City of River Falls
North Kinnickinnic River Monitoring Project

2012 Summary

Report prepared by SEH Inc., for the

City of River Falls Engineering Department
December 2012

City of River Falls
North Kinnickinnic River Monitoring Project

2012 Summary

<u>Project Introduction:</u>

The Kinnickinnic River is one of the premier, naturally sustaining trout fisheries in the Upper Midwest, primarily producing brown trout. There has been a lot of concern about how new development in River Falls may affect the river, especially due to storm water runoff from impervious surfaces in these urbanizing areas. Not only can storm water runoff contribute chemicals from lawns, cars, etc., but the thermal impacts of untreated storm water are also a concern, as described on the North Kinnickinnic River Monitoring Project website (see "The Thermal Impacts of Storm Water"). In 2002, the City adopted a new Storm Water Management Ordinance, which is designed to protect the Kinnickinnic River from the negative impacts of storm water runoff associated with new development. For new development and re-development projects, the City of River Falls Storm Water Management Ordinance requires that, for a 1.5-inch, 24-hour rainfall event, the post-development runoff volume and peak flow rate must not exceed the pre-development runoff volume and peak flow rate. To achieve this requirement, developers must provide on-site infiltration of storm water.

To take an active role in the river's health and well-being, the City of River Falls implemented the North Kinnickinnic River Monitoring Project in 2004. The goal of the project is to evaluate the effectiveness of our Storm Water Management Ordinance for preventing degradation of the Kinnickinnic River due to new City development. The project scope includes four primary monitoring elements:

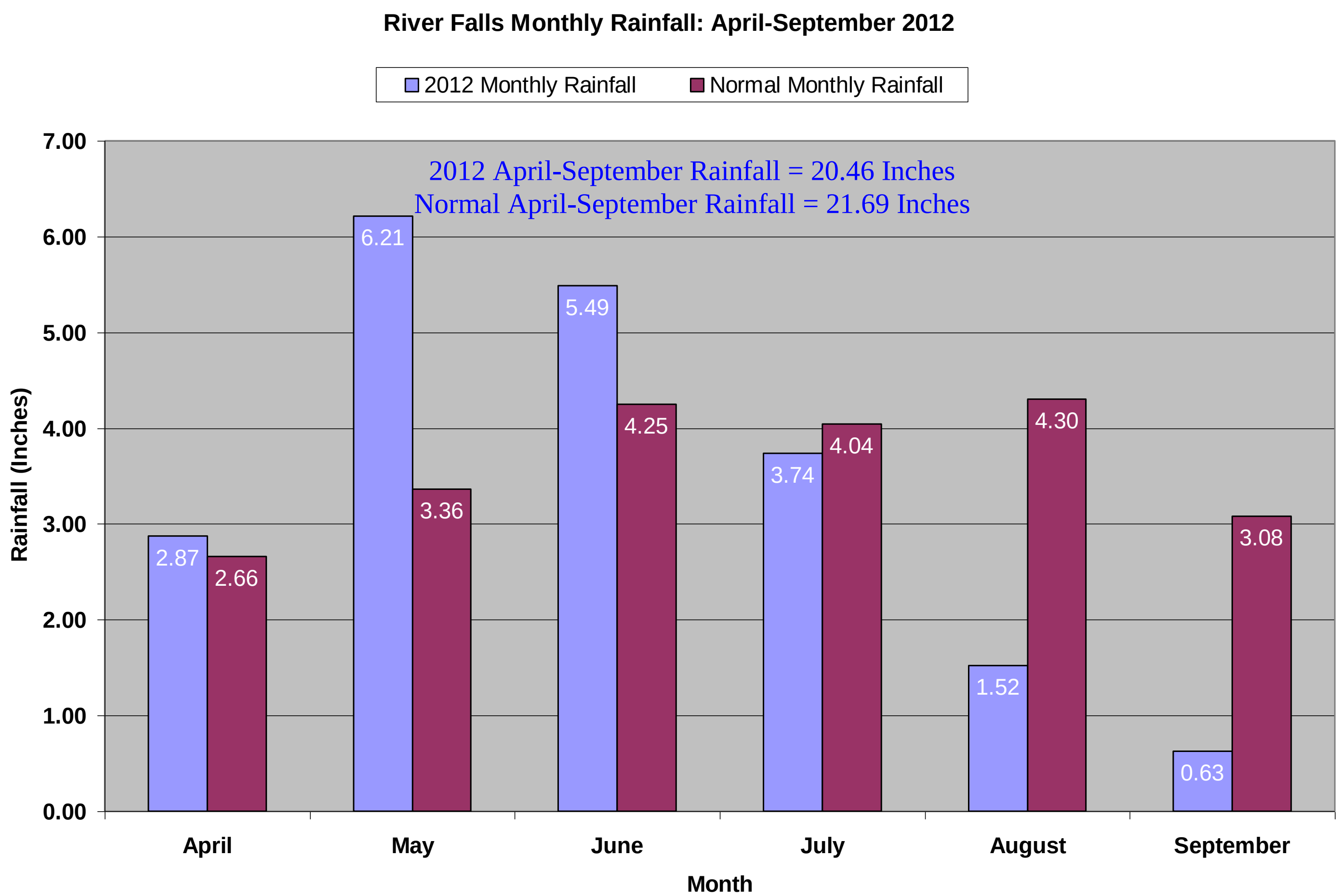
- Temperature Monitoring
- Water Quality Monitoring
- Base Flow Surveys
- Macroinvertebrate Monitoring

The City is examining the long-term results of each of these four monitoring elements to determine whether the storm water ordinance is protecting the river as new development occurs. The project uses an "upstream/downstream" approach to determine if storm water management practices in the Sterling Ponds subdivision protect downstream river conditions. We are also taking a focused look at the performance of the on-site storm water management practices that are incorporated into new developments. Our hope is that, due to the ordinance requirements, the thermal, water quality, and biological impacts of new development will be undetectable or greatly reduced.

<u>River Falls Precipitation:</u>

Due to the major influence of precipitation on river flow, temperature, and water quality, an analysis of seasonal precipitation is conducted as a part of this project. A total of 20.46 inches of precipitation was recorded in River Falls during the April-September 2012 period, 1.23 inches less than the normal total of 21.69 inches for the April-September time period. Rain fell on 59 days, or 32% of the April-September 2012 period.

Monthly rainfall amounts during the April-September 2012 period, with a comparison to normal monthly rainfall amounts, are presented in the figure below. April, May, and June were all wetter than normal, with a slight rainfall excess of 0.21 inch evident in April, a significant excess of 2.85 inches evident in May, and a moderate excess of 1.24 inches evident in June. The combined rainfall of 14.57 inches in April, May, and June was 4.30 inches above normal, and accounted for 71% of the total April-September 2012 precipitation. In contrast, July, August, and September were all drier than normal. A slight rainfall deficit of 0.30 inch was evident in July, but significant deficits of 2.78 inches and 2.45 inches were evident in August and September, respectively. The combined rainfall of 5.89 inches in July, August, and September was 5.53 inches below normal, and accounted for only 29% of the total April-September 2012 precipitation. The largest rain events of the monitoring year occurred on May 6 (1.40 inches), May 24 (1.61 inches), June 14 (1.79 inches), and June 20 (2.05 inches). Due to an extremely dry September 2011 and below-normal winter snowfall, abnormally dry conditions persisted in the North Kinnickinnic River Monitoring Project Area until early May 2012, when above-normal precipitation in May and June brought drought conditions to an end. However, with a much drier-than normal August and September 2012, severe drought conditions developed in the North Kinnickinnic River Monitoring Project Area by early October 2012.



Besides being slightly drier than normal, the April-September 2012 monitoring period was slightly warmer than normal. The mean air temperature in River Falls during the April-September 2012 period was 65.3º Fahrenheit (F), 1.6º F higher than the normal mean of 63.7º F for this time period. The months of April, May, June, and July were all warmer than normal, with May (+3.9º F) and July (+3.9º F) experiencing the greatest departures. The months of August and September were both cooler than normal, with temperature departures of -1.1º F and -1.3º F, respectively.

