Stormwater Management And Ground Water: Are They Compatible?

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2006 MGWA Conference

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What Do They Have In Common and How Do They Communicate?

Hydrogeologist

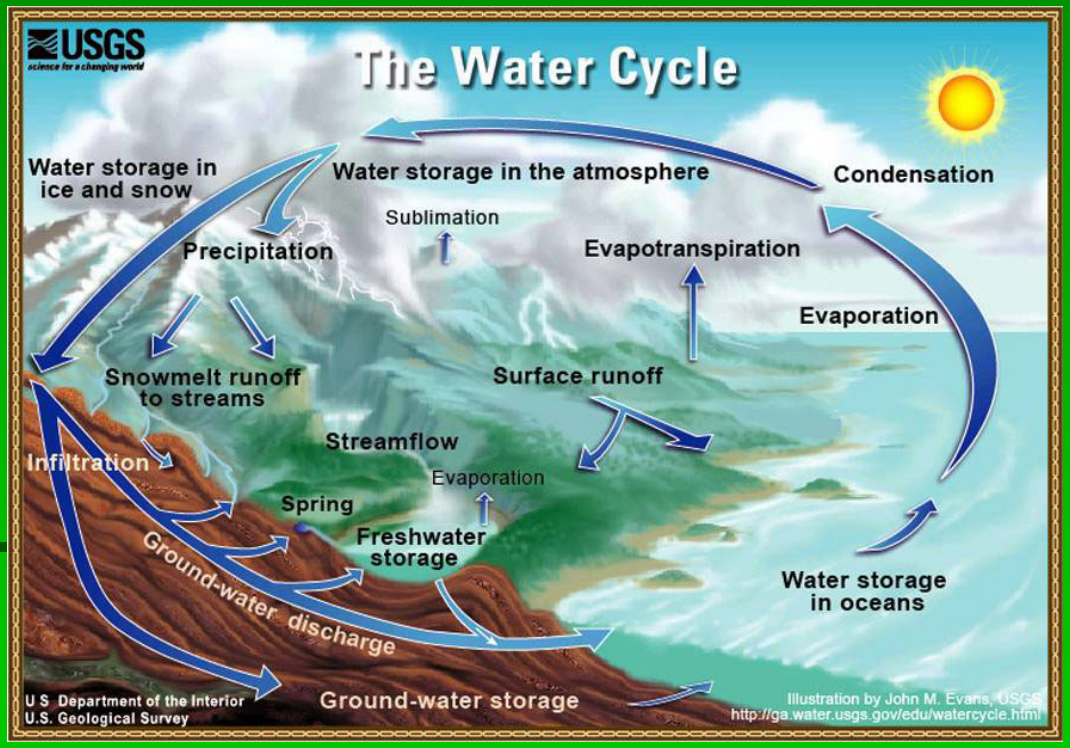
Engineer

Clarify Stormwater Infiltration Terminology

- What is stormwater infiltration?
- What are we trying to achieve with stormwater infiltration?
- What are stormwater infiltration practices?

Infiltration – What Are We Talking About?

- Infiltration: movement of water into the soil profile



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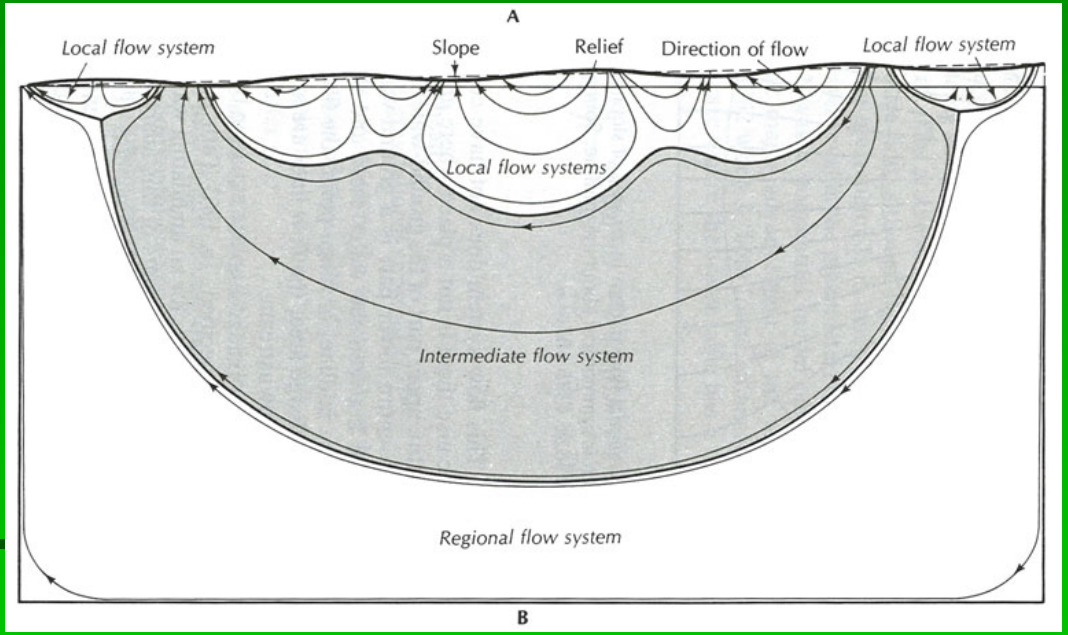
Infiltration – What Are We Talking About?

- Interflow
- Throughflow
- Ground water recharge



Source: J.A. Toth, Journal of Geophysical Research 68 (1963): 4795-4811

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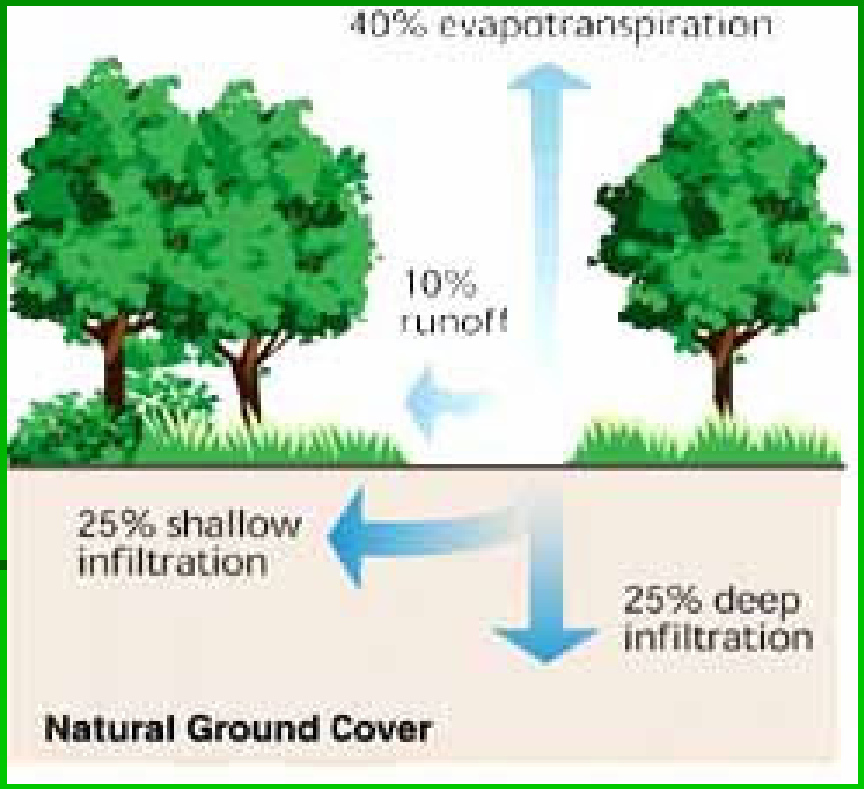
Impacts of Urbanization

