# Regression Analysis of Total Suspended Solids Concentrations to Estimate Streambank, Upland Field, and Classic Gully Sediment Contributions to Minnesota River Tributaries

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# Acknowledgements


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- Watonwan River CWP
- Maple River CWP
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- USGS
- Bill VanRyswyk - MDA

# Sediment source contributions: what are the percentages?

Chetomba Creek

**Photos courtesy of Stephanie Klamm – Hawk Creek CWP**

# Sediment Sources:

Streambanks and Bluffs

Construction Sites

Classic Gullies

Urban Stormwater

Agricultural Fields (includes sediment from open tile intakes)

# The Link Between Runoff Source and Sediment Source Contributions to Rivers

# The Link Between Runoff Type and Sediment Source Contributions to Rivers

Bottom of ravine 10/18/07

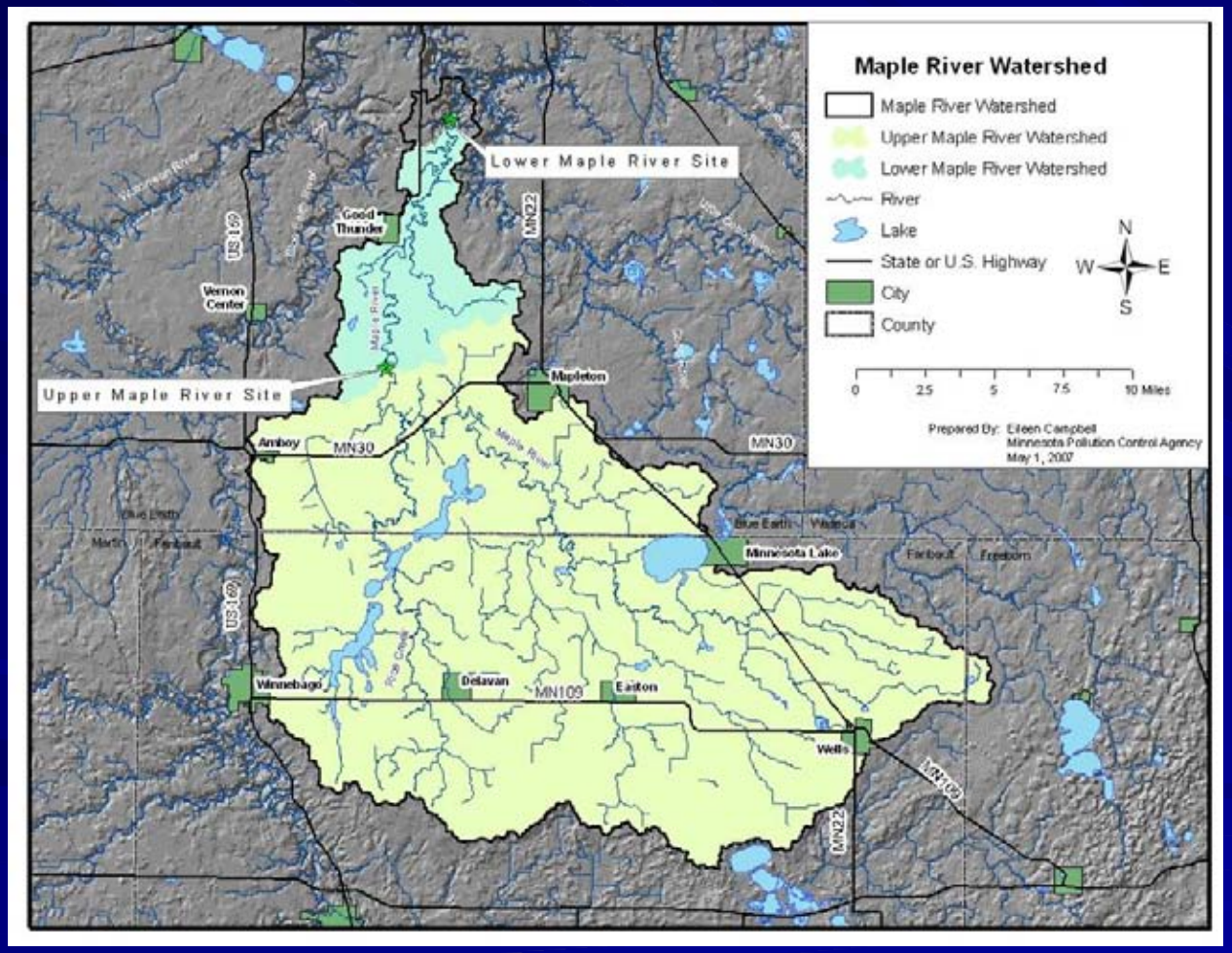
Top of ravine 10/18/07

