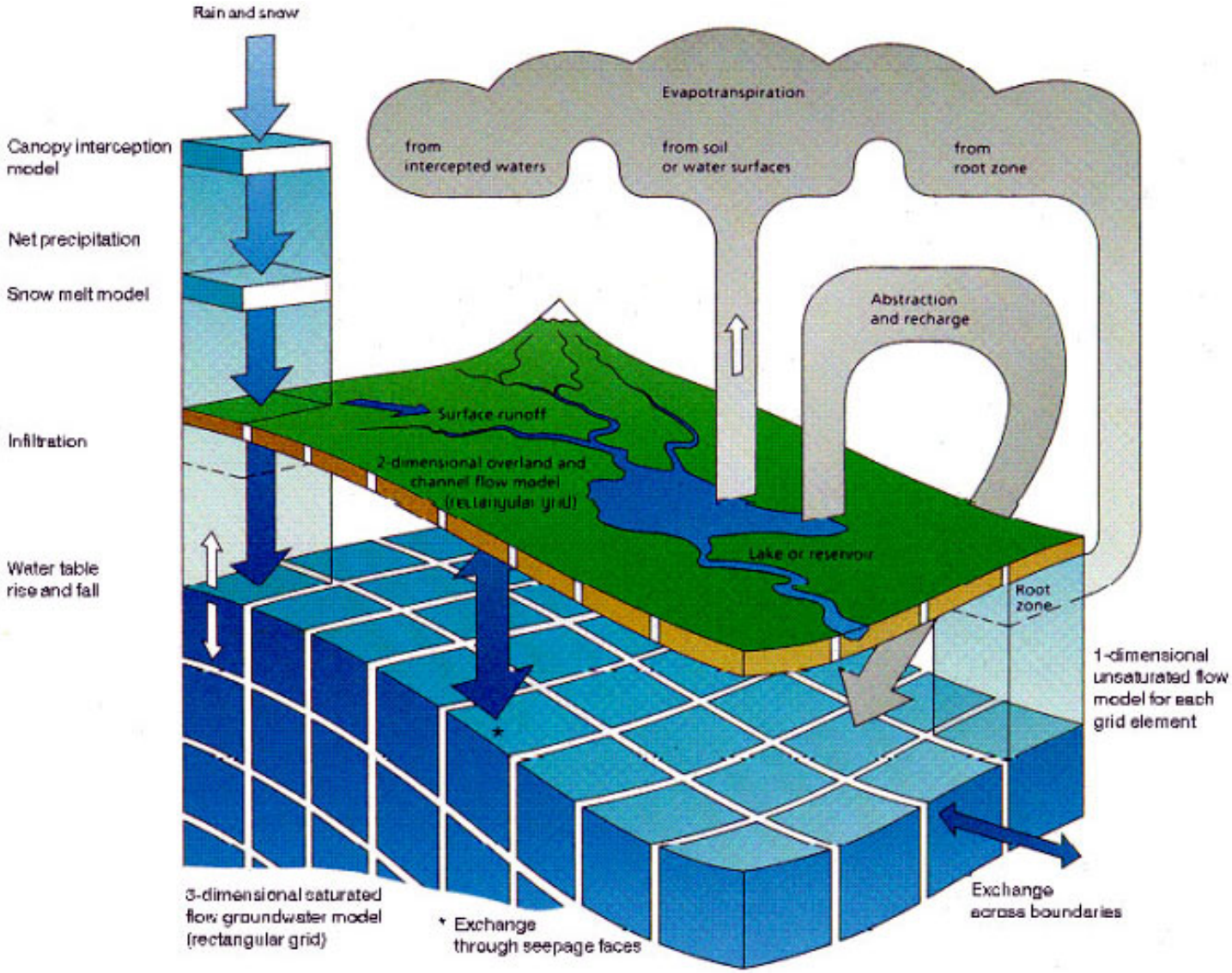
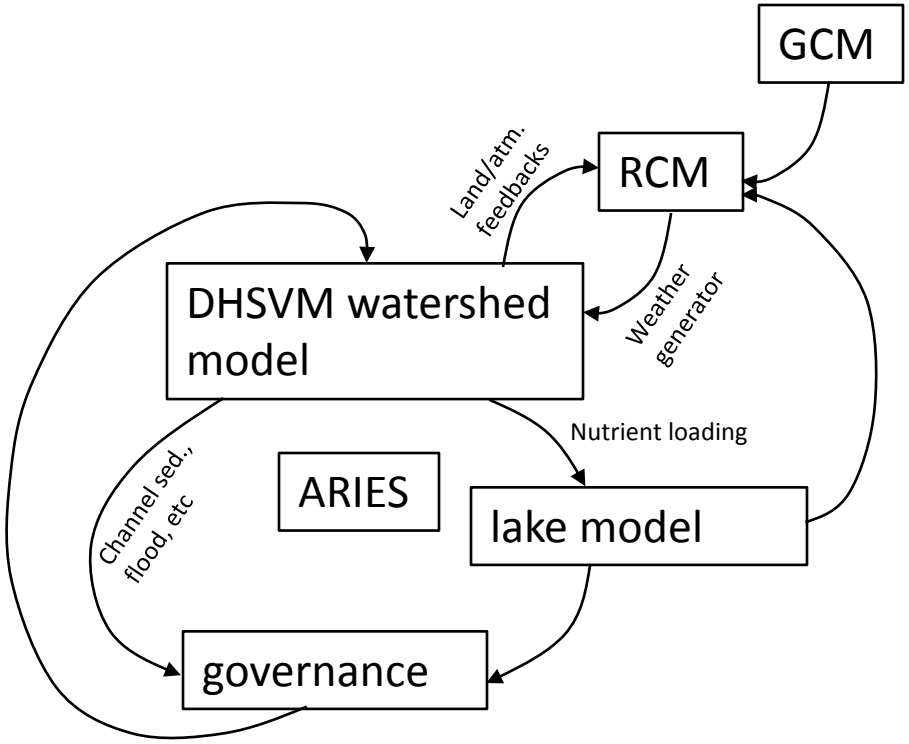
Q2: Understanding watersheds using computer models



Time frame of models: short-term (20-30 years) and long-term (100-200 years).