- Increases in peak flow and total volume of stormwater runoff
- Accelerated stream channel erosion

Impacts of Urbanization

- Decreases in water quality and stream environment
- Reduced recharge/baseflow

Impacts of Urbanization



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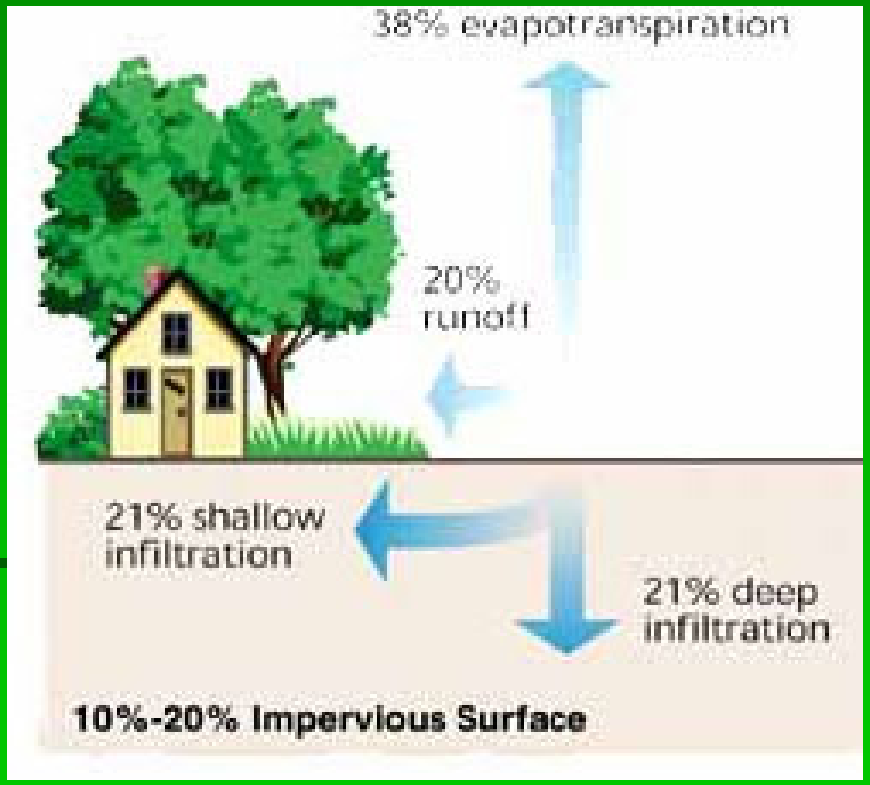
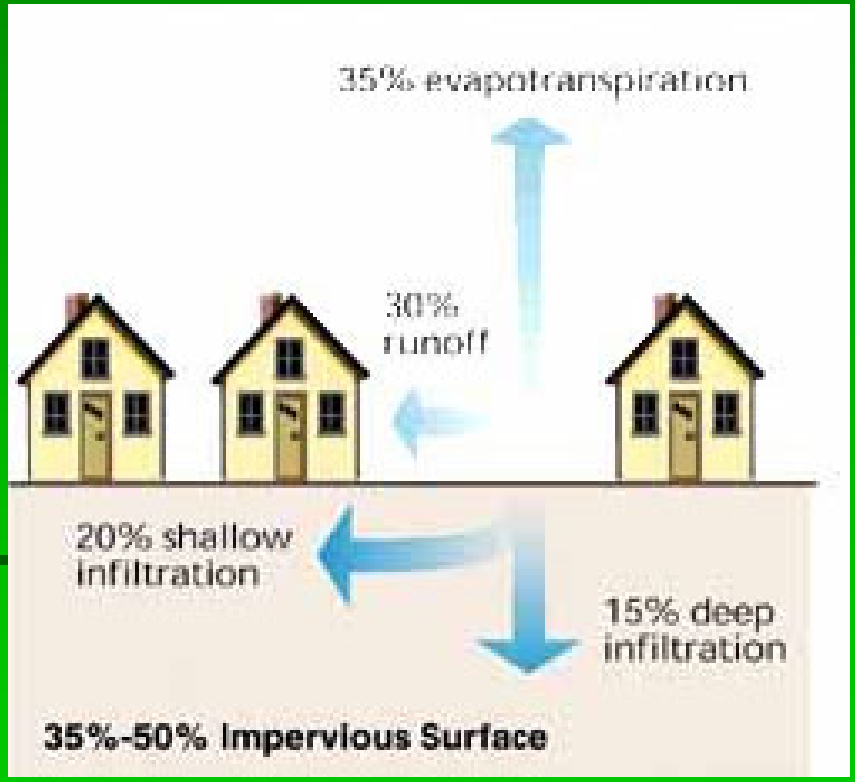
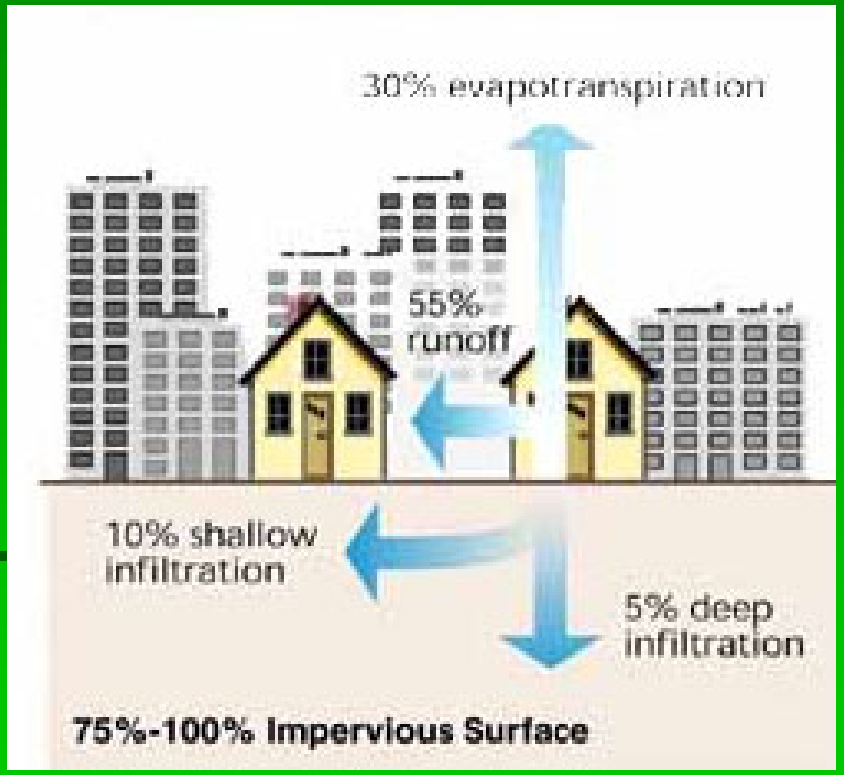
Impacts of Urbanization



Impacts of Urbanization



Impacts of Urbanization



Traditional Stormwater Management

- How has the issue of increased stormwater runoff been dealt with in the past?

