

**City of River Falls  
North Kinnickinnic River Monitoring Project**

**2010 Summary**



**Report prepared by SEH Inc., for the  
City of River Falls Engineering Department  
December 2010  
City of River Falls  
North Kinnickinnic River Monitoring Project**

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**Project Introduction:**

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

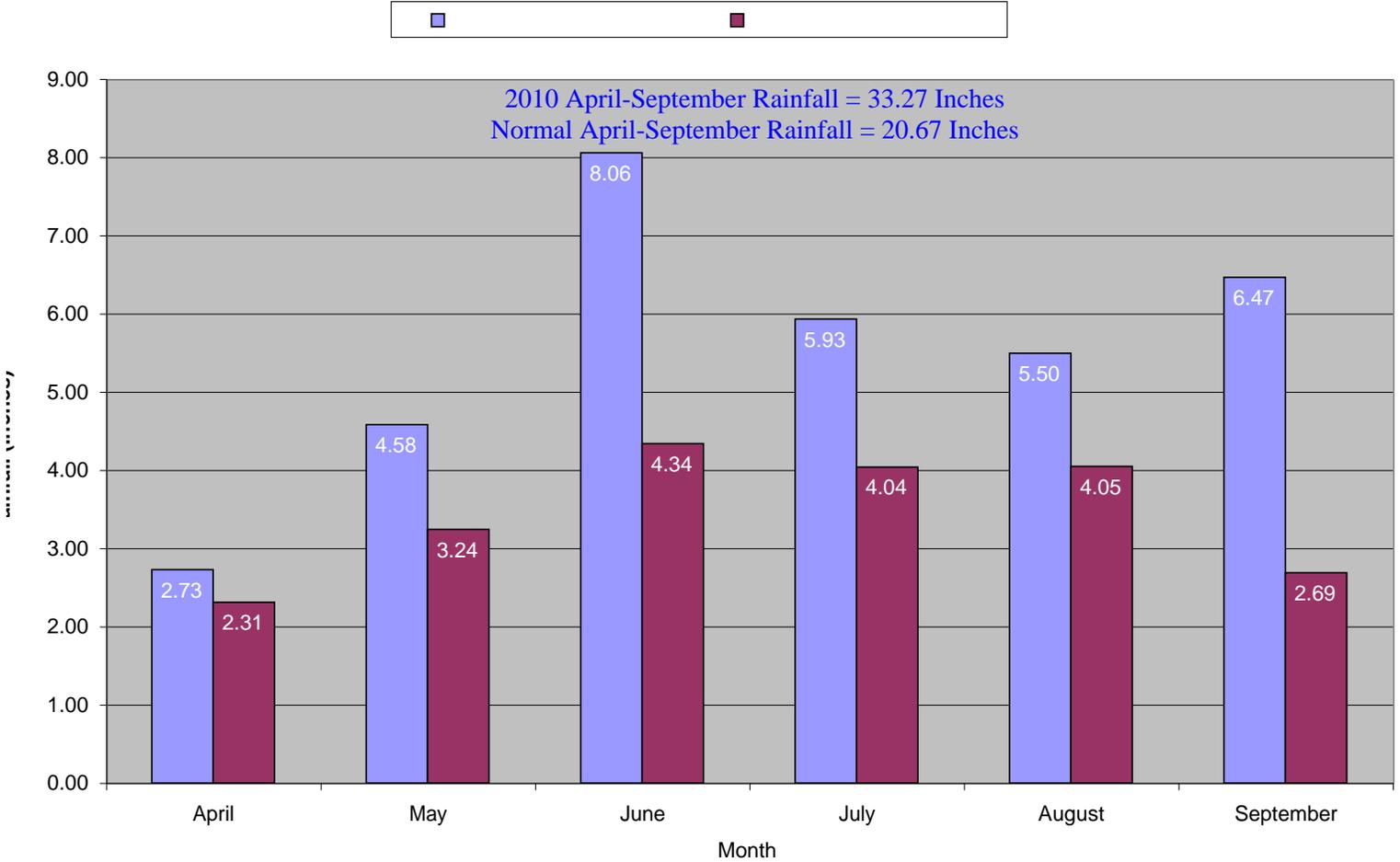
The City is examining the long-term results of each of these four monitoring elements to determine whether the storm water ordinance is protecting the river as new development occurs. The project uses an “upstream/downstream” approach to determine if storm water management practices in the Sterling Ponds 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.

### **River Falls Precipitation:**

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 33.27 inches of precipitation was recorded in River Falls during the April-September 2010 period, 12.60 inches more than the normal total of 20.67 inches for this time period. Rain fell on 69 days, or 38% of the April-September 2010 period.

Monthly rainfall amounts during the April-September 2010 period, with a comparison to normal monthly rainfall amounts, are presented in the figure below. All months during the April-September 2010 period were wetter than normal, with monthly rainfall excesses ranging from 0.42 inch to 3.78 inches. April and May were the driest months, while June and September were the wettest months. The combined rainfall in June and September accounted for 44% of the total April-September 2010 precipitation. The largest rain events of the summer occurred on June 25 (2.97 inches), August 10 (2.19 inches), and September 23 (2.58 inches). Although abnormally dry conditions were apparent in May and June 2010, above-normal precipitation in April and May, combined with an extremely wet June, brought drought conditions to an end by late July 2010. Above-normal precipitation in July and August, combined with a very wet September, kept drought conditions at bay for the duration of the summer.

### River Falls Monthly Rainfall: April-September 2010



Besides being wetter than normal, the April-September 2010 monitoring period was warmer than normal. The mean air temperature in River Falls during the April-September 2010 period was 65.6° Fahrenheit (F), 2.4° F higher than the normal mean of 63.2° F for this time period. The months of April, May, July, and August were all warmer than normal, with April (+7.6° F) and August (+5.3° F) experiencing the greatest departures. The temperature in June was near-normal, while the temperature in September was slightly cooler than normal.

The City of River Falls Storm Water Management Ordinance should have provided infiltration of 89% (29.64 inches) of the total rainfall (33.27 inches) that occurred during the April-September 2010 period. This percentage was determined using some conservative estimates further described in the 2010 technical report.

