ILLINOIS POLLUTION CONTROL BOARD
March 3, 2016

EXELON GENERATION LLC (DRESDEN NUCLEAR GENERATING STATION),	)	
Petitioner,	)	
v.	)	PCB 15-204 (Thermal Demonstration)
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY,	)	
Respondent.	)	

OPINION AND ORDER OF THE BOARD[1] (by J.D. O'Leary):

On June 12, 2015, Exelon Generation LLC (Exelon) filed a petition (Pet.) requesting that the Board grant alternative thermal effluent limitations (ATL) for discharges to the Illinois River from the Dresden Nuclear Generating Station (Dresden or DNS). Exelon seeks this relief pursuant to Section 316(a) of the Clean Water Act (CWA), Section 304.141(c) of the Board's water pollution regulations (35 Ill. Adm. Code 304.141(c)), and Part 106, Subpart K of the Board's procedural rules (35 Ill. Adm. Code 106.1100 – 106.1180). Dresden is located at the confluence of the Kankakee and Des Plaines Rivers where they form the Illinois River near Morris, Grundy County.

Section 302.211(e) of the Board's General Use Water Quality Standards limits water temperatures in the Illinois River to 60ºF during the months of December to March and 90ºF during the months of April to November. The rule allows the temperature limits to be exceeded by up to 3ºF for up to one percent of the hours in a rolling twelve-month period. 35 Ill. Adm. Code 302.211(e). In 1981, the Board granted a petition for alternative thermal limits for Dresden. The alternative limits allow discharges to exceed 90ºF by up to 3ºF for ten percent of the time between June 15 and September 30. <u>401(c) Petition for Dresden Nuclear Generating Station</u>, PCB 79-134, slip op. at 4 (July 9, 1981). Dresden has since operated under the alternate limits granted by the Board. In its current petition, Exelon requests that, between June 15 and September 30, discharge temperatures will not exceed 90ºF more than ten percent of the time during that period and will never exceed 95ºF, provided that discharge temperatures may exceed 93ºF only when intake temperature exceeds 90ºF and that any single such discharge does not exceed 24 hours in duration.

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[1] Before joining the Board as an attorney assistant on June 16, 2015, Jason E. James was an associate at Sidley Austin LLP, three attorneys from which have filed an appearance on behalf of Exelon Generation LLC, the petitioner in this case. Mr. James took no part in the Board's drafting of this order or deliberation of any issue in this matter.

On July 27, 2015, the Illinois Environmental Protection Agency (Agency) filed a recommendation that the Board grant Exelon's requested relief. *See* 35 Ill. Adm. Code 106.1145(a), (b).

Exelon did not request a hearing on its petition. Exelon published notice of filing the petition on June 26, 2015 in the *Morris Herald-News*. The notice stated that any person within 21 days after the date of publication may request that the Board hold a hearing. *See* 35 Ill. Adm. Code 106.1135. The Board did not receive a request to hold a hearing and did not hold a hearing on Exelon's petition. *See* 35 Ill. Adm. Code 106.1150. On September 1, 2015, the Board's hearing officer submitted to Exelon 29 questions regarding its petition (Board Questions), and Exelon filed a written response (Resp.).

Based on the record before it, the Board grants Exelon alternative thermal effluent limitations as described in its order below.

GUIDE TO THE BOARD'S OPINION

The Board's opinion begins with the procedural history at pages 2-6 and then summarizes the factual background at pages 6-37. The Board then presents the applicable thermal effluent limitations at pages 37-38 and Exelon's requested alternative standard at page 38. Next, the Board summarizes the Agency's recommendation and Exelon's response to it at pages 38-39. The Board then addresses the legal background, including statutory and regulatory authorities and the burden of proof, at pages 39-41.

The opinion includes discussion of the Biotic Category Analysis at pages 42-60, the Representative Important Species (RIS) Demonstration at pages 60-67, the Retrospective Demonstration at pages 67-77, and the Predictive Demonstration at pages 77-98. The Board addresses Exelon's Master Rationale at pages 98-101 before making its overall determination. In these sections, the Board's discussion and criteria applied are based on draft guidance for demonstrations under Section 316(a) of the CWA prepared by the United States Environmental Protection Agency (USEPA) and entitled Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Section of Nuclear Facilities Environmental Impact Statements (DRAFT), dated May 1, 1977 (Draft Manual). Exelon requests relief under authorities including Section 316(a) of the CWA, and the Board considers the Draft Manual as a useful and instructive guide for its analysis of the petition. *See* 35 Ill. Adm. Code 106.1120(e).

Finally, the Board reaches its conclusion and issues its order at pages 102-03.

PROCEDURAL HISTORY

Procedure Before Filing Petition with the Board

In a letter to the Agency dated April 14, 2014, Exelon submitted both early screening information and a detailed plan of study in support of alternative thermal effluent limits for Dresden. Exh. 2 at 2, 10; *see* 35 Ill. Adm. Code 106.1115(a), 106.1120(a); Exh. 1 at 1-2 (§1.2:

Resource Agency Interaction). USEPA received a copy of the study plan, participated in a meeting with Exelon and the Agency on it, and provided comments. Resp. at 6.

Within ninety days after a petitioner submits a plan of study, the Agency must respond in writing by either approving the plan or recommending revisions. 35 Ill. Adm. Code 106.1120(f). The Agency and the Illinois Department of Natural Resources (IDNR) recommended changes regarding the list of Representative Important Species and freshwater mussel surveys. Exelon accepted and incorporated these recommended changes into its studies and analysis. Exh. 1 at 1-2 (§1.2: Resource Agency Interaction); Pet. at 12; Rec. at 12; Resp. at 6. Exelon stated that it received no further comment on the plan from USEPA. Resp. at 6. After receiving the Agency's response, a petitioner must then complete the plan of study before filing a petition for an alternative thermal demonstration with the Board. 35 Ill. Adm. Code 106.1120(g).

Petition to the Board

On June 12, 2015, Exelon filed a petition for alternative thermal effluent limitations for discharges from Dresden. The petition requested relief from the generally applicable requirements of 35 Ill. Adm. Code 302.211(e). Pet. at 1, 23. Accompanying the petition was Exelon's "Dresden Nuclear Station § 316(a) Demonstration, May 29, 2015" (Exh. 1).

Attached to Exhibit 1 were the following appendices:

Description of the Des Plaines, Kankakee, and Illinois Rivers (App. A);

Information Supporting Representative Important Species Rationale: Biothermal Assessment – Predictive Demonstration (App. B);

Information Supporting Biotic Category Rationales: Protection of Balanced Indigenous Community – Retrospective Demonstration (App. C);

Engineering and Hydrological Information: Dresden Nuclear Station Operations and Hydrothermal Analysis (App. D);

Supportive Reports: Data Collection Programs (App. E);

Supportive Reports: Dresden Nuclear Station Aquatic Monitoring 2013 Upper Illinois Waterway River Mile 270.5 – 273.4 (App. F);

Supportive Reports: Dresden Nuclear Station Aquatic Monitoring 2014 Upper Illinois Waterway River Mile 270.5 – 273.4 (App. G), including the following six exhibits

Physiochemical Measurements (Exh. A);

Catch-Per-Effort and Relative Abundance Summaries (Exh. B);

Raw Data Listing – Fish (Exh. C);

Index of Well Being Scores (Exh. D);

Incidence of Disease, Parasitism, and Abnormalities of Fish (Exh. F); and

Raw Data Listing – Macroinvertebrates (Exh. G); and

Supportive Reports: Dresden Nuclear Station 2014 Mussel Survey Upper Illinois Waterway River Mile 270.5 – 273.4 (App. H), including the following two exhibits:

Mussel Survey Work Plan (Exh. A); and

Freshwater Mussel Survey Photographic Record (Exh. B).

Also attached to the petition was a letter dated April 14, 2014, on behalf of Exelon to the Agency (Exh. 2), which included the following:

Fish and Benthos Sample Locations in the Kankakee, Des Plaines, and Illinois Rivers near Dresden Station (Exh. 2, Figure 1);

Proposed Mussel Survey Transects (Exh. 2, Figure 2); and

Candidate Representative Important Species for the Dresden Generating Station 316(a) (App. A).

Notice and Opportunity to Request Hearing

Exelon served a copy of the petition on the Agency and the Illinois Department of Natural Resources. *See* 35 Ill. Adm. Code 106.1125. On July 7, 2015, Exelon filed a certificate of publication stating that the *Morris Herald-News* published notice of the filing of the petition on June 26, 2015. *See* 35 Ill. Adm. Code 106.1135(a), 106.1140. The notice stated that any person may within 21 days after the date of publication request that the Board hold a hearing. Accordingly, such a request was to be received by the Board on or before July 17, 2015. The Board has not received any public comment.

Board Order Accepting Petition

On July 23, 2015, the Board adopted an order finding that Exelon had provided sufficient notice of filing the petition and noting that it had not received a request to hold a hearing. The Board also stated that the Agency's recommendation was due July 27, 2015 (35 Ill. Adm. Code 106.1145(a)), and that Exelon's response would be due 21 days after the Agency files its recommendation (35 Ill. Adm. Code 106.1145(c)). The Board accepted the petition but stated that it had not determined whether it would hold a hearing. The order added that the Board "may submit questions to Exelon at a later date through either a Board or hearing officer order."

Agency Recommendation and Exelon Response

On July 27, 2015, the Agency filed its recommendation (Rec.). *See* 35 Ill. Adm. Code 106.1145(a). Two attachments accompanied the recommendation:

> NPDES Permit No. IL0002224 issued to Dresden, effective November 3, 2011 (Att. 1); and
>
> 410(c) Petition for Dresden Nuclear Generating Station, PCB 79-134 (July 9, 1981) (granting Commonwealth Edison request for alternate thermal standard) (Att. 2).

The Agency recommended that the Board grant the relief requested by Exelon. Rec. at 4, citing 35 Ill. Adm. Code 106.1145.

On August 14, 2015, Exelon filed its response to the Agency's recommendation (Resp. Rec.). *See* 35 Ill. Adm. Code 106.1145(c). The response concurred with the Agency's assessment and renewed Exelon's request that the Board grant the petition. Resp. Rec. at 2.

Board Questions and Exelon Response

On September 1, 2015, the Board's hearing officer issued an order, attached to which were 29 questions addressed to Exelon regarding the petition and exhibits. The order directed Exelon to file written responses to the questions on or before October 16, 2015. On October 16, 2015, Exelon timely filed its responses (Resp.), accompanied by 15 attachments:

> Daily Average Discharge and Intake Temperature, 15 June – September, 2006-2009, 2012-2014 (Resp. Att. 1);
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> Daily Average Delta Temperature as a Function of Intake Temperature, 15 June – September, 2006-2009, 2012-2014 (Resp. Att. 2);
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> Exelon Generation Company, LLC Dresden Nuclear Generating Station v. IEPA, IEPA 12-05 (Aug. 8, 2011) (Resp. Att. 3);
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> Exelon Generation Company, LLC Dresden Nuclear Generating Station v. IEPA, IEPA 12-14 (Mar. 22, 2012) (Resp. Att. 4);
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> Exelon Generation Company, LLC Dresden Nuclear Generating Station v. IEPA, IEPA 12-22 (July 6, 2012) (Resp. Att. 5);
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> Exelon Generation Company, LLC Dresden Nuclear Generating Station v. IEPA, IEPA 12-23 (July 18, 2012) (Resp. Att. 6);
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> Exelon Generation Company, LLC Dresden Nuclear Generating Station v. IEPA, IEPA 12-25 (Aug. 2, 2012) (Resp. Att. 7);

Letter Report – Provisional Variances IEPA 12-05 Temperature and Environmental Condition Monitoring (Resp. Att. 8);

Temperature & Environmental Condition Report Provisional Variance (IEPA 12-22) (Resp. Att. 9);

Temperature & Environmental Condition Report Provisional Variance (IEPA 12-23) (Resp. Att. 10);

Temperature & Environmental Condition Report Provisional Variance (IEPA 12-25) (Resp. Att. 11);

Dresden 1981 Environmental Program (Resp. Att. 12);

Hydrothermal Surveys of Dresden Station Units 2/3 Discharge to the Illinois River During Indirect Open Cycle Operation, June 15 – September 30, 1981 (Resp. Att. 13);

Final Report Dresden Station Aquatic Monitoring 1999 (Resp. Att. 14); and

Transcript of Direct Examination of Ben B. Ewing (Resp. Att. 15).

FACTUAL BACKGROUND

General Description of Dresden

Site

Dresden is situated on the south shore of the Illinois River immediately below the confluence of the Kankakee and Des Plaines Rivers approximately eight miles east of Morris in Goose Lake Township, Grundy County. Pet. at 6; *see* App. A at A-16; App. A, Figure A-1 (Location of Kankakee, Des Plaines, and Illinois Rivers Near Dresden Nuclear Station); App. D, Figure D-1 (Location of Dresden Nuclear Station).

The Dresden "site consists of approximately 2,500 acres owned by Exelon with an additional 17 acres of river frontage leased from the State of Illinois. In addition to the two nuclear generating units and their turbine building, intake and discharge canals, cooling pond and canals, and auxiliary buildings, the site includes switchyards." App. A at A-16, citing Commonwealth Edison Company, Updated Final Safety Analysis Report for Dresden Station, Rev.01A (Dec. 1995). The site also includes Unit 1, the original generating unit, which was shut down in 1978 and retired in 1984 and remains "in long term safe storage." Pet. at 6; Exh. 1 at 3; App. A at A-16; App. D at D-1.

Fuel, Generating Capacity, and Estimated Retirements

Dresden "is a nuclear-fueled steam electric generating facility." Pet. at 6; *see* 35 Ill. Adm. Code 106.1130(a)(2). "Unit 2 started commercial service on April 13, 1970 and Unit 3 started commercial service on July 22, 1971." Pet. at 6. "In 2004, the Nuclear Regulatory Commission granted Dresden Units 2 and 3 a 20-year extension of their operating licenses until 2029 and 2031, respectively." *Id*.; *see* Exh. 1 at 32; *see also* 35 Ill. Adm. Code 106.1130(a)(6).

Exelon reports that Units 2 and 3 "have a combined maximum generating capacity of 2006 megawatts." Pet. at 6, citing App. D at D-1; *see* 35 Ill. Adm. Code 106.1130(a)(1). In its questions, the Board noted that Exelon also reports "a combined maximum generating capacity of 1,824 megawatts electric." Board Questions at 1, citing App. D at D-1. The Board requested that Exelon "clarify the values for the generating capacity." Board Questions at 1. Exelon responds that "generating capacity can vary depending upon conditions." Resp. at 1. Exelon elaborates that maximum rated name plate capacity is 1009 megawatts for both Units 2 and 3, resulting in combined generating capacity of 2018 megawatts. *Id*.

Load Factors

For the last five years, Exelon reports the load factor of the plant as 95.1% in 2010, 95.8% in 2011, 94.1% in 2012, 95.5% in 2013, and 93.6% in 2014. Pet. at 7; *see* 35 Ill. Adm. Code 106.1130(a)(4).

For the next five years, Exelon projects the load factor of the plant as 94.0% in 2015 and 2016, 95.2% in 2017, 93.9% in 2018, and 93.7% in 2019. Pet. at 7; *see* 35 Ill. Adm. Code 106.1130(a)(5).

Shutdowns

For the last five years, Exelon reported planned and emergency shutdowns of Units 2 and 3 with frequency and duration. *See* 35 Ill. Adm. Code 106.1130(a)(7), (8). In 2010, Unit 2 was not shut down, but "Unit 3 had 2 shutdowns of approximately 3 days and 26 days." Pet. at 7. In 2011, Unit 3 was not shut down, but "Unit 2 was shutdown once for approximately 25 days." *Id*. In 2012, "Unit 2 was shutdown once for approximately 7 days," and "Unit 3 was shutdown once for approximately 24 days." *Id*. In 2013, "Unit 2 was shutdown once for approximately 19 days," and "Unit 3 was shutdown for approximately 8 days." *Id*. In 2014, Unit 2 was shut down three times "for approximately 17 days, 4 days, and 1 day. Unit 3 was shutdown once for approximately 16 days." *Id*.

For the next five years, Exelon reported planned and projected shutdowns of Units 2 and 3 with frequency and duration. *See* 35 Ill. Adm. Code 106.1130(a)(9). For 2015, "Unit 2 has already had two shutdowns of approximately 3 and 6 days. Unit 2 has one more planned shutdown projected to be 18 days." Pet. at 8. Exelon added that "[t]here are no planned shutdowns for Unit 3" in 2015. *Id*. For 2016, "Unit 3 has one planned shutdown projected to be 17 days. There are no planned shutdowns for Unit 2." *Id*. For 2017, "Unit 2 has one planned shutdown projected to be 16 days. There are no planned shutdowns for Unit 3." *Id*. For 2018, "Unit 3 has one planned shutdown projected to be 16 days. There are no planned shutdowns for

Unit 2." *Id*. For 2019, "Unit 2 has one planned shutdown projected to be 16 days. There are no planned shutdowns for Unit 3." *Id*.

Heat Dissipation

Condenser Cooling

Dresden employs "a cooling pond and cooling tower system to cool condenser cooling water." Pet. at 9. "The Kankakee River is the only surface water intake source for cooling water." App. D at D-2; *see* Pet. at 6; Exh. 1 at 34. "River water enters the intake canal, and splits into two canals, one for Unit 1 (that is shutdown) and the other for Units 2 and 3." Pet. at 6. The intake canal for Units 2 and 3 "is 2,400 feet long, 56 feet wide, and 13 feet deep." App. D at D-3; *see* Pet. at 6. "When both units are at power, cooling water flows through the Unit 2 and 3 condensers and service water systems at a rate that varies from 688,000 gallons per minute (gpm) (1,533 cfs) in the winter to 1,017,000 gpm (2,266 cfs) during the summer." Exh. 1 at 34; App. D at D-2.

Type of Heat Dissipation System

After cooling water passes through heat exchangers in the plant, its discharges to the Hot Canal. Exh. 1 at 3, 34. "The Hot Canal routes the cooling water approximately 2.5 miles south to the Lift Station." App. D at D-2; *see* Exh. 1 at 3. The station lifts cooling water approximately 23 feet to the cooling pond. Exh. 1 at 34; App. D at D-2, D-4. The cooling pond is situated southeast of the station and "was formed by constructing an impervious earth-fill ring dike having an area of approximately 1,275 acres. . . . The cooling pond has an average depth of 8 feet at the normal pool elevation of 522.0 ft. . . ." App. D at D-1; *see* Pet. at 9. "Cooling water takes between 2.5 to 3.5 days to route around the cooling pond to the Discharge Weir Gates (spillway) located just south of the Lift Station." App. D at D-2. From the spillway, cooling water enters the Cold Canal, which runs approximately 2.5 miles back to the plant. *Id*.; *see* Exh. 1 at 3, 34. "The Cold Canal and Hot Canal cooling system is used to provide supplemental cooling capacity to the cooling pond prior to water being discharged back to the Illinois River." Exh. 1 at 3, 34; *see* 35 Ill. Adm. Code 106.1130(a)(3).

To supplement the cooling capacity of the cooling pond, Exelon installed hot canal and cold canal cooling tower systems from 2000 to 2003. Pet. at 10; *see* Exh. 1 at 3. "The hot canal cooling towers take water from the hot canal, cool the water via a counter flow of air, and return the cooled water back into the hot canal downstream of the cooling tower intake. Likewise, the cold canal system takes water from the cold canal, cools the water via a counter flow of air, and discharges back to the cold canal downstream of the intake." Pet. at 10; *see* Exh. 1 at 3; App. D at D-4.

Between October 1 and June 14, Dresden operates in Closed Cycle mode. Pet. at 9; Exh. 1 at 3, 34; App. D at D-2. In Closed Cycle mode, "approximately 700,000 gpm of cooling water is drawn into the Plant's intake structure, passes through the Plant's heat exchangers," and then discharges through the Hot Canal to the cooling pond. Pet. at 9; *see* App. D at D-1. The majority of the cooling water is then directed back through the cold canal back to the Plant's intake structure for reuse. Pet. at 9; App. D at D-2; *see* Exh. 1 at 3. "A small portion of the water is diverted as blowdown flow to the Illinois River via the Units 2/3 discharge canal." Exh. 1 at 32. "Blowdown is discharged for control of dissolved solids in the cooling pond" and averages approximately 50,000 gpm or 72 million gpd. Pet. at 9; Exh. 1 at 34; *see* App. D at D-4. To replace water lost as a result of evaporation and blowdown flow, "[m]akeup water is obtained through the Station's Kankakee River intake." Exh. 1 at 32; App. D at D-1; *see* Pet. at 9.

From June 15 to September 30, Dresden operates in Indirect Open Cycle mode. Exh. 1 at 3, 34. In this mode, "all the cooling water flows required for Units 2 and 3 are taken directly from the Kankakee River, routed once through the cooling pond, and then, discharged to the Illinois River" from the Cold Canal. App. D at D-2; *see* Pet. at 9; Exh. 1 at 3, 32. "The maximum design flow during indirect open cycle is 1,548 mgd." Pet. at 10; *see* App. D at D-2.

Dresden is authorized to operate in Direct Open Cycle mode when Units 2 and 3 are both shut down. App. D at D-3. "In this mode the cooling pond is bypassed and all cooling water is routed from the Kankakee River through the plant cooling systems then directly out to the Illinois River." *Id*. With Dresden operating "in a completely open-cycle mode, discharge from the Units 2 and 3 averages about 1,000,000 gpm." Exh. 1 at 35.

In its questions, the Board noted that a previous variance described both a "diffuser pipe" and "slot-jet discharge structure." Board Questions at 6, citing Commonwealth Edison Co. v. IEPA, PCB 73-359, slip op. at 4 (Jan. 17, 1974). The Board requested that Exelon "specifically describe the current outfall configuration where the discharge canal meets the Illinois River." Board Questions at 6. Exelon reports that "[t]here is no diffuser pipe or slot-jet discharge structure" and that Appendix D of its demonstration accurately describes the outfall. Resp. at 16. Exelon adds that "[f]low regulating gates divert all cooling water from the cold canal to the Illinois River *via* the discharge canal, which is simply an open canal that flows directly into the Illinois River." *Id*.

Summary of Discharge Temperature

Exelon stated that, because its proposed alternative thermal limits applied only from June 15 to September 30 when operation in Indirect Open Cycle mode is authorized, it summarized discharge temperature information only for that period. Pet. at 10; *see* 35 Ill. Adm. Code 106.1130(b)(2). Data for 1998-2014 show that "[t]he highest discharge temperatures were during July with a median (50-percentile) temperature of 87.4ºF and the upper 10-percentile temperatures were above 90.7ºF." Pet. at 10, citing App. D, Table D-1 (Frequency Distribution of Hourly Intake (2003-2014) and Discharge (1998-2014) Temperature). For August discharges, the median temperature was 87.0ºF with the upper 10-percentile at 89.9ºF. Pet. at 10; *see* App. D, Table D-1. In June, the median discharge temperature was 85.7ºF with the upper 10-percentile at 88.5ºF. In September, the median was 83.5ºF and the upper 10-percentile at 88.2ºF. Pet. at 10; *see* App. D, Table D-1. Exelon reported that, from June to September, discharge flows were predominately at a rate of 1,465 mgd, and power production was above 98 percent capacity 85 percent of the time. Pet. at 10; *see* App. D at Table D-2 (Frequency Distribution of Hourly Discharge Flow and Power Production, 2003-2014).

In its questions to Exelon, the Board noted that both Table D-1, Frequency Distribution of Hourly Intake (2003-2014) and Discharge (1998-2014) Temperature, and Table D-2, Frequency Distribution of Hourly Discharge Flow and Power Production, 2003-2014, note a gap in data from July 2003 to November 2005. Board Questions at 1. The Board requested that Exelon "explain the reason for the gap in data noted by EA Engineering, Science, and Technology (EA) from July 2003 to November 2005." *Id*. Exelon reports that thorough searches of Dresden records and files did not locate these data. Resp. at 2. Exelon states that it has data for many years prior to and after the years for which data could not be found. *Id*. Exelon adds that it also reviewed Discharge Monitoring Reports for years for which it lacks data. *Id*. Exelon argues that "EA was able to develop an accurate representation of temperature variability and operating conditions to conduct the hydrothermal analysis used in the Demonstration." *Id*.

In its questions, the Board noted that Exelon had provided the frequency distribution of intake and discharge temperatures in Table D-1. Board Questions at 1. Citing 35 Ill. Adm. Code 106.1130(b)(2), the Board requested that Exelon provide "[s]ummary information on temperature of discharge to receiving waters in narrative form" and on the difference between intake and discharge temperatures. Board Questions at 1.

Exelon responds that the demonstration includes frequency distributions for hourly intake and discharge temperatures between June 15 and September. Resp. at 1, citing App. D, Table D-1. Exelon states that the data show

> discharge temperatures increased with increasing intake temperatures, although the delta temperature rise decreased with increasing intake temperatures. For the June 15 to September 30 time period, the warmest intake and discharge temperatures occurred in July or August and the coolest occurred in September. In July, as the intake temperature increased from 72.8ºF at the 10-percentile level to 87.2ºF at the 90-percentile level, the discharge temperature increased from 83.5ºF to 90.7ºF, while the delta temperature decreased from 10.7ºF to 3.5ºF. During September, the intake temperature increased from 63.6ºF (10-percentile) to 79.8ºF (90-percentile), while the discharge temperature increased from 77.4ºF to 88.2ºF. The corresponding delta temperature decreased from 13.8ºF to 8.4ºF while still providing a noticeable margin below the 90ºF discharge limit. Resp. at 2; citing Resp. Atts. 1, 2.

From 1998 to 2014, "[d]uring July, the number of hours with discharge temperatures above 90.7ºF exceeded 200 in 1998, 1999 and 2012, and exceeded 100 hours in 2001 and 2011." Pet. at 10-11; *see* App. D at Table D-3 (Number of Hours With Discharge Temperature Greater Than 90ºF, 15 June to 30 September, 1998-2014). During August, the number of hours with discharge temperatures above 90.7ºF exceeded 100 in 1998, 1999, 2001, and 2011. Pet. at 10-11; *see* App. D at Table D-3. "There were no years during which discharge temperatures were above 90ºF for more than 200 hours in August." Pet. at 11; *see* App. D at Table D-3. For the month of June, the greatest number of hours the discharge exceeded 90.7ºF was 81 hours in 2009, and for the month of September, the greatest number of hours was eight hours in 1998. Pet. at 11; *see* App. D at Table D-3.

In its questions to Exelon, the Board noted that Table D-3 "presents the number of hours with discharge temperatures greater than 90ºF by month." Board Questions at 2. The Board requested that Exelon "calculate the total number of hours with discharge temperatures greater than 90ºF from June 15 to September 30 for each year from 1998-2014." *Id*. Exelon expanded Table D-3 to show that total number of hours for each year ranged from 0 in 2003, 2004, 2005, and 2014 to 407 in 1999 and 457 in 1998. Resp. at 3-4.

In addition, the Board requested that Exelon "calculate the number of hours over the maximum number of [259] hours provided by PCB 79-134 for the same time periods." *Id*.; *see* 401(c) Petition for Dresden Nuclear Generating Station, PCB 79-134 (July 9, 1981). Exelon expanded Table D-3 to show that the number of hours with discharge temperatures above 90ºF exceeded 259 by 198 hours in 1998, by 148 hours in 1999, by 80 hours in 2001, and by 11 hours in 2012. Resp. at 4. In the other reported years, discharge temperatures were not above 90ºF for more than 259 hours. *Id*.

The Board requested that, to the extent Table D-3 shows hours with discharge temperatures greater than 90ºF, Exelon "indicate how many of those hours discharge temperatures were above 93ºF by year." Board Questions at 2. Dresden responded that eight hours in 1998, 106 hours in 1999, and six hours in 2012 had discharge temperatures greater than 93ºF. Resp. at 5.

In its questions, the Board noted that, "[b]ased on Table D-3, the number of hours with discharge temperature greater than 90ºF has generally decreased from 1998 to 2014." Board Questions at 2. The Board asked Exelon to what it might attribute that apparent decrease. *Id*. Exelon credited "advances in modeling the cooling water use for Dresden Station, that have resulted in improved management of the plant's cooling system, along with the installation and operation of the cooling towers that help cool the water in the Dresden Station cooling canal before it is discharged to the Illinois River." Resp. at 5. Exelon notes that the cooling tower system "consists of 54 helper cooling towers that were constructed between 1999 and 2002." *Id*., citing App. D at D-3 – D-5 (Discharge System).

NPDES Permit

Dresden discharges wastewater from the cooling pond to the Illinois River under the terms of National Pollutant Discharge Elimination System (NPDES) Permit No. IL0002224, issued by the Agency on December 1, 2011, and expiring on November 30, 2016. Exh. 1 at 3, 32; App. D at D-1; *see* Rec., Att. 1 (permit). Special Condition 3 of the permit establishes thermal limits based on the Board's regulations for operation in Closed Cycle mode. Pet. at 2, citing 35 Ill. Adm. Code 302.211 (general use water quality standards for temperature); Exh. 1 at 3; App. D at D-4. The condition restricts the discharge from causing natural temperatures in the Illinois River to rise more than 5ºF. Rec., Att. 1; Exh. 1 at 3; Att. D at D-4. It also restricts the discharge from causing river temperatures to exceed 60ºF from December to March and 90ºF from April to November, but the condition includes "an allowance of 3ºF above these maximum temperatures for 1% of the hours per calendar year." Att. D at D-4; *see* Rec., Att. 1; Pet. at 12; Exh. 1 at 3. Compliance with these standards "is measured at the edge of a mixing zone." Exh.

1 at 4; Att. D at D-5; Rec., Att. 1, citing 35 Ill. Adm. Code 302.102 (Allowed Mixing, Mixing Zones, and ZIDs).

Special Condition 3 also includes alternate thermal limits authorized by the Board for operation in Open Cycle mode. Pet. at 2; App. D at D-4, citing 401(c) Petition for Dresden Nuclear Generating Station, PCB 79-134 (July 9, 1981). The alternate limits provide that, from June 15 to September 30, the temperature of the discharge shall not exceed 90ºF more than ten percent of the time during that period and never will exceed 93ºF. Pet. at 13; Exh. 1 at 3-4; Rec., Att. 1. Compliance with this alternate standard is measured at the point of discharge from Dresden to the Illinois River. Pet. at 13; Rec., Att. 1; Exh. 1 at 4; App. D. at D-5.

In its questions, the Board noted language in the permit indicating that Dresden meets criteria for establishment of a mixing zone and also noted that the Agency's recommendation refers to a mixing zone. Board Questions at 4, citing Rec. at 2-3, 9, Att. 1. The Board asked Exelon to "clarify whether, from June 15 to September 30, compliance with the alternative thermal effluent limits would be measured at the Dresden Station's discharge point into the Illinois River instead of being measured at the edge of a mixing zone." Board Questions at 4. Exelon responded that compliance is measured at the discharge point. Resp. at 8. Exelon added that "[n]either the alternative thermal limit ordered by the Board in PCB 79-134 nor the alternate limit requested in this proceeding includes a mixing zone for measuring compliance with the thermal effluent limit in effect from June 15 to September 30." *Id*.

The Board also asked Exelon to explain the relevance of a mixing zone to compliance with an alternative thermal effluent limitation to be measured at the discharge point. Board Questions at 4. Exelon responded that, when Dresden is not subject to the alternative thermal limit, "compliance with the Board's generally applicable thermal standards is measured at the edge of a 26-acre mixing zone authorized by the Station's NPDES Permit and the Board's regulations." Resp. at 8. Exelon added that the concept of a mixing zone is useful for assessing impacts of Dresden's thermal plume. Exelon argues that "[t]he fact that there are no or minimal impacts beyond the boundaries of a conceptual mixing zone is strong evidence the balanced indigenous community[2] will be unaffected by the discharge." *Id*. at 9. Exelon asserts that, "if modeling shows that temperatures beyond the conceptual mixing zone may exceed upper limits for certain species within the BIC, Illinois EPA's finding that such occurrences will be infrequent and short-term provides evidence that the BIC will be preserved." *Id*.

[2] The Board's rules provide that "'balanced, indigenous community' is synonymous with the term 'balanced, indigenous population' in the CWA and means a biotic community typically characterized by diversity, the capacity to sustain itself through cyclic seasonal changes, presence of necessary food chain species, and by 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 pursuant to this Subpart or through regulatory relief from otherwise applicable thermal limitations under Chapter I of Subtitle C or standards granted by the Board." 35 Ill. Adm. Code 106.1110 (Definitions).

In addition, the Board also requested that Exelon clarify whether "[r]eceiving water temperatures outside any (State established) mixing zone will not be in excess of the upper temperature limits for survival, growth, and reproduction, as applicable, of any RIS occurring in the receiving water." Board Questions at 4, citing Draft Manual at 71. Exelon states that, because the current or requested alternate limits do not include a mixing zone, the cited provision of the Draft Manual is inapplicable. Resp. at 9. Exelon adds that the Draft Manual does not apply RIS methodology to retrospective demonstrations. *Id*. Exelon argues that the retrospective analysis shows "that past operations have not caused prior appreciable harm to the BIC" and "fully supports a finding that the Demonstration is successful regardless of mixing zone considerations." *Id*.

In its questions, the Board noted that Special Condition 3 applies the alternative thermal effluent standards to cooling pond blowdown through Outfall 002. The Board also noted that Special Condition 18 requires a thermal demonstration without identifying a specific outfall. Board Questions at 3. The Board requested that Exelon "clarify whether the requested alternative thermal effluent limitation applies only to Outfall 002 Cooling Pond Blowdown." *Id*. Exelon responds that "Outfall 001 applies to Unit 1, which was removed from service in 1979." Exelon states that, it if discharges from that outfall, it will be subject to generally-applicable thermal limits. Resp. at 7. Exelon states that its request "applies only to Outfall 002 – Cooling Pond Blowdown." *Id*. Exelon adds that the U.S. Army Corps of Engineers designed and installed an Outfall 004 "operated by the Illinois Emergency Management Agency for the purposes of preventing ice jams, and related flooding, that occur in the winter." *Id*. at 8. Exelon stresses that Outfall 004 "is not operated in the months during which the proposed alternative thermal limits would apply." *Id*.

In its questions, the Board noted that one of the conditions of the relief granted in PCB 79-134 was that Exelon's predecessor conduct specified hydrothermal and environmental monitoring studies. Board Questions at 2, citing 401(c) Petition for Dresden Nuclear Generating Station, PCB 79-134, slip op. at 4 (July 9, 1981). The Board requested that Exelon "provide results of the monitoring studies required by this condition or explain whether and how the studies were incorporated into the current petition." Board Questions at 2. Exelon submitted results of the studies as attachments to its responses. Resp. at 6, citing Resp. Atts. 12, 13.

Special Condition 18 of the permit states that Exelon had demonstrated under Section 316(a) of the CWA that the thermal discharge from Dresden "has not caused and cannot be reasonably expected to cause significant ecological damage to receiving waters" as approved by the Board in 401(c) Petition for Dresden Nuclear Generating Station, PCB 79-134, and Commonwealth Edison Co. v. IEPA, PCB 73-359 (granting variance). Rec., Att. 1; *see* Pet. at 15 (noting previous retrospective analysis of 1971-1974 monitoring data). The condition also provides that,

> [p]ursuant to 40 CFR 125.72(c), the permittee shall submit an updated [Section] 316(a) demonstration based on current facility operating conditions. This update demonstration may include new studies or other information necessary to support the seasonal alternative effluent limitations granted under the original

demonstration. This information shall be submitted with the next permit renewal application. Rec., Att. 1; *see* Pet. at 13.

Compliance History and Provisional Variances

Exelon reports that Dresden has operated in compliance with the thermal discharge limits in its NPDES permit during the past five years, except that it was granted provisional variances allowing it to exceed those limits in 2011 and 2012. Pet. at 11; *see* 35 Ill. Adm. Code 106.1130(c). In 2011, Dresden "was granted an additional 100 hours during which the discharge temperature could exceed 90ºF." Pet. at 11; *see* Resp. Att. 3. In 2012, Dresden was granted four provisional variances. From March 21 through March 31, the provisional variance provided that "[w]ater temperature at [the] edge of [the] mixing zone shall not exceed 60ºF by more than 5ºF or 2ºF above ambient river temperature, whichever is greater." Pet. at 11; *see* Resp. Att. 4. From July 6 through July 16 and again from July 18 through August 1, a provisional variance established that the "[t]emperature of [the] Plant's discharge cannot exceed 95ºF." Pet. at 11; *see* Resp. Att. 5, Resp. Att. 6. From August 3 through August 16, a provisional variance "granted an additional 14 days during which the Plant's discharge may exceed 90ºF." Pet. at 11; *see* Resp. Att. 7.