# The Link Between Runoff Type and Sediment Source Contributions to Rivers

Maple River

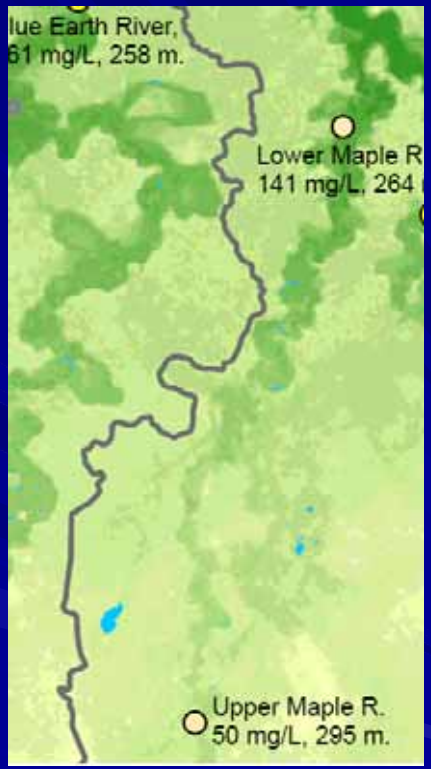
Lower Monitoring Site

# TSS Streambank Erosion Regression Method Example: Maple River



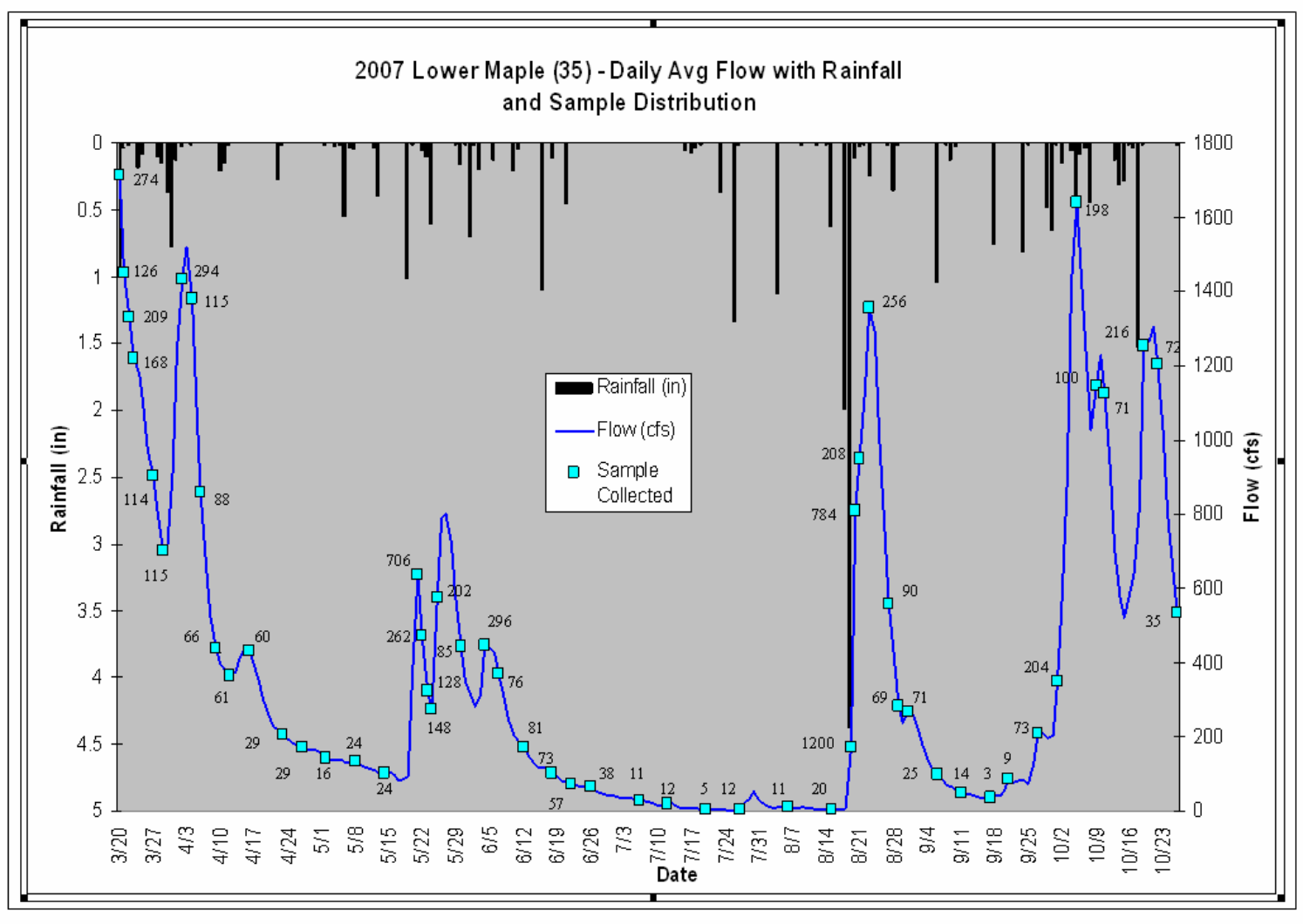

Map courtesy of Eileen Campbell - MPCA

**Watershed slope**

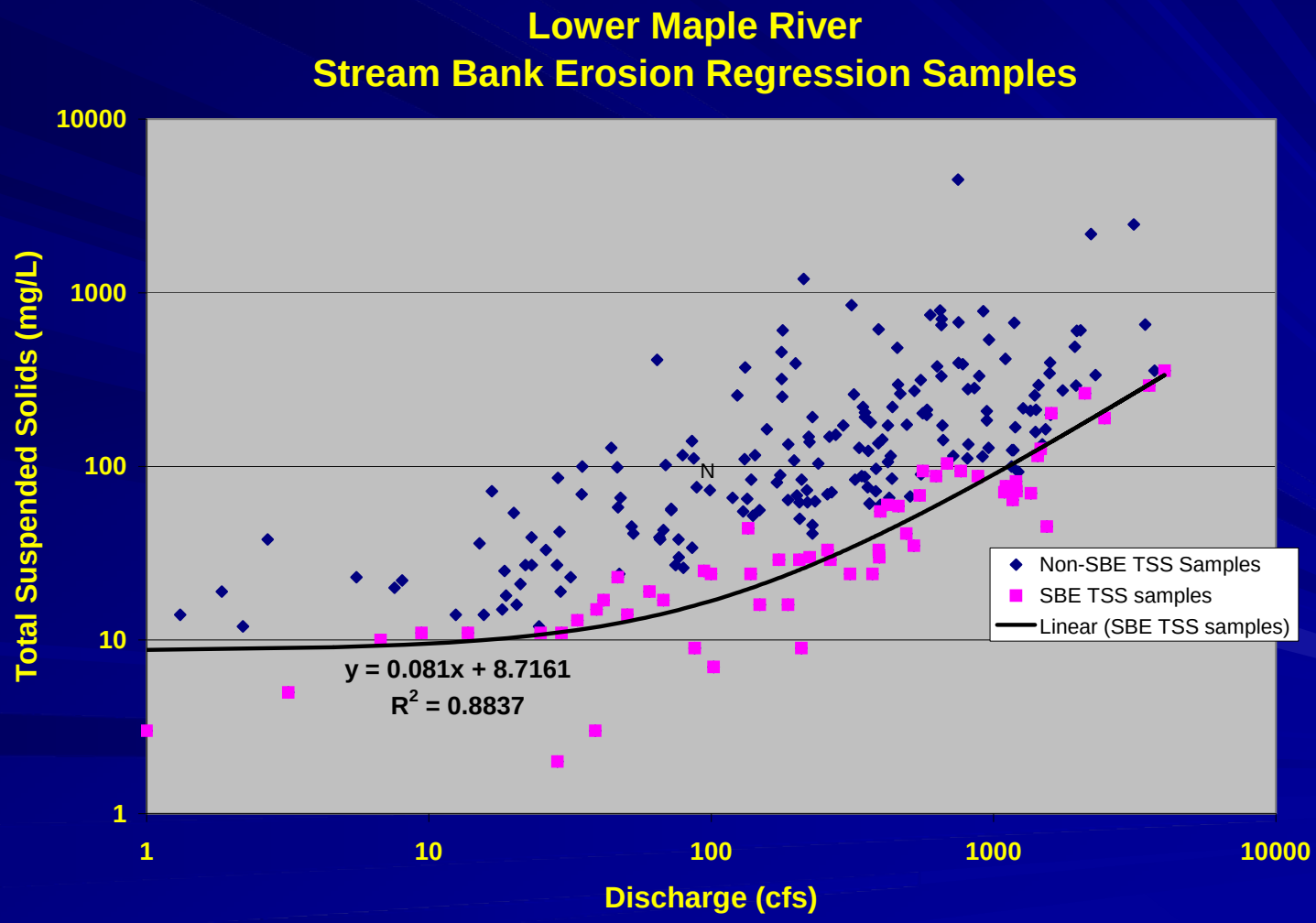



Map courtesy of Scott Matteson MNSU Water Resource Center

# Sampling Frequency



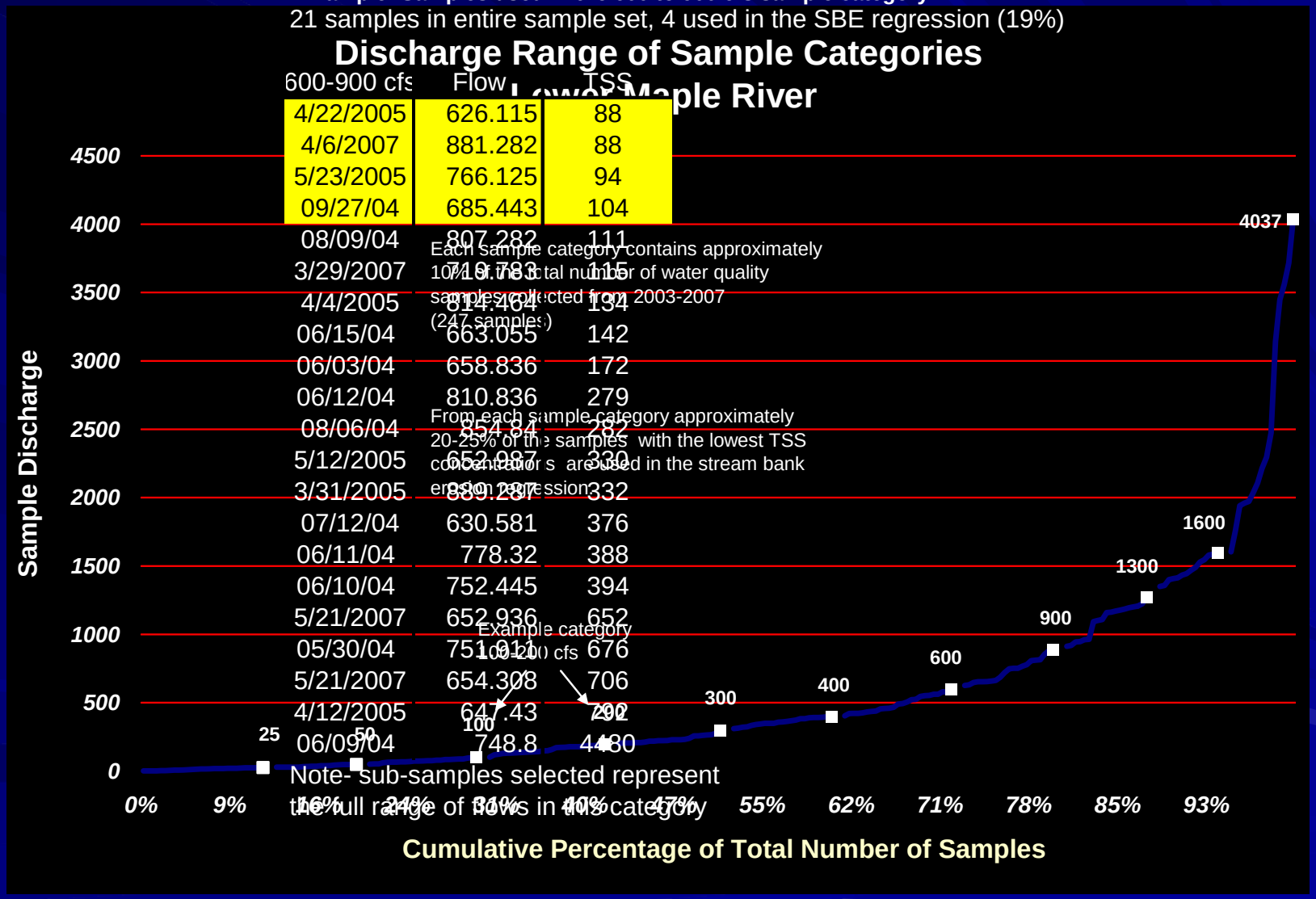
# TSS Streambank Erosion Regression Method – Hypothesis



