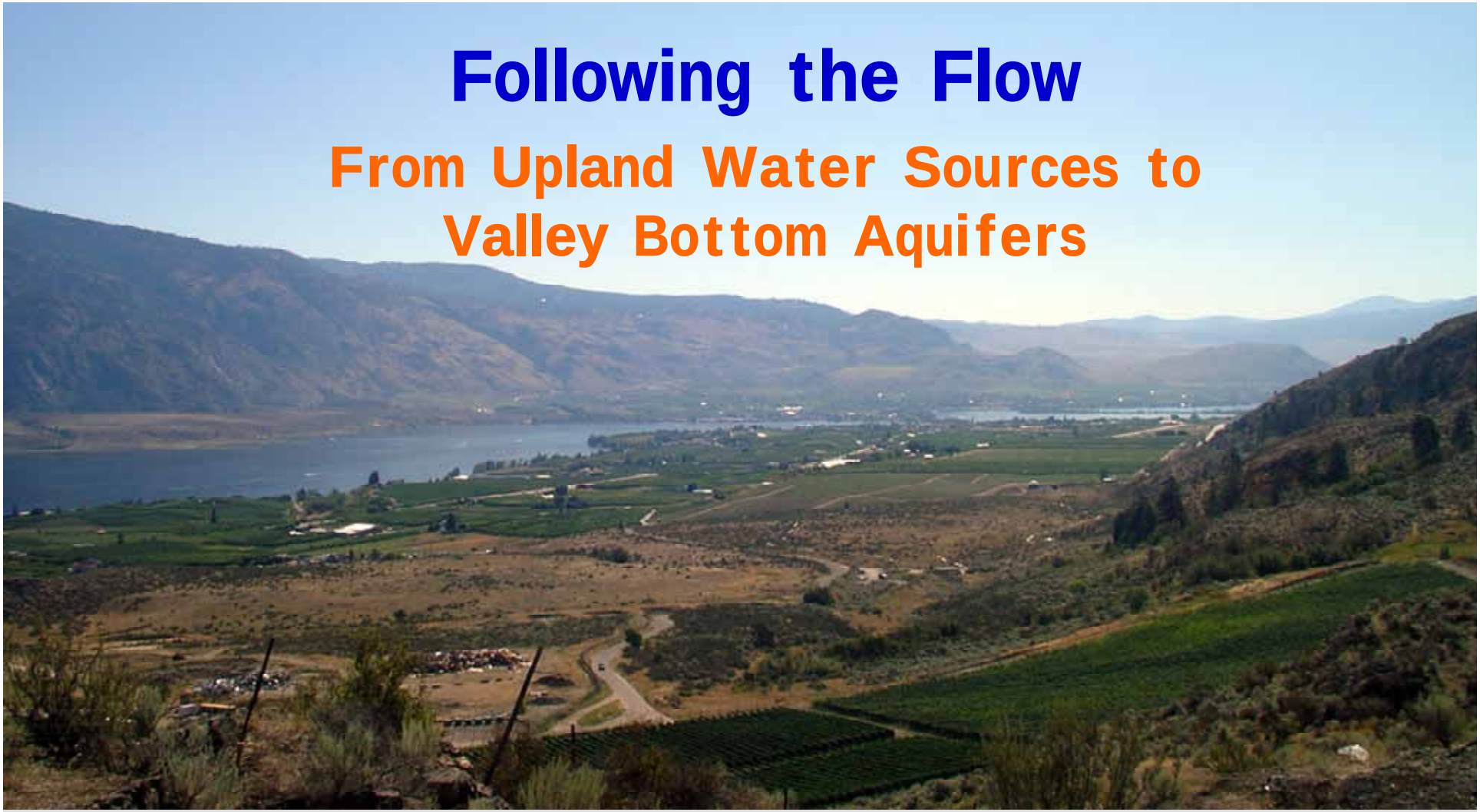
Following the Flow

From Upland Water Sources to Valley Bottom Aquifers



Brian Smerdon, Mary Ann Berg, Diana Allen
Simon Fraser University

Steve Grasby
Geological Survey of Canada

CWN Project

A Basin Approach to Groundwater Recharge in the Okanagan:

Bridging the Gap Between Science and Policy

Objectives:

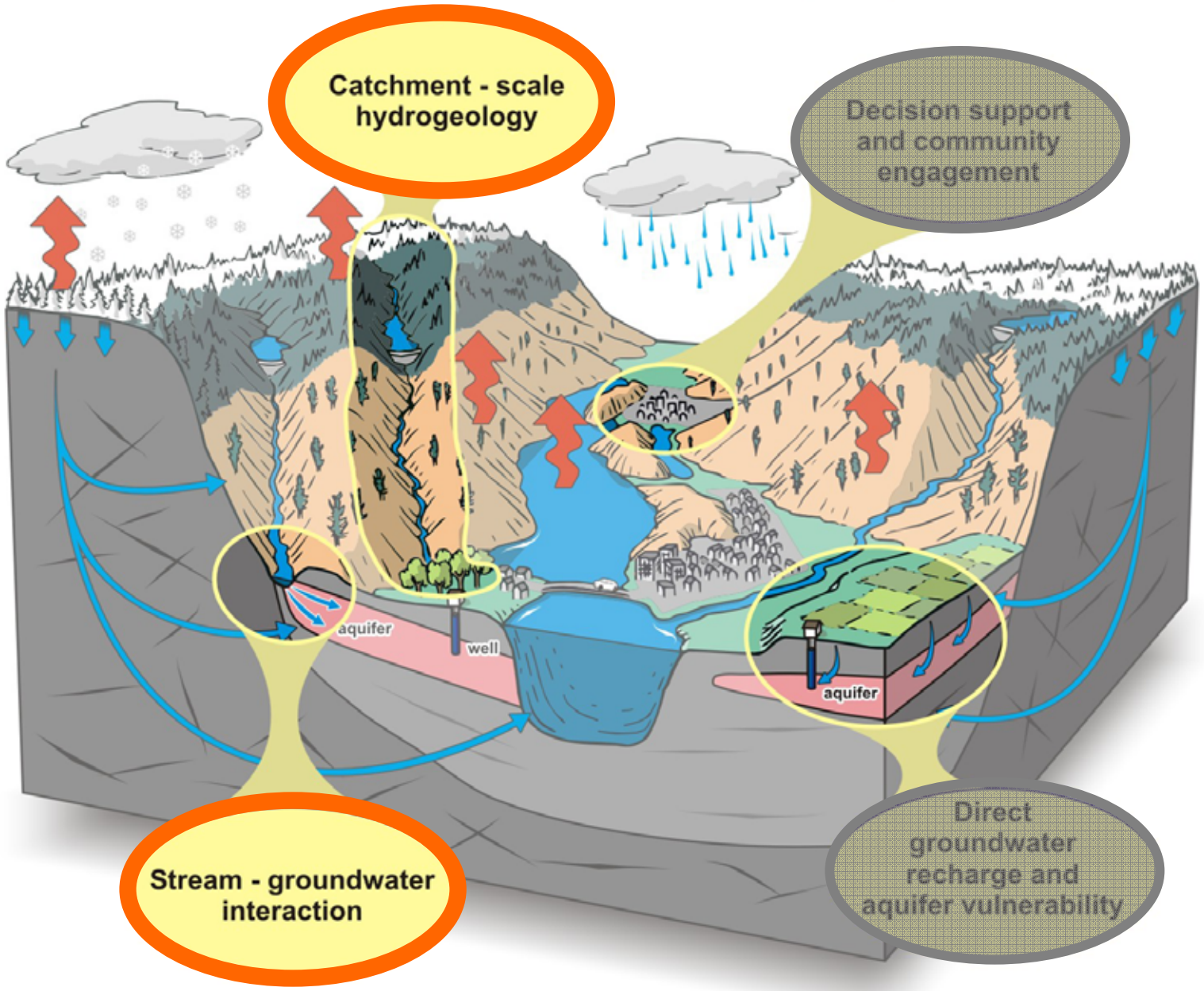
- Understand groundwater recharge in the Okanagan Basin
- Provide a scientific basis for water budget assessments and water use planning

CWN Project #2

Distinguish between highland, benchland and valley bottom contributions to recharge

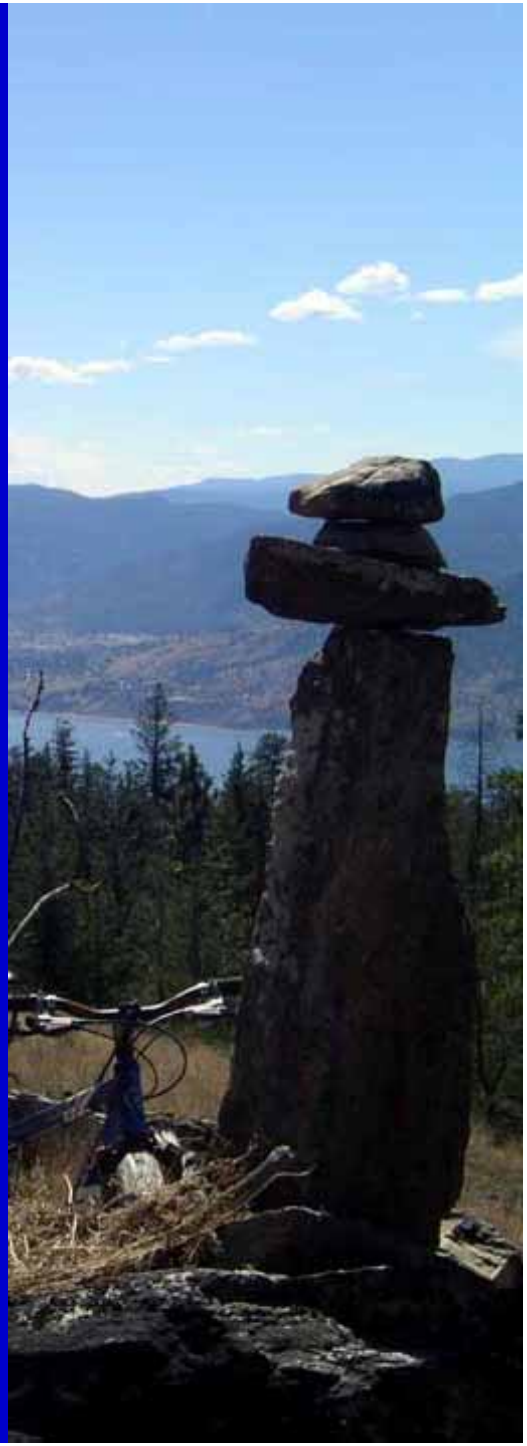
- Investigate the link between upland source water zones and valley bottom aquifers
- Develop a model of the BX Creek watershed

Canadian Water Network projects

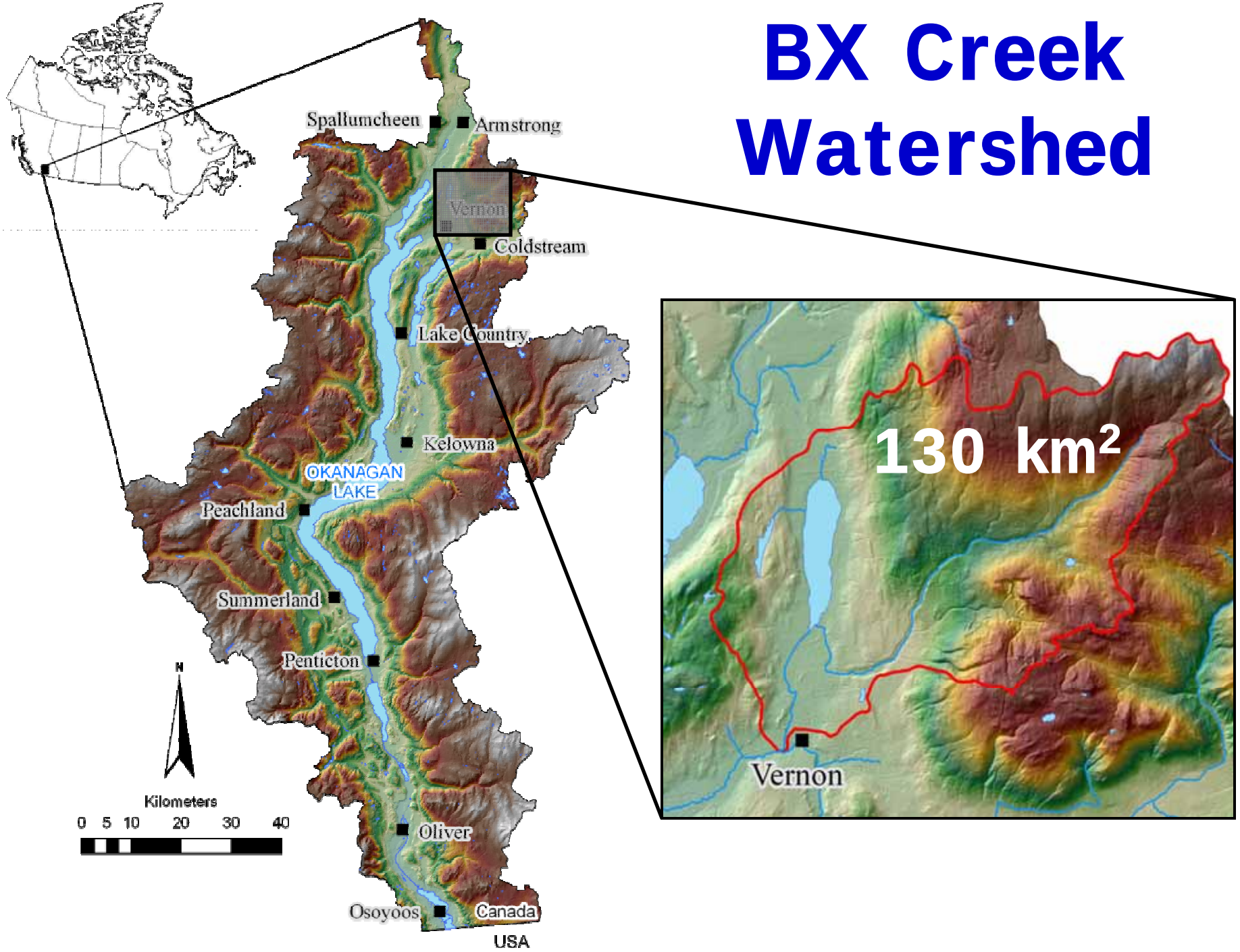


Presentation Outline

- CWN Project #2
- The BX Creek watershed
- Watershed models
- BX Creek geology & hydrology
- Conceptual flow model
- Linking uplands, benchlands, & valley bottoms



