Modifications of the Soil Water and Assessment Tool for streamflow modelling in a small, forested watershed on the Canadian Boreal Plain.

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Outline

- FORWARD Project Description
- Data Preparation Protocol
- Model Adaptations
- Results
- Conclusions

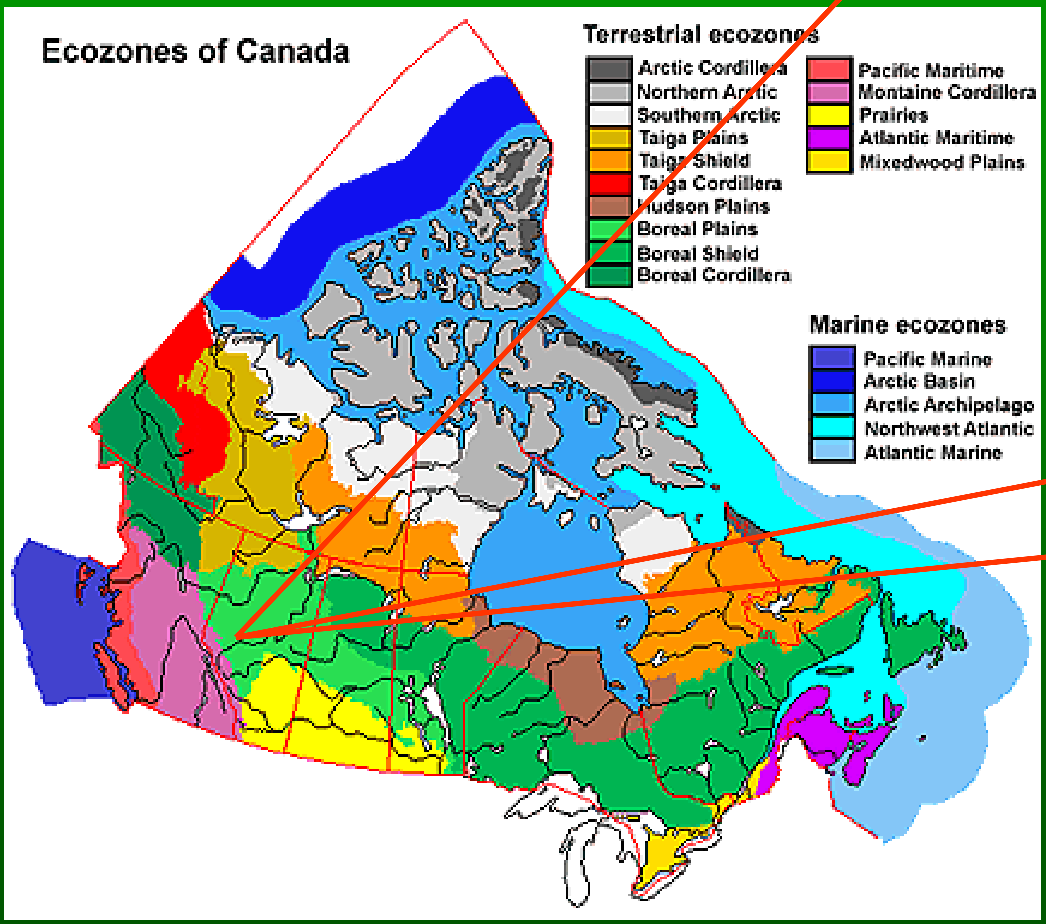
FORWARD Project Description

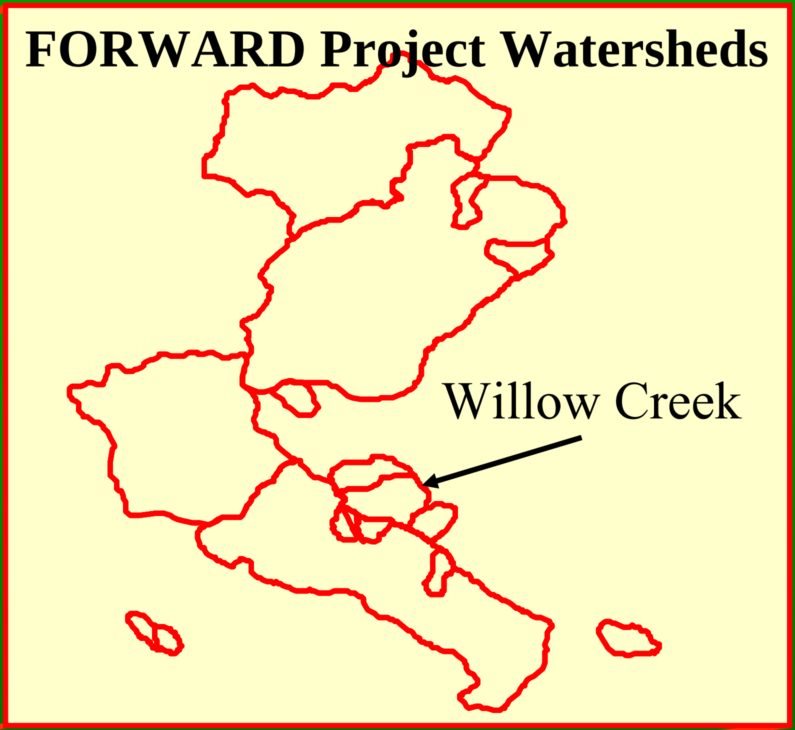
- FORWARD - Forested Watershed and Riparian Disturbance Group
  - Impact of disturbance on water quality and quantity
  - Mitigating effect of buffer riparian zones
  - Compare effect of fire and harvesting
  - Provide a management tool for industry

FORWARD Project Description cont'd

- Group Members
  - University
  - Industry
  - Government
- Other Group Affiliations
  - SWAT group
  - Marcell Experimental Forest

Study Site


Ecozones of Canada
Terrestrial ecozones
Arctic Cordillera
Northern Arctic
Southern Arctic
Taiga Plains
Taiga Shield
Taiga Cordillera
Hudson Plains
Boreal Plains
Boreal Shield
Boreal Cordillera
Pacific Maritime
Montaine Cordillera
Prairies
Atlantic Maritime
Mixedwood Plains
Marine ecozones
Pacific Marine
Arctic Basin
Arctic Archipelago
Northwest Atlantic
Atlantic Marine


