HYDROGEOLOGY – BASIC PRINCIPLES TO LIVE BY

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What Sets Geosyntec Apart?

**Services:**
- Technical support to legal counsel: CERCLA sites, vapor intrusion, due diligence
- Contaminated site assessment and cleanup
- Water resources design and engineering

**Overview:**
- Founded in 1983
- Strong reputation for technology innovation and solving complex problems
- Over 1000 engineers, scientists and project support personnel worldwide, offices in over 50 locations, including Minneapolis

![Professional Staff Highest Degree](chart.png)
FOR TODAY!!!!!

- WHY HYDROGEOLOGY IS IMPORTANT – Where is the groundwater and what is it doing?
- POROSITY AND PERMEABILITY – Are you an aquifer or an aquitard?
- GROUNDWATER FLOW AND GRADIENTS – What Henry Darcy would want you to know!
- NOW FOR A TWIST: CONTAMINATION! – So easy to get in, and so hard to get out
Water Use & Hydrogeology General Concepts

A Condensed Version
The Importance of Groundwater
Minnesota Water Use

(excluding Power Generation) in Billions of Gallons

Public Supply

Industrial Processing

Irrigation

Other

MN DNR
Ecological and Water Resources
Subsurface View of an Aquifer

Unsaturated zone

Saturated zones

Ground water

Surface water

Creviced rock

Water (not ground water) held by molecular attraction surrounds surfaces of rock particles

Approximate level of the water table

All openings below water table full of ground water

Land surface

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Porosity Is the Void Spaces Between the Grains in Aquifers
Porosity of Soils

- Well-sorted sand or gravel **25-50%**
- Mixed sand and gravel 20-35%
- Silt 35-50%
- Clay **33-60%**
  - Clay is more porous than sand.....but not more permeable
Hydraulic Conductivity, “Permeability”

- Good ability to transmit water
  - Sand
  - Gravel
  - Fractured rock

- Poor ability to transmit water
  - Clay
  - Shale
  - Un-fractured rock
Geology Makes a Difference!

1/2 gallon per minute

soil

saprolite

granite

20 gallons per minute

sandstone

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engineers | scientists | innovators
Where’s the water going?

Groundwater Movement
Hypothetical Flow Model
Groundwater Movement Takes a Long Time!
How are these concepts used?

Evaluating and Making Use of the Data
Data Collection & Analysis: Hydrogeological Cross-Section
Data Collection & Analysis: Measuring Water Level in Wells
Data Collection & Analysis: It’s not a Static World

![Graph showing water level fluctuations over time with mean water level and standard deviations marked.](image-url)
How Does a Hydrogeologist Use All of This Information?

- Speed and direction of groundwater flow
- Capture zones of pumping wells
- Volume of contaminated water migrating across a site boundary
- Rate of movement of a contaminant plume
- Expected drawdown and area of influence from proposed pumping wells

Also:
- 2D analytical modeling and 3D numerical modeling of a wide range of hydrogeologic situations
Contaminants: Easy to get into the ground and hard to get out
Getting in is easy
Getting out is a bit more difficult (remember porosity/permeability?)

Porosity at the Project Scale
Figure 1.1: Setup - Sand and Clay

Figure 1.2: Fluorescein Inflow (Matrix Storage)

Figure 1.3: Source Off – Back Diffusion

Figure 1.4: Close-up of Back Diffusion

Back Diffusion

Sand

Clay

50 cm
What Does a Groundwater Plume Look Like?

Typical Groundwater Contamination Issues
Trichlororoethene

Cis-1,2-Dichlororoethene

Vinyl Chloride

Different Contaminants = Different Plumes
What about that hard to get out part?

See us next time!