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

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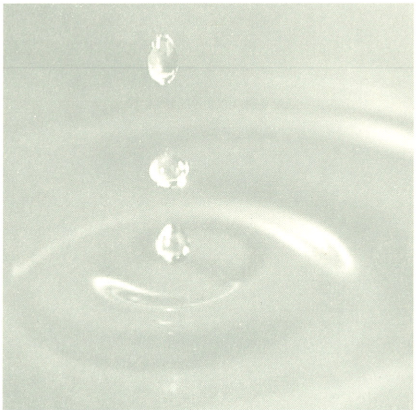
Project No. 112310



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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)

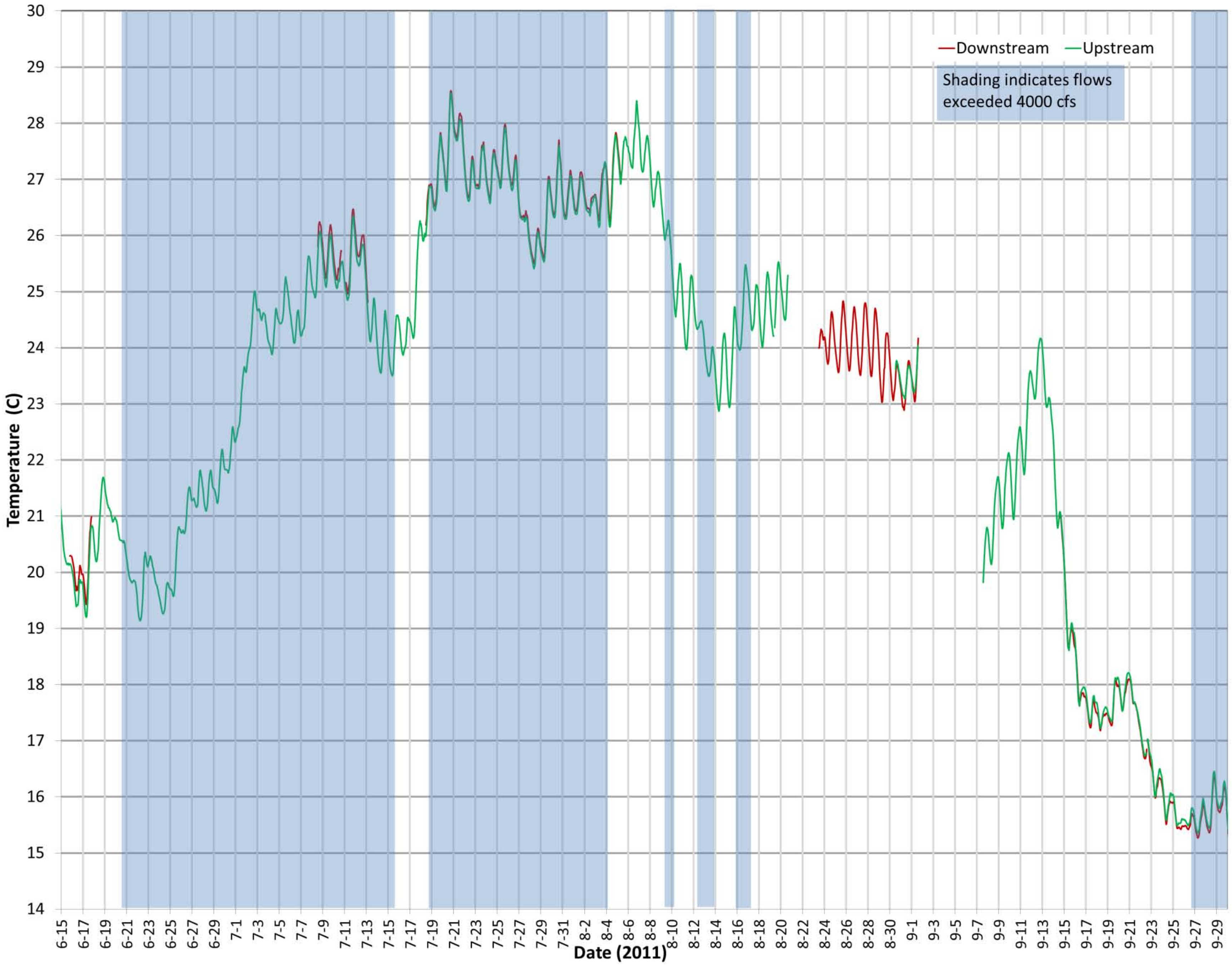

Figure 1. Hourly Temperature Readings Upstream and Downstream of Little Chute Project (High Flow Periods Shaded)

