APPENDIX B-1. Using Large Continuous-Monitoring Datasets to Assess Attainment of Aquatic Life Use at Some Illinois Stream Sites

This document explains how the Surface Water Section (hereafter, "we") of the Illinois Environmental Protection Agency uses water-quality monitoring data, collected by the United States Geological Survey (USGS), to assess attainment of aquatic-life use in Illinois streams. These data represent 12 sites (Table 1) at which USGS automated meters repeatedly measure various parameters in water at short intervals (e.g., 15 minutes) over extended periods (e.g., multiple days, months, or years). For this reporting cycle, we use pH, water temperature, and dissolved oxygen, collected once every 15 minutes from USGS automated meters from January 1, 2015 through December 31, 2019.

Data quality and parameters

The relevant data were collected and reported online by USGS subject to an appropriate Quality Assurance Project Plan. USGS only releases data online that meet quality assurance/quality control criteria. We downloaded the data from USGS online sources.

We use data for parameters that have applicable Illinois water-quality standards (i.e., water temperature, pH, dissolved oxygen). We do not address parameters to which no Illinois standard applies (i.e., specific conductivity, nitrate, phosphate).

Assessing attainment of aquatic-life use

Multiple standards in 35 Illinois Administrative Code Part 302 pertain to these data. We first determine applicability of the relevant standards relative to stream flow. Part 302 standards apply *at all times except during periods when flows are less than the average minimum seven day low flow which occurs once in ten years* (Section 302.103). This low-flow period is commonly called "7Q10" flow. We download and review available discharge information from USGS gage sites and compare discharge values to 7Q10 values provided by the Illinois State Water Survey [7-Day 10-Year Low Flow Maps (illinois.edu)]. We exclude data associated with discharges below the 7Q10 threshold. For each water-quality standard, we define an exceedance as any value that is outside of the range allowed by the standard, whether high or low.

Table 1. Location of USGS automated meters and applicable water-quality standards at 35 Ill. Adm. Code.

Assessment Unit	Assessment-Unit Length (miles)	Site Code	Stream Name and Site Location	pH Standard	Temperature Standard	Dissolved-Oxygen Standard
IL_BE_01	29.06	BE-01	Embarras River at Billett	302.204	302.211	302.206(b)
IL_BP_01	4.98	BP-08	Vermilion River at Danville	302.204	302.211	302.206(c)
IL_C_23	16.02	C-23	Little Wabash River at Carmi	302.204	302.211	302.206(b)
IL_D_09	19.1	D-12	Illinois River at Henry	302.204	302.211	302.206(b)
IL_D_20	13.67	D-37	Illinois River above Starved Rock Lock and Dam	302.204	302.211	302.206(c)
IL_D_23	30.51	D-18	Illinois River at Seneca	302.204	302.211	302.206(c)
IL_D_32	34.05	D-22	Illinois River at Florence	302.204	302.211	302.206(b)
IL_G_23	3.82	G-23	Des Plaines River at Joliet	302.404	302.408	302.405(d)
IL_N_12	15.19	N-12	Big Muddy River at Murphysboro	302.204	302.211	302.206(b)
IL_O_03	15.18	O-03	Kaskaskia River at New Athens	302.204	302.211	302.206(b)
IL_P_04	29.63	P-04	Rock River at Joslin	302.204	302.211	302.206(b)
IL_PB_04	6.48	PB-04	Green River at Geneseo	302.204	302.211	302.206(b)

pH

The pH standards of Sections 302.204 or 302.404 apply (Table 1). These regulations similarly stipulate that pH must not be below 6.5 or above 9.0 units at any time throughout the year. For all 12 sites, a percentage of pH exceedances greater than 10% in a calendar year indicates potential impairment of aquatic-life use (Table 2).

Table 2. Guidelines to Assess Aquatic Life Use in Specified Streams with Continuously Monitored Results of pH, in 2015-2019

Use Support	Guidelines for pH
Fully Supporting	≤ 10% of pH observations <6.5 or >9.0 in a calendar year.
Not Supporting	> 10% of pH observations <6.5 or >9.0 in a calendar year.

Water Temperature

The water-temperature standards of Sections 302.211 and 302.408 apply (Table 1); both Sections have identical requirements. To determine exceedances, we require: a minimum number of readings per month (i.e., 1440: at least 50% of 15-minute-interval readings in a 30-day period); and a minimum number of months per calendar year that each have the required number of readings (i.e., seven).

