Stormwater Sampling, Water Quality Monitoring & Active DOT Construction Sites:

Lessons learned from two years of data.

August 20, 2014
Melissa Serio – Iowa DOT
Rebecca Kauten - University of Northern Iowa

"In many cases, the resources being spent for outfall monitoring could be more effectively spent to better understand many other aspects of an effective stormwater management program."

Robert Pitt, et.al. (2004)

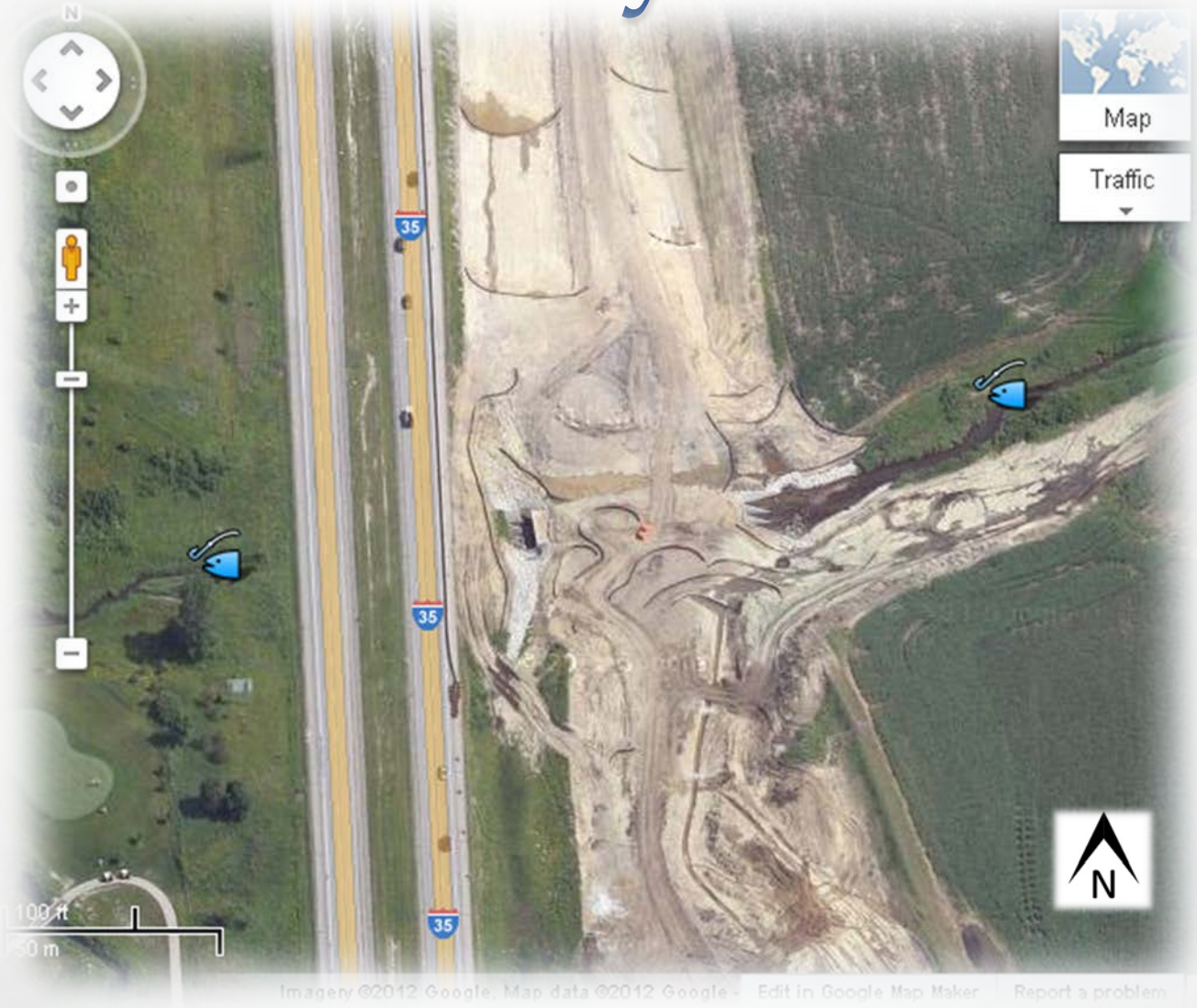
Monitoring isn't about identifying "new" problems.

If we don't know what's wrong, how can we fix it?

