Appendixes

Appendix I. SWIFT2D Equations

The governing partial differential equations of two-dimensional flow are presented in Schaffranek (2004). These equations are transformed to finite-difference form and solved numerically using the staggered grid and staggered timestep discussed in the "Formulation and Terminology" section. In this appendix, instead of describing "bathymetry points," as in the "Formulation and Terminology" section, the elevation of the water surface (stage) and the bottom of the water column (land elevation) are used as parameters. The land elevation is equal to the reverse sign of the bathymetry point value used in the "Formulation and Terminology" section and in the model input data set in appendix II. For example, 1 meter below sea level has a bathymetry point value of 1 meter, but a land-elevation value of -1 meter.

Finite-Difference Forms

The finite-difference forms of the equations of flow are incorporated in the staggered timestep scheme by solving the continuity equation and the momentum equation in one direction each half timestep. For the first half timestep, time *n+1/2*, the continuity equation takes the finite-difference form:

$$\frac{2}{\Delta t}\left(\zeta_{i,j}^{n+\frac{1}{2}} - \zeta_{i,j}^{n}\right) + \frac{\left(\zeta^{*}_{i+1,j} + \zeta^{*}_{i,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)u^{n+\frac{1}{2}}_{i+\frac{1}{2},j} - \left(\zeta^{*}_{i,j} + \zeta^{*}_{i-1,j} - z_{i-\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)u^{n+\frac{1}{2}}_{i-\frac{1}{2},j}}{2\Delta x} +$$

$$\frac{\left(\zeta^{n}_{i,j+1} + \zeta^{n}_{i,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right)v^{n}_{i,j+\frac{1}{2}} - \left(\zeta^{n}_{i,j} + \zeta^{n}_{i,j-1} - z_{i+\frac{1}{2},j-\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)v^{n}_{i,j-\frac{1}{2}}}{2\Delta y} = 0\,, \tag{A1}$$

where:

- Δt is the timestep (see HALFDT in appendix II part 1, record 4),
- ζ is stage (see SEINV in appendix II, part 1, record 18).
- n is superscript indicating the timestep level,
- i,j are superscripts indicating grid location in the x- and y-directions,
- $*$ is superscript indicating that the timestep level depends on user-defined options discussed later,
- z is land elevation (see H in appendix II, part 2, record 27),
- u is velocity in the x-direction,
- Δx is the spatial discretization in the x-direction (see AL in appendix II, part 1, record 18),
- v is velocity in the y-direction, and
- Δy is the spatial discretization in the y-direction (see AL in appendix II, part 1, record 18).

The equation of conservation of momentum in the x-direction becomes:

$$\frac{u^{n+\frac{1}{2}}_{i+\frac{1}{2},j} - u^{n-\frac{1}{2}}_{i+\frac{1}{2},j}}{\Delta t} + A(x) - f\bar{v} + g\frac{(\zeta^{n}_{i+1,j} - \zeta^{n}_{i,j}) + \left(\zeta^{n+\frac{1}{2}}_{i+1,j} - \zeta^{n+\frac{1}{2}}_{i,j}\right)}{2\Delta x} + g\frac{\rho^{n}_{i+1,j} - \rho^{n}_{i,j}}{2\rho^{n}_{i,j}\Delta x}\,\frac{\left(\zeta^{n}_{i,j} + \zeta^{n}_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)}{2} +$$

$$R(x)\frac{u^{n+\frac{1}{2}}_{i+\frac{1}{2},j} + u^{n-\frac{1}{2}}_{i+\frac{1}{2},j}}{2} - \frac{2C_d\rho_a W^2\sin\theta}{\rho^{n}_{i,j}\left(\zeta^{n}_{i,j} + \zeta^{n}_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)} - k\nabla^2 u = 0\,, \tag{A2}$$

where:

$A(x)$ is the convective acceleration term,

f is the Coriolis coefficient (see ANGLAT in appendix II, part 1, record 18),

$\bar{v}$ is $\left(v^n_{i+1,j+\frac{1}{2}} + v^n_{i,j+\frac{1}{2}} + v^n_{i+1,j-\frac{1}{2}} + v^n_{i,j-\frac{1}{2}}\right)/4$,

g is gravitational acceleration (see AG in appendix II, part 1, record 18),

ρ is water density (see DWAT in appendix II, part 1, record 19),

$R(x)$ is the frictional resistance term,

C_d is the wind-friction coefficient (see WSTR in appendix II, part 1, record 19),

ρ_a is air density (see DAIR in appendix II, part 1, record 19),

W is wind speed (see ZWIND in appendix II, part 3, record 1),

θ is the angle between wind direction and the y-axis (see ZWINDA in appendix II, part 3, record 1),

k is the horizontal momentum exchange coefficient (see VIVOR in appendix II, part 1, record 18), and

$\nabla^2 u$ is $\left(u^{n-\frac{1}{2}}_{i+\frac{3}{2},j} - 2u^{n-\frac{1}{2}}_{i+\frac{1}{2},j} + u^{n-\frac{1}{2}}_{i-\frac{1}{2},j} + u^{n-\frac{1}{2}}_{i+\frac{1}{2},j+1} - 2u^{n-\frac{1}{2}}_{i+\frac{1}{2},j} + u^{n-\frac{1}{2}}_{i+\frac{1}{2},j-1}\right)/(\Delta x)^2$.

The frictional resistance term can take two forms; the most commonly used is:

$$R(x) = \frac{8g\sqrt{\left(u^*_{i+\frac{1}{2},j}\right)^2 + \bar{v}^2}}{\left(\zeta^n_{i,j} + \zeta^n_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)(C_{i+1,j} + C_{i,j})^2}, \qquad \text{(A3)}$$

where C is the Chezy frictional coefficient. The second form of the friction term utilizes a subgrid energy scale formulation and is not normally used in a two-dimensional simulation.

The convective acceleration term $A(x)$ in equation A2 has three possible user-defined forms. The first is:

$$A(x) = 0. \qquad \text{(A4)}$$

The second form of the convective acceleration term is:

$$A(x) = \frac{1}{3}\left[\frac{\left(u^*_{i+\frac{3}{2},j} + u^*_{i+\frac{1}{2},j}\right)^2 - \left(u^*_{i+\frac{1}{2},j} + u^*_{i-\frac{1}{2},j}\right)^2}{2\Delta x} + \frac{1}{2\Delta x}\left(u^*_{i+\frac{3}{2},j}\left(u^*_{i+\frac{3}{2},j} + \hat{\nabla} u^*_{i+\frac{3}{2},j}\right) - u^*_{i-\frac{1}{2},j}\left(u^*_{i-\frac{1}{2},j} + \hat{\nabla} u^*_{i-\frac{1}{2},j}\right)\right) + \right.$$

$$\left.\bar{v}\frac{\left(u^*_{i+\frac{1}{2},j+1} - u^*_{i+\frac{1}{2},j-1}\right)}{2\Delta y} + \frac{\left(v^n_{i,j+\frac{1}{2}} + v^n_{i+1,j+\frac{1}{2}}\right)\left(u^*_{i+\frac{1}{2},j+1} - u^*_{i+\frac{1}{2},j}\right) + \left(v^n_{i,j-\frac{1}{2}} + v^n_{i+1,j-\frac{1}{2}}\right)\left(u^*_{i+\frac{1}{2},j} - u^*_{i+\frac{1}{2},j-1}\right)}{2\Delta y}\right], \qquad \text{(A5)}$$

where:

$\hat{\nabla} u^*_{i+\frac{3}{2},j}$ is $\left(u^*_{i+\frac{3}{2},j+1} - u^*_{i+\frac{3}{2},j}\right) - \left(u^*_{i+\frac{3}{2},j} - u^*_{i+\frac{3}{2},j-1}\right) + u^*_{i+\frac{3}{2},j-1} - 2u^*_{i+\frac{3}{2},j+1} + u^*_{i+\frac{1}{2},j}$, and

$\hat{\nabla} u^*_{i-\frac{1}{2},j}$ is $\left(u^*_{i-\frac{1}{2},j+1} - u^*_{i-\frac{1}{2},j}\right) - \left(u^*_{i-\frac{1}{2},j} - u^*_{i-\frac{1}{2},j-1}\right) + u^*_{i-\frac{1}{2},j-1} - 2u^*_{i-\frac{1}{2},j+1} + u^*_{i+\frac{1}{2},j}$.

The third form of the convective acceleration term is:

$$A(x) = u^*_{i+\frac{1}{2},j}\frac{\left(u^*_{i+\frac{3}{2},j} - u^*_{i-\frac{1}{2},j}\right)}{2\Delta x} + \bar{v}\frac{\left(u^*_{i+\frac{1}{2},j+1} - u^*_{i+\frac{1}{2},j-1}\right)}{2\Delta y}\,. \tag{A6}$$

Equation A4 is used to set the convective acceleration to zero as a test of the nonuniform characteristics of the flow. Equation A5 is the Arakawa representation for nondiverging flow (Arakawa, 1966). This formulation conserves vorticity and squared vorticity. Equation A6 does not conserve vorticity, but is commonly used owing to its simplicity.

Equations A1 and A2 are solved for $u^{n+\frac{1}{2}}_{i+\frac{1}{2},j}$ and $\zeta^{n+\frac{1}{2}}_{i,j+1}$ utilizing the alternating direction implicit (ADI) scheme. For the nexthalf timestep (time $n+1$), the finite-difference form of the continuity equation is:

$$\frac{2}{\Delta t}\left(\zeta^{n+1}_{i,j} - \zeta^{n+\frac{1}{2}}_{i,j}\right) + \frac{\left(\zeta^{n+\frac{1}{2}}_{i+1,j} + \zeta^{n+\frac{1}{2}}_{i,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)u^{n+\frac{1}{2}}_{i+\frac{1}{2},j} - \left(\zeta^{n+\frac{1}{2}}_{i,j} + \zeta^{n+\frac{1}{2}}_{i-1,j} - z_{i-\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)u^{n+\frac{1}{2}}_{i-\frac{1}{2},j}}{2\Delta x} +$$

$$\frac{\left(\zeta^*_{i,j+1} + \zeta^*_{i,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right)v^{n+1}_{i,j+\frac{1}{2}} - \left(\zeta^*_{i,j} + \zeta^*_{i,j-1} - z_{i+\frac{1}{2},j-\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)v^{n+1}_{i,j-\frac{1}{2}}}{2\Delta y} = 0\,, \tag{A7}$$

and the finite-difference form of the momentum equation in the y-direction is:

$$\frac{v^{n+1}_{i,j+\frac{1}{2}} - v^{n}_{i,j+\frac{1}{2}}}{\Delta t} + A(y) - f\bar{u} + g\frac{\left(\zeta^{n+\frac{1}{2}}_{i,j+1} - \zeta^{n+\frac{1}{2}}_{i,j}\right) + \left(\zeta^{n+1}_{i,j+1} - \zeta^{n+1}_{i,j}\right)}{2\Delta y} + g\frac{\left(\rho^{n+\frac{1}{2}}_{i,j+1} - \rho^{n+\frac{1}{2}}_{i,j}\right)}{2\rho^{n+\frac{1}{2}}_{i,j}\Delta y}\frac{\left(\zeta^n_{i,j} + \zeta^n_{i,j+1} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right)}{2} +$$

$$R(y)\frac{v^{n+1}_{i,j+\frac{1}{2}} + v^{n}_{i,j+\frac{1}{2}}}{2} - \frac{2C_d\rho_a W^2\cos\theta}{\rho^{n+\frac{1}{2}}_{i,j}\left(\zeta^n_{i,j} + \zeta^n_{i,j+1} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right)} - k\nabla^2 v = 0\,, \tag{A8}$$

where:

$\bar{u}$ is $\left(u^{n+\frac{1}{2}}_{i+\frac{1}{2},j+1} + u^{n+\frac{1}{2}}_{i-\frac{1}{2},j+1} + u^{n+\frac{1}{2}}_{i+\frac{1}{2},j} + u^{n+\frac{1}{2}}_{i-\frac{1}{2},j}\right)/4\,,$

$\nabla^2 v$ is $\frac{1}{(\Delta y)^2}\left(v^n_{i,j+\frac{1}{2}} - 2v^n_{i,j-\frac{1}{2}} + v^n_{i,j-\frac{3}{2}} + v^n_{i+1,j+\frac{1}{2}} - 2v^n_{i,j+\frac{1}{2}} + v^n_{i-1,j+\frac{1}{2}}\right)$, and

the friction term is expressed by:

$$R(y) = \frac{8g\sqrt{\bar{u}^2 + \left(v^*_{i,j+\frac{1}{2}}\right)^2}}{\left(\zeta^n_{i,j} + \zeta^n_{i,j+1} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right)(C_{i,j+1} + C_{i,j})^2}. \quad \text{(A9)}$$

The optional forms of the convective acceleration terms for equation A8 are similar to equations A4 to A6. The first form is:

$$A(y) = 0. \quad \text{(A10)}$$

The second form of the convective acceleration term is:

$$A(y) = \frac{1}{3}\left[\frac{\left(v^*_{i,j+\frac{3}{2}} + v^*_{i,j+\frac{1}{2}}\right)^2 - \left(v^*_{i,j+\frac{1}{2}} + v^*_{i,j-\frac{1}{2}}\right)^2}{2\Delta y} + \frac{1}{2\Delta y}\left(v^*_{i,j+\frac{3}{2}}\left(v^*_{i,j+\frac{3}{2}} + \hat{\nabla} v^*_{i,j+\frac{3}{2}}\right) - v^*_{i,j-\frac{1}{2}}\left(v^*_{i,j-\frac{1}{2}} + \hat{\nabla} v^*_{i,j-\frac{1}{2}}\right)\right) + \right.$$

$$\left. \bar{u}\frac{\left(v^*_{i+1,j+\frac{1}{2}} - v^*_{i-1,j+\frac{1}{2}}\right)}{2\Delta x} + \frac{\left(u^{n+\frac{1}{2}}_{i+\frac{1}{2},j} + u^{n+\frac{1}{2}}_{i+\frac{1}{2},j+1}\right)\left(v^*_{i+1,j+\frac{1}{2}} - v^*_{i,j+\frac{1}{2}}\right) + \left(u^{n+\frac{1}{2}}_{i-\frac{1}{2},j} + u^{n+\frac{1}{2}}_{i-\frac{1}{2},j+1}\right)\left(v^*_{i,j+\frac{1}{2}} - v^*_{i-1,j+\frac{1}{2}}\right)}{2\Delta x}\right]. \quad \text{(A11)}$$

where:

$\hat{\nabla} v^*_{i,j+\frac{3}{2}}$ is $\left(v^*_{i+1,j+\frac{3}{2}} - v^*_{i,j+\frac{3}{2}}\right) - \left(v^*_{i,j+\frac{3}{2}} - v^*_{i-1,j+\frac{3}{2}}\right) + v^*_{i-1,j+\frac{3}{2}} - 2v^*_{i+1,j+\frac{3}{2}} + v^*_{i,j+\frac{3}{2}}$, and

$\hat{\nabla} v^*_{i,j-\frac{1}{2}}$ is $\left(v^*_{i+1,j-\frac{1}{2}} - v^*_{i,j-\frac{1}{2}}\right) - \left(v^*_{i,j-\frac{1}{2}} - v^*_{i-1,j-\frac{1}{2}}\right) + v^*_{i-1,j-\frac{1}{2}} - 2v^*_{i+1,j-\frac{1}{2}} + v^*_{i,j-\frac{1}{2}}$.

The third form of the convective acceleration term is:

$$A(y) = v^*_{i,j+\frac{1}{2}}\frac{\left(v^*_{i,j+\frac{3}{2}} - v^*_{i,j-\frac{1}{2}}\right)}{2\Delta y} + \bar{u}\frac{\left(v^*_{i+1,j+\frac{1}{2}} - v^*_{i,j+\frac{1}{2}}\right)}{2\Delta x}. \quad \text{(A12)}$$

Equations A7 and A8 are solved for $v^{n+1}_{i,j+\frac{1}{2}}$ and $\zeta^{n+1}_{i,j+1}$ utilizing the ADI scheme.

In the solution, the Chezy (C) value is treated as a dependent variable of the water depth and the bottom roughness, expressed by the Manning coefficient (n). The Chezy value is related to the Manning coefficient according to:

$$C_{i,j} = \lambda\frac{(\zeta^n_{i,j} - \bar{z})^{1/6}}{n}, \quad \text{(A13)}$$

where:

- n is the Manning coefficient (see VMDEF and CDMAN in appendix II, part 2, records 32 and 33, respectively).
- λ is 1 or 1.49 for metric or inch-pound units, respectively, and
- $\bar{z}$ is $\left(z_{i+\frac{1}{2},j+\frac{1}{2}} + z_{i+\frac{1}{2},j-\frac{1}{2}} + z_{i-\frac{1}{2},j+\frac{1}{2}} + z_{i-\frac{1}{2},j-\frac{1}{2}}\right)/4$.

For bodies of water in which a considerable horizontal density gradient exists because of salinity, the Chezy value also depends on the direction of flow and can be treated as a linear function of the salinity gradient:

$$C = \lambda \frac{(\zeta^n_{i,j} - \bar{z})^{1/6}}{n}\left[1 + \alpha_1 \frac{\left(\frac{s^n_{i+1,j} - s^n_{i-1,j}}{2\Delta x}\left(u^n_{i+\frac{1}{2},j} + u^n_{i-\frac{1}{2},j}\right) + \frac{s^n_{i,j+1} - s^n_{i,j-1}}{2\Delta y}\left(v^n_{i,j+\frac{1}{2}} + v^n_{i,j-\frac{1}{2}}\right)\right)}{\left[\left(u^n_{i+\frac{1}{2},j} + u^n_{i-\frac{1}{2},j}\right)^2 + \left(v^n_{i,j+\frac{1}{2}} + v^n_{i,j-\frac{1}{2}}\right)^2\right]^{1/2}}\right], \tag{A14}$$

where α_1 is an empirical coefficient (see CCOR in appendix II, part 1, record 18); and s is salinity, in grams per kilogram. This adjustment increases frictional resistance (decreases C) when the flow is toward the lower salinity cell (flood) and decreases frictional resistance (raises C) when flow is toward the higher salinity cell (ebb) (Leendertse, 1987). Although little testing of the coefficient α_1 has been made, a value of 300 meter • kilogram per gram has been used successfully (R.W. Schaffranek, U.S. Geological Survey, written commun., 1992).

The SWIFT2D transport simulation uses time-varying concentrations of constituents specified at open boundaries and internal outfall sources to compute the advection, dispersion, and resultant concentrations of constituents throughout the computational domain. Salinity, chloride, temperature, dissolved oxygen, biochemical oxygen demand, energy, and dye are constituents that have been simulated in past applications. Seven constituents and their interactions can be simulated simultaneously. A source and sink term is defined for each constituent for each cell. Changes to constituent concentration from reactions and interactions are accounted for as a source or sink.

