Section A2

Sediment Properties

and

Transport Functions

A2.1 Title Records - Comments (five required - T4 - T8)

Five Title Records are required to precede the sediment data for each segment in a network. They each have a T in Column 1 and the sequence number in Column 2. The number four is suggested for the first sequence number. A Data Echo print option is available; see below for details.

Field	Variable	Value	Description
0	ID	T4	Record identification in Columns 1 and 2. T4, T5, T6, T7, and T8 for the fourth through eighth title records, respectively.
Column 4 of T4 record only	OPTION	B	Data Echo. Each input record is echoed to the output file as it is read. This is available to help the user verify the initial conditions and is not recommended for normal use. To exercise this option, enter B in Column 4 of the first title record (T4) of this group. Otherwise leave blank.
1-10[4]			Fields 1 through 10 (Columns 5-80) may be used for identifying the stream segment, project date, or any other relevant information.

[4] Column 4 of the first title record (**T4**) is reserved for requesting an output option that echoes the input and should be left blank if a data echo is not required.

A2.2 I1 Record - Sediment Properties (required)

The I1 record contains sediment properties.

Field	Variable	Value	Description
0	ID	I1	Record identification.
1			Leave Blank.
2	SPI		Iterations of the Exner computations.
		+	Specify the number of exchange increments used during each time step to recalculate the composition of material in the bed.
			Note: More than any other input variable, SPI affects computation time. If too small of a value is used, calculations may display oscillations in the amount of sediment being transported and in the bed profile. The value can be increased to 20 or more, until the computed results are essentially the same as those calculated with SPI left blank or zero.
		0	HEC-6 calculates a value for SPI.
			Note: The value of SPI computed by HEC-6 (if the user does not specify a value) can be very large for some problems. We suggest that users avoid using values greater than SPI = 50. A message will appear in your output if the computed SPI value is greater than 50. If the user chooses to use the larger values,

A2.3 I2 Record - Parameters Required for Clay Transport (optional)

The presence of an I2 record instructs HEC-6 to calculate transport of clay. The data included on this record provides parameters and guidelines with which to structure the computations for clay transport.

Note: The clay transport relationships were derived from experiments where the suspended sediment concentrations were less than 300 mg/€ (Krone 1962). Applications to field situations where suspended sediment concentrations are greater than 300 mg/€ may exceed the intended range of applicability of the relationships. Also note, that the relationships for clay deposition were derived from one-dimensional channels where the velocity and sediment concentration profiles are reasonably uniform. Users may experience difficulty simulating clay deposition rates in deep reservoirs.

If the I2 record is used by itself, HEC-6 will only compute deposition of clay. However, if two Special I2 records are used in addition to the first I2, both deposition and erosion of cohesive sediment (clay and silt) will be computed.

Field	Variable	Value	Description
0	ID	I2	Record identification.
1		Comment	Any alphanumeric characters or comments.
2	MTCL		Clay Transport Method.
		0, 1	Deposition of clay using settling velocity is computed only. No clay erosion is computed.
		2	Deposition and erosion of cohesive sediments are computed. Deposition is computed by the Krone (1962) equation and erosion by the Ariathurai (1976) method. Note that this method requires the addition of two Special I2 records.
3	ICS	b, 1	Initial size class interval for clay - there is only one clay size available, so enter 1 or leave blank.
4	LCS	b, 1	Last size class interval for clay - there is only one clay size available, so enter 1 or leave blank.
5	SPGC	+	Specific gravity of clay particles.
		0	The default is 2.65.
6	DTCL	+	The shear threshold for clay deposition. This is the average bed shear stress in lbs/sq ft above which clay will not be deposited. This value is ignored when the Special I2 records are used.
		0	The default is 0.02 lb/sq ft.
7			Leave blank.

[5] There is no default, user must enter a value.

A2.5 I3 Record - Parameters Required for Silt Transport (optional)

The presence of an I3 record instructs HEC-6 that the mixture of sediment to be analyzed contains silt size particles. The data included on this record provides parameters and guidelines within which to structure the computations for silt transport. Do not attempt to include silt particles without also including clay. If no clay is present in the system, enter zero for clay on the LF and PF records.

When modeling erosion of silts, you must provide an I2 and two Special I2 records to define erosion parameters of silt grains.