In its questions, the Board requested that Exelon provide a copy of the cited provisional variances and any extensions of them. Board Questions at 1. Exelon submitted copies of the cited provisional variances as attachments to its responses. Resp. at 3, citing Resp. Atts. 3-7. The Board also requested that Exelon indicate whether it "was required to perform any studies or provide reports to the Illinois Environmental Protection Agency or Illinois Department of Natural Resources as a condition of receiving the provisional variances." Board Questions at 1. If it had been required to do so, the Board requested that Exelon provide the copy of any report or study for the record. *Id*. Exelon submitted copies of those documents as attachments to its responses. Resp. at 3, citing Resp. Atts. 8-11. Exelon added that it did not locate a "report documenting conditions associated with the March 2012 provisional variance in its files, though it believes such a report was prepared and submitted to the Illinois EPA." Resp. at 3.

In its questions, the Board also asked Exelon to indicate whether Dresden had "received any violation notices related to discharge temperature during the last five years." Board Questions at 1. Exelon responded that "Dresden Station has not received any violation notices related to discharge temperatures during the last five years." Resp. at 3.

Data Collection Programs

Commonwealth Edison Company (ComEd), Exelon's predecessor, began performing studies to assess the potential effects of Dresden's operation on the Illinois River in 1968. Pet. at 14; App. E at E-1. "The earliest studies considered a wide scope of potential biological effects." App. E at E-1. More recent studies examined fish and benthic macroinvertebrate[3] communities

[3] A macroinvertebrate is "[a]n invertebrate animal (*i.e.,* without a backbone) large enough to be seen without magnification. Major groups of invertebrates include sponges, hydroids, flatworms, bryozoans, segmented worms, leeches, crayfish, insects, snails, and mussels. The life cycle of a macroinvertebrate goes from egg to adult form and they can undergo either complete

near the Dresden discharge. Pet. at 14; App. E at E-1. This recent emphasis "reflects the continued belief that if any long-term impacts should occur, these components of the biota are most likely to exhibit detectable changes that are representative of the entire aquatic community." App. E at E-1; *see* Pet. at 14-15.

Hydrographic

Dresden has used hydrographic data both in plant operations and in studying the plant's effects on the Des Plaines, Kankakee, and Illinois Rivers. App. E at E-1. One source of this data is the United States Geological Survey (USGS), which operates five gage stations in the vicinity of Dresden on the Du Page, Des Plaines, Kankakee, and Illinois Rivers. *Id*. at E-1 – E-2, citing USGS Current Water Data for Illinois (2014). "Depending on the station, data for stage and/or discharge, as well as select parameters such as temperature and velocity are available." *Id*. at E-2. The United States Army Corps of Engineers (USACE) is another source of hydrographic data, including information regarding navigational control structures upstream and downstream of Dresden. *Id*., citing USACE, Rivergages.com, water levels of rivers and lakes (2014).

Temperature

Thermal studies at Dresden began before Units 2 and 3 started operation in 1970 and 1971, respectively. App. E at E-2 (listing nine "most relevant" studies). These studies collected data for a number of purposes. *Id*. Initial studies "were baseline investigations used to evaluate the additions of Units 2 and 3 as well as for annual monitoring." *Id*. at E-3. A later study "addressed the operational change as proposed" in a Section 316(a) demonstration. *Id*., citing ComEd, 316(a)-410(c) Demonstration for the Dresden Nuclear Generating Station (1980). During the 1980s, studies characterized the thermal regime and monitored effects on biological communities in the receiving waters. App. E at E-3. EA Engineering, Science & Technology, Inc. (EA) conducted the most recent investigation in 2013-2014 "to examine alternative thermal limits, the distribution of thermal conditions, and the effects of those alternative conditions on the aquatic community" for Exelon's current demonstration under Section 316(a). *Id*. at E-3 - E-4.

Habitat

A 1992 study sought to characterize aquatic habitat in various segments throughout the Upper Illinois Waterway (UIW) to below the Dresden Island Lock and Dam. App. E at E-4. "In 1993 and 1994, habitat quality at individual fish and benthic macroinvertebrate sampling locations on the UIW was assessed using the Qualitative Habitat Evaluation Index (QHEI) to determine the extent to which that habitat is limiting the aquatic biota of the UIW." *Id*.; *see* App. A at A-22. QHEI measures factors affecting aquatic life: substrate, instream cover, channel

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or incomplete metamorphosis. Complete metamorphosis has four stages: egg, larvae, pupa, and adult. Organisms, which undergo complete metamorphosis, include true flies, beetles, and caddisflies. Many of these organisms are aquatic during the egg and larval stages, but not in the adult stage. Incomplete metamorphosis has three stages: egg, nymph, and adult. Organisms that undergo incomplete metamorphosis include stoneflies, mayflies, dragonflies, and true bugs. App. F at F-xiii - F-xiv; App. G at G-xvi.

morphology, riparian and bank condition, pool and riffle quality, and gradient. App. C at C-7. In 2014, EA performed a habitat assessment in the vicinity of Dresden to evaluate changes in aquatic habitat that may have occurred since 1994. App. E at E-4, citing App. G. The assessment included QHEIs at various locations. App. E at E-4. In addition, a 2014 mussel survey provided substrate characterization data. *Id.*, citing App. H.

Phytoplankton and Periphyton Communities

There have been numerous collections of phytoplankton and periphyton samples in the vicinity of Dresden since 1968. App. E at E-4 (citations omitted); *see* App. A at A-26. Between 1968 and 1977, samples were collected at a variable number of locations upstream and downstream of the Dresden discharge in the Des Plaines, Kankakee, and Illinois Rivers, and also collected at the cooling pond in 1972-73 and the discharge canal in 1977. App. E at E-4 - E-5. This sampling originally provided pre-operational assessment of Units 2 and 3 and monitoring data. In addition, ComEd used results from 1972 through 1974 to develop its 1980 demonstration under Section 316(a). *Id.* at E-5.

The 1981 sampling program intended to “sample the same water mass as it moved from one sampling point to the next within the DNS cooling system.” App. E at E-5. The program also sought “to describe changes in algal assemblages as they passed from the Des Plaines and Kankakee Rivers” through Dresden under an indirect open cycle. *Id.*

Through 1981, studies collected composite samples “using a grab sampler for phytoplankton while periphyton samples were collected by scraping natural or artificial substrates.” App. E at E-5. Analysis of the samples determined composition and density of phytoplankton. *Id.* In addition, “Shannon-Weaver diversity and evenness were calculated along with temporal and spatial comparisons to assess the phytoplankton assemblage.” *Id.* Some of the studies performed during this time also assessed chlorophyll production. *Id.*

Studies in 1991 and 1993 examined the entire UIW “to assess the algal community system-wide, evaluate the effects of various power generating stations along the waterway, and characterize the importance of tributary inputs to the algal community of the UIW.” App. E at E-5, citing ComEd, Final Report: Aquatic ecological study of the Upper Illinois Waterway (1996). The study collected samples from locations upstream of Dresden and downstream from the Dresden Island Lock and Dam. App. E at E-5. These studies “analyzed composite samples to determine community composition, density, and chlorophyll concentration.” *Id.* Analysis also included “Shannon-Weaver diversity and similarity along with trichromatic chlorophyll and spatial retention time comparisons.” *Id.*

Zooplankton

Until 1981, limited zooplankton sampling occurred near Dresden during open-cycle operation. App. E at E-5 (citations omitted); *see* App. A at A-26. Quarterly samples were collected both upstream of Dresden in the Des Plaines and Kankakee Rivers and downstream from Dresden’s discharge. App. A. at A-26; App. E at E-5. The studies sought “to document and characterize the spatial and temporal distribution of the community.” App. E at E-5. Results were compared to address composition, taxa richness, and density. *Id.*

Benthos[4]

Numerous surveys of benthic microinvertebrates in the vicinity of Dresden took place from 1968 to 2014. App. A at A-27; App. E at E-6 (citations omitted). "The studies have been conducted primarily to characterize the benthic community composition, statistically analyze temporal and/or spatial differences, and examine these results in respect to potential effects" of the Dresden discharge. App. A at A-27; App. E at E-6. However, the scope of the studies and assessment methods varied until 2001. *Id*. From 2001 to 2014, each of the 11 studies evaluated the benthic community at six locations in the Des Plaines, Kankakee, and Illinois Rivers both upstream and downstream from the Dresden Island Lock and Dam. *Id*. The studies obtained samples by using a combination of Hester-Dendy (HD)[5] artificial substrate samplers and Ponar[6] samplers. *Id*.

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[4] "Benthos" is a "[c]ollective term for aquatic organisms living in or on the bottom substrates and large enough to be seen with the naked eye. . . . Benthic macroinvertebrates help maintain the health of the water ecosystem by eating bacteria, dead and decaying plants, and animals, and are a source of food for other organisms. USEPA indicates that benthic macroinvertebrates make good indicators of watershed health because they live in the water for all or most of their life, stay in areas suitable for their survival, are relatively easy to collect, differ in their tolerance to the amount and types of pollution, often live for more than one year, have limited mobility, and are integrators of environmental condition." App. F at F-xi; App. G at G-xiii.

[5] HD "sampling gear provides an artificial substrate for benthic macroinvertebrate organisms to colonize. They are used where the substrate (rock) will not allow grab samples or there is an interest in data from locations above the bottom substrate. The HD multiple-plate substrate sampler mimics substrates by providing cover and narrow openings, such as found under, between rocks, under, or in leaves or woody debris. The hardboard plates are stacked on top of each other and divided by spacers. The plates have smooth surfaces on each side, are fastened together with a long eyebolt, and can easily be disassembled for specimen examination. A good collection of insect larva and other organisms can be attracted when the sampler is left in place for four or more weeks. After the samplers are recovered, the insects that have colonized the surfaces are counted and identified. Since the surface area of the plates is known, the multiple-plate samplers yield quantitative results." App. F at F-xiii (Definitions); App. G. at G-xv (Definitions).

[6] A Ponar sampler "is used to collect samples of benthic macroinvertebrates in the bottom substrate. The Ponar grab (or dredge) sampler consists of two opposing semi-circular jaws that are normally held open by a trigger mechanism. It is called a grab sampler because of the manner in which it obtains samples. The sampler is lowered to the bottom where contact with the bottom sets off the trigger and a strong spring snaps the jaws shut trapping a sample of the bottom inside. A fine screen covers the top of the jaws so that the trapped material will not wash out as the sampler is retrieved. The grab sampler provides a means to obtain a somewhat quantitative and undisturbed sample of the bottom material. The Ponar sampler is a commonly used sampler that is very versatile for both soft and hard bottoms such as sand, gravel, and clay. Samples retrieved from the sampler are preserved and returned to the laboratory for analysis." App. F at F-xiv; App. G. at G-xvi.

Information on native mussels near Dresden is limited. App. E at E-6. "Freshwater mussels were occasionally taken with the Ponar dredges used for the benthic macroinvertebrate surveys." App. A at A-28. In 2014, Exelon commissioned a survey of the mussel community both upstream and downstream from the Dresden discharge. App. E at E-7, citing App. H. The survey sought to characterize the community and evaluate it with regard to the Dresden discharge. App. A at A-29; App. E at E-7. Over 2,300 meters of the Illinois River, "[s]emi-quantitative sampling was conducted along 30 transects with qualitative sampling in between transects. In addition, substrate was visually examined and composition estimated." App. E at E-7.

Macrophytes

"[M]uch of the vegetation disappeared from the Illinois River and its bottomland lakes by the 1960s." App. E at E-7; *see* App. A at A-24. Reappearance of aquatic vegetation in the Dresden Pool in the 1980s triggered studies of vegetation and habitat in the lower Des Plaines River. App. E at E-7 (citations omitted); *see* App. A at A-24. These studies included low-altitude aerial photographs, mapping aquatic vegetation, collecting specimens for identification, and measuring biomass. App. E at E-7. From 1992 to 1995 an aquatic macrophyte study of the UIW investigated "the physical[,] chemical and biological factors that may limit establishment and/or growth of these communities. . . . Results from this study and previous studies indicated that the resident aquatic macrophyte community in Dresden Pool remained relatively stable over a 10-year period." *Id*., citing ComEd, Final Report: Aquatic ecology study of the Upper Illinois Waterway (1996); *see* App. A at A-24. The 2013 and 2014 surveys of the thermal plume, fish, and mussels include additional observations of macrophyte production in the vicinity of the Dresden discharge. App. A at A-24; App. E at E-7.

Fishery

In most years since 1971, fish near Dresden have been monitored. App. E at E-8. Initial studies consisted of quarterly seining[7] "to characterize the fish community composition in the study area." *Id*. Later studies relied on electrofishing[8] and increased the number of sampling

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[7] "Seining" is "[t]he process of using a seine net to sample fish in ponds or streams. A seine net has fine mesh netting attached to a sturdy stake or pole at each end. The netting is equipped with an upper float line and lower weighted line to keep the net in a vertical position when stretched horizontally and dragged through shallow waters. . . . The technique involves pulling the seine along the bottom in shallow waters where many types of small and young fish are found." App. F at F-xv; App. G at G-xvii.

[8] Electrofishing is "a fish collection technique that employs an electric current to attract (DC current) or temporarily stun (AC current) fish enabling them to be captured so they can be weighed and measured. . . . Dip nets are used to retrieve fish that have been stunned. Electrofishing is a useful sampling technique because it provides a good indication of which species are present in a waterway. . . . Electrofishing efficiency is affected by stream conductivity, temperature, depth, and transparency (clarity) of water. App. F at F-xii; App. G at G-xiv.

locations. *Id*. Study objectives shifted "to spatial and temporal assessments of the fish community" with regard to Dresden operations. *Id*. "From 1980 to 1994, the river fish monitoring program evolved into its present general scope." *Id*. (citations omitted); *see* App. A at A-30. In addition, three studies of fish within the Dresden cooling pond were conducted in the 1970s "to characterize the fishery over time and provide guidance for management objectives." App. E at E-8, citing Hazleton Environmental Sciences Corporation, Fisheries studies at Dresden Station (1978).

<u>Ichthyoplankton</u>

During 1976 and 1977, ichthyoplankton[9] surveys sought to estimate entrainment in the intake canals during plant operation. App. E at E-8 (citations omitted). "Fish eggs and larvae as well as other small organisms are susceptible to entrainment." App. F at F-xii; App. G at G-xiv. In 1978, sampling in the discharge canal sought to estimate escape from the cooling pond. *Id*. (citation omitted). In 1993 and 1994, a study of ichthyoplankton in the UIW intended "to determine what portion of the fish community in the Illinois River drainage was using the UIW as a spawning or nursery area as well as when and where use occurred." *Id*. at E-9, citing ComEd, Final Report: Aquatic ecological study of the Upper Illinois Waterway (1996); *see* App. At at A-31. A study conducted in 2005 and 2006 assessed ichthyoplankton in the Kankakee River near the intake canal and in the intake and discharge canals. App. E at E-9, citing EA, Entrainment Characterization Study, 2005-2006, Dresden Station (2007); *see* App. A at A-31.

<u>Impingement</u>

At various times until 1986, studies estimated impingement of fish in the Dresden intake and escape from the cooling pond. App. E at E-9. In 2005-2007, Exelon conducted additional studies to provide current information on impingement of fish and select shellfish. *Id*., citing EA, Impingement Mortality Characterization Study, 2005-2007, Dresden Station (2007); *see* App. A at A-31.

<u>Ecological Setting</u>

<u>Hydrology</u>

Dresden is situated just downstream of the confluence of the Des Plaines and Kankakee Rivers where they form the Illinois River. In 1871, the flow of the Chicago River was reversed so that wastes from the City of Chicago were directed "through the Illinois and Michigan (I&M) Canal into the Des Plaines River and subsequently into the Illinois River." App. A at A-1. Beginning in 1900, the Chicago Sanitary & Ship Canal provided added flow of diverted Lake Michigan water that ultimately entered the Des Plaines River. *Id*. In 1919, the State began construction of the Illinois Waterway to provide a larger channel from Lake Michigan to the Mississippi River. *Id*. The project included construction of locks and dams, including the

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[9] Ichthyoplankton refers to the "early life stages of fish, *i.e.*, eggs, larvae, and early juveniles" that occur in the water column. Exh. 1 at 27; App. C at C-15.

Dresden Island Lock and Dam, which is 22 feet high and situated approximately two miles downstream from the confluence of the Kankakee and Des Plaines Rivers. *Id*.

"The mean annual flow of the Des Plaines River just above its confluence with the Kankakee River is 6,080 cfs; seasonal flows parallel those of the Illinois River." Exh. 1 at 33; App. A at A-2. "Flows in the Des Plaines River are derived principally from three sources: discharge from Chicago area storm drains and wastewater treatment plants, flow diversion from Lake Michigan, and runoff from its 1,500 square mile drainage area." App. A at A-1.

"The mean annual flow of the Kankakee River near Wilmington, Illinois from 1934 to 1999 was 4,739 cfs (ranging from 1,965 to 8,153 cfs); seasonal flows parallel those of the Illinois River." Exh. 1 at 33; App. A at A-2. The Kankakee River drains 5,165 square miles. App. A at A-1.

The mean annual flow of the Illinois River at Marseilles, Illinois downstream from Dresden was 10,820 cfs (ranging from 7,568 to 16,380 cfs) from 1920 to 1999. Exh. 1 at 33-34; App. A at A-2. "Flows tend to be highest in spring (March – May), when the Upper Illinois River Basin receives snowmelt and runoff from spring rains, and lowest during late summer and early fall (August – October) when precipitation in the region is lowest." Exh. 1 at 34, citing USGS, Water Year 1999 Annual Report (2000).

The Dresden Island Lock and Dam forms Dresden Pool, which has "natural, as opposed to armored, shoreline areas and a number of tributaries." App. A at A-2. Near Dresden, pool habitat is characterized by "[e]xtensive shallow areas with patches of rubble and aquatic vegetation." *Id*. In some areas, fallen trees provide cover. *Id*. "Silt substrates characterize a majority of the area; however, there are some areas with sand substrates." *Id*. While much of the area is standing water, the dredged Dresden discharge canal has "a swift current and riprapped substrates colonized with periphytic algae." *Id*. (citation omitted). Dresden Pool and upstream pools at Brandon Road and Lockport have had "a wide variety of historical and present-day sources of pollutants. . . . As a result, the water column and sediments have been contaminated by these sources along the river and its tributaries." *Id*.

<u>Water Quality</u>

> The lower Des Plaines River has been heavily impacted for nearly a century by channelization of the Des Plaines River, construction of the Dresden Island Lock and Dam in 1933, periodic dredging, stormwater runoff from expansion of upstream urban areas, and its use as a conduit for sanitary and industrial discharges from the greater Chicago metropolitan area within the Upper Illinois River Basin. App. A at A-8.

The Des Plaines River is listed as an impaired water body by USEPA for dissolved oxygen, fecal coliform, mercury, total nitrogen, total phosphorus, polychlorinated biphenyls (PCBs), silver, and pH. Exh. 1 at 33. "The lower Des Plaines River, Kankakee River, and Dresden Pool are on the State of Illinois list of impaired waters due to priority organics, metals, nutrients, and siltation." App. A at A-8, citing IEPA, Illinois Integrated Water Quality Report and Section 303(d) List (2014). However, the Board notes that, in a recent rulemaking proceeding, the Board stated that it "continues to believe that the CWA aquatic life goal is attainable" in the Upper Dresden Island Pool (UDIP), the segment of the Lower Des Plaines River extending from the Brandon Road Lock and Dam to the Interstate 55 bridge. 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(C), slip op. at 54 (Nov. 21, 2013).

Dresden's current permit "specifies effluent limits for pH, total residual chlorine, oil, grease, biological oxygen demand, fecal coliform, total suspended solids, boron, temperature, and flow." App. A at A-8; Rec., Att. 1 at 5 (setting effluent limitation for oil/grease). Dresden monitors water quality parameters including temperature, dissolved oxygen, specific conductivity, and water transparency from May to September at points above and below its discharge. *Id*. at A-9, citing App. F, App. G.

Temperature. Dresden's aquatic monitoring program from 1991 to 2014 shows that "June through September water temperatures ranged from 15.8º to 35.0ºC (60.4 to 95.0ºF)." App. A at A-9. The warmest temperatures were in the discharge canal, and the coolest temperatures were upstream of the discharge in either the Des Plaines or Kankakee River. *Id.* "Mean temperatures have been less than 30.6ºC (87.1ºF) with all locations outside the discharge canal being 0.3º to 7.5ºC (0.5 to 13.5ºF) cooler." *Id.*

Dissolved Oxygen (DO). DO data from 1987-1990 obtained through a USGS study of the upper Illinois River basin show that "[m]edian DO concentrations ranged from 3.4 to 12.2 milligrams per liter at eight long-term monitoring stations in the basin." App. A at A-10. However, "[d]uring low-flow conditions, DO concentrations at 59 percent of the sites in the agricultural Kankakee River Basin and 49 percent of the sites in the urban Des Plaines River Basin were less than the Illinois water-quality standard of 5.0 milligrams per liter." *Id.*

Data from the Agency's monitoring station on the Des Plaines River in Joliet from March 2006 through December 2011 show that DO concentrations ranged from 0.45 milligrams per liter (mg/L) to 11.66 mg/L. App. A at A-10. "DO concentrations averaged 7.46 mg/L over the available data record." *Id*.

Dresden's long-term monitoring program shows June-September DO concentrations ranging from 2.8 to 17.5 parts per million (ppm) with monitoring locations averaging from 7.5 to 10.6 ppm. App. A at A-10. Concentrations were generally higher in the Kankakee River and lower "in the discharge canal and thermally-influenced locations in Dresden Pool." *Id*. "DO concentrations were consistently above the General Use minimum standards for the Upper Illinois Waterway (UIW) of 5.0 ppm, at all times from March through July, and 3.5 ppm from August through February." *Id*.

In its questions, the Board noted the Agency's statement that "[t]his segment of the Illinois River is subject to enhanced dissolved oxygen standards." Board Questions at 7, citing Rec. at 2; *see* 35 Ill. Adm. Code 302.206(c). The Board further noted that the only Illinois River segment listed for enhanced DO protection is Segment 236. Board Questions at 7, citing 35 Ill.

Adm. Code 302.APPENDIX D (Section 302.206(d): Stream Segment for Enhanced Dissolved Oxygen Protection). The Board asked Exelon to elaborate on the statement that Dresden "operations have not been shown to impact dissolved oxygen levels in the upper Illinois River Basin." Board Question at 7; *see* App. A at A-10.

Exelon responded that its demonstration should have cited the enhanced DO limit of 4.0 ppm as applicable to Segment 236 instead of the general use limit of 3.5 ppm. Resp. at 16-17. Exelon states that there have been concentrations below that standard upstream from Dresden in the Des Plaines and Kankakee Rivers but that downstream concentrations have consistently been above both the General Use and enhanced DO limits. *Id*. at 17. Exelon argues that these results show that the Dresden discharge "has not resulted in DO concentrations lower than the water quality standards for Segment 236 of the Illinois River Basin." *Id*.

The Board also asked Exelon to "address the impact of the proposed alternative thermal effluent limitation in Segment 236 under the enhanced dissolved oxygen standards." Board Questions at 7. Exelon cites conditions during 1999 to illustrate this impact of the discharge on DO levels. Exelon states that extreme conditions that year caused intake temperatures to exceed 90ºF and necessitated provisional variances. Resp. at 17. These variances required special studies in addition to routine sampling. The studies included biological sampling, water quality measurements, and supplemental DO and temperature data. *Id*., citing Resp. Att. 14, App. A (Physiochemical Measurements); Table 4 (Summary of Water Temperature (C) and Dissolved Oxygen (ppm) Profile Measurements Near Dresden Station, 1999).

Exelon states that monitoring in 1999 showed intake temperature ranging from 88.5ºF to 94.1ºF and discharge temperature as high as 96.6ºF. Resp. at 17. Exelon reports that "DO levels within and downstream from the Station discharge were consistently above 5.0 ppm." *Id*., citing Resp. Att. 14. Exelon concludes that these data demonstrate that, "even under extreme thermal conditions, the proposed alternative limits will not reduce DO levels below prescribed standards." Resp. at 17.

Finally, the Board noted testimony in support of the current alternative thermal effluent limitation stating that "[i]ndirect open cycle operation benefits water quality in the Illinois River by . . . adding dissolved oxygen. . . ." Board Questions at 7, citing 401(c) Petition for Dresden Nuclear Generating Station, PCB 79-134, slip op. at 3 (July 9, 1981). The Board asked Exelon to "comment on the applicability of this earlier testimony regarding dissolved oxygen to the pending petition." Board Questions at 7. Exelon responded that the Board apparently refers to the testimony of Dr. Ben Ewing, who was at the time a professor of Environmental Engineering at the University of Illinois. Resp. at 17, citing Resp. Att. 15. Exelon summarized Dr. Ewing's opinion: "during periods of low flow in the Kankakee River, much of the flow into the Illinois River would be from the Des Plaines River which has lower DO levels than the Kankakee. On such occasions the contribution of DO from cooling pond water discharged during indirect open cycle operations would actually serve to increase DO concentrations in the Illinois River." Resp. at 17-18; *see* Resp. Att. 15. Dr. Ewing attributed this increase to factors such as cooling pond surface aeration and "the cascading of water over the spillway at the pond outlet." Resp. Att. 15 at 50.

Sediments

"The Des Plaines River transports moderate to high quantities of sediments that enter the river from row crop farming, mining, and urban development. . . ." App. A at A-21. The demonstration states that this "reflects a substantial increase in inputs from erodible agricultural lands." *Id*. Sediment near Chicago reveals some of the highest levels nationally of polycyclic aromatic hydrocarbons (PAHs). PAHs "are formed by the incomplete combustion of hydrocarbons, namely coal, oil, gasoline and wood and can result from many urban sources including fires, industrial and power plant emissions, home heating, and automobile and other vehicle emissions." *Id*. "PAHs are toxic to aquatic life, and several are suspected carcinogens, causing tumors in fish and other animals." *Id*., citing USGS, Water Quality in the Upper Illinois River Basin 1999-2001 (2004).

In 2008, Northern Illinois Hydropower, LLC analyzed sediment at four locations in Dresden Pool and two downstream of the Dresden Island Lock and Dam. App. A at A-19. The survey detected concentrations of several metals exceeding Tier 1 Soil Remediation Objectives in the impoundment. *Id*.; *see* 35 Ill. Adm. Code 742 (Tiered Approach to Corrective Action Objectives). "Sediment analysis detected arsenic at 26.2 mg/kg, chromium at 478 mg/kg, lead at 482 mg/kg, and mercury at 0.83 mg/kg. Downstream of the dam, mercury was detected at 0.15 mg/kg." App. A at A-19.

Aquatic Habitats

Studies of the UIW near Dresden in the 1990s showed that "any riverine habitat that existed prior to hydrologic regulation of the waterway for navigation has largely been diminished and replaced with lentic-like pools." App. A at A-22 – A-23; *see* App. E at E-4. Near Dresden, the dominant habitat type was main channel. App. A at A-23; App. B at B-23; App. G at G-42; *see* App. A, Figure A-2, App. B, Figure B-17 (Distribution of habitat in the Illinois, Des Plaines, and Kankakee Rivers within the area bounded by the hydrothermal model for the DNS cooling water discharge); App. G, Figure G-2. As measured by QHEI, main channel "was lowest among all habitat types, consistently in the poor to fair range." App. A at A-23.

A 2014 survey sought to evaluate habitat changes that may have occurred since the 1990s. App. E at E-4. Results of the survey showed that "habitat complexity and quality have changed only minimally." App. A at A-23; *see* App. E at E-4; App. G. at G-43. QHEI scores continue to fall in the fair or poor category. App. A at A-23; App. G at G-43; *see* App. G, Tables G-38, G-39, G-40 (Summary of QHEI Metric Scores for the Dresden Nuclear Generating Station Sampling Stations, July 2014, September 2014, and July/September 2014).

Substrate complexity near Dresden is "generally low." App. A at A-23, citing App. A, Figure A-2, App. H. "Gravel is the predominant substrate type throughout the area followed by silt, sand, and clay." App. A at A-23. Coarse substrates such as boulder and cobble are not generally present upstream of the Dresden Island Lock and Dam. Downstream of the dam, the predominant substrate is gravel, followed by sand and cobble. *Id*.

Several areas, chiefly upstream from Dresden, provide shallow habitat and increase habitat diversity. App. B. at B-23. "These shallows typically have substrates comprised of silt and detritus overlaying sand, gravel, or cobble." *Id*.; *see* App. B, Figure B-17 (map of distribution of habitat). These areas may feature scattered submerged aquatic vegetation or floating vegetation and may also provide spawning habitat for various fish species. App. B at B-23. Aquatic vegetation can also provide cover and foraging habitat for predator species. *Id*. at B-24.

Fish

Dresden sought to "determine and compare the composition, distribution, abundance, condition, and incidence of anomalies of fish within and among the segments above and below the Dresden discharge and upstream and downstream of the Dresden Island Lock and Dam." Exh. 2 at 4.

The 2013 monitoring program ran from July through September and included 45 gear efforts, 24 electrofishing and 21 seining, at eight locations in the Dresden Pool and downstream of the Dresden Island Lock and Dam. App. F at F-14. "3,708 fish were collected representing 50 species and one hybrid. . . . Collectively, the 15 most abundant species accounted for 91 percent of the numerical catch. . . . Thirteen species accounted for 96 percent of the biomass collected." *Id*. at F-1, citing App. F, Table F-3 (Species Composition, Number, Biomass, and Relative Abundance of Fish Collected Near Dresden Nuclear Generating Station, 2013).

The 2014 monitoring program ran from May through September and included 120 gear efforts, 64 electrofishing and 56 seining, at 10 locations in the Dresden Pool and downstream of the Dresden Island Lock and Dam. App. G at G-14. "12,986 fish representing 71 species, and two hybrids were collected." *Id*. at G-1, citing *id*., Tables G-2 (List of Common and Scientific Names for Fish Taxa Collected Near Dresden Nuclear Station, 2014), G-3 (Species Composition, Number, Biomass, and Relative Abundance of Fish Collected Near Dresden Nuclear Generating Station, 2014). "[T]he 19 most abundant species accounted for 91 percent of the numerical catch. . . . Fifteen species accounted for 91.7 percent of the total biomass. *Id*. at G-14.

Dresden Pool (2013). Sampling in Dresden Pool in 2013 "yielded 2,746 native fish representing 45 species and one hybrid. . . . Collectively, 14 species accounted for 92.4 percent of the total catch." App. F at F-2, F-19, citing App. F, Table F-5 (Species Composition, Number, Biomass, and Relative Abundance of Native Fish Collected From Dresden Pool, 2013). Based on all electrofishing trips combined, mean native species richness above the Dresden discharge was 13 and below it was 10. App. F at F-20; App. F at Table F-7. Native species richness upstream and downstream of the Dresden discharge were statistically similar to one another. *Id*. at F-20, Table F-7.

Catch per Effort (CPE)[10] for native fish based on all electrofishing trips combined was 253.1 fish per km above the Dresden discharge and 160.1 fish per km below it. App. F at F-20,

[10] Catch per Effort (CPE) is "[a] common method fisheries biologists use to compare the relative abundance of fish between one area and another, where the only common link is the method used to catch the fish. CPE is the catch of fish in numbers or weight taken by a defined effort," *e.g.*, the number of fish captured divided by the amount of time it took to catch the fish (fish per hour)." App. F at F-xi; App. G at G-xiii.

citing App. F, Table F-7 (Results of Upstream v. Downstream Statistical Comparisons for Electrofishing Catch Parameters Near Dresden Nuclear Station). CPE upstream and downstream of the Dresden discharge were statistically similar to one another. App. F at F-20; App. F at Table F-7.

Based on the Ohio EPA's Modified Index of Well Being (IWBmod)[11] scores, "Dresden Pool would be classified fair, as it has been during most study years." *Id*. at F-2 – F-3. For all electrofishing trips combined, mean IWBmod above the Dresden discharge was 7.2 and below it 6.8. App. F at F-20; App. F at Table F-7. IWBmod upstream and downstream of the Dresden discharge were statistically similar to one another. App. F at F-20; App. F at Table F-7.

Analysis of the 2013 monitoring also examined these parameters based solely on results of electrofishing trips in July/August, "typically the period of highest air temperatures and high power demand." App. F at F-21. For those July/August trips, mean native species richness above the Dresden discharge was 14 and below it was 10. *Id*; App. F at Table F-7. Native fish CPE averaged 211.7 fish per km above the discharge and 127.5 below it. App. F at F-21; App. F, Table F-7. During July/August, mean IWBmod was 7.4 upstream and 6.8 downstream from the Dresden discharge. App. F at F-21; App. F, Table F-7. "[D]uring July/August when the river temperature was highest and discharge temperatures are typically at their maximum," there were no statistically significant differences in native species richness, native species CPE and IWBmod scores upstream and downstream from the Dresden discharge. App. F at F-21; App. F, Table F-7.

Analysis of the 2013 monitoring results also compared electrofishing catch rates, relative abundance, and total species "between the two seasonal groups [July/August and September] for all Dresden Pool locations combined." App. F at F-21, citing App. F, Table F-9 (Comparison of Electrofishing CPEs (no./km) and relative Abundance Between Sampling Periods for Native Species Collected from Dresden Pool, 2013). While more species were collected in July/August, "CPE was higher in September." App. F at F-21. "CPEs for all native fish, IWBmod scores, and mean native species richness were not statistically different between sampling periods." *Id*., citing App. F, Table F-10 (Results of Statistical Comparisons Between Sampling Periods for Electrofishing Data Collected from Dresden Pool, 2013).

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[11] The Index of Well Being (IWB) is "a composite index that combines several parameters to help assess the health of a community. The four parameters that comprise the IWB are (1) fish density (number), (2) fish biomass (weight), (3) Shannon-Weiner Index of Diversity based on numbers of fish, and (4) Shannon-Weiner Index of Diversity based on weight of fish." App. F at F-xiii, App. G at G-xv – G-xvi. The Modified IWB (IWBmod) excludes the "weight and number of 13 common pollution-tolerant fish species, although these taxa are included in the fish diversity calculations. This makes the index more sensitive to a wider array of environmental disturbances, particularly those that result in shifts in community composition without large reductions in species richness, numbers, and/or biomass. This modification eliminates the 'undesired' effect caused by a high abundance of tolerant species like common carp (which clearly is the case in the Upper Illinois Waterway), but retains their 'desired' influence on the diversity indices." App. F at F-xiv; App. G at G-xvi.

The 2013 electrofishing data were also "compiled and compared among results from 16 years of monitoring to assess potential impacts on the fish community related to thermal conditions." App. F at F-23. Total CPE of native species for 2013 of 141.1 fish per km was "somewhat below the long-term average" of 150.1 fish per km but was "statistically similar to all years except 1994." *Id*. at F-24, citing App. F, Table F-14 (Results of Statistical Comparisons Among Years for Electrofishing Data Collected from Dresden Pool for the Period of 15 June through August 1994, 1995, 1997-2008, 2011, and 2013). The 2013 IWBmod score of 7.0 "is statistically similar to the [1994-2013] scores except the significantly lower scores in 1994 and 1999." App. F at F-24. Under the Ohio EPA classification, the fish community in the Dresden Pool during the June-August period would be categorized as fair in 2013 and all other years except 1994, 1995, and 1999. *Id*. at F-25 – F-25. The 2013 mean native species richness value of 10.7 "was statistically similar to all years" and "higher than 10 of the 16 years." *Id*. at F-25, citing App. F, Table F-14.

The 2013 monitoring program also assessed the condition of fish using relative weight (*Wr*)[12] for six species. App. F at F-3. During 2013, monitoring collected 604 fish representing 14 native species that met criteria for minimum length in published standard weights (*Ws*). *Id*. at F-26, citing App. F at Table F-15 (Comparisons of Mean Relative Weights Among Sampling Periods for All Native Species Collected from Dresden Pool, 2013). "Ten of these 14 species were represented by low numbers of individuals in some or all of the months, samples that were too small for monthly comparisons of mean *Wr* values." *Id*. at F-26. For the remaining four species, composite mean *Wr* values ranged from 84 to 114. *Id*., citing App. F at Table F-16 (Statistical Comparisons of Mean Relative Weights Between Sampling Periods for Selected Native Species Collected from Dresden Pool, 2013). "Based on relative weight, condition of these species was good in 2013." App. F at F-3. Between 1994 and 2013, catches of six species allowed annual comparisons of mean *Wr* values. *Id*. at F-26, citing App. F, Table F-17 (Annual Mean Relative Weights for All Native Species Collected from Dresden Pool During the Period 15 June - August, 1994, 1995, 1997-2008, 2001, and 2013). Results of these comparisons show that populations of these species "typically were in average or better than average condition, which suggests that there have not been significant health, food availability, and/or feeding relationship problems for these species." App. F at F-28.

