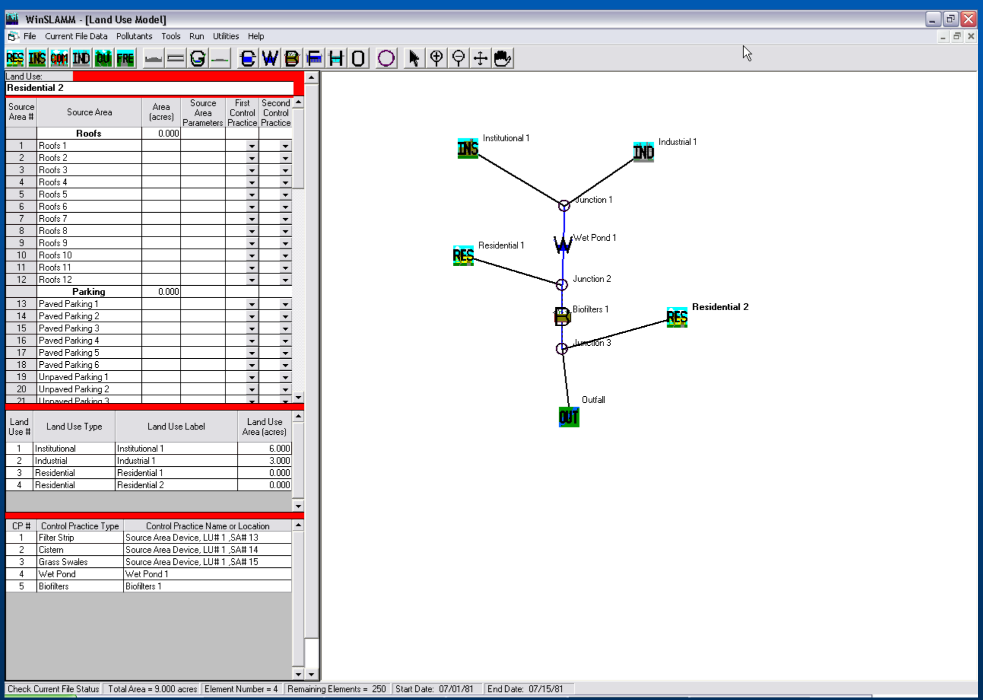
Stormwater Modeling – Formula for Success

Regional Monitoring Program Annual Meeting

Roger Bannerman
October 9, 2012

What are We Going Cover ?



1. Justification for WI Performance Standards.
2. Performance by Design – Steps in Modeling Sources and Practice Effectiveness
3. Reducing Uncertainty – Monitoring Results
4. Example Stormwater Plan.

Institutional Process

State Statute ***(281.16)***

Describe intent

Administrative Rules

Establish specific goals: Performance standards

Local Ordinances

Technical Standards

How to achieve performance standards

The Runoff Management Rules (NR 151)

TMDLs

Reduce:
Phosphorus,
Bacteria,
Turbidity

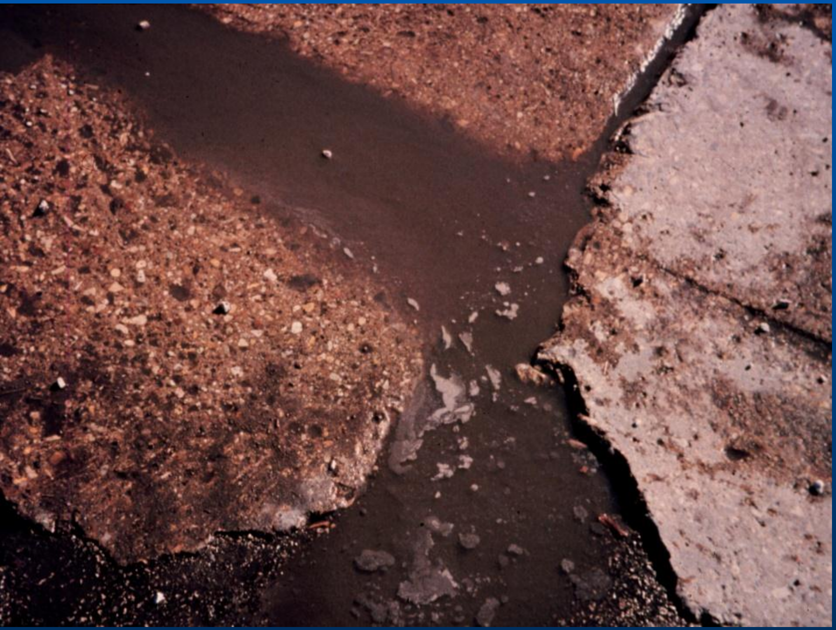
Post-Construction Performance Standards – Suspended Solids

For New Development, by design, Reduce to the MEP the Average Annual Total Suspended Solids Load by 80% as Compared to No Runoff Management Controls.

Reduce Average Annual Total Suspended Solids Load by 40% for Redevelopment.

Developed Area Performance Standards – Stage 1& 2

Permitted Municipalities Must:



- Stage 1: Reduce TSS by 20% as Compared to No Controls (by 2008).
- **Stage 2: Reduce TSS by 40% as Compared to No Controls (by 2013).**

Example of Water Samples Collected From Residential Storm Sewers – Total Suspended Solids

% Total P that is Particulate

Mixed Land Use – 60%
(Bannerman, 1996)

Med. Resid. – 74 %

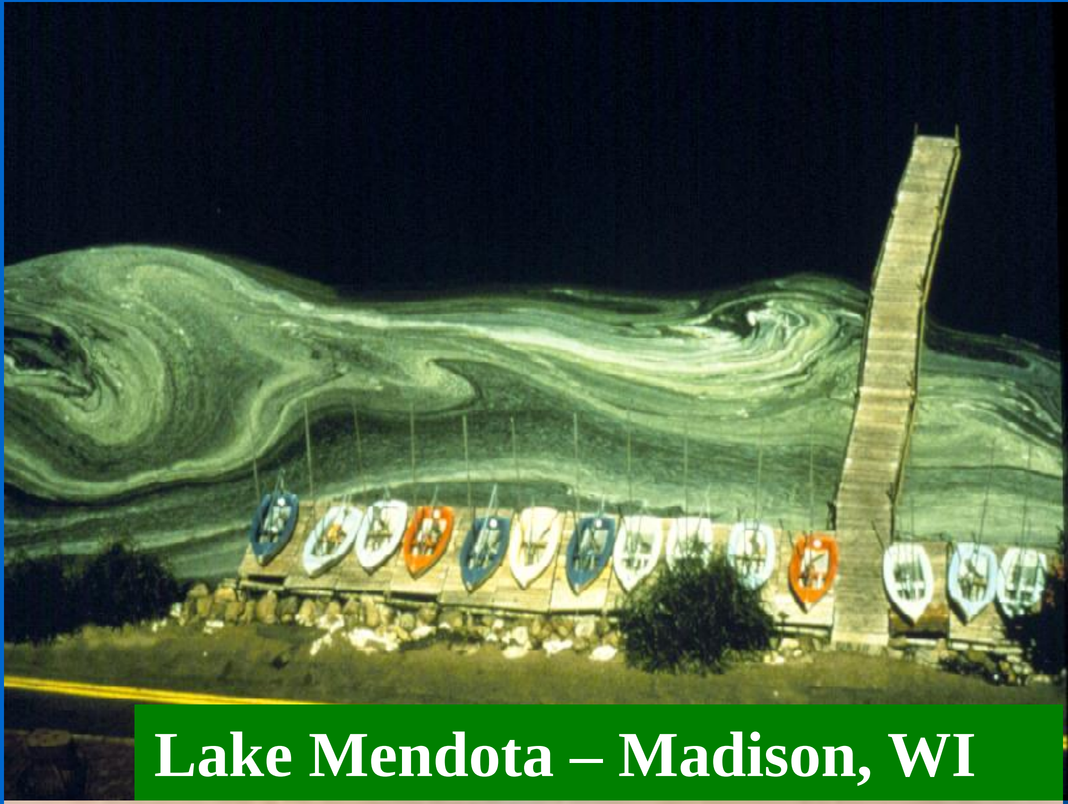
(Selbig, 2007)

Parking Lot – 72 %

(Horwatich, 2004)

Milwaukee Streams – 87 %

(Bannerman,1996)



% Copper and (Zinc) that is Particulate

Mixed Land Use – 75%
(55%) (Bannerman, 1996)

Med. Resid. – 84 %

(80%) (Selbig, 2007)

Freeway – 74 %

(78%) (Horwatich, 2011)

***Milwaukee Streams* – 76 %**
(64%) (Bannerman,1996)

Steps in Stormwater Modeling to Achieve MS4 Permit TSS Reduction Requirements

- Select and Calibrate Urban Water Quality Model
- Use Computer Model to Calculate TSS Loads *(by Drainage Area, Landuse, and Source Area)* for "No Control" Condition
- Determine Existing % Control for the City
- Identify Additional Measures Needed to Meet Required TSS Reduction
  - *Include regional and source control measures*
  - *Select Most Cost Effective Combination of Stormwater Control Measures*
- Implement Plan

Example Sediment Pollution Goal Calculation

Must achieve 40% reduction of Total Suspended Solids

1. "Base" (no management) Condition = **1,000 tons/yr**
2. 40% Reduction Goal = **600 tons/yr** (reduce by 400 tons)
3. Existing Management Condition = **850 tons/yr**
4. Thus, Existing Management = **15% Reduction**
5. Must Further Reduce TSS by: **250 tons / yr to reach 40%**