When constituents are defined, the transport equations are solved in finite-difference form each half timestep after the solution of the flow equations. For the first half timestep, time $n+1/2$, the transport equation takes the form:

$$\begin{aligned}
&S + \frac{2}{\Delta t}\left[P^{n+\frac{1}{2}}_{i,j}\left(\zeta^{n+\frac{1}{2}}_{i,j} - \bar{z}\right) - P^n_{i,j}(\zeta^n_{i,j} - \bar{z})\right] + \\
&\frac{\left(\zeta^*_{i-1,j} + \zeta^*_{i,j} - z_{i-\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)u^{n+\frac{1}{2}}_{i-\frac{1}{2},j}\left(P^{n+\frac{1}{2}}_{i-1,j} + P^{n+\frac{1}{2}}_{i,j}\right) - \left(\zeta^*_{i,j} + \zeta^*_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)u^{n+\frac{1}{2}}_{i+\frac{1}{2},j}\left(P^{n+\frac{1}{2}}_{i,j} + P^{n+\frac{1}{2}}_{i+1,j}\right)}{4\Delta x} + \\
&\frac{\left(\zeta^n_{i,j-1} + \zeta^n_{i,j} - z_{i+\frac{1}{2},j-\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)v^n_{i,j-\frac{1}{2}}(P^n_{i,j-1} + P^n_{i,j}) - \left(\zeta^n_{i,j} + \zeta^n_{i,j+1} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right)v^n_{i,j+\frac{1}{2}}(P^n_{i,j+1} + P^n_{i,j})}{4\Delta y} - \\
&D_X\frac{\left(\zeta^*_{i,j} + \zeta^*_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)\left(P^{n+\frac{1}{2}}_{i+1,j} - P^{n+\frac{1}{2}}_{i,j}\right) - \left(\zeta^*_{i-1,j} + \zeta^*_{i,j} - z_{i-\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)\left(P^{n+\frac{1}{2}}_{i,j} - P^{n+\frac{1}{2}}_{i-1,j}\right)}{2(\Delta x)^2} - \\
&D_y\frac{\left(\zeta^n_{i,j} + \zeta^n_{i,j+1} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right)(P^n_{i,j+1} - P^n_{i,j}) - \left(\zeta^n_{i,j-1} + \zeta^n_{i,j} - z_{i+\frac{1}{2},j-\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)(P^n_{i,j} - P^n_{i,j-1})}{2(\Delta y)^2} = 0,
\end{aligned} \tag{A15}$$

where S is the source of simulated substances or properties, P is the vector of vertically averaged simulated substances or properties (see RINT and R in appendix II, part 2, records 20 and 36, respectively), and D_x, D_y are the diffusion coefficients of simulated substances or properties.

The dispersion coefficients in each coordinate direction are calculated in finite-difference form from the isotropic dispersion coefficient $D_{i,j}$ by the equations:

$$D_x = \frac{D_{i,j} + D_{i+1,j}}{2} + \frac{C_c\left(\zeta^n_{i,j} + \zeta^n_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)u^{n-\frac{1}{2}}_{i+\frac{1}{2},j}\sqrt{g}}{C_{i,j} + C_{i+1,j}} \tag{A16}$$

and:

$$D_y = \frac{D_{i,j} + D_{i,j+1}}{2} + \frac{C_c\left(\zeta^n_{i,j} + \zeta^n_{i,j+1} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right)v^n_{i,j+\frac{1}{2}}\sqrt{g}}{C_{i,j} + C_{i,j+1}}, \tag{A17}$$

where D is the isotropic dispersion coefficient (see DIFDEF and CDDIF in appendix II, part 2, records 30 and 31, respectively), and C_c is a coefficient relating the dispersion coefficient to Chezy's friction coefficient and the isotropic dispersion coefficient (see CDCON in appendix II, part 1, record 19). This coefficient (C_c) is dimensionless with a nominal value of 14.3 (R.W. Schaffranek, U.S. Geological Survey, written commun., 1992).

For the second half timestep, the transport equation takes the form:

$$S + \frac{2}{\Delta t}\left[P^{n+1}_{i,j}(\zeta^{n+1}_{i,j} - \bar{z}) - P^{n+\frac{1}{2}}_{i,j}\left(\zeta^{n+\frac{1}{2}}_{i,j} - \bar{z}\right)\right] +$$

$$\frac{\left(\zeta^{n+\frac{1}{2}}_{i-1,j} + \zeta^{n+\frac{1}{2}}_{i,j} - z_{i-\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)u^{n+\frac{1}{2}}_{i-\frac{1}{2},j}\left(P^{n+\frac{1}{2}}_{i-1,j} + P^{n+\frac{1}{2}}_{i,j}\right) - \left(\zeta^{n+\frac{1}{2}}_{i,j} + \zeta^{n+\frac{1}{2}}_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)u^{n+\frac{1}{2}}_{i+\frac{1}{2},j}\left(P^{n+\frac{1}{2}}_{i,j} + P^{n+\frac{1}{2}}_{i+1,j}\right)}{4\Delta x} +$$

$$\frac{\left(\zeta^*_{i,j-1} + \zeta^*_{i,j} - z_{i+\frac{1}{2},j-\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)v^{n+1}_{i,j-\frac{1}{2}}(P^{n+1}_{i,j-1} + P^{n+1}_{i,j}) - \left(\zeta^*_{i,j} + \zeta^*_{i,j+1} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right)v^{n+1}_{i,j+\frac{1}{2}}(P^{n+1}_{i,j+1} + P^{n+1}_{i,j})}{4\Delta y} -$$

$$D_x\frac{\left(\zeta^{n+\frac{1}{2}}_{i,j} + \zeta^{n+\frac{1}{2}}_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)\left(P^{n+\frac{1}{2}}_{i+1,j} - P^{n+\frac{1}{2}}_{i,j}\right) - \left(\zeta^{n+\frac{1}{2}}_{i-1,j} + \zeta^{n+\frac{1}{2}}_{i,j} - z_{i-\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)\left(P^{n+\frac{1}{2}}_{i,j} - P^{n+\frac{1}{2}}_{i-1,j}\right)}{2(\Delta x)^2} -$$

$$D_y\frac{\left(\zeta^*_{i,j} + \zeta^*_{i,j+1} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right)(P^{n+1}_{i,j+1} - P^{n+1}_{i,j}) - \left(\zeta^*_{i,j-1} + \zeta^*_{i,j} - z_{i+\frac{1}{2},j-\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)(P^{n+1}_{i,j} - P^{n+1}_{i,j-1})}{2(\Delta y)^2} = 0. \tag{A18}$$

If salt is a constituent, the effects of salt concentration on density are taken into account. For each half timestep, before the implementation of the flow equations, the density is computed by:

$$\rho^{n+\frac{1}{2}}_{i,j} = \rho_f + 0.7143(s^n_{i,j}), \tag{A19}$$

where ρ_f is density of freshwater (see RHOM in appendix II, part 1, record 26), s is salt concentration, and both variables must be in the same units. Equation A19 effectively couples the transport and flow equations. Stability aspects of the finite-difference approximations are documented by Leendertse (1987).

Certain variables are defined with a * superscript in the continuity equations A1 and A7, within advection terms *A(x)* and *A(y)* and friction terms *R(x)* and *R(y)* of the momentum equations A2 and A8 and the transport equations A15 and A18. These variables can be set to either future timestep values (computed in the last iteration of the ADI solution), previous timestep values (computed in the last half timestep or the previous half timestep), or a combination of future and previous values by setting a user-defined input variable called ICORR (see appendix II, part 1, record 6). This affects the nonlinearity of the equations to be solved and the behavior of the solution. Values of stage, ζ^*, as well as velocities in the x- and y-directions, u^* and v^*, are subject to these options. Table A1 summarizes the values of these terms for each of the seven values of ICORR. The ~ symbol indicates values used from the previous iteration of the ADI method. The user may also choose how many iterations of the ADI method are performed at each timestep. The number of iterations is defined by the variable NCORR (see appendix II, part 1, record 6).

Option 0 (ICORR = 0) should be used only when the flow velocities are very low. This method is potentially unstable because negative viscosity may be introduced by the advection terms as shown by Vreugdenhil (1983). Option 5 (ICORR = 5) approaches second-order accuracy after a few iterations because the advection terms in the momentum equations are centered in time. This integration option has proven to be the most accurate of these methods (Leendertse, 1987). Multiple iterations for each timestep also can be performed to improve intermediate estimators used in the integrations by specifying a value for NCORR. More than one iteration is rarely justified, however, given the increased need for computational resources.

Table A1. Nonlinear term approximation options in SWIFT2D

[ICORR is a user selected input variable. Superscripts on u, v, and ζ are the timestep level. Variables with a ~ are from the previous iteration of the Alternative Direction Implicit method]

ICORR	Velocity in the advection term u^* or v^*		Water level in continuity equation ζ^*	
	Timestep $t+1/2$	Timestep $t+1$	Timestep $t+1/2$	Timestep $t+1$
0	$u^{t-1/2}$	v^t	ζ^t	$\zeta^{t+1/2}$
1	$\tilde{u}^{t+1/2}$	$\tilde{v}^{t+1}$	ζ^t	$\zeta^{t+1/2}$
2	$\frac{\tilde{u}^{t+1/2}+u^{t-1/2}}{2}$	$\frac{\tilde{v}^{t+1}+v^t}{2}$	ζ^t	$\zeta^{t+1/2}$
3	$u^{t-1/2}$ alternating $\tilde{u}^{t+1/2}$	$\tilde{v}^{t+1}$ alternating v^t	ζ^t	$\zeta^{t+1/2}$
4	$\tilde{u}^{t+1/2}$	$\tilde{v}^{t+1}$	$\tilde{\zeta}^{t+1/2}$	$\tilde{\zeta}^{t+1}$
5	$\frac{\tilde{u}^{t+1/2}+u^{t-1/2}}{2}$	$\frac{\tilde{v}^{t+1}+v^t}{2}$	$\tilde{\zeta}^{t+1/2}$	$\tilde{\zeta}^{t+1}$
6	$u^{t-1/2}$ alternating $\tilde{u}^{t+1/2}$	$\tilde{v}^{t+1}$ alternating v^t	ζ^t alternating $\tilde{\zeta}^{t+1/2}$	$\tilde{\zeta}^{t+1}$ alternating $\zeta^{t+1/2}$

Alternating Direction Implicit Solution

The finite-difference forms of the flow equations are solved with an ADI technique. Equation A1 is rearranged with the future timestep values on the left-hand side:

$$-\left[\frac{\zeta^*_{i,j}+\zeta^*_{i-1,j}-z_{i-\frac{1}{2},j+\frac{1}{2}}-z_{i-\frac{1}{2},j-\frac{1}{2}}}{2\Delta x}\right]u^{n+\frac{1}{2}}_{i-\frac{1}{2},j}+\left[\frac{2}{\Delta t}\right]\zeta^{n+\frac{1}{2}}_{i,j}+\left[\frac{\zeta^*_{i+1,j}+\zeta^*_{i,j}-z_{i+\frac{1}{2},j+\frac{1}{2}}-z_{i+\frac{1}{2},j-\frac{1}{2}}}{2\Delta x}\right]u^{n+\frac{1}{2}}_{i+\frac{1}{2},j}=$$

$$\frac{\left(\zeta^n_{i,j}+\zeta^n_{i,j-1}-z_{i+\frac{1}{2},j-\frac{1}{2}}-z_{i-\frac{1}{2},j-\frac{1}{2}}\right)v^n_{i,j-\frac{1}{2}}+\left(\zeta^n_{i,j+1}+\zeta^n_{i,j}-z_{i+\frac{1}{2},j+\frac{1}{2}}-z_{i-\frac{1}{2},j+\frac{1}{2}}\right)v^n_{i,j+\frac{1}{2}}}{2\Delta y}-\frac{2\zeta^n_{i,j}}{\Delta t}\,. \quad \text{(A20)}$$

Equation A2 also is rearranged with the future timestep values on the left-hand side:

$$\left[\frac{1}{2\Delta x}\right]\zeta_{i,j}^{n+\frac{1}{2}} + \left[\frac{1}{\Delta t} + \frac{R(x)}{2}\right]u_{i+\frac{1}{2},j}^{n+\frac{1}{2}} - \left[\frac{1}{2\Delta x}\right]\zeta_{i+1,j}^{n+\frac{1}{2}} =$$

$$\frac{u_{i+\frac{1}{2},j}^{n-\frac{1}{2}}}{\Delta t} - A(x) + f\bar{v} - g\frac{(\zeta_{i+1,j}^{n} - \zeta_{i,j}^{n})}{2\Delta x} - g\frac{(\rho_{i+1,j}^{n} - \rho_{i,j}^{n})}{2\rho_{i,j}^{n}\Delta x}\frac{\left(\zeta_{i,j}^{n} + \zeta_{i+1,j}^{n} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)}{2} - R(x)\frac{u_{i+\frac{1}{2},j}^{n-\frac{1}{2}}}{2} +$$

$$\frac{2C_d\rho_a W^2 \sin\theta}{\rho_{i,j}^{n}\left(\zeta_{i,j}^{n} + \zeta_{i+1,j}^{n} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)} + k\nabla^2 u\,. \qquad \text{(A21)}$$

Equations A20 and A21 can be placed in a tridiagonal matrix as shown:

$$\begin{bmatrix} \psi_1 & \beta_1 & \gamma_1 & & & & \\ & \eta_1 & \xi_1 & \phi_1 & & & \\ & & \psi_2 & \beta_2 & \gamma_2 & & \\ & & & \eta_2 & \xi_2 & \phi_2 & \\ & & & & & \dots & \dots \end{bmatrix} \begin{bmatrix} u_{i-\frac{1}{2},j}^{n+\frac{1}{2}} \\ \zeta_{i,j}^{n+\frac{1}{2}} \\ u_{i+\frac{1}{2},j}^{n+\frac{1}{2}} \\ \zeta_{i+1,j}^{n+\frac{1}{2}} \\ \dots \end{bmatrix} = \begin{bmatrix} CRHS_1 \\ MRHS_1 \\ CRHS_2 \\ MRHS_2 \\ \dots \end{bmatrix} \qquad \text{(A22)}$$

where:

ψ_i is $-\dfrac{\zeta_{i,j}^{*} + \zeta_{i-1,j}^{*} - z_{i-\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}}{2\Delta x}$,

β_i is $\dfrac{2}{\Delta t}$,

‘γ_i is $\dfrac{\zeta_{i+1,j}^{*} + \zeta_{i,j}^{*} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}}{2\Delta x}$,

η_i is $\dfrac{1}{2\Delta x}$,

ξ_i is $\dfrac{1}{\Delta t} + \dfrac{R(x)}{2}$,

ϕ_i is $\dfrac{1}{2\Delta x}$,

$CRHS_i$ is $\dfrac{\left(\zeta^n_{i,j} + \zeta^n_{i,j-1} - z_{i+\frac{1}{2},j-\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right) v^n_{i,j-\frac{1}{2}} + \left(\zeta^n_{i,j+1} + \zeta^n_{i,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right) v^n_{i,j+\frac{1}{2}}}{2\Delta y} - \dfrac{2\zeta^n_{i,j}}{\Delta t}$, and

$MRHS_i$ is $\dfrac{u^{n-\frac{1}{2}}_{i+\frac{1}{2},j}}{\Delta t} - A(x) + f\bar{v} - g\dfrac{(\zeta^n_{i+1,j} - \zeta^n_{i,j})}{2\Delta x} - g\dfrac{(\rho^n_{i+1,j} - \rho^n_{i,j})}{2\rho^n_{i,j}\Delta x} \dfrac{\left(\zeta^n_{i,j} + \zeta^n_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)}{2} - R(x)\dfrac{u^{n-\frac{1}{2}}_{i+\frac{1}{2},j}}{2} +$

$\dfrac{2C_d\rho_a W^2 \sin\theta}{\rho^n_{i,j}\left(\zeta^n_{i,j} + \zeta^n_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)} + k\nabla^2 u$.

At the top of the solution matrix where the x-direction index $i = 1$, the coefficient for $u^{n+\frac{1}{2}}_{i-\frac{1}{2},j}$, which is ψ_1, is zero. Through normalization and back substitution, the first two equations in the matrix equation A22 are reduced to obtain the form:

$$\begin{bmatrix} 0 & 1 & \frac{\gamma_1}{\beta_1} & & & \\ & 0 & 1 & \frac{\phi_1}{\xi_1 - \frac{\gamma_1\eta_1}{\beta_1}} & & \\ & & \psi_2 & \beta_2 & \gamma_2 & \\ & & & \eta_2 & \xi_2 & \phi_2 \\ & & & & \dots & \dots \end{bmatrix} \begin{bmatrix} u^{n+\frac{1}{2}}_{i-\frac{1}{2},j} \\ \zeta^{n+\frac{1}{2}}_{i,j} \\ u^{n+\frac{1}{2}}_{i+\frac{1}{2},j} \\ \zeta^{n+\frac{1}{2}}_{i+1,j} \\ \dots \end{bmatrix} = \begin{bmatrix} \frac{CRHS_1}{\beta_1} \\ \frac{MRHS_1 - (CRHS_1\eta_1)/\beta_1}{\xi_1 - \frac{\gamma_1\eta_1}{\beta_1}} \\ CRHS_2 \\ MRHS_2 \\ \dots \end{bmatrix}. \quad \text{(A23)}$$

This recursion procedure is repeated through the matrix to obtain the final form:

$$\begin{bmatrix} 0 & 1 & P_1 & & & \\ & 0 & 1 & Rx_1 & & \\ & & 0 & 1 & P_2 & \\ & & & 0 & 1 & Rx_2 \\ & & & & \dots & \dots \end{bmatrix} \begin{bmatrix} u^{n+\frac{1}{2}}_{i-\frac{1}{2},j} \\ \zeta^{n+\frac{1}{2}}_{i,j} \\ u^{n+\frac{1}{2}}_{i+\frac{1}{2},j} \\ \zeta^{n+\frac{1}{2}}_{i+1,j} \\ \dots \end{bmatrix} = \begin{bmatrix} Q_1 \\ S_1 \\ Q_2 \\ S_2 \\ \dots \end{bmatrix}. \quad \text{(A24)}$$

where P_i, Rx_i, Q_i, and S_i are the variable names used in the SWIFT2D code for the resulting recursion coefficients. Equation A24 need not be solved in matrix form; simple back substitution is used in SWIFT2D. This is very efficient, and the procedure is repeated for each of the grid rows in the x-direction. For the second half timestep, equations A7 and A8 are rearranged for solution in the y-direction using the same method as shown in equations A20 to A24.

