Watershed Sediment Model

Watershed Hydrological Analysis Team

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Primary Focus Areas

- **Support for "Save Our Water" -** ***Artesian Broad Run Well*:**
  - Base Flow monitoring (depth gages/conductivity)
  - Understand sources of water into BR stream (SL, Cockeysville, etc.)
  - Develop high precision/accuracy models to assess impact of production well:
  - Maintain relationship with DRBC
- **Support White Clay Creek Watershed Monitoring:**
  - Support monitoring *(Mayfly system)*
  - Developed Watershed Rain Event RunOff analysis tool
  - Support Broad Run – Somerset Lake Program *(reduce sediment from BR):*
- **Support "Delaware River Basin Sensor Program":**
  - Data analysis *(gage curves/sediment/, etc.)*
  - Model development to support needs *(eg. Bartram Tidal flow/RunOff flow model)*

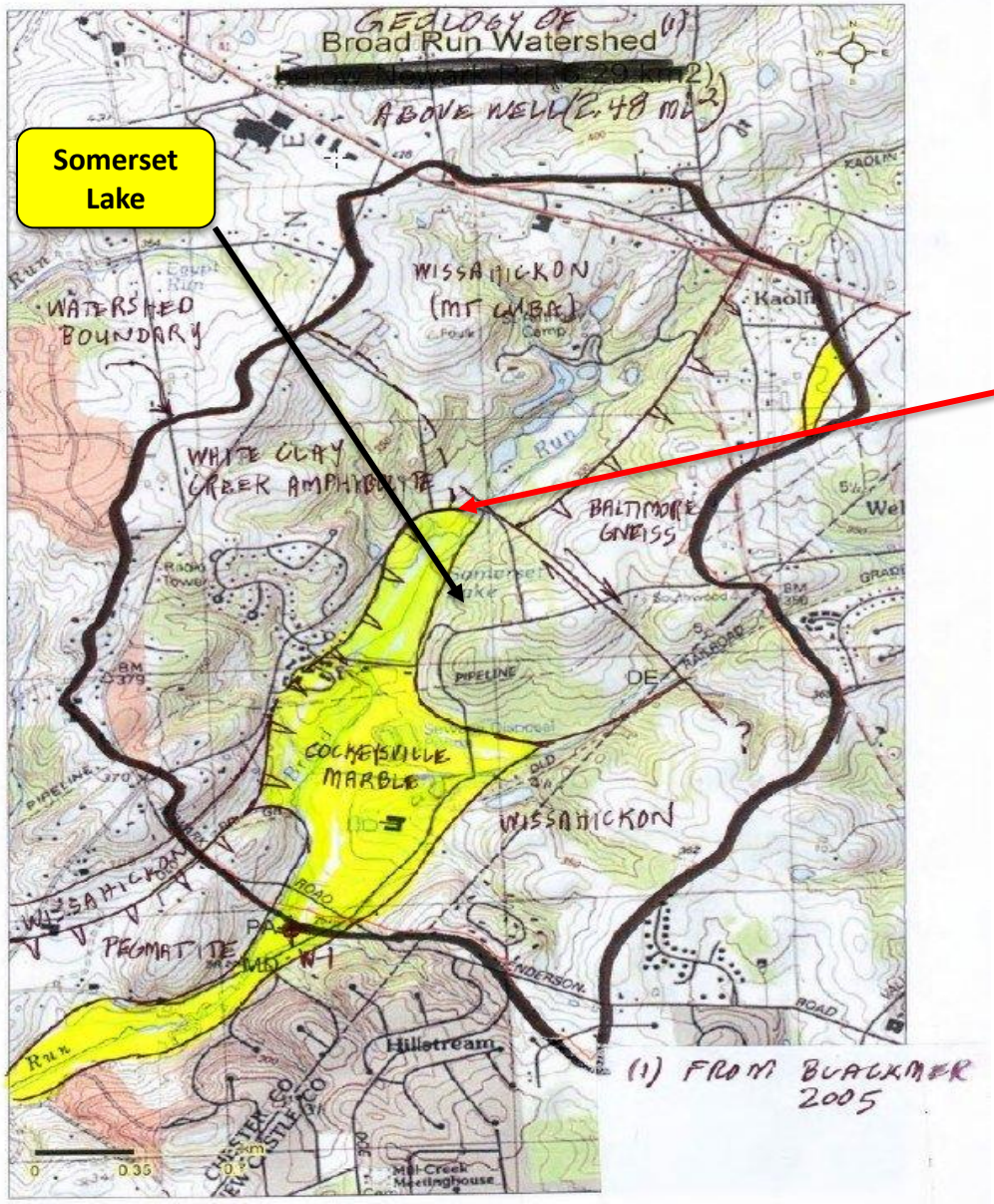
WHAT Technology Tool Kit

- **Modeling Stream Flow:**
  - Daily Base Flow/RunOff Water Balance Models
  - Real-time 5 min. - 1 hr. RunOff Models
  - Base Flow Correlation with nearby USGS Streams or other Gaged Streams
  - Gage/Flow Correlation Analysis
  - Cockeysville Aquifer Water Balance Model:
  - Rain Event CN RunOff Model:

- **Sensor Data Analysis:**
  - Using Conductivity to determine % Cockeysville flow into Broad Run
  - Turbidity - TSS: *Sediment Stream Loading Correlation vs. RunOff Intensity*
    Multiple Watershed Generalize Sediment Loading Correlation
  - Low cost sensor development: IR / Sonic / Turbidity

- **Linear and non-linear Multi-variable Analysis:**

Broad Run Watershed



BRUNHOUSE REPORT REVIEW EXHIBIT 5

Size: Above Lake - ~0.727 sq. mi.

