A Study to Assess the Water Resource Impacts of City of River Falls (WI) Hydropower Facilities on the Kinnickinnic River

Kiap-TU-Wish Chapter of Trout Unlimited

May 8, 2014

A study determined by the Kiap-TU-Wish Chapter of Trout Unlimited as necessary to be performed by the City of River Falls for the River Falls Hydroelectric Project in Pierce County, Wisconsin (FERC Project P-10489), consistent with 18 CFR 4.38(b)(5).

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Study Component I. Temperature Impacts

Background Information:

The Kiap-TU-Wish Chapter of Trout Unlimited (Kiap-TU-Wish) has a goal of maintaining the healthy cold-water ecosystem that supports naturally-reproducing brown and brook trout populations in the Kinnickinnic River. Kiap-TU-Wish has been conducting temperature monitoring of the Kinnickinnic River since 1992. One of the primary objectives of this monitoring work is to evaluate the thermal impacts of the City of River Falls hydropower facilities on the Kinnickinnic River.

Kiap-TU-Wish temperature monitoring is conducted at five Kinnickinnic River sites (two upstream and three downstream of the City of River Falls hydropower facilities) and at two sites on Kinnickinnic River tributaries (South Fork of the Kinnickinnic River and Rocky Branch Creek) (Figure 1). Monitoring is generally conducted during the mid-April to mid-October period each year; although monitoring has been conducted during four winters as well (1995, 1998, 2003, 2006). Monitoring is conducted via the use of electronic instrumentation that continuously measures river temperatures at 10-minute intervals, generating approximately 22,000 temperature measurements/monitoring site/year.

