Basin-Wide Infiltration Assessment using GIS Techniques

Presented by:

Aspect Consulting, LLC

J. Scott Kindred, PE

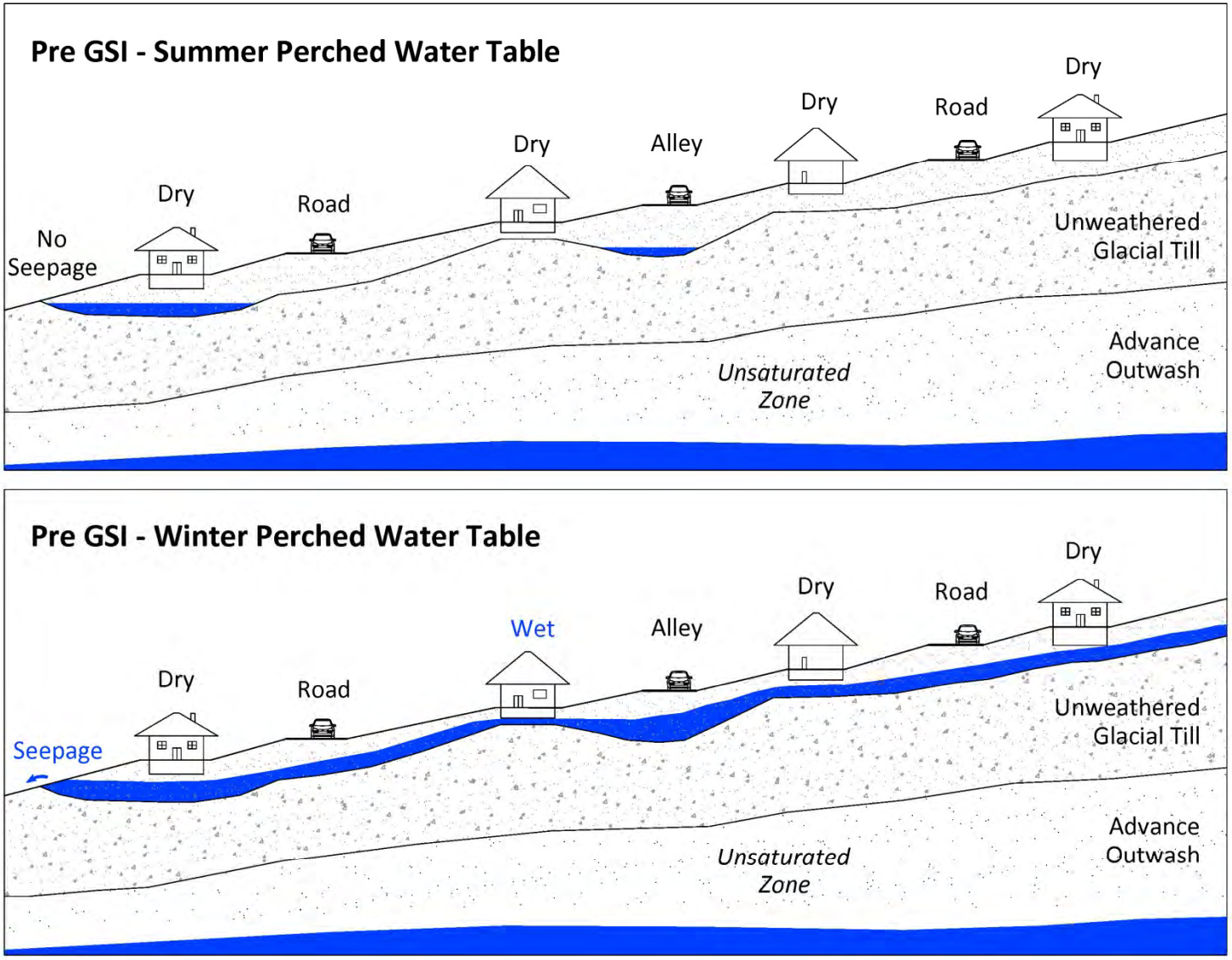
It hasn’t always been popular to add more water to the ground

Proceed with Caution…

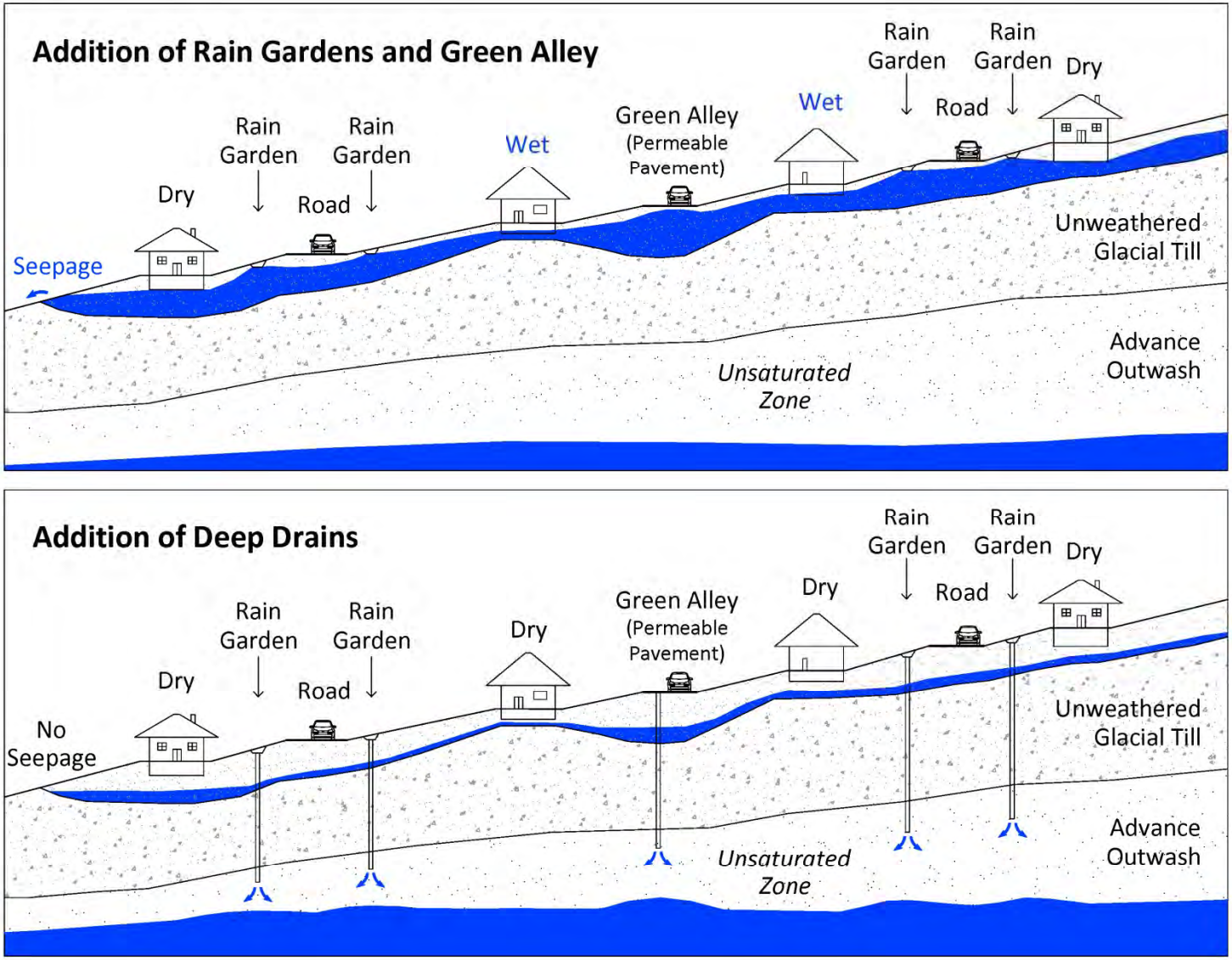
LID Requires Good Site Characterization

Perched Groundwater on Glacial Till

Perched Water Table before GSI (LID)



