KAUKAUNA UTILITIES

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December 20, 2017

VIA E-FILING

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

RE: Kimberly Hydroelectric Project, FERC Project No. 10674
Filing Final Study Report: Desktop Water Quality Study
Docket No.: P-10674-016

Dear Secretary Bose:

Kaukauna Utilities is filing its Final Desktop Water Quality Study Report, dated October, 2017. The report was sent to agencies and stakeholders for a 30 day review and comment on October 31, 2017. No comments modifying the report were received.

If there are any questions or comments regarding the filing, please contact Mike Pedersen by phone at (920) 462-0220 or by email at mpedersen@ku-wi.org.

Sincerely,

Mike Pedersen
Manager of Generation and Operations
Kaukauna Utilities

cc: Distribution List

CERTIFICATE OF SERVICE
Kimberly Hydroelectric Project (FERC No. 10674)
Study Report

I, Mike Pedersen, Manager of Generation and Operations, Kaukauna Utilities, hereby certify that copies of the foregoing document have been transmitted to the following parties on December 20, 2017.

One copy, eFile to:

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888 First Street N.E., Dockets Room
Washington, DC 20426

Via email, hard copy or compact disc, regular mail, postage paid to:

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DESKTOP WATER QUALITY STUDY

KIMBERLY HYDROELECTRIC PROJECT
FERC NO. 10674

SUBMITTED BY:

KAUKAUNA UTILITIES
777 ISLAND STREET
KAUKAUNA, WI 54130

PREPARED BY:

TRC
150 NORTH PATRICK BOULEVARD
BROOKFIELD, WI 53045

OCTOBER 2017

Results you can rely on

KAUKAUNA UTILITIES

KIMBERLY HYDROELECTRIC PROJECT

FERC NO. 10674

DESKTOP WATER QUALITY STUDY

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1.0 INTRODUCTION

Kaukauna Utilities (Licensee) is in the process of relicensing the existing 2,013 kilowatt (kW) Kimberly Hydroelectric Project, FERC Project No. 10674 (Kimberly Project or Project) with the Federal Energy Regulatory Commission (FERC). The Project is located on the Lower Fox River in Outagamie County, Wisconsin. The Project is located at the Cedars Dam, which is owned and operated by the U.S. Army Corps of Engineers (USACE). The Project is operated in a run-of-river mode and the dam and accompanying flowage are not part of the Project license and are not included in the Project boundary. The Licensee is not currently proposing any changes to the Project as part of the relicensing.

The Licensee is using FERC's Traditional Licensing Process (TLP) as established in FERC regulations, Title 18 of the US Code of Federal Regulations (CFR), Part 16. The Licensee filed a Pre-Application Document (PAD) and Notice of Intent (NOI) to seek a new license for the Project on September 23, 2016 and Errata/Clarifications on September 30, 2016. The PAD provides a complete description of the Project, including its structures, operations, and exiting environment.

The Licensee prepared a Study Plan (SP), which outlined a Desktop Water Quality Study and a Recreation Facilities Inventory and Public Recreation Use Assessment. The plans were sent to agencies and stakeholders for a 30 day review and comment on March 10, 2017. No comments modifying the plans were received. The SP was filed with FERC on May 15, 2017.

The Licensee has completed the Desktop Water Quality Study, and the results of this study are shown in this report.

2.0 METHODS

2.1 Study Goals and Objectives

The Licensee conducted a desktop water quality study utilizing existing data collected by the Wisconsin Department of Natural Resources (Wisconsin DNR) and the Licensee. The objective of this study was to evaluate dissolved oxygen (DO) and water temperature in the impoundment and downstream of the Project powerhouse, and to determine if the operation of the Project has a significant effect on DO and temperature.

2.2 Study Scope and Methods

DO and Temperature Assessment: DO and temperature data were evaluated above and below the Project between the Wisconsin Highway 441 bridge and the Little Chute Hydroelectric Project (FERC Project No. P-2588) (Little Chute Project). The Kimberly Project Water Quality Study Area (Study Area) is shown in Figure 1.

The Wisconsin DNR regularly collects water quality data on the Lower Fox River. The Licensee requested DO and temperature data specific to the Study Area on May 31, 2017, which were received on July 14, 2017. In total, data samples were taken at six Wisconsin DNR water quality sampling stations within the Study Area, four upstream of the Project and two downstream of the Project. Station locations are shown in Figure 2. Wisconsin DNR data included grab samples taken between 1975 and 2006.

The original intent, as outlined in the SP, was to pool the Wisconsin DNR data into two groups, 1) Project impoundment data and 2) Project tailwater data, in order to evaluate DO and temperature upstream and downstream of the Project. Upon receiving the data, however, it was determined that because of the age of samples (1975 – 2006)[1] and limited quantity of the data, the Wisconsin DNR data were not appropriate for evaluating current water quality conditions in the Lower Fox River in the Study Area, or for comparing the DO levels and temperatures above and below the Project to evaluate possible effects of Project operation on water quality.

As an alternative to the Wisconsin DNR data analysis, available water quality data at the Little Chute Project were considered as a possible surrogate for evaluating Project effects on water quality. The Little Chute Project (P-2588) is located immediately downstream of the Kimberly Project and is also owned and operated by the Licensee. The Kimberly Project tailwater discharges directly into the Little Chute Project headwaters with no free-flowing river between the two Projects. The Licensee conducted water quality studies for the Little Chute Project in

[1] The water quality in the Lower Fox River continues to improve with river cleanups and polychlorinated biphenyl (PCB) removal projects and water quality conditions have likely changed since 2006. It is also important to note that all Wisconsin DNR data were taken prior to the decommissioning and removal of the NewPage paper mill, which may have had an effect on water quality in the Study Area.

2001, 2006, 2011, and 2016. During these studies, continuous (hourly) DO and temperature data were collected at stations upstream and downstream of the Little Chute Project (Figure 3). The upstream station is located at the upper end of the Little Chute Project impoundment. This station is located along the right side of the river, approximately 0.1 mile downstream of the Kimberly Project powerhouse. The downstream Little Chute Project station is located approximately than 0.1 mile downstream of the Little Chute Project powerhouse. Available data were analyzed to compare the DO levels and temperatures above and below the Little Chute Project to evaluate possible effects of the Little Chute Project operation on water quality. Both Projects have similar characteristics, such as being located on relatively low head dams that create small riverine impoundments, are operated as run-of-river projects, are located at dams which are owned and operated by USACE, and have associated navigation canals. Because the Little Chute and Kimberly Projects are located in close proximity on the Lower Fox River (less than 1 mile apart) and the Kimberly tailwater forms the Little Chute headwater, a comparison of water quality conditions above and below the Little Chute Project to assess Project effects may be representative of water quality conditions upstream and downstream of the Kimberly Project. The Little Chute Project upstream data also represents the tailwater conditions of the Kimberly Project.

To evaluate the effect of hydroelectric generation on DO and temperature, the Little Chute Project daily average DO and temperature were computed from the hourly records (Kaukauna Electric & Water Department, 2001; Kaukauna Utilities, 2006, 2011, 2016). The daily average data for the available sample years (2001, 2006, 2011, 2016), were then pooled and the average, minimum, and maximum DO levels and temperature data at both the upstream and downstream sample locations were summarized. Project effects on water quality were evaluated by comparing the upstream and downstream data to determine if there were statistically significant differences (as determined by a *t*-test) between the DO level and temperature data above and below the Little Chute Project. Data and findings are summarized in this study report.

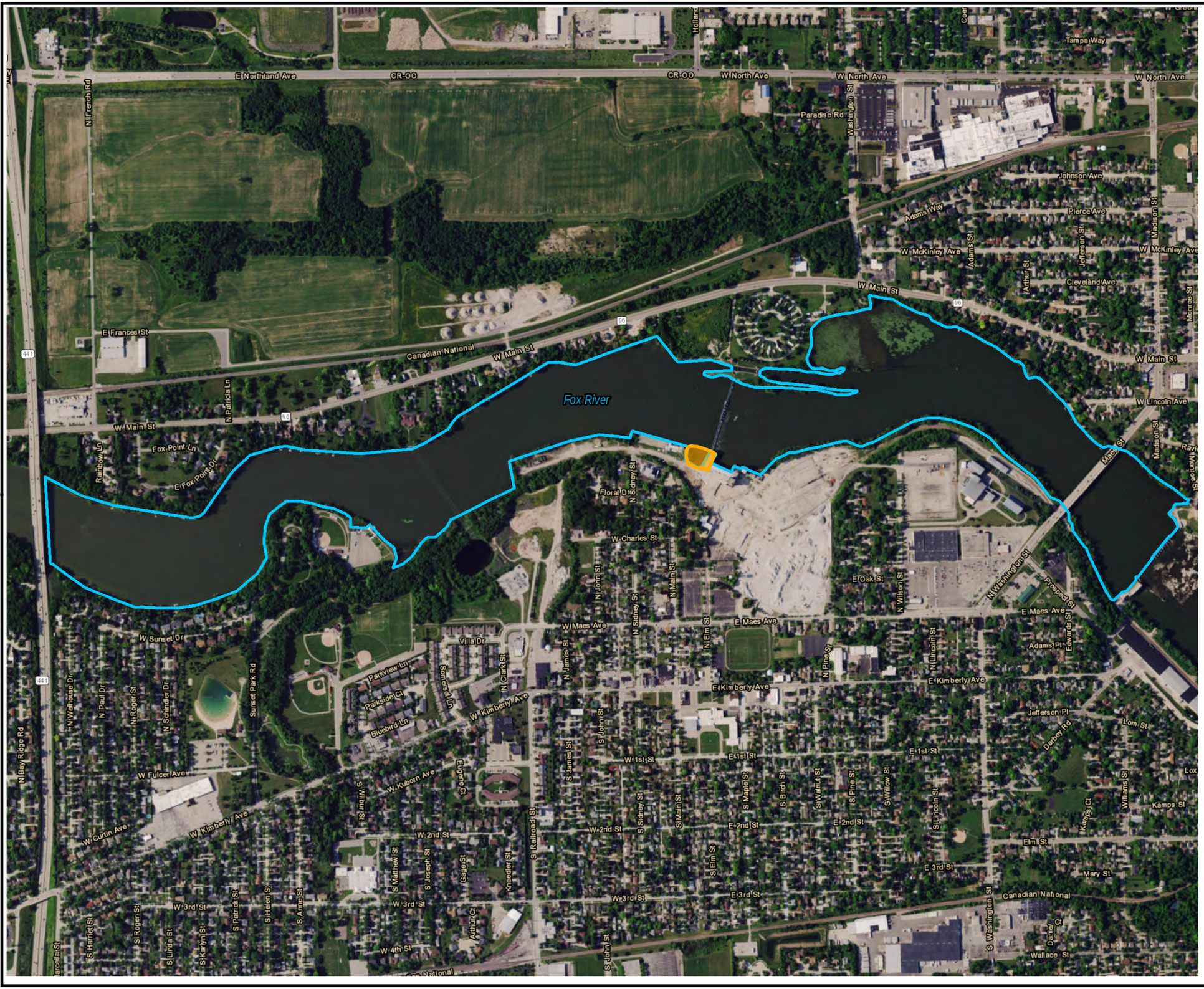
In addition, water quality data in the Kimberly Project tailwater (collected at the upstream station for the Little Chute Project) were compared with water quality standards for the Lower Fox River. Water quality standards consistent with the Clean Water Act (CWA) have been established by the Wisconsin State Legislature in Chapter 281 of the Wisconsin Statutes, explained in detail in NR 102, 103, 104, 105, and 207 of the Wisconsin Administrative Code. For DO and temperature, the standards for the Lower Fox River include a minimum DO concentration of 3 milligrams per liter (mg/L) and natural daily/seasonal temperature fluctuations maintained within the temperature ranges as outlined in the regulations.

2.3 Study Schedule

The data were gathered and evaluated between April and September, 2017. Study results were compiled and a draft study report was prepared in October, 2017. The agencies and interested

stakeholders will be provided a 30 day period to review and provide comments on the draft study report. A final study report will be completed in November, 2017.

Plot Date: 3/7/2017, 15:12:27 PM by DSWEENEY -- LAYOUT: ANSI B(11"x17")
Path: V:\PROJECTS\AUGUSTA\Kaukauna Utilities\235559 Kimberly Hydro PAD\Figure_1_Water_Qual_Study_Area.mxd
Coordinate System: NAD 1983 StatePlane Wisconsin Central FIPS 4802 Feet (Foot US)
Map Rotation: 0



LEGEND

- Approximate Project Boundary
- Water Quality Study Area

NOTES

1. BASE MAP ESRI WORLD IMAGERY

N

0 1,000 2,000 Feet

1 " = 817 '
1:9,800

PROJECT:

KIMBERLY HYDROELECTRIC PROJECT
KIMBERLY, OUTAGAMIE COUNTY, WISCONSIN

TITLE:

DESKTOP WATER QUALITY STUDY AREA

DRAWN BY:	SWEENEY D	PROJ NO.:	235559
CHECKED BY:			
APPROVED BY:		**FIGURE 1**	
DATE:	MARCH 2017		

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Madison, WI 53717
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FILE NO.: Figure_1_Water_Qual_Study_Area.mxd

3.0 RESULTS AND DISCUSSION

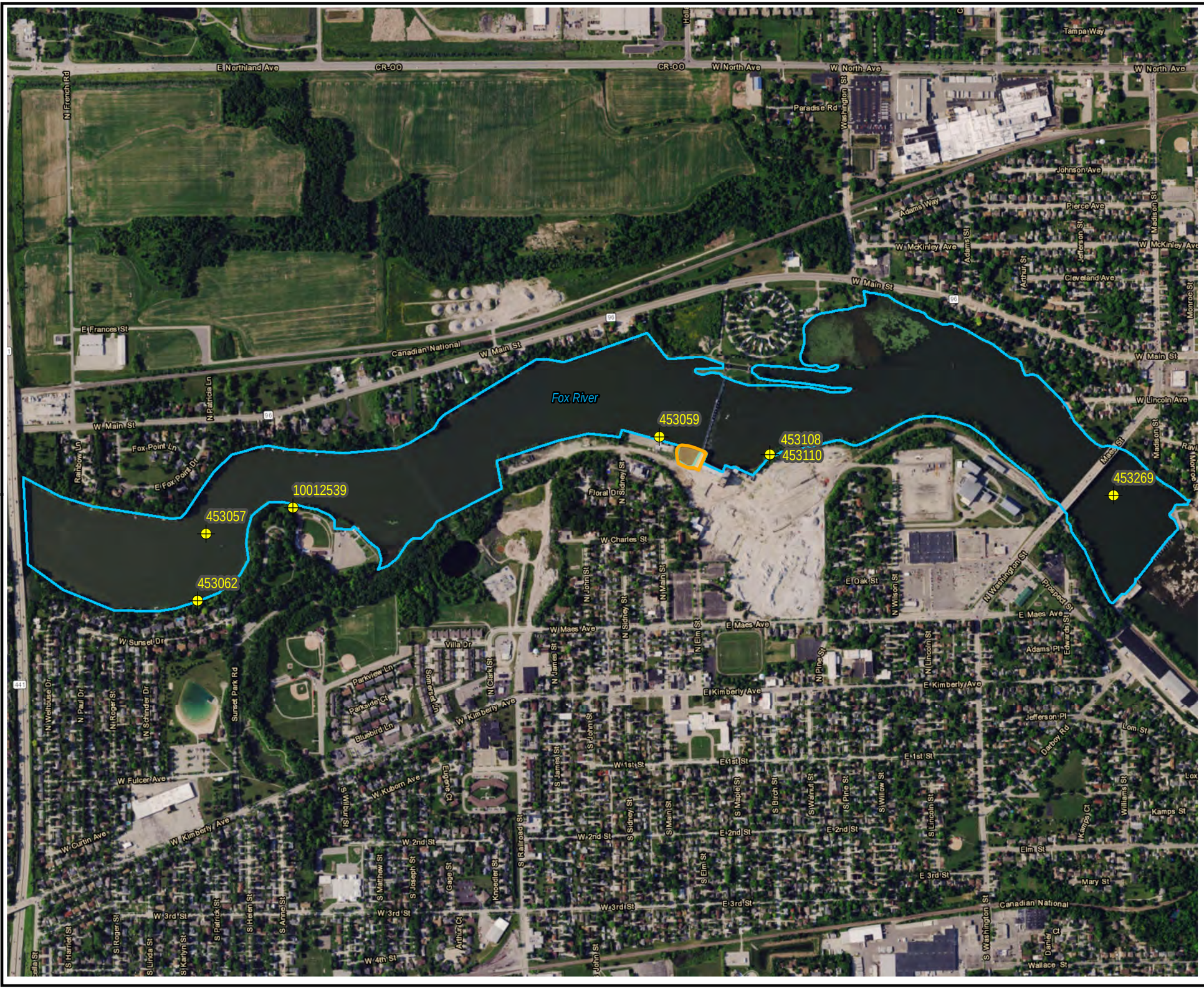
3.1 Review of Available Data

The available data in the Study Area included data from the Wisconsin DNR and data collected in compliance of the Little Chute Project (P-2588) Water Quality Monitoring Plan (WQMP) in the Little Chute Project upstream area (which is the Project tailwater).

The Wisconsin DNR provided water quality data in the Study Area. The data sample dates ranged from 1975 through 2006 and were taken across all seasons (January through December). Grab samples were taken occasionally, but not on a regular schedule. Data were never taken during the same date in both the Project impoundment and Project tailwater areas, thus meaningful statistical comparisons cannot be made of these data. During this time, a total of 70 field water quality samples (measurements taken on a single day at a single Station ID) for temperature and DO were collected: water temperature (°C) n = 43 and DO (mg/L) n = 27. If multiple measurements were taken on a single day at the same location (station ID), the average of those measurements was used to create a single sample. The Wisconsin DNR water quality sampling locations are displayed in Figure 2. The available data from Wisconsin DNR are provided in Appendix A.

At the Little Chute Project, water quality is monitored pursuant to Article 403 of the Little Chute Project License Order and the Order Approving WQMP issued August 24, 2000. In accordance with the approved WQMP, water temperature and DO are monitored upstream and downstream of the Little Chute Project for the period of June 15 through September 30 (monitoring season), and data are summarized in a report every five years. The Little Chute Project water quality monitoring locations are shown in Figure 3. The Little Chute Project is immediately downstream of the Kimberly Project, and the Kimberly Project tailwater immediately forms the Little Chute Project headwater with no free-flowing riverine section separating the two Projects. The Little Chute Project upstream station is located on the right side of the river at the upper end of the Little Chute Project impoundment. Because the Projects are located so close together on the Lower Fox River and share similar hydrologic, hydraulic, and operational characteristics, water quality data collected above and below the Little Chute Project are expected to be representative of water quality data for the Kimberly Project. The Little Chute Project upstream data represents the water quality of the Kimberly discharge based on the location and proximity of the two Projects.

Daily average DO and temperature data for the Little Chute Project stations for the 2001, 2006, 2011, and 2016 sample years are provided in Appendix B. The complete Little Chute Project water quality reports for 2001, 2006, 2011, and 2016 were filed with FERC and are provided in Appendix C. The water quality reports provide complete information of the Little Chute Project data including quality assurance data, statistics, compliance information, and a description of outages or erroneous data.



LEGEND

- Approximate Project Boundary
- Water Quality Study Area
- WDNR Data Sample Location

NOTES

1. BASE MAP ESRI WORLD IMAGERY

N

0 1,000 2,000 Feet

1 " = 800 '
1:9,600

PROJECT:
KIMBERLY HYDROELECTRIC PROJECT
KIMBERLY, OUTAGAMIE COUNTY, WISCONSIN

TITLE:
DESKTOP WATER QUALITY STUDY - SAMPLE LOCATIONS

DRAWN BY:	D KENWORTHY	PROJ NO.:	235559
CHECKED BY:	E KRCHNAVEK		
APPROVED BY:			**FIGURE 2**
DATE:	SEPTEMBER 2017		

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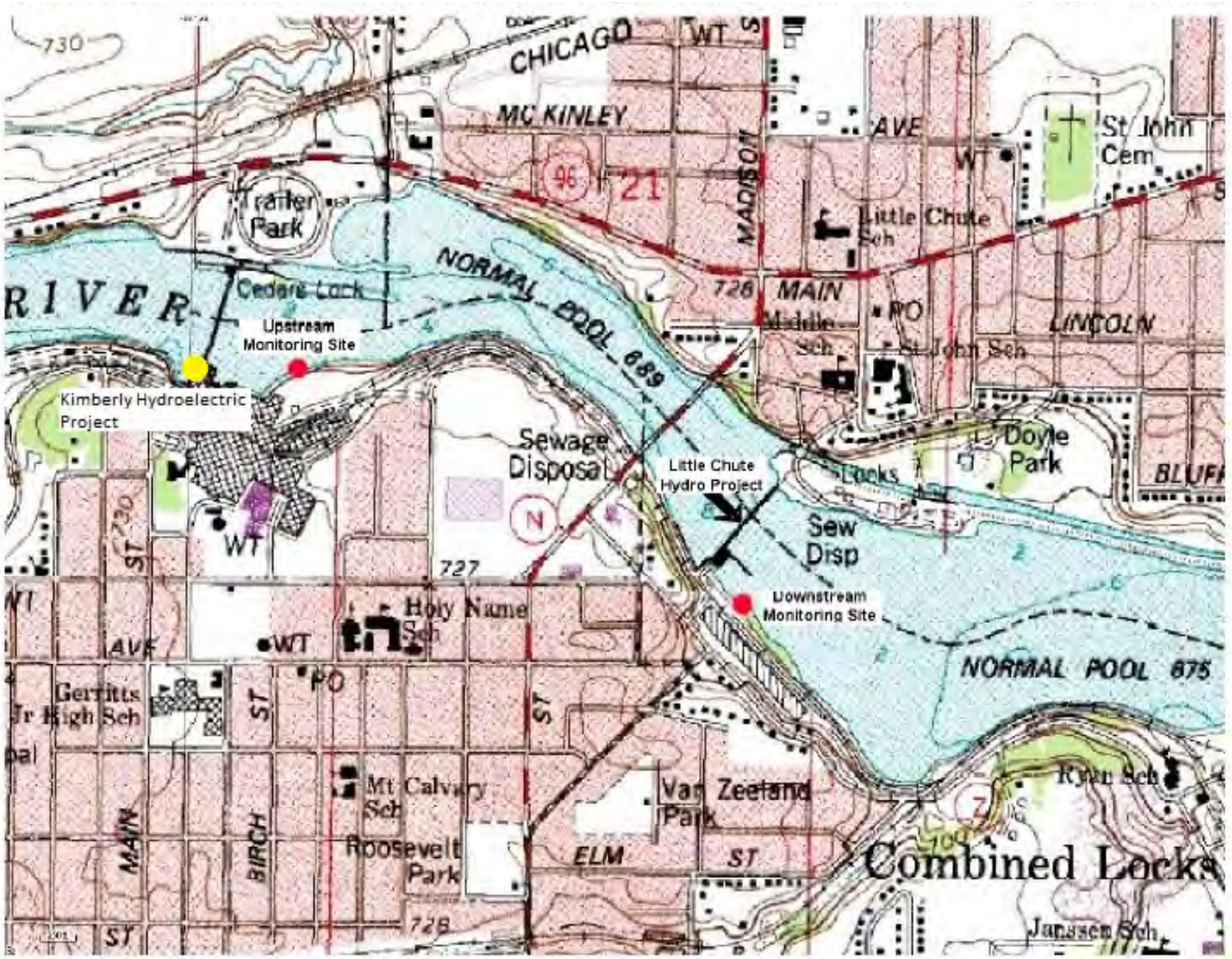
FILE NO.: Figure_2_Desktop_WaterQuality_Study_SampleLocations.mxd

Figure 3: Little Chute Hydroelectric Project (P-2588) Water Quality Monitoring Locations



3.2 DO and Temperature Conditions

3.2.1 Wisconsin DNR Data

Due to the limited quantity of samples, infrequency between data samples, and age of the samples (1975 – 2006)[2], the Wisconsin DNR data (Appendix A) provides limited insight into current water quality conditions in the Study Area. The minimum and maximum DO (mg/L) levels and temperature in degrees Celsius (°C) of the available Wisconsin DNR data in the Study Area (impoundment and tailwater) are summarized and shown in Table 1.

Table 1: Summary of Wisconsin DNR Data – Dissolved Oxygen and Temperature

Temperature and Dissolved Oxygen Summary of Wisconsin DNR Data in Study Area				
	Impoundment[1]		Tailwater	
	Temperature (°C)	DO (mg/L)	Temperature (°C)[2]	DO (mg/L)[3]
Minimum	-0.1	4	6.1	6.8
Maximum	26.5	14.5	33.5	9.2
Total n = Days Sampled, at Different Stations	25	25	18	2

Source: Wisconsin DNR, 2017

[1] The dates of the samples were between years 1975 and 2006. The samples were not taken on a regular interval, and the dates of the samples ranged between January 10 and December 20.

[2] The dates of the samples were between years 1979 and 2000. The samples were not taken on a regular interval, and the dates of the samples ranged between February 17 and September 17.

[3] The two sampling dates were August 21, 1979 and June 22, 2000.

3.2.2 Little Chute Project Data

The daily average, minimum, and maximum temperature (°C) and DO (mg/L) data for the two Little Chute Project stations (upstream and downstream) across the four study years (2001, 2006, 2011, 2016) are summarized in Table 2 and Table 3; a breakdown of these data by year are located in Appendix B, Table 7 and Table 8. The Little Chute Project upstream data were collected in the Project tailwater within the Study Area.

As shown in Table 2, during the Little Chute Project water quality monitoring season the average temperature upstream of the Little Chute Project was 23.8°C in the upstream area and 23.6°C in the downstream area. During the survey periods for the four survey years, the average temperature was not impacted by the operation of the Little Chute Project. As indicated in the

[2] The water quality in the Lower Fox River continues to improve with river cleanups and polychlorinated biphenyl (PCB) removal projects and water quality conditions have likely changed since 2006. It is also important to note that all Wisconsin DNR data were taken prior to the decommissioning and removal of the NewPage paper mill, which may have had an effect on water quality in the Study Area.

reports, there were dates when the river flow exceeded the Little Chute Project maximum generating flow of 4,000 cfs and water was released from the Tainter gates. This indicates that the USACE releases water throughout the summer in order to supplement river flow and may be one reason the water temperature does not appear to be impacted by operation. At the Kimberly Project, flows greater than 3,405 cfs exceed the hydraulic capacity of the Project and water is released from the Tainter gates. At the upstream Little Chute Project station, the maximum temperature recorded was 29.8°C and the minimum temperature recorded was 14.5°C. The temperature never exceeded the acute criteria of the current NR 102 water quality criteria for temperature for the Lower Fox River.

As shown in Table 3, during the Little Chute Project water quality monitoring season, the average DO of the Little Chute Project was 7.7 mg/L in the upstream area and 8.1 mg/L in the downstream area. At the upstream station, the maximum DO in the Project tailwater was 10.8 mg/L and the minimum DO was 3.2 mg/L. With erroneous data removed[3], the DO was not recorded to fall below 3 mg/L (the standard for minimum DO concentration for the Lower Fox River). Similar to the temperature readings, additional flow released upstream by the USACE to supplement the Lower Fox River flow during the summer boating months resulting in water being released through the Tainter gates may also assist in maintaining overall river DO levels.

Table 2: Little Chute Temperature Data Summary (2001, 2006, 2011, 2016)

Temperature at Little Chute Project				
	Upstream		Downstream	
	Temperature (°C)	Quantity of Samples	Temperature (°C)	Quantity of Samples
Minimum	14.5	n = 363	14.9	n = 311
Average[1]	23.8	n = 275	23.6	n = 275
Maximum	29.8	n = 363	29.9	n = 311

Sources: Kaukauna Electric & Water Department, 2001; Kaukauna Utilities, 2006, 2011, 2016

[1] The average temperature summarized are the average of data available at both the upstream and downstream locations on the same date.

[3] Erroneous data were not used during this evaluation. The most common reason for data to be considered erroneous was sedimentation or biofouling at the sonde. Complete explanations for erroneous data and outages are available in the water quality reports provided in Appendix C.

Table 3: Little Chute Dissolved Oxygen Data Summary (2001, 2006, 2011, 2016)

Dissolved Oxygen at Little Chute Project				
	Upstream		Downstream	
	DO (mg/L)[2]	Quantity of Samples	DO (mg/L)	Quantity of Samples
Minimum	3.2	n = 349	3.7	n = 311
Average[1]	7.7	n = 263	8.1	n = 263
Maximum	10.8	n = 349	12.4	n = 311

Sources: Kaukauna Electric & Water Department, 2001; Kaukauna Utilities, 2006, 2011, 2016

[1] The average DO summarized are the average of data available at both the upstream and downstream locations on the same date.

[2] Erroneous data were removed July 16 through 18, and July 28 through August 4, 2011. Significant sedimentation or biofouling observed at the upstream probe was interpreted to significantly reduce river water flow across the DO probe and led to atypical patterns of suppressed DO readings. Erroneous data from July 3 through July 5, 2016 were omitted from the final data set due to sedimentation and/or biofouling. Erroneous DO datum (upstream) for July 6, 2016 was changed to 7.40, as the upstream sonde was recalibrated and redeployed.

3.3 Assessment of Project Effects on Water Quality

The Little Chute Project temperature and DO data were evaluated to determine if there is a statistically significant difference in water quality above and below the USACE Little Chute dam (Little Chute dam).

To compare water quality parameters above and below the Little Chute Project, DO and temperature data[4] were pooled across all sample years (2001, 2006, 2011, 2016). A two-tailed *t*-test was used to determine if there were any statistically significant ($p \leq 0.05$) differences in water temperature or DO between the upstream and downstream Little Chute Project stations. The results are provided in Table 4. As shown, average DO concentrations upstream of the Little Chute Project are slightly lower (7.7 mg/L) than those downstream (8.1 mg/L). A *t*-test showed that this difference is statistically significant ($p = 0.002$). Average temperatures upstream of the dam and downstream of the dam are very similar, and *t*-test results indicate that there is no statistically significant difference between upstream and downstream temperature ($p = 0.372$). These results make sense, since water being spilled from the Tainter gates and moving through navigational canals, would be expected to aerate the water and increase DO to some degree, but have no noticeable effect on water temperature.