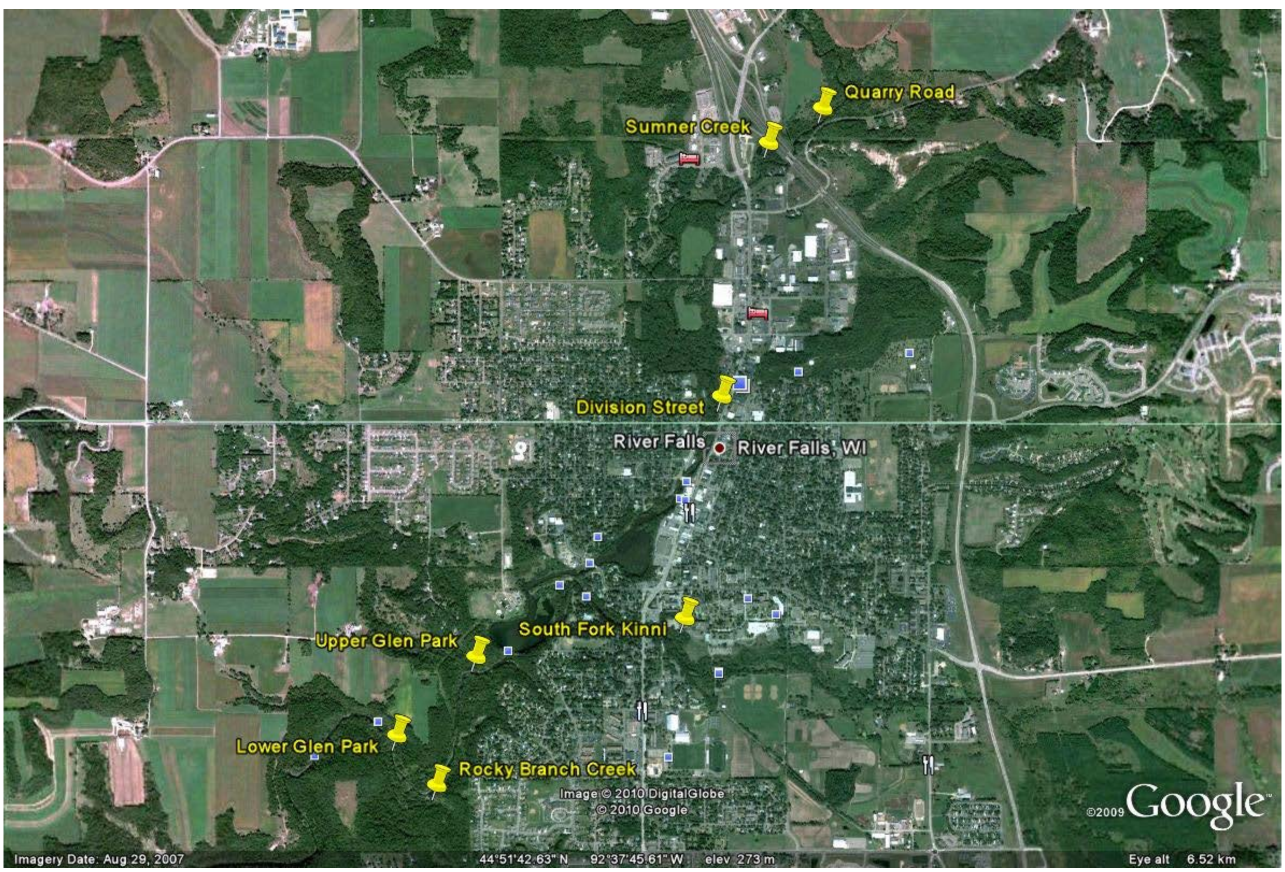

Figure 1. Kiap-TU-Wish temperature monitoring sites on the Kinnickinnic River and tributaries in River Falls, WI.

Evidence of Temperature Impacts:

- The two City of River Falls hydropower impoundments (Lakes George and Louise) have transformed a 0.7-mile reach of the Kinnickinnic River from a coldwater to a warm water ecosystem. Lakes George and Louise are classified by WDNR as a warm water sport fishery (WWSF), while the remainder of the Kinnickinnic River is classified as a COLD Class I trout fishery (WDNR, et al., 1999).
- The two City of River Falls hydropower impoundments (Lakes George and Louise) have a significant warming influence on the downstream Kinnickinnic River in the summer, and a cooling influence in the winter.
- The Nonpoint Source Control Plan for the Kinnickinnic River Priority Watershed Project (Kinni NPS Plan) (WDNR et al., 1999) notes (p. 94): "The downstream reach (below Lake Louise and Powell Dam)….has elevated water temperatures…caused by the two upstream impoundments and stormwater runoff". "The impoundments have an overall constant warming effect of about 3° C (5° F) on downstream water temperatures during base flow (Schreiber, 1998)."
- The Kinni NPS Plan (WDNR et al., 1999) notes about Lake George (p. 94): "Warming in the shallow areas tends to cause a general increase in downstream water temperatures".
- On average (1993-2013), the downstream Kinnickinnic River summer (June-August) temperature is 4.2° F higher than the upstream temperature (59.7° F upstream vs. 63.9° F downstream) (Kiap-TU-Wish, unpublished data).
- On average (1993-2013), the downstream Kinnickinnic River July temperature is 4.7° F higher than the upstream temperature (61.0° F upstream vs. 65.7° F downstream) (Kiap-TU-Wish, unpublished data).
- A climate vulnerability analysis of Kiap-TU-Wish data (1992-2009) by WDNR (Mitro, et al., 2011) noted that a warming trend is occurring at both upstream and downstream Kinnickinnic River sites. However, the warming trend is greater at downstream sites and begins at a much higher baseline temperature, indicating that the downstream Kinnickinnic River may be much more sensitive to future climate change impacts.
- Future climate change impacts (Mitro, et al., 2011) must be a critical consideration for evaluating future hydropower-related temperature impacts on the currently-impounded and downstream reaches of the Kinnickinnic River. With higher system-wide temperatures due to climate change, thermal impacts due to the hydropower impoundments will further exacerbate downstream warming, possibly creating future temperature regimes that are unsuitable for a coldwater ecosystem.

Recommended Study Elements to Evaluate Temperature Impacts:

Ia. Conduct a rigorous assessment of the Kiap-TU-Wish temperature monitoring dataset (1992-2013), using multiple statistical metrics, making comparisons to critical thermal thresholds for trout and invertebrates, assessing cumulative heat exposure, conducting a regression analysis of temperature trends, and evaluating susceptibility to air temperature and climate change.

Ib. Conduct year-round temperature monitoring of Lakes George and Louise (1-2 years), to better understand in-lake temperature dynamics. In addition to lateral and longitudinal characterization of temperature, vertical profiling work should be conducted to determine the extent of seasonal thermal stratification in the two hydropower impoundments.

Ic. Conduct additional winter temperature monitoring at upstream and downstream Kinnickinnic River sites, to better understand the winter temperature impacts of Lakes George and Louise.

