BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
WATER QUALITY STANDARDS AND	)	R08-9
EFFLUENT LIMITATIONS FOR THE	)	(Rulemaking - Water)
CHICAGO AREA WATERWAY SYSTEM	)	
AND THE LOWER DES PLAINES RIVER:	)	Subdocket C
PROPOSED AMENDMENTS TO 35 Ill.	)	
Adm. Code Parts 301, 302, 303 and 304	)	

NOTICE OF FILING

To: ALL COUNSEL OF RECORD
(Service List Attached)

PLEASE TAKE NOTICE that on the 2nd day of February, 2011, I electronically filed with the Office of the Clerk of the Illinois Pollution Control Board, the **Pre-Filed Testimony of Jennifer Wasik Regarding MWRDGC Proposal for Aquatic Life Uses and Water Quality Criteria in the CAWS.**

Dated: February 2, 2011.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

By: */s/ Fredric P. Andes*
One of Its Attorneys

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PROOF OF SERVICE

The undersigned attorney certifies, under penalties of perjury pursuant to 735 ILCS 5/1-109, that I caused a copy of the foregoing, **Notice of Filing** and **Pre-Filed Testimony of Jennifer Wasik Regarding MWRDGC Proposal for Aquatic Life Uses and Water Quality Criteria in the CAWS**, to be served via First Class Mail, postage prepaid, from One North Wacker Drive, Chicago, Illinois, on the 3rd day of February, 2011, upon the attorneys of record on the attached Service List.

/s/ David T. Ballard
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PRE-FILED TESTIMONY OF JENNIFER WASIK REGARDING MWRDGC PROPOSAL FOR AQUATIC LIFE USES AND WATER QUALITY CRITERIA IN THE CAWS

Introduction

I am Jennifer Wasik, and I have been a biologist in the Aquatic Ecology and Water Quality Section at the District for over 9 years, and am currently the Supervising Aquatic Biologist. I have a Bachelor of Science degree in Biology from the University of Michigan and a Master of Science degree in Environmental Management from the Illinois Institute of Technology. In addition to overseeing the collection of biological, habitat, and sediment samples for our Ambient Water Quality Monitoring (AWQM) Program, I manage the Illinois Waterway Monitoring Program, and the District's Continuous Dissolved Oxygen Monitoring Program. I serve on various local water quality-related committees and am very involved in reviewing and assessing water quality standards that are proposed for waterways in the District's service area.

The purpose of my testimony is to describe the District's proposed water quality criteria and Aquatic Life Uses (ALUs) for the Chicago Area Waterway System (CAWS) along with the rationale in support of this proposal. The District proposes three categories of ALUs for the CAWS: CAWS Category 1 (Modified Warm Water Aquatic Life Use), CAWS Category 2 (Limited Warm Water Aquatic Life Use), and CAWS Category 3 (Severely Limited Water Aquatic Life Use).

The District is proposing minimum dissolved oxygen (DO) criteria for CAWS Categories 1 and 2 that are identical to those proposed by IEPA. The proposed criteria are 4.0 milligrams per liter (mg/L) for CAWS Category 1 and 3.5 mg/L for CAWS Category 2. However, the District proposes a narrative criterion to prevent offensive conditions for CAWS Category 3 Waters, similar to section 302.206a of the Illinois General Use Standard. Another difference between the District proposal and the original IEPA proposal is that we do not believe a 7-day mean of minima or early life stage DO standard are appropriate for the CAWS, as I will explain in my testimony. Finally, the District proposes a wet weather provision from the DO water quality standard due to the significant and unavoidable negative impact of precipitation on the CAWS.[1]

The District believes that our proposal of DO minima ranging from 3.5-4.0 mg/L is actually more stringent than is needed to support the current and potential aquatic life in the CAWS for the following reasons, which are supported in my testimony:

1) The LimnoTech Habitat Evaluation Report (filed with IPCB on January 6, 2010, PC Number 284) summarized in Scott Bell's testimony for the District indicates that physical habitat explains most of the variation in the CAWS fish community beyond natural variation, and that factoring in DO makes very little difference. Therefore, increasing the DO in the CAWS is unlikely to result in a measurable improvement in fish community.
2) Popular game fish such as largemouth bass for which adequate physical habitat exists in the CAWS can withstand periods of low DO according to the scientific literature.

[1] This proposal is subject to approval by the District's Board of Commissioners as to any expenditures that would be needed to comply with the District's proposed DO standards.

3) Our proposed DO minima standards are as protective as those set forth in the Illinois General Use standards and also those described in the 1986 USEPA Ambient Water Quality Criteria Document for DO (IEPA Attachment X).

4) Waterways in other states with similar physical characteristics to the CAWS are subject to DO minimum standards between 1-2 mg/L to protect their ALUs.

The District is also proposing an alternative chronic cyanide criteria to support ALUs in the CAWS. As I testified previously in R08-9, IEPA has proposed a chronic cyanide standard of 5.2 µg/L, which is identical to the Illinois General Use Water Quality Standard (General Use Standard). We propose a standard of 10 µg/L in order to be consistent with the site-specific chronic cyanide water quality standard that has been applied to several of the General Use Waters of Cook County.

Finally, the District believes the proposed criteria for chronic zinc should be corrected to reflect an error that IEPA discovered in the General Use Standards. The standard proposed for the CAWS is identical to the erroneous General Use Standard which IEPA reported in November, 2010.

1. DESIGNATED AQUATIC LIFE USES

In determining the uses that should be designated for various segments of the CAWS, the District relied principally on the findings of the Habitat Evaluation and Habitat Improvement reports that have been prepared for the District by LimnoTech. As stated in the testimony of Dr. Mackey, and as confirmed by the Habitat Evaluation Report, the primary limiting factor affecting the structure and function of the biotic communities in the CAWS is the lack of physical habitat. In the Habitat Evaluation Report, physical habitat characteristics were assessed throughout reaches of the CAWS and data were evaluated to develop a habitat index that is

uniquely applicable to these urban waterways. This index was used along with fish data to assess the relative importance of physical habitat compared to water quality factors in the CAWS. Subsequently, the Habitat Improvement Report estimated habitat index scores based on potential habitat improvements in various reaches of the CAWS. The District believes that those index scores should be considered in determining the appropriate designated uses for each segment. Other important environmental factors should be considered when the habitat and habitat improvement index scores are borderline or inconclusive, including sediment toxicity and unique flow conditions.

The District is proposing three aquatic life use categories for the CAWS. The categories, and the rationale for designating individual waters in one of the three categories, are described below.

Chicago Area Waterway System Modified Warm Water Aquatic Life Waters (CAWS Category 1)

The Habitat Evaluation Report indicates that the North Shore Channel, upper North Branch Chicago River, and Little Calumet River habitats have relatively high index scores as compared to other segments. These waterways would be classified as CAWS Category 1 Waters. The CAWS Category 1 Waters are artificially constructed or channelized and contain reaches with earthen banks (steeper than most found in natural systems) and some areas of instream cover (e.g., overhanging riparian vegetation, fixed aquatic vegetation, boulders, or woody debris). Relatively lower depth areas may be present in these waters. Commercial navigation is generally absent in Category 1 Waters, with the exception of the Little Calumet River. While fine sediments may be widespread in the CAWS Category 1 Waters, a majority of

sediment samples were demonstrated to be non-toxic. The habitat features that are important to sustaining healthy and balanced warmwater aquatic communities as discussed in Dr. Mackey's testimony are not widespread in Category 1 Waters. However, the physical habitat in Category 1 Waters is relatively better than other waterways in the CAWS. Physical habitat in these reaches is not adequate to support a warmwater aquatic community that fully meets the goals of the Clean Water Act, nor do they have the potential to do so. Based on the physical habitat data collected by the District and the UAA contractors, a number of habitat attributes prevent Category 1 waters from maintaining a biological condition that meets the Clean Water Act's Aquatic Life goal. Such conditions are not reversible in the foreseeable future, however, some of the physical habitat limitations in reaches of Category 1 Waters may be improved to a degree as described in the LimnoTech Habitat Improvement Report.

A stable and tolerant fish community with representative species from various trophic levels exists and thrives in the CAWS. The abundance (number and weight) of largemouth bass and bluegill is significantly higher in Category 1 Waters than Category 2 Waters. In addition, the abundance of these fish species has increased more in Category 1 Waters than in Category 2 Waters, even though water quality improved throughout all of these waterways. The District believes this can be attributed to the slightly better physical habitat conditions present in Category 1 Waters.

The abundance and weight of intolerant fish, such as smallmouth bass, are also significantly higher in CAWS Category 1 Waters, but they are almost exclusively found at sampling stations in close proximity to Lake Michigan, particularly the Calumet River. The physical habitat characteristics generally prohibit these intolerant species from becoming widespread in the CAWS, even in Category 1 Waters.

Since physical habitat limits the biological condition of the CAWS, the management goal for Category 1 Waters is to maintain current fish populations that have demonstrated tolerance of its irreversible physical habitat features.

The District believes that there are other segments, not extensively analyzed in the Habitat Evaluation Report, that contain habitat attributes similar to Category 1 Waters: the Calumet River and Lake Calumet. The Calumet River, south of 130th Street to the O'Brien Lock and Dam, has a substantial continuous reach which contains certain physical habitat attributes that are either absent or found in isolated pockets in the rest of the CAWS. A side channel shallow (approximately 3 feet depth) area with relatively abundant fixed aquatic vegetation is present where the channel widens. A gradually sloping bank with emergent vegetation is present in this reach of the Calumet River to an extent not found in other areas of the CAWS. In addition, the Calumet River north of the O'Brien Lock and Dam has a direct hydrological connection to Lake Michigan, without a control structure, where fish species uncommon to the rest of the CAWS are sometimes found. Lake Calumet also exhibits several shallow areas, and instream cover consisting of woody debris and extensive overhanging vegetation near the shoreline. As a result, the District is proposing that the five previously mentioned CAWS segments be included in use Category 1. As noted below, these waters would be covered by a dissolved oxygen (DO) standard of 4.0 mg/L, to be met at all times except for time periods during which the wet-weather provision applies.

Chicago Area Waterway System Limited Warm Water Aquatic Life Waters (CAWS Category 2)

The Habitat Evaluation Report indicates that the habitat scores for the South Branch Chicago River, the Chicago Sanitary & Ship Canal, and the Cal-Sag Channel are significantly

lower than those for the Category 1 Waters. Therefore, these segments should be designated Category 2 Waters, with lower aquatic life attainment goals. CAWS Category 2 Waters are artificially constructed or channelized and generally lack significant reaches of earthen banks and instream cover (e.g., overhanging riparian vegetation, fixed aquatic vegetation, boulders, or woody debris). Lower depth areas are rare in these waters. Most of the commercial navigation in the CAWS occurs in the Category 2 Waters. A majority of sediment samples tested from some of the Category 2 Waters were demonstrated to be toxic.

There are two segments that do not fall obviously into a category based on the habitat index scores that also belong in Category 2: the Chicago River main stem, and the lower North Branch of the Chicago River. Both of these segments are "borderline" in the habitat index. However, available information concerning habitat improvement potential, the physical nature of these segments, and/or sediment toxicity, indicate that they belong in Category 2 rather than Category 1.

Potential index scores after physical habitat improvements listed on page 57 of the Habitat Improvement Report indicate that, unlike the other waterway reaches, the Chicago River demonstrates no potential for habitat improvement due to 97% vertical wall armored banks and the lack of overhanging vegetation and bank pocket areas. As stated on page 49 of the Habitat Improvement Report, "because of the developed urban nature of the riparian land of the Chicago River, it is assumed that any measure requiring significant use of that riparian land for habitat improvement would be infeasible."

While the habitat index scores in the upper and lower North Branch Chicago River are similar (49 and 47, respectively), the lower North Branch should be in Category 2 due to the

important distinctions observed between these two reaches. The primary physical habitat attributes which distinguish the lower North Branch from the upper reach include a preponderance of vertical wall banks, a lower incidence of overhanging vegetation, and fewer bank pocket areas. The lower North Branch is also subject to commercial navigation, unlike the upper North Branch.

Moreover, sediment toxicity data show that half the sediment samples collected from the lower North Branch Chicago River are considered to be toxic. This frequency of toxic sediment is uncharacteristic of Category 1 waters, but is more often associated with waterways classified as Category 2. The sediment toxicity present in the lower North Branch Chicago River is likely to limit further improvements in the biological communities of macroinvertebrates and fish regardless of further water quality improvements that would be required to meet higher DO standards.

The IEPA UAA report classified the Lake Calumet Connecting Channel as Aquatic Life Use B. The Lake Calumet Connecting Channel is very deep and its shoreline consists of vertical sheet piling and rip rap. There is no instream cover or overhanging vegetation. While the Habitat Evaluation Report does not assess this segment, available information leads the District to believe that it belongs in Category 2.

The fisheries management goal in Category 2 Waters would also be to maintain current fish populations, recognizing that with even more severe physical habitat limitations and fewer opportunities for habitat improvement, these populations will not reach the levels present in Category 1 Waters.

As explained below, Category 2 Waters will comply with a DO standard of 3.5 mg/L, to be met at all times except for time periods during which the wet-weather provision applies.

Chicago Area Waterway System Severely Limited Aquatic Life Waters (CAWS Category 3)

The habitat index score in the south fork of the south branch of the Chicago River (Bubbly Creek) is in the range of other CAWS Category 2 Waters, but other factors indicate that its attainable aquatic uses are considerably more limited than other segments in the CAWS. In addition to significant sediment contamination, Bubbly Creek also exhibits a unique flow regime. It is stagnant during dry weather, and it is dominated by high-velocity CSO flows from the Racine Avenue Pumping Station during wet-weather periods.

Similarly, the Grand Calumet River exhibits stagnant conditions during dry weather. Seventy-five percent of sediment samples from the Grand Calumet River show toxicity. Between 2001 and 2008, only 3 fish species were collected from the Grand Calumet River. Other information regarding beneficial use impairments on the Grand Calumet River can be found on the USEPA website, as an area of concern (AOC) at http://www.epa.gov/glnpo/aoc/grandcal.html#Beneficial. The Grand Calumet River was not evaluated by LimnoTech during the physical habitat assessment. However, because of the stagnant conditions during dry weather and a preponderance of fine grained, organic, toxic sediments, the Grand Calumet River is designated as a Category 3 Water.

There are several other segments, such as the North Branch Canal, the Collateral Channel, and other off-channel slips, that are similarly stagnant. These isolated, quiescent

waters should be treated in the same way as other quiescent waters under the IEPA water quality standards, which are covered by narrative provisions rather than numeric DO criteria.

Additional information and technical support for the District's proposal for Aquatic Life Use designations in the CAWS is contained in Attachment 1.

2. DO CRITERIA AND NARRATIVE STANDARDS

The Habitat Evaluation Report indicates that the limited physical habitat in the CAWS has much more influence on aquatic communities than DO. The statistical analysis of the relative importance of water quality and physical habitat showed that "DO alone can only explain between 2% and 27% of the fish data variability, while the physical habitat can explain 48%." (Page 125 Habitat Evaluation Report). Moreover, while the Habitat Improvement Study found that a limited potential for enhancements to physical habitat in the CAWS exists, it was unable to conclude that they would result in significant benefits to the CAWS fish communities. Therefore, in considering appropriate standards for the three designated use categories explained above, the District focused on the DO standards necessary to support the existing biotic communities.

It should be noted that for other highly modified water bodies around the country, DO criteria have been adopted that are substantially less stringent than the criteria in IEPA's proposal (see Attachment 2). For instance, the standards for the Cuyahoga River in Ohio contain a minimum DO level of 1.5 mg/L. The Wisconsin water quality standards for the Milwaukee River contain a DO variance of 2.0 mg/L. Similar to the IEPA proposal, the District recommends a minimum DO standard of 4.0 mg/L for Category 1 Waters and a minimum DO standard of 3.5 mg/L for Category 2 Waters. The District believes that these criteria support the

existing biotic communities in these segments. The waters in Category 3, which are stagnant and support limited biotic assemblages, cannot (and do not need to) meet a specific numeric criterion on a consistent basis, and so these waters will instead be protected by narrative requirements, designed to protect against offensive conditions (such as odors) and to protect the limited ecologic functions and biotic assemblages that are present.

There are several elements of the IEPA DO criteria that were not incorporated into the District's proposal because the District does not believe that these criteria are justified or appropriate. For instance, IEPA's proposed DO criteria for "early life stage present" are not included in the District proposal. Fish species that require higher DO are limited by the scarcity of spawning habitat in the CAWS rather than DO conditions. If early life stages of more tolerant fish are currently present in the CAWS, more stringent DO criteria than proposed by the District are not necessary to support this current biotic community.

Published scientific studies suggest that juvenile largemouth bass, for instance, do not exhibit behavioral changes until DO falls below 2 mg/L (Hasler et al., 2009), and that "all sizes of largemouth bass may briefly tolerate hypoxic exposure" (Burleson et al., 2001). There is no basis to conclude that more stringent DO criteria will promote spawning in the CAWS, or significantly improve or expand the current biotic community. As a result, special and more stringent DO criteria to support early life stages are not appropriate for inclusion in standards for the CAWS.

The District is also proposing to eliminate the 7-day mean of daily minima proposed by IEPA. For CAWS Category 1 Waters, the 4.0 mg/L 7-day mean of daily minima would be redundant since the District is proposing that the DO will never go below 4.0 mg/L. Thus, it

would be arithmetically impossible to meet the minimum DO criteria while violating the 7-day mean of daily minima. Furthermore, the 7-day mean of daily minima is not warranted in these man-made or modified channels comprising either Category 1 or 2 Waters. The 1986 USEPA Ambient Water Quality Criteria Document for DO (IEPA Attachment X) states on page 36:

> "Because repeated exposure to dissolved oxygen concentrations at or near the acute lethal threshold will be stressful and because stress can indirectly produce mortality or other adverse effects (e.g., through disease), the criteria are designed to prevent significant *episodes of continuous or regularly recurring exposures to dissolved oxygen concentrations at or near the lethal threshold*. This protection has been achieved by setting the daily minimum for early life stages at the subacute lethality threshold, by the use of a 7-day averaging period for early life states, by stipulating a 7-day mean of minimum value of other life stages…"

The italicized portion of this quote suggests that the 7-day mean of minimum standard is meant to protect fish communities from predictable consistent daily low DO concentrations that may occur due to diurnal DO fluctuations, for instance. Testimony provided by the District based on continuous monitoring data throughout the system has shown that diurnal DO fluctuation rarely occurs in these deep draft waters. Rather, low DO in the CAWS is unpredictable, infrequent (at most stations), and transient based on weather conditions. The behavior of this system during wet weather events is such that low DO concentrations do not occur throughout the system all at once, thus allowing fish to avoid the low DO areas (see Attachment 3 of my testimony for evidence of fish avoidance of low DO areas). As such, the 7-day standard would be inappropriate for the CAWS. There is no evidence that such criteria are necessary to support the existing biotic community, or that application of such criteria will improve or expand the biotic community currently present in the CAWS.

Existing Illinois Standards and USEPA Guidance

The minimum DO standard to protect adult life stages in General Use Waters of Illinois is 3.5 mg/L. The District proposes minimum DO standards for the CAWS that are as stringent as for the General Use Waters for Category 2 Waters and more stringent for Category 1 Waters (4.0 mg/L). These standards have been approved by the IPCB and deemed protective of adult life stages of fish in General Use Waters. It has been established that the CAWS waterways have lower ALU potential than General Use Waters and that the majority of physical habitat in the CAWS is not and cannot become conducive for spawning of most fish species. As such, the District's proposed DO criteria for the CAWS would be protective for the CAWS dominant fish community and consistent with the previous IPCB Rulemaking on General Use Waters.

Furthermore, DO minima of 3.5-4.0 mg/L are consistent with the DO criteria described for Other Life Stages of fish in Nonsalmonid Waters in the 1986 USEPA Ambient Water Quality Criteria Document for DO. This document lists 3.0 mg/L as the DO limit to avoid acute mortality. The DO standards proposed by the District allow for an extra margin of safety for the protection for CAWS fish species.

