



INPUT DATA FOR SIMPLIFIED DAM-BREAK MODEL (SDB)

Modifications by Janice Sylvestre

Includes Modifications to the NWS Document

THE NWS SIMPLIFIED DAM-BREAK FLOOD FORECASTING MODEL¹

By Danny L. Fread, Janice M. Lewis, and Stephen M. Wiele

This document contains portions of the NWS SMPDBK document¹ which includes a description of the input and output variables. It contains corrections to the original documentation in addition to a description of the enhancements to the model (renamed SDB to distinguish it from the NWS model). It is recommended that the SDB-J application be used to create input files and to display the results.

Description of Input Parameters

The NWS SMPDBK document (Appendix I)¹ contains a detailed description of the data needed to run NWS SMPDBK and the assumptions made to run the model in an emergency situation. It also contains step-by-step instructions on how to compute the output parameters manually. All of these calculations utilize data supplied by the user. Although the model supplies default values for several input variables, the most accurate results are produced when the most accurate data are entered. It is strongly recommended that the best possible estimates of the input variables be used for each application.

Although the Metric option allows the input and output parameters to be displayed in Metric units, all computations within the SDB model are done in English units. Unless noted, the English/Metric conversion units are as follows:

Table 1. English/Metric Equivalents

Property	English Unit	Metric Unit	Conversion Factor (English to Metric)
Time	hr	hr	--
Elevation/depth/width	ft	m	1/3.281
Flow	ft ³ /sec	m ³ /sec	1/35.32
Velocity	ft/sec	m/sec	1/3.281
Area	ft ²	m ²	1/10.765
Surface Area	acres	km ²	1/247.1
Bottom Slope of channel	ft/mile	dimensionless	1/5280
Manning's n	English and Metric are same		
Note: Although the documentation refers to English units only (unless noted), the Metric option is fully functional. This table should be used to determine comparable units and to convert the recommended values to Metric units.			

The input data is written to a text file. The data is fixed formatted with fields of 10 characters. If a number field is left blank, it will be read in as a zero value. Each line of data (except lines 1 and 2 which are alphanumeric as defined below) allows a maximum of 7 values (real or integer numbers). Real numbers (F format) should include a decimal point. Integer numbers (I Format) should end in the last column of the field. The first field on each line is reserved for a descriptor code that represents the type of data on the line. The code type must start in

the first column. A sample input files are included in the installation package. It can be displayed using a text editor. A description of the input parameters is below. [New parameters are in blue.](#)

Line

No. Data Description and Input Form

(1) CODE, DAMN - A5, 5X, A40

C1 Set CODE="C1" for line containing dam name

DAMN Name of the dam. DAMN has a maximum of 40 characters.

(2) CODE, RIVN, TOWN - A5, 5X, A40, 5X, A25

C2 Set CODE="C2" for line containing river and town name

RIVN Name of the river. RIVN has a maximum of 40 characters, and should start in column 11.

TOWN Name of primary point of interest or town along the routing reach. TOWN has a maximum of 25 characters, and should start in column 56.

(3) CODE, METRIC, JNK, IDAM, IPLT, IREC - A5, 5X, 7I10

C3 Set CODE="C3" for SDB options

METRIC [Parameter indicating if input/output is in English \(METRIC = 0\) or Metric \(METRIC = 1\) units. All computations within SDB are done in English units; only the input/output can be displayed in metric units.](#)

JNK Debug parameter indicating what will be printed. Set JNK=0 for no debug info; set JNK=1 for hydraulic info; set JNK=2 for system-level debug info.

IDAM Type of Dam. Set IDAM=0 for earthen dam; IDAM=1 for Concrete gravity dam; or IDAM=2 for concrete arch dam.

IPLT Obsolete parameter. Set IPLT=1

IREC Obsolete parameter. Set IREC=0

(4) CODE, HDE, BME, VOL, SA, BW, TFM, QO - A5, 5X, 7F10.2

CODE Set CODE="C4" for dam and breach parameters

HDE Dam breach elevation (feet). For immediate or overtopping failure, set HDE=the dam crest. If piping failure, set HDE=the reservoir elevation when breaching begins.