Id. Conduct thermal modeling of the Kinnickinnic River, to determine the extent to which dam removal would improve the temperature regime (lower the baseline temperature) in the currently-impounded and downstream river reaches, how far down river this temperature improvement would extend, and the amount of "thermal buffering capacity" created for protection against future climate change. With a lower downstream baseline temperature, the Kinnickinnic River could better utilize the significant groundwater inputs to the lower five miles of the river (river flow approximately doubles from Main Street in River Falls to County Road F near the river mouth). Conversely, the thermal model could also be used to evaluate the temperature impacts of the hydropower impoundments (or absence thereof) under several future climate change scenarios, as outlined by WDNR (Mitro, et al., 2011). With enhancements, the existing U.S. Army Corps of Engineers (USACE) thermal model created for the Lake George Stormwater Treatment Concept Plan (City of River Falls, 2005) could be used for this effort.

Study Component II. Hydrologic Impacts

Background Information:

The U.S. Geological Survey (USGS) has been conducting flow monitoring of the Kinnickinnic River since 1998 (http://waterdata.usgs.gov/wi/nwis/uv/?site_no=05342000&PARAmeter_cd=00065,00060). A one-year record of flow data exists for the 1999 water year (October 1998-September 1999), while a continuous record of flow data exists from July 2002 to present.

The USGS monitoring station is located on the lower Kinnickinnic River near County Road F, approximately 5 miles west of River Falls. The station continuously measures river stage (water height) and flow at 15-minute intervals year-round, generating approximately 35,000 stage and flow measurements per year.

Evidence of Hydrologic Impacts:

- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 93-94): "The condition of the Kinnickinnic River downstream from the City of River Falls is worse than the condition upstream. Increased temperatures from the two lakes and flow fluctuations caused by dam management procedures contribute to adverse impacts on the Kinnickinnic River ecosystem".
- The Kinni NPS Plan notes (WDNR et al., 1999) (p. 94): "The downstream reach (below Lake Louise and Powell Dam)….is impacted….by flashy stream flows caused by urban runoff and hydropower manipulations".
- The Kinni NPS Plan notes (WDNR et al., 1999) (p. 8): "The impoundments were also shown to have significant impacts on stream flow during trash rack cleaning operations".
- On a number of occasions, recreational users along the lower Kinnickinnic River (downstream from River Falls) have noted sudden flow fluctuations that are likely attributed to irregular operation of the City of River Falls hydropower facilities. For instance, a Kiap-TU-Wish Chapter member observed a dramatic decrease in Kinnickinnic River flow (from 126 cfs to 53 cfs) on July 11, 2008, during the 15:00-18:45 CDT time period, as measured at the USGS monitoring station

(Figure 2). The Wisconsin Department of Natural Resources (Marty Engel, personal communication) subsequently linked this flow irregularity to a gate malfunction at the lower (Powell Falls Dam) hydropower facility.