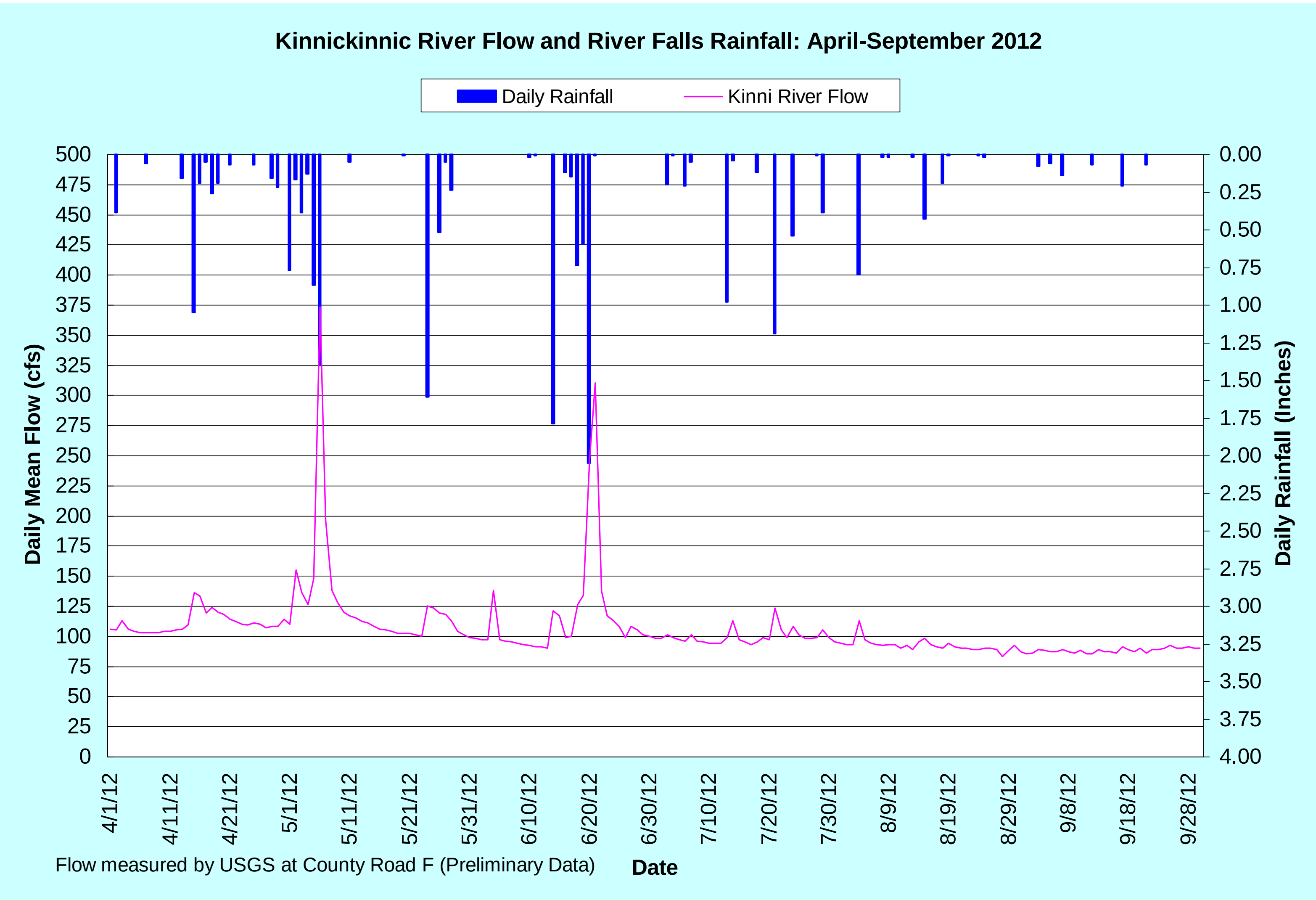
The City of River Falls Storm Water Management Ordinance should have provided infiltration of 95% (19.51 inches) of the total rainfall (20.46 inches) that occurred during the April-September 2012 period. This percentage was determined using some conservative estimates further described in the 2012 technical report.

Kinnickinnic River Flow:

The flow of the Kinnickinnic River is a reflection of strong ground water contributions, as well as precipitation-induced storm water runoff from predominantly agricultural and urban land uses throughout the 165-square mile Kinnickinnic River Watershed. The daily mean (average) flow of the Kinnickinnic River during the April-September 2012 period, as measured at the USGS monitoring station (County Highway F), is presented in the figure below. Daily rainfall, as measured at the USGS monitoring station, is also presented in the figure below.

The Kinnickinnic River hydrograph suggests that seven significant runoff events occurred during the April-September 2012 period (see the figure below). Peak daily mean flows for all of these runoff events exceeded 120 cubic feet per second (cfs). One of these seven significant runoff events occurred in April, when the thermal impacts of storm water runoff are generally not a concern, but water quality impacts can be problematic. Back-to-back rain events on May 1 (0.77 inch) and May 2 (0.17 inch), with a combined 0.94 inch of rain, produced a 3-day runoff event (May 2-4), with a peak daily mean flow of 155 cfs. Shortly thereafter, a combined 2.27 inches of rain during back-to-back rain events on May 5 (0.87 inch) and May 6 (1.40 inch) produced the largest runoff event of the summer (May 5-9), with a peak daily mean flow of 373 cfs. A very large rain event on May 24 (1.61 inches), followed by a combined 0.81 inch of rain during the May 26-28 period, produced a 5-day runoff event (May 24-28), with a peak daily mean flow of 125 cfs. A very large rain event on June 14 (1.79 inches) produced a 2-day runoff event (June 14-15), with a peak daily mean flow of 121 cfs. A combined 3.39 inches of rain during moderate rain events on June 18 (0.74 inch) and June 19 (0.60 inch) and a very large rain event on June 20 (2.05 inches) produced the second-largest runoff event of the summer (June 18-24), with a peak daily mean flow of 310 cfs. A large rain event on July 21 (1.19 inches) produced a 2-day runoff event (July 21-22), with a peak daily mean flow of 123 cfs. The six runoff events in May, June, and July should be the focus for evaluating possible storm water impacts in the North Kinnickinnic River Monitoring Project Area in 2012, and are further analyzed in the 2012 technical report.

With slightly below-normal rainfall during the April-September 2012 period, Kinnickinnic River base flows generally ranged from 85-110 cfs, as measured at County Highway F (see the figure below). As the April-September 2012 period became increasingly drier, base flows gradually decreased. Base flows tended to be a bit higher (90-110 cfs) during the wetter-than-normal months of April, May, and June, and a bit lower (83-98 cfs) during the drier-than-normal months of July, August, and September.



Temperature Monitoring:

The thermal impacts of untreated storm water discharges on segments of the Kinnickinnic River within the City of River Falls, especially in the downtown and Glen Park areas, have been clearly documented by temperature monitoring research conducted by the local Kiap-TU-Wish Chapter of Trout Unlimited (TU). These thermal impacts are also evident in the South Fork of the Kinnickinnic River. The TU temperature monitoring research can be viewed at:

