APPENDIX C

RMA4 Documentation

Draft Copy

United States Army Engineer
Waterways Experiment Station

RMA4, VERSION 4.27

Tl-T3 **Job Title** **(required)**

Field	Variable	Value	Description
0, c 1	IC1	T	Card group identifier
0, c 2	IC2	1, 2, 3	Card group identifier
l-10	TITLE	Any	Any alpha-numeric data, up to 77 characters

Any number of Tl and T2 cards may be used and the sequence is not significant. Only one T3 card may be used and it must be the last title card in the set. The program reads the "3" as meaning END of the T cards.

$F **Formatted or Fixed Field Input** **(optional)**

Field	Variable	Value	Description
0, c l-2	ICl	$F	Card group identifier Specifies fixed field (formatted) run control input. Required for formatted input data.

$L **Logical Unit Control** **(required)**

Field	Variable	Value	Description
0, C 1-2	IC1	$L	Card group identifier
1	IGEON	+	File number for geometric input. Typically the binary output from GFGEN (RMA1). (default ℓu = 10)
2	IVELN	+	File number for input flow and depths. Binary output from an RMA2 run. (default eu = 20)
3	IHOTN	+	File for input initial quality conditions. (default ℓu = 30)
4	IALTBC	+	File number for alternate input file for time varying boundary conditions, see text. (default ℓu = 4)
5	IFINO	+	File number for binary output of final results (default ℓu = 31)
6	IHOTO	+	File number for binary output of restart quality conditions. (default ℓu = 32)
7	IOT	+	File number for full print output of results (default ℓu = 33)
8	ISPRT	+	File number 'for special summary output of results. (default ℓu = 34)

NOTE: The file numbers are automatically assigned the default if the value is positive. Negative entries allow the user to assign their own file numbering. A zero indicates the file is never used. (The HEC-style card input is read on logical unit 3)

$M **Machine Identifier** **(required)**

Field	Variable	Value	Description
0, c l-2	IC1	$M	Card group identifier
1	IVRSID	+	Controller for record length and word size for front solver buffering = 1 Micro with-Definicon 032 Board Direct access record length. Unlimited and defined in terms of bytes. = 2 Prime Mini-computer with direct access record length. Unlimited and defined in terms of short words (ie, 2 bytes). = 3 Dec VAX with direct access record length. Limited to 32K bytes and defined in terms of long words (4 bytes). = 4 Apple MAC II using ABSOFT FORTRAN, Definicon 020 Board, or Dec VAX to avoid short record length. Direct access defined files that are opened as required. CAUTION: many files are left on disk. = 5 Cray or Cyber 205. Direct access for systems using 64 bit or 8 byte words and whose record lengths are defined in bytes. = 6 Same as option 4 above, except the names of the files that are open will not contain a '.'

CO **COMMENT CARD** **(optional)**

Field	Variable	Value	Description
0, c 1-2	IC1	co	Card group Identifier
l-10	FLD	A	Any alpha-numeric data

Comments may be supplied on this card any where within the run control input.

CS **RMA4 Flow Control Structures** **(optional)**

Field	Variable	Value	Description
0, c l-2	IC1	cs	Card group identifier
1	NJN	+	Flow controller identifier >= 904. Applies these parameters to IMAT = NJN
2	NJT	+	RMA4 flow controller type = 1 match concentrations = 2 lock operation
If NJT = 2, fields 3-6 must be specified			
3	ALFAl	+	Angle of control structure in radians counterclockwise from the positive X axis.
4	VOLLK	+	Volume of the lock (ft3) ??
5	GAMLK	+	Mixing exchange factor for a locking event (0.0 <= GAMLK <= 1.0)
6	ALOCF	+	Locking frequency per hour (decimal ???)

DF Card **Full Diffusion Coefficient (Combination of DX & DY)** **(required)**

Field	Variable	Value	Description
0, c l-2	IC1	DF	Card group identifier
1	J		Element material type (IMAT)
2	ORT(J,1)		Invokes automatic scaling of x and y diffusion of the element type J (m2/sec). Scaling is a function of both velocity and grid size. Example: -20 will multiply the x diffusion auto-scale by 20.
		+	X-direction diffusion coefficient of element type J (m2/sec)
	ORT(J,2)	+	Y-direction diffusion coefficient of element type J (m2/sec) Note: If auto-scaling is invoked the y diffusion will be multiplied by Ort(J,2)

DM **Wetting and Drying by Marsh Porosity (optional)**

Field	Variable	Value	Description
0, c 1-2	IC1	DM	Card group identifier
0, c 3	IC3	b/	Option 1: IDNOPT
		N	Option 2: Wet and dry by node
		E	Option 3: Wet and dry by element
		T	Option 4: Wet and dry by IMAT
1	J	-, 0, +	For option 1, J = IDNOPT J = O Marsh option inoperative. A11 DM cards are ignored. J = -1 Use given default values for all nodes J = -2 User specifies values for all nodes J = + User specifies values for all nodes >= J For option 2, code the node # For option 3, code element # For option 4 code the IMAT #
2	WDMCl	+	Depth shift (default = 3.0 FT)
3	WDMC2	+	Depth range over which section reduces (default = 2.0 FT)
4	WDMC3	+	Minimum active fraction over lower section (Kappa default = 0.02)
5	WDMC4	+	Absolute bottom elevation of the marsh channel.