BX Creek Watershed



Watersheds & Models

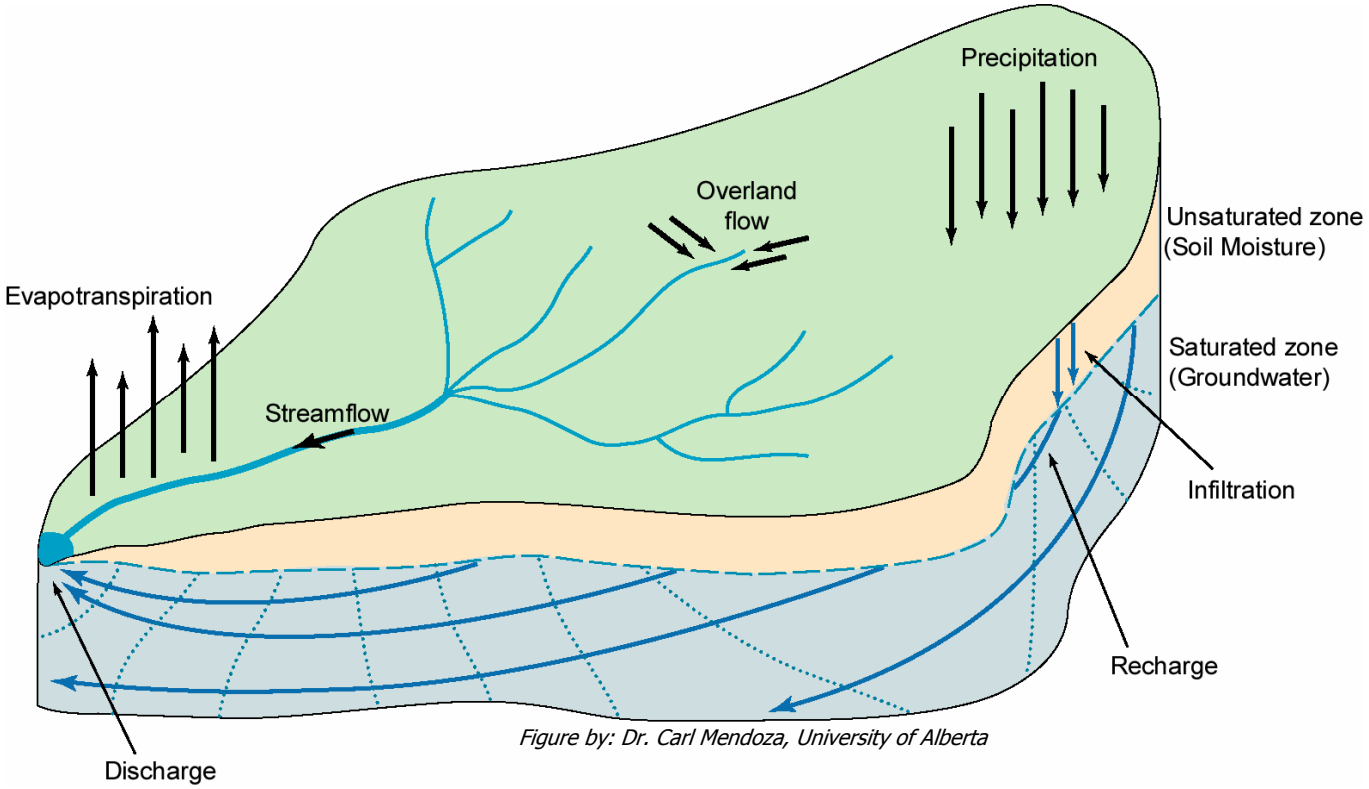


Figure by: Dr. Carl Mendoza, University of Alberta

- Watersheds are defined by natural hydrology
- Convenient area for studying water movement & storage

Model → Water Budget

- Surface & groundwater CONNECTED!
- An accounting problem…

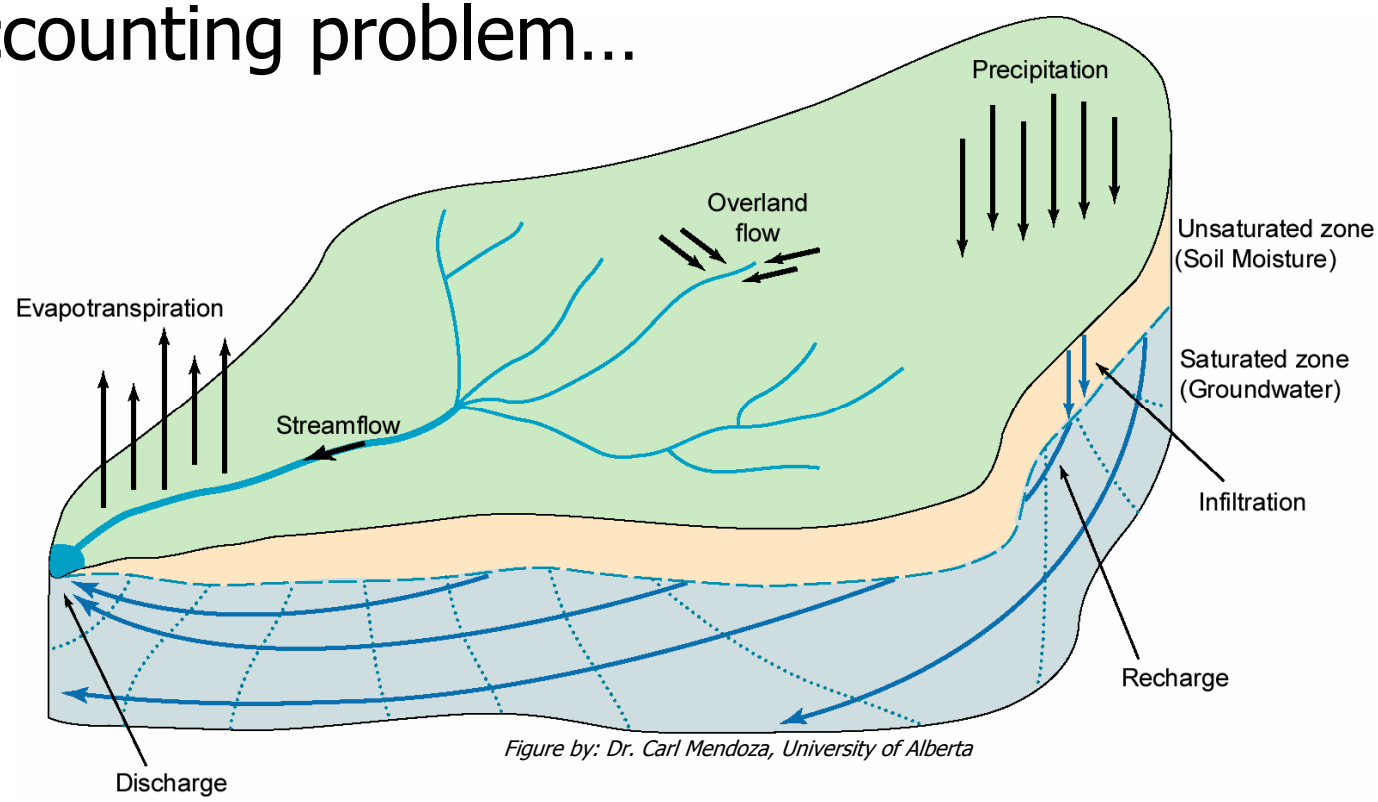
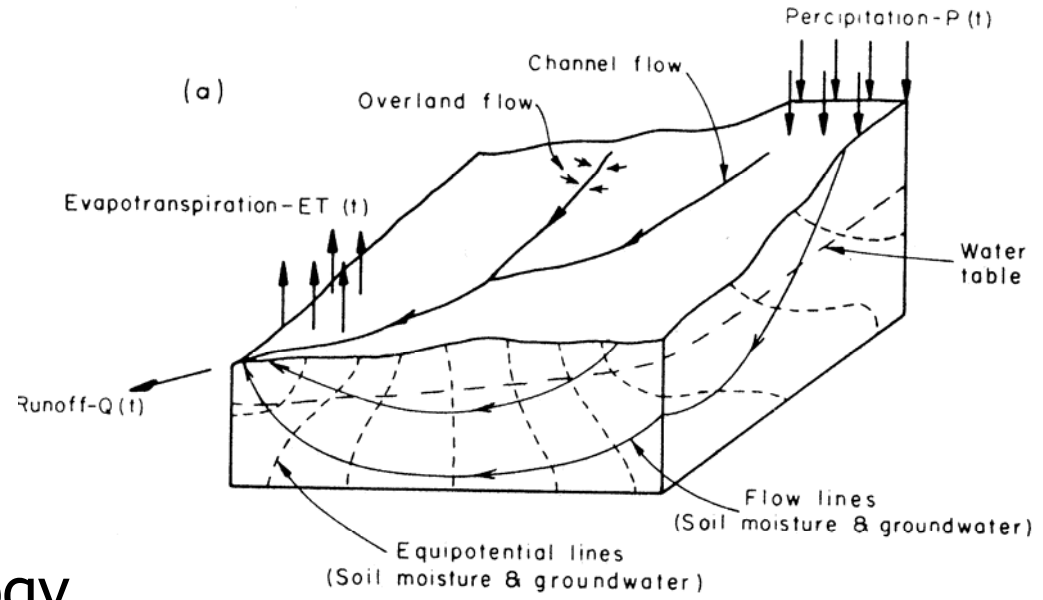


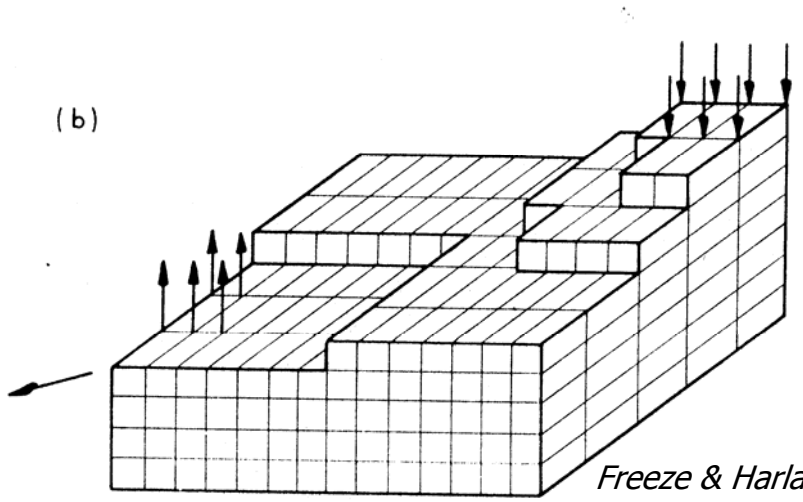
Figure by: Dr. Carl Mendoza, University of Alberta

INFLOW – OUTFLOW = Change in STORAGE

Integrated Watershed Models

- Traditionally, flow models for **surface water** and **ground water** were separate
- Hydrology vs. Hydrogeology
- When combined, the ***entire water cycle*** can be simulated

