CHAPTER 7

GUIDELINES FOR DETERMINING PEAK DISCHARGES

7.1 Purpose

Hydrology is a multidisciplinary subject addressing the occurrence, circulation and distribution of waters of the earth. The discharges for a stream are a function of the stream's watershed characteristics as well as local meteorological conditions. For most purposes in the assessment of the hydraulic properties of a waterway, the hydrologic response of the watershed is reflected in the value of the peak discharge. The purpose of this chapter is to detail the most widely accepted methodologies for estimating peak discharges. These methodologies include the Coordinated Discharge program, discharge determination by the IDNR, and obtaining discharges using a rainfall—runoff model.

7.2 Coordinated Discharges

Many Indiana streams feature coordinated discharges which means that the IDNR, Natural Resource Conservation Service (NRCS), USACE, and USGS have developed and agreed upon discharges for certain streams. Discharge versus drainage area graphs or tables for these streams are available at the IDNR website (http://www.in.gov/dnr/water). Directions for using and determining discharges using these graphs are also included on this website.

For IDNR approval purposes, if a coordinated discharge is available for a modeled study reach, then that is the only discharge acceptable to the Department. The IDNR will not determine a discharge for an applicant that is on a coordinated stream, but will review a determination performed independently. Refer to the website for directions on determining discharges, along with directions for submitting a determination for review.

IDNR practice requires that the discharges used in a FIS be coordinated. Therefore, FIS models obtained from IDNR should, with limited exceptions, be based on coordinated discharges.

While it is possible to challenge and modify a coordinated discharge, the IDNR discourages modification unless discharges are analyzed, and modified as needed, for an entire watershed. Changes to coordinated discharges must be supported by detailed hydrologic modeling and/or gage analysis. In addition, coordinated discharges that are in a published FIS must be changed for the entire stream reach through a LOMR. The requester is responsible for performing all hydrologic and hydraulic modeling and redelineation of all floodplain and floodway boundaries, including obtaining necessary approvals from the IDNR and FEMA.

Coordination of the modeling efforts with IDNR personnel in the early stages of such an effort is essential.

7.3 Discharges Determined by IDNR

For streams where coordinated discharges are not available, the IDNR will estimate the 100-year peak discharge upon request. Because the IDNR usually has jurisdiction over only the 100-year peak discharge, peak discharges for other frequencies will not be determined by the Department. Address requests to the IDNR's Technical Services Center and include:

- stream name as it appears on the USGS 7 ½ minute quadrangle,
- location of point(s) where discharge is needed (e.g., County, road intersections, Section, Township and Range), and
- a copy of the USGS quadrangle with specific point(s) marked.

The IDNR determines discharges based on one or more of the following methods:

- NRCS Unit Hydrograph method
- USGS Regression equations (Glatfelter, 1984)
- IDNR, Division of Water Regression equations
- Previous determinations on the same stream
- Determinations for similar nearby streams
- Discharges for similar gauged streams
- Discharges for similar coordinated streams
- Other methods that may be available

IDNR's 100-year peak discharge determination is not made based on one particular method, but rather on engineering judgment used to evaluate the merits of each method and estimate the appropriate discharge to use.

7.4 Discharges Determined by Others and Submitted to the IDNR for Approval

Instead of having the IDNR determine discharges, other knowledgeable individuals or organizations can develop discharges and submit them to the IDNR for review. The decision to exercise this option should be followed by a meeting, early in the hydrologic analysis process, with IDNR's Engineering Service Center staff.

Factors to consider in determining discharges for submittal to IDNR are described below.

For rainfall depths and distributions within a hydrologic model, IDNR will only accept:

- U.S. Weather Bureau Technical Paper 40 rainfall depths and either NRCS Type B (6 hour) or Type II (24 hour) distributions, or

- Illinois State Water Survey Bulletin 71 (Huff-Angel) depths and distributions

The prescribed rainfall information is available on the IDNR website (http://www.in.gov/dnr/water). Mixing and matching depths and distributions is not acceptable, nor are other sources of depths or distributions.

The hydrologic analysis can be based on a statistical analysis of gage data following the guidelines set forth in Bulletin 17B by the Interagency Advisory Committee on Water Data. The hydrologic analysis report must explain the source of all data, which are typically peak discharges observed and recorded regularly over a period of time by a government agency or private firm. Historical events, which refer to isolated peak discharges observed outside the systematic period, should be documented. The report must also include any adjustments made to the statistical data/record, such as the use of data from a second gaging station to extend a short record or adding data for missing flood years.

