Effect of Parallel Strip Water Sources Spacing On Lateral Infiltration Flux

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OVERVIEW

- Introduction
- Previous research review
  - Vertical vs. vertical and lateral infiltration
- Formulation of the problem for numerical solution
- Edge effect in parallel water wources
  - Steady state flow
  - Transient flow (not shown)
- Conclusions


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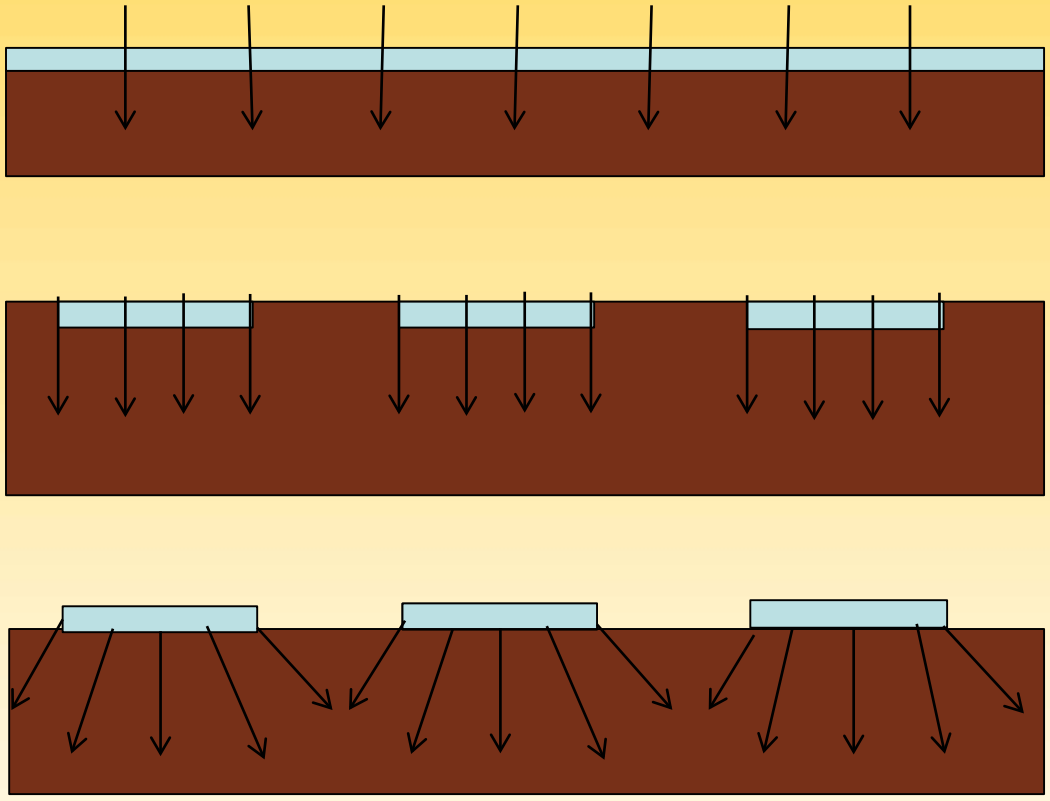
INFILTRATION WITH PARTIAL SURFACE COVERAGE OF WATER



