

# Advancements in Urban Stormwater Management for Water Quality Improvements

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**MICHIGAN STATE**  
UNIVERSITY | College of Agriculture  
and Natural Resources



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

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# 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 Neutral<sup>SM</sup>** – 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 Neutral<sup>SM</sup> is a service mark of Kieser & Associates, LLC

  
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# 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



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# 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  
(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



Lake Simcoe  
Region  
Conservation  
Authority



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# WMU – Paradigm Shift

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

## \* All Voluntary Efforts

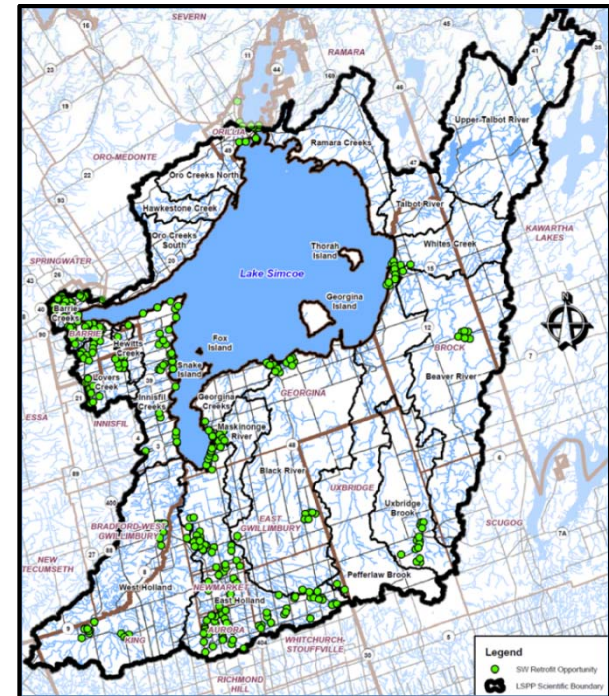
Above and beyond current  
MS4 regulatory  
requirements



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# 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



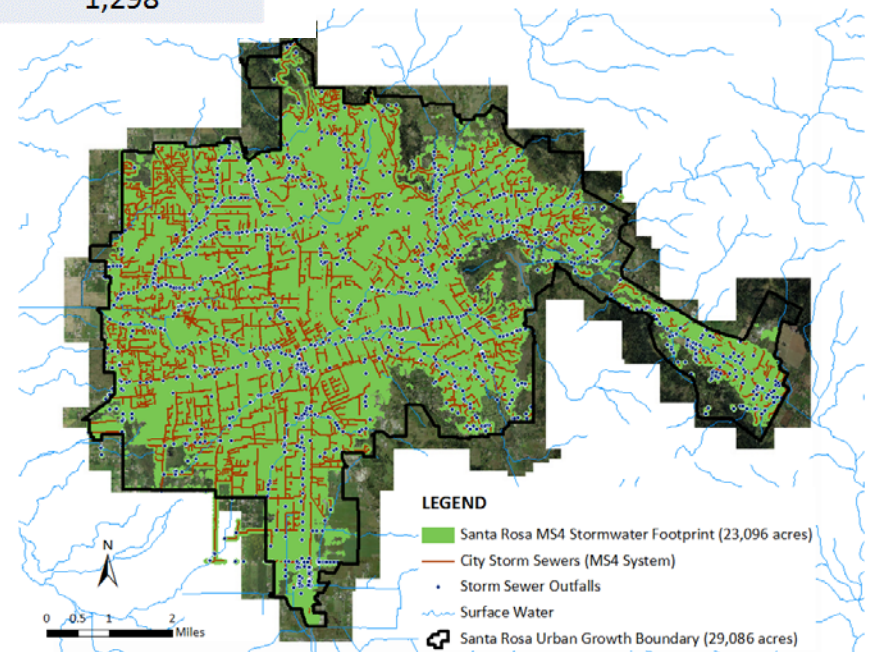
# Santa Rosa, CA – Paradigm Shift

## Potential TMDL MS4 Load Reductions

Loads Based on City EMC Values

Pollutant	Potential TMDL Load Reduction Target		
	25%	50%	75%
TN (lbs/yr)	24,347	48,694	73,040
TP (lbs/yr)	3,823	7,646	11,469
TSS (tons/yr)	433	865	1,298

- 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

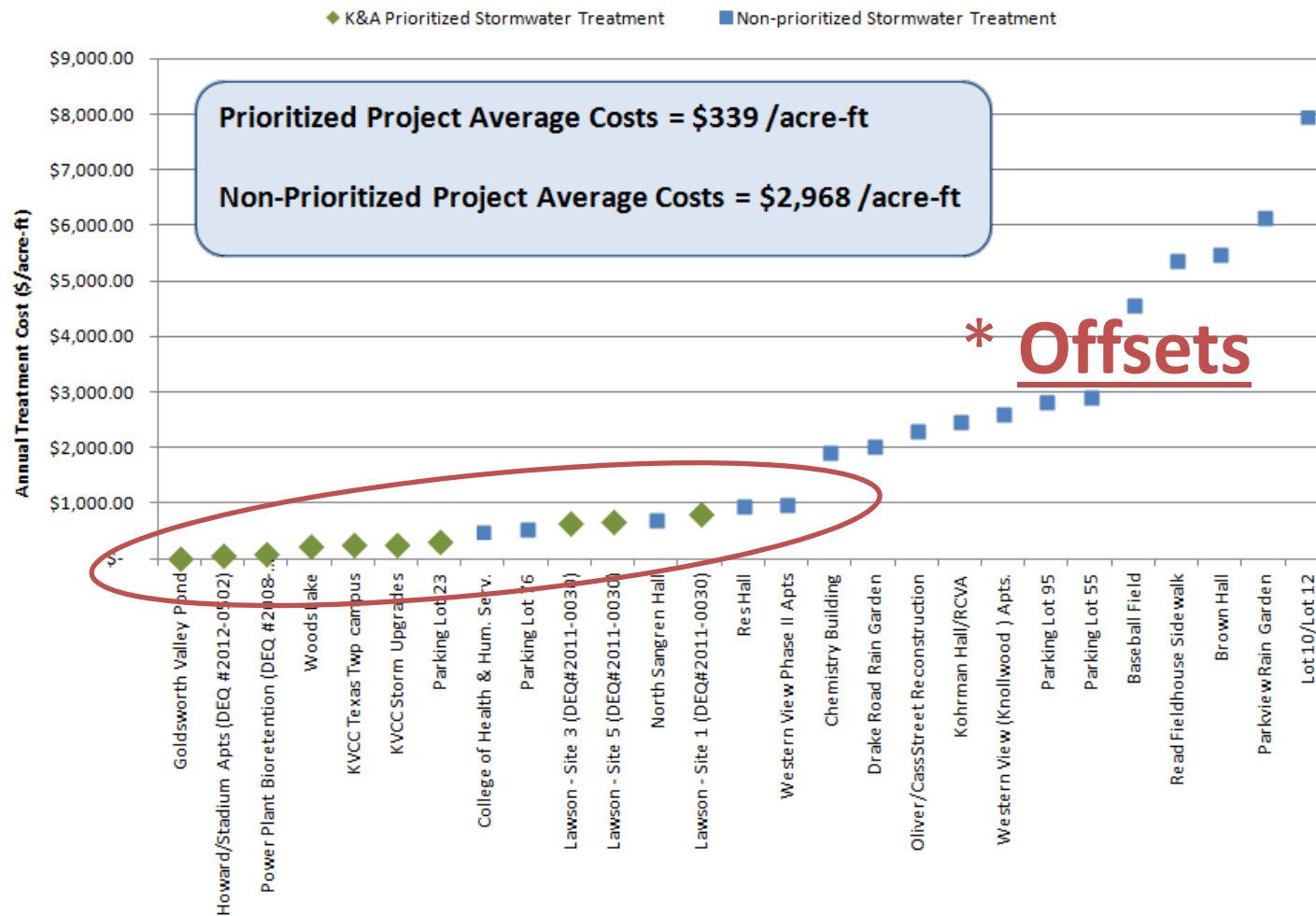
## **NEW – MI Regulatory MS4 Program Changes**

