

D-R-A-F-T

Users Guide To

SED2D WES Version 4.5

**US Army, Engineer Research And Development Center
Waterways Experiment Station
Coastal and Hydraulics Laboratory**

D-R-A-F-T

This manual and on-line documentation were produced using *Doc-To-Help*[®], by WexTech Systems, Inc.



WexTech Systems, Inc.
310 Madison Avenue, Suite 905
New York, NY 10017
(212) 949-9595



FastTABS (1990-1994),



SMS 5 and 6 (1994-2000),



SMS7 (1999-2002),



SMS 8.0

SMS8 (2002-2005) and



SMS9- (2005-2007)



SMS10 (2007-present) are products of the Environmental Modeling Research Laboratory (EMRL), Brigham Young University.

Users Guide To SED2D WES Version 4.5

Last document modification date: Sept 27, 2011

Effective SED2D source code modification date: Sept 09, 2009

Editor: *Barbara P. Donnell*
Original Author: *Dr. Ian King*
Contributing Authors: *Joseph V. Letter, Jr., Allen M. Teeter, Barbara P. Donnell, Dr. William. H. McAnally, Jr., and William A. Thomas, Steve A. Adamac, Jr.*
Source Code Authors: *Joseph V. Letter, Jr., Dr. Ian King, Dr. Lisa C. Roig, Allen M. Teeter, and Barbara P. Donnell.*
Technical Assistance: *Joseph V. Letter, Jr.*

Technical Support

World Wide Web: <http://chl.erdc.usace.army.mil/tabs>

E-mail: SMS@usace.army.mil

Cataloging Information

Letter, Joseph V., Teeter, Teeter, Allen M., Donnell, Barbara P., and others, "User's Guide for SED2D Version 4.5 [27 Sept] 2011, [http://chl.wes.army.mil/software/tabs/doc.htm]

Contents

IMPORTANT NOTICE	1
PREFACE	2
OVERVIEW	5
Origin Of The Program	5
Applications For SED2D	5
Capabilities Of SED2D	6
Limitations Of SED2D	6
CONCEPTUAL PROGRAM DESIGN	7
The Derivation	7
Convection-Diffusion Governing Equation	8
Bed Shear Stress Calculation.....	8
Smooth-wall log velocity profile	8
The Manning’s shear stress equation.....	9
A Jonsson-type equation for surface shear stress.....	9
A Bijker-type equation for total shear stress caused by waves and currents	9
Ultra-Shallow Water Waves	10
Marsh Porosity Corrections	11
The Bed Source/Sink Term	11
Sand Transport.....	11
Clay Transport: Option 1	12
Clay Transport: Option 2.....	13
The Bed Strata Discretization.....	14
Sand Beds	14
Clay Beds.....	14
Lateral Boundary Condition	16
Inflow Boundary Conditions	16
Outflow Boundary Conditions.....	16
Reversal Boundary Conditions	16
Finite Element Formulation	17
Galerkin Finite Element Form	17
Elements Types Supported	18
Two Dimensional Elements.....	18
One Dimensional Elements	19

D-R-A-F-T

Special One-Dimensional Elements	19
USING SED2D	21
Assumed User Knowledge Base.....	21
Modeling Process.....	21
Dynamic Memory Allocation.....	21
Modes of Operation.....	22
Running in Interactive Mode	23
Running in Batch Mode.....	24
Why Use Batch Mode.....	25
Running In Auto Mode (Simulation Super File)	25
Guidelines for Obtaining a Good Solution	26
Issues Directly Related to Hydrodynamic Solution	27
Conservation of Mass Problems	27
Nodes with a Negative Depth Calculation.....	27
Resolution to Capture Concentration Gradients	27
Wetting and Drying	27
Time Step Selection.....	27
Appropriate Boundary Condition Placement for Sediment	27
Sediment Issues Not Related to Hydrodynamic Solution	27
Sediment Parameter Selection	27
Additional Resolution Needed to Resolve High Concentration Gradients	27
Sources of Error.....	28
Bottom Friction.....	28
When Boundary Conditions change	28
No Off Channel Storage Concentration Bookkeeping.....	28
Basic Operation.....	28
Input File Description	29
SED2D Run Control File.....	31
Geometry File	31
Hydrodynamic File	31
Wave binary solution file.....	31
Output File Description	31
Full Results Listing File.....	32
New Geometry File	32
Concentration Delbed Solution File	33
Bed Structure File.....	33
Using Titles.....	33
Including Title Information	33
The Last Title Card.....	33
What Kind Of Computer Do You Have?	33
Why Should You Care?	33
What You Need To Do About It?.....	34
Obtaining The Mesh Geometry	34
Obtaining The Velocity Field.....	35

D-R-A-F-T

Marsh Porosity Parameters	35
Specifying Initial Concentrations	35
Sediment Time Control.....	36
Time Step Control	36
Total Simulation Control	36
Hydrodynamic Time Control.....	36
Simulating with Steady State Input	36
Simulating with Transient Input	36
Bed Characteristics	36
Bed Initialization	36
Bed Roughness	36
Specifying Lateral Boundary Conditions.....	37
Inflow	37
Outflow.....	37
Reversals.....	37
Stopping the Simulation	37
Interpretation of the Results.....	37
QA/QC Check.....	37
Check for Negative Concentrations.....	37
Check for Mass Conservation.....	37
Check for Unusual Deposition Patterns.....	38
Check if Updated Hydrodynamics are needed.....	38
Re-Starting the Simulation	38
VERIFYING THE SIMULATION	39
Verification: A Process.....	39
Run	39
Inspect – Compare to Field Data - Adjust	39
Re-Run.....	39
Compare to Field Data	39
Direct Approach	39
Compare to Observed Sediment Flux	39
Compare to Observed Concentrations	39
Compare to Observed Bed Elevation Evolution	40
Indirect Approach	40
Shoaling Patterns for Bed Deposition Rates	40
Dredging Volume and Distribution	40
Turbidity Plume Patterns from Satellite or Aerial Photography	40
If Your Verification Fails.....	40
Wrong Choice of Model	40
Geometry Related Problems	40
Wetting and Drying	40
Marsh Porosity.....	40
Resolution Issues	40
Hydrodynamic Related Problems	41
Accurate.....	41
Representative for Sediment Transport	41
Boundary Condition Problems	41
Boundary Location	41
Boundary Specifications	41
Initial Condition Effects	41
Sediment Class	41

D-R-A-F-T

Energy Sources	41
Wind	41
Waves	41
LONG TERM PREDICTIONS	42
Just Run It for the Full Period	42
Simple Extrapolation.....	42
Joint Probability Method	42
Combining Sediment Classes	42
Combining Multiple Hydrodynamic Conditions	42
Combining Multiple Wave Conditions	42
ADVANCED TECHNIQUES	43
Analytical Test Cases.....	43
Non-dimensional Analysis of Governing Equation.....	43
Transforming The CD Equation	43
Transform The Sand Deposition Equation	44
Advection/Diffusion Ratio.....	45
Advection/Storage Ratio.....	45
Diffusion/Storage Ratio	46
Transform The Bed Source-Sink Terms	46
Sand Deposition.....	46
Sand Erosion.....	47
Clay Deposition	48
Clay Particle Erosion	49
Clay Mass Erosion.....	50
Summary: Non-D Terms in the CD Equation.....	51
Test problems	52
RUN CONTROL.....	54
Overview.....	54
Summary of Run Control Data Cards.....	54
Information cards T1, T2, T3, \$D.....	54
Run control cards: \$L1, \$L2, \$H, END, STOP, TO, TR, EF	54
Geometry cards: GE, GNN, GT, GS, GC, DA, DM	56
Timing and run length control: TZ card	56
Implicitness factor: TT card.....	56
Sediment size classes for sand: SA ,SR, ST	57
Settling velocity: WC cards	57
Cohesive sediment characteristics: CC and CI cards.....	57
Bed structure: SB and CL cards.....	59
Effective diffusion: DF, PE and DD cards.....	59
Initial concentration: IC cards.....	61
Boundary conditions: BC cards	61
Description of Output:	61
Required Run Control Data Cards.....	63

D-R-A-F-T

SED2D Execution Job Sheet	65
Input Variables	66
SED2D DATA CARDS	71
T1-T3 CARD: Title Description.....	72
SD CARD: Start Date Control	73
SH CARD: Hotstart Control	74
SL1 CARD: Input File Control.....	75
SL2 CARD: Output File Control	76
SM CARD: Machine Type Identifier.....	77
BC CARD: Boundary Conditions.....	78
BL Card: Boundary Loading (Mass)	79
BF CARD: Bed Flux Controls.....	80
BW CARD: Boundary Wind Speed / Direction	81
CC CARD: Clay Characteristics.....	82
CI CARD: Clay Characteristics By ID.....	83
CL CARD: Clay Distribution By Layer	84
CO CARD: Comments	85
CS Card: Concentrations at a Flow Control Structures	86
DD CARD: Effective Diffusion Coefficient By Equation 64.....	87
DA Card: Automatic Wet/Dry by Marsh Porosity.....	88
DM CARD: Marsh Porosity Parameters.....	90
DF CARD: Diffusion Coefficient (Effective).....	92
EF CARD: Error Flags	93
END CARD: End Of Time Step Separation.....	94
FD CARD: Fluid Density	95
FT CARD: Fluid Temperature.....	96
GCL Card: Geometry, Continuity Check Line	97
GC CARD: Geometry, Continuity Check Lines.....	98
GE CARD: Grid, Element Connection Table.....	99
GNN CARD: Geometry Nodal Coordinate	100
GS CARD: Geometry, Nodal Scale Factor.....	101
GT Card: Geometry, Element Material Types.....	102
GW Card: Geometry, Channel Width Attributes.....	103
HD Card: Hydrodynamic, Water Depth	104
HN CARD: Roughness, (Manning's n-Value)	105
HS CARD: HYDRAULIC BED SHEAR STRESS	106
HU Card: Hydrodynamic, X-Velocity.....	107
HV Card: Hydrodynamic, Y-Velocity.....	108
HW CARD: Wave Model Input Control	109
IC CARD: Initial Conditions	110
MC Card: Mass Check.....	111
ND CARD: Non-dimensional Analysis.....	112
PC CARD: Point Source Control.....	113
PE CARD: Control Of The Effective Diffusion Coefficient By Peclet Number	114
PV CARD: Physical Variables	115
RD CARD: Automatic Roughness Coefficient Assignment by Depth.....	116
SA CARD: Sand Characteristics	118
SB CARD: Sand Bed Thickness.....	119
SR CARD: Sand Grain Size For Roughness	120
ST CARD: Sand Grain Size For Transport.....	121
SI CARD: System International Units.....	122
STO(P) CARD: Stop The SED2D Simulation	123
T1-T3 CARD: Title Description.....	124
TH CARD: Timing of the Hydrodynamic File.....	125

D-R-A-F-T

TO CARD: Timing Of Binary Write	126
TR CARD: Trace Print Control	127
TRE CARD: Element List For Special Summary Trace Print.....	128
TRN CARD: Node List For Special Summary Trace Print.....	129
TRT CARD: Material Type List For Special Summary Trace Print	130
TT CARD: Crank-Nicholson Theta.....	131
TZ CARD: Computational Time Control.....	132
WC CARD: Settling Velocity	133
WF CARD: Settling Velocity Function Option.....	134
PERFORMANCE ENHANCEMENTS	135
Redimensioning SED2D	135
Compiling SED2D WES.....	135
COMMON PROBLEMS	137
Displaying your results with FastTABS.....	137
WARNINGS AND ERROR MESSAGES.....	139
SED2D FILE FORMATS.....	140
TABS Binary File Header Format	140
GFGEN Binary Geometry File Format	142
RMA2 Binary Solution (u,v,h) File Format.....	143
SED2D Binary Concentration and DelBed Format.....	144
SED2D Binary Bed Strata (a.k.a Structure) File Format	145
New GFGEN Ascii Geometry File Format.....	146
SED2D Binary Wave File Format.....	147
UTILITIES	148
TECHNICAL SUPPORT	149
On-Line Support.....	149
Option 1: World Wide Web.....	149
Option 2: E-mail	149
TABS Hotline	149
REFERENCES.....	150
NOTATION.....	151

D-R-A-F-T

GLOSSARY OF TERMS	153
INDEX	172
NOTES	177

Index of Equations

Equation 1.....	8
Equation 2.....	8
Equation 3.....	8
Equation 4.....	8
Equation 5.....	9
Equation 6.....	9
Equation 7.....	9
Equation 8.....	10
Equation 9.....	10
Equation 10.....	10
Equation 11.....	11
Equation 12.....	11
Equation 13.....	12
Equation 14 a and b	12
Equation 15.....	13
Equation 16.....	13
Equation 17.....	13
Equation 18.....	13
Equation 19.....	14
Equation 20.....	14
Equation 21.....	15
Equation 22.....	15
Equation 23.....	15
Equation 24.....	17
Equation 25.....	17
Equation 26.....	17
Equation 27.....	18
Equation 28.....	18
Equation 29.....	18
Equation 30.....	44
Equation 31.....	44
Equation 32.....	45
Equation 33.....	45
Equation 34.....	45
Equation 35.....	46
Equation 36.....	46
Equation 37.....	46
Equation 38.....	46
Equation 39.....	47
Equation 40.....	47
Equation 41.....	47
Equation 42.....	47
Equation 43.....	48

D-R-A-F-T

Equation 44.....	48
Equation 45.....	48
Equation 46.....	48
Equation 47.....	48
Equation 48.....	49
Equation 49.....	49
Equation 50.....	49
Equation 51.....	49
Equation 52.....	49
Equation 53.....	50
Equation 54.....	50
Equation 55.....	50
Equation 56.....	50
Equation 57.....	51
Equation 58.....	51
Equation 59.....	51
Equation 60.....	51
Equation 61.....	58
Equation 62.....	59
Equation 63.....	59
Equation 64.....	59

Important Notice

This manual and the accompanying computer model **SED2D is in Beta test** mode. It is being distributed to a limited number of users in order to test the capabilities of the model, and to determine if there are bugs that persist in the code. By accepting either this manual or the computer code you are indicating your assent to be a Beta test user. Beta test users are responsible for reporting bugs and/or errors in the manual to the TABS-MD system consultants by sending email to “SMS@usace.army.mil”. We will attempt to respond to reported bugs in a timely manner, but the response time will vary according to the availability of the program development staff. Beta test users are also responsible for performing model testing and model sensitivity analyses to determine the model capabilities. The Beta test version should not be used for engineering design and analysis by any person who has not undertaken a comprehensive program of model testing and analysis. The user must first determine if the model is appropriate and accurate for the type of problem that he or she expects to simulate, and that coding errors do not exist that may yield erroneous results. The model is designed to be widely applicable to a range of physical hydrodynamic conditions and is, consequently, a complex model that requires a degree of modeler experience and knowledge of sediment transport to successfully apply the model. An unsuccessful attempt in an application by a relatively new user may not indicate any inherent problem with the model.

Preface

The program described herein was developed over the period 1972-2000 at several institutions under funding from a number of sources. SED2D WES Version 4.5 described herein and preparation of this user's manual was performed during the period 1993 to 2000 at the US Army Engineer Research and Development Center (ERDC), Waterways Experiment Station (WES) under the Army Corps of Engineers Rehabilitation, Evaluation, and Maintenance Research Program (REMR). SED2D WES is a rewrite of an earlier program called STUDH. Additional model enhancements have been made by project specific needs, supported by USACE Districts.

The original STUDH program development was performed by Dr. Ranjan Ariathurai under the direction of Dr. R. B. Krone at the University of California, Davis (UCD). It was extended by Drs. Ariathurai, Krone, and R. C. MacArthur at UCD with funding provided by the US Army Engineer Dredged Material Research Program. The result of that effort was program SEDIMENT II. Enhancements were subsequently made by Dr. Ariathurai while working at Nielson Engineering and Research, Inc., under contract to WES. Funds were provided by the US Army Engineer District, Portland. Major revisions to the program were performed by personnel of WES (in consultation with Dr. Ariathurai) with funds from the OCE research program, IOMT. Dr. Ariathurai developed new versions of SEDIMENT II called SEDIMENT 4H and SEDIMENT 4H.MLT, also funded by the IOMT program. Some of the features of those programs were then adapted by WES personnel for use in the program called STUDH. During the period 1993 to 1995 STUDH was substantially rewritten and modernized to create the program SED2D WES Version 1.2 Beta. During the period of 1996-1998 SED2D WES has been further expanded in its capability well beyond the previous version of STUDH.

Personnel of the WES Coastal and Hydraulics Laboratory that performed the development of the STUDH program did so under the direction of Messrs. H. B. Simmons and F. A. Herrmann, Jr., former and present Chiefs of the Hydraulics Laboratory; M. B. Boyd, Chief of the Hydraulics Analysis Division; R. A. Sager, Chief of the Estuaries Division, G. M. Fisackerly, Chief of the Harbor Entrance Branch, and E. C. McNair, Chief of the Sedimentation Branch. Mr. W. A. Thomas designed the program structure, wrote much of the code, and supervised program development. Additional coding was performed by Messrs. W. H. McAnally, Jr., and S. A. Adamec, Jr. Other WES personnel participating in coding and testing were C. B. Berger, B.P. Donnell, J. D. Ethridge, Jr., J. V. Letter, Jr., and R. D. Schneider.

Personnel of the WES Coastal and Hydraulics Laboratory that performed the development of the SED2D WES program did so under the direction of Messrs. F. A. Herrmann, Jr. and R. A. Sager, former Chief and present Acting Chief of the Hydraulics Laboratory, W. H. McAnally, Chief of the Waterways and Estuaries

D-R-A-F-T

Division, and W. D. Martin, Chief of the Hydrosciences Division. Dr. Lisa C. Roig restructured the code and performed most of the code modernization in the original version of SED2D WES (version 1.2). Ms. Barbara P. Donnell wrote several new subroutines. Other WES personnel participating in coding and testing were Mr. Chris Callegan, Dr. Greg Nail, Ms. Lisa Benn, Ms. Jackie Pettway, and Ms. Cassandra Gaines. This report was prepared by Dr. Roig and Ms. Donnell. Much of this report is derived from the 1983 STUDH manual prepared by Messrs. Thomas, McAnally, and Adamec. Revisions to SED2D WES to bring it to its present form were performed by Mr. J. V. Letter, Jr. from 1996-2000. In support of USEPA Region II, the current documentation was updated and a special edition of STUDH (version 2000) was created. The version of STUDH 2000 described here is functionally equivalent to SED2D-WES, Version 4.5.

Commanders and Director of the ERDC WES during preparation of this report were COL Bruce K. Howard and COL Robin Cababa. Technical Director was Dr. Robert W. Whalin. The recent work was performed under the general supervision of Dr. James R. Houston, Chief, Coastal and Hydraulics Laboratory, Dr. W. H. McAnally, Chief, Estuaries and Hydrosciences Division.

Overview

This user's guide describes the generalized finite element computer program (model) for vertically averaged sediment transport in open channel flows. It is the sediment transport companion for the RMA2 hydrodynamic model within the TABS-MD Numerical Modeling System.

Origin Of The Program

The initial code development was accomplished by Dr. Ranjan Ariathurai (1974) in partial fulfillment of the requirements for his Doctor of Philosophy degree at the University of California, Davis. That work, a 2D model in the horizontal plane, was extended to include the vertical plane by Ariathurai, MacArthur, and Krone (1977) under contract with the US Army Corps of Engineers, Dredged Material Research Program. Dr. Ariathurai consulted with Waterways Experiment Station (WES) personnel during the early testing phases of the program during which time he made several enhancements to the program.

Starting with that basic work, WES personnel and Dr. Ariathurai produced a code known as STUDH. Dr. Ariathurai subsequently developed several new versions of the models with funding from WES. Selected features of those models were adopted and placed in the STUDH model. STUDH version 3.3 was a standard tool for sediment transport analysis during the period 1983 to 1993. During the period 1993 to 1995 STUDH was substantially rewritten and modernized by WES personnel to create the program SED2D WES (version 1.2). This modernization was undertaken in order to improve model maintenance and to facilitate the addition of new features to the code. A series of major revisions to SED2D WES have been performed recently; adding marsh porosity compatibility and rewriting the cohesive bed layering routines (version 2.0); adding one-dimensional (1-D) elements (version 3.0); and adding the automatic boundary specification in reversing tidal flows including boundary buffering and automatic computation options for dispersion coefficients (version 4.0).

Applications For SED2D

SED2D WES can be applied to clay or sand bed sediments where flow velocities can be considered two-dimensional in the horizontal plane (i.e., the speed and direction can be satisfactorily represented as a depth-averaged velocity). It is useful for both deposition and erosion studies and, to a limited extent, for stream width studies. The program treats two categories of sediment: 1) noncohesive, which is referred to as sand herein; and 2) cohesive, which is referred to as clay.

Capabilities Of SED2D

Either steady-state or transient flow problems can be analyzed. The exchange of material with the bed can be calculated or suppressed. Default values may be used for many sediment characteristics or these values may be prescribed by input data. Either the smooth wall velocity profile or the Manning's equation may be used to calculate bed shear stress due to currents. Shear stresses for combined currents and wind waves may be calculated

Limitations Of SED2D

Both clay and sand may be analyzed, but the model considers a single, effective grain size during each simulation. Therefore, a separate model run is required for each effective grain size. Fall velocity must be prescribed along with the water surface elevations, x-velocity, y-velocity, diffusion coefficients bed density, critical shear stresses for erosion, erosion rate constants, and critical shear stress for deposition.

The program does not compute water surface elevations or velocities; these data must be provided from an external calculation of the flow field. For most problems, a numerical model for hydrodynamic computations, RMA2-WES, is used to generate the water surface elevations and velocities. An implicit assumption of the SED2D WES model is that the changes in the bed elevation due to erosion and/or deposition do not significantly affect the flow field. When the bed change calculated by the model does become significant and the externally calculated flow field supplied by the user is no longer valid, then the SED2D WES run should be stopped, a new flow field calculation should be made using the new channel bathymetry generated by SED2D WES, and the SED2D WES run should be restarted with the new flow field as input.

In addition, the sediment transport model formulation assumes that the input geometric mesh and the resulting hydrodynamic solution from RMA2 are of adequate resolution, accuracy and quality to allow for an accurate and reasonable solution to the governing sediment transport equation to be solved. This may not always be true. In such a case, then the mathematical solution from SED2D or STUDH will potentially have severe oscillations with negative concentrations. The resolution of such "unstable" solutions cannot always be obtained within the coefficient adjustments of the sediment model. It may be necessary to return to the basic mesh resolution and obtain a better hydrodynamic solution.

Conceptual Program Design

The program is based on the following conceptual model:

1. Basic processes in sedimentation can be grouped into erosion, entrainment, transportation, and deposition.
2. Flowing water has the potential to erode, entrain, and transport sediment whether or not sediment particles are present.
3. Sediment on the streambed will remain immobile only as long as the energy forces in the flow field remain less than the critical shear stress threshold for erosion.
4. Even when sand particles become mobile, there may be no net change in the surface elevation of the bed. A net change would result only if the rate of erosion was different from the rate of deposition - two processes which go on continuously and independently.
5. Cohesive sediments in transport will remain in suspension as long as the bed shear stress exceeds the critical value for deposition. In general, simultaneous deposition and erosion of cohesive sediments do not occur.
6. The structure of cohesive sediment beds changes with time and overburden.
7. The major portion of sediment in transport can be characterized as being transported in suspension, even that part of the total load that is transported close to the bed.

The Derivation

The derivation of the basic finite element formulation is presented in Ariathurai (1974) and Ariathurai, MacArthur, and Krone (1977) and is summarized below. There are four major computations.

1. Convection-Diffusion Governing Equation
2. Bed Shear Stress Calculation
3. The Bed Source/Sink Term
4. The Bed Strata Discretization

D-R-A-F-T

Convection-Diffusion Governing Equation

The basic convection - diffusion equation is presented in Ariathurai, MacArthur, and Krone (1977),

Equation 1

$$\frac{\partial C}{\partial t} + u \frac{\partial C}{\partial x} + v \frac{\partial C}{\partial y} = \frac{\partial}{\partial x} \left(D_x \frac{\partial C}{\partial x} \right) + \frac{\partial}{\partial y} \left(D_y \frac{\partial C}{\partial y} \right) + \alpha_1 C + \alpha_2$$

where

- C = concentration, kg/m³
- t = time, sec
- u = flow velocity in x - direction, m/sec
- x = primary flow direction, m
- v = flow velocity in y - direction, m/sec
- y = direction perpendicular to x , m
- D_x = effective diffusion coefficient in x - direction, m²/sec
- D_y = effective diffusion coefficient in y - direction, m²/sec
- α_1 = a coefficient for the source term, 1/sec
- α_2 = the equilibrium concentration portion of the source term,
kg/m³/sec = - $\alpha_1 C_{eq}$

Bed Shear Stress Calculation

The bed shear stress is needed to evaluate the bed source-sink terms in the governing equation. Several options are available for computing bed shear stresses using

Equation 2

$$\tau_b = \rho (u^*)^2$$

where

- ρ = water density
- u^* = shear velocity

Smooth-wall log velocity profile

Equation 3

$$\frac{\bar{u}}{u^*} = 5.75 \log \left(3.32 \frac{u^* D}{\nu} \right)$$

which is applicable to the lower 15 percent of the boundary layer when

Equation 4

D-R-A-F-T

$$\frac{u^* D}{\nu} > 30$$

where

- u = mean flow velocity
- D = water depth
- ν = kinematic viscosity of water

The Manning's shear stress equation

Equation 5

$$u^* = \frac{\sqrt{g \bar{u} n}}{CME D^{1/6}}$$

where

- g = acceleration due to gravity
- n = Manning's roughness value
- CME = coefficient of 1.0 for metric units and 1.486 for English units

A Jonsson-type equation for surface shear stress

The Jonsson-type equation is for plane beds caused by waves and currents.

Equation 6

$$u^* = \sqrt{\frac{1}{2} \left(\frac{f_w u_{om} + f_c \bar{u}}{u_{om} + u} \right) \left(\bar{u} + \frac{u_{om}}{2} \right)}$$

where

- f_w = shear stress coefficient for waves
- u_{om} = maximum orbital velocity of waves
- f_c = shear stress coefficient for currents

A Bijker-type equation for total shear stress caused by waves and currents

Equation 7

$$u^* = \sqrt{\frac{1}{2} f_c \bar{u}^2 + \frac{1}{4} f_w u_{om}^2}$$

For further information on the shear stress computation equations, see McAnally and Thomas (1980).

D-R-A-F-T

Ultra-Shallow Water Waves

In broad shallow areas with depths less than about 2 m, wind-waves most often are in the transition range where wave length L_w is greater than twice the local depth D and wave bed friction affects wave growth and depth-limited wave conditions. Atmospheric drag coefficients are also affected since they depend on wave conditions, and since:

Equation 8

$$\tau_a = \rho_a C_d U_a^2$$

where

ρ_a = air density

C_d = atmospheric drag coefficient

U_a = wind speed corrected to 10 m reference height

atmospheric shear stress is affected as well. It was found in Laguna Madre Texas that atmospheric drag coefficients can be approximated by:

Equation 9

$$C_d = \left(\frac{0.4}{16.11 - 0.5 \ln(D') - 2.48 \ln(U_a)} \right)^2$$

in water depths less than 2 m, where D' is an effective depth. Wave height and period were found to be related to C_d and D' at this site, and D' was found to be the water depth or depth to the vegetation canopy top.

A momentum balance approach is used to estimate wind-wave shear stress, since the uncertainties in specifying widely varying wave friction factors makes it possible to over estimate momentum transfer. Wind-waves are assumed to be fully-developed with dissipation equal to momentum input from the atmosphere. Atmospheric shear stress is partitioned between currents and waves. In deep water, dissipation by white capping and wave-wave interaction leads to most atmospheric momentum eventually going into the currents. In ultra-shallow water the shear stress going into bed by wave action is a fraction of the input such that:

Equation 10

$$\frac{\tau_{wb}}{\tau_a} = 5.38 U_a^{-0.5}, \text{ for } U_a > 5 \text{ m/sec}$$

When RMA2 has used the marsh porosity option (DM cards) shear stresses should be adjusted in the SED2D WES simulation for more accurate estimates of the bed exchange. Therefore, the marsh porosity information must be provided (in appropriate units) and the program will compute the needed adjustments. The adjustment is made by computing a conveyance distribution within the marsh porosity depth distribution based on Manning's equation. This is then extended to a shear stress distribution that is averaged and a correction factor developed for the conventionally derived shear stress from one of the options above

Marsh Porosity Corrections

Marsh Porosity parameters are preferably transferred to the SED2D model by way of the GFGEN geometry and RMA2 hydrodynamic input files.

Another method is to replicate the DA-Cards (or DM-Cards) using in the corresponding RMA2 hydrodynamic simulation. Remember that SED2D expects these marsh porosity input parameters in metric units.

The Bed Source/Sink Term

The form of the bed source term, $S = \alpha_1 C + \alpha_2$, as given in Equation 1 is the same for deposition and erosion of both sands and clays. Methods of computing the alpha coefficients depend on the sediment type and whether erosion or deposition is occurring.

Sand Transport

For sand transport, the supply of sediment from the bed (i.e., the sediment reservoir) is controlled by the transport potential of the flow and availability of material in the bed. The bed source term is

Equation 11

$$S = \frac{C_{eq} - C}{t_c}$$

where

- S = source term
- C_{eq} = equilibrium concentration (transport potential)
- C = sediment concentration in the water column
- t_c = characteristic time for effecting the transition

There are many transport relations for calculating C_{eq} for sand size material. The Ackers-White (1973) formula was adopted for this model because it performed satisfactorily in tests by WES and others (White, Milli, and Crabbe 1975; Swart 1976), because it seems to be complete, and because it is reasonably simple. The transport potential is related to sediment and flow parameters by the expressions in the following paragraphs. The Ackers-White formula computes the total load, including suspended load and bed load, and was developed originally for fine sand. The formulation was later updated to include coarser sands and these revised coefficients are included in the current model formulation. However, the appropriateness of the use of SED-2D with the Ackers-White formula diminishes with coarsening of the sediment.

