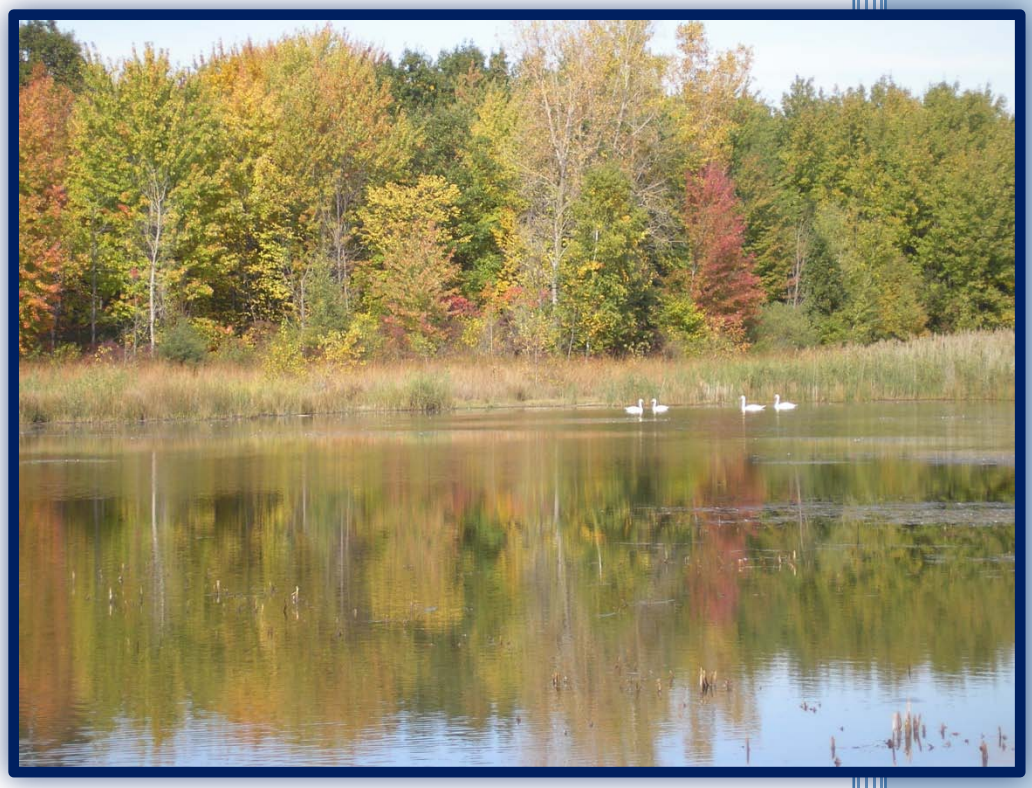
Chapter 8 – Methods of Measuring Progress



8.0 METHODS OF MEASURING PROGRESS

OBJECTIVES

- How will the Watershed's progress be quantified?
- What conditions need to be monitored in order to gauge progress?
- How will these conditions be monitored?
- How will the WMP be evaluated?

8.1 MEASURES OF SUCCESS

Measures of success are essential to any project to evaluate and assess the achievements of the project, and determine the benefits to water quality and the quality of life resulting from the implementation of the Best Management Practices (BMPs). The success of the project toward meeting its goals of improving water quality and restoring the designated uses of the Lower Grand River Watershed (Watershed) depends on many factors, all of which need to be continuously evaluated.

Various groups are currently monitoring several parameters in the Watershed, as described in Table 8.1. Some are conducted at a local level, such as the City of East Grand Rapids monitoring Reeds Lake, while others are administered at the county and state levels, such as the beach monitoring program. Establishing monitoring targets, against which observed measurements are compared, helps the Steering Committee determine whether progress is being made toward targets and ultimately the Watershed goals. The targets set are not enforceable, just a measure for the Steering Committee to use to gauge the implementation efforts. Section 8.2 describes measurements that can be taken to indicate overall water quality. Section 8.3 describes ongoing Watershed monitoring efforts. Section 8.4 outlines Watershed monitoring components to evaluate overall changes in Watershed conditions. Section 8.5 describes the Volunteer Monitoring Toolbox and its application to subwatershed evaluation. Section 8.6 provides the evaluation framework to assess the success of the WMP implementation efforts.

8.2 INDICATORS OF OVERALL WATER QUALITY

8.2.1 Measurements

Methods of evaluation will be used to monitor the success of the project, both immediately following implementation and for continual monitoring of water quality. Measurements are used in this evaluation to determine the level and rate of water quality improvements, focusing on areas of physical, chemical, and biological improvements.

Measurements are defined by categories of indirect indicators and direct environmental indicators. Indirect indicators are measurements of practices and activities that could indicate water quality improvements but do not actually measure the water quality itself. For example, estimating the pollutant reductions achieved by a practice is stating that a certain amount of the pollutant will be prevented from entering the stream. Another indirect indicator would be the miles of filter strips installed as a percentage of the total miles of riparian areas without buffers. This percentage of installation could be compared to the goals of the Watershed and the success could be measured.

Direct environmental indicators would be measuring the quality of the water through scientific investigation. Sediment load reduction could be measured by total suspended sediment concentration, embeddedness, or pebble counts; and nutrient load reductions could be measured through chemical analysis of the water. Macroinvertebrate surveys are also direct environmental indicators of water quality, since some insects are very sensitive to changes in a stream's health.

Measurements will be used to determine whether the pollutant load reduction goals are being met, as calculated in Tables 6.3 through 6.6. Pollutant reduction criteria have been established for the known and suspected pollutants of the Watershed as described below.