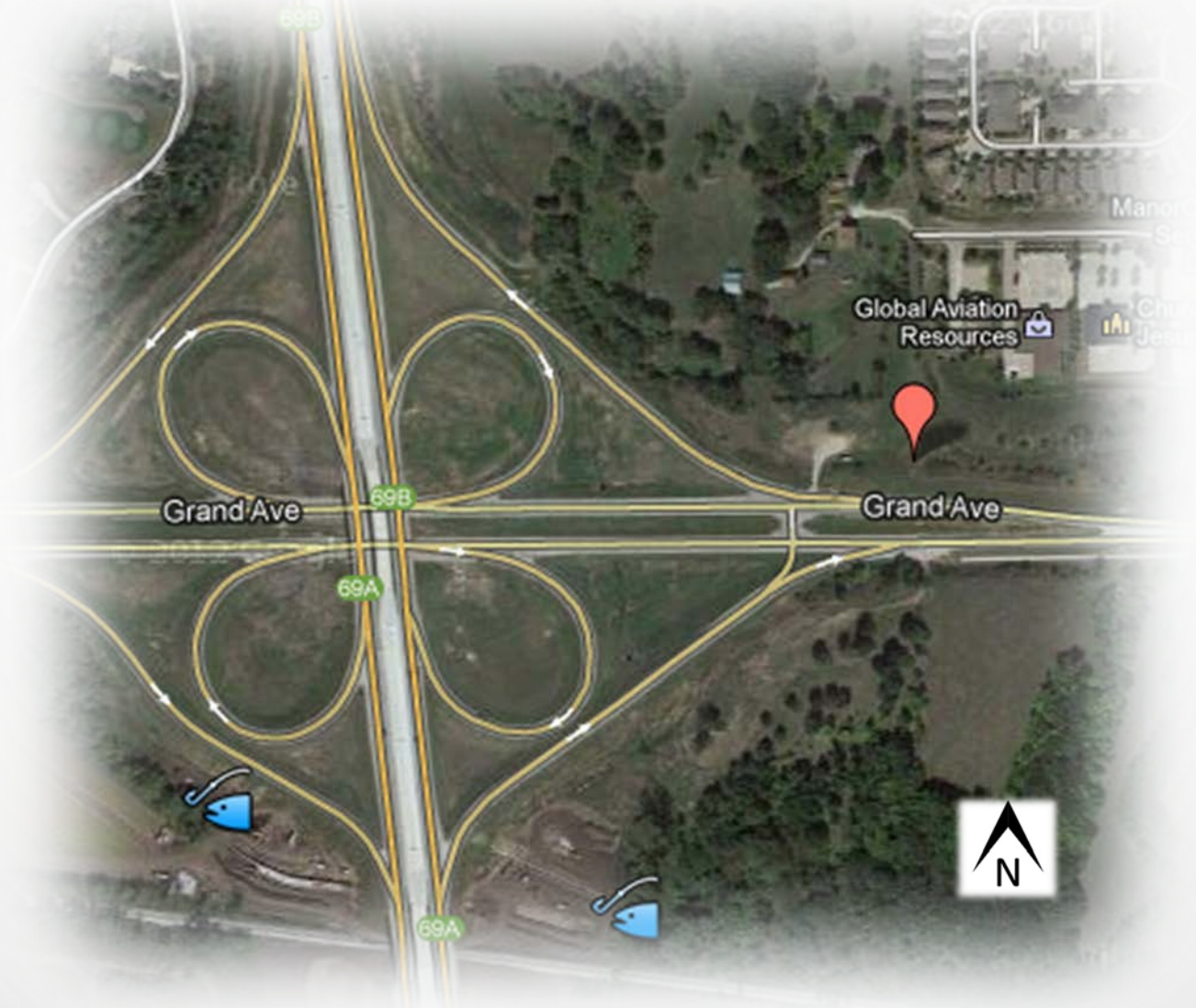
Initial Monitoring Plan

- Initial site review and selection.
- Monthly site visits for regular maintenance.
- Samples collected within 24 hours of ≥.25 inch rainfall events.
- Data collected and analyzed over two construction seasons.

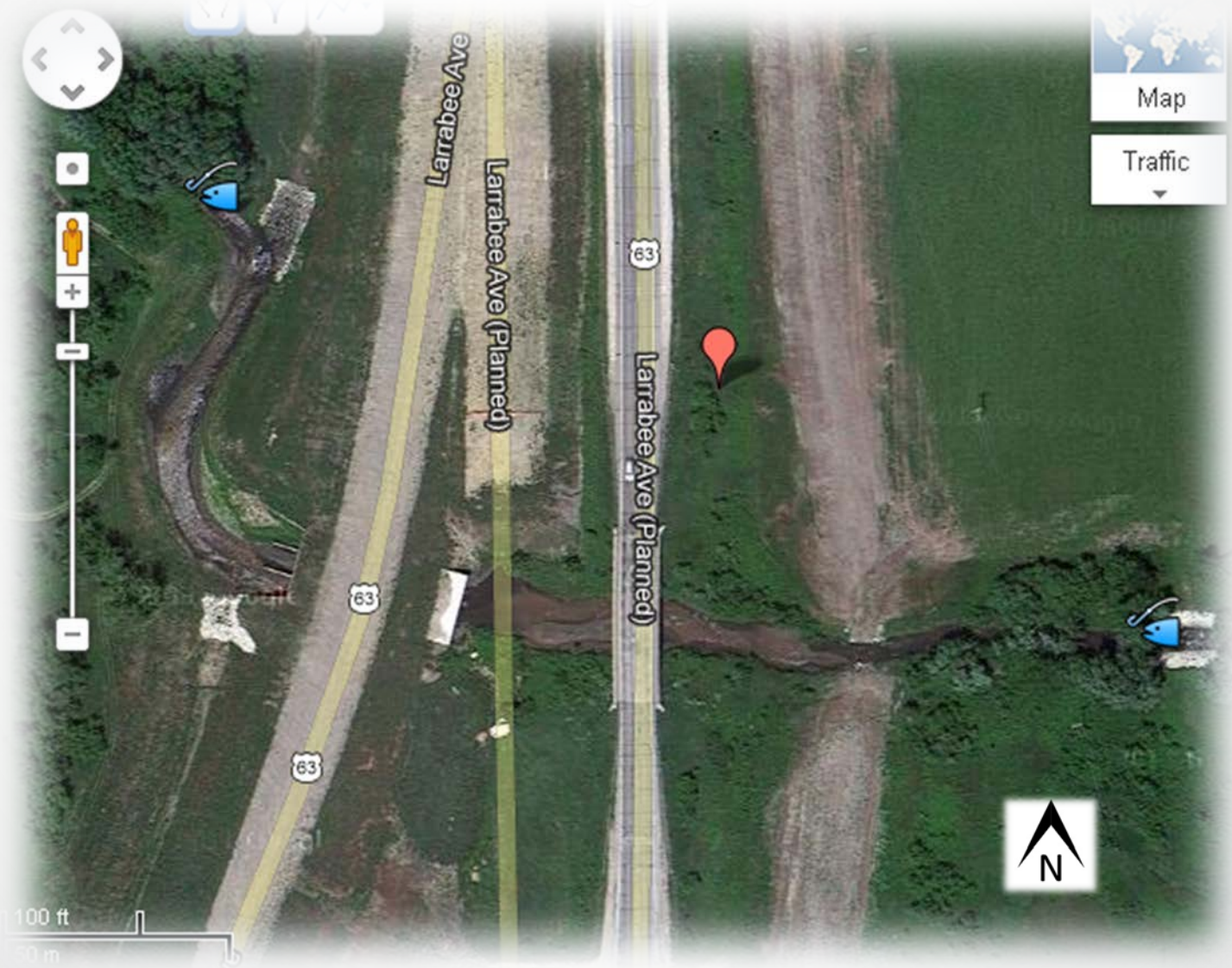
Ankeny – I-35


Map
Traffic
35
35
35
N
100 ft
50 m
Imagery ©2012 Google, Map data ©2012 Google
Edit in Google Map Maker
Report a problem

WDM I-35 &Grand



Waverly – US 63 & IA 3



Buchanan Co. – IA 150 Bear Creek

Parameters

- Field Sampling
  - Temperature
  - Dissolved oxygen (DO)
  - Transparency
  - pH
  - Soil samples collected at each site

- Lab-based Testing
  - Transparency
  - Turbidity
  - Nutrient sampling at WAV1 and ANK1 (Total N, P)
  - Soils analysis

For the sake of the study, emphasis was on transparency, turbidity, nutrients and soils/water analysis.