Field	Variable	Value	Description
0	ID	I3	Record identification.
1		Comment	Any alphanumeric characters or comments.
2	MTSL		Silt Transport Method
		1	Settling velocity method for calculating deposition of silt.
		2	Method for computing scour and deposition of silt.
			Note: This method requires the use of an I2 record and two Special I2 records, as described on the preceding pages.
3	IASL	+	ID number of the smallest grain size classification of silt to be transported (see Table A2-1). IASL must always be less than LASL.
		0	Default IASL=1.
4	LASL	+	ID number of the largest grain size classification of silt to be transported (see Table A2-1).
		0	Default LASL=4.

Table A2-1
Grain Size Classes; Silts

ID Number	Classification	Grain Size (mm)	Geometric Mean (mm)
1	Very fine	.004 - .0080	.005
2	Fine	.008 - .0160	.011
3	Medium	.016 - .0310	.022
4	Coarse	.031 - .0625	.044

The data in Table A-2 is predefined in HEC-6; IASL and LASL must be selected from this table. HEC-6 automatically includes all sizes between IASL and LASL if the I3 record is present in the input. If transport of clay is to be computed as well as silts, IASL should equal one to provide a continuous representation of grain size classes from clay to silts. If transport of sands is to be computed as well as silts, LASL should equal four for the same reason. Grain sizes which are not found in the bed may be so noted (with zero values) in the bed material gradation specified on the PF records.

Field	Variable	Value	Description
5	SGSL	+	Specific gravity of silt particles.
		0	Default = 2.65
6	DTSL		Deposition threshold for silt.
		+	The average bed shear stress in lb/sq ft above which silt material will not be deposited. This value is ignored if Special I2 records are used.
		0	Default = 0.02 lb/sq ft (for lack of better data).
7			Leave blank.
8	PUSD	+	Unit weight of fully consolidated silt deposits in lb/cu ft.
		0	Default = 82 lb/cu ft.
9	UWSL	+	Unit weight of silt material at the moment it is deposited on the stream bed.
		0	Default = 65 lb/cu ft.
10	CCSD	+	Compaction coefficient for silt deposits for the equation $\epsilon_{silt} = UWSL + [CCSD \cdot (\log_{10}(Time)]$ where time is the accumulated simulation time expressed in years.
		0	Default = 5.7 lb/cu ft/yr.

A2.6 I4 Record - Parameters Required for Sand Transport (optional)

The presence of an I4 record indicates that sand sizes are present in the mixture of sediment to be analyzed. The data on this record provides parameters and guidelines within which to perform the computations for sand transport.

Field	Variable	Value	Description
0	ID	I4	Record identification.
1		Comment	Any alphanumeric characters or comments.
2	MTC		Transport capacity relationship[6] to be used by HEC-6 to compute sediment load for a given water discharge.
		0, 1	Toffaleti's (1966) transport function.
		2	User Specified Transport Function. User specification of transport coefficients based upon observed data. User must supply his own transport relationship in the form of DS vs. transport coefficients (on records J and K), where DS is depth times slope. See instructions for the J and K records for a

[6] Users should refer to Chapter 2 of Vanoni's Sedimentation Engineering (1975), for information regarding the best transport function to use for specific types of rivers and bed material types.

Field	Variable	Value	Description
3	IASA	+	ID number of the smallest grain size classification of sand to be transported in the calculations (see Table A-3). IASA must always be less than LASA.
		0	Default IASA = 1.
4	LASA	+	ID number of the largest grain size classification of sand to be transported in the calculations (see Table A-3).
		0	Default LASA = 10.

The following table of grain sizes is predefined in HEC-6. IASA and LASA must be selected from this table. All sizes between, and including, IASA and LASA will be transported. If transport of silts is to be computed as well as sands, IASA should equal one to provide a continuous representation of grain size classes from silts to sands even if the very fine sand sizes are not found in the bed. Grain sizes which are not found in the bed may be so noted in the bed material gradation specified on the PF record.