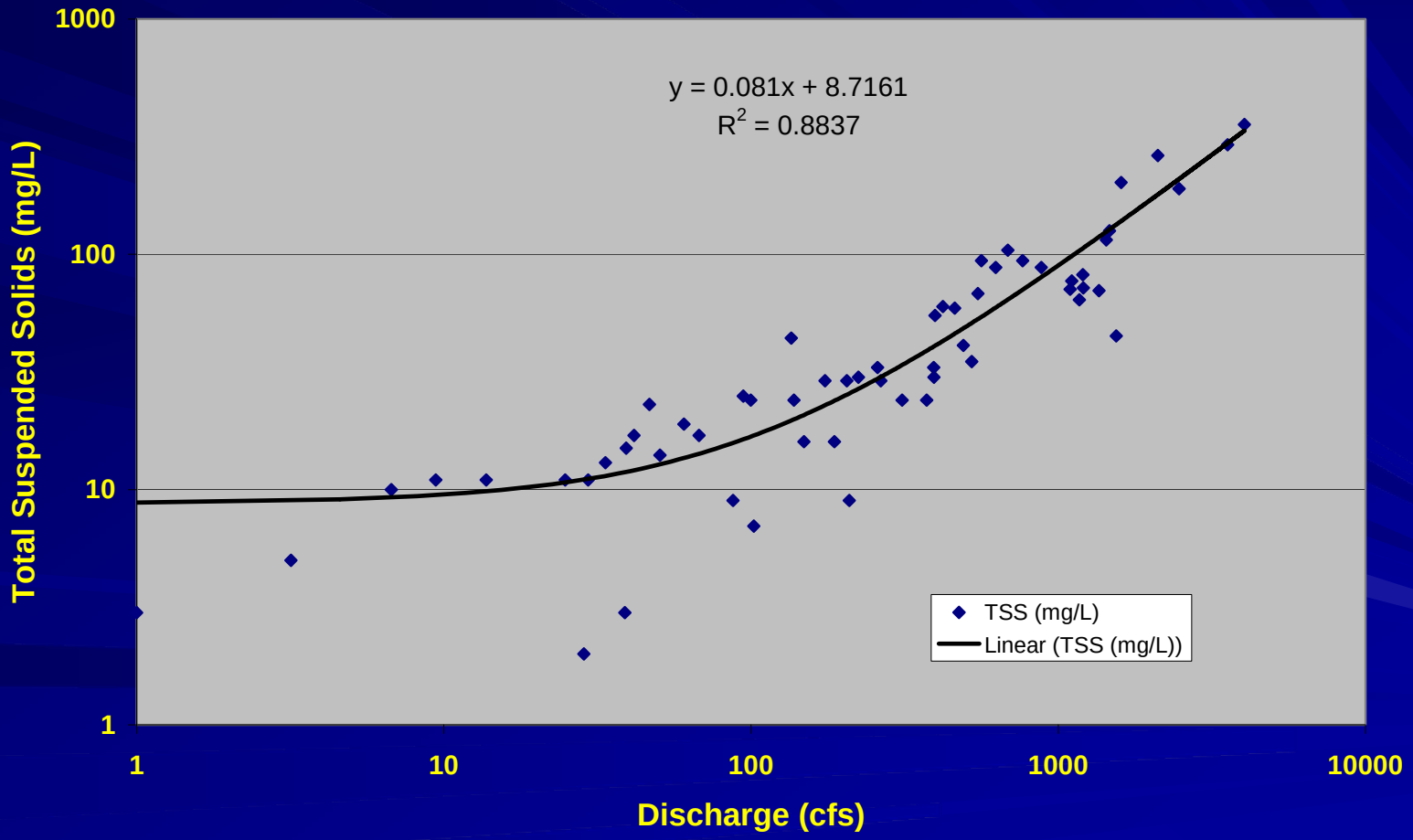
# Step 1: Select Samples For SBE Regression

