ILLINOIS POLLUTION CONTROL BOARD
June 26, 2025

INEOS JOLIET, LLC	)	
	)	
Petitioner,	)	
	)	
v.	)	PCB 23-135
	)	(Thermal Demonstration)
ILLINOIS ENVIRONMENTAL	)	
PROTECTION AGENCY,	)	
	)	
Respondent.	)	

OPINION AND ORDER OF THE BOARD (by M.D. Mankowski):

This case concerns discharges to the Upper Dresden Island Pool (UDIP) of the Lower Des Plaines River (LDPR) from a facility in Joliet, Will County, owned by INEOS Joliet, LLC (the Facility). The Facility manufactures organic dyes, pigments, cyclic organic crudes and their intermediates. It is located downstream from the Midwest Generation (MWG) Joliet 9 and 29 Stations, which are subject to alternate thermal effluent limitations (ATELs) granted by the Board in PCB 20-38 and 20-39.

On June 30, 2023, INEOS filed a petition (Pet.) for relief from thermal effluent limitations at the Facility, based on the near-field ATELs granted to MWG, and as allowed under Section 316(a) of the federal Clean Water Act (CWA) and Parts 106 and 304 of the Board's regulations. *See* 33 U.S.C. § 1326(a); 35 Ill. Adm. Code 106.Subpark K, 304.141(c). INEOS also requested a mixing zone that allows the use of 25% of the 7Q10 flow (lowest 7-day average flow that occurs once every 10 years) of the UDIP to maintain compliance with MWG's ATELs.

Based on the record before it, the Board finds that the demonstration satisfies the legal standards for the requested relief. The otherwise applicable effluent limitations are more stringent than necessary to assure the protection and propagation of a balanced indigenous community of shellfish, fish, and wildlife in and on the UDIP near the Facility. The proposed ATELs will assure the protection and propagation of that community and are also in part more stringent than necessary. Therefore, the Board grants the proposed ATELs to INEOS and directs IEPA to include these ATELs in the Facility's NPDES permits.

GUIDE TO THE BOARD'S OPINION

Below, the Board first lists abbreviations and acronyms used in this opinion. It then provides the procedural background, followed by discussion of a motion to incorporate. Next, the Board presents the Facility's history. Next, the Board addresses the legal background relevant to INEOS' request, including statutory and regulatory authorities. The Board then presents the otherwise applicable temperature water quality standards, the proposed ATELs, and the burden of proof. The Board then outlines the remainder of INEOS' petition, including details of thermal plume mapping, data collection programs, ecological setting, water quality, aquatic habitats, and aquatic life.

The opinion then turns to the Board's discussion, which is divided between two primary issues. First, the opinion addresses whether INEOS has demonstrated that its proposed ATELs will assure the protection and propagation of balanced, indigenous communities. In this first part of the discussion, the Board:

- Summarizes the Master Rationale;
- Reviews the biotic categories;
- Reviews the retrospective demonstration;
- Reviews the predictive demonstration;
- Analyzes the biotic category criteria; and
- Analyzes the Master Rationale.

In these sections, the Board's analysis is based on draft guidance for demonstrations under Section 316(a) of the CWA. This guidance, prepared by the United States Environmental Protection Agency (USEPA), is entitled "Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Section of Nuclear Facilities Environmental Impact Statements (DRAFT), May 1, 1977" (USEPA 316(a) Manual). INEOS requests relief under authorities including Section 316(a). The Board also considers the guidance as a useful and instructive guide to analyzing the petition. *See* 35 Ill. Adm. Code 106.1120(e).

In the second part of its discussion, the Board addresses whether INEOS has demonstrated that the effluent limitations based on the applicable thermal water quality standards are more stringent than necessary. This discussion includes the Board's analysis of:

- Numeric temperature water quality standards under Section 302.408(h);
- "Excursion" hours under Section 302.408(f);
- Minimum zone of passage left by the thermal mixing zone under Section 302.102(b)(8); and
- Narrative temperature water quality standards of Sections 302.408(c), (d), and (e).

The Board then reaches its conclusions and issues its order.

ABBREVIATIONS AND ACRONYMS USED IN THIS OPINION

ACRCC	Asian Carp Regional Coordination Committee
AEL	Alternate Effluent Limits
ANS	Aquatic Nuisance Species
ATEL	Alternative Thermal Effluent Limits
BIC	Balanced Indigenous Community
CAWS	Chicago Area Waterway System
cfs	cubic feet per second
cfu	colony forming unit
CSO	Combined Sewer Overflow

CSSC	Chicago Sanitary and Ship Canal
CTM	Critical Thermal Maximum
CWA	Clean Water Act
DAF	Design Average Flow
DELT	Deformities, Erosions, Lesions, Tumors
DMF	Design Maximum Flow
DO	Dissolved Oxygen
DSP	Detailed Study Plan
EA	EA Engineering, Science, and Technology, Inc. (before December 12, 2014) and EA Engineering, Science, and Technology, Inc., PBC (on and after December 12, 2014)
EAV	Emergent Aquatic Vegetation
EPA	Environmental Protection Agency
EPT	Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)
Five-Mile Stretch	Portion of the Lower Des Plaines River between the I-55 Bridge and Kankakee River Confluence
GLMRIS	Great Lakes and Mississippi River Interbasin Study
gpm	gallons per minute
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
INHS	Illinois Natural History Survey
IWBmod	Modified Index of Well-Being
LDB	Left Descending Bank
LDPR	Lower Des Plaines River
LTA	Long-Term Average
MG or MWG	Midwest Generation, LLC
MGD	Million Gallons per Day
MIKE3	Three-Dimensional Thermodynamic Mathematical Model
MW	Megawatt
MWAT	Maximum Weekly Average Temperature
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NPDES	National Pollutant Discharge Elimination System
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated biphenyls
POTW	Publicly-Owned Treatment Works
QHEI	Qualitative Habitat Evaluation Index
RDB	Right Descending Bank
RIS	Representative Important Species
RM	River Mile
SAV	Submerged Aquatic Vegetation 4
TLWQS	Time-Limited Water Quality Standard
TOC	Total Organic Carbon
TSS	Total Suspended Solids
UAA	Use Attainability Analysis
UDIP	Upper Dresden Island Pool

UIW	Upper Illinois Waterway
USACE	U.S. Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USEPA 316(a) Manual	Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Section of Nuclear Facilities Environmental Impact Statements (DRAFT), May 1, 1977, USGS United States Geological Survey
Wr	Relative Weight
Ws	Standard Weight
ZOP	Zone of Passage

PROCEDURAL BACKGROUND

Pre-Petition Communications

INEOS submitted the required Early Screening Information to IEPA on December 2, 2021. Pet. at 11; 35 Ill. Adm. Code 106.1115(a). On December 10, 2021, IEPA agreed that MWG's demonstration from PCB 20-38 and 20-39 could be incorporated by reference into INEOS' demonstration. Pet. Ex. 1 at 57; *see also* 35 Ill. Adm. Code 106.1115(b). INEOS submitted to IEPA the required DSP dated January 28, 2022. Pet. at 16; 35 Ill. Adm. Code 106.1120(a). On March 13, 2022, IEPA approved INEOS' plan. Pet. at 16; *see also* 35 Ill. Adm. Code 106.1120(f).

After receiving IEPA's response, INEOS and IEPA agreed that additional field studies were not necessary, based on MWG's ATEL demonstration for Joliet Stations 9 and 29 in PCB 20-38 and 20-39. Pet. at 16. IEPA agreed that "supporting information from the MG Demonstration could be incorporated by reference in the INEOS Demonstration." *Id.*

Petition to the Board

On June 30, 2023, INEOS filed its petition for ATELs. The Board did not receive any requests for a hearing.

The following documents accompanied the petition:

Exhibit 1:	INEOS Joliet Facility § 316(a) Demonstration
Appendix 1:	INEOS Detailed Study Plan and IEPA Approval Letter
Appendix 2:	INEOS Discharge Temperature and Flow Monitoring System
Appendix 3:	INEOS NPDES Permit (IL 0001643)
Appendix 4:	INEOS Thermal Compliance Analysis and Proposed Mass-Balance Model
Appendix 5:	Review of LDPR Mussel Information to Support Mixing Zone Requirements

IEPA Recommendation

IEPA's recommendation was due by August 14, 2023. On August 14, 2023, IEPA filed a motion for extension of time, seeking an additional 45 days to file a recommendation.

On September 27, 2023, IEPA filed its recommendation (Rec. 2) that the Board grant the requested ATELs for discharge from the Facility.[1] On May 23, 2024, IEPA filed a supplement to its recommendation (IEPA Supp.). The Board did not receive any responses to IEPA's recommendation or supplement.

MOTION TO INCORPORATE

In its petition, INEOS supported its request for ATELs and a mixing zone "[b]ased on the entirety of the MG case record in PCB 20-38 and 20-39, as well as the site-specific information contained in the INEOS Demonstration document [Pet. Ex. 1]." Pet. at 32. The INEOS demonstration also discussed incorporating by reference "the entirety of the MG case record." Pet. Ex. 1 at 10-11 (emphasis in original). Similarly, IEPA based its recommendation on both INEOS-specific information and the MWG demonstration. Rec. at 5.

Section 101.306 of the Board's rules sets forth the requirements for incorporating documents from another Board proceeding:

> a) Upon the separate written request of any person or on its own initiative, the Board or hearing officer may incorporate materials from the record of another Board docket into any proceeding. The person seeking incorporation must file the material to be incorporated with the Board in compliance with Section 101.302(h). The person seeking incorporation must demonstrate to the Board or the hearing officer that the material to be incorporated is authentic, credible, and relevant to the proceeding. Notice of the request must be given to all identified participants or parties by the person seeking incorporation.
>
> b) The Board will give the incorporated matter the appropriate weight in light of the following factors: the standard of evidence under which the material was previously presented to the Board; the present purpose for incorporating the material; and the past and current opportunity for cross-examination of the matters asserted within the incorporated material. 35 Ill. Adm. Code 101.306.

Although INEOS did not file a separate written request or the material to be incorporated, the Board construes the multiple references to MWG's ATEL cases as a motion to incorporate the entire record of those cases. IEPA did not object to this request but rather used MWG data in its recommendation. Thus, the Board grants the motion to incorporate and directs the Clerk to place the records of PCB 20-38 and 20-39 into the record of this proceeding.

[1] IEPA also filed a recommendation for MWG's petitions in PCB 20-38 and 20-39. That recommendation will be cited as "Rec." Any references to IEPA's recommendation for INEOS' petition will be cited as "Rec. 2".

For ease of reference, the following documents accompanied MWG's petitions:

Exhibit A: Joliet Generating Stations 9 and 29 § 316(a) Demonstration
- Appendix A: Description of the Lower Des Plaines River
  - Exhibit A-1: Joliet Station 9 NPDES Permit IL 0002216
  - Exhibit A-2: Joliet Station 29 NPDES Permit IL 0064254
- Appendix B: Information Supporting Representative Important Species Rationale: Biothermal Assessment Predictive Demonstration
- Appendix C: Information Supporting Biotic Category Rationales: Protection of Balanced Indigenous Community – Retrospective Demonstration
- Appendix D: Station Operations and Hydrothermal Analysis
  - Exhibit D-1a: Description of the Joliet Station 9 and 29 Near-Field Thermal Compliance Models
  - Exhibit D-1b: Description of the Joliet Station 9 and 29 Far-Field (I-55) Thermal Compliance Model
  - Exhibit D-2a: Downstream Discharge Thermal Compliance Assessment
  - Exhibit D-2b: Downstream Discharger Thermal Compliance Modeling Assessment
- Appendix E: Data Collection Programs
- Appendix F: 2016 Upper Illinois Waterway Fisheries Investigation RM 274.4-296.0
- Appendix G: 2017 Upper Illinois Waterway Fisheries Investigation RM 274.4-296.0
- Appendix H: 2018 Upper Illinois Waterway Fisheries Investigation RM 274.4-296.0
- Appendix I: Previously Conducted Joliet Station 9 and 29 Thermal Plume Surveys and Associated Documentation
- Appendix J: Summary of Upper Dresden Island Pool Fisheries Data Collected Following Operational Changes at Joliet Stations 9 and 29, 2017-2018
- Appendix K: Habitat and Submerged Aquatic Vegetation (SAV) Survey of the Lower Des Plaines River Joliet, IL
- Appendix L: 2017-2018 Benthic Macroinvertebrate Assessment of the Des Plaines River Joliet, IL

Exhibit B: Correspondence from IEPA to MG dated March 3, 2016
Exhibit C: Email correspondence from IDNR
Exhibit C1: IDNR response dated June 7, 2016
Exhibit D: Detailed Study Plan for § 316(a) Demonstration to Support Application for Alternative Thermal Limits at the Joliet #9 Generating Station
Exhibit E: Detailed Study Plan for § 316(a) Demonstration to Support Application for Alternative Thermal Limits at the Joliet #29 Generating Station
Exhibit F: IEPA Construction Permit for Joliet #29 issued May 9, 2017
Exhibit G: History of Plant Shutdowns (Units 6, 7, 8)
Exhibit H: Planned and Projected Shutdowns (Units 6, 7, 8)
Exhibit I: Modification of NPDES Permit No. IL0064254 dated February 19, 2016 (Joliet #29)
Exhibit J: NPDES Permit No. IL0002216 issued September 30, 2014 (Joliet #9)

FACILITY BACKGROUND

Below, the Board provides the background details from INEOS' petition, including information required by Section 106.1130. 35 Ill. Adm. Code 106.1130(a)-(c).

Location of Facility

The Facility is located on the UDIP portion of the LDPR at RM 280.3 in Channahon, IL. Pet. Ex. 1 at 9, 12. It is located downstream from MWG's Joliet 9 and 29 Stations, which are subject to ATELs granted by the Board in PCB 20-38 and 2039. *Id.* at 1, 20. The Facility does not generate power. *Id.* at 12. Instead, it is a manufacturer of organic dyes, pigments, cyclic organic crudes, and their intermediates, producing produces isophthalic acid (IPA), maleic anhydride (MAN), and trimellitic anhydride (TMA) through three separate processes.

INEOS NPDES Permit

IEPA issued NPDES Permit No. IL0001643 to INEOS on September 23, 2020, with an effective date of October 1, 2020. App. 3 at 82. The permit authorizes five discharges, Outfalls 001 through 005, all to the Des Plaines River. *Id*. at 84.

Heat Dissipation Process and Equipment

The Facility runs on steam power produced by three units: the CB706 boiler, the IPA unit, and the MAN unit. Pet. at 9. The boiler uses natural gas from Nicor and biogas from the wastewater treatment unit. *Id.* at 9-10. The IPA and MAN units produce steam from exothermic reactions. *Id.* at 10.

The Facility treats process wastewater using anaerobic, aerobic, clarification, and air floatation process units. Pet. at 11. The anaerobic reactor is operated year-round at temperatures between 98 ^{o}F and 100 ^{o}F, which requires a steam heat exchanger during the winter months and a cooling water exchanger during the summer months. *Id.* at 11-12. The Facility does not have a condenser cooling system; however, there is "natural heat loss to the atmosphere" that occurs as the water moves "in parallel" through the four aerobic basins, three clarifiers, and the air floatation channel before its discharge to Outfall 001. *Id.* at 12. These processes contribute approximately 60% to 80% of the annual discharge flow volume to Outfall 001. *Id.*

INEOS also operates three cooling towers that provide cooling water to the various processes at the Facility. Pet. at 12. These towers – CU401, CU402, and CU403 – have capacities of 12,000 gpm, 16,800 gpm, and 8,400 gpm, respectively. *Id.* CU401 supplies cooling water to IPA oxidation and the utilities unit; CU402 is the supplier for the utility's unit, IPA purification, the MAN unit, and Air Products; and CU403 is the supplier to the TMA unit. *Id.* Cooling water is used to remove heat from process steam in heat exchangers, in that cooling water from the basin of each tower is circulated by pumps to the distribution system that supplies the plant. *Id*. The warm water is then returned to the top of the tower, evenly released across each cell by spray nozzles, and cascades down through the tower's packing. *Id.* at 12-13. Blowdown occurs as needed. *Id*. at 13. The thermal component of the INEOS discharge goes through Outfall 001. *Id*.

Plans to Retire and Add Units

INEOS states it has no plans to retire or add any additional process units currently. Pet. at 10. However, it plans to continuously improve and repair equipment as needed. *Id.*

Shutdowns

The Facility is typically never entirely shutdown, but units are individually shut down for maintenance and repair about once a year for about two to three weeks. Pet. at 11.

Discharges

Characteristics of Discharge

The wastewater discharges at the Facility are regulated by the NDPES permit that covers Outfalls 001 through 005. Pet. Ex. 1 at 12. Outfall 001 discharges wastewater, analytical lab waste, fire field waste, impacted groundwater and stormwater, utilities waste, and alternate sanitary waste. *Id.* Outfalls 002, 003, and 005 intermittently discharge stormwater, non-process wastewater, and hydrostatic test wastewater. *Id.* Outfall 004 discharges approximately 6 gpm of treated sanitary waste. *Id.*

History of Thermal Monitoring of Discharge

Before receiving its current NPDES permit in 2020, INEOS was not required to monitor outfall temperature. Pet. at 13. Additionally, the UDIP standards did not become effective until July 1, 2018. 35 Ill. Adm. 302.408. Thus, INEOS has Discharge Monitoring Reports (DMRs) starting from October 2020 for Outfall 001. Pet. at 13. INEOS was also documenting daily average maximum values and hourly maximum values for internal purposes. Pet. Ex. 1 at 16 n.5. As shown below, INEOS provided both sets of data for its demonstration but intends to rely on hourly instantaneous measurements for compliance with the proposed ATELs. *Id.*

Outfall 001

The focus of INEOS's petition is the discharge from Outfall 001 because the thermal component of the discharge goes through this outfall. Pet. Ex. 1 at 13. Warm process water from the Facility's wastewater treatment plant is discharged from Outfall 001. *Id.* The DMF through this outfall is 2.8 MGD (4.3 cfs), with a DAF of 2.318 MGD (3.6 cfs) and an LTA Flow of 1.22 MGD (1.9 cfs). *Id.* The discharge flows underground in a 275-ft linear 24-in high-density polyethylene (HDPE) pipe to a concrete revetment-lined channel (i.e. discharge structure), which is located on the right descending bank of the LDPR at approximately River Mile 280. *Id.* The temperature monitor for this discharge is located at the head of the pipe, prior to combining with the Outfall 004 flow. *Id.*

As noted above, about 60% to 80% of the annual discharge from Outfall 001 is from the Facility's wastewater treatment processes. Pet. at 12. Other discharges to Outfall 001 are from the treatment of clean water utility streams, including cooling tower and boiler water blowdown, water filter backwash, and reject water from the reverse osmosis and filtration system. *Id.* The other discharges' average flow is approximately 0.3 MGD (0.46 cfs). *Id.*

Between 2016 and 2021, the average flow from Outfall 001 was 56% of the DMF and is 0.07% of the long-term monthly average flow of the LDPR. Pet. at 14. Additionally, the DMF flow is approximately less than 0.3% of the 7Q10 flow for this section of the LDPR (1,493 cfs). *Id.* at 15.

Table 3: Flow and Temperature Statistics of Discharge from Outfall 001 (2016-2021)

Flow	
Design Maximum Flow (DMF)	2.8 MGD (4.3 cfs)
Design Average Flow (DAF)	2.318 MGD (3.6 cfs)
Long Term Average Flow	1.22 MGD (1.9 cfs)
Average Annual Flow	2.4 cfs
Monthly Maximum Flow Average	3.1 cfs
Temperature Monitoring Data (ºF)	
Maximum Daily Average	94.5
Hourly Maximum	97.8
Minimum Daily Average	71.9
Hourly Minimum	34.0
Long-term Annual Average	79.1
Average Winter Month Temperature	75.3
Average Non-Winter Month Temperature	81

Thermal Compliance History

In 2015, INEOS filed for a variance that was converted into a TLWQS petition in 2017 by operation of law. Pet. at 15. The TLWQS petition was amended, consolidated into MWG's TLWQS petition, and found to be in substantial compliance. *Id.* Because INEOS filed for the variance, the Board granted a stay from the applicable thermal standard until it rules on the TLWQS. *Id.* The applicable standards have not applied to INEOS, and thus there is no history of noncompliance. *Id.* at 16.

LEGAL BACKGROUND

It is unlawful for any person to discharge a pollutant from a point source into waters of the United States without a permit under the CWA. 33 U.S.C. § 1311(a). Because heat is a pollutant (33 U.S.C. § 1362(6)), heated discharges require a permit. In general, discharge limitations in a permit are technology-based or water quality-based. 33 U.S.C. § 1311(b). Technology-based effluent limits generally are developed for an industry and reflect the "best available technology economically achievable." 33 U.S.C. § 1311(b)(2)(A); *see also, e.g.,* 40 C.F.R. Parts 405-471.

Water quality-based effluent limits ensure that water quality standards are met regardless of technology or economics considered in establishing technology-based limits. Water quality-based effluent limits are defined as "any more stringent limitation, including those necessary to meet water quality standards, treatment standards, or schedules of compliance, established pursuant to any State law or regulations . . . or any other Federal law or regulation, or required to implement any applicable water quality standard." 33 U.S.C. § 1311(b)(1)(C).

Thus, if a discharge from a point source interferes with attainment or maintenance of a water quality standard, an effluent limitation is established for that discharge, regardless of any other technology-based standard. 33 U.S.C. §§ 1311(b)(1)(C), 1312(a); *see* also 35 Ill. Adm. Code 304.105 (Violation of Water Quality Standards). Water quality standards are set under authority provided in Section 303 of the CWA. 33 U.S.C. § 1313. Illinois law authorizes the Board to adopt water quality standards, including thermal standards. 415 ILCS 5/13 (2024). The Board adopted water quality temperature standards for the CAWS at 35 Ill. Adm. Code 302.408.

Since adoption of the CWA in 1972, Section 316(a) has allowed a point source with a thermal discharge to obtain relief from otherwise applicable thermal effluent limitations. Specifically, CWA Section 316(a) provides that,

> [w]ith respect to any point source otherwise subject to the provisions of section 1311 of this title or section 1316 of this title, whenever the owner or operator of any such source, after opportunity for public hearing, can demonstrate to the satisfaction of the Administrator (or, if appropriate, the State) that any effluent limitation proposed for the control of the thermal component of any discharge from such source will require effluent limitations more stringent than necessary to assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made, the Administrator (or, if appropriate, the State) may impose an effluent limitation under such sections for such plant, with respect to the thermal component of such discharge (taking into account the interaction of such thermal component with other pollutants), that will assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on that body of water. 33 U.S.C. § 1326 (Thermal Discharges).

Accordingly, Section 304.141(c) of the Board's rules provides that:

> [t]he standards of this Chapter shall apply to thermal discharges unless, after public notice and opportunity for public hearing, in accordance with section 316 of the CWA, and applicable federal regulations, and procedures in 35 Ill. Adm. Code 106.Subpart K, the Board has determined that different standards shall apply to a particular thermal discharge. 35 Ill. Adm. Code 304.141(c).

Therefore, under Section 316(a) of the CWA and 35 Ill. Adm. Code 304.141(c), the Board may establish "alternative thermal effluent limitations" based on a demonstration that the alternate limits will assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in the receiving water. Part 106 Subpart K of the Board's rules provides for review of a petition for an ATEL. 35 Ill. Adm. Code 106.1100-106.1180. Establishing ATELs is not a change in the water quality standard.

In 1977, USEPA issued its 316(a) Manual, a draft manual on demonstrations under CWA Section 316(a). This manual provides that it "is intended to be used as a general guidance and as a starting point for discussions," and that delegated state agencies "are not rigidly bound by the contents of this document." USEPA 316(a) Manual at 8–9. The guidance was never finalized and remains a draft. Nevertheless, the Board has previously found that the decision criteria in the USEPA 316(a) Manual are a useful guide for the Board's analysis, and the Board has followed the guidance's decision-making outline. Exelon Generation LLC v. IEPA, PCB 14-123, slip op. at 2

(Sept. 18, 2014). Furthermore, Section 106.1120 of the Board's rules requires a petitioner seeking alternative thermal effluent relief to consider guidance published by USEPA in making its demonstration. 35 Ill. Adm. Code 106.1120(e). In 1979, USEPA promulgated rules implementing CWA Section 316(a), which are codified at 40 C.F.R. 125.Subpart H.

TEMPERATURE WATER QUALITY STANDARDS

Background

Under Illinois' use designations, the UDIP was formerly designated as a Secondary Contact and Indigenous Aquatic Life Water. MWG Pet. at 16, citing 35 Ill. Adm. Code Part 303; MWG App. A at A-16; MWG App. D at D-9. Regulations for this designation were less stringent than the General Use water quality standards that applied to most waters of the state. MWG Pet. at 16; MWG Ex. A at 3-1; *see also* 35 Ill. Adm. Code 303.201; MWG App. D at D-9.

In 2007, IEPA presented UAAs to the Board. IEPA argued that these analyses showed the UDIP "had attained, or had the potential to attain, higher designated recreational and aquatic life uses" under the CAA than the secondary contact designation. MWG Pet. at 17; *see also* MWG App. A at A-16. In the rulemaking based on the UAAs, the Board redesignated the UDIP to a "UDIP Water" use:

> Lower Des Plaines River from the Brandon Road Lock and Dam to the Interstate 55 bridge is designated as the Upper Dresden Island Pool Aquatic Life Use. These waters are capable of maintaining, and shall have quality sufficient to protect, aquatic-life populations consisting of individuals of tolerant, intermediately tolerant, and intolerant types that are adaptive to the unique flow conditions necessary to maintain navigational use and upstream flood control functions of the waterway system. Such aquatic life may include, but is not limited to, largemouth bass, bluntnose minnow, channel catfish, orangespotted sunfish, smallmouth bass, shorthead redhorse, and spottail shiner. 35 Ill. Adm. Code 303.230(a); *see also* Water Quality Standards and Effluent Limitations for the Chicago Area Waterway System (CAWS) and the Lower Des Plaines River: Proposed Amendments to 35 Ill. Adm. Code 301, 302, 303 and 304, PCB 08-9(C); MWG Ex. A at 3-1 – 3-2; MWG App. A at A-17; MWG App. D at D-9 – D-10.

Temperature Standards

The Board adopted thermal standards for the UDIP in Section 302.408, the relevant provisions of which are:

* * *

> b) The temperature standards in subsections (c) through (i) will become applicable beginning July 1, 2018.
>
> c) There must not be any abnormal temperature changes that may adversely affect aquatic life unless caused by natural conditions.

d) The normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes must be maintained.

e) The maximum temperature rise above natural temperatures must not exceed 2.8°C (5°F).

f) Water temperature at representative locations in the main river must never exceed the maximum limits in the applicable table in subsections (g), (h), and (i) during more than one percent of the hours in the 12-month period ending with any month. The water temperature must not exceed the maximum limits in the applicable table that follows by more than 1.7°C (3.0°F).

* * *

i) Water temperature for the Upper Dresden Island Pool Aquatic Life Use waters, as defined in 35 Ill. Adm. Code 303.230, must not exceed the limits in the following table in accordance with subsection (f):

Months	Daily Maximum (°F)
January	60
February	60
March	60
April	90
May	90
June	90
July	90
August	90
September	90
October	90
November	90
December	60

35 Ill. Adm. Code 302.408.

<u>Request for Regulatory Relief</u>

While the Board concluded that waters designated as UDIP Use should have the same thermal water quality standards as General Use waters, it recognized that some dischargers may need to seek relief from those thermal standards. MWG Pet. at 17. The Board delayed the effective date of the thermal standard three years to 2018. *Id*. at 2, 17-18, <u>citing Water Quality Standards and Effluent Limitations for the Chicago Area Waterway System (CAWS) and the Lower Des Plaines River: Proposed Amendments to 35 Ill. Adm. Code 301, 302, 303 and 304</u>, PCB 08- 9(D), slip op. at 77 (Mar. 19, 2015).

Compliance with Thermal Limits

As described above, the Board granted a stay from the applicable thermal water quality standards after INEOS filed for a variance. The standards have not applied to INEOS, and thus there is no history of noncompliance.

SUMMARY OF INEOS' PROPOSED ATELs

UDIP Standards and Comparisons

INEOS' petition includes a table comparing the standards that took effect on July 1, 2018, to its proposed alternate near-field limits (taken from MWG's petition):

Table 1: INEOS Requested Thermal Standards

Month	UDIP Thermal Standards (Effective July 1, 2018) Daily Maximum (°F)	Approved MWG Near-Field ATELs Daily Maximum (°F) Requested to be applied to INEOS Thermal Discharge
January	60	65
February	60	65
March	60	70
April	90	80
May	90	85
June	90	93
July	90	93
August	90	93
September	90	93
October	90	90
November	90	85
December	60	70
Excursion Hours	Shall not exceed maximum limits during more than 1% of the hours in the 12-month period ending with any month; at no time shall water temperature	Daily maximum not to be exceeded by more than 5% of the time in a calendar year; at no time shall water temperature exceed the maximum limits by more than 3°F

	exceed the maximum limits by more than 3.0°F	

MWG Pet. at 32; MWG Ex. A at 3-12; MWG App. B at B-48; *see also* MWG Resp. at 8 (clarifying MWG Pet. at 21).

INEOS' proposed standards for its station "would be effective at the edge of the allowed mixing zone." INEOS would measure compliance through the existing near-field compliance model used by MWG. INEOS is not requesting coverage under the granted far-field MWG ATELs (which are effective below the I-55 Bridge in the LDPR), as its overall volume of discharge is too small to affect any thermal impact on these downstream waters.

MWG noted that the UDIP Use standards include the following narrative requirements:

c) There must not be any abnormal temperature changes that may adversely affect aquatic life unless caused by natural conditions.

d) The normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes must be maintained.

e) The maximum temperature rise above natural temperatures must not exceed 2.8 °C (5 °F). 35 Ill. Adm. Code 302.408(c)-(e).

INEOS relies on MWG's demonstration and granted ATELs throughout its petition, citing to the Board's opinion from PCB 20-38 and 20-39 that the thermal standards of general applicability were "more stringent than necessary to assure the protection and propagation of the BIC." Pet. at 20. As part of its CWA Section 316(a) demonstration, MWG was required to demonstrate that the "INEOS thermal discharge would not have any discernable impact on the temperature of the main body of the UDIP." *Id*. Additionally, IEPA indicated that USEPA found it "appropriate to include downstream dischargers in the relief requested as long as the dischargers were considered in the Demonstration Report." *Id.* However, due to lack of specific information on INEOS, the Board declined to include it within MWG's ATELs but allowed INEOS to file its own petition. Pet. Ex. 1. at 56.

Mixing Zone

To maintain compliance with MWG's ATELs, INEOS also requests a mixing zone that allows 25% of the 7Q10 flow of the UDIP. Pet. at 31. This is based on a 75% ZOP available under the proposed maximum thermal ATELs. *Id*. INEOS asserts that the Facility cannot meet the UDIP standards largely because IEPA could not grant a mixing zone under Section 302.102(b)(9). *Id*. at 20. IEPA had already approved MWG's ATELs for the Joliet Stations. *Id*. Under Section 302.102(b)(9), no mixing is allowed "when the water quality standard for the constituent in question is already violated in the receiving water." 35 Ill. Adm. Code

302.102(b)(9).

BURDEN OF PROOF

INEOS bears the burden of proof. 35 Ill. Adm. Code 106.1160(a). INEOS must demonstrate that the otherwise applicable thermal effluent limitations based on temperature water quality standards, from Section 302.408(c)-(e) and (h), are "more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made." 35 Ill. Adm. Code 106.1160(b); *see also* 40 C.F.R. § 125.73(a); Pet. at 7.

INEOS must also demonstrate that the requested ATELs, "considering the cumulative impact of its thermal discharge, together with all other significant impacts on the species affected, will assure the protection and propagation of a balanced indigenous community of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made." 35 Ill. Adm. Code 106.1160(c); *see also* 40 C.F.R. § 125.73(a); Pet. at 7.

An existing discharger may base its demonstration on the absence of prior appreciable harm instead of using "predictive" studies. 35 Ill. Adm. Code 106.1160(d). This "retrospective" demonstration must show either:

> A) That no appreciable harm has resulted from the normal component of the discharge, taking into account the interaction of such thermal component with other pollutants and the additive effect of other thermal sources to a balanced, indigenous community . . . ; or
>
> B) That despite the occurrence of such previous harm, the desired alternative thermal effluent limitation (or appropriate modifications thereof) will nevertheless assure the protection and propagation of a balanced, indigenous community . . . . 35 Ill. Adm. Code 106.1160(d)(1)(A), (B); *see also* 40 C.F.R. § 125.73(c).

In determining whether prior appreciable harm has occurred, the Board considers "the length of time during which the petitioner has been discharging and the nature of the discharge." 35 Ill. Adm. Code 106.1160(d)(2).

EA Engineering, Science, and Technology, Inc., PBC (EA), INEOS' consultant, prepared the Section 316(a) demonstration based on both predictive and retrospective studies and experience from other demonstrations in the area. Pet. Ex. 1.

INEOS DATA FOR PROPOSED ATELs

Below, the Board outlines the remainder of INEOS' petition, including details required by Section 106.1130(e). 35 Ill. Adm. 106.1130(e). As discussed above, IEPA did not require INEOS to conduct additional field studies and agreed that INEOS could incorporate MWG's demonstration into its request. Therefore, while the summary below describes data from MWG's Joliet Stations, the Board views it in the context of INEOS' request.

Thermal Plume Mapping

MWG's demonstration included thermal plume mapping. Pet. at 16. The Joliet Stations most recently conducted thermal plume mapping in 2017. Field studies included one summer survey in July 2017 and two winter surveys in February and December 2017. MWG App. D at D-14. The data obtained developed a site-specific three-dimensional model to examine the Stations' thermal plumes under various operating and meteorological conditions. *Id*., citing MWG App. B.

Joliet Stations – Operations and Discharges

Mapping used hourly operating data from both stations from 2012 to 2017, which included both earlier base load operating conditions and current peaking operation. MWG App. D at D-14. Data employed in the mapping included monthly frequency distributions of intake and discharge temperatures for summer (Tables D-1a, D-1b), winter (Tables D-1c, D-1d), and transitional months (Tables D-1e, D-1f). Data also included monthly frequency distributions for discharge flow and power production for summer (Tables D-2a, D-2b), winter (Tables D-2c, D-2d), and transitional months (Tables D-2e, D-2f).

Summer Data for Joliet Stations

Joliet 9. Because Unit 6 at Joliet 9 does not have supplemental cooling, it has regularly been derated to comply with thermal limits under AS 96-10 at the I-55 Bridge. MWG App. D at D-14. Derating Joliet 9 allows Joliet 29 to comply at higher operating levels by using its supplemental cooling towers. *Id*. at D-14 – D-15. Summer discharge temperatures are lower than if Joliet 9 operated at consistently high levels. *Id*. at D-15.

MWG's demonstration argued that Joliet 9 discharge data represented "measured end-of-pipe temperatures and therefore provide conservative estimates of compliance point temperatures under most conditions." MWG App. D at D-14.

Discharge Temperatures. Mean summer discharge temperatures were all below 90 °F, with highest monthly means in July and August. MWG Pet. at 12; MWG App. D at D-15, citing Table D-1a.

In July, median discharge temperatures were 84.6 °F, with upper 10th percentile temperatures at or above 92.9 °F. MWG App. D at D-15. The maximum measured July discharge temperature was 100.0 °F. MWG Pet. at 12; MWG App. D at D-15. For August, upper 10th percentile discharge temperatures were at or above 92.7 °F, with a maximum measured temperature of 98.1 °F. MWG App. D at D-15.

During the proceedings for the MWG ATEL requests, the Board noted that MWG's proposed near-field temperature limit for July and August was 93 °F. Board Questions at 1.[2] The Board asked MWG to comment how often it expected discharge temperatures above this proposed limit and on the availability of excursion hours. *Id*.

MWG stressed that these discharge temperatures were end-of-pipe temperatures. "Because compliance with the Proposed Near Field limit is determined at the edge of the allowed mixing zone, these end-of-pipe temperatures do not determine compliance and do not require the use of excursion hours to maintain compliance." MWG Resp. at 1.[3] MWG stated that, because it uses near-field thermal models to calculate edge-of-mixing-zone compliance temperatures, it could not provide a full range of expected compliance temperatures. *Id*. at 2. However, MWG argued that historical compliance records and its demonstration showed that the Stations would be able to consistently meet the proposed ATELs with excursion hours for periods presenting adverse compliance conditions. *Id*. MWG added that, if extreme conditions brought it close to exhausting its requested excursion hours, it would implement the necessary measures to remain in compliance with the maximum proposed summer ATELs. *Id*.

For June and September, upper 10th percentile temperatures were at or above 86.4 °F and 90.0 °F, respectively, with measured maximum temperatures of 96.2 °F and 97.8 °F, respectively. MWG Pet. at 12; MWG App D. at D-15.

Discharge Flows. Summer discharge flows were at or close to the maximum 579 cfs (375 MGD) over 50% of the time. MWG App. D at D-15, citing Table D-2a.

The demonstration reported that, under coal-fired operation, the summer circulating water flow rate was kept essentially constant at the maximum rate, aside from intermittent pump issues and short-term outages. MWG App. D at D-15. Since converting to natural gas, the circulating water system can remain idle for weeks or months at a time. *Id*.

Summer Power Production. Unit 6 operated at or over 90% of capacity or 303 MW for 10% of the time during the summer. MWG App. D at D-16, citing Table D-2a. Median summer operating levels ranged from 0% to 43% of total capacity, or 145 MW. *Id*.

The demonstration reported that, since converting to natural gas, operating levels have been much lower than in the past and can be expected to remain below historical levels on a sustained basis. MWG App. D at D-16. During high demand periods with hot weather and low river flows, the Stations will run at high levels and discharge at the same high temperatures. *Id*. The historical data provided a "reasonably reliable representation of future discharge temperatures under adverse compliance conditions." *Id*.

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[2] The "Board Questions" were filed in PCB 20-38 and 20-39 and directed to MWG. The Board did not file questions in this case for INEOS.

[3] The "MWG Responses" were filed in PCB 20-38 and 20-39 in response to Board questions. MWG did not file responses in this case for INEOS.

Discharge Temperature Over 90 °F. July discharge temperatures exceeded 90 °F for over 300 hours during 2012 and 2013, over 200 hours in 2015, and over 100 hours in 2014 and 2015. MWG App. D at D-16, citing Table D-3a. July discharge temperatures exceeded 93 °F for over 200 hours in 2012, 199 hours in 2013, and from 0 to 73 hours from 2014 to 2017. *Id*.

August discharge temperatures exceeded 90 °F for over 300 hours in 2013 and 2015, over 100 during 2012 and 2014, and for 31 hours in 2016. MWG App. D at D-17, citing Table D-3a. August discharge temperatures exceeded 93 °F for 177 hours in 2013, 190 hours in 2015, and from 0 to 77 hours in 2012, 2014, 2016, and 2017. *Id*. September discharge temperatures exceeded 93 °F from 0 to 15.7% of the time. MWG App. D at D-17.