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What Have We Achieved With The Traditional Approach?

- Rate control
- Water quality treatment
- Flood protection

What Have We Lost With The Traditional Approach?

- Recharge/baseflow
- Thermal pollution
- Quality of the stream environment and resources

Regulatory Context – Stormwater Management

- Watershed districts/water management organizations
- Agencies (e.g. MPCA)
- Counties (e.g. Washington County)
- Municipalities (via stormwater regulations)

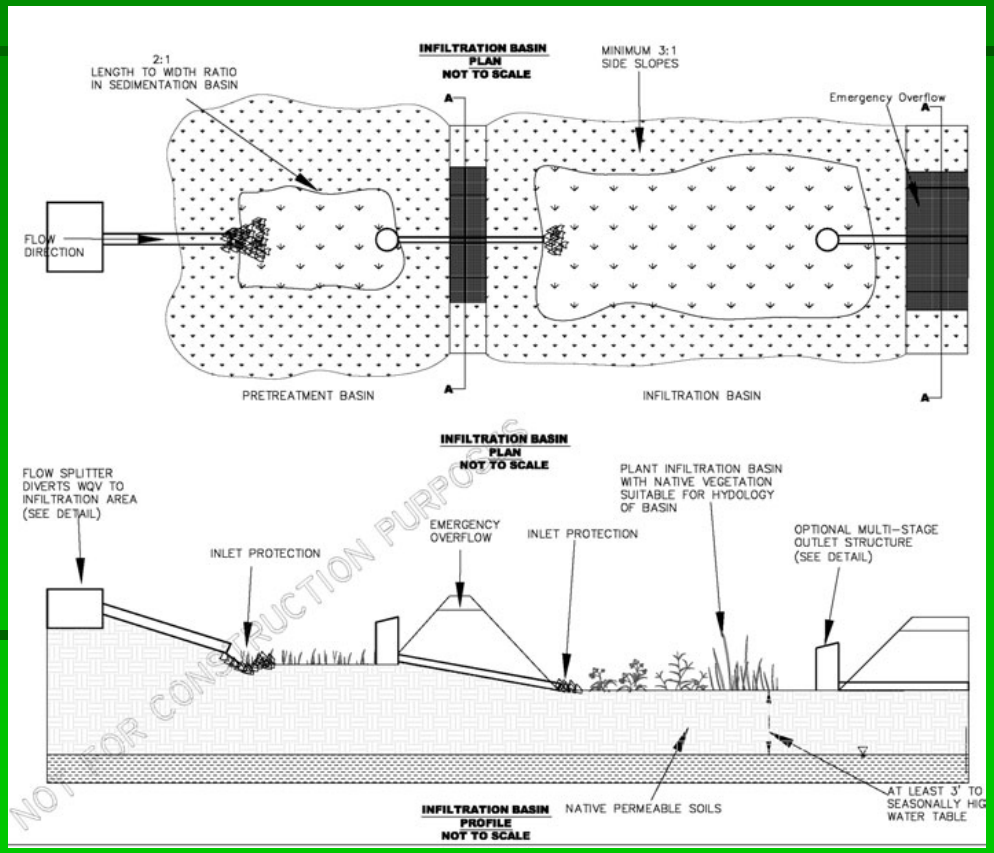
Stormwater Infiltration

- Mimic the natural hydrology
- What types of practices are used to infiltrate stormwater?

Infiltration Basin

- Natural or constructed impoundment that captures, stores and infiltrates the design volume of water over several days

Infiltration Basin



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Infiltration Basin – Example Site

Regional Infiltration Basin CD-P85

Woodbury, MN

April 12, 2006

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Infiltration Basin – Example Site

Whispering Valley

Lake Elmo, MN

Oxbow Creek Elementary

Champlin, MN

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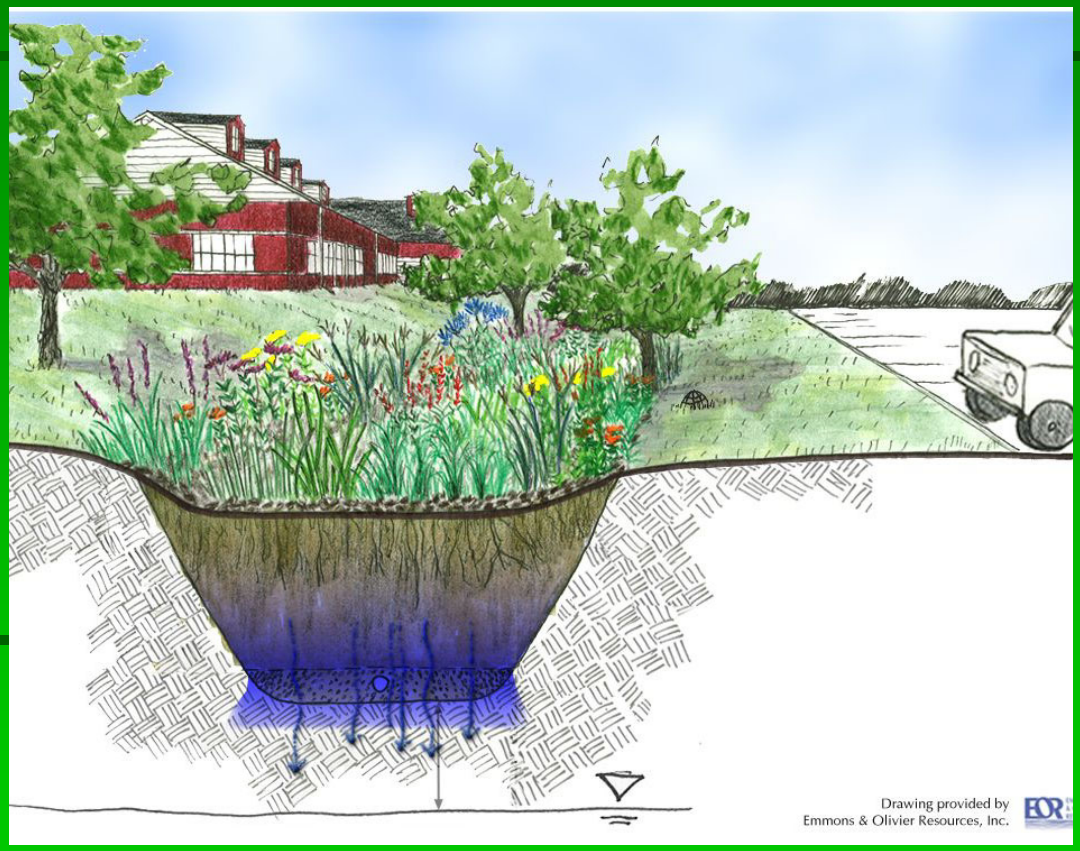
Raingardens

- A shallow, landscaped depression commonly located in parking lot islands or within small pockets in residential areas that receive stormwater runoff

