

ILLINOIS POLLUTION CONTROL BOARD  
September 18, 2014

EXELON GENERATION LLC,	)	
	)	
Petitioner,	)	
	)	
v.	)	PCB 14-123
	)	(Thermal Demonstration)
ILLINOIS ENVIRONMENTAL	)	
PROTECTION AGENCY,	)	
	)	
Respondent.	)	

OPINION AND ORDER OF THE BOARD (by J.A. Burke):

Exelon Generation LLC (Exelon) petitions the Board to grant an alternative thermal effluent limitation for heated discharge from Quad Cities Nuclear Generating Station (Quad Cities Station) instead of limits imposed by 35 Ill. Adm. Code 302.102(b)(8) and 303.331. Exelon seeks this relief pursuant to Section 316(a) of the Clean Water Act (CWA), 33 U.S.C. § 1326(a), and 35 Ill. Adm. Code 304.141(c), as well as the Board’s Subpart K procedural rules, 35 Ill. Adm. Code 106.Subpart K. Quad Cities Station is located on the east bank of the Mississippi River on Pool 14 near Cordova, Rock Island County.

The Illinois Environmental Protection Agency (Illinois EPA) filed a recommendation (Rec.) that the Board grant Exelon’s petition with two additional conditions, described below. Exelon responded to Illinois EPA’s recommendation (Resp.) and accepted the two conditions. No other federal, Illinois, or Iowa agency provided any comment or presented any concern to the Board. A technical advisory committee for Quad Cities Station includes Illinois EPA, Illinois Department of Natural Resources (Illinois DNR), United States Environmental Protection Agency (USEPA), United States Army Corps of Engineers (Army Corps), United States Fish and Wildlife Service (USFWS), Iowa Department of Natural Resources (Iowa DNR), and Illinois Natural History Survey.

Notice of Exelon’s petition was published in a local newspaper. However, no citizen or other organization provided any comment to the Board. Exelon did not request a hearing on its petition; no other person requested that the Board hold a hearing; and the Board did not hold a hearing.

Based on the record before it, the Board finds that Exelon demonstrated that limits imposed by 35 Ill. Adm. Code 302.102(b)(8) and 303.331 are more stringent than necessary to assure the protection and propagation of a balanced and indigenous population of shellfish, fish, and wildlife in Pool 14 of the Mississippi River. The Board grants an alternative thermal effluent limitation, as detailed below, that assures the protection and propagation of a balanced and indigenous population of shellfish, fish, and wildlife in Pool 14 of the Mississippi River.

## **OPINION OVERVIEW**

Exelon seeks an alternative thermal effluent limitation to increase the excursion hours applicable to heated effluent discharged from Quad Cities Station to Pool 14 of the Mississippi River. Exelon also seeks to decrease the zone of passage around the mixing zone it uses to comply with thermal standards and to change to a calendar year method of calculating excursion hours. Exelon submitted a prospective analysis to show that its proposed alternative thermal effluent limits will assure the protection of aquatic life and a retrospective analysis to show that prior thermal discharges have not caused appreciable harm to aquatic life. Exelon has been studying aquatic life in the vicinity of Quad Cities Station since the beginning of plant operations in the early 1970s. Exelon cites to forty-one years of fish monitoring data and fish monitoring is ongoing. Exelon describes mussel monitoring beginning in 2004 and the terms of a USFWS Incidental Take Permit and Habitat Conservation Plan to protect endangered mussels. This extensive data is presented below.

To assist the reader through this lengthy opinion, the Board notes at the outset that the opinion includes the following sections: (1) Procedural Background; (2) Quad Cities Nuclear Generating Station; (3) Ecological Setting; (4) Applicable Thermal Effluent Limitations; (5) Exelon's Proposed Alternative Thermal Effluent Limitations; (6) Illinois EPA Recommendation and Exelon Response; (7) Legal Background; (8) Burden of Proof; (9) Board Discussion; and (10) Conclusion. The Board Discussion section includes three parts (A) Biotic Category Analysis; (B) Representative Important Species Analysis; and (C) Master Rationale. These three parts and the decision criteria applied by the Board are based on USEPA's draft guidance for CWA Section 316(a) demonstrations titled *Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Sections of Nuclear Facilities Environmental Impact Statements (DRAFT)* dated May 1, 1977 (Draft USEPA 316(a) Manual). Exelon seeks relief pursuant to Section 316(a) of the federal CWA, 33 U.S.C. § 1326(a), and the Board views USEPA's draft guidance as a useful guide for its analysis.

## **PROCEDURAL BACKGROUND**

### **Pre-Petition Communications**

Board rules provide for pre-petition communications between the petitioner and Illinois EPA. Prior to filing a petition with the Board, the petitioner must submit early screening information to Illinois EPA including a description of the requested alternative standard, how the petitioner will make the required demonstration, and types of data the petitioner intends to submit. 35 Ill. Adm. Code 106.1115(a). Within thirty days after submitting the early screening information to Illinois EPA, the petitioner must consult with Illinois EPA to discuss the information. 35 Ill. Adm. Code 106.1115(b). Within sixty days after the petitioner submits the early screening information to Illinois EPA, the petitioner must submit a detailed plan of study to Illinois EPA. 35 Ill. Adm. Code 106.1120(a). Within ninety days after the petitioner's submittal, Illinois EPA must respond in writing to either approve the plan or recommend changes. 35 Ill. Adm. Code 106.1120(f). The petitioner must then complete the plan of study prior to filing a petition with the Board. 35 Ill. Adm. Code 106.1120(g).

Exelon works closely with a technical advisory committee comprised of Exelon, Illinois EPA, Illinois DNR, USEPA, Army Corps, USFWS, and Iowa DNR. Petition (Pet.) at 13-14, n. 14. Exelon also identifies the Illinois Attorney General, Southern Illinois University at Carbondale, Illinois Natural History Survey, Isaak Walton League of America, United Autoworkers Union, Mensiger Aquatic Resources, and MidAmerican Energy as additional members of the committee. Pet. Exh. 1 at 2, n. 1. This committee meets annually “to consider water-related environmental issues concerning Quad Cities Station, and reviews the results of environmental data collection efforts conducted during the prior year.” Pet. at 14.

In 2003, Exelon commenced studies “aimed at determining whether existing thermal limits could be relaxed without causing unacceptable environmental impacts.” Pet. at 14. Exelon presented these plans in committee meetings as well as to Illinois EPA and Illinois DNR “to obtain their input.” *Id.* In 2007, Exelon submitted to USEPA, with copies to USFWS, Illinois DNR, Iowa DNR, and Illinois EPA, its “detailed plans for additional studies to support its 316(a) Demonstration.” *Id.*; *see also* Pet. Exh. 2.

In 2007, Exelon submitted a letter to USEPA Region 5 regarding Exelon’s efforts to obtain the following alternate limits: “(1) increasing the number of hours the Station would be allowed to exceed monthly maximum river temperature standards (excursion hours) from the currently allowed 1% of the hours per rolling 12-month period, (2) changing the rolling 12-month method of tracking excursion hours to a calendar year method, and (3) increasing the current 3°F cap for excursion hours.” Pet. Exh. 2 at 1. Exelon asked USEPA to review and comment on Exelon’s plans to conduct field investigations in 2007 and 2008. *Id.* at 2. Exelon’s investigation included three topics of study: (a) monitoring of the mussel beds near Quad Cities Station by Ecological Specialists Inc.; (b) fish monitoring by HDR Engineering, Inc. (HDR); and (c) thermal modeling by Iowa Institute of Hydraulic Research (University of Iowa) (IIHR). *Id.* at 2-4. Exelon’s letter indicates that it sent copies of the letter to USEPA Region 7, USFWS, Illinois DNR, Iowa DNR, and Illinois EPA. *Id.* at 5.

In August 2009, Exelon met with USEPA to discuss Exelon’s demonstration under CWA Section 316(a) and the process to obtain alternative thermal limits. Exelon’s Response to Board Questions (July 16, 2014) (Exelon Ans.) at 8. In June 2013, Exelon again met with USEPA to continue discussing Exelon’s demonstration under CWA Section 316(a) and a rulemaking pending before the Board to promulgate procedural rules for reviewing requests for relief under CWA Section 316(a). *Id.*, *see also* Procedural Rules for Alternative Thermal Effluent Limitations under Section 316(a) of the Clean Water Act, R13-20. Exelon states, “USEPA did not express any objection or opposition to Exelon’s plans.” Exelon Ans. at 8.

As to Illinois DNR’s review, Exelon describes various communications with Illinois DNR. *See* Exelon Ans. at 8. Exelon provided a copy of a March 28, 2011 letter from Illinois DNR to Exelon wherein Illinois DNR discusses its review of Exelon’s demonstration under CWA Section 316(a). *See* Exelon Ans. at Exh. 30. It mentions prior communications dated November 25, 2009 and February 1, 2011. *Id.* Illinois DNR discussed data relating to a die off incident of mooneye fish and its desire to prevent fish kills and protect fish of the State. *Id.* Illinois DNR states that it “generally agrees” with Exelon’s proposals. *Id.* Exelon explains that Exelon committed to monitoring during high temperature/low flow events, coordinating with the

Army Corps when river flows yield a zone of passage less than 75%, and including site specific zone of passage measures. Exelon Ans. at 8.

As to Iowa DNR, in late 2009, Exelon provided Iowa DNR a copy of its draft CWA Section 316(a) demonstration for review. Exelon Ans. at 9; Exelon Ans. Exh. 35, 36. In response, two divisions of Iowa DNR, the Fisheries Bureau and the NPDES<sup>1</sup> Section, provided comments. *Id.* Exelon explains changes it made to its requested alternate limits and demonstration based on Iowa DNR's comments. Exelon Ans. at 9. Iowa DNR's comments are discussed below under the relevant portions of the opinion.

On March 11, 2014, Illinois EPA sent a letter to Exelon stating that Exelon "satisfied the new requirements of Section 106.1115 (Early Screening) and Section 106.1120 (Detailed Plan of Study)." Pet. Exh. 3. Illinois EPA explains that it has been "intimately involved since prior to January 2006" with Exelon's efforts and Illinois EPA along with the other governmental entities have participated in the process of determining fish species to be studied and discussing studies of the mussel beds containing federally endangered species. *Id.*

The Board adopted Sections 106.1115 and 106.1120 of the Board's procedural rules for alternative thermal effluent limitation petitions on February 20, 2014. *See Procedural Rules for Alternative Thermal Effluent Limitations under Section 316(a) of the Clean Water Act*, R13-20. The Board's rules became effective on February 26, 2014, and Exelon submitted its petition on April 2, 2014. Thus, much of the demonstration contained in Exelon's petition and the underlying studies and data pre-date the Board's procedural rules. In addition, as summarized above, Exelon communicated with governmental agencies and other interested entities about the substance of its petition. For its part, Illinois EPA acknowledges that it is satisfied with Exelon's pre-petition communications. Rec. at 6.

### **Petition to the Board**

On April 2, 2014, Exelon filed a petition with the Board for alternative thermal effluent limitations for discharge from Quad Cities Station requesting relief from limits imposed by 35 Ill. Adm. Code 302.102(b)(8) and 303.331. Exelon filed its petition with five exhibits including its CWA Section 316(a) Demonstration Summary (Pet. Exh. 1) consisting of a narrative summary and the following supporting appendices:

Appendix A. Description of the Mississippi River in the Vicinity of Pool 14: Hydrology, Geology, Water Quality, Biology, and Anthropogenic Influence;

Appendix B. Biothermal Assessment: Prospective Demonstration;

Appendix C. Retrospective Demonstration and Conclusions Regarding Protection and Propagation of a Balanced Indigenous Community under Clean Water Act Section 316(a);

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<sup>1</sup> "NPDES" is the abbreviation for the National Pollutant Discharge Elimination System established under Section 402 of the CWA. *See* 33 U.S.C. § 1342.

Appendix D. Quad Cities Nuclear Station Operations; and

Appendix E. Data Collection Programs.

Exelon's petition also attached an April 19, 2007 letter from Exelon to USEPA (Pet. Exh. 2), a March 11, 2014 letter from Illinois EPA to Exelon (Pet. Exh. 3), a Habitat Conservation Plan to Support Issuance of an Incidental Take Permit for the Federally Endangered *Lampsilis higginsii* Mussel and the Candidate Mussel Species *Plethobasus cyphus* (Pet. Exh. 4), and USFWS Federal Fish and Wildlife Permit effective August 16, 2010 (Pet. Exh. 5).

### **Notice and Hearing**

Exelon served a copy of the petition on Illinois EPA and Illinois DNR. On May 2, 2014, Exelon filed proof of publication indicating that notice of the petition was published on April 10, 2014 in the *Quad-City Times*. See 35 Ill. Adm. Code 106.1135(a), 106.1140. The notice was timely and met the content requirements of 35 Ill. Adm. Code 106.1135. Any person may request that a public hearing be held and such requests were to be received by the Board no later than May 1, 2014. The Board did not receive any request for hearing and did not hold a hearing.

### **Illinois EPA Recommendation**

Illinois EPA filed its recommendation on May 19, 2014. Illinois EPA recommends the Board grant Exelon's requested relief, subject to two conditions. Rec. at 4. Illinois EPA agrees that current effluent limitations are more stringent than necessary and that the requested alternative thermal requirements can assure the protection and propagation of a balanced and indigenous population of shellfish, fish, and wildlife in the Mississippi River where Quad Cities Station discharges heated effluent. *Id.* at 6. Exelon filed its response to the Agency's recommendation on May 23, 2014 stating Exelon is willing to agree to Illinois EPA's conditions. Resp. at 2.

### **Board Questions**

On June 25, 2014, the Board's hearing officer issued questions addressed to Illinois EPA and to Exelon. The hearing officer ordered responses to the questions within twenty-one days of receipt. Both Illinois EPA and Exelon responded on July 16, 2014. Responses to the questions are incorporated below in the relevant portions of the Board's discussion.

## **QUAD CITIES NUCLEAR GENERATING STATION**

### **Description of Station and Discharge Diffuser System**

Quad Cities Station is a nuclear fuel steam electric generating plant designed to operate twenty-four hours per day, seven days per week. Pet. at 8. The station has two units. Each unit has a maximum power level of 2,957 megawatts thermal and a combined output of 5914

megawatts thermal. *Id.* at 8; Pet. Exh. 1 App. D at D-2. The two units began commercial operation in 1973. Pet. Exh. 1 at 1; Pet. Exh. 1 App. D at D-2.

A diffuser system was installed in the Mississippi River in 1972 “as an interim mode of discharge until the spray canal (closed cycle cooling) was completed.” Pet. Exh. 1 at 14. This diffuser system consists of two 16-foot diameter multi-riser manifolds buried in the riverbed. Pet. Exh. 1 App. D at D-9. A thermal modeling investigation by IIHR in 1970-1971 recommended the current diffuser piping system and location. Exelon Ans. at 6. The recommendation was based on “field measurements from U.S. Geological Survey and three-dimensional modeling designed to distribute the Station thermal discharge across the river channel nearly in proportion to the river flow per unit width.” *Id.*

This diffuser system began operation in August 1972 and was operated until May 1, 1974 when the spray canal commenced operations with one unit discharging to the spray canal and the other unit discharging to the river. Pet. Exh. 1 App. D at D-9. On May 1, 1975, both units began discharging to the spray canal. *Id.* Closed-cycle cooling continued until 1979. *Id.*

On August 2, 1979, Quad Cities Station began operating under a revised permit that “allowed partial open-cycle operation of the condenser cooling system at times when the temperature of the water returning from the spray canal to the intake exceeded 93°F.” Pet. Exh. 1 App. D at D-10. Quad Cities Station sought relief from operating in closed-cycle mode because warm water returning from the spray canal in the summer reduced turbine efficiency and resulted in significant loss of electrical production available to the grid. Pet. Exh. 1 at 15. On December 23, 1983, the station “commenced the current full open cycle mode of operation via the diffuser pipes.” Pet. Exh. 1 App. D at D-10.

Quad Cities Station currently operates an open cycle condenser cooling water system. Pet. at 8. The designed maximum cooling water flow is 2,253 cubic feet per second (cfs) or 1,011,000 gallons per minute. *Id.*; Pet. Exh. 1 App. D at D-3. The cooling water system operates “at or near design flow except during refueling and maintenance outages and during the winter period when one circulating water pump per unit is turned off.” *Id.* at 8-9. The summer average cooling water flow is 2,191 cfs or 983,400 gallons per minute. Pet. Exh. 1 App. D at D-3. The winter average cooling water flow is 1,200 cfs or 538,570 gallons per minute. *Id.*

Quad Cities Station draws water from the Mississippi River through an intake canal, circulates the water through station systems, and discharges cooling water through the diffuser piping system to the Mississippi River. Pet. at 8. The discharge bay is “immediately south” of the intake canal, separated by a concrete retaining wall. Pet. at 11; Pet. Exh. 1 App. D at D-5. The discharge bay is “approximately 700 feet long by 150 feet wide.” Pet. at 11-12; Pet. Exh. 1 App. D at D-5. The effluent from the discharge bay is “distributed across the Mississippi River through a diffuser pipe system.” Pet. at 12; Pet. Exh. 1 App. D at D-5. The diffuser pipe system consists of two 16-foot diameter pipes buried in the river bed. *Id.* The north pipe “extends approximately 2,100 feet across the river.” *Id.* The south pipe “terminates about 390 feet before the end of the north pipe.” *Id.* In the deep portion of the river, each diffuser pipe has twenty 36-inch diameter discharge risers spaced at 19 feet, 8 inches. *Id.* In the shallow portion of the river, each diffuser pipe has fourteen 24-inch diameter discharge risers spaced at 78 feet 8 inches. *Id.*

Nine of these fourteen discharge risers presently are closed. *Id.* These nine risers are the first risers from the Illinois side of the river and “no heated water is discharged to the shallow portions of the river because lower velocity of the shallow portion of the river does not provide effective dilution.” *Id.* The operational diffusers begin approximately 840 feet from the Illinois shore and distribute the discharge 1,200 feet across the deeper portion of the river. *Id.* at 13. Exelon provided detailed dimensioned drawings of the diffuser piping system. Exelon Ans. Exh. 28.

The diffuser piping system currently in use is the same system that was installed in 1972. Exelon Ans. at 5. Exelon has not modified the system other than closing the nine risers in the shallow zone of the river. *Id.* The diffuser pipe system “was designed to optimize mixing of the Station’s condenser cooling water with the volume of the Mississippi River flows” within a short distance downstream of the diffuser pipe. *Id.* at 7. With both units operating at full power, the temperature differential between discharged cooling water and ambient river temperature at the intake canal ranges from 28°F during the summer to 48°F during the winter. Pet. at 12; Pet. Exh. 1 App. D at D-11.

In 1990, IIHR conducted an investigation “to develop strategies and associated diffuser pipe modifications to enable [Quad Cities Station] to operate at full load during periods of low flow.” Pet. Exh. 1 App. A at A-11; *see also* Exelon Ans. at 6, citing IIHR, *Evaluation of the Quad Cities Nuclear Generating Station Diffuser Pipe System at Low River Flows* (1990) (Exelon Ans. Exh. 29). IIHR analyzed field data from eight surveys during the summers of 1988 and 1989. Using this data and modeling, IIHR concluded that mixing of Exelon’s thermal discharge “was almost uniform, except for local ‘hot spots’ and ‘cold spots.’” Pet. Exh. 1 App. A at A-11. A higher temperature region was identified near the Iowa shore. A numeric model was used to simulate blocking the diffuser ports near the Iowa shore to eliminate the higher-temperature region and promote more uniform temperature distribution along the river cross-section 500 feet downstream of the diffuser. The numeric model arrived at an optimized diffuser configuration to show that reducing the thermal discharge near the Iowa shore and increasing it in the deeper portion of the river would result in a more uniform temperature distribution. Pet. Exh. 1 App. A at A-11.