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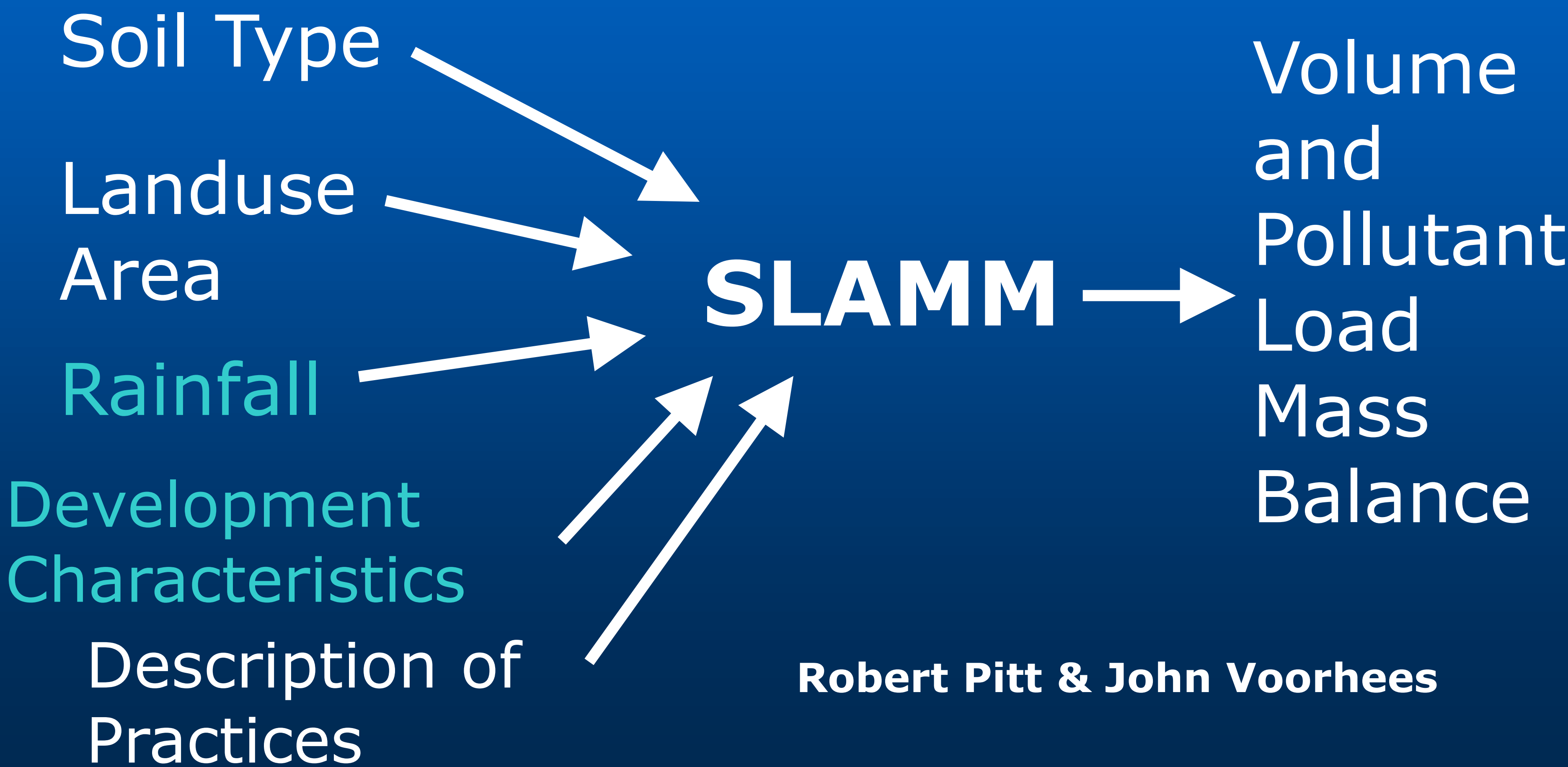
WDNR Modeling Guidelines

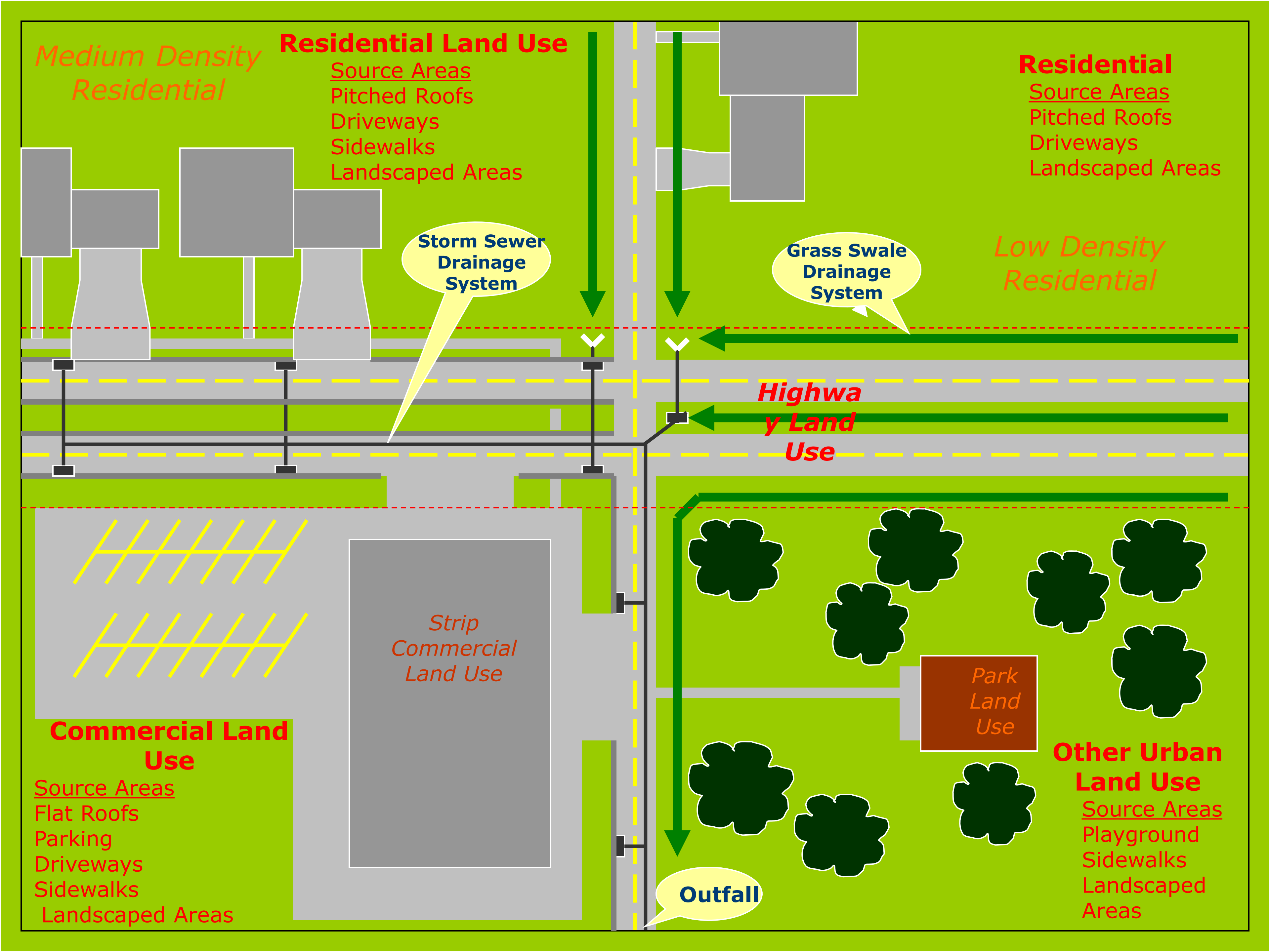
- Rainfall data standardized (5 regions)
- Municipal land use represented by DNR defined land use files.
- Requirements for determining "Analyzed Area"
- "Base Conditions" drainage system standardized
- Each Existing and Proposed BMPs included in modeling

Modeling Guidelines create Consistency

Source Loading and Management Model (SLAMM) Inputs and Outputs



Robert Pitt & John Voorhees

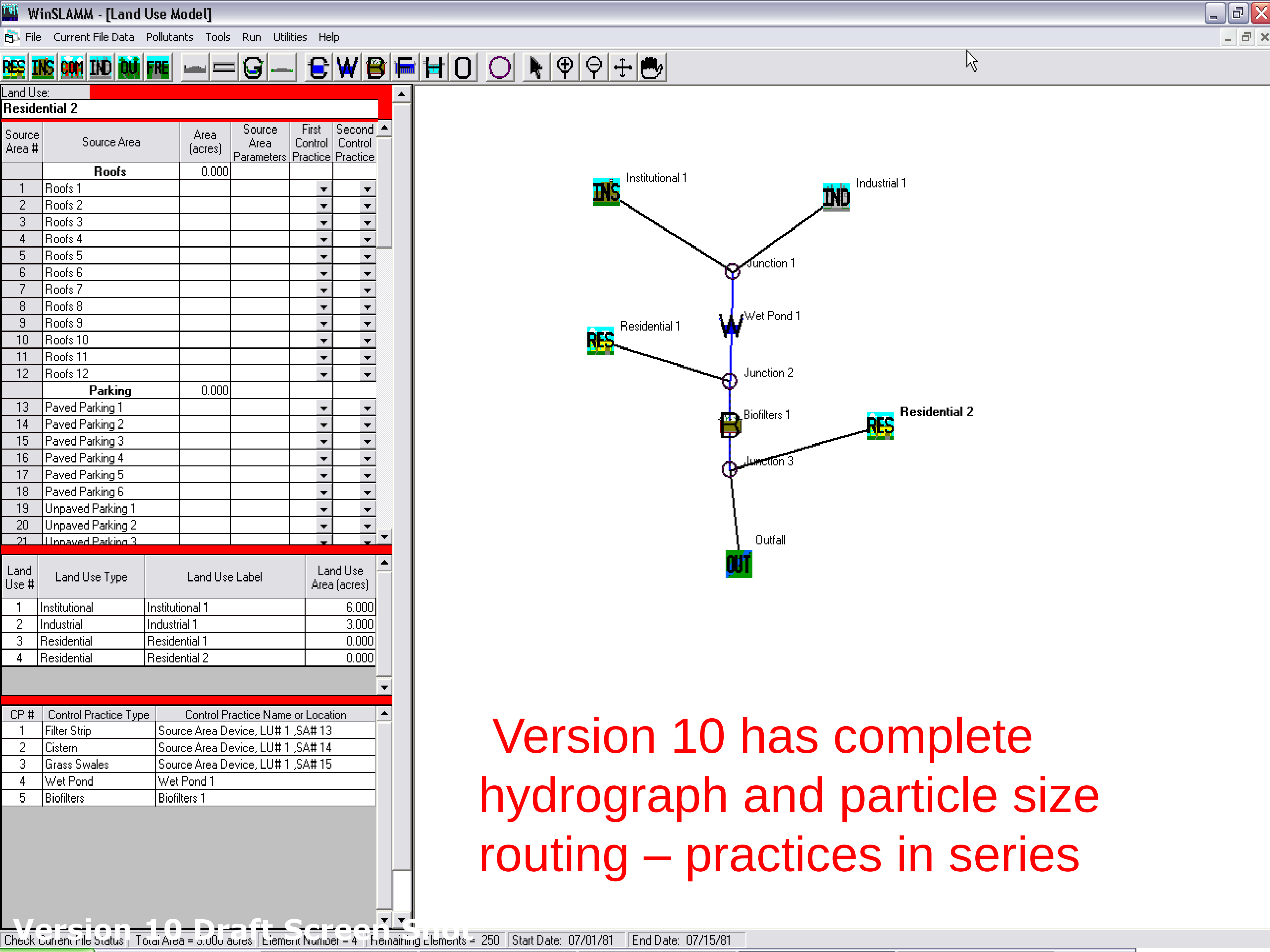


Medium Density Residential
Residential Land Use
Source Areas
Pitched Roofs
Driveways
Sidewalks
Landscaped Areas
Residential
Source Areas
Pitched Roofs
Driveways
Landscaped Areas
Storm Sewer Drainage System
Grass Swale Drainage System
Low Density Residential
Highway Land Use
Strip Commercial Land Use
Commercial Land Use
Source Areas
Flat Roofs
Parking
Driveways
Sidewalks
Landscaped Areas
Park Land Use
Other Urban Land Use
Source Areas
Playground
Sidewalks
Landscaped Areas
Outfall