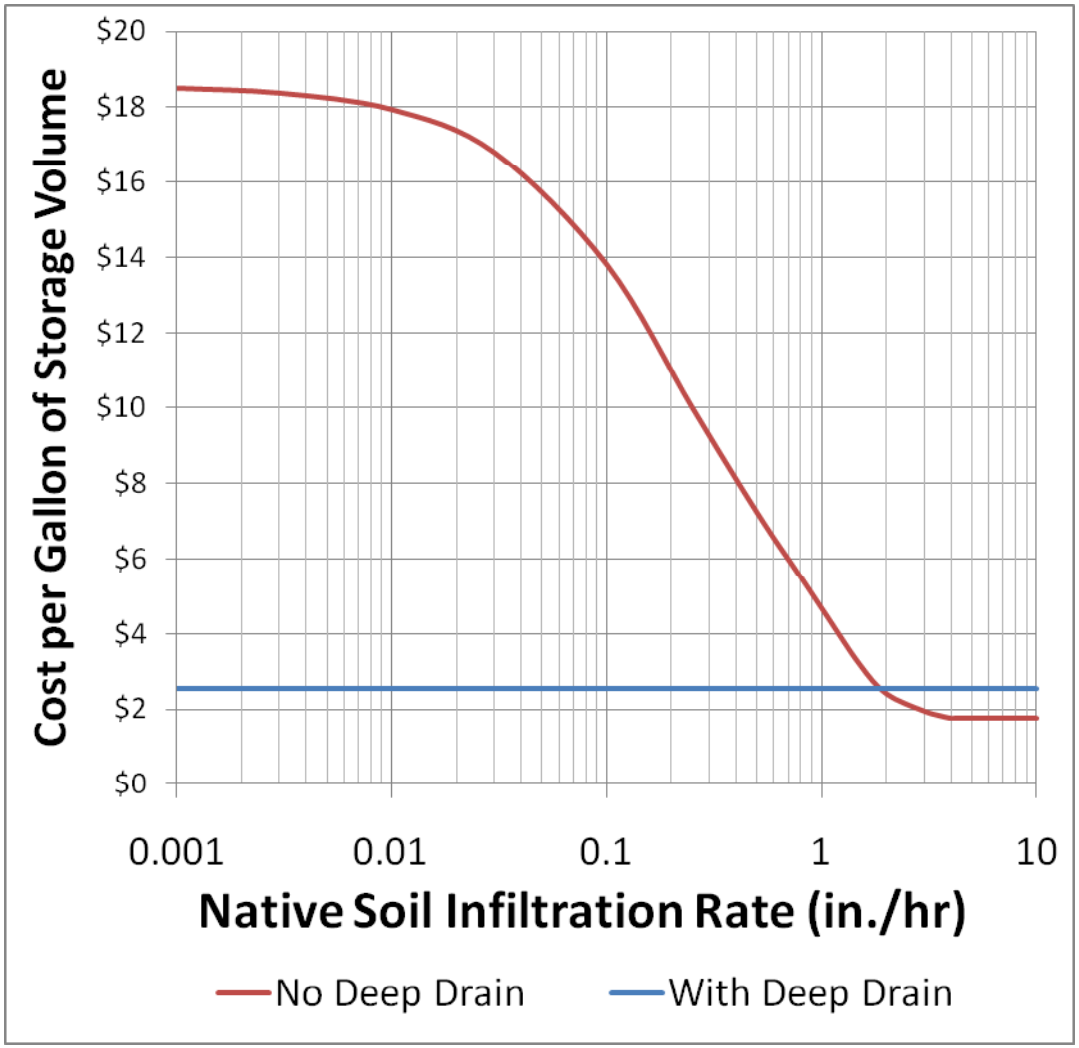
Perched Water Table after GSI (LID)



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.



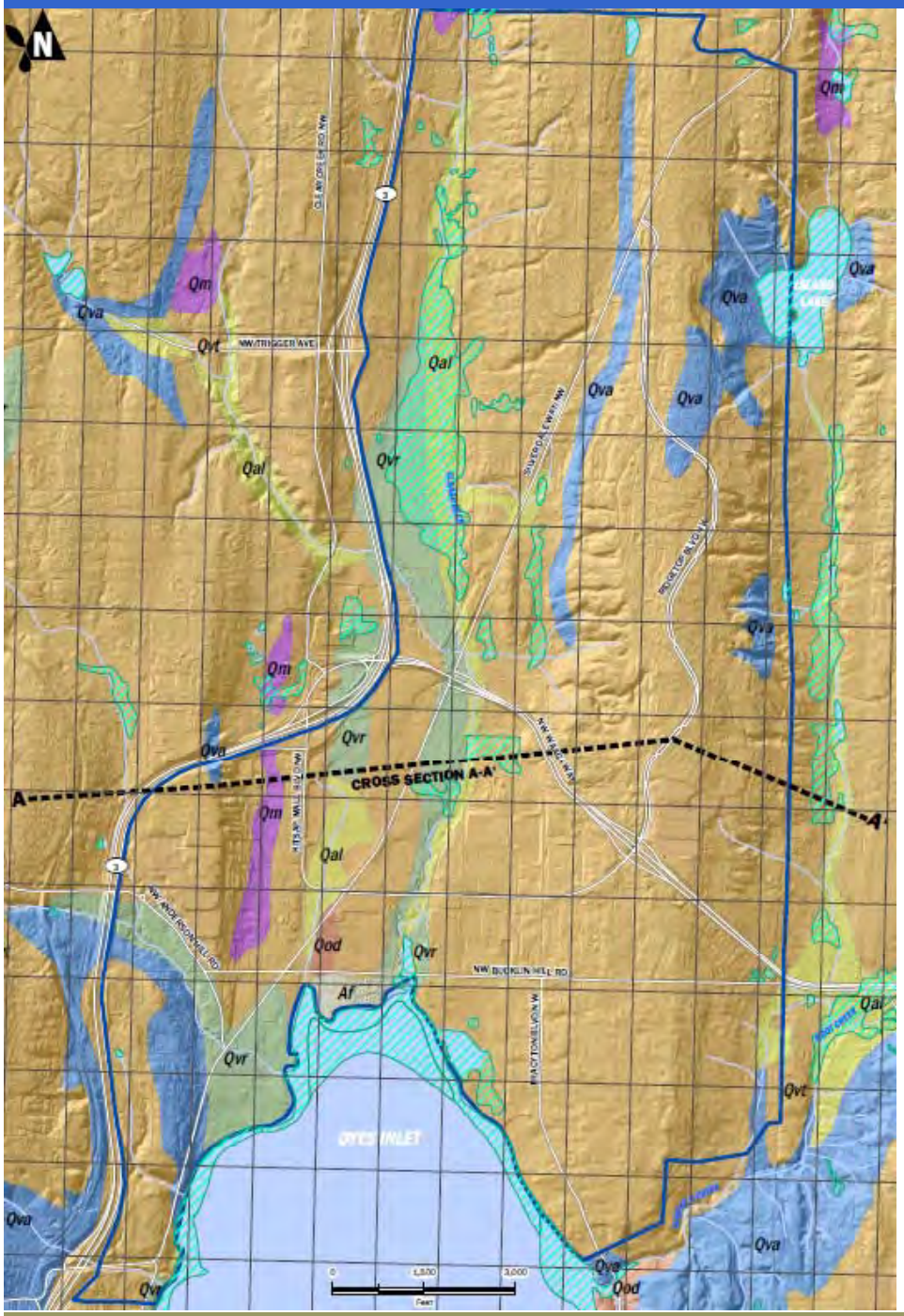
Case Study

- 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

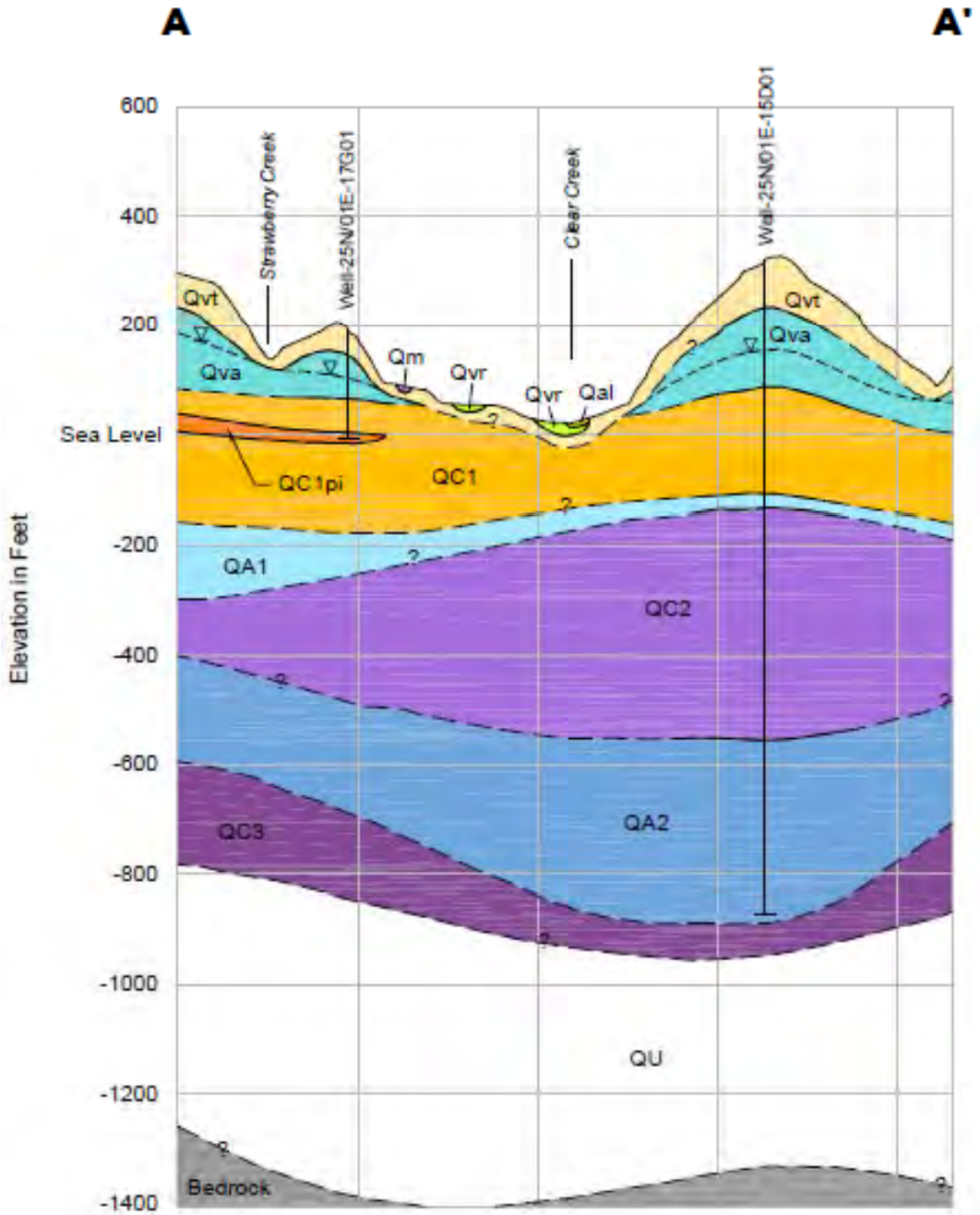
- Surficial geology (permeability)
- Wetlands
- Surface slope gradient
- Proximity to steep slopes
- Depth to groundwater
- Depth to permeable zone (deep infiltration only)
- Thickness of unsaturated zone (deep infiltration only)