- 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

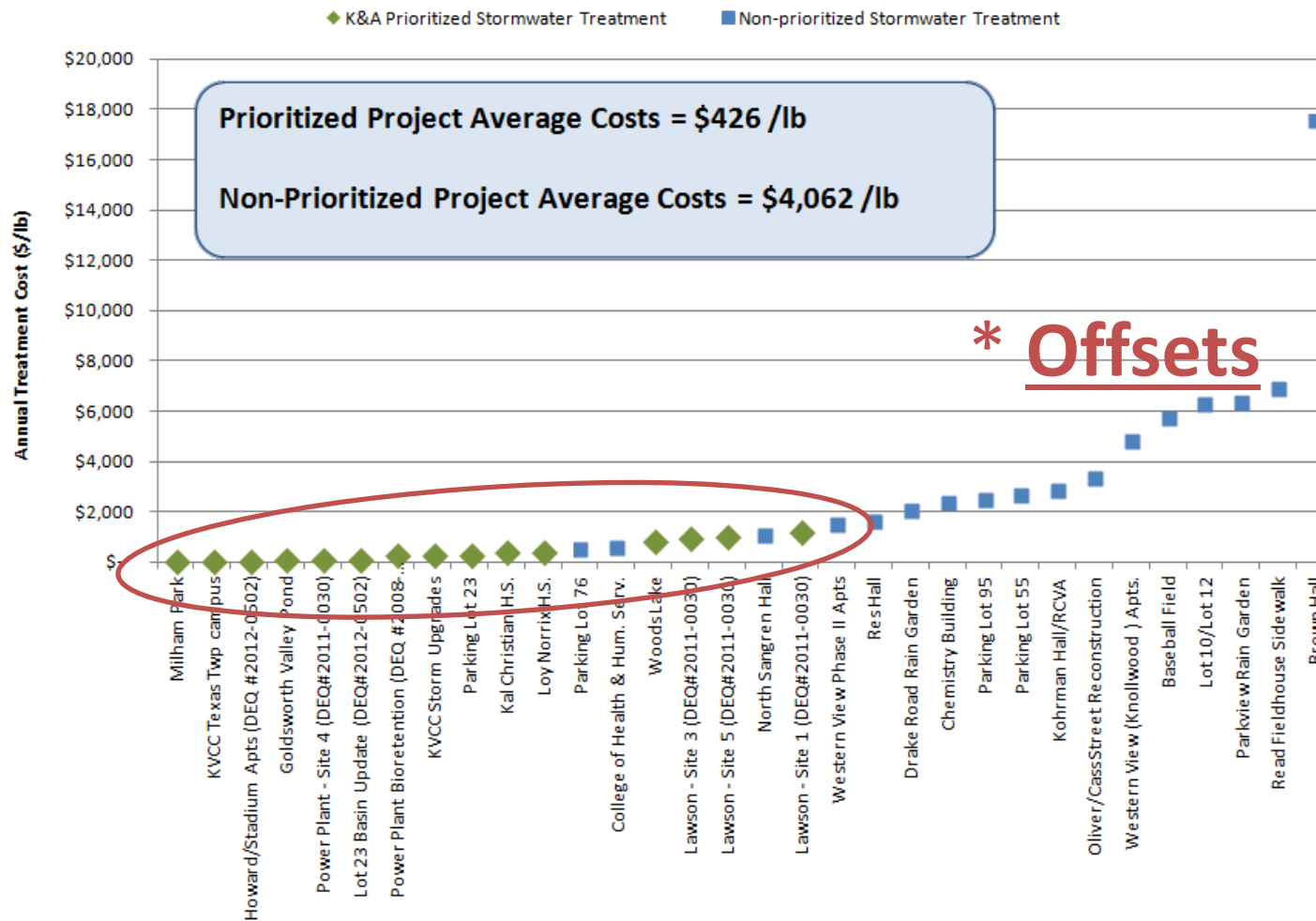
## Stormwater Volume Annual Reduction Costs





# Costs of Urban Stormwater Mngt

## TP Stormwater Load Annual Reduction Costs

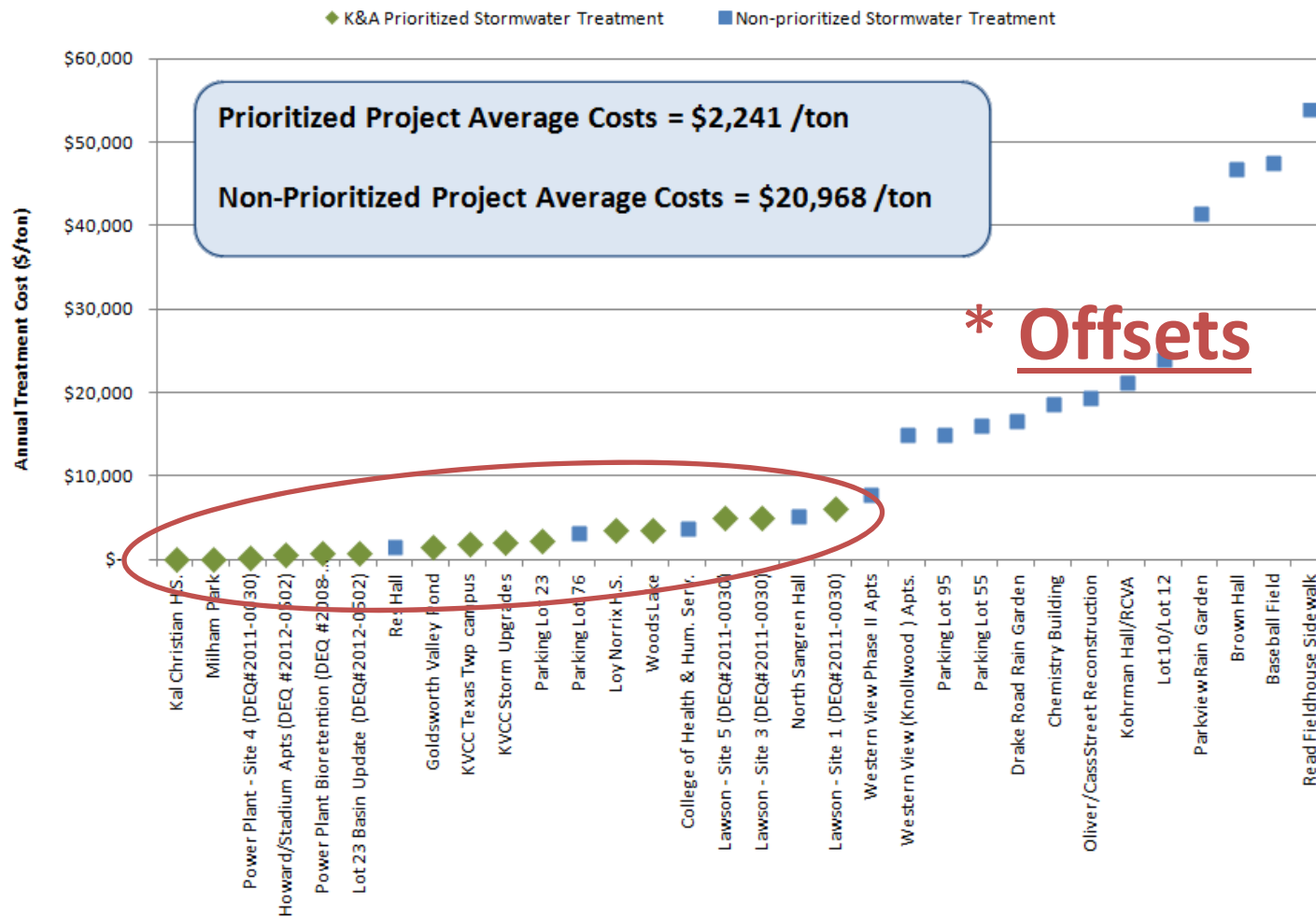


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# Costs of Urban Stormwater Mngt

## TSS Stormwater Load Annual Reduction Costs



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# Costs Comparisons

## Urban Runoff

TP	\$400 - \$4,000
TSS	\$2,000 - \$20,000



## Agricultural Runoff

TP	\$11 - \$140
TSS	\$6 - 60



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# Cost-Effective Examples



Project	Control Type	Annual TP Reduction		Annual TSS Reduction		Annual Volume Reduction	
KVCC Texas Township Campus	Infiltration	36 lbs	100%	7 tons	100%	18.2 Mgal	100%



\* Re-use

# Cost-Effective Examples



Project	Control Type	Annual TP Reduction		Annual TSS Reduction		Annual Volume Reduction	
WMU Parking Lot 23	Detention/ Infiltration	48 lbs	85%	7 tons	85%	25 ac-ft	85%





# Cost-Effective Examples



Project	Control Type	Annual TP Reduction		Annual TSS Reduction		Annual Volume Reduction	
WMU Howard/ Stadium CMI	Detention/ Infiltration	176 lbs	100%	27 tons	100%	184 ac-ft	100%



# Cost-Effective Examples



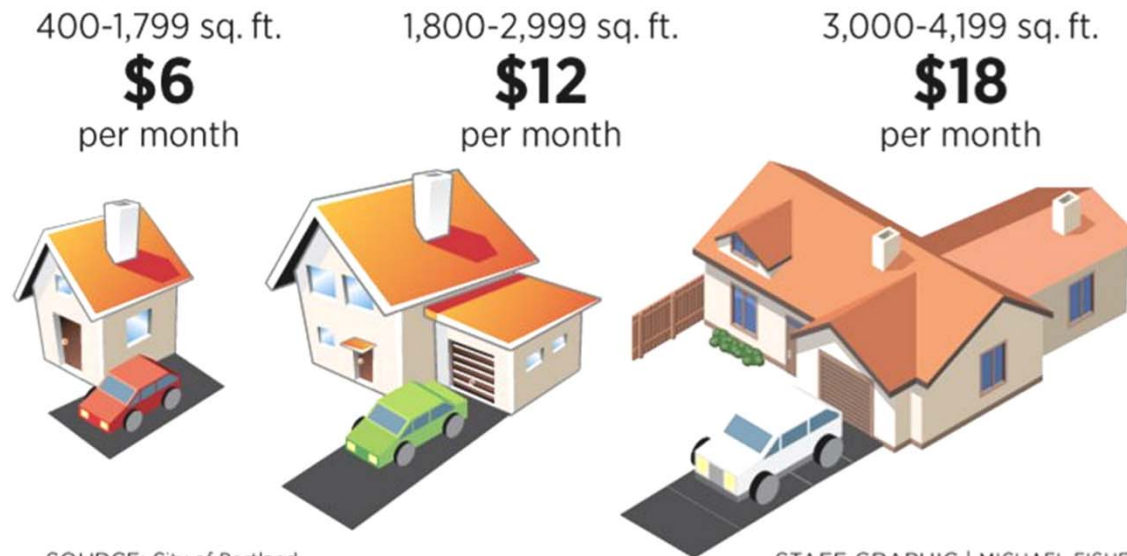
Project	Control Type	Annual TP Reduction		Annual TSS Reduction		Annual Volume Reduction	
MSU Lot 89 Stormwater	Detention/ Bioretention	81 lbs	80%	13 tons	90%	73 ac-ft	80%