The transport equation A15 is rearranged for solution to put all the future timestep values on the left-hand side:

$$\left[\frac{\left(\zeta^*_{i-1,j}+\zeta^*_{i,j}-z_{i-\frac{1}{2},j+\frac{1}{2}}-z_{i-\frac{1}{2},j-\frac{1}{2}}\right)u^{n+\frac{1}{2}}_{i-\frac{1}{2},j}}{4\Delta x}-D_X\frac{\left(\zeta^*_{i-1,j}+\zeta^*_{i,j}-z_{i-\frac{1}{2},j+\frac{1}{2}}-z_{i-\frac{1}{2},j-\frac{1}{2}}\right)}{2(\Delta x)^2}\right]P^{n+\frac{1}{2}}_{i-1,j}+$$

$$\left[\frac{2\left(\zeta^{n+\frac{1}{2}}_{i,j}-\bar{z}\right)}{\Delta t}+\frac{\left(\zeta^*_{i-1,j}+\zeta^*_{i,j}-z_{i-\frac{1}{2},j+\frac{1}{2}}-z_{i-\frac{1}{2},j-\frac{1}{2}}\right)u^{n+\frac{1}{2}}_{i-\frac{1}{2},j}-\left(\zeta^*_{i,j}+\zeta^*_{i+1,j}-z_{i+\frac{1}{2},j+\frac{1}{2}}-z_{i+\frac{1}{2},j-\frac{1}{2}}\right)u^{n+\frac{1}{2}}_{i+\frac{1}{2},j}}{4\Delta x}+\right.$$

$$\left.D_x\frac{\left(\zeta^*_{i,j}+\zeta^*_{i+1,j}-z_{i+\frac{1}{2},j+\frac{1}{2}}-z_{i+\frac{1}{2},j-\frac{1}{2}}\right)+\left(\zeta^*_{i-1,j}+\zeta^*_{i,j}-z_{i-\frac{1}{2},j+\frac{1}{2}}-z_{i-\frac{1}{2},j-\frac{1}{2}}\right)}{2(\Delta x)^2}\right]P^{n+\frac{1}{2}}_{i,j}-$$

$$\left[\frac{\left(\zeta^*_{i,j}+\zeta^*_{i+1,j}-z_{i+\frac{1}{2},j+\frac{1}{2}}-z_{i+\frac{1}{2},j-\frac{1}{2}}\right)u^{n+\frac{1}{2}}_{i+\frac{1}{2},j}}{4\Delta x}+D_X\frac{\left(\zeta^*_{i,j}+\zeta^*_{i+1,j}-z_{i+\frac{1}{2},j+\frac{1}{2}}-z_{i+\frac{1}{2},j-\frac{1}{2}}\right)}{2(\Delta x)^2}\right]P^{n+\frac{1}{2}}_{i+1,j}=$$

$$\frac{\left(\zeta^n_{i,j}+\zeta^n_{i,j+1}-z_{i+\frac{1}{2},j+\frac{1}{2}}-z_{i-\frac{1}{2},j+\frac{1}{2}}\right)v^n_{i,j+\frac{1}{2}}(P^n_{i,j+1}+P^n_{i,j})-\left(\zeta^n_{i,j-1}+\zeta^n_{i,j}-z_{i+\frac{1}{2},j-\frac{1}{2}}-z_{i-\frac{1}{2},j-\frac{1}{2}}\right)v^n_{i,j-\frac{1}{2}}(P^n_{i,j-1}+P^n_{i,j})}{4\Delta y}+$$

$$D_y\frac{\left(\zeta^n_{i,j}+\zeta^n_{i,j+1}-z_{i+\frac{1}{2},j+\frac{1}{2}}-z_{i-\frac{1}{2},j+\frac{1}{2}}\right)(P^n_{i,j+1}-P^n_{i,j})-\left(\zeta^n_{i,j-1}+\zeta^n_{i,j}-z_{i+\frac{1}{2},j-\frac{1}{2}}-z_{i-\frac{1}{2},j-\frac{1}{2}}\right)(P^n_{i,j}-P^n_{i,j-1})}{2(\Delta y)^2}+\quad\text{, and}$$

$$\frac{2}{\Delta t}P^n_{i,j}(\zeta^n_{i,j}-\bar{z})-S\,. \tag{A25}$$

Equation A25 can then be placed in a tridiagonal matrix:

$$\begin{bmatrix}\sigma_1 & \tau_1 & \iota_1 & & & \\ & \sigma_2 & \tau_2 & \iota_2 & & \\ & & \sigma_3 & \tau_3 & \iota_3 & \\ & & & \sigma_4 & \tau_4 & \iota_4 \\ & & & & \dots & \dots\end{bmatrix}\begin{bmatrix}P^{n+\frac{1}{2}}_{i-1,j}\\ P^{n+\frac{1}{2}}_{i,j}\\ P^{n+\frac{1}{2}}_{i+1,j}\\ \dots\end{bmatrix}=\begin{bmatrix}TRHS_1\\ TRHS_2\\ TRHS_3\\ \dots\end{bmatrix}, \tag{A26}$$

where:

σ_i is $\dfrac{\left(\zeta^*_{i-1,j} + \zeta^*_{i,j} - z_{i-\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right) u^{n+\frac{1}{2}}_{i-\frac{1}{2},j}}{4\Delta x} - D_X \dfrac{\left(\zeta^*_{i-1,j} + \zeta^*_{i,j} - z_{i-\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)}{2(\Delta x)^2}$,

τ_i is $\dfrac{2\left(\zeta^{n+\frac{1}{2}}_{i,j} - \bar{z}\right)}{\Delta t} + \dfrac{\left(\zeta^*_{i-1,j} + \zeta^*_{i,j} - z_{i-\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right) u^{n+\frac{1}{2}}_{i-\frac{1}{2},j} - \left(\zeta^*_{i,j} + \zeta^*_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right) u^{n+\frac{1}{2}}_{i+\frac{1}{2},j}}{4\Delta x} +$,

$$D_x \frac{\left(\zeta^*_{i,j} + \zeta^*_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right) + \left(\zeta^*_{i-1,j} + \zeta^*_{i,j} - z_{i-\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)}{2(\Delta x)^2},$$

ι_i is $\dfrac{-\left(\zeta^*_{i,j} + \zeta^*_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right) u^{n+\frac{1}{2}}_{i+\frac{1}{2},j}}{4\Delta x} - D_X \dfrac{\left(\zeta^*_{i,j} + \zeta^*_{i+1,j} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i+\frac{1}{2},j-\frac{1}{2}}\right)}{2(\Delta x)^2}$, and

$TRHS_i$ is $\dfrac{2}{\Delta t} P^n_{i,j}(\zeta^n_{i,j} - \bar{z}) - S +$

$$\frac{\left(\zeta^n_{i,j} + \zeta^n_{i,j+1} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right) v^n_{i,j+\frac{1}{2}} (P^n_{i,j+1} + P^n_{i,j}) - \left(\zeta^n_{i,j-1} + \zeta^n_{i,j} - z_{i+\frac{1}{2},j-\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right) v^n_{i,j-\frac{1}{2}} (P^n_{i,j-1} + P^n_{i,j})}{4\Delta y} +$$

$$D_y \frac{\left(\zeta^n_{i,j} + \zeta^n_{i,j+1} - z_{i+\frac{1}{2},j+\frac{1}{2}} - z_{i-\frac{1}{2},j+\frac{1}{2}}\right)(P^n_{i,j+1} - P^n_{i,j}) - \left(\zeta^n_{i,j-1} + \zeta^n_{i,j} - z_{i+\frac{1}{2},j-\frac{1}{2}} - z_{i-\frac{1}{2},j-\frac{1}{2}}\right)(P^n_{i,j} - P^n_{i,j-1})}{2(\Delta y)^2}.$$

The lower diagonal in equation A26 is eliminated in the same fashion as in equations A22 to A24 to yield:

$$\begin{bmatrix} 0 & 1 & E_1 & & & & \\ & 0 & 1 & E_2 & & & \\ & & 0 & 1 & E_3 & & \\ & & & 0 & 1 & E_4 & \\ & & & & & \dots & \dots \end{bmatrix} \begin{bmatrix} P^{n+\frac{1}{2}}_{i-1,j} \\ P^{n+\frac{1}{2}}_{i,j} \\ P^{n+\frac{1}{2}}_{i+1,j} \\ \dots \end{bmatrix} = \begin{bmatrix} Fx_1 \\ Fx_2 \\ Fx_3 \\ \dots \end{bmatrix}, \qquad \text{(A27)}$$

where E_i, and Fx_i are the variable names used in the SWIFT2D code for the resulting recursion coefficients. As was the case in solving the flow equations, equation A27 can be solved by back substitution. For the second half timestep, equation A18 is rearranged for solution by the same method shown in equations A25 to A27. A thorough treatment of the stability and accuracy requirements of the ADI technique is given in Stelling and others (1986).

Appendix II. SWIFT2D Program Input with Modifications for Application to Coastal Wetlands

The data input structure for SWIFT2D is included in this appendix with the modifications for wetland application noted in **bold**. This includes part 2, record 3 data; part 3, record 6A data; and part 5 data. Note that the data input structure is defined here as input to the preprocessor SWIFT_IDP. Sections where this format differs from the direct input to SWIFT2D are followed by the direct input format in *italics*.

PART 1: RECORDS - CONTROL PARAMETERS

Part 1 consists of 26 or 27 records (27th record is optional)

RECORD 1: Model Identification (one required per execution)

Variable	Position	Format	Default	Definition
MODID	1-8	A8	blanks	Model identification, that is used in the generation of run identifications. Normally, MODID does not contain an experiment number.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 2: Run Title (one required per execution)

Variable	Position	Format	Default	Definition
TITL	1-72	A72	blanks	The full run title. This title appears in the Run Log and carried in the History and Map files.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 3: Titles and Dates (one required per execution)

Variable	Position	Format	Default	Definition
HTITL	1-16	A16	blanks	The title for displays. This is generally the name of the geographical area being modelled. This title is also written on the Run Log and printed.
ITDAY	17-18	I2	1	The simulation start day (1-31). This and the next three variables define the start of the simulation in the form "DD MMM "YY" (for example, 01 JAN ‘93). All specified times, such as TSTART on Times Record A, are specified as elapsed minutes from midnight of the simulation start date. The simulation date is printed and displayed in the form YY/MM/DD (for example, 93/01/01).

Variable	Position	Format	Default	Definition
ITDATE(1)	19-22	A4	" JAN"	The simulation start month abbreviation (" JAN", " FEB", " MAR", " APR", " MAY", " JUN", " JUL", " AUG", " SEP", " OCT"," NOV", " DEC")
ITDATE(2)	23-24	A2	" \`"	The string " \`" (space and apostrophe).
ITYR	25-26	I2	0	The simulation start year in the century (0-99)
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 4: Times A (one required per execution)

Note: this and the next record specify times and time intervals for computations and output for SWIFT2D. All times are specified in minutes. Times are given as the elapsed time from midnight of the simulation begin date (specified on record 3 above). All times must be multiples of HALFDT*2. Therefore, all times except TITIDE will be set to the nearest multiple of HALFDT*2 that is greater than zero, if a non-zero value was given.

HALFDT	1-6	E6.0	0.5	The half time step duration. Each of the multi-operation steps is stepped forward every HALFDT minutes. Thus, the same type of operation occurs at steps HALFDT*2 minutes apart. LIMITATION: HALFDT can have 3 decimal places, or 4 if the last digit is 5, for example, HALFDT= 0.3125.
TITIDE	7-12	E6.0	15.0	The time interval to read time-varying data in Part 3. Time-varying tide levels or velocities are read at every TITIDE number of simulated minutes, starting just after TSTART (or after TRST, if TRST is greater than zero). Other time-varying data may be read at any of the same times, but not necessarily at every interval. Time-varying tide may begin earlier than TSTART (or TRST), however the other time-varying data may not begin earlier than time-varying tide begins. LIMITATION: TITIDE must be an exact multiple of HALFDT*2, and it must also be an integer number of minutes.

Variable	Position	Format	Default	Definition
TSTART	13-18	E6.0	0.0	The time to start the simulation. TSTART is chosen based on the availability of input data, particularly of time-varying tide in Part 3 and of the hydrodynamics of the model system. SWIFT2D is started with the same water level and velocity equal zero for the entire computational grid. For small model areas, TSTART should be chosen near high or low-water slack. For large model areas, this may not be advisable as long duration oscillations may be generated. LIMITATION: TSTART may be no earlier than the first time of time-varying tide minus TITIDE, if the number of time-varying openings, NTOT, is greater than zero.
TRST	19-24	E6.0	0.0	The time to restart the simulation. The simulation will restart at the first time available on the Restart File that is equal to or greater than TRST (see TIRST below). If all available times on the Restart File are earlier than TRST, the last time available is used. A value of zero implies that no restart is being made. If TRST is non-zero, then special care should be taken in changing any other data since the previous simulation run was made. Most important are the dimensions MMAX and NMAX and the number of constituents LMAX which can not change (see Data Array Dimensions Record A).

Note: It is a good practice to test a new model by making a short simulation run, and then use the restart facility to start a long simulation if the results of the short run were successful. Restarting may also be used to make comparative simulations using different inputs.

Variable	Position	Format	Default	Definition
TSTOP	25-30	E6.0	0.0	The time to stop the simulation. LIMITATION: The maximum value of time to stop is 999999 minutes, however, the maximum time of time-varying input is 99 days (142560 minutes). TSTOP may be no greater than the last time of time-varying tide if the number of time-varying openings, NTOT, is greater than zero.
TIRST	31-36	E6.0	0.0	The time interval to write to the Restart file. In addition to this interval, the Restart File is written at the time the simulation terminates successfully at TSTOP, except as noted below. If TIRST is zero, the Restart File is not written to. If TIRST is greater than TSTOP, the Restart file is written once, at TSTOP. Note: In successive runs, the simulation can be restarted at any time when the Restart file was written. The Restart file can also be used as a protection against computer failure during a long simulation, although the Emergency Restart files could be used for this purpose. A long interval TIRST should be used, as all arrays are written on the Restart File, to conserve space.
TIHISP	37-42	E6.0	0.0	The time interval to print computations for water level, current, and transport at stations chosen for the output of history data. These stations are defined at the beginning of Part 2. Also, computations at barriers or sluices are printed.
TIHIST	43-48	E6.0	0.0	The time interval at which to write computation results for water level, current, and transport at specified stations, barriers or sluices, weighted values of constituents, and other optional computations to the History file. (See also the flags NEXAN and NHST, on the Flags record, below.)

Variable	Position	Format	Default	Definition
TIMAPC	49-54	E6.0	0.0	The time interval to draw maps for constituent concentration (not used).
TIMAPV	55-60	E6.0	0.0	The time interval to draw maps for velocity (not used).
TIMAPM	61-66	E6.0	0.0	The time interval to draw maps for mass transport (not used).
TIMAPL	67-72	E6.0	0.0	The time interval to draw maps for water levels (not used).
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 5: Times B (one required per execution)

Variable	Position	Format	Default	Definition
TICG	1-6	E6.0	0.0	The time interval to write a Coarse Grid file.
TFCG	7-12	E6.0	0.0	The first time to write to the Coarse Grid file.
TLCG	13-18	E6.0	0.0	The last time to write to the Coarse Grid file.
TITSMO	19-24	E6.0	0.0	The time interval for time smoothing, used to obtain more stable computations.

Note: If only minor changes in the boundary occur, the value of TITSMO can be large. This value has to be determined by experimentations. (See the Time Smoothing section in the body of the report for a description of the time smoothing process.)

Variable	Position	Format	Default	Definition
TICVAL	25-30	E6.0	0.0	The time interval at which to compute Chezy values from given Manning's N values.

Note: When a large tidal range exists, this interval should be smaller than for simulations with a very small variation in tide level; typically Chezy values have been recomputed every 15 to 20 minutes of simulated time. This computation is rather time consuming, because it involves fractional exponents.
Limitation: TICVAL and TIFLOD next should not be multiples of each other. When their request coincide, computing Chezy values will be delayed.

Variable	Position	Format	Default	Definition
TIFLOD	31-36	E6.0	0.0	The time interval to check for flooding and drying at all points in the computational grid. (See also VAR, the marginal depth in tidal flats, on the Physical Characteristics record).
TIFLUX	37-42	E6.0	0.0	The time interval to compute heat flux.

Variable	Position	Format	Default	Definition
TLFSMO	43-48	E6.0	0.0	The last time for interpolation from initial values at open boundaries driven by Fourier or harmonic functions. That is, during the initial period TLFSMO, the initial water levels and velocities, and the Fourier-generated levels or velocities are interpolated to obtain a "smooth start-up" of the simulation.
TIMAPF	49-54	E6.0	0.0	The time interval to write to the Map file. Note: the Map file can be used to display the standard simulation maps after the simulation has been run.
TFMAPF	55-60	E6.0	0.0	The first time to write to the Map file.
TFMAPF	61-66	E6.0	0.0	The last time to write to the Map file.
TIERST	67-72	E6.0	0.0	The time interval to write the Emergency Restart files. If TIERST is non-zero, then the two files must pre-exist.

Note: the Emergency Restart files retain only the latest data written for restart. In case of computer failure during a simulation, SWIFT2D can be restarted. However, it is recommended that the Restart File be used for all restarts. This functionality is not fully implemented; therefore, TIERST should always be zero.

DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 6: Flags (one required per execution)

NEXAN	1-6	I6	0	Flag to write to the History file additional computations (acceleration, advection, kinetic and potential energy, friction, gradient and vorticity) at current stations; and the energies are also computed at transport cross-sections (0=no, 1=yes).
NHST	7-12	I6	0	Flag to append to existing History file on restart (0=no, 1=yes).

Note: The advantage of turning this flag on is to create continuous history of results. However, the History file header (Title, Runid, and Simulation Date) is not updated, thus, all labeling information comes from the first simulation, which may be misleading.

Variable	Position	Format	Default	Definition
NOLAN	13-18	I6	0	Land boundary option. Not used
MET	19-24	I6	0	Units flag (0=English, 1=metric). This flag applies to both input and output data. Velocities are computed as either feet per second or meters per second.
ISVWP	25-30	I6	0	Flag to input space-varying wind and pressure-gradient in Part (0=no, 1=yes).
ICORR	31-36	I6	0	Integration method option used in the simulation (0-6) 0 = no integration correction (prediction only) 1 = correct the velocity in the advection terms using the predicted value 2 = correct the velocity in the advection terms using the average of the previous and predicted values 3 = correct the velocity in the advection terms at every other time step, using the predicted value 4 = correct the velocity in the advection terms and water level in the continuity equation, using the predicted value 5 = correct the velocity in the advection terms using the average of the previous and predicted values, and correct the water level in the continuity equation using the predicted value only 6 = correct the velocity and water level at every other time step, using the predicted value
NCORR	37-42	I6	0	The number of corrective iterations to make in the chosen integration correction method (ICORR) above. Ordinarily, a value of 1 is adequate. Increasing this value will greatly increase execution time.

Variable	Position	Format	Default	Definition
MAPMOT	43-48	I6	0	Map output option. (0=no map output—not recommended,1=draw map during simulation--not available, 2=write a Map file in alternate format--not available,3=1 and 2, 4=write Map file, 5=1 & 4, 6=2 & 4, and 7=1 & 2 & 4. Note: this flag overrides the times TIMAPC, TIMAPV, TIMAPM, TIMAPL and TIMAPF, TFMAPF, TLMAPF on Times records A and B above. For example, TIMAPC is the time interval to write to the Map file only if MAPMOT > 3.
IDKFMT	49-54	I6	0	Depth and initial constituent concentrations values format flag (0=old format 16F4.1, 1=new format 10E6.1)

Note: the old format allows 16 values per record versus 10. The new format is more flexible, allowing two more places of accuracy, and allowing an exponent for constituent concentrations.

Variable	Position	Format	Default	Definition
ICOFMT	55-52	I6	0	Viscosity, diffusion, Manning's N, and benthic demand values format flag (0=old formats--F5.0 for the default coefficient and 3I5, 10F5.0 for the override coefficients, 10 per record; 1=new format--E8.0 for the default coefficient and 3I5, 7E8.0 for the override coefficients, 7 per record.
IADVEC	61-66	I6	0	Advection option (0=Arakawa 1966 method; 1=Leendertse 1970 method, 2=None, no advection term)
IPAR	67-72	I6	0	Particle movement input flag (0=no, 1=yes). Only if IPAR is non-zero are the particle movement input records given at the end of Part 1 (record 27) and near the end of Part 2.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 7: Input Print-Flags (one required per execution)

Note: The purpose of this and the next record is to reduce the volume of print. However, some care needs to be taken that the print is not lost entirely, if a record of the input defining a model is to be kept for the future. All of the flags on this and record 8 have the same codes and meanings, as follows: O and 3=print in the SWIFT2D print; 4 and 7=do not print this input at all).