Narrative standard for Category 3 Waters. The waters in Category 3, which are stagnant and support limited biotic assemblages, cannot (and do not need to) meet a specific numeric criterion on a consistent basis, and so these waters will instead be protected by narrative requirements, designed to protect against offensive conditions (such as odors) and to protect the limited ecologic functions and biotic assemblages that are present. There is precedent for narrative DO criteria in Section 302.206a of the General Use Water Quality Standards for Illinois, which states:

> "General use waters at all locations must maintain sufficient dissolved oxygen concentrations to prevent offensive conditions as required in

> Section 302.203 of this Part. Quiescent and isolated sectors of General Use waters including but not limited to wetlands, sloughs, backwaters and waters below the thermocline in lakes and reservoirs must be maintained at sufficient dissolved oxygen concentrations to support their natural ecological functions and resident aquatic communities."

Stagnant waters in the CAWS should be treated in the same way as other quiescent waters under the IEPA water quality standards, which are covered by narrative provisions rather than numeric DO criteria.

Additional information and technical support for the District's proposal for DO criteria in the CAWS is contained in Attachment 3.

3. WET WEATHER PROVISION

During and after precipitation, wet weather impacts can affect stream DO concentrations and cause excursions from water quality standards. DO in certain reaches can be significantly reduced (sometimes to zero) for up to a week after some wet weather events. The lingering effects of precipitation on DO in the CAWS differ greatly based on the magnitude of the storm and the location in the system (Alp and Melching, 2009). The existing biotic community appears to be tolerant of these conditions. For example, fish kills do not occur following wet weather events in the CAWS except under extremely rare circumstances (e.g., in the case of a high intensity rain event following a prolonged antecedent dry period in the midst of extremely hot weather >90° F).

Wet weather conditions must be considered when setting water quality standards for the CAWS since these events will occur whether or not there is a wet weather provision for the DO standard. Because the proposed DO standard cannot possibly be met during and for periods after wet weather events, the District believes that a Wet Weather Limited Use (WWLU) designation

should apply when wet-weather events cause DO levels to fall below the DO standard (4.0 or 3.5 mg/L, as appropriate for each segment).

This designation would apply to water receiving or otherwise affected by wet weather flows and may remain in effect during, and up to a predefined maximum amount of time after, a wet weather event. When the WWLU designation is in effect, the DO standard would be temporarily suspended. The WWLU designation could be applied in each segment of the CAWS when all of the following criteria are fulfilled:

1. A "trigger," such as a CSO discharge or specified rainfall amount occurs.
2. There are DO standard exceedances during or following the trigger event for a predefined maximum period.
3. There were no DO standard exceedances prior to the trigger event.

The District would use data from CSO discharges, rainfall gages, and continuous DO monitors to keep track of the number of hours in which the WWLU is applied throughout the CAWS and report this to IEPA on an agreed upon schedule. To ensure that the amount of time below the DO minimum levels is minimized, sources would be subject to appropriate operational requirements set forth in applicable permits (for sources such as MS4s) or Long-Term Control Plans (for CSOs). At all other times, the DO criteria set forth in 302.710 and 302.715 would apply to the CAWS. The WWLU designation would be reassessed over time as significant changes were made to the CAWS, such as the progress of TARP reservoir construction.

The details regarding the District's wet weather provision proposal are covered in Adrienne Nemura's testimony filed February 2, 2011.

4. OTHER WATER QUALITY CRITERIA

Chronic Cyanide Criteria

The District proposes a chronic cyanide standard of 10 µg/L or higher as recommended in my earlier testimony in R08-9 (Exhibit 230). While the Illinois General Use Standard is 5.2 µg/L, an IPCB ruling in R95-14 favored a higher site-specific chronic cyanide standard for Salt Creek, Higgins Creek, the West Branch DuPage River, and the Des Plaines River because it was considered protective of the fish species that reside in these waters. From the final IPCB ruling: "The current cyanide CS standard of 5.2 µg/L was established based upon a calculation that included toxicities to rainbow trout, brook trout, yellow perch, and bluegill."

As described in my previous testimony: "The rainbow trout are the most cyanide-sensitive fish considered and are a coldwater fish species. As such, they should not be considered in warmwater aquatic environments. By removing rainbow trout and adding the next most cyanide-sensitive species, black crappie, the calculated chronic standard for cyanide would be 9.8 µg/L, which was rounded up to 10 µg/L in the final ruling. Incidentally, brook trout do not occur in the General Use waterways of Cook County or the CAWS either, however, this species was not removed from the calculation for the purposes of the R95-14 Rulemaking." Clearly, a water quality standard in the CAWS should not be based on the tolerance levels of coldwater species like trout. Since the chronic cyanide standard was amended due to absence of rainbow trout in the General Use waterways of Cook County, the absence of rainbow trout in the CAWS should also be acknowledged, and the chronic cyanide standard should be 10 µg/L or higher.

Chronic Zinc Criteria

An error in the derivation of the current General Use chronic zinc standard, which is identical to what has been proposed by IEPA for the CAWS, was described on pages 9 and 10 of the Statement of Reasons for IPCB Case Number R2011-018 (*Triennial Review of Water Quality Standards for Boron, Fluoride, and Manganese: Amendments to 35 Ill Adm. Code 302. Subparts B, C, E, F and 303.312*, Attachment 4). Apparently, an incorrect chronic toxicity value for *Hyalella* was used to determine the final chronic value (FCV) equation for zinc. In order to correct this error, the equation used to calculate the chronic zinc standard should be changed from:

$FCV = e^{(0.8473[\ln(hardness)] - 0.8168}$ to $FCV = e^{(0.8473[\ln(hardness)] - 0.44599}$

This amendment should also be reflected in the proposal for the chronic zinc water quality standard for the CAWS.

Conclusion

The District is proposing DO minimum criteria that are protective of the CAWS dominant fish community and are supported by multiple lines of evidence. In addition to being identical to the IEPA proposed minimum DO criteria, more stringent than the IPCB-approved DO minimum criteria for General Use Waters of Illinois, and consistent with the USEPA Criteria document for DO, the District's proposed DO criteria are actually more stringent than those that have been adopted for similar waterways in several other states. The 7-day mean of daily minima DO criteria proposed by IEPA is inappropriate for the CAWS because this standard is designed to protect aquatic life against, "*continuous or regularly recurring exposures to dissolved oxygen concentrations at or near the lethal threshold*" (USEPA, 1986), whereas DO sags that occur in this system are episodic and unpredictable. Furthermore, the 4.0 mg/L 7-day

mean of daily minima would be arithmetically redundant in Category 1 Waters where the District proposes a daily minimum DO of 4.0 mg/L. Early Life Stage DO criteria are not required in the CAWS because the permanent physical habitat in the CAWS limits spawning of fish species like smallmouth bass and channel catfish. Studies have shown that adult and juvenile largemouth bass, an abundant and popular game fish species in the CAWS, are tolerant of occasional DO sags down to approximately 2 mg/L.

A wet weather provision also needs to be part of the CAWS standards because wet weather sources of pollution have been shown to decrease DO significantly for days to weeks following precipitation events (Alp and Melching 2009). The DO impact of these events needs to be acknowledged in the Aquatic Life Use designations for the CAWS because it is not feasible to eliminate or capture the wet weather sources in the foreseeable future.

The District proposes a chronic cyanide standard of 10 µg/L to be consistent with the site-specific standard that has been applied to several General Use Waters in Cook County. As described in the final Opinion and Order from R94-14, the chronic cyanide standard is derived from studies on sensitive fish that are not even found in General Use Waters of Cook County, let alone CAWS waters.

Finally, the District urges the proposed chronic zinc standard for the CAWS be updated as previously described in order to correct a known error in its calculation.

Thank you for the opportunity to present the District's alternative recommendations for water quality criteria to protect aquatic life in the CAWS.

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Hasler, C.T., C.D. Suski, K.C. Hanson, S.J. Cooke, and B.L. Tufts. 2009. “The Influence of Dissolved Oxygen of Winter Habitat Selection by Largemouth Bass: An Integration of Field Biotelemetry Studies and Laboratory Experiments.” *Physiological and Biochemical Zoology* 82(2): 143-152.

Respectfully submitted,

By: Jennifer Wasik

Testimony Attachments

Attachment 1. Technical Support for Aquatic Life Use Designation Proposal in the CAWS
Attachment 2. Description of DO standards in waterways similar to the CAWS
Attachment 3. Technical Support for District Dissolved Oxygen Criteria Proposal in the CAWS
Attachment 4. IPCB Case Number R2011-018, IEPA Statement of Reasons

TECHNICAL SUPPORT FOR AQUATIC LIFE USE DESIGNATION PROPOSAL IN THE CAWS

The purpose of this document is to provide a more detailed basis for the Aquatic Life Use designations that the District is proposing for the Chicago Area Waterway System (CAWS). Key findings from the LimnoTech Habitat Evaluation and Improvement reports (filed with IPCB on January 6, 2010, PC Number 284) that were used to inform the District's proposal are summarized herein. The relative importance of physical habitat versus dissolved oxygen (DO) in affecting the potential CAWS fish community has been statistically quantified and is explained.

Also included in this document is a discussion of the dominant fish community that has adapted to the irreversible physical habitat features of these waterways and can exist in the CAWS.

The CAWS habitat index created by LimnoTech was used to calculate current and potential habitat index scores for the CAWS reaches. These scores were utilized for classification of CAWS reaches into one of three ALU designation categories. Other environmental factors were considered when the scores did not provide an obvious basis for classification. The exact procedure utilized by the District for ALU designation is described below.

LimnoTech Habitat Evaluation and Improvement Reports

The District contracted LimnoTech to assess physical habitat limitations in the CAWS, to provide the technical information needed to determine the extent to which physical habitat is the limiting stressor in the system, and to develop a habitat index specifically for the CAWS in order to determine the relative range in habitat quality across the CAWS for use in developing appropriate Aquatic Life Use designations for each waterway. The results from the Chicago

Area Waterway System Habitat Evaluation and Improvement Study are presented in 2 reports, entitled, “Habitat Evaluation Report” and “Habitat Improvement Report.”

Physical Habitat as Limiting Stressor. The Habitat Evaluation Report outlines the process of the habitat index development and explains the physical habitat attributes in the CAWS which are expected to most influence fish communities. Page 104 of the Habitat Evaluation Report identifies the methods for reducing the initial set of 241 habitat variables to the final 16 variables that were compared through multiple regression with fish data. The six habitat variables that were statistically most predictive of fish data were as follows: Maximum depth of channel, off-channel bays, percent of vertical wall banks in reach, percent of riprap banks in reach, manmade structures in reach, and percent macrophyte cover in reach. The model consisting of these six variables accounts for 48 percent of the variability in fish data in the CAWS. Habitat index scores for the CAWS waterways are shown on page 139 of the report. Other habitat variables of interest identified and discussed in the report were bank pocket areas, large substrate in shallow and deep parts of the channel, organic sludge, and overhanging vegetation. Anthropogenic factors such as navigation were deemed crucial limitations to aquatic life use in the CAWS (pages 91-93 of the Habitat Evaluation Report describe navigation impacts).

The Illinois EPA proposed water quality standards for the CAWS included proposed DO criteria that were higher than existing conditions. The Habitat Evaluation Report therefore included an evaluation of whether improvements in DO could lead to potential improvements in the fish community in the CAWS.

Various key DO metrics were then compared to fish metrics and it was determined that the percent of time that DO was less than 5 mg/L at each station from June through September

was the DO metric most highly correlated with fish metrics (a negative correlation). However, multiple regression analysis indicates that, "DO alone can only explain between 2% and 27% of the fish data variability, while the physical habitat can explain 48%. The addition of the key DO metric to the main habitat variables only resulted in a 4% improvement over using habitat alone." (Page 125, Habitat Evaluation Report). The report also explains that "Of the half of fish data variability that is not explained by these physical habitat variables, as much as 70% of that half can be explained by variation in fish sampling results from year to year." (Page 125). This analysis lead LimnoTech to conclude that water quality, including DO, was of relatively less importance to aquatic life than physical habitat which is the limiting stressor in the system. Increased DO is not likely to facilitate improved fish metrics.

This conclusion is consistent with the testimony of Dr. Scudder Mackey, an aquatic habitat expert, who discussed physical habitat limitations and lack of critical habitat linkages in the CAWS. For instance, on pages 15-16 of his pre-filed testimony for the District, Dr Mackey explains, "In my opinion, the substantial investments needed for infrastructure to provide incremental increases in DO and/or reductions in temperature will *not* yield a proportionate biological response with respect to attaining sustainable fish communities and/or other beneficial uses. The lack of diverse bank-edge and instream habitats within the CAWS may be a much more significant limitation on the development of sustainable fish communities than current levels of DO or temperature. Without suitable habitat pattern and diversity, sustainable populations of these species can not be established *irrespective of how much improvement there is in water quality*" (emphasis in original).

CAWS Habitat Index Scores. The CAWS Habitat Evaluation Report determined habitat index scores for all of the CAWS reaches between the Wilmette Pump Station, Chicago

River Controlling Works and O'Brien Lock and Dam, and the Lockport Lock and Dam. The results of this evaluation are presented in Table 7-7 on page 139 of the report. This table indicates that on a scale of 0 to 100, the current CAWS habitat index scores are 75 for the upper North Shore Channel, 60 for the lower North Shore Channel, 52 for the Little Calumet River, 49 for the upper North Branch Chicago River, 47 for the lower North Branch Chicago River, 45 for the Chicago River, 37 for Bubbly Creek, 37 for the Calumet Sag Channel, and 34 for both the South Branch Chicago River and the Chicago Sanitary and Ship Canal.

Habitat Improvement Potential. The Habitat Improvement Report evaluated the potential for physical habitat enhancement in each of the CAWS reaches, the cost, and the likelihood that the enhancements would improve fisheries condition in the CAWS. Recognizing that the CAWS is irretrievably altered due to severe and irreversible hydrological modifications, channelization, watershed urbanization and substrate alteration and contamination, the study did not attempt to evaluate strategies for restoration of native or natural conditions. Rather, the study evaluated improvements that could potentially optimize habitat in the reaches that have the best current habitat index scores (North Shore Channel) and that could potentially elevate physical habitat quality in other reaches to levels approaching the North Shore Channel, which represents the optimum achievable habitat for this system

Table 4-1 on page 57 of this report presents the potential index scores after described habitat improvements. This table indicates that on a 100 point scale, the potential CAWS habitat index scores are 80 for the upper North Shore Channel, 71 for the lower North Shore Channel, 58 for the upper North Branch Chicago River, 57 for the Little Calumet River, 56 for the lower North Branch Chicago River, 48 for Bubbly Creek, 47 for the South Branch Chicago River, 45

for the Chicago River, 44 for the Calumet Sag Channel, and 43 for the Chicago Sanitary and Ship Canal.

Several major irreversible limiting physical habitat attributes in the CAWS were reported to have no potential for improvement. For example, it would not be feasible to alter channel depth, channel complexity (alternating riffle-pool habitat), hydrologic pattern, floodplain connectivity, lack of large substrates, presence of organic sludge, and water clarity, in the CAWS. As a result, potential habitat improvements resulted in small to modest increases in the projected habitat index scores. Therefore, these enhancements are unlikely to substantially improve the composition of aquatic life in the CAWS.

Since so many physical habitat attributes that have positive effects on fish metrics cannot be improved, the fish species currently present in the CAWS are indicative of the types of fish that can tolerate these irreversible physical habitat conditions and the presence of commercial navigation. The District now believes that physical habitat is limiting further changes in aquatic life in the CAWS. LimnoTech reported on page 94 of the Habitat Evaluation Report: "The constructed and heavily modified conditions within the CAWS, combined with the management of the system for its intended uses of wastewater conveyance and navigation, have limited the structural and functional conditions for aquatic habitat. These limited habitat features have resulted in a biotic community (as measured by fish) that is tolerant of the modified conditions and appears to be thriving. These conditions also impose a significant limitation on the potential of the CAWS to support fish communities different than what presently exist there."

The existing tolerant fish community has achieved a sustainable balance of its own with the existing limitations for fish living in an urban waterway with other major uses such as navigation and wastewater conveyance.

Fish Community in the CAWS

The CAWS fish species assemblage is composed primarily (96%) of fish in three families, including the herring family (Clupiedae – 40% of all fish collected), the carp and minnow family (Cyprinidae – 37%), and the sunfish family (Centrarchidae -19%). The most abundant sunfish were largemouth bass, bluegill, and pumpkinseed sunfish, which are popular game fish species. The dominant community has representation from all trophic levels, suggesting that it represents a relatively complete fish community of mostly tolerant species.

Abundance of largemouth bass and bluegill has increased more dramatically in Category 1 (Modified Warm Water Aquatic Life Use) than Category 2 (Limited Warm Water Aquatic Life Use), and Category 3 (Severely Limited Water Aquatic Life Use) Waters over the past 3 decades. Since water quality has improved across all of the waterways, it is likely that the increase is more significant among Category 1 Waters due to their incrementally better physical habitat features.

ALU Categories for the CAWS

Three aquatic life use designations were developed by the District based on the goal of sustaining the CAWS fish community. The District utilized the habitat index scores as a starting point for grouping reaches into aquatic life use categories with relatively high and low capability of providing habitat suitable for optimizing the CAWS fish community.

Aquatic Life Use Categories 1 and 2. The upper and lower North Shore Channel reaches, the upper North Branch Chicago River, and the Little Calumet River had the highest scores and represent the optimum CAWS fish community putting them into Category 1 Waters.

Evaluating the many appreciable habitat differences between the upper and lower North Branch Chicago River caused the District to propose that these two reaches should be in different

categories despite their close index scores (49 and 47 currently and 58 and 56 potentially, respectively). Pages 48-49 of the Habitat Improvement Report discuss several of the significant habitat attributes that set the upper and lower North Branch segments apart. Vertical wall banks are much more prevalent in the lower North Branch Chicago River. In addition, "Overhanging riparian vegetation varies from 25% in the upper North Branch Chicago River to 5% in the lower North Branch Chicago River," and "The number of bank 'pocket areas' is relatively high in the upper North Branch Chicago River, but low in the lower North Branch Chicago River."

Table 7-5 on page 136 of the Habitat Evaluation Report also shows that other key habitat variables indicate better physical habitat in the upper North Branch, including more large substrate in "shallow" areas, and less organic sludge than the lower North Branch.

Toxic sediments present in the lower North Branch Chicago River further support its inclusion in Category 2. Fifty percent of sediment samples collected from Grand Avenue and Diversey Parkway in the lower North Branch in 2005 exhibited toxicity to *Chironomus tentans*. (Attachment 1). The District believes that these properties combine to limit the full realization of the fish community in the lower North Branch Chicago River and it is thereby designated as a Category 2 waterbody.

The habitat index score for the Chicago River (45) is similar to the upper North Branch (49), and consequently could be designated as a Category 1 Water. However, with the exception of sediment toxicity, the same physical habitat limitations apply here, including 97% vertical walls and 0% overhanging vegetation in the reach, as were discussed for the lower North Branch Chicago River and the Habitat Improvement Report concluded that there was no opportunity for physical habitat enhancement in the Chicago River as described on pages 49-50, so it was subsequently designated as a Category 2 Water.

The South Branch Chicago River, Chicago Sanitary and Ship Canal, and Cal-Sag Channel all had appreciably lower CAWS Habitat Index scores, with correspondingly lower quality fish community which justifies classification as Category 2 Waters. For instance, catch per unit effort (CPUE) for popular game fish was significantly higher in Category 1 than Category 2 Waters between 2001-2008. CPUE (in number of fish per 30 minutes of sampling) for largemouth bass was 11.9 and 3.9, respectively, for Category 1 and 2. Bluegill CPUE was 7.2 and 3.8, respectively.

Aquatic Life Use Category 3. The full potential of the CAWS fish community is even lower in Bubbly Creek because of dry-weather stagnant conditions and periodic combined sewer discharges from the Racine Avenue Pumping Station (RAPS). On page 1-8 of the CAWS UAA report, it states, "The South Fork is a stagnant waterbody that receives no flow unless the Racine Avenue Pump Station, storm sewers or other CSOs are discharging." The report further describes the extensive DO nonattainment issues in Bubbly Creek. IEPA has thus acknowledged the unusual conditions in Bubbly Creek, which were highlighted in Dr. Samuel Dennison's testimony in IPCB R08-9.