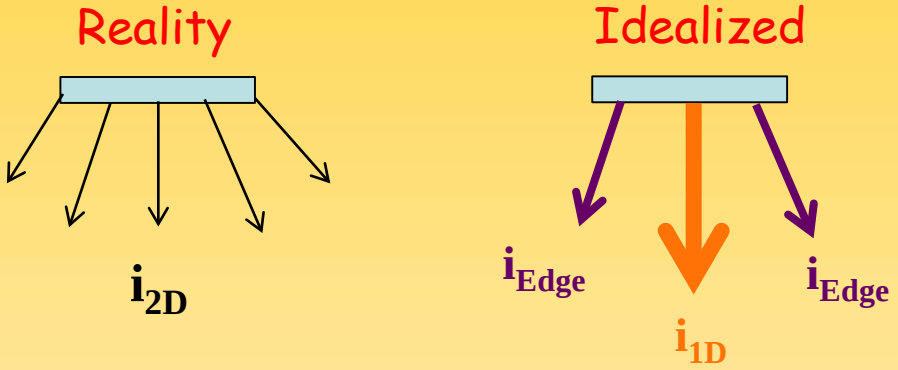
Sheet flow
Usual assumption

Concentrated flow
1D-vertical infiltration
A lot better assumption

Concentrated flow
Vertical and lateral infiltration
Even better

VERTICAL AND LATERAL FLOW

$i_{2D} = i_{1D} + i_{Edge}$



i_{1D} is the term for vertical flow

$i_{Edge} = \gamma\, i_{Horiz}$; term for capillary-driven lateral flow

- γ is a function of strip spacing, soil texture and time
- The challenge is to determine γ
- We should be able to do this with numerical simulation of the Richards equation

w term

i_{Horiz} 007),

rce

Numerical modeling

Simulations of two-dimensional infiltration based on numerical solution of the Richards within the porous media module of COMSOL_MP.

Governing equation:

$$\frac{\partial}{\partial t}(\epsilon_p \rho) + \nabla \cdot (\rho \boldsymbol{u}) = Q_m$$

