CHAPTER 7

HYDROLOGY
1. Introduction
This Section outlines the design criteria and guidelines to follow for hydrologic analysis of drainage systems. Hydrologic analyses provide estimates of flow magnitudes as a result of precipitation.

2. Design Criteria and Guidelines
(a) General
- For all hydrologic analyses, consider the flood history of the area and the effect on existing and proposed features.
- Maintain and mimic natural drainage characteristics and patterns to the maximum extent practicable.
- Use the design frequencies in Table 7-1 to design drainage features for conveyance with the following exception;
  - Use a 100-year design frequency for conveying offsite flows in FEMA designated flood hazard areas.

Table 7-1 Design Frequency (Year) Requirements for Conveyance Calculations

<table>
<thead>
<tr>
<th>DRAINAGE FEATURE</th>
<th>ROADWAY CLASSIFICATION</th>
<th>NON-INTERSTATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>INTERSTATE(^1)</td>
<td>HIGH VOLUME (OVER 1000 AADT(^2))</td>
</tr>
<tr>
<td>OFF-SITE FLOW</td>
<td>BRIDGE</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>CULVERT</td>
<td></td>
</tr>
<tr>
<td>ON-SITE FLOW</td>
<td>GUTTER, DITCH</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>INLET</td>
<td></td>
</tr>
<tr>
<td></td>
<td>STORM DRAIN</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CULVERT</td>
<td></td>
</tr>
<tr>
<td>ON-SITE FLOW</td>
<td>MAJOR SAG</td>
<td>50</td>
</tr>
</tbody>
</table>

Note:
1. Includes ramps
2. Based on a thirty year traffic projection

(b) Pedestrian and Bicycle Paths
- Use the 10-yr design frequency to design drainage features for conveyance with the following exceptions:
  - Convey the same or greater design flow of an adjacent structure when within 1,000 feet upstream or downstream.
  - Use a 100-year design frequency for conveying offsite flows in FEMA designated flood hazard areas.
(c) Hydrologic Methods

The type and source of information available for hydrologic analyses will vary from site to site. The designer is responsible for determining what information is available and applicable to a particular analysis.

Estimate peak flow rates using the following methods. Results from several methods may be compared, but should not be averaged.

- **Statistical Methods (log-Pearson Type III)**
  - Use a log-Pearson Type III method for designs on drainage basins at or near streamflow gaging stations. The best results are obtained from continuous or synthesized records that meet at least the following:
    - 10 years for estimating the 10-yr discharge,
    - 15 years for estimating the 25-yr discharge,
    - 25 years for estimating the 50-yr discharge, and
    - 50 years for estimating the 100-yr discharge.
  - Determine the appropriate station skew, regional skew, or weighted skew to calculate the log-Pearson curve fit.
    - See Figure 7-1 for Utah generalized (regional) skew map. Use 0.20 as the mean square error for this map.
Figure 7-1 Utah Generalized Skew Map
- **Regression Equations**
  - Best available regional regression equations (such as the USGS StreamStats application) may be used for estimating peak flows at ungauged sites or sites with insufficient data for other hydrologic methods.
  - Limit the use of regression equations to watersheds that fall within the limitations and assumptions of the equations.
  - Limit the use of rural regional regression equations to undeveloped areas.
  - Regression equations should not be used where dams, flood-detention structures, or other man-made features exist that significantly affect annual peak flows.

- **Rational Method**
  - Use for peak flow estimates from drainage areas less than 200 acres with uniform watershed characteristics and uniform precipitation across the watershed. Consider other methods if the time of concentration exceeds 30 minutes and do not use if time of concentration exceeds 1 hour.
  - Use to locate and size storm drains or ditches that collect or convey roadway runoff.
  - Use a minimum time of concentration of 5 minutes. Calculate time of concentration using a method that is appropriate for the drainage basin characteristics.

- **NRCS Curve Number Method**
  - Use for peak flow estimates from drainage areas less than 25 square miles or where hydrographs are required such as or storage basins or complex conveyance networks.
  - Use the NRCS (SCS) Type II 24-hr rainfall distribution with a 24-hr precipitation depth.
  - Use appropriate time of concentration and lag time equations from HDS-2, HEC-22, or Part 630 of the National Engineering Handbook.

- **Other Methods**
  - Other hydrologic methods may be used with prior approval and with adequate documentation showing that they are appropriate and applicable to the watershed being modeled.
  - Use the discharges specified in FEMA Flood Insurance Studies in regulatory floodways and floodplains. If the published flows appear to be outdated, values based on current hydrologic methods may be used subject to approval from necessary regulatory agencies. Verification that the published discharges are reasonable must be completed prior to using the flow values for design.
(d) **Precipitation Data**

Use precipitation data obtained from NOAA Atlas 14 via the Precipitation Frequency Data Server.

3. **Design References**

(a) FHWA. *HDS No. 2, “Highway Hydrology.”*

(b) FHWA. *HEC No. 22, “Urban Drainage Design Manual.”*

(c) NRCS. *National Engineering Handbook, “Part 630 Hydrology.”*


(e) USGS. *Guidelines for Determining Flood Flow Frequency, “Bulletin 17B.”*