1—OBJECTIVES

Drainage design should achieve the most effective and economical methods by which runoff water can be passed through and removed from the roadway. The primary objectives should be to:

- Maintain historic drainage patterns.
- Provide culvert openings for natural drainage channels.
- Prevent undue accumulation and retention of water upon and adjacent to the roadway.
- Protect the roadway against storm and subsurface water damage.
- Provide a safe driving surface for the traveling public.
- Provide detention for storm water runoff.

2—DRAINAGE ANALYSIS

Scope. The design-builder shall be responsible for designing the drainage and stormwater management systems and obtaining all associated permits. All design work shall be in compliance with the Mn/DOT Drainage Manual (August 2000 edition) and the requirements of regulatory agencies. This work shall include the engineering analysis necessary to design any or all of the following: culverts, roadway ditches, and retention/detention facilities. Full coordination with all permitting agencies and with the Hydraulics Section of the Department’s District 6 office shall be required from the outset. Full documentation of all meetings and decisions are to be submitted to the Hydraulics Section. These activities and submittals shall be coordinated through the Department’s Project Manager.

Quantities. The exact number of drainage basins, outfalls, and water management facilities (retention/detention areas, weirs, etc.) shall be the design-builder’s responsibility.

Tasks and Submittals. The objective is to maintain the existing drainage pattern and obtain approval of the stormwater treatment and attenuation design by the Minnesota Pollution
Control Agency’s National Pollution Discharge Elimination System (NPDES) program. This design shall include, but is not limited to, the following:

- Design and generate construction plans documenting that the permitted systems function as specified by NPDES criteria.
- Submit general permit applications for the project with construction plans to a level of completion sufficient to document that the previously permitted systems function as specified by NPDES criteria.

**Cross Culverts.** The design-builder shall check all existing cross culverts to determine capacity and design life. Flood flow requirements shall be determined in accordance with Department procedures.

**Optional Materials.** The design-builder shall consider optional culvert materials in accordance with the criteria of the Mn/DOT Drainage Manual.

**Drainage Design Report.** The design-builder shall provide the Department’s District Drainage Engineer a signed and sealed Drainage Design Report. It shall be a record set of all drainage computations, both hydrologic and hydraulic. The engineer shall include all support data such as soil borings and permeability tests.

### 3—STORMWATER POLLUTION PREVENTION PLANS (SWPPP)

The design-builder shall prepare an Erosion Control Plan that complies with the Storm Water Pollution Prevention Plan (SWPPP) as required by the National Pollution Discharge Elimination System (NPDES). The design-builder shall refer to the August 2000 edition of the Mn/DOT Drainage Manual and Standard Plans for information regarding the SWPPP and Minnesota Rules Chapter 7001. Detailed limits of the erosion control items must be shown on the roadway plan sheets. This plan shall be submitted along with the design-builder’s certification at least fifteen days prior to beginning construction activities.

### 4—DRAINAGE PLANS

The design-builder shall prepare plan sheets, notes, and details to include the following:

- Drainage map sheet(s)
- Drainage structure sheet(s)
- Drainage plan sheet(s)
- Summary of drainage structure sheet(s)
- Water resources engineering notes
- Ditch and outfall plan sheet(s)
- Ditch and outfall cross section sheet(s)
DRAINAGE AND HYDRAULICS DESIGN CRITERIA

- Retention/detention plan sheet(s)
- Retention/detention cross sections
- Special drainage detail sheet(s)
- Pipe tabulation
- Erosion control details and plans
- Drain tile details and plans

5—DESIGN STORM

**Major/Minor Storms.** Minor storm = 10-year; major storm = 500-year or 1.7 x 100-year.


**Methodology.** See current Mn/DOT *Hydraulics Manual*.

- *Rational method:* Urban DA < 200 acres
- *TR 55:* Rural DA < 2000 acres
- *Minnesota USGS Regression Equations:* Culverts with 54” or larger widths

6—CULVERTS

**Minimum Pipe Sizes**

<table>
<thead>
<tr>
<th>Type of Road</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trunk Highway Centerline</td>
<td>24”</td>
</tr>
<tr>
<td>County-State Aid Highway Centerline</td>
<td>18”</td>
</tr>
<tr>
<td>Local Road Centerline</td>
<td>18”</td>
</tr>
<tr>
<td>Ramp, Loop, and Rest Area</td>
<td>18”</td>
</tr>
<tr>
<td>Side Culvert</td>
<td>15”</td>
</tr>
<tr>
<td>Median Drain</td>
<td>15”</td>
</tr>
<tr>
<td>Entrance</td>
<td>15”</td>
</tr>
</tbody>
</table>

**Major/Minor Culverts:** Minor culverts are less than or equal to 48”; major culverts are greater than 48”.

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Drainage and Hydraulics.doc Page 3 of 9 Printed on 3/20/01
Culvert Design

<table>
<thead>
<tr>
<th>Road Classification</th>
<th>Pipe Size</th>
<th>Design Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Centerline</td>
<td>&gt;48&quot;</td>
<td>Need risk assessment</td>
</tr>
<tr>
<td>All Centerline</td>
<td>=48&quot;</td>
<td>50-year</td>
</tr>
<tr>
<td>Median Drain</td>
<td>15&quot;</td>
<td>50-year</td>
</tr>
<tr>
<td>Entrance</td>
<td>15&quot;</td>
<td>10-year</td>
</tr>
</tbody>
</table>

According to the current Mn/DOT Drainage Manual, for culverts that are less than or equal to 48”, overtopping calculations are generally not necessary. For major culverts, the 500-year flood or overtopping flood shall be computed, whichever is less. If flood frequency data are not available, use 1.7 x 100-year flood.

