Section A1

Geometry and Channel Properties

A1.1 Title Records (T1 - T3)

Three title records are required at the beginning of the geometric data for each stream segment. Additional output of geometric data can be requested by specifying a B or C in Column 3 on the T1 record.

Field	Variable	Value	Description
0	ID	T1	Record identification in Columns 1 and 2. Enter T1, T2 and T3 for the first, second and third title records, respectively.
Column 3 of T1, record only	OPTION	Blank (zero not allowed)	Normal output-lists data from title records and the NC record. Only the cross section identification number is listed for records X1 through EJ.
		B	This option outputs the initial geometry of the model and causes the input records to be echoed in the output enabling the user to verify the initial geometry of the model. B-level output is normally not recommended, but it may provide useful additional information when initially developing a data set.
		C	This option activates trace level output. Use of this print option is not recommended. C-level trace output is intended only for error checking purposes.
2-10		Comments	Fields 2 through 10 (Columns 9-80) may be used for identification purposes such as labeling the data set, noting the date of the run, or other relevant information.

A1.2 NC Record - Manning's *n* values (required for first cross section)

The NC record specifies Manning's *n* values and the expansion and contraction coefficients for transition losses. An NC is required prior to the first cross section definition (the first X1 record). When changing previously specified values additional NC records are required at those cross sections where *n* values change. The NC record values are constant with depth and will be used until changed by the next NC record. NC records may be inserted before any X1 record. The *n* values apply over the reach, and will be used starting in the reach in which the record appears in the data set. Expansion and/or contraction coefficients apply to the next upstream reach.

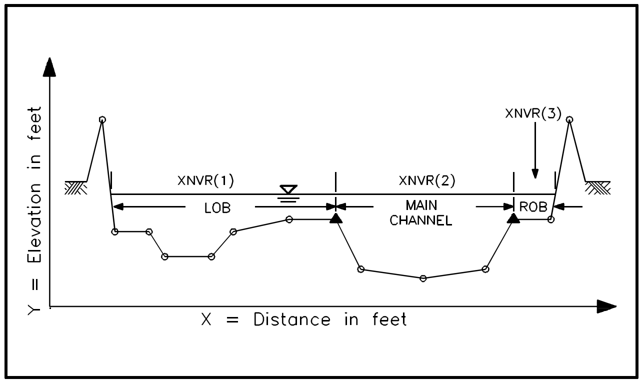

Figure A1-1
Channel and Overbank *n* values

Note: HEC-6 applies *n* values to the upstream reach whereas HEC-2 applies them halfway to the cross section on either side of the one for which they appear in the data set. However, results using either method are usually in close agreement without changing the *n* values.

Field	Variable	Value	Description
0	ID	NC	Record identification.
1	XNVR(1)	+	Manning's *n* value for the left overbank.
		0	No change from previous *n* value for the left overbank.
2	XNVR(3)	+	Manning's *n* value for the right overbank.
		0	No change from previous *n* value for the right overbank.
3	XNVR(2)	+	Manning's *n* value for the channel.
		0	No change from previous *n* value for the channel.
4	CC	+	Contraction coefficient used in computing transition losses.
		0	No change in contraction coefficient.
5	CE	+	Expansion coefficient used in computing transition losses.
		0	No change in expansion coefficient.
6-10			Leave blank.

A1.3 NV Record[1] - Vary *n* Values by Elevation or Discharge (optional)

A table of Manning's *n* values vs. either elevations or discharges can be entered on the NV record. The left overbank, the channel, and the right overbank are the three subsections. A separate NV record must be entered for each subsection. Code values in order of increasing elevation or discharge. The values on this record will be used for all succeeding cross sections until changed by the next NC or NV record.

HEC-6 linearly interpolates when elevations or discharges are between values specified in the table. When elevations or discharges are outside the range of values specified in the table the extreme values are used; i.e., no extrapolation occurs.