BME Final elevation (feet) of breach bottom. BME must be less than HDE.

VOL Volume (acre-feet) of the reservoir. Leave blank if the volume of the reservoir is unknown, but the surface area of reservoir is known; the default value is VOL = Pool height*SA/2. Either VOL or SA must be nonzero.

Line

No.	CODE	Data Description and Input Form
	SA	Surface area (acres) of reservoir at the dam crest. Leave blank if the surface area is unknown, but the volume of reservoir is known; the default value is SA= 2*VOL /Pool height. Either VOL or SA must be nonzero.
	BW	Width (feet) of rectangular breach. Leave blank if the width is unknown, and a default value from Table 2 will be used. If BW is greater than 1.5 times the total channel width at the 2 nd level, BW is set to 0.9 times the total channel width at the 2 nd level. To override this feature, set BW to a negative number.
	TFM	Time (minutes) required for breach formation. Leave blank if the failure time is unknown, and a default value from Table 2 will be used. TFM represents the time of significant rise in the breach hydrograph.
	QO	Non-breach flow (turbine, spillway and overtopping) which occurs with maximum breach flow.

(5) CODE, NS, NCS, CMS, DISTTN - A5, 5X, 2I10, 2F10.2

CODE	Set CODE="C5" for cross section parameters
NS	Number of cross-sections. NS must be greater than one.
NCS	Number of channel widths for each cross-section. NCS must be greater than one.
CMS	Manning n roughness coefficient associated with off-channel storage. The default value is CMS=0.5.
DISTTN	Distance (miles) to primary point of interest or town along the routing reach. The default value is DISTTN is equal to the downstream-most cross section location.

**Table 2. Estimation of Breach Parameters
(Dr. Danny Fread's Rule of Thumb Recommendations)**

Dam Type	Codes	Rule of Thumb		SMPDBK	
		TFH (hrs)	BW	TFH (min)	BW
Earth	ER	0.1-0.5	2HD-5HD	HD/10	3HD < CL
Concrete Gravity	PG	0.0-0.2	≤ 0.5CL	HD/40	5HD < CL
Concrete Arch	VA	0.0-0.1	≥ 0.8CL	HD/50	0.9CL
Rock Fill	RE			HD/5	4HD < CL
Buttress	CB			HD/40	5HD < CL
Multi-Arch	MV			HD/50	0.9CL
Other	OT			HD/10	CL
Slag Pile		0.0-0.1	≥ 0.8CL	HD/10	Min(CL,10HD)
Concrete	CN			HD/50	0.9CL
Masonry	MS			HD/5	4HD
Stone	ST			HD/5	4HD
Timber Crib	TC			HD/5	CL
TFH = time of failure		HD = dam height			
BW = average rectangular breach width		CL = dam crest length			

Line

<u>No.</u>	<u>CODE</u>	<u>Data Description and Input Form</u>
(6)	CODE, D(I), FLD(I), XLAT(I), XLONG(I), TWN(I) - A5, 5X, 2F10.2, 2F10.4, A26	
	CODE	Set CODE="C6-i" for cross section location information, <i>i</i> is the <i>i</i> th cross section.
	D(I)	Distance (miles) from dam to cross-section <i>I</i> . The 1 st cross section is the tailwater section. Distance locations must be in ascending order.
	FLD(I)	Depth (feet) in cross section <i>I</i> at which flooding and de-flooding times will be computed. If the flood depth is unknown, set FLD(I)=0.
	XLAT(I)	Latitude (in decimal degrees) of channel centerline at cross section <i>I</i> . If the latitude is unknown, set XLAT(I)=0.
	XLON(I)	Longitude (in decimal degrees) of channel centerline at cross section <i>I</i> . If the longitude is unknown, set XLON(I)=0.
	TWN(I)	Station name associated with cross section <i>I</i> . If left blank, TWN(I) is equal to the river location.
(7)	CODE, HS(K,I), BS(K,I), BSS(K,I), CM(K,I) - A5, 5X, 4F10.2	
	CODE	Set CODE="C7-k" for cross section information, <i>k</i> is the <i>k</i> th channel width.
	HS(K,I)	Elevation associated with the <i>k</i> th channel width (BS) of cross-section <i>I</i> ; the first elevation is the invert elevation. The elevations must be in ascending order.
	BS(K,I)	<i>K</i> th active channel width (feet) of the cross-section <i>I</i> . The active width is that portion of the channel cross section where the flow velocity in the x-direction is non-negligible. Each active width cannot be less than the previous width, i.e., $BS(K,I) \geq BS(K-1,I)$.
	BSS(K,I)	<i>K</i> th inactive channel width (feet) of the cross-section <i>I</i> . The inactive width is that portion of the channel cross section where the flow velocity in the x-direction is negligible relative to the velocity in the active portion.
	CM(K,I)	<i>K</i> th manning n associated with the <i>k</i> th channel width of cross-section <i>I</i> . If CM(K,I)=0, CM(K,I) is set equal to the previous non-zero CM value. If CM(1,I)=0, CM(1,I) is set equal to 0.05.

