

DRINKING WATER SOURCE PROTECTION

Trent Conservation Coalition Source Protection Region



Tier 2 Water Budget: Crowe 4 Subwatershed: Havelock

November 3, 2009



Expert People. Better Decisions.





Water Budgets

§ Overview

- Main Outputs – Water Budget and %Water Demand

§ Water Budget Equation

- $P + G_{\text{net}} = ET + Q + \Delta S$

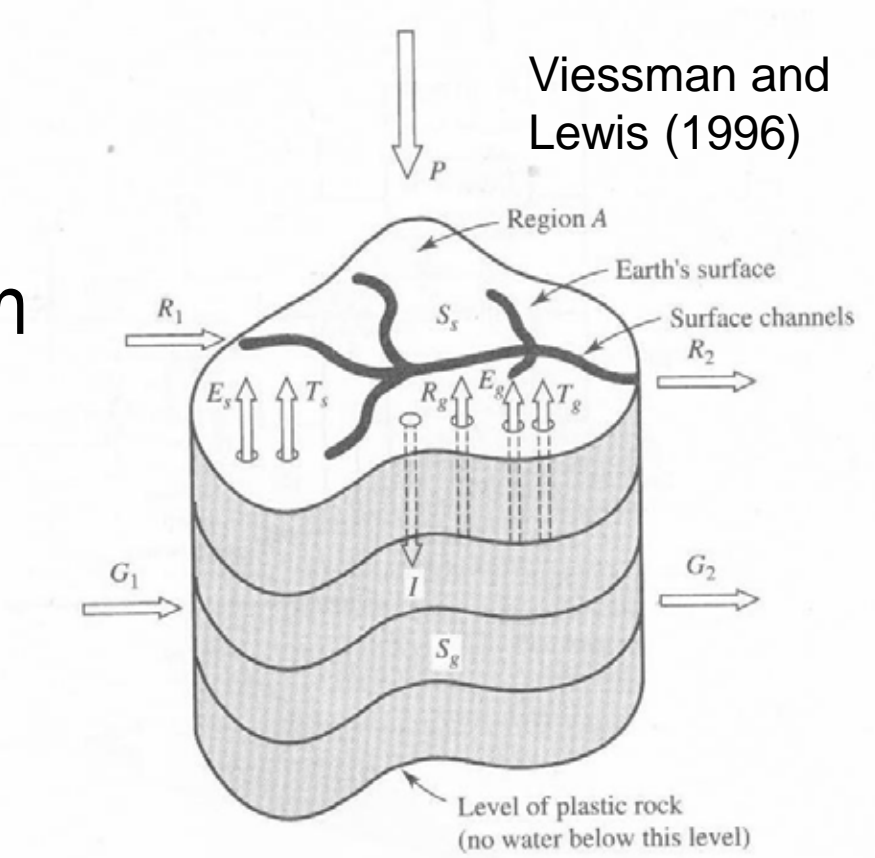
§ %Water Demand Equation

- $\% = \frac{\text{Demand}}{Q_{50} - Q_{10}} \times 100$

$$Q_{50} - Q_{10}$$

- $\% = \frac{\text{Demand}}{Q_R - Q_{10}} \times 100$

$$Q_R - Q_{10}$$



Water Budgets



§ Conceptual Water Budget

- Data Gathering
- Development of Broad Scale Understanding

§ Tier 1 – Simple Water Budget

- Uses Information from Conceptual Water Budget
- WBs and %Water Demand Calculated per subwatershed

§ Tier 2 – Complex Water Budget

- Refines information from Tier 1; Complex Model Applied
- WBs and %Water Demand Calculated per subwatershed

Tier 1 Water Budget



Surface Water Stress Level Assignment

Stress Level Assignment	Maximum Monthly % Water Demand
Low	< 20%
Moderate	20% - 50%
Significant	> 50%