Although there are fewer discharges at higher temperatures, discharge temperatures at Joliet 9 exceeded 95 °F up to 12.5% of the time in August and 10.2% of the time in July. Temperatures exceeded 96 °F for up to 5.5% of the time and 98 °F for up to 1.5% of the time during the same period. MWG App. D at D-17, citing Table D-3a. The demonstration attributed these lower percentages to "the significant unit deratings which were taken during critical periods when the unit was operated on coal under more baseload conditions." MWG App. D at D-17. When summer months did not show higher discharge temperatures, they reflected "cooler summer weather, along with increased average river flow conditions, which both generally correspond with decreased power production and resultingly lower discharge temperatures." *Id*.

Joliet 29. MWG's demonstration noted that narrative descriptions of discharge temperatures did not account for the use of supplemental cooling towers, so all Joliet 29 data represented measured end-of-pipe temperatures. MWG Pet. at 13 n.9. MWG argued that the data presented conservative estimates of compliance point temperatures, while acknowledging that mechanical issues and seasonal conditions could negatively affect cooling tower use and performance. *Id*.

Discharge Temperatures. Mean summer discharge temperatures were all below 90 °F, with highest monthly means of 86.9 °F in July and 85.6 °F in August. MWG Pet. at 13; MWG App. D at D-15, citing Table D-1b.

The highest discharge temperatures occurred in July, with a median temperature of 86.6 °F and upper 10th percentile temperatures at or above 97.4 °F. MWG Pet. at 13; MWG App. D at D-15, citing Table D-1. For August, the median discharge temperature was 85.6 °F, and upper 10th percentile temperatures were at or above 93.9 °F. *Id*. Maximum measured temperatures (at end-of-pipe) for July and August were 105.5 °F and 105.0 °F, respectively. *Id*.

For June and September, the upper 10th percentile temperatures were at or above 90.2 °F and 91.7 °F, respectively. MWG App. D at D-15, Table D-1b. For those two months, maximum measured temperatures were 102.3 °F and 103.5 °F, respectively. MWG Pet. at 13; MWG App. D at D-15, Table D-1b.

Discharge Flows. Discharge flows were at or close to the normal operating rate of 1,537 cfs (994 MGD), representing the use of three of the four circulating water pumps for over 60% of the time during the summer. MWG App. D at D-16, Table D-2b. About 1% of the time, Joliet 29 operated at the design flow rate of 2,050 cfs (1,325 MGD). *Id*.

The demonstration stated that when the Station was coal-fired, "the summer circulating water flow rate was essentially 1,537 cfs during the summer, aside from intermittent pump rotations and short-term outages." MWG App. D at D-16, Table D-2b. Since converting to gas, the system can remain idle for weeks or months at a time. *Id*.

<u>Summer Power Production.</u> Units 7 and 8 had maximum load capacity of 1116 MW. MWG App. D at D-16. Median summer operating levels ranged from 45% to 52% of total capacity, or 479MW to 579 MW. *Id*. at Table D-2b. The units operated at or greater than 90% capacity, or 1004 MW, for just under 15% of the time on average, and at or greater than 95% capacity about 5% of the time. *Id*.

The demonstration reported that, since converting to natural gas, operating levels had been much lower than in the past and can be expected to remain below historical levels on a sustained basis. MWG App. D at D-16. During high demand periods with hot weather and low river flows, the Stations will run at high levels and discharge at the same high temperatures. *Id*. The historical data provided a "reasonably reliable representation of future discharge temperatures under adverse compliance conditions." *Id*.

<u>Discharge Temperatures Over 90 °F.</u> July discharge temperatures exceeded 90 °F for over 700 hours in 2012, over 400 hours in 2013, and from 142 to 238 hours from 2014 to 2016. MWG App. D at D-16, citing Table D-3d. July discharge temperatures exceeded 93 °F, ranging from 647 hours in 2012 to 0 hours in 2017. *Id*. July discharge temperatures exceeded 96 °F, ranging from 466 hours in 2012 to 0 hours in 2014 and 2017. *Id*. Maximum discharge temperatures were 105.5 °F and 105.0 °F in July and August of 2012, respectively, a period of drought and heat during which the Stations operated under a provisional variance. MWG App. D at D-17 n.9, Table D-1b.

After 2012, discharge temperatures still exceeded 93 °F up to 36.8% of the time in July 2013, about 23% of the time in August and September of 2013, and 16.4% of the time in July 2016 after conversion to gas. MWG App. D at D-18, Table D-3d. In September, discharge temperatures exceeded 93 °F, ranging from 0 to nearly 23% of the time depending on the year. *Id*.

In 2012, discharge temperatures exceeded 96 °F up to 62.6% of the time in July and 22.7% of the time in August. MWG App. D at D-18, Table D-3d. In 2013, they exceeded 96 °F up to 17.2% of the time in July and 9% of the time in August. Discharge temperatures exceeded 98 °F 48.8% of the time in July 2012 and from 0 to 10.1% of the time in July of other years. *Id*.

<u>Use of Supplemental Cooling Towers.</u> Joliet 29 normally operates its cooling towers whenever discharge temperatures are expected to exceed 93 °F for an extended period. MWG App. D at D-18. By mixing plant discharge with cooling tower effluent, discharge temperatures are lower than the end-of-pipe value. *Id*.

The demonstration argued that end-of-pipe temperatures provided "conservative estimates of compliance point temperatures under most conditions." MWG Pet. at 13 n.9. Because mechanical issues and adverse dew points can have negative effects on cooling tower operations, "it is not excessively conservative to look at end-of-pipe temperatures as a valid means of assessing potential thermal impact under unfavorable conditions." MWG Pet. at 13 n.9; *see also* MWG App. D at D-18.

Summer Discharge Summary. The demonstration argued that, with fluctuating river flows, the Stations' historical discharge data indicated that neither will consistently be able to meet the thermal water quality standards for the UDIP and Five-Mile Stretch, even with the small allotment of excursion time allowed up to a maximum of 93 °F. MWG App. D at D-18 – D-19.

Winter Data for Joliet Stations

Joliet 9. The demonstration argued that Joliet 9 discharge data represented measured end-of-pipe temperatures and therefore provided conservative estimates of compliance point temperatures under most conditions. MWG App. D at D-19. It added that ranges of discharge temperatures reflected non-seasonal weather conditions, low LDPR flow, and higher winter power demand. MWG Pet. at 13; MWG App. D at D-19.

Discharge Temperatures. Mean winter discharge temperatures were all below 60 °F. MWG App. D at D-19, Table D-1c. The highest mean discharge temperatures occurred in February (50.8 °F) and March (53.6 °F). Pet. at 12; MWG App. D at D-19, Table D-1c.

During December and March, discharge temperatures exceeded 60 °F more than 10% of the time, with maximum temperatures of 80.8 °F and 70.0 °F, respectively. Pet. at 12-13; MWG App. D at D-19, Table D-1c.

During the proceedings for MWG's ATEL requests, the Board noted that the proposed temperature limits for December and March were 65 °F for far-field and 70 °F for near-field. The Board asked MWG to comment on how often it expected discharge temperatures above the proposed limits and on the availability of excursion hours. Board Questions at 1.

MWG responded that these maximum temperatures were end-of-pipe temperatures, which did not necessarily indicate temperatures at the edge of the mixing zone or far-field temperatures. MWG Resp. at 2. MWG argued that both Stations would be able to meet the proposed near-field winter limits, which included excursion hours. *Id*. at 2-3. It also expected to meet the far-field ATEL most of the time with a requested period of excursion hours to cover limited periods during unseasonable conditions that may limit downstream cooling. *Id*. at 3. If it came close to exhausting the requested excursion hours, MWG stated that it would implement whatever measures necessary to remain in compliance with the maximum proposed winter near-field and far-field ATELs. *Id*. at 3.

In the cooler months of January and February, discharge temperatures exceeded 60 °F for up to 5% of the time, with maximum temperatures of 68.6 °F and 68.2 °F, respectively. Pet. at 12-13; MWG App. D at D-19, Table D-1c.

Discharge Flows. Because of maintenance operations and lower historic power production, cooling water flow rates were "somewhat lower than during the summer." MWG App. D at D-20, Table D-2c. The Station maintained a cooling water flow rate less than the design maximum of 579 cfs about 50% of the time in December and March, and 20% to 30% of the time in January and February. *Id*. Under peaking operation, if Unit 6 is not running, then there is generally no cooling water flow. MWG App. D at D-20. In unseasonable weather conditions, however, the Station may operate all available circulating water pumps to meet power demand. *Id*.

Winter Power Production. "Under gas peaking operations, the unit has not, to date, been run for more than a few days at a time during the winter months." MWG App. D at D-20 n.10. Maximum winter load was 334 MW. MWG App D, Table D-2c. Median operating levels ranged from 0 to 46% of total capacity (155 MW). *Id*. Power production was at or above 75% capacity (251 MW) for up to 20% of the time and at or above 90% of capacity (301 MW) for up to 10% of the time. *Id*.

Discharge Temperatures Over 60 °F. Discharge temperatures exceeded 60 °F during all four winter months. MWG App. D at D-21, Table D-3b. They exceeded 70 °F for 69 hours in December 2012 and 27 hours in December 2013. *Id*. Discharge temperatures exceeded 60 °F for over 400 hours in December and March 2012 and over 300 hours in December 2013. *Id*.

Discharge temperatures exceeded 63 °F from 0 to 44.2% of the time in December and 0 to 45.2% of the time in March. MWG App. D at D-21, Table D-3b. During the colder months of January and February, discharge temperatures exceeded 63 °F up to 9.1% and 10.1% of the time, respectively. *Id*. During a period of unusual winter warmth in February 2017, discharge temperatures exceeded 67 °F for five hours. *Id*. Discharge temperatures exceeded 68 °F from 0 to 16.1% of the time in December and 0 to 13.1% of the time in March. *Id*.

Joliet 29. The demonstration stated that winter discharge temperatures did not reflect the use of supplemental cooling towers, which are not designed to operate in winter. MWG App. D at D- 17; *see also* MWG Pet. at 13 n.9. As noted above, the demonstration argued that discharge data represented "measured end-of-pipe temperatures and therefore provide conservative estimates of compliance point temperatures under most conditions." MWG App. D at D-19.

Discharge Temperatures. Mean winter discharge temperatures were all below 60°F, with the highest monthly means in December (51.1 °F) and March (54.1 °F). Pet. at 13; MWG App. D at D-19, Table D-1d. Discharge temperatures were above 60 °F up to 15% of the time during those two months, with maximum temperatures of 80.5 °F and 69.1 °F, respectively. Pet at 13-14; MWG App. D at D-19, Table D-1d. During the colder months of January and February, discharge temperatures exceeded 60 °F up to 1% of the time, with maximum measured temperatures of 67.5 °F and 64.6 °F, respectively. Pet. at 14; MWG App. D at D-19, Table D-1d. The range of winter discharge temperatures reflected a combination of non-seasonal weather conditions, low UDIP/LDPR flow, and higher winter power demand. Pet. at 14; MWG App. D at D-19.

Discharge Flows. Because of maintenance operations and lower historic power production, cooling water flow rates were "somewhat lower than during the summer." MWG App. D at D-20, Table D-2d. When it operates, Joliet 29 generally uses three of four circulating water winter pumps, with a total flow of 1,537 cfs. *Id*. The Station maintained this flow approximately 60% of the time during winter months. *Id*. Higher flows have been related primarily to pump switching, which occurs infrequently. Lower flows occurred under single-unit operation or during plant maintenance activities. MWG App. D at D-20.

Winter Power Production. Maximum winter load was 1101 MW. Median operating levels ranged from 30% (330 MW) to 56% (620 MW) of total two-unit capacity. MWG App. D at D-21. Production was at or above 75% of capacity (826 MW) up to 25% of the time. Units 7 and 8 were operated at up to 90% capacity for up to 10% of the time. MWG App. D at D-20 – D-21, Table D-2d.

Discharge Temperatures Over 60 °F. Discharge temperatures exceeded 60 °F for over 400 hours in March 2012 and December 2014. MWG App. D at D-21, Table D-3e. Temperatures exceeded 63 °F from 0 to 33.9% of the time in December and 0 to 39.3% of the time in March. *Id*. Discharge temperatures exceeded 68 °F from 0 to 8.3% of the time in December and 0 to 2.3% of the time in March. *Id*. at D-21 – D-22, Table D-3e.

During the colder months of January and February, discharge temperatures exceeded 63 °F for up to 2.7% and 0.6% of the time, respectively. MWG App. D at D-22, Table D-3e. During a period of unusual winter warmth in February 2017, discharge temperatures exceeded 60 °F for nine hours. *Id*. The demonstration argued that "discharge temperatures would have been higher, but operational issues prevented Unit 8 from running at full load during this period." MWG App. D at D-22 n.12.

Winter Discharge Summary. The demonstration stated that winter flows in the UDIP/LDPR "are often chronically low, which could potentially limit the amount of dilution flow available for dissipation of discharge temperatures," thereby limiting the Stations' ability to comply with the UDIP winter thermal limits. MWG App. D at D-22. It argued that historical temperature data indicated that discharges from the Stations would be unable to consistently meet the UDIP numeric winter limit of 60 °F and the 63 °F maximum. *Id*. It added that the available excursion hours would not be sufficient to support winter operations, "especially if unseasonable weather patterns and/or low flow conditions persisted during any given year." *Id*.

Transitional Months Data for Joliet Stations

The transitional months of April to May and October to November experienced significant discharge temperature fluctuations. MWG App. D at D-23, Tables D-3c, D-3f. Joliet 9 discharge temperatures exceeded 90 °F for 19 hours, with a maximum temperature of 93.6 °F in October 2013. MWG App. D at D-23, Tables D-1e, D-3c. Joliet 29 discharge temperatures exceeded 90 °F for 42 hours, with a maximum temperature of 92.3 °F. MWG App. D at D-23, Tables D-1f, D-3f.

The demonstration suggested that this data indicated that the Stations' thermal discharges could meet UDIP thermal limits for transitional months most of the time. MWG App. D at D-23. However, MWG proposed near-field thermal ATELs that, for some months, "are more stringent than the UDIP limits for this period." *Id*. (emphasis in original). The demonstration argued that this provided a more seasonally-based and gradual transition between the summer and winter months and addressed the purpose of narrative standards regarding abnormal temperature changes. *Id*.

Thermal Plume Surveys for Joliet Stations

The demonstration included thermal plume surveys performed in 2017 on February 23, July 13, and December 14. MWG App. D at D-24. The units were placed into operation at least two days before each survey to obtain representative thermal plumes. *Id*. at D-29. Data collected during a 2012 survey supplemented the summer data. MWG App. D at D-29, citing MWG App. I; *see also* MWG App. D at D-24 n.15. Each thermal survey consisted of mapping the plume by continuously recording near-surface temperatures along a transect grid and by performing a series of vertical temperature profiles. MWG App. D at D-24 – D-25.

Mapping. The sampling grid included 25 transects within the UDIP ranging from 3,350 ft upstream from the Stations (near the Brandon Road Lock & Dam) to 33,350 ft downstream (at the I-55 Bridge). MWG App. D at D-25, Figures D-3a – D-3c. The surveys re-established the 14 original near-field locations and extended the far-field area with nine additional downstream transects. *Id*. at D-26. The surveys established vertical profiling stations that are evenly spaced along each of the transects based on channel width. *Id*. They included additional transects and vertical stations in each of the discharge canals. *Id*.

Bathymetric Survey. On September 7-8, 2017, a survey collected bathymetric data along each of the 25 study transects. MWG App. D at D-27, citing Figure D-6 (bathymetric contour map). The survey collected depth soundings and measured physical characteristics of the water column to determine sound velocity. Sound velocity is a product of water density and is employed to correct raw soundings. Once reviewed and corrected, this data was used to develop the hydrothermal model. MWG App. D at D-27 – D-28.

Survey on February 23, 2017

Survey Conditions. LDPR flows during the February 23 survey ranged from 1,656 to 8,580 cfs, from approximately the 20th percentile to slightly below the 99th percentile. MWG App. D at D-28 – D-29, citing Figure D-7a; *see also* Table D-4b. The demonstration characterized flow fluctuations of this nature as "typical of the LDPR." MWG App. D at D-29.

Station Operations. Intake temperatures during the study ranged from 50.4 °F to 53.9 °F at Joliet 9 and between 49.7 °F and 50.5 °F at Joliet 29. MWG App. D at D-29, citing Table D-5a, D-5b. Power production at Joliet 9 ranged from 115 MW to 240 MW before completely shutting down. *Id*. The Joliet 9 intake/discharge flow was constant at 290 cfs during the survey, representing a single circulating water pump. The highest discharge temperature at the point of discharge was 67.4 °F with a mean of 66.3°F. *Id*.

At Joliet 29, intake temperatures ranged from 49.7 °F to 50.5 °F. MWG App. D at D-29, citing Table D-5b. Power production at Joliet 29 ranged up to 390 MW during the survey period before shutting down. *Id*. Flow at Joliet 29 decreased from 1,537 cfs to 1,025 cfs during the survey period before all circulating water pumps cycled off. *Id*. The highest discharge temperature at the point of discharge was 59.0 °F, with a mean of 58.2 °F. *Id*.

Although Joliet 29 does not customarily use its supplemental cooling towers during the winter, 14 of the towers were in service during the February 23 survey. MWG App. D at D-29. The demonstration explained that the survey occurred "at the end of a string of six consecutive dates with record-breaking warm air temperatures." *Id*. at D-30. The demonstration argued that operating the towers helped maintain compliance with far-field temperature standards. *Id*. However, using the towers "did not result in any significant decrease in effective discharge temperature (a calculated value which assumes complete mixing of the cooling tower flow with the non-cooled discharge flow)." *Id*.

Plume Survey Results. At the Joliet 9 discharge canal, the plume temperature was as high as 67 °F, with elevated temperatures continuing to the -1720, 1/5 transect point (63.1 °F to 66.5 °F). MWG App. D at D-31 – D-32, citing Table D-6. On the RDB at transect -1720 4/5, the survey found cooler temperatures ranging from about 61 °F in the surface layers to 51.7 °F at the bottom (12 ft.). *Id*. Downstream, the plume remained closer to the LDB, where surface temperatures ranged from 60 °F to 65.1 °F in the top three feet and 52.1 °F to 52.7 °F at the bottom. *Id*. At the -750, 4/5 transect point, the RDB had cooler and relatively consistent temperature from top to bottom ranging from 54.5 °F to 53.9 °F, respectively. *Id*. The plume remained laterally distributed within the top five to six feet through the -250 ft transect, with some heat dissipation observed. *Id*. The 63 °F isotherm of approximately 19 acres was all within the -250ft transect boundary, marking the theoretical edge of Joliet 9's 26-acre mixing zone. All water temperatures were at or below 61.2 °F near the surface, with decreasing temperatures as depth increased. MWG App. D at D-32; *see also* Figure D-8a.

From Joliet 29, the discharge enters the river just below the 250ft transect. Because Joliet 29 used 14 cooling towers on this date, its discharge temperature was slightly cooler than the receiving water. This plume of cooler water pushed the warmer water against the LDB. MWG App. D at D-32. Surface temperatures exceeded 60 °F over about 35 acres, with subsurface temperatures about 2 °F to 3 °F cooler. MWG App. D at D-32; *see also* Figure D-8a; Table D-6. At the 2,000 ft transect, the edge of a 26-acre mixing zone, "more complete mixing was observed," with maximum surface temperatures ranging from 57.8 °F on the LDB to 59.1 °F on the RDB, and corresponding bottom temperatures of 56.7 °F to 56.1 °F, respectively. *Id*. Beyond the 2,750 ft transect, river surface temperatures were better mixed. *Id*. Thermal plume depth was variable from transect to transect, which may result from low flow conditions in the waterway. This low flow can cause pooling and slow plume dispersion and downstream travel, which can affect overall heat dissipation. The demonstration also noted that prevailing weather conditions were extremely unseasonable, with a high local air temperature of 65 °F. *Id*. The plume became horizontally and vertically mixed at the 15,000 ft transect, where temperatures ranged from 56.3 °F at the bottom to 55.8 °F at the surface. "These temperatures were similar to ambient temperatures observed at the -3,350 ft transect." MWG App. D at D-32; *see also* Figure D-5a.

At the I-55 Bridge at the 33,350 ft transect, the study showed full mixing, with temperatures ranging from 54.3 °F to 54.7 °F. MWG App. D at D-32; *see also* Table D-6.

<u>Survey on July 13, 2017</u>

<u>Survey Conditions.</u> LDPR flows during the July 13 survey ranged from 3,371 cfs to 6,996 cfs, from about the 50th to the 85th percentile. MWG App. D at D-28 – D-29, citing Figure D-7b. The demonstration characterized this flow fluctuation as typical of a summer day. MWG App. D at D-29, citing Table D-4a.

<u>Station Operations.</u> Intake temperatures during the survey ranged from 75.2 °F to 77 °F at Joliet 9. MWG App. D at D-30, citing Table D-7a. Power production at Joliet 9 ranged from 133 MW to 312 MW before dropping to 220 MW. *Id*. The Joliet 9 discharge flow was constant at 579 cfs during the survey. *Id*. The highest discharge temperature at the point of discharge was 87.9 °F, with a mean of 87.2 °F. *Id*.

At Joliet 29, intake temperatures ranged from 75.1 °F to 75.7 °F. MWG App. D at D-30, citing Table D-7b. Power production at Joliet 29 ranged from 314 MW up to 999 MW before dropping to 662 MW. *Id*. Flow at Joliet 29 was constant at 1,537 cfs during the survey. *Id*. The highest discharge temperature at the point of discharge was 92 °F, with a mean of 90.9 °F. *Id*.

During the July 13 survey, cooling towers were not in use because they were not deemed necessary to maintain compliance with the existing near-field or far-field thermal standards. MWG App. D at D-30. The demonstration argued that performing the thermal surveys without tower use "also provided the opportunity to assess heat dissipation in the waterway solely based on ambient conditions." *Id*.

<u>Plume Survey Results.</u> From Joliet 9, the maximum discharge temperature measure was 87.9 °F. Adjacent to the discharge canal at the -1,720 ft transect, the plume temperature was 86.8 °F, with cooler surface temperatures on the RDB. MWG App. D at D-34, Table D-8. Downstream at the -750 ft transect, the plume moved across the river, with surface temperatures at the RDB at 85.1 °F and the LDB at 78.6 °F. *Id*. Near the 250 ft transect, the plume began to spread more evenly. *Id*. The 250 ft transect was considered the approximate hypothetical edge of a 26-acre mixing zone.

The Joliet 29 discharge was measured at 88.7 °F just upstream of the discharge canal confluence with the UDIP. MWG App. D at D-34, Table D-8. At the 750 ft transect, the thermal plume was still discernable, with temperatures ranging from 87.8 °F on the RDB to 86.0 °F on the LDB. *Id*. Lower depth temperatures were in the 77.0 °F to 81.5 °F range, except at the LDB, where temperatures approached 86.0 °F. *Id*. T he 2,000 ft transect corresponds to the approximate edge of the hypothetical 26-acre mixing zone for the Joliet 29 discharge. MWG App. D at D-34. At depths down to eight feet, temperatures ranged from 84.3 °F to 87.0 °F. *Id*. The temperatures below eight feet ranged from 78.2 °F to 84.3 °F, with the highest temperatures along the RDB. *Id*. At the 15,000 ft transect, the plume became mixed horizontally and vertically, with temperatures ranging from 79.2 °F to 81.7 °F. *Id*.

At the I-55 Bridge at the 33,350 feet transect, the study showed temperatures ranging from 78.9 °F to 79.1 °F. MWG App. D at D-35; *see also* Table D-8. "These temperatures do not reflect any upstream thermal influence." MWG App. D at D-35.

Survey on December 14, 2017

Survey Conditions. LDPR flows during the December 14 survey ranged from 235 cfs to 3,946 cfs, from below the 1st percentile to approximately the 85th percentile. MWG App. D at D-29, citing Table D-4b; *see also* Figure D-7c.

Station Operations. Intake temperatures during the study ranged from 37.1°F to 39.2°F at Joliet 9, with a mean of 37.9 °F. MWG App. D at D-30, citing Table D-9a. Power production at Joliet 9 ranged from 135 MW to 250 MW. *Id*. The Joliet 9 discharge flow was constant at 579 cfs during the survey. MWG App. D at D-30; *see also* Figure D-7c. The highest discharge temperature at the point of discharge was 49.6 °F, with a mean of 47.3 °F. MWG App. D at D-30, citing Table D-9a.

At Joliet 29, intake temperatures ranged from 37.7 °F to 38.9 °F, with a mean of 38.3 °F. MWG App. D at D-30 – D-31, citing Table D-9b. Power production at Joliet 29 ranged from 815 MW to 1024 MW. *Id*. Flow at Joliet 29 was constant at 1,537 cfs during the survey. *Id*. The highest discharge temperature at the point of discharge was 52.3 °F, with a mean of 50.6 °F. *Id*.

During the December 14 survey, cooling towers were not in use because they were not deemed necessary to maintain compliance with the existing near-field or far-field thermal standards. MWG App. D at D-30. The demonstration argued that performing the thermal surveys without tower use "also provided the opportunity to assess heat dissipation in the waterway solely based on ambient conditions." *Id*.

Plume Survey Results. For Joliet 9, the study observed the plume recirculating with warmer water upstream towards the -3,350 ft transect. MWG App. D at D-36, citing Figure D-8c. The 1/4 vertical showed a temperature of 45.1 °F at the surface and 38.9 °F at the bottom. The bottom temperature was similar to the surface temperature observed at the -4,620 ft transect, an upstream monitoring location. *Id*. "When the Joliet 9 plume enters the river at the -1,720 ft transect, the surface layers will move both upstream and downstream when river flow is low." MWG App. D at D-36. At the -1,720 ft transect, the plume surface had lateral temperature differences attributable to the Joliet 9 discharge. MWG App. D at D-37, citing Table D-10. Temperatures near 50 °F were observed on the RDB, whereas the LDB was between 52.9 °F at the surface and 52.4 °F at a depth of three feet. *Id*. "The surface plume stretched laterally across the entire river width from the -1,720 ft through the -750 ft transect, but dissipated rapidly by the -250 ft transect." MWG App. D at D-37.

At Joliet 29, the study measured discharge temperatures of 50.3 °F to 50.5°F, which was similar to temperatures near the discharge point because of the influence of the Joliet 9 thermal discharge. MWG App. D at D-37, citing Table D-10. The study found similar temperatures at the 250 ft transect, where the Joliet 29 discharge meets the UDIP. At the 750 ft transect, the water column was fully mixed at about 50 °F. *Id*.

With slight stratification, the entire river channel remained at about 50 °F through the 5,500 ft transect. *Id*. Differences likely resulted from "both complex mixing processes within the LDPR, as well as the impact of upstream lock and dam operations." MWG App. D at D-37. The study observed the same stratification pattern downstream at the 10,800 ft and 15,000 ft transects. *Id*. Farther downstream, the water column was essentially of uniform temperature. *Id*.

At the I-55 Bridge, the study found uniform water temperatures of 40.3 °F to 40.4 °F at the 1/2 and 3/4 width, and less than 0.5 °F cooler on the LDB.

Joliet Stations Data Collection Programs

In the 1990s, several biological and physiochemical studies were developed in cooperation with the UIW Task Force and examined areas including the UDIP near the Stations. MWG App. E at E-1. Since the 1990s, additional studies have been sponsored by MWG or as part of the efforts of the ACRCC and other agencies. *Id*. The demonstration summarized data collection programs conducted near the Stations.

Hydrographic Surveys

Hydrographic data were collected and used to operate the Stations and in studies to evaluate their effects on the LDPR. MWG App. E at E-2, citing App. D. USACE and USGS, which operate gauges on the CSSC and LDPR, were the primary sources of this data. *Id*. Depending on the station, data for stage, elevation, and/or discharge, as well as select parameters such as temperature and velocity, are available. *Id*.

Temperature Monitoring

Numerous thermal studies were conducted near the Stations.

From 1977 to 2011, MWRDGC monitored water quality at 49 fixed locations along a 133-mile stretch of the UIW, including eight locations in the Dresden Island Pool, with four of them upstream from the I-55 Bridge. MWG App. E at E-3. MWRDGC performed monitoring three times per year before discontinuing it beyond its immediate service area in 2011. *Id*., citing App. C.

In 1996, the Board ordered a study of the UIW as part of a variance issued to MWG's predecessor as owner of the Stations. MWG App. E at E-3. In 2002, studies conducted on MWG's behalf obtained information concerning near-field thermal plume characteristics for each generating facility under a variety of summer operating, river flow, and meteorological conditions. *Id*. The surveys included surface plume measurements. *Id*. at E-3 – E-4, citing App. I.

In 2012, surveys on behalf of MWG examined thermal plumes near the Stations. MWG App. E at E-4, citing App. I. Based on its DSP, MWG performed a summer thermal plume survey on July 13, 2017, and two winter surveys on February 23 and December 14, 2017. MWG App. E at E-4. The collected data were used to construct and calibrate a hydrodynamic model and develop MWG's proposal. *Id*., citing App. D.

Finally, the Stations maintain a continuous record of intake and discharge temperatures and other operational data under their NPDES permits. The collected data supported their approved near-field thermal compliance model. MWG App. E at E-4, citing App. D.

<u>Nutrient Data</u>

Since 1977, MWRDGC collected and analyzed samples from the entire UIW. MWG App. E at E-5. Monitored parameters included nutrients described below. *Id*.

<u>Phytoplankton and Periphyton Communities</u>

In 1991 and 1993, MWG's predecessor as owner of the Stations collected phytoplankton and periphyton samples as part of a UIW study. The Board required a study to address a variance granted to the predecessor. MWG App. E at E-7. The study objectives were to assess the algal community system-wide, evaluate the effects of power generating stations along the waterway, and to characterize the importance of tributary inputs to the algal community. *Id*. at E-7 – E-8.

Since 2002, MWRDGC has annually monitored phytoplankton productivity near the Stations to monitor the community assemblage. MWG App. E at E-8. The ACRCC conducted monthly plankton sampling at six sites along the Illinois Waterway from 2009 to 2010 and at 12 additional sites from 2011 to 2013. MWG App. E at E-8.

The ACRCC also conducted weekly sampling for chlorophyll *a*, zooplankton, and phosphorus in 2017 and 2018. Monitoring sought to assess productivity by measuring concentrations of chlorophyll *a*, zooplankton, and phosphorus to locate areas where Asian Carp were most likely. *Id*. In addition, annual monitoring sought to identify relationships between the abundance of Asian Carp and the three variables. *Id*.

<u>Zooplankton</u>

The demonstration reported that limited zooplankton sampling has been conducted within the UIW. MWG App. E at E-9; *see also* MWG Ex. A at 6-4. Because zooplankton have a high reproductive capacity and short generation times, the category is considered to have low potential for impact from thermal discharges. MWG App. E at E-9. Also, testing had shown that "zooplankton typically have relatively high thermal tolerance levels." *Id*.

Zooplankton sampling was conducted in the Dresden Island Pool from 1972 to 1975 and in 1981 to characterize the spatial and temporal distribution of the community. MWG App. E at E-9. Also, in 2009 to 2010 and 2011 to 2014, ACRCC conducted plankton sampling to assess composition of the community before and after occurrence of Asian Carp and to document the ecosystem's response before and after Asian Carp removal activities. *Id*.

<u>Benthos</u>

The demonstration reported that there were only limited studies of benthic macroinvertebrates near the Stations since the mid-1990s. MWG App. E at E-11. Because the Stations' discharges result in buoyant thermal plumes, "habitat for benthic macroinvertebrates has minimal exposure to the warmest portions of the plumes that occur in the immediate vicinity of the stations." *Id*.

MWG's predecessor investigated benthic macroinvertebrate communities in the UIW in 1993 and 1994. MWG App. E at E-11. The first investigation sought to characterize the communities, and the second sought to identify potential relationships between invertebrate community composition and selected water, sediment, and habitat parameters. *Id*. Both included sampling locations directly upstream and downstream from the Stations. *Id*.

In 2017 and 2018, the demonstration sampled the benthic macroinvertebrate communities at 12 locations near the Stations to determine and compare the composition, distribution, and abundance of the benthic community among segments. MWG App. E at E-11, citing App. L.

Macrophytes

From 1992 to 1995, macrophyte sampling sought to determine the location and extent of these communities and investigate factors that may limit their establishment and growth. MWG App. E at E-14. These aquatic communities were assessed using aerial photography with field reconnaissance and ground truthing. *Id*.

MWG conducted additional studies to supplement the earlier UIW studies. MWG App. E at E-14, citing App. K. These studies included QHEI assessments and a survey of submerged aquatic vegetation and habitat in the UDIP during peak growing season. MWG App. E. at E-14.

Ichthyoplankton

In 1994, MWG's predecessor as owner of the Stations studied early life stages of fish in the UIW. MWG App. E at E-16. The study's goal was to determine what portion of the fish community in the Illinois River drainage used this physically limited and impacted subunit in the system as a spawning or nursery area, as well as when and where those uses occurred. *Id*.

In 2004 and 2005, both Stations conducted entrainment studies. In 2016, Joliet 9 conducted an entrainment study to evaluate technology for USEPA regulations. MWG App. E at E-17. In 2017, MWG reported UDIP water quality, hydrology, and fisheries data to assess whether entrainment data form 2004 and 2005 reflected current conditions. *Id*. IEPA approved the report. *Id*.

Since 2010, INHS on behalf of ACRCC has collected larval fish from 12 sites in the Illinois Waterway. MWG App. E at E-17. These studies help to show the distribution of Asian Carp eggs and larvae and factors contributing to Asian Carp recruitment. *Id*.

Impingement

From July 2004 to August 2005, an impingement mortality study was conducted at both Stations. MWG App. E at E-18. From April 2004 through April 2006, a two-year impingement study was conducted at Joliet 29. *Id*. During the same period, 52 weekly impingement samples were collected at the Joliet 9 intake, and 10 concurrent sampling events were conducted at Joliet

Stations 9 and 29. *Id*., citing Apps. A, B.

Joliet Stations Ecological Setting

The Stations discharge treated wastewater to the UDIP under the terms of their respective NDPES permits. The Board's regulations designate the UDIP as the Lower Des Plaines River from the Brandon Road Lock and Dam to the Interstate 55 bridge. 35 Ill. Adm. Code 303.230(a); *see also* MWG Pet. at 3 n.4; MWG App. A at A-1. Although the UDIP ends at the bridge, the Stations' thermal influence can extend beyond it into the Five-Mile Stretch. MWG Pet. at 1. Although not designated in the Board's regulations, the Five-Mile Stretch is the segment of the LDPR running from the I-55 Bridge at RM 277.9 to the head of the Illinois River formed by the confluence of the Des Plaines and Kankakee Rivers at RM 273.0. *Id*. at 3 n.5.

In 2015, the Board adopted new thermal water quality standards, effective July 1, 2018. MWG Pet. at 1-2; Water Quality Standards and Effluent Limitations for the Chicago Area Waterway System (CAWS) and the Lower Des Plaines River: Proposed Amendments to 35 Ill. Adm. Code 301, 302, 303 and 304, R08-9(D) (June 18, 2015). While those thermal standards are based on standards for General Use waters, the Board designated the UDIP as "Upper Dresden Island Pool Aquatic Life Use Waters." 35 Ill. Adm. Code 303.230(a); *see also* MWG Pet. at 2; Rec. at 2. During consideration of the 2018 thermal standards, MWG stated that the Joliet Stations could not consistently meet the proposed standards and would avoid violations only by shutting down or derating. MWG Pet. at 2.

The Five-Mile Stretch was not addressed by the Board's 2018 thermal standards. Pet. at 3. MWG asserted that, although Board regulations assign different uses to the UDIP and Five-Mile Stretch, "there is little meaningful difference between the two adjacent waterbodies, and MWG addresses a single biological community inhabiting both segments." Pet. at 2 n.2; MWG App. B at B-1 n.1; MWG Resp. at 7.

MWG argued that the Board in 1996 "found 'adequate proof' that the impact of the Joliet Stations on water temperatures past the I-55 Bridge did not cause nor could be reasonably expected to cause significant ecological damage to the waters of the Five-Mile Stretch." MWG Pet. at 3, citing Petition of Commonwealth Edison Company for Adjusted Standard from 35 Ill. Adm. Code 302.211(d) and (e), AS 96-10 (Oct. 3, 1996). The Board adopted alternate thermal standards applicable at the I-55 Bridge, which have been incorporated as far-field temperature limits in all NPDES limits for the Joliet Stations issued since 1996. MWG Pet. at 3.

Human Uses

Surrounding Land Use. Land surrounding Joliet Stations 9 and 29 is "dominated by industrial and commercial properties that have taken advantage of proximity to the river system for the transport of commodities, as well as industrial water usage." MWG Ex. A at A-34. Commercial shipping uses the UDIP and Five-Mile Stretch to connect the Great Lakes and Mississippi River Basin. The water had been channelized for barge traffic, and USACE maintains navigational depth. *Id*.

The UDIP and Five-Mile Stretch are also receiving waters for industrial discharges. Review of major NPDES facilities with individual permits showed 12 major permittees discharging into the UDIP or Five-Mile Stretch near the Stations, including upstream and indirect dischargers to the LDPR. MWG Ex. A at A-35.

Recreational Uses. The UDIP near the Stations is designated as an Incidental Contact Recreational Use Water. Recreational use is limited to activities in which human contact with the water is incidental and the probability of ingesting appreciable quantities of water is minimal. MWG Ex. A at A-34, citing 35 Ill. Adm. Code 303.225.

Heavy Metal Contaminants. Contaminant levels in river water and sediments are affected by land use practices, floods, other natural events, spills, and other human caused incidents within the watershed. MWG Ex. A at A-35. Typical sources of heavy metals released to the UDIP/Five-Mile Stretch over time include municipal wastewater-treatment plants, manufacturing industries, and past agricultural activities. *Id*. at A-37. Sediment collected near the Brandon Road Lock & Dam from 2008 to 2011 contained high levels of cadmium, chromium, iron, lead, manganese, arsenic, and mercury, as well as one PCB contaminant, Aroclor 1242. *Id*. at A-35 – A-36; *see also* MWG Table A-2: 303(d) list; MWG App. C at C-7.

Organic Contaminants. The UDIP/Five-Mile Stretch also receives a variety of organic wastes, some of which are detrimental to human health and aquatic organisms. MWG Ex. A. at A-36. Although historical data show improved nutrient concentrations over time, nutrient levels remain a concern in the waterway system. *Id*.

ANS Dispersal Barrier. Construction of an ANS dispersal barrier system and the migration of Asian Carp from the Illinois River have generated intensive sampling in the IWS including the UDIP. MWG App. A at A-39. Because species in the by-catch could be affected, sampling pressure likely has localized impacts on the UDIP fish community. *Id*. at A-40. Plans for additional activities to control ANS "will almost certainly result in additional changes and stresses to the waterway near the Joliet Station that have nothing to do with their thermal discharges." *Id*. at A-41.

Contaminant Concentrations in Sediments. A 2008 sediment study collected 35 samples from the Dresden Island Pool and lower Brandon Pool. Chemical analysis showed that both had high concentrations of metals and tested organic constituents. Data indicated that sediment quality in these areas would overall be characterized as "poor." MWG App. A at A-43, A-49, citing Figure A-6 (sampling locations); App. C at C-7. MWRDGC conducted sediment chemical analysis for 11 trace metals between 2004 and 2011. MWG App. A at A-43, citing Tables A-9, A-10 (UDIP data). Also, some of the highest levels nationally of PAHs were detected in sediment near Chicago. MWG App. A at A-44. Frequent barge traffic re-suspends fine sediments. MWG App. A at A-44; MWG App. C at C-8. The demonstration stated that "movement of metals from the sediments into the water column is mediated principally by pH, which is not affected by temperature. Therefore, the Joliet Stations thermal discharges do not cause the release of heavy metals from the sediments." MWG App. C at C-9.