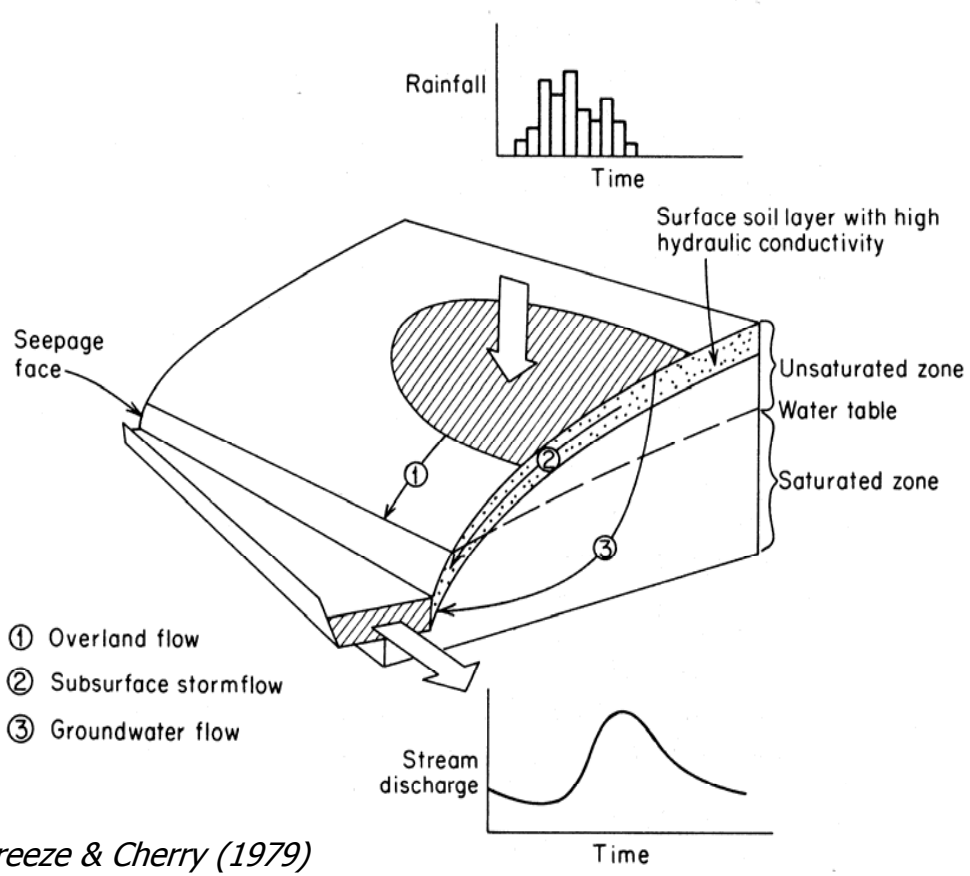




Freeze & Harlan (1969)

Watershed Modeling Benefits

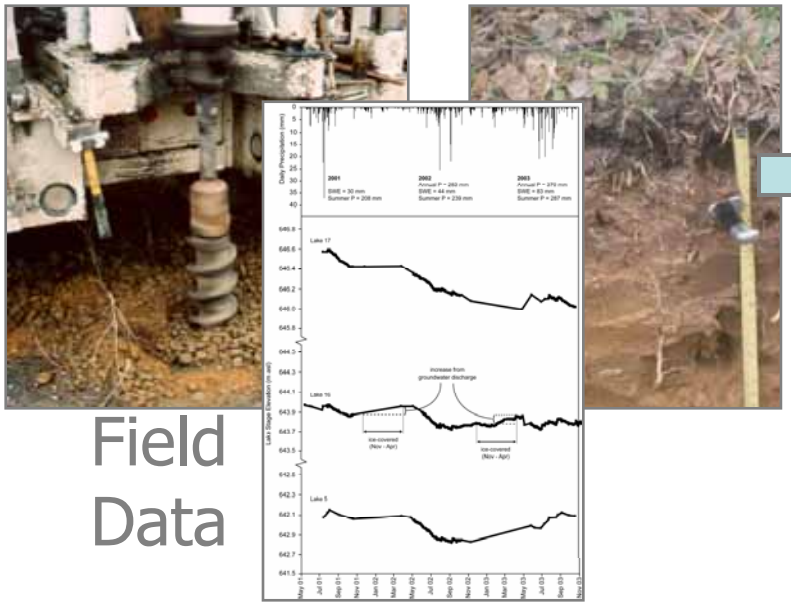
- A framework for water cycle to be **QUANTIFIED**
- Integrates response of water table + stream flow



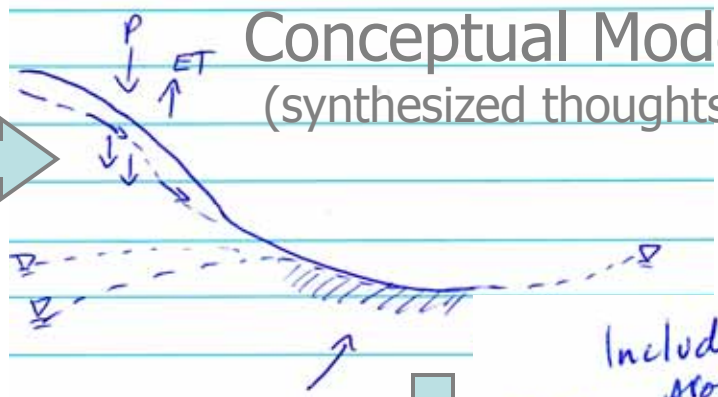
Freeze & Cherry (1979)

- Combines climate, geology, & hydrology
- A virtual test of our understanding
- Predict response to different scenarios

"Modeling" is a *PROCESS*



Field Data

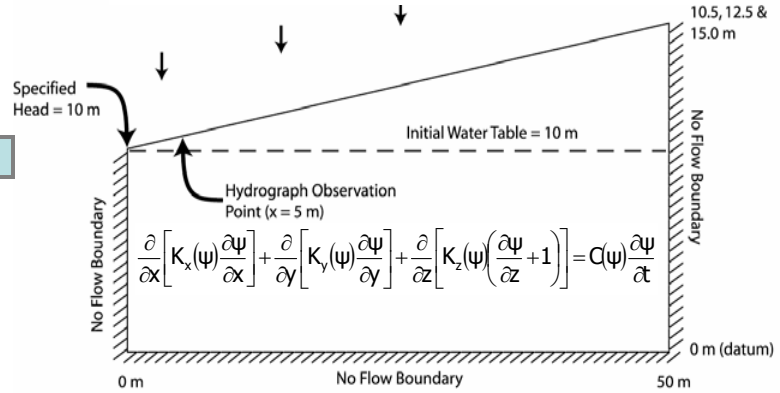


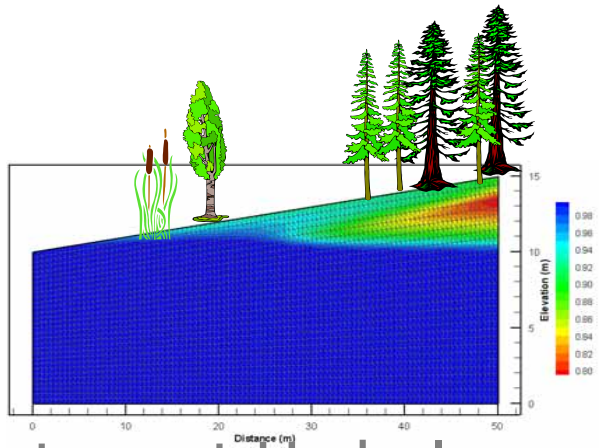
Conceptual Model
(synthesized thoughts)

Include properties

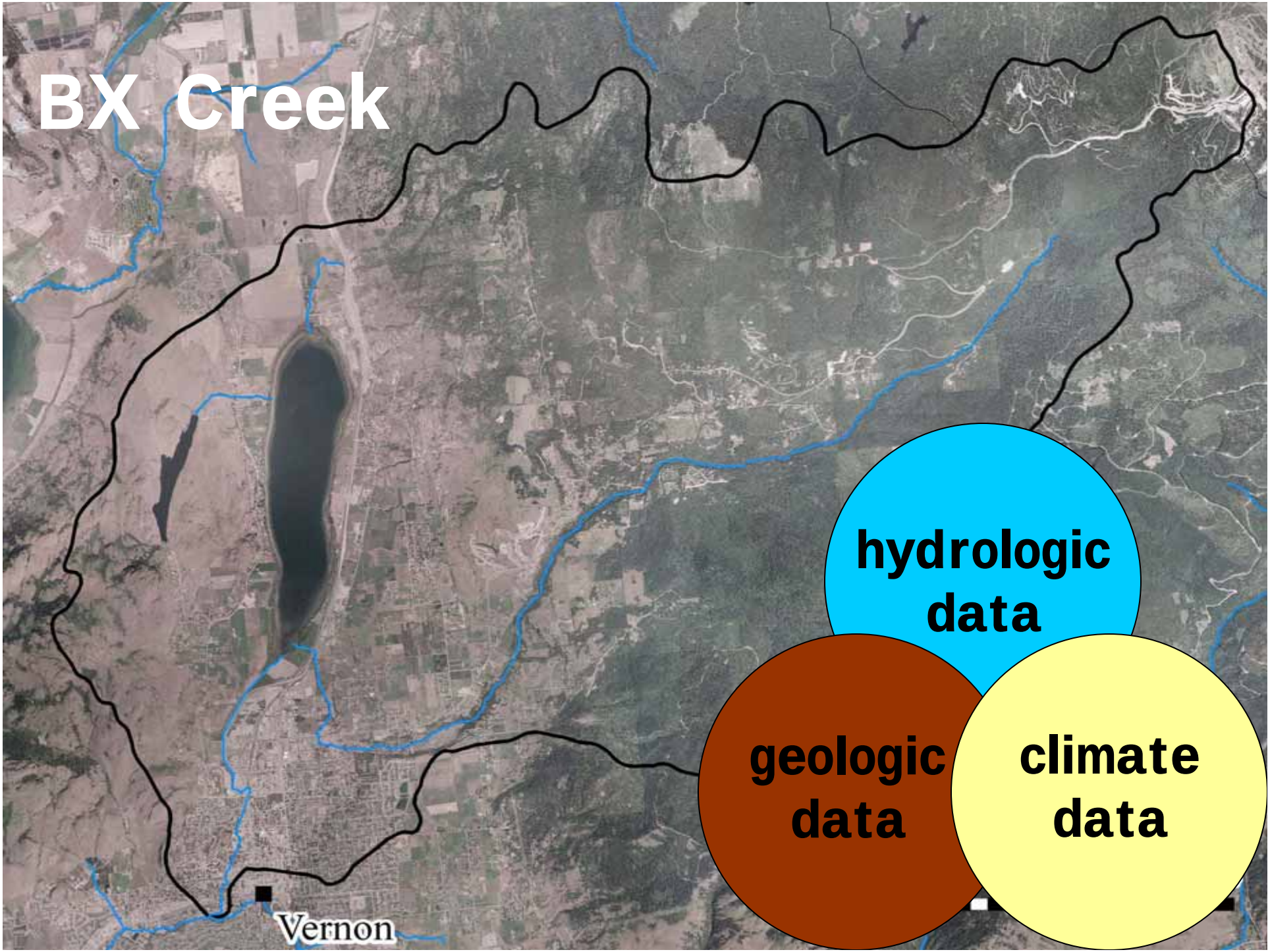
$\phi, \rho_b, n, \sigma, \theta_r, \theta_s$