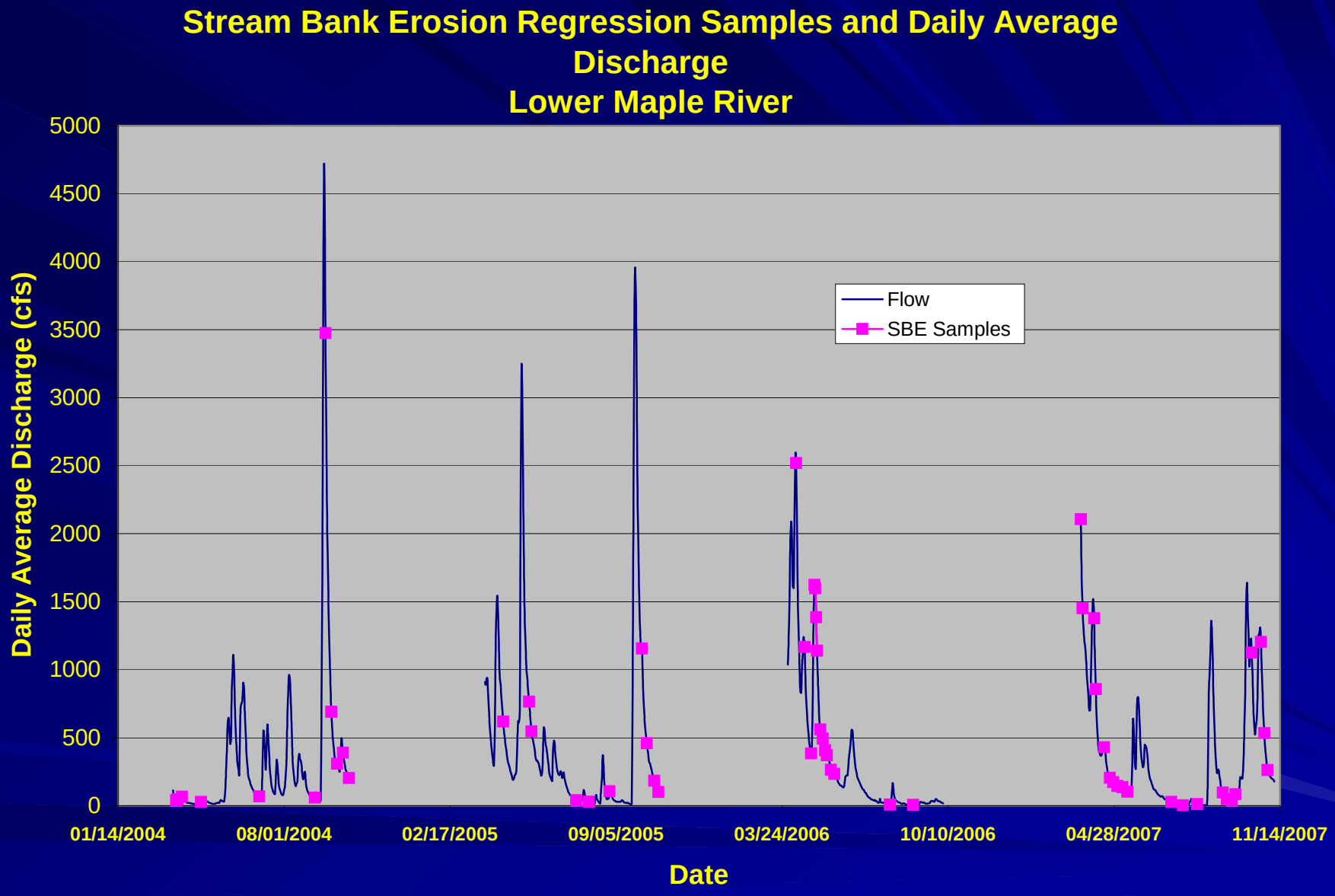
**Example: Samples used in the 600 to 900 cfs sample category**:

21 samples in entire sample set, 4 used in the SBE regression (19%)