FORWARD Project Watersheds
Willow Creek

Data Preparation Protocol

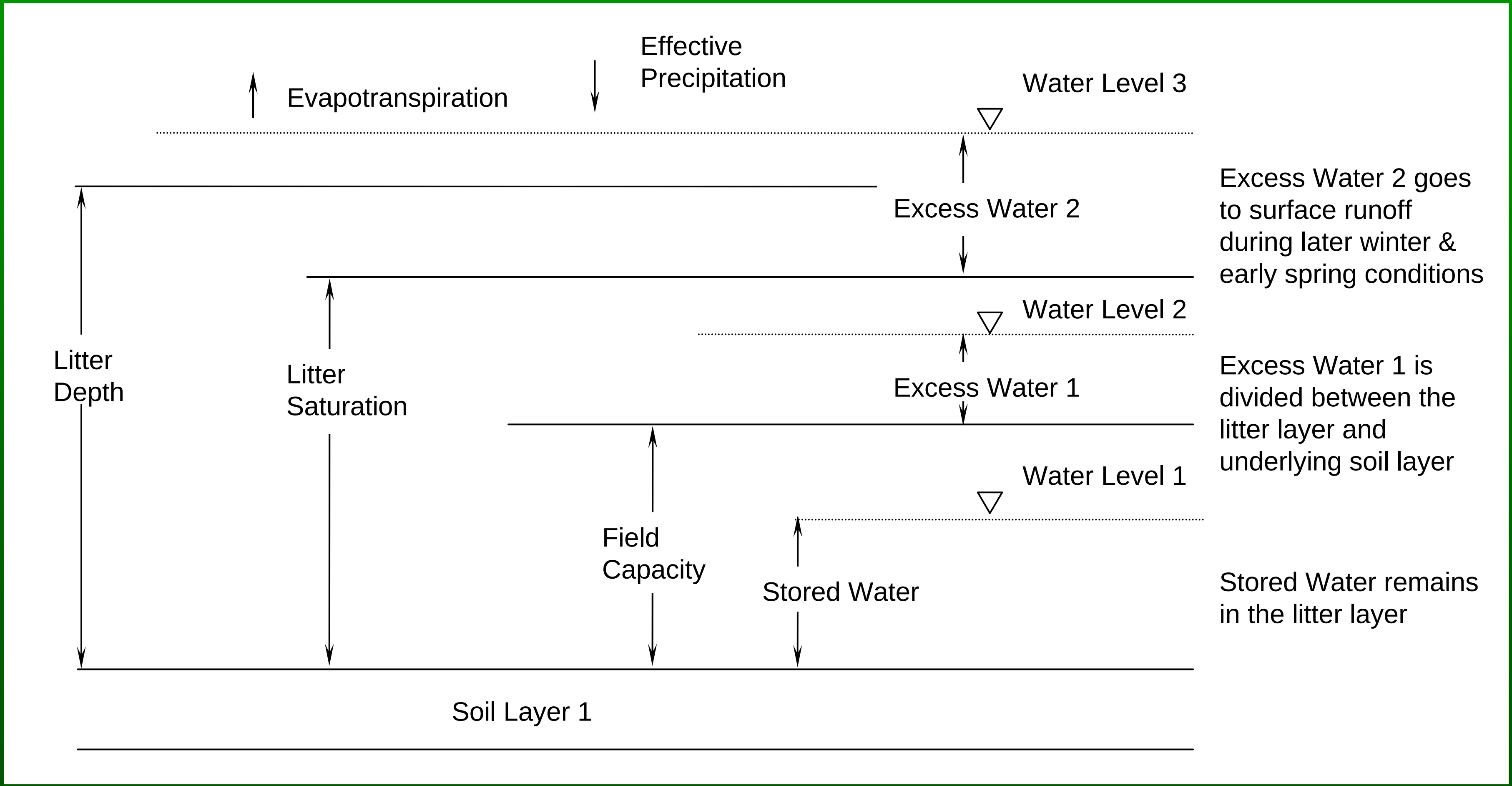
- Original data preparation program was developed by A. Rudy with help of I. Whitson & R. McKeown
  - Vegetation
  - Reach
  - Soils

SWAT Code Developed

- Model Development
  - Litter Layer
  - Wetlands
  - Aspect and slope
  - Vegetation
  - Damping factor
- SWATC-2000 Code Framework