http://www.kiaptuwish.org/storm-water

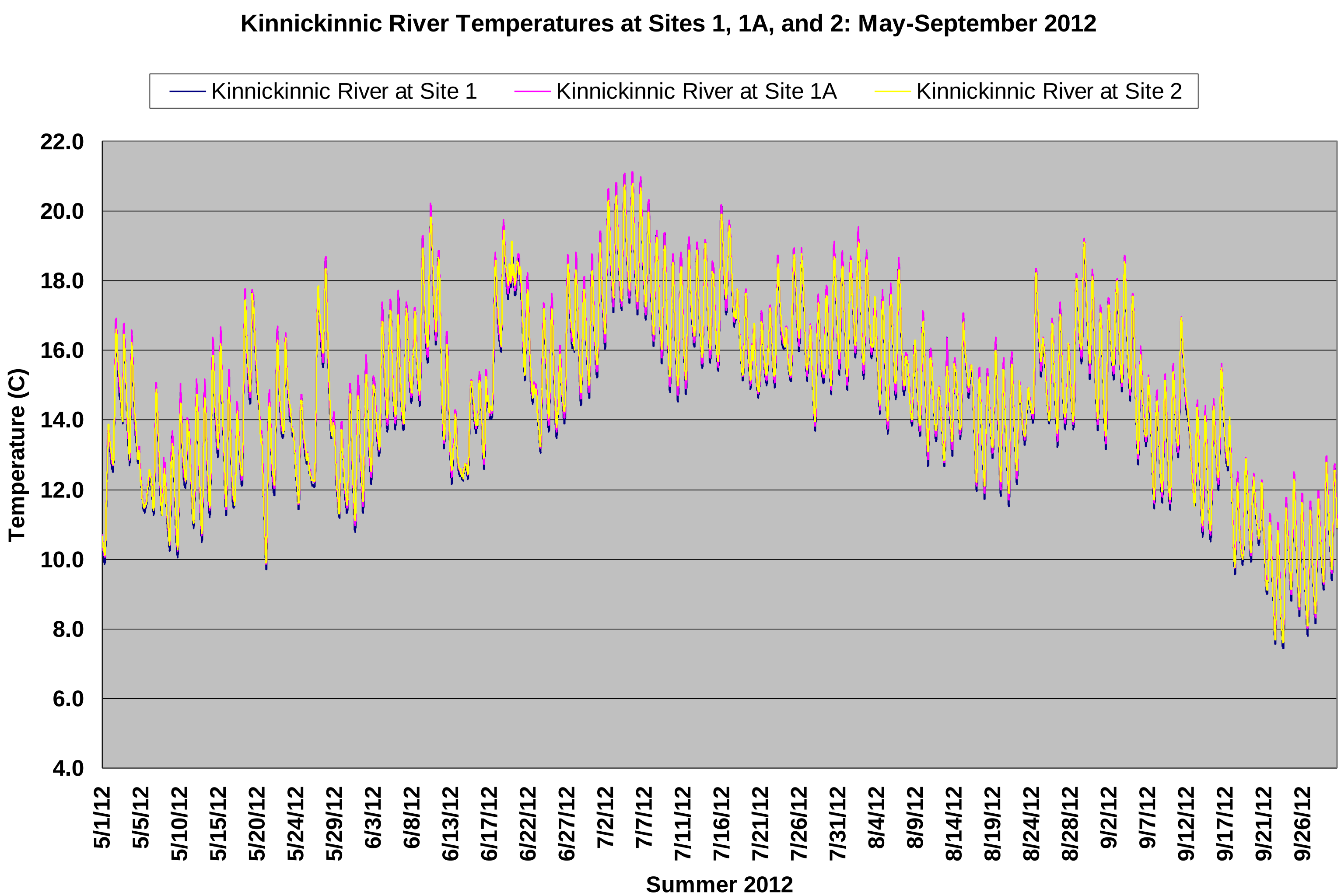
A direct storm sewer discharge to the Kinnickinnic River at Division Street

The intent of the City of River Falls Storm Water Management Ordinance is to prevent storm water impacts on the Kinnickinnic River, including thermal pollution, in areas of the city with new development, such as the Sterling Ponds subdivision.

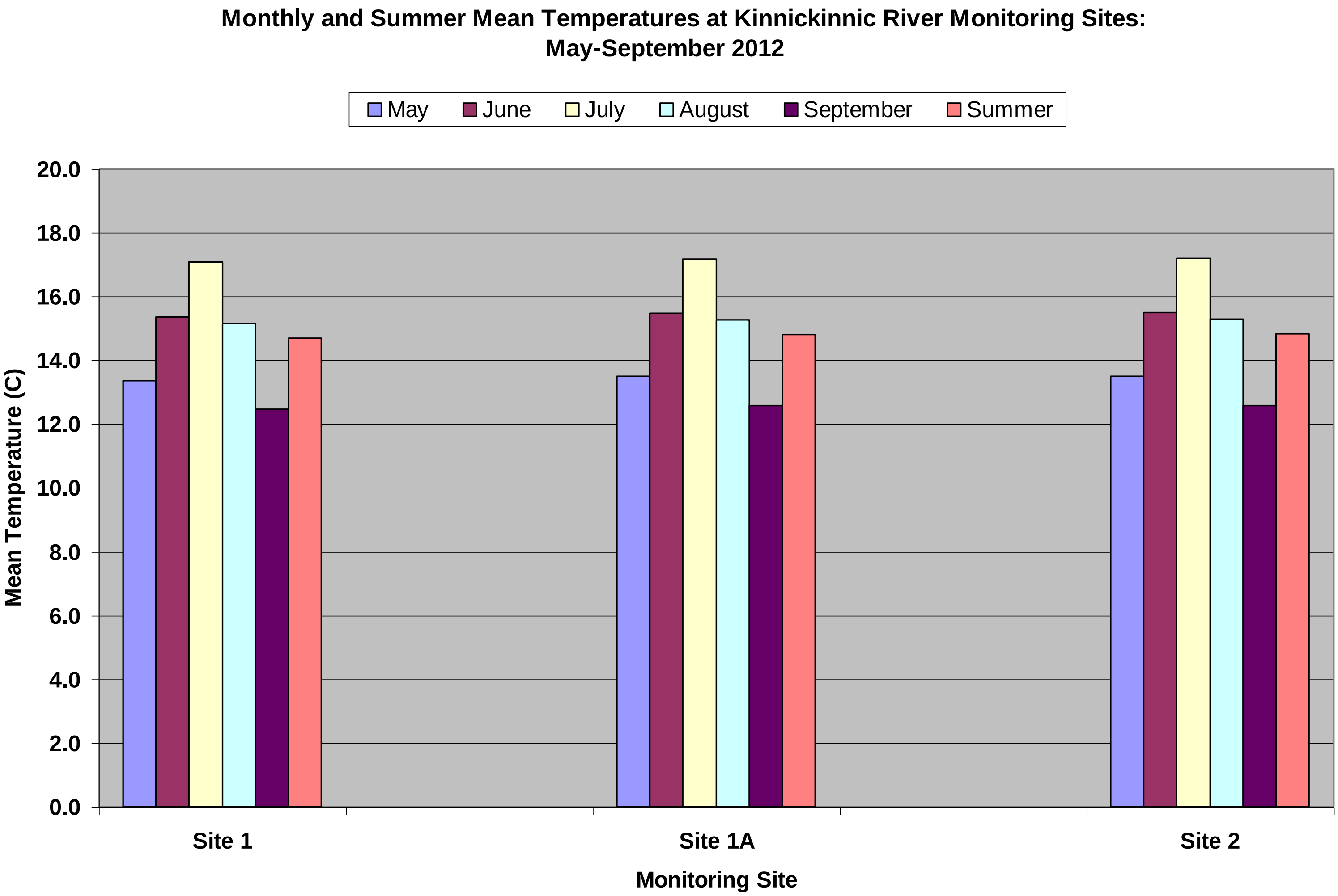
Kinnickinnic River Temperature Monitoring Results:

May-September (summer) 2012 temperature monitoring data were obtained for the Kinnickinnic River at Sites 1, 1A, and 2. River temperatures at these three monitoring sites averaged 14.8° C and ranged from 7.4-21.1° C over the course of the summer. The 2012 summer average river temperature of 14.8º C was the third-highest summer average river temperature recorded during the 2004-2012 period. The warmest summer average river temperature was recorded in 2007 (15.2º C), while summer average river temperatures in 2004-2006 and 2008-2011 ranged from 13.7º-14.9º C. Higher-than-normal river temperatures probably prevailed in the North Kinnickinnic River Project Area during the summer of 2012, since the 2012 summer average air temperature of 20.3º C (68.6º F) was notably higher than the normal summer average air temperature of 19.4° C (67.0° F). The 2012 summer average air temperature of 20.3º C was the second-highest summer average air temperature recorded in the North Kinnickinnic River Monitoring Project Area during the 2004-2012 period.