The characteristic time, t_c , is somewhat subjective. It should be the amount of time required for the concentration in the flow field to change from C to C_{eq} . In the case of deposition, t_c is related to fall velocity. The following expression was adopted.

Equation 12

D-R-A-F-T

$$T_c = \text{larger of } \left\{ \begin{array}{l} C_d \frac{D}{V_s} \\ or \\ DT \end{array} \right.$$

where

- t_c = characteristic time
- C_d = coefficient for deposition
- D = flow depth
- V_s = fall velocity of a sediment particle
- DT = computation time interval

In the case of scour, there are no simple parameters to employ. The following expression is used.

Equation 13

$$t_c \text{ is larger of } \left\{ \begin{array}{l} C_e \frac{D}{\bar{u}} \\ or \\ DT \end{array} \right.$$

where

- C_e = coefficient for entrainment
- V = flow speed

Clay Transport: Option 1

For clay transport, option 1 is the default. Deposition rates of clay beds are calculated with the equations of Krone (1962).

Equation 14 a and b

$$S = \left\{ \begin{array}{l} -\frac{V_s}{D} C \left(1 - \frac{\tau}{\tau_d} \right) \text{ for } C < C_c, \tau < \tau_d \\ -\frac{V_k}{D} C^{7/3} \left(1 - \frac{\tau}{\tau_d} \right) \text{ for } C > C_c, \tau < \tau_d \end{array} \right.$$

where

- τ = bed shear stress
- τ_d = critical shear stress for deposition
- C_c = critical concentration = 300 mg/l.

D-R-A-F-T

Erosion rates are computed by a simplification of Partheniades (1962) results for particle by particle erosion. The source term is computed by

Equation 15

$$S = \frac{M}{D} \left(\frac{\tau}{\tau_e} - 1 \right), \tau > \tau_e$$

where

- M = erosion rate constant,
- τ_e = critical shear stress for particle erosion.

In all cases, it is expected that $T_e > \tau_d$. When bed shear stress is high enough to cause mass failure of a bed layer, the erosion source term is

Equation 16

$$S = \frac{T_L \rho_L}{D \Delta t} \text{ for } \tau > \tau_s$$

where

- T_L = thickness of the failed layer,
- ρ_L = density of the failed layer,
- Δt = time interval over which failure occurs,
- τ_s = bulk shear strength of the layer.

Clay Transport: Option 2

For modeling wind-wave resuspension where the primary goal is to reproduce water column concentrations, an alternate clay transport formulation is provided where erosion and deposition are taken as independent processes that can operate simultaneously, and thus:

Equation 17

$$S = \text{Deposition} + \text{Erosion}$$

In this way the model can produce features such as steady-state water column concentrations, deposition at relatively high shear-stresses, etc. The sediment system is assumed to be composed of silt and clays represented by a single sediment class. Deposition is similar to that of Option 1 except that depositional probabilities P depend on τ such that:

Equation 18

D-R-A-F-T

$$P = \left(1 - \frac{\tau}{\tau_d}\right), \tau \leq \tau_d$$

$$P = \exp\left(\frac{-0.2}{\tau - \tau_d}\right), \tau > \tau_d$$

and

$$P' = \text{MAX}(P, \text{PMIN})$$

where the default for PMIN is 0.1 . Deposition is computed as:

Equation 19

$$\text{Deposition} = P' V_s C$$

Erosion rate is calculated much as for Option 1 but with an exponent on the excess shear stress term:

Equation 20

$$\text{Erosion} = \frac{M}{D} \left(\frac{\tau}{\tau_e} - 1\right)^{\text{esse}}, \tau > \tau_e$$

The Bed Strata Discretization

The sink - source term in Equation 1 becomes a source - sink term for the bed model, which keeps track of the elevation, composition, and character of the bed. Bed change computations utilize the Crank - Nicholson weighting of the time-step contributions.

Sand Beds

Sand beds are considered to consist of a sediment reservoir of finite thickness, below which is a nonerodible surface. Sediment is added to or removed from the bed at rate determined by the value of the sink/source term at the previous and present time - steps. The mass rate of exchange with the bed is converted to a volumetric rate of change by the bed porosity parameter.

Clay Beds

Clay beds are treated as a sequence of layers. Each layer has its own characteristics as follows:

- Thickness.
- Density.
- Age.
- Bulk shear strength.
- Type.

In addition, the layer type specifies a second list of characteristics.

- Critical shear stress for erosion.

D-R-A-F-T

- Erosion rate constant.
- Initial and 1-year densities.
- Initial and 1-year bulk shear strengths.
- Consolidation coefficient.
- Clay or sand.

New clay deposits form layers up to a specified initial thickness and then increase in density and strength with increasing overburden pressure and age. Variation with overburden occurs by increasing the layer type value by one for each additional layer deposited above it. The original version of SED2D WES and all previous versions of STUDH did not perform ongoing consolidation. Rather, the age was specified and at the beginning of the simulation the parameters were computed. This strategy worked well when simulations were always relatively short because of historical limitations of computer resources. However, as computing power has evolved we now have included active consolidation during the model simulation. The present change in density with time is governed by the following equations:

Equation 21

$$\rho = \rho_f - (\rho_f - \rho_i)e^{-\beta t}$$

where

- ρ = time - varying characteristic of density
- ρ_e = density at some reference end time
- ρ_f = final ultimate density = 1000 kg/m³ default
- t_o = starting time = zero
- t_e = reference end time
- t = time
- β = consolidation coefficient, 1/sec

The consolidation coefficient β is computed from user input for initial density and density at the reference time by solving Equation 21 for β .

Equation 22

$$\beta = -\frac{1}{t_e} \ln \left[1 - \frac{\rho_e - \rho_i}{\rho_f - \rho_i} \right]$$

The bulk shear strength, QS, of the deposits is related to the density by the relationship

Equation 23

$$\frac{QS_e}{QS_i} = \left(\frac{\rho_e}{\rho_i} \right)^\alpha \Rightarrow \alpha = \frac{\ln(QS_i) - \ln(QS_e)}{\ln(\rho_i) - \ln(\rho_e)}$$

D-R-A-F-T

where α is solved from these reference values above and the general form is obtained by replacing Q_{s_e} and ρ_e with the time-varying values of each.

Mass deposition rates are converted to volumetric deposits by the specified density for the type 1 layer, and erosion rates are converted to a corresponding volume by the actual density of the eroding layer.

Use of the layer type can be used to control whether or not erosion and consolidation are allowed to occur, and to keep track of sand layers in a mixed bed problem. The layer structure and time - varying consolidation can be used to specify a subsidence rate for the modeled area.

Lateral Boundary Condition

The lateral boundary condition is applicable to inflow, outflow, or areas of flow reversals.

Inflow Boundary Conditions

Outflow Boundary Conditions

Reversal Boundary Conditions

In the case of tidally fluctuating flow across a model boundary the specification of an accurate concentration is not simple. In earlier versions of STUDH and SED2D WES the boundary condition was either always specified or always not specified. If a node along the boundary had flow entering the model the normal convention would be to specify a concentration. However, in older versions when the tide turned and flow left the model that specification was still applied. This creates artificial conditions that lead to severe oscillations near the boundary.

In the current version (4.3) this situation has been addressed in two steps. First, the logic has been added to the code to allow the model to determine whether to apply the concentration specification (Dirichlet BC) or whether to apply a zero concentration gradient BC (von Neuman). The gradient BC allows the concentration to be solved from the interior concentration field of the model. This provides some relief; but strong concentration gradients reaching the boundary can result in abrupt jumps in the concentration as the tide turns to enter the model and the concentration returns to the Dirichlet specification. This is the result of not accounting for the concentration history of waters that have crossed the boundary.

In order to provide a form of memory of the concentration history under dynamic tidal conditions a method termed “boundary condition buffering” was developed. This technique assigns a finite (MBB parameter in the program include file) number of buffer chambers to each boundary node. The program maintains the specified nominal boundary concentration C_b in the last chamber. At the beginning of the simulation all buffer chambers are initialized to C_b . As flow leaves the model the concentration of the exiting water is stored in the first chamber and all remaining buffer chamber concentrations are shifted to the next higher chamber, keeping the last chamber at C_b . Then a mixing factor is applied to the chambers to simulate the diffusive processes external to the model. When the currents turn and begin to enter

D-R-A-F-T

the model the chamber values are shifted back one chamber per time step and the mixing process repeated. This procedure results in memory of the history of concentrations crossing the boundary, delays full specification of the nominal boundary concentration C_b , and generally provides more realistic boundary conditions. Furthermore, the buffering also provides a buffer for the changes that any plan alternatives to be tested may have on the boundary conditions.

Finite Element Formulation

Galerkin Finite Element Form

The governing equation (1) is then cast into the Galerkin finite element form using quadratic shape functions, N ,

Equation 24

$$\sum_{ne=1}^{NE} \iint_{D_{ne}} \left[N_j \left\{ Q + u \frac{\partial \hat{C}}{\partial x} + v \frac{\partial \hat{C}}{\partial y} - \alpha_1 \hat{C} \right\} + \frac{\partial N_j}{\partial x} D_x \frac{\partial \hat{C}}{\partial x} + \frac{\partial N_j}{\partial y} D_y \frac{\partial \hat{C}}{\partial y} \right] dx dy + \sum_{i=1}^{NL} \int_{\zeta} N_j q_i^s d\zeta = 0$$

$$\text{Where } Q = \left(\frac{\partial \hat{C}}{\partial t} \right) + \alpha_2 \text{ for the transient problem}$$

where

- NE = total number of elements
- N = the quadratic shape(or basis) functions
- Q = See above
- \hat{C} = the approximate concentration in an element as evaluated from shape functions and nodal point values of C
- NL = total number of boundary segments
- ζ = the local coordinate
- q_i^s = flux from source on boundary i

The transient equation is expressed as

Equation 25

$$[T] \frac{\partial \{C\}}{\partial t} + [K] \{C\} - \{F\} = 0$$

where each element in the computation mesh contributes the following terms to the global matrix

Equation 26

D-R-A-F-T

$$[T] = \iint_D [N]^T [N] dx dy$$

the steady-state system coefficient matrix [K] is

Equation 27

$$[K] = \iint_D \left[K_j \left\{ u \frac{\partial \hat{C}}{\partial x} + v \frac{\partial \hat{C}}{\partial y} - \alpha_1 \hat{C} \right\} + \frac{\partial N_j}{\partial x} D_x \frac{\partial \hat{C}}{\partial x} + \frac{\partial N_j}{\partial y} D_y \frac{\partial \hat{C}}{\partial y} \right] dx dy$$

the boundary loadings vector {F} is

Equation 28

$$\{F\} = - \iint_D [N]^T \{ \alpha_2 \} dx dy + \int_{\zeta} [N]^T \{ q \} d\zeta$$

Applying the Crank-Nicholson scheme, where θ is the implicitness coefficient, gives the following equation, where n refers to the present, $n+1$ to the future time-step, and Δt the computation time interval.

Equation 29

$$\begin{aligned} & \left\{ \frac{[T]}{\Delta t} + \theta [K]^{n+1} \right\} \{C\}^{n+1} \\ &= \left\{ \frac{[T]}{\Delta t} - (1-\theta)[K]^n \right\} \{C\}^n + \theta \{F\}^{n+1} + (1-\theta)\{F\}^n \end{aligned}$$

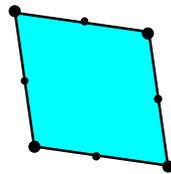
Elements Types Supported

- Two Dimensional Elements
- One-Dimensional Elements
- Special Elements

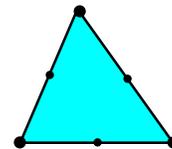
Two Dimensional Elements

The sediment transport model has always supported the traditional two dimensional 6-noded isoperimetric triangle and 8-noded isoperimetric quadrilateral elements. These are the same types of elements supported by RMA2.

However, the 2D off-channel storage features within RMA2 are not fully supported in SED2D WES. There is no concentration book-keeping in the off-channel storage area in the sediment model.

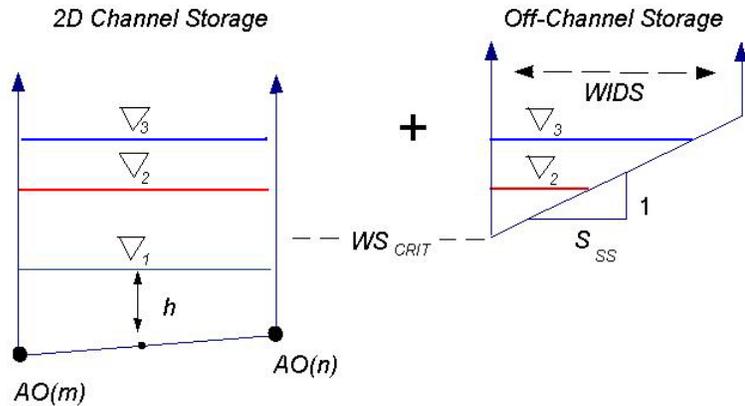


Rectangular Element



Triangular Element

D-R-A-F-T

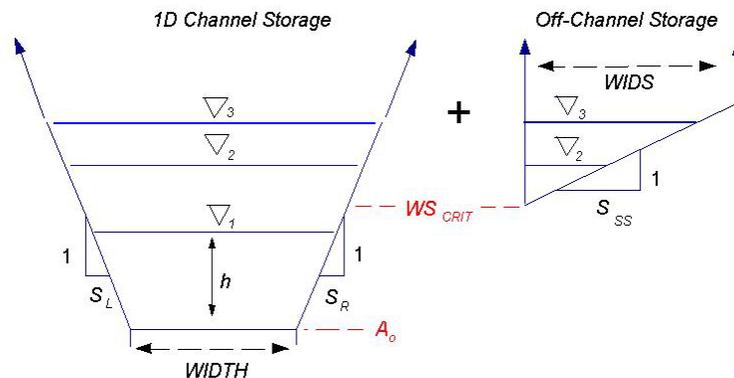


One Dimensional Elements

The ability to simulate one-dimensional (1D) elements was added to SED2D WES in 1994. The formulation assumes a trapezoidal cross section, consistent with the 1D formulation in RMA2. The implementation is provided as a convenience to allow the user to efficiently utilize the benefits of 1D elements in RMA2 for ease of domain discretization and boundary condition placement. The current formulation incorporates the traditional isoperimetric 1D element, 1D junctions, and transition elements from 1D to 2D.

The 1D capability in SED2D WES is not meant to give the ability to seriously model sediment transport as an alternative to HEC-6, for example, which is a fully developed 1D sediment model. This simply allows for use of the benefits of simplified schematization.

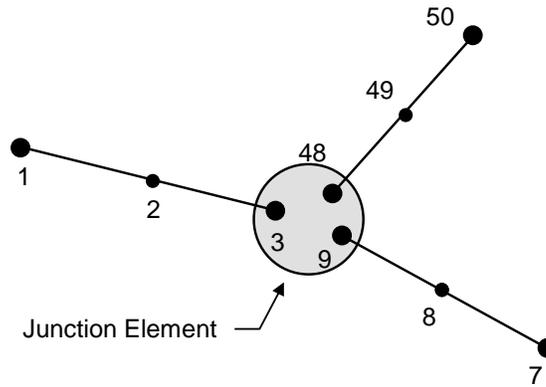
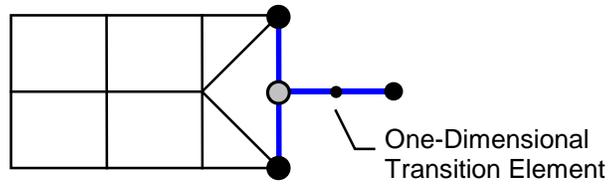
However, the 1D off-channel storage features within RMA2 are not fully supported in SED2D WES. There is no concentration book-keeping in the off-channel storage area in the sediment model.



Special One-Dimensional Elements

SED2D only supports the transition and junction type 1D elements.

D-R-A-F-T



GE elem# 3 9 48 0 0 0 0 0 901 ≤ imat ≤ 903

The formulation for 1D and 2D control structures is not operational at this time.

Using SED2D

Assumed User Knowledge Base

SED2D WES can be used by engineers and scientists to solve sediment transport problems that are satisfactorily described as unsteady, suspended transport in two horizontal dimensions with bed interaction. Users are cautioned that the program is relatively easy to use but somewhat more difficult to use properly. Persons using the program are assumed to be familiar with using a computer system. Knowledge of basic concepts in numerical methods is necessary. It is essential that the user possess considerable knowledge of hydraulic and sedimentation processes and that he or she understand the computer program and its proper use. At least one person on the modeling team should be familiar with the prototype system being modeled. In order to supply data to the model, verify the model, and understand the model results it is usually necessary to undertake a complimentary data collection program. The adage “Garbage in, garbage out” applies here.

Modeling Process

As mentioned previously, SED2D WES requires that hydrodynamic data be externally supplied, usually by a numerical hydrodynamic model. The TABS-MD modeling system has been designed to satisfy this and other needs for a comprehensive modeling package. TABS-MD consists of RMA2 WES, a general-purpose program for hydrodynamic modeling, in addition to SED2D WES. The graphical user interface, SMS, and a number of utility programs are used to develop input, translate data, analyze output, and provide graphical output from the models.

The **following flow chart** illustrates the SED2D modeling process. Items with bold borders are required; others are optional

Dynamic Memory Allocation

Effective April 2003 with version 4.54 of SED2D, the code was converted to FORTRAN 90 dynamic memory allocation. This allows the user the ability to control the dimensionality of the model without having to recompile.

D-R-A-F-T

The file “sedmemsize.dat” allows the user to customize the dimensions of the SED2D model.

By placing the file named “sedmemsize.dat” in the same directory as the SED2D run control file (.trn file), the dimensions of the model can be customized for your project specific requirements and accommodate your personal computer’s memory/disk space specifications.

The default memory model is set for approximately 2 gigabytes of random access memory (RAM). The user may customize the memory requirement by modifying the third line of the file “sedmemsize.dat”. A representative sample of the contents of the file is shown below. The first line contains the word “user” in columns one through four. The second line has no function other than to serve as a character string header for the third line. The third line of data are integer values corresponding to variable names in the header list. These integer values are list directed, so at least one space or a comma must separate each variable.



Example: Contents of “sedmemsize.dat”

```
user
MNN  MNE  MNEQ  MNL  MNFE  MBUF      MCC  MCCN  MNSPRT  MBNP  MBB  MQAL  MSTEP
35000 15000 35000 10   700   3000000 50   100   200     300  10   1     5000
```

Where the SED2D dimension variables are defines as

MNE	Maximum number of node numbers
MNE	Maximum number of element numbers
MNEQ	Maximum number of equations (suggestion MNEQ=MNE)
MNL	Maximum number of clay bed layers (suggest: 10)
MNFE	Maximum number of matrix columns
MBUF	Maximum buffer size
MCC	Maximum number of continuity check lines (GCL strings)
MCCN	Maximum number of nodes on a check lines (includes corner and midside nodes)
MNSPRT	Maximum number of special print nodes or elements
MBNP	Maximum number of Boundary condition (BC) buffer nodes
MBB	Maximum number of BC buffer cells (suggest: 10)
MQAL	Maximum number of quality constituents (MQAL = 1)
MSTEP	Maximum number of time steps

Modes of Operation

Typically SED2D is set to automatic, simulation super file, mode for compatibility with simulation super file saved by SMS.

SED2D may be executed either in *interactive mode*, *batch mode* or *automatic mode*. The mode is determined by the value of the IBATCH variable within the program. You can change the mode only if you have the source code and a FORTRAN compiler.

D-R-A-F-T

Running in Interactive Mode

To run interactively, execute SED2D directly and answer the series of questions referring to input and output file names. For instructions, enter a “?”.

The figure below illustrates the startup procedure for SED2D in interactive mode. Note that the question regarding a particular file will only be asked if that file is active on the \$L card. You may choose to null or prevent that file from being opened by typing “null” in response to a file name prompt. For information on SED2D files, see “Data Files” on page 23.

If the files specified are not in the directory from which the program was launched, then the full path to the files must be specified. Otherwise, the program will abort on input file reads. Responses to the screen queries should be as follows:

filename	- save as requested
null	- do not save file
quit	- stop program, now

D-R-A-F-T



. An example interactive session for a clay SED2D simulation follows.

```
C:\SED2D> sed2dv45.exe
To receive a response menu, type ?
ENTER RUN CONTROL INPUT FILE NAME
claysed.sed
ENTER FULL PRINT OUTPUT FILE NAME
claysed.out
ENTER INPUT GEOMETRY FILE FROM GFGEN (binary)
madora.gbn
ENTER INPUT RMA2 HYDRODYNAMIC FILE (binary)
madora.sol
ENTER OUTPUT CONCENTRATION/DELBED FILE (binary)
claysed.cd
ENTER OUTPUT BED STRUCTURE (binary)
claysed.bs
ENTER OUTPUT GEOMETRY CONTAINING NEW BATHYMETRY (ascii)
claysed.geo
```

The program now will run. Some information will be written to the screen as the program progresses. If the process finishes normally, the prompt appears. Check that the files requested to be created were saved. By default, the output files will be saved to the same directory from which the program was launched. If the process does not finish normally, an error message will be written to the screen. Examine the error message carefully to determine the cause of the error. Also check the bottom of the full print file (“claysed.out”) to find clues about when and how the program was aborted. For further information, see WARNINGS AND ERROR MESSAGES

The program may be run in interactive mode on a mainframe computer, such as the Cray T3E located at the WES High Performance Computer Center (HPC). Because of the way data are stored and accessed on the WES HPC, including the Mass Storage Facility (MSF), and the changing rules regarding the amount of memory available per processor, there is not a straight forward way to just execute the TABS-MD models. In this example, the IBATCH variable is set to interactive. In the /tmp director, compile SED2D using CF77. If you have prepared a run file, containing the input file names in the proper order, you can free up the terminal session for other activities. The actual command to run the SED2D model in this mode would use the direct (<) command re-direct (>) command, and the optional unix C-shell *nohup* utility would be as shown.

```
SED2D_executable_file_name<run_file_name>output_file_name & nohup
```

Running in Batch Mode

Batch mode is typically used on a large mainframe computer system, such as the Cray T3E at the Waterways Experiment Station. On the WES Cray computers and other mainframes, the batch mode execution of SED2D requires computer specific job control language. Since the specific syntax changes frequently, it will not be presented in this document. The WES Information Technology Laboratory (ITL)

D-R-A-F-T

help line is available to assist super computer users. The ITL High Performance computing assistance help line can be reached by calling 1-800-LAB-6WES extension 4400, option 1.



NOTE: The WES High Performance Computer Center (HPC) has established policies and procedures that may change the above stated method. Therefore, be sure to check with the HPC before planning and/or executing projects with hard milestone dates that could be affected by the operational demands on the DOD HPC.

Why Use Batch Mode

If you have access to the Cray computers at WES, or another mainframe computer containing the TABS programs, you may wish to execute SED2D in batch mode – especially if you have a large problem. Generally, you will have access to more CPU time and more system RAM when executing in batch mode.

Another advantage of batch mode is that it does not tie up your terminal. Once the job has been submitted to the system, your terminal is free and available for you to perform other tasks.

Running In Auto Mode (Simulation Super File)

Automatic Super Mode in SED2D (version 4.5 or higher) was designed to be compatible with the simulation super file concept in SMS.

When SED2D is compiled in automatic super mode, all input/output file names are controlled based upon a key-word character string. The user either edits the simulation super file created by SMS or creates a super file containing a list of key-words and file names. The \$L card still activates the existence of the input/output files.

The key-word must start in column one and be spelled exactly as shown, note that both upper and lower case is permitted. The user does not have to be overly concerned with the order in which file names are provided. The only order dependency is for the FILE_PATHWAY key-word which sets the directory information defining the pathway for all subsequent files. To de-activate a file I-O request, simply enter the word, “**null**” (in lower case), for the file name, as shown in the SED2D auto mode example.

When SED2D executes from within SMS, the only interactive question presented to the user is a request for the name of the simulation super file (*site.sup* in this example).

The actual command to run the SED2D model outside of SMS in this mode could use the direct (<) and re-direct (>) commands as shown.

```
SED2D < site_sed2d.run > site.screen
```

Super File Key-Word	File Name	Description
FILE_PATHWAY	/disk2/proj/	Sets the pwd for these I/O files
S2_BC	site.s2bc	SED2D run control BC file
S2_FRL	site.s2frl	SED2D full results listing
GEOMETRY_BIN	site.gbn	GFGEN binary geometry
R2_SOL	site.sol	RMA2 binary hydro solution file

D-R-A-F-T

S2_HOTCDB	site.iccdb	SED2D IC Hotstart for conc and/or delbed
S2_HOTSTRATA	site.icstrata	SED2D IC Hotstart for bed strata (structure)
S2_WAVE	site.wave	SED2D binary wave input
S2_WIND	site.wind	SED2D wind speed /direction input
S2_FETCH	site.fetch	SED2D wind fetch length input
S2_CDBSOL	site.s2cdb	SED2D binary conc/delbed solution file
S2_STRATA	site.s2strata	SED2D binary clay bed structure solution file
S2_SRLN	site.s2srl	SED2D summary results listing by node
S2_SRLE	site.s2srle	SED2D summary results listing by element
S2_GEOMETRY	site.s2geo	SED2D output geometry reflecting delbed changes
S2_NONDIM	site.s2nda	SED2D non-dimensional analysis results
S2_ALTBC	site.s2altbc	SED2D alternate BC transient file
S2_PARAMETER	site.s2param	SED2D auto diffusion echo



Example of a SMS, GFGEN, RMA2, RMA4, and SED2D simulation super file compatible set. This example assumes the project name to be “site”.

SMS Simulation File <i>site.sim</i>	GFGEN Simulation Super Run File <i>site_gfgen.run</i>	RMA2 Simulation Super Run File <i>site_rma2.run</i>
TABSSIM	GEOMETRY_INP site.geo	R2_BC site.bc
GFGEN site_gf.run	GEOMETRY_FRL site.gfp	R2_FRL site.frl
RMA2 site_rma2.run	GEOMETRY_BIN site.gbn	GEOMETRY_BIN site.gbn
RMA4 site_rma4.run		R2_SOL site.sol
SED2D stie_sed2.run		R2_SRL site.sum
		R2_PARAMETER site.auto

RMA4 Simulation Super Run File <i>site_rma4.run</i>	SED2D Simulation Super Run File <i>site_sed2d.run</i>
R4_BC site.r4bc	S2_BC site.s2bc
R4_FRL site.r4frl	S2_FRL site.s2frl
GEOMETRY_BIN site.gbn	GEOMETRY_BIN site.gbn
R2_SOL site.r4sol	R2_SOL site.sol
R4_SOL site.r4sol	S2_CDBSOL site.s2cdb
R4_PARAMETER site.r4auto	S2_PARAMETER site.s2auto

Guidelines for Obtaining a Good Solution

All aspects of a sediment transport simulation must be planned prior to finalization of the hydrodynamic RMA2 simulations. The geometry and hydrodynamic results

D-R-A-F-T

are all important to a successful sediment transport model. Reference the RMA2 user's manual for the guidelines for obtaining a good hydrodynamic solution.

Issues Directly Related to Hydrodynamic Solution

Conservation of Mass Problems

Conservation of mass problems are a result of two issues: boundary break angles along the perimeter of the mesh, and interpolation of the original incoming RMA2 time step.

Shore-Line Boundary Break Angles

Interpolated RMA2 Time Step

Nodes with a Negative Depth Calculation

Resolution to Capture Concentration Gradients

Wetting and Drying

Identical Marsh Porosity Parameters for RMA2 and SED2D

Time Step Selection

Appropriate Boundary Condition Placement for Sediment

Sediment Issues Not Related to Hydrodynamic Solution

Sediment Parameter Selection

Additional Resolution Needed to Resolve High Concentration Gradients

D-R-A-F-T

Sources of Error

Bottom Friction

RMA2

Calculations based on elemental properties

Has an accumulative average over the water column

SED2D

Calculations based on nodal properties

Directly assigns a bottom shear stress

When Boundary Conditions change

No Off Channel Storage Concentration Bookkeeping

No Auto-Roughness capability in SED2D

Basic Operation

SED2D WES is written in the FORTRAN programming language. It must be compiled prior to execution time. The assignment of file names for all of the input and output files required by the program is accomplished interactively.

SED2D may read and write several files during a simulation. The number and type of files depends upon choices you have made about how the simulation will run and what type of information you want to see in the results.

A SED2D WES run control file is always required. This is the "card image" input for SED2D WES described in this document. The other file choices must be specified within the run control file (see the description of the \$L cards).

Files used by SED2D fall into two basic format categories: ascii and binary. Files created by the user (such as the SED2D WES run control file) are usually created with an editor and consequently use the ASCII character set. These files can be transferred back and forth from one computer to another. This is convenient when a

D-R-A-F-T

“front end” computer is being used to create files that will eventually be passed to a batch-processing computer. On the other hand, files that are referred to as “binary” or “unformatted” files are specific to the computer on which they were generated. These files cannot be transferred arbitrarily between computing platforms.

Since SED2D WES requires binary solution files created by GFGEN and RMA2 WES, the user should be aware that same type of computer and compiler should be used to run each of the models. This will ensure that the binary files are compatible between runs.

There are numerous files for both input and output.

Input File Description

There are numerous input files required for SED2D. Table 1 shows the required and optional input data files for SED2D WES. Although this may seem overly complex, the typical SED2D simulation would require only a small subset of these possibilities.

Table 1: Standard Input Files.