Monthly & Triggered Sampling

- Monthly Sampling: Thursdays of each month (alternating between “North” and “South” sites.)
- Event Sampling: .25 inch rainfall triggers

Fixed Instruments

(Transducer image courtesy of InSitu)

Rising Stage Samplers

- Pros
  - Captures discrete samples during rise of hydrograph
  - Can collect sample when potentially unsafe to access.
  - Inexpensive
  - No intensive calibration required
- Cons
  - Subject to the elements
  - Flooding may prevent access
  - Sample collection is arbitrary
  - No way to calibrate to a set water level (always at the mercy of current conditions.)


CPESC, Inc.
(828) 655-1600
www.cpesc.org
info@cpesc.org
CESSWI
CPSWQ
CPESC

Turbidity/Transparency

Discrete (Grab) Samples

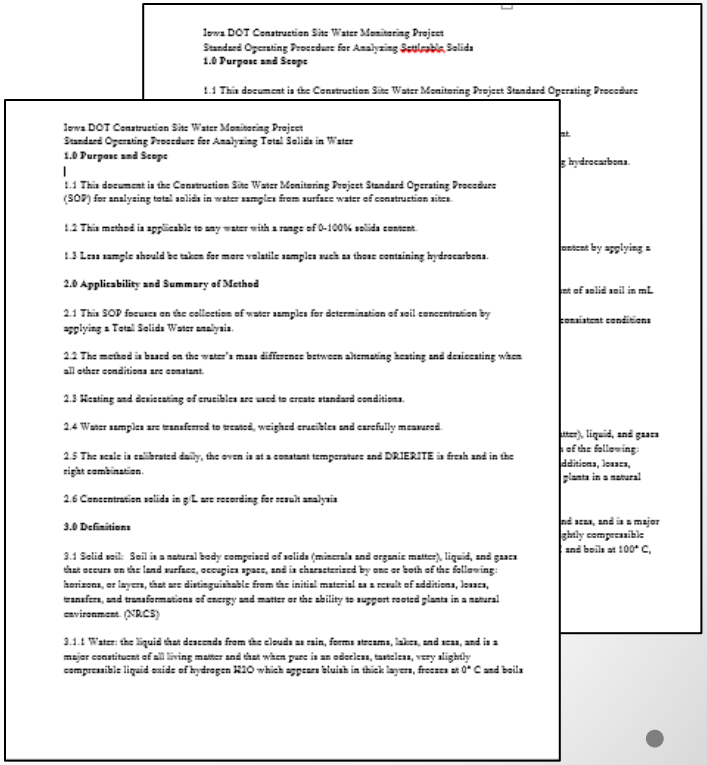

HACH
2100Q
1
2
3
4

2 People, 2 Tests

SOPs Developed

(for Surface Water Bodies Near Construction Sites)

- Measuring Transparency
- Measuring Turbidity
- Field Sampling for Select Water Quality Parameters
- Measuring Settable Solids
- Measuring Total Solids



Iowa DOT Construction Site Water Monitoring Project
Standard Operating Procedure for Analyzing Settleable Solids
1.0 Purpose and Scope

1.1 This document is the Construction Site Water Monitoring Project Standard Operating Procedure

Iowa DOT Construction Site Water Monitoring Project
Standard Operating Procedure for Analyzing Total Solids in Water
1.0 Purpose and Scope

1.1 This document is the Construction Site Water Monitoring Project Standard Operating Procedure (SOP) for analyzing total solids in water samples from surface water of construction sites.

1.2 This method is applicable to any water with a range of 0-100% solids content.

1.3 Less sample should be taken for more volatile samples such as those containing hydrocarbons.

2.0 Applicability and Summary of Method

2.1 This SOP focuses on the collection of water samples for determination of soil concentration by applying a Total Solids Water analysis.

2.2 The method is based on the water's mass difference between alternating heating and desiccating when all other conditions are constant.

2.3 Heating and desiccating of crucibles are used to create standard conditions.

2.4 Water samples are transferred to treated, weighed crucibles and carefully measured.

2.5 The scale is calibrated daily, the oven is at a constant temperature and DRIERITE is fresh and in the right combination.