Contaminant Concentrations in Animal Tissue. Many pesticides and other synthetic organic compounds (SOC), particularly those with low solubility, show a tendency to bioaccumulate in organisms. MWG App. A at A-44. The demonstration stated that the Joliet Station thermal discharges "are not associated with presence of these contaminants or their bioaccumulation in animal tissue." *Id*. at A-45.

Hydrodynamics

Hydrology. The Brandon Road Lock & Dam at RM 286 is directly upstream from the Joliet Stations. It controls both the flow and navigational traffic entering the Dresden Island Pool of the LDPR. MWG Ex. A at 2-2; *see also* MWG App. A, Figure A-2; MWG App. D at D-1. Since the upstream Brandon Pool is only five river miles long and accepts drainage from the much larger Lockport Pool (total length of 36.2 river miles), flows in the UDIP/Five-Mile Stretch are largely controlled and manipulated by operation of the Lockport Controlling Works in order to prevent flooding and maintain navigational depth. MWG Ex. A at 2-2; MWG App. A at A-1; MWG App. D at D-1 – D-2.

River Flow. The UDIP is a natural waterway that, in the early 20th century, was heavily modified and channelized to accommodate barge traffic. MWG Pet. at 3. The main body of the UDIP near the Joliet Stations has depths ranging from 16 to 20 feet. MWG App. A at A-4. The UDIP/Five-Mile Stretch flow derives primarily from three sources: (1) discharge from Chicago area storm drains and wastewater treatment plants; (2) regulated flow diversion from Lake Michigan; and (3) runoff from its 1,500 square mile drainage area. MWG Ex. A at 2-2; MWG App. A at A-2. Twelve major waterways contribute to the UDIP/Five-Mile Stretch, and the CSSC drainage area is the largest of any of the tributaries. *Id*. CSSC base flow is dominated by treated and partially treated effluents from MWRDGC wastewater reclamation plants and 408 CSO points that ultimately discharge to the UDIP/Five-Mile Stretch. MWG Ex. A at 2-2; MWG App. A at A-3; *see also* Pet. at 3.

Mean annual flow in the UDIP at the Brandon Road Lock & Dam near the Stations is 3,494 cfs. MWG Ex. A at 2-2; *see also* MWG Table A-1; MWG App. A at A-4. For summer months, median LDPR flow ranged from 2,390 cfs to 3,373 cfs. MWG App. D at D-24, citing Table D-4a. For winter months, median LDPR flow ranged from 2,187 cfs to 3,278 cfs. *Id*. at D-24, citing Table D-4b. Because of year-round fluctuations for flood control and navigation, the demonstration argued that there is no seasonal, steady-state flow condition in the LDPR. *Id*. at D-24, citing Figures D-2a-d.

The 7Q10 flow for this portion of the LDPR is 1,493 cfs. MWG Ex. A at 2-2 – 2-3; MWG App. A at A-4; *see also* Rec. at 2. This low flow is largely based on design flow of three upstream POTWs discharging into the upstream CAWS, which essentially dictates base flow, especially in winter. *Id*. Because of upstream manipulations and regular flow fluctuation, the demonstration argued that a 7Q10 value "is not wholly applicable to the UDIP/LDPR." MWG App. D at D-24 n.14.

MWG noted that its Will County Generating Station at RM 296 was the only potentially significant thermal discharger upstream of the Joliet Stations. MWG App. C at C-9. MWG argued that, based on the current single-unit operation of the Will County Station and the demonstration submitted in support of its alternative thermal effluent limitations, "there is no significant upstream thermal effects anticipated for either Joliet Station, based on average weather and river conditions." *Id*. at C-10.

MWG noted three thermal dischargers downstream on the UDIP: Flint Hills Resources, (now INEOS) at RM 280.3; Stepan Chemical at RM 280; and the ExxonMobil Joliet Refinery at RM 278.2. MWG App. C at C-10. MWG asserted that all three have "an insignificant impact on the thermal regime of the UDIP, whether assessed individually or collectively." *Id*., citing App. D.

Anthropogenic Freshwater Sources. The MWRDGC owns and controls the upstream CAWS canal system, working cooperatively with the USACE to adjust waterway levels to accommodate stormwater flows and prevent localized flooding. MWG App. A at A-5. The CAWS also drains millions of gallons of stormwater runoff and treated wastewater effluent daily. *Id*.

A small component of CSSC flow is contributed, typically during the summer months, in the form of a diversion from Lake Michigan. MWG App. A at A-5. The diversion includes three components. First, domestic water supply is used to serve communities and industries. MWG App. A at A-6. Second, direct diversion provides a safe depth for navigation, and discretionary diversion is used to improve water quality. *Id*. For 2015, average direct diversion was 348.5 cfs. *Id*. Finally, stormwater runoff is water that has been diverted from the original Lake Michigan watershed (673 square miles) by the reversal of the Chicago and Calumet Rivers. *Id*. For 2015, average stormwater runoff diversion into the CAWS was 859.9 cfs. *Id*.

When significant precipitation is predicted, MWRDGC may direct USACE to lower the level of the Lockport Pool to accommodate stormwater runoff and CSO. MWG App. A at A-6. This increases flows downstream in the UDIP. When precipitation ends, USACE stops flow at the Lockport Lock & Dam to restore the Lockport Pool level. During these periods, there is little or no flow in the downstream waterway for extended periods of time, which may affect water quality. *Id*.

Wastewater Treatment Plant Discharges. MWRDGC provides sewage treatment and wastewater service to areas surrounding Chicago. MWG App. A at A-7. Three of MWRDGC's sewage treatment plants – O'Brien, Calumet, and Stickney – are the largest contributors of flow to the CSSC, and via the CSSC to the LDPR. *Id*. The Stickney Plant has a DAF of 1,200 MGD. Under low flow conditions, it contributes from 70% to 100% of the base-flow of the CSSC, which is the primary source water for the UDIP. MWG App. C at C-9. Also, the City of Joliet has a municipal wastewater treatment plant, which discharges into the UDIP just upstream from the Joliet 9 intake. MWG App. A at A-7.

In addition, both Joliet Stations have an on-site sewage treatment plant that discharges to the UDIP. MWG App. A at A-7. The system at Joliet 9 has a DAF of 0.01 MGD, and the system at Joliet 29 has a DAF of 0.04 MGD. *Id*. Both stations discharge under an NPDES permit. *See id*. at A-7 n.7.

Combined Sewer Overflows. MWRDGC owns 35 CSO outfalls located on the CAWS.

The City of Chicago and the 51 satellite communities own a total of 408 CSO outfalls which discharge directly or indirectly into the CAWS. MWG App. A at A-8; *see also* MWG App. A, Figure A-3.

Joliet Stations Water Quality

As a result of historical and current industrial and navigational uses, POTW effluents, CSOs, and upstream stormwater runoff, there are many sources of pollutants in the Dresden Pool of the LDPR. MWG App. A at A-14. While main channel areas are relatively scoured by barge traffic, shallow shoreline and backwater and side channel areas accumulate sediments. Sediments have accumulated legacy pollutants that may affect water quality if re-suspended by navigational traffic. *Id*.

Segments near the Joliet Stations have for many years been listed by the State as impaired waters due to arsenic, copper, methoxychlor, DDT, PCBs, TSS, phosphorus (total), mercury, fecal coliform, sedimentation/siltation, and flow regime alterations. MWG App. A at A-14. "The sources of these various impairments have been identified as one or more of the following: Industrial Point Source Discharge, Municipal Point Source Discharge, Urban Runoff/Storm Sewers, Contaminated Sediment, Impacts from Hydrostructure Flow Regulation/Modification, Atmospheric Deposition, CSOs, and Unknown Sources." *Id*. Impairments have decreased over time, but PCB and mercury contamination persist in the LDPR. MWG App. A at A-14; *see also* MWG Table A-2.

Discharges from Joliet Stations

Joliet 9. Joliet 9 generates wastewater from once-through condenser cooling, conditioning boiler feed water, backwashing the condenser cooling water intake screens, sanitary, non-chemical cleaning of plant equipment, low volume wastewater, and precipitation which contacts the site. MWG App. A at A-14. Operation results in

> an average discharge of 45.0 MGD of condenser cooling water and house service water from outfall 001, 0.02 MGD of reverse osmosis reject from outfall A01, 0.02 MGD of sewage treatment plant flow from outfall B01, and intermittent discharge of boiler blowdown from outfall C01, 0.89 MGD of roof and yard area runoff from outfall 003, an intermittent discharge of runoff from the former coal pile from [outfall] 004, and an intermittent discharge of quarry discharge from outfall 005. *Id*.

Permitted discharges enter the UDIP. MWG App. A at A-14; MWG Ex. A-1.

Joliet 29. Joliet 29 generates wastewater from once-through condenser cooling, conditioning boiler feed water, backwashing the condenser cooling water intake screens, sanitary, non-chemical cleaning of plant equipment, low volume wastewater, and precipitation which contacts the site. MWG App. A at A-15. Operations result in

> an average discharge of 362.4 MGD of condenser cooling water and house service water from outfall 001; 0.08 MGD of reverse osmosis reject tributary to outfall

> A01; an intermittent discharge of plant drains, former coal pile and west area basin emergency overflow from outfall B01; an intermittent discharge of boiler blowdown from outfall C01; 0.04 MGD of sanitary from outfall D01; an intermittent discharge of pond 3 effluent from outfall G01; an intermittent discharge of cooling tower area runoff from outfall H01; an intermittent discharge of gas side non-chemical metal cleaning wastes from outfall J01; an intermittent 31 discharge of junction tower area runoff from [outfall] 002; and an intermittent discharge of vegetated former fill area runoff from outfall 003. *Id*.

Permitted discharges enter the UDIP. MWG App. A at A-15; MWG Ex. A-2.

Water Temperature

Near the Joliet Stations, mean monthly water temperature has remained relatively consistent over the past six years, with the only notable departure occurring during the abnormally warm weather/low flow periods of 2012. MWG App. A at A-20, citing Tables A-3a, A-3b; MWG Figures A-4a, A-4b.[4]

Intake temperatures on the two banks of the river varied slightly because of localized factors. MWG App. A at A-20. Mean summer intake temperatures for the two Joliet Stations have ranged from 73.7 ° F to 79 ° F. MWG App. A at A-20 n.15, citing App. D, Tables D-1a, D-1b. Maximum intake temperature was 95.4 ° F at Joliet 9 in July and August 2012 and 92.5 ° F at Joliet 29 in July 2012. Minimum intake temperature was 32.0 ° F at Joliet 9 in January 2014 and 31.2 ° F at Joliet 29 in February 2012. MWG App. A at A-20.

Special Condition 4D of the Stations' NPDES permits provides that, when it appears that discharges "have the reasonable potential to cause water temperatures at the I-55 Bridge to exceed" specified values, "the permittee shall determine whether, and the extent to which, station operations must be restricted . . . The permittee shall make such a determination based upon the outputs of a predictive model reasonably suited for such a purpose and which has been submitted to the Agency." MWG App. A, Ex. A-1 at 12, Ex. A-2 at 11-12. From 2012 to 2018, temperatures at the I-55 Bridge have been on average 3 °F higher than the corresponding Joliet 29 intake temperature, and ranged from 8.7 °F warmer to 2.1 °F cooler, depending upon the combination of weather, flow, and Joliet Station operating conditions. MWG App. A at A-21, citing Table A-4.

Dissolved Oxygen

DO concentrations were measured in the UDIP at seven locations from 1977 to 2011. Over that time, the mean DO concentration ranged from 6.6 mg/L to 7.9 mg/L, depending on the season. MWG App. A at A-22, citing Tables A-6a, A-6b. All measured concentrations complied with applicable water quality standards. MWG App. A at A-22, citing 35 Ill. Adm. Code 302.405(b).

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[4] In its response to Board questions, MWG reported that the header in the second table in Figure A-4b should read "Joliet Station 29 Maximum Monthly Intake Temperature 2012-2018" and provided a corrected Figure A-4b as Attachment 1. MWG Resp. at 4.

Since 1997, MWG has monitored DO concentration at the I-55 Bridge. Between 2012 and 2017, all hourly mean DO measurements met applicable water quality standards, except one hourly measurement in August 2014 of 3.68 mg/L. MWG App. A at A-23. In 2018 hourly mean DO concentrations ranged from 4.07 mg/L to 14.41 mg/L. *Id*. at A-22.

Since 1994, adult fisheries monitoring has also measured DO, both between the Brandon Road Lock & Dam and the I-55 Bridge and in the Five-Mile Stretch. MWG App. A at A-23, citing Tables A-5a, A-5b. The lowest minimum DO, and highest maximum DO were recorded in areas characterized as sloughs, which have shallower depths and are more heavily influenced by solar radiation. MWG App. A at A-23. "There is no indication that the operation of the Joliet Stations has any influence on these slough areas." *Id*.

The Stations' NPDES permit requirements included DO monitoring at intake and discharge. From August 2014 to mid-August 2018, minimum DO levels "were all well over 6.0 mg/L, while the averages were all above 9.0 mg/L. Most importantly, there was no significant difference between the measured intake and discharge DO levels for any sampling date." MWG App. A at A-23, citing Figures A-5a, A-5b. Based on these DO monitoring results, MWG discontinued this monitoring with IEPA's approval. MWG App. A at A-23 – A-24.

Based on available monitoring data, the demonstration concluded that "the Joliet Stations operations have not been shown to negatively impact DO levels in the UDIP or Five-Mile Stretch." MWG App. A at A-24.

<u>Fecal Coliform</u>

In the CSSC upstream from the Stations, pathogens reach the water directly in urban and suburban areas from wastewater treatment plant effluents, CSOs, sewage dumped overboard from recreational boats, pet waste, litter, and garbage. MWG App. A at A-24. Due to frequent CSOs in the upstream CAWS, as well as smaller contributions from local sources, the UDIP near the Joliet Stations has been designated as Incidental Contact Recreation Waters. MWG App. A at A-24, citing 35 Ill. Adm. Code 303.225(h). Based on this use designation, "UDIP Water Quality Standards do not include a fecal coliform limit." MWG App. A at A-24, citing 35 Ill. Adm. Code 302.406.

MWRDGC monitored fecal coliform levels in the Dresden Island Pool from 1977 to 2011. Average concentration of fecal coliform ranged from 514 cfu/100mL in the spring to 3,993 cfu/100mL in the summer. MWG App. A at A-25, citing Tables A-6a, A-6b.

The major source of fecal coliform loading to the system continues to come from multiple CSOs from the upstream Chicago metropolitan area, as well as local POTW CSO discharges. MWG App. A at A-25. The Stations' permitted on-site sewage treatment plants have DAFs of 0.01 MGD at Unit 6 and 0.04 at Units 7 and 8. *Id*. The demonstration concluded that "Joliet Station operations have not been shown to impact the levels of fecal coliform in the LDPR." *Id*.

Mercury

MWRDGC monitored mercury concentrations at seven locations in the Dresden Island Pool in the spring, summer, and fall from 1977 to 2011. During that time, the average concentration of total mercury ranged from 0.15 µg/L in the spring and fall to 0.18 µg/L in the summer. MWG App. A at A-26, citing Table A-6a. IEPA had identified the segments of the LDPR adjacent to the Stations as impaired for mercury. MWG App. A at A-26.

The Stations have monitored mercury in several of their permitted outfalls. Data collected since 2014 indicated that intake water from the UDIP likely contributes to detectable levels of mercury in the Station's discharge. MWG App. A at A-26. Concentrations are generally higher for cooling water outfalls than internal outfalls. *Id*., citing Tables A-7a, A-7b.

Based on this information, the demonstration concluded that "Joliet Station 9 and 29 operations have not been shown to have an impact on mercury concentration in the UDIP or Five-Mile Stretch in the past, nor is any adverse impact expected under current or future operating conditions." MWG App. A at A-26.

Nutrients

The UIW has numerous point and nonpoint sources of nutrients, including agricultural runoff. MWRDGC's monitoring program had measured nutrient concentrations in the UDIP and Five-Mile Stretch. MWG App. A at A-26.

Total Nitrogen. MWRDGC monitored nitrate nitrogen concentrations in the Dresden Island Pool from 1977 to 1990 and 1992 to 2011, and it monitored total Kjeldahl nitrogen during many of those years. MWG App. A at A-27; MWG App. A at A-27 n.27; *see also* MWG Table A-6a.

The Stations do not routinely use nitrogen-based products in their processes, and any use of those products has been approved by IEPA. MWG App. A at A-27. Both Stations have implemented site-specific Stormwater Pollution Prevention Plans addressing potential runoff. MWG App. A at A-27; *see also* MWG Ex. A-1 at 16-20; MWG Ex. A-2 at 15-19.

Based on these factors, the demonstration concluded that "Joliet Station 9 and 29 operations have not been shown to impact the levels of total nitrogen found in the UDIP or Five-Mile Stretch." MWG App. A at A-27.

Total Phosphorus. Wastewater treatment plants and urban and agricultural nonpoint sources are generally the major contributors of phosphorus. MWG App. A at A-28. From 2002 through 2010, Illinois identified phosphorus as a cause of impairment in the Five-Mile Stretch. Improved wastewater treatment practices and reduced use of phosphorus-based products resulted in removing phosphorus from the list of impairments for that segment. MWG App. C at C-5.

MWRDGC monitored total phosphorus in the Dresden Island Pool from 1977 to 2011 and found concentrations ranging from 0.69 mg/L in the spring to 0.90 mg/L in the fall. MWG App.

A at A-28, citing Table A-6a, A-6b. However, no phosphorus water quality limits now apply to the UDIP. MWG App. A at A-28. Phosphorus discharges are chiefly regulated by effluent limitations directed at municipal and domestic wastewater treatment facilities. *Id*. On-site sewage treatment plants at the Stations have DAF below the threshold of concern (>1 MGD) for any significant phosphorus discharge. *Id*. Neither Station uses phosphorus-based additives, other than those approved by IEPA with no significant presence in discharges. *Id*.

Based on these factors, the demonstration concluded that "the operation of the Joliet Stations 9 and 29 does not have any impact on the overall phosphorus concentrations in the 34 UDIP or Five-Mile Stretch, which remain primarily influenced by upstream POTW effluent discharges." MWG App. A at A-28.

Ammonia. In the CAWS, common sources of ammonia include fertilizer application and run-off, treated and untreated municipal treatment works discharges, and industrial effluents. MWG App. A at A-29. MWRDGC monitored ammonia nitrate levels from 1977 to 2011. *Id*. Ammonia nitrogen decreased from approximately 2.0 mg/L to 2.8 mg/L in the spring and fall of 1977, respectively, to less than 1.0 mg/L in the spring, summer, and fall for years 1995 to 2011. MWG App. A at A-27, citing Tables A-6a, A-6b. These concentrations are consistently below the applicable limit of 15 mg/L. MWG App. A at A-27, citing 35 Ill. Adm. Code 302.412(b). While the Stations sometimes use ammonia-based additives, IEPA has approved these uses. *Id*. at A-29.

Based on these factors, the demonstration concluded that operation of the Joliet Station was "unlikely to have any impact on the level of ammonia nitrate in the UDIP or Five-Mile Stretch." MWG App. A at A-29.

PCBs

IEPA has identified PCB concentration in fish tissue as impairing fish consumption in the LDPR from the Brandon Road Lock & Dam to the confluence with the Kankakee River. MWG App. A at A-20. The LDPR has a long-standing fish-consumption advisory related to PCB and contamination due to legacy bottom contaminants. MWG App. A at A-20; *see also* MWG App. C at C-7 – C-8.

The demonstration stated that there is no PCB-containing equipment located at either of the Joliet Station properties, and "operations have not been show to impact the levels of PCBs in the UDIP or the Five-Mile Stretch." MWG App. A at A-29; *see also* MWG App. A at A-45.

Silver

MWRDGC monitored silver concentrations from 1977 to 2011. Annual mean concentrations measured 0.003 mg/L for spring, summer, and fall. MWG App. A at A-30, citing Table A-6a. MWRDGC also calculated location-specific means in the Dresden Island Pool for 2008 to 2011. MWG App. A at A-30, citing Table A-6b. All silver levels have remained consistently at or below detection levels. MWG App. A at A-30. MWG also performs semi-annual metals monitoring under Special Condition 15 of the Stations' NPDES permits. MWG App. A at A-30; *see also* MWG Ex. A-1 at 15; MWG Ex. A-2 at 14-15.

Based on these factors, the demonstration concluded that "station operations have not been shown to impact the levels of silver found in the UDIP or Five-Mile Stretch." MWG App. A at A-30.

Other Metals

Other common metals can occur naturally and from industrial and municipal effluents, such as arsenic, cadmium, chromium, copper, lead, nickel, selenium, and zinc. MWG App. A at A-30. There is no current aquatic life impairment identified in the UDIP/Five-Mile Stretch near the Joliet Stations for metals other than mercury. *Id*.

MWRDGC monitored several of these metals from 1977 to 2011. MWG App. A at A-30 – A-31; citing Table A-6b. The Stations have also monitored total metals as required by Special Condition 15 of their NPDES permits. MWG App. A at A-31; *see also* MWG Table A-8b; Ex. A-1 at 15; Ex. A-2 at 14-15.

Based on the results from this monitoring, the demonstration concluded that "Joliet Station operations have not influenced the levels of metals found in the UDIP or Five-Mile Stretch." MWG App. A at A-31.

pH

Based on MWRDGC monitoring date from 1977 to 2011, mean pH in the Dresden Island Pool ranged from 7.3 in the spring to 7.4 in the summer and fall. MWG App. A at A-32, citing Table A-6a. The demonstration also included location-specific means for the Dresden Pool. MWG App. A at A-32, citing Table A-6b. All these values fall within the accepted water quality range on 7 to 9 pH units. MWG App. A at A-32, citing 35 Ill. Adm. Code 302.404.

The demonstration concluded that the Stations' required monitoring had shown no violations of pH limits and that they have not impacted pH levels in the waterway. MWG App. A at A-32.

TOC

MWRDGC monitoring data from 1983 and 1985 to 1994 show that mean concentrations of TOC in the Dresden Island Pool ranged from 8 mg/L in the summer to 11 mg/L in the spring. MWG App. A at A-32, citing Table A-6a.

The demonstration stated that TOC is not an environmental pollutant and, at the levels observed, "has had no adverse impact on the aquatic community in the UDIP or Five-Mile Stretch." MWG App. A at A-32. MWG added that the Joliet Stations "have not affected TOC levels in the Dresden Island Pool of the LDPR." *Id*.

Specific Conductance

From 2012 to 2018, mean specific conductance at nine sampling locations upstream from the I-55 bridge ranged from 849 µS/cm to 913 µS/cm depending on location, season, and flow. MWG App. A at A-32, citing Table A-5a. At four sites downstream from the I-55 Bridge to the confluence of the Kankakee River, specific conductance ranged from 904 µS/cm to 1,002 µS/cm. MWG App. A at A-32, citing Table A-5b. From 1977 to 2011, MWRDGC measured specific conductance in the Dresden Island Pool. It averaged 762 µS/cm in the summer and 1,091 µS/cm in the spring. MWG App. A at A-32. From 2008 to 2011, specific conductance at monitoring locations upstream from the I-55 Bridge averaged 906 µS/cm, while locations downstream from it averaged 872 µS/cm. *Id*. at A-33, citing Table A-6b.

The demonstration stated that "Joliet Station operations have not been shown to affect specific conductance levels in the UDIP or Five-Mile Stretch." MWG App. A at A-33.

Water Transparency

Based on MWRDGC monitoring in the Dresden Island Pool from 1977 to 2011, mean TSS concentrations ranged from 22 mg/L in the summer to 30 m/L in the spring. MWG App. A at A-33, citing Tables A-6a, A-6b. MWG also measured water transparency based on Secchi disk measurements. MWG App. A at A-33, citing Table A-5b.

The Stations' NPDES permits include TSS limitations to prevent adverse changes in water transparency. MWG App. A at A-33; *see also* MWG Exs. A-1, A-2. The demonstration stated that to date, there have been no exceedances of the TSS limit. *Id*. As such, "Joliet Stations operation has not had adverse impact on TSS levels, and therefore water transparency, in the UDIP or Five-Mile Stretch." *Id*.

Joliet Stations Aquatic Habitats

From 1993 to 1995, a comprehensive UIW study included extensive habitat surveys of the UDIP and Lower Dresden Island Pool. MWG App. A at A-46. The surveys used QHEI to evaluate habitat quality. MWG App. A at A-46; MWG App. E at E-6. QHEI corresponds to physical factors that affect fish communities and which are generally important to other aquatic life. MWG App. C at C-13. QHEI scores are based on six interrelated factors: substrate, instream cover, channel morphology, riparian and bank condition, pool and riffle quality, and gradient. *Id*. Narrative ratings assigned to numeric QHEI scores are as follows:

Narrative Rating	QHEI Range	
	Headwaters	Larger Streams
Excellent	> 70	> 75
Good	55 to 69	60 to 74
Fair	43 to 54	45 to 59
Poor	30 to 42	30 to 44
Very Poor	< 30	0

Id.

A 2003 study surveyed the entire Dresden Pool at 0.5-mile intervals, and a 2008 study provided QHEI data for both banks of the UDIP near the Joliet Stations. MWG App. A at A-46; *see also* MWG App. E at E-6. Both studies were performed as part of the Use Attainability Analysis for the LDPR. MWG App. A at A-46, citing Water Quality Standards and Effluent Limitations for the Chicago Area Waterway System (CAWS) and the Lower Des Plaines River: Proposed Amendments to 35 Ill. Adm. Code 301, 302, 303 and 304, R 08-9.

Surveys generally showed that habitat upstream of Brandon Road Lock & Dam was poor. Although habitat improves downstream from it, scores were still typically in the "fair" to "poor" range. MWG App. A at A-46, citing App. K, Exh. C-3; MWG App. E at E-6. QHEI scores obtained from 2016 to 2018 at long-term electrofishing locations were consistent with previous scores. MWG App. A at A-46. Based on these results, the demonstration concluded that "aquatic habitat conditions have remained relatively unchanged since the initial QHEI assessments were made in the mid-1990s to the mid-2000s." MWG App. A at A-46, citing App. K; MWG App. E at E-7.

Habitat Types

The UDIP near the Stations is a modified, impounded waterway that continues to be subject to upstream anthropogenic influences. MWG App. A at A-47. The UDIP's habitat is 79% main channel and main channel border, areas where the effects of barge transport and industrial and municipal discharges are especially dominant. *Id*. Habitat quality near the Stations was largely considered fair to poor due to: (1) the lack of functional riffle/run habitat; (2) sparse amounts of clean, hard substrates (i.e., gravel, cobble, and boulder); (3) excessive siltation, particularly in the shallow littoral zone areas; (4) channelization; (5) poor riparian and floodplain quality; and (6) a general lack of instream cover, except for macrophytes in the shallow littoral zone area. MWG App. A at A-47, citing App. K, Exs. C-1, C-2, C-3.

While habitat variety was greater in the UDIP than in the CSSC, UDIP habitats are subject to stressors including commercial navigation and flood control management. MWG App. A at A-47. For example, frequent barge traffic can generate significant local turbulence, and flood control can affect water levels and flows. *Id*. at A-47 – A-48.

Substrates

Silt over bedrock or hardpan substrates characterize the majority of the main channel area. MWG App. A at A-4. Unnatural stream flow dynamics have deposited homogeneous silt sediment through much of the UIW, which can result in unfavorable conditions for macroinvertebrate and fish populations. *Id*. at A-48. While finer substrate supports macrophyte production, thereby providing habitat and food for aquatic and semi-aquatic animals, excessively dense vegetation has limited habitat and affected water quality. *Id*. There is limited instream cover or rooted aquatic vegetation in the immediate vicinity of the Joliet Stations. *Id*. at A-4. In addition, regular barge traffic disturbs the bottom substrate and re-suspends sediments, which can adversely affect aquatic communities. *Id*. at A-48. Substrate characteristics continue to limit habitat suitability in the UDIP and Five-Mile Stretch. *Id*.

Joliet Stations Aquatic Life

Aquatic Macrophytes

A 1992 to 1995 study of aquatic macrophytes on a 53-mile stretch of the UIW from Upper Lockport Pool yielded 34 distinct aquatic macrophytes, most of which are common and relatively pollution-tolerant. MWG App. A at A-49; *see also* MWG App. E at E-14. A more limited 2017 survey along the banks of the UDIP from the Brandon Road Dam tailwater to the I-55 Bridge recovered eight species. MWG App. A at A-50, citing App. K. The demonstration stated that the areas of the historically highest diversity and density were outside the area of the 2017 study. MWG App. A at A-50.

The demonstration noted that areas in the Dresden Island Pool had experienced macrophyte proliferation. MWG App. A at A-50, citing App. K; *see also* MWG App. E at E-14. This had hampered sampling efforts and reduced the fisheries monitoring at several locations in the Five-Mile Stretch. MWG App. A at A-50, citing App. H §§ 2, 4. However, the demonstration argued that this excess growth "is not caused by upstream power plant operations, but is likely the result of a combination of nutrients and high productivity in shallow off-channel areas." MWG App. A at A-50.

Phytoplankton and Periphyton

Near the Joliet Stations, the phytoplankton community and densities reflect the overall assemblage of the CAWS. MWG App. A at A-50. Studies indicated that the community was low for species diversity and evenness. MWG App. A at A-50; *see also* MWG App. E at E-7 – E-8. Morisita's index (a similarity index comparing intake and discharge data) indicated that the community upstream of the stations was closely related to that of the discharge. MWG App. A at A-50 – A-51. The demonstration argued that these factors indicated that the Stations have not adversely affected the plankton community. *Id*. at A-51.

Zooplankton

Zooplankton sampling near the Stations had been limited. *See* MWG Ex. A at 6-4; MWG App. E at E-9. The demonstration asserted that thermal discharges are not expected to affect zooplankton adversely because they have evolved tolerances, are rapidly transported by currents, and have high reproductive capacities. MWG App. A at A-51.

Benthic Invertebrates

Surveys of the UDIP and Five-Mile Stretch have shown a community consisting "primarily of environmentally tolerant to, at best, facultative taxa." MWG App. A at A-51. Studies from 1993 to 1994 concluded that habitat condition, sedimentation, and water quality issues other than temperature influenced community composition. MWG App. A at A-51; *see also* MWG App. E at E-11. Studies conducted in 2000 showed a dominance of tolerant taxa in the Dresden Pool. MWG App. A at A-52. Results of a 2017-2018 assessment "were generally consistent with historic results in the sense that the community continues to be dominated by a tolerant and/or facultative fauna." MWG App. A at A-52., citing MWG App. L; *see also* MWG App. E at E-11.

Mussels

The demonstration argued that "there is minimal suitable habitat for mussels in the parts of the UDIP influenced by the Joliet Stations' thermal plume." MWG App. A at A-53. State agencies reviewed the Stations' DSP and generally agreed that significant mussel populations do not exist in the UDIP. *Id*. at A-52. Even if present, the buoyant thermal plume would not be expected to have a negative effect on them. *Id*. at A-53.

Sampling in the LDPR in 1994 and 2000 found a small number of mussel species, including invasive species. MWG App. A at A-52; MWG App. E at E-12. The demonstration argued that neither habitat nor the mussel assemblage had appreciably changed over time. MWG App. A at A-52. However, a 2017 survey conducted just downstream from the Stations yielded 275 mussels representing eight species. MWG App. A at A-53 – A-54; MWG App. E at E-13. The survey did not collect live or relic shells of any threatened or endangered state or federal listed species. MWG App. A at A-54; MWG App. E at E-13. The demonstration argued that these data support the conclusion that additional surveys are not necessary because the Stations' operations had not affected mussels in the UDIP or the LDPR as a whole and were not likely to do so in the future. MWG App. A at A-54.

Fish

The fish community in the UIW has been monitored since 1994. MWG App. A at A-54, *see also* MWG App. E at E-14 – E-16. Habitat in the UDIP and Five-Mile Stretch supports a community of tolerant and moderately tolerant species. MWG App. A at A-54, A-61 – A-62. Intolerant species continue to account for a small percentage of the assemblage. *Id*. at A-62. IWBmod scores for the fish community below the Brandon Road Lock & Dam have consistently rated as fair. MWG App. A at A-55; *see also* MWG App. C, Figure C-16. Recent monitoring results show that the fish community had remained comparable to earlier years when the Stations ran in a more base-load manner, suggesting that the community "is largely unaffected by the overall thermal regime of the waterway." MWG App. E at E-16. The demonstration argued that the "past, present and expected future fisheries assemblage is driven by the prevailing habitat and water quality conditions of this artificially controlled waterway." MWG App. A at A-54, A-61 – A-62.

Birds

The bird population near the Joliet Stations includes numerous resident and migratory species. MWG App. A at A-56 – A-57. Several state-listed species are commonly found in areas near the Stations. *Id*. at A-57. However, the demonstration argued that there is "no reason to suspect that any of these species would be negatively impacted by the Joliet Stations' operations or the proposed thermal AELs." *Id*.

Threatened and Endangered Species

Federally listed threatened and endangered species for Will County include no fish and one endangered mussel species. MWG App. A at A-57; MWG Table A-11; MWG App. C at C-27. However, the demonstration argued that habitat near the Stations was not conducive to mussel species. MWG App. A at A-57. The most recent mussel survey of the UDIP encountered no federally or state-listed threatened or endangered mussels. *Id*. at A-58. The federal list included mammals and plants, but the demonstration asserted that these species "are not expected to be affected by operation of the Joliet Stations or their thermal discharge." MWG App. A at A-58; MWG App. C at C-27.

While state-listed threatened and endangered species for Will County include 11 fish and six mussel species, the demonstration argued that the LDPR habitat was not conducive to mussels. MWG App. A at A-58; MWG Table A-12; MWG App. C at C-27. Long-term fisheries monitoring had collected state-listed species. MWG App. A at A-58, citing App. C, Table C-7. Since 2012, the state threatened Banded Killifish had been collected in the UDIP and Five-Mile Stretch. MWG App. A at A-58. Total catch of Banded Killifish had steadily increased since 2012, with a reduction in 2018. MWG App. A at A-58 – A-59; *see also* App. C, Table C-7. The demonstration argued that this suggested the Stations' thermal discharges do not adversely affect this species. MWG App. A at A-59. It noted that, in a separate proceeding, IDNR found that thermal discharges to the CSSC were not likely to have an adverse effect on the Banded Killifish. MWG App. A at A-59, citing Midwest Generation v. IEPA, PCB 18-58 (Apr. 2, 2018).

In addition to fish and mussel species, five reptile and two amphibian species are listed for Will County. MWG App. A at A-59 – A-60. However, there are "no expected adverse impacts expected for any of these species as the result of current or expected future Joliet Station operations." *Id*. at A-60.

Other Wildlife

A 2013 assessment of the area near the Stations found degraded terrestrial wildlife communities. The area near the Joliet Stations has very little vegetation and high levels of human use. However, the demonstration argued that none of the species noted in the area "would be expected to be impacted by the Joliet Station 9 and/or Joliet Station 29 thermal discharges." MWG App. A at A-60.

IEPA RECOMMENDATION

Using the required analysis under Section 106.1145(b), IEPA recommends that the Board grant the requested ATELs. Rec. 2 at 5; 35 Ill. Adm. 106.1145(b). IEPA's rationale is based on INEOS's petition and largely on MWG's demonstration. Rec. 2 at 5.

IEPA notes that MWG's demonstration already performed both a protective and retrospective analysis for the § 316(a) demonstration. Rec. 2 at 5. IEPA states that, according to the demonstration, "there is no evidence that operation of the Joliet Stations in accordance with the former Secondary Contact Waters thermal limits, nor the identical current interim thermal limits, have caused appreciable harm to a BIC in the UDIP/Five-Mile Stretch." *Id*. at 7. Additionally, IEPA agrees that the numeric thermal ATELs will protect the BIC in lieu of other narrative criteria found in Section 302.408(c)-(f) and (i) and Section 302.211. *Id*.

IEPA reports that IDNR agreed that including INEOS under MWG's ATELs is unlikely to result in any adverse environmental impact on the BIC of the UDIP. Rec. 2 at 10. The IDNR consultation was valid until April 15, 2024. IEPA Supp. at 3. Before that consultation expired, INEOS requested a new consultation, which IDNR provided dated May 9, 2024. *Id*. at 3-4. In the 2024 consultation, IDNR again agreed that including INEOS under MWG's ATELs is unlikely to result in any adverse environmental impact on the BIC of the UDIP. *Id*. at 4. The new consultation is valid until May 9, 2026. *Id*.

BOARD DISCUSSION

INEOS proposes ATELs to increase the daily maximum numeric temperature limits and excursion hours in its NPDES Permit in lieu of the UDIP Aquatic Life Use Waters standards at Section 302.408 (c)-(f), and (i) (near field), and the General Use standards at Section 302.211 (b)-(d) that apply to the Five-Mile Stretch. INEOS also requests a mixing zone to be able to comply with these ATELs.

INEOS must demonstrate that the thermal effluent limitations applicable to the heated effluent from its Channahon facility are more stringent than necessary to assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in the UDIP and the Five-Mile Stretch. The demonstration must also show that the proposed ATELs will assure the protection and propagation of this balanced, indigenous population. 33 U.S.C. § 1326(a); 35 Ill. Adm. Code 106.1160; 40 C.F.R. § 125.73. The USEPA 316(a) Manual provides the components for this demonstration.

A petitioner must provide a master rationale supported by a biotic category rationale, which demonstrates that decision criteria specific to each of the six biotic categories are satisfied. The first step in the biotic category rationale is an early screening process that identifies the biotic community in the area affected by the discharge. Based on this early screening process, the petitioner selects any one or combination of four types of demonstrations to support its biotic category rationale: "Type I" (Retrospective/Absence of Prior Appreciable Harm); "Type II" (Predictive/Representative Important Species); "Type III" (Low Potential Impact); and "Other Type III" (Biological, Engineering, and Other Data). These demonstrations are synthesized into a master rationale for the proposed ATELs to support the conclusion that each biotic category's criteria are satisfied.

Below, the Board first decides whether INEOS has shown that the proposed ATELs will assure the protection and propagation of the balanced, indigenous community. 35 Ill. Adm. Code 106.1160(c); *see also* 33 U.S.C. § 1326(a). This involves reviewing whether INEOS' Section 316(a) demonstration identifies the balanced, indigenous community and shows that the proposed alternatives will assure the protection and propagation of that community. Then, the Board decides whether effluent limits based on its numeric temperature limits, excursion hour limits, and narrative temperature limits (Sections 302.211 (b)-(d) and 302.408(c)–(f) and (i)) are more stringent than necessary to assure the protection and propagation of the balanced, indigenous community in the UDIP and the Five-Mile Stretch. 35 Ill. Adm. Code 106.1160(b); *see also* 33 U.S.C. § 1326(a).

Protection and Propagation of the Balanced Indigenous Community

The proposed ATELs must "assure the protection and propagation of a balanced, indigenous community [BIC] of shellfish, fish, and wildlife in and on the body of water into which the discharge is made." USEPA 316(a) Manual at 52; *see also* MWG Ex. A at 4-1.

