

# EEMS Demonstration Model Description

## DM\_Straight\_Flume\_SEDZLJ\_Toxics

## 1 Objective

This demonstration model uses EFDC+ Explorer (EE) and EFDC+ to simulate sediment transport using the SEDZLJ sub-model, along with chemical fate and transport of naphthalene in a straight rectangular flume. Two sub-models are included: one activates bedload transport, and the second is configured to be diffusion-dominated. Together, they demonstrate the contrasting behavior of a sediment-bound contaminant under advective bedload versus pore-water diffusion controlled conditions. The model was originally developed by DSI for testing the SEDZLJ sediment transport and toxics modules in EFDC+, and step-by-step guidance is available on the EE Knowledge Base at [www.eemodelingsystem.com](http://www.eemodelingsystem.com).

## 2 Model Description

The shared 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  $-1,000$  m to  $0.3$  m. Both sub-models share a 3-hour simulation period with a nominal time step of  $0.05$  s and a dynamic maximum of  $3,600$  s.

**Table 1** Shared model configuration summary

| Run Period (hours) | Horizontal Cells | Vertical Layers                                                                                         | Activated Modules                                                                                                                         |
|--------------------|------------------|---------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 3                  | 302 cells        | <ul style="list-style-type: none"> <li>4 water column layers</li> <li>10 sediment bed layers</li> </ul> | <ul style="list-style-type: none"> <li>Hydrodynamics</li> <li>Sediment transport (SEDZLJ)</li> <li>Chemical fate and transport</li> </ul> |

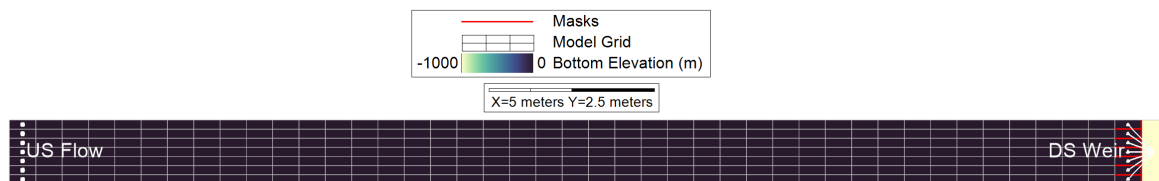


**Figure 1** Model domain showing the straight rectangular flume (302 active cells, IC = 48, JC = 11). Bottom elevation ranges from  $-1,000$  m (upstream) to  $0.3$  m (downstream weir).

### 2.1 Shared Hydrodynamic Configuration

Both sub-models use a two-time-level integration scheme ( $IS2TIM = 1$ ) on a 302-cell Cartesian flume grid with 4 equal sigma layers and Mellor–Yamada 2.5 turbulence closure ( $ISTOPT(TURB) = 2$ ). Wetting and drying is activated ( $ISDRY = 99$ ) with a minimum depth of  $0.001$  m and a wet threshold of  $0.006$  m. No wind, tidal, or atmospheric forcing is applied.

Boundary conditions consist of a time-series upstream inflow distributed across seven cells at the west face ( $I = 3$ ,  $J = 3-9$ ) and a downstream weir structure across seven cells at  $I = 45-46$ ,  $J = 3-9$  (uncontrolled, rating table 1).

## 2.2 SEDZLJ Sediment Configuration

The SEDZLJ sediment sub-model is used with 10 bed layers ( $KB = 10$ ), spatially variable bed initial conditions defined by core and core-field files, and a bed layer thickness of 0.015 m. Erosion rates are specified via a lookup table by core ID. The two sub-models differ in the number of sediment classes and whether bedload transport is active, as described in Table 2.

## 2.3 Naphthalene Toxics Configuration

One toxic contaminant (naphthalene,  $NTOX = 1$ ) is simulated in both sub-models using equilibrium  $K_d$  partitioning ( $ISTOC = 0$ ). The  $K_d$  partition coefficient is identical in both cases:  $K_d = 0.0022909$  L/mg for both water-column and sediment bed phases. No decay or volatilization kinetics are applied. The initial bed naphthalene concentration is 1 mg/kg (in bed layers 7–10 only, with layers 1–6 empty) and zero initial water-column concentration.

The key difference between the two sub-models is the pore-water particle mixing depth ( $DPDFTOX$ ), which controls how deeply particle mixing redistributes naphthalene within the bed. In the bedload case ( $DPDFTOX = 10.0$  m), deep particle mixing combined with active bedload transport drives redistribution of naphthalene along the flume and enhances flux to the water column. In the diffusion-dominated case ( $DPDFTOX = 0.1$  m), the shallow mixing depth restricts inter-layer exchange to near the sediment–water interface, so naphthalene release is controlled primarily by molecular diffusion and is spatially more uniform.