During dry weather, Bubbly Creek is stagnant and stream DO can often plummet to zero. The fine sediments deposited throughout most of the creek exhibit a heavy oxygen demand. In 2001, the District measured a sediment oxygen demand (SOD) of 3.64 g/m^2/day at Interstate Highway 55 on Bubbly Creek. During 2008, DO was below the IPCB Secondary Contact DO standard of 4.0 mg/L in Bubbly Creek 61 and 22 percent of the time at 36^{th} Street and Interstate Highway 55, respectively (Gallagher et al., 2009).

During significant precipitation events when RAPS discharges to Bubbly Creek, the water elevation can rise over three feet and flow velocity in the narrow creek can reach in excess

of five feet per second. Following a CSO discharge from RAPS, the organic content of the flow from RAPS as well as re-suspended sediments from the creek bed exert an oxygen demand for a number of days, severely impacting DO in the channel (Garcia *et.al.* 2010). The District continuous DO data indicates that DO recovery at Bubbly Creek stations sometimes takes several days longer than at other stations in the CAWS. Figure 1 indicates that DO at 36th Street on Bubbly Creek remains at 0.0 mg/L for over 3 days.

Various technologies were assessed by the District for meeting proposed water quality DO standards in Bubbly Creek. The CAWS water quality model indicates that in addition to flow augmentation, three supplemental aeration stations would have to be constructed within the 1.3 mile length of Bubbly Creek in order to comply with the IEPA proposed DO standards 100% of the time (Melching, *et.al.* 2010). However, supplemental aeration stations would likely cause re-suspension of the fine silt sediments deposited in Bubbly Creek, further contributing to oxygen demand and biological impairment. (Garcia *et.al.* 2010).

In addition to these issues, 50 percent of sediment samples collected from Bubby Creek between 2002-2007 exhibited toxicity to macroinvertebrates in bioassays. (Attachment 1).

In light of the impaired sediment, wet-weather CSO overflows at the RAPS, and the extreme variability in flow, the District recommends that Bubbly Creek be classified as a CAWS Category 3 Water.

Waterways not assessed by Habitat Evaluation and Improvement Study

Among the CAWS waterways that were not assessed by LimnoTech were the Grand Calumet River, Calumet River, Lake Calumet Connecting Channel, Lake Calumet, as well as several stagnant segments, such as the North Branch Canal, the Collateral Channel, and other off-channel slips, that were not assessed. Therefore, these waterways do not have a CAWS

Habitat Index score at this time. However, based on the available physical habitat and aquatic life information, we propose to include Lake Calumet and the Calumet River in the higher ALU tier (Category 1), the Connecting Channel in the lower ALU tier (Category 2), and the Grand Calumet River in the lowest ALU tier (Category 3). These designations are consistent with IEPA's proposal with two exceptions. The District believes the Calumet River should be included in Category 1 and that the Grand Calumet River be included in Category 3. The IEPA had classified the Calumet River as an ALU B Water and the Grand Calumet River as an ALU A Water. The IEPA did not include stagnant segments of the CAWS, like the North Branch Canal, the Collateral Channel, and other off-channel slips in their proposal, but these segments would reasonably be Category 3 Waters since they do not receive flow.

The fish community in the Grand Calumet River was assessed by the District during 2003 and 2007. The total number of fish collected near Burnham Avenue on the Grand Calumet River was 0 and 5, respectively. Attachment 1 shows that 75% of the sediment samples collected from the Grand Calumet River for sediment toxicity testing are toxic. The results from a chemical assessment of Grand Calumet River sediments by the District and others confirm elevated levels of heavy metals and organic compounds in the sediment (Cahill et al, 1999 and District testimony by Wasik in IPCB R08-09). Given the extremely limited aquatic life present in the Grand Calumet River, stagnant conditions during dry weather, severe sediment toxicity, and elevated levels of heavy metals and organic compounds in sediments, the Grand Calumet River is designated as a Category 3 Water and would have a narrative DO standard in accordance with our proposal.

Literature Cited

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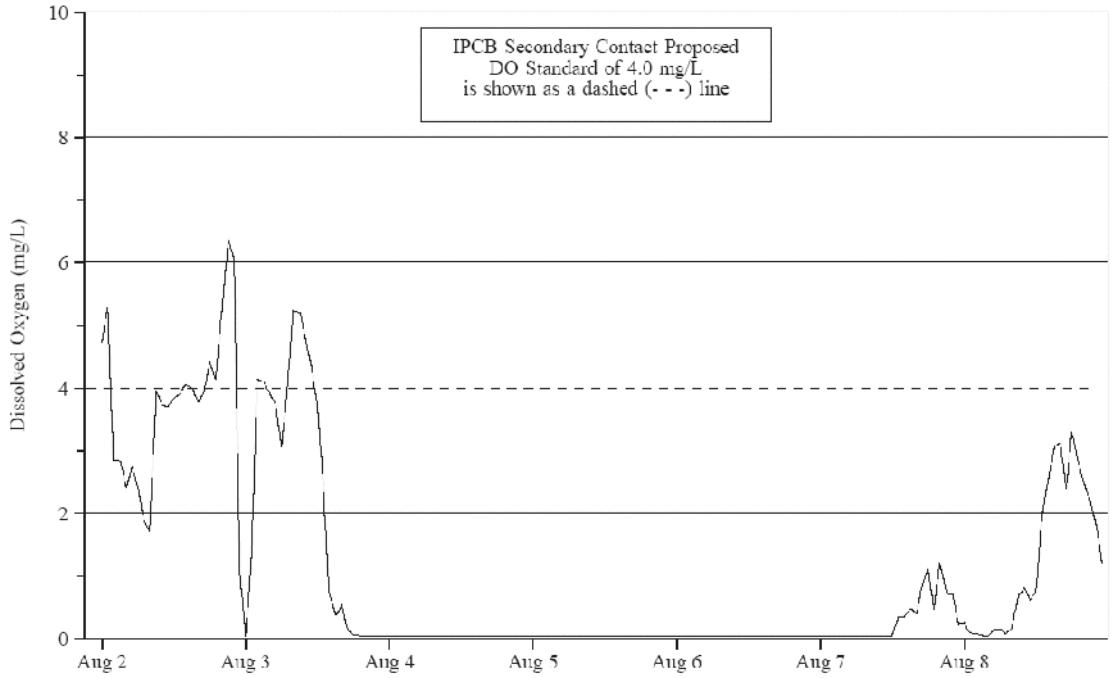
Garcia, Marcelo H., David Waterman, Andrew Waratuke, Davide Motta, and Yovanni Cataño-Lopera. 2010. *Bubbly Creek Sediment Oxygen Demand (SOD) Study with the U of I Hydrodynamic SOD Sampler*, Prepared for MWRDGC. Available on-line at the following link: http://www.mwrd.org/pv_obj_cache/pv_obj_id_4D8FA97ACF7221734B5C381F8BE1807E73BC6800/filename/UIUC_BC_Resuspension_Report.pdf

Melching, C.S., Emre Alp, and Yaping Ao. 2010. *Development of Integrated Strategies to Meet Proposed Dissolved Oxygen Standards for the Chicago Waterway System*, Technical Report No. 20, prepared for MWRDGC. Available on-line at the following link: http://www.mwrd.org/pv_obj_cache/pv_obj_id_51207D98F824A63150480D53A64F1E51F7258000/filename/CWS_Integrated_Study-Calibration-December-2010-Final.pdf

Attachment

Attachment 1. MWRDGC Sediment Toxicity Data in the CAWS from 2002-2007.

FIGURE 1: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT 36TH STREET ON BUBBLY CREEK
FROM AUGUST 2, 2006 THROUGH AUGUST 8, 2006



WATERWAY	SITE #	LOCATION		YEAR	*Chironomus tentans* 10-Day Test		
					Survival (%)	Dried Weight (mg/org)	Ash-free Dried Weight (mg/org)
North Shore Channel	35	Central St.	Side	2005	96	NA	1.47
North Shore Channel	35	Central St.	Center	2005	96	NA	1.35
North Shore Channel	102	Oakton St.	Side	2005	80	NA	1.62
North Shore Channel	102	Oakton St.	Center	2005	79	NA	1.16
North Shore Channel	36	Touhy Ave.	Side	2005	95	NA	1.25
North Shore Channel	36	Touhy Ave.	Center	2005	94	NA	1.23
North Shore Channel	101	Foster Ave.	Side	2005	51[a]	NA	0.17[e]
North Shore Channel	101	Foster Ave.	Center	2005	94	NA	1.4
North Branch Chicago River	37	Wilson Ave.	Side	2005	93	NA	1.44
North Branch Chicago River	37	Wilson Ave.	Center	2005	84	NA	0.93
North Branch Chicago River	73	Diversey Parkway	Side	2005	49[a]	NA	0.43[e]
North Branch Chicago River	73	Diversey Parkway	Center	2005	86	NA	0.98
North Branch Chicago River	46	Grand Ave.	Side	2005	13[a]	NA	0.13[e]
North Branch Chicago River	46	Grand Ave.	Center	2005	93	NA	0.88
Chicago River	74	Lake Shore Drive	Side	2002	99	1.07	0.76
Chicago River	74	Lake Shore Drive	Center	2002	94	1.09	0.79
Chicago River	74	Lake Shore Dr.	Side	2006	ND	ND	ND
Chicago River	74	Lake Shore Dr.	Center	2006	98	NA	0.92
Chicago River	100	Wells St.	Side	2002	99	0.9	0.64[a]
Chicago River	100	Wells St.	Center	2002	94	0.97	0.67[a]
Chicago River	100	Wells St.	Side	2006	98	NA	1.54
Chicago River	100	Wells St.	Center	2006	88	NA	1.46
South Branch Chicago River	39	Madison St.	Center	2002	91	0.83[a]	0.62[a]
South Branch Chicago River	39	Madison St.	Side	2006	80	NA	0.65
South Branch Chicago River	39	Madison St.	Center	2006	90	NA	1.06
South Branch Chicago River	108	Loomis St.	Side	2002	83	0.86	0.61[a]
South Branch Chicago River	108	Loomis St.	Center	2002	90	0.70[a]	0.53[c]
South Branch Chicago River	108	Loomis St.	Side	2006	95	NA	0.88
South Branch Chicago River	108	Loomis St.	Center	2006	98	NA	1.22
Bubbly Creek	99	Archer Ave.	Side	2002	59[c]	0.25[c]	0.16[c]
Bubbly Creek	99	Archer Ave.	Center	2002	14[c]	0.24[c]	0.14[c]
Bubbly Creek	99	Archer Ave.	Side	2006	75	NA	0.54[a]
Bubbly Creek	99	Archer Ave.	Center	2006	66	NA	0.52[a]
Chicago Sanitary and Ship Canal	40	Damen Ave.	Side	2002	80	0.67[c]	0.48[c]
Chicago Sanitary and Ship Canal	40	Damen Ave.	Center	2002	76	0.62[c]	0.44[c]
Chicago Sanitary and Ship Canal	40	Damen Ave.	Side	2006	88	NA	0.61
Chicago Sanitary and Ship Canal	40	Damen Ave.	Center	2006	85	NA	0.79
Chicago Sanitary and Ship Canal	75	Cicero Ave.	Side	2002	93	1.17[b]	0.81[a]
Chicago Sanitary and Ship Canal	75	Cicero Ave.	Center	2002	93	0.64[c]	0.46[c]
Chicago Sanitary and Ship Canal	75	Cicero Ave.	Side	2006	94	NA	0.63[a]
Chicago Sanitary and Ship Canal	75	Cicero Ave.	Center	2006	98	NA	0.7
Chicago Sanitary and Ship Canal	41	Harlem Ave.	Side	2002	89	1.53	1.04

Chicago Sanitary and Ship Canal	41	Harlem Ave.	Center	2002	91	1.48	1.16
Chicago Sanitary and Ship Canal	41	Harlem Ave.	Side	2006	90	NA	0.48[a]
Chicago Sanitary and Ship Canal	41	Harlem Ave.	Center	2006	93	NA	0.95
Chicago Sanitary and Ship Canal	92	Lockport	Side	2002	98	1.28	0.95[a]
Chicago Sanitary and Ship Canal	92	Lockport	Center	2002	90	0.58[c]	0.43[c]
Chicago Sanitary and Ship Canal	92	Lockport	Side	2006	93	NA	1.41
Chicago Sanitary and Ship Canal	92	Lockport	Center	2006	63*	NA	0.65
Calumet River	49	Ewing Ave.	Side	2003	8[a]	0.63	0.36[a]
Calumet River	49	Ewing Ave.	Side	2007	91	1.61	1.05
Calumet River	49	Ewing Ave.	Center	2007	58[a]	0.37[a]	0.27[a]
Calumet River	55	130th St.	Side	2003	98	1.61	1.1
Calumet River	55	130th St.	Center	2003	95	1.33	0.99
Calumet River	55	130th St.	Side	2007	84	1.73	1.41
Calumet River	55	130th St.	Center	2007	74	1.11	0.80[a]
Wolf Lake	50	Burnham Ave.	Side	2003	36[a]	0.45[a]	0.18[a]
Wolf Lake	50	Burnham Ave.	Center	2003	19[a]	0.65	0.55
Wolf Lake	50	Burnham Ave.	Side	2007	90	1.39	1.03
Wolf Lake	50	Burnham Ave.	Center	2007	79	2.10	1.53
Grand Calumet River	86	Burnham Ave.	Side	2003	25[a]	0.19[a]	0.19[a]
Grand Calumet River	86	Burnham Ave.	Center	2003	86	0.51[a]	0.46[a]
Grand Calumet River	86	Burnham Ave.	Side	2007	58[a]	1.07	0.88
Grand Calumet River	86	Burnham Ave.	Center	2007	14[a]	0.28[a]	0.22[a]
Little Calumet River	57	Ashland Ave.	Side	2003	84	0.84[a]	0.68[a]
Little Calumet River	57	Ashland Ave.	Side	2007	94	1.63	1.20
Little Calumet River	56	Indiana Ave.	Side	2003	55[d]	0.29[a]	0.21[a]
Little Calumet River	56	Indiana Ave.	Center	2003	58[a]	0.38[a]	0.30[a]
Little Calumet River	56	Indiana Ave.	Side	2007	94	1.64	1.07
Little Calumet River	56	Indiana Ave.	Center	2007	96	1.65	1.08
Little Calumet River	76	Halsted St.	Side	2003	89	0.34[a]	0.25[a]
Little Calumet River	76	Halsted St.	Center	2003	3[a]	0.25[a]	0.17[a]
Little Calumet River	76	Halsted St.	Side	2007	100	1.05[a]	0.79[a]
Little Calumet River	76	Halsted St.	Center	2007	30[a]	0.18[a]	0.17[a]
Cal-Sag Channel	58	Ashland Ave.	Side	2003	19[a]	0.14[a]	0.11[a]
Cal-Sag Channel	58	Ashland Ave.	Center	2003	84	0.54[a]	0.47[a]
Cal-Sag Channel	58	Ashland Ave.	Side	2007	90	0.52[a]	0.46[a]
Cal-Sag Channel	58	Ashland Ave.	Center	2007	73[a]	0.51[a]	0.45[a]
Cal-Sag Channel	59	Cicero Ave.	Side	2003	0[a]	NA	NA
Cal-Sag Channel	59	Cicero Ave.	Center	2003	9[a]	1.06	0.65
Cal-Sag Channel	59	Cicero Ave.	Side	2007	7.5[a]	0.23[a]	0.17[a]
Cal-Sag Channel	59	Cicero Ave.	Center	2007	2.5[a]	0.24[a]	0.21[a]
Cal-Sag Channel	43	Route 83	Side	2003	0[a]	NA	NA
Cal-Sag Channel	43	Route 83	Center	2003	11[a]	0.83	0.52
Cal-Sag Channel	43	Route 83	Side	2007	43[a]	0.18[a]	0.17[a]
Cal-Sag Channel	43	Route 83	Center	2007	33[a]	0.24[a]	0.20[a]

[a] Significantly different than the West Bearskin Lake control results.

[b] Significantly different than the Negative Control-Sand control results.

[c] Significantly different than the West Bearskin Lake and Negative Control-Sand control results.

[d] Not statistically different due to high variability among replicates.

[e] Not formally compared since survival data were statistically different.

Ohio Dissolved Oxygen Standard

The Ohio Environmental Protection Agency (OEPA) has established the following seven Aquatic Life Use (ALU) designations for surface waters in Ohio: (1) warmwater; (2) limited warmwater; (3) exceptional warmwater; (4) modified warmwater; (5) seasonal salmonid; (6) coldwater; and (7) limited resource waters (OEPA, Use Designations, Aquatic Life Habitat, OAC 3745-1-07).

Surface waters in the State of Ohio designated as limited resource waters are subject to a use attainability analysis (UAA). "The UAA must demonstrate that the extant fauna is substantially degraded, and that the potential for recovery of the fauna to the level characteristic of any other aquatic life habitats is realistically precluded due to natural background conditions or irretrievable human-induced conditions" (OEPA, OAC 3745-1-07). Limited resource waters are highly modified surface waters that have been irretrievably altered (e.g., dredged navigation channel) and do not possess the stream morphology and habitat characteristics necessary to support any appreciable assemblage of aquatic life.

The Federal Navigational Channel (Cuyahoga River Ship Channel) is a distinct segment of the Lower Cuyahoga River. The Navigational Channel is a federally maintained navigation channel which originates at the Newburgh and South Shore Railroad Bridge and flows approximately 5.6 miles through the City of Cleveland before emptying into Lake Erie.

The channel has an average width of 270 feet and is maintained by the United States Army Corp of Engineers at a mean dredged depth of approximately 29 feet. Over the years, the Cuyahoga River Ship Channel has not only been deepened, but also widened and largely straightened with limited meandering to accommodate commercial shipping. As a result of the extensive physical alterations and modifications to the channel, the velocity has been substantially reduced resulting in widespread sediment deposition. It takes water approximately 12 days to travel the 5.6 river miles. The predominate substrates includes silt and clay. The riverbanks along the channel are typically armored with steel sheet piling and concrete bulkheads resulting in a limited floodplain and riparian corridor. The watershed draining the Navigation Channel is heavily industrialized providing facilities for a wide range of commerce. Twenty-one industrial outfalls from the ISG complex (formerly LTV Steel) discharge to the channel. The Cuyahoga River Ship Channel also receives combined sewer overflows from the Northeastern Ohio Regional Sewer District. The channel characteristics highlighted above have a significant impact on attainable water uses and water quality standards.

Water quality modeling of the Navigational Channel has shown that levels of oxygen demanding materials are sufficient to depress dissolved oxygen (DO) below the warmwater habitat criteria. However, the ship channel is used by warmwater fish during the spring months as a migratory route.

For the period of June through January, and during the remaining months of the year whenever the river flow is less than 703 cfs measured in the Cuyahoga River at the US Geological Survey gage at Independence, "the aquatic life use shall be **limited resource water – navigation maintenance,** as defined in rule 3745-1-07 of the Administrative Code" (OEPA,

OAC 3745-1-26). During the months of February through May whenever the river flow equals or exceeds 703 cfs measured at the US Geological Survey gage at Independence, "the aquatic life use shall be fish passage" (OEPA, OAC 3745-1-26). "The fish passage use is defined as those rivers that have been the subject of a UAA and have been found to be incapable of supporting and maintaining a balance, integrated, adaptive community of warmwater organisms but are capable of supporting the passage of warmwater fish during migratory periods" (OEPA, OAC 3745-1-26).

The minimum DO criterion during the months of June through January for limited resource water – navigation maintenance use of the ship channel is 1.5 mg/L. There is no daily mean (average) DO criterion for the channel during the seven month period (OEPA, OAC 3745-1-26).

During the months of February though May, the minimum DO criterion measured during a 24-hour period for the fish passage use in the Navigation Channel is 5.0 mg/L (OEPA, OAC 3745-1-26).

Paragraph 5 of OEPA Administrative Code 3745-1-26 recommends that in addition to point and nonpoint source controls, remedial action planning should consider innovative means for improving DO in the Navigation Channel such as off channel reaeration, sediment remediation, and flow augmentation.