2. Control Devices Included in WinSLAMM

- Hydrodynamic devices
- Development characteristics
- Wet detention ponds
- Porous pavements
- Street cleaning
- Green/blue roofs
- Catchbasin cleaning
- Grass swales and grass filtering
- Biofiltration and bioretention
- Water tanks and stormwater use
- Media filtration/ion exchange/sorption



Version 10 has complete hydrograph and particle size routing – practices in series

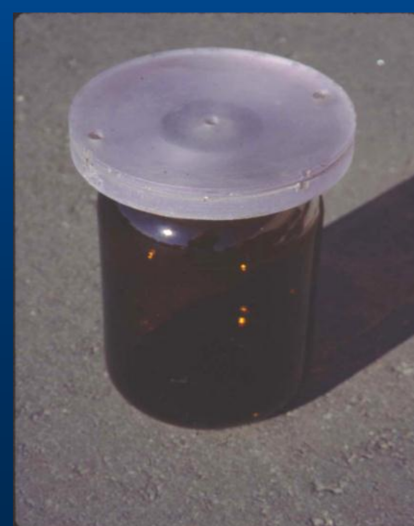
Model Strength – Based on Extensive Field Monitoring Data:

- **Source Areas – Roofs, Streets, etc.**
- **End of Pipe – Many Land uses**
- **Stormwater Control Practices**

Lawn Sheet Flow Sampler: Tipping Bucket for Flow and Cone Splitter for Water Sample