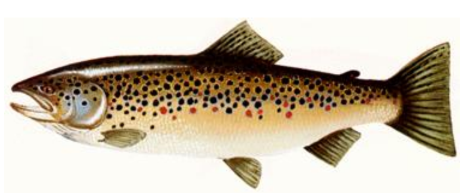
The most direct way to determine if any thermal impacts occurred in the Kinnickinnic River as a result of the Sterling Ponds subdivision is to compare the temperature monitoring data at Site 1, located immediately downstream from Sumner Creek, to the temperature monitoring data at Sites 1A and 2, located immediately upstream from Sumner Creek. In 2012, downstream summer temperatures at Site 1 were nearly identical to upstream summer temperatures at Sites 1A and 2, as shown below.

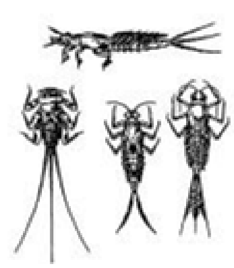


The 2012 monthly and summer mean (average) temperatures at Sites 1, 1A, and 2 were also nearly identical, as shown below.



The summer 2012 temperature regime in the Kinnickinnic River at Sites 1, 1A, and 2 was generally excellent for coldwater macroinvertebrate and brown trout communities. Approximately 81% of all temperatures recorded at Sites 1, 1A, and 2 during the May-September 2012 period were less than or equal to (≤) 17° C, which is the top of the optimum temperature range for a healthy coldwater macroinvertebrate community. A temperature of 17° C is also considered to be the optimum for brown trout survival. Approximately 97% of all temperatures recorded at Sites 1, 1A, and 2 during the May-September 2012 period were ≤ 19° C, which is the top of the optimum temperature range for brown trout growth. Approximately 99% of all temperatures recorded at Sites 1, 1A, and 2 during the May-September 2012 period were ≤ 20° C, which is the top of the optimum temperature range for brown trout survival. In spite of a warmer-than-normal summer, river temperatures exceeding 20º C were only recorded on one date in June and seven dates in July.

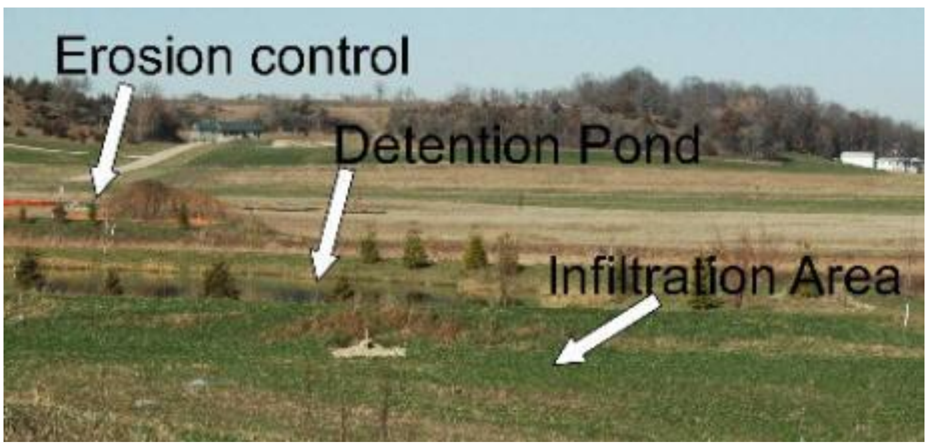




Downstream from Sumner Creek and Sterling Ponds, no storm water-related thermal impacts were apparent at Site 1 after summer rain events, including six significant rainfall events in May, June, and July 2012.

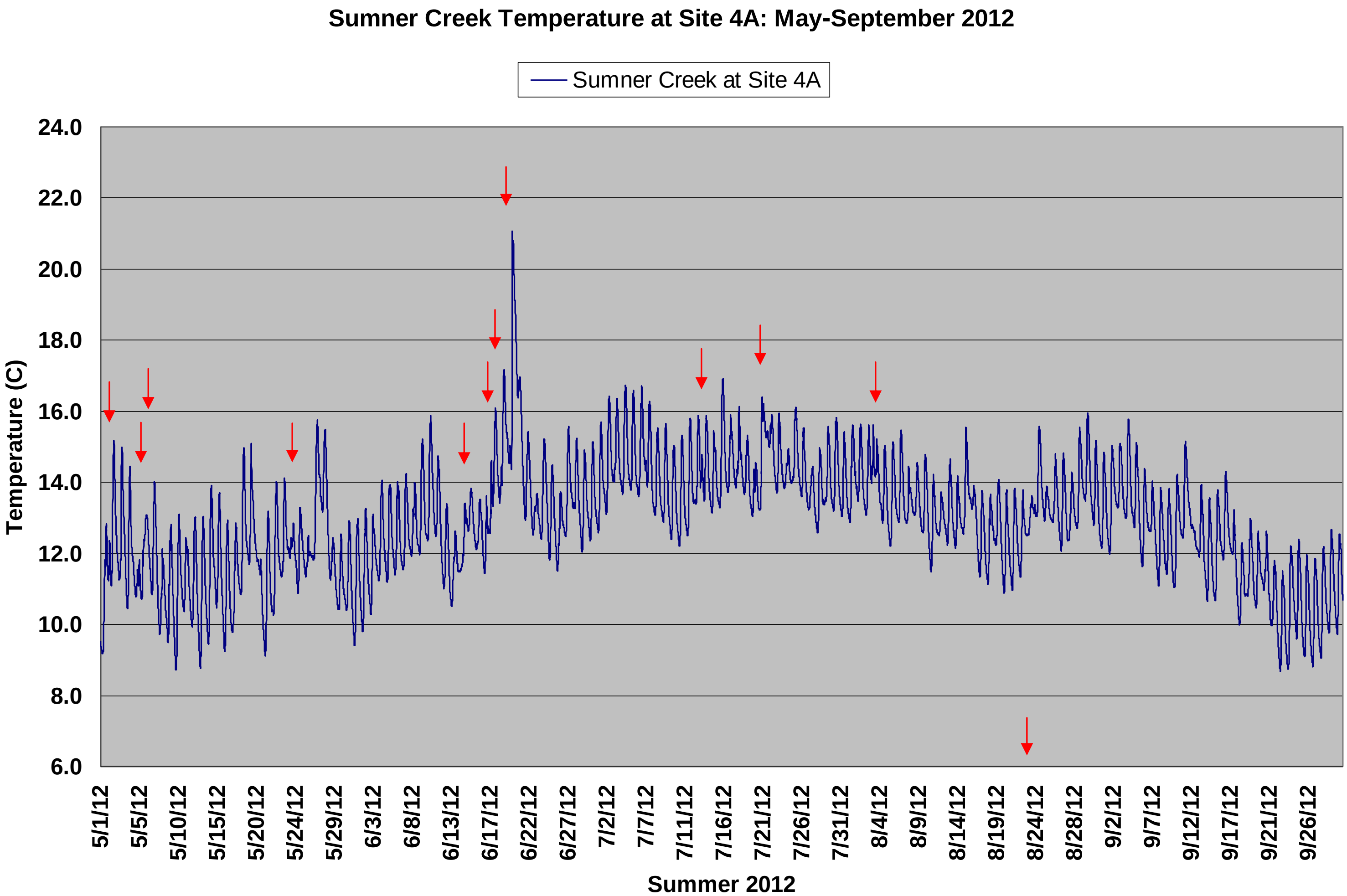
Sumner Creek and Sterling Ponds Temperature Monitoring Results:

May-September (summer) 2012 temperature monitoring data were obtained for Sumner Creek at Sites 4 and 4A (downstream from Sterling Ponds). Site 4 is located immediately downstream from Sterling Ponds, while Site 4A is located 1.5 miles downstream, near the mouth of Sumner Creek. Temperature monitoring data for the Sterling Ponds storm water management practices were obtained in the wet detention pond (Site 5P), at the wet pond discharge to the infiltration basin (Site 5IB) (see photo below), and at the wet pond discharge to Sumner Creek (Site 5MHW). The Sumner Creek and Sterling Ponds temperature monitoring results helped document the effectiveness of the City of River Falls Storm Water Management Ordinance in 2012.



