

URBAN STORMWATER MANGEMENT—AN MS4 SUCCESS STORY FOR WESTERN MICHIGAN UNIVERSITY

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INTRODUCTION

Regulation of stormwater runoff is increasing throughout the United States. The Environmental Protection Agency (EPA) and state agencies are beginning to move toward effluent and/or load limits for pollutants in stormwater. Compliance costs for treating urban stormwater runoff, especially in highly-developed areas where retrofits are required, will only continue to increase.

Western Michigan University (WMU) is a permitted Municipal Separate Storm Sewer System (MS4) along Arcadia Creek and the West Fork of Portage Creek in Kalamazoo, Michigan. As such, it falls within the nonpoint source (NPS) load allocation for a phosphorus total maximum daily load (TMDL) developed for the Kalamazoo River and Lake Allegan (refer to Figures 1 and 2 for location maps). The Kalamazoo River TMDL was established in 2001 and requires a 50% reduction in total phosphorus (TP) originating from NPSs, using the 1998 load as a baseline. The original timeline outlined in the TMDL set 2009 as the target date for meeting the TP reduction goal. To date, no other MS4s (or any other NPSs) in the watershed have been able to document progress or demonstrate an ability to meet this goal.

WMU has employed a unique approach toward resolving their stormwater concerns, which include MS4 permit requirements, TMDL compliance, and flooding. The University's efforts have utilized federal/state grant funding and strategic MS4 partnerships to implement stormwater best management practices (BMPs) identified within an EPA-approved Watershed Management Plan. Efforts also included applying engineering designs to target floodplain enhancements, TMDL compliance, flood mitigation, and infrastructure protection.

During the past decade, WMU implemented 14 stormwater BMPs. The most recent stormwater BMP project leveraged state funding and was completed in November 2011. The project focused on multiple goals: reducing direct discharges of urban stormwater runoff to surface waters; naturalizing conveyances and stream corridors using native plants; repairing erosion caused by urban runoff; restoring original floodplains; reducing phosphorus and sediment loads to tributaries of the Kalamazoo River; and increasing groundwater recharge.

In 2011, a WMU TMDL Compliance Planning Project demonstrated that WMU has achieved TP load reductions sufficient to meet TMDL load allocation compliance goals. The final TMDL Compliance Plan document provided a "road map" outlining

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future implementation of on-campus and off-campus stormwater BMPs. This plan will also help move WMU into a position of becoming Stormwater Neutral™. A framework for a water quality monitoring program also was included in the plan to enable successful measurement of stormwater BMP effectiveness. To complement the compliance plan, several BMP treatment recommendations for future implementation were pre-designed. These designs clearly defined costs and environmental benefits in terms of water quality and hydrology improvements to ensure that efforts are reasonable, feasible, and beneficial.

KEYWORDS

urban stormwater, nonpoint source, MS4, TMDL, total phosphorus, stormwater BMP, load allocation, Stormwater Neutral™, water quality monitoring

WHAT ARE THE STORMWATER ISSUES?

Western Michigan University (WMU) is located in Kalamazoo, Michigan, and is a dynamic, student-centered research institution with an enrollment of approximately 25,000 students. The current WMU campus footprint, illustrated in Figure 2, is approximately 807 acres and includes more than 100 buildings. Arcadia Creek meanders through the campus and ultimately discharges to the Kalamazoo River in downtown Kalamazoo. The University's interests and concerns related to stormwater include: MS4 stormwater permit requirements, total phosphorus TMDL compliance requirements, campus flooding and infrastructure protection, and long-term sustainability toward Stormwater Neutral™ status for total phosphorus (i.e., "net-zero" phosphorus loading).

FIGURE 1. Kalamazoo River Watershed (spanning 10 counties and 76 townships) and the Portage and Arcadia Creek Subwatershed located in Kalamazoo, Michigan.