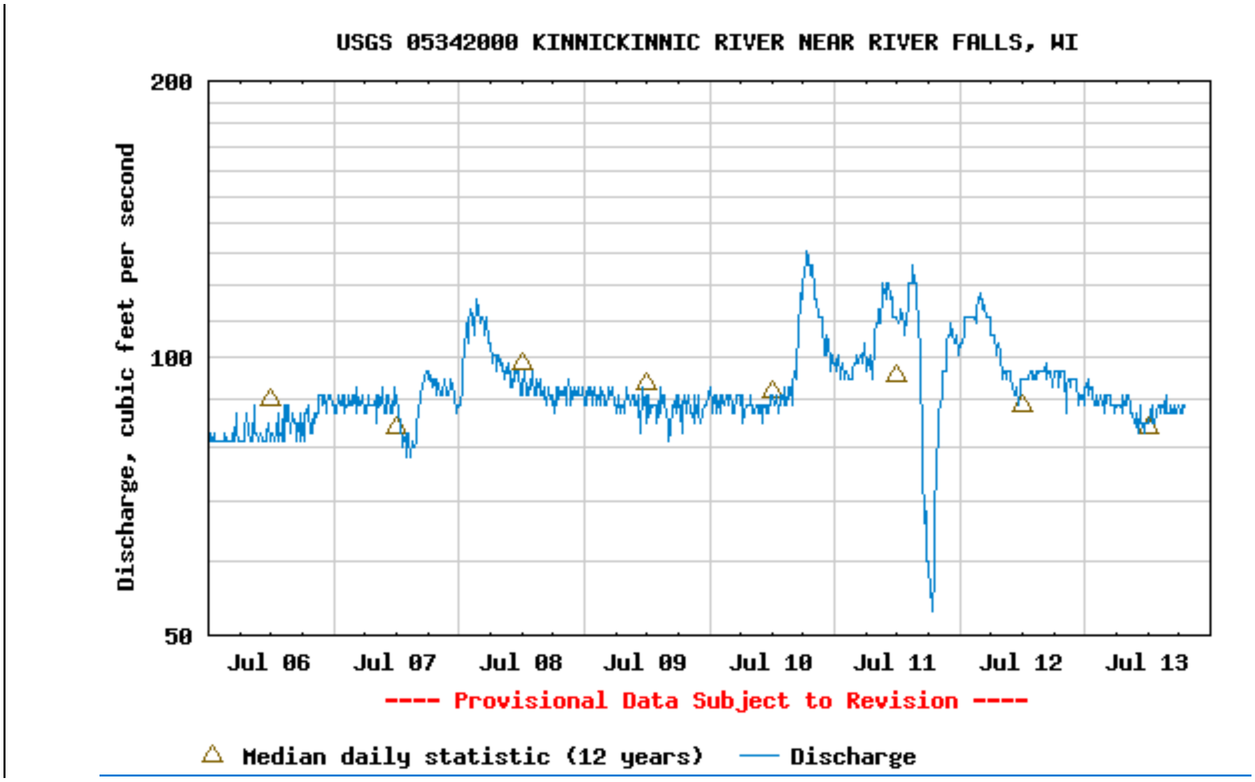

Figure 2. Hydropower-related Kinnickinnic River flow irregularity on July 11, 2008.

Maintaining a "run-of-river" condition downstream from the City of River Falls hydropower facilities is critical for protecting the Kinnickinnic River habitats that support healthy coldwater macroinvertebrate and brown trout communities. Sudden decreases in water flow can de-water macroinvertebrate habitats and trout redds, while sudden increases in water flow can de-stabilize the river channel, thereby increasing bank erosion, decreasing water clarity, and damaging in-stream habitat. The Federal Energy Regulatory Commission (FERC) permit for the City of River Falls hydropower facilities requires that a downstream "run-of-river" condition be maintained at all times.

Recommended Study Elements to Evaluate Hydrologic Impacts:

IIa. Using the 15-minute USGS Kinnickinnic River flow data, conduct a thorough assessment of the extent to which the City of River Falls hydropower facilities have maintained a "run-of-river" condition during the 1998-1999 and 2002-2013 periods. Examine the Kinnickinnic River hydrograph during periods of stable river flow (base flow), when precipitation and runoff are not occurring, to determine the frequency, magnitude, and duration of flow and stage irregularities.

IIb. Assemble and review observational reports of flow irregularities by recreational users, the public, and other sources. These reports may have been received by the City of River Falls, WDNR, and/or FERC.

IIc. Obtain and review any pertinent records maintained by the City of River Falls hydropower utility, to determine if the operation and/or maintenance of the hydropower facilities has resulted in abnormal (non "run-of river") flow conditions.

Study Component III. Water and Sediment Quality Impacts

Background Information:

Very minimal water quality monitoring of the Kinnickinnic River and Lakes George and Louise has been conducted. WDNR (Schreiber, 1998) evaluated baseline water resource conditions in the Kinnickinnic River Watershed in 1996-1997, to inform the development of the Kinni NPS Plan (WDNR et al., 1999). However, the extent of water quality monitoring was minimal, and no recent assessment of water quality has been conducted by WDNR or other agencies.

Similarly, very limited monitoring of sediment quality has been conducted in Lakes George and Louise. The City of River Falls collected a limited number of sediment core samples from Lake George in 1989-1990, with analysis of trace metals, organic compounds, and total Kjeldahl and ammonia nitrogen (City of River Falls, unpublished data).

Evidence of Water and Sediment Quality Impacts:

- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 94): "Lake George is a shallow, eutrophic 18-acre impoundment that….is nearly filled with sediment and experiences summer algae blooms and turbidity".
- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 94): "Lake Louise is a shallow, eutrophic 15-acre impoundment that….is nearly filled with sediment and experiences summer algae blooms and turbidity".

The two hydropower impoundments (Lakes George and Louise) have extended water residence times, creating in-lake water and sediment quality problems. In the presence of ample sunlight, favorably warm water temperatures, and adequate nutrient sources, summer algae blooms occur, creating unsightly (green) conditions, reduced water clarity, odors, possible human health impacts, and reduced oxygen concentrations. The extended water residence time also allows suspended sediment (silt) from upstream sources (both urban and agricultural) to accumulate in the lakes. In addition to in-filling the lakes, the suspended sediment carries contaminants (phosphorus, trace metals, and organic compounds (PAHs and pesticides)) that are deposited in the lake bottom, with possible impacts on benthic invertebrates and fish. Large numbers of Canada geese and ducks congregate on Lakes George and Louise in the fall and winter, resulting in phosphorus, nitrogen, and bacterial loading to the lakes. Biological, chemical, and physical processes can transfer sediment contaminants to the overlying water column in the lakes, thereby causing in-lake and downstream water quality problems. For instance, increased water flows through the impoundments during storm runoff events can re-suspend the fine silt and contaminants from the lake bottom, with impacts on in-lake and downstream water quality. Water and sediment contaminants can also be transferred to biota through bioaccumulation and biomagnification processes, with implications for aquatic and human health (typically via fish consumption). Experience has shown that remediation of sediment contamination is often difficult, costly, time consuming, and disruptive to the local environment and community (Parkerton and Maruya, 2013).