The CWA uses the phrase "balanced, indigenous population" and the federal regulations define the phrase "balanced, indigenous community." These phrases have come to be synonymous and mean:

> a biotic community typically characterized by diversity, the capacity to sustain itself through cyclic seasonal changes, presence of necessary food chain species, and a lack of domination by pollution tolerant species. Such a community may include historically non-native species introduced in connection with a program of wildlife management and species whose presence or abundance results from substantial, irreversible environmental modifications. Normally, however, such a community will not include species whose presence or abundance is attributable to the introduction of pollutants that will be eliminated by compliance by all sources with section 301(b)(2) of the CWA; and may not include species whose presence or abundance is attributable to alternative thermal effluent limitations imposed under this Subpart or to regulatory relief, granted by the Board, from otherwise applicable thermal limitations or standards under 35 Ill. Adm. Code 301 through 312. 35 Ill. Adm. Code 106.1110; *see also* 40 C.F.R. § 125.71(c); MWG Ex. A at 4-1; USEPA 316(a) Manual at 74.

Master Rationale

The demonstration's Master Rationale "should form a convincing argument that the balanced, indigenous community will be protected." USEPA 316(a) Manual at 52. The rationale should summarize the ecosystem as projected by the six Biotic Category Rationales and the resource zones impacted. *Id*. It should also summarize "why the information in the rationales, along with the predictions in the RIS Rationale, the engineering and hydrological data, and other key facts, suggest that the balanced indigenous community will be protected." USEPA 316(a) Manual at 52, 72.

As discussed above, INEOS incorporates MWG's demonstration into its own but requests coverage only under the near-field ATELs, which apply to the UDIP. MWG's demonstration has two components: (1) a retrospective evaluation to demonstrate that the Joliet Stations' operations have not caused appreciable harm to the BIC; and (2) a prospective predictive demonstration for representative important species, based on hydrothermal surveys and modeling, to evaluate the potential effects of future operation of the Joliet Stations under the proposed limitations. MWG Pet. at 21; MWG Ex. A at 4-1; MWG App B; MWG App. C. Based on these studies, MWG asserted that the thermal discharges from the Joliet Stations have not caused prior appreciable harm to the BIC, and that the proposed ATELs will assure the protection and propagation of the balanced, indigenous community in the UDIP and the Five-Mile Stretch. 35 Ill. Adm. Code 106.1160(c), (d).

INEOS cites the Board's decision in PCB 20-38 and 20-39 that the proposed ATELs will assure the protection and propagation of a BIC of shellfish, fish, and wildlife, thus meeting the standard for granting ATELs under the CWA and the Board's regulations. Pet. at 20, 22. In those previous cases, the Board found that MWG had addressed each of the following biotic category criteria for a demonstration to be judged successful. Midwest Generation, LLC v. Illinois Environmental Protection Agency, PCB 20-38 and PCB 20-39 (consolidated), slip op. at 122, 125-126 (July 8, 2021).

Below, the Board summarizes the supporting material for the Master Rationale – the biotic category identification, the Type I retrospective evaluation, and the Type II predictive assessment.

Biotic Category Identification

A CWA Section 316(a) demonstration begins with the early screening process to identify the balanced, indigenous population of aquatic life in the receiving water. USEPA 316(a) Manual at 18, 34.

Because biotic communities may contain numerous species, USEPA suggests assessing thermal impacts on a community-by-community basis. The USEPA 316(a) Manual identifies six categories of biotic communities: (1) habitat formers; (2) phytoplankton; (3) zooplankton; (4) macroinvertebrates and shellfish; (5) fish; and (6) other vertebrate wildlife. USEPA 316(a) Manual at 18-32.

After completing the early screening process and the preliminary assessment of the additional work needed in each of the six biotic categories, the petitioner chooses the most appropriate type of demonstration for the site. USEPA 316(a) Manual at 34. A demonstration describes the impact of the thermal discharge on each biotic category. *Id*. at 16. A successful demonstration must show that each biotic category meets either the decision criteria for a site that is a low potential impact area or the decision criteria for a site that is not a low potential impact area. *Id*. at 18-32. Below, the Board summarizes the six biotic categories assessed by MWG.

Habitat Formers (Aquatic Vegetation). Habitat formers are the plants providing cover, foraging, spawning, or nursery habitat for fish and shellfish. USEPA 316(a) Manual at 76-77. The USEPA 316(a) Manual states that habitat formers play a role "unquestionably unique and essential to the propagation and well-being of fish, shellfish, and wildlife." *Id*. at 57. These organisms may be vulnerable to the temperature, velocity, or turbidity of a heated discharge and may also be damaged by biocides present in the discharge. *Id*.

The demonstration for this category must show that the site is a low potential impact area, or, if not, show that it meets the following criteria:

1. The heated discharge will not result in any deterioration of the habitat formers community or that no appreciable harm to the balanced indigenous population will result from such deteriorations.

2. The heated discharge will not have an adverse impact on threatened or endangered species as a result of impact upon habitat formers. USEPA 316(a) Manual at 22.

The USEPA 316(a) Manual lists information that an applicant should provide for areas that do not qualify as low impact areas in this category. *Id*. at 22-23.

QHEI Scores. As noted above, habitats in the UIW have been evaluated using the QHEI, which determines the quality of biota that can reasonably be expected in various waterbodies. MWG App. C at C-13. The QHEI is based on six interrelated metrics: substrate, instream cover, channel morphology, riparian and bank condition, pool and riffle quality, and gradient. *Id*. Narrative ranges correspond to QHEI scores as follows:

Narrative Rating	QHEI Range	
	Headwaters	Larger Streams
Excellent	> 70	> 75
Good	55 to 69	60 to 74
Fair	43 to 54	45 to 59
Poor	30 to 42	30 to 44
Very Poor	< 30	0

MWG App. C at C-13.

1993/1994 Habitat Evaluation. A study performed in 1993 to 1994 used the QHEI to assess the extent to which habitat limits aquatic biota in the UIW. MWG App. C at C-13. QHEI scores varied based on mesohabitat type. *Id*. Mean QHEI scores were lowest in the main channel and main channel border habitats and the Five-Mile Stretch, where they are the dominant mesohabitat types. MWG App. C at C-13; *see also* MWG App B. at B-39. "Tailwater habitat is not influenced by the discharges under normal operations, nor are the backwater habitats upstream and downstream of the Joliet discharges." MWG App. B at B-39.

The highest QHEI score was found at the single tailwater area found in the entire Dresden Pool (Brandon Road Lock & Dam tailwater), which comprises only about 5% of all habitat types found in the pool. MWG App. C at C-13. Over the entire Dresden Pool, the mean QHEI score was 51, at the lower end of the 45-59 range of the fair rating. *Id*.

The demonstration attributed lower QHEI scores to the following: a lack of riffle/run habitat; lack of clean, hard substrates such as gravel and cobble; areas of excessive siltation; channelization; poor riparian and floodplain areas; and lack of instream cover. MWG App. C at C-13; *see also* MWG Ex. A at 6- 3. The lower Dresden Island Pool ranked slightly higher, "because it has a greater percentage of slough (23.1%) and tributary mouth (20.3%) habitats." MWG App. C at C-13. However, its mean QHEI value of 56.6 was still in the fair range. *Id*.

2016 Habitat Evaluation. Beginning in 2016, a habitat assessment evaluated habitat changes since the mid-1990s. MWG App. C at C-14, citing App. K. QHEI scores remained in the poor and fair ranges, except for the Brandon Road Lock & Dam tailwater area that makes up about 5% of the UDIP area. *Id*. The demonstration stated that new QHEI and other habitat-related information show that "there have been no significant changes in habitat quality in the UDIP." MWG App. C at C-14. It argued that the continued low QHEI scores result from many of the same factors noted in the 1993-1994 evaluation, and that "[n]one of the habitat limitations are related to the operation of Joliet Stations 9 or 29 or their thermal discharges." *Id*. at C-15.

2017 Macrophyte Survey. Macrophytes are aquatic plants growing in or near water that are characterized as emergent (upright portions above the water surface), submergent (growing underwater), or floating (either rooted or non-rooted vegetation). MWG App. K at K-1. Macrophytes provide cover for fish and substrate for aquatic invertebrates. *Id*. The depth, density, diversity and types of macrophytes indicate the health of a waterbody. MWG App. K at K-1; MWG Table K-2.

The survey observed and recorded a total of eight species of Submerged Aquatic Vegetation (SAV). MWG App. K. at K-3. Species were recorded in order of dominance and included wild celery (*Vallisneria americana*), coontail (*Ceratophyllum demersum*), Eurasian watermilfoil (*Myriophyllum spicatum*), sago pondweed (*Potamogeton pectinatus*), water stargrass (*Heteranthera dubia*), Canadian waterweed (*Elodea canadensis*), curly pondweed (*Potamogeton crispus*) and longleaf pondweed (*Potamogeton nodosus*). *Id*. Six of the eight species of SAV observed are considered native to the Des Plaines River and not nuisance species, but Eurasian watermilfoil and curly pondweed are introduced SAV species. MWG App. K. at K-4; *see also* MWG App. C at C-15 – C-16. Most species of SAV observed provide important ecological benefits. MWG App. K at K-4; *see also* MWG App. K, Table K-2.

The survey also examined the shoreline riparian buffer to document overhanging vegetation, which can provide bird habitat or shading for fish species. MWG App. K at K-5. Overhanging species included box elder (*Acer negundo*), silver maple (*Acer saccharinum*), dogwood species (*Cornus spp.*), catalpa (*Catalpa speciosa*), bush honeysuckle species (*Lonicera spp.*), Osage orange (*Maclura pomifera*), elm species (*Ulmus spp.*), willow species (*Salix spp.*), elderberry (*Sambucus canadensis*), and sumac species (*Rhus spp.*). MWG App. K at K-5; *see also* MWG App. C at C-17. Where present, the herbaceous understory of the shoreline riparian buffer included the following species: Canada thistle (*Cirsium arevense*), Canadian wood-nettle (*Laportea canadensis*), tall coneflower (*Rudbeckia laciniata*), wingstem (*Verbesina alternifolia*), and swamp vervain (*Verbena hastata*). *Id*.

The survey showed that, while Emergent Aquatic Vegetation (EAV) area had declined, Emergent Wetland Vegetation (EWV) had expanded. MWG App. C at C-17. Also, some species had replaced others. For example, narrowleaf cattail was more common in the 1990s, while broadleaved cattail was more common in 2017. *Id*. However, the demonstration argued that "these changes are unrelated to Joliet Station 9 and 29 thermal discharges. Rather, they signify successional changes that have occurred in shallow, near-shore areas over the past twenty-plus years that are related to a lack of disturbance as well as the deposition of detrital material and fine sediment." *Id*.

Habitat Quality. While much of the habitat studied rated fair to poor, about 6% of the study area was considered as potentially productive fish habitat. MWG App. K at K-6, citing App. K, Figure C-3; *see also* MWG Ex. A at 6-3. The survey found that water depth had the greatest influence on SAV. MWG App. K at K-6. At sampling stations where the survey recovered SAV, water depth ranged from 1.0 to 7.6 feet. Only two sampling stations less than 6.0 feet deep recorded no SAV; conversely, no stations greater than 8.0 feet deep recorded SAV. *Id*.

Of stations with SAV present, 51% were dominated by a silt substrate, 26% by sand, 18% by gravel, 3% by clay, and 2% by boulder substrate. MWG App. K. at K-6; *see also* MWG Figure K-5. During the survey, 9 of the 17 transects recovered SAV at 100% of the sampling stations that were less than 8.0 feet deep. MWG App. K. at K-6; *see also* MWG Table K-6. The remaining eight transects recovered SAV from at least 67% of sampling stations less than 8.0 feet deep. *Id*. Only 10 of 140 sampled stations that were less than 8.0 feet deep did not recover SAV. *Id*. At most of these stations, gravel, cobble, or hardpan substrate were present. *Id*. These substrates may preclude SAV growth and establishment. MWG App. K at K-6.

SAV, EAV, and EWV enhance aquatic and riparian habitat in some portions of the project area. In other segments, particularly near the head of Treats Island, SAV may attain such high density as to be limiting habitat potential. MWG App. K at K-7, citing Ex. C; MWG Figure C-2. In addition, most of the survey area was deep and dredge-maintained Main Channel, which is generally less productive. MWG App. K at K-7. Also, QHEI scores show that, except for a few locations during some years, most areas rate fair to poor. MWG App. K. citing Ex. C; MWG Figure C-3. Even in areas rated good, such as the Brandon Dam tailrace or Treats Island backwater/side channel, QHEI scores have regularly rated fair. The Brandon Dam tailrace is subject to rapid fluctuations in water level and velocity due to lock operation, upstream hydro-peaking operations, and storm event planning. "These factors almost certainly limit the potential of even the best areas within the UDIP." MWG App. K at K-7; *see also* MWG Ex. A at 6-3.

Summary. Based on the above, MWG's consultant, EA, concluded that the thermal discharges from the Joliet Stations

> do not affect the quality of aquatic habitat in the UDIP/Five-Mile Stretch and have not caused appreciable harm to the habitat former community. The distribution and abundance of habitat formers and habitat quality in this anthropogenically influenced impounded waterway are dictated primarily by dominance of main channel/main channel border habitat and subsequent lack of appropriate conditions for development of a greater diversity of habitat former types. Due to these ongoing constraints, this community would be substantively the same regardless of the operation of the Joliet Stations' cooling water discharges with the proposed near-field and far-field thermal AELs. MWG Ex. A at 6-3 – 6-4.

Phytoplankton. Phytoplankton are microscopic plants, such as algae, transported by river current. USEPA 316(a) Manual at 78. Phytoplankton are a food source for zooplankton and fish. *Id*. at 55.

The demonstration for this category must show that the site is a low potential impact area, or, if not, show that it meets the following criteria:

1. A shift towards nuisance species of phytoplankton is not likely to occur;

2. There is little likelihood that the discharge will alter the indigenous community from a detrital to a phytoplankton-based system; and

3. Appreciable harm to the balanced indigenous population is not likely to occur as a result of phytoplankton community changes caused by the heated discharge. USEPA 316(a) Manual at 18.

The USEPA 316(a) Manual lists information that an applicant should provide for areas that do not qualify as low impact areas in this category. *Id*. at 20.

Background. In the 1960s and 1970s, studies on the effect of power plants on phytoplankton showed that adverse effects from power plant thermal discharges are rare. MWG App. C at C-10. If they occurred, the effects were limited to a small area in the immediate vicinity of the discharge. These effects were limited to periods of maximum discharge temperatures during the summer and during those hours when the circulating water was chlorinated to control biofouling of the condensers. *Id*.

Population. The phytoplankton community and density near the Joliet Stations are similar to the overall assemblage in the LDPR and the inputs from the CSSC and upstream tributaries. MWG App. C at C-11. On the Shannon-Weaver diversity indices, the entire UIW scored low for both diversity and evenness. *Id*. Upstream (CSSC) locations had the sparest phytoplankton density, while the highest density was found in the sample from the Joliet 29 discharge. *Id*. Total density was not low in portions of the waterway which have more extensive habitats for the development of both periphyton and phytoplankton. *Id*.

Mean diversity and evenness values were both slightly higher at the intakes than at the discharges (2.58/0.78 vs. 2.51/0.75). MWG App. C at C-11. Comparing similarity between both intake and discharge samples using Morisita's Index indicated that "the community upstream of the Joliet Stations was closely related to that of the discharges." *Id*. These results indicated that "there is no adverse impact from the operation of the Stations on the plankton community." *Id*.

Species Composition. Phytoplankton samples collected in 1993 from the Des Plaines River upstream of the Joliet Stations at RM 290.2, and at the Joliet Station 29 intake (RM 285.2) and discharge (RM 284.5), contained 69 taxa. MWG App. C at C-11. Most taxa occurred at only one of the three sampled locations. *Id*. Eleven taxa occurred at all three locations and collectively composed 39% to 45% of the phytoplankton at the three sampling locations. *Id*. Overall, only four taxa (*Chroococcus minimus*, *Lygnbya contoria*, *Cyclollea menghiniana*, and *Melosira granualta*) accounted for more than 5% of the total densities. *Id*.

By sampling area, the relative abundance of blue-green algae (Cyanophyta) was much higher upstream of the stations and in the discharge than at the intake, and diatom taxa

(Bacillariophyta) were much higher upstream and at the intake than at the discharge. MWG App. C at C-11. The relative abundance of green algae (Chlorophyta) was greatest at the intake and discharge sampling locations. *Id*. There were minor spatial differences for the other three major taxonomic groups. *Id*.

Food Source for Asian Carp. Asian carp consume phytoplankton, zooplankton, and macroinvertebrates voraciously. MWG App. C at C-12. Asian carp grow quickly and are highly adapted for feeding on these communities, allowing them to outcompete native species and quickly grow too large for most native predators. *Id*. Limited phytoplankton densities in the upper portions of the UIW may slow the upstream migration of Asian carp due to low chlorophyll *a* concentrations. MWG App. C at C-12; *see also* MWG App. E at E-8. Measured chlorophyll *a* in the UDIP ranged from 5 µg/L from 2004 through 2011, while locations downstream with large numbers of Asian carp typically have chlorophyll *a* levels greater than 20 µg/L. MWG App. C at C-12, citing Table C-1; *see also* MWG App. E at E-8.

Summary. Based on studies including ongoing monitoring of invasive species, MWG concluded that "the Joliet Station 9 and 29 thermal discharges have not caused any appreciable harm to the phytoplankton community of the LDPR." MWG App. C at C-12.

Zooplankton and Meroplankton. Zooplankton are animal microorganisms living unattached in water. USEPA 316(a) Manual at 79. Zooplankton refer to small crustacea, such as daphnia and cyclops, single-celled animals such as protozoa, and the planktonic life stage of many important species of fish and wildlife. *Id*. at 56, 79. Zooplankton are the primary food source for larval fish and shellfish. *Id*. at 56. Some species are planktonic throughout their life, while others termed "meroplankton" are planktonic only during a portion of their life cycles. *Id*. If a heated discharge kills or prevents development of the meroplankton, fewer adult fish and shellfish will be produced each year. *Id*.

The demonstration for this category must show that the site is a low potential impact area, or, if not, show that it meets the following criteria:

1. Changes in the zooplankton and meroplankton community in the primary study area that may be caused by the heated discharges will not result in appreciable harm to the balanced indigenous fish and shellfish population.

2. The heated discharge is not likely to alter the standing crop, relative abundance, with respect to natural population fluctuations in the far field study area from those values typical of the receiving water body segment prior to plant operation.

3. The thermal plume does not constitute a lethal barrier to the free movement (drift) of zooplankton and meroplankton. USEPA 316(a) Manual at 20.

The USEPA 316(a) Manual lists information that an applicant should provide for areas that do not qualify as low impact areas in this category. *Id*. at 21. MWG's demonstration addressed zooplankton generally.

Background. Zooplankton generally are not expected to be adversely impacted by thermal discharges. MWG App. C at C-18. They have broad physiological tolerances and behavior that allow them to survive in unstable environmental conditions. *Id*. Because zooplankton are rapidly transported and dispersed by currents, it was not likely that any organism would spend a significant amount of time in the discharge zone. *Id*. Zooplankton also have short generation times and high reproductive capacities, which allows populations to readily offset losses. *Id*. Consequently, even when transported through thermal plumes, it was unlikely that any meaningful change in growth or reproduction of zooplankton will occur. *Id*. at C-19; *see also* MWG Ex. A at 6-4.

Studies. Studies of power plant thermal discharges in the 1970s and 1980s support the conclusion that zooplankton represent a low potential impact biotic category. MWG App. C at C-18. Studies showed that any effects on zooplankton populations were limited to a small area in the immediate vicinity of the discharge, occurring with maximum discharge temperatures in the summer and during those hours when the circulating water was chlorinated to control biofouling. *Id*.

Limited zooplankton sampling had been conducted near the Joliet Stations. MWG App. C at C-19; *see also* MWG Ex. A at 6-4; MWG App. E. at E-9. At a single location in the Dresden Pool, the ACRCC performed zooplankton sampling at a single location. The zooplankton species assemblage was dominated by rotifers, and overall abundance of the four groups assessed was sparse. MWG App. C at C-19.

Summary. The demonstration argued that "[t]he zooplankton assemblage in the LDPR is primarily determined by the dominance of main channel habitat, limited backwater sources, short residence times, and the physical-chemical limitations of the waterway." MWG App C at C-19; *see also* MWG Ex. A at 6-5. It further argued that there was no evidence to conclude that the Stations' discharges have had any measurable effect on the downstream zooplankton assemblage. *Id*.

Macroinvertebrates and Shellfish. Macroinvertebrates, including shellfish, are an important part of "aquatic food webs" and provide a source of bait for sport and commercial fishing. USEPA 316(a) Manual at 58; *see also* MWG App. C at C-19. Thermal discharges may have numerous effects on macroinvertebrates, including reproduction and survival. USEPA 316(a) Manual at 59.

The demonstration for this category may show that the site is a low potential impact area for this category. USEPA 316(a) Manual at 23, 25. If it does not, it must meet the following decision criteria:

1. Standing Crop. Reductions in the standing crop of shellfish and macroinvertebrates may be cause for denial of a 316(a) waiver unless the applicant can show that such reduction caused no appreciable harm to balanced indigenous populations within the water body segment.

2. Community Structure. Reductions in the components of diversity may be a cause for the denial of a 316(a) waiver unless the applicant can show that the critical functions of the macroinvertebrate fauna are being maintained in the water body segment as they existed prior to the introduction of heat.

3. Drift. The discharge of cooling water equal to 30% or more of the 7Q10 flow of a river or stream would be cause for concern and possible rejection of a 316(a) waiver unless the applicant can show that:

    1. Invertebrates do not serve as a major forage for fisheries;

    2. Food is not a factor limiting fish production in the water body segment; or

    3. Drifting invertebrate fauna is not harmed by passage through the thermal plume.

4. Critical Functions (Estuaries). Areas which serve as spawning and nursery sites for important shellfish and/or macroinvertebrate fauna are considered as zero allowable impact areas and will be excluded from consideration for the discharge of waste heat. Plants sited in locations which would impact these critical functions will not be eligible for a 316(a) waiver. Most estuaries will fall into this category. USEPA 316(a) Manual at 24. "Macroinvertebrates" may be considered synonymous with "aquatic macroinvertebrates," which are invertebrates that are large enough to be retained by a U.S. Standard No. 30 sieve (0.595-mm openings) and generally can be seen by the unaided eye. USEPA 316(a) Manual at 73, 77. "Shellfish" are all mollusks and crustaceans (such as oysters, clams, shrimp, crayfish, and crabs) which, in the course of their life cycle, constitute important components of the benthic, planktonic, or nektonic fauna in fresh and salt water. USEPA 316(a) Manual at 79.

The USEPA 316(a) Manual lists information that an applicant should provide for areas that do not qualify as low impact areas in this category. *Id*. at 25-28.

<u>Benthic Macroinvertebrates.</u> The demonstration argued that a combination of factors unrelated to the Stations' operations had led to conditions favoring "a tolerant to facultative benthic macroinvertebrate community." MWG App. L at L-10; *see also* MWG App. C at C-20. These factors included the prevalence of maintained deep-draft main channel habitat, lack of coarse substrate, limited-to-nonexistent riffle/run habitat, frequent fluctuating flows and water levels, legacy sediment contamination, barge traffic, disruption of near shore habitat, and upstream urban inputs and influence. MWG App. L at L-10. The demonstration argued that this characterization was supported by "the lack of meaningful temporal and spatial trends among the variety of completed and documented assessments." MWG App. L at L-10; *see also* MWG Ex. A at 6-7.

A 1993 study sampled 13 locations within the upper Dresden Pool, including two locations just upstream of the Stations' discharges and one location within the Joliet 29's discharge. MWG

App. C at C-20; *see also* MWG App. E at E-11. QHEI scores suggested that habitat factors – including tailwater habitat with limited improved substrate characteristics and multiple current velocity regimes, as well as macrophyte beds providing instream cover – contributed to a similar or higher quality community near the Stations, compared to upstream. MWG App. C at C-20.

A 1994 survey collected samples at locations upstream, downstream, and within the discharges of the Stations. MWG App. C at C-20; *see also* MWG App. E at E-11. Densities ranged from 558/m2 to 1573/m2, and taxa richness ranged from 22 to 28. MWG App. C at C-20. Community metrics suggested a fair to poor benthic community. *Id*. QHEI scores were generally higher in and upstream from the Joliet 29 discharge primarily due to the presence of very limited coarse substrate and higher current velocity. *Id*. Community metrics generally trended higher downstream from Joliet 29, indicating a higher quality benthic community, "which suggests that the coarse substrate and higher current velocity in the Brandon Road Dam tailwater have little positive effect on the quality of the benthic community at these sampling locations." *Id*. at C-20 - C-21.

In 2000 studies performed by MWRDGC, the trichopteran *Cynellus fraternus* accounted for 34% of observed taxa in the Dresden Pool. MWG App. C at C-21. Oligochaeta were the next most dominant taxa at 20%. *Id*.

Although the demonstration cited thermal plume studies to argue that the benthic macroinvertebrate community was primarily outside the influence of the Stations' thermal plumes, additional benthic surveys took place in 2017 and 2018 in the UDIP upstream from, downstream from, and in the vicinity of the Stations' discharges. MWG App. C at C-20, citing MWG App. L; *see also* MWG Ex. A at 6-6; MWG App. E at E-11.

The studies found 85 total taxa including 14 *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Trichoptera* (caddisflies) taxa known as EPT taxa, which are considered to be less tolerant of environmental stressors. MWG App. C at C-21, citing App. L, Table 1. More tolerant midges and aquatic worms make up 48 of the 85 total taxa observed and make up more than 75% of the fauna each year. MWG App. C at C-21, citing App. L, Table 2. The demonstration reported that there were no obvious compositional changes from upstream to downstream, as midges and worms consistently dominated at each sampling transect in both years and for 2017 to 2018 combined. MWG App. C at C-21, citing App. L, Table 4; *see also* MWG Ex. A at 6-6.

Nonetheless, specific dominant taxa varied by transect, with five different taxa accounting for the highest density among the six transects sampled in 2017 and 2018 combined. MWG App. C at C-21, citing App. L, Table 5; *see also* MWG Exa. A at 6-6. Total taxa richness was highest at the furthest upstream locations on Transect 1 and lowest at Transect 4, the nearest locations downstream of the Stations' mixing zones. MWG App. C at C-21. However, less tolerant EPT taxa were similar among the four upstream transects and higher downstream at Transects 5 and 6. MWG App. C at C-21, citing App. L, Table 5. These same longitudinal patterns largely repeated in individual years. Individual taxa dominance varied by location, total taxa was similar among transects, and EPT richness was higher downstream of the Joliet stations than upstream. MWG App. C at C-21, citing App. L, Tables 6 and 7.

Freshwater Mussels. The demonstration argued that it would be extremely unlikely for mussels to be present in the immediate vicinities of the discharge areas. The demonstration attributed this primarily to the high-water velocities and scouring, as well as elevated overall water temperatures, which have existed since the Stations began operating. MWG App. C at C-22; *see also* MWG Ex. A at 6-7 – 6-8. Though the demonstration acknowledged that there was limited information on current mussel distribution in the LDPR, the available evidence indicated that potential habitat in the UDIP for mussels was poor in quality. MWG App. C at C-23; *see also* MWG App. E at E-12.

Based on earlier surveys, there were no known significant mussel source waters between the Brandon Road tailwater and the confluence of the Kankakee River and the LDPR. MWG App. C at C-24. Because mussels are long-lived species that do not move around and require long periods to establish themselves, the demonstration argued that 2008 data should be considered representative of the current population, particularly because the physical habitat had not changed. MWG App. C at C-24; *see also* MWG Ex. A at 6-8.

In 2009 and 2011, basin-wide surveys formed part of the GLMRIS and evaluated mussel populations in the Des Plaines River. MWG App. C at C-25; *see also* MWG Ex. A at 6-8; MWG App. E at E-12. The surveys found only 18 of the 38 historically known species and no federally listed mussel species. *Id*. Additionally, reproduction was not observed at any of the sites surveyed. MWG App. C at C-25.

A 2017 survey of the Des Plaines River found a total of 275 freshwater mussels representing eight species. MWG App. C at C-26. No threatened or endangered species were found. *Id*. Many of the transects exhibited unsuitable substrate for the state-listed mussel species known to inhabit the region. *Id*.

Summary. The demonstration argued that a persistent benthic macroinvertebrate community through the previous assessments suggests that a factor more systemic than thermal discharges limits the community. MWG App. L. at L-10; *see also* MWG Ex. A at 6-9. The demonstration concluded that these data demonstrate that "the thermal discharges of Joliet Stations 9 and 29 have had no significant adverse effect on the UDIP or Five-Mile Stretch benthic macroinvertebrate assemblages." MWG App. C at C-22; *see also* MWG Ex. A at 6-9.

Fish. The discharge of waste heat can affect fish populations in many ways. USEPA 316(a) Manual at 60. The applicant for alternative thermal effluent limitations must characterize the indigenous fish community to identify habitat use and provide baseline information on the fish community. *Id*.

The demonstration for this category may show that the site is a low potential impact area for this category. USEPA 316(a) Manual at 28. The USEPA 316(a) Manual lists conditions that must be met to determine that a discharge is in a low-impact area for fishes. *Id*. at 29. If not, it must demonstrate that fish communities will not suffer appreciable harm from:

1. Cold shock;

2. Excess heat;

3. Reduced reproductive success or growth;

4. Exclusion from unacceptably large areas; or

5. Blockage of migration. *Id*. at 28-29.

The USEPA 316(a) Manual lists information that an applicant should provide for areas that do not qualify as low impact areas in this category. *Id*. at 29-32.

Background. Since 1977, MWG or its predecessor as owner of the Stations has continued annual fisheries monitoring. MWG App. E at E-15. In 1993 and 1994, MWG's predecessor conducted a series of studies to assess the fish community along a 53-mile segment of the UIW, including the entire UDIP. *Id*. at E-14. In addition to fish distribution and abundance, the studies assessed fish age and growth, condition, movement, reproductive success, food habits, and incidence of disease or anomalies. *Id*. at E-14 – E-15.

From 1994 to 2018, either MWG or its predecessor has annually monitored the fish community in the UDIP with a standardized methodology. MWG App. E at E-15. These studies seek to document changes in the fish community in response to the two Joliet Stations' operations. MWG App. E at E-15, citing MWG Apps. F (2016), G (2017), H (2018). MWG also prepared a report of the UDIP fish community under reduced operation as peaking facilities fueled by natural gas. MWG App. E at E-15 – E-16, citing App. J; *see also* MWG Ex. A at 6-14. The demonstration argued that the 2017-2018 analysis "did not show a substantive improvement of the UDIP fishery during reduced operations to the Joliet Stations and resultant decrease in thermal loading." MWG Ex. A at 6-14. It further argued that a fish community that had been stable since 1997 indicated that "the historical heat load under more base-loaded Joliet Station operations had not influenced the overall well-being of the UDIP fish community." *Id*. at 6-15.

Also, since 2010 the ACRCC has overseen fisheries monitoring by the INHS and IDNR below the Electric Dispersal Barrier. MWG App. E at E-15. While chiefly performed to monitor Asian Carp, monitoring also obtains information on other species. *Id*.

Criterion (1): Cold Shock. Cold shock occurs when fish become acclimated to an elevated waterway temperature during winter months, but a sudden termination of the heat source causes a rapid drop in temperatures that can, in extreme circumstances, result in fish kills. MWG Pet. at 29; *see also* MWG App. B at B-44. Four factors are significant in evaluating the potential for cold shock: (1) the length of time fish have resided at the elevated temperatures in the plume; (2) the difference between discharge and ambient temperatures; (3) the rate of temperature decrease; and (4) the absolute magnitude of the lower temperature. MWG App. B at B-44; *see also* MWG Pet. at 29.

At ambient temperatures exceeding 45 °F, cold shock typically does not occur, regardless of the magnitude of the change. MWG Pet. at 29; *see also* MWG App. B at B-44. Ambient winter temperatures near the Stations are normally between 40.6 °F and 48.1 °F because much of their flow consists of treated wastewater discharged upstream. MWG App. B at B-44; MWG Pet. at

29. Also, the Stations' thermal plumes do not experience an extremely rapid change in temperature after operations shut down. *Id*. The demonstration concluded that the Stations have not historically caused cold shock in the UDIP and that cold shock was not expected to be a concern in the future. *Id*.

The Board asked MWG to comment on how often winter water temperatures fall below 45 °F and on the temperature drop below that level that would be significant enough to cause cold shock. Board Questions at 1.

MWG responded that ambient winter water temperatures in the LDPR were at or below 45 °F about 60% of the time. It added that they were at or above 40 °F 80% to 85% of the time. MWG Resp. at 3, citing MWG App. D, Tables D-1c, D-1d. MWG stressed that upstream temperatures lower than 40 °F were infrequent because POTW effluent consistently maintained winter temperatures within the 40-45 °F range. MWG Resp. at 3.

MWG argued that, with ambient temperatures in the range of 40-45 °F, "a temperature drop of 27 °F (i.e., a weekly average fully mixed discharge temperature of 67-72 °F) would not cause cold shock mortality even if a unit were to shut down suddenly." MWG Resp. at 3-4. It added that this drop was "far below" the maximum design temperature change for the Stations' condensers. *Id.* at 4.

MWG stated that the Stations continue to discharge heated effluent for several hours following a shut down, thereby allowing for a more gradual transition back to ambient temperatures. MWG Resp. at 4. Since converting to natural gas, the Stations have not and are not generally expected to run continuously at length during the winter, which would allow aquatic life to acclimate to higher temperatures. *Id*. These factors limit the potential for cold shock to occur in the UDIP due to the operation of the Joliet Stations. *Id*. MWG added that there have been no known cold shock incidents in the UDIP/Five Mile Stretch since the Joliet Stations began operating as peaker plants, and there were not any such incidents documented in the past when the Stations operated in a more base-loaded manner. *Id*.

Criterion (2): Excess Heat. Aquatic organisms are not exposed to constant elevated temperatures but experience thermal reductions during summer evenings as air temperatures decline. MWG App. B at B-38. Also, compared to thermal mortality test protocols providing well-mixed and constant temperature, natural habitats provide a range of temperatures. In addition, organisms are capable of avoiding stressful temperatures. *Id*.

At ambient/acclimation temperatures above 31.1 °C (88 °F), acute mortality is not predicted for the RIS until temperatures in the thermal discharges exceed about 35 °C (95 °F). MWG App. B at B-37, citing Figures B-2 – B-10. Worst-case modeled temperatures below this level were predicted at the 250 foot transect at the theoretical edge of Joliet 9 mixing zone and at the 2,000 foot transect at the theoretical edge of the Joliet 29 mixing zone. MWG App. B at B-37, citing App. D, Tables D-12a-p. Consequently, the demonstration predicted no acute or chronic mortality for any of the RIS. MWG App. B at B-37. Even at both transects, there was a zone of passage in the lower water column. Based on avoidance temperatures, the RIS can be expected to avoid near-field acute or chronic water temperatures. *Id*. at B-37 – B-38. "Also, the assumption that ambient temperatures are representative of acclimation temperatures is conservative and could predict higher potential for thermal mortality than would actually be observed." *Id*. at B-38. Fish in the discharge "may be acclimated to temperatures higher than the upstream ambient." *Id*.

Criterion (3): Reproductive Success or Growth.

Spawning. Entrainment samples collected at the Stations included ichthyoplankton from April through August. MWG App. B at B-41, citing App. C at C-28 – C-29. Mean water temperatures during those months ranged from about 62 °F to 82 °F in 2004, 56 °F to 88 °F in 2005, and 53 °F to 85 °F in 2016. MWG App. B at B-41. For RIS, reported upper spawning temperatures range from 63.6 °F to 84.7 °F. *Id*. Average intake temperatures upstream from the Stations have been within these spawning temperatures except for White Sucker, which have been collected infrequently in the UDIP. MWG App. B at B-41, citing App C. Measured discharge temperatures and worst-case modeled temperatures have exceeded these spawning temperatures, although they "exaggerate actual temperatures found outside the allowable mixing zones." MWG App. B at B-41.

The only RIS likely to spawn after June are Channel Catfish and Bluegill. MWG App. B at B-42. Their reported upper range for spawning was about 84 °F to 85 °F. Under the two typical summers temperature scenarios, models showed downstream transects slightly warmer for part of the day and cooler at other times. MWG App. B at B-42, citing MWG App. D, Figures D-16b, D-16c. Under the worst-case temperature scenario, downstream temperatures would exceed 84 °F at all downstream transects but with cooler temperatures during off-peak periods. MWG App. B at B-42, citing App. D, Figure D-16c. The demonstration argued that Channel Catfish and Bluegill could continue spawning into July in areas upstream of the Stations and downstream during period of lower temperatures. MWG App. B at B-42.

Growth. For Common Carp, Channel Catfish, Bluegill, and Largemouth Bass, available upper zero growth temperatures exceed 93 °F. MWG App. B at B-43, citing Table B-7a; *see also* MWG Table B-9. Under average conditions, the demonstration argued that temperatures in the Stations' thermal plumes are unlikely to affect or halt growth for the RIS. MWG App. B at B-43. Under the worst-case scenario, temperatures exceed 93 °F near the surface in the discharge zones and downstream. Under the two typical summer scenarios, it would do so only occasionally in the discharge zone. *Id*. The demonstration concluded that temperatures in the plumes "are not expected to adversely affect normal patterns of growth as long as high temperature periods are of limited duration." *Id*.

Criterion (4): Exclusion from Unacceptably Large Areas. Although ability to avoid stressful temperatures may minimize potential fish mortality, it could result in avoiding habitats that may be affected by the thermal plume. MWG App. B at B-39. The demonstration included avoidance endpoints for Gizzard Shad, Channel Catfish, Bluegill, and Largemouth Bass. MWG App. B at B-39, citing Table B-6, Figures B-2, B-7, B-8, B-9. Under the modeled worst-case scenario at ambient/acclimation temperatures of 80 °F to 95 °F, RIS with avoidance temperatures would not avoid areas at the edge of the mixing zones. MWG App. B at B-39. Under the two typical summer scenarios, avoidance temperatures for these RIS "are typically higher than the highest plume cross-section temperature" at the edge of the mixing zones. MWG App. B at B-39, citing App. D, Tables D-14f, D-14i, D-16f, D-16i. The demonstration argued that RIS for which avoidance data are not available generally have thermal endpoints similar to RIS for which they are available and would not be expected to avoid large areas of available habitat. MWG App. B at B-39.

Criterion (5): Blockage of Migration. Because RIS would not be expected to avoid large areas of habitat, "it is unlikely that the thermal plumes would interfere with the migration and localized movement patterns (e.g., diel and seasonal onshore/offshore, upstream/downstream, or spawning) of the fish community in the UDIP or the Five-Mile Stretch." MWG App. B at B-40. Under the worst-case summer scenario, the 250 foot transect provides a 97% zone of passage for temperatures at or below 96 °F. MWG App. B at B-40, citing Table B-7a. Under the two typical summer conditions, temperatures at transects downstream of the 250 ft transect will not limit upstream/downstream movements, "as 66% to 100% of the water column are projected to be below known avoidance temperatures." MWG App. B. at B-40. Under the worst-case winter scenario, 85% to 100% of the water column from 250 ft transect downstream were greater than 60 °F. MWG App. B. at B-40, citing Table B-8a.