Texas Dissolved Oxygen Standard

To account for local environmental conditions, the Texas Commission of Environmental Quality (TCEQ) may amend designated water uses and numeric criteria for specific surface waters in Texas (TCEQ, Texas Surface Water Quality Standards, TAC 307.2). A site-specific standard is an explicit amendment to the Texas Surface Water Quality Standards. An amendment which establishes a site-specific water quality standard for a waterway in the State of Texas requires a use attainability analysis.

Six subcategories of aquatic life use for surface waters in Texas have been established by the TCEQ. The subcategories include, exceptional, high, intermediate, limited, and minimal (no significant) aquatic life and oyster waters (TCEQ, Texas Surface Water Quality Standards, Site-Specific Uses and Criteria, TAC 307.7).

The Houston Ship Channel originates upstream from US 59 in Harris County and flows approximately 50 miles through the City of Houston before emptying into Galveston Bay at Morgan's Point. The TCEQ has subdivided the ship channel into three distinct segments (1005, 1006, and 1007). Segment 1005 extends from Galveston Bay to US 10. Segment 1006 continues from the confluence with the San Jacinto River to a point immediately upstream of Green's Bayou. Segment 1007 extends from Green's Bayou to US 59.

Over the years, the Houston Ship Channel has been periodically widened and deepened by the United States Army Corps of Engineers to accommodate large ocean going commercial ships. Currently, the channel is 530 feet wide and 45 feet deep. The islands in the ship channel

are part of an ongoing widening and deepening project. The dredge disposals are used to form the islands. As a result of the extensive physical alterations and modifications to the channel, the velocity has been substantially reduced resulting in widespread sediment deposition. The predominate substrates includes course silt and clay. The riverbanks along the Houston Ship Channel include a combination of natural earthen banks and armoring with steel sheet piling and concrete bulkheads. Much of the ship channel is associated with various petrochemical refineries and heavy industry that provides facilities for a wide range of commerce. Numerous industries and urban stormwater discharge to the channel. The ship channel characteristics highlighted above have a significant impact on attainable water uses and water quality standards.

No aquatic life use category has been assigned to segments 1006 and 1007 in the Houston Ship Channel (TCEQ, Texas Surface Water Quality Standards, Site-Specific Water Uses and Standards, TAC 307.10, Appendix A). Other uses assigned to segments 1006 and 1007 are navigational and industrial water supply. No contact recreation is allowed in segments 1006 and 1007. Segment 1005 has been designated as a high aquatic use water.

The minimum dissolved oxygen (DO) criterion measured during a 24-hour period for segment 1006 in the Houston Ship Channel is 2.0 mg/L (TCEQ, Texas Surface Water Quality Standards, Site-Specific Water Uses and Standards, TAC 307.10, Appendix A). DO criteria of 2.0 mg/L are allowed a daily variation down to 1.5 mg/L for no more than eight hours during a 24-hour period. The minimum DO criterion at any time for segment 1007 is 1.0 mg/L (TCEQ, Texas Surface Water Quality Standards, Site-Specific Water Uses and Standards, TAC 307.10, Appendix A). There is no daily mean (average) DO criterion for ship channel segments 1006 and 1007.

Dissolved Oxygen Criteria for Use II Waters in Maryland (Patapsco River; Chesapeake Bay UAA)

Maryland has a 5.0 mg/L DO minimum for all "Use I Waters – Water Contact Recreation and Protection of Nontidal Warmwater Aquatic Life." Less stringent DO standards were set in portions of the Patapsco River after the Chesapeake Bay UAA, which involved several states including Maryland. Uses were designated for the Patapsco River and "applied spatially and temporally based on the needs of living resources and the hydrology and bathymetry of the Patapsco River."

UAA factors 1, 3, and 4 were relevant to these tidal tributaries to the Chesapeake Bay (naturally occurring pollutant concentrations, human caused conditions, and hydrologic modifications, respectively). The Patapsco River channel was dredged and widened to allow for a commercial port in Baltimore Harbor, and has been further deepened to various degrees between 1838 and the present. The benthic community in these deep dredged channels is characterized as "unstable due to frequent disturbances, such as the 42-foot dredging project, annual maintenance dredging and prop-washes associated with ship movements, and is though to consist primarily of opportunistic species."

While the Patapsco River can be compared to the CAWS based on commercial navigation uses and limited aquatic habitat, the Patapsco River navigation channels are up to

about 20 feet deeper than the deepest CAWS waterways (such as the Chicago Sanitary and Ship Canal and Calumet River), and are estuarine, tidal waters.

The DO criteria for certain subcategories of Use II Waters, as defined by the Chesapeake Bay UAA are as follows:

Seasonal Deep-Water Fish and Shellfish Subcategory

(i) Greater than or equal to **3.0 milligrams/liter** for a **30-day averaging** period from June 1 through September 30;

(ii) Greater than or equal to **2.3 milligrams/liter** for a **1-day averaging period** from June 1 through September 30;

(iii) Greater than or equal to **1.7 milligrams/liter** as an instantaneous **minimum** from June 1 through September 30;

(iv) The open-water fish and shellfish subcategory criteria apply from October 1 to May 31;

(v) For the dissolved oxygen criteria **restoration variance** for Chesapeake Bay Mainstem Segment 4 mesohaline (CB4MH) seasonal deep-water fish and shellfish subcategory, not lower for dissolved oxygen in segment CB4MH than the stated criteria for the seasonal deep-water seasonal fish and shellfish use for **more than 7 percent spatially and temporally** (in combination), from June 1 to September 30; and

(vi) For dissolved oxygen criteria restoration variance for Patapsco River mesohaline (PATMH) seasonal deep-water fish and shellfish subcategory, not lower for dissolved oxygen in segment PATMH than the stated criteria for the deep-water seasonal fish and shellfish use **for more than 7 percent spatially and temporally** (in combination), from June 1 to September 30.

Seasonal Deep-Channel Refuge Subcategory

(i) Greater than or equal to **1.0 milligrams/liter** as an instantaneous **minimum** from June 1 through September 30 except for Chesapeake Bay segments subject to variances;

(ii) For dissolved oxygen criteria **restoration variance** for Chesapeake Bay Mainstem Segment 4 mesohaline (CB4MH) deep-channel refuge subcategory, not lower for dissolved oxygen in segment CB4MH than the stated criteria for the seasonal deep-channel **refuge for more than 2 percent spatially or temporally** (in combination), from June 1 to September 30; and

(iii) The same as for the open-water fish and shellfish subcategory from October 1 to May 31.

Notice there are both less stringent standards in place as well as a variance allowing for the criteria to be violated 7 or 2 percent spatially or temporally. These variances are based on water quality modeling and are to be reviewed at least every 3 years. They may be modified based on new data or assumptions incorporated into the model.

Patapsco River Dissolved Oxygen Standards

The Maryland Department of the Environment (MDE) water quality standards for the Patapsco River build off of general MDE standards and those for the Chesapeake Bay, with some standards specific to the Patapsco. MDE has defined four primary designated aquatic life uses for surface waters in Maryland: Nontidal Warmwater Aquatic Life (Use I), Estuarine and Marine Aquatic Life (Use II), Nontidal Cold Water (Use III), and Recreational Trout Waters (Use IV), with additional subcategories for Use II waters (COMAR 26.08.02). These Use II subcategories include Shellfish Harvesting, Seasonal Migratory Fish Spawning and Nursery, Seasonal Shallow-Water Submerged Aquatic Vegetation, Open-Water Fish and Shellfish, Seasonal Deep-Water Fish and Shellfish, and Seasonal Deep-Channel Refuge Use (COMAR 26.08.02-1). In addition to water quality criteria for the specific subcategories, MDE's water quality standards include restoration variances allowing limited nonattainment of dissolved oxygen criteria for designated waterbody segments.

A restoration variance is a temporary modification that allows for the realistic recognition of current conditions, while retaining the designated use and setting attainment as a future goal. A restoration variance allows dissolved oxygen to violate applicable criteria for a specified spatial and temporal extent in certain specific areas, recognizing that fish do not live in a single location within the water column, and some spatial and temporal flexibility can be incorporated without harming the aquatic community. . This modification to the water quality standards was necessary because in certain areas, dissolved oxygen requirements could not be met, despite spending billions of dollars to reduce pollutant loadings. A restoration variance was chosen as a more "protective" and politically palatable alternative than permanently lowering the standard. The State is required to review the restoration variances at least every three years (based on EPA regulations), and adjust it accordingly.

With regard to DO, the Patapsco River Mesohaline (PATMH) segment is designated as a Use II Tidal Water, with several use subcategories at certain locations and during specific periods. These are summarized below, with the corresponding DO criteria:

- Open Water Fish and Shellfish Use: January 1 to December 31, inclusive (applies throughout the water column and time period, with the exception of the dates and locations indicated for the other subcategories)
    - 5.5 mg/l 30-day average, low salinity waters
    - 5.0 mg/l 30-day average, high salinity waters
    - 4.0 mg/l 1-day average
    - 3.2 mg/l instantaneous minimum
- Migratory Spawning and Nursery Use: February 1 to May 31, inclusive
    - 6.0 mg/l 7-day average
    - 5.0 mg/l instantaneous minimum

- Seasonal Deep Water Fish and Shellfish Use: applies only in the upper pycnocline to lower pycnocline from June 1 to September 30, inclusive
    - 3.0 mg/l 30-day average
    - 2.3 mg/l 1-day average
    - 1.7 mg/l instantaneous minimum
    - Patapsco River mesohaline segment (PATMH) restoration variance: not lower than above criteria for more than 7 percent spatially and temporally (in combination)
- Seasonal Deep Channel Refuge: applies only from the lower pycnocline boundary to the bottom from from June 1 to September 30, inclusive
    - 1.0 mg/l instantaneous minimum
    - Patapsco River mesohaline segment (PATMH) restoration variance: not lower than above criterion for more than 2 percent spatially and temporally (in combination)

In addition to a restoration variance, there has been ongoing discussion between MDE and EPA with regard to further changes in water quality standards for the navigation channel. MDE had proposed a subcategory for the dredged navigation channel that would have included a seasonal dissolved oxygen criterion of 0 mg/l. MDE's TMDL analysis for the Patapsco indicated that existing criteria could not be met even with source reductions of "everything, everywhere, by everybody." EPA did not accept MDE's conclusions nor the 0 mg/l criterion for the navigation channel, and has recommended that MDE conduct a UAA. MDE is currently developing a strategy to address the situation.

CAWS Applicability

The Maryland standards for DO may provide guidance relevant to the CAWS with regard to developing appropriate subcategory designations for attainability, similar to those considered for the Patapsco River (EPA 2006). Patapsco River subcategories were developed to take into account considerations such as deep water, dredged navigation channel, and other site-specific characteristics affecting attainment of DO criteria. Similarly, subcategory assignments for DO may be appropriate within the CAWS because of the varying channel types, depths, dredged channels, and hydraulic controls found within the CAWS that affect DO attainment. Similarities between the CAWS and the Patapsco River include industrialized and urbanized channels, dredged navigational channels, and modified shorelines. However, the Patapsco River criteria are not directly applicable to the CAWS, due to the complex interactions of the tidal and saline influences that affect Patapsco River DO. The restoration variance approach, in which criteria are allowed to be violated on a limited basis, could also be appropriate within the CAWS because there are irreversible human alterations and no realistic expectation of attainment

Reference:

EPA. 2007. National Management Measures to Control Nonpoint Source Pollution from Hydromodification. http://www.epa.gov/owow/nps/hydromod/index.htm#10 , accessed May 2009. Version July 2007.

EPA. 2006. Technical support document for identifying Chesapeake Bay designated uses and attainability. http://www.epa.gov/region03/chesapeake/uaasupport.htm , accessed May 2009. Version December 2006.

Chesapeake Bay Dissolved Oxygen Standards

The Maryland Department of the Environment (MDE) has defined four primary designated aquatic life uses for surface waters in Maryland: Nontidal Warmwater Aquatic Life (Use I), Estuarine and Marine Aquatic Life (Use II), Nontidal Cold Water (Use III), and Recreational Trout Waters (Use IV), with additional subcategories for Use II waters (COMAR 26.08.02). These Use II subcategories include Shellfish Harvesting, Seasonal Migratory Fish Spawning and Nursery, Seasonal Shallow-Water Submerged Aquatic Vegetation, Open-Water Fish and Shellfish, Seasonal Deep-Water Fish and Shellfish, and Seasonal Deep-Channel Refuge Use (COMAR 26.08.02-1). In addition to water quality criteria for the specific subcategories, MDE's water quality standards include restoration variances allowing limited nonattainment of dissolved oxygen criteria for designated waterbody segments.

A restoration variance is a temporary modification that allows for the realistic recognition of current conditions, while retaining the designated use and setting attainment as a future goal. A restoration variance allows dissolved oxygen to violate applicable criteria for a specified spatial and temporal extent, specifically in this case in some of the deepest areas of the Chesapeake Bay. The restoration variance acknowledges the reality that fish do not live in a single location within the water column, and some spatial and temporal flexibility can be incorporated without harming the aquatic community. This modification to the Chesapeake Bay water quality standards was necessary because in those few deep areas, dissolved oxygen requirements could not be met, despite spending billions of dollars to reduce nitrogen, phosphorus, and sediment pollution to clean up the rest of the Bay. A restoration variance was chosen as a more "protective" and politically palatable alternative than permanently lowering the standard. The State is required to review the restoration variances at least every three years (based on EPA regulations), and adjust it accordingly.

The Use II Seasonal Deep-Water Fish and Shellfish Subcategory has the following dissolved oxygen criteria (COMAR 26.08.02.03-3 C(8)(e)):

- June 1 through September 30:
  - 3.0 mg/l 30-day average
  - 2.3 mg/l 1-day average
  - 1.7 mg/l instantaneous minimum
  - Chesapeake Bay Mainstem Segment 4 mesohaline (CB4MH) restoration variance: not lower than above criteria for more than 7 percent spatially and temporally (in combination)
- October 1 through May 31:
  - 5.5 mg/l 30-day average, low salinity waters
  - 5.0 mg/l 30-day average, high salinity waters
  - 4.0 mg/l 1-day average
  - 3.2 mg/l instantaneous minimum

The Use II Seasonal Deep-Channel Refuge Subcategory has the following dissolved oxygen criteria (COMAR 26.08.02.03-3 C(8)(f)):

- June 1 through September 30:
  - 1.0 mg/l instantaneous minimum
  - Chesapeake Bay Mainstem Segment 4 mesohaline (CB4MH) restoration variance: not lower than above criterion for more than 2 percent spatially and temporally (in combination)
- October 1 through May 31:
  - 5.5 mg/l 30-day average, low salinity waters
  - 5.0 mg/l 30-day average, high salinity waters
  - 4.0 mg/l 1-day average
  - 3.2 mg/l instantaneous minimum

CAWS Applicability

The Maryland standards for DO may provide guidance relevant to the CAWS with regard to developing appropriate subcategory designations for attainability similar to those considered for the Chesapeake Bay. Chesapeake Bay subcategories were developed to take into account considerations such as deep water, dredged channel, stratification, and other site-specific characteristics affecting attainment of DO criteria. Similarly, subcategory assignments for DO may be appropriate within the CAWS because of the varying channel types, depths, stratification, dredged channels, and hydraulic controls found within the CAWS that affect DO attainment. In addition, the restoration variance approach, in which criteria are allowed to be exceeded on a limited basis, could also be appropriate within the CAWS because there are irreversible human alterations and no realistic expectation of attainment. The specific DO criteria for the Chesapeake Bay are not directly applicable to the CAWS because the saline conditions, depths, bathymetry and complex tidal influences found within the Chesapeake Bay are much different than the CAWS. Nonetheless, the conceptual basis for the subcategories, criteria, and restoration variance have relevance to the CAWS.

Reference:

EPA. 2007. National Management Measures to Control Nonpoint Source Pollution from Hydromodification. http://www.epa.gov/owow/nps/hydromod/index.htm#10 , accessed May 2009. Version July 2007.

EPA. 2006. Technical support document for identifying Chesapeake Bay designated uses and attainability. http://www.epa.gov/region03/chesapeake/uaasupport.htm , accessed May 2009. Version December 2006.

Wisconsin Dissolved Oxygen Standard

"It is the goal of the State of Wisconsin that, wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and

provides for recreation in and on the water be achieved by 1983. Certain waters of the state may not meet these goals for the following reasons: (a) the presence of inplace pollutants; (b) low natural streamflow; (c) natural background conditions; and (d) irretrievable cultural alterations. Where it is determined that one or more of these factors may interfere with the attainment of the statutory objectives, a variance from the criteria necessary to achieve those objectives is provided" (Wisconsin Department of Natural Resources, Uses and Designated Standards, Intrastate Waters, Wisconsin Administrative Code NR 104.01).

The Wisconsin Department of Natural Resources has established the following Aquatic Life Use (ALU) categories for surface waters in Wisconsin: (1) coldwater communities; (2) warm water communities; (3) warm water forage communities; (4) limited forage fish communities, and (5) limited aquatic life (Wisconsin Department of Natural Resources, Water Quality Standards for Wisconsin Surface Waters, Categories of standards, Wisconsin Administrative Code NR 102.04). Surface waters receiving a water use variance are classified as a "Special Variance Water A or B" (Wisconsin Department of Natural Resources, Uses and Designated Standards, Variances and Additions Applicable in the Southeast District, Wisconsin Administrative Code NR 104.06).

The Milwaukee Harbor Estuary is a distinct segment of the mainstem of the Milwaukee River. The waterway segment originates at the site of the former North Avenue dam and flows approximately 3.1 river miles through the City of Milwaukee before merging with the Kinnickinnic River.

Over the years, the Milwaukee River below the former North Avenue dam has been largely straightened with limited meandering. The physical alterations and modifications to the Milwaukee River Estuary segment have resulted in a non-wadable river with reduced stream velocity, widespread sediment deposition, reduced instream and riparian vegetative cover, and a decrease in substrate diversity. The river banks along the segment are typically concrete bulheads resulting in a limited riparian corridor and floodplain. The watershed draining the 3.1 mile reach of the Milwaukee River below the former North Avenue dam is predominantly urban (50-60% imperviousness). The Milwaukee Harbor Estuary segment receives combined sewer overflows from the Milwaukee Metropolitan Sewerage District. The waterway characteristics described above have a significant impact on attainable water uses and water quality standards.

Variances for dissolved oxygen (DO) for a number of surface waters in the State of Wisconsin have been established by the Wisconsin Department of Natural Resources. These variances are described in Wisconsin Administrative Code NR 104.02 (3) and NR 104.06 (2).

The Milwaukee Harbor Estuary segment of the Milwaukee River is subject to a DO variance. The surface waters of the 3.1 mile segment of the mainstem of the Milwaukee River downstream from the former North Avenue dam "shall meet the water quality standards for fish and aquatic life except that the **dissolved oxygen may not be lowered to less than 2.0 mg/L at anytime"** (Wisconsin Department of Natural Resources, Uses and Designated Standards, Variances and additions applicable in the southeast district, Wisconsin Administrative Code NR 104.06).

Site Specific Dissolved Oxygen Standard for the Upper South Platte River Segment 15 in Colorado

Segment 15 of the South Platte River is a 26-mile reach of the mainstem from the Burlington Ditch diversion in Denver, Colorado, ending below the confluence with Big Dry Creek near Fort Lupton, Colorado. The physical habitat in Segment 15 of the Upper South Platte River has been drastically altered from its natural state by commercial, agricultural, flood control, and water supply activities which have affected the hydrology and morphology of the river. The river is channelized and regulated by water storage and diversion facilities. Flow in Segment 15 is dominated by effluent from the Denver Metro Wastewater Reclamation District's Central Treatment Plant (CTP), which constitutes 100% during low flow. The annual average monthly flow from the CTP is about 185 million gallons per day (mgd). Aquatic habitat limitations include channelization, low diversity of streambed structure, limited cover, stream size, and flow fluctuation, and habitat mapping of the area revealed low to moderate habitat quality along the reach.