However, the numerical simulation also concluded that the zone of passage would be smaller with the optimized diffuser pipe system than for the as-built configuration. Zone-of-passage curves were developed for both the as-built and the optimized diffuser pipe system. The curves showed that a 75% zone of passage with respect to discharge volume would be achieved with river flows above 16,400 cfs with the as-built diffuser, but with the optimized configuration, river flows would need to be at least 17,000 cfs. Exelon Ans. Exh. 22; *see also* Exelon Ans. Exh. 29 at 11-12. Similar results were found with optimizing the sizes of the orifice plates for the risers of the diffuser pipe system to achieve more uniform temperature distribution. Pet. Exh. 1 App. E at E-5; Exelon Ans. at 7. Exelon states, “[i]n other words, reconfiguring the diffuser would be detrimental to maintaining a zone of passage,” so Exelon did not reconfigure the diffuser piping system. Exelon Ans. at 4, 7.

Board regulation and Special Condition 6 of the station’s permit require that a mixing zone may not exceed 26 acres. Pet. Exh. 1 App. D at D-7; *see also* 35 Ill. Adm. Code

302.102(b)(12). The surface area of the river between the diffuser pipes and 500 feet downstream is 24.9 acres. Pet. Exh. 1 App. D at D-5. Accordingly, the station's permit requires temperature readings at 500 feet downstream of the diffuser. *Id.* at D-7. Exelon conducted surveys "to determine the distribution of the temperature rise in the 500 feet downstream of the diffuser pipes." *Id.* at D-5, citing IIHR, *Model Studies and Design of Thermal Outfall Structures Quad-Cities Nuclear Plant* (1971) and IIHR, *Evaluation of the Quad Cities Nuclear Generating Station Diffuser Pipe System at Low River Flows* (1990) (Exelon Ans. Exh. 29).

Quad Cities Station concluded that both units "could operate at full load without violating discharge permit limits under most river flow conditions." Pet. Exh. 1 App. A at A-12, citing Commonwealth Edison Company, *Supplement to 316(a) and (b) Demonstration to USEPA* (1981). To demonstrate compliance with the NPDES limitations during low river flows, Exelon developed a temperature monitoring curve to calculate "permissible plant load as a function of river flow." *Id.* The temperature monitoring curve was last modified in December 2000 (Exelon Ans. at 4; Exelon Ans. Exh. 25) and is referenced in Exelon's current NPDES permit as a means to establish compliance for power generation levels and river flows. Exelon Ans. Exh. 1 at 6.

As noted above, the diffuser system in use today is the same system that was installed in 1972 and has not been modified other than closing the nine risers in the shallow zone of the river. Exelon Ans. at 5. Exelon states that maintenance on the diffuser pipe system has not been necessary. *Id.* at 6. To verify that the diffuser piping system is performing as designed, Exelon compares field data collected from river temperature measurements to previous field data. *Id.* River temperature measurements are taken during periods when ambient river temperatures approach permit discharge limits. *Id.*

### **1978 No Ecological Damage Determination**

In 1978, Quad Cities Station requested that the Board determine, pursuant to Rule 203(i)(5) of the Board's Water Regulations (now codified at 35 Ill. Adm. Code 302.211(f)), that thermal discharges from the station "have not caused and cannot be reasonably expected to cause significant ecological damage" to the receiving waters of the Mississippi River. Proposed Determination of No Significant Damage for the Quad Cities Generating Station of Commonwealth Edison Company, PCB 78-61 (Dec. 14, 1978). The Board found

During periods of open cycle cooling and full plant operation, 12 billion BTUs/hr are discharged. Under these conditions, a 5° temperature rise above ambient is limited to a 500 foot, 25 acre area for all river flows. The only recorded violations of the Board's thermal standards occurred when a side jet discharge was used in 1973 and during September, 1976 when river flows were less than the 7 day, 10 year low flow. A safe zone of passage exceeding 75% of the total river is expected to occur during all flows in excess of 15,300 cfs. *Id.* at 1.

The Board concluded that thermal discharges from the station have not caused, and cannot reasonably be expected to cause, significant ecological damage to the Mississippi River. *Id.* at 2.



### **NPDES Permit**

Illinois EPA issued the current NPDES permit for Quad Cities Station on August 26, 2010 and it is effective until August 31, 2015. Pet. Exh. 1 App. A at A-10; Exelon Ans. Exh. 1. The permit specifies effluent limits for pH, total residual chlorine, oil, grease, biological oxygen demand, fecal coliform, total suspended solids, boron, temperature, and flow. Pet. Exh. 1 App. A at A-10. The permit defines a mixing zone for the station's thermal discharges. The mixing zone boundary is a straight line across the Mississippi River 500 feet downstream of the diffuser pipes. Pet. Exh. 1 App. B at B-3. The permit contains monthly maximum temperature limits for "representative locations in the main river" at the edge of the mixing zone. Pet. Exh. 1 App. A at A-11. In addition, the permit sets a maximum temperature increase of 5°F above ambient temperature at the edge of the mixing zone and "restrictions on the size of the thermal mixing zone." *Id.* The permit also "contains specific requirements for daily monitoring of plant circulating water flows, daily continuous monitoring of discharge temperatures, weekly determination of river flow rate, daily monitoring of the ambient temperature of the river, daily determination of plant load (percent power), and, as warranted, daily determination of the temperature at a river cross-section 500 feet downstream from the plant's diffuser system." *Id.* at A-12; *see also* Revised Temperature Monitoring Curve for Quad Cities Nuclear Generating Station (December 2000) found at Exelon Ans. Exh. 25.

Quad Cities Station uses biocides at the condenser inlets to treat river water. Pet. Exh. 1 App. A at A-9. Specifically, the station uses sodium bromide and sodium hypochlorite. Pet. Exh. 1 App. D at D-4. The station neutralizes the biocide in the discharge bay with sodium bisulfate. *Id.* The station's permit limits total residual chlorine/total residual oxidant to 0.05 ppm discharged to the river. *Id.* The station also uses silt dispersant, scale inhibitor, and corrosion inhibitor. Pet. Exh. 1 App. A at A-9; Pet. Exh. 1 App. D at D-4. Sanitary waste is sent to a wastewater treatment system and discharged to the river. Pet. Exh. 1 App. A at A-9.

### **Prior Provisional Variances**

The Board previously granted provisional variances<sup>2</sup> to Quad Cities Station for relief from thermal discharge requirements. *See Commonwealth Edison Quad Cities Power Station v. Illinois Environmental Protection Agency*, PCB 88-129 (Aug. 18, 1988) (Exelon Ans. Exh. 2); *Commonwealth Edison Quad Cities Power Station v. Illinois Environmental Protection Agency*, PCB 89-115 (July 13, 1989) (Exelon Ans. Exh. 3). Subsequently, Illinois EPA granted provisional variances to Quad Cities Station to exceed its 12-month allocation of excursion hours as listed below. Pet. at 13; Exelon Ans. at 2-3.

2005: IEPA 05-07, issued July 22, 2005. Exelon Ans. Exh. 4.

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<sup>2</sup> Under the Environmental Protection Act (415 ILCS 5 (2012)), a provisional variance generally provides a person with relief from a Board regulation or permit requirement for up to 45 days when the person proves that compliance on a short-term basis would impose an arbitrary or unreasonable hardship. *See* 415 ILCS 5/35(b), 36(c) (2012). Provisional variances were previously issued by the Board and are now issued by Illinois EPA. *See* P.A. 93-152 (eff. July 10, 2003).

- 2006: IEPA 07-01, issued July 19, 2006. Exelon Ans. Exh. 5.  
 IEPA 07-03, issued August 2, 2006. Exelon Ans. Exh. 7.
- 2007: IEPA 08-11, issued August 10, 2007. Exelon Ans. Exh. 12.
- 2012: IEPA 12-11, issued March 21, 2012. Exelon Ans. Exh. 13.  
 IEPA 12-17, issued May 5, 2012. Exelon Ans. Exh. 16.  
 IEPA 12-19, issued July 3, 2012. Exelon Ans. Exh. 18.  
 IEPA 12-19 extension, issued July 12, 2012. Exelon Ans. Exh. 19.  
 IEPA 12-19 2nd extension, issued July 24, 2012. Exelon Ans. Exh. 20.

As conditions of the provisional variances, Exelon provided Illinois EPA and Illinois DNR with reports consisting of a study plan (Exelon Ans. Exh. 6), mussel bed monitoring results (Exelon Ans. Exh. 8, 10, 11), and temperature and fish/aquatic life stress/mortality surveys (Exelon Ans. Exh. 9, 15, 17, 21). Exelon Ans. at 2-3.

### **ECOLOGICAL SETTING**

Exelon describes the hydrology, geology, water quality, biology, and anthropogenic influences in Appendix A to its CWA Section 316(a) demonstration. Pet. Exh. 1 App. A.

#### **Hydrology**

Quad Cities Station is located adjacent to, and discharges heated effluent to, the upper portion of the Mississippi River. Pet. at 8. The upper portion of the river is divided longitudinally into navigation pools by twenty-nine lock-and-dam structures. Pet. Exh. 1 App. A at A-3. Pool 14 is approximately twenty-nine miles long and located between Lock & Dam 14 at river mile 493.3 and Lock & Dam 13 at river mile 522.4. *Id.* Quad Cities Station is located on the east bank of Pool 14 approximately sixteen miles below Lock & Dam 13 and thirteen miles from Lock & Dam 14. *Id.* at A-16.

Annual high river flows occur between April and June, and low flows occur between December and February. Pet. Exh. 1 App. A at A-3. The mean annual flow at Lock & Dam 14 was approximately 54,114 cfs for the forty-year period from 1968 to 2008. *Id.* The lowest 7-day average flow that occurs on average once every 10 years (7Q10) in Pool 14 is 13,800 cfs while the typical summertime flow is 30,000 cfs. Pet. Exh. 1 App. C at C-31; Pet. Exh. 1 at 20. Historical flow records show that from January 1986 through December 2011 there were 209 days when river flow was below 16,400 cfs. Pet. Exh. 1 App. C at C-21, citing Army Corps records for Lock & Dam 14, [www.rivergages.com](http://www.rivergages.com). Further, during this time period, 25 of the 209 days occurred during the biologically important months of March, April, May, and October. *Id.* Specifically, river flow dropped below 16,400 cfs on four days during March to May and twenty-one days during October. Pet. Exh. 1 App. B at B-5; Pet. Exh. 1 at 5.

### Temperature

Ambient river temperatures at the intake to Quad Cities Station “range from 32°F during the winter months up to 88°F during July and August.” Pet. Exh. 1 App. D at D-10. Average high temperatures for July and August are in the upper 70s to low 80s. *Id.* 35 Ill. Adm. Code 303.331 sets numerical temperature limits at 86°F in July and August and 85°F in June and September. Starting in 1990, temperatures at the intake exceeded 86°F on three days in July 1995, two days in July 1999, eight days in July-August 2001, and four days in July-August 2006. Pet. Exh. 1 App. D at D-10 to D-11. In addition, intake temperatures ranged from 85°F to 86°F on seven days in 2005. *Id.* at D-10. In other words, the ambient water temperature at the intake has exceeded the water quality standard at times.

### Water Quality

A portion of Pool 14 of the Mississippi River is identified in the Illinois State 2008 Section 303(d) list of impaired waters due to the presence of mercury, polychlorinated biphenyls, and manganese. Pet. Exh. 1 App. A at A-10. Iowa identifies another portion of Pool 14, the area from Lock & Dam 13 to the Wapsipinicon River, as impaired due to aluminum and nutrient loads. *Id.*

Federal, state, and local agencies conducted monitoring from 1980 to 1999 assessing water quality in the upper Mississippi River, including three monitoring sites in Pool 14. Pet. Exh. 1 App. E at E-3, citing Sullivan, et al., *Upper Mississippi River Water Quality Assessment Report* (2002). Two databases were compiled. *Id.* One database includes field and laboratory inorganic chemistry data from samples collected near or in the main channel of the river during June 1 to September 15. *Id.* The second database includes contaminant data on polychlorinated biphenyls, chlordane, and mercury needed for agencies providing fish consumption advice. *Id.* at E-4.

Dissolved oxygen levels impact the distribution and abundance of fish and aquatic life in the upper Mississippi River. Pet. Exh. 1 App. A at A-12. States bordering the upper Mississippi River have established a water quality criterion of 5 milligrams per liter (mg/L). *Id.* Summer concentrations ranged from 5 to 12 mg/L. *Id.* During 1995 to 1999, levels below 5 mg/L were observed from Pool 9 to Pool 14. *Id.* at A-13. Exelon concludes that this may be due to growth in zebra mussel populations, increased biochemical oxygen demand, and reduced photosynthetic activity due to major rainfall events. *Id.*

Phosphorus and nitrogen are essential plant nutrients. Pet. Exh. 1 App. E at E-3. In excess, phosphorus and nitrogen can be detrimental to aquatic health. *Id.* Total phosphorus concentrations in the upper Mississippi River exceed 0.5 mg/L at many sites and from 1995 to 1999 exceeded 1 mg/L at many sites. Pet. Exh. 1 App. A at A-14. Major sources of phosphorus are wastewater treatment discharges as well as agricultural and urban nonpoint discharges. *Id.* Nitrogen levels decrease downstream from the Twin Cities metropolitan area and increase again below LeClaire, Iowa. *Id.* Nitrogen is used in fertilizers and runoff from cultivation and livestock areas is a major source of nitrogen. *Id.*

Exelon also discussed general trends in total suspended solids, organics, and heavy metals in the Mississippi River. Pet. Exh. 1 App. A at A-15 to A-24.

**Aquatic Habitats**

Exelon reports that Pool 14 of the Mississippi River includes a variety of aquatic habitats: channel; channel border; side-channel; slough; island lake; and river, lake, and pond. Pet. Exh. 1 App. A at A-26, citing U.S. Atomic Energy Commission, *Final Environmental Statement Related to Quad Cities Nuclear Power Station* (1972). The main channel at Quad Cities Station is characterized by a scoured sand bottom and high current velocity. *Id.* Downstream from the station along the Illinois shore are several small islands with relatively quiet shallow water areas. *Id.* Downstream and across the main channel are side channel and slough habitats. *Id.* Upstream also has side channel and slough habitats. *Id.* As described more fully below under the biotic category analysis, Exelon adds that there are also unique habitats in Pool 14, two of which USFWS designated as essential habitat areas for the endangered species *Lampsilis higginsii* (Higgins eye pearlymussel). Pet. Exh. 4 at 17.

**APPLICABLE THERMAL EFFLUENT LIMITATIONS**

Sections 303.331 and 302.102(b)(8) of the Board’s water pollution regulations are the applicable standards from which Exelon seeks alternative standards. 35 Ill. Adm. Code 303.331, 302.102(b)(8).

Section 303.331 provides the water quality standard for the northern Illinois portion of the Mississippi River, including the area where Quad Cities Station discharges. 35 Ill. Adm. Code 303.331. Section 303.331 “Mississippi River North Temperature” provides:

Instead of the standards of Section 302.211(e) the water temperature at representative locations in the main river of the Mississippi River from the Wisconsin border to the Rock River shall not exceed the maximum limits in the following table during more than 1% of the hours in the 12 month period ending with any month. Moreover, at no time shall the water temperature at such locations exceed the maximum limits in the following table by more than 1.7°C (3°F).

	<u>° C</u>	<u>° F</u>		<u>° C</u>	<u>° F</u>
JAN.	7	45	JUL.	30	86
FEB.	7	45	AUG.	30	86
MAR.	14	57	SEPT.	29	85
APR.	20	68	OCT.	24	75
MAY	26	78	NOV.	18	65
JUN.	29	85	DEC.	11	52

35 Ill. Adm. Code 303.331.

Section 302.102(b)(8) “Allowed Mixing, Mixing Zones and [Zones of Initial Dilution (ZIDs)]” provides in relevant part

- b) The portion, volume and area of any receiving waters within which mixing is allowed pursuant to subsection (a) shall be limited by the following:
  - 8) The area and volume in which mixing occurs, alone or in combination with other areas and volumes of mixing must not contain more than 25% of the cross-sectional area or volume of flow of a stream . . . . 35 Ill. Adm. Code 302.102(b)(8).

**EXELON’S PROPOSED ALTERNATIVE  
THERMAL EFFLUENT LIMITATIONS**

As an alternative to Section 303.331 limits on monthly maximum temperatures, Exelon proposes:

The monthly temperature standards set forth in 35 Ill. Adm. Code 303.331 shall apply to discharges from Quad Cities Nuclear Station provided that Quad Cities Nuclear Station may exceed such standards by 3°F for no more than 219 hours (2.5%) per calendar year, except that during July, August and September the temperature standards may be exceeded by up to 5°F for no more than 131.4 hours of the 219 hour annual allotment. Pet. at 28.

As an alternative to the Section 302.102(b)(8) requirement for a zone of passage, Exelon proposes:

The mixing zone for Quad Cities Nuclear Station shall allow for a zone of passage that includes at least 66% of the cross sectional area and volume of flow of the Mississippi River. Pet. at 28.

Exelon maintains that these alternative thermal effluent limits assure the protection and propagation of a balanced and indigenous population of shellfish, fish, and wildlife in Pool 14 of the Mississippi River. Pet. at 3. Exelon’s proposal will be discussed in more detail below.

**ILLINIOS EPA RECOMMENDATION  
AND EXELON RESPONSE**

Illinois EPA recommends the Board grant Exelon’s requested relief, subject to two conditions. Rec. at 4. Illinois EPA agrees that current effluent limitations are more stringent than necessary and that the requested alternative thermal requirements can assure the protection and propagation of a balanced and indigenous population of shellfish, fish, and wildlife in the Mississippi River where Quad Cities Station discharges heated effluent. *Id.* at 6. Exelon responded to Illinois EPA and agreed to Illinois EPA’s conditions. Resp. at 2.

### **White Crappie, Black Crappie, and Sauger Population Decrease**

Illinois EPA asks the Board, as a condition of the thermal relief, to require Exelon to study the decrease in the number of white crappie, black crappie, and sauger reported in Exelon's CWA Section 316(a) demonstration. Rec. at 4. Illinois EPA argues that Exelon has not provided direct evidence that the fish decrease is caused by habitat changes at the fixed location sampling sites. *Id.* Illinois EPA therefore recommends that the Board require Exelon to study these species to determine that the decrease is not attributable to heat discharged by Quad Cities Station. *Id.*

Exelon agrees that, as a condition to the grant of the requested relief, Exelon will study white crappie, black crappie, and sauger populations in Pool 14 of the Mississippi River during the initial permit cycle when alternative thermal effluent limits for Quad Cities Station are in effect. Resp. at 2. This study will examine fish population data obtained from the Bellevue Field Station Long Term Resource Monitoring Program in Pool 13 of the Mississippi River upstream of Pool 14 to evaluate the white crappie, black crappie and sauger population trends in Pool 13. *Id.* at 2-3. Exelon believes data from this program will be "very useful" because the program uses random site sampling methods and because Pool 13 does not have any industrial thermal inputs. *Id.* at 3, fn. 1. Exelon notes that conclusions derived from the study will be available for the subsequent permit renewal review, at which time the alternative thermal effluent limits for Quad Cities Station will also be subject to review. *Id.*

### **Calendar Year Excursion Hours**

As a condition of the requested thermal relief, Illinois EPA contends that Exelon also should be required to study further the effect on aquatic life of using excursion hours on a calendar year basis instead of a rolling twelve-month basis. Rec. at 5. Illinois EPA believes that Exelon should "provide clearer and more-convincing evidence" that if Exelon uses more than 219 excursion hours in any twelve-month period, the heated discharge will not contribute to harm of aquatic life in the receiving water. *Id.* Illinois EPA acknowledges Exelon's position that Exelon likely will not use excursion hours in December and January, but contends that this is not the only scenario that needs to be considered to assure protection of aquatic life. *Id.*

Exelon agrees that, if more than 219 excursion hours are used in any twelve-month period during the course of the next permit cycle after the alternate thermal effluent limits are in effect, Exelon will monitor aquatic life to assess adverse impacts to biota. Resp. at 4. As with the condition above, the results of all such monitoring events will be made available for the subsequent permit renewal review for Quad Cities Station. *Id.* at 3-4.