Variable	Position	Format	Default	Definition
NPRLAN	1-6	I6	0	The input print flag for the land boundary outlines (See also NOLAN on the Flags record, above.)
NPRDEP	7-12	I6	0	The input print flag for depth values. Note: If these are likely to be changed, then their print should not be suppressed in the listing of all input records, because it is the only accurate reflection of the actual values read.
NPRVIS	13-18	I6	0	The input print flag for viscosity coefficient overrides and the resulting viscosity throughout the computational grid.
NPRDIF	19-24	I6	0	The input print flag for diffusion coefficient overrides and the resulting diffusion throughout the computational grid.
NPRMAN	25-30	I6	0	The input print flag for Manning's N overrides and the resulting Manning's N. (Also, the SWIFT2D print includes the initial Chezy values computed from Manning's N; see NPRC in the Output Print-Flags record, below).
NPRBEN	31-36	I6	0	The input print flag for Benthic demand overrides and results in the computational grid.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 8: Input Print-Flags (one required per execution)
Note: The code values for these flags are the same as in the previous record.

NPRCON	1-42	7I6	0	Array of input print flags for initial constituent concentration throughout the computational grid. Entries 1-7 correspond to constituents 1-7. The printing only applies to constituents that initial constituent concentrations were specified (near end of Part 2).

Variable	Position	Format	Default	Definition
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 9: Output Print-Flags (one required per execution)

Note: In this and the next record, all defined code values are the same (0=no, 1=yes--print the pertinent output (computational results) in SWIFT2D at the times indicated in the array TPRINT (se the Print Times records, below).

Variable	Position	Format	Default	Definition
NPRSE	1-6	I6	0	The output print flag for water levels and the residual water level on tidal flats. At wet points, the water level is printed for the previous half time step; at dry points the residual water is printed, preceded by a "P" or "N" for positive or negative.
NPRSEP	7-12	I6	0	The output print flag for water levels. At all points, the water level value is printed for the latest time step. At dry points, the value is zero.
NPRVCU	13-18	I6	0	The output print flag for U-velocity components.
NPRVCV	19-24	I6	0	The output print flag for V-velocity components.
NPRVML	25-30	I6	0	The output print flag for velocity magnitude, computed at water level grid points. This computation is not made unless the print is requested.
NPRVMD	31-36	I6	0	The output print flag for velocity magnitude at depth points. This computation is not made unless the print is requested.
NPRVMU	37-42	I6	0	The output print flag for velocity magnitude at U-velocity grid points. This computation is not made unless the print is requested.
NPRVMV	43-48	I6	0	The output print flag for velocity magnitude at V-velocity grid points. This computation is not made unless the print is requested.
NPRC	49-54	I6	0	The output print flags for Chezy values. (Separately controlled by input print flag NPRMAN above is the print of the initial Chezy values determined from the given Manning's N values.)

Variable	Position	Format	Default	Definition
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 10: Concentration Output Print Flags (one required per execution)
Note: The code values for these flags are the same as in record 9.

Variable	Position	Format	Default	Definition
NPRR	1-42	7I6	0	An array of 7 output print flags for computed constituent concentration throughout the grid. Entries 1-7 correspond to constituents 1-7, such that print is produced only for those constituents that were defined in the input (see LMAX on Dimensions record A, below).
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 11-14: Print Times (four required per execution)
Note: All times are in minutes. Twelve values coded on the first 3 records and six on the fourth one.

Variable	Position	Format	Default	Definition
TPRINT	1-72	12F6.0	0.0	An array of times to print computations.

Note: these computed values are selected by the output print flags on the previous two records, and might include constituent concentrations, water levels, velocities and Chezy values. As many as 42 print times may be selected. The times are given in ascending order, and the first zero value ends the effective list of times. However, all four records must be input. Limitation: TPRINT times should not be multiples of TITSMO (see Times B record) because time smoothing delays by one time step the printing of computations.

RECORD 15: Data Array Dimension A (one required per execution)
Note: In SWIFT2D, data arrays may vary in size, depending on the complexity of the model being run. Parameters on this and the next record indicate the size of the grid, the number of locations on the grid selected for the insertion or abstraction of data, and similar number related to the model.

Variable	Position	Format	Default	Definition
MMAX	1-6	I6	0	The number of stage grid points in the U direction (see Space-staggered grid description in the body of the report).
NMAX	7-12	I6	0	The number of stage grid points in the V direction.
LMAX	13-18	I6	0	The number of constituents. LMAX can range from 0 to 7.
NOWL	19-24	I6	0	The number of water-level checkpoints.

Variable	Position	Format	Default	Definition
NOCUR	25-30	I6	0	The number of current checkpoints.
NSRC	31-36	I6	0	The number of discharge sources.
KPOL	37-42	I6	0	The number of constituent checkpoints.

KPOL may be zero, or it may be non-zero even though LMAX is zero, because constituent checkpoints are retained in Map files, and may be associated with computed values other than concentrations.

Variable	Position	Format	Default	Definition
NTRA	43-48	I6	0	The number of transport cross sections in the U direction. This means where GRDANG (on the Physical Characteristics record) is zero, there are NTRA number of cross-sections running north-south and NTRAV number running east-west.
NTRAV	49-54	I6	0	The number of transport cross section in the V direction.
NTOT	55-60	I6	0	The number of tide openings or open boundaries where time-varying tide inputwill be given in Part 3 (see also TITIDE on the Times A record, above). NTOT may be zero; however, in that case, NTOF (given next) should not be zero.
NTOF	61-66	I6	0	The number of tide openings or open boundaries where Fourier functions of tide will be given in Part 2 (see also KC, next). NTOF may be zero, if so, then NTOT above should not also be zero; else there is no tide to drive the model.
KC	67-72	I6	0	The number of Fourier or harmonic components given for the Fourier-driven open boundaries. KC should be zero if NTOF above is zero, but not otherwise.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 16: Data Array Dimension B (one required per execution)

NSLU	1-6	I6	0	The number of sluices or time-varying barriers in the U direction. The related sill depth, gate height and effective width of the barriers are given in Part 3.

Variable	Position	Format	Default	Definition
NSLV	7-12	I6	0	The number of sluices or time-varying barriers in the V direction.

Note: The remaining variables on the record pertain to space-varying wind and air pressure gradient. There may be separately defined grids for wind and for air pressure gradient, and these will probably be coarser than the grid defined above by MMAX and NMAX.

Variable	Position	Format	Default	Definition
IWM	13-18	I6	0	The number of grid points in the U direction for the space-varying wind input grid. IWM should be zero if ISVWP=0 (see the Flags record, above).
JWM	19-24	I6	0	The number of grid points in the V direction for the space-varying wind input grid. JWM should be zero if ISVWP=0 (see the Flags record, above).
IPM	25-30	I6	0	The number of grid points in the U direction for the space-varying air-pressure gradient input grid. IPM should be zero if ISVWP=0.
JPM	31-36	I6	0	The number of grid points in the V direction for the space-varying air-pressure gradient input grid. JPM should be zero if ISVWP=0.
MWF	37-42	I6	0	The grid ratio for wind in the U direction. For example, MWF is the number of grid spaces per space-varying wind input grid space in the U direction, unused if ISVWP=0.
NWF	43-48	I6	0	The grid ratio for wind in the V direction, unused if ISVWP=0.
MPF	49-54	I6	0	The grid ratio for air pressure gradient in the U direction, unused if ISVWP=0.
NPF	55-60	I6	0	The grid ratio for air pressure gradient in the V direction, unused if ISVWP=0.
NSPANS	61-66	I6	0	Number of times to write minimum current values
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 17: Constituents (one required per execution)

Variable	Position	Format	Default	Definition
AKTP	1-6	E6.0	0.0	The re-aeration coefficient for dissolved oxygen. This value overrides the constituent interaction rate for dissolved oxygen, within the array AKK given in Part 2 for constituent interaction rates.
SOX	7-12	E6.0	0.0	The saturation value for dissolved oxygen.
GAMM	13-18	E6.0	0.0	The weighting factor for concentration smoothing

Note: Discontinuities may occur in the concentrations. This discontinuity may even be so large that negative values are present in the computational field. This occurs very rarely, but experience shows that it does occur. In such cases the isolines on constituent concentration maps would show many contours between two grid points. To prevent this, a smoothing operation is used upon the computational array before plotting (the actual data in the simulation is not smoothed, only the data to be plotted). GAMM is that fraction of the value for concentration at grid point n,m which is to be replaced by the average value of the surrounding points. Thus, for GAMM=0.4, 60 percent of the value at location n,m is used, plus 10 percent of the values for each of the 4 surrounding points. This smoothing operation is also applied to concentrations written on the History file. GAMM should be > 0.0 and < 1.0.

LRMX	19-24	I6	0	The number of interactive constituents.

Note: LRMX should be less than or equal to LMAX, and may be zero. It is advisable to give the constituents which interact the lowest constituent numbers, then LRMX is as small as possible, so the computation is as fast as possible. LRMX should be equal to or greater than LOX and LBOD (see below).

LOX	25-30	I6	0	The constituent number used for dissolved oxygen. If LOX=0, then none of the constituents are dissolved oxygen.

Limitation: LOX should be greater than LRMX, that is dissolved oxygen should be an interactive constituent.

LTEMP	31-36	I6	0	The constituent number used for temperature. If LTEMP=0, temperature is not computed.

Limitation: LTEMP can be non-zero only if Part 1 flag MET is zero, (using English units).

LBOD	37-42	I6	0	The constituent number used for Benthic oxygen demand. If LBOD=0, Benthic demand is not computed, if LOX also is zero.

Limitation: LBOD should be greater than LRMX, that is Benthic oxygen demand should be an interactive constituent.

Variable	Position	Format	Default	Definition
LCG	43-48	I6	0	The constituent number used for coarse grid computation (see TICG on Times record). LCG may be zero unless coarse grid data are being saved, or it may be the same number as LTERM, LBOD, LSAL, or LERG, or any other constituent.
LSAL	49-54	I6	0	The constituent number used for salinity when the salinity pressure gradient is included in the equation of motion.

Thus, the use of LSAL not equal to zero couples the advective and diffusive transport computation to the hydrodynamic computation. To compute the pressure gradient from the salinity, an equation of state is used.

Variable	Position	Format	Default	Definition
LERG	55-60	I6	0	The constituent number used for energy.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 18: Physical Characteristics (one required per execution)

Variable	Position	Format	Default	Definition
ANGLAT	1-6	F6.0	0.0	The angle of latitude at the middle of the computational field, in degrees.
GRDANG	7-12	F6.0	0.0	The angle between the V direction and north, in degrees. For example, if the upward direction of V is west, then GRDANG is 90 degrees. In general, GRDANG is the angle from the upward direction rotating clockwise to the direction of the north direction arrow.
AL	13-18	F6.0	0.0	The distance between grid points, in feet or meters. (See MET on the Flags record) The total geographical area represented by the grid is MMAX*AL by NMAX*AL.

Variable	Position	Format	Default	Definition
SEINV	19-24	F6.0	0.0	The initial water level throughout the grid at which the simulation is started. SEINV may be zero. Note: this value must be closely correlated with the levels at tide openings (not necessarily TIDA and TIDB in the tide opening initial values in Part 2). These in turn must be well chosen considering the Fourier-computed amplitude at start time of any Fourier-driven openings (see record sets 14-16 in Part 2), as well as, the first time-varying levels used for any time-varying openings in Part 3(see TLVL1 and TLVL2 on the A and B records). Correlating all of these inputs is often a difficult task. It is recommended that the input tides are examined graphically, prior to their use in SWIFT2D

Note: If a water level value (given in Part 2) is zero, then that value is replaced by the negative of DEPDEF, so that the result is a point that is above high tide and always dry. DEPDEF is in feet or meters (see MET on FLAGS record), although the depth values are given in tenths of feet or in decimeters. DPEDEF should have a positive value, slightly greater than the difference between high tide and the reference level, because then the DEPDEF value has a limited effect in taking points out of the computation by means of the flooding routines. (The reference level is probably either mean sea level or mean low water, an implicit zero level from which other levels and depths are reckoned.)

Variable	Position	Format	Default	Definition
DEPDEF	25-30	F6.0	0.0	The default depth value, although it is actually the negative of that.
VAR	31-36	F6.0	0.0	The marginal depth in tidal flats, in feet or meters.

Note: VAR should have a value at least twice the maximum rate of rise of the tide time TIFLOD (see Time B record). This will avoid repeated backtracking in the simulation through the grid when flooding and drying occur, and thereby avoid increased computation time. When the water level at a cross-section between two grid points becomes half the value of VAR, then the two points are taken out of the computation (see also CSET, below).

Variable	Position	Format	Default	Definition
DCO	37-42	F6.0	0.0	DCO is a depth threshold, in feet or meters, under which the multiplier DML (next) is not applied. DCO and DML can be used to investigate the sensitivity of the computations to a small variation in depth.

Variable	Position	Format	Default	Definition
DML	43-48	F6.0	0.0	Experimental multiplier for depths greater than DCO. The normal value for DML is one.
SPA	49-54	F6.0	0.0	Weighting factor for surface smoothing, that is, smoothing of water levels only at times when time smoothing is done (not available).
VIVOR	55-60	F6.0	0.0	Vorticity-related viscosity factor.
CSET	61-66	F6.0	0.0	Chezy value, used where the depth is less than VAR, above. The intention is to use a small Chezy value for these shallow depths so that when the water becomes shallow the friction increases considerably, and thus the currents decrease.
CCOR	67-72	F6.0	0.0	Correction coefficient for Chezy values due to salinity gradient.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 19: Coefficients and Constants A (one required per execution) See also Coefficients and Constants B (record 26)

Variable	Position	Format	Default	Definition
AG	1-8	E8.0	0.0	Acceleration due to gravity, in feet per second squared, or meters per second squared (set MET on Flags record).
WSTR	9-16	E8.0	0.0	Wind stress coefficient
DAIR	17-24	E8.0	0.0	Air density.
DWAT	25-32	E8.0	0.0	Water density.

Note: WSTR, DAIR, and DWAT are the coefficients used in the computation of the force due to wind.

Variable	Position	Format	Default	Definition
WCONV	33-40	E8.0	0.0	Wind conversion factor. WCONV is a multiplier that will be applied to the given wind speed to convert them to the units used in the simulation. For example, if wind speed is given in knots and the simulation is in metric units, set WCONV=0.5144. (see MET on Flags record).

Variable	Position	Format	Default	Definition
CDCON	41-48	E8.0	0.0	Coefficient relating diffusion coefficients and Chezy values. It is used in the computation of the dispersion coefficient.
PRES	49-56	E8.0	0.0	Atmospheric pressure, in millibars, used in temperature computations.
ABSF	57-64	E8.0	0.0	Absorption factor (emissivity), used in temperature computations.
CMASTR	65-72	E8.0	0.0	Mass transfer coefficient, used in temperature computations.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 20: Displays - Plotter Specifications (one required per execution) Graphics are no longer supported during a simulation. All graphical operations are via pre- or post-processing operations. Data specified on records 20 through 24 are saved in the Map file and printed, otherwise they are not used. The 5 Display records define the display arrangement of maps.

Variable	Position	Format	Default	Definition
PLOTER	1-4	A4	"FR80"	Plot device name.
IFILM	7-12	I6	35	Film size in millimeters.
CAMERA	13-16	A4	"UNSP"	UNSProcketed or SPROcketed camera flag, valid values are "UNSP" and "SPRO".
ROTCAM	25-30	F6.0	1.0	Camera rotation flag. (1.0=comic mode, 2.0= movie mode-rotated 90 degrees counter-clockwise from comic mod).
ROTGRI	31-36	F6.0	1.0	Grid rotation flag. (1.0=no rotation-V direction upward, 2.0=90 degree rotation counter-clockwise-U direction upward).
ISAVEG	37-42	I6	0	Flag to call FR80 graphics routines SAVEG and MERGEG. DCDID 73-80 A8 blanks Record identifier (annotation only).

RECORD 21: Displays - Title Block A (one required per execution)
Graphics are no longer supported during a simulation.

Variable	Position	Format	Default	Definition
NCTITL	1.6	I6	32	The number of characters of TITL (on Run-Title record) to display on maps.
ISOCOL	7-12	I6	3	The number of columns of isoline values to display in the map legend.

Variable	Position	Format	Default	Definition
FMTISO	13-18	F6.0	0.0	The code for the format of isoline values in the legend on maps (0.0=exponential format, e.g. -12.3 displayed as 0.123E-04, 1.0= scientific format, e.g. $0.123x10^{-4}$.

Note: In general, the fractional part of FMTISO is the number of decimal places to display, and the integer part is the total number of character positions in which to display the isoline values. The minus sign indicates exponential format. If a positive number (greater than the code 1.0) were given, e.g., if FMTIS8.3, the resulting display would be floating point, like "1234.678". In general notation, a display forma of the form -w.d corresponds to a Fortran format Ew.d, and a display format w.d corresponds to a Fortran format Fw.d.

Variable	Position	Format	Default	Definition
CLKRAD	19-24	F6.0	5	Radius of the clock in the map title block, in grid space units. ARRLEN 25-30 F6.0 2*CLKRAD Length of the North direction arrow in the map title block.
VECTW	31-36	F6.0	0.0	Number of units of wind speed corresponding to a vector as long as the width of a grid space unit, on displays.
PWUNIT	37-42	F6.0	blanks	Name of the wind speed unit to display. For example if MET=0, PWUNIT="MPH ".

Note: if VECTW=10.0 and PWUNIT="MPH ", then a wind speed of 10mpg would be represented by a vector as long as one M grid space unit. SIZISO 43-48 F6.0 0.75 Character size for displaying isoline sequence numbers within certain contours.

Variable	Position	Format	Default	Definition
ISONUM	49-54	I6	0	Interval of opportunities to use for displaying isoline sequence numbers within certain contours.

Note: An "opportunity" is a grid space where the contour segment is long (where the segment would reach from left to right or from bottom to top). Larger values of ISONUM cause fewer numbers to be displayed. If ISONUM=0, then no numbers are displayed within contours.

Variable	Position	Format	Default	Definition
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 22: Displays - Title Block B (one required per execution) Graphics are no longer supported during a simulation. Assigns variables to specify the position on maps of, and the character size of, four sub-blocks of the title block. The HZ array gives the character size of the first line of sub-blocks where lines below these may be in correspondingly smaller character sizes. Only the first two, HX(1) and HY(1), must be given; all the other have defaults.

Variable	Position	Format	Default	Definition
HX(1)	1-6	F6.0	0.0	Position of sub-block 1 (HTITL block) in terms of M grid units.
HY(1)	7-12	F6.0	0.0	Position of sub-block 1 (HTITLE block) in terms of N grid units.
HZ(1)	13-18	F6.0	1.5	Character size of the first line of sub-block 1.
HX(2)	19-24	F6.0	HX(1)	Position of sub-block 2 (legend block) in terms of M grid units.
HY(2)	25-30	F6.0	HX(1)	Position of sub-block 2 (legend block) in terms of N grid units.
HZ(2)	31-36	F6.0	1.0	Character size of the first line of sub-block 2.
HX(3)	37-42	F6.0	***	Position of sub-block 3 (clock block) in terms of M grid units. The default is to the right of and above sub-block 1.
HY(3)	43-48	F6.0	***	Position of sub-block 3 (clock block) in terms of N grid units. The default is to the right of and above sub-block 1.
HZ(3)	49-54	F6.0	0.75	Character size of sub-block 3.
HX(4)	55-60	F6.0	***	Position of sub-block 4 (north direction arrow and wind) in terms of M grid units of the center of the north direction arrow. The default is to the right of the clock block.
HX(4)	61-66	F6.0	***	Position of sub-block 4 (north direction arrow and wind) in terms of N grid units of the center of the north direction arrow. The default is to the right of the clock block.
HZ(4)	67-72	F6.0	0.75	Character size of sub-block 4.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 23: Displays - Grid A (one required per execution)

Variable	Position	Format	Default	Definition
DXPDY	1-6	F6.0	0.0	The ratio of DX and DY, that is, the ratio between the width and height of a grid space on displays. Normally DXPDY=1.0, since the grid space represents a square in geographic space.