2.6 Concentration solids in g/L are recording for result analysis

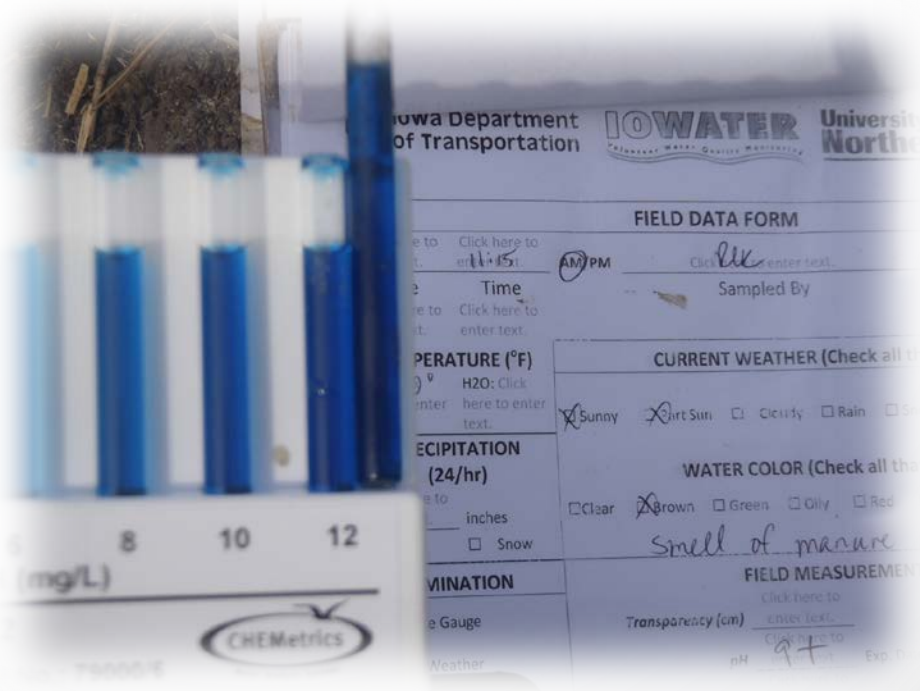
3.0 Definitions

3.1 Solid soil: Soil is a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment. (NRCS)

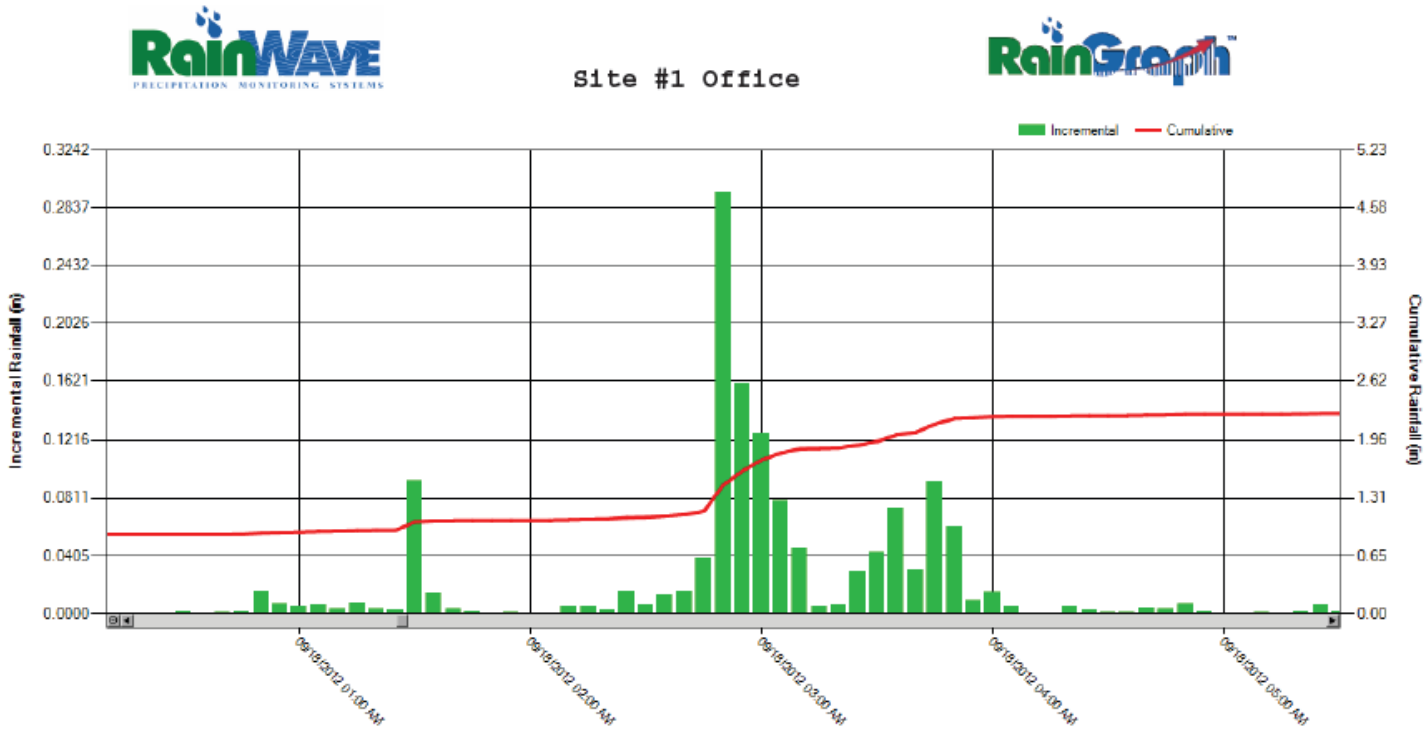
3.1.1 Water: the liquid that descends from the clouds as rain, forms streams, lakes, and seas, and is a major constituent of all living matter and that when pure is an odorless, tasteless, very slightly compressible liquid oxide of hydrogen H_2O which appears bluish in thick layers, freezes at 0° C and boils

Additional Testing & Analysis

- Total Solids
- Settleable Solids
- Comparison of other parameters to soils/sediment data
  - Nutrients
  - DO
  - pH
  - Temperature