In response to Board questions, Exelon identified all twelve month periods when the Quad Cities Station exceeded the maximum numerical temperatures in 35 Ill. Adm. Code 303.331 by any degree during more than 87.6 and 219 hours as well as by more than 3°F. Exelon Ans. at 25. Exelon noted that Quad Cities Station has not exceeded the monthly maximum limits by more than 5°F. *Id.* at 26. Exelon also identified two instances when Exelon requested a provisional variance from Illinois EPA for additional excursion hours based on the rolling twelve month calculation which would not have been required based a calendar

calculation: (1) July 1989, based on the use of 108 hours in August 1988, and (2) March 2012, based on the use of 33 hours in July of 2011. *Id.* Due to the timely issuance of provisional variances, Exelon states that it has not needed to curtail power due to a rolling 12-month calculation. *Id.* at 26. Based on a rolling 12-month calculation, Exelon states that Quad Cities Station used excursion hours greater than 2.5% or 219 hours. *Id.* at 26-27. During the 12 month period from March 2012 through February 2013, Quad Cities Station used 442.5 hours. *Id.* at 27. Based on follow-up mussel surveys and long term fish monitoring, Exelon concluded there was no adverse impact to aquatic life. *Id.* at 27; Exelon Ans. Exh. 15, 17, 21.

### **LEGAL BACKGROUND**

The federal 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 thus 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 also* 35 Ill. Adm. Code 304.105. Water quality standards are set under authority provided in CWA Section 303. 33 U.S.C. § 1313. Illinois law authorizes the Board to adopt water quality standards, including thermal standards. 415 ILCS 5/13 (2012). The Board has done so and the Board's water quality temperature standards for general use waters are found at 35 Ill. Adm. Code 302.211. In addition, the Board has set site-specific temperature limits at 35 Ill. Adm. Code 303.Subpart C. Relevant to this petition, the Board set site-specific water quality standards at 35 Ill. Adm. Code 303.331 for the segment of the Mississippi River where Quad Cities Station discharges. Section 303.331 provides numerical temperature limits as well as limits on hours during which these temperature limits can be exceeded.

Since the 1972 passage of the CWA, 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:

With 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.

Accordingly, Section 304.141(c)<sup>3</sup> of the Board's rules provides:

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

Thus, under CWA Section 316(a) and 35 Ill. Adm. Code 304.141(c), 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. Such establishment of alternative thermal effluent limitations is not a water quality standard change.

In 1977, USEPA issued draft guidance on CWA Section 316(a) demonstrations in "Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Sections of Nuclear Facilities Environmental Impact Statements (DRAFT)" dated May 1, 1977 (Draft USEPA 316(a) Manual). The Draft USEPA 316(a) 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 USEPA 316(a) Manual at 8-9. This guidance has not been finalized and remains a draft. Nevertheless, the Board followed the outline of the Draft USEPA 316(a) Manual in preparing this opinion and finds the decision criteria in the guidance to be a useful guide for its analysis. The Board also notes that Section 106.1120 of its procedural rules requires a petitioner seeking alternative thermal effluent relief to consider guidance published by USEPA in making its demonstration. *See* 35 Ill. Adm.

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<sup>3</sup> The Board originally adopted 35 Ill. Adm. Code 304.141(c) as Rule 410(c) of Chapter 3 of the Board's Water Pollution Regulations on August 29, 1974:

The 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.



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 to demonstrate that an applicable thermal effluent limitation, specifically 35 Ill. Adm. Code 303.331 and 302.102(b)(8), is more stringent than necessary to assure the protection and propagation of a balanced and indigenous population of shellfish, fish, and wildlife in and on the receiving water, specifically Pool 14 of the Mississippi River. *See* 35 Ill. Adm. Code 106.1160(a), (b). Exelon must also demonstrate that the requested alternative thermal effluent limitation assures the protection and propagation of a balanced and indigenous population of shellfish, fish, and wildlife in the receiving water. *See* 35 Ill. Adm. Code 106.1160(c). Exelon's demonstration must consider the cumulative impact of its thermal discharge together with all other significant impacts on the species affected. *Id.* This demonstration may be referred to as a prospective demonstration.

An existing discharger, such as Quad Cities Station, may base its demonstration that its proposed alternate limit is sufficiently protective on the absence of prior appreciable harm instead of using predictive studies. This demonstration may be referred to as a retrospective demonstration. Such a demonstration must show either:

- (A) That no appreciable harm has resulted from the normal component of the discharge, taking into account the interaction of such thermal component with other pollutants and the additive effect of other thermal sources . . . ;  
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 and indigenous population . . . . 35 Ill. Adm. Code 106.1160(d)(1)(A), (B);  
*see also* 40 C.F.R. § 125.73(c).

Exelon describes its requested alternate limit as “only incrementally different” than the limit in effect since December 1983. *Pet.* at 5. Accordingly, Exelon's demonstration addresses both whether prior operations caused appreciable harm as well as predictive future effects of the requested alternate limit. *Id.* at 5-6.

### **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 Pool 14 of the Mississippi River. *See* 33 U.S.C. § 1326(a). The Draft USEPA 316(a) Manual sets forth the main components for such demonstrations: (1) biotic category analysis; (2) representative important species analysis; and (3) master rationale for the proposed alternate limit.

### **Biotic Category Analysis**

The starting point in a CWA Section 316(a) demonstration is the early screening process to identify the balanced and indigenous population of aquatic life in the receiving water. Draft USEPA 316(a) Manual at 33. The CWA uses the phrase “balanced, indigenous population” (BIP) and the federal regulations define the phrase “balanced, indigenous community” (BIC). These phrases have come to be synonymous and mean

a biotic community typically characterized by diversity, the capacity to sustain itself through cyclic seasonal changes, presence of necessary food chain species, and 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; *see also* 40 C.F.R. § 125.71(c).

Biotic communities may contain numerous species, and, as a result, USEPA suggests that an assessment of thermal impacts be done on a community-by-community basis. The Draft USEPA 316(a) Manual identifies the following biotic categories: habitat formers, phytoplankton, zooplankton, macroinvertebrates and shellfish, fish, and other vertebrate wildlife. Draft USEPA 316(a) Manual at 18-32. After completing the early screening process and making a preliminary assessment of the amount of additional work needed in each biotic category, the applicant chooses the demonstration type most appropriate for the site. *Id.* at 33.

A CWA Section 316(a) demonstration describes the impact of the thermal discharge on each biotic category. The applicant must present data justifying the conclusions reached for each biotic category. Draft USEPA 316(a) Manual at 16. If a site is a low potential impact area for a biotic category, “it would be unnecessary to conduct detailed studies to give the taxonomic identification of every species of [the biotic category] in the vicinity.” *Id.* at 6. Rather, the applicant needs to complete a brief description of the thermal impact on the biotic category. *See id.* at 14, 33. For biotic categories that are not of low potential impact, the applicant must conduct a more comprehensive analysis. *Id.* at 15, 33.

For a CWA Section 316(a) demonstration to be successful, the demonstration must show that each biotic category meets specified decision criteria. Draft USEPA 316(a) Manual at 16. The Draft USEPA 316(a) Manual sets forth decision criteria for each biotic category. The demonstration must show that impacts to each biotic category are sufficiently inconsequential that the protection and propagation of community will be assured. *Id.* at 34.

### **Habitat Formers (Aquatic Vegetation)**

Exelon's demonstration explains that "habitats are chiefly defined by location, depth, bottom material, and vegetation." Pet. Exh. 1 App. A at A-26. Habitat formers are the plants providing cover, foraging, spawning, or nursery habitat for fish and shellfish. Draft USEPA 316(a) Manual at 76-77. The Draft USEPA 316(a) Manual defines low potential impact areas as areas devoid of habitat formers due to low levels of nutrients, inadequate light, sedimentation, scouring stream velocities, substrate character, or toxic materials. *Id.* at 22. The Draft USEPA 316(a) Manual provides that a CWA Section 316(a) demonstration is successful if the applicant shows either the site is a low potential impact area for habitat formers or: (i) the heated discharge will not result in deterioration of habitat formers so as to cause appreciable harm to the balanced and indigenous community; and (ii) heated discharge will not have adverse impact on threatened or endangered species as a result of impact on habitat formers. *Id.* In addition, a request may be denied if there is any probable thermal elimination of habitat formers or if important fish, shellfish, or wildlife are thermally excluded from use of the habitat. *Id.*

Exelon reports that beginning in the 1960s and 1970s, submerged and emergent vegetation declined throughout the Upper Mississippi River National Wildlife and Fish Refuge. Pet. Exh. 1 App. A at A-26. More recently, "beds of submerged plants have been naturally re-established throughout Pool 14." *Id.*, citing HDR, *Presentation of 2008 Aquatic Program Results at Annual Steering Committee Meeting* (March 2009) and USFWS, *Upper Mississippi River Refuge Final Environmental Impact Statement/Comprehensive Conservation Plan* (July 2006). The emergent plant community in Pool 14 "is sparse and a concern of resource managers." *Id.* at A-27. The emergent plant community is characterized by abundant river bulrush and reduced cattail, burred, and arrowhead since the 1970s. *Id.*

Exelon characterized habitat within the study area for largemouth bass, walleye, channel catfish, and spotfin shiner, which were selected as representative important species for in depth study as discussed below. Pet. Exh. 1 App. B at B-8, B-29 to B-32 (Table 5), B-48 to B-53 (Figures 9A, 9B, 10, 11A, 11B, 12). For young-of-the-year (YOY) largemouth bass, habitat was identified along the littoral zone (shoreline) of Pool 14 in the summer as sheltered weedy areas near spawning grounds. *Id.* at B-29. The YOY largemouth bass typically reside in tree roots and fallen log structures along the river banks, while some move offshore in autumn to areas with substrates consisting of vegetation, sand, mud, detritus, and occasionally stone or rubble. *Id.*, *see also* B-48 to B-49. Habitat for juvenile and adult largemouth bass was identified along the littoral zone and wing dams. *Id.* at B-29. For juvenile and adult walleye, habitat was identified along the wing dams throughout the summer and autumn, using the channel flats at depths of 6 to 12 feet. *Id.* at B-30, B-50. For YOY channel catfish, habitat was identified mainly in the deeper waters of the main channel away from the shore, while habitat for juvenile and adult channel catfish was identified in deep pools around submerged logs, rocks, and other debris closer to shore. *Id.* at B-31, *see also* B-51 to B-52. For juvenile and adult spotfin shiner, habitat was identified very close to shore in Pool 14 in shallow flats and island points. *Id.* at B-32, *see also* B-53.

Exelon's demonstration predicted the percentage of habitat that would be avoided by the four representative important species. Pet. Exh. 1 at 22. From June 1 to September 30, Exelon

found that less than two percent of the habitat would be avoided by channel catfish, largemouth bass, and spotfin shiner, which Exelon concluded would not be a material change in available habitat for these three species. *Id.* For walleye, a supplemental analysis using data from HDR's summertime electro-fishing program was done because sufficient acclimation/avoidance temperature data were not available. *Id.* Exelon's demonstration concluded that displacement of walleye because of either low flow or thermal stress would be transitory and not cause appreciable harm to the walleye population. *Id.*

Exelon adds that there are also unique habitats in Pool 14, two of which USFWS designated as essential habitat areas for Higgins eye pearl mussel. Pet. Exh. 4 at 17, citing USFWS, *Higgins Eye Pearlmussel (Lampsilis higginsii) Recovery Plan: First Revision* (2004). The Higgins eye pearl mussel is a federal, Illinois, and Iowa endangered species. Pet. at 21, Pet. Exh. 1 App. C at C-12. Another species of mussel, Sheepsnose mussel, was also identified in Pool 14 and is a candidate for federal listing. Pet. at 33; Pet. Exh. 5. The term "essential habitat area" is used "to identify those areas that [USFWS] and its partners have found to be of utmost importance to the conservation of the species." Pet. Exh. 4 App. A at iii. Exelon explains that essential habitat areas are "those areas capable of supporting reproducing populations of *L. higginsii* and are considered important to the conservation of the species." Pet. Exh. 4 at 23. One essential habitat area is the Cordova Bed located approximately 1.0 mile downstream of Quad Cities Station Units 1 and 2 thermal mixing zone at river mile 505.5 to 503.<sup>4</sup> Pet. Exh. 1 at A-32; Pet. Exh. 1 App. C at C-12; Pet. Exh. 4 at 19. The second is Hanson Slough located upstream of the Quad Cities Station diffuser at river mile 510 to 509. Pet. Exh. 1 App. C at C-12; Pet. Exh. 4 at 19. USFWS designated the Cordova Bed as an essential habitat area for the Higgins eye pearl mussel "because it is used as a source of brood stock for mitigation activities" involving this species throughout the Mississippi River system. Pet. Exh. 1 App. C at C-14.

Currently, no "critical habitat," as provided for under the Endangered Species Act, has been designated for the Higgins eye pearl mussel. Essential habitat differs from critical habitat, which is defined in and designated pursuant to the Endangered Species Act. *See* 16 USC 1532(5)(B), 50 CFR 424.02, 50 CFR 424.12. Pet. Exh. 4 App. A at 113. Exelon explains, "[i]f a proposal for critical habitat is prepared in the future, it would be based on the habitat features essential to the conservation of the species, similar to those used to identify essential habitat areas in the recovery plan [Pet. Exh. 4]." Pet. Exh. 4 App. A at 114.

In connection with the Cordova Bed, Exelon coordinated with USFWS to develop a Habitat Conservation Plan to minimize and mitigate the effects of the proposed alternative thermal effluent limitations on endangered and candidate species. Pet. at 3; Pet. Exh. 5. The Habitat Conservation Plan is part of the requirements under the Endangered Species Act to apply for an Incidental Take Permit to allow incidental taking of the Higgins eye pearl mussel and Sheepsnose mussel as result of the proposed alternative thermal effluent limitations. USFWS

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<sup>4</sup> The petition describes the Cordova Bed as located at river mile 505.5 to 503. The petition also describes the Cordova Bed as located approximately 1.0 mile downstream of Quad Cities Station Units 1 and 2 thermal mixing zone and as located approximately 3,300 to 3,700 meters downstream of the station.

approved the Habitat Conservation Plan. Pet. at 25; Pet. Exh. 1 at 34. The Habitat Conservation Plan and Incidental Take Permit are discussed below.

The Board finds that the proposed thermal discharge to Pool 14 of the Mississippi River, taking into consideration the Habitat Conservation Plan and Incidental Take Permit, meets the decision criteria of the Draft USEPA 316(a) Manual for habitat formers. *See* Draft USEPA 316(a) Manual at 22. Exelon's demonstration shows the proposed alternative effluent limitations would result in an immaterial habitat avoidance of less than two percent for channel catfish, largemouth bass, and spotfin shiner and no appreciable harm for walleye. Pet. Exh. 1 at 22. Additionally, Exelon has an approved Habitat Conservation Plan and Incidental Take Permit that address habitat for the federally endangered species found in Pool 14, Higgins eye pearl mussel, and the candidate species, Sheepsnose mussel, to minimize and mitigate the effects of the proposed alternative thermal effluent limitations. As discussed further below, the existence of balanced and indigenous communities of fish and mussel near Quad Cities Station supports the conclusion that adequate habitat is available and will continue to be available under the proposed alternative effluent limitations. Exelon's demonstration meets the decision criteria and shows that the proposed thermal discharge from Quad Cities Station (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.

### **Phytoplankton**

Phytoplankton are microscopic plants, such as algae, transported by river current. Phytoplankton are a food source for zooplankton and fish. Draft USEPA 316(a) Manual at 55. The Draft USEPA 316(a) Manual defines areas of low potential impact for phytoplankton and these areas include ecosystems where phytoplankton are not the food chain base, for example, an ecosystem in which the food web is based on detrital material. *Id.* at 18-19. An area is not considered as low potential impact for phytoplankton if: (a) phytoplankton contribute a substantial amount of the primary synthetic activity supporting the community; (b) a shift toward nuisance species may be encouraged by the thermal discharge; or (c) the thermal discharge may alter the community from detrital to phytoplankton-based system. *Id.* at 19. The Draft USEPA 316(a) Manual provides that a CWA Section 316(a) demonstration is successful if the applicant shows either the site is a low potential impact area for phytoplankton or if the applicant shows: (i) a shift toward nuisance phytoplankton is not likely; (ii) little likelihood of altering the community from detrital to phytoplankton-based system; and (iii) appreciable harm to the community is not likely to occur as a result of phytoplankton changes. *Id.* at 18.

At Quad Cities Station, phytoplankton were studied in the early 1970s both prior to the start of operations and after. Pet. Exh. 1 App. C at C-9. The study protocol included collecting composite phytoplankton and determining in a laboratory the abundance, biomass, chlorophyll a, and carbon fixation rate. Pet. Exh. 1 at 9; Pet. Exh. 1 App. E at E-5. Exelon studied the differences in phytoplankton variety and abundance upstream and downstream of the diffuser pipes while both units were operating in open cycle cooling mode. *Id.*

These studies showed stable phytoplankton communities dominated by diatoms. Pet. Exh. 1 App. C at C-9. Specifically, biological studies in 1969 and 1970 showed that the most prevalent phytoplankton were diatoms *Cyclotella*, *Melosira*, and *Stephanodiscus*. Pet. Exh. 1 App. A at A-27, citing Industrial Bio-test Laboratories, *Preoperational Monitoring (Thermal) of the Mississippi River Near Quad Cities Station July 1969-June 1970* (1970) and Industrial Bio-test Laboratories, *Preoperational Monitoring (Thermal) of the Mississippi River Near Quad Cities Station July 1970-December 1970* (1971). In summer samples, “diatoms were the common organisms and blue-green alga seldom comprised 10% of the population.” Pet. Exh. 1 App. A at A-27.

Samples collected in 1972, and reported in a 1975 report, were “characteristic of a somewhat enriched habitat and, although seasonal variations exist, the phytoplankton communities have been relatively stable.” Pet. Exh. 1 App. A at A-27, citing Commonwealth Edison Company, *316(a) & (b) Demonstration to USEPA* (1975). Further, Exelon concluded that neither the side-jet discharge system nor the diffuser pipe system “had any detectable effect upon phytoplankton numbers or community composition” in comparisons between upstream and downstream samples. Pet. Exh. 1 App. A at A-27.

By 1975, phytoplankton studies were discontinued because “[c]omparisons of total phytoplankton, major algal divisions, and dominant species at locations upstream and downstream from the originally designed side-jet discharge or of the diffuser pipe dissipation system indicated that neither mode of heat discharge had any detectable effect upon phytoplankton numbers or community composition.” Pet. Exh. 1 App. C at C-9.

During fish monitoring, HDR observed that phytoplankton blooms begin in backwater areas in late April or May and are seen in the main channel of the river by the end of June. Pet. Exh. 1 App. C at C-9. These blooms continue until mid-October. *Id.* The early blooms are filamentous and non-filamentous green algae and are replaced by brown algae as the season progresses. *Id.* Exelon observes that “[t]hese blooms do not appear to be dominated by ‘nuisance’ algae.” *Id.* Exelon has not observed or received any reports of nuisance algal blooms in Pool 14, adding, “Quad Cities Station has not caused or contributed to the presence of nuisance organisms in Pool 14 and there is no reason to believe that discharges authorized by the proposed alternative thermal limitations would alter that situation.” Exelon Ans. at 14.

