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CHAPTER 6-3

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6.3 River Hydrology

River hydrology describes the timing, amount, and duration of water moving through a river system. These values can be measured at specific landscape locations through the use of stream gauges. Gauge data provide a historical record and a body of statistical value observations, which can be very useful in understanding seasonal patterns of stream flow and flooding, and in turn, their effects on salmon habitat and flood risk. This section covers streamflow gauging and streamflows in the Tillamook Basin, flow duration, flood frequency, and flood wave and flood pulse concepts.

6.3.1 Mean Daily Streamflows

■ Objectives

The objective of this assessment was to develop an understanding of the daily variability and magnitude of streamflow to guide flood management and floodplain restoration planning.

■ Methods

Mean maximum and minimum daily discharge values for the Wilson River were obtained directly from the USGS because these data are not available over the Internet.

■ Discussion

These seasonal flow data can be translated into river stage elevations in upland and lowland reaches of the river system, once the relationship between stage and discharge is known from field observations and/or floodplain computer modeling. The resulting stage discharge relationships can be used together with floodplain topography to estimate the depth, lateral extent and duration of flooding at various locations along the river system.

Maximum mean daily discharges exceed the flood stage of the Wilson River (13,200 cfs) during the months of December through February (Figure 6-3-1). Knowledge of the river stage elevations associated with these high discharges can be used in the restoration design of seasonal wetlands and floodplains.

Viewing the data on a semi-log plot (Figure 6-3-2) helps to show the variability in the minimum mean daily discharges through the water year. The lowest values of mean daily discharge (August through September) tend to be indicative of baseflow conditions, when a majority of the river flow is derived from groundwater sources.

The average mean daily discharge, and the discharges between the maximum and minimum mean daily discharge values represent the range of daily discharges that can be expected throughout the water year. Since these flows are daily values, and not longer-term monthly average values or short duration peak values, they represent the daily flow conditions occurring during plant growing seasons. The translation of these flows to river stage elevations can be used to guide restoration re-vegetation efforts by defining the elevation and extent of aquatic and riparian plant communities for given floodplain topography. For example, aquatic vegetation would be expected to grow at elevations below the stage of minimum mean daily discharges because land below this elevation would remain consistently wet; similarly riparian vegetation would be expected to grow above the minimum mean daily discharge stage and up to the mean or maximum mean daily discharge stage because these land areas would be periodically wet.