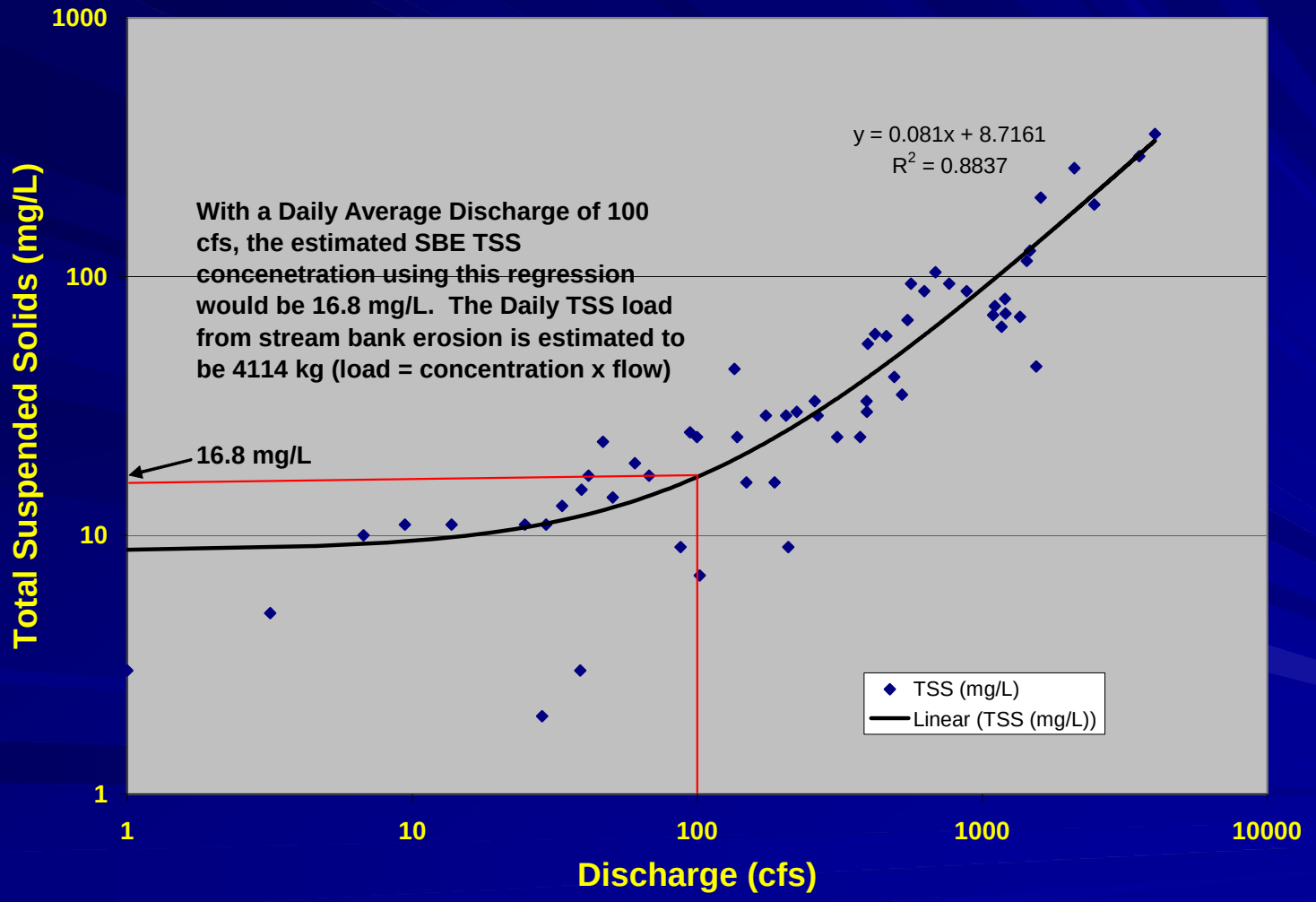


# Step 2: Create SBE Regression




Stream Bank Erosion Regression Samples and Daily Average Discharge
Lower Maple River
Daily Average Discharge (cfs)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Flow
SBE Samples
01/14/2004
08/01/2004
02/17/2005
09/05/2005
03/24/2006
10/10/2006
04/28/2007
11/14/2007
Date

# Step 2: Compute Daily Streambank Erosion (SBE) Loads




**Daily Average Flow x SBE TSS Concentration = Daily SBE Load**

# Step 3: Compute Seasonal Streambank Erosion Load
(generally 4/1 through 9/30)

- Sum of Daily SBE loads = Seasonal SBE load

# Step 4: Compute the Streambank Erosion Proportion of Seasonal TSS Loads

| Lower Maple River Streambak Erosion Contribution | | | |
|---|---|---|---|
| **Year** | **Seasonal TSS Load (tons)** | **Seasonal Stream Bank Erosion TSS Load (tons)** | **% of Seasonal TSS Load from Stream Bank Erosion** |
| 2003 | 20511 | 4190 | 20% |
| 2004 | 111604 | 25572 | 23% |
| 2005 | 93808 | 33129 | 35% |
| 2006 | 24610 | 18217 | 74% |
| 2007 | 36902 | 16953 | 46% |
| **Numeric 5 year average SBE contribution** | | | **40%** |

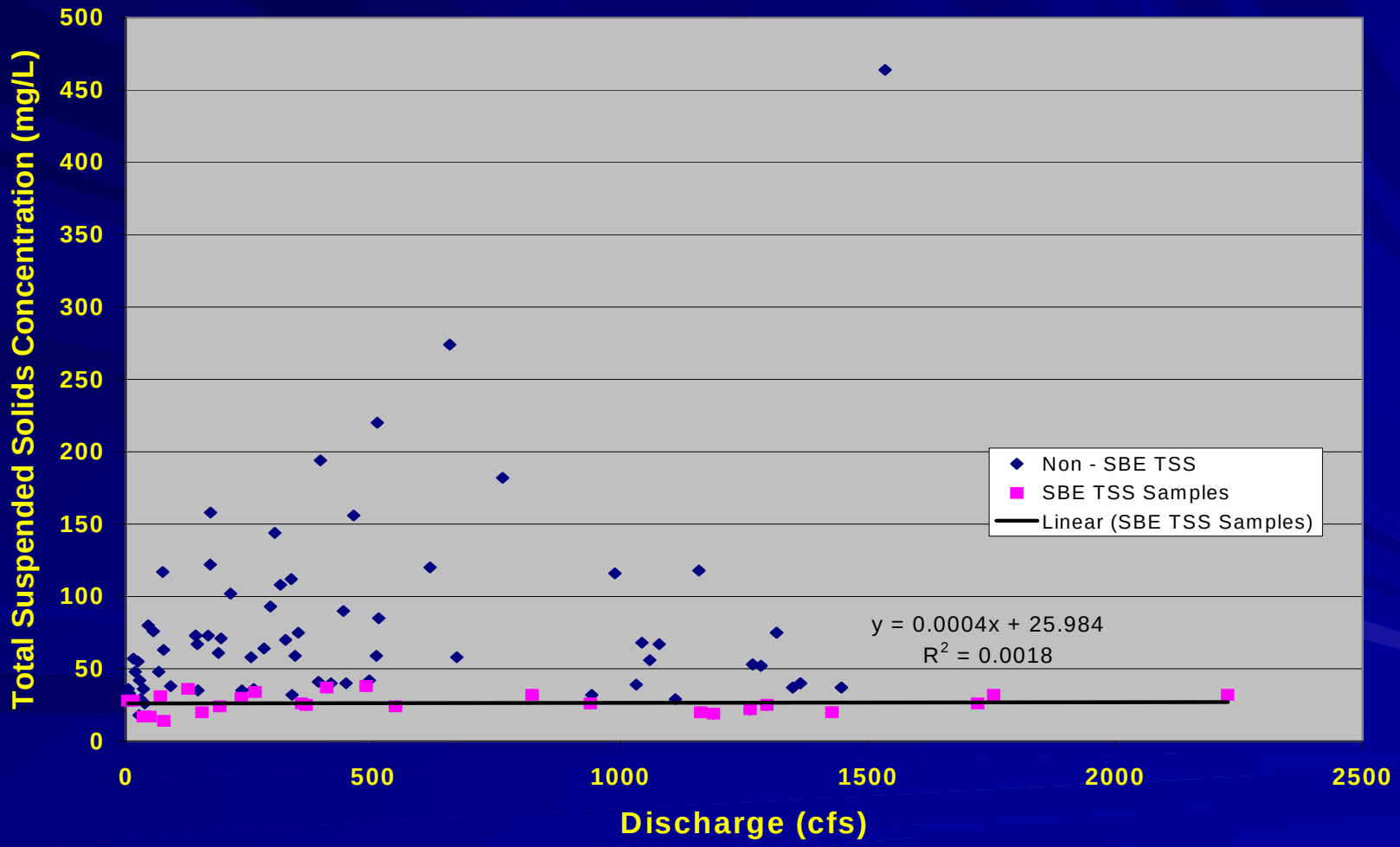
# Percentage of Seasonal TSS Loads from Streambank Erosion Using TSS Flow Weighted Mean Concentrations