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# 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)



SOURCE: City of Portland

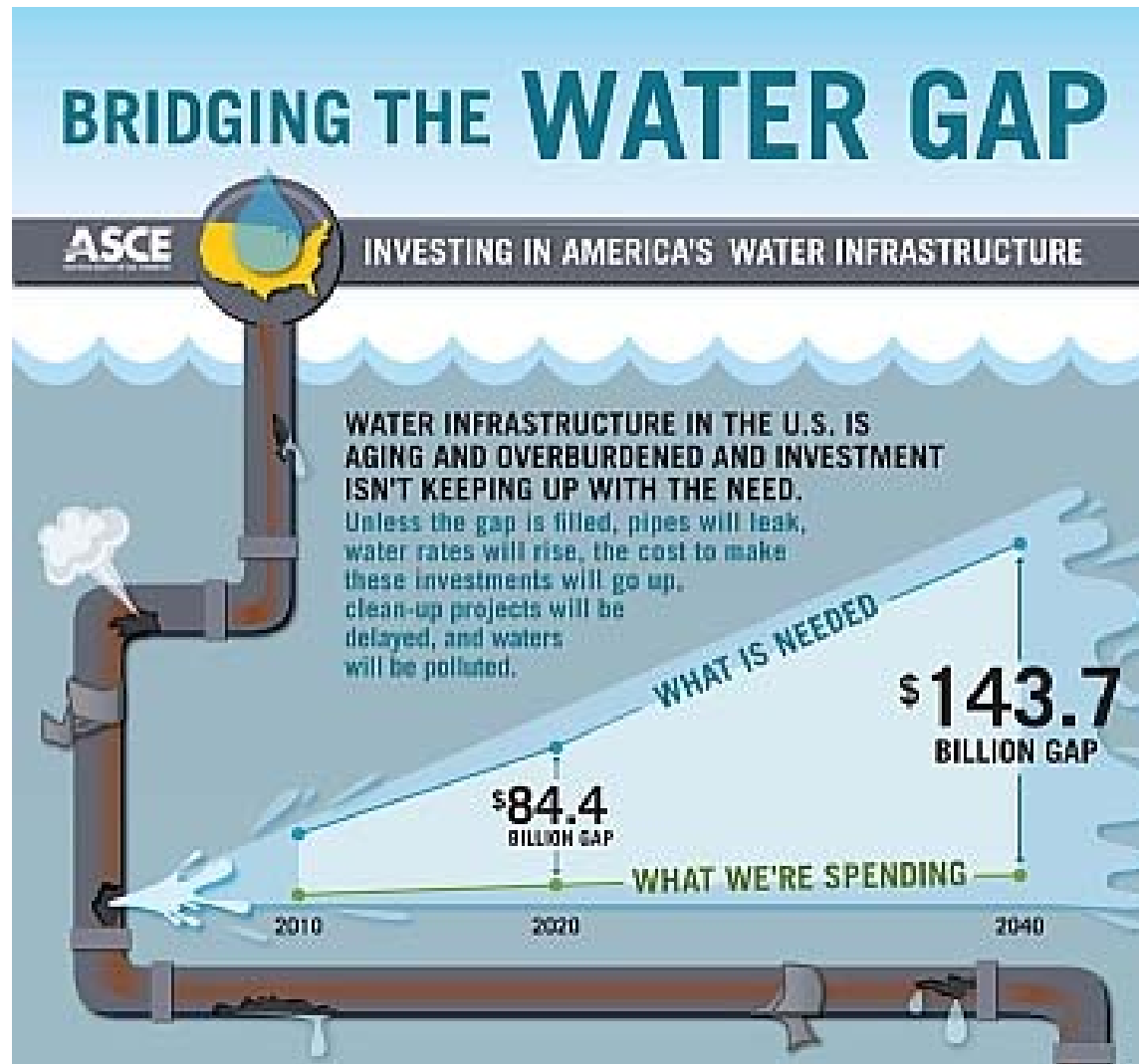
STAFF GRAPHIC | MICHAEL FISHER



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# Need for Innovative Financing...



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# 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)

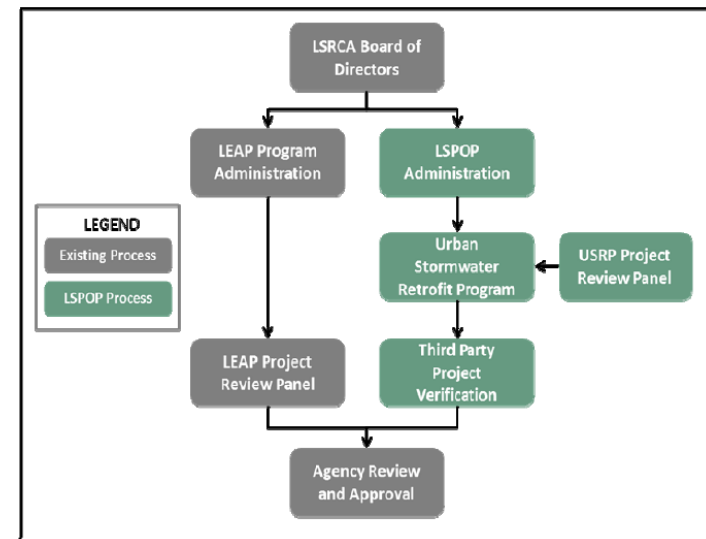


# Innovative Solutions

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

Examples include:

- Offset ratios
- Third-party verifiers
- Eligibility requirements



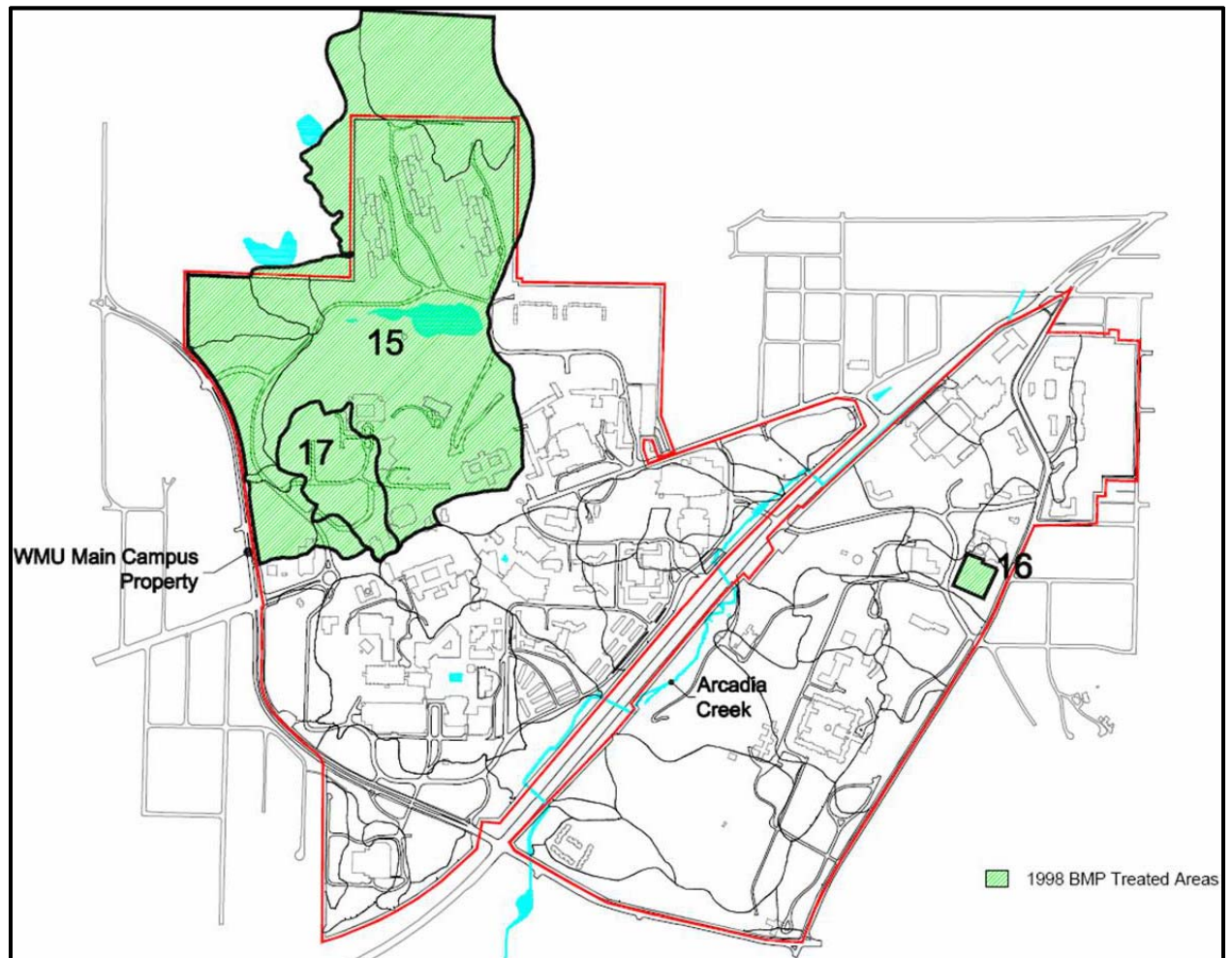
# WMU – Innovative Solutions

1998

- **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<sup>SM</sup>



Stormwater Neutral<sup>SM</sup> is a service mark of Kieser & Associates, LLC

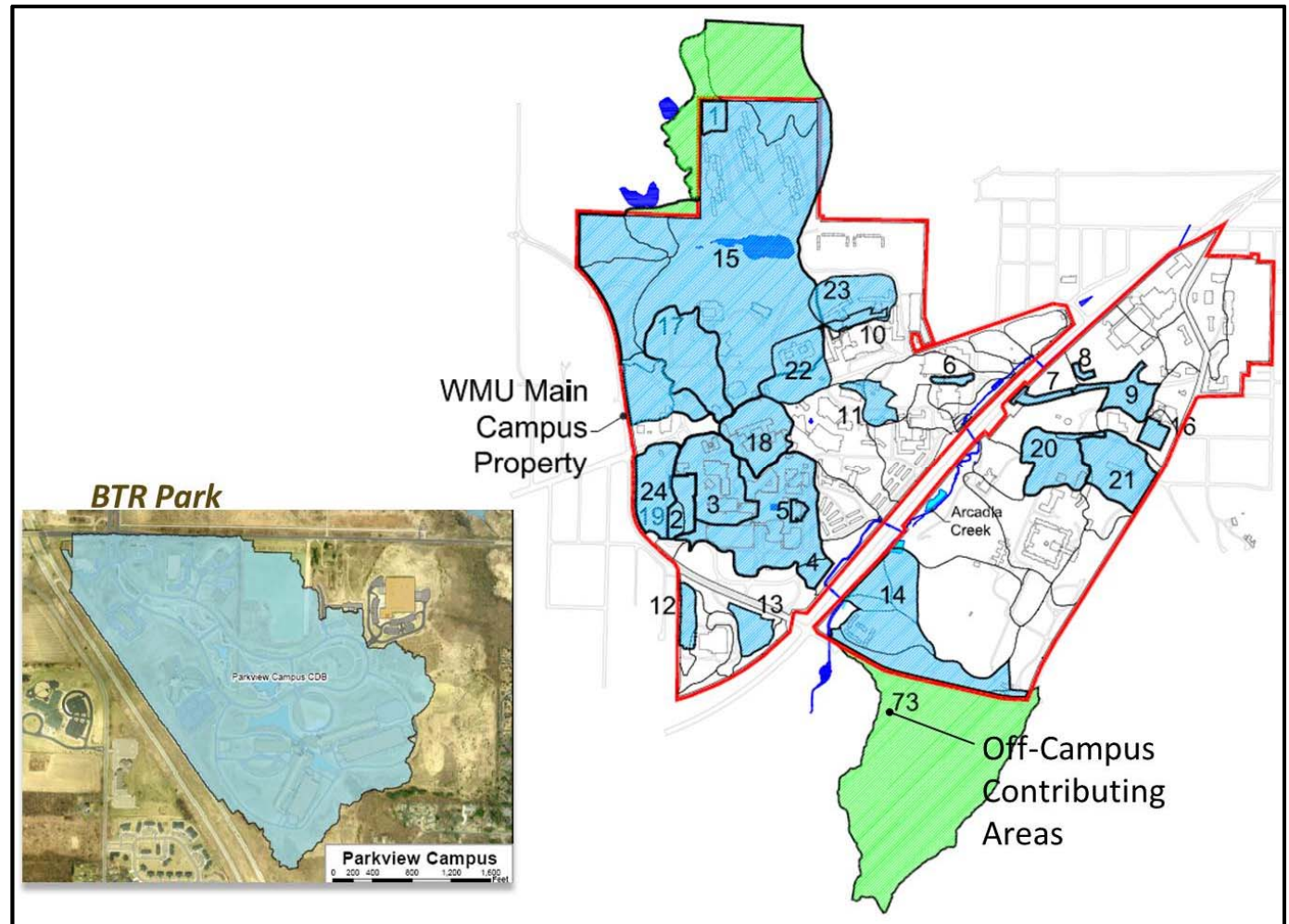