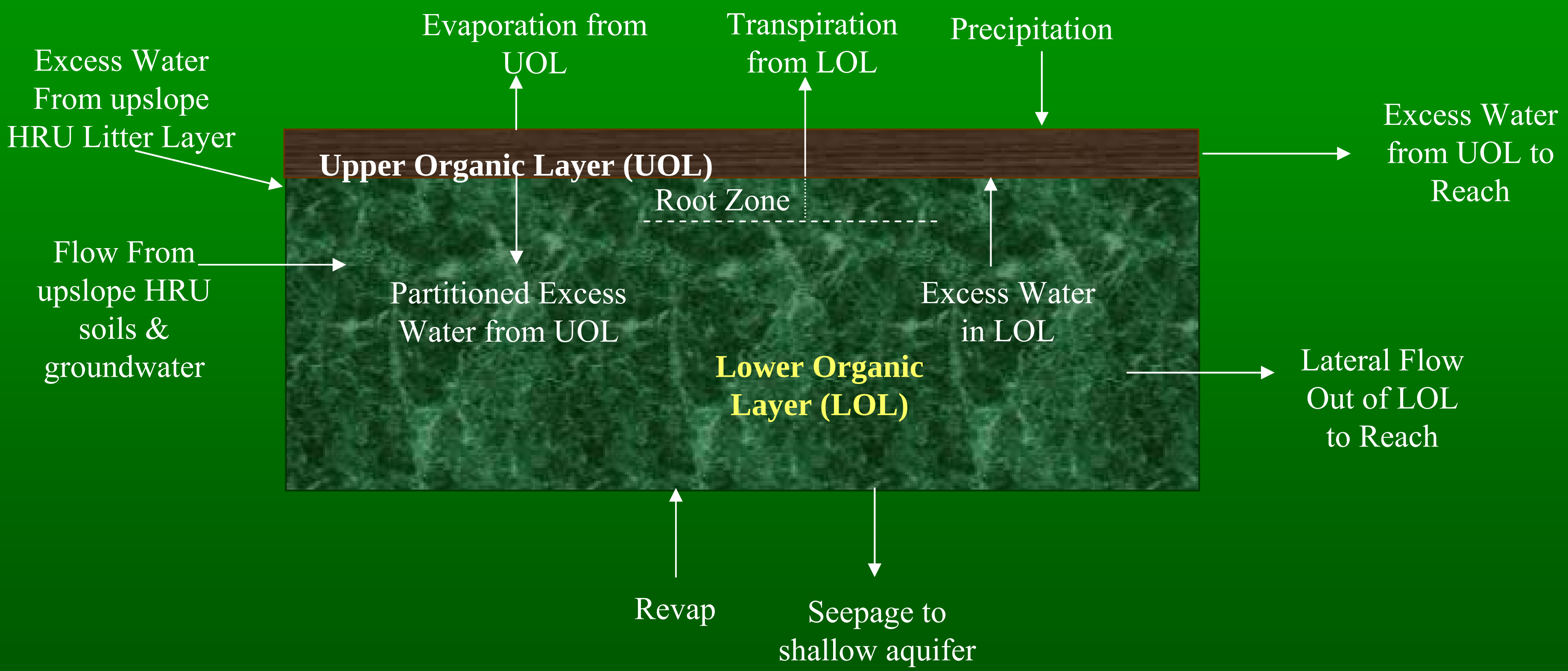
Model Adaptation

- Litter layer incorporated for the forested land base



Wetlands Code

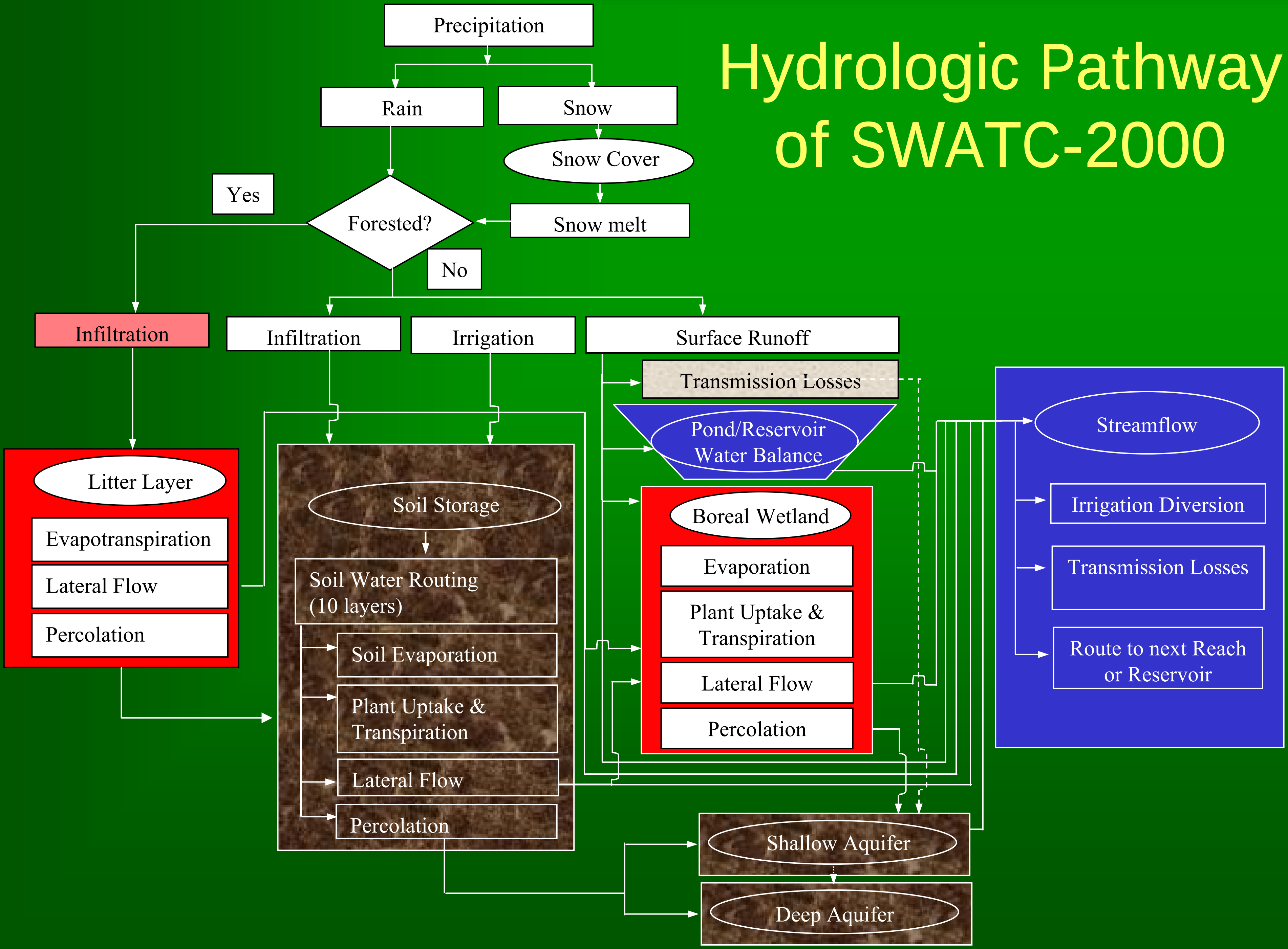
- Wetlands incorporated in a watershed
  - Maximum of one wetland per subbasin