Repeat data line number 7 for all NCS channel widths then; repeat line numbers 6 and 7 for all NS cross sections.

Description of Output Parameters

The SDB model has three levels of output based on the value of JNK (line no. 3). System level debug output which consists of the values of variables in the SDB equations (JNK>0) is useful when debugging SDB programming problems. It is also useful for understanding the manual computations as described in the NWS SMPDBK documentation. A description of the output features follows.

1. An echo print of the input parameters (Always printed)
2. Input parameters updated with the default values (Always printed)
3. Profile crest table (Always printed)
4. Actual and weighted cross section properties (JNK > 0)
5. Dam outflow (JNK > 0)
6. Average Depth estimation (JNK > 0)
7. Routed discharge outflow (JNK > 0)
8. Travel Time (JNK > 0)
9. Dam Outflow estimation (JNK > 1)
10. Depth computations (Bisection Method) (JNK > 2)
11. Depth computations (Newton-Raphson Iterative Technique) (JNK > 2)
12. Final depth and routed discharge estimates (JNK > 2)
13. Total slope computation (JNK > 2)
14. System level debug output which consists of the values of variables in the SDB equations (JNK>0)

The SDB GUI (SDB-J) will display the information generated when JNK = 0. It will also display a plot of the peak water surface and discharge profiles. A description of all of the output table values follows.

Actual and Weighted Cross Section Properties

Using the top width vs. elevation tables, SDB generates area-elevation tables for each cross section. Computations are done between two cross sections: the dam and the cross section I. All cross sections between the dam and cross section I are weight-averaged and the average cross sectional properties are used for computations. The composite roughness coefficients (N) at are computed at each depth.

Name	Description of Variable
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HS(1,I)	Invert elevation at cross section I.
DEPTH	Channel depth
TOTAL BS	Total channel top width corresponding to DEPTH . Total BS is equal to the sum of the active and inactive storage (BS+BSS).
TOTAL AS	Total channel area corresponding to DEPTH .
COMPOS N	Total composite roughness coefficient (N) corresponding to DEPTH . The composite roughness coefficient is equal to the weighted average of the roughness coefficient in the active portion of the channel (CM) and the inactive portion of the channel (CMS).

Dam Outflow

The maximum breach outflow is computed using the falling head, broad-crested weir flow equation (Equation 1).

Name	Description of Variable
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QS	Dam outflow which includes the breach outflow adjusted for submergence and the non-breach flow.
YS	Tailwater depth corresponding to QS.

Dam Outflow Estimation

The breach outflow is estimated by adjusting the submergence coefficient until the depth converges.

Name	Description of Variable
SUB	Discharge submergence coefficient.
QDM	Maximum breach outflow (Equation 1).
HW	Breach depth.
Y	1 st estimate for the tailwater depth.

Average Depth Estimation

At each section, the average depth (Equation 23) is determined by iteratively solving for the theta weighting factor (F1).