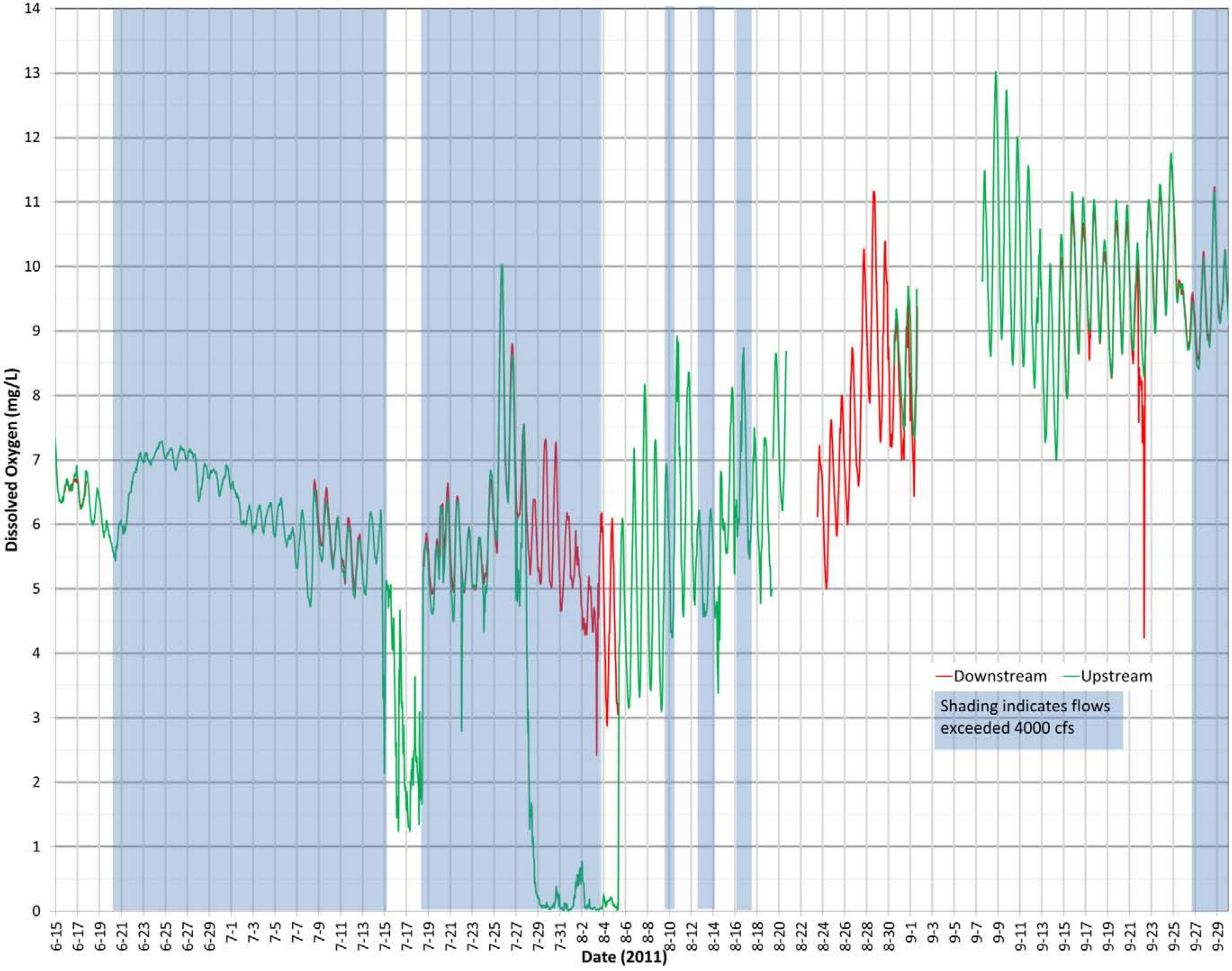

Figure 2. Hourly Dissolved Oxygen Readings Upstream and Downstream of Little Chute Project (High Flow Periods Shaded)