Geographic scope of models: Winooski and Missisquoi watersheds, divided into subwatersheds

Model time step: range from hourly to yearly for various processes

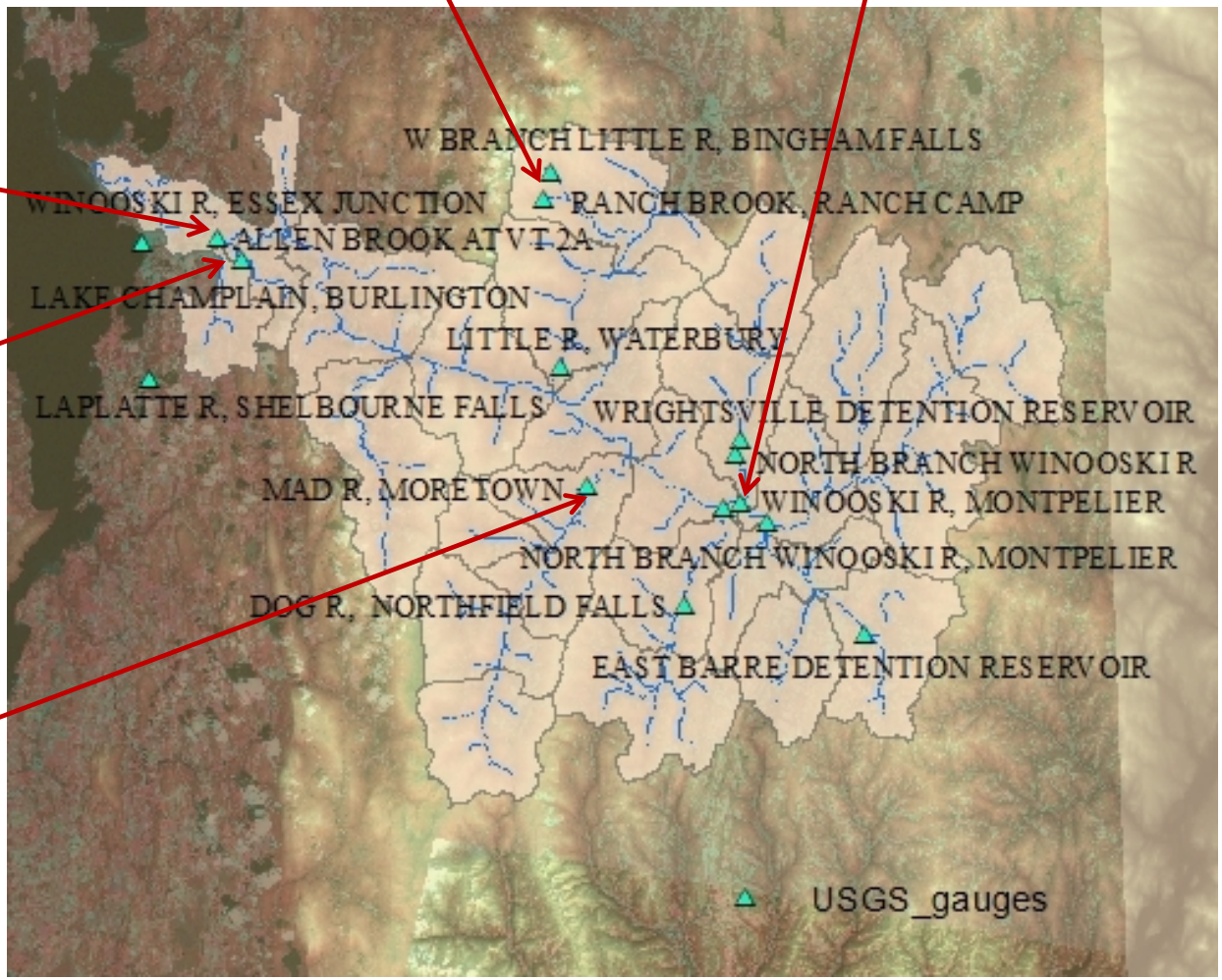


Ranch brook and W Branch Little River: Since 2000. Small, forested (Wemple)