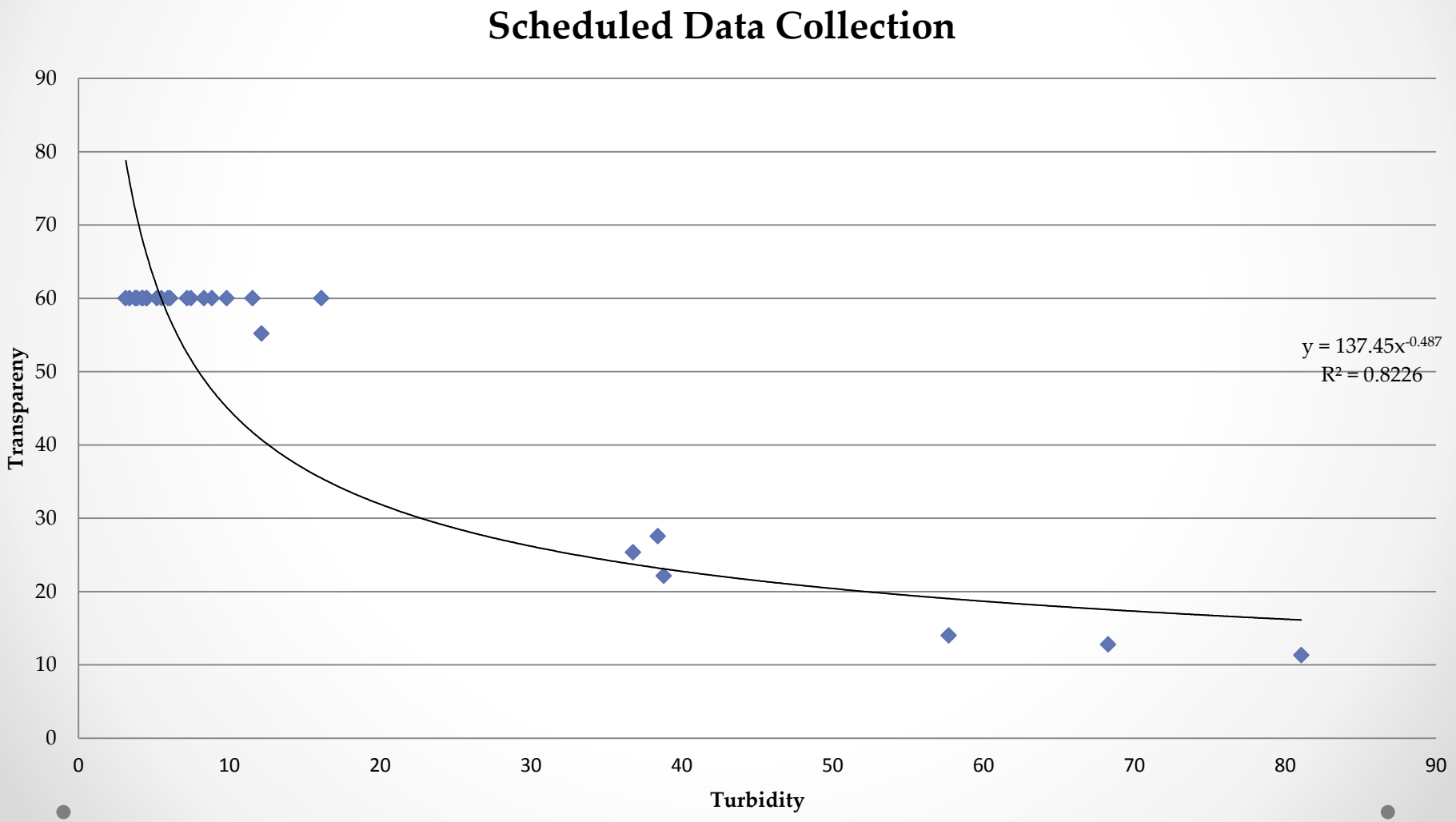
RainWave


RainWAVE
PRECIPITATION MONITORING SYSTEMS
Site #1 Office
RainGraph
Incremental
Cumulative
Incremental Rainfall (in)
Cumulative Rainfall (in)
0.3242
0.2837
0.2432
0.2026
0.1621
0.1216
0.0811
0.0405
0.0000
5.23
4.58
3.93
3.27
2.62
1.96
1.31
0.65
0.00
06/19/2012 01:00 AM
06/19/2012 02:00 AM
06/19/2012 03:00 AM
06/19/2012 04:00 AM
06/19/2012 05:00 AM

Transparency/Turbidity Data

- 82 samples taken
  - Triggered & Scheduled
- 16 sub-sets for each sample analyzed
  - N=1,312 for statistical significance
- Regression Analysis
  - What is the relationship between the two measurements?