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# WMU – Innovative Solutions

2015

- 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<sup>SM</sup>



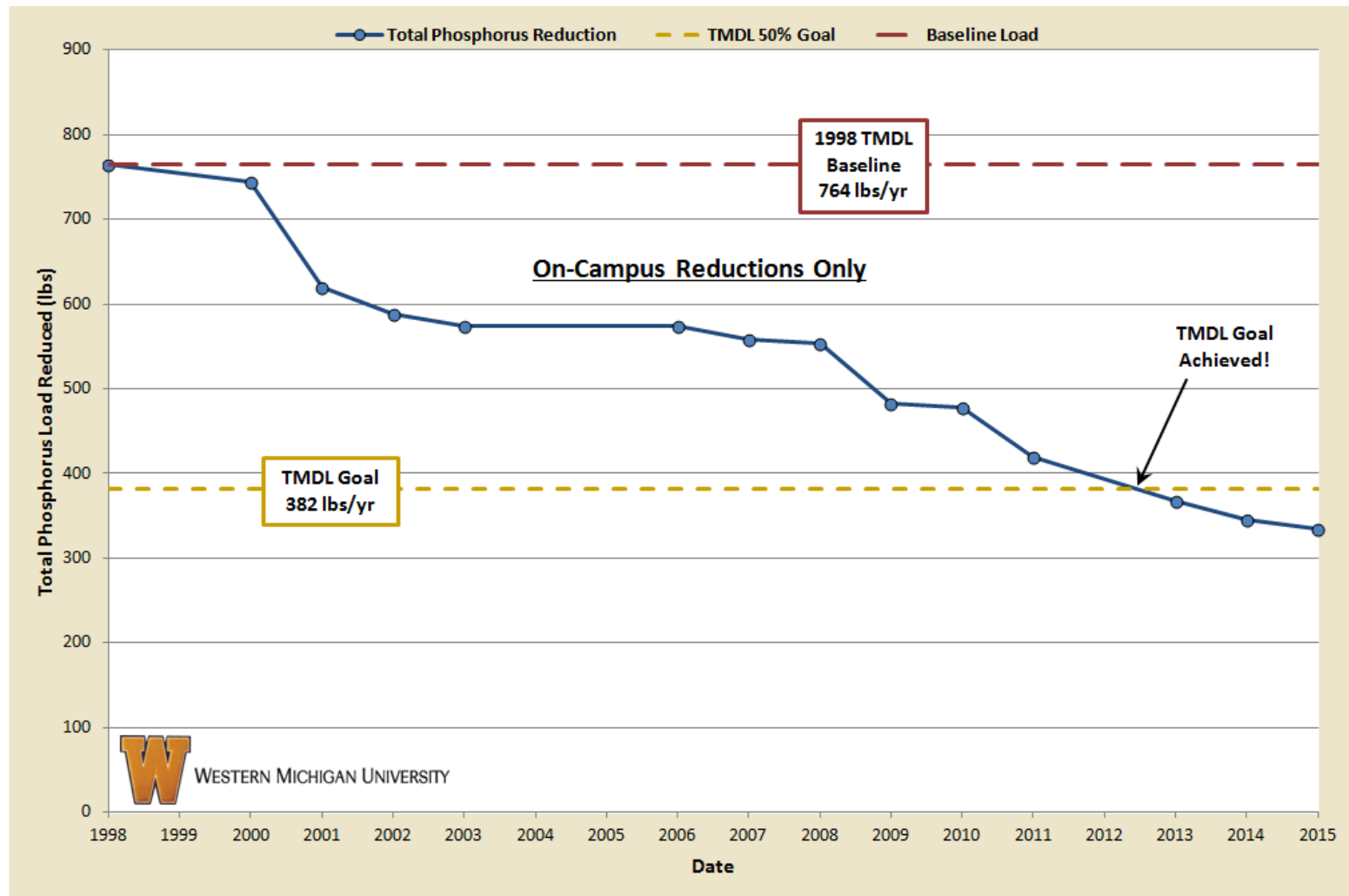
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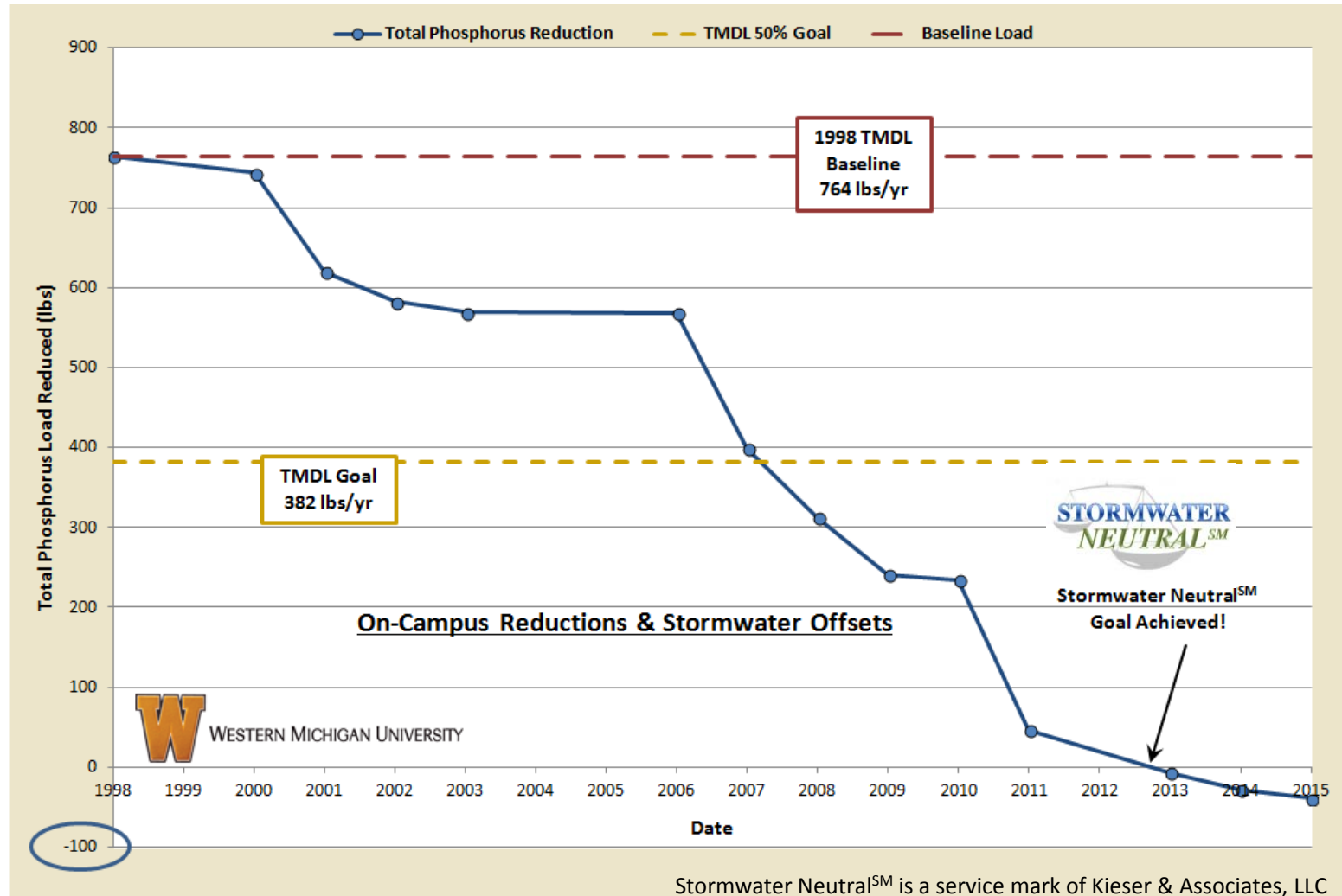
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# WMU – Innovative Solutions