Winooski at Montpelier: Since 1914
Influenced by dam; mostly forested

Winooski at Essex Jct:
Since 1928
Flow influenced by dam upstream

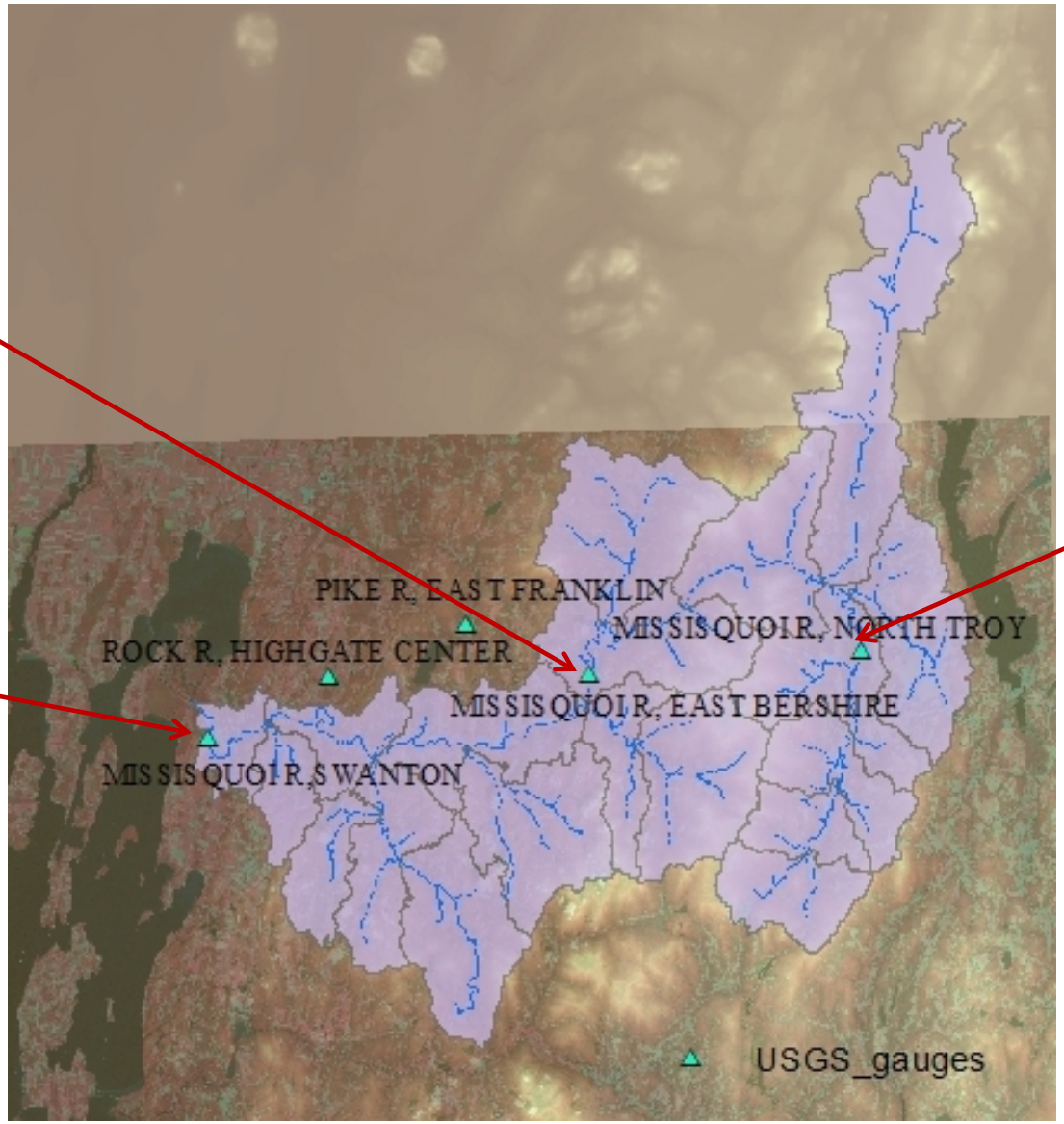
Allen Brook:
since 2005
Mostly urban, small



Mad River at Moretown:
since 1927
Mixed use; very typical of Winooski basin and similar to Huntington R. and Dog River.

Missisquoi River at East Berkshire: Since 1915 Mostly forested

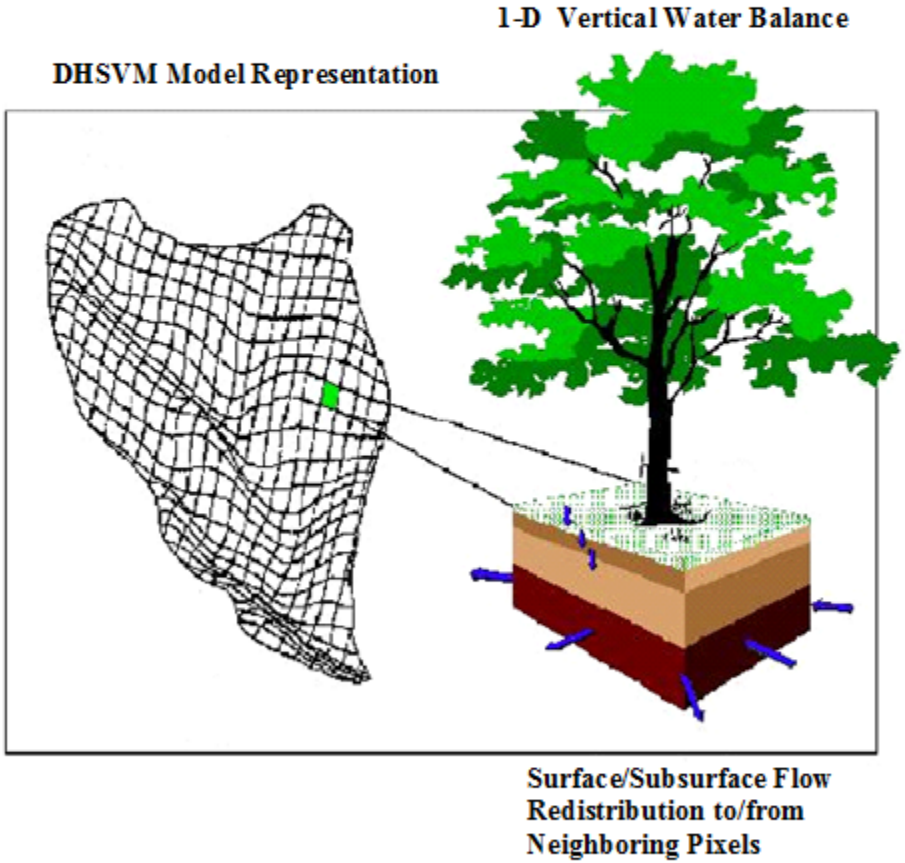
Missisquoi River at Swanton: Since 1990 Influenced by dam.



Missisquoi River at North Troy. Since 1931. Forested.