| Lower Maple River Streambak Erosion Contributions | | | | |
|---|---|---|---|---|
| **Year** | **monitoring season dates** | **Lower Maple Seasonal TSS FWMC** | **Lower Maple Stream Bank Erosion TSS FWMC** | **% of TSS load from Streambank Erosion** |
| 2003 | 4/24-10/1 | 264 | 54 | 20.4% |
| 2004 | 3/21-10/18 | 561 | 129 | 23.0% |
| 2005 | 4/1-10/26 | 353 | 126 | 35.7% |
| 2006 | 3/31-10/4 | 140 | 103 | 73.2% |
| 2007 | 3/20-10/26 | 171 | 79 | 45.9% |
| | **Numeric 5 year average SBE contribution** | | | **40%** |

# Summary Table – Average Streambank Erosion Proportion of Seasonal TSS Loads by Watershed

| Watershed | Data Years | Average streambank erosion proportion of seasonal TSS load |
|---|---|---|
| Watonwan R. | 7 | 41% |
| High Island Cr. | 5 | 31% |
| Little Cottonwood R. | 7 | 20% |
| Chippewa R. | 8 | 38% |
| 7 Mile Cr. | 8 | 20% |
| Maple River | 5 | 40% |

# Upper Maple River SBE Regression



# Streambank Erosion Proportion of Seasonal TSS Load by Year – Upper Maple River

| Upper Maple River - TSS Source Contributions | | | | | |
|---|---|---|---|---|---|
| Year | Seasonal TSS FWMC. | Streambank Erosion TSS FWMC | Field Erosion TSS FWMC | % of Seasonal TSS Load from SBE | % of TSS Load from Field Erosion |
| 2006 | 50.86 | 26.4 | 24.5 | 51.9% | 48.1% |
| 2007 | 61.57 | 26.3 | 35.2 | 43% | 57.2% |
| | Two Year numeric Average SBE contribution | | | 47% | |