Raingardens



Raingardens – Example Site

Hugo City Hall

Hugo, MN

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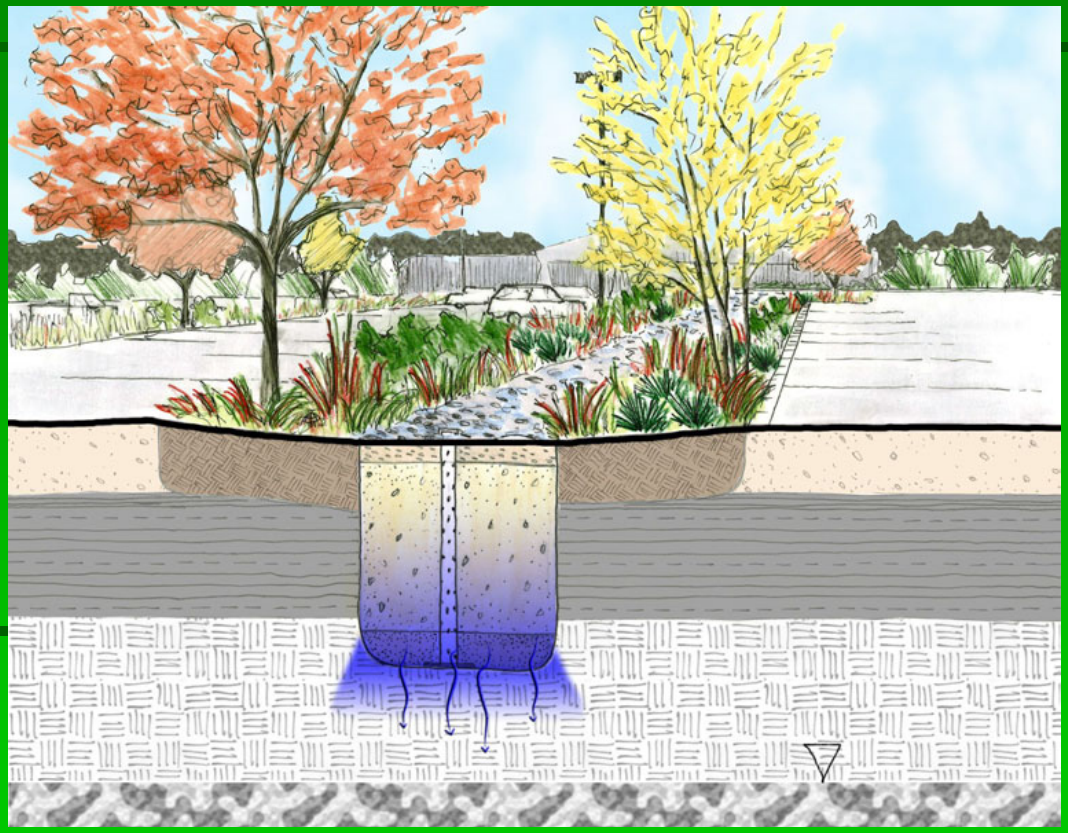
Infiltration Trench

- A shallow excavated trench that is backfilled with a coarse stone aggregate allowing for temporary storage of runoff in the void space of the material

Infiltration Trench



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Infiltration Trench – Example Site

Math and Science Academy

Woodbury, MN

April 12, 2006

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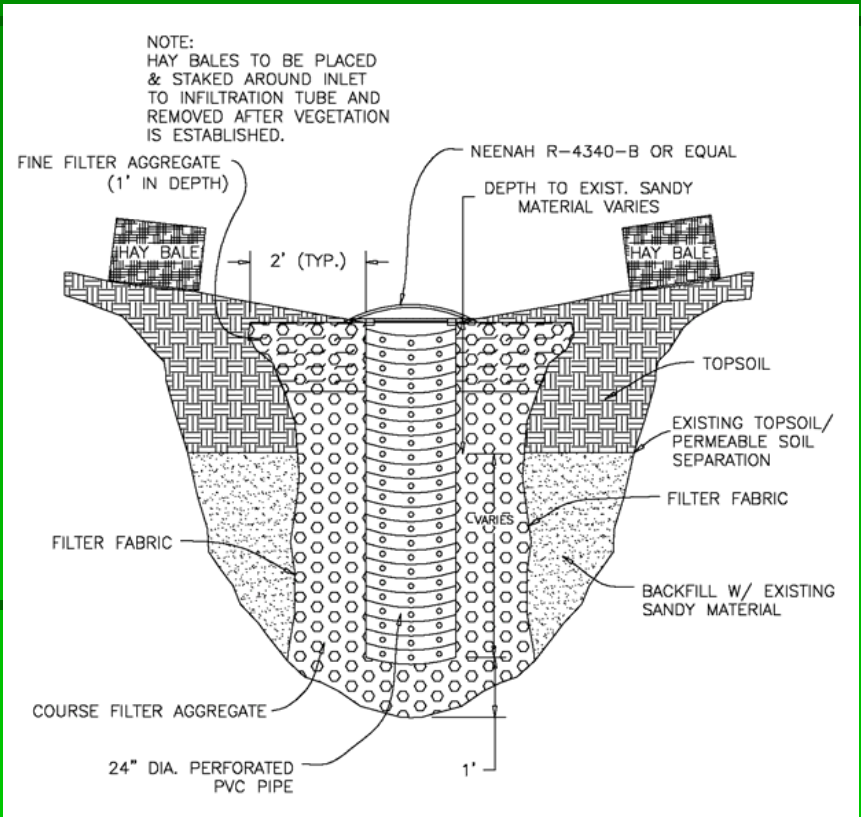
Dry Wells, French Drains, Infiltration Tubes

- A subsurface storage facility (a structural chamber or an excavated pit backfilled with a coarse stone aggregate) that receives and temporarily stores stormwater runoff

Dry Wells, French Drains, Infiltration Tubes



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Dry Wells – Example Sites

1 Excavation 2 Form 3 Dry Well 4 Backfill 5 Remove Form 6 Grate

Infiltration Enhancement in Regional Basin CD-P85

Woodbury, MN

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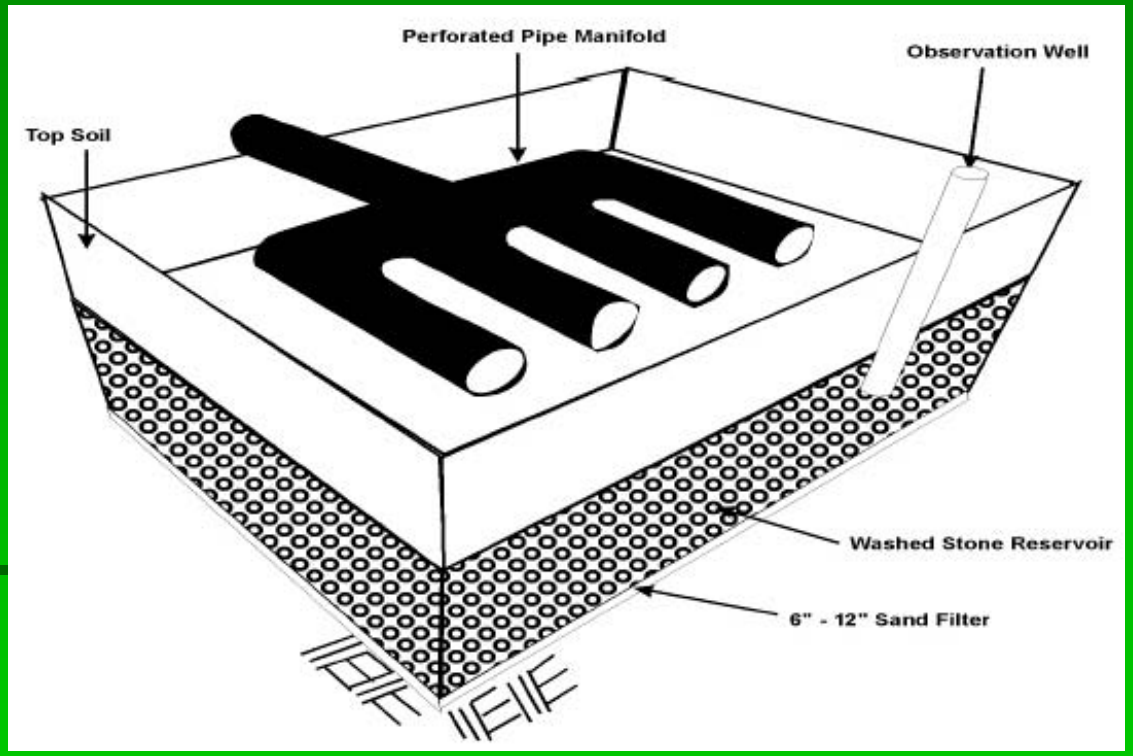
Underground Infiltration Systems

