Advancements in Urban Stormwater Management for Water Quality Improvements

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Kalamazoo, MI

March 4, 2016

Systems Approaches to Managing Great Lakes Landscapes
Kellogg Hotel Conference Center
Michigan State University
East Lansing, MI

Fostering Innovation and Partnerships Since 1992
Overview

• Historic context
• Stormwater management paradigm shift
• Stormwater retrofits and cost implications
• Innovative solutions
• Watershed impacts
• Sustainable management
• Concluding remarks
Acronyms & Definitions

**MS4** – municipal separate storm sewer system

**TMDL** – total maximum daily load

**BMP** – best management practice

**NPS** – nonpoint source

**Stormwater NeutralSM** – An independent, K&A third-party verification associated with "net-zero" stormwater loading resulting from stormwater controls, which may include offsets, relative to a quantifiable baseline condition.

Stormwater NeutralSM is a service mark of Kieser & Associates, LLC
Historic Management Approach

• Clean Water Act (over 40 years ago)
• Stormwater viewed as nuisance
• Goal: remove runoff as quickly as possible
• Focus on conventional designs
• Created centralized system of gutters, manholes, and sewer pipes
• Management typically did not incorporate water quality considerations
The Need for a New Approach...

- Stormwater discharges contribute to surface water impairments
  - Increase pollutant loading
  - Alter stream hydrology
  - TMDLs

- NPS agriculture/urban runoff
- >40% surveyed waters are impaired
  \textit{(U.S. EPA National Water Quality Inventory: Report to Congress, 2010)}
- Need new, dynamic management approaches that integrate watershed-wide considerations
The Need for a New Approach...

- Alternative ways to:
  - Educate Public
  - Finance
  - Design/Retrofit/Construct
  - Operate
  - Maintain/Manage Assets

- Multiple vs. Singular benefits
Paradigm Shift

- Stormwater considered an asset
  - Groundwater recharge
  - Re-use/harvesting
- Incorporate ecosystem protection
- Acknowledge complexity of water systems
- Emphasize innovation and holistic approach
- Quantify environmental outcomes (metrics)
Paradigm Shift

Specific Examples:

• WMU, Kalamazoo, MI
• City of Santa Rosa, CA
• KVCC, Kalamazoo, MI
• Lake Simcoe, Ontario, Canada
WMU – Paradigm Shift

• No new outfalls
• New projects: 0% runoff increase
• Verify with computer modeling
• Infiltration preferred

* **All Voluntary Efforts**
Above and beyond current MS4 regulatory requirements
Lake Simcoe – Paradigm Shift

- New/redevelopment “zero export”
- Minimum on-site controls
- Reduction offsets offered if needed
- Off-site offsets from urban stormwater retrofits
- 2.5 to 1 trade ratio
Santa Rosa, CA – Paradigm Shift

Potential TMDL MS4 Load Reductions

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>TN (lbs/yr)</td>
<td>24,347</td>
<td>48,694</td>
<td>73,040</td>
</tr>
<tr>
<td>TP (lbs/yr)</td>
<td>3,823</td>
<td>7,646</td>
<td>11,469</td>
</tr>
<tr>
<td>TSS (tons/yr)</td>
<td>433</td>
<td>865</td>
<td>1,298</td>
</tr>
</tbody>
</table>

- Significant Capital Costs for Urban Stormwater
- Requires Stormwater Offset Options
Drivers

- Regulations targeting pollutant reductions
- Flexible permit requirements (options)
- Development/redevelopment standards
- Compliance options are expensive
- High costs tend to stall action

Innovative options can help accelerate progress toward improving water quality
Drivers

**NEW** – MI Regulatory MS4 Program Changes

- Off-site mitigation or payment in lieu
- Redevelopment projects <minimum standards
- Justify infeasibility (i.e., not difficult/costly...)
- 2:1 offset ratio
- 24-month schedule
- Deed restrictions / long-term O&M
Costs of Urban Stormwater Mngt

Stormwater Volume Annual Reduction Costs

Prioritized Project Average Costs = $339 /acre-ft
Non-Prioritized Project Average Costs = $2,968 /acre-ft

Offsets
Costs of Urban Stormwater Mngt

TP Stormwater Load Annual Reduction Costs

- K&A Prioritized Stormwater Treatment
- Non-prioritized Stormwater Treatment

Prioritized Project Average Costs = $426/lb
Non-Prioritized Project Average Costs = $4,062/lb