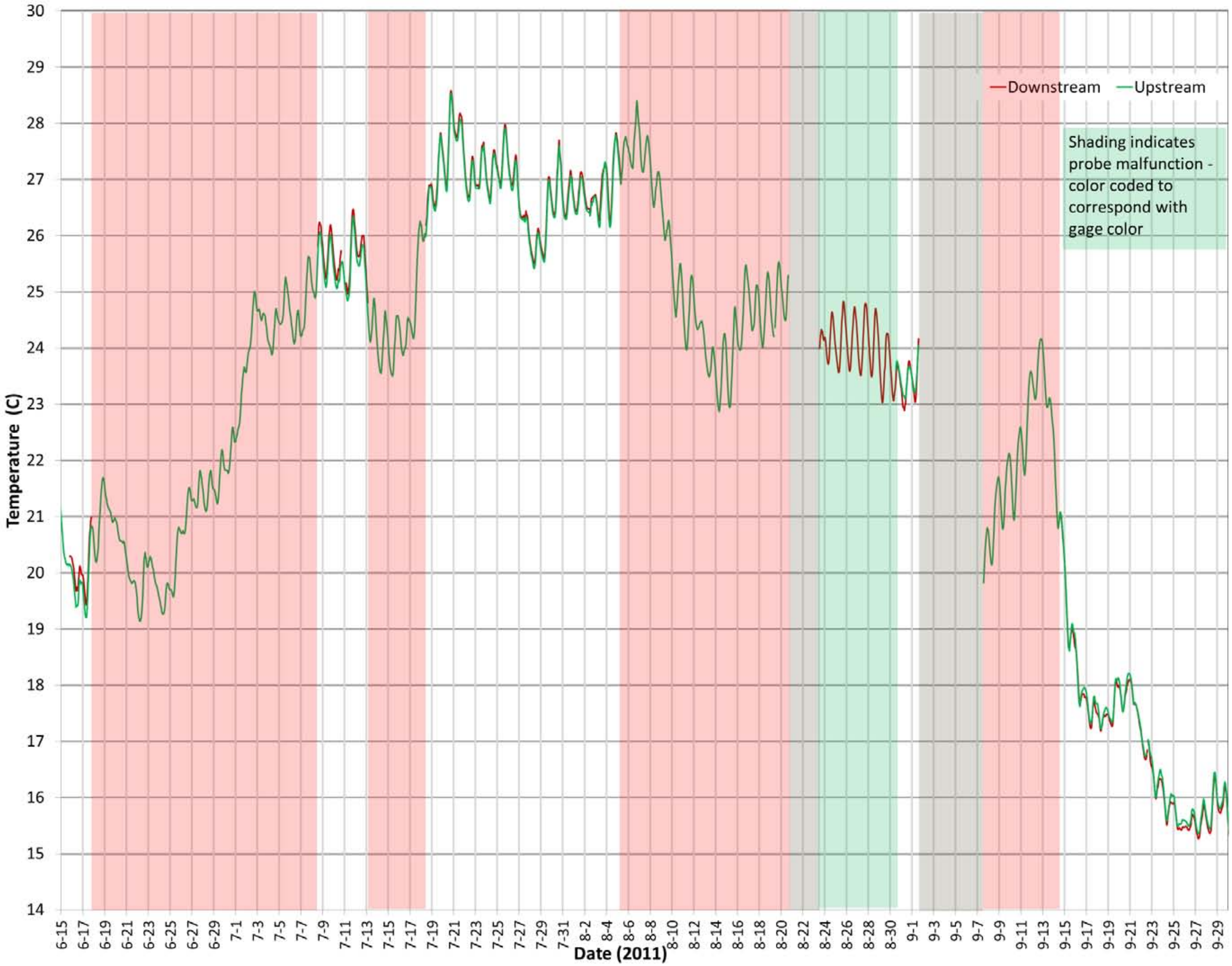

Figure 3. Hourly Temperature Readings Upstream and Downstream of Little Chute Project (Probe Malfunction Periods Shaded)

