Basin-Wide Infiltration Assessment using GIS Techniques

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It hasn’t always been popular to add more water to the ground.
Proceed with Caution...
LID Requires Good Site Characterization
Perched Groundwater on Glacial Till
Perched Water Table before GSI (LID)
Perched Water Table after GSI (LID)
Deep Infiltration Drain Can Substantially Improve Infiltration at a Glacial Till Site

Conclusion:
Deep drains are cost effective when native soil infiltration rate < 2 in./hr.
Case Study

- Clear Creek Basin (Silverdale)
- Kitsap County LID Retrofit Program
- Objective is to reduce fecal coliform and restore estuarine health to Dyer Inlet
- Team led by Herrera Environmental and funded in part by an EPA grant
- Aspect tasked to estimate the suitability of infiltration and identify potential geologic hazard areas
Key Factors

- Surficial geology (permeability)
- Wetlands
- Surface slope gradient
- Proximity to steep slopes
- Depth to groundwater
- Depth to permeable zone (deep infiltration only)
- Thickness of unsaturated zone (deep infiltration only)
Geologic Map

- Qvt over most of the project area
- Qvr and alluvium in valley bottom
- Outcrops of Qva on hillsides
Kahle, S.C. 1998, Hydrogeology of Navel Submarine Bangor and Vicinity
Permeability Categories

**Surficial Geologic Units: Permiability Category**
- G1 (good) - coarse outwash/alluvium
- G2 (moderate) - slightly silty outwash/alluvium
- G3 (poor) - till or other silty/clayey soil
Steep Slope Proximity

Proximity to Steep Slopes
- More than 300 feet from Steep Slope (SS1)
- Between 100 and 300 feet from Steep Slope (SS2)
- Within 100 feet of Steep Slope (SS3)
Surface Slope

Surface Slope Percent (from USGS DEM)

- < 5% (S1)
- 5 to 15% (S2)
- > 15% (S3)
Depth to Shallow Aquifer

- More than 20 feet (GW1)
- 10 to 20 feet (GW2)
- Less than 10 feet (GW3)
Depth to Qva Aquifer

- More than 20 feet (GW1)
- 10 to 20 feet (GW2)
- Less than 10 feet (GW3)
Depth to Groundwater Combined Analysis

Depth to Groundwater Analysis Classification:
- More than 20 feet (GW1)
- 10 to 20 feet (GW2)
- Less than 10 feet (GW3)
- Perched (GWp)
Thickness of Target Unsaturated Zone

- 20 or more feet (U1)
- 0 to 20 feet (U2)
- Less than 0 feet - confined (U3)

Qva Water Level Elevation Contours (Interpreted from Kahle, 1998)
Depth to Qva
(thickness of Qvt)

USGS-Mapped Qva Outcrops

Estimated Depth to Qva
- Less than 10 feet
- 10 to 20 feet
- 20 to 40 feet
- 40 to 70 feet
- Greater than 70 feet
Depth to Qva Classification

Depth to Qva: Analysis Classification

- Less than 20 feet (D1)
- 20 to 70 feet (D2)
- More than 70 feet (D3)
Shallow Infiltration Factors

- Surficial geology (permeability)
- Wetlands
- Surface slope gradient
- Proximity to steep slopes
- Depth to groundwater
Shallow Infiltration Feasibility
Deep Infiltration Factors

- Wetlands
- Proximity to steep slopes
- Depth to permeable zone
- Thickness of unsaturated zone
Deep Infiltration Feasibility
More Information

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Ponding Elevation for Different Groundwater Elevations

- GW 0.5 ft above raingarden
- GW at base of raingarden
- GW 0.5 ft below raingarden
- GW 1 ft below raingarden
- GW 2 ft below raingarden
- GW 5 ft below raingarden

Pond Elevation (ft)

Time (hours)

0 10 20 30 40 50 60 70 80 90 100

8.0 8.2 8.4 8.6 8.8 9.0 9.2
Stand-Alone Drilled Drain Completion Detail

- Typically 2-3 ft in diameter
- Backfilled with Pea Gravel
- Type 2 Structure
- Piezometer
- May include surface casing
Regulatory Considerations

- Most deep drains are Class V underground injection control (UIC) wells
  - Must be deeper than their widest dimension or contain perforated pipe
  - Department of Ecology regulates UICs (requires permit)
  - Guidance for UIC Wells that Manage Stormwater (Ecology, 2006)
- UICs are standard practice in Eastern Washington
- Raingardens are not UICs
Deep Drain Costs and Benefits

- Requires hydrogeologic assessment (cost variable, assume $10,000)
- Depending on thickness of low permeability soil, cost of drain between $1,000 (dug) and ~$20,000 (drilled and cased)
- Raingarden with deep drain provides ~50,000 gal of control volume

Cost per gallon of control volume < $2.6 per gallon