Project Location
Sequim
Port Hadlock-Irondale
Port Ludlow
Freeland
Langley
Clinton
Marysville
Granite Falls
Everett
Snohomish
Northwest Snohomish
Three Lakes
Monroe
Cathcart
Maltby
Echo Lake
Kingston
Indianola
Poulsbo
Suquamish
Bangor Trident Base
Silverdale
Tracyton
Bainbridge Island
Seattle
Bellevue
Kitsap County
Hood Canal
Puget Sound
Lake Washington
Bremerton
Port Orchard
Manchester
Parkwood
Vashon
Kent
Allyn-Grapeview
101
405

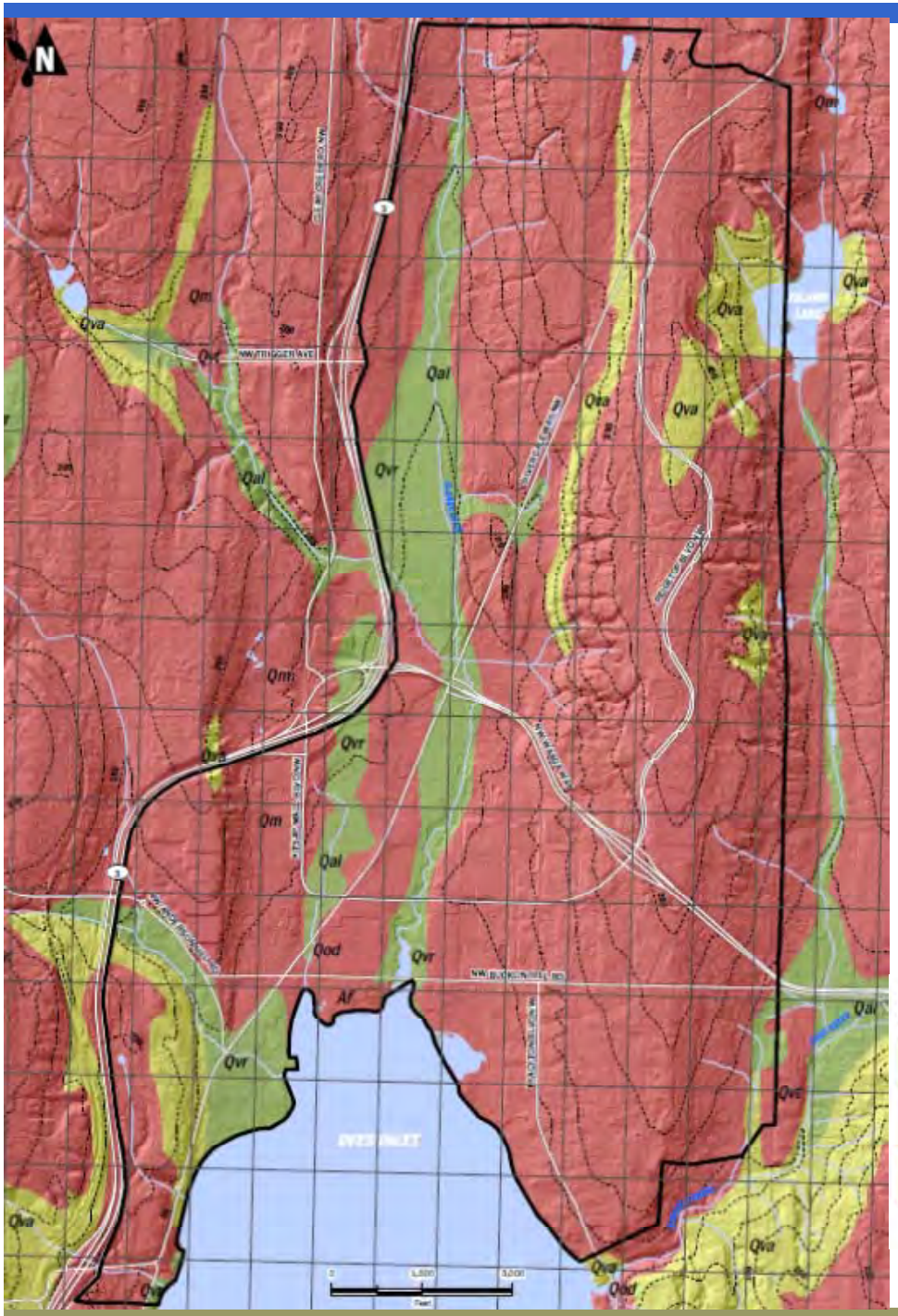


Geologic Map

- Qvt over most of the project area
- Qvr and alluvium in valley bottom
- Outcrops of Qva on hillsides



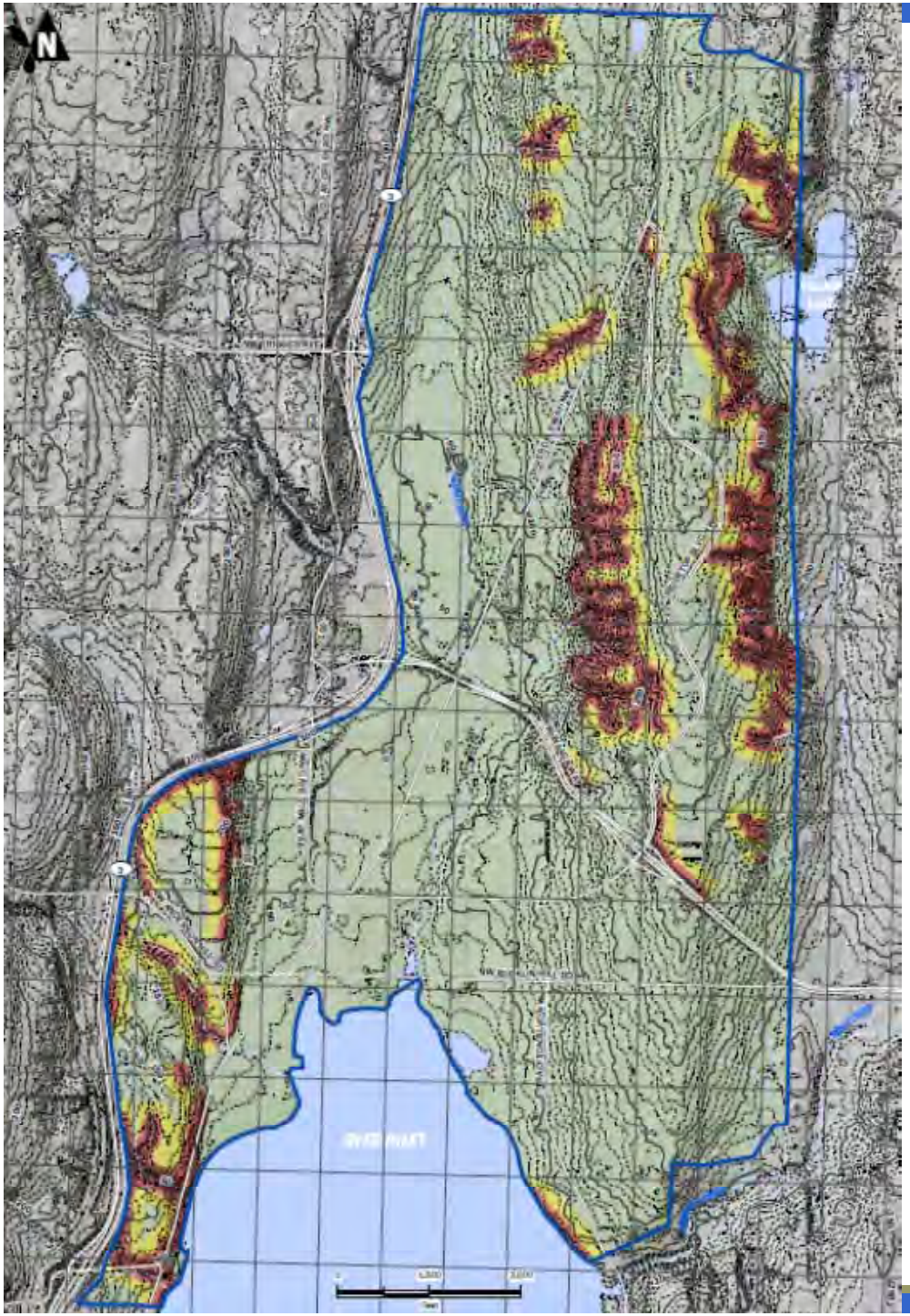
Kahle, S.C. 1998, Hydrogeology of Navel Submarine Bangor and Vicinity