Recommended Study Elements to Evaluate Water and Sediment Quality Impacts:

IIIa. Conduct seasonal (April-October) water quality monitoring of Lakes George and Louise and at upstream and downstream Kinnickinnic River locations (1-2 years), to better assess in-lake water quality problems and possible downstream water quality impacts. Water quality monitoring should be conducted during both baseflow and storm runoff conditions, to fully characterize in-lake and downstream impacts. Monitoring will also help determine whether applicable state water quality standards are being met (example: phosphorus standard of 75 ug/l, per WI Chapter NR 102). Monitoring of multiple water quality variables is recommended: dissolved oxygen, turbidity, suspended solids, nutrients (various forms of phosphorus and nitrogen), trace metals, bacteria, and chlorophyll (estimate of algal presence). In addition to longitudinal water quality characterization at upstream, in-lake, and downstream locations, in-lake vertical profiling work and/or continuous monitoring of dissolved oxygen, pH, and conductivity should be conducted, to determine the extent of stratification and dynamic changes (daily, weekly, monthly) that occur in the two hydropower impoundments. With possible decreased in-lake dissolved oxygen concentrations due to eutrophication and increased sediment oxygen demand, an upstream-downstream comparison of diel oxygen fluctuations should also be conducted via continuous monitoring.

IIIb. Determine the extent to which Lakes George and Louise have been filled by the historical deposition of sediment. Conduct a bathymetric survey of Lakes George and Louise, and prepare a digital model of current sediment surface elevations in both lakes. Conduct a sediment probe survey to determine depth to bedrock in Lakes George and Louise, and prepare a digital model of bedrock elevations for both lakes. Using the digital models, map the sediment depths and calculate sediment volumes in both lakes. To determine the rate of sediment in-filling in Lakes George and Louise, a select number of deep sediment cores from both lakes should be dated (^{14}C, ^{137}Cs, ^{210}Pb, loss on ignition, magnetic susceptibility, and pollen analysis). The amount of sediment in-filling and the extent of sediment contamination (see study elements IIIc-IIIe below) would have significant implications in the event that future dredging of the two impoundments would be necessary to maintain or improve capacity for hydropower generation. In addition to a need for proper disposal and/or re-use of the dredged material, any dredging operation could cause in-lake and downstream water quality impacts. Information on the amount of sediment in-filling and contamination in the two hydropower impoundments would also be critical to inform site restoration and/or remediation in the event of future dam removal.

IIIc. Evaluate the existing Lake George sediment core data (1989-1990), to determine implications for in-lake biological impacts and possible future disposal and/or re-use of dredged material.

IIId. Collect deep sediment core samples and associated sediment pore water samples from Lakes George and Louise, to fully assess the levels and extent of sediment contaminants (sediment oxygen demand, total phosphorus, ammonia nitrogen, trace metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn), and organic compounds (PAHs, PCBs, and pesticides)) (U.S. EPA and U.S. ACE, 1998; Balogh, et al., 2009; MCES, 2006). Ancillary analyses (physical sediment appearance, particle size distribution, percent moisture, total volatile solids, acid volatile sulfide, and total organic carbon) should also be conducted on the sediment core samples. Contaminant levels in bed sediment and sediment pore water can be compared to Level I and Level II Sediment Quality Targets (SQTs) (Crane and MacDonald, 2003) and state water quality standards, respectively, to evaluate the likelihood of biological impacts. Information on sediment contaminant levels would also be critical in the event that future dredging of the two hydropower impoundments would create a need for disposal and/or re-use of the dredged material. A limited number of sediment core samples were previously collected from Lake George in 1989-1990 (as noted above). However, no sediment samples have been previously collected from Lake Louise. Due to the probable rapid rate of sediment deposition in both lakes, a comprehensive analysis of sediment quality in both lakes is highly recommended, to better reflect both historical and current conditions.