Variable	Position	Format	Default	Definition
XLEFT	7-12	F6.0	0.0	Left-hand margin in terms of grid units.
YBOT	13-18	F6.0	0.0	Bottom margin in terms of grid units.
XRIGHT	19-24	F6.0	0.0	Right-hand margin in terms of grid units.
YTOP	25-30	F6.0	0.0	Top margin in terms of grid space units.
XDELT	31-36	F6.0	0.0	The X adjustment of position of all land boundary outlines, in grid units.
YDELT	37-42	F6.0	0.0	The Y adjustment of position of all land boundary outlines, in grid units.
VECWDR	43-48	F6.0	0.5	The normal line width of vectors on constituent concentration maps (maximum= 1.0).
VECWDV	49-54	F6.0	0.5	The normal line width of vectors on all other maps (maximum=1.0).
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 24: Displays - Grid B (one required per execution)

Variable	Position	Format	Default	Definition
IPLC	1-6	I6	0	Interval of vectors on constituent maps. If IPLC=1, vectors are drawn at every grid point; if IPLC=2, vectors are drawn at every other grid point, etc. IPLC should not be zero.
IPLV	7-12	I6	0	Interval of vectors in all other maps. If IPLV=1, vectors are drawn at every grid point, as in IPLC. IPLV should not be zero.
IWLDP	13-18	I6	0	Flag for vectors on all maps (1=draw vectors at water-level grid points; 2=draw vectors at depth points; 3=draw vectors at both water level and depth points).
VECT	19-24	F6.0	0.0	Current speed (in units of feet per second or meters per second) to represent by a vector of length DX or the width of a grid space. VECT is similar in purpose to VECTW in Displays - Title Block A.

Variable	Position	Format	Default	Definition
VECTM	25-30	F6.0	0.0	Transport per unit width. That is, VECTM is the number of units of transport to represent by a vector of length DX. VECTM is similar in purpose to VECT. The units of mass transport are cfs/foot or cms/meter.
ARRR	31-36	F6.0	0.0	Ratio of arrowhead to vector length in concentration maps. If negative, a full arrowhead is drawn, if positive, a half arrowhead is drawn.
ARRV	37-42	F6.0	0.0	Ratio of arrowhead to vector length in all other maps. If negative, a full arrowhead is drawn, if positive, a half arrowhead is drawn.
TANG	43-48	F6.0	0.0	Tangent of the angle of arrowheads to vectors.
DOR	49-54	F6.0	0.0	Flag for displaying dots at flooded grid points (0.0=no, 1.0=yes) on concentration maps.
DOV	55-60	F6.0	0.0	Flag for displaying dots at flooded grid points (0.0=no, 1.0=yes) on all other maps.
MAPX	61-66	I6	0	Flag to omit display of checkpoint location and computed values. For concentration maps the computed values are concentration and water level, for mass-transport maps: mass transport and water level; for velocity and water-level maps: velocity magnitude and water level. (0=include checkpoint data, 1=omit).
MAPO	67-72	I6	0	Flag for omitting marker at outfall or sources locations on maps (0=no, 1=yes).
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 25: Coarse-Grid Parameters (one required per execution)

Variable	Position	Format	Default	Definition
LINX	1-6	I6	0	Number of grid spaces in the first coarse grid space on the left. LINX must be > 0.

Variable	Position	Format	Default	Definition
LINY	7-12	I6	0	Number of grid spaces in the first coarse grid space on the right. LINY must be >0.
MCG	13-18	I6	0	Number of grid spaces per coarse grid space other than the first and last in the M direction. MCG must be > 0
NCG	19-24	I6	0	Number of grid spaces per coarse grid space other than the first and last in the N direction. NCG must be > 0
MCGM	25-30	I6	0	Number of coarse grid points in the M direction.
NCGM	31-36	I6	0	Number of coarse grid points in the N direction.

Note: The combination of LINX, MCG and MCGM determine the number of grid spaces in the rightmost grid space, which must be at least 1. Similarly, LINY, NCG and NCGM determine the number of fine grid spaces in the topmost grid space, which must be at least 1.

Variable	Position	Format	Default	Definition
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 26: Coefficients and Constants B (one required per execution)
See also the Coefficients and Constants A record, (record 19).

Variable	Position	Format	Default	Definition
TEMPW	1-8	F8.0	0.0	Water temperature in the equation of state, in Fahrenheit or centigrade degrees.
RHOM	9-16	F8.0	0.0	Reference specific gravity used in the computation of the effect of the pressure gradient caused by the salinity (see LSAL on Constituents record, above). In other words, RHOM is the ambient specific gravity of the sea water surrounding the model. The normal specific gravity of water is 1.0.
ALPH0	17-24	F8.0	0.0	Constant in the equation of state.
ERGC1	25-30	F8.0	0.0	Fraction of energy height upstream of a barrier that is to be used in computation.
ERGC2	33-40	F8.0	0.0	Turbulent energy coefficient times the depth/length scale. ERGC2 may not be zero when LERG is non-zero, because it is a divisor in energy calculations.

Variable	Position	Format	Default	Definition
ERGC3	41-48	F8.0	0.0	Energy coefficient 3 (not used).
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD 27: Particle Parameters (one required if IPAR<0 of Flags record)

Variable	Position	Format	Default	Definition
INRAND	1-6	I6	0	Random number initializer for particle movement due to energy (0=use computer clock for randomness, other = initializing number for random numbers (the number will be set to the next highest odd integer).
TIPARP	7-12	F6.0	0.0	Time interval to print particle positions, in minutes. TIPARP should be a multiple of HALFDT*2.
PAR1	13-18	E6.0	0.0	Coefficient for random movement of particles due to energy in the same direction as the current.
PAR2	19-24	E6.0	0.0	Coefficient for random movement of particles due to energy in the direction normal to the current direction.
PAR3	25-30	E6.0	0.0	Coefficient 3 for random movement (not used).
DCDID	73-80	A8	blanks	Record identifier (annotation only).

PART 2: RECORDS - INITIAL ARRAY DATA

Part 2 input defines stations at which computations are saved in file, Fourier components of tide, and initial values in the computational and control arrays and constituents. Part 2 consists of 39 or 40 (1 is optional) input record sets. All records in Part 2 must be given in order: first by record set; then by sequence number of the data type, for example 1,2,3,...NOCUR (number of current stations) within the record sets that have multiple records. Eight record sets consist of a single record. Five other record sets have a variable number of records, delimited by a blank record or 999999. The optional record set (Particle Group Description) is delimited by an "END PART" record. The other record sets have a number of records based on input dimensions defined in Part 1, such as number of tide openings, number of discharge sources, grid size (NMAX and MMAX), etc.

Stations and Cross-Sections (Record sets 1-6)
Only outfalls or discharge sources are input stations; all other stations and cross-sections are locations at which computations are printed (see TIHISP), and saved on the History file for subsequent post-processing (see TIHIST). Some of these stations (or checkpoints) will normally correspond to points for which field measurements are available. Then model results can be directly compared to the field measurements for model calibration and verification activities.

The transport cross-sections may not include open boundaries, because no flow computations are made there. Other locations may lie on the computational grid boundary, but not normally outside of it. The recommended convention for naming stations and cross-sections is: "STATION AT XXXXX (n,m)", where XXXXX is the geographic location and n,m is the grid-point location.

RECORD SET 1: Water-Level Stations (NOWL number of records)

Variable	Position	Format	Default	Definition
I	1-5	I5	0	Sequence number (1,2,3,...,NOWL)
MWL	6-10	I5	0	M grid-point location.
NWL	11-15	I5	0	N grid-point location.

Limitation: Water-level stations should be placed within the computational grid or on water-level open boundaries just outside the computational grid.

Variable	Position	Format	Default	Definition
NAMWL	16-35	A20	blanks	Station name.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 2: Current Stations (NOCUR number of records)
Current stations are selected grid points at which current magnitude is printed, and U- and V-components are saved on the History file. Also, saved (depending on the value of NEXAN in Part 1) are acceleration, advection, kinetic and potential energy, friction, gradient, and vorticity.

I	1-5	I5	0	Sequence number (1,2,3,...,NOCUR)
MC	6-10	I5	0	M grid-point location.
NC	11-15	I5	0	N grid-point location.

Limitation: Current is always zero outside the computational grid.

Variable	Position	Format	Default	Definition
NAMC	16-35	A20	blanks	Station name.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 3: Discharge Sources **and Solar Radiation** (NSRC number of records)

If the M and N grid locations are both set to zero, the sequence number defines the location in the time-series data where solar radiation is input for evapotranspiration computations.

I	1-5	I5	0	Sequence number (1,2,3,...,NSRC)
MINT	6-10	I5	0	M grid-point location.
NINT	11-15	I5	0	N grid-point location.

Limitation: Discharge sources have considerable limitations on their placement, see body of report for more detail.

NAMINT	16-35	A20	blanks	Station name.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 4: Constituent Stations (KPOL number of records)

I	1-5	I5	0	Sequence number (1,2,3,...,KPOL)
MPOL	6-10	I5	0	M grid-point location.
NPOL	11-15	I5	0	N grid-point location.

Limitation: Constituent stations should be placed within the computational grid.

NAMPOL	16-35	A20	blanks	Station name.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 5: U-Transport Stations (NTRA number of records)

U-transport cross-sections are selected segments of grid columns at which mass transport and advective, diffusive, and total constituent transport are printed and saved to the History file. Optionally written to the History file are kinetic and potential energy based on the value of NEXAN in Part 1.

I	1-5	I5	0	Sequence number (1,2,3,...,NTRA)
MIT	6-10	I5	0	M grid-point location of cross section.
NIT1	11-15	I5	0	First N grid-point location of cross section.
NIT2	16-20	I5	0	Last N grid-point location of cross section.

Limitation: If cross section extends beyond the computational grid, then there will be zero contribution to transport from the grid points outside the computational grid.

NAMTRA	16-35	A20	blanks	Cross section name.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 6: V-Transport Stations (NTRAV number of records)

V-transport cross-sections are selected segments of grid columns at which mass transport and advective, diffusive, and total constituent transport are printed and saved to the History file. Optionally written to the History file are kinetic and potential energy based on the value of NEXAN in Part 1.

Variable	Position	Format	Default	Definition
I	1-5	I5	0	Sequence number (1,2,3,...,NTRAV)
NIT	6-10	I5	0	N grid-point location of cross section.
MIT1	11-15	I5	0	First M grid-point location of cross section.
MIT2	16-20	I5	0	Last M grid-point location of cross section.

Limitation: If cross section extends beyond the computational grid, then there will be zero contribution to transport from the grid points outside the computational grid.

Variable	Position	Format	Default	Definition
NAMTRV	16-35	A20	blanks	Cross section name.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 7: Dams or Dry Points (0 to any number of records, delimited by a blank record)
These records give the locations of permanently dry points, even though the depth surrounding this point would normally cause this point to be flooded. This provides a means to make a dam or causeway through the water body with considerable depth at each side.

Variable	Position	Format	Default	Definition
MDAM	1-5	I5	0	M grid-point location of a dam point.
NDAM	6-10	I5	0	N grid-point location of a dam point.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

A blank record is given after all of the Dam or Dry points are input.

Variable	Position	Format	Default	Definition
CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 8: Initial Wind and Temperatures (one required per execution)
This record gives the initial conditions pertaining to the entire grid.

Variable	Position	Format	Default	Definition
WIND	1-8	E8.0	0.0	Initial wind speed, in units indicated by WCONV and PWUNIT in Part 1. If ISVWP=1, then space-varying wind is given, which overrides this value.

Variable	Position	Format	Default	Definition
WINDA	9-16	E8.0	0.0	Initial wind direction, in degrees. Wind direction is measured from North, where North equals 0 degrees, east equals 90 degrees, and so on, clockwise, WINDA is not used if ISVWP=1.
QNRFL	17-24	E8.0	0.0	Radiation flux from the surface, in cal/ cm^2day. This and the following temperatures are not effective unless LTEMP is set equal to a constituent number. At present, these variables are only valid when using English units in the simulation.
TDRYB	25-32	E8.0	0.0	Dry bulb air temperature, in degrees centigrade.
TWETB	33-40	E8.0	0.0	Wet bulb air temperature, in degrees centigrade.
TWMS	41-48	E8.0	0.0	Water temperature at measuring station, in degrees centigrade.

RECORD SET 9: Barrier or Sluice Description (NSLU+NSLUV number of records)

The barrier computation in the simulation program permits computation through an opening in a dam. The flow can be in the U- or V-direction or both. If a U barrier is at point n,m, then the computation takes water out of m-1 and discharges it at m+1, if the water level is higher than at m+1. If U- and V-barriers are placed at the same grid point, the flow in each direction is independent of the other.

The History File contains the following computations at barriers: barrier flow condition, gate height, sill depth, effective width or ratio; water level, current, and transport rate at left or bottom and at right or top of barrier; and = concentrations of constituents.

U-barriers may be no closer than three grid spaces to one another in the m direction, and must be similarly spaced away from the computational grid enclosure. Likewise, V-barriers must be spaced by at least three grid points in the n direction and from the computational grid enclosure.

IBUV	1-5	I5	0	Barrier flag (1=U-barrier, 2=V-barrier)
I	6-10	I5	0	Sequence number (1,2,3,...,NSLU-if IBUV=1 and 1,2,3,...,NSLV-if IBUV=2). Note: Input all U-barriers and then all V-barriers with I starting at 1 for each set.
MBAR	11-15	I5	0	M grid-point location of barrier.
NBAR	16-20	I5	0	N grid-point location of barrier.

Limitation: See body of report for limitation on placement of barriers.

Variable	Position	Format	Default	Definition
NAMBAR	21-40	A20	blanks	Cross section name.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 10: Barrier Coefficients (NSLU+NSLUV number of records)

Variable	Position	Format	Default	Definition
IBUV	1-5	I5	0	Barrier flag (1=U-barrier, 2=V-barrier)
I	6-10	I5	0	Sequence number (1,2,3,...,NSLU-if IBUV=1 and 1,2,3,...,NSLV-if IBUV=2).

Note: Input all U-barrier coefficients and then all V-barrier coefficients with I starting at 1 for each set.

Variable	Position	Format	Default	Definition
BARMU	11-58	6E8.0	0.0	Array of six coefficients. The first four are contraction coefficients, two for sub-critical flow (positive and negative), and two for super-critical flow (positive and negative). Coefficients 5 and 6 are for gate restricting flow (positive and negative flow).
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 11: Barrier Initial Input (NSLU+NSLUV number of records)

Variable	Position	Format	Default	Definition
IBUV	1-5	I5	0	Barrier flag (1=U-barrier, 2=V barrier)
I	6-10	I5	0	Sequence number (1,2,3,...,NSLU-if IBUV=1 and 1,2,3,...,NSLV-if IBUV=2).

Note: Input all U-barrier coefficients and then all V-barrier coefficients with I

starting at 1 for each set.

Variable	Position	Format	Default	Definition
SILL	11-20	E10.0	0.0	Initial sill depth, in feet or meters. SILL is positive downwards.
GATE	21-30	E10.0	0.0	Initial gate height, in feet or meters. GATE is positive upwards.
BRAT	31-40	E10.0	0.0	Initial effective width or ratio (barrier width divided by the grid size AL). BRAT is the fraction of the grid space that is open (BRAT=0.0 means the grid is entirely closed to flow).
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Tide Openings (Record sets 12-19)
At each open boundary, water levels or velocities or transport rates are to be given. These can be described by a time-varying data (given in Part 3), or by Fourier components of amplitude and phase (given in Part 2). The inputs are given or implied at both ends of the opening. Linear interpolation between these inputs is used for time-varying data. If Fourier components are used, then the amplitude and phase of each component are linearly interpolated between the inputs at the two ends. If an open boundary is long (greater than 10 percent of the shortest grid dimension), it must be places at the edge of the rectangular grid (and the computational grid chosen to correspond).

If the data are the same at each side of the opening, then the flag LVSAME is set to one and the inputs at end B are not given (these values are automatically set in the program). The initial tide levels given here override the initial level (SEINV in Part 1) at the openings.

Concentrations and constituent return times are also described at both ends of openings. Constituent return time is the time interval after outflow changes to inflow during which the concentration returns to the value of the inflow. Concentrations and return times are also interpolated linearly across the opening, and the results override at the opening the concentrations given by RINT and R in Part 2.

RECORD SET 12: Tide Opening Description (NTO=NTOT+NTOF number of records)
Open boundaries may be defined in any order regardless of their position on the grid. However, the NTOT number of time-varying tide openings are input first, followed by the NTOF number of Fourier-related tide openings. Also, the ends of the tide opening need not be in any specific order. The convention is that ends are ordered in the clockwise direction.

Variable	Position	Format	Default	Definition
ISQ	1-2	I2	0	Sequence number (1,2,3,...,NTO). Fourier-related tide openings are numbered NTOT+1 to NTOF.
KBO	3-4	I2	0	Type of opening option as to water level or velocity or transport rate input, and position relative to the computational grid. KB0 range is 1-16.

Note: For water-level openings there are 8 possibilities: 4 diagonals at 45-degree multiples and 2 vertical and 2 horizontal sides of the grid. For velocity and transport rate openings, there are 4 possibilities each: the 2 vertical and 2 horizontal sides of the grid. Table 10 in the body of this report describe the possible KB0 values.

Variable	Position	Format	Default	Definition
KB1M	5-7	I3	0	M grid-point location of end A of the opening.
KB1N	8-10	I3	0	N grid-point location of end A of the opening.
KB2M	11-13	I3	0	M grid-point location of end B of the opening.

Variable	Position	Format	Default	Definition
KB2N	14-16	I3	0	N grid-point location of end B of the opening.

Note: The two coordinates are the same values if the opening consists of a single grid point. Otherwise they define a diagonal, vertical, or horizontal line as indicated by KB0.

Limitation: Tide openings must be positioned just outside the computational grid. The default computational grid, if none is explicitly specified, extends from m=2 through m=MMAX-1 and from n=2 through n=NMAX-1. In this case, a tide openings are located on one of the four lines m=1, m= MMAX, n=1, or n=NMAX, except for velocity and transport rate openings which are located on m=1, m=MMAX-1, n=1, or n=NMAX-1. The reason for these exceptions is that in the space-staggered grid the velocity points are already above and to the right of the water level grid point with the same n,m index.

Variable	Position	Format	Default	Definition
LVSAME	17-18	I2	0	Flag to indicate that the values at both ends of the opening are the same. (0=no, 1=yes).
CBND	19-26	E8.0	0.0	Chezy value along the opening. These Chezy values are not computed from Manning's N input, although Chezy values in the interior are.
NAMT1	27-46	A20	blanks	Name of end A
NAMT2	47-66	A20	blanks	Name of end B
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 13: Tide Opening Initial Values at End A (NTO number of records)

Variable	Position	Format	Default	Definition
NSQ	1-2	I2	0	Sequence number (1,2,3,...,NTO). Fourier-related tide openings are numbered NTOT+1 to NTOF.
TID1	3-10	E8.0	0.0	Initial water level, velocity, or transport rate at end A of the opening, depending on the KB0 code. For Fourier-related openings, TIDA is also used in the initial interpolation through time TLFSMO as given in Part 1.
TCRETA	11-16	F6.0	0.0	Constituent return time at end A after the current reverses to inward flow, in minutes. This value will be set to the nearest non-zero multiple of HALFTD*2.

Variable	Position	Format	Default	Definition
TRBNDA	17-72	7E8.0	0.0	Array of 7 entries, for the initial concentration at end A of the tide opening for as many as 7 constituents.