DMb/ (DM blank) card is required, then optionally followed by DMT. DME, or DMN cards. If a node receives multiple assignments, the last assignment is processed.

DX Card Diffusion Coefficient in X-Plane (optional)

Field	Variable	Value	Description
0, c l-2	IC1	DX	Card group identifier
1	J		Element material type (IMAT)
2	ORT(J,l)		X-direction diffusion coefficient of element type J (m2/sec)

DY Card Diffusion Coefficient in Y-Plane (optional)

Field	Variable	Value	Description
0, c 1-2	IC1	DY	Card group identifier
1	J		Element material type (IMAT)
2	ORT(J,2)		Y-direction diffusion coefficient of element type J (m2/sec)

FT Card Water Temperature (optional)

Field	Variable	Value	Description
0, c 1-2	IC1	FT	Card group identifier
1	WTEMP		Average Initial water temperature in degrees Celsius

NOTE: If no FT card is present, 15 degrees Celsius is used.

FQ **Card Fluid Qualities Concentration (required)**

Field	Variable	Value	Description
0, c l-1	IC1	FQ	Card group identifier
1	NQAL	+	Number of quality constituents
2	IDOS	0, +	= 1 dissolved oxygen and BOD are constituents 1 and 2 , respectively. = 0 otherwise BOD => biological oxygen demand

FQC **Card** **Fluid Qualities, Decay Control**

Field	Variable	Value	Description
0, c l-2	IC1	FQ	Card group identifier
0, c 3	IC3	C	Card group identifier
1	XKCOEF	+	Decay coefficient for each constituent. (day-1) Provide a decay coefficient for each constituent as specified by NQAL on FQ-card. 0 No decay ∞ decay rapidly

NOTE: $\frac{C(t)}{C(+=0)} = e^{-XKCOEF(t)}$

where t = time in days
C(+) = concentration
C(+=0) = concentration at time ∅

GC Card Continuity Check Line Calculation (required infusing BCL card)

Field	Variable	Value	Description
0, c 1-2	IC1	GC	Card group identifier
1			Continuity line #
2	LINE(K,J)		Corner node number 1, . . number **8.** If a continuation line is needed (> 8 numbers in formatted input), start in field 1 of next GC card (**maximum** of **150** nodes per check line). End each list with a (-1)

Mass flux continuity can be calculated at up to 150 lines across part or all of the grid. Prescribe the boundary line first since that line is used in calculating the percents displayed on all subsequent lines. Code corner nodes only. Code all lines in the same direction; otherwise, sign changes will occur in the printout. In general, code right to left when facing downstream. The first list should be the inflow boundary because it will be assumed to be 100%.

GE Card GRID, Element Connection Table (optional)

The element connection table will usually be provided by the GFGEN preprocessor as defined by $L-card. If so, this card is not required. If small revisions are indicated code the nodal point-element connection table.

Field	Variable	Value	Description
0, c 1-2	IC1	GE	Card group identifier
1	J		Element number
2-9	NOP(J,I)		Up to 8 node numbers for element J, listed counterclockwise around the element STARTING FROM ANY CORNER.
10	IMAT(J)		Element type (optional, may be specified on GT card)
11	ANG(J)		Element orientation for eddy viscosity tensor (radians measured counterclockwise from positive X-axis)

GN **Card** **Grid, Nodal Point Coordinates** **(optional)**

Field	Variable	Value	Description
0, c l-2	IC1	GN	Card group identifier
0, c 3	IC3	b	Option 1: Code X and Y coordinates only
0, c 3	IC3	N	Option 2: Code X and Y coordinates and bed bottom elevations (as in GFGEN)
1	J		Node number
2	CORD(J,l)		X-coordinate input at node J
3	CORD(J,2)		Y-coordinate input at node J
4	WD(J)		bottom elevation at node J
For 1D problem continue			
	WIDTH(J)		Channel width at zero depth for node J
	SSl(J)		Left side slope
	SS2 (J)		Right side slope
	WIDS(J)		Storage width associated with zero depth

GS **Grid, General Geometry Parameters (optional)**

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

NOTE: To convert feet to meters; the scale factor should be .3048

GT **Grid, Element Types (optional)**

Field	Variable	Value	Description
0, c 1-2	IC1	GT	Card group identifier
1	J		Element number
2	IMAT(J)		Element type
3-10			Need as many (J, IMAT (J) sets) as GE cards present.