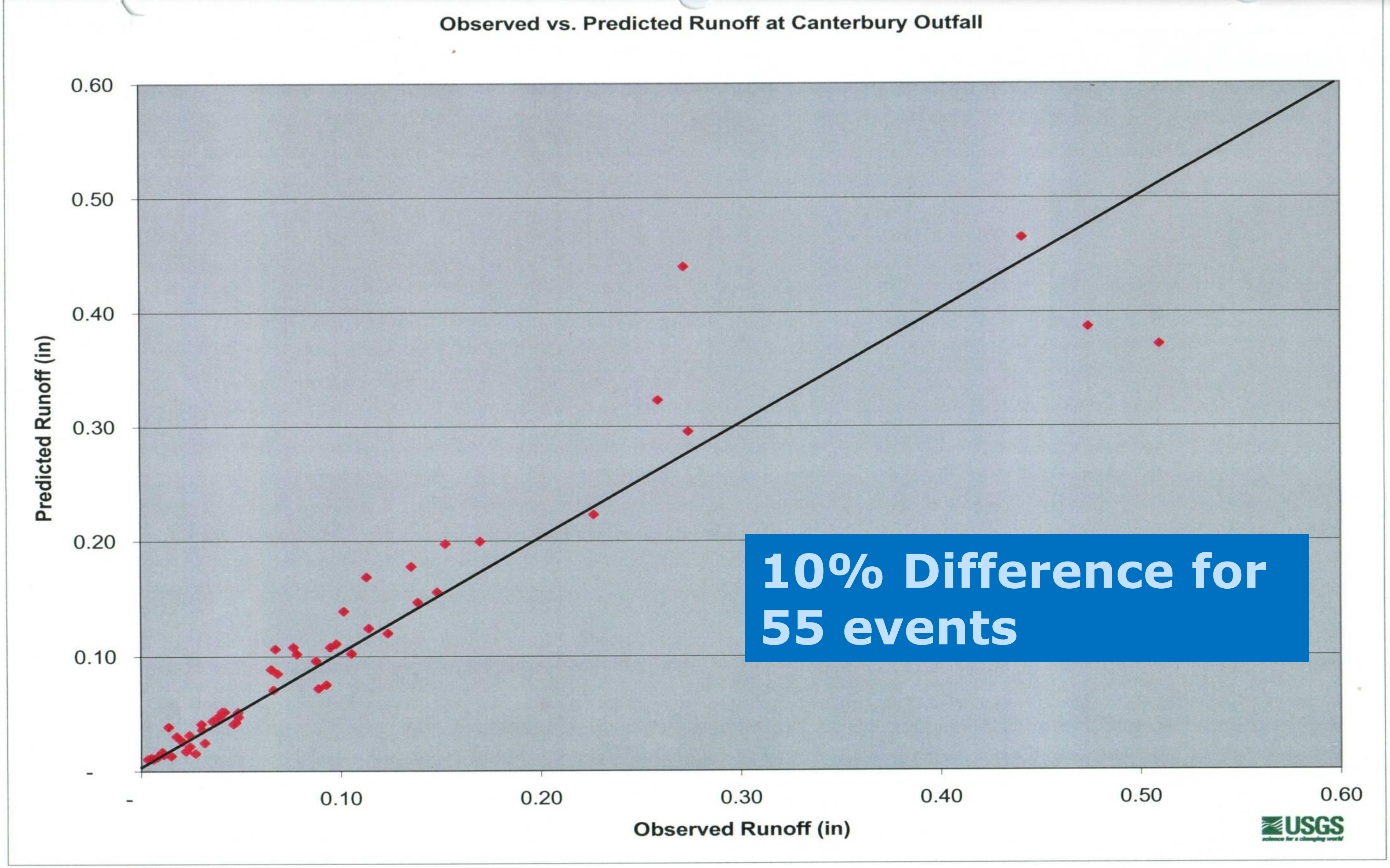


Source Area Sampling

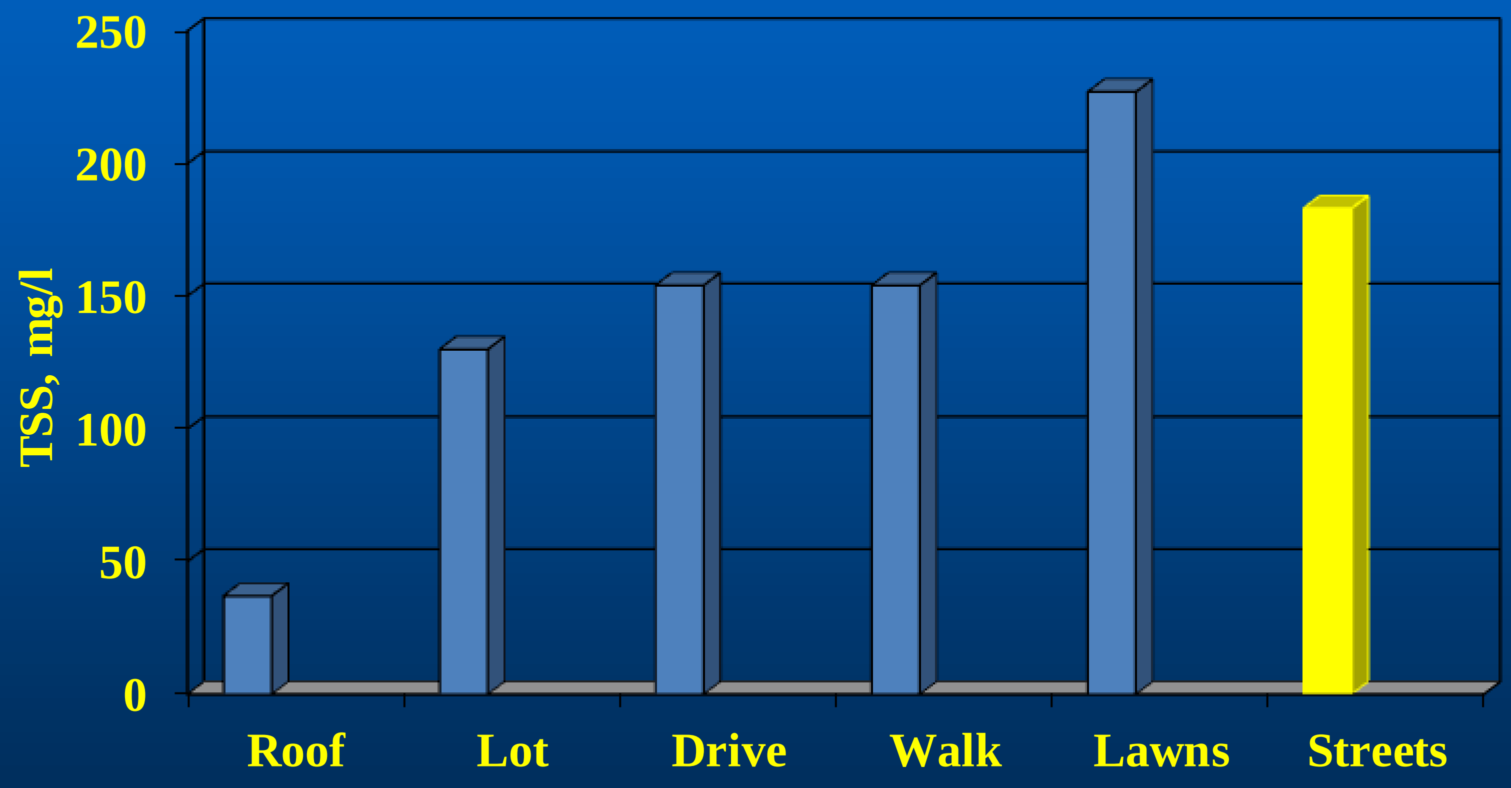

End of Pipe Monitoring :Mass Balance

Model Results for Mixed Resid. / Comm. Landuse – 984 acres



Draft 5/16/01

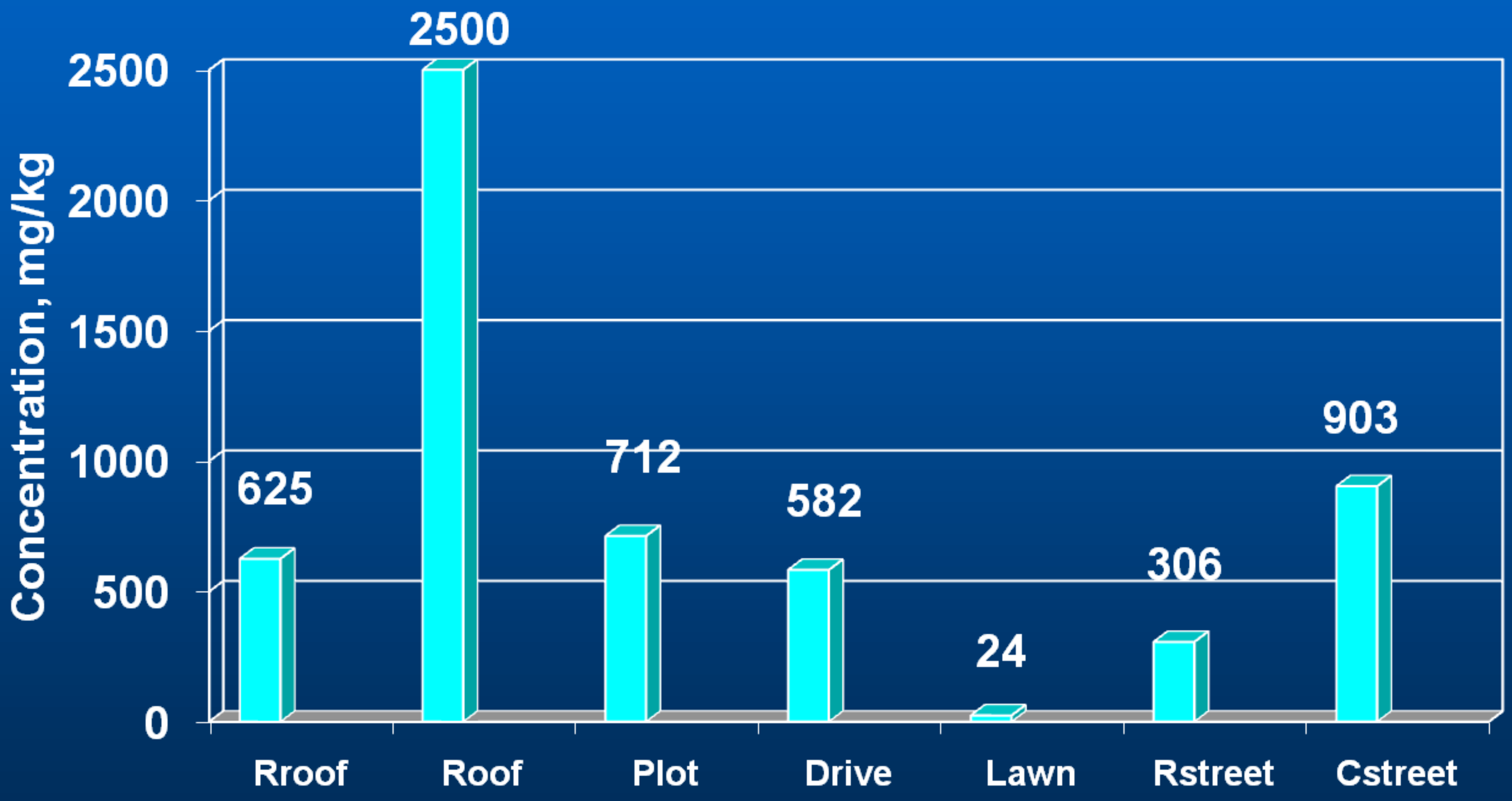
Residential TSS Concentrations Used in SLAMM - .psc



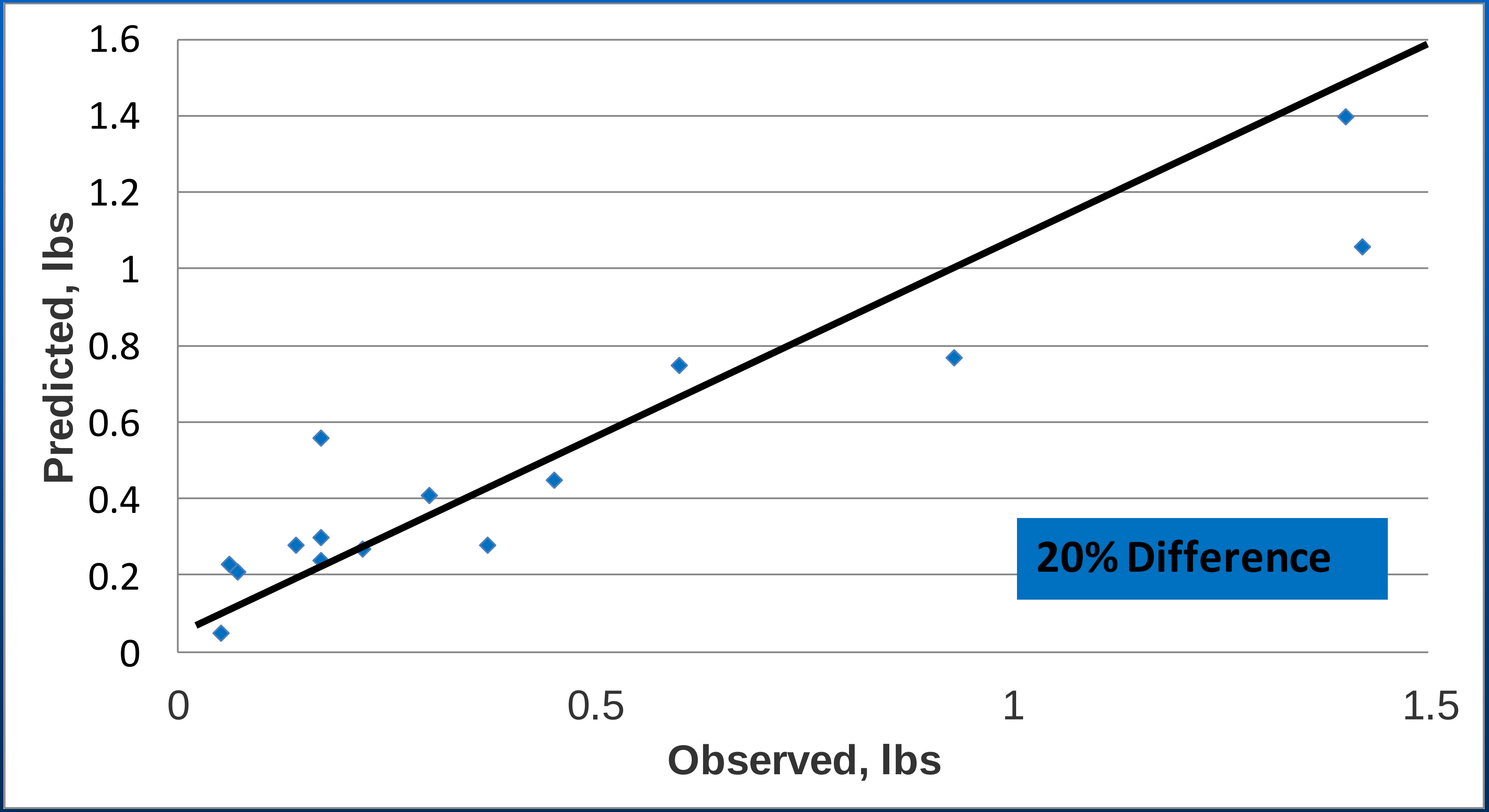
Comparison of Measured and Predicted Suspended Solids Loads

Site	Landuse	Percent Difference
Harper	Residential	11%
Marquette	Resid./Comm.	28%
Canterbury	Resid./Comm.	35%
Superior	Commercial	-30%
Syene	Light Industrial	1%
Badger Rd.	Light Industrial	-14%

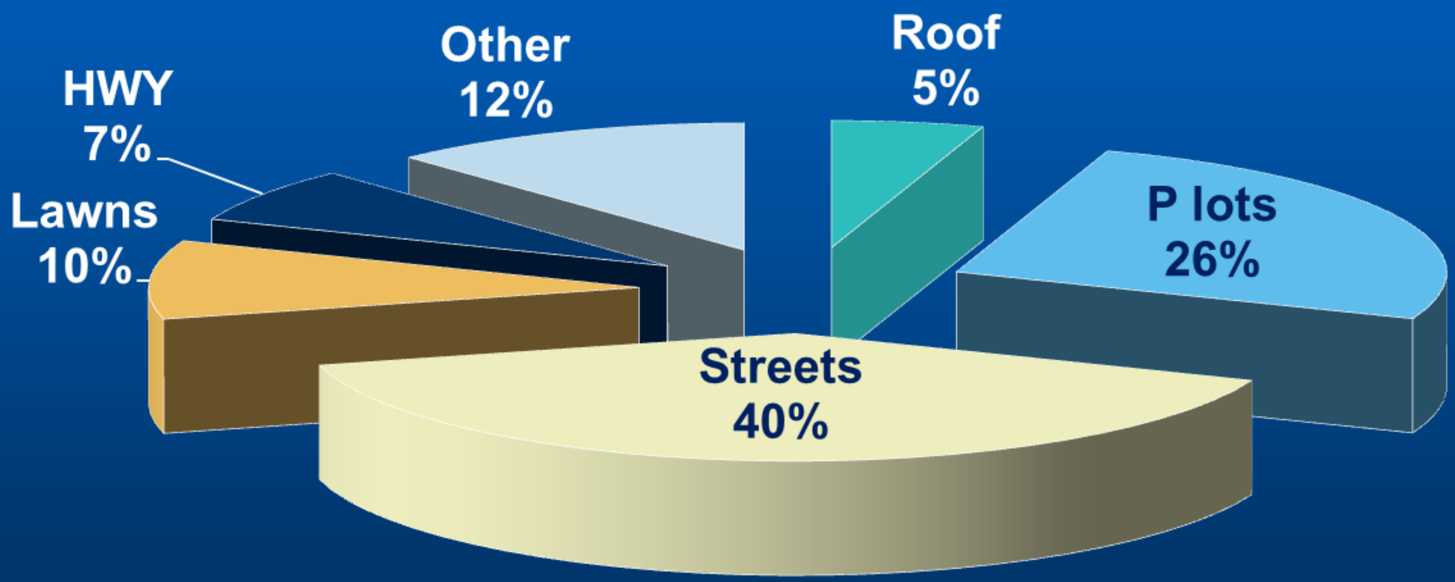
Zinc Concentrations in Runoff from Source Areas