The USACE operates the Lower Fox River such that there is sufficient flow in the river to support boating during the boating season. Lake Winnebago is operated by the USACE as a seasonal storage reservoir. Water is released upstream from Lake Winnebago to supplement the

[4] Erroneous data were not used during this evaluation. The most common reason for data to be considered erroneous was sedimentation or biofouling at the sonde. Complete explanations for erroneous data and outages are available in the water quality reports provided in Appendix C.

Lower Fox River flow throughout the summer, generally late June through early September. Flow releases continue through October and November, reducing the Lake Winnebago elevation in order to take advantage of water run-off from winter snow and spring rain. This flow supplement will increase river flow and potentially lower temperature and increase DO. Both the Kimberly and Little Chute Projects are operated as run-of-river projects, and the instances when the river flow was greater than the maximum hydroelectric plant generation flow indicates that the excess is spilled through Tainter gates, which can tend to increase aeration. Further, there are no longer industrial discharges into the river between the Kimberly and Little Chute Projects so the temperature and DO are not influenced by industrial discharges.

Table 4: DO and Temperature Data Comparison and *t*-Test Results for Upstream and Downstream of the Little Chute Project

Comparison of Upstream and Downstream Data - Little Chute Project		
	DO (mg/L)	**Temperature (°C)**
All Years		
Upstream Mean (Average)	7.7	23.8
Downstream Mean (Average)	8.1	23.6
Upstream Standard Deviation	1.3	3.1
Downstream Standard Deviation	1.5	3.0
***t*-Statistic**	-3.062	0.894
p (T<=t) two-tail	0.002	0.372
Count (n)	263	275

4.0 CONCLUSIONS

The Wisconsin DNR data provided limited useable information due to the irregular sampling dates, limited quantity of samples, and age of the data. The water quality in the Lower Fox River continues to improve with river cleanups and PCB removal projects. In the Study Area, the Wisconsin DNR data were taken prior to the decommissioning and removal of the NewPage paper mill, which likely had an effect on DO and/or temperature in the Study Area. Overall, water quality conditions have changed significantly since the 1980s and have likely continued to improve even since 2006.

Water quality data collected at the Little Chute Project provide a means to assess water quality in the Project vicinity. The upstream sampling station for the Little Chute Project is located in the Kimberly Project tailwater and is representative of tailwater conditions. A comparison of DO and temperature data upstream and downstream of the Little Chute dam allows us to assess possible Little Chute Project effects on DO and temperature. The Little Chute Project data provide a reasonable surrogate for the Kimberly Project, as effects on DO and temperature are expected to be similar based on the similar physical and operational characteristics of the two Projects. Both Projects are located on relatively low head dams that create small riverine impoundments, are operated as run-of-river projects, and are located at dams which are owned and operated by USACE. The USACE supplements the Lower Fox River flow with flow releases from Lake Winnebago. These flow releases increase the river flow and likely have an effect on downstream temperature and DO.

Comparison of water temperature data upstream and downstream of the Little Chute Project demonstrated similar average water temperature conditions upstream and downstream of the Little Chute dam. Comparison of DO conditions demonstrated that there is slight improvement in average DO conditions downstream of the Little Chute dam. A statistical comparison (*t*-test) of the Little Chute Project data confirmed that there is no difference between upstream and downstream water temperature, while the small increase in DO observed upstream to downstream was found to be statistically significant. Similar results at the Kimberly Project would be expected.

The Little Chute Project data were also compared with water quality standards for the Lower Fox River. With erroneous data removed, the DO levels at the Little Chute Project (including in the Project tailwater) did not fall below 3 mg/L, and therefore met the current Wisconsin state water quality standard for the Lower Fox River. The temperature never exceeded the acute criteria of the current NR 102 allowable WQ parameters for the Lower Fox River. Water quality data collected at the station upstream of the Little Chute Project are representative of Kimberly tailwater conditions because the data sonde was located in the Kimberly tailwater and there is no riverine stretch between the two Projects. Data from the Little Chute Project upstream station

indicate that the discharge from the Kimberly Project is in compliance with Wisconsin state water quality parameters related to acute temperature criteria and DO.

Based on the results of this study, it is concluded that the continued operation of the Kimberly Project will have no adverse effect on Lower Fox River water temperature or DO.

5.0 REFERENCES

Kaukauna Electric & Water Department (prepared by Mead & Hunt). 2001, December. Water Quality Monitoring Report Little Chute Hydroelectric Project FERC No. 2588.

Kaukauna Utilities (prepared by White Water Associates, Inc.). 2006, November 15. Water Quality Monitoring Report Little Chute Hydroelectric Project FERC No. 2588.

Kaukauna Utilities (prepared by GEI Consultants, Inc.). 2011, October 21. Water Quality Monitoring Report Little Chute Hydroelectric Project FERC No. 2588-007.

Kaukauna Utilities (prepared by GEI Consultants, Inc.). 2016, December 21. Water Quality Monitoring Report Little Chute Hydroelectric Project FERC No. 2588-007.

Wisconsin Department of Natural Resources (Wisconsin DNR). 2017. Surface Water Integrated Monitoring System (SWIMS). Water quality data received 7/14/2017 from Matt Rehwald (Wisconsin DNR).

Wisconsin State Legislature. 2010. Chapter NR 102, Water Quality Standards for Wisconsin Surface Waters. Register November 2010 No. 659. Available online: https://docs.legis.wisconsin.gov/code/admin_code/nr/100/102

APPENDIX A

Wisconsin DNR Water Quality Tables

Table 5: Temperature (°C) Wisconsin DNR Available Data in Study Area

Temperature (°Celsius) Available data from Wisconsin DNR in Study Area			
Study Area Location	**Fieldwork Date**[1]	**Station ID**	**Result (°C)**
Impoundment			
Impoundment	7/27/1975	453059	25.0
Impoundment	8/31/1976	453057	21.0
Impoundment	8/31/1976	453059	20.8
Impoundment	8/31/1976	453062	22.0
Impoundment	8/30/1978	453059	24.0
Impoundment	9/24/1979	453059	17.0
Impoundment	9/25/1979	453059	17.0
Impoundment	8/29/1988	453059	20.0
Impoundment	8/21/2001	10012539	22.7
Impoundment	9/19/2001	10012539	17.8
Impoundment	7/26/2005	10012539	25.2
Impoundment	8/23/2005	10012539	22.7
Impoundment	9/21/2005	10012539	21.5
Impoundment	10/11/2005	10012539	12.8
Impoundment	11/8/2005	10012539	8.5
Impoundment	12/20/2005	10012539	-0.1
Impoundment	1/10/2006	10012539	0.5
Impoundment	2/7/2006	10012539	1.1
Impoundment	3/14/2006	10012539	2.7
Impoundment	4/4/2006	10012539	4.7
Impoundment	5/2/2006	10012539	12.3
Impoundment	6/6/2006	10012539	22.3
Impoundment	9/5/2006	10012539	21.7
Impoundment	7/18/2006	10012539	26.5
Impoundment	8/8/2006	10012539	24.9
Tailwater[2]			
Tailwater	8/20/1979*	453108	28.5
Tailwater	8/21/1979*	453108	30.05
Tailwater	8/21/1979*	453110	26.75
Tailwater	9/6/1979*	453108	33.5
Tailwater	9/17/1980*	453110	21.15
Tailwater	2/17/1981*	453108	23.9
Tailwater	2/18/1981	453108	22.2
Tailwater	2/19/1981*	453110	6.5

Tailwater	2/22/1982*	453108	24.45
Tailwater	2/23/1982*	453110	6.1
Tailwater	2/22/1983	453108	26.1
Tailwater	2/23/1983*	453110	7.0
Tailwater	4/17/1984*	453108	26.25
Tailwater	4/18/1984*	453110	12.9
Tailwater	3/27/1985*	453108	26.1
Tailwater	3/28/1985*	453110	8.3
Tailwater	6/22/2000	453269	21.2
Tailwater	7/24/2000	453269	22.2

Source: Wisconsin DNR, 2017

[1] The fieldwork date was obtained using the "Start Date/Time" column (column AF) of the SWIMS data provided by Wisconsin DNR 7/14/2017.

[2] Some temperature data in the Project tailwater area appear to potentially be misleading of the actual current water quality in the Project tailwater. Large differences between temperatures on specific dates were shown in the data. For example, on 2/22/1982, 2/22/1983, and 3/27/1985, the temperatures were measured to be above 20°C, but on the subsequent date for each of those measurements, the temperature was below 10°C. A possible rationale for these large differences could be due to the industrial nature of those sampling locations, which were at the NewPage paper mill (which has since stopped operations and has been demolished).

* Dates marked with an asterisk (*) had multiple samples taken on the same day at the same station location. If multiple measurements were taken at a single station on a single day, the average of those measurements is displayed.

Table 6: Dissolved Oxygen (mg/L) Wisconsin DNR Available Data in Study Area

Dissolved Oxygen (mg/L) Available data from Wisconsin DNR in Study Area			
Study Area Location	**Fieldwork Date**[1]	**Station ID**	**Result (mg/L)**
Impoundment			
Impoundment	7/27/1975	453059	8.0
Impoundment	8/31/1976	453057	7.3
Impoundment	8/31/1976	453059	4.0
Impoundment	8/31/1976	453062	6.0
Impoundment	8/30/1978	453059	9.4
Impoundment	9/24/1979	453059	9.9
Impoundment	9/25/1979	453059	8.2
Impoundment	8/29/1988	453059	9.2
Impoundment	8/21/2001	10012539	8.5
Impoundment	9/19/2001	10012539	8.1
Impoundment	7/26/2005	10012539	6.8
Impoundment	8/23/2005	10012539	7.5
Impoundment	9/21/2005	10012539	8.3
Impoundment	10/11/2005	10012539	7.9
Impoundment	11/8/2005	10012539	10.2
Impoundment	12/20/2005	10012539	14.5
Impoundment	1/10/2006	10012539	12.8
Impoundment	2/7/2006	10012539	14.0
Impoundment	3/14/2006	10012539	12.7
Impoundment	4/4/2006	10012539	12.9
Impoundment	5/2/2006	10012539	9.1
Impoundment	6/6/2006	10012539	6.0
Impoundment	9/5/2006	10012539	9.5
Impoundment	7/18/2006	10012539	5.4
Impoundment	8/8/2006	10012539	7.0
Tailwater			
Tailwater	8/21/1979	453108	6.8
Tailwater	6/22/2000	453269	9.2

Source: Wisconsin DNR, 2017

[1] The fieldwork date was obtained using the "Start Date/Time" column (column AF) of the SWIMS data provided by Wisconsin DNR 7/14/2017.

APPENDIX B

Little Chute Hydroelectric Project (P-2588) Water Quality Data Tables

Table 7: Little Chute Project Temperature Data by Year

Temperature (°C) at Little Chute Project, All Data								
	Upstream				Downstream			
	2001[1]	2006	2011	2016	2001[1]	2006	2011	2016
Minimum	14.51	15.29	14.98	16.82	20.09	15.99	14.92	16.83
Average	22.94	23.94	22.88	23.64	24.35	23.92	22.78	23.83
Maximum	29.80	29.21	27.81	27.23	29.89	28.44	27.89	27.77
Standard Deviation	3.35	3.46	3.59	2.20	2.31	2.85	4.37	2.28
Number of Sample Dates	64	108	94	97	60	95	55	101

Sources: Kaukauna Electric & Water Department, 2001; Kaukauna Utilities, 2006, 2011, 2016

[1] In 2001, temperature data were measured in Fahrenheit (°F), and have been converted to Celsius (°C) for the purpose of consistency throughout the Project SP report.

Table 8: Little Chute Project Dissolved Oxygen Data by Year

Dissolved Oxygen (mg/L) at Little Chute Project, All Data								
	Upstream				Downstream			
	2001	2006	2011[1]	2016[2]	2001	2006	2011	2016
Minimum	6.81	5.34	3.24	5.19	6.00	5.40	3.68	5.42
Average	8.21	8.12	7.21	7.21	8.22	8.68	7.33	7.45
Maximum	9.85	10.80	10.82	9.25	10.51	12.42	10.53	9.42
Standard Deviation	0.71	1.27	1.85	0.75	0.92	1.68	1.88	0.79
Number of Sample Dates	64	108	83	94	60	95	55	101

Sources: Kaukauna Electric & Water Department, 2001; Kaukauna Utilities, 2006, 2011, 2016

[1] Erroneous data were removed July 16 through 18, and July 28 through August 4. As described in Kaukauna Utilities, 2011, significant sedimentation or biofouling observed at the upstream probe was interpreted to significantly reduce river water flow across the DO probe and led to atypical patterns of suppressed DO readings.

[2] Erroneous data from July 2 through July 5 were omitted from the final data set due to sedimentation and/or biofouling. Erroneous DO datum (upstream) for July 6 was changed to 7.40, as the upstream sonde was recalibrated and redeployed.

APPENDIX C

Little Chute Hydroelectric Project (P-2588)
Water Quality Monitoring Reports 2001, 2006, 2011, 2016

MEAD & HUNT
ENGINEERS
ARCHITECTS
SCIENTISTS
PLANNERS
Providing responsive and innovative service since 1900

December 28, 2001

ORIGINAL

David Boergers
Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Subject: Article 403
Order Approving Water Quality Monitoring Plan (Issued August 24, 2000)
Little Chute Hydroelectric Project; FERC No. 2588
Kaukauna, WI

014

Dear Mr. Boergers:

On behalf of the City of Kaukauna Electric & Water Department, we are hereby filing an original and eight (8) copies of the Water Quality Report for 2001 in compliance with Article 403 and the Order Approving Water Quality Monitoring Plan issued on August 24, 2000.

We have also submitted a copy of the report to the Wisconsin Department of Natural Resources as required by the Order Approving Water Quality Monitoring Plan.

Thank you for your time and attention to this matter. If you have any questions, please contact me.

Sincerely,

MEAD & HUNT, Inc.

Dennis M. Geary

Dennis M. Geary
Senior Project Scientist

Enclosures

cc: Mr. Peter D. Prast, Kaukauna Electric and Water Department

090108.0135.3

Mead & Hunt Inc. 6501 Watts Road Madison Wisconsin 53719-2700
608 273 6380 fax: 608 273 6391 email: madison@meadhunt.com www.meadhunt.com

K_14A097/K14-01A

ORIGINAL

ORIGINAL

Water Quality Report
Little Chute Hydroelectric Project
FERC Project No. 2588

Prepared for:

Kaukauna Electric & Water Department
Kaukauna, Wisconsin

Prepared by:

MEAD & HUNT
ENGINEERS
ARCHITECTS
SCIENTISTS
PLANNERS

December 2001

Table of Contents

Appendix

Water Quality Report
Little Chute Hydroelectric Project
FERC Project No. 2588

1. Project Information

Article 403 of the City of Kaukauna's current license for the Little Chute Project (FERC No. 2588) requires the City to file a water quality plan. The City filed the plan on August 14, 2000, and FERC issued an Order Approving Water Quality Plan on August 24, 2000. The order calls for the licensee to monitor dissolved oxygen (DO) and temperature upstream and downstream of the project for the period from June 15 through September 30 for the first year (2001) and then once every five years for the duration of the license. The order further states that the water quality probes (Hydrolab Datasondes) will not be deployed unless flows in the Fox River are below 4,000 cubic feet per second (cfs).

In 2001, flows in the Fox River at the Little Chute Project exceeded 4,000 cfs throughout the month of June and into the first week o f July. Consequently the downstream probe was not installed until July 3. A lack of access to the proposed upstream monitoring location delayed installation of the upstream probe until July 24.

What follows in this report is a presentation of motoring data, statistics, water quality compliance information, quality assurance data, and a description of any problems or malfunctions as required by the Order Approving Water Quality Plan.

2. Data

Graphs comparing the hourly upstream and downstream dissolved oxygen and temperature readings are provided in Appendix A and the corresponding raw data is provided on disk in Excel format in Appendix B.

For both upstream and downstream temperature and dissolved oxygen data, the daily means were calculated and compared. The mean and standard deviation of the difference between the daily means for the upstream and downstream readings were calculated. For the temperature comparison, the mean of difference in the daily averages was -0.30 °F (the negative sign denotes that the downstream temperature was lower than the upstream temperature) with a standard deviation of ±0.43 °F. The mean of the difference in the average daily dissolved oxygen concentration was -0.40 mg/l (the negative sign denotes that the downstream dissolved oxygen concentration was lower than the upstream dissolved oxygen concentration) and the standard deviation was ±0.95 mg/l. A comparison of the daily means for temperature and dissolved oxygen concentration are provided in Appendix C.

The dissolved oxygen daily averages of the upstream and downstream data were compared, when both data sets were available, and at no time did they vary by greater than 2 mg/l for five or more consecutive days. The difference between daily means for dissolved oxygen only exceeded 2 mg/l on August 6th and this daily mean was based only on 8 hours of data rather than 24 hours of data due to data loss. The daily means for both dissolved oxygen and temperature are shown in Appendix C.

3. Quality Assurance

The upstream and downstream monitors were calibrated every two weeks at which time the data was also checked. The pre-calibration and post-calibration dissolved oxygen values were compared and never differed by greater than 0.8 mg/l. Calibration summaries for the upstream and downstream monitors are provided in Appendix D.

4. Complications in Monitoring During Study Period

A. Upstream Data

Data was lost on three occasions which are detailed below:

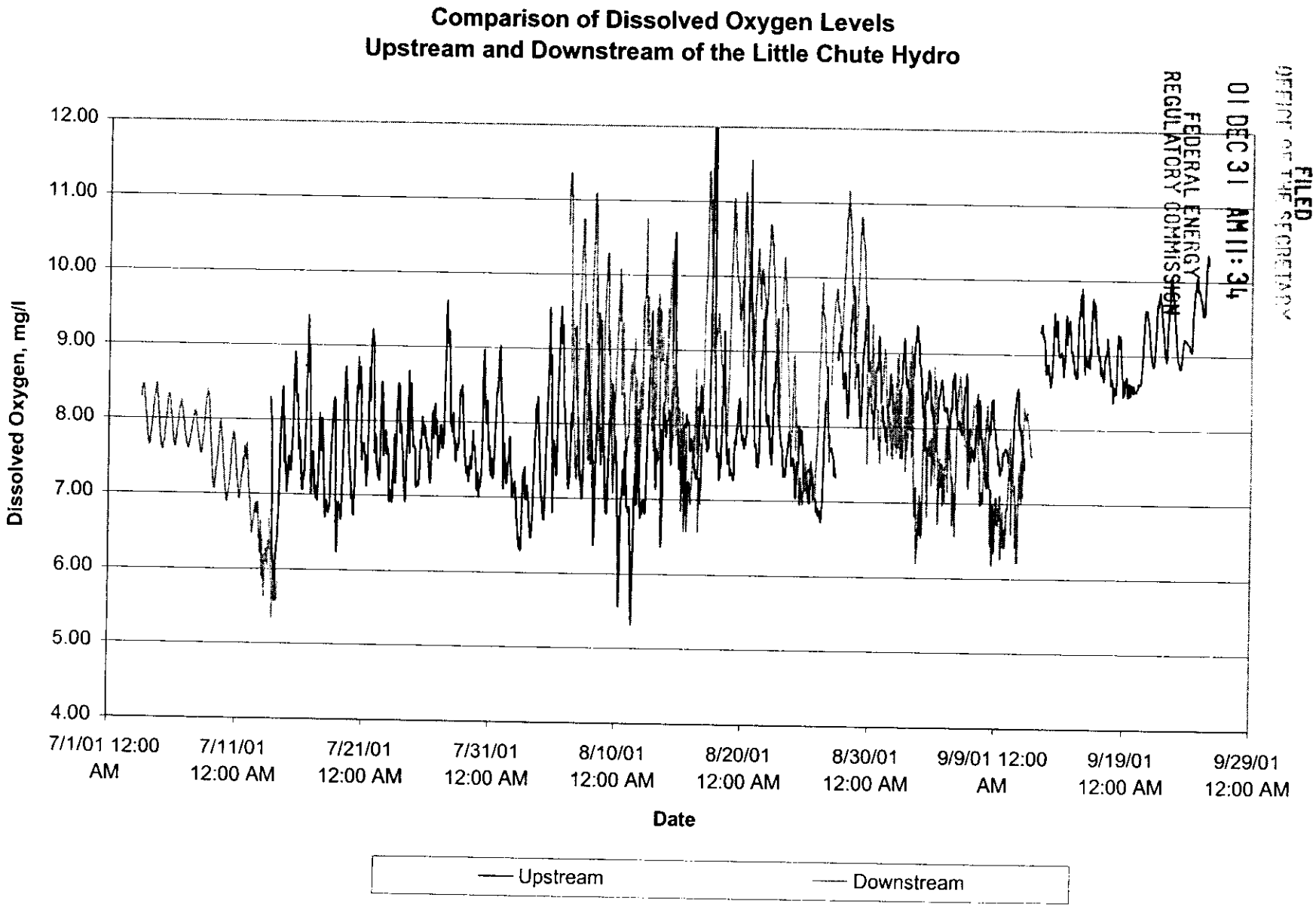
7/3/01 to 7/13/01	We were unable to access an appropriate deployment site on July 3rd, 2001, when we deployed the downstream monitor. We were able to gain access on July 13th, 2001, when we calibrated the downstream monitor.
9/11/01 to 9/12/01	When the meters were calibrated on August 27th, 2001, the sample time was accidently set for every ten minutes instead of every hour. This caused the monitor's voltage to decrease faster than normal and by September 11th, 2001, the battery voltage was too low for the monitor to sample.
9/25/01 to 9/30/01	The monitor's memory was full, therefore no additional data could be stored.

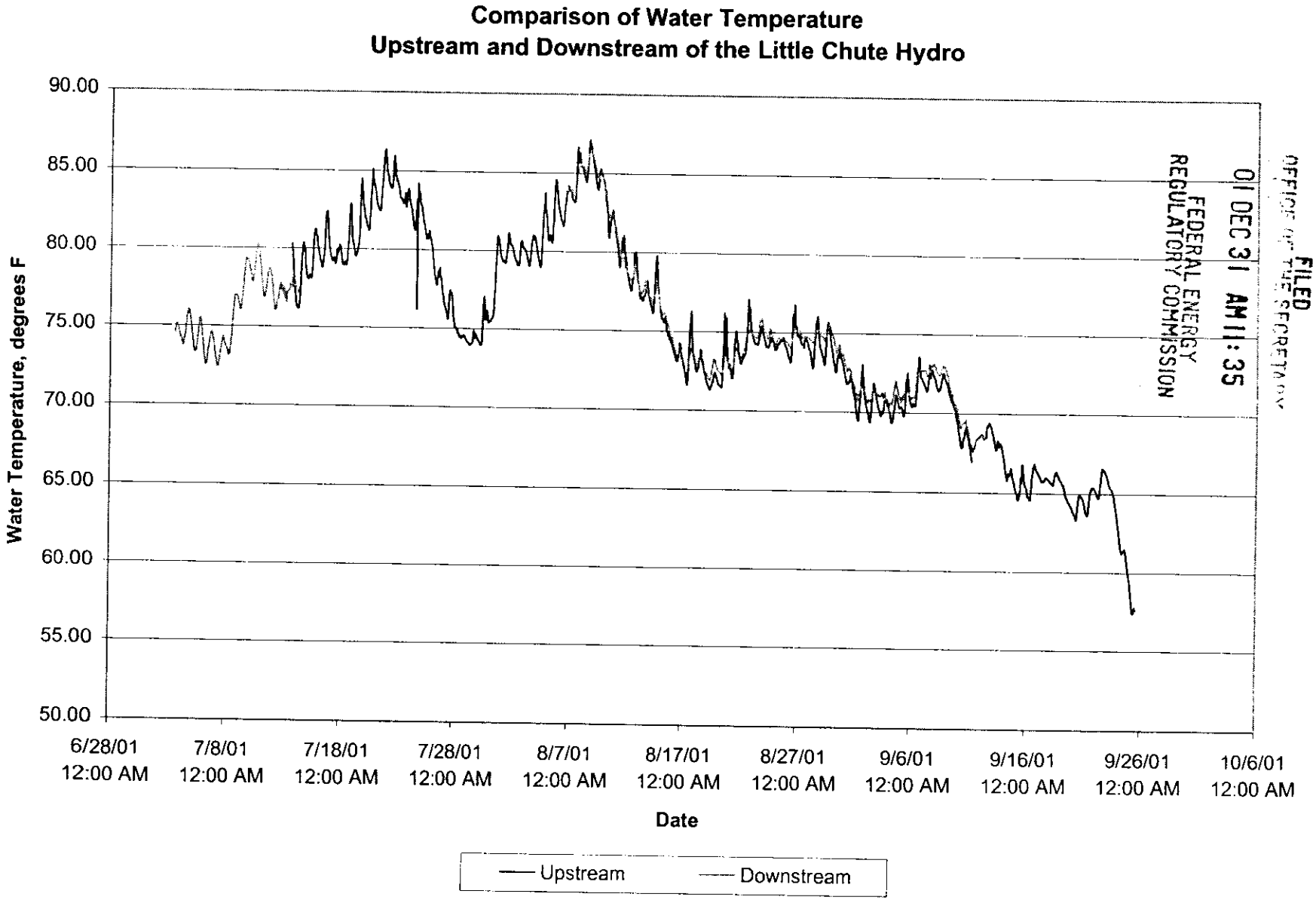
B. Downstream Data

Data was lost on three occasions which are detailed below:

7/14/01 to 7/24/01	When we arrived to calibrate the monitor on July 24th, 2001, the monitor was found along the shore with the probes exposed to the air. Given the weight of the casing that holds the monitor, the monitor had to be physically moved by someone. In reviewing the data, the monitor appears to have been removed from its deployment location on the morning of July 14th, 2001.
7/24/01 to 8/6/01	The monitor's battery pack malfunctioned, and therefore, data was lost until the next calibration on August 6th, 2001.
9/12/01 to 9/30/01	The monitor's memory was full, therefore no additional data could be stored. We were unable to obtain communication between the monitor and the computer during the September 12th, 2001 calibration. The spare meter had already been deployed that day at the upstream location, therefore there was no spare meter to use at the downstream location. Thus, the downstream meter was re-deployed without calibration or checking the data.