Two different standards exist: one for "cool season" months (i.e., 16 °C/60 °F from December through March) and the other for "warm season" months (i.e., 32 °C/90 °F from April through November). For all sites, water temperature must not exceed the standard *during more than one percent of the hours in* any 12-month period that ends in any month. Given the sporadic gaps in continuous monitoring data, we evaluated data by calendar year and require a minimum of 7 months of useable data for the analysis. Additionally, at no time should the applicable seasonal standard be exceeded by more than 1.7° C (3 °F).

Table 3 shows the guidelines that we use when applying the temperature standards to assess Aquatic Life Use.

Table 3. Guidelines to Assess Aquatic Life Use in Specified Streams with Continuously Monitored Results of Water Temperature, in 2015-2019

Use Support	Guidelines for Water Temperature	
	Observations During a 12-month Period	**Instantaneous Observations**
Fully Supporting	April - November No more than 1% of hours with temperature > 90 °F in any calendar year. December - March No more than 1% of hours with temperature > 60 °F in any calendar year.	April - November Temperature does not exceed 93 °F at any time. December - March Temperature does not exceed 63 °F at any time.
Not Supporting	April - November More than 1% of hours with temperature > 90 °F in any calendar year. December - March More than 1% of hours with temperature > 60 °F in any calendar year.	April - November Temperature exceeds 93 °F at any time December - March Temperature exceeds 63 °F at any time.

Dissolved Oxygen (DO)

Three different DO standards apply among the 12 sites (Table 1). The general-use standards of Section 302.206(b) apply to eight sites. The general-use enhanced-protection standards of Section 302.206(c) apply to three sites: Vermilion River at Danville (site BP-08), Illinois River at Seneca (D-18), and Illinois River at Starved Rock (D-37). Section 302.405(d) for the Chicago Area Waterways System applies to Des Plaines River (G-23). For all DO data, DO values that exceed 100% saturation are adjusted to the air-equilibrated concentration. We apply DO standards at three time scales: instantaneous, weekly, and monthly.

Each day represents a 24-hour period that begins and ends at midnight (12:00AM). To determine daily means and minima, we require a minimum of 92 readings in a day. Each week comprises seven consecutive days beginning with each Monday. No week shares days with another week. Weekly means or minima require that at least six days meet the minimum requirements to calculate daily statistics. Monthly means require at least 26 days of data in a calendar month, with each day meeting the minimum requirements to calculate daily statistics. No month shares days with another month.

Table 4 shows the applicable DO standards. The DO standards of sections 302.206(b) and 302.206(c) apply to two different seasons, March through July (we call this "early") and August through February ("late"). We compare DO readings to the appropriate early- or late-season

daily (instantaneous) standard (Table 5). Percent exceedances of the daily standard greater than 10% in a calendar year indicates potential aquatic-life impairment. For the seven-day standard, we calculate weekly means of daily means (early season) or of daily minima (late season) and compare results to the standards. A single exceedance of a seven-day standard indicates potential aquatic-life impairment. The 30-day standard applies only to the late season. We calculate monthly means of daily means and compare results to the 30-day standard. A single exceedance indicates potential aquatic-life impairment. When DO indicates potential impairment, we identify it as a potential cause of impairment of aquatic-life use.

The DO standard of section 302.405(d) does not vary seasonally. We compare DO readings to the daily (instantaneous) standard. Percent exceedances of the daily standard of 10% or greater in a calendar year indicates potential aquatic-life impairment. For the seven-day standard, we compare weekly means of daily minima to the seven-day standard. No 30-day standard applies for section 302.405(d).

Table 4. Dissolved-Oxygen Standards

DO Standard	Early Season (March – July)		Late Season (August – February)		
	Daily (instantaneous) (mg/l)	7-Day Mean of Daily Means (mg/l)	Daily (instantaneous) (mg/l)	7-Day Mean of Daily Minima (mg/l)	30-Day Mean of Daily Means (mg/l)
302.206(b)	5.0	6.0	3.5	4.0	5.5
302.206(c)	5.0	6.25	4.0	4.5	6.0
302.405(d)	All Year				
	Daily (instantaneous) (mg/l)		7-Day Mean of Daily Means (mg/l)		
	3.5		4.0		

Table 5. Guidelines to Assess Aquatic Life Use in Specified Streams with Continuously Monitored Results of Dissolved Oxygen, in 2015-2019

Use Support	**Guidelines for Dissolved Oxygen**	
	Daily Standard	**7-day or 30-day Standard**
Fully Supporting	≤ 10% exceedances of the applicable standard in a calendar year.	No exceedances of the applicable standards.
Not Supporting	> 10% exceedances of the applicable standard in a calendar year.	At least one exceedance of an applicable standard.