasement or other approved methods. If the designer has any question about which the stress influence lines in a particular structure, he should contact the Geotechnical Services Unit of Construction Field Services Division.

4.02.20 (revised 4-20-2015)

Jacked-in-Place Sewers

See Drainage Manual Section 7.4.8.1.

At times it may be necessary to install sewer pipe by jacking or tunneling methods. A sewer installed by jacking or tunneling may be considered a special design, therefore a request to determine the design of the pipe should be made to the Design Engineer - Municipal Utilities. However, some general jacking information for designers is listed below.

1. The smallest practical pipe size that can be jacked is 36" in diameter. However, a smaller size pipe may be inserted inside a jacked casing and the void outside the sewer filled with a flowable fill.

2. Concrete pipe is to be specified when jacking a storm sewer.

3. If circumstances require jacking a pipe smaller than 36", a C76 Wall Class 5 pipe shall be specified.

4. Jacking a storm sewer will normally be more economical than an open trench installation when either the fill height exceeds approximately 16' or maintaining traffic is beneficial. The situation should be reviewed at The Plan Review Meeting and a recommendation provided to the designer.

5. Jacking will usually continue on a 24-hour-per-day operation due to the pipe's tendency to set up if the jacking operation is interrupted for more than a few hours

6. Jacking is usually done from the low side up grade to allow water to drain out during the jacking operation. However, it may also be done by jacking down grade, which allows for better control of the pipe grade due to the weight of the pipe.

4.02.20 (continued)

Jacked-in-Place Sewers

7. Pipe that is being jacked is subjected to vertical loads from the weight of earth and horizontal loads from the jacking pressure. The resultant vertical earth load on a horizontal plane at the top of the bore is a function of the weight of earth above the bore minus the upward friction forces, minus the cohesion of the soil along the limits of the prism above the bore.

   a. The vertical load from the weight of earth and possible live load will determine the class of pipe to be specified.

   b. The cross-sectional area of the concrete pipe is adequate to resist axial compression from jacking, and unless unusual circumstances exist, little or no gain is accomplished in increasing crushing resistance by specifying a higher class of concrete pipe than required for vertical loads.

   c. Soil borings are required when storm or culvert pipe is installed by jacking or tunneling. Contact, coordination, and follow up with the Region/TSC Soils Engineer as described in the following section is important in reducing potential risks to the operation.

4.02.21 (revised 11-28-2011)

Storm Sewer Soil Borings

The plans and specifications do not automatically provide for the additional work required to install sewers through areas of unstable soils. Therefore, soil borings must be obtained and shown on the plans to identify where remedial treatment is necessary. Corrective treatment usually means undercutting and backfilling. Also, in areas having a high water table, a well point system may sometimes be considered. The designer should use the following procedures.

4.02.21 (continued)

1. The need for soil borings should be discussed at the scope verification meeting. The Project Manager should provide the Region/TSC Soils Engineer with any necessary information for locating proposed sewer lines. The Region/TSC Soils Engineer will then provide the Project Manager with pertinent soils data and recommendations.

2. Follow up requests to be sure soil borings are received. The complete boring data shall be made part of the plans and proposal. The data report will include the log of borings, the complete shear report, the weight and moisture report, as well as a plot of the shear strength. The report by the Geotechnical Services Unit, Construction Field Services Division can be reproduced on a plan sheet.

3. When unstable soils are encountered, the Designer and the Geotechnical Services Unit, Construction Field Service Division engineers should confer to determine the best method of correction.

4. Estimated quantities for the correction should be included in the plans.

5. Where unstable soil conditions, or obstructions other than rock, require excavation of the sewer trench below the elevation shown on the plans, such excavation shall be made to the dimensions authorized by the Engineer. The pay item "Trench Undercut and Backfill" is used to pay for this excavating and backfilling of the trench with a specified aggregate up to the bottom of the trench elevation on the plans. Many jobs will include short runs of relatively shallow depth sewers where undercutting is unnecessary, therefore, the designer will have to make some judgement when requesting soil borings.

4.02.22 (revised 7-10-2006)

Storm Sewer Pipe - Curved

See Drainage Manual Section 7.4.8.5.

Curved pipe, if necessary, needs to be reviewed and approved by the Design Engineer - Municipal Utilities.

4.03

DRAINAGE OUTFALLS

4.03.04 (revised 4-28-2025)

Design Guidelines to Reduce Impacts of Nonpoint Source Pollution on Receiving Waters

See the MDOT Drainage Manual and MDOT Stormwater Treatment Manual for additional information and requirements.