Appendix A. Graphs of Upstream and Downstream Hourly Temperature and Dissolved Oxygen Readings





Appendix B. Raw Data

Appendix C. Daily Means for Dissolved Oxygen and Temperature

Daily Means of the Upstream and Downstream Temperature and Dissolved Oxygen Data

Date	Upstream Data Daily Means Temperature °F	Upstream Data Daily Means DO mg/l	Downstream Data Daily Means Temperature °F	Downstream Data Daily Means DO mg/l	Difference in Daily Means Temperature °F	Difference in Daily Means DO mg/l
03-Jul-01			74.84	8.29		
04-Jul-01			74.88	8.03		
05-Jul-01			74.32	7.94		
06-Jul-01			73.62	7.93		
07-Jul-01			73.38	7.85		
08-Jul-01			75.08	7.91		
09-Jul-01			77.80	7.49		
10-Jul-01			78.99	7.35		
11-Jul-01			77.86	7.28		
12-Jul-01			76.99	6.62		
13-Jul-01	78.42	6.90	77.43	6.00	0.99	0.90
14-Jul-01			76.98	6.75		
15-Jul-01			77.33	8.37		
16-Jul-01			77.23	8.05		
17-Jul-01			75.86	8.38		
18-Jul-01			76.01	8.46		
19-Jul-01			79.53	7.88		
20-Jul-01			79.73	8.21		
21-Jul-01			83.01	7.89		
22-Jul-01			83.73	7.80		
23-Jul-01			81.77	7.57		
24-Jul-01			79.51	7.86		
25-Jul-01	80.84	7.59				
26-Jul-01	78.04	7.71				
27-Jul-01	76.26	8.41				
28-Jul-01	74.56	7.92				
29-Jul-01	74.26	7.44				
30-Jul-01	75.27	7.83				
31-Jul-01	78.25	8.03				
01-Aug-01	80.00	7.35				
02-Aug-01	79.79	6.85				
03-Aug-01	80.10	7.35				
04-Aug-01	80.96	7.75				
05-Aug-01	82.38	8.39				
06-Aug-01	82.95	8.05	83.87	10.51	-0.92	-2.46
07-Aug-01	84.75	8.08	84.63	9.06	0.12	-0.97
08-Aug-01	85.64	8.06	85.80	9.14	-0.16	-1.08
09-Aug-01	84.66	7.71	84.89	8.70	-0.23	-0.99
10-Aug-01	82.01	6.92	82.34	8.70	-0.33	-1.78
11-Aug-01	79.89	6.81	79.78	8.27	0.11	-1.46
12-Aug-01	78.56	7.92	78.51	8.89	0.05	-0.97
13-Aug-01	77.35	7.66	77.58	8.76	-0.24	-1.10
14-Aug-01	77.43	8.55	77.24	8.96	0.19	-0.41
15-Aug-01	75.17	7.85	75.60	7.76	-0.44	0.09
16-Aug-01	73.54	7.81	73.72	7.52	-0.18	0.30
17-Aug-01	73.43	9.05	73.09	9.30	0.34	-0.25
18-Aug-01	72.81	7.89	73.02	8.96	-0.21	-1.07
19-Aug-01	71.80	7.79	72.54	9.45	-0.74	-1.66
20-Aug-01	73.13	8.70	72.85	10.04	0.28	-1.35

Daily Means of the Upstream and Downstream Temperature and Dissolved Oxygen Data

Date	Upstream Data Daily Means Temperature °F	Upstream Data Daily Means DO mg/l	Downstream Data Daily Means Temperature °F	Downstream Data Daily Means DO mg/l	Difference in Daily Means Temperature °F	Difference in Daily Means DO mg/l
21-Aug-01	73.38	8.36	73.24	9.65	0.13	-1.29
22-Aug-01	74.62	8.27	74.47	10.04	0.16	-1.77
23-Aug-01	74.65	7.62	75.15	9.11	-0.51	-1.49
24-Aug-01	74.27	7.53	74.76	8.18	-0.49	-0.65
25-Aug-01	74.28	7.15	74.49	7.25	-0.21	-0.10
26-Aug-01	74.62	7.61	74.69	8.40	-0.07	-0.79
27-Aug-01	74.43	8.37	74.82	8.90	-0.39	-0.53
28-Aug-01	74.27	9.00	74.86	10.13	-0.60	-1.13
29-Aug-01	74.24	8.86	74.99	9.87	-0.75	-1.02
30-Aug-01	73.23	8.54	74.05	8.78	-0.82	-0.25
31-Aug-01	71.87	8.21	72.49	8.32	-0.62	-0.11
01-Sep-01	70.87	8.52	71.28	8.06	-0.41	0.46
02-Sep-01	70.54	8.81	70.99	8.03	-0.44	0.77
03-Sep-01	70.29	8.41	70.98	7.09	-0.69	1.32
04-Sep-01	70.20	8.24	71.08	7.75	-0.89	0.49
05-Sep-01	70.83	8.29	71.13	7.52	-0.30	0.77
06-Sep-01	71.65	8.10	72.06	7.86	-0.42	0.24
07-Sep-01	72.12	7.92	72.73	7.87	-0.61	0.05
08-Sep-01	71.91	7.82	72.68	7.55	-0.77	0.28
09-Sep-01	70.60	7.61	71.11	6.75	-0.51	0.86
10-Sep-01	68.46	7.96	69.25	7.08	-0.79	0.87
11-Sep-01	67.44	7.71	68.17	7.46	-0.73	0.26
12-Sep-01	69.12	9.09	68.56	7.81	0.55	1.28
13-Sep-01	68.00	9.03				
14-Sep-01	66.16	9.12				
15-Sep-01	65.43	9.18				
16-Sep-01	65.75	9.23				
17-Sep-01	65.90	8.86				
18-Sep-01	65.91	8.78				
19-Sep-01	64.84	8.56				
20-Sep-01	64.22	9.11				
21-Sep-01	64.61	9.34				
22-Sep-01	65.69	9.48				
23-Sep-01	64.92	9.06				
24-Sep-01	61.34	9.58				
25-Sep-01	58.11	9.85				
				Mean:	-0.30	-0.40
				Standard Deviation:	0.43	0.95

Appendix D. Calibration Summaries

Summary of Calibration for Upstream DataSonde3

Date	Pre-Calibration Dissolved Oxygen % saturation	Pre-Calibration Dissolved Oxygen mg/l	Post-Calibration Dissolved Oxygen % saturation	Post-Calibration Dissolved Oxygen mg/l	Bar. Pres. mmHg	Notes
07/13/01	NA	NA	NA	NA		
07/24/01	109.8	7.95	99.9	7.23	760.0	
08/06/01	98.3	6.77	100.0	6.97	765.6	
08/27/01	NA	NA	NA	NA	760.5	Original u/s DataSonde was swapped out with spare DataSonde because I was unable to detach the original DataSonde from the Battery Pack which is necessary in order to calibrate the meter. When I went to calibrate the original meter in the lab, I found a bubble under the DO membrane so I did not perform a final calibration.
09/07/01	89.6	7.77	99.9	8.54	754.6	DO Membrane was replaced and allowed to soak for several days, then the meter was calibrated.
08/27/01	---	---	100.0	6.97	760.5	Spare DataSonde
09/12/01	103.0	8.73	100.0	8.60	764.8	Spare DataSonde was replaced with original DataSonde
09/12/01	---	---	99.9	9.41	764.8	Spare DataSonde was replaced with original DataSonde

Summary of Calibration for Downstream DataSonde3

Date	Pre-Calibration Dissolved Oxygen % saturation	Pre-Calibration Dissolved Oxygen mg/l	Post-Calibration Dissolved Oxygen % saturation	Post-Calibration Dissolved Oxygen mg/l	Bar. Pres. mmHg	Notes
07/03/01	NA	NA	NA	NA		
07/13/01	NA	NA	NA	NA		
07/24/01	101.9	7.05	100.0	6.89	760.0	Note that DataSonde was found at the edge of the water with the probes exposed to the air.
08/06/01	101.1	6.69	100.0	6.63	765.6	
08/27/01	100.0	8.65	100.1	8.30	760.5	
09/12/01	NA	NA	NA	NA	764.8	Unable to communicate between either the d/s DataSonde or the spare, therefore the d/s DataSonde was re-deployed for without calibration

KAUKAUNA UTILITIES

ORIGINAL

"Community Owned, Customer Driven"

December 14, 2006

Secretary of the Commission
Federal Energy Regulatory Commission
888 First Street NE
Washington D C 20426

2006 DEC 20 P 4:37

Re: Article 403
Order Approving Water Quality Plan (issued August 24, 2000)
Little Chute Hydroelectric Project FERC No 2588 -021

Dear Secretary of the Commission:

In accordance with the Kaukauna Utilities approved Water Quality Plan (issued on August 24, 2000) for FERC Project No. 2588 – Little Chute Hydroelectric Project, we are hereby filing one (1) original and four (4) copies of the KU Water Quality Report with raw data disc for 2006 in compliance with Article 403 and the Order approving the Water Quality Monitoring Plan.

We have also submitted a copy of the report to the Wisconsin Department of Natural Resources as required by the Order approving the Water Quality Monitoring Plan.

Thank you for your time and attention to this matter. If you have any questions, please contact me at 920-462-0220.

Sincerely,

Michael Pedersen
Generation Superintendent

cc: Jeff Feldt (letter only)
Bruce Gomm (letter only)
Janet Smith
Kevin Kapuscinski
Kurt Premo (letter only)

777 ISLAND STREET • P.O. BOX 1777 • KAUKAUNA, WI 54130 • PHONE: (920) 766-5721 • FAX: (920) 766-7698 • www.kaukaunautilities.com

PROJECT REPORT

Water Quality Monitoring Report
Little Chute Hydroelectric Project
FERC Project No. 2588

Prepared for:

Kaukauna Utilities

Kaukauna, Wisconsin

Contact: Michael Pedersen, Generation Superintendent

Phone: 920-462-0220

Prepared by:

White Water Associates, Inc.

Contact: Kent Premo, M.S., Associate Consultant

429 River Lane, P.O. Box 27

Amasa, Michigan 49903

Date: November 16, 2006

TABLE OF CONTENTS

1. Project Information

Article 403 of the City of Kaukauna's current license for the Little Chute Project (FERC No. 2588) requires the City to file a water quality plan. The City filed the plan on August 14, 2000, and FERC issued an Order Approving Water Quality Plan on August 24, 2000. The order calls for the licensee to monitor dissolved oxygen (DO) and temperature upstream and downstream of the project for the period from June 15 through September 30 for the first year (2001) and then once every five years for the duration of the license.

In 2006, the City of Kaukauna contracted White Water Associates, Inc., of Amasa, Michigan to carry out the required study for the current period. This report is a presentation of monitoring data, statistics, water quality compliance information, quality assurance data, and a description of problems or malfunctions as required by the Order Approving Water Quality Plan (Appendix A, Documents).

2. Data

Graphs comparing the hourly upstream and downstream dissolved oxygen (Figure 1) and temperature readings (Figure 2) are provided in Appendix A and the corresponding raw data is provided on disk in Excel format in Appendix B as an attached CD-ROM. A copy of this report is also provided as PDF file on the same CD-ROM.

For both upstream and downstream temperature and dissolved oxygen data, the daily means were calculated and graphed (Figure 3, Appendix A). The mean and standard deviation of the difference between the daily means for the upstream and downstream readings were calculated. For the temperature comparison, the mean of the difference in the daily averages was 0.81°C (upstream minus downstream –the positive sign denotes the upstream temperature was higher than the downstream temperature) with a standard deviation of ± 0.17°C. The mean of the difference in the average daily dissolved oxygen concentration was -0.67 mg/L (upstream minus downstream–the negative sign denotes the upstream dissolved oxygen concentration was lower than the downstream dissolved oxygen concentration) with a standard deviation of ± 0.63 mg/L. A comparison of the daily means for dissolved oxygen concentration and temperature are provided in Appendix C (Tables 1 and 2, respectively).

The dissolved oxygen daily averages of the upstream and downstream data were compared, when both data sets were available, and at no time did they vary by greater than 2 mg/L for five or more consecutive days, a condition indicated as a cause for special discussion with the WDNR according to the FERC order. The difference between daily means for dissolved oxygen only exceeded 2 mg/L on four days: August 20-22, and September 1 (-2.44, -2.2, -2.60, and -2.02, respectively). The daily averages for DO of the upstream unit was lower than those of the downstream unit in all four cases, resulting in negative values. The first three instances occurred near the end of a deployment and maintenance cycle. It is unclear why the difference was this large in any of the cases, but there was often a lot of biological activity and fouling, and even the occasional crawfish found around the probes. The daily means for both dissolved oxygen and temperature are shown in Appendix C.

3. Quality Assurance

The upstream and downstream monitoring equipment were calibrated every two weeks at which time the data was also checked. The pre-calibration and post-calibration dissolved oxygen values were compared and never differed by greater than 0.54 mg/L (on October 2 at the downstream location, reading higher before calibration). Calibration summaries for the upstream and downstream monitoring units are provided in Appendix D.

4. Complications in Monitoring During Study Period

A. Upstream Data

Data were never lost during deployment at the upstream location.

B. Downstream Data

Data were lost on two occasions, first from September 10 (3:00) to 20 (11:00) then again from September 26 (8:00) through the duration of the deployment, effectively September 30 (23:00). In both cases, the same unit failed to acquire readings sometime between maintenance visits. Fortunately, these failures occurred at a time when dissolved oxygen and water temperatures, as indicated by readings immediately preceding and following the failures, were moderate. What follows is a description of steps taken and conclusions drawn after each failure.

During the first failure event, the unit failed to acquire readings for the 10 days immediately preceding the maintenance visit on September 20. The unit was totally unresponsive until batteries were changed. After data were downloaded, the data loss was discovered, having been last serviced on September 6. The last reading showed the battery voltage was good. Indeed, batteries had been changed on the previous visit and should have lasted for perhaps a month more. (Batteries were routinely changed every other visit; i.e. monthly.) Nonetheless, the batteries that came out of the unresponsive unit were reading a bit low, as if there was some dissipation of power. Nothing obvious indicated the reason why readings had failed to be acquired: the battery storage area was dry and after a change of batteries the unit was fine and recording on the hour. Perhaps the cleaning motor which rotates once an hour stayed on for some reason drawing down the unit's power, but the loss of readings occurred suddenly.

I consulted with the manufacturer (Hach-Hydrolab) several times from the field without determining a clear reason why this first failure occurred. Both units used after June 27 were new as of June 2006. Hydrolab's technician suggested that the unit should be checked at the end of the season by them. With two weeks to go, the unit was redeployed after a thorough check and recalibration; it was reading properly before I left it.

On the occasion of the second failure on September 26, 5 days of data were lost until the study period concluded September 30. The unit had been thoroughly checked last visit and redeployed with new batteries, but the unit was found totally unresponsive until batteries were once again changed. The last readings showed the unit had plenty of power until the failure, after which no readings were acquired. A check of batteries shows they were further depleted from the last recorded voltage. There were no signs of leakage from the batteries or infiltration of water. The unit was returned to the manufacturer for service at the end of the season.

APPENDIX A

Graphs of Upstream and Downstream Temperature and Dissolved Oxygen Readings

Figure 1. Hourly Dissolved Oxygen Readings, Upstream and Downstream of Little Chute Project
FERC No. 2588 on the Fox River in Combined Locks, Wisconsin

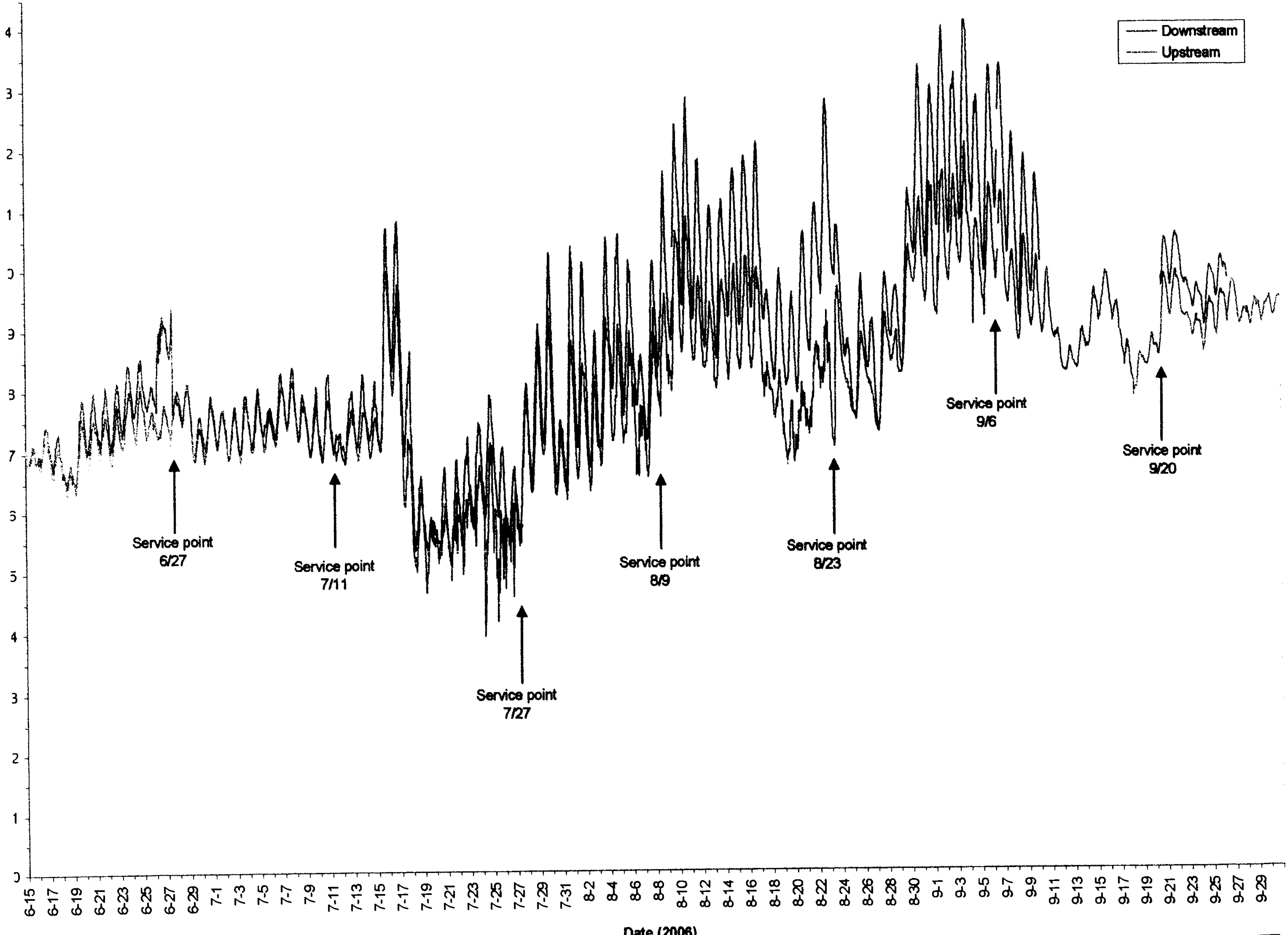


Figure 2. Hourly Temperature Readings, Upstream and Downstream of Little Chute Project FERC No. 2588 on the Fox River in Combined Locks, Wisconsin

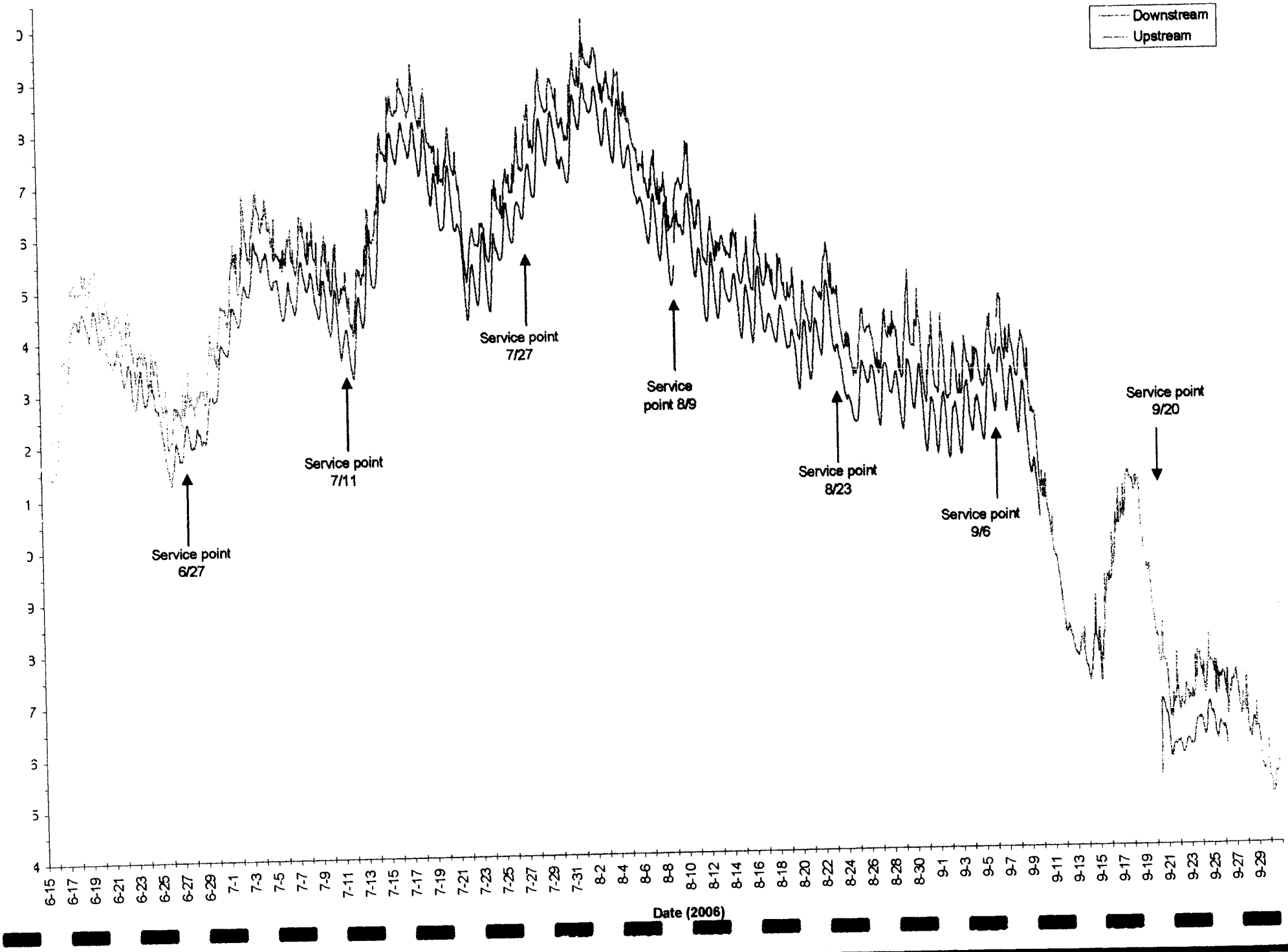
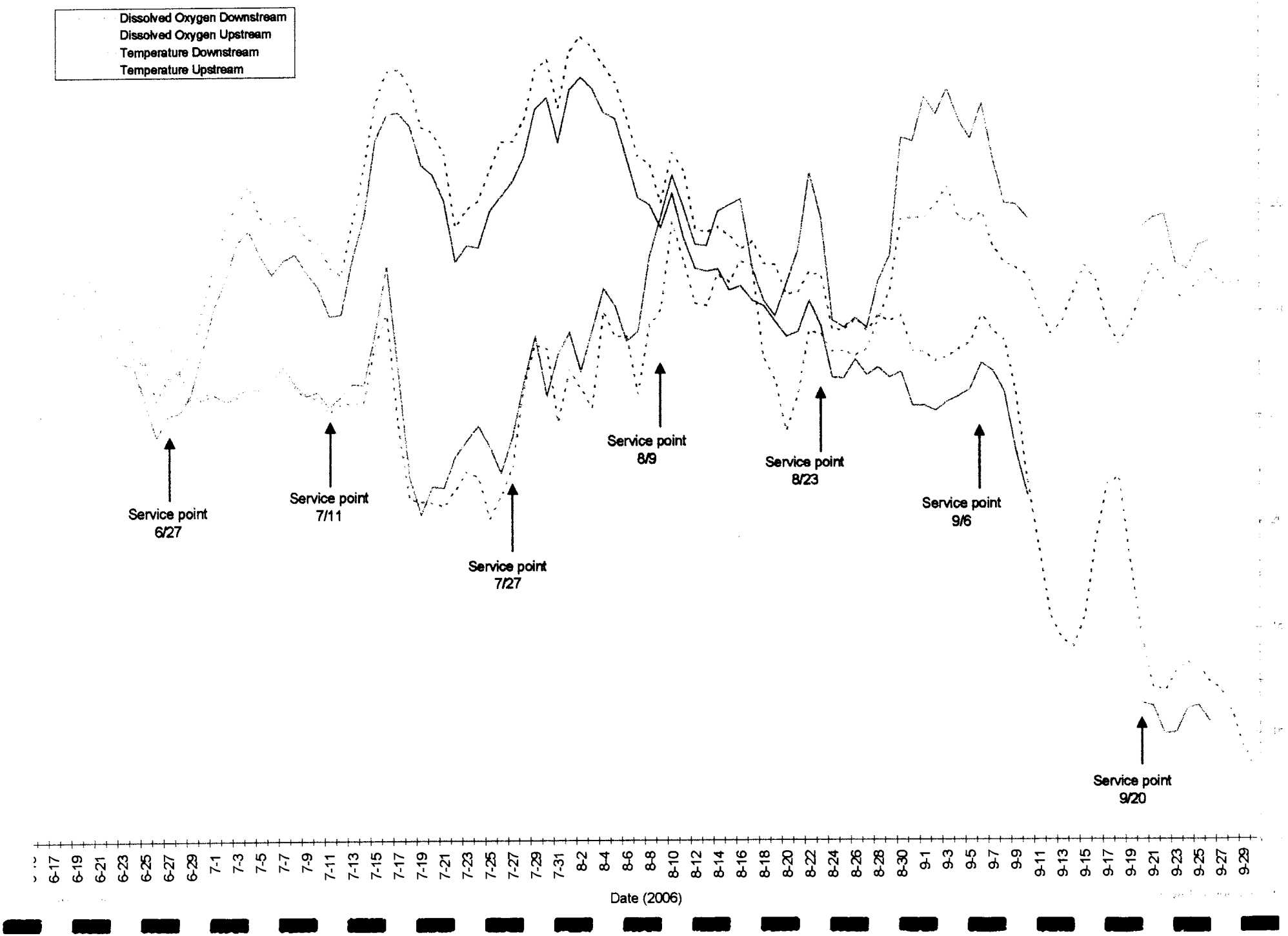


Figure 3. Daily Averages for Dissolved Oxygen and Temperature, Upstream and Downstream of Little Chute Project FERC No. 2588 on the Fox River in Combined Locks, Wisconsin



APPENDIX B

Raw Data

APPENDIX C

Daily Means for Dissolved Oxygen and Temperature

Little Chute Project, FERC No. 2588 on the Fox River in Combined Locks, Wisconsin
Daily Means of the Upstream and Downstream Temperature and Dissolved Oxygen Data

Difference= Upstream - Downstream

Date (shading = service date)	Dissolved Oxygen (mg/L)			Temperature (°C)		
	Upstream	Downstream	Difference	Upstream	Downstream	Difference
6-15-2006	6.80	6.95	-0.15	21.68	21.00	0.68
6-16-2006	6.97	7.11	-0.14	22.69	22.09	0.61
6-17-2006	6.87	7.01	-0.14	24.11	23.51	0.60
6-18-2006	6.58	6.66	-0.08	25.08	24.45	0.63
6-19-2006	6.91	7.08	-0.17	25.24	24.38	0.86
6-20-2006	7.14	7.45	-0.31	24.70	24.06	0.64
6-21-2006	7.26	7.50	-0.24	24.39	23.67	0.72
6-22-2006	7.23	7.57	-0.34	24.17	23.42	0.75
6-23-2006	7.47	7.86	-0.39	23.66	23.05	0.61
6-24-2006	7.61	8.03	-0.42	23.49	23.00	0.49
6-25-2006	7.49	7.91	-0.42	23.06	22.32	0.73
6-26-2006	7.45	8.67	-1.22	22.34	21.65	0.69
6-27-2006	7.59	8.35	-0.77	22.77	22.05	0.72
6-28-2006	7.84	7.77	0.07	22.86	22.11	0.75
6-29-2006	7.32	7.23	0.09	23.29	22.45	0.84
6-30-2006	7.41	7.32	0.08	24.07	23.31	0.75
7-1-2006	7.43	7.39	0.03	24.88	24.11	0.76
7-2-2006	7.27	7.28	-0.01	25.64	24.64	1.00
7-3-2006	7.35	7.41	-0.06	26.06	25.33	0.74
7-4-2006	7.39	7.49	-0.10	26.42	25.56	0.86
7-5-2006	7.38	7.47	-0.09	25.83	25.09	0.74
7-6-2006	7.56	7.64	-0.08	25.70	24.72	0.98
7-7-2006	7.75	7.85	-0.10	25.74	24.99	0.75
7-8-2006	7.52	7.57	-0.05	25.82	25.11	0.71
7-9-2006	7.30	7.37	-0.06	25.43	24.77	0.66
7-10-2006	7.35	7.43	-0.08	25.32	24.49	0.83
7-11-2006	7.08	7.17	-0.09	24.88	23.94	0.94
7-12-2006	7.23	7.35	-0.12	24.70	23.98	0.72
7-13-2006	7.25	7.56	-0.31	25.70	25.01	0.69
7-14-2006	7.25	7.54	-0.29	26.71	25.80	0.91
7-15-2006	8.22	8.42	-0.21	27.96	27.25	0.71
7-16-2006	8.73	9.53	-0.80	28.55	27.74	0.81
7-17-2006	6.89	7.79	-0.90	28.60	27.78	0.81
7-18-2006	5.66	6.02	-0.36	28.30	27.52	0.77
7-19-2006	5.61	5.40	0.21	27.52	26.77	0.75
7-20-2006	5.59	5.86	-0.27	27.39	26.59	0.80
7-21-2006	5.53	5.84	-0.30	26.97	26.11	0.87
7-22-2006	5.81	6.36	-0.55	25.61	24.95	0.67
7-23-2006	6.10	6.62	-0.51	25.94	25.26	0.68
7-24-2006	6.01	6.87	-0.86	26.12	25.22	0.90
7-25-2006	5.34	6.53	-1.18	26.67	25.92	0.75
7-26-2006	5.70	6.08	-0.38	27.21	26.19	1.01
7-27-2006	6.17	6.68	-0.51	27.22	26.46	0.76
7-28-2006	7.49	7.57	-0.08	27.63	26.92	0.71
7-29-2006	8.22	8.36	-0.14	28.57	27.84	0.73
7-30-2006	8.14	7.34	0.80	28.78	28.06	0.72
7-31-2006	6.92	8.05	-1.13	27.87	27.19	0.68
8-1-2006	7.77	8.43	-0.66	28.93	28.2	0.73
8-2-2006	7.47	7.76	-0.29	29.21	28.44	0.77
8-3-2006	7.16	8.45	-1.29	29	28.23	0.77
8-4-2006	8.75	9.13	-0.38	28.65	27.77	0.88
8-5-2006	8.35	8.85	-0.50	28.34	27.65	0.69
8-6-2006	8.35	8.27	0.08	27.67	26.89	0.78
8-7-2006	7.38	8.43	-1.05	26.93	26.15	0.78

Little Chute Project, FERC No. 2588 on the Fox River in Combined Locks, Wisconsin
Daily Means of the Upstream and Downstream Temperature and Dissolved Oxygen Data

Difference= Upstream - Downstream

Date (shading = service date)	Dissolved Oxygen (mg/L)			Temperature (°C)		
	Upstream	Downstream	Difference	Upstream	Downstream	Difference
8-8-2006	8.53	9.65	-1.12	26.78	26.03	0.75
8-9-2006	8.77	10.31	-1.54	26.06	25.58	0.48
8-10-2006	10.22	11.00	-0.78	26.98	26.24	0.75
8-11-2006	9.57	10.46	-0.89	26.66	25.38	1.28
8-12-2006	8.89	9.86	-0.97	25.57	24.81	0.76
8-13-2006	8.85	9.83	-0.98	25.49	24.75	0.74
8-14-2006	9.36	10.41	-1.05	25.59	24.79	0.80
8-15-2006	9.23	10.51	-1.28	25.43	24.40	1.03
8-16-2006	9.57	10.61	-1.04	25.16	24.48	0.68
8-17-2006	9.51	9.47	0.04	25.32	24.21	1.11
8-18-2006	7.97	8.93	-0.96	24.9	24.11	0.79
8-19-2006	7.61	8.67	-1.06	24.87	23.81	1.06
8-20-2006	6.76	9.20	-2.44	24.31	23.53	0.78
8-21-2006	7.33	9.75	-2.42	24.37	23.61	0.76
8-22-2006	8.43	11.03	-2.60	24.73	24.21	0.53
8-23-2006	8.37	10.29	-1.92	24.67	23.72	0.95
8-24-2006	8.09	8.60	-0.51	23.66	22.73	0.93
8-25-2006	8.09	8.49	-0.39	23.64	22.71	0.93
8-26-2006	8.01	8.64	-0.63	23.86	23.08	0.78
8-27-2006	8.13	8.48	-0.35	23.63	22.78	0.86
8-28-2006	8.61	9.24	-0.64	23.91	22.92	0.98
8-29-2006	9.10	9.66	-0.57	23.82	22.72	1.10
8-30-2006	10.26	11.60	-1.34	23.91	22.84	1.07
8-31-2006	10.29	11.54	-1.25	23.24	22.19	1.04
9-1-2006	10.29	12.30	-2.02	23.23	22.20	1.03
9-2-2006	10.51	11.99	-1.48	23.04	22.09	0.95
9-3-2006	10.80	12.42	-1.63	23.12	22.26	0.85
9-4-2006	10.30	11.90	-1.60	23.27	22.36	0.91
9-5-2006	10.22	11.58	-1.35	23.40	22.50	0.90
9-6-2006	10.39	12.18	-1.79	23.92	23.01	0.91
9-7-2006	9.80	11.23	-1.43	23.63	22.84	0.79
9-8-2006	9.54	10.53	-0.99	23.44	22.45	0.99
9-9-2006	9.46	10.51	-1.05	22.45	21.36	1.10
9-10-2006	9.33	10.28	-0.95	20.76	20.50	0.26
9-11-2006	8.79			19.51		
9-12-2006	8.38			18.21		
9-13-2006	8.57			17.81		
9-14-2006	9.04			17.66		
9-15-2006	9.48			18.20		
9-16-2006	9.24			19.71		
9-17-2006	8.55			20.70		
9-18-2006	8.20			20.84		
9-19-2006	8.52			19.25		
9-20-2006	9.03	10.13	-1.10	17.82	16.59	1.22
9-21-2006	9.51	10.28	-0.77	16.89	16.52	0.37
9-22-2006	9.25	10.34	-1.09	16.81	15.99	0.82
9-23-2006	8.97	9.52	-0.55	17.17	16.01	1.16
9-24-2006	8.99	9.43	-0.44	17.35	16.47	0.88
9-25-2006	9.21	9.81	-0.60	17.27	16.53	0.74
9-26-2006	9.43	9.89	-0.46	17.01	16.23	0.78
9-27-2006	9.19			16.85		
9-28-2006	9.19			16.39		
9-29-2006	9.24			15.74		
9-30-2006	9.31			15.29		

APPENDIX D

Calibration Summaries

Little Chute Project, FERC No. 2588 on the Fox River in Combined Locks, Wisconsin
Calibration check data

Must be within 1 mg/L 70 % of time
Percent within limits: 100%

Date	Site	Unit (S/N)	Before	After	Diff.
27-Jun	Down	41968	7.64	7.96	-0.32
	Up	42015	8.74	8.3	0.44
11-Jul	Down	44139	8.6	8.4	0.2
	Up	44140	8.62	8.42	0.2
27-Jul	Down	44139	7.79	7.87	-0.08
	Up	44140	7.64	7.67	-0.03
9-Aug	Down	44139	8.09	8.23	-0.14
	Up	44140	7.95	7.91	0.04
23-Aug	Down	44139	8.37	8.52	-0.15
	Up	44140	8.47	8.63	-0.16
6-Sep	Down	44139	8.43	8.46	-0.03
	Up	44140	8.28	8.23	0.05
20-Sep	Down	44139	9.46	9.74	-0.28
	Up	44140	9.52	9.74	-0.22
2-Oct	Down	44139	9.51	8.97	0.54
	Up	44140	9.01	8.83	0.18

APPENDIX E

FERC Order Approving Water Quality Monitoring Plan

(Issued August 24, 2000)

92 FERC ¶ 62,170

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

City of Kaukauna — Project No. 2588-007

ORDER APPROVING WATER QUALITY MONITORING PLAN

(Issued August 24, 2000)

The City of Kaukauna (licensee) filed, on August 14, 2000, its water quality monitoring plan under article 403 of the license for the Little Chute Project (FERC No. 2588). The project is located on the Fox River, in the Village of Combined Locks, in Outagamie County, Wisconsin.