Issue: **Heavy Sediment Loading**
Expensive Dredging needed

Primary Objectives:

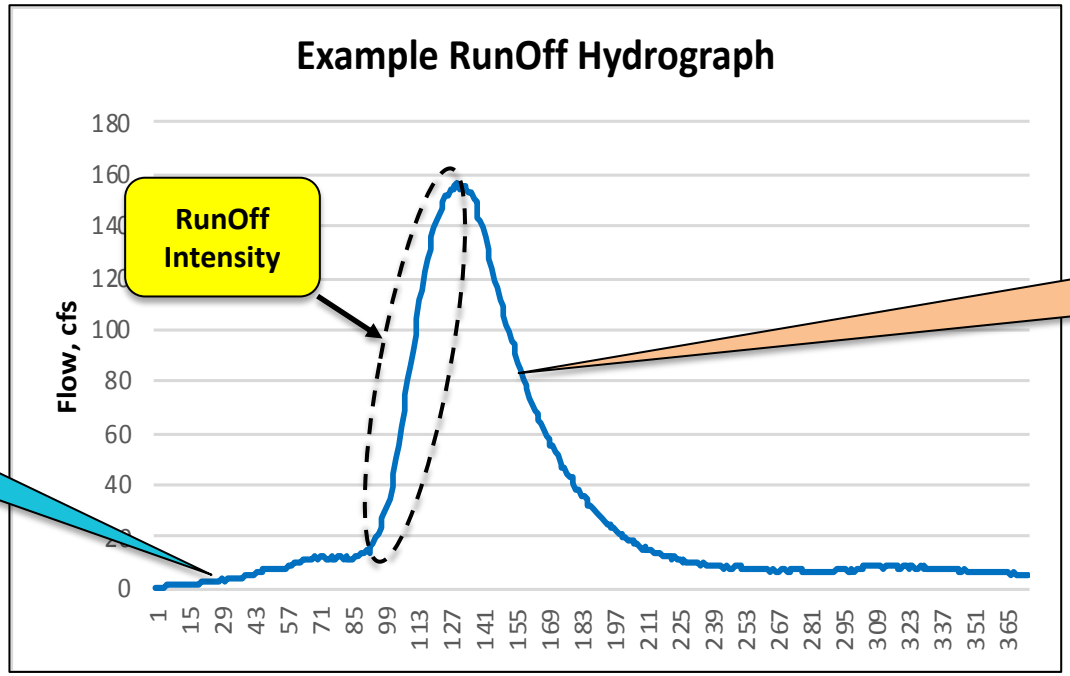
- Quantify Sediment from stream
- Characterize current state
- Develop model to detect changes
- Work w/ SL and NGT to minimize

Watershed Sediment RunOff

Complex and influenced by many variables

Options to Correlate Erosion?

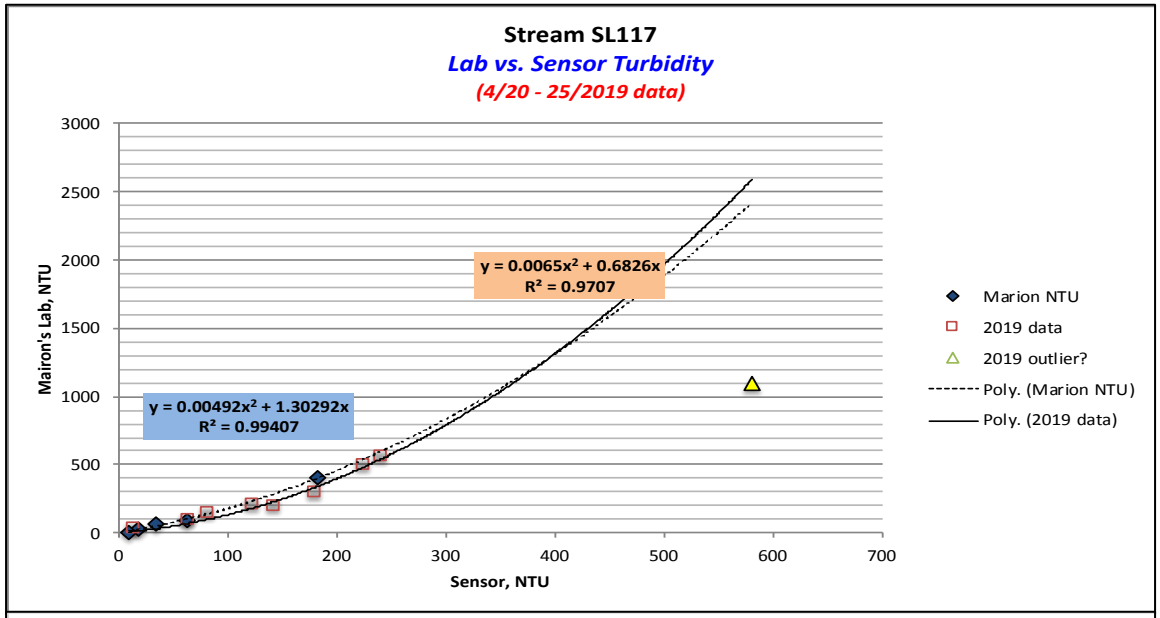
RO rate and Surface RunOff are critical variables