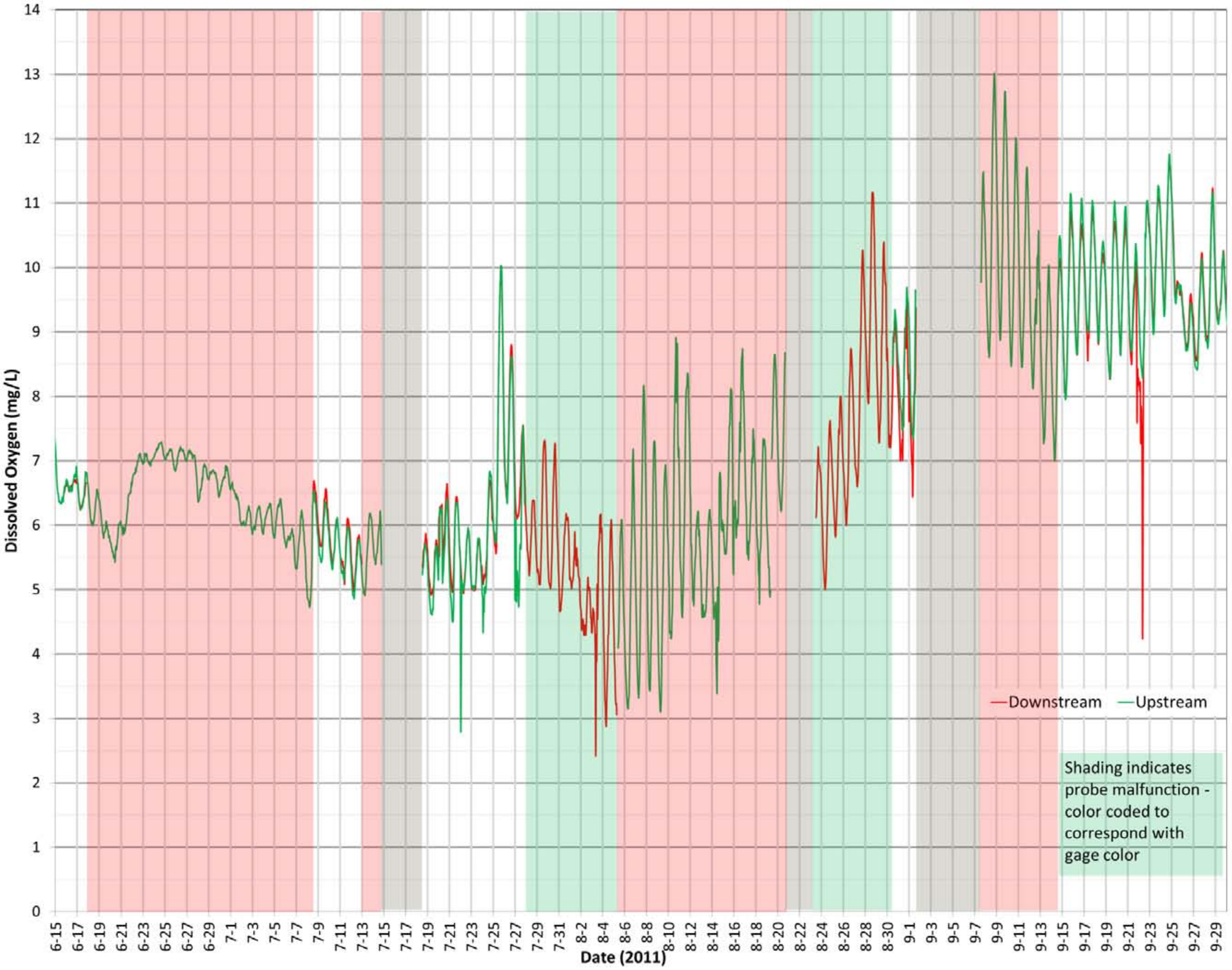

Figure 4. Hourly Dissolved Oxygen Readings Upstream and Downstream of Little Chute Project (Probe Malfunction Periods Shaded)

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
- 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

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 (^{o}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 (^{o}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.