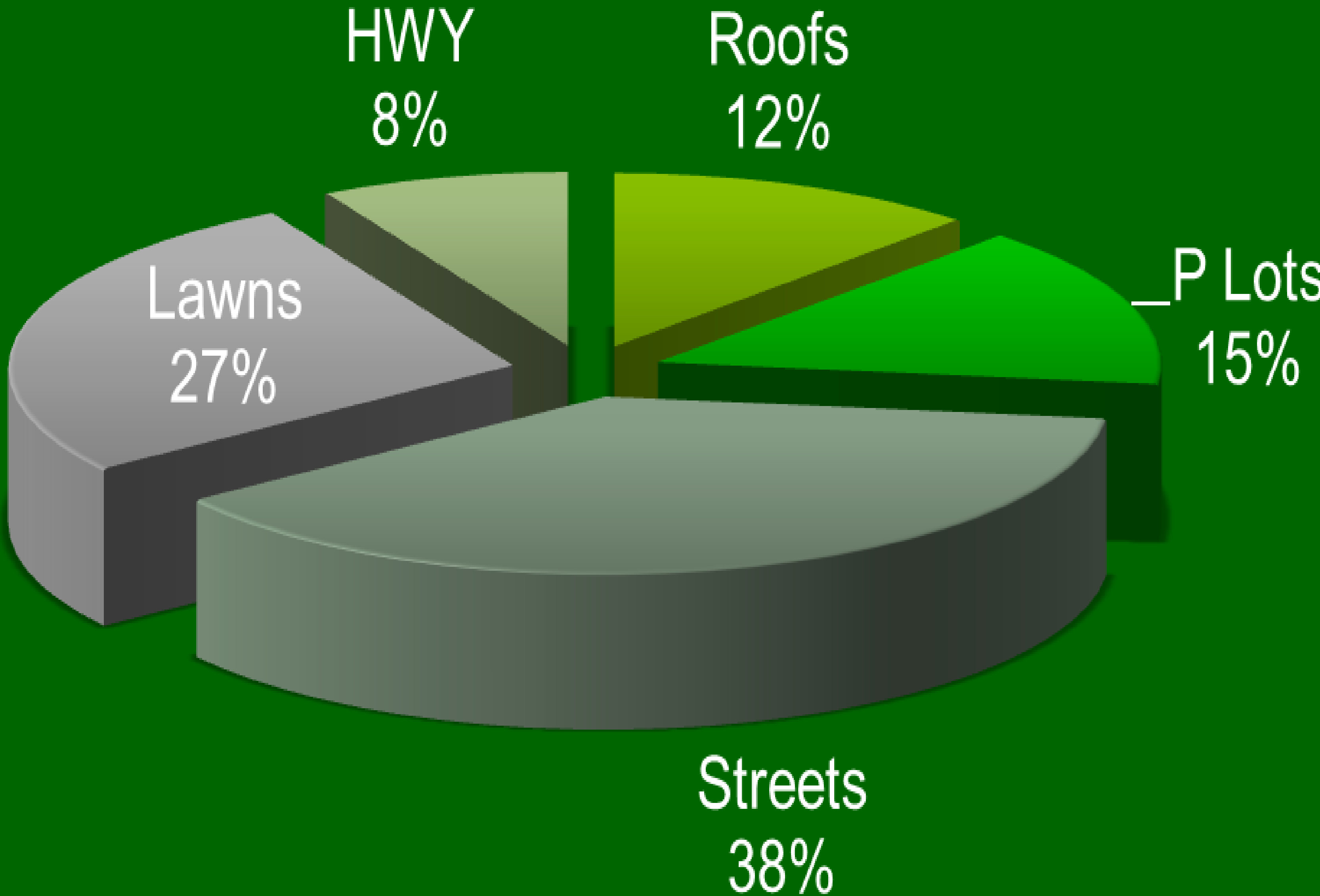
Observed VS. Predicted for Total Zn at Superior – 22 acres



% Suspended Solids Loads from Source Areas in 4 Subwatersheds



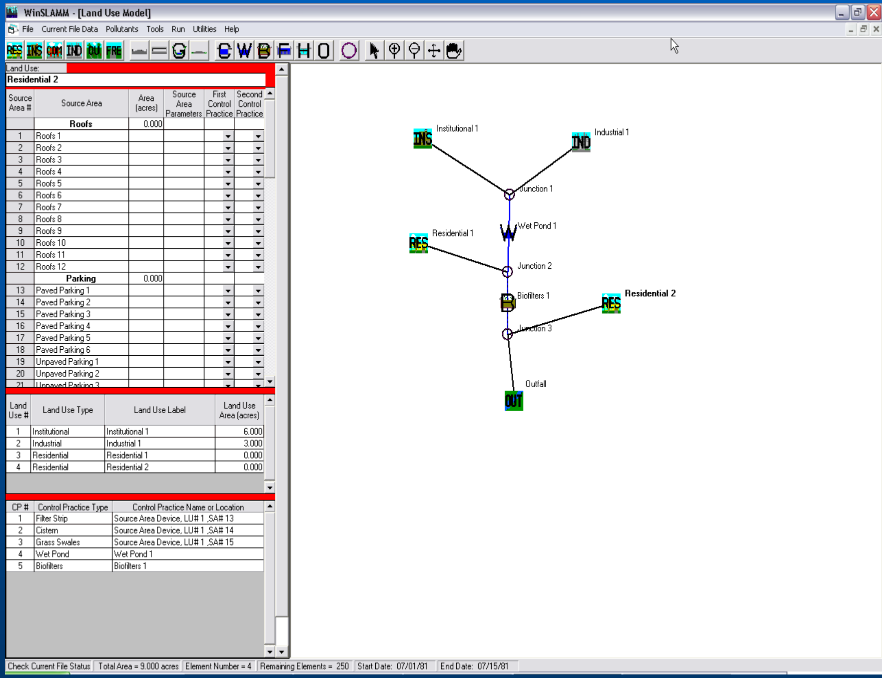
% Total P Loads for Four Subwater-sheds in Lake Wingra Basin



New Source Area Sampling

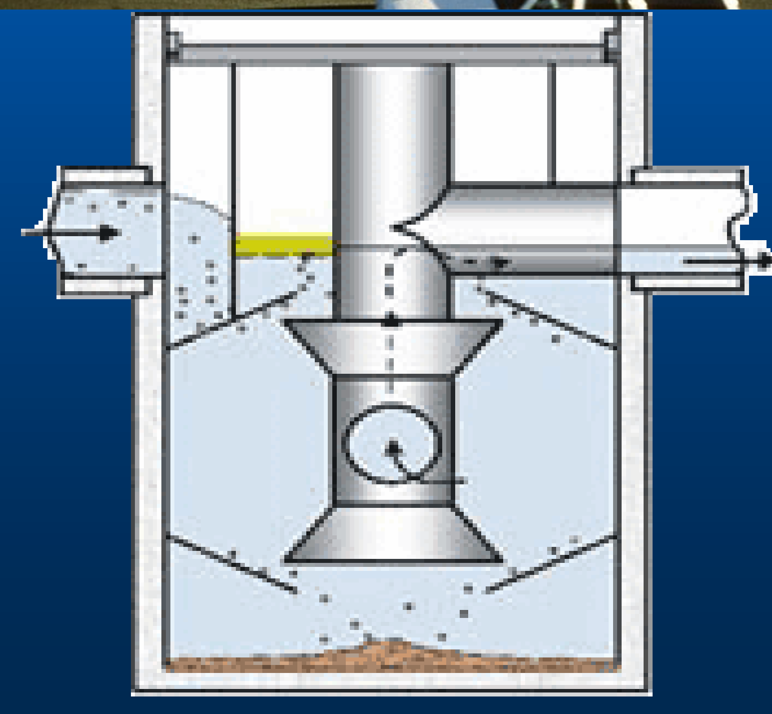
Monitoring to Reduce Uncertainty in Technical Standards & Model

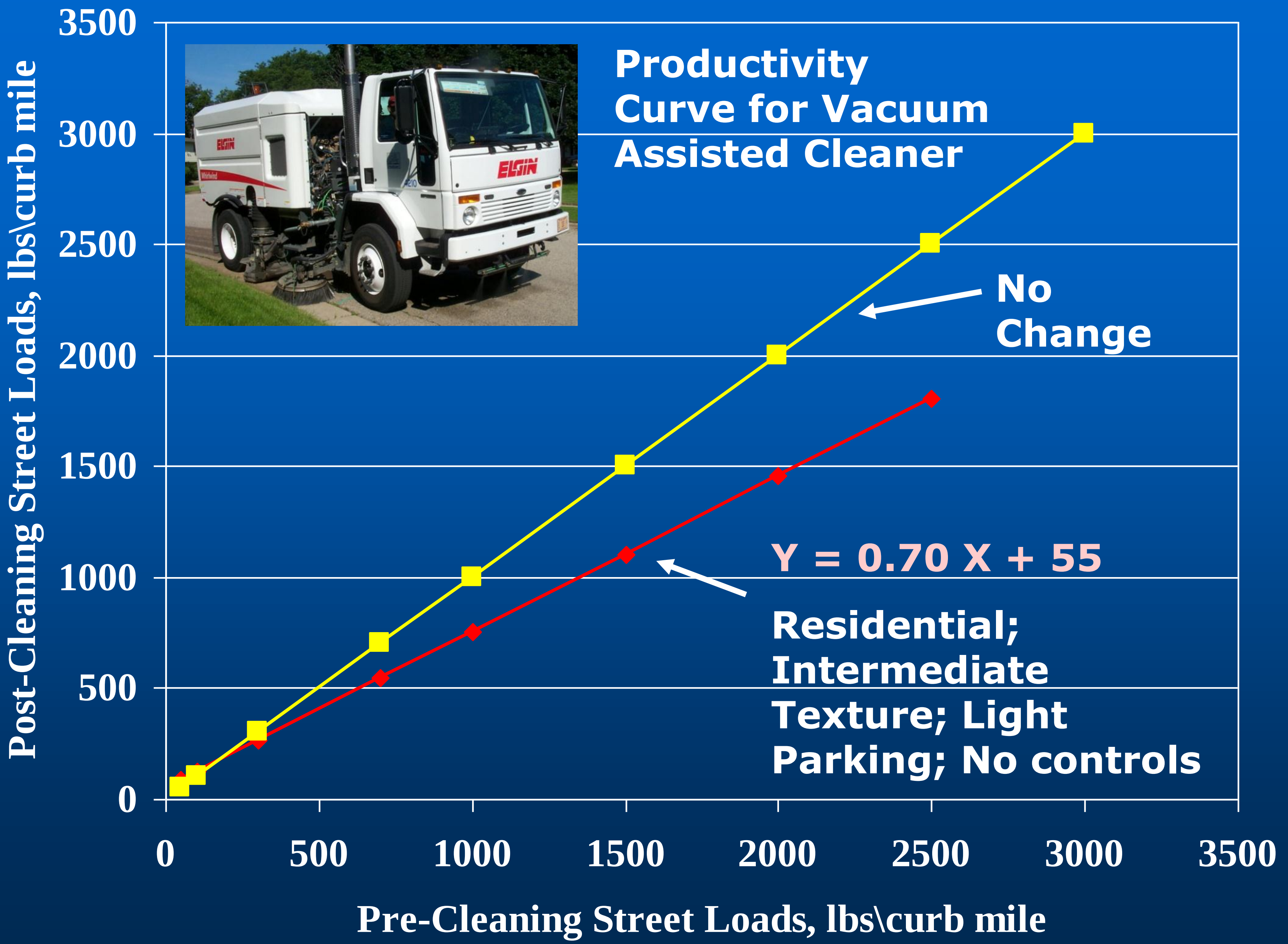
- Site Evaluation Standard
- Bioretention Standard
- Infiltration Basin Standard
- Grass Swale Standard
- Rain Garden Standard
- Hydrodynamic Separator Std
- Wet Detention Pond Standard
- Proprietary Filters