BACKGROUND

Article 403 requires the licensee to file, for Commission approval, a plan to monitor water quality in the project area. The plan is required to include a description of the methods which will be used to collect dissolved oxygen (DO) and water temperature data from the project area every five years for the term of the license. In addition, the licensee is required to cooperate with any future plans developed by state or federal agencies to remove contaminated sediments from the lower Fox River. Such cooperation by the licensee may include, for example, providing reasonable access to project facilities and may also include brief and temporary modification of project operations to allow safe working conditions for agency personnel. The licensee is also required to prepare the plan after consultation with the Wisconsin Department of Natural Resources (WDNR).

LICENSEE'S PLAN

The licensee proposes that Hydrolab DataSonde probes, or their equivalent, be deployed at locations upstream and downstream of the project. The probes would be deployed from June 15 through September 30, unless flows in the river are above 4,000 cubic feet per second, which would inhibit safe deployment of the probes. The probes would continuously monitor and record DO and water temperature at 1-hour intervals during this period. The upstream probe would be located at the upstream end of the project's reservoir to provide information on the DO and water temperature as it enters the project. The downstream probe would be located approximately 100 yards below the powerhouse and in the discharge flow. Routine profile monitoring of the reservoir will not be included since results of previous monitoring provided evidence that the reservoir does not stratify significantly.

The data generated from the proposed monitoring will be surveyed biweekly. Should a comparison of the DO data from the upstream and downstream monitoring show a daily average difference between locations of greater than 2 milligrams per liter (mg/L) for a period of five consecutive days or more, discussions will be initiated with the WDNR to determine the cause of the difference. It may be determined during those discussions that profile monitoring should be implemented to help explain the differences.

The probes at each location will be calibrated every 10 to 14 days. Calibration will be performed by using the air calibration method recommended by the manufacturer. Prior to calibration, the oxygen concentration of air readings will be recorded. These data will be compared to post-calibration air oxygen concentrations to derive data on meter error or drift. At the end of the monitoring period, the DO data will be considered acceptable if the meters at each location provide readings during the pre- and post-calibration comparison that is within 1 mg/L at least 70 percent of the time. Should a problem with meeting this calibration standard become apparent during the sampling period, the WDNR will be advised and a plan devised to ensure that the calibration standard is met for the remainder of the sampling period.

A report of the findings during the sampling period will contain: raw data; graphs comparing hourly DO readings from upstream and downstream locations; graphs comparing hourly temperature readings from upstream and downstream locations; basis statistics; quality assurance data and comparison percentage; and a description of all mechanical or other complications in monitoring experienced during the sampling period. The report will be submitted to the WDNR and the Commission by December 31, 2001, and every 5 years thereafter, for the term of the license, unless the WDNR and the licensee agree that future water quality monitoring is no longer necessary.

AGENCY COMMENTS

The WDNR, by letter dated August 2, 2000, concurred with the licensee's proposed plan.

DISCUSSION AND CONCLUSIONS

The licensee's plan to monitor water quality at the project satisfies the requirements of article 403. The licensee will monitor DO and water temperature upstream and downstream of the project for the period from June 15 through September 30 for the first year (2001) and then once every five years for the duration of the license.

The licensee will provide a report following the monitoring season to the WDNR and the Commission by December 31 of the monitoring year.

The licensee states that the monitoring will continue through the term of the license unless the licensee and the WDNR agree that monitoring is no longer needed. In the event that it is determined that monitoring is no longer need at the project, the licensee would need to file with the Commission, for approval, a request to discontinue monitoring and include concurrence from the WDNR.

The licensee's plan to monitor water quality fulfills the requirements of article 403 and should, therefore, be approved.

The Director orders:

(A) The licensee's water quality monitoring plan for the Little Chute Project (FERC No. 2588), filed on August 14, 2000, is approved.

(B) This order constitutes final agency action. Requests for rehearing by the Commission may be filed within 30 days of the date of issuance of this order, pursuant to 18 CFR § 385.713.

Rebecca Martin

Rebecca Martin
Team Leader
Division of Hydropower Administration
and Compliance

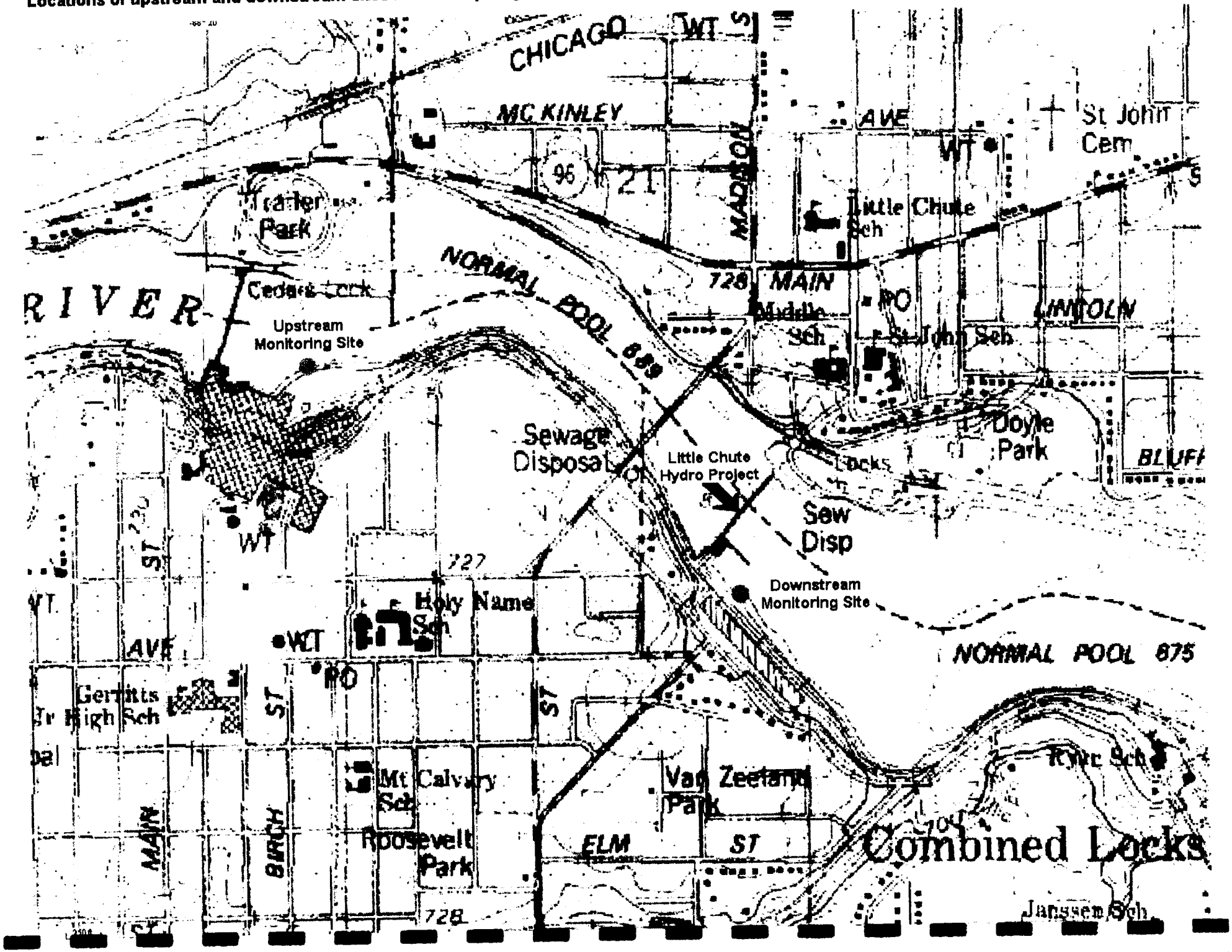
APPENDIX F

Correspondence

APPENDIX G

Map of Monitoring Locations

Locations of upstream and downstream sites for water quality monitoring, Little Chute Hydroelectric Project, June 15 through September 30, 2006.



GEI Consultants

Geotechnical
Environmental
Water Resources
Ecological

Water Quality Monitoring Report
Little Chute Hydroelectric Project
FERC No. 2588-007

Little Chute, Wisconsin

Submitted to:
Kaukauna Utilities

Submitted by:
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Project No. 112310

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Project Background

Article 403 of the City of Kaukauna's current license for the Little Chute Project (FERC No. 2588) requires the City to file a water quality plan. The City filed the plan on August 14, 2000, and FERC issued an Order Approving Water Quality Plan on August 24, 2000. The order calls for the licensee to monitor dissolved oxygen (DO) and temperature upstream and downstream of the project for the period from June 15 through September 30 for the first year (2001) and then once every five years for the duration of the license.

In 2011, the City of Kaukauna retained GEI Consultants, Inc., of Green Bay, Wisconsin, to conduct monitoring for the current period.

This study utilized a Hach Mini Sonde-5 (MS5) with temperature and LDO (Luminescent Dissolved Oxygen) probes on board. Data were stored and downloaded on a two week schedule (except when high flows inhibited safe probe access) and probes were calibrated for DO per manufacturer requirements before redeployment. These new LDO probes were developed since the last study (2006) and use a light activated dissolved oxygen probe (LDO technology) compared to older membrane technology. The benefits include more accuracy and less biofouling. Although we obtained good data, some of the problems we encountered with probe outages suggest design changes may be needed in these new units to strengthen software and hardware components to deal with high discharge conditions and sediment.

This report presents monitoring data, statistics, water quality compliance information, quality assurance data, and a description of equipment outages as required by the Order Approving Water Quality Plan Graphs comparing the hourly upstream and downstream dissolved oxygen and temperature readings are provided in Appendix A and the corresponding raw data is provided on disk in Excel format in Appendix B as an attached CD-ROM. A copy of this report is also provided as a PDF file on the same CD-ROM.

Overview of the Study Results

2011 was a year of flooding in many parts of the country including the Fox River. High water made access difficult and flow levels exceeded 4000 cubic feet per second (cfs) more than half the study period. Data collection is not required at flows above 4,000 cfs, but because the river rose and fell above this level six times during the study period, high and variable flows made it challenging to collect the data and service the probes (see shaded areas of Figures 1 and 2 in Appendix A). High water also included significant bedload movement and may have been responsible for equipment outages and resulting data gaps (see shaded areas of Figures 3 and 4 in Appendix A). Typically, high flows lead to better conditions for temperature and dissolved oxygen and would tend to reduce any differences between headwater and tailwaters due to low reservoir residence times and more mixing in the water column. The data corroborate this. For both upstream and downstream dissolved oxygen and temperature data, the daily averages of the difference between the daily means were graphed (Figures 5 and 6, Appendix C) and the standard deviation of the difference between the daily means calculated (Table 1, Appendix C).

Results of the study show that temperature variation of upstream and downstream environments displayed nearly identical patterns of temporal variation (i.e., no differences). Dissolved oxygen differences

between upstream and downstream environments were also negligible when erroneous data from equipment outages or probe malfunction were eliminated.

Details in the Data

The average daily DO ranged between 5 mg/L and 11 mg/L for the entire study upstream and downstream except during an equipment outage July 31 to August 2 when a probe became fouled. Differences between upstream and downstream DO daily averages were less than 2 mg/L throughout the study, excluding the July 28 to August 4 data when a probe became fouled (Table 1, Appendix C).

Temperature: For the temperature comparison, the mean of the difference in the daily averages was -0.04°C (upstream minus downstream) with a standard deviation of ± 0.16°C. (The negative sign indicates that the daily averages for upstream temperature were lower than downstream; however, the mean difference in daily averages was less than the error variance of the recording instrument—i.e., zero).

Dissolved Oxygen: When all data are included, the mean of the difference in the average daily dissolved oxygen concentration was -0.91 mg/L (upstream minus downstream) with a standard deviation of ± 1.92 mg/L. This average deviation statistic is misleading because it contains erroneous data. Actual differences between upstream and downstream are much closer when erroneous data are removed. As described in Appendix E, significant sedimentation or biofouling observed at the upstream probe was interpreted to significantly reduce river water flow across the DO probe and led to atypical patterns of suppressed DO readings on July 18, and July 28 through August 4. When DO data for these dates are omitted from the statistical calculations, the mean of the difference in the average daily dissolved oxygen concentration was -0.04 mg/L (upstream minus downstream) with a standard deviation of ± 0.34 mg/L. A comparison of the daily means for dissolved oxygen concentration and temperature are provided in Appendix C (Table 1).

The DO daily averages of the upstream and downstream data were compared. When both data sets were available and omitting DO data from the upstream probe during periods of significant sedimentation and/or biofouling, at no time did upstream and downstream vary by greater than 2 mg/L for five or more consecutive days, a condition indicated as a cause for special discussion with the WDNR according to the FERC order. The daily means and average daily differences for both dissolved oxygen and temperature are shown in Table 1 (Appendix C).

Quality Assurance

The upstream and downstream monitoring equipment were calibrated every two weeks (except when high river flows inhibited safe probe access) at which time the data were also checked. The pre- and post-calibration DO values were compared and never differed by more than 1.04 mg/L at the downstream probe, or 0.46 mg/L at the upstream probe. Pre- and post-calibration DO readings of calibration water were within 1.0 mg/L 94% of the time; pre- and post-calibration DO readings of the river were within 1.0 mg/L 100% of the time. Accordingly, DO data are considered acceptable, because pre- and post-calibration readings were within 1.0 mg/L at least 70% of the time. Calibration summaries for the upstream and downstream monitoring units are provided in Appendix D.

Complications in Monitoring During Study Period

According to the FERC order approving the Water Quality Monitoring Plan for the Little Chute Project dated August 24, 2000 (Appendix F), upstream and downstream probes should be deployed from June 15 through September 30, "unless flows in the river are above 4,000 cubic feet per second, which would inhibit safe deployment of the probes." As shown on Figures 1, 2, 5 and 6, provisional data from the USGS Fox River Station in Appleton, Wisconsin, indicate that flows exceeded 4,000 cfs for 56 of the 108 days within the monitoring period (52% of the period). It is also interesting that USGS data shows a number of gaps presumably due to similar problems of high flow and sediment during the study period. The highest flows (>10,000 cfs) were recorded over several days in early summer; however, mid-summer storms brought flows up over 4000 cfs five additional times during the study period complicating access, logistics and sampling during the study. Equipment failures also required significant effort to expedite replacement and corroborate functionality of newly deployed units.

High flow contributed to poor performance of the instruments based on sediment observed embedded in the protective casing around the upstream probe DO probe when it was serviced on August 5. This service date was preceded by a spate of higher flows from approximately July 18 through August 1 (Figures 5 and 6). We also experienced a unit failure which may have been due to bedload movement or debris in the river. Units were cracked, flooded and the batteries had failed on August 5 and 20. During the final month of deployment (September 14), we discovered the downstream unit to have "no data" in the memory even though the unit was calibrated and responded successfully to reset instructions. After consultation with Hach, they replaced this unit with a backup for the final ten days of the sampling season, but were unable to explain this anomalous occurrence. For detailed accounts of outages, refer to Appendix E.

Conclusions Regarding Results

The detailed description of how we handled outages (Appendix E) and the resulting data provides rationale for revised data sets. Based on missing data, data completely out of normally expected ranges, or data that showed rapid progressive declines to zero, we modified the data sets to set these data points to "missing" and did not use them to re-compute the daily averages. Since data were downloaded approximately every two weeks, a failure early in the sample period could lead to many days of missing data. This explains why some days have missing averages either upstream or downstream of the project. Calibration of the instruments enabled us to check unit functionality and identify clearly erroneous data from the periods prior to calibration. Calibration also confirmed the reliability of data during many of the sampling periods.

We obtained reliable DO readings from one or both probes on the majority of the study period even though flows were in excess of 4000 cfs more than half the period. Days in which both DO probes were providing good data showed no daily variances greater than required by the FERC License.

Based on consistently similar values during all times when both probes were functioning simultaneously, we concluded there is no reason to suspect divergence may have occurred unnoticed when one probe was out of service for either DO or temperature. As discussed earlier, the high flows kept temperature nearly identical up and downstream. Turbulence along with low residence times in the reservoir also contributed

to similar DO values up and downstream. With or without data corrections, computations show that the data were within compliance for all variables in the FERC License.

Conclusions Regarding Equipment Performance

GEI selected Hach equipment based on historical use of previous Hach technology at this site and Hach's reputation as a leader in LDO technology. The new LDO probe is a Hach innovation and considered the best in the industry. Costs were similar to other manufacturers. We can assume that use of older DO technology using membranes which are more sensitive to fouling and damage would have fared even worse under the higher than average runoff conditions that prevailed nearly all summer. The failure of the housing that led to battery failure suggests fragility in these new units.

Appendix A: Graphs of Upstream and Downstream Temperature and Dissolved Oxygen Readings

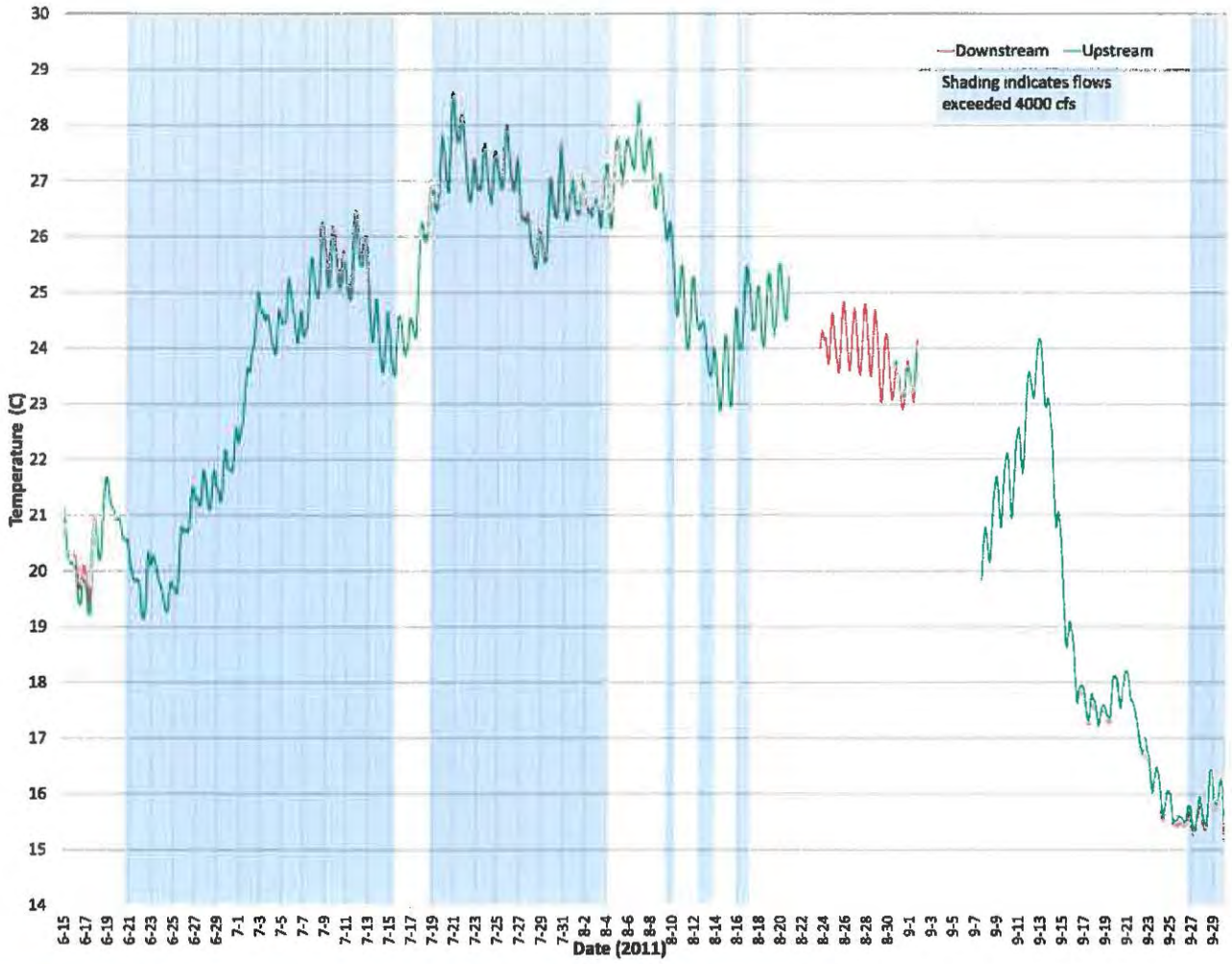


Figure 1. Hourly Temperature Readings Upstream and Downstream of Little Chute Project (High Flow Periods Shaded)

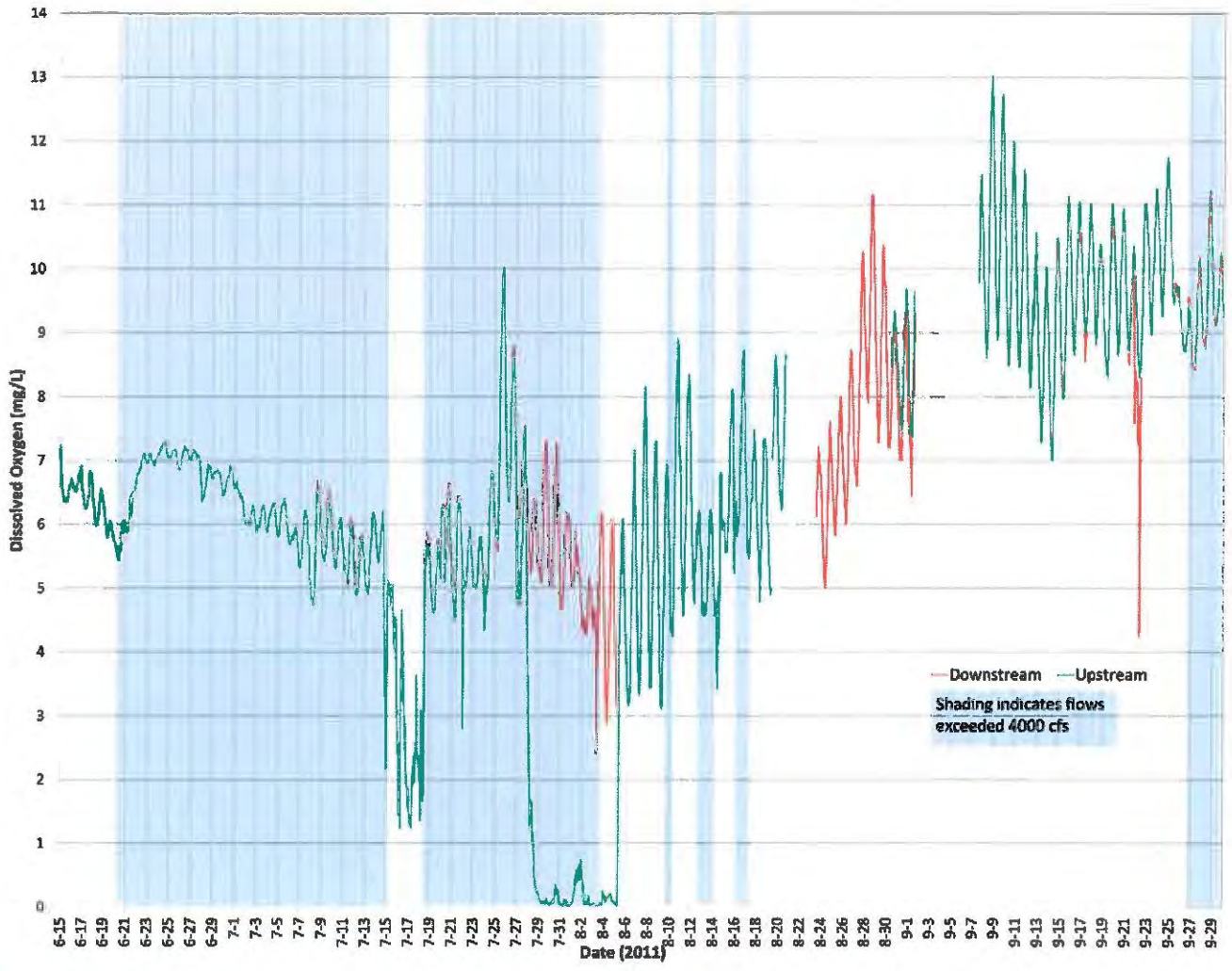


Figure 2. Hourly Dissolved Oxygen Readings Upstream and Downstream of Little Chute Project (High Flow Periods Shaded)

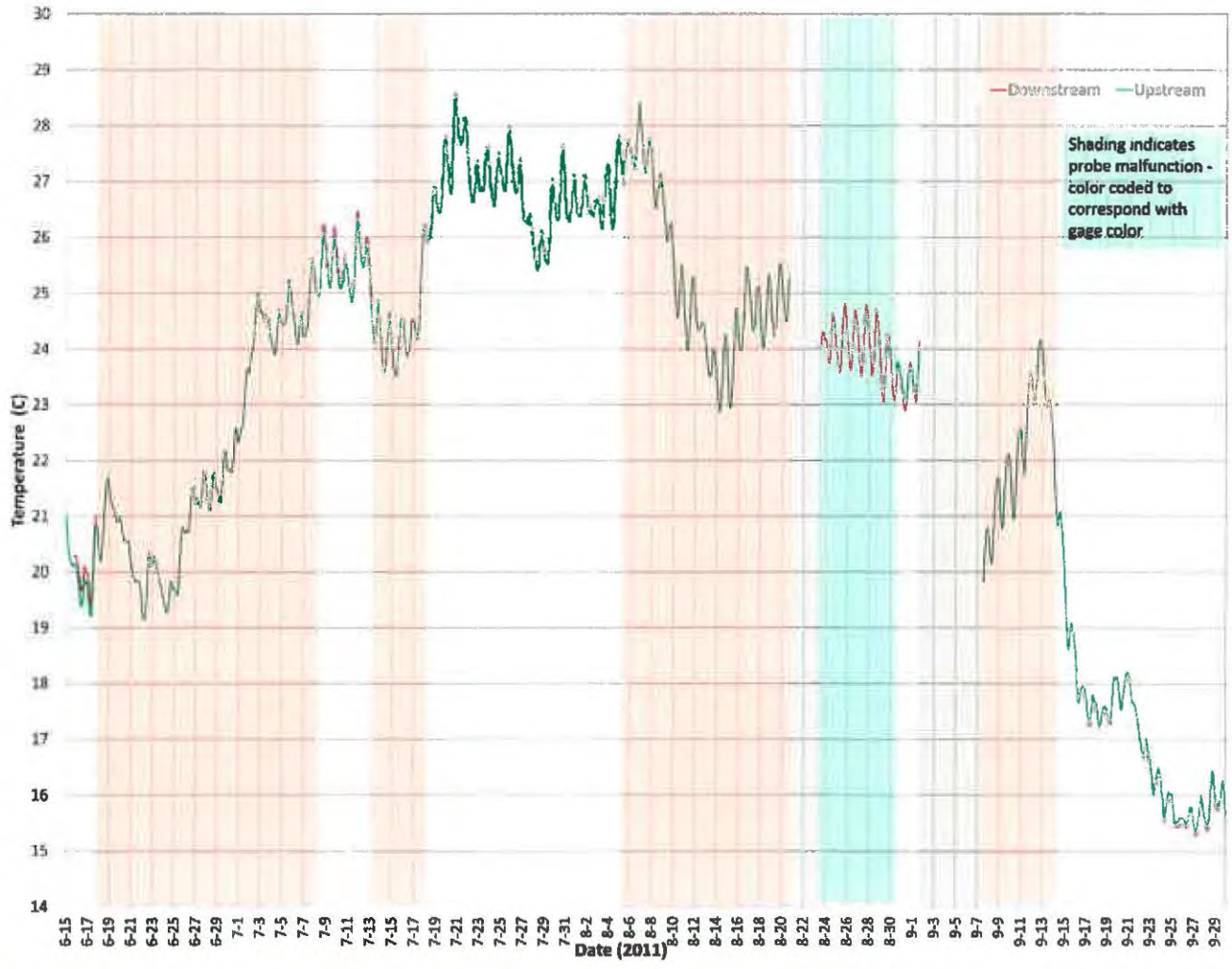


Figure 3. Hourly Temperature Readings Upstream and Downstream of Little Chute Project (Probe Malfunction Periods Shaded)

