# Chapter 8

## Hydrograph Routing

## Introduction

***Overview***

Hydrograph routing in HEC-1 can be used to represent hydrograph movement in a channel or (conceptually) through a storage facility. The hydrograph is routed based on the characteristics of the channel or the storage-outflow characteristics of the storage facility. This section lists the routing methods using HEC-1 with the Sacramento method. It also describes techniques for modelling two types of detention basins.

***UNET***

This section is superseded when the Corps of Engineers hydraulic model, UNET, is used instead of HEC-2. The channel routing is performed by UNET, and the detention routing is more effectively modelled by UNET than HEC-1. The City and the County reserve the right to require that designs of detention basins be modelled by UNET.

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## Introduction (continued)

***Routing Methods***

The HEC-1 program contains several methods to route runoff hydrographs. Three of the methods, Modified Puls, Muskingum-Cunge, and Muskingum, are recommended for use in Sacramento County and are included as routing options in SACPRE. These methods, applications and required parameters are summarized in Table 8-1 in order of preference. In most cases Modified Puls routing will be required where HEC-2 models are available. Additional information on these routing methods is available in Chapter 12, and in the HEC-1 User's Manual.

**Table 8-1. Hydrograph Routing Options**

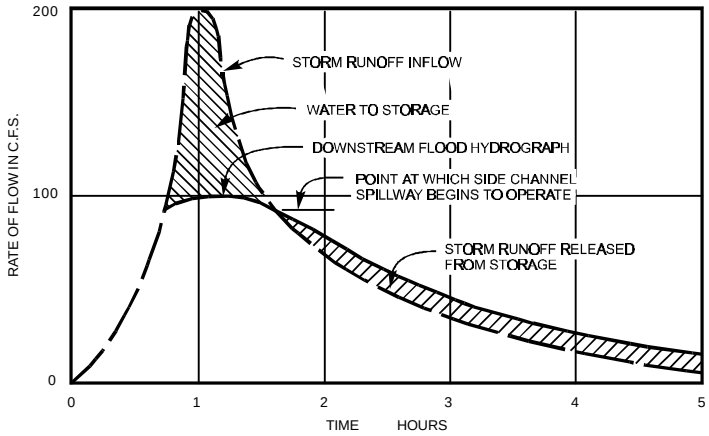
| Method | Application | Required Parameters |
|---|---|---|
| Modified Puls* | channels influenced by backwater<br>channels with available HEC-2 storage-discharge information | reach length<br>velocity in reach<br>storage-discharge information |
| | reservoir routing | storage-elevation information<br>elevation-discharge information or orifice data and spillway data |
| Muskingum-Cunge | channels with insignificant backwater effects<br>channels represented by 8 point cross-section<br>channels with a standard cross-section, trapezoidal, rectangular or circular | channel length<br>channel slope<br>Manning's roughness for overbanks and channel<br>cross-section data |
| Muskingum | channels with limited cross-sectional information | number of subreaches<br>Muskingum "K" coefficient, hrs<br>Muskingum "X" attenuation coefficient |

* required for development submittals

# Off-Channel Detention Routing

***Introduction***

Off-channel detention basins are usually the most effective means of reducing peak flow in a channel for a given storage volume. Off-channel detention basins are located adjacent to, but separate from a channel. Peak flows in the channel are diverted into the detention basin over a weir in the side of the channel. The figure below shows the effect of off-channel detention on the runoff hydrograph.




**EFFECT OF OFF-CHANNEL RESERVOIR ON STORM RUNOFF HYDROGRAPH**

***Modelling in HEC-1***

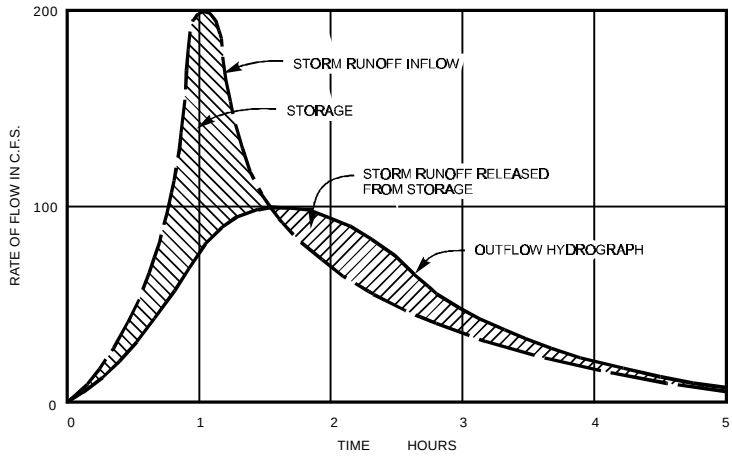
Off-channel detention can be conceptually modelled using the diversion option in HEC-1. The diversion option allows a flow to be diverted from a channel based on the total flow in the channel. The typical steps for modelling off-channel detention are outlined below.

- Divert flow to limit flow in the channel to the desired design flow .
- Determine the required channel overflow structure and off-channel storage based on diverted hydrograph (In some cases, the detention volume is known and the reduction of flow in the channel is determined).
- Route the diverted flow through the off-channel detention basin.
- Return the routed detention basin flow to the channel (Guidelines for estimating return flow to the channel are available from Sacramento County Water Resources Division).

# On-Channel Detention Routing

***Introduction***

On-channel detention includes using the excess storage capacity of a channel by building a berm across the channel and/or expanding the storage in a reach of the channel, for example, through excavation. Another example of on-channel detention is an "end-of-pipe" basin that collects runoff from a subdivision before entering the channel. With on-channel detention the entire runoff hydrograph is routed through the detention facility. The figure below shows the effect of on-channel detention on the runoff hydrograph.




**EFFECT OF ON-CHANNEL RESERVOIR ON STORM RUNOFF HYDROGRAPH**

***Modelling in HEC-1***

On-channel detention can be modelled in HEC-1 by using the Modified Puls routing method for reservoirs. In cases where detention storage is provided predominantly by the natural floodplain of the channel it may be more appropriate to use the Modified Puls routing method for channels.