City of River Falls

North Kinnickinnic River Monitoring Project

2004 Technical Review

River Falls Precipitation:

During the April-September 2004 monitoring period, hourly precipitation was measured in 0.01-inch increments with an electronic tipping-bucket rain gauge. The rain gauge, provided by the Wisconsin Department of Natural Resources (WDNR), was located in the Whitetail Ridge Corporate Park at the northwest corner of the City of River Falls. This location places the rain gauge in very close proximity to all six North Kinnickinnic River monitoring stations. Since the WDNR rain gauge was not in service for short time periods in early April and late September, supplemental precipitation data were obtained from the United States Geological Survey (USGS) Kinnickinnic River monitoring station at County Highway F, near Kinnickinnic State Park.

A total of 19.82 inches of precipitation were recorded in River Falls during the April-September 2004 period, compared to the normal total of 20.67 inches for this time period. Rain fell on 55 days, or 30% of the April-September 2004 period.

Daily rainfall amounts during the April-September 2004 period are presented in Figure 1. Monthly rainfall amounts during the April-September 2004 period, with a comparison to normal monthly rainfall amounts, are presented in Figure 2. The months of April, June, July and August 2004 were drier than normal; whereas the months of May and September were wetter than normal. Nearly 60% of the total April-September rainfall occurred in May and September.

The distribution of River Falls daily rainfall amounts during the April-September 2004 period is presented in Figure 3. On 33 (60%) of the 55 days with measurable precipitation, rainfall amounts were 0.25 inch or less. These 33 days contributed only 17% of the total April-September 2004 precipitation. The majority of these 33 days occurred in May and August (Figure 4). On 10 (18%) of the 55 days with measurable precipitation, rainfall amounts ranged from 0.26-0.50 inch. These 10 days contributed 18% of the total April-September 2004 precipitation. Five of these 10 days occurred in May (Figure 4). On 6 (11%) of the 55 days with measurable precipitation, rainfall amounts ranged from 0.51-0.75 inch. These 6 days contributed 19% of the total April-September 2004 precipitation. On 6 (11%) of the 55 days with measurable precipitation, rainfall amounts exceeded 0.75 inch. These 6 days with the largest rainfall events contributed 46% of the total April-September 2004 precipitation. Rainfall amounts in excess of 1 inch occurred on May 9, July 11, and September 5, 14, and 15 (Figures 1 and 4).

For new development and re-development projects, the City of River Falls Storm Water Management Ordinance requires infiltration of all storm water runoff generated by rain events of 1.5 inch or less. Of the 55 days with measurable precipitation during the April-September 2004 period, 53 days (96%) met this criterion. Only rainfall amounts on September 14 (2.44 inches) and September 15 (1.80 inches) exceeded this criterion. Even so, the storm water ordinance would require infiltration of the first 1.5 inches of both of these rainfall events, thereby accounting for infiltration of 94% (18.58 inches) of the total rainfall (19.82 inches) that occurred during the April-September 2004 period.

Kinnickinnic River Flow:

Since July 2002, the United States Geological Survey (USGS) has been operating a Kinnickinnic River monitoring station (number 05342000) at County Highway F, near Kinnickinnic State Park. This station was also in service during the October 1998-September 1999 period. The station measures river stage (water height) and flow at 15-minute intervals. Stage is measured using a nitrogen gas bubbling system and a pressure transducer. Stage measurements are converted to flow measurements via a rating curve. Hourly precipitation is measured in 0.01-inch increments with an electronic tipping-bucket rain gauge. Real-time and recent (31-day) stage, flow, and precipitation data for this monitoring station are web-accessible at:

http://waterdata.usgs.gov/wi/nwis/uv?dd_cd=02&format=gif&period=7&site_no=05342000

