The Finite Element Heat- and Mass-Transfer (FEHM) Model

- Nonisothermal multiphase flow and reactive transport.
- Reduced degree of freedom method for coupled system of equations.
- Equivalent continuum and dual-permeability modeling capabilities.
- Geometric modeling and unstructured meshes for geological applications.
- Inverse modeling of nonlinear parameter estimation.

Preferences On Coupling LADHS/FEHM

- Preserve the full capability of FEHM.
- Maintain modular structure of codes.
- Couple at the land surface.
- Allow the flexibility of using both 1-D and 3-D descriptions of multiphase flow.
- Allow both two-way coupling (i.e., with iteration) and one-way coupling (i.e., without iteration).

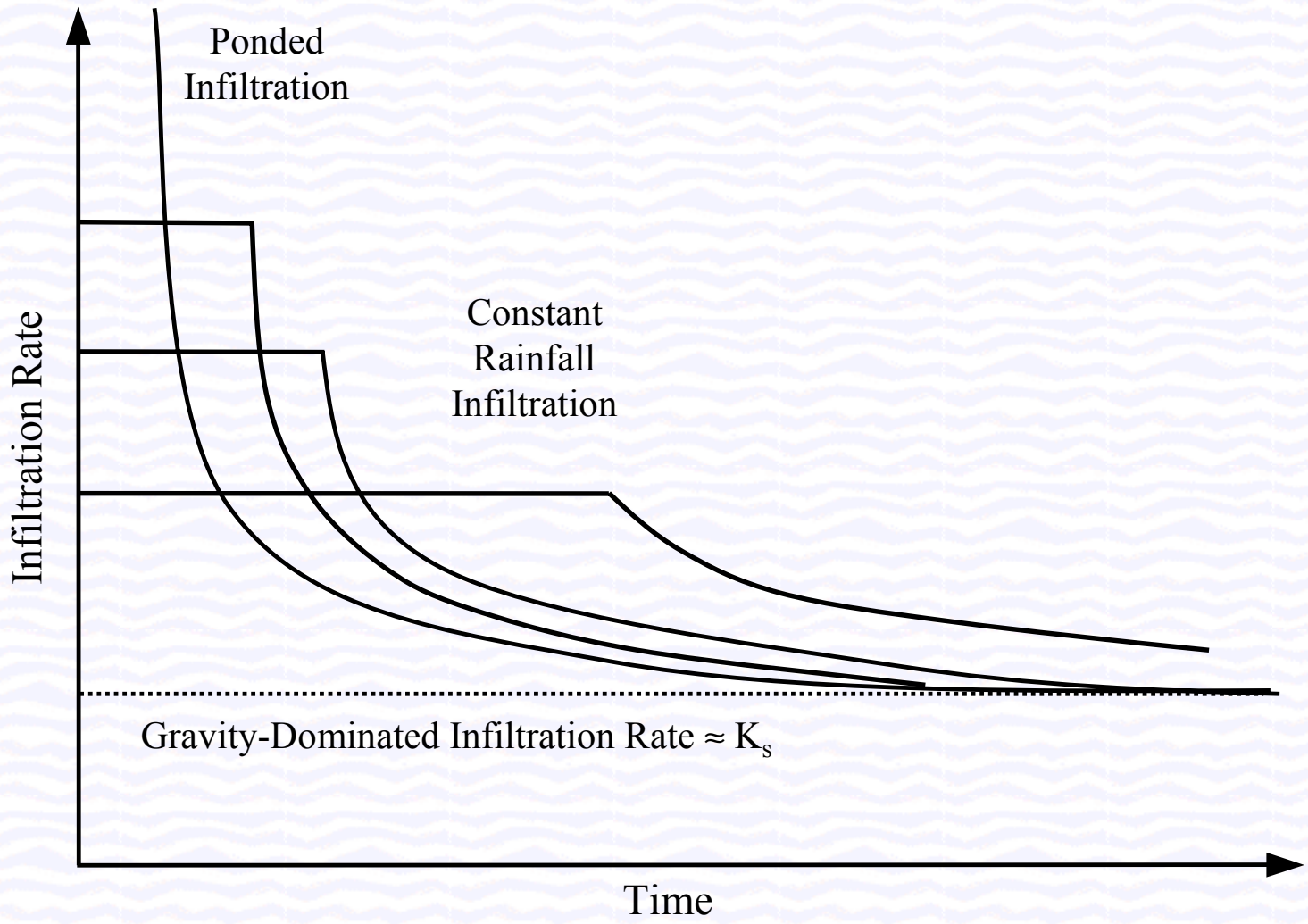
Boundary Conditions at the Land Surface

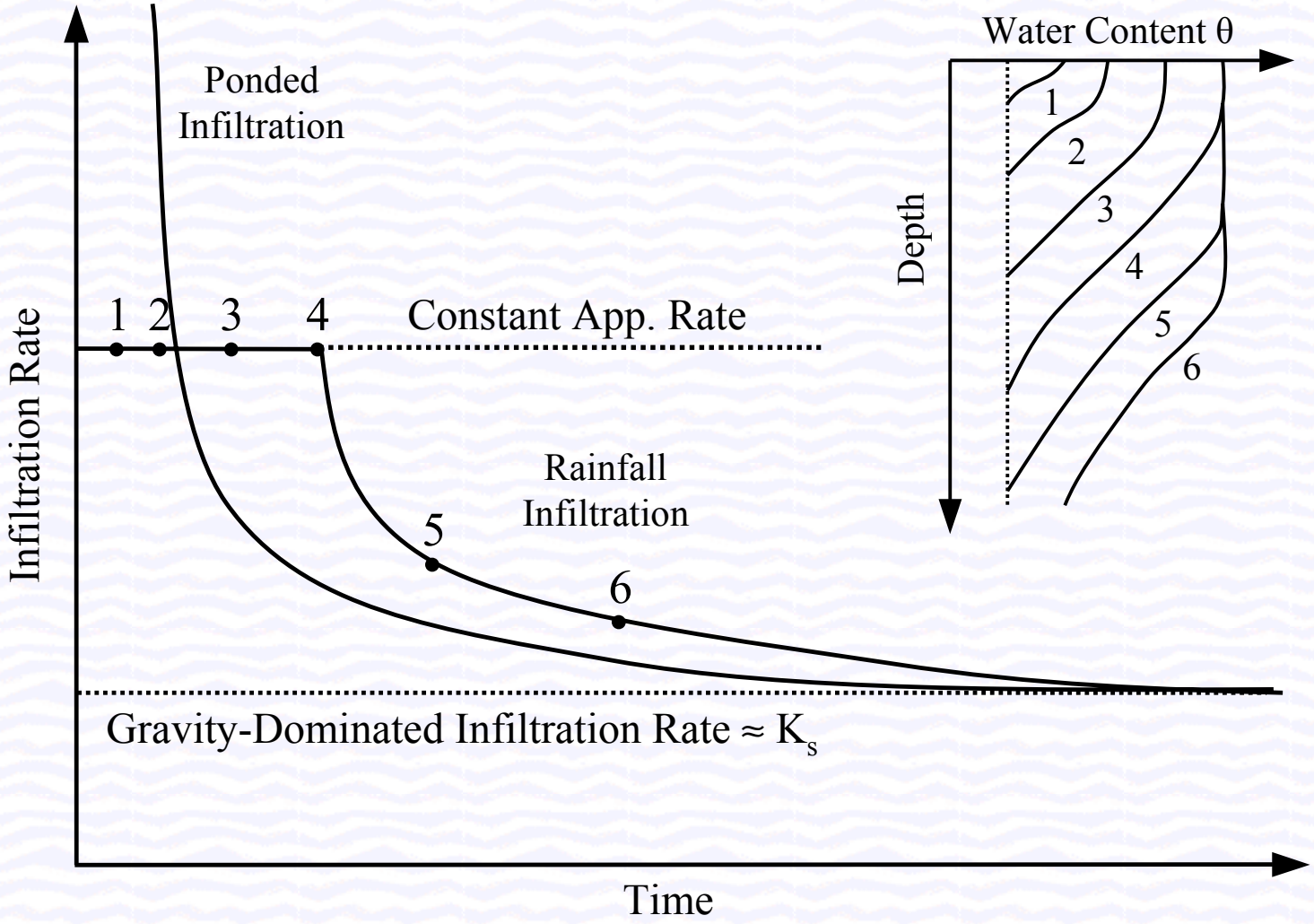
System-Independent BCs:

- Specified head (or saturation).
- Specified flux.
- Head (or saturation) dependent flux.

System-Dependent BCs:

- Seepage face.
- Switch from prescribed flux to prescribed head (and vice-versa) depending on system conditions.


Ponded
Infiltration
Constant
Rainfall
Infiltration
Infiltration Rate
Gravity-Dominated Infiltration Rate ≈ K_s
Time


Water Content θ
Depth
1
2
3
4
5
6
Ponded
Infiltration
Infiltration Rate
1 2 3 4
Constant App. Rate
Rainfall
Infiltration
5
6
Gravity-Dominated Infiltration Rate ≈ K_s
Time

General Requirements

- The absolute value of flux is limited by the max. potential rate of infiltration or evaporation.
- $\Psi_{min} \leq \Psi \leq \Psi_{max}$; where Ψ is the pressure head.
- Surface ponding commences when

$$K(\theta)\left[\frac{\partial \psi}{\partial x_i}+1\right] \bullet n_i = J_w ; \text{ where } J_w \text{ is the rainfall rate.}$$

- Other possible type of BC include natural drainage (or gravity drained or unit gradient) condition.