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Print version

CEE 577: Surface Water Quality Modeling

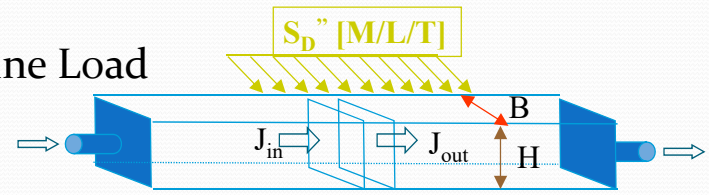
Lecture #17

Streeter-Phelps: Distributed Sources & Nitrogen

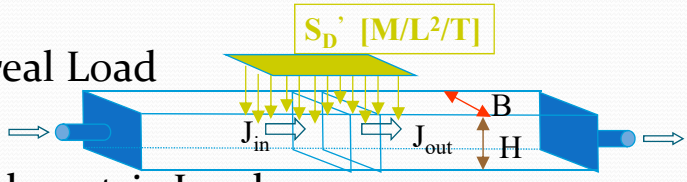
(Chapra, L22 & L23)

General Types of disperse loading

- Line Load



- Areal Load



- Volumetric Load
  - $S_d = \frac{S_d''}{A_c} = \frac{S_d'}{H}$

No-flow Diffuse Sources

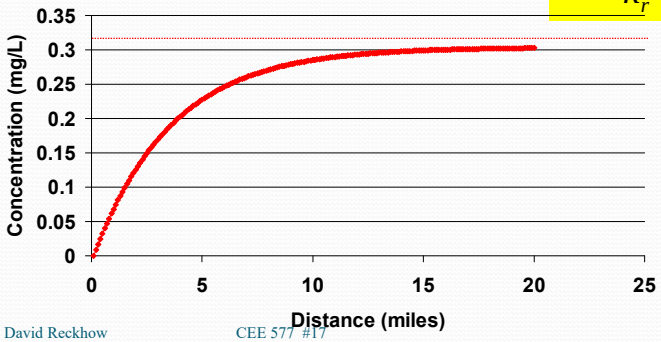
- Examples
  - sediment release

$$\frac{\partial L}{\partial t} = -U\frac{\partial L}{\partial x} - k_r L + S_d$$

At steady state: zero

And solving for: L=0, at t=0

$$L = \frac{S_d}{k_r}\left(1 - e^{-k_r t}\right)$$



Deficit from a Distributed BOD Source

$$\frac{\partial D}{\partial t} = -U\frac{\partial D}{\partial x} - k_a D + k_d L$$

$$L = \frac{S_d}{k_r}\left(1 - e^{-k_r t}\right)$$

And solving for: L=0, at t=0

$$D = \frac{k_d S_d}{k_r k_a}\left(1 - e^{-k_a t}\right) - \frac{k_d S_d}{k_r\left(k_a - k_r\right)}\left(e^{-k_r t} - e^{-k_a t}\right)$$

Where: t = time of travel (x/U)

Distributed DO source/sink

- Sources: algae (photosynthesis)
- Sinks: algae (respiration); SOD
- Mass Balance

$$\frac{\partial D}{\partial t} = -U\frac{\partial D}{\partial x} - k_a D - P + R + \frac{S_B'}{H}$$

- Solution

$$D = \frac{-P + R + \left(S_B'/H\right)}{k_a}\left(1 - e^{-k_a t}\right)$$

Overall Solution: D

Point Deficit

Point BOD

$$D = D_o e^{-k_a t} + \frac{k_d L_o}{k_a - k_r}\left(e^{-k_r t} - e^{-k_a t}\right)$$

$$+ \frac{-P + R + \left(S_B'/H\right)}{k_a}\left(1 - e^{-k_a t}\right)$$

Distributed Deficit

$$+ \frac{k_d S_d}{k_r k_a}\left(1 - e^{-k_a t}\right) - \frac{k_d S_d}{k_r\left(k_a - k_r\right)}\left(e^{-k_r t} - e^{-k_a t}\right)$$

Distributed BOD

Overall Solution: L

$$L = L_o e^{-k_r t} + \frac{S_D}{k_r}\left(1 - e^{-k_r t}\right)$$

Point

Distributed

Diffuse Sources with Flow:

Analytical and Numerical Solutions

- To next lecture