Using Wetbud: Surface Water Considerations

Tess Wynn Thompson ,W. Lee Daniels, Matt Gloe, Karen Hall, Eric Neuhaus, O. Waverly Parks, and Candice Piercy

Virginia Tech

With thanks to:

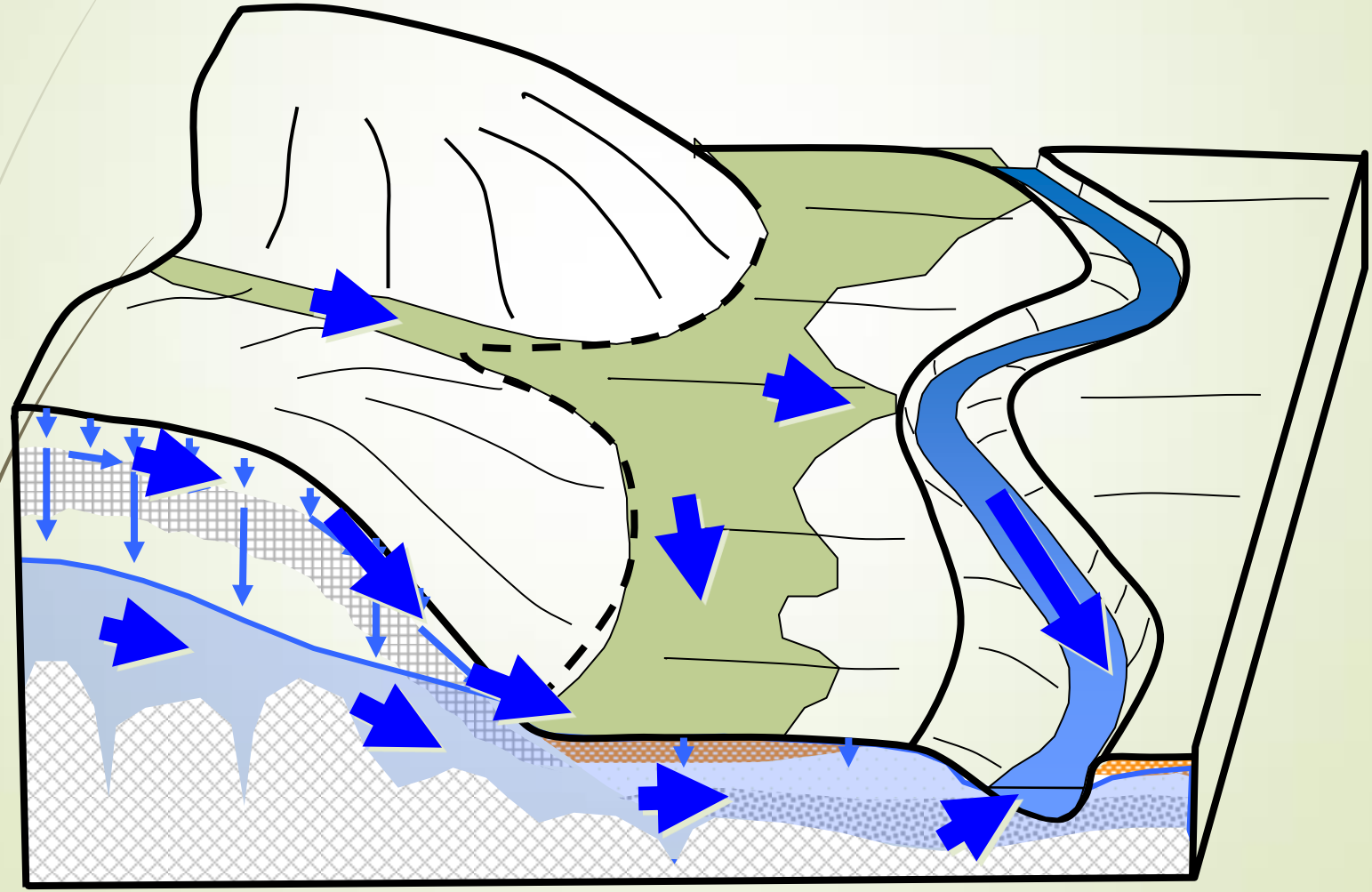
Rich Whittecar, Kerby Dobbs, John McLeod, Matthew Richardson, Tracy Thornton, and Cal Smith