The flow of the Kinnickinnic River is a reflection of precipitation and storm water runoff from predominantly agricultural and urban land uses throughout the 165-square mile Kinnickinnic River Watershed. The mean (average) daily flow of the Kinnickinnic River at County Highway F during the April-September 2004 period is presented in Figure 5. Daily rainfall, as measured in River Falls, is also presented in Figure 5. The precipitation pattern during the April-September 2004 period helps explain the changes in the Kinnickinnic River hydrograph, due to runoff events in the watershed. Frequent rainfall in May and early June 2004 resulted in a series of 5 substantial runoff events, with peak flows ranging from 137-184 cubic feet per second (cfs). The river departed from a baseflow condition (approximately 100 cfs) on May 8 and remained above baseflow until the end of June. Drier conditions and below-normal rainfall prevailed in June, July, and August 2004. However, a 1.47-inch rainfall on July 11 produced a significant runoff event in mid-July, with a peak flow of 150 cfs. Although September 2004 was wetter than normal, nearly all of the rainfall occurred on three days. A 1.45-inch rainfall event on September 5 produced only a very modest increase in the Kinnickinnic River hydrograph, with a peak flow of 115 cfs. However, back-to-back 2.44-inch and 1.80-inch rain events on September 14 and 15 produced the largest runoff event of the year, with a peak flow of 235 cfs and a 7-day duration.

Because accurate monitoring of river stage and flow entails a significant investment in equipment and labor, no measurement of river flow is currently being conducted within the North Kinnickinnic River Monitoring Project Area. For this reason, the Kinnickinnic River flow information provided by the USGS monitoring station at County Highway F is particularly valuable, as it clearly documents when runoff events are occurring and storm water impacts may be apparent.

Evaluating 2004 Storm Water Impacts:

The Kinnickinnic River hydrograph suggests that seven significant runoff events occurred during the April-September 2004 period: four throughout the month of May, one during the June 9-14 period, one during the July 11-13 period, and one during the September 14-19 period. These runoff events should be the focus for evaluating possible storm water impacts in the North Kinnickinnic River Monitoring Project Area in 2004. While smaller runoff events can cause significant storm water impacts on the river, it seems unlikely that storm water runoff from the Sterling Ponds subdivision caused any impacts on the Kinnickinnic River during these smaller rainfall events (less than 1 inch) in 2004, due to several factors:

1. Development was just beginning in the Sterling Ponds subdivision in 2004 and was limited to only a small portion of the subdivision. Only 16 single-family housing units were built by October 2004, compared to a projected build-out total of 600 units; and impervious surfaces (rooftops, sidewalks, driveways, and streets) accounted for only ??% of the overall subdivision area.

2. Four wet storm water detention ponds were already in place, with some capacity for storing storm water runoff from the existing impervious areas, especially during smaller rain events.

3. The Sterling Ponds subdivision is approximately 1.5 miles from the Kinnickinnic River, with a connection via Sumner Creek. Sumner Creek is a low-gradient tributary that typically exhibits only intermittent flow during larger rain events. Downstream wetland areas that are part of the Sumner Creek drainage way and the Sumner Creek channel itself likely provided some storage of any Sterling Ponds storm water discharges, especially during smaller rain events.

The infiltration areas paired with the Sterling Ponds wet storm water detention ponds were not yet functional in 2004. These infiltration areas were designed and constructed to meet the River Falls Storm Water Management Ordinance requirement for infiltrating all storm water runoff from rain events of 1.5 inch or less, after water quality treatment via the wet detention ponds. The Sterling Ponds infiltration areas remained off-line throughout 2004, so that percolation testing could be conducted and native vegetation had an opportunity to become established. These infiltration areas should be functional in 2005, thereby providing effective storm water treatment as required by the ordinance. Continued monitoring in 2005 will evaluate ordinance effectiveness and determine any storm water impacts related to rainfall events in excess of 1.5 inch. This will be especially important as the Sterling Ponds subdivision continues to develop and impervious area increases.