Storm water best management practices at Sterling Ponds

Permanent flow occurred in lower Sumner Creek at Site 4A throughout the summer. The summer mean temperature (12.9º C) reflects strong spring flow, and approximately 99% of all temperatures recorded at Site 4A during the May-September 2012 period were ≤ 17° C. As such, the creek potentially provides a good thermal environment for a brook trout fishery, and is an important contributor of cold water to the Kinnickinnic River. However, thermal spikes of notable magnitude (0.5-6.3º C) occurred at this location during eleven rain events (0.60-2.05 inches) throughout the May-August period, as shown in the figure below. The most prominent Sumner Creek thermal spike (6.3º C) on June 20 exceeded optimum temperature thresholds for macroinvertebrates (17º C) and brown trout (20º C). A thermal spike of this magnitude may have detrimental impacts on aquatic life (especially macroinvertebrates) in lower Sumner Creek. The June 20 thermal spike also caused a small temperature spike (0.4º C) in the Kinnickinnic River at Site 1, downstream from Sumner Creek. However, the ten additional Sumner Creek thermal spikes were characterized by small to moderate magnitudes (0.5-3.1° C). None of these ten thermal spikes exceeded the optimum temperature thresholds for macroinvertebrates and brown trout, and none of these thermal spikes had a discernible impact on Kinnickinnic River temperatures at Site 1. A storm water discharge at Sterling Ponds contributed to the extended duration of the thermal spike evident at Site 4A after the June 20 rain event; but all thermal spikes at this location also had a more local cause that needs further investigation.



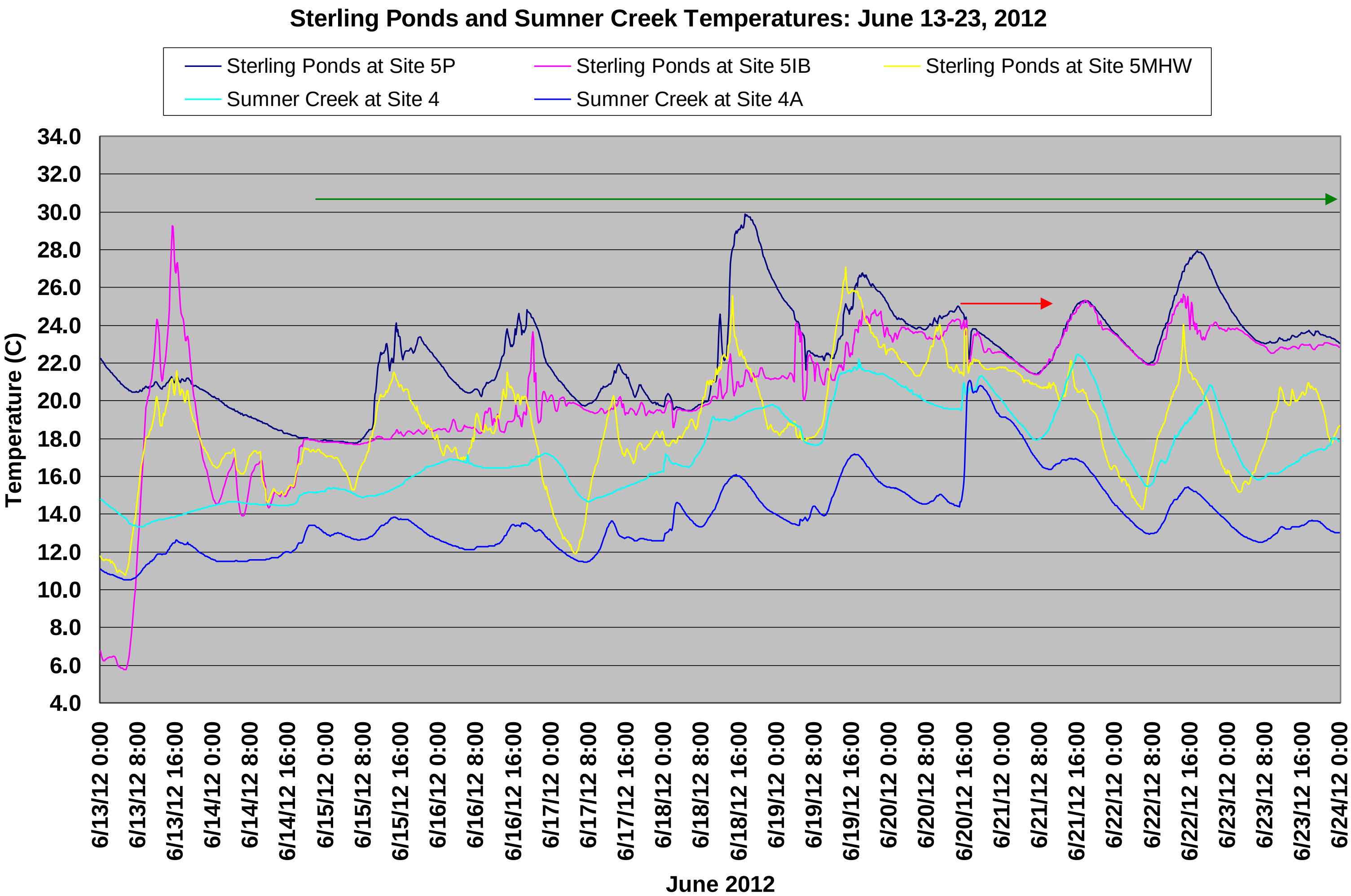
The summer mean temperature of the Sterling Ponds wet detention pond at Site 5P was 22.4º C (range = 11.5-36.3° C), but much of this warm storm water was effectively infiltrated in the wet pond and/or discharged to the adjacent infiltration basin. Approximately 70% of all summer wet pond temperatures exceeded 20° C, and wet pond temperatures consistently remained above 20° C from June 3 until September 8. Substantial warming of small, shallow ponds such as this can be expected, especially with no shading or canopy cover. The summer mean temperature of the Sterling Ponds wet detention pond (22.4° C) was substantially higher than the summer mean temperature of Sumner Creek at Site 4A (12.9º C), clearly demonstrating the potential for thermal impact when the wet pond discharges to the creek, and emphasizing the importance of the River Falls Storm Water Management Ordinance, which requires storm water infiltration.

Effectiveness of Sterling Ponds Storm Water Management Practices:

Temperature monitoring data from the three Sterling Ponds monitoring stations (Sites 5P, 5IB, and 5MHW) and the two downstream Sumner Creek monitoring stations (Sites 4 and 4A) can be used to evaluate the effectiveness of the Sterling Ponds storm water management practices for infiltrating storm water and minimizing warm storm water discharges to Sumner Creek.

These temperature monitoring data indicate that the Sterling Ponds storm water management practices prevented thermal impacts on the Kinnickinnic River during the May-September 2012 period. With the exception of two very large rain events in May and June, all summer rainfall events were fully infiltrated. All storm water runoff from 43 rain events ≤1.5 inches was infiltrated, as required by the River Falls Storm Water Management Ordinance. Although not required by the ordinance, all storm water runoff from two rain events ≥1.5 inches was also infiltrated. These 45 rain events, ranging in magnitude from 0.01-1.79 inches, represent a total of 14.14 inches of precipitation, or 80% of the total summer rainfall amount (17.59 inches). Of these 45 rain events, 23 events, ranging in magnitude from 0.01-0.98 inch and totaling 2.88 inches of precipitation (16% of the total summer rainfall amount) were entirely stored in the Sterling Ponds wet detention pond, with the storm water infiltrating in the pond or evaporating. The 22 remaining summer rain events, ranging in magnitude from 0.01-1.79 inches and totaling 11.26 inches of precipitation (64% of the total summer rainfall amount), were diverted into the Sterling Ponds infiltration basin. Due to below-normal rainfall (-1.44 inches) and a reduced frequency of rainfall during the May-September (summer) 2012 period, the Sterling Ponds wet detention pond discharged to the infiltration basin for 46 days, or 30% of the summer period.