Old Dominion University

Zach Agioutantis @ Technical University of Crete

Mike Rolband and Staff @ WSSI

Piedmont Wetlands:
the interface between uplands, groundwater, and surface water

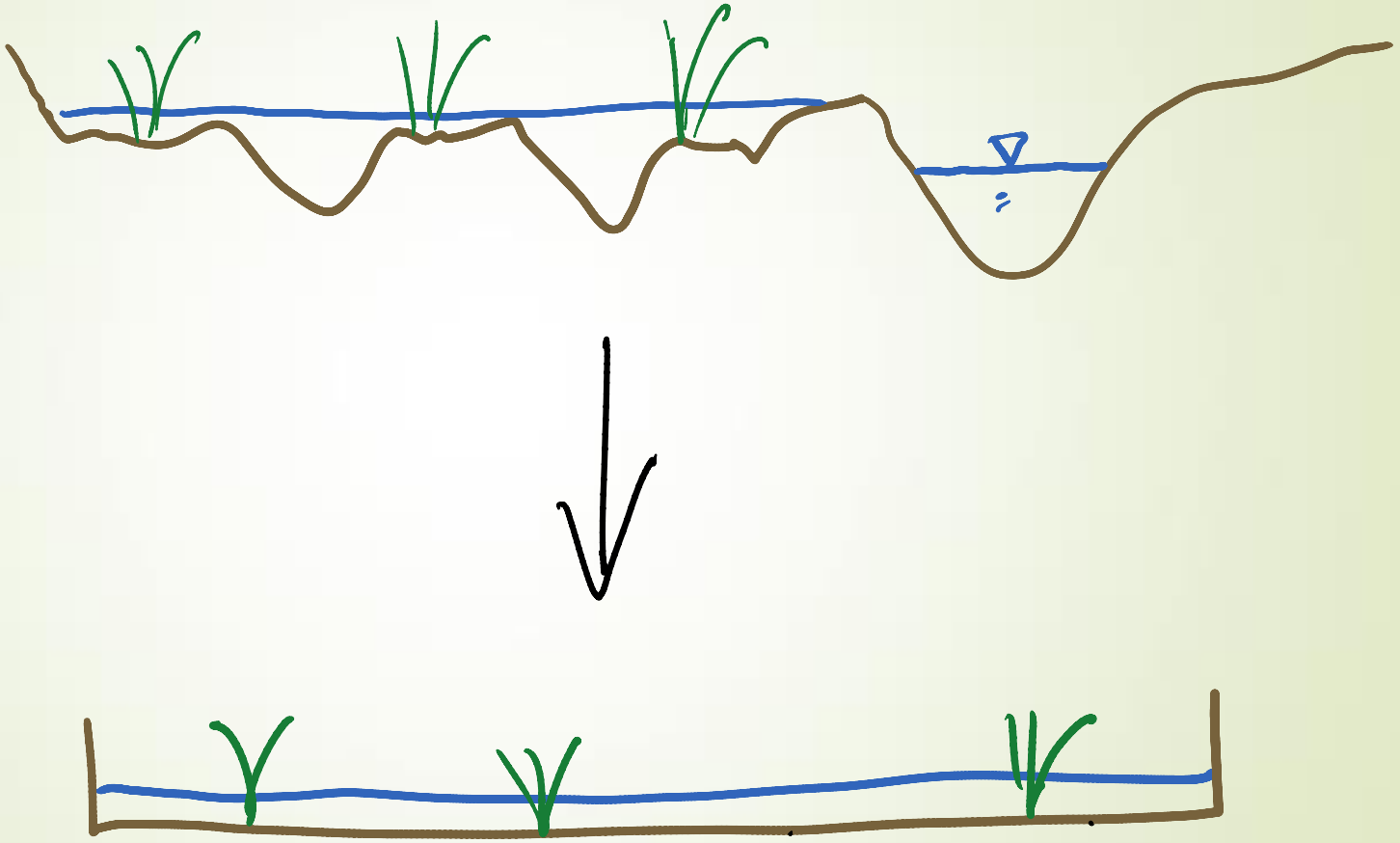


Surface Water: Inflows and Outflow

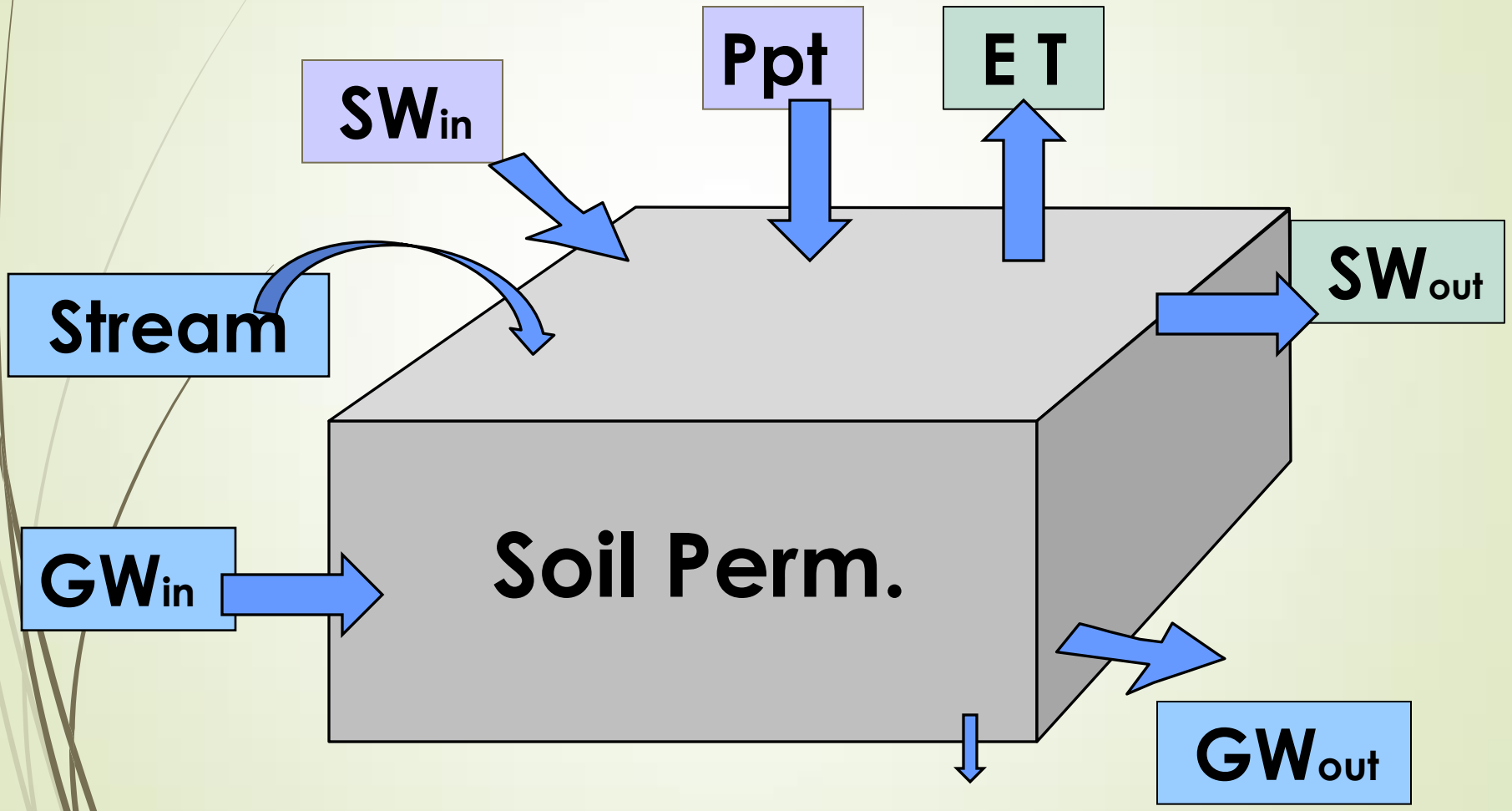
- Precipitation falling on the wetland surface
- Surface runoff (overland flow) from hillslopes immediately adjacent to wetland
- Overbank flows from stream adjacent to wetland

- Evapotranspiration
- Vertical and horizontal seepage out of wetland
- Outflow through outlet structure (e.g. weir)