With limited development in the Sterling Ponds subdivision in 2004, with some Sterling Ponds storm water management practices (wet detention ponds and erosion control measures) in place, and with Sumner Creek providing a buffer between the subdivision and the Kinnickinnic River, any Sterling Ponds storm water impacts on the river were projected to be minimal in 2004. The 2004 North Kinnickinnic River temperature monitoring, macroinvertebrate monitoring, and fisheries survey results have been evaluated to determine if any storm water impacts were evident. Those results are presented below. The two remaining components of the North Kinnickinnic River Monitoring Project, water quality monitoring and base flow surveys, will be initiated in 2005.

Temperature Monitoring:

In 2004, temperature monitoring was conducted at all six City of River Falls monitoring stations (Sites 1-6) in the North Kinnickinnic River Monitoring Project Area. The local Kiap-TU-Wish Chapter of Trout Unlimited (TU) also conducted temperature monitoring of the Kinnickinnic River at one station (Site 1A) within the project area, between Sites 1 and 2. The TU monitoring station is located along Quarry Road on the northeast edge of River Falls, just east of the WI Highway 35 bypass, and just upstream of the Sumner Creek confluence. The TU station has been in service during all summer periods (May-September) since 1992.

Onset Computer Corporation's® Optic StowAway Temploggers were used to measure river temperature at all City of River Falls monitoring stations (Sites 1-6). A Ryan Instruments® RTM 2000 Temperature Logger was used to measure river temperature at the TU monitoring station at Quarry Road (Site 1A). All Onset and Ryan temperature loggers were programmed to record temperatures at 10-minute intervals. Date and time stamps and the 10-minute temperature data were electronically recorded by each logger; and all recorded information was downloaded as necessary. The brief 10-minute time interval was selected so that any rapid temperature increases associated with warm storm water runoff could be documented. With the exception of Site 3, all temperature loggers were deployed throughout the May-September (summer) period. The thermal impacts of storm water runoff are most likely to occur during this summer period, when air temperatures are highest. The 2004 deployment periods for the temperature loggers at the seven monitoring stations were as follows:

Site 1:	May 5-October 1, 2004
Site 1A:	April 10-October 2, 2004
Site 2:	May 5-October 1, 2004
Site 3:	July 9-October 1, 2004

Site 4: May 5-October 1, 2004

Site 5: May 5-October 1, 2004

Site 6: May 5-October 1, 2004

The temperature logger at Site 3 was not deployed until early July, when the monitoring station was installed. Site logistics and access issues caused a delay in monitoring station installation at this location.

The Thermal Impact of Untreated Storm Water:

The thermal impacts of untreated storm water discharges to 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. These thermal impacts are also evident in the South Fork of the Kinnickinnic River. The Trout Unlimited temperature monitoring research can be viewed at:

http://www.lambcom.net/kiaptuwish/stormwater/stormwater.html

When summer rainfall flows over warm impervious surfaces, it absorbs heat (thermal pollution) that is discharged to the Kinnickinnic River through storm sewers, causing a rapid and marked temperature increase at the beginning (first flush) of a storm water runoff event. These rapid temperature increases (thermal spikes) in the Kinnickinnic River may be particularly harmful to macroinvertebrate (aquatic insects), which serve as a critical food source for trout. Scientific research (Galli, 1990) shows that macroinvertebrates have little ability to compensate for rapid temperature changes. Hence temperature changes of 1-2 degrees centigrade can reduce insect size and reproduction, while temperature changes of 2-3 degrees centigrade could eliminate sensitive insect species.

The City of River Falls is currently evaluating several storm water management options for 24 direct storm sewer discharges to the Kinnickinnic River between Division Street and Lake George. 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.