GV Card **Grid, Eddy Viscosity Tensor** **(optional)**

Field	Variable	Value	Description
0, c l-2	IC1	GV	Card group identifier
1	J	+	Element number
2	ANG	-, 0, +	Direction of eddy viscosity tensor (Radians, counterclockwise from x-axis)

NOTE: Need as many (J, ANG(J) sets) as GE cards present. Continue to fill the card with element and direction pairs, then use another GV card. Default angle is zero.

GW Card **l-Dimensional Node Width Assignment** **(optional)**

Field	Variable	Value	Description
0, c l-2	IC1	GW	Card group Identifier
0, c 3	IC3	b	Option 1: Universal assignment for all nodes
		N	Option 2: individual node assignment
	NODE		Corner 1D node number
	WIDTH		Channel width at zero depth
	SS1		Left side slope
	SS2		Right side slope
	WIDS		Storage width associated with zero depth

HD Card **Water Depth** **(optional)**

Field	Variable	Value	Description
0, c l-2	IC1	HD	Card group identifier
1	LOC1	+	Starting node number at which this global assignment will be made
2	VEL(3,LOC1)		Depth of water at node LOCl (meters)

HU Card **X-Velocity** **(optional)**

Field	Variable	Value	Description
0, c 1-2	IC1	HU	Card group Identifier
1	LOC1		Starting node number at which this global assignment will be made
2	VEL(l,LOC1)		X- velocity at node LOCl (meters/sec)

HV Card **Y-Velocity** **(optional)**

Field	Variable	Value	Description
0, c l-2	IC1	Hv	Card group identifier
1	LOC1		Node number
2	VEL(2,LOC1)		Y- velocity at node LOCl (meters/sec)

HS Card **Hydrodynamic Scale Factors** **(optional)**

Field	Variable	Value	Description
0, c -12	IC1	IC	Card group identifier
1	USCALE		X velocity scale factor. May be used to convert input to M/SEC. Default = 1.0
2	VSCALE		Y velocity scale factor. May be used to convert input to M/SEC. Default = 1.0
	WSCALE		Depth scale factor. May be used to convert input to M/SEC. Default = 1.0

*NOTE: Set scale to .3048 to convert English to metric.

IC Card Initial Quality Concentration (required for COLDSTART)

Field	Variable	Value	Description
0, c l-2	IC1	IC	Card group identifier
0, c 3	IC3	b/	Option 1: universal assignment
0, c 3	IC3	T	Option 2: for material type
0, c 3	IC3	E	Option 3: for element number
0, c 3	IC3	N	Option 4: for node number
1	ISTART	+	Option 1: Starting node number for universal assignment Option 2: the material type (IMAT) Option 3: the element number Option 4: the node number
2	TOLD	+	Initial quality concentration, ( ) Enter from 1 to the maximum number of quality constituents (NQAL)

RE Card **Re-Solve Solution Technique**

Field	Variable	Value	Description
0, c 1-2	IC1	RE	Card group identifier
1	ISAV		Re-solve save switch = -1 do not save global matrix for resolution = 0 act on value of IRESL = 1 save global matrix for resolution
	IRESL		Re-solve restore switch = 0 act on value of ISAV = N use resolve file saved during time step N
	DELT		Time step for this solution step (hours). Value used only when ISAV is active. Time step from resolve file is used if IRESL is active.

NOTE: skip this card if delt = 0.0, ie, steady state

TC Card **Time Control** **(required)**

Field	Variable	Value	Description
0, c 1-2	IC1	TC	Card group identifier
	TSTART		Starting time for simulation(hours)
2	DELT		Time step (hours)
3	NTIME		Total number of time steps
4	TMAX		Maximum simulation time (hours)
5	SSF		Steady state flag -1 -> ALPHA is 1.0 and time terms are on 0 --> time terms are omitted otherwise ALPHA = 1.5 (2nd order in time)

TH Card **Timing for Hydrodynamics** **(required)**

Field	Variable	Value	Description
0, c l-2	IC1	TH	Card group identifier
1	TCORR		Hours to be subtracted from input velocity file generated by RMA2.
2	TEND		Time of last step on input velocity file

NOTE: Upon reaching 'TEND', the RMA2 velocity file will rewind to be used again.

TO Card Timing for Binary Output File Write (optional*)

Field	Variable	Value	Description
0, c 1-2	IC1	TO	Card group
1	TMOD	-,0	Save all computed time steps (ie TMOD = DELT, see TC-Card)
			Decimal hour frequency to save final results. Example: 0.25 will save at l/4 hours
	BEGINT		Save all times satisfying TMOD
		0,+	Decimal hour to begin saving final results
	ENDT		Save all times satisfying TMOD
		+	Decimal hour to stop saving final results

*NOTE: All computed time steps are saved if this card is missing.