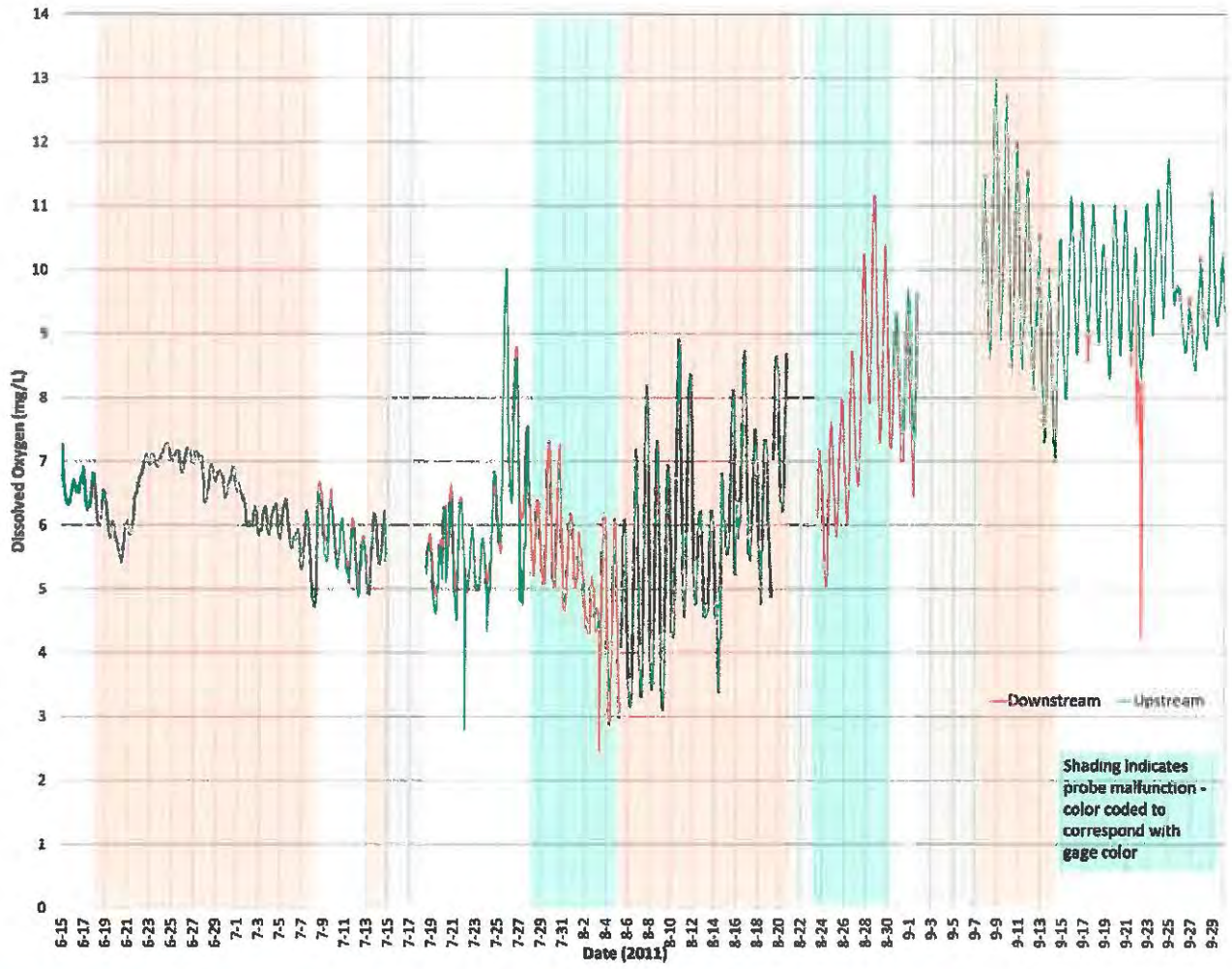


Figure 4. Hourly Dissolved Oxygen Readings Upstream and Downstream of Little Chute Project (Probe Malfunction Periods Shaded)

Appendix B: Raw Data (CD-ROM)

Appendix C: Daily Averages for Temperature and Dissolved Oxygen

Table 1.
Daily Averages of Upstream and Downstream Dissolved Oxygen and Temperature Data
Little Chute Project, FERC No. 2588 on the Fox River In Combined Locks, Wisconsin

Difference = Upstream - Downstream

Date (shading = service date)	Date with Flow >4,000 CFS?	Dissolved Oxygen (mg/L)			Temperature (°C)		
		Upstream	Downstream	Difference	Upstream	Downstream	Difference
6/15/2011		6.55	6.56	-0.02	20.32	20.29	0.03
6/16/2011		6.66	6.63	0.03	19.71	19.95	-0.24
6/17/2011		6.50	6.44	0.07	19.99	20.06	-0.07
6/18/2011		6.27			20.89		
6/19/2011		6.00			21.12		
6/20/2011	Yes	5.73			20.62		
6/21/2011	Yes	6.18			19.89		
6/22/2011	Yes	6.92			19.70		
6/23/2011	Yes	7.01			19.99		
6/24/2011	Yes	7.18			19.53		
6/25/2011	Yes	7.06			20.15		
6/26/2011	Yes	7.09			21.05		
6/27/2011	Yes	7.03			21.42		
6/28/2011	Yes	6.69			21.44		
6/29/2011	Yes	6.74			21.66		
6/30/2011	Yes	6.71			22.10		
7/1/2011	Yes	6.43			23.01		
7/2/2011	Yes	6.09			24.37		
7/3/2011	Yes	6.07			24.53		
7/4/2011	Yes	6.12			24.26		
7/5/2011	Yes*	6.12			24.78		
7/6/2011	Yes	5.74			24.38		
7/7/2011	Yes	5.72			24.93		
7/8/2011	Yes	5.62	6.42	-0.80	25.46	26.05	-0.59
7/9/2011	Yes*	5.87	6.07	-0.19	25.55	25.72	-0.17
7/10/2011	Yes	5.70	5.72	-0.02	25.29	25.44	-0.14
7/11/2011	Yes	5.54	5.66	-0.11	25.47	25.69	-0.21
7/12/2011	Yes	5.33	5.45	-0.12	25.61	25.78	-0.17
7/13/2011	Yes	5.55	5.30	0.26	24.51	25.01	-0.51
7/14/2011	Yes	5.36			24.05		
7/15/2011	Yes	4.44			24.00		
7/16/2011		2.68			24.19		
7/17/2011		2.04			25.01		
7/18/2011	Yes	3.78	5.66	-1.88	26.36	26.74	-0.38
7/19/2011	Yes	5.10	5.29	-0.19	27.01	27.08	-0.08
7/20/2011	Yes	5.88	6.06	-0.17	27.60	27.67	-0.07
7/21/2011	Yes	5.50	5.71	-0.21	27.81	27.89	-0.09
7/22/2011	Yes	5.26	5.41	-0.15	26.95	27.02	-0.07
7/23/2011	Yes	5.33	5.30	0.03	27.14	27.20	-0.06
7/24/2011	Yes	5.76	5.85	-0.08	27.03	27.09	-0.07
7/25/2011	Yes	7.71	7.64	0.07	27.34	27.40	-0.07
7/26/2011	Yes	7.38	7.52	-0.14	27.02	27.10	-0.08

Table 1.
Daily Averages of Upstream and Downstream Dissolved Oxygen and Temperature Data
Little Chute Project, FERC No. 2588 on the Fox River In Combined Locks, Wisconsin

Difference = Upstream - Downstream

Date (shading = service date)	Date with Flow >4,000 CFS?	Dissolved Oxygen (mg/L)			Temperature (°C)		
		Upstream	Downstream	Difference	Upstream	Downstream	Difference
7/27/2011	Yes	5.87	6.65	-0.78	26.25	26.31	-0.06
7/28/2011	Yes	1.43	5.85	-4.42	25.73	25.80	-0.07
7/29/2011	Yes	0.10	6.09	-5.99	26.18	26.27	-0.08
7/30/2011	Yes	0.14	5.93	-5.79	26.84	26.91	-0.07
7/31/2011	Yes	0.05	5.49	-5.44	26.63	26.71	-0.08
8/1/2011	Yes	0.34	5.28	-4.94	26.69	26.77	-0.08
8/2/2011	Yes*	0.19	4.64	-4.46	26.53	26.59	-0.06
8/3/2011		0.05	4.93	-4.88	26.71	26.80	-0.09
8/4/2011		0.16	4.54	-4.38	26.95	27.04	-0.10
8/5/2011		3.24	3.68	-0.44	27.45	27.40	0.05
8/6/2011		4.74			27.69		
8/7/2011		5.59			27.50		
8/8/2011		5.36			26.91		
8/9/2011	Yes	5.04			26.16		
8/10/2011	Yes	6.35			25.10		
8/11/2011	Yes	6.56			24.62		
8/12/2011	Yes	5.65			24.46		
8/13/2011	Yes	5.27			23.76		
8/14/2011	Yes	5.18			23.53		
8/15/2011	Yes	6.53			23.78		
8/16/2011	Yes	7.06			24.61		
8/17/2011	Yes	6.45			24.76		
8/18/2011		6.29			24.66		
8/19/2011		6.86			24.85		
8/20/2011		6.98			24.82		
8/21/2011							
8/22/2011							
8/23/2011			6.76			24.18	
8/24/2011			6.27			24.16	
8/25/2011			6.88			24.16	
8/26/2011			7.33			24.16	
8/27/2011			8.23			24.15	
8/28/2011			9.48			24.10	
8/29/2011			8.77			23.70	
8/30/2011		9.00	8.26	0.74	23.64	23.44	0.20
8/31/2011		8.48	8.06	0.42	23.38	23.33	0.06
9/1/2011		8.09	7.71	0.38	23.42	23.42	0.00
9/2/2011							
9/3/2011							
9/4/2011							
9/5/2011							
9/6/2011							

Table 1.
Daily Averages of Upstream and Downstream Dissolved Oxygen and Temperature Data
Little Chute Project, FERC No. 2588 on the Fox River in Combined Locks, Wisconsin

Difference = Upstream - Downstream

Date (shading = service date)	Date with Flow >4,000 CFS?	Dissolved Oxygen (mg/L)			Temperature (°C)		
		Upstream	Downstream	Difference	Upstream	Downstream	Difference
9/7/2011		10.82			20.45		
9/8/2011		10.61			20.86		
9/9/2011		10.81			21.47		
9/10/2011		10.22			21.76		
9/11/2011		9.97			22.61		
9/12/2011		9.27			23.62		
9/13/2011		8.63			23.15		
9/14/2011		8.72	9.69	-0.98	21.15	20.79	0.37
9/15/2011		9.46	9.40	0.07	19.11	19.09	0.02
9/16/2011		9.86	9.77	0.09	18.01	17.97	0.04
9/17/2011		9.96	9.84	0.12	17.60	17.52	0.08
9/18/2011		9.74	9.71	0.03	17.47	17.40	0.08
9/19/2011		9.56	9.49	0.07	17.70	17.64	0.06
9/20/2011		9.87	9.81	0.06	17.91	17.84	0.06
9/21/2011		9.53	9.10	0.43	17.70	17.67	0.03
9/22/2011		9.62	8.92	0.70	16.89	16.83	0.06
9/23/2011		10.18	10.22	-0.04	16.33	16.26	0.07
9/24/2011		10.49	10.53	-0.04	15.92	15.84	0.08
9/25/2011		9.85	9.90	-0.06	15.64	15.56	0.08
9/26/2011	Yes	9.05	9.15	-0.10	15.62	15.53	0.09
9/27/2011	Yes	9.15	9.29	-0.14	15.63	15.55	0.08
9/28/2011	Yes	9.75	9.84	-0.09	15.86	15.79	0.08
9/29/2011	Yes	9.57	9.63	-0.06	15.97	15.90	0.07
9/30/2011	Yes	9.49	9.57	-0.08	14.98	14.92	0.05
	Average			-0.91			-0.04
	Standard Deviation (STDEV)			1.92			0.16
	Average (omit 7-18, and 7-28 to 8-4)			-0.04			
	STDEV (omit 7-18, and 7-28 to 8-4)			0.34			

*Flow >4,000 CFS inferred from prior day's records (flow data unavailable for this date).

= Service Date.

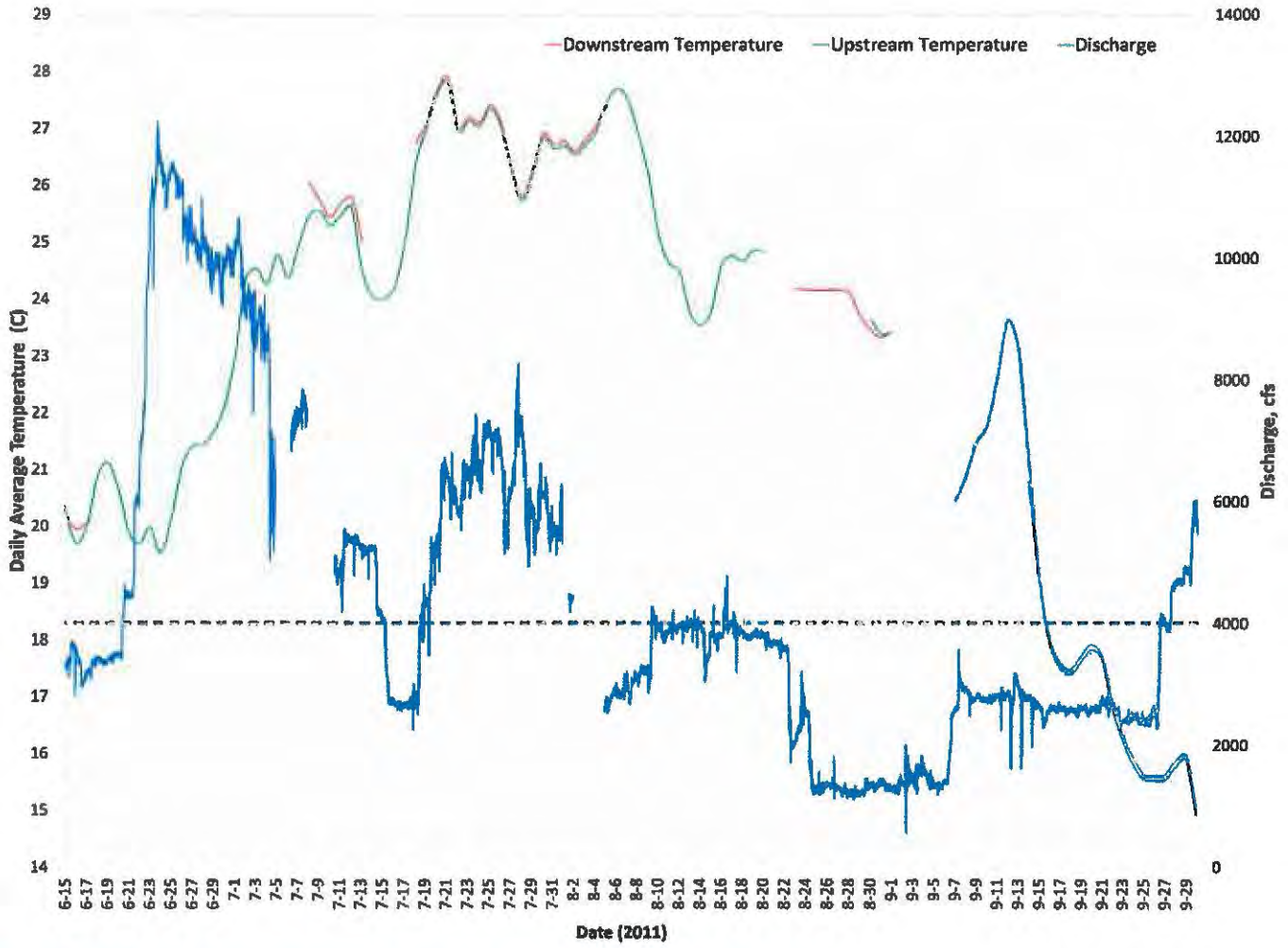


Figure 5. Daily Averages for Temperature Upstream and Downstream of the Little Chute Project and Fox River Discharge

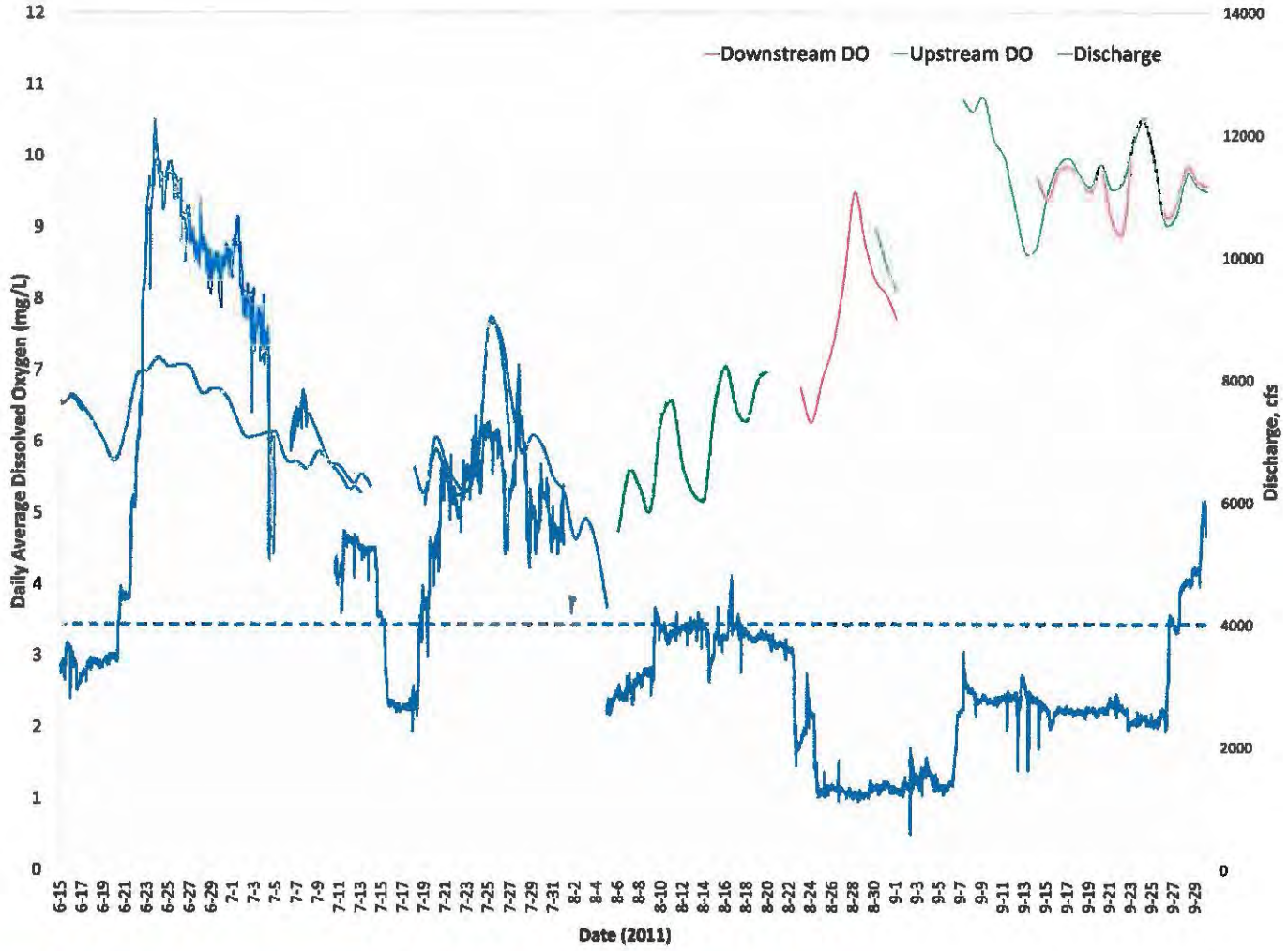


Figure 6. Daily Averages for Dissolved Oxygen Upstream and Downstream of the Little Chute Project and Fox River Discharge

Appendix D: Calibration Summaries

Luminescent Dissolved Oxygen Calibration Check Data
Little Chute Project, FERC No. 2588 on the Fox River in Combined Locks, Wisconsin

DO data considered acceptable if pre- and post-calibration readings within 1mg/L at least 70% of the time.
Percent within limits (calibration water): 94%
Percent within limits (river water): 100%

			Calibration Water			River Water			
Date	Site	Unit (SN)	Before	After	Difference	Before	After	Difference	Notes
8-Jul-11	Downstream	49431	8.25	8.33	-0.08	6.11	6.46	-0.35	
	Upstream	37765	8.19	8.26	-0.07	5.58	6.00	-0.42	
18-Jul-11	Downstream	49431							Replaced malfunctioning downstream unit.
	Upstream	37765	8.18	8.21	-0.03	5.14	5.25	-0.11	
5-Aug-11	Downstream	49504	8.08	8.19	-0.11	3.87	4.05	-0.18	
	Upstream	37765	8.16	8.14	0.02	4.14	4.04	0.1	
19-Aug-11	Downstream	49504							Unit unresponsive, cracked battery sleeve and water in battery chamber. Replaced unit on 8/23/11.
	Upstream	37765	7.98	8.07	-0.09	6.58	6.70	-0.12	
26-Aug-11	Downstream	45811	7.75	8.09	-0.34	7.78	7.46	0.32	
	Upstream	37765							Unit unresponsive, cracked battery sleeve and water in battery chamber. Replaced unit on 8/30/11.
1-Sep-11	Downstream	45811	6.58	7.62	-1.04	10.08	9.9	0.18	
	Upstream	61113	7.39	7.6	-0.21	9.5			Unit not recording unless near vertical (downward). Replaced unit on 9/7/11.
14-Sep-11	Downstream	45811	9.39	9.43	-0.04	8.49	8.56	-0.07	
	Upstream	49162	9.59	9.64	-0.05	8.41	8.48	-0.07	
22-Sep-11	Downstream 1	45811	9.07	9.22	-0.15	10.39	10.77	-0.38	
	Downstream 2	61102	8.87	9.17	-0.3				Deployed Downstream 2 unit as backup for Downstream 1.
	Upstream	49162	9.03	9.10	-0.07	9.76	10.11	-0.35	
3-Oct-11	Downstream 1	45811	9.67	9.44	0.23	10.33	10.08	0.25	
	Downstream 2	61102	9.65	9.59	0.06	10.25	10.27	-0.02	
	Upstream	49162	10.00	9.77	0.23	9.06	8.60	0.46	

Appendix E: Outage Details

Appendix E Outage Details

Upstream Data

Data were unavailable during two periods from outage problems: August 20 to 30; and September 1 to 7. In addition, on August 5 we observed significant sedimentation/biofouling around the probe which led to near zero DO readings on July 29 to August 5 (Figure 2, Appendix A). Temperature data were generally not sensitive to biofouling, but were lost when the upstream unit failed to collect data from August 20 to 30 due to battery failure (Figures 1 and 3, Appendix A). Observations and corrective actions taken for these two periods are described in the following paragraphs.

August 20 – 30. The upstream probe ceased recording data between maintenance visits on August 20. When the probe was retrieved on August 26, the battery sleeve was observed to be bulged out approximately 1 cm with a thin horizontal crack in the lower threaded section of the sleeve. Water was observed to be in the battery chamber. After drying out the battery chamber and installing fresh batteries, the probe would not communicate with the laptop. GEI contacted the vendor/manufacturer of the instrument (Hach Hydromet [Hach]) from the field to discuss the observations and order a replacement probe. Hach technical staff indicated that water which had entered the chamber caused the batteries to short and the acidified water to soften the plastic battery sleeve causing the bulge. The unit was shipped back to Hach for further review and to download recorded data (prior to the short) from the CPU in their laboratory. Data was retrieved for August 19 to 20 at which time water leakage into the battery chamber apparently caused a short which ended data recording by the probe.

The cause of water leakage into the battery chamber was not determined; however, water may have leaked through o-rings in the lower threaded portion of the battery sleeve or at the top of the sleeve, or a small crack may have developed in the thin, threaded section of the sleeve after re-deployment of the probe. No crack in the battery sleeve was observed prior to re-deployment on August 19. According to Hach technical staff, general wear of the plastic battery sleeve, along with the relatively thin-wall design of the sleeve in its lower threaded section, may have contributed to the water leakage observed. Hach agreed to ship a replacement probe as soon as possible and ensure that a new battery sleeve would be provided with the replacement unit. The replacement probe with new battery sleeve was deployed on August 30.

September 1 – 7. The second period of missing data began on September 1 when the upstream unit was found to operate only when oriented near vertically (with the probe downward). While attempting to calibrate the probe using Hach's standard method (with calibration water cup around the DO probe with the probe pointing upwards), the unit would not read DO (but would read temperature). The probe was found to read DO only when the unit was oriented within approximately 20 degrees of vertical (probe pointing downwards). GEI contacted Hach technical staff from the field and learned that some probes exhibit a fault whereby the electrical connection with the DO probe is not maintained unless gravity pulls the internal DO electronics downward. Hach indicated they have only rarely observed this fault and would ship a replacement probe as soon as possible. Per Hach instructions, GEI calibrated the unit downwards in a bucket of distilled water and re-deployed the unit. When this unit was replaced on September 7, no data was found to have been recorded since its re-deployment. The replacement unit recorded data through the end of the project.

During routine maintenance and data downloading on July 18, significant algal coatings and some fine sediment were removed from around the DO and temperature probes. Following cleaning of the DO probe on July 18, DO readings increased from 1.97 to 5.23 mg/L. This is consistent with our conclusion that DO readings less than approximately 4 mg/L recorded from July 16 to 18 were suppressed due to biofouling and/or sedimentation around the probe just prior to servicing.

During routine maintenance and data downloading on August 5, we removed significant quantities of silt, sand, and fine gravel lodged within the screen surrounding the DO and temperature probes. Following cleaning of the probe, DO readings increased from near zero to greater than 4 mg/L and were consistent with pre-calibration DO levels in the river. On July 27, DO readings dropped off rapidly to near zero through the remainder of the sampling period (August 5). Based on our review of the data including field observations of unusually heavy deposition of sediment around the probe, we concluded that sedimentation around the probe likely caused erroneous DO readings.

Downstream Data

Data were unavailable during the following periods: June 17 to July 8; July 13 to 18; August 5 to 23; and September 1 to 14. Exact hourly failures can be explored in the raw data (Appendix B). Observations and corrective actions taken for these four periods are described in the following paragraphs.

June 17 – July 8. Flows decreased sufficiently to allow for initial retrieval and servicing of the downstream probe on July 8. Review of data in the field on this date indicated the unit rapidly lost power on the third day of deployment and ceased recording. GEI contacted Hach from the field in an effort to determine the cause of the fault and to request a replacement unit. Hach could not determine a cause of the fault based on field observations. Following subsequent investigation of the unit in their laboratory, Hach concluded the unit experienced a sensor failure which caused the rapid power loss. Per discussion with Hach from the field, we installed fresh batteries and redeployed the original unit on July 8, pending receipt of the replacement unit.

July 13 – 18. When the original unit was retrieved and the replacement unit deployed on July 18, the original unit was found to have rapidly lost power on July 13 and ceased recording. As mentioned above, following investigation in their laboratory, Hach concluded the unit experienced a sensor failure which caused the rapid power loss.

August 5 – 23. When the probe was retrieved on August 19, an approximately two-inch-long hairline crack was observed in the lower threaded section of the battery sleeve. Water was observed in the battery chamber. After drying out the battery chamber and installing fresh batteries, the probe would not communicate with the laptop. GEI contacted Hach from the field to discuss the observations and order a replacement probe. Hach technical staff indicated that water which had entered the chamber caused the batteries to short. The unit was shipped back to Hach for further review. Hach was unable to download any data off the CPU in their laboratory.

Based on field observations and discussion with Hach, water appears to have leaked into the battery chamber through a hairline crack in the lower threaded portion of the battery sleeve. Nevertheless, the possibility of leakage through o-rings in the lower threaded portion of the battery sleeve or at the top of the sleeve cannot be ruled out. No crack was observed in the battery sleeve prior to re-deployment of the

unit on August 5. According to Hach technical staff, general wear of the plastic battery sleeve, along with the relatively thin-wall design of the sleeve in its lower threaded section, may have contributed to the water leakage observed. Hach agreed to ship a replacement probe as soon as possible and ensure that a new battery sleeve would be provided with the replacement unit. The replacement probe with new battery sleeve was deployed on August 23.