Scheduled Sampling: R_2= 0.8226

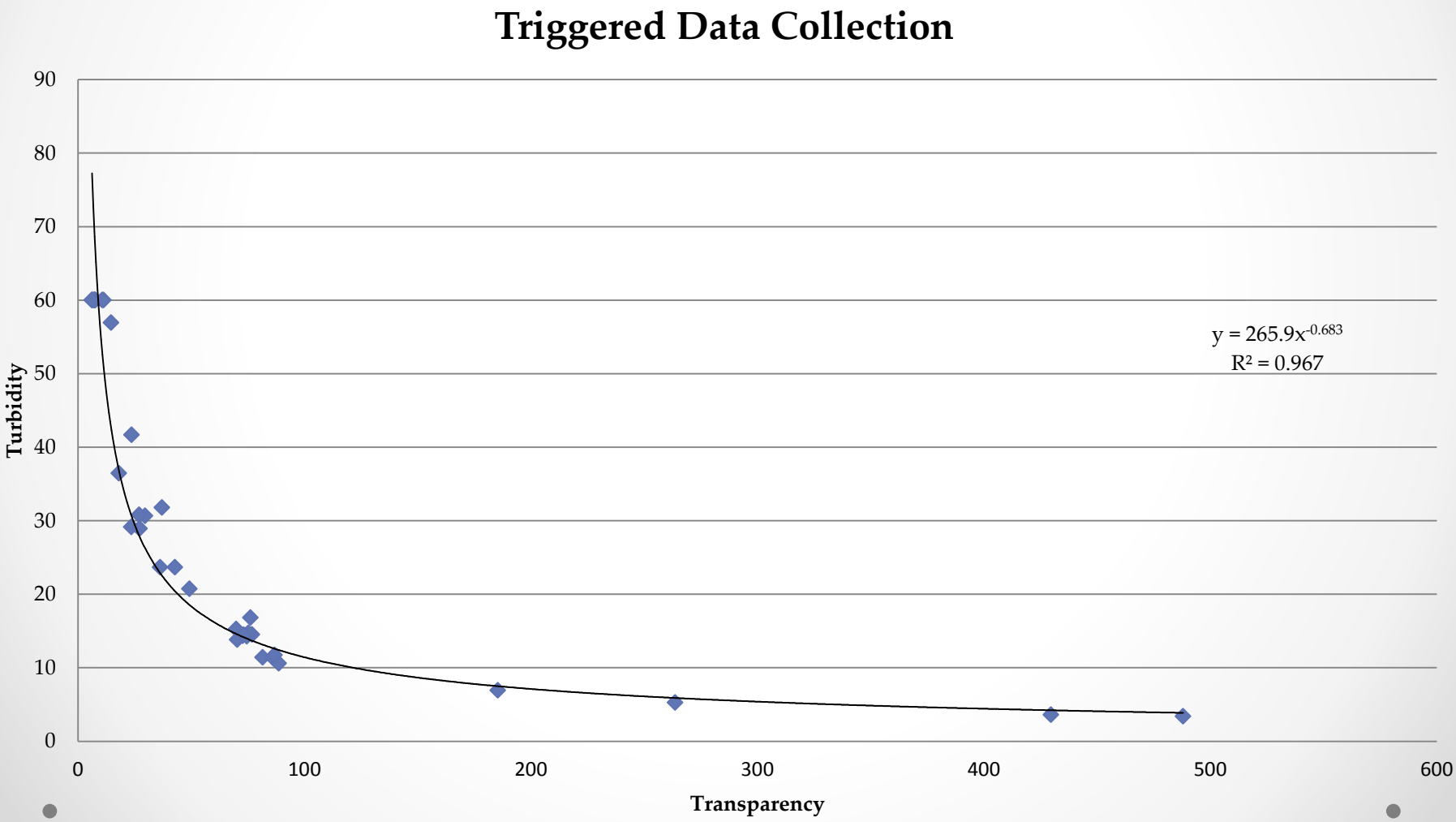


Scheduled Sampling

- Does not occur during triggered events.
- 60cm/low NTU anticipated
- Skews the regression to the left.

	NTU	Transparency (cm)
Mean	17.05506	50.67901
St Dev	21.66203	17.62787

Triggered Sampling: R_2=0.967

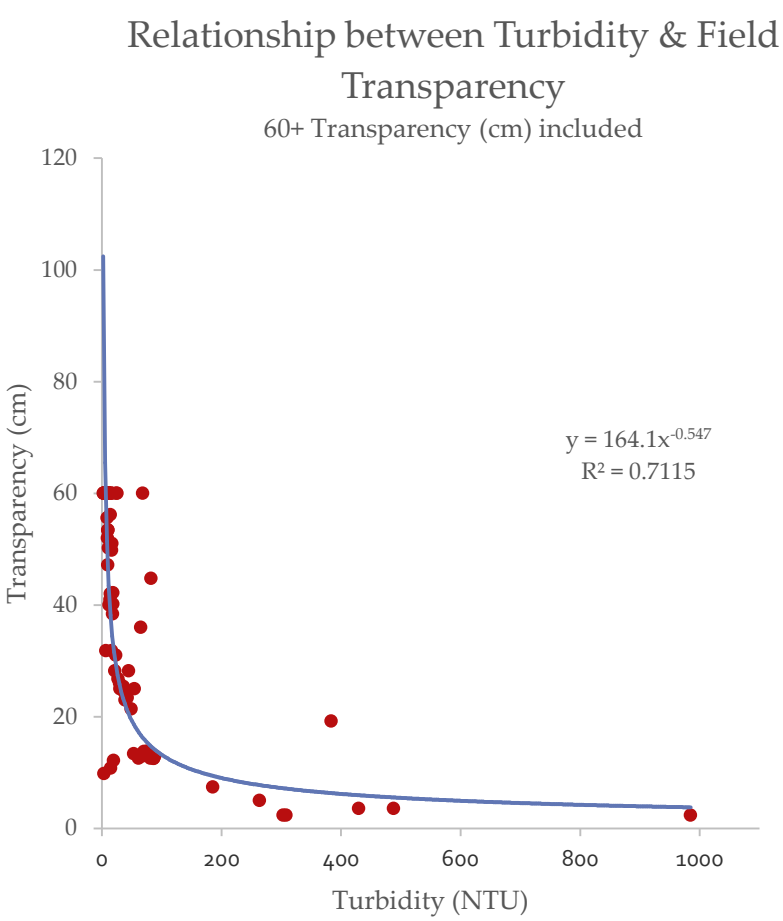


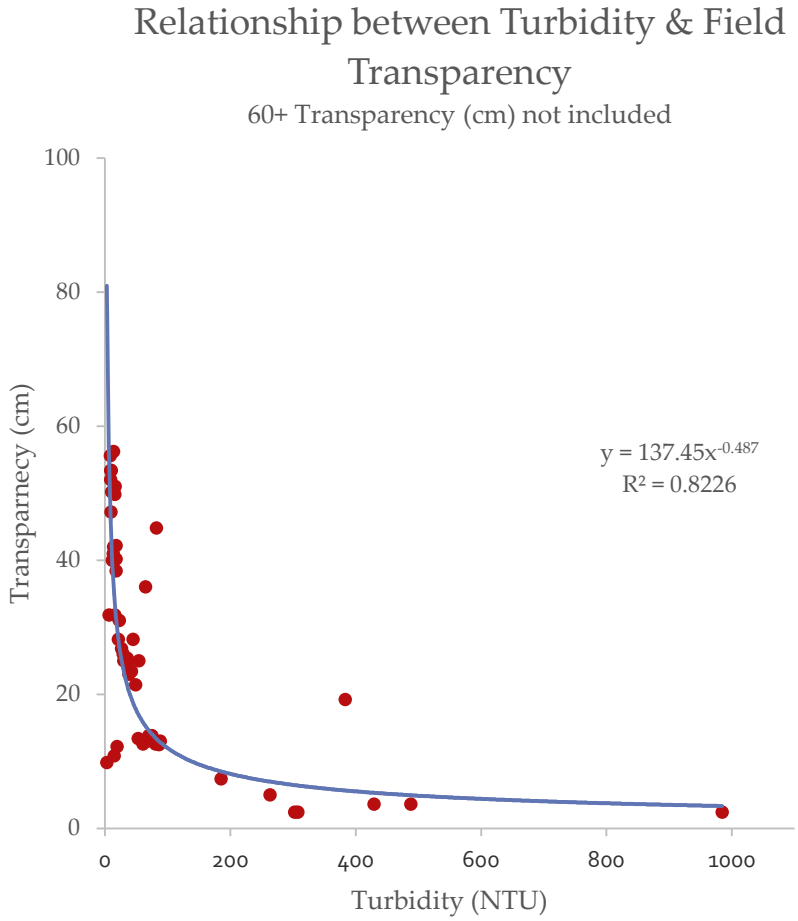
Triggered Sampling

- More closely represents the correlation between measurements.

