Hydrology is generally defined as a science dealing with the interrelationship between water on and under the earth and in the atmosphere. For the purpose of this manual, hydrology will deal with estimating flood magnitudes as the result of precipitation. In the design of highway drainage structures, floods are usually considered in terms of peak runoff or discharge in cubic feet per second (cfs) and hydrographs as discharge per time. The entire discharge hydrograph shall be used for the design of facilities which are intended to control volume of runoff, such as detention facilities.

V–01.01 Hydrologic Design Policies

Following is a summary of general practices which should be used in performing hydrologic analyses: [For a more detailed discussion refer to the publication," Highway Drainage Guidelines," published by the American Association of State Highway and Transportation Officials. (AASHTO)]

1. Studies–Hydrologic considerations can influence the selection of a highway corridor. Special studies may be required at some locations. The magnitude and complexity of these studies should be commensurate with the importance and magnitude of the project and problems encountered. Typical data to be included in such studies are:

    - Topographic Maps
    - Aerial Photographs
    - Stream Flow Records
    - Historical High Water Elevations

2. Coordination–It is desirable and often necessary to share information with other agencies to assure the completion of accurate hydrologic analyses.

3. Documentation–The design of highway drainage facilities should be adequately documented and records should be retained indefinitely.

V–01.02 Design Flood Frequency

Design flood frequency (recurrence interval) shall comply with the requirements of Article 89-14 of North Dakota Administrative Code.

V–01.03 Hydrologic Analysis

V–01.03.1 General

The following factors may need to be considered in performing a hydrologic analysis:

1. Drainage basin characteristics including: size, shape, slope, land use, geology, soil type, surface infiltration and storage.

2. Stream channel characteristics including slope, geometry and configuration, natural and artificial controls, channel deposition or erosion, ice and debris.

3. Flood plain characteristics.

4. Drainage history of the area and any drainage problems relating to existing and proposed structures. The NDDOT Bridge Division may be able to provide historical information relative to drainage problems.

5. Precipitation amount and storm distribution.

6. Ground cover

7. Type of soil

8. Soil moisture condition.

9. Storage potential (overbank, ponds, wetlands, reservoirs, channel, etc.).

10. Type of precipitation.

V–01.03.2 100-Year Frequency

Discharges for 100 year frequencies and associated water surface elevations shall be computed and these should be listed on the plans for all drainage structures and centerline culverts.

V–01.04 Hydrologic Methods

The hydrologic methods to be used are listed below. If possible the method should be calibrated to local conditions and tested for accuracy and reliability.

Approved Methods:

Rural: For all sizes of drainage areas on the rural roadway system, design discharge shall be calculated using USGS Regression Equations, in accordance with the methods described in U.S. Geological Survey Scientific Investigations Report 2015-5096.

The Ruggedness Number is used in the Regression Equations for Hydrologic Zones B and C. When calculating the Ruggedness Number, the stream lines to be used in determining the stream density shall be the total length of all NHD Flowlines within a drainage area which are represented on the USGS National Hydrography Dataset (NHD). The NHD can be downloaded from the USGS website. For small drainage areas which do not contain any NHD stream lines, a single stream line representing the longest drainage path in the drainage area shall be drawn, and its length shall be used for the stream length in calculating the Ruggedness Number.

Urban: For urban drainage areas, the method used to determine design discharge shall be the Rational Method. This method is limited to drainage areas of less than 200 acres. Storm rainfall intensity for use in the Rational Method estimation of discharge shall be determined using the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 - Precipitation-Frequency Atlas of the United States (Atlas 14).

Other Methods:

Deviations from these methods must be approved by the NDDOT Bridge Division.