Permeability Categories

Surficial Geologic Units: Permiability Category

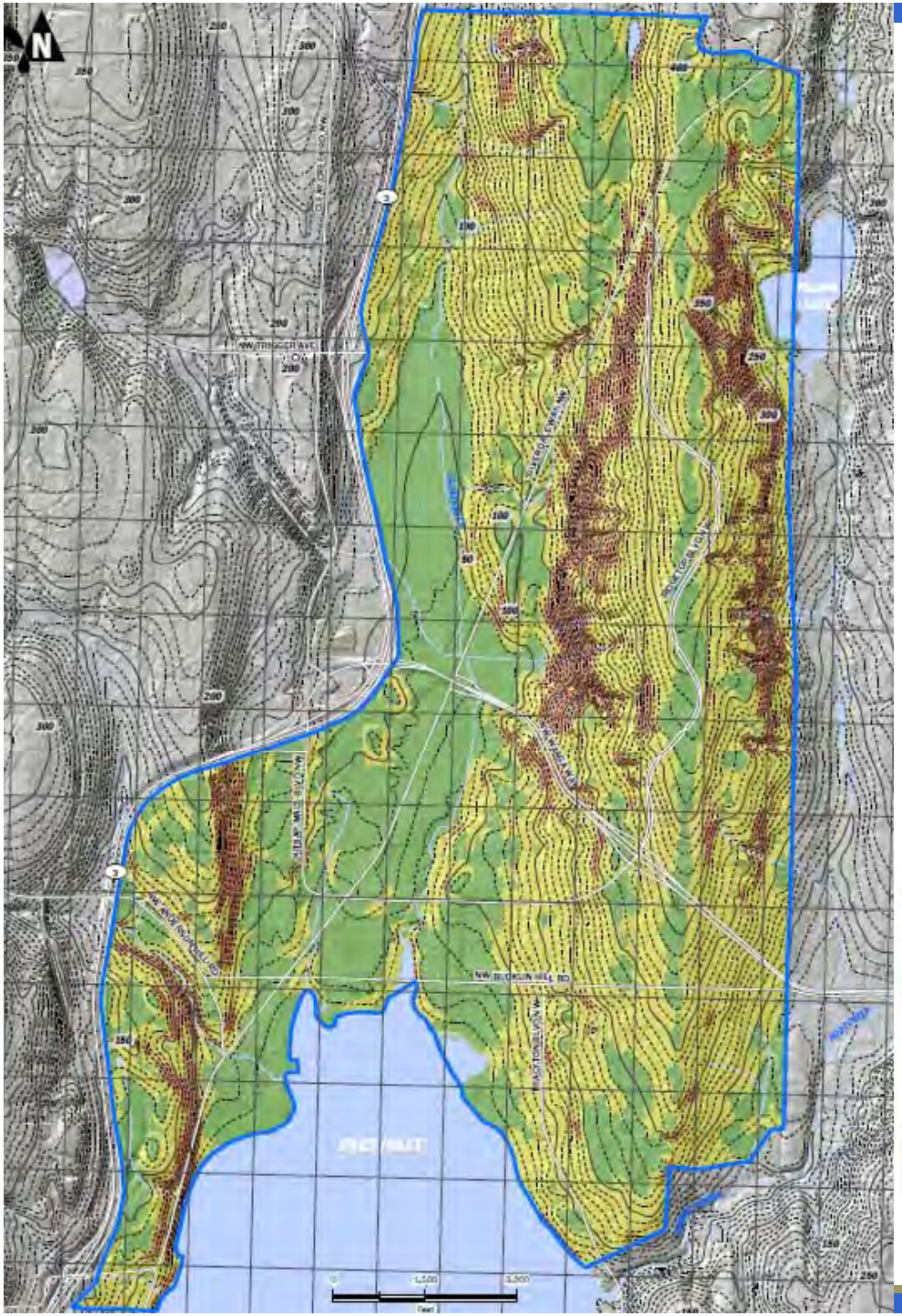
- G1 (good) - coarse outwash/alluvium
- G2 (moderate) - slightly silty outwash/alluvium
- G3 (poor) - till or other silty/clayey soil



Steep Slope Proximity

Proximity to Steep Slopes

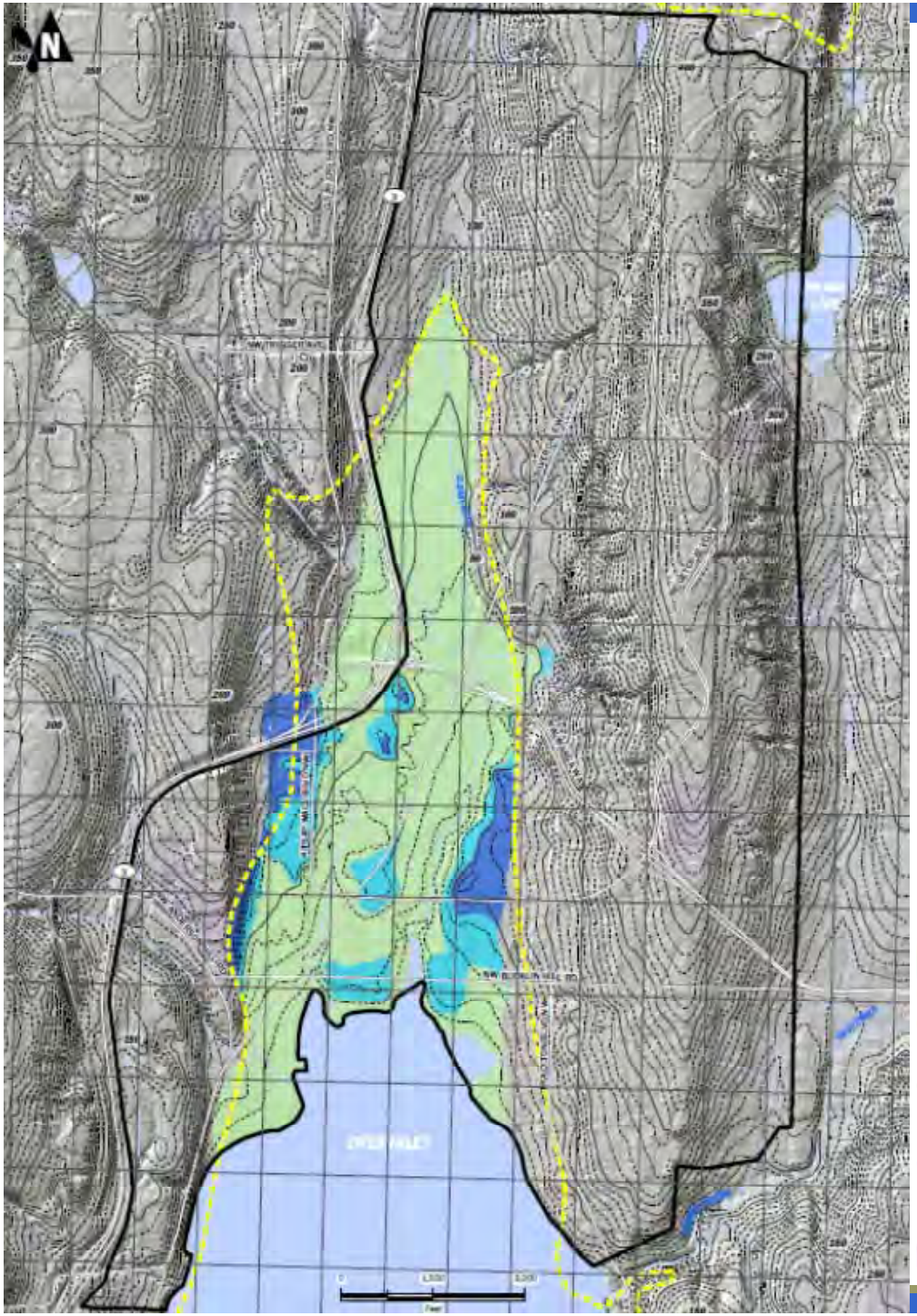
- More than 300 feet from Steep Slope (SS1)
- Between 100 and 300 feet from Steep Slope (SS2)
- Within 100 feet of Steep Slope (SS3)



Surface Slope

Surface Slope Percent (from USGS DEM)

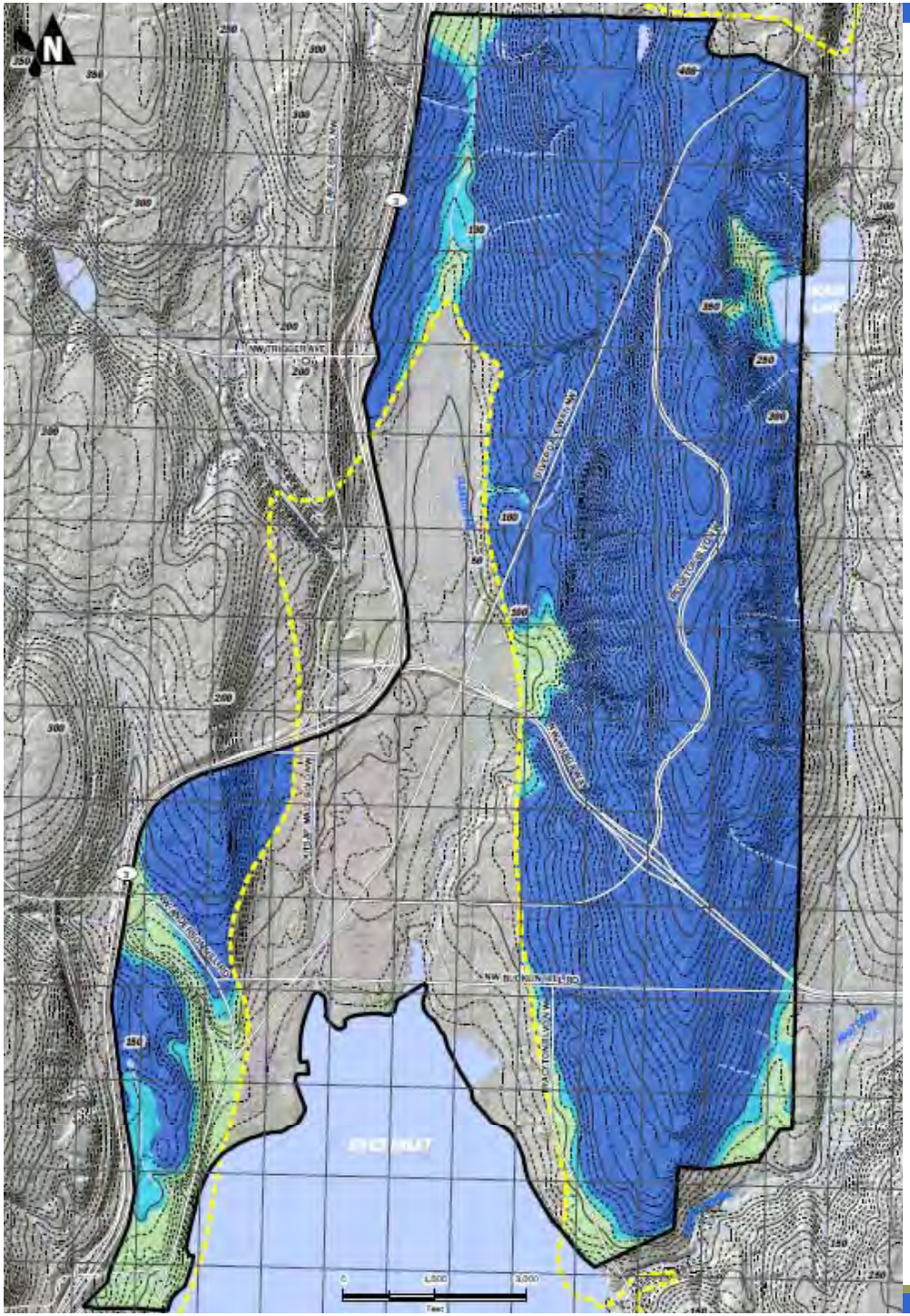
- < 5% (S1)
- 5 to 15% (S2)
- > 15% (S3)