MDOT is regulated and permitted as a municipal separate storm sewer system (MS4) under the National Pollutant Discharge Elimination System (NPDES) program. The permit requires inclusion of stormwater control measures (SCMs) that provide water quality treatment and volume control to address the long-term impacts of stormwater discharges from state highways to waters of the state. As such, any project that meets the following criteria requires SCMs:

- Has an acre or more earth disturbance, discharges to a water of the state, and modifies the drainage system

Or

- Falls within a watershed with an established total maximum daily load (TMDL) for a pollutant

4.03.04 (continued)

Volume control SCMs are required when the above conditions are met and the project increases imperviousness, either by the addition of new pavement or the conversion of land to a more impervious condition. Some receiving waterbodies are exempt from volume control requirements. See the Stormwater Treatment Manual for additional information.

Site constraints may preclude the inclusion of SCMs on a project. In these cases, the project must follow the maximum extent practicable (MEP) process that documents what treatment was provided and why the total treatment is less than what is required by the MS4 permit. Use Form 2650 when proceeding with the MEP process. Additionally, the Designer must work with the Environmental Services Section to obtain environmental clearance on stormwater as part of the projects NEPA review.

The following general guidelines for controlling stormwater runoff are applicable to virtually all highway situations. There are many drainage design practices that have significant potential for reducing pollutant loads from highway stormwater runoff. The principal concepts to be considered when designing highway systems include:

4.03.04 (continued)

Design Guidelines to Reduce Impacts of Nonpoint Source Pollution on Receiving Waters

1. ***Eliminate direct discharges*** – Prioritize eliminating direct discharges of untreated highway stormwater runoff to receiving waters (including groundwater). Route highway stormwater runoff through one or a combination of SCMs including: vegetated ditches, detention basins, infiltration systems, or hydrodynamic separators prior to discharge to receiving waters.

   Eliminate drains along bridge decks over water and unstabilized soil.

2. ***Keep runoff velocity at a non-erosive level*** - Reduce the runoff velocity to a non-erosive level to decrease the transport of sediment. The methods for reducing the runoff velocity include reducing gradients, installing velocity reduction devices (such as: permanent check dams, drop structures, baffles, basins and diversions), and by using vegetative controls (vegetated ditches and swales).

3. ***Maintain existing discharge rates and volumes*** – Projects that add imperviousness, by adding lanes, paving shoulders, or change drainage routing can increase the rate of stormwater runoff or the discharge volume to the receiving waterbody. Include SCMs to maintain the existing (pre-project) discharge rate and volume over a range of flows to the MEP. Applicable SCMs include detention and infiltration basins. Permanent check dams may be used when there is only a small increase in the discharge rate or volume.

4.03.04 (continued)

4. ***Meet MS4 treatment criteria*** – Projects that disturb more than 1 acre, have a discharge to a water of the state, and work is being done on the drainage system are required to provide post construction SCMs to treat the long-term stormwater runoff impacts of the project on water quality and water quantity. Projects may use the established MEP process when site constraints preclude the inclusion of SCMs. See the Stormwater Treatment Manual for additional information on how project type affects water quality and channel protection treatment requirements as well as information on the MEP process.

5. ***Label outfalls*** – Follow the provisions in the Standard Specifications for Construction and label all MDOT stormwater outfalls with a direct discharge to a water of the state. Any new, not reconstructed, outfalls included as part of the project must be authorized by MDEGLE. Contact the Stormwater Program Manager for assistance.

Sediment is transported along the pavement, curbs, and shoulders as suspended solids. The following water quality treatment SCMs are intended to reduce the volume of suspended solids available for transport by runoff.

4.03.04 (continued)

Design Guidelines to Reduce Impacts of Nonpoint Source Pollution on Receiving Waters

A. Vegetative Controls

Vegetative controls that include grassed channels,, filter strips, and shallow overland flow, work by reducing the velocity of the surface flow or channel flow allowing sediment and suspended solids to settle out. Since sediments can contain attached pollutants, these pollutants may be reduced prior to entering the receiving waterbody if the velocity of runoff is slowed over an adequate length of vegetation.

Vegetated controls can be applied wherever suitable land area is available. Vegetative controls are adaptable to a variety of site conditions, are flexible in design and layout, and are the least costly management procedure. Vegetative controls can be used as sole management measures or in conjunction with other measures.