Generic File Name*	Standard Logical Unit	Contents	Status
project1.sed	9 (required)	SED2D WES run control file. FORM= FORMATTED	OLD (created by the user: see users manual)
project0.gbn	10 (required)	Information about the numerical mesh geometry, connectivity, bathymetry, and material type associations. FORM= UNFORMATTED	OLD (created by GFGEN)
project0.sol	20 (required)	Information about the steady state or dynamic flow field. FORM= UNFORMATTED	OLD (created by RMA2-WES)
project0.cdb	30 (required to hotstart either concentration and/or bed change; not required for coldstart)	Information about the concentration field and the net bed change calculated from a previous SED2D WES run. FORM= UNFORMATTED	OLD (created by SED2D WES)
project0.bs	40 (required to hotstart clay bed structure; not required for coldstart)	Information about the clay bed structure calculated from a previous SED2D WES run. FORM= UNFORMATTED	OLD (created by SED2D WES)
project1.fch	50 (required for wave shear stress option; otherwise not required)	Information about wind fetch by node. FORM= FORMATTED	OLD (created by the user: see description of HS card)
project1.wnd	60 (required for wave shear stress option; otherwise not required)	Information about the wind speed and direction by node. FORM= FORMATTED	OLD (created by the user: see description of HS card)

D-R-A-F-T

project1.psc	70 (required for point source option; otherwise not required)	Information about the point source loadings. FORM= FORMATTED	OLD (created by the user: see description of PC card)
--------------	--	---	---

*These are examples only; the user may develop any organized file naming strategy.

D-R-A-F-T

SED2D Run Control File

The SED2D run control file consists of a set of text or ascii data supplied by the modeler. This file is always required.

Geometry File

It is possible to code the entire mesh in the SED2D run control file. However, this is highly discouraged. The ability to code mesh geometry for SED2D is intended for making minor geometry modifications when testing a proposed change to the mesh.

The mesh geometry, which SED2D will use, is normally defined in a binary file produced by the Geometry File Generation program, GFGEN. This mesh geometry file consists of the nodes and elements that define the size, shape, and bathymetry of the study area.

SED2D will not read a text, or ASCII, type file as input for the mesh geometry. If you do not have a binary geometry file, and you do not want to code the mesh geometry in the SED2D run control file, you must run GFGEN to obtain the geometry file before running SED2D. The \$L card is used to include the geometry file in the simulation run.

Hydrodynamic File

It is possible to code the entire mesh in the SED2D run control file. However, this is highly discouraged. The ability to code mesh geometry for SED2D is intended for making minor geometry modifications when testing a proposed change to the mesh.

The hydrodynamic input, which SED2D will use, is normally defined in a binary file produced by the TABS-MD depth averaged hydrodynamic model, RMA2. This binary solution file consists of the u-, and v-velocity components, water depth, water surface elevation, and wet/dry status at each node within the computational domain. This data set may be either steady state or time varying.

SED2D will not read a text, or ASCII, type file as input for the hydrodynamics. If you do not have a binary hydrodynamic RMA2 file, and you do not want to code the values in the SED2D run control file, you must run RMA2 to obtain the u-,v-,h-hydrodynamic solution file before running SED2D. The \$L card is used to include the RMA2 hydrodynamic solution file in the simulation run.

Wave binary solution file

Output File Description

There are numerous input files required for SED2D. Table 2 shows the required and optional output data files for SED2D WES. Although this may seem overly complex, the typical SED2D simulation would require only a small subset of these possibilities.

Table 2: Standard Output Files

Generic	Standard		
---------	----------	--	--

D-R-A-F-T

File Name*	Logical Unit	Contents	Status
screen or standard output redirect	6 depends on operating system (required)	Run-time information for monitoring the progress of the SED2D WES run. FORM= FORMATTED	UNKNOWN (created by SED2D WES)
project1.out	15 (not required)	SED2D WES printed output. FORM= FORMATTED	UNKNOWN (created by SED2D WES)
project1.spn	55 (not required)	Special summary output by node. FORM= FORMATTED	UNKNOWN (created by SED2D WES)
project1.spe	65 (not required)	Special summary output by element. FORM= FORMATTED	UNKNOWN (created by SED2D WES)
project1.geo	75 (required to make a follow-on RMA2-WES run with new bathymetry; otherwise not required)	Saves a new GFGEN input geometry file with new bed elevations resulting from the SED2D WES run. FORM= FORMATTED	UNKNOWN (created by SED2D WES)
project1.cdb	35 (required to hotstart either concentration and/or bed change in a follow-on SED2D WES run; otherwise not required)	Information about the concentration field and the net bed change calculated from a previous SED2D WES run. FORM= UNFORMATTED	UNKNOWN (created by SED2D WES)
project1.cdb	45 (required to hotstart clay bed structure in a follow-on SED2D WES run; otherwise not required)	Information about the clay bed structure calculated from a previous SED2D WES run. FORM= UNFORMATTED	UNKNOWN (created by SED2D WES)

*These are examples only; the user may develop any organized file naming strategy.

Full Results Listing File

The listing files can contain a plethora of information pertaining to the simulation results. Upon normal completion of an SED2D simulation run, a results listing file may be written, depending upon the settings of the parameters that pertain to results listing files on the \$L2 card.

New Geometry File

A new GFGEN geometry ASCII file will be created after normal completion of an SED2D simulation if the KGEOM variable was activated on the \$L2 card. This new geometry may be read into SMS for visualization of the nodal elevations reflecting the calculated delbed changes.

D-R-A-F-T

Concentration Delbed Solution File

A SED2D Concentration and Delbed binary solution file is saved upon normal completion of an SED2D simulation if the KPU variable was activated on the \$L2 card

Bed Structure File

A SED2D bed structure binary solution file is saved upon normal completion of an SED2D simulation if the KOHOTB variable was activated on the \$L2 card. The SED2D Bed Structure binary file contains information about the age and consolidation of the bed strata.

Using Titles

The ability to add Titles in the SED2D run control input file provides a means to describe the data which is being modeled. Titles are specified using the T1 and T2 cards, and a T3 card.



Note: A Title card must be the *first* card in the run control file, otherwise SED2D will not recognize the file as valid input. The T3 card actually identifies your solution file.

Including Title Information

Enter the Title and descriptive information about your data on T1, T2, and T3 cards. You may use as many T1 and T2 cards as you wish, and card order is unimportant. Be sure to end your set of Title cards with a T3 card.

The Last Title Card

The last Title card is the T3 card. Only one T3 card is allowed and it must be the very *last* title card. SED2D reads the '3' to mean the *end* of the Title cards.



Tip: The information on the T3 card is retained by SED2D and is written into the binary solution file header. Use the T3 card to your advantage. Supply information which will allow your solution file to be more easily identified in the future.

What Kind Of Computer Do You Have?

Why Should You Care?

Because different computer systems may store and retrieve information in different ways, SED2D needs to know the type of system on which it is running so it can properly transfer information on the system.

D-R-A-F-T

SED2D solution files and buffer files are written in a binary form. Binary files are strictly associated with the type of system upon which they are created. Word size and record length may be different from one system to the next.



Note: The computer identification is vital only if there is insufficient memory allotted during execution of SED2D which would require it to write temporary buffer files to solve the large matrix.

Want You Need To Do About It?

Tell SED2D what type of system on which you will be running by providing a value for the machine identifier with the \$M card. The type of computer you specify determines how temporary buffer files will be written and read.

The \$M card is necessary if your system does not have enough memory available for the simulation. In this case, SED2D will write temporary buffer files to your disk.

See the chapter entitled "**Error! Reference source not found.**" on page **Error!**

Bookmark not defined. for additional information on temporary buffer files.



Example: If you are running SED2D on a DOS or Windows-95/98 or Windows 2000 based PC, the machine identifier value should be 1.

```
.  
CO   Running on a PC  
$M   1  
.  
.
```

Obtaining The Mesh Geometry

As with all of the TABS-MD system numerical models, the finite element mesh is typically constructed with a graphical user interface, such as SMS, then processed through the GFGEN program.

A basic rule for constructing a finite mesh geometry to represent a given problem, is to move the boundaries of the model far enough from the area of primary interest such that if something is happening at the boundary its effect will be insignificant in the area of interest. When transport simulations follow a hydrodynamic study, it is imperative to consider transport issues when defining the model domain and its corresponding boundary condition locations.

First, you may directly input from within the SED2D run control file the information for all nodes and for all elements. The GE-, GNN-, and GW- cards may be used to directly specify the finite element mesh for the SED2D simulation. This manual technique is very rare and typically only used to illustrate analytical test cases.

The second, and more accurate method is to provide SED2D with a geometry input file containing the nodal assignments and element connections. The binary geometry file created by GFGEN is the ideal way to communicate the finite element mesh to SED2D

In *almost all* model applications the mesh geometry used in RMA2 and SED2D should be identical. The one notable exception would be a deliberate IMAT=0 setting.

Obtaining The Velocity Field

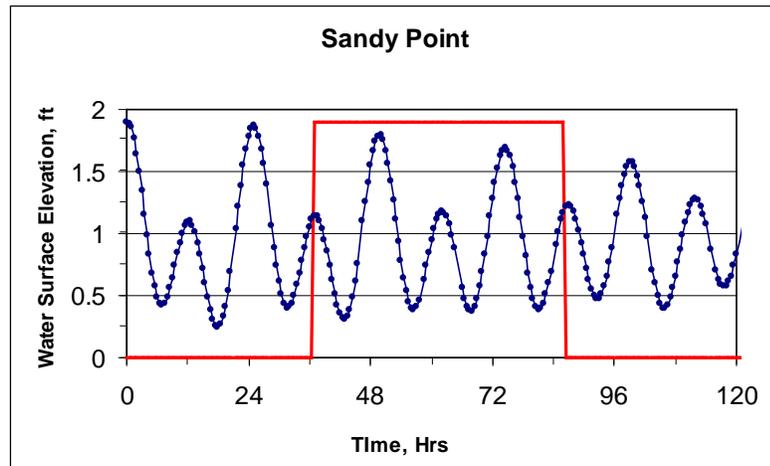
The accuracy of SED2D's calculations is dependent on the proper temporal and spatial estimate of the velocity field. There are two alternatives for specifying the velocity field.

First, you may estimate some representative behavior from field experience or statistical analysis for all nodes and for each time interval. The HD-, HU-, and HV-cards will be used to directly specify the velocity field for the SED2D simulation.

The second, and more accurate method is to supply the binary final results solution file from RMA2 as the flow field. You must control the starting and ending time of the RMA2 velocity field (TH card) to be used in the RMA4 simulation. Whenever the RMA4 selected delta time step does not match the RMA2 hydrodynamic delta time step, RMA4 will skip over or interpolate (which ever is appropriate) the RMA2 solution. If the RMA2 solution is shorter than the requested RMA4 simulation, the RMA2 results file will be re-wound and re-used again and again.



Example of hydrodynamic time control, TH card: TCORR=37, TEND=86 hrs.



Marsh Porosity Parameters

Specifying Initial Concentrations

IC By Explicitly Assigning Nodal values

The IC card, with options blank, provides

IC By Transport Potential

The ICP card provides a mechanism for initializing the concentration based upon transport potential (for sand) at each node.

D-R-A-F-T

Sediment Time Control

Time Step Control

Total Simulation Control

Hydrodynamic Time Control

Simulating with Steady State Input

Simulating with Transient Input

Hydrograph

Tide

Bed Characteristics

Bed Initialization

Sand

SB-Card

Clay

Initialization: CI-Card

Layer: CL-Card

Apply Stress to Define the Structure: CS-Card

Bed Roughness

D-R-A-F-T

Sand

Shear Stress: SR-Card

Transport: ST-Card

Clay

Specifying Lateral Boundary Conditions

Inflow

Dirichlet Type

Outflow

Von Neuman Type

Reversals

Stopping the Simulation

Interpretation of the Results

QA/QC Check

Check for Negative Concentrations

Check for Mass Conservation

D-R-A-F-T

Check for Unusual Deposition Patterns

Check if Updated Hydrodynamics are needed

Re-Starting the Simulation

Verifying The Simulation

Verification: A Process

Run

Inspect – Compare to Field Data - Adjust

Re-Run

Compare to Field Data

Direct Approach

Compare to Observed Sediment Flux

Compare to Observed Concentrations

D-R-A-F-T

Compare to Observed Bed Elevation Evolution

Indirect Approach

Shoaling Patterns for Bed Deposition Rates

Example

Dredging Volume and Distribution

Example

Turbidity Plume Patterns from Satellite or Aerial Photography

Example

If Your Verification Fails

Wrong Choice of Model

Geometry Related Problems

Wetting and Drying

Marsh Porosity

Resolution Issues

D-R-A-F-T

Hydrodynamic Related Problems

Accurate

Representative for Sediment Transport

Boundary Condition Problems

Boundary Location

Boundary Specifications

Initial Condition Effects

The simulation trends to the goal but never achieves it
Massive changes in the bed during start up

Sediment Class

Really clay – Really sand – or complicated mixture

Energy Sources

Wind

Waves

Long Term Predictions

Just Run It for the Full Period

Simple Extrapolation

Joint Probability Method

Combining Sediment Classes

Combining Multiple Hydrodynamic Conditions

Combining Multiple Wave Conditions

Advanced Techniques

Analytical Test Cases

Non-dimensional Analysis of Governing Equation

This section reviews the numerical formulation used in SED2D-WES and presents an analysis of the use of the appropriate numerical coefficients for a given numerical mesh and simulation design. The numerical mesh and hydrodynamic solution present certain dimensional characteristics to the governing equations of sediment transport. For a given mesh and hydrodynamic solution (RMA-2) the transport model will have certain numerical restrictions that will limit the ability of the program to provide accurate solutions. A clear understanding of these limitations can lead to either a redesign of the mesh and hydrodynamic simulation or guidance in the compromises necessary in the numerical coefficients in SED2D-WES.

Transforming The CD Equation

Recall that the convection-diffusion equation (Equation 1), a.k.a. CD equation, solved by SED2D is of the basic form:

$$\frac{\partial C}{\partial t} + u \frac{\partial C}{\partial x} + v \frac{\partial C}{\partial y} - \frac{\partial}{\partial x} D_x \frac{\partial C}{\partial x} - \frac{\partial}{\partial y} D_y \frac{\partial C}{\partial y} - \alpha_1 C - \alpha_2 = 0$$

where

C	=	depth-averaged sediment concentration, kg/m ³
T	=	time, sec
x,y	=	horizontal Cartesian coordinates, meters
u,v	=	current velocity components in the x,y directions, m/sec
D_x,D_y	=	dispersion/diffusion coefficients for the x,y directions, m ² /sec
α_1	=	coefficient for the bed source/sink term, 1/sec

D-R-A-F-T

α_2 = coefficient for the bed source/sink terms, $\text{kg}/(\text{m}^3\text{-sec})$

The general characteristics of the governing equation are best understood by performing dimensionless analysis of the equation to develop the characteristics for certain conditions. To facilitate the analysis the following scaling factors are applied

$$\begin{aligned} C &= C_0 c' \\ T &= \Delta t t' \\ U &= V u' \\ V &= V v' \\ X &= L x' \\ Y &= L y' \\ D_x &= D_r D_x' \\ D_y &= D_r D_y' \end{aligned}$$

The source/sink term coefficients α_1 and α_2 vary for sand and clay and whether deposition or erosion is occurring. These conditions will be addressed separately later. For the first analysis, sand deposition will be assumed.

Transform The Sand Deposition Equation

For sand deposition the source sink terms take on the form

Equation 30

$$S = \alpha_1 C + \alpha_2 = -\frac{(C - G_p)V_s}{L_{de}D}$$

where

$$\begin{aligned} G_p &= \text{transport potential from Ackers-White, } \text{kg}/\text{m}^3 \\ V_s &= \text{sediment fall velocity, m/s} \\ L_{de} &= \text{scale length factor deposition, dimensionless} \\ D &= \text{water depth, m} \end{aligned}$$

For this condition, the following scaling factors are used

$$\begin{aligned} G_p &= \mathbf{C}_0 G_p' \\ D &= \mathbf{H} D' \\ V_s &= \mathbf{W}_s V_s' \end{aligned}$$

From the application of these scaling factors we get

Equation 31

D-R-A-F-T

$$\alpha_1 C + \alpha_2 = - \left(\frac{C_o V_s}{L_{de} H} \right) \frac{(C' - G_p') V_s'}{D'}$$

The full equation for sand deposition becomes

Equation 32

$$\begin{aligned} & \left(\frac{C_o}{\Delta t} \right) \frac{\partial c'}{\partial t'} + \left(\frac{C_o V}{L} \right) u' \frac{\partial c'}{\partial x'} + \left(\frac{C_o V}{L} \right) v' \frac{\partial c'}{\partial y'} \\ & - \left(\frac{D_r C_o}{L^2} \right) \frac{\partial}{\partial x'} D_x' \frac{\partial c'}{\partial x'} - \left(\frac{D_r C_o}{L^2} \right) \frac{\partial}{\partial y'} D_y' \frac{\partial c'}{\partial y'} \\ & - \left(\frac{C_o V_s}{L_{de} H} \right) \frac{(C' - G_p') V_s'}{D'} = 0 \end{aligned}$$

where the first term is storage, the second and third terms are x- and y- advection, the fourth and fifth terms are x- and y-diffusion, and the last term is the bed sink (sand deposition)

These terms in the equation above represent the various aspects of the transport process. Note that the terms with the primed variables have been scaled such that these terms are non-dimensional, taking on the scale of unity. The bolded terms now contain the dimensional characteristics of the process. The normal method for the interpretation of these scaling factors is to develop the ratios of these terms.

There are several dimensional groupings that are independent of the bed source-sink variables. The ratios of these terms will be addressed first.

Advection/Diffusion Ratio

For example, the ratio of the advective terms to the diffusion terms yields the Peclet Number

Equation 33

$$P_e = \left(\frac{C_o V}{L} \right) / \left(\frac{C_o D_r}{L^2} \right) = \left(\frac{V L}{D_r} \right)$$

This parameter has been used extensively to deal with numerical oscillations caused by over-advecting the solution.

Advection/Storage Ratio

Another basic parameter is the ratio of the advection and storage term

Equation 34

$$C_n = \left(\frac{C_o V}{L} \right) / \left(\frac{C_o}{\Delta t} \right) = \left(\frac{V \Delta t}{L} \right)$$

D-R-A-F-T

This term can be called an advective Courant number, using the advective velocity rather than the wave celerity. This is a measure of the fraction of the element over which a parcel of water is transported within a single time step.

Diffusion/Storage Ratio

For the three basic groupings of dimensional parameters (storage, advection and diffusion), there are only three unique ratios to be defined (ignoring the inverses of each ratio). When two of the three ratios are known then the other ratio is defined from the other two.

Equation 35

$$\left(\frac{C_o D_r}{L^2} \right) / \left(\frac{C_o}{\Delta t} \right) = \left(\frac{D_r \Delta t}{L^2} \right) = \frac{C_n}{Pe}$$

This term could be called a non-dimensional diffusion coefficient or simply the ratio of the advective Courant number and the Peclet number.

The SED2D model's response to various ranges of these non-dimensional parameters can best be evaluated experimentally.

Transform The Bed Source-Sink Terms

The bed source-sink terms will now be addressed separately. There are four basic cases to be considered. These are: sand deposition, sand erosion, clay deposition and clay erosion.

Sand Deposition

The sand deposition terms were developed earlier.

Equation 36

$$\alpha_1 C + \alpha_2 = - \left(\frac{C_o V_s}{L_{de} H} \right) \frac{(C' - G_p') V_s'}{D'}$$

This dimensional grouping can now be ratioed to the other terms in the equation.

(sand deposition/storage). The sand deposition to storage ratio is

Equation 37

$$\left(\frac{C_o V_s}{L_{de} H} \right) / \left(\frac{C_o}{\Delta t} \right) = \left(\frac{V_s \Delta t}{L_{de} H} \right) = C_v$$

The term L_{de} , already dimensionless, so that this non-dimensional term can be viewed as a vertical advective Courant number.

(sand deposition/convection). The ratio of sand deposition to convection is

Equation 38

D-R-A-F-T

$$\left(\frac{C_o V_s}{L_{de} H} \right) / \left(\frac{C_o V}{L} \right) = \left(\frac{V_s L}{V L_{de} H} \right) = \frac{C_v}{C_n}$$

(*sand deposition/diffusion*). The ratio of sand deposition to diffusion is

Equation 39

$$\left(\frac{C_o V_s}{L_{de} H} \right) / \left(\frac{C_o D_r}{L^2} \right) = \left(\frac{V_s L^2}{D_r L_{de} H} \right) = \frac{C_v}{C_n} Pe$$

Sand Erosion

Sand erosion is represented in SED2D as

Equation 40

$$S = \alpha_1 C + \alpha_2 = - \frac{(C - G_p) |V|}{L_{er} D}$$

where:

- G_p = transport potential from Ackers-White, kg/m³
- $|V|$ = velocity magnitude, m/s
- L_{er} = scale length factor erosion entrainment dimensionless
- D = water depth, m

The velocity magnitude is

Equation 41

$$|V| = \sqrt{u^2 + v^2} = \sqrt{(V u')^2 + (V v')^2} = V \sqrt{u'^2 + v'^2} = V V_m'$$

where V_m' is the non-dimensional velocity magnitude

For this condition, the following scaling factors are used

- $G_p = C_o G_p'$
- $D = H D'$
- $|V| = V V_m'$

From the application of these scaling factors we get

Equation 42

D-R-A-F-T

$$\alpha_1 C + \alpha_2 = - \left(\frac{C_o V}{L_{er} H} \right) \frac{(C' - G_p') V_m'}{D'}$$

(*sand erosion/storage*). The sand deposition to storage ratio is

Equation 43

$$\left(\frac{C_o V}{L_{er} H} \right) / \left(\frac{C_o}{\Delta t} \right) = \left(\frac{V \Delta t}{L_{er} H} \right) = \left(\frac{V}{V_s L_{er}} \right) \left(\frac{V_s \Delta t}{H} \right) = V_r C_v$$

The term L_{de} , already dimensionless, so that this non-dimensional term is the vertical advective Courant number multiplied by a velocity ratio, V_r , of the current velocity and the fall velocity times the entrainment length factor L_{er} .

(*sand erosion/convection*). The ratio of sand deposition to convection is

Equation 44

$$\left(\frac{C_o V}{L_{er} H} \right) / \left(\frac{C_o V}{L} \right) = \left(\frac{L}{L_{er} H} \right) = \frac{C_{ve}}{C_n}$$

(*sand erosion/diffusion*). The ratio of sand deposition to diffusion is

Equation 45

$$\left(\frac{C_o V}{L_{er} H} \right) / \left(\frac{C_o D_r}{L^2} \right) = \left(\frac{V L^2}{D_r L_{er} H} \right) = \frac{C_{ve}}{C_n} P_e$$

Clay Deposition

Clay deposition in SED2D is represented by

Equation 46

$$\alpha_1 C + \alpha_2 = \frac{V_{se} C}{D} \left(1 - \frac{\tau}{\tau_d} \right)$$

where:

- τ = bottom shear stress, N-m/sec²
- τ_d = critical bottom shear stress for deposition, N-m/sec²
- V_{se} = the effective fall velocity, m/sec

These terms will all scale as before and the term in parentheses that includes the ratio of shear stresses is already non-dimensional. The effective fall velocity is used for clay deposition because for clay the relationship between concentration and fall velocity, if the option is used in the program, is nonlinear.

Equation 47

D-R-A-F-T

$$\alpha_1 C + \alpha_2 = - \left(\frac{C_o V_{se}}{H} \right) \frac{V_{se} 'c'}{D'} \left(1 - \frac{\tau}{\tau_d} \right)$$

This dimensional grouping for clay deposition can now be ratioed to the other terms.

(Clay deposition/storage). The clay deposition to storage ratio is

Equation 48

$$\left(\frac{C_o V_{se}}{H} \right) / \left(\frac{C_o}{\Delta t} \right) = \left(\frac{V_{se} \Delta t}{H} \right) = C_v$$

This Courant number is essentially the same as for the sand deposition if the term L_{de} for the sand is taken as 1.0.

(Clay deposition/convection). The ratio of clay deposition to convection is

Equation 49

$$\left(\frac{C_o V_{se}}{H} \right) / \left(\frac{C_o V}{L} \right) = \left(\frac{V_{se} L}{VH} \right) = \frac{C_v}{C_n}$$

(Clay deposition/diffusion). The ratio of clay deposition to diffusion is

Equation 50

$$\left(\frac{C_o V_{se}}{H} \right) / \left(\frac{C_o D_r}{L^2} \right) = \left(\frac{V_{se} L^2}{D_r H} \right) = \frac{C_v}{C_n} Pe$$

Clay Particle Erosion

The clay particle erosion in SED2D is represented as

Equation 51

$$\alpha_1 C + \alpha_2 = \frac{E}{D} \left(\frac{\tau}{\tau_e} - 1 \right)$$

where:

- E erosion rate constant, kg/(m² sec)
- τ_e critical shear stress for erosion, N-m/sec²

The erosion rate constant must be scaled in a manner that reflect the

$$E = \mathbf{E}_0 E'$$

As before this source-sink term can be scaled as

Equation 52

D-R-A-F-T

$$\alpha_1 C + \alpha_2 = -\left(\frac{E_o}{H}\right) \frac{E_o'}{D'} \left(\frac{\tau}{\tau_e} - 1\right)$$

(clay particle erosion/storage). The clay particle erosion to storage ratio is

Equation 53

$$\left(\frac{E_o}{H}\right) \bigg/ \left(\frac{C_o}{\Delta t}\right) = \left(\frac{E_o \Delta t}{C_o H}\right) = \left(\frac{E_o}{C_o V_s}\right) \left(\frac{V_s \Delta t}{H}\right) = P_d C_v$$

This ratio reflects the relative speed at which the entrainment of sediment from the bed causes the concentration in the water column to change. It is the product of the vertical advective Courant number and a non-dimensional term, P_d , which can be viewed as a particle Peclet number (Teeter, 1984).

(clay particle erosion/convection). The ratio of clay particle erosion to convection is

Equation 54

$$\left(\frac{E_o}{H}\right) \bigg/ \left(\frac{C_o V}{L}\right) = \left(\frac{E_o L}{C_o V H}\right) = \left(\frac{E_o}{C_o V_s}\right) \left(\frac{V_s L}{V H}\right) = \left(\frac{C_v}{C_n}\right) P_d$$

(clay particle erosion/diffusion). The ratio of clay particle erosion to diffusion is

Equation 55

$$\left(\frac{E_o}{H}\right) \bigg/ \left(\frac{C_o D_r}{L^2}\right) = \left(\frac{E_o L^2}{C_o D_r H}\right) = \left(\frac{E_o}{C_o V_s}\right) \left(\frac{V_s L^2}{D_r H}\right) = \frac{C_{ve}}{C_n} P_e P_d$$

Clay Mass Erosion

When the bottom shear stress is greater than the shear strength of the clay layer the entire layer is entrained into suspension during the model time step. The relationship is encoded as

Equation 56

$$S = \frac{\rho_L \delta_L}{D t_c}$$

where:

- ρ_L = the density of the layer, kg/m³
- δ_L = the thickness of the layer, m
- t_c = characteristic time of response, sec

D-R-A-F-T

This term is scaled by the following

$$\begin{aligned}\rho_L &= \rho_0 \rho' \\ \delta_L &= \delta_0 \delta' \\ t_c &= \Delta t t'\end{aligned}$$

This leads to the non-dimensionalized term

Equation 57

$$S = \left(\frac{\rho_0 \delta_0}{H \Delta t} \right) \frac{\rho' \delta'}{D' t'}$$

(clay mass erosion/storage). The clay mass erosion to storage ratio is

Equation 58

$$\left(\frac{\rho_0 \delta_0}{H \Delta t} \right) / \left(\frac{C_o}{\Delta t} \right) = \left(\frac{\rho_0 \delta_0}{C_o H} \right) = M_r$$

This ratio reflects the relative mass entrained from the bed to the mass in the water column.

(clay mass erosion/convection). The ratio of clay mass erosion to convection is

Equation 59

$$\left(\frac{\rho_0 \delta_0}{H \Delta t} \right) / \left(\frac{C_o V}{L} \right) = \left(\frac{\rho_0 \delta_0 L}{C_o H V \Delta t} \right) = \frac{M_r}{C_n}$$

(clay mass erosion/diffusion). The ratio of clay mass erosion to diffusion is

Equation 60

$$\left(\frac{\rho_0 \delta_0}{H \Delta t} \right) / \left(\frac{C_o D_r}{L^2} \right) = \left(\frac{\rho_0 \delta_0 L^2}{C_o D_r H \Delta t} \right) = \frac{M_r}{C_n} P_e$$

Summary: Non-D Terms in the CD Equation

Non-dimensional Terms in the Convective-Diffusion Equation (SED2D-WES)

D-R-A-F-T

	Term in Numerator							
Term in Denominator	Storage	Advection	Diffusion	Sand Deposition	Sand Erosion	Clay Deposition	Clay Particle Erosion	Clay Mass Erosion
Storage	1	C_n	C_n / P_e	C_v	$C_v V_r$	C_v	$C_v P_d$	M_r
Advection	$1/C_n$	1	$1/P_e$	C_v/C_n	$C_v V_r/C_n$	C_v/C_n	$P_d C_v/C_n$	M_r/C_n
Diffusion	P_e/C_n	P_e	1	$(C_v/C_n)P_e$	$P_e C_v V_r/C_n$	$(C_v/C_n)P_e$	$(C_v/C_n)P_e P_d$	$M_r P_e/C_n$
Sand Deposition	$1/C_v$	C_n/C_v	$(C_n/C_v)P_e$	1	-	-	-	-
Sand Erosion	$1/(C_v V_r)$	$C_n/(C_v V_r)$	$C_n/(C_v V_r P_e)$	-	1	-	-	-
Clay Deposition	$1/C_v$	C_n/C_v	$C_n/(C_v P_e)$	-	-	1	-	-
Clay Particle Erosion	$1/(C_v P_d)$	$C_n/(P_d C_v)$	$C_n/(C_v P_e P_d)$	-	-	-	1	-
Clay Mass Erosion	$1/M_r$	C_n/M_r	$C_n/(M_r P_e)$	-	-	-	-	1

Where

$$\begin{aligned}
 C_n &= V \Delta t / L \\
 C_v &= V_s \Delta t / H \\
 P_e &= V L / D_r \\
 P_d &= E_0 / (C_0 V_s) \\
 V_r &= V / (V_s L_{er}) \\
 M_r &= \rho_0 \delta_0 / (C_0 H) \\
 V &= \text{current velocity, m/sec} \\
 \Delta t &= \text{time step, sec} \\
 L &= \text{horizontal size of element, m} \\
 D_r &= \text{diffusion coefficient, m}^2/\text{sec} \\
 V_s &= \text{fall velocity, m/sec} \\
 L_{er} &= \text{horizontal entrainment factor, m} \\
 H &= \text{water depth, m} \\
 E_0 &= \text{particle rate of entrainment for clay, kg/(m}^2 \text{ sec)} \\
 C_0 &= \text{suspended sediment concentration, kg/m}^3 \\
 \rho_0 &= \text{density of clay bed layer, kg/m}^3 \\
 \delta_0 &= \text{thickness of clay bed layer, m}
 \end{aligned}$$

Test problems

The model performance will be tested with a series of test problems designed to evaluate the response of SED2D to these parameters. These tests will utilize the following test meshes:

1. A simple settling column problem. There may be a range of these meshes with progressively greater resolution, but the simplest is a single element. The settling column is 1m by 1m and 10m deep. The hydrodynamics for the test is zero velocity throughout. This test case eliminates the advective terms in the equation and allows for the isolation of the storage, diffusion and bed source-sink terms.