$$\boldsymbol{u} = -\frac{k}{\mu}(\nabla p + \rho g \nabla D)$$

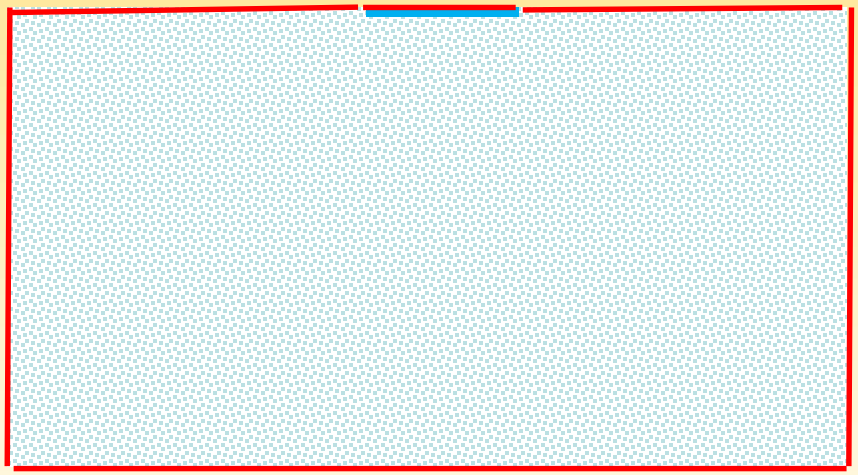
subject to: $p(x, y, t = 0) = p_0$

Initial condition

$$\frac{\partial}{\partial n}(p + \rho g D) = 0$$