Offsets
Costs of Urban Stormwater Mngt

TSS Stormwater Load Annual Reduction Costs

- K&A Prioritized Stormwater Treatment
- Non-prioritized Stormwater Treatment

Prioritized Project Average Costs = $2,241 /ton

Non-Prioritized Project Average Costs = $20,968 /ton

* Offsets
## Costs Comparisons

<table>
<thead>
<tr>
<th></th>
<th>Urban Runoff</th>
<th>Agricultural Runoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP</td>
<td>$400 - $4,000</td>
<td>TP</td>
</tr>
<tr>
<td>TSS</td>
<td>$2,000 - $20,000</td>
<td>TSS</td>
</tr>
<tr>
<td></td>
<td>$11 - $140</td>
<td>$6 - 60</td>
</tr>
</tbody>
</table>
## Cost-Effective Examples

<table>
<thead>
<tr>
<th>Project</th>
<th>Control Type</th>
<th>Annual TP Reduction</th>
<th>Annual TSS Reduction</th>
<th>Annual Volume Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>KVCC Texas Township Campus</td>
<td>Infiltration</td>
<td>36 lbs</td>
<td>7 tons</td>
<td>18.2 Mgal</td>
</tr>
</tbody>
</table>

*Re-use*
Cost-Effective Examples

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<th>Annual Volume Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMU Parking Lot 23</td>
<td>Detention/Infiltration</td>
<td>48 lbs 85%</td>
<td>7 tons 85%</td>
<td>25 ac-ft 85%</td>
</tr>
</tbody>
</table>
## Cost-Effective Examples

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<tr>
<td>WMU Howard/Stadium CMI</td>
<td>Detention/Infiltration</td>
<td>176 lbs 100%</td>
<td>27 tons 100%</td>
<td>184 ac-ft 100%</td>
</tr>
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<tr>
<td>MSU Lot 89 Stormwater</td>
<td>Detention/Bioretention</td>
<td>81 lbs, 80%</td>
<td>13 tons, 90%</td>
<td>73 ac-ft, 80%</td>
</tr>
</tbody>
</table>
Need for Innovative Financing...

- Vast funding gap (**MS4 costs**) ($600 billion, and growing, price tag, U.S. EPA)
  - Grants (limited, increasing competition)
  - Loans (no administrative/programmatic funding)
Need for Innovative Financing...
Need for Innovative Financing...

- Massive public information gap (MS4 requirements)
  - Only need flood protection
  - Rainfall runoff is harmless
  - This used to be free?
  - “Rain tax”
  - General fund shortages/political heat
Innovative Financing

- **New/redevelopment** ($10’s billions/yr, *U.S. EPA*)
- **Public-Private Partnerships (P3s)**
  (P3 market predicted to triple 2016-2020, surpassing $58 billion)
- **Social impact bonds** (a.k.a., pay-for-success contracts)
  (i.e., foundation, philanthropic, NGO investors)
- **Stormwater credits/offsets** (within the same watershed)
- **Stormwater utility fees** (per acre impervious surface)
- **Cost-share funding** (capital funds/grant funds)

*Explore all viable options*
Innovative Solutions

- Min. stormwater standards (built-in flexibility)
- Stormwater utility fees (1,500 cities and counting)
- Stormwater credit/offset programs (offset ratio)
- Payment in Lieu (stormwater management fund)
- Targeted design/outcomes (defined goal)
- Metrics/Tracking system (measure progress)
Innovative Solutions

- Offset policy/framework elements necessary to ensure water quality protection/benefits

Examples include:
- Offset ratios
- Third-party verifiers
- Eligibility requirements
WMU – Innovative Solutions

- Campus Area - 807 Acres
  (including Parkview Campus)
- 151.7 Acres Treated
- 18.8% of Campus
- TMDL Baseline
  – 764 lbs/yr TP

WMU Goals
- TMDL 50% Reduction
- Stormwater Neutral SM

Stormwater NeutralSM is a service mark of Kieser & Associates, LLC

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WMU – Innovative Solutions

- Currently 30 BMPs
- 514 Acres Treated
  (152 in 1998)
- 64% of Campus
  (18.8% of Campus in 1998)
- 55% Reduction in Runoff Volume
- TMDL Reduction – 56%
- 100% Stormwater Neutral™

Stormwater Neutral™ is a service mark of Kieser & Associates, LLC
WMU – Innovative Solutions

Fostering Innovation and Partnerships Since 1992
WMU – Innovative Solutions

On-Campus Reductions & Stormwater Offsets

- Total Phosphorus Reduction
- TMDL 50% Goal
- Baseline Load

1998 TMDL Baseline 764 lbs/yr
TMDL Goal 382 lbs/yr

Stormwater Neutral\textsuperscript{SM}
Goal Achieved!