Example: TO 0 100 200 will save all computed time steps between 100 and 200, inclusive.

TP Card **Trace by Constituents** for **All Nodes** **(required)**

Field	Variable	Value	Description
0, c l-2	IC1	TP	Card group identifier
1	IPRT	0-2	Print option: = 0 suppress node/element print = 1 print all input data & expanded form of results = 2 suppress node and element data and print short form of the results
	NTSEG	0-+	Print interval = 0 no print = + use modulo function to determine print interval
	IECHO	0-1	Input Card Echo Print = 0 Suppress = 1 Print
	ITRACE	0-1	= 0 no subroutine trace = 1 trace program logic as each subroutine is called
	OHGOSH	0-4	= 0 no detail internal print trace = 1-4 diagnostic debug print trace

TQ Card **Trace by Quality** **(optional)**

Field	Variable	Value	Description
0, c 1-2	IC1	TQ	Card group identifier
0, c 3	IC3	1	Constituent 1
0, c 3	IC3	2	Constituent 2
0, c 3	IC3	3	Constituent 3
0, c 3	IC3	4	Constituent 4
0, c 3	IC3	5	Constituent 5
0, c 3	IC3	6	Constituent 6
1	JSPRT(J,l)		Node number(s)
			end the list with a (-1)

TR Card **Trace the Following Nodes for All Active Constituents** **(optiona1)**

Field	Variable	Value	Description
0, c l-2	IC1	TR	Card group identifier
0, c 3	IC3	N	trace for all active constituents at node JSPRT
1	JSPRT(J,l)		Node number(s)
			End the list with a -1

BCC Card **Boundary Condition Type** **(optional)**

The parameters on this card are necessary if and only if the user wishes to revise the boundary condition update parameters between dynamic time steps. If this card is present for steady state, the boundary condition parameters specified on previous cards (TZ, Gl, and BW) will be overruled.

Field	Variable	Value	Description
0, c 1-2	IC1	BC	Card group identifier
0, c 3	IC3	C	Card group identifier
1	DELTN		The delta time step length in decimal hours (DELT is revised only if the value is > 0)
2	IQF		The number of time steps to be skipped off the boundary condition input file.

BCN Card Nodal Boundary Conditions (optional)

Field	Variable	Value	Description
0, c 1-2	IC1	BC	Card group identifier
0, c 3	IC3	N	Boundary specification (BC) by node
		L	Boundary specification by continuity check line.
1	J	+	Node/line number at which a global boundary condition is to be specified. If negative the model holds outflow to constant value specified in TBC array.
2,NQAL+l	TBC(JBX,l)		BC for quality constituent 1 at node/line J
	NQAL		
NQAL+2	IBCFCT(JBX)	0	BC is exactly equal to the constituent's concentration when flow is into the model. Potential shock (default) if direction of flow reverses with time.
			A factor will be applied to the BC concentration to allow a gradual change in the inflow BC after a flow reversal
NQAL+3	BCFCT(JBX)	+	A factor between 0 and 1 is applied to BC if ISPCLBC(J)=l Factor close to one is very gradual

BL **Boundary Loading (Mass)** **(optional)**

Field	Variable	Value	Description
0, c 1-2	IC1	BL	Card group identifier
0, c 3	IC3	b/	Option 1: global
0, c 3		T	Option 2: by material type
0, c 3		E	Option 3: by element number
0, c 3		N	Option 4: by node number
1	ISTART		node, element or IMAT number, Note for Option 1: Negative ISTART loads all nodes ≥ ABS(ISTART) Positive ISTART loads all elements ≥ ISTART
2	PBCX(I,1)		Mass loading (units see below) for constituent 1 at ISTART
3	PBCX(I,2)		Mass loading for constituent 2 at ISTART
4	PBCX(I,3)		Mass loading for constituent 3 at ISTART
5	PBCX(I,4)		Mass loading for constituents 4 at ISTART
6	PBCX(I,5)		Mass loading for constituents 5 at ISTART
7	PBCX(I,6)		Mass loading for constituents 6 at ISTART

UNITS: Total mass/sec in the appropriate units of the simulation
Example, use ppt for salinity

END Card Used to **Separate Time Steps** **(required)**

Field	Variable	Value	Description
0, c l-2	IC1	EN	Card group identifier
0, c 3	IC3	D	Card group identifier
l-l.0	FLD	A	may be used for comments

This card signals the end of boundary condition input for a given time step.

STOP Card **Stop Simulation** **(required)**

Field	Variable	Value	Description
0, c l-2	IC1	ST	Card group identifier
0, c 3	IC3	0	Card group identifier
2-10	FLD	A	may be used for comments

This card will override any previous control concerning the length of the RMA4 simulation.

INDEX