Exelon’s investigation of phytoplankton communities in Pool 14 of the Mississippi River “did not require the extent of sampling data that HDR reviewed in connection with its investigation of higher trophic level communities (freshwater mussels and fish).” Pet. at 20. Exelon explains that its detailed assessment of mussel and fish communities “would reveal whether the lower trophic level communities (which serve as a source of food for the fish populations) were suffering adverse effects as a result of Quad Cities Station’s operations.” *Id.* at 20-21. Exelon found that the mussel and fish communities are balanced and indigenous communities and this “demonstrates that an adequate food supply (of plankton) has been available.” *Id.* at 21. Exelon concludes that thermal discharge from Quad Cities Station “has not caused appreciable harm to the phytoplankton community.” Pet. Exh. 1 App. C at C-10; Pet. Exh. 1 at 24. Consequently, the “incremental changes” Exelon seeks as an alternative thermal effluent limit will not cause appreciable harm to the balanced and indigenous community. *Id.*

The Board finds that the proposed thermal discharge to Pool 14 of the Mississippi River meets the decision criteria of the Draft USEPA 316(a) Manual for phytoplankton. *See* Draft USEPA 316(a) Manual at 18. Phytoplankton populations appear stable in Pool 14 before and after station operations as well as upstream and downstream of the diffuser system. The record contains no evidence of nuisance algal blooms. Accordingly, there is no reason to believe that nuisance species are likely to be encouraged by the thermal discharge or that the thermal discharge is likely to alter the community from detrital to phytoplankton-based system. Further, the existence of a balanced and indigenous population of fish and mussels shows that sufficient phytoplankton have been available to support fish and mussel populations. Exelon's demonstration meets the decision criteria and shows: (i) a shift toward nuisance species of phytoplankton is not likely to occur as a result of the proposed thermal discharge from Quad Cities Station; (ii) the proposed thermal discharge is not likely to alter the community from a detrital to phytoplankton-based system; and (iii) appreciable harm to the balanced indigenous population is not likely to occur as a result of phytoplankton community changes caused by the proposed thermal discharge.

### **Zooplankton**

Zooplankton are animal microorganisms that live unattached in the water column and drift with river current. Zooplankton have two subgroups: holoplankton and meroplankton. Pet. Exh. 1 App. C at C-10. Holoplankton are planktonic for their entire lives. *Id.* Meroplankton are planktonic during a portion of their life cycles. *Id.* Zooplankton are a food source for larval fish and shellfish. Draft USEPA 316(a) Manual at 56. The Draft USEPA 316(a) Manual defines areas of low potential impact for zooplankton as areas with low concentrations of species that are commercially important, rare, endangered, or important components of the food web, or as areas where the thermal discharge will affect a relatively small portion of the receiving water. *Id.* at 20-21. The Draft USEPA 316(a) Manual provides that a CWA Section 316(a) demonstration is successful if the applicant shows either the site is a low potential impact area for zooplankton or if the applicant shows: (i) changes in zooplankton will not result in appreciable harm to the balanced and indigenous community; (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 free movement of zooplankton. *Id.* at 20.

At Quad Cities Station, zooplankton were studied together with phytoplankton in the early 1970s both prior to the start of operations and after. Pet. Exh. 1 App. C at C-11. Exelon collected samples with a filter-pump system near the surface at the station intake, discharge bay, 1,600 feet upstream of the diffuser, and downstream of the diffuser at 375 feet, 4,000 feet, and 8,000 feet. Pet. Exh. 1 at 10. Exelon also studied entrainment of zooplankton. *Id.* at 9. Motile and non-motile zooplankters were examined under a microscope at twenty-minutes and 4 hours after collection. Pet. Exh. 1 App. E at E-6.

Exelon found that the "zooplankton community in Pool 14 is dominated by several true planktonic species such as *Cyclops vernalis*, *Cyclops bicuspidatus thomasi*, *Diaptomus siciloides*, and *Bosmina longiorstris*." Pet. Exh. 1 App. A at A-29. Seasonally, *Diaphanosoma spp.* and *Moina spp.* are present. *Id.* Zooplankton density is inversely related to flow conditions

of the river. *Id.* at A-28. The Mississippi River’s variable flow and water level, as well as the impact from tributaries, “enhances the randomness of zooplankton distribution.” *Id.* at A-29. Noting samples collected in 1973, and reported in a 1975 report, Exelon concludes that comparisons of zooplankton “prior to and during all phases of the station operation at locations upstream and downstream from Quad Cities Station did not reveal any differences attributable to plant operations.” *Id.* citing Commonwealth Edison Company, 316(a) & (b) *Demonstration to USEPA* (1975); Pet. Exh. 1 App. C at C-11.

Exelon’s investigation of zooplankton communities in Pool 14 of the Mississippi River “did not require the extent of sampling data that HDR reviewed in connection with its investigation of higher trophic level communities (freshwater mussels and fish).” Pet. at 20. Exelon explains that its detailed assessment of mussel and fish communities “would reveal whether the lower trophic level communities (which serve as a source of food for the fish populations) were suffering adverse effects as a result of Quad Cities Station’s operations.” *Id.* at 20-21. Exelon found that the mussel and fish communities are balanced and indigenous communities and this “demonstrates that an adequate food supply (of plankton) has been available.” *Id.* at 21. Exelon found no commercially important, threatened, or endangered species of zooplankton in the vicinity of Quad Cities Station. Pet. Exh. 1 App. C at C-11.

Exelon asserts that “operation of the Station has not caused prior appreciable harm to the zooplankton community.” Pet. Exh. 1 App. C at C-11. Exelon notes that zooplankton are broadly tolerant, able to survive variable conditions, reproduce rapidly, and are quickly transported and dispersed by current. *Id.* at C-10. Accordingly, Exelon concludes “the probability is low that there could be any meaningful change (positive or negative) in growth or reproduction of zooplankters transported through the thermal plume.” *Id.* Exelon further notes that mussels and fish rely on phytoplankton and zooplankton as food and asserts that adequate supply had been available. *Id.* at C-11 to C-12.

The Board finds that the proposed thermal discharge to Pool 14 of the Mississippi River meets the decision criteria of the Draft USEPA 316(a) Manual for zooplankton. *See* Draft USEPA 316(a) Manual at 20. Studies before and during operations, as well as upstream and downstream of the diffuser system, indicate that thermal discharges from Quad Cities Station have not impacted zooplankton populations. Further, the existence of a balanced and indigenous population of fish and mussels shows that sufficient zooplankton have been available to support fish and mussel populations. Exelon’s demonstration meets the decision criteria and shows: (i) changes in zooplankton will not result in appreciable harm to the balanced and indigenous community; (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 free movement of zooplankton.

### **Macroinvertebrates and Shellfish**

Macroinvertebrates, including shellfish, are components of aquatic food webs as a source of food and as bait for fishers. The Draft USEPA 316(a) Manual defines areas of low potential impact as various areas where macroinvertebrates are not present or are present in low numbers. Draft USEPA 316(a) Manual at 25. The Draft USEPA 316(a) Manual provides that a CWA



Section 316(a) demonstration is successful if the applicant shows either the site is a low potential impact area for macroinvertebrates and shellfish or if the applicant shows: (i) no appreciable harm to the balanced and indigenous community; (ii) critical functions of macroinvertebrates are being maintained as they existed prior to introduction of heat; (iii) invertebrates as a food source are not a factor limiting fish production or drifting invertebrates are not harmed by passage through thermal plume; and (iv) the discharge area does not include a spawning or nursery site for important shellfish and/or macroinvertebrates. *Id.* at 23-24.

In studies from July 1969 to June 1970, Exelon found the dominant macroinvertebrates were insects of Ephemeroptera (mayflies), Trichoptera (caddisflies), and Diptera (midge flies). Pet. Exh. 1 App. A at A-29, citing Industrial Bio-test Laboratories, *Preoperational Monitoring (Thermal) of the Mississippi River Near Quad Cities Station July 1969-June 1970* (1970) and Industrial Bio-test Laboratories, *Preoperational Monitoring (Thermal) of the Mississippi River Near Quad Cities Station July 1970-December 1970* (1971). Samples from the main channel contained few organisms. Pet. Exh. 1 App. A at A-29. Exelon concluded that this may be due to the scouring action of the current and unsuitable sandy substrate. *Id.* In areas protected from river current, Exelon observed “a greater abundance and diversity of invertebrates,” most abundantly midges and sludge worms. *Id.* Crustaceans, caddisflies, and leeches comprised three percent or less of the total organisms. *Id.*

In 1972, the Army Corps conducted additional studies and found 33 families representing 40 to 53 genera of macroinvertebrates. Pet. Exh. 1 App. A at A-30, citing Army Corps, *Final Environmental Impact Statement Pool 14 Supplement* (July 1974). Based on samples collected in 1973, and reported in a 1975 report, benthos data compiled over a four year period showed that “variation of the major organisms between locations upstream and downstream of Quad Cities Station was due to seasonal fluctuations, substrate differences and changes in river flows.” Pet. Exh. 1 App. A at A-30, citing Commonwealth Edison Company, *316(a) & (b) Demonstration to USEPA* (1975).

Thirty-one species of unionid have been collected in Pool 14 of the Mississippi River. Pet. Exh. 1 App. A at A-31. The most abundant types include *Amblema p. plicata*, *Quadrula p. pustulosa*, *Lampsilis cardium*, *Fusconaia flava*, *Obliquaria reflexa*, *Quadrula quadrula*, and *Pyganodon grandis*. *Id.* Populations of Sphaeriidae have declined during low-flow periods associated with droughts. *Id.* Exelon reports that the zebra mussel became established in the upper Mississippi River by 1992 and its increase “causes a decline among many native mussels” and displaces other macroinvertebrates such as hydropsychid caddisflies. *Id.*

Among the species of unionid found in Pool 14 are the Higgins eye pearl mussel (*Lampsilis higginsii*) and Sheepnose mussel (*Plethobasus cyphus*). The Higgins eye pearl mussel was listed as a federally endangered species on June 14, 1976, as well as an Illinois and Iowa endangered species, while the Sheepnose mussel is a candidate for federal listing. Pet. at 21, 33; Pet. Exh. 1 App. A at A-32, citing 41 Fed. Reg. 24064 (June 14, 1976); Pet. Exh. 1 App. C at C-12; Pet. Exh. 5. The Higgins eye pearl mussel is found in the Mississippi River, St. Croix River, Wisconsin River, and Rock River. Pet. Exh. 1 App. A at A-32. Although no critical habitat has been designated for the Higgins eye pearl mussel pursuant to the Endangered Species Act, fourteen essential habitat areas for this species have been designated in the upper

Mississippi River watershed by USFWS in the “Higgins Eye Pearlymussel (*Lampsilis higginsii*) Recovery Plan.” Pet. Exh. 4 at 17, citing USFWS, *Higgins Eye Pearlymussel (Lampsilis higginsii) Recovery Plan: First Revision* (2004). One such area, the Cordova Bed, begins approximately one mile downstream of Quad Cities Station at river mile 503.0-505.5. *Id.*; see also Pet. Exh. 1 App. A at A-44. USFWS designated the Cordova Bed as an essential habitat “because it is used as a source of brood stock for mitigation activities involving Higgins Eye mussels throughout the Mississippi River system.” Pet. Exh. 1 App. C at C-14.

In 2004, Exelon established a monitoring program for unionids near the Quad Cities Station diffuser. Pet. Exh. 1 App. A at A-33. The purpose of monitoring was “to provide data and information regarding the unionid community, to evaluate the effects [Quad Cities Station’s] discharge has had on the community, and to establish the baseline unionid community characteristics for comparison with community characteristics observed following the issuance of alternate thermal standards.” *Id.* Three unionid beds occur within 3,500 meters (two river miles) of Quad Cities Station diffuser: Steamboat Slough located approximately 675 to 1,125 meters downstream of the station’s mixing zone, Upstream Bed located approximately 730 to 1,130 meters upstream of the diffuser, and the Cordova Bed located approximately 3,300 to 3,700 meters downstream of the station. *Id.* Ecological Specialists Inc. (ESI) monitored each of these beds in 2004, 2005, 2006, 2007, and 2008. *Id.* The purpose of ESI’s study was to define the balanced indigenous mussel community within Pool 14 of the Mississippi River. Pet. Exh. 1 App. C at C-14. Exelon points out that the Cordova Bed is situated downstream of the mixing zone, and that there are no features listed in 35 Ill. Adm. Code 302.102(b)(4), such as mussel beds, endangered species habitat, and fish spawning areas, present in the mixing zone authorized for Quad Cities Station. Exelon Ans. at 15.

In 2007, ESI added three additional beds to the monitoring program: Albany Bed located approximately 14,000 to 14,400 meters upstream of the diffuser, Hansons Slough located approximately 5,000 to 5,400 meters upstream of the diffuser, and Woodward’s Grove Bed located approximately 10,500 to 10,900 meters downstream of the diffuser. *Id.* ESI sampled fifteen unionid beds upstream and downstream of the thermal diffuser. Pet. Exh. 1 App. C at C-14. ESI found federally endangered *Lampsilis higginsii* in seven of fifteen beds, most abundantly in the Albany Bed (upstream) and the Cordova Bed (downstream). *Id.* ESI found state-listed species *Lampsilis teres* (Iowa endangered species) and *Ellipsaria lineolata* (Illinois threatened species) in eight of the fifteen beds. *Id.* Sheepnose mussel is present and it is a candidate species for federal listing. *Id.*

In July and August 2006, Quad Cities Station used 222.75 excursion hours due to high ambient water temperature and low river flows. Pet. Exh. 1 App. A at A-35. Exelon observed “changes to unionid community characteristics” in the Upstream Bed, Cordova Bed and Steamboat Slough in 2006 compared to prior years. *Id.* at A-36. Exelon observed “increased mortality” in the Upstream and Cordova Beds in 2006. *Id.* at A-36, citing Ecological Specialists Inc., *Final Report Results of Unionid Mussel Monitoring in 2007 near Quad Cities Nuclear Station* (2009). However, in October 2007 and August 2008, “community characteristics” in the Upstream, Cordova, and Steamboat Slough Beds “were similar to previous monitoring events.” Pet. Exh. 1 App. A at A-36. Exelon also notes that “most of the increase in 2006 mortality,

particularly in the [Upstream] Bed, was due to mortality of *Lampsilinae* . . . , which was most apparent upstream of the [Quad Cities Station].” *Id.*, Exelon Ans. at 15.

Exelon concludes that the unionid community in the discharge area and Pool 14 of the Mississippi River generally is a balanced and indigenous population. Pet. at 22. Exelon also asserts that the unionid community presently in Steamboat Slough, the closest bed to Quad Cities Station, is similar to the community that would have existed if the station had not operated. *Id.*; Pet. Exh. 1 App. C at C-15. Steamboat Slough displays similar density to beds upstream and further downstream of the diffuser with similar habitat characteristics. *Id.* Exelon further concludes that monitoring in 2007 and 2008 showed that these unionid communities “do not seem to be significantly affected by the [Quad Cities Station] thermal effluent.” Pet. Exh. 1 App. A at A-36. The increase in unionid mortalities in 2006 “was not observed in 2007 or 2008 and did not appear to affect unionid density either upstream or downstream” of Quad Cities Station. *Id.* at A-37.

Exelon notes that the federal Endangered Species Act includes a provision in Section 10 to allow for the incidental take of endangered and threatened species by non-federal entities. Pet. Exh. 4 at 7, citing 16 U.S.C. § 1539. An incidental take is permitted under the Endangered Species Act “if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.” Pet. Exh. 4 at 7, citing 16 U.S.C. § 1539(a)(1)(B). The Endangered Species Act requires an applicant for an incidental take permit to submit a conservation plan that specifies the impact of the taking and steps the permit applicant will take to minimize and mitigate such impacts. Pet. Exh. 4 at 7, citing 16 U.S.C. § 1539(a)(2)(A).

Exelon coordinated with USFWS to develop a Habitat Conservation Plan as part of its Incidental Take Permit application for the Higgins eye pearl mussel and Sheepnose mussel covering possible impacts associated with the proposed alternative thermal effluent limitations. Pet. Exh.4 at 10. The Sheepnose mussel was included in the Habitat Conservation Plan because USFWS stated the species is expected to be federally listed as threatened or endangered in the near future. *Id.* USFWS approved the Habitat Conservation Plan and issued the Incidental Take Permit in August 2010. Pet. at 3, 25, *see also* Pet. Exh. 1 at 34, Pet. Exh. 5. The Incidental Take Permit becomes effective on the date the Board grants the alternative thermal effluent limitations and expires on August 15, 2034.

Under the Incidental Take Permit, Quad Cities Station is to:

establish a fund through the National Fish and Wildlife Foundation (NFWF) that will be used for implementation of the [Habitat Conservation Plan] and funding projects that satisfies [Quad Cities Station] minimization and mitigation obligations in concert with those activities that will occur at the [Quad Cities Station] fish hatchery . . . . The fund will be created by and maintained through contributions by [Quad Cities Station]. During years when propagation activities are reduced, any funds remaining from the \$15,000 annual mitigation budget will be added to an initial \$15,000 donation by [Quad Cities Station] to the National Fish and Wildlife Foundation . . . . Exelon Corporation will fund all minimization

and mitigation measures, including monitoring associated with this [Habitat Conservation Plan] . . . . Pet. Exh. 5 at 2.

The Incidental Take Permit triggers the mussel bed monitoring program if Quad Cities Station uses excursion hours in excess of 1% (87.6 hours), if the Quad Cities Station Biological Steering Committee or USFWS deems monitoring necessary due to a plant incident and concern for the essential habitat area, or if four years have lapsed since the last monitoring effort. Pet. Exh. 5 at 2-3. Quad Cities Station must file an annual report that includes presumptive take, minimization and mitigation measures implemented, financial contributions to provide mitigation, temperature monitoring data, and the status of the biological goals of the Habitat Conservation Plan, among other requirements. *Id.* at 3. If a negative deviation from the trends in mussel monitoring is associated with the thermal discharge, USFWS will reopen the Habitat Conservation Plan consultation and Incidental Take Permit conditions to avoid a taking in excess of natural variation or permit conditions. *Id.*

The Habitat Conservation Plan states that the Cordova Bed “has historically harbored a dense and diverse unionid community. However, density within the bed has declined in recent years primarily due to heavy zebra mussel infestation [].” Pet. Exh. 4 at 17, citing Ecological Specialists, Inc., *Final Draft Report: Unionid Mussel Biothermal Assessment for the Quad Cities Nuclear Station, Mississippi River Miles 503.0 to 506.9, prepared for Exelon Generation Company, Warrenville, IL* (2005). Under the Habitat Conservation Plan, Exelon would expand its fish stocking program to promote Higgins eye pearlymussel propagation and recovery in coordination with USFWS to mitigate unavoidable impacts. Pet. Exh. 4 at 70. In 1984, Quad Cities Station converted the former spray cooling canal to a game fish rearing facility, which remains currently viable. *Id.* Quad Cities Station would produce several thousand walleye host fish per year (or other quantities as specified by USFWS). *Id.* at 70-71. The host fish would be used in the inoculation process of glochidia for the Higgins eye pearlymussel and Sheepnose mussel. *Id.*

The Board notes that the three unionid beds found within 3,500 meters of the Quad Cities Station diffuser are outside the thermal mixing zone designated in Exelon’s NPDES permit as a straight line across the Mississippi River, 500 feet (152.4 meters) downstream of the diffuser. Pet. Exh. 1 at 3. Steamboat Slough is located approximately 675 to 1,125 meters downstream of the mixing zone; Upstream Bed is located approximately 730 to 1130 meters upstream of the diffuser; and Cordova Bed is located about 3300 to 3700 meters downstream of the diffuser. Pet. Exh. 1 App. A at A-33.