- Large scale, underground facility designed to store and infiltrate the design volume of stormwater over several days

Underground Infiltration Systems



Source: Metropolitan Council of Governments

Underground Infiltration Systems – Example Sites

Bradshaw Celebration of Life

Stillwater, MN

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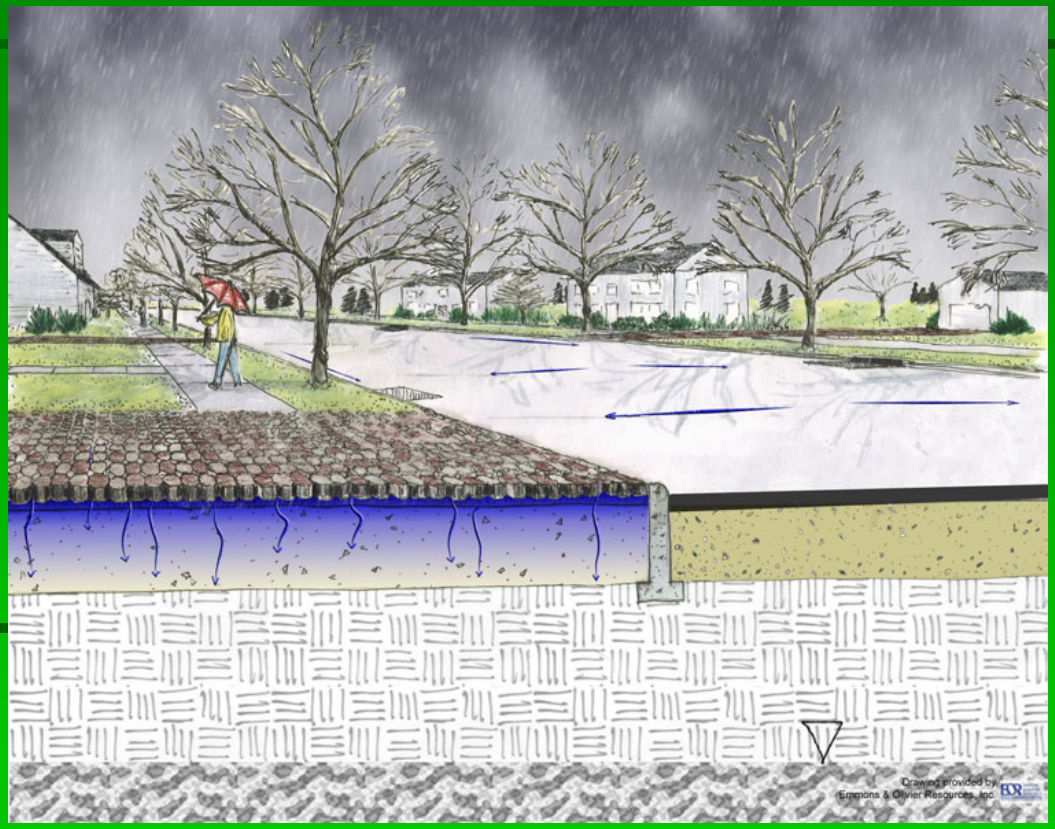
Permeable Surfaces

- Reduce the amount of runoff by allowing water to pass through surfaces that would otherwise be impervious

Permeable Surfaces

- Porous pavement
- Porous asphalt
- Modular porous paver systems (e.g. block pavers and grid structures)

Permeable Surfaces



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Permeable Surfaces – Example Sites

Tara Springs Development, Stillwater, MN

Bradshaw Celebration of Life

Stillwater, MN

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Making The Surface Water And Ground Water Connection

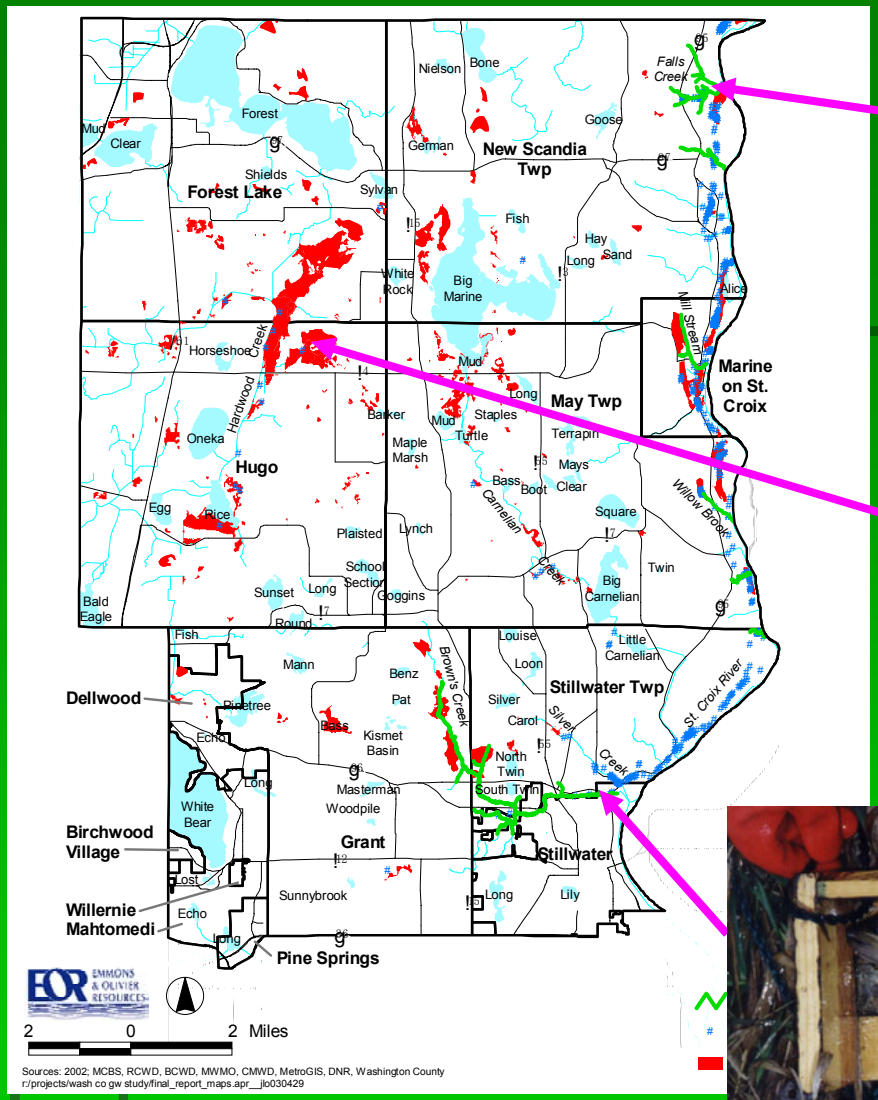
- Potential ground water impacts (quality and quantity)
- Design considerations
- How are practices being evaluated