	NTU	Transparency (cm)
Mean	74.93991	29.91296
St Dev	108.0739	20.69571

Transparency vs Turbidity Comparison





2013 Project Challenges

- Timely collection of samples
  - Two sites located two hours from the lab
  - Monitoring sites inundated with sediment
- Flooding & Consecutive Storm Events
  - Impassable roads limited access during spring rainfall (BUC1)
  - Repeat storm triggers meant multiple sampling days in a row – often limiting time for monthly sampling

Challenges with Instruments

- WeatherLink Service Subscription
  - iWireless Network Carrier
  - Limited coverage.
  - Looking into alternatives for 2013.
- Transducers
  - Devices do not work properly in mud.

Equipment Challenges

- Fenceposts for rising stage samplers
  - Buried in sediment
    - Ankeny
    - West Des Moines-Grand

- ESC concerns
  - Sedimentation during active construction
  - Dewatering impacts
    - To monitoring site
    - To habitat/streambed
  - Potential for exploring alternative solutions?
  - Monitor for effectiveness?

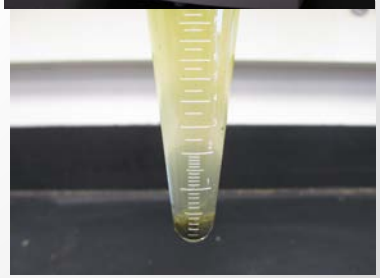
Not Included in 2013

- Weather Stations
  - RainWave and BridgeWatch alarms appear to work more reliably

- Transducers
  - Flooding prevented early access
  - Ruled unnecessary as grab sampling occurred.
  - Can be re-incorporated at DOT request. However, the current plan is to stick with grab sampling and rising stage samplers.
  - High margin of error when used in muddy conditions
  - Not recommended for construction site activities.