The monitoring program also examined 1,795 fish collected in 2013 for external Deformities, Erosions, Lesions, and Tumors (DELT)[13] anomalies. App. F at F-3, F-29. "DELT

[12] Relative weight is "a condition index that quantifies fish condition (*i.e.*, how much does a fish weigh for its length). . . . While growth may be difficult to measure, condition or plumpness of fish is easy to measure and indicates if fish are under stress. Relative weight is the ratio of the actual weight of a fish to what a rapidly growing healthy fish of the same length should weigh, called standard weight (*Ws*) that are published in the scientific literature. Fish with high relative weights are plump while those with low relative weights are thin. A *Wr* range of 90-100 is a typical objective for most fish species. When mean *Wr* values are well below 100 for a size group, problems may exist in food and feeding relationships." App. F at F-xiv; App. G at G-xvi – G-xvii.

[13] "DELT anomalies (Deformities, Erosions, Lesions, and Tumors) are a subset of external anomalies. . . . An external anomaly on fish is defined as the presence of externally visible skin or just under the skin disorders, and is expressed as a percentage of fish among all fish

anomalies were observed on 2.4 percent of the catch [43 fish] within the Dresden Pool study area," and fin erosion accounted for more than 90 percent of these anomalies. *Id*. at F-3. The incidence rate of DELT anomalies fell from 2.8 percent and 10 species in July/August to 1.9 percent and nine species in September. *Id*. at F-29. "Since 1998, and except for 2000 and 2004 when DELT incidence rate was in the poor category, fish collected from the Dresden Pool have been in the fair category for DELT anomalies." *Id*. at F-3, *see* App. F, Table F-22 (Inter-Year Comparisons of DELT Anomalies Within Dresden Pool for the Period of 15 June through August 1994, 1995, 1997-2008, 2011, and 2013). Bottom feeders such as common carp and channel catfish generally show the highest rates of affliction with DELT anomalies in the Dresden Pool, suggesting "that substrates within the study area, as well as other upstream areas in the UIW, likely contain contaminants that are responsible for many of the DELT anomalies observed on these species." App. F at F-30.

Dresden Pool (2014). In 2014, sampling in Dresden Pool "yielded 7,318 native fish representing 57 species and one hybrid. . . . Collectively, 17 species accounted for 90.9 percent of the total catch." App. G at G-19, citing App. G, Table G-5 (Species Composition, Number, Biomass, and Relative Abundance of Native Fish Collected from Dresden Pool, 2014). Based on all electrofishing trips combined, mean native species richness above the Dresden discharge was 17 and below it was 13. App. G at G-20, citing App. G, Table G-7 (Results of Upstream vs. Downstream Statistical Comparisons for Electrofishing Catch Parameters Near Dresden Nuclear Station, 2014). Native species richness was statistically higher upstream for all trips combined and for July/August trips. App. G at G-21, citing App. G at Table G-7.

CPE for native fish based on all electrofishing trips combined was 296.5 fish per km upstream from the Dresden discharge and 196.9 fish per km below it. App. G at G-20, citing App. G, Table G-7. "The upstream/downstream differences in CPE were statistically similar for trips combined and for the May/June, July/August, and September trips." App. G at G-20 – G-21, citing App. G, Table G-7.

Based on IWBmod scores, "the fishery in the Dresden Pool segment in 2014 would be considered fair. . . ." App. G at G-2. For all electrofishing trips combined, mean IWBmod was 7.7 above the Dresden discharge and 6.8 below it. *Id*. at G-20, citing App. G, Table G-7. IWBmod scores were statistically higher upstream for all trips combined and for the July/August and September trips. App. G at G-21, citing App. G, Table G-7.

Analysis of the 2014 monitoring data also examined these parameters based solely on electrofishing trips in July/August, "when the river temperature was highest and discharge temperatures are typically at their maximum." App. G at G-21. For those July/August trips, mean native species richness above the Dresden discharge was 18 and below it was 14. App. G, Table G-7. Native fish CPE averaged 378.3 fish per km above the discharge and 238.2 fish per

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processed. . . . Biosurvey results collected by Ohio EPA show a high frequency of DELT anomalies to be an accurate indication of pollution stress usually caused by multiple sub lethal stresses as the result of degraded water quality. . . . There also appears to be a positive relationship between sites containing chemically contaminated sediments (*e.g.*, metals, PAHs) and very high percent occurrence of DELT anomalies" combined with very low IBI and IWBmod scores. App. F at F-xi – F-xii; App. G at G-xiii – G-xiv.

km below it. *Id*. IWBmod scores above the discharge were 7.69 and below it were 7.03. *Id*. While native species CPE "were statistically similar upstream and downstream throughout the study," both native species richness and IWBmod scores during July/August were significantly higher upstream. *Id*.

Analysis of the 2014 monitoring results also compared electrofishing catch rates, relative abundance, and total species "between the three seasonal groups for all Dresden Pool locations combined." App. G. at G-21, citing App. G, Table G-9 (Comparison of Electrofishing CPEs (No./km) and Relative Abundance Among Sampling Periods for Native Species Collected from Dresden Pool, 2014). "CPEs for all native fish were statistically higher in July/August and September compared to the May/June rates." App. G at G-21, citing App. G, Table G-10 (Results of Statistical Comparisons Among Sampling Periods for Electrofishing Data Collected from Dresden Pool, 2014). "Seasonal differences in IWBmod scores were not statistically different among sampling periods, whereas native species richness was statistically higher in July/August and September compared to richness in May/June." App. G at G-21, citing App. G, Table G-10.

The 2014 electrofishing data were also "compiled and compared among results from 17 years of monitoring to assess potential impacts on the fish community because of thermal conditions." App. G at G-24. "[T]he 2014 CPE was significantly similar to all years except 1994," and "[t]he 2014 total CPE (273.3) was exceeded only by the record rate in 2003 (299.0)." *Id*. at G-24 - G-25, citing App. G, Table G-14 (Results of Statistical Comparisons Among Years for Electrofishing Data Collected from Dresden Pool for the Period of 15 June through August 1994, 1995, 1997-2008, 2011, 2013, and 2014). The 2014 IWBmod score of 7.2 was the second highest of the study period and "is statistically similar to scores from all other years except 1994 and 1999." App. G. at G-25 – G-26, citing App. G, Table G-14. Under Ohio EPA IWBmod classification, the fish community in Dresden Pool would be categorized as fair in 2014 and in all other years except 1994, 1995, and 1999. App. G at G-25. "The mean native species richness value for 2014 (15.3) was the highest value observed during the 16 study years. It was statistically higher than eight of the previous 16 years." *Id*., citing App. G, Table G-14.

During the 2014 monitoring program, "603 fish representing 21 native species were collected that met the minimum length criteria of published *Ws* equations." App. G. at G-27, citing App. G, Table G-15 (Comparisons of Mean Relative Weights Among Sampling Periods for All Native Species Collected from Dresden Pool, 2014). For the combined months of the program, mean *Wr* values for six common species ranged from 95 to 119, indicating that "these species were in average or better than average condition." App. G at G-27, citing App. G, Table G-16 (Statistical Comparisons of Mean Relative Weights Among Sampling Periods for Selected Native Species Collected from Dresden Pool, 2014). From 1994 to 2014, annual catches of seven species were large enough for annual comparisons of mean *Wr* values. Those results show that six of these species "were in average or better than average conditions, which suggests there have not been significant health, food availability, and/or feeding relationship problems." App. G at G-29. For the seventh species, the smallmouth buffalo, the 2014 summer *Wr* "was above the composite mean but overall the data suggest they experience less than optimal conditions compared to the other common species." *Id*.

The 2014 monitoring program also examined 6,431 fish for DELT anomalies, and 123 or 1.9 percent exhibited DELT anomalies within the Dresden Pool. App. G at G-30, citing App. G, Table G-19. The incidence rate of DELT anomalies fell from 10.3 percent and 15 species in May/June to 1.3 percent and 13 species in July/August, and 0.8 percent and seven species in September. App. G at G-30.

Downstream of Dresden Island Lock & Dam (2013). During the 2013 monitoring program, sampling downstream from the Dresden Island Lock and Dam "resulted in the collection of 847 fish representing 29 species and one hybrid." App. F at F-32, citing App. F, Table F-24 (Species Composition, Number, Biomass, and Relative Abundance of Native Fish Collected Downstream of Dresden Island Lock and Dam, 2013). Electrofishing collected 25 species in July/August and 19 in September and CPE increased from 90 to 147. Mean number of species was 13 for both periods. App. F at F-33, citing App. F, Table F-25 (Comparison of Electrofishing CPEs (No./km) and Relative Abundance Between Sampling Periods for Native Species Collected Downstream of Dresden Island Lock and Dam, 2013).

"CPE (fish per km), mean IWBmod, and mean native species richness in 2013 were not statistically different from the other 13 years." App. F at F-34, citing App. F, Table F-28 (Statistical Comparisons Among Years for Electrofishing Data Collected Downstream of Dresden Island Lock and Dam During the Period 15 June through August, 1995, 1995, 1999-2008, 2011, and 2013). Under Ohio EPA IWBmod classification, "the fisheries downstream of Dresden Island Lock and Dam during the mid-June through August period would have been considered fair during the 14 year study." App. F at F-34. "There were no clear direct relationships between mean water temperatures and mean CPE, IWBmod, or species richness." *Id*. at F-35.

During 2013, monitoring collected 130 fish representing 11 native species meeting the minimum length criteria of published *Ws* equations. App. F at F-36. "All were represented by low numbers of individuals in some or all of the months, precluding monthly comparisons of mean *Wr* values." *Id*. Mean relative weight ranged from 82 to 106, with five species exhibiting *Wr* greater than 90. *Id*., citing App. F, Table F-29. Between 1994 and 2013, 2,237 fish representing 20 native species that met the minimum length criteria were collected downstream of the Dresden Island Lock and Dam. App. F. at F-36. Considering seven native species, inter-year comparison of mean *Wr* values show some differences for some species, but "[m]ean *Wr* has been close to or exceeded 100 for five species." *Id*. at F-38; *see* App. F, Table F-30.

During 2013, monitoring examined 328 fish for DELT anomalies and determined that 13 or 4.0 percent exhibited them. App. F at F-38, citing App. F, Table F-31 (Number and Percent of Fish with DELT Anomalies Downstream of Dresden Island Lock and Dam, 2013). The incidence of DELT anomalies fell from 5.0 percent in July/August to 2.7 percent in September. App. F at F-38 – F-39, citing App. F, Table F-33 (Comparisons of DELT Anomalies Between Sampling Periods Downstream of Dresden Island Lock and Dam, 2013). While DELT affliction rates have varied from 2.4 in 2007 to 8.2 in 1999, rates for 2013 "were the eighth highest in the 14 years studied." App. F at F-39. In the Dresden Island Lock and Dam segment, DELT anomalies have been rated poor in all years for which there are data except 2007. *Id*.

Downstream of Dresden Island Lock & Dam (2014). During the 2014 monitoring program, sampling downstream from the Dresden Island Lock and Dam "resulted in the collection of 4,631 fish representing 47 species and one hybrid." App. G at G-34, citing App. G, Table G-24 (Species Composition, Number, Biomass, and Relative Abundance of Native Fish Collected Downstream of Dresden Island Lock and Dam, 2014). Electrofishing collected 29 species in May/June, 40 in July/August, and 31 in September. App. G at G-34. CPE ranged from 138.0 fish per km in May/June, 179.9 in July/August, and 110.5 in September. *Id*., citing App. G, Table G-25. "Differences in total CPE (all native species) among seasons were not statistically significant." App. G at G-34, citing App. G, Table G-26 (Results of Statistical Comparisons Among Sampling Periods for Data Collected by Electrofishing Downstream of Dresden Island Lock and Dam, 2014). For 2014, IWBmod scores were 7.2 for May/June, 7.40 for July/August, and 7.6 for September. App. G at G-35. Mean number of native species increased from 14 in May/June to 17 in September. *Id*. "The IWBmod and mean number of native species were also statistically similar among the three seasonal surveys." *Id*., citing App. G, Table G-26.

For 2014, neither native species CPE (fish per km) nor mean IWBmod in 2014 was statistically different from the other 14 years of monitoring. App. G. at G-36, citing App. G, Table G-29 (Statistical Comparisons Among Years for Electrofishing Data Collected Downstream of Dresden Island Lock and Dam During the Period of 15 June through August 1994, 1995, 1999-2008, 2011, 2013, and 2014). "Native species richness in 2014 was the highest to date" and was statistically higher than six other years. App. G at G-36. Under Ohio EPA IWBmod classification, "the fisheries downstream of Dresden Island Lock and Dam during the mid-June through August period would have been considered fair each year." *Id*. In addition, inter-year comparison indicates that "[t]here were no clear direct relationships between mean water temperature and mean CPE, IWBmod, or species richness." *Id*. at G-37.

During 2014, monitoring collected 420 fish representing 15 native species meeting the minimum length criteria of published *Ws* equations. App. G at G-38. "All were represented by low numbers of individuals in some or all of the months, precluding monthly comparisons of mean *Wr* values." *Id*. Mean relative weights ranged from 74 to 112. While four species had mean *Wr* values of less than 90, "[t]he remaining [11] species examined appeared to reflect optimal health and utilization of food resources based upon relative weight. *Id*., citing App. G, Table G-30. Between 1994 and 2013, 2,493 fish representing 20 native species that met the minimum length criteria were collected downstream of the Dresden Island Lock and Dam. App. G at G-39. Considering six native species, mean *Wr* values have been close to or exceeded 100 for four. *Id*. at G-40; *see* App. G, Table G-33. For the remaining two species, the reasons for sub-optimal *Wr* values "are unclear." App. G at G-40.

During 2014, monitoring examined 2,607 fish downstream of the Dresden Island Lock and Dam for DELT anomalies and determined that 122 or 4.7 percent exhibited them. App. G at G-41, citing App. G, Table G-34 (Number and Percent of Fish with DELT Anomalies Downstream of Dresden Island Lock and Dam, 2014). The incidence of DELT anomalies ranged from 8.8 percent in May/June to 2.8 percent in July/August to 5.9 percent in September. App. G at G-41, citing App. G, Table G-36 (Comparisons of DELT Anomalies Among Sampling Periods Downstream of Dresden Island Lock and Dam, 2014). DELT affliction rates have varied from 2.4 in 2007 to 8.2 in 1999, and rates for 2014 "were the second lowest in the 15 years studied." App. G at G-41 – G-42. In the Dresden Island Lock and Dam segment, DELT anomalies have been rated poor in all years for which there are data except 2007 and 2014. *Id*. at G-42.

Benthos

Exelon's benthos study sought "to determine/compare the composition, distribution, and abundance of the benthic community within/among segments above and below the Dresden discharge and upstream and downstream of the Dresden Island Lock and Dam." Exh. 2 at 7. At each of six locations, four in the Dresden Pool and two downstream from the Dresden Island Lock and Dam, the monitoring program collected one HD sampler array and two Ponar samples. App. F at F-40. The 2013 study collected a total of 63 macroinvertebrate taxa. *Id*., citing App. F, Table F-35. The 2014 study collected a total of 88 taxa. App. G at G-44.

Dresden Pool (2013). From 2013 Ponar samples within the Dresden Pool, total taxa richness was higher above the Dresden discharge than below it. App. F at F-40, citing App. F, Table F-37. Density was higher downstream, but there were no statistically meaningful differences in mean total density and mean taxa richness observed between the upstream and downstream areas. App. F at F-41, citing App. F, Table F-38.

Inter-year comparison shows that "Dresden Pool richness in 2013 was similar to most years while [Ephemeroptera, Plecoptera, and Trichoptera] EPT[14] richness was slightly higher than most years." App. F at F-41, citing App. F, Table F-39. For the combined locations upstream of the Dresden discharge, the total richness and EPT richness "were the highest values observed." App. F at F-41, citing App. F at Table F-40. Downstream of the discharge, total richness was average for the 11 years studied, and EPT richness "was similar to most years." App. F at F-41, citing App. F, Table F-41.

For all areas combined, mean taxa richness in 2013 was statistically similar to four previous study years and statistically higher than the remaining six. App. F. at F-41, citing App. F, Table F-42. Upstream from the discharge, annual differences in mean taxa richness were not statistically significant. App. F at F-41. Downstream from the discharge, mean taxa richness was significantly lower in 1999, 2002, and 2005 than in four of the five most recent years. *Id*.

For 2013, mean total density was statistically similar to density in all but two years and significantly higher than in 2001 and 2005. App. F at F-42, citing App. F, Table F-42. Upstream from the discharge, mean total density for 2013 was statistically similar to 10 of the 11 years

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[14] "USEPA uses the presence and abundance of pollution-sensitive benthic invertebrates, primarily aquatic insects, as indicators of stream water quality. Pollution-sensitive insect species typically include EPT taxa. This refers to members of the insect groups Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). . . . A stream is considered healthy if a good distribution of these three insect groups is well-documented. . . . EPT taxa usually dominate gravel and cobble habitats in good quality rivers and streams." App. F at F-xii; App. G at G-xiv.

studied. App. F at F-42. Downstream, mean total density was statistically similar to five years and statistically higher than the other five years studied. *Id.*

From 2013 HD samples in the Dresden Pool, total taxa richness and EPT richness were lower downstream from the Dresden discharge than upstream. App. F at F-42, citing App. F, Table F-43. Total mean density was higher upstream, although the difference results primarily from higher densities of two taxa. App. F at F-42 – F-43. "Mean taxa richness of benthos collected on HD samplers in Dresden Pool in 2013 was statistically similar to all other years." *Id*. at F-43, citing App. F, Table F-48. Upstream from the Dresden discharge, mean total density was more than twice the lowest observed densities but approximately half of the long-term mean. App. F at F-44. Downstream, mean total density was roughly average but well above previous densities and more than half of the highest measured downstream density. *Id.*

Dresden Pool (2014). In 2014, Ponar samples showed similar total taxa richness upstream and downstream from the Dresden discharge. App. G at G-45, citing App. G, Table G-43. While total densities were nearly twice as high downstream as upstream, the mean total densities were not statistically different. App. G. at G-45, citing App. G, Table G-44. Inter-year comparison shows that, for all Dresden Pool locations combined, "total and EPT richness in 2014 were higher than all previous study years." App. G at G-45, citing App. G, Table G-45. Mean taxa richness "was significantly higher than all previous years." App. G at G-46, citing App. G, Table G-48. The mean total density for the combined Dresden Pool locations was statistically similar to three previous years and significantly higher than eight years. App. G. at G-46, citing App. G, Table G-48.

In 2014, HD samples in the Dresden Pool showed that total taxa richness and EPT richness are lower downstream from the Dresden discharge than upstream from it. App. G at G-46, citing App. G, Table G-50. Upstream from the discharge, total taxa richness was the second highest observed since 2001, and downstream total taxa were the third highest observed since 2001. App. G at G-47 – G-48, citing App. G, Table G-53. Annual taxa richness was the third highest to date. *Id*. at G-47, citing App. G, Table G-51. Mean taxa richness in Dresden Pool in 2014 was statistically higher than 2005 and statistically similar to all other years. App. G at G-48, citing App. G, Table G-54. Total EPT taxa richness "was above average and the second highest value observed since 2001." App. G at G-47. Both upstream and downstream from the discharge, the number of EPT taxa was above the average for the 11 years of the study. *Id*. at G-48.

Total density was "was higher than five of the previous 10 years." App. G at G-48, citing App. G, Table G-51. Total mean density was higher upstream, although the difference results primarily from higher densities of two taxa. App. G at G-46 – G-47. While mean total density upstream from the Dresden discharge was lower than the long-term average, it was more than three times the lowest densities observed. *Id*. at G-48, citing App. G, Table G-52. Downstream from the discharge, density was slightly lower than the highest density to date. App. G at G-48, citing App. G, Table G-53.

Monitoring data indicate that the benthic community in the Dresden Pool is generally poor and consists largely of tolerant species. App. F at F-4, F-44; App. G at G-2, G-48. "[T]he number of EPT taxa was lower than would be expected for a waterway of this size." App. F at F-4, F-44; App. G at G-2, G-48.

Downstream of Dresden Island Lock & Dam (2013). In 2013, Ponar samples taken below the Dresden Island Lock and Dam collected 17 benthic invertebrates and one EPT taxon. App. F at F-46, citing App. F, Table F-49. "The 17 taxa observed in 2013 is above the long-term average and ranked third highest for the study." App. F at F-46, citing App. F, Table F-50. HD samples generated 23 total taxa and six EPT taxa with a mean density of 2,196 per square meter. App. F at F-47, citing App. F, Table F-52. Collection of 23 total taxa was lower than average but consistent with previous years. App. F at F-47. Mean total density was the lowest of the 10 years studied. App. F, Table F-53.

Downstream of Dresden Island Lock & Dam (2014). In 2014, Ponar samples taken below the Dresden Island Lock and Dam collected a total of 39 benthic macroinvertebrate and two EPT taxa. App. G. at G-50, citing App. G, Table G-55. "The 39 taxa observed in 2014 is the highest for the study." App. G at G-50. The two ETP taxa are within the range of the previous ten study years. *Id*., citing App. G, Table G-56. Total taxa richness was higher than in 2001 and 2002 but similar to all other years. App. G at G-50, citing App. G, Table G-57. Total density was significantly higher than in 2001 and 2004 but similar to the remaining years. *Id*.

In 2014, HD samples yielded 25 total and 3 EPT taxa with mean density of 1,073 per square meter. App. G at G-51, citing App. G, Table G-58. The total number of taxa was similar to six of the previous ten years and within the range of 21 to 42 taxa reported from 2001 to 2013. App. G at G-51, citing App. G, Table G-59. However, "the EPT taxa richness observed in 2014 is the lowest on record." App. G at G-51. Mean total density was the lowest recorded in 11 years of study, although densities varied widely over that period. *Id*., citing App. G, Table G-60.

Monitoring data indicate that the benthic community below the Dresden Island Lock and Dam is generally poor and consists largely of tolerant species. App. F at F-4, F-47; App. G at G-51. Exelon's report asserts that the monitoring program indicates that Dresden does not affect the benthic community below the Dresden Island Lock and Dam. App. F at F-48; App. G at G-52. The report states that "variability observed in this area and the lack of clear relationships to trends observed upstream are likely artifacts of the unstable conditions below the Dam and the substantial differences in habitat between the Dresden Pool and the area downstream of the Dresden Island Lock and Dam." App. F at F-48; App. G at G-51.

Mussels

As part of its Section 316(a) study plan, Exelon from October 23-27, 2014, performed a mussel survey of the Illinois River from the Dresden discharge to the Dresden Island Lock and Dam and from below the lock and dam to Little Dresden Island. Exh. 2 at 8; App. H at H-2; *see* App. H, Figure H-1 (Site Location Map). The survey sought "to characterize the unionid mussel assemblage and/or habitat that may occur within area potentially affected" by the Dresden discharge. Exh. 2 at 8; App. H at H-2.

The survey collected 3,349 individuals representing 25 species. App. H at H-4, H-6. Above the Dresden Island Lock and Dam, the survey collected 2,421 individuals representing 24 species and below it, the survey collected 928 individuals representing 20 species. App. H at H-4, citing App. H, Tables H-1 (Species, composition and age of mussels collected near Dresden Nuclear Station using semi-quantitative and qualitative techniques), H-2 (Species, composition and age of mussels collected downstream of Dresden Island Lock and Dam using semi-quantitative and qualitative techniques), H-3 (Species, composition and age of mussels collected upstream of Dresden Island Lock and Dam using semi-quantitative and qualitative techniques). Of the total mussels, 2,271 or 68 percent were aged, with 31 percent considered juveniles or young individuals and the remaining 69 percent ranging in age from six to 25 years. App. H at H-4 – H-5, H-7. "Federally-protected mussels are not known to currently exist" in the vicinity of Dresden. *Id*. at H-2. Two State threatened species were encountered both upstream and downstream of the Dresden Island Lock and Dam: purple wartyback and black sandshell. *Id*. at H-4, citing App. H, Tables H-2, H-3.

The survey included semi-quantitative sampling along 30 transects extending perpendicular to the river flow. App. H at H-3. "Each transect was sub-divided into 10 m segments . . . and searched within 0.5 m on both sides of the transect line, resulting in a search areas of $10m^2$ for each transect segment." *Id*. Surveys of the 30 transects collected 2,305 individuals representing 23 species. *Id*. at H-5, citing App. H, Table H-4 (Species and compositions mussels collected near Dresden Nuclear Station using semi-qualitative techniques). Higher mussel densities were found upstream of the Dresden Island Lock and Dam on the right descending bank. App. H at H-5; *see* App. H, Figure H-3 (Survey Results), H-4 (Transect Group Summary). Transects located on the right descending bank opposite and downstream from the Dresden discharge showed more than 170 mussels per transect. *Id*.

The survey also included qualitative sampling, "15-minute searches between transects that focused on areas where substrate was favorable and/or interpolated from mussel data collected during the adjacent semi-quantitative surveys." *Id*., citing App. H, Figure H-2 (Survey Map). A total of 24 qualitative searches conducted over six hours collected 1,044 individuals representing 20 species. App. H at H-5; *see* App. H, Table H-5 (Species and composition mussels collected near Dresden Nuclear Station using qualitative searches). "The results of the qualitative searches generally confirmed the pattern of abundance and distribution data collected during the transect survey and indicated large mussel concentrations were not missed within the survey area." *Id*.

Exelon's study states that "[r]esults show the presence of a diverse mussel assemblage upstream and downstream of the Dresden Island Lock and Dam." App. H at H-8. Concentrations and densities of mussels were highest along the right descending bank opposite and downstream of the Dresden discharge, near the discharge's typical path. *Id*.; Resp. at 11-12; *see* App. H, Figures H-3 (Survey Results), H-4 (Transect Group Summary). The study concluded that these results show that the Dresden discharge "is not adversely affecting freshwater mussels in Dresden Pool or downstream of the Dresden Island Lock and Dam." App. H at H-8.

In its questions, the Board noted that Exelon and the Agency had cited factors mitigating the risk of exposure to thermal discharges: "fluctuation from day to night in discharge temperature, short-term nature of exposure, capability of organisms to avoid stressful temperatures, and availability of thermal refuge." Board Questions at 5, citing App. B at B-26 – B-35, Rec. at 7, 9. The Board requested that Exelon "identify and discuss mitigating factors applicable to mussels that are not able to seek thermal refuge." Board Questions at 6.

Exelon's response acknowledges that "unionid mussels can be particularly susceptible to ecosystem stress due to their relatively limited mobility during juvenile and adult life stages." Resp. at 12. However, Exelon states that, "[p]articularly during short-term exposure to acute stressors, unionid mussels exhibit stress-avoidance responses such as tightly closing valves, mucus excretion, reduction of siphoning and mantle display behavior, and burrowing." *Id*. Exelon adds that "mussels are relatively tolerant of temperatures up to and, for some species, beyond 95°F." *Id*. Exelon argues that the results of its 2014 mussel study show that these factors "effectively protect freshwater mussels from occasional extreme thermal conditions that may result from the proposed alternative thermal limits." *Id*. Exelon cites extreme temperatures experienced in 1999 and 2012 to support its claim that the study area has supported a diverse mussel community. *Id*. at 12-13.

<u>Threatened/Endangered Species</u>

The United States Fish and Wildlife Service (USFWS) lists 29 Illinois species as federally threatened and endangered, lists two species as candidates for listing, and also proposes one species for listing as endangered. App. A at A-32, citing USFWS, Illinois County Distribution: Federally Endangered, Threatened, and Candidate Species (Dec. 2014). Most of these species are not known to occur in Grundy or Will County or would not be affected by the Dresden discharge because they are terrestrial. App. A at A-32. The demonstration notes that no federally threatened or endangered fish species were collected in Dresden Pool. Exh. 1 at 8. Federally protected freshwater mussels have not recently been known to exist near Dresden. One federally-listed endangered species of mussel, the sheepnose (*Plethobasus cyphyus*), is believed to have extirpated from the Illinois and Des Plaines Rivers. The sheepnose "was last observed in 1940 in the Illinois River and 1970 in the Des Plaines River. *Id*. Another mussel species, the snuffbox (*Epioblasma triquetra*), is federally listed for Will County. Neither the sheepnose nor the snuffbox was collected in the 2014 mussel survey. *Id*., citing App. H. One federally-listed fish species, the pallid sturgeon, is listed in seven counties bordering the Mississippi River in southwestern Illinois and is not known to occur near Dresden. App. A at A-32; App. C at C-15. Federally listed terrestrial species, including a bat and various plants, "would not be affected" by Dresden operations. App. A at A-32.

In its questions, the Board noted that USFWS "identifies the endangered Scaleshell mussel (*Leptodea leptodon*) in Grundy County" and also noted that the 2014 mussel survey did not encounter it. Board Questions at 3. The Board requested that Exelon "address whether any other information indicates that this species is now known to exist" in the vicinity of Dresden. *Id*. Exelon states that, "[p]rior to 2013, the known populations of this species (a total of 14) were all located in Arkansas, Missouri, and Oklahoma." Resp. at 6 (citation omitted). Exelon argues that, although it remains listed as endangered in Illinois, "the species is essentially extirpated from the state." *Id*. Exelon states that, "[i]n July 2013, during an extensive mussel survey conducted during 4 foot drawdown of the Illinois River to repair the Marseilles Lock and Dam, a single Scaleshell mussel specimen was found as river mile 258.5" 13.5 river miles downstream from Dresden. *Id*. at 7. Exelon adds that, "[t]o date, no other confirmed collections of this species have occurred in Illinois." *Id*. at 7.

The State of Illinois lists 28 threatened and endangered species in Grundy County and 76 in Will County. App. A at A-33, citing Illinois Department of Natural Resources, Illinois Endangered Species Protection Board: Illinois Endangered and Threatened Species by County (Oct. 2014). Of those species, six mussels and 12 fish are potentially affected by Dresden if they appear in its vicinity. App. A at 33. Two of the listed mussel species were collected during the 2014 mussel survey: purple wartyback and black sandshell. Both were present upstream and downstream of the Dresden Island Lock and Dam. *Id*. at A-33 – A-34, citing App. H at H-4. The demonstration explains that the preferred riverine habitats for these mussel species are upstream in the Kankakee River and downstream of the Dresden Island Lock and Dam. The demonstration adds that "[n]early 80 percent of the listed [mussel] species were collected downstream of the Dresden Island Lock and Dam" outside the thermal influence of the DNS discharge." Exh. 1 at 9; *see* App. A at A-32 - A-35.

Of the listed fish species, long-term monitoring near Dresden has collected five: river redhorse, greater redhorse, pallid shiner, western sand darter, and banded killifish. App. A at A-34; App. C at C-15. The pallid shiner, listed as endangered and once thought to have been extirpated from Illinois, first appeared in monitoring in 2001 and has been collected every year since. App. A at A-34. Of the total of 905 pallid shiner collected to date, most have been collected from the Kankakee River upstream from Dresden or below the Dresden Island Lock and Dam, "where suitable riverine habitat occurs." *Id*. Occurrence of the pallid shiner after Dresden began operations "indicates the plant operations had not impacted that population." *Id*.

The banded killifish, listed as threatened, was first observed in 2013 and observed in greater numbers in 2014 in both the Dresden Pool and downstream from the Dresden Island Lock and Dam. App. A at A-34, citing Apps. F, G; App. C at C-15. "[I]ncreased macrophyte production in the lower Des Plaines River" may be a factor in these observations. App. A at A-34. The western sand darter, listed as endangered, has been collected downstream of the Dresden Island Lock and Dam in 2003, 2006, and 2014. *Id*.; *see* App. C at C-15. Habitat below the dam "is more suitable for darters than in Dresden Pool where the river channel is flooded by the impounded UIW." App. A at A-34. The threatened river redhorse and endangered greater redhorse "were collected infrequently and in low numbers." *Id*.; *see* App. C at C-15. The golden redhorse "was selected as a surrogate RIS because the incidental occurrence of both the state-listed redhorse species precluded evaluation of thermal effects on these species." *Id*.

In its recommendation, the Agency notes that IDNR's EcoCAT, a web-based tool, indicated on April 20, 2015, that there are seven endangered or threatened species present in the vicinity of the Dresden discharge: American Bittern (bird), Common Moorhen (bird), Greater Redhorse (fish), King Rail (bird), Northern Harrier (bird), Pallid Shiner (fish), and River Redhorse (fish). Rec. at 12. Additionally, IDNR's EcoCAT identified three Illinois Natural Areas Inventory (INAI) sites: Goose Lake Prairies INAI site, Illinois River – Dresden INAI Site, and Goose Lake Prairie Nature Preserve. The Agency states that IDNR evaluated this information "and determined that impacts to the protected resources are unlikely." *Id*. at 12-13. The Agency adds that IDNR terminated its consultation on May 5, 2015. *Id* at 13. In its questions, the Board requested that Exelon clarify whether the information evaluated by IDNR included Exhibit 1 and its appendices, particularly Appendices A and H. Board Questions at 3. Exelon responded that IDNR "received all sections of the Demonstration, including Appendices A and H." Resp. at 7.

APPLICABLE THERMAL EFFLUENT LIMITATIONS

Section 302.211(d) of the Board's General Use Water Quality Standards provides in its entirety that "[t]he maximum temperature rise above natural temperatures shall not exceed 2.8ºC (5ºF)." 35 Ill. Adm. Code 302.211(d). Section 302.211(e), the standard from which Exelon seeks alternative standards, provides that, in addition to the requirements of the preceding subsections,

> the water temperature at representative locations in the main river shall not exceed the maximum limits in the following table during more than one percent of the hours in the 12-month period ending with any month. Morever (sic), at no time shall the water temperature at such locations exceed the maximum limit in the following table by more than 1.7º C (3º F).

	ºC	ºF		ºC	ºF
JAN	16	60	JUL.	32	90
FEB.	16	60	AUG.	32	90
MAR.	16	60	SEPT.	32	90
APR.	32	90	OCT.	32	90
MAY	32	90	NOV.	32	90
JUNE	32	90	DEC.	16	60

35 Ill. Adm. Code 302.211(e); *see* Pet. at 1.

Special Condition 3C of NPDES Permit No. IL0002224 issued to Exelon for Dresden provides that "[t]he permittee may discharge cooling pond blowdown using an indirect open cycle cooling mode from June 15 through September 30 in accordance with the following limitation in lieu of 35 Ill. Adm. Code 302.211(d) and 302.211(e) . . . During the period June 15 through September 30, the temperature of the plant discharge shall not exceed 32.2ºC (90ºF) more than 10% of the time in the period and never will exceed 33.9ºC (93ºF)." Rec., Att. 1; *see* Att. D at D-5 (Table 1-1: Existing Thermal Limits for Dresden Nuclear Station).

EXELON'S PROPOSED ALTERNATIVE THERMAL EFFLUENT LIMITATION

Exelon requests a Board finding that the requirements of Section 302.211(e) limiting Dresden discharges from exceeding specified monthly maximum temperatures between June 15 and September 30 are "more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in the waters that receive the Plant's discharge." Pet. at 23.

In the place of the generally-applicable requirements, Exelon requests that the Board approve the following alternate thermal limit for discharges from Dresden:

> [d]uring the period June 15 through September 30, the temperature of the Dresden Station discharge shall not exceed 90º F more than 10% of the time in the period and will never exceed 95º F, provided that (1) discharges above 93º F are allowed only when Dresden Station intake temperature is above 90º F, and (2) any single episode of such discharges does not exceed 24 hours in duration. At all other times, Dresden Station will be operated in accordance with 35 Ill. Adm. Code § 302.211(e). Pet. at 23; *see* Exh. 1 at 4 (Table 1: Existing and Proposed Alternative Thermal Limits For Dresden Nuclear Station).