D-R-A-F-T

-
2. A long flume through which a steady-state discharge is run. The discharge itself can be varied to achieve various shear stresses. The water depth can also be changed by varying the downstream head boundary condition.
3. A schematic tidal wetland mesh

Run Control

Overview

SED2D obtains its run control data from a set of input data cards provided in run control files. These data cards conform to what is known as HEC format. Each card has 80 columns of characters in which to hold its data. The first three columns are reserved for the card name, so there are actually 77 columns in which to hold functional data.

A data card occupies a single line in the run control input file. The card line is divided into data fields, of which the first contains the card name, and is designated as field 0. Field 1 begins the actual data for the card. SED2D uses a free field format for data card input. Each item of data constitutes a field. There can be as many fields on a card as there is room within the 80 columns of characters.

Note: If more than one card modifies a variable, the last card rules.

Summary of Run Control Data Cards

Input to the program consists of card image data in data files. The following paragraphs describe the input data in detail.

Information cards T1, T2, T3, \$D

These cards contain descriptive information used to identify a model run. As many T1 and T2 cards can be used as are needed. The final title card must be a T3 card. Information on the T3 card is saved with the program output files (along with data management banners, if used), so it can be used to identify the data file. The \$D card permits the user to tag the beginning date of simulation for information purposes (but this information is not used by the program).

Run control cards: \$L1, \$L2, \$H, END, STOP, TO, TR, EF

These cards are used to control various aspects of program control. The \$L1 and \$L2 cards are used to specify which input and output files the program will use. The

D-R-A-F-T

END card signals the end of the card list pertaining to a specific time step. One END card must be supplied for every time step. The STOP card signals the end of the card list pertaining to the entire simulation period.

The \$H card is used to control HOTSTART runs of the program. In a cold start, a model run begins fresh, not using the results of any previous run as a starting point. In a hot start, some of the variables, such as concentration or bed thickness, begin with values that were computed in a previous run. The files needed for hot starting a model run are written if so requested on the \$L2 card. In order to make a hot start run, first submit a cold start model run in which bed structure and/or concentrations and bed elevation changes are saved (see \$L2 card). Then submit a run with the appropriate hot start switches on the \$H card, and specify the appropriate hot start unit numbers on the \$L1 card.

In a cold start run, all of the important processes must spin - up from an artificial condition such as a uniform sediment concentration field. The spin - up time is the length of time a simulation must run before the solution has recovered from the artificial initial condition. For example, in a sand bed problem, if the initial sediment concentrations are too low in one area the bed may erode during spin - up until equilibrium concentration is reached. This may happen even if the prototype bed is stable in that area. To overcome this problem, a hot start run would be made in which concentrations are hot started from the previous run, but bed structure and bed elevation changes are cold started.

The TO card specifies the frequency for printing the binary solution. The TR card specifies the frequency for printing to the ASCII output file, and provides the user with options for the volume of information to be printed. The primary purpose of the trace printout controls is to assist in diagnosing problems with a run, but they also provide for printing of some parameters that may be useful in interpreting model results. If a trace printout is selected, it will print only at the locations specified on the TRE, TRT and TRN cards if they are present (Note: the TRN and TRT cards are not fully operational in this version of SED2D WES).

The EF card specifies two flags that affect how the computations proceed. The flag denoted as IHYDOPT permits the user to allow the flow field to be “adjusted” during the run. That is, as the bed moves up and down because of erosion or deposition, the depth of flow is adjusted at each node to maintain the same water surface elevation and the velocities are adjusted to maintain the same unit flow at each node. This option is included to be consistent with earlier versions of STUDH. Whether this adjustment is appropriate is a matter of significant differences in opinion, even among the authors of this documentation.

One side of the issue maintains that this artificial adjustment of the flow field can lead to numerical inaccuracies, and is physically unsupportable. That position **highly recommends** that the user choose the default option, IHYDOPT = 0. However, by choosing IHYDOPT = 0 the user must realize that he or she is accepting the assumption that the changes in the bed calculated by SED2D WES are small, and they do not have a significant impact on the hydrodynamic solution. When the bed changes become large enough that this assumption is no longer valid, the user should stop the SED2D WES run and generate a new hydrodynamic flow field using the new geometry file generated by SED2D WES (which contains the new bed elevations). The user may then “hot start” the sediment run using the new flow field and the initial conditions saved from the previous sediment run. This process is repeated until the whole period of simulation has been covered.

The counter position to the above argument is that by not adjusting the flow field the model may produce excessive erosion or deposition. As the sediment deposits, if the flow field is adjusted the velocities will increase, increasing the shear stress and potentially reaching a level that will inhibit further deposition. If the sediment is

D-R-A-F-T

being eroded, then adjusting the flow field will result in lower velocity, lower shear stresses and potentially reach a level where erosion will be inhibited. The adjustment can provide some measure of control on excessive bed change. Both positions on the issue agree that the user must ultimately be responsible for interpreting the model results and insuring that when the bed changes reach a level where the hydrodynamics will be dramatically altered that the hydrodynamics are reassessed.

The second variable on the EF card is the DEPLIMIT variable. This variable causes the sediment run to abort when a “significant” bed change occurs at one or more nodes. That is, the user may specify a percentage of the total water column as the characteristic length beyond which the assumption of a pre-calculated flow field is no longer valid. The default is DEPLIMIT = 0.25, or when the bed change at a node is greater than 25% of the water depth at that node then the program will abort. The hot start files requested on the \$L cards will be saved, so that the user may generate a new hydrodynamic flow field and then “hot start” the sediment simulation from the point when the depth tolerance was exceeded. For greatest accuracy, make DEPLIMIT as small as possible and generate new flow fields often.

Geometry cards: GE, GNN, GT, GS, GC, DA, DM

The preferred method of handling geometry related issues is to make changes/modifications within the ASCII geometry file and re-run GFGEN.

However, SED2D does permit the usage of geometry related input. The GE card permits the user to put in an element connection table. The GNN card permits the user to assign the (x,y) coordinate, and z-elevation of a node. The GT permits the user to assign or modify an element's material type number. The GS card allows the user to scale the coordinates provided in the GFGEN binary file by a constant value. The GC card allows the user to specify lists of nodes that define channel cross-sections. The GC cards are useful for specifying boundary conditions along cross-sections that lie on the mesh boundary. The DA and/or DM cards are used to specify the marsh porosity parameters, using the same format as RMA2. However, the user must remember to convert the first three variables if the units are changes between RMA2 and SED2D WES.

Timing and run length control: TZ card

The TZ card specifies the computational interval and number of time - steps to be run. Choice of a computational interval is dependent on the size of mesh cells used, speed of the flow, effective settling velocity of the sediment, and how well the modeler wishes to resolve small - scale bed features. It is recommended that the time interval for SED2D WES be identical to the RMA2-WES time interval. To obtain the number of time-steps needed to reach a given length of run, use the equation

$$\#TimeSteps = \frac{RunLength}{ComputationalInterval} + 1$$

Implicitness factor: TT card

The program uses the Crank Nicholson time - stepping scheme that employs an implicitness factor. A value of 0.66 is recommended, but variations from 0.5 (equal weighting of this time - step and the previous time - step) to 1.0 (no influence from

D-R-A-F-T

the previous time - step) are permitted. A higher value of Theta produces results that are more stable but numerical (artificial) dispersion of sediment is increased.

Sediment size classes for sand: SA ,SR, ST

The program requires that sediment sizes and/or their characteristics be specified. For noncohesive sediment bed problems, input allows for multiple grain sizes on the SA card, BUT AT PRESENT THE PROGRAM CONSIDERS ONLY ONE EFFECTIVE GRAIN SIZE. (The input reflects some changes that are planned for the SED2D WES program, but are not currently functional). The grain size specified on the SA card is applied to every node in the mesh. Values at specific nodes may be changed by use of the SR and ST cards. The ST card specifies grain sizes to be used in noncohesive sediment transport equations and the SR card specifies the effective grain size to be used in bed roughness calculations (Ackers-White transport equations only). These two sizes will be the same only for plane beds in straight channels. Bed forms and channel curvature introduce form roughness that causes the roughness size to be larger than the size used for transport computations.

Note that the SA, SR, and ST cards constitute a cascading set of defaults. The SA card should precede the SR and ST cards. If neither an SR nor ST card is present, the grain size on the SA card will be used at all nodes for both transport and effective roughness. If SR cards are present, they override the roughness size on the SA card at those nodes specified. The ST cards override the transport size on the SA card at every node specified on the ST card.

Two characteristic length parameters are requested on the SA card. CLDE is the length factor for deposition. The default is a value of 1, corresponding to an average settling depth equal to the water depth. For fine sediments that are distributed throughout the water column, a value of 0.5 is recommended. For coarser sediments in less turbulent flow, a smaller value is suggested. CLER is the length factor for erosion. The default value of 10 is suggested, but more investigation is needed to find the best value.

Settling velocity: WC cards

Settling velocities are specified on the WC cards. This settling velocity is an effective fall velocity which goes up with grain size, goes down with increasing turbulence, goes up with increasing aggregation (cohesive sediments), and goes up if a too large value of CLDE is used. The best starting point for noncohesive sediments are fall velocities for spherical particles of equal diameters. For data on appropriate values for settling velocities see "Some Fundamentals of Particle Size Analysis," 1957, Committee on Sedimentation, Interagency Committee on Water Resources. For cohesive sediments, the settling velocity of particles can vary enormously with sediment type, salinity, turbulence, and other chemical and physical conditions. Laboratory or field tests are needed to define effective settling velocities.

Cohesive sediment characteristics: CC and CI cards

The Figure below illustrates the relation between the various critical shear stresses for cohesive sediments. These values must generally be determined by laboratory or field experimentation, but published results for similar sediments can be used if caution is exercised. Values specified on the CC card for critical shear stresses for erosion and the erosion rate constant are overridden by those contained on the CI cards. The CC card should precede the CI cards. The CI cards are used to assign

D-R-A-F-T

characteristics to various types of cohesive sediment bed layers. These characteristics are assigned to existing bed layers as specified on the CL cards and to new layers as they are deposited. Freshly deposited sediments are assigned a type 1 designation and increase to higher numbered types as the thickness of sediment above them increases. Data for the CI cards should come from laboratory tests on the sediments to be modeled.



Cohesive bed behavior as a function of shear stress

Dry density as specified on the CI cards can be calculated by the following formula:

Equation 61

$$\rho_{dry} = \rho_s \frac{(\rho_B - \rho_w)}{(\rho_s - \rho_w)}$$

where

- ρ_s = density of individual sediment particles
- ρ_B = bulk (wet) density of sediment
- ρ_w = density of water entrained in the sediment

Note that a lower density for layer types 1 - 4 will result in fluffier deposits, increased thickness of deposited layers, and greater bed change.

In the field, the density and shear strength of cohesive layers generally increase as they consolidate. The shifting to higher layer types in the program accounts for this, but the user must accurately specify the parameters for each layer type in order to obtain a realistic solution. The greatest accuracy will be achieved by specifying a larger number of layers, each having a small thickness. When a thin layer is filled up it will move down into the bed and be given a higher layer type, and the effect of the

D-R-A-F-T

overburden will be calculated more accurately than if a small number of thicker layers are used.

Bed structure: SB and CL cards

The initial thickness of the sediment bed at the beginning of a run is specified on the SB (noncohesive) and CL (cohesive) cards. If that thickness is eroded, it is assumed that nonerodible rock has been reached. The CL cards specify which layer types (CI cards) are present, the thickness of each layer, and the age of each layer. In hotstart runs (\$H card), the bed structure from a previous run is used and information on the CL and SB cards is disregarded.

Effective diffusion: DF, PE and DD cards

Diffusion of suspended sediment occurs because of turbulence in the flow field. When the transport equation is simplified by averaging over depth, as in SED2D WES, dispersion is introduced because of vertical variations in the flow field and settling of the sediment through the water column. In practice, this effect is lumped together with turbulent diffusion and the effect of averaging in time and the combined effect is called dispersion or effective diffusion. In this program, these various effects are combined in a pair of effective diffusion coefficients given on the DF card.

Selection of appropriate values for the dispersive coefficients is not a straightforward task. Elder (1959) gave approximate expressions for longitudinal (direction of flow) turbulent diffusion coefficients as

Equation 62

$$D_e = 5.93 D u^*$$

and for the transverse (perpendicular to the flow direction) diffusion coefficient as

Equation 63

$$D_t = 0.23 D u^*$$

where

D = water depth, and

u^* = shear velocity as given by equation 8.

Experimentally derived values of the constants in Equation 62 and Equation 63 are often orders of magnitude greater than those given. This is attributed to nonuniformity of the flow, wind effects, wave effects, and so on.

In choosing an effective diffusion coefficient to use in numerical modeling, consideration must also be given to the mesh cell size. Exact relations are not available, but generally, larger element sizes require larger diffusion coefficients.

Allen Teeter of the WES Coastal and Hydraulics Laboratory has suggested that an equation of the form

Equation 64

$$D_e = K_1 \left(K_2 D u^* + 10^{-5} \lambda^2 \right)$$

where

λ = the element size

D-R-A-F-T

K_1 and K_2 = constants

This formulation is provided through the DD card, where the variables K_1 , K_2 and K_3 (10^{-5} above) are specified.

Equation 62 through Equation 64 differentiate between dispersion coefficients parallel and transverse to the direction of flow. Since the coefficients in the present version of SED2D WES apply in the x - and y - directions, not necessarily in the flow directions, these equations can be used only as a guide.

Fortunately, in most applications, effective diffusion is smaller than convection by the calculated flow velocities, so a wrong choice does not affect the results very much unless the chosen coefficient is far too large. The best approach then is to use a moderately high value (say 50 m²/sec) during the first few runs, and then reduce the coefficients until the run becomes numerically unstable. This will allow the user to determine a range of values for which the model gives a converged solution. The user can then perform sensitivity analyses to determine how the solution changes as the effective diffusion is varied over this range. If the solution does not vary greatly then the model is "insensitive" to this coefficient, and no further testing is needed. If the solution varies widely as this coefficient is varied then the user must rely upon validation of the model against field measurements in order to determine the appropriate values. If no field data is available for comparison, the user should use as small a value as possible, effectively de-emphasizing the importance of these terms in the overall solution of the system of equations.

The PE card provides a method of specifying the effective diffusion in an automatic fashion based on the Peclet number:

$$P_e = \frac{\lambda \bar{u}}{D_e}$$

If the user specifies the Peclet number, then the effective diffusion is

$$D_e = \frac{\lambda \bar{u}}{P_e}$$

which provides generally for the diffusion coefficient proportional to the current velocity. However, as prescribed on the PE card there is a minimum value of D_e based on a specified minimum velocity (VPEC).

The table below lists some previous applications and the effective diffusion coefficients that were used.

Table Example Dispersion Coefficients

Typical Location	Current Speed, mps	Typical Element Size, km	Dispersion Coefficient <u>m²sec</u>
Medium-size river	1 - 1.5	0.1 - 0.5	100
Open bay	0.5 - 1.0	0.75	100
Tidal river	0.2 - 1.0	0.1 - 0.3	5 - 10

Initial concentration: IC cards

The nodal concentrations at the first time-step are specified on the IC cards, or in a file if a hot start is used.

Depending on the length of a run, the initial concentrations can have a significant effect on the results. If they are too high, deposition will be high for the first few time - steps. The run should be long enough to overcome start - up anomalies. If the initial concentrations are too low, the model may artificially erode the bed until an equilibrium concentration is reached. It is best to use field data to obtain an approximation to the actual initial concentrations; to make a spin-up run to stabilize the concentrations (see \$H card), then hot start the run that simulates the period of interest.

Boundary conditions: BC cards

BC cards are used to prescribe concentrations at the water boundaries of the models. Concentrations need not be specified at land boundaries. Boundary concentrations should be based on field measurements.

If sand concentrations are too low on an incoming flow boundary, the model will erode material from the bed (if the specified bed thickness is adequate) to transport a volume of sediment that is equal to the bed material transport capacity. If sand concentrations are too high, the excess material will deposit, again bringing the concentration to that needed to satisfy transport capacity. The rows of computational elements near the boundaries will have erroneous deposition/erosion effects under these conditions. For example, a too-high boundary concentration will form a delta at the inflow point. If the model run is long enough, the delta will propagate throughout the area of interest, producing erroneous results. The boundaries should be sufficiently removed from the problem area and an attempt should be made to adjust boundary concentrations that are seriously different from near-equilibrium conditions. This process does not apply to cohesive sediments.

For boundaries at which there is always flow out of the model, for example, a downstream section in a nontidal river, boundary concentrations can be left unspecified, and the program will calculate the out flowing concentrations. However, invoking *boundary condition buffering* for tidal situations is controlled by the variables IBCFACT and BCFACT on the BC card.

Description of Output:

Output from a model run consists of summaries of input data, computed parameters, and computed results. Input data summaries include an echo of all card image input data and a tabulation of options and sediment characteristics that have been chosen. A number of data set codes are output that are of use primarily in debugging. A listing of program dimensions is provided and data management system banners from input files (geometry, hydrodynamics, and hot start data) are printed. These summaries should be carefully reviewed to ensure that input data were correctly specified and interpreted by the program.

At selected time-steps, some results and some associated parameters are printed for selected elements, if requested on the TRE card. Standard results output includes suspended sediment concentration in kilograms per cubic meter at the nodes, flow speed in meters per second; water depth in meters; total bed change in meters from the start of the run; volume of bed change in cubic meters for the elements; and net bed change (algebraic sum) and gross bed change (sum of absolute values) in cubic meters over the entire mesh to that point in the run.

D-R-A-F-T

A number of specialized output results are available through the trace printout (TR) cards. Most are detailed listings of the input data or parameters calculated from input data.

Required Run Control Data Cards

Although most of the data cards are independent of order, there are indeed some dependencies.

The following table lists all the data cards available in SED2D, and whether or not the card is required. The order of the list is the suggested order in which the cards should appear in the SED2D run control file.

Card	Descriptive Content	Required
T1-T2	Title cards	No
T3	Title card	Yes
\$D	Start date control	No
\$M	Machine type identifier	No
\$L1	Input file numbers	Yes
\$L2	Output file numbers	Yes
SI	System international units	No
BF	Bed Flux Controls	No
CC	Clay characteristics	Yes for Clay
CI	Clay characteristics by ID	Yes for Clay
CL	Clay distribution by layer	Yes for Clay
CO	Comment (anywhere except the first line)	No
DD	Effective diffusion coefficients via EQ 22	
DA	Wet / dry by automatic marsh porosity	No
DM	Wet / dry by marsh porosity	No
DF	Diffusion coefficient	No
ED	Discontinued card for diffusion	-
EF	Error flags	No
FD	Fluid density	Yes
FT	Fluid temperature	Yes
GC	Geometry,continuity check line (use GCL)	Replaced
GCL	Geometry,continuity check line (new)	No
GE	Geometry,element connection table	No
GNN	Geometry,nodal coordinates,bottom elevations	No
GS	Geometry, scale factors	No
GT	Geometry, element type (IMAT)	No
GV	Geometry, eddy viscosity tensor	No
GW	Geometry, width and off-channel parameters	No
HD	Hydrodynamic water depth	No
HN	Hydraulics, Manning's n-values	No
HS	Hydraulics, Shear Stress	No
HU	Hydrodynamic Fluid velocity in x-direction	No
HV	Hydrodynamic Fluid velocity in y-direction	No
HW	Wave Model Input Control	No

D-R-A-F-T

IC	Initial conditions, concentration	Yes
MC	Mass Check	No
ND	Non-dimensional Analysis	No
PC	Point source (see BL card)	No
PE	Peclet Method for Automatic Turbulence	No
PV	Physical parameters	No
RD	Automatic Manning's n-value by water depth	No
SA	Sand characteristics	Yes for sand
SB	Sand bed thickness	Yes for sand
SR	Grain size for roughness	Yes for sand
ST	Sand grain size for transport	Yes for sand
TH	Timing for the hydrodynamic RMA2 input file	Yes
TO	Timing for binary output write	No
TR	Trace print controls	Yes
TRE	Summary print by element list	No
TRN	Summary print by node list	No
TRT	Summary print by material list (equivalent to TRE card)	No
TT	Crank-Nicholson Theta	Yes
TZ	Timing, of simulation	Yes
WC	Settling velocity	Yes
WF	Settling velocity function option	No
BC	Boundary condition control parameters	Yes *
BL	Boundary mass loading	Yes *
BW	Boundary Wind speed and direction	No
END	End of boundary condition specification for the time step	Yes
STOp	Stop the simulation	Yes

* At least one of these specifications of boundary conditions is required.

SED2D Execution Job Sheet

JOB EXECUTED _____ DATE OF RUN ____/____/____

TIME OF RUN _____

JOB PRINTED _____ SUBMITTED BY _____

CPUs _____ PRIORITY _____

PURPOSE:

SIMULATION TIME: Start _____ Finish _____

FILES:

Primary Run Control File (.sed) _____

Geometry file from GFGEN (binary) _____

RMA2 Input hydrodynamics (binary) _____

SED2D Input Hot start (binary) _____

SED2D full results listing _____

SED2D summary results listing _____

SED2D Output Hot start (binary) _____

SED2D output conc/delbed file _____

SED2D output bed strata file (binary) _____

SED2D output new geometry bathymetry file _____

GRAPHICAL ANALYSIS:

Film Loops _____

Time Series plots _____

COMMENT: _____

Input Variables

The following is a table of input variables which are the parameters found on the SED2D data cards. The table lists the variable name, a description, and the card or cards to which it is associated.

Variable	Description	Content
AC1	Marsh Porosity offset depth from mean elevation	DM
AC2	Marsh Porosity depth range	DM
AC3	Marsh Porosity minimum fractional area	DM
AC4	Marsh Porosity override of min elevation	DM
AGE	Clay layer age, in years	CL
ACGR	Acceleration due to gravity	PV
ALFA1	Angles of control structure in radians counterclockwise from the positive x-axis	CS
ALOCF	Locking frequency per hour	CS
BCFACT	Boundary buffering chamber mixing factor	BC
CCC	Consolidating coefficient	CI
CLDE	Characteristic length factor for sand deposition	SA
CLER	Characteristic length factor for sand erosion	SA
CORD(j,1-2)	X- and Y- nodal (J) coordinate	GNN
CONC(j)	Initial suspended sediment concentration at node J	IC
CRFLOC	Critical concentration above which flocculation increased the fall velocity	WF
CRHIND	Critical concentration above which hindered settling leads to a constant fall velocity	WF
DEPLIMIT	Max depth change permitted before program stops	EF
DIF(j,1)	Turbulent exchange coefficient in x-dir, element J	ED
DIF(j,2)	Turbulent exchange coefficient in y-dir	ED
DK1(i)	Turbulent exchange coefficient K1 in eq	DD
DK2(i)	Turbulent exchange coefficient K2	DD
DK3(i)	Turbulent exchange coefficient K3	DD
DT	Length of a SED2D simulation time step (dec hrs)	TZ
EFDR(j)	Effective sand grain size for roughness	SR
EFDT(j)	Effective sand grain size for transport	ST
ELEV(j)	Nodal (J) elevation	GNN
EROCON	Constant for the clay erosion equation	CC
ERODCP	Critical shear stress for particle erosion for clay	CC
ESPLPT	List of element type numbers for special print	TRT

D-R-A-F-T

ESSE	Excess shear stress exponent	CC
FALLFACT	Factor applied to the water depth of which the sediment falls	BF
FRCTIC	Fraction of transport potential applied	ICP
GAMLK	Mixing exchange factor a locking event	CS
GSF	Grain shape factor	SA
HSFACT	Factor applied to wave height	HW
HSLIM	Max allowable wave height	HW
HSVAR	Scaling factor for the variance about the mean wave height	HW
IBCFACT	On/Off switch for boundary buffering	BC
ICBOT	On/Off switch for concentration correction for bed flux for clay.	BF
ICP_FLAG	On/Off switch for initializing the concentration by transport potential (only for sand simulations)	ICP
IDA	Starting day of the simulation	\$D
IECHO	On/Off switch for echo of run control input	TR
IHR	Starting hour of the simulation	\$D
IHYDOPT	On/Off switch to adjust velocity as delbed changes	EF
ILOADE	On/Off switch for boundary mass loading of an element	BL
IMAT(j)	Material type for element J	NE
IMN	Starting minute of the simulation	\$D
IMO	Starting month of the simulation	\$D
INGEOM	Input request for GFGEN binary geometry file	\$L1
INFETCH	Input request for Wind fetch length file	\$L1
INHOT	Input request for Hotstart concentration delbed binary file	\$L1
INHOTB	Input request for Hotstart clay bed strata binary file	\$L1
INRMA2	Input request for RMA2 hydrodynamic binary file	\$L1
INWAVE	Input request for wave model results binary file	\$L1
INWIND	Input request for wind speed/direction file	\$L1
ISC	Starting second of the simulation	\$D
ITRACE	Trace print control for debug	TR
ITRINC	Increment for printing for full results listing	TR
ITYPE	Layer ID type (also see CI card)	CL
IVRSID	Machine type identifier	\$M
IVSC	On/Off switch controlling adjustment of ave flux over a time step	

D-R-A-F-T

IWAV	On/Off switch to adjust wave model input	HW
IWBIN	Increment for saving to binary output files	TO
KAUTO	Output request to save table of status regarding automatic assignments for diffusion coefficients	\$L2
KBSHOT	Hotstart the clay bed strata (structure)	\$H
KCHOT	Hotstart sediment concentration	\$H
KDBHOT	Hotstart delta bed change	\$H
KGEOM	Output request to save new GFGEN ascii geometry	\$L2
KOHOTB	Output request to save bed strata (structure) information	\$L2
KPU	Output request to save concentration/delbed binary solution file	\$L2
KSPN	Output request for summary results listing via TRN	\$L2
KSPE	Output request for elemental summary results listing	\$L2
LAYER	Clay Layer number	CL
LINE(j,k)	Corner nodes (k=1,LMT) which define check line J	GCL
LMT	Number of nodes on a continuity check line	GCL
METRIC	System international for GFGEN and RMA2 input	SI
MNCL	Max number of consolidating clay layers	CC
MSC	Option for shear stress computation	HS
MSETV	Switch to control fall velocity activity	WF
MTC	Ackers-White sand transport function	SA
MTCL	Apply the original Krone & Partheniades eqn. For deposition and erosion for clay	CC
KNODIM	Output request to save non-dimensional analysis results	\$L2
NDEL	Flag for elemental summary of non-dimensional parameters (not yet operational)	ND
NDND	On/Off switch to summarize non-dim parameters	ND
NESPRT	List of element for special print	TRE
NNSPRT	List of nodes for special print	TRN
NSACI	Sand class number	SA
NSRC	Point source control	PC
NOP(j,k)	Element (J) connection table composed of nodes (K)	GE
PERC	Erosion rate constant for particle erosion	CI
PMIN	Minimum deposition, P	CC
PWCORR	Time shift for starting time in wave model input	HW
QSE	Bed shear stress at which cohesive at age=1 yr begin to erode in mass	CI

D-R-A-F-T

QSI	Bed shear stress at which cohesive layers begin to erode in mass	CI
RHO(i)	Fluid density at node I	FD
TCORR	Time to subtract from RMA2 time	TH
TEND	RMA2 time for last time step to use	TH
TETA	Crank-Nickolson theta	TT
THICKL	Layer thickness	CL
THOE	The consolidated dry density of deposits of this type of cohesive material at age = 1 yr.	CI
TMAX	Max time for the simulation (dec hrs)	TZ
RHOI	Initial dry density of a deposit of this type of cohesive material	CI
SACLL	Min sand grain size	SA
SACUL	Max sand grain size	SA
SGSA	Specific gravity of sand grain	SA
SPEC(j)	Sediment concentration array for each node j	BC
TAUCD	Critical shear stress for deposition	CC
TAUP	Bed shear stress at which cohesive particles begin to erode	CI
TH(j)	Direction of eddy viscosity tensor for element J	GE
THKTYPE	Typical clay layer thickness for a given id type	CI
TTHICK	Sand bed thickness in meters	SB
TITLE	Character identifier for the run and all output files	T1-T2, T3
VOLLK	Volume of the lock (m³)	CS
VPEC(j)	Min velocity to use in computing effective diffusion	PE
VS(j)	Settling velocity at node J	WC
WNSPD(j)	Wind speed for node j	BW
WDIR(j)	Wind direction for node j	BW
WPFAC	Factor applied to the wave period	HW
WPLIM	Max allowable wave period (sec)	HW
WPVAR	Scaling factor for variance about the mean wave period	HW
WTC	Water temperature in degrees centigrade	FT
XICMAX	Maximum value limit placed on transport potential associated with init concentration	ICP
XNVALU(j)	Manning's n-value for node J	HN and RD
XPEC(j)	Peclet number	PE
XSCALE	X-coordinate scale factor	GS
YSCALE	Y-coordinate scale factor	GS

D-R-A-F-T

SED2D DATA CARDS

This section describes all of the data cards used by SED2D. Every effort has been made to describe each card in a clear and complete manner. However, the appropriate sections in the manual text should be consulted when further explanation is desired.