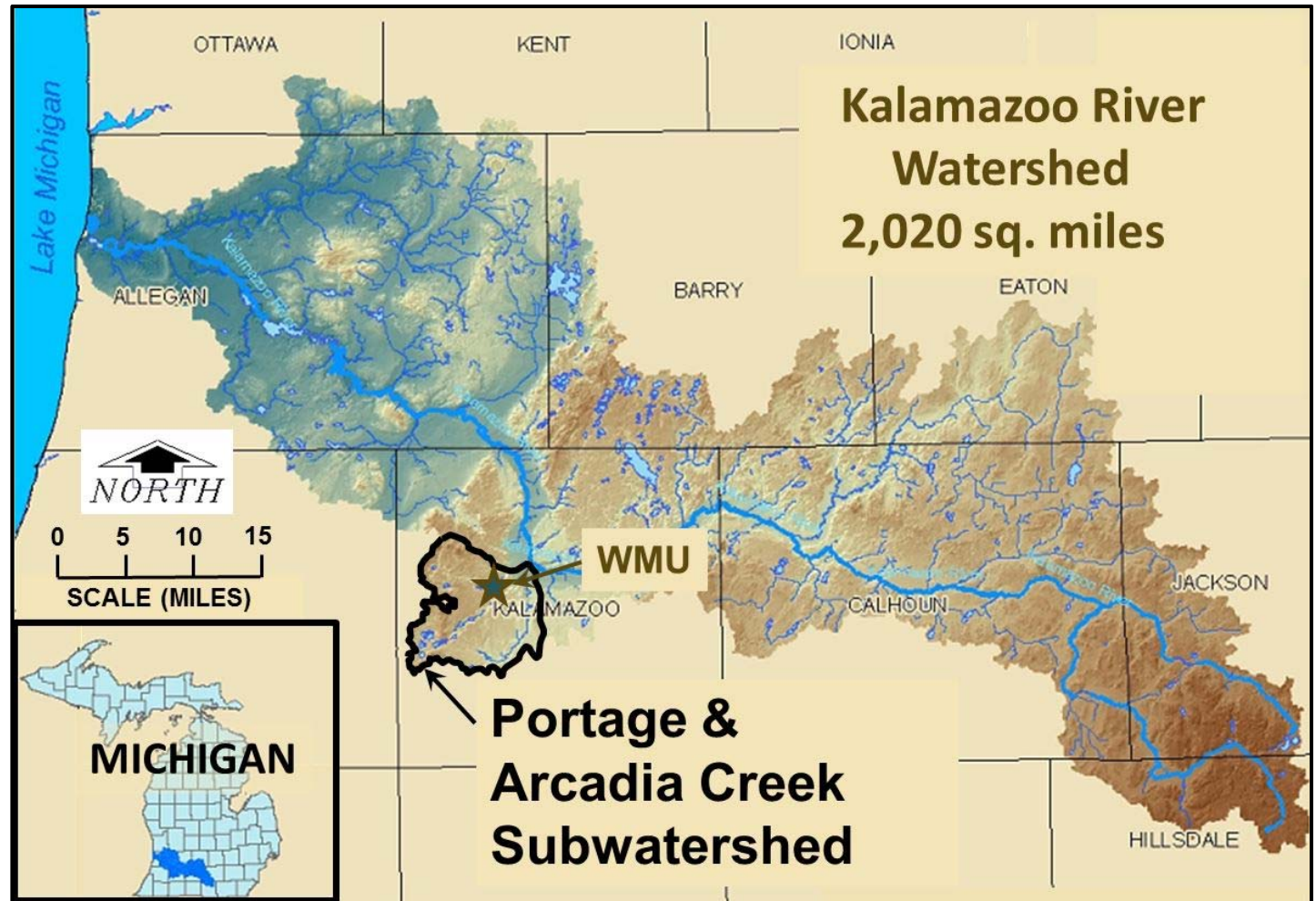


# WMU – Innovative Solutions



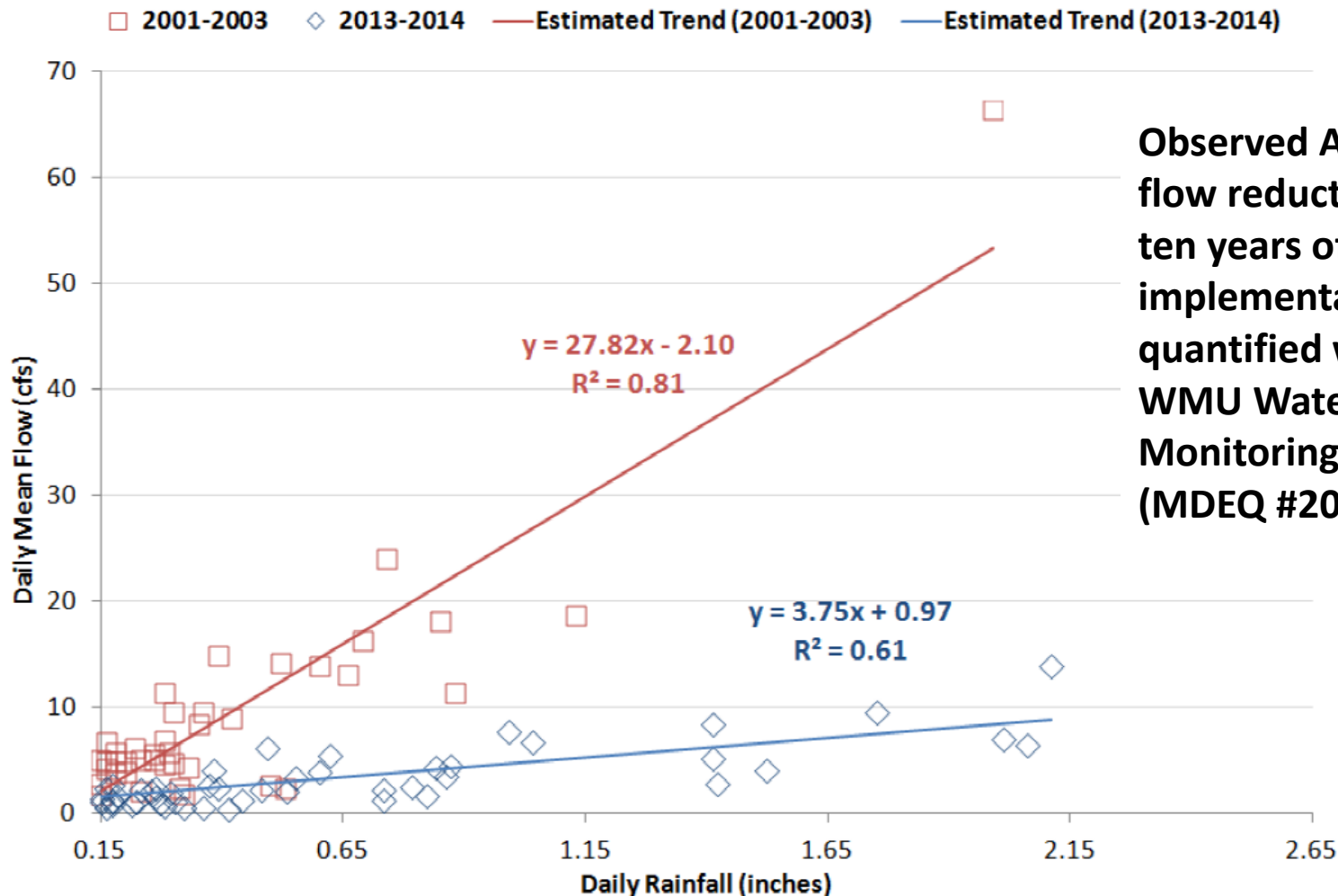
# WMU – Innovative Solutions

- Only MS4 to document 1998 baseline to MDEQ
- First MS4 to document TMDL Reduction Goal – 56%
- First MS4 to achieve Stormwater Neutral<sup>SM</sup> Status – “net –zero discharge”



Stormwater Neutral<sup>SM</sup> is a service mark of Kieser & Associates, LLC

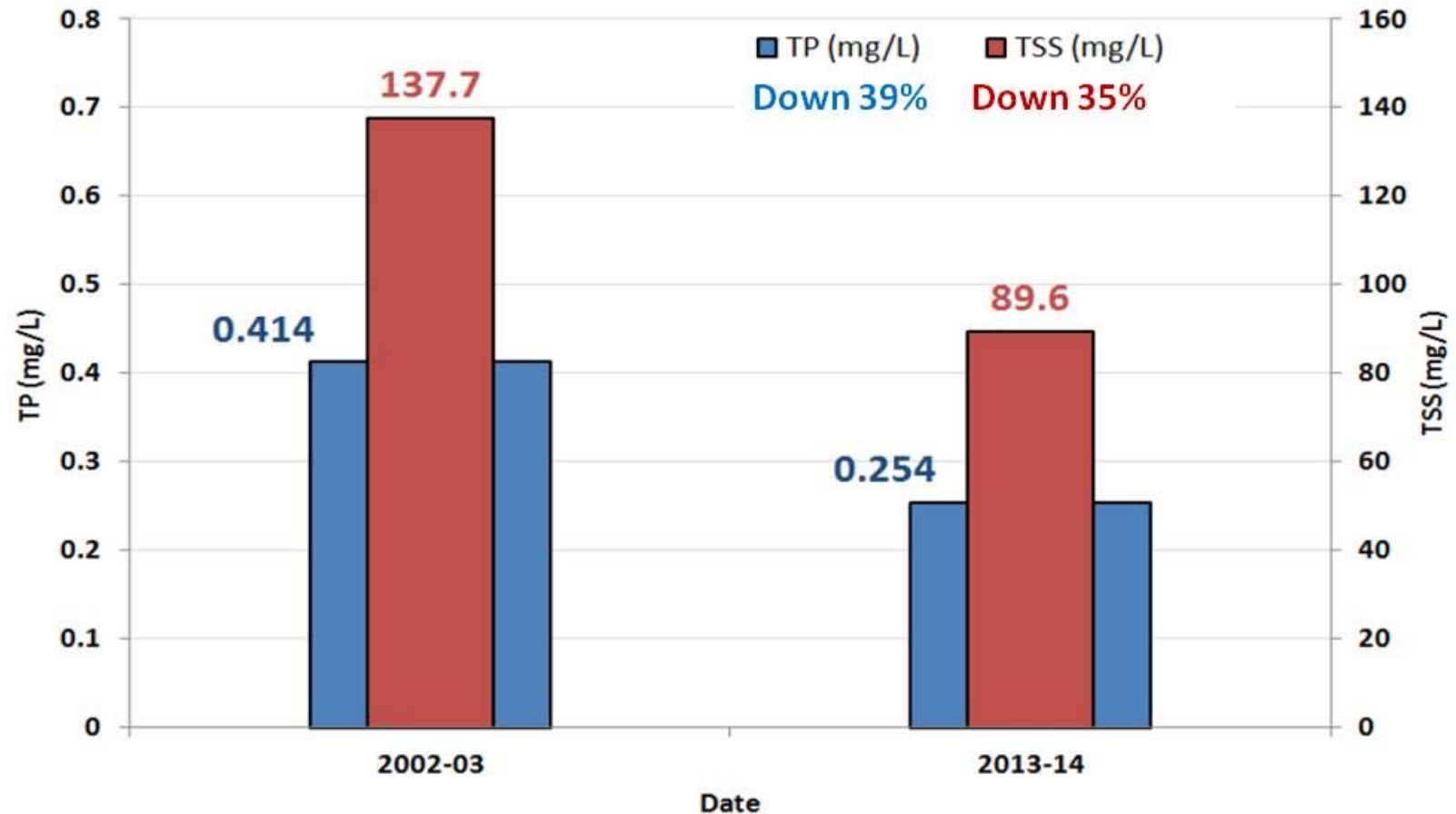
# WMU - Watershed Impacts



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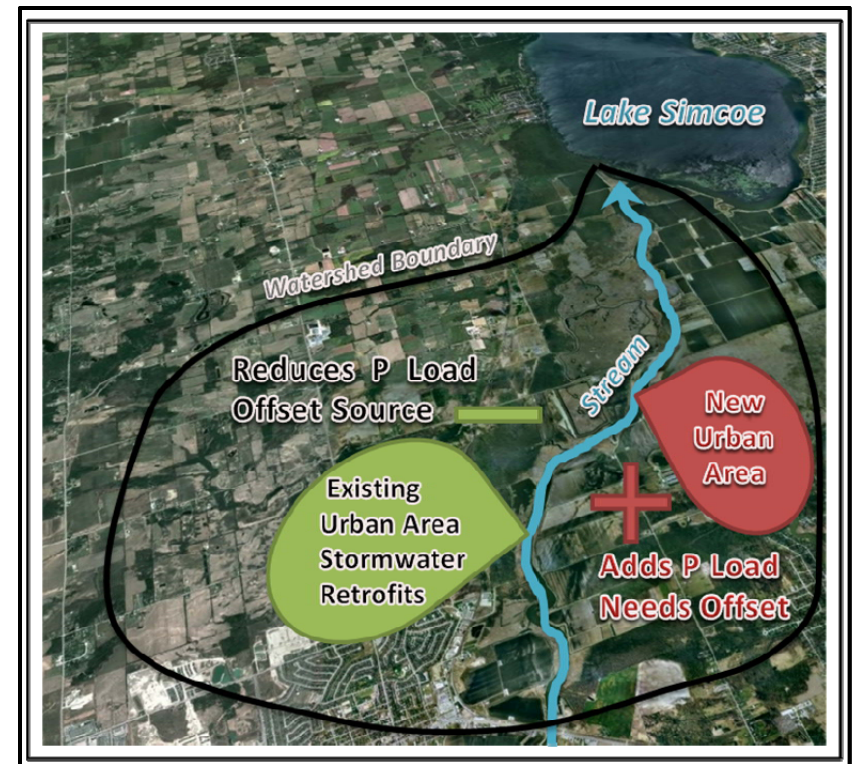
Observed Arcadia Creek water quality improvements (MDEQ #2012-0502)