Field	Variable	Value	Description
0	ID	NV	Record identification.
1	NPAR, NCH	++	Enter subsection number in Column 7 and number of *n* values in Column 8. Subsection numbers are: 1 = left overbank 2 = channel 3 = right overbank A maximum of five *n* values are permitted per subsection. (For example, 13 denotes that three *n* values are coded for subsection number 1, the left overbank.)
2	VALN(1)	+	Manning's *n* value for lowest elevation in the table. A positive (+) *n* value denotes that a "*n* vs. elevation" table is being defined.
		-	Manning's *n* value for smallest discharge in the table. A negative (-) *n* value denotes that a "*n* vs. discharge" table is being defined. Note: Do not mix discharge tables and elevation tables at the same cross section.
3	ELQ(1)	-, 0, +	The elevation for positive VALN(1) or the discharge for negative VALN(1).
4	VALN(2)	+	Enter the next *n* value in the table. This can be blank if there is only one *n* value for this subsection.
5	ELQ(2)	-, 0, +	Enter the elevation or discharge for VALN(2).
6-10			Continue entering table values across the record. Code the fifth elevation or discharge value in Field 1 of a second NV record if five points are desired. Note: A maximum of five points may be entered per subsection.

[1] This record is different from HEC-2's **NV** record.

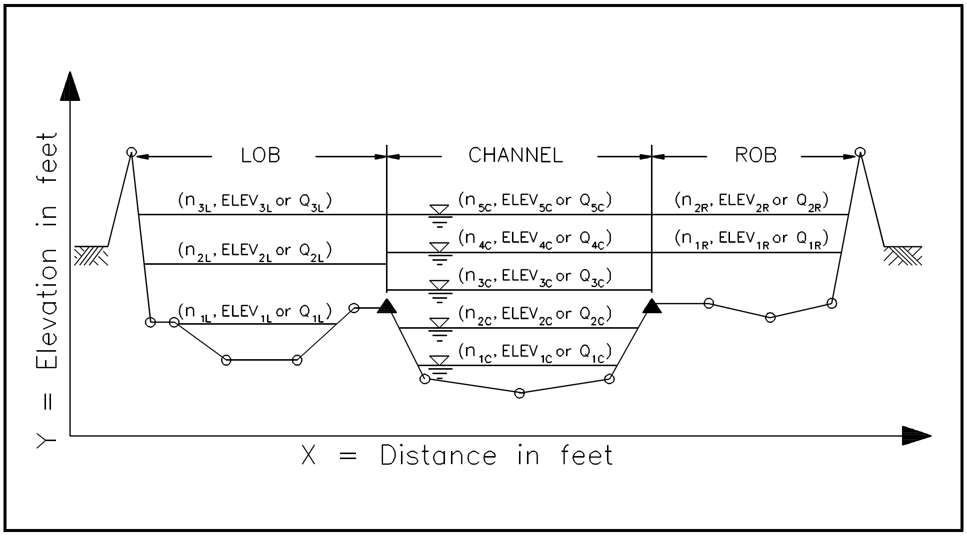

Figure A1–2
An Illustration of VALN and ELQ

Table A1-1

Relationship of *n* values to Elevations or Flows

n vs. Elevation			*n* vs. Discharge	
VALN(i)	ELQ(i)		VALN(i)	ELQ(i)
$+n_1$	$ELEV_1$		$-n_1$	Q_1
n_2	$ELEV_2$	OR	n_2	Q_2
n_3	$ELEV_3$		n_3	Q_3
n_4	$ELEV_4$		n_4	Q_4
n_5	$ELEV_5$		n_5	Q_5

A1.4 QT Record - Tributary or Local Inflow/Outflow Location (optional)

This record identifies the location of a tributary or a diversion point. It should be placed immediately before the X1 record for the first cross section upstream from the tributary or local inflow/outflow location. See Section 3.6.2.

Field	Variable	Value	Description
0	ID	QT	Record identification.
1	KQCH		Control point number.
			A local inflow/diversion point. When defining a local inflow/outflow point, leave Field 1 blank.
		2-10	A tributary junction (control) point. When defining a tributary junction point, a value must be entered in Field 1. This value should be within the range 2 through 10.
2-10			Leave blank.

A1.5 X1 Record - Cross Section Location (required for each cross section)

This record is used to identify the cross section and define its location relative to its downstream neighbor. Figure A1-3 illustrates the basic cross section information entered on this record.