Table A2-2
Grain Size Classes; Sands

ID Number	Classification	Grain Size (mm)	Geometric Mean (mm)
1	Very Fine Sand	.062 - .125	.088
2	Fine Sand	.125 - .250	.177
3	Medium Sand	.25 - .50	.354
4	Coarse Sand	.50 - 1.0	.707
5	Very Coarse Sand	1 - 2	1.414
6	Very Fine Gravel	2 - 4	2.828
7	Fine Gravel	4 - 8	5.657
8	Medium Gravel	8 - 16	11.31
9	Coarse Gravel	16 - 32	22.63
10	Very Coarse Gravel	32 - 64	45.26
11	Small Cobbles (SC)	64 - 128	90.51
12	Large Cobbles (LC)	128 - 256	181.0
13	Small Boulders (SB)	256 - 512	362.0
14	Medium Boulders (MB)	512 - 1024	724.1
15	Large Boulders (LB)	1024 - 2048	1446.2

A2.7 I5 Record - Weighting Factors for Numerical Integration Method (optional)

Use this record to enter hydraulic parameter weighting factors. Section 2.2.4 presents two sets or schemes of weighting factors for the numerical integration method used by HEC-6. If the I5 record is omitted, HEC-6 defaults to the Scheme 2 weighting factors. All values must be supplied.

Field	Variable	Value	Description
0	ID	I5	Record identification.
1		Comment	Any alphanumeric characters or comments.
2	DBI	+	Weight assigned to hydraulic properties at second cross section when calculating at downstream boundary.
3	DBN	+	Weight assigned to hydraulic properties at downstream boundary for downstream boundary calculations. Note: DBI + DBN must equal 1.0.
4	XID	+	Weight assigned to hydraulic properties at the downstream cross section - interior point calculations.
5	XIN	+	Weight assigned to hydraulic properties at cross section of interest - interior point calculations.
6	XIU	+	Weight assigned to hydraulic properties at the upstream cross section - interior point calculations. Note: XID + XIN + XIU must equal 1.0.
7	UBI	+	Weight assigned to hydraulic properties at next to last cross section for calculation at upstream boundary.
8	UBN	+	Weight assigned to hydraulic properties at upstream boundary. Note: UBI + UBN must equal 1.0.

A2.8 J Record[7] - User Specified Transport Function (optional)

Use the J record to define the coefficients of the User Specified Transport Function. This function is expressed by the equation:

$$GP_i \quad ((((EFD \quad SLO) \quad C_i) / A_i)^{B_i}) \quad EFW \quad STO$$

where: A_i, B_i, C_i=coefficients entered on the J records in units of

[7] If the user decides to use the special transport function option, then **both** a set of **J** records and **K** record must be provided in order to specify the required information and coefficients to use this option.

A2.11 LT Record - Total Sediment Load for the Water Discharge-Sediment Load Relationship (required)

The inflowing sediment load is related to water discharge by prescribing the discharge in cfs on the LQ record, total sediment load in tons per day on the LT record and the fraction of the sediment load in each grain size class on LF records. Each LF record describes one grain size fraction; they should be entered from fine to coarse. Enter the total sediment load in tons per day on the LT record as follows.

Field	Variable	Value	Description
0	ID	LT	Record identification.
1		Comment	Any alphanumeric characters or comments.
2	QSED	+, 0	Total sediment load in tons per day. This value corresponds to the water discharge entered in Field 2 of the LQ record.
3	QSED	+, 0	Total sediment load in tons per day. This value corresponds to the water discharge entered in Field 3 of the LQ record.
4-10	QSED	+, 0	Continue to enter the total sediment load values for each subsequent water discharge entered on the LQ record. A maximum of nine values is permitted.

Field	Variable	Value	Description
5	DAXIS(2)	+	The grain size diameter in millimeters at the first coordinate point down the percent finer curve from DMAX. If DAXIS (1) or (2) particle size is larger than 2048 mm, choose a point that will approximate the PF-Curve with two straight line segments from DMAX to 2048 mm. Note: It is not necessary that this or any PF-coordinate correspond to a grain size class interval boundary - although they can. Semi-log interpolation is used to calculate the percent finer at each class interval boundary and these are subtracted to calculate the fraction of sediment in each size class.
	PFAXIS(2)	0, +	The percent finer corresponding to DAXIS(2). Code as a percent (e.g., enter 10 for 10%, 20 for 20%, etc.).
7-10	DAXIS-PFAXIS	0, +	Continue to code points from the percent finer curve in (grain size diameter, percent finer) pairs. Use up to 3 continuation PFC records to code a maximum of 16 points. Begin coding data in Field 1 of continuation records.