Note: TRBNDA is also the ambient concentration outside this end of the boundary, and the computation automatically returns to this concentration over the given period of time (TCRETA), after the current reverses to inward flow. TRBNDA as the ambient concentration can be varied with time (see record type C in Part 3).

DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 14: Tide Opening Initial Values at End B (NTOM number of records) NTOM equals NTO less the number of openings where LVSAME=1.

NSQ	1-2	I2	0	Sequence number (1,2,3,...,NTO).

Fourier-related tide openings are numbered NTOT+1 to NTOF. No records are input for those openings where LVSAME was specified as 1.

TID2	3-10	E8.0	0.0	Initial water level, velocity, or transport rate at end B of the opening, depending on the KB0 code. For Fourier-related openings, TIDB is also used in the initial interpolation through time TLFSMO as given in Part 1.
TCRETB	11-16	F6.0	0.0	Constituent return time at end B after the current reverses to inward flow, in minutes. This value will be set to the nearest non-zero multiple of HALFTD*2.
TRBNDB	17-72	7E8.0	0.0	Array of 7 entries, for the initial concentration at end B of the tide opening for as many as 7 constituents.

Note: An interpolation between TRBNDA and TRBNDB overrides at the opening the initial concentration, as given below. TRBNDB is also the ambient concentration outside this end of the boundary, and the computation automatically returns to this concentration over the given period of time (TCRETB), after the current reverses to inward flow. TRBNDB as the ambient concentration can be varied with time (see record type C in Part 3).

DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 15: Frequencies of Fourier or Harmonic Components If NTOF>0(NOFC=INT(KC+7)/8 number of records) This set consists of 1 record per 8 components. For example, if KC=10, then there are 8 components defined on record 1 and 2 components defined on record 2.

Variable	Position	Format	Default	Definition
OMEGA	11-66	8E7.0	0.0	Array of angular frequencies, in 0.0001 radians per second.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 16: Amplitude Components at End A (NTOF number of record groups with each group consisting of NOFC=INT(KC+7)/8 number of records)
This and the next three record sets define the Fourier components of amplitude and phase at both ends of relevant tide openings. Amplitudes pertain to water level or velocity or transport rate, depending on the value of KB0. The form is identical in these four record sets, except that amplitude is given at the initial zero frequency, and phase is not.

Variable	Position	Format	Default	Definition
CDTYPE	1	A1	blank	The value "A" for end A of each opening.
NSQ	2-3	I2	0	Sequence number (NTOT+1,NTOT+2,...,NTO)

The same NSQ value is repeated in continuation records with a record group.

Variable	Position	Format	Default	Definition
AZEROA	4-10	E7.0	0.0	Amplitude at end A for zero frequency, given only on the first record of group.
AMPLA	11-66	8E7.0	0.0	Array of amplitudes at end A of the opening for the KC number frequencies, 8 per record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 17: Amplitude Components at End B (NTOFM number of record groups with each group consisting of NOFC=INT(KC+7)/8 number of records)
NTOFM is NTOF less the number of Fourier-related openings where the flag LVSAME=1. In other words, the amplitude at end B is only given for openings where the values differ at each end.

Variable	Position	Format	Default	Definition
CDTYPE	1	A1	blank	The value "B" for end B of each opening.
NSQ	2-3	I2	0	Sequence number (NTOT+1,NTOT+2,...,NTO)

The same NSQ value is repeated in continuation records with a record group. No records appear for tide opening numbers whose flag LVSAME=1.

Variable	Position	Format	Default	Definition
AZEROB	4-10	E7.0	0.0	Amplitude at end B for zero frequency, given only on the first record of group.
AMPLB	11-66	8E7.0	0.0	Array of amplitudes at end B of the opening for the KC number frequencies, 8 per record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 18: Phase Components at End A (NTOF number of record groups with each group consisting of NOFC=INT(KC+7)/8 number of records)

Variable	Position	Format	Default	Definition
CDTYPE	1	A1	blank	The value "A" for end A of each opening.
NSQ	2-3	I2	0	Sequence number (NTOT+1,NTOT+2,...,NTO)

The same NSQ value is repeated in continuation records with a record group.

Variable	Position	Format	Default	Definition
PHASEA	11-66	8E7.0	0.0	Array of phases at end A of the opening for the KC number frequencies, 8 per record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 19: Phase Components at End B (NTOFM number of record groups with each group consisting of NOFC=INT(KC+7)/8 number of records)
NTOFM is NTOF less the number of Fourier-related openings where the flag LVSAME=1. In other words, the amplitude at end B is only given for openings where the values differ at each end.

Variable	Position	Format	Default	Definition
CDTYPE	1	A1	blank	The value "B" for end B of each opening.
NSQ	2-3	I2	0	Sequence number (NTOT+1,NTOT+2,...,NTO)

The same NSQ value is repeated in continuation records with a record group. No records appear for tide opening numbers whose flag LVSAME=1.

Variable	Position	Format	Default	Definition
PHASEB	11-66	8E7.0	0.0	Array of phases at end B of the opening for the KC number frequencies, 8 per record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 20: Constituent Description (LMAX number of records)
The constituents should be ordered so that interacting constituents come first
(see LMRX on the Constituents record in Part 1).

Variable	Position	Format	Default	Definition
NSQ	1-2	I2	0	Constituent number (1,2,...,LMAX) maximum=7.
RINT	3-10	E8.0	0.0	Initial concentration in the interior. This value is overridden if concentrations are given in record set 35 below, except that this value replaces any zero values given in record set 35
POLT	11-30	A20	blanks	Constituent name, used for annotation and saved in History file for display on graphics.

Variable	Position	Format	Default	Definition
POLTUN	31-50	A20	blanks	Units of the concentration data for this particular constituent, used for annotation and saved in History file.
KPFLAG	51	I1	0	Axis type for graphics (not currently used) (0=linear axis, 1=log axis).
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 21: Constituents - Interaction Rates (LMAX number of records)

Variable	Position	Format	Default	Definition
NSQ	1-2	I2	0	Constituent number (1,2,...,LMAX)
AKK	3-50	6E8.0	0.0	Array of 6 entries defining the interaction rates between constituent NSQ and constituent 1 through 6.

Note: Non-zero interaction rates are given for the first LRMX number of interactive constituents, and decay (action upon itself) is possible for all constituents, regardless of LRMX. If LOX is not zero (on Constituents record in Part 1), then the interaction rate given here for constituent LOX will be overridden by AKTP (in Part 1).

Variable	Position	Format	Default	Definition
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 22: Constituents Isolines (LMAX number of records)

Variable	Position	Format	Default	Definition
NSQ	1-2	I2	0	Constituent number (1,2,...,LMAX)
PLEC	3-74	9E8.0	0.0	Isoline values for drawing maps for this constituent (not currently used). The first zero isoline value ends the list, so that if a zero isoline is intended, a number very close to zero should be given.
DCDID	75-80	A6	blanks	Record identifier (annotation only).

RECORD SET 23: Velocity Isolines (1 record required per execution)

Variable	Position	Format	Default	Definition
PLEV	3-74	9E8.0	0.0	Isoline values for drawing velocity maps (not currently used). The first zero isoline value ends the list, so that if a zero isoline is intended, a number very close to zero should be given.

Variable	Position	Format	Default	Definition
DCDID	75-80	A6	blanks	Record identifier (annotation only).

RECORD SET 24: Mass-Transport Isolines (1 record required per execution)

Variable	Position	Format	Default	Definition
PLEM	3-74	9E8.0	0.0	Isoline values for drawing mass-transport maps (not currently used). The first zero isoline value ends the list, so that if a zero isoline is intended, a number very close to zero should be given.
DCDID	75-80	A6	blanks	Record identifier (annotation only).

RECORD SET 25: Water-Level Isolines (1 record required per execution)

Variable	Position	Format	Default	Definition
PLEW	3-74	9E8.0	0.0	Isoline values for drawing water-level maps (not currently used). The first zero isoline value ends the list, so that if a zero isoline is intended, a number very close to zero should be given.
DCDID	75-80	A6	blanks	Record identifier (annotation only).

RECORD SET 26: Land-Boundary Outlines (1 or more boundary-outline groups may be given) The geography of the land boundaries can be digitized by tracing the outlines on a position-sensitive device. The results are connected by straight-line segments approximating the land boundary (represented by the end points defining the lines). A record is input for each point giving the m and n grid coordinate values. Multiple sets of continuous lines can be input. A continuous outline group consists of an outline header record, a variable number (at least two) of point records, and a blank record to indicate the end of the group. After all outline groups are input a Land-Boundary End record is input.

Outline Header record (1 per outline group)

Variable	Position	Format	Default	Definition
BMOD	1-6	F6.0	0.0	Line width to use for this group (not currently used).
BLIN	7-12	F6.0	0.0	Dash length, in grid space units (not currently used).
BSPC	13-18	F6.0	0.0	Space between dashes. If BSPC=0.0 then the line will be solid (not currently used).
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Variable	Position	Format	Default	Definition
Outline End-Point records (2 to any number per outline group)				
XLAND	1-12	E12.0	0.0	Location in the grid in terms of M for this end point on the outline segment.
YLAND	13-24	E12.0	0.0	Location in the grid in terms of N for this end point on the outline segment.
DCDID	73-80	A8	blanks	Record identifier (annotation only).
Blank Record Delimiter (1 per outline group) A blank record is given to signal the end of an outline segment.				
CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).
Note: the above three record types are repeated until the land-boundary is completely specified.				
Land-Boundary End record (1 required per execution)				
RFLAG	1-10	F10.0	0.0	The value "999999999." must be coded to signal the end of record set 26.

RECORD SET 27: Bathymetry Values (1 set of bathymetry records required per execution) This record set specifies the bathymetry points in terms of a downward distance. These are the vertical distances, measured positive downward, from the zero datum elevation to bottom surface for all points on the grid. However, for grid points high enough to be always dry, values should be left blank or set to zero, and they will be reset to the negative of the default depth value DEPDEF. Downward distances greater than the depth threshold DCO will be multiplied by the experimental depth multiplier DML (DEPDEF, DCO, and DML are on the Physical Characteristics record in Part 1). The bathymetry point (n,m) is actually located in the grid at (n+.5, m+.5) (see staggered grid description in body of this report)

If bathymetry values are specified as integers (no decimal point), then one decimal point is assumed, so that the units of these integer values are tenths of feet or decimeters. If a decimal point is explicitly given, then the units are feet or meters. Bathymetry values (and concentrations--record set 35 below) can be input as either 16 values per record with a field width of 4 or 10 values per record with a field width of 6, depending on the value of IDKFMT in Part 1.

Variable	Position	Format	Default	Definition
If IDKFMT=0				
H	1-64	16F4.1	SEINV	Array of 16 bathymetry values. On the first MMAX number of records are the bathymetry values for rows n=1 to 16. On the second MMAX number of records are the bathymetry values for grid rows n=17 to 32, and so, for a total of MMAX*INT((NMAX+15)/16) number of records.
If IDKFMT=1				
H	1-60	10F6.1	SEINV	Array of 10 bathymetry values. On the first MMAX number of records are the bathymetry values for rows n=1 to 10. On the second MMAX number of records are the bathymetry values for grid rows n=11 to 20, and so, for a total of MMAX*INT((NMAX+9)/10) number of records.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Coefficient Input (Record sets 28-35)

Viscosity coefficients, diffusion coefficients, Manning's N, and benthic demand are all input in the same manner. First, a default coefficient is input, then a variable number of overrides to that default are given for particular sections of the grid, then a blank record ends the set.

RECORD SET 28: Default Value - Viscosity Coefficient (1 required per execution)

Variable	Position	Format	Default	Definition
If ICOFMT=0				
VICO	1-5	F5.0	0.0	Default viscosity coefficient.
If IDKFMT=1				
VICO	1-8	E8.0	0.0	Default viscosity coefficient.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 29: Viscosity Coefficients (any number per execution)

Variable	Position	Format	Default	Definition
If ICOFMT=0				
MVIS	1-5	F5.0	0.0	The M row in the grid at which to override.
N1VIS	6-10	I5	0	The first N grid point to override.
N2VIS	11-15	I5	0	The last N grid point to override. N1VIS+9 is the maximum value for N2VIS, as only 10 viscosity values can be input per record.

Variable	Position	Format	Default	Definition
CDVIS	16-65	10F5.0	0.0	Viscosity coefficients for grid points (MVIS,N1VIS) through (MVIS,N2VIS)
If IDKFMT=1				
MVIS	1-5	F5.0	0.0	The M row in the grid at which to override.
N1VIS	6-10	I5	0	The first N grid point to override.
N2VIS	11-15	I5	0	The last N grid point to override. N1VIS+6 is the maximum value for N2VIS, as only 7 viscosity values can be inputper record.
CDVIS	16-71	7E8.0	0.0	Viscosity coefficients for grid points (MVIS,N1VIS) through (MVIS,N2VIS)
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Blank Record Delimiter (1 required per execution)
A blank record is given to signal the end of record set 29.

Variable	Position	Format	Default	Definition
CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 30: Default Value - Diffusion Coefficient (1 required per execution)

Variable	Position	Format	Default	Definition
If ICOFMT=0				
DIFDEF	1-5	F5.0	0.0	Default diffusion coefficient.
If IDKFMT=1				
DIFDEF	1-8	E8.0	0.0	Default diffusion coefficient.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 31: Diffusion Coefficients (any number per execution)

Variable	Position	Format	Default	Definition
If ICOFMT=0				
MDIF	1-5	F5.0	0.0	The M row in the grid at which to override.
N1DIF	6-10	I5	0	The first N grid point to override.
N2DIF	11-15	I5	0	The last N grid point to override. N1DIF+9 is the maximum value for N2DIF, as only 10 diffusion values can be input per record.

Variable	Position	Format	Default	Definition
CDDIF	16-65	10F5.0	0.0	Diffusion coefficients for grid points (MDIF,N1DIF) through (MDIF,N2DIF)
If IDKFMT=1				
MDIF	1-5	F5.0	0.0	The M row in the grid at which to override.
N1DIF	6-10	I5	0	The first N grid point to override.
N2DIF	11-15	I5	0	The last N grid point to override. N1DIF+6 is the maximum value for N2VIS, as only 7 viscosity values can be input per record.
CDDIF	16-71	7E8.0	0.0	Diffusion coefficients for grid points (MDIF,N1DIF) through (MDIF,N2DIF)
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Blank Record Delimiter (1 required per execution)
A blank record is given to signal the end of record set 31.

Variable	Position	Format	Default	Definition
CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 32: Default Value - Manning's Coefficient (1 required per execution)

Variable	Position	Format	Default	Definition
If ICOFMT=0				
VMDEF	1-5	F5.0	0.0	Default Manning's coefficient.
If IDKFMT=1				
VMDEF	1-8	E8.0	0.0	Default Manning's coefficient.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 33: Manning's Coefficients (any number per execution)

Variable	Position	Format	Default	Definition
If ICOFMT=0				
MMAN	1-5	F5.0	0.0	The M column in the grid at which to override.
N1MAN	6-10	I5	0	The first N grid point to override.
N2MAN	11-15	I5	0	The last N grid point to override. N1MAN+9 is the maximum value for N2MAN, as only 10 Manning's values can be input per record.
CDMAN	16-65	10F5.0	0.0	Manning's coefficients for grid points (MMAN,N1MAN) through (MMAN,N2MAN)

Variable	Position	Format	Default	Definition
If IDKFMT=1				
MMAN	1-5	F5.0	0.0	The M column in the grid at which to override.
N1MAN	6-10	I5	0	The first N grid point to override.
N2MAN	11-15	I5	0	The last N grid point to override. N1MAN+6 is the maximum value for N2VIS, as only 7 viscosity values can be input per record.
CDMAN	16-71	7E8.0	0.0	Manning's coefficients for grid points (MMAN,N1MAN) through (MMAN,N2MAN)
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Blank Record Delimiter (1 required per execution)
A blank record is given to signal the end of record set 33.

Variable	Position	Format	Default	Definition
CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 34: Default Value - Benthic Demand (1 required per execution)
Benthic demand is not used if LBOD and LOX are both zero (see the Constituents record in Part 1). However, at least the blank delimiter must be input.

Variable	Position	Format	Default	Definition
If ICOFMT=0				
VMDEF	1-5	F5.0	0.0	Default Benthic demand value.
If IDKFMT=1				
VMDEF	1-8	E8.0	0.0	Default Benthic demand value.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 35: Benthic demand values (any number per execution, if either LBOD or LOX are not zero)

Variable	Position	Format	Default	Definition
If ICOFMT=0				
MBEN	1-5	F5.0	0.0	The M row in the grid at which to override.
N1BEN	6-10	I5	0	The first N grid point to override.
N2BEN	11-15	I5	0	The last N grid point to override. N1BEN+9 is the maximum value for N2BEN, as only 10 Manning's values can be input per record.

Variable	Position	Format	Default	Definition
CDBEN	16-65	10F5.0	0.0	Benthic demand values for grid points (MBEN,N1BEN) through (MBEN,N2BEN)
If IDKFMT=1				
MBEN	1-5	F5.0	0.0	The M row in the grid at which to override.
N1BEN	6-10	I5	0	The first N grid point to override.
N2BEN	11-15	I5	0	The last N grid point to override. N1BEN+6 is the maximum value for N2VIS, as only 7 viscosity values can be input per record.
CDBEN	16-71	7E8.0	0.0	Benthic demand values for grid points (MBEN,N1BEN) through (MBEN,N2BEN)
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Blank Record Delimiter (1 required per execution)
A blank record is given to signal the end of record set 35.

Variable	Position	Format	Default	Definition
CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 36: Initial Concentration (optional, at least a blank record required)
If initial concentration for a constituent is non-uniform, then concentration at all grid points is given here for that constituent. The units of concentration are given in POLTUN. Where concentration values are left blank or set to zero, they will be reset to RINIT for that constituent (see POLTUN and RINIT on Constituent Description record set 20). Also, at open boundaries, values given in the tide opening initial values override values given here at the same grid points (see TRBNDA and TRBNDB in record sets 12 and 13).

Preceding each concentration set is a record indicating which constituent those values pertain to. Ending each concentration set is a blank record delimiter. The concentration set is specified in the same format as initial depth values based on the value of IDKFMT. If integer values (no decimal point specified), then one decimal place is assumed, e.g. 100=10.0.

Initial Concentration Header (1 required for each concentration set input)

Variable	Position	Format	Default	Definition
L	1-5	I5	0	Constituent number to which the following concentration set pertains.

Concentration Set (1 set required for each concentration set input)

Variable	Position	Format	Default	Definition
If IDKFMT=0				
R	1-64	16F4.1	RINIT	Array of 16 initial concentration values for constituent L. On the first MMAX number of records are the values for columns n=1 to 16. On the second MMAX number of records are the concentration values for grid columns n=17 to 32, and so on, for a total of MMAX*INT((NMAX+15)/16) number of records.
If IDKFMT=1				
R	1-60	10F6.1	RINIT	Array of 10 initial concentration values for constituent L. On the first MMAX number of records are the values for columns n=1 to 10. On the second MMAX number of records are the concentration values for grid columns n= 11 to 20, and so, for a total of MMAX*INT((NMAX+9)/10) number of records.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Note: these two record types are repeated for any constituents with nonuniform initial concentration.

Blank Record Delimiter (1 required per execution)

A blank record is given to signal the end of record set 36.

CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Note: A blank record delimiter is required, whether or not there are any constituents (even though LMAX=0)

RECORD SET 37: Permanent Titles (optional, at least a blank record required)
Permanent titles may be given, to be written to the Map file for later use in labeling map displays. Usually these will label geographical areas and features, for orientation of generated graphics. In a similar way, titles may be input in Part 3 to be displayed for a given time during the simulation (not currently supported)

TITLM	18-23	F6.0	0.0	The M grid position of the center of the first character in the title.
TITLN	24-29	F6.0	0.0	The N grid position of the center of the first character in the title.