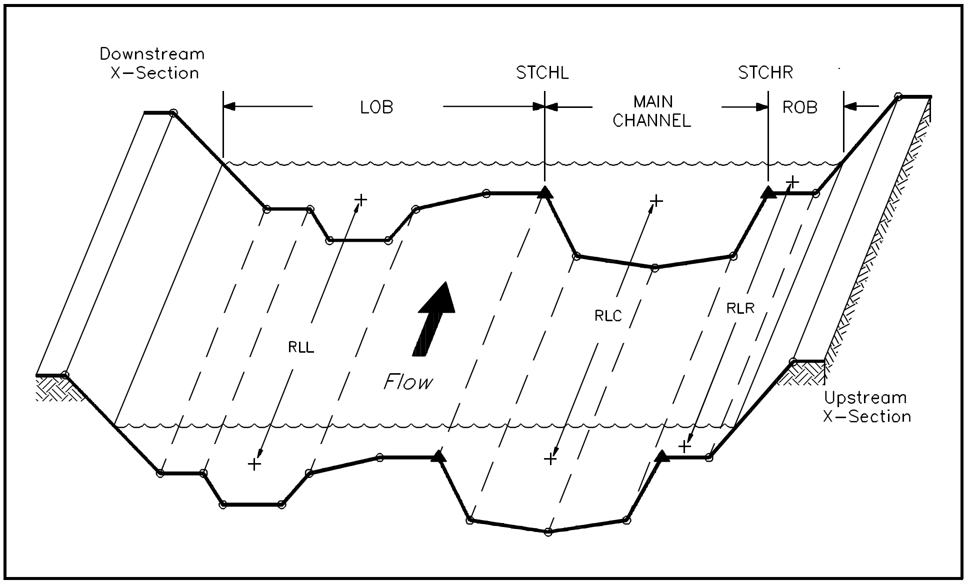

Figure A1–3
Example Illustrating the Main Channel and Right and Left Overbank Reach Lengths Between Consecutive Cross Sections

Field	Variable	Value	Description
0	ID	X1	Record identification.
1	SECID	-, 0, +	Cross section identification number.
2	NXY	+	Total number of coordinate points used to describe the cross section's geometry on the GR records which follow (5 € NXY € 100).
		0	Repeat Cross Section Option. The geometry of the previous (downstream) cross section (GR records) will be repeated for the present cross section. Therefore, no GR records will be entered for this section. Do not enter zero for the first cross section.
3	STCHL	-, +	Station of the left bank of the channel. Use top-bank when the bank roughness is included in channel *n* values. Toe of bank is recommended when channel bank roughness is included in overbank *n* values. STCHL need not equal one of the station values entered on the GR records for this cross section.
		0	For a repeat cross section, enter zero (or blank); i.e., when NXY is zero. The bank stations from the previous section will be used.

Field	Variable	Value	Description
4	STCHR	-, 0, +	Station of the right bank of the channel. Same rules as for STCHL above.
5	RLL	+	Reach length of the left overbank between current cross section and the (previous) downstream cross section.
		0	Enter zero (or blank) for the first cross section or when there is no left overbank subsection.
6	RLR	0, +	Reach length of the right overbank. Same rules apply as for RLL above.
7	RLC	0, +	Channel Reach Length. The same rules apply as for overbank reach lengths (RLL and RLR) above.
8	RX		Cross Section Width Adjustment Factor. Each station value defined in the GR data for this cross section will be multiplied by RX. For a repeat cross section, station values from the previous cross section will be changed before they are reused. For example, an RX value of 1.1 would increase each station by 10% and thereby, effectively widen the entire cross section by 10%. Note: The left and right channel stations, conveyance limits, ineffective area limits, movable bed limits, and limits of the dredged channel will all be adjusted by RX.
		+	Use a value for RX between 0.0 and 1.0 to narrow the cross section. Use a value greater than 1.0 to widen the cross section.
		0	No change to cross section stations.
9	DH		Cross Section Elevation Adjustment Factor. The constant DH will be added to each elevation value defined in the GR data for the cross section. For a repeat cross section, elevation values from the previous cross section will be changed before they are reused. For example, to describe a 4,000 ft long flume having a 1 ft/thousand slope, just enter the GR data for the first cross section and insert four repeat cross sections spaced 1,000 ft apart with DH=1. Note: If NV records are present, elevations will be changed, but the dredging template elevation, EDC, (H.6 or HD.6), is not changed.
		+	Constant that will be added to all elevations.
		-	Constant that will be subtracted from all elevations.
		0	No change to cross section elevations.

A1.6 X3 Record[2] - Encroachments (optional)

The X3 record provides three methods for defining encroachments to a cross section. These methods are: (1) ineffective flow area, defined using Field 1; (2) effective width, defined using Field 3; and (3) encroachment stations, defined using Fields 4-7. See Section 3.2.6 for a complete description of these three methods.