Model Selection:

Distributed hydrology-soil-vegetation model (DHSVM)



- Physically based hydrologic model that represents the effects of
  - Topography
  - Soil
  - Vegetation
- Solves the energy and water balance at each grid cell at each timestep

DHSVM

Water and Energy Balances

1-D Vertical Water Balance

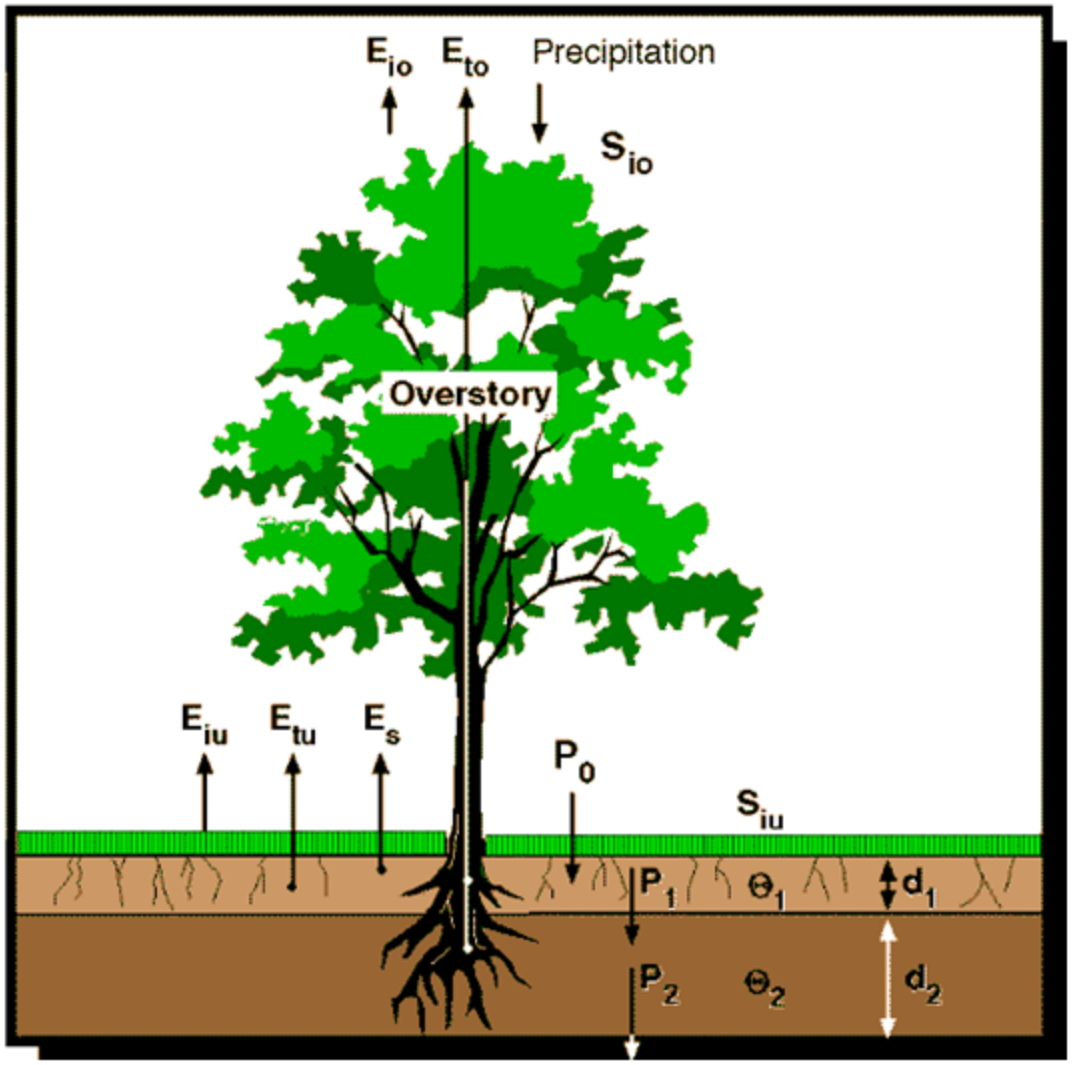
Evaporation (E)
- Interception (E_{io} E_{iu})
- Soil (E_s)

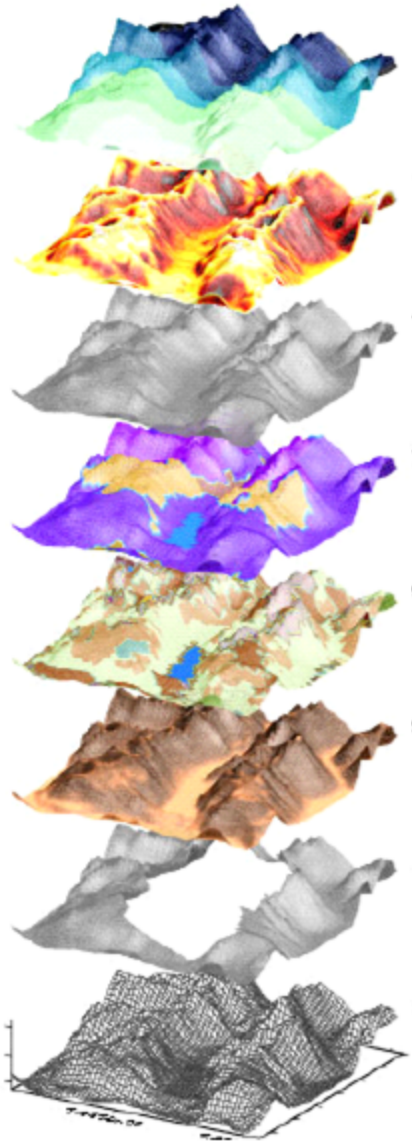
Transpiration
- Overstory (E_{to})
- Understory (E_{tu})

Storage (S)
- Overstory (S_{io})
- Understory (S_{iu})
- Soil layer 1 ($\theta_1 d_1$)
- Soil layer 2 ($\theta_2 d_2$)