**Pipe Material**
- Reinforced concrete
- Galvanized corrugated steel
- Corrugated polyethylene (up to 24” for trunk highway centerline)

Materials for centerline culverts shall be selected by engineering analysis, based on hydraulic performance, structural stability, serviceability, and economy.

**Manning’s n Values.** See Table 5.3, Current Mn/DOT Drainage Manual.

**Pipe Class.** See Mn/DOT Standard Plates, No. 3000L.

**Pipe Bedding.** See Current Mn/DOT Drainage Manual, Chapter 2.

**Analysis Procedure**
- HY-8
- HEC-RAS
- WSRPO
Outlet Protection

<table>
<thead>
<tr>
<th>Outlet Velocity, Vo</th>
<th>Riprap Specifications</th>
<th>Filter Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 &lt; Vo &lt; 6 fps</td>
<td>Riprap or stable vegetation</td>
<td>(None)</td>
</tr>
<tr>
<td>6 &lt; Vo &lt; 8 fps</td>
<td>12” Class II riprap</td>
<td>6” granular or geotextile filter</td>
</tr>
<tr>
<td>8 &lt; Vo &lt; 10 fps</td>
<td>18” Class III riprap</td>
<td>9” granular or geotextile filter</td>
</tr>
<tr>
<td>10 &lt; Vo &lt; 12 fps</td>
<td>24” Class IV riprap</td>
<td>12” granular or geotextile filter</td>
</tr>
<tr>
<td>Vo &gt; 12 fps</td>
<td>Consider other energy dissipators (See Chapter 6, current Mn/DOT Drainage Manual.)</td>
<td></td>
</tr>
</tbody>
</table>

See Mn/DOT Standard Plates 3313 and 3134 for outlet riprap.

Safety Aprons. Culvert ends located outside of the clear zone do not need safety aprons or grates. If culvert ends are located within the clear zone, they shall be treated in accordance with the current Mn/DOT Road Design Manual guidelines. If safety aprons (grate or trash guards) are installed on the downstream end of the culvert, they must be installed on the upstream end.

Culvert Documentation

The design-builder shall supply the following for culvert documentation:

- For minor culvert:
  - Culvert design sheet (see Culvert Form, attached)

- For major culvert:
  - Design computation and letter of recommendation
  - Risk analysis (see Mn/DOT Drainage Manual, Appendix A)
7—OPEN CHANNELS AND DITCHES

Design Requirements. See typical sections on the base plan and as shown in the following diagram.

Ditch Shape

<table>
<thead>
<tr>
<th>Ditch Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side Slopes:</td>
</tr>
<tr>
<td>Depth:</td>
</tr>
<tr>
<td>Width:</td>
</tr>
<tr>
<td>Freeboard:</td>
</tr>
<tr>
<td>Minimum Grade:</td>
</tr>
</tbody>
</table>

Manning’s n Values. See Table 4.4, Mn/DOT Drainage Manual.

Retardance vs. Vegetal Cover. See Table 4.2, Mn/DOT Drainage Manual.

Permissible Shear Stress. See Table 4.3, Mn/DOT Drainage Manual.

8—STORMWATER MANAGEMENT SYSTEM

Design must comply with the rules of the Minnesota Pollution Control Agency’s best management practices for detention basins and the Minnesota Department of Transportation, as shown in the following diagram.
Wet Detention Basin Design

*Drainage Area.* A 4-acre drainage area is recommended for each acre-foot (ac-ft) of storage in each basin.

*Runoff.* The basins’ hydraulic volume must capture ½ inch of runoff from the impervious watershed.

*Dead Storage.* The basin must provide a minimum of 250 cubic feet (ft$^3$) of dead storage below the hydraulic volume (impervious acre[s] drained).

*Inlets.* Basin inlets shall be above dead sediment storage volume.

*Outlet.* Basin outlets shall be designed to remove all suspended solids greater than five microns with a settling velocity of 1.3 x 10-4 feet per second (fps).

*Debris.* Basins shall be designed to prevent circuiting and discharge of floating debris (skimmer baffle).

*Spillways.* Basins must provide spillway(s) to accommodate storm events in excess of the basin’s hydraulic design.

*Basin Depth.* The average depth of the permanent pool (the hydraulic volume) shall be greater than 4 feet but less than 10 feet.

*Basin Shape.* To promote plug flow and enhance water quality benefits, a length-to-width ratio of 3 or more must be maintained.

**Erosion Control**

This project shall meet the NPDES requirements (including an SWPPP) to control erosion and sediment.
Drain Tiles

The design-builder shall determine the impact on drain tiles adjacent to the Mn/DOT right of way and within the proposed right-of-way taking, and submit site and design plans to the Department. If necessary, drain tiles must be capped or reconstructed, as they will not be permitted to outlet into a trunk highway ditch. Before implementing any drain tile design, the Mn/DOT District 6 Hydraulics Section must be allowed a 7-day review period. If no comments are made within that 7-day period, the design builder is authorized to proceed as designed.
Insert “Drainage Attach. (Culvert Form).xls”

(1 page, 8 ½ x 11, B/W)