Maximize the use of vegetative controls where possible. A vegetated ditch with a length of at least 200 feet' has been shown to be very effective in removing suspended sediment. Sediment removal may be increased on vegetated ditches that are less than 200 feet in length by adding permanent check dams. Sediment removal using vegetative control is consistently effective.

4.03.04 (continued)

B. Storage Basins

Storage basins are constructed to either temporarily store stormwater runoff and release it at a rate consistent with conditions prior to construction (detention basin) or remove the stored water from the system (infiltration basins). Storage basins provide volume control and water quality treatment.

Detention basins are utilized in areas where:

1. suitable depressions occur or can be constructed, and where acceptable inflow and outflow conditions can be achieved.

2. soils are able to provide a stable embankment;

3. storage to detain the runoff volume from a specified storm event of the contributing drainage area is available.

Infiltration basins are utilized in areas where:

1. soil/subsoils have acceptable permeability. Review criteria in the Geotechnical Manual and contact the Region/TSC Soils Engineer for assistance for obtaining a percolation test and soil gradation.

2. the seasonal high groundwater table is the appropriate depth below the bottom of the basin. See the Drainage Manual and Stormwater Treatment Manual for additional guidance.

3. pretreatment will be used to minimize the amount of sediment entering the basin.

4. there is sufficient storage for the runoff volume to be stored and drained from the basin within the acceptable draw down time.

4.03.04B (continued)

Design Guidelines to Reduce Impacts of Nonpoint Source Pollution on Receiving Waters

C. Catch Basin Sumps

Catch basins are a main point of stormwater entry into enclosed storm sewer systems. Catch basins with sumps, as shown in Standard Plan R-1 series, allow for collection of coarse sediments and space for some suspended solids to settle out before reaching the outfall. They are primarily used on enclosed systems and provide a small amount of sediment removal. In heavily urbanized corridors, they may be the only opportunity for water quality treatment.

Catch basin sumps need frequent maintenance to remove accumulated sediments. Failure to maintain the sumps will result in sediment resuspension and impacts to receiving waterbodies

4.03.04C (continued)

D. Hydrodynamic Separators

A hydrodynamic separator (HDS) is a proprietary manufactured treatment device that creates a vortex within the unit to separate suspended solids from stormwater. They are typically used in urban areas where opportunities for vegetated stormwater treatment are limited.

Flow rates through HDSs are limited by the manufacturers to obtain the required sediment removal, typically 80%, so these devices must include a bypass piping configuration to allow flows higher than the treatment flow to bypass the system. See the Stormwater Treatment Manual for more information.

HDSs need frequent maintenance to remove accumulated sediments. Failure to maintain a HDS will result in sediment resuspension and impacts to receiving waterbodies.

4.05

DESIGN CRITERIA FOR ROADWAY CULVERTS

4.05.02 (revised 7-10-2006)

Culvert Pay Lengths

Concrete pipe 24" diameter and above is available in commercial lengths of 8'. When installing new culverts or extending existing culverts, the length quantities should be based on available commercial lengths.

4.05.08 (revised 4-22-2019)

Estimating Peak Flows for Culverts

The hydrologic analysis required for culverts can use either the method described in the Michigan Department of Environment, Great Lakes and Energy paper entitled ***Computing Flood Discharges For Small Ungaged Watersheds***, (Drainage Manual Appendix 3-C) referred to as the MDEGLE SCS Method, or the Rational Method. All cross culverts must be designed for the 50-year flow and checked against the 100-year flood flow.

A. MDEGLE's **Soil Conservation Service (SCS) Method**

Reference Drainage Manual Section 3.4.4 and Appendix 3-C.

The MDEGLE SCS Method is based on Section 4, ***Hydrology***, from the SCS National Engineering Handbook. It is an acceptable method to be used for drainage areas of less than 20 square miles. Assistance on determining estimated peak flows can be obtained from the Design Engineer - Hydraulics.

B. The Rational Method for Estimating Peak Flows for Culverts

Reference Drainage Manual Section 3.4.1 and Table 3-1.

If the area is less than 20 acres and the flow to the culvert crossing is low or intermittent, the more simplified Rational Method may be used for design.

4.05.10 (revised 6-27-2022)

Hydraulic Analysis Data and Soil Borings on Plans

See Drainage Manual Appendix 6-B.