Rooting Zones

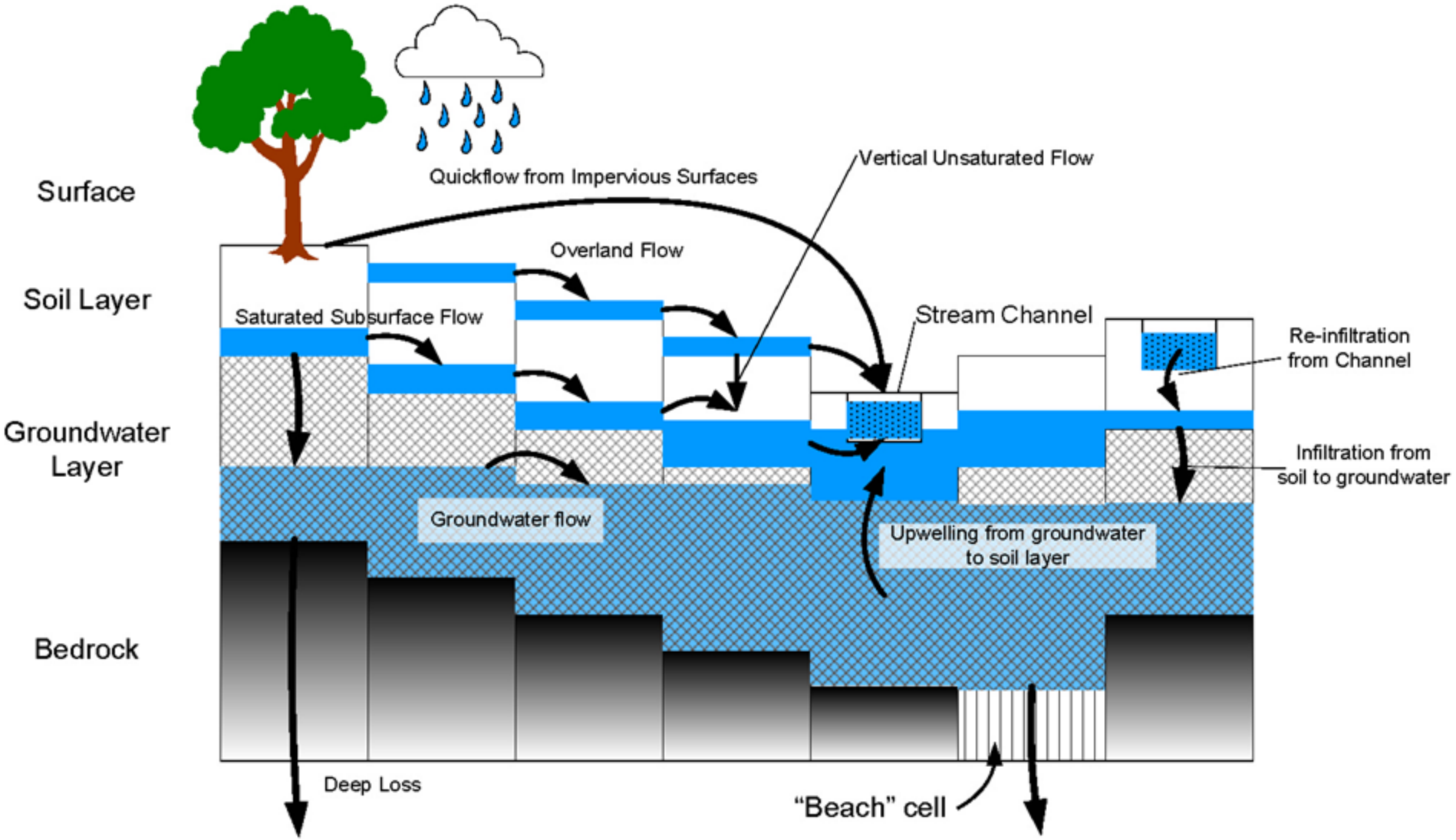
$S_s = \Theta_1 d_1 + \Theta_2 d_2$





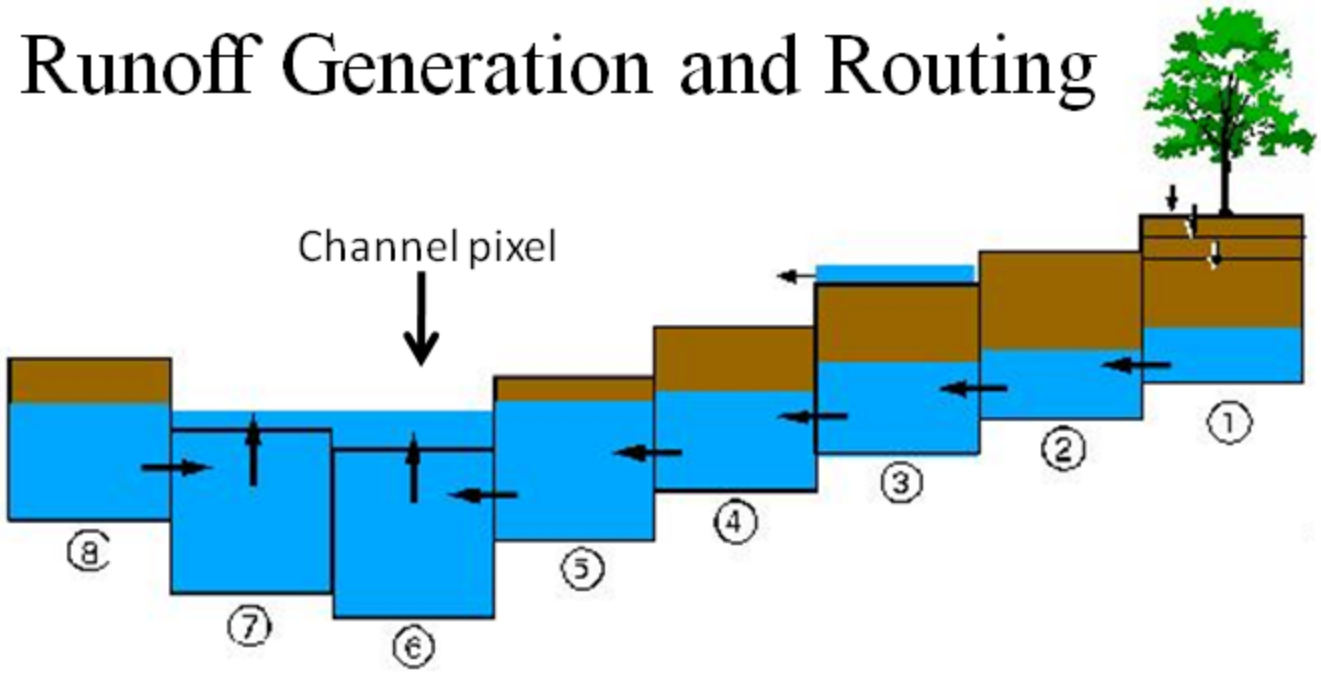
DHSVM

DHSVM Processes - water movement



DHSVM

Runoff Generation and Routing



- Surface runoff is produced via saturation excess (6 and 7) and infiltration excess (3) based on a user-specified static maximum infiltration capacity (pixel 3)

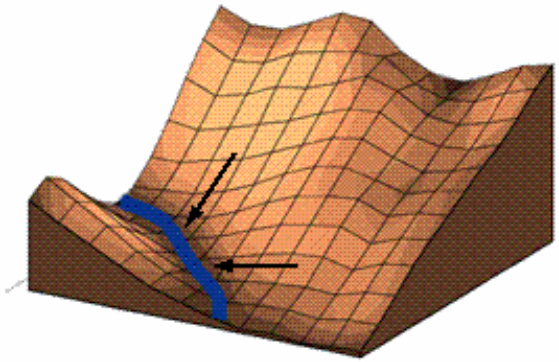
- Table depth computation based on : percolation, reinfiltration of incoming surface runoff (4 and 6), incoming saturated and unsaturated flow from uphill pixels