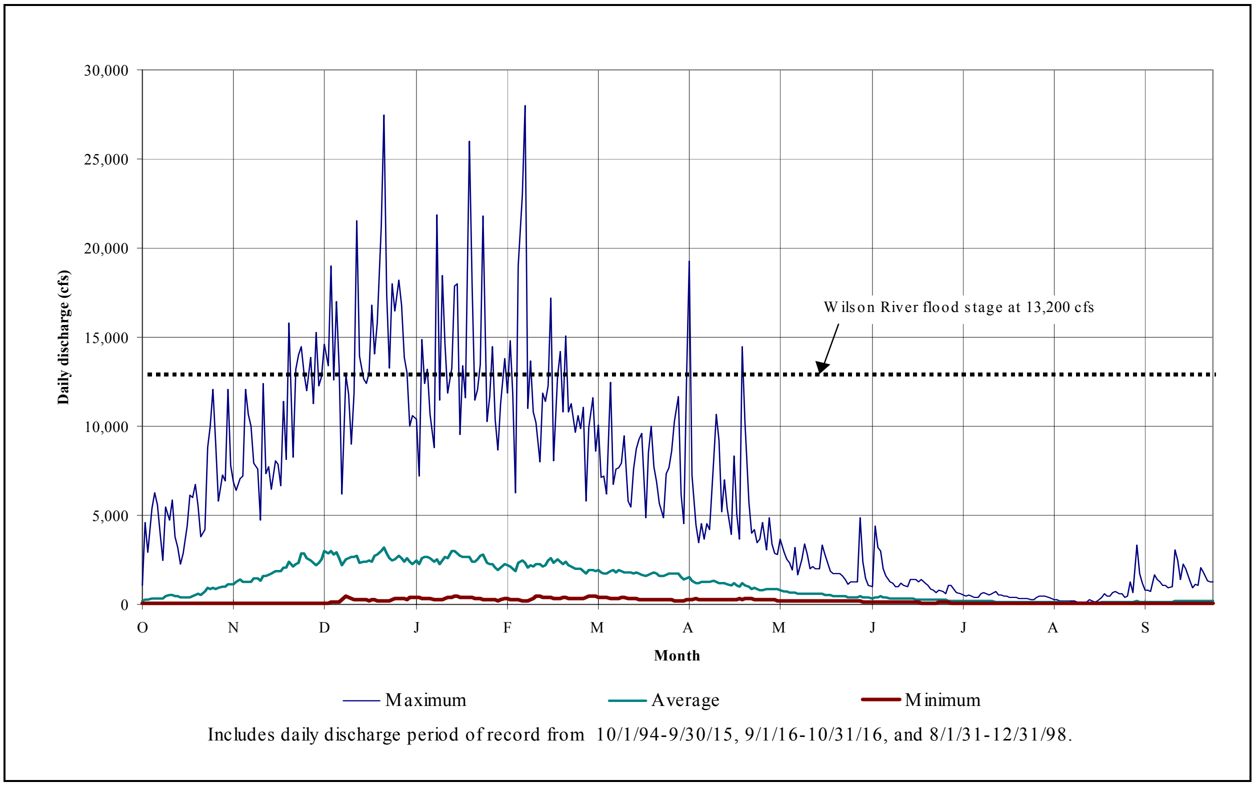

Figure 6-3-1. Wilson River Mean Daily Discharge (Maximum Mean Daily Discharge Focus)

