Chapter 5

Modeling Guidelines

5.1 General

Training Document No. 13, entitled "Guidelines for the Calibration and Application of Computer Program HEC-6," (HEC 1992) describes methods and procedures for calibrating and applying computer program HEC-6. Other useful documents for sediment transport modeling are Thomas (1977), Gee (1984), Vanoni (1975), USACE (1989), and USACE (1993). Data requirements for river geometry, sediment characteristics and hydrology are discussed in these documents. Sensitivity of computed water surface profiles to data uncertainties is presented by HEC (1986).

5.2 Establishing Geometry

With the study reach located on a topographic map, mark the upstream boundary, the downstream boundary, the lateral limits and the location of each cross section. Assign an identification number to each cross section; river miles are recommended. Subdivide the floodplain into channel and overbank portions. These can be considered as subsections having similar hydraulic properties in the direction of flow. Within a subsection, flow conditions (depth, velocity, roughness) should be similar and, therefore, representative *n* values and reach lengths can be selected.

Plot each cross section as it appears at the starting time of the simulation (time zero) and divide each into two parts; the movable bed part in the main channel and the fixed part. Mark the elevations of geologic controls such as bedrock and clay layers on each cross section. If none are present, the program will arbitrarily assign ten feet below channel bottom to provide some finite depth of sediment material in the model. If more than ten feet of scour is expected, assign a lower bottom elevation.

It is necessary to locate the downstream end of the reach where there is a stable rating curve or known water surface elevation. For analysis of potential degradation this may be many miles downstream from the dam at a rock outcrop or concrete weir. For studies of reservoirs, the operating policy will define the reservoir level for the water surface profile computations and the program will adjust the bed according to calculated results.

5.3 Sediment Data

5.3.1 Sediment Particle Characteristics

Only inorganic sediments are addressed by the HEC-6 transport functions. Therefore, the amount of organic sediments in samples should be measured, expressed as a percentage, and removed before testing for the inorganic properties presented below. If a significant quantity of organic particles is present, such as on the Big Sandy River where coal amounted to 40% of the sample by weight, a suitable procedure for correcting the calculations must be developed. In the Big Sandy River case, the coal was represented by an equivalent sand size and treated as inorganic sediment having a specific gravity of 2.65.

5.3.2 Inflowing Sediment Load Synthesis

If the inflowing sediment load is not available, HEC-6 can calculate it from gradation curves for the bed material. This procedure is less desirable than obtaining measured inflowing sediment load data because of the difficulty of obtaining representative sediment samples for the entire bed. However, simulating conditions along a segment of the river permits the use of indicators such as aggradation, degradation and fluctuation in sediment discharge from one cross section to another. Use of these indicators helps to make a better estimate of the noncohesive sediment load than can be made by applying transport theory at only one point on the river.

5.4 Hydrologic Data

It is important that the water discharges in the computational hydrograph reproduce the long term flow-duration curve (for long term simulations). If a period of record flow sequence is not available, an annual pattern hydrograph can be determined from knowledge of the duration curve and the annual pattern of flows. It is important to include a wet and dry year in addition to an average year.

It is desirable to repeat discharges at selected time intervals throughout the hydrologic data set to provide a common basis for comparing rates of change. For example, the ending of each year with the same discharge (of short duration) will permit the comparison of water surface and bed profiles at fixed time intervals as time progresses.

Representation of the discharge hydrograph as a series of steady flows requires the preservation of total annual water and sediment volume while maintaining the shape and peak discharges of flood events. The duration of each discharge in the computational hydrograph should be at least long enough to permit the flow to pass through the longest reach. For instance, if the average water velocity is 10 ft/sec and the longest reach is 10,000 ft, the minimum flow duration for that flow is 10,000 ÷ 10 or 1,000 seconds (0.278 days). Longer durations may be used; however, since this is an explicit formulation of the basic equations, care must be taken to insure that time steps are not so long that oscillations are introduced into the sediment bed and water surface profiles. Limiting bed oscillations may require time steps on the order of the flow-through time for the shortest reach. See HEC (1992) for further information.

For moderate to large rivers, it is usually acceptable to approximate an annual hydrograph with 15 to 25 discharge segments. In general, the larger the discharge, the shorter its duration must be, because the larger discharges carry greater amounts of sediment and result in larger bed movements, increasing the possibility of numerical oscillations. A large discharge can be entered as several successive constant discharges to satisfy the requirement for shorter durations.