If either the size or location of the culvert are changed, the Road Design Unit must obtain new approval from the Design Engineer - Hydraulics. A plan sheet should be included in all projects showing the project drainage (see Section 1.02.04). All drainage structures should be accompanied by a tabulation of drainage data shown on the Drainage Map. For culverts, the tabular form illustrated below is required and can be obtained from the Design Engineer – Hydraulics. The tabulation must include the design flood frequency discharge and the drainage area.

Soil borings must be requested from the Geotechnical Services Unit for any new or extended culverts that have the following sizes **or equivalent area:**

a. Pipe culverts equal to or greater than 60” diameter

b. Box and slab culverts equal to or greater than 4’ x 4’

For culverts smaller than these sizes, the soil borings must be requested from the Region/TSC Soils and Materials Engineer (see Section 14.25). All soil borings and related information must be shown on the plans.

See section 8.05F of the Bridge Design Manual for bridge hydraulic analysis table and scour analysis table.

4.05.10 (continued)

CULVERT TABLES

LOCATION	
STRUCTURE NUMBER	
CONTROL SECTION	
JOB NUMBER	
LOCATION	
WATERCOURSE	
TOWNSHIP	
COUNTY	
DISCHARGE	
10-YEAR	
50–YEAR	
100-YEAR	
ADDITIONAL INFORMATION	
DRAINAGE AREA	
METHOD OF ANALYSIS	

Stream: **County:**	**EXISTING (ft)**	**PROPOSED (ft)**	**CHANGE**
CULVERT TYPE			
SPAN			
RISE			
LENGTH			
ENTRANCE TYPE			
U/S INVERT ELEV			
D/S INVERT ELEV			
U/S FLOWLINE			
D/S FLOWLINE			
K_e:			
50-YEAR			
VELOCITY AT OUTLET			
HEADWATER			
100-YEAR			
VELOCITY AT OUTLET			
HEADWATER			
50-YR AND 100-YEAR FLOOD ELEVATIONS ARE FOR COMPARISON ONLY			
Note:			

4.05.12 (revised 7-10-2006)

Bedding and Filling Around Pipe Culverts

Reference Drainage Manual Section 5.3.7.

The bedding and filling around pipe culverts is done according to Standard Plan R-82-Series upon which the Culvert Class-Depth-Usage Table is based. This type of installation is referred to as a "Positive Projecting Embankment Conduit" for a concrete pipe. The following information describes other types of installations for concrete pipe. However, when special designs or installations are required, a design request should be made to the Bridge Design Section.

A. Trench Installation

When the culvert pipe is placed in a narrow trench and covered with earth, the backfill will tend to settle downward. This downward movement or tendency for movement of the backfill within the trench above the conduit is retarded by frictional forces along the sides of the trench that act upward and help support the backfill. As this type of installation applies normally to a sewer-type installation and our standard plans and specifications do not restrict the trench width for a culvert, this type of installation is not normally considered in design.

B. Positive Projecting Conduits

Positive projecting pipes are installed in shallow bedding with the top of the conduit projecting above the surface of the natural ground or compacted fill at the time of installation and then covered with earth fill. Culverts placed in wide trenches also are included with this classification. This classification is the basis for our Standard Plan R-82-Series.

4.05.12 (continued)

C. Negative Projecting Embankment Conduit

Negative projecting embankment culvert pipes are installed in relatively shallow trenches of such depth that the top of the pipe is below the level of the natural ground surface or compacted fill at the time of installation and then covered by earth fill, the height of fill being greater than the depth of trench. As with a trench installation, the load on the pipe is reduced by frictional forces along the sides of the trench. This may reduce the ASTM class of concrete pipe required; however, a request to Bridge Design for a design will be required before reducing pipe class.

D. Induced Trench Conduit

The induced or imperfect trench installation is used when it is necessary to relieve or reduce the load on a concrete pipe under a high fill. The culvert is initially installed as a positive projecting pipe. When the embankment fill has been placed to an elevation of two to three times the diameter of the culvert above natural ground, a trench is excavated over the culvert and backfilled with compressible material simulating a negative projecting installation. As this is a special design, the design and details for this type of construction are to be requested from Bridge Design.