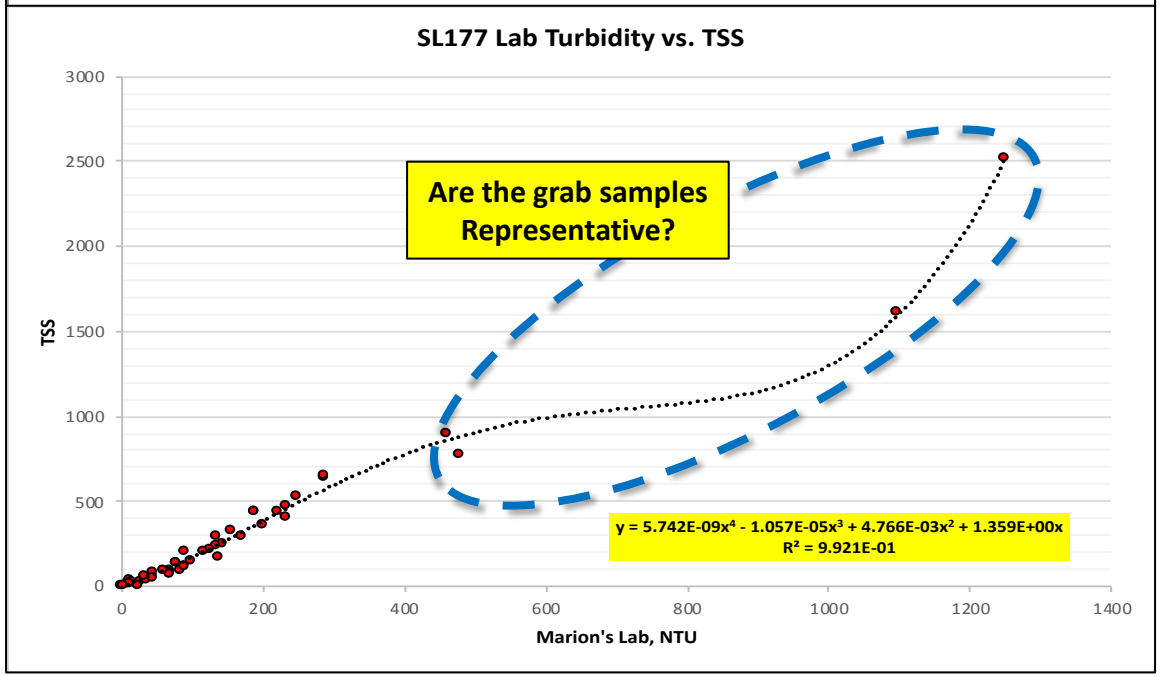


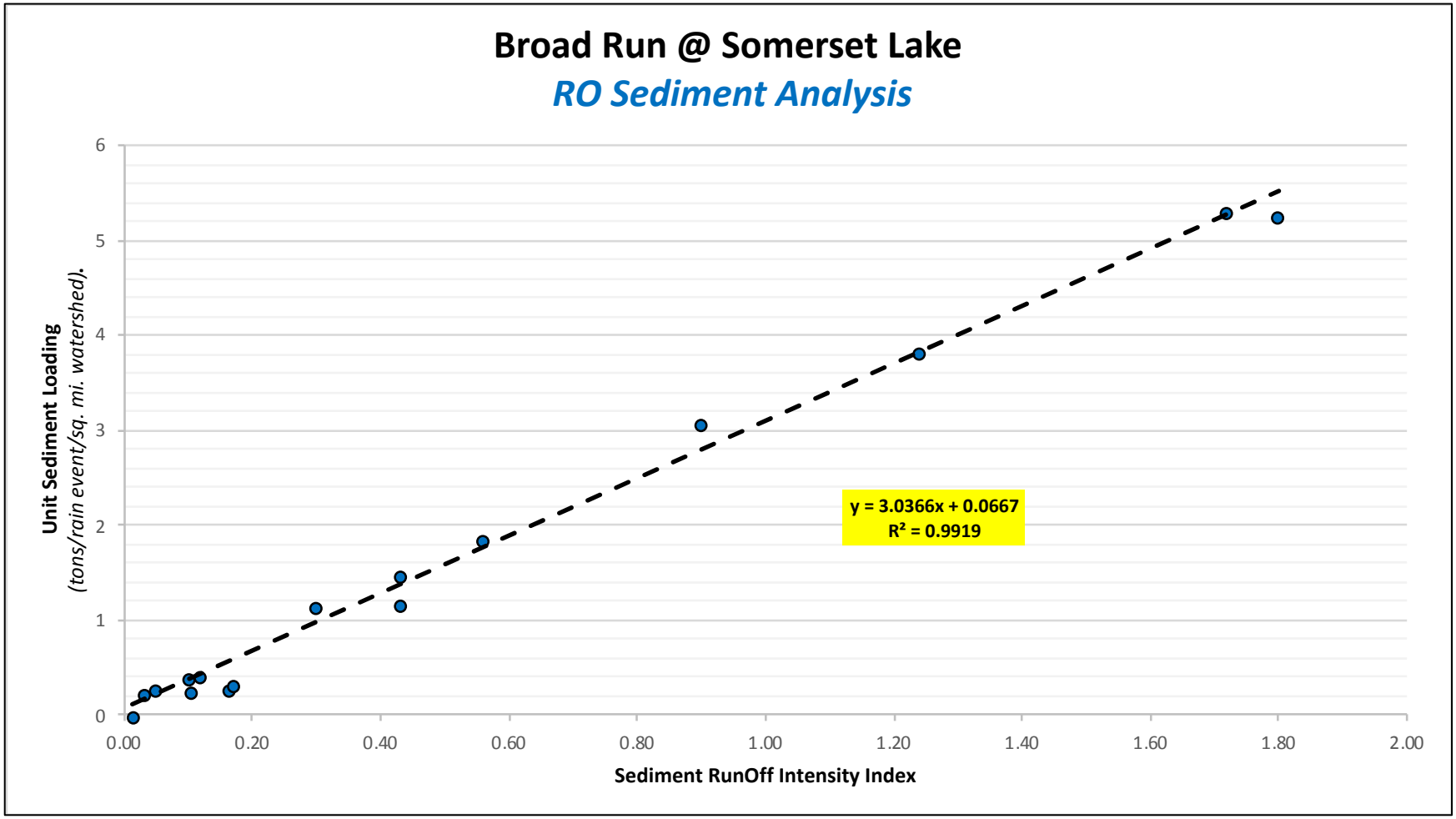
Sediment RunOff Intensity Index

(SROI)