Numerical Model

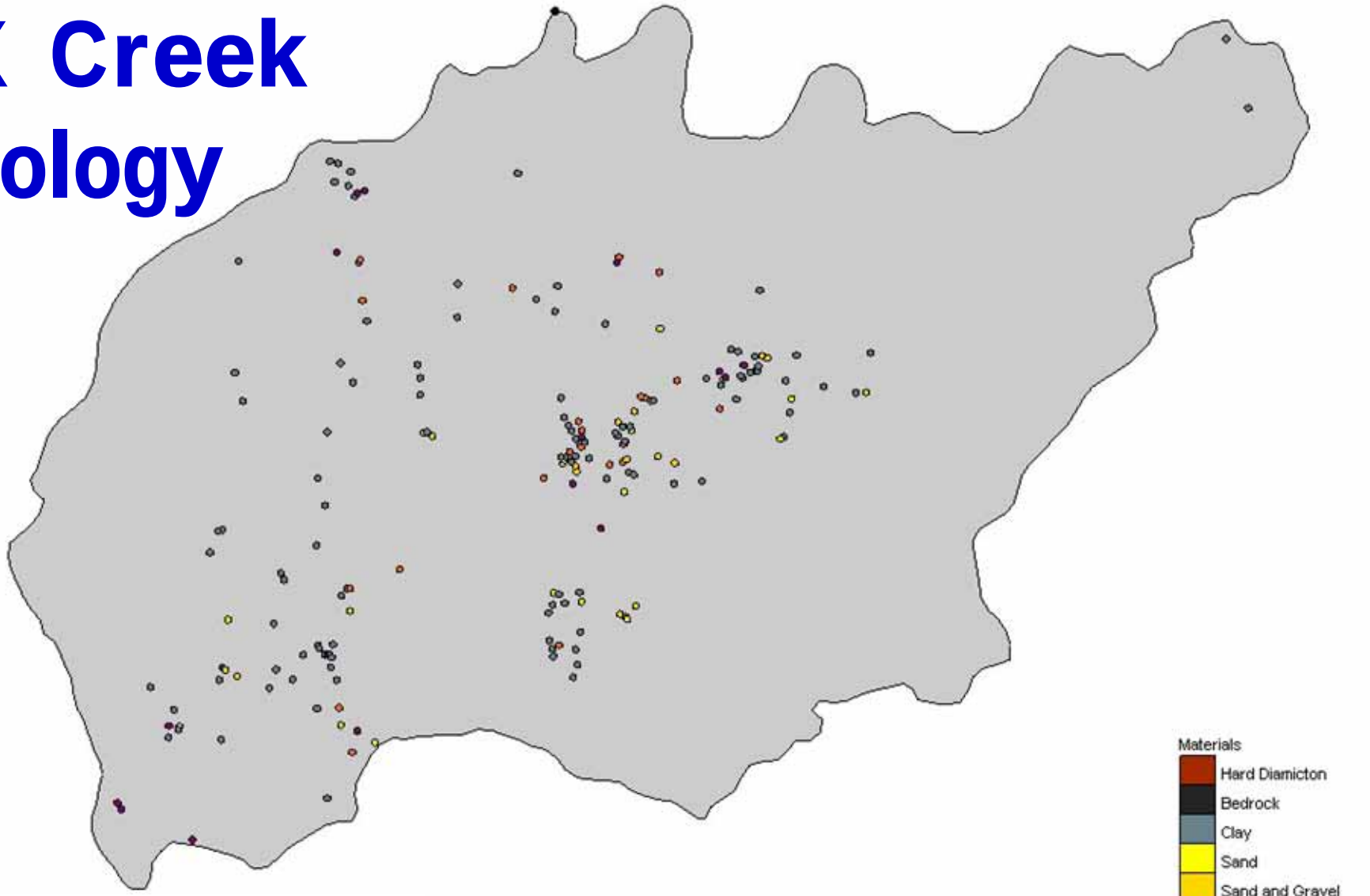




Interpret Hydrology
& Predict Response


BX Creek
hydrologic data
geologic data
climate data
Vernon

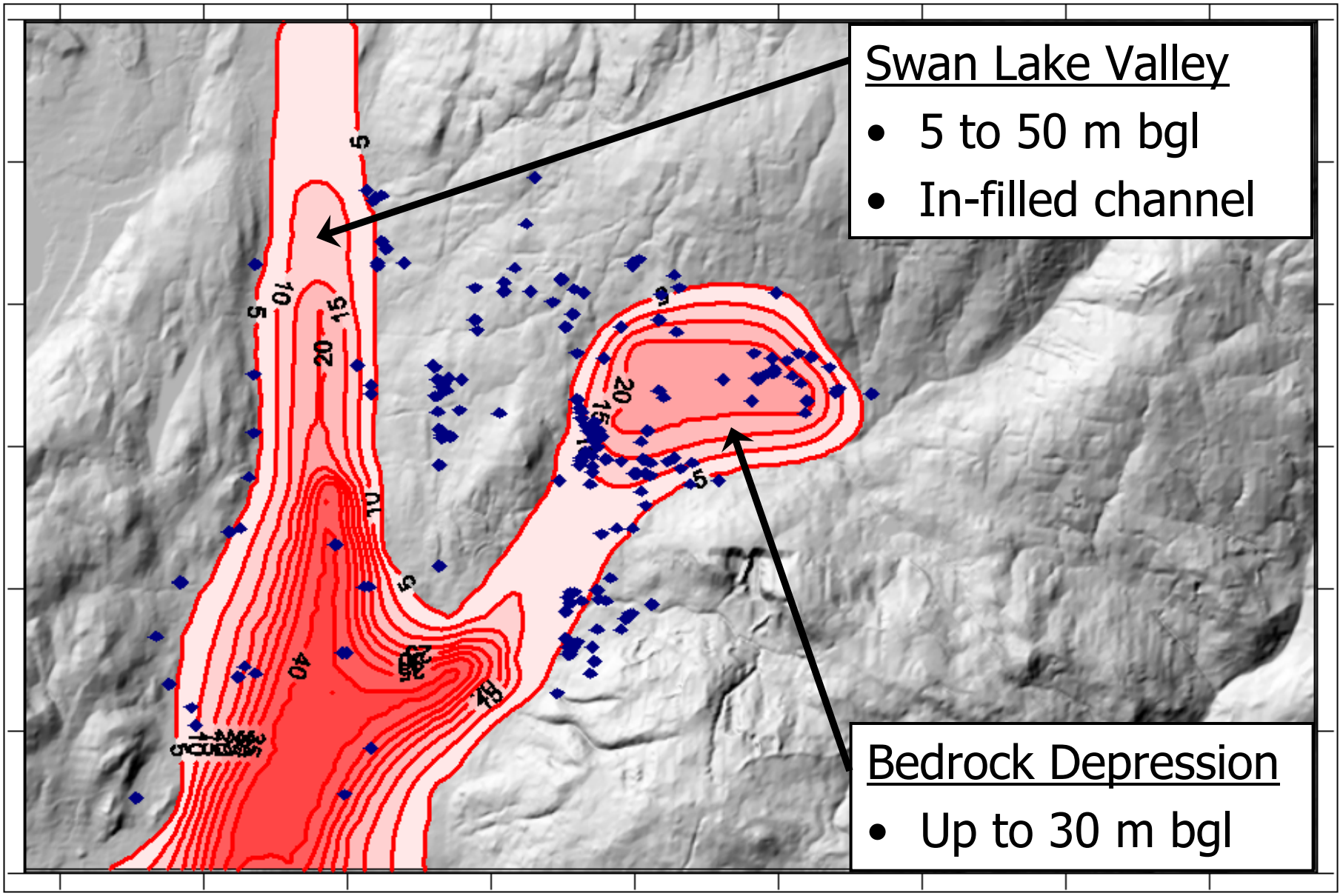
BX Creek Geology

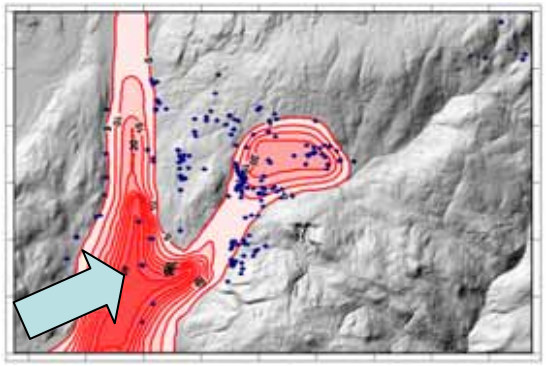


- BC WELLS database (611 records)
- Rating from 0 to 10

- 198 *acceptable* borehole logs
- 12 material types
- 6 hydrogeologic units

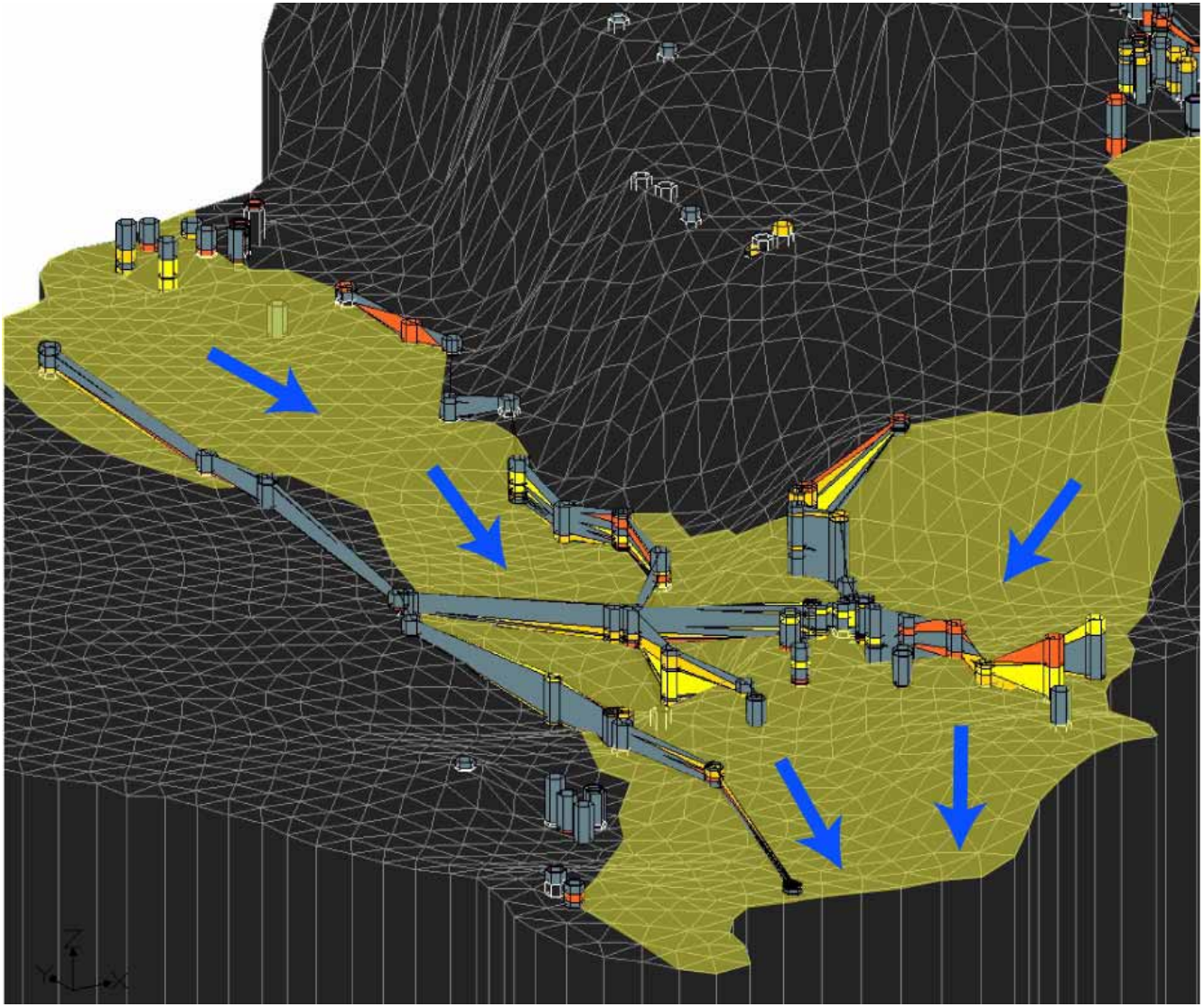
Drift Thickness



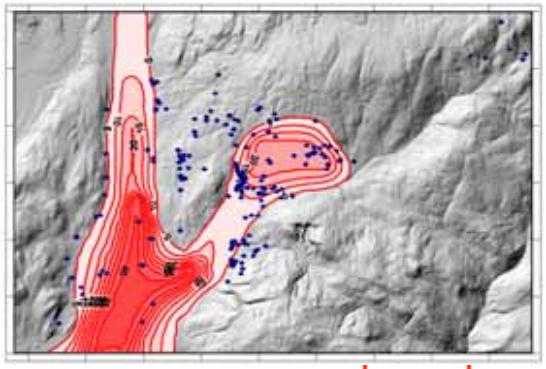


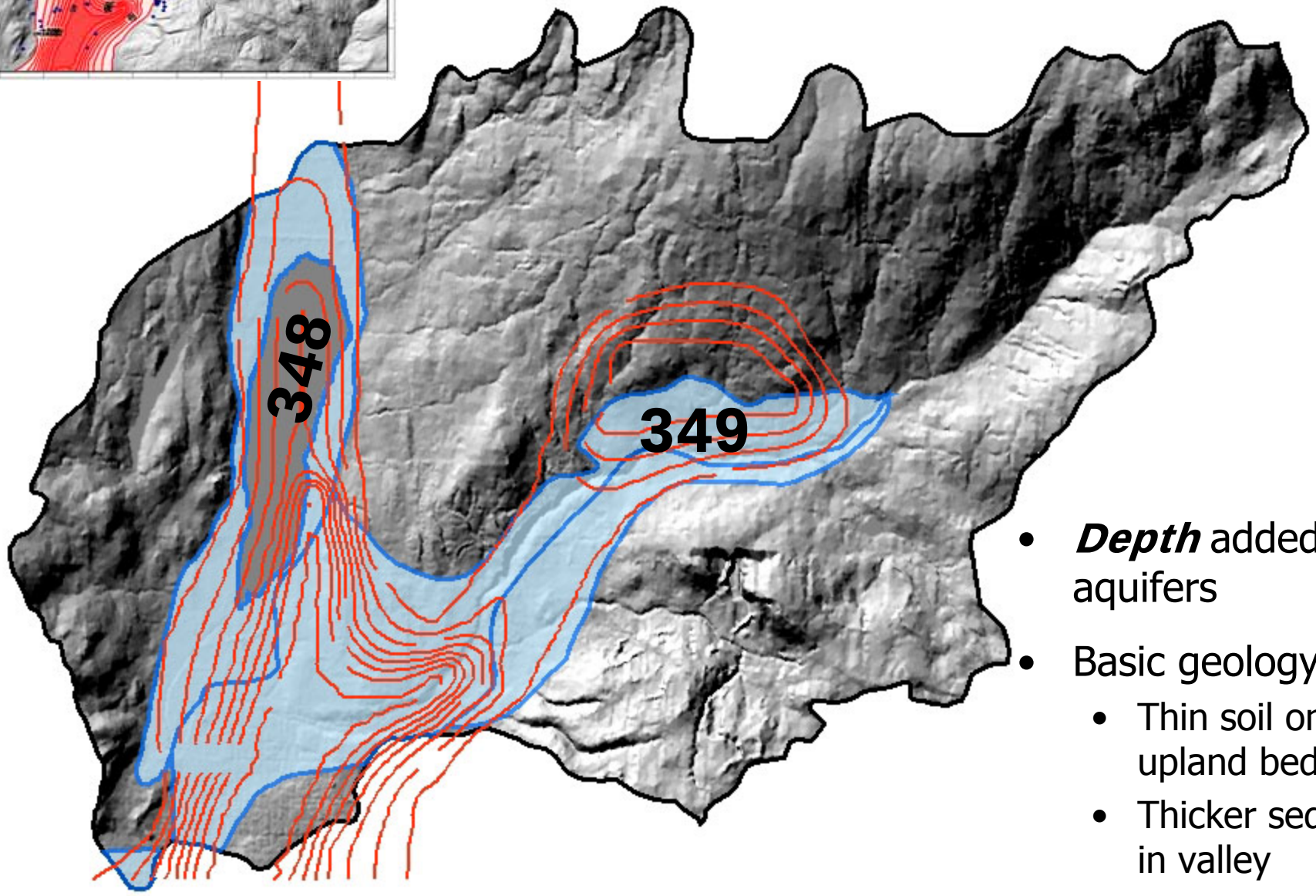