The Board has not found substantial evidence of harm to the identified mussels from past thermal discharges. In 2006, 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. During this time, it appears that thermal discharges from Quad Cities Station did not cause harm to the balanced indigenous unionid community in the Quad Cities Station receiving waters. With the Habitat Conservation Plan and Incidental Take Permit in place, it is reasonable to expect that the proposed thermal loading will not cause appreciable harm to the balanced and indigenous population. The Board finds that the proposed thermal discharge to Pool 14 of the Mississippi River, in combination with the Habitat

Conservation Plan and Incidental Take Permit, meet the decision criteria of the Draft USEPA 316(a) Manual for macroinvertebrates and shellfish. *See* Draft USEPA 316(a) 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; (iii) invertebrates as a food source are not a factor limiting fish production or drifting invertebrates are not harmed by passage through thermal plume; and (iv) the Quad Cities Station designated thermal mixing zone does not include a spawning or nursery site for important shellfish and/or macroinvertebrates.

### **Fish**

The Draft USEPA 316(a) Manual defines areas of low potential impact on fish as areas where: (a) the occurrence of sport and commercial species is marginal; (b) the discharge site is not a spawning or nursery area; (c) thermal plume will not block or hinder fish migration; (d) thermal plume will not cause fish to be vulnerable to cold shock; and (e) thermal plume will not have an adverse impact on threatened or endangered species. Draft USEPA 316(a) Manual at 29. The Draft USEPA 316(a) Manual provides that a CWA Section 316(a) demonstration is successful if the applicant shows either the site is a low potential impact area for fish or if the applicant shows 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 heated discharge; (iv) exclusion from unacceptably large areas; or (v) blockage of migration. *Id.* at 28-29.

Forty-one years of fish monitoring data is available to analyze the types and numbers of fish in the area of Quad Cities Station. Pet. Exh. 1 App. C at C-17. During fish monitoring, Exelon collected ninety-four fish species. Pet. Exh. 1 App. A at A-37, Table A-3; *see also* Stueck, et al., *Distribution and Relative Abundance of Upper Mississippi River Fishes* (2010). The dominant species was carp which is non-native to Pool 14 of the Mississippi River. Pet. Exh. 1 App. A at A-38. Sport fish species included walleye, sauger, largemouth bass, smallmouth bass, white bass, bluegill, black and white crappie, pumpkinseed, and channel catfish. *Id.* Commercial fisheries existed for bigmouth buffalo, common carp, catfish, bullheads, and freshwater drum. *Id.* Walleye and hybrid striped bass are reared at Quad Cities Station's site and stocked in the river. *Id.* Exelon estimates that the adult walleye population in Pool 14 is comprised of approximately 30 percent stocked fish. *Id.*

Exelon reported increases in numbers of freshwater drum, channel catfish, largemouth bass, and bluegill. Pet. Exh. 1 App. C at C-17; *see also* Pet. Exh. 1 App. A at A-39. Exelon reported decreases in numbers of white crappie, black crappie, and sauger. *Id.* Exelon reported that flathead catfish population has been stable. *Id.* Figures C-1 and C-2 illustrate the numbers of fish caught from 1971 to 2011 for the above listed species as well as common carp, river carpsucker, and gizzard shad. Pet. Exh. 1 App. C, Fig. C-1 and C-2. Exelon did not track trends in walleye population because this species is stocked annually in Pool 14. Pet. at 22, n. 21.

In response to Board questions, Exelon further explained the observed trends in white crappie, black crappie, and sauger populations between 1971 and 2011 in relation to the types of cooling cycle modes Quad Cities Station operated over the years. Exelon Ans. at 17.

Collections were the largest for white crappie during the first five years of open-cycle operations. Exelon Ans. at 17. From 1976 to 1983, during closed-cycle operations, white crappie collections decreased. *Id.* From 1984 to the present, white crappie numbers have been fairly stable, but low compared to the first ten years. *Id.* For black crappie, catch-per-effort (CPUE) numbers were the highest during four of the first five years of open-cycle operation. *Id.* From 1976 to 1996, numbers of black crappie were relatively stable, followed by lower but stable number from 1997 to present. *Id.* From 2008 through 2013, black crappie numbers have increased from the lows observed in 1997. *Id.* For sauger, from 1971 to 1990, CPUE was highly variable. *Id.* From 1991 through 2005 sauger was lower but stable, while highly variable numbers were again observed from 2006 to 2013, although lower than historical peaks. *Id.* Over the years, Exelon observed that much of the sauger's preferred sand and gravel habitat has become populated with rooted aquatic macrophytes, which might explain the variability. *Id.* Exelon explains that, as Mississippi River pools have aged over the past 40 years, siltation has increased and reduced the total amount of preferred habitat for these fishes. *Id.* at 18. This is a systemic issue that applies directly to white crappie, black crappie, and sauger as noted by multiple conservation organizations. *Id.* Exelon notes that the change in habitat also corresponds with the increase in bluegills and largemouth bass. *Id.* at 17. Illinois EPA states that it does not disagree with this assertion. Illinois EPA's Response to Board Questions (July 16, 2014) (IEPA Ans.) at 4.

Exelon concluded that backwater species, such as white crappie and black crappie, "have generally decreased due to degradation of the backwater areas and sloughs from sedimentation associated with operation of the 9-foot navigation channel." Pet. Exh. 1 App. A at A-39, citing Bowzer, et al., *A Summary Review of Long-Term Fisheries Monitoring in Pool 14 of the Upper Mississippi River Near Quad Cities Station* (2000). Exelon notes that these trends appear at locations both upstream and downstream of Quad Cities Station. Pet. Exh. 1 App. A at A-39; Pet. Exh. 1 App. C at C-17, Exelon Ans. at 18. Exelon further notes various factors contributing to these trends including commercial and recreational fishing and changes in fishing regulations. Pet. Exh. 1 App. C at C-17. These trends "are most likely the product of long term sampling at fixed locations that have undergone substantial habitat changes such as backwater siltation and the appearance of beds of rooted aquatic plants." Pet. Exh. 1 App. A at A-39, citing HDR, *Presentation of 2008 Aquatic Program Results at Annual Steering Committee Meeting* (March 2009). Exelon states, "Overall, white crappie, black crappie, and sauger populations declined at different rates and times during the 41 year period. None of these population changes correspond with the operation changes or high temperature events that occurred at Quad Cities Station." Exelon Ans. at 17.

Over the twenty-five years of open cycle cooling at Quad Cities Station, ninety-four taxa have been collected with a typical range during most years of fifty to sixty taxa. Pet. Exh. 1 App. C at C-17. HDR found that neither nuisance species nor heat tolerant species are dominant in Pool 14. Pet. at 23. Exelon concludes that thermal discharges since 1983 "have caused no appreciable harm to the finfish in Pool 14 and that the requested modifications to the thermal limits will assure the protection and propagation of a balanced indigenous population of finfish in the pool." Pet. Exh. 1 App. C at C-18.

Pool 14 of the Mississippi River above Quad Cities Station is a spawning and nursing area. Pet. Exh. 1 App. A at A-40. Peak larval drift tends to occur at ambient river temperatures

of 69.8°F to 73.4°F. Pet. Exh. 1 App. C at C-16. Ichthyoplankton (fish eggs and larvae) begin to drift by Quad Cities Station in late April or early May and continue to be present until August. Pet. Exh. 1 App. A at A-41. Peak numbers pass by the station during the first half of June. *Id.* Based on sampling in 1984 and 1985, 65% to 96% of total larvae and 94% to 99% of freshwater drum larvae pass by the station by the end of June. Pet. Exh. 1 App. A at A-41. Freshwater drum eggs made up 84% and emerald shiner eggs 11.7%. *Id.* Cyprinid, carp, and unidentifiable eggs made up the remainder. *Id.*

The majority of eggs and larvae sampled were freshwater drum. Pet. Exh. 1 App. C at C-16; *see also* Pet. Exh. 1 App. A at A-40 to A-41. The highest concentrations of freshwater drum were found near the Illinois shoreline. Pet. Exh. 1 App. C at C-16. Ninety-five percent of freshwater drum egg drift occurs before July 2 with the peak occurring before June 5. *Id.* During the prior twenty-eight years, Quad Cities Station used excursion hours only rarely prior to July 1. *Id.* Specifically, the station used five hours on June 26, 2009; 36 hours between May 30 and June 1, 2010; and 223.5 hours in March 2012. *Id.* Exelon concludes that “the proposed increases in excursion hours should have a negligible effect on eggs and larvae of freshwater drum.” *Id.* at C-17. In addition, the diffuser openings begin at 840 feet from the Illinois shore or approximately 80% of the distance to mid-river. Pet. Exh. 1 App. A at A-42. Accordingly, most freshwater drum larvae will not pass over the open ports. *Id.* Exelon concludes “the majority of these larvae will not be exposed to the maximum discharge temperatures which would result in thermal mortality.” *Id.*

In a 2000 report, Exelon analyzed the effect of larvae being exposed to an instantaneous increase of 15.2°C (59.4°F) as the larvae pass over the diffusers. Pet. Exh. 1 App. A at A-42. Exelon collected data for total larvae, freshwater drum, and gizzard shad. *Id.* These species were the two most abundant species taken in impingement collections. *Id.* Exelon reports that mortality for freshwater drum larvae begins at ambient river temperatures of 22°C (71.6°F) and river flow of 30,000 cfs. *Id.* at A-43. Exelon estimates that mortality will remain below one percent until ambient river temperatures reach 23.5°C (74.3°F) at this flow. *Id.* Exelon concludes that the thermal discharge from Quad Cities Station has little effect on freshwater drum larvae during their peak period of drift. *Id.* Freshwater drum larvae spawned later in the summer may experience higher mortality as they drift over the diffusers. *Id.* For gizzard shad larvae, mortality first occurs at ambient river temperatures of approximately 25°C (77°F) and lethal temperatures occur at 28°C and 29°C (82°F and 84°F) at flows of 30,000 cfs. *Id.* Similar to freshwater drum, Exelon concludes that gizzard shad spawned later in the season may suffer mortality. *Id.* Exelon also reported that gizzard shad “contribut[es] substantially to the larval drift.” Pet. Exh. 1 App. C at C-17. Based on the past 25 years of monitoring gizzard shad in Pool 14 and adjacent pools, Exelon concludes that gizzard shad has not been harmed by thermal discharge based on the numbers collected during monitoring and observations. *Id.*

Exelon also analyzed the effect of a decreased zone of passage of less than 75% on fish. Pet. Exh. 1 App. C at C-21 to C-22. Exelon notes that of the 155 fish species found in the Mississippi River, 34 were migratory and 30 of those species have been found in Pool 14. *Id.* at C-21 citing Haas, J., *Practical Applications and the Examination of the Zone of Passage at Quad Cities Nuclear Station* (2011). Exelon explains that migration occurs for spawning, feeding, or moving to a wintering area. *Id.* These migration events occur during spring and fall when flows

typically are high and temperatures are moderate. *Id.* Exelon concludes that because migration occurs over a period of weeks, a slight reduction in the zone of passage for a brief period is of negligible biological consequence. *Id.* Exelon further concludes that when the zone of passage is reduced during non-biologically important times, there should also be no adverse biological impacts on fish in Pool 14. *Id.* at C-22. As discussed below in the representative important species analysis, Exelon states there is abundant habitat both above and below the mixing zone in the event that fish are unable to navigate the existing zone of passage. *Id.*

The Board finds that the proposed thermal discharge to Pool 14 of the Mississippi River meets the decision criteria of the Draft USEPA 316(a) Manual for fish. *See* Draft USEPA 316(a) Manual at 28-29. Exelon's demonstration shows 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 heated discharge; (iv) exclusion from unacceptably large areas; or (v) blockage of migration.

Illinois EPA notes in its recommendation that Exelon reported "decreases in the numbers of white crappie, black crappie, and sauger." *Rec.* at 4; *see* *Pet. Exh. 1 App. C* at C-17. Exelon responds that it will commit to further studying these populations. *Resp.* at 3. Exelon states that it will assess the populations of white crappie, black crappie, and sauger in Pool 14 by studying fish population data obtained upstream from Quad Cities Station in Pool 13 through the Bellevue Field Stations Long Term Resource Monitoring Program. *Exelon Ans.* at 19. Exelon notes that Pool 13 has minimal industrial and municipal inputs, so comparing Pool 13 data to Pool 14 data will confirm expert conclusions that white crappie, black crappie, and sauger trends are not unique to Pool 14. *Id.*

As discussed above, based on current information, the Board finds that Exelon's requested alternative thermal effluent limitations will assure the protection of the populations of white crappie, black crappie, and sauger in Pool 14. However, the Board also finds it appropriate to continue studying these populations to ensure that the alternative thermal effluent limitations will assure the protection of the populations of white crappie, black crappie, and sauger in Pool 14. Accordingly, the Board includes such a condition in its order below.

### **Other Vertebrate Wildlife**

"Other vertebrate wildlife" includes non-fish vertebrates such as ducks and geese. The Draft USEPA 316(a) Manual states that most sites in the United States will be considered to have low potential impact for other vertebrate wildlife because thermal plumes should not generally impact large or unique populations of wildlife. Draft USEPA 316(a) Manual at 32. The main exception is sites in cold areas where the thermal plume is predicted to attract geese and ducks and encourage them to stay through the winter. *Id.* The Draft USEPA 316(a) Manual provides that a CWA Section 316(a) demonstration is successful if the applicant shows either the site is a low potential impact area for other vertebrate wildlife or if the applicant shows that other wildlife will not suffer appreciable harm. *Id.*

Exelon notes that the Upper Mississippi River National Wildlife and Fish Refuge is a 261-mile refuge beginning at the Chippewa River near Wabasha, Minnesota and ending near



Rock Island, Illinois. Pet. Exh. 1 App. A at A-43. The refuge provides migratory habitat for birds. *Id.* The refuge is a critical migration corridor for ten species including seven species on USFWS's Region 3 resource conservation priority list. *Id.*

Exelon reports that Pool 14 and its shoreline are “used by various resident mammalian, avian, reptilian and amphibian species as nesting, nursery, and foraging grounds, and by migratory birds.” Pet. Exh. 1 App. C at C-19. Exelon notes various observations of migrating birds near Quad Cities Station and concludes that “the requested change in thermal limits will not affect these activities.” *Id.*

The Board finds that Pool 14 is a low potential impact area for other vertebrate wildlife because thermal plumes should not impact any large or unique populations of wildlife. Exelon's demonstration meets the decision criteria and shows that other wildlife will not suffer appreciable harm. *See* Draft USEPA 316(a) Manual at 32.

### **Board Finding on Biotic Category Analysis**

The Board finds that Exelon's proposed thermal discharge to Pool 14 of the Mississippi River meets the decision criteria of the Draft USEPA 316(a) Manual to find a CWA 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 and indigenous community of aquatic life currently exists in Pool 14 of the Mississippi River. The Board observes that the record contains no evidence of nuisance algal blooms, abnormal phytoplankton blooms, or fish kills attributable to prior thermal discharges from Quad Cities Station. However, endangered and threatened species of mussels inhabit the receiving waters of Pool 14 outside the designated thermal mixing zone of Quad Cities Station, and the biotic category analysis shows that fish may be impacted by thermal discharge. Accordingly, macroinvertebrates and fish are discussed further below under representative important species analysis.

### **Representative Important Species Analysis**

A CWA Section 316(a) demonstration also must identify the representative important species for further study. “Representative important species” or “RIS” means

species that are representative, in terms of their biological needs, of a [balanced and indigenous community] 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).

RIS are selected from any combination of the following biotic categories: shellfish, fish, or habitat formers. Draft USEPA 316(a) Manual at 36. The Draft USEPA 316(a) Manual lists the following considerations in selecting RIS:

1. Species mentioned in state water quality standards;

2. Species identified in consultation with other governmental agencies;
3. Threatened or endangered species;
4. Thermally sensitive species;
5. Commercially or recreationally valuable species;
6. Far-field and indirect effects on entire water body; and
7. Critical to structure and function of ecological system. Draft USEPA 316(a) Manual at 37-38.

The Draft USEPA 316(a) Manual further provides:

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. Draft USEPA 316(a) Manual at 37.

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. To this end, the Board's procedural rules require a petitioner to serve a copy of its petition on both Illinois EPA and Illinois DNR as well as requiring the petitioner to inform Illinois EPA of its proposed RIS list and supporting data and information. *See* 35 Ill. Adm. Code 106.1115(a)(4), 106.1120(b)(5), 106.1125. In addition, the Draft USEPA 316(a) Manual advises that the permitting authority:

checks with the Regional Director of the [USFWS] and representatives of the [National Marine Fisheries Service] and States to make sure the study plan includes appropriate consideration of threatened or endangered species as well as other fish and wildlife resources. Draft USEPA 316(a) Manual at 15.

The applicants must collect thermal effects data for each RIS including: (i) high temperature survival for juveniles and adults; (ii) thermal shock tolerance; (iii) optimum temperature for growth; (iv) minimum and maximum temperatures for early development; (v) normal spawning dates and temperatures; and (vi) any special temperature requirements for reproduction. Draft USEPA 316(a) Manual at 43-45. A CWA Section 316(a) demonstration must show that RIS will not suffer appreciable harm from the heated discharge. *Id.* at 35.

### **Representative Important Species Selection**

On behalf of Exelon, HDR selected species to study, conducted a literature search, and created a database of temperature tolerances. Pet. Exh. 1 App. B at B-5. HDR started with a list of ninety-three species collected during the fish monitoring program at Quad Cities Station. *Id.* at B-7. HDR filtered this list to fifteen species by eliminating: hybrid taxa, exotic taxa, taxa not collected within the prior ten years, incidental taxa, taxa known to have avoidance temperatures higher than 89°F, taxa captured only occasionally, taxa for which less than two hundred specimens had been collected, and congeneric species. *Id.* HDR's objective was to produce a list of indigenous riverine species including forage fish, threatened or endangered species, recreationally important species, and commercially important species. *Id.* Several perceived thermally sensitive species were included in the list of fifteen species from which the RIS were selected. Exelon Ans. at 12. Exelon explained that such "[t]hermally sensitive species would typically be near the edge of their natural range or would be slow thermally orienting species." *Id.*

HDR conducted a literature search for each of the fifteen species "to determine if the thermal tolerance data needed to conduct the analyses were available in the scientific literature." Pet. Exh. 1 App. B at B-7. HDR found "sufficient thermal tolerance information" for four species: channel catfish, largemouth bass, spotfin shiner, and walleye. *Id.* HDR selected these four species as RIS for Pool 14. *Id.* at B-8. Of these, walleye, which is a cold water-guided species, is considered representative of the most thermally sensitive species. Exelon Ans. at 12

As described above, Exelon works closely with a technical advisory committee including natural resource agencies such as Illinois EPA, Illinois DNR, Iowa DNR, USEPA, and USFWS. Pet. at 13-14, n. 14. As specific examples of Exelon's communication with these agencies, Exelon notes that in 2003 it presented plans in committee meetings as well as to Illinois EPA and Illinois DNR to obtain input on Exelon's planned studies "aimed at determining whether existing thermal limits could be relaxed without causing unacceptable environmental impacts." Pet. at 14. In 2007, Exelon submitted to USEPA, with copies to USFWS, Illinois DNR, Iowa DNR, and Illinois EPA, its "detailed plans for additional studies to support its 316(a) Demonstration." *Id.*; *see also* Pet. Exh. 2.