Sumner Creek and Sterling Ponds Temperature Monitoring Results:

Sumner Creek is a low-gradient tributary of the Kinnickinnic River that exhibits only intermittent flow for the majority of its length. Permanent flow begins in the vicinity of the WI Highway 35 bypass, near the creek confluence with the Kinnickinnic River. From this location, the creek drainage way extends upstream to Radio Road on the far northwest corner of River Falls. This upper portion of the Sumner Creek drainage way, including Sites 4 and 6, conveys no flow for the majority of the year. The headwaters area near Site 6 is a dry run; however, rather extensive wetland areas are apparent in the Sumner Creek drainage way through the Sterling Ponds subdivision, and for an appreciable distance downstream from Site 4. Anecdotal evidence suggests that flow may occur during the spring snowmelt period and perhaps during large summer rain events. During large summer rain events, however, the wetland areas and dry portions of the Sumner Creek channel likely provide considerable water storage, making it very difficult to determine if and when any upstream flow is conveyed all the way downstream to the Kinnickinnic River.

The May-September 2004 temperature monitoring data obtained for Sumner Creek at Sites 4 and 6 and for Sterling Ponds at Site 5 were very difficult to interpret, primarily due to the intermittent water flows at all three sites, as well as the nature of the specific monitoring locations.

Because accurate monitoring of water stage and flow entails a significant investment in equipment and labor, no flow information is available for Sumner Creek at Sites 4 and 6, or for any storm water discharges that may occur from the Sterling Ponds wet detention pond at Site 5. When the North Kinnickinnic River Monitoring Project plan was devised, it was thought that, in addition to measuring water temperature during time periods when water was flowing at these three sites, the temperature loggers might detect sudden changes in temperature that would be indicative of the onset and cessation of water flow at the monitoring sites.

The temperature logger at Site 4 in Sumner Creek, downstream from the Sterling Ponds subdivision, was deployed in a pool of standing water in the culvert under County Road U. Because of the very intermittent creek flow at this location, the May-September temperatures at Site 4 primarily documented the water temperature fluctuations that occurred in this isolated pool.

The temperature logger at Site 5 was deployed in the wet well of the concrete outlet structure for the easternmost Sterling Ponds wet detention pond. Because of the very intermittent storm water discharges from the wet pond at this location, the May-September temperatures at Site 5 primarily documented the water temperature fluctuations that occurred in the standing water within the wet well of the outlet structure.

The temperature logger at Site 6 in Sumner Creek, upstream from the Sterling Ponds subdivision, was deployed on the concrete apron at the bottom of the culvert under WI Highway 35. Because of the very intermittent creek flow at this location, the May-September temperatures at Site 4 primarily documented the air temperature fluctuations that occurred in the highway culvert.

An examination of the May-September 2004 temperature data for Sites 4-6 indicated that some estimation of the duration of water flow was possible at these sites when the largest rain events occurred on May 9 (1.12 inches), July 11 (1.47 inches), September 5 (1.45 inches), September 14 (2.44 inches), and September 15 (1.80 inches). While it was often possible to determine the onset of flow based upon sudden temperature increases, it was more difficult to determine when flow ceased as the water temperature slowly decreased to a location-specific baseline temperature for each monitoring site. When flow was occurring at any given site, water temperature was accurately documented.

Based upon an examination of the temperature data for these largest rainfall events, other complications related to flow became apparent. For instance, it was not possible to determine if any intermittent flow in Sumner Creek at Site 6 carried downstream to Site 4, through the extensive wetland area within the Sterling Ponds subdivision. More importantly, it was not possible to determine if any intermittent flow in Sumner Creek at Site 4, including any storm water discharge from the Sterling Ponds subdivision, with an accompanying thermal impact, carried 1.5 miles downstream to the Kinnickinnic River.

In summary, accurate measurement of Sumner Creek flow at Sites 4 and 6 and documentation of discharges from the Sterling Ponds wet pond at Site 5 were not possible in 2004, using temperature monitoring data alone. Nor was it possible to determine if any discharges of storm water from the Sterling Ponds subdivision, with any accompanying thermal impacts, carried all the way downstream to the Kinnickinnic River, via Sumner Creek. Adjustments to the temperature monitoring scheme at Sites 4-6 will be made in 2005 to improve this situation. An additional temperature monitoring site at the mouth of Sumner Creek would also be very desirable.