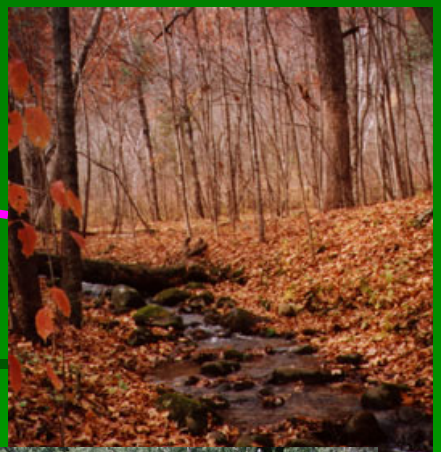
What Are We Trying To Protect?

- Drinking water
- Ground water dependent resources

Ground Water Dependent Resources

- Cold water streams
  - Spring creeks
  - Trout streams
- Wetlands
  - Seepage swamps
- Fens





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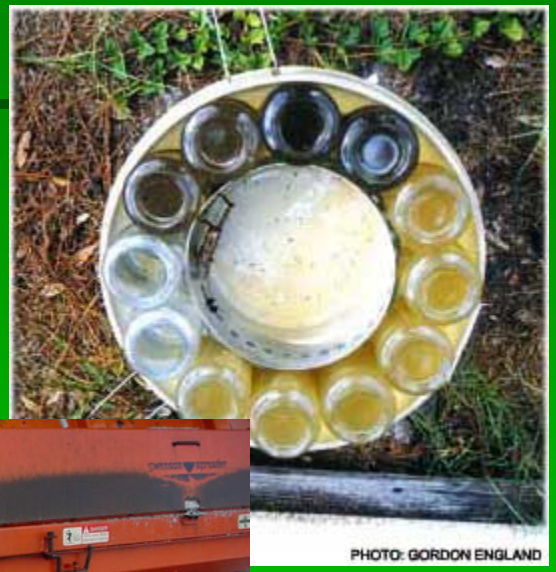
Ground Water Dependent Resources

- High quality and rare resources
- Rely on ground water flow
  - Stable water level
  - Quality
  - Temperature

Potential Impacts to Ground Water - Quality

- Stormwater pollutants of concern
  - Soluble metals
  - Oil and PAHs
  - Pesticides
  - Pathogens
  - **Chlorides**
  - **Nitrates**



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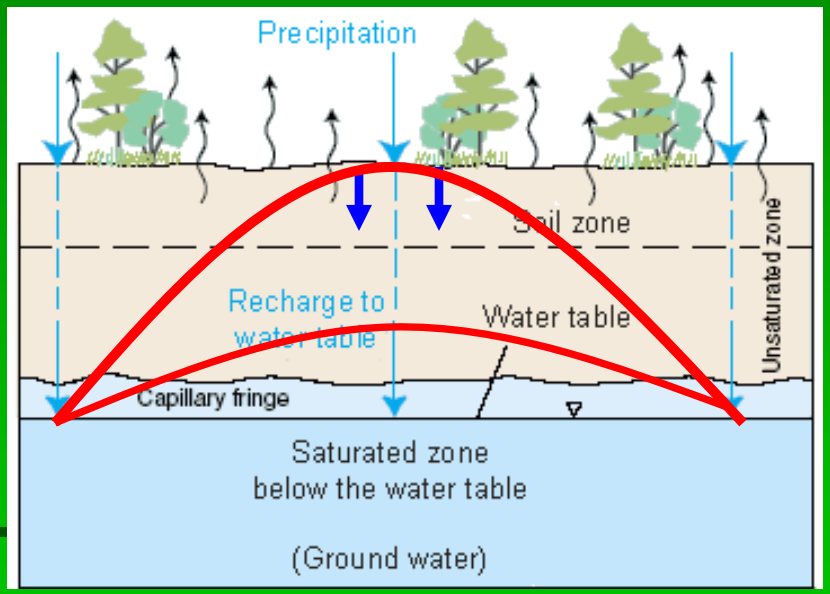
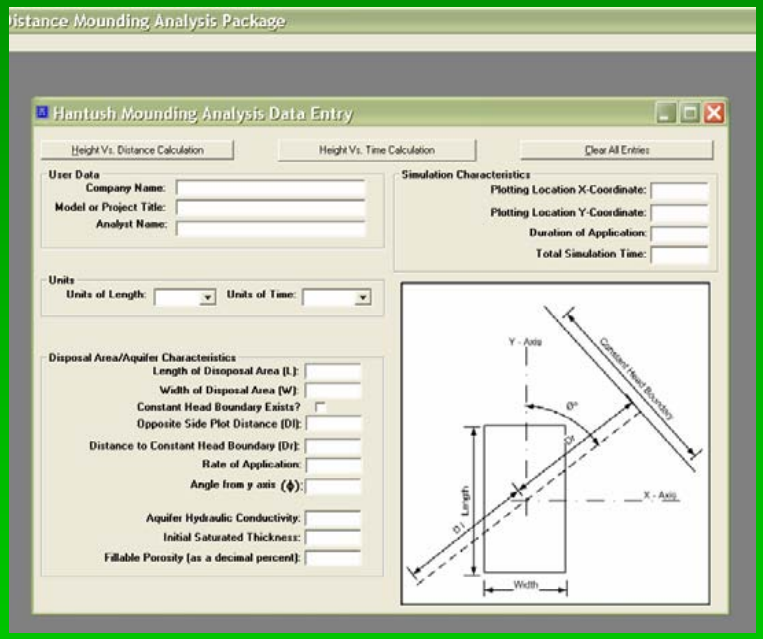
Potential Impacts to Ground Water - Quantity

- Ground water mounding
- Concerns
  - Impedes infiltration
  - Diminishes soil treatment capacity



Mounding Solutions

- Hantush, 1967
- Analytical and numerical methods
  - Commercially available
  - Model constraints