Swan Lake Valley Aquifer

- BC Aquifer 348
- Clay & silt over coarse sand
- *Likely* extends north to Deep Creek basin, at a groundwater divide



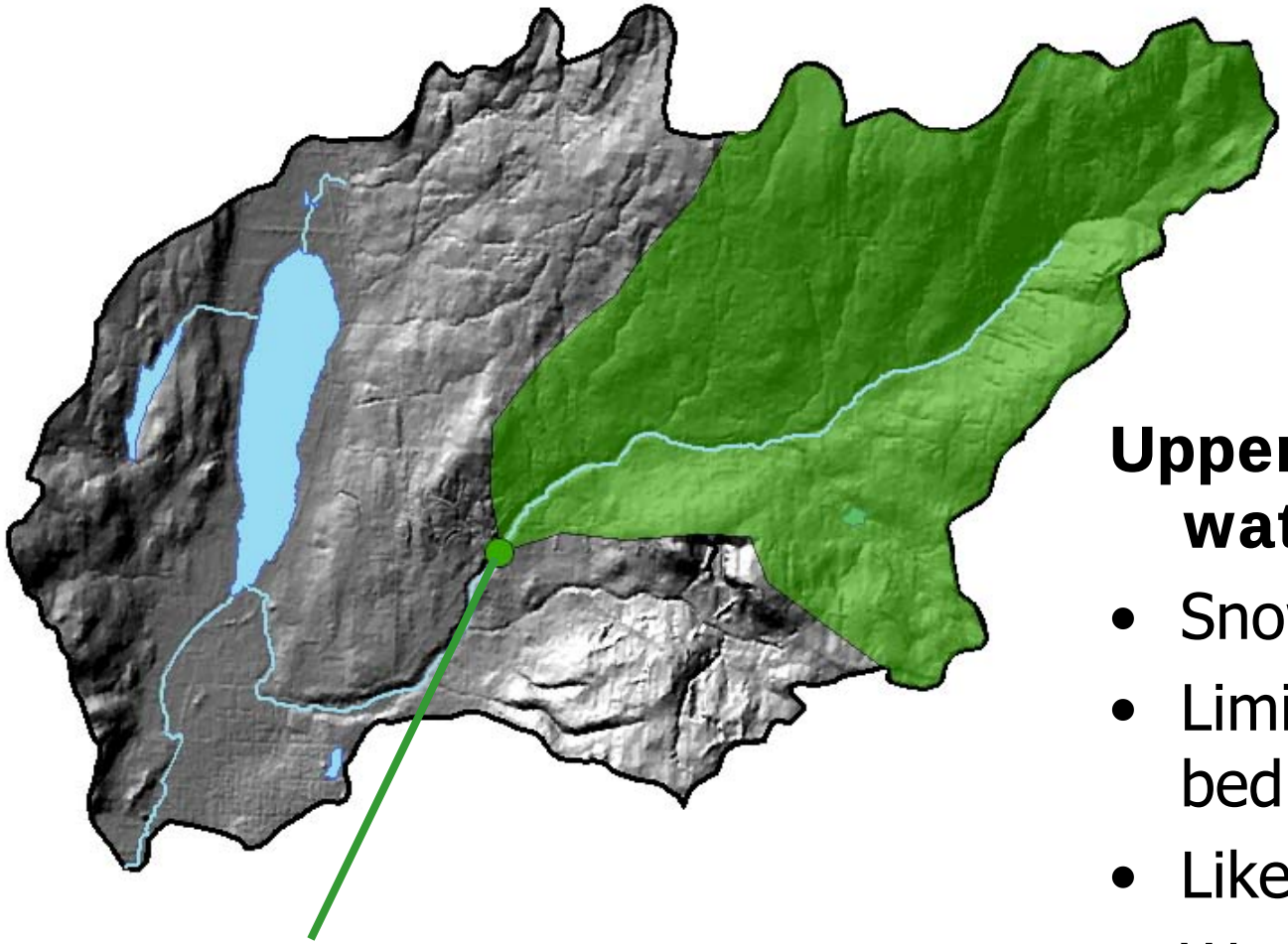
Aquifer Mapping





- ***Depth*** added to BC aquifers
- Basic geology:
  - Thin soil on upland bedrock
  - Thicker sediments in valley

Water Contribution from Upland Areas

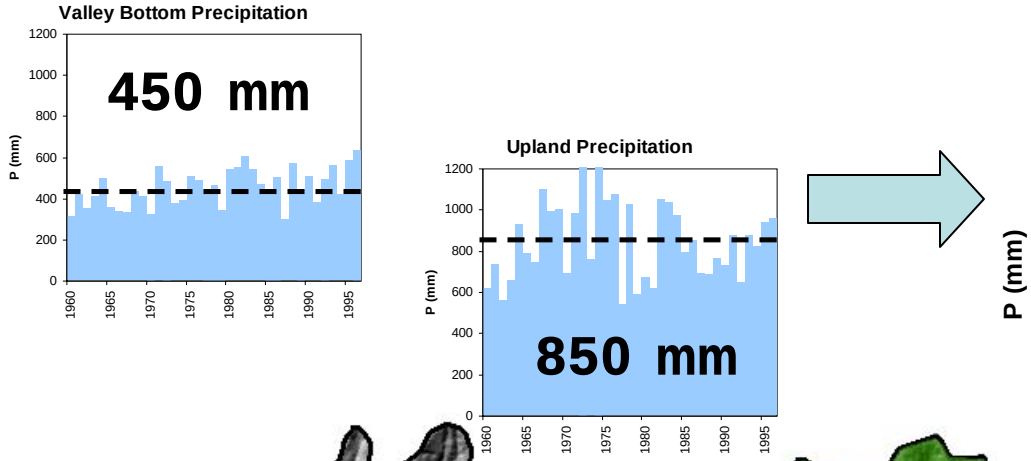


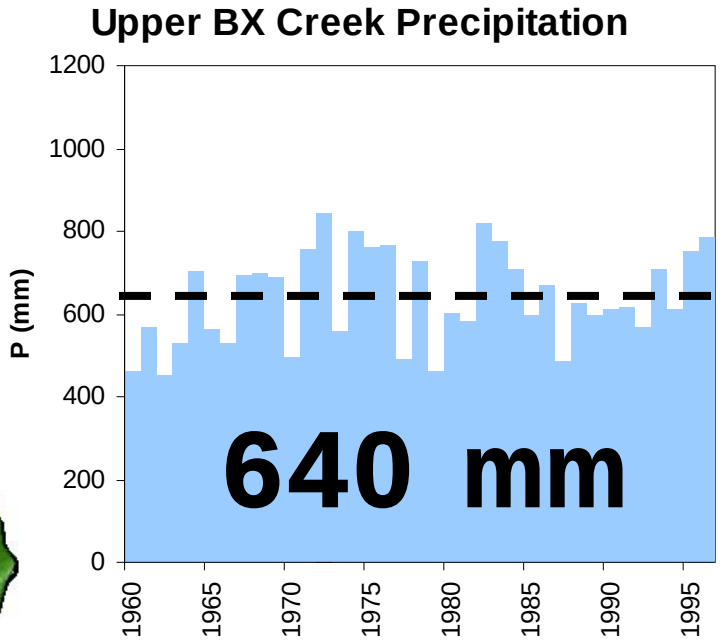
Stream gauge
08NM020

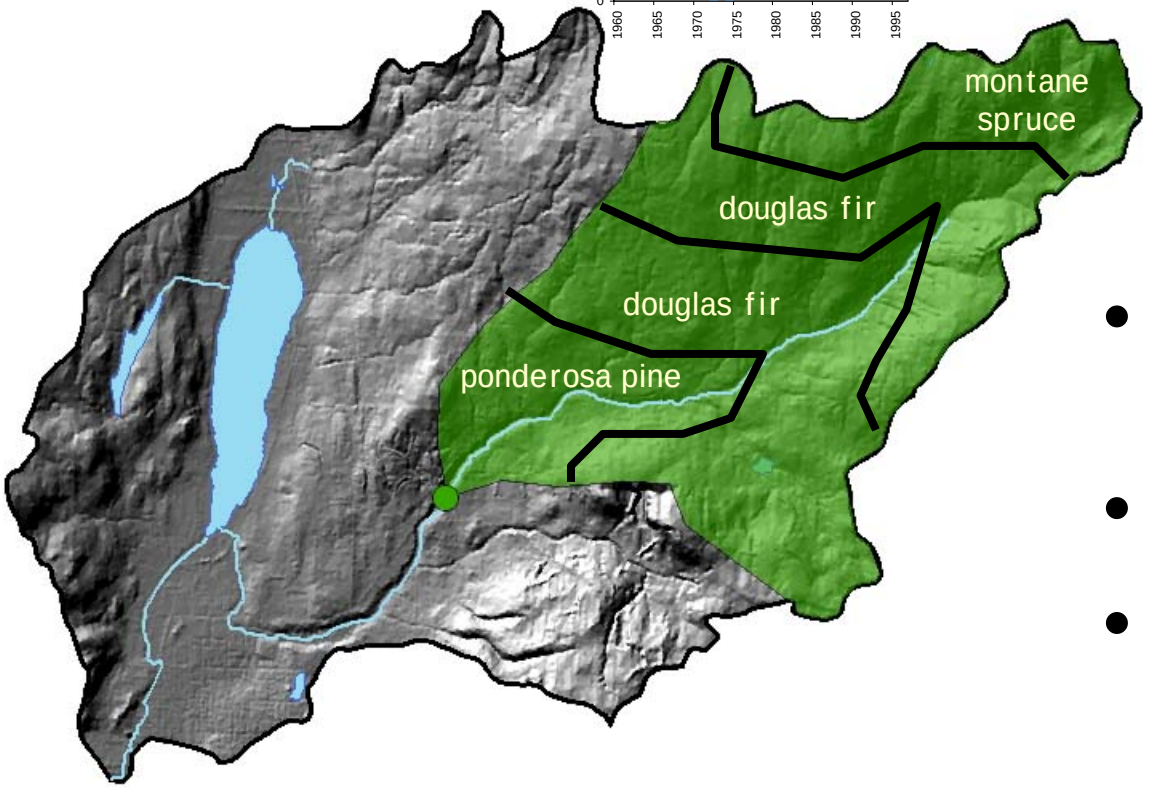
Upper BX Creek sub-watershed (52 km²)