Wetbud Basic Model



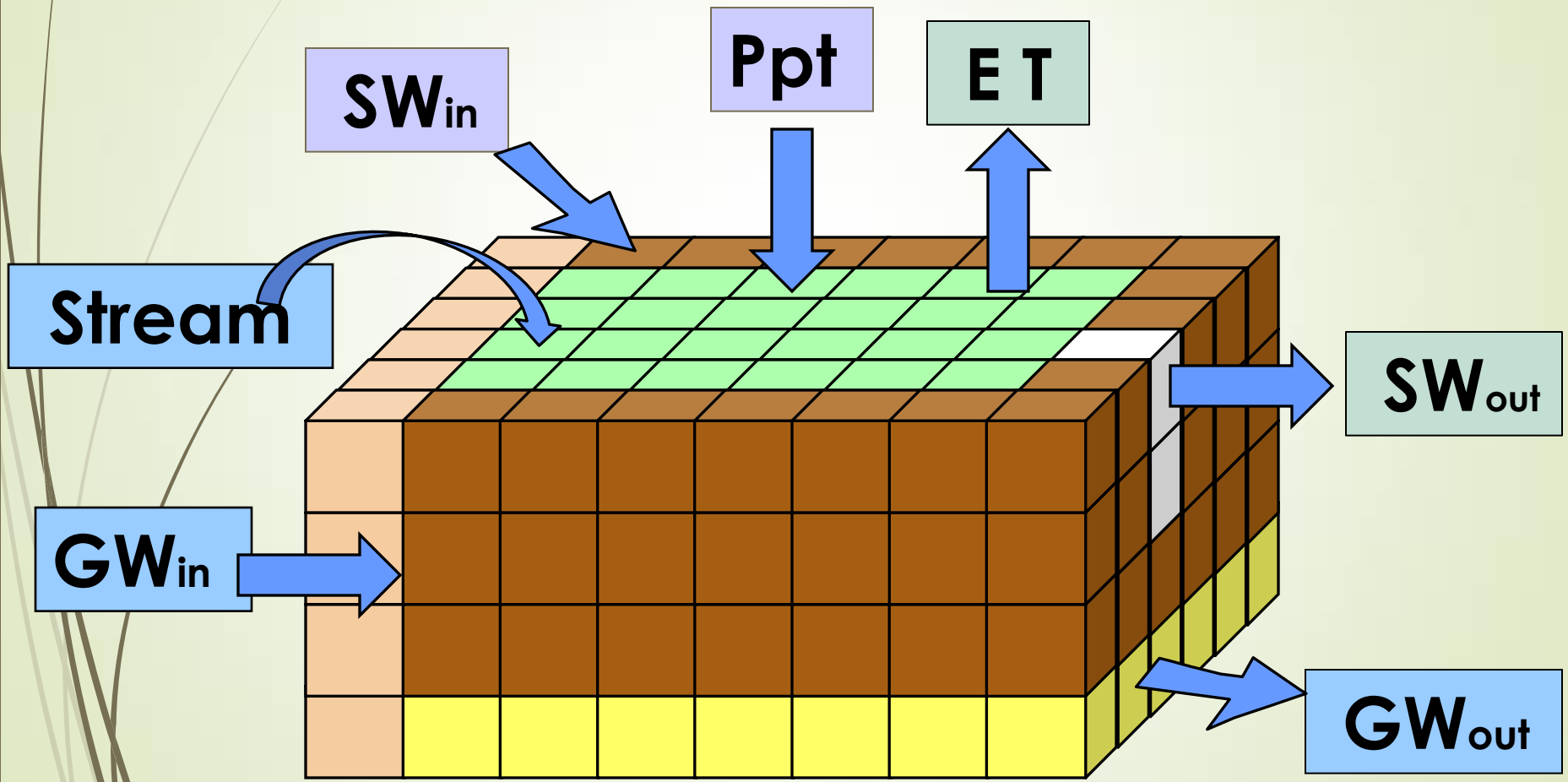
Wetbud Basic Version



The Basic model computes a monthly water balance.

- Assumes “level-pool” routing
- All inputs and outputs are summed for the month as depth over the wetland
- Any excess water is removed from the calculations

Wetbud Advanced Version

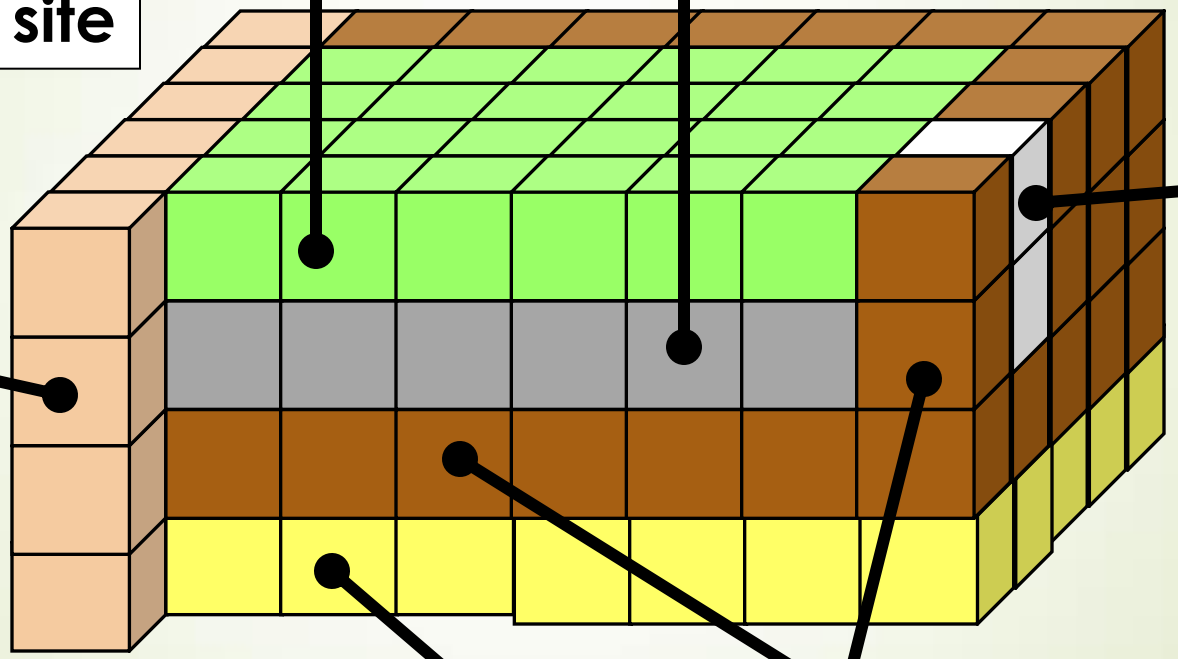


The Advanced model determines daily flow rates between cells/boxes using Darcy's law and then determines volume of water in the cell for that day