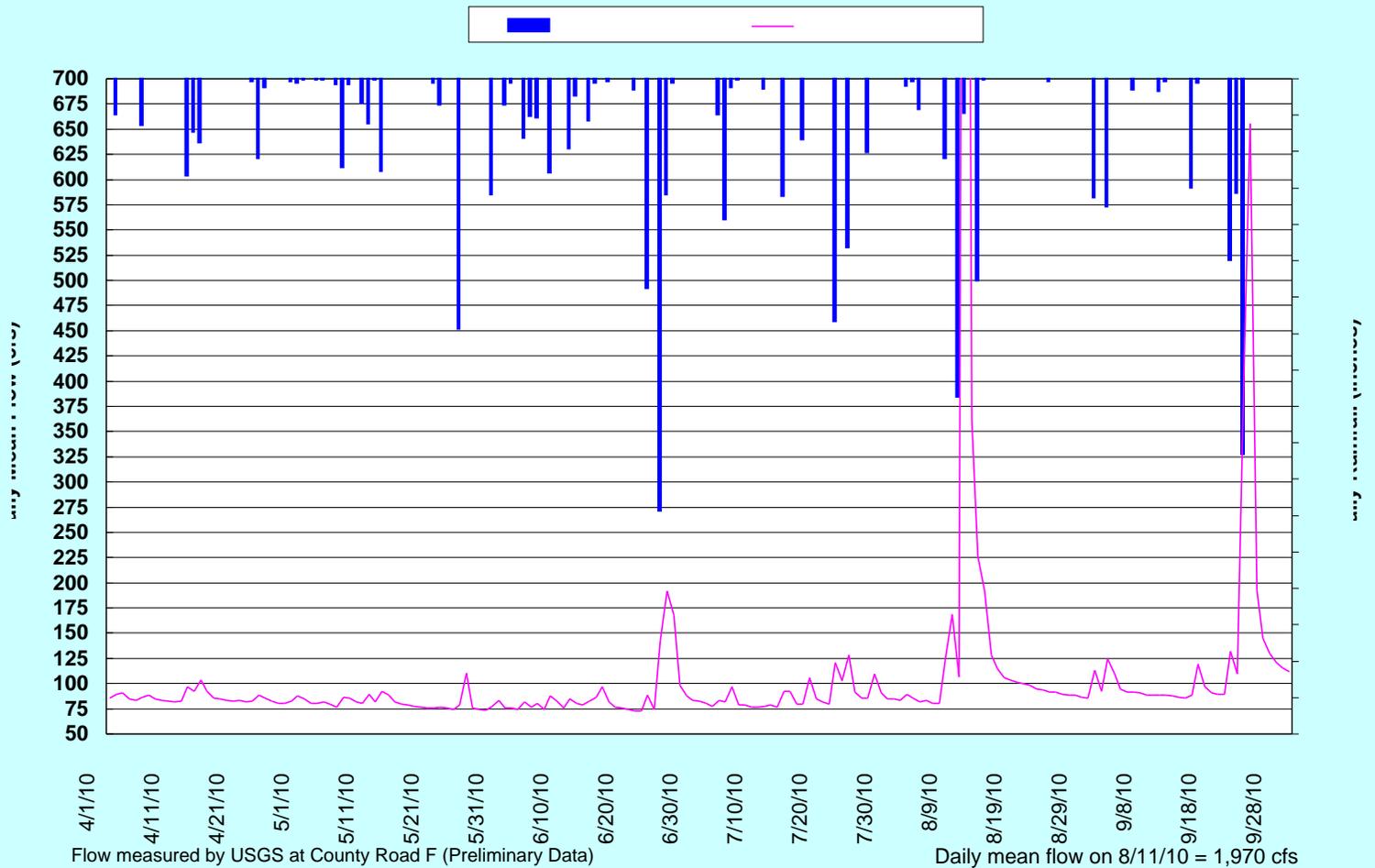
### **Kinnickinnic River Flow:**

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 2010 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 six significant runoff events occurred during the April-September 2010 period (see the figure below). Peak daily mean flows for all of these runoff events exceeded 110 cubic feet per second (cfs). A large rain event on May 25 (1.72 inches) produced a moderate increase in the Kinnickinnic River hydrograph, with a peak daily mean flow of 111 cfs. A succession of large rain events on June 23 (1.44 inches), June 25 (2.97 inches), and June 26 (0.80 inch) produced a significant increase in the Kinnickinnic River hydrograph, with a peak daily mean flow of 192 cfs. Nearly back-to-back rain events on July 22 (1.67 inches) and July 24 (1.16 inches) also produced a significant increase in the Kinnickinnic River hydrograph, with a peak daily mean flow of 129 cfs. Large rain events on August 10-11 (2.43 inches) and August 13 (1.39 inches) produced a major flood, with a peak daily mean flow of 1,970 cfs. Nearly back-to-back rain events on August 31 (0.82 inch) and September 2 (0.88 inch) produced a significant increase in the Kinnickinnic River hydrograph, with a peak daily mean flow of 125 cfs. Three consecutive days of heavy rainfall on September 21 (1.25 inches), September 22 (0.79 inch), and September 23 (2.58 inches) produced a major runoff event, with a peak daily mean flow of 656 cfs. The six runoff events in May, June, July, August, and September should be the focus for evaluating possible storm water impacts in the North Kinnickinnic River Monitoring Project Area in 2010, and are further analyzed in the 2010 technical report.

With above-normal rainfall throughout the April-September 2010 period, and with drought conditions abating by the end of July 2010, Kinnickinnic River base flows remained very stable throughout the April-September period, generally ranging from 75-85 cfs, as measured at County Highway F (see the figure below). Base flows tended to be a bit lower (75-80 cfs) during the April-July period, and a bit higher (80-85 cfs) during the August-September period, after the two largest runoff events in mid-August and late September.