WinSLAMM Version 10 – Stormwater Management Practices in Series




11/3/2003




Productivity Curve for Vacuum Assisted Cleaner
No Change
Y = 0.70 X + 55
Residential; Intermediate Texture; Light Parking; No controls
Post-Cleaning Street Loads, lbs\curb mile
Pre-Cleaning Street Loads, lbs\curb mile
0
500
1000
1500
2000
2500
3000
3500
ELGIN

Example:

City of Fond du Lac, WI

- Population: 45,000
- Area: 12,870 acres

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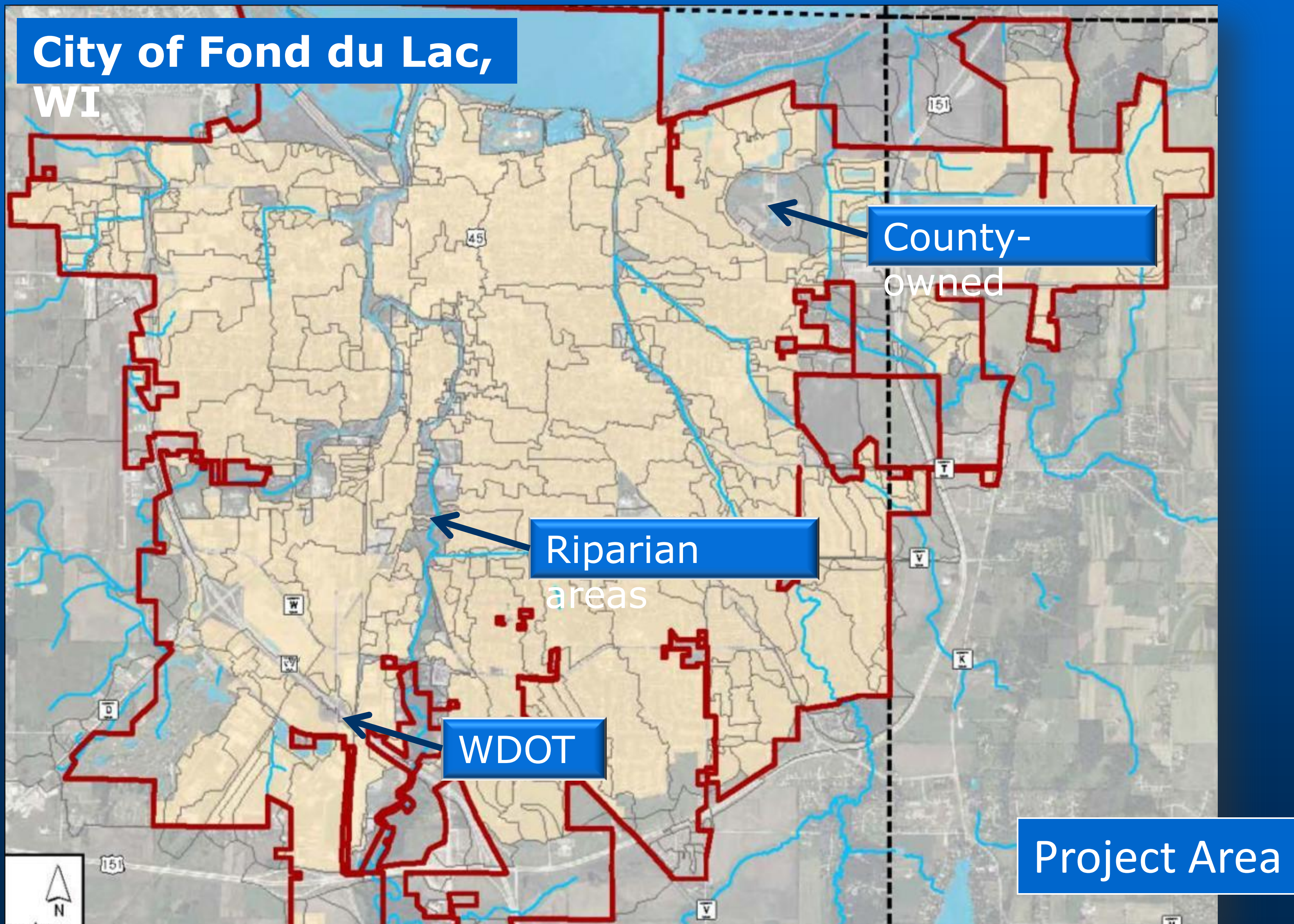
City-wide Analysis For MS4 Permit Compliance - *Existing Urban Land*



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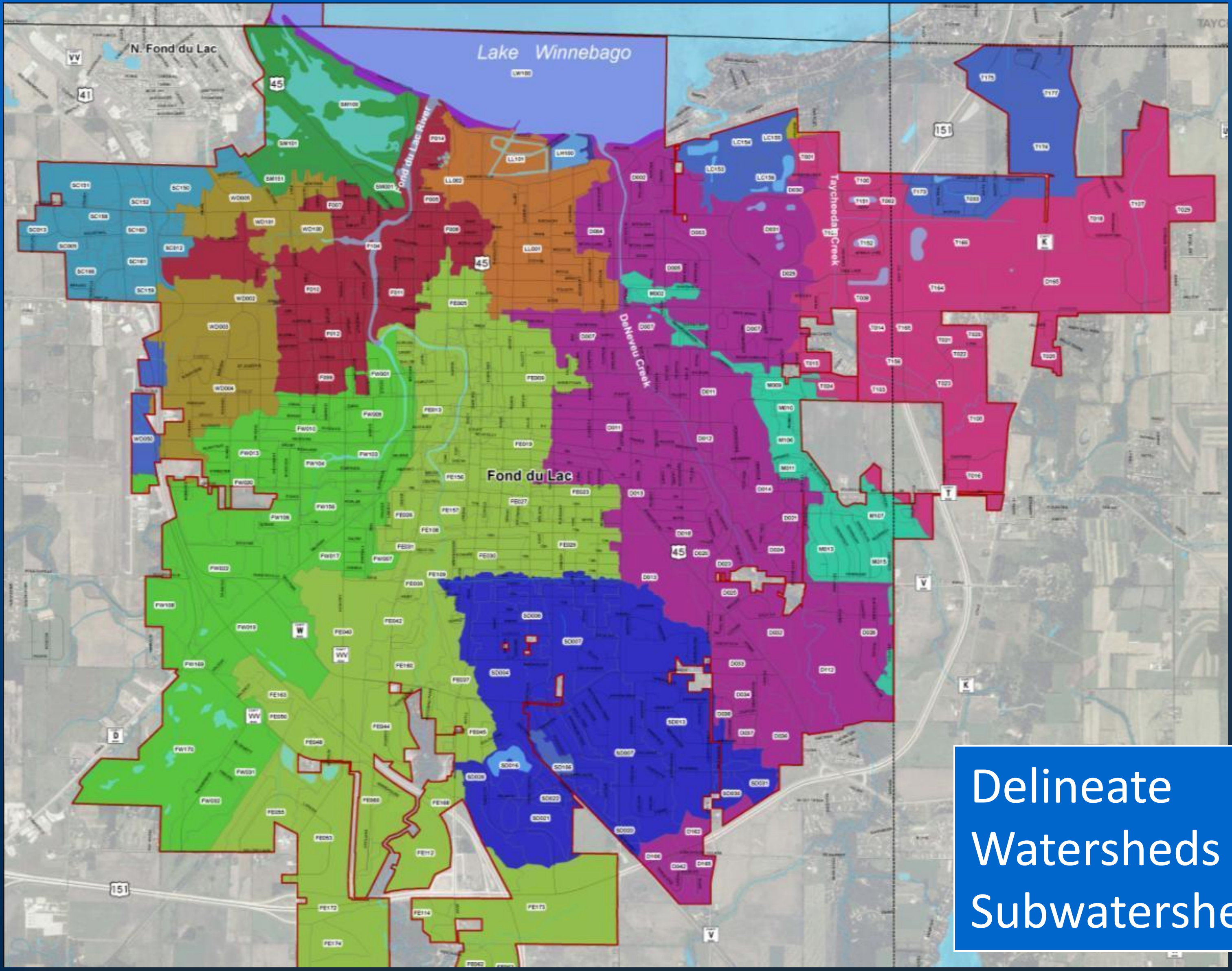
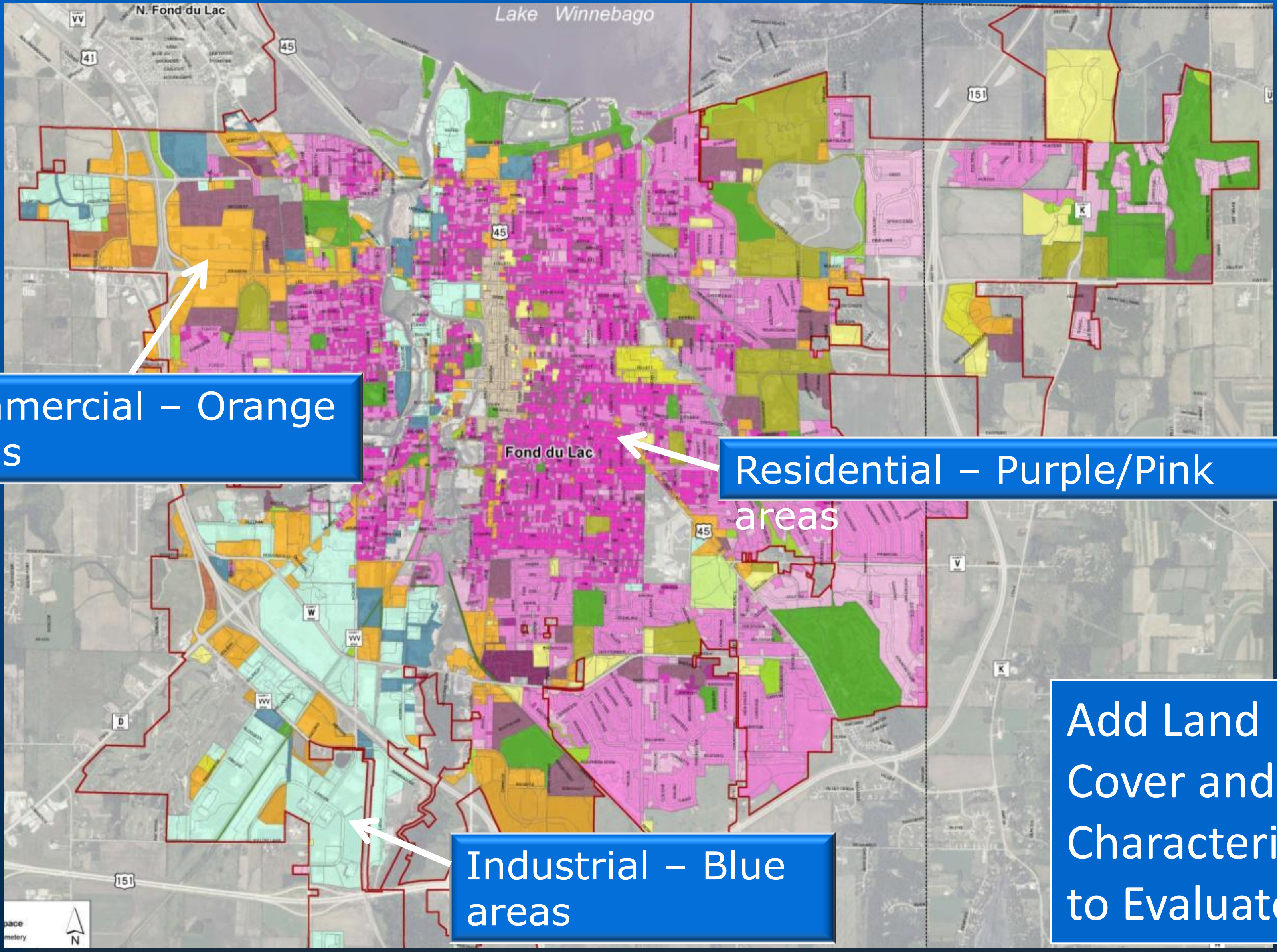