- Surface, saturated and unsaturated subsurface flows routed to downslope neighbors one pixel (150m)/time step (1 hour)

- Channel network segments (6): intercept subsurface flow, intercept all surface flow, route water between segments using linear reservoir scheme

DHSVM

Sediment Routing



Hillslope Sediment Routing

Hillslope:

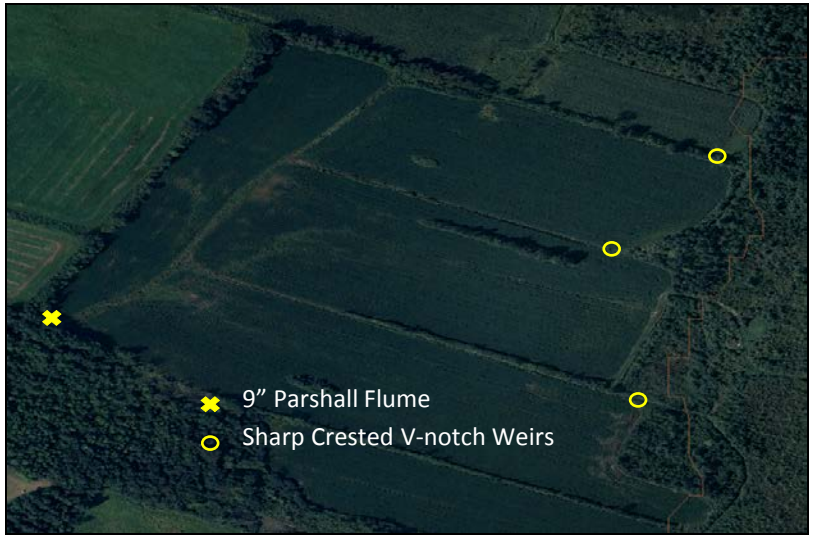
- If a pixel contains a channel (including road-side ditches), all sediment enters the channel.

Road surface sediment:

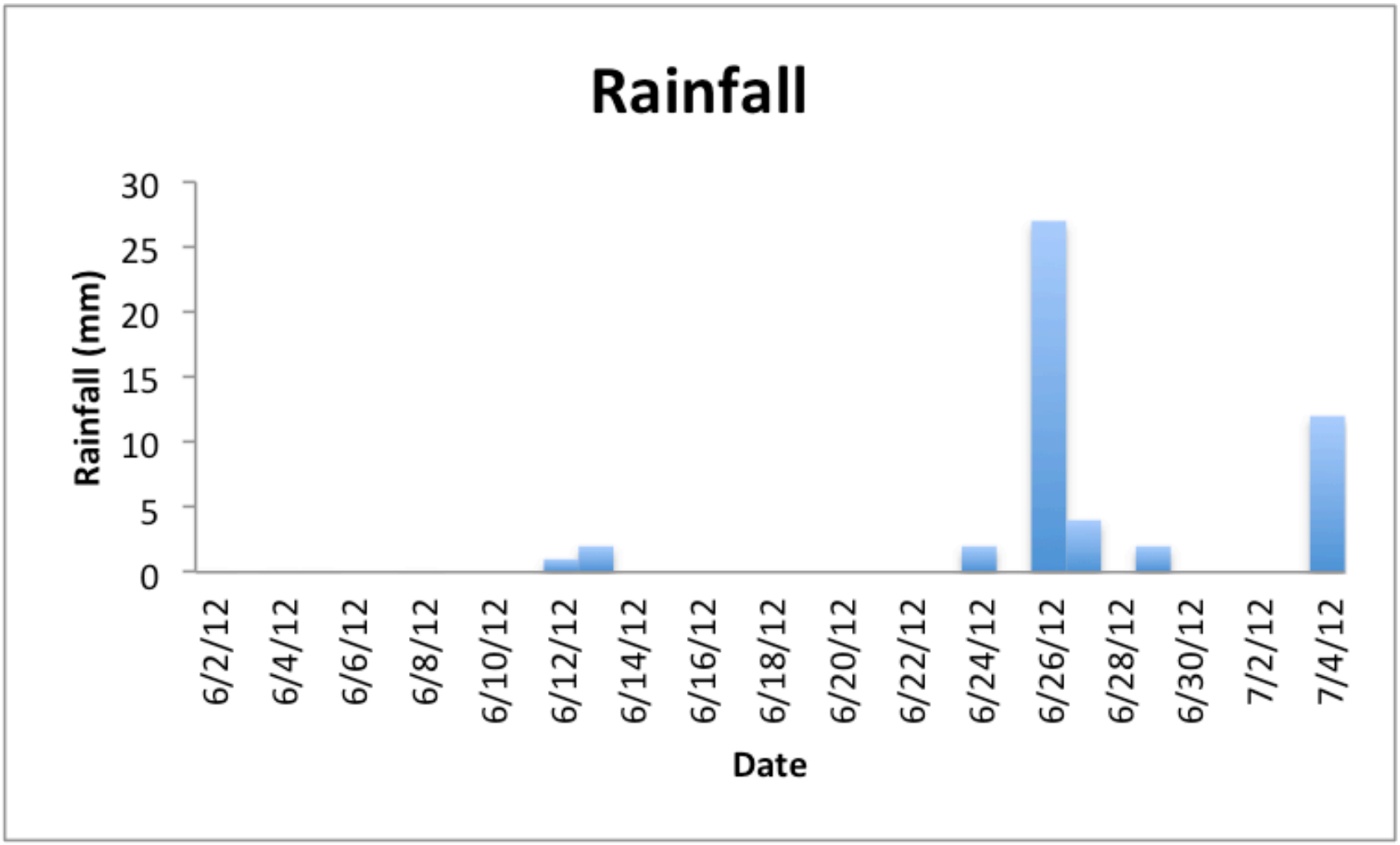
- Routed according to the crown type.
- Added to the road-side ditch is routed through the network to a culvert.
- Delivery from culvert to stream based on proximity and particle size:

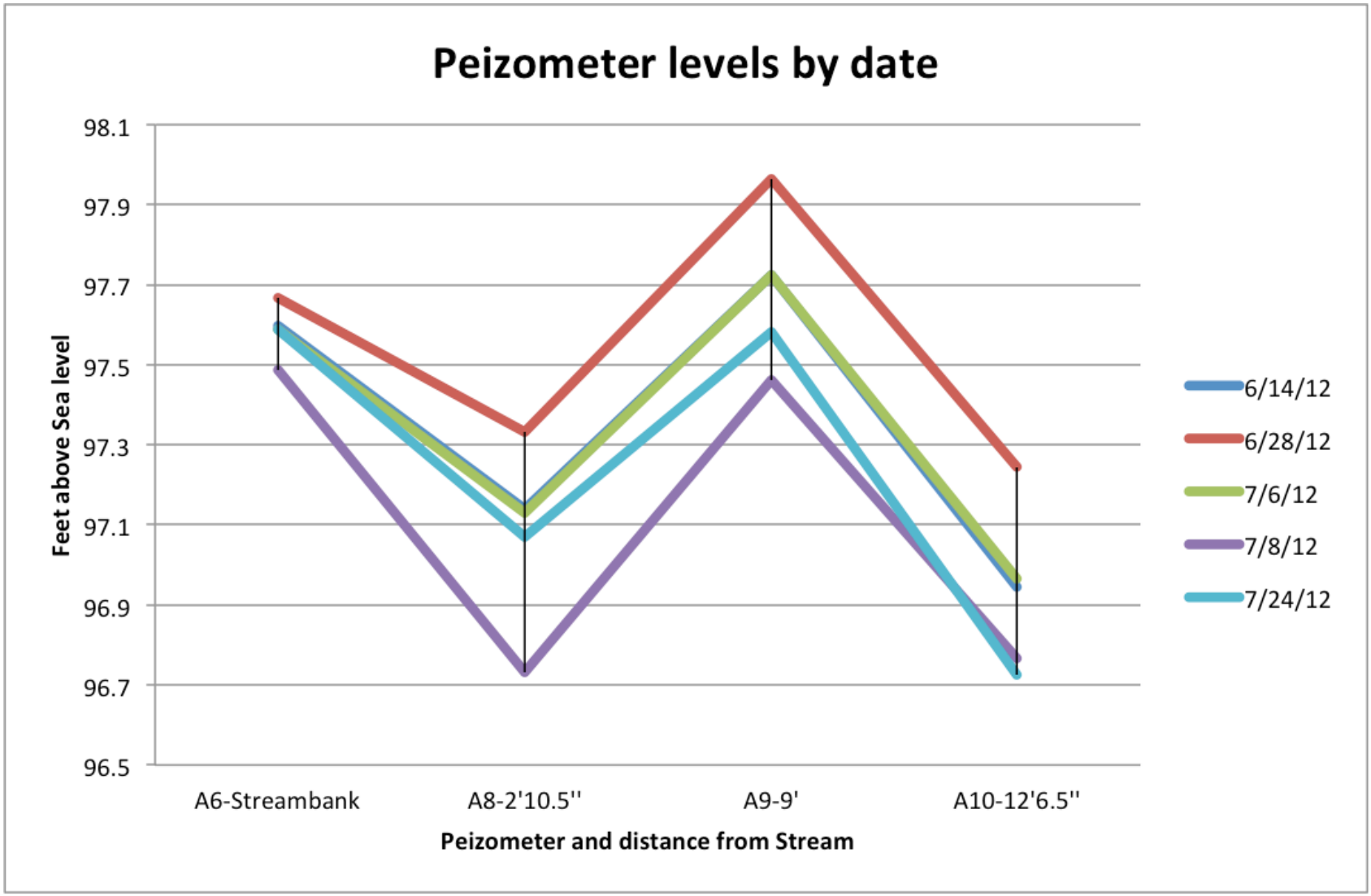
Particle Size, mm	Percent Delivered
0.5-2	10
0.63-0.5	30
≤0.63	100