Kinnickinnic River Flow and River Falls Rainfall: April-September 2010



**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**

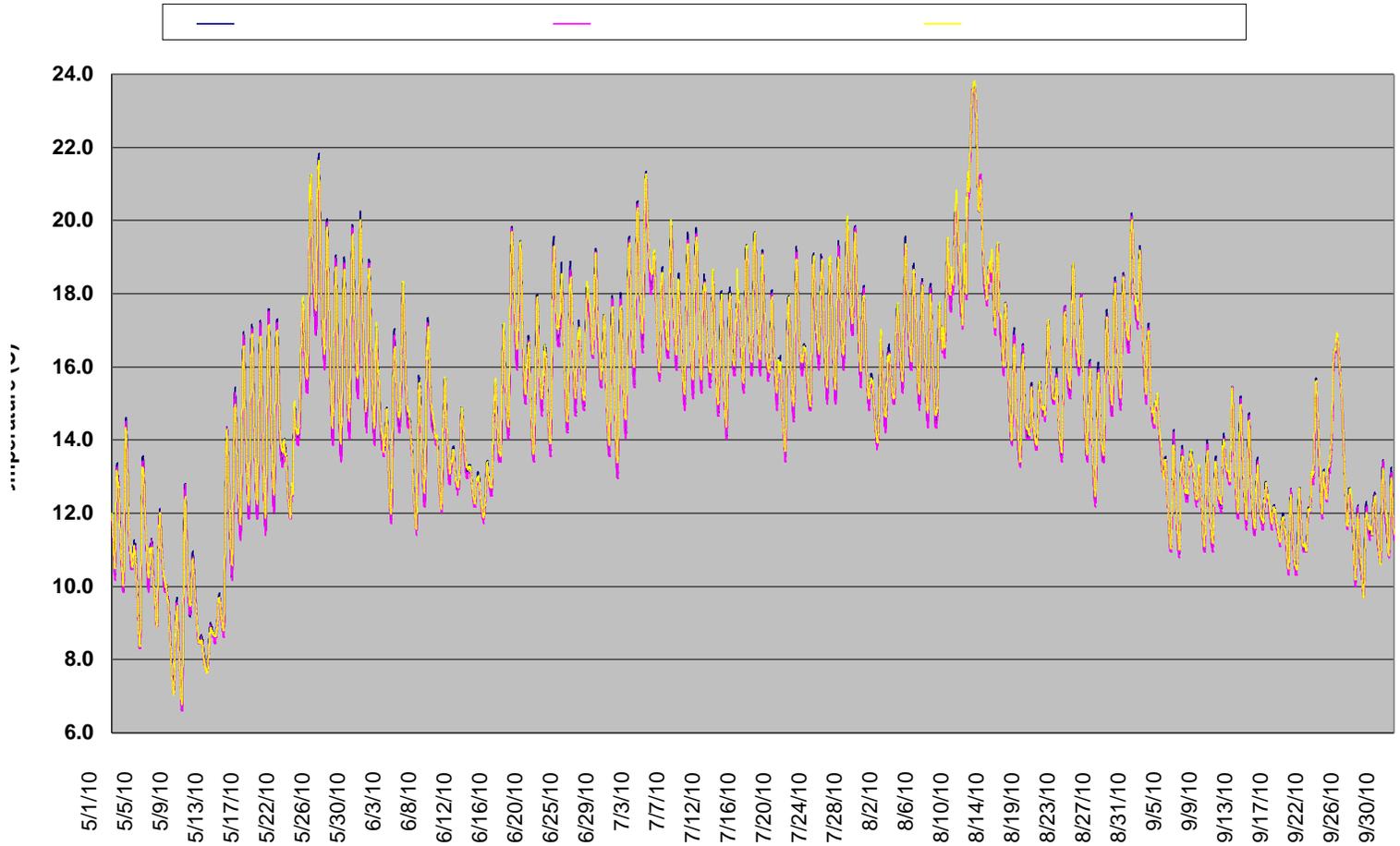
The intent of the City of River Falls Storm Water Management Ordinance is to prevent storm water impacts on the Kinnickinnic River, including thermal pollution, in areas of the city with new development, such as the Sterling Ponds subdivision.

#### ***Kinnickinnic River Temperature Monitoring Results:***

May-September (summer) 2010 temperature monitoring data were obtained for the Kinnickinnic River at Sites 1, 1A, and 2. River temperatures at these three monitoring sites averaged 14.9° C and ranged from 6.6-23.8° C over the course of the summer. Higher-than-normal river temperatures probably prevailed in the North Kinnickinnic River Project Area during the summer of 2010, since the 2010 summer average air temperature of 19.9° C (67.8° F) was notably higher than the normal summer average air temperature of 19.2° C (66.5° F). The 2010 summer average air temperature (19.9° C) was the second-highest summer average air temperature recorded in the North Kinnickinnic River Monitoring Project Area during the 2004-2010 period. Similarly, the 2010 summer average river temperature of 14.9° C (at Sites 1, 1A, and 2) was the second-highest summer average river temperature recorded during the 2004-2010 period. The warmest summer average river temperature was recorded in 2007 (15.2° C), while summer average river temperatures in 2004-2006 and 2008-2009 ranged from 13.8°-14.6° C.

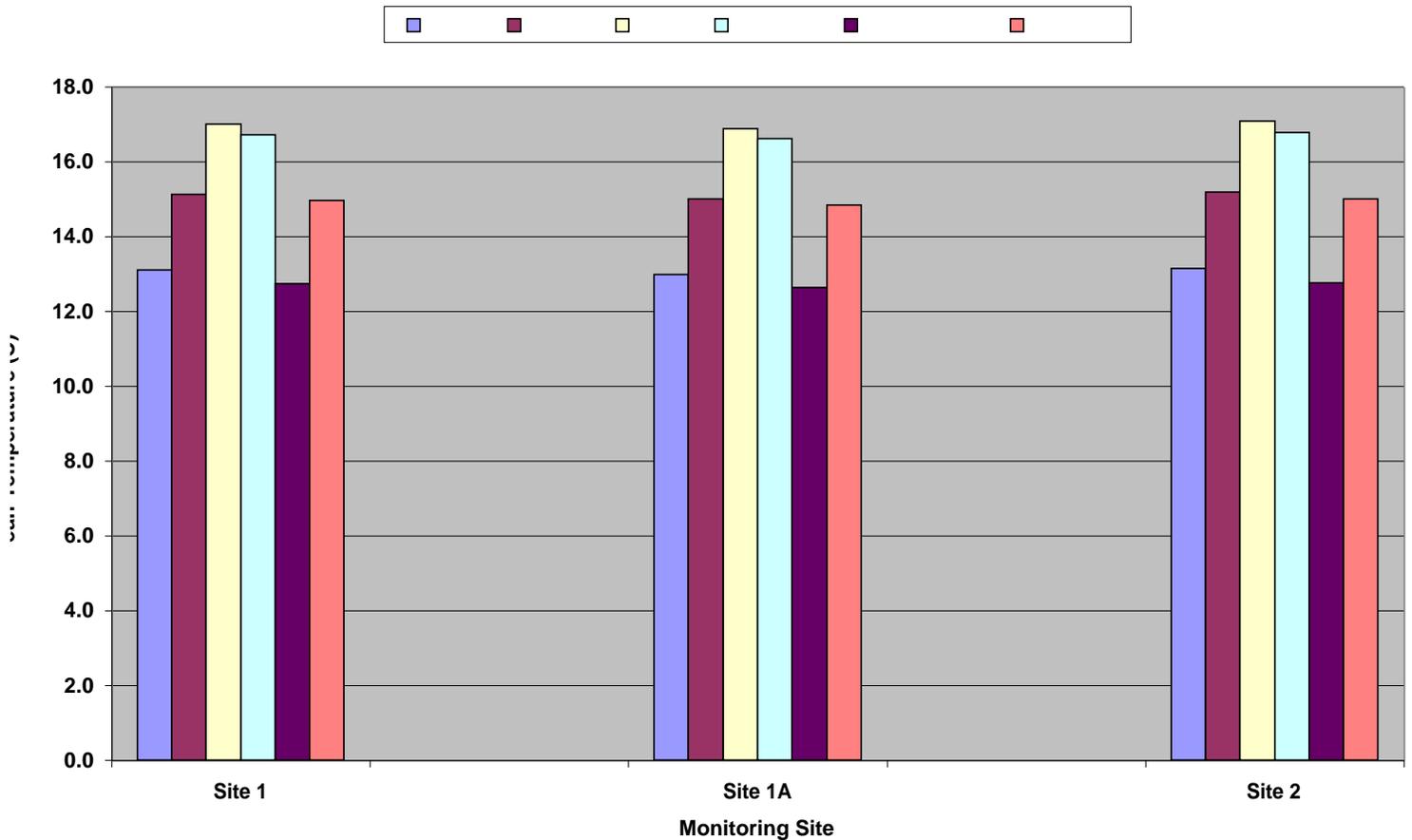
The most direct way to determine if any thermal impacts occurred in the Kinnickinnic River as a result of the Sterling Ponds subdivision is to compare the temperature monitoring data at Site 1, located immediately downstream from Sumner Creek, to the temperature monitoring data at Sites 1A and 2, located immediately upstream from Sumner Creek. In 2010, upstream summer temperatures at Sites 1A and 2 were nearly identical to downstream summer temperatures at Site 1, as shown below.