As such, studies conducted by the Denver Metro supported a site-specific dissolved oxygen (DO) standard for Segment 15, which was implemented in the late 1990s and approved by USEPA. In 2004 the same standard was applied to the next segment downstream of Segment 15 as well. Target fish species for Segment 15 were studied in order to propose appropriate and protective DO standards. These fish species included the fathead minnow, johnny darter, yellow perch, largemouth bass, sand shiner, longnose dace, and central stoneroller, the first 4 of which are present to varying degrees in the CAWS.

While the South Platte River shares certain common characteristics with the CAWS (channelized, effluent dominated, habitat limited) it is a non-navigable waterway and not technically man-made. Channel depth and width is substantially lower in the South Platte than in the CAWS. As a result, low DO concentrations generally result from diurnal fluctuation and occur at night.

The site specific DO standard for the applicable segments of the South Platte River are as follows:

Early Life Stage Protection Period (April 1 through July 31)	
1-Day [1.5.6]	3.0 mg/L (acute)
7-Day Average [1.2.4.]	5.0 mg/L
Older Life Stage Protection Period (August 1 through March 31)	
1-Day [1.5]	2.0 mg/L (acute)
7-Day Mean of Minimums [1.3.]	2.5 mg/L
30-Day Average [1.2.]	4.5 mg/L

Certain footnotes to the standards which may be worth considering for the CAWS site specific standard include:

> "However, if during the ELS period multiple measurements are below 3.0 mg/L during the same nighttime period, the multiple measurements shall be considered a single exceedance of the acute standard." (from Footnote 5).
>
> "In July, the DO level in Segment 15 may be lower than the 3.0 mg/L acute standard for up to 14 exceedances ain any one year and up to a total of 21 exceedances in three years before there is a determination that the acute DO standards are not being met." (from Footnote 6).

Nevada Dissolved Oxygen Standard

Nevada water quality standards contained in Nevada Administrative Code (NAC) 445A.120 through 445A.225, inclusive, apply to all natural surface waters (streams, creeks, lakes), reservoirs, impoundments, and other specified waterways, unless excepted on the basis of existing irreparable conditions which preclude such water use. Man-made waterways, unless otherwise specified, must be protected of public health and the water use for which the waterway was developed (Nevada Division Environmental Protection, Standards for Water Quality, Applicability, NAC 445A.120).

The Nevada Division Environmental Protection has established the following beneficial aquatic life use categories for surface waters in the State of Nevada: (1) class A waters (relatively undisturbed by man's activity); (2) class B waters (moderately influenced by man's activity); (3) class C waters (considerably altered by man's activity); and (4) class D waters (highly altered by man's activity) (Nevada Division Environmental Protection, Standards for Water Quality, Description, Beneficial Uses, Quality Standards, NAC 445A.124-445A.127).

Class D waters or portions of surface waters are located in areas of urban development, highly industrialized districts, or intensively used areas for agriculture or a combination of all of the above, and where effluent sources including a municipality discharging wastewater from a highly altered watershed (Nevada Division Environmental Protection, Standards for Water Quality, Beneficial Uses, NAC 445A.127). The beneficial uses of class D waters include recreation not involving contact with the water, aquatic life, propagation of wildlife, irrigation, and industrial supply water except for food production.

Seven waterways in the State of Nevada (Sillwater Marsh, Quinn River, Humbolt River, Long Valley Creek, Steamboat Creek, Gleason Creek, and Murray Creek) are designated class D waters (Nevada Division Environmental Protection, Standards for Water Quality, Beneficial Uses, NAC 445A.127). The class D surface waters in Nevada are not comparable or equivalent to the man-made waterways or highly altered natural rivers in the Chicago region.

The dissolved oxygen standard for class D waters in Nevada is $\geq$ 3.0 mg/L (Nevada Division Environmental Protection, Standards for Water Quality, Beneficial Uses, NAC 445A.127).

Oklahoma Dissolved Oxygen Standard

Title 82 of the Oklahoma Statutes, Section 1085.1 provides as follows: "It is hereby declared to be the public policy of this state to conserve and utilize the waters of the state and to protect, maintain, and improve the quality thereof for public water supplies, for the propagation of wildlife, fish, and aquatic life and for domestic, agricultural, industrial, recreational and other legitimate beneficial uses" (Oklahoma Water Resources Board, Oklahoma's Water Quality Standards, General Provisions, OAC 785:45-5-1).

Title 82 of the Oklahoma Statutes, Section 1085.30 provides that the Oklahoma Water Resources Board "… is authorized to adopt, amend, and otherwise promulgate rules to be known as Oklahoma Water Quality Standards which establish classifications of uses of waters of the state, criteria to maintain and protect such classifications, and other standards or policies pertaining to the quality of such waters" (Oklahoma Water Resources Board, Oklahoma's Water Quality Standards, General Provisions, OAC 785:45-5-1).

The Oklahoma Water Resources Board "may amend water quality standards to downgrade a designated use of any waters of this state, may establish subcategories of a use for less stringent criteria in those circumstances permissible under the Federal Water Pollution Control Act" (Oklahoma Water Resources Board, Oklahoma's Water Quality Standards, General Provisions, OAC 785:45-5-1).

The beneficial water use classification Fish and Wildlife Propagation consists of several aquatic life use subcategories which are capable of sustaining different climax communities of fish and shellfish. The aquatic life use subcategories are trout fishery, cool water aquatic community, warm water aquatic community, and habitat limited aquatic community (Oklahoma Water Resources Board, Oklahoma's Water Quality Standards, General Fish and Wildlife Propagation, OAC 785:45-5-12).

The subcategory habitat limited aquatic community is defined as a biological community that is not adequate to support a warm water aquatic community because of the following factors: (1) natural occurring water chemistry that prevents attainment of use; (2) natural occurring ephemeral, intermittent or low flow conditions that prevent attainment of use; (3) human caused conditions that prevent attainment which cannot be remedied; (4) dams, diversions, and other hydrologic modifications that prevent attainment of use; and (5) physical conditions such as the lack of proper substrate, cover, flow, depth, pools, an riffles that prevent attainment of use (Oklahoma Water Resources Board, Oklahoma's Water Quality Standards, Fish and Wildlife Propagation, OAC 785:45-5-12).

Numerous waterways in the State of Oklahoma (e.g., Tar Creek, Chambers Creek, Mossy Creek, Riddle Creek, and Children Creek) are designated as habitat limited aquatic community waters (Oklahoma Water Resources Board, Oklahoma's Water Quality Standards, Appendix A, OAC 785:45). Habitat limited aquatic community surface waters in Oklahoma are not comparable or equivalent to the man-made waterways or highly altered natural rivers in the Chicago region.

During the summer, fall, and winter (6/16-3/31), the minimum dissolved oxygen (DO) standard for habitat limited aquatic community waters in Oklahoma is 3.0 mg/L (Oklahoma Water Resource Board, Oklahoma's Water Quality Standards, Appendix G, OAC 785:45). The minimum DO standard for early life stages of fish in habitat limited aquatic community waters is 4.0 mg/L during the spring (4/1-6/15).

Man Made Water Body Classification and Dissolved Oxygen Standards for the New Iberia Southern Drainage Canal and W-14 Main Diversion Canal in Louisiana

The State of Louisiana has established three categories of water bodies that are eligible to receive an exception classification on a case-by-case basis, including a Man-Made Water Body category (Described in LAC 33:IX.1109.C).

A man-made water body is defined in the LAC as,

> "a ditch, canal or channelized stream created specifically and used primarily for drainage or conveyance of water. Some natural streams have been channelized to such an extent that conveyance of water is the principal use, usually precluding reasonable primary contact recreation and balanced fish and wildlife propagation. Such natural, channelized streams may be considered for classification as man-made water bodies."

The regulation goes on to state that,

> "the physical characteristics of man-made water bodies that may fall under this exception are not conducive to the establishment of a balanced population of aquatic biota or to the full support of recreational activities."

Classification of a man-made water body may involve a Use Attainability Analysis for justification, whereupon revised water quality criteria and uses are established.

The New Iberia Southern Drainage Canal from headwaters to ICWW (NISDC) is one of the water bodies classified as man-made and having site-specific dissolved oxygen (DO) standards. This waterway is considered "Limited Aquatic Life and Wildlife Use," and has the following DO standard:

> "Designated Man-Made Water Bodies; Seasonal DO Criteria: 3.0 mg/L November-April, 2.0 mg/L May-October…" (LAC 33:IX.1307)

Another man-made water body example, the W-14 Main Diversion Canal-From headwaters to Salt Bayou, is designated "Fish and Wildlife Propagation." The DO standard is defined as

> "Designated Man-Made Water body; Seasonal DO Criteria: 4.0 mg/L November-March, 2.5 mg/L April-October; Subcategory Fish and Wildlife Use, Blue Crab Use."

Similarities between the NISDC and the CAWS are limited to both being man-made and channelized. The NISDC is estuarine and shallow. According to the City of New Iberia Wastewater Department, they no longer discharge into the NISDC, so it is not likely an effluent dominated water body, and its function is generally stormwater conveyance.

TECHNICAL SUPPORT FOR DISTRICT DISSOLVED OXYGEN CRITERIA PROPOSAL IN THE CAWS

The purpose of this document is to provide the scientific and technical basis for assigning minimum dissolved oxygen (DO) criteria for three proposed Aquatic Life Uses for the Chicago Area Waterway System (CAWS). The District proposes minimum DO criteria identical to those proposed by IEPA. The proposed criteria are 4.0 milligrams per liter (mg/L) for CAWS Category 1 (Modified Warm Water Aquatic Life Use); 3.5 mg/L for CAWS Category 2 (Limited Warm Water Aquatic Life Use), and a narrative criterion for CAWS Category 3 (Severely Limited Water Aquatic Life Use). The District does not propose 7-day mean of minima or early life stage DO standards because they are inappropriate for the CAWS, as described in this document. Finally, the District proposes a wet weather provision from the applicable DO standard in the CAWS as described in detail in Adrienne Nemura's testimony submitted February 2, 2011.

The Habitat Evaluation Report (filed with IPCB on January 6, 2010, PC Number 284) indicates that physical habitat is more of a limit to the fish community in the CAWS than water quality factors including DO. Furthermore, waterways in other states with similar physical characteristics to the CAWS are subject to DO minimum standards between 1-2 mg/L, as discussed below. For the reasons highlighted in this document, the District believes that our proposal of DO minima ranging from 3.5-4.0 mg/L is actually more stringent than is needed to support the current and potential aquatic life in the CAWS.

Physical Habitat is the Limiting Factor affecting Fish in the CAWS

The Habitat Evaluation Report assessed the relative importance of DO versus physical habitat on the fish communities in the CAWS using data from 2001 to 2008. Discussion of this analysis is presented on pages 123-125 of the Habitat Evaluation Report and in detail in its

Appendix C. The statistical analysis performed by LimnoTech indicated that DO explained 2-27 percent of the variability in fish data, whereas physical habitat explained 48 percent. Multiple regression analyses were performed with several key DO metrics to determine whether they significantly improved habitat models predicting fish data. The DO metric with the strongest (negative) relationship to CAWS fish data was found to be percent of time between June and September that DO was below 5 mg/L. However, adding this metric to the habitat variable model only improved the model by 4 percent. These results indicate that physical habitat is more important to the biological integrity of CAWS fish than DO. Since physical habitat is the limiting stressor in the CAWS, improving DO would not result in a statistically significant, or measureable, improvement in fish populations in any of the CAWS reaches. Therefore, the DO standards the District is proposing are designed to protect the dominant CAWS fish community.

This CAWS community contains fish species representing the various trophic levels as shown in Figure 1. The tolerant and moderately tolerant fish species listed in this figure represent 92% of the total number of fish (25,493) collected in the CAWS between 2001-2008. The Hierarchical Cluster Analysis (HCA) that was performed by LimnoTech to determine the dominant CAWS fish community is described in Attachment 1.

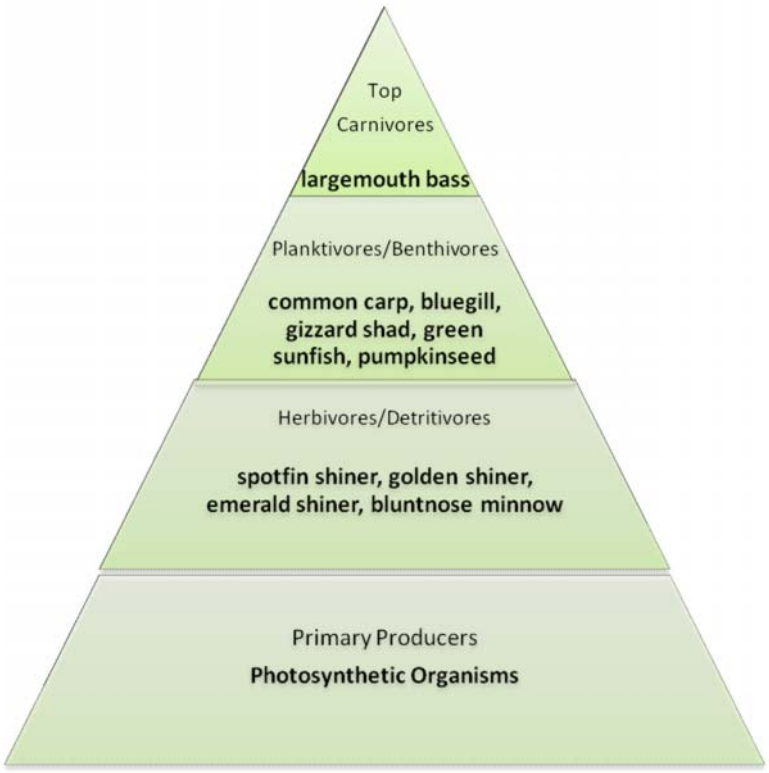


Figure 1: Trophic levels of the CAWS dominant fish community.

Low DO tolerance of Largemouth Bass

There are extensive studies regarding the DO tolerance of largemouth bass in the scientific literature. Since largemouth bass are a popular game fish that have been collected throughout the CAWS, the DO tolerance of these fish should be considered as part of these proceedings. Several studies indicate that largemouth bass can tolerate low DO concentrations and practice avoidance of low DO waters. Hasler et al., 2009, describes behavioral and physiological responses of largemouth bass to various DO gradients. Experimental fish avoided DO concentrations of <2.0 mg/L and showed behavioral signs like gulping air at this concentration. However, fish exposed to 2.0 mg/L did not undergo changes in tissue lactate, which would have indicated a physiological response to low DO, ie. anaerobic metabolism. Burleson, 2001 concluded that "all sizes of largemouth bass may briefly tolerate hypoxic exposure to the lowest levels of dissolved oxygen used in this study." Oxygen sensitive receptors

on fish gills allow for avoidance and selection responses to various DO levels. It should be noted that juvenile stages of largemouth bass migrated to lower DO concentrations and are thought to have wider tolerance ranges than the adults (Burleson et al., 2001).

A document entitled, *Dissolved Oxygen Requirements for Fishes* (Doudoroff et al, 1970) that was often referenced in the 1986 USEPA DO Criteria document stated, "We have worked much with juvenile largemouth bass and have found them to be very tolerant of O_2 deficiency. They not only survived for weeks but also grew, and they swam continuously for 24 hours at a fairly high speed in summer, at O_2 levels near 2 mg/L and temperatures near 25°C."

These and other studies suggest that 2.0 mg/L is a critical DO threshold for largemouth bass. Based on these results, this game fish common to the CAWS would be adequately protected by minimum DO standards of 4.0 and 3.5 mg/L for CAWS Category 1 and 2 Waters, respectively.

7-Day Mean of Daily Minima Standard is Unnecessary for the CAWS

The 7-day mean of daily minima is not included in the District's alternative aquatic life use proposal. A 4.0 mg/L 7-day mean of daily minima standard would be redundant to the 4.0 mg/L daily minimum DO standard proposed by the District for Category 1 Waters. Moreover, this standard is also inappropriate for Category 2 Waters. A study simulating diurnal DO fluctuations conducted by Camp Dresser & McKee Inc. (CDM) for Denver Metro Wastewater Reclamation District found that significant behavioral effects were not observed in largemouth bass until the 7-day mean of minima exposure was as low as 0.86 mg/L. Opercular rates were affected when the 7-day mean of daily minima was 2.81 mg/L. The proposed 7-day mean of daily minima criteria of 4.0 mg/L is much higher than required for protection of fish species expected to reside in the CAWS.

Furthermore, the rationale for the 7-day mean of daily minima standard described in the 1986 USEPA Ambient Water Quality Criteria Document for DO (IEPA Attachment X) applies to natural waterways that incur frequent diurnal DO fluctuations on a regular basis. The deep draft waters of the CAWS, with few shallow littoral areas compared to the channel width, are generally not subject to diurnal DO fluctuations. Because unpredictable CSOs triggered by wet weather events are usually the cause of an unexpected decrease in DO in the CAWS, a 7-day mean of daily minimum for DO would not be appropriate. As described in Dr. Sam Dennison's testimony about District DO monitoring, wet weather events do not cause the entire system to suffer low DO at one time. A slug of low-DO waters can originate near a pumping station, for instance, and then slowly make its way downstream. Waters recover to pre-event conditions within hours or days and the effect of the slug is diminished as it moves downstream. This system behavior is thought to enable the resident fish to practice avoidance of the lowest DO areas in the CAWS.

A number of studies confirm that fish will avoid areas where DO is limited. Larval, juvenile and adult fishes that were tested responded to oxygen gradients by moving upwards or laterally away from waters with physiologically stressful or potentially lethal dissolved oxygen concentrations. Most fish avoid oxygen concentrations that would reduce growth or require increased energy expenditure in addition to avoiding lethal concentrations (Breitburg, 2002). A study of wet weather discharges in the Thames River noted that fish species actively avoid low DO well above lethal values, protecting fish populations as long as they avoid the hypoxic front or find refuge in side channels (Jacobs, 2006).

DO Standards for Early Life Stages are Inappropriate for the CAWS

In order to protect and support early life stages of fish, the Illinois Environmental Protection Agency (IEPA) has proposed in R08-9, a 5.0 mg/L dissolved oxygen (DO) standard for Aquatic Life Use A Waters in the CAWS during March through July.

Mr. Roy Smoger with IEPA testified on March 10, 2008 (pages 70-71), that the DO standards proposed for the CAWS were consistent with the United States Environmental Protection Agency's 1986 ambient water quality criteria for DO. In his April 24, 2008 testimony (pages 98-99), Mr. Smoger referenced the protection of early life stages of smallmouth bass, channel catfish, and largemouth bass relative to the proposed 5.0 mg/L DO standard. Therefore, in order for an aquatic life use and an early life stage DO standard for smallmouth bass and channel catfish to be applicable in the CAWS, consideration should be given to whether the waterways offer suitable physical habitat for spawning and the development of early life stages of channel catfish, smallmouth bass, and largemouth bass.

Length and weight measurements of fish collected by District personnel suggest that juvenile largemouth bass may be present in the CAWS but, as discussed above, they have DO requirements much less than 5 mg/L. Early life stages of relatively intolerant species like smallmouth bass are rare in the CAWS, other than in direct proximity to Lake Michigan in the Calumet or Chicago Rivers. According to the Illinois Department of Natural Resources (IDNR) Public Comment Number 505, they observed young of the year channel catfish during the Asian carp fish poisoning event which occurred near Lockport in the Chicago Sanitary and Ship Canal. However, this information is difficult to verify since the tables included in the IDNR comment lacked fish size and abundance data from the event (see February 2, 2011 pre-filed testimony of Scudder Mackey). As the District has previously described in testimony from Scudder Mackey

and Samuel Dennison, the CAWS has limited areas that are suitable for spawning. To the extent that channel catfish are able to find suitable nesting grounds in the CAWS, it appears that current DO conditions are adequate for spawning and survival of young of the year. Since the physical habitat in the CAWS only provides small pockets of potential nesting areas for a fish species like channel catfish, and these pockets may or may not be adjacent to appropriate nursery habitats for fish, there is no reason to expect that increasing DO without improving habitat would promote additional catfish spawning.