Pathogens and Bacteria

Pathogen monitoring programs should be designed to determine whether surface waters meet WQS for partial and total body contact recreation between May 1 and October 31. R 323.1062 State of Michigan Part 4 Water Quality Standards requires that all waters of the state shall be protected for total body contact recreation and shall not contain more than 130 *E. coli* (*Escherichia Coli*) per 100 milliliter (mL) as a 30-day geometric mean. In addition, at no time shall the waters of the state protected for total body contact contain more than 300 *E. coli* per 100 mL, as a geometric mean of at least three samples collected during the same sampling event.

The criteria for evaluating *E. coli* will be based on water samples collected and tested for levels of *E. coli.* Results will be analyzed for exceedances of Water Quality Standards (WQS) for partial and total body contact recreation. Recommendations for monitoring include *E. coli* monitoring by the MDNRE as part of the Watershed-wide biological survey every 5 years, and the subsequent monitoring of reaches with pending or approved TMDLs (Figure 3.1 B).

Another recommendation is to monitor the status of BMP implementation to eliminate identified *E. coli* contributing sources, such as failing septic systems. Municipalities and county health departments can track implementation where septic system failures are suspected. Permitted waste dischargers currently monitor for coliform bacteria as specified in their permits.

Sediment

The criteria for sediment evaluation would be reaching a goal of WQS for 80 mg/L (milligrams per liter) for total suspended solids (TSS) measured by a certified laboratory; more sites having sedimentation consistent with the soil types as rated through the pebble count; implementation of BMPs on all identified nonpoint source (NPS) sites of sediment loading; and a measurable increase in the water quality and macroinvertebrate rating, as rated through the Great Lakes and Environmental Assessment Section (GLEAS) Procedure No. 51 (P51) survey for macroinvertebrates. The measurements for sediment reduction will use the following: (1) before and after TSS measurements, (2) pebble count survey data, (3) P51 survey data, (4) number of BMPs implemented, and (5) before and after photos of BMPs. Plaster Creek is the one exception in the Watershed related to its criteria for sediment evaluation. The Plaster Creek TMDL has a goal for TSS of 30 mg/L instead of 80 mg/L. Other monitoring recommended includes an evaluation of streambank erosion.

Nutrients

According to the Michigan Department of Natural Resources and Environment (MDNRE), nutrients shall be limited to the extent necessary to prevent stimulation of growth of aquatic rooted, attached, suspended, and floating plants, fungi, or bacteria which are or may become injurious to the designated

uses of the surface waters of the state. Nutrient reduction goals should align with the total maximum daily loads (TMDLs) that have been established for the Watershed. For Morrison Lake, the spring turnover period must meet the target value of 0.030 mg/L over a sustained period of time and under various flow regimes. The measurements for nutrient reduction will include before and after water quality data (DO, chlorophyll a, phosphorus, and other parameters listed in Table 8.1), number of BMPs implemented, and photos of the site before and after implementation of BMPs.

Water grab samples should be collected from surface waters with elevated nutrient concentrations. These waterways may experience occasional algal blooms with the input of phosphorus and nitrogen from surface water runoff. Livestock, septic tanks, cropland and urban landscapes, ducks and geese, and sanitary sewer leaks are all known or suspected sources of nutrients in the Watershed. Nutrient monitoring is recommended for stream reaches and lakes on the State's 303(d) list for organic enrichment (Figure 3.1D), phosphorus (Figure 3.1C), and dissolved oxygen (Figure 3.1A).

High Temperature

High water temperature has the potential to have negative impacts on fish and macroinvertebrate communities. Water temperatures should be monitored to ensure that values are within standards set for coldwater and warmwater streams.

To support a coldwater fishery, heat load cannot cause exceedance of monthly limits (maximum 68°F in June, July, and August). To support a warmwater fishery, heat load cannot cause exceedance of monthly limits (maximum 77°F in July and August [Creal and Wuycheck 2002]). Measurements for temperature impacts include before and after water quality data (DO, temperature), P51 fisheries and macroinvertebrate data, number of BMPs implemented, and photos of the site before and after implementation of BMPs.

Continuously recording data loggers (such as HOBO Pro v2, http://www.onsetcomp.com/products/data-loggers/u22-001) can be secured into a stream location and downloaded periodically. Specific focus should be placed on stream reaches that lack riparian buffer or have recently been denuded of vegetation.

Sites currently monitored for temperature are included in Table 8.1.

Schrems West Michigan Trout Unlimited (TU) completed temperature studies in the spring and summer of 2009. They are trying to identify the impact of agriculture practices on coldwater streams. Temperature data was collected at the following locations:

- Prairie Creek, Ionia County: Charles Road and Prairie Creek Road
- Rogue River, Kent County: Packer Road below and above the Rockford Dam on Stegman Creek; the Rogue River below and above Stegman Creek's outlet to the Rogue River; on Cedar Creek; and the Rogue River below and above Cedar Creek's outlet to the Rogue River.
- Tyler Creek, Kent County: At Pratt Lake Drain, on Bear Creek, and on Tyler Creek on the Dolan property near the confluence with the Coldwater River.

Additional sites should be identified in coordination with TU current temperature monitoring program. Baseline information in other subwatersheds will be useful and necessary for measuring improvements related to the installation of BMPs.

Chemicals

The criteria for chemical evaluation will be based on implementing BMPs on areas where chemical containment facilities are constructed or chemicals are applied to the land. Chemicals will be prevented from reaching surface water by using proper application methods and amounts, and the use of filter and

buffer strips where appropriate. Measurements for reduction of chemicals include before and after water quality data (chemical analysis), P51 fisheries and macroinvertebrate data, number of BMPs implemented, and photos of the site before and after implementation of BMPs.

8.3 ONGOING WATERSHED MONITORING EFFORTS

Monitoring activities within the Watershed have been conducted by many partners, as described in Table 8.1. This table serves as the basis for developing the environmental monitoring component for this WMP. Particular attention to future monitoring will be given to stream reaches identified on the State's 303(d) list in the Integrated Report. (Figures 3.1 A-D). Table 8.1 lists significant previous and current water quality monitoring programs in the Watershed, sorted by the organization conducting the monitoring.