AGENCY RECOMMENDATION AND EXELON RESPONSE

In its recommendation, the Agency states that Exelon complied with the Board's procedural rules by submitting a study plan to the Agency and IDNR on April 14, 2014. Rec. at 12, citing 35 Ill. Adm. Code 106.1115. Although the Agency and IDNR recommended changes to the study plan regarding the list of RIS and a survey of freshwater mussels, the Agency reports that Exelon accepted the changes and completed a detailed plan of study. Rec. at 12, citing 35 Ill. Adm. Code 106.1120. The Agency states that IDNR identified seven endangered/threatened species and three sites on the Illinois Natural Areas Inventory near Dresden. Rec. at 12. However, the Agency reports that IDNR "determined that impacts to the protected resources are unlikely." *Id*. at 13. The Agency adds that it is not aware of other comments from IDNR and is not aware of any comments on the petition from the U.S. Fish and Wildlife Service or USEPA. *Id*.

The Agency agrees that Exelon "has demonstrated that the current effluent limitations are more stringent than necessary and that the proposed alternative limits would not adversely affect the balanced, indigenous population of fish, shellfish, and wildlife currently inhabiting the receiving water." Rec. at 4. The Agency recommends that the Board grant Exelon's request for alternative standards. *Id*., citing 35 Ill. Adm. Code 106.1145. Exelon's response notes the Agency's statement that Exelon has satisfied procedural requirements regarding early screening and a detailed plan of study. Resp. Rec. at 1-2, citing 35 Ill. Adm. Code 106.1115, 106.1120. Exelon also notes the Agency's agreement that current effluent limitations applicable to Dresden are more stringent than necessary to protect a balanced, indigenous population and that proposed alternative limitations will adequately protect that population. Resp. Rec. at 2; *see* Rec. at 4. Exelon states that it concurs with the Agency's assessment on these matters and renews its request that the Board grant its petition. Resp. Rec. at 2.

LEGAL BACKGROUND

Statutory and Regulatory Authorities

The Clean Water Act makes it unlawful for any person to discharge a pollutant from a point source into waters of the United States without a permit. 33 U.S.C. § 1311(a). Heat is a pollutant (33 U.S.C. § 1362(6)), and 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, 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).

Accordingly, 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 notwithstanding any other technology-based standard. 33 U.S.C. §§ 1311(b)(1)(C), 1312(a); *see* 35 Ill. Adm. Code 304.105 (Violation of Water Quality Standards). Water quality standards are set under authority provided in Section 303 of the Clean Water Act. 33 U.S.C. § 1313. Illinois law authorizes the Board to adopt water quality standards, including thermal standards. 415 ILCS 5/13 (2014). The Board's water quality temperature standards for general use waters are found at 35 Ill. Adm. Code 302.211.

Since adoption of the Clean Water Act in 1972, Section 316(a) has allowed a point source with 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 projection (sic) 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(a) (Thermal Discharges).

Accordingly, Section 304.141(c)[15] of the Board's rules provides that

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[15] The Board originally adopted 35 Ill. Adm. Code 304.141(c) on August 29, 1974, as Rule 410(c) of Chapter 3 of the Board's Water Pollution Regulations, which provided 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, 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).

Thus, under Section 316(a) of the Clean Water Act and Section 304.141(c) of the Board's general effluent standards, the Board may establish an alternative thermal effluent limitation based on a demonstration that the alternate limit will assure the protection and propagation of a balanced and indigenous population of shellfish, fish, and wildlife in the receiving water. Part 106, Subpart K of the Board's procedural rules provides for review of a petition for an alternative thermal effluent standard. 35 Ill. Adm. Code 106.1100 – 106.1180. Such establishment of alternative thermal effluent limitations is not a water quality standard change.

In 1977, USEPA issued a draft manual on demonstrations under Clean Water Act Section 316(a). The draft 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." Draft Manual at 8-9. This guidance has not been finalized and remains a draft. Nevertheless, the Board has found that its decision criteria are a useful guide for its analysis and followed its decision-making outline. Exelon Generation LLC v. IEPA, PCB 14-123, slip op. at 2 (Sept. 18, 2014). The Board also notes that Section 106.1120 of its procedural rules provides that a petitioner seeking alternative thermal effluent limitations must consider guidance published by USEPA in making its demonstration. *See* 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.

Burden of Proof

The burden of proof is on Exelon. 35 Ill. Adm. Code 106.1160(a). Exelon must demonstrate that an otherwise applicable thermal effluent limitation is "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 made." 35 Ill. Adm. Code 106.1160(b). Exelon must also demonstrate that the requested alternative thermal effluent limitation, "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). This demonstration may be referred to as a predictive demonstration.

> [t]he standards of Chapter 3 shall apply to thermal discharges unless, after public notice and opportunity for public hearing, in accordance with Section 316 of the [Federal Water Pollution Control Act] and applicable federal regulations, the Administrator and the Board have determined that different standards shall apply to a particular thermal discharge.

An existing discharger such as Dresden may base a demonstration that its proposed alternate limit is sufficiently protective on the absence of prior appreciable harm instead of using predictive studies. 35 Ill. Adm. Code 106.1160(d). This demonstration may be referred to as a retrospective demonstration and 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 of shellfish, fish, and wildlife in and on the body of water into which the discharge has been made; 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 of shellfish, fish, and wildlife in and on the body of water into which the discharge is been made. 35 Ill. Adm. Code 106.1160(d)(1); *see* 40 C.F.R. § 125.73(c) (Criteria and standards for the determination of alternative effluent limitations under section 316(a)).

BOARD DISCUSSION

As explained above, Exelon must demonstrate that the current standard is more stringent than necessary to assure, and the requested alternative limit will assure, the protection and propagation of a balanced and indigenous population of shellfish, fish, and wildlife in the receiving water. *See* 33 U.S.C. § 1326(a). The Draft Manual sets forth the main components for such demonstrations: (1) biotic category analysis; (2) representative important species demonstration; (3) low potential impact (predictive) demonstration; (4) absence of prior appreciable harm (retrospective) demonstration; and (5) master rationale for the proposed alternate limit. In the following sections of the opinion, the Board summarizes the record on these elements of the demonstration and makes its findings on them.

Biotic Category Analysis

The Draft Manual identifies the following biotic categories: habitat formers; phytoplankton; zooplankton; macroinvertebrates and shellfish; fish; and other vertebrate wildlife. Draft Manual at 18-32. A Section 316(a) demonstration begins with the early screening process to determine the most appropriate type of demonstration for the site. Draft Manual at 33. The Draft Manual establishes requirements that must be met for an area to be defined as low impact for the various biotic categories. *E.g.*, *id*. at 25 (shellfish/macroinvertebrates). If a site is a low potential impact area for each biotic category, the applicant may conduct a relatively streamlined demonstration. *Id.* at 6, 14, 33; *see id*. at 63 (§3.6: Type III Low Potential Impact Demonstrations). If a site is not a low potential impact area for each biotic category, the applicant must conduct a more comprehensive analysis. *Id.* at 15, 33; *see id*. at 34-61 (§3.5: Type II Demonstrations (Representative Important Species)).

For a CWA Section 316(a) demonstration to be successful, the demonstration must show that each biotic category meets specified decision criteria. Draft Manual at 16. The Draft Manual sets forth decision criteria for each biotic category. *E.g.*, Draft Manual at 18 (phytoplankton). "[T]he applicant should address each decision criteria for the biotic category in question." *Id*. at 34. The demonstration must show that impacts to each biotic category "are sufficiently inconsequential that the protection and propagation of the balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water will be assured." *Id.*

Habitat Formers (Aquatic Vegetation)

Habitat formers are the assemblage of plants and/or animals providing functions including cover areas, stabilization of sediments, food sources, spawning sites, and nursery areas. Draft Manual at 76-77. The Draft Manual states that habitat formers play a role that is "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 Draft Manual notes that sites may lack habitat formers as a result of "low levels of nutrients, inadequate light penetration, sedimentation, scouring stream velocities, substrate character, or toxic materials." Draft Manual at 22. These conditions may lead to designation as a low impact area. *Id*. If these limiting factors may be overcome and habitat formers established in the area, then "the applicant will be required to demonstrate that the heated discharge would not restrict re-establishment." *Id*. A site will not be considered low impact for habitat formers if "there is a possibility that the power plant will impact a threatened or endangered species through adverse impacts on habitat formers." *Id*.

If an applicant can show that a site is a low impact area for habitat formers, then that section of the demonstration "will be judged successful." Draft Manual at 22. For all other sites, the decision criteria for this section require an applicant to demonstrate that:

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. Draft Manual at 22; Exh. 1 at 20.

For sites that are not low impact for habitat formers, the Draft Manual lists information that an applicant should provide. Draft Manual at 22-23, 57-58. A request may be denied if there is "[a]ny probable thermal elimination of habitat formers" or "if important fish, shellfish, or wildlife are thermally excluded from the use of the habitat." *Id*. at 22.

Exelon reports that, although submerged and emergent aquatic plants had historically flourished in the Illinois River, by the early 1960s much of the vegetation had disappeared. App.

A at A-24. Exelon attributed this to "[s]edimentation and turbidity associated with navigation coupled with fluctuating water levels," factors which reduced the penetration of light and created unstable substrates. *Id*., citing F.C. Bellrose, *et al*., Fish and Wildlife Habitat Changes Resulting from the Construction of a Nine-Foot Navigation Channel in the Illinois Waterway from LaGrange Lock to Lockport Lock and Dam (1977). Downstream from the Dresden discharge, the Illinois River "is dominated by relatively deep open channel with limited habitat diversity." Exh. 1 at 21. In the late 1970s, "limited growth of more tolerant submerged aquatic plants was reported." App. E at E-7, citing S.P. Havera, *et al*., Projected effects of increased diversion of Lake Michigan water on the environment of the Illinois River valley (1980); App. A at A-24. By the early 1980s, an observed resurgence of aquatic vegetation at certain locations generated studies of general habitat quality. *Id*.; App. E at E-7 (citations omitted).

A study conducted in the UIW from 1992 to 1995 "indicated that the resident aquatic macrophyte community in Dresden Pool remained relatively stable over a ten year period." App. A at A-24; App. E at E-7, citing Commonwealth Edison Co. and UIW Ecological Study Task Force, Aquatic Ecological Study of the UIW (1996). Habitat was poor to fair, with mean QHEI scores less than 60 at all but two sampling locations. Exh. 1 at 21; App. C at C-7, citing App. C, Tables C-1 – C-3. Scores were lowest in the main channel, the dominant habitat in the UIW. Exh. 1 at 21; App. C at C-7. The demonstration states that low QHEI scores resulted from "a lack of riffle/run habitat, lack of clean, hard substrates (*i.e*., gravel/cobble), excessive siltation, channelization, poor quality riparian and floodplain areas, and lack of cover." Exh. 1 at 21; App. C at C-7.

Since the mid-2000s, observers have noted increasing macrophyte production in Dresden Pool. App. A at A-24; App. E at E-7. Submerged aquatic vegetation, including plants anchored to the bottom by roots and growing below the surface of the water, has "increased noticeably along both the northeast and southeast banks of the Des Plaines River upstream of the Kankakee River confluence." App. A at A-25, citing Figure A-2 (habitat distribution). The 1992-1995 studies also showed several species of emergent vegetation, which are rooted under water with much of the plant extending above the surface. *Id*. More recent observations showed an increase in the American lotus (*Nelumbo lutea*), although the greatest increase occurred upstream of the Dresden discharge and is not related to Dresden operations. *Id*. at A-25 – A-26.

Habitat assessment in 2014 sought to evaluate any changes to aquatic habitats that may have occurred. Exh. 1 at 21; App. C at C-7. "[M]ean QHEI scores were again less than 60 at all sampling locations." App C. at C-8, citing App. C, Table C-3; App. G at G-43, citing App. G. Tables G-38 – G-40. The demonstration attributes these QHEI scores to the same factors as the 1990s study: "a lack of riffle/run habitat, lack of clean, hard substrates, excessive siltation, channelization, poor quality riparian and floodplain areas, and lack of cover." App. C at C-8. The demonstration acknowledges some observed increase in macrophytes since the 1992-1995 studies. However, abundance affects only the cover element of the QHEI score and has a limited effect. App. G. at G-43. The demonstration asserts that, because the area near Dresden is dominated by main channel habitat in which macrophytes do not grow, "habitat complexity and quality have changed only minimally over the past 20+ years." App. A at A-25; App. G. at G-43. The demonstration states that the dominant channel habitat, low habitat quality, and lack of habitat complexity are limiting factors in the Dresden Pool. Exh. 1 at 22; App. C at C-8. It adds that "[n]one of these factors is affected" by Dresden's operation in indirect open cycle mode. Exh. 1 at 22.

The demonstration argues that the Dresden discharge "does not affect the quality of aquatic habitat and has not caused appreciable harm to the habitat former community." Exh. 1 at 22. The dominant channel habitat and substrate are the chief limits on distribution and abundance of habitat formers and habitat quality. *Id*. The demonstration concludes that "[t]he habitat former community would be essentially the same" if Dresden continued operation with the proposed alternate thermal limitations. *Id*.

The Board finds that the proposed thermal discharge to the Illinois River meets the decision criteria of the Draft Manual for habitat formers. *See* Draft Manual at 22. Based on aquatic macrophyte studies from the 1990s through 2014, Exelon's demonstration showed that "habitat complexity and quality have changed only minimally over the past 20+ years." App. A at A-25. The 2014 habitat assessment found the same factors observed in the 1990s still exist: "a lack of riffle/run habitat, lack of clean, hard substrates, excessive siltation, channelization, poor quality riparian and floodplain areas, and lack of cover." App. C at C-8. The Board agrees with Exelon's assertion that such factors would not be affected by the open cycle mode of operation at the Dresden facility. Exh. 1 at 22. Even under the modeled extreme high temperature scenario, Exelon's demonstration found the habitat former community would essentially be the same. Exh. 1 at 22, App. B at B-26.

Although IDNR's EcoCAT identified three Illinois Natural Area Inventory sites, IDNR determined that impacts to these protected resources would be "unlikely." Rec. at 12-13. Additionally, Exelon demonstrated that there is no rare, unique, or critical habitat downstream from the Dresden discharge from which RIS might be excluded. Exh. 1 at 16. IEPA's recommendation added that IDNR's evaluation of State endangered and threatened species present in the vicinity of the Dresden Station found that impacts to these species are also unlikely. Rec. at 12-13.

Also, as discussed further below, the existence of balanced and indigenous communities of fish and mussels near the Dresden discharge supports the conclusion that habitat is available and will continue to be available under the proposed alternative thermal effluent limitations. Exelon's demonstration meets the decision criteria and shows that the proposed thermal discharge from Dresden (i) will not result in deterioration of habitat formers so as to cause appreciable harm to the balanced and indigenous community of fish or mussels; and (ii) will not have adverse impact on threatened or endangered species as a result of impact on habitat formers.

<u>Phytoplankton</u>

Phytoplankton are "[p]lant microorganisms such as certain algae, living unattached in the water." Draft Manual at 78. The demonstration elaborates that they are "free-floating microscopic plants that are transported by water currents; are generally broadly distributed and abundant; have high reproductive and growth rates; and short generation times. Rapid dispersal by water currents and prolific rates of reproduction enable phytoplankton to recover rapidly from localized stresses within the environment." App. C at C-5. Phytoplankton are "a principal food source for most zooplankton and for some fish species." Draft Manual at 55.

The Draft Manual states that systems where the food chain base is detrital material rather than phytoplankton, such as most rivers and streams, are areas of low potential impact for this category. Draft Manual at 18. An area is not considered low impact for phytoplankton if

1. The phytoplankton contribute a substantial amount of the primary photosynthetic activity supporting the community;

2. A shift towards nuisance species[16] may be encouraged; or

3. Operation of the discharge may alter the community from a detrital to a phytoplankton based system. *Id*. at 19.

If an applicant can show that a site is a low impact area for phytoplankton, then that section of the demonstration "will be judged successful." Draft Manual at 18. For other sites, the decision criteria for this section require an applicant to demonstrate that:

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. *Id*.

For sites that are not low impact, the Draft Manual lists information that an applicant should provide. Draft Manual at 19-20, 55-56.

Exelon's demonstration states that "studies conducted during the 1970s showed there was no adverse influence on phytoplankton populations in the Illinois River from indirect open-cycle operation." Exh. 1 at 19; *see* App. C at C-6; App. E at E-4 – E-5. Data indicated that "the composition of the phytoplankton community at the cooling water intake was similar to the discharge location during the months studied." App. C at C-6. Although studies noted minor annual shifts, "there were no substantial changes in the community structure and no unusually large shifts in abundance among the algal divisions during the years studied." *Id*.; *see* App. A at A-26; App. C at C-6.

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[16] The Draft Manual states that "[a]ny microbial, plant or animal species which indicates a hazard to ecological balance or human health and welfare that is not naturally a dominant feature of the indigenous community may be considered a nuisance species. Nuisance species of the phytoplankton include those algae taxa which in high concentration are known to produce toxic, foul tasting, or odiferous compounds to a degree that the quality of water is impaired." Draft Manual at 77.

Surveys conducted in 1991 and 1993 examined phytoplankton abundance from the Chicago Locks to below Dresden Island Lock and Dam. Exh. 1 at 19; *see* App. A at A-26; App. C at C-5; App. E at E-4 – E-5. The studies assessed algae system-wide "to determine community composition, density, and chlorophyll concentration." App. E. at E-5. Results indicated that phytoplankton density increased with distance downstream from the Chicago Locks in the UIW with Dresden Pool having the highest total density. Exh. 1 at 19, citing Commonwealth Edison Co. and UIW Ecological Study Task Force, Aquatic Ecological Study of the UIW (1996); *see* App. A at A-26; App. C at C-6.

While "[w]armwater effluents stimulated production of the most abundant species" and inhibited minor elements of the population, inhibited species were not eliminated from the UIW. App. A at A-26; *see* App. C at C-6. Because the community below the Dresden Island Lock and Dam is similar to the communities in the Des Plaines and Kankakee Rivers, "[t]hese results indicate that members of the phytoplankton communities in the system receiving warmwater effluents were similar to those removed from this influence and that they were not impacted on a long term basis by power generation." *Id*., citing Commonwealth Edison Co. and UIW Ecological Study Task Force, Aquatic Ecological Study of the UIW (1996). Any differences in the algal community between the areas upstream and downstream of the Dresden discharge "were attributed to spatial and temporal variations, differences in river hydrology and morphology, and differences in ambient water temperatures." App. A at A-26, citing Commonwealth Edison Co., § 316(a) – 401(c) Demonstration for the Dresden Nuclear Generating Station (Dec. 1980).

Since 1994, observers have noted that phytoplankton blooms appear in backwaters of the UIW in June and often appear in main channel areas by July. Exh. 1 at 19; *see* App. C. at C-6. While these blooms generally continue to September, they "do not appear to be dominated by 'nuisance' species of algae." Exh. 1 at 19-20; *see* App. C at C-6.

The demonstration argues that these studies and data from other facilities show that the thermal discharge from Dresden "has not caused appreciable harm to the phytoplankton community." Exh. 1 at 20. The demonstration asserts that, although the UIW and its tributaries have been degraded over a long period of time by urbanization and agricultural, commercial, and industrial uses, the aquatic community near the Dresden discharge "is not significantly different than areas outside of the influence of the thermal plume." *Id*. Discharges under the present alternative thermal effluent limits have "*not caused a shift in the phytoplankton community towards nuisance species* and blooms." *Id*. (emphasis in original). The demonstration argues that diversity, composition, and abundance have been maintained during more than 40 years of operation and that the phytoplankton community supports a diverse food chain. *Id*. The demonstration adds that Dresden does not discharge other pollutants or affect other parameters such as nutrients that are implicated in impairment of the aquatic community. *Id*. It also argues that improvements associated with reduced nutrient loadings are not impeded by Dresden's discharge. *Id*. The demonstration concludes that the proposed alternative thermal effluent standards "would not be predicted to have adverse effects on phytoplankton communities" in the vicinity of Dresden. *Id*.

In its questions, the Board noted the requirement in Section 3.3.1.3 of the Draft Manual that phytoplankton data should include specified elements. Board Questions at 4-5, citing Draft Manual at 20. The Board also noted the demonstration's conclusion that monitoring data satisfy the decision criteria for phytoplankton under Section 3.3.1.1. Board Questions at 5, citing Exh. 1 at 19-20; *see* Draft Manual at 18. The Board requested that Exelon "clarify whether the data collected included the Section 3.3.1.3 items and whether such data was used to arrive at the conclusions EA made regarding the Section 3.3.1.1 criteria. . . ." Board Questions at 5.

Exelon responded that the demonstration supports a finding that the waters receiving the Dresden discharge are areas of low potential impact for phytoplankton. Resp. at 10, citing Draft Manual at 18-19. First, Exelon argues that phytoplankton are part of the aquatic community near the discharge but "are not the primary factor supporting the community through photosynthetic activity." Resp. at 10. Exelon states that "river flow and associated mixing play a significant role in oxygenating the water, along with photosynthetic activity of the abundant macrophytes and periphyton in the River." *Id*. Exelon states that proposed alternative thermal limits are not expected to change these conditions. *Id*. Second, Exelon argues that no shift toward nuisance phytoplankton species has been observed during more than 40 years of monitoring near Dresden. Exelon further argues that the proposed alternative limits "are not expected to cause or encourage a shift toward nuisance species." *Id*. Third, Exelon states that the discharge adds flow and mixing to the river and "does not pose a risk of altering the community from a detrital-based to a photosynthetic-based system." *Id*. Based on its review of these criteria, Exelon concludes that the Illinois River near the Dresden discharge "qualifies as a low impact area for phytoplankton." *Id*.

The Board finds that the proposed thermal discharge to the Illinois River meets the decision criteria of the Draft Manual for phytoplankton to be considered an area of low potential impact. *See* Draft Manual at 19. Exelon explains that the riverine nature of the system along with photosynthetic activity of macrophytes and periphyton, rather than phytoplankton, account for the primary contribution to oxygenating the water. Historical data from 1994 through 2014 indicate that operation of the Dresden station in indirect open cycle cooling mode under the current alternative thermal effluent limitations has not caused a shift towards nuisance species of algae. Pet at 20, App. C at C-6. Exelon's demonstration shows that, over the past 40 years, the diversity of phytoplankton and periphyton primary producers continues to support a diverse food chain, and the proposed alternative thermal effluent limitations are not expected to change the balance from a detrital-based to a photosynthetic-based system. Exh. 1 at 20, Resp. at 10.

Also, as discussed below, the presence of balanced and indigenous populations of fish and mussels shows that sufficient phytoplankton have been available to support those populations. Exelon's demonstration meets the decision criteria and shows that the Dresden receiving waters are areas of low potential impact for phytoplankton: (i) phytoplankton are not the primary factor supporting the community through photosynthetic activity; (ii) a shift toward nuisance species would not be encouraged; and (iii) the discharge does not pose a risk of altering the community from a detrital to a phytoplankton based system.

<u>Zooplankton</u>

Zooplankton are "[a]nimal microorganisms living unattached in water. They include small crustaceans such as daphnis and cyclops, and single-celled animals such as protozoa, etc." Draft Manual at 79; *see* App. C. at C-10. Zooplankton provide "a primary food source for larval fish and shellfish and also makes up a portion of the diets of some adult species." Draft Manual at 56, 77. The demonstration states that zooplankton "have relatively limited powers of locomotion, and drift with currents." App. C at C-10. Many fish species have a planktonic life stage termed meroplankton to distinguish those species from organisms that remain planktonic for their entire life cycle. Draft Manual at 56, 77. "If a heated discharge kills or prevents development of the meroplankton, fewer adult fish and shellfish will be produced each year." *Id*.

If an applicant can show that a site is a low impact area for zooplankton, then that section of the demonstration "will be judged successful." Draft Manual at 20. The Draft Manual states that "[a]rea of low potential impact for zooplankton and meroplankton are defined as those characterized by low concentrations of commercially important species, rare and endangered species, and/or those forms that are important components of the food web or where the thermal discharge will affect a relatively small proportion of the receiving water body." *Id*. at 20-21. For other sites, the decision criteria for this section require an applicant to demonstrate that:

1. Changes in the zooplankton and meroplankton community in the primary study area that may be caused by the heated discharge 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. *Id*.

For sites that are not low impact, the Draft Manual lists information that an applicant should provide. Draft Manual at 21, 56-57.

Exelon's demonstration asserts that zooplankton growth and reproduction "are not expected to be adversely impacted by thermal discharges." App. C at C-10. The demonstration first argues that, "because they spend their entire life in a variable environment, they have evolved broad physiological tolerances and behavioral patterns that allow them to survive changing conditions." Exh. 1 at 22; App. C at C-10. The demonstration also argues that "zooplankton are rapidly transported and dispersed by currents, such that no organism would spend significant amount of time (conservatively less than 10 minutes) in the immediate discharge zone." Exh. 1 at 22; App. C at C-10. Finally, it also asserts that zooplankton "have short generation times and high reproductive capacities, allowing populations to readily offset the loss of individuals and to recover rapidly from local and short-term perturbations." Exh. 1 at 22; App. C at C-10.

Zooplankton studies performed during indirect open-cycle operation in the 1970s generated samples consisting largely of copepods, cladocerans, and rotifers. Exh. 1 at 22-23, citing Commonwealth Edison Co., § 316(a) - 401(c) Demonstration for the Dresden Nuclear Generating Station (Dec. 1980); *see* App. A at A-26; App. C at C-10; App. E at E-5. The studies showed that the Des Plaines River has higher zooplankton abundance but lower diversity than the Kankakee River. Exh. 1 at 23; App. A at A-26 - A-27; App. C at C-10. The study attributed these different assemblages to the "hydrology, physiochemistry, and morphology of the two rivers." Exh. 1 at 23; *see* App. A at A-27; App. C at C-10. The studies showed that the typical zooplankton assemblage on the north shore of Dresden Pool downstream from the Dresden discharge "was very similar" to that on the north bank of the Des Plaines River upstream of the discharge. Exh. 1 at 23; App. A at A-27; App. C at C-11. On the south shore of the Dresden Pool downstream from the discharge, densities and composition "exhibited characteristics of both the Kankakee and Des Plaines Rivers, which reflects mixing of the two rivers downstream of their confluence." Exh. 1 at 23; *see* App. A at A-27; App. C at C-11. "It appeared that zooplankton abundance and species composition in the cooling pond discharge was masked when the cooling pond discharge was diluted in Dresden Pool, mixing with communities transported and dispersed downstream from the Des Plaines and Kankakee Rivers." App. C at C-11. Because the zooplankton community in the portions of the Dresden Pool influenced by the Dresden discharge "is similar to the mixed communities of the Des Plaines and Kankakee Rivers well upstream," the demonstration concludes that the thermal discharge from Dresden has not caused appreciable harm to the zooplankton community. Exh. 1 at 23; *see* App. C at C-11. It adds that the "community structure of higher trophic levels such as benthic macroinvertebrates and fish have remained similar or improved." App. C at C-11. The demonstration states that the Dresden discharge has "had no measurable effect on the downstream zooplankton assemblage" and that the proposed alternative limits are not predicted to have an adverse effect on zooplankton communities in the vicinity of the discharge. *Id*.

In its questions, the Board cited Section 3.3.2.1 of the Draft Manual, which lists three decision criteria for zooplankton and meroplankton. The third criterion requires that "[t]he thermal plume does not constitute a lethal barrier to the free movement (drift) of zooplankton and meroplankton." Board Questions at 5, citing Draft Manual at 20. The Board noted that the demonstration addresses the first two criteria. Board Questions at 5, citing Exh. 2 at 23. The Board requested that Exelon "address the third criterion or point to the section(s) of the petition in which it is already addressed." Board Questions at 5.

Exelon states that thermal endpoints for zooplankton indicate lethal temperatures ranging from 95ºF to 104ºF depending on duration of exposure and acclimation. Resp. at 11. Exelon argues that zooplankton typically experience thermal changes that are "generally not of a duration to be lethal, even when discharge temperatures are high." *Id*. (citation omitted). Exelon adds that results of studies also support the conclusion that the Dresden thermal plume does not form a lethal barrier. Exelon reports that the Des Plaines and Kankakee River assemblages are dominated by rotifers, and "copepopds and cladocerns are more abundant in the cooling lake." *Id*. Exelon states that "[t]he cooling lake assemblage influences the composition at the Dresden Station discharge location in the Illinois River and further downstream. However, when the influence of the cooling lake contribution is accounted for, the zooplankton composition at the discharge and downstream closely resembles the Kankakee River assemblage. . . ." *Id*. Exelon concludes that "the absence of long-term and far-field differences in the historic Dresden Station zooplankton data indicates that the Station's discharge allows free movement and drift of zooplankton and does not represent a lethal barrier. *Id*.

The Board finds that the proposed thermal discharge to the Illinois River meets the decision criteria of the Draft Manual for zooplankton. *See* Draft Manual at 20. Exelon's demonstration shows that samples taken during indirect open cycle cooling operation found the zooplankton community in the Dresden Pool is similar to that in the Des Plaines and Kankakee Rivers upstream. Exelon's demonstration further shows that the seasonal cycles of zooplankton continue to be sustained in the UIW. Exh. 1 at 23. Exelon notes that the similar composition of the zooplankton upstream and downstream of the discharge support the conclusion that the discharge does not present a lethal barrier to the free movement and drift of zooplankton. Resp. at 11.

Also, as discussed below, the presence of balanced and indigenous populations of fish and mussels shows that sufficient zooplankton have been available to support those populations. Exelon's demonstration meets the decision criteria and shows that: (i) changes in the zooplankton community will not result in appreciable harm to the balanced indigenous fish and shellfish population; (ii) the heated discharge is not likely to alter the standing crop or relative abundance; and (iii) the thermal plume does not constitute a lethal barrier to the free movement of zooplankton.

Macroinvertebrates and Shellfish

Macroinvertebrate Community

Macroinvertebrates[17] including shellfish are an important part of aquatic food webs and provide a source of bait for sport and commercial fishing. Draft Manual at 58. An area with low potential impact for macroinvertebrates and shellfish is defined as one that can meet five requirements:

1. Shellfish/macroinvertebrate species of existing or potential commercial value do not occur at the site. This requirement can be met if the applicant can show that the occurrence of such species is marginal.

2. Shellfish/macroinvertebrates do not serve as important components of the aquatic community at the site.

3. Threatened or endangered species of shellfish/macroinvertebrates do not occur at the site.

4. The standing crop of shellfish/macroinvertebrates at the time of maximum abundance is less than one gram ash-free dry weight per square meter.

[17] "Macroinvertebrates" are synonymous with "aquatic macroinvertebrates," which are "those 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." Draft Manual at 73, 77.

5. The site does not serve as a spawning or nursery area for the species in 1, 2, or 3 above. *Id*. at 25.

A shellfish/macroinvertebrate section of the demonstration is successful "if the applicant can demonstrate that no appreciable harm to the balanced indigenous population will occur as a result of macroinvertebrate changes caused by the heated discharge." Draft Manual at 23; *see* Exh. 1 at 23. The Draft Manual provides decision criteria related to individual parameters. First, a reduction in the standing crop of macroinvertebrates may be a cause for denial, "unless the applicant can show that such reductions cause no appreciable harm to balanced indigenous populations within the water body segment." Draft Manual at 23. Second, reduction in diversity may be a cause for denial unless the applicant can show that critical macroinvertebrate functions "are being maintained in the water body segment as they existed prior to the introduction of heat." *Id*. at 24. Third, if a discharge accounts for 30% or more of the 7-day, 10-year low flow of a river, the applicant must show that:

1. [i]nvertebrates do not serve as a major forage for the fisheries,

2. [f]ood is not a factor limiting fish production in the water body segment, or

3. [d]rifting invertebrate fauna is not harmed by passage through the thermal plume. *Id*.

Finally, "[a]reas 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 the discharge of waste heat." *Id*. at 24-25. For sites that are not low impact, the Draft Manual lists information that an applicant should provide. Draft Manual at 25-28, 58-60.

Exelon reports that there has been intermittent sampling of macroinvertebrates in the vicinity of the Dresden discharge from both natural and artificial substrates since 1972. Exh. 1 at 24. Exelon states that these studies intended to characterize the composition of the benthic community, analyze differences over time and space, and examine results with regard to potential effects of the Dresden discharge. App. A at A-27.

From 1972 to 1974, samples from natural substrates in the Dresden Pool when Dresden operated in indirect open-cycle cooling mode included primarily Tubificidae (worms) and Chironomidae (midges). Exh. 1 at 24; *see* App. C at C-11. Beginning in 1974, the study included HD samplers. App. A at A-27; *see* App. C at C-11, App. E at E-6. From 1974 to 1976, samples upstream from the Dresden discharge also consisted primarily of Tubificidae and Chironomidae taxa "with Ephemeroptera (mayflies) of secondary abundance." Exh. 1 at 24; App. C at C-12; *see* Exh. A at A-28. The demonstration asserts that "artificial substrate samples indicate that availability of good quality natural substrates rather than temperature limits the benthic macroinvertebrate diversity" downstream from Dresden. Exh. 1 at 24; *see* App. C at C-11 – C-12. Even in the discharge canal, samples from artificial substrates revealed densities and abundance not reflected in samples from natural substrates in the Dresden Pool. Exh. 1 at 24.

A 1993 study collected samples from both natural and artificial substrates. Exh. 1 at 24; App. A at A-27; *see* App. C at C-11. Ponar samples downstream from the Dresden discharge showed lower taxa richness, lower diversity, and higher density. App. A at A-27. Artificial substrates downstream from the discharge showed greater densities, high biotic index (BI) scores, and lower diversity. Exh. 1 at 24; *see* App. C at C-12. The study attributed these spatial differences to "several factors including flow, flow-induced sampling variation, and differences in water quality, in addition to temperature." App. C at C-12, citing Environmental Science & Technology, Inc., UIW Study Interim Report, Benthic Macroinvertebrate Investigation and Habitat Assessment RM 272.0 – 323.0 (1994); *see* App. C at C-12. Exelon also cites the results of the study to state that habitat and sediment regulate the benthic community. Att. A at A-28.

From 1999 through 2014, data from Ponar grab samples and HD artificial substrate samples near the Dresden discharge "were consistent with the results of the earlier studies." Exh. 1 at 25; *see* App. C at C-12. The benthic community is "dominated by pollution tolerant taxa that are capable of achieving high densities in habitats that consist of low current velocity, unconsolidated sediment, and frequent disturbance associated with barge traffic." App. A at A-28; *see* Exh. 1 at 25; App. C. at C-12.

"Statistical analysis of these data exhibit no consistent trends associated with spatial or thermal differences." App. A at A-28. The demonstration states that "artificial substrates samples typically had higher total taxa richness, higher EPT taxa richness, and a more even distribution of abundance among the taxa than did Ponar samples in natural substrate from the same locations." Exh. 1 at 25. Artificial substrate results showed that areas upstream and downstream from the Dresden discharge had a similar number of EPT taxa. *Id*. Data from these samples "were statistically similar among the majority of study years for all parameters." *Id*. Also, mean Ephemeroptera densities were not significantly different over time. *Id*. Inter-year differences "could be the result of a number of factors including natural annual variation, stream flow conditions, food availability, predator abundance, and legacy pollutants." *Id*.; App. C at C-13. The demonstration concludes that these results show the Dresden discharge "has had no measurable effect on the downstream benthic macroinvertebrate assemblage." App. A at A-28.

Exelon's demonstration argues that these data show that the current thermal effluent standards "have *not caused appreciable harm* to the benthic community" in the vicinity of the Dresden discharge. Exh. 1 at 26 (emphasis in original). The demonstration further argues that operation in the indirect open-cycle mode under these thermal standards "has not and is not expected to result in reductions in [the] standing crop of the benthic macroinvertebrate community." *Id*. The demonstration asserts that indirect open-cycle mode also is not expected to reduce macroinvertebrate diversity. *Id*. Finally, the demonstration states that operation under the proposed standard "is *not expected to interfere with maintenance or critical, seasonal, life history cycles*" of the macroinvertebrate community, including spawning and recruitment, in the vicinity of the Dresden discharge. *Id*. (emphasis in original); *see* Draft Manual at 23-25 (Decision Criteria).

In looking at the overall macroinvertebrate community, the Board notes the differences in results from sampling efforts with artificial and natural substrates in the Dresden Pool and discharge canal. Exelon's demonstration shows that the artificial and natural substrates had similar numbers of pollution-sensitive EPT taxa, but also shows that the artificial substrate samples resulted in higher densities and greater abundance compared to the samples from the available natural substrates. Exh. 1 at 24-25. Statistical analysis found no trends associated with thermal differences in the sampling areas. App. A at A-28. Exelon's demonstration supports the assertion that "availability of good quality natural substrates rather than temperature limits the benthic macroinvertebrate diversity". Exh. 1 at 24-25. As such, Exelon's demonstration supports the assertion that the proposed alternative thermal effluent limitations are not expected to interfere with the seasonal and critical life cycles of the benthic macroinvertebrate community (*e.g*. spawning and recruitment) in the vicinity of the Dresden discharge. Exh. 1 at 26.