4.05.19 (revised 4-26-2021)

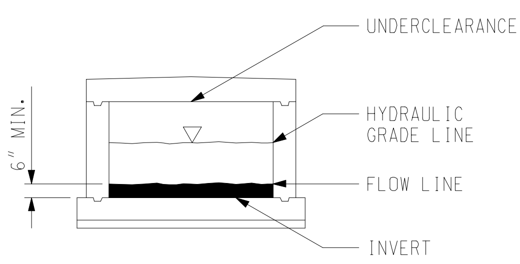
Precast Concrete Box Culverts

Precast box culverts are available in numerous sizes state-wide. The designer should contact a local supplier to verify that a particular size is available. The supplier, in some instances, may be willing to furnish a larger size if his available forms do not match the required size. Precast box culverts offer the advantage of rapid installation and are competitively priced with cast-in-place box culverts for new construction or culvert extensions.

Precast concrete box culverts are called for by size, as specified in the ***Standard Specifications for Construction***. It should be noted on the plans that the box culvert shall meet the specified AASHTO and ASTM requirements for HS25 loading. If the culvert is located under a railroad crossing, consult the Railroad Grade Separations Engineer of the Railroad Coordination Unit – Office of Rail and specify American Railway Engineering and Maintenance of Way Association (AREMA) Loading. When the culvert requires headwalls, details must be obtained from the Bureau of Bridges & Structures, Structure Design Section, Special Structures Unit.

When extending box culverts, adhesive anchored bolts shall be used to tie the new construction to the existing.

The invert of a box culvert is to be set 6" below the normal flow line. This elevation is to be referred to as the invert elevation on the details to avoid confusion with the flow line of the waterway that appears on the profile.



4.05.20 (revised 7-10-2006)

Lining Culverts

Reference Drainage Manual Section 5.5.3.

When a culvert has structural deterioration, it may be possible to line the culvert instead of replacing it. Caution must be used by the designer and a hydraulic analysis should be done to determine the potential hydraulic impacts of inserting the liner. The analysis should cover the range of flows passed by the culvert.

Lining may be in the form of inserting plastic pipe and grouting the annulus or insertion of a resin-impregnated flexible liner. Installation is covered by appropriate Special Provision, e.g. "In Place Culvert Rehabilitation, Liner." The installation of a liner may be allowed for the following conditions:

1. The culvert is a cross culvert that acts as an equalizer between two bodies of water (e.g. between two wetlands).
2. A driveway culvert that is only carrying ditch flow generated from MDOT ROW. For the range of design flows, the water surface elevation upstream of the culvert is contained within the ROW.
3. The culvert is a CMP that will not experience inlet control over the range of design flows.

Any questions regarding the hydraulic analysis or potential impacts should be directed to the Design Engineer – Hydraulics.

4.05.21 (revised 4-26-2021)

Drainage Marker Posts

Drainage marker posts are installed to help maintenance personnel locate end sections or headwalls of transverse culverts 36" diameter or less and on all underdrain outlet endings. Drainage marker posts are to be placed outside the shoulder hinge lines and should not be used in medians except on spread roadways (medians 150' wide or greater). Drainage marker posts shall be at least 6' long and shall conform to the delineator or steel line posts that are specified in the current standard specifications.

4.06

UNDERDRAINS

4.06.01 (revised 9-23-2024)

Purpose of Underdrains

Current methods of installing underdrains are shown on Standard Plan R-80-Series. In order to protect a roadway surface from early deterioration, a stable base must be built for the roadway. Water in subbase materials weakens the foundation soils, therefore a good roadway requires good drainage. Underdrains intercept and remove seepage from the subbase, eliminating springy or bad subsoil conditions. Underdrains are used on both enclosed and daylighted drainage systems.

The various underdrains either capture and drain the water trapped below the pavement surface or intercept seepage water before it enters the space below the pavement and then convey the seepage to either an outlet ditch or a storm sewer system.

Where underdrain is required to facilitate drainage, there should be a minimum of two underdrains per roadway located per Standard Plan R-80-Series and not under wheel loads. Additional underdrains should be placed to ensure lateral spacing does not exceed 30 feet center-to-center.

4.06.02

Bank Underdrains

Bank underdrains are sometimes placed in the back slopes to intercept seepage planes before they reach the roadway to minimize erosion or sloughing. Two basic methods of installing bank underdrains are shown on the standard plan. One method backfills the trench with a granular material and wraps the underdrain pipe with a geotextile. The other method envelopes both the open-graded material and the underdrain pipe by lining the trench with a geotextile.