Threatened and Endangered Species. Fisheries monitoring had collected state-listed species. MWG App. C at C-27, citing Tables C-6, C-7. A single River Redhorse was collected upstream below the Brandon Lock & Dam in 1994 and 2003. MWG App. C at C-27. One Greater Redhorse was collected in 2010 at a far-field location. *Id*. The Pallid Shiner was first collected in 2000 and consistently through 2015. *Id*.

State-threatened Banded Killifish have been collected from the UDIP and Five-Mile Stretch every year since 2012. Twenty-two were collected in 2014, 52 in 2015, and 196 in 2016, most at downstream and far-field locations. MWG App. C at C-28.

The demonstration stated that factors contributing to the recent occurrence and expansion of the Banded Killifish population are not known, but its success near the Stations was likely due to the increased density of aquatic plants in the system. MWG App. C at C-28. However, the demonstration reported that Pallid Shiner catches have declined since 2003 and 2004 because expansion of aquatic macrophytes has reduced sampling efficiency in the Five-Mile Stretch. MWG Ex. A at 4-9, citing Apps. F, G.

The Board asked MWG to comment in detail on how sampling efficiency has been affected by aquatic macrophytes. Board Questions at 1. MWG first stressed that catches of the Pallid Shiner in the UDIP have in most years ranged from none to three, with unusually high collections of them in 2003 and 2004. MWG Resp. at 5. Also, dense aquatic plant growth may in some sampling locations make it difficult for biologists to get into the sampling areas and collect fish. This limits the effectiveness of sampling by restricting the overall sampling area or reducing sampling efficiency. *Id*.

The Board also asked MWG to summarize the sampling data to show whether the numbers for Pallid Shiner show an upward or downward trend since it was first caught in the study area. Board Questions at 1. MWG included the requested numbers from its Appendix C, Table C-7. It argued that the data "indicate a slight increase in the number of Pallid Shiner collected in the UDIP and the Five-Mile Stretch study areas in 2017 and 2018." MWG Resp. at 6.

Federally-listed species for Will County include no fish species and one mussel species for which the UDIP does not provide suitable habitat. MWG App. C at C-27. The federal list also includes a number of other species such as mammals and plants that are not expected to the affected by the operation of the Joliet Stations. *Id*.

Ichthyoplankton. Entrainment studies conducted at the Stations collected a total of 58 taxa. MWG App. C at C-28, citing Tables C-8, C-9; *see also* MWG App. E at E-17. Ichthyoplankton composition was consistent with the fish community in the UDIP. MWG App. C at C-28; *see also* MWG Ex. A at 6-10.

Juvenile and Adult Fish.

Species Composition. Surveys in the UDIP and Five-Mile Stretch documented the occurrence of 78 native and 10 non-native species. MWG App. C at C-29, citing App. C, Table C-2; *see also* MWG Ex. A at 6-12. Three of the ten RIS (Gizzard Shad, Bluntnose Minnow, and Bluegill) accounted for 59% of the total catch. MWG App. C at C-29. Twenty-six species were collected each year, including seven of the ten RIS: Gizzard Shad, Common Carp, Bluntnose Minnow, Channel Catfish, Bluegill, Largemouth Bass, and Freshwater Drum. *Id*. Common Carp and Goldfish were the only non-native species collected all or most years. *Id*.

Distribution and Abundance. Statistical comparisons of 12 electrofishing catch parameters showed differences among four sampling areas. MWG App. C at C-31, citing Table C-12. Catch parameters in the mixing zone were statistically lower than the upstream area except for Native Fish, Bluntnose Minnow, and Channel Catfish. MWG App. C at C-31. However, 11 of the 12 parameters had statistically higher values downstream than in the mixing zone, which indicated that the Stations' discharges have limited influence. MWG App. C at C-31, citing Table C-12. MWG argued that "available or preferred habitat likely plays a more important role in fish distribution in this waterway than temperature." MWG App. C at C-31, citing App. K, Ex. C-2, Ex. C-3.

Interyear Comparisons. MWG compared electrofishing data to determine whether the Stations have had an adverse impact on the fish community. MWG App. C at C-31. The comparison focused on the difference between 2016 and all other years because the Stations' 2016 overall heat load was the lowest of the previous 21 years. *Id*. at C-32.

Total. Among all years, total catch rates were statistically similar to the 2016 rate in the upstream and downstream sampling areas, and nearly all years in the mixing zone and far-field areas. MWG App. C at C-32, citing App. C, Figure C-6, Table C-12. Overall, total catch rates were stable during the 22 years monitored. MWG App. C at C-32, citing App. C, Figures C-7, C-8, C-9.

Gizzard Shad. Upstream rates were similar among years, except that the highest upstream rate in 2012 was significantly higher than in 1994 when the lowest rate was recorded. MWG App. C at C-33, citing App. C, Figure C-10, Table C-12. Downstream rates were statistically similar, except for 1998 when that rate was higher than in 1994, 2009, and 2013. Similar differences were apparent for the downstream catch rates, where rates in 1994, 2008, 2015, and 2016 were lower than in 1998. MWG App. C at C-33. Inter-year differences were not significant most years in the three sampling areas with non-significant ANOVA results, and "there were no significant differences in the mixing zone where water temperatures were highest." MWG App. C at C-33, citing App. C, Figure C-10.

Common Carp. Declining catch rates, especially in the upstream sampling area, resulted in significantly lower catches in 2016 compared to 11 years between 1994 and 2008. MWG App. C at C-33, citing App. C, Figure C-9. In 2006, 2007, and 2009 through 2016, upstream catches of Common Carp were lower but statistically similar among years. MWG App. C at C-33. Fewer differences were evident for the mixing zone, where only the 1994 rate was higher than in 2016, and all other years were statistically similar. *Id*. Before 2002, downstream catches were significantly higher than in 2016 and declined after 2001. *Id*. Catches from 2002 through 2016 were lower but statistically similar among years. *Id*.

Bluntnose Minnow. Catch rates have been statistically different among years at each of the four sampling areas. MWG App. C at C-33, citing App. C, Figure C-11; MWG Table C-12. The 2016 catch rate from the upstream sampling area was significantly lower than the high rates found in both 2003 and 2009, whereas catch rates in the mixing zone were similar among most years except 1994, 2000, 2011, and 2013, when rates were statistically lower than the highest rate in 2009. MWG App. C at C-33. Downstream, rates were similar among years, except for the higher rate in 2009, which was statistically higher than in 1994, 1995, and 1997. *Id*. Far-field rates were lower in 2016 than rates for 10 other years, including six from 2005 through 2010. *Id*. The demonstration argued that "Bluntnose Minnow catches varied more than other RIS because of schooling behavior and annual fluctuations in recruitment." MWG App. C at C-33, citing Figure C-11.

Channel Catfish. Catch rates from the upstream and mixing zone sampling areas were statistically similar among all years. MWG App. C at C-33. For downstream catches, analyses showed that catch rates in 2016 were similar to all other years. MWG App. C at C-33, citing App. C, Figure C-12, Table C-12. Far-field catch rates were statistically similar among all years, except that rates in 2003 and 2004 were higher than in 1994 and 1995. MWG App. C at C-34. The demonstration argued that catch rates were more consistent than the other RIS, "with higher rates in the mixing zone most years suggesting attraction to the warmer water from the Joliet Stations," but mixing zone rates were statistically similar to the upstream rates. MWG App. C at C-34, citing Figure C-12.

Bluegill. Catch rates have generally increased since 1994, particularly in downstream and far-field areas. MWG App. C at C-34, citing Figure C-13. In 2016, upstream and downstream rates were statistically similar to rates from 15 of the 21 previous years and significantly higher than in 1994 and/or 1995. MWG App. C at C-34. The 2016 mixing zone rate was higher than years with the lowest rates (1994 through 1999) and the 2016 far-field rate was higher than in 1994, 1995, and 1997. MWG App. C at C-34, citing Table C-12. Overall, Bluegill catch rates have increased since 1995 but were highly variable in the far-field and to a lesser extent downstream. In comparison, the upstream and mixing zone rates were both much lower but increased from 2011 to 2013. MWG App. C at C-34, citing Figure C-13.

Largemouth Bass. Catch rates generally follow the trend for Bluegill, with increased catch rates after 1997. MWG App. C at C-34, citing Figure C-14. In 2016, the catch rate was significantly higher than the 1994 and 1995 rates from each of the four sampling areas. MWG App. C at C-34, citing Table C-12. Overall, Largemouth Bass catch rates increased and were variable in the far-field and to a lesser extent in the downstream sampling area. MWG App. C at C-34, citing Figure C-14. Upstream and mixing zone catch rates were lower, but they followed the same annual trend as the two downstream sampling areas, with higher rates after 2012. MWG App. C at C-34.

Freshwater Drum. Upstream catch rates before 2005 were significantly higher than in 2016, but rates were statistically similar in 1999, 2001, and 2006 to 2016. MWG App. C at C-34, citing Table C-12. Overall, Freshwater Drum rates in the mixing zone, downstream, and far-field sampling areas were relatively stable compared to the upstream rates that peaked in 2000 and declined through 2016. MWG App. C at C-35, citing Figure C-15.

IWBmod. The demonstration applied the IWB, which uses the number of fish, weight, and diversity evaluation criteria, to electrofishing data as an indicator of fish health in the four sampling areas. MWG App. C at C-35; *see also* MWG Ex. A at 6-13. IWBmod "is sensitive to an array of environmental disturbances, particularly those that result in shifts in community composition without large reductions in species richness, numbers, and/or biomass. MWG App. C at C-35. IWBmod classifies streams or stream segments as:

- Exceptional = ≥9.6;
- Very Good = 9.1-9.5;
- Good = 8.5-9.0;
- Marginally Good = 8.0-8.4;
- Fair = 6.4-7.9;
- Poor = 5.0-6.3; and
- Very Poor = <5.0. *Id.*

IWBmod scores in the Joliet Stations study area ranged from 7.79 to 8.09 during the 22 study years, and nearly 90% of the means in the upstream, downstream, and far-field sampling areas were in the fair range. MWG App. C at C-35, citing Table C-12. In most years, the fish communities in the upstream, far-field, and downstream sampling areas would be considered fair. MWG App. C at C-35. Nearly 70% of the mixing zone means were in the poor range. MWG App. C at C-35, citing Figure C-16; *see also* MWG Ex. A at 6-13. The demonstration argued that the lower scores "had no apparent effect on the far field and downstream trends." MWG App. C at C-35. Overall, IWBmod followed similar annual trends in each sampling area and were consistent among years. MWG App. C at C-35; *see also* MWG Ex. A at 6-13.

Native Species Richness. The mean number of native species collected in the four sampling areas was higher in the upstream sampling area than in the mixing zone and downstream sampling areas. MWG App. C at C-36, citing Figure C-17. For the four areas, annual means were statistically similar most years. MWG App. C at C-36, citing Table C-12. The demonstration argued that differences in mean species richness "reflect the influence of incidental species because seven of the 10 RIS were collected from each sampling areas, as were 67 species/taxa." MWG App. C at C-36, citing Table C-3.

<u>Fish Condition.</u> The demonstration used *Wr* and incidence of DELT anomalies to evaluate the condition of fish in the four sampling areas associated with the Stations. MWG App. C at C-35; *see also* MWG Ex. A at 6-13.

Wr. *Wr* is the ratio of the actual weight of a fish to what a healthy fish of the same length would weigh. MWG App. C at C-37. A *Wr* range of 90 to 100 is a typical objective for most fish species. When mean *Wr* values are well below 90, problems may exist in food and feeding relationships. *Id*.

Mean *Wr* for the four sampling areas combined ranged from 82.4 (Longnose Gar) to 110.5 (Bluegill). MWG App. C at C-37. All but three species had mean *Wr* exceeding 90, and the mean for 14 species exceeded 100. MWG App. C at C-37, citing Table C-14. Of the seven RIS for which *Wr* could be calculated, Gizzard Shad and White Sucker were the only RIS with mean *Wr* less than 100. MWG App. C at C-37. Overall, *Wr* for the RIS that were collected each year approached or exceeded the goal of 90 or greater. MWG App. C at C-37, citing Figure C-18. The demonstration argued that the RIS had consistently good *Wr* throughout the 22 study years at each of the four sampling areas. MWG App. C at C-37.

Wr Interyear Comparisons. The demonstration included inter-year analyses for 11 species that had sufficient sample sizes in 2016 and in four or more of the previous study years. MWG App. C at C-38. Although inter-year differences for seven species were often significant, mean *Wr* values were consistently greater than or equal to 96, and usually greater than 100. *Id*. at C-39, citing Table C-17. The demonstration argued this indicates that when significant inter-year differences occurred, "they were due primarily to the extent in which *Wr* values exceeded the optimal value of 100 and not to suboptimal fish condition." MWG App. C at C-39.

Wr Summary. Analyzing fish condition showed significant longitudinal and inter-year differences in *Wr* values. However, because 82% of the inter-year means were greater or equal to 90, MWG argued that the significant differences were due primarily to the extent in which *Wr* values exceeded the optimal value of 100 and not to suboptimal fish condition. MWG App. C at C-39, citing Table C-14; *see also* MWG Ex. A at 6-13. Over the past 22 study years, 18% of inter-year mean *Wr* values were low enough (i.e., less than 90) to suggest that there may have been a health, food availability, and/or feeding relationship problem. MWG App. C at C-39, citing Table C-17. The demonstration argued that values below 90 "may be an artifact associated with their *Wr* equations not being appropriate for Midwestern populations." MWG App. C at C-39.

<u>DELT Anomalies.</u> Higher incidence of DELT anomalies is a good indication of stress that may be caused by sublethal stresses, intermittent stresses, and chemically contaminated substrates. MWG App. C at C-40; *see also* MWG Ex. A at 6-13. Surveys examined nearly 200,000 fish, and 9,354 of them (4.9% of the electrofishing catch) exhibited DELT anomalies. MWG App. C at C-39, citing Table C-15. Among RIS, affliction rates were highest for Channel Catfish (83%), Freshwater Drum (39%), and Common Carp (37%). Rates were intermediate for White Sucker

(15%) and Largemouth Bass (12%), or much lower for Gizzard Shad (<1.0%) and Bluegill (1.1%). *Id.*

The demonstration argued that "higher affliction rates for bottom feeders suggest that the contaminated substrates within the study area are likely responsible for many of the DELTs observed on these species." MWG App. C at C-39; *see also* MWG App. C at C-40; MWG Ex. A at 6-13. It further argued that incidence rates were noticeably lower for other common taxa. MWG App. C at C-39, citing Table C-15. For example, at the family level cyprinids (excluding Common Carp and Bluntnose Minnow) and centrarchids (excluding Bluegill and Largemouth Bass) had very low incidence rates (0.3% and 1.8%, respectively) compared to the suckers (32%) and ictalurids (excluding Channel Catfish (17%). MWG App. C at C-39.

DELT Longitudinal Comparisons. Longitudinal patterns for rates of DELT anomalies were relatively similar among the 22 years that were compared. Rates "typically exhibited stepwise decreases" from the upstream sampling area to the Five-Mile Stretch. MWG App. C at C-40, citing Table C-16. Annual mean incidence rates decreased from 15.6% in the upstream sampling area to 3.0% in the far-field. MWG App. C at C-40. RIS with the lowest affliction rated (Gizzard Shad, Bluntnose Minnow, and Bluegill) had low mean rates in each of the four sampling areas. MWG App. C at C-40, citing Table C-15. RIS with higher affliction rates (Common Carp, Channel Catfish, and Freshwater Drum) had higher rates in the upstream sampling areas. *Id.* Overall, affliction rates for all taxa combined were highest in the upstream sampling area (13%), intermediate in the mixing zone and downstream sampling areas (9% and 4%, respectively), and lowest in far-field sampling area (2.5%). MWG App. C at C-40.

DELT Interyear Comparisons. Inter-year comparisons revealed that affliction rates for upstream and downstream segments were higher in 1994 and 1995 than most subsequent years. MWG App. C at C-40, citing Figure C-19, Table C-16.

DELT Summary. DELT incidence rates for the upstream, mixing zone, and downstream sampling areas have always been in the poor range, while far-field rates have been in the fair category during 16 of the past 22 years. MWG App. C at C-41. The demonstration argued that "disproportionately higher rates of affliction for bottom feeders suggest that the contaminated substrates within the study area are likely responsible for many of the DELTs observed on these species." *Id.*

<u>Invasive Species.</u> The demonstration reported that since 2010, 16 non-native species have been captured, accounting for 15% of total fish caught and 22% of the total species found upstream of the Electric Barrier on the CSSC. MWG App. C at C-18. The demonstration argued that the Stations' operations "have not been responsible for these non-native introductions or their spread through the UIW. Operation of Joliet Stations 9 and 29 under the proposed near or far-field thermal AELs will not have any influence on the presence of ANS in the future." *Id.*

<u>Summary.</u> MWG asserted that the data and supporting record demonstrated that the proposed ATELs are supportive of seasonal cycles of spawning and reproduction of the fish community in the UDIP/LDPR. MWG Ex. A at 6-16. Further, the thermal plumes of Joliet Stations 9 and 29 do not reduce the important life history functions of the fish in the affected waterways when compared with areas upstream and downstream of the stations. *Id*. Given the physical characteristics of the waterway and its available habitat, MWG maintained that the fish community was supported and was not excluded from a significant portion of the UDIP. Additionally, MWG noted that an "adequate zone of passage existed near the two Joliet Station thermal plumes under prior thermal limits, and will continue to exist under the proposed near-field thermal AELs." *Id*. MWG concluded that the operation of the Joliet Stations under the proposed near-field or far-field thermal ATELs would not result in adverse effects on the fish community in the UDIP or LDPR below the I-55 Bridge.

Other Vertebrate Wildlife. "Other vertebrate wildlife" includes birds (such as ducks and geese), mammals, and reptiles, but not fish. USEPA 316(a) Manual at 32, 77. The demonstration for this category must show that the site is one of low potential impact for other vertebrates. USEPA 316(a) Manual at 32. If not, the demonstration must show that other wildlife community components will not suffer appreciable harm or will actually benefit from the heated discharge. *Id*.

Background. As a result of habitat fragmentation, hydrologic and geomorphic alterations, and urbanization and industrial use, "there is very little available habitat for a fully integrated wildlife community near the Joliet Stations." MWG App. C at C-41; *see also* MWG Ex. A at 6-16. Nearby areas that have not industrialized consist largely of bottomland forest. MWG App. C at C-41. Terrestrial wildlife in those areas is limited mostly to mammals such as White-tailed Deer (*Odocoileus virginianus*), Striped Skunks (*Mephitis mephitis*), and Raccoons (*Procyon lotor*). Other animals that have been documented but rarely seen in the area include Virginia Opossum (*Didelphis virginiana*), Muskrat (*Ondatra zibethicus*), North American Beaver (*Castor canadensis*), and American Mink (*Mustela vison*). *Id*.

Migratory Bird Species. Despite habitat fragmentation and industrialization, the UIW is still utilized by resident and migratory bird species. MWG App. C at C-41; *see also* MWG Ex. A at 6-16 – 6-17. IDNR conducted surveys in 2014 and 2015 to identify migratory bird species utilizing the Des Plaines River, which included Canada Goose (*Branta canadensis*), Mallard (*Anas platyrhynchos*), Common Golden Eye (*Bucephala clangula*), Bufflehead (*Bucephala ableola*), and American Coot (*Fulica americana*). MWG App. C at C-41. Also, bald eagles have been observed along the UIW and near the Joliet Stations. *Id*. The demonstration argued that these bird species do not have direct or indirect interaction with Station operations or related site activities. *Id*. The thermal plumes do not attract large numbers of birds during spring or fall migration and do not attract over-wintering populations. MWG Ex. A at 6- 17. Also, "there is no unique or critical nesting, rearing, or feeding habitat for waterfowl in the immediate vicinity of the Joliet Stations." *Id*.

Other Species. Urbanization and industrialization have also affected amphibian and reptile species. MWG App. C at C-42; *see also* MWG Ex. A at 6-16. While there are no federally listed threatened or endangered species in Will County, there are several state-listed species, including the Four-Toed Salamander (*Hemidactylium scutatum*), Common Mudpuppy (*Necturus maculosus*), Ornate Box Turtle (*Terrapene ornata ornata*), Kirtland's Snake (*Clonophis kirtlandii*), Eastern Massasauga (*Sistrurus catenatus*), Spotted Turtle (*Clemmys guttata*), and Blanding's Turtle (*Emydoidea blandingii*). *Id*. Because many of these species are found in deciduous forests, prairies, or near streams with connecting wetlands, the demonstration argued that they are not likely to be found near the thermal discharge of the Joliet Stations, in the main river channel, or in the industrialized properties surrounding the UDIP and Five-Mile Stretch. *Id*.

Summary. MWG concluded that activity of vertebrate wildlife found in the area "has not been affected by the thermal limits that Joliet Stations 9 and 29 have operated under since the Secondary Contact Standards were enacted in 1972 and are not expected to be affected by the proposed near or far-field thermal AELs in the future." MWG App. C at C-42.

Aquatic Nuisance Species (ANS). ANS are invasive organisms that are introduced into new habitats and produce harmful impacts on natural resources in the ecosystems into which they are introduced. MWG App. C at C-17. More than 180 non-native species have been introduced into the Great Lakes region, and more ANS are expected to be introduced in the Lake Michigan and the UIW over time. *Id*. MWG concluded that the Stations' operations "have not been responsible for these nonnative introductions or their spread through the UIW. Operation of Joliet 9 and 29 under the proposed near or far-field thermal AELs will not have any influence on the presence of ANS in the future." MWG App. C at C-18.

Type I Demonstration (Retrospective/Absence of Prior Appreciable Harm)

MWG argued that the retrospective assessment showed "that there have been no substantial changes in abundance of nuisance species or in the physical and biological components of the UDIP/Five-Mile Stretch during the past 24 years of biological monitoring data collected in these waterways." MWG Pet. at 30. MWG stated that, for much of that 24-year period, the UDIP was subject to standards "significantly less stringent" than the 2018 standard and its proposal. *Id*. MWG added that, during this time, both the UDIP and the Five-Mile Stretch were subject to significantly more thermal loading from upstream sources, such as the Crawford and Fisk Generating Stations that have been inactive since 2012 and the Will County Generating Station that has reduced its generating capacity. *Id*. Finally, MWG noted that the Stations have converted from base load to "peaker" operation, resulting in lengthy periods offline and "a dramatic drop in annual thermal loading." MWG Pet. at 30; *see also* MWG App. E at E-15.

MWG collected biological monitoring data during "peaker" operations at the Station. MWG reported that electrofishing results in 2017 and 2018 were consistent with findings from the pre-peaker historical studies (conducted between 1994 and 2016). MWG Pet. at 26. MWG argued that this indicated that "mean summertime water temperatures have not influenced catch results within the UDIP on a consistent basis among the past 24 years." MWG Pet. at 26; *see also* MWG App. E at E-15 – E-16. MWG also argued that winter electrofishing results further indicated that "water temperature is not the primary limiting factor to the UDIP fish community." MWG Pet. at 26, citing MWG Exh. A at 6-15 – 6-17.

MWG reported that it conducted its retrospective evaluation in two parts. First, it analyzed the condition of each biotic category by comparing available information on its abundance and species composition to what would be expected based on existing habitat, flow, and chemical characteristics of the UDIP and Five-Mile Stretch. MWG Pet. at 25; *see also* MWG App. C at C-2; Rec. at 5. MWG stated that its DSP focused on the fish community. It argued that this focus is practical and based on "the reasonable assumption that significant disruption at lower trophic levels will be reflected in the fish community that relies on those biotic communities for food." MWG Pet. at 25; *see also* MWG App. C at C-3. MWG stressed that its demonstration summarized data on all of the biotic categories. MWG Pet. at 25; *see also* MWG Ex. A at 4-1; MWG App. C at C-2. Second, the demonstration analyzed long-term trends on the abundance for the biotic categories to determine whether a change in population abundance has occurred that can be attributed to the operation of the Joliet Stations. MWG Pet. at 25; *see also* MWG App. C at C-2; Rec. at 5-6. MWG also studied the water quality changes affected by factors other than excess heat.

Water Quality Changes. Factors other than excess heat can influence water quality and the biological function of aquatic systems. MWG App. C at C-3. These factors may interact with other pollutants in the water body, with the heat and chemical discharges, or with other uses of the water body. *Id*. MWG's demonstration addressed factors that may influence water quality in connection with the Stations' heated discharges.

Nutrients. MWG's demonstration argued that power plants are not significant sources of nutrients. MWG App. C at C-3. However, "[o]rganic carbon, phosphorus, and nitrogen are elements most often associated with nutrient richness," and the demonstration addressed each of them. *Id*.

Organic Carbon. Although MWG reported that limited organic carbon data was available for the LDPR, the demonstration stated that it "is not identified by IEPA as a cause of impairment for the LDPR." MWG App C at C-3. The demonstration reported that dissolved carbon was generally unavailable to aquatic organisms other than bacteria. *Id*. While the Stations' thermal discharges may increase bacterial growth rates, their operating history did not indicate any harm caused by this interaction under previous less stringent standards. *Id*. The demonstration argued that "[t]here is no reason to expect" that the Station's thermal discharges under the proposed ATELs "would cause a harmful or detrimental reaction." *Id*. at C-4.

Total Phosphorus. Until 2010, phosphorus had been identified as a cause of impairment in the segment including the Five-Mile Stretch. MWG App. C at C-5. However, decreasing phosphorus levels since 2010 – attributed to improved wastewater treatment – resulted in removing phosphorus from the impairment listing for that segment. MWG App. C at C-5, citing MWG Table A-2. In the segment adjacent to the Stations, there have not been any identified water quality impairments due to phosphorus. MWG App. C at C-5. The demonstration added that phosphorus containing additives used in the Stations' operations have been pre-approved for use by IEPA, with no reasonable potential of any adverse impact on the receiving water at the final discharge concentrations. *Id*. The demonstration acknowledged that the most likely result of an interaction between the thermal plume and phosphorus would be an increase in the rate of algal growth during warm periods. MWG App. C at C-6. However, it argued "there have been no observed or documented incidences of increased algal abundance" near the Stations. *Id*. It also argued that this would be a localized effect. *Id*. The demonstration concluded that, since there had been no evidence of an interaction between phosphorus and the Stations' thermal discharges in the past, there was no reason to expect that the heat discharged under the proposed ATELs would cause one. *Id*.

Total Nitrogen. The demonstration argued that between 2008 and 2011, levels of nitrogen decreased or remained stable in the Dresden Pool. MWG App. C at C-6, citing App. A Table A-6. It also argued that total nitrogen has not been listed as an impairment for the LDPR in IEPA's reports. MWG App. C at C-6, citing App. A Table A-2. The demonstration added that nitrogen-containing additives used in the Stations' operations have been pre-approved for use by IEPA, with no reasonable potential of any adverse impact on the receiving water at the final discharge concentrations. MWG App. C at C-6.

Biocides. Power plants generally apply some type of biocide to control biofouling organisms in cooling water systems. MWG App. C at C-6. Joliet 9 does not use biocides, or any other chemical processes, to minimize biofouling of its condenser cooling system. *Id*. Joliet 29 uses sodium hypochlorite to control biofouling in its condensers, but that use is limited to only two hours per unit per day when the station is in operation. *Id*. at C-7. The Station's final effluent must be de-chlorinated, and its NPDES permit limits total residual chlorine concentration to 0.5 mg/L whenever biocides are used. *Id*. The demonstration reported that this limit "has never been exceeded by the station." *Id*.

Heavy Metals. A Use Attainability Analysis for the LDPR showed prevalent sediment contamination. MWG App. C at C-8. A 2008 sediment study in the Dresden Island Pool and the lower portion of the Brandon pool showed high concentrations of metals. *Id*. The demonstration stated that "movement of metals from the sediments into the water column is mediated principally by pH, which is not affected by temperature." *Id*. at C-9. It argued that discharges from the Stations do not cause the release of heavy metals from the sediments. *Id*. The thermal plume was chiefly at the surface and does not interact with sediments. *Id*. The demonstration concluded that "[t]here has not been and should not be any potential for interactive impacts between the two thermal plumes, heavy metals and the biotic community." *Id.*

Potability, Odor, and Aesthetics. The demonstration stated that the LDPR had not been and was not now considered impaired for aesthetic reasons. MWG App. C at C-9. It argued that factors such as upstream POTW discharges may sporadically affect its aesthetic quality. *Id*. However, because the proposed ATELs are more stringent than thermal limits that were in place for decades, the demonstration concluded that "there is no reason to expect that future thermal discharges from the Joliet Stations will have any negative effect on potability, odors or aesthetics of the LDPR." *Id.*

Other Thermal Discharges. Based on average weather and river conditions, the demonstration reported that there is no significant upstream thermal effects anticipated for either Joliet Station. MWG App. C at C-10. Although there are three downstream thermal dischargers, each has "an insignificant impact on the thermal regime of the UDIP, whether individually or collectively." MWG App. C at C-10, citing App. D.

Summary. The demonstration concluded that there is "no evidence of harmful interactions" between the Stations' thermal discharges and other pollutants or other thermal discharges. MWG App. C at C-10. It also concluded that there is "no evidence suggesting that operation under the proposed near or far-field thermal AELs for the two Joliet Stations would cause such interactions." *Id*.

MWG's Conclusions. MWG argued that, based on the demonstration, there was no evidence that operating the Stations under previous thermal limits caused appreciable harm to the BIC in the UDIP or the Five-Mile Stretch. MWG Ex. A at 3-4; *see also* MWG App. C at C-1; MWG Ex. F. at 4-15. It argued this was true for the period prior to the conversion of both stations from base-loaded, coal fired units to gas-fired peaking units in mid-2016. MWG Ex. A at 3-4; *see also* MWG Pet. at 26. MWG stressed that, even with this reduced thermal loading, "the waterway continues to be dominated by tolerant and highly tolerant species." MWG Pet. at 30. MWG argued that, because temperature was not limiting or harming the BIC, it will be adequately protected by the proposed ATELs. *Id*. MWG further argued that the 2018 numeric standards and narrative standards at 35 Ill. Adm. Code 302.211 "are more stringent than necessary." *Id*.

Type II Demonstration (Predictive/Representative Important Species)

INEOS notes that as of the date of this opinion and order, the Banded Killifish (*Fundulus diaphanus*) is now recognized as two sub-species by the IDNR: the Eastern Banded Killifish (*Fundulus diaphanus diaphanus*), which is not threatened or endangered, and the Western Banded Killifish (*Fundulus diaphanus menona*), which is state-threatened. Pet. Ex.1 at 24. The Eastern (non-listed) form has been confirmed to be the subspecies found in the UDIP and therefore should be removed from the RIS list. *Id.*

Hydrothermal Model

The predictive demonstration used quantitative hydrothermal modeling. MWG App. B at B-2; *see also* MWG Pet. at 26, 28. MIKE3 model outputs characterize and predict hydrothermal conditions under both typical and worst-case scenarios based on real-world data. MWG Pet. at 26, citing MWG App. D. The assessment compared the predicted thermal plumes to available biothermal metric data related to survival, avoidance, spawning, and growth of fish. MWG Pet. at 26-27; *see also* MWG Ex. A at 3-5; MWG App. B at B-2, B-17 – B-18.

Stressing the limitations of modeling and the Stations' operating history and existing data, the demonstration argued that "the model results should mostly serve to supplement the Joliet Stations' existing data and provide supplemental information for sets of conditions that may not have been fully captured in prior field studies." MWG App. D at D-40.

Model Development. The Danish Hydraulics Institute's MIKE3 model used bathymetric mapping, three-dimensional field surveys of water temperature and flow, and meteorological conditions to predict the configuration and temperature distribution of the Stations' thermal discharges under various conditions. MWG App. B at B-3; *see also* MWG Pet. at 28; MWG Ex. A at 2-5; MWG App. D at D-39.

Model Domain and Mesh Generation. The model contained 3,711 cells, each of which was divided into eight layers of variable thickness. MWG App. B at B-3, citing App. D, at D-40, Figures D-9a, D-9b. Variable depths allowed the model to capture the stratification of the water column as demonstrated by the measured field data. MWG App. B at B-3; App. D at D-40. Near the Stations' discharges and other areas of interest, the model increased grid complexity to aid in accuracy. MWG App. D at D-40. As distance from the discharges increased, cell size increased to optimize the number of model cells for shorter model simulation time. *Id*.

The demonstration addressed the physical parameters used to establish model boundaries and develop the model.

Model Input/Output Parameters. Specific sources provided data for model simulations. First, the model used hourly Joliet Station 9 and Joliet 29 operational data. MWG App. D at D-43. Second, it used historical hourly weather history and observations from the Joliet Regional Airport. *Id*. Third, as the upstream boundary condition, it used flow and elevation data from the Brandon Road Lock & Dam, and as the downstream boundary condition, elevation data from the Dresden Island Lock & Dam. *Id*. Finally, the model assumed steady-state maximum seasonal flow and temperature data from each of the three downstream dischargers. *Id*. at D-43, D-47. The model generated output for 16 transects along the UDIP from the Stations to the I-55 Bridge. *Id*. at D-43 – D-44.

River Bathymetry. The demonstration reported that UDIP bathymetric data was collected in 2017. MWG App. D at D-41 Figure D-6. From the Stations to the I-55 Bridge, the entire reach is channelized for commercial barge traffic and maintained by routine USACE dredging. *Id*. at D-41.

Local Meteorological Data. The model used parameters including air temperature, relative humidity, cloud cover, solar radiation, and wind speed and direction to calculate surface heat exchange. MWG App. D at D-42.

Downstream Thermal Dischargers. The model also included data from three downstream dischargers: Stepan Chemical, Flint Hills Resources, and ExxonMobil. MWG App. D at D-41 – D-42, D-46. IEPA requested that any potential thermal influence from the Stations on the three downstream thermal dischargers be identified and, if necessary, addressed as part of the proposed thermal ATELs. *Id*. at D-46. IEPA sought to determine whether their compliance with thermal limits would be affected by MWG's proposed thermal ATELs. *Id*. at D-47. MWG obtained data from them to incorporate into the MIKE3 model. *Id*. Modeling that included their thermal discharges did not show any discernable influence from them on the modeled water temperatures in the UDIP. *Id*. The demonstration argued that "[t]he small volume of discharge flow contributed by each of the three thermal dischargers therefore did not translate into any distinctly measurable thermal signature once mixed with the flow in the waterway." *Id*.

The demonstration included a compliance analysis for each of them "to determine whether, and to what extent upstream river temperatures influenced by Joliet Stations' discharges may negatively impact ongoing compliance with the UDIP thermal limits." MWG App. D at D-48; MWG Exs. D-2a, D-2b. If so, the demonstration then considered whether the three downstream dischargers should have "conditional coverage" under the proposed ATELs. MWG App. D at D-48.

Summer Model Calibration and Validation. The demonstration calibrated the summer model with data from the July 13, 2017, thermal plume survey, which is detailed above. MWG

App. D at D-44, citing App. D, Table D-8. Calibrated results showed "good agreement (within 1 °C)" between modeled and measured temperatures. MWG App. D at D-44, citing App. D Figure D-10a.

The summer model was also calibrated with data from a July 17, 2012, thermal plume survey. MWG App. D at D-45, citing App. I. Results showed "good agreement (within 1 °C/1.8 °F)" between modeled and measured temperatures. MWG App. D at D-45, citing App. D Figure D-10b.

Winter Model Calibration and Validation. The demonstration calibrated the winter model with data from the February 23, 2017, thermal plume survey, which is detailed above. MWG App. D at D-45, citing App D Table D-6. Calibrated results "showed good agreement (within 1 °C/1.8 °F)" between modeled and measured temperatures. MWG App. D at D-46, citing App. D Figure D-11a.

The winter model was also calibrated with data from the December 14, 2017, thermal plume survey, which is detailed above. MWG App. D at D-46; *see also* MWG App. D, Table D-10. Calibrated results showed "good agreement (within 1.5 °C/2.7 °F)" between modeled and measured temperatures. MWG App. D at D-46, citing App. D, Figure D-11b.

Conditions Evaluated. The USACE monitors UDIP/LDPR flow and elevation at the Brandon Road Lock & Dam, which is immediately upstream from the Stations. MWG App. D at D-23; *see also* MWG App. D, Tables D-4a, D-4b, D-4c. USACE also monitors flow and elevations of the entire Dresden Pool at the Dresden Island Lock & Dam, which is about 13.5 miles downstream from the Stations. *Id*. The demonstration argued that these flow data "do not adequately reflect the magnitude and frequency of the flow fluctuations characteristic of this waterway that are due to upstream manipulations for flood control and the maintenance of adequate navigational depth." MWG App. D at D-24; citing Figures D-2a – d. The demonstration further argued that there is "no seasonal, steady-state flow condition in the LDPR, which makes spatial and temporal predictive modeling of water temperature distributions challenging." MWG App. D at D-24.

Summer Worst-Case: Scenario Development. The demonstration intended to develop model input to represent the combination of "worst-case" thermal compliance conditions that may be expected to occur at the Joliet Stations in the future, based on past conditions and with consideration of recent changes in upstream heat inputs. MWG App. B at B-25; *see also* MWG App. D at D-48; MWG App. D at D-48 n.24. The "summer worst case" model scenario reflects 25th percentile low flow (2012-2017) and weather conditions similar to those encountered during 2012, combined with 75th percentile projected July megawatt load conditions for both Joliet Station. MWG App. D at D-48; *see also* MWG Ex. A at 4-2; MWG App. B at B-3. Use of the Joliet 29 cooling towers was also incorporated. MWG Ex. A at 4-2.

Meteorological Data. The demonstration determined that "early July 2012 weather conditions were closely represented by the 95th percentile July (2012-2017) weather records." MWG App. B at B-25. Using the 95th percentile July data reflects "the widespread heat wave and drought conditions prevalent over the entire Midwest, including the Chicago area, during this period." MWG App. B at B-25; MWG App. D at D-49.

Ambient River Temperature. After reviewing the Stations' intake temperature data for July 2012, the demonstration determined that local recirculation of the discharge to the intake had occurred, resulting in "artificially increased temperatures under extended high unit loads and low river flow conditions." MWG App. D at D-49. The demonstration noted that the Joliet Stations are no longer operated as base-load units, so they would not be run as they were in 2012, even under extreme weather conditions with high load demand. *Id*. Also, the Fisk and Crawford Stations were permanently closed in 2012, and the Will County Station had been indefinitely idled since 2015, reducing maximum potential heat contributions to the upper waterway and upstream temperatures from July 2012 conditions. *Id*. Based on these factors, the demonstration concluded that "subtracting 3 °F from the average hourly July Joliet 9 and 29 intake temperatures would provide the necessary adjustment to reflect values that would be expected during an extreme summer period during current and future modeled conditions." *Id*.

River Flow. Noting that LDPR flow continuously fluctuates, the demonstration argued that using changing flow inputs would make three-dimensional modeling of the entire waterway "extremely challenging." MWG App. D at D-50. The demonstration selected a constant flow value to limit flow variability and represent typical worst-case conditions. *Id*. The demonstration chose the 25th percentile July low flow (2,338 cfs) as a valid representation of the river condition expected during a hot, dry summer. MWG App. D at D-50; *see also* MWG Table D-4. The demonstration argued that actual average LDPR flow for July 1-7, 2012, was 2,314 cfs, confirming this flow value. MWG App. D at D-50.