D-R-A-F-T

T1-T3 CARD: Title Description

Required

Card Description: A “T” card must be the first user input line in the primary SED2D WES run control file. Any number of T1 and T2 lines may be used and the sequence is not significant. Only one T3 line may be used, and it must be the last title line in the set. The program reads the ‘3’ as meaning the END of the “t” cards.

Field	Variable	Value	Description
0, C 1-2	IC1	T	Card group identifier.
0, C 3	IC3	1,2,3	Card type identifier.
1	TITLE		Any alpha-numeric data, up to 77 characters

D-R-A-F-T

\$D CARD: Start Date Control

Optional

Card Description: This data may be included for the benefit of the user to distinguish between runs. It is not used by SED2D.

Field	Variable	Value	Description
0, C 1-2	IC1	\$D	Card group identifier.
1	IYR	+	Last 2 integers digits of the year of simulation. Used for run identification purposes only.
2	IMO	+	Month
3	IDA	+	Day
4	IHR	+	Hour
5	IMN	+	Minute
6	ISC	+	Second

D-R-A-F-T

\$H CARD: Hotstart Control

Required for Hotstart

Card Description: The parameters on this card cause the program to read a previously computed solution to use as the initial condition for the current run (HOTSTART)

Field	Variable	Value	Description
0, C 1-2	IC1	\$H	Card group identifier.
1	KCHOT	+	Hotstart sediment concentration
		0	Do not hotstart concentration
2	KDBHOT	+	Hotstart bed change (delbed)
		0	Do not hotstart bed change
3	KBSHOT	+	Hotstart bed structure (applicable for cohesive only)
		0	Do not hotstart bed structure



NOTE: The previous run must have saved output file (see \$L1 and \$L2 cards) of the desired parameters.

D-R-A-F-T

\$L1 CARD: Input File Control

Required

Card Description: Active parameters on this card cause the program to read data from the requested file. The user will be asked to interactively supply file names for the requested files.

Field	Variable	Value	Description
0, C 1-2	IC1	\$L1	Card group identifier.
1	INGEOM	+	GFGEN binary geometry. (Input LU= 10. No default) <i>See note below.</i>
		0	Off (GNN and GE cards required)
2	INRMA2	+	RMA2 binary hydrodynamic. (Input LU = 20. No default)
			This file is mandatory
3	INHOT	+	HOTSTART Concentration/Delbed binary (Input LU = 30)
		0	Off (This is the default)
4	INHOTB	+	HOTSTART Bed structure binary (Input LU = 40)
		0	Off (This is the default)
5	INFETCH	+	Wind fetch (Input LU = 50)
		0	Off (This is the default)
6	INWIND	+	Wind speed and direction (Input LU = 60)
		0	Off (This is the default)
7	INWAVE	+	Wave model results input (Input LU= 80)
		0	Off (This is the default)

 NOTE: One-dimensional elements are currently not supported by SED2D WES. Any one-dimensional elements within the mesh will be modified to have material type = 0 when the geometry file is read in.

D-R-A-F-T

\$L2 CARD: Output File Control

Required

Card Description: Active parameters on this card cause the program to write data to the requested file. The user will be asked to interactively supply file names for the requested files.

Field	Variable	Value	Description
0, C 1-2	IC1	\$L2	Card group identifier.
1	IOUT	+ 0	Full print (Output LU = 15. This is the default) Off
2	KSPN	+ 0	Summary node print requested via TRN-card (Output LU = 55) Off (This is the default)
3	KSPE	+ 0	Summary element print requested via TRE-card (Output LU = 65) Off (This is the default)
4	KGEOM	+ 0	Save new GFGEN input with new bathymetry update (Output LU = 75. This is the default) Off
5	KPU	+ 0	Save concentration and delbed solution (Output LU [binary] = 35. This is the default) Off
6	KOHOTB	+ 0	Save bed structure solution (Output LU [binary] = 45. This is the default) Off
7	KNONDIM	+ 0	Save non-dimensional analysis results (LU = 69) Off (This is the default)
8	KAUTO	+ 0	Save table showing the status of automatic diffusion coefficient assignments (LU=59) Off (This is the default)



NOTE: A scratch file (file code NSCR = 2) is created if the parameter variable NBS is set too small to fit the problem in memory. The \$M-card is controls the way this scratch file is handled.

D-R-A-F-T

\$M CARD: Machine Type Identifier

Required

Card Description: The optimization for different machines that is implied by this card is not fully implemented in this version of SED2D WES. This card is supported in anticipation of future model enhancements. It is listed as required in order that files created for this version of the model will be compatible with future versions.

Field	Variable	Value	Description
0, C 1-2	IC1	\$M	Card group identifier.
1	IVRSID	1	Direct access record length unlimited, and defined in terms of bytes. Examples systems are: DOS PC
		2	Direct access record length unlimited, and defined in terms of short words (2 bytes). Example systems are: Prime mini-computers
		3	Direct access record length limited to 32 bytes, and defined in terms of long words (4 bytes) Example systems are: DEC Vax
		4	Direct access defined using multiple sequential access files that are opened as required. Note that this may generate and leave many files on disc. Example systems are: APPLE MAC II under ABSOFT FORTRAN Definicon 020 beard, DEC Vax to avoid short record lengths HP Workstation
		5	Direct access defined for a system using 64 bit or 8 byte words and where record lengths are defined in bytes. Example systems are: Cray Y-MP or Cray C90
		6	Direct access defined using multiple sequential access files that are opened as required. Note that this version does not put a period (.) in the file names. It may generate and leave many files on disc. Example systems are: CDC Cyber
		8	Same as 4 except PAUSE statement is activated MacIntosh PC

D-R-A-F-T

BC CARD: Boundary Conditions

Required

Card Description: Boundary condition control, parameters may be specified by node or by continuity line number, for which sediment concentration will be specified. Initial and dynamic solutions.

Field	Variable	Value	Description
0, C 1-2	IC1	BC	Card group identifier.
0,C3	IC3	L	Option 1: Boundary condition control, parameters specified by continuity line number for which concentration will be specified. Initial and dynamic solutions.
		N	Option 2: Boundary condition control parameter specified by node number.
1	J	+	Node or continuity line number
2	SPEC (J)	+	Sediment Concentration (kg/m ³)
3	IBCFACT	0,1	Switch for <i>boundary buffering</i> ; 0 off, 1 on
		blank	Default = 0
4	BCFACT	+	<i>Boundary buffering</i> chamber mixing factor
		blank	Default = 0 is the only option at this time



NOTE: GCL card must precede BCL card type.

EXAMPLE: To calculate total mass contribution (kg) from a BCL boundary specification:

$(\text{CONC kg/m}^3) \times (\text{Discharge m}^3/\text{sec}) \times (\#\text{TimeSteps}) \times (\text{deltaT hr}) \times (60 \text{ min/hr}) \times (60 \text{ sec/min}) = \text{MASS in kg}$

Helpful unit conversions:

1 ppm = 1 mg/liter = 0.001 kg/m³

1 ppt = 1 x 10⁻⁶ kg/m³

D-R-A-F-T

BL Card: Boundary Loading (Mass)

Optional

Card Description: Used to assign mass loading on the boundary.

Field	Variable	Value	Description
0, C 1-2	IC1	BL	Card group identifier.
0, C 3	IC3		Card type identifier.
		b	Specifies Option 1: The mass boundary loading in data field 2 and 3 of this card will be used for all values (J) equal to or greater than ISTART.
		E	Specifies Option 2: The mass boundary loading are coded by <i>element</i> number.
		T	Specifies Option 3: The mass boundary loading are coded by <i>material type</i> number (IMAT).
1	ISTART		Code the node number, element number or material type as specified by IC3 above in data field 0, column 3.
		-,+	Option 1 and 2: The <i>starting element</i> number. Will load all the elements that are \geq ISTART.
		-,+	Option 3: The element <i>material type</i> number. Will load all the elements which satisfy the material type.
2	SRCEL(J)	-,0,+	Mass loading at ISTART=J. Units= kg/sec.

Units: Total mass/sec in the appropriate units of the simulation.

EXAMPLE: To calculate total mass contribution (kg) from a BLE boundary specification in kg/sec:

$$(\text{LOAD kg/sec}) \times (\#\text{Elem Loaded}) \times (\#\text{TimeSteps}) \times (\text{deltaT hr}) \times (60 \text{ min/hr}) \times (60 \text{ sec/min}) = \text{MASS in kg}$$

D-R-A-F-T

BF CARD: Bed Flux Controls

Not Required

Card Description: Active parameters on these cards cause the program to use the specified parameter values in place of the default values.

Field	Variable	Value	Description
0, C 1-2	IC1	BF	Card group identifier.
1	ICBOT	1	(Default) Flag controlling the application of a correction factor to the concentration used for bed flux for clay reflecting the fact that the bottom concentration is larger than the depth-averaged value. The correction factor is function of the vertical fall velocity, the horizontal velocity.
		0	No correction is made
2	IVSC	+	Flag controlling the adjustment of the average flux over a time step based on development in Appendix B
		0	No adjustment made (default)
3	FALLFACT	0-1	A factor applied to the water depth over which the sediment falls. This value has historically been set to 0.5. Based on conversations with Dr. Ray Krone, it is now recommended that this be set to 1.0 (default). For backward compatibility use 0.5.

D-R-A-F-T

BW CARD: Boundary Wind Speed / Direction

Version 4.52 dated April 2001 or higher

Optional

Card Description: Used to assign wind speed and direction.

Field	Variable	Value	Description
0, C 1-2	IC1	BW	Card group identifier.
0, C3	IC3	b (blank)	Option 1: The wind data in fields 2 and 3 of this card will be used for all nodes equal to or greater than J.
		N	Option 2: Wind data are coded by specific <i>node</i> number
		E	Option 3: Wind data are coded by specific <i>element</i> number
		T	Option 4: Wind data are coded by specific <i>material type</i> number
1	J		Code the node number, element number or material type as specified by IC3 above in data field 0, column 3.
		+	Option 1: The starting <i>node</i> number Option 2: The <i>node</i> number Option 3: The <i>element</i> number Option 4: The <i>material type</i> number
2	WNDSPD(J)	0,+	The wind velocity (units = miles/hour)
3	WNDIR(J)	-,0,+	Direction toward which the wind is blowing, measured in degrees counterclockwise from the positive x-axis.



NOTE: The required order for wind assignments should be BW blank, BWT, BWE, and BWN.



See Also: "Ultra-Shallow Water Waves" on page 10.

D-R-A-F-T

CC CARD: Clay Characteristics

Required for Clay

Card Description: Active parameters on this card cause the program to use the specified parameter values in place of the default values.

Field	Variable	Value	Description
0, C 1-2	IC1	CC	Card group identifier.
1	MTCL	1	Option 1: Original Krone (1964) equations for deposition and Ariathurai/Partheniades equations for erosion.
		2	Option 2: Krone (1962 modified) equations for deposition and Alishahi & Krone (1964) for erosion
2	MNCL	≥ 0	Maximum number of consolidating layers (<10)
		< 0	Default = 4
3	TAUCD	≥ 0	Critical shear stress for deposition
		< 0	Default = 0.06 Newton/sq m
4	ERODCP	≥ 0	Critical shear stress for particle erosion
		< 0	Default = 0.06 kg/sq m/sec
5	EROCON	≥ 0	Constant for the erosion equation
		< 0	Default = 0.002 kg/sq m/sec
6	ESSE	> 0	Excess shear stress exponent
		< 0	Default = 1.0
7	PMIN		Minimum deposition, P

See Reference Section: Alishahi and Krone, (1964) for wind wave generated waves and Krone (1962; modified at high shear stress), for deposition.



See Also: "Clay Transport: Option 1" on page 12, Clay Transport: Option 2" on page 13, and the "REFERENCES" section on page 150.



NOTE: Option 2 was added to SED2D v 452 in April 2001.

D-R-A-F-T

CI CARD: Clay Characteristics By ID

Required for Clay

Card Description: Active parameters on this card cause the program to use the specified parameter values in place of the default values

Field	Variable	Value	Description
0, C 1-2	IC1	CI	Card group identifier.
1	IDCL	≥ 0	ID type number (#1 is freshly deposited and unconsolidated) If IDCL > MNCL (CC card) do not consolidate
2	THKTYP	≥ 0 < 0	Typical layer thickness (m) for this id type Default = .03 meters
3	TAUP	≥ 0 < 0	Bed shear stress at which cohesive particles begin to erode (Newtons/sq m) Default = 0.06 n/m ²
4	PERC	≥ 0 < 0	Erosion rate constant for particle erosion Default = 0.002 kg/m ² /sec
5	QSI	≥ 0 < 0	Bed shear stress at which cohesive layers begin to erode in mass (newtons/m2) Default = 0.06, .12, .41, and 3.4 for layers 1 through 4 and 3.4 (n/m ²) for layers 5 through MNCL
6	QSE	≥ 0 < 0	Bed shear stress at which cohesive at age = 1 year begin to erode in mass (n/m ²) Default = 1.1 x QSI values (see above)
7	RHOI	≥ 0 < 0	Initial dry density of a deposit of this type of cohesive material (kg/m ³) Default = 90, 108, 144, and 263 for layers 1 through 4 and 402 for layers type 5 through MNCL
8	RHOE	≥ 0 < 0	The consolidated dry density of deposits of this type of cohesive material at age = 1 year. Default = 1.1 times default values for RHOI (above)
9	CCC	≥ 0 < 0	Consolidation coefficient relating the change from RHOE and QSE to time in years CCC=reference time (<i>days</i>) for QSE and RHOE

 NOTE: Values of the variables in Fields 5-8 vary widely among sediment types. The default values may be wrong for a given sediment. ID types are numbered such that the highest number is the deepest core.

 NOTE: CC card should precede CI cards.

D-R-A-F-T

CL CARD: Clay Distribution By Layer

Required for Clay

Card Description: Active parameters on this card cause the program to use the specified parameter values in place of the default values.

Field	Variable	Value	Description
0, C 1-2	IC1	CL	Card group identifier.
C3		b/	Option 1: Global assignment to all nodes, starting with = J
		T	Option 2: Explicit assignment for IMAT J
		E	Option 3: Explicit assignment for Element J
		N	Option 4: Explicit assignment for Node J
1	J	+	Starting or explicit value
2	LAYER	+	Layer number to be applied to J
3	ITYPE	+	Layer ID type (see CI-card)
4	THICKL	≥ 0	Layer thickness (m)
		< 0	Default value from CI card used
5	AGE	≥ 0	Layer age (years)
		< 0	Default = 0.0



NOTE: Layer numbers are arranged such that the highest number is the first to erode.



NOTE: CI cards should precede CL cards.

D-R-A-F-T

CO CARD: Comments

Optional

Card Description: Comments may be supplied on this card anywhere within the run control input, except as the first card.

Field	Variable	Value	Description
0, C 1-2	IC1	CO	Card group identifier.
1	FLD	A	Any alpha-numeric data, up to 77 characters



NOTE: Comments may be incorporated on the same line as the END-card

D-R-A-F-T

CS Card: Concentrations at a Flow Control Structures

Optional

Card Description:

Field	Variable	Value	Description
0, C 1-2	IC1	CS	Card group identifier.
1	NJN	+	Flow controller identifier (904 or larger). Applies these parameters to IMAT = NJN.
2	NJT	+	RMA4 flow controller type: 1 = match concentrations 2 = lock operation; specify fields 3 through 6.
3*	ALFA1	+	Angle of control structure in radians counterclockwise from the positive x axis.
4*	VOLLK	+	Volume of the lock (use either ft^3 or m^3)
5*	GAMLK	+	Mixing exchange factor for a locking event ($0.0 \leq \text{GAMLK} \leq 1.0$).
6*	ALOCF	+	Locking frequency per hour.

* Use if $NJT = 2$.

NOT ACTIVATED!

D-R-A-F-T

DD CARD: Effective Diffusion Coefficient By Equation 64

Optional

Card Description: Effective diffusion may be activated by using the ED, PE, and DD cards.

Field	Variable	Value	Description
0, C 1-2	IC1	DD	Card group identifier.
0,C3	IC3	b/ T E N	Option 1 Global: Starting with node = J Option 2 Explicit by material type = J Option 3: Explicit assignment for Element = J Option 4: Explicit assignment for Node = J
1	J	+	Starting or explicit value
2	DK1 (J)	≥ 0 < 0	Turbulent exchange coefficient K1 in Eq. 22 (units = m ² /sec) Default = 1.0
3	DK2 (J)	≥ 0 < 0	Turbulent exchange coefficient K2 in Eq. 22 Default = 5.0
4	DK3(J)	≥ 0 < 0	Turbulent exchange coefficient K3 in Eq. 22 Default = 10 ⁻⁵

The DD card uses an equation of the form suggested by Allen Teeter, Coastal and Hydraulics Laboratory.

Equation 64 simplified

$$D_e = K_1 \left(K_2 D u^* + 10^{-5} \lambda^2 \right)$$

where

λ = the element size

K_1 and K_2 = constants

the variables K_1 , K_2 and K_3 (10^{-5} above) are specified.

D-R-A-F-T

DA Card: Automatic Wet/Dry by Marsh Porosity

Version 4.55 dated 1-19-2006 or higher.

Optional

Card Description: Used to specify information for the Marsh Porosity wetting and drying option. If the marsh porosity method was used in the hydrodynamic simulation used as input for the SED2D simulation, then the same marsh porosity parameters must be communicated to SED2D either by: reading a binary geometry that contains the marsh porosity information, or by reading in the DA or DM-cards..

Field	Variable	Value	Description
0, C 1-2	IC1	DA	Card group identifier.
0, C 3	IC3		Card type identifier.
		b (blank)	Specifies Option 1: Identified Node Option
		T	Specifies Option 2: Set wet/dry option for <i>material type (IMAT) J</i> .
1	J	+	Code J according to which option was chosen above with IC3 in data field 0, column 3...
			Option 1: Code J as one of the following
		0	Turns off the Automatic Marsh Porosity option. All DA type cards are ignored.
		+	Turns on the Automatic Marsh Porosity assignments.
		+	Option 2: Code J as the <i>material type (IMAT)</i> number. The values in data fields 2 through 5 will be used for all nodes comprising each element of this material type.
2	AC1_MIN	+	AC1 will be assigned the larger of AC1_MIN or (A0 –AC4X) Suggested AC1_MIN = 3.0 feet or 0.91 m  Note: A0 = average regional (nodal area) bed elevation (the 'z' value on GFGEN GNN card).
3	SLOPE_A C2	+	SLOPE_AC2= (AC2/AC1). AC2 will be calculated to obtain the Transition range of the distribution. <u>Suggestion:</u> Keep SLOPE_AC2 < 2.0
4	AC3X *	+	Minimum wetted surface area factor (Default = .02).
5	AC4X *	+	Minimum regional bed elevation. <u>Suggestion:</u> Make AC4X slightly lower than the minimum expected water elevation for the simulation.

- *DA card parameters for fields 2 through 5 will derive the nodal AC1, AC2, AC3, AC4 marsh porosity parameters, as described on the DM card.*

D-R-A-F-T

The order in which DA cards should appear is: DA \bar{b} (DA blank), followed by one or more DAT cards.



Note: To include computations for the automatic Marsh Porosity option, at least one DA \bar{b} (DA blank) card is required, then optionally followed by DAT cards (in that order). If a node receives multiple assignments, the last assignment is processed.

Default values are automatically converted to metric if the SI card indicates System International units.

GFGEN version 4.56 or higher accommodates DA/DM information in the geometry

Supplementary notes for the automatic marsh porosity, DA-Card.

The DA-Card was created to develop an automatic method for specifying marsh porosity parameters to prevent the mesh from actually going dry. Notice that the new option has a fixed relationship between AC1 and AC2 as SLOPE_AC2. Otherwise said, the ratio of AC2 to AC1 is fixed. Note that the ration should nominally be less than 2.0, since 2.0 would put the “hip” of the transition zone approximately down at the offset elevation (A0 – AC1)

DA-Card example:

For the Automatic Marsh Porosity card assignment of:

DA 1 2 0.6 .02 -3.0 and given a bottom elevation = A0= 1.0

The final nodal marsh porosity parameters generated by this DA-Card are:

$$AC1 = \max(A0 - AC4X, AC1_MIN) = \max((1 - (-3)), 2) = 4.0$$

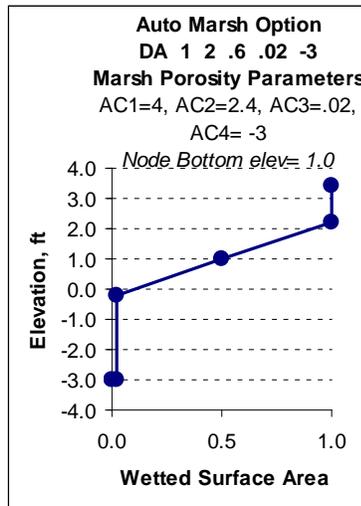
$$AC2 = SLOPE_AC1 * AC1 = (0.6 * 4) = 2.4$$

$$AC3 = AC3X = .02$$

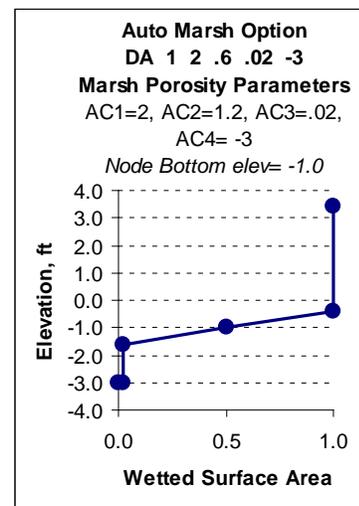
$$AC4 = AC4X = -3.0$$

Similarly, the final nodal marsh porosity parameters generated by this DA-Card for a given bottom elevation = A0= -1.0 are:

AC1 = 2.0, AC2 = 1.2, AC3 = .02, and AC4 = -3.0



(a) Auto Marsh if A0 = +1.0



(b) Auto Marsh if A0 = -1.0

DM CARD: Marsh Porosity Parameters

Optional

Card Description: Used to specify information for the Marsh Porosity wetting and drying option. If the marsh porosity method was used in the hydrodynamic simulation used as input for the SED2D simulation, then the same marsh porosity parameters must be communicated to SED2D either by: reading a binary geometry that contains the marsh porosity information, or by reading in the DA or DM-cards.

Field	Variable	Value	Description
0, C 1-2	IC1	DM	Card group identifier.
0,C3	IC3	b/	Option: 1 Global: Starting with node = J
		T	Option: 2 Explicit by material type = J
		E	Option 3: Explicit assignment for Element = J
		N	Option 4: Explicit assignment for Node = J
1	J	+	Starting or explicit value
2	AC1 (J)	≥ 0	Offset depth from mean elevation (m)
		< 0	(Default = 3.0 ft or 0.91 m)
3	AC2 (J)	≥ 0	Marsh surface depth range (m)
		< 0	(Default = 2.0 ft or 0.61 m).
4	AC3(J)	≥ 0	Minimum fractional area for marsh
		< 0	Default = 0.02
5	AC4(J)	≥ 0	Override minimum elevation (m)
		< 0	Default = 0.0

The order in which DM cards should appear is: DMb (DM blank), DMT, DME, and finally, DMN. If a DMT card, for example, appears after a DME card, the DME card is potentially overruled by the DMT card..



Note: To include computations for the Marsh Porosity option, at least one DMb (DM blank) card is required, then optionally followed by DMT, DME, or DMN cards (in that order). If a node receives multiple assignments, the last assignment is processed.

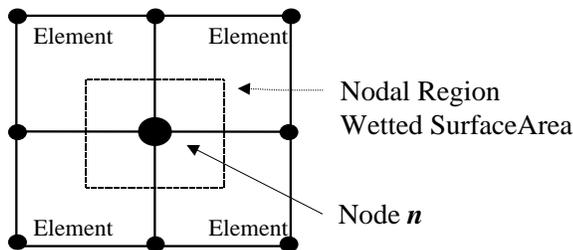
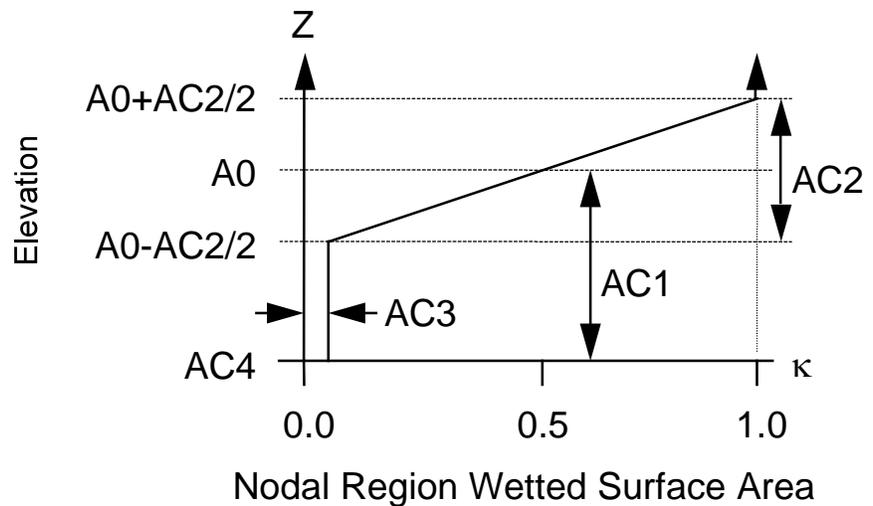
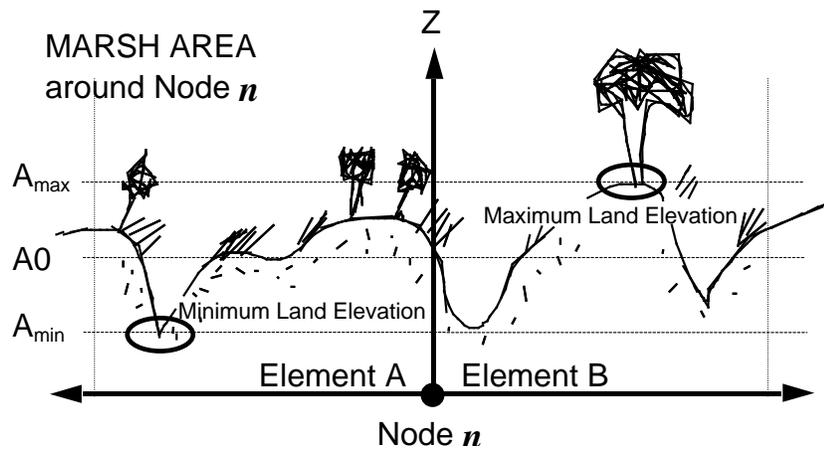
The values for AC1 through AC4 are used as an “initial guess” for SED2D.

As an element becomes completely wet and water depth increases, DM card information for all nodes comprising that element becomes progressively less significant. The DM card information is critical as the water depth of the element falls within the transitional range and begins to dry.

Default values are automatically converted to metric if the SI card indicates System International units. GFGEN v 4.56 or higher accommodates DM information in the geometry.



See also



Where:

- A₀** = average nodal area bed elevation ('z' value from GFGEN GNN Card). **A₀** is the mean land elevation in the vicinity of node *n*.
- AC₁** = distance from **A₀** to minimum regional bed elevation.
- AC₂** = transition range of the distribution.
- AC₃** = minimum wetted area of the distribution.
- AC₄** = minimum regional bed elevation.

“Regional” refers to the “nodal area”; the area in the immediate vicinity of node n.

D-R-A-F-T

DF CARD: Diffusion Coefficient (Effective)

Required

Card Description: Diffusion of suspended sediment occurs because of turbulence in the flow field. When the transport equation is simplified by averaging over depth, as in SED2D WES, dispersion is introduced because of vertical variations in the flow field and settling of the sediment through the water column. In practice, this effect is lumped together with turbulent diffusion and the effect of averaging in time and the combined effect is called dispersion or effective diffusion. In this program, these various effects are combined in a pair of effective diffusion coefficients given on the DF card.

Field	Variable	Value	Description
0, C 1-2	IC1	DF	Card group identifier.
0,C3	IC3	b/ T E N	Option 1: Global: Starting with node = J Option 2: Explicit by material type = J Option 3: Explicit assignment for Element = J Option 4: Explicit assignment for Node = J
1	J	+	Starting or explicit value
2	DIF (J,1)	≥ 0 < 0	Turbulent exchange coefficient in X direction (X plane). (units = m ² /sec) Default = 0.0
3	DIF (J,2)	≥ 0 < 0	Turbulent exchange coefficient in Y direction (Y plane). (units = m ² /sec) Default = 0.0



Note: As of 12-2-2004, the DF Card replaced the ED card.

EF CARD: Error Flags

Optional

Card Description: This option is *NOT* recommended. It is supplied here only to be consistent with STUDH, an earlier version of SED2D.

Field	Variable	Value	Description
0, C 1-2	IC1	EF	Card group identifier.
2	IHYDOPT	1	The hydrodynamic flow field is “adjusted” during the SED2D run such that as the bed moves up and down the depth of flow is changed and the velocities are changed to preserve the same unit flow as was calculated by RMA2. This option is NOT recommended and is supplied here only to be consistent with earlier versions of STUDH. Two types of errors occur when using this option 1) the flow field is no longer a true solution to the shallow water equations, and thus mass is not conserved according to the finite element formula; 2) as sediment deposits in backwater areas this adjustment will cause velocities to increase over the sediment bed which may artificially reduce the rate of deposition, or even erode the newly deposited bed. Advanced users: go ahead and use it, but be aware.
		0	No adjustment of the hydrodynamic solution is performed during the SED2D run. The implicit assumption of the model is that the change in the bed geometry is small enough that it does not significantly affect the flow field. When significant erosion or deposition does occur, the user should stop the SED2D run and rerun RMA2 using the new bed geometry generated by SED2D. (See the definition of DEPLIMIT below to establish a stopping criterion). This is the default value.
3	DEPLIMIT	≥ 0	Execution of the program is stopped when the bed change (due to either erosion or deposition) at any node exceeds DEPLIMIT*(the water column depth at that node). This check prevents the user from continuing to calculate the sediment transport based on a hydrodynamic solution that is not valid for the current bed geometry. When this criterion is exceeded the user should re-run RMA2 using the new bed geometry generated by SED2D.
		< 0	Default = 0.25



NOTE: If no EF card is present the default values will be assigned.