- Flow resistance (hydraulic conductivity) and hydraulic head (slope of water surface) determines flow rate
- Precipitation and evapotranspiration added or removed from highest cell with water
- Overland and overbank flows added to the cell at the point where they enter the wetland
- Outflow rate is calculated; water removed from cell where drain is located

Wetbud Advanced Version

Setup for a Piedmont valley bottom mitigation site



Vegetation

Loose surface soil w/ added OM

Outlet

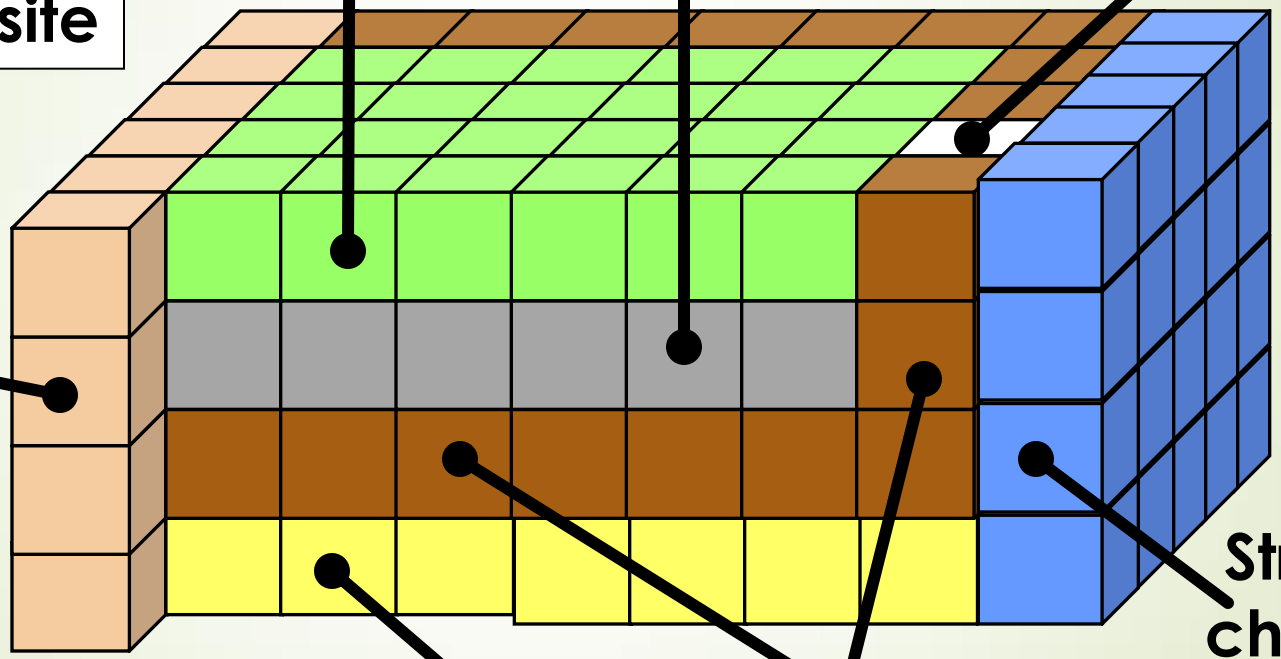
Saprolite rotted bedrock

Stream gravel

Compacted subsoil/berm

WetBud Advanced Version

One setup for a Piedmont valley bottom mitigation site



Vegetation

Loose surface soil w/ added OM

Outlet

Saprolite rotted bedrock

Stream channel

Stream gravel

Compacted subsoil/berm

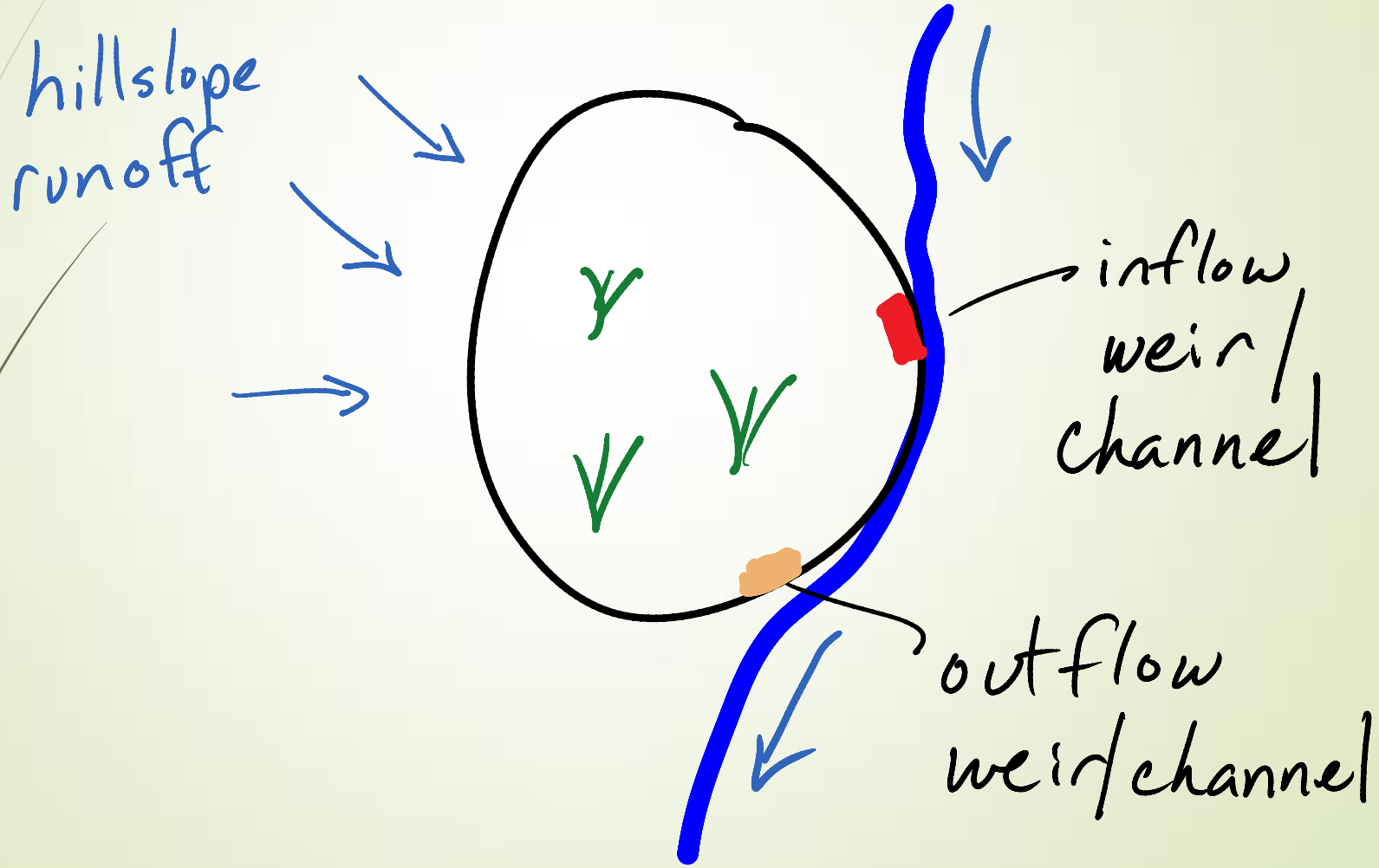
Precipitation is simply added to the wetland