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) – MDNRE						
Grand River and its tributaries (including Libhart, Tibbets, Crooked Creek & Deer Creek)	Water Chemistry	TDS, Total Phosphorus, Nitrogen	MDNRE Protocol	Conducted in 2003	Once every 5 years (scheduled for 2013)	MDNRE
Flat River	Macroinvertebrate community and stream habitat	Biological survey	GLEAS P51	Conducted, most recently, in July & August 2008.	Once every 5 years (2013)	MDNRE
Rogue River	Macroinvertebrate community and stream habitat	Biological survey	GLEAS P51	Conducted, most recently, in July 2008.	Once every 5 years (2013)	MDNRE
Thornapple River	Macroinvertebrate community and stream habitat	Biological survey	GLEAS P51	Conducted, most recently, in July 2008.	Once every 5 years (2013)	MDNRE
Lower Grand River	Macroinvertebrate community and stream habitat	Biological survey	GLEAS P51	Conducted, most recently, in June, July & August 2004.	Once every 5 years (2014)	MDNRE
Lower Grand River	Water Chemistry	TDS, Total Phosphorus, Nitrogen	MDNRE Protocol	Conducted, most recently, in July & August 2009.	Once every 5 years (2014)	MDNRE
Coldwater River	Macroinvertebrate community	Macroinvertebrate Survey	MDNRE Protocol/ GLEAS P51	Conducted in 2008	Once every 5 years (2013)	MDNRE
Entire Watershed	Hydrologic assessment to evaluate the impact of urban development on the stability of stream channels in the Watershed; and compare the erosion potential of several common storm water management approaches for stream protection, to ensure that effective controls are being requested by local units of government within the Watershed.	Hydrology	MDNRE Protocol	Conducted in 2009	Not currently monitored	Consultants, MDNRE

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Bear Creek	Hydrologic assessment to help determine the effect of land use changes in the Watershed on Bear Creek's flow regime, evaluate what effect potential urbanization will have on peak stream flows, and to provide design flows for streambank stabilization BMPs.	Hydrology	MDNRE Protocol	Conducted in 2003	Not currently monitored	MDNRE
Cedar Creek	Hydrologic assessment to help determine the effect of land use changes in the Watershed on Cedar Creek's flow regime, and to provide design flows for streambank stabilization BMPs.	Hydrology	MDNRE Protocol	Conducted in 2004	Not currently monitored	MDNRE
Coldwater River	Hydrologic assessment to help determine the effect of drainage system alterations and land use changes on the Coldwater River's flow regime, and to provide design flows for streambank stabilization BMPs.	Hydrology	MDNRE Protocol	Conducted in 2003	Not currently monitored	MDNRE
Hager Creek	Hydrologic analysis of Hager Creek Reference Reaches, including a comparison of the physical characteristics of the Watersheds and calculation of surface runoff volumes and peak flows.	Hydrology	MDNRE Protocol	Conducted in 2002	Not currently monitored	MDNRE
Sand Creek	Hydrologic assessment to help determine the effect of land use changes in the Watershed on Sand Creek's flow regime, and to provide design flows for streambank stabilization BMPs.	Hydrology	MDNRE Protocol	Conducted in 2003	Not currently monitored	MDNRE

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Thornapple River	Hydrology	Volume and velocity measurements	MDNRE Protocol	Conducted in 2008	Not currently monitored	MDNRE
Plaster Creek Watershed: Plaster Creek at Market Street; Godfrey Street; 28th Street; Schaffer Street; 44th Street; 60th Street; 68th Street tributary at 28th Street; 60th Street	Pathogens	(*E. coli* count/100 mL)	MDNRE Protocol	Conducted in 2002	Once/5 Years	MDNRE
Organization(s) – West Michigan Environmental Action Council (WMEAC)						
Rogue River Watershed: Barkley, Rum, Shaw, and Stegman Creeks on Northland Drive; Becker Creek on Lyons Property; Rogue River at Rector and Jericho; Cedar Creek at Friske; Duke Creek at Division	Macroinvertebrate community, Sediment, and Temperature	Stream Habitat Assessment; Benthic Macroinvertebrates	MDNRE Protocol/GLEAS P51	2009 – 2019	2 times/year (spring and fall)	WMEAC
Rush Creek	Macroinvertebrate/Habitat Analysis	Benthic Macroinvertebrates/Habitat Analysis	MiCorps Volunteer Stream Monitoring Procedure/MiCorps Habitat Analysis	2009-Present	1 time/year (fall)	WMEAC volunteers
Plaster Creek at Division; Plaster Creek Family Park	Macroinvertebrate community	Macroinvertebrate Survey	MDNRE Protocol/GLEAS P51	2000 – Present	Once/Year	WMEAC Volunteers
Organization(s) – Michigan Lakes and Stream Association Members						
Rogue River Watershed: Bills Lake, Freska Lake, Big Pine Island Lake, High Lake	Temperature and Nutrients	Total Phosphorus	Cooperative Lakes Monitoring Program	2009 – 2019	2 times/year (spring/late summer)	Michigan Lakes and Stream Association Members
		Chlorophyll a			1/month (May – September)	
		DO			Every 2 weeks (May – September)	
		Water Temperature			Every 2 weeks (May – September)	
		Carlson's Trophic State Index (Transparency)			18 weekly measurements (May – September)	