D-R-A-F-T

END CARD: End Of Time Step Separation

Required

Card Description: This card signals the end of boundary input for a given time step.

Field	Variable	Value	Description
0, C 1-2	IC1	EN	Card group identifier.
0,C3	IC3	D	Card group identifier
1-10	ENDCOM	A	May be used for comments

FD CARD: Fluid Density

Optional

Card Description: Used to supply a fluid density for all nodes or a specified node.

Field	Variable	Value	Description
0, C 1-2	IC1	FD	Card group identifier.
0,C3	IC3	b/	Option 1: Global assignment to all nodes, starting with = J
		T	Option 2: Explicit assignment for IMAT = J
		E	Option 3: Explicit assignment for Element = J
		N	Option 4: Explicit assignment for Node = J
1	J	+	Starting or explicit value
2	RHO (J)	≥ 0	Fluid Density at location J (units = kg/m ³)
		< 0	Default = 1000.00 kg/m ³

 NOTE: If no FD card is present the default value of 1000.00 kg/m³ will be assigned globally.

Densities for Fresh Water and Sea Water.

Type of Water	English Units slugs/ft ³	Metric Units kg/m ³
Fresh Water	1.935	998.46
Sea Water	1.990	1026.84

D-R-A-F-T

FT CARD: Fluid Temperature

Optional

Card Description: Used to supply the average initial water temperature for the entire mesh.

Field	Variable	Value	Description
0, C 1-2	IC1	FT	Card group identifier.
0,C3	IC3	b/	Option 1: Global assignment to all nodes, starting with = J
		T	Option 2: Explicit assignment for IMAT = J
		E	Option 3: Explicit assignment for Element = J
		N	Option 4: Explicit assignment for Node = J
1	J	+	Starting or explicit value
2	WTC	≥ 0	Fluid temperature in degrees centigrade at location J
		< 0	Default = 10 degrees centigrade



NOTE: If no FT card is present the default value will be assigned globally.

Question ???? RMA2 v45 uses 15 degrees Celsius for default – if user applied defaults to both RMA2 and SED2D there would be inconsistency ????

GCL Card: Geometry, Continuity Check Line

Optional

This GCL card replaces the GC card.

Card Description: The GCL card is used to specify a line within the grid where the flow rate is of interest. GCL lines may be used to specify the location of boundary conditions.

Field	Variable	Value	Description
0, C 1-2	IC1	GC	Card group identifier.
0, C 3	IC3	L	Card type identifier.
1	J	+	Continuity check line number described by this GCL card.
2-n	LINE(J,K)	+	List the nodes that define this continuity check line.  Note: If there are more node numbers specifying a continuity check line than will fit in the data fields remaining on the current GCL card, continue coding the remaining node numbers starting in data field 1 of the next GCL card.
n	End of List	-1	A node number of -1 is required to mark the end of the list of nodes that specify this continuity check line.



Example:

```
CO Line# Node numbers...Negative number marks the end
GCL 1 10 11 12 13 14 15
GCL 16 17 18 19 20 21
GCL 22 23 -1
GCL 2 100 101 102 109 107 99 -1
```

GC CARD: Geometry, Continuity Check Line (See GCL)

Optional

Card Description: *Code corner nodes only.* Code all lines in the same direction. The lines will be numbered (J = 1, number of lines) according to their order of appearance in this file.

Automatic calculation of the sediment flux across a continuity check line is not available in current version of SED2D WES. Code all lines in the same direction to ensure a consistent sign for the flux direction. . In general, code left to right when facing downstream.

Field	Variable	Value	Description
0, C 1-2	IC1	GC	Card group identifier.
1	NNL	+	Number of corner nodes to be specified in this continuity line.
2 to NNL plus 1	Line (J,K)	+	List of corner nodes which define line segments for automatic generation of boundary conditions (K = 1, NNL).



NOTE: If a continuation line is necessary, start the next corner node in field1 of the next GC card.

GCL card has replaced the old GC line format.

GE CARD: Grid, Element Connection Table

Optional

Card Description: The element connection table will usually be provided by the GFGEN pre-processor and will reside on logical unit ING on the \$L1-card. If so, omit GE and GNN cards.

Field	Variable	Value	Description
0, C 1-2	IC1	GE	Card group identifier.
1	J	+	Element number
2-9	NOP (J,K)	+	Up to 8 node numbers for element J, listed counterclockwise around the element starting from any corner.
10	IMAT (J)	+	Element material type
11	TH (J)	+	Direction of eddy viscosity tensor in RMA2. Optional, may be specified on the GV card. Radians, counter-clockwise from the X-axis. For 1D elements, the direction is automatically aligned with the orientation of the 1D element

 NOTE: Use GE and GNN cards only to create simple grids for model testing. SED2D WES does not contain grid generation or band width optimization routines.

D-R-A-F-T

GNN CARD: Geometry Nodal Coordinate

Optional

Card Description: The coordinate values read from this card are multiplied by the appropriate scale factors, XSCALE and ZSCALE from the GS card, and should result in the proper X and Y coordinates (units are determined by the SI card) after transformation.

Field	Variable	Value	Description
0, C 1-2	IC1	GNN	Card group identifier.
0,C3	IC3	N	Card group identifier
1	J	+	Node number
2	CORD (J,1)	+	The X node coordinate (m or ft).
3	CORD (J,2)	+	The Y nodal coordinate (m or ft)
4	ELEV (J)	+	The bottom elevation at node J (m or ft)



NOTE: Use GE and GNN cards only to create simple grids for model testing. SED2D WES does not contain grid generation or band width optimization routines.

GS CARD: Geometry, Nodal Scale Factor

Optional

Card Description: Used to apply scale factors to the x and y coordinates.

Field	Variable	Value	Description
0, C 1-2	IC1	GS	Card group identifier.
1	XSCALE	> 0 ≤ 0	Scale factor for X coordinate input Default = 1.0
2	YSCALE	> 0 ≤ 0	Scale factor for Y coordinate input Default = 1.0



NOTE: If no GS card is present, the default values will be applied.

D-R-A-F-T

GT Card: Geometry, Element Material Types

Optional

Card Description: Used to specify or modify element material types.

Field	Variable	Value	Description
0, C 1-2	IC1	GT	Card group identifier.
1	J	+	Element number.
2	IMAT(J)	0, +	Element material type number.
3-10		+	You may provide (J, IMAT(J)) sets of values.



Tip: To effectively remove an element from the computational mesh, set the material type (IMAT) for the element to a value of zero (the element will appear to be land).



See also: GFGEN manual

GW Card: Geometry, Channel Width Attributes

Required for one-dimensional nodes

Card Description: Used to only specify or modify *one-dimensional* trapezoidal channel attributes at the node specified.

Field	Variable	Value	Description
0, C 1-2	IC1	GW	Card group identifier.
0, C 3	IC3	b (blank)	Specifies Option 1: Universal assignment for all nodes \geq NODE.
		N	Specifies Option 2: Individual node assignment.
1	NODE		The <i>one dimensional</i> starting node or node number as specified by IC3 above.  Note: Enter one dimensional corner nodes and transition nodes. + Option 1: The <i>starting</i> node number. + Option 2: The node number.
2	WIDTH	+	Channel surface width at zero depth for NODE.
3	SS1	-, +	Left side slope at NODE.
4	SS2	-, +	Right side slope at NODE.  Note: Off-Channel Variables Follow.
5	WIDS	+	Off-Channel Storage width associated with NODE at zero depth.
6	WSCRIT	-,+	Water surface elevation to activate Off-Channel storage
7	SSS	-,0,+	Side slope for off-channel storage

 **Note:** Code only *one* corner node per GW card. All slopes are with respect to one unit of rise.

If you are using SMS, the GW card is the preferred method for defining one-dimensional channel width attributes as opposed to the GN card.

 **SMS7 Note:** As of this writing, SMS will read and interpret, but will not update GW card data. Be aware that if the grid is renumbered by SMS, the node numbers on GW cards may no longer agree with the new element connection table. If this is the case, you will have to update the GW cards manually.

 **See also:** GFGEN manual

HD Card: Hydrodynamic, Water Depth

Optional

Card Description: This card assigns the water depth when no RMA2 hydrodynamics are specified.

Field	Variable	Value	Description
0, C 1-2	IC1	HD	Card group identifier.
1	J	+	Starting node number at which this global assignment will be made.
2	VEL(3,J)	+	Depth of water at node J (meters)



Note: If no HD card is read, the input RMA2 solution will be used to specify depth at each individual node.

HN CARD: Roughness, (Manning's n-Value)

HN and/or RD is required if an HS card is used and MSC = 2 or 4

Card Description: Used to assign a Manning's n roughness value to the entire grid, or to an individual material type.

Field	Variable	Value	Description
0, C 1-2	IC1	HN	Card group identifier.
0,C3	IC3	b/	Option 1: Global assignment to all nodes, starting with = J
		T	Option 2: Explicit assignment for IMAT = J
		E	Option 2: Explicit assignment for Element = J
		N	Option 2: Explicit assignment for Node = J
1	J	+	Starting or explicit value
2	XNVALU (J)	≥ 0	Manning's n-value for location J
		< 0	Default = 0.0



SED2D WES applies Manning's n-values by node. The node will retain the n-value it receives from the last HN card that affects that node.

HS CARD: HYDRAULIC BED SHEAR STRESS

Required

Card Description: Used to assign the option for shear stress computation.

Field	Variable	Value	Description
0, C 1-2	IC1	HS	Card group identifier.
1	MSC		Code the option number for shear stress computation
		1	Log-velocity distribution for a smooth wall (This is the default)
		2	Manning's equations (HN-cards are required)
		3	Wave shear stress by ACKRSHR. Wind direction, speed, and wind fetch must be specified in INWIND and INFETCH files (see \$L1 card). See subroutine JONFW for descriptions of these files.
		4	Wind-wave shear stress for ultra-shallow water by the CHL method.

HU Card: Hydrodynamic, X-Velocity

Optional

Card Description: This card assigns the water depth when no RMA2 hydrodynamics are specified.

Field	Variable	Value	Description
0, C 1-2	IC1	HU	Card group identifier.
1	J	+	Starting node number at which this global assignment will be made.
2	VEL(1,J)	+	X component of velocity at node J (meters/sec)



Note: If no HU card is read, the input RMA2 solution will be used to specify velocity components at each individual node.

D-R-A-F-T

HV Card: Hydrodynamic, Y-Velocity

Optional

Card Description: This card assigns the water depth when no RMA2 hydrodynamics are specified.

Field	Variable	Value	Description
0, C 1-2	IC1	HV	Card group identifier.
1	J	+	Starting node number at which this global assignment will be made.
2	VEL(2,J)	+	Y component of velocity at node J (meters/sec)



Note: If no HU card is read, the input RMA2 solution will be used to specify velocity components at each individual node.

HW CARD: Wave Model Input Control

Optional

Card Description:

Field	Variable	Value	Description
0,C 1-2	IC1	HW	Card group identifier.
1	IWAV	1	Flag for performing adjustments to wave model input. IWAV = 1 invokes adjustments
		0	No adjustments are made (default)
2	PWCORR	+	Time shift for starting time in wave model input file (hr)
3	HSFACT	+	Factor applied to the wave height
4	HSLIM	+	Maximum allowable wave height (m)
5	HSVAR	+	Scaling factor for the variance about the mean wave height. A value of 0.0 would return a constant mean wave height over the entire model.
26	WPFACT	+	Factor applied to the wave period
7	WPLIM	+	Maximum allowable wave period (sec)
8	WPVAR	+	Scaling factor for the variance about the mean wave period. A value of 0.0 would return a constant mean wave period over the entire model

D-R-A-F-T

IC CARD: Initial Conditions

Required for cold start

Card Description: Used to assign initial conditions for a cold start.

Field	Variable	Value	Description
0, C 1-2	IC1	IC	Card group identifier.
0,C3	IC3	b/ T E N P	Option 1: Global assignment to all nodes, starting with = J Option 2: Explicit assignment for IMAT = J Option 3: Explicit assignment for Element = J Option 4: Explicit assignment for Node = J Option 5: Global assignment of transport potential (sand only)
			Option 1 through 4:
1	J	+	Starting or explicit value
2	CONC (J)	≥ 0 < 0	Initial suspended sediment concentration for location = J(kg/m ³) Default = 0.0 kg/m ³
			Option 5: "ICP"
1	ICP_FLAG	ICP_FLAG	Flag to apply the initial concentration based on transport potential (Acker-White) Disables specification by transport potential
2	FRCTIC	FRCTIC	Fraction of transport potential (unitless) to be used as the initial concentration
3	XICMAX	XICMAX	Maximum value limit placed on transport potential (kg/m ³ ; only associated with initial concentrations)

MC Card: Mass Check

Optional

Card Description: This card assigns the initial concentration of constituent particles for the simulation.

Field	Variable	Value	Description
0, C 1-2	IC1	MC	Card group identifier.
0, C 3	IC3		Card type identifier.
		b (blank)	Option 1: Request a Conservation of Mass Check.
		I	Option 2: Specify a list of inflow check lines.
		O	Option 3: Specify a list of outflow check lines.
1	MC_FLAG	0,+	Option 1: On/Off switch to request a check for mass conservation upon completion of the simulation. <u>Default is no checking</u>
2	NQAL_CHECK	+	Option 1: The quality constituent number to use for the mass conservation check. <u>Default = constituent #1</u>
1-10	IGCL_IN	+	Option 2: List of continuity check lines representing the total inflow for purposes of performing a mass continuity check. <u>Default:</u> line #1 is inflow (IGCL_IN),
1-10	IGCL_OT	+	Option 3: List of continuity check lines representing the total inflow for purposes of performing a mass continuity check. <u>Default:</u> the last continuity check line defined will be the outflow (IGCL_OT).



Example: Mass Check request, where lines 4 and 5 are the inflow, and line 6 is the outflow.

```
MC    1    1
MCI   4    5
MCO   6
```

D-R-A-F-T

ND CARD: Non-dimensional Analysis

Optional

Card Description:

Field	Variable	Value	Description
0,C 1-2	IC1	ND	Card group identifier.
1	NDEL	-	Flag for elemental summary of non-dimensional parameters (This is not currently operational)
2	NDND	>0	Flag for nodal summary of non-dimensional parameters
		0	No nodal summary

PC CARD: Point Source Control

Optional

Card Description:

Field	Variable	Value	Description
0, C 1-2	IC1	PC	Card group identifier.
1	NSRC		Point source control
		≥ 0	Number of point sources (supply point source data file in file INPSC - see \$L1 card)
		< 0	Default = 0



NOTE: The format of the INPSC file is (I10, F10.0), where the integer is the element where the source is located and the real variable is the mass load of the source in kg over the time step. Specify one source per line, and NSRC lines per time step.

PC-Card is no longer available. The capability is on the BL card.

D-R-A-F-T

PE CARD: Control Of The Effective Diffusion Coefficient By Peclet Number

Optional

Card Description: Used to provide for *real time* adjustment of diffusion based upon the computed velocity and individual size of each element.

Field	Variable	Value	Description
0, C 1-2	IC1	PE	Card group identifier.
0,C3	IC3	b/ T E N	Option 1 Global: Starting with node = J Option 2 Explicit by material type = J Option 3: Explicit assignment for Element = J Option 4: Explicit assignment for Node = J
1	J	+	Starting or explicit value
2	XPEC (J)	≥ 0 < 0	Peclet Number Default = ?
3	VPEC (J)	≥ 0 < 0	Minimum velocity to use in computing Effective Diffusion units = m/sec Default = ?
4	DIF(j,1)	≥ 0 < 0	Diffusion scaling factor; applied to Peclet derived Default = ?
5	DIF(j,2)	≥ 0 < 0	Diffusion scaling factor; applied to Peclet derived Default = ?

PV CARD: Physical Variables

Optional

Card Description: Active parameters on this card cause the program to use the specified parameter values in place of the default values.

Field	Variable	Value	Description
0, C 1-2	IC1	PV	Card group identifier.
1	ACGR	≥ 0	Acceleration due to gravity (m/sec ²)
		< 0	Default = 9.807 m/sec ²

D-R-A-F-T

RD CARD: Automatic Roughness Coefficient Assignment by Depth

HN and/or RD is required if an HS card is used and MSC = 2 or 4

Card Description: Provides for real time adjustment of the bottom roughness coefficient. Automatically changes the Manning's n-value of a node depending upon the water depth at each node. Generally, the deeper the water, the lower the roughness value.

Field	Variable	Value	Description
0, C 1-2	IC1	RD	Card group identifier.
0, C 3	IC3		Card type identifier.
		b (blank)	Specifies Option 1: Global assignment for element numbers \geq ISTART.
		T	Specifies Option 2: Set n-value by element <i>material type</i> (IMAT).
		E	Specifies Option 3: Set n-value by element <i>number</i> .
1	ISTART	+	If Option 1: Code the <i>first</i> element number for global assignment to begin. If Option 2: Code the element <i>material type</i> . If Option 3: Code the element <i>number</i> .
2	IRUFF	-, 0, +	On/Off switch for auto Manning's n-value calculations based upon an average depth (AVEDEP in the equation) of the element. A positive value turns the option on and sets defaults as in the table on the next page . A negative value or zero will turn the auto option off for those nodes.
3	RDR0	0, +	Maximum Manning's n-value for non-vegetated water (a positive value will override the default).
4	RDD0	0, +	Depth at which vegetation effects roughness (a positive value will override the default).
5	RDRM	0, +	Manning's n-value for vegetated water (a positive value will override the default).
6	RDCOEF	0, +	Roughness by depth coefficient (a positive value will override the default).
7	RDMIN	+	Minimum allowed roughness, default n-value = .01 (a positive value will override the default)
8	RDMAX	+	Maximum allowed roughness, default n-value = .20 (a positive value will override the default)

$$NVALUE = (RDR0 / (AVEDEP^{RDCOEF})) * (SCALE^{RDCOEF}) + (RDRM * EXP(-AVEDEP/RDD0)),$$

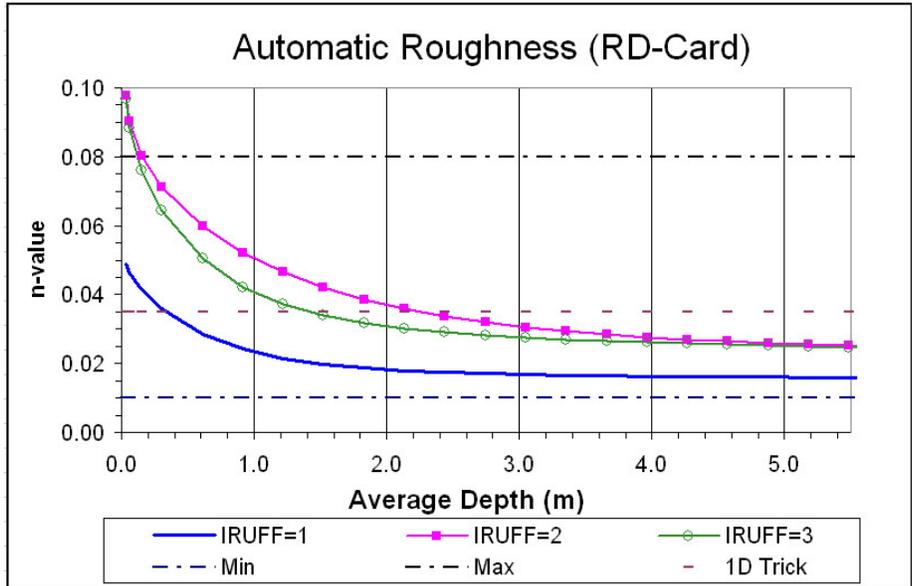
where SCALE=1 for ENGLISH units and SCALE = .3048 for Metric units



Note: If convergence instability occurs in the 1D sections of the mesh, set the parameters to achieve a more constant n-value in the 1D sections. See the "1D trick" suggestion in the table below.

(Continued on next page)

It is recommended to use the same RD-Card parameters from the RMA2 simulation, but you must convert the RDD0 variable to metric units. There are minute differences in auto roughness: RMA2 used gauss points, while SED2D used the nodal values. Computed n-value are assigned to the SED2D array XNVALU(i).



$$NVALUE = (RDR0 / (AVEDEP^{RDCOEFF})) * (SCALE^{RDCOEFF}) + (RDRM * EXP(-AVEDEP/RDD0)),$$

where SCALE=1 for ENGLISH units and SCALE= .3048 for metric units

Default values for n-value parameters on RD card.

IRUFF	Project used for	RDR0	RDD0 Depth	RDRM	RDCOEFF
1	Miss River Delta project	.02	2.0 ft 0.61 m	.026	.08
2	S-shaped River example test case	.04	4.0 ft 1.22 m	.040	.166667
3	San Francisco Bay Estuary project	.04	2.0 ft 0.61 m	.040	.166667
1D Trick*	For a Constant Roughness settings	.02 or Desired constant	2.0 ft 0.61 m	0	1 e -14

 **Note:** The SED2D user must input the metric value for RDD0. The automatic roughness equation will be internally scaled to accept metric units.

D-R-A-F-T

SA CARD: Sand Characteristics

Required for Sand

Card Description: Active parameters on this card cause the program to use the specified parameter values in place of the default values.

Field	Variable	Value	Description
0, C 1-2	IC1	SA	Card group identifier.
1	MTC	7	Ackers-White transport function. This is the only option available in the current version of SED2D WES.
2	SACLL	≥ 0 < 0	Minimum sand grain size for NSACI Default = 0.0625 mm. <i>See note below.</i>
3	SACUL	≥ 0 < 0	Maximum sand grain size for NSACI Default = 0.0625 mm. <i>See note below.</i>
4	NSACI	+	Class number. The class interval is calculated for the log of particular sizes. <i>See note below</i>
5	SGSA	≥ 0 < 0	Specific gravity of sand grains Default = 2.65
6	GSF	≥ 0 < 0	Grain shape factor This variable name is basically not used. Default = 0.67
7	CLDE	≥ 0 < 0	Characteristic length factor for deposition Default = 1 times the depth
8	CLER	≥ 0 < 0	Characteristic length factor for erosion Default = 10 times the depth



NOTE: The current version of SED2D WES handles only one size class. Therefore NSACI must equal 1, and SACLL must equal SACUL. A multiple grain size algorithm is under development.

SB CARD: Sand Bed Thickness

Required for Sand

Card Description:

Field	Variable	Value	Description
0, C 1-2	IC1	SB	Card group identifier.
C3	IC3	b/ T E N	Option 1: Global assignment to all nodes, starting with = J Option 2: Explicit assignment for IMAT = J Option 3: Explicit assignment for Element = J Option 4: Explicit assignment for Node = J
1	J	+	Starting or explicit value
2	TTHICK(J)	≥ 0 < 0	Sand bed thickness in meters Default = 0.0 m



NOTE: To prevent sand erosion, consider setting the sand bed thickness to zero.

D-R-A-F-T

SR CARD: Sand Grain Size For Roughness

Required for Sand

Card Description:

Field	Variable	Value	Description
0, C 1-2	IC1	SR	Card group identifier.
0,C3	IC3	b/	Option 1: Global assignment to all nodes, starting with = J
		T	Option 2: Explicit assignment for IMAT = J
		E	Option 3: Explicit assignment for Element = J
		N	Option 4: Explicit assignment for Node = J
1	J	+	Starting or explicit value
2	EFDR(J)	≥ 0	Effective grain size for roughness (mm)
		< 0	Value of SACLL from SA card will be used



NOTE: SA card must precede SR card.

ST CARD: Sand Grain Size For Transport

Required for Sand

Card Description:

Field	Variable	Value	Description
0, C 1-2	IC1	ST	Card group identifier.
0,C3	IC3	b/	Option 1: Global assignment to all nodes, starting with = j
		T	Option 2: Explicit assignment for IMAT = J
		E	Option 3: Explicit assignment for Element = J
		N	Option 4: Explicit assignment for Node = J
1	J	+	Starting or explicit value
2	EFDT(J)	≥ 0	Effective grain size for transport (mm)
		< 0	Value of SACLL from SA card will be used



NOTE: SA card must precede ST card.

D-R-A-F-T

SI CARD: System International Units

Required

Card Description: Used to identify the units on the input binary formats of GFGEN and RMA2.

Field	Variable	Value	Description
0, C 1-2	IC1	SI	Card group identifier.
1	METRIC		Units for binary input.
		0	The GFGEN binary geometry file and the RMA2 binary solution file are expected to be in English units. The data from these files will be converted to metric units upon being read. Other parameters specified on cards should be input according to the units specified in this manual. SED2D WES output will be in Metric units, except for the new GFGEN geometry created on unit KGEOM (see the \$L2 card). The KGEOM file will revert to English units if METRIC = 0.
		1	The GFGEN binary geometry file and the RMA2 binary solution file are expected to be in Metric units. Other parameters specified on cards should be input according to the units specified in this manual. SED2D WES output will be in Metric units.

STO(P) CARD: Stop The SED2D Simulation

Required

Card Description: Required to stop the SED2D simulation.

Field	Variable	Value	Description
0, C 1-2	IC1	ST	Card group identifier.
0,C3	IC3	0	Card type identifier
2-10	FLD	A	May be used for comments

D-R-A-F-T

T1-T3 CARD: Title Description

Required

Card Description: A “T” card must be the first user input line in the primary SED2D WES run control file. Any number of T1 and T2 lines may be used and the sequence is not significant. Only one T3 line may be used, and it must be the last title line in the set. The program reads the ‘3’ as meaning the END of the “t” cards.

Field	Variable	Value	Description
0, C 1-2	IC1	T	Card group identifier.
0, C 3	IC3	1,2,3	Card type identifier.
1	TITLE		Any alpha-numeric data, up to 77 characters

TH CARD: Timing of the Hydrodynamic File

Required

Card Description: Used to define the RMA2 time steps used

Field	Variable	Value	Description
0, C 1-2	IC1	TH	Card group identifier.
0, C 3	IC3	b/	Card type identifier.
1	TCORR	Real	Time (hr) to subtract from the RMA2 time to define SED2D time 0.
2	TEND	Real	RMA2 Time value of the last time step on RMA2 file.
3	DT_REPE AT	≥ 0 <0	Time increment for RMA2 solution file rewind (decimal hours). When using a repeating hydrodynamic solution (such as a repeating tide or a steady state hydrodynamic solution) the time increment between the last time step in the RMA2 solution file and the first time step of the rewound RMA2 solution file must be specified. For steady state hydrodynamics let DT_REPEAT = TMAX to avoid re-reading the RMA2 file every time step. Default to the delta time step value on the TZ card (DT variable)



See also TZ CARD: Computational Time Control

D-R-A-F-T

TO CARD: Timing Of Binary Write

Optional

Card Description: Used to prevent SED2D from writing to the solution file until the simulated hour matches a user specified time.

Field	Variable	Value	Description
0, C 1-2	IC1	TO	Card group identifier.
1	IWBIN	≥ 0	Increment for printing to binary output files (print every IWBIN'th time step). Files affected include KOHOTB, KPU, and KGEOM - see \$L2 card)
		< 0	Default = 1

TR CARD: Trace Print Control

Optional

Card Description: Used to specify what information will appear on the special print file.

Field	Variable	Value	Description
0, C 1-2	IC1	TR	Card group identifier.
1	IREPRT	≤ 0	No reporting
		> 0	Report the input parameters to the full results listing file. The value of IREPRT serves as an incremental counter for input parameters that are nodal or elemental based.
2	ITRINC	> 0	Increment for printing to full print output file (print every ITRINC th time step)
		≤ 0	Default = 1
3	IECHO	< 0	Do not echo the run control input cards
		≥ 0	Echo the run control input cards (This is the default)
4	ITRACE	0	No trace for debug purposes (This is the default)
		-1	No trace, but diagnostic files are created, see NOTE
		1	Trace between major subroutine calls for debug purposes
		2	Exhaustive debug trace to the standard output ("screen")



NOTE: Diagnostic files compatible with SMS scatter file format are created if $|ITRACE|=1$ or $ITRACE \geq 1$. The default file names are "s2negdepth.dat" and "s2negconc.dat" and will contain the vital information for nodal locations experiencing either a negative depth or negative concentration values during the SED2D simulation.



Example TR 1000 24 1 -1

This TR Card configuration will report the initial conditions for every 1000th node and 1000th element. A summary status of every 24th time step will be echoed to the full results listing file. All input card and related parameters will be echoed as they are read. Diagnostic files indicating the locations where either negative concentrations occur.

D-R-A-F-T

TRE CARD: Element List For Special Summary Trace Print

Optional

Card Description: Used to assign the elements whose properties will appear on the special print file.

Field	Variable	Value	Description
0, C 1-2	IC1	TRE	Card group identifier.
1-10	NESPRT(I)	+	List of element numbers for special print summary. Auto count of total number of elements = JESPRT



NOTE: Multiple TRE cards may be required to enter all requested elements.

TRN CARD: Node List For Special Summary Trace Print

Optional

Card Description: Used to assign the nodes whose properties will appear on the special print file.

Field	Variable	Value	Description
0, C 1-2	IC1	TRN	Card group identifier.
1-10	NNSPRT(I)	+	List of node number for special print summary. Auto total = JNSPRT



NOTE: Multiple TRN cards may be required to enter all requested nodes.

Special node printout is not implemented in the current version of SED2D WES. An algorithm for this option is under development.