Plant Operational Data. The demonstration based the Stations' load values on 2019- 2021 projections by MWG. MWG App. D at D-50. It considered 75% July loads appropriate based on analysis and review of historical load cycle data during similar weather and river conditions. MWG App. D at D-50, citing Figure D-12a. While the demonstration compared 75th and 95th percentile future load projections, it stated that loads up to the 95th percentile "may or may not be possible under all sets of adverse weather and flow conditions, and would need to be assessed based on continuing compliance assessments under such conditions." *Id*. at D-50. The demonstration concluded that "the 75th percentile load cycle would best reflect how the Joliet Stations would actually be expected to operate." *Id*.

The demonstration also established hourly discharge temperatures for the Stations for the 75th percentile July load projections. MWG App. D at D-51, citing Figure D-12c. Finally, the demonstration maintained a 24-hour load cycle for both Stations with lower loads in the overnight hours. MWG App. D at D-51. It argued that this would be the expected type of unit operation under high load demand periods, which typically occur during summer heat wave/drought conditions. *Id*.

Intake and Discharge Flows. The demonstration set intake and discharge flows at Joliet 9 at 579 cfs (375 MGD), which reflects two-pump operation. MWG App. D at D-51. It set Joliet 29 flows at 1,537 cfs (994 MGD). This reflects three-pump operation, which has been standard when the Station uses cooling towers. *Id*.

Use of Joliet 29 Cooling Towers. The demonstration developed model input data assuming the Joliet 29 supplemental cooling towers would be in use during the entire run time, with an average cooling effect on the end-of-pipe discharge temperature of 7 °C. MWG App. D at D-51. The demonstration based this value on cooling tower operating data from July 2012. *Id*. The model also assumed that 22 of the 24 towers would operate at any given time based on the average number of towers in service in July 2012. MWG App. D at D-5; *see also* MWG Ex. A at 4-2.

Input Parameters. Based on the analyses and assumptions above, the final model input variables for the "summer worst-case" scenario were selected. MWG App. D at D-51; *see also* Table D-11.

Summer Typical Median Flow and Typical Low Flow: Scenario Development. Both "summer typical" scenarios were based on the 75th percentile values for intake temperature and corresponding 75th percentile weather parameters for the month of July from the 2012-2017 period of record, along with the 75th percentile projected load cycles for all three Joliet units for the month of July (2019-2021). MWG App. D at D-59; *see also* MWG Ex. A at 4-2; MWG App. B at B-3, B-19, B-29.

River Flow. For the median flow scenario, the model used flow of 3,373 cfs, median July flow summer from 2012 to 2017. MWG App. D at D-59; *see also* MWG App. D, Table D-4a; MWG App. B at B-29.

For the low-flow scenario, the model used 2,720 cfs, the 50th percentile August flow from 2012 to 2017. MWG App. D at D-59; *see also* MWG Table D-4a; MWG App. B at B-29. The demonstration stated that August has historically been a low-flow summer month with a concurrently higher load demand. MWG App. D at D-59.

Plant Operational Data. For both summer typical scenarios, the model used intake and discharge flows of 579 cfs for Joliet 9. MWG App. D at D-59. For Joliet 29, the intake and discharge flow rate was 1,537 cfs with a cooling tower benefit of 7 °F. *Id*. For both stations, the model used 75th percentile hourly measured intake temperatures from July 2012 to 2017. *Id*. The model based the loads for both Stations on 75th percentile future load projections, with corresponding discharge temperatures based on the analysis performed for the "summer worst-case" scenario. *Id*. at 59-60

Meteorological Data. Both scenarios used 75th percentile of hourly values for air temperature and relative humidity. MWG App. D at D-60. Both also used a constant wind speed of eight mph based on averages July 2012 to 2017 for Joliet. *Id*.

Input Parameters. Based on the analyses and assumptions above, the final model input variables for the "summer typical" scenario were selected. MWG App. D at D-60; *see also* MWG Tables D-13, D-15.

Winter Worst-Case: Scenario Development. The demonstration used the MIKE3 model to assess the impact of expected Joliet Stations operations under the unseasonably high air temperatures and low flows that occurred from December through March in 2012 to 2017. MWG App. D at D-69; *see also* MWG Ex. A at 4-3; MWG App. B at B-4, B-33.

River Flow. The "winter worst-case" scenario was based on 25th percentile low flow. MWG App. D at D-69; *see also* MWG App. D Table D-4b. In the four winter months, the 25th percentile flow ranged from 1,653 cfs to 2,518 cfs. MWG App. B at B-20. The demonstration argued that "low-flow conditions are driven primarily by upstream publicly-owned treatment works (POTW) flows (up to 100%) during this time of year." MWG App. B at B-20; *see also* MWG Ex. A at 3-7.

Meteorological Data. From the four winter months, the demonstrations first identified the high monthly air temperature readings for 2012 to 2017. MWG App. D at D-69. Within those months, it then identified the maximum temperature dates:

Selected Date(s)	Daily High Air Temperature (°F)	Daily Low Air Temperature (°F)
31 January 2012	58	43
20-21 March 2012	84	61
12-13 December 2015	64	56
18 February 2017	70	36

MWG App. D at D-69 – D-70; *see also* MWG App. B at B-32. The model then used an average of the hourly air temperatures and relative humidity readings for these six dates. MWG App. D at D-70. The model also used a constant wind speed of 7 mph, the average wind speed over the six identified winter dates. *Id*. Based on average monthly values, cloud cover for the winter condition was set at a constant 56%. *Id*.

Ambient River Temperature. The model used 95th percentile intake temperature for 2012 to 2017 to represent ambient water temperature. MWG App. D at D-70; *see also* MWG Tables D-1c, D-1d.

Plant Operational Data. While the model used current winter hourly load projections, those projections do not show Joliet 9 operating at any time during the months of December through March from 2019 through 2021. Therefore, the winter model runs were performed without operation of Joliet Station 9. MWG App. D at D-71, citing Figure D-12b; *see also* MWG Ex. A at 3- 8, 4-3 n.12. Operational data from 2012 to 2017 showed that the overall heat contribution of Joliet Station 9 during the winter months is limited. MWG Ex. A at 4-3 n.12. The model used a 95th percentile load as a surrogate for the Joliet 9 load. MWG Ex. A at 4-3 n.12; *see also* MWG App. B at B-32; MWG App. D at D-69.

To develop representative winter operating conditions, the model used the same analysis as the summer models. MWG App. D at D-71, citing App. D Figure D-12c.

Joliet 29 Cooling Towers. At Joliet 29, "cooling towers are not designed for winter operation, and were therefore not incorporated into any of the winter model scenarios." MWG App. D at D-70.

Model Input Data. Based on the analyses and assumptions above, the final model input variables for the "winter worst-case" scenario were selected. MWG App. D at D-71; *see also* MWG Table D-17.

Winter Typical Median Flow: Scenario Development. For the "winter typical/medial flow" scenario, the model used median river flow, 75th percentile projected winter load, intake temperatures, and weather parameters (air temperature and relative humidity) for December-March in 2012 to 2017. MWG App. D at D-76; *see also* MWG App. B at B-4, B-20, B-33. The demonstration considered these conditions to be most reflective of a typical set of winter operating conditions for the Joliet Stations. MWG App. D at D-76.; *see also* MWG App. D, Tables D-4b, D-19.

Winter Typical Low Flow: Scenario Development. This scenario used the 25th percentile low flow average for the months of December through March for the UDIP/LDPR. MWG App. D at D-78. The demonstration stated that low flow conditions are common in the UDIP/LDPR during the winter months "when there is no upstream Lake Michigan diversion, lesser POTW flows, and little or no precipitation that results in run-off." All other parameters were unchanged from the "winter typical – median" scenario. MWG App. D at D-79; *see also* MWG Tables D-4b, D-21.

Biothermal Metrics Evaluated

The predictive demonstration matches hydrothermal modeling of the Station's thermal discharges to thermal response metrics for the RIS. MWG App. B at B-4. The demonstration used data from scientific literature to determine thermal sensitivity of each of the RIS. *Id*. It evaluated potential effects of the discharges for five thermal effects: (1) temperature requirements for survival of juveniles and adults; (2) avoidance temperatures; (3) temperature requirements for early development; (4) optimum temperature for performance and growth; and (5) thermal shock tolerance. MWG App. B at B-4; *see also* USEPA 316(a) Manual at 43-44. The demonstration examined the four biothermal metrics summarized in the following subsections.

Spawning Temperature Range. Spawning for many aquatic species is closely tied to water temperature. MWG App. B at B-5. Data on spawning temperatures are generally based on field observations of spawning activity and physical condition in a species' geographic range. *Id*. Where adequate documented data exists, the demonstration plotted thermal effects to indicate the reported temperature range for spawning based on the spawning period near the Stations. *Id*.

Optimum Temperature for Growth. Water temperature plays a significant role in the growth of aquatic species. MWG App. B at B-5. For most temperate freshwater fish species, growth is minimal during the winter and peaks between spring and fall. *Id*. Because aquatic organisms often prefer temperatures within their optimum growth range, preferred temperatures can be used as a surrogate for the optimum range of growth and performance. *Id*. Outside an optimum range, growth can occur at a slower rate. *Id*.

Temperature Avoidance. Many aquatic species actively avoid potentially stressful temperatures, both high and low, depending on their acclimation conditions. MWG App. B at B-5. While this minimizes exposure to temperatures that could result in mortality, avoidance "may preclude access to critical habitat located within a thermal discharge plume." *Id*.

Chronic Thermal Mortality. As water temperature increases, aquatic organisms exhibit responses including avoidance, impaired growth and reduced feeding, impaired swimming ability, loss of equilibrium, and mortality. MWG App. B at B-7. Acclimation history affects these responses, and it is important to evaluate laboratory studies of thermal effects with reference to acclimation history. *Id*. The demonstration argued that "it is unusual to observe mortality related to elevated water temperatures because of the ability of many organisms to avoid potentially lethal temperatures." *Id*.

Mortality data associated with temperature can be qualified by rate of temperature increase or duration of exposure. MWG App. B at B-6. Chronic thermal mortality is estimated with tests where organisms are subjected to a controlled rate of temperature increase over time until loss of equilibrium. *Id*. The tolerance limit for 95% of test organisms (TL95) measures the temperature at which 95% of the organisms survive for the exposure period. *Id*. The lethal dose to 50% of the test organisms (LD50) measures the temperature causing mortality to 50% of the test organisms. *Id*.

Representative Important Species Selection

A CWA Section 316(a) Type II Predictive Demonstration must identify the representative important species for further study. "Representative important species" are defined as "species that are representative, in terms of their biological needs, of a balanced, indigenous community of shellfish, fish, and wildlife in the body of water into which a discharge of heat is made." 35 Ill. Adm. Code 106.1110; *see also* 40 C.F.R. § 125.71(b). Because it was not economically feasible to study each species in detail, a few were selected as representative important species for more detailed study. *See* MWG Ex. A at 4-3, 5-1; MWG App. B at B-7, citing App. B Figure B-1, Tables B-1, B-2, B-3.

The USEPA 316(a) Manual lists these seven considerations for selecting representative important species: (1) species mentioned in state water quality standards; (2) species identified in consultation with other governmental agencies; (3) threatened or endangered species; (4) thermally sensitive species; (5) commercially or recreationally valuable species; (6) far-field and indirect effects on entire water body; and (7) critical to structure and function of ecological system. USEPA 316(a) Manual at 36-39; *see also* MWG Ex. B at B-8; MWG Pet. at 28.

MWG's predictive analysis considered additional factors in selecting RIS: (1) numerical dominance or prominence in the BIC; (2) their role in energy transfer through the aquatic food chain as important forage or predator species; (3) important links between primary producers, primary consumers, and secondary consumers; (4) similarity of their food, habitat, and life history requirements to groups of other species utilizing aquatic habitat near the Joliet Stations; (5) non-native and potential nuisance species; and (6) species with unique or critical habitat or life history stages near the thermal discharge. MWG App. B at B-8.

Representative important species are selected from any combination of these three biotic categories: shellfish; fish; and habitat formers. USEPA 316(a) Manual at 36. However, the demonstration selected only fish species as RIS. MWG App. B at B-8 – B-9. The demonstration argued that "fish represent the top of the food chain, are important to the public because of their recreational and/or commercial value, and because their overall well-being shows that the lower trophic levels are supporting the trophic levels occupied by the RIS." MWG App. B at B-8 – B-9; *see also* MWG Pet. at 25. The demonstration did not select lower trophic levels as RIS because studies historically have shown only localized thermal effects that did not result in harm, and also because of a "general lack of thermal endpoint data." MWG App. B at B-9.

In preparing a CWA Section 316(a) demonstration and underlying studies, petitioners must consult federal and state agencies to ensure that studies address appropriate wildlife. To this end, the Board's rules require that a petitioner serve a copy of its petition on both IEPA and IDNR, as well as inform IEPA of its proposed representative important species list and supporting data and information. *See* 35 Ill. Adm. Code 106.1115(a)(4), 106.1120(b)(5), 106.1125. In addition, the USEPA 316(a) Manual advises that the permitting authority check with the Regional Director of the U.S. Fish and Wildlife Service and representatives of the National Marine Fisheries Service and States, to make sure the study plan includes appropriate consideration of threatened or endangered species as well as other fish and wildlife resources. USEPA 316(a) Manual at 15. The demonstration reported that IEPA and IDNR approved the RIS "after notice to and review by USEPA Region 5." MWG Ex. A at 5-1.

The USEPA 316(a) Manual elaborates on the most thermally sensitive species, stating that they

> should be identified and their importance should be given special consideration, since such species (or species groups) might be most readily eliminated from the community if effluent limitations allowed existing water temperatures to be altered. Consideration of the most sensitive species will best involve a total aquatic community viewpoint. USEPA 316(a) Manual at 37.

The applicant must collect thermal effects data for each representative important species, including: (1) high temperature survival for juveniles and adults; (2) thermal shock tolerance; (3) optimum temperature for growth; (4) minimum and maximum temperatures for early development; (5) normal spawning dates and temperatures; and (6) any special temperature requirements for reproduction. USEPA 316(a) Manual at 43–45.

Gizzard Shad. The gizzard shad is an important forage species near the Stations and a prolific warmwater species found throughout the Illinois River drainage and the state. MWG App. B at B-11. Near the Stations from 1994 to 2016, it was the most or second most abundant species collected during 20 of the 22 years surveyed. *Id*. at B-12. Electrofishing and seine catches averaged 2,062 Gizzard Shad with a range of 393 to 6,591. *Id*. While this varies widely, "annual catches have not exhibited any long-term trends." *Id*.

Spawning occurs in open water from about late April through June. *Id*. Samples found peak densities of yolk-sac larvae in May when temperatures were between 55.3 °F and 73.3 °F. MWG App. B at B-11. Post yolk-sac larvae were most abundant in late June when temperatures ranged from 73.1 °F to 87.2 °F. *Id*.

Common Carp. Common Carp is a non-native warmwater species introduced to Lake Michigan in the nineteenth century. MWG App. B at B-12. At high numbers, it is considered a nuisance species, particularly during spawning season when they can be responsible for high turbidity levels as they thrash about in shallow weed beds and over silty substrates. *Id*. Near the Stations from 1994 to 2016, it was collected during each survey year and was the eighth most abundant species collected overall. *Id*. Catches of Common Carp peaked in the 1990s and have with few exceptions declined since 1997. *Id*.

Common Carp spawn in shallow weedy areas in the spring and early summer where their adhesive eggs are broadcast over debris and vegetation. MWG App. B at B-12. During entrainment sampling, early life states of the Common Carp accounted for 20% of the ichthyoplankton collected at Joliet 29 in 2004 and 2005 and 16% at Joliet 9 in 2016. *Id*.

Bluntnose Minnow. The Bluntnose Minnow is a native forage species occurring throughout Illinois. MWG App. B at B-12. They are nest builders that provide parental care. *Id*. Near the Stations from 1994 to 2016, it was collected each survey year and was the most abundant species overall. *Id*. at B-13. Catches were lowest in the 1990s, peaked in 2003, and have been abundant since, but catches have been variable. *Id*.

Spawning occurs in gravel or sandy shoals from about May into August. MWG App. B. at B-12. Early life stages of the Bluntnose Minnow are rarely collected in ichthyoplankton samples around the Stations. *Id*.

River Redhorse. The River Redhorse is a native river species in the sucker family that is distributed widely in the eastern U.S. MWG App. B at B-13. It is listed as threatened in Illinois and included as an RIS for that reason. *Id*. Only two River Redhorse have been collected from the Stations' study area, one in 1994 and one in 2003. *Id*.

River Redhorse normally spawn in April and May. They prefer riffle and run habitats with clean coarse substrates, particularly for spawning. MWG App. B at B-13. It would not be expected for them to be prevalent in the UDIP or the Five-Mile Stretch, which consist of slow water currents and predominantly soft, fine substrates. *Id*.

The demonstration selected Golden Redhorse as surrogate species. MWG App. B at B-13. It was collected in each of the 22 survey years and was the most abundant redhorse species. Near the Stations from 1994 to 2016, annual catches averaged 27 with a range of 2 to 101. *Id*. at B-13 – B-14.

White Sucker. The White Sucker is a demersal warmwater species widely distributed through Illinois and Lake Michigan. MWG App. B at B-14. It prefers sand and coarse substrates in small creeks and rivers but may be found in habitats with silt and fine sediment. *Id*. White

Sucker occurred in 19 of the 22 survey years with an average catch of 13 and a maximum of 160. *Id*. Although it is not common near the Stations, the thermal assessment included it because it is relatively sensitive to increases above ambient temperatures in the summer. MWG App. B at B-14.

Spawning occurs during April and May over gravel substrate in riffles and pools. MWG App. B at B-14. During entrainment studies at Joliet 29, two White Sucker yolk-sac larvae and three post yolk-sac larvae were collected. *Id*. When they were found, water temperatures were between 55.3 °F and 66.0 °F. *Id*.

Banded Killifish. Banded Killifish is a state-listed native species that is normally found in clean water with vegetation and substrates of sand or organic debris free of silt. MWG App. B at B-14. Banded Killifish were not collected in surveys of the UIW until 2012. It had been found near the Stations every year from 2012 to 2016. *Id*. The 2016 catch was nine times higher than prior annual catches. *Id*. The demonstration considered increased density of aquatic plants as a likely cause of this increase. *Id*. at B-15.

Spawning occurs in late spring through early summer when temperatures are about 73 °F. MWG App. B at B-15. While 2004 and 2005 entrainment studies were performed before Banded Killifish were first found near the Stations, low numbers were entrained in 2016 at Joliet 9. *Id*.

Channel Catfish. Channel Catfish is a common native sport and food fish found throughout Illinois. MWG App. B at B-15. They are usually found in the greatest abundance in fast flowing, medium to large rivers with sand and gravel-substrates, but they tolerate the range of habitats near the Joliet Stations. *Id*. From 1994 to 2016 near the Stations, Channel Catfish have been collected each year with an average catch of 148 and a maximum of 280. *Id*. It was the most abundant of five catfish species collected. MWG App. B at B-15.

Spawning typically occurs in June and July. App. B at B-15. Because of its nesting behavior, Channel Catfish do not commonly appear in ichthyoplankton surveys. *Id*. However, in the week before early life stages are first observed, water temperatures were between 74.7 °F and 84.6 °F. *Id*.

Largemouth Bass. Largemouth Bass is a popular recreational fish species that uses a variety of habitats. MWG App. B at B-16. From 1994 to 2016 near the Stations, it occurred every year with an average catch of 596 and a maximum of 1,771. *Id*. Catch rates suggest increasing abundance since 2000. *Id*.

Spawning mostly occurs in May and June with nest construction in sand, gravel, and around vegetation. Males guard the nest in early life stages. MWG App. B at B-16. Because nesting behavior limits exposure to entrainment, Largemouth Bass larvae and early fry were not collected in 2004-2005 studies at Joliet 29 or the 2016 study at Joliet 9. *Id*.

Bluegill. Bluegill is a widely distributed native species usually found in clear lakes, although it can tolerate habitats near the Joliet Stations. MWG App. B at B-16. From 1994 to 2016 near the Station, Bluegill was the most abundant of eight sunfish species. It occurred in each of 22 survey years with an average catch of 2,577 and a maximum of 6,307. *Id*. at B-17. It ranked 1st to 13th annually in abundance and averaged second overall. MWG App. B at B-17. While catch rates varied, they have generally increased since 2000. *Id*.

Spawning begins in late May and often continues into August. MWG App. B at B-16. Entrainment studies do not collect juvenile Bluegill in large numbers. *Id*. During the week prior to the first observation of yolk-sac larvae, water temperatures were 74.6 °F in 2004 and 81.7 °F in 2005. *Id*.

Freshwater Drum. Freshwater Drum is a native species that prefers large rivers, but it is also found in larger lakes and may ascend smaller rivers. MWG App. B at B-17. From 1994 to 2016 near the Stations, Freshwater Drum occurred in every study year with an average catch of 89 and a maximum of 144. It ranked 3rd to 22nd annually in abundance and averaged 19th overall. *Id*. Catch rates have varied but decreased after 2004. *Id*.

Although spawning information is limited, it is believed that spawning occurs during May and June. MWG App. B at B-17. During 2004-2005 entrainment studies at Joliet 9 and 29, Freshwater Drum eggs were the most abundant taxa/life stage. *Id*. In 2016 entrainment studies at Joliet 9, Freshwater Drum eggs accounted for 5.4% of the ichthyoplankton collected. *Id*. When eggs first appeared in entrainment samples, water temperatures ranged from 59.8 °F to 65.4 °F. *Id*.

Species-Specific Biothermal Response Data

Acclimation-Ambient Temperatures. Because fish are cold-blooded, their body temperature is determined by the temperature of the surrounding water. MWG App. B at B-18. Acclimation temperature is the temperature to which an organism has been exposed for a period adequate to achieve physiological equilibrium. *Id*. Acclimation condition can affect response to a water temperature gradient. As an example, organisms acclimated to winter or early spring water temperatures typically exhibit avoidance or preference for temperatures significantly lower than the same organisms acclimated to warmer summer ambient water temperatures. *Id*.

The demonstration argued that thermal effects data based on controlled laboratory acclimation temperatures "need to be considered in the context of the acclimation history of organisms that might be exposed to the Joliet Station 9 and 29 thermal discharges and conditions in available proximal habitat." *Id*.

Thermal Assessment Diagrams for RIS. The demonstration constructed thermal diagrams for the RIS "to graphically present the relationship of acclimation temperature and the selected biothermal response metrics" to help interpret potential effects of the Stations' thermal discharges on the RIS and the aquatic community they represent." MWG App. B at B-20; *see also* MWG Figures B-2 – B-10. The demonstration noted that, because of limited thermal endpoint data, it could not develop a thermal diagram for Banded Killifish. MWG App. B at B-20. The demonstration used the thermal diagrams to predict potential effects of measured and modeled thermal discharges on the aquatic community represented by the RIS. *Id*.

Acute Thermal Mortality. This metric depicts the lethal response of organisms to dynamic temperature increases over a relatively short period. MWG App. B at B-21. It was expressed by chronic thermal mortality, which may use loss of equilibrium in place of final mortality as the test endpoint. *Id.*

Chronic Thermal Mortality. This metric depicts a mean tolerance limit, the acclimation/exposure temperature combinations at which 50% mortality would occur due to elevated temperatures for a prolonged exposure of more than 24 hours. MWG App. B at B-21. The demonstration argued that chronic mortality is "a very conservative measure of potential thermal effects because it assumes fish are unable to avoid potentially lethal elevated temperatures by moving to cooler temperatures." *Id.*

Avoidance. A thermal avoidance response occurs when mobile species evade stressful high temperatures by moving to water with lower, more acceptable temperatures. MWG App. B at B-21. While avoidance can minimize mortality, it can also deter organisms from occupying otherwise useful or critical habitat that may occur near a thermal plume. *Id.*

Thermal Preference Zone. Optimal temperatures for growth are defined as the preferred temperature of fish in a thermal gradient. MWG App. B at B-21. Thermal preference data delineate the acclimation and exposure temperature combinations from which optimal growth (preferred temperatures) would be predicted. *Id.* Distribution of optimal and non-optimal water temperatures vary naturally, and the configuration of a thermal plume can add variability. *Id.* Using MWAT for growth attempts to account for this variability. *Id.* The demonstration argued that "growth occurs to a greater or lesser extent over a range of temperatures and a thriving population can be maintained even when temperatures are nonoptimal during certain periods or in a segment of a waterbody." MWG App. B at B-22. It further argued that fish can avoid areas with non-optimal temperatures. *Id.* Because it was difficult to measure the effect of the plume on individuals, the demonstration considered the amount of habitat affected by the thermal plume where water temperatures are outside of the optimum range for growth and the frequency of that effect. *Id.*

Thermal Tolerance Zone. This extends beyond the preference zone and delineates the temperature regime over which each species can survive and continue to grow, but at less than optimum rates. MWG App. B at B-22. The demonstration argued that temperatures outside the tolerance zone but below the onset of predicted chronic mortality "delineate the temperature regime over which a species can survive, but in which they may be stressed and experience near-zero growth or weight loss." *Id.*

Thermal Range for Spawning. This range is typically based on field observations of natural spawning activity. MWG App. B at B-22. With adequate documented data, this range indicates the temperature range for spawning based on the season during which it occurs near the Stations. *Id.*

Lower Lethal Temperatures. Lower incipient lethal temperatures (chronic exposure) and cold shock (acute rapid exposure) measure mortality caused when organisms acclimated to warm temperatures in the thermal plumes are exposed to significantly colder ambient water temperatures.

MWG App. B at B-23. This may occur after a Station outage when fish attracted to plumes in winter are exposed to cold ambient water temperatures. *Id*.

The demonstration stressed that ambient winter temperatures in the LDPR typically are higher than in other systems because much of the winter flow is treated wastewater. MWG App. B at B-23. At Joliet 29, measured intake temperatures from 2012 to 2017 "have been greater than 40.0 °F more than 50% of the time." *Id*. The demonstration argued that at ambient temperatures exceeding 45 °F, "cold shock typically does not occur, regardless of the magnitude of the change." MWG App. B at B-23.

Periods of Occurrence. Entrainment studies conducted at the Stations "confirmed spawning of resident species in the LDPR occurs from April through August." MWG App. B at B-23. Primary spawning activity generally occurred in May, increased and stabilized through June, and then tapered off through July, with significantly lower abundance of early life stages of fish in April and August. *Id*.

For the RIS, the demonstration stated that young of the year and adults of the RIS occur June through September, during which proposed summer near-field limits would apply. MWG App. B at B-23. Proposed winter near-field limits are not expected to affect RIS near the Stations because temperatures will remain lower than avoidance temperatures and preferred temperatures. *Id*.

Hydrothermal Analysis

The demonstration compared model-estimated water temperatures to biothermal metrics to estimate the extent of otherwise available aquatic habitat that would be excluded or would be at less than optimum conditions for selected life history functions of RIS due to water temperature, while still allowing for an adequate zone of passage. MWG Pet. at 29; *see also* MWG Ex. A at 3-5, 4-2; MWG App. B at B-17 – B-18, B-25, B-45.

Summer Worst-Case Model Results.

Projected Isotherm Extents. The model calculated the thermal isotherm surface area for different temperature increments:

Scenario 1	Isotherm Temperature		Near-Surface Layer Plume Area in Entire Model Domain
	(ºF)	(ºC)	(acres)
	>90	32.2	460
	>93	33.9	291
	>94	34.4	183
	>95	35.0	47
	>96	35.6	21

"Worst-Case" Summer Conditions comparable to July 2012	>97	36.1	11
	>98	36.7	0

MWG App. B at B-28; MWG App. D at D-56; *see also* MWG App. D at D-68. The demonstration acknowledged that the "summer worst-case" scenario "resulted in temperatures in excess of the numeric thermal limits" that took effect in 2018. MWG App. D at D-56. However, it argued that the isotherm distribution and cross-sectional temperature distribution show that "the highest water temperatures are largely confined to the areas immediately below each Station's discharge, and become largely surficial and/or fully mixed as the thermal influence of the Joliet Stations' discharges moves downstream." *Id.*

Zone of Passage. Although this scenario resulted in plume temperatures exceeding new numerical thermal water quality standards, cross-sectional temperature distributions show that the thermal plume, once downstream of the immediate discharge area, is largely surficial. MWG App. B at B-28, citing MWG App. B Table B-7a; MWG App. D Table D-12a – D-12p, Figures D-12a, D-12b; *see also* MWG Ex. A at 2-5. The demonstration argued that the proposed ATELs maintain an adequate ZOP:

Transect (ft)	**Transect Description**	**Mean Transect Temperature (°F)**	**ZOP ≤90°F**	**ZOP ≤93°F**	**ZOP ≤94°F**	**ZOP ≤95°F**	**ZOP ≤96°F**	**ZOP ≤97°F**	**ZOP ≤98°F**
-3350	Upstream	86.2	100%	100%	100%	100%	100%	100%	100%
-1720	J9 discharge into river	92.8	29%	40%	46%	59%	94%	100%	100%
-250	Upstream of J29 discharge	93.4	20%	44%	51%	70%	77%	91%	100%
250	J29 discharge into river/theoretical J9 MZ edge	93.7	3%	17%	64%	91%	97%	100%	100%
2000	Theoretical J29 MZ edge	93.9	0%	20%	54%	89%	100%	100%	100%
7000	Downstream of both J9/J29 discharges	94.3	0%	0%	31%	100%	100%	100%	100%
15000	~Halfway down to I-55	93.2	0%	19%	100%	100%	100%	100%	100%
26700	Jackson Creek/downstream dischargers	93.5	0%	7%	83%	100%	100%	100%	100%
33350	I-55 Bridge/end of model domain	92.3	0%	67%	100%	100%	100%	100%	100%

Adjacent shaded areas generally represent a difference between isotherms of less than 0.5-1.0°F

(The above represents specific transects of interest and is a sub-set of the 16 transects for which model data was generated – all cross-section data is provided in Appendix D, Tables D-12a through D-12p).

MWG App. D at D-56, citing 35 Ill. Adm. Code 302.102(b)(6), (b)(8).

Downstream Dischargers. Under worst-case scenarios, model results suggest that two of the three downstream dischargers may not consistently be able to comply with the UDIP summer thermal limit. MWG App. D. at D-86, citing Figures D-13a, D-13b, Tables D-12n, D-12o. The demonstration added that "worst-case summer" modeling showed that downstream thermal dischargers could potentially experience upstream water temperatures directly attributable to the operation of the Joliet Stations that would make it difficult or impossible for the discharges to consistently meet the UDIP summer limits. MWG App. D at D-84. MWG recommended that IEPA consider whether these downstream discharges may be afforded coverage under the proposed ATELs, if granted, under specified adverse conditions. *Id*.

Summary. This scenario generated the highest expected discharge temperatures and the largest thermal plume extents, with maximum surface plume isotherms near 96 °F. MWG App. B at B-45. The demonstration noted that this was the proposed maximum near-field limit. *Id*. Based on recorded discharge temperatures from 2012 to 2017, temperatures approaching this scenario are expected in July and/or August up to 10% of the time on average. MWG App. B at B-45; *see also* MWG Ex. A at 3-5. The demonstration stressed that, "on an annual basis, the Joliet Stations' discharge temperatures have never exceeded 93 °F for more than 5% of the time." MWG Ex. A at 3-5.

The demonstration added that extended periods of low river flow "can limit allowable dilution and thereby lessen the available heat dissipation, resulting in higher calculated near-field compliance temperatures." MWG App. B at B-45. This was the basis for MWG's proposed summer thermal limit of 93 °F applied at the edge of the mixing zone, with excursions up to 96 °F. *Id*.

The demonstration argued that these summer worst-case modeling results show that MWG "has proposed near-field summer thermal AELs which will remain protective of the BIC in the UDIP, while allowing both Joliet Stations to continue to operate under adverse weather and flow conditions when power demand is generally at its greatest." MWG App. B at B-28. The demonstration further argued that the previous limit of 93 °F, with excursions allowed up to 100 °F, had been shown to have no detrimental effect on the BIC in the UDIP. It added that temperatures reaching or exceeding 96 °F "would occur infrequently and for short durations. Furthermore, fish are able to seek cooler temperatures if their avoidance temperatures are reached or exceeded." *Id*. at B-46.

The demonstration also argued that proposed far-field thermal ATELs, in place as the AS 96-10 standards, "continue to be protective of the RIS and, by extension, the BIC of the LDPR as a whole." MWG App. B at B-28; *see also* MWG App. D. at D-55.

Summer Typical Median Flow Model Results.

Projected Isotherm Extents. The demonstration included the thermal plume surface area as a function of temperature:

Scenario 2	Isotherm Temperature		Near-Surface Layer Plume Area in Entire Model Domain
	(°F)	(°C)	(acres)
	>90	>32.2	25
	>93	>33.9	7

"Typical" Summer/Median Flow	>94	>34.4	5
	>95	>35.0	2
	>96	>35.6	0
	>97	>36.1	0
	>98	>36.7	0

MWG App. D at D-62, citing Figure D-14; MWG App. B at B-29; *see also* MWG App. D at D-68. The demonstration argued that this area was "substantially smaller" than the "summer worst-case" scenario. MWG App. B at B-29.

The demonstration argued that modeled conditions indicated that both Stations could meet 90 °F to 93 °F at the edge of their respective 26-acre mixing zone extents. MWG App. D at D-62; *see also* MWG App. B at B-29, citing MWG App. D Table D-14a – D-14p.

Zone of Passage. The demonstration included cross-sectional temperature distributions at nine transects:

Transect (ft)	**Transect Description**	**Mean Transect Temperature (°F)**	**ZOP of =<90°F**	**ZOP of =<93°F**	**ZOP of =<94°F**	**ZOP of =<95°F**	**ZOP of =<96°F**
-3350	Upstream	82.0	100%	100%	100%	100%	100%
-1720	J9 discharge into river	84.3	89%	89%	89%	100%	100%
-250	Upstream of J29 discharge	86.3	89%	100%	100%	100%	100%
250	J29 discharge into river/theoretical J9 MZ edge	88.4	59%	100%	100%	100%	100%
2000	Theoretical J29 MZ edge	88.2	98%	100%	100%	100%	100%
7000	Downstream of both J9/J29 discharges	88.5	100%	100%	100%	100%	100%
15000	~Halfway down to I-55	87.9	100%	100%	100%	100%	100%
26700	Jackson Creek/downstream dischargers	86.9	100%	100%	100%	100%	100%
33350	I-55 Bridge/end of model domain	87.3	100%	100%	100%	100%	100%

MWG App. D at D-63; *see also* MWG App. D Figures D-14a, D-14b, D-16b, Tables D-14a – D-14p; MWG Ex. B, Table B-7b. Outside of the immediate areas of the discharges, there were no areas where the entire water column was at an elevated temperature. MWG App. D at D-66.

Summary. The demonstration argued that these modeled results "indicate that under typical/average summer weather and with consistently favorable river flow conditions, the Joliet Stations would be able to meet the existing UDIP near-field summer numeric thermal limits at the edge of their respective 26-acre allowed mixing zones." MWG App. D at D-63; *see also* MWG App. D at D-66; MWG App. B at B-29.

However, the demonstration noted that, because anthropogenic factors influence the UDIP, it is unclear whether the "5 °F above natural temperature" requirement would apply to this waterway, or how it would be assessed if it did. MWG App. D at D-63; *see also* MWG Ex. A at 3-6. The demonstration acknowledged that, between the transect farthest upstream and the edge of each Station's mixing zone, water temperatures "would rise more than 5 °F even under favorable conditions." MWG App. D at D-63; *see also* MWG App. D at D-66.

The demonstration argued that this narrative standard had not applied to the UDIP before 2018. MWG Ex. A at 3-9, citing 35 Ill. Adm. Code 302.408(e). It further argued that this standard was not necessary to maintain the BIC in the UDIP, "as long as the seasonal numeric standards remain protective of the resident aquatic community." Ex. A at 3-9.

Summer Typical Low Flow Model Results.

Projected Isotherm Extents. The demonstration included the thermal plume surface area as a function of temperature:

Scenario 3	Isotherm Temperature		Near-Surface Layer Plume Area in Entire Model Domain
	(ºF)	(ºC)	(acres)
"Typical" Summer with Low Flow	>90	>32.2	106
	>93	>33.9	13
	>94	>34.4	8
	>95	>35.0	4
	>96	>35.6	0
	>97	>36.1	0
	>98	>36.7	0

MWG App. D at D-65, D-68. The demonstration argued that this scenario reflects the influence of lower flow conditions, which resulted in some upstream plume intrusion. MWG App. D at D-65, citing Figures D-15a, D-15b. Also, with a river flow 20% lower, "the plume areas greater than 90 °F increased by more than 400% over the corresponding typical flow case." MWG App. D at D-65; MWG App. B at B-31. Plume temperatures also persisted longer than in the median flow scenario. MWG App. D at D-65.

Zone of Passage. The demonstration included cross-sectional temperature distributions at nine transects:

Transect (ft)	Transect Description	Mean Transect Temperature (°F)	ZOP of =<90°F	ZOP of =<93°F	ZOP of =<94°F	ZOP of =<95°F	ZOP of =<96°F
-3,350	Upstream	82.0	100%	100%	100%	100%	100%
-1,720	J9 discharge into river	83.6	89%	92%	93%	100%	100%
-250	Upstream of J29 discharge	85.1	97%	100%	100%	100%	100%

250	J29 discharge into river/theoretical J9 MZ edge	89.6	40%	100%	100%	100%	100%
2,000	Theoretical J29 MZ edge	89.4	66%	100%	100%	100%	100%
7,000	Downstream of both J9/J29 discharges	89.6	72%	100%	100%	100%	100%
15,000	~Halfway down to I-55	89	100%	100%	100%	100%	100%
26,700	Jackson Creek/downstream dischargers	88.7	100%	100%	100%	100%	100%
33,350	I-55 Bridge/end of model domain	89	100%	100%	100%	100%	100%

MWG App. D at D-66, citing Tables D-16a – D-16p, Figure D-16c; MWG App. B, Table B-7c. Outside of the immediate areas of the discharges, there were no areas where the entire water column was at an elevated temperature. MWG App. D at D-66.

Summary. While the limited flow in this scenario did not result in exceeding the UDIP near-field numeric limit, it illustrates how lower flows under adverse weather conditions could affect the Stations' compliance. MWG App. D at D-65; *see also* MWG App. B at B-30 – B-31. The demonstration argued that low-flow conditions occur regularly in the UDIP "as the result of upstream flood control and hydropower generation activities, as well as navigational depth manipulations." MWG App. D at D-67; MWG App. B at B-31. Although expected, these fluctuations do not follow a seasonal pattern and are beyond the Stations' control. The demonstration suggested that these factors illustrate the situations requiring the proposed ATELs. MWG App. D at D-67; *see also* MWG App. B at B-31.

Winter Worst-Case Model Results.