Depth to Shallow Aquifer

Depth to Shallow Aquifer

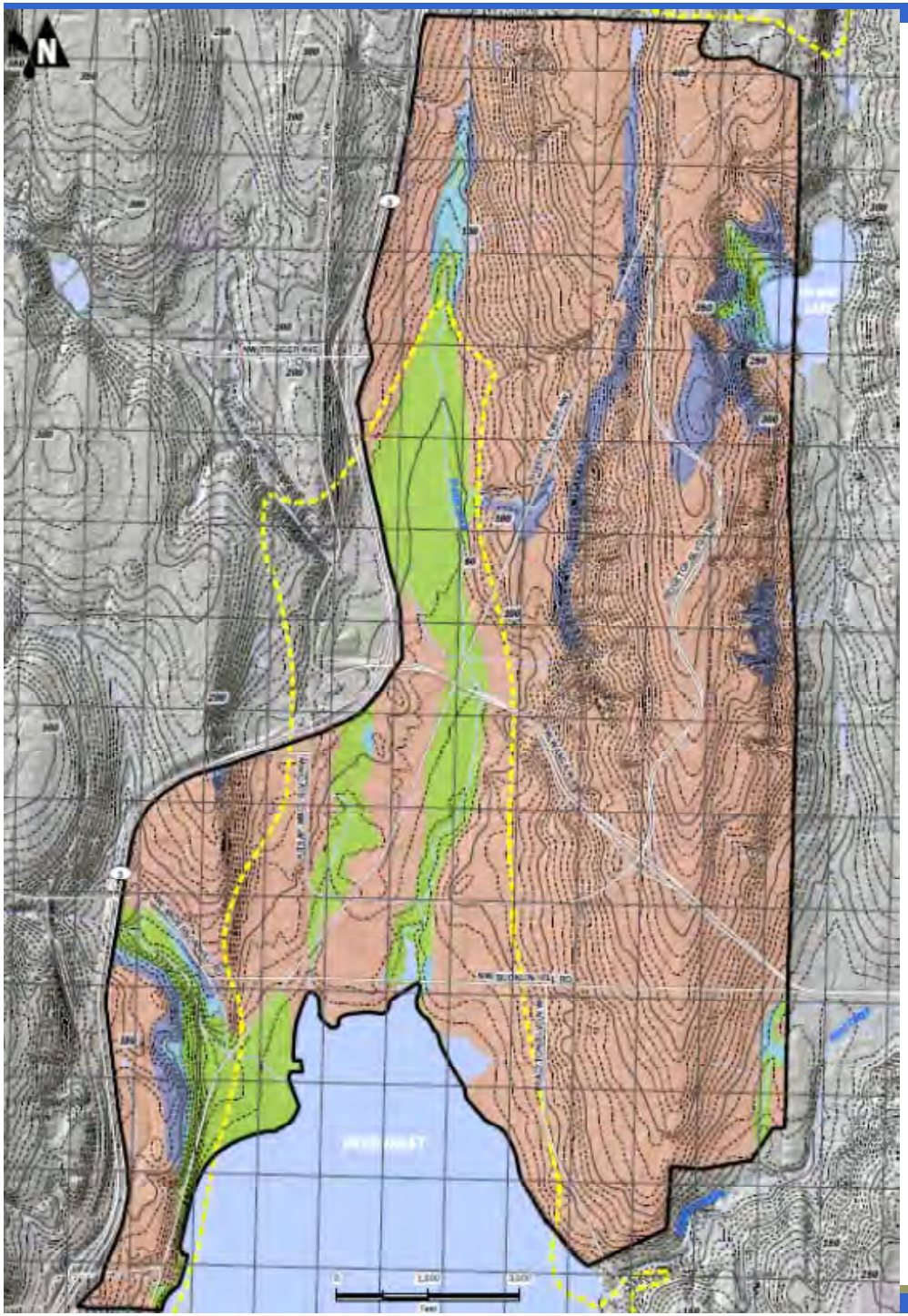
- More than 20 feet (GW1)
- 10 to 20 feet (GW2)
- Less than 10 feet (GW3)



Depth to Qva Aquifer

Depth to Qva Aquifer

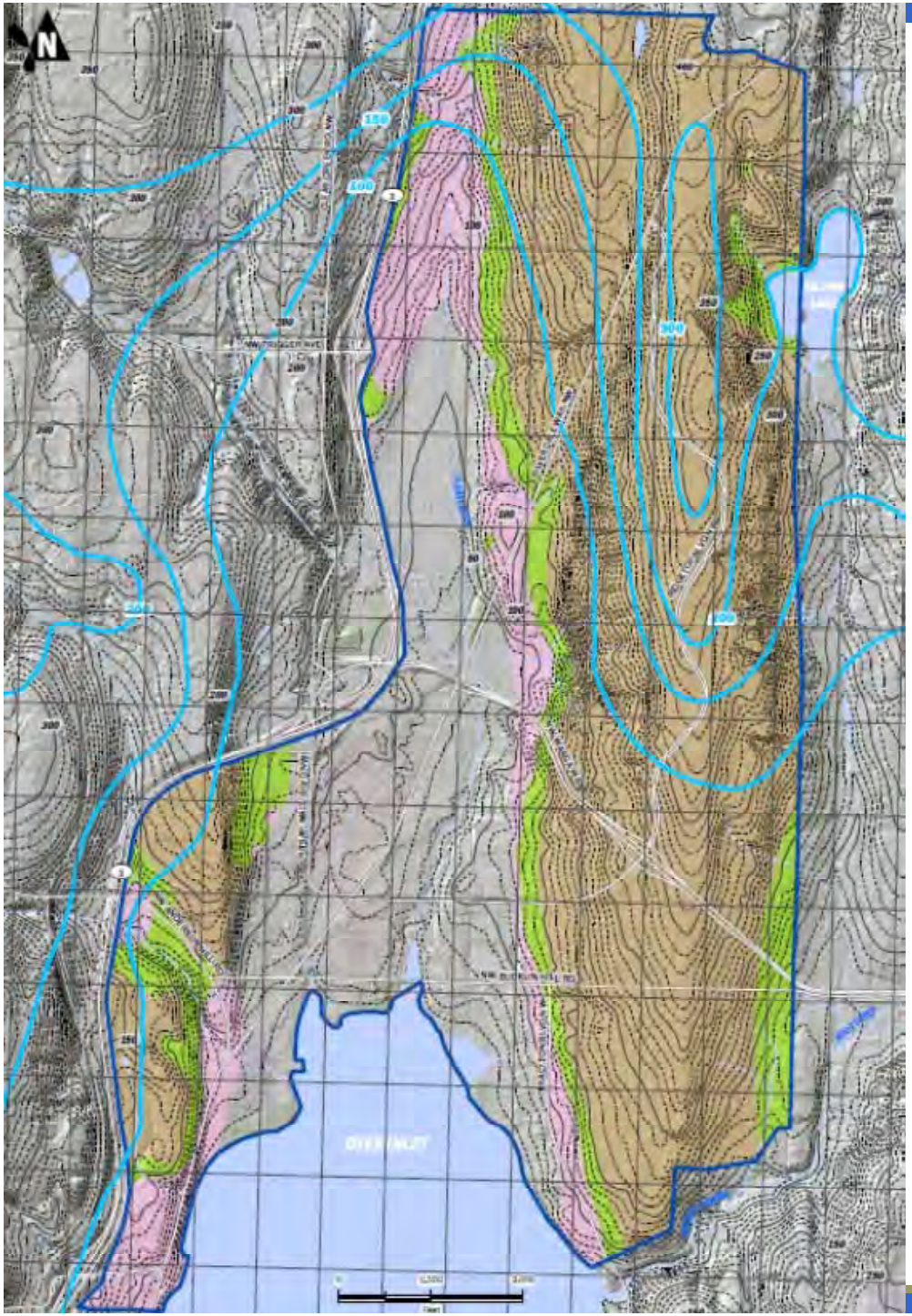
- More than 20 feet (GW1)
- 10 to 20 feet (GW2)
- Less than 10 feet (GW3)