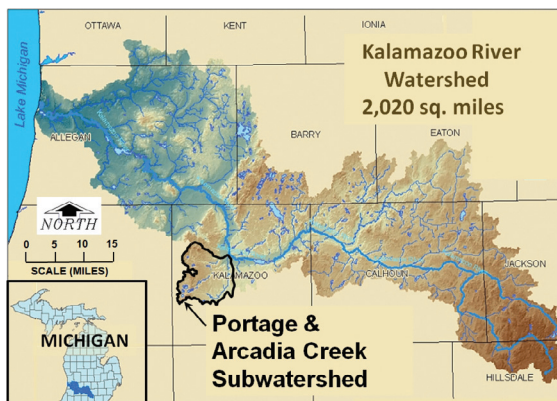
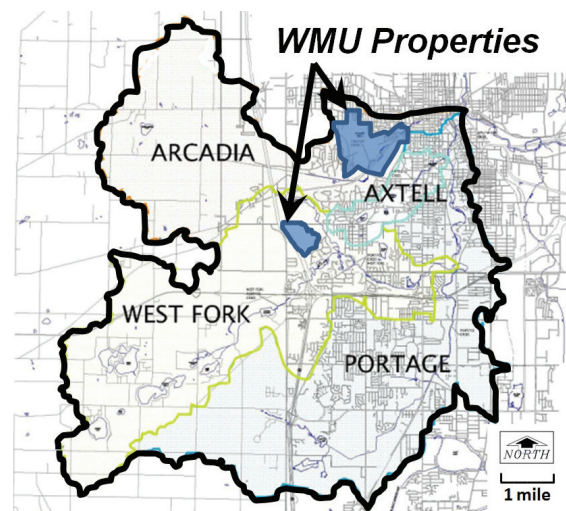


FIGURE 2. Portage and Arcadia Creek Subwatershed and WMU campus properties, Kalamazoo, Michigan.



Why Treat Stormwater Runoff?

Traditional rooftops, parking lots, sidewalks, and streets within urbanized areas prevent rainfall infiltration and groundwater recharge. Stormwater runoff from these impervious surfaces collects pollutants, including nutrients (such as phosphorus and nitrogen), sediments, heavy metals, grease, oils, and other toxic substances. Impervious surfaces also greatly speed up the flow of stormwater runoff, leading to flashy hydrographs and increased erosion in receiving streams. These conditions increase nutrient and sediment loading and degrade aquatic habitats, as well as contribute to further degradation of downstream waters. Stormwater runoff also contributes to flooding, especially in urban environments. (See Figure 3 for photographs of WMU stormwater flooding and infrastructure protection concerns.)

FIGURE 3. Recent WMU campus flooding conditions. Waldo Football Stadium (*center*) and stadium stairwell (*bottom left*) flooding in 2005, and WMU primary steam heating pipes nearly compromised in 2006 (*top right*).



What is a TMDL?

A TMDL is a calculation of the maximum amount of a pollutant a water body can receive and still meet water quality standards. Examples of water quality standards include acceptable levels of dissolved oxygen, water clarity, or other criteria that are established to meet the goals of the Clean Water Act.

The federal Clean Water Act requires a TMDL to be established for all water bodies that fail to achieve water quality standards. Every two years, states provide the EPA with a list of impaired waters. The EPA may add water bodies to the list if the agency has evidence of impairment. All states are required to calculate a TMDL for each impaired water body. If the states fail to act, the EPA may elect to determine a TMDL for them.

Approximately 1,600 square miles of the Kalamazoo River/Lake Allegan Watershed has had a total phosphorus (TP) TMDL for nearly a decade. The Kalamazoo River/Lake Allegan TMDL calls for a 50% reduction of annual phosphorus loads compared to discharge levels in 1998, the base year for the TMDL. To date, there have been no other MS4s in the Kalamazoo River/Lake Allegan basin able to demonstrate any progress towards the TP reduction goals, let alone an ability to meet the TMDL load allocation goals for urban stormwater. Urban stormwater loads comprise nearly 45% of the TP loading to Lake Allegan, yet urban areas are only 8% of the watershed land cover.