Kinnickinnic River Temperatures at Sites 1, 1A, and 2: May-September 2010



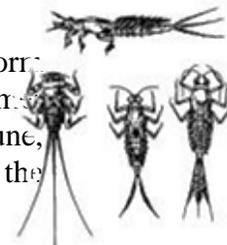
The 2010 monthly and summer mean (average) temperatures at Sites 1, 1A, and 2 were also nearly identical, as shown below.

**Monthly and Summer Mean Temperatures at Kinnickinnic River Monitoring Sites:  
May-September 2010**



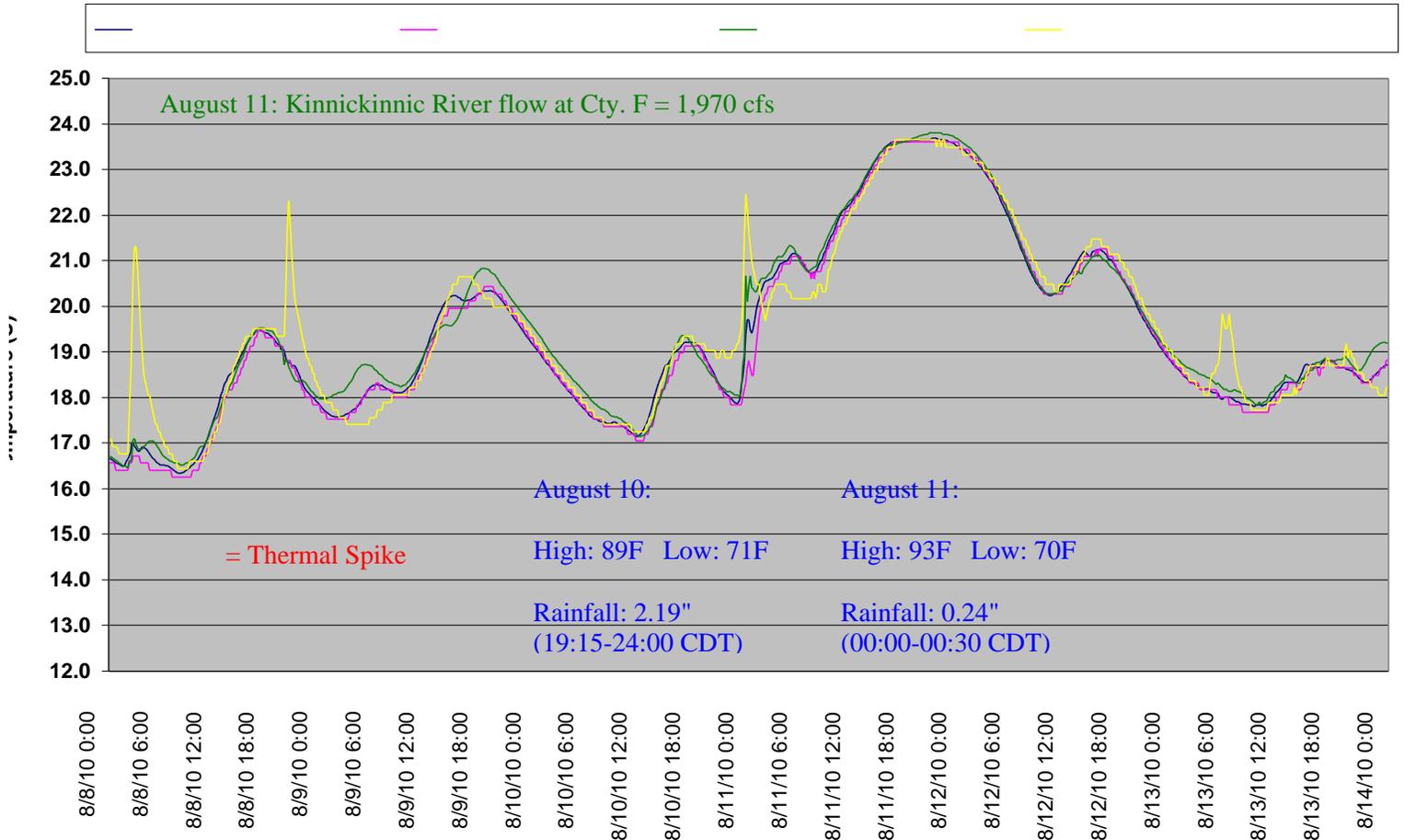
The summer 2010 temperature regime in the Kinnickinnic River at Sites 1, 1A, and 2 was generally excellent for coldwater macroinvertebrate and brown trout communities. Approximately 76% of all temperatures recorded at Sites 1, 1A, and 2 during the May-September 2010 period were less than or equal to ( $\leq$ ) 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 94% of all temperatures recorded at Sites 1, 1A, and 2 during the May-September 2010 period were  $\leq$  19° C, which is the top of the optimum temperature range for brown trout growth. Approximately 98% of all temperatures recorded at Sites 1, 1A, and 2 during the May-September 2010 period were  $\leq$  20° C, which is the top of the optimum temperature range for brown trout survival. With a warmer-than-normal summer, river temperatures exceeding 20° C were recorded on 4 dates in May, 3 dates in July, and 4 dates in August.