Groundwater Stress Level Assignment

Stress Level Assignment	Average Annual	Maximum Monthly
Low	0 - 10%	0 – 25%
Moderate	> 10%, <= 25%	> 25%, <= 50%
Significant	> 25%	> 50%

Tier 1 Water Budget



§ Identified as Stressed and have a Municipal Supply

- Lindsay Surface water Stress / SW Supply
- Havelock Groundwater Stress / GW Supply
- Brighton Groundwater Stress / GW Supply
- Colborne Groundwater Stress / GW Supply
- Orono Surface water Stress / GW Supply

§ Tier 2 must be completed for those Identified Above

Tier 2 Water Budget



§ Overall Tier 2 Requirements

- Complete a water budget on identified subwatersheds
- Simulate several scenarios to assign a subwatershed “stress level”
- Refine Demand Estimates

§ A Complex Model Must be Developed to:

- Generate the terms of the water budget
- Estimate the supply term
- Calculate the level of the aquifer / reservoir

Tier 2 Water Budget



§ Model Selection

- Based on ability of model to represent hydrologic system
- Approved by Peer Review Committee

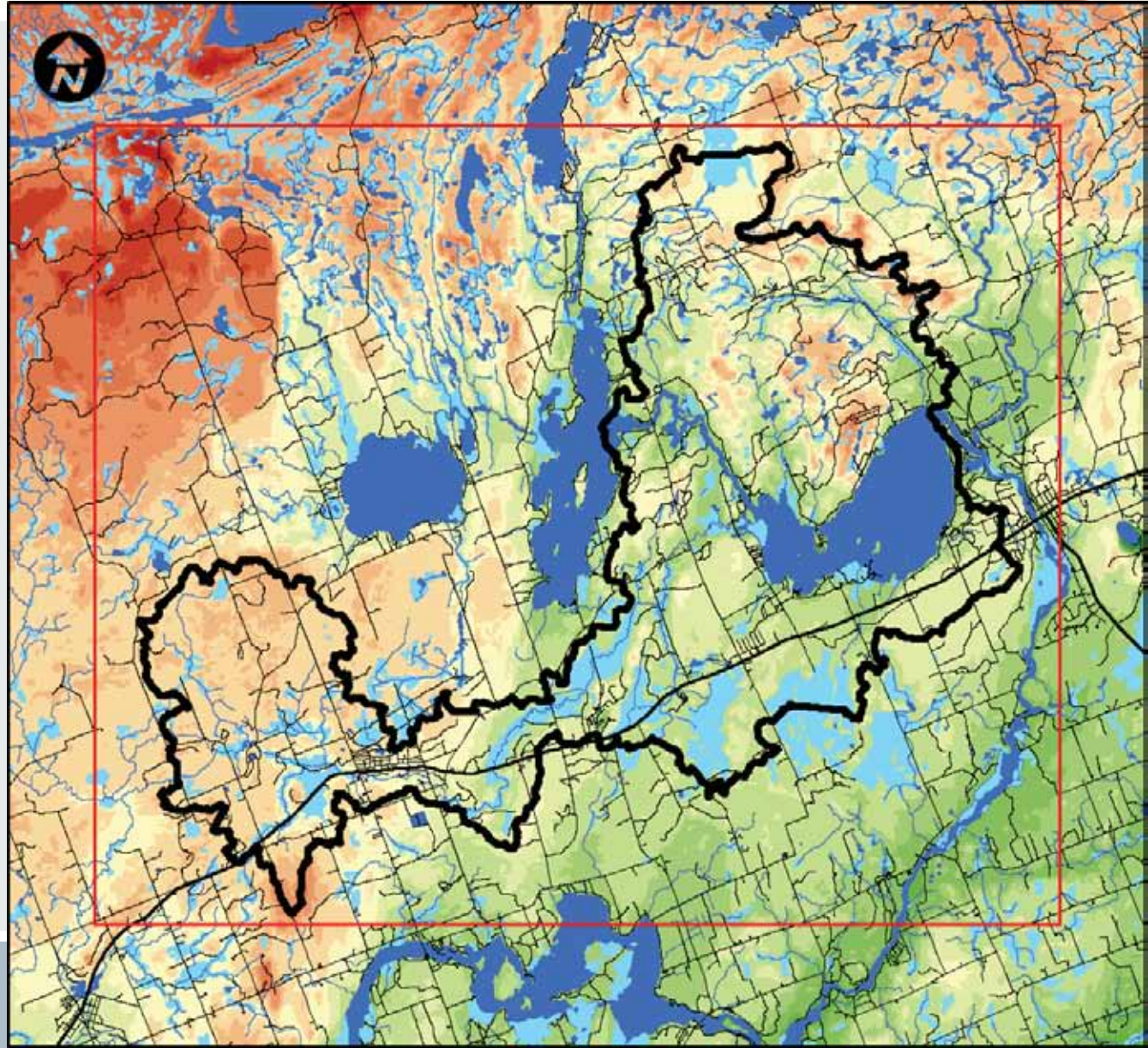
§ Models Selected

- Lindsay – HSPF and RESCOM by XCG SW
- Havelock – MODFLOW by XCG GW
- Brighton / Colborne – MODFLOW by EARTHFX
- Orono – HSPF and MODFLOW by Ganaraska and UoG