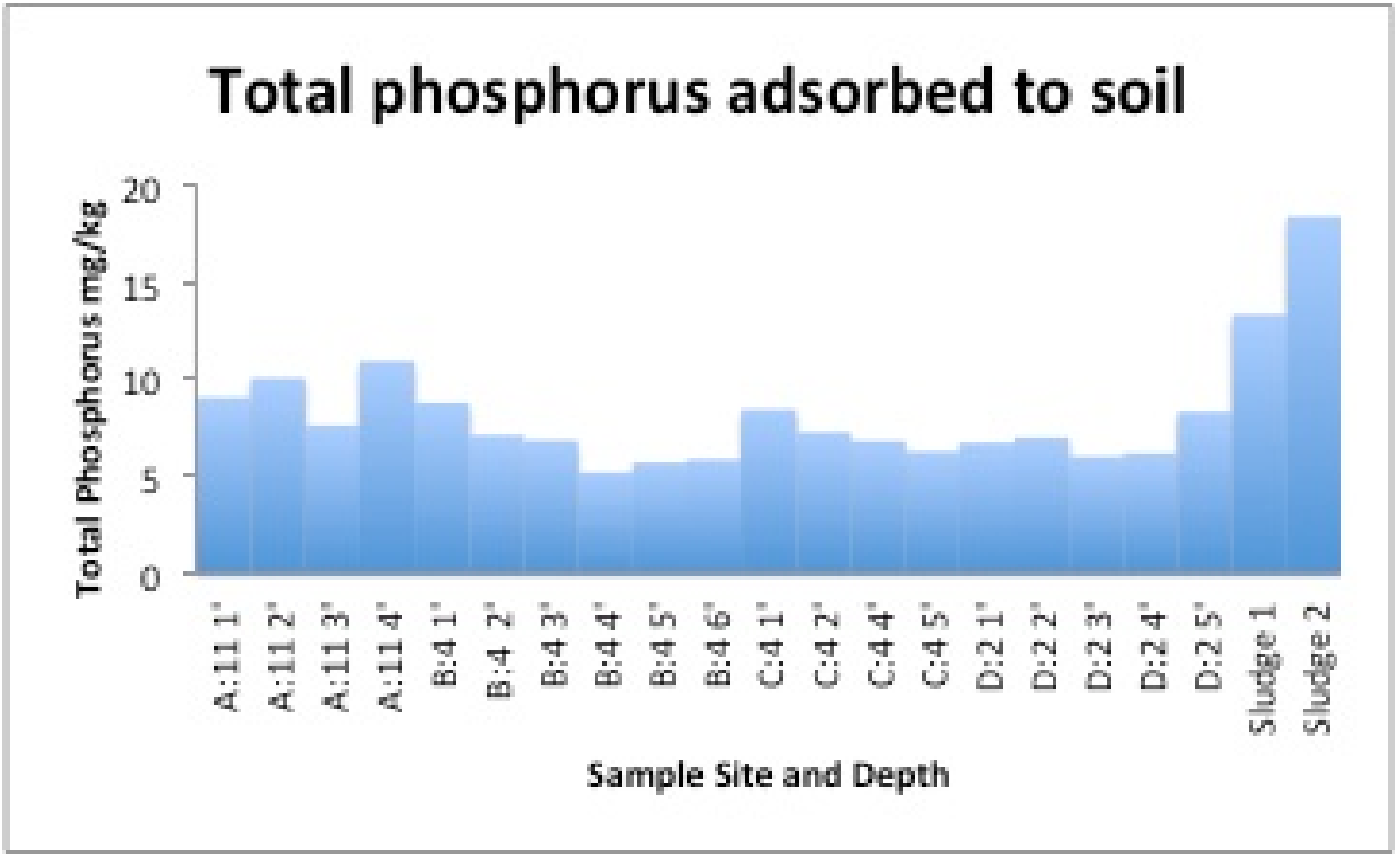

To Lake
Champlain


9” Parshall Flume
Sharp Crested V-notch Weirs


North Transect
A:1-A:5
South Transect
A:6-A:11
1
2
3
4
5
6
7
8
11
9
10


Rainfall
Rainfall (mm)
30
25
20
15
10
5
0
6/2/12
6/4/12
6/6/12
6/8/12
6/10/12
6/12/12
6/14/12
6/16/12
6/18/12
6/20/12
6/22/12
6/24/12
6/26/12
6/28/12
6/30/12
7/2/12
7/4/12
Date


Peizometer levels by date
98.1
97.9
97.7
97.5
97.3
97.1
96.9
96.7
96.5
Feet above Sea level
A6-Streambank
A8-2'10.5''
A9-9'
A10-12'6.5''
Peizometer and distance from Stream
6/14/12
6/28/12
7/6/12
7/8/12
7/24/12


Total phosphorus adsorbed to soil
Total Phosphorus mg/kg
20
15
10
5
0
A:11 1"
A:11 2"
A:11 3"
A:11 4"
B:4 1"
B:4 2"
B:4 3"
B:4 4"
B:4 5"
B:4 6"
C:4 1"
C:4 2"
C:4 4"
C:4 5"
D:2 1"
D:2 2"
D:2 3"
D:2 4"
D:2 5"
Sludge 1
Sludge 2
Sample Site and Depth