IIIe. Conduct in-laboratory sediment and pore water toxicity tests to directly determine the impacts of sediment contaminants on representative invertebrate species (Hyalella azteca, Chironomus tentans, and Ceriodaphnia dubia) (U.S. EPA, 1994; Winger and Lasier, 1998; MCES, 2006).

Study Component IV. Biological Impacts

Background Information:

Regular WDNR fisheries surveys (1996, 2004-2013) have been conducted at Kinnickinnic River locations upstream and downstream from the two City of River Falls hydropower impoundments. However, no WDNR fisheries surveys have been conducted in Lakes George and Louise (Marty Engel, WDNR, personal communication).

Occasional macroinvertebrate surveys have been conducted by the WDNR (1995-1998), University of Wisconsin-River Falls (1997, 1999, 2001), and the City of River Falls (2004-2012), at Kinnickinnic River locations upstream and downstream from the two City of River Falls hydropower impoundments (Garry, 2006). However, no known macroinvertebrate surveys have been conducted in Lakes George and Louise.

Evidence of Biological Impacts:

- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 36): "The entire main stem of the Kinnickinnic River is classified as a COLD Class I trout fishery. The two impoundments in the City of River Falls, Lake Louise and Lake George, support a warm water sport fishery (WWSF)".
- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 94): "Lake George….has a limited warmwater and coldwater sport fishery consisting of largemouth bass, panfish, and brown trout".
- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 94): "Lake Louise…. has a limited warmwater and coldwater sport fishery consisting of largemouth bass, panfish, and brown trout. The lake also supports a significant carp population".
- The temperature, hydrologic, and water quality conditions created by the two City of River Falls hydropower impoundments have significantly impacted a 0.7-mile reach of a coldwater resource, as evidenced by the classification of Lakes George and Louise by WDNR as warmwater sport fisheries.

Recommended Study Elements to Evaluate Biological Impacts:

IVa. Conduct a comparative assessment of available Kinnickinnic River fisheries and macroinvertebrate survey results from locations upstream and downstream of the two City of River Falls hydropower impoundments, to determine if downstream biological impacts are evident, especially via alterations in aquatic community composition and abundance. Multiple biotic metrics and indices can be used to make this comparison. Conduct additional upstream and downstream Kinnickinnic River macroinvertebrate survey work, if existing data are insufficient and/or do not reflect current conditions.

IVb. Conduct fisheries and macroinvertebrate surveys of Lakes George and Louise, to characterize current biological conditions and assess the in-lake biological impacts of these two hydropower impoundments, especially via alterations in aquatic community composition and abundance.

IVc. Assess possible impacts of the two City of River Falls hydropower impoundments related to contaminant bioaccumulation and biomagnification, with implications for aquatic and human health. Determine contaminant levels in macroinvertebrate and fish samples obtained from Lakes George and Louise, and from upstream and downstream Kinnickinnic River locations. Contaminant levels (trace metals, PAHs, PCBs, and pesticides) in representative samples from these two biotic groups can be compared to thresholds for biological impact and human health (via fish consumption) (Blanchard, et al., 1993; Steingraeber and Wiener, 1995; Simpson and Lusk, 1999).

IVd. Conduct Kinnickinnic River surveys of aquatic vegetation (periphyton and macrophytes) at locations upstream and downstream of the two City of River Falls hydropower impoundments, to evaluate the extent to which increased downstream temperatures, nutrient availability, and primary productivity have enhanced nuisance growths of aquatic vegetation, potentially impacting habitat quality for trout and macroinvertebrates (BC Ministry of Environment, Lands, and Parks, 2001; DeNicola, 1996).

IVe. With dam removal, evaluate the potential for significant restoration of a coldwater ecosystem in the 0.7-mile Kinnickinnic River reach currently impacted by the two hydropower impoundments.

IVf. Through survey work, determine the extent to which Lakes George and Louise may be harboring NR40-listed aquatic invasive species. This information is needed to evaluate any risks posed for other portions of the Kinnickinnic River and to develop appropriate management strategies.

Study Component V. Implications for Storm Water Management

Background Information:

As noted in **Study Component I. Temperature**, above, Kiap-TU-Wish has been conducting temperature monitoring of the Kinnickinnic River since 1992. In addition to evaluating the thermal impacts of the City of River Falls hydropower facilities, this monitoring work is evaluating the thermal impacts of City of River Falls storm water runoff on the Kinnickinnic River.

Since 2004, the City of River Falls has been conducting monitoring of the Kinnickinnic River, Sumner Creek, and the on-site storm water best management practices (BMPs) at the Sterling Ponds subdivision. The goal of the City of River Falls North Kinnickinnic River Monitoring Project is to evaluate the effectiveness of the city's Storm Water Management Ordinance for preventing degradation of the Kinnickinnic River due to new city development.