Resolving Stormwater Issues

WMU employed a unique approach to resolve its stormwater concerns. Capital improvement funds involving stormwater upgrades for planned campus renovations were used to leverage state/federal grant funds to double the impact of stormwater BMPs on campus and within

the watershed. WMU formed strategic partnerships with local stakeholders such as the City of Kalamazoo, Michigan Department of Transportation (MDOT), Michigan Department of Environmental Quality (MDEQ), Kalamazoo River Watershed Council, and other local watershed stakeholders to allow for collaboration toward common goals and interests. BMP implementation projects previously identified within the Portage-Arcadia Watershed Management Plan (WMP) have been—and continue to be—prioritized for grant funding requests. Lastly, BMP design efforts focused on enhancing floodplains for additional storage to reduce flooding, as well as TMDL compliance through treatment approaches involving total phosphorus reduction and infrastructure protection in critical areas.

During the past decade, WMU implemented 14 stormwater BMPs. These BMPs include improvements such as rain gardens, underground detention/infiltration systems, perforated storm sewer networks and leaching basins, grassed swales, floodplain bioretention areas, stormwater detention ponds, and infiltration basins. These projects were funded using WMU capital improvement funds and state/federal grants.

WMU ARCADIA CREEK BMP PROJECT

The most recent WMU stormwater BMP project was implemented at the university in the fall of 2011. A Clean Michigan Initiative (CMI) Grant awarded in 2008 by MDEQ provided funding for engineering design and implementation of urban stormwater BMPs involving two implementation sites. Site #1, illustrated in Figure 4, included property at the WMU Stadium Drive Apartments, MDOT right-of-way along Stadium Drive, and the WMU Robert M. Beam Power Plant (power plant) floodplain. BMPs at Site #1 included a grassed waterway, sediment forebay, detention ponds, streambank restoration, and floodplain improvements (refer to Figure 5 for a schematic diagram). The second site, Site #2, involved underground stormwater detention and infiltration BMPs at the new WMU Western View Apartments (refer also to Figure 4) and was funded by WMU to satisfy the 25% match requirement for the CMI grant funds utilized for Site #1.

The purpose of the CMI project was to reduce untreated stormwater runoff discharging directly to Arcadia Creek. This project served to improve overall stream habitat conditions