In connection with Illinois DNR's review of Exelon's demonstration, Exelon responded to Illinois DNR questions, including an incident of mooneye die off. Exelon Ans. at 8, Exh. 30. Exelon committed to monitoring during high temperature/low flow events, coordinating with the Army Corps when river flows yielded a zone of passage less than 75%, and including site specific zone of passage measures. Exelon Ans. at 8. On March 28, 2011, Exelon received a letter from Illinois DNR acknowledging general agreement with Exelon's proposals. Exelon Ans. Exh. 30.

In late 2009, Exelon provided Iowa DNR a copy of its demonstration for review. Exelon Ans. at 9; Exelon Ans. Exh. 35; Exelon Ans. Exh. 36. In response, the Iowa DNR Fisheries Bureau's comments:

1. questioned whether Exelon's request for 3% excursion hours (262.8 hours) was based on summer 2006 when 222 excursion hours were used;
2. requested additional information regarding the 2006 fish die-off;
3. questioned whether fish avoidance behavior during warm water events could have an adverse impact on recreational fishing in Pool 14;
4. questioned whether Heidi Dunn, Exelon's mussel expert, supported the request for 3% excursion hours; and
5. questioned why the bio-thermal (prospective) demonstration did not address the Higgins eye pearlymussel. Exelon Ans. at 9; Exelon Ans. Exh. 35.

In response, Exelon reduced the proposed excursion hours from 3% to 2.5% (219) hours and included additional detail about the 2006 fish die-off. Exelon Ans. at 9. Exelon stated that any impacts to recreational fishing from avoidance behavior due to the additional 1.5% of excursion hours beyond those currently allowed would be minimal. *Id.* In the absence of thermal tolerance data for mussels, Exelon explained that it enlisted Ms. Dunn to study the mussel community in Pool 14, and that the resulting studies support the conclusion that the mussel population would not be harmed by the proposed alternative thermal limits. *Id.* The Higgins eye pearlymussel is discussed in more detail below.

Additionally, the Iowa DNR permitting section commented that:

1. the CWA Section 316(a) demonstration discussion regarding Illinois EPA's NPDES permitting authority for Quad Cities Station should include Iowa's role as a permit signatory;
2. Iowa's water quality standards should be addressed;
3. the CWA Section 316(a) demonstration should include the list of 93 species from which the RIS were selected;
4. the CWA Section 316(a) demonstration should include additional graphics showing potential areas of impacts to fish; and
5. the list of impaired waters in Pool 14 should be updated. Exelon Ans. at 9, Exelon Ans. Exh. 36.

In response, Exelon included the list of 93 species and updated the list of impaired waters in its demonstration. Exelon Ans. at 9.

Further, on March 11, 2014, Illinois EPA sent a letter to Exelon confirming that Illinois EPA was satisfied with Exelon's communications with Illinois EPA relating to the CWA

Section 316(a) demonstration for Quad Cities Station. Pet. Exh. 3. Illinois EPA explained that it has been “intimately involved since prior to January 2006” with Exelon’s efforts and Illinois EPA along with the other governmental entities have participated in the process of determining fish species to be studied and discussing the mussel beds for federally endangered species. *Id.*

### **Threatened and Endangered Species**

The definition of RIS in USEPA’s Draft 316(a) Manual specifically includes threatened or endangered species. Draft USEPA 316(a) Manual at 78-79. Although HDR’s master taxa list also identified a few federal and state listed threatened and endangered species, Exelon explains that these were not selected as RIS for Pool 14 because insufficient thermal tolerance data were available. Exelon Ans. at 12.

For federally listed endangered species, Exelon found the federally endangered Higgins eye pearlymussel in seven of fifteen beds sampled near Quad Cities Station, most abundantly in the Albany Bed (upstream) and the Cordova Bed (downstream). Pet. Exh. 1 App. C at C-15. Exelon also found the Sheepnose mussel is present and is a candidate species for federal listing. *Id.* at C-14. The Higgins eye pearlymussel was listed as a federally endangered species on June 14, 1976. Pet. Exh. 1 App. A at A-32, citing 41 Fed. Reg. 24064 (June 14, 1976); 40 C.F.R. § 17.11. USFWS designated the Cordova Bed as an essential habitat area for this mussel. Pet. Exh. 1 App. A at A-32, A-44. Quad Cities Station completed a habitat conservation plan which sets forth a plan to avoid and minimize any incidental take of the Higgins eye pearlymussel and Sheepnose mussel and a mitigation plan if an incidental take occurs. Pet. Exh. 1 App. C at C-14. USFWS issued a Federal Fish and Wildlife Permit authorizing incidental taking of Higgins eye pearlymussel and Sheepnose mussel effective August 16, 2010. *See* Pet. Exh. 5.

State-listed threatened and endangered fish species have also been collected in Pool 14 during the 41-year fish monitoring program conducted by Quad Cities Station. Pet. Exh. 1 App. A at A-37-38. Three species collected are listed as endangered by Iowa DNR: weed shiner, pearl dace, and lake sturgeon. *Id.* at 37. Three species collected are listed as threatened by Iowa DNR: grass pickerel, western sand darter, and chestnut lamprey. *Id.* Four species collected are listed as endangered by Illinois: lake sturgeon, pallid shiner, weed shiner, and western sand darter. *Id.* at A-38. One species collected is listed as threatened by Illinois: longnose sucker. *Id.* Exelon also found state-listed mussel species *Lampsilis teres* (Iowa endangered species) and *Ellipsaria lineolata* (Illinois threatened species) in eight of the fifteen beds. Pet. Exh. 1 App. C at C-14.

In the absence of thermal tolerance data for these mussel species, Exelon extensively sampled and monitored mussels to evaluate how mussels responded to prior thermal episodes similar to those from the proposed alternative thermal effluent limitations. Exelon Ans. at 12-13. As noted above, monitoring in 2007 and 2008 showed that that mussel communities “do not seem to be significantly affected by the [Quad Cities Station] thermal effluent.” Pet. Exh. 1 App. A at A-36. The increase in unionid mortalities in 2006 “was not observed in 2007 or 2008 and did not appear to affect unionid density either upstream or downstream” of Quad Cities Station. *Id.* at A-37. Exelon concludes that the proposed limitations would not adversely impact the mussel populations, and developed the Habitat Conservation Plan in connection with

obtaining an Incidental Take Permit, to address possible impacts to mussels. Exelon Ans. at 13, citing Pet. Exh. 1 App. C at C-14, C-15.

As noted above, Exelon works closely with a technical advisory committee including natural resource agencies such as Illinois EPA, Illinois DNR, Iowa DNR, USEPA, and USFWS. Pet. at 13-14, n. 14. Illinois EPA states that both Illinois DNR and Iowa DNR came to the consensus that the threatened or endangered species that needed to be addressed in connection with Exelon's petition were the federally listed Higgins eye pearl mussel and the candidate species Sheepnose mussel. IEPA Ans. at 2. On July 16, 2014, Illinois EPA informed the Board that it requested consultation with Illinois DNR through the Ecological Compliance Assessment Tool (EcoCAT) noting the following protected resources may be in the vicinity of the project location: Mississippi River – Cordova INAI Site, Black sandshell (*Ligumia recta*), Butterfly (*Ellipsaria lineolata*), Higgins eye pearl mussel (*Lampsilis higginsii*), and Longnose Sucker (*Catostomus catostomus*). *Id.* at 3. Illinois DNR is reviewing the submitted information. *Id.* Illinois EPA also submitted a request for Environmental Review for Natural Resources to Iowa DNR. *Id.* Iowa DNR is also reviewing the submitted information. *Id.* As of this date, the Board has not received any comment on any aspect of Exelon's petition from Illinois DNR or Iowa DNR.

Exelon explains that the Incidental Take Permit is issued pursuant to section 10(a)(1)(B) of the Endangered Species Act of 1973 (16 U.S.C. §§ 1531-1544, 87 Stat. 884) as amended from USFWS for the potential incidental take of the Higgins eye pearl mussel and Sheepnose mussel. Pet. Exh. 4 at 5. The Incidental Take Permit authorizes Exelon the incidental take of Higgins eye pearl mussel and Sheepnose mussel associated with the implementation of minimization measures and mitigation measures. *Id.*

Exelon states that the state-listed species are addressed in the Habitat Conservation Plan and Incidental Take Permit developed for the proposed alternative thermal limitations for Quad Cities Station. Exelon Ans. at 5. Exelon states that both Illinois DNR and Iowa DNR participated in the original study plans for Exelon's demonstration and received copies of its draft demonstration. Exelon Ans. at 10. Illinois DNR and Iowa DNR also participated in the development of the Habitat Conservation Plan and federal Incidental Take Permit. *Id.* Exelon states,

[t]he consensus was that the threatened or endangered species that needed to be addressed in connection with Exelon's proposed alternative thermal limits were mussel species, particularly the federally-listed Higgins Eye mussel and the candidate species Sheepnose mussel. However, to insure against possible impacts to State-listed species, a provision was included in the [Habitat Conservation Plan] requiring continued coordination with state conservation agencies, and provisions were included in the Incidental Take Permit requiring monitoring of other rare mussel species and to providing for [*sic*] adaptive measures to be implemented to address possible impacts, if warranted. *Id.*

With regard to Illinois rules for incidental take authorization, Exelon cites to 17 Ill. Adm. Code 1080.10(c) and (d), which allows federally-approved Habitat Conservation Plans and Incidental Take Permits to be substituted for the Illinois counterpart. Exelon Ans. at 10-11.

The Board notes that in the event that Iowa DNR or Illinois DNR provides additional information on the presence of other state-listed endangered or threatened species and specifies additional necessary action after the effective date of this order, Exelon would be required, in an application for renewal of the 316(a) determination through its NPDES permit renewal application, to provide sufficient information on “the current nature of the petitioner’s thermal discharge and the balanced, indigenous population . . . .” See 35 Ill. Adm. Code 106.1180(b).

### **Biothermal Modeling Design**

To analyze the prospective impact of Exelon’s requested alternate limits on aquatic life, and specifically the RIS, HDR conducted biothermal modeling. At the start, HDR selected operating and river conditions to use in biothermal modeling to evaluate the thermal plume caused by the thermal discharge from Quad Cities Station. Pet. Exh. 1 App. B at B-8. HDR selected conditions occurring in June through September because this is the time of year when excursion hours predominantly occur. *Id.* HDR selected parameters to represent the “reasonable worst-case conditions.” *Id.* at B-9.

**Operating and River Conditions.** One factor assessed in the biothermal modeling was the amount of waste heat added to the river. Pet. Exh. 1 App. B at B-8. HDR calculated the amount of heat added to the river as the difference in water temperature between intake from and discharge to the river multiplied by the cooling water discharge flow rate based on Quad Cities Station operating at full capacity with all six circulating water pumps in operation. Pet. Exh. 1 App. B at B-8 to B-9; Exelon Ans. at 22.

Another factor was the amount of water in the river. Pet. Exh. 1 App. B at B-9. As river flow decreases, less river water is available to mix with heated effluent. *Id.* HDR evaluated nine river flow scenarios: 13,800 cfs, 15,000 cfs, 17,500 cfs, 20,000 cfs, 22,500 cfs, 25,000 cfs, 30,000 cfs, and a variable rate. *Id.* For the six lowest flow simulations (13,800 cfs, 15,000 cfs, 17,500 cfs, 20,000 cfs, 22,500 cfs, and 25,000 cfs), the number of excursion hours would exceed a limit of 262.8 hours (3% of 8,760 hours in a year) for temperatures up to 3°F over the limit. Pet. Exh. 1 App. B at B-9. At the two lowest flow simulations (13,800 cfs and 15,000 cfs), the number of excursion hours also would exceed a limit of 131.4 hours (1.5% of 8,760 hours in a year) for temperatures up to 5°F over the limit. *Id.* at B-9 to B-10.

Another factor used in the modeling was the ambient temperature of the river. Pet. Exh. 1 App. B at B-9. The ambient temperature was measured upriver of the discharge at Lock & Dam 13. *Id.* HDR reviewed temperature data taken by the Army Corps at the lock from October 1996 through April 2006. *Id.* HDR then selected June through September 2006 and adjusted those temperatures to derive the ambient river temperature. *Id.* HDR adjusted the actual temperature readings “by increasing the temperatures exponentially with river flow with the goal of exceeding the 86°F criterion at the end of the mixing zone (EOMZ) temperature 3.0%

of annual hours and exceeding the 89°F EOMZ temperature 1.5% of the annual hours without exceeding the 91°F EOMZ temperature limit.” *Id.*

**Model Design.** HDR developed a six-step model.

The first step in the model was to characterize the thermal plume from Quad Cities Station. Pet. Exh. 1 App. B at B-11. In September 2003, HDR “conducted a thermal field study comprising river-wide surface and vertical profile temperature measurements from above the plant diffuser pipes down to the southern end of Steamboat Island.” *Id.* at B-6. HDR also conducted an aerial infrared survey. *Id.* IIHR-Hydroscience & Engineering (formerly Iowa Institute of Hydraulic Research) then used its three-dimensional computational fluid dynamics model to obtain the spatial characterization of the plume. *Id.* at B-11. The modeling provided water temperature, depth, and velocity values used as inputs for the biothermal model. *Id.* at B-6. HDR also used adjusted 2006 Army Corps temperatures measured at Lock & Dam 13 for the temporal characterization of the plume. *Id.* at B-11.

The second step in the model was to determine acclimation temperatures. Pet. Exh. 1 App. B at B-11. Ambient temperatures in Pool 14 vary during the year. *Id.* For example, from June through late July, ambient water temperature increases from approximately 67°F to 83°F. *Id.* Fish acclimate or undergo physiological changes such as a change in metabolic rate in response to such changes in temperature. *Id.* The acclimation temperature is the temperature sufficient to allow these physiological changes. *Id.* at B-11 to B-12. The time required for acclimation to a temperature varies from several days to more than a week. *Id.* at B-12. HDR determined an acclimation temperature for each species habitat for each day under each of the river flow scenarios. *Id.*

The third step in the model was to determine temperature tolerances for the RIS. Pet. Exh. 1 App. B at B-12. HDR considered temperature tolerances for growth, avoidance, and chronic mortality. *Id.* In general, “the higher the acclimation temperature, the higher the tolerance temperature – until a maximum limit is reached, which is the point at which no further increase in thermal tolerance is possible via acclimation.” *Id.*

The fourth step in the model was to determine when RIS inhabit Pool 14. Pet. Exh. 1 App. B at B-13. Table 5 details the time of year the RIS reside in Pool 14 and the life stages of the RIS during those times. *Id.*; *see also* Pet. Exh. 1 App. B at B-29 to B-32. HDR obtained this information from “decades-long sampling programs (LMS 2004) combined with period-of-occurrence data found in the scientific literature.” Pet. Exh. 1 App. B at B-13.

The fifth step in the model was to determine the horizontal and vertical habitats for RIS in Pool 14. Pet. Exh. 1 App. B at B-13. HDR delineated each RIS’s life stage habitats in Figures 9 through 12. *Id.* at B-48 to B-53. HDR derived this information from sampling and scientific literature. *Id.* at B-13. HDR determined acclimation and exposure temperatures (the temperature on the day being evaluated (Pet. Exh. 1 App. B at B-15)) for benthic species using the predicted bottom layer temperature. *Id.* HDR used the average full water column temperatures for pelagic species. *Id.*



The sixth step in the model was to input the data. HDR determined the acclimation temperature for each species habitat. Pet. Exh. 1 App. B at B-13. For each day, HDR analyzed the acclimation temperature and exposure temperature against the temperature tolerances “to predict expected biothermal effects.” *Id.*

### **Biothermal Modeling Results**

HDR selected three biological parameters to evaluate the impact on RIS of the thermal plume caused by the thermal discharge from Quad Cities Station: growth, avoidance, and mortality. Pet. Exh. 1 App. B at B-10.

**Growth.** The growth parameter considers the impact of the thermal discharge on the temperature range “conducive to growth in fish.” Pet. Exh. 1 App. B at B-10. HDR expressed the growth parameter as the number of days the temperature is within the range rendering the habitat available for growth of each RIS, or conversely, the number of days lost due to temperatures exceeding the growth range.

Each RIS has a temperature range for growth. Pet. Exh. 1 App. B at B-14. HDR evaluated the effect of plume temperature on growth from June 1 through September 30 (122 days). *Id.* HDR assumed that the rate of species growth is uniform and sufficient food is available. *Id.* HDR compared exposure temperature to acclimation temperature in 50-foot by 50-foot cells. *Id.* The cell was designated as available for growth if the point at which acclimation temperature and exposure temperature intersect on the temperature tolerance polygon<sup>5</sup> fell within the tolerance temperature limit. *Id.* at B-15. HDR combined the cells available for growth to determine the habitat area available for growth. *Id.* For each day from June 1 through September 30 (122 days), HDR divided the habitat area available for growth by the total habitat area. *Id.* A value of one means that all of the cells were available for growth. *Id.* HDR calculated the cumulative number of these days for each RIS. *Id.* The difference between 122 days and the predicted number of growth days is the number of growth days lost or the number of days when the water temperature is not favorable for growth. *Id.*

Based on this calculation, HDR found that there will be “[l]ittle to no change in growth” for largemouth bass and channel catfish. Pet. Exh. 1 App. B at B-15. The thermal discharge “tends to shift temperatures into the temperature range favorable for growth” for the spotfin shiner. *Id.* In other words, the number of growth days lost with the station operating is less than under ambient conditions for spotfin shiner. *Id.* For walleye, the number of growth days lost with 87.6 excursion hours (1% of 8,760 hours in a year) was predicted as 9.6 days and the number of growth days lost with 262.8 excursion hours (3% of 8,760 hours in a year) is 15 days. *Id.* at B-16. Therefore, under the constant river flow scenario, this increase in excursion hours was predicted to result in losing an additional 5.7 growth days for walleye. *Id.* Under the variable flow scenario, this increase in excursion hours results in losing an additional 2.6 days. *Id.*

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<sup>5</sup> The polygon is a diagrammatic presentation of data that demonstrates how temperature tolerances change in response to changing combinations of acclimation and exposure temperatures. Pet. Exh. 1 App. B at B-11.

**Avoidance.** The avoidance parameter is fish behavior observed when temperatures reach the level where fish evade the stressful water condition. Pet. Exh. 1 App. B at B-10. Avoiding certain temperatures may “deter species from occupying otherwise useful habitat in the vicinity of a thermal plume.” *Id.* at B-16. HDR expressed the avoidance parameter in terms of the percentage portion of the habitat area that is unavailable to a species because the species avoids the area.

HDR first determined the percentage of the area in each cell above the avoidance temperature for each day. Pet. Exh. 1 App. B at B-16 to B-17. HDR multiplied this avoidance area percentage by the total area of the cell and calculated the sum for all the cells. *Id.* at B-17. HDR calculated the average percentage of total habitat avoided by dividing the above sum by the total habitat area and multiplying by 100. *Id.*

Species	Average percentage of habitat loss	Daily maximum avoidance
Channel catfish	0.32%	6.2%
Spotfin shiner	0.99%	11.9%
Largemouth bass	1.10%	15.8%

HDR found that for all RIS “the instances of percent habitat avoided above the nominal level of 5% are both infrequent and brief.” Pet. Exh. 1 App. B at B-18. Further, increasing excursion hours from 87.6 excursion hours (1% of 8,760 hours in a year) to 262.8 excursion hours (3% of 8,760 hours in a year) “would yield only a very slight increase in the average percentage of habitat avoided.” *Id.* By using 50-foot by 50-foot cells, HDR delineated the “spatial distribution of predicted avoidance.” *Id.*; see Pet. Exh. 1 App. B. at B-55 to B-58 (Figures 14-17). According to this spatial analysis, HDR found “isolated pockets of elevated avoidance along the Iowa shoreline” but that “the overall depth-weighted avoidance percentage is small.” Pet. Exh. 1 App. B at B-18.