Projected Isotherm Extents. The model calculated the area of the near-surface thermal isotherm for different temperatures:

Winter Scenario 1	**Isotherm Temperature**		**Near-Surface Layer Isotherm Area**
	(ºF)	**(ºC)**	**(acres)**
"Worst-Case" Winter	60	15.6	620
	63	17.2	419
	65	18.3	260
	68	20.0	14
	70	21.1	0
	75	23.9	0

MWG App. B at B-32; MWG App. D at D-73. The demonstration argued that these modeled conditions would result in temperatures higher than those that became effective on July 1, 2018. MWG App. D at D-73; MWG App. B at B-32. However, it also argued that cross-sectional temperature distributions show that, even under these circumstances, there are no areas within the Stations' thermal influence that would be considered adverse to the BIC of the UDIP. *Id.*, citing MWG App. D Figures D-17a, D-17b; MWG App. D Tables D-18a – D-18p; MWG App. B at B-32 – B-33. It stressed that this area was acclimated to warmer water temperatures as a result of upstream flow from POTWs. MWG App. D at D-73; MWG App. B at B-33. It added that these extreme conditions are likely to develop over a period of days, which would allow for additional acclimation. *Id*.

Zone of Passage. For this scenario, the demonstration included a percent cross-sectional area as a function of temperature at nine transects. MWG App. D at D-75, citing Figures D-17a, D-17b; MWG App. B at B-33, citing Table B-8a. It argued that the 70 °F near-field limit applied at the edge of the mixing zone provides a ZOP of greater than 75 while maintaining the current far-field limit of 65 °F. MWG App. D at D-75, citing Tables D-18a – D-18p, Figure D-20a.

The demonstration argued that, because these worst-case conditions are more likely in the transitional months of December and March, MWG proposed a slightly lower limit for January and February. MWG App. D at D-75 – D-76.

Downstream Dischargers. Under the worst-case scenario, model results suggested that two of the three downstream dischargers may not be able to consistently comply with the UDIP winter thermal limit. MWG App. D. at D-86, citing Figures D-17a, D-17b, Tables D-18n, D-18o. MWG recommended that IEPA consider whether these downstream discharges may be afforded coverage under the proposed ATELs, if granted, under specified adverse conditions. MWG App. D. at D-86, citing Exs. D-2a, D-2b.

Summary. Results show that the Stations' "surface thermal plumes disperse quickly under lower air temperatures, with somewhat more subsurface mixing and diffusion than found during the summer." MWG Ex. A at 3-8; *see also* MWG App. D at D-72. Chronic or sporadic low flow conditions may result in larger plume areas and slower heat dissipation. MWG Ex. A at 3-8.

This winter scenario resulted in the highest discharge temperatures and largest downstream thermal influence. MWG App. B at B-35; MWG App. D at D-82, D-85. "The lower the flow, the greater the overall plume dimensions and magnitude of thermal influence downstream." MWG App. B at B-35. The demonstration argued that data and modeling show neither Station could consistently meet the winter numeric UDIP thermal limit of 60 °F under all expected combinations of weather, river flow, and/or station operating conditions during the winter, even with allowed excursion hours. MWG App. B at B-36; *see also* MWG Pet. at 28; MWG Ex. A at 2-5, 3-8; MWG App. B at B-32; MWG App. D at D-83, D-85. However, ambient water temperatures did not exceed 53.4 °F, and the Stations' discharge temperatures did not exceed 69.1 °F. MWG App. B at B-20, citing App. D, Tables D-19, D-21. Under these conditions, the demonstration argued that no temperatures within the thermal range of Joliet 29 would be considered adverse to the BIC. MWG App. B at B-32 – B-33; *see also* MWG Ex. A at 4-4. The demonstration argued that upstream flow from POTWs would acclimate the BIC to warmer water temperatures. It further argued that worst-case conditions are likely to develop over a period of days, a period that would allow for additional acclimation. MWG App. B at B-33.

Winter Typical Median Flow Model Results.

Projected Isotherm Areal Extents. The model calculated the area of the near-surface thermal isotherm for different temperatures:

Winter Scenario 2	Isotherm Temperature		Surface Layer Plume Area
	(ºF)	(ºC)	(acres)
"Typical" Winter with Median Flow	60	15.6	10
	63	17.2	2
	68	6.2	0
	70	21.1	0
	75	23.9	0

MWG App. B at B-33 – B-34, citing MWG App. D Figures D-18a, D-18b; MWG App. D at D-77.

Zone of Passage. For this scenario, the demonstration included a percent cross-sectional area as a function of temperature at nine transects. MWG App. D at D-78, citing MWG App. D Figures D-18a, D-18b, D-20b, Tables D-20a – D-20p; *see also* MWG App. B Table B-8b.

Summary. Based on these results, the demonstration argued that the Stations could potentially be able to comply with a near-field UDIP 60 °F numeric limit under typical conditions at the edge of their respective mixing zones. MWG App. D at D-78; *see also* MWG App. B at B-35; MWG Pet. at 28. However, under more adverse or fluctuating conditions, it argued that neither could consistently meet this limit without load reductions. MWG App. D at D-78. MWG proposed winter near-field thermal ATELs to allow the Stations to comply under these conditions. MWG App. B at B-35.

Winter Typical Low Flow Model Results.

Projected Isotherm Areal Extents. The model calculated the area of the near-surface thermal isotherm for different temperatures:

Winter Scenario 3	Isotherm Temperature		Surface Layer Plume Area
	(ºF)	(ºC)	(acres)
"Typical" Winter with 25th Percentile Low Flow	60	15.6	45
	63	17.2	4
	68	6.2	0
	70	21.1	0
	75	23.9	0

MWG App. D at D-79 - D-80, citing MWG App. D Figures D-19a, D-19b, Tables D-22a – D-22p; MWG App. B at B-34 – B-35. The demonstration stated that, under lower flow conditions, "the plume temperature diffuses across and along the river more slowly, resulting in higher overall temperatures throughout the water column." MWG App. D at D-79. Also, reduced dilution resulted in a more compact plume that extended further downstream. *Id.*

Zone of Passage. For this scenario, the demonstration included a percent cross-sectional area as a function of temperature at nine transects. MWG App. D at D-81 – D-82, citing Figures D-19a, D-19b, D-20c; *see also* MWG App. B at B-35, citing MWG Table B-8c, MWG App. D Tables D-22a – D-22p.

Summary. Based on these results, the demonstration argued that the Stations "would theoretically be able to comply with the numeric UDIP limits most of the time." MWG App. D at D-81; *see also* MWG App. B at B-35; MWG Pet. at 28. However, under more adverse or fluctuating conditions, adverse compliance conditions can and do occur. MWG App. D at D-81; *see also* MWG App. B at B-36. MWG proposed winter near-field thermal ATELs to allow the Stations to comply under these conditions. MWG App. B at B-35.

Transitional Months. In the months of April, May, October, and November, both water and air temperatures are in transition between summer and winter extremes. MWG App. D at D-86; *see also* MWG Ex. A at 4-5; MWG App. B at B-47. Historical data for these transitional months show the same type of inter-annual variation that is seen for the remainder of the year. MWG Ex. A at 4-5.

Instead of modeling scenarios for transitional months, the demonstration applied a "stairstep" approach. It argued that this reflects "the natural variability observed during the spring and fall, and is more realistic than either the former Secondary Contact thermal limits, or the UDIP numeric limits for these months." *Id.* It stressed that the proposed ATELs for transitional months "are also more stringent than the corresponding UDIP numeric limitations." MWG App. B at B-47; *see also* MWG Ex. A at 4-5. The demonstration argued that this approach will protect the BIC "and will effectively supersede, yet still fulfill the intent of the '5 °F above natural temperature' and related narrative criteria in the UDIP limits." MWG App. B at B-47; *see also* MWG Ex. A at 4-5.

Decision Criteria

Potential for Thermal Mortality. The demonstration reported the following acute, chronic, and avoidance thermal endpoints for available for the RIS:

Species	Acute	Chronic	Avoidance
Gizzard Shad	34.2°C 93.6°F	34.6°C 94.3°F	32.1°C 89.8°F
Common Carp	36.7°C 98.2°F	36.8°C 98.1°F	34.5°C 94.1°F
Bluntnose Minnow	37.5°C 99.5°F	33.8°C 92.8°F	>31.1°C >89.9°F
Golden Redhorse	33.4°C 92.1°F	- -	28.5°C 83.3°F
White Sucker	36.2°C 97.2°F	31.6°C 88.9°F	31.8°C 89.4°F

Channel Catfish	38.6°C 101.5°F	36.4°C 97.5°F	33.6°C 92.5°F
Banded Killifish**	39.7°C 103.5°F	--	--
Bluegill	32.0°C 89.6°F	33.6°C 92.5°F	32.0°C 89.6°F
Largemouth bass	38.9°C 102.0°F	34.7°C 94.5°F	33.3°C 91.8°F
Freshwater Drum	34.0°C 93.2°F	32.8°C 91.0°F	30°C 86.0°F
Thermal endpoints assume an acclimation temperature of 25.6°C (78.0°F) **Based on surrogate data (see Table B-5).			

MWG App. B at B-37, citing Figures B-2 – B-10.

At ambient/acclimation temperatures above 31.1 °C (88 °F), the demonstration does not predict acute mortality for the RIS "until temperatures in the thermal discharges exceed about 35 °C (95 °F)." MWG App. B at B-37. Worse-case modeled temperatures averaged 34.3 °C to 34.4 °C (93.7- 93.9 °F) at the 250 foot transect, the theoretical edge of Joliet 9 mixing zone, and at the 2,000 foot transect, the theoretical edge of the Joliet 29 mixing zone. MWG App. B at B-37, citing Tables D-12f, D-12i. Based on these data, the demonstration predicted no acute or chronic mortality for any of the RIS. MWG App. B at B-37. Even at these two transects, there was a ZOP in the lower water column of 93 °F or less. Based on avoidance temperatures, the RIS could be expected to avoid near-field acute or chronic water temperatures. MWG App. B at B-37 – B-38, B-49; *see also* MWG Ex. A at 4-4.

Because flow conditions in the LDPR constantly change, the demonstration argued that these temperatures and worst-case ZOP gradients would not be expected to persist for long periods of time. MWG App. B at B-38. It cited long-term fisheries investigations that the Stations' thermal discharges "have not had a significant effect on the fish community, even under the extreme weather conditions experience in the summer of 2012." *Id*.

The demonstration argued that assuming ambient temperatures represent acclimation temperatures was conservative and could predict higher potential for thermal mortality. It argued that fish may become acclimated to temperatures higher than the upstream ambient if they reside in the discharge where temperatures are above ambient but lower than avoidance. MWG App. B at B-38. The demonstration stressed that aquatic organisms near the Stations are not exposed to constant elevated temperatures. *Id*. It added that various thermal mortality test protocols expose the organisms in a regulated test chamber and not in natural habitats where ranges of temperatures are often available, and organisms may be able to avoid stressful temperatures. *Id.*

<u>Thermal Avoidance and Habitat Loss.</u> The demonstration reported avoidance temperature test data for RIS with known avoidance temperatures:

Acclimation Temperature (°F)	**Avoidance Temperature (°F)**						
	80	**86**	**87**	**88**	**91.4**	**93.2**	**95**

Gizzard Shad	91	93	94	94	95	96	97
Channel Catfish	95	96	96	96	98	99	99
Bluegill	91	94	95	95	97	98	99
Largemouth Bass	93	96	96	96	98	99	100

MWG App. B at B-39; MWG Table B-6. It argued that, under the worst-case summer scenarios, these RIS would not consistently avoid the thermal plume areas at the edge of the Station's mixing zones. MWG App. B at B-39. Even under this scenario, there was substantial habitat upstream and downstream from the Stations "with cooler water temperatures for fish that may prefer to avoid portions of the elevated thermal discharge temperatures." *Id*.

Although this avoidance reduces the risk of fish mortality, it could result in avoidance of habitat areas that may be affected by portions of the thermal plume. MWG App. B at B-39. The demonstration argued that the Stations' discharges chiefly affect the main channel and main channel border habitats that account for nearly 80% of the habitat between the Brandon Road tailwaters downstream to the I-55 Bridge. *Id*. It further argued that the discharges do not typically influence tailwater habitat or backwater habitat upstream and downstream from the discharges. *Id*.

The RIS for which avoidance data are available would not consistently avoid the Stations' thermal plumes under the summer worst-case scenario. MWG App. B at B-39, B-50, citing App. D Tables D-12f, D-12i. For those RIS, "the temperatures avoided are typically higher than the highest plume cross-section temperature for the two typical summer scenarios." MWG App. B at B-39, citing App. D Tables D-14f, D-14i, D-16f, D-16i. These temperatures typically fall several degrees below chronic mortality temperatures. MWG App. B at B-39, B-50.

The demonstration argued that species for which avoidance data were not available generally have acute or chronic thermal endpoints similar to the RIS for which the data are available. *Id*. Consequently, it concluded that none of the RIS would be expected to avoid large areas of habitat near the Stations. *Id*.

Potential Effects on Spawning and Early Development. The demonstration reported the upper spawning temperatures for the RIS:

RIS	Mean Spawning Temperature
Gizzard Shad	22.8°C/72.9°F
Common Carp	27.0°C/80.6°C
Bluntnose Minnow	26.0°C/78.4°F
Golden Redhorse	22.2°C/72.0°F
White Sucker	17.6°C/63.6°F
Channel Catfish	29.0°C/84.2°F
Banded Killifish	25.7°C/78.3°F
Bluegill	29.3°C/84.7°F
Largemouth Bass	22.5°C/72.5°F
Freshwater Drum	23.6°C/74.5°F

MWG Ex. B at B-41. Upstream of the Stations, ambient intake temperatures averaged 73.7 °F to 79.0 °F from June through August from 2012 to 2017. MWG Ex. B at B-41, citing MWG Tables D-1a, D-1b.

While the upper range of spawning temperatures for Largemouth Bass was 72.5 °F, ambient water temperatures upstream of the Stations exceeded 79.0 °F under the three summer scenarios. MWG App. B at B-41, citing MWG App. D Tables D-11, D-13, D-15. However, Largemouth Bass spawn in shallow weed-free habitat, which tends to warm faster. The demonstration concluded that Largemouth Bass spawning ends before temperatures reach these levels. MWG App. B at B-42.

Of the RIS, both Channel Catfish and Bluegill may continue spawning into July or August in parts of their ranges. MWG App. B at B-42, B-50. Under the two typical summer scenarios, ambient temperatures upstream of the Stations are not expected to exceed their upper range of spawning temperatures. MWG App. B at B-42, citing MWG App. D at D-11, D-13, D-15. Under the summer worst-case scenario, temperatures above 84 °F would exist at all transects downstream from the Stations. The demonstration argued that there will be cooler water temperatures at off-peak hours. MWG App. B at B-42, citing MWG App. D Figures D-16b, D-16c. While Channel Catfish and Bluegill spawning could not continue in July in areas within the immediate areas of the Stations' discharge plumes, it could continue into July upstream of the Stations and downstream during lower temperatures. MWG App. B at B-42, B-50; *see also* MWG Ex. A at 5-3. The demonstration added that the worst-case scenario could occur in August after spawning had ended. MWG App. B at B-42.

For ichthyoplankton occurring into late June and July, mortality was not predicted based on available thermal tolerance data. MWG App. B at B-42.

Finally, the demonstration argued that fisheries monitoring data since 1994 indicated consistent recruitment of fish, showing that they are spawning as expected. MWG App. B at B-41.

<u>Potential Effects on Performance and Growth.</u> The demonstration included available upper zero growth temperatures for RIS:

RIS	Upper Zero-Growth		Optimum Growth		Lower Zero-Growth	
	°C	°F	°C	°F	°C	°F
Gizzard shad	34	93.2	29-32	84.2-89.6	--	--
Common carp	35	95	14.5-32	58.1-89.6	10-13.8	50.0-56.8
Bluntnose Minnow	34	93.2	7-31	44.6-87.8	--	--
Golden Redhorse	29.6	85.3	--	--	--	--
White Sucker	29	84.2	19-26	66-79	--	--
Channel catfish	34.7	94.5	20-32	68.0-89.6	10	50
Banded Killifish	--	--	--	--	--	--
Bluegill	34.0	93.2	13-28	56-82	20	68
Largemouth bass	36	96.8	23-31	73.4-87.8	10	50

Freshwater Drum	33	91.4	14.4-22	57.9-71.6	--	--

MWG App. B, Table B-9. Because this temperature exceeds 93 °F for a number of the RIS, it was not likely that temperatures in the Stations' thermal plumes would adversely affect growth or cause a cessation of growth for these RIS under average conditions. MWG App. B at B-43, citing MWG App. D Tables D-1a, D-1b. Under the worst-case summer scenario, near surface temperatures exceed 93 °F in and downstream from the Stations' immediate discharge zones. Under the typical summer scenarios, these temperatures would occur "only occasionally in the immediate discharge zones." MWG App. B at B-43, citing MWG App. D Tables D-12a-p, D-14a-p, D-16a-p.

The demonstration concluded that temperatures in the Stations' thermal plumes "are not expected to adversely affect normal patterns of growth as long as high temperature periods are of limited duration." MWG App. B at B-43, B-50 – B-51.

Potential to Block Migration. The demonstration argued that, because the RIS are not likely to avoid significant areas of habitat, it was not likely that the Stations' thermal plumes would interfere with their migration or localize movement patterns. MWG App. B at B-40; *see also* MWG Ex. A at 5-2. Under the summer worst-case scenario, the demonstration argued that modeled water temperatures at various transects would allow passage through ZOPs. MWG App. B at B-40, citing MWG App. B, Table B-7a; *see also* MWG Ex. A at 5-2. During the two summer typical scenarios, it argued that temperatures at transects downstream of the 250 ft transect "will not limit upstream/downstream movements." MWG App. B at B-40; *see also* MWG Ex. A at 5-2.

Under the winter worst-case scenario, water temperatures in 85% to 100% of the water column from the 250 ft transect downstream were greater than 60 °F. MWG App. B at B-40, citing MWG Table B-8a. The demonstration argued that the proposed winter ATELs do not approach avoidance temperatures and trigger the need for a ZOP. MWG App. B at B-40. While these water temperatures may attract fish, they are not expected to persist long enough for fish to become acclimated. *Id*.

Potential for Reduced Survival from Thermal Shock.

Cold Shock. Cold shock can occur when plants shut down because fish are acclimated to warmer discharge temperatures. MWG App. B at B-44. The demonstration cited four factors for evaluating the potential for cold shock: (1) the length of time fish have resided at the elevated temperatures in the plume; (2) the difference between discharge and ambient temperatures; (3) the rate of temperature decrease; and (4) the absolute magnitude of the lower temperature. *Id*.

At final temperatures exceeding 45 °F, cold shock typically does not occur, regardless of the magnitude of the change. MWG App. B at B-44; *see also* MWG Ex. A at 5-5; MWG Pet. at 29. From 2012 to 2017, mean winter ambient temperatures at the Stations generally fell between 40.6 °F and 48.1 °F with maximums from 52.2 °F to 72 °F. MWG App. B at B-44; MWG Pet. at 29. The demonstration argued that cold shock "is not expected to be a concern with the current and expected future cycling of the two Joliet Stations, as they will not be running consistently enough to allow for acclimation to warmer water temperatures than those coming downstream from POTW flow contributions." MWG App. B at B-44; *see also* MWG Ex. A at 5-5. The demonstration also stressed that the Stations did not experience cold shock incidents during their past operation in a more base-loaded manner. MWG Ex. A at 5-5; *see also* MWG Pet. at 30.

Plume Entrainment. When water currents transport and distribute the early life stages of fish and invertebrates, they are at greater risk of plume entrainment and exposure to rapid temperature increases. MWG Ex. A at 5-5. The early life stages of these species generally move through the Stations' thermal plumes when summer near-field ATELs would apply.

Based on available thermal tolerance data, mortality was not predicted for ichthyoplankton with life stages occurring before July. MWG Ex. A at 5-6. Eggs and larvae of the RIS Common Carp and Channel Catfish tolerate chronic and acute exposure to temperatures higher than those predicted in the Stations' plumes even in the worst-case scenario. *Id*.

MWG's Conclusion on Decision Criteria. The demonstration argued that, under proposed nearfield thermal ATELs, the predictive assessment did not indicate that the Stations' thermal plumes were likely to have more than minimal and transitory effects on incidental components of the aquatic community, even under rare and extreme meteorological conditions. MWG App. B at B-51; *see also* MWG Ex. A at 4-15 – 4-16.

The demonstration further argued that the proposed near-field thermal ATELs for winter and transitional months "are also not expected to have any adverse effect upon the BIC of the UDIP/Five-Mile Stretch." MWG App. B at B-51. It stressed that the BIC "is already acclimated to higher winter temperatures due to the predominance of POTW effluents during these times of year." *Id*.

MWG's Conclusions on Protecting BIC

The demonstration argued that satisfying the criteria summarized below satisfies the standard of protecting the BIC. MWG Ex. A at 4-11; *see also* MWG App. C at C-43. It argued that MWG's retrospective and prospective evaluations show that the criteria would be met if the Board adopted its proposed ATELs. MWG App. C at C-43; *see also* MWG Pet. at 26; MWG Ex. A at 4-11.

No Substantial Increases in Abundance or Distribution of Any Nuisance Species and Pollution-Tolerant Organisms. The demonstration argued that the retrospective analysis showed "no appreciable changes in the physical and biological components of the system" while the Stations were subject to the Secondary Contact thermal standards. MWG App. C at C-43; *see also* MWG Pet. at 26, 30. It argued that the LDPR's channelized nature and regulated flow influence the aquatic species assemblage, which is able to successfully carry out their life histories in the waterway. MWG App. C at C-43. It indicated that the presence of invasive species must also be taken into consideration as a permanent part of the LDPR environment. MWG App. C at C-43 – C-44; *see also* MWG Ex. A at 4-6 – 4-7. However, the demonstration argued that the Stations' operations have not been responsible for the introduction or spread of nuisance species in the LDPR. MWG Ex. A at 4-7.

The demonstration argued that to date, no substantial changes in abundance of nuisance species have been observed in the LDPR near the Stations. MWG App. C at C-43; *see also* MWG Ex. A at 4-12. While it noted that the Stations will discharge less heat overall under the proposed ATELs, the demonstration argued that this change "will not benefit or in any way affect the abundance or distribution of nuisance species." MWG Ex. A at 4-12. The demonstration concluded that the proposed ATELs, which are more stringent than previous Secondary Contact limits, "are not expected to cause changes in abundance or distribution of other indigenous or nuisance species." MWG App. C at C-44; *see also* MWG Ex. A at 4-7; MWG Pet. at 26.

No Substantial Decreases of Formerly Abundant Indigenous Species Other Than Nuisance Species. The demonstration argued that the retrospective analysis indicated that the Stations are not a significant contributing factor influencing the current or future fish assemblage in the UDIP or the Five-Mile Stretch. MWG App. C at C-44; *see also* MWG Pet. at 26. The demonstration acknowledged the presence of ANS but argued that there is no connection between their presence and the Stations' operations. MWG App. C at C-44. Fish monitoring from 1994 to 2016 showed no significant shift in the fish community over time. MWG App. C at C-44, citing MWG Apps. G, H; *see also* MWG Ex. A at 4-12. The demonstration argued that this supports a conclusion that the lower trophic levels on which fish depend have also been unaffected. MWG App. C at C-44; *see also* MWG Ex. A at 4- 12. It also noted the conclusion of the prospective analysis that indigenous fish species will not suffer appreciable harm from the proposed ATELs, which are "more stringent than the former Secondary Contact thermal standards." MWG App. C at C-44, citing MWG App. B; *see also* MWG Ex. A at 4-12.

No Unaesthetic Appearance, Odor or Taste. The demonstration argued that there is no evidence of an unnatural odor or an unaesthetic appearance attributable to the Stations' operations. MWG App. C at C-44; *see also* MWG Ex. A at 4-12. It further argued that the proposed ATELs are not expected to cause any such impacts. *Id.*

No Elimination of Established or Potential Economic or Recreational Use of the Waters. The demonstration argued that the Stations' operations have neither eliminated nor minimized any economic or recreational uses of the LDPR. MWG App. C at C-45; *see also* MWG Ex. A at 4-13; MWG Pet. at 26. It cited several factors supporting this conclusion: the absence of commercial or recreational fishing; fish consumption advisories; frequent barge traffic limiting boating; frequent CSO events; and designation of the waterway only for incidental contact recreation that was unsuitable for swimming and similar uses. MWG App. C at C-45, citing 35 Ill. Adm. Code 303.225. The demonstration also argued that according to the prospective analysis, the small increment in additional heat above the UDIP limits that may be released if the proposed ATELs are authorized will not affect these conditions. MWG App. C at C-45; *see also* MWG Ex. A at 4-13. It added that operation under AS 96-10 standards had not adversely impacted recreational uses at or downstream from the I-55 Bridge. MWG Ex. A at 4-13. While it acknowledged that that segment was subject to a fish consumption advisory because of fecal coliform, the demonstration argued that this was not attributable to the Stations' operations. *Id.*

No Reductions in Successful Completion of Life Cycles of Indigenous Species. The demonstration cited the retrospective analysis to argue that thermal effects have not compromised the overall success of indigenous species in competing their life cycles. MWG App. C at C-45;

see also MWG Ex. A at 4-13; MWG Pet. at 26. When combined with the prospective analysis, it argued that "the small increment of heat" allowed under the proposed ATELs would result in no change in condition. The demonstration stressed that the proposed ATELs are more stringent than previous limits that resulted in no appreciable harm. MWG App. C at C-45; *see also* MWG Ex. A at 4-13.

No Substantial Reduction of Community Heterogeneity or Trophic Structure. The demonstration argued that the results of long-term monitoring "indicate that the number of species collected has remained reasonably consistent across years." MWG App. C at C-45; *see also* MWG Ex. A at 4-14; MWG Pet. at 26. It attributed long-range changes to evolving practices at upstream POTWs unrelated to the Stations' operations. MWG App. C at C-45; *see also* MWG Ex. A at 4-14. The demonstration argued that the proposed ATELs are not significantly different from otherwise applicable standards and are not expected to contribute to these changes. MWG App. C at C-45.

No Adverse Impacts on Threatened or Endangered Species. Although the retrospective analysis did not find federally-listed threatened or endangered species, it identified four state-listed fish species. MWG App. C at C-45; MWG Ex. A at 4-8, 4-14; *see also* MWG App. C Table C-7. Surveys collected the threatened River Redhorse "infrequently and in low numbers downstream of the Brandon Road Lock and Dam." MWG Ex. A at 4-8; *see also* MWG App. B at B-9; MWG App. C at C-27. Surveys collected one endangered Greater Redhorse in 2010 at a far-field sampling location. MWG Ex. A at 4-8 – 4-9; *see also* MWG App. C at C-27. The demonstration argued that the Stations' operations have a low potential impact on these incidental species because their preferred habitat was downstream in the Kankakee River beyond the Stations' thermal influence. MWG Ex. A at 4-14. The demonstration added that these species were found when the former Secondary Contact thermal standards were in place, indicating that the Stations' discharges had not negatively affected them or their habitat. MWG Ex. A at 4-9, 4-15; *see also* MWG App. C at C-45; MWG Pet. at 26.

The endangered Pallid Shiner was first collected downstream of the I-55 Bridge in 2001 and has since been collected chiefly in the Five-Mile Stretch. MWG Ex. A at 4-9; *see also* MWG Ex. A at 4-14; MWG App. B at B-9; MWG App. C at C-27. The demonstration added that this species was found when the former Secondary Contact thermal standards were in place, indicating that the Stations' discharges had not negatively affected it or its habitat. MWG Ex. A at 4-9, 4-15; *see also* MWG App. C at C-45; MWG Pet. at 26.

Surveys first collected the threatened Banded Killifish in 2012, and it had "increased dramatically over time" with less stringent thermal standards in place. MWG Ex. A at 4-9; *see also* MWG Ex. A at 4-14; MWG App. B at B-9; MWG App. C at C-45; MWG Pet. at 26. The demonstration cited the INHS to argue that this increase "represents an expansion of the Lake Michigan population through the CAWS into the Des Plaines River." MWG Ex. A at 4-9. It also argued that the Banded Killifish found in the LDPR are an invasive subspecies (the Eastern Banded Killifish) and not the threatened Western Banded Killifish. *Id*. Because the Western Banded Killifish populations and distributions had remained unchanged from 1880 to 2000, the demonstration argued that its recent growth is unusual. *Id*. The demonstration reported that IDNR was expanding its research on the Banded Killifish to determine whether it should be listed as threatened. *Id*.

The Board asked MWG to comment on whether its rationale would change if the Western Banded Killifish was in fact the Eastern Banded Killifish. Board Questions at 2. MWG responded that it would not change because adverse impacts on the BIC, including either subspecies, are not expected to occur as the result of the Stations' discharges. MWG Resp. at 6. It added that water temperature has not been found to either attract or cause long-term avoidance for both native and invasive species in the LDPR or the Upper Illinois Waterway as a whole. *Id*.

The Board also asked whether IDNR had provided additional information on distinguishing the two species from one another. Board Questions at 2. MWG reported that IDNR recently updated Illinois' Threatened and Endangered Species list, which recognizes only the Western Banded Killifish as threatened. MWG Resp. at 6. MWG stated that, while research continues on the geographic range of the Western subspecies, data collected by natural resource agencies and other researchers in the Upper Illinois Waterway suggest that the non-listed Eastern subspecies (*Fundulus diaphanus diaphanus*) prevails in the LDPR. MWG Resp. at 6.

The Board also asked MWG whether it would be opposed to additional surveillance of state-listed Banded Killifish numbers in the study area if the Board grants ATELs. Board Questions at 2. MWG responded that it continues its annual fisheries monitoring program, including monitoring for the Banded Killifish population, under Special Conditions 17 and 18 of the Stations' NPDES Permits. MWG Resp at 7. MWG argued that "it is not necessary to condition a grant of an alternative standard on additional surveillance of their numbers because this is something that the IEPA already requires." *Id*. In addition, MWG noted that there is also continued fisheries monitoring work in this waterway by IDNR and other agencies involved with the Asian Carp Regional Coordinating Committee (ACRCC) monitoring programs that would provide similar information. *Id*.

Based on these factors, the demonstration argued that the Stations' discharges are unlikely to have had and are not expected to have adverse effects on any threatened or endangered species. MWG Ex. A at 4-10, 4-15; *see also* MWG Pet. at 26.

No Destruction of Unique or Rare Habitat. The demonstration reported that factors such as flow modification, impoundment, and channelization have altered flow conditions and limited the types of habitat available in the LDPR. MWG Ex. A at 4-10. It argued that these factors have not resulted from the Stations' discharges. *Id*. QHEI scores have generally characterized habitats near the Stations as fair or poor. *Id*. at 4-10, 4-15. The demonstration concluded that there are no unique or rare habitat components that would be affected by the Joliet Station thermal discharges, either in the UDIP or Five-Mile Stretch. MWG Ex. A at 4-10, 4-15; *see also* MWG App. C at C-45; MWG Pet. at 26.

Biocides. The demonstration reported that Joliet 9 relies on dehumidification and does not use biocides or other chemical processes to minimize biofouling of its condenser cooling system. MWG Ex. A at 4-10. Although Joliet 29 is permitted to use the biocide sodium hypochlorite, it uses dechlorination so that its final effluent complies with its NPDES permit. *Id*. at 4-10 – 4-11.

It had also relied more recently on dehumidification. *Id*. at 4-11. The demonstration concluded that neither Station poses a threat of appreciable harm to the BIC as a result of biocide use. *Id*.

No Interactions with Other Pollutants, Discharges, or Other Activities. The demonstration argued that the Stations' thermal discharges have not had a detrimental effect on the recreational or commercial uses of the UDIP or Five-Mile Stretch. MWG Ex. A at 4-15; *see also* MWG App. C at C-46. It added that cumulative effects from upstream or downstream thermal discharges have not occurred. MWG Ex. A at 4-15. If the Board adopted the proposed ATELs, no harmful interactions with other pollutants, such as organic carbon, phosphorus, and nitrogen, had occurred, or were expected to occur. MWG Ex. A at 4-15; *see also* MWG App. C at C-46; MWG Pet. at 26. The demonstration added that these interactions have not occurred under the far-field standards in AS 96-10. MWG Ex. A at 4-15.

Cold Shock. The demonstration argued that the risk of cold shock depends on the acclimation temperature and rarely occurs at ambient temperatures above 45 °F. MWG App. B at B-44; *see also* MWG Pet. at 29-30. It argued that mean winter ambient temperatures near the Stations are normally between 40.6 ° F and 48.1 ° F because much of the flow in the UDIP is treated wastewater discharged upstream. MWG App. B at B-44. It also argued that water temperatures do not immediately decrease when the Stations stop generating. *Id*. It stressed that the Stations have not caused cold shock in the UDIP and Five-Mile Stretch. MWG Pet. at 30. Based on these factors, the demonstration concluded that "cold shock is not expected to be an issue or concern for the Joliet Stations." MWG App. B at B-44; *see also* MWG Ex. A at 4-5.

Applicable Limitations More Stringent Than Necessary

MWG requested near-field thermal ATELs for specified thermal standards that the Board adopted in 2015 and became effective July 1, 2018: Sections 302.408(c), (d), (e), (f), and (i). MWG Ex. A at 3-4. MWG's request included applicable ZOP provisions. *Id*. Below, the Board summarizes how MWG developed values for the proposed ATELs.

Temperature Limitations. The demonstration argued that 93 °F was the appropriate summer near-field ATEL for the Stations. MWG Ex. A at 3-7. It argued that long-term data show that the previous Secondary Contact standard of 93 °F had not had a detrimental effect on the BIC of the UDIP/Five-Mile Stretch. *Id*.

Under the summer worst-case scenario, modeling results showed that neither Station could consistently meet new UDIP thermal limits. MWG Ex. A at 3-6; *see also* MWG Pet. at 20. At the theoretical edge of the Stations' mixing zones, the maximum surface temperature under this scenario would be approximately 96 °F, which was the maximum compliance temperature MWG requested as its proposed near-field ATEL. MWG Ex. A at 3-5; *see also* MWG App. B at B-45.

The demonstration stated that, under more typical summer conditions, both Stations could meet the UDIP limits "but would not be able to consistently meet the narrative portions." MWG Ex. A at 3-6.

For winter months, the demonstration stated that the July 1, 2018, UDIP standards set a limit of 60 °F at the edge of the mixing zone, "which is up to 33 °F cooler than the prior thermal standard." MWG Ex. A at 3-7. A review of data for discharge temperature and river flow showed that there would be periods, ranging from 0 to 45% of the time during one or more of the winter months, when this standard could not be met. *Id*. The demonstration added that the Joliet 29 cooling towers are not available during the winter months. *Id*. If required to run during the winter, neither of the Stations could consistently meet the thermal limit, "even with the allowed 3 °F excursion for up to 1% of the hours in any 12-month period." *Id*. at 3-9. However, the demonstration argued that the Stations would be able to meet the proposed ATELs, which are more stringent than the previous Secondary Contact standards, while adequately protecting the BIC. *Id*.

Excursion Hours. The UDIP and General Use standards provide excursion hours of up to 1% of the hours in any period, which MWG characterizes as "entirely insufficient" to operate the Stations, "especially if unseasonal weather patterns and/or low flow conditions persisted during any given year." MWG Pet. at 20.

The demonstration proposed excursion hours during which the maximum compliance temperature can be up to 3 °F above the proposed limit. It argued that the BIC will be adequately protected if near-field excursions are allowed up to 5% of the time in a calendar year. MWG Ex. A at 3-4, 3-7; *see also* MWG App. B at B-45 – B-46.

The demonstration stressed that the far-field limits from AS 96-10 "allows for temperatures up to 3 °F higher than the applicable period limit, up to 2% of the hours in a calendar year, with the additional provision that at no time would the temperature at the I-55 Bridge be allowed to exceed 93 °F at any time." MWG Ex. A at 3-4. It argued that complying with these standards had not resulted in appreciable harm to the BIC. *Id*. MWG requests that the Board approved the AS 96-10 standards as the far-field thermal standards in lieu of the General Use standards. *Id*. at 3-5.

Cooling Towers. IEPA's recommendation noted that Joliet 29 currently uses cooling towers to avoid or limit excursion hours. Rec. at 3. IEPA recommended that cooling towers should be used prior to and during excursion hours when possible. *Id*. IEPA acknowledged that "the cooling towers cannot be operated in the winter and at other times where mechanical and other issues could prevent them from operating." *Id*.

MWG responded that it had no objection to the substance of IEPA's recommendation. MWG Resp. at 2. It suggested clarifying the condition to provide that MWG "will continue to operate its Joliet 29 Generating Station Cooling Towers to minimize the use of excursion hours when possible." *Id*. at 3. IEPA did not object to MWG's proposed language.

Narrative Criteria. The demonstration argued that the "5 °F above natural temperature" limit at 35 Ill Adm. Code 302.408(e) had not historically applied to the UDIP. MWG Ex. A at 3-9. It added that the current far-field standard under AS 96-10 does not contain this limit or any other narrative criteria. *Id*. MWG argued that this limit was difficult to apply in a regulated and anthropogenically influenced waterway such as the LDPR, and it did not provide any protections that would not be afforded by the proposed seasonal ATELs. MWG Ex. A at 3-6. MWG concluded that this limit is "overly restrictive and unnecessary to maintain and protect the BIC of the UDIP/LDPR." *Id*. at 3-10.

The demonstration noted that the UDIP limits include other narrative standards. Under 35 Ill. Adm. Code 302.408(c), "there must not be any abnormal temperature changes that may adversely affect aquatic life unless caused by natural conditions." Under 35 Ill. Adm. Code 302.408(d), "the normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes shall be maintained." MWG Ex. A at 3-9.

The demonstration acknowledged that these narrative criteria apparently intend to prevent elevated water temperatures from impeding the movement of fish in a natural system. MWG Ex. A at 3-9. The demonstration stressed that natural habitats in the LDPR have undergone significant modifications. *Id*. It argued that, even if normal temperature changes could be identified, applying them would not change the BIC. *Id*.

The demonstration added that proposed near-field standards for transitional months would limit the need for a "5 °F above natural temperature" limit to minimize abrupt temperature changes. MWG Ex. A at 3-10. Also, the proposed thermal ATELs for April, May, October, and November are more stringent than the corresponding UDIP limits. *Id*. The proposed far-field standards based on AS 96-10 provide the same seasonally-based transitions. *Id*. The demonstration argued that these standards "have been shown over years of study to not have caused any adverse harm to the Five-Mile Stretch BIC at and below the I-55 Bridge." *Id*. at 3-11.

The demonstration argued that field studies and modeling show that the Stations' discharges do not result in any kind of thermal block during summer or winter operations. *Id*. It concluded that the BIC can be maintained without these narrative criteria, "as long as the seasonal numeric standards remain protective of the resident aquatic community." *Id*.

Zone of Passage. The demonstration argued that the Brandon Road Lock & Dam and proposed nuisance species barriers impede maintaining a ZOP near the Stations. MWG Ex. A at 3-9 – 3-10. Under proposed near-field limits, it argued that modeling showed the Stations' discharges would meet ZOP requirements. MWG Ex. A at 3-10, citing 35 Ill. Adm. Code 302.102(b)(8); *see also* MWG Pet. at 20. The demonstration concluded that the Stations' operations would "at no time" completely eliminate a ZOP. MWG Ex. A at 3-10.