Kinnickinnic River Temperature Monitoring Results:

The May-September 2004 (summer) temperature monitoring data obtained for the Kinnickinnic River at Sites 1, 1A, 2, and 3 are presented as thermographs in Figures 6-9, respectively. Of immediate note in these thermographs is the strong daily (diurnal) temperature pattern in the river. Although cold groundwater continually feeds the river via springs along the entire riverway, the temperature of the Kinnickinnic River is greatly influenced by ambient air temperature. During the daylight hours, the river gradually warms and generally reaches a daily maximum temperature in the late afternoon or early evening (4:30-6:30 PM). At night, the river gradually cools and typically reaches a daily minimum temperature just after sunrise (7:30-9:30 AM). These diurnal temperature fluctuations in the river are natural, and the river’s residents, including macroinvertebrates and trout, have become accustomed to a constant but slowing changing temperature regime.

Also of note in the 2004 Kinnickinnic River thermographs are the relatively frequent changes in the daily minimum and maximum river temperatures and daily temperature ranges that are influenced by local weather patterns (cold fronts and warm fronts) and seasonal climate changes. During the summer 2004 period, for example, the average monthly river temperature was coolest in May (12.1 degrees centigrade (°C)) and warmest in July (15.3°C).

At Sites 1, 1A, and 2, river temperatures averaged 13.8°C and ranged from 7.7-19.9°C over the course of the summer. Near-normal river temperatures probably prevailed in the

North Kinnickinnic River Monitoring Project Area during the summer of 2004, since the 2004 average summer air temperature of 18.7°C (65.6°F) was only slightly lower than the normal average summer air temperature of 19.2°C (66.5°F).

Of primary importance for this project are any thermal impacts in the Kinnickinnic River that may be attributed to storm water runoff from the Sterling Ponds subdivision in 2004. The goal of this monitoring project is to determine if the City of River Falls Storm Water Management Ordinance effectively prevents thermal and other storm water impacts to the Kinnickinnic River as a result of development at Sterling Ponds. Given the flow uncertainties and limitations in the temperature monitoring scheme for Sumner Creek and Sterling Ponds in 2004, as discussed above, it was not possible to ascertain if any discharges of storm water from the Sterling Ponds subdivision, with any accompanying thermal impacts, is carried all the way down Sumner Creek to the Kinnickinnic River.

Therefore, the most direct way to determine if any thermal impacts occurred in the Kinnickinnic River is to compare the temperature monitoring data at Site 1, located immediately downstream from Sumner Creek, to the temperature monitoring data at Sites 1A, 2 and 3, located upstream from Sumner Creek. The three upstream sites serve as control or reference sites which are not impacted by Sterling Ponds storm water discharges. Since the temperature monitoring data at Site 3 (Figure 9) only covers the July-September 2004 period, data for this site is not included in the assessment.

Thermal impacts can be assessed in several ways:

1. By comparing all upstream summer temperature data at Sites 1A and 2 to all downstream summer temperature data at Site 1. This will ensure that the overall temperature regime in the Kinnickinnic River remained stable and unchanged at Site 1 during all rainfall and runoff events throughout the summer of 2004.

2. By comparing thermographs at Sites 1 and 2 to determine if rapid temperature increases, which are characteristic of warm storm water discharges, were apparent at Site 1. Comparisons shall be made for each of the seven significant rainfall and runoff events in May, June, July, and September 2004.