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) – Kent County Health Department						
Rogue River Watershed: Long Lake and Myers Lake	Pathogens	*E. coli*	MDNRE Protocol	2009 – 2019	1 time/year: summer	Kent County Health Department
Organization(s) – City of Grand Rapids		***sent to Ed V. to revise 9-21-10, sent to Kurt Anderson for review.***				
Plaster Creek at Burton Street; Silver Creek at Croften	Temperature	Temperature (°C)	Hand-held Temperature probe	1985 – Present	Quarterly	City of Grand Rapids
	DO	DO (%)	Standard Methods 18th Ed., SM, 4500G			
	pH	pH	SM 4500B			
	BOD	BOD (mg/L)	SM 5210B			
	TSS	TSS (mg/L)	SM 2540D			
	Pathogens	Fecal Coliform	SM 9222D			
	Sodium Chloride	Sodium Chloride (mg/L)	SM 4500E			
	Phosphorus	Phosphorus (mg/L)	SM 4500E B5			
	Nitrate	Nitrate (mg/L)	SM 4500E			
	Nitrite	Nitrite (mg/L)	SM 4500B			
Organization(s) – City of East Grand Rapids						
Two established stations on Reeds Lake	Phosphorus	Phosphorus (mg/L)	MDNRE Protocol	Conducted in 2008	Every other year (next is 2010)	City of East Grand Rapids
	Chloride	Chloride (mg/l)	MDNRE Protocol			
	Temperature	Temperature (°C)	MDNRE Protocol			
	Dissolved Oxygen	DO (%)	MDNRE Protocol			
	pH	pH	MDNRE Protocol			
	Conductivity	Conductivity (Microsemens)	MDNRE Protocol			
	Dissolved Solids		MDNRE Protocol			
	Transparency		MDNRE Protocol			

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) – MS4 Permitees						
Outfalls throughout urbanized areas of Watershed (see NPDES MS4 IDEP program)	Temperature	Temperature (°C)	Hand-held Temperature probe	Conducted in 2004	Once/5 Years	MS4 Communities/FTC&H
	Conductivity	Conductivity (Microsemens)	Hand-held Conductivity probe			
	pH	pH	Hand-held pH probe			
	Ammonia	Ammonia (mg/L)	Test Strips			
	Copper	Copper (mg/L)	Test Strips			
	Nitrate	Nitrate (mg/L)	Test Strips			
	Nitrite	Nitrite (mg/L)	Test Strips			
	Phosphorus	Phosphorus (mg/L)	Test strips/HACH kit			
	Surfactants	Surfactants (presence/absence)	Jar/glass			
Organization(s) – Plaster Creek Steering Committee						
Plaster Creek at Market Street, Godfrey Street, 28th Street, Schaffer Street, 44th Street, 60th Street, and 68th Street Tributary at 28th Street and 60th Street	Pathogens	*E. coli* count/100 mL	MDNRE Protocol	Unknown	Monthly wet and dry weather sampling	Kent County Health Department and Grand Rapids Clean Water Plant
Plaster Creek at Godfrey Ave., Eastern Ave., 68th Street, and East Paris Avenue.	TSS	TSS (mg/L)	MDNRE Protocol	Unknown	Monthly	Grand Rapids Clean Water Plant

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) –CRWC and MDNRE						
Coldwater River - 8 sites	Pathogens, Sediment, Nutrients, DO, Temperature	*E. coli* MPN/100 mL	IDEXX method	Conducted from 2004 to 2009, MDNRE assessment in 2009	4x/yr Rain Event; 6x/yr - Summer (Not currently monitored)	Kent County Health Department, CRWC, Volunteers, MDNRE
		TSS (mg/L)	MDNRE Protocol	MDNRE assessment in 2009	6x/yr - Summer (Not currently monitored)	Kent County Health Department, CRWC, Volunteers, MDNRE
		Total Phosphorus/ Ortho phosphorus (mg/L)	MDNRE Protocol	MDNRE assessment in 2009	6x/yr - Summer (Not currently monitored)	Kent County Health Department, CRWC, Volunteers, MDNRE
		Nitrate/Nitrite (mg/L)	MDNRE Protocol	MDNRE assessment in 2009	6x/yr - Summer (Not currently monitored)	Kent County Health Department, CRWC, Volunteers, MDNRE
		DO	Handheld Specific Conductance/DO Meter	MDNRE assessment in 2009	6x/yr - Summer (Not currently monitored)	CRWC, Volunteers, MDNRE
		Temperature (°C)	Handheld Temperature Probe	MDNRE assessment in 2009	6x/yr - Summer (Not currently monitored)	CRWC, Volunteers, MDNRE
		Stream embeddedness	MDNRE Protocol	MDNRE assessment in 2009	6x/yr - Summer (Not currently monitored)	Kent County Health Department, CRWC, Volunteers, MDNRE

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) – Michigan State University – Water Quality & Health Laboratory						
Coldwater River (4 sites)	Pathogens, pH, Turbidity, Temperature	Bacterial source tracking	USEPA Method 1601/1602, mTec (APHA standard method 9222), PCR Human source marker, qPCR Bovine/human source marker, qPCR Human source marker	Assessed in 2007 – 2008. Reassess in 2011	3x/yr (dry) – Summer 3x/yr (wet) – Summer	MSU Water Quality & Health Laboratory
		pH	Handheld pH Probe			
		Turbidity	MDNRE Protocol			
		Temperature (°C)	Handheld Temperature Probe			
Buck Creek (2 sites)	Pathogens, pH, Turbidity, Temperature	Bacterial source tracking	USEPA Method 1601/1602, mTec (APHA standard method 9222), PCR Human source marker, qPCR Bovine/human source marker, qPCR Human source marker	Assessed in 2008	Weekly for 6 weeks in Summer	MSU Water Quality & Health Laboratory
Organization(s) – Bear Creek Watershed Council						
Bear Creek	Macroinvertebrate/Habitat Analysis	Benthic Macroinvertebrates/Habitat Analysis	MiCorps Volunteer Stream Monitoring Procedure/MiCorps Habitat Analysis	2010	1 time/year (fall)	Bear Creek Watershed Council, volunteers