Summary. The demonstration argued that operating the Stations for more than 40 years under the previous limits did not result in documented adverse effects on the aquatic community in the UDIP and Five-Mile Stretch. MWG Ex. A at 3-6. It added that long-term fish monitoring showed that the community had improved over time. *Id*. With the Stations operating less frequently as peaking plants, MWG argued that "there is even less likelihood of adverse impacts" from the Stations' thermal discharges. *Id*. It stressed that its proposed ATELs are more stringent than the previous Secondary Contact limits. *Id*. MWG proposed the ATELs "to maintain regulatory flexibility" so that it could operate the Stations "to serve expected power demands during critical weather and flow periods, not just operations under average conditions." *Id*. at 3-6 – 3-7.

Board Findings

Based on the record before it, the Board finds that the generally applicable thermal water quality standards are more stringent than necessary to assure the protection and propagation of the BIC in the receiving waters. The Board further finds that INEOS' demonstration, which incorporated MWG's demonstration, shows that the proposed thermal ATELs will protect the BIC in the UDIP.

Biotic Category Criteria That Assure the Protection and Propagation of the BIC

A CWA Section 316(a) demonstration describes the impact of the thermal discharge on each of six biotic categories: (1) habitat formers; (2) phytoplankton; (3) zooplankton and meroplankton; (4) macroinvertebrates and shellfish; (5) fish; and (6) other vertebrate wildlife. A successful demonstration shows that each biotic category meets specified decision criteria. USEPA 316(a) Manual at 18-32. MWG's retrospective assessment first analyzed the condition of each biotic category "by comparing available information on its abundance and species composition to what would be expected based on existing habitat, flow, and chemical characteristics of the UDIP and Five-Mile Stretch." MWG Pet. at 25; *see also* MWG App. C at C-2; Rec. at 5. Second, the demonstration analyzed long-term trends for the biotic categories "to determine whether a change in population abundance has occurred that can be attributed to the operation of the Joliet Stations." MWG Pet. at 25; *see also* MWG App. C at C-2; Rec. at 5-6.

MWG argued that its assessment showed "there have been no substantial changes in abundance of nuisance species or in the physical and biological components of the ecology of the UDIP/Five-Mile Stretch during the past 24 years." MWG Pet. at 30. MWG stressed that, for much of that 24-year period, the UDIP was subject to thermal standard less stringent than its proposed ATELs. *Id*. It also stressed that the Stations have converted from base-load to peaking operations, reducing the Stations' thermal loading. *Id*.

MWG concluded that temperatures in the UDIP/Five-Mile Stretch are not harming the BIC, and this BIC can be adequately protected by its proposed ATELs. MWG Pet. at 30. In the following subsections, the Board summarizes the record on criteria for the biotic categories.

Habitat Formers (Aquatic Vegetation). The demonstration argued that, while the UDIP/Five-Mile Stretch included habitat suitable for aquatic life, the potential for habitat formers was limited by the waterway's uses to convey treated wastewater and transport materials in an urban and industrial environment. MWG Ex. A at 6-3; *see also* MWG App. K at K-7. The demonstration further asserted that the distribution and abundance of habitat formers result chiefly from the dominance of main channel and main channel border habitats, which hinder developing greater diversity of habitat formers. MWG Ex. A at 6-4. It maintained that the Station's thermal discharges have not affected the quality of aquatic habitat and have not caused appreciable harm to this community. *Id*. at 6-3. The demonstration concluded that the community of habitat formers "would be substantively the same regardless of the operation of the Joliet Stations' cooling water discharges" under the proposed ATELs. *Id*. at 6-4.

In PCB 20-38 and 20-39, the Board noted that QHEI scores from 2016 supported MWG's contentions that there have been no significant changes in habitat quality in the UDIP and that the existing habitat limitations are not related to the operation of Joliet Stations 9 or 29 or their thermal discharges. MWG's demonstration showed that the low QHEI scores are attributable to a lack of riffle/run habitat; lack of clean, hard substrates such as gravel and cobble; areas of excessive siltation; channelization; poor riparian and floodplain areas; and lack of instream cover. Thus, the habitat former community will continue to be essentially the same regardless of MWG's operation under the proposed alternative thermal effluent limitations. MWG's demonstration showed that the proposed thermal discharges: (1) will not result in deterioration of habitat formers so as to cause appreciable harm to the balanced, indigenous community of fish or mussels; and (2) will not adversely impact threatened or endangered species due to impact on habitat formers. Based on these factors, and in the context of INEOS' ATEL request, the Board finds that MWG's Section 316(a) Demonstration meets the decision criteria for habitat formers at sites that are not low potential impact areas. *See* USEPA 316(a) Manual at 22.

Phytoplankton. The demonstration argued that existing data show the Station's thermal discharges have not caused appreciable harm to the phytoplankton community. MWG Ex. A at 6-2. "The similarity between the plankton communities at the intake and discharge areas of the Stations indicated that there is no adverse impact from the thermal discharges of the Joliet Stations on the plankton community." *Id*. at 6-1 – 6-2. It added that the Stations' operations under previous thermal limits did not result in a shift toward nuisance species or algal blooms. *Id*. at 6- 2. It also noted that phytoplankton diversity supports a diverse food chain in the UDIP/Five-Mile Stretch. *Id*. It concluded that the proposed ATELs are not expected "to have any adverse effects on phytoplankton communities in the vicinity of Joliet Stations 9 and 29, nor those further downstream." *Id*.

The Board previously found that MWG's 316(a) demonstration showed that the proposed thermal discharges are not likely to: (1) result in a shift toward nuisance species of phytoplankton; (2) alter the indigenous community from a detrital-based to phytoplankton-based system; and (3) cause appreciable harm to the balanced indigenous population resulting from phytoplankton community changes. In the context of INEOS' ATEL request, the Board finds that MWG's Section 316(a) demonstration meets the decision criteria for phytoplankton at sites that are not low potential impact areas. *See* USEPA 316(a) Manual at 18.

Zooplankton. The demonstration cited three factors indicating that the Station's thermal discharges are not likely to affect the zooplankton community: it had adapted to variable environments by evolving tolerances and behaviors; it was rapidly transported through the discharge plumes; and it had high reproductive capacity to offset the loss of individuals. MWG Ex. A at 6-4. The demonstration argued there was no evidence indicating that thermal discharges from the Stations have caused appreciable harm to the downstream zooplankton assemblage. *Id*. at 6-5. The demonstration emphasized "the long-term success of the fish community that would utilize zooplankton as a food source." *Id*. Based on these factors, it concluded that more stringent proposed ATELs would likely not result in any adverse effect in the UDIP/Five-Mile Stretch. *Id*.

The Board previously found that MWG's 316(a) Demonstration showed that: (1) changes in zooplankton and meroplankton will not result in appreciable harm to the balanced, indigenous community of fish and shellfish; (2) the heated discharge was not likely to alter the standing crop or relative abundance of zooplankton; and (3) the thermal plume was not a lethal barrier to free movement (drift) of zooplankton. In the context of INEOS' ATEL request, the Board finds that

MWG's Section 316(a) demonstration meets the decision criteria for zooplankton at sites that are not low potential impact areas. *See* USEPA 316(a) Manual at 21.

Macroinvertebrates and Shellfish. This category consists of benthic community and mussels in the receiving waterways.

Benthic Community. The demonstration argued that the persistence of this community through various assessments indicated that a factor other than thermal discharge was limiting the community. MWG App. A at 6-7. It further argued that the absence of significant temporal differences among the assessments indicates that there have not been observable cumulative effects from the Stations' thermal discharges. *Id*. The demonstration concluded that these discharges "have had no significant adverse effect on the benthic macroinvertebrate community." *Id*.

Freshwater Mussels. The demonstration argued that surveys and studies establish that areas in vicinity of the Stations' thermal plumes include "minimal suitable habitat for mussels." MWG Ex. A at 6-7. Because the plumes are buoyant, water temperatures will be lower in sediments where mussels reside. *Id*. While there are native mussel species present in limited areas of the UDIP, "they have not been adversely affected" by the Stations under previous thermal limits. *Id*. at 6-9. Consequently, there is no expectation that mussels would be negatively impacted by the Stations' discharges. *Id*. at 6-7, 6-9. The proposed ATELs are not expected to interfere with maintaining the community or with its life history cycles such as spawning. *Id*. at 6-9 – 6-10.

Board Finding. The demonstration showed that the lack of a diverse benthic macroinvertebrate and mussel community near the Joliet Stations was due to limitations related to habitat and modified physical/hydrological characteristics of the waterway rather than the thermal discharges. In the context of INEOS' ATEL request, the Board finds that MWG's Section 316(a) Demonstration shows that any measurable reduction of standing crop of shellfish and macroinvertebrates is not likely to: cause appreciable harm to balanced indigenous populations; or interfere with maintenance or critical, seasonal, life cycle of mussels or benthic macroinvertebrates. *See* USEPA 316(a) Manual at 23-25.

Fish. At a site that is not classified as a low potential impact area, a successful CWA Section 316(a) demonstration for fish must show that fish communities "will not suffer appreciable harm" from: (1) direct or indirect mortality from cold shocks; (2) direct or indirect mortality from excess heat; (3) reduced reproductive success or growth as a result of plant discharges; (4) exclusion from unacceptably large areas; or (5) blockage of migration. USEPA 316(a) Manual at 28–29; *see also* MWG Ex. A at 6-10.

The demonstration argued that the entire range of data both before and after the Stations' conversion to gas indicate no adverse effect on the fish community under the former thermal limits. MWG Ex. A at 6-16. The UDIP and Five-Mile Stretch sustain spawning and reproduction near the plume. *Id*. The demonstration argued that the community was consistent with the characteristics of the waterway and available habitat. It added that an adequate zone of passage exists near the Stations' plumes and that it will continue to exist under the proposal ATELs. *Id*. The demonstration concluded that "there is no expectation" that operating the Stations under the proposed ATELs would cause adverse effects on the fish community. *Id*.

Based on the demonstration's extensive information on fish communities (discussed above under identification of biotic categories), the Board previously found that MWG's requested ATELs will protect the balanced, indigenous fish communities in the UDIP and the Five-Mile Stretch. Accordingly, in the context of INEOS' ATEL request, the Board finds that MWG's Section 316(a) Demonstration meets the criteria for a site that is not a low potential impact area for fish. MWG demonstrated that: (1) there will be no direct or indirect mortality from cold shock; (ii) there will be no direct or indirect mortality from excess heat; (iii) there will be no reduced reproductive success or growth due to the heated discharge; (iv) there will not be exclusion from unacceptably large areas; and (v) there will not be blockage of migration due to the thermal discharge.

Other Vertebrate Wildlife. The USEPA 316(a) Manual states that most sites in the United States will be considered to have low potential impact for other vertebrate wildlife "simply because the projected thermal plume will not impact large or unique populations of wildlife." USEPA 316(a) Manual at 32. The main exceptions are: (1) sites where important, threatened, or endangered wildlife may be adversely affected by the discharge; and (2) sites in cold areas where the thermal plume is predicted to attract geese and ducks and encourage them to stay through the winter. *Id*. The demonstration argued that, consistent with the USEPA Guidance, this can be considered a low potential impact biotic category for the Stations' thermal discharges. MWG Ex. A at 6-17.

The demonstration argued that the previous thermal limits for the Stations have not limited activity of other vertebrate wildlife. It added that the thermal discharge does not prohibit or restrict access to the shoreline by wildlife in areas that do not already have limited access. MWG Ex. A at 6-17. It stressed that the thermally-influenced area was small and that "higher water temperatures occur in the summer when migratory waterfowl use is at its lowest." *Id*. The demonstration concluded that this category was not expected to be affected by the proposed ATELs. *Id*.

In the context of INEOS' ATEL request, the Board finds that the UDIP near the Joliet Stations' mixing zones is a low potential impact area for other vertebrate wildlife. Further, the Board finds that MWG's demonstration meets the decision criteria for low potential impact areas by showing that the thermal plume does not harm any important, threatened, or endangered populations of vertebrate wildlife, including migratory birds.

INEOS' Master Rationale

The Board notes that the decision train in the USEPA 316(a) Manual provides steps to ensure that: (1) the demonstration is complete; (2) required data has been submitted; (3) the studies justify the conclusions for each of the biotic category criteria; (4) the information shows the representative important species will not suffer appreciable harm; (5) the engineering and hydrological data justify the conclusions for the Master Rationale; (6) technical experts were consulted that include other government agencies; and (7) the information is not negated by outside evidence. USEPA 316(a) Manual at 16–17, 70. Through its Type I Retrospective/Absence of

Prior Appreciable Harm and Type II Predictive/Representative Important Species Demonstrations, and its reliance on MWG's demonstration, INEOS has addressed each of the following biotic category criteria for a demonstration to be judged successful. MWG App. C at C-43; *see also* MWG Pet. at 26; MWG Ex. A at 4- 11.

No Appreciable Harm to the Balanced, Indigenous Community. MWG's demonstration argued that extensive monitoring and studies show that the aquatic community in the vicinity of the Stations' discharges was similar to the community in adjacent upstream and downstream areas. MWG Ex. A at 4-2, 4-4. It attributes any differences to the availability of suitable habitat and not to the Stations' thermal discharges. *Id*. at 4-2. The demonstration argued that the retrospective analysis showed the Stations' discharges under the previous Secondary Contact limits have not resulted in appreciable harm to the BIC. *Id*. at 4-1.

The demonstration also argued that predictive modeling showed the Stations' operations under the proposed ATELs will not appreciably affect survival, reproduction, development, and growth of the RIS. MWG Ex. A at 4-6; *see also* MWG App. C at C-45. It concluded that the proposed near-field and far-field ATELs "will assure the propagation and protection of the BIC represented by the RIS that reside in the UDIP/Five-Mile Stretch, given its existing and inherent habitat limitations and upstream anthropogenic influences." MWG Ex. A at 4-6.

Not in Excess of Upper Temperature Limits. Under the typical summer scenarios, the demonstration argued that modeled "discharge temperatures do not exceed the chronic or acute thermal mortality threshold or avoidance temperatures for the RIS." MWG Ex. A at 4-4. The demonstration argued that these modeled scenarios are typical of both previous and expected summer operations, and it projected shorter operations in the future under peaking operation than under earlier base-loaded operation. *Id*.

The demonstration added that modeling for winter scenarios indicates that even under "worst-case" conditions, "there would be no temperatures that would have an adverse impact" in the UDIP on avoidance, reproduction, or mortality. MWG Ex. A at 4-4; *see also* MWG App. C at C-45. It argued that, because the UDIP was commonly warmer than a natural waterway during winter months because of the flow of treated POTW effluent, the BIC was acclimated to warmer winter water temperatures than a typical natural system. MWG Ex. A at 4-4 – 4-5. Also, the demonstration argued that, under peaking operation for shorter durations, the fish community was not expected to become acclimated to temperatures in the discharge plumes. *Id*. at 4-5. Finally, the demonstration added that the gradual rate of heat decay after a shutdown was expected to limit temperature fluctuations and minimize the risk of cold shock. *Id*. Based on these factors, the demonstration concluded that proposed winter ATELs will ensure adequate protection for the BIC. *Id*.

For the transitional months of April, May, October, and November, MWG proposed transitional limits similar to those adopted in AS 96-10. MWG Ex. A at 4-5. The demonstration argued that this seasonal approach reflects transitions between the extremes of summer and winter. *Id*. It added that many of the proposed ATELs are more stringent than near-field UDIP standards or General Use standard applicable at the I-55 Bridge. *Id*. The demonstration concluded that this seasonal approach "will ensure continued protection of the BIC." *Id*.

Nuisance Organisms. The demonstration argued that the retrospective analysis showed "no appreciable changes in the physical and biological components of the system" while the Stations were subject to the Secondary Contact thermal standards. MWG App. C at C-43; *see also* MWG Pet. at 26, 30. It argued that the LDPR's channelized nature and regulated flow influence the aquatic species assemblage, which is able to successfully carry out their life histories in the waterway. MWG App. C at C-43. It indicated that the presence of invasive species must also be considered a permanent part of the LDPR environment. MWG App. C at C-43 – C-44; *see also* MWG Ex. A at 4-6 – 4-7. However, the demonstration argued that the Stations' operations have not been responsible for the introduction or spread of nuisance species in the LDPR. MWG Ex. A at 4-7. The demonstration argued that to date, no substantial changes in abundance of nuisance species have been observed in the LDPR near the Stations. MWG App. C at C-43; *see also* MWG Ex. 124 A at 4-12. While it noted that the Stations will discharge less heat overall under the proposed ATELs, the demonstration argued that this change will not benefit or in any way affect the abundance or distribution of nuisance species. MWG Ex. A at 4-12. The demonstration concluded that the proposed ATELs, which are more stringent than previous Secondary Contact limits, "are not expected to cause changes in abundance or distribution of other indigenous or nuisance species." MWG App. C at C-44; *see also* MWG Ex. A at 4-7; MWG Pet. at 26.

Zone of Passage Not Impaired. The demonstration argued that, whether under typical or worst-case scenarios, the RIS are not likely to avoid significant areas of habitat near the Stations. MWG Ex. A at 4-7. It added that the Stations' thermal plumes are not likely to interfere with localized movement or migration patterns. *Id*. It argued that avoidance, "if it occurred, would be of very short duration." *Id*. The demonstration concluded that the proposed ATELs will maintain an adequate zone of passage for the fish community near the Stations' discharges. MWG Ex. A at 4-8; *see also* MWG Ex. A at 6-16; MWG Pet. at 31.

No Adverse Impact on Threatened or Endangered Species. Although the retrospective analysis did not find federally-listed threatened or endangered species, it identified four state-listed fish species. MWG App. C at C-45; MWG Ex. A at 4-8, 4-14; *see also* MWG App. C, Table C-7. Surveys collected the threatened River Redhorse "infrequently and in low numbers downstream of the Brandon Road Lock and Dam." MWG Ex. A at 4-8; *see also* MWG App. B at B-9; MWG App. C at C-27. Surveys collected one endangered Greater Redhorse in 2010 at a far-field sampling location. MWG Ex. A at 4- 8 – 4-9; *see also* MWG App. C at C-27. The demonstration argued that the Stations' operations have a low potential impact on these incidental species because their preferred habitat was downstream in the Kankakee River beyond the Stations' thermal influence. MWG Ex. A at 4-14. The demonstration added that these species were found when the former Secondary Contact thermal standards were in place, indicating that the Stations' discharges had not negatively affected them or their habitat. MWG Ex. A at 4-9, 4-15; *see also* MWG App. C at C-45; MWG Pet. at 26.

The endangered Pallid Shiner was first collected downstream of the I-55 Bridge in 2001 and has since been collected chiefly in the Five-Mile Stretch. MWG Ex. A at 4-9; *see also* MWG Ex. A at 4-14; MWG App. B at B-9; MWG App. C at C-27. The demonstration added that this species was found when the former Secondary Contact thermal standards were in place, indicating that the Stations' discharges had not negatively affected it or its habitat. MWG Ex. A at 4-9, 4-15; *see also* MWG App. C at C-45; MWG Pet. at 26.

Surveys first collected the threatened Banded Killifish in 2012, and it has "increased dramatically over time" with less stringent thermal standards in place. MWG Ex. A at 4-9; *see also* MWG Ex. A at 4-14; MWG App. B at B-9; MWG App. C at C-45; MWG Pet. at 26. The demonstration cited the INHS to argue that this increase represents an expansion of the Lake Michigan population through the CAWS into the Des Plaines River. MWG Ex. A at 4-9. It also argued that the Banded Killifish found in nonpreferred habitat such as the LDPR are an invasive subspecies (the Eastern Banded Killifish) and not the threatened Western Banded Killifish. *Id*. Because the Western Banded Killifish populations and distributions had remained unchanged from 1880 to 2000, the demonstration argued that its recent growth was "unusual." *Id*. The demonstration reported that IDNR was expanding its research on the Banded Killifish to determine whether it should be listed as threatened. MWG Ex. A at 4-9; *see also* MWG App. C. at C-28. Also, IDNR had determined that adverse impacts on the Banded Killifish were unlikely. Rec. at 11, citing Att. A (IDNR letter to IEPA).

Based on these factors, the demonstration argued that the Stations' discharges are unlikely to have had and are not expected to have adverse effects on any threatened or endangered species. MWG Ex. A at 4-10, 4-15; *see also* MWG Pet. at 26.

No Destruction of Unique or Rare Habitat. The demonstration reported that factors such as flow modification, impoundment, and channelization have altered flow conditions and limited the types of habitats available in the LDPR. MWG Ex. A at 4-10. It argued that these factors have not resulted from the Stations' discharges. *Id*. QHEI scores have generally characterized habitats near the Stations as fair or poor. *Id*. at 4-10, 4-15. The demonstration concluded that "[t]here are no unique or rare habitat components that would be affected by the Joliet Station thermal discharges, either in the UDIP or Five-Mile Stretch." MWG Ex. A at 4-15; *see also* MWG Ex. A at 4-10; MWG App. C at C-45; MWG Pet. at 26.

Biocides. The demonstration reported that Joliet 9 relies on dehumidification and does not use biocides, or other chemical processes, to minimize biofouling of its condenser cooling system. MWG Ex. A at 4-10. Although Joliet 29 was permitted to use the biocide sodium hypochlorite, it uses dechlorination so that its final effluent complies with its NPDES permit. *Id*. at 4-10 – 4-11. It had also relied more recently on dehumidification. *Id*. at 4-11. The demonstration concluded that neither Station poses a threat of appreciable harm to the BIC from biocide use. *Id*.

MWG's Conclusion. The demonstration argued that 24 years of monitoring have shown no significant change in the abundance of nuisance species or the physical and biological components of the ecology of the UDIP/Five Mile Stretch. MWG Pet. at 30. It stressed that, for most of that time, the UDIP was subject to thermal standards less stringent than both the 2018 limits and the proposed ATELs. *Id*. MWG also stressed that the UDIP had been subject to significantly more thermal loading from upstream generating stations that have become inactive or reduced generating capacity. *Id*. In addition, MWG argued that converting the Joliet Stations from baseload to peaker operations results in "a dramatic drop in annual thermal loading." *Id*.

Based on the results of its predictive assessment, MWG argued that its proposed ATELs will maintain temperatures consistent with normal growth pattern for aquatic life in the BIC. MWG Pet. at 31. It argued that, even under temporary "worst-case" conditions, "thermal discharge temperatures will not fundamentally change the habitability of the UDIP or Five-Mile Stretch."

Id. It also argued that the Stations' thermal discharges will be able to meet requirements for maintaining a zone of passage even under the modeled worst-case conditions. *Id*.

The demonstration concluded that the BIC can be adequately protected by the proposed ATELs and that the narrative thermal criteria at 35 Ill. Adm. Code 302.211(b)-(d) do not benefit aquatic life. *Id*.

IEPA agreed that MWG had met its burden of proof and shown that proposed ATELs would not adversely affect the BIC in the receiving water. Rec. at 5, 9-10. Similarly, IEPA agrees here that INEOS has met its same burden of proof. Rec. 2 at 5, 7.

Board Finding. Based on the above, the Board found that MWG's 316(a) Demonstration successfully addressed each of the elements of the Master Rationale outlined in the USEPA 316(a) Manual. *See* USEPA 316(a) Manual at 70–71. Specifically, for the alternative thermal effluent limitations in the order below, the Board found that MWG's demonstration showed the following: (1) due consideration of the requisite steps in the USEPA 316(a) Manual's "decision train"; (2) there will be no appreciable harm to the balanced, indigenous community; (3) receiving water temperatures will not be in excess of the upper temperature limits for the life cycles of the representative important species; (4) the absence of the proposed thermal discharge would not result in excessive growth of nuisance organisms; (5) a zone of passage provides for the normal movement of representative important species; (6) there will be no adverse impact on threatened or endangered species; (7) there will be no destruction of unique or rare habitat, and (8) there will be no use of biocides and therefore biocides will not result in appreciable harm to the balanced, indigenous community. Based on these factors, the Board reaches the same conclusion in the context of INEOS' ATEL request.

Applicable Effluent Limits Are More Stringent Than Necessary

INEOS has the burden of demonstrating that the generally applicable thermal water quality standards are more stringent than necessary to assure the protection and propagation of the BIC in the receiving waters. Pet. at 7, citing 35 Ill. Adm. Code 106.1160(a), (b).

The demonstration argued that INEOS was found to be eligible for coverage under the approved MWG ATELs, which were shown to have no adverse impact on the BIC in the UDIP/Five-Mile Stretch. MWG Ex. A at 3-6. MWG argued in its demonstration that "this community has, in fact, improved over the time during which the two Joliet Stations have been in operation." MWG Ex. A at 3-6, citing MWG Apps. A, C, F, G, H, J. With less frequent operation as peaking plants in the future, it argued that the Stations are less likely to result in adverse impacts under proposed ATELs that are more stringent than the previous limits. MWG Ex. A at 3-6. MWG concluded that the 2018 UDIP thermal standards are more stringent than necessary to assure the protection and propagation of the BIC. MWG App. B at B-1; *see also* MWG Pet. at 15, 30, 34; Rec. at 10.

UDIP Numeric Temperature Water Quality Standards. Section 302.408(i) limits daily maximum water temperatures to 60 °F (December-March) and 90 °F (April-November). 35 Ill. Adm. Code 302.408(i).

The demonstration argued that the previous Secondary Contact baseline standard of 93 °F had been shown not to have had a detrimental effect on the BIC. MWG Ex. A at 3-7; *see also* Rec. at 9, 10. It also argued that far-field numeric standards in place since 1996 under AS 96-10 "have also resulted in no adverse harm to the BIC." MWG Ex. A at 3-7; *see also* MWG Pet. at 22; Rec. at 9, 10.

The demonstration cited the predictive assessment as providing "reasonable assurance that the proposed numeric ATELs will allow for the protection and propagation of the UDIP/Five-Mile Stretch BIC." MWG Pet. at 30. It argued that the proposed limits are consistent with maintaining temperatures within normal patterns for growth. *Id*. at 31. Although less stringent than the 2018 UDIP standard for December-March and June-September, MWG argued, and INEOS now argues, that they were within the thermal tolerances of the RIS. MWG Ex. A at 4-5; *see* Rec. at 8.

Based on these factors, for the Joliet Stations' thermal discharges, the Board finds that INEOS has demonstrated that effluent limitations based on the 2018 UDIP numeric temperature water quality standards of Section 302.408(i) are more stringent than necessary to assure the protection and propagation of BIC in the UDIP/Five-Mile Stretch.

Five-Mile Stretch Numeric Temperature Water Quality Standards. MWG noted that the Board granted adjusted thermal water quality standards applicable to the Five-Mile Stretch in 1996 to Commonwealth Edison, the previous owner of the Joliet Stations under 35 Ill. Adm. Code 304.141(c) and CWA § 316(a). MWG Pet at 23, citing AS 96-10. MWG asserted that the proposed seasonal far-field ATELs for the Five-Mile Stretch would result in temperature standards that are more stringent than the AS 96-10 Standards that currently govern the waterway. MWG Pet. at 23-24. Further, MWG clarifies that the far-field thermal ATELs would, in effect, replace both the existing AS 96-10 limits and the Stations' obligation to comply with the existing General Use thermal standards that would otherwise be effective at and below the I-55 Bridge, specifically, the narrative criteria under 35 Ill. Adm. Code 302.211 (b), (c), (d), and (e). *Id*. at 24.

Excursion Hours. Section 302.408(f) of the Board's UDIP water quality standards limit excursion hours to 87.6 hours in each 12-month period ending with any month (1% of the 8,760 hours in 12 months). 35 Ill. Adm. Code 302.408(f). A similar requirement applies to the Five-Mile Stretch under Section 302.211(e). However, MWG asserted that this small number of allowable excursion hours under the 2018 UDIP thermal standards and the General Use standards were "entirely insufficient" to support the Stations' operation in the event of persistent unseasonable weather or low flow conditions. MWG Pet. at 20; *see also* MWG Ex. A at 3-6 – 3-7. MWG's proposed ATELs considered worst-case scenarios when elevated air and water temperatures coincide with low flow conditions and included excursion hours "so that the Joliet Stations can continue to remain in compliance during these periods of time." MWG Pet. at 31.

As for the UDIP ATELs, MWG proposed that the daily maximum temperature would not exceed more than five percent of the time in a calendar year. MWG Pet. at 21. IEPA's recommendation agreed that this was similar to the previous Secondary Contact standards. Rec. at 8. The recommendation also agreed that the MWG demonstration showed there was no evidence that operating the Stations under the previous standards had caused appreciable harm to the BIC in the UDIP/Five-Mile Stretch. *Id.*

MWG argued that species inhabiting the UDIP/Five-Mile Stretch are generally tolerant and can avoid temperatures outside their preferred range. MWG Pet. at 31; *see also* MWG App. B at B-46. The demonstration argued that higher temperatures would occur infrequently and for short durations. MWG App. B at B-46. It argued that temporary increases in thermal discharge temperatures "will not fundamentally change the habitability of the UDIP or the Five-Mile Stretch." MWG Pet. at 31. The demonstration further argued that the previous limit of 93 °F with excursions allowed up to 100 °F had been shown to have no detrimental effect on the BIC in the UDIP. MWG App. B at B-46; *see also* MWG Ex. A at 3-4.

Also, MWG proposed to "track the use of excursion hours on a calendar-year basis, rather than the rolling 12-month period described in the 2018 Thermal Standards." MWG App. B at B-46 n.13. MWG argued that this tracking was consistent with ATELs approved by the Board. MWG App. B at B-46 n.13, citing Midwest Generation v. IEPA, PCB 18-58, slip op. at 74 (Nov. 21, 2019); Exelon Generation v. IEPA, PCB 14-123, slip op. at 48, 54 (Sept. 18, 2014).

Based on these factors, the Board previously concluded that it was appropriate for the Stations' ATELs to include excursion hours limited to five percent of hours in the UDIP/NEAR-Field, based on the twelve-month period ending on December 31. The Board now concludes the same for INEOS' ATELs.

Minimum Zone of Passage. MWG argued that, even under worst-case modeled conditions, it expected that a 75% or greater ZOP under the proposed maximum thermal ATELs would still be available near the Stations in the UDIP. MWG Pet. at 20, 31. It added that, even if the dilution ratio drops below 3:1, the Stations would be able to comply with the lower 50% ZOP requirement during that time. MWG Pet. at 20, 31; *see also* MWG App. B at B-40 Tables B-7a, b, c; B-8a, b, c. MWG concluded that its hydrothermal modeling and predictive assessment show the Stations' thermal discharges would be able to meet the existing ZOP criteria in place under the proposed near-field thermal ATELs. MWG Pet. at 31; *see also* MWG Ex. A at 3-10, citing 35 Ill. Adm. Code 302.102(b)(8).

Based on these factors, the Board previously concluded that MWG's proposed near-field thermal ATELs were projected to maintain an adequate ZOP. The Board now concludes the same for INEOS' near-field ATELs.

Narrative Temperature Water Quality Standards. MWG argued that the apparent purpose of narrative thermal standards is to prevent elevated water temperatures from negatively impacting fish movement and activity in a natural system. MWG Ex. A at 3-9. However, it suggests that the UDIP and Five-Mile Stretch "are anything but natural." *Id.*

MWG argued that the UDIP and Five-Mile Stretch have been adequately protected solely by numeric thermal criteria. MWG Pet. at 22. Because its proposed ATELs will adequately protect the BIC, MWG argued that "narrative thermal criteria like those in 35 Ill. Adm. Code 302.211(b) – (d) would offer no foreseeable benefit to aquatic life." MWG Pet. at 30; *see also* 35 Ill. Adm. Code 302.408; Rec. at 8.

Section 302.408(c) provides that "[t]here must not be any abnormal temperature changes that may adversely affect aquatic life unless caused by natural conditions." 35 Ill. Adm. Code 302.408(c). Section 302.408(d) provides that "[t]he normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes must be maintained." 35 Ill. Adm. Code 302.408(d). MWG stressed that modifications such as channelization and locks and dams have significantly changed the natural habitat in the UDIP and Five-Mile Stretch. MWG Ex. A at 3-9. It argued that, even if the historic normal and seasonal temperature fluctuations before the addition of heat could be identified, their application here would not significantly change or improve the BIC.[5] *Id*. MWG asserted that, because its proposed thermal ATELs protect the BIC, it can be maintained without this narrative standard. *Id*.

Section 302.408(e) provides that "[t]he maximum temperature rise above natural temperatures must not exceed 2.8 °C (5 °F)." 35 Ill. Adm. Code 302.408(e). MWG argued that this standard had not historically applied to the UDIP and does not now apply as the far-field standard under AS 96-10. MWG Ex. A at 3-9. MWG argued that, because its proposed ATELs will continue to maintain an adequate ZOP, applying this narrative standard "is overly restrictive and unnecessary to maintain and protect the BIC of the UDIP/Five-Mile Stretch near the Joliet Stations." *Id*. at 3-10. It added that its proposed thermal ATELs for transitional months provide an appropriate progression between summer and winter months, which limits the need for a narrative standard intended to minimize abrupt temperature changes. *Id*. MWG noted that AS 96-10 included similar seasonally based standards instead of narrative criteria to limit abrupt changes. *Id*. at 3-10 – 3-11, 4-5.

In its recommendation, IEPA agreed that MWG's "requested numeric thermal ATELs will protect the BIC in lieu of other narrative criteria found in [Sections] 302.408(c)-(f) and (i) and 302.211." Rec. at 8.

Based on the above, for the Joliet Stations' thermal discharges, the Board previously found that the narrative temperature standards under Sections 302.408(c) through (e) and 302.211(b) through (d) are more stringent than necessary to assure the protection and propagation of the balanced, indigenous population in and on the UDIP and the Five-Mile Stretch. The Board now concludes the same for INEOS' ATELs.

Mixing zone. INEOS requests that the Board grant a mixing zone that allows the use of 25% of the 7Q10 flow of the UDIP rather than the full flow of UDIP to maintain compliance with the MG ATELs. Pet. Ex. 1 at 5-5. INEOS argues that requiring the mixing zone to be "a percentage of the 7Q10, instead of real-time flow, is extremely conservative, but still provides sufficient mixing to bring the INEOS discharge temperature down to near-ambient levels." *Id.* Additionally, INEOS maintains that the Facility's thermal discharge meets all the other mixing zone requirements under Section 302.102, including the absence of any mussel beds in the vicinity of the discharge and the provision of best degree of treatment under Section 304.102 (referenced

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[5] As noted throughout this opinion, MWG also stated that upstream POTW effluents have increased the temperatures in that area, altering them "from what would be encountered in a natural system." MWG Ex. A at 3-8. Because of this, the Board acknowledges that it may be difficult to determine what constitutes the area's "natural" condition or any "abnormal" changes to it.

in 302.102(a)). IEPA agrees that INEOS has demonstrated that it meets the requirements of 302.102 and qualifies for a mixing zone. *See* 35 Ill. Adm. Code 302.102.

The Board concludes that, based on the anticipated 75% minimum ZOP, INEOS' request for a mixing zone that allows the use of 25% of the 7Q10 flow of the UDIP is appropriate to maintain compliance with MWG's ATELs.

CONCLUSION

Based on the record, the Board finds that INEOS has justified the grant of ATELs for its Channahon Facility in compliance with 33 U.S.C. § 1326(a), 35 Ill. Adm. Code 304.141(c), and 35 Ill. Adm. Code 106.Subpart K.

The Board finds that INEOS demonstrates, for the discharges from its facility, that thermal effluent limitations based on Sections 302.211(b) through (d) and 302.408(c) through (f) and (i) of the Board's water pollution regulations are more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish, and wildlife in and on the UDIP near INEOS' station and the Five-Mile Stretch. INEOS' Type I Retrospective/Absence of Prior Appreciable Harm Demonstration shows that no appreciable harm to the balanced, indigenous community has resulted from the heated discharge from INEOS's station. The Board also finds that INEOS' Type II Predictive/Representative Important Species Demonstration shows that the ATELs in the order below will assure the protection and propagation of a balanced, indigenous community in and on the UDIP near its Channahon Facility, and the Five-Mile Stretch. Accordingly, the Board grants INEOS' requested relief, effective today.

ORDER

Under 35 Ill. Adm. Code 106.Subpart K and 35 Ill. Adm. Code 204.141(c), the Board directs IEPA to include the following alternative thermal effluent limitations (ATELs) in INEOS Joliet's NPDES permit for the discharges to the Upper Dresden Island Pool from INEOS' Channahon Facility located in Channahon, Will County:

1) Temperature

    a. Instead of thermal effluent limitations based on the UDIP Use thermal water quality standards provisions contained in 35 Ill. Adm. Code 302.408 (c)-(f), and (i), the following daily maximum temperature effluent limitations apply to INEOS' Channahon Facility:

Month	**Daily Maximum Near-Field (UDIP) (°F)**
January	**65**
February	**65**

March	**70**
April	**80**
May	**85**
June	**93**
July	**93**
August	**93**
September	**93**
October	**90**
November	**85**
December	**70**

b. Instead of the water temperature requirements of 35 Ill. Adm. Code 302.408(c), (d), (e), (f) and (i) applicable to UDIP, effluent temperatures must not exceed the near-field daily maximum temperature limitations in paragraph (1)(a) during more than 5% of the hours (438 hours) in a calendar year. Moreover, the effluent temperature must never exceed the daily maximum near-field temperature limitations in paragraph (1)(a) by more than 3 °F.

c. The alternative thermal effluent limitations in paragraph (1)(a) apply at the edge of the mixing zone described below in paragraph 4.

2) INEOS will continue to minimize the use of excursion hours through the use of its Channahon Facility Cooling Towers.

3) Compliance.

INEOS must demonstrate compliance with the temperature limits in paragraph (1)(a) by ensuring that the maximum effluent discharge temperature measured at Outfall 001 during any given month (based on hourly data) is at or below 100°F.

4) Mixing Zone.

INEOS' thermal discharge from Outfall 001 is allowed a mixing zone that may use up to 25% of the 7Q10 flow (lowest 7-day average flow that occurs once every 10 years) of the UDIP to maintain compliance with the temperature limitations in paragraph (1)(a).

5) NPDES Permit.

IEPA must expeditiously modify INEOS' NPDES permit for its Channahon facility to make the permit consistent with this opinion and order.

IT IS SO ORDERED.

Section 41(a) of the Act provides that final Board orders may be appealed directly to the Illinois Appellate Court within 35 days after the Board serves the order. 415 ILCS 5/41(a) (2024);

see also 35 Ill. Adm. Code 101.300(d)(2), 101.906, 102.706. Illinois Supreme Court Rule 335 establishes filing requirements that apply when the Illinois Appellate Court, by statute, directly reviews administrative orders. 172 Ill. 2d R. 335. The Board's procedural rules provide that motions for the Board to reconsider or modify its final orders may be filed with the Board within 35 days after the order is received. 35 Ill. Adm. Code 101.520; *see* also 35 Ill. Adm. Code 101.902, 102.700, 102.702.

<table>
<tr><th colspan="2">Names and Addresses for Receiving Service of
Any Petition for Review Filed with the Appellate Court</th></tr>
<tr><th>Parties</th><th>Board</th></tr>
<tr><td>INEOS Joliet, LLC
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I, Don A. Brown, Clerk of the Illinois Pollution Control Board, certify that the Board adopted the above opinion and order on June 26, 2025, by a vote of 5-0.

Don A. Brown

Don A. Brown, Clerk
Illinois Pollution Control Board