Depth to Groundwater Combined Analysis

Depth to Groundwater Analysis Classification

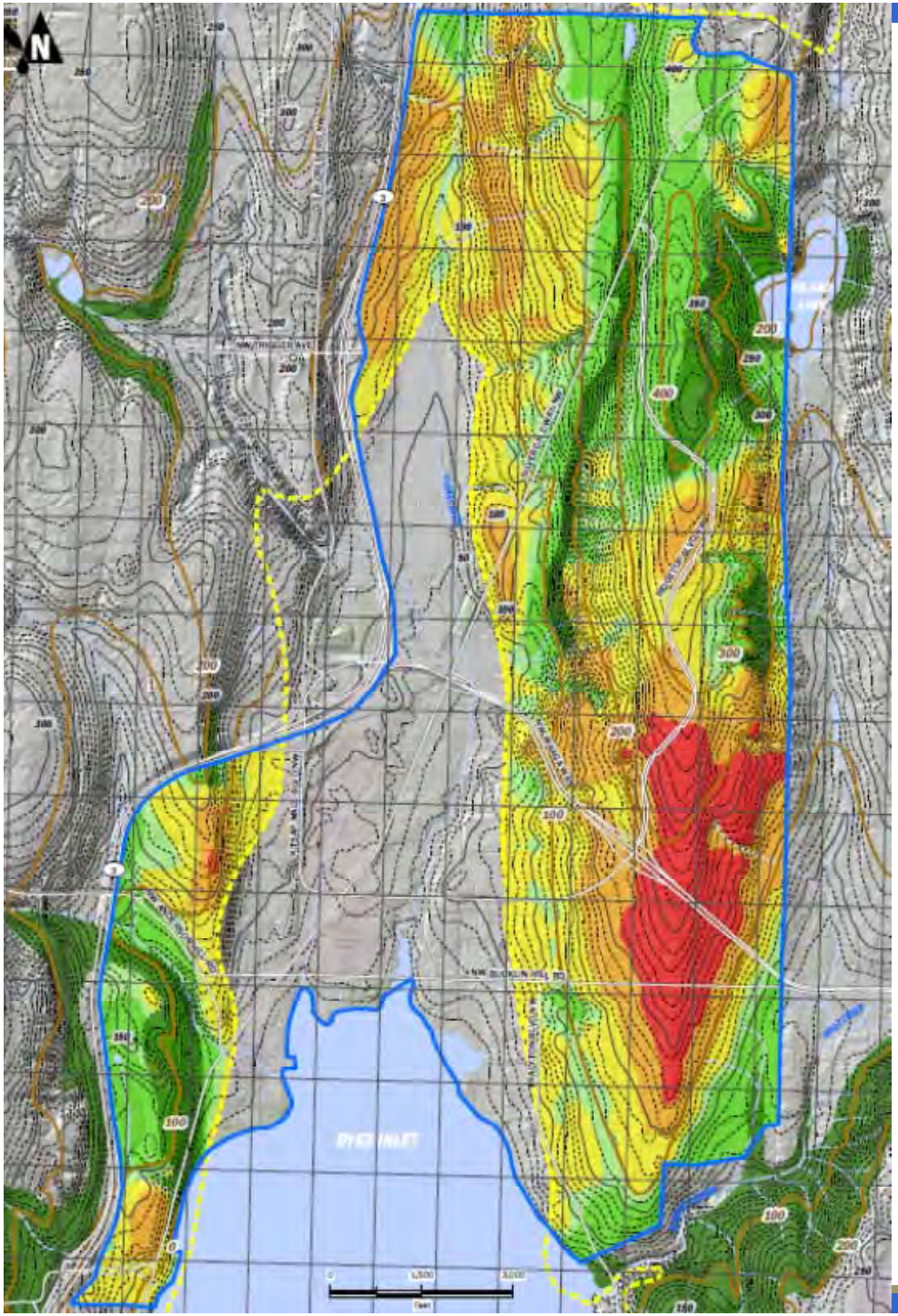
- More then 20 feet (GW1)
- 10 to 20 feet (GW2)
- Less than 10 feet (GW3)
- Perched (GWp)



Thickness of Target Unsaturated Zone

Thickness of Target Unsat 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)

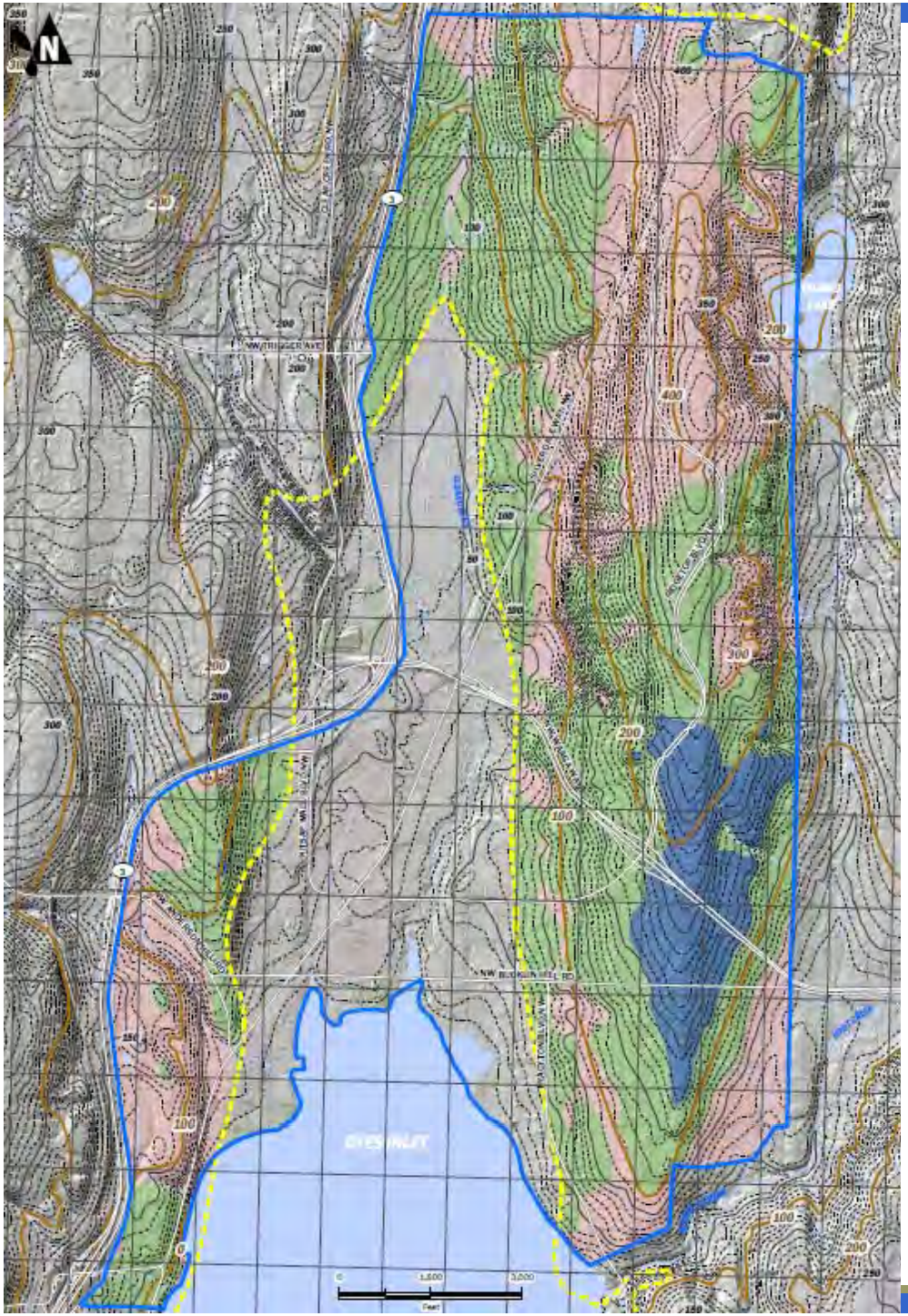


Depth to Qva (thickness of Qvt)