A2.14 $LOCAL Record - Local Inflow (optional)

This record indicates that a water-sediment discharge table for a local inflow or diversion follows. It is used to separate inflow/diversion data from other data in the data stream.

Place the $LOCAL record after the PF records in the sediment data to separate the sediment data for the current stream segment from the water-sediment discharge table information needed for the local inflow(s) on the same stream segment. Use only one $LOCAL record per branch of the network even though several sediment inflow/diversion data sets may be present on that stream segment.

A separate set of LQL, LTL and LFL records is required to specify each local inflow and/or diversion. Enter each set of LQL, LTL and LFL records in the same order as the local inflow points appear in the stream segment's geometry (downstream to upstream). The range of water discharges are specified on the LQL records, with corresponding sediment loads (for each water discharge) on the LTL records. Each LFL record specifies the sediment load fraction associated with each grain size defined by the I2 - I4 records.

Note: The $LOCAL record replaces the $TRIB record in old data sets.

Field	Variable	Value	Description
0	ID	$LOCAL	Record identification (Columns 1 through 6).

A2.16 LTL Record - Total Sediment Load for Local Inflows/Diversions Specification (optional)

A set of LQL, LTL, and LFL records are used to specify the water discharge and sediment load associated with a local inflow or diversion. The total sediment load corresponding to the discharges entered on the LQL record is entered on the LTL record in units of tons/day.

Field	Variable	Value	Description
0	ID	LTL	Record identification (Columns 1 through 3).
1		Comment	Any alphanumeric characters or comments.
Inflows			
2-10	QSED	+	Total sediment load (tons/day) corresponding to each water discharge given on the LQL record, for the local flow-sediment load table. A maximum of nine values is permitted.
Diversions			
2, 3	QSED	1.0	If only diversions make up the local hydrograph, enter 1.0 in Fields 2 and 3 and leave Fields 4 through 10 blank.
4-10			Leave blank.
Combined Diversions and Inflows			
2, 3	QSED	1.0	If diversions are included in the local hydrograph, enter 1.0 in Fields 2 and 3.
4-10	QSED	+	Total sediment load (tons/day) corresponding to each water discharge given on the LQL record, for the local flow-sediment load table. A maximum of seven values is permitted.

A2.17 LFL Record - Sediment Grain Size Distribution for Local Inflows/Diversions (optional)

A set of LQL, LTL, and LFL records are used to specify the water discharge and sediment load associated with a local inflow or diversion. The LFL records specify the fraction of the total local sediment load per size class.

The LFL records should be entered from fine to coarse with one LFL record for each of the sediment size classes specified on the I2 - I4 records. If only inflows occur as this local point, then the LFL records have the same format and rules as the LF records. Diversion points and combination inflow-diversion points require a slight variation from the upstream inflowing sediment load table. All diversions are prescribed by a ratio of the concentration of sediment in diverted water to that in the main channel just upstream from the diversion point.

Field	Variable	Value	Description
0	ID	LFL	Record identification (Columns 1 through 3).
1		Comment	Any alphanumeric character comment. (It is recommended that the grain size class be entered in the comment field, i.e. CLAY, SILT1, SILT2, VFS, FS, ... VCG).
Inflows			
2-10	QSF	+, 0	Enter the fraction of the total sediment load for this sediment size class corresponding to each water discharge specified on the LQL record.
Diversions			
2, 3	QSF		Enter the diversion coefficient (ratio of diverted sediment concentration to the ambient channel concentration) for the corresponding diversion (negative) discharge specified on the LQL record.
		+	When field data is available, calculate the ratio of $C_{Diverted}/C_{Ambient}$ and use that value. Otherwise, a value of 1.0 may be appropriate for suspended load and possibly, >1.0 for bed load.
4-10			Leave blank.

Field	Variable	Value	Description
Combined Diversions and Inflows			
2, 3	QSF		Enter the diversion coefficient (ratio of diverted sediment concentration to the ambient channel concentration) for the corresponding diversion (negative) discharge specified on the LQL record.
		+	When field data is available, calculate the ratio of $D_{diverted}/C_{Ambient}$ and use that value. Otherwise, a value of 1.0 may be appropriate for suspended load and possibly, >1.0 for bed load.
4-10	QSF	+, 0	Enter the fraction of the total sediment load or this sediment size class corresponding to each water discharge specified on the LQL record.