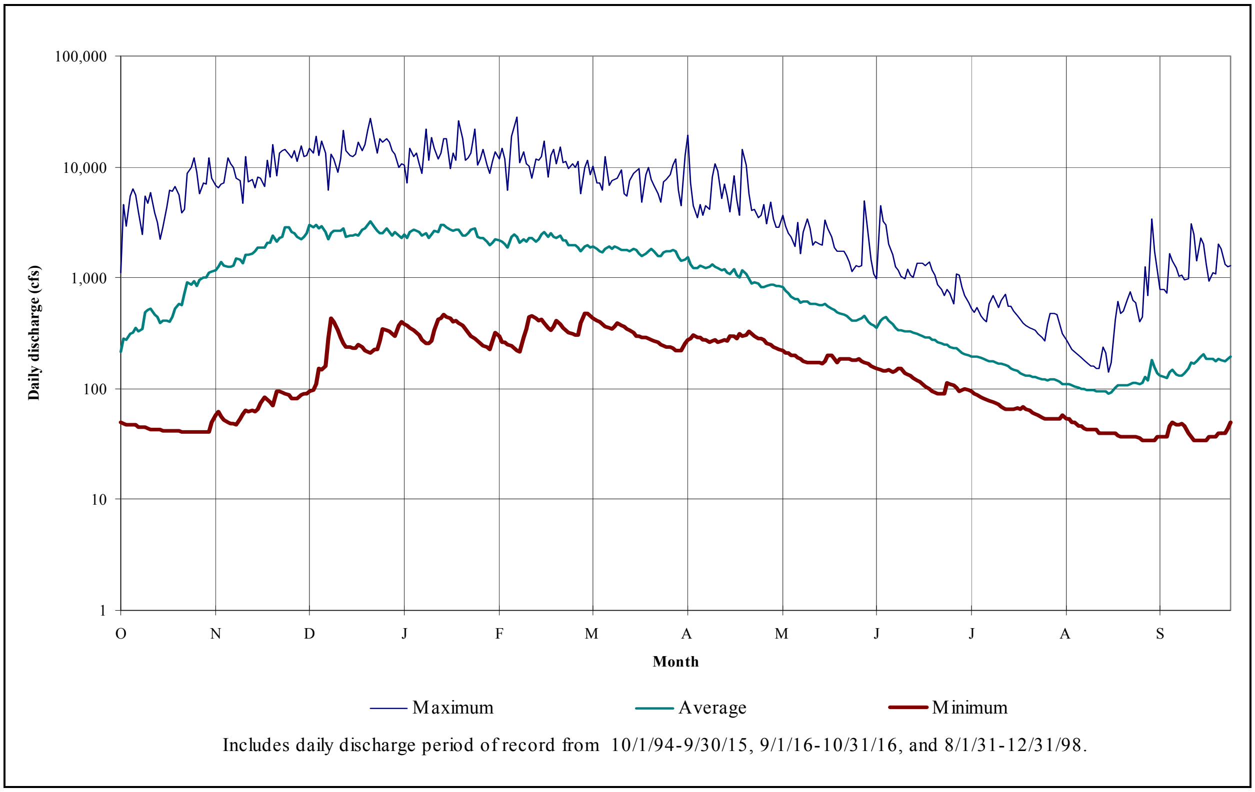

Figure 6-3-2. Wilson River Mean Daily Discharge (Minimum Mean Daily Discharge Focus)

6.3.2 Flood Event Hydrographs

■ Objectives

The objectives of this analysis were to compare: 1) the rate of rise and fall of historic flood event hydrographs; and, 2) the duration and volume of flood events, to assess the effects of historic flood hydrograph characteristics on streambank erosion.

■ Methods

Flow values for bankfull and flood stages were estimated by comparing river stage data from the National Weather Service (NWS) to the recent rating table (stage-discharge relationship) for the Wilson River stream gauge obtained from the USGS. For example, the NWS has designated a 13-foot river stage as "flood stage." This corresponds to a discharge of about 13,200 cfs from the USGS rating table. The area of the flood event hydrograph above flood stage represents the volume of water exceeding flood stage (Figure 6-3-5).

Floods travel downstream in a river system as a wave (Figure 6-3-3). The flood's wave is recorded at a streamgauge and the resulting record of the wave is the flood event hydrograph. Flood event hydrographs provide a chronology of the variation of streamflow over time. Hydrographs show the peak flow of a given flood event, but they also document hydrologic conditions before and after the peak of the event. Additional hydrologic conditions of interest (Figure 6-3-4) are the volume of the flood event (indicated by the area under the hydrograph curve) and the speed at which the flood peaks and recedes (indicated by the slope of the rising and falling limbs of the hydrograph). In the Tillamook Bay basin, the rate of the rise and fall of flood stage is of particular interest because "flashy" floods can saturate and destabilize the soil of levees and dikes, leading to erosion.

Hourly discharge data for the Wilson River gauge were obtained from the USGS for the period from October 1994 through April 1998 (the period of record for which hourly data is readily available). Peak discharges for the five largest flood events were identified, and the range of flood discharge values were selected from the data by including all values greater than an assumed base flow determined from visual inspection. Flood peaks were aligned together at a common time (day number 200) so that hydrograph limbs could be readily compared. Ordinates for the December 1964 flood event were taken from a figure of the flood hydrograph in the Corps post-flood report (Corps., 1972). Figure 6-3-6 shows a comparison of flood hydrographs for the Wilson River for flood events for the December 1964 flood and those flood events between October 1994 and April 1996.

■ Discussion

All flood events appear to have had similar durations above the 13,200 cfs flood stage, typically less than 24 hours. The rate of rise and fall for the lesser flood events (those peaking around 20,000 cfs) are fairly consistent. Although recording equipment malfunctioned soon after the peak of the February 1996 flood, this event appears to have been the largest in terms of peak magnitude, peak duration, and volume above flood stage.

Flood volumes are also noticeably similar for these events, with the exception of the November 29, 1995 flood event, which displays multiple peaks, presumably owing to storm surges producing overlapping flood hydrographs. Multiple peaked flows are significant to streambank erosion because of the increased incidence of wetting (Knighton, 1998).