Field	Variable	Value	Description
0	ID	X3	Record identification.
1	MEID		Method 1. Ineffective flow area option.
		10	All water is confined to the channel, as defined by variables STCHL and STCHR on the X1 record, until the calculated water surface elevation exceeds the channel bank elevation (the elevations corresponding to STCHL and STCHR on the X1 record). The rest of this record may be left blank. See Figure A1-4.
		0	No ineffective flow area. Total area of the cross section described on GR records below the water surface elevation is used in the computations.
2			Leave blank.
3	ENCFP		Method 2. Effective width for all flow.
		+	HEC-6 confines all flow to the width specified by ENCFP. It will be centered between the left and right bank stations of the channel (STCHL and STCHR on X1 record). Side boundaries will be vertical and frictionless. Method 2 may be used in conjunction with Method 1.
		0	The width option is not being used or is not changed from previous value.

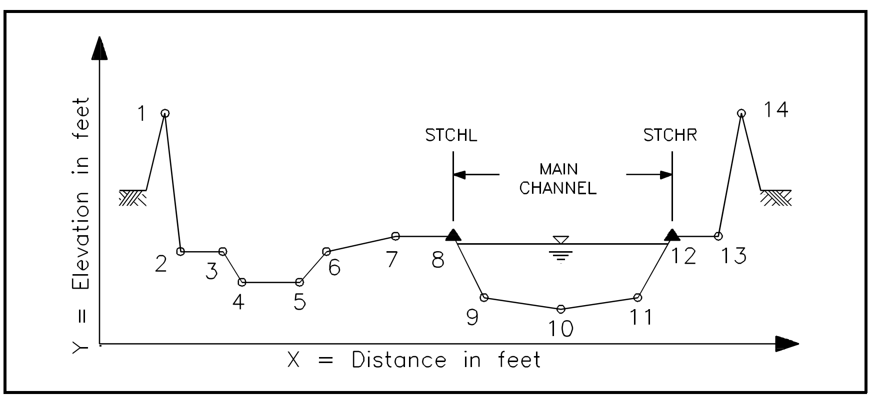

Figure A1-4
Example of Method 1 Encroachment to Keep Flow in the Main Channel up to the Designated Bank Elevations

[2] The HEC-6 **X3** record is different from the HEC-2 **X**-3 record.

Field	Variable	Value	Description
4	STENCL		Method 3. **Encroachment station left.** Method 3 may not be used in conjunction with Methods 1 and/or 2.
		-, +	STENCL sets a limit for flow on the left side of the channel. The side will be vertical and frictionless unless ELENCL is also used (see Field 5 below). See also Figure A1-5. Note: Do not enter a station value of zero since it will be treated as if no value was entered. Enter a small positive number like 0.01 instead.
5	ELENCL		Method 3. **Encroachment elevation left.**
		-, +	Enter the elevation at the top of the left encroachment. All cross section elevations for stations to the left of STENCL are raised to this elevation. Note: Do not enter a value of zero since it will be treated as if no value was entered as cautioned above.
6	STENCR		Method 3. **Encroachment station right.**
		-, +	Same rules and purpose as STENCL but for use on the right side of the channel.
7	ELENCR		Method 3. **Encroachment elevation right.**
		-, +	Same rules and purpose as ELENCL but for use on the right side of the channel.

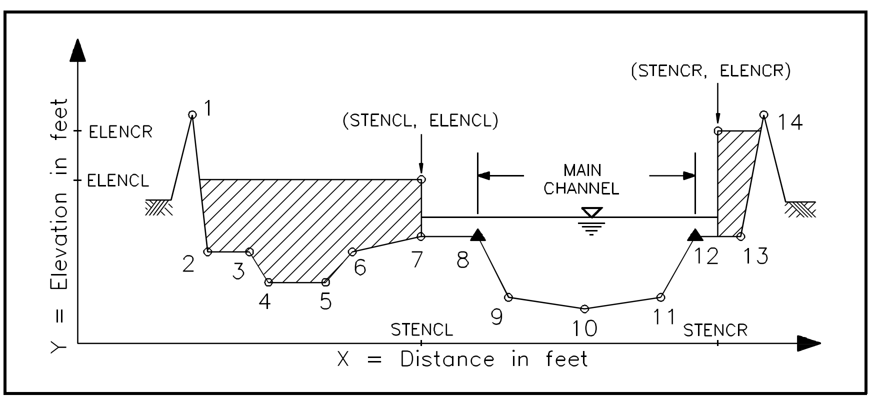

Figure A1–5
Example of Method 3 Encroachment Using
Prescribed Stations and Elevations (STENCL, ELENCL)

A1.7 X5[3] Record - Internal Boundary Condition (optional)

The X5 record creates an internal boundary (or hydraulic control point) within a project reach. If a minimum water surface elevation is specified at this internal boundary, it is called an internal boundary condition.