- Snowmelt on bedrock
- Limited data on bedrock hydrogeology
- Likely limited recharge
- Water budget…

Average for Upland Area





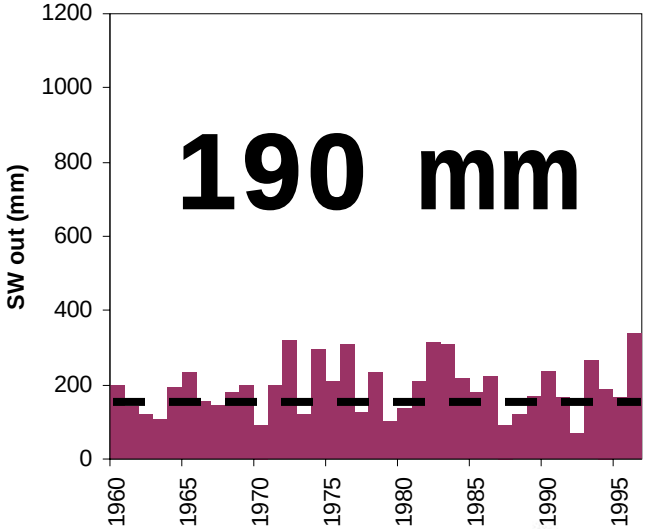


- BC Forestry **bio-geo-climatic** zones
- Elevation & tree species
- 4 areas of precipitation & evapotranspiration

Water Budget

Upper BX Creek

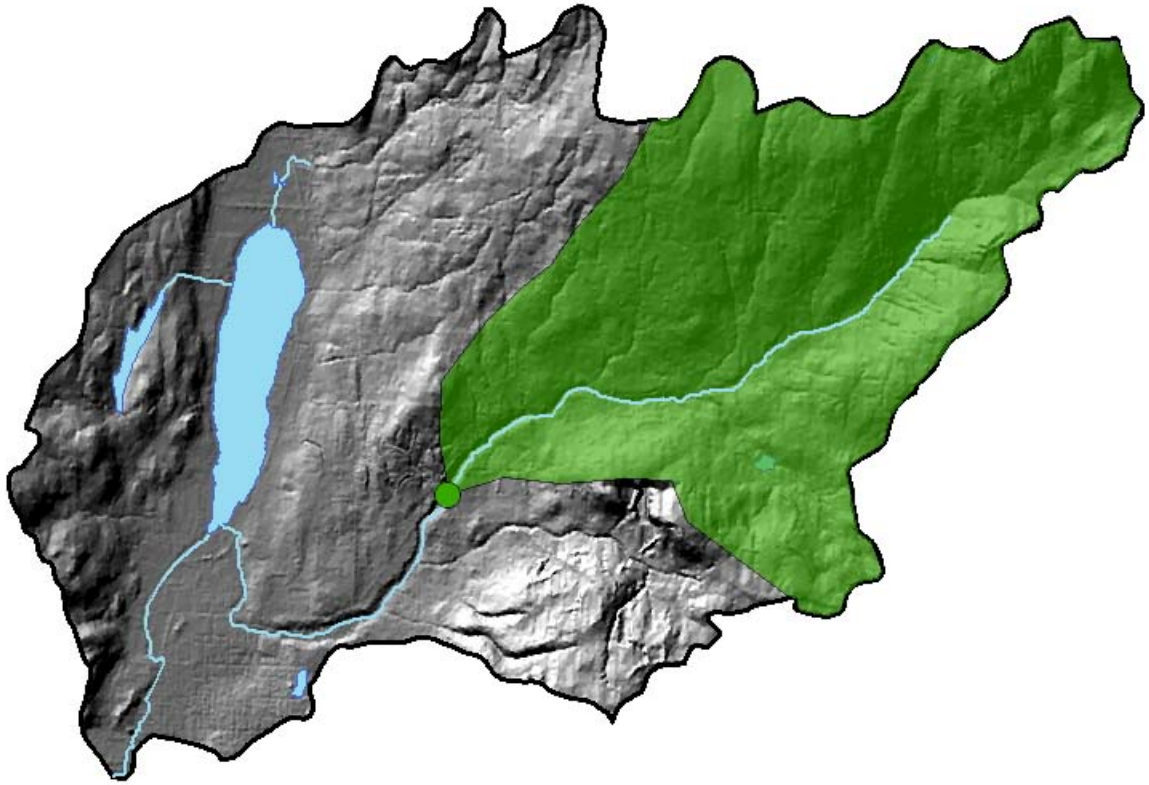
Stream Discharge



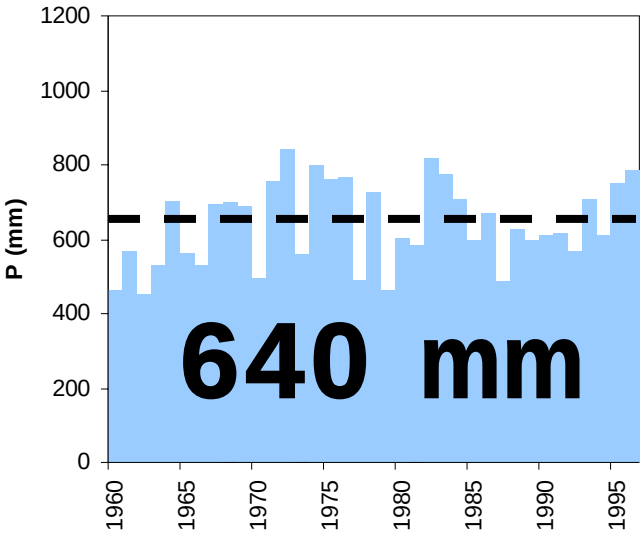
Evapotranspiration

~320 mm

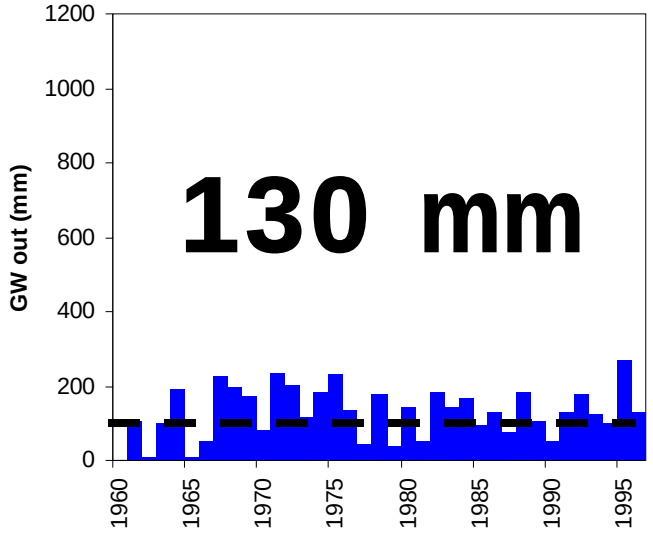
Upper Penticton Creek
Thyer et al (2004)