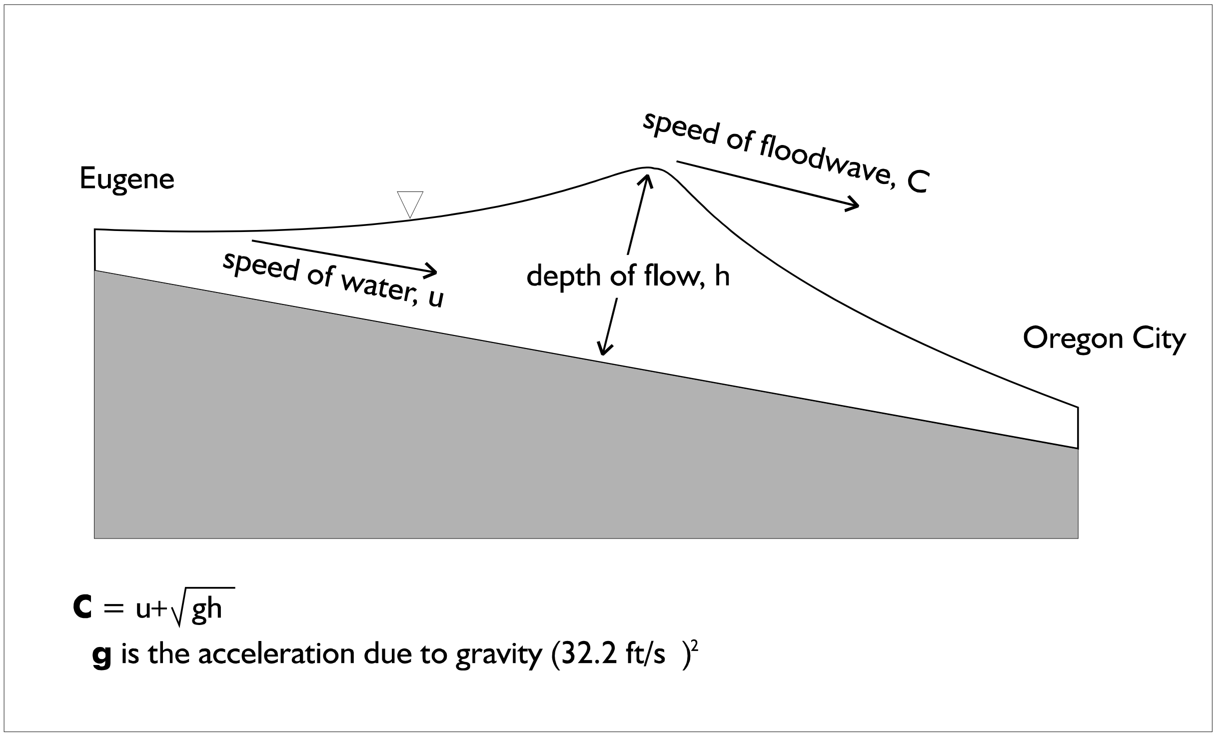

Figure 6-3-3. Flood Wave Propagation. Source: Coulton *et al.*, 1996

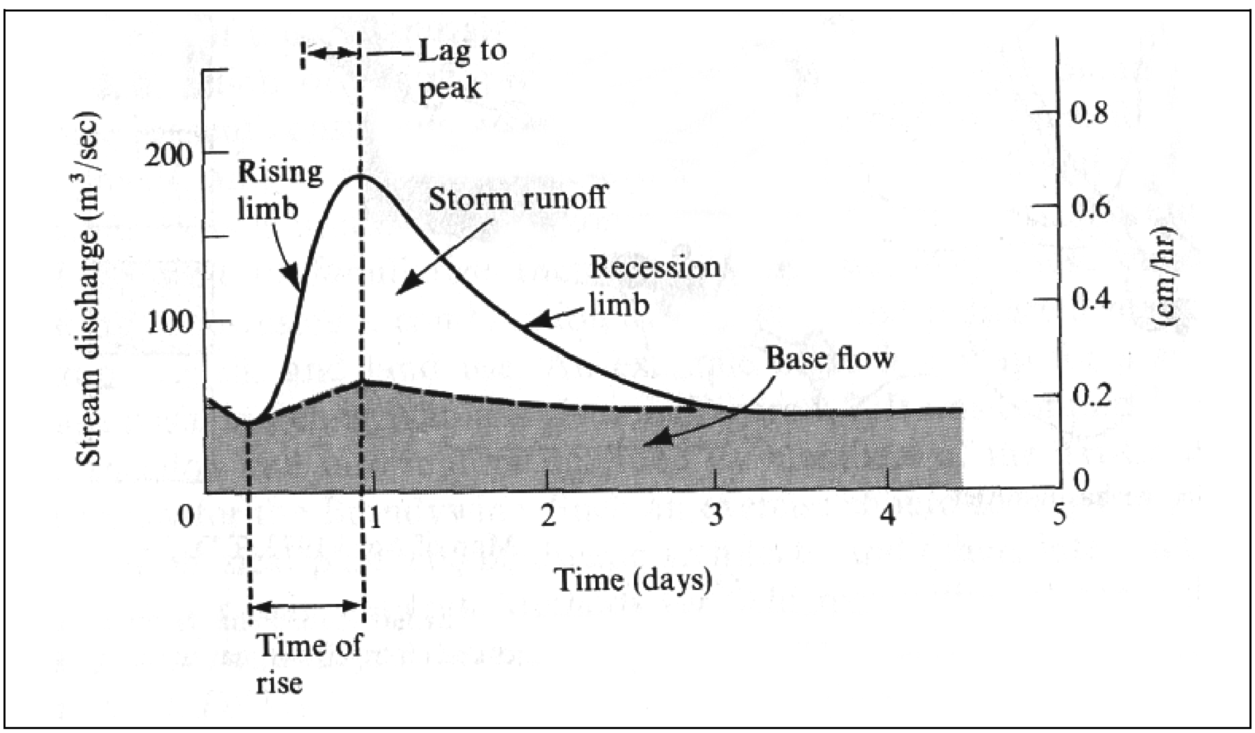

Figure 6-3-4. Hydrograph of Streamflow in Response to a Rainstorm from a 100-sq-km Basin.
Source: Dunne and Leopold, 1978