An internal boundary effectively divides the reach into two subreaches; the cross section where the X5 is placed becomes the downstream boundary for the reach upstream and the cross section immediately downstream becomes an upstream boundary for the downstream reach. Therefore, X5 records cannot be placed at successive cross sections, nor can they be placed at the cross section immediately upstream of an existing downstream boundary. It is important to note that the reach immediately downstream from the cross section at which an X5 record is placed is "transmissive"; i.e., no sediment interaction with the bed is computed in this reach. Therefore, the length of the reach downstream from the X5 location should be quite short or zero. Because this reach is transmissive, its length can be short (or zero) without impacting upon the time step selection. Use of repeat cross sections facilitates use of the X5 option.

An internal boundary can be used for two functions: (1) it provides two methods for setting an internal boundary condition as discussed below, and (2) it separates the reach into smaller subreaches for the purposes of sediment volume accounting and trap efficiency calculations. Example Problems 2 through 5 show how to use both methods of feature (1) and Example Problem 7 has an example using feature (2).

Method 1 is used to establish a minimum water surface elevation at dams, weirs, bridges, etc. This method allows the user to define a minimum water surface elevation as the internal boundary condition at an internal cross section. If the computed water surface at the next downstream cross section plus a specified head loss (field 3) is less than the minimum water surface elevation, then the specified elevation is assigned to the internal cross section and the step backwater computations proceed upstream.

Method 2 enables the user to prescribe the minimum water surface elevation at an internal cross section at each time step during the hydraulic computations. This is accomplished by specifying (in field 4 of the X5 record) the field on the R record where the minimum water surface elevation for this cross section can be found. Fields 2 through 10 are available on the R record for this purpose, therefore the user may not specify a value less than two nor greater than ten in Field 4 of the X5 record. The effect of this R record field specification occurs each time an R record is encountered in the hydrologic data set with a new value in the specified field. When this occurs, the new minimum water surface elevation is compared to the computed water surface of the downstream cross section plus the specified head loss (field 3). As in Method 1, the greater water value is assigned to the internal cross section as the computed water surface elevation.

By separating the project reach into smaller subreaches, the X5 record provides a mechanism for obtaining trap efficiency and sediment volume accounting for each subreach. This feature is invoked simply by the existence of the X5 record in the cross section definition. If it is not desired to specify the water surface elevation (internal boundary condition), but trap efficiency values are of interest, simply enter an X5 record with Fields 1-10 blank.

[3] The HEC-6 **X5** record is different from the HEC-2 **X5** record.

Field	Variable	Value	Description
0	ID	X5	Record Identification
1			Leave blank.
2	UPE	-, +	Method 1 - Minimum Water Surface Elevation. The water surface elevation at this cross section will be UPE unless the water surface at the downstream section plus HLOS exceeds UPE. (HLOS is coded in Field 3.)
		0	Zero indicates that Method 1 is not used. If the desired minimum water surface elevation is zero, enter a small positive value (e.g., 0.001).
3	HLOS	0, +	Head loss between this section and the cross section immediately downstream. The specified water surface elevation is overridden when the tailwater elevation plus HLOS is higher.
4	ICSH	2-10	Method 2 - R Record Field. This method allows the user to specify the minimum water surface elevation for this cross section on each R record in the hydrologic data set. The value entered here is the number of the field of each R record where HEC-6 will look for the minimum water surface elevation for this cross section (see R record description in Section A3.4). Note: Do not use ICSH=1. Field 1 is reserved for specifying the water surface elevation at the downstream boundary control point.
		0	Zero indicates that Method 2 is not used. When using Method 2, allowable values are in the range from 2 to 10.