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



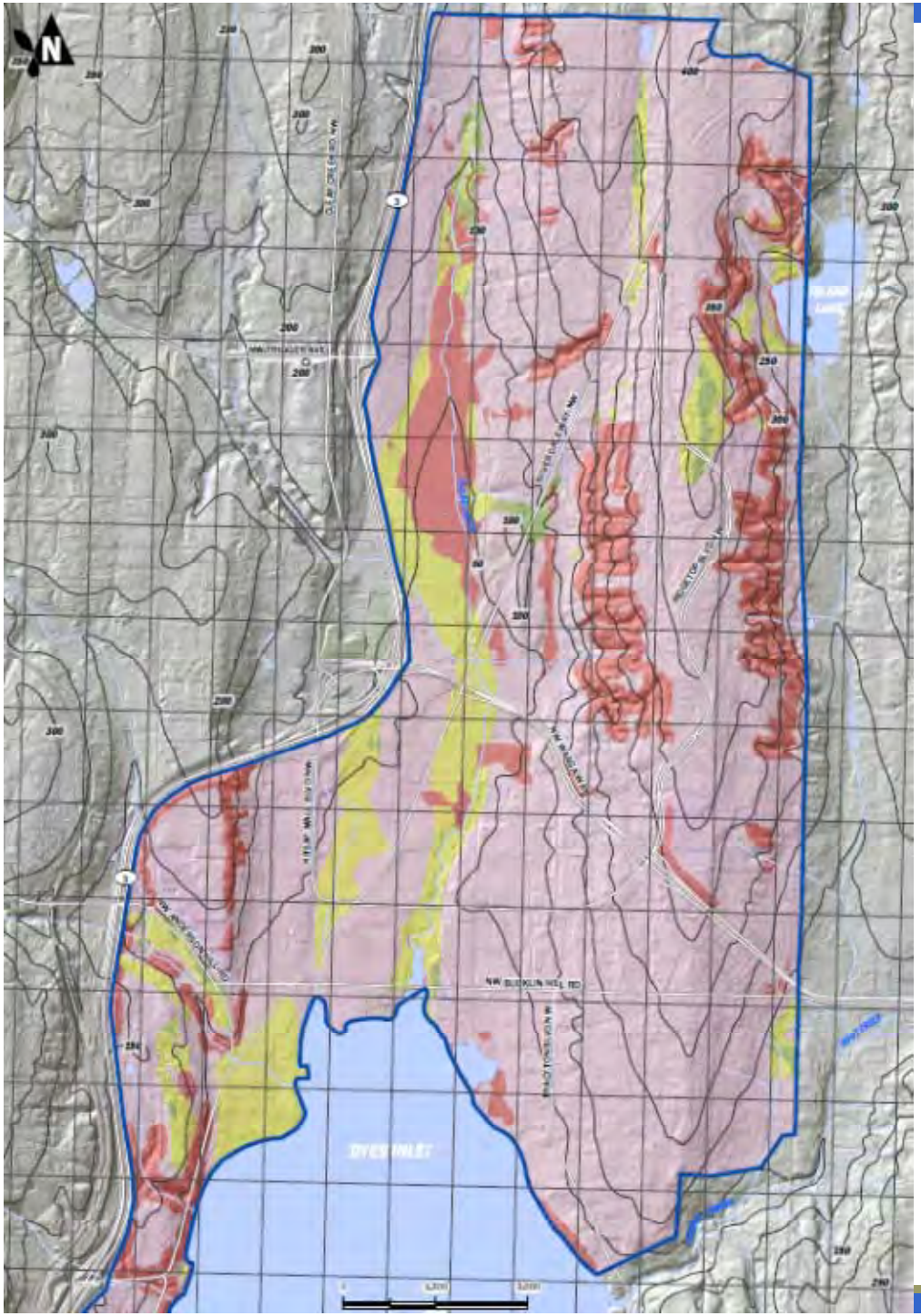
Depth to Qva Classification

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 (permeabilty)
- Wetlands
- Surface slope gradient
- Proximity to steep slopes
- Depth to groundwater



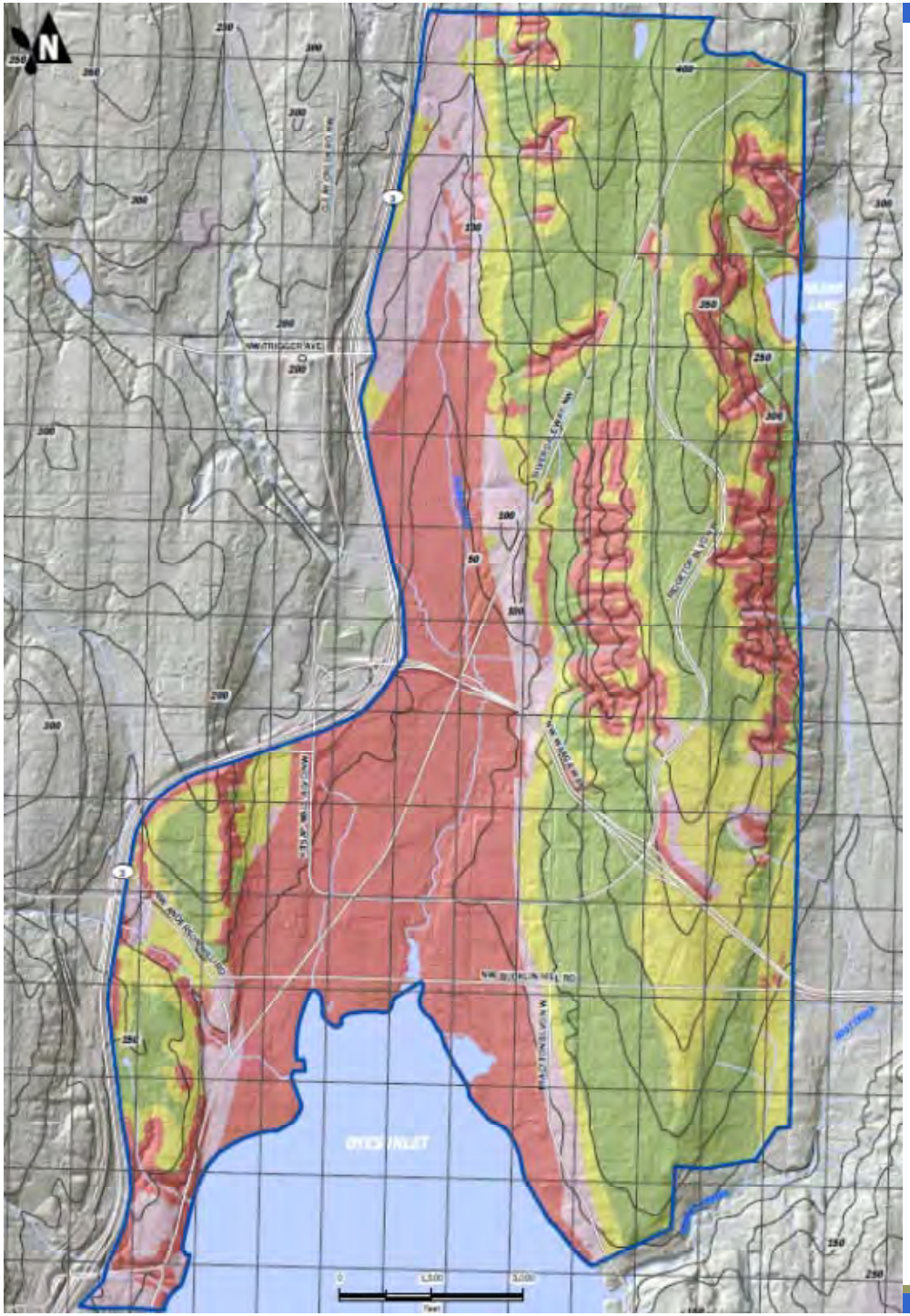
Shallow Infiltration Feasibility

Shallow Infiltration Feasibility:

- Good
- Moderate
- Likely Poor
- Poor

Deep Infiltration Factors

- Wetlands
- Proximity to steep slopes
- Depth to permeable zone
- Thickness of unsaturated zone



Deep Infiltration Feasibility

Deep Infiltration Feasibility:

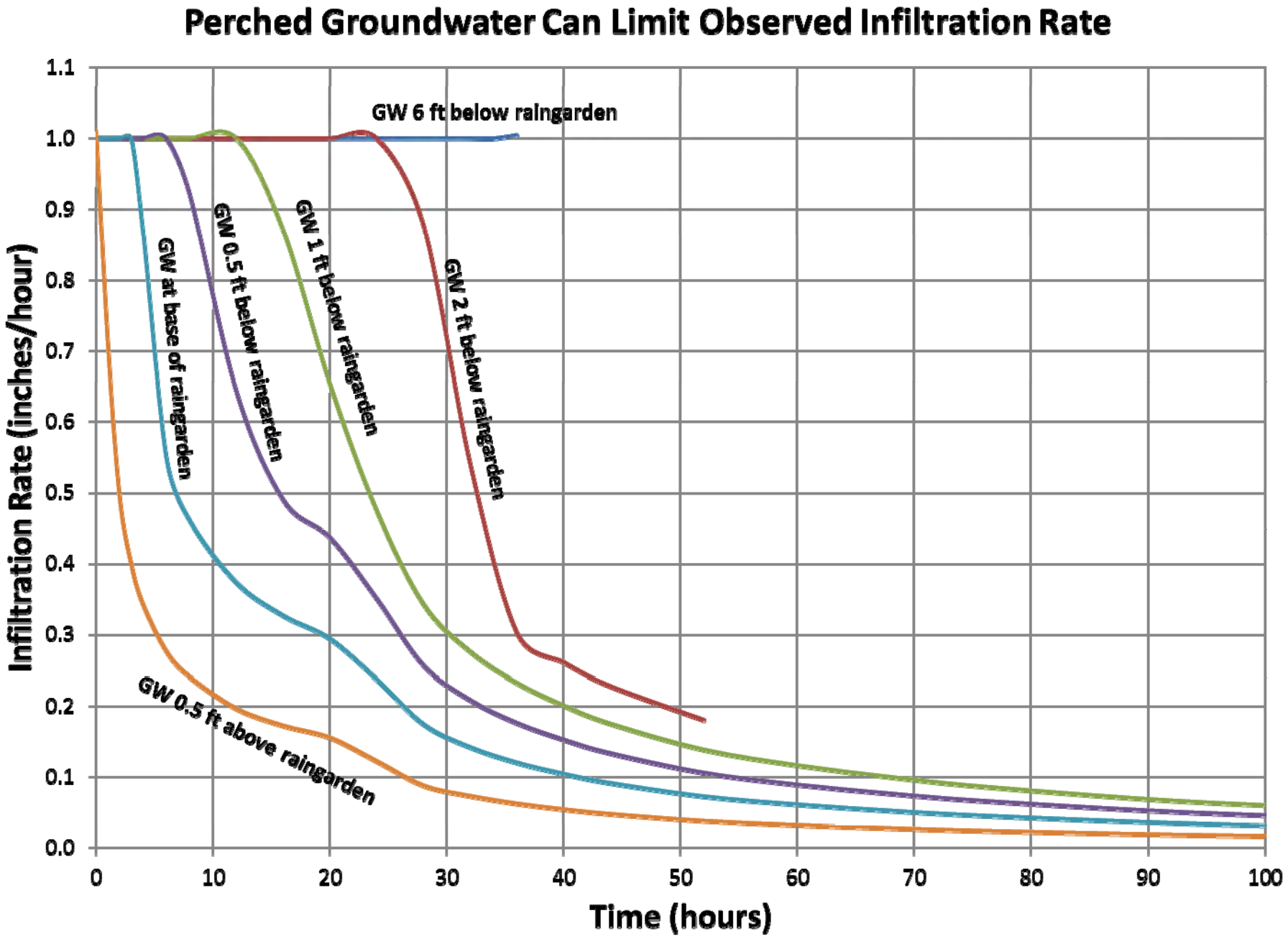
- Good
- Moderate
- Likely Poor
- Poor

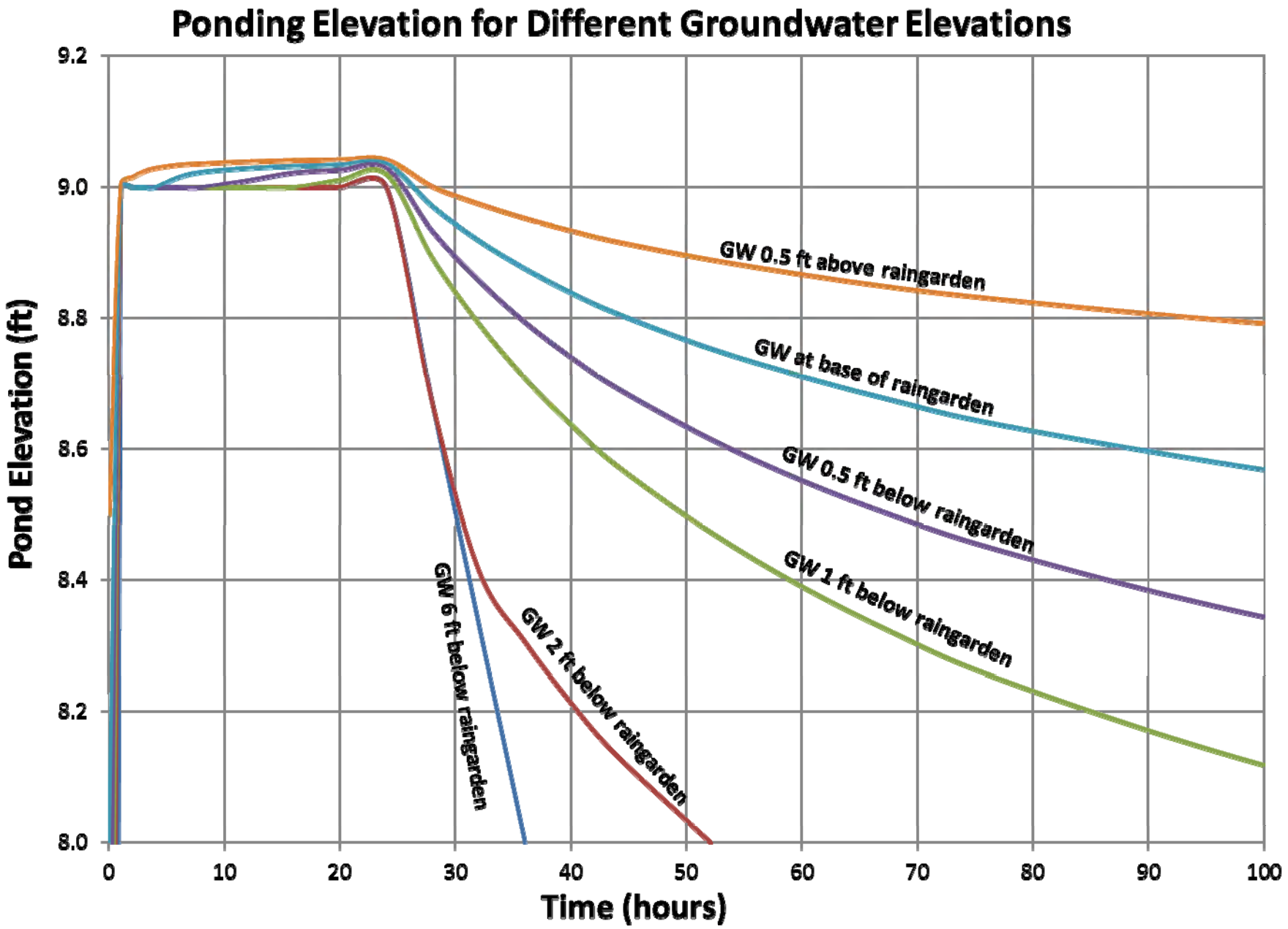
More Information

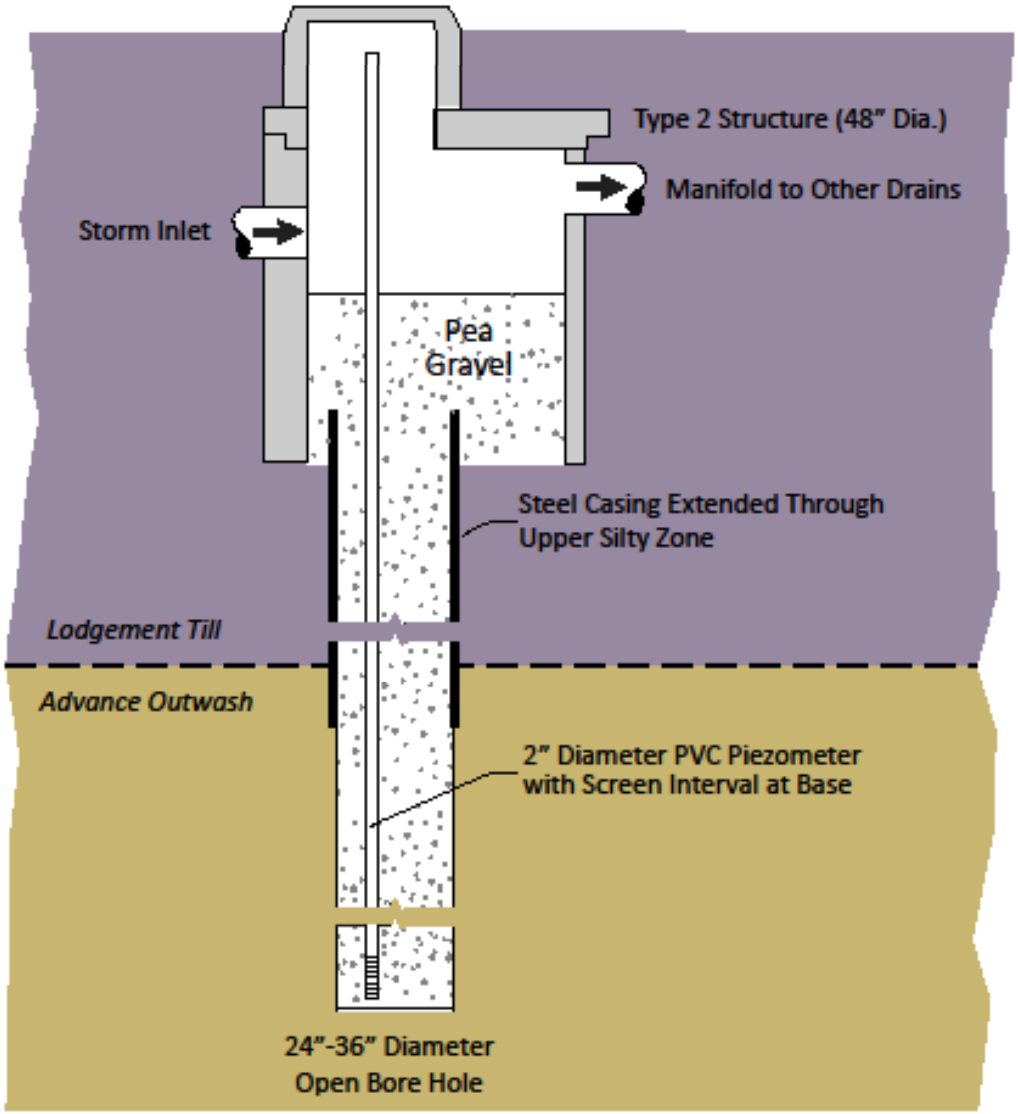
J. Scott Kindred, PE
Associate Water Resources Engineer
skindred@aspectconsulting.com
206.838.6589

Aspect
earth + water

Bainbridge Island – Mount Vernon – Seattle - Wenatchee


Perched Groundwater Can Limit Observed Infiltration Rate
Infiltration Rate (inches/hour)
Time (hours)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
10
20
30
40
50
60
70
80
90
100
GW 6 ft below raingarden
GW at base of raingarden
GW 0.5 ft below raingarden
GW 1 ft below raingarden
GW 2 ft below raingarden
GW 0.5 ft above raingarden


Ponding Elevation for Different Groundwater Elevations
Pond Elevation (ft)
9.2
9.0
8.8
8.6
8.4
8.2
8.0
0
10
20
30
40
50
60
70
80
90
100
Time (hours)
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 6 ft below raingarden



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