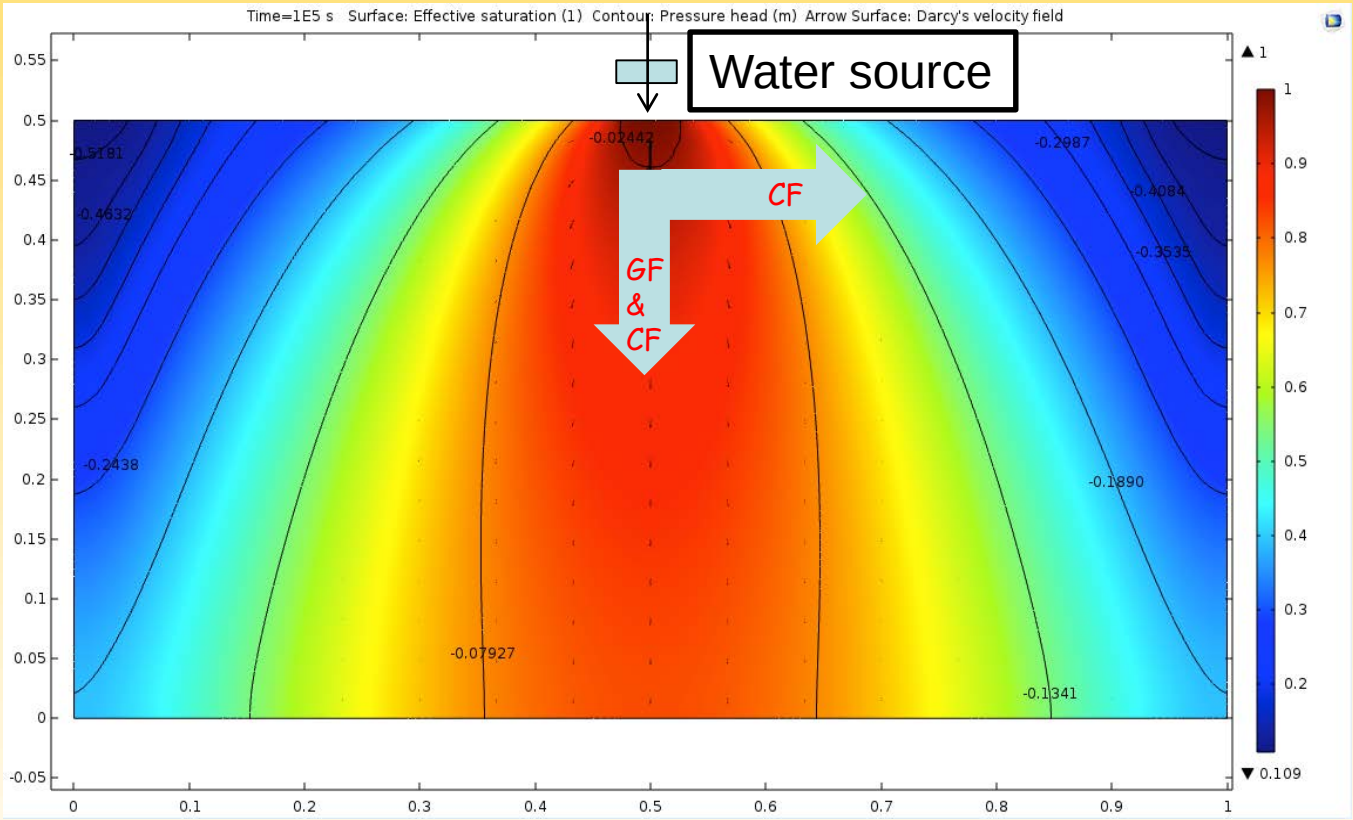
$$\frac{\partial p}{\partial n} = 0$$

$$p = 0$$



VERTICAL AND LATERAL INFILTRATION

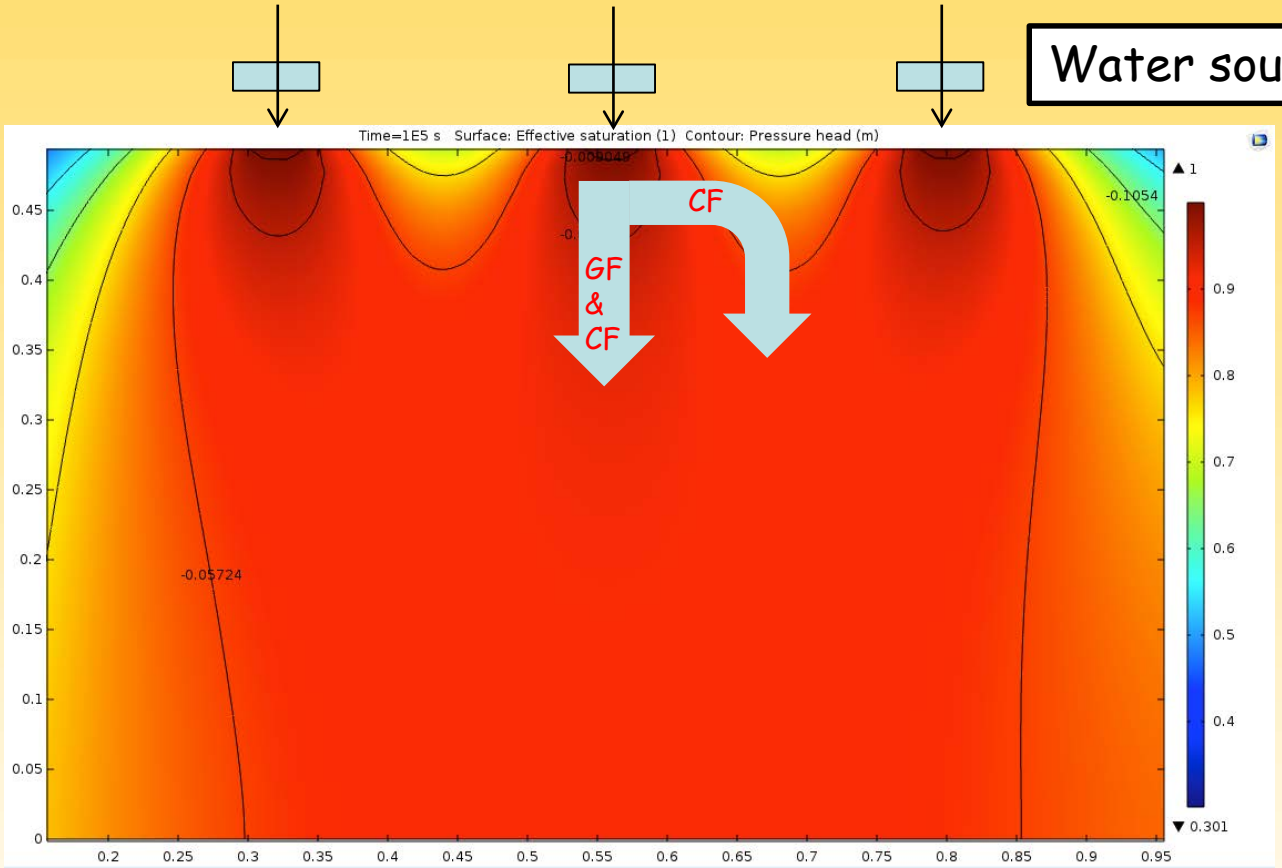
At Steady State