Havelock

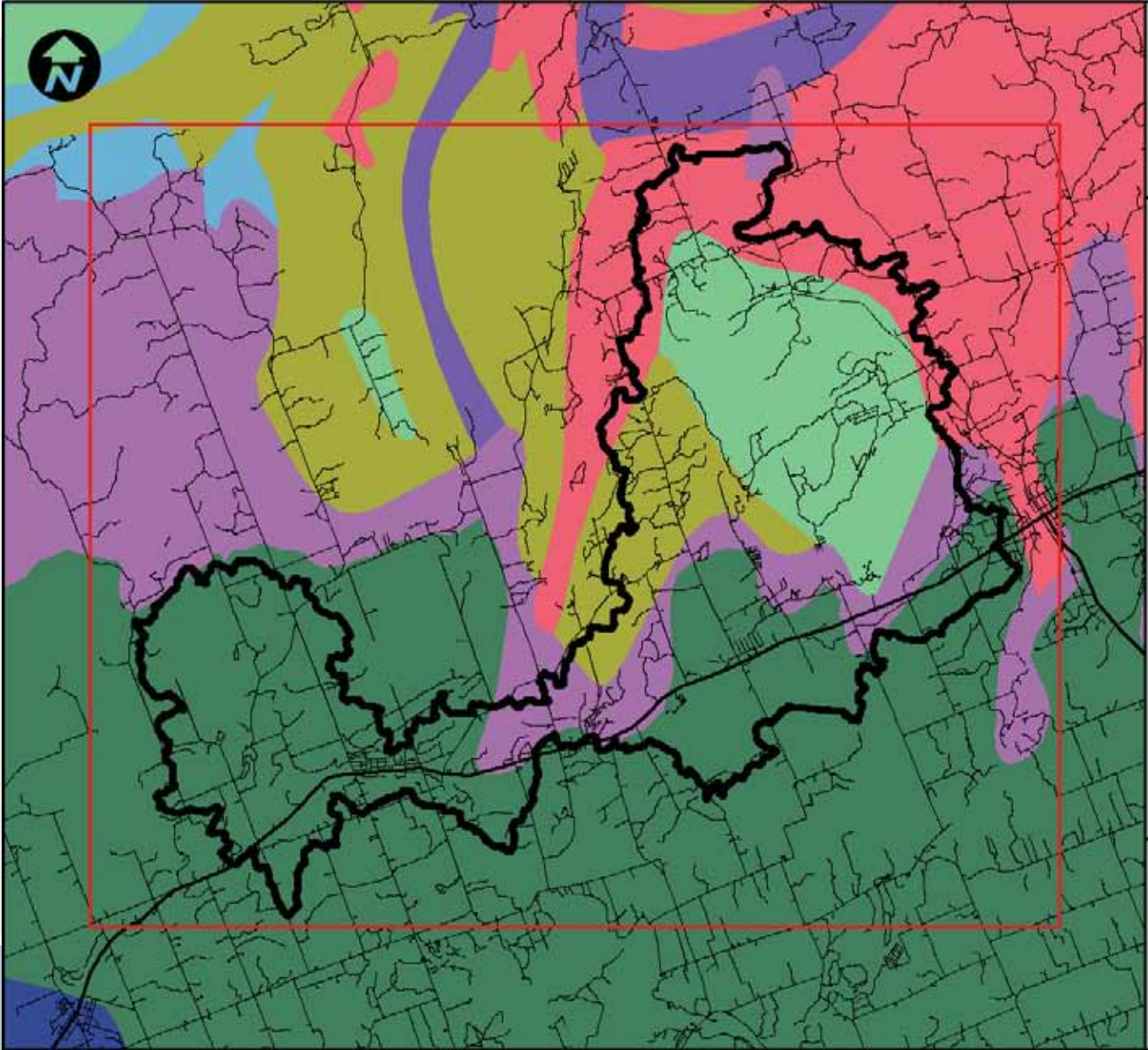


- § T1 designated stress level “low”
- § T1 designated uncertainty as “high”
- § Therefore T2





Havelock - Bedrock



Bedrock Geology Havelock

- Subwatershed Boundary
- Model Grid Extent
- Major Roads
- Minor Roads

Bedrock Geology

Code, Description

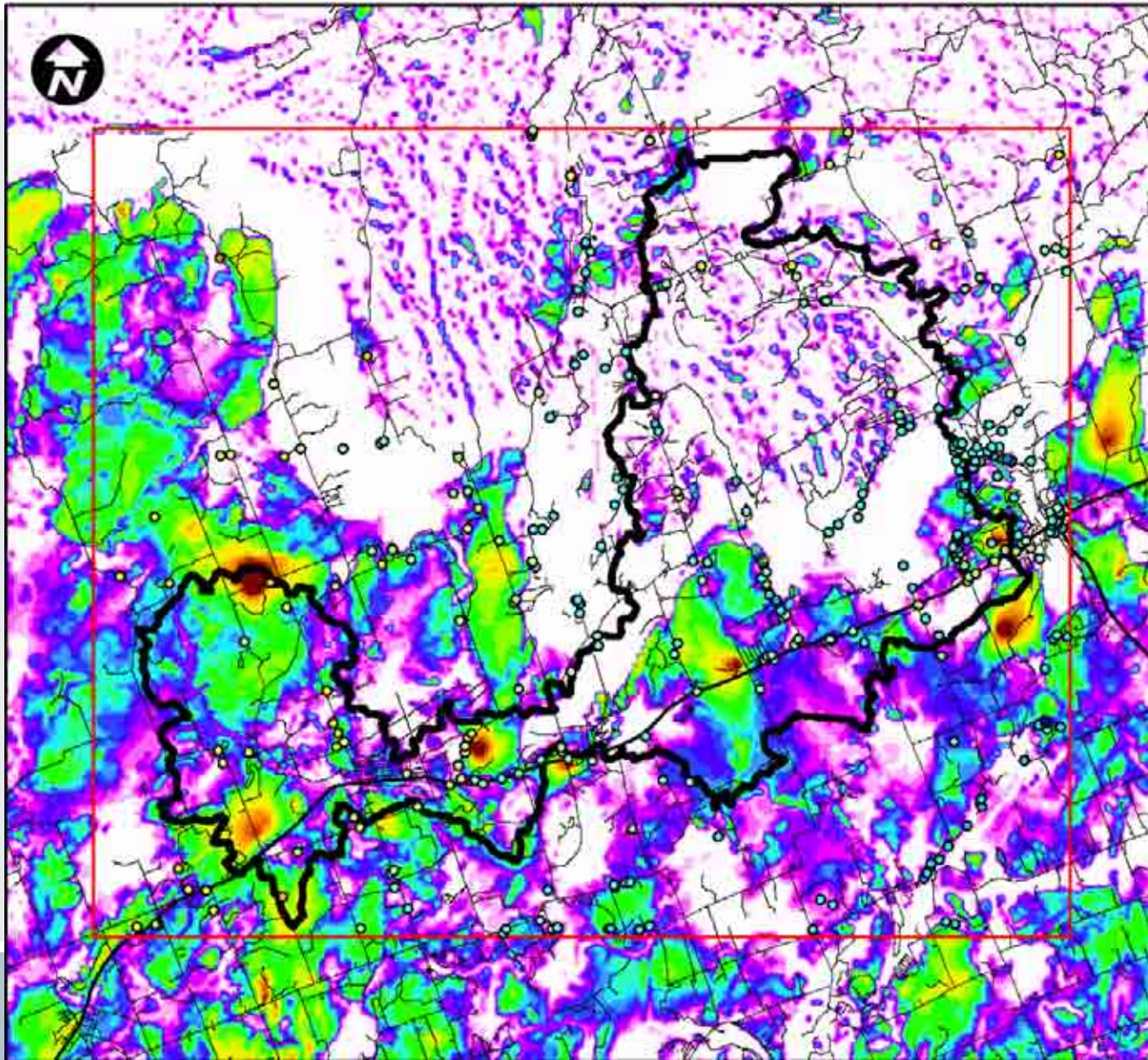
- 41. flows, tuffs, breccias, minor iron formation, minor metasedimentary rocks; includes reworked pyroclastic units, amphibolite
- 42. conglomerate, wacke, quartz arenite, arkose, limestone, siltstone, shal, minor iron formation, minor metavolcanic rocks
- 43. marble, calc-silicate rocks, skarn, tectonic breccias
- 44. granodiorite, tonalite, monzogranite, syenogranite; derived gneisses and migmatites
- 46. diorite, gabbro, peridotite, pyroxenite, anorthosite, derived metamorphic rocks
- 51a. Fine-grained to micritic limestone, minor dolostone; arkose, siltstone, shale
- 51b. Bioclastic limestone, nodular limestone
- 51c. Micritic to coarse-grained limestone with calcareous shale interbeds