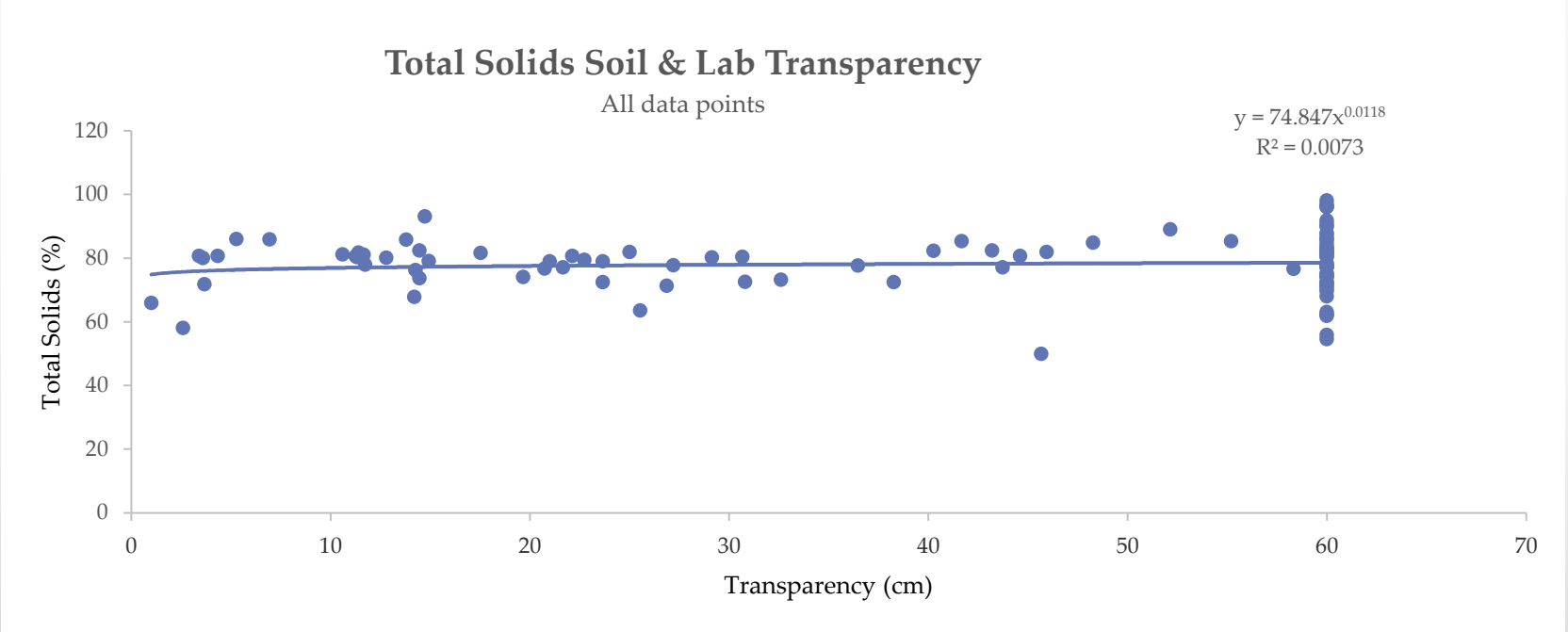
May-July BUC Upstream

Seeking Relationships for Soils Analysis



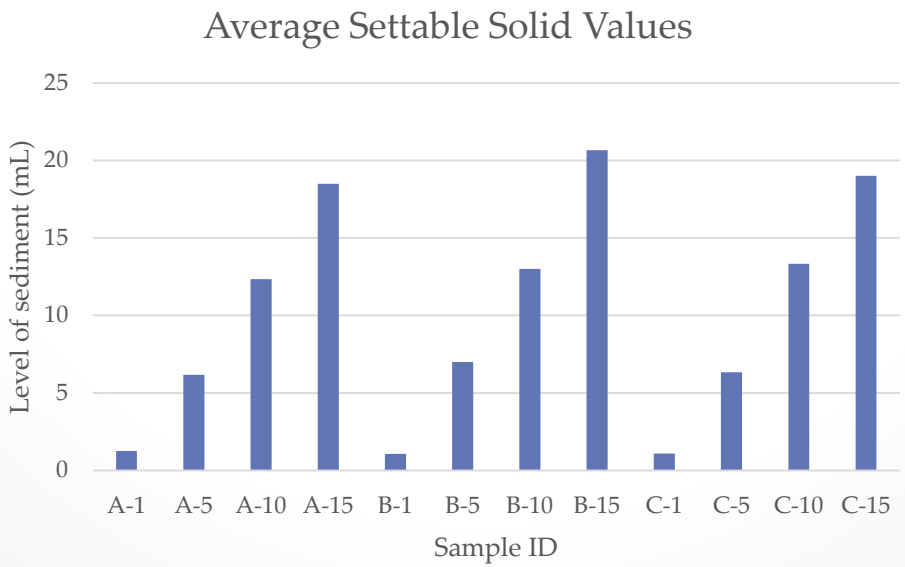
Results

- Total Solids – Soils and Water: not recommended for use when sampling from construction sites.
  - Relatively inexpensive
  - Time constraint
  - Weak relationship between transparency/turbidity as comparison



Results

- Settleable Solids – Indicates only one conversion chart is necessary for transparency/turbidity.
  - Statistically significant, albeit not as strong as anticipated.
  - More sample data may further validate this conclusion.
  - N=24 per soil horizon, subdivided by 1, 5, 10 and 15 grams per liter



Results

Comparison to Transparency & Turbidity			
Sample ID	Average mL	Average Cm	Average NTU
A-1	1.27	11.80	112.03
A-5	6.17	5.00	756.00
A-10	12.33	5.00	1000.00
A-15	18.50	5.00	1000.00
B-1	1.07	15.00	33.50
B-5	7.00	5.33	182.00
B-10	13.00	5.00	673.00
B-15	20.67	5.00	978.67
C-1	1.10	13.33	57.83
C-5	6.33	5.13	238.33
C-10	13.33	5.00	1000.00
C-15	19.00	5.00	1000.00
	r^2 =	**0.55**	**0.79**

Nutrients Sampling

- 2013 samples taken from two project sites
- Concentrations were found to decrease from upstream sites to downstream at both locations.
- Both sites receive run-on from agricultural land (versus urban)

Results

Nutrient Values at Ankeny Site

Nitrate + Nitrite nitrogren as N

Date	Location	Method	Value
4/30/2013	Upstream	SHL	**29 mg/L**
4/30/2013	Downstream	SHL	**29 mg/L**
6/17/2013	**Fertilizer Application**		
6/25/2013	Upstream	SHL	**23 mg/L**
6/25/2013	Downstream	SHL	**22 mg/L**
6/25/2013	Upstream	Strips	**Nitrate 0 Nitrite 20 (mg/L)**
6/25/2013	Downstream	Strips	**Nitrate 0 Nitrite 20 (mg/L)**

Total Phosphorus as P

Date	Location	Method	Value
4/30/2013	Upstream	SHL	**0.05 mg/L**
4/30/2013	Downstream	SHL	**0.05 mg/L**
6/17/2013	**Fertilizer Application**		
6/25/2013	Upstream	SHL	**0.25 mg/L**
6/25/2013	Downstream	SHL	**0.30 mg/L**
6/25/2013	Upstream	Kit	**Water too cloudy**
6/25/2013	Downstream	Kit	**Water too cloudy**

Results

Nutrient Values at Ankeny Site

Nitrate + Nitrite nitrogren as N

Date	Location	Method	Value
9/5/2013	Upstream	SHL	**< 0.10 mg/L**
9/5/2013	Downstream	SHL	**< 0.10 mg/L**
9/5/2013	Upstream	Strips	**Nitrate 0 Nitrite 0 (mg/L)**
9/5/2013	Downstream	Strips	**Nitrate 0 Nitrite 0 (mg/L)**
9/9/2013	**Fertilizer Application**		
9/23/2013	Upstream	SHL	**< 0.10 mg/L**
9/23/2013	Downstream	SHL	**< 0.10 mg/L**
9/23/2013	Upstream	Strips	**Nitrate 0 Nitrite 20 (mg/L)**
9/23/2013	Downstream	Strips	**Nitrate 0 Nitrite 20 (mg/L)**

Total Phosphorus as P

Date	Location	Method	Value
9/5/2013	Upstream	SHL	**2.5 mg/L**
9/5/2013	Downstream	SHL	**0.54 mg/L**
9/5/2013	Upstream	Kit	**Too Green**
9/5/2013	Downstream	Kit	**Too Green**
9/9/2013	**Fertilizer Application**		
9/23/2013	Upstream	SHL	**0.90 mg/L**
9/23/2013	Downstream	SHL	**1.0 mg/L**
9/23/2013	Upstream	Kit	**3 mg/L**
9/23/2013	Downstream	Kit	**Water too cloudy**

What did we learn?

- Transparency tubes may be used as a surrogate for turbidity sampling.
  - High degree of confidence in correlation (field and lab)
  - Works well as a simple data collection tool. (Triage, rapid response)
  - Accuracy/precision are sacrificed for economics
- Field sampling (in general) incurs a high degree of variables
  - Active construction sites incur even more.
  - Turbidity is just one measureable factor.
  - Land use activity, pre-mid-post construction conditions also highly relevant data.
  - Local contacts for sample collection are critical (versus having to travel long distance)
  - There are options when it comes to weather alert systems.

What *else* did we learn?

- Nutrient concentrations from DOT construction sites are not necessarily significant contributors to overall nutrient loading in water bodies. (However sediment does transport nutrients.)
- A single conversion chart may be used to reference turbidity for transparency as a means of rapid field data collection.
- Phosphorus levels in upstream samples indicate a high nutrient concentration in water before it reached two DOT sites.

Questions/Comments?

Thank you!