Water free to flow in all directons

MULTIPLE STRIP EDGE EFFECT

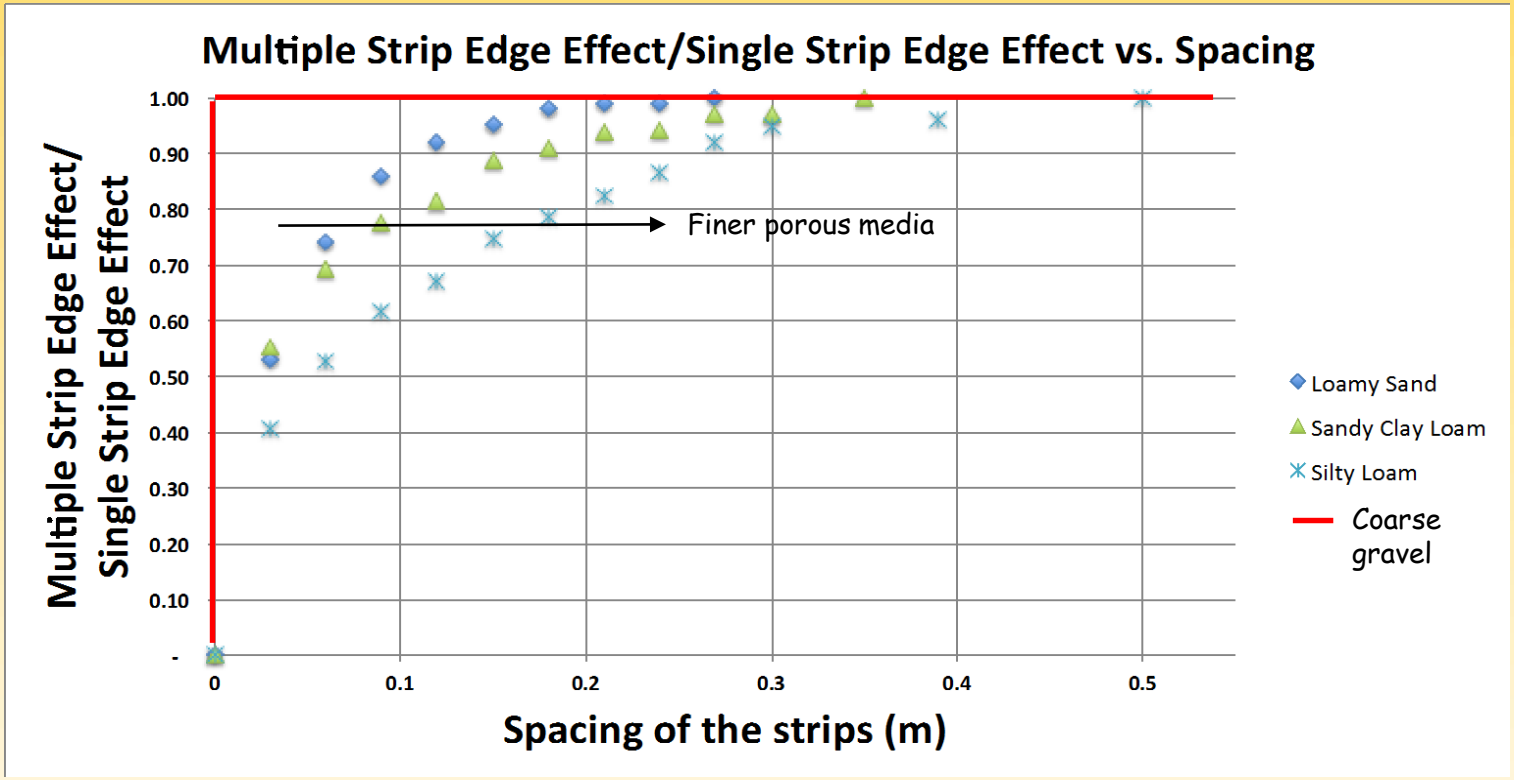
At Steady State



Water flow confined due to neighboring strip sources (reduces γ)