ROI * CSRO

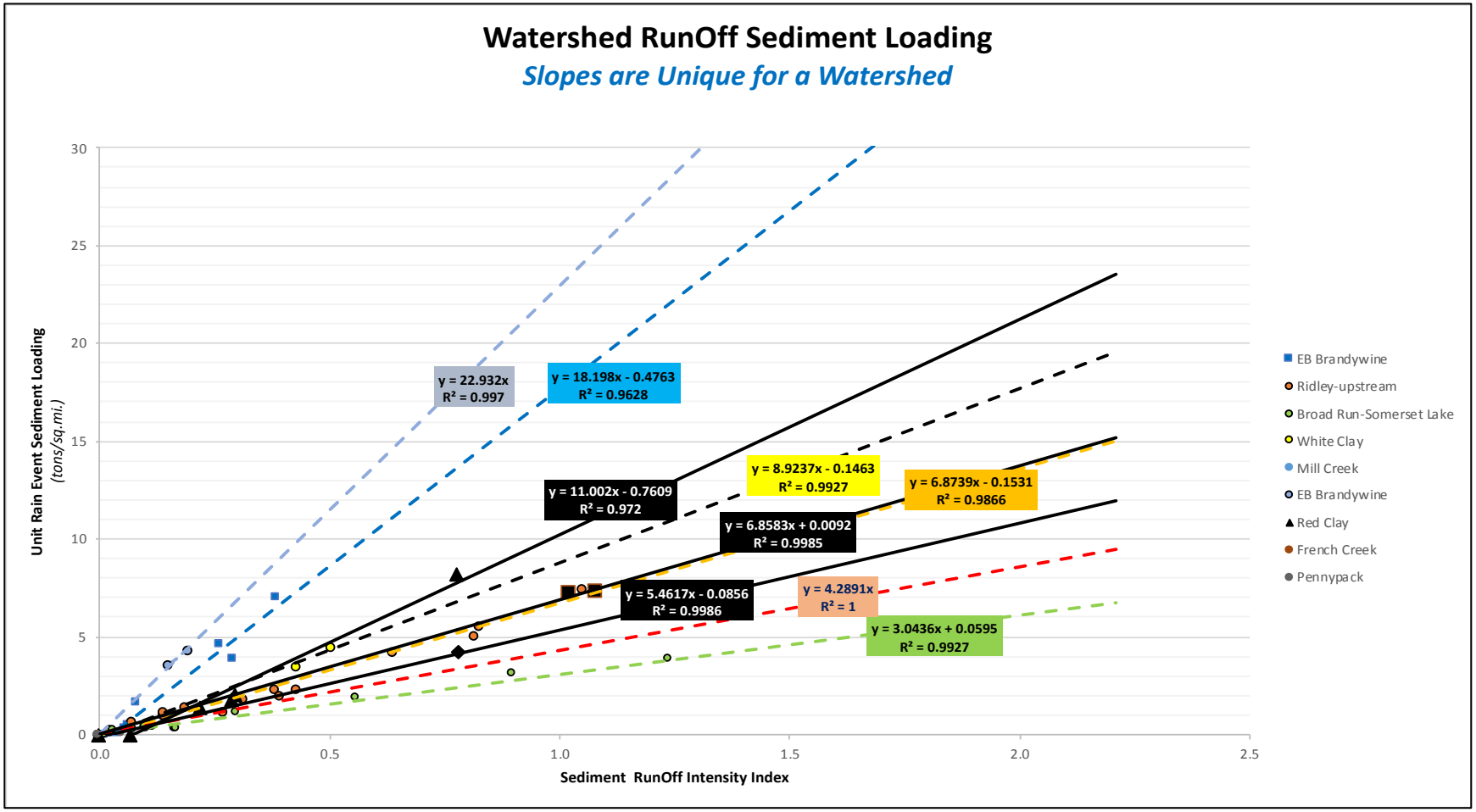

Stream SL117
Lab vs. Sensor Turbidity
(4/20 - 25/2019 data)
Mairon's Lab, NTU
Sensor, NTU
y = 0.0065x² + 0.6826x
R² = 0.9707
y = 0.00492x² + 1.30292x
R² = 0.99407
Marion NTU
2019 data
2019 outlier?
Poly. (Marion NTU)
Poly. (2019 data)


SL177 Lab Turbidity vs. TSS
TSS
Marion's Lab, NTU
Are the grab samples Representative?
y = 5.742E-09x⁴ - 1.057E-05x³ + 4.766E-03x² + 1.359E+00x
R² = 9.921E-01


Broad Run @ Somerset Lake
RO Sediment Analysis
Unit Sediment Loading