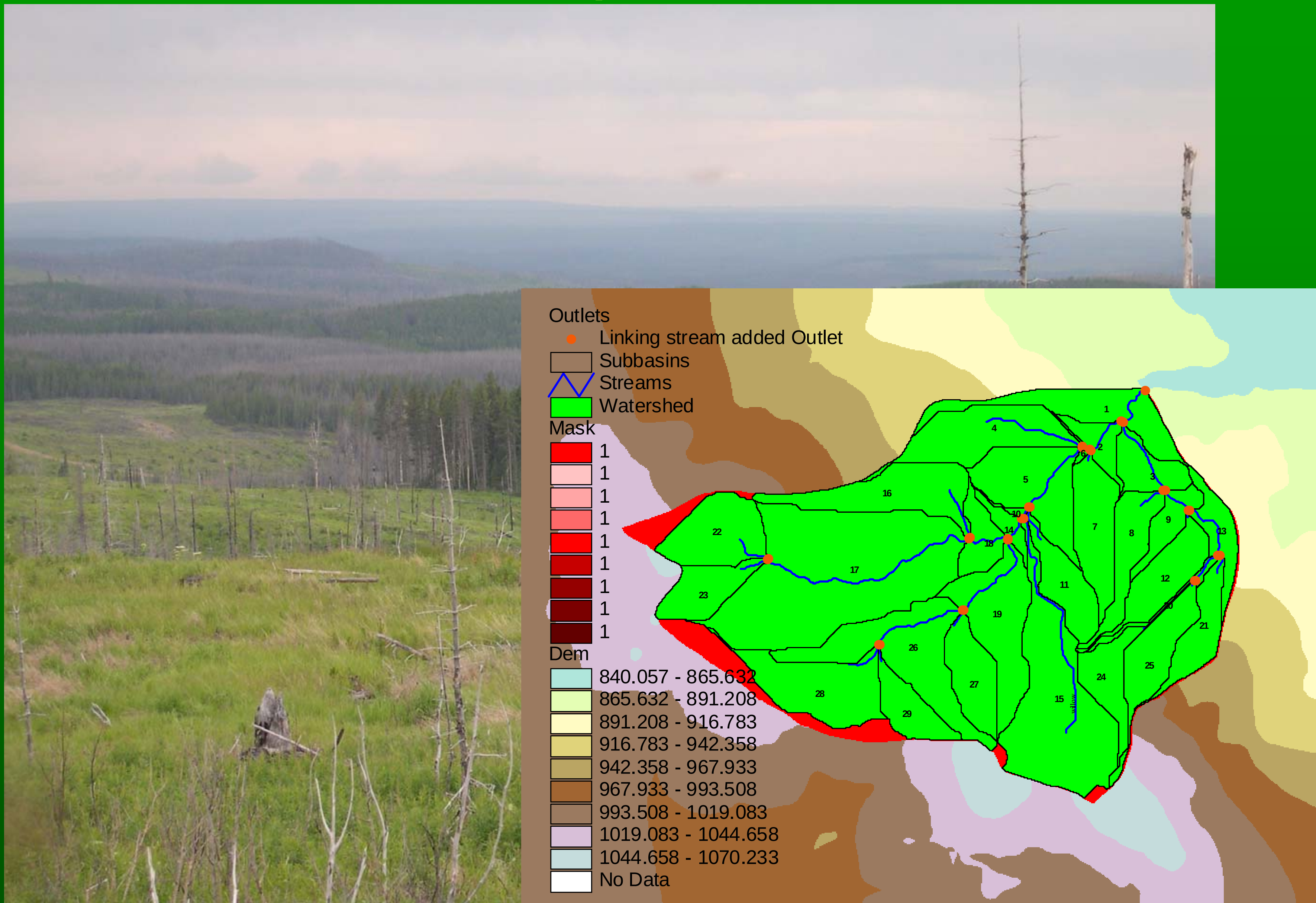
Soil Temperature Code

- Aspect & Slope
  - The aspect and slope was included to reduce incoming solar radiation
- Vegetation
  - Equation was based on Beers Law of light extinction
- Damping Effect
  - An equation was developed to represent the damping effect due to the litter layer