**Table 2** Sub-model configurations

| Parameter                       | Kd_SEDZLJ_DP_Bedload | Kd_SEDZLJ_DP_Diffusion_Dominated |
|---------------------------------|----------------------|----------------------------------|
| Sediment classes (NSED)         | 1                    | 3                                |
| Specific gravity (SSG)          | 2.65                 | 2.65 / 2.649                     |
| Critical shear stress, class 2  | —                    | $7 \times 10^{-5}$ Pa            |
| Toxics–sediment interactions    | 1 class              | 3 classes                        |
| Particle mixing depth (DPDFTOX) | 10.0 m               | 0.1 m                            |
| Bedload transport               | Active               | Inactive                         |
| Dominant mechanism              | Bedload advection    | Pore-water diffusion             |

## 3 Folder Structure

The model package contains the following components:

- **Models:** Two EFDC+ model project directories, each loadable directly in EFDC+ Explorer for pre- and post-processing:
  - **Kd\_SEDZLJ\_DP\_Bedload:** Bedload-activated configuration with one sediment class and  $DPDFTOX = 10.0$  m.
  - **Kd\_SEDZLJ\_DP\_Diffusion\_Dominated:** Diffusion-dominated configuration with three sediment classes and  $DPDFTOX = 0.1$  m.
- **Test\_record file:** A record file identifying the EFDC+ executable version used to run the models.

All boundary condition and parameter data are embedded directly in the model input files; no separate Data folder is included.

## 4 Model Results

Figure 2 shows the bottom-layer water-column naphthalene concentration at Cell 171 ( $I = 43$ ,  $J = 6$ ) for both sub-models. The bedload model (red, left axis) produces a sharp pulse peaking at  $\approx 1.0 \mu\text{g/L}$  near day 0.05 as naphthalene-laden sediment is transported to the downstream end of the flume. The diffusion-dominated model (blue, right axis) remains approximately four orders of magnitude lower throughout, confirming that reducing the particle mixing depth ( $\text{DPDFTOX} = 0.1 \text{ m}$ ) effectively locks naphthalene in the bed and suppresses release to the water column.

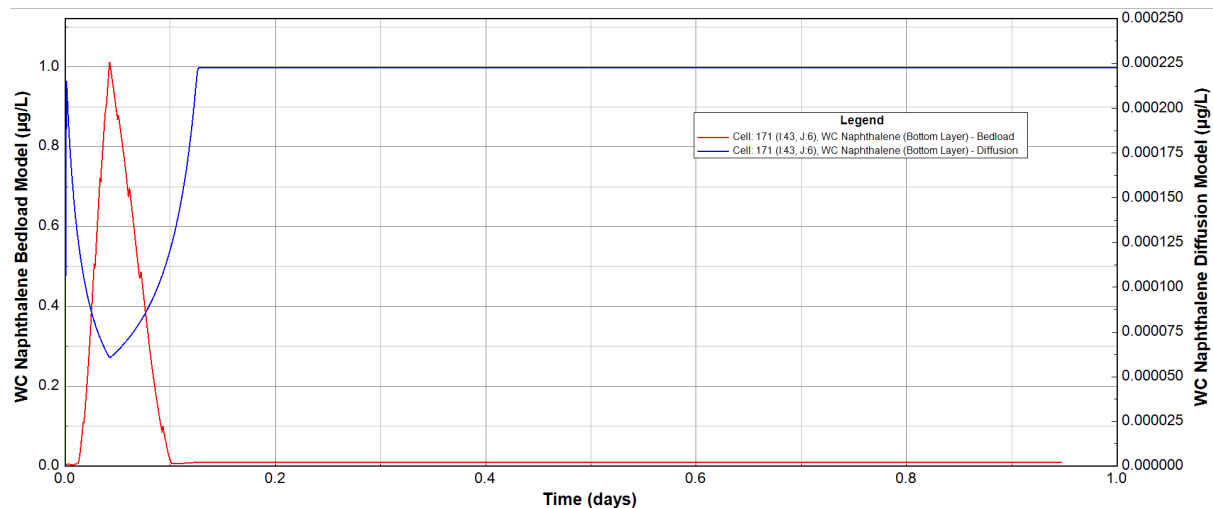


**Figure 2** Bottom-layer water-column naphthalene ( $\mu\text{g/L}$ ) at Cell 171 ( $I = 43$ ,  $J = 6$ ). Red (left axis): bedload model; blue (right axis): diffusion-dominated model.

## 5 Notes

### 5.1 Disclaimer

This model is provided to demonstrate that EFDC+ Explorer and EFDC+ can be used to simulate SEDZLJ sediment transport coupled with chemical fate and transport. 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.

### 5.2 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.

### 5.3 Support

For technical support, additional documentation, or to obtain the latest version of EFDC+ Explorer, please visit: [www.eemodelingsystem.com](http://www.eemodelingsystem.com)