A1.8 XL Record - Conveyance Limits (optional)

Two methods are available for specifying conveyance limits. In Method 1, only a width is specified which is centered between the left and right bank stations specified on the X1 record. Use Field 3 to specify this width and leave Fields 4 and 5 blank. In Method 2 both a left and right station must be specified to define the conveyance portion of the channel. Enter the left and right stations for the conveyance limits in Fields 4 and 5 and enter a zero in Field 3 or simply leave it blank.

Field	Variable	Value	Description
0	ID	XL	Record identification.
1-2			Leave blank.
3	CLC	+	*Method 1.* Enter the width of the conveyance channel. It will be centered between left and right bank stations (STCHL and STCHR on X1 record).
		0	Use Method 2.
4	CLL	-, +	*Method 2.* Enter the cross section station for the *left* side of the conveyance channel. It does not have to coincide with a GR station point. It can be any place in the cross section, but it must be less than CLR. *Note:* Do not enter a value of zero since it will be interpreted as though no value was entered. Enter a small positive value (e.g., 0.001) when a value of zero is desired.
5	CLR	-, +	*Method 2.* Enter the cross section station on the right side of the conveyance channel. It does not have to coincide with a coordinate point. It can be any place in the cross section, but it must be greater than CLL. *Note:* Do not enter a value of zero since it will be interpreted as though no value was entered. Enter a small positive value (e.g., 0.001) when a value of zero is desired.
6-10			Leave blank.

A1.9 GR Record - Cross Section Coordinates (required)

Cross section geometry is defined as a series of elevation and station coordinates entered on GR record. This record specifies the elevation and station of each coordinate used to describe the geometry of a cross section as illustrated in Figure A1-6. A set of GR records is required for each cross section unless NXY (X1.2) is zero indicating a repeat cross section. Stations must be entered in increasing order. Enter up to five coordinates per GR record. A maximum of 100 points (or twenty GR records) per cross section is permitted.

Field	Variable	Value	Description
0	ID	GR	Record identification.
1	EL(1)	-, 0, +	Elevation of first ground point.
2	STA(1)	-, 0, +	Station of first ground point.
3	EL(2)	-, 0, +	Elevation of second ground point.
4	STA(2)	-, 0, +	Station of second ground point.
5-10			Etc., continue elevation and station values for up to 100 ground point pairs. Each continuation record is identified with GR in Field 0, and the format is identical for all records.

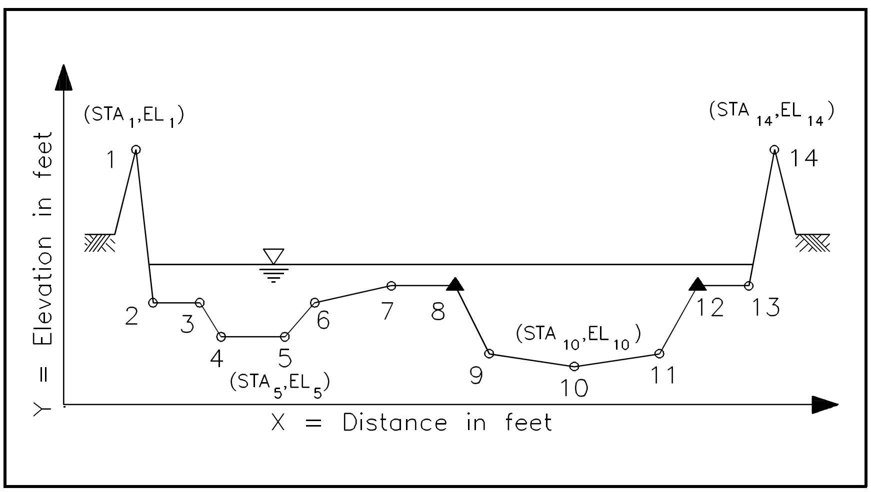

Figure A1-6
Example of GR Station and Elevation Pairs
Defining a Channel Cross Section

A1.10 H Record - Movable Bed Limits (required if not using HD Record)

This record prescribes the width and depth of the bed sediment control volume and the dredging template at a cross section. HEC-6 computes the depth of sediment in the bed from the elevation of the model bottom, EMB, defined in Field 2 of this record. The HD record allows the user to directly prescribe the depth of the bed sediment control volume in Field 2. Other data on this record is the same as the HD record and either record is acceptable. Note that if a movable bed limit coincides with a GR point, that point is movable.