September 1 – 14. When the unit was retrieved on September 14, the unit appeared not to have recorded data even though a log file for the time period was created. The same field procedures were used to create and enable log files during other monitoring periods for this project. Discussions with Hach technical staff were inconclusive regarding the cause(s) of this data gap. Hach indicated that the design of the control interface might make it possible for a log file to be inadvertently disabled while closing out of the program; however, GEI's field operator recalls that a banner on the control panel was flashing the time until next reading (as normal) before closing out of probe's software interface.

Appendix F: FERC Order Approving Water Quality Monitoring Program (Issued August 24, 2000)

92 FERC ¶ 62,170

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

City of Kaukauna — Project No. 2588-007

ORDER APPROVING WATER QUALITY MONITORING PLAN

(Issued August 24, 2000)

The City of Kaukauna (licensee) filed, on August 14, 2000, its water quality monitoring plan under article 403 of the license for the Little Chute Project (FERC No. 2588). The project is located on the Fox River, in the Village of Combined Locks, in Outagamie County, Wisconsin.

BACKGROUND

Article 403 requires the licensee to file, for Commission approval, a plan to monitor water quality in the project area. The plan is required to include a description of the methods which will be used to collect dissolved oxygen (DO) and water temperature data from the project area every five years for the term of the license. In addition, the licensee is required to cooperate with any future plans developed by state or federal agencies to remove contaminated sediments from the lower Fox River. Such cooperation by the licensee may include, for example, providing reasonable access to project facilities and may also include brief and temporary modification of project operations to allow safe working conditions for agency personnel. The licensee is also required to prepare the plan after consultation with the Wisconsin Department of Natural Resources (WDNR).

LICENSEE'S PLAN

The licensee proposes that Hydrolab DataSonde probes, or their equivalent, be deployed at locations upstream and downstream of the project. The probes would be deployed from June 15 through September 30, unless flows in the river are above 4,000 cubic feet per second, which would inhibit safe deployment of the probes. The probes would continuously monitor and record DO and water temperature at 1-hour intervals during this period. The upstream probe would be located at the upstream end of the project's reservoir to provide information on the DO and water temperature as it enters the project. The downstream probe would be located approximately 100 yards below the powerhouse and in the discharge flow. Routine profile monitoring of the reservoir will not be included since results of previous monitoring provided evidence that the reservoir does not stratify significantly.

The data generated from the proposed monitoring will be surveyed biweekly. Should a comparison of the DO data from the upstream and downstream monitoring show a daily average difference between locations of greater than 2 milligrams per liter (mg/L) for a period of five consecutive days or more, discussions will be initiated with the WDNR to determine the cause of the difference. It may be determined during those discussions that profile monitoring should be implemented to help explain the differences.

The probes at each location will be calibrated every 10 to 14 days. Calibration will be performed by using the air calibration method recommended by the manufacturer. Prior to calibration, the oxygen concentration of air readings will be recorded. These data will be compared to post-calibration air oxygen concentrations to derive data on meter error or drift. At the end of the monitoring period, the DO data will be considered acceptable if the meters at each location provide readings during the pre- and post-calibration comparison that is within 1 mg/L at least 70 percent of the time. Should a problem with meeting this calibration standard become apparent during the sampling period, the WDNR will be advised and a plan devised to ensure that the calibration standard is met for the remainder of the sampling period.

A report of the findings during the sampling period will contain: raw data; graphs comparing hourly DO readings from upstream and downstream locations; graphs comparing hourly temperature readings from upstream and downstream locations; basis statistics; quality assurance data and comparison percentage; and a description of all mechanical or other complications in monitoring experienced during the sampling period. The report will be submitted to the WDNR and the Commission by December 31, 2001, and every 5 years thereafter, for the term of the license, unless the WDNR and the licensee agree that future water quality monitoring is no longer necessary.

AGENCY COMMENTS

The WDNR, by letter dated August 2, 2000, concurred with the licensee's proposed plan.

DISCUSSION AND CONCLUSIONS

The licensee's plan to monitor water quality at the project satisfies the requirements of article 403. The licensee will monitor DO and water temperature upstream and downstream of the project for the period from June 15 through September 30 for the first year (2001) and then once every five years for the duration of the license.

The licensee will provide a report following the monitoring season to the WDNR and the Commission by December 31 of the monitoring year.

The licensee states that the monitoring will continue through the term of the license unless the licensee and the WDNR agree that monitoring is no longer needed. In the event that it is determined that monitoring is no longer need at the project, the licensee would need to file with the Commission, for approval, a request to discontinue monitoring and include concurrence from the WDNR.

The licensee's plan to monitor water quality fulfills the requirements of article 403 and should, therefore, be approved.

The Director orders:

(A) The licensee's water quality monitoring plan for the Little Chute Project (FERC No. 2588), filed on August 14, 2000, is approved.

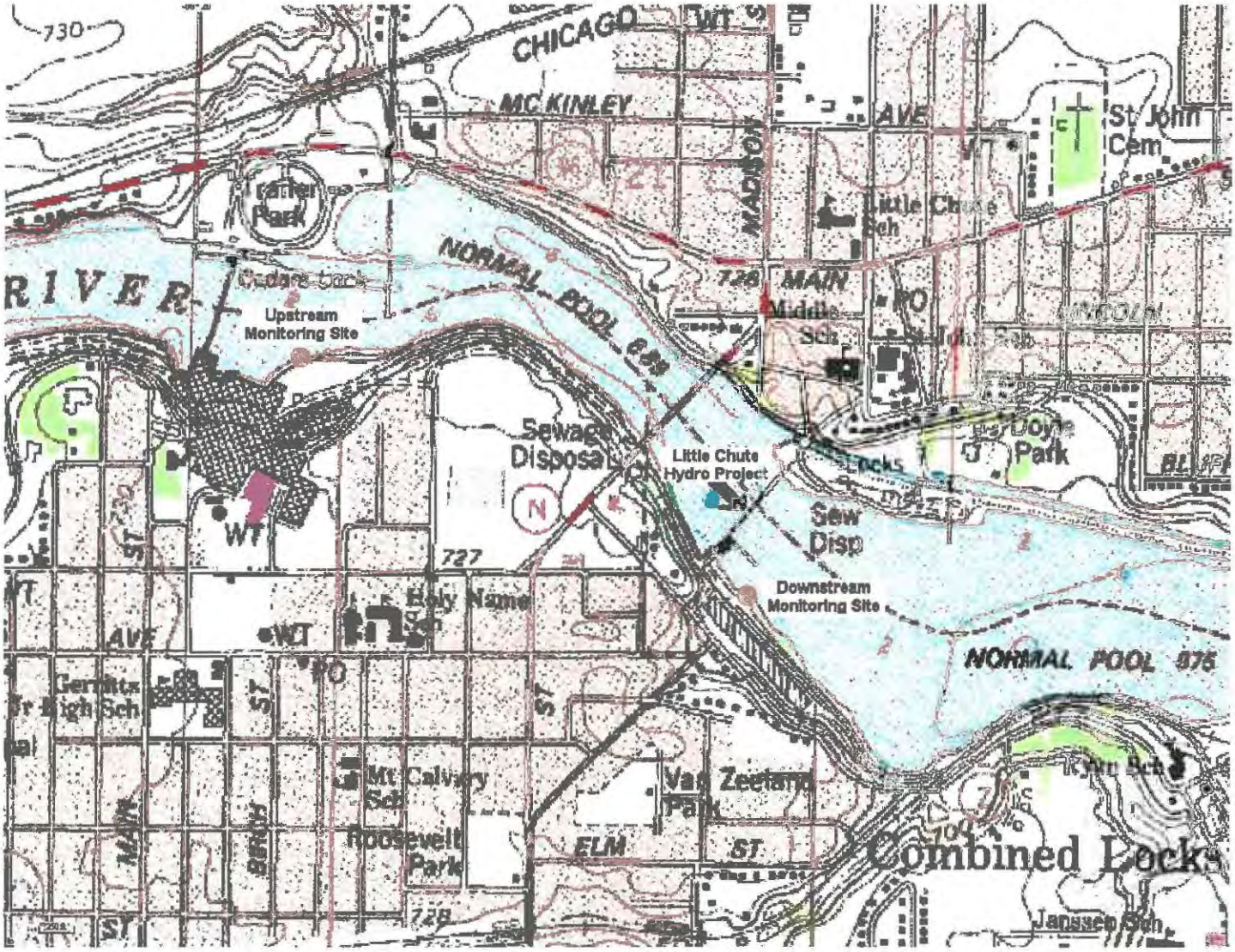
(B) This order constitutes final agency action. Requests for rehearing by the Commission may be filed within 30 days of the date of issuance of this order, pursuant to 18 CFR § 385.713.

Rebecca Martin

Rebecca Martin
Team Leader
Division of Hydropower Administration
and Compliance

Appendix G: Map of Monitoring Locations

Locations of upstream and downstream sites for water quality monitoring, Little Chute Hydroelectric Project, June 15 through September 30, 2011.



KAUKAUNA UTILITIES

"Community Owned, Customer Driven"

December 21, 2016

Ms. Kimberly Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Subject: Water Quality Monitoring Report
Little Chute Hydroelectric Project, FERC No. 2588-007

Dear Ms. Bose:

City of Kaukauna (Kaukauna Utilities) received a new Federal Energy Regulatory Commission (FERC) License on April 11, 2000. Article 403 of the License includes Water Quality Monitoring every five years in consultation with your agency. Attached is our fourth, five-year report for your review and comment.

Specifically, Article 403 requires the City to record temperature and dissolved oxygen upstream and downstream of Little Chute Dam. Article 403 specifies data, criteria and methods which are included in Appendix B of the attached report. The primary criterion of concern is that differences in daily average of dissolved oxygen between upstream and downstream be less than 2 mg/l and that WDNR be notified if variances occur for five consecutive days. This criterion was always met in 2016 where data were available. Temperatures were nearly identical upstream and downstream of the project and remained within normal ranges for the season and discharges experienced in 2016. In reviewing results for 2016 as well as 2011, 2006, and 2001, there is no evidence that operations of the Little Chute Hydroelectric Project are affecting dissolved oxygen or temperature.

Kaukauna Utilities also submitted this report to the Wisconsin Department of Natural Resources (WDNR), the U.S. Fish and Wildlife Service, and the Outagamie County Land Conservation Department (collectively, the agencies) on December 8, 2016, and confirmed receipt by the agencies shortly thereafter. We also supplied data electronically to the WDNR (Excel file) at their request on December 9, 2016. Based on communications with each agency, Kaukauna Utilities confirmed that none of the agencies would be submitting written comments.

The WDNR has invited Kaukauna Utilities to discuss appropriate modifications to the monitoring program for the Project in early 2017. Such modifications would recognize the findings of the four Water Quality Monitoring Reports completed to date and the fact that Kaukauna Utilities has limited ability to control conditions because ACOE is the authority on water levels and flows at this dam. We will follow up with FERC next year on proposed modifications to the monitoring program after consultation with the WDNR.

Thank you for assisting the City of Kaukauna. We are available to respond to questions or comments.

Michael Pedersen

Manager of Generation and Operations
Kaukauna Utilities

Enclosure: 2016 Report including CD-ROM with all data and a PDF of the full Report

Copy to:

Mr. John Zygaj ***(hard copy of the report)***
Regional Engineer
Federal Energy Regulatory Commission
Chicago Regional Office
230 South Dearborn Street, Room 3130
Chicago, IL 60604

Ms. Cheryl Laatsch ***(copy of the cover letter, previously received an electronic copy of the report)***
WI Department of Natural Resources
Horicon Field Office
N7725 Highway 28
Horicon, WI 53023-9783

Mr. Nick Utrup ***(copy of the cover letter, previously received an electronic copy of the report)***
U.S. Department of Interior
Fish and Wildlife Service
4101 American Boulevard E.
Bloomington, MN 55425-1665

Mr. Gregory Baneck ***(copy of the cover letter, previously received an electronic copy of the report)***
Outagamie Co. Land Conservation Dept.
3365 W. Brewster Street
Appleton, WI 54914

GEI Consultants

Consulting
Engineers and
Scientists

2016 Water Quality Monitoring Report

Little Chute
Hydroelectric Project
FERC No. 2588-007
Little Chute, Wisconsin

Submitted to:
Kaukauna Utilities

Submitted by:
GEI Consultants, Inc.
3159 Voyager Drive
Green Bay, Wisconsin 54311

December 21, 2016
Project No. 1609770

Faith Zangl
Staff Engineer

Roger A. Miller, P.G., C.P.G.
Senior Hydrogeologist

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1.0 Project Background

Article 403 of the City of Kaukauna's current license for the Little Chute Project (FERC No. 2588) requires the City to file a water quality plan. The City filed the plan on August 14, 2000, and FERC issued an Order Approving Water Quality Plan on August 24, 2000. The order calls for the licensee to monitor dissolved oxygen (DO) and temperature upstream and downstream of the project for the period from June 15 through September 30 for the first year (2001) and then once every five years for the duration of the license.

In 2016, the City of Kaukauna retained GEI Consultants, Inc., of Green Bay, Wisconsin, to conduct monitoring for the current period.

Instrumentation consisted of Hach HL4 sondes outfitted with sensors positioned upstream and downstream from the project to record hourly temperature and dissolved oxygen (DO) data. HL4 technology is more compact with longer battery life. Each sonde had a backup temperature probe to the real time data probe and was equipped with LDO (Luminescent Dissolved Oxygen) technology. Data were stored onboard the sonde data logger and downloaded to a computer for in-season analysis and compliance purposes initially at biweekly intervals in June and then at 7 to 10 day intervals for the remainder of the study. After each download, the DO probe was calibrated prior to redeployment. Limited data losses and calibration issues are discussed and logged in Appendix D.

Sondes were deployed and monitoring compliance data began June 16, 2016, and the first results were downloaded on June 27, 2016. Sondes had been factory calibrated but were recalibrated prior to deployment in 2016. Probes were calibrated according to manufacturer recommendations at each data download and analyzed for WQMP compliance. Sondes were retrieved, calibrated, and removed from operation on October 3, 2016, after the close of the monitoring season on September 30.

This report presents monitoring data, statistics, water quality compliance information, quality assurance data, and a description of equipment outages as required by the Order Approving Water Quality Plan. Graphs comparing the hourly and averaged daily upstream and downstream dissolved oxygen and temperature readings are provided in Appendix A. The corresponding raw data is included as Appendix B and provided on disk in Excel format in Appendix C as an attached CD-ROM. A copy of this report is also provided as a PDF file on the same CD-ROM.

2.0 Results

Fox River inflows are under the control of Army Corps of Engineers (Corps) and outflows are nearly synchronous to inflows at the dam. Figures in Appendix A show discharge in the Fox River during the study period, as measured at a U.S. Geological Survey monitoring station in Appleton, Wisconsin (USGS Station 04084445). Fox River discharge ranged between 5,500 cfs and 8,000 cfs from June 15 to June 21. Flows dropped about 2,500 cfs to 3,500 cfs from June 21 to July 7. Flows increased to 4,500 cfs from July 7 to July 13. Flows dropped to 800 cfs to 3,500 cfs from July 13 to July 25. Flows increased to 4,000 cfs to 8,000 cfs from July 25 through August 2. Flows decreased to 700 cfs to 3,500 cfs from August 2 through August 26. Flows increased from 4,500 cfs to 5,000 cfs from August 26 through August 30. Flows decreased from 2,500 cfs to 3,600 cfs from August 30 to September 6. Flows increased to 6,000 cfs to 10,000 cfs from September 6 to September 15. Flows decreased to 1,900 cfs to 4,000 cfs from September 15 to September 21. Flows increased to above 4,000 cfs for the reminder of the monitoring period. High water also included significant bedload movement and may have been contributed to equipment outages and resulting data gaps observed.

According to the FERC order approving the Water Quality Monitoring Plan for the Little Chute Project dated August 24, 2000 (Appendix E), upstream and downstream probes should be deployed from June 15 through September 30, "unless flows in the river are above 4,000 cubic feet per second, which would inhibit safe deployment of the probes." Flows exceeded this threshold for approximately 40% of the monitoring period. Nevertheless, sondes were deployed for the vast majority (94%) of the study period[1]. The shaded areas of the Figures in Appendix A depict the time periods when Fox River flow rose higher than 4,000 cfs during the study period. In general, high flows lead to better conditions for temperature and dissolved oxygen and would tend to reduce any differences between headwater and tailwaters due to low reservoir residence times and more mixing in the water column. The data corroborate this. For both upstream and downstream dissolved oxygen and temperature data, the daily averages of the difference between the daily means were graphed (Figures 4, 5, and 6, Appendix A) and the standard deviation of the difference between the daily means calculated (Table 1, Appendix A).

Results of the study show that temperature variation of upstream and downstream environments displayed nearly identical patterns of temporal variation (i.e., no differences). Dissolved oxygen differences between upstream and downstream environments were also negligible when erroneous data from equipment outages were eliminated.

The average daily DO ranged between 5.1 mg/L and 9.4 mg/L for the entire study upstream and downstream except for a period between July 2 and July 6 where the upstream sonde likely experienced significant sedimentation. The sonde was serviced on July 6, and the DO increased accordingly. This data was clipped from the Figures 1 and 4 in Appendix A. The original

[1] The sondes were initially deployed on June 16, 2016 during a period of flows exceeding 4,000 cfs that began before the target start date for monitoring of June 15, 2016.

unabridged/raw data is included as Figures 1 and 4 in Appendix B. The summary of clipped data and data outages are included in Table 2 of Appendix A and in Appendix D.

When compiling the unabridged data, the mean of the difference in the average daily dissolved oxygen concentration was -0.38 mg/L (upstream minus downstream) with a standard deviation of ± 0.99 mg/L. The unabridged data set included four days in which the daily DO average difference exceeded 2 mg/L. As explained in Table 2 of Appendix A, data from July 2 through July 6 was clipped from the final data set due to observed sedimentation and was remedied by recalibration and redeployment of the upstream sonde. After compiling the clipped data, the mean of the difference in the average daily dissolved oxygen concentration was reduced to -0.18 mg/L with a standard deviation of ± 0.24 mg/L. When both data sets were available and by omitting DO data from the upstream probe during periods of significant sedimentation and/or biofouling, at no time did upstream and downstream vary by greater than 2 mg/L for five or more consecutive days, a condition indicated as a cause for special discussion with the WDNR according to the FERC order. A comparison of the daily means for dissolved oxygen concentration and temperature are provided in Appendix A (Table 1).

The mean of the difference in the daily temperature averages was -0.04°C (upstream minus downstream) with a standard deviation of ± 0.04°C. (The negative sign indicates that the daily averages for upstream temperature were lower than downstream; however, the mean difference in daily averages was less than the error variance of the recording instrument - i.e., zero).

Little Chute met WQMP criteria for temperature and dissolved oxygen in 2016. Temperature never exceeded the 89°F maximum criterion; and differences between DO upstream and downstream never exceeded 2 mg/L for more than one day after the erroneous data was omitted.

The upstream and downstream monitoring equipment was calibrated at least every two weeks at which time the data were also checked. The pre- and post-calibration DO values were compared and never differed by more than 0.99 mg/L at the downstream probe, or 0.21 mg/L at the upstream probe. Accordingly, DO data are considered acceptable, because pre- and post-calibration readings were within 1.0 mg/L at least 70% of the time. Calibration summaries for the upstream and downstream monitoring units are provided in Appendix A.

3.0 Conclusions

Table 2 of Appendix A and Appendix D explain data gaps, outages, and rationale for revised data sets. Based on missing data, data out of normally expected ranges, equipment failure, and equipment tampering, the original data sets were modified and were not used to re-compute the daily averages. Since data were downloaded approximately every seven to ten days, a failure early in the sample period could lead to several days of missing data. This explains why some days have missing averages either upstream or downstream of the project. Calibration of the instruments enabled us to check unit functionality and identify erroneous data from the periods prior to calibration. Calibration also confirmed the reliability of data during many of the sampling periods.

We obtained reliable DO readings from one or both probes for 94% of the study period even though flows were in excess of 4,000 cfs for approximately 40% of the period. Days in which both DO probes were providing good data showed no daily variances greater than required by the FERC License.

Based on consistently similar values during all times when both probes were functioning simultaneously, we concluded there is no reason to suspect divergence may have occurred unnoticed when one probe was out of service for either DO or temperature. As discussed earlier, the high flows kept temperature nearly identical both upstream and downstream. Turbulence along with low residence times in the reservoir also contributed to similar DO values upstream and downstream. With or without data corrections, computations show that the data were within compliance for all variables in the FERC License.

Hach's latest technology HL4 sondes were deployed in 2016. They are smaller, more compact and have improved electronics and battery life compared to the older MS-5 sondes employed in 2011. The HL4 sondes may also have manufacturing issues including periodic battery housing leakage, although this did not require replacement sondes to be deployed. Rather, cracked battery housings (two instances) were replaced with new ones.

The data provide confidence that the projects in 2016 met the WQMP criteria as follows: (1) average daily temperatures were within the natural range of the river and no greater than 89°F; and (2) average daily dissolved oxygen was always above 5 ppm (mg/L) with upstream and downstream differences greater than 2 mg/L never occurring on any sequential day (5 days is the criterion). Sonde malfunctions and fouling occurred and caused data gaps; however, no variable provided less than 94 days of data at the Little Chute upstream and downstream locations. With the exception of a three-day period from August 1 through August 3, complete records were obtained for every variable for the entire season. Daily averages from the collective data set were always in compliance with the WQMP. Further, the correlated patterns

and close relationships of the upstream and downstream variables during the 94 to 101 days when comparative data were available support the conclusion that no criteria were ever violated.

In summary, we conclude that the Little Chute project has met the WQMP criteria for 2016. Overall, data and findings presented in WQMRs for previous monitoring periods under this FERC License in 2001, 2006, and 2011 are consistent with the 2016 monitoring period.

Appendix A

Figures (Clipped Data)

Tables (Clipped Data)

Figure 1. Hourly Dissolved Oxygen Readings, Upstream and Downstream of the Little Chute Hydroelectric Plant
FERC No. 2588 on the Fox River in Little Chute, Wisconsin

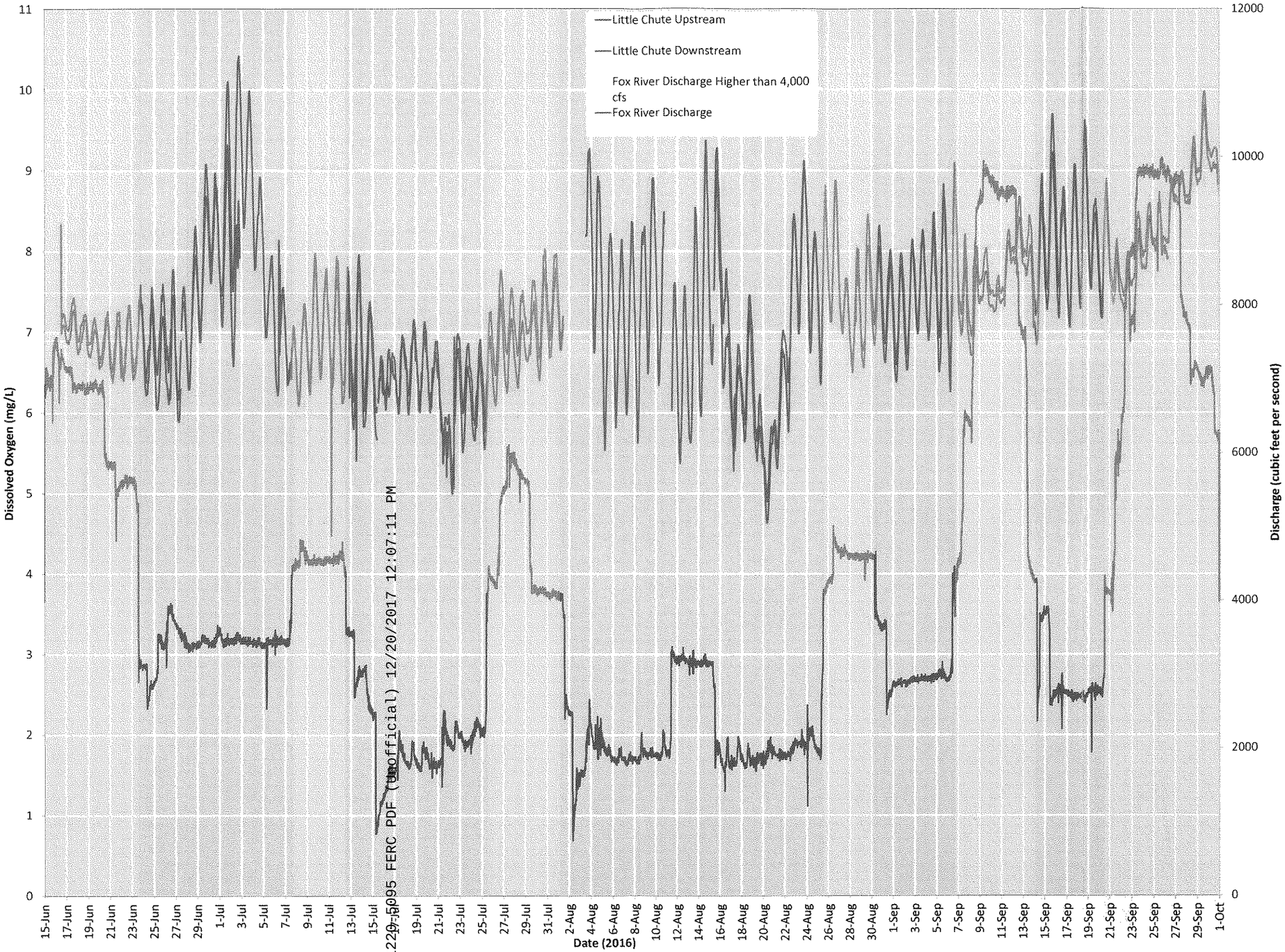


Figure 2. Hourly Temperature Readings, Upstream and Downstream of the Little Chute Hydroelectric Plant
FERC No. 2588 on the Fox River in Little Chute, Wisconsin

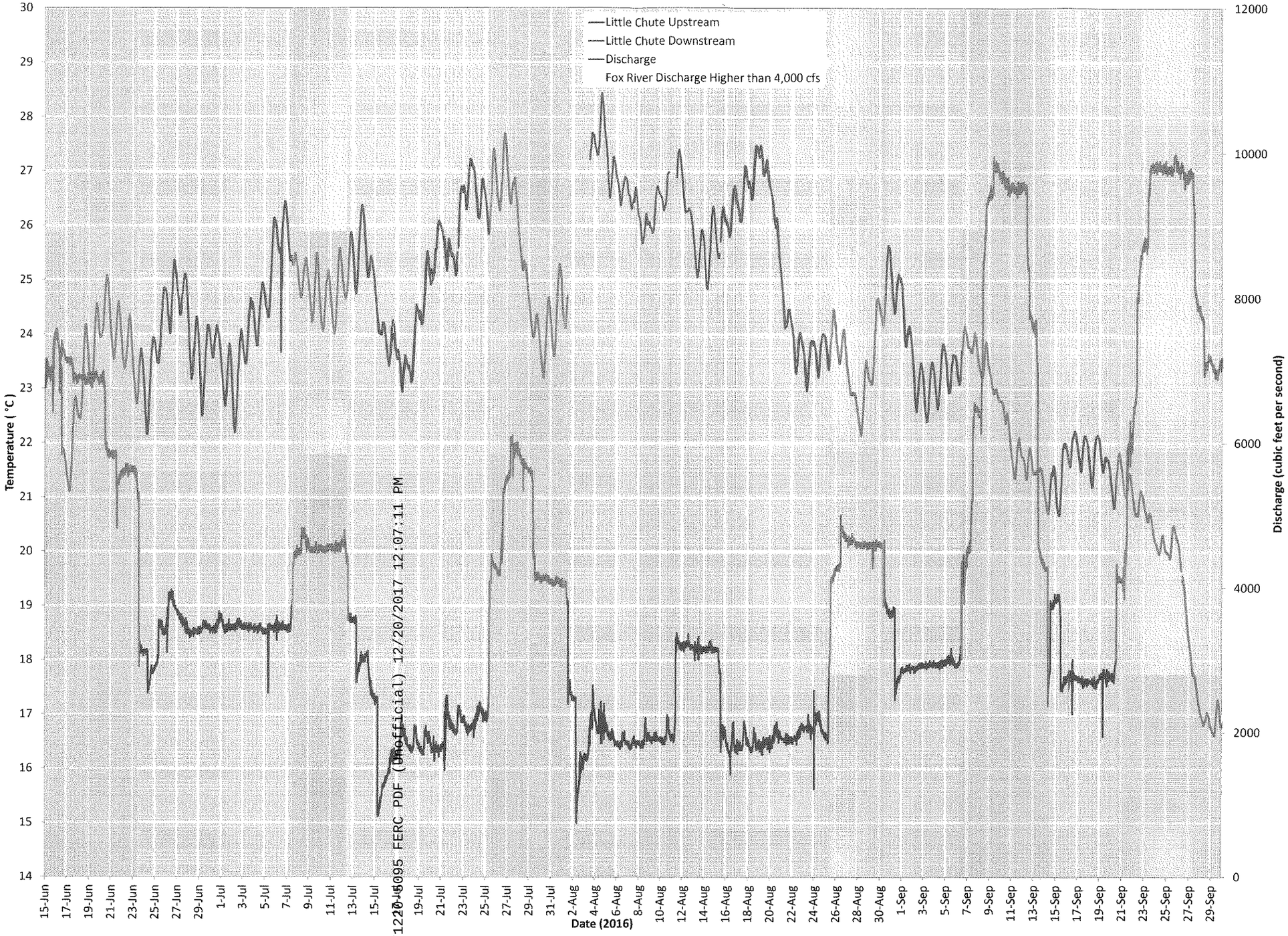


Figure 3. Hourly Electrical Conductivity Readings, Upstream and Downstream of the Little Chute Hydroelectric Plant
FERC No. 2588 on the Fox River in Little Chute, Wisconsin