- Basic – total monthly precipitation
- Advanced – Daily total is added to highest cell with water

Hillslope runoff from wetland watershed is calculated using the NRCS Curve Number method

- 24-hr precipitation depth and watershed CN are inputs
- Determines depth of water available to run off (precipitation excess)
- Assumes all precipitation excess for the day enters the wetland
- No runoff hydrograph computed
- No flow routing
- Both basic and advanced models

Assumptions for overbank flow calculations



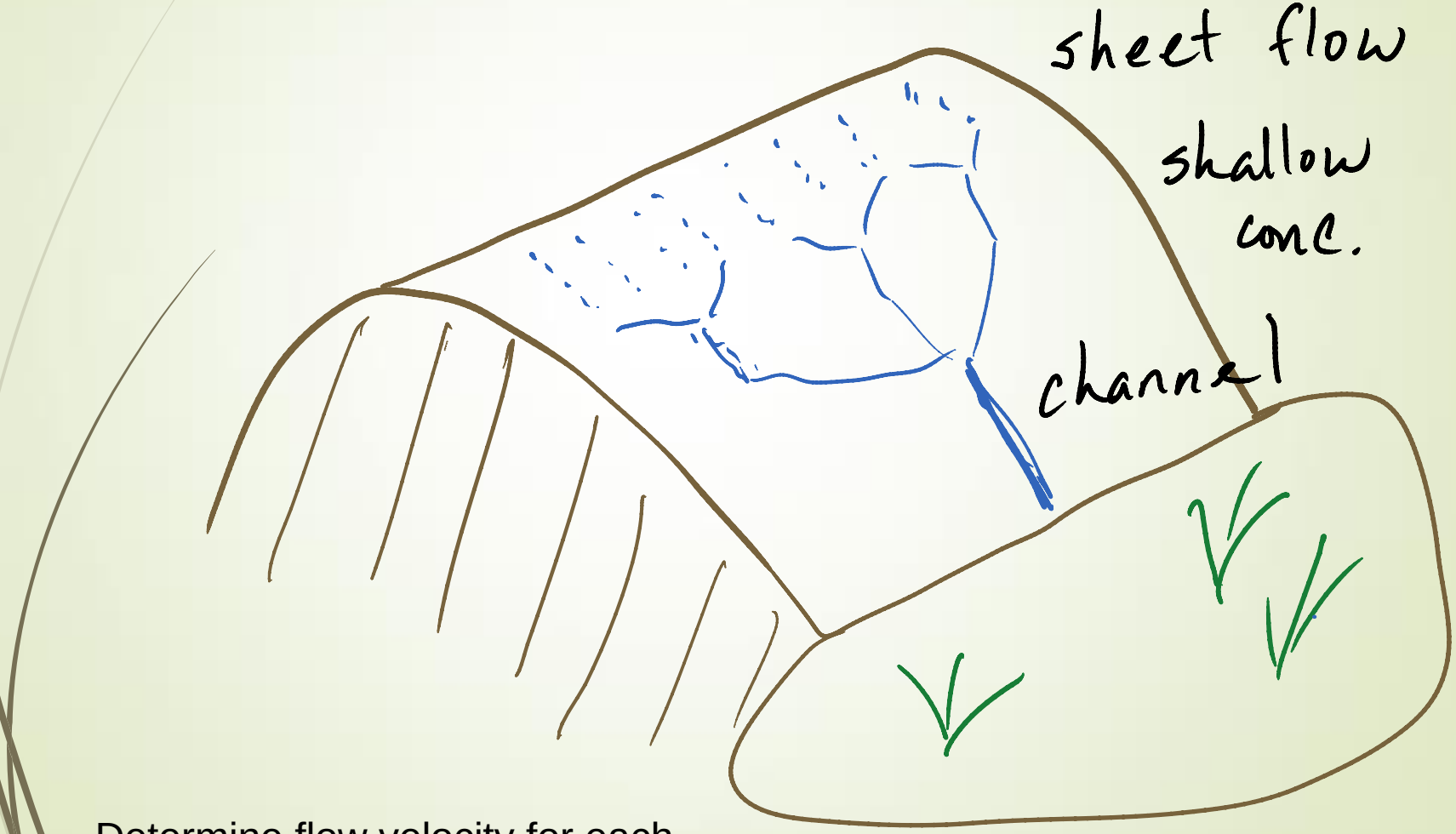
Inflows are calculated daily using NRCS methods and hydraulics equations

1. Determine precipitation excess using NRCS CN method
2. Determine time of concentration for stream watershed
3. Determine peak flow rate
4. Use NRCS dimensionless unit hydrograph to estimate stream hydrograph for the calculated runoff amount
5. Determine stream elevation using Manning's equation, assuming a trapezoidal stream channel
6. Compute flow rate into the wetland using hydraulics equations

Inflows are calculated daily using NRCS methods and hydraulics equations

1. Determine precipitation excess using NRCS CN method
2. Determine time of concentration for stream watershed
3. Determine peak flow rate
4. Use NRCS dimensionless unit hydrograph to estimate stream hydrograph for the calculated runoff amount
5. Determine stream elevation using Manning's equation, assuming a trapezoidal stream channel
6. Compute flow rate into the wetland using hydraulics equations

Time of concentration is the sum of travel times for overland sheet flow, shallow concentrated flow, and concentrated channel flow



Determine flow velocity for each type of flow and divide flow distance by flow velocity to get travel time.