Variable	Position	Format	Default	Definition
ITICV	30	I1	0	Flag for character font (0=hardware font, 1=stroke font) (not currently supported).
TITSZ	31-34	F4.0	0.0	Character size. The normal size is 1.0 with a maximum of 2.7 (not currently supported).
TITLW	35-38	F4.0	0.0	Line width for characters in title.

TITLW=0.0 allows software to choose a value, maximum value is 2.0 (not currently supported).

Variable	Position	Format	Default	Definition
TITOR	39-42	F4.0	0.0	Orientation of the title line, in degrees. (0.0=horizontal, 90.0=vertical).
TTITL	43-70	A28	blanks	Title
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Blank Record Delimiter (1 required per execution)

A blank record is given to signal the end of record set 37.

Variable	Position	Format	Default	Definition
CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Note: A blank record delimiter is required, whether or not there are any permanent titles.

RECORD SET 38: Particle Group Description (optional, any number of records if IPAR > 0)
This record set is delimited by an END PART record and is only input if IPAR is greater than 0.

Variable	Position	Format	Default	Definition
TFPAR	9-16	E8.0	0.0	The first time for particles in this particle group to appear, in minutes. TFPAR must be a multiple of HALFDT*2, if not it is reset and a warning is issued.
TLPAR	17-24	E8.0	0.0	The last time for particles in this particle group to appear, in minutes. TLPAR must be a multiple of HALFDT*2, if not it is reset and a warning is issued.
XPAR	25-32	E8.0	0.0	The M grid position where the particle group begins.
YPAR	33-40	E8.0	0.0	The N grid position where the particle group begins.

Variable	Position	Format	Default	Definition
IPARG	41-48	I8	0	Option for type of particle movement (1=by current only, 2=by current and a uniform random function of energy, 3=by current and a Gaussian random function of energy). IPARG may be 2 or 3 only when Part 1 flag LERG is nonzero.
NPARI	49-56	I8	0	Number of particles in this particle group. NPARI must be set to 1 if IPARG=1)
DCDID	73-80	A8	blanks	Record identifier (annotation only).

End Particle Record Delimiter (1 required if IPAR>0 per execution)

This record is given to signal the end of record set 38.

CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD SET 39: Computational Grid Enclosure (optional, any number of records)

This record set is delimited by a blank record. A computational grid may be defined within the rectangular grid defined by MMAX and NMAX. The purpose of the computational grid is to limit the computation to those grid points which are potentially flooded. If the full grid rectangle is to be computed in the simulation, then only a blank record is given here. In this case, the effective computation rows and columns are m=2 to MMAX-1 and n=2 to NMAX-1. The computational grid enclosure itself is not included in the computations. As it is just outside the computation field, tide openings are located along the computational grid enclosure. Considerable computer time can be saved by defining a computational grid that fits the shape of the waterbody as compared to the default rectangular enclosure.

MBE	1-5	I5	0	The M grid-point location of a "corner".
NBE	6-10	I5	0	The N grid-point location of a "corner".
NMLAST	11-15	I5	0	Flag to signal the end of a polygon (0=no,1= yes).
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Blank Record Delimiter (1 required per execution)

This record is given to signal the end of record set 39.

CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

Variable	Position	Format	Default	Definition
RECORD SET 39A: Direct SWIFT2D Input - Active Model Rows (optional, any number of records) This record set is delimited by an blank record. This is the format by which The rows in the computational grid enclosure are input directly to SWIFT2D, not using the SWIFT_IDP preprocessor.				
Irocol(1)	1-5	I5		Row number
Irocol(2)	6-10	I5		Column of first active grid
Irocol(3)	11-15	I5		Column of last active grid
Irocol(4)	16-20	I5		Boundary condition of first active grid (1 = noflow, 2 = water level, 3 = velocity, 4 = barrier, 5 = flow
Irocol(5)	16-20	I5		Boundary condition of last active grid (1 = noflow, 2 = water level, 3 = velocity, 4 = barrier, 5 = flow
Blank Record Delimiter (1 required per execution) This record is given to signal the end of record set 39A.				
CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).
RECORD SET 40A: Direct SWIFT2D Input - Active Model Columns (optional, any number of records) This record set is delimited by an blank record. This is the format by which The columns in the computational grid enclosure are input directly to SWIFT2D, not using the SWIFT_IDP preprocessor.				
Irocol(1)	1-5	I5		Column number
Irocol(2)	6-10	I5		Row of first active grid
Irocol(3)	11-15	I5		Row of last active grid
Irocol(4)	16-20	I5		Boundary condition of first active grid (1 = noflow, 2 = water level, 3 = velocity, 4 = barrier, 5 = flow
Irocol(5)	16-20	I5		Boundary condition of last active grid (1 = noflow, 2 = water level, 3 = velocity, 4 = barrier, 5 = flow
Blank Record Delimiter (1 required per execution) This record is given to signal the end of record set 40A.				
CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

PART 3: RECORDS - TIME-VARYING DATA

Part 3 consists of record types A-N and Z. All time-varying data are optional. If time-varying tide is given, it must be specified at every interval TITIDE after TSTART through TSTOP. Other time-varying data can be given at irregular intervals as long as the time is a multiple of TITIDE and linear interpolation is valid over the time interval. The maximum duration allowed by time-varying inputs is 99 days. All time-varying data are identified by a time as the day, hour, and minute, relative to midnight at the beginning of the simulation start date (ITDATE) which is day 1, hour 0, minute 0. Midnight ending the first day of simulation is called day 1, hour 24, minute 0. All records in Part 3 must be given in order: first by record type; then by constituent number (for concentrations only) or U- or V-type (for barriers only); then by place number such as tide opening or outfall or barrier number, and lastly by time in day, hour, and minute. There may be tide values for 6 time intervals on a type A or B record. In the other record types, only one value is given per record, or two values in the case of concentration at the ends of a tide opening.

RECORD TYPE A: Tide at End A (required if NTOT > 0)Tide values at grid points across the opening are the result of linear interpolation between the given tide at end A and the result of linear interpolation between the given tide at end A and at end B (interpolation across space), as with the initial values in Part 2. Tide values at each half time step (HALFDT) are the result of linear interpolation between values at two given times (interpolation across time), for all grid points in the opening.

Variable	Position	Format	Default	Definition
CDTYPE	1	A1	blank	Code "A".
ITO	4-5	I2	0	Time-varying tide opening number (the same number as NSQ in the Tide Opening Description record set in Part 2).
CDDAY	6-7	I2	0	Day of first tide value on this record.
CDHOUR	8-9	I2	0	Hour of first tide value on this record.
CDMIN	10-11	I2	0	Minute of first tide value on this record.
KDNUMS	12-13	I2	6	The number of tide values given on this record (maximum=6).
TLVL1(6)	16-63	6E8.0	0.0	Array of KDNUMS tide values at end A of tide opening ITO.

Note: Input values are water level, velocity, or transport rate, depending on the code KB0 in the tide opening description of Part 2, for the corresponding NSQ. The units of water levels are feet or meters. The KDNUMS values pertain to times starting at CDDAY, CDHOUR, and CDMIN with an interval of TITIDE number of minutes. The first value of TLVL1 on the first type "A" record should be considered when choosing the value of TIDA in the tide opening initial values in Part 2. If water levels are given here, then see global initial level SEINV in Part 1 for the default. If velocities or transport rates are given, the default value is zero.

Variable	Position	Format	Default	Definition
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE B: Tide at End B (required if NTOT > 0 and LVSAME is non-zero for at least one time-varying tide opening)

CDTYPE	1	A1	blank	Code "B".
ITO	4-5	I2	0	Time-varying tide opening number (the same number as NSQ in the Tide Opening Description record set in Part 2).If, associated with NSQ, the flag LVSAME=1, then no type "B" records are given for that opening.
CDDAY	6-7	I2	0	Day of first tide value on this record.
CDHOUR	8-9	I2	0	Hour of first tide value on this record.
CDMIN	10-11	I2	0	Minute of first tide value on this record.
KDNUMS	12-13	I2	6	The number of tide values given on this record (maximum=6).
TLVL1(6)	16-63	6E8.0	0.0	Array of KDNUMS tide values at end A of tide opening ITO.

Note: Input values are water level, velocity, or transport rate, depending on the code KB0 in the tide opening description of Part 2, for the corresponding NSQ.

DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE C: Concentrations at Tide Openings (LMAX > 0)

Concentrations at grid points across the opening are the result of a linear interpolation between concentrations at end A and at end B (interpolation across space), as with initial water levels in Part 2. Concentrations at tide openings are automatically varied during the simulation, the constituent return times at the opening (TCRETA and TCRETB), and the concentration in the interior. During outgoing flow, the concentrations are computed from inside the field. After current reverses to inward flow at points on the boundary, the concentrations return over the return period, to the concentrations given as input here. If no value has been presented here, the initial concentrations at the boundary are used. The data in this section thus permit time-varying concentrations at the boundary during and after the return period.

CDTYPE	1	A1	blank	Code "C".
ICON	2-3	I2	0	The constituent number (the same as NSQ in the Part 2 constituent description, varying from 1 to LMAX).

Variable	Position	Format	Default	Definition
ITO	4-5	I2	0	Time-varying tide opening number (the same number as NSQ in the Tide Opening Description record set in Part 2.
CDDAY	6-7	I2	0	Day of the values on this record.
CDHOUR	8-9	I2	0	Hour of the values on this record.
CDMIN	10-11	I2	0	Minute of the values on this record.
KDEXPO	14-15	I2	0	The exponent to apply to values on the record.
CTOA	16-23	E8.0	0.0	The concentration of constituent ICON at end A of

tide opening ITO

CTOB	16-23	E8.0	0.0	The concentration of constituent ICON at end B of tide opening ITO

Note: If LVSAME=1 for ITO, then only the first value need be given, and the concentration at end B will be set equal to the concentration at end A. If a zero concentration is intended, then a value very near zero should be given, i.e., 1.0E-10.

DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE D: Discharges (NSRC > 0)

All discharge rates are automatically set to zero at simulation time zero. Any discharge rates are given here in Part 3, and a particular rate persists until interpolation to a new rate at the same discharge source. Thus, if a discharge is to be "turned off", a zero discharge rate is given. The discharge rate cannot be negative.

CDTYPE	1	A1	blank	Code "D".
ISRC	4-5	I2	0	Source number (the same number as I in the Discharge sources record set in Part 2, varies from 1 to NSRC).
CDDAY	6-7	I2	0	Day of the value on this record.
CDHOUR	8-9	I2	0	Hour of the value on this record.
CDMIN	10-11	I2	0	Minute of the value on this record.
KDEXPO	14-15	I2	0	The exponent to apply to value on this record.
DISCHG	16-23	E8.0	0.0	Discharge rate at outfall (discharge source) ISRC. Discharge is given in cubic feet per second or meters per second.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE E: Concentration at Discharge Sources (NSRC > 0 and LMAX > 0)

All concentrations at discharge sources are automatically set to zero at simulation time zero. Any change in concentration at sources is given here in Part 3, and a particular concentration persists for the same constituent at the same source. This means if a discharge is "turned off" and restarted, then the associated concentrations resume at the latest value given as input here for each constituent.

Variable	Position	Format	Default	Definition
CDTYPE	1	A1	blank	Code "E".
ICON	2-3	I2	0	The constituent number (the same as NSQ in the part 2 constituent description, varying from 1 to LMAX).
ISRC	4-5	I2	0	Source number (the same number as I in the Discharge sources record set in Part 2, varies from 1 to NSRC).
CDDAY	6-7	I2	0	Day of the value on this record.
CDHOUR	8-9	I2	0	Hour of the value on this record.
CDMIN	10-11	I2	0	Minute of the value on this record.
KDEXPO	14-15	I2	0	The exponent to apply to value on this record.
COF	16-23	E8.0	0.0	Concentration of constituent ICON at source ISRC.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE F: Wind Speed (ISVWP=0)

Values specified on record types F-K are initially given in Part 2. Global wind is not used if input and space-varying wind is also input (Part 4). Radiation flux and the three temperatures have no effect unless one of the constituents is temperature (that is, unless LTEMP is non-zero in the Constituents record in Part 1). Any change in any one condition is given by a record here with the new value, and a record type to indicate which condition is changing. As with the initial values, a new value persists until interpolation to a new value given here at a later time interval.

CDTYPE	1	A1	blank	Code "F".
CDDAY	6-7	I2	0	Day of the value on this record.
CDHOUR	8-9	I2	0	Hour of the value on this record.
CDMIN	10-11	I2	0	Minute of the value on this record.
WIND	16-23	E8.0	0.0	Global wind speed.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE G: Wind Direction (ISVWP=0)

See general description under record type F.

Variable	Position	Format	Default	Definition
CDTYPE	1	A1	blank	Code "G".
CDDAY	6-7	I2	0	Day of the value on this record.
CDHOUR	8-9	I2	0	Hour of the value on this record.
CDMIN	10-11	I2	0	Minute of the value on this record.
WINDA	16-23	E8.0	0.0	Global wind direction, in degrees. Wind direction is measured from North, where North equals 0.0 degrees, east equals 90.0 degrees, and so on, clockwise.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE H: Radiation Flux from Surface (ISVWP=0)

See general description under record type F.

CDTYPE	1	A1	blank	Code "H".
CDDAY	6-7	I2	0	Day of the value on this record.
CDHOUR	8-9	I2	0	Hour of the value on this record.
CDMIN	10-11	I2	0	Minute of the value on this record.
KDEXPO	14-15	I2	0	The exponent to apply to value on this record.
QNRFL	16-23	E8.0	0.0	Radiation flux from surface. The E format allows an exponent; however, more significance can be attained if the exponent KDEXPO is specified.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE I: Dry Bulb Air Temperature (ISVWP=0)

See general description under record type F.

CDTYPE	1	A1	blank	Code "I".
CDDAY	6-7	I2	0	Day of the value on this record.
CDHOUR	8-9	I2	0	Hour of the value on this record.
CDMIN	10-11	I2	0	Minute of the value on this record.
TDRYB	16-23	E8.0	0.0	Dry-bulb air temperature.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE J: Wet Bulb Air Temperature

See general description under record type F.

Variable	Position	Format	Default	Definition
CDTYPE	1	A1	blank	Code "J".
CDDAY	6-7	I2	0	Day of the value on this record.
CDHOUR	8-9	I2	0	Hour of the value on this record.
CDMIN	10-11	I2	0	Minute of the value on this record.
TWETB	16-23	E8.0	0.0	Wet-bulb air temperature.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE K: Temperature at Measuring Station

See general description under record type F.

CDTYPE	1	A1	blank	Code "K".
CDDAY	6-7	I2	0	Day of the value on this record.
CDHOUR	8-9	I2	0	Hour of the value on this record.
CDMIN	10-11	I2	0	Minute of the value on this record.
TWMS	16-23	E8.0	0.0	Water temperature at measuring station.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE L: Barrier Sill Depth

The initial value of barrier sill depth is given in Part 2. This value persists until interpolation to a new value given here; then that value persists until interpolation to a new value given at a later time for the same barrier.

CDTYPE	1	A1	blank	Code "L".
IBUV	2-3	I2	0	Barrier sequence number (the same as IBUV in the Barrier Initial Input record set in Part 2).
I	4-5	I2	0	Barrier sequence number (the same as I in the Barrier Initial Input record set in Part 2).

Note: I begins at 1 again, for V-barriers.

CDDAY	6-7	I2	0	Day of the value on this record.
CDHOUR	8-9	I2	0	Hour of the value on this record.
CDMIN	10-11	I2	0	Minute of the value on this record.

Variable	Position	Format	Default	Definition
KDEXPO	14-15	I2	0	The exponent to apply to value on this record.
SILL	16-23	E8.0	0.0	Barrier sill depth, in feet or meters. SILL is positive downwards.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE M: Barrier Gate Height

The initial value of barrier gate height is given in Part 2. This value persists until interpolation to a new value given here; then that value persists until interpolation to a new value given at a later time for the same barrier.

CDTYPE	1	A1	blank	Code "M".
IBUV	2-3	I2	0	Barrier sequence number (the same as IBUV in the Barrier Initial Input record set in Part 2).
I	4-5	I2	0	Barrier sequence number (the same as I in the Barrier Initial Input record set in Part 2).

Note: I begins at 1 again, for V-barriers.

CDDAY	6-7	I2	0	Day of the value on this record.
CDHOUR	8-9	I2	0	Hour of the value on this record.
CDMIN	10-11	I2	0	Minute of the value on this record.
KDEXPO	14-15	I2	0	The exponent to apply to value on this record.
GATE	16-23	E8.0	0.0	Barrier gate height, in feet or meters. GATE is positive upwards.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE N: Barrier Effective Width

The initial value of barrier effective width is given in Part 2. This value persists until interpolation to a new value given here; then that value persists until interpolation to a new value given at a later time for the same barrier.

CDTYPE	1	A1	blank	Code "N".
IBUV	2-3	I2	0	Barrier sequence number (the same as IBUV in the Barrier Initial Input record set in Part 2).
I	4-5	I2	0	Barrier sequence number (the same as I in the Barrier Initial Input record set in Part 2).

Note: I begins at 1 again, for V-barriers.

CDDAY	6-7	I2	0	Day of the value on this record.

Variable	Position	Format	Default	Definition
CDHOUR	8-9	I2	0	Hour of the value on this record.
CDMIN	10-11	I2	0	Minute of the value on this record.
KDEXPO	14-15	I2	0	The exponent to apply to value on this record.
BRAT	16-23	E8.0	0.0	Barrier effective width or ratio (the fraction of the grid space that is open to flow)
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE ' ': Blank Record Delimiter

A blank record is given after all of the above card types A to N.

Variable	Position	Format	Default	Definition
CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE Z: Temporary Titles (no longer used)

Temporary titles can be introduced for a given time span, during which they will be displayed on maps (in addition to the permanent titles given in Part 2.

Variable	Position	Format	Default	Definition
CDTYPE	1	A1	blank	Code "Z".
CDDAY	6-7	I2	0	Initial Day to display this title.
CDHOUR	8-9	I2	0	Initial Hour to display this title.
CDMIN	10-11	I2	0	Initial Minute to display this title.
ENDDAY	12-13	I2	0	Day to stop displaying this title.
ENHOUR	14-15	I2	0	Hour to stop displaying this title.
ENDMIN	16-17	I2	0	Minute to stop displaying this title.
TITLM	18-23	F6.0	0.0	The M grid position of the center of the first character in the title.
TITLN	24-29	F6.0	0.0	The N grid position of the center of the first character in the title.
ITICV	30	I1	0	Character font flag.
TITSZ	31-34	F4.0	0.0	Character size. Normal range 1.0-3.0.

Variable	Position	Format	Default	Definition
TITLW	35-38	F4.0	0.0	Line width of characters in title (0.0= software determined based on character size, maximum=2.0).
TITOR	39-42	F4.0	0.0	Orientation of the title line, in degrees. (0.0=horizontal, 90.0=vertical).
TITLE	43-70	A28	blanks	Temporary title.
KDEXPO	14-15	I2	0	The exponent to apply to value on this record.
SILL	16-23	E8.0	0.0	Barrier sill depth, in feet or meters. SILL is positive downwards.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD TYPE ' ': Blank Record Delimiter

A blank record is given to signal the end of record type Z input. This record should be present whether record type Z input is present or not.

CDTYPE	1-72	A72	blanks	Blank record.
DCDID	73-80	A8	blanks	Record identifier (annotation only).

