6.14 Computer Programs for Hydrologic Modeling

6.14.1 Introduction HEC-1 and TR-20

The "HEC-1" or “HEC-HMS” computer program was developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center to simulate flood hydrology in complex river basins. The program entitled "Technical Release 20, Computer Program for Project Formulation, Hydrology", (TR20), was written by the Hydrology Branch of the Soil Conservation Service, (SCS), now NRCS, for use in the hydrologic evaluation of flood events for water resource projects. Both are single event models designed to estimate direct surface runoff resulting from synthetic or natural rainstorms.

6.14.2 Application

These computer programs are recommended for use under the following circumstances:

1) The watershed under study is ungaged and significant reservoir or valley storage is present, thereby preventing the use of regional regression equations.

2) A stormwater detention design or study is to be undertaken and reservoir routing computations are required.

3) The designer must construct a model to simulate an actual storm event and sufficient data is available to facilitate calibration of the results. (May be desirable or necessary in circumstances which involve litigation).

4) Pre/post development peak discharge rates must be determined in order to document the effects of a proposed activity.

5) A dam breach analysis is required.

6) May be used on any watershed, as is limited by individual computer program, and is recommended when watershed exceeds the limits established by other methods.

In addition to the circumstances noted above, the Department may require the use of these or similar programs for various site specific reasons.

Due to the complex nature of these programs, it is not intended that this chapter provide the user with comprehensive guidelines for program application. Rather, the ensuing text will provide a brief overview of program capabilities and recommendations for report documentation.

6.14.3 Description

Program Descriptions and Modeling Recommendations

The Hydrologic Modeling System HEC-HMS is designed to simulate the precipitation-runoff processes of dendritic watershed systems. It supercedes HEC-1 and provides a similar variety of options but represents a significant advancement in terms of both computer science and hydrologic engineering. In addition to unit hydrograph and hydrologic routing options, capabilities include a

linear quasi-distributed runoff transform (ModClark) for use with gridded precipitation, continuous simulation with either a one-layer or more complex five-layer soil moisture method, and a versatile parameter estimation option.

HEC-1 This computer program simulates a) rainfall and/or snowmelt runoff from subbasins within a watershed, b) flow through stream reaches, c) flows from urban areas, d) flow diversions, and e) flow through reservoirs including a breached dam condition with a varying (degrading) failure section. Effectively, there is no limitation related to basin size as the program is suitable for use in the analysis of watersheds which vary in size from small urban catchments to large, multi-basin river systems. In order to transform rainfall values to runoff, a unit hydrograph or kinematic wave approach is employed. The unit hydrograph, which is most commonly used, is the method recommended by the Department unless it can be demonstrated by the designer that basin characteristics require the use of the kinematic wave method.

Point rainfall amounts for synthetic storms shall be those quantities presented in Table B-1 of Appendix B of this chapter for the appropriate duration and return frequency. The model shall be constructed such that multiple flood analyses are generated and to include as a minimum the 2, 10, 25, 50, 100 and 500 year events. In studies which involve large dams, the 1/2 Probable Maximum Flood (PMF) or Probable Maximum Flood (PMF) may also be required as directed by the Department of Environmental Protection. The computer model shall be calibrated to a gage if possible.

Times of concentration and travel times for use in the HEC-1 program shall be developed using the methodology described in Appendix C of this chapter.

TR-20 Technical Release No.20 is a computer program which computes direct runoff from a rainstorm, generates flood hydrographs from surface runoff, and routes flow through channel reaches or reservoirs. Output data includes peak discharges with related times of occurrence and water surface elevations at designated cross sections or structures. With the exception of the channel routing routine (Modified Att-Kin Method), TR-20 is based upon the methodologies contained in the NRCS (formerly SCS) National Engineering Handbook, Section 4, Hydrology, commonly referred to as NEH 4.

Based on the assumption that rainfall depth is uniformly distributed throughout the watershed, the areal limitations for subcatchment or overall basin size range from approximately 0.25 km^2 (0.1 mi^2) to 1035 km^2 (400 mi^2).

As required with the HEC-1 program, the hydraulic engineer shall utilize the rainfall data presented in Table B-1 of Appendix B of this chapter as input for the desired storm event. The rainfall distribution for all watersheds in Connecticut shall be the 24 hour "Type III" storm as recommended by the NRCS, and Appendix C methodologies shall be used for time of concentration and travel time computations.

All hydrologic studies performed utilizing TR-20 for watersheds greater than 2.59 square kilometers (one square mile) shall include multiple flood analyses to include the 2, 10, 25, 50, 100 and 500 year events, except where dam studies require the analysis of probable maximum floods.

The computer model shall be calibrated to a gage station if possible.

TR-55 Urban Hydrology for Small Watersheds, Version 2.0. This Rainfall Runoff Model was developed by the US Soil Conservation Service, now known as the Natural Resources Conservation Service (NRCS). TR-55 presents simplified procedures to calculate storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for flood water reservoirs. These procedures are applicable in small watersheds, especially urbanizing watersheds, in the United

States. The primary functions of the program are for peak runoff computations using the Graphical Peak Discharge Method, the Tubular Peak Discharge Method and Temporary Storage. Support functions include the computation of the runoff curve number (CN), the Time of concentration (Tc) and travel time through a subarea (Tt). Limits: NRCS type distributions, 24-hour duration rainfall, 10 subwatersheds, minimum 0.1 hour and maximum 10-hour time of concentration.

6.14.4 Schematic

A watershed schematic representing the physical subbasin elements and their interrelationships shall be constructed for all cases in which a computer program is used to develop a hydrologic model.

6.14.5 Documentation

Input Data Documentation

All input parameters used in hydrologic computer models shall be fully documented for inclusion in a hydrologic design report. The designer must submit, as appropriate, watershed mapping which indicates overall basin limits and subbasin divides, T_c and T_t computations including flow paths for the various elements, curve number determinations, soil type determinations based on appropriate mapping, cover types or zoning information, stage/storage/discharge relationships for reservoir routing, structure routing, channel routing data and any other pertinent data.