HOW AND WHERE DOES INFILTRATION WORK? —

- Context: Summary of Geologic History
- Constraints/benefits for different geologic units
- Key geologic and groundwater flow parameters critical to site planning/engineering
- Subgrade preparation
Reference: D. Molenaar, 1987

**Juan de Fuca Lobe**
The ice flowed westward to the Pacific via the trough of today's Strait of Juan de Fuca.

**Puget Lobe**
The ice flowed southward down the Puget Trough, with large discharges of glacial meltwater draining to the Pacific via the ancestral Skagit River.

**Ice-Marginal River**
A large stream, formed by the meltwater from Cascade glaciers and the Puget Lobe, flowed along the margin of the ice to the Columbia River and thence to the Pacific Ocean.
TYPICAL PUGET SOUND STRATIGRAPHY

- **Recessional outwash**: Bedded and sorted sand, gravel. River deposits flowing from wasting and retreating ice.

- **Till**: Unsorted mixture of clay, silt, sand, gravel, cobbles – nature’s concrete 5 to 30 feet thick on average. Compacted beneath ice sheet.

- **Advance outwash**: Bedded and sorted gravel and sand at top: River deposits flowing from advancing ice; well-bedded clay and silt at base: deposits of lakes (or salt water) farther in front of the ice.
RECESSIONAL OUTWASH

Constraints:

- Thin
  - Removed during grading
  - Shallow ground water
  - Downslope impacts (slope stability, springs, wetland hydrology)

Benefits:

- High permeability
- Dispersed infiltration options
LODGEMENT TILL

Constraints:

- Thin weathered horizon removed during grading
- Very low permeability parent material
  - Good for earthen dams/berms
  - In-situ amendments not feasible
- Ground water mounding
- 1 to 1-1/2 inches/month of recharge through till
- 0.001 to 0.002 inches/hour
ADVANCE OUTWASH

- **Constraints**
  - Depth
  - Variable receptor soil characteristics
  - Downslope impacts (slope stability)

- **Benefits**
  - Adequate receptor soil
  - Recharges aquifer system
  - Only viable solution at many sites
SITE ASSESSMENT OVERALL PROJECT LEVEL CONSTRAINTS

- Geology/soil characteristics
- Ground water conditions
- Infiltration potential
- Water balance issues
  - Wetlands
  - Springs
  - Water Supply
- Final Site Use
  - Commercial
  - Residential
  - Industrial
SITE ANALYSIS

- Exploration
  - Exploration pits
  - Deep exploration borings
- Testing
- Modeling
READILY AVAILABLE RESOURCES

- USGS and DNR Geologic Maps
- USDA Maps
- In House Previous Work
RECEPTOR SOILS

- Organic Content
- Infiltration rate of native soils
- Cation Exchange Capacity
- Grain Size Distribution
SPECIAL CASE ONLY:
- Grain Size Distribution
- Published Soil Infiltration Rates

OUTDATED:
- Percolation Test (Single Standpipe)
- Double Ring Infiltrometer

PREFERRED:
- Large-Diameter Single Ring
- Pilot-Scale PIT
\[
\log_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{\text{fines}}
\]
Table 3.7—Recommended Infiltration Rates based on USDA Soil Textural Classification

<table>
<thead>
<tr>
<th>Clean sandy gravels and gravelly sands</th>
<th><em>Short-Term Infiltration Rate (in/hr)</em></th>
<th>Correction Factor</th>
<th>Estimated Long-Term (Design) Infiltration Rate (in/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean sandy gravels and gravelly sands</td>
<td>20</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Sand</td>
<td>8</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Loamy Sand</td>
<td>2</td>
<td>4</td>
<td>0.5</td>
</tr>
<tr>
<td>Sandy Loam</td>
<td>4</td>
<td>4</td>
<td>0.25</td>
</tr>
<tr>
<td>Loam</td>
<td>0.5</td>
<td>4</td>
<td>0.13</td>
</tr>
</tbody>
</table>
OLD SCHOOL INFILTRATION

Falling Head Test (EPA)

Double Ring Test
Pilot Infiltration Test (PIT)
LARGE DIAMETER RING INFILTRATION TEST (AESI)

Modified PIT Test
Commercial Sites

- 1 test per 5,000 sq. ft.
- Groundwater thru wet season

Residential Sites

- 1 Test per 200 feet of road and every lot
- Groundwater thru wet season
MODELING ANALYSIS

- Depth to water table
- Infiltration rate of native soils
- Hydrographs
- MODRET
Characterization of Receptor Soils – Hydraulic Parameters – water quality characteristics

Infiltration Rate – Laboratory/Field Measurements

Depth to Water Table – Thickness of Unsaturated Zone

Groundwater Flow Direction – Impacts to Environment/Wells

Depth of Aquitard – Aquifer Capacity

Design Storm Event – Peak Flow Rate/Total Volume
SUBGRADE PREPARATION

- Stripping depth - know where receptor soils are
- Uniformity of subgrade support – Look for soft spots
- Proof Roll – use a fully loaded dump truck
- Firm and Unyielding
- Geotextile – only for separation – not always advisable
CONSTRUCTION

- Truck traffic to a minimum, establish haul routes
- Erosion control
- Finished product protection
- Siltation from other areas
- Truck Traffic
- Concrete washouts
Ballast placement – push forward without tracking on subgrade

Static Roll – or minor vibratory rolling, minimize compaction to the receptor soils