D-R-A-F-T

TRT CARD: Material Type List For Special Summary Trace Print

Optional

Card Description: Used to assign the material types whose properties will appear on the special print file.

Field	Variable	Value	Description
0, C 1-2	IC1	TRT	Card group identifier.
1-10	ESPLPT(I)	+	List of element type (IMAT) numbers for special print summary. Note: This will become an equivalent TRE card list.



NOTE: Multiple TRT cards may be required to enter all requested nodes.

Special element type printout is not implemented in the current version of SED2D WES. An algorithm for this option is under development.

TT CARD: Crank-Nicholson Theta

Required

Card Description: Used to specify a value for THETA in the Crank-Nicholson time-stepping scheme.

Field	Variable	Value	Description
0, C 1-2	IC1	TT	Card group identifier.
0,C3	IC3	b/	
1	TETA		Crank-Nicholson THETA
		> 0	A value between zero and one (0.66 is recommended)
		≤ 0	Default = 0.5 This produces the most sensitive model response but often causes oscillations in the solution.



NOTE: A value of 0.66 is recommended, but variations from 0.5 (equal weighting of this time - step and the previous time - step) to 1.0 (no influence from the previous time - step) are permitted. A higher value of Theta produces results that are more stable but numerical (artificial) dispersion of sediment is increased.

TZ CARD: Computational Time Control

Required

Card Description: Used to control the simulation time.

Field	Variable	Value	Description
0,C1-2	IC1	TZ	Card group identifier
3	NTTS	≥ 0	Maximum number of cycles
		< 0	Default = 0
1	DT	≥ 0	Length of a time step for SED2D WES simulation (decimal hours). Note: The capability exists to specify a time step that is different from the RMA2 time step when using a dynamic RMA2 solution file. However, this is NOT RECOMMENDED . If the SED2D time step is less than the RMA2 time step then a linear interpolation will be performed to evaluate the velocities at the intermediate time steps. The SED2D time step cannot be larger than the RMA2 time step. WARNING: It is highly recommended that the SED2D time step be set exactly equal to the RMA2 time step. Severe accuracy errors can result from using an interpolated flow field.
		< 0	Default = 0.0
2	TMAX	≥ 0	Maximum time for a simulation (decimal hours)
		< 0	Default = 0.0

 **NOTE:** It is highly recommended that the SED2D time step be set exactly equal to the RMA2 time step

WC CARD: Settling Velocity

Required

Card Description: This settling velocity is an effective fall velocity which goes up with grain size, goes down with increasing turbulence, goes up with increasing aggregation (cohesive sediments), and goes up if a too large value of CLDE. WC is used by both sand and clay.

Field	Variable	Value	Description
0, C 1-2	IC1	WC	Card group identifier.
0,C3	IC3	b/	Option 1: Global assignment to all nodes, starting with = J
		T	Option 2: Explicit assignment for IMAT = J
		E	Option 3: Explicit assignment for Element = J
		N	Option 4: Explicit assignment for Node = J
1	J	+	Starting or explicit value
2	VS(J)	≥ 0	Settling velocity (m/sec)
		< 0	Default = 0.0 (no deposition)



Tip: The best starting point for noncohesive sediments are fall velocities for spherical particles of equal diameters. For data on appropriate values for settling velocities see "Some Fundamentals of Particle Size Analysis," 1957, Committee on Sedimentation, Interagency Committee on Water Resources. For cohesive sediments, the settling velocity of particles can vary enormously with sediment type, salinity, turbulence, and other chemical and physical conditions. Laboratory or field tests are needed to define effective settling velocities.

D-R-A-F-T

WF CARD: Settling Velocity Function Option

Optional

Card Description: Used to select the function used to define the fall velocity, for both Sand and Clay.

Field	Variable	Value	Description
0, C 1-2	IC1	WF	Card group identifier.
1	MSETV	0	Make fall velocity a function of concentration. The functional form is If concentration is greater than or equal to 0.3 kg/m ³ then VS(NN) = VS(NN) from WC cards If concentration is greater than or equal to 0.3 kg/m ³ then VS(NN) = VS(NN) from WC cards * CONC(NN)**(4/3)
		1	Make fall velocity a function of concentration. The functional form is If concentration is greater than or equal to 1 kg/m ³ then VS(NN) = VS(NN) from WC cards If concentration is greater than or equal to 0.01 kg/m ³ and less than 1 kg/m ³ then VS(NN) = VS(NN) from WC cards * CONC(NN)** (4/3) If concentration is less than or equal to 0.01 kg/m ³ then VS(NN) = VS(NN) from WC cards * (0.01)**(4/3)
		2	Make fall velocity a function of concentration. The functional form is If concentration is less than or equal to CRFLOC kg/m ³ then VS(NN) = VS(NN) from WC cards If concentration is greater than or equal to CRFLOC and less than CRHIND then VS(NN) = VS(WC cards) * CONC(NN)/CRFLOC** (4/3)
2	CRFLOC	+	Critical concentration (kg/m ³) above which flocculation increased the fall velocity (used only for MSETV=2)
3	CRHIND	+	Critical concentration (kg/m ³) above which hindered settling leads to a constant fall velocity (used only for MSETV=2)

Performance Enhancements

Redimensioning SED2D

There are several arrays whose size can be modified, and it should be determined by your problem and the system on which you are running SED2D. These array dimensions can be changed in the source code by editing the SED2D include file and recompiling. The array dimension variables are as listed in the table below.

Variable	Description
MNN	Maximum number of nodes
MNE	Maximum number of elements
MNEQ	Maximum number of system
MNL	Maximum number of clay bed layers
MNFE	Maximum number of matrix columns
MBUF	Buffer size
MCCN	Maximum number of continuity
MNSPRT	Maximum number of special print
MQAL	Maximum number of quality
MBNP	Maximum number of BC buffer nodes
MBB	Maximum number of BC buffer cells

Compiling SED2D WES

SED2D WES is a FORTRAN-77 program with some FORTRAN-90 enhancements that can be compiled on any computer where a FORTRAN compiler resides. The exact command for compiling SED2D WES on your computer will depend upon the brand of your compiler. In general, Unix based computers will use a command similar to the following Fortran-77 command:

```
f77 -o sed2dv45.exe -O4 -static sed2dv45.f
```

D-R-A-F-T

where “-o” is a flag to set the filename of the executable file,” -O4” is an optimization flag (this happens to be the default optimization flag for DEC FORTRAN), “-static” is a flag that causes all local variables to be statically allocated (this is the same as the “SAVE” flag for some PC compilers), and sed2dv45.f is the name of the source file. The source file contains an “INCLUDE” statement which will require the presence of the file “sed2dv45.inc” in the working directory at the time of compilation. The file “sed2dv45.inc” contains the global variable declarations for SED2D WES. In particular, the array sizes (the number of nodes and elements permitted) are set in this file. For large grids, you may need to increase the array sizes and recompile the program in order to successfully run your application. If you need help with this process contact the TABS-MD consultants at “SMS@usace.army.mil”.

COMMON PROBLEMS

Displaying your results with FastTABS

This version of SED2D WES was designed to run with the SMS Graphical User Interface. If you are using FastTABS (the predecessor to SMS) you must first run a conversion program to convert your SED2D WES output to a format that is compatible with FastTABS. The conversion program is written in FORTRAN and is called “v12_2_ft.f”. The compiled version of this program is typically called “v12_2_ft.exe”. You will be prompted at the terminal for the input data required to run this program. The input is self-explanatory. Simply answer the questions as they appear on the screen. The following is an example interactive session to run “v12_2_ft.exe”:

```
C:\SED2D>v12_2_ft.exe
enter studh concentration/delbed file (binary) name
claysed.cd
enter fasttabs concentration/delbed file name
clsed_ft.sol
do you want the concentration in log10 form (def=n)
n
enter the number of time steps to retrieve, or
enter a negative number to specify a time window.
-1
enter minimum and maximum times (in hours)
0,500
enter the save increment n (save every nth time step)
1
```

The program will process. Some information will be written to the screen as the program proceeds. When the program is complete, the prompt will appear.

D-R-A-F-T

You may now run FastTABS. Once FastTABS has been launched, open the geometry file. To look at the solution file, read the solution “clsed_ft.sol” under the solution menu. FastTABS interprets this file as an RMA4 output file containing three concentration fields. You should interpret these three fields as follows: 1) concentration 1 is the concentration of suspended sediment in ppt; 2) concentration 2 is the net bed change (“delbed”) in feet; 3) concentration 3 is the bed shear stress in $\text{kg}/(\text{m sec}^2)$.

WARNINGS AND ERROR MESSAGES

SED2D FILE FORMATS

TABS Binary File Header Format

All TABS-MD models operate on and generate binary files, each of which have several header or banner records that describe critical features about the contents of the file. The binary files are written by standard FORTRAN 77 unformatted write statements. The variable types follow standard FORTRAN assignments, where variables are REAL, except for those beginning with the characters 'I' through 'N' which are INTEGER.

Record 1

MFLG, IREC, NP, NE

where

MFLG	Model identifier flag (120-129 for RMA2 results) (135-139 for RMA2 Hotstart file)
IREC	Version number of the RMA2 program
NP	Number of nodes in the mesh
NE	Number of elements in the mesh

Record 2

IWRT1, (IBAN(i),i=1,IWRT1)

where

IWRT1	Number of items contained in the banner array
IBAN	Integer interpretation of the banner character strings

Record 3

IWRT2, IWRT3 , (IREC(i),i=1,IWRT2), (FREC(i),i=1,IWRT3)

where

IWRT2	Number of items contained in the IREC array
IWRT3	Number of items contained in the FREC array
IREC	Integer flags which are set during execution
FREC	Floating point flags which are set during execution

Record 4

IWRT4, (ITIT(i),i=1,IWRT4)

where

ITIT	Integer interpretation of the title character string
IWRT	Number of items contained in the ITIT array

Records 5-End are not header records....

The contents of record number 5 through the end varies depending upon the type of file you are dealing with (RMA2 u-v-h solution, SED2D concentration/delbed solution, etc.)

GFGEN Binary Geometry File Format

Records 1-4 are the same as the header records in "TABS Binary File Header Format" on page 140.

Record 5

NP, NE, ((CORD(j,k),k=1,2), ALFA(j), AO(j), j=1,N),
 ((NOP(j,k),k=1,8), IMAT(j), TH(j), NFIXH(j),j=1,M),

Record 6

(WIDTH(j),SS1(j),SS2(j),WIDS(j), j=1,N)

where

NP	Number of nodes in the mesh
NE	Number of elements in the mesh
CORD	Array containing X- and Y-coordinate
ALFA	Array containing
AO	Array containing bottom elevation
NOP	Array containing element connection
IMAT	Array containing each elements material type assignment
TH	Array containing elemental direction for Eddy Viscosity
NFIXH	Array containing elemental direction for Eddy Viscosity
WIDTH	Array containing 1D element, channel bottom width
SS1	Array containing 1D element, left side slope
SS2	Array containing 1D element, right side slope
WIDS	Array containing each element's off-channel storage width
WSCRIT	Array containing each element's off-channel storage width critical water surface elevation switch
SSS	Array containing each elements off-channel storage side slope

RMA2 Binary Solution (u,v,h) File Format

Records 1-4 are the same as the header records in "TABS Binary File Header Format" on page 140.

Record 5

TET, NP, ((VEL(j,k),j=1,3), k=1, NP), (NDRY(k), k=1, NP), NE,
(IMAT(k), k=1, NE), (WSEL(k), k=1, NP)

where

TET	Simulation time, in decimal hours
NP	Number of nodes in the mesh
VEL	Array containing --> X-velocity, Y-velocity, and Depth
NDRY	Array containing wet/dry status for each node (1 = wet, 2 = dry, -1 = About to become re-wet)
NE	Number of elements in the mesh
IMAT	Array containing each elements material type assignment
WSEL	Array containing water surface elevation for each node

Records 6 (through the *Last record*)

Continue reading simulation records in a loop until an end-of-file is reached.

SED2D Binary Concentration and DelBed Format

Records 1-4 are the same as the header records in "TABS Binary File Header Format" on page 140.

Records 5 (startup time)

NTTS, IYR, IMO, IDA, IHR, IMN, ISC

Records 6 (geometry and initial condition)

NP, NE, ((CORD(i,J),J=1,2),i=1,NP),
 ((NOP(i,J),J=1,8),i=1,NE), (AT(i),i=1,NE),
 (ELEV(i),i=1,NP), (CONC(i),i=1,NP)

where

NTTS	Maximum number of SED2D time steps (see TZ card)
<i>start time</i>	Starting year/month/day/hour/min/second
NP	Number of nodes in the mesh
NE	Number of elements in the mesh
CORD	Array of (x,y) coordinates for each node point (m)
NOP	Element connection table for each element
AT	Element surface area (m ²)
ELEV	Initial Bed elevation (m)
CONC	Initial concentration (kg/m ³)

Records 7 (solution arrays for current time step)

TETHR, (CONC(i),i=1,NP), (DELBED(i),i=1,NP),
 (IMAT(i),i=1,NE), (ELDELBED(i),i=1,NE), (BSHEAR(i),i=1,NP),
 (DEP(i),i=1,NP), (NDRY(i),i=1,NP)

where

TETHR	Simulation time, in elapsed decimal hours
CONC	Sediment concentration at current time, kg/m ³
DELBED	Bed change by node (m)
IMAT	Element material type
ELDELBED	Bed change by element (m)
BSHEAR	Bed shear stress (Pa)
DEP	Water depth
NDRY	Array containing wet/dry status for each node (1 = wet, 2 = dry, -1 = About to become re-wet)

Records 7 (through the *Last record*)

Continue reading simulation in a loop until an end-of-file is reached.

SED2D Binary Bed Strata (a.k.a Structure) File Format

Records 1-4 are the same as the header records in "TABS Binary File Header Format" on page 140.

Records 5 (bed strata, density, thickness, age, strength)

TETHR, NP, NE, MNL,
(NLAY(i),(i=1,NP),
(RHOB(i,j),i=1,NP),
(THICKL(i,j),i=1,NP),
(AGE(i,j),i=1,NP),
(ITYPE(i,j),i=1,NP),
(SST(i,j),i=1,NP),j=1,MNL)

where

TETHR	Simulation time, in decimal hours
NP	Number of nodes in the mesh
NE	Number of elements in the mesh
MNL	
NLAY	
RHOB	
THICKL	
AGE	
ITYPE	
SST	

Records 5 (through the *Last record*)

Continue reading simulation records in a loop until an end-of-file is reached.



Note:

New GFGEN Ascii Geometry File Format

Records 1-3 (Titles)

T1 New SED2D Geometry. NE=',I7,' NP=',I7

T2 Delbed results after ',F15.1,' seconds. Units=',A

T3 ', A

Element Connection Table Section

'GE ',10I7, F6.2

Geometry Nodal coordinate and bottom elevation

'GNN ',I7, 2F15.2,F10.4

Geometry 1D and 2D Off Channel Storage

I, CHWIDTH(I),SS1(I),SS2(I),WIDS(I)

GWN ', I7, 4F12.4

NE	Number of elements in the mesh
NP	Number of nodes in the mesh
NOP	Element connection table for each element
ALFA	Reference angel for the element
IMAT	Material type for the element
CORD	Array of (x,y) coordinates for each node point (m)
AO (new)	Bottom elevation as computed to date
SS1	Array containing 1D element, left side slope
SS2	Array containing 1D element, right side slope
WIDS	Array containing each element's off-channel storage width
WSCRIT	Array containing each element's off-channel storage width criticle water surface elevation switch
SSS	Array containing each elements off-channel storage side slope

SED2D Binary Wave File Format

Records 1-4 are the same as the header records in "TABS Binary File Header Format" on page 140.

Records 5 (vorticity arrays)

WAVE_HR, NSET, NPPW2, (WAVEHIT(k), k=1,NPPW2),
(WAVEDIR(k), k=1,NPPW2),(WAVEPER(k), k=1,NPPW2),
NEPW2_VOID, (IMAT_VOID(k),k=1,NE)

where

WAVE_HR	Wave time, in decimal hours
NSET	Number of nodal arrays to follow (NSET=3 for wave)
NPPW2	Number of nodes represented in the wave file
WAVEHIT	Array containing wave height results at each node
WAVEDIR	Array containing wave direction results at each node
WAVEPER	Array containing wave period results at each node
NEPW2_void	Number of elements represented (NEPW2=0 for wave)
IMAT_void	Array containing each elements material type assignment. IMAT_void is read but not used.

Records 6 (through the *Last record*)

Continue reading simulation records in a loop until an end-of-file is reached



Note: The wave binary file is primarily used by advanced users. The file format mimics the RMA4 solution file format to permit easy visualization by the SMS graphical user interface. SMS will label the contents as constituents 1-3, but they are actually the wave height, direction, period, respectively.

UTILITIES

This version of SED2D is designed to work with the SMS Graphical User Interface. If you are using FastTABS you will need to convert the binary “concentration/delbed” file to a different format in order to view your results within FastTABS. A utility program call “v12_2_ft.exe” has been developed to accomplish this. This utility program will yield a solution file that FastTABS recognizes as an RMA4 file, where

- concentration 1 = suspended sediment concentration (ppt),
- concentration 2 = cumulative bed elevation change (feet),
- concentration 3 = bed shear stress (kg/ m sec^2).

To run the conversion program, simply type “v12_2_ft.exe<cr>“, then answer the questions from the screen. If you are using SMS you can view the “concentration/delbed” file generated by SED2D directly from within SMS. However, note that SMS will convert the bed change units to be the same as specified in the geometry file (SI card). The program v12_2_ft.exe converts from meters to feet, regardless of units.

TECHNICAL SUPPORT

There are several technical support options available to TABS-MD users. We are continually striving to improve your support options to provide you with the answers you need as simply and as quickly as possible.

On-Line Support

Technical support is available on the Internet 24 hours a day, 7 days a week.

Option 1: World Wide Web

Check out our list of Frequently Asked Questions on the Internet at URL

<http://hlnet.wes.army.mil>.

Option 2: E-mail

If you cannot find a solution to your problem yourself, you can send us E-mail at SMS@usace.army.mil. We will try to obtain a solution to your problem and reply with our findings.

TABS Hotline

Currently there is one person to handle Hotline support phone calls for TABS, so we request that you try all possible avenues to find a solution to your problem before calling for support. If you must call, please have the following pertinent data available:

- The GFGEN Geometry file
- The RMA2 run control file (.rc2 file)
- Computer information: type, memory capacity, etc.
- Any error messages
- Your E-mail and FTP addresses if applicable

The Hotline phone number is (601) 634-2730, FAX (601)634-4208.

REFERENCES

Ackers, P., and White, W. R. 1973 (Nov). "Sediment Transport: New Approach and Analysis," Journal of the Hydraulics Division, American Society of Civil Engineers., No. HY11.

Ariathurai, R. 1974 (Aug). A Finite Element Model for Sediment Transport in Estuaries, Ph. D. Thesis, Department of Civil Engineering, University of California, Davis.

Ariathurai, M. R., and Krone, R. B. 1964. Suspension of cohesive sediments by wind-generated waves. Tech. Rep HEL-2-9, Hydraulic Engrg. Lab., Univ California, Berkeley, U.S.A., 24 pp.

Ariathurai, M. R., MacArthur, R. C., and Krone, R. B. 1977 (Oct). "Mathematical Model of Estuarial Sediment Transport," Technical Report D-77-12, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Krone, R. B. 1962 (Jun), Flume Studies of the Transport of Sediment in Estuarial Shoaling Processes. Final Report. Hydraulic Engineering Laboratory and Sanitary Engineering Research Laboratory, University of California, Berkeley.

McAnally, W. H., and Thomas, W. A. 1980 (Aug). "Shear Stress Computations in a Numerical Model for Estuarine Sediment Transport," Memorandum for Record, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Swart, D. H. 1976 (Sep). "Coastal Sediment Transport, Computation of Longshore Transport," R968, Part I, Delft Hydraulics Laboratory, The Netherlands.

White, W. R., Milli, H., and Crabbe, A. D. 1975. "Sediment Transport Theories: An Appraisal of Available Methods," Report Int. 119 (Vols. 1 and 2), Hydraulics Research Station, Wallingford, England.

Notation

\square_i	=	coefficient for the source term 1/sec
\square_p	=	equilibrium concentration portion of the source term $\text{kg/m}^3/\text{sec}$
C	=	Chezy roughness coefficient
c	=	concentration of sediment, kg/m^3
CME	=	coefficient of 1 for metric units and 1.486 for English units
C_c	=	critical concentration = 300 mg/l
C_d	=	coefficient for deposition
C_e	=	coefficient for entrainment
C_{eq}	=	equilibrium concentration
\square	=	approximate concentration in an element as evaluated from the shape functions and nodal point values of c
D	=	water depth
D_s	=	effective grain size
D_x	=	effective diffusion coefficient in x-direction, m^2/sec
D_y	=	effective diffusion coefficient in y-direction, m^2/sec
DT	=	computation time interval
t	=	time
f(t)	=	time-varying characteristic
f_c	=	shear stress coefficient for currents
f_w	=	shear stress coefficient for waves
GP	=	transport potential
GS	=	transport capacity
g	=	acceleration due to gravity
i	=	number of grain size class
M	=	consolidation coefficient
N	=	quadratic shape functions
NE	=	total number of elements

D-R-A-F-T

NL	=	total number of boundary segments
n	=	Manning's roughness value
P	=	erosion rate constant
PI	=	percent of bed surface covered by grain size, expressed as a function
Q	=	 for the transient problem
q_i^s	=	flux from source on boundary i
ρ	=	water density
L	=	density of the failed layer
S	=	source term
T_1	=	thickness of the failed layer
t	=	time, sec
t_c	=	characteristic time
t_0	=	time zero
t_1	=	time, 1 year
τ	=	bed share stress
τ_d	=	critical shear stress for deposition
τ_e	=	critical shear stress for particle erosion
τ_s	=	bulk shear strength of the layer
u	=	flow velocity in x-direction, m/sec
u_{om}	=	maximum orbital velocity of waves
u_*	=	shear velocity
v	=	flow velocity in y-direction, m/sec
ν	=	kinematic viscosity of water
V_k	=	$V_s / (C_c)^{4/3}$
V_s	=	fall velocity of a sediment particle
V	=	mean flow velocity
x	=	primary flow direction, m
y	=	direction perpendicular to x, m
z	=	local coordinate

Glossary of Terms



NOTE: We used EM 1110-2-4000, 15 Dec 89, Appendix B, Sedimentation Glossary of Terms, and have added other glossary entries for the SED2 manual.

ASCII

The **American Standard Code for Information Interchange** 8-bit character set. ASCII values represent letters, digits, special symbols, and other characters.

An ASCII file, or text file, is a file which contains only ASCII characters in the range from 0 to 127.

Achers-White Transport Equation

The transport formulation for assessing sediment transport for sand adopted for the SED2D numerical model. The Achers-White formula (see Eq 11-13) computes the total bed load, including suspended load and bed load, and was developed originally for fine sand. The formulation was later updated to include coarser sands and these revised coefficients are included in SED2D. See reference Ackers P. and White W. Sediment Transport: New Approach and Analysis. Journal of the Hydraulics Division, American Society of Civil Engineers, 1973, 99, HY11, 2041-2060.



See Also Equations 11-13

Aggradation

The geologic process by which stream beds, flood plains, and the bottoms of other water bodies are raised in elevation by the deposition of material eroded and transported from other areas. It is the opposite of degradation.

Alluvial

Pertains to alluvium deposited by a stream of flowing water.

Alluvium

A general term for all detrital deposits resulting directly or indirectly from the sediment transported of (modern) streams, thus including the sediments laid down in riverbeds, flood plains, lakes, fans, and estuaries.

D-R-A-F-T

Banner

An alphanumeric set of information included in all TABS-MD binary output files which describes the flow of data between GFGEN, RMA2, RMA4, and SED2D.

Base to Plan comparisons

The process of identifying differences in numerical model results between existing conditions and revised conditions, usually a change in geometry.

Basis Function

The interpolation polynomial used to approximate the spatial distribution of the solution over a portion of the model domain (element). Also called Shape function.

Batch mode

A queuing procedure and computer specific job control language which permits dedicated resources for a numerical simulation.

Bathymetry

The measurement of the depth of large bodies of water.

Bed load

Material moving on or near the stream bed by rolling, sliding, and sometimes making brief excursions into the flow a few diameters above the bed

Bed material

The sediment mixture of which the bed is composed. In alluvial streams bed material particles are likely to be moved at any moment or during some future flow condition.

Bed Source Term

The form of the bed source term, $S = \alpha_1^C + \alpha_2$, as given in Equation 1 is the same for deposition and erosion of both sands and clays. Methods of computing the alpha coefficients depend on the sediment type and whether erosion or deposition is occurring.

Binary

A numbering system consisting of only the numerals 0 and 1.

The TABS-MD system uses some binary files. A binary file permits an efficient means to store numerical results.

Binary files are dependent on the word length of the computer from which they were created. They cannot be directly moved across computer platforms.

A TABS binary file is created by an unformatted FORTRAN WRITE statement.

Boundary Condition Buffering

In order to provide a form of memory of the concentration history under dynamic tidal conditions a method termed "boundary condition buffering" was developed. This technique assigns a finite (MBB parameter in the program include file) number

of buffer chambers to each boundary node. This procedure results in memory of the history of concentrations crossing the boundary, delays full specification of the nominal boundary concentration C_b , and generally provides more realistic boundary conditions. Furthermore, the buffering also provides a buffer for the changes that any plan alternatives to be tested may have on the boundary conditions.

Boundary conditions

Water levels, flows, concentrations, stage/discharge relationships, etc., that are specified at the boundaries of the area being modeled. A specified tailwater elevation and incoming upstream discharge are typical boundary conditions.

Boundary effect

A consequence of dissimilarities between the model boundary conditions and the conditions occurring in the prototype at the location of the model boundaries. This effect may be minimized if the model's boundaries are far from the area of interest.

Boundary node

Any node which lies along an *exterior element* edge, or demarcates the wet/dry interface.

Bulk Shear Stress

Card

A term which comes from the 1960-1980's when computers received data on punched cards. Each card supplied the computer with a line of data.

The TABS-MD programs use cards in the same way. The difference is that the card data are stored in a disk file and not in a filing cabinet.

Card image

An ASCII line of data for the computer to read.

Coastal and Hydraulics Laboratory (CHL)

The US Army Engineer Research and Development Center, at the Waterways Experiment Station, Coastal Hydraulics Laboratory, Vicksburg, Mississippi, is the principal Corps agency for engineering research and experimentation in hydraulics and hydrodynamics and is one of the largest hydraulics laboratories in the world.

The Coastal Hydraulics Laboratory provides TABS Numerical Model maintenance and support for Army Corps installations. To find out about availability and support for the TABS modeling system, contact the Coastal and Hydraulics Laboratory via e-mail at **SMS@usace.army.mil**, or call (601) 634-3339.

Cohesiveness

The cohesion of a sediment particle is associated with soil type and particle size. Cohesion increases with decreasing particle size for the same type of material. Cohesive sediment is characterized by the dispersed particle fall velocity, flocculated

D-R-A-F-T

fall velocity of the suspension, the clay and nonclay mineralogy, organic content, and the cation exchange capacity.

Cohesive Sediment

Sediments whose resistance to initial movement or erosion is affected mostly by cohesive bonds between particles. A sediment grain size descriptor, commonly known as clay.

Cold start

A model run using initial conditions that are not expected to be close to conditions as solved by the model, i.e., a level water surface elevation and velocity values of zero.

Compiler

A special computer program which converts a higher level language (such as FORTRAN) to a coded set of machine dependent instructions (fetch the contents of REGISTER 1). All TABS-MD programs are written for a FORTRAN-77 compiler.

Concentration of sediment

The dry weight of sediment per unit volume of water-sediment mixture, i.e., mg/L.

Consolidation

Consolidation is the process of compaction of a deposit with time or with overburden pressure.

Continuity

The term continuity refers to conserving mass within the model. The continuity check lines are typically used to estimate the flow rates and serve as an error indicator. The SED2D model *????* satisfied mass conservation in a weighted residual manner. The continuity lines can be used to check mass conservation a different way, by direct integration. Large discrepancies between the two methods indicate probable oscillations and a need to improve model resolution and/or to correct large boundary break angles.

Although continuity checks are optional, they are a valuable tool for diagnosing a converged steady state solution. For steady state, the continuity check lines should represent *total flow in equals total flow out*. However, if the continuity checks indicate a mass conservation discrepancy of $\pm 3\%$, you may want to address the resolution in the geometry. Large mass conservation discrepancies can lead to difficulty when the hydrodynamics are used for transport models, RMA4 and/or SED2D.

Continuity line

(or Continuity Check Line)

A string of corner nodes across which the total flow (or constituent if running RMA4) can be measured. The use of continuity lines also provides a convenient way to specify boundary conditions.

Control structure element

A special 2-node element with an IMAT ≥ 904 . The first node in the element connection table should be the side of the structure with the typical higher elevation.

Convergence

The process of obtaining a solution by way of an iterative solution technique, such as the Newton-Raphson method.



See Also:

Consolidation

Convection

Crank-Nicholson

Critical Shear Stress

Curved boundary

An optional aesthetic means to outline key landmarks within the computational domain. A quadratic curved side is created by assigning (x, y) coordinates to the mid-side node of an element. Curving can help conserve mass in the transport models.



SMS Note: Curved boundaries may be created within the SMS program by unlocking the nodes and moving the mid-side node. Some automatic curving features are available as well.

Data Field

A specific location on a record (card in TABS-MD programs) in a data file where a data value occurs.

Delta time step

The increment of prototype time between two time steps.

Density

The mass of a substance per unit volume. In the English system the units are pounds-seconds square/feet to the fourth power. In the metric system the units are kg/L

D-R-A-F-T

Deposition

The mechanical or chemical processes through which sediments accumulate in a resting place.

Diffusion

Dirichlet Boundary Condition Specification

Dispersion

To de-flocculate or disaggregate compound particles, such as clays and fine silts, into individual component particles.

Diverge

The inability of the numerical model to achieve convergence by the iteration technique.