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) – CRWC						
Coldwater River, Duck Creek, and Tyler Creek	Habitat, Nutrients, DO	Stream Habitat Assessment	USEPA Rapid Bioassessment	Ongoing	4x/yr	Lakewood Schools, Hastings Schools, Thornapple Kellogg Schools, Caledonia Schools, and the Lamps Home School Group, CRWC
		Nitrate/Nitrite (mg/L)	MDNRE Protocol	Ongoing	4x/yr	Lamps Home School Group, CRWC
		DO	Handheld Specific Conductance/ DO Meter	Ongoing	4x/yr	Lamps Home School Group, CRWC
		Total Phosphorus (mg/L)	MDNRE Protocol	Ongoing	4x/yr	Lamps Home School Group, CRWC
Coldwater River Watershed - Brown Road and Hastings Road	Macroinvertebrate community	Macroinvertebrate Survey	MDNRE Protocol/GLEAS P51	Ongoing	4x/yr	Thornapple Kellogg Schools, Lowell High School, and Home School Groups, CRWC
Coldwater River Watershed - Coldwater River and Tyler Creek	Number of Brown Trout	Electroshocking	MDNRE Protocol	2004, 2005, reassess in 2009	1x/yr	GVSU, CRWC
Coldwater River Watershed, 7 wells	Groundwater well monitoring for *E. coli*	*E. coli* MPN/100 mL	IDEX Method EPA	Scheduled for summer 2009	6x/yr – Summer	CRWC, MDNRE
Coldwater River Watershed: Baker, Morin, and Versluys	Rainfall	Rain gauge	Standard protocol	Ongoing, data from 2003 available	Continuous	CRWC
	Hydrology	Velocity (ft/sec)	Pygmy Flow Meter	Assessed in 2009	4x/year during wet and dry weather	CRWC, MDNRE, GVSU
Organization(s) – Schrems West Michigan Trout Unlimited						
Prairie Creek, Rogue River, and Tyler Creek	Temperature	Temperature (°C)	Handheld Temperature Probe	Assessed in 2009 (Spring and Summer)	Hourly (May through October)	Schrems West Michigan Trout Unlimited, Volunteers

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Organization(s) – LGROW Partners/FTC&H						
Buck Creek (12 sites), Plaster Creek (13 sites), Coldwater River (17 sites)	Pathogens	*E. coli* count/100 mL	MDNRE Protocol	Sampling data collected as part of the LGRW *E. coli* Implementation Project (May 17, 2005 – October 31, 2007)	Monthly dry weather sampling; 3 wet weather sampling events; one-time microbial source tracking (6 sites only)	Kent County Health Department, Barry Eaton District Health Department
Organization(s) – Wastewater Treatment Plants						
Buck Creek, Plaster Creek	Temperature	Temperature (°C)	Hand-held Temperature probe	No sites yet identified	Not yet determined	Wyoming Clean Water Plant
	DO	DO (%)	Standard Methods 18th Ed., SM, 4500G			
	pH	pH	SM 4500B			
	BOD	BOD (mg/L)	SM 5210B			
	TSS	TSS (mg/L)	SM 2540D			
	Pathogens	Fecal Coliform	SM 9222D			
	Sodium Chloride	Sodium Chloride (mg/L)	SM 4500E			
	Phosphorus	Phosphorus (mg/L)	SM 4500E B5			
	Nitrate	Nitrate (mg/L)	SM 4500E			
	Nitrite	Nitrite (mg/L)	SM 4500B			
Organization(s) – MiCorps						
Thornapple River Watershed (46 sites)	Macroinvertebrate community	Macroinvertebrate Survey	MDNRE Protocol/GLEAS P51	May 23, 2007 – October 29, 2007	2x/year	Volunteers
	Temperature	Temperature (°C)	Handheld Temperature Probe	May 23, 2007 – October 29, 2007	2x/year	Volunteers
	DO	DO	Handheld Specific Conductance/DO Meter	May 23, 2007 – October 29, 2007	2x/year	Volunteers
	pH	pH	Handheld pH Probe	May 23, 2007 – October 29, 2007	2x/year	Volunteers

Table 8.1 – Water Quality Monitoring and Evaluation for the Watershed

Monitoring Site(s)	Parameter Target	Type of Analysis	Protocol	Status	Frequency	Test Agent
Lower Grand River Watershed (11 sites)	Macroinvertebrate community	Macroinvertebrate Survey	MDNRE Protocol/GLEAS P51	June 21, 2008 and October 4, 2008	2x/year	Volunteers
	Temperature	Temperature (°C)	Handheld Temperature Probe	June 21, 2008, October 4, 2008, and May 25, 2009	2x/year	Volunteers
	DO	DO	Handheld Specific Conductance/ DO Meter	June 21, 2008, October 4, 2008, and May 25, 2009	2x/year	Volunteers
	pH	pH	Handheld pH Probe	June 21, 2008, October 4, 2008, and May 25, 2009	2x/year	Volunteers

BMP best management practice
CRWC Coldwater River Watershed Council
DO dissolved oxygen
GVSU Grand Valley State University
GLEAS P51 Great Lakes and Environmental Assessment Section Procedure 51
IDEP Illicit Discharge Elimination Plan
MDNRE Michigan Department of Natural Resources and Environment
mg/L milligrams per liter
mL milliliter
MS4 Municipal Separate Storm Sewer System
MSU Michigan State University
NPDES National Pollutant Discharge Elimination System
TDS total dissolved solids
TSS total suspended solids
USEPA U.S. Environmental Protection Agency
WMEAC West Michigan Environmental Action Council

8.4 ENVIRONMENTAL ASSESSMENTS

8.4.1 Erosion Assessments

The purpose of conducting a Bank Erosion Hazard Index (BEHI) Assessment is: to increase the understanding of the Watershed's characteristics and the impact of changes on stream stability; to provide a basis for water quality recommendations; and to help determine critical areas. Bank erosion rates are quantified to develop sediment loading calculations and prioritize critical erosion sites.