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, July, August, and September 2010. The largest rain event of the



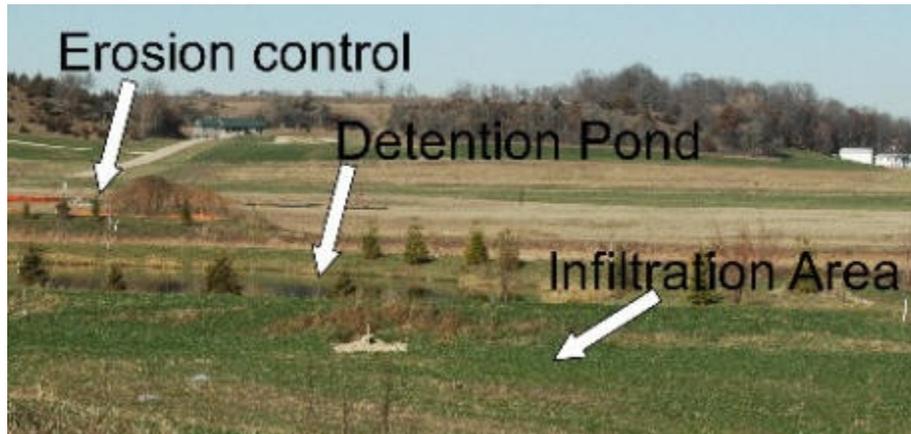
summer on August 10-11 (2.43 inches) caused significant thermal spikes at Sites 1, 1A, and 2, as shown below. However, these spikes cannot be attributed to storm water runoff from the Sterling Ponds subdivision and/or discharge from Sumner Creek. Rather, the thermal impacts at these three sites were caused by major flooding and warm water inundation on the mainstem of the Kinnickinnic River.

**Kinnickinnic River Thermal Impacts During the August 10-11, 2010 Rain Event**



***Sumner Creek and Sterling Ponds Temperature Monitoring Results:***

May-September (summer) 2010 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), 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 2010.

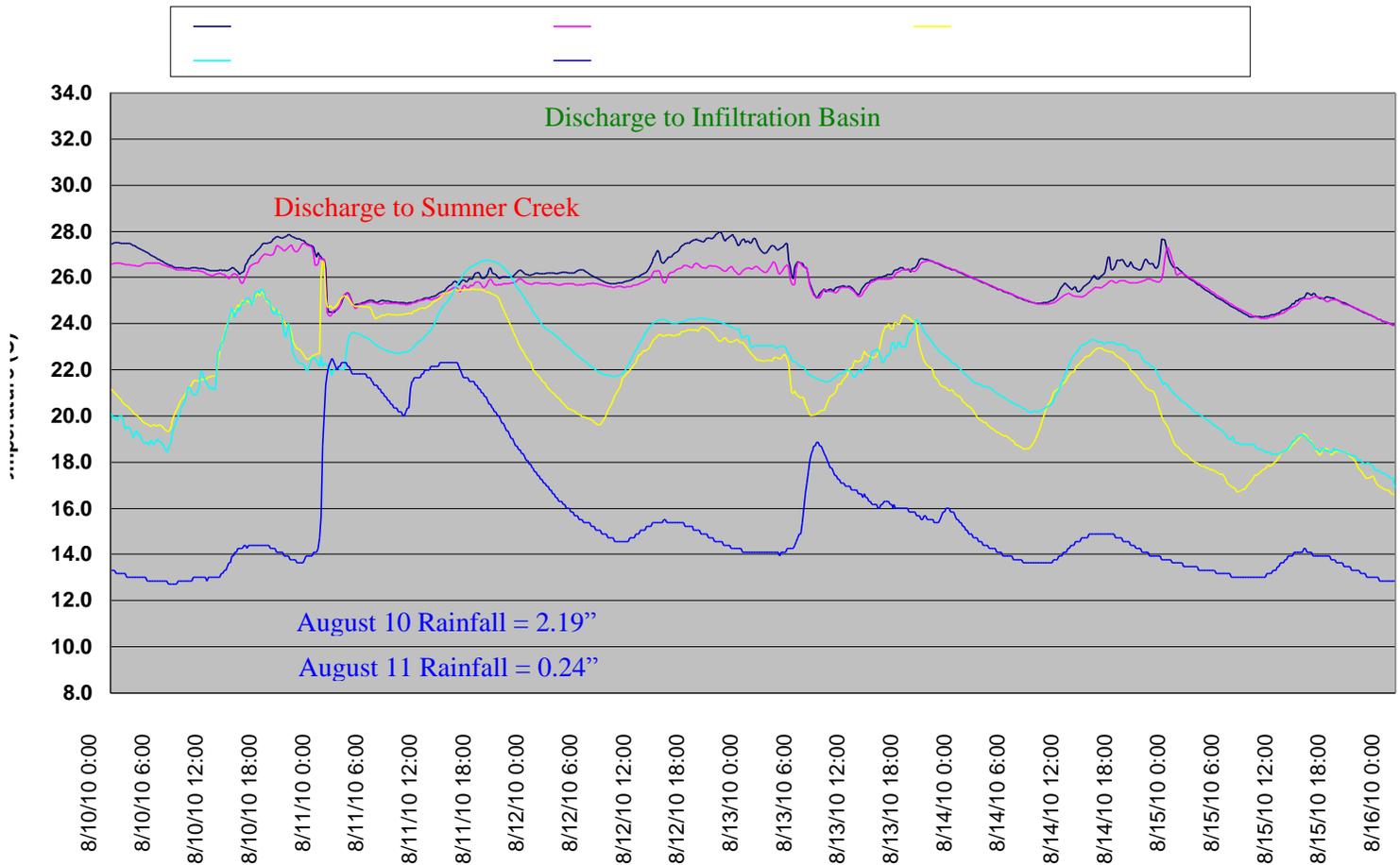


### **Storm water best management practices at Sterling Ponds**

Temperature monitoring data indicate that the storm water management practices at Sterling Ponds prevented thermal impacts on the Kinnickinnic River during the May-September 2010 period. The summer mean temperature of the Sterling Ponds wet detention pond at Site 5P was 21.7° C (range = 10.5-30.3° C), but much of this warm storm water was effectively infiltrated in the wet pond and/or discharged to the adjacent infiltration basin. With the exception of four moderate to very large rain events in June, August, and September, all summer rainfall events were fully infiltrated, as required by the River Falls Storm Water Management Ordinance. These 54 rain events, ranging in magnitude from 0.01-1.72 inches, represent a total of 22.01 inches of precipitation, or 72% of the total summer rainfall amount (30.54 inches).