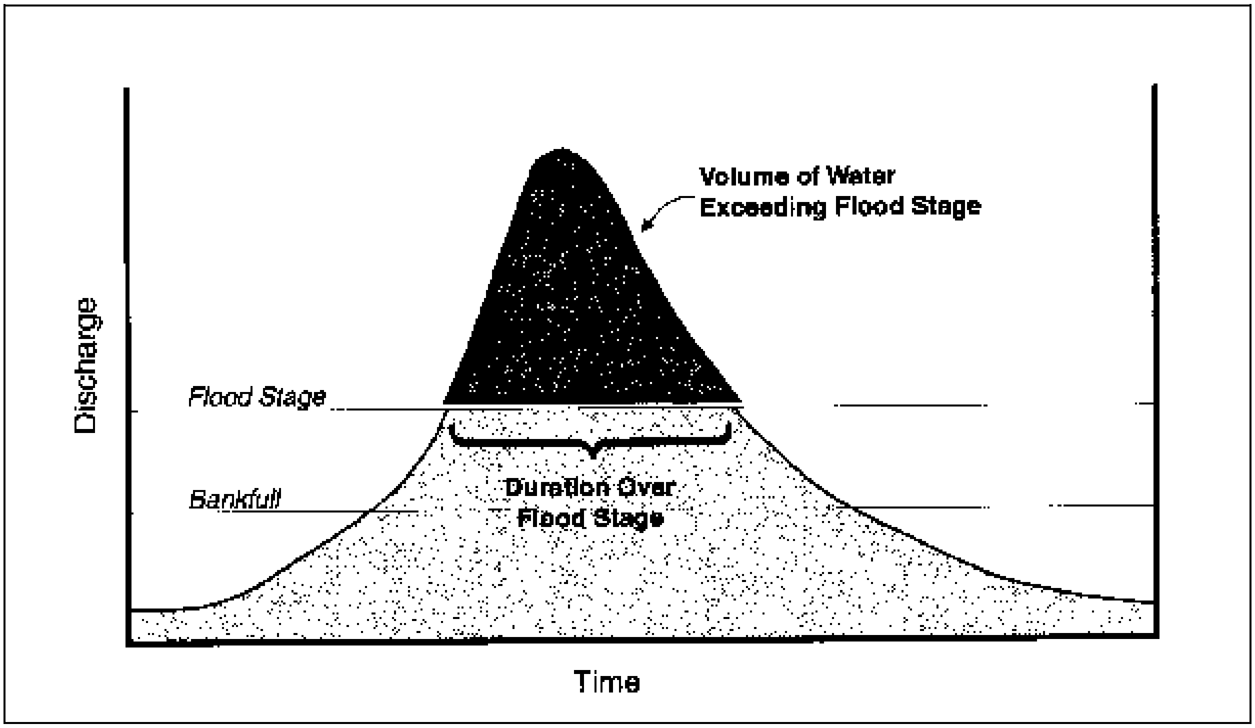

Figure 6-3-5. Relationship between flood stage and flood volume

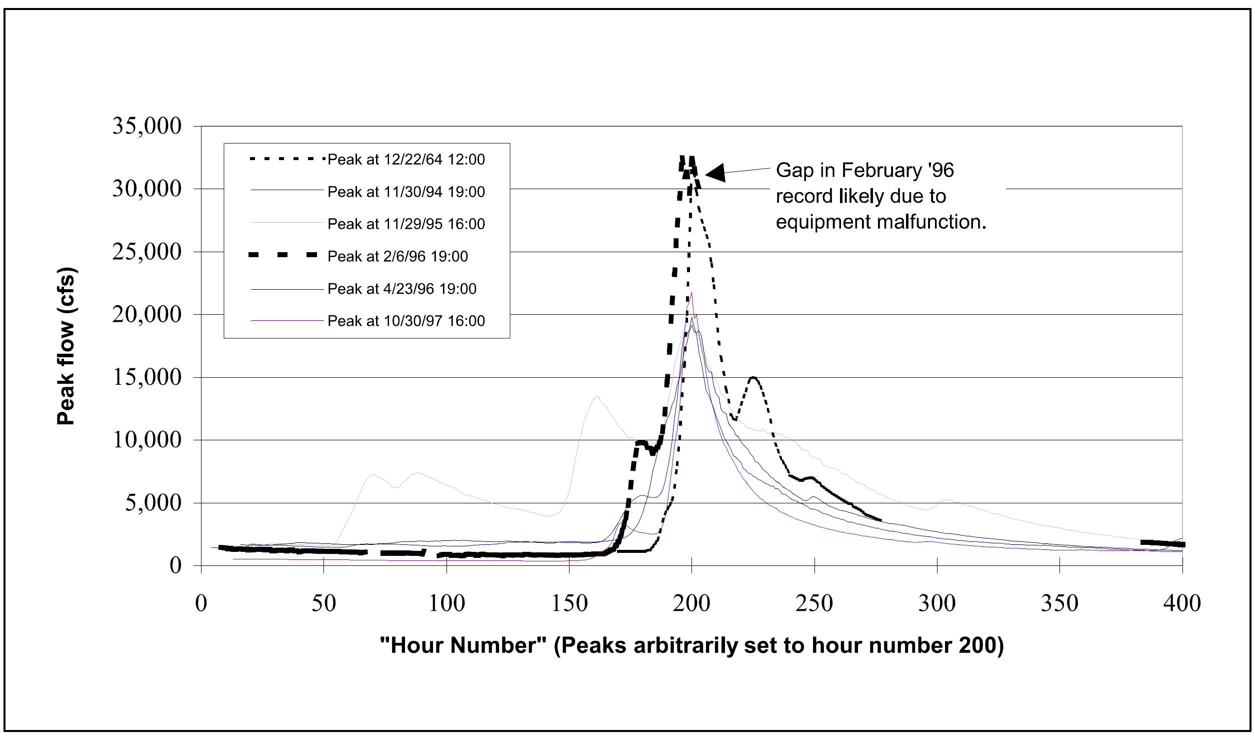

Figure 6-3-6. Peak Flows of the Wilson River, October 1994 through April 1998, and December 1994