Delineate Watersheds and Subwatersheds…

City-wide Analysis For MS4 Permit Compliance - *Existing Urban Land*



Commercial – Orange areas

Residential – Purple/Pink areas

Industrial – Blue areas

Add Land Cover and Soil Characteristics to Evaluate…

How is MS4 Permit Pollution Reduction Requirement Met?

- Use Computer Model to Calculate Sediment Pollution Quantity
  - "Base" (no management) Condition

Base Load = 1,298 Tons TSS/Year

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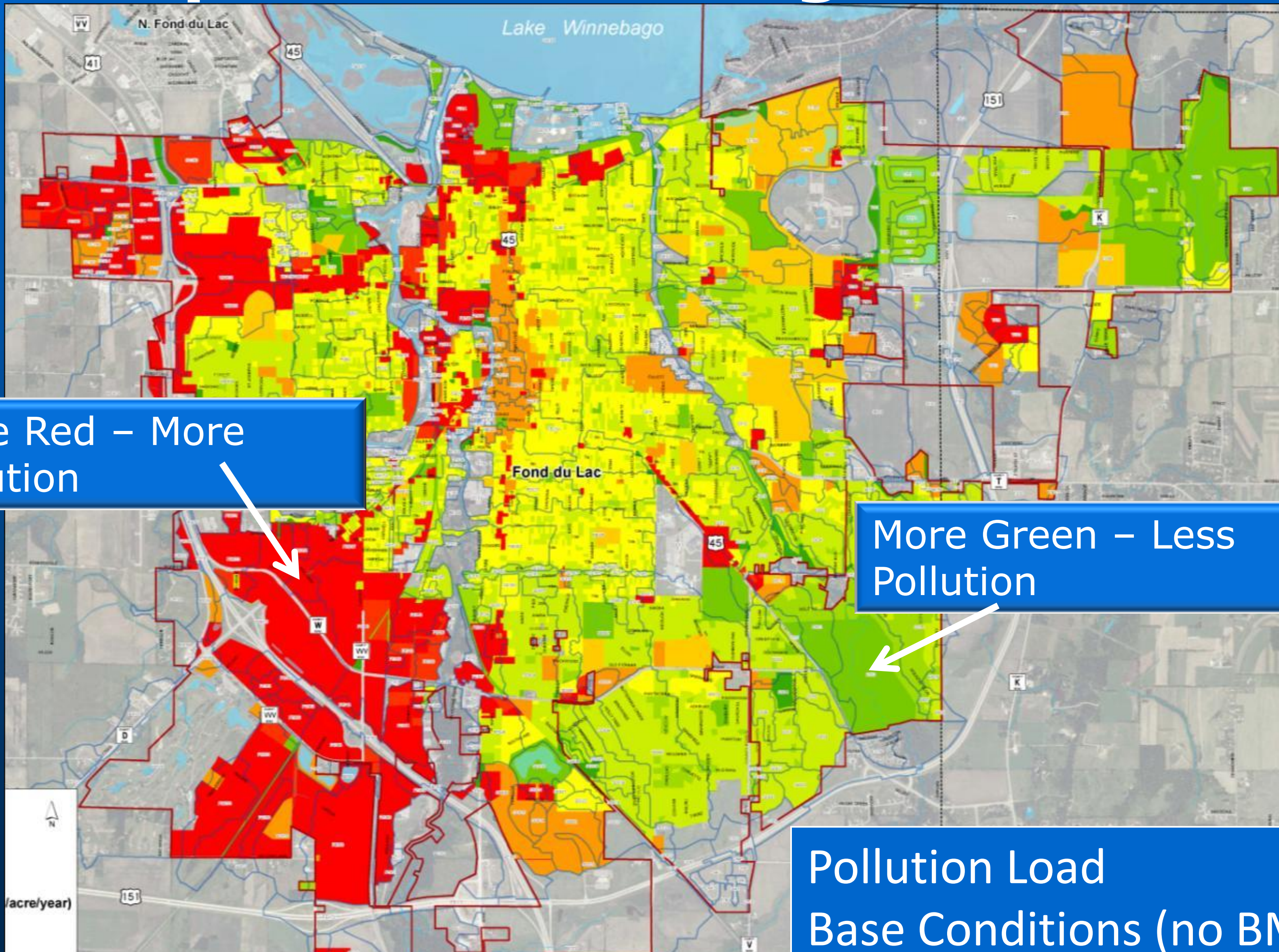
City-wide Analysis For MS4 Permit Compliance - *Existing Urban Land*



More Red – More Pollution

More Green – Less Pollution

Pollution Load
Base Conditions (no BMPs)

How is MS4 Permit Pollution Reduction Requirement Met?

- Use Computer Model to Calculate Sediment Pollution Quantity
  - "Base" (no management) Condition
- Determine Existing % Control for the City

Existing Load (in 2006) =
1,122 Tons TSS/Year or 13.6% Reduction

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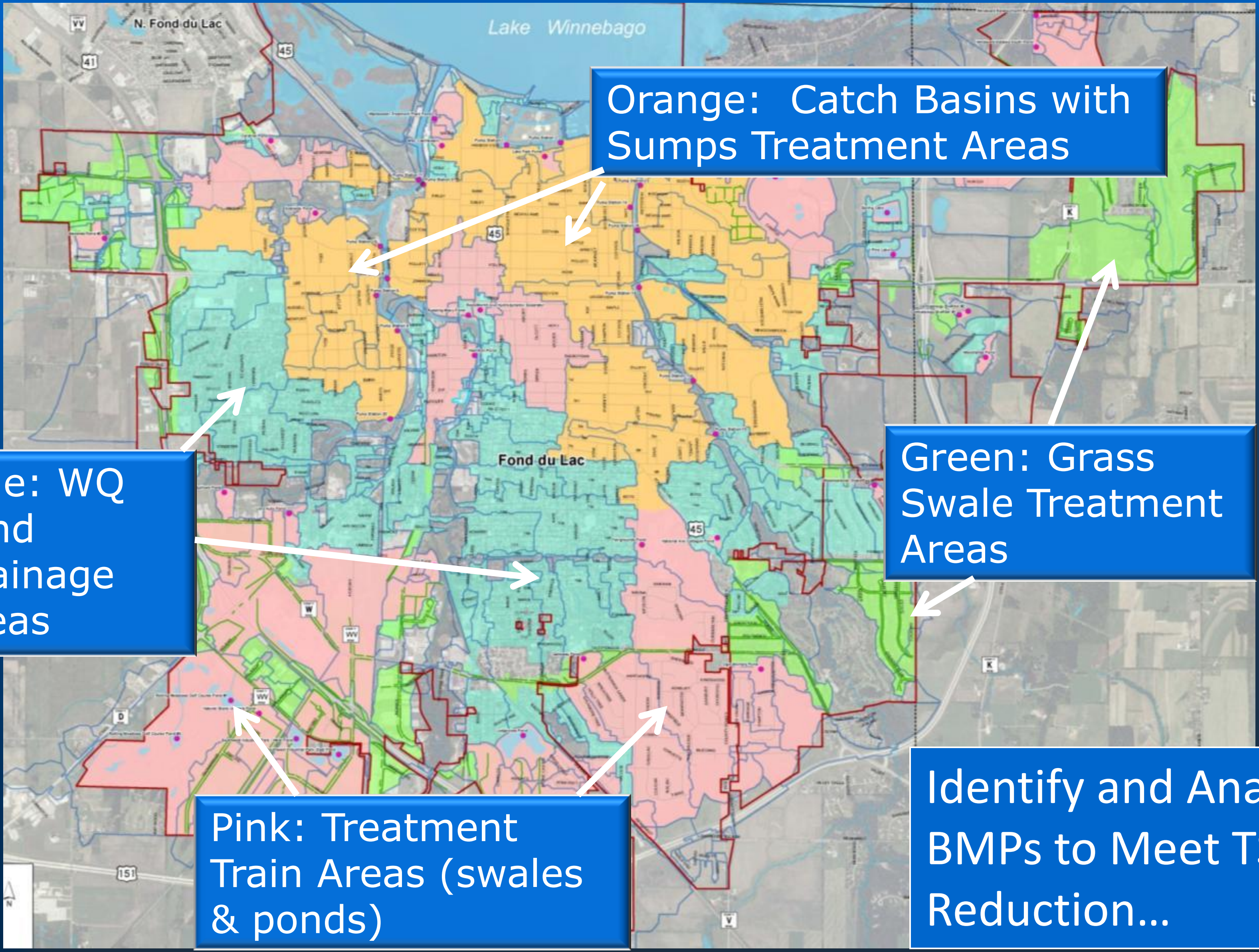
Stormwater Management Plan