During the 1980s, the United States Fish and Wildlife Service (USFWS) reviewed the physical habitat requirements and chemical water quality referenced in the scientific literature for 157 species of animals (fish, amphibians, birds, and mammals). Specific habitat suitability information was summarized for early life stages and adult smallmouth bass, channel catfish, and largemouth bass in technical reports authored by Edwards et al. (1983), McMahon and Terrell (1982), and Stuber et al. (1982), respectively.

Smallmouth Bass. Edwards et al. (1983) identified six physical habitat features (dominant substrate, % pools, depth of pools, % cover, water level fluctuations, and stream gradient) and eight chemical water quality parameters required for early life stages and adult smallmouth bass. A summary of these physical habitat variables follows.

Smallmouth bass require clean stone or broken rock substrate for spawning. Nests are common in coarse gravel or broken rock substrate, near boulders, submerged logs, or other cover. Nests are usually located in shallow water (1 to 3 feet). A slow rise in water level before spawning is also required. Most early life stages remain in shallow water during their development.

Optimal riverine physical habitat for adult smallmouth bass is characterized by cool, clear water, abundant shade and cover, moderate current, gravel/rubble substrate, and alternating riffles and pools. Adult smallmouth bass exhibit little tolerance for siltation and turbidity.

The physical habitat characteristics described above are absent from the CAWS indicating that the habitat is unsuitable for both early life stages and adult smallmouth bass. District fish data collected in the field show that smallmouth bass are absent or infrequently collected from the CAWS (CDM, 2007).

Channel Catfish. McMahon and Terrell (1982) described four physical habitat variables (% pools, % cover, substrate for food, and velocity) and nine chemical constituents required for early life stages and adult channel catfish. A summary of the physical habitat attributes follows.

Spawning by channel catfish is inhibited if suitable nesting cover is unavailable. Shallow areas are required for spawning. Nests are built in cavities, burrows of muskrats and beavers, under rocks, and in other protected areas. Channel catfish usually spawn in shallow, flooded backwater areas. Catfish fry are commonly found aggregated near cover in protected, slow-moving areas of rocky riffles, debris covered gravel, or sand bars in clear riverine ecosystems.

Adult channel catfish prefer a diversity of depths and velocities characterized by alternating pools and riffles, low or moderate gradient, rubble gravel substrate, and abundant structural features (submerged logs, boulders, and backwaters) that provide adequate cover and food.

While there are a relatively small number of channel catfish in isolated areas of the CAWS, the lack of ideal physical habitat as described above limits their abundance in this system.

Largemouth Bass. Stuber et al. (1982) documented eleven physical habitat variables (% pool, % bottom cover for adult and juvenile, percent bottom cover for fry, substrate composition for embryo, water level fluctuation for adult and juvenile, maximum water level fluctuation for embryo, water level fluctuation during growing season, current velocity for adult and juvenile, maximum current velocity for embryo, current velocity during summer for fry, and stream gradient) and ten water quality parameters required for early life stages and adult largemouth bass. A summary of some of these physical habitat variables follows.

Successful spawning by largemouth bass is determined by the composition of the substrate and the stream velocity. In order to spawn, a gravel substrate is required by largemouth bass. Silty bottom substrates are unsuitable for spawning. Nests are common in gravel substrate. Largemouth bass prefer to spawn in pools with low velocity currents.

Optimal riverine physical habitat for adult largemouth bass is characterized by large slow moving rivers with pools, a low gradient, soft bottoms, and some aquatic vegetation.

The physical habitat characteristics described above for early life stages of largemouth bass are rare in the CAWS indicating unsuitable habitat. However, near optimal physical habitat for adult largemouth bass is confirmed by the fact that largemouth bass are a dominant game fish species in many waterway reaches in the CAWS (CDM, 2007).

A 5.0 mg/L DO standard for the CAWS was proposed by the IEPA in order to protect early life stages of smallmouth bass, channel catfish, and largemouth bass. Several studies in the scientific literature described previously in this document demonstrate that juvenile largemouth bass can tolerate much lower DO concentrations, even lower than their adult counterparts. Physical habitat information in USFWS habitat suitability index reports show that the CAWS provides a poor, unsuitable physical habitat for early life stages of smallmouth bass and channel

catfish. The CAWS are also a poor habitat for adult smallmouth bass and channel catfish, which is consistent with the relatively low abundance of these fish in the CAWS. However, habitat suitability data in a USFWS report demonstrate near optimal physical habitat for adult largemouth bass in the CAWS which is confirmed by the abundance of largemouth bass in the waterways.

The limited area of physical habitat for early life stages of smallmouth bass and channel catfish in the CAWS, and the DO tolerance levels of juvenile largemouth bass indicate that a 5.0 mg/L DO standard for early life stages is not required for the CAWS. Since the optimal habitat for various stages of these fish is limited in the CAWS, increasing the DO will not result in an increase in their abundance.

DO Minima for Similar Waterways in Other States Show Proposed Minima are Protective

In developing the rationale for assigning appropriate DO standards for the CAWS, the District performed an extensive search of existing water quality criteria in other states for waterways that resemble the CAWS. Table 1 describes DO standards in 8 other states (Colorado, Louisiana, Maryland, Nevada, Ohio, Oklahoma, Texas, and Wisconsin) for waterways that have several similar physical habitat features to the CAWS. Site specific standards, variances, and separate aquatic life use tiers are among the regulatory mechanisms used to assign DO criteria in these other states. In the four waterways that most resemble the CAWS (Cuyahoga River Ship Channel in Ohio, Houston Ship Channel in Texas, Patapsco River in Maryland, and the Milwaukee river in Wisconsin) minimum DO standards are generally in the 1-2 mg/L range. For instance, the standards for the Cuyahoga River in Ohio contain a minimum DO level of 1.5 mg/L. The Wisconsin water quality standards for the Milwaukee River contain a DO variance of 2.0 mg/L.

These DO standards are much less stringent than the minimum DO standards that the District has proposed for the CAWS, yet they are considered protective of aquatic life in similar waterways.

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Stuber, R.J., G. Gebhart, and O.E. Maughan. 1982. *Habitat Suitability Index Models: Largemouth Bass.* United States Fish and Wildlife Service Report 82, 33 pages.

Attachments

Attachment 1: . Fish Cluster Memorandum from LimnoTech Inc.

Table 1: Summary of Decreased DO Standards in Other States and their Applicability to the CAWS

STATE and WATERWAY	CLASSIFICATION/ TIER	DO STANDARD	TIER DESCRIPTION	CAWS APPLICABILITY
Ohio Cuyahoga River Ship Channel	Limited Resource Waters Fish Passage	June-Jan: 1.5 mg/L min, Feb-May: 5.0 mg/L min	Fauna substantially degraded, Irretrievably altered	29 ft depth, 270 ft wide, low velocity, sediment deposition, sheet pile, CSOs, commercial shipping
Texas Houston Ship Channel Segment 1006 and 1007	Site Specific, no aquatic life use category assigned	Segment 1006- 2.0 mg/L min, 1.5 mg/L for <8 hrs/day Segment 1007-1.0 mg/L min	No ALU tier assigned. Other uses include navigation and industrial water supply	45 ft depth, 530 ft wide, low velocity, sediment deposition, sheet pile and natural banks, industrial and urban stormwater drainage, commercial shipping
Maryland Patapsco River	Use II Waters subcategories: Seasonal deep water fish and shellfish Seasonal deep channel refuge	June-Sept: 3 mg/L 30-day avg, 2.3 mg/L 1-day avg. 1.7 mg/L min. Oct-May: Open water fish and shellfish subcat. June-Sept: 1mg/L min Oct-May: Open water fish and shellfish subcat.	Estuarine and Marine Aquatic Life	Deep dredged navigational channels, industrialized and urban, unstable sediments, modified shorelines, estuarine habitat.
Wisconsin Milwaukee River below the North Avenue dam	DO variance	2.0 mg/L min.	Shall meet the WQ standards for fish and aquatic life except DO.	Straightened channel, low velocity, sediment deposition, low vegetative cover, concrete bulheads, urban land use, 50-60% impervious surfaces, CSOs
Colorado South Platte River Segment 15	Site-specific DO standard	April-July: 3.0 mg/L min, 5.0 mg/L 7-day avg. Aug-March: 2.0 mg/L min, 2.5 mg/L 7-day mean of mins, 4.5 mg/L 30-day avg.	No ALU tier, site specific DO standard for 2 segments now	Non-navigable waterway, low depth and width, channelization, effluent dominated, habitat limited.
Nevada Stillwater Marsh, Quinn River, Humboldt River, Long Valley Creek, etc.	Class D	3.0 mg/l min.	Highly altered by man's activity	Seven waterways in Nevada are considered Class D. They are generally small creeks and not comparable to the CAWS.
Oklahoma Tar, Chambers, Mossy, Riddle, and Children Creeks, etc.	Habitat limited aquatic community	June 16-March: 3.0 mg/L min April-June 15: 4.0 mg/L min	Not adequate to support a warm water aquatic community b/c of 5 UAA factors.	Several waterways have this designation, but they are not comparable to the CAWS.
Louisiana New Iberia Southern Drainage Canal and W-14 Main Diversion Canal	Site-specific DO standards for 3 categories including "Man-made water body," considered Limited Aquatic Life and Wildlife Use or Fish and Wildlife Use, Blue Crab Use	NISDC- Nov-Ap: 3.0 mg/L min May-Oct: 2.0 mg/L W-14- Nov-March: 4.0 mg/L Ap-Oct: 2.5 mg/L	A channelized stream created specifically and used primarily for drainage or conveyance of water (incl. certain altered natural streams). Evaluated on case-by-case basis and may require UAA.	Man-made, channelized waterways, NISDC is estuarine, shallow, and functions for stormwater conveyance.

LimnoTech
Water | Environment | Scientists | Engineers

DATE: January 14, 2010

TECHNICAL MEMORANDUM

FROM: Tim Towey
Doug Bradley
Scott Bell

PROJECT: Chicago Area Waterways Habitat Evaluation and Improvement Study

TO: Tom Granato, Ph.D (Metropolitan Water Reclamation District of Greater Chicago)
Sam Dennison, Ph.D (Metropolitan Water Reclamation District of Greater Chicago)

CC: Jennifer Wasik (Metropolitan Water Reclamation District of Greater Chicago)

SUBJECT: Cluster Analysis of Fish Abundance Data in the CAWS.

Introduction

This memo documents statistical cluster analysis of fish abundance data from the Chicago Area Waterway System (CAWS) as a means to help describe the dominant fish community in the managed part of the CAWS. This work was completed as part of the CAWS Habitat Evaluation and Improvement Study, under contract to the Metropolitan Water Reclamation District of Greater Chicago (the District).

Cluster analysis is a multivariate statistical technique used to group similar observations or variables into discreet groups. Cluster analysis was applied to the fish abundance data collected in the CAWS to identify groups of fish species (communities) that tend to be found together. This analysis was undertaken to provide the Metropolitan Water Reclamation District of Greater Chicago (District) with information about the current fish communities that exist in the CAWS and to support decision-making related to the determination of appropriate biological endpoints (that is, target fish communities) for system management and habitat restoration efforts.

Data Description and Treatment

The District has been collecting fish data annually since 1974 (with the exception of 1981 and 1982) within the CAWS and surrounding area. In 2001, the District formalized their Ambient Water Quality Monitoring (AWQM) program for waterways managed by the District, which include the CAWS. For the purposes of this analysis, LimnoTech has limited the fish data analysis to the fish data collected between 2001 through 2008. During this period, the District has collected fish data at 43 stations within the CAWS. Twenty-six of these 43 stations are part of the District's AWQM program, including three locations outside of the managed area; six stations are located at the District's five Side Elevated Pool Aeration (SEPA) locations; three stations are sites of particular interest to the District on Bubbly Creek; three stations are

supplemental sites sampled only in 2007[1]; and five stations are supplemental sites sampled only in 2008. The District collected fish data within the CAWS using boat electrofishing procedures following standard protocols.

Sixty-seven different species were collected at the 43 District monitoring stations between 2001 and 2008. For the purpose of this analysis, the species that were only observed during a single collection event were not included, leaving 50 species observed during 148 events.

Cluster Methodology

Hierarchical cluster analysis (HCA) was performed using the R statistical environment. HCA is an agglomerative clustering method, meaning that each variable, fish species in this case, begins as an independent cluster. The algorithm proceeds in a stepwise fashion, with the two most similar clusters merged at each step until all the variables are grouped into a single cluster. The determination of cluster similarity depends on two factors: the distance measurement method and the cluster linkage method. The distance measurement is the method used to measure distance between two points, while the linkage method determines between what points the cluster similarity criterion is applied.

For this analysis, the Bray-Curtis, or Sorenson, distance measurement was used. This is a commonly used distance measurement in ecological applications. The Bray-Curtis distance (d_{BC}) between species *i* and *j* for *n* observations is calculated as follows:

$$d_{BC}(i,j) = \frac{\sum_{k=1}^{n} |y_{i,k} - y_{j,k}|}{\sum_{k=1}^{n} (y_{i,k} + y_{j,k})}$$

where *y* is the number of fish collected at each observation (*k*).

Two candidate linkage methods were evaluated: complete linkage and Ward's linkage. Complete linkage merges clusters based on the distance between the furthest observations in the clusters, while Ward's linkage minimizes the intracluster sum-of-squares distance. Both of these linkage methods tend to produce multiple clusters with many members and relatively few clusters with only one or two members. However, in this case, the complete linkage method produced several clusters associated with a single species and one very large cluster that included nearly all of the species found in the CAWS. Ward's linkage produced clusters with several members, and was determined to be the better method for this application.

To determine the appropriate number of clusters to retain for further evaluation, a plot of the maximum cluster dissimilarity was plotted as a function of the number of clusters (Figure 1). Generally, a value in the range of the "knee-of-the-curve" is chosen as the appropriate number of clusters. The knee for this analysis occurs at, approximately, the six cluster level, suggesting that the six cluster model should be evaluated further. Results from a six-cluster analysis were evaluated and were determined to yield informative results.

[1] These three supplemental sites were all in the Cal-Sag Channel and were identified as Cal Sag – 104th, Cal Sag – Kedzie, and Cal Sag – SW Highway. In 2007, electro-fishing was performed at these three sites and the data from those samples were included in the analysis. Fyke net data were also collected from the Cal Sag – SW Highway site, but were not included in the analysis.

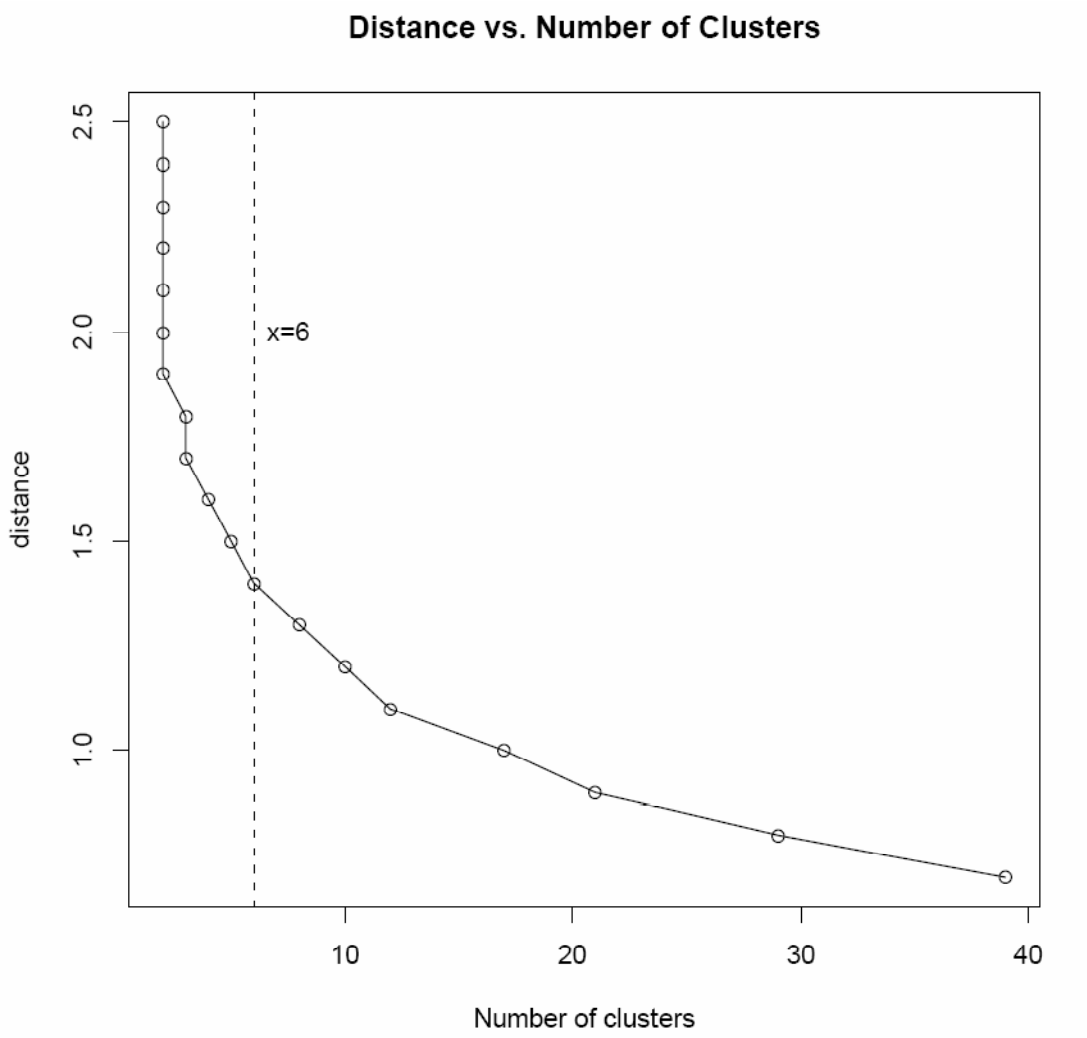

Figure 1. Plot of distance or dissimilarity as function of the number of clusters. The six cluster value was chosen as the approximate knee of the curve.

Results

The cluster analysis using six clusters produced several clusters with multiple species. A dendrogram showing the clusters is provided in Figure 2. The dendrogram shows the six clusters retained for further evaluation (bracketed in red) and the relationships between species within each cluster. The species that have the greatest tendency to occur together in the CAWS are bracketed furthest to the left.

Five of the six clusters include at least one species with a minimum count of 45 fish collected. The sixth cluster, which includes steelcolor shiner, only contains three species, none of which had more than 5 total fish observed. This cluster does not appear to represent an important community in the CAWS and was not included in the evaluations of fish traits and geographic distribution.