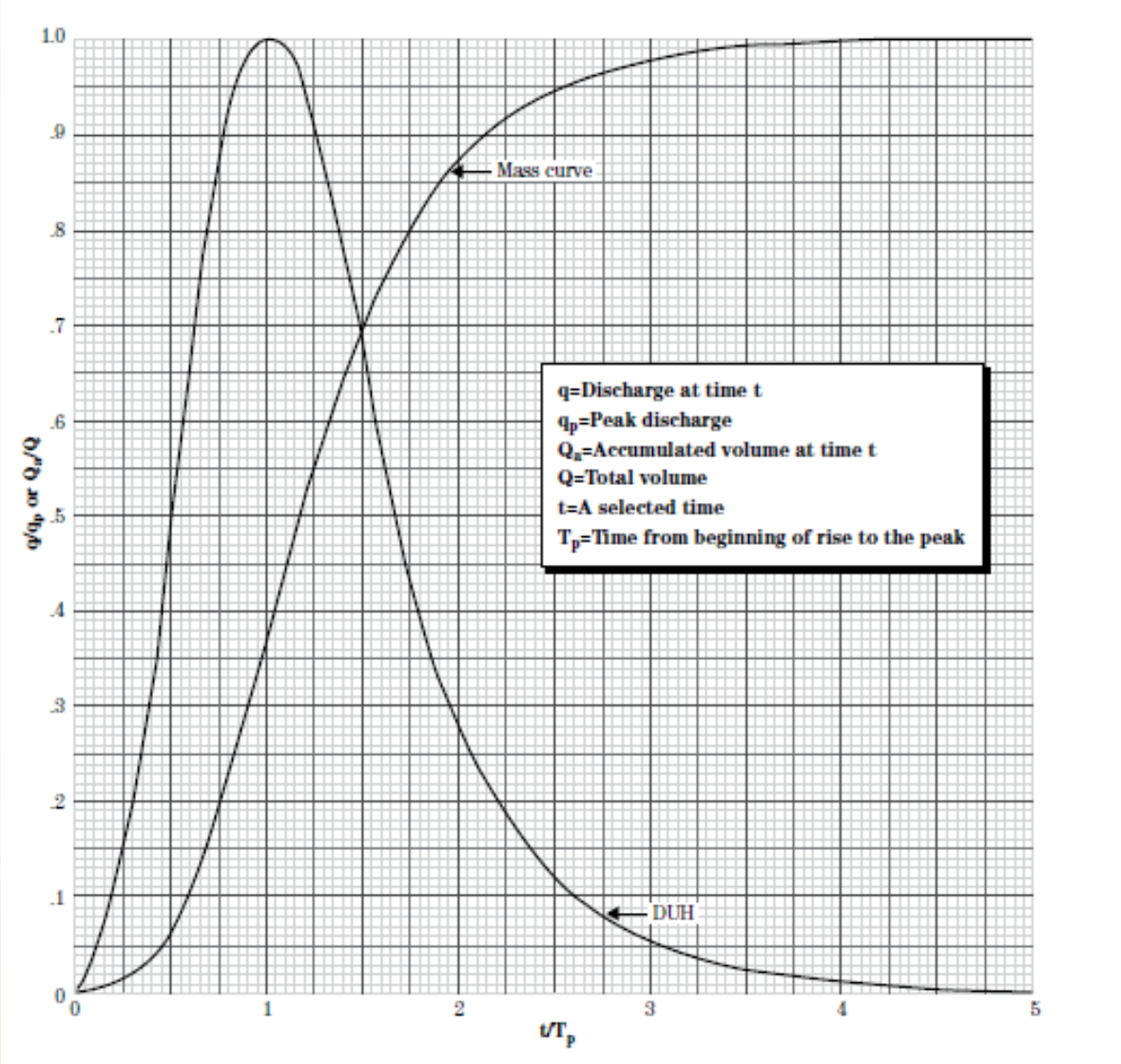
Inflows are calculated daily using NRCS methods and hydraulics equations

1. Determine precipitation excess using NRCS CN method
2. Determine time of concentration for stream watershed
3. Determine peak flow rate
4. Use NRCS dimensionless unit hydrograph to estimate stream hydrograph for the calculated runoff amount
5. Determine stream elevation using Manning's equation, assuming a trapezoidal stream channel
6. Compute flow rate into the wetland using hydraulics equations

Inflows are calculated daily using NRCS methods and hydraulics equations

1. Determine precipitation excess using NRCS CN method
2. Determine time of concentration for stream watershed
3. Determine peak flow rate
4. Use NRCS dimensionless unit hydrograph to estimate stream hydrograph for the calculated runoff amount
5. Determine stream elevation using Manning's equation, assuming a trapezoidal stream channel
6. Compute flow rate into the wetland using hydraulics equations

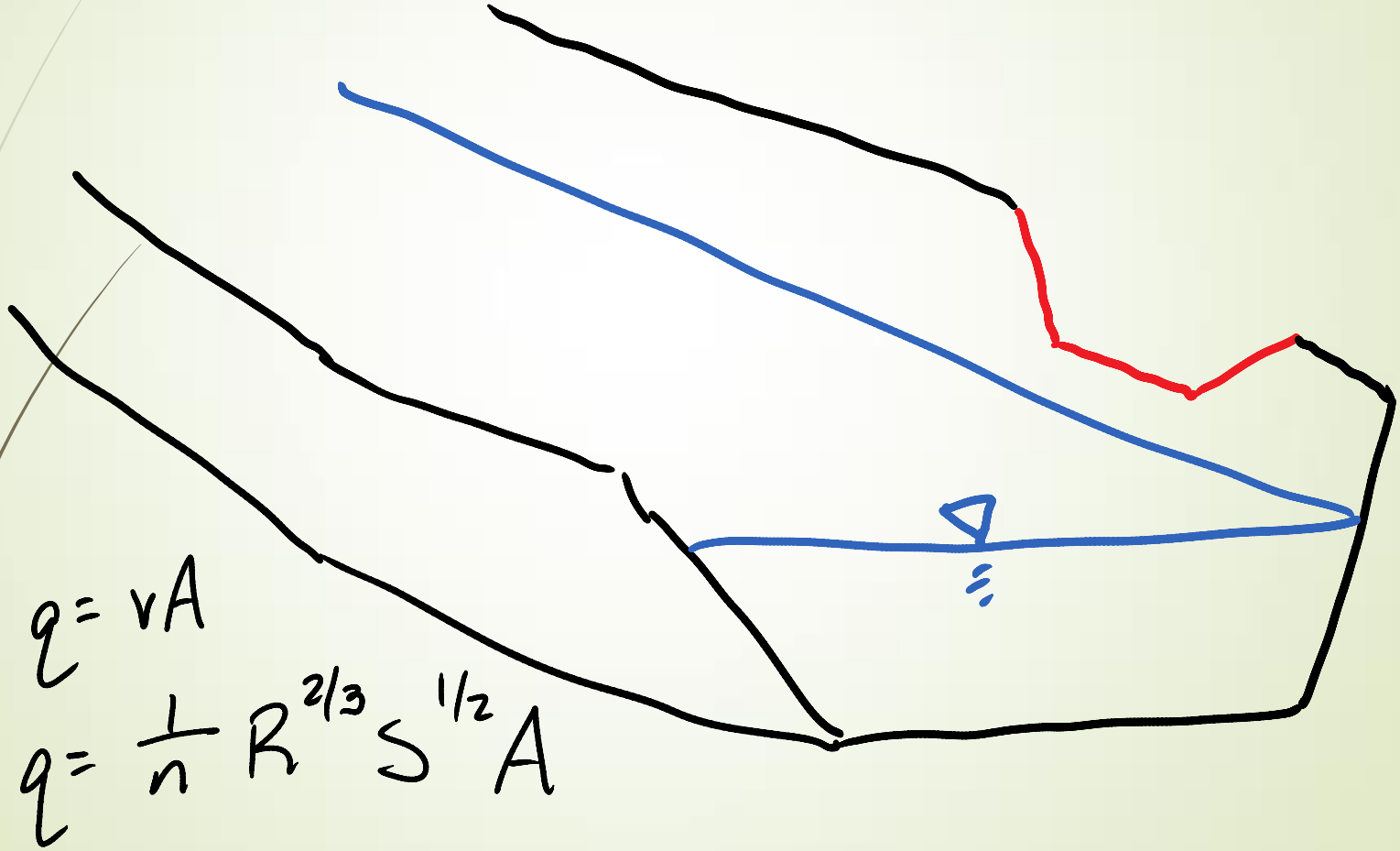
Stream discharge at any time is scaled by q_p and T_p