Name	Description of Variable
F1	Theta weighting factor.
F1N	New estimate for the theta weighting factor (Equation 28).
YDM	Tailwater depth based on SW (defined below).
Y	Depth at the point of interest.
Q	Routed discharge at the point of interest.
S	Channel bottom slope between cross sections I and (I-1).
SW	Weighted total slope from dam to the point of interest (Equation 7).
XC	Characteristic distance (mi) used in routing curves (Equation 22).
FR	Average Froude number used in routing curves (Equation 26).
VS	Dimensionless volume parameter used in routing curves (Equation 27).

Routed Discharge Estimation

The routed discharge is determined by computing the routing parameters and using the routing curves.

Name	Description of Variable
XX	Routed distance from the dam to the point of interest.
XC	Characteristic distance (mi) used in routing curves (Equation 22).
FR	Average Froude number used in routing curves (Equation 26).
VS	Dimensionless volume parameter used in routing curves (Equation 27).
S	Channel bottom slope between cross sections I and (I-1).
YS	Tailwater depth corresponding to QS.

Name **Description of Variable**

- QS** Routed discharge at the point of interest.
- QDM** Discharge at the dam.

Travel Time Computation

The travel time (Equation 33) is computed using the routing curves.

Name **Description of Variable**

- QA** Routed discharge at the mid-point between the dam and the point of interest.
- Y** Depth associated with QA at the point of interest.
- V** Reference flow velocity at the mid-point (Equation 31).
- CV** Wave speed (mi/hr) (Equation 32)
- TRT** Travel time (hr) to the point of interest (Equation 33).
- FM** Shape factor **m** used in Equation 32.

Depth Computations (Bisection Method)

For non-breach flow (QO), the channel depth (Y) is computed by iteratively solving Manning's equation (Equation 6) using the Bisection Method until the known discharge is converged upon. The depth may be computed up to three times depending on the channel width used: active width only, total width, or weighted total width.

Name **Description of Variable**

- I** Cross section number.
- LC** Iteration counter.
- YMAX** Maximum depth in bisection technique.
- YMIN** Minimum depth in bisection technique.
- Y** Depth estimate.
- QN** Computed discharge using Y.
- Q** Known discharge ($Q = QO$).
- CMM** Manning roughness coefficient.
- B** Channel top width at depth Y.

Depth Computations (Newton-Raphson Technique)

For breached and routed discharges, the channel depth (Y) is computed by iteratively solving Manning's equation (Equation 6) using the Newton-Raphson technique until the known discharge is converged upon.

Values are shown at each iteration. In addition to being computed based on channel width as described in the Bisection Method, the depth may also be computed depending on whether the channel bottom slope or the total slope is used.

Name	Description of Variable
I	Cross section number.
LC	Iteration counter.
QN	Computed discharge using Y.
B	Channel top width at depth Y.
A	Cross sectional area at depth Y. The area may be either active area only or total area (active + inactive)
DB	Rate of change in channel width over change in depth ($\Delta(BS+BSS)/ \Delta HS$) relative to depth Y.
S	Depending on the depth being computed, S is equal to either the channel bottom slope (SO) or the total slope computed from the momentum equation (Equation 7).
DS	Change in slope. Since there is no change in slope, DS should be equal to zero.
F	The difference between the computed discharge (QN) and the known discharge (Q).
FP	1 st derivative of Manning's equation with respect to the change in Y (Equation 11).

Final Depth and Discharge Estimations

The discharge and depth computations are done iteratively until an error tolerance is met.

Name	Description of Variable
YN	New estimate for Y using Newton Raphson technique (Equation 10).
Y	Depth estimate.
QN	Computed discharge using Y.
Q	Known discharge.

Total Slope Computation

The total slope is computed using Equation 7.

Name	Description of Variable
SO	Channel bottom slope.
TERM1	1 st term in the momentum component of the Total slope equation.
TERM2	2 nd term in the momentum component of the Total slope equation.
TERM3	3 rd term in the momentum component of the Total slope equation.
SUM	The momentum component of the Total slope equation (TERM1 + TERM2 + TERM3).

REFERENCE

¹Fread, Danny L., Lewis, Janice M., and Wiele, Stephen M. 1991, "The NWS Simplified Dam-Break Flood Forecasting Model", Hydrology Laboratory, National Weather Service, Silver Spring, MD.