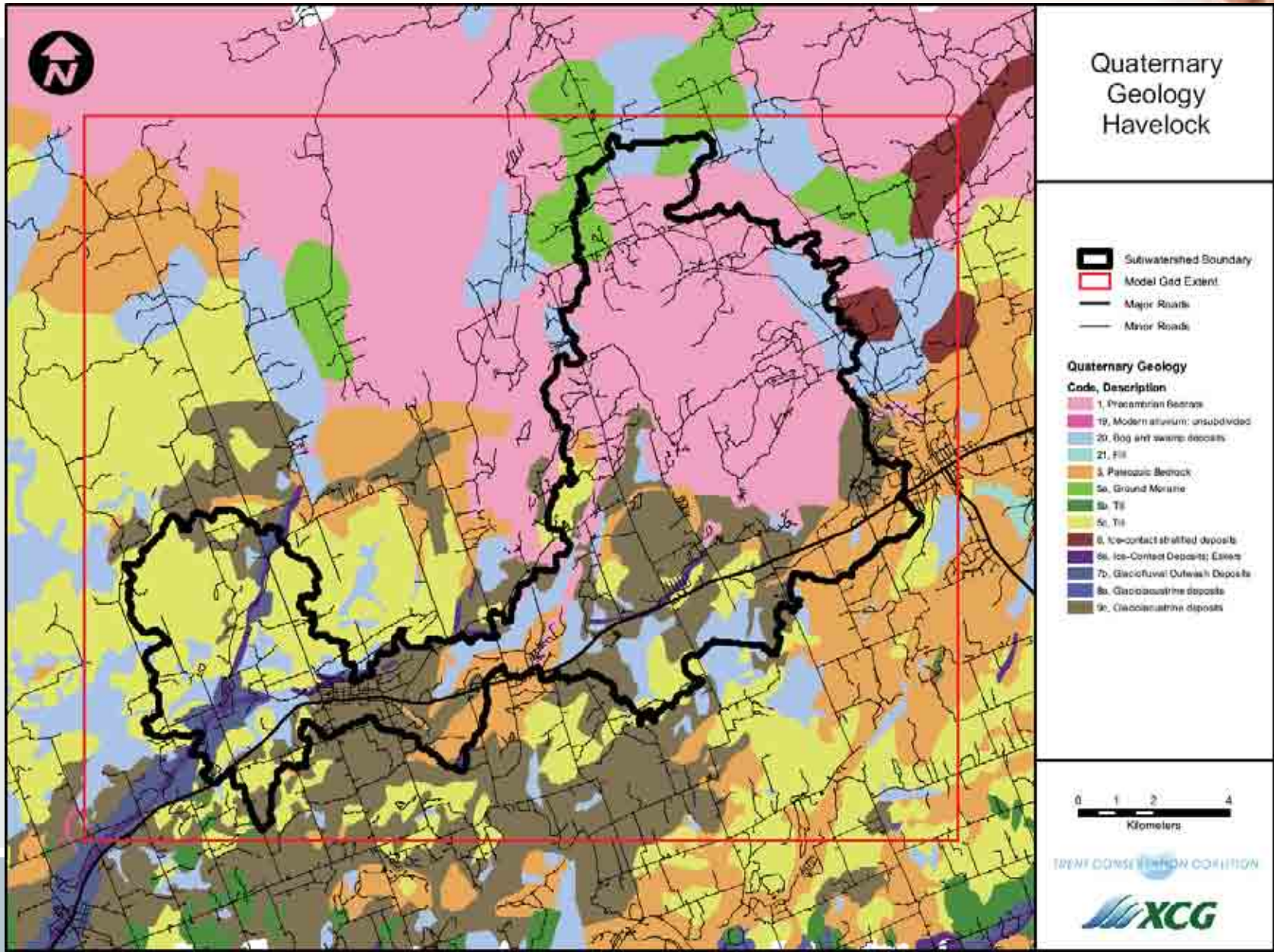
TWENT CONSERVATION COALITION



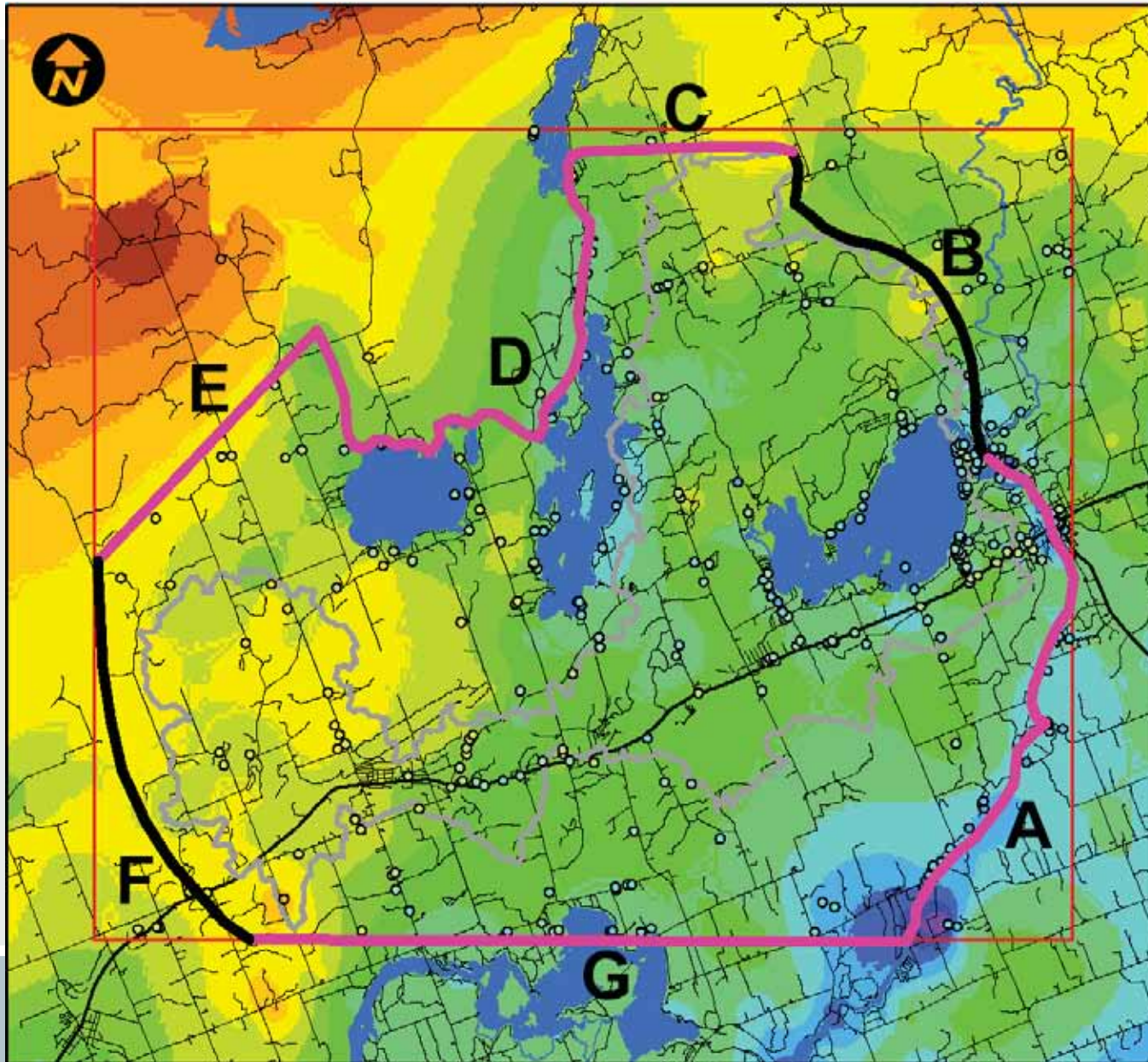
Havelock – Overburden Depth



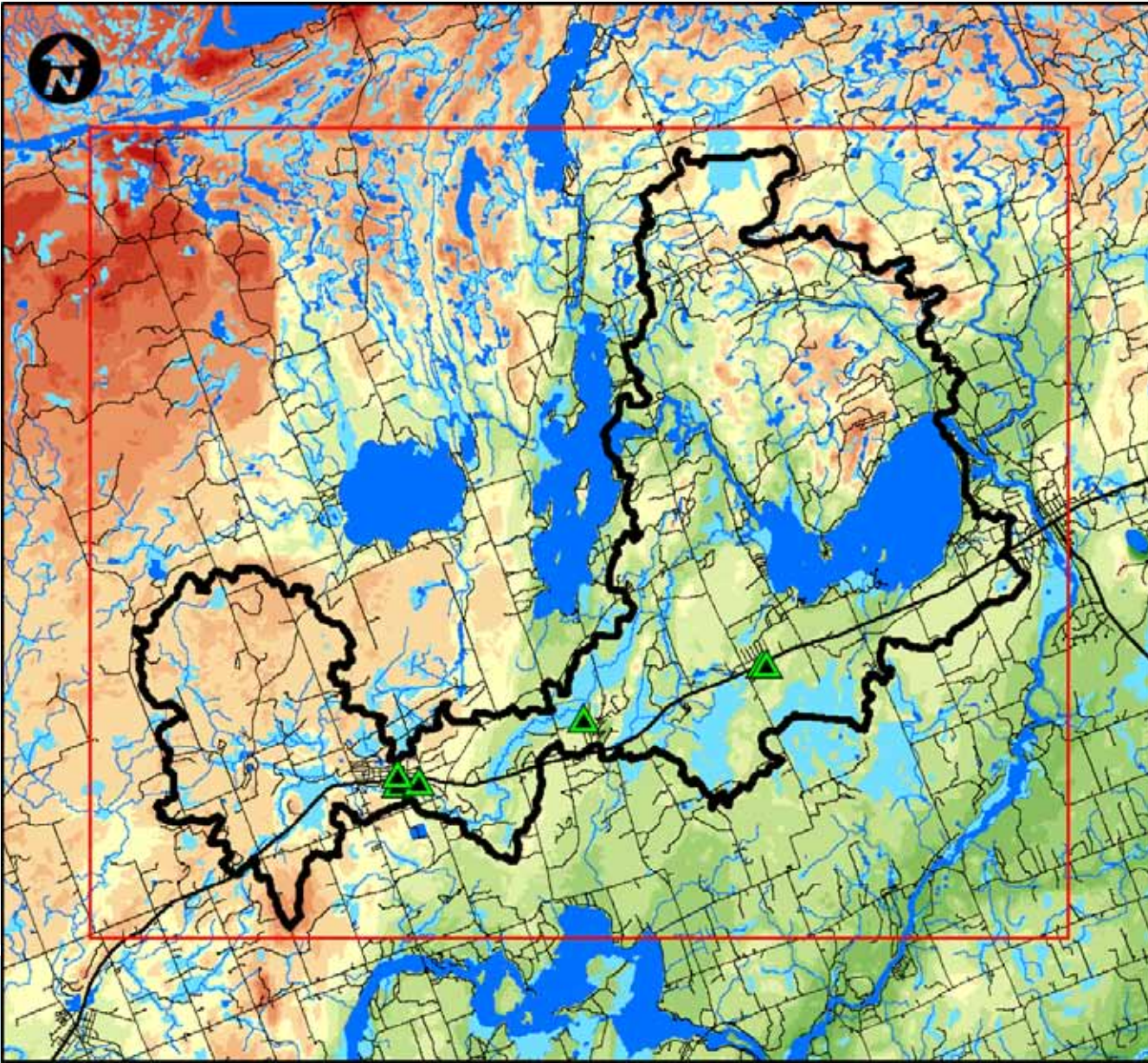
Havelock – Overburden Soils



Havelock – Model Boundaries



Major GW Withdrawals



Development, Calibration & Stress Scenarios



- § Model Selection (MODFLOW) accepted by Peer Review Committee