HDR had insufficient data from scientific literature to define the relationship between acclimation temperature and exposure temperature in walleye. Pet. Exh. 1 App. B. at B-17. Accordingly, HDR provided an alternative analysis in Attachment 3. *Id.*, see also Pet. Exh. 1 App. B at B-84 (Attachment 3). HDR analyzed data from its summertime electro-fishing program. Pet. Exh. 1 App. B at B-17. Based on this data, HDR found “that any displacement of walleye due to the plant’s thermal plume will be transitory and will not cause appreciable harm to the walleye population in Pool 14.” *Id.* HDR also found that at low river flows, the numbers of walleye collected at shoreline locations were reduced while larger numbers were collected at higher flows, indicating the walleye return to the sampled habitats when those are available. *Id.* at B-87.

**Mortality.** The third parameter, chronic thermal mortality due to prolonged exposure, is the temperature at which fish remaining in the impacted area die during exposure. Pet. Exh. 1 App. B at B-10. HDR noted that fish mortality occurs when fish do not avoid the impacted area. *Id.* at B-18 to B-19. Accordingly, HDR assumed no avoidance in this portion of the analysis. *Id.* at B-19. In addition, HDR used maximum daily exposure temperatures in its analysis. *Id.*

HDR found that “[l]ittle or no mortality is predicted for largemouth bass, catfish, or spotfin shiner.” Pet. Exh. 1 App. B at B-19. HDR predicted that increasing excursion hours from 87.6 excursion hours (1% of 8,760 hours in a year) to 262.8 excursion hours (3% of 8,760 hours in a year) “increases the potential of chronic mortality for walleye from 1.1% to 3.4%.” *Id.* HDR found that this increase of 2.3 percentage points “under reasonable worst-case conditions is not expected to cause appreciable harm to the local walleye population.” *Id.* Under the variable flow scenario, HDR calculated a 9.63% chronic mortality for walleye. *Id.* HDR explained that this scenario assumed walleye would not avoid the warmer temperatures, which is not what has been observed. *Id.* at B-19 to B-20. HDR maintained that “low flows cause walleye to move away from warmer shoreline habitats as they become too shallow to use.” *Id.* at B-20. HDR surmised that during these periods walleye move to deeper water and return to the habitat when more favorable conditions develop in the fall. *Id.*

Exelon explains, “[a]lthough exceedances of the upper temperature limits in the tolerance polygons could occur, prospective modeling results and actual experience at Quad Cities Station, based on mussel studies and long term fish monitoring, show that the RIS will not be impaired as a result of exposure to the maximum temperatures allowed by the alternate thermal limitations for the limited time periods in question.” Exelon Ans. at 13; *see also* Pet. Exh. 1 App. B at B-12, B-80 to B-83.

### **Board Finding on RIS Analysis**

The Board finds that Exelon demonstrated that RIS will not suffer appreciable harm from the proposed thermal discharge to Pool 14 of the Mississippi River. To analyze an RIS, Exelon selected for four species: channel catfish, largemouth bass, spotfin shiner, and walleye. Exelon analyzed the impact of the proposed thermal discharge on growth, avoidance, and mortality. As described in more detail above, Exelon concluded that there was no material change in growth, avoidance, or mortality for channel catfish, largemouth bass, and spotfin shiner. Exelon found some potential impacts to walleye assuming worst-case scenarios and no avoidance behavior. Exelon’s demonstration concluded that displacement of walleye because of either low flow or thermal stress would be transitory and not cause appreciable harm to the walleye population. Exelon assumed that walleye is representative of the most thermally sensitive species.

In addition, Exelon analyzed the impact of its proposed thermal discharge on Higgins eye pearl mussel and Sheepnose mussel. With the Habitat Conservation Plan and Incidental Take Permit in place, it is reasonable to expect that the proposed thermal discharge will not cause appreciable harm to the balanced and indigenous population of these mussels.

### **Master Rationale**

Exelon seeks an alternative thermal effluent limitation to increase the excursion hours applicable to heated effluent discharged from Quad Cities Station to Pool 14 of the Mississippi River. Exelon also seeks to decrease the zone of passage around the mixing zone it uses to comply with thermal standards. For the reasons set forth 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 that Sections 303.331 and 302.102(b)(8) of the Board's water pollution regulations are more stringent than necessary to assure the protection and propagation of the balanced and indigenous population in Pool 14 of the Mississippi River. Exelon further demonstrates that the requested increase in excursion hours, change in monitoring to a calendar year basis, and decrease in zone of passage around its mixing zone will assure the protection and propagation of the balanced and indigenous population in Pool 14 of the Mississippi River.

**Applicable Effluent Limit 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 in Pool 14 of the Mississippi River. *See* 33 U.S.C. § 1326. Sections 303.331 and 302.102(b)(8) of the Board's water pollution regulations are the applicable standards from which Exelon seeks alternative standards. 35 Ill. Adm. Code 302.102(b)(8), 303.331.

**Section 303.331 "Mississippi River North Temperature"**. As quoted above in this opinion, Section 303.331 of the Board's water pollution regulations sets temperature standards for the stretch of the Mississippi River from the Rock River to the Wisconsin border, which includes Pool 14. 35 Ill. Adm. Code 303.331. The rule includes a table of maximum temperatures for each month of the year. *Id.* Water temperature must not exceed the maximum temperature during more than 1% of the hours in the twelve month period ending with any month (1% of 8,760 total hours in a year is 87.6 hours). *Id.* In addition, the water temperature must not exceed the maximum limit by more than 3°F at any time. *Id.*

Section 303.331 was promulgated precisely for the anticipated heated discharge from Quad Cities Station. In December 1970, during construction, the Izaak Walton League filed a petition requesting that the Board adopt more stringent temperature standards for this area of the river. Mississippi Thermal Standards, R70-16 (Nov. 23, 1971). At that time, existing standards limited temperature in the Mississippi River to 90°F, and in any case no more than 5°F above natural temperature, outside a mixing zone extending 600 feet from the point of a heated discharge. *Id.* at 1. Evidence at hearing indicated that temperatures near Davenport were as high as 85°F only one percent of the time so that a 4°F rise at the edge of the mixing zone (as predicted would be caused by the heated discharge from Quad Cities Station) would almost always be allowable. *Id.* at 3. The Board then set about to develop temperature regulations by determining the monthly natural highs, allowing 5°F above natural highs, but no more than 3°F above the numerical limit. *Id.* at 5. On November 23, 1971, the Board adopted substantially the same language as in the current Section 303.331. The Board recodified the 1971 rule as Rule 203(i)(4) in Water Quality Standards Revisions, R71-14 (March 7, 1972), and again recodified the rule as Section 303.331 in Rulemaking for Codification of Chapter 3 Water Pollution, R81-3 (Jan. 21, 1982).

The Board finds that 35 Ill. Adm. Code 303.331 is more stringent than necessary in two respects to assure the protection and propagation of the balanced and indigenous population in Pool 14 of the Mississippi River. First, Section 303.331 is unduly stringent as to limiting excursion hours to 87.6 hours per year (1% of 8,760 hours in a year) for Quad Cities Station's

thermal discharge. For the reasons discussed in more detail below, increasing excursion hours to 219 hours (2.5% of 8,760 hours in a year) for Quad Cities Station is sufficiently protective of aquatic life in Pool 14. In prior years when the station exceeded the regulatory limit of 87.6 hours, no appreciable harm was observed. *See* Exelon Ans. at 15. Under these circumstances, a 1% limit is overly stringent.

Second, Section 303.331 is overly stringent as to requiring a rolling twelve month calculation of excursion hours with respect to thermal discharge from Quad Cities Station. Quad Cities Station expends excursion hours during warm weather and low river flow. To date, Exelon has used excursion hours between March and August. Pet. Exh. 1 at 5. The March hours only occurred in one year which was 2012. In general, the station uses excursion hours in the summer months. Thus, when the allotment of 87.6 hours is used in August of one year, the station will not have any excursion hours available until one year later. If the station needs to use excursion hours in July of that second year because of warm ambient temperatures, it would not be able to do so. The record contains no evidence that using the allotment of excursion hours in August of one year and then July of the following year would cause appreciable harm to aquatic life. Under these circumstances, a rolling twelve-month calculation is overly stringent.

In response to Board questions, Exelon identified twelve month periods when Quad Cities Station exceeded the maximum numerical temperatures in 35 Ill. Adm. Code 303.331. Exelon Ans. at 25. Exelon also identified two instances when Exelon requested a provisional variance from Illinois EPA for additional excursion hours based on the rolling twelve month calculation which would not have been required based a calendar calculation: (1) July 1989, due to the use of 108 hours in August 1988; and (2) March 2012, due to the use of 33 hours in July 2011. *Id.* Based on a rolling twelve-month calculation, Quad Cities Station used excursion hours greater than the proposed 2.5% (219 hours) during the twelve-month period from March 2012 through February 2013. *Id.* at 27. Based on follow-up mussel surveys and long term fish monitoring, Exelon concluded there was no adverse impact to aquatic life. *Id.* at 27; Exelon Ans. Exh. 15, 17, 21.

The Board notes that Section 303.331 sets lower numeric temperature thresholds than Illinois temperature standards for general use waters at 35 Ill. Adm. Code 302.211(e). The Board further notes that 35 Ill. Adm. Code Section 302.211(d) requires that a discharger must not cause temperatures in the receiving stream to increase by more than 5°F above natural temperatures. Exelon does not seek relief from this requirement and this temperature limit will remain as an additional safeguard on water quality. Quad Cities Station has not exceeded the monthly maximum limits by more than 5°F. Exelon Ans. at 26.

**Section 302.102(b)(8) Mixing Zone.** In Quad Cities Station's discharge permit, Illinois EPA authorized the station to measure compliance with 35 Ill. Adm. Code 303.331 and 302.211 at the edge of a mixing zone 500 feet downriver from the diffuser pipes. Pet. at 15. Among other requirements for establishing a mixing zone, Section 302.102(b)(8) requires that such a mixing zone be no more than 25% of the cross-sectional area or volume of flow of the receiving stream. 35 Ill. Adm. Code 302.102(b)(8).

A discharger, upon meeting certain requirements, is allowed to use a limited portion of the receiving water to mix the effluent with the receiving water and is excused from compliance with the applicable water quality standard in that limited portion of the receiving water. See Marathon Oil Co. v. IEPA, PCB 92-166 (Mar. 31, 1994); see also 40 C.F.R. § 131.13. A mixing zone is “an area for allowed mixing which is formally defined by Illinois EPA in the NPDES permitting process and, if granted, is included as a condition in the permittee’s NPDES permit.” Granite City Division of National Steel Co. v. PCB, 155 Ill.2d 149, 160 (1993). Where a permit is silent as to mixing, the discharger has the burden of proof to show compliance with the mixing zone regulations if it uses mixing as a means of compliance with water quality standards. 35 Ill. Adm. Code 302.102(i). To satisfy CWA Section 316(a), the mixing zone would need to ensure the protection and propagation of the balanced and indigenous population.

In addressing the appropriate mechanism for relief from the mixing zone provisions, Illinois EPA states that the CWA Section 316(a) approach to thermal relief is different from the requirements for obtaining relief from other effluent limitations, such as an adjusted standard. Illinois EPA states the petitioner must meet the burden of proof found at CWA Section 316(a). IEPA Ans. at 9. Illinois EPA states that thermal relief could take various forms, such as: “(1) relief from a maximum temperature, (2) relief from an existing thermal mixing zone limit, (3) additional excursion hours, or (4) any combination of the above.” *Id.* at 10.

The Board finds that a 75% zone of passage required by 35 Ill. Adm. Code 302.102(b)(8) is more stringent than necessary to assure the protection and propagation of the balanced and indigenous population of aquatic life in Pool 14 of the Mississippi River. Section 302.102(b)(8) requires that the area and volume in which mixing occurs, alone or in combination with other areas and volumes of mixing, must not contain more than 25% of the cross-sectional area or volume of flow of a stream except for those streams where the dilution ratio is less than 3:1. Correspondingly, the zone of passage would be no less than 75% by area or volume. Exelon’s demonstration shows that a zone of passage only would be less than 75% (corresponding to mixing zone greater than 25%) when flow in Pool 14 is below 16,400 cfs. Pet. Exh. 1 App. C at C-31. Such low flows historically have been rare. Historical flow records show that from January 1986 through December 2011 there were 209 days when river flow was below 16,400 cfs. Pet. Exh. 1 at 5 citing Haas, J., *Practical Applications and the Examination of the Zone of Passage at Quad Cities Nuclear Station* (2011); Pet. Exh. 1 App. C at C-21 citing Army Corps records for Lock & Dam 14 found at [www.rivergages.com](http://www.rivergages.com). Further, during this time period, only 25 of the 209 days occurred during the biologically important months of March, April, May, and October. *Id.* Based on long-term fish monitoring and mussel bed studies, there is no evidence that these reductions in the size of the zone of passage caused appreciable harm to the fish or mussel population in Pool 14.

### **Prospective Demonstration (Appendix B)**

Exelon must demonstrate that its requested alternative thermal effluent limitation will assure the protection and propagation of the balanced and indigenous population of Pool 14 of the Mississippi River. As explained above, there are two methods for making this demonstration: a prospective demonstration or a retrospective demonstration. Exelon argues that under both analyses, its requested alternate limit is sufficiently protective.

Exelon's prospective demonstration addresses the biological implications on Pool 14 of the Mississippi River of Exelon's requested alternative thermal effluent limit. Exelon's prospective demonstration, titled "Biothermal Assessment: Prospective Demonstration," is found at Appendix B to Exhibit 1 of Exelon's Petition. Pet. Exh. 1 App. B. Specifically, Exelon analyzes the effect of:

1. Changing the limitation in Section 303.331 that water temperature must not exceed the maximum monthly temperature during more than 1% of the hours in the twelve month period ending with any month (87.6 hours) to 3% (262.8 hours). Only 1.5% (131.4 hours of the 262.8 hours) may be used for temperatures between 89°F and 91°F. Exceedances in July, August, and September may be up to 5°F rather than 3°F.
2. Changing the limitation in Section 303.331 that water temperature must not exceed the maximum monthly temperature during more than 1% of the hours in the twelve month period ending with any month to a calendar year ending in December.
3. Changing the requirement in Section 302.102(b)(8) that the area of the river outside of the mixing area (zone of passage) contain at least 75% of the cross-sectional area or volume flow to 66%. Pet. Exh. 1 App. B at B-3 to B-4.

Exelon's prospective demonstration predicts how its proposed alternate thermal effluent limitation might alter the thermal environment of Pool 14 of the Mississippi River during the months of June through September. HDR assessed the thermal tolerances of four RIS (largemouth bass, channel catfish, spotfin shiner, and walleye) in relation to the proposed thermal effluent limit.

**Increase in Excursion Hours.** Exelon requests an increase in excursion hours from 87.6 excursion hours (1% of 8,760 hours in a year) to 219 excursion hours (2.5% of 8,760 hours in a year). Quad Cities Station expends excursion hours when the temperature at the edge of the mixing zone exceeds the numerical limit up to 3°F over the limit. Exelon further requests that 131.4 (1.5% of 8,760 hours in a year) of these hours may be exceeded by up to 5°F in July, August, and September. In other words, 131.4 of these hours may be used for temperatures between 89°F and 91°F in July and August and between 88°F and 90°F in September.

However, Exelon's prospective analysis used 262.8 excursion hours (3% of 8,760 hours) and concluded that 262.8 excursion hours, along with using 131.4 hours (1.5% of 8,760 hours) of the 262.8 hours for temperatures up to 5°F above the limit, will not cause appreciable harm to the balanced and indigenous population in Pool 14 of the Mississippi River. Exelon argues that its current petition requesting 219 excursion hours is more protective than its prospective analysis and thus also does not cause appreciable harm.

Specifically, Exelon concludes that there will be negligible impact on growth of largemouth bass and channel catfish and potential benefit to spotfin shiner. Pet. Exh. 1 App. B at B-15. For walleye under constant flow scenarios, the number of growth days lost with 87.6 excursion hours is predicted at 9.6 days and with 262.8 excursion hours is 15 days. *Id.* at B-16. Exelon's requested increase in excursion hours is predicted to result in losing an additional 5.7 growth days for walleye. *Id.* Under the variable flow scenario, the number of walleye growth days lost with 262.8 excursion hours is 12.22 days or an additional 2.62 days. *Id.*

**Calendar Year Calculation.** Exelon argues that tracking excursion hours on a calendar year basis instead of a twelve-month rolling basis "should have no biological impact." Pet. Exh. 1 App. B at B-4; Pet. Exh. 1 at 5. Exelon reviewed operating records of the Quad Cities Station's excursion hours. *Id.* From 1983 to 2013, excursion hours "occurred exclusively during the March-August period." *Id.* Exelon represents that "[t]here is virtually no possibility that Exelon would use excursion hours in December or January." *Id.*

Quad Cities Station expends excursion hours during warm ambient water temperatures and low river flow. Ambient river temperatures at the intake to Quad Cities Station have exceeded the numerical temperature limits in 35 Ill. Adm. Code 303.331 of 86°F in July and August and 85°F in June and September. Temperatures at the intake exceeded 86°F on three days in July 1995, two days in July 1999, eight days in July-August 2001, and four days in July-August 2006. Pet. Exh. 1 App. D at D-10 to D-11. In addition, intake temperatures ranged from 85°F to 86°F on seven days in 2005. *Id.* at D-10. When the allotment of 87.6 hours is used in August of one year, the station will not have any excursion hours available until one year later. If the station needs to use excursion hours in July of that second year because of warm ambient temperatures, it would not be able to do so. The record contains no evidence that using the allotment of excursion hours in August of one year and then July of the following year would cause appreciable harm to aquatic life.

To date, Exelon has used excursion hours between March and August. Pet. Exh. 1 at 5. Based on prior operations and conditions, it is reasonable to predict that, to the extent Quad Cities Station expends excursion hours, this will occur in the warmer months and not at the turn of the calendar year between December and January. Accordingly, using a calendar year allotment of excursion hours rather than a rolling twelve month allotment should not be expected to cause harm to aquatic life in Pool 14 of the Mississippi River.

Illinois EPA contends in its recommendation that Exelon also should be required to further study the effect on aquatic life of using excursion hours on a calendar year basis instead of a rolling twelve-month basis. Rec. at 5. Exelon responds that it will commit to further studying this concern. Resp. at 4. As discussed above, based on current information, the Board finds that Exelon's requested alternative thermal effluent limitations will assure the protection and propagation of the balanced and indigenous populations of aquatic life in Pool 14 of the Mississippi River. However, the Board also finds it appropriate to continue to monitor whether increasing the number of excursion hours will assure the protection of aquatic life in Pool 14. Accordingly, the Board includes such a condition in its order below.



**Zone of Passage.** Exelon argues that reducing the zone of passage from 75% to 66% “is expected to have a negligible effect on” RIS. Pet. Exh. 1 App. B at B-4. Exelon addressed four species in its prospective analysis: channel catfish, largemouth bass, spotfin shiner, and walleye. Only walleye “shows seasonal movements that, at least in theory, could be affected by reducing the [zone of passage].” Pet. Exh. 1 App. B at B-5. However, Exelon concludes reducing the zone of passage to 66% “should have no impact on walleye migration/movement in Pool 14 in the future.” *Id.* Walleye move within the pool at two times of the year, during late March to early April and during October, and during these times river flow rarely drops low enough to result in a zone of passage less than 75%. *Id.* Exelon’s models indicate that the zone of passage will be less than 75% when flow is below 16,400 cfs. *Id.*; *see also* Pet. Exh. 1 App. C at C-31 (Table C-1). Historical flow records show that river flow was below 16,400 cfs for four days during March to May and twenty-one days during October during 1986 to 2013. *Id.* Pet. Exh. 1 App. B at B-5; Pet. Exh. 1 at 5.