The Sterling Ponds wet detention pond only discharged to Sumner Creek during a moderate rain event on August 8 (0.55 inch) and very large rain events on June 25 (2.97 inches), August 10-11 (a combined 2.43 inches), and September 23 (2.58 inches). During these events, the wet detention pond discharged warmer water (16.4-26.7° C) to Sumner Creek for extended time periods (2.5-34.5 hours). The warm storm water discharges during the August 10-11 and September 23 rain events caused thermal spikes in Sumner Creek at Site 4, and also contributed to extended durations of much warmer-than-normal water at Site 4A. Although wet pond discharges to Sumner Creek occurred on June 25, August 8, August 10-11, and September 23-24, it seems likely that the majority of these rainfall events (a combined 8.53 inches) was infiltrated rather than discharged. The durations of these discharges to Sumner Creek were relatively short (2.5-34.5 hours), compared to the durations of discharges to the infiltration basin (a minimum of 56-192 hours). While storm water discharges to Sumner Creek occurred during the very large rain events on June 25, August 10-11, and September 23, it should be noted that the 24-hour rainfall amounts for these three 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 August 10-11 rain event are shown below. Temperature monitoring results for the June 25, August 8, and September 23 rain events are presented in the 2010 technical report.

**Sterling Ponds and Sumner Creek Temperatures: August 10-15, 2010**

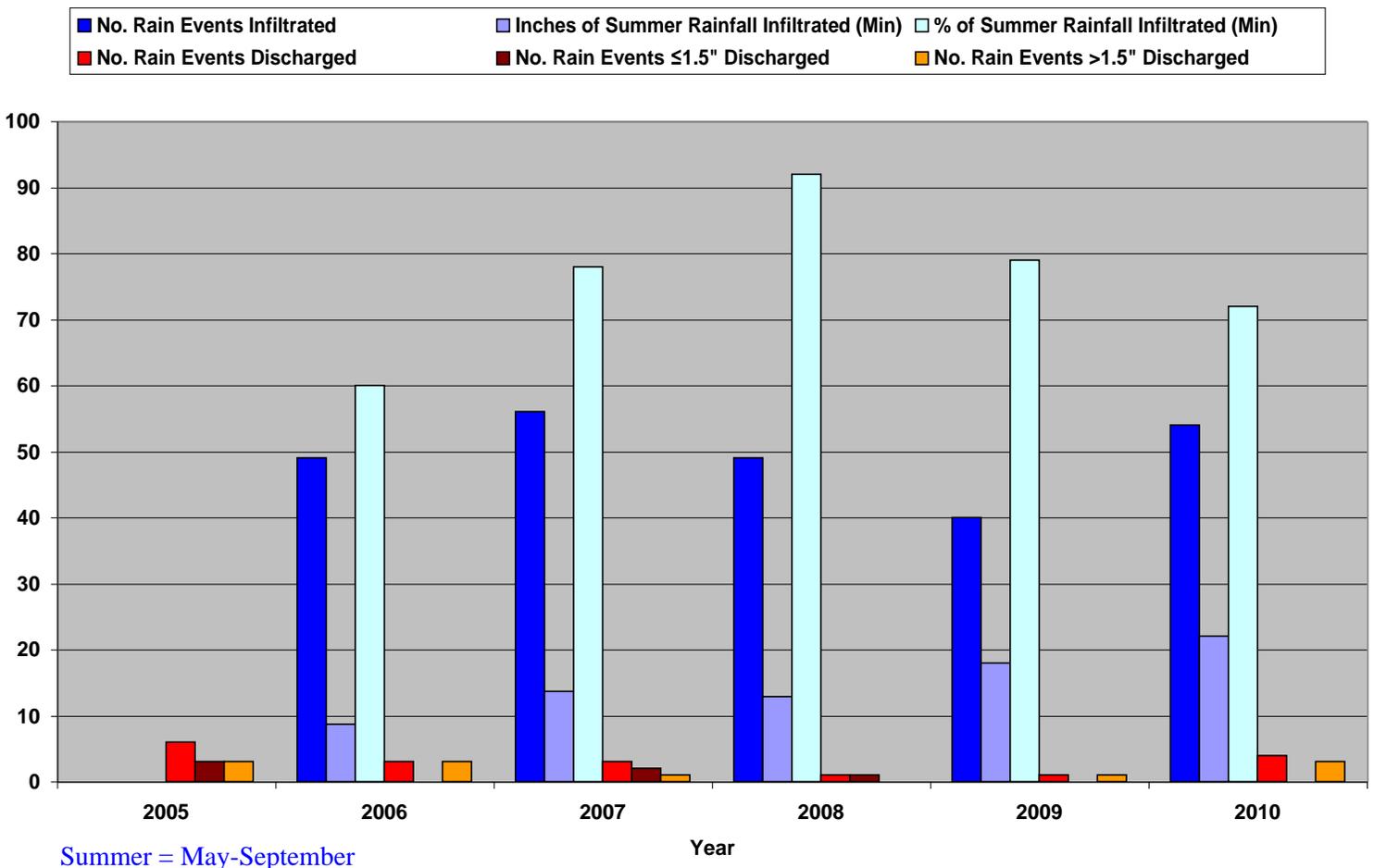


Temperature monitoring of the Sterling Ponds storm water practices during the 2005-2010 period indicates that storm water discharges to Sumner Creek typically occur during rain events larger than 1.5 inches, during back-to-back rain events, when rainfall amounts range from 1.0-1.5 inches and time periods between rain events are less than 48 hours, and during very intense rain events, when rainfall amounts range from 1.0-1.5 inches. Modifications 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. 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 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.

Based upon the 2005-2010 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 2005-2010 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 2006-2010 period. Beyond 2010, these same trends will be monitored from year to year, to determine if favorable results are apparent in the future.