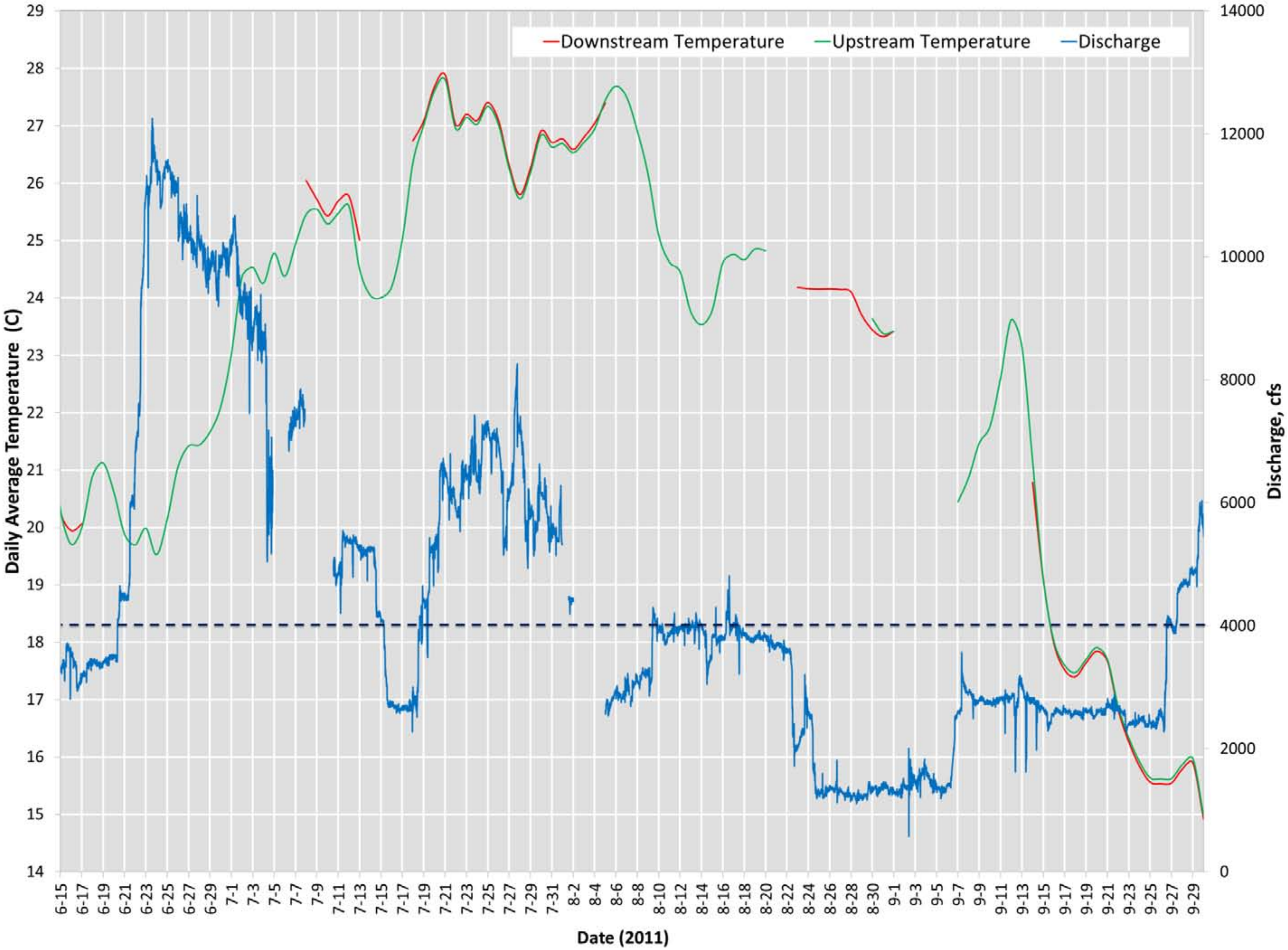

Figure 5. Daily Averages for Temperature Upstream and Downstream of the Little Chute Project and Fox River Discharge