Element

A segment, triangle, or quadrilateral shape composed of corner nodes and mid-side nodes. An element must be 'connected' to a neighboring element.

An element is composed of a list of nodes in a counterclockwise fashion and may define a 1, 2, or 3 dimensional problem. A line segment defines a one dimensional area, a triangle or quadrilateral defines a two dimensional area, while the three dimensional area is defined by adding layers to an element.

SED2D can handle one dimensional and two dimensional elements.

Entrainment

The carrying away of bed material produced by erosive action of moving water.

Erosion

The wearing away of the land surface by detachment and movement of soil and rock fragments through the action of moving water and other geological agents.

Exit boundary

A boundary condition location at which flow exits the mesh.

FastTABS

This was the predecessor to SMS. A computer program that provides a graphical, point and click means for performing pre- and post-processing for surface water numerical models.

Developed at the Waterways Experiment Station (WES) and Brigham Young University (BYU).

Field data

Data which has been collected at an existing, physical site, used when verifying the simulation.

Fine material

Particles of a size finer than the particles present in appreciable quantities in the bed material; normally silt and clay particles (particles finer than 0.062 mm).

Fine-material load

That part of the total sediment load that is composed of particles smaller than the particles present in appreciable quantities in the stream bed. Normally, that is of sediment particles smaller than 0.062 mm.

Finite element

A method of solving the basic governing equations of a numerical model by dividing the spatial domain into elements in each of which the solution of the governing equations is approximated by some continuous function. This method lends itself well to the river/estuarine environments because of its diversity in computational mesh (element size, shape, orientation), flexibility of boundary conditions, and continuity of the solution over the area.

Flocculent

An agent that produces flocs or aggregates from small suspended particles.

Flocculation agent

A coagulating substance which, when added to water, forms a flocculent precipitate that will entrain suspended matter and expedite settling; for example, alum, ferrous sulfate, or lime.

Flow fields

The domain in which the water flows.

Fluvial

(1) Pertaining to streams. (2) Growing or living in streams or ponds. (3) Produced by river action, as a fluvial plain.

Fluvial sediment

Particles derived from rocks or biological materials which are transported by, suspended in, or deposited by streams

Flux

D-R-A-F-T

Free field

A data format where spaces or commas separate the data items on the input line. There is no fixed position in which the data is required to be located. Only the order of the items is important.

Froude Number

A non-dimensional number indicating the ratio of inertial forces to gravitational forces in a fluid. The Froude number is not important in SED2D because there are no terms for gravity in the formulation.

Gaging station

A selected cross section of a stream channel where one or more variables are measured continuously or periodically to index discharge and other parameters.

Gate

A movable barrier, such as a tide gate, in a river or stream.

GFGEN

Geometry File **GEN**eration program used to create the computational mesh for all TABS-MD applications.

Grain Size



See particle size.

HEC-6

HEC format

A naming convention for the style of run control input derived by Hydrologic Engineering Center (HEC) in which each line of input is defined by a 'Card Type in data field 0' and the data follows in fields 1 through n.

Example, GN card with the N option:

Field 0	Field 1	Field 2	Field 3	Field 4
GNN	node	x coordinate	y coordinate	bottom elevation

Hotstart

The process of supplying the numerical model a set of initial conditions which were obtained from the results of a previous simulation.

Hydraulics Laboratory



See Coastal and Hydraulic Laboratory.

The US Army Corps of Engineers, Waterways Experiment Station, Hydraulics Laboratory, Vicksburg, Mississippi, merged with the Coastal Engineering Research Laboratory in 1996 to form the Coastal and Hydraulics Laboratory (WES-CHL). The CHL provides TABS-MD Numerical Model maintenance and support for Army Corps installations. .

Hydrodynamic

Relates to the specific scientific principles that deal with the motion of fluids and the forces acting on solid bodies immersed in fluids, and in motion relative to them.

Hydrograph

A time series recording of the measurement of flow across a river or stream.

IMAT

Material Type. A variable name used in TABS-MD programs to specify a number representing the type of material within an element. The IMAT is located on the GE card and is used to aid in assigning modeling coefficients.



Note: IMAT=0 is equivalent to assigning a land boundary around the element.

Inflow boundary

A boundary condition location at which flow and sediment concentration enter the mesh.

Interactive mode

Opposite of Batch mode. The program requires the user to respond to questions.

If the program is running on a mainframe computer, the program is time sharing the CPU with other jobs, which can cause delays in some cases.

Iteration

Repeating a sequence of instructions a specific number of times, changing parameters and obtaining a new solution each time, until a predetermined condition is met.



See also:

Junction element

A special element, consisting of 3 to 8 nodes, which defines the intersection of 3 to 8 one dimensional elements.

D-R-A-F-T

Load



See sediment load

Logical unit

Computer lingo used to associate a device number with a data file. In this FORTRAN statement, **10** is the logical unit number:

READ(10,*) DATA

Marsh Porosity

Manning's n value

n is the coefficient of roughness with the dimensions of $T*L^{-1/3}$. n accounts for energy loss due to the friction between the bed and the water. In fluvial hydraulics, the Manning's n value includes the effects of all losses, such as grain roughness of the movable bed, form roughness of the movable bed, bank irregularities, vegetation, bend losses, and junction losses. Contraction and expansion losses are not included in Manning's n , but are typically accounted for separately.

Material type

A number representing the type of material within an element. The associated variable is IMAT.

Mesh

A collection of nodes and elements which defines the domain of the study area.

Mixed Bed

Node

A point containing an x , y , and z coordinate which defines a location in space. Mid-side nodes (x , y , z) are linearly interpolated from adjacent corner nodes, unless the element side is curved.

Noncohesive Sediments

Sediments consisting of discrete particles. For given erosive forces, the movement of such particles depends only on the properties of shape, size, and density, and on the position of the particle with respect to surrounding particles.



See Sand.

Non-Dimensional Analysis



See ND card and Appendix

Off-channel storage

A one dimensional element feature. The storage width associated with the node at zero depth, as specified on GN or GW cards using the N option.

One dimensional element

A line segment composed of two corner nodes and one mid-side node. The geometry is defined by cross section (a straight bottom line between corner nodes) and reach length. The calculated velocity is averaged over the cross section.

Parameter revision

The process of modifying a run control input parameter during a simulation in the middle of a time step. The REV card is used for this purpose.

Particle fall velocity

The falling or settling rate of a particle in a given medium. The standard fall velocity of a particle is the average rate of fall that the particle would finally attain if falling alone in quiescent distilled water of infinite extent and at a temperature of 24°C. Fall velocity is the most fundamental property governing the motion of the sediment particle in a fluid; it is a function of the volume, shape, and density of the particle and the viscosity and density of the fluid.

Particle shape

Sediment property defined by the shape factor, SF.

$$SF = \frac{c}{\sqrt{ab}}$$

where a, b , and c are the lengths of the longest axis, the intermediate axis, and the shortest axis, respectively.

Particle size

A linear dimension, usually designated as “diameter,” used to characterize the size of a particle. The dimension may be determined by any of several different techniques, including sedimentation sieving, micrometric measurement, or direct measurement.

Particle-size classification



See Table B-1

Particle-size distribution

The frequency distribution of the relative amounts of particles in a sample that are within specified size ranges, or a cumulative frequency distribution of the relative amounts of particles coarser or finer than specified sizes. Relative amounts are usually expressed as percentages by weight.

D-R-A-F-T

Peclet number

Defines the relationship between element properties, velocity, and eddy viscosity for the Peclet Method of assigning automatic turbulence.

$$P = \frac{\rho u dx}{E}$$

Porosity

Porosity of deposited sediment is volume of voids divided by the total volume of sample.

Prototype

Field data or physical model data.

The original, or basis for the new study.

Record length

In this context, a FORTRAN specific term dealing with the size of a data type in a binary file.

Resource Management Associates

The TABS numerical models were initially developed by Dr. Ian King at Resource Management Associates, (RMA), in Lafayette, California. A RMA representative can be reached at (707) 864-2950. Web site: <http://www.rmanet.com/>

Dr. King now resides in Australia.

RMA10 (aka TABS-MDS)

RMA10 is a multi-dimensional (combining 1-D, 2-D either depth or laterally averaged, and 3-D elements) finite element numerical model written in FORTRAN-77. It is capable of steady or dynamic simulation of 3-dimensional hydrodynamics, salinity, and sediment transport. It utilizes an unstructured grid and uses a Galerkin-based finite element numerical scheme. The US Army ERDC-WES-CHL version is based upon the work of Dr. Ian King of Resource Management Associates. Many enhancements have been made to the WES version. Charlie Berger is the ERDC-CHL point of contact. Email: Charles.R.Berger.erdcd.usace.army.mil

RMA2

The one dimensional/two dimensional depth averaged hydrodynamic Finite Element numerical model within TABS-MD.

RMA4

The one dimensional/two dimensional depth averaged water constituent transport Finite Element numerical model within TABS-MD.

Roughness

In a river or stream bed, the material on the side slopes or the bottom, such as stones, etc., which inhibit the flow.

 **See Also:**

Run control file

An input data file which provides parameters that control the RMA2 simulation run.

Sand

 See non-cohesive

 See [Table B-1](#)

Scour

The enlargement of a flow section by the removal of boundary material through the action of the fluid in motion.

SED2D

Originally known as STUDH, SED2D is a two dimensional depth averaged sediment transport Finite Element numerical model within TABS-MD. Joe Letter is the ERDC-CHL point of contact for SED2D theory.

Sediment

(1) Particles derived from rocks or biological materials that have been transported by a fluid. (2) Solid material (sludges) suspended in or settled from water.

SEDIMENT II

SEDIMENT 4H.MLT

Sedimentation

A broad term that embodies the processes of erosion, entrainment, transportation, deposition, and the compaction of sediment.

Sedimentation Processes

Erosion, entrainment, transportation, deposition

Sediment classification system

The relationship between sieve diameter and fall diameter as a function of shape for a specific gravity of 2.65 was determined by the Interagency Committee on Water Resources (1957) and is shown in [Figure XX](#).

D-R-A-F-T

American Geophysical Union Sediment Classification System			
Sediment Size Range			
Sediment	millimeters	microns	Inches
Very large boulders	4096-2048		160-80
Large cobbles	256-128		80-40
Medium boulders	1024-512		40-20
Small boulders	512-256		20-10
Large cobbles	256-128		10-5
Small cobbles	128-64		5-2.5
Very coarse gravel	64-32		2.5-1.3
Coarse gravel	32-16		1.3-0.6
Medium gravel	16-8		0.6-0.3
Fine gravel	8-4		0.3-0.16
Very fine gravel	4-2		0.16-0.08
Very coarse sand	2.0-1.0	2000-1000	
Coarse sand	1.0-0.5	1000-500	
Medium sand	0.5-0.25	500-250	
Fine sand	0.25-0.125	250-125	
Very fine sand	0.125-0.062	125-62	
Coarse silt	0.062-0.031	62-31	
Medium silt	0.031-0.016	31-16	
Fine silt	0.016-0.008	16-8	
Very fine silt	0.008-0.004	8-4	
Coarse clay	0.004-0.002	4-2	
Medium clay	0.002-0.001	2-1	
Fine clay	0.0010-0.0005	1.0-0.5	
Very fine clay	0.0005-0.00024	0.5-0.24	

Sediment concentration

The weight of dry sediment in a water-sediment mixture per volume of mixture and is expressed in milligrams/liter (mg/l), or sometimes parts per million (ppm).

Sediment discharge

The mass or volume of sediment (usually mass) passing a stream cross section in a unit of time. The term may be qualified, for example; as suspended-sediment discharge, bed load discharge, or total-sediment discharge.

Sediment grade scale

The grouping of sediment particles into size classes based on particle diameters uses the American Geophysical Union size classification scale of 1947.



See Table B-1

Sediment load

A general term that refers to material in suspension and/or in transport. It is not synonymous with either discharge or concentration.



See total sediment load

Sedimentology

The scientific study of sediment, sedimentary rocks, and the processes by which they are formed—more specifically for this report, it is a study of detachment, transport, and deposition of sediment particles in streams and other water bodies.

Sediment particles

Fragments of mineral or organic material in either a singular or aggregate state.

Sediment property categories

Sediment properties can be divided into two categories: (a) those related to the particle itself and (b) those related to the sediment mixture or deposit.

Sediment transport (rate)



See sediment discharge.

Sediment yield

The total sediment outflow from a drainage basin in a specific period of time. It includes bed load as well as suspended load, and usually is expressed in terms of mass, or volume per unit of time.

Settling

The downward movement of suspended-sediment particles.

Shape Function



See Basis function

Shear Stress (Bed)

Frictional force per unit of bed area exerted on the bed by the flowing water. An important factor in the movement of bed material.

Silt



See Table B-1

Siltation

An unacceptable term. Use sediment deposition, sediment discharge, or sediment yield as appropriate.

Sink-Source

Source-Sink

SMS

SMS officially replaced *FastTABS* in 1996. A computer program that provides a graphical, point and click means for performing pre- and post-processing for surface water numerical models.

Developed at the Waterways Experiment Station and Brigham Young University. Corps of Engineers employees may contact the Waterways Experiment Station for more information via e-mail at SMS@usace.army.mil, or call (601) 634-3339.

Source code

The US Army Corps of Engineers, Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, Mississippi, provides TABS-MD Numerical Model maintenance and support for Army Corps installations. To find out about availability and support for the TABS modeling system, contact the Coastal and Hydraulics Laboratory via e-mail at SMS@usace.army.mil, or call (601) 634-3339.

Special elements

Junction element, transition element, or control structure element.

Specific gravity

Ratio of the mass of any volume of a substance to the mass of an equal volume of water at 4 degrees C.

Specific weight of sediment deposits

The dry weight of sediment particles within a unit volume of the deposit expressed as pounds per cubic foot.

Specific weight of sediment particles

The dry weight of sedimentary material per cubic foot of volume assuming no voids.

Spin-up

The process by which a model moves from an unrealistic set of initial conditions to more realistic results that represent a solution that is not strongly influenced by the initial conditions.

To estimate spin-up, calculate the time for a wave to travel the length of the mesh and return.

The speed of the gravity wave is calculated as

$$S = \sqrt{gh}$$

where

S = wave speed

g = gravity

h = depth

Steady state

A simulation in which the boundary conditions are static. The variables being investigated do not change with time. SED2D considers the steady state simulation time as hour zero.

STUDH

Predecessor to the SED2D numerical model.

Suspended load

That part of the sediment load which is suspended sediment.



See Sediment load

Suspended sediment

Sediment that is carried in suspension by the turbulent components of the fluid or by Brownian movement.

Suspended-sediment concentration



See concentration of sediment

System International

(SI) Formally named in 1960 by an international general conference on weights and measures. This system provides exact definitions of the metric system units for the fields of science and industry.

TABS-MD

The TABS-MD Modeling System is comprised of four main programs: GFGEN, RMA2, RMA4, and SED2D. Maintained by US Army ERDC-WES-CHL

D-R-A-F-T

Tide

The periodic variation in the surface level of the oceans and of bays, gulfs, inlets, and estuaries, caused by gravitational attraction and relative motions of the moon and sun.

The types of tides are:

- Diurnal tide
- Mixed tide
- Neap tide
- Semidiurnal tide
- Spring tide

Total-sediment load (total load)

All of the sediment in transport; that part moving as suspended load plus that moving as bed load.

EXPLANATION OF TOTAL LOAD

MODE OF	AVAILABILITY IN	METHOD OF
<u>TRANSPORT</u>	<u>STREAMBED</u>	<u>MEASUREMENT</u>
SUSPENDED	WASH LOAD	MEASURED LOAD
+	+	+
<u>BED LOAD</u>	<u>BED MATERIAL LOAD</u>	<u>UNMEASURED LOAD</u>
TOTAL LOAD	TOTAL LOAD	TOTAL LOAD

Transition element

A special 'T' shaped 5 node element which makes the transition between a one dimensional element and a two dimensional element.

Transient Flow

Changes with time.

Transportation (sediment)

The complex processes of moving sediment particles from place to place. The principal transporting agents are flowing water and wind.

Turbidity

Only a general definition is possible because of the wide variety of methods in use. This term has been used as an expression of the optical properties of a sample which causes light rays to be scattered and absorbed rather than transmitted through the sample.

Turbulence

In a turbulent motion, the true velocity and pressure vary in a disorderly manner. A turbulent motion is always unsteady, since at a given point the velocity changes continuously in a very irregular way.

Turbulent Diffusion

Two delta-X

A numerical instability which presents itself as a high value followed by a low value followed by a high value at the corners of the elements. When contoured, a two delta-X oscillation looks like a case of mesh measles.

Two dimensional element

A triangle (3 corners and 3 mid-side nodes) or quadrilateral (4 corners and 4 mid-side nodes) shape which defines the geometry in two space coordinates and averages over the third space coordinate. In a two dimensional *Horizontal* model, the averaging occurs over depth. In a two dimensional *Vertical* model, the averaging occurs over width. Several two dimensional horizontal elements aligned side by side may accurately define the bottom elevation of a navigation channel.

Verification

The process by which we gain confidence in the ability of our model to predict behavior of the prototype. Field data, like the model results, are only an approximation of reality and must be treated with skepticism. In verifying SED2D, the primary adjustments to be made are **???** to the geometry, boundary conditions, roughness, and eddy viscosity. These adjustments are made interactively until the model agrees satisfactorily with field (prototype) observations.

Von Neuman Boundary Condition Specification

Water column

An elemental projection in the z direction. The water profile from the surface to the bottom of the water body.

D-R-A-F-T

Waterways Experiment Station

The US Engineering Research and Development Center (ERDC), at the Waterways Experiment Station (WES), located in Vicksburg, Mississippi, is the principal research, testing, and development facility of the ERDC. Its mission is to conceive, plan, study, and execute engineering investigations and research and development studies in support of civil and military missions of the Chief of Engineers and other federal agencies.

ERDC at WES is composed of the following laboratories:

Coastal and Hydraulics Laboratory

NOTE: Hydraulics Laboratory and Coastal Engineering Research Center Merged, Aug 1996.

Geotechnical-Structures Laboratory (Official new Lab title not yet determined)

NOTE: Geotechnical Laboratory and Structures Laboratory Merged, Feb 2000.

Environmental Laboratory

Information Technology Laboratory

Wave Model Input

Weir

An obstruction placed in a stream, diverting the water through a prepared aperture for measuring the rate of flow.

Word size

A Computer term. A word is made up of a group of bytes. A system's word size is defined by the number of bytes necessary to make a word on that particular type of computer system. For example, a typical PC uses a two byte word (16 bits), where the Unix platforms ??? use an eight byte word (64 bits).

Index

AC1 variable, 88
AC1() variable, 90
AC2 variable, 88
AC2() variable, 90
AC3 variable, 88

AC3() variable, 90
AC4 variable, 88
AC4() variable, 90
ACGR variable, 115
AGE variable, 84

- ALFA1 variable, 86
- ALOCF variable, 86
- Automatic mode, 25
 - example, 26
- Batch mode, 24
- BCFACT variable, 78
- Bed flux
 - BF card, 80
- Bed Roughness
 - HN card, 105
 - RD card, 116
- Bed Shear Stress, 6, 8, 12, 68–69, 83, 106, 138, 144, 148
 - Bijker-type*, 9
 - Jonsson-type*, 9
 - Manning's*, 9
 - Smooth-wall log*, 8
 - Ultra-shallow wind waves, 10
- Bed Source/Sink, 11
 - Clay, 12, 13, 14
 - Sand, 11
- Bed strata, 14
- Bed Structure File. *See* Files, Bed Structure
- Bijker-type equation*, 9
- Boundary conditions
 - BC card, 78
 - BL card, 79
- CCC variable, 83
- Clay Bed, 14
- Clay characteristics
 - CC card, 81, 82
 - CI card, 83
- Clay distribution
 - CL card, 84
- Clay Transport Option 1, 12
- Clay Transport Option 2, 13
- CLDE variable, 118
- CLER variable, 118
- Comments
 - CO card, 85
- Computer
 - Specifying type, 33
- CONC() variable, 110
- Concentration Delbed File. *See* Files, Concentration Delbed
- Concentrations in structures
 - CS card, 86
- Conservation. *See* Mass conservation
- Conservation of mass, 27
- Continuity Check Line
 - GCL card, 97
- Convection-Diffusion Equation, 8
- CORD() variable, 100
- Crank Nicholson weighting, 14
 - THETA, 131
 - TT card, 56
- Crank-Nicholson weighting
 - TT card, 131
- CRFLOC variable, 134
- CRHIND variable, 134
- DEPLIMIT variable, 93
- DIF() variable, 92, 114
- Diffusion (Effective)
 - DF card, 92
- DK1() variable, 87
- DK2() variable, 87
- DK3() variable, 87
- DT variable, 132
- DT_REPEAT variable, 125
- EFDR() variable, 120
- EFDT() variable, 121
- Effective Diffusion
 - DD card, 87
 - PE card, 114
- Element connections
 - GE card, 99
- Elements
 - Material type
 - GT card, 102
- ELEV() variable, 100
- End a time step
 - EN(d) card, 94
- ENDCOM variable, 94
- EROCON variable, 82
- ERODCP variable, 82
- Error flags
 - EF card, 93
- ESPLPT() variable, 130
- Execution
 - Automatic mode, 25
 - Batch mode, 24
 - Input file summary, 29
 - Iterative mode, 23
- FALLFACT variable, 80
- Files
 - Bed Strata
 - Format of, 145
 - Bed Structure, 33
 - Concentration Delbed, 33
 - Format of ascii output
 - new GFGEN geometry, 146
 - Format of binary input
 - wave, 147
 - Format of binary output
 - Bed Strata, 145
 - File Header, 140
 - GFGEN geometry, 142
 - Hotstart, 144
 - Solution (u,v,h), 143
 - Full results listing, 32
 - Geometry, 31, 34
 - Format of, 142, 146

- new, 32
- Hotstart
 - Format of, 144
- Hydrodynamic, 31, 35
- SED2D Run Control, 31
- Solution
 - Format of, 143
- Wave, 31
 - Format of, 147
- FLD variable, 85, 123
- Fluid density
 - FD card, 95
- Fluid temperature
 - FT card, 96
- FRCTIC variable, 110
- GAMLK variable, 86
- Geometry. *See* Files, Geometry new. *See* Files,
 - Geometry
 - GC card (retired), 98
 - GCL card, 97
 - GE card, 99
 - GNN card, 100
 - GS card, 101
 - GT card, 102
 - GW card, 103
 - Geometry File. *See* Files, Geometry
 - Geometry File new. *See* Files, Geometry:new
 - Geometry, Obtaining, 34
- GFGEN, 31
- Governing Equations, 7
- GSF variable, 118
- Hotstart control
 - \$H card, 74
- HSFACT variable, 109
- HSLIM variable, 109
- HSVAR variable, 109
- Hydraulic bed shear stress
 - HS card, 106
- Hydraulic wave field
 - HW card, 109
- Hydrodynamic File. *See* Files, Hydrodynamic
- Hydrodynamic Velocity-X
 - HU card, 107
- Hydrodynamic Velocity-Y
 - HV card, 108
- Hydrodynamic Water Depth
 - HD card, 104
- IBCFAC variable, 78
- ICBOT variable, 80
- IDA variable, 73
- IDCL variable, 83
- IECHO variable, 127
- IGCL_IN variable, 111
- IGCL_OT variable, 111
- IGCP variable, 110
- IHR variable, 73
- IHYDOPT variable, 93
- IMAT variable, 99, 102
- IMN variable, 73
- IMO variable, 73
- INFETCH variable, 75
- ING variable, 75
- INHOT variable, 75
- INHOTB variable, 75
- Initial concentrations
 - IC card, 110
- Input control
 - \$L1 card, 75
- Input files
 - ASCII
 - Run control, 31
 - BINARY
 - Geometry, 31, 34
 - Hydrodynamic, 31, 35
 - Wave solution, 31
 - Geometry file, 31, 34
 - Hydrodynamic file, 31
 - Hydrodynamic file, 35
 - MANUAL
 - Geometry, 34
 - Velocity, 35
 - Run control file, 31
 - Wave file, 31
- Input files, 29
- INPW2 variable, 75
- INRMA2 variable, 75
- Interactive mode, 23
- INWIND variable, 75
- IOUT variable, 76
- IRUFF variable, 116
- ISC variable, 73
- ISTART variable, 79, 116
- ITRC variable, 127
- ITRINC variable, 127
- ITYPE variable, 84
- IVRSID variable, 77
- IVSC variable, 80
- IWAV variable, 109
- IWBIN variable, 126
- IYR variable, 73, 135
- Jonsson-type equation*, 9
- KBSHOT variable, 74
- KCHOT variable, 74
- KDBHOT variable, 74
- KGEOM variable, 32, 76
- KOHOTB variable, 33, 76
- KPU variable, 33, 76
- KSPE variable, 76
- KSPN variable, 76
- LAYER variable, 84
- LINE variable, 97
- LINE() variable, 98

- Machine identifier
 - \$M card, 77
- Manning's shear stress eqn*, 9
- Marsh porosity, 11
- Marsh Porosity
 - DA card, 88
 - DM card, 90
- Mass Check
 - MC card, 111
- Mass conservation, 111
- MBNPvariable, 135
- MBUF variable, 135
- MC_FLAG variable, 111
- MCCN variable, 135
- Mesh Geometry. *See* Files:Geometry
- MNCL variable, 82
- MNE variable, 135
- MNEQ variable, 135
- MNFE variable, 135
- MNL variable, 135
- MNN variable, 135
- MNSPRT variable, 135
- Modes of Operation, *see Execution*, 23
- MQAL variable, 135
- MSC variable, 106
- MSETV variable, 134
- MTC variable, 118
- MTCL variable, 82
- NDEL variable, 112
- NDND variable, 112
- NDOUT variable, 76
- NESPRT() variable, 128
- NJN variable, 86
- NJT variable, 86
- NNL variable, 98
- NNSPRT() variable, 129
- Nodal (x,y,z)
 - GNN card, 100
- Nodal widths
 - GW card, 103
- non-dimensional analysis
 - ND card, 112
- NOP variable, 99
- NQAL_CHECK variable, 111
- NSACI variable, 118
- NSRC variable, 113
- NTTS variable, 132
- Origin of SED2D, 5
- Output control
 - \$L2 card, 76
- Output files
 - ASCII
 - Full results listing, 32
 - Geometry File new, 32
 - BINARY
 - Bed Structure File, 33
 - Concentration Delbed File, 33
- Output files, 31
- Peclet
 - PE card, 114
- PERC variable, 83
- Physical variables
 - PV card, 115
- Point Source
 - PC card (retired), 113
- PWCORR variable, 109
- QSE variable, 83
- QSI variable, 83
- RDCOEF variable, 116
- RDD0 variable, 116
- RDMAX variable, 116
- RDMIN variable, 116
- RDR0 variable, 116
- RDRM variable, 116
- Results Listing
 - Full File. *See* Files, Full results listing
- RHO() variable, 95
- RHOE variable, 83
- RHOI variable, 83
- RMA2, 31
- RMA2 File. *See* Files,Hydrodynamic
- Run
 - Auto mode, 25
 - Batch mode, 24
 - Iterative mode, 23
- Run Control File. *See* Files, SED2D Run Control
- SACLL variable, 118
- SACUL variable, 118
- Sand
 - SA card, 118
- Sand Bed, 14
- Sand bed thickness
 - SB card, 119
- Sand Grain Size
 - SR card, 120
 - ST card, 121
- SED2D
 - Applications for, 5
 - Capabilities of, 6
 - Conceptual Design of, 7
 - Derivation, 7
 - File I/O, 28
 - Input file summary, 29
 - Limitations of, 6
 - Modeling process, 21
 - Modes of Operation, 22
 - Output file summary, 31
 - Required knowledge base, 21
- SED2D File. *See* Files,Full results listing
- Settling velocity
 - WC card, 133
 - WF card, 134

SGSA variable, 118
Smooth-wall log equation, 8
 SPEC() variable, 78
 SRCEL variable, 79
 SS1 variable, 103
 SS2 variable, 103
 SSS variable, 103
 Start Date
 \$D card, 73
 Stop the simulation
 STO(p) card, 123
 STUDH, 2
 Super file mode, *see Automatic mode*, 25
 System International
 SI card, 122
 TAUCD variable, 82
 TAUP variable, 83
 TCORR variable, 125
 TEND variable, 125
 TETA variable, 131
 TH() variable, 99
 THICKL variable, 84
 THKTYPE variable, 83
 Time control for the simulation
 TZ card, 132
 Timing of output solution write
 TO card, 126
 Timing of the Hydrodynamics
 TH card, 125
 Tips and Suggestions, 26
 Diagnostic, 27
 Sediment parameters, 27
 Sources of error, 28
 Time step, 27
 Wetting and drying, 27
 TITLE variable, 72, 124
 Titles, 33, 72, 124
 End of, 33
 T1-T2 cards, 72, 124
 T3 card, 72, 124
 TMAX variable, 132
 Trace print
 TR card, 127
 Trace print by element
 TRE card, 128
 Trace print by IMAT
 TRT card, 130
 Trace print by node
 TRN card, 129
 TTHICK() variable, 119
 University of California, Davis, 5
 VEL() variable, 104, 107, 108
 Velocity. *See* Hydrodynamic, Velocity. *See*
 Hydrodynamic, Velocity
 Velocity Field, Obtaining, 35
 VOLLK variable, 86
 VPEC() variable, 114
 VS() variable, 133
 Water Depth. *See* Hydrodynamic, Water Depth
 Wave File. *See* Files, Wave
Waves, 9
 Wetting and drying, 11
 WIDS variable, 103
 WIDTH variable, 103
 Wind, 10
 WNDIR variable, 81
 WNDSPD variable, 81
 WPFACT variable, 109
 WPLIM variable, 109
 WPVAR variable, 109
 WSCRIT variable, 103
 WTC variable, 96
 XICMAX variable, 110
 XNVALU() variable, 105
 XPEC() variable, 114
 XSCALE variable, 101, 104, 107, 108
 YSCALE variable, 101

Notes