Evidence of Storm Water Impacts:

- Untreated storm water from the City of River Falls is currently discharged directly to the Kinnickinnic River via 25 storm water outfalls along the river reach from County Road MM to Upper Glen Park. Twenty-four of these storm water outfalls discharge directly to Lake George or the 1.1-mile Kinnickinnic River reach immediately upstream. The Bartosh Canyon storm water outfall discharges to the Kinnickinnic River, just downstream from the Powell Falls Dam and Lake Louise.
- Untreated storm water from the City of River Falls is currently discharged to the South Fork of the Kinnickinnic River and conveyed to the Kinnickinnic River, just downstream from the Junction Falls Dam.
- Untreated storm water is a significant issue for the Kinnickinnic River, delivering excess inputs of water and pollutants (thermal, suspended sediment, nutrients, trace metals, and organic compounds), which can impact the river's flow regime, water quality, and aquatic biota.
- Kiap-TU-Wish temperature monitoring results show evidence of warm storm water inputs to the Kinnickinnic River during most summer rain events, from Division Street to Upper Glen Park, and in the South Fork of the Kinnickinnic River (Kiap-TU-Wish, unpublished data).
- The Bartosh Canyon storm water outfall (below Lake Louise) is contributing thermal pollution to a downstream Kinnickinnic River reach that is already thermally impacted by the two City of River Falls hydropower impoundments. With a higher baseline temperature, the downstream Kinnickinnic River reach has less capacity to absorb the thermal impacts of Bartosh Canyon storm water. Kiap-TU-Wish temperature monitoring data at two downstream Kinnickinnic River sites show compounding thermal impacts (due to storm water inputs) on top of a higher river baseline temperature (due to the impacts of the hydropower impoundments) (Kiap-TU-Wish, unpublished data).
- Any thermal benefits gained via implementation of the Lake George Area Stormwater Treatment Concept Plan (City of River Falls, 2005) are partially offset by the thermal impacts of Lake Louise.

Recommended Study Elements to Evaluate Implications for Storm Water Management:

The following studies would help determine whether removal of the City of River Falls hydropower impoundments would have significant benefits for future City of River Falls storm water management efforts:

Va. Determine the extent to which implementation of the Lake George Area Stormwater Treatment Concept Plan could be more effective with the hydropower impoundments removed. Benefits could include enhanced thermal performance and additional space and infiltration capacity for the stormwater BMPs in Lake George and at upstream storm sewershed outlet locations. The existing USACE thermal model created for the Lake George Stormwater Treatment Concept Plan (City of River Falls, 2005) could be used to compare the thermal performance of Lake George stormwater BMPs with and without the two hydropower impoundments.

Vb. Determine the extent to which removal of the hydropower impoundments could create additional space and infiltration capacity for treatment of West Side and Bartosh Canyon storm water. This could perhaps be achieved with infiltration-based stormwater BMPs in existing or newly-created upland areas proximate to the new river channel. The City of River Falls North Kinnickinnic River Monitoring Project (2004-2013) has demonstrated the effectiveness of the city's storm water ordinance and the use of infiltration-based storm water BMPs (City of River Falls, 2013). Benefits would include reducing storm water volume, thermal impacts, and pollutants and re-charging shallow aquifers that provide cool baseflow to the river. Any concept plan created for this storm water management scenario could incorporate other community amenities, including park land, wildlife habitat, and recreational opportunities.

Study Design and Implementation

All of the study elements recommended above (in Study Components I-V) should be designed and conducted by qualified water resource professionals. The study protocols used for monitoring, data collection, and/or analysis should be consistent with those used by water resource agencies (Minnesota Pollution Control Agency, Minnesota Department of Natural Resources, Metropolitan Council Environmental Services, Wisconsin Department of Natural Resources, U.S. Geological Survey, U.S. Environmental Protection Agency) and/or as documented in peer-reviewed literature and reports (see **References**, below). Kiap-TU-Wish would greatly appreciate the opportunity to work with the City of River Falls and their water resource consultants on study design, selection of appropriate protocols and methodologies, and data analysis.

From the Nonpoint Source Control Plan for the Kinnickinnic River Priority Watershed Project (p. 96):

"This plan does not take a position relative to the future of the dams in River Falls. However, it is important to recognize that the dams do create both positive and negative impacts for the ecosystem and human users of the watershed that should be analyzed prior to major reinvestment in the future."