(tons/rain event/sq. mi. watershed).
Sediment RunOff Intensity Index
y = 3.0366x + 0.0667
R² = 0.9919
0
1
2
3
4
5
6
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00

Sediment RunOff Intensity Index

Applicable to other Watersheds



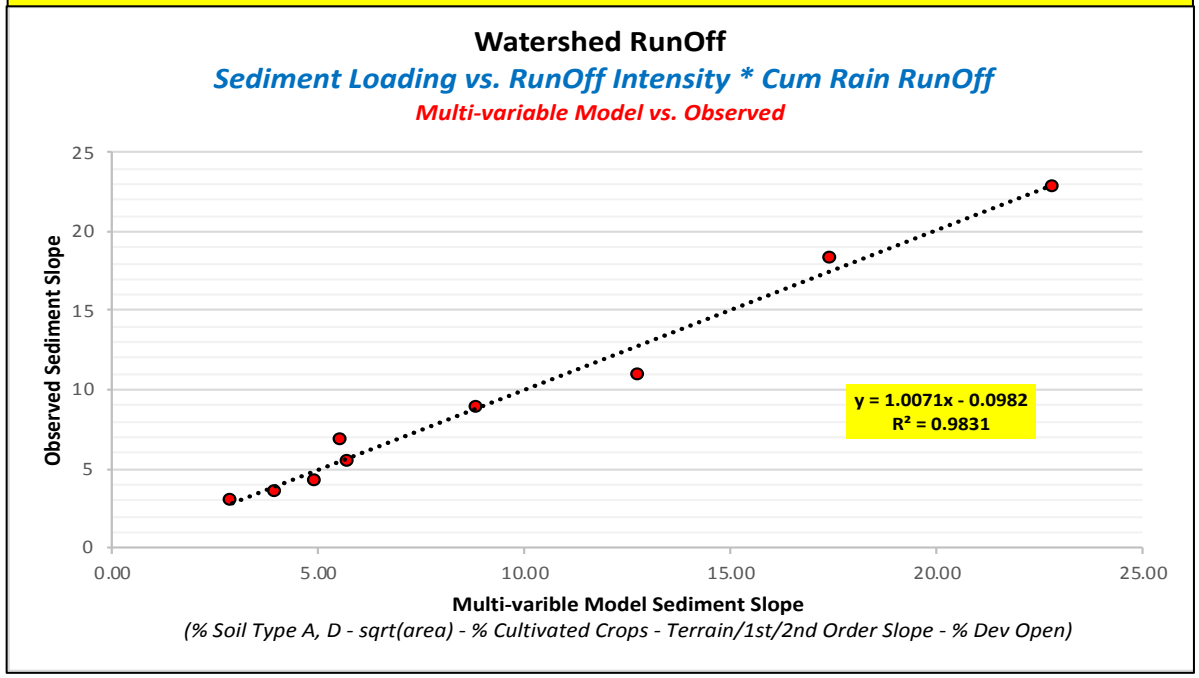
Watershed Unit Sediment Loading Slope

Correlated to Watershed Characteristics

Key Variables:

Sqrt(drainage area)
Terrain Slope
1st & 2nd Order Stream Slope
% Soil Type A & D
% Cultivated Crops

(from Wiki-Watershed)