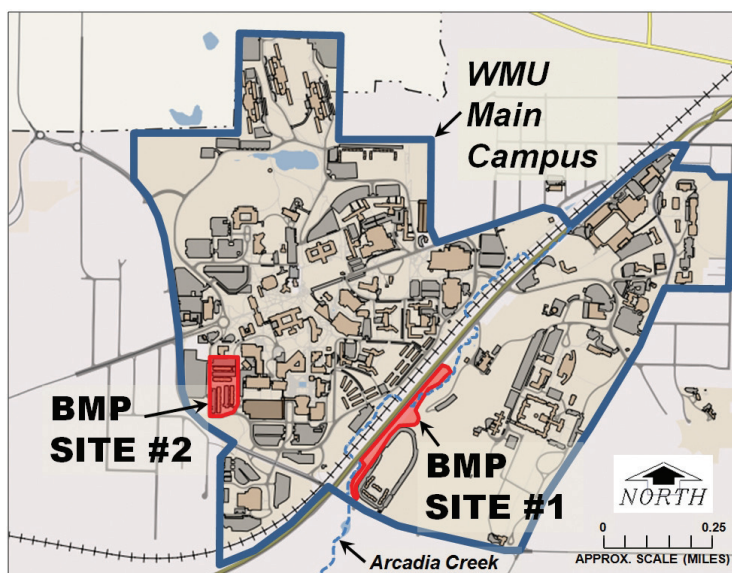
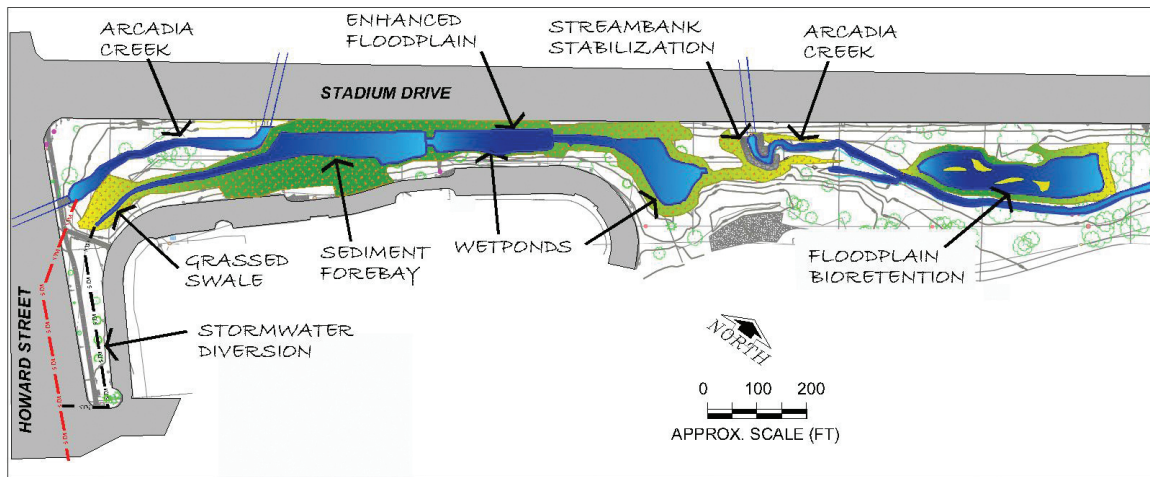


FIGURE 4. Location of Western Michigan University CMI Grant stormwater BMP implementation sites, Kalamazoo, Michigan.

FIGURE 5. Conceptual schematic of new WMU stormwater treatment areas along Stadium Drive, Kalamazoo, Michigan. (Arcadia Creek Project, Site #1.)



for nearly one-quarter of a mile along Arcadia Creek and provided additional flood relief for downstream urban areas in Kalamazoo. These BMPs now reduce sediment loading and further reduce phosphorus loading to the Kalamazoo River. They also protect WMU campus facilities from damage by flooding and bank erosion. Lastly, these efforts provide valuable watershed educational opportunities for both students and the general public.

Arcadia Creek BMP Project Outcomes

Project goals for the Arcadia Creek BMP project are summarized in Tables 1 and 2. Photographs of Site #1 are provided in Figures 6 and 7 and depict substantial completion status

TABLE 1. Arcadia Creek BMP Project Goals for Site #1.

Improvement	Quantification
Redirect urban stormwater runoff from impervious surfaces	102 acres
Provide treatment for first-flush stormwater runoff	120 ac-ft/yr
Streambank restoration and construction of bioengineering/soil stabilization BMP practices along eroding streambanks	268 ft
Restoration of disconnected floodplains used for bioretention	1.6 acres
Increased floodplain capacity	9,500 cyd
Increasing groundwater recharge	60 ac-ft/yr
Enhanced habitat through use of native Michigan vegetation/seed mixes	3.5 acres
Reduction of total phosphorus load to Arcadia Creek	85 lbs/yr
Reduction of sediment loading to Arcadia Creek	27 tons/yr

TABLE 2. Arcadia Creek BMP Project Goals for Site #2.

Improvement	Quantification
Redirect urban stormwater runoff from impervious surfaces	4.5 acres
Provide treatment for first-flush stormwater runoff	8.5 ac-ft/yr
Reduction of total phosphorus loading to Arcadia Creek	9 lbs/yr
Reduction of sediment loading to Arcadia Creek	1.5 tons/yr



FIGURE 6. Series of new WMU stormwater detention ponds along Stadium Drive, Kalamazoo, Michigan. (Substantial completion photograph, November 2011.)