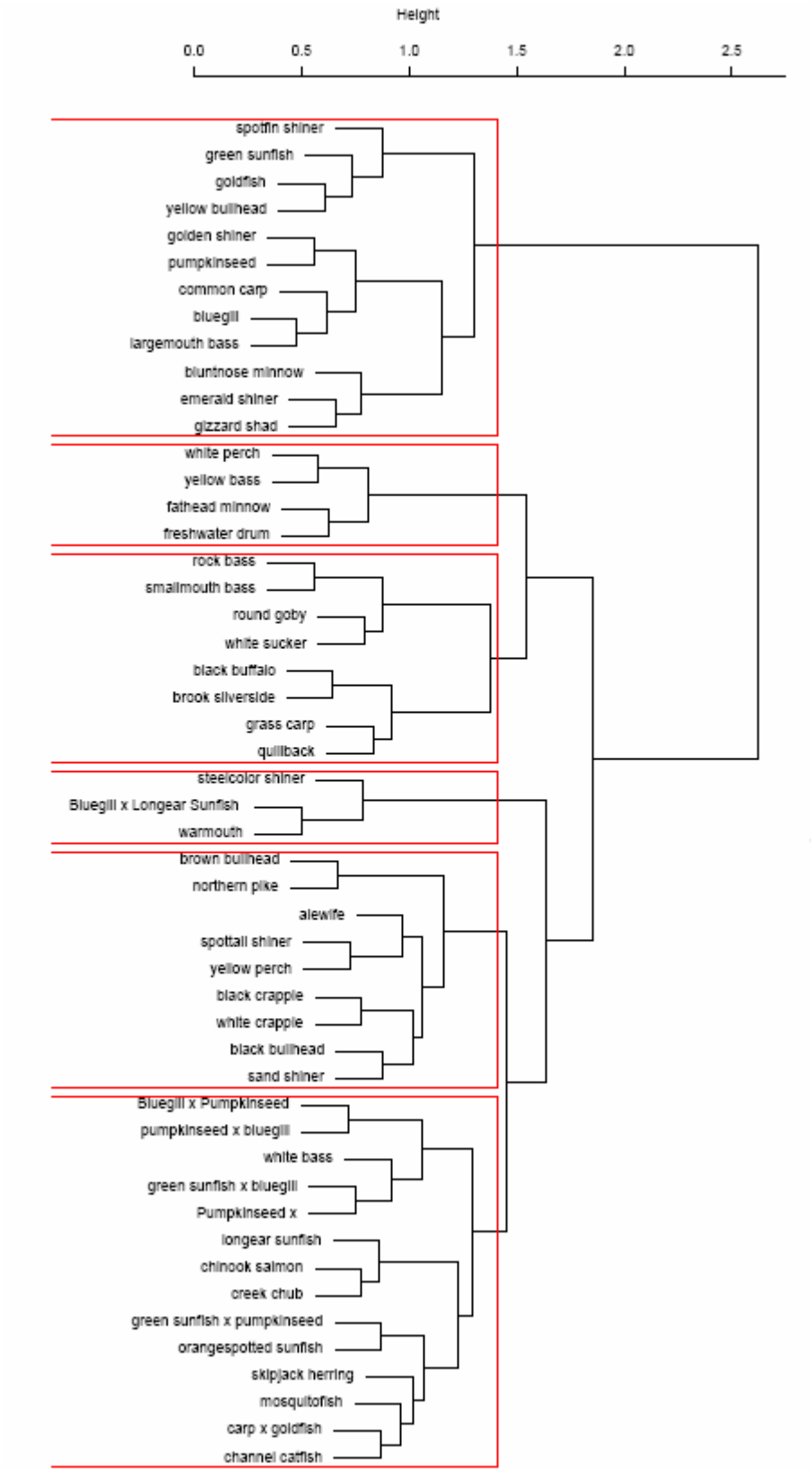

Figure 2. Dendrogram showing groupings of fish species found in the CAWS. The height axis represents a measure of dissimilarity. The groupings bracketed in red are the six clusters retained for further evaluation.

One cluster comprised the majority of the most abundant fish species, including largemouth bass, bluegill, common carp, and a number of minnow and sunfish species. This group was observed at every station in the CAWS. For this evaluation, that cluster will be referred to as the "dominant fish community." The remainder of the clusters will be referred to by the two most abundant species in that group.

Distribution of Traits within Clusters

The traits of the fish species in the clusters were evaluated using species trait data assembled from a variety of sources. Although no single source covered all species found within the CAWS, the majority of the trait data was derived from local sources. Where available, trait assignments were first established using state level data (IDNR 2000; 2008), then using data collected in the Midwest (Lyons et al., 2001), then using national level data (Meador and Carlisle, 2007), and finally using species-specific references where the relevant information was not available in the previously cited documents. The traits examined in this analysis include trophic level, substrate association, and parameters related to pollution tolerance.

Table 1 presents the percentage of total fish in each cluster that are associated with various trophic levels.

Table 1. Percentage of total fish collected in each cluster associated with various trophic levels. Many species are associated with more than one trophic level, so the percentages do not sum to 100%.

	Carnivore	Invertivore	Planktivore	Detritivore	Herbivore
Black crappie/Yellow perch	73%	90%	24%	3%	2%
Rock bass/Smallmouth bass	63%	66%	2%	22%	22%
Dominant community	15%	35%	14%	20%	47%
Channel catfish/Mosquitofish	36%	79%	1%	0%	0%
White perch/Yellow bass	90%	100%	0%	10%	0%

An evaluation of the distribution of the trophic levels (food chain links) represented within the clusters indicates that the dominant community has the most complete representation from all trophic levels, while other clusters primarily consist of fewer components of the food web. This suggests that the dominant community represents a relatively complete fish community, in the sense that its members occupy most trophic levels. The other clusters lack the components (such as prey base) to exist as independent communities.

Notably, the dominant community appears to contain trophic relationships found, or managed for, within other warm-water systems. For example, the strongest associations in this group appear between largemouth bass (a top predator) and bluegill (prey and omnivore), a commonly recommended combination of warm-water species found in angler management programs within lakes and reservoirs (Becker, 1983; Hayes et al., 1998). No formal fisheries management strategy has existed within the CAWS, so the community relationships are essentially self-regulated. Because of the unique characteristics of the CAWS, it is impossible to compare the existing, dominant community composition to a reference system or target community. However, recent work of Overman et al. (2009) posits that the trophic makeup of urban lake fisheries is commonly shaped by the forage fish component (gizzard shad and emerald shiner), and that

these communities can differ among systems. This suggests that the current species composition within the CAWS may be appropriate for the limits of the system. The lack of fish management within the CAWS has resulted in a self-forming fish community that may be unique, but the community includes regionally important species and contains a general structure similar to natural lake systems.

The association of the various clusters with differing substrates was also examined to determine if substrate was a potential differentiating factor in the occurrence of the clusters. Table 2 presents the percentage of total fish in each cluster that are associated with various substrate types. The distribution of substrate types among the different groups suggests that the differentiation of the clusters may be, at least in part, due to habitat preferences found within the habitat-limited environment of the CAWS. In particular, the rock bass/smallmouth bass group consists primarily of fish that are associated with large substrates (boulder, cobble, and gravel), while most of the other fish in the CAWS tend to be associated with mud, sand, and vegetated substrates.

Table 2. Percentage of total fish collected in each cluster associated with various substrate types. Many species are associated with more than one substrate type, so the percentages do not sum to 100%.

	Boulder	Cobble/ Rubble	Gravel	Mud	Sand	Vegetated
Black crappie/Yellow perch	0%	15%	3%	52%	68%	49%
Rock bass/Smallmouth bass	39%	46%	85%	0%	0%	24%
Dominant community	0%	0%	9%	16%	30%	31%
Channel catfish/Mosquitofish	0%	34%	1%	26%	35%	16%
White perch/Yellow bass	0%	0%	0%	67%	10%	0%

The clusters were also evaluated with respect to their pollution tolerance. Meador and Carlisle (2007) conducted an extensive analysis of numerous fish species and their associations with a variety of physiochemical variables using data from the USGS National Water Quality Assessment Program. This effort resulted in a database of tolerance assignments for most fish species. Table 3 presents the percentage of total fish in each cluster that are classified as tolerant, moderately tolerant, and intolerant according to the Meador and Carlisle analysis.

Table 3. Percentage of total fish collected in each cluster classified according to their pollution tolerance.

	Tolerant	Moderately tolerant	Intolerant
Black crappie/Yellow perch	52%	33%	15%
Rock bass/Smallmouth bass	31%	2%	66%
Dominant community	89%	11%	0%
Channel catfish/Mosquitofish	98%	9%	4%
White perch/Yellow bass	81%	19%	0%

The distribution of pollution tolerances among the clusters indicates that all but one of the clusters are dominated by tolerant species. The exception to this is the rock bass/smallmouth bass

cluster. The geographic distribution analysis discussed below and depicted in Figure 4 indicates that this may be due to proximity to Lake Michigan.

Geographic Distribution of Clusters

The geographic distribution of the clusters was evaluated to determine if there are differences among the CAWS reaches in terms of species composition. The fraction of the total number of individual fish collected that belong to each cluster was calculated for each fish collection event. The fractions were then averaged by station. Figure 3 (included at the end of this memorandum) shows a map with pie charts indicating the average composition at each sampling station. The figure shows that the dominant community makes up a large fraction of the fish observed at every station, with the exception of AWQM 49, which is located very close to Lake Michigan. This suggests that there are no locations on the CAWS that do not have the conditions to sustain this community. On average, this cluster represents 93% of the fish collected at each event.

However, because this cluster is found in such high proportions across the entire system, it is not particularly useful for differentiating between reaches, despite the fact that the dominant community cluster contains fishes considered regionally important (for example, largemouth bass, bluegill, gizzard shad and emerald shiner). Therefore, an additional map was generated using only the clusters outside of the dominant community to attempt to identify geographic differences within the CAWS. This map is included as Figure 4.

Figure 4 does illustrate some geographic trends of species abundance. The rock bass/ smallmouth bass group appears to occur in the highest proportions in areas where some water exchange with Lake Michigan occurs, such as: the North Shore Channel, the Chicago River, and the Calumet and Little Calumet Rivers in the vicinity of the O'Brien Lock and Controlling Works. The single exception to this trend is at one of the 2007 supplemental stations (LimnoTech ID 1092), where a single smallmouth bass was the only fish observed outside of the dominant community.

Other clusters also exhibit some geographic trends. The channel catfish/mosquitofish cluster tends to occur in higher proportion in the Chicago Sanitary and Ship Canal, while the white perch/yellow bass are most prevalent in the Cal-Sag Channel and the Little Calumet River. No clear geographic trend was observed for the black crappie/yellow perch group.

A final map is included as Figure 5 which is limited to the sampling stations with more than a single collection event. This map illustrates similar geographic trends as noted previously, however the trends appear more consistent among the reaches.

Conclusions

The hierarchical cluster analysis performed on the CAWS fish abundance data demonstrated that:

- There is a dominant fish community that occurs throughout the CAWS. This population includes species representing multiple trophic levels, an abundant and diverse prey base, and predator-prey relationships commonly observed in natural waterways within the region.

- The ubiquity of the dominant community suggests that the CAWS is supporting a viable, structurally complete, and regionally appropriate fish community under the existing, unmanaged conditions.
- The clusters outside of the dominant community generally consisted of fewer, less abundant species, and they did not comprise the same diversity of trophic levels. Additionally, these clusters occurred in conjunction with the dominant community, suggesting that these are not independent communities, but rather groups of species that occur with the dominant community under certain conditions.
- Some species traits and geographic trends associated with these clusters outside of the dominant community were observed, suggesting that habitat, water quality, or other factors may affect their occurrence.

This analysis was performed to help describe the current state of fish communities in the CAWS. Further investigation may be warranted to better understand the factors that relate to the occurrence of particular clusters or species outside of the dominant community. Additionally, further investigations would be needed to better understand certain aspects of the dominant community, including:

- the factors impacting the overall abundance of the group,
- the geographic distribution of the sub-clusters, and
- the conditions that promote desirable proportions of species within the community.

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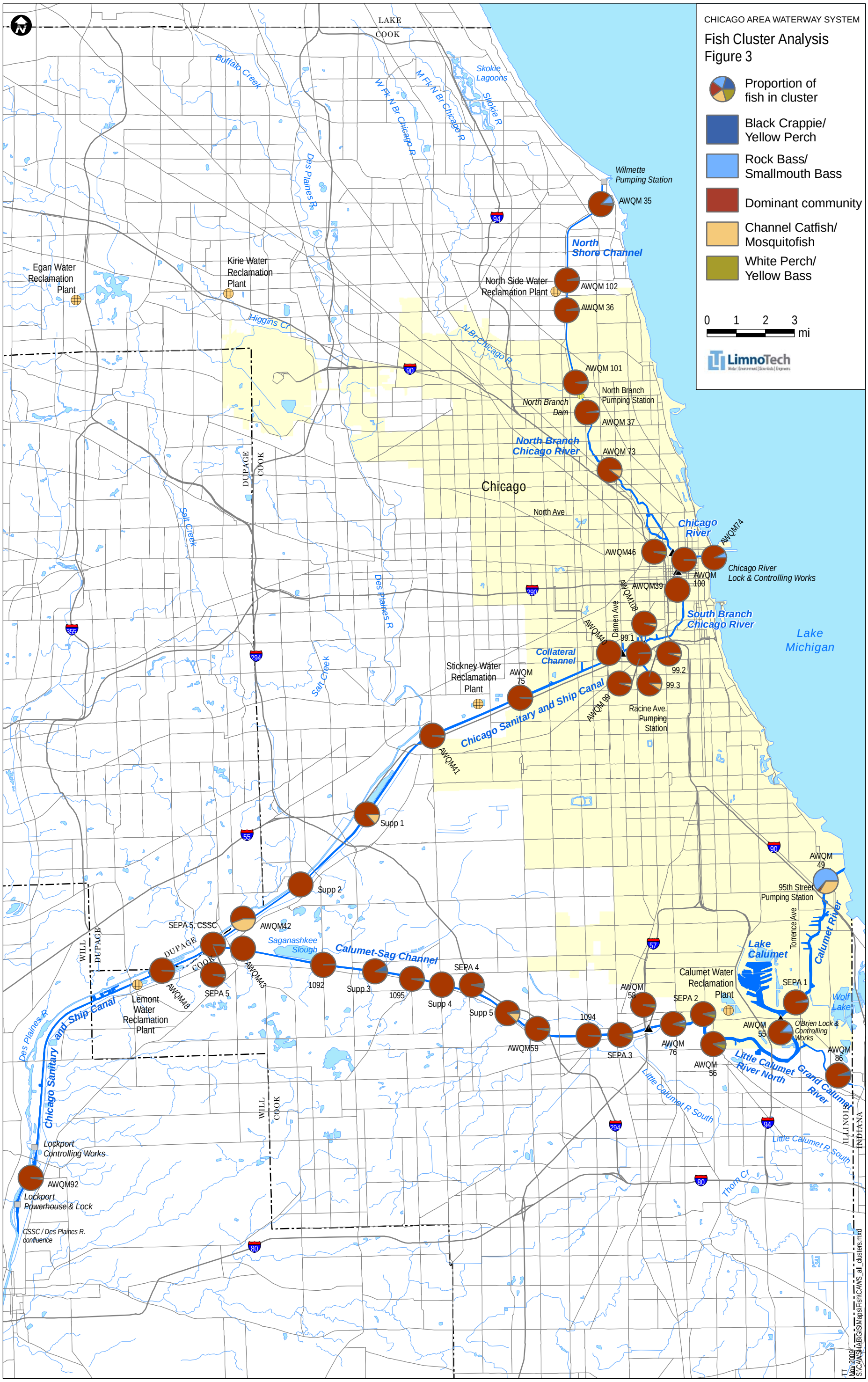
CHICAGO AREA WATERWAY SYSTEM
Fish Cluster Analysis
Figure 3
Proportion of fish in cluster
Black Crappie/ Yellow Perch
Rock Bass/ Smallmouth Bass
Dominant community
Channel Catfish/ Mosquitofish
White Perch/ Yellow Bass
0 1 2 3 mi
LimnoTech
LAKE
COOK
DUPAGE
WILL
Buffalo Creek
W Fk N Br Chicago R
M Fk N Br Chicago R
Skokie Lagoons
Skokie R
Des Plaines R
Wilmette Pumping Station
AWQM 35
North Shore Channel
Egan Water Reclamation Plant
Kirie Water Reclamation Plant
North Side Water Reclamation Plant
AWQM 102
AWQM 36
Higgins Cr
N Br Chicago R
AWQM 101
North Branch Pumping Station
North Branch Dam
AWQM 37
North Branch Chicago River
AWQM 73
Chicago
North Ave
Chicago River
AWQM74
AWQM46
AWQM 100
Chicago River Lock & Controlling Works
AWQM39
AWQM108
Damen Ave
South Branch Chicago River
AWQM40
99.1
99.2
99.3
Collateral Channel
Stickney Water Reclamation Plant
AWQM 75
Chicago Sanitary and Ship Canal
AWQM 99
Racine Ave. Pumping Station
AWQM41
Lake Michigan
Salt Creek
Supp 1
Supp 2
AWQM42
SEPA 5, CSSC
Saganashkee Slough
Calumet-Sag Channel
AWQM43
AWQM48
SEPA 5
1092
Supp 3
1095
Supp 4
SEPA 4
Supp 5
AWQM59
1094
SEPA 3
AWQM 58
AWQM 76
AWQM 56
SEPA 2
Calumet Water Reclamation Plant
Lake Calumet
SEPA 1
Wolf Lake
AWQM 55
O'Brien Lock & Controlling Works
AWQM 86
Little Calumet River North
Grand Calumet River
Little Calumet R South
Thorn Cr
Torrence Ave
Calumet River
AWQM 49
95th Street Pumping Station
Lemont Water Reclamation Plant
Des Plaines R
Chicago Sanitary and Ship Canal
Lockport Controlling Works
AWQM92
Lockport Powerhouse & Lock
CSSC / Des Plaines R. confluence
ILLINOIS
INDIANA
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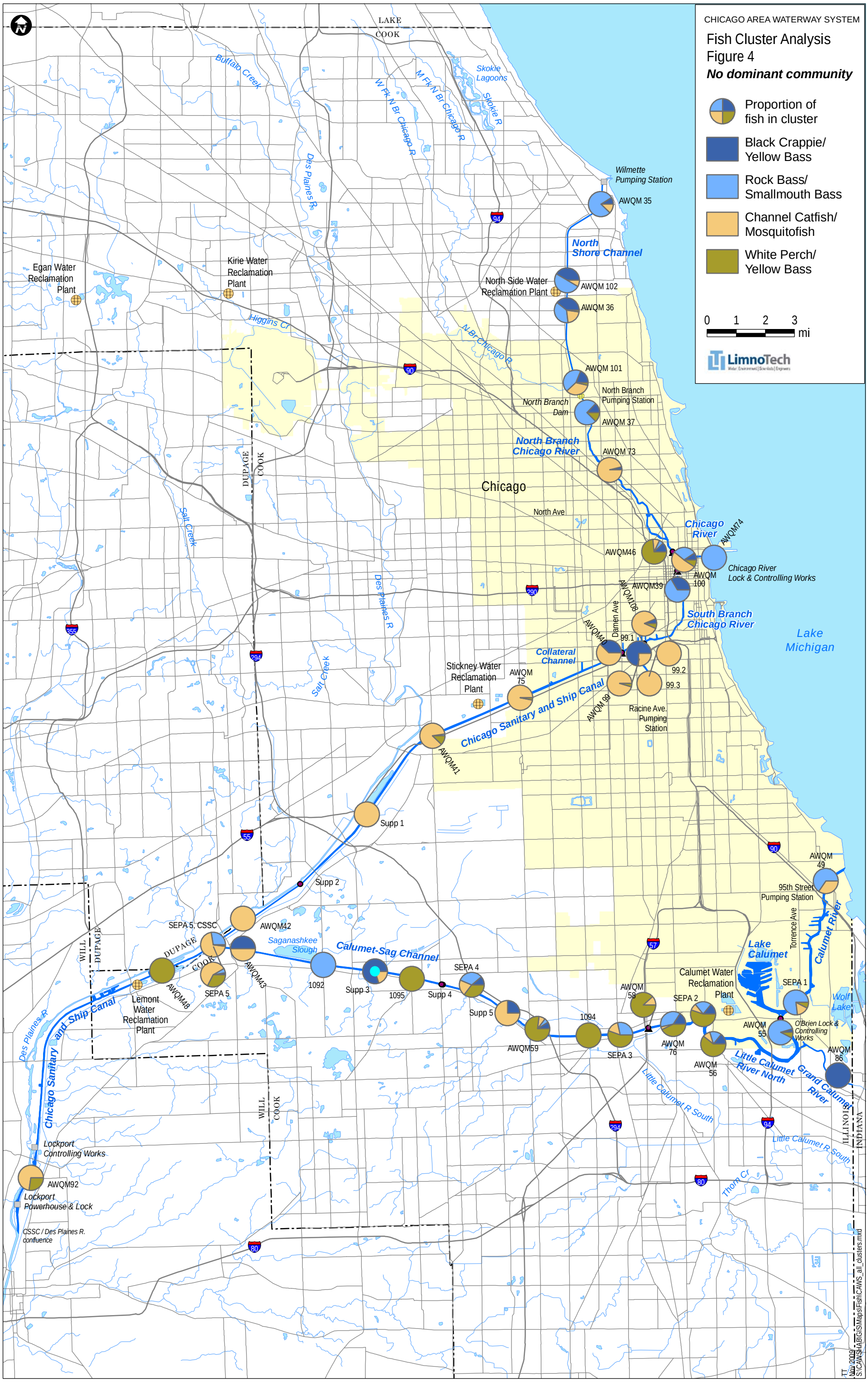
CHICAGO AREA WATERWAY SYSTEM
Fish Cluster Analysis
Figure 4
No dominant community
Proportion of fish in cluster
Black Crappie/ Yellow Bass
Rock Bass/ Smallmouth Bass
Channel Catfish/ Mosquitofish
White Perch/ Yellow Bass
0 1 2 3 mi
LimnoTech
LAKE
COOK
DUPAGE
WILL
Buffalo Creek
W Fk N Br Chicago R
M Fk N Br Chicago R
Skokie Lagoons
Skokie R
Des Plaines R
Wilmette Pumping Station
AWQM 35
North Shore Channel
Egan Water Reclamation Plant
Kirie Water Reclamation Plant
North Side Water Reclamation Plant
AWQM 102
AWQM 36
Higgins Cr
N Br Chicago R
AWQM 101
North Branch Pumping Station
North Branch Dam
AWQM 37
North Branch Chicago River
AWQM 73
Chicago
North Ave
Chicago River
AWQM74
AWQM46
Chicago River Lock & Controlling Works
AWQM 100
AWQM39
AWQM108
Damen Ave
South Branch Chicago River
Lake Michigan
AWQM40
99.1
99.2
99.3
Collateral Channel
Stickney Water Reclamation Plant
AWQM 75
Chicago Sanitary and Ship Canal
AWQM 99
Racine Ave. Pumping Station
AWQM41
Salt Creek
Supp 1
Supp 2
SEPA 5, CSSC
AWQM42
Saganashkee Slough
Calumet-Sag Channel
AWQM43
AWQM48
Lemont Water Reclamation Plant
SEPA 5
1092
Supp 3
1095
Supp 4
SEPA 4
Supp 5
AWQM59
1094
SEPA 3
AWQM 58
SEPA 2
Calumet Water Reclamation Plant
SEPA 1
AWQM 55
O'Brien Lock & Controlling Works
AWQM 76
AWQM 56
Lake Calumet
Torrence Ave
Calumet River
Wolf Lake
AWQM 86
AWQM 49
95th Street Pumping Station
Little Calumet River North
Grand Calumet River
Little Calumet R South
Thorn Cr
Lockport Controlling Works
AWQM92
Lockport Powerhouse & Lock
CSSC / Des Plaines R. confluence
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INDIANA
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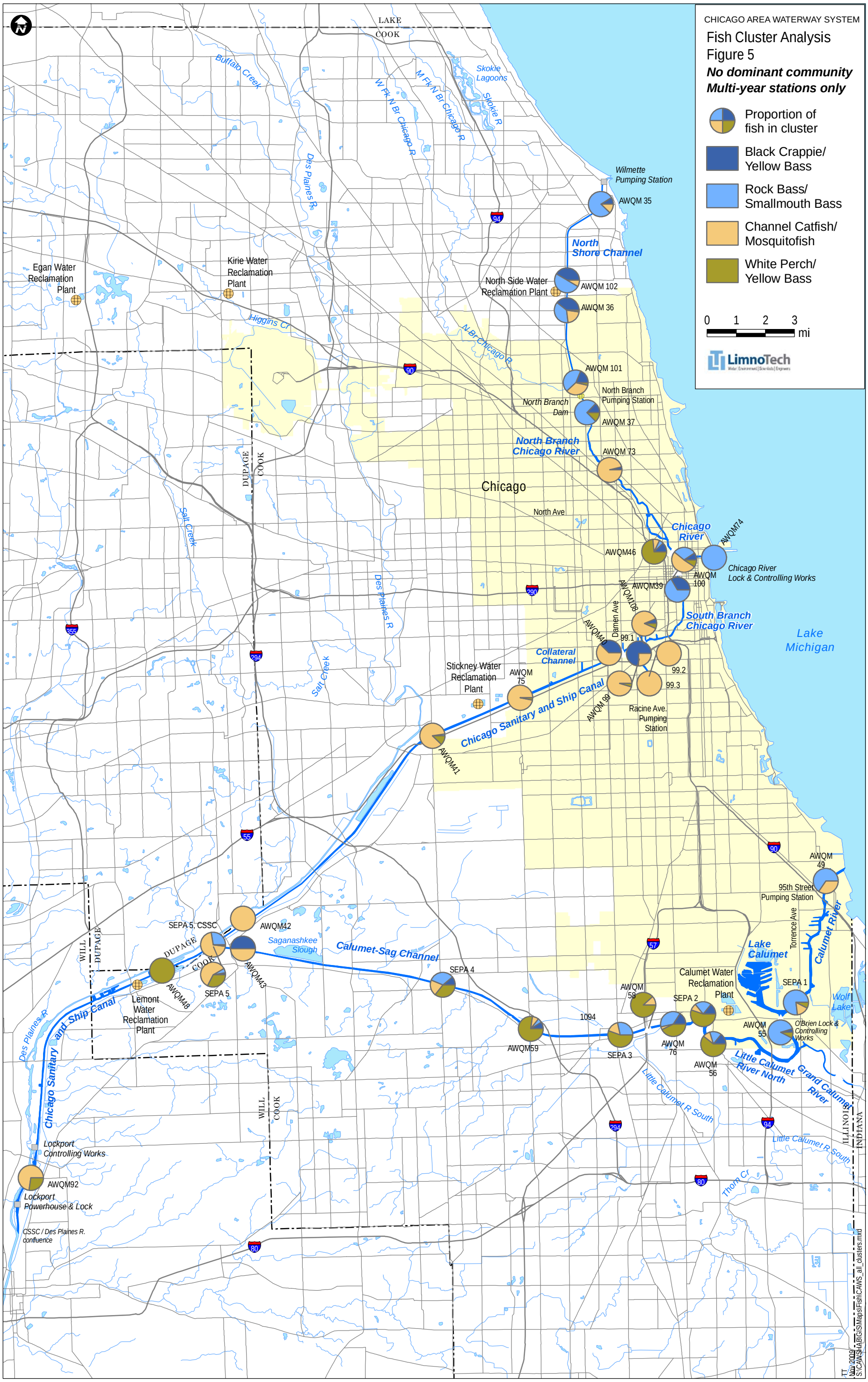
Nov 2009


