Model Calibration & Verification

Using WinSLAMM v10 to Meet Urban Stormwater Management Goals

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
Description of Seven Study Areas

<table>
<thead>
<tr>
<th>SITE</th>
<th>LAND USE</th>
<th>ACRES</th>
<th>FLOW</th>
<th>Conc.</th>
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<tbody>
<tr>
<td>Harper</td>
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<td>41</td>
<td>55</td>
<td>32</td>
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<tr>
<td>Monroe</td>
<td>Residential</td>
<td>232</td>
<td>75</td>
<td>71</td>
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<tr>
<td>Canterbury</td>
<td>Residential</td>
<td>964</td>
<td>55</td>
<td>23</td>
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<tr>
<td>Marquette</td>
<td>Resid/Com.</td>
<td>288</td>
<td>64</td>
<td>14</td>
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<td>Commercial</td>
<td>22</td>
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<td>21</td>
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<tr>
<td>Syene Rd.</td>
<td>Industrial</td>
<td>114</td>
<td>108</td>
<td>82</td>
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<tr>
<td>Badger Rd.</td>
<td>Maint. Yard</td>
<td>4</td>
<td>40</td>
<td>18</td>
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Marquette Michigan: Res/Comm. (288 acres)

Maintenance Yard Madison WI: 4 acres
<table>
<thead>
<tr>
<th>SITE</th>
<th>Number of Events</th>
<th>Measured Runoff</th>
<th>Modeled Runoff</th>
<th>Difference, %</th>
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<tbody>
<tr>
<td>Harper</td>
<td>55</td>
<td>7.3</td>
<td>5.3</td>
<td>-27%</td>
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<tr>
<td>Monroe</td>
<td>75</td>
<td>8.2</td>
<td>8.8</td>
<td>7%</td>
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<td>Canterbury</td>
<td>55</td>
<td>5.4</td>
<td>5.9</td>
<td>10%</td>
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<tr>
<td>Marquette</td>
<td>64</td>
<td>2.4</td>
<td>2.4</td>
<td>0% (19%)</td>
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<tr>
<td>Superior</td>
<td>91</td>
<td>19.8</td>
<td>20.2</td>
<td>2% (-4%)</td>
</tr>
<tr>
<td>Syene</td>
<td>108</td>
<td>29.5</td>
<td>28.7</td>
<td>-3% (-8%)</td>
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<tr>
<td>Badger</td>
<td>40</td>
<td>14.9</td>
<td>14.3</td>
<td>-4%</td>
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Type of Pollutants

- Suspended Solids
- Total Solids
- Total Phosphorus
- Total Lead
- Total Zinc
- Total Copper

- Dissolved Phosphorus
- Dissolved Lead
- Dissolved Zinc
- Dissolved Copper
- Bacteria
- Organic Toxicants
Basic Program Operation
Particulate Solids Loading – Street Dirt Accumulation

![Graph showing street dirt accumulation over time]

Street dirt washoff and runoff test plot, Toronto

Pitt 1987
Suspended Solids Concentrations during Washoff Tests

Street Dirt Changes Over Time
We will cover . . .

- WinSLAMM Purpose, History and Unique Features
- Model Applications
- Small Storm Hydrology
- Basic Program Structure and Operation
- Treatment Practices
- Model Input/Output

Basic Program Structure Control Devices

- Wet Detention Ponds
- Porous Pavement
- Street Cleaning
- Catchbasin Cleaning
- Grass Swales and Grass Filters
- Biofiltration/bioretention
- Green Roofs
- Proprietary Controls (media filters and hydrodynamic devices)
- Beneficial Uses
Full-scale street cleaning tests using conventional and high-energy street cleaners (street dirt loading and washoff monitoring and outfall water quality monitoring)

Measured Versus Modeled Street Loads With Mechanical Broom Street Cleaning - Residential 2004

- Pre Sweeping
- Post Sweeping
- Modeled

0 250 500 750 1,000 1,250 1,500 1,750 2,000 2,250 2,500

lb/curb-mile
Three flow rates: 10, 5, and 2.5 LPS (160, 80, and 40 GPM)
- Velocity measurements (Vx, Vy, and Vz)
- Five overlying water depths above the sediment: 16, 36, 56, 76, and 96 cm

- 155 total points per test
- 30 velocity measurements at each point

CFD Modeling to Calculate Scour/Design Variations

- Used CFD (Fluent 6.2 and Flow 3D) to determine scour from stormwater controls; results being used to expand WinSLAMM analyses after verification with full-scale physical model

- This is an example of the effects of the way that water enters a sump on the depth of the water jet and resulting scour
Monitored Full-Scale Setup in Tuscaloosa, AL

National Stormwater Quality Database
### Number of Standard Land Use Files Used for Each Category

<table>
<thead>
<tr>
<th></th>
<th>Commer.</th>
<th>Indus.</th>
<th>Instit.</th>
<th>Open Space</th>
<th>Resid.</th>
<th>Freeways/Highways</th>
<th>Total by Region</th>
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<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>11</td>
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<tr>
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<td>4</td>
<td>4</td>
<td>2</td>
<td>11</td>
<td>4</td>
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<td>1</td>
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<td>3</td>
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<tr>
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<td>5</td>
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<td>4</td>
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<tr>
<td>Southwest</td>
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<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>13</td>
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<tr>
<td>Total by Land Use</td>
<td>27</td>
<td>11</td>
<td>14</td>
<td>11</td>
<td>31</td>
<td>20</td>
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### Data Plots

1. **Total Suspended Solids (mg/L)**
   - Observed TSS (mg/L) vs. Modelled TSS (mg/L)
   - Data points follow a linear trend.

2. **Nitrite plus Nitrate (mg/L as N)**
   - Observed NO3+NO2 (mg/L) vs. Modelled NO3+NO2 (mg/L)
   - Data points follow a linear trend.

3. **Total Copper (µg/L)**
   - Observed Total Copper (µg/L) vs. Modelled Total Copper (µg/L)
   - Data points follow a linear trend.

4. **Fecal Coliform Bacteria (MPN/100 mL)**
   - Observed Fecal Coliforms (MPN/100 mL) vs. Modelled Fecal Coliforms (MPN/100 mL)
   - Data points follow a linear trend.
Current Project Calibrating and Setting up WinSLAMM for US Naval Facilities (15 San Diego, Norfolk, and Puget Sound Bases)

San Diego naval bases observed vs. calculated loads (p = 0.56)

Virginia naval bases observed vs. calculated loads (p = 0.26)

Washington naval bases observed vs. calculated loads (p = 0.67)

All sites naval bases observed vs. calculated loads (p = 0.44)
Probability Plot of obs Zn mass lbs, calc Zn mass lbs
Lognormal - 95% CI

<table>
<thead>
<tr>
<th>Variable</th>
<th>obs Zn mass lbs</th>
<th>calc Zn mass lbs</th>
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</thead>
<tbody>
<tr>
<td>Loc</td>
<td>Scale</td>
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<td>-2.246</td>
<td>2.918</td>
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<tr>
<td>-1.792</td>
<td>2.458</td>
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Total Zn (lbs)

Observed Total Zn Mass (lbs)

Calculated Total Zn Mass (lbs)
Main features of the naval facilities project included:

- Historical monitoring data used for calibration
- Many unique surfaces (compacted soil in scrapyards, airfields, piers, etc.)
- Field washoff tests for material sources (galvanized metals, roofing, fencing, pallets, gang planks, generators, etc.
- Laboratory leaching tests for pipe and tank materials used to supplement the field washoff tests
- Expanded WinSLAMM to allow additional paved and non-paved areas having unusual characteristics