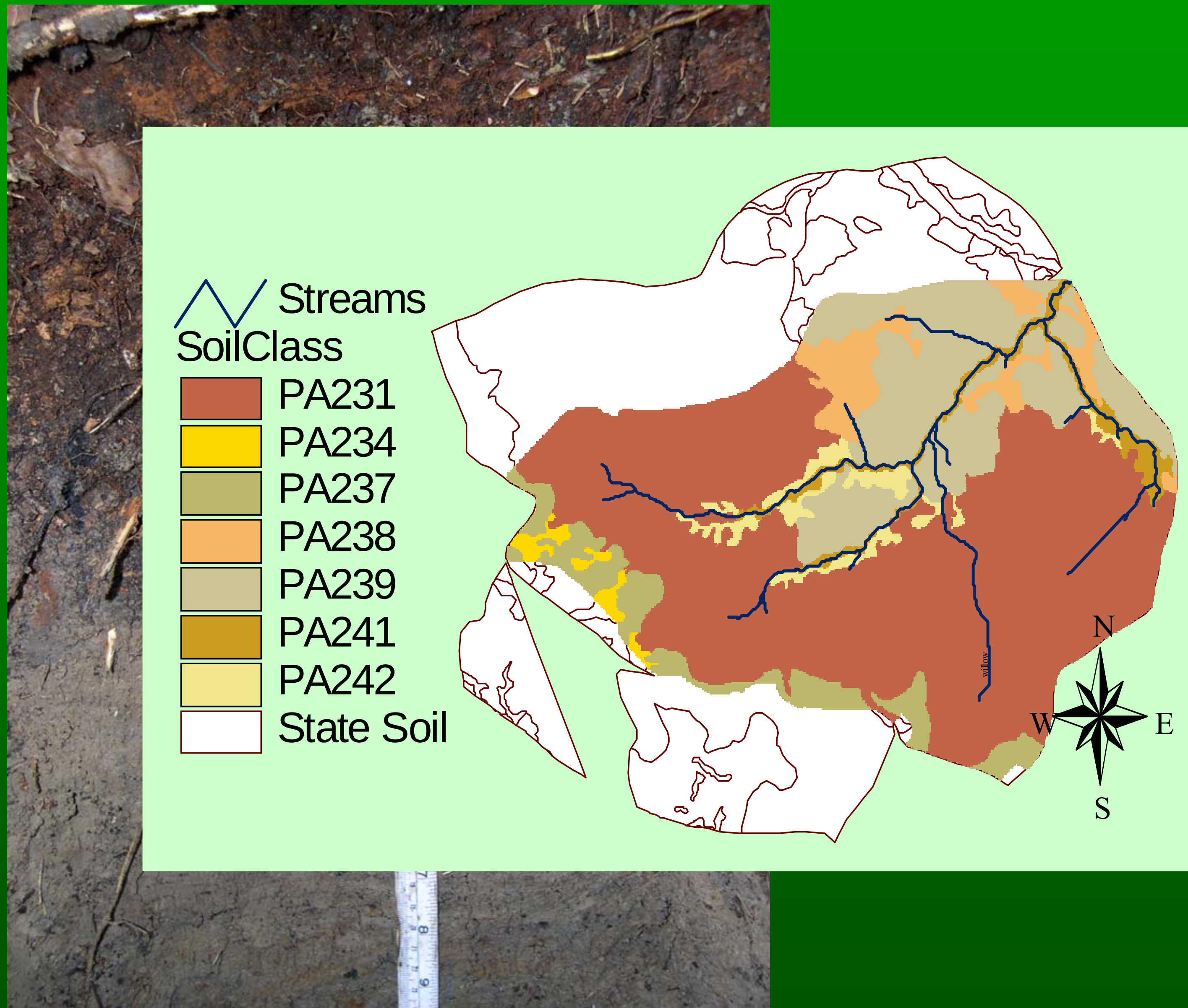
Hydrologic Pathway of SWATC-2000



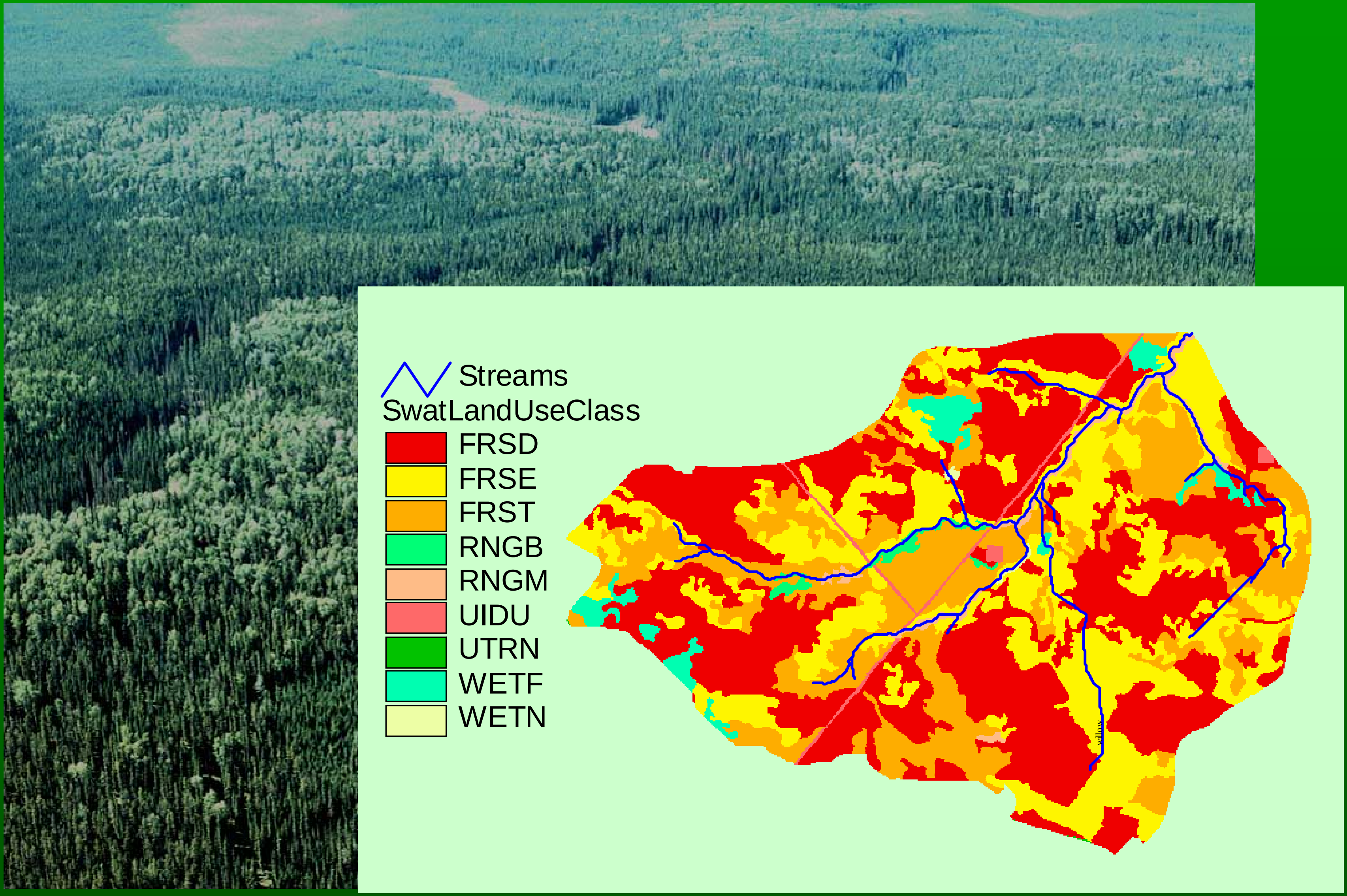
Model Setup: Delineation



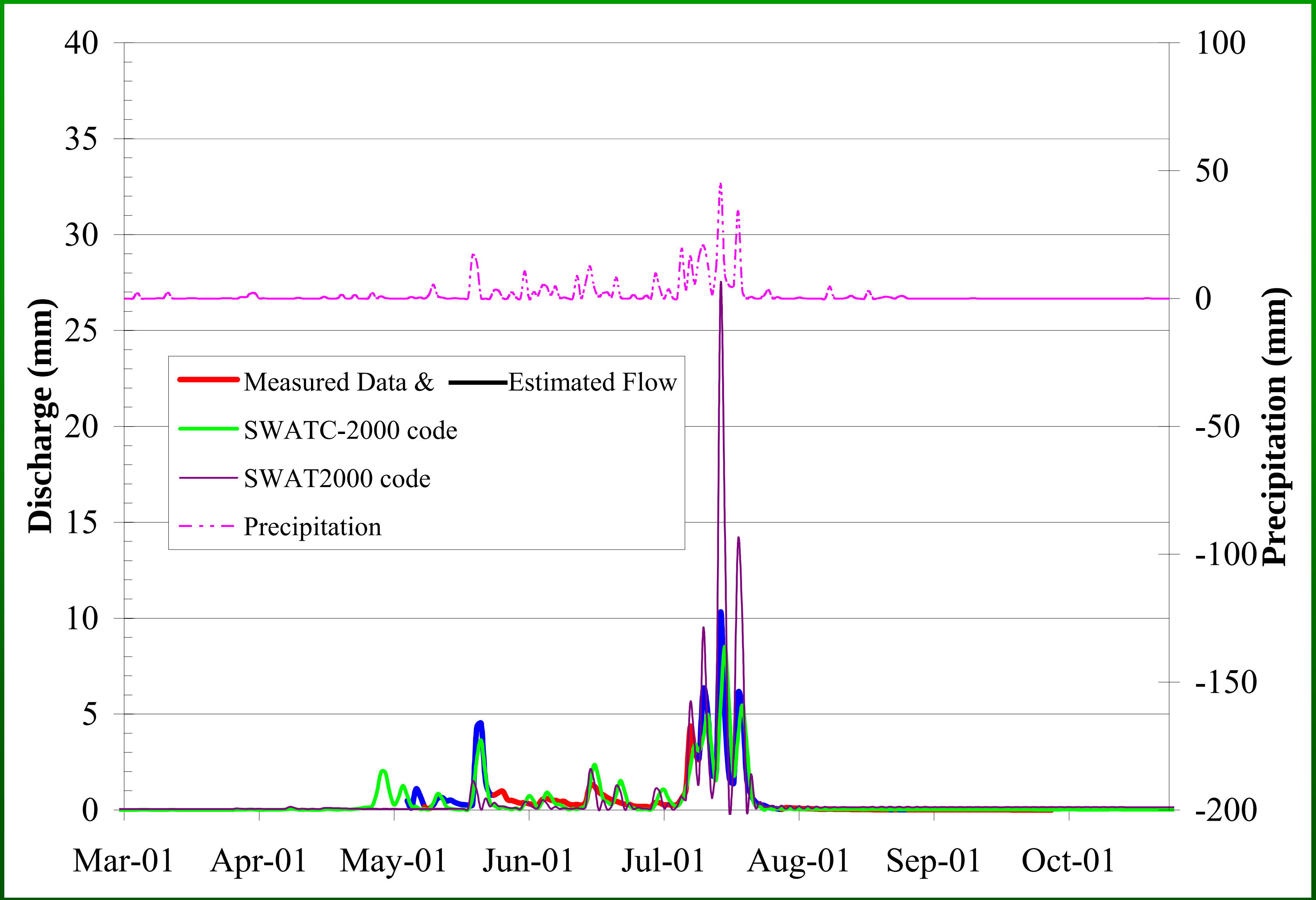
Model Setup: Soils



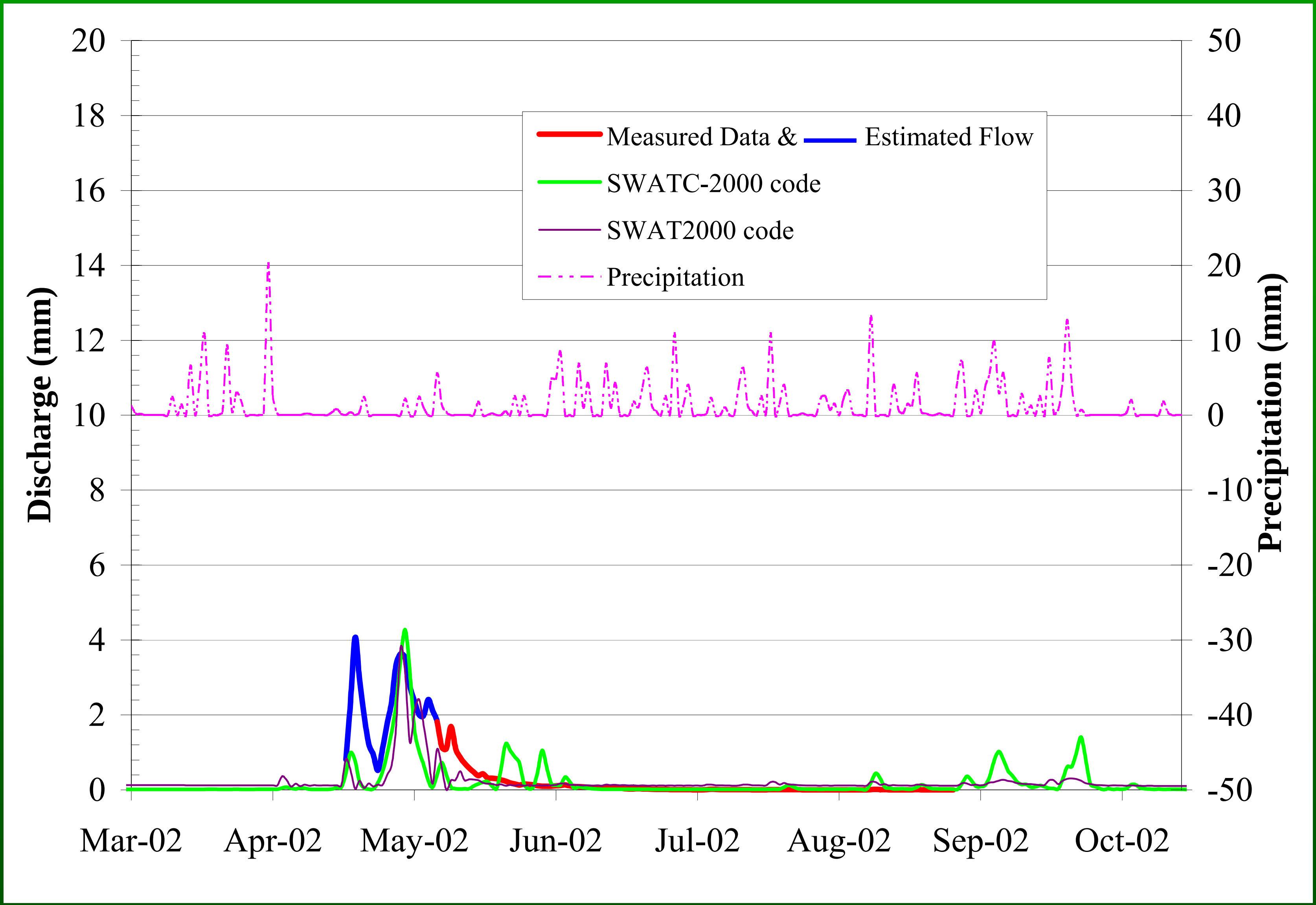
Model Setup: Land Cover



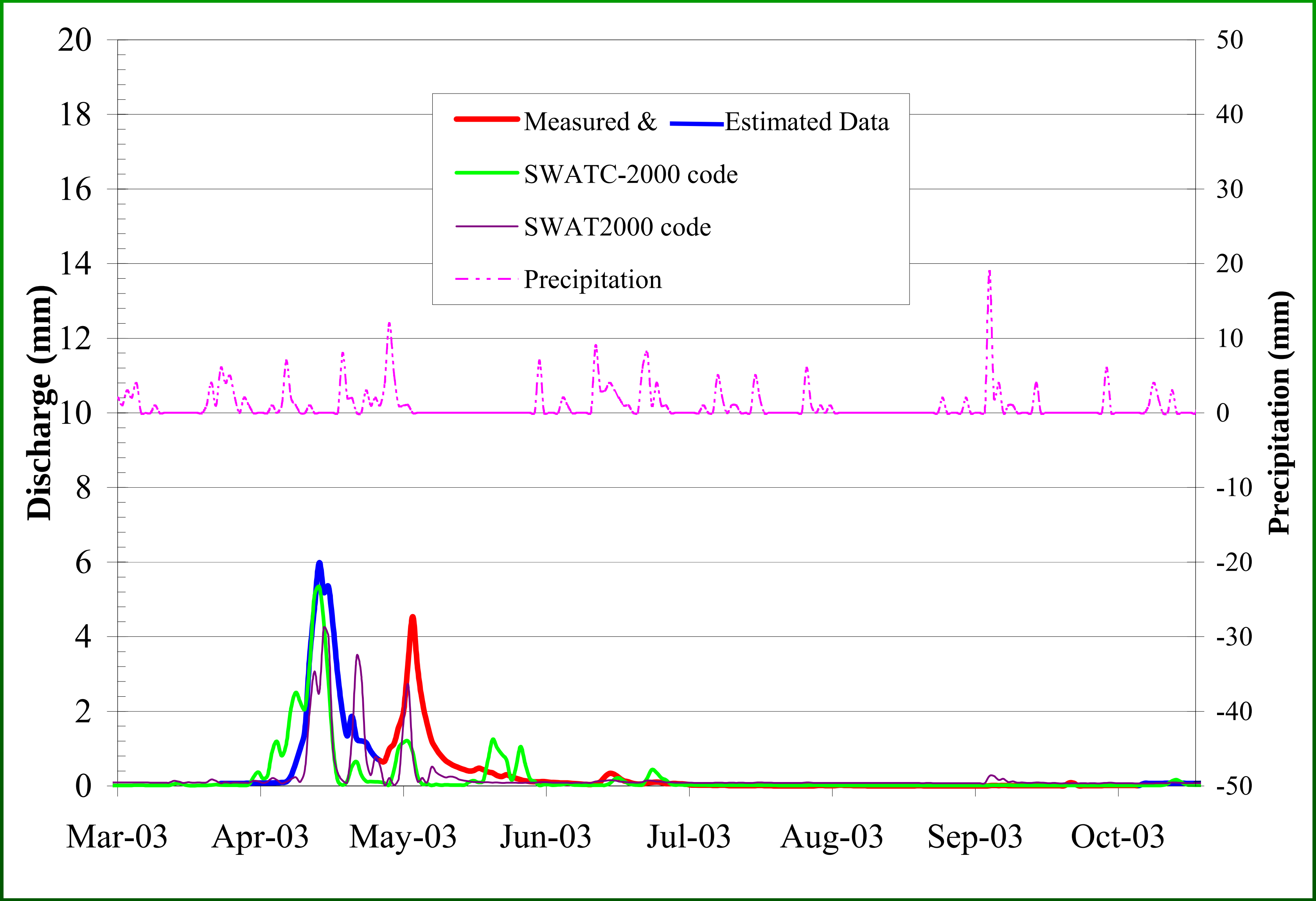
Results: Daily Flow 2001



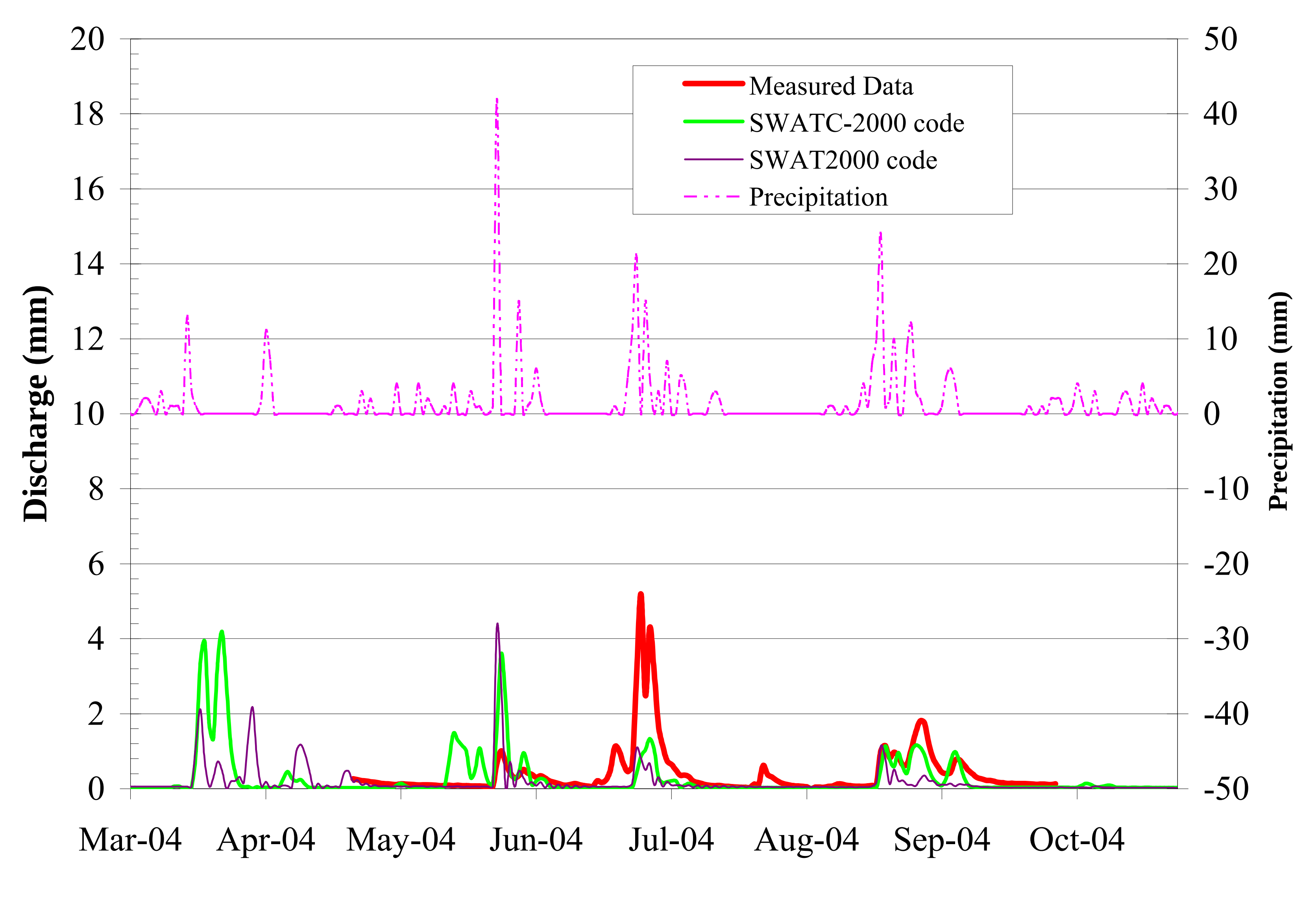
Results: Daily Flow 2002



Results: Daily Flow 2003



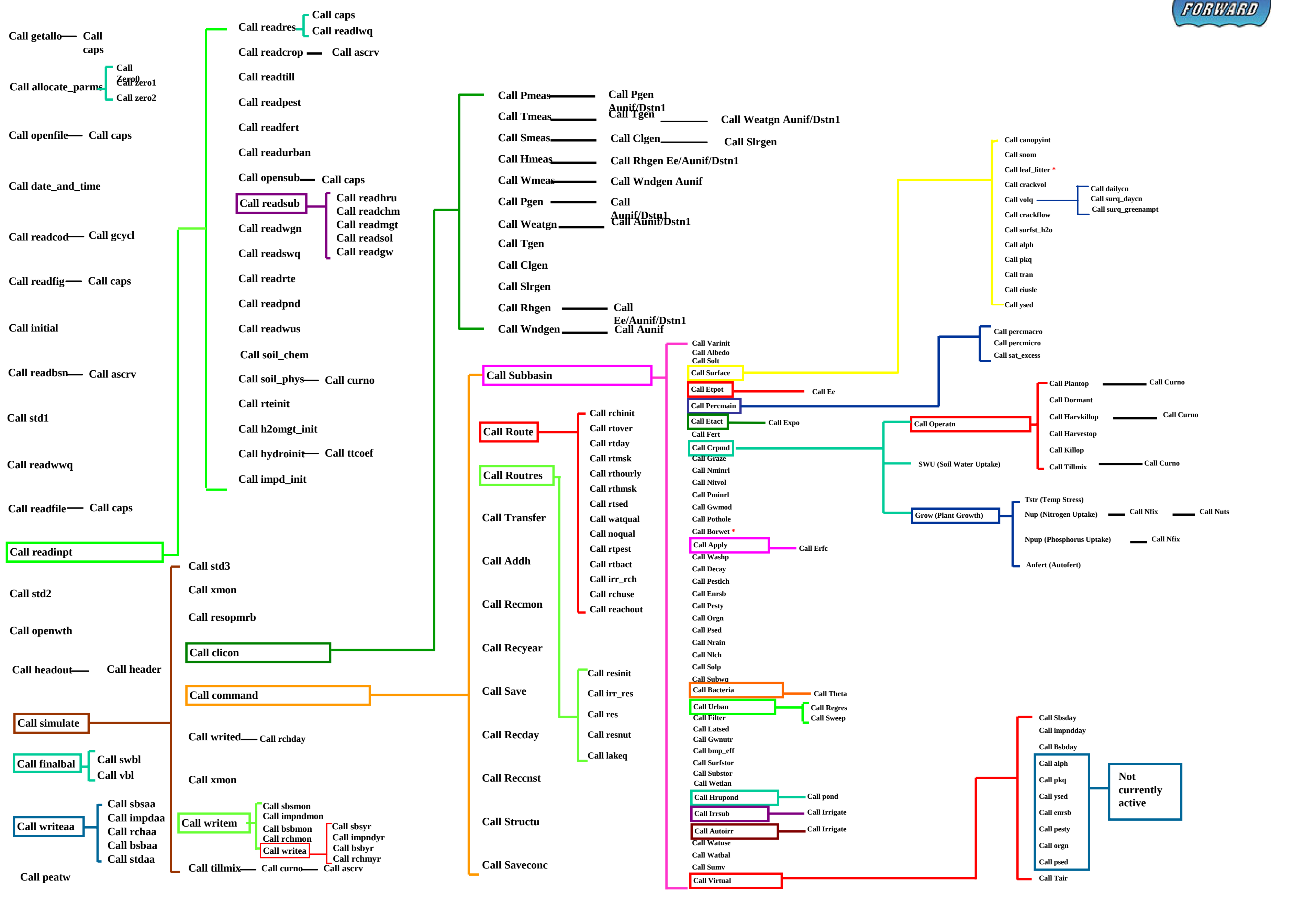
Results: Daily Flow 2004



Conclusions

- The data preparation protocol and SWAT code completed to date are a significant improvement for both data management and modelling in a forested setting.
- As data becomes available, additional SWAT code improvements include litter layer growth, wetlands freeze & thaw, refined damping effect equation, and the development of an improved radiation reduction equation.