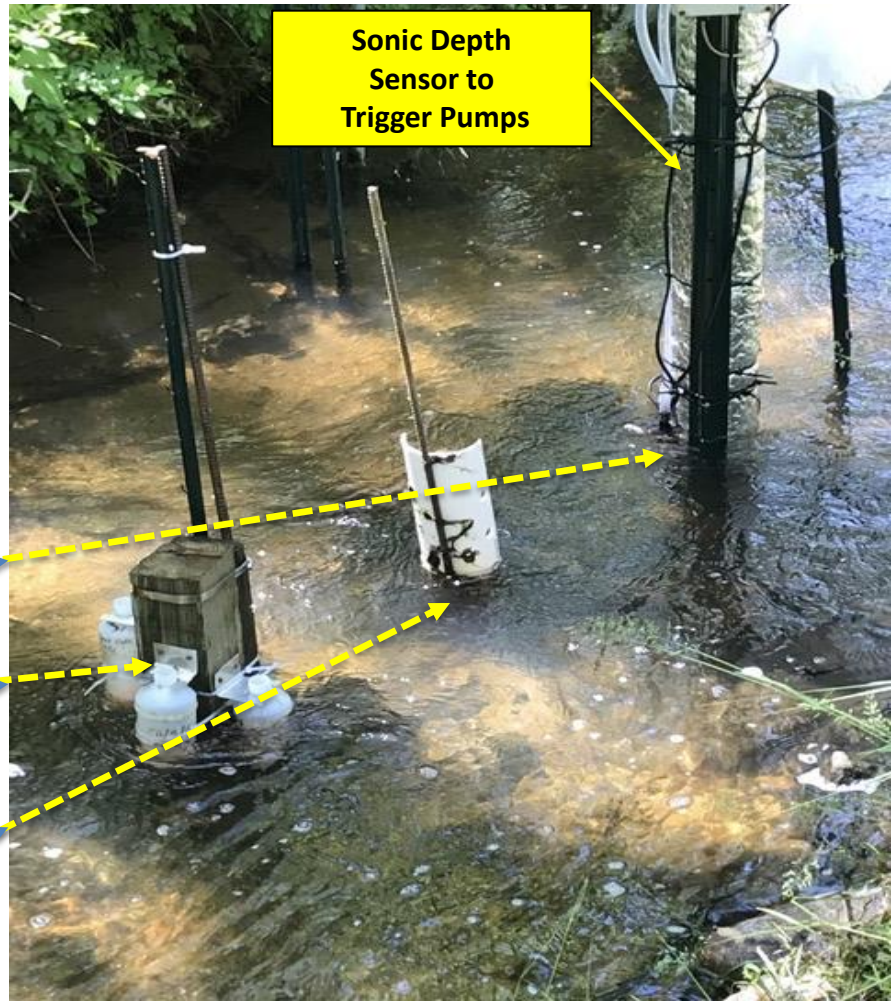
What if Turbidity Data is Compromised?

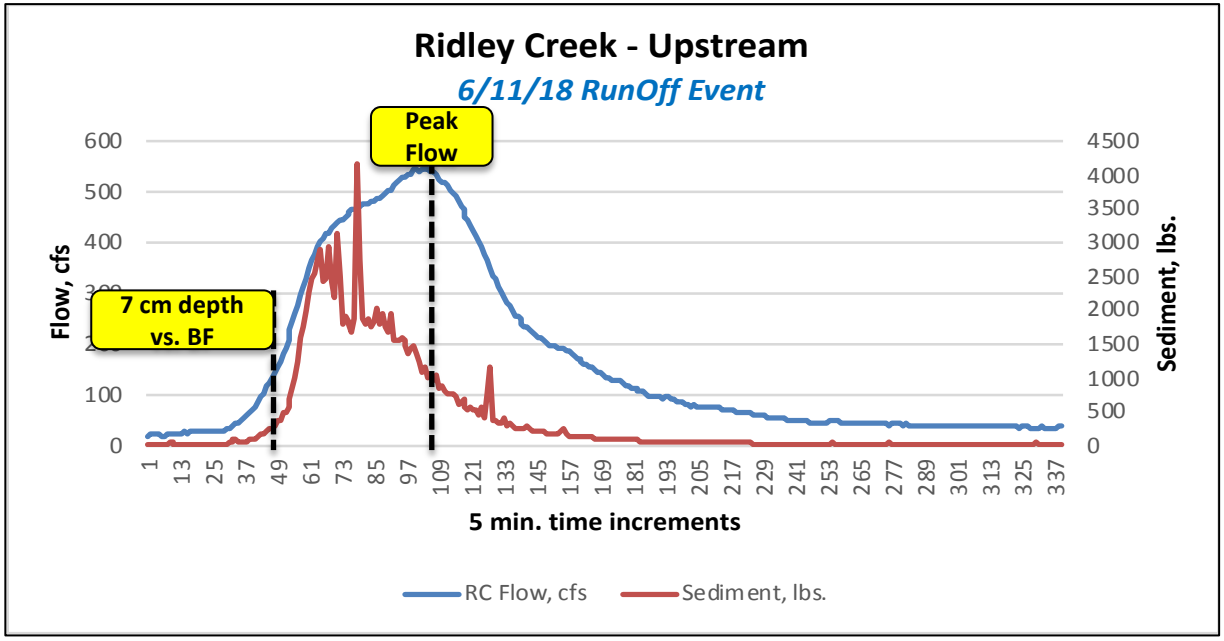
Debris or Silt Coated Sensor

- **Turbidity Sensor has useful data…BUT may not have sufficient data to integrate over a rain event !**

- **Option to use an "auto-sampler:**
  - **Electronic "Mayfly" System**
  - **Manual**