Freshwater Mussels

Exelon commissioned a 2014 mussel study to characterize the mussel community in the vicinity of Dresden. Exh. A at A-29; *see* App. H at H-1 - H-2. The mussel survey included 2300 meters of the Illinois River, including 400 meters upstream of the DNS discharge. App. H. Exelon argues that the study shows a diverse assemblage of mussels both upstream of and downstream from the Dresden Island Lock and Dam. Exh. 1 at 26; Exh. A at A-29; App. H. at H-8. The study collected 928 individuals of 20 species downstream from the dam and 2,421 individuals of 24 species upstream. Exh. 1 at 26; App. H at H-4. Of those 3,349 total mussels, 2,271 or 68% were aged, 31% of which were less than five years old and 69% of which ranged from six to 25 years old. App. H at H-4 – H-5. Two State threatened mussel species were found both upstream and downstream of the Dresden discharge in the study area: purple wartyback and black sandshell. App. H at H-4. The study indicates that recruitment is apparent in both areas, "although the upstream assemblage had a more even mix of immature and adult mussels than downstream." Exh. 1 at 26; *see* App. H. at H-5, H-8. The study attributes mussel distribution to "substrate composition with the highest densities of mussels occurring in areas with substrates composed primarily of gravel mixed with sand and/or silt." Exh. 1 at 26; *see* App. A at A-29; App. C at C-14; App. H, Figure H-3. The study states that the "highest densities of mussels encountered during the survey occurred along the right descending bank within the flow path of the elevated temperatures in the thermal plume, but where preferred substrate occurred." Exh. 1 at 26, Resp. at 12; *see* App. H. at H-8. Exelon concludes that these results show that the Dresden discharge "is not adversely affecting freshwater mussels in Dresden Pool or downstream of the Dresden Island Lock and Dam." App. H. at H-8; *see* App. A at A-29, citing App. A, Figure A-3 (Mussel Survey Results and Thermal Plume Under Median July River Conditions).

Exelon's demonstration argues that, consistent with the Draft Manual, these data show that "a balanced, indigenous mussel community is supported in the vicinity" of the Dresden discharge. Exh. 1 at 27; *see* Draft Manual at 23-25. The demonstration further argues that Dresden's operation in the indirect open cycling mode has not adversely affected that community. *Id*. The demonstration asserts that operation in that mode "has not and is not expected to result in a reduction in the diversity of the freshwater mussel community." *Id*. Finally, the demonstration states that operation under the proposed standard "is *not expected to interfere with maintenance or critical, seasonal, life history cycles* (*e.g.*, spawning and recruitment) of the freshwater mussel community" in the vicinity of the Dresden discharge. *Id*. (emphasis in original).

Exelon acknowledges that "unionid mussels can be particularly susceptible to ecosystem stress due to their relatively limited mobility during juvenile and adult life stages." Resp. at 12. However, Exelon describes stress-avoidance responses that unionid mussels exhibit during short-term exposure that protect them from occasional extreme thermal conditions. The Board notes that in 2012, when ambient temperatures were high and river flow was low, conditions were comparable to thermal exposures that would be permitted under the proposed alternative thermal effluent limits. Exh. 1 at 6. Despite the extreme temperatures which occurred in 1999 and 2012, Exelon notes that the species and age distribution of the mussel community within the area of elevated temperatures consists of both adults and juveniles. Exelon further notes that these distributions show that a diverse mussel community with recruitment, including two State-threatened species, continues to exist. App. H at H-4 - H-5; Resp. at 12-13. For these threatened mussel species, IDNR determined that an impact would be "unlikely." Rec. at 12-13. Additionally, Exelon's demonstration found "no unique or critical habitat for spawning and early development of RIS or threatened/endangered species exists in the Dresden Pool." Exh. 1 at 17. The Board finds that the proposed alternative thermal effluent limits meet the decision criteria of the Draft USEPA 316(a) Manual for macroinvertebrates and shellfish. *See* Draft Manual at 23-24. Exelon's demonstration shows: (i) no appreciable harm to the balanced and indigenous population; (ii) critical functions of macroinvertebrates are being maintained as they existed prior to introduction of heat; and (iii) there will be no impact to spawning or nursery sites for important shellfish and/or macroinvertebrates.

Fish

"The discharge of waste heat can affect fish populations in many ways." Draft Manual at 60. If an applicant can show that a site is a low impact area for fish, then that section of the demonstration "will be judged successful." Draft Manual at 28. The Draft Manual states that a discharge may be determined to be in an area of low potential impact for fishes if it meets the following conditions:

1. The occurrence of sport and commercial species of fish is marginal;

2. The discharge site is not a spawning or nursery area;

3. The thermal plume . . . will not occupy a large portion of the zone of passage which would block or hinder fish migration under the most conservative environmental conditions (based on 7-day, 10-year low flow or water level and maximum water temperature);

4. The plume configuration will not cause fish to become vulnerable to cold shock or have an adverse impact on threatened or endangered species. *Id*. at 29.

For other sites, the decision criteria for this section require an applicant to demonstrate 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. *Id*. at 28-29.

For sites that are not low impact, the Draft Manual lists information that an applicant should provide. *Id*. at 29-32, 60-61. The study requirements are in part that "[a]ppropriate sampling methods and gear will be used to provide a basis for identifying the Representative Important Species (RIS) of fish. . . ." *Id*. at 29; *see id*. at 60.

The demonstration reports that studies in the UIW near Dresden conducted since 1971 have documented "the occurrence of 105 species including 80 native species and 25 introduced/exotic species." App. A at A-30, citing App. A. Table A-1 (Checklist of Fish Species Collected near Dresden Nuclear Station Upstream and Downstream of Dresden Island Lock and Dam, 1971-1989 and 1991-2014).

Addressing reproduction of fish species, the demonstration states that ambient currents strongly affect distribution and dispersal of ichthyoplankton. Exh. 1 at 27. Exelon reports data showing that "ichthyoplankton occurred in the drift in 2005 and 2006 when ambient river temperatures ranged from 10.5 to 31.4ºC (51 to 88.5ºF)." *Id*. These temperatures suggest that "ichthyoplankton were not exposed to temperatures high enough or for sufficient duration to caused thermally-induced mortality during the 2005 and 2006 study." *Id*., citing EA Engineering, Science, and Technology, Inc., Entrainment Characterization Study, 2005 – 2007, Dresden Station (2007); *see* App. C at C-15. Exelon also reports that 82.5 percent of the ichthyoplankton drift passed the Dresden intake by June 15 during closed cycle operations in 2005 and 86.5 percent did so in 2006. Exh. 1 at 27-28. Remaining drift occurred during indirect open cycle cooling from the middle of June through late August. *Id*.

In addition, the demonstration argues that data on native species richness show that a diverse fish community has been maintained near Dresden since it began operation. Exh. 1 at 28. Exelon reports that total catch-per-effort of native species has been statistically similar for 15 of 17 years compared. *Id*. at 29. Exelon states that mean IWBmod scores were statistically similar for 13 of 17 years. Exelon adds that the difference between mean IWBmod scores upstream of and downstream from Dresden was not statistically different in 15 of those 17 years, indicating that Dresden had little effect on the fish community. *Id*. Exelon argues that, compared with Dresden's operation, "[e]nvironmental conditions in the UIW resulting from impoundment of the Illinois River, operation of the navigation system, and significant discharges from wastewater treatment facilities has a greater effect on the fish community and prevents it from meeting higher IWBmod scores. . . .” *Id*.

In addressing the first of the 316(a) decision criteria for the fish biotic category, Exelon points out that mortality from cold shock is not at issue because “the proposed ATLs do not affect the period during cooler ambient temperatures between 1 October and 14 June, when DNS operates in closed cycle cooling mode.” App. B at B-35; *see* Draft Manual at 28-29.

Regarding the second decision criterion for mortality from excess heat, Exelon’s demonstration refers to the available data for acute and chronic thermal tolerance limits for the RIS. App. B at B-27 - B-30. Acute mortality represents minutes to hours of exposure while chronic mortality is measured under more extended periods of time (48-96 hours). The Board notes that Exelon’s demonstration predicted no acute mortality for any of the RIS based on data showing their acute thermal temperature tolerance ranges. App. B at B-28, Figures B-5 - B-16. IEPA’s recommendation added that,

> “[p]roviding these excursions above 93°F do not exceed 24 hours in duration, as specified by the proposed alternative thermal limits, no acute mortality of any of the RIS is expected to occur under the modeled conditions of the Extreme High Temperature Scenarios. This is supported by the published acute thermal mortality thresholds for each RIS, as well as documentation of the July 2012 heat event that resulted in upstream and downstream temperatures of the study area temporarily exceeding 93°F for several hours, yet with no observed fish kills or other adverse effects reported in the study area.” Rec. at 10.

The demonstration also predicted chronic morality is unlikely. Exelon states, “White sucker is the only RIS for which the potential exists for mortality associated with chronic exposure to temperatures above 90.5.” Pet. at 19. However, Exelon explains that conditions permitted by the alternative thermal effluent limitations would not persist for more than 24 hours, which the Board notes is shorter than the chronic exposure periods. Pet. at 19. Additionally, the demonstration and IEPA note that thermal refuge is available to the white sucker for the short duration of less than 24 hours when the extreme temperatures would exist under the alternative thermal effluent limit. Pet. at 19, App. B at B-30, Rec. at 11-12. Additionally, the Board notes that no mixing zone would be provided during the period from June 15 to September 30, so the alternative thermal effluent limitations would apply only at the discharge outfall. Resp. at 8.

Addressing the third 316(a) criterion regarding reproductive success or growth, Exelon’s demonstration states that “[m]ost spawning by the RIS in the vicinity of DNS appears to occur prior to 15 June . . . and would therefore, not be affected by the proposed ATLs.” App. B at B-38. The demonstration further states that “[i]t is unlikely that temperatures in the DNS thermal plume even under the extreme conditions of July 2012 would adversely affect growth or cause a cessation of growth for these RIS.” App. B at B-39. Exelon provides data on critical temperatures for growth for each of the RIS. App. B at B-33 - B-35; Figures B-5 - B-16. In general the thermal plume is not expected to adversely affect the normal patterns of growth. Exelon and IEPA point out that, while growth may decline in the summer if temperatures rise above a critical level, the thermal plume may also stimulate growth earlier and later in the year compared to conditions without the thermal plume. Rec. at 10, App. B at B-38 - B-39. "[D]ata demonstrate that the current and proposed ATLs are supportive of seasonal cycles of spawning and reproduction of the fish community in Dresden Pool; these important life history functions are sustained and do not appear to be reduced. . . ." Exh. 1 at 30-31.

Exelon's demonstration referred to *Wr* data as a measure of fish condition used to assess fish growth, where a range of 90-100 is considered optimal. Exelon states that the *Wr* data show that fish collected since 1994 from both the Dresden Pool and downstream from the Dresden Island Lock and Dam "were consistently in good condition" with most summer readings approaching 90. Exh. 1 at 30. Exelon also reports that the incidence of DELT anomalies, as indicators of stress, decreased from about14 percent in 1995 to about 2 percent in 1999 and has remained at that level for the last 14 years. *Id*.

The fourth 316(a) criterion addresses exclusion of the fish community from unacceptably large areas. The demonstration states that, under the current and proposed alternative thermal effluent limitations,

> "[w]ater temperatures with the potential to exclude key members of the fish community are limited to a relatively small area and for brief periods of time downstream of the DNS cooling water discharge compared to the available surface area and volume of the UIW. Beach seine and electrofishing samples indicate that the most abundant species are widely distributed in the vicinity of DNS with no evidence of avoidance of areas influenced by the DNS thermal plume." Exh. 1 at 30-31; App. B at 30 to B-31.

Additionally, the Board notes that the alternative thermal effluent limitations would apply at the discharge outfall and do not include provisions for a mixing zone from June 15 to September 30. Resp. at 8.

As to the fifth criterion addressing blockage of migration, the predictive demonstration modeled the extreme temperature scenario and found that conditions would not result in either habitat loss or extended blockage of migration. Exh. 1 at 6, App. B at B-26 - B-31, Table B-6, Rec. at 7, 9. Exelon's demonstration states that "it is unlikely that the thermal plume would interfere with migration and localized movement patterns (e.g., diel and seasonal onshore/offshore, upstream/downstream, or spawning) of the fish community. . . . Although it is likely that white sucker [the most thermally sensitive of the RIS] might avoid significant areas of the DNS thermal plume during such extreme conditions, moving to more moderate upstream habitat, the duration that avoided temperatures persist is short, less than 24 hours . . . [and] unlikely to have any extended effect on habitat utilization by this species…" App. B at B-31.

Exelon concludes that, consistent with the Draft Manual, the current alternative thermal limits and proposed limits "are *supportive of seasonal cycles* of spawning and reproduction of the fish community in Dresden Pool." Exh. 1 at 30 (emphasis in original); *see* Draft Manual at 28-32. The demonstration states that "these *important life history functions are sustained* and do not appear to be reduced" near the Dresden plume compared to areas upstream including the Des Plaines and Kankakee Rivers." Exh. 1 at 30 (emphasis in original). Exelon adds that "[a] typical *diverse, fish community is supported* in the UIW and does not appear to be excluded from a significant portion of the Dresden Pool unique or critical habitats." *Id*. (emphasis in original). Finally, Exelon states that "[a]n *adequate zone of passage exists*" in the vicinity of the Dresden thermal plume under both the current and proposed alternative thermal limits. *Id*. at 30-31 (emphasis in original).

The Board finds that the proposed alternative thermal effluent limits meet the decision criteria of the Draft USEPA 316(a) Manual for fish. *See* Draft Manual at 28-29. Exelon's demonstration shows that fish communities will not suffer appreciable harm from: (i) direct or indirect mortality from cold shock; (ii) direct or indirect mortality from excess heat; (iii) reduced reproductive success or growth as a result of Dresden's discharges; (iv) exclusion from unacceptably large areas; or (v) blockage of migration.

<u>Other Vertebrate Wildlife</u>

"Other vertebrate wildlife" includes species such as ducks and geese, but not fish. Draft Manual at 32, 77. If an applicant can show that a site is a low impact area for other vertebrates, then that section of the demonstration "will be judged successful." *Id*. at 32. "Most sites in the United States will be considered ones of low potential impact for other vertebrate wildlife simply because the projected thermal plume will not impact large or unique populations of wildlife." *Id*. Exceptions include the "few sites" where important, threatened, or endangered wildlife may be affected by the discharge. *Id*. Exceptions may also include sites in the northern regions of the United States that attract species such as ducks and geese and encourage them to stay through the winter. *Id*. These sites may be considered low impact if there is a demonstration that a wildlife protection plan or other method would protect those species from specified harms. *Id*. For sites that are not considered low impact for other vertebrate wildlife, the decision criteria for this section require an applicant to demonstrate "that other wildlife community components will not suffer appreciable harm or will actually benefit from the heated discharge." Draft Manual at 32. For these sites, the Draft Manual lists information that an applicant should provide. *Id*. at 33, 61.

Exelon acknowledges that the Dresden Pool is used as nesting, nursery, and foraging grounds by various species of mammals, song birds, reptiles, and amphibians and is also used as a resting area by migratory birds. Exh. 1 at 31; *see* App. A at A-32. However, Exelon states that "other vertebrate wildlife can be considered as a *low potential impact biotic category*" with regard to the Dresden thermal discharge. Exh. 1 at 31 (emphasis in original); *see* Draft Manual at 32. The demonstration states that "[t]he DNS thermal discharge plume does not disrupt normal migratory patterns by attracting large numbers of birds during spring and fall migration periods or by causing conditions that attract large overwintering populations of otherwise migratory species." *Id*. Exelon continues that "Dresden Pool does not provide unique or critical habitat for the survival and growth of these wildlife species." Exh. 1 at 31. Exelon states that "[t]he thermally-influenced area is relatively small and higher water temperatures occur in the summer when migratory waterfowl use is at its lowest." *Id*. Based on past observations, Exelon's Retrospective Demonstration states that "[a]ctivity of other vertebrate wildlife has not been limited by the thermal limits that DNS has operated under since 1981 and are not expected to be affected by the proposed ATL." Exh. 1, App. C at C-23.

The Board finds that the area influenced by the thermal element of the DNS discharge is a low potential impact area for other vertebrate wildlife because the thermal plume resulting from the proposed alternative thermal effluent limitations should not impact any large or unique populations of vertebrate wildlife. Exelon's demonstration meets the decision criteria and shows that other wildlife will not suffer appreciable harm. *See* Draft Manual at 32.

Board Finding on Biotic Category Analysis

The demonstration concludes that surveys of biotic categories representing appropriate food chain trophic levels show that the aquatic community in the vicinity of Dresden "is not consistently or significantly different from that found upstream in the Des Plaines and Kankakee Rivers or downstream of Dresden Island Lock and Dam" beyond the influence of the Dresden thermal plume. Exh. 1 at 15.

The Board finds that Exelon's proposed alternative thermal effluent limitations meet the decision criteria of the Draft Manual to find a Section 316(a) demonstration successful for each of the biotic categories: habitat formers; phytoplankton; zooplankton; macroinvertebrates and shellfish; fish; and other vertebrate wildlife. The Board finds that a balanced indigenous community of aquatic life currently exists in the area influenced by the thermal element of the DNS discharge to the Illinois River. The Board observes that the record contains no evidence of a shift to nuisance species or of fish kills attributable to prior thermal discharges from Dresden, including conditions similar to the proposed alternative thermal effluent limitations. The Board notes that state-listed threatened and endangered species were identified in the vicinity of the Dresden Station. Accordingly, these are discussed further below under the RIS Demonstration.

RIS Demonstration

If a site is not one of low potential impact for all of the biotic categories, the CWA Section 316(a) demonstration must address an RIS demonstration, a predictive demonstration, or a demonstration based on biological, engineering, and other data. The Draft Manual recommends use of an RIS demonstration as a starting point for the amount of detail required by most CWA Section 316(a) demonstrations. Draft Manual at i, 33.

"RIS" means "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); Draft Manual at 78-79. Analysis of RIS reflects the following assumptions:

1. It is not possible to study in great detail every species at a site; there is not enough time, money, or expertise.

2. Since all species cannot be studied in detail, some smaller number will have to be chosen.

3. The species of concern are those casually related to power plant impacts.

4. Some species will be economically important in their own right, *e.g.*, commercial and sport fishes or nuisance species, and thus ‘important.’

5. Some species, termed ‘representative,’ will be particularly vulnerable or sensitive to power plant impacts or have sensitivities of most other species and, if protected, will reasonably assure protection of other species at the site.

6. Wide-ranging species at the extremes of their ranges would generally not be considered acceptable as ‘particularly vulnerable’ or ‘sensitive’ representative species but they could be considered as ‘important.’

7. Often, all organisms that might be considered ‘important’ or ‘representative’ cannot be studied in detail, and a smaller list (*e.g.*, greater than 1 but less than 15) may have to be selected as the ‘representative and important’ list.

8. Often, but not always, the most useful list would include mostly sensitive fish, shellfish, or other species of direct use to man or for structure or functioning of the ecosystem.

9. Officially listed ‘threatened or endangered species’ are automatically ‘important.’ Draft Manual at 35-36; *see* Exh. 1 at 6.

The Draft Manual lists the following considerations in selecting RIS “[w]here information pertinent to species selection is adequate:”

1. Species designated in state water quality standards as requiring protection;

2. Species identified in consultation with the USEPA Director, other governmental agencies, and other appropriate persons;

3. Any present threatened or endangered species;

4. The most thermally sensitive species (and species group) in the local area 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;

5. Commercially or recreationally valuable species;

6. Far-field and indirect effects on the entire water body, including the additive or synergistic effects of heat combined with other existing thermal or other pollutants; and

7. Species critical to structure and function of ecological system. Draft Manual at 36-38.

In its definition of "RIS," the Draft Manual includes the third, fifth, and seventh of these considerations but also specifically includes species that are "[p]otentially capable of becoming localized nuisance species," those "[n]ecessary in the food chain for the well-being of species" determined under other factors, and those "[r]epresentative of the thermal requirements of important species but which themselves may not be important." Draft Manual at 78-79.

In preparing a CWA Section 316(a) demonstration and underlying studies, federal and state agencies must be consulted to ensure that studies address appropriate wildlife. The Board's procedural rules require the petitioner to inform Illinois EPA of its proposed RIS list and data and information supporting it. 35 Ill. Adm. Code 106.1115(a)(4), 106.1120(b)(5). The Draft Manual advises that the permitting authority consult "with the Regional Director of the FWS [U.S. Fish and Wildlife Service] and representatives of the NMFS [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." Draft Manual at 15. Also, the Board's procedural rules require the petitioner to serve a copy of its petition on both the Agency and Illinois IDNR. *See* 35 Ill. Adm. Code 106.1125.

Petitioners must collect thermal effects data for each RIS including the following:

1. high temperature survival for juveniles and adults;

2. thermal shock tolerance of selected life-history stages;

3. optimum temperature for growth;

4. minimum and maximum temperatures allowing completion of early development;

5. normal spawning dates and temperatures; and

6. special temperature requirements for reproduction. Draft Manual at 43-45; *see id*. at 65 (Decision Criteria).

A CWA Section 316(a) demonstration must show "that the RIS will not suffer appreciable harm as a result of the heated discharge. *Id.* at 35.

<u>Representative Important Species Selection</u>

Exelon reports that it selected candidate RIS from a checklist of native species collected during surveys of the Dresden Pool and downstream from the Dresden Island Lock and Dam over 17 years from 1994 to 2014. App. B at B-5; *see* Exh. 2, App. A at 1. Exelon suggests that assessing impacts on each of the collected species would be difficult and, in the absence of available data on thermal requirements, "nearly impossible." App. B at B-6. Exelon cites factors from the Draft Manual for selection of RIS. *Id*.; *see* Draft Manual at 36-38, 78-79; Exh. 2, App. A at 1. Exelon lists factors specifically considered in selection of RIS for Dresden:

1. Numerical dominance or prominence in the balanced indigenous community;

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 in the vicinity of the Dresden thermal plume;

5. Support of important commercial or recreational fisheries;

6. Thermally sensitive species;

7. Species of special interest or concern (*e.g.*, rare, threatened, or endangered species);

8. Non-native and potential nuisance species; and

9. Species with unique or critical habitat or life history stages in the vicinity of the thermal discharge. *Id*. at B-6 – B-7.

Exelon states that it selected only fish species as RIS for evaluation of the Dresden discharge "because 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 wellbeing shows that the lower trophic levels are supporting the trophic levels occupied by the RIS." App. B at B-7; *see* Exh. 2, App. A at 2. Exelon adds that it did not select lower trophic levels as RIS because they generally lack thermal data and because previous studies have shown localized thermal effects that did not result in harm. App. B. at B-7, citing Duke/Fluor Daniel, North Oak Creek Power Plant 316(a) Demonstration, Information Review (Apr. 1992); *see* Exh. 2, App. A at 2.

Exelon submitted an Early Screening study plan to IEPA and IDNR. Exh. 2, Rec. at 12. IEPA and IDNR recommended the following changes to the plan, and Exelon accepted these changes. Pet. at 12, Exh. 1 at 1-2, Rec. at 12. The changes included:

1) The addition of white sucker, smallmouth bass, and black crappie to the RIS list, and

2) The addition of four semi-quantitative transects and two qualitative search areas for the freshwater mussel investigation. Two additional transects were suggested for each bank of the Illinois River, upstream of the DNS discharge with qualitative search areas between the added transects. Exh. 1 at 1-2.

Exelon reports that it finally selected as RIS 12 fish species, each of which represents one or more of the nine criteria listed above from the Draft Manual. App. B. at B-7. The RIS selected are: gizzard shad, common carp, golden redhorse, white sucker, channel catfish, emerald shiner, largemouth bass, smallmouth bass, bluegill, black crappie, logperch, and freshwater drum. Exh. 1, App. B at B-7.

Exelon notes that studies in and near Dresden Pool have not collected federally threatened or endangered fish species, although studies collected five State-listed fish species: the threatened river redhorse and banded killifish and the endangered greater redhorse, pallid shiner, and western sand darter. *Id*. at B-8; *see* Exh. 2, App. A at 1. Exelon indicates that studies generally collected these species infrequently and in low numbers. App. B at B-8. Exelon selected as candidate species only those that "have published thermal tolerance endpoints in order to conduct the required thermal evaluation. *Id*. at B-7. Exelon excluded from the list of RIS 42 species considered either incidental or occasional. *Id*. at B-8. Exelon also excluded dominant and common species having "habitat, feeding, and life history requirements very similar to the selected RIS. . . ." *Id*. Exelon adds that, when several congeneric species were present in the vicinity of Dresden, it generally selected only one as an RIS. *Id*. However, Exelon selected both largemouth and smallmouth bass "because both are the target in recreational fisheries." *Id*. Exelon argues that its selected RIS include species that feed on various food sources, use various habitats, prefer a variety of substrates, and represent various levels of the food chain. *Id*.

In its questions, the Board referred to IDNR's EcoCAT identification of three State threatened/endangered fish species in the vicinity of the Dresden discharge as well as the other five fish and two mussel species collected. The Board noted that, although listed threatened and endangered species are automatically important, "[t]he RIS did not include threatened or endangered species." Board Questions at 6, citing Draft Manual at 36. The Board requested that Exelon clarify "whether the RIS selected are representative of all the listed threatened and endangered species known to be present" near the Dresden discharge. Board Questions at 6.

Exelon responds that it provided its list of RIS to the Agency, which approved it "with a few changes," and to USEPA, which "offered no objections." Resp. at 13. Exelon argues that its list "includes species that are representative of the fish community diversity in Dresden Island Pool, including listed and threatened and endangered fish." *Id*. Exelon states that "thermal effects data are scarce for many threatened and endangered species." *Id*.; *see* Exh. 2, App. A. Exelon submits a table describing the surrogate relationship, including habitat requirements, between the selected RIS and threatened and endangered fish species. *Id*. at 13-14. Exelon adds that mussel species have limited data on thermal effects. *Id*. at 14. Exelon states that its comprehensive 2014 mussel survey encountered State-listed mussel species and argues that the survey demonstrates no previous appreciable harm to those species resulting from Dresden operations. *Id.*

RIS Selected

Below, the Board summarizes the record on each of the 12 RIS selected by Exelon.

Gizzard shad. Gizzard shad is a prolific species "feeding primarily on invertebrates in mud substrate as well as zooplankton and phytoplankton." App. B at B-9. "In the Illinois River and its tributaries, spawning occurs in open water from about late April through June." *Id*. at B-10. Juvenile gizzard shad are an important part of the forage base for such predators as largemouth bass. *Id*.; *see* Exh. 2, App. A at 2.

Common carp. Common carp is a non-native species introduced to Lake Michigan in the nineteenth century. App. B at B-10. Because of their large average size, they may form a significant portion of the biomass collected without being numerically abundant. *Id*. Where abundant, common carp may become a nuisance species. *Id*. at B-9, B-10; *see* Exh. 2, App. A at 2. "Common carp spawn in shallow weedy areas during spring and early summer." App. B at B-11. During spawning, they may cause "high turbidity levels as they thrash about in shallow weed beds and over silty substrates." *Id*. at B-10.

Golden redhorse. "Golden redhorse is a native riverine species in the sucker family" similar in many respects to species including the state-listed river redhorse. App. B at B-11. "It is the most abundant of five redhorse species" collected in the vicinity of Dresden. *Id*. at B-12. The species "prefers clear rivers and medium-sized streams with gravelly riffles, permanent pools, and moderate currents." *Id*.; *see* Exh. 2, App. A at 3. Redhorse typically spawn during April and May in riffle habitat. App. B at B-11. "Redhorse are a popular sport fish for hook and line anglers." *Id*.

White sucker. White sucker is a native bottom-dwelling species preferring "sand and coarse substrates in clear creeks and small rivers" but also "found in habitat with silt and fine sediment." App. B at B-12. Although it is not common near Dresden, Exelon listed it "because it is considered to be relatively sensitive to increases in summer water temperatures above ambient." *Id*. White suckers spawn "during April and May over gravel substrate in riffles and pools." *Id*.

Channel catfish. Channel catfish is a native sport and food fish most often found in "fast-flowing medium to large rivers with sand and gravel substrates," but it tolerates a range of conditions found near Dresden. App. B at B-12; *see* Exh. 2, App. A at 3. "Adults typically inhabit deep water in large pools near submerged logs, debris, and other cover. Juvenile catfish feed primarily on small insects; adults are omnivores and scavengers, feeding on fish, crayfish, mollusks, insects, plant material, and other organic material." App. B at B-12 - B-13. Channel catfish usually spawn in June and July, using "natural cavities and undercut banks to lay their eggs." *Id*. at B-12.

Emerald shiner. "Emerald shiner is a native forage species that utilizes nearshore habitats in shallow water. It is most common in open water near the surface and avoids dense vegetation." App. B at B-11; *see* Exh. 2, App. A at 2. "Spawning occurs in open water from about May through June. . . ." App. B at B-11. Emerald shiner was the most abundant minnow species collected near Dresden. Exh. 2, App. A at 2.

Largemouth bass. Largemouth bass is a popular recreational species. Exh. 2, App. A at 3. "It utilizes a wide range of habitat from small streams to large rivers and lakes and is common throughout Illinois." App. B at B-14. "They are relatively intolerant of turbidity and siltation." *Id*. Spawning generally occurs during May and June. *Id*.

Smallmouth bass. Smallmouth bass is also a popular recreational species distributed widely throughout northern Illinois. "It prefers clear streams and rivers with gravel and rocky substrate, moderate to fast currents, and relatively cooler summer conditions than do largemouth bass." App. B at B-13. Smallmouth bass are also relatively intolerant of turbidity and siltation. *Id*. "Insect larvae and micro-crustaceans are the primary food for young bass; adults feed primarily on crayfish and fish, but also opportunistically consume insects." *Id*. Smallmouth bass spawn in May and June. *Id*.

Bluegill. "Bluegill is a widely distributed native species that is usually most abundant in clear lakes with aquatic vegetation, but can tolerate a wide range of habitats" such as those occurring near Dresden. App. B at B-14; *see* Exh. 2, App. A at 3. "Bluegill was the most abundant of six sunfish species collected" by electrofishing between 2001 and 2014. App. B at B-14; *see* Exh. 2, App. A at 3. They prefer gravel substrates but will use most other substrates. App. B. at B-14. They feed chiefly on insects, small crustaceans, and small fish. *Id*. "Spawning begins in late May and often continues into August." *Id*. Bluegill are a "target for recreational fishing." *Id*.

Black crappie. "Black crappie is a popular sportfish widely distributed in Illinois. It is relatively intolerant of turbidity and silt, avoids areas with strong currents, and is common in well-vegetated habitat." App. B at B-15. They feed primarily on aquatic insects, crustaceans, and small fish. *Id*. "Spawning begins when water temperatures rise above 13ºC (55.4ºF)." *Id*. Exelon reports that "[b]lack crappie was never abundant" near Dresden "but was collected in low numbers during electrofishing surveys during most years" in all areas studied. *Id*.

Logperch. "Logperch is a widely distributed darter species that occurs throughout Illinois where streams are large and stable enough to provide habitat. It is particularly common in the sluggishly flowing and sand-bottomed Illinois River and associated pools." App. B at B-15; *see* Exh. 2, App, A at 4. Logperch prefer mixed sand and gravel substrates and feed primarily on immature stages of aquatic insects. App. B at B-15. Although surveys in the vicinity of Dresden between 1991 and 2014 identified nine darter species, "[l]ogperch was the only darter among the common dominant taxa collected." *Id*. However, "[l]ogperch catches were low relative to the other candidate RIS as they contributed less than one percent of the total numerical catch during the 15-year monitoring period." Exh. 2, App. A at 4.

Freshwater drum. Freshwater drum is a native species targeted by both sport and commercial fisheries. App. B. at B-16. It is a bottom-dwelling species, most abundant in turbid water over a bottom of mixed sand and silt. Exh. 2, App. A at 4; *see* App. B at B-16. Freshwater drum generally forage on bottom substrates and feed on mollusks, crayfish, and fish. App. B at B-16. They were collected throughout the study area near Dresden in almost every year, although abundance varies from year to year. *Id*. "Information on spawning habits of drum is limited, but it appears that spawning occurs during May and June. . . ." *Id*.; *see* Exh. 2, App. A at 4.

Board Finding on Representative Important Species Analysis

The Board finds that Exelon demonstrated that the RIS will not suffer appreciable harm from the proposed alternative thermal effluent limitations applicable to its thermal discharge to the Illinois River. With IEPA and IDNR input, Exelon selected twelve species as RIS: gizzard shad, common carp, golden redhorse, white sucker, channel catfish, emerald shiner, largemouth bass, smallmouth bass, bluegill, black crappie, logperch, and freshwater drum. Exh. 1, App. B at B-7. Exelon also specifically identified which of the 12 RIS were selected as surrogate species for State-listed threatened and endangered species collected in the study area for the Dresden discharge. Resp. at 13-14. Exelon analyzed the impact of the proposed alternative thermal effluent limitations on reproduction, growth, mortality, and avoidance. As described in more detail above, Exelon's demonstration indicated and IEPA agreed that conditions under the proposed ATL were unlikely to affect spawning and growth or result in significant mortality of the RIS and would not result in habitat loss or extended blockage of migration.

As to reproductive success and growth of the RIS, Exelon demonstrated that most spawning in the vicinity of Dresden occurs prior to the June 15th beginning of the alternative thermal effluent limitations and that temperatures, even under extreme conditions, are unlikely to adversely affect or cause a cessation of growth based on critical temperature data for each RIS. App. B at B-33 - B-35, B-38 - B-39, Figures B-5 - B-16. Exelon and IEPA point out that, while growth may decline in the summer if temperatures rise above a critical level, the thermal plume may also stimulate growth earlier and later in the year compared to conditions without the thermal plume. Rec. at 10, App. B at B-38 - B-39.

Exelon's demonstration explained that acute mortality data represent the effects of short-term exposure of minutes to hours, while chronic mortality data are the result of longer exposure of 48-96 hours. App. B at B-28. The demonstration predicted no acute mortality for any of the RIS based on data showing their acute thermal temperature tolerance ranges. App. B at B-28, Figures B-5 - B-16. IEPA agreed, noting that no fish kills were observed during the July 2012 heat event. Rec. at 10.

The demonstration also predicted that chronic mortality is unlikely, and IEPA agreed. Pet. at 10, App. B at B-30, Rec. at 11. For chronic exposure, with the exception of white sucker, all of the RIS for which chronic temperature tolerance data were available are able to tolerate water temperatures above 95°F for 48-96 hours. App. B at B-30, Figures B-5 to B-16. Exelon states that "[w]hite sucker is the only RIS for which the potential exists for mortality associated with chronic exposure to temperatures above 90.5." Pet. at 19. However, Exelon explains that conditions permitted by the alternative thermal effluent limitations would not persist for more than 24 hours, which the Board notes is shorter than the chronic exposure periods. Pet. at 19. Additionally, the demonstration and IEPA note that thermal refuge is available to the white sucker for the short duration of less than 24 hours when the extreme temperatures would exist under the alternative thermal effluent limit. Pet. at 19, App. B at B-30, Rec. at 11-12. As to aquatic organisms with limited mobility, Exelon explains that mussels have stress-avoidance responses such as burrowing to protect from occasional extreme thermal conditions that may result from the proposed alternative thermal effluent limitations. Resp. at 12-13. IEPA explains that, "given the short-term nature of these exposures [less than 24 hours under the proposed alternative thermal effluent limit], temporary avoidance of the area or stunting of growth experienced by inhabiting RIS would be uneventful on a long-term scale and would not adversely affect the balanced indigenous population of aquatic life near the study area." Rec. at 9.

Finally, as to habitat avoidance, the Board notes that thermal discharges under the ATL would be limited to 24 hours. As Exelon points out, although even the most thermally sensitive RIS white sucker might avoid the DNS thermal plume during such extreme conditions, thermal refuge is available and the duration is short so as not to have an extended effect on habitat utilization. App. B at B-31.