FIGURE 7. Streambank stabilization of previous erosion areas in Arcadia Creek along Stadium Drive, Kalamazoo, Michigan. (Substantial completion photograph, November, 2011.)

in November 2011. Figure 8 provides two photographs illustrating how the native seed mix vegetation might look in the future, based upon other successful WMU implementation sites.

Public ownership of these implementation sites and stormwater infrastructure allows for continued maintenance through integration into existing maintenance programs, which protect infrastructure and public assets. WMU is obligated within the context of the WMP³ to sustain these BMP implementation efforts under its current MS4 stormwater permit.

To view the project fact sheet for this WMU grant project, visit www.kieser-associates.com/uploaded/final_fact_sheet_1_17_12.pdf

³<http://www.kalamazooriver.net/pa319new/index.htm>

FIGURE 8. Example photographs of mature vegetation at the WMU Lot 23 Stormwater BMP (left) and the WMU Chemistry Building Stormwater BMP (right). These photographs depict how the new Arcadia Creek BMP Project Site #1 might look at WMU two years from now.



STORMWATER TMDL COMPLIANCE

In 2010, MDEQ awarded WMU a TMDL Compliance Planning Grant utilizing funding from the American Recovery and Reinvestment Act (ARRA) of 2009. WMU's TMDL project involved developing a TMDL Compliance Plan for municipal separate storm sewer system (MS4) phosphorus discharges to Arcadia Creek. This urban stream passes directly through the main campus of WMU and discharges directly to the Kalamazoo River (refer to Figure 4).

WMU set out to become the first documented MS4 to achieve the TMDL TP reduction goal of 50% for nonpoint sources within the Kalamazoo River/Lake Allegan Watershed. Furthermore, WMU set a goal to achieve a Stormwater Neutral™ status for TP (i.e., “net-zero” phosphorus loading). Throughout the past decade, WMU has been an active partner and a leader in BMP implementation on its campus and within the watershed. WMU is a recent signatory to the Southwest Michigan Regional Sustainability Covenant, and this planning project aligned with the WMU Office of the President and Vice President's public commitment to making the university a more sustainable campus.

“Western Michigan University is concerned about the environment, and stormwater management is a critical part of an overall, sustainable campus program. Stormwater runoff is a concern that must be addressed. Stormwater BMPs have moved us in the direction of stormwater neutrality.”

Determining WMU TMDL Compliance Status

The compliance planning approach provided a cost-effective strategy to identify and plan for MS4 TMDL compliance needs. This approach was not only novel in most TMDL watersheds, but it also provided a means to gauge compliance feasibility and costs. The planning process included the following approved work steps:

Step 1

Historic loading assessments and BMP inventories of stormwater infrastructure were completed for approximately 807 acres of the WMU campus stormwater footprint. The 1998 baseline campus TP loading was quantified using relevant land cover data circa 1998, detailed

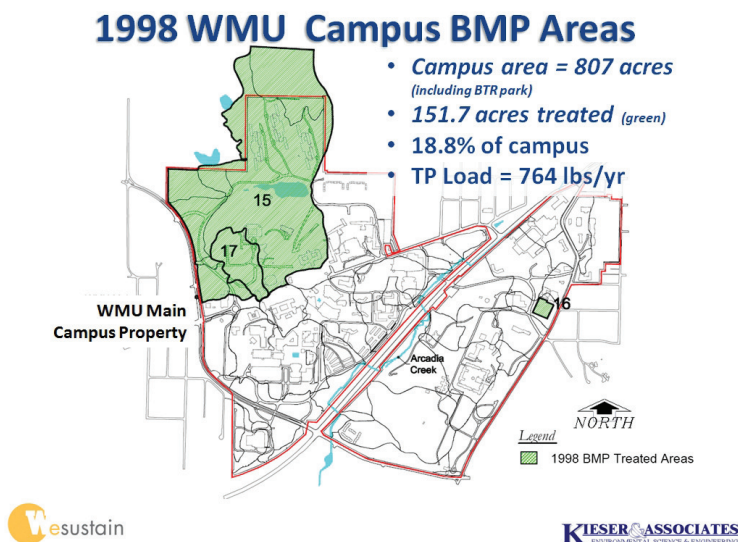


FIGURE 9. WMU campus map depicting 1998 treated areas (18.8% of WMU stormwater footprint).