# TSS Load Source Proportions for the Lower Maple River

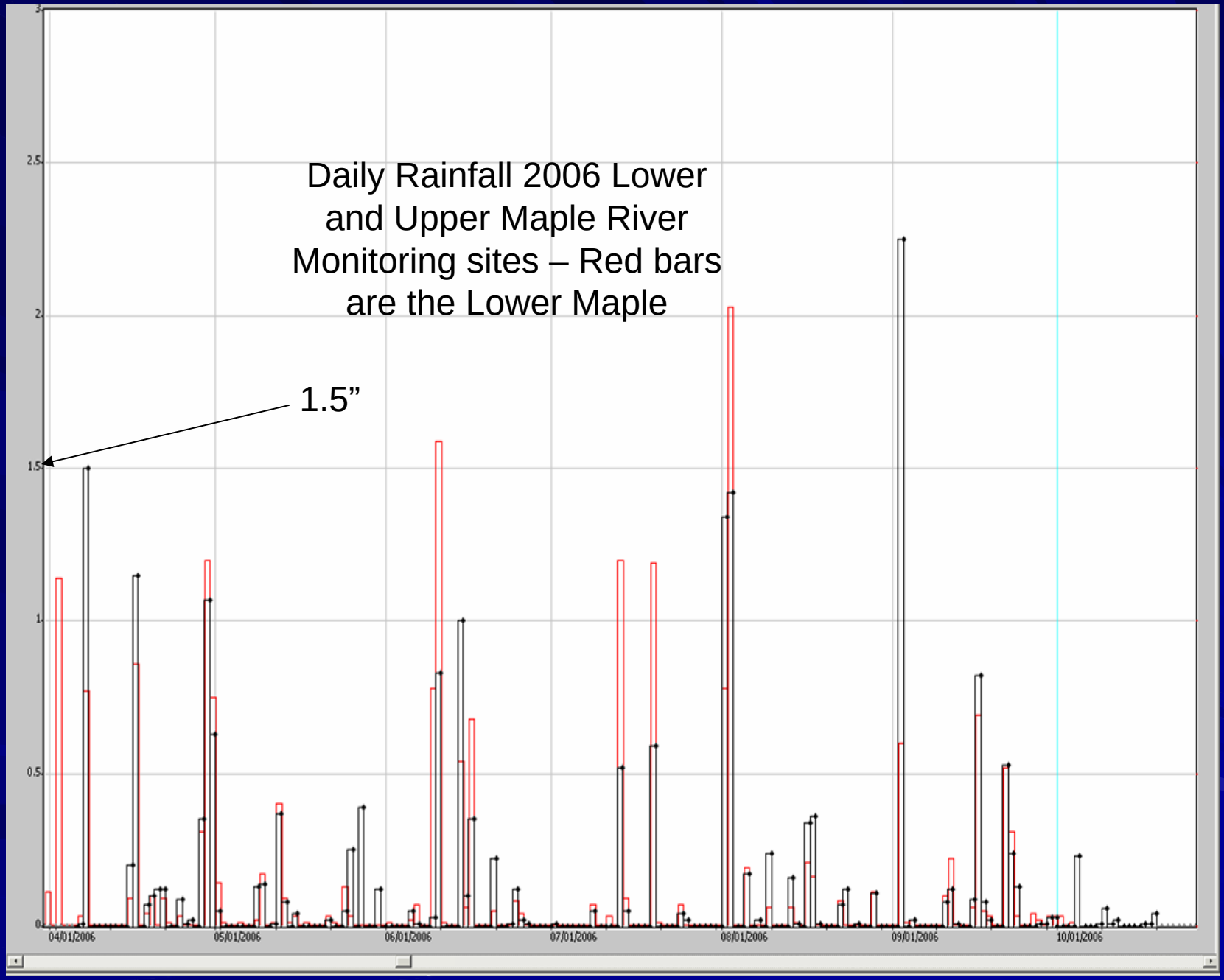
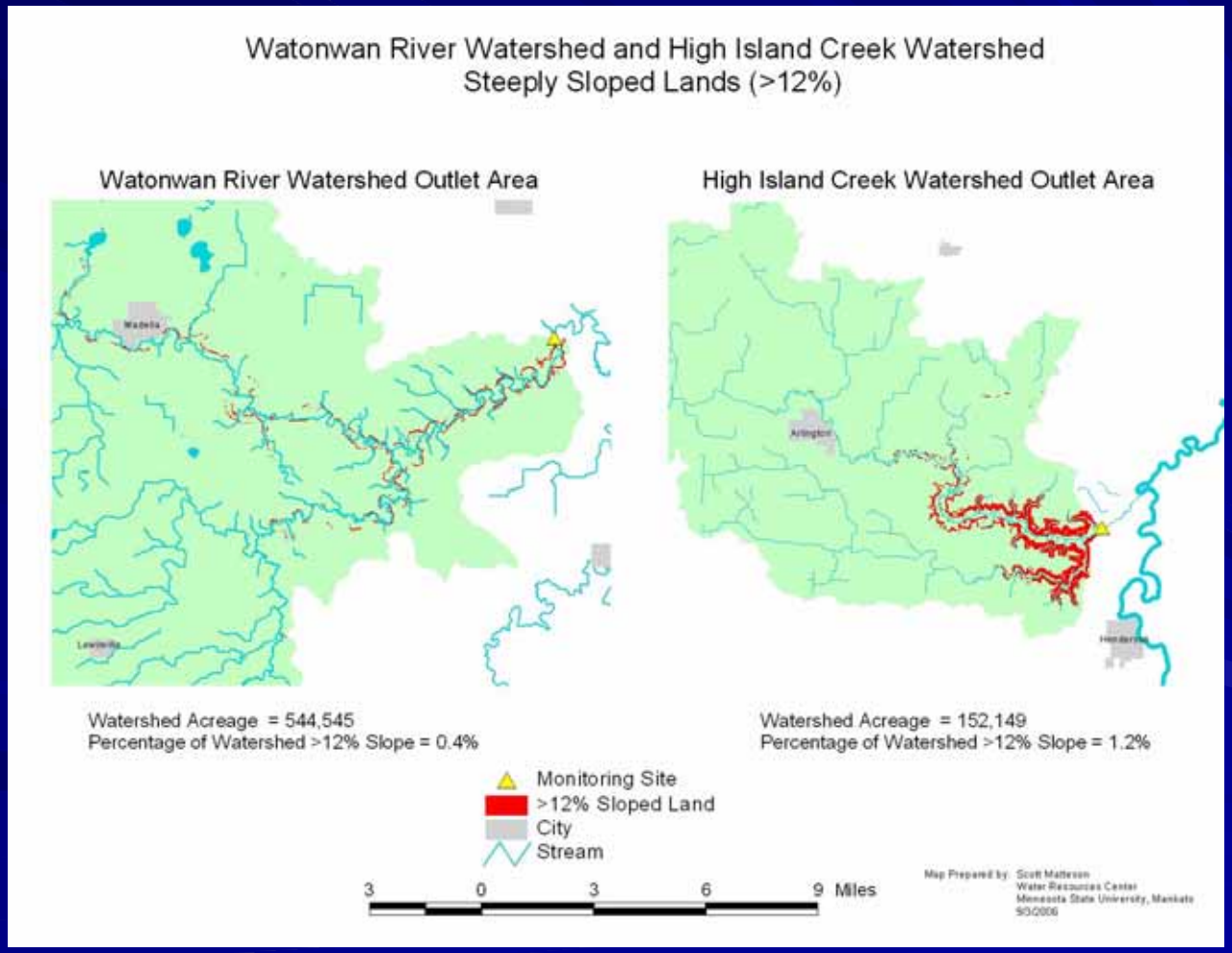
| Lower Maple River Source Contributions | | | | | | |
|---|---|---|---|---|---|---|
| **Year** | **Lower Maple Seasonal TSS FWMC** | **Lower Maple SBE TSS FWMC** | **Field Erosion TSS FWMC (computed from Upper Maple site)** | **% of TSS load from SBE** | **% of TSS load from Field Erosion** | **% of TSS load from Classic Gulleys** |
| 2003 | 264.3 | 54.0 | | **20.4%** | | |
| 2004 | 561.1 | 128.8 | | **23.0%** | | |
| 2005 | 353 | 126.0 | | **35.7%** | | |
| 2006 | 140 | 102.5 | 24.5 | **73.2%** | **17.5%** | **9.3%** |
| 2007 | 171.25 | 78.7 | 35.2 | **45.9%** | **20.6%** | **33.5%** |

# Caveats and Criticisms

- Streambank Erosion from ice
- Rainfall on streambanks is not included
- Ephemeral gully erosion from tile outlets is included in the SBE calculation
- Too many samples: over-predicting SBE contributions
- More SBE occurs when flows are rising

# Conclusions

- For the analyzed watersheds, on average no more than 40% of TSS load can be from SBE
- SBE proportions are variable from year to year: climate, timing of events affect TSS source contributions
- When field and gully erosion are the dominant sediment sources, streams are the dirtiest
- In some watersheds all major sediment source contributions can be determined with this method.


Daily Rainfall 2006 Lower and Upper Maple River Monitoring sites – Red bars are the Lower Maple
1.5”
2.5
2
1.5
1
0.5
0
04/01/2006
05/01/2006
06/01/2006
07/01/2006
08/01/2006
09/01/2006
10/01/2006

# Percentage of Land with Slopes Greater than 12% by Watershed