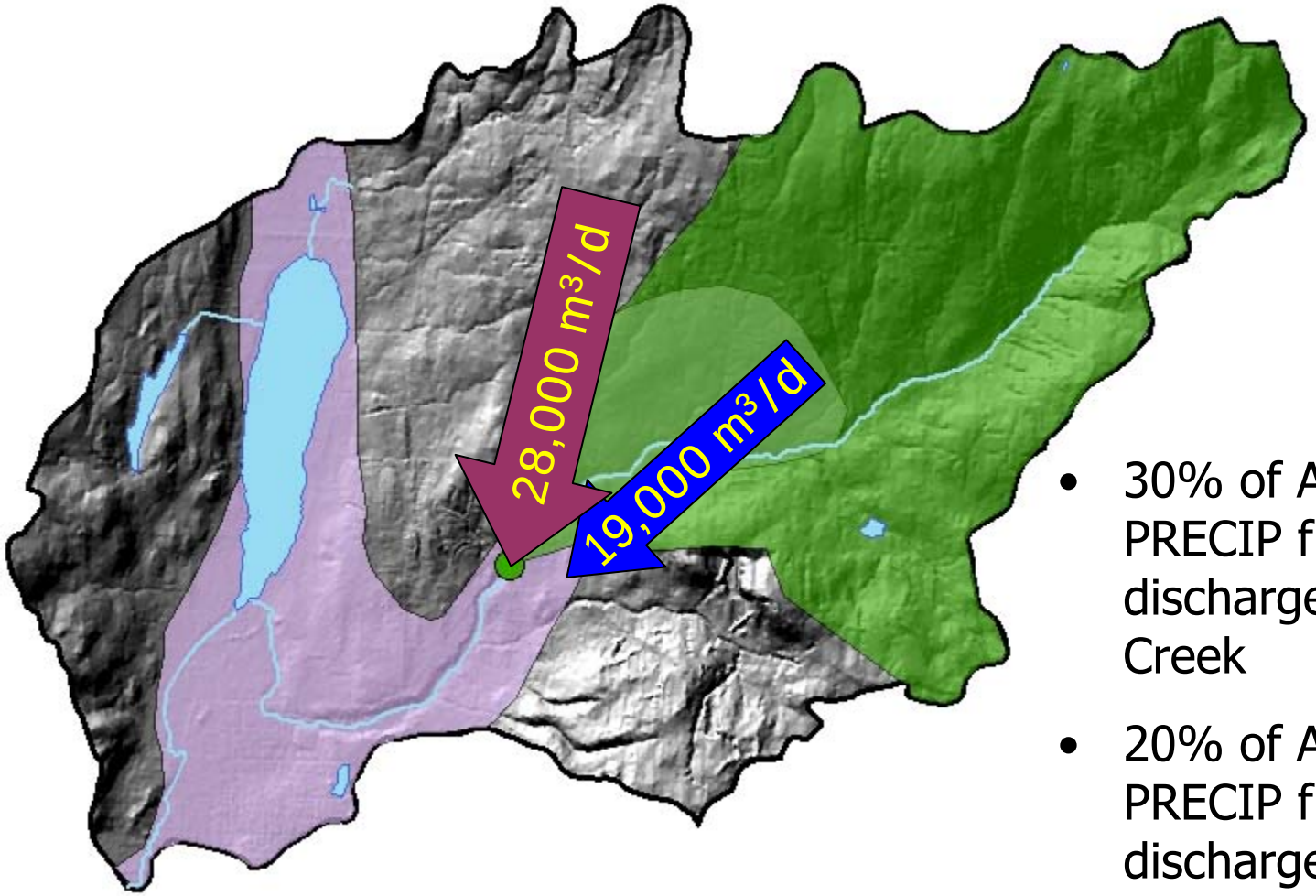
Upper BX Creek Precipitation



Groundwater Discharge

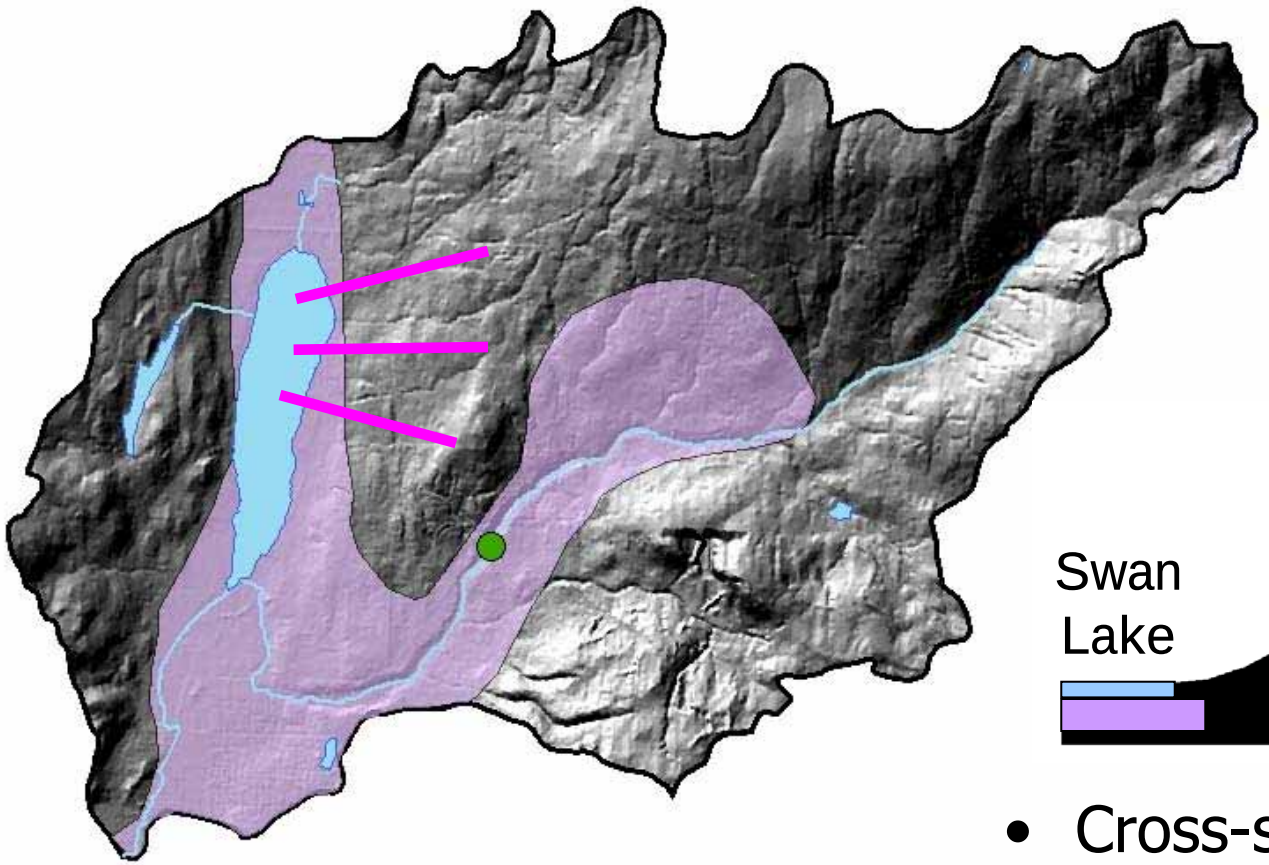


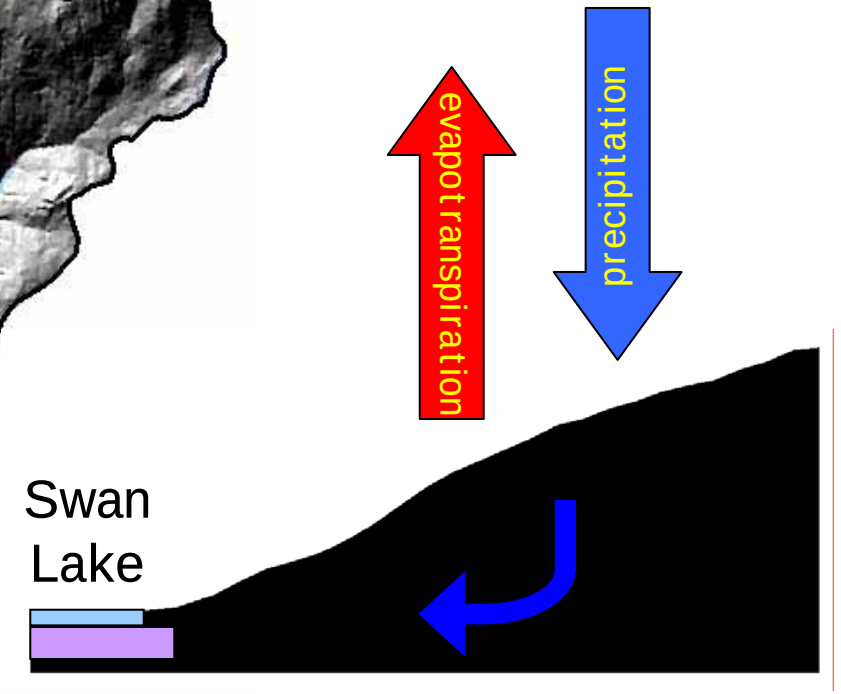
Water Contribution from Upland Areas



- 30% of AVG annual PRECIP from uplands discharges through BX Creek
- 20% of AVG annual PRECIP from uplands discharges as groundwater

Water Contribution from Benchlands





- Cross-sectional analysis
- Estimate recharge to valley bottom from benches

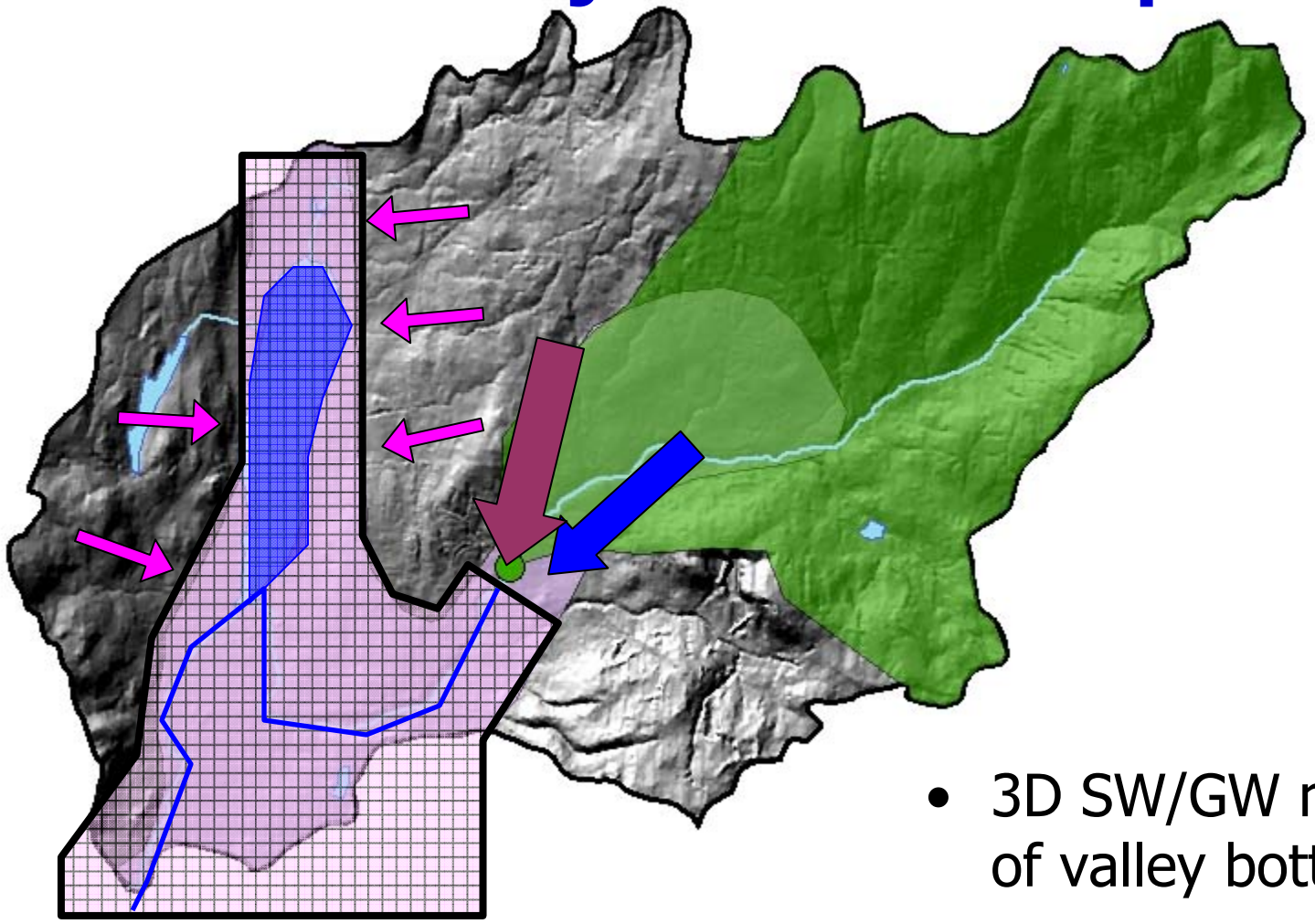
CWN Project #2

Distinguish between highland, benchland and valley bottom contributions to recharge

- Investigate the link between upland source water zones and valley bottom aquifers
- Develop a model of the BX Creek watershed

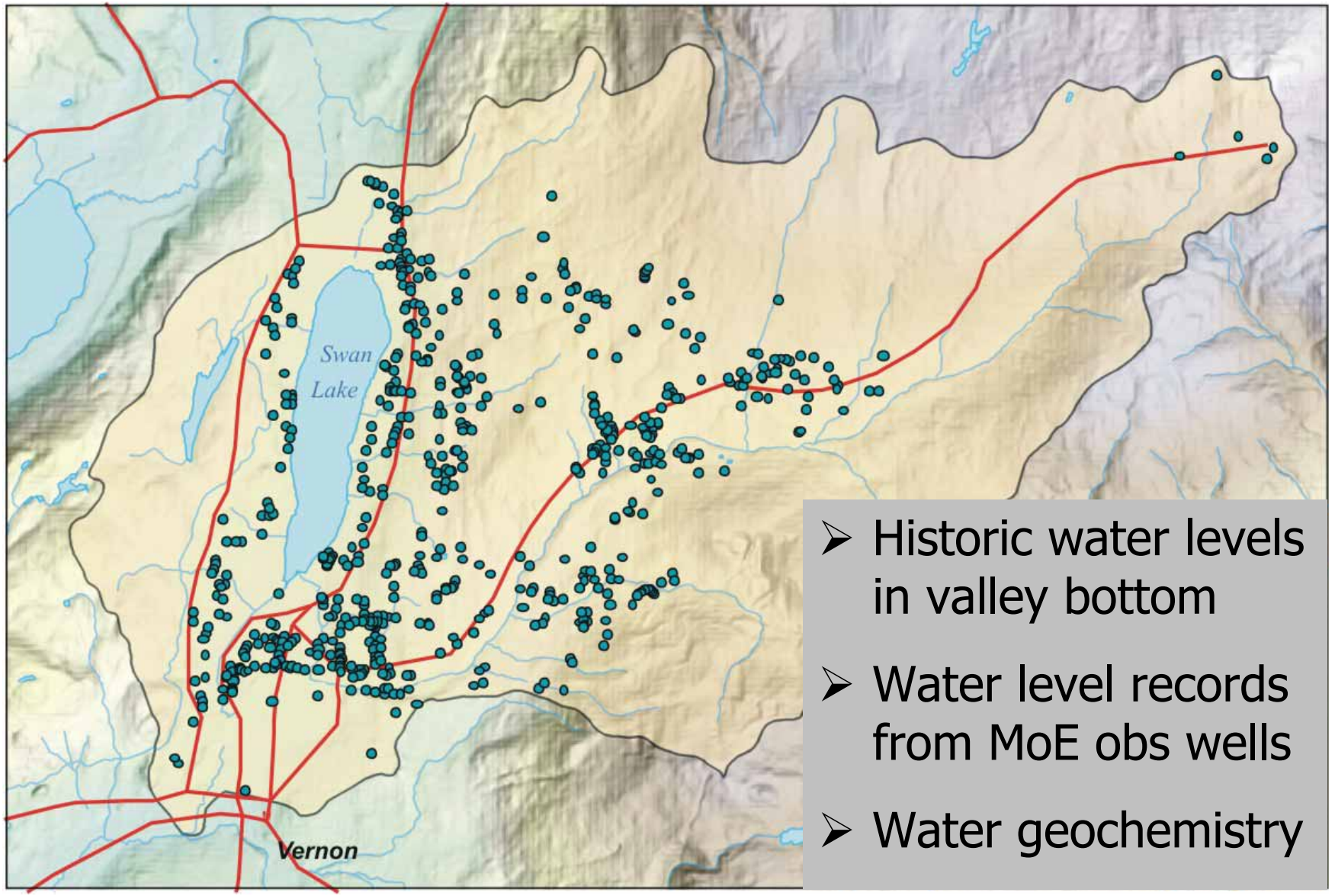
Follow the Flow to Valley Bottom Aquifers