Inflows are calculated daily using NRCS methods and hydraulics equations

1. Determine precipitation excess using NRCS CN method
2. Determine time of concentration for stream watershed
3. Determine peak flow rate
4. Use NRCS dimensionless unit hydrograph to estimate stream hydrograph for the calculated runoff amount
5. Determine stream elevation using Manning's equation, assuming a trapezoidal stream channel
6. Compute flow rate into the wetland using hydraulics equations

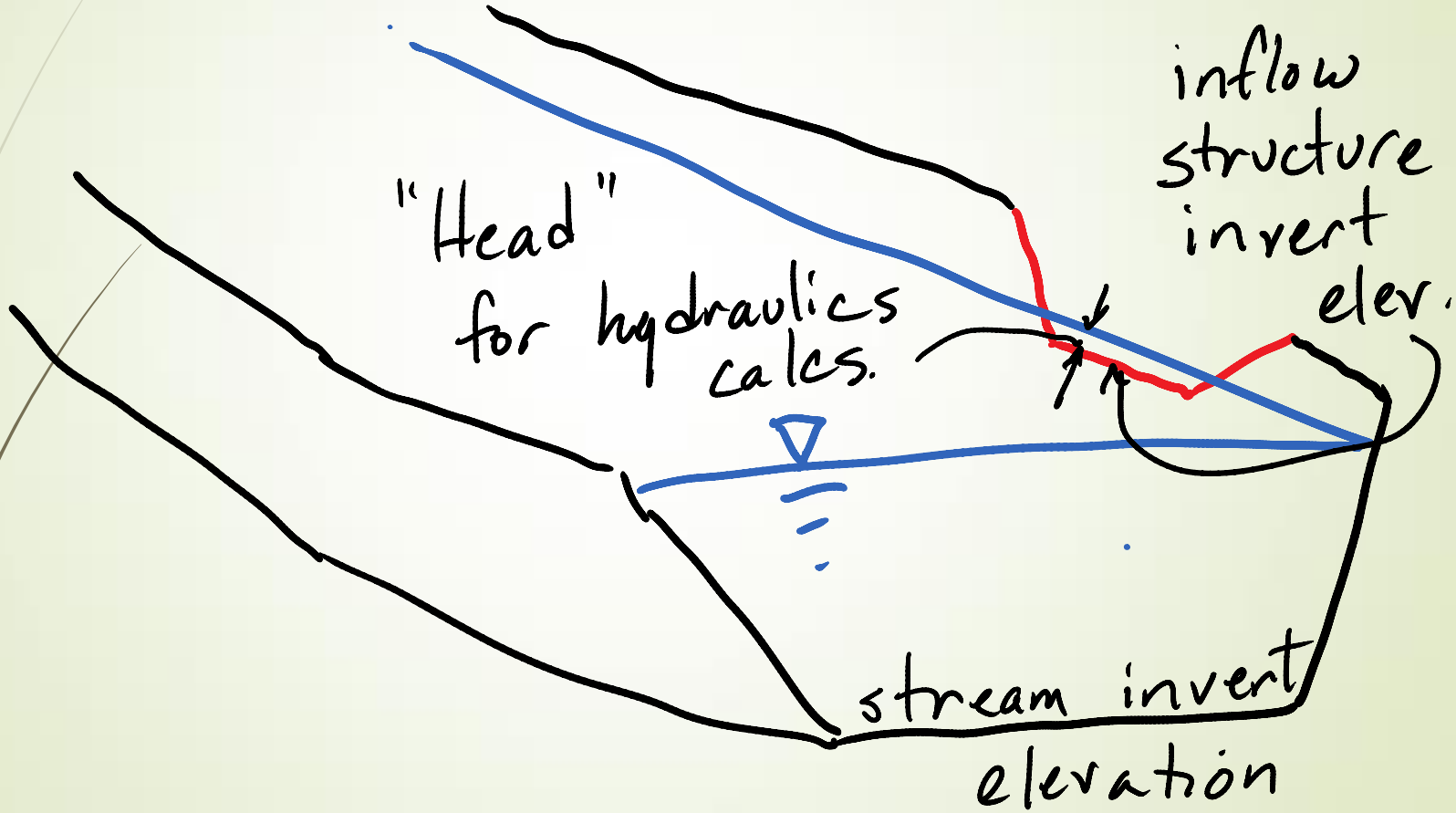
Given flow at each time step, calculate water depth in channel using Manning's equation



Inflows are calculated daily using NRCS methods and hydraulics equations

1. Determine precipitation excess using NRCS CN method
2. Determine time of concentration for stream watershed
3. Determine peak flow rate
4. Use NRCS dimensionless unit hydrograph to estimate stream hydrograph for the calculated runoff amount
5. Determine stream elevation using Manning's equation, assuming a trapezoidal stream channel
6. Compute flow rate into the wetland using hydraulics equations