The Sterling Ponds wet detention pond only discharged to Sumner Creek during a very large rain event on May 5-6 (2.27 inches) and a very large rain event on June 20 (2.05 inches). During these events, the wet detention pond discharged warmer water (averaging 15.0º C on May 6 and 21.5º C on June 20-21) to Sumner Creek for extended time periods (14.8 hours on May 6 and 19.3 hours on June 20-21). The warm storm water discharges during these two rain events caused thermal spikes in Sumner Creek at Site 4, and the June 20-21 discharge also contributed to an extended duration of much warmer-than-normal water at Site 4A. Although the May 5-6 and June 20 rain events caused wet pond discharges to Sumner Creek, it seems likely that the majority of these rainfall events (a combined 4.32 inches) was infiltrated rather than discharged. The durations of these discharges to Sumner Creek were relatively short (14.8 hours and 19.3 hours, respectively), compared to the lengthy durations of discharges to the infiltration basin (6.9 days and 6.1 days, respectively). While storm water discharges to Sumner Creek occurred during the very large rain events on May 5-6 and June 20, it should be noted that the 24-hour rainfall amounts for these two storms greatly exceeded the 1.5-inch infiltration standard set by the River Falls Storm Water Management Ordinance. The Sterling Ponds and Sumner Creek temperature monitoring results for the June 20 rain event are shown below. Temperature monitoring results for the May 5-6 and June 20 rain events are presented and discussed in detail in the 2012 technical report.



Temperature monitoring of the Sterling Ponds storm water practices during the 2005-2012 period has revealed some performance issues and possible opportunities for improvement of the current Sterling Ponds storm water management practices and/or revision of the River Falls Storm Water Management Ordinance. Temperature monitoring results indicate that storm water discharges to Sumner Creek typically occur during rain events larger than 1.5 inches, during back-to-back rain events, when rainfall amounts range from 0.7-1.5 inches and time periods between rain events are less than 48 hours, and during very intense rain events, when rainfall amounts range from 1.0-1.5 inches.

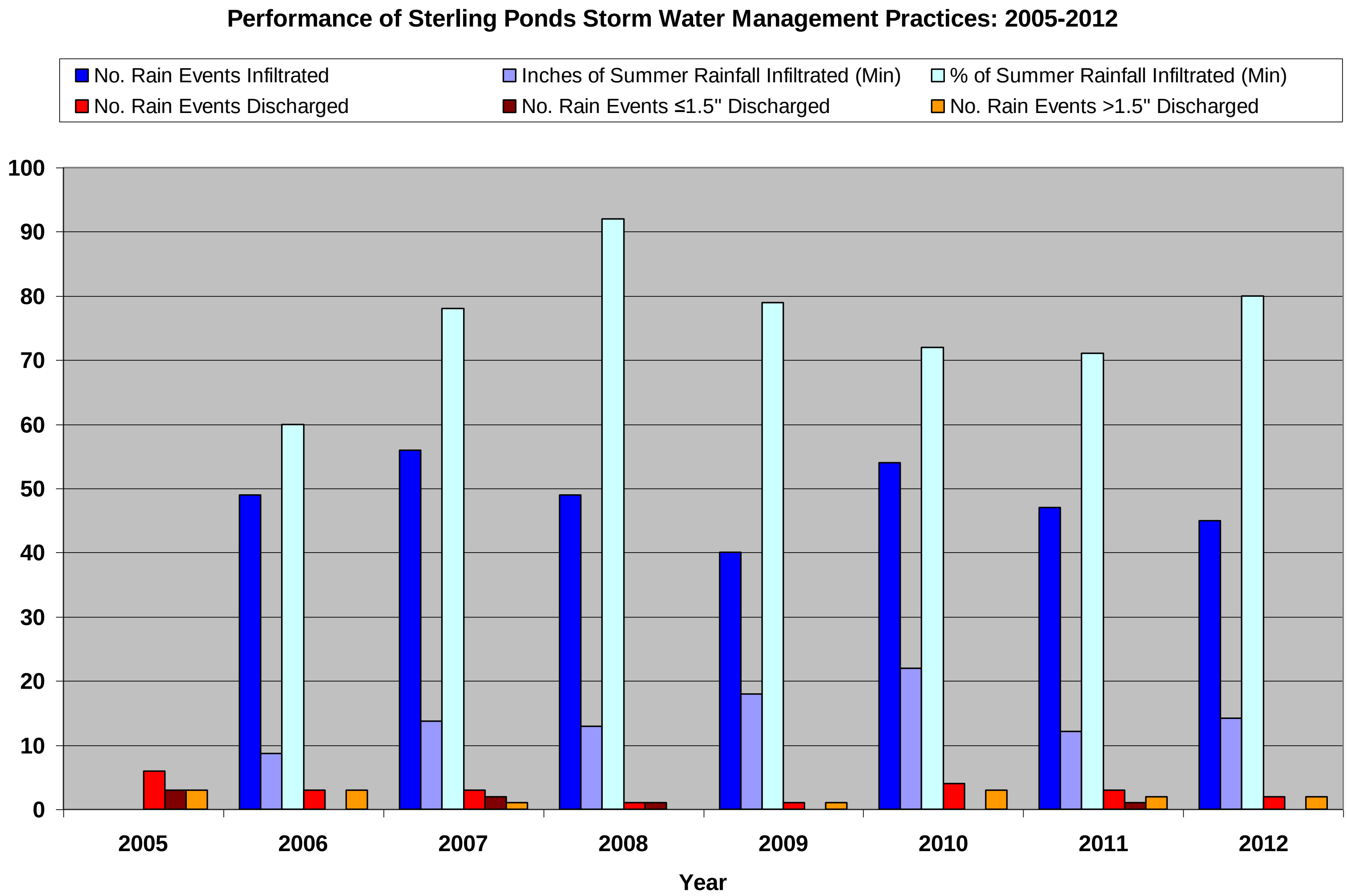
In June 2007, River Falls Engineering Department staff investigated these performance issues and determined that the control structure for the wet detention pond outlet should be raised by 6 inches, to provide more storm water storage in the wet pond and allow the discharge of more storm water volume to the infiltration basin. This modification should be beneficial for the back-to-back rain events and very intense rain events ≤1.5 inches that are occasionally causing wet pond discharges to Sumner Creek. More storm water storage capacity in the wet pond should also increase discharge lags and reduce the discharge times associated with rain events larger than 1.5 inches.

The modification made to the control structure for the Sterling Ponds wet pond outlet in June 2007 seemed to improve storage and infiltration capacity for these types of events in 2007, 2008, and 2009, but was not particularly helpful for the very large rain events (8 events ≥1.5 inches) that occurred in 2010, 2011, and 2012. Rain events larger than 1.5 inches exceed the intent of the River Falls Storm Water Management Ordinance, so storm water discharges to Sumner Creek might be expected. However, storm water discharges to Sumner Creek during back-to-back or very intense rain events, when rainfall amounts are less than the 1.5-inch ordinance requirement, may need further attention. For back-to-back rain events, more rapid delivery of storm water to the infiltration basin may be desirable between rain events, to ensure substantial infiltration of the first rain event within a 24-hour period. In addition, perhaps some provision should be made in the River Falls Storm Water Management Ordinance to ensure adequate infiltration of back-to-back 1.5-inch, 24-hour rain events. Additional capacity in the Sterling Ponds wet pond may be helpful for capturing more storm water volume during very intense rain events, but the increased volume in the pond could require more infiltration time, which may prove problematic when large, back-to-back rain events occur.

Given the frequent number of rain events ≥1.5 inches during the 2004-2012 monitoring period (22), including 16 that resulted in wet pond discharges to Sumner Creek during the 2005-2012 period, perhaps an ordinance amendment should be considered, to require infiltration of all 24-hour rain events ≤2.0 inches. Such an ordinance modification would have covered 9 (41%) of the 22 rain events ≥1.5 inches during the 2004-2012 monitoring period, and potentially would have resulted in 5 fewer rain events with wet pond discharges to Sumner Creek.