historic GIS land cover and infrastructure information compiled by WMU, empirically-based loading model estimates using local and regional event mean concentrations and published BMP efficiencies confirmed with local monitoring (K&A, 2011). This evaluation included 64 stormwater outfalls covered under WMU's current Certificate of Coverage (COC) for their General Permit (refer to Figure 9).

Step 2

Load reductions associated with BMPs funded and implemented by WMU since 1998 were estimated to assess progress towards NPS load allocation reduction goals. These included assessment of the following categories:

1. On-campus BMPs (within the WMU MS4 campus stormwater footprint)
2. Off-campus, adjacent properties contributing stormwater to WMU BMPs (nearby adjacent properties contributing stormwater onto WMU property were evaluated separately but were incorporated into the evaluation of WMU stormwater treatment and total phosphorus TMDL load reductions)
3. Off-campus, non-MS4 BMPs (outside the WMU stormwater footprint but not associated with another MS4 jurisdiction)
4. Off-campus, MS4 BMPs (outside the WMU stormwater footprint and partially credited according to funding provided by WMU)

Step 3

Untreated stormwater TP loads and drainage areas were prioritized based on projected cost-effectiveness of implementing future BMPs.

Step 4

Optimal treatment solutions for all previously untreated areas (where feasible, practical, and effective) were pre-designed for future implementation grant funding requests.

Step 5

Potential load reductions were identified using pre-designed treatment solutions to assess compliance with TMDL reduction goals.

Step 6

As the first watershed compliance plan, it was created as a guide for other MS4s and non-MS4 developed areas using tools and approaches that were created for and incorporated into a Kalamazoo River Watershed Management Plan by the Kalamazoo River Watershed Council (KRWC, 2011).

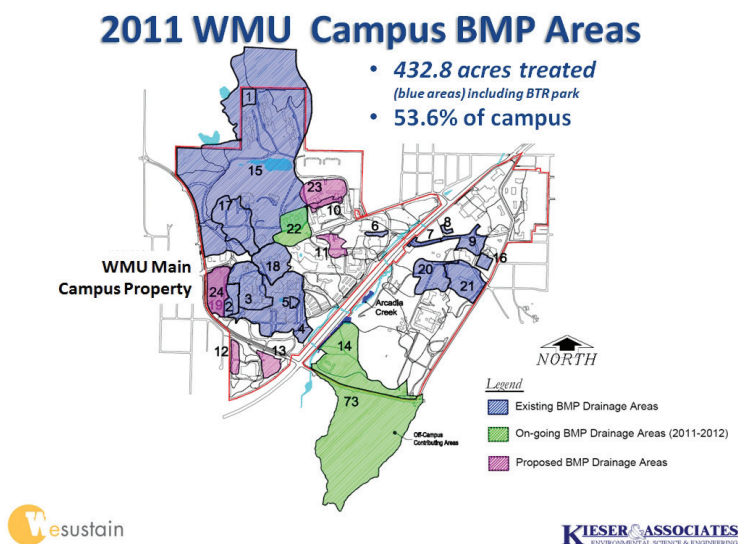
TMDL Project Outcomes and Benefits

These efforts revealed that, to date, 53% of the WMU MS4 main campus footprint is now treated by a stormwater BMP following an intentional integration of stormwater BMPs into a capital improvement program to leverage state/federal grant funding assistance (refer to Figures 10 and 11). This now includes a total of fourteen stormwater BMP projects implemented since 1998.