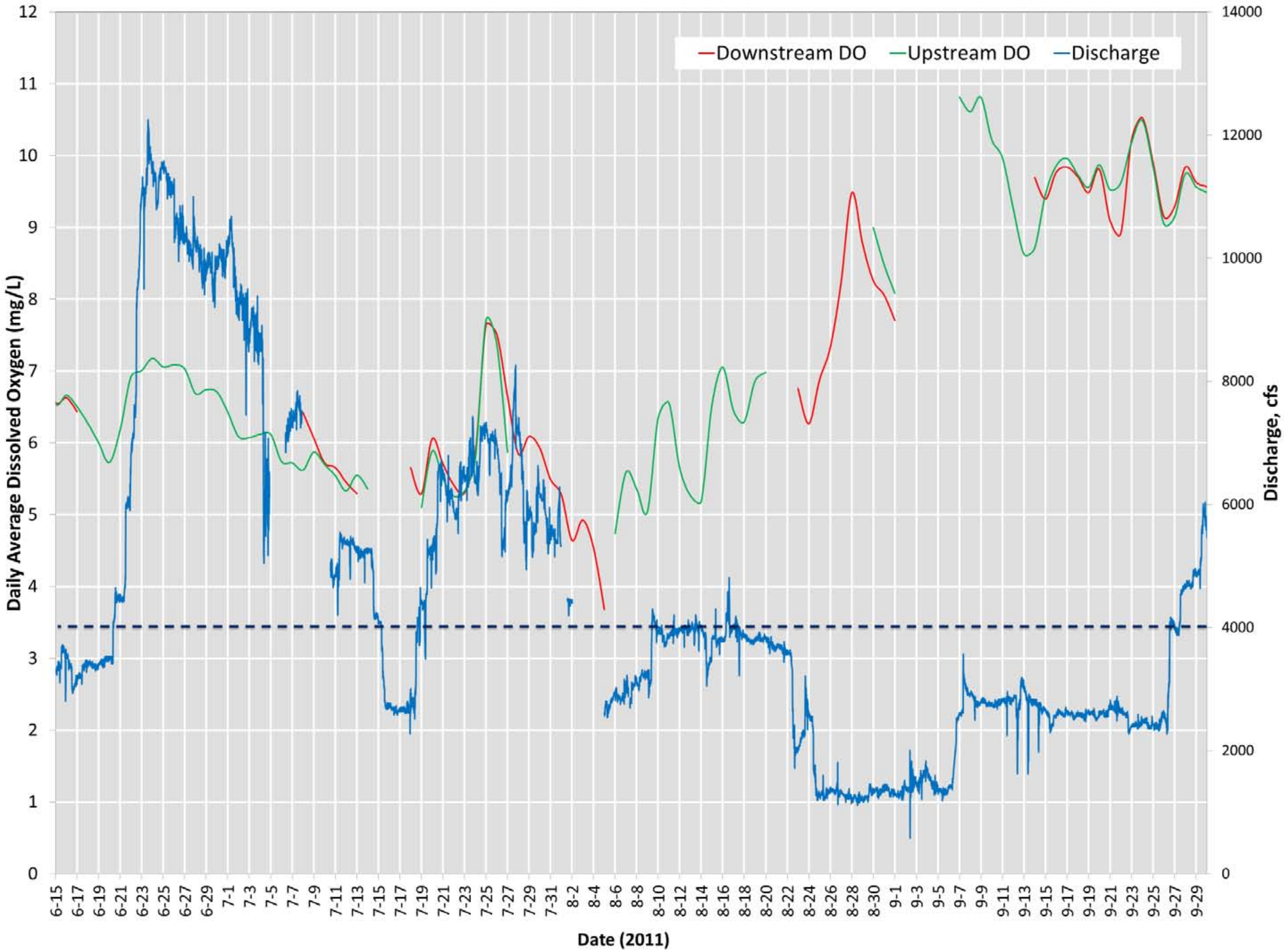

Figure 6. Daily Averages for Dissolved Oxygen Upstream and Downstream of the Little Chute Project and Fox River Discharge

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.

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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.