References

Balogh, S.J., D.R. Engstrom, J.E. Almendinger, C. McDermott, J. Hu, Y. Nollet, M.L. Meyer, and D.K. Johnson. 2009. A Sediment Record of Trace Metal Loadings in the Upper Mississippi River. Journal of Paleolimnology 41: 623-639.

Blanchard, P.J., R.R. Roy, and T.F. O'Brien. 1993. Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the San Juan River Area, San Juan County, Northwestern New Mexico, 1990-1991. U.S. Geological Survey Water-Resources Investigations Report 93-4065. 148 p.

British Columbia Ministry of Environment, Lands, and Parks. 2001. Towards a Water Quality Guideline for Temperature in the Province of British Columbia. British Columbia Ministry of Environment, Lands, and Parks. Water Management Branch. Water Quality Section.

City of River Falls. 2005. Lake George Area Stormwater Treatment Concept Plan: Final Report. Prepared by Bonestroo Rosene Anderlik and Associates for the City of River Falls, Wisconsin. 49 p.

City of River Falls. 2013. City of River Falls North Kinnickinnic River Monitoring Project: 2013 Report. Prepared by SEH, Inc. for the City of River Falls, WI. 42 p.

Crane, J.L. and D.D. MacDonald. 2003. Applications of Numerical Sediment Quality Targets for Assessing Sediment Quality Conditions in a U.S. Great Lakes Area of Concern. Environmental Management 32: 128-140.

DeNicola, D.M. 1996. Periphyton Responses to Temperature at Different Ecological Levels. In *Algal Ecology: Freshwater Benthic Ecosystems* (J.R. Stevenson, M.L. Bothwell, and R.L. Lowe, Eds.), pp. 150-183. Academic Press, San Diego, CA.

Engstrom, D.R., J.E. Almendinger, and J.A. Wollin. 2009. Historical Changes in Sediment and Phosphorus Loading to the Upper Mississippi River: Mass-Balance Reconstructions from the Sediments of Lake Pepin. Journal of Paleolimnology 41:563-588.

Garry, C. 2006. A Survey of the Benthic Macroinvertebrates of the Kinnickinnic River of Western Wisconsin. University of Wisconsin-River Falls. Department of Biology. 42 p.

MCES. 2006. Physical, Chemical, and Biological Characteristics of Mississippi, Minnesota, and St. Croix River Bed Sediments in the Twin Cities, MN Area during a 1998-2001 Survey. Metropolitan Council Environmental Services, Environmental Monitoring and Assessment Section. Unpublished report.

Mitro, M., J. Lyons, and S. Sharma. 2011. Wisconsin Initiative on Climate Change Impacts: Coldwater Fish and Fisheries Working Group Report. 31 p.

Parkerton, T.F. and K.A. Maruya. 2013. Passive Sampling in Contaminated Sediment Assessment: Building Consensus to Improve Decision-Making. Integrated Environmental Assessment and Management 10 (2): 163-166.

Schreiber, K. 1998. Kinnickinnic River Priority Watershed Surface Water Resources Appraisal Report. Wisconsin Department of Natural Resources, West Central Region. 26 p.

Simpson, Z.R. and J.D. Lusk. 1999. Environmental Contaminants in Aquatic Plants, Invertebrates, and Fishes of the San Juan River Mainstem, 1990-1996. U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Environmental Contaminants Program. 214 p.

Steingraeber, M.T. and J.G. Wiener. 1995. Bioassessment of Contaminant Transport and Distribution in Aquatic Ecosystems by Chemical Analysis of Burrowing Mayflies (*Hexagenia*). Regulated Rivers Research and Management 11(2): 201-209.

U.S. EPA. 1994. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates. U.S. Environmental Protection Agency, Office of Research and Development, Duluth, MN. EPA 600/R-94/024. 133 p.

U.S. EPA and U.S. ACE. 1998. Great Lakes Dredged Material Testing and Evaluation Manual. U.S. Environmental Protection Agency, Great Lakes National Program Office, Chicago, Illinois. U.S. Army Corps of Engineers, Great Lakes and Ohio River Division. 73 p.

Winger, P.V. and P.J. Lasier. 1998. Toxicity of Sediment Collected Upriver and Downriver of Major Cities Along the Lower Mississippi River. Archives of Environmental Contamination and Toxicology 35(2): 213-217.

Wisconsin Department of Natural Resources; Wisconsin Department of Agriculture, Trade, and Consumer Protection; and St. Croix and Pierce County Land Conservation Departments. 1999. Nonpoint Source Control Plan for the Kinnickinnic River Priority Watershed Project. Publication WT-522. 225 p.

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