- **Upstream ½ PVC Pipe Shield**



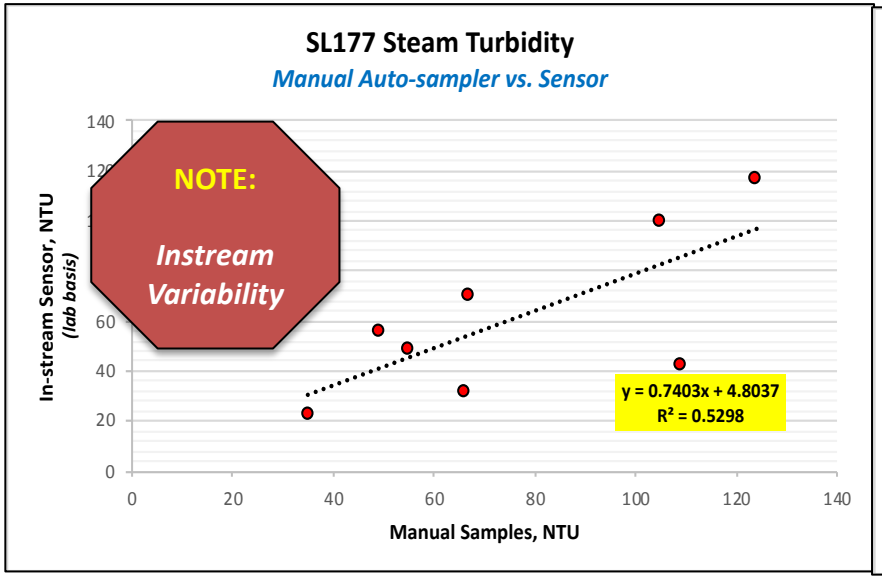


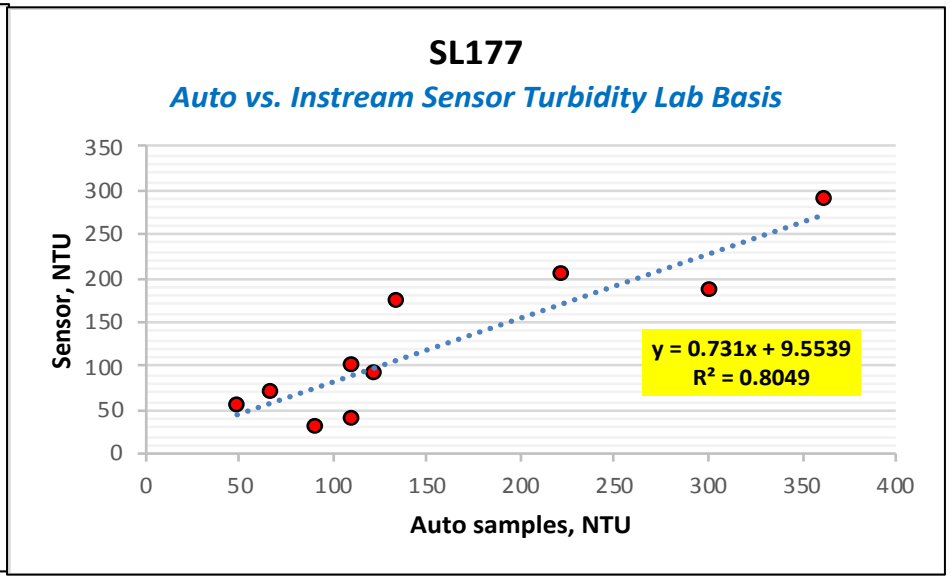
Avg. Sediment/Flow:
@ Near Peak Flow
@ 7 cm > BF

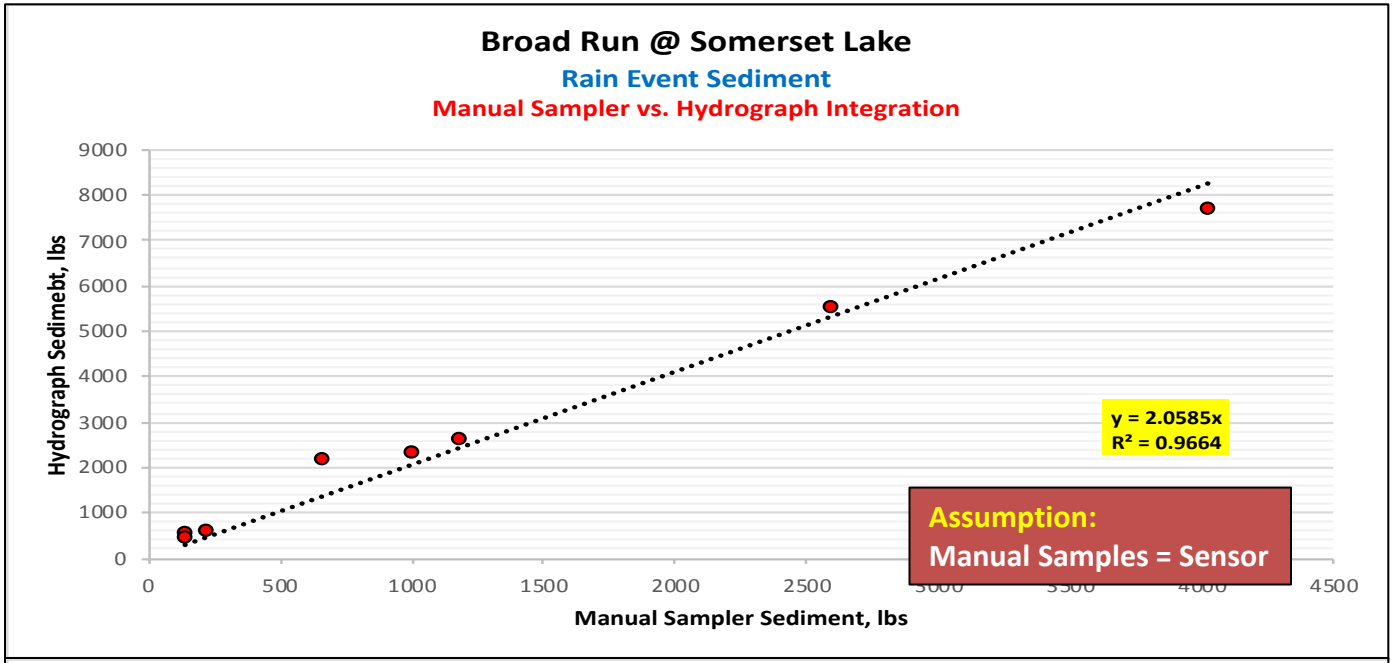
Cum Total Flow to Peak Flow:
(start of RO to Peak Flow)