RECORD NUMBER 1A Direct SWIFT2D Input - TIME AND WIND (required if NTOT > 0)
This is the format by which values are input directly to SWIFT2D, not using the SWIFT_IDP preprocessor.

NTCT1	*1*	*I1*	*blank*	*Flag to indicate data type input (time and wind =0).*
TITI	*2-11*	*E10.0*	*0*	*Time in minutes since the beginning of the simulation.*
NF	*12-14*	*I3*	*0*	*Number of Fourier tide components.*
ND	*15-17*	*I3*	*0*	*Number of defined discharge locations.*
NS	*18-20*	*I3*	*0*	*Number of defined sluice locations.*
LTITL	*21-23*	*I3*	*0*	*Length of temporary titles.*
ZWIND	*24-31*	*E8.0*	*0*	*Global wind speed.*
ZWINDA	*32-39*	*E8.0*	*0*	*Global wind direction in degrees.*
Q1	*40-47*	*E8.0*	*0*	*Radiation flux from surface*
Q2	*48-55*	*E8.0*	*0*	*Dry bulb air temperature*
Q3	*56-63*	*E8.0*	*0*	*Wet bulb air temperature*
Q4	*64-71*	*E8.0*	*0*	*Temperature at measuring station*

RECORD NUMBER 2A Direct SWIFT2D Input - WATER LEVEL AND CONCENTRATION AT BOUNDARY END A (required if NTOT > 0). This is the format by which values are input directly to SWIFT2D, not using the SWIFT_IDP preprocessor.

NTCT1	*1*	*I1*	*blank*	*Flag to indicate which end of the boundary is defined (A = 1).*

Variable	Position	Format	Default	Definition
TID1	*2-9*	*E8.0*	*0*	*Water level at end A.*
TRBNDA(LMAX)	*13-68*	*7E8.0*	*0*	*Concentrations for the seven constituents at end A*

RECORD NUMBER 3A Direct SWIFT2D Input - WATER LEVEL AND CONCENTRATION AT BOUNDARY END B (required if NTOT > 0). This is the format by which values are input directly to SWIFT2D, not using the SWIFT_IDP preprocessor.

NTCT1	*1*	*I1*	*blank*	*Flag to indicate which end of the boundary is defined (B = 2).*
TID2	*2-9*	*E8.0*	*0*	*Water level at end B.*
TRBNDB(LMAX)	*13-68*	*7E8.0*	*0*	*Concentrations for the seven constituents at end B.*

RECORD NUMBER 4A Direct SWIFT2D Input - CONCENTRATION AT FOURIER TIDAL BOUNDARY END A (required if NF > 0). This is the format by which values are input directly to SWIFT2D, not using the SWIFT_IDP preprocessor.

NTCT1	*1*	*I1*	*blank*	*Flag to indicate the type of data (Fourier end A = 3).*
NT	*2-4*	*I3*	*0*	*Sequence number of Fourier boundary*
TRBNDA(LMAX)	*21-76*	*7E8.0*	*0*	*Concentrations for the seven constituents at the discharge source*

RECORD NUMBER 5A Direct SWIFT2D Input - CONCENTRATION AT FOURIER TIDAL BOUNDARY END B (required if NF > 0). This is the format by which values are input directly to SWIFT2D, not using the SWIFT_IDP preprocessor.

NTCT1	*1*	*I1*	*blank*	*Flag to indicate the type of data (Fourier end B = 4).*
NT	*2-4*	*I3*	*0*	*Sequence number of Fourier boundary*
TRBNDB(LMAX)	*21-76*	*7E8.0*	*0*	*Concentrations for the seven constituents at the discharge source*

RECORD NUMBER 6A Direct SWIFT2D Input - FLOWRATE AND CONCENTRATION AT DISCHARGE SOURCES (required if ND > 0). This is the format by which values are input directly to SWIFT2D, not using the SWIFT_IDP preprocessor. ***If the sequence number corresponds to the solar radiation data used to compute evapotranspiration, the solar radiation value is input.***

NTCT1	*1*	*I1*	*blank*	*Flag to indicate the type of data (discharge = 5).*

Variable	Position	Format	Default	Definition
IN2	*2-4*	*I3*	*0*	*Sequence number of discharge source.*

If sequence number IN2 corresponds to a discharge location in Part 2, Record number 3 then:

DISCH1	*5-12*	*E8.0*	*0*	*Discharge rate*

If sequence number IN2 corresponds to solar radiation data in Part 2, Record number 3 then:

PYRA1	***5-12***	***E8.0***	***0***	***Solar Radiation in watts/square meter***
TCONC(LMAX)	*13-68*	*7E8.0*	*0*	*Concentrations for the seven constituents at the discharge source*

RECORD NUMBER 7A Direct SWIFT2D Input - SLUICE WIDTH AND GATE HEIGHT (required if NS > 0). This is the format by which values are input directly to SWIFT2D, not using the SWIFT_IDP preprocessor.

NTCT1	*1*	*I1*	*blank*	*Flag to indicate the type of data (sluice gate = 6).*
IBUVT	*2-4*	*I3*	*0*	*Orientation of sluice gate (u direction = 1, v direction = 2)*
ISL	*5-7*	*I3*	*0*	*Sluice sequence number*
SILLT	*8-15*	*E8.0*	*0*	*Sill elevation*
GATET	*16-23*	*E8.0*	*0*	*Gate height*
BRATT	*24-31*	*E8.0*	*0*	*Sluice width*

PART 4: RECORDS - SPACE AND TIME-VARYING WIND AND PRESSURE DATA

Part 4 input contains optional time- and space-varying wind and pressure. Wind and pressure throughout the field are read at irregular time intervals (usually longer intervals than in Part 3, since these data tend to have greater volume). SWIFT2D interpolates across time steps, beginning as soon as the data are read; there is no given time interval or interpolation period for Part 4. SWIFT2D also interpolates to the fine grid from the wind and pressure grid, which is typically coarser. The time intervals for Part 3 and Part 4 data tend to be staggered. Part 4 is binary input to SWIFT2D.

Variable	Position	Format	Default	Definition
Iwm	*1*	*Binary*		*Coarse grid I location of wind data*
Jwm	*2*	*Binary*		*Coarse grid J location of wind data*
Ipm	*3*	*Binary*		*Coarse grid I location of pressure data*
Jpm	*4*	*Binary*		*Coarse grid J location of pressure data*
Mwf	*5*	*Binary*		*Number of fine grids per coarse grid for wind data in U direction*
Nwf	*6*	*Binary*		*Number of fine grids per coarse grid for wind data in V direction*
Mpf	*7*	*Binary*		*Number of fine grids per coarse grid for pressure data in U direction*
Npf	*8*	*Binary*		*Number of fine grids per coarse grid for pressure data in V direction*
Nstw1	*9*	*Binary*		*Timestep at which values first apply*
Nstw2	*10*	*Binary*		*Timestep at which values last apply*
Xwf	*11*	*Binary*		*Spacing of coarse grid in U direction for wind data*
Ywf	*12*	*Binary*		*Spacing of coarse grid in V direction for wind data*
Xpf	*13*	*Binary*		*Spacing of coarse grid in U direction for pressure data*
Ypf	*14*	*Binary*		*Spacing of coarse grid in V direction for pressure data*
Windf	*15*	*Binary*		*Global wind speed*
Wmulf	*16*	*Binary*		*Multiplier for wind speed to convert to units used in the simulation*
Wvel1	*17*	*Binary*		*Wind speed at first timestep*
Wvel2	*18*	*Binary*		*Wind speed at last timestep*
Wdir1	*19*	*Binary*		*Wind direction at first timestep*
Wdir2	*20*	*Binary*		*Wind direction at last timestep*
Dpdx1	*21*	*Binary*		*U direction pressure gradient at first timestep*
Dpdx2	*22*	*Binary*		*U direction pressure gradient at last timestep*
Dpdy1	*23*	*Binary*		*U direction pressure gradient at first timestep*
Dpdy2	*24*	*Binary*		*V direction pressure gradient at first timestep*

PART 5: RECORDS - SPACE AND TIME-VARYING RAINFALL

Part 5 input contains space and time varying rainfall data. This is included as part of the code modifications made for representing coastal wetlands. Data is input at the same time interval as the tidal data in Part 3. To reduce the volume of input, a flag is read in every time interval which specifies if rainfall occurs during the interval. Part 5 is binary input.

Variable	Position	Format	Default	Definition
Irfl		Binary		Flag to indicate if rainfall occurs in the time interval (0 = no rain, 1 = rain)
Rain(Nmax,Mmax)		Binary		Array of rainfall values read in by m = 1, Mmax and n = 1, Nmax. Only read in if Irfl =1.

Appendix III. SWIFT2D Example Input Data Set

An annotated input data set for SWIFT2D is presented in this appendix as an example for the user. The simulated area is rectangular (5,000 x 7,500 meters) and discretized with 250-meter cells (20 columns and 30 rows). The simulation timestep is 2 minutes (1 minute half-timestep) and the simulation lasts 2,500 timesteps (3 days, 11 hours, 20 minutes). There is a single tidal boundary across the lower (southern) edge of the model with a fixed salinity concentration of 36 grams per kilogram. The tidal fluctuation is defined by a Fourier boundary condition with a mean elevation of 0.2 meter above an arbitrary datum, an amplitude of 0.5 meter, and a frequency of 0.0001454 radian per second (12-hour cycle). The bathymetry points are 4 meters below the datum for all grid cells, indicating that the elevation of the bottom of the water column is -4 meters. Manning's *n* is 0.025 in all cells and evapotranspiration is defined with a constant solar radiation of 200 watts per square meter. The dataset begins with 48 lines for the "instream" input (Schaffranek, 2004).

```
TEST - Rectangular Basin using 250 m grid

END NOTE

      NOSAMV=        5(NUMBER OF DIMENSIONS THAT MUST STAY THE SAME)

      NODIMV=       43(NUMBER OF DIMENSIONS TOTAL)

      NOTIV =        11 + TITLES, PERMANENT PLUS TEMPORARY

      NMAXV =      100GRID  (SEE PART 1)

      MMAXV =      150GRID  (SEE PART 1)

      NOPTV =        11+POINTS IN LAND BOUNDARY OUTLINES (SEE NOLAN&PT2)

      NOLINV=        11 +LINES IN LAND BOUNDARY OUTLINES (SEE NOLAN&PT2)

      NOWLV =       14WATER LEVEL STATIONS  (SEE NOWL IN PART 1)

      NOCURV=       36CURRENT STATIONS  (SEE NOCUR IN PART 1)

      NSRCV =        9DISCHARGE SOURCES  (SEE NSRC IN PART 1)

      KPOLV =       36CONSTITUENT STATIONS  (SEE KPOL IN PART 1)

      NTRAUV=        3U-TRANSPORT CROSS-SECTIONS  (SEE NTRA IN PART 1)

      NTRAVV=        7V-TRANSPORT CROSS-SECTIONS  (SEE NTRAV IN PART 1)

      LDAMV =        11 + DAMS OR PERMANENT DRY POINTS  (SEE PART 2)

      NSLUVV=      250U & V BARRIERS (SEE NSLU,NSLV,AND NSLUV)

      NTOV  =        9TIDE OPENINGS  (SEE NTOT, NTOF, NTO IN PART 1)

      NTOPTV=      250TIDE OPENING GRID POINTS  (SEE PART 2)

      NTOP1V=       101 + TIDE OPENINGS  (SEE NTOT,NTOF,NTO IN PART 1)

      KCV   =        1FOURIER FREQUENCIES  (SEE KC IN PART 1)
```

```
NTOFV =        5FOURIER TIDE OPENINGS  (SEE NTOF IN PART 1)

LMAXV =        4CONSTITUENTS  (SEE LMAX IN PART 1)

LMAX3V=        73 + CONSTITUENTS  (SEE LMAX IN PART 1)

NPARGV=      191+PARTICLE GROUPS  (SEE PART 2)

NPARIV=      191 +PARTICLES  (SEE PART 2)

MXPARV=       21+MAX NUMBER OF PARTICLES IN 1 GROUP  (SEE PART 2)

NOROCV=     5001 +COMPUTATIONAL GRID ROWS & COLUMNS  (GENERATED)

MNMAXV=     150GRID EDGE  (GREATER OF MMAX AND NMAX IN PART 1)

NMAXRV=        1OXYGEN GRID  (SEE LOX AND NMAX IN PART 1)

MMAXRV=        1OXYGEN GRID  (SEE LOX AND MMAX IN PART 1)

NMAXQV=        1TEMPERATURE GRID  (SEE LTEMP AND NMAX IN PART 1)

MMAXQV=        1TEMPERATURE GRID  (SEE LTEMP AND MMAX IN PART 1)

NMAXBV=        1BENTHIC DEMAND GRID  (SEE LOX,LBOD,NMAX IN PART 1)

MMAXBV=        1BENTHIC DEMAND GRID  (SEE LOX,LBOD,MMAX IN PART 1)

NMAXEV=        1ENERGY GRID  (SEE LERG AND NMAX IN PART 1)

MMAXEV=        1ENERGY GRID  (SEE LERG AND MMAX IN PART 1)

NCGMV =        1COARSE GRID  (SEE NCGM IN PART 1)

MCGMV =        1COARSE GRID  (SEE MCGM IN PART 1)

JWMV  =        1SPACE-VARYING WIND GRID  (SEE JWM IN PART 1)

IWMV  =        1SPACE-VARYING WIND GRID  (SEE IWM IN PART 1)

JPMV  =        1SPACE-VARYING AIR PRESSURE GRID (SEE JPM IN PART1)

IPMV  =        1SPACE-VARYING AIR PRESSURE GRID (SEE IPM IN PART1)

NSPANV=        1MINIMUM CURRENT REQUESTS (SEE NSPANS IN PART 1)

NMAXTV=        1MIN. CURRENT TIME GRIDS (SEE NSPANS,NMAX)

MMAXTV=        1MIN. CURRENT TIME GRIDS (SEE NSPANS,MMAX)

NOBYTV= 11999999(TOTAL NUMBER OF BYTES IN GENERATED COMMON)
```

```
Column number
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

WETMTZ  /IDP...R07        00        00        00        00        00   Part 1 Record 1

RUN NUMBER 1                                                                   Record 2

Rectangular Grid 1 JAN '00                                                     Record 3

    1.    2.   0.0    0. 4998.999999  100.999999  500.  500.  500.  500.       Record 4

999999999999999999999999.   10.   12.999999   30.   60.999999999999     0       Record 5

     0     0     2     1     0     5     1     4     0     0     0     0       Record 6

     7     3     4     4     0     4                                           Record 7

     1                                                                         Record 8

     0     1     1     1     0     0     0     0     0                         Record 9

     1     0     0     0     0     0     0                                     Record 10

   100   200   300   400   500   600   700   800   900  1000      999999       Record 11

                                                                  999999       Record 12

                                                                  999999       Record 13

                              999999                                           Record 14

    20    30     1     4     0     1     3     1     1     0     1     1       Record 15

     0     0                                                                   Record 16

               0.5                                   1                         Record 17

00.000    0.0 250.0  0.00   0.2  0.10    1.  1.00   0.5   1.0   5.0 300.0       Record 18

    9.81  0.0012   1.205   998.2  1.0000    14.3  1000.0    0.97  0.0023       Record 19
```

```
Column number
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

FR80      35SPRO          1.0   1.0       Plotter specs                      Record 20

    25      1   0.0  13.0  20.0  14.0K/HR            5   Title block A       Record 21

   10.   5.0  2.00 121.0 163.0  1.25  74.0  89.0  1.00 122.0 103.0  1.00      Record 22

   1.0   2.0   2.0   2.0   2.0                                               Record 23

     1     1     2   0.5   1.0 -0.40 -0.40  0.25   1.0   0.0     1     1      Record 24

                                                                             Record 25

    25.0  1.0250   0.698   1.0                                               Record 26

    1   10    3                                                      Part 2 Record 1

    2   10   10                                                              Record 1

    3   10   20                                                              Record 1

    4   10   30                                                              Record 1

    1    0    0                                                              Record 3

    1    5   15                                                              Record 4

    2    8   15                                                              Record 4

    3   15   15                                                              Record 4

    1    5    5   10                                                         Record 5

    1   13    5   20                                                         Record 6

                                                                             Record 7

                                                                             Record 8

 1 8  2  1 19  1 1    60.0                                                   Record 12

 1   0.200  15.0    36.0                                                     Record 13

           1.454                                                             Record 15

A 1    0.2    0.5                                                            Record 16

A 1      0                                                                   Record 18

 1  0.0001 SAL                psu                                            Record 20
```

```
Column number
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

 1                                                                              Record 21

 1                                                                              Record 22

                                                                                Record 23

                                                                                Record 24

                                                                                Record 25

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.                Record 27
```

```
Column number
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.  4.              Record 27
0.005                                                                         Record 28
                                                                              Record 29
  10.                                                                         Record 30
                                                                              Record 31
0.025                                                                         Record 32
```

```
Column number
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

                                                                                Record 33

0.                                                                              Record 34

                                                                                Record 35

                                                                                Record 36

                                                                                Record 37

    2    2   19    1    1                                                       Record 39A

    3    2   19    1    1                                                       Record 39A

    4    2   19    1    1                                                       Record 39A

    5    2   19    1    1                                                       Record 39A

    6    2   19    1    1                                                       Record 39A

    7    2   19    1    1                                                       Record 39A

    8    2   19    1    1                                                       Record 39A

    9    2   19    1    1                                                       Record 39A

   10    2   19    1    1                                                       Record 39A

   11    2   19    1    1                                                       Record 39A

   12    2   19    1    1                                                       Record 39A

   13    2   19    1    1                                                       Record 39A

   14    2   19    1    1                                                       Record 39A

   15    2   19    1    1                                                       Record 39A

   16    2   19    1    1                                                       Record 39A

   17    2   19    1    1                                                       Record 39A

   18    2   19    1    1                                                       Record 39A

   19    2   19    1    1                                                       Record 39A

   20    2   19    1    1                                                       Record 39A

   21    2   19    1    1                                                       Record 39A
```

```
Column number
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

   22     2    19     1     1                                                    Record 39A

   23     2    19     1     1                                                    Record 39A

   24     2    19     1     1                                                    Record 39A

   25     2    19     1     1                                                    Record 39A

   26     2    19     1     1                                                    Record 39A

   27     2    19     1     1                                                    Record 39A

   28     2    19     1     1                                                    Record 39A

   29     2    19     1     1                                                    Record 39A

                                                                                 Record 39A

    2     2    29     2     1                                                    Record 40A

    3     2    29     2     1                                                    Record 40A

    4     2    29     2     1                                                    Record 40A

    5     2    29     2     1                                                    Record 40A

    6     2    29     2     1                                                    Record 40A

    7     2    29     2     1                                                    Record 40A

    8     2    29     2     1                                                    Record 40A

    9     2    29     2     1                                                    Record 40A

   10     2    29     2     1                                                    Record 40A

   11     2    29     2     1                                                    Record 40A

   12     2    29     2     1                                                    Record 40A

   13     2    29     2     1                                                    Record 40A

   14     2    29     2     1                                                    Record 40A

   15     2    29     2     1                                                    Record 40A

   16     2    29     2     1                                                    Record 40A

   17     2    29     2     1                                                    Record 40A
```

```
Column number
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

   18    2   29    2    1                                                        Record 40A

   19    2   29    2    1                                                        Record 40A

                                                                                 Record 40A

0    2.         1                                                        Part 3 Record 1A

5  1  200.                                                                       Record 6A

0 5000.                                                                          Record 1A

999999.999                                                                       End
```