

EEMS Demonstration Model Description

DM_Sluice_Gate_With_Dye_Tracer

1 Objective

This demonstration model uses EFDC+ Explorer (EE) and EFDC+ to simulate a sluice gate hydraulic structure in a straight rectangular flume, coupled with conservative dye transport to visualize the hydraulic impact of the structure. The model was originally developed by DSI for demonstrating how a sluice gate boundary condition is configured in EE and how the resulting flow restriction is captured in both hydrodynamics and tracer concentrations.

The sluice gate is configured between upstream cell ($I = 19$, $J = 4$) and downstream cell ($I = 20$, $J = 4$). Dye injected at the upstream boundary is used to track the propagation of water through the gate.

2 Model Description

The model configuration is summarized in Table 1 and the model domain is shown in Figure 1. The domain represents a straight rectangular flume with bottom elevations ranging from -0.5 m to 0.0 m. The simulation covers a 24-hour period with a nominal time step of 0.5 s and a dynamic maximum of $3,600$ s.

Table 1 Model configuration summary

Run Period (hours)	Horizontal Cells	Vertical Layers	Activated Modules
24	90 cells	10 layers (Sigma)	- Hydrodynamics - Dye

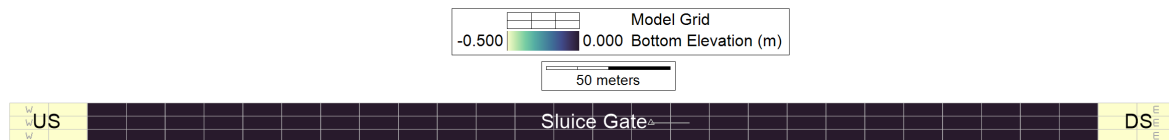


Figure 1 Model domain

2.1 Hydrodynamic Configuration

The model uses a two-time-level integration scheme on a Sigma vertical grid. Wetting and drying is activated with a nominal dry depth of 0.05 m and a wet threshold of 0.10 m.

Boundary conditions are as follows. The upstream boundary uses a time-series water surface elevation across three cells ($I = 3$, $J = 3-5$, time series 3). The downstream boundary uses a combined M_2 tidal harmonic (amplitude = 0.5 m, phase = $21,500$ s) and a time-series water surface elevation (series 2) across three cells ($I = 32$, $J = 3-5$). This combination of a time-varying upstream head and a tidally forced downstream head drives a periodically reversing flow through the sluice gate over the 24-hour simulation.

2.2 Sluice Gate Configuration

The sluice gate is configured as a single hydraulic structure using the sluice gate equation type. The gate is located between upstream cell ($I = 19$, $J = 4$) and downstream cell ($I = 20$, $J = 4$), and is uncontrolled, always open). The key gate geometry and discharge parameters are summarized in Table 2.

Table 2 Sluice gate hydraulic structure parameters

Parameter	Value
Upstream cell (I, J)	19, 4
Downstream cell (I, J)	20, 4
Structure type	6 (sluice gate)
Gate width (m)	5.0
Gate height (m)	0.25
Upstream invert elevation (m)	0.75
Downstream invert elevation (m)	0.0
Reverse flow allowed	No (HS_REVERSE = 0)
Discharge coeff. (super-critical weir)	1.45
Discharge coeff. (sub-critical weir)	0.61
Discharge coeff. (free sluice)	0.60
Discharge coeff. (submerged orifice)	0.50
Control type	Uncontrolled
Initial gate state	Open (height = 0.25 m, width = 5 m)

2.3 Dye Transport Configuration

One dye tracer class is simulated. Dye is injected via time-series concentration boundary conditions at the upstream boundary ($I = 3$, $J = 3-5$, dye series 1). The downstream boundary carries zero dye concentration. The dye is treated as conservative (no decay) at a reference temperature of 20°C.