A comparison of all upstream summer temperature data at Site 2 to all downstream summer temperature data at Site 1 is presented in Figure 10. This comparison indicates that summer temperatures were very similar at these two locations. The temperature similarity at Sites 1 and 2 is even more evident in the monthly thermographs for May, June, July, August, and September 2004 (Figures 11-15, respectively). Figures 10-15 indicate that daily maximum temperatures tended to be lower and daily minimum temperatures tended to be higher at Site 2, but this is likely due to stronger groundwater inputs upstream. A comparison of all upstream summer temperature data at Site 1A to all downstream summer temperature data at Site 1, as presented in Figure 16, indicates that summer temperatures were nearly identical at these two locations. Figure 17 shows that the average monthly and summer temperatures at Sites 1, 1A, and 2 were also nearly identical. Approximately 95% of all temperatures recorded at Sites 1, 1A, and 2 during the May-September 2004 period were less than 17°C, which is considered to be the top of the optimum temperature range for a healthy coldwater macroinvertebrate community (Galli, 1990). A temperature of 17°C is considered to be the physiological optimum for brown trout survival (Armour, 1994). Greater than 99% of all temperatures recorded at Sites 1, 1A, and 2 during the May-September 2004 period were less than 19°C, which is considered to be the top of the optimum temperature range for brown trout growth (Armour, 1994). One hundred percent of all temperatures recorded at Sites 1, 1A, and 2 were less than 20°C, which is considered to be the top of the optimum temperature range for brown trout survival (Armour, 1994).

During seven significant rainfall and runoff events in May, June, July, and September 2004, thermographs at Sites 1 and 2 can be compared to determine if rapid temperature increases (thermal spikes), which are characteristic of warm storm water discharges, were apparent at Site 1. In spite of frequent rainfall events in May 2004, including four larger rainfall and runoff events on May 9, 13, 23, and 30, no thermal spikes were evident throughout the month at Site 1 (Figure 11). A closer examination of the thermographs for Sites 1 and 2 during a 0.82-inch rainfall event on May 30 (Figure 18) indicates that no thermal spike occurred at Site 1, downstream from the Sterling Ponds subdivision. However, the thermograph for the Trout Unlimited temperature monitoring site at Division Street during the same rain event (Figure 18) shows a series of two very prominent thermal spikes, due to the thermal impacts of direct storm water discharges from the downtown area of River Falls. Thermographs for Sites 1, 2, and Division Street can be similarly compared for larger rainfall and runoff events on June 8-9 (Figure 19), July 11 (Figure 20), September 5 (Figure 21), and September 14-15 (Figure 22). During all of these rainfall events, no thermal spikes were evident at Site 1, while prominent thermal spikes were evident at Division Street. The thermal spikes at Division Street ranged in magnitude from 0.3-3.0 degrees centigrade. While the presence of thermal spikes at Division Street is attributed to the thermal impacts of untreated storm water discharges to the Kinnickinnic River, the lack of thermal spikes at Site 1 could be attributed to several factors, including effective storm water management at the Sterling Ponds subdivision, or simply a lack of Sterling Ponds storm water discharges and/or storm water conveyance down Sumner Creek, even during the largest runoff events.

In summary, no storm water-related thermal impacts were evident at Site 1, downstream from Sumner Creek and Sterling Ponds, during the summer of 2004. Furthermore, the temperature regime in the Kinnickinnic River at Sites 1, 1A, and 2 was ideal for coldwater macroinvertebrate and brown trout communities. With limited development in the Sterling Ponds subdivision in 2004, with some Sterling Ponds storm water management practices (wet detention ponds and erosion control measures) in place, and with Sumner Creek providing a lengthy buffer between the subdivision and the Kinnickinnic River, any Sterling Ponds storm water impacts on the river were projected to be minimal in 2004. As such, the 2004 Kinnickinnic River temperature monitoring data should serve as a useful baseline condition for evaluating the future effectiveness of the City of River Falls Storm Water Management Ordinance as development progresses at Sterling Ponds.

Macroinvertebrate Monitoring: Information will be available soon

Fisheries Survey: Information will be available soon