Retrospective Demonstration (Appendix C)

As explained above, Exelon must demonstrate that its requested alternative thermal effluent limitation will assure the protection and propagation of the balanced and indigenous population of shellfish, fish, and wildlife in the Illinois River in the vicinity of the thermal discharge from Dresden. For its existing discharge, Exelon may make this demonstration through a retrospective demonstration. Exelon's retrospective demonstration addresses the effects of past thermal discharges from Dresden on the Illinois River. Exelon's retrospective demonstration is found at Appendix C to Exhibit 1 of Exelon's petition.

Exelon's retrospective analysis consists of two parts. First, Exelon analyzed the condition of each biotic category by comparing its current abundance and composition to what would be expected without Dresden's operation. App. C at C-1; *see* Exh. 1 at 19-31. Exelon placed primary emphasis on the fish community. App. C at C-2. This reflects the presence of "recreational fisheries and the key role of many fish species in the aquatic food web." *Id*. at C-1. Exelon explains that, because lower level communities such as phytoplankton and zooplankton are a source of food for fish, any adverse effect at those lower levels would be reflected in the fish community. *Id*. at C-1 – C-2. Exelon argues that this analysis shows "that any thermal effects to each biotic category are sufficiently inconsequential that the protection and propagation of the BIC will be assured." Pet. at 17.

Second, the analysis examined long-term trends to determine whether there has been any change in population abundance attributable to Dresden operations. App. C at C-1. Exelon states that the analysis draws on monitoring data including data based on operation of the cooling pond in indirect open cycle mode. Pet. at 16-17. Exelon concludes that,

> after more than 30 years of operating under the Board-approved alternative thermal limits, the aquatic community in the vicinity of the Dresden Station discharge is similar to the community in adjacent areas of the lower Des Plaines and Kankakee Rivers, and Illinois River upstream of the Dresden Station

> discharge, which are not influenced by the Plant's thermal discharge, thereby corroborating that no appreciable harm to the BIC has occurred as a result of the existing alternative thermal limits. *Id*. at 17; *see id*. at 22; Exh. 1 at 4, 5, 15; *see also* 401(c) Petition for Dresden Nuclear Generating Station, PCB 79-134 (July 9, 1981).

Below, the Board summarizes Exelon's Retrospective Demonstration.

Water Quality Changes. Exelon's demonstration first addresses factors that may interact with excess heat to influence water quality: nutrients, biocides, heavy metals, and other thermal discharges. App. C at C-2 – C-5. Exelon argues that "there is no evidence of harmful interactions" between these factors and Dresden's thermal discharge. *Id*. at C-5. Exelon concludes that "[t]here is also no evidence suggesting that the small amount of additional heat that would be permitted to be discharged under the proposed ATL would cause such interactions." *Id*. Below the Board summarizes the Exelon's review of these factors.

Nutrients. Exelon identifies organic carbon, phosphorus, and nitrogen as elements associated with nutrient richness. Exelon first addresses organic carbon and indicates that "[t]here is limited organic carbon data available on the Kankakee River, Des Plaines River and Illinois River systems." App. C at C-2. The demonstration adds that carbon "is not identified by the USEPA as a cause of impairment for the Des Plaines River." App. C at C-2. The demonstration indicates that dissolved carbon is for the most part "unavailable to aquatic organisms other than bacteria." *Id*. Exelon argues that, although the thermal discharge from Dresden may increase the rate of bacterial growth, "there is no indication of any harm caused by this potential interaction and there is no reason to expect that the small amount of additional heat that would be permitted to be discharged under the proposed ATLs would cause a harmful interaction." *Id*., citing United States Environmental Protection Agency, National Strategy for the Development of Regional Nutrient Criteria (1998).

Turning to phosphorus, Exelon argues that agricultural watersheds contributing sediment may cause relatively high levels of phosphorus in waters such as the UIW. *Id*. Exelon states that the most likely interaction of phosphorus with the thermal discharge "would be an increase in the rate of algal growth during warm periods." *Id*. at C-3. Exelon argues that "no difference in algal abundance or growth has been observed in the plume" and that any effect would be limited. *Id*. Exelon concludes that, "[g]iven that there has been no evidence of a synergistic effect between total phosphorus and the station's thermal discharge in the past, there is no reason to expect that the small amount of additional heat that would be permitted to be discharged under the proposed ATLs would cause any such effect." *Id*.

Addressing nitrogen, Exelon states that its sources in the Illinois River include runoff from agricultural areas, certain industrial discharges, and municipal wastewater effluents. App. C at C-3. Exelon suggests that the "small amount" of nitrogen discharged from Dresden is "negligible" in comparison with the large number of agricultural sources in the vicinity. *Id*. Exelon states that the most likely interaction of nitrogen with the thermal discharge "would be an increase in the rate of algal growth during warm periods." *Id*. Exelon argues that "no difference in algal abundance or growth has been observed in the plume" and that any effect would be limited. *Id*. Exelon concludes that, "[g]iven that there has been no evidence of a synergistic effect between total nitrogen and the thermal discharge in the past, there is no reason to expect that the small amount of additional heat that would be permitted to be discharged under the proposed ATL would cause any such effect." *Id*., citing United States Environmental Protection Agency, National Strategy for the Development of Regional Nutrient Criteria (1998).

The demonstration concludes that power plants such as Dresden "are not significant sources of nutrients." App. C at C-2. Exelon stresses that "[t]here are no nutrients added" to the once-through cooling water passing through Dresden. *Id*.

Biocides. Exelon states that power plants control the growth of organisms fouling the cooling system by applying biocides. App. C at C-3. Exelon has historically treated its cooling system with sodium hypochlorite to control growth of these organisms and normally uses sodium hypochlorite as the sole biocide. *Id*. at C-3 – C-4, citing App. D at D-4 (Supporting Cooling Towers); *see* Exh. 1 at 9. Exelon uses sodium bisulfite "as a neutralizing agent prior to discharge to the river to ensure compliance with the Total Residual Chlorine/Total Residue Oxidants limit of 0.05 ppm." App. C at C-4. Exelon argues that "[t]he detection limit is 0.05 ppm, an order of magnitude lower than the levels that cause fish mortality." *Id*.; *see* Exh. 1 at 9. Exelon states that Dresden's "discharge of chlorine is well below levels that would cause harm to fish." App. C at C-4. Exelon concludes that its "use of biocides cannot reasonably be expected to alter or cause harm to fish communities in the Des Plaines, Kankakee, and Illinois River, nor does it pose any risk of harm to the BIC." *Id*. Exelon adds that "[a]ny potential interaction of the thermal discharge with the biocides is similarly harmless." *Id*.; *see* Exh. 1 at 9.

Heavy Metals. Exelon states that heavy metals are typically released to the Illinois River from natural sources and from artificial sources including municipal wastewater treatment facilities, manufacturing facilities, mining, and agriculture. App. C at C-4. Exelon asserts that "[h]eavy metals can be harmful to fish at low concentrations, by altering prey availability via shifts in community structure." *Id*., citing United States Environmental Protection Agency, National Strategy for the Development of Regional Nutrient Criteria (1998). Exelon indicates that USEPA lists mercury and silver as sources of impairment for the Des Plaines River. App. C at C-4.

Exelon states that heavy metals in the Illinois River are mostly associated with sediment, where they "are typically chemically bound to colloidal materials such as clay particles." App. C at C-4. While the strength of this bond is affected by pH, the pH of the river is basic at a range of 7.0 to 9.0, which inhibits the process that would free heavy metals to go into solution in the water. *Id*. Exelon argues that, "[b]ecause movement of metals from the sediments into the water column is mediated principally by pH and pH is not affected by temperature, the thermal discharge has not caused the release of heavy metals from the sediments." *Id*. Exelon concludes that "heavy metals bound in the sediments can be expected to remain there," and the proposed alternative limit will not affect this. *Id*.

Potability, Odor, and Aesthetics. Exelon reports that there is "no evidence of an unnatural odor or an unaesthetic appearance in the Illinois River" in the vicinity of Dresden and associated with its operations. App. C at C-5. Exelon argues that, "[g]iven the small incremental change in the proposed ATL, there is no reason to expect it will have any effect on potability, odors or aesthetics of the Illinois, Des Plaines, and Kankakee Rivers." *Id*., citing United States Environmental Protection Agency, National Strategy for the Development of Regional Nutrient Criteria (1998).

Other Thermal Discharges. Exelon states that three power plants with thermal discharges subject to NPDES permits issued by IEPA are located 12 to 23 miles upstream from Dresden. App. C at C-5. Exelon argues that, by the time the discharge from those plant reaches Dresden, the thermal component "is diluted and dissipated to ambient conditions." *Id*. Exelon concludes that the three plants are too far upstream from Dresden to be able to interact with its thermal discharge. *Id*.

Aquatic Habitat. The Retrospective Demonstration reviews studies of the aquatic habitat in the vicinity of Dresden. App. C at C-6 – C-8; *see supra* at 42-45. Studies in both 1993-1994 and 2014 showed similar low QHEI scores attributable to the same causes. Exh. 1 at 21; *see* App. C, Table C-1 – C-3 (summary of QHEI scores for Dresden sampling stations); Exh. E at E-4. Exelon states that the dominant main channel habitat type makes it reasonable to conclude that "low habitat quality and the lack of habitat complexity are limiting factors for the biota in Dresden Pool. . . ." App. C at C-8; *see id*., Figure C-1 (distribution of habitat). Exelon concludes that Dresden's thermal discharge "does not affect the quality of aquatic habitat and has not caused appreciable harm to the habitat former community. Exelon argues that the community "would be essentially the same" if Dresden operated with the proposed alternative limits. Exh. 1 at 22.

Phytoplankton. The Retrospective Demonstration reviews studies of phytoplankton in the vicinity of Dresden. App. C at C-5 – C-6; *see supra* at 45-48 (Biotic Category Analysis). Exelon concludes that the Dresden discharge "has not caused appreciable harm to the phytoplankton community." App. C at C-6. Exelon argues that the limited change proposed Dresden's alternative thermal limit is "not expected to have any detectable effect on the phytoplankton community in the Dresden Pool." *Id*.

Nuisance Species. Exelon states that, of the aquatic nuisance species found in Illinois, six were observed or collected near Dresden during monitoring in 2013 and 2014. App. C at C-9. However, Exelon asserts that Dresden operations have not introduced nuisance species near the plant and "are unlikely to be a vector of introduction in the future." *Id*. Exelon argues that Dresden operations have not contributed to the spread of nuisance species or created conditions causing them to flourish. *Id*. at C-9 – C-10; *see* Exh. 1 at 8.

Zooplankton. The Retrospective Demonstration reviews studies of zooplankton in the vicinity of Dresden. App. C at C-10 – C-11; *see* Exh. E at E-5; *supra* at 48-50 (Biotic Category Analysis). Exelon concludes that the Dresden discharge has not affected the downstream assemblage of zooplankton. App. C at C-11. Exelon argues that, because operating conditions have not essentially changed since earlier studies and because the structures of higher trophic levels such as fish have remained similar or improved, Dresden's discharge "has no measureable effect on the zooplankton assemblage." *Id*.; *see* Exh. 1 at 23.

Macroinvertebrates and Shellfish. The Retrospective Demonstration reviews studies of the aquatic invertebrate community in the vicinity of Dresden. App. C at C-11 - C-14; *see* Exh. E at E-6; *supra* at 50-53 (Biotic Category Analysis). Exelon states that these studies show an indigenous macroinvertebrate community in the natural substrates dominated by pollution tolerant taxa. Exh. 1 at 25. On artificial substrates, the studies show more sensitive taxa more evenly represented. *Id*. For benthic invertebrates, the thermal demonstration found no statistical trends associated with spatial or thermal differences based on studies covering 1968 through 2014. A 1993 study found pollution intolerant species had increased since the earlier years, but habitat, sediment, and water quality were the primary factors regulating the benthic community, not temperature. Exelon argues that this shows spatial differences stemming from substrate conditions and factors including flow and water quality rather than the Dresden discharge temperature. *Id*. at 25-26; *see* App. C at C-12. Exelon concludes that these data show the current alternative limits have not caused harm to the benthic macroinvertebrate community. Exh. 1 at 26.

The Retrospective Demonstration also reviews the 2014 study of freshwater mussels in the vicinity of Dresden. App. C at C-13 – C-14; *see* App. E at E-6 – E-7; App. H; *supra* at 53-54. The study shows the highest mussel density found in the survey was in the flow path of the Dresden thermal plume. App. C at C-14; App. H. at H-8. The study also reports that mussel distribution appears to be influenced chiefly by substrate composition. App. C at C-14; App. H at H-8. Exelon stresses that the survey took place two years after extreme temperature and low flow conditions, yet the presence of juveniles shows continued successful reproduction, and the significant number of mussels more than 10 years old shows they had survived the extreme ambient conditions. Resp. at 14. Exelon concludes that a balanced and indigenous community of mussels is supported in the vicinity of Dresden and that it has not been affected by operation in the indirect open cycle mode. Exh. 1 at 27; App. H at H-8; Resp. at 14. Exelon adds that operation of the Dresden Station under the proposed alternative thermal effluent limit is not expected to interfere with the life cycles of the mussels. Exh. 1 at 26-27, App. C at C-13 to C-14.

Fish. The Retrospective Demonstration reviews studies of the fish community in the vicinity of Dresden. App. C. at C-15 – C-23; *see supra* at 55-58. The demonstration first addresses five state-listed threatened and endangered fish species, three of which were collected infrequently and in low numbers. The other two were first collected many years after Dresden began operation, indicating that the plant has not prevented their presence. App. C at C-15; *see* Exh. 1 at 8. The demonstration adds that federally-listed threatened and endangered species had not been collected in the vicinity of Dresden. App. C at C-15; *see* Exh. 1 at 8.

The Demonstration next addressed ichthyoplankton. Exelon cited entrainment studies indicating that ichthyoplankton were present when ambient river temperatures were not high enough or of sufficient duration to result in thermally-induced mortality. App. C at C-15, citing Figure C-3 (Cumulative Percentage of Kankakee River Ichthyoplankton Drift, 3 April – 27 August 2005); Figure C-4 (Cumulative Percentage of Kankakee River Ichthyoplankton Drift, 2 April – 26 August 2006); *see* Exh. 1 at 27-28. Exelon argues that "[e]arly life stages frequently have higher thermal tolerance than adults." App. C at C-15. Exelon adds that the entrainment studies show ichthyoplankton impacted by entrainment at Dresden represent chiefly "forage and other fish that have high reproductive potentials and high natural mortality rates." *Id*. at C-16.

The Demonstration next addressed the species composition of juvenile and adult fish. Exelon cited studies conducted in the vicinity of Dresden since 1991 and argued that native species richness in the study area was statistically similar during most of those years. App. C at C-17, citing Table C-7 (Results of Statistical Comparison Among Years for Electrofishing Data Collected from Dresden Pool for the Period of 15 June through August, 1994, 1995, 1997-2008, 2011, 2013, and 2014). Exelon argues that differences in native species richness between areas upstream and downstream from Dresden result in part from differences in habitat. App. C at C-17.

The Demonstration also addressed the abundance and well-being of fish species. Exelon argues that, of 17 years compared, total CPE was statistically similar among 15 of them. App. C at C-18, citing Table C-7. Exelon also cites mean IWBmod scores for the June 15 through August monitoring period and argues that they "were statistically similar 13 of the 17 years compared." App. C at C-19, citing Table C-7. Although Exelon acknowledges that mean IWBmod scores upstream of Dresden average higher than scores downstream, Exelon states that the differences from 15 June through August were statistically similar for 15 of the 17 years monitored. App. C at C-19. Exelon argues that this indicates Dresden "had little effect on the wellbeing of the fish community in Dresden Pool." *Id*. Exelon further argues that factors other than the discharge from Dresden prevent higher IWBmod scores. *Id*.

Finally, the Demonstration addressed the condition of fish species in the vicinity of Dresden. Exelon argues that "[m]ean *Wr* of species for which sample sizes were adequate to calculate relative weights" indicate that "the fish in Dresden Pool were generally in good condition." App. C at C-20, citing Table C-10 (Annual Mean Relative Weights (*Wr*) for Selected Species Collected from Dresden Pool, 15 June – August, 1994-2014). Exelon also cites comparisons of DELT anomalies, which remained near two percent for the last 14 study years. App. C at C-21. Exelon argues that higher rates of DELT anomalies among bottom-feeding species suggests that substrates "contain contaminants that are responsible for many of the DELT anomalies observed on those species." *Id*. at 22 (citations omitted).

Other Vertebrate Wildlife. The Retrospective Demonstration reviews studies of other vertebrate wildlife in the vicinity of Dresden. App. C at C-23; *see* Exh. 1 at 31; *supra* at 58-59 (Biotic Category Analysis). Exelon acknowledges that various mammals, songbirds, reptiles, and amphibians use the waters and shoreline of the UIW and Dresden Pool. App. C at C-23. The demonstration concludes that the other vertebrate wildlife have not been limited by thermal limits in effect since 1981 and are not expected to be affected by the proposed alternate limits. App. C at C-23.

Interaction with Other Pollutants. For demonstrations based upon the "absence of prior appreciable harm", 35 Ill. Adm. Code 106.1160(d)(1)(A) requires that the retrospective demonstration must show "[t]hat 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 of shellfish, fish, and wildlife in and on the body of water into which the discharge has been made.

Exelon's demonstration evaluates the interaction of the thermal component with fecal coliform, mercury, nutrients, PCBs, silver, pH, organic carbon, specific conductance, and water transparency. Each of these is summarized below. Exelon states that "DNS operations have not been show to impact [these parameters] found in the upper Illinois River Basin." App. A at A-10 - A-16.

Fecal Coliform. "Disease-causing microbes and other microbes (viruses and protozoa) are called pathogens, and they usually come from human or animal waste." App. A at A-11. The demonstration states that

> [t]hese microbes enter US waters from both man-made and natural sources, and can affect human and animal health as well as several beneficial uses. They reach the water directly in urban and suburban areas from wastewater treatment plants, sewer overflows, and failing sewer lines; slaughterhouses and meat processing facilities; tanning, textile, and pulp and paper factories; fish and shellfish processing facilities; sewage dumped overboard from recreational boats; and pet waste, litter, and garbage. Rural source include livestock manure from barnyards, pastures, rangelands, feedlots, unfenced farm animals in streams, improper manure or sewage land application, poorly maintained manure storage, and wildlife sources such as geese, beaver and deer. The amount of bacteria and other microbes present, and thus the health risks they represent, can change rapidly due to factors such as rainfall and runoff. . . ." App. A at A-11.

Exelon's demonstration states that Dresden's "operations have not been shown to impact levels of fecal coliform found in the upper Illinois River Basin." App. A at A-11.

Mercury. Mercury is a metal found in air, water, and soil. Exelon attributes more than half of man-made mercury emissions in the U.S. to coal-burning power plants. App. A at A-11. "Mercury in the air eventually settles into water or onto land where it can be washed into water. Once deposited, certain microbes can change it into a highly toxic form that builds up in fish, shellfish, and animals that eat fish." *Id*. "As a water pollutant, mercury can build up in fish tissue, be dissolved in the water, or be deposited in bottom sediments." *Id*.

Exelon's demonstration states that Dresden's "operations have not been shown to impact the levels of mercury found in the upper Illinois River Basin." App. A at A-12.

Nutrients. Wastewater treatment plants discharge an estimated 2,810 cfs of effluent into streams in the upper Illinois River Basin. App. A at A-12, citing J.S. Zagorski, *et al*, Availability and suitability of municipal wastewater information for use in a national water-quality assessment – A case study of the upper Illinois River Basin in Illinois, Indiana, and Wisconsin (1990). "Most domestic and industrial wastewaters have much higher concentrations of ammonia, nitrate, and phosphorus than stream water does," and wastewater treatment plants provide "a major influence" on streams. App. A at A-12; *see* Att. E at E-4. Agricultural sources also contribute nutrients to streams. App. A at A-12. "Excess nitrogen or phosphorus can cause too much aquatic plant growth and algae blooms, sometimes choking off waterways and causing toxic or oxygen-poor conditions that can kill fish and other aquatic life." *Id*. at A-13. "Ammonia is a common cause of fish kills and can harm people's health after it is converted to nitrate by bacteria in the water. . . . Too much ammonia can also cause oxygen-poor waters, since DO in water is used up by bacteria and other microbes in converting ammonia into their food." *Id*. at A-14.

Data from the Agency's monitoring station on the Des Plaines River at Joliet from May 2006 through December 2010 show that "total Kjeldahl nitrogen (TKN) concentrations ranged from 0.53 mg/L to 1.61 mg/K. TKN concentrations averaged 1.01 mg/L over the available data record." App. A at A-12. For total phosphorus, the data show "concentrations ranged from 0.26 mg/L to 2.13 mg/L between March 2006 and December 2011. Total phosphorus concentrations averaged 0.81 mg/L over the available data record." *Id*. at A-13. Data also showed that "[a]mmonia-nitrogen concentrations ranged from 0.15 mg/L in April 2011 to 0.61 mg/L in May 2011. Ammonia average concentrations averaged 0.38 mg/L over the available data record." *Id*. at A-14.

Exelon's demonstration states that Dresden's operations have not been shown to impact the levels of total nitrogen, phosphorus, or ammonia in the upper Illinois River Basin. App. A at A-12 – A-14.

Polychlorinated Biphenyls (PCBs). "PCBs are a toxic mixture of chlorinated chemicals that were banned in the late 1970s but are still a common pollutant because they build up in fish flesh and are long-lasting in the bottom sediments of rivers and lakes." App. A at A-14. Exelon's demonstration states that "PCBs have reached waterways worldwide by direct dumping, leakage from landfills not designed to handle hazardous waste, and through the air after burning PCB-containing waste." *Id*. The Agency's recommendation notes that segment D-10 of the Illinois River "is listed on the draft 2014 Illinois Integrated Water Quality Report and Section 303(d) List as impaired for fish consumption use with potential causes given as mercury and polychlorinated biphenyls." Rec. at 2. However, the demonstration reports that 2008 sediment analysis showed that PCBs "were not detected either upstream or downstream of the Dam." App. A at A-19, citing Patrick Engineering, Report of Investigation – Sediment Sampling (2008).

Exelon's demonstration states that Dresden's "operations have not been shown to impact the levels of PCBs found in the upper Illinois River Basin." App. A at A-14.

Silver. "Metals in waterways can come from human activities (industrial processes, mining, and rainwater runoff from urban areas) and natural processes (mainly erosion of soil and rocks) resulting in the release of metals into the air, water, and soil. . . . Excess metals at toxic concentrations can affect the survival, reproduction, and behavior of aquatic animals and can result in fish kills." App. A at A-14. Data from the Agency's monitoring station on the Des Plaines River at Joliet from May 2006 through December 2011 show that total silver concentrations "ranged from 0.43 µg/L to 7.87 µg/L" and "averaged 2.1 µg/L over the available data record." *Id*. at A-15. Dissolved silver concentrations "ranged from 0.4 µg/L to 7.41 µg/L and averaged 1.7µg/L over the available data record." *Id*. *See* 35 Ill. Adm. Code 302.208(g) (establishing single-value standard of 5.0 µg/L total silver).

Exelon's demonstration states that Dresden's "operations have not been shown to impact the levels of silver found in the upper Illinois River Basin." App. A at A-15.

pH. "Most aquatic plants and animals under extreme pH conditions have reduced ability to grow, reproduce, and survive. Low pH can cause toxic metals such as aluminum and copper to dissolve into the water from bottom sediments. High pH can increase the toxic form of ammonia, which can further harm fish and other aquatic life." App. A at A-15. Data from the Agency's monitoring station on the Des Plaines River at Joliet from May 2006 through December 2011 show that pH "ranged from 6.98 to 7.74 and averaged 7.41 over the available data record." *Id*. *See* 35 Ill. Adm. Code 302.204 (establishing range of 6.5 to 9.0, except for natural causes, in general use water quality standards).

Exelon's demonstration states that Dresden's "operation have not been shown to impact pH levels found in the upper Illinois River Basin." App. A at A-15.

Organic Carbon. "Organic carbon is not a cause of impairment for the Des Plaines River." App. A at A-15. Data from the Agency's monitoring station on the Des Plaines River at Joliet from May 2006 through December 2010 show that total organic carbon (TOC) concentrations "ranged from 4.1 mg/L to 8.32 mg/L. Total organic carbons concentrations averaged 5.43 mg/L over the available data record." *Id*.

Exelon's demonstration states that Dresden's "operations have not been shown to impact organic carbon levels found in the upper Illinois River Basin." App. A at A-15.

Specific Conductance. From June to September, specific conductance[18] has "ranged from 400 to 1,665 µS/cm [microSiemens per centimeter] with mean readings of 603 to 998 µS/cm, depending on location, season, and/or river flow conditions." App. A at A-16. For combined sampling periods, "mean conductivity readings were consistently greater than 700 µS/cm in all study areas." *Id*. "Conductivity in rivers in the United States range from 50 to 1,500 µS/cm." App. F at F-xv.

Exelon's demonstration states that Dresden's "operations have not been shown to impact specific conductance levels found in the upper Illinois River Basin." App. A at A-16.

Water Transparency. Data from the Agency's monitoring station on the Des Plaines River at Joliet from May 2006 through December 2011 show that turbidity "ranged from 7 NTU

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[18] Specific conductance "is the measure of the water's ability to conduct an electric current. Conductivity depends on the number of ions or charged particles (total dissolved salts) in the water. Conductivity is reported in micromhos per centimeter (µmhos/cm) which has been recently renamed as microSiemans per centimeter (µS/cm) at 25ºC. . . . Low conductivity (less than 50 µS/cm) makes it difficult to use electrofishing to stun fish for monitoring. . . . High specific conductance values are observed in waters rich in dissolved minerals and organics where plant nutrients (fertilizer) are in greater abundance. . . . Lakes and rivers vary in conductivity based on the geology of an area. Water bodies underlain by granite have lower conductivity than those areas of clay soils." App. F at F-xv.

[Nephelometric Turbidity Unit] to 80 NTU and averaged 22.77 NTU over the available data record." App. A at A-16. From February 2009 through December 2010, concentrations of total suspended solids (TSS) ranged from 4 mg/L to 101 mg/L and averaged 24.57 mg/L. *Id*.

Based on Secchi disk[19] readings from June through September, transparency "ranged from 3 to 151 cm with mean readings of 40 to 110 cm." App. A at A-16. "[M]ean readings at the thermally-influenced locations (65 cm, range = 41-89 cm) were similar to those at the other locations (62 cm, range = 40 to 100)." *Id*.

Exelon's demonstration states that Dresden's "operations have not been shown to impact water transparency or TSS levels found in the upper Illinois River Basin." App. A at A-16.

Exelon Summary of Retrospective Demonstration

Exelon argues that its retrospective demonstration shows that operation of Dresden's "indirect open cycle cooling water system annually between 15 June and 30 September has not caused prior appreciable harm to the BIC." Exh. 1 at 5, citing App. C. The demonstration applies monitoring data to biotic categories recommended by the Draft Manual. *Id*. The demonstration states that "[t]hese empirical studies in the Des Plaines, Kankakee, and Illinois Rivers clearly document the normal temporal and spatial variability of the aquatic community characteristic of complex ecosystems." *Id*. It concludes that data show an aquatic community in the vicinity of the Dresden discharge that is similar to that in areas upstream beyond the influence of the thermal plume. *Id*.

Board Conclusion on Retrospective Demonstration

Exelon's Retrospective Demonstration covers nearly two decades of studies conducted while Dresden station operated under the current alternative thermal effluent limitations. It evaluates each of the 316(a) biotic categories: phytoplankton; habitat formers; zooplankton; shellfish and macroinvertebrates; fish; and other vertebrate wildlife. EA Engineering evaluated each category against the decision criteria in the Draft Manual. Pet. at 16-17. The Board finds that, after more than 30 years of operating under the current alternative thermal effluent limits, Exelon has demonstrated that Dresden's operation has not caused prior appreciable harm to the balanced, indigenous community of shellfish, fish and wildlife in the Illinois River near the discharge from Dresden. Pet. at 16-17, Exh. 1 at 5, App. C at C-1.

Predictive Demonstration (Appendix B)

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[19] Secchi disk "sampling gear provides a means of determining the limit of water transparency (clarity) that is based on contrast. The upper surface of the Secchi disk is divided into four equal quadrants that are alternately black and white. . . . The disk, which has a 6-inch radius, is lowered into the water . . . until it can no longer be seen and then lifted up until it can be seen again. Averaging the two depths gives the clarity of the water. Higher Secchi readings mean more rope was let out before the disk disappeared from sight and indicates clearer water. Lower readings indicate turbid or colored water. Clear water lets light penetrate more deeply into the lake than murky water. This light allows photosynthesis to occur and oxygen to be produced." App. F at F-xv.

Exelon submitted a predictive demonstration, which evaluates potential effects of the Dresden thermal plume resulting from operation of the cooling pond under the proposed alternative thermal effluent limitations. Pet. at 17; *see* App. B. In the following subsections of the opinion, the Board reviews the chief steps in this evaluation.

Background on Model Employed. The predictive demonstration employed the Danish Hydraulic Institute's MIKE3 model, which provides a three-dimensional mathematical modeling framework. App. B at B-2, B-16; *see* App. D at D-16; Pet. at 17; Rec. at 4. "The model domain included portions of both the Des Plaines and Kankakee Rivers upstream of their confluence and extended downstream to the Dresden Island Lock and Dam." App. B at B-2. The model grid encompasses 1,530 cells divided into 12 vertical layers. *Id*. "Bathymetric mapping, three-dimensional field surveys of water temperature and flow, and meteorological conditions were used as inputs to calibrate and validate the MIKE3 model. . . ." *Id*.; *see* App. D at D-16 – D-17. The model then predicts configuration and distribution of temperatures in the thermal plume "under selected operating, river flow, and weather conditions." App. B at B-2. The demonstration then compared these conditions "to available biothermal metric data related to survival, avoidance, spawning, and growth of 12 species of fish as representative of the BIC." Pet. at 17-18; *see* Exh. 1 at 6-7; App. B at B-1, B-16. The model then predicts potential effects of the Dresden discharge under both the current and proposed limits. Exh. 1 at 6-7.

Mapping and Modeling. Exelon conducted mapping and modeling to develop a hydrodynamic model of plume configurations during operation in the open-cycle cooling mode. App. D at D-5. To construct the model, Exelon relied on hourly operating data from 2003 to 2014 and hourly discharge temperatures from 1998 to 2014, although the demonstration notes that "[t]he data sets contained a gap from July 2003 to November 2005." *Id*. at D-6; *see id*., Table D-1 (frequency distribution of hourly intake and discharge temperatures); Table D-2 (frequency distribution of discharge flow and power production). Exelon also reviewed the relationship of power production to discharge temperatures to examine de-rating as discharge temperatures approached and exceeded 32.2ºC (90ºF). App. D at D-6, citing Table D-4. Data for discharge temperatures above that threshold show "a significant decrease in power production." App. D at D-6.

The demonstration based flows of the Des Plaines and Kankakee Rivers on data from USGS gaging stations scaled to reflect the flow input of un-gaged tributaries in the watersheds. App. D at D-6 – D-7; *see id*. Tables D-5, D-6, D-7 (frequency distributions of daily average flows). The demonstration reports that, since the fall of 2012, "[f]ifteen minute provisional temperature data are available at the USGS web site" for the Kankakee River, the Des Plaines River, and the Dresden intake. App. D at D-7. These data reveal that the Des Plaines River is warmer by several degrees than the Kankakee River. *Id*. at D-8. These warmer temperatures cause "upstream surface intrusion into the Kankakee River." *Id*.

Thermal Plume Surveys. Thermal plume surveys took place on August 1, 2013, and August 29, 2013, with an additional survey performed on September 18, 2014. App. D at D-8; *see id*. at D-11. "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." *Id*. Transects ranged from 2,400 meters upstream from Dresden on the Des Plaines River and 2,350 meters upstream on the Kankakee River to 1,000 meters downstream from the discharge canal on the Illinois River. *Id*. at D-8 – D-9; *see id*., Figure D-2 (map of transects). Mapping collected near-surface temperatures "along each transect and along a diagonal between transects. . . ." *Id*. at D-9. One temperature probe and a replicate were attached to a strut on the side of a boat and deployed at a depth of 1.5 feet, and a third was deployed on a weighted line at a depth of approximately 3 feet. *Id*.

Mapping established 38 vertical profiling stations along the primary transects. App. D at D-10, citing Figure D-3 (map including vertical stations). "At the majority of transects, 3 vertical profiles were performed at the 1/4, 1/2, and 3/4 river width locations." *Id*. The profile employed an instrument that collected temperature and depth data at a regular interval as it was lowered to the bottom of the river and then returned to the surface. *Id*. The survey also employed thermographs at a depth of 1.5 feet at locations upstream on the Des Plaines and Kankakee Rivers and downstream near the Dresden Island Lock and Dam. *Id*., citing Figure D-3. The demonstration suggests that the thermographs intended "to provide data directly at the model boundary." *Id*. In addition, mapping included a bathymetric survey of the Des Plaines, Kankakee, and Illinois Rivers near Dresden performed on November 15 and 16, 2013. App. D at D-10. The survey employed equipment able to record river bottom elevations without being affected "by changes in water surface elevations due to lock and dam operations." *Id*. at D-11.

Plume Survey Results. In the August 1, 2013 survey, the surface plume survey generated temperature contours, which the demonstration analyzes. App. D at D-12, citing Figure D-5. The survey also obtained vertical profile temperature data, and the demonstration assesses vertical gradients at the various transects. App. D at D-13, citing Tables D-11a – D-11e. The survey also reported upstream and downstream thermograph temperatures. *Id*. at D-13, citing Figure D-6. The demonstration states that the upstream readings "are used as the ambient river temperatures at the upstream model boundaries." *Id*.

The August 29, 2013 survey also developed temperature contours, which are described in the demonstration. App. D at D-13, citing Figure D-7. The survey obtained vertical profile temperature data, and the demonstration notes vertical gradients in those temperatures. *Id*., citing Tables D-12a – D-12e. The survey again provided upstream and downstream thermograph temperatures. *Id*., citing Figure D-8.

The September 18, 2014 survey again developed temperature contours described in the demonstration. App. D at D-14 – D-15, citing Figure D-9. The demonstration also assesses vertical profile temperature data obtained in this survey. *Id*. at D-15, citing Tables D-13a – D13e. In addition, the demonstration notes deployment of upstream thermographs earlier and at different locations than the previous two surveys. *Id*., citing Figure D-3. The demonstration reported results of these surveys, including results obtained from thermographs added below the Dresden Island Lock and Dam. *Id*. at D-15 – D-16, citing Figures D-10, D-11.

Model Development and Calibration. Using MIKE3, Exelon developed a model to evaluate the thermal discharge plume. The model range extends from upstream of Dresden in the Des Plaines and Kankakee Rivers downstream to the Dresden Island Lock and Dam and includes entrances to the intake and discharge canals. App. D at D-16. The model is based upon a grid of 1,530 cells, each of which is divided into 12 vertical layers. *Id.*, citing Figure D-12. "The upper three layers were confined to a maximum 1.0 m depth. Below a 1.0 m depth, layer thickness increased from 0.5 m to 1.0 m in the deepest layer. These additional layers were added as necessary to extend to the river bottom." *Id.*

The model requires a number of physical parameters. First, the bathymetry in the vicinity of Dresden relies on the survey conducted in November 2013. App. D at D-16; *see id.* at D-10 – D-11. The demonstration includes a bathymetric contour map of the rivers within the model boundaries. *Id.*, Figure D-13 (Bathymetric Contours, 15-16 November 2013). Second, the model reflects meteorological parameters including air temperature, relative humidity, cloud cover, and wind speed and direction as factors in determining surface heat exchange. *Id.* at D-17. Data were obtained from two National Oceanic and Atmospheric Administration weather stations located near Dresden for the three days of surveys. *Id.* Finally, the model required boundary conditions. App. D at D-16; *see id.* at D-6 – D-7. The demonstration accounts for setting factors such as flow, upstream temperatures, and temperature gradients. *Id.* at D-16 – D-17.