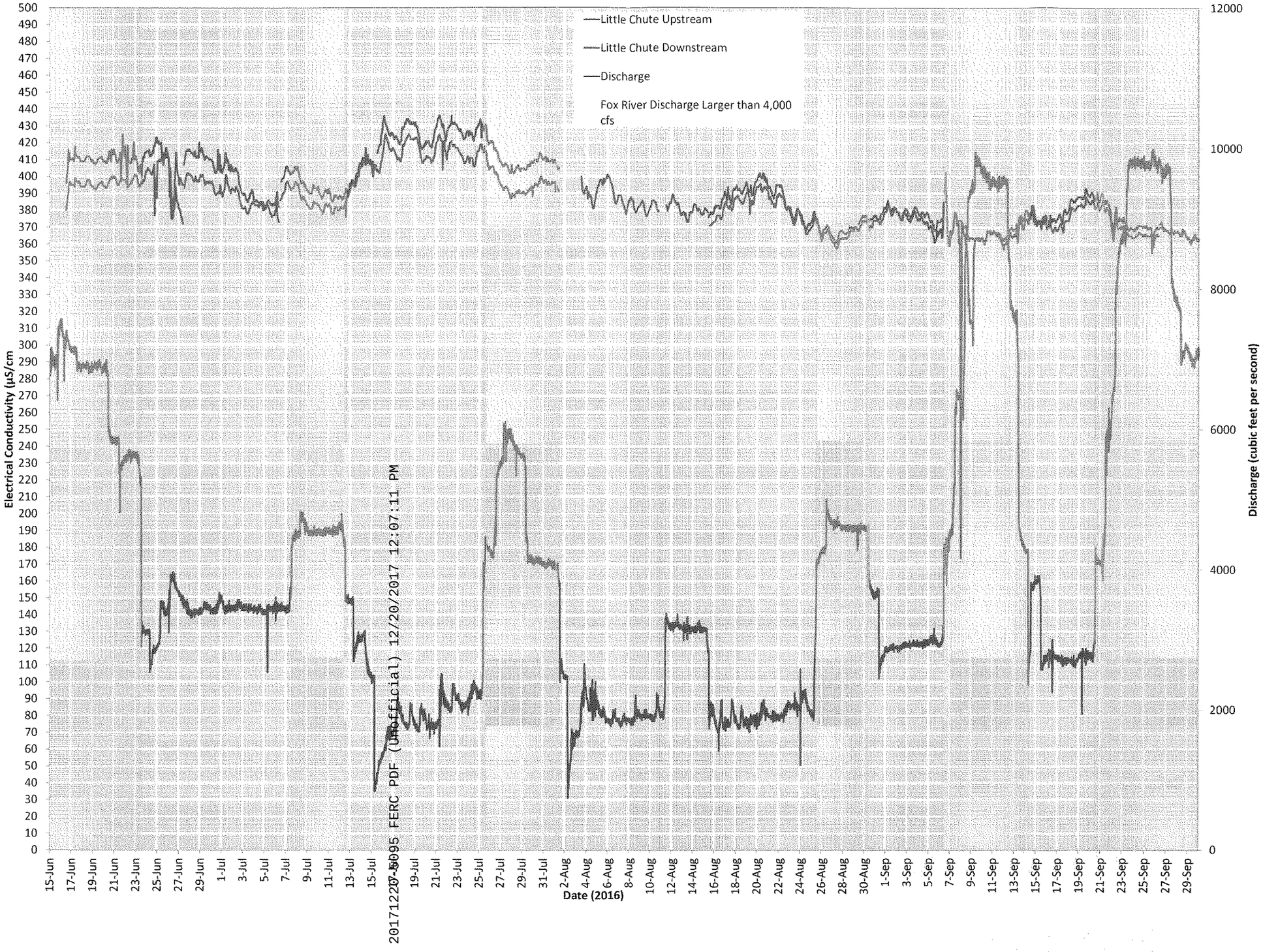


Figure 4. Daily Dissolved Oxygen Readings, Upstream and Downstream of the Little Chute Hydroelectric Plant
FERC No. 2588 on the Fox River in Little Chute, Wisconsin

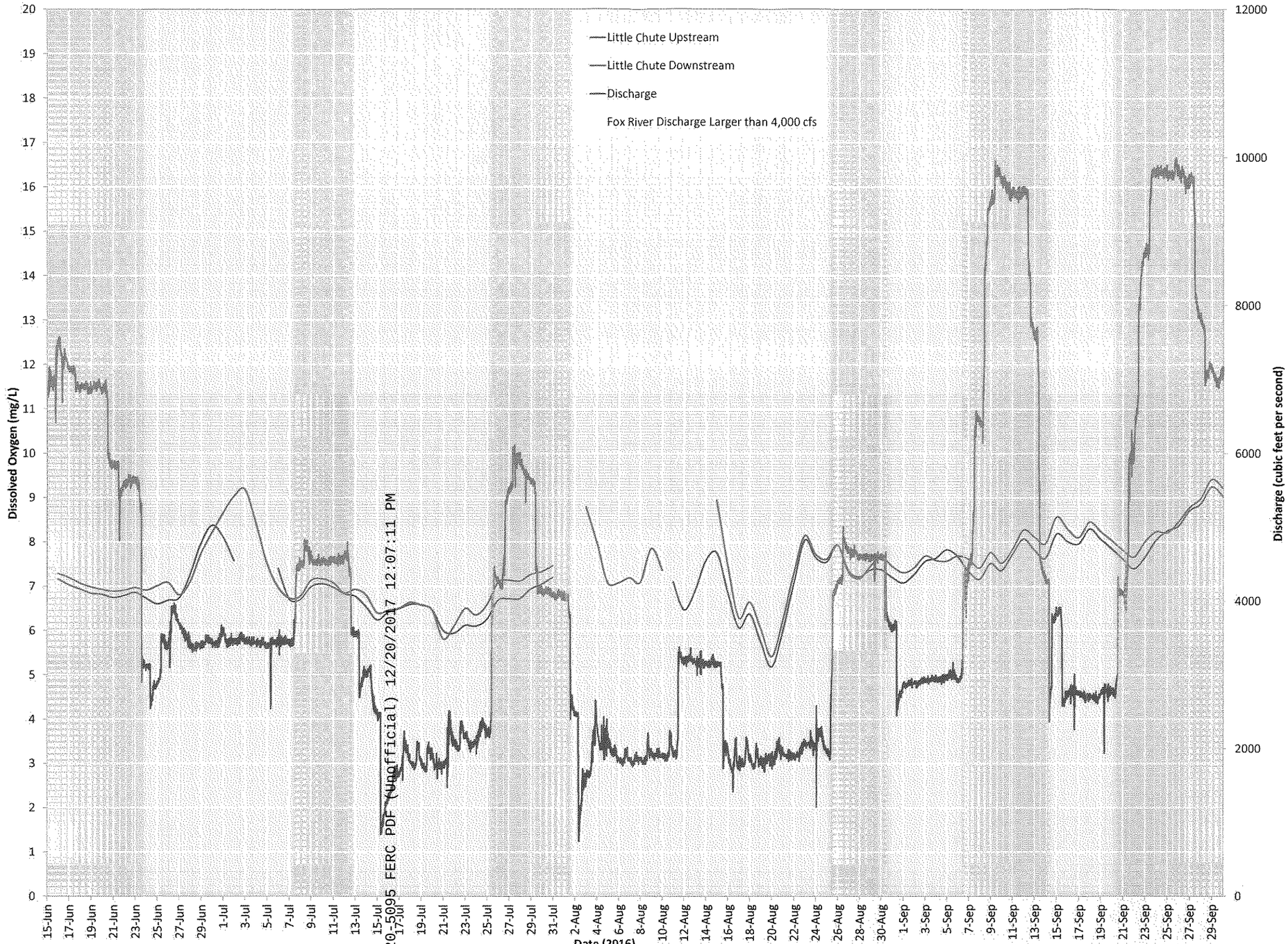


Figure 5. Daily Temperature Readings, Upstream and Downstream of the Little Chute Hydroelectric Plant
FERC No. 2588 on the Fox River in Little Chute, Wisconsin

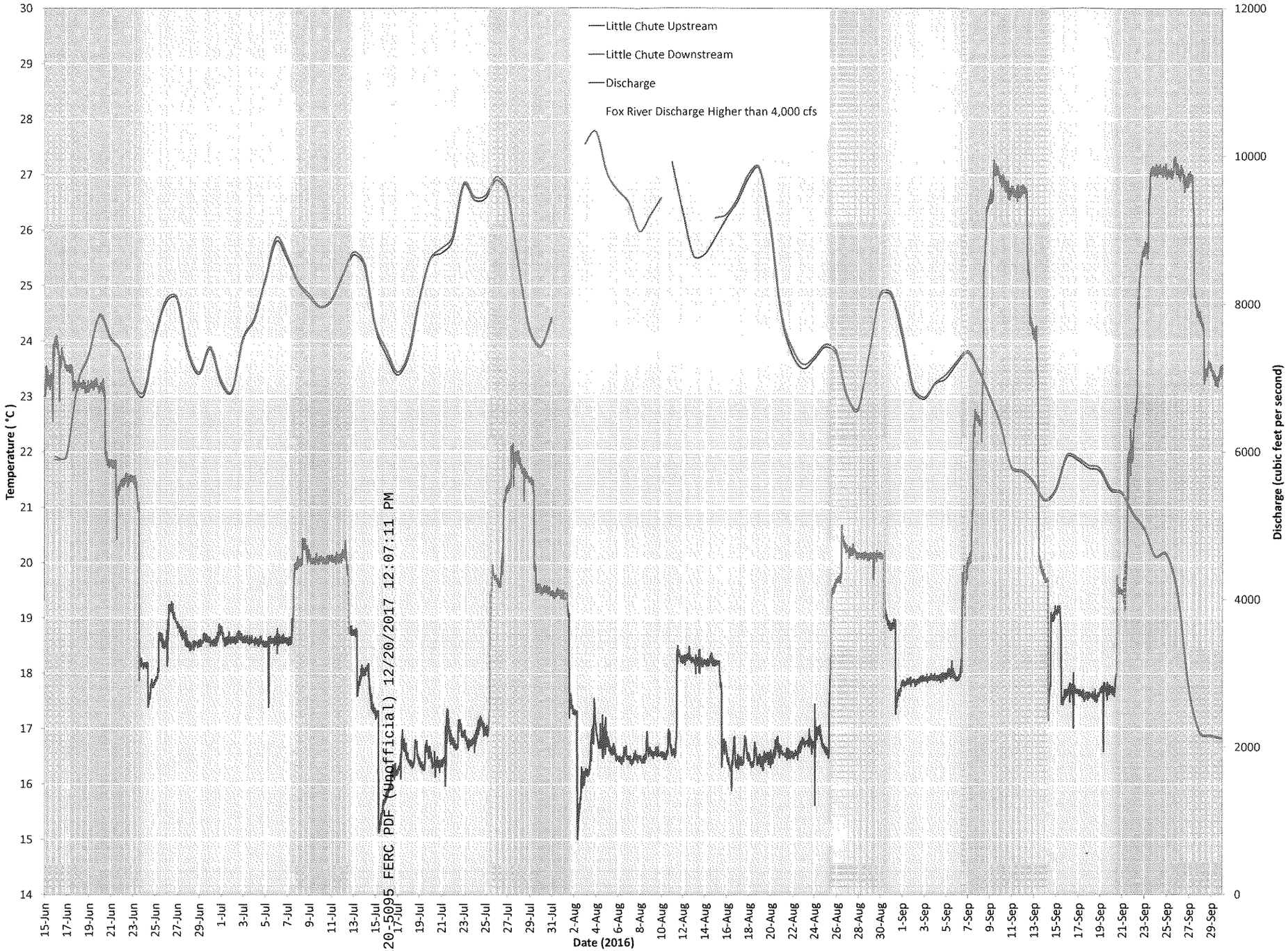


Figure 6. Daily Electrical Conductivity Readings, Upstream and Downstream of the Little Chute Hydroelectric Plant
FERC No. 2588 on the Fox River in Little Chute, Wisconsin

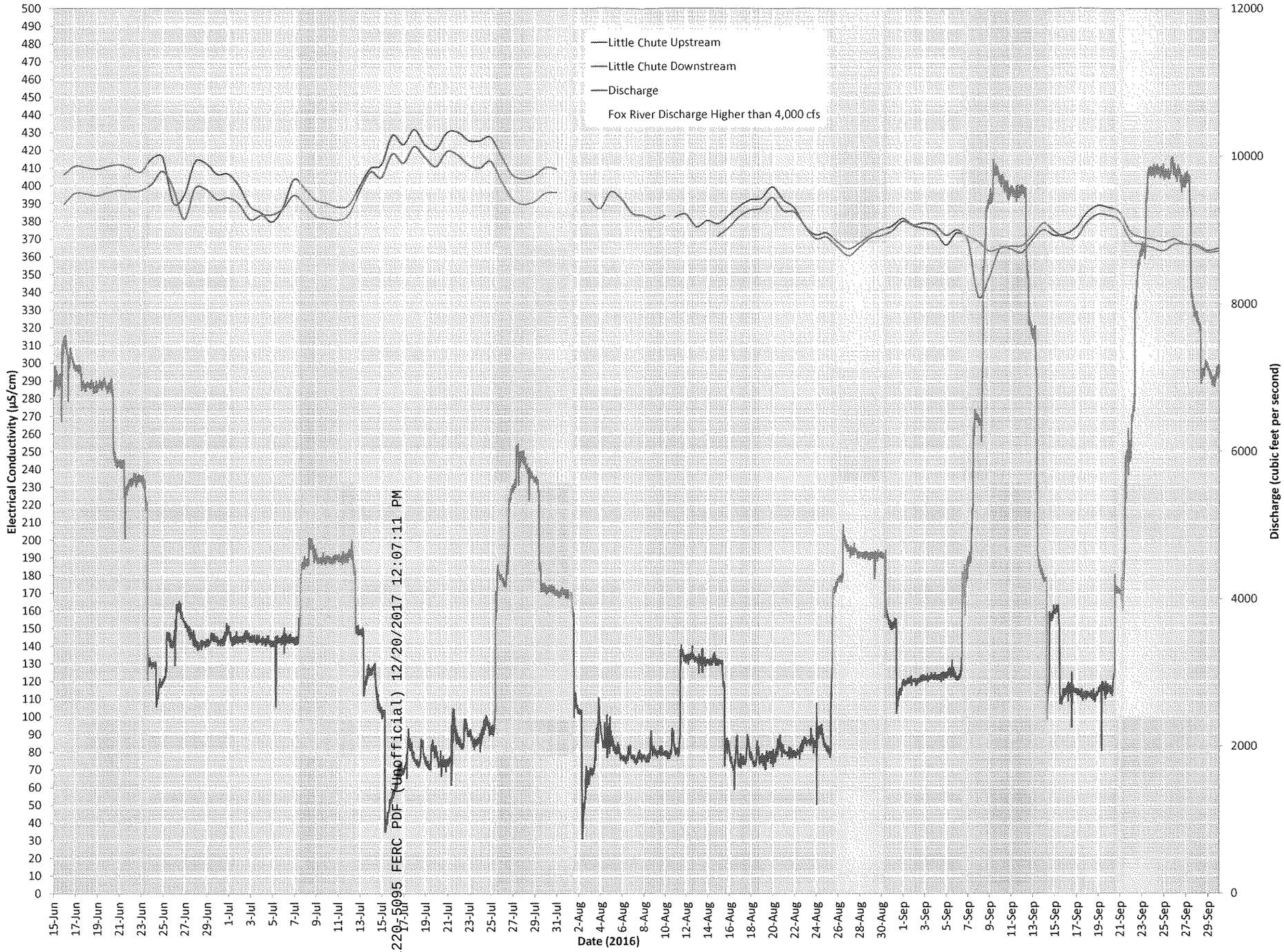


Table 1.
Little Chute, FERC No. 2588 on the Fox River In Little Chute, Wisconsin
Little Chute Daily Averages of Upstream and Downstream Dissolved Oxygen and Temperature Data
Difference = Upstream - Downstream
**Note: Shaded dates = service date (data downloads and calibration)

Date (shading = service date)	Date with flow >4,000 cfs?	Dissolved Oxygen (mg/L)			Temperature (°C)		
		Upstream	Downstream	Difference	Upstream	Downstream	Difference
6/16/2016	Yes	7.17	7.29	-0.12	21.92	21.86	0.06
6/17/2016	Yes	7.03	7.20	-0.17	21.91	21.93	-0.03
6/18/2016	Yes	6.94	7.07	-0.13	23.22	23.25	-0.03
6/19/2016	Yes	6.84	6.98	-0.14	23.73	23.77	-0.04
6/20/2016	Yes	6.82	6.93	-0.11	24.45	24.48	-0.04
6/21/2016	Yes	6.74	6.89	-0.14	24.03	24.07	-0.04
6/22/2016	No	6.79	6.91	-0.12	23.80	23.82	-0.02
6/23/2016	No	6.86	6.97	-0.11	23.22	23.26	-0.03
6/24/2016	No	6.73	6.91	-0.18	23.03	23.09	-0.06
6/25/2016	No	6.60	7.01	-0.41	24.05	24.08	-0.04
6/26/2016	No	6.69	7.09	-0.40	24.70	24.75	-0.06
6/27/2016	No	6.74	6.81	-0.07	24.76	24.80	-0.03
6/28/2016	No	7.26	7.10	0.16	23.81	23.87	-0.06
6/29/2016	No	7.98	7.75	0.23	23.40	23.44	-0.04
6/30/2016	No	8.38	8.22	0.16	23.86	23.90	-0.04
7/1/2016	No	8.12	8.66	-0.54	23.24	23.29	-0.05
7/2/2016	No	7.58	9.03	-1.45	23.08	23.11	-0.02
7/3/2016	No		9.19		24.03	24.06	-0.03
7/4/2016	No		8.42		24.38	24.41	-0.03
7/5/2016	No		7.51		25.09	25.12	-0.03
7/6/2016	No	7.40	6.97	0.43	25.80	25.87	-0.07
7/7/2016	No	6.71	6.74	-0.02	25.47	25.53	-0.05
7/8/2016	Yes	6.70	6.77	-0.07	25.03	25.07	-0.03
7/9/2016	Yes	6.99	7.13	-0.14	24.79	24.85	-0.06
7/10/2016	Yes	7.06	7.17	-0.11	24.61	24.63	-0.01
7/11/2016	Yes	6.98	7.08	-0.10	24.72	24.75	-0.04
7/12/2016	Yes	6.83	6.85	-0.02	25.17	25.19	-0.02
7/13/2016	Yes	6.77	6.93	-0.16	25.55	25.60	-0.05
7/14/2016	No	6.53	6.80	-0.27	25.37	25.41	-0.05
7/15/2016	No	6.36	6.54	-0.18	24.00	23.96	0.04
7/16/2016	No	6.42	6.46	-0.04	23.74	23.84	-0.10
7/17/2016	No	6.49	6.50	-0.01	23.39	23.44	-0.05
7/18/2016	No	6.60	6.64	-0.04	23.73	23.79	-0.06
7/19/2016	No	6.59	6.58	0.01	24.74	24.77	-0.03
7/20/2016	No	6.47	6.47	0.00	25.48	25.48	0.00
7/21/2016	No	6.00	5.82	0.19	25.59	25.68	-0.09
7/22/2016	No	5.95	6.11	-0.16	25.81	25.88	-0.08
7/23/2016	No	6.12	6.50	-0.38	26.81	26.84	-0.03
7/24/2016	No	6.10	6.35	-0.25	26.55	26.60	-0.05
7/25/2016	No	6.26	6.59	-0.33	26.57	26.63	-0.06
7/26/2016	Yes	6.69	7.09	-0.40	26.91	26.97	-0.06
7/27/2016	Yes	6.72	7.14	-0.42	26.64	26.70	-0.06
7/28/2016	Yes	6.73	7.12	-0.39	25.34	25.39	-0.05
7/29/2016	Yes	6.95	7.28	-0.33	24.18	24.22	-0.04
7/30/2016	Yes	7.06	7.34	-0.28	23.89	23.93	-0.03
7/31/2016	Yes	7.21	7.47	-0.26	24.40	24.43	-0.04
8/1/2016	Yes						
8/2/2016	Yes						
8/3/2016	No		8.80			27.56	
8/4/2016	No		7.99			27.77	
8/5/2016	No		7.08			27.03	
8/6/2016	No		7.09			26.72	
8/7/2016	No		7.20			26.50	
8/8/2016	No		7.10			25.99	
8/9/2016	No		7.86			26.28	
8/10/2016	No		7.37			26.58	

Table 1.
Little Chute, FERC No. 2588 on the Fox River In Little Chute, Wisconsin
Little Chute Daily Averages of Upstream and Downstream Dissolved Oxygen and Temperature Data
Difference = Upstream - Downstream
**Note: Shaded dates = service date (data downloads and calibration)

Date (shading = service date)	Date with flow >4,000 cfs?	Dissolved Oxygen (mg/L)			Temperature (°C)		
		Upstream	Downstream	Difference	Upstream	Downstream	Difference
8/11/2016	No	7.11			27.23		
8/12/2016	No	6.48			26.35		
8/13/2016	No	6.89			25.54		
8/14/2016	No	7.59			25.57		
8/15/2016	No	7.76	8.95	-1.19	25.88	26.23	-0.35
8/16/2016	No	6.86	7.46	-0.61	26.22	26.29	-0.07
8/17/2016	No	6.07	6.30	-0.22	26.52	26.57	-0.05
8/18/2016	No	6.38	6.65	-0.27	26.94	27.01	-0.08
8/19/2016	No	5.75	6.05	-0.30	27.11	27.13	-0.02
8/20/2016	No	5.19	5.42	-0.23	26.06	26.13	-0.07
8/21/2016	No	6.00	6.24	-0.24	24.44	24.48	-0.04
8/22/2016	No	7.08	7.31	-0.23	23.75	23.86	-0.11
8/23/2016	No	8.05	8.15	-0.10	23.51	23.59	-0.08
8/24/2016	No	7.66	7.74	-0.08	23.68	23.72	-0.05
8/25/2016	No	7.56	7.62	-0.06	23.90	23.94	-0.05
8/26/2016	No	7.93	7.94	-0.01	23.77	23.83	-0.06
8/27/2016	Yes	7.36	7.32	0.04	22.98	23.02	-0.04
8/28/2016	Yes	7.22	7.18	0.04	22.77	22.80	-0.04
8/29/2016	Yes	7.38	7.46	-0.08	23.78	23.80	-0.01
8/30/2016	Yes	7.38	7.67	-0.29	24.82	24.87	-0.04
8/31/2016	No	7.21	7.46	-0.25	24.83	24.88	-0.05
9/1/2016	No	7.08	7.31	-0.23	24.11	24.20	-0.09
9/2/2016	No	7.27	7.43	-0.15	23.13	23.18	-0.05
9/3/2016	No	7.57	7.69	-0.12	22.96	22.99	-0.03
9/4/2016	No	7.64	7.59	0.05	23.23	23.25	-0.02
9/5/2016	No	7.83	7.58	0.25	23.33	23.40	-0.07
9/6/2016	No	7.68	7.69	-0.01	23.59	23.63	-0.04
9/7/2016	Yes	7.34	7.62	-0.28	23.79	23.83	-0.04
9/8/2016	Yes	7.16	7.42	-0.25	23.47	23.51	-0.04
9/9/2016	Yes	7.52	7.77	-0.25	23.01	23.04	-0.03
9/10/2016	Yes	7.36	7.53	-0.17	22.50	22.53	-0.03
9/11/2016	Yes	7.72	7.84	-0.12	21.72	21.75	-0.03
9/12/2016	Yes	8.07	8.28	-0.20	21.64	21.67	-0.04
9/13/2016	Yes	7.83	8.12	-0.29	21.45	21.48	-0.03
9/14/2016	Yes	7.64	7.97	-0.33	21.13	21.16	-0.03
9/15/2016	Yes	8.19	8.57	-0.38	21.31	21.33	-0.02
9/16/2016	No	8.01	8.29	-0.28	21.91	21.95	-0.04
9/17/2016	No	7.97	8.11	-0.14	21.86	21.90	-0.05
9/18/2016	No	8.30	8.46	-0.16	21.72	21.76	-0.05
9/19/2016	No	8.07	8.25	-0.17	21.66	21.71	-0.05
9/20/2016	No	7.86	8.05	-0.18	21.31	21.35	-0.04
9/21/2016	No	7.62	7.82	-0.20	21.25	21.28	-0.03
9/22/2016	Yes	7.41	7.67	-0.26	20.87	20.91	-0.03
9/23/2016	Yes	7.67	8.02	-0.35	20.61	20.64	-0.03
9/24/2016	Yes	8.05	8.24	-0.19	20.12	20.14	-0.02
9/25/2016	Yes	8.26	8.21	0.05	20.15	20.17	-0.03
9/26/2016	Yes	8.36	8.45	-0.09	19.45	19.50	-0.06
9/27/2016	Yes	8.71	8.78	-0.07	17.74	17.78	-0.04
9/28/2016	Yes	8.86	8.98	-0.12	16.93	16.95	-0.02
9/29/2016	Yes	9.25	9.42	-0.17	16.86	16.89	-0.03
9/30/2016	Yes	9.03	9.22	-0.19	16.82	16.83	-0.01
Minimum		5.19	5.42	-1.45	16.82	16.83	-0.35
Average		7.21	7.45	-0.18	23.64	23.83	-0.04
Maximum		9.25	9.42	0.43	27.23	27.77	0.06
Standard Deviation		0.75	0.79	0.24	2.20	2.28	0.04
Number of Data Points		94	101	90	97	101	93

Table 2.
Little Chute, FERC No. 2588 on the Fox River in Little Chute, Wisconsin
Summary of Data Gaps and Clipped Data

Time Period	Little Chute Upstream				Little Chute Downstream			
	DO		EC		DO		EC	
	Clipped Data	Justification	Clipped Data	Justification	Clipped Data	Justification	Clipped Data	Justification
6/15/2016								
6/16/2016								
6/17/2016								
6/18/2016								
6/19/2016								
6/20/2016								
6/21/2016								
6/22/2016								
6/23/2016								
6/24/2016								
6/25/2016								
6/26/2016								
6/27/2016								
6/28/2016								
6/29/2016								
6/30/2016								
7/1/2016								
7/2/2016	7/2/16 22:00 to 7/6/16 11:00	7/6/16 Notes: Sonde experienced moderate biofouling						
7/3/2016								
7/4/2016								
7/5/2016								
7/6/2016								
7/7/2016								
7/8/2016								
7/9/2016								
7/10/2016								
7/11/2016								
7/12/2016								
7/13/2016								
7/14/2016								
7/15/2016								
7/16/2016								
7/17/2016								
7/18/2016								
7/19/2016								
7/20/2016								
7/21/2016								
7/22/2016								
7/23/2016								
7/24/2016								
7/25/2016								
7/26/2016								
7/27/2016								
7/28/2016								
7/29/2016								
7/30/2016								
7/31/2016								
8/1/2016	Data gap from 8/1/16 13:00 to 8/11/16 13:00 due to cracked battery housing				Data gap from 8/1/16 12:00 to 8/3/16 13:00 due to cracked battery housing			
8/2/2016								
8/3/2016								
8/4/2016								
8/5/2016								
8/6/2016								
8/7/2016								
8/8/2016								
8/9/2016								
8/10/2016								
8/11/2016								
8/12/2016					8/10/2016 21:00 to 8/15/16 11:00	Sonde found out of water	8/10/2016 21:00 to 8/15/16 11:00	Sonde found out of water
8/13/2016								
8/14/2016								
8/15/2016								
8/16/2016								
8/17/2016								
8/18/2016								
8/19/2016								
8/20/2016								
8/21/2016								
8/22/2016								

Table 2.
Little Chute, FERC No. 2588 on the Fox River in Little Chute, Wisconsin
Summary of Data Gaps and Clipped Data

Time Period	Little Chute Upstream				Little Chute Downstream			
	DO		EC		DO		EC	
	Clipped Data	Justification	Clipped Data	Justification	Clipped Data	Justification	Clipped Data	Justification
8/23/2016								
8/24/2016								
8/25/2016								
8/26/2016								
8/27/2016								
8/28/2016								
8/29/2016								
8/30/2016								
8/31/2016								
9/1/2016								
9/2/2016								
9/3/2016								
9/4/2016								
9/5/2016								
9/6/2016								
9/7/2016								
9/8/2016								
9/9/2016								
9/10/2016								
9/11/2016								
9/12/2016								
9/13/2016								
9/14/2016								
9/15/2016								
9/16/2016								
9/17/2016								
9/18/2016								
9/19/2016								
9/20/2016								
9/21/2016								
9/22/2016								
9/23/2016								
9/24/2016								
9/25/2016								
9/26/2016								
9/27/2016								
9/28/2016								
9/29/2016								
9/30/2016								

Table 3
Little Chute, FERC No. 2588 on the Fox River In Little Chute, Wisconsin
Little Chute Upstream Station - Sonde Calibration Data

Sonde Serial Number (Bold = Changed Sondes)	Date	Conductivity (µS/cm)			LDO (mg/L)		
		Before	Standard	% Difference	Before	After	% Difference
14289H400114	6/15/2016	1390	1412	1.6%	8.63	8.65	0.2%
14289H400114	6/27/2016	1411	1412	0.1%	8.00	7.99	0.1%
14289H400114	7/6/2016	1412	1412	0.0%	7.90	7.82	1.0%
14289H400114	7/15/2016	1415	1412	0.2%	8.56	8.61	0.6%
14289H400114	7/22/2016	1406	1412	0.4%	7.16	7.35	2.6%
14289H400114	8/1/2016	1409	1412	0.2%	7.01	7.22	2.9%
14289H400114 - Water infiltration in cracked battery housing; lost data from 8/1 to 8/8	8/8/2016						
14289H400114 - Sonde replaced	8/11/2016	1403.5	1412	0.6%	8.29	8.32	0.4%
14289H400114	8/15/2016	1414	1412	0.1%	7.96	7.93	0.4%
14289H400114	8/22/2016	1409	1412	0.2%	8.22	8.33	1.3%
14289H400114	8/29/2016	1414	1412	0.1%	8.01	8.07	0.7%
14289H400114	9/6/2016	1409	1412	0.2%	7.70	7.67	0.4%
14289H400114	9/16/2016	1405	1412	0.5%	8.85	8.78	0.8%
14289H400114	9/26/2016	1408	1412	0.3%	8.87	9.04	1.9%