CHICAGO AREA WATERWAY SYSTEM
Fish Cluster Analysis
Figure 5
No dominant community
Multi-year stations only
Proportion of fish in cluster
Black Crappie/ Yellow Bass
Rock Bass/ Smallmouth Bass
Channel Catfish/ Mosquitofish
White Perch/ Yellow Bass
0 1 2 3 mi
LimnoTech
LAKE
COOK
DUPAGE
WILL
Buffalo Creek
W Fk N Br Chicago R
M Fk N Br Chicago R
Skokie Lagoons
Skokie R
Des Plaines R
Wilmette Pumping Station
AWQM 35
North Shore Channel
Egan Water Reclamation Plant
Kirie Water Reclamation Plant
North Side Water Reclamation Plant
AWQM 102
AWQM 36
Higgins Cr
N Br Chicago R
AWQM 101
North Branch Pumping Station
North Branch Dam
AWQM 37
North Branch Chicago River
AWQM 73
Chicago
North Ave
Chicago River
AWQM74
AWQM46
Chicago River Lock & Controlling Works
AWQM 100
AWQM39
AWQM108
Damen Ave
South Branch Chicago River
AWQM40
99.1
99.2
99.3
Collateral Channel
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AWQM 75
Chicago Sanitary and Ship Canal
AWQM 99
Racine Ave. Pumping Station
AWQM41
Lake Michigan
Salt Creek
Des Plaines R
AWQM 49
95th Street Pumping Station
Torrence Ave
Calumet River
SEPA 5, CSSC
AWQM42
Saganashkee Slough
Calumet-Sag Channel
AWQM43
SEPA 4
Lake Calumet
Calumet Water Reclamation Plant
SEPA 1
Wolf Lake
SEPA 2
AWQM 58
AWQM 55
O'Brien Lock & Controlling Works
AWQM 76
AWQM 56
Little Calumet River North
Grand Calumet River
Little Calumet R South
Thorn Cr
AWQM48
SEPA 5
Lemont Water Reclamation Plant
AWQM59
1094
SEPA 3
Lockport Controlling Works
AWQM92
Lockport Powerhouse & Lock
CSSC / Des Plaines R. confluence
ILLINOIS
INDIANA
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Nov 2009

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
UPDATED WATER QUALITY	)	R11-18
STANDARDS FOR BORON, FLUORIDE	)	(Rulemaking – Water)
AND MANGANESE: PROPOSED	)	
AMENDMENTS TO 35 Ill. Adm. Code	)	
Part 302, Subparts B, C, E and F and	)	
Section 303.312	)	

NOTICE OF FILING

John Therriault, Clerk
Illinois Pollution Control Board
James R. Thompson Center
100 West Randolph Street, Suite 11-500
Chicago, Illinois 60601

Division Chief of Environmental Enforcement
Office of the Attorney General
100 W. Randolph Street, Suite 1200
Chicago, Illinois 60601

Office of Legal Services
Illinois Department of Natural Resources
One Natural Resources Way
Springfield, Illinois 62702-1271

PLEASE TAKE NOTICE that I have filed today with the Office of the Clerk of the Illinois Pollution Control Board the Motion for Acceptance; Appearance; Certificate of Origination; Statement of Reasons and Attachments; and Proposed Amendments to 35 Ill. Adm. Code Part 302, Subparts B, C, E and F of the Illinois Environmental Protection Agency, a copy of which is herewith served upon you.

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

By: _____
Deborah J. Williams
Assistant Counsel

Dated: 12/1/10

1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276
(217) 782-5544

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
UPDATED WATER QUALITY	)	R11- 18
STANDARDS FOR BORON, FLUORIDE	)	(Rulemaking – Water)
AND MANGANESE: PROPOSED	)	
AMENDMENTS TO 35 Ill. Adm. Code	)	
Part 302, Subparts B, C, E and F and	)	
Section 303.312	)	

MOTION FOR ACCEPTANCE

NOW COMES the Illinois Environmental Protection Agency ("Illinois EPA"), by and through its attorney, Deborah J. Williams, and pursuant to 35 Ill. Adm. Code 102.106, 102.200, and 102.202, moves that the Illinois Pollution Control Board ("Board") accept for hearing the Illinois EPA's proposal for the adoption of amendments to 35 Ill. Adm. Code Parts 301, 302, 303 and 304. This regulatory proposal includes:

1. Notice of Filing;
2. Appearance of Attorney for the Illinois Environmental Protection Agency;
3. Certification of Origination;
4. Statement of Reasons (including list of attachments and documents relied on);
5. Attachments to the Statement of Reasons;
6. Proposed Amendments;
7. Proof of Service;

8. Computer disc containing Proposed Amendments.

Respectfully Submitted,

ILLINOIS ENVIRONMENTAL
PROTECTION AGENCY

By: _____
Deborah J. Williams
Assistant Counsel
Division of Legal Counsel

Dated: 11/30/10

1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

(217) 782-5544

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
UPDATED WATER QUALITY	)	R11-18
STANDARDS FOR BORON, FLUORIDE	)	(Rulemaking – Water)
AND MANGANESE: PROPOSED	)	
AMENDMENTS TO 35 Ill. Adm. Code	)	
Part 302, Subparts B, C, E and F and	)	
Section 303.312	)	

APPEARANCE

The undersigned, as one of its attorneys, hereby enters her appearance on behalf of the Illinois Environmental Protection Agency.

ILLINOIS ENVIRONMENTAL
PROTECTION AGENCY

By: Deborah J. Williams

Deborah J. Williams
Assistant Counsel
Division of Legal Counsel

Dated: 11/30/10

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BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
UPDATED WATER QUALITY	)	R11-18
STANDARDS FOR BORON, FLUORIDE	)	(Rulemaking – Water)
AND MANGANESE: PROPOSED	)	
AMENDMENTS TO 35 Ill. Adm. Code	)	
Part 302, Subparts B, C, E and F and	)	
Section 303.312	)	

CERTIFICATION OF ORIGINATION

NOW COMES the Illinois Environmental Protection Agency to certify in accordance with 35 Ill. Adm. Code. 102.202(i) that this proposal amends the most recent version of Part 302, Subparts B, C, E and F and Section 303.312 of the Pollution Control Board's regulations, as published on the Board's web site at

http://www.ipcb.state.il.us/SLR/IPCBandIEPAEnvironmentalRegulations-Title35.asp.

Respectfully Submitted,

ILLINOIS ENVIRONMENTAL
PROTECTION AGENCY

By: _____

Deborah J. Williams
Assistant Counsel
Division of Legal Counsel

Dated: 11/30/10

1021 North Grand Avenue East
P.O. Box 19276
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BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
UPDATED WATER QUALITY	)	R11-18
STANDARDS FOR BORON, FLUORIDE	)	(Rulemaking – Water)
AND MANGANESE: PROPOSED	)	
AMENDMENTS TO 35 Ill. Adm. Code	)	
Part 302, Subparts B, C, E and F and	)	
Section 303.312	)	

STATEMENT OF REASONS

The Illinois Environmental Protection Agency ("Illinois EPA" or "Agency") hereby submits its Statement of Reasons for the above captioned rulemaking to the Illinois Pollution Control Board ("Board") pursuant to Section 27 of the Environmental Protection Act ("Act") [415 ILCS 5/27] and 35 Ill. Adm. Code 102.200 and 102.202.

I. INTRODUCTION AND STATUTORY AUTHORITY

Pursuant to the Federal Water Pollution Control Act (hereinafter "Clean Water Act"), it is the primary responsibility of the States to set water quality standards for intrastate waters and submit changes to those standards to U.S. EPA for approval. 33 U.S.C. §1313. Clean Water Act Section 303 provides that "the State water pollution control agency . . . shall from time to time (but at least once each three year period beginning with October 18, 1972) hold public hearings for the purpose of reviewing applicable water quality standards and, as appropriate, modifying and adopting standards." 33 U.S.C. 1313(c)(1). This requirement to periodically review and update standards is commonly referred to as the "triennial review" requirement. This proposal is a culmination of the Illinois EPA's obligation to conduct a triennial review and includes updated

water quality standards for boron, fluoride and manganese and a handful of clean-up amendments and updates to Part 302 of the Board's regulations and a repeal of Section 303.312.

Section 5(c) of the Act gives the Board "authority to act for the State in regard to the adoption of standards for submission to the United States under any federal law respecting environmental protection. Such standards shall be adopted in accordance with Title VII of the Act and upon adoption shall be forwarded to the Environmental Protection Agency for submission to the United States . . . " 415 ILCS 5/5(c). The Agency is given the responsibility under Section 4(l) of the Act to transmit the standards adopted by the Board to the United States Environmental Protection Agency ("U.S. EPA") for approval where required by federal law. 415 ILCS 5/4(l).

In the provisions specific to protection of waters of the State, Section 13(a) of the Act provides that

> The Board, pursuant to procedures prescribed in Title VII of this Act, may adopt regulations to promote the purposes and provisions of this Title. Without limiting the generality of this authority, such regulations may among other things prescribe: (1) Water quality standards specifying among other things, the maximum short-term and long-term concentrations of various contaminants in the waters, the minimum permissible concentrations of dissolved oxygen and other desirable matter in the waters, and the temperature of such waters; ...

415 ILCS 5/13(a).

The contents of this regulatory proposal are within the general substantive rulemaking authority conferred upon the Board under Sections 27 and 13(a) of the Act. This proposal is also one of general applicability pursuant to Sections 27 and 28 of the Act and Section 5-40 of the Illinois Administrative Procedure Act. 415 ILCS 5/27 and 28, 5 ILCS 100/5-40, 35 Ill. Adm. Code 102.106(a)(3) and (b)(1). In evaluating these proposed rules, the Board is required to take into account "the existing physical conditions, the character of the area involved, including the

character of surrounding land uses, zoning classifications, the nature of the existing air quality, or receiving body of water, as the case may be, and the technical feasibility and economic reasonableness of measuring or reducing the particular type of pollution." 415 ILCS 5/27(a).

This Statement of Reasons will address the purpose and effect of this regulatory proposal and outline the specific amendatory language being proposed. A technical support document was prepared by the Bureau of Water in support of the proposed changes to the boron, fluoride and manganese water quality standards and is included as Attachment 1 to this Statement of Reasons.

II. REGULATORY PROPOSAL: PURPOSE AND EFFECT

A. History of the Existing Boron, Fluoride and Manganese water quality standards

The existing General Use and Lake Michigan Basin Standards for boron, fluoride, and manganese were adopted by the Board in its 1972 standards rulemaking establishing the initial Board water quality standards and have not been updated since that time. *See*, R71-14 (March 7, 1972). The existing General Use and non-open water Lake Michigan Basin standard for boron is 1.0 mg/L. The existing General Use and non-open water Lake Michigan Basin standard for fluoride is 1.4 mg/L. The existing General Use and non-open water Lake Michigan Basin standard for manganese is 1.0 mg/L.

The Open Waters of Lake Michigan standards are based on background conditions of Lake Michigan rather than protection of human health or aquatic life. The existing manganese standard is 0.15 mg/L and will remain unchanged. Presently there are no boron or fluoride standards specifically adopted for the Open Waters of Lake Michigan, therefore the existing non-open waters Lake Michigan Basin Standards for these substances are applicable in these waters.

The Secondary Contact and Indigenous Aquatic Life standards for fluoride and manganese are 15 mg/L and 1 mg/L, respectively. No standard for this designated use currently exists for boron. At this time, the Agency intends to address all standards for Secondary Contact and Indigenous Aquatic Life Use waters in the "Use Attainability Analysis of the Des Plaines and Chicago Waterways" rulemaking. *See*, R08-09 (Sub-Docket D).

There are no existing Public and Food Processing Water Supply standards for boron or fluoride, therefore the General Use standards for these substances are applicable in these waters and are protective of Public and Food Processing Water Supply use. The existing Public and Food Processing Water Supply standard for manganese is 0.15 mg/L, which is based on aesthetics rather than human health.

B. Purpose and Effect of the Proposal

1. Boron, Fluoride and Manganese Water Quality Standards

The Agency's rulemaking proposal updates the water quality standards for boron, fluoride and manganese. Changes are proposed to the General Use standard itself as well as the to the Public and Food Processing Water Supply standards in Subpart C of Part 302 and the Lake Michigan standards in Subpart E of Part 302.

With no existing Public and Food Processing Water Supply water quality standards for boron or fluoride, the existing General Use standards for these substances are applied to these waters by default. As the Board stated in R71-14 "Since general criteria apply to all waters designated for public supply, the present regulation omits separate requirements for those parameters whose general standards are tight enough to protect public supplies; boron, chromium, copper, fluoride, mercury, silver and zinc." *See*, R71-14, March 7, 1972, Slip. Op. at 9. Since the proposed new General Use standards for boron and fluoride are higher than the

existing standards of 1.0 mg/L and 1.4 mg/L, respectively, Illinois EPA is proposing to designate 1.0 mg/L boron and 1.4 mg/L fluoride as Public and Food Processing Water Supply standards. The proposed standards would be applied at the point of surface water intake and would be regulated as one-number, not to be exceeded standards. Because there are no specific Open Waters of Lake Michigan standards for boron and fluoride in Subtitle E, the Lake Michigan Basin standards for these substances are currently applicable. Relocating the existing Lake Michigan Basin standards of 1.0 mg/L boron and 1.4 mg/L fluoride into the Open Waters of Lake Michigan standards will provide a measure of protection against harmful loadings of these substances within these waters, and will continue to allow protection of these waters for Public and Food Processing Water Supply uses.

For manganese, the Public and Food Processing Water Supply and Open Waters of Lake Michigan standards are presently set at 0.15 mg/L. Open Waters of Lake Michigan standards are based on background conditions of Lake Michigan rather than protection of human health or aquatic life, therefore the existing manganese standard for these waters will remain unchanged.

Public and Food Processing Water Supply standards are intended to represent the maximum allowable concentration of a substance at the point of surface water intake that will allow for attainment of the finished drinking water maximum contaminant level ("MCL") for that substance following conventional treatment. As explained in the Agency's technical support document (Attachment 1, pages 9-12), the existing manganese Public and Food Processing Water Supply standard of 0.15 mg/L is overly protective of the finished manganese standard, as the finished