For many applications, an acceptable method of determining the appropriate duration is to run a model with a series of different durations and select the “critical” duration, that is, the duration that results in the highest peak discharge.

The IDNR will not accept a discharge that is based on the effect of detention basins that are not approved as flood control projects under IC 14-28-1-29 and that are not operated and maintained by a government entity in perpetuity. This includes the majority of subdivision detention basins. If a project is approved as a flood control structure under IC 14-28-1-29, then the effect of the storage caused by the structure can be included in the hydrologic model.

Reduced discharge resulting from a restrictive stream crossing, such as a railroad fill, may not be used downstream of the structure unless the structure is expected to remain in place for the foreseeable future, and the peak discharge is reduced by 15% or more. When that occurs, the reduced (routed) discharge must be agreed upon and coordinated through the IDNR according to the May 1976 procedure for Coordinated Discharges in order to be accepted. The referenced agreement is done on a case-by-case basis. All routed discharges should be reviewed by the IDNR and approved through the coordination procedure before they are used in a FIS or any other study requiring IDNR approval.

In Indiana, watershed hydrologic response varies greatly depending on location. For example, runoff from a watershed in northern Indiana's "lake country" is dramatically different than a watershed in the rolling hills of the southeastern part of the state. These response differences impact assessment of watershed hydrology in many different ways. For example, when using the NRCS unit hydrograph method, the default unit hydrograph shape is typically not adjusted for the type of terrain or for storage in a watershed. Therefore, the engineer must fully understand the limitations of the methodology used for determining a discharge and the implications for properly applying it to the watershed and its location.

In the science of hydrology there are uncertainties and limitations for any method chosen for the estimation of peak discharges and runoff volumes for a watershed. Evaluation of the rainfall-runoff characteristics of a watershed, especially for rare frequency storms, is extremely complex with many interrelated variables, and existing data are typically too sparse and limited to provide the resulting degree of accuracy involved in many other engineering disciplines. When IDNR determines discharges, many different methods are used to estimate peak discharges and runoff volumes. Consequently, experience and engineering judgment are necessary aspects of making a final determination. Good engineering practice rarely includes one method to obtain a "final answer" for a discharge. Instead, challenge the results by applying other methods, running sensitivity analyses, and/or evaluating other similar watersheds where more information may be available.

Many engineers use a hydrologic modeling program, such as HEC-1, HEC-HMS, or Technical Release 20 (TR-20) to determine discharges for a watershed. While these programs can be very complex and require detailed input data, the results only represent a "well worked out opinion," rather than an absolute answer. The results from these widely used models should be carefully evaluated to ascertain if assumptions inherent in the models adequately reflect the particular system being modeled.

7.5 Historic Flood Profiles and Discharges

After floods of record occur on major Indiana streams and rivers, IDNR has occasionally developed historic flood profiles for these events. Development of historic flood profiles requires a comprehensive effort by trained personnel to determine and establish peak flood elevations along a stream or river by close study of debris limits, flood damage, photographs, local observations, and other sources of information. Obviously, the quality of the historic flood elevation data is dependent upon how soon after the flood event that the field work occurs. Once reliable flood elevations along a reach of stream or river are determined and marked, survey crews then establish benchmarks and tie the located flood elevations into accepted horizontal and vertical datums.

Historic flood profiles provide a valuable tool in development of reasonable 100-year flood profiles for reaches of major streams and rivers. The modeler compares and calibrates a developed flood model profile against an actual flood profile.

Estimating peak discharges for historic flood events on non-gaged streams or rivers typically poses a formidable task and may require extensive hydrologic study and modeling of rainfall-runoff conditions for a specific rainfall event over the contributing watershed area. In the event that control sections such as bridges, culverts, or weirs are located along a stream or river, and reliable high water information has been established both upstream and downstream, it may be possible to estimate the peak discharge for a historic flood event at particular control section locations by performing channel ratings or backwater calculations.

Peak discharge information for a historic flood event should always include analysis of available stream gage information, both in the vicinity and upstream and/or downstream of the study reach, if information is available for the historic flood event. IDNR staff should be consulted when determining peak discharges for historic flood events.