The Michigan Water Quality Trading Rules⁴ (promulgated in 2002, Part 30 of 1994 Part 451, MCL 323.3013) served as a template to assess WMU Stormwater Neutral™ status and account for off-campus stormwater BMP projects, financially supported by WMU, as phosphorus offsets toward the university's TMDL compliance status. For example, an off-campus 2007 BMP project located immediately upstream of WMU resulted in a 154 lbs/yr TP reduction associated with NPS urban streambank stabilization. Off-campus NPS urban streambank stabilization BMPs also were implemented in 2008 in partnership with the City of Kalamazoo and resulted in a TP load reduction of 70 lbs/yr. These BMP projects did not involve MS4 stormwater runoff (that might otherwise be included in other MS4 permit footprints), but rather were voluntary, non-stormwater/non-MS4 projects. Thus, WMU was credited with the full TP load reduction achieved. These grant projects would not have been possible without the financial support of WMU.

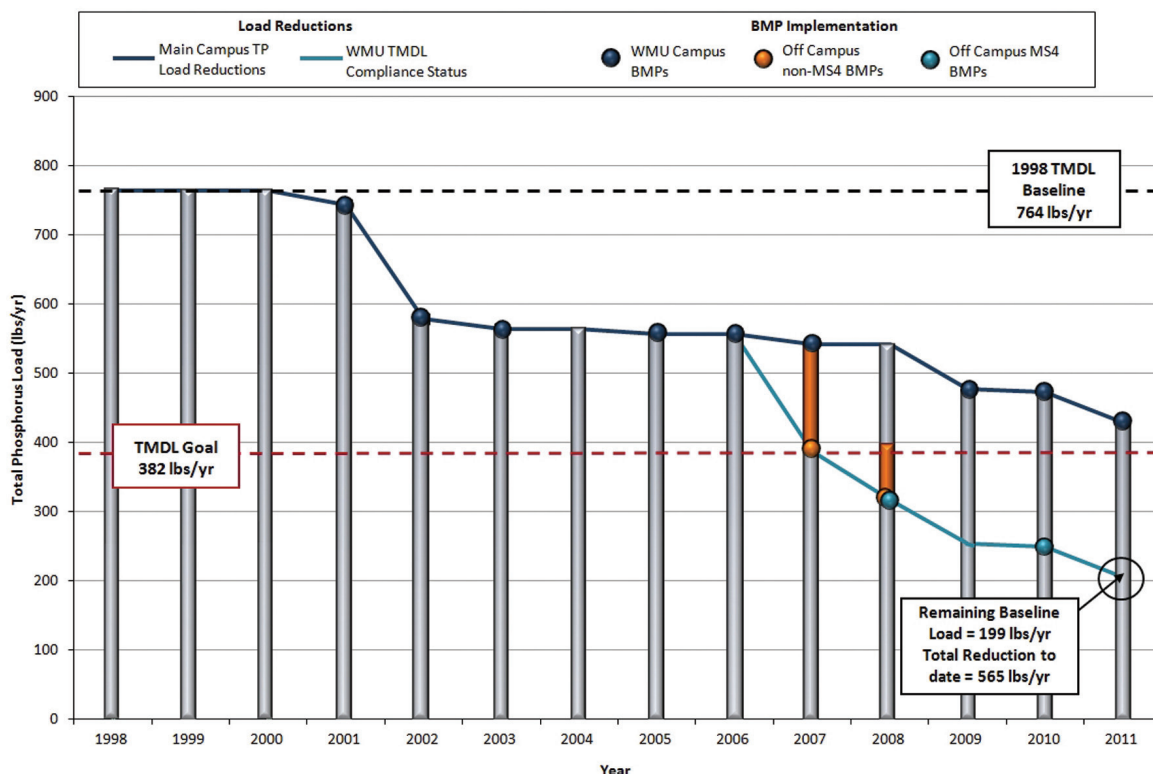
Figure 11 provides a timeline summary illustrating WMU BMP implementation from 1998 through 2011. Since the 1998 TMDL baseline year, WMU has installed 14 stormwater

FIGURE 10. WMU campus map depicting 2011 treated areas (53.6% of WMU stormwater footprint).