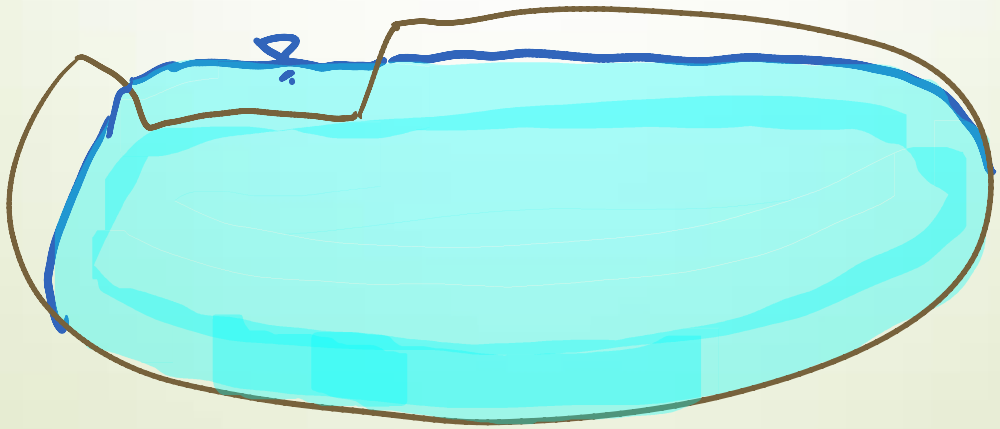
Assume inflow structure (in red on diagram) is a Cipolletti weir or a trapezoidal channel



Broad crested weirs coming soon to represent levees…

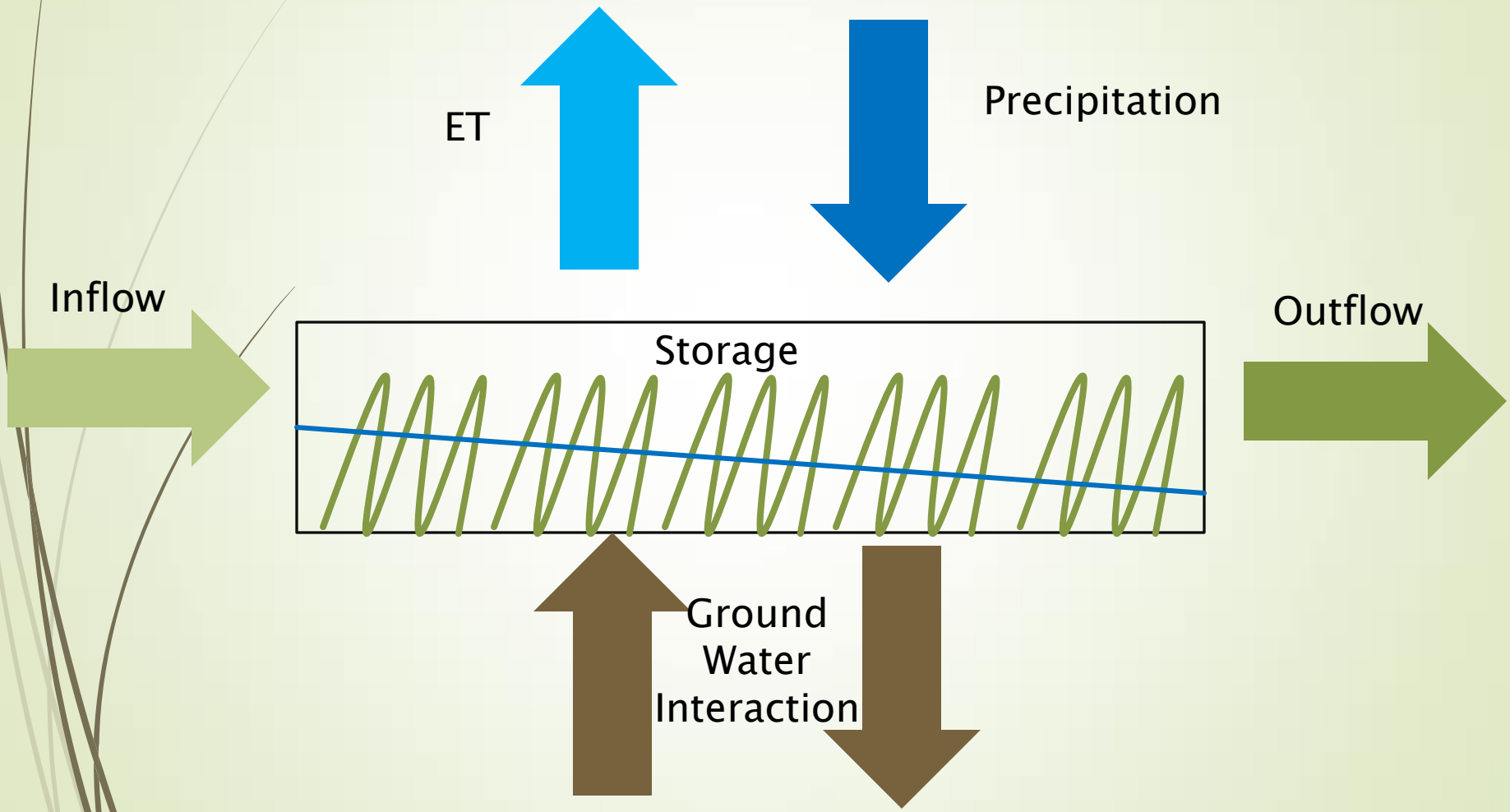
Outflows

- Evapotranspiration
  - Thornthwaite – Temperature and latitude
  - Penman – Solar radiation
- Vertical and horizontal seepage out of wetland
  - Rich's presentation
- Outflow through outlet structure (e.g. weir)
  - Calculate using hydraulics equations



What are the differences between the Basic and Advanced Models?

- Advanced model allows modeling of sloped wetlands, pools, etc.
- Basic model assumes wetland water surface is flat and automatically adjusts to any change in water volume
  - Outflow rates not calculated for Basic model
- Advanced model includes flow resistance due to wetland vegetation
  - Have a slope on water surface
  - Important for large wetlands
- Allows 2-way interaction between SW and GW, stream and wetland


ET
Precipitation
Inflow
Outflow
Storage
Ground
Water
Interaction

Soft Rush (*Juncus effusus*) were planted in a 1-m x 6-m flume


Questions?