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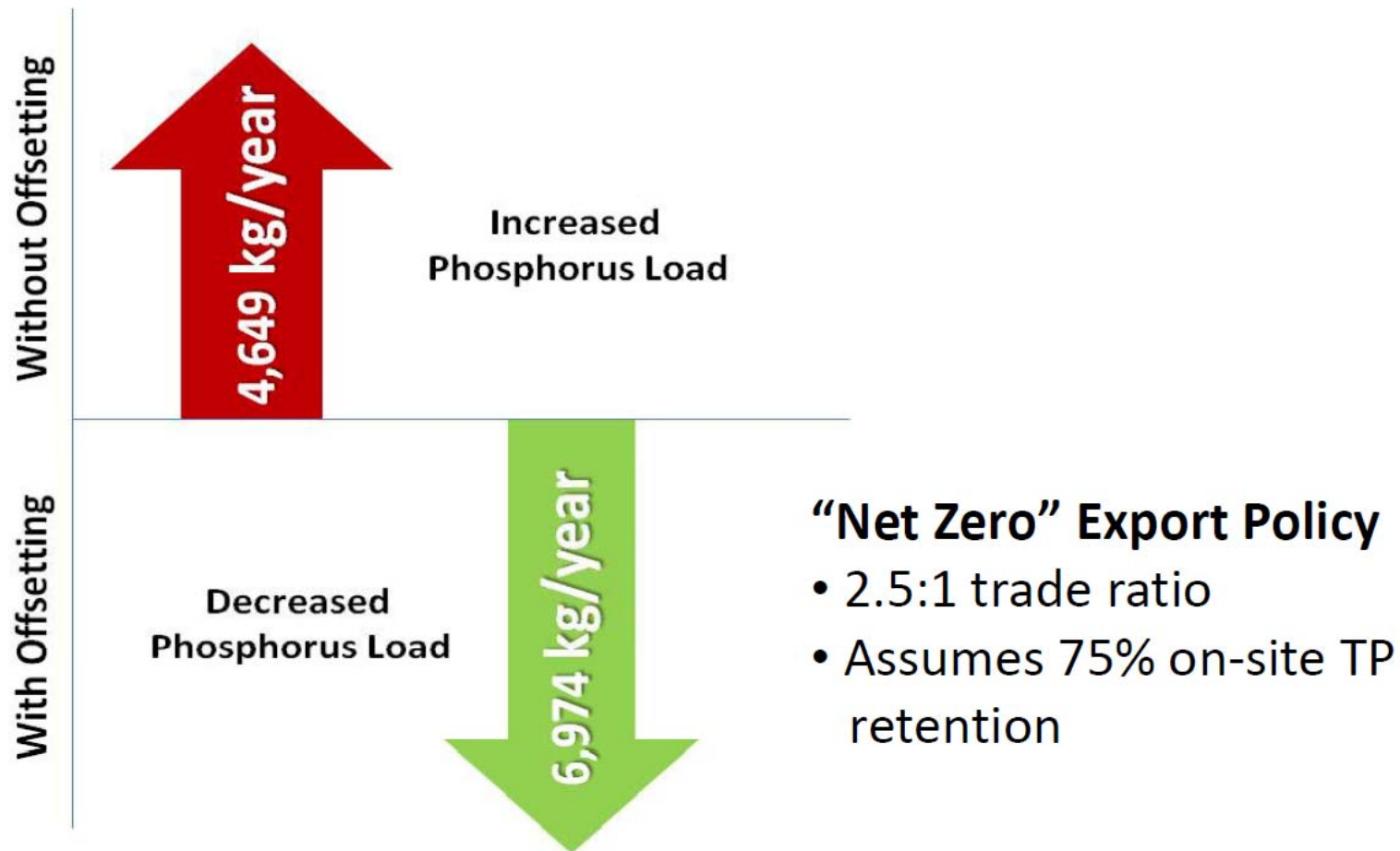
# Lake Simcoe – Innovative Solutions