⁴Michigan Water Quality Trading Rules available at: <http://www.state.mi.us/orr/emi/arcrules.asp?type=Numeric&id=1999&subId=1999-036+EQ&subCat=Admincode>

FIGURE 11. Timeline summary of WMU TMDL status since 1998 as a result of stormwater BMPs installed on the WMU campus and other off-campus projects financially supported by WMU (i.e., total phosphorus offsets).



BMPs on campus, serving more than half of the MS4 stormwater footprint. These implementation efforts have resulted in an estimated on-campus reduction of 331 lbs TP/yr, as well as 5 lbs TP/yr from contributing non-university adjacent properties (a 38% reduction from the estimated 764 lbs/yr baseline load). Off-campus non-MS4 related BMP projects installed in 2007 and 2008, for which WMU also contributed financial match, have been substantial and amount to an additional reduction of 224 lbs TP/yr. Off-campus MS4 related projects constructed in 2008 and 2010 (stormwater falling under the jurisdiction of other permittees) that were financially supported by WMU provided an additional 5 lbs TP/yr reduction. In all, these efforts reflect a TP reduction of 565 lbs/yr from the 1998 baseline TP load from the WMU campus (Figure 11). These efforts have met and surpassed the Kalamazoo River TMDL load allocation reduction goal for total phosphorus (a 74% reduction from the estimated 764 lbs/yr baseline load from 1998).

Two currently funded WMU stormwater BMP implementation projects are estimated to generate additional phosphorus reductions, which will allow WMU to achieve a Stormwater Neutral™ status for phosphorus (Figure 11). An additional nine potential/proposed on-campus stormwater BMP projects have been identified that will be evaluated and prioritized for implementation as future funding opportunities arise. Future monitoring at five existing BMP locations will verify ongoing WMU TMDL compliance, complement current initiatives for sustainability, as well as prompt additional stormwater infrastructure improvements in portions of the MS4 campus footprint.

To view the project fact sheet for this WMU TMDL Compliance Grant, visit www.kieser-associates.com/uploaded/wmu_final_tmdl_fact_sheet.pdf

Summary of Stormwater Accomplishments

WMU is the first documented MS4 permittee to achieve the 10-year old TMDL reduction goal of 50% for nonpoint sources within the Kalamazoo River Watershed. Furthermore, the university is well on its way to achieving a Stormwater Neutral™ goal through future implementation of additional on-campus and off-campus stormwater BMP projects.

Presently, WMU has reduced approximately 20% of the total Arcadia Creek NPS loading for TP and sediment to the Kalamazoo River. WMU has spent over \$4M on urban stormwater BMP projects since 1998. These costs reflect an average of \$33,000/lb TP and \$215,000/ton sediment to retrofit existing infrastructure and treat urban stormwater runoff. As part of their Stormwater Neutral™ goal for long-term sustainability, WMU will continue to pursue on-campus and off-campus BMP implementation opportunities.

WHAT'S NEXT?

WMU has no intention of stopping its stormwater treatment progress. Rather, the university is already moving on to its next stormwater BMP project. The MDEQ recently awarded WMU a Section 319 Clean Water Act Grant for a project that will help improve water quality in other off-campus stormwater projects. This new grant project recently was announced to the public by the Kalamazoo Gazette in August⁵ 2011 and again in October⁶ 2011.

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ABOUT THE AUTHORS

Kieser & Associates, LLC provides engineering design, water resources, TMDL compliance, and watershed management and planning services to industry, commercial businesses, state agencies, municipalities, legal counsel, and private clients. They have served WMU in these capacities for more than a decade. To learn more about K&A and their services, visit www.kieser-associates.com.

⁵http://www.mlive.com/news/kalamazoo/index.ssf/2011/08/asylum_lake_water_quality_to_b.html

⁶http://www.mlive.com/news/kalamazoo/index.ssf/2011/10/restoring_asylum_lake_stormwat.html

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