Unusually long Sterling Ponds wet pond discharges to Sumner Creek and the Sterling Ponds infiltration basin have been noted after a number of larger rain events in 2011 and 2011. These circumstances suggest that maintenance work may be needed to clear the pipe between the wet pond and the infiltration basin. The wet pond end (entrance) of the pipe should be checked to ensure that it is not partially plugged by pond vegetation or other organic material. In addition, it may be beneficial to flush the entire length of the pipe.

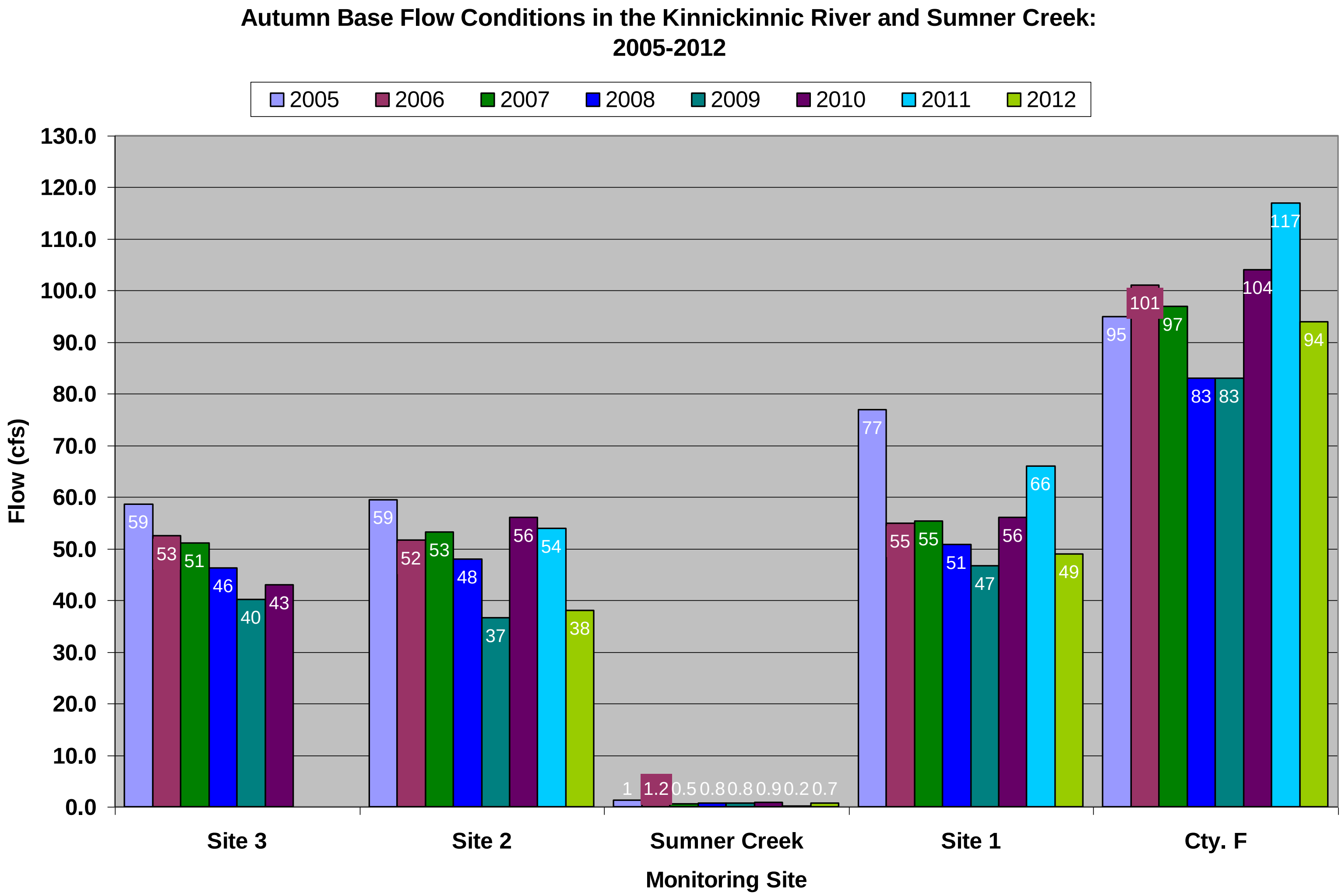
Based upon the 2005-2012 temperature monitoring results, it appears that the Sterling Ponds storm water management practices are producing long-term positive results that protect the Kinnickinnic River. A summary of the performance of Sterling Ponds storm water management practices during the 2005-2012 period is presented in the figure below. Note that the number of summer rain events infiltrated far exceeds the number of rain events (partially) discharged to Sumner Creek each year. Also note that the minimum percentage of summer rainfall infiltrated ranged from 60-92% during the 2006-2012 period. Beyond 2012, these same trends will be monitored from year to year, to determine if favorable results are apparent in the future.



Base Flow Surveys:

In June (spring) and October (autumn) 2012, base flow surveys were conducted at Sites 1-3 in the Kinnickinnic River and at the mouth of Sumner Creek (Site 4A) within the North Kinnickinnic River Monitoring Project Area. Spring base flow surveys have been conducted for seven consecutive years (2006-2012), while autumn base flow surveys have been conducted for eight consecutive years (2005-2012). The Kinnickinnic River was assumed to be in a base flow condition when 3-4 days of "flat-line" flow were observed at the USGS stream flow gauging station located at County Highway F (as described in the 2012 technical report). During the April-September 2012 period, the Kinnickinnic River generally maintained a base flow condition of approximately 85-110 cfs at County Highway F.

The autumn 2012 base flow survey results are presented below, with a comparison to the autumn 2005-2011 survey results. In autumn 2012, Kinnickinnic River base flows increased notably (29%) from upstream (Site 2) to downstream (Site 1) in the project area. Sumner Creek provided a small contribution upstream of Site 1. With slightly below-normal precipitation in 2012, including a late summer period of much-reduced rainfall in August and September, severe drought conditions developed in the North Kinnickinnic River Monitoring Project Area by early October 2012, causing decreased autumn 2012 base flows.



More information on the spring and autumn base flow survey results can be found in the 2012 technical report. Based upon several years of base flow survey data, it seems apparent that climatic variability can cause significant annual changes in spring and autumn base flows within the North Kinnickinnic River Monitoring Project Area. One goal of the River Falls Storm Water Management Ordinance is to maintain strong base flow conditions in the Kinnickinnic River by requiring storm water management practices that promote infiltration of rainfall, thereby re-charging and maintaining shallow aquifer levels, as well as the springs that provide cold water for the river. Performance monitoring at Sterling Ponds has demonstrated that the storm water management practices have provided excellent infiltration capacity since 2004, thereby helping to sustain groundwater recharge during all summer periods, but especially during extended dry periods. Annual spring and autumn base flow surveys will provide an ongoing measure for determining if base flow conditions will be sustained in the future as development progresses in the North Kinnickinnic River Monitoring Project Area.