Erosion monitoring, using "bank pins" or a similar method, should be conducted at a representative sample of erosion sites. One of the best ways to quantify bank erosion is to measure it directly in the field. A 4-foot rod is driven horizontally into an eroded streambank, flush with the surface, and the amount of exposed pin is measured over time. Results are useful for making accurate predictions of annual erosion and, when combined with other measurements, annual sediment loading. These results can be used for a number of purposes, including inclusion in grant applications for funding of implementation projects. A detailed description of the use of bank pins can be found on the internet at: http://www.dnr.state.wi.us/waterways/factsheets/Bank_pin_form.pdf

It is recommended to conduct erosion assessments using BEHI or bank pins, whatever method is most appropriate, along reaches with established TMDLs for siltation (Figure 3.1D), if streambank erosion is a concern. Monitoring efforts should be undertaken as soon as possible to establish baseline conditions. This baseline information will provide detailed measures of bank erosion prior to project implementation, which can later be used to calculate load reductions from installed BMPs.

8.4.2 Biological and Physical Habitat Monitoring

Metrics from the P51 physical habitat methods should be used to assess the amount of sediment present in the stream and the condition of the riparian corridor. Specifically, Metric 2 – Embeddedness and Metric 4 – Sediment Deposition are good measures of the amount of fine sediment present on the stream bottom. Care should be taken, however, to note the difference between a coarse bed stream covered with fine sediment, and a sand bed stream which is inherently composed of fine sediment. Another simple method useful for quantifying substrate composition, and degree of sedimentation, is the Wolman (1954) pebble count (http://relicensing.pcwa.net/documents/Library/PCWA-L-161.pdf). Relative to the riparian corridor, P51 Metrics 9 – Vegetative Protection and 10 – Riparian Vegetative Zone Width should be estimated.

For assessment of macroinvertebrate communities, collection and analysis pursuant to methods described in P51 are useful for documenting change over time at established sites. More basic methods, such as those described by MiCorps, may be more appropriate for volunteer efforts. Biological sampling is especially useful to document community changes following installation of BMPs. The MDNRE currently conducts this monitoring in various watersheds on somewhat regular cycles, so all additional efforts should be coordinated with the MDNRE to avoid duplicate sampling.

Biological and physical habitat monitoring should begin immediately on stream reaches with approved and pending TMDLs for siltation (Figure 3.1D). Baseline information will be useful and necessary for measuring improvements related to installation of BMPs.

8.4.3 Hydrologic Monitoring

Altered hydrology was identified in this WMP as being a cause of streambank erosion. Hydrologic/hydraulic monitoring would be useful for determining changes in flow over time, including effects of changing land use, direct channel impacts, or water withdrawal. As well, the information gathered is useful in the design of stream restoration and streambank stabilization projects. This type of monitoring should be conducted by a professional. Hydrologic monitoring is recommended for reaches impaired by anthropogenic flow alterations (Figure 3.1C) to establish trends over time.

8.4.4 Subwatershed Monitoring

sMonitoring stations should be established near the outlet of each of the 31 subwatershed management units as an initial screening and to obtain records of water quality over time. Pathogens, TSS, embeddedness, macroinvertebrate communities, nutrient parameters, and water temperature would be useful measures for monitoring larger-scale improvements to water quality on a subwatershed scale. Data could be collected by regular site visits by trained individuals. Potential sites for monitoring should also include the downstream ends of TMDL reaches (Figures 3.1A to 3.1D), and sites where NPS pollutants will be reduced due to installation of BMPs (Appendix 4.1). Additional monitoring sites have been identified in previously approved WMP for Buck Creek, Plaster Creek, and Coldwater River.

The MDNRE provides a monitoring request form for stakeholders to submit information about potential monitoring sites that follow surface water quality monitoring recommendations, to support implementation of the Watershed-specific component of the MDNRE's Strategic Environmental Quality Monitoring Program for Michigan 's Surface Waters (Strategy). More information and the request form can be found at: http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728-12735--,00.html

The Data, Information, and Procedures (DIP) Subcommittee has the responsibility to oversee future monitoring efforts in the LGRW. Table 8.2 outlines the strategy that the Committee will take to implement the assessment necessary to document improvements in the Watershed.

Table 8.2 – Assessment Strategy for the LGRW

Strategy Steps	Action Items	Potential Responsible Partners	Milestone
1. Review Existing Information	1. Review LGRW Management Plan's Monitoring Strategy (Chapter 8). 2. Review list of impaired waterways (reaches requiring TMDLs). 3. Review the MS4 storm water monitoring requirements.	1. LGROW/DIP Committee, WMEAC	Year 1 Qtr 1
		2. LGROW/DIP Committee, MDEQ, Subwatershed Groups with TMDL water bodies, County Drain Commissioners, Health Departments	Year 1 Qtr 1
		3. LGROW/DIP Committee, MS4 Communities, MDEQ	Year 1 Qtr 2
2. Determine Priorities	1. Select priority pollutant/impairment based on Step 1. 2. Select target subwatershed(s) based on Step 1.	1. LGROW/DIP Committee, WMEAC	Year 1 Qtr 3
		2. LGROW/DIP Committee. WMEAC	Year 1 Qtr 3
3. Gather Pertinent Resources	1. Identify organizations/projects with relevant data. 2. Send requests for this additional information. 3. Enter new data into the data repository.	1. LGROW/DIP Committee, MDEQ, WMEAC, GVSU	Year 2 Qtr 1
		2. GVSU	Year 2 Qtr 1
		3. GVSU	Year 2 Qtr 1
4. Identify Information Gaps	1. Identify data gaps for selected subwatersheds based on priorities.	1. LGROW/DIP Committee	Year 2 Qtr 2
5. Develop Assessment Strategy	1. Identify existing partners and programs (e.g., volunteer monitoring toolbox). 2. Identify tasks to build on existing efforts.	1. LGROW/DIP Committee, WMEAC	Year 2 Qtr 3
		2. LGROW/DIP Committee, WMEAC	Year 2 Qtr 3
6. Implement Assessment Strategy	1. Apply and secure funding. 2. Complete assessment strategy. 3. Implement project.	1. LGROW/Subwatershed groups	Year 2 Qtr 4
		2. LGROW, MS4 Communities	Year 3 Qtr 1
		3. LGROW/DIP Committee, WMEAC, MS4 Communities	Year 3 Qtr 1