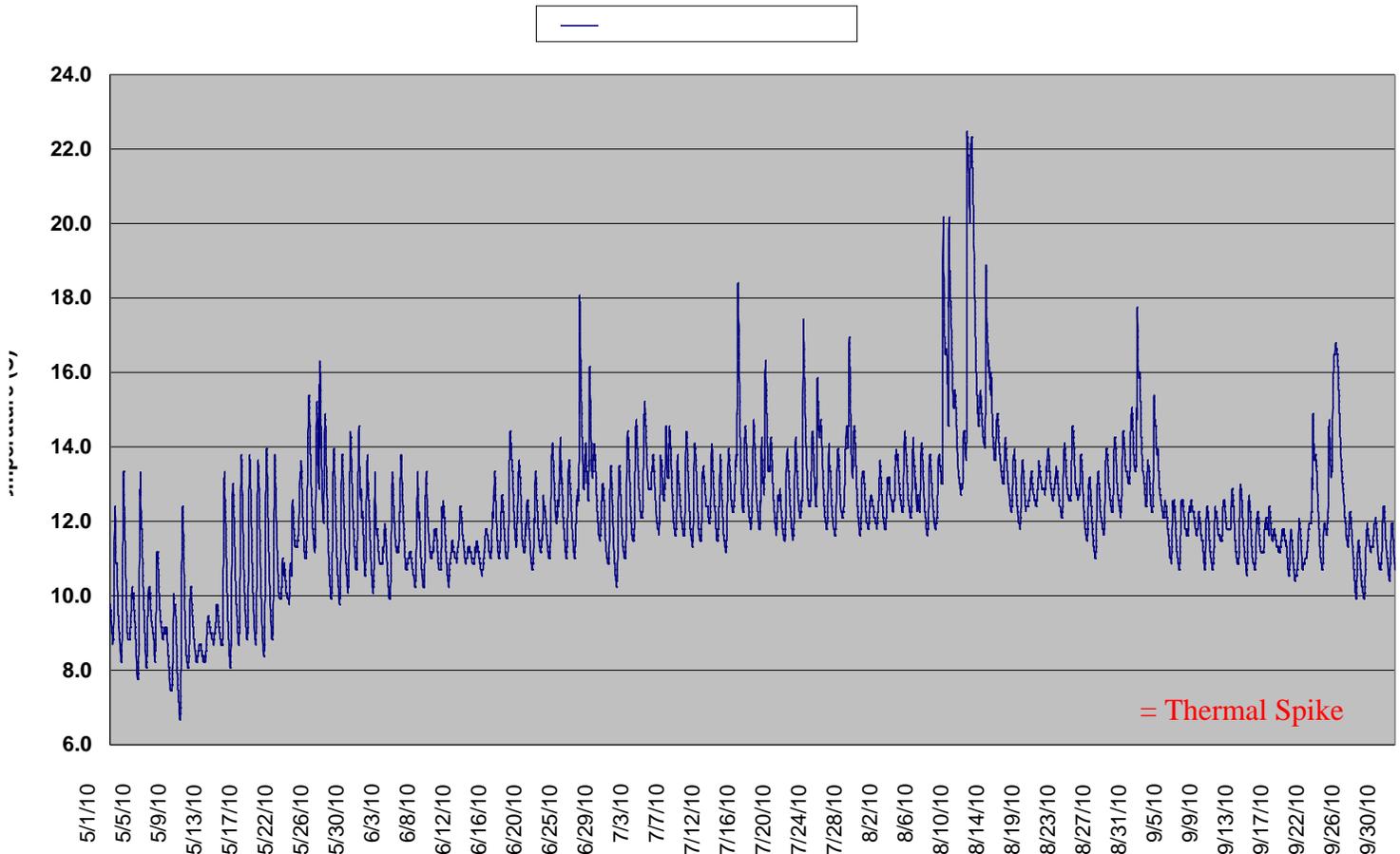
Performance of Sterling Ponds Storm Water Management Practices: 2005-2010



Permanent flow occurred in lower Sumner Creek at Site 4A throughout the summer. The summer mean temperature (12.2° C) reflects strong spring flow. 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, numerous thermal spikes of notable magnitude (2.8-8.8° C)

occurred at this location during fifteen rain events throughout the May-September period, as shown in the figure below. Storm water discharges at Sterling Ponds contributed to the thermal spikes on August 11 and September 23; but all thermal spikes also had a more local cause that needs further investigation. Thermal spikes of this frequency and magnitude may have detrimental impacts on aquatic life (especially macroinvertebrates) in lower Sumner Creek

Sumner Creek Temperature at Site 4A: May-September 2010

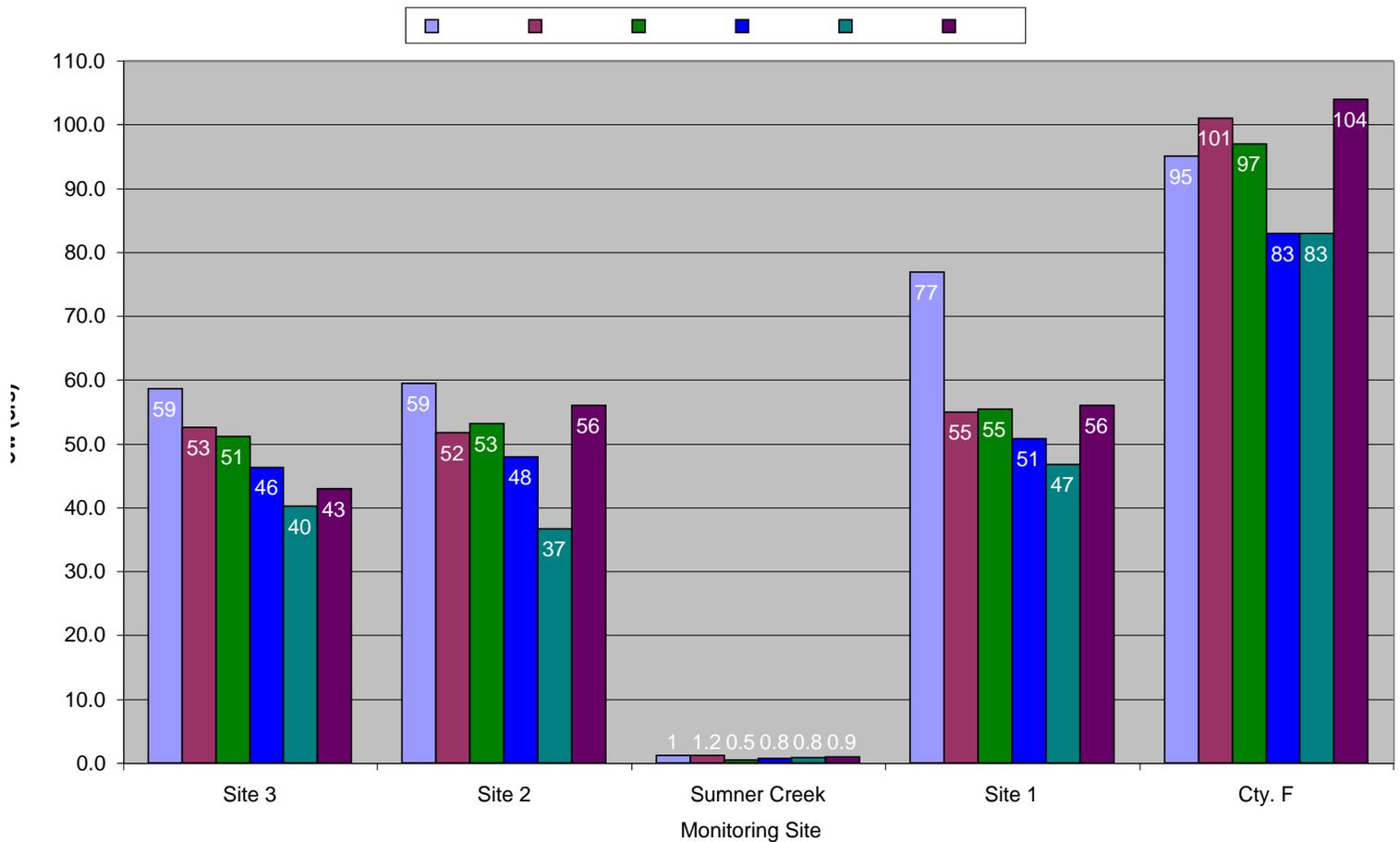


**Base Flow Surveys:**

In May (spring) and November (autumn) 2010, 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 five consecutive years (2006-2010), while autumn base flow surveys have been conducted for six consecutive years (2005-2010). 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 2010 technical report). During the April-September 2010 period, the Kinnickinnic River generally maintained a base flow condition of approximately 75-85 cfs at County Highway F.