SWAT FlowChart



Meteorological Data

Model Adaptation

- Equation used for proportioning

$$Pptn = \frac{K_{sat\_ly1} * 1}{\left(K_{sat\_ly1} * 1\right) + \left(K_{sat\_litter} * Slope\right)}$$

Wetlands Code

- Inflows
  - Flow from upslope
    - The volume of water released from the upslope hru(s) – surface flow (if applicable), litter layer, groundwater flow and lateral flow enters the wetland.

$$V_{flowin} = \sum_{hru=1}^{n}\left[fr_{pot,hru} * 10 * \left(Q_{surf,hru} + Q_{gw,hru} + Q_{lat,hru} + Q_{litter,hru}\right) * area_{hru}\right]$$

Wetlands Code

- Precipitation
  - Enters litter layer first and excess water is partitioned as per the litter code
- Revap
  - Water moves upward from the shallow groundwater

Wetlands Code

- Outflows
  - Litter flow downslope
    - Excess flow is calculated, lagged and then fed directly to the reach. The amount of litter flow released each day is determined using the kinematic storage model.
  - Lateral flow out via soil
    - This flow is limited by the downslope soil Ksat values. The flow is then lagged to the stream using the kinematic storage model.

Wetlands Code

- Seepage
  - The Ksat of the underlying soil limits the seepage. The water then passes through the soil horizons as with other hru's.
- Excess Water in Wetland
  - Water that exceeds the capacity of the wetland is sent to the litter layer and routed as per the litter code.
- Evaporation
  - This occurs from the litter layer if the litter has sufficient excess water.

Wetlands Code

- Transpiration
  - limited by the root depth of the vegetation growing within the wetland hru.
  - the equation is the same as that used in SWAT2000

$$E_t = \frac{E_o'*LAI}{3.0} \qquad 0 \leq \text{LAI} \leq 3.0$$

$$E_t = E_o' \qquad \text{LAI} > 3.0$$

Soil Temperature Code

- Aspect & Slope
  - The aspect and slope are included to reduce incoming solar radiation

$$G_a = G_m \left\lfloor R_d \left(1 - K_r\right) + f_\beta K_r + 0.2\left(1 - f_\beta\right) \right\rfloor$$

$$R_d(\varphi, \delta, \beta, b) = \frac{\left(\dfrac{\sin \Phi *}{\sin \Phi}\right)\left(d - \dfrac{\sin d \cos e \cos g}{\cos w *}\right)}{\omega_s - \tan \omega_s}$$

Soil Temperature Code

- Vegetation
  - Equation used is based on Beers Law of light extinction

$$G_f = G_a * e^{(-K*LAI)}$$

Soil Temperature Code

- Damping Effect
  - An equation was developed to represent the damping effect due to the litter layer

$$bcv_{forest} = \frac{D_{LL}}{D_{LL} + Exp\left(-2.598 + 0.845 * D_{LL}\right)}$$