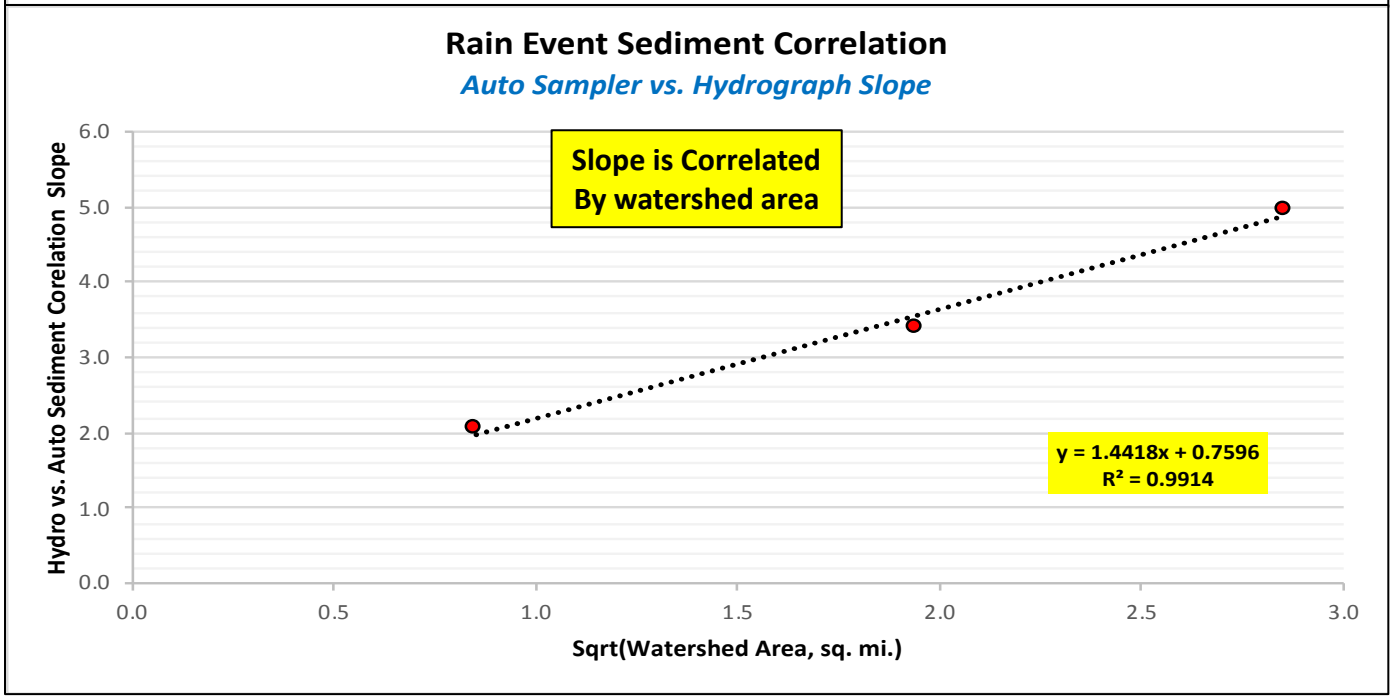
Estimated Sediment:

(*Cum Flow to Peak * Avg. Sediment/Flow)*






Broad Run @ Somerset Lake
Rain Event Sediment
Manual Sampler vs. Hydrograph Integration
Hydrograph Sedimebt, lbs
Manual Sampler Sediment, lbs
y = 2.0585x
R² = 0.9664
Assumption:
Manual Samples = Sensor


Rain Event Sediment Correlation
Auto Sampler vs. Hydrograph Slope
Hydro vs. Auto Sediment Corelation Slope
Sqrt(Watershed Area, sq. mi.)
Slope is Correlated
By watershed area
y = 1.4418x + 0.7596
R² = 0.9914