The autumn 2010 base flow survey results are presented below, with a comparison to the autumn 2005-2009 survey results. In autumn 2010, Kinnickinnic River base flows increased notably from upstream (Site 3) to downstream (Site 1), with Sumner Creek provided a small contribution upstream of Site 1. Due to above-normal precipitation throughout the April-September 2010 period, autumn base flows rebounded at all sites in 2010, reversing a downward trend that had been occurring since 2005, due to three consecutive summers of below-normal precipitation (2006-2008) and a continuation of moderate-severe drought conditions throughout the summer of 2009.

Autumn Base Flow Conditions in the Kinnickinnic River and Sumner Creek:  
2005-2010



More information on the spring and autumn base flow survey results can be found in the 2010 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 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 an extended dry period (2006-2009). 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.

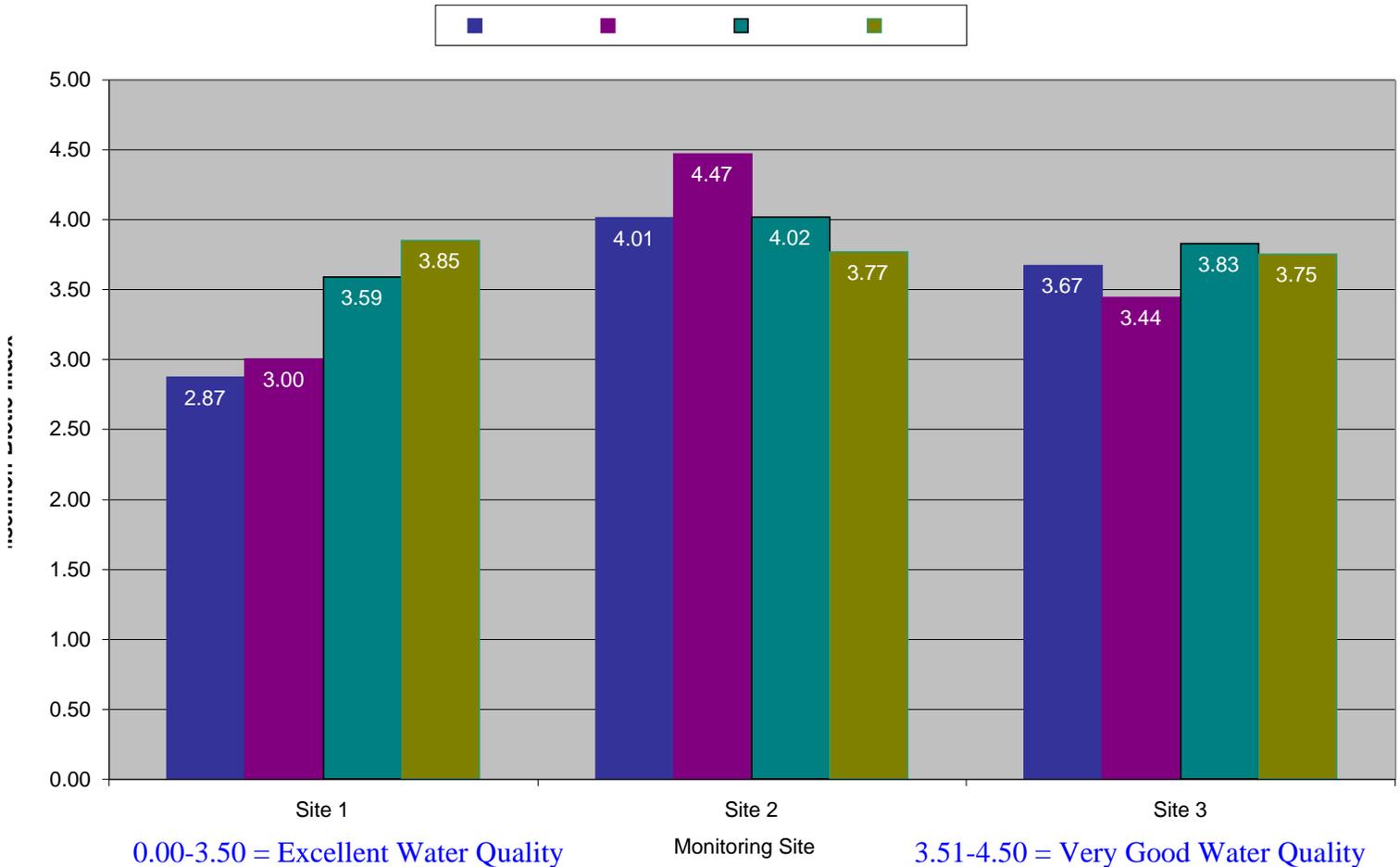
The Hilsenhoff Biotic Index (HBI) is particularly useful for determining the influence of organic pollution on macroinvertebrates. The Wisconsin Department of Natural Resources has used this index for many years in long-term stream monitoring programs. Each macroinvertebrate taxon (genus and/or species) 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:

| <b>HBI Value</b> | <b>Water Quality</b> | <b>Degree of Organic Pollution</b>   |
|------------------|----------------------|--------------------------------------|
| 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 2004-2007 macroinvertebrate HBI values at Sites 1-3 in the North Kinnickinnic River Monitoring Project Area are presented below. The 2004-2007 data establish a baseline for assessing the long-term health of the macroinvertebrate community within the project area. During the 2004-2007 period, HBI values at Site 1 were indicative of very good-excellent water

quality, HBI values at Site 2 were indicative of 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 all 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 2004-2007 period indicates that no storm water impacts were apparent at Site 1, downstream from Sumner Creek and the Sterling Ponds subdivision.

Kinnickinnic River Macroinvertebrates: Hilsenhoff Biotic Index



Macroinvertebrate monitoring was also conducted in May 2008, May 2009, and May 2010, 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. 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 was re-located to Sites 5IN (Sterling Ponds wet detention pond inlet) and 5MHW (Sterling Ponds wet detention pond outlet) in 2010. 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 2011, 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.

### **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 2004-2010 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.