+quantify



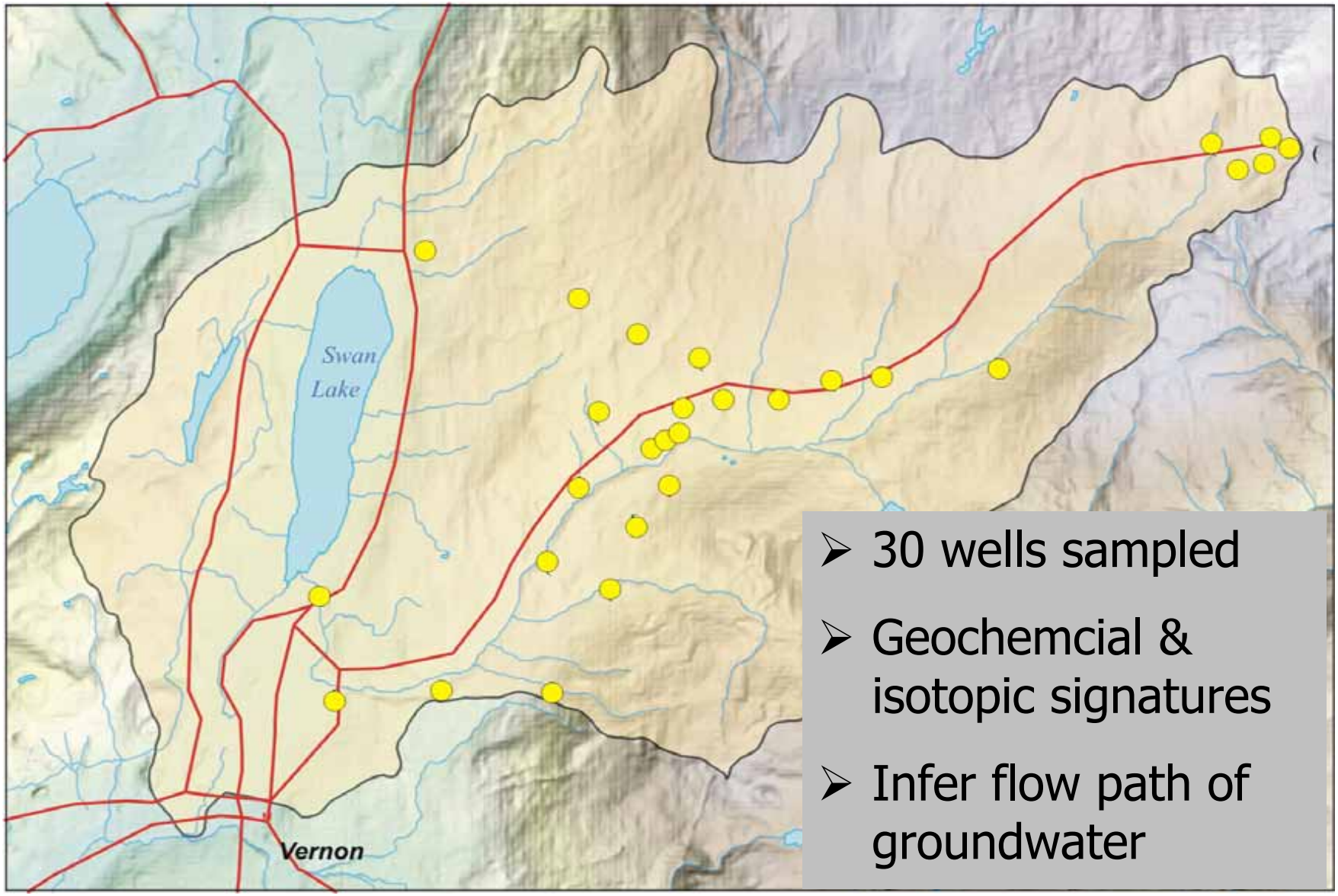
- 3D SW/GW model of valley bottom

Additional Hydrologic Data



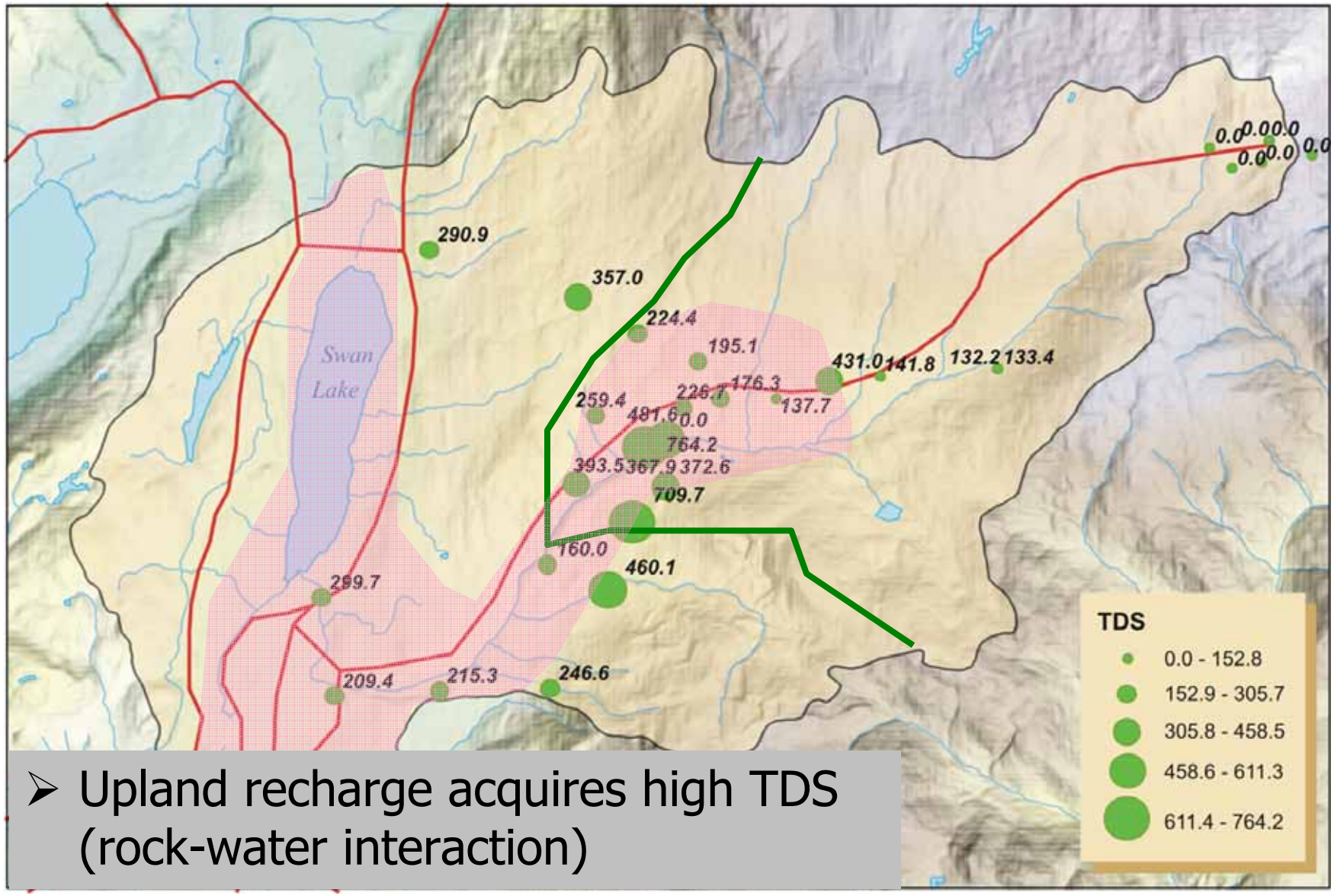
- Historic water levels in valley bottom
- Water level records from MoE obs wells
- Water geochemistry

Well Sampling: Summer 2005



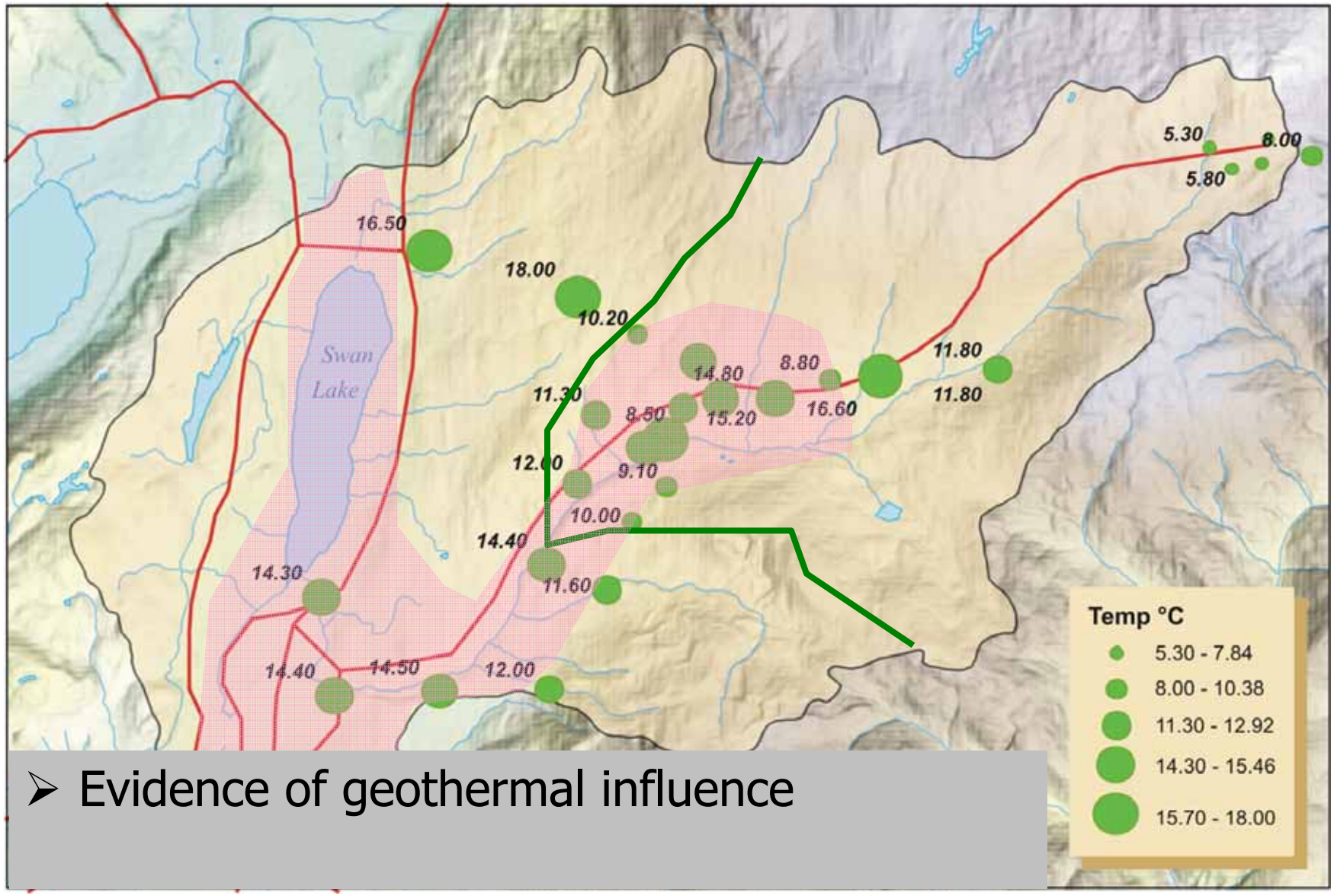
- 30 wells sampled
- Geochemcial & isotopic signatures
- Infer flow path of groundwater

Total Dissolved Solids



- Upland recharge acquires high TDS (rock-water interaction)

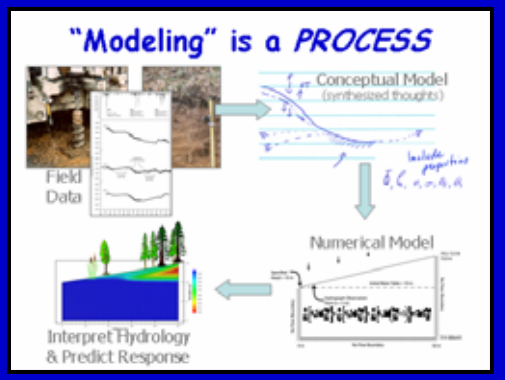
Groundwater Temperature



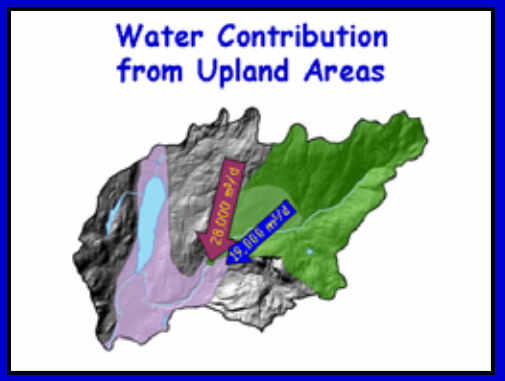
- Evidence of geothermal influence

Concluding Remarks

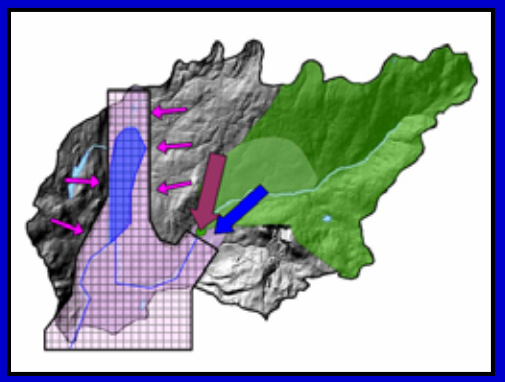
- Modeling watersheds is an (iterative) PROCESS
  - Acquire new data to improve understanding



- Limited knowledge of groundwater flow in upland bedrock
  - 30% of PRECIP discharges through BX Creek
  - 20% of PRECIP discharges as groundwater



- Investigate recharge by looking at individual components



Acknowledgements

CANADIAN WATER NETWORK
RÉSEAU CANADIEN DE L'EAU

CANADA 1842 GEOLOGICAL SURVEY - COMMISSION GÉOLOGIQUE

NSERC
CRSNG