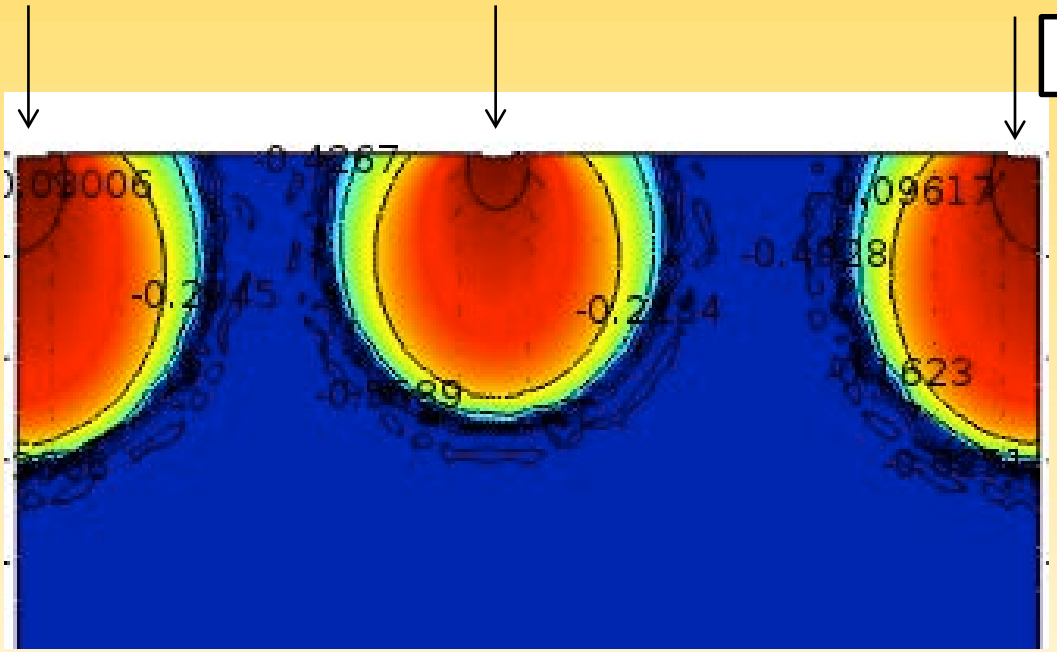
MULTIPLE STRIP EDGE EFFECT

At Steady State



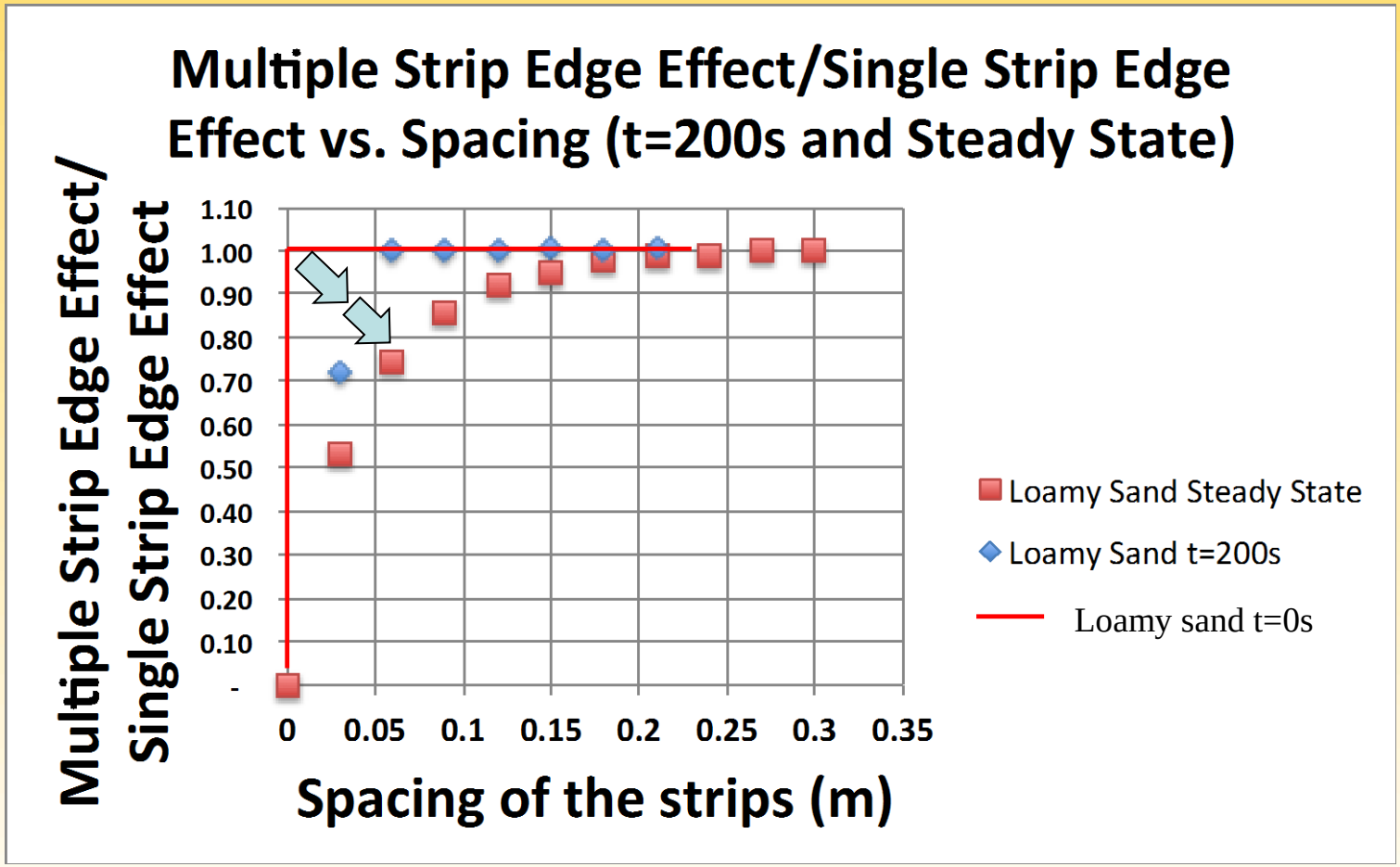
MULTIPLE STRIP EDGE EFFECT

Transient flow



MULTIPLE STRIP EDGE EFFECT

Transient flow



CONCLUSIONS

- The calculation of infiltration from parallel strip water sources depends on:
  - Width of the strip
  - Texture of the porous media
  - Initial moisture content
  - Strip spacing
  - Time (not shown)

- The calculation of infiltration from parallel strip sources can be approximated by using a 1-D approximation with a shape factor (γ) to account for the enhancement of infiltration introduced by the actual 2-D flow. The value of γ can be quantified with numerical solutions to the Richards equation.

Questions?

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