Macroinvertebrate Monitoring:

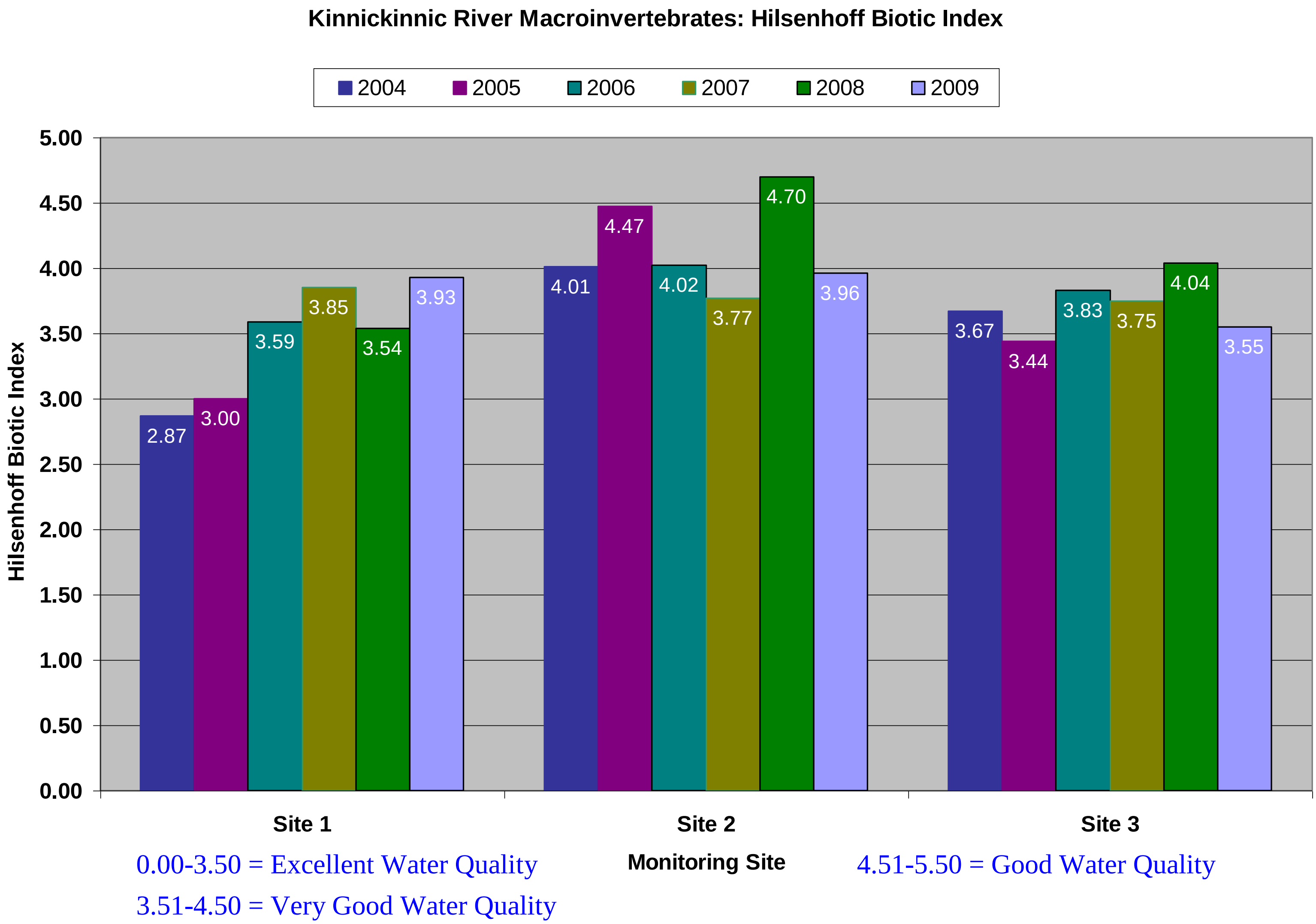
Biological indicators such as macroinvertebrates (aquatic insects) are often used to complement physical and chemical measurements in stream monitoring programs. Because macroinvertebrates live in the stream environment for a year or more, they are excellent indicators of past as well as present water quality conditions. Annual macroinvertebrate samples are collected at Sites 1-3 within the North Kinnickinnic River Monitoring Project Area. Organisms are identified and counted in the laboratory, and various biological indices can then be calculated for each monitoring site. The index values are indicative of water quality, depending upon the pollution tolerances of the macroinvertebrates collected at the monitoring sites.

The Hilsenhoff Biotic Index (HBI) is particularly useful for determining the influence of organic pollution on macroinvertebrates. The Wisconsin Department of Natural Resources has used this index for many years in long-term stream monitoring programs. Each macroinvertebrate taxon (genus and/or species) has been assigned a specific tolerance value, ranging from 0 (extremely intolerant of organic pollution) to 10 (extremely tolerant of organic pollution). The more intolerant taxa that are present, the lower the HBI value, indicating better water quality, as follows:

HBI Value	**Water Quality**	**Degree of Organic Pollution**
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very Poor	Severe organic pollution

The 2004-2009 macroinvertebrate HBI values at Sites 1-3 in the North Kinnickinnic River Monitoring Project Area are presented below. The 2004-2009 data establish an ongoing baseline for assessing the long-term health of the macroinvertebrate community within the project area. During the 2004-2009 period, HBI values at Site 1 were indicative of very good-excellent water quality, HBI values at Site 2 were indicative of good-very good water quality, and HBI values at Site 3 were indicative of very good-excellent water quality. The annual HBI values at Site 1 are generally less than or comparable to the annual HBI values at Sites 2 and 3, indicating slightly better water quality at Site 1. The comparability of annual macroinvertebrate

HBI values at Sites 1-3 during the 2004-2009 period indicates that no storm water impacts were apparent at Site 1, downstream from Sumner Creek and the Sterling Ponds subdivision.



Macroinvertebrate monitoring was also conducted in May 2010, May 2011, and May 2012, but the analysis of these samples has not yet been completed by the University of Wisconsin-Stevens Point laboratory. Annual HBI values and other macroinvertebrate indices will continue to be posted as they become available, and long-term trends in these indices will continue to be evaluated, to assess the ongoing health of the Kinnickinnic River macroinvertebrate community.

Water Quality Monitoring:

At the outset of the North Kinnickinnic River Monitoring Project in 2004, water quality monitoring was envisioned at Kinnickinnic River Sites 1 and 2, to assess any water quality impacts related to storm water runoff from the Sterling Ponds subdivision. Due to technical difficulties with the automated monitoring equipment and the complexity of open-channel monitoring, no runoff event-based water quality monitoring has been conducted at Sites 1 and 2 to date. However, the results of temperature and macroinvertebrate monitoring at these locations have consistently demonstrated that Sterling Ponds storm water impacts on the Kinnickinnic River have been very minimal. With these two key monitoring components in place, water quality monitoring is probably not necessary at Sites 1 and 2.

Rather, to obtain water quality information on the performance of the Sterling Ponds storm water management practices, the automated monitoring equipment at Sites 1 and 2 has been re-located to Sites 5IN (Sterling Ponds wet detention pond inlet) and 5MHW (Sterling Ponds wet detention pond outlet). Along with automated sampling at these two locations, grab sampling can be conducted at Site 5IB (Sterling Ponds infiltration basin). Monitoring at these three locations, beginning in 2013, will determine if Sterling Ponds wet pond pollutant removal efficiencies are meeting target removal efficiencies (80%) for total suspended solids (TSS) and total phosphorus (TP). Monitoring will also better characterize the water quality impacts of any Sterling Ponds wet pond discharges to Sumner Creek. In addition, potential impacts on pollutant removal efficiencies can be determined, if Sterling Ponds storm water management practices are adjusted to provide improved storm water infiltration capability.

North Kinnickinnic River Monitoring Project Indicators:

As a part of the North Kinnickinnic River Monitoring Project, key physical and biological indicators have been monitored to evaluate the effectiveness of the River Falls Storm Water Management Ordinance for preventing degradation of the Kinnickinnic River due to development-related storm water impacts. These ten key indicators, which have been monitored since the onset of the project in 2004, include:

- Total rainfall in River Falls during the April-September period
- % April-September rainfall infiltrated, per the River Falls Storm Water Management Ordinance
- Number of summer (May-September) rain events infiltrated and % summer rainfall infiltrated, as measured by monitoring at Sterling Ponds
- Summer (May-September) average air temperature in River Falls
- Summer (May-September) average temperatures in the Kinnickinnic River and Sumner Creek
- % of the summer Kinnickinnic River temperatures favorable for biota
- % of the summer Sumner Creek temperatures favorable for biota
- Spring base flow conditions in the Kinnickinnic River and Sumner Creek
- Autumn base flow conditions in the Kinnickinnic River and Sumner Creek
- Kinnickinnic River macroinvertebrate HBI values

The North Kinnickinnic River Monitoring Project Indicators for the 2004-2012 period can be found on the project website. As monitoring continues in the future, these indicators can evaluate the annual effectiveness of the River Falls Storm Water Management Ordinance and track long-term trends that document protection of the Kinnickinnic River.