4.06.03

Subgrade and Subbase Underdrains

Subgrade underdrains are meant to drain both the subbase and subgrade under the pavement. Currently, two methods of constructing subgrade underdrains are shown on the standard plan. One method lines the trench with a geotextile that envelopes both the open-graded material and the underdrain pipe. The other method uses granular material and wraps the underdrain pipe with a geotextile.

The subbase underdrain is meant to drain only the subbase. The flow line of the underdrain is normally a maximum of 10” below the top of the subgrade. The underdrain pipe is wrapped with a geotextile.

4.06.04 (revised 3-8-99)

Open-Graded Underdrains

Four methods of installing open-graded underdrains are shown on the standard plan. All four have an open-graded material immediately below the pavement surfacing. Their purpose is to drain quickly any water that enters through joints or cracks in the pavement and to minimize the amount of water entering the subbase material. Two of the methods use underdrain pipe and two use the Prefabricated Drainage System (PDS).

4.06.05

Underdrain Outlets & Outlet Endings

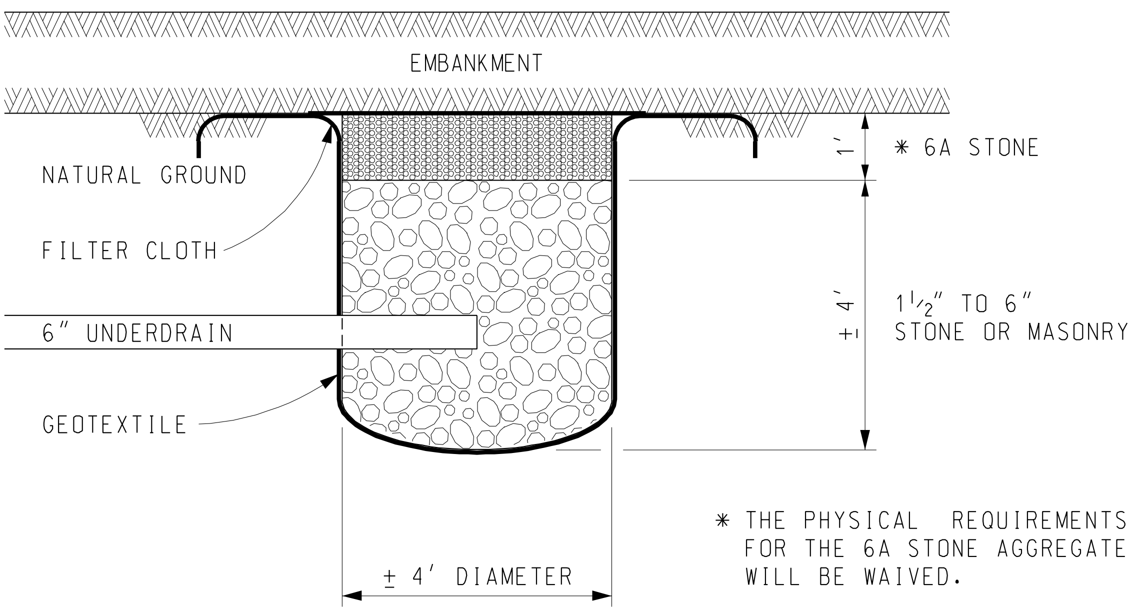
Underdrain outlets are used to connect underdrains to the outlet endings. To resist crushing from heavy construction and maintenance vehicles and to insure positive flow, rigid PVC or corrugated steel pipe shall be used for underdrain outlets.

Currently three approved outlet endings are shown on Standard Plan R-80-Series. Other designs may be used when approved by the Engineer.

4.06.06 (revised 3-8-99)

Stone Baskets

Stone baskets are used to drain springs that occur below the roadway. The stone basket is constructed by making an excavation at the spring head 4' in diameter and approximately 5' below the bottom of embankment. A geotextile shall be placed in the excavated hole and backfilled with 1½" to 6" stone or masonry, and a 1' thick layer of 6A stone. A 6" diameter underdrain is used to dissipate water from the stone basket. The location of the stone basket should be shown on the typical cross section and the following sketch detailed in the construction plans.



TYPICAL STONE BASKET SECTION

4.06.07 (added 9-23-2024)

Underdrain in Roundabouts

Underdrain in roundabouts follows the same design principles as typical roadways but with additional attention paid to drainage of the center island. Regardless of the permeability of the center island surface, underdrain should be installed at the inside of the circulating lane in accordance with Standard Plan R-80-Series. Alternatively, a separate drainage system can be installed solely for the center island.