DIP	Data, Information, and Procedures	MDEQ	Michigan Department of Environmental Quality
GVSU	Grand Valley State University	MS4	Municipal Separate Storm Sewer System
LGROW	Lower Grand River Organization of Watersheds	TMDL	total maximum daily loads
LGRW	Lower Grand River Watershed	WMEAC	West Michigan Environmental Action Council

8.5 VOLUNTEER MONITORING TOOLBOX

As part of the LGROW initiative, a volunteer stream monitoring toolbox (toolbox) was developed by the West Michigan Environmental Action Council (WMEAC). The purpose of this toolbox was to assist volunteer monitoring groups in implementing water quality monitoring programs in the LGRW. It is instrumental as a capacity-building tool, and is intended to simplify the process of Watershed protection by providing advice in determining which water quality parameters to sample, sampling frequency, sampling site selection, and appropriate methodology. An outline of the toolbox's approach is included in Appendix 8.1. The toolbox will be of value to Watershed residents for implementation at all levels of organization; from individually concerned citizens and Watershed councils, who seek to protect the water quality of the Grand River, to Municipal Planning units, who seek direction in complying with regulation mandates.

The toolbox took its shape following review and critique from various Watershed partners, including: the Grand Valley Metropolitan Council (GVMC), the MDNRE, Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H), and the Annis Water Resources Institute (AWRI). Additionally, two training sessions were conducted with: (1) Calvin College, an institution that monitors Plaster Creek Watershed, and (2) Trinity Christian Reformed Church, a faith-based group that monitors the Rush Creek Watershed. During these training sessions, feedback forms were used to evaluate the toolbox for the purpose of enhancing its capabilities and user friendliness. The completed feedback forms are included in Appendix 8.1

Presently, the toolbox is embedded (http://148.61.56.211/ISCWEBDocuments/Stream%20Monitoring%20Toolbox.ppt) in an online PowerPoint format. The PowerPoint platform imposes inherent, but negotiable, limitations. As one navigates through the decision tree, the user can use the "previous slide" button to return to the previously viewed slide. However, the program will not allow the user to view a succession of previously viewed slides. Additionally, at various points, the toolbox takes the user into a separate internet browser, at which point the user cannot use the browser's "back" button to navigate back into the toolbox. These limitations can be overcome by simply returning to the first slide and running through the progression of slides iteratively. Future funding is being explored to create an internet platform that will overcome these limitations.

8.6 EVALUATION FRAMEWORK

8.6.1 Evaluation of Future Accomplishments

Measuring progress is critical to both meeting the long-term goals of protecting and restoring water quality in the LGRW and the West Michigan Regional goals to be a great place to live, learn, work, and play. Historically, measuring progress has not been done in a strategic, systemic way. Goals for BMP implementation were incorporated in the 2004 WMP, but many were contingent on receiving grant support for implementation. There was little ownership by the various stakeholder groups ensuring this kind of assessment received the necessary priority. There was no integrated system in place within the framework of LGROW partners to collect, use, and distribute assessment information. However, as the WMP was updated, a strategy was developed regarding the measurement of expected accomplishments.

The following vision and mission statements were developed:

Vision:

LGROW measures of success and accomplishments will be used to celebrate achievements, evaluate progress, make appropriate adjustments in approaches, and provide education and awareness about what is being done. Providing stakeholders with access to assessment data will help to leverage resources and encourage a high level of engagement by everyone involved.

Mission:

LGROW will use measures of success and an accomplishment assessment to give direction, provide encouragement, and help prioritize future actions for all Watershed stakeholders.

The following benefits for measuring progress and tracking accomplishments were identified:

1. It is important to see the progress and celebrate what has been accomplished. It encourages those doing the work to keep focused on the goals and not give up.
2. It helps to evaluate what is working, what is not, and make adjustments to actions plans, keeping work effective and efficient.
3. It provides opportunity for networking, sharing ideas, and assistance for stakeholders within the Watershed.
4. It promotes cutting edge thinking and encourages a “can do” attitude among all stakeholders.
5. It keeps Watershed residents educated and informed about what is going on.
6. It makes grant proposals more marketable.

The following barriers to tracking accomplishments were identified:

1. Measures of success are not currently well defined.
2. No one has identified what is being collected
3. Only the MS4 permit measures are correlated to the Lower Grand River 2004 and 2007 WMPs.
4. LGROW partners do not have an integrated system in place to collect, analyze, and distribute accomplishment data.
5. There are no resources in place to identify measures or institutionalize data collection by various stakeholder groups.
6. There is no coordinated plan to record data so that it can be retrieved easily.
7. There is no plan in place to acknowledge and celebrate the successes.

The following goals were developed:

- Goal 1: Identify, collect, analyze, and summarize what accomplishments have been made from 2004-2009 regarding the implementation of the 2004 LGRW Management Plan.

- Goal 2: Develop a plan that will define measures of success and the system necessary to measure progress and track accomplishments. This system should meet the data management criteria listed in the Lower Grand Vision Outline (Appendix 8.2).

- Goal 3: Implement the plan, so that in 3 years there is an integrated system in place to measure progress and make adjustments, track accomplishments, distribute results, and celebrate accomplishments.