Model Calibration. The demonstration notes that the two 2013 surveys took place under different conditions than the 2014 survey. "In 2013, the Illinois River flow was less than 4,000 cfs and the temperature difference between the Dresden discharge and the cooler Kankakee River was typically less than 4ºC (7.2ºF). In 2014, river flow was greater than 9,000 cfs and the temperature difference between the discharge and the Kankakee River was typically 8-10ºC (14.4-18.0ºF)." App. D at D-17. In addition, these high flows impeded the intrusion of warmer Des Plaines River water upstream into the Kankakee River. *Id.* As a result, the demonstration developed separate calibrations of the model for the two sets of conditions in order to validate the MIKE3 model. *Id.* at D-18; *see* App. B at B-2. Comparison of the calibrated model to the three surveys employed "the primary surface transects, the vertical profile measurements, and the downstream thermographs." App. D at D-18. The demonstration stresses that the model cannot reproduce transitory events such as the passage of barge traffic, so "allowances need to be made in comparing the model with instantaneous field data." *Id.*

The demonstration compares modeled and observed surface temperatures for the August 1, 2013 survey. App. D at D-18, citing Figures D-14 – D-17. The comparison generally shows that the model agrees with the observed temperatures at the transects. *Id.* The demonstration also includes figures comparing the modeled and observed temperatures at vertical stations. *Id.* at D-19, citing Figures D-18 – D-20. "The figures generally show very good agreement between the model and the survey data." *Id.* Finally, the demonstration also includes a comparison of the model to the downstream thermographs. *Id.* at D-19, citing Figure D-21. "[T]he model accurately represented the left bank temperatures and under predicted the right bank temperatures by typically 0.1-0.2ºC (0.2-0.4ºF)." *Id.*

The demonstration also compares modeled and observed temperatures for the August 29, 2013 survey. App. D at D-19, citing Figures D-22 – D-25. Again, the comparison shows "excellent" or "very good" agreement between the two both upstream and downstream from the Dresden discharge. *Id.* The demonstration also compares the modeled and observed temperatures at vertical stations. *Id.*, citing Figures D-26 – D-28. "The figures generally show very good agreement between the model and the survey data." *Id.* Finally, the demonstration also includes a comparison of the model to downstream thermographs. *Id.* at D-20, citing Figure D-29. "[T]he model simulation was a good representation of the left bank thermograph temperatures, but under predicted the right bank temperatures by up to 0.7ºC (1.3ºF)." *Id.*

Finally, the demonstration also compares modeled and observed temperatures for the September 18, 2014 survey. App. D at D-20, citing Figures D-30 – D-33. The two generally agree with one another, particularly at upstream transects. *Id.* The demonstration also compares the modeled and observed temperatures at vertical stations. *Id.* at D-20 – D-21, citing Figures D-34 – D-36. Comparisons "generally show very good agreement between the model and survey data." *Id.* at D-20.

Thermal Plume Configurations. The MIKE3 model developed plume configurations under various hypothetical discharges. App. D at D-21. The demonstration employed the model with discharge temperatures of 32.2ºC, 33.3ºC, and 34.4ºC (90ºF, 92ºF, and 94ºF, respectively) under two combinations of river flow and temperature. *Id.* The first scenario applied these temperatures to the river conditions present during the August 29, 2013 survey, the most restrictive of the three with flow in the lower 5-percentile and higher upstream river temperatures. *Id.* "[T]he second scenario used median (50-percentile) July river flows and average July river temperatures." *Id.*

For the first scenario, the demonstration reported the thermal plume surface area as a function of temperature. App. D at D-21, citing Figure D-37. The demonstration provides surface temperature contours for this scenario with a discharge temperature of 33.3ºC (92ºF). *Id.*, citing Figure D-38. In that figure, the 32.2ºC (90ºF) contour "has a surface area of 15.2 acres." *Id.* For this scenario, the demonstration also includes "[t]he percent cross-sectional Illinois River area as a function of temperature at four transects extending downstream toward the dam. . . ." *Id.*, citing Table D-14, Figures D-41, D-42. With a discharge of 34.4ºC (94ºF), "84.8 percent of the cross section was below 32.2ºC (90ºF) at transect IL0, 84.3 percent at IL475, and 100 percent at IL1000." *Id.* at D-23.

For the second scenario, the demonstration also reported the thermal plume surface area as a function of temperature. App. D at D-22, citing Figure D-39. It also provided surface temperature contours for this scenario with a discharge temperature 34.4º (94ºF). *Id.*, citing Figure D-40. In that figure, the 32.2ºC (90ºF) contour "has a surface area of 20.3 acres." *Id.*, citing Figure D-39. For this scenario, the demonstration also includes "[t]he percent cross-sectional Illinois River area as a function of temperature at four transects extending downstream toward the dam. . . ." *Id.*, citing Table D-15. With a discharge of 34.4ºC (94ºF), "88.3 percent of the cross section was below 32.2ºC (90ºF) at transect IL0, 99.2 percent at IL475, and 100 percent at IL1000." *Id.* at D-23.

The demonstration argues that these cross sections maintain temperatures "adequate to support biological communities under both typical summer and adverse summer conditions." App. D at D-23. It stresses that they maintain these conditions with discharge temperatures exceeding Dresden's current 32.2ºC (90ºF) discharge permit condition. *Id.*

<u>Determination of Acclimation/Ambient Temperatures.</u> The demonstration stresses that fish are cold-blooded species "unable to control their body temperature, which is consequently determined by the temperature of the surrounding water." App. B at B-17. Fish are therefore affected by the water temperature to which they have acclimated. *Id*. "Acclimation temperature is the temperature to which an organism has been exposed for a period adequate to achieve physiological equilibrium; it can take a few days to more than a week for an organism to fully acclimate to a new temperature regime." *Id*. The demonstration argues that "[a]cclimation is an important factor in evaluating most of the biothermal metrics selected in order to relate them to the effects of temperature exposure in a thermal plume." *Id*.

The response of organisms to changes or gradients of temperature "is affected by the temperature and other physical and chemical conditions to which the organism has acclimated over a period of time." App. B at B-17. In a laboratory, these conditions can be set and controlled. In a body of water, these conditions can vary significantly over short distances and brief periods of time. *Id*. The demonstration argues that seasonal natural ambient temperatures in the Illinois River can represent acclimation temperatures in order to predict thermal effects of the Dresden discharge plume based on results from laboratory studies. *Id*. at B-18. The demonstration further argues that this is a conservative assumption because organisms can become acclimated to temperatures in the discharge plume, "which could result in higher thermal tolerance and avoidance temperatures for some organisms." *Id*.

Exelon states that Dresden's NPDES permit requires continuous water temperature monitoring at the cooling water intake on the Kankakee River. App. B at B-18. Exelon adds that, since September 2012, it has monitored water temperature at three additional sites: in the Des Plaines River 4.1 miles upstream from the discharge, in the Kankakee River 6 miles upstream from the discharge, and in the Illinois River 19 miles from the discharge. *Id*. The demonstration estimated acclimation temperature curves based on seven-day running average ambient temperatures for each of these four monitoring sites. *Id*., citing App. B, Figure B-1. The demonstration selected the seven-day average as representative of acclimation under variable natural water conditions. App. B at B-18. The demonstration estimated the ambient temperature in the Illinois River near the Dresden discharge "based on flow-weighted mixing of the upstream temperatures from the Des Plaines and Kankakee Rivers." *Id*., citing App. B, Figure B-3.

<u>Operating and Environmental Scenarios Evaluated.</u> Exelon states that the model predicted dimensions and distributions of the thermal plume under three flow and temperature situations based on Dresden operations "at full load using indirect open cycle cooling between 15 June and 30 September." App. B at B-2; *see* Pet at 18.

The model used cross sectional and bottom areas affected by the thermal discharge to assess effects of the thermal plume on habitat and RIS. App. B at B-24. The model estimated the percentage of cross section area at certain transects and the percent of bottom areas upstream and downstream from the discharge that would be below specified temperatures. *Id*., citing Tables B-7 – B-11. "The area encompassed by selected temperatures was compared to the biothermal metrics for each of the RIS." *Id*. The model also addressed zone of passage by determining whether "temperatures in at least 75 percent of the plume cross section are less than the avoidance temperature for an RIS." *Id*.

Typical Conditions. Exelon based this scenario on 50th percentile river flow, which ranged from 9,720 cfs in June to 5,366 cfs in September. App. B at B-2, B-18, Table B-5; *see* Pet. at 18; Exh. 1 at 6. "The ambient Illinois River temperatures were estimated at the 60 percentile based on flow-weighted mixing of ambient temperatures in the Des Plaines and Kankakee Rivers." Exh. 1 at 6; *see* App. B at B-24. These temperatures ranged from 25ºC (77ºF) in June and September to 27.6ºC (81.7ºF) in August. App. B at B-24, Table B-5. This scenario used median Dresden discharge temperatures, which ranged from 29.8ºC (85.7ºF) in June to 30.8ºC (87.4ºF) in July to 28.6ºC (83.5ºF) in September. App. B at B-24, Table B-5.

Typical High Temperature Conditions. Exelon based this scenario on 5th percentile river flow. App. B at B-2, B-19, B-25; *see* Pet. at 18; Exh. 1 at 6. These flows ranged from 4,134 cfs in June to 3,032 cfs in September, which are 42-56 percent of flows under the typical conditions scenario. App. B at B-25, citing Table B-5. "The ambient Illinois River temperatures were estimated at the 95 percentile based on flow-weighted mixing of ambient temperatures in the Des Plaines and Kankakee Rivers." Exh. 1 at 6; *see* App. B at B-25. These temperatures ranged from about 27.2ºC (81ºF) in June to 31.1ºC (88ºF) in July and 28.3ºC (89.2ºF) in September. *Id*., citing Table B-5; *see* Rec. at 7. This scenario also used discharge temperatures at the 95th percentile, which ranged from 31.8ºC (89.2ºC) in June to 33.2ºC (91.8ºF) in July and 31.6ºC (88.8ºF) in September. App. B at B-25, citing Table B-5; *see* Rec. at 7. The Agency states that these "conditions occur approximately once every 20 years. . . ." Rec. at 7.

Extreme High Temperature Conditions. Exelon based this scenario on conditions similar to an unusual heat wave in July 2012. Exh. 1 at 6. Exelon states that these conditions are "approximately equivalent" to the proposed alternate limits. *Id*.; *see* App. B at B-26. The maximum intake temperature was 34.4ºC (93.9ºF). App. B. at B-27, Figure B-18. The discharge temperatures peaked at about 34.9ºC (94.9ºF) and exceeded 34.4ºC (94ºC) for approximately 3 hours and exceeded 33.9ºC (93ºF) for approximately 11 hours. Exh. 1 at 6; App. B at B-26. River flows were in the lower 1st-4th percentile for the Des Plaines River, where they declined from 2,170 cfs on July 6, 2012, to 1,610 cfs on July 8, 2012. River flows were in the lower 15th-20th percentile for the Kankakee River, where they declined from 1,000 cfs on July 6, 2012, to 770 cfs on July 8, 2012. Pet. at 18; App. B, Table B-6.

Thermal Endpoints. The demonstration includes thermal diagrams for each RIS "to graphically present the relationship of acclimation temperature and the selected biothermal response metrics." App. B at B-19, citing Figures B-5 – B-16 (diagrams of thermal parameter data). The diagrams reflect test results reported in scientific literature "along with the associated linear regression line for these data when appropriate." App. B at B-19. Exelon states that these diagrams "help interpret the potential effects of thermal loading from the Dresden cooling water discharge on the RIS and the aquatic community they represent." *Id*. With thermal plume modeling and habitat mapping, Exelon relies on these diagrams to predict possible effects of the Dresden thermal plume on the RIS. *Id*. Below, the Board briefly summarizes the biothermal metrics evaluated by the demonstration.

__Acute Thermal Mortality.__ "As water temperatures increase, organisms progressively exhibit a range of integrated physiological and behavioral responses including avoidance, impaired growth and reduced feeding, impaired swimming ability, loss of equilibrium, and finally mortality." App. B at B-5. "Exposure to rapid short-term changes in water temperature can cause mortality to organisms passing through, or resident within, portions of the thermal discharge plume." *Id*. at B-4. The demonstration states that "[t]his metric depicts the lethal response of organisms to dynamic temperature increases over a relatively short period." App. B at B-19. This response is measured by CTM [Critical Thermal Maximum], which is "estimated with tests where organisms are subjected to a controlled rate of temperature increase over time (*e.g.*, 0.5ºC/min [0.9ºF/min]) until loss of equilibrium." *Id*. at B-5. "The tolerance limit for 95 percent of test organisms (TL95) measures the temperature at which 95 percent of the organisms survive for the exposure period. . . . In contrast, lethal dose to 50 percent of the test organisms (LD50) measures the temperature causing mortality to 50 percent of the test organisms." *Id*.

CTM "is not necessarily an indication of final mortality, but frequently uses the loss of equilibrium as the test endpoint." *Id*. at B-20; *see id*. at B-4. While CTM can be estimated under controlled conditions, "resulting CTM metrics can be difficult to compare to real-world conditions due to the variation in test methods (*e.g.* temperature step, rate of increase, observed test end point)." *Id*. at B-5. The demonstration argues that, because organisms in the natural environment adapt to variability, laboratory results of thermal effects studies must be "evaluated relative to acclimation history." *Id*.

__Chronic Thermal Mortality.__ The demonstration states that "[t]his line depicts the species' mean tolerance limit; that is, the acclimation/exposure-temperature at which 50 percent mortality would occur due to elevated temperatures for a prolonged exposure of more than 24 hours (typically 24 to 96 hours)." App. B at B-20. Chronic thermal mortality approaches zero at a point approximately 2ºC (3.6ºF) below the TL 50. *Id*. "[A]ssuming a normal distribution, chronic thermal mortality would effectively be 100 percent at 2ºC (3.6ºF) higher than the TL50. *Id*. Exelon argues that "[c]hronic mortality is a very conservative measure of potential thermal effects because it assumes that fish are unable to avoid potentially lethal elevated temperatures by moving to cooler temperatures. . . ." *Id*.

__Avoidance.__ The demonstration states that "[a] thermal avoidance response occurs when mobile species evade stressful high temperatures by moving to water with lower, more acceptable temperatures." App. B at B-20 (citations omitted); *see id*. at B-4. Water temperatures avoided generally depend on an organisms' acclimation. *Id*. at B-4. "When avoided temperatures exist over a large enough cross-section of the receiving water body, passage of organisms upstream or downstream of the discharge location may be inhibited." *Id*.

The thermal diagrams reflect "the expected mean avoidance response of a population." *Id*. at B-20. The demonstration argues that, "[w]hile the avoidance response can minimize the potential for thermal mortality associated with elevated water temperatures in portions of a thermal plume, it can also deter organisms from occupying otherwise useful or critical habitat that may occur in the vicinity of a thermal plume." *Id*.; *see id*. at B-4.

__Thermal Preference Zone.__ The demonstration states that "[w]ater temperature plays a significant role in the growth of aquatic species, affecting metabolic rates and the energy expended seeking and capturing food material. The optimum temperature range for growth occurs when there is a balance between the energy expended capturing food, the energy for maintenance, and for growth." App. B at B-4. "Aquatic organisms typically prefer water temperatures that are within the optimum range for growth; preferred temperatures can be used as a surrogate for the optimum range for growth and performance." *Id*. The demonstration asserts 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] non-optimal during certain periods or in a segment of a waterbody." *Id*. at B-21. "During some periods of the year, portions of the thermal plume may provide optimal temperatures for growth that are not present with available ambient temperatures (*e.g.*, spring and fall for many species)." *Id* at B-4.

Although laboratory data define this zone for some of the RIS, it cannot be defined under laboratory or hatchery conditions for all species. App. B at B-20 – B-21; *see id*. at B-4. The demonstration adds that, for these species, the thermal preference zone "provides a surrogate to delineate the acclimation and exposure temperature combinations for which optimal growth (*i.e.*, preferred temperatures) would be predicted." *Id*. at B-21. Exelon notes that water temperatures vary naturally over space and time and indicates that a thermal plume occurs within this natural variability. *Id*. "Maximum weekly average temperatures for growth (MWAT) is a metric that attempts to account for this variability, using a 7-day running average of ambient water temperature. . . ." *Id*.

Thermal Tolerance Zone. The demonstration states that "[t]he thermal tolerance zone extends beyond the preference zone. It delineates the temperature regime over which each species can survive and continue to grow, but at less than optimum rates." App. B at B-21. The demonstration adds that optimum growth temperatures do not consistently occur in nature and that a tolerance zone clarifies "that non-optimal temperatures are not necessarily adverse." *Id*. The demonstration indicates that areas in the thermal diagrams that fall outside the tolerance zone and below the onset of chronic mortality "delineate the temperature regime over which a species can survive, but in which they may be stressed. . . ." *Id*. (citations omitted).

Thermal Range for Spawning. For many aquatic species, the onset and completion of spawning are tied to closely to water temperature. App. B at B-3. The demonstration states that, "[w]hen adequate thermal range data have been documented, a polygon on the thermal effects figure indicates the reported temperature range for spawning based on the seasonal period during which spawning typically occurs" in the vicinity of Dresden. App. B at B-22; *see id*. at B-3. The demonstration reports that the range typically is based on field observations of spawning activity and the physiological condition of species. *Id*. at B-3, B-22. The demonstration asserts that "the reported range of spawning temperatures for a given species is typically based on the observation of spawning across the geographic range of the species and may not be indicative of conditions at a given site." *Id*. at B-31. However, the demonstration states that the spawning of RIS in the vicinity of Dresden "appears to occur prior to 15 June during the period of closed cycle cooling operation and is, therefore, not affected by indirect open cycle cooling operation that is the subject of this assessment." *Id*.

Lower Lethal Temperatures. The demonstration states that "[l]ower incipient lethal temperatures (chronic exposure) and cold shock (acute rapid exposure) measure mortality caused when organisms acclimated to warm temperatures in the thermal plume are exposed to significantly colder ambient water temperatures." App. B at B-22. Exelon reports that this exposure typically occurs when fish attracted during the winter to the thermal plume experience colder ambient water temperatures when the source of the plume is taken off-line. *See id*. Exelon argues that, because the demonstration addresses indirect open cycle cooling between June 15th and September 30th, "lower incipient lethal temperatures and cold shock are presented for completeness but are not a significant issue for this analysis." *Id*.

Key Life Stages of RIS. The demonstration focuses on operation in indirect open cycle cooling mode between June 15th and September 30th. App. B at B-22. Exelon states that "most of the RIS spawn prior to 15 June." *Id*. The demonstration reports that "[i]chthyoplankton sampling during 2005-2006 collected few or no eggs of most of the RIS." *Id*. Sampling near the Dresden intake in the Kankakee River showed that "85-88 percent of the ichthyoplankton drift occurred prior to 15 June. . . ." *Id*. (citation omitted). The demonstration states that, with the two exceptions of emerald shiner and freshwater drum, "peak abundance for yolk-sac larvae of most of the RIS also occurs before mid-June." *Id*. However, "[a]bundance of post yolk-sac larvae and early juvenile life stages of all RIS typically peaks" when Dresden operates in indirect open cycle cooling mode. *Id*. "Young of the year and adults of the RIS" are present during the summer when the proposed alternate limits would apply. *Id*. at B-22 – B-23. Although the most common RIS show abundance increasing from spring to fall, other RIS occurring in lower abundance decreased in number from spring to fall. Other RIS occurring in low abundance showed "no apparent seasonal trend." *Id*. at B-23. The demonstration concludes that, during the summer, abundance of RIS fish "is generally at an intermediate level, compared to spring and fall." *Id*.

Biothermal Effects Evaluated. The Predictive Demonstration applies hydrothermal modeling to thermal response metrics for RIS. App. B at B-3; *see* Exh. 1 at 15. The thermal discharge was then evaluated for categories of thermal effects as recommended by the Draft Manual. App. B at B-3. The analysis then predicts "the potential effects of the plume on the RIS under each assessment scenario." *Id*.; *see id*. at B-17. The Board addresses Exelon's analysis of these effects in the following subsections.

Potential for Thermal Mortality. Under the Typical Conditions scenario, the demonstration shows that upstream ambient water temperatures are below 28.3ºC (83ºF) and discharge temperatures are below 31.1ºC (88ºF) during the period of indirect open cycle operation. App. B at B-28, citing Tables B-7 – B-10 (cross-sectional temperature distributions by month). The demonstration argues that, "[a]t this acclimation temperature, chronic mortality is typically not observed for most of the RIS until exposure temperatures exceed 32.2ºC (90ºF), 1.7ºC (3ºF) higher than the highest discharge temperature under this scenario." App. B at B-28, citing Figures B-5 – B-16; *see* Exh. 1 at 7.

Under the Typical High Temperature scenario, the demonstration shows that the upstream ambient water temperature near the Dresden discharge is less than 31.1ºC (88ºF) in July and less than 30ºC (86ºF) for the remainder of the period of indirect open cycle operation. App. B at B-28; *see* Tables B-7 – B-10. Data show that white sucker is the most thermally sensitive of the RIS. At an acclimation temperature of 31.1ºC (88ºF), "the predicted threshold for chronic thermal mortality is about 32.2ºC (90ºF)." App. B at B-28.

Under the Typical High Temperature scenario for July with a discharge temperature of 33.2ºC (91.8ºF), the Illinois River between the Dresden discharge and the Dresden Island Lock and Dam "becomes relatively well mixed with temperatures at each of the modeled transects generally between 32.2ºC (90ºF) and 32.8ºC (91ºF)." App. B at B-29, citing Tables B-8, B-11; *see* Resp. at 14. While it acknowledges that "temperatures in this range could create stressful conditions for white sucker under an extended period of exposure, the demonstration cites mitigating factors reducing the risk of thermal mortality. *Id*. at B-29. First, because water temperatures vary with daily cycles in air temperature, organisms do not experience constant elevated temperatures. *Id*., citing Figure B-4 (intake, discharge, and air temperatures). In addition, compared to laboratory conditions, natural river habitats often provide a range of temperatures allowing avoidance of stressful temperatures. App. B at B-29. The demonstration notes that areas immediately upstream of the discharge offer significantly more shallow water habitat for avoidance and are predicted to have lower water temperatures. *Id*. The demonstration concludes that the potential for mortality is "negligible" under this scenario. Exh. 1 at 7, 13.

In addition, the demonstration argues that "fish may be acclimated to temperatures higher than the upstream ambient. . . ." *Id*. The assumption that the upstream ambient temperature represents acclimation may be conservative and may predict a higher risk of thermal mortality than would be observed. *Id*. The demonstration adds that the white sucker was designated as RIS because of its thermal sensitivity, occurs only incidentally near Dresden, and "has only been collected during three of the past 20 sampling years." *Id*.; *see id.* at B-30, B-37.

Under July 2012 conditions reflecting the Extreme High Temperatures scenario, intake temperatures exceeded 32.2ºC (90ºF) for three days and reached a peak of 34.4ºC (93.9ºF). App. B at B-29. Discharge temperatures exceeded 33.9ºC (93ºF) for approximately 17 hours over two non-consecutive days and reached a maximum of 34.6ºC (94.3ºF). *Id*., citing Table B-6, Figures B-4, B-19. On July 7, 2012, the percent of the cross-sectional area downstream from the Dresden discharge exceeding 33.9ºC (93ºF) increased from less than five percent at the transect 125 meters downstream to greater than 95 percent at the transect 475 meters downstream. *Id*. at B-29; *see* Table B-12.

The demonstration states that "[m]ost RIS for which chronic temperature tolerance data are available are able to tolerate water temperatures above 35ºC (93ºF) for extended periods of time (48-96 hours) at acclimation temperatures above 32.2ºC (90ºF), with the exception of white sucker." App. B at B-30; *see id*. at B-37; Pet. at 19. For white sucker, juveniles appear to have an upper tolerance limit for chronic exposure of approximately 35ºC (93ºF) at an acclimation temperature of 32.2ºC (90.5ºF). *Id*. at B-30, B-37; Pet. at 19. For adults the highest thermal tolerance for chronic exposure is 32.5ºC (90.5ºF) at an acclimation temperature of 26ºC (78.8ºF). App. B at B-30, B-37; Pet. at 19. The demonstration argues that, "under the extreme conditions observed during early July 2012, the maximum exposure duration was approximately 11 hours, considerably less than the exposure durations for the test data." *Id*.; *see id*. at B-37; Pet. at 19. The demonstration also argues that a portion of habitat upstream from the discharge is predicted to have ambient water temperatures below 32.5ºC (90.5ºF), allowing white sucker to avoid higher temperatures. App. B at B-30, B-37; Pet. at 19; Resp. at 15. The demonstration concludes that, even under these rare and extreme conditions, temperatures in the thermal plume "are unlikely to result in any significant mortality." App. B at B-30, B-37; Pet. at 19; *see* Exh. 1 at 7. The demonstration stresses that the July 2012 heat resulted in no fish kills in the vicinity of Dresden. App. B at B-30, B-37; Pet. at 19.

Thermal Avoidance and Habitat Loss. For the modeled extreme high temperature scenario, Exelon's demonstration found that conditions would not result in habitat loss. Exh. 1 at 6; App. B at B-26 to B-31, Table B-6; Rec. at 7, 9. The demonstration acknowledges that, although avoidance of stressful temperatures reduces the risk of fish mortality, "it could result in avoidance of important habitat areas that may be affected by portions of the thermal plume." App. B at B-30, B-37; *see id*. at B-4; Pet. at 20. However, the demonstration states that there is no rare, unique, or critical habitat downstream from the Dresden discharge from which RIS might be excluded. Exh. 1 at 16.

Exelon obtained avoidance data available for five of the RIS: gizzard shad, channel catfish, largemouth bass, smallmouth bass, and bluegill. App. B. at B-30, citing Figures B-5, B-10 – B-13; *see id*. at B-37. The demonstration states that, "[a]s would be expected, these avoidance data plot a few degrees below the chronic mortality data. . . ." *Id*. at B-30. The demonstration argues that, at acclimation temperatures of 30.6-33.3ºC (87-92ºF) typical of the three scenarios evaluated, the five RIS "would not avoid any portion of the plume under typical, typical warm, and extreme warm conditions." App. B at B-30, citing Table B-13 (Estimated Avoidance Temperatures at Selected Ambient/Acclimation Water Temperatures for DNS RIS for Which Avoidance Test Data are Available), Figures B-5, B-6, B-10, B-11, B-13; *see id*. at B-37; Pet. at 20; Exh. 1 at 7. The demonstration elaborates that avoidance temperatures for these RIS are generally several degrees higher than estimated plume temperatures under the three scenarios. App. B. at B-31, B-37.

Documented avoidance temperatures typically fall "slightly below the threshold of chronic mortality." App. B at B-31, B-38. "RIS for which avoidance data were not available generally exhibited acute and/or chronic mortality metrics within a similar range to the five RIS with avoidance information. . . ." *Id*.; *see id*. at B-38; Pet. at 20. The demonstration asserts that the RIS without avoidance data would show "a similar pattern of avoidance and would not be expected to avoid significant areas of habitat" near the Dresden thermal plume. App. B at B-31, B-38. The demonstration concludes that this analysis supports a finding that the Dresden thermal plume "would not be expected to cause avoidance of aquatic habitat for any of these species," even under the Extreme High Temperatures scenario. *Id*. at B-31, B-38; *see* Pet. at 20; Exh. 1 at 7, 13.

The demonstration acknowledges that, under the Extreme High Temperature scenario, white sucker may avoid a large part of the thermal plume by moving to upstream habitat with cooler water temperatures. App. B at B-38. Because avoidance is expected to last 12 hours or less, the demonstration argues that it is "unlikely to have any extended effect on habitat utilization by this species which has been only an incidental component of the aquatic community." *Id*. The demonstration concludes that the thermal plume "is unlikely to inhibit local movement or diel and seasonal migration of RIS." *Id*.

Potential for Blockage of Migration. The demonstration states that RIS typically migrate to preferred spawning habitat before June 15 when Dresden operates in closed cycle mode. Exh. 1 at 15. However, "[w]hen avoided temperatures exist over a large enough cross-section of the receiving water body, passage of organisms upstream or downstream of the discharge location may be inhibited." App. B at B-4. The demonstration states that most transects within the thermal plume and most of the channel bottom habitat are predicted to have water temperatures below avoidance and chronic mortality temperatures of most RIS under a range of conditions. *Id*. at B-31; *see* Exh. 1 at 16. The demonstration argues that "it is unlikely that the thermal plume would interfere with the migration and localized movement patterns . . . of the fish community in the upper Illinois River." App. B at B-31. For the modeled scenario, Exelon's demonstration found that conditions would not result in habitat loss or extended blockage of migration. Exh. 1 at 6; App. B at B-26 - B-31, Table B-6; Rec. at 7, 9.

The demonstration acknowledges that white sucker is the most sensitive of the RIS to elevated water temperatures. App. B at B-31. While white sucker may avoid a significant part of the thermal plume under the Extreme High Temperature scenario, avoided temperatures are expected to continue for 24 hours or less. *Id*.; *see* Exh. 1 at 16. The demonstration argues that avoidance of that duration is "unlikely to have any extended effect on habitat utilization" by white sucker. App. B at B-31. The demonstration adds that the white sucker "has been only an incidental component of the aquatic community" in the vicinity of Dresden "because preferred habitat and substrate are not available for the species." Exh. 1 at 16; *see* App. B at B-31. The demonstration concludes that these "relatively minor effects will not preclude maintaining the BIC" near Dresden. Exh. 1 at 16.

Spawning Temperature Range. For many aquatic species, the onset and completion of spawning are tied to closely to water temperature. App. B at B-3; Exh. 1 at 16. "In addition, the survival, development, and hatching of fertilized eggs and maturation of larvae can be strongly influenced by water temperature among many other factors." Exh. 1 at 16. Spawning by RIS in the vicinity of Dresden mostly occurs before June 15 during closed cycle cooling operation. App. B at B-31, B-33, B-38; Pet. at 20; Exh. 1 at 16; Rec. at 5. The demonstration states that "[g]izzard shad, white sucker, golden redhorse, black crappie, and logperch typically finish spawning prior to mid-June and the start of indirect open cycle cooling operation." App. B at B-31 – B-32; *see* Pet. at 20. The spawning of these five species "would, therefore, not be affected." App. B at B-32, B-38. However, "[e]merald shiner, common carp, smallmouth bass, largemouth bass, and freshwater drum typically spawn during May and June and could, therefore, be affected" by indirect open cycle cooling in the final quarter of their spawning season. *Id*. at B-32.

The demonstration states that the reported "upper range of spawning temperatures for emerald shiner is about 27.2ºC (81ºF)." App. B at B-32, citing M. Wenholz, Draft Technical Support Document for Wisconsin's Thermal Water Quality Rules, Wisconsin Department of Natural Resources (2007). Under the Typical Conditions scenario during June, the temperature exceeds that threshold in less than 10 percent of a cross-section of the Illinois River for a distance of approximately 475 meters downstream from the discharge. App. B at B-32. Under the Typical High Temperatures scenario, June ambient water temperatures are predicted to exceed 27.8ºC (82ºF) upstream from Dresden in the Illinois and Des Plaines Rivers. *Id*. The demonstration argues that "it is likely that emerald shiner spawning would end as a result of rising ambient temperatures during typical and extremely warm years" before Dresden begins indirect open cycle cooling. *Id*.

The demonstration states that the reported "upper range of spawning temperatures for common carp is about 27.8ºC (82ºF)." App. B at B-32, citing D.A. Wismer and A.E. Christie, Temperature Relationships of Great Lakes Fishes: A Data Compilation, Great Lakes Fishery Commission (1987). Under the Typical Conditions scenario, "water temperature rarely exceeds 82ºF in any portion of the cross-section of the Illinois River" downstream from Dresden. App. B at B-32. Under the Typical High Temperatures scenario, ambient water temperatures are predicted to exceed that threshold in June both upstream from Dresden in the Illinois and Des Plaines Rivers and most of the Illinois River cross-section downstream from it. *Id*. The demonstration argues that "it is likely that common carp spawning would end as a result of rising ambient temperatures during typical and extremely warm years" before Dresden begins indirect open cycle cooling. *Id*.

The demonstration states that the reported "upper range of spawning temperatures for largemouth bass and smallmouth bass is about 22.8ºC (73ºF)." App. B at B-32, citing M. Wenholz, Draft Technical Support Document for Wisconsin's Thermal Water Quality Rules, Wisconsin Department of Natural Resources (2007). The demonstration reports that, under both Typical and Typical High Temperature scenarios, June ambient water temperatures in in the Illinois and Des Plaines Rivers upstream from Dresden are predicted to exceed 24.4ºC (76ºF). App. B at B-32. The demonstration adds that, "even in the cooler Kankakee River, ambient temperatures are predicted to exceed 23.3ºC (74ºF)." *Id*., citing Table B-7 (cross-section temperature distribution). The demonstration concludes that "it is likely that largemouth bass and smallmouth bass spawning would end as a result of rising ambient temperatures during typical years" before Dresden begins indirect open cycle cooling. App. B at B-32. The demonstration also argues that, because these two species "spawn in shallow weed free habitat which would tend to warm faster, it is likely that bass spawning ends before June in the Illinois River." *Id*.

The demonstration states that the reported "upper range of spawning temperatures for freshwater drum is about 28.9ºC (84ºF)." App. B at B-32. Under the Typical Conditions scenario, ambient water temperatures in June are not predicted to exceed that threshold upstream of the Dresden discharge or in any part of the discharge plume. *Id*., citing Table B-7. Under the Typical High Temperature scenario, water temperatures above that threshold "occupy more than 90 percent of the cross-section of the Illinois River" downstream of the Dresden discharge. App. B at B-32. The demonstration concludes that freshwater drum spawning would not be likely to occur downstream of the Dresden discharge in the second half of June under the Typical High Temperatures scenario. *Id*. The demonstration argues, however, that freshwater drum spawning would continue to the end of June upstream of the discharge. *Id*. at B-32 – B-33. The demonstration stresses that "[o]pen water spawning habitat utilized by freshwater drum is abundant upstream in the Illinois, Des Plaines, and Kankakee Rivers." *Id*. at B-33.

The demonstration states that channel catfish and bluegill are "[t]he only RIS likely to spawn after June." App. B at B-33; *see id*. at B-38; Pet. at 20-21. The upper range of spawning temperatures for these two species is approximately 28.9 – 29.4ºC (84-85ºF). *Id*. at B-33, citing D.A. Wismer and A.E. Christie, Temperature Relationships of Great Lakes Fishes: A Data Compilation, Great Lakes Fishery Commission (1987). Under the Typical Conditions scenario, water temperatures are not predicted to exceed that threshold in June through August either upstream from Dresden or in most of the thermal plume. App. B at B-33, citing Tables B-7, B-8, B-9. Under the Typical High Temperature scenario, water temperatures above 28.9ºC are predicted to occupy more than 90 percent of the cross-section of the Illinois River from June through August. App. B at B-33. The demonstration states that spawning would not be likely to occur downstream from Dresden later than the middle of June, although spawning could continue upstream to the end of June. *Id*. However, ambient temperatures upstream from Dresden in the Illinois and Des Plaines Rivers in July and August are generally "well above the reported upper spawning temperature." *Id*.; *see id*. at B-38 The demonstration concludes that channel catfish and bluegill continue are not likely to continue spawning in the vicinity of Dresden past the end of June under the Typical High Temperature scenario. *Id*. at B-33; *see* Pet. at 21; Rec. at 5-6.

The demonstration argues that these conclusions are reflected in ichthyoplankton drift sampling conducted near Dresden in 2005-2006. That sampling indicated that 85-88 percent of the early life stages of fish occurred by June 15. App. B at B-33, B-38; Exh. 1 at 17; Rec. at 6. The demonstration further argues that, for ichthyoplankton occurring on and after June 15, "mortality is not predicted based on available thermal tolerance data." App. B at B-33. At acclimation to temperatures as high as 33ºC (91.4ºF), eggs and larvae of several RIS "tolerate acute exposure to temperatures of 31-41ºC (87.8-105.8º) and chronic exposure up to 38.8ºC (101.8ºF). *Id*. (citations omitted). The demonstration states that, even under the Extreme High Temperatures scenario, these temperatures are "considerably higher" than those predicted in the vicinity of the Dresden thermal discharge under even the extreme high temperature scenario. *Id*.

Critical Temperatures for Growth. The demonstration states that "[w]ater temperature plays a significant role in the growth of aquatic species, affecting metabolic rates and the energy expended seeking and capturing food material." App. B at B-4. The rate of growth is variable and is affected by factors in addition to water temperature: "food availability, habitat availability, physico-chemical conditions, and population density, among others." *Id*. at B-33. Because there are limited methods and resources for testing adult fish and larger species, "quantitative data on growth is frequently limited to early life stages or species that are reared in hatcheries. . . ." *Id*.; *see id*. at B-4. Although laboratory testing can yield quantifiable results, those results "are difficult to interpret in the context of variability that occurs in the natural environment and habitat of these species." *Id*. at B-33. Nonetheless, "[m]any mobile aquatic species have demonstrated in laboratory 'preference-avoidance' studies the ability to detect and select a preferred range of temperatures within a temperature gradient." Exh. 1 at 17. These preferred temperatures generally correspond to those associated with optimum growth. *Id*.; App. B at B-4, B-33 – B-34. "Outside of the optimum temperature range, growth can continue to occur at a lower rate." *Id*. at B-4; *see* Exh. 1 at 17. The demonstration argues that the range of optimal growth temperatures "can appear to be artificially constrained given the seasonal range of temperatures over which growth occurs." App. B at B-34. The demonstration asserts that water temperatures can move in and out of the optimum range on a daily basis and that "[m]ost species experience optimum temperature conditions during a relatively short period of the annual seasonal cycle. . . ." Exh. 1 at 17.