3 Model Results

Figure 2 shows the depth-averaged dye concentration time series over the 1-day simulation at two monitoring cells: Cell 38 ($I = 9$, $J = 4$, blue), located upstream of the sluice gate, and Cell 56 ($I = 27$, $J = 4$, red), located downstream.

Both cells show a sustained dye peak, reflecting a prolonged period of dye-laden inflow from the upstream boundary. The upstream cell rises sharply to 1.0 mg/L at approximately day 0.27, maintains this concentration until approximately day 0.75, then drops sharply back to zero. The downstream cell follows the same pattern but with a small lag on both the rising and falling limbs, reaching its peak slightly after the upstream cell and returning to zero slightly later. Peak concentrations are identical at 1.0 mg/L in both cells, indicating that no dilution of the dye occurs between the two monitoring locations under these flow conditions.

The lag between the upstream and downstream cells is the key result: it represents the travel time for dye-laden water to pass through the sluice gate opening at $I = 19-20$ and advect from Cell 38 to Cell 56.

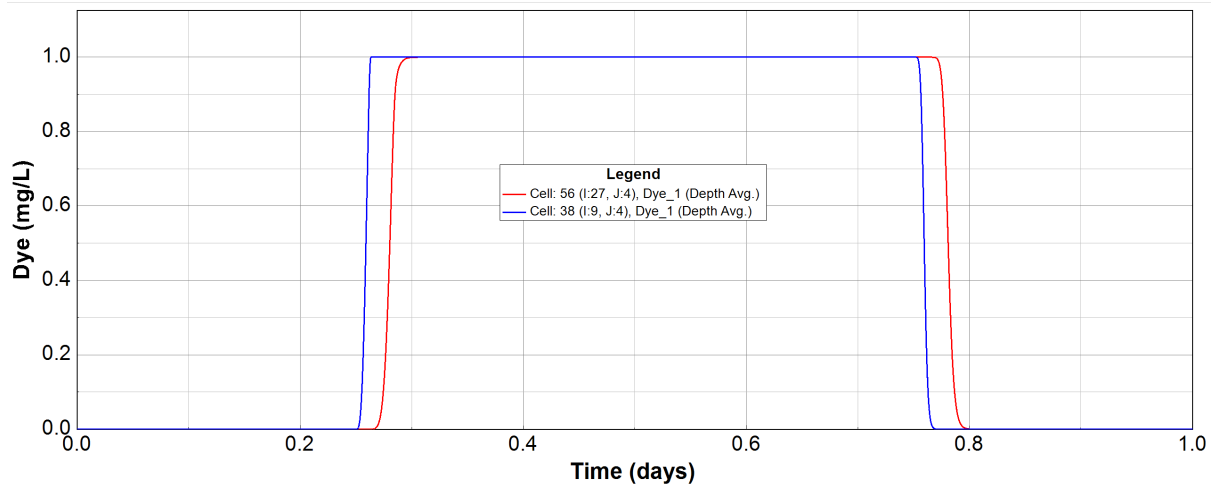


Figure 2 Depth-averaged dye concentration (mg/L) at Cell 38 (upstream of sluice gate) and Cell 56 (downstream of sluice gate) over the 1-day simulation.

4 Notes

4.1 Disclaimer

This model is provided to demonstrate that EFDC+ Explorer and EFDC+ can be used to build and analyze this type of models. The simulation results are consistent with expected behavior; however, the model should not be considered a final or validated product. Users are encouraged to review, modify, and refine model parameters to obtain results appropriate for their specific application.

4.2 EEMS Demo Mode

In Demo mode, the model is validated against a set of predefined signatures, including grid size, domain area, center coordinates, transport count, and module configuration. While certain parameter values may be adjusted, the grid cannot be modified, transports cannot be added, and the prescribed module setup cannot be altered. Any deviation from these conditions results in the model no longer being considered a valid demo model.

4.3 Support

For technical support, additional documentation, or to obtain the latest version of EFDC+ Explorer, please visit: www.eemodelingsystem.com