- Current city management measures
  - Street sweeping
  - Wet detention basins
  - Roadside drainage swales
  - Fall leaf pick-up

- Currently reducing pollution by 13%

City-wide Analysis For MS4 Permit Compliance - *Existing Urban Land*



Orange: Catch Basins with Sumps Treatment Areas

Blue: WQ Pond Drainage Areas

Green: Grass Swale Treatment Areas

Pink: Treatment Train Areas (swales & ponds)

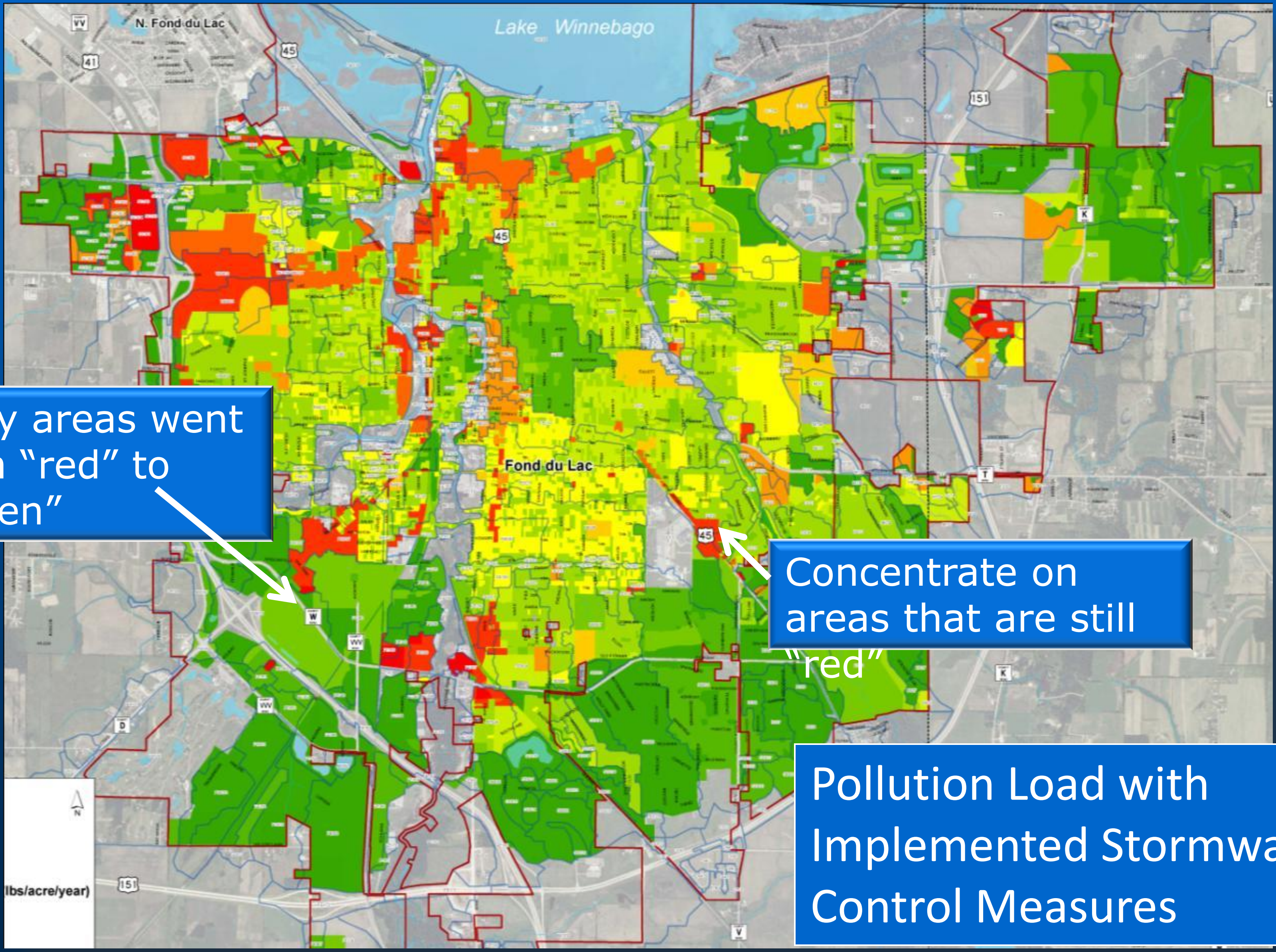
Identify and Analyze BMPs to Meet TSS Reduction…

How is MS4 Permit Pollution Reduction Requirement Met?

- Use Computer Model to Calculate Sediment Pollution Quantity
  - “Base” (no management) Condition
- Determine Existing % Control for the City
- Identify Measures to Meet Required Sediment Reduction

Post Implementation Load (in 2012) = 723 Tons TSS/Year or 44.3% Reduction

City-wide Analysis For MS4 Permit Compliance - *Existing Urban Land*



Many areas went from “red” to “green”

Concentrate on areas that are still “red”

Pollution Load with Implemented Stormwater Control Measures

Stormwater Management Plan

- To meet 40% reduction goal
  - Maintain current street cleaning practices
  - Maintain current stormwater control measures
  - Maintain catch basin sumps annually
  - Construct 5 new wet detention basins
  - Retrofit 2 existing wet detention basins
- Construction Cost = $4,354,400

- Design Fees = $329,200
- Estimated annual maintenance cost = $107,300

Steps in Stormwater Modeling to Achieve MS4 Permit TSS Reduction Requirements

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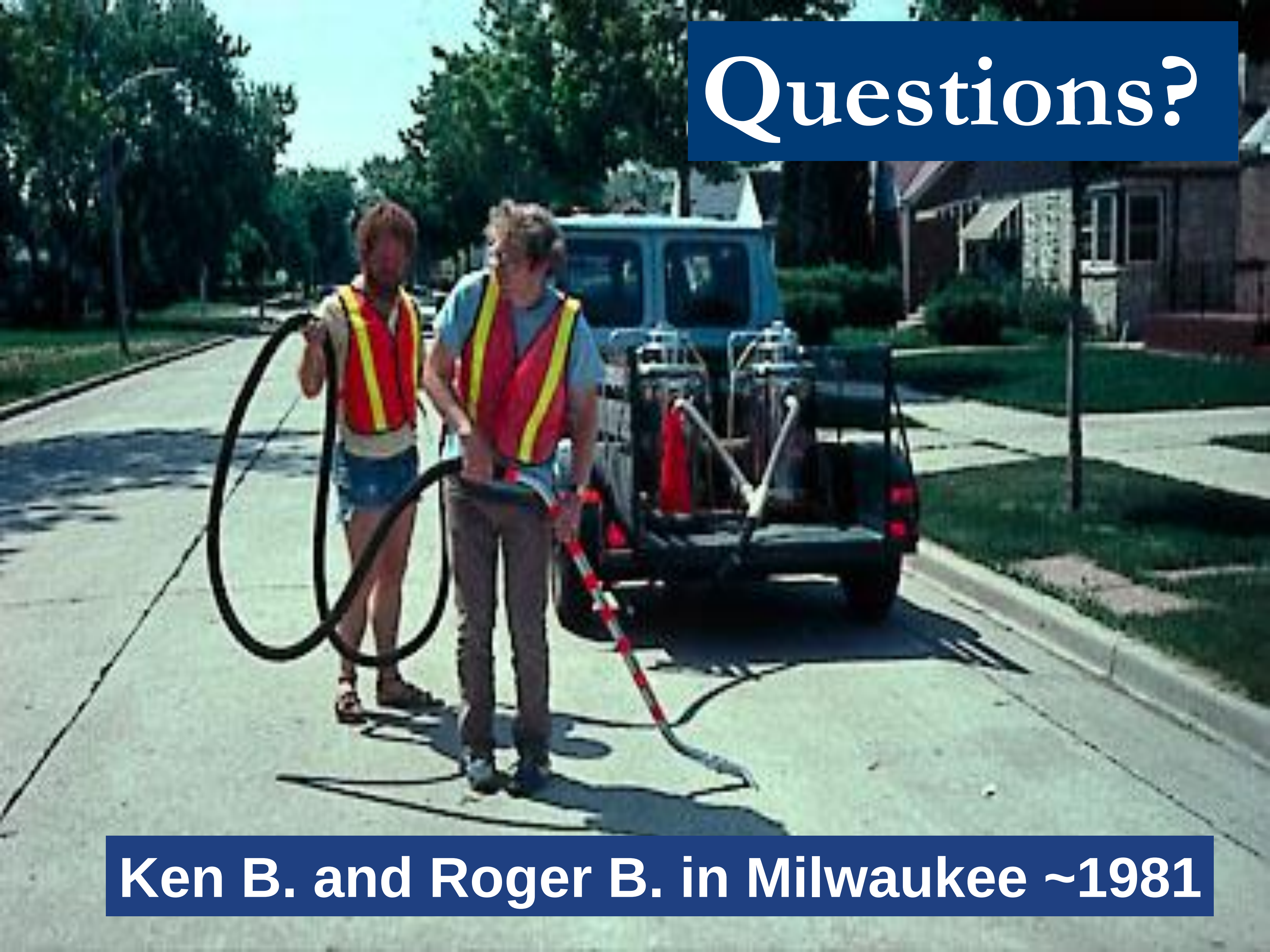
Questions?



Ken B. and Roger B. in Milwaukee ~1981