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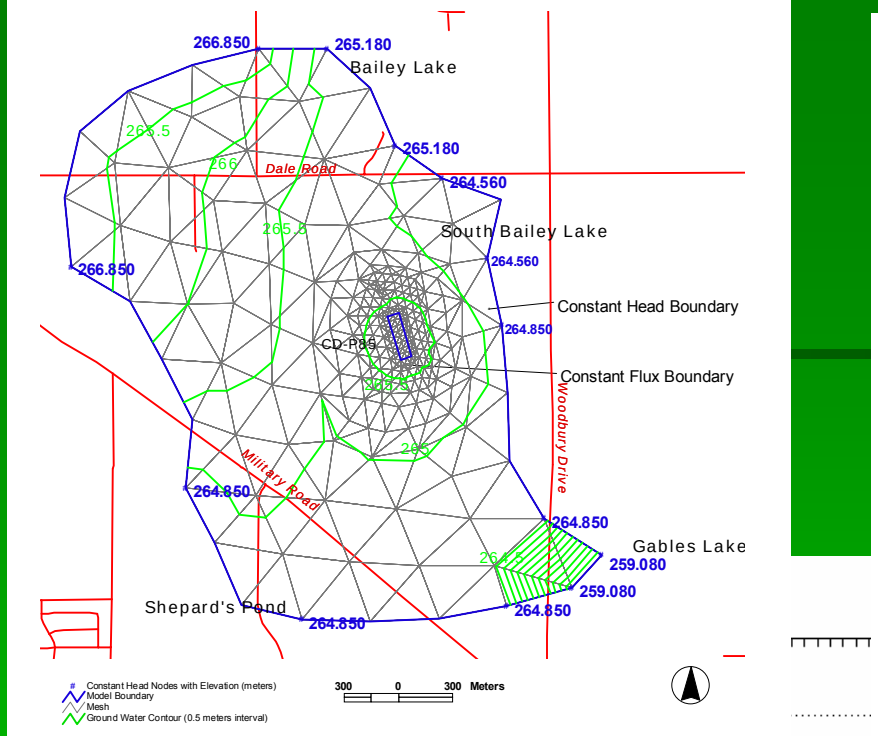

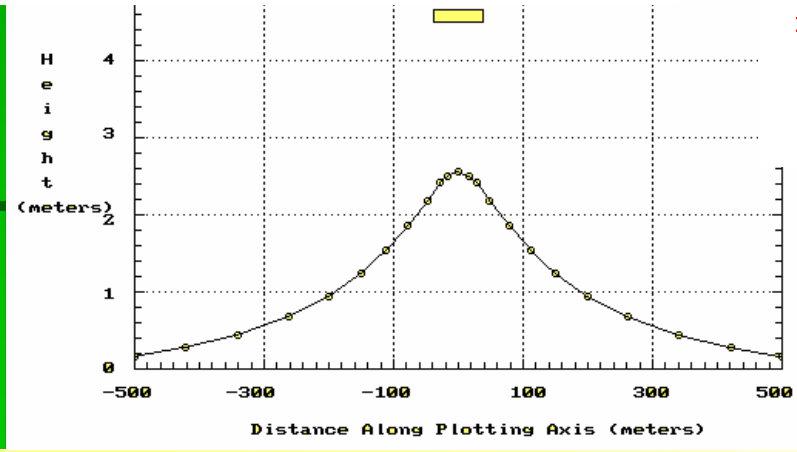

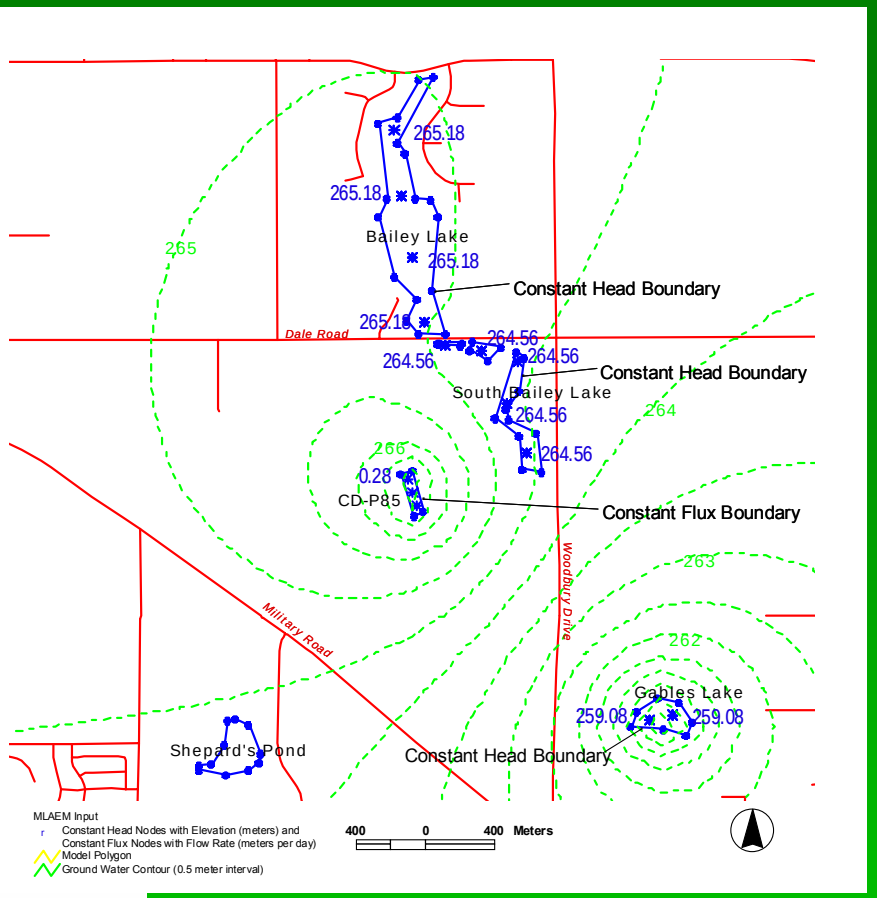

Many models available, each has constraints and financial considerations

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Design Considerations

- Drainage area
- Site location/minimum setbacks
- Site topography and slopes
- Land use considerations

Design Considerations

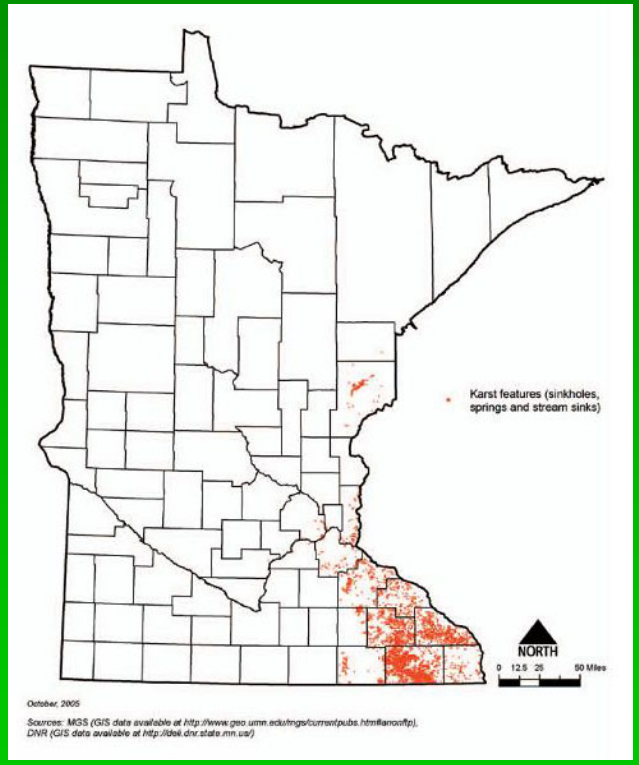
- Soils/geologic
  - Soil type
  - Depth to water table and bedrock
  - Sensitive geology
- Pretreatment requirements
- Design infiltration rates

Soils / Geologic Analysis

- Soil survey
- Soil borings
  - Location
  - Depth of borings
  - Depth of infiltration practice(s)

Soils / Geologic Analysis

- Sensitive soils/geology
  - Depth to seasonally high water table
  - Bedrock near surface
  - Karst
  - Wellhead protection areas