To assure that the zone of passage does not drop below 66%, Quad Cities Station plans to derate at river flows of 13,200 cfs. Pet. Exh. 1 App. B at B-4. Exelon notes that to comply with the 35 Ill. Adm. Code 302.211(d) requirement that a discharger not cause temperatures in the receiving stream to increase by more than 5°F above natural temperatures, Quad Cities Station must derate at river flows of 13,000 cfs. *Id.*

**Board Conclusion on Prospective Demonstration.** The Board finds that Exelon demonstrated that its requested alternative thermal effluent limitation will assure the protection and propagation of the balanced and indigenous population of Pool 14 of the Mississippi River. Exelon addressed four species in its prospective analysis: channel catfish, largemouth bass, spotfin shiner, and walleye. The increase in excursion hours and decrease in zone of passage are predicted to have negligible impact on channel catfish, largemouth bass, and spotfin shiner. For walleye, the increase in excursion hours is predicted to cause a loss of no more than 2.62 to 5.7 growth days using conservative assumptions including assuming no avoidance behavior. A decreased zone of passage is unlikely to harm walleye appreciably because river flow rarely falls low enough to result in a zone of passage less than 75% during late March to early April and during October when walleye move through Pool 14. The Board does not consider these predicted impacts to be appreciable harm to the walleye population in Pool 14.

To further ensure that thermal discharges from Quad Cities Station do not appreciably harm aquatic life, the Board orders three conditions to the requested relief relating to a study of crappie and sauger populations, a study of the impact of a calendar year allotment of excursion hours, and restrictions on the minimum size of the zone of passage based on river flow.

### **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 in Pool 14 of the Mississippi River. For a pre-existing discharge, Exelon may make this demonstration through a retrospective demonstration. Although Exelon is requesting new alternative thermal effluent limitations, Exelon argues that the proposed limit is similar to

conditions observed during its operations and under a retrospective analysis its requested alternate limit is sufficiently protective.

Exelon's retrospective demonstration addresses the biological implications on Pool 14 of past thermal discharges from Quad Cities Station. Exelon's retrospective demonstration, titled "Retrospective Demonstration and Conclusions Regarding Protection and Propagation of a Balanced Indigenous Community under Clean Water Act Section 316(a)," is found at Appendix C to Exhibit 1 of Exelon's Petition. Pet. Exh. 1 App. C. Exelon's retrospective analysis consists of two parts. First, Exelon analyzed the condition of each biotic category by comparing its current composition to what its composition would have been without the operation of Quad Cities Station. *Id.* at C-3. Second, Exelon analyzed whether station operations caused any change in population for each biotic category. *Id.*

**Aquatic Life Populations.** Over the years of operations at Quad Cities Station, Exelon has not observed substantial changes in any nuisance species or heat-tolerant species. Pet. Exh. 1 App. C at C-24. Any changes to these populations have been observed upstream and downstream of the diffuser and the station's thermal discharge does not appear to be a contributing factor to these populations. *Id.* Most indigenous species in Pool 14 have either maintained or increased in abundance during station operations. *Id.* Declines in black crappie, white crappie, and sauger appear to have other causes. *Id.* Trends in abundance appear at both upstream and downstream sampling locations. *Id.* Similarly, trends in mussel populations are apparent at both upstream and downstream sampling locations and do not appear to be impacted by thermal discharge from the station. *Id.* at C-25. These population trends of each biotic category are discussed in more detail above in the biotic category analysis.

**Extreme Weather Events.** In July and August 2006, Illinois experienced very hot weather. In July and August 2006, Quad Cities Station used 222.75 excursion hours due to high ambient water temperature and low river flows. Pet. Exh. 1 App. A at A-35. On July 31, 2006, the Army Corps informed Quad Cities Station that it would reduce the flow in Pool 14 from 23,300 cfs to 12,700 cfs. Pet. Exh. 1 at 27; Exelon Ans. at 15-16. Quad Cities Station derated through August 3 when river flow returned to 23,000 cfs. *Id.* On August 1, 2006, "distressed and dead fish were observed both above and below the plant." *Id.* Exelon collected 292 dead fish both upstream and downstream of the station and identified fifteen species. *Id.* Seven of the species were represented by a single specimen. *Id.* 215, or 74 percent, of the dead fish were mooneye. *Id.* Sauger, smallmouth buffalo, and bigmouth buffalo were found only upstream of the station. *Id.* Exelon continued to find mooneye in impingement samples from the intake for nearly a week after river flow returned to normal. *Id.* Exelon concludes that the mooneye die-off occurred in the vicinity of the station as well as upstream of the station, and "that the die-off was a systemic issue occurring quite far upstream from Quad Cities Station and was not related to the Station's discharge." *Id.*; Exelon Ans. at 15. In other words, ambient temperatures upstream of the station outside of the plant's discharge reached lethal levels for mooneye. *Id.* Exelon analyzed data on mooneye abundance before and after 2006 and found that the mooneye standing stock returned to near normal in 2007. *Id.* at 28; Exelon Ans. at 15.

In 2006, Exelon also observed "changes to unionid community characteristics" in the Upstream Bed, Cordova Bed and Steamboat Slough compared to prior years. Pet. Exh. 1 App. A

at A-36. Exelon observed “increased mortality” in the Upstream and Cordova Beds. *Id.*, citing Ecological Specialists Inc., *Final Report Results of Unionid Mussel Monitoring in 2007 near Quad Cities Nuclear Station* (2009). However, in October 2007 and August 2008, “community characteristics” in the Upstream, Cordova, and Steamboat Slough Beds “were similar to previous monitoring events.” Pet. Exh. 1 App. A. at A-36.

During July 2012, Illinois experienced another hot weather period and Quad Cities Station used 219 excursion hours. Pet. Exh. 1 at 29. Exelon visually inspected during these excursion periods for dead or stressed aquatic life. *Id.* On July 7, 8, and 9, Exelon observed “very small numbers” of dead fish upstream and downstream of the station. *Id.* Upstream of the diffuser, Exelon found seventeen dead northern pike, two carp, two freshwater drum, and two walleye. *Id.* Downstream of the diffuser, Exelon found two dead northern pike and one catfish. *Id.* Exelon found one dead catfish at the diffuser. *Id.* Exelon states the die-off was documented fifteen river miles north of Quad Cities Station, and that both Illinois DNR and Iowa DNR concluded that the situation was not caused by Quad Cities Station operations. Exelon Ans. at 15. Exelon concludes that thermal discharge from Quad Cities Station did not increase thermal stress on aquatic life during these July 2012 excursion hours. Pet. Exh. 1 at 29.

**River Flow.** The Quad Cities Station NPDES permit requires recording of river flow weekly when flows are above 23,000 cfs and daily when river flow falls below 23,000 cfs. Exelon Ans. at 22; IEPA Ans. at 5. Historical flow records show that from January 1986 through December 2011 there were 209 days when river flow was below 16,400 cfs. Pet. Exh. 1 at 5, citing Haas, J., *Practical Applications and the Examination of the Zone of Passage at Quad Cities Nuclear Station* (2011); Pet. Exh. 1 App. C at C-21, citing Army Corps records for Lock & Dam 14 found at [www.rivergages.com](http://www.rivergages.com). Further, during this time period, only 25 of the 209 days occurred during the biologically important months of March, April, May, and October. *Id.* Specifically, river flow dropped below 16,400 cfs on four days during March to May and twenty-one days during October. Pet. Exh. 1 App. B at B-5; Pet. Exh. 1 at 5. The four springtime days were May 27 (14,921 cfs), 28 (14,887 cfs) and 29 (15,195 cfs), 1988, and March 2 (14,539 cfs), 1990 (river flow noted in parentheses). Pet. Exh. 1 App. C at C-21. The October days occurred in 1988, 1989, 2000, and 2003. *Id.* at C-22.

In June 1988, river flow dropped below 16,400 cfs. Pet. Exh. 1 App. C at C-21. Low flow during June potentially could impact freshwater drum and flathead catfish. *Id.* Freshwater drum eggs and larvae drift through the diffuser area during June. Quad Cities Station has been monitoring freshwater drum population since 1971, and intensively since 1978 at the request of Illinois DNR. *Id.*; Pet. Exh. 1 at 11. These studies show that thermal discharge from Quad Cities Station has not impacted freshwater drum population. *Id.* Flathead catfish move in Pool 14 to spawning areas above and below the diffuser during June. *Id.* Long-term fish monitoring shows “very little fluctuation in flathead catfish populations since [Quad Cities Station] returned to open cycle cooling in 1983.” *Id.* at C-22.

**Zone of Passage.** Over the years of operation, Exelon extensively studied the dynamics of the thermal plume from Quad Cities Station at various river flows through both sampling and modeling.

Exelon provided results of thermal modeling conducted by IIHR in 2002 and 2011 used to develop zone of passage curves. Exelon used the 2002 zone of passage curves to develop Table C-1, indicating the percent zone of passage associated with the river flow based on a full thermal load with both units operating at full capacity and all six circulating water pumps in operation. Pet. Exh. 1 App. C at C-20, C-31; Exelon Ans. at 3-4, 22; Exelon Ans. Exh. 22,23. Illinois EPA explained that the IIHR 2002 modeling “used the hydrothermal simulation engine, U<sup>2</sup>-THERM, which is a special engine for simulating three-dimensional (3D) coupled hydrodynamic and heat transfer flows with buoyancy effect.” IEPA Ans. at 4-5. Illinois EPA stated that the data from the model are reliable. *Id.* at 5.

Table C-1 and the 2002 zone of passage curve assessed the size of the zone of passage with respect to the volume of discharge, showing a zone of passage of 75% (corresponding to mixing zone greater than 25%) when river flow in Pool 14 is at least 16,400 cfs using the current diffuser configuration. The 2011 zone of passage curve assessed the zone of passage with respect to area, showing a zone of passage of 75% when river flow is at least 12,700 cfs. Exelon Ans. at 4. Since the zone of passage calculated with respect to the volume of discharge is smaller than the zone of passage calculated with respect to cross-sectional area, the zone of passage calculated by volume is the limiting factor. Pet. Exh. 1 App. C. at C-20. Based on the zone of passage curve with respect to the volume of discharge, Exelon’s proposed zone of passage of 66% would not occur until flow drops to 13,200 cfs. *Id.* As noted above, the 7Q10 rate in Pool 14 is 13,800 cfs while the typical summertime flow is 30,000 cfs. *Id.* at C-31; Pet. Exh. 1 at 20. Exelon states that, even under the requested 66% zone of passage, the mixing zone would remain 24.9 acres, less than the 26 acre maximum allowed under 35 Ill. Adm. Code 302.102(b)(12). Exelon Ans. at 19.

Based on Table C-1, the requested 66% zone of passage would only occur at flows less than the lowest 7Q10 of 13,800 cfs. Pet. Exh. 1 at 20; Pet. Exh. 1 App. C at C-31. Exelon concludes that, while modeling shows brief periods when the zone of passage was less than 75%, there is no evidence that these reductions in the size of the zone of passage caused appreciable harm to the fish population in Pool 14. Pet. Exh. 1 App. C at C-22. Further, Exelon asserts that there is abundant habitat for the RIS outside the mixing zone. *Id.* The long-term fish monitoring program since 1971 shows that the thermal discharge from Quad Cities Station has caused no appreciable harm to the fish population in Pool 14. *Id.* In addition, mussels are not impacted by the size of the zone of passage. *Id.* Mussel habitat is available throughout Pool 14 both upstream and downstream of the diffuser. *Id.*

**NPDES Permit Compliance.** The Quad Cities Station mixing zone is currently defined in the NPDES permit as “a straight line across the Mississippi River, 500 Feet downstream of the diffuser pipes.” Pet. Exh. 1 at 2; *see also* Exelon Ans. Exh. 1. Exelon states that this definition of the mixing zone would remain the same under Exelon’s requested 66% zone of passage, and would not change based on river flow or plant discharge flow. Exelon Ans. at 20.

Under a revised NPDES permit, Illinois EPA states that compliance with the thermal limits and excursion hours would continue to be determined by Special Condition 7. IEPA Ans. at 8. Exelon would continue to monitor temperature along the straight line 500 feet downstream from the diffuser pipes as well as upstream. Exelon Ans. at 20. Quad Cities Station takes

temperature readings typically from ten locations upstream and ten locations downstream at depths in 5-foot intervals starting at 1 foot below the surface of the water down to the river bottom. *Id.* Although temperature is continuously monitored at the intake structure as well as the discharge bay at the inlet to the diffuser pipe, the frequency of in-river monitoring varies with river and environmental conditions according to Special Condition 7 of the NPDES permit from once per day up to ten times per day when required. *Id.* at 20-21. As currently allowed under Special Condition 7, Exelon also plans to continue using the existing temperature monitoring curve incorporated in its current NPDES permit in combination with other data (Quad Cities Station and ambient) or actual temperature measurements in the river to demonstrate compliance. *Id.* at 21.

In the modified NPDES permit incorporating the alternative thermal effluent limitations, Illinois EPA states that Exelon will have to demonstrate compliance with the zone of passage if river flow is below 16,400 cfs. IEPA Ans. at 9. Exelon plans to use the zone of passage curve from the April 2002 IIHR report to demonstrate compliance with the minimum 66% zone of passage at flows greater than or equal to 13,200 cfs. Exelon Ans. at 21. Exelon states, “[f]or flows below 13,200 cfs, [Quad Cities Station] may need to reduce the amount of heat discharged to the river by reducing output or making other operation changes to maintain a 66% minimum zone of passage.” *Id.* During the initial cycle for the modified NPDES permit, Exelon intends to evaluate the use of a table based on the zone of passage curve from the IIHR report. *Id.* Rather than using the 2002 zone of passage curve for the purposes of demonstrating compliance, Illinois EPA states that a condition providing the zone of passage must include at least 75% at river flows of 16,400 cfs or more and no less than 66% when river flow is less than 16,400 cfs would be better understood by those reading the NPDES permit at this time. IEPA Ans. at 6, 8.

**Cumulative Impacts on Water Quality.** Exelon analyzed the water quality near Quad Cities Station and considered how other factors including organic carbon, total phosphorus, total nitrogen, biocides, heavy metals, and other thermal discharges interact with thermal discharges. Pet. Exh. 1 App. C at C-4 to C-8. Quad Cities Station itself is not a significant source of nutrients. *Id.* at C-4. Quad Cities Station has treated its cooling water system with sodium hypochlorite as a biocide. *Id.* at C-6. The station uses sodium bisulfite as a neutralizing agent prior to discharge to the river to comply with the total residual chlorine/total residual oxidant limit. The limit of 0.05 ppm is an order of magnitude lower than the level that causes fish mortality. *Id.* Accordingly, Exelon concludes that the station’s use of biocides has not caused harm to fish communities in Pool 14 or harm to the balanced and indigenous population. *Id.* at C-6 to C-7. Exelon contends that heavy metals mostly are found in the sediment of the river and thermal discharge from Quad Cities Station will not cause release of these metals from the sediment. *Id.* at C-7. Exelon notes that there are cooling water discharges approximately 6.5 miles upstream from Quad Cities Station intake but that the thermal component of these discharges dissipates to ambient conditions by the time they reach Quad Cities Station. *Id.* at C-8. Exelon concludes that “[t]here is no evidence of harmful interactions between the Station’s thermal discharge and other pollutants.” *Id.*

**Board Conclusion on Retrospective Demonstration.** Exelon’s retrospective demonstration looked at Quad Cities Station’s operating history and observed impacts dating back to 1973. During that time, mussel and fish populations have remained diverse and stable.

Balanced and indigenous populations of aquatic life have continued during this time. Thermal discharges from Quad Cities Station do not appear to have contributed to population declines during hot weather periods in 2006 and 2012 because dead aquatic life were observed both upstream and downstream of the station. Accordingly, the Board finds that Exelon's retrospective demonstration provides further support that Exelon has demonstrated that its requested alternative thermal effluent limitation will assure the protection and propagation of the balanced and indigenous population of Pool 14 of the Mississippi River.

### **CONCLUSION**

Based on the record before it, the Board finds that Exelon provided adequate proof that the heated effluent from Quad Cities Station to Pool 14 of the Mississippi River under the alternative thermal effluent limitations in the order below "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. The Board grants Exelon's requested relief subject to conditions described in this opinion and order, effective today.

In granting an alternative thermal effluent limitation, the Board "may impose such conditions as may be necessary to accomplish the purposes of the Act." 35 Ill. Adm. Code 106.1170(b). As discussed above, Illinois EPA recommended and Exelon agreed to conditions of the thermal relief related to further study of white crappie, black crappie, and sauger, as well as the impact on aquatic life when Quad Cities Station uses more than 219 excursion hours based on a rolling twelve-month calculation. Exelon and Illinois EPA agreed to conditions contained in the order below as set forth in the Board's questions addressed to Illinois EPA and to Exelon. Exelon Ans. at 19, 22, 25, 27; IEPA Ans. at 4, 5-6, 11-12.

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

### **ORDER**

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

1. In lieu of 35 Ill. Adm. Code 303.331, the following shall apply:

The monthly temperature standards set forth in 35 Ill. Adm. Code 303.331 shall apply to discharges from Quad Cities Nuclear Station provided that Quad Cities Nuclear Station may exceed these standards by 3°F for no more than 219 hours (2.5%) per calendar year, except that during July, August, and September, the temperature standards may be exceeded by up to 5°F for no more than 131.4 hours of the 219 hour annual allotment.

2. In lieu of 35 Ill. Adm. Code 302.102(b)(8), the following shall apply:

The mixing zone for Quad Cities Nuclear Station shall allow for a zone of passage that includes at least 66% of the cross sectional area and volume of flow of the Mississippi River.

3. The following conditions shall apply to Exelon's alternative thermal effluent limitations:
  - a. Exelon must conduct a study of white crappie, black crappie, and sauger populations in Pool 14 of the Mississippi River. Exelon must conduct this study during the term of the first NPDES permit containing this order's alternative thermal effluent limitations. The results of this study must be made available by Exelon to Illinois EPA and Illinois DNR when the Quad Cities Nuclear Generating Station applies for renewal of its NPDES permit.
  - b. The mixing zone for the Quad Cities Nuclear Generating Station shall allow for a zone of passage that includes at least 75% of the cross sectional area and volume of flow of the Mississippi River when the river flow is 16,400 cubic feet per second or more and no less than 66% when river flow is less than 16,400 cubic feet per second.
  - c. Exelon must assess the impact on aquatic life when the Quad Cities Station uses more than 219 excursion hours in any twelve-month period. Exelon must conduct this study the first time that more than 219 excursion hours are used in a twelve-month period. The results of this study must be made available by Exelon to Illinois EPA and Illinois DNR when the Quad Cities Nuclear Generating Station applies for renewal of its NPDES permit.
4. The Agency must expeditiously modify Exelon's NPDES permit consistent with the foregoing opinion and order.

IT IS SO ORDERED.

Section 41(a) of the Act provides that final Board orders may be appealed directly to the Illinois Appellate Court within 35 days after the Board serves the order. 415 ILCS 5/41(a) (2012); *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, John T. Therriault, Clerk of the Illinois Pollution Control Board, certify that the Board adopted the above opinion and order on September 18, 2014, by a vote of 4-0.

A handwritten signature in black ink that reads "John T. Therriault". The signature is written in a cursive style with a long horizontal stroke at the end.

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John T. Therriault, Clerk  
Illinois Pollution Control Board