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



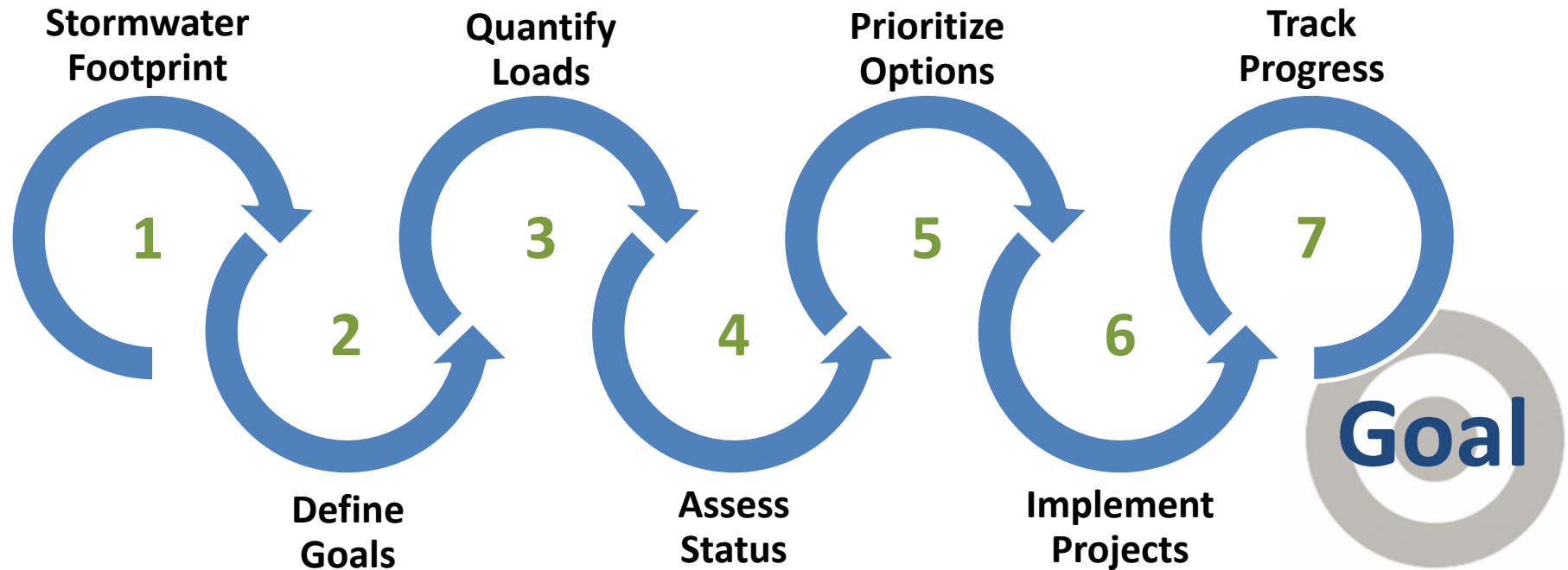


# Lake Simcoe – Watershed Impacts





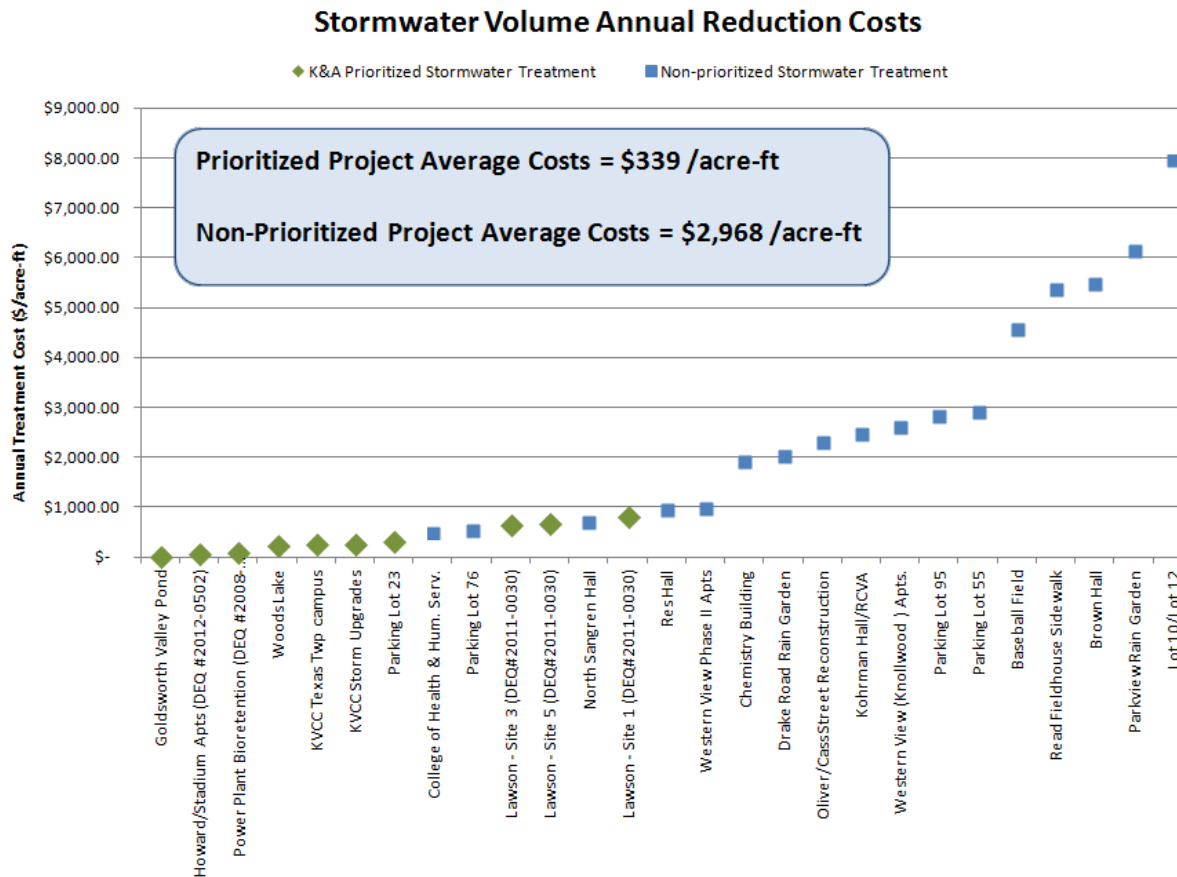
# Sustainable Management



## MS4 Reporting Simplified/Verified



# Metrics Matter...

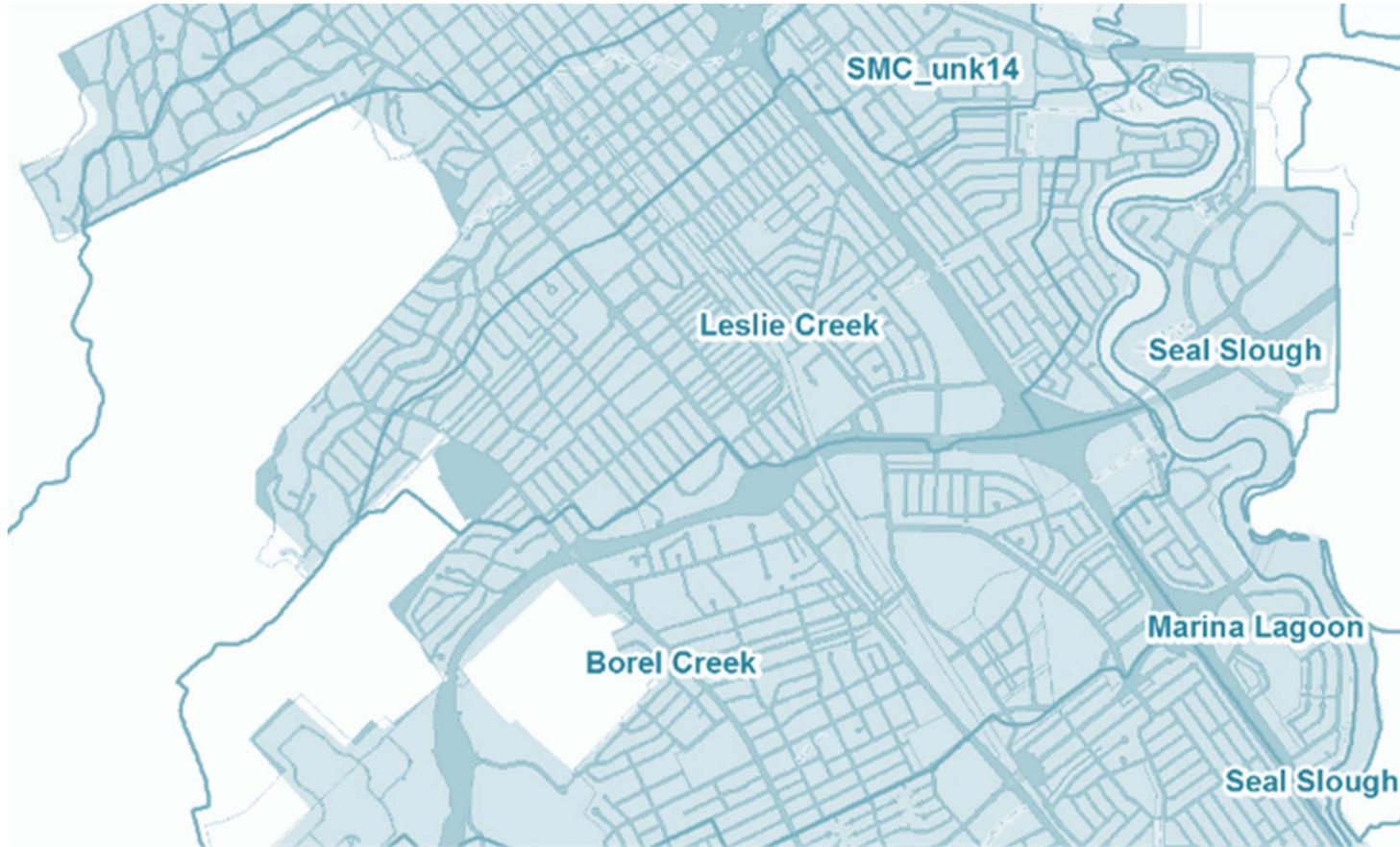


## Cost-Effective and Innovative Solutions



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# Identify Your Footprint...



## Not likely Property Boundaries



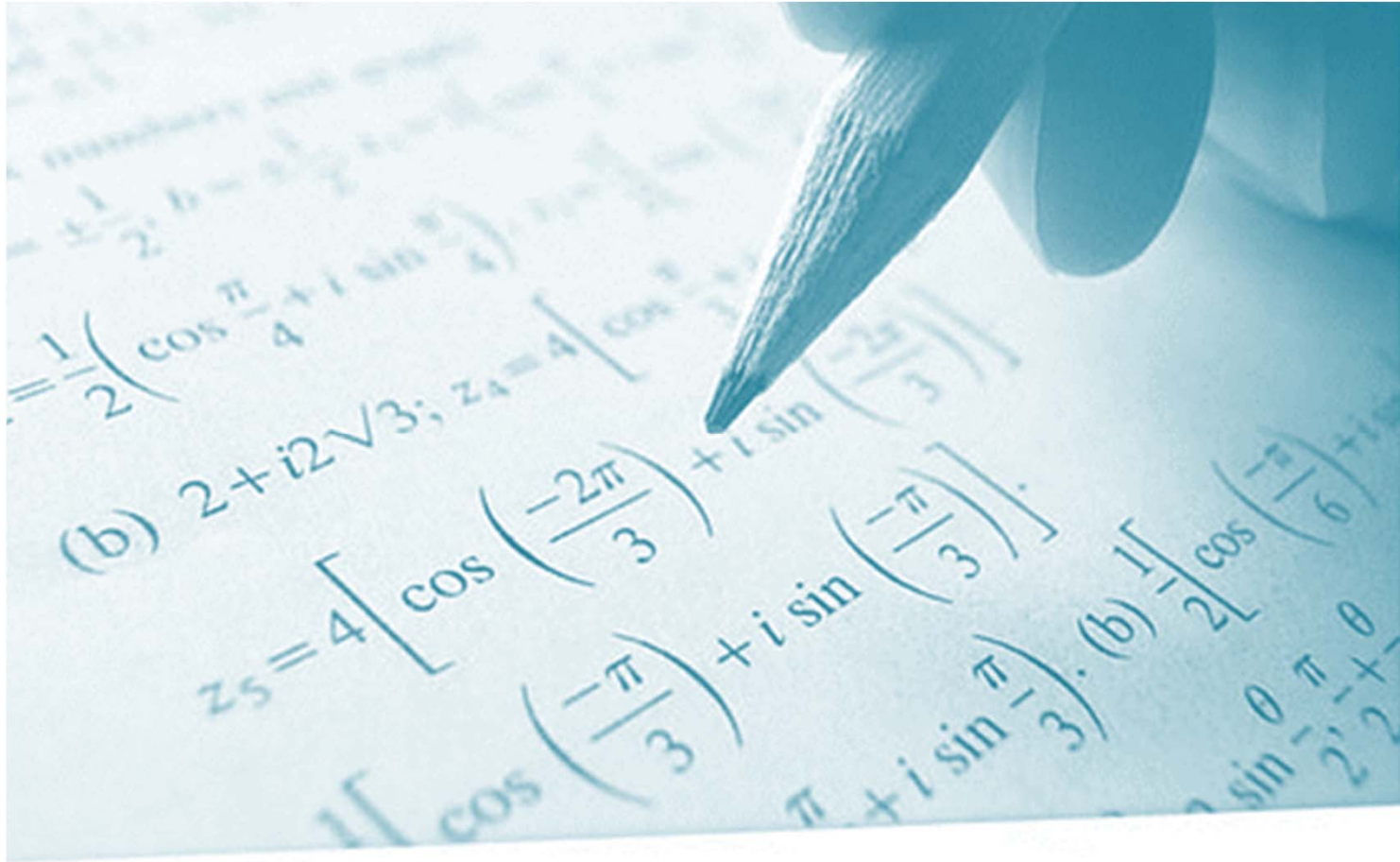
# Define Your Goal...



**Odds Increase when you Aim at Your Target**



# Quantify Existing Conditions...



## How have Past Efforts Helped?



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# 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

Michigan State University Stormwater Controls	Capital Cost (\$)	Life-Cycle (\$)	Nutrient Load Reduction (lbs)	Cost- Efficiency (\$/lb)	Sediment Load Reduction (\$/ton)	Cost- Efficiency (\$/ton)	Volume Reduction (ac-ft)	Cost- Efficiency (\$/ac-ft)
West Circle Steam - Phase 1								
West Circle Steam - Phase 1								
Chestnut Road Reconstruction								
Michigan State Police - Demolition								

## How Can MSU Reach MS4 Stormwater Goals and Stormwater Neutral<sup>SM</sup> 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?



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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



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# Appreciative Partners

*“WMU is honored to be the first U.S. recipient of the Stormwater Neutral<sup>SM</sup> certification thanks to 16-year commitment of Kieser & Associates to this University and our local watershed”*

**- Lu Deboef, Environmental Specialist, MS<sub>4</sub> Program, Western Michigan University**

*“Kieser’s commitment to both stormwater and watershed innovation has resulted in WMU being the only regulated MS<sub>4</sub> 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 Neutral<sup>SM</sup> 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!

**Brian Boyer, P.E.**  
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