In November 2009, the MDNRE, GVMC, and a Florida intern teamed up to tackle Goal 1. The following strategy was created in order to accomplish this goal.

Strategy steps:

1. Divide stakeholders into manageable categories or groups for the purpose of distributing an assessment questionnaire.

2. Review the Lower Grand River WMP and MS4 permits to determine the type of accomplishments that are expected and should be measured.
3. Using the Lower Grand River WMP and MS4 permits as a basis, develop the draft questionnaires.
4. Get feedback from representatives of the various stakeholder groups regarding the draft questionnaires on how to improve them.
5. Revise questionnaires by incorporating the comments from the representative stakeholder groups.
6. Distribute questionnaires using online survey system.
7. Analyze the return rate.
8. Make follow-up telephone calls and e-mails to find out why questionnaires are not being returned and record responses.
9. Encourage targeted stakeholders to fill out the questionnaire.
10. Analyze responses.
11. Analyze and modify strategy to develop a better approach.
12. Report on the findings in the 2010 Lower Grand River WMP Update.

Due to limited resources and time constraints, only four counties in the Watershed were selected in a pilot study of accomplishments: Barry, Ionia, Kent, and Ottawa Counties. The Watershed stakeholders were divided into groups. The groups were: (1) Natural Resource Conservation Service (NRCS)/Farm Service Agency, (2) Conservation Districts, (3) Land Conservancies, (4) County Drain Commissioners, (5) County Road Commissions, (6) County Health Departments, (7) County Parks and Recreation Departments, (8) Subwatershed Groups, and (9) Local Governments/Counties.

Recommended activities from the 2004 Lower Grand River WMP were combined with BMP implementation measurement goals offered by local MS4 projects to develop initial draft questionnaires for each stakeholder group. These Lower Grand River WMP activities and BMP implementation measurement goals ranged from a wide array of reporting topics including:

- Various BMPs,
- Illicit connection counts,
- Enforcement actions,
- Earth change projects,
- Sanitary and storm system repairs,
- Spill incidents,
- Street sweeping,
- Streambank erosion measures,
- Storm inlet stenciling,
- Newly dedicated open lands,
- Adopted rules related to protecting water quality,
- Septic system manifests and records,
- Development restrictions or riparian easements,
- The adoption of storm water or Low Impact Development (LID) ordinances,
- Yard waste management,

- Drainage retrofits,
- Public education efforts,
- River cleanups,
- Watershed monitoring,
- Stakeholder outreach,
- Grant awards, and
- Construction site and soil and erosion permits.

A draft questionnaire was developed for each stakeholder group keyed on their various goals, activities, and the type of work they performed. The questionnaire also included open-ended questions for each of the stakeholder groups, giving them the opportunity to report their respective success and failures and their overall reaction to the online questionnaire.

MDNRE staff and their intern met with several stakeholders representing several stakeholder groups to obtain feedback regarding the draft questionnaires. Based on the feedback from those meetings, the questionnaires were revised, downloaded into an online survey tool, and a notice sent to the selected stakeholder groups. The MDNRE made telephone calls to many of the recipients who received the questionnaire but had not yet responded, in an attempt to encourage their participation. Returns varied depending on the stakeholder group.

Worth particular mention are the efforts of the NRCS and the Farm Service Agency. Through a meeting and telephone conversations with NRCS and the Farm Service Agency, it was discovered that implemented agricultural structural BMPs are regularly reported as part of ongoing database development for each Watershed. A questionnaire was not required for the NRCS or Farm Service Agency, in that they were able to deliver an Excel spreadsheet (Appendix 8.3) listing the agricultural BMPs that have been implemented in the LGRW from 2004 to 2009. Result summaries from the remaining stakeholder groups are also included in Appendix 8.3.

Initially, the following challenges were encountered:

1. Attention given to what tasks get done and how success is measured varies considerably between and within stakeholder groups.
2. Many of the stakeholders were unfamiliar with the 2004 Lower Grand River WMP and, as such, there is little correlation between what was being measured and what the WMP proposes to measure.
3. Measurements do not necessarily focus on water quality and, therefore, do not always address water pollutants, sources, or causes.
4. What is measured is mostly quantitative data and does not address behavior change or show improvement trends in water quality.
5. Some of the data collected were not tied to a specific Watershed, which makes retrieval of accomplishments from a specific Watershed difficult.
6. The online survey system used, Zoomerang.com, has limited format capability and does not easily accommodate complex, multi-answer questions. Certain groups, such as Local Governments and County Road Commissioners, have more reporting categories than the others. Due to the length of these questionnaires and effort required to retrieve records, many stakeholders were frustrated by the process and simply did not respond. Out of 76 invitations to local governments, 26 opened the request and only 7 replied. Other groups appeared to have a better response rate; however, it is difficult to compare, given that local governments was such a large group.
7. Not all the recipients of the survey notice were able to read the e-mail that contained the survey link due to a formatting issue, so they just ignore it.

8. MDNRE staff followed up by contacting several key stakeholders that did not reply. The follow-up included an e-mail with the link to the survey questionnaire. Recipients were encouraged to fill out the questionnaire. The survey system was not able to record which organization filled out the questionnaire when they used the link provided by the MDNRE staff person.
9. The data being reported by stakeholders were in a form that must be reorganized into spreadsheets or some other data management software program, a function that is very labor intensive.
10. Communications regarding the questionnaires and promoting involvement in the survey needed to be expanded. Direct telephone calling and one-on-one interviews were done this time to encourage the completion of the survey. This proved a successful approach for most of the stakeholder groups. However, this was very labor intensive and not reasonable as part of a long-term sustainable process.

During the development of this WMP, information was collected that helped address these challenges. Table 6.2 – Measureable Milestones was the first step in addressing many of these challenges, and future work will reduce the inconsistencies of what evaluation methods are recommended and how information is collected.