Stormwater Neutral\textsuperscript{SM} is a service mark of Kieser & Associates, LLC

Fostering Innovation and Partnerships Since 1992
WMU – Innovative Solutions

- Only MS4 to document 1998 baseline to MDEQ
- First MS4 to document TMDL Reduction Goal – 56%
- First MS4 to achieve Stormwater NeutralSM Status – “net zero discharge”

Kalamazoo River Watershed
2,020 sq. miles

Portage & Arcadia Creek Subwatershed

Stormwater NeutralSM is a service mark of Kieser & Associates, LLC

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WMU - Watershed Impacts

Observed Arcadia Creek flow reductions following ten years of stormwater implementation efforts as quantified within the WMU Water Quality Monitoring Grant Project (MDEQ #2012-0502).
WMU - Watershed Impacts

Observed Arcadia Creek water quality improvements (MDEQ #2012-0502)

- TP (mg/L) Down 39%
- TSS (mg/L) Down 35%

2002-03:
- TP: 0.414 mg/L
- TSS: 137.7 mg/L

2013-14:
- TP: 0.254 mg/L
- TSS: 89.6 mg/L
Lake Simcoe – Innovative Solutions

- Excessive phosphorus loading
- Restore water quality and recreational use
- Substantial new development projections
- “Zero Export” requirements
- Currently in-effect
Lake Simcoe – Watershed Impacts

Without Offsetting

Increased Phosphorus Load
4,649 kg/year

With Offsetting

Decreased Phosphorus Load
6,974 kg/year

“Net Zero” Export Policy
- 2.5:1 trade ratio
- Assumes 75% on-site TP retention
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Sustainable Management

1. Stormwater Footprint
   Define Goals

2. Quantify Loads
   Assess Status

3. Prioritize Options
   Implement Projects

4. Track Progress

MS4 Reporting Simplified/Verified
Metrics Matter...

Cost-Effective and Innovative Solutions
Identify Your Footprint...

Not likely Property Boundaries
Define Your Goal...

Odds Increase when you Aim at Your Target
Quantify Existing Conditions...

How have Past Efforts Helped?
Assess Current Status...

Where are You, How will You get There?
Prioritize Options...

Optimize Value and Function (Metrics)
Implement Your Plan...

Innovative Solutions and Financing
Progress, You have to Measure it...

Measure what You should, not what You can...
Celebrate Success along the Way...

Success will Inspire Those around You
## MSU - MS4 Options

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<td>Chestnut Road Reconstruction</td>
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<td>Michigan State Police - Demolition</td>
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### How Can MSU Reach MS4 Stormwater Goals and Stormwater Neutral℠ Status?

| Grounds Maintenance                          |                  |                     |                               |                        |                                 |                         |                          |                          |
| Farm Lane Underpass                          |                  |                     |                               |                        |                                 |                         |                          |                          |
| Shooting Center                               |                  |                     |                               |                        |                                 |                         |                          |                          |
| Recycle and Surplus Center                   |                  |                     |                               |                        |                                 |                         |                          |                          |
| Wharton Center Addition                      |                  |                     |                               |                        |                                 |                         |                          |                          |
| Cyclotron Addition                           |                  |                     |                               |                        |                                 |                         |                          |                          |
| Forest Akers East Driving Range              |                  |                     |                               |                        |                                 |                         |                          |                          |
| Old College Field - Press box                |                  |                     |                               |                        |                                 |                         |                          |                          |

### Where do each of these projects land on the cost curve?

Stormwater Neutral℠ is a service mark of Kieser & Associates, LLC

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WEF National Municipal Stormwater and Green Infrastructure Awards Program

MS4 Program
- SILVER
Innovation
- SILVER

Water Environment Federation
WEFTEC - September 28, 2015
Chicago, Illinois
Appreciative Partners

“WMU is honored to be the first U.S. recipient of the Stormwater NeutralSM certification thanks to 16-year commitment of Kieser & Associates to this University and our local watershed”

- Lu Deboef, Environmental Specialist, MS4 Program, Western Michigan University

“Kieser’s commitment to both stormwater and watershed innovation has resulted in WMU being the only regulated MS4 in the State of Michigan (if not the country) to meet and surpass regulatory requirements under the Clean Water Act. The University now has a ‘net-zero’ footprint for stormwater pollution (TP) and has been Stormwater NeutralSM verified by K&A”

- Peter Strazdas, Vice President Facilities Management, Western Michigan University
Concluding Remarks

• Cost-effective analyses needed to achieve maximum reductions at least cost

• Quantification and flexible implementation options are vital to tackling stormwater regulations given uncertain costs and limited available resources

• Existing programs demonstrate that offsets provide flexible, cost-effective options for reducing stormwater loading
Bridging the Gap

Your Goal can be Reached
Thank You!

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