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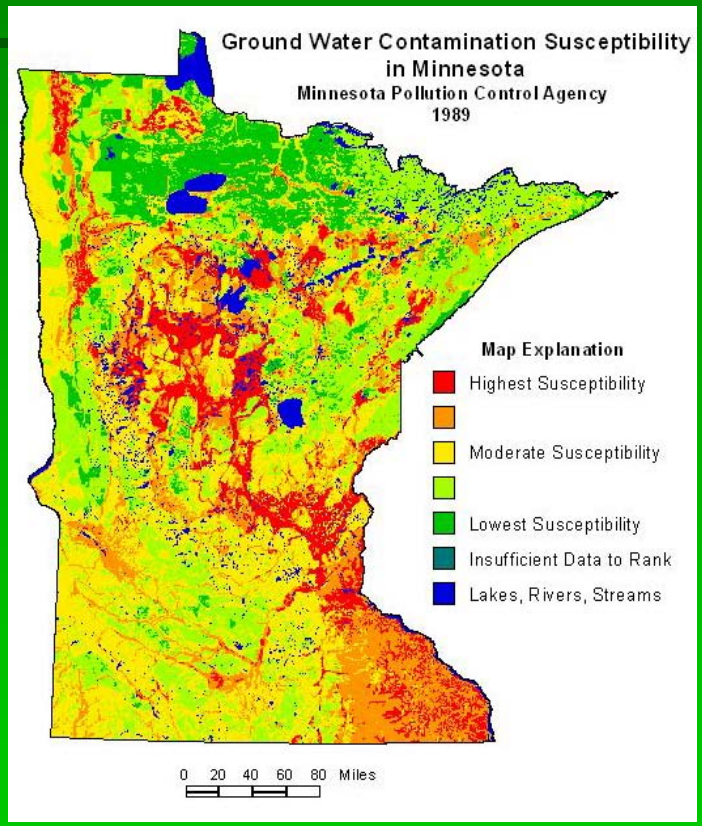
Soils / Geologic Analysis

- Sensitive soils/geology
  - High permeability soil
    - Pretreatment requirements



Maximize recharge of "clean runoff" and minimize risk of ground water contamination of "dirty runoff"

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Treatment Techniques

- Pre-infiltration treatment
- Soil treatment
- Dependent on runoff and soils characteristics
  - High intensity land use

Infiltration Rates

- Field measurements (point)
- Monitoring data (long-term)
- Literature values

Design Infiltration Rates

Hydrologic Soil Group	Soil Textures*	Corresponding Unified Soil Classification**	Infiltration Rate [inches/hour]
A	Gravel, sand, sandy gravel, silty gravel, loamy sand, sandy loam	**GW** - Well-graded gravel or well-graded gravel with sand **GP** – Poorly graded gravel or poorly graded gravel with sand	1.63
		GM - Silty gravel or silty gravel with sand **SW** - Well-graded sand or well-graded sand with gravel **SP** – Poorly graded sand or poorly graded sand with gravel	0.8
B	Loam, silt loam	**SM** - Silty sand or silty sand with gravel	0.6
		ML – Silt **OL** – Organic silt or organic silt with sand or gravel or gravelly organic silt	0.3
C	Sandy clay loam	**GC** – Clayey gravel or clayey gravel with sand **SC** – Clayey sand or clayey sand with gravel	0.2
D	Clay, clay loam, silty clay loam, sandy clay, silty clay	**CL** – Lean clay or lean clay with sand or gravel or gravelly lean clay **CH** – Fat clay or fat clay with sand or gravel or gravelly fat clay **OH** – Organic clay or organic clay with sand or gravel or gravelly organic clay **MH** – Elastic silt or elastic silt with sand or gravel	< 0.2

Source: Minnesota Stormwater Manual 2005

Regulatory Considerations

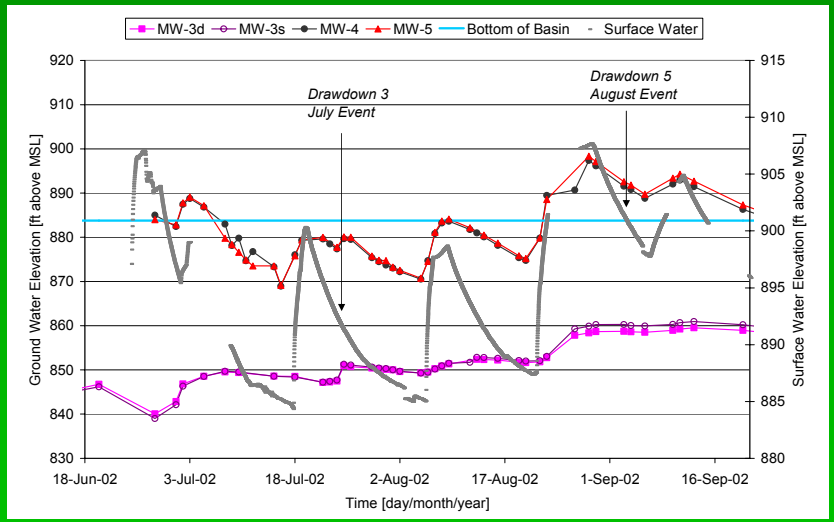
- Class V injection wells require registration
- Wellhead protection planning
  - MDH Guidance
- NPDES General Construction Permit

Monitoring of Infiltration Practices

- Why monitor
  - Performance evaluation
  - Effectiveness
  - Identify impact

Available Data

- USGS rain gardens
- SWWD infiltration trenches and basins
- Other smaller scale studies



Data Gaps

- Long-term performance in cold climates
  - Infiltration rates
- Effectiveness of practices
- Coupled surface and ground water quality

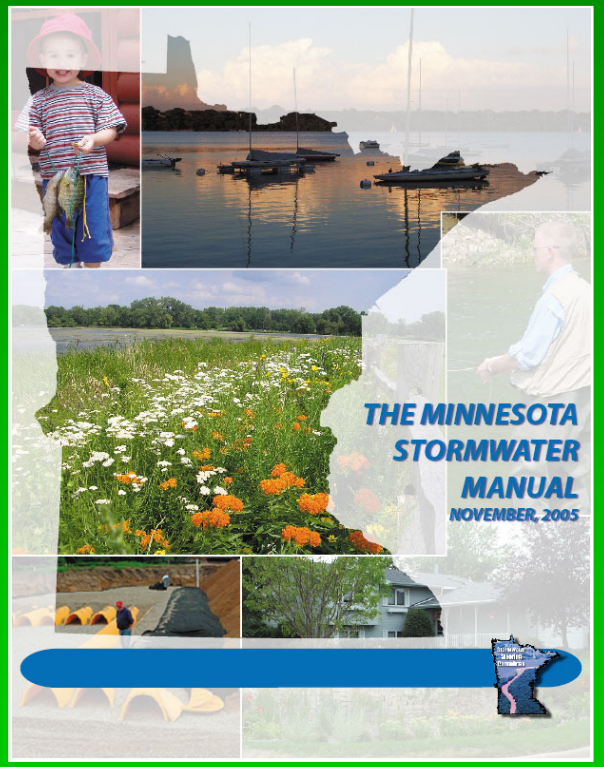
Data Collection Protocols

- U of M protocol
- EPA/ASCE protocol – National Stormwater BMP Database
- USGS
- SWWD

Best Source of Information

Minnesota Stormwater Manual, 2005

http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html



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