Each of the RIS show patterns of growth typical of temperate zone fishes. App. B at B-34. They will exhibit zero growth "over winter beginning when temperatures decline below some critical temperature in the fall." *Id*.; *see* Exh. 1 at 17; App. B at B-4, B-38; Pet. at 21. They begin to exhibit growth in the spring as temperatures rise above that critical temperature. *Id*. at B-34, B-38; *see* Exh. 1 at 17; Pet. at 21. If temperatures rise above a certain level during the summer, growth may continue at a slower rate or cease for a period of time. App. B at B-34; *see* Pet. at 21. The demonstration states that "[w]hile elevated temperatures in portions of the thermal plume may inhibit growth during peak summer periods, they may also stimulate growth earlier and later in the year than typically observed without the artificial source of heat in the water body." App. B at B-34; *see* Pet. at 21. The demonstration argues that, "[a]s long as the cumulative conditions that promote growth occur over an annual period adequate to sustain normal growth increments the BIC will be sustained." Exh. 1 at 17.

The demonstration states that "reported upper zero growth temperatures for gizzard shad, emerald shiner, common carp, channel catfish, largemouth bass, and smallmouth bass exceed 33.9ºC (93ºF). App. B at B-34, B-39; *see id*., Table B-14 (Temperature Range for Optimum Growth and Upper and Lower Zero Growth Temperatures for DNS RIS); Pet. at 21. The demonstration argues that, even under the Extreme High Temperatures scenario, it is unlikely that the Dresden thermal plume "would adversely affect growth or cause a cessation of growth for these RIS." App. B at B-34, B-39; *see* Exh. 1 at 18; Pet. at 21. The demonstration asserts that "[t]his is consistent with data collected during field surveys between 1994 and 2014 that show relatively good growth for the more common species including RIS." Exh. 1 at 18. The demonstration reports no upper zero growth, lower zero growth or optimum growth range temperatures for either golden redhorse or logperch. App. B, Table B-14.

The demonstration states that "[t]he upper zero growth temperature for bluegill and freshwater drum is about 32.8ºC (91ºF)." App. B at B-34, citing Table B-14. Under the Typical High Temperature scenario, July temperatures in much of the thermal plume downstream from the Dresden discharge are approximately 32.2-32.8ºC (90-91ºF), approaching the upper zero growth temperature for these two species. App. B at B-34, citing Table B-8. The demonstration states that temperatures upstream from the discharge "are within the optimum range for these two species." App. B at B-34. During Extreme High Temperature conditions in July 2012 , both upstream ambient temperatures and thermal plume temperatures were above zero growth temperatures for these two species. *Id*., citing Table B-12. The demonstration acknowledges that growth of bluegill and freshwater drum may have diminished to zero in July 6-8, 2012, but it argues that growth would have resumed once ambient and plume temperatures fell below 32.8ºC (91ºF) at the end of that period. App. B at B-34, citing Figures B-20, B-21 (intake, discharge, surface, mid, and bottom temperatures).

The demonstration states that black crappie and white sucker "have the lowest reported zero growth temperatures of the RIS, 30.5ºC and 29.6ºC (86.9ºF and 85.3ºF, respectively)." App. B at B-34. These species were included as RIS "because they are expected to be more sensitive to high temperatures." *Id*. Under the Typical Conditions scenario, "ambient and plume temperatures are below the zero growth temperature throughout the summer for both species." *Id*.

For black crappie under the Typical High Temperatures scenario in June, ambient temperatures and at least 90 percent of the plume will be below the zero growth temperature. *Id*., citing Table B-7, B-14. In July, upstream ambient temperatures in the Illinois and Des Plaines Rivers and throughout the plume will exceed the zero growth temperature for black crappie. App. B at B-34, citing Table B-8; *see* Pet. at 21-22. In August, upstream temperatures will either approach or exceed the zero growth temperature for black crappie, and temperatures in the plume will exceed it. App. B at B-34, citing Table B-9; *see* Pet. at 21-22. The demonstration argues that ambient temperatures at these levels would not be exacerbated by the Dresden thermal plume. App. B at B-39. In September, upstream ambient temperatures will be below the upper zero growth temperature for black crappie but "higher than the upper temperature range for optimum growth except in a portion of the Kankakee River. App. B at B-35, citing Table B-10. Also, at least 90 percent of the thermal plume will exceed the upper zero growth temperature for black crappie by 0.1-0.6ºC (0.2-1.1ºF). App. B at B-35.

The demonstration reports that, "[d]uring the extreme high temperature scenario of July 2012, the entire modeled reach, including ambient temperatures in upstream areas, exceeded the black crappie zero growth temperature by 2.2-3.3ºC (4-6ºF)." *Id*., citing Table B-12. The demonstration states that temperatures at this level "are predicted to limit growth for a brief period of several days" but argues that "[t]he brief period of extreme temperatures is not predicted to have an extended long-term effect on growth patterns." App. B at B-39; Pet. at 22. The demonstration stresses that black crappie are not common in the fish community near Dresden. App. B at B-39; Pet. at 22. The demonstration acknowledges that temperatures in the Dresden thermal plume "are not particularly favorable" to growth of black crappie but also argues that upstream temperatures are also unfavorable. Exh. 1 at 18. The demonstration argues that relatively poor thermal conditions for growth of black crappie suggest that, even in the absence of the Dresden discharge, the species would not "constitute a more significant component of the BIC." *Id*.

The demonstration argues that "[w]hite sucker occur incidentally in the Des Plaines, Kankakee, and upper Illinois Rivers." App. B at B-35. Under the Typical Conditions scenario, July and August "ambient temperatures in the Des Plaines and upper Illinois Rivers exceed the upper range for optimum growth of white sucker." *Id*. Ambient temperatures in the Kankakee River remain within the range of optimum growth. *Id*. Under the Typical High Temperatures scenario, July-September ambient temperatures in the Des Plaines and upper Illinois Rivers exceed 27ºC (80.6ºF), the upper range for optimum growth of white sucker. *Id*., citing Tables B-8, B-9, B-14. However, ambient temperatures in the Kankakee River remain within the range of optimum growth. App. B at B-35. During July and August, "ambient temperatures in much of the upstream area exceed white sucker zero growth temperature (29.6ºC [85.3ºF])." *Id*., citing Tables B-8, B-9; *see* Pet. at 21-22. The demonstration argues that ambient temperatures at these levels would not be exacerbated by the Dresden thermal plume. App. B at B-39. From July to September, the entire plume and, during June, "about 50 percent of the plume exceed the white sucker zero growth temperature." *Id*. at B-35, citing Tables B-7 – B-11. The demonstration acknowledges that temperatures in the Dresden thermal plume "are not particularly favorable" to growth of white sucker but also argues that upstream temperatures are generally unfavorable. Exh. 1 at 18. The demonstration argues that relatively poor thermal conditions for growth of white sucker suggest that, even in the absence of the Dresden discharge, the species would not "constitute a more significant component of the BIC." *Id*.

Under Extreme High Temperature conditions in July 2012, "the entire modeled reach, including ambient temperatures in upstream areas, exceeded the white sucker zero growth temperature by 3.3-4.4ºC (6-8ºF)." App. B at B-35, citing Table B-12. The demonstration states that temperatures at this level "are predicted to limit growth for a brief period of several days" but argues that "[t]he brief period of extreme temperatures is not predicted to have an extended long-term effect on growth patterns." App. B at B-39; Pet. at 22. The demonstration stresses that white sucker are not common in the fish community near Dresden. App. B at B-39; Pet. at 22.

The demonstration concludes that, for most RIS and the species they represent, temperatures in the Dresden thermal plume "are not expected to adversely affect normal patterns for growth." App. B at B-35, B-38; *see* Exh. 1 at 17. The demonstration states that, under the Typical High Temperature and Extreme High Temperature scenarios, July and August ambient temperatures "can exceed the upper temperature for optimum growth and the zero growth temperature" for white sucker and black crappie. App. B at B-35; *see* Exh. 1 at 17. The demonstration argues that effects of these temperatures are predicted to be "minimal and transitory." Pet. at 22.

Potential for Cold Shock Mortality. The demonstration states that "[c]old shock can occur when fish are quickly exposed to much lower temperatures than those to which they are acclimated." App. B at B-35. As one example of cold shock, the demonstration identifies cases in which "fish attracted and acclimated to a thermal plume during winter are returned to much colder ambient temperatures in the event of a station shutdown." *Id*.; *see id*. at B-4. Because Dresden operates in closed cycle between October and mid-June, "the risk of cold shock is minimal because the winter thermal plume is relatively small with less differential over ambient temperatures." *Id*. at B-35. The proposed alternate thermal limits do not affect the period from October 1 to June 14 when cooler ambient water temperatures prevail and Dresden operates in closed cycle cooling mode. *Id*.; *see* Exh. 1 at 18. The demonstration states that it presents cold shock data available for the RIS for completeness. App. B at B-35.

Threatened and Endangered Fish and Mussel Species. Regarding threatened and endangered species, the Board's questions requested that Exelon "address any adverse effects that may result from the requested alternative thermal effluent limitation and clarify how the thermal demonstration shows that the alternative limitation will assure protection and propagation of a balanced, indigenous population." Board Questions at 6.

In response, Exelon first notes that the lock and dam system in the UIW has permanently altered the natural aquatic habitat near Dresden. Resp. at 15. Changes such as inundation of riffle/run habitat and resulting sedimentation have resulted in habitat "less than optimal for various species represented by the darter and sucker families" and their spawning requirements.

Id. Exelon argues that RIS affected by these habitat changes, the golden redhorse and logperch, were collected near the station in every sampled year. *Id*. Exelon further argues that these bottom-dwelling species "under most operating conditions would have limited potential exposure to the warmer portions of the buoyant Dresden Station thermal plume." *Id*. Exelon concludes that benthic substrates and water velocities near Dresden have a greater effect on the distribution of these species than the temperature of the thermal plume. *Id*.

Exelon addresses the endangered pallid shiner by noting that, although it was not collected before 2001, it has been collected every year since 2001 and is represented on the RIS list by the emerald shiner. Resp. at 15; *see* Exh. 1 at 8. Exelon states that the threatened banded killifish is also represented by the emerald shiner. Exelon notes that a sudden presence and increase of the banded killifish near Dresden suggest that its discharge "is not an impediment to the survival or range expansion of banded killifish." Resp. at 15; *see* Exh. 1 at 8-9. Exelon adds that the vegetated backwater habitat frequented by pallid shiner and banded killifish is limited downstream from the Dresden discharge so that habitat "is expected to have minimal exposure" to the thermal plume. *Id*.

Exelon acknowledges that sedentary mussels may be more vulnerable to exposure to the Dresden thermal plume because they cannot move to cooler habitat. Resp. at 15-16. However, Exelon argues that the buoyant plume near the river's surface limits the risk to mussels residing on the bottom. Exelon states that mussels burrow into sediments, which are cooler than water at the bottom. *Id*. at 16. Exelon adds that its 2014 study observed the highest densities of mussels opposite the discharge "in areas occasionally influenced by higher temperatures in the thermal plume." *Id*. The study also showed that two threatened mussel species, the purple wartyback and black sandshell, were present both upstream and downstream of the Dresden discharge. Exh. 1 at 9, App. H at H-4.

Exelon concludes that the thermal plume from Dresden is not expected to have material effects on threatened or endangered species of fish or mussels. *Id*.

<u>Exelon Models</u>

<u>Typical Conditions.</u> Under this scenario, river flows and temperatures and discharge temperatures "are most constraining during July and August." App. B at B-24. At a median July discharge temperature of 30.8ºC (87.4ºF), water temperatures immediately downstream from the discharge "ranged from 27.6ºC to 30.3ºC (81.7ºF to 86.6ºF); temperatures in 75 percent of the cross-section were less than 29.0ºC (84.2ºF)." *Id*., citing Table B-8; *see* Rec. at 6; Pet. at 18. The Agency's recommendation states that this 84.2ºF temperature "would not adversely affect growth of RIS or lead to avoidance in these species, and is actually within the optimum temperature range for most RIS." Rec. at 6. In bottom habitats, 75 percent of upstream water temperatures are less than 27.9ºC (82.3ºF), and 75 percent of downstream water temperatures are less than 28.7ºC (83.7ºF). App. B at B-24, citing Table B-11.

The demonstration notes that, although the median August discharge temperature is slightly lower than July, upstream water temperatures are higher and flow is lower. App. B at B-25, citing Table B-9. Under typical August conditions, water temperatures immediately downstream from the discharge "are less than 29.2ºC (84.5ºF) in 75 percent of the cross-section." *Id*. Downstream, "75 percent of the cross-section is predicted to be below 29.0ºC (84.2ºF)." *Id*., citing Table B-9; *see* Rec. at 6. Water temperatures are predicted to be less than 28.1ºC (82.5ºF) in 75 percent of upstream bottom habitats, and are predicted to be less than 28.9ºC (84.1ºF) in 75 percent of downstream bottom habitats. App. B at B-25, citing Table B-11.

The Agency's recommendation notes that, under this scenario, "the entire study area conforms with the 90ºF summer temperature standard." Rec. at 6; *see* Pet. at 18.

<u>Typical High Temperature Conditions.</u> Under this scenario, river flows and temperatures and discharge temperatures "are most constraining during July and August." App. B at B-25. At a 95th percentile July discharge temperature of 33.2ºC (91.8ºF), water temperatures immediately downstream from the discharge "ranged from 31.9ºC to 32.9ºC (89.5ºF to 91.3ºF); temperatures in 75 percent of the cross-section were less than 32.7ºC (90.9ºF)." *Id*., citing Tables B-5, B-8; *see* Rec. at 7; Pet. at 18. In bottom habitats, 75 percent of upstream water temperatures are less than 31.4ºC (88.5ºF), and 75 percent of downstream water temperatures are less than 32.6ºC (90.6ºF). App. B at B-24, citing Table B-11.

The demonstration notes that, although the 95th percentile August discharge and upstream water temperatures are lower, flow is approximately the same as in July. App. B at B-26, citing Table B-9. Under typical high temperature conditions for August, water temperatures immediately downstream from the discharge "are less than 31.9ºC (89.5ºF) in 75 percent of the cross-section." *Id*. Farther downstream near the Dresden Island Lock and Dam, "75 percent of the cross-section is predicted to be below 31.7ºC (89ºF)." *Id*., citing Table B-9. Water temperatures are predicted to be less than 30.2ºC (86.4ºF) in 75 percent of upstream bottom habitats, and are predicted to be less than 31.7ºC (89.0ºF) in 75 percent of downstream bottom habitats. *Id*., citing Table B-11.

The Agency's recommendation notes that, at temperatures above 90ºF, black crappie, freshwater drum, golden redhorse, and white sucker "could potentially be adversely affected by temperatures outside the mixing zone." Rec. at 7. At temperatures above this level, "these RIS would likely avoid the thermal plume or would incur no growth if they continued to inhabit the area." *Id*. The Agency notes that, at an acclimation temperature of 31.1ºC (88ºF), the white sucker's predicted threshold for chronic mortality is about 32.2ºC (90ºF). *Id*. While temperatures at this level "could create stressful conditions for white suckers exposed for an extended period of time," the Agency states that discharge and ambient water temperatures vary diurnally. *Id*. In addition to cooler temperatures that may be available in the benthos, the Agency stresses that the temperature in a majority of aquatic habitat immediately upstream from Dresden is predicted to be less than 31.7ºC (89ºF). *Id*. at 7-8.

The Agency's recommendation states that these modeled conditions reflect conditions now authorized by alternative thermal limits. Rec. at 8. The Agency adds that this combination of low flow and higher ambient temperatures occurs approximately once every 20 years. *Id*. The Agency cites long-term fisheries monitoring to argue that this scenario "has not had an observable impact on the balanced indigenous populations of aquatic life or other biotic categories." *Id*.

Extreme High Temperature Conditions. The demonstration states that, under extreme high temperature and river flow conditions, intake temperatures increase as warmer and more buoyant water from the Des Plaines River intrudes over cooler and less buoyant water from the Kankakee River. App. B at B-26. The demonstration further states that temperatures generally moderate upstream from the Dresden discharge where the two rivers mix. *Id*. Exelon reports that it used the hydrothermal model to evaluate the plume in "unusual conditions of high air temperatures and low flow that occurred during July 2012." *Id*. The Agency's recommendation indicates that these conditions "occur once every 33 years." Rec. at 8. Noting that these conditions are similar to the upper limits requested, the Agency states that "modeling of this event would be an accurate representation of how the proposed alternative thermal limits would affect receiving water temperatures. . . ." *Id*.

The demonstration reports that, from July 6-8, 2012, the maximum recorded intake water temperature was 34.4ºC (93.9ºF) with temperatures above 33.9ºC (93ºF) for approximately nine hours on July 7, 2012. App. B at B-27, citing Table B-6; *see* Rec. at 8; Pet. at 18. Discharge temperatures then peaked at about 34.9ºC (94.9ºF), remaining above 34.4ºC (94ºF) for about three hours and above 33.9ºC (93ºF) for about 11 hours. App. B at B-27; *see* Rec. at 8-9; Pet. at 18. Exelon's petition notes that this is "the approximate maximum discharge temperature limit sought in the revised alternative thermal limit." Pet. at 18. "The combined flow from the Des Plaines and Kankakee Rivers during this period ranged from slightly below to slightly above the 7Q10 (2456 cfs) calculated from upstream USGS gages scaled to the confluence of the two rivers." App. B at B-27, citing App. D.

The demonstration notes that, under the proposed alternate limits, Dresden's "discharge could exceed 93ºF (up to 95ºF) for up to 24 hours when intake temperatures exceed 90ºF (32.2ºC)." App. B at B-27. The demonstration states that, at transect IL-200 upstream from the Dresden discharge, modeled water temperatures at surface, middle, and bottom depths peaked above that 90ºF threshold at 33.3ºC (92ºF) for as long as four hours on July 7, 2012. *Id*., citing Figure B-18; *see* Rec. at 9. At transect IL475 downstream from the Dresden discharge, "modeled water temperatures at surface, middle and bottom depths exceeded 33.3ºC (92ºF) on 6 July for about 15 hours, declining below 33.3ºC (92ºF) for about three hours near dawn on 7 July, then increasing again to the peak for the 3-day period on the afternoon of 7 July. Temperatures at this transect exceeded 33.9ºC (93ºF) for approximately 6 hours on 7 July." *Id*., citing Figure B-19. The demonstration adds that, by 3:00 AM on July 8, 2012, "[t]emperatures at all depths were below 32.8ºC (91ºF)." *Id*.

The Agency's recommendation states that "no acute mortality of any of the RIS is expected to occur under the modeled conditions of the Extreme High Temperature Scenario." Rec. at 10. In support of this conclusion, the Agency cites both published acute mortality thresholds for the RIS and the lack of reported adverse effects during the July 2012 heat event. *Id*. While the Agency acknowledges that "there is a greater potential for chronic mortality to occur," it states that "[m]ost RIS for which chronic temperature tolerance data are available are able to tolerate water temperatures above 35ºC (95ºF) for extended periods of time (48-96 hours) at acclimation temperatures above 29.4ºC (85ºF). . . ." *Id*. at 11. The Agency notes that the upper thermal tolerance limit for the white sucker is lower than the other RIS. However, it stresses that the maximum exposure during the July 2012 conditions would have been "approximately 11 hours, considerably less than the exposure durations for the test data, and the ambient acclimation temperature of the Dresden Station intake was approximately 84ºF prior to the heat event." *Id*. The Agency adds that, under this scenario, five of the 12 RIS "would temporarily be exposed to temperatures outside of the mixing zone that exceed the upper zero growth and/or avoidance temperatures for these species." Rec. at 9. The Agency indicates that these effects would not be significant "on a long-term scale and would not adversely affect the balanced indigenous population of aquatic life near the study area." *Id*.

Exelon Summary of Predictive Demonstration

Exelon concludes that its modeling allows a detailed assessment of the thermal discharge from Dresden. Exh. 1 at 5. Exelon states that this assessment "predicts negligible potential effects of the thermal discharge on selected RIS." *Id*., citing Apps. B, D. Even under the Extreme High Temperatures scenario, Exelon argues that the proposed limits "would result in temperature conditions adequate to support and protect the BIC" in the vicinity of the Dresden discharge. *Id*. at 7; *see* App. B. at B-39.

Board Conclusion on Predictive Demonstration

The Board finds that Exelon's Predictive Demonstration shows that the requested alternative thermal effluent limitation will assure the protection and propagation of the balanced, indigenous community of shellfish, fish and wildlife in the Illinois River near the discharge from Dresden. Exelon's Predictive Demonstration used a hydrodynamic model to predict conditions under the extreme high temperature scenario and compare them to biothermal metric data related to survival, avoidance, spawning, and growth of each of the 12 RIS. As stated by IEPA, any temporary avoidance of the area or stunting of growth under proposed alternative thermal effluent limitations are predicted to be "uneventful" and not to adversely affect the balanced indigenous population of aquatic life in the vicinity of the DNS thermal discharge. Rec. at 9. Most spawning of the RIS and the species they represent occurs before the proposed alternative effluent limitation would begin on June 15, and would not be affected. App B at B-38. For growth, the thermal plume is not expected to have an extended long-term effect on the normal patterns based on the data for critical temperatures for growth addressed in Appendix B. Although the most thermally sensitive RIS, the white sucker, displays an upper thermal tolerance limit for chronic exposure of 90.5°F, which is below the requested alternative thermal effluent limitation, the maximum exposure duration of 24 hours is less than a chronic exposure duration. App. B at B-33 - B-35, B-38 - B-39, Figures B-5 - B-16. Both Exelon and IEPA agree that temperatures in the Dresden thermal plume, even under the modeled extreme high temperature scenario, are unlikely to adversely affect aquatic life. Exelon states that the proposed alternative thermal effluent limitations will not preclude improvements in the aquatic community in response to recent and future improvements in water quality and habitat conditions. Exh. 1 at 13, 20, App. A at A-28, A-38.

Master Rationale

For a CWA Section 316(a) demonstration to be successful under the Master Rationale, the demonstration as a whole must show that (1) the demonstration is acceptable for the considerations under the decision train outlined in Section 3.2.2 of the Draft Manual; (2) the demonstration shows there will be no appreciable harm to the balanced indigenous community; (3) receiving water temperatures outside any mixing zone will not be in excess of the upper temperature limits for the life cycles of the RIS; (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 RIS; (6) there will be no adverse impact on threatened or endangered species; (7) there will be no destruction of unique or rare habitat without convincing justification; and (8) the use of biocides will not result in appreciable harm to the balanced, indigenous community. Draft Manual at 70-71.

For the reasons discussed herein and further below, the Board finds that Exelon justified the grant of an alternative thermal effluent limitation in compliance with 33 U.S.C. § 1326 and 35 Ill. Adm. Code Part 106.Subpart K. Exelon demonstrates through the Biotic Category Analysis, the RIS Demonstration, as well as the Retrospective and Predictive Demonstrations that the requested alternative effluent standard will assure protection and propagation of the balanced and indigenous population of shellfish, fish, and wildlife in the Illinois River near the discharge from Dresden. Exelon further demonstrates that Section 302.211(e) of the Board's water pollution regulations is more stringent than necessary to assure the protection and propagation of the balanced and indigenous population of shellfish, fish, and wildlife in the Illinois River in the vicinity of the Dresden thermal discharge.

Exelon Summary of Final Assessment

Exelon states that the Dresden thermal discharge protects a balanced, indigenous community if specified criteria are met. Exh. 1 at 10; App. C at C-24. Exelon argues that the retrospective and predictive demonstrations show that the criteria will be satisfied, and the Board summarizes Exelon's arguments on those criteria in the following subsections.

Nuisance Species. Exelon states that substantial change in the abundance of nuisance species has not been observed to date. App. C at C-24; Exh. 1 at 10. Exelon indicates that its thermal discharge has not contributed to changes in non-thermal components of the system. App. C at C-24 – C-25. Exelon argues that, based on these factors, the amount of additional heat that will be discharged under the proposed alternate limits "is not expected to cause change in abundance or distribution of nuisance species." App. C at C-25; *see* Exh. 1 at 10.

Decreases of Formerly Abundant Species. Exelon states that monitoring shows that the abundance of most indigenous species near Dresden "has been either unchanged or increased during the period of indirect open cycle cooling" as authorized by the current alternate thermal limits. App. C at C-25; *see* Exh. 1 at 11. Exelon adds that any trends are apparent both upstream and downstream of Dresden, "indicating that the thermal discharge is not a significant contributing factor" in the presence of these species. App. C at C-25; *see* Exh. 1 at 11. Exelon also cites its 2014 mussel study and argues that the thermal discharge from Dresden has not caused appreciable harm to the mussel community. Exh. 1 at 11; App. C at C-25. Exelon adds that the absence of retrospective effects on these indigenous species of fish, shellfish, and macroinvertebrates "supports the conclusion that the lower trophic levels on which they are dependent for food have been similarly unaffected. . . ." App. C at C-25; *see* Exh. 1 at 11. Exelon also argues that its predictive demonstration shows that the proposed alternate limits "will not interfere with maintaining the indigenous fish species populations" in the vicinity of the Dresden discharge. Exh. 1 at 11.

Unaesthetic Appearance, Odor, or Taste. Exelon argues that the Dresden receiving waters show "no evidence of an unnatural odor or an unaesthetic appearance." Exh. 1 at 11; App. C at C-25. Exelon adds that the Illinois River in the vicinity of the Dresden discharge "is not listed as an impaired waterbody for use potentially affected by such conditions." Exh. 1 at 11. Exelon further argues that the proposed alternate limits "are not expected to cause a change in odor or aesthetic appearance. . . ." *Id.*; *see* App. C at C-25.

Elimination of Economic or Recreational Uses. Exelon argues that the thermal discharge from Dresden has not eliminated or minimized any "economic or recreational uses of the upper Illinois River." App. C at C-25; Exh. 1 at 11. Exelon asserts that fish consumption advisories in the UIW stem from PCB contamination that is not related to Dresden and that can be seen throughout the UIW system. App. C at C-25; Exh. 1 at 11. Exelon argues that its predictive demonstration shows that additional heat allowed by its proposed limits "will not affect these conditions." Exh. 1 at 11.

Reduction of Successful Completion of Life Cycles. Exelon asserts that monitoring and analyses "indicate that thermal effects have not compromised the overall success of indigenous species in completing their life cycles." Exh. 1 at 11-12; App. C at C-26. Exelon argues that its predictive demonstration shows that any additional heat released under the proposed limitations "will not cause any change in these conditions." Exh. 1 at 12.

Substantial Reduction of Heterogeneity or Trophic Structure. Exelon argues that monitoring conducted since the 1970s shows "the number of species collected has remained reasonably constant across years." Exh. 1 at 12; App. C at C-26. Exelon further argues that long-term changes to the fish community result from changes not related to the operation of Dresden. Exh. 1 at 12; App. C at C-26. Exelon asserts that these changes are seen throughout the UIW and that "there is no evidence" that Dresden contributes to them. Exh. 1 at 12. Exelon adds that the proposed alternate limits are "not expected to contribute to any such changes." App. C at C-26; *see* Exh. 1 at 12.

Endangered or Threatened Species. Exelon notes that its analysis identified seven state-listed species but no federally listed threatened or endangered species. Exh. 1 at 12; App. C at C-26. Exelon argues that the Dresden discharge has not affected the state-listed species and that they are not expected to be affected if the proposed alternate limits are approved. Exh. 1 at 12; App. C at C-26.

Unique or Rare Habitat. Exelon states that, downstream from the Dresden discharge, there are no unique habitats "that could potentially be affected by the thermal discharge." Exh. 1 at 12; App. C at C-26. Exelon argues that the Dresden Island Lock and Dam "permanently altered the habitat of Dresden Pool" into which Dresden discharges. Exh. 1 at 12.

Detrimental Interaction with Other Pollutants, Discharges, or Activities. Exelon argues that "[c]umulative effects of thermal additions discharged by industries upstream have not occurred." Exh. 1 at 12; App. C at C-26. Exelon asserts that operation of Dresden has not detrimentally affected recreational activities or commercial activities including shipping and fishing. Exh. 1 at 12; App. C at C-26. Exelon argues that, if the proposed alternate limits are adopted, "no harmful interactions with other pollutants such as organic carbon, phosphorus, and nitrogen are expected." *Id*; *see supra* at 68-69 (Nutrients).

Exelon's Conclusion on Final Assessment. Exelon argues that its predictive demonstration applies water temperatures to various responses of the RIS to predict that the Dresden plume operating under current alternative effluent limits does not have "the potential to adversely affect the reproduction, growth, and survival of these key species." Exh. 1 at 12; *see* Pet. at 22. Exelon further argues that operating Dresden under the proposed limits will not "cause appreciable harm to, or interfere with the successful completion of, key life history functions of the RIS." Exh. 1 at 12; *see* Pet. at 22. Exelon states that, even in the absence of a thermal plume, aquatic organisms "experience considerable spatial variation in water temperature and a wide range of seasonal temperatures." Exh. 1 at 13. Exelon argues that the proposed alternate limits "will not significantly alter this overall experience." *Id*. Exelon asserts any temperatures potentially lethal to the most thermally sensitive species "would be limited to a small portion of the plume during extremely warm meteorological conditions, and juvenile and adult fish are generally able to detect and avoid potentially lethal temperatures." *Id*.; *see* Pet. at 22. Exelon concludes that its predictive and retrospective demonstrations support a conclusion that operating Dresden under the proposed alternative limits "would continue to maintain the BIC." Exh. 1 at 12-13.

Exelon concludes that its retrospective and predictive demonstrations support the following conclusions: there has been no prior appreciable harm to the BIC resulting from the operation of Dresden under existing alternative thermal effluent limits; the existing aquatic community in the vicinity of Dresden is similar to the community in other parts of the UIW outside of Dresden's thermal influence; the BIC "is characterized by typical diversity, a capacity to sustain itself through seasonal cycles, and a dynamic food chain including an appropriate mix of key trophic level species;" and the proposed alternate limits "will not preclude overall improvements in the composition of the BIC in response to future improvements in water quality and habitat conditions." Exh. 1 at 13. Exelon concludes that, consistent with the Draft Manual, these conclusions support a determination to approve the proposed alternate limits. *Id*. at 14.

Board Finding on Final Assessment

The Board finds that Exelon's Biotic Category Analysis, RIS Demonstration and Retrospective and Predictive Demonstrations meet the applicable decision criteria of the Draft Manual for the Master Rationale. *See* Draft Manual at 70-71. Exelon's demonstration as a whole shows that: (1) it followed the considerations under the decision train outlined in Section 3.2.2 of the Draft Manual; (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 RIS; (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 RIS; (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) the use of biocides will not result in appreciable harm to the balanced, indigenous community. *See* Draft Manual at 70-71.

Applicable Effluent More Stringent Than Necessary

Exelon must demonstrate that the current standard is more stringent than necessary to assure the protection and propagation of the balanced and indigenous population of shellfish, fish, and wildlife in the Illinois River. *See* 33 U.S.C. § 1326. Section 302.211(e) of the Board's water pollution regulations is the applicable standard from which Exelon seeks an alternative thermal effluent limitation. 35 Ill. Adm. Code 302.211(e).

Exelon states that its predecessor's 1980 request for alternative thermal limitations relied on a retrospective analysis "to demonstrate that the existing thermal limitation requiring closed-cycle cooling year-round was 'more stringent than necessary to assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife.'" App. B at B-1. That analysis concluded that indirect open cycle operations in the 1970s had not resulted in appreciable harm to the aquatic community. *Id*. The current demonstration relies on a retrospective analysis augmented by "nearly 20 years of additional monitoring of the aquatic community" to show the absence of prior appreciable harm. *Id*.; *see infra* at 67-77. In addition, the demonstration also employs a predictive demonstration to predict the effect of the Dresden thermal discharge plume on the aquatic community under conditions including those represented by the proposed alternate limits. *Id*.; *see infra* at 77-98.

The Agency agrees that Exelon has demonstrated that "the current effluent limitations are more stringent than necessary" and that the proposed alternative limitations would not affect the balanced, indigenous population of shellfish, fish, and wildlife now inhabiting the Illinois River in the vicinity of the Dresden thermal discharge. Rec. at 4.

The Board finds that 35 Ill. Adm. Code 303.211(e) is more stringent than necessary to assure the protection and propagation of the balanced and indigenous population in the Illinois River near the discharge from Dresden between June 15 and September 30. Specifically, the Board finds that a limit of 3°F above 90°F for one percent of the hours in a 12-month period is more stringent than necessary.

Since 1981, the current alternative thermal effluent limitations granted under PCB 79-134 have allowed discharges to exceed 90ºF by up to 3ºF for ten percent of the time between June 15 and September 30. 401(c) Petition for Dresden Nuclear Generating Station, PCB 79-134, slip op. at 4 (July 9, 1981). Exelon's demonstration shows that a balanced and indigenous population continues to exist under the current alternative thermal effluent limitations as well as under the extreme temperature conditions that occurred in July 2012. Conditions under Exelon's proposed alternative thermal effluent limitations were modeled after the July 2012 extreme temperature event and demonstrated that the proposed alternative thermal effluent limitations will not adversely affect aquatic life. IEPA added that the short-term nature of the exposure under the proposed alternative thermal effluent limitations resulting in temporary avoidance of the area or stunting of growth would be "uneventful" and would not adversely affect the balanced indigenous population of aquatic life near the study area. Rec. at 9. Based on the Biotic Category Analysis, RIS Demonstration, and Retrospective and Predictive Demonstrations, the Board finds that increasing the allowed discharge temperature over 90ºF from 3ºF to 5ºF when intake temperatures are above 90ºF for periods less than 24 hours and continuing to allow such excursions during as much as 10% of the time in the period is sufficiently protective of the balanced, indigenous community of shellfish, fish and wildlife in the Illinois River near the discharge from Dresden.

CONCLUSION

Based on the record before it, the Board finds that Exelon has demonstrated that the limits imposed by 35 Ill. Adm. Code 302.211(e) are more stringent than necessary to assure the protection and propagation of a balanced and indigenous population of shellfish, fish, and wildlife in the Illinois River near the discharge from Dresden. The Board finds that Exelon's retrospective determination shows that no appreciable harm has resulted from the discharge to a balanced, indigenous community of shellfish, fish, and wildlife in and on the Illinois River. The Board also finds that Exelon's predictive demonstration shows that the requested alternative thermal limit, considering the cumulative impact of the discharge and other significant impacts, will assure the protection and propagation of a balance, indigenous community of shellfish, fish, and wildlife in and on the Illinois River. 33 U.S.C. § 1326. Accordingly, the Board grants Exelon an alternative thermal effluent limitation as described in its order below, effective today.

This opinion constitutes the Board's findings of fact and conclusions of law.

ORDER

Pursuant to 35 Ill. Adm. Code 106.Subpart K and 35 Ill. Adm. Code 304.141(c), the Board determines that the following alternative thermal effluent limitations apply to Exelon Generation LLC's (Exelon) Dresden Nuclear Station.

1. In lieu of 35 Ill. Adm. Code 302.211(e), the following shall apply:

   The monthly temperature standards set forth in 35 Ill. Adm. Code 302.211(e) shall apply to discharges from the Dresden Nuclear Station, provided that during the period June 15 through September 30, the temperature of the Dresden Station discharge shall not exceed 90ºF more than 10% of the time in the period and will never exceed 95ºF, provided that (1) discharges above 93ºF are allowed only when Dresden Station intake temperature is above 90ºF, and (2) any single episode of such discharges does not exceed 24 hours in duration.

2. The Illinois Environmental Protection Agency must expeditiously modify Exelon's NPDES permit consistent with this opinion and order.

IT IS SO ORDERED.

Board Member D. Glosser concurred.

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) (2014); *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.

I, Don A. Brown, Assistant Clerk of the Illinois Pollution Control Board, certify that the Board adopted the above opinion and order on March 3, 2016, by a vote of 5-0.

Don A. Brown, Assistant Clerk
Illinois Pollution Control Board