Table 4
Little Chute, FERC No. 2588 on the Fox River In Little Chute, Wisconsin
Little Chute Downstream Station - Sonde Calibration Data

Sonde Serial Number (Bold = Changed Sondes)	Date	Conductivity (µS/cm)			LDO (mg/L)		
		Before	Standard	% Difference	Before	After	% Difference
15035H400228	6/15/2016	1406	1412	0.4%	8.67	8.62	0.6%
15035H400228	6/27/2016	1425	1412	0.9%	8.08	7.75	4.3%
15035H400228	7/6/2016	1398	1412	1.0%	7.73	8.06	4.1%
15035H400228	7/15/2016	1412	1412	0.0%	8.79	8.77	0.2%
15035H400228	7/22/2016	1420	1412	0.6%	6.14	7.13	13.9%
15035H400228 - Battery housing cracked; removed sonde from operation until battery housing replaced	8/1/2016	1415	1412	0.2%	7.66	7.60	0.8%
15035H400228 - Battery housing replaced	8/3/2016	1397	1412	1.1%	8.80	8.44	4.3%
15035H400228	8/8/2016	1424	1412	0.8%	7.87	7.89	0.3%
15035H400228 - Sonde found above water; data clipped from 8/10/16 21:00 to 8/15/16 11:00	8/15/2016	1408	1412	0.3%	7.54	7.73	2.5%
15035H400228	8/22/2016	1387	1412	1.8%	8.89	8.80	1.0%
15035H400228	8/29/2016	1410	1412	0.1%	7.48	7.85	4.7%
15035H400228	9/6/2016	1411	1412	0.1%	7.64	7.57	0.9%
15035H400228	9/16/2016	1407	1412	0.4%	8.74	8.58	1.9%
15035H400228	9/26/2016	1401	1412	0.8%	9.15	9.13	0.2%

Appendix B

Figures (Unabridged Data)

Figure 1 Raw Data Little Chute Hourly Dissolved Oxygen

Figure 4 Raw Data Little Chute Daily Dissolved Oxygen

Tables (Unabridged Data)

Table 1 Raw Data Little Chute Upstream and Downstream Daily Averages

Figure 1. Hourly Dissolved Oxygen Readings, Upstream and Downstream of the Little Chute Hydroelectric Plant
FERC No. 2588 on the Fox River in Little Chute, Wisconsin

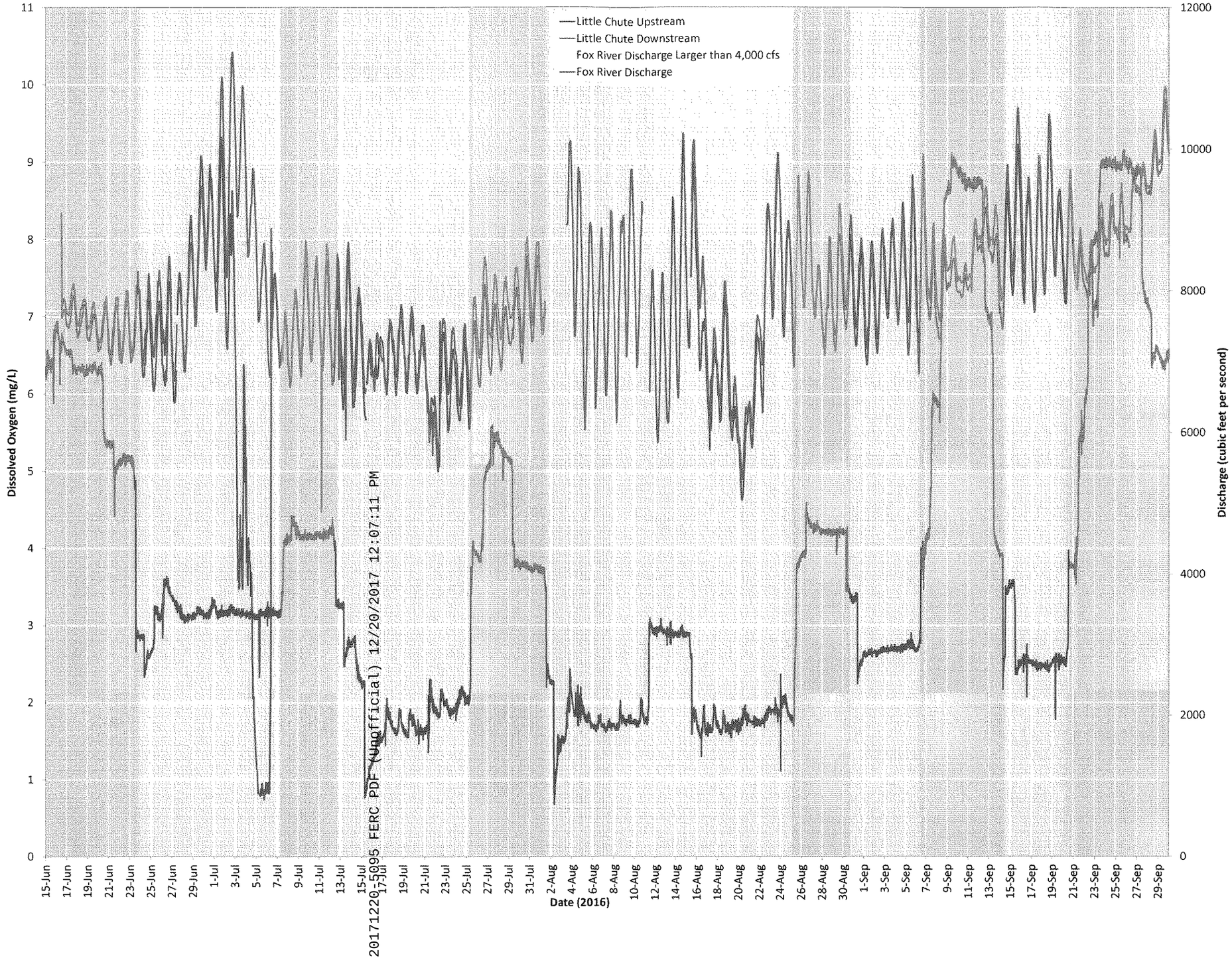


Figure 4. Daily Dissolved Oxygen Readings, Upstream and Downstream of the Little Chute Hydroelectric Plant
FERC No. 2588 on the Fox River in Kaukauna, Wisconsin

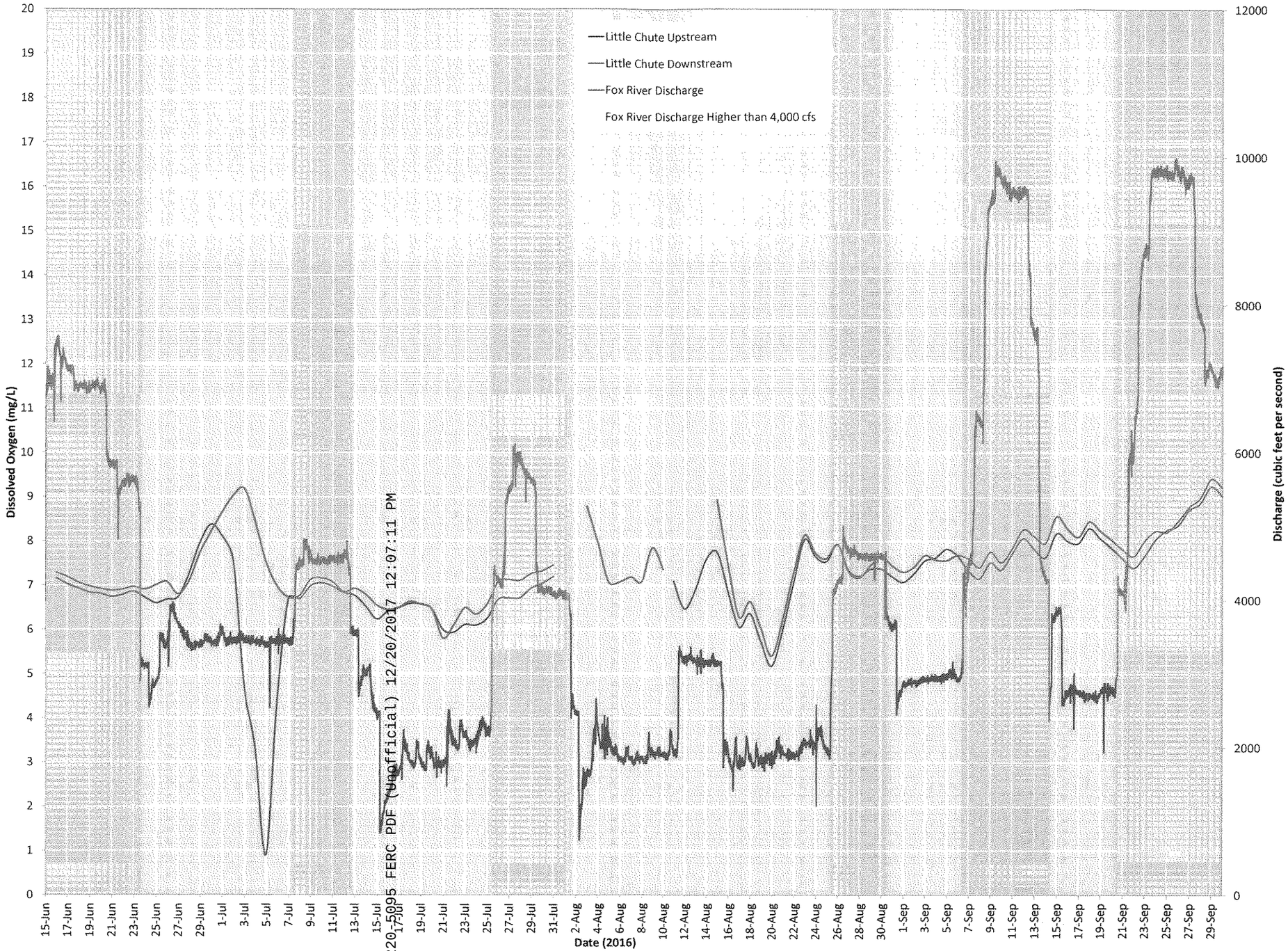


Table 1.
Little Chute, FERC No. 2588 on the Fox River In Little Chute, Wisconsin
Little Chute Daily Averages of Upstream and Downstream Dissolved Oxygen and Temperature Data
Difference = Upstream - Downstream
**Note: Shaded dates = service date (data downloads and calibration)

Date (shading = service date)	Dissolved Oxygen (mg/L)			Temperature (°C)		
	Upstream	Downstream	Difference	Upstream	Downstream	Difference
6/16/2016	7.17	7.29	-0.12	21.92	21.86	0.06
6/17/2016	7.03	7.20	-0.17	21.91	21.93	-0.03
6/18/2016	6.94	7.07	-0.13	23.22	23.25	-0.03
6/19/2016	6.84	6.98	-0.14	23.73	23.77	-0.04
6/20/2016	6.82	6.93	-0.11	24.45	24.48	-0.04
6/21/2016	6.74	6.89	-0.14	24.03	24.07	-0.04
6/22/2016	6.79	6.91	-0.12	23.80	23.82	-0.02
6/23/2016	6.86	6.97	-0.11	23.22	23.26	-0.03
6/24/2016	6.73	6.91	-0.18	23.03	23.09	-0.06
6/25/2016	6.60	7.01	-0.41	24.05	24.08	-0.04
6/26/2016	6.69	7.09	-0.40	24.70	24.75	-0.06
6/27/2016	6.74	6.81	-0.07	24.76	24.80	-0.03
6/28/2016	7.26	7.10	0.16	23.81	23.87	-0.06
6/29/2016	7.98	7.75	0.23	23.40	23.44	-0.04
6/30/2016	8.38	8.22	0.16	23.86	23.90	-0.04
7/1/2016	8.12	8.66	-0.54	23.24	23.29	-0.05
7/2/2016	7.57	9.03	-1.46	23.08	23.11	-0.02
7/3/2016	4.72	9.19	-4.47	24.03	24.06	-0.03
7/4/2016	3.31	8.42	-5.11	24.38	24.41	-0.03
7/5/2016	0.91	7.51	-6.60	25.09	25.12	-0.03
7/6/2016	4.44	6.97	-2.53	25.80	25.87	-0.07
7/7/2016	6.71	6.74	-0.02	25.47	25.53	-0.05
7/8/2016	6.70	6.77	-0.07	25.03	25.07	-0.03
7/9/2016	6.99	7.13	-0.14	24.79	24.85	-0.06
7/10/2016	7.06	7.17	-0.11	24.61	24.63	-0.01
7/11/2016	6.98	7.08	-0.10	24.72	24.75	-0.04
7/12/2016	6.83	6.85	-0.02	25.17	25.19	-0.02
7/13/2016	6.77	6.93	-0.16	25.55	25.60	-0.05
7/14/2016	6.53	6.80	-0.27	25.37	25.41	-0.05
7/15/2016	6.36	6.54	-0.18	24.00	23.96	0.04
7/16/2016	6.42	6.46	-0.04	23.74	23.84	-0.10
7/17/2016	6.49	6.50	-0.01	23.39	23.44	-0.05
7/18/2016	6.60	6.64	-0.04	23.73	23.79	-0.06
7/19/2016	6.59	6.58	0.01	24.74	24.77	-0.03
7/20/2016	6.47	6.47	0.00	25.48	25.48	0.00
7/21/2016	6.00	5.82	0.19	25.59	25.68	-0.09
7/22/2016	5.95	6.11	-0.16	25.81	25.88	-0.08
7/23/2016	6.12	6.50	-0.38	26.81	26.84	-0.03
7/24/2016	6.10	6.35	-0.25	26.55	26.60	-0.05
7/25/2016	6.26	6.59	-0.33	26.57	26.63	-0.06
7/26/2016	6.69	7.09	-0.40	26.91	26.97	-0.06
7/27/2016	6.72	7.14	-0.42	26.64	26.70	-0.06
7/28/2016	6.73	7.12	-0.39	25.34	25.39	-0.05
7/29/2016	6.95	7.28	-0.33	24.18	24.22	-0.04
7/30/2016	7.06	7.34	-0.28	23.89	23.93	-0.03
7/31/2016	7.21	7.47	-0.26	24.40	24.43	-0.04
8/1/2016						
8/2/2016						
8/3/2016		8.80			27.56	
8/4/2016		7.99			27.77	
8/5/2016		7.08			27.03	
8/6/2016		7.09			26.72	
8/7/2016		7.20			26.50	
8/8/2016		7.10			25.99	
8/9/2016		7.86			26.28	
8/10/2016		7.37			26.58	

Table 1.
Little Chute, FERC No. 2588 on the Fox River In Little Chute, Wisconsin
Little Chute Daily Averages of Upstream and Downstream Dissolved Oxygen and Temperature Data
Difference = Upstream - Downstream
**Note: Shaded dates = service date (data downloads and calibration)

Date (shading = service date)	Dissolved Oxygen (mg/L)			Temperature (°C)		
	Upstream	Downstream	Difference	Upstream	Downstream	Difference
8/11/2016	7.11			27.23		
8/12/2016	6.48			26.35		
8/13/2016	6.89			25.54		
8/14/2016	7.59			25.57		
8/15/2016	7.76	8.95	-1.19	25.88	26.23	-0.35
8/16/2016	6.86	7.46	-0.61	26.22	26.29	-0.07
8/17/2016	6.07	6.30	-0.22	26.52	26.57	-0.05
8/18/2016	6.38	6.65	-0.27	26.94	27.01	-0.08
8/19/2016	5.75	6.05	-0.30	27.11	27.13	-0.02
8/20/2016	5.19	5.42	-0.23	26.06	26.13	-0.07
8/21/2016	6.00	6.24	-0.24	24.44	24.48	-0.04
8/22/2016	7.08	7.31	-0.23	23.75	23.86	-0.11
8/23/2016	8.05	8.15	-0.10	23.51	23.59	-0.08
8/24/2016	7.66	7.74	-0.08	23.68	23.72	-0.05
8/25/2016	7.56	7.62	-0.06	23.90	23.94	-0.05
8/26/2016	7.93	7.94	-0.01	23.77	23.83	-0.06
8/27/2016	7.36	7.32	0.04	22.98	23.02	-0.04
8/28/2016	7.22	7.18	0.04	22.77	22.80	-0.04
8/29/2016	7.38	7.46	-0.08	23.78	23.80	-0.01
8/30/2016	7.38	7.67	-0.29	24.82	24.87	-0.04
8/31/2016	7.21	7.46	-0.25	24.83	24.88	-0.05
9/1/2016	7.08	7.31	-0.23	24.11	24.20	-0.09
9/2/2016	7.27	7.43	-0.15	23.13	23.18	-0.05
9/3/2016	7.57	7.69	-0.12	22.96	22.99	-0.03
9/4/2016	7.64	7.59	0.05	23.23	23.25	-0.02
9/5/2016	7.83	7.58	0.25	23.33	23.40	-0.07
9/6/2016	7.68	7.69	-0.01	23.59	23.63	-0.04
9/7/2016	7.34	7.62	-0.28	23.79	23.83	-0.04
9/8/2016	7.16	7.42	-0.25	23.47	23.51	-0.04
9/9/2016	7.52	7.77	-0.25	23.01	23.04	-0.03
9/10/2016	7.36	7.53	-0.17	22.50	22.53	-0.03
9/11/2016	7.72	7.84	-0.12	21.72	21.75	-0.03
9/12/2016	8.07	8.28	-0.20	21.64	21.67	-0.04
9/13/2016	7.83	8.12	-0.29	21.45	21.48	-0.03
9/14/2016	7.64	7.97	-0.33	21.13	21.16	-0.03
9/15/2016	8.19	8.57	-0.38	21.31	21.33	-0.02
9/16/2016	8.01	8.29	-0.28	21.91	21.95	-0.04
9/17/2016	7.97	8.11	-0.14	21.86	21.90	-0.05
9/18/2016	8.30	8.46	-0.16	21.72	21.76	-0.05
9/19/2016	8.07	8.25	-0.17	21.66	21.71	-0.05
9/20/2016	7.86	8.05	-0.18	21.31	21.35	-0.04
9/21/2016	7.62	7.82	-0.20	21.25	21.28	-0.03
9/22/2016	7.41	7.67	-0.26	20.87	20.91	-0.03
9/23/2016	7.67	8.02	-0.35	20.61	20.64	-0.03
9/24/2016	8.05	8.24	-0.19	20.12	20.14	-0.02
9/25/2016	8.26	8.21	0.05	20.15	20.17	-0.03
9/26/2016	8.36	8.45	-0.09	19.45	19.50	-0.06
9/27/2016	8.71	8.78	-0.07	17.74	17.78	-0.04
9/28/2016	8.86	8.98	-0.12	16.93	16.95	-0.02
9/29/2016	9.25	9.42	-0.17	16.86	16.89	-0.03
9/30/2016	9.03	9.22	-0.19	16.82	16.83	-0.01
Minimum	0.91	5.42	-6.60	16.82	16.83	-0.35
Average	7.05	7.45	-0.38	23.64	23.83	-0.04
Maximum	9.25	9.42	0.25	27.23	27.77	0.06
Standard Deviation	1.11	0.79	0.99	2.20	2.28	0.04
Number of Data Points	97	101	93	97	101	93

Appendix D

Description of 2016 Sonde Outages, Replacements, and Comments

APPENDIX D
Description of Little Chute HL4 Sonde Outages, Replacements and Comments

After installing new HL4 Hach Sondes at two agency approved locations in June 2016, GEI serviced each location at weekly to biweekly intervals. Parts of the data set were also compromised by the following history of mechanical failures and replacements:

6/16/16 **LITTLE CHUTE UPSTREAM SONDE S/N H400114 and LITTLE CHUTE DOWNSTREAM SONDE S/N H400228. SONDES S/N H400114 and H400228** were deployed at Little Chute Upstream and Downstream, respectively.

8/1/16 **LITTLE CHUTE DOWNSTREAM SONDE S/N H400228.** The protective battery casing on the sonde cracked during battery replacement. **GEI temporarily removed SONDE S/N H400228** until a new battery casing could be acquired from HACH. Data was lost from 8-1-2016 through 8-3-2016. **SONDE S/N H400228** was redeployed with a new protective battery casing on 8-3-2016.

8/3/16 **LITTLE CHUTE UPSTREAM SONDE S/N H400114. SONDE S/N H400114** was removed from the water and was covered with algae and sediment. The Sonde would not connect to the computer during the attempted data download. GEI attempted to replace the battery and observed the battery cavity as being filled with water and algae. GEI called HACH to troubleshoot the issue. Based on recommendations of HACH, **GEI temporarily removed SONDE S/N H400114**. Data was lost from 8-1-2016 through 8-11-2016. **SONDE S/N H400114** was redeployed with a new protective battery casing on 8-11-2016.

8/15/16 **LITTLE CHUTE DOWNSTREAM SONDE S/N H400228. SONDE S/N H400228** was observed as having been removed from the water and set along the riverbank. Clear evidence of tampering with the unit and damage to the deployment chord was observed. The sonde was recalibrated and GEI replaced the battery. **GEI redeployed SONDE S/N H400228** with a new chord.

Appendix E

FERC Order Approving Water Quality Monitoring Program (Issued August 24, 2000)

92 FERC ¶ 62,170

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

City of Kaukauna — Project No. 2588-007

ORDER APPROVING WATER QUALITY MONITORING PLAN

(Issued August 24, 2000)

The City of Kaukauna (licensee) filed, on August 14, 2000, its water quality monitoring plan under article 403 of the license for the Little Chute Project (FERC No. 2588). The project is located on the Fox River, in the Village of Combined Locks, in Outagamie County, Wisconsin.

BACKGROUND

Article 403 requires the licensee to file, for Commission approval, a plan to monitor water quality in the project area. The plan is required to include a description of the methods which will be used to collect dissolved oxygen (DO) and water temperature data from the project area every five years for the term of the license. In addition, the licensee is required to cooperate with any future plans developed by state or federal agencies to remove contaminated sediments from the lower Fox River. Such cooperation by the licensee may include, for example, providing reasonable access to project facilities and may also include brief and temporary modification of project operations to allow safe working conditions for agency personnel. The licensee is also required to prepare the plan after consultation with the Wisconsin Department of Natural Resources (WDNR).

LICENSEE'S PLAN

The licensee proposes that Hydrolab DataSonde probes, or their equivalent, be deployed at locations upstream and downstream of the project. The probes would be deployed from June 15 through September 30, unless flows in the river are above 4,000 cubic feet per second, which would inhibit safe deployment of the probes. The probes would continuously monitor and record DO and water temperature at 1-hour intervals during this period. The upstream probe would be located at the upstream end of the project's reservoir to provide information on the DO and water temperature as it enters the project. The downstream probe would be located approximately 100 yards below the powerhouse and in the discharge flow. Routine profile monitoring of the reservoir will not be included since results of previous monitoring provided evidence that the reservoir does not stratify significantly.

The data generated from the proposed monitoring will be surveyed biweekly. Should a comparison of the DO data from the upstream and downstream monitoring show a daily average difference between locations of greater than 2 milligrams per liter (mg/L) for a period of five consecutive days or more, discussions will be initiated with the WDNR to determine the cause of the difference. It may be determined during those discussions that profile monitoring should be implemented to help explain the differences.

The probes at each location will be calibrated every 10 to 14 days. Calibration will be performed by using the air calibration method recommended by the manufacturer. Prior to calibration, the oxygen concentration of air readings will be recorded. These data will be compared to post-calibration air oxygen concentrations to derive data on meter error or drift. At the end of the monitoring period, the DO data will be considered acceptable if the meters at each location provide readings during the pre- and post-calibration comparison that is within 1 mg/L at least 70 percent of the time. Should a problem with meeting this calibration standard become apparent during the sampling period, the WDNR will be advised and a plan devised to ensure that the calibration standard is met for the remainder of the sampling period.

A report of the findings during the sampling period will contain: raw data; graphs comparing hourly DO readings from upstream and downstream locations; graphs comparing hourly temperature readings from upstream and downstream locations; basis statistics; quality assurance data and comparison percentage; and a description of all mechanical or other complications in monitoring experienced during the sampling period. The report will be submitted to the WDNR and the Commission by December 31, 2001, and every 5 years thereafter, for the term of the license, unless the WDNR and the licensee agree that future water quality monitoring is no longer necessary.

AGENCY COMMENTS

The WDNR, by letter dated August 2, 2000, concurred with the licensee's proposed plan.

DISCUSSION AND CONCLUSIONS

The licensee's plan to monitor water quality at the project satisfies the requirements of article 403. The licensee will monitor DO and water temperature upstream and downstream of the project for the period from June 15 through September 30 for the first year (2001) and then once every five years for the duration of the license.

The licensee will provide a report following the monitoring season to the WDNR and the Commission by December 31 of the monitoring year.

The licensee states that the monitoring will continue through the term of the license unless the licensee and the WDNR agree that monitoring is no longer needed. In the event that it is determined that monitoring is no longer need at the project, the licensee would need to file with the Commission, for approval, a request to discontinue monitoring and include concurrence from the WDNR.

The licensee's plan to monitor water quality fulfills the requirements of article 403 and should, therefore, be approved.

The Director orders:

(A) The licensee's water quality monitoring plan for the Little Chute Project (FERC No. 2588), filed on August 14, 2000, is approved.

(B) This order constitutes final agency action. Requests for rehearing by the Commission may be filed within 30 days of the date of issuance of this order, pursuant to 18 CFR § 385.713.

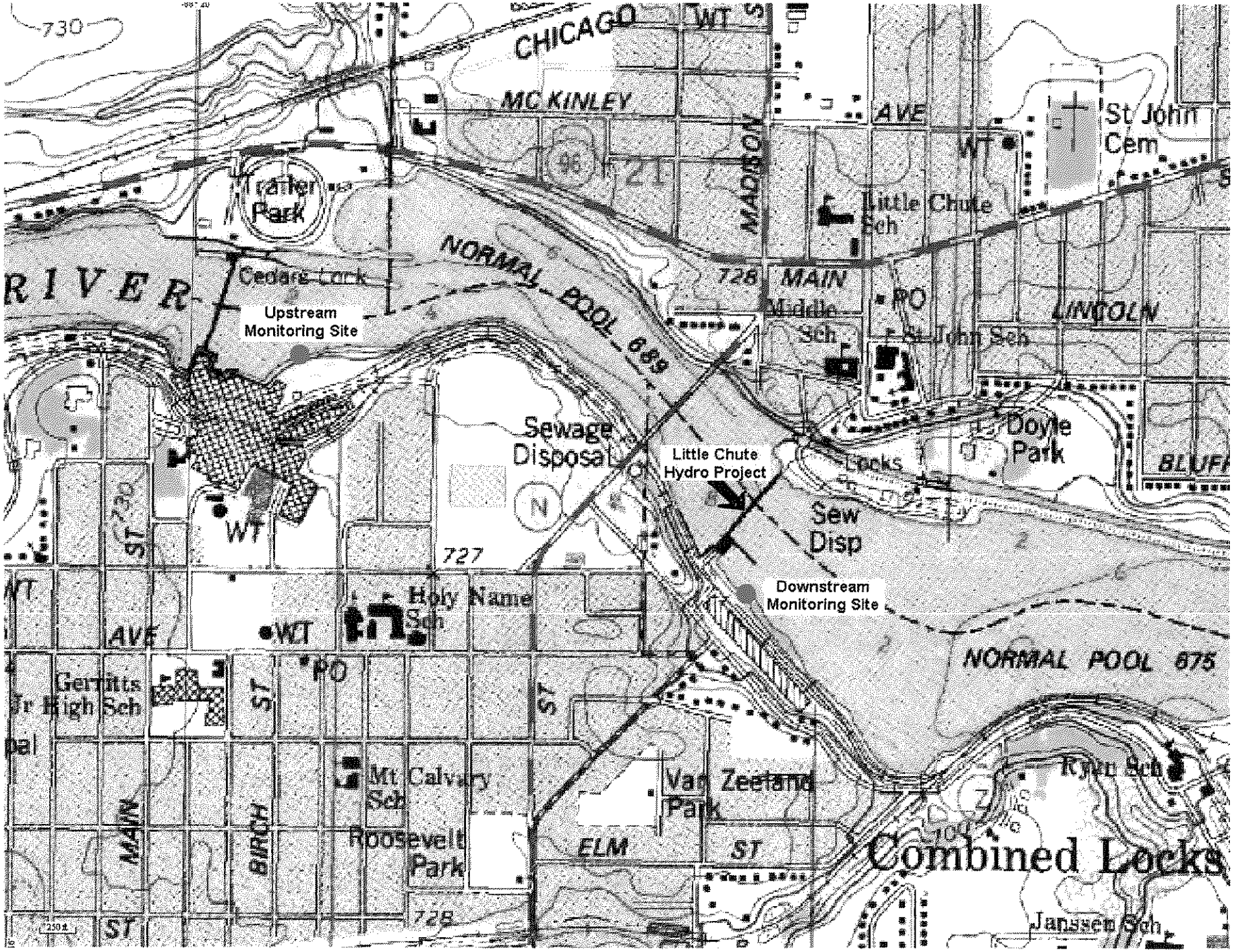
Rebecca Martin

Rebecca Martin
Team Leader
Division of Hydropower Administration
and Compliance

Appendix F

Map of Monitoring Locations

Locations of upstream and downstream sites for water quality monitoring, Little Chute Hydroelectric Project, June 15 through September 30, 2016.



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