Floodway Analysis for SWMM Models

This document explains the procedures to follow in performing a floodway analysis in the U.S. Environmental Protection Agency's SWMM model.

Floodway analyses in unsteady flow models, such as SWMM, can consider the loss of floodplain storage and the loss of conveyance, while steady flow models can consider only the loss of conveyance in computing floodways. However, unsteady flow programs do not have an option to determine floodways automatically to account for the loss of floodplain storage and conveyance. Therefore, the encroachment stations for the floodway must be determined first from a steady flow model, such as HEC-2, using the equal conveyance reduction method. The computed encroachment stations will then be inserted into the unsteady flow model to compute the water-surface elevations for the floodway analysis to account for the loss of floodplain storage.

The following procedures should be followed in computing floodways for the SWMM model. This procedure assumes that the floodplain areas beyond the encroachment stations will be completely filled.

Data for natural cross sections

The data for the natural cross sections are specified by C2, C3, and C4 records (SWMM format) or NC, X1, and GR records (HEC-2 format). The natural (irregular) cross section is coded as 8 as the type of conduit shape on the C1 record of the SWMM model. The HEC-2 format is recommended when specifying data for the natural cross sections in the SWMM model.

The NC record specifies left overbank n-value, right overbank n-value, and channel n-value. The X1 record specifies cross section identification number (same as the conduit number on the C1 record), total number of ground stations on the following GR data lines, left bank station, right bank station, length of channel reach represented by this cross section, factor to modify the ground stations, and constant to be added (+ or -) to ground elevation data. The GR record specifies the elevation and station of the ground points. The user should refer to the SWMM user's manuals for the detail explanation of the variables on these records.

Maximum computed flow (discharge) and corresponding water-surface elevation

The maximum computed flow at the cross sections (conduits) and the corresponding time of occurrence is obtained from the Conduit Summary Statistics Table for the 1% annual chance flood. The SWMM output data also include water-surface elevations at the junctions and flows at the conduits for user-specified time intervals. The corresponding water-surface elevation at the time of occurrence of maximum computed discharge at a junction is obtained from the output data. The exact time of occurrence of the maximum computed flow at a conduit may not match the user-defined time interval. In that case the water-surface elevation at a junction should be obtained from the user-defined time intervals before and after the time of maximum discharge occurrence. A conduit in SWMM model is bounded by two junctions.

The water-surface elevation at the upstream junction and the flow at the conduit (cross section) should be used for the floodway analysis. The maximum computed flow at a conduit obtained from the Conduit Summary Statistics Table should be verified with the flow at the same conduit in the output data for the user-specified time interval.

Creation of steady flow file

The HEC-2 cross section data from the SWMM model are then copied to create a separate HEC-2 file. The user should refer to the HEC-2 user's manual for a detailed explanation of each record. The combination of QT, ET, and X5 records provide encroachment stations at each cross section based on the equal conveyance reduction principle for different target surcharge values. The maximum computed discharges from SWMM output data are specified on QT records for each cross section. The equal conveyance reduction method is specified on ET record with different target surcharge values. The X5 record specifies the 1% annual chance water-surface elevation for the unencroached profile and the floodway water-surface elevations for the encroached profiles. The floodway water-surface elevation is obtained by adding the target surcharge value to the 1% annual chance water-surface elevation. The HEC-2 program will not compute the backwater analysis if the water-surface elevations are specified on the X5 record. The HEC-2 program will determine the floodway encroachment stations for the specified floodway water-surface elevations.

The following steps should be followed to modify the HEC-2 file thus created to compute encroachment stations based on the equal conveyance reduction method.

Insert T1, T2, T3, J1, J2, and J3 records.

T1, T2, T3 are the title records.

Specify 2 in field 2 of the J1 record. Specify 0 in field 5 of the J1 record. In field 9 of the J1 record, specify the 1% annual chance water-surface elevation at the upstream junction of the first cross section (conduit) obtained from the SWMM output data. The number of the first cross section (conduit) is specified in the first field of the first X1 record.

Specify 1 in field 1 of the J2 record. Specify –1 in field 3 of the J2 record.

Specify 110, 115, and 200 in fields 1, 2, and 3 of the J3 record to obtain encroachment data in summary output tables 110, 115 and 200.

Insert QT record before every X1 record.

Specify the number of profiles to be analyzed in field 1 of the QT record. The number of profiles is equal to the number of floodway profiles for different target surcharge values to be considered plus one for the unencroached profile of the 1% annual chance flood. For example, if 5 different target surcharge values are to be considered, the number of profiles will be equal to 6 (1 unencroached profile plus 5 target surcharge profiles).

Specify the maximum computed flow (discharge) obtained from the SWMM output data at the conduit for the unencroached and floodway profiles. For this example, the maximum computed discharge will be specified on fields 2 through 7 of the QT record.

Insert ET record before the first X1 record.

Only one ET record is required before the first X1 record for the equal conveyance reduction method. Encroachment Method 4 is the equal conveyance reduction method in HEC-2. Specify different target surcharge values and the encroachment method starting from field 3 of the ET record. For example, for a target surcharge value of 1 foot, the number 10.4 is specified in field 3 of the ET record. If additional target surcharge values of 0.8, 0.6, 0.4, and 0.2 are to be considered, the numbers 8.4, 6.4, 4.4, and 2.4 are specified in fields 4, 5, 6, and 7 of the ET record, respectively.

Insert X5 record after every X1 record.

The X5 record is used in HEC-2 to specify the known water-surface elevation. HEC-2 will use this elevation to compute the floodway encroachment stations, and the backwater analysis will not be performed at this cross section. Specify the number of profiles to be analyzed in field 1 of the X5 record. Specify the 1% annual chance water-surface elevation at the junction upstream of the conduit (specified in field 1 of the X1 record) in field 2 of the X5 record. Specify the floodway water-surface elevations starting from field 3. The floodway water-surface elevation is obtained by adding the target surcharge value on the ET record to the 1% annual chance water-surface elevation in field 2 of the X5 record.

Insert EJ record after the last GR record.

Insert the group of T1, T2, T3, J1, and J2 records for each target surcharge value specified on the ET record. For example, if five different target surcharge values are specified, five groups of T1, T2, T3, J1, and J2 records must be inserted.

Insert ER record.

Save the newly created HEC-2 file and run the HEC-2 program.

Obtain one set of encroachment stations for a selected target surcharge value at each cross section from Table 110 of the HEC-2 output file.

Floodway analysis

The following procedure should be followed to analyze the floodway in the SWMM model.

Modify the SWMM file by deleting the ground stations beyond the selected encroachment stations and inserting the selected encroachment stations at each cross section. The weir length for the road profiles and weirs must be shortened based on the width between the selected encroachment stations at the cross sections bounding the road or the weir. The other conduit shapes that are considered between the natural cross sections should also be modified based on the encroachment stations at the natural cross sections, if necessary. Save the SWMM file for the floodway analysis and run the SWMM (EXTRAN) program.

The maximum computed flow at the cross sections (conduits) and the corresponding time of occurrence for the floodway analysis is obtained from the Conduit Summary Statistics Table for

the floodway run. The corresponding water-surface elevation at the same time of occurrence of maximum computed discharge at the upstream junction for each conduit (cross section) is obtained from the output data.

Create a table for junctions and the water-surface elevations for the unencroached run and the floodway run. The difference in water-surface elevations will provide the surcharge value. If the surcharge value is more than the allowable value at any cross section, a new set of encroachment stations from the HEC-2 run must be used to modify the cross section in the SWMM input file and the new floodway run must be conducted. This procedure should be followed until all the surcharge values are no more than the allowable value.