- § Model Development, Calibration (steady-state model) and Scenario Report (transient model) is current under review by Peer Review Committee
 - Calibration to recharge and hydraulic conductivities
- § Waiting for Final Peer Review Comments

Stress Scenarios



§ Scenarios Assessed include:

- Scenario A: existing conditions
- Scenario B: future conditions
- Scenario D: 2-year drought – existing conditions
- Scenario E: 2-year drought – future conditions
- Scenario G: 10-year drought – existing conditions
- Scenario H: 10-year drought – future conditions

Preliminary Results



Measurement of Interest	Well #1		Well #3		Well #4	
	Depth (m bgs)	Elevation (masl)	Depth (m bgs)	Elevation (masl)	Depth (m bgs)	Elevation (masl)
Ground Surface	0	213.74	0	212.50	0	213.52
Top of Screen	7.30	206.44	7.32	205.18	6.40	207.12
Static Water Level	4.56	209.18	3.90	208.60	4.34	209.18
Scenario A	4.56	209.18	3.90	208.60	4.34	209.18
Scenario B	4.91	208.83	4.25	208.25	4.69	208.83
Scenario D	7.16	206.58	6.5	206.00	6.94	206.58
Scenario E	7.52	206.22	6.86	205.64	7.30	206.22
Scenario G	3.70	207.04	6.04	206.46	6.48	207.04
Scenario H	6.75	206.99	6.09	206.41	6.53	206.99