Field	Variable	Value	Description
0	ID	H or HD	Record identification.
1	SECID	-, +	Cross Section Identification Number. Use the same value as previously entered in X1.1 for this cross section.
For H Record			
2	EMB	-, +	Elevation of Model Bottom (EMB). Enter the desired elevation. HEC-6 will not scour the bed below this elevation. Beware, a large depth of sediment can cause calculated volumes to be too large for computer word lengths, resulting in program failure.
		0	HEC-6 sets EMB to 10 ft below the minimum channel elevation of this cross section.
For HD Record			
2	DSM	0, +	Depth of the Bed Sediment Control Volume at this cross section. Negative values are not permitted. There is no default. (See warning for EMB above.)
3	XSM	-, +	Movable Bed Boundary, Left. Cross section station at change from fixed bed to movable bed; counterpart to XFM (H.4). Cross section coordinates between and including XSM and XFM will be adjusted vertically for scour and deposition. This station need not coincide with an existing GR point.
		0	HEC-6 will automatically set the movable bed limits according to the location of the water surface.
4	XFM	-, +	Movable Bed Boundary, Right. Cross section station at change from movable bed to fixed, counterpart to XSM (H.3). See XSM.
		0	HEC-6 will automatically set the movable bed limits according to the location of the water surface.
5			Leave blank.

Field	Variable	Value	Description
6	EDC	-, +	Elevation of Bottom of Dredged Channel. Do not include overdredging here (see H.10). This value should always be above the model bottom. (EMB in field H.2.)
		0	Dredging is not desired at this cross section. If the desired elevation of the dredged bottom channel is zero, enter a small positive value.
7	XSD	-, +	Dredged Channel Boundary, Left. Enter the station of the cross section coordinate point on the left side of the dredged channel, so that the elevation of coordinate points within the dredged channel (from XSD to XFD (H.8)) can be corrected for dredging. XSD should always be greater than or equal to XSM.
		0	XSD is set equal to XSM (H.3).
8	XFD	+	Dredged Channel Boundary, Right. Enter the station of the cross section point at the right of the dredged channel, beyond which no dredging is performed, counterpart to XSD. XFD should always be less than or equal to XFM.
		0	XFD is set equal to XFM (H.4).
9	XDM	+	Cross section station of highest elevation inside the dredge template. HEC-6 tests the elevation of that point against the elevation of dredged channel to determine whether or not dredging is required. Enter the station value of the cross section having the highest elevation within the portion of channel to be dredged.
		0	HEC-6 uses the first (left-most) station within the dredged channel portion of the cross section.
10	DOD	+	Depth of Overdredging. Used to establish some extra depth below the required bottom elevation. Enter the amount of overdredging desired at this cross section. Do not allow overdepth dredging below the bottom of the bed sediment control volume.
		0, b	Leave blank if overdredging is not required.

A1.11 EJ Record (required) - End of Geometric Data

End of geometric model data is established by an EJ record. This record must be the last geometry record entered for each stream segment described in the geometry section.

Field	Variable	Value	Description
0	ID	EJ	Record identification.
1-10			Leave blank.

A1.12 $TRIB Record - Tributary Inflow Point (optional)

This is the HEC-6 record which identifies the beginning of the geometry or sediment data set for each tributary in the stream network. The difference between a tributary and a local inflow is that the tributary is a branch in the network geometry data set whereas a local inflow point has no geometry. Refer to Section 3.6 for instructions on assembling data for tributary systems.

Place a $TRIB command in front of each tributary geometric data set and in front of each tributary sediment data set.

Important Note: A $TRIB record for this version of HEC-6 has a different meaning than a $TRIB record for versions released prior to June 1991. A $TRIB record from an old (pre 1991) data file should be changed to a $LOCAL record in order to run the data using Version 4.0 or later of HEC-6.

Field	Variable	Value	Description
0	ID	$TRIB	Record identification (Columns 1 - 5).
2-10			Leave blank.

A1.13 CP Record - Control Point Identification (optional)

The CP record is used to associate each tributary data set with the cross section where it enters the network. The value entered in Field 1 should equal that given on the QT record associated with the tributary.

A CP record must follow each $TRIB record used in the geometry data set. The appropriate records (described previously in this section) needed to detail the geometry of the tributary should follow the CP record.

Field	Variable	Value	Description
0	ID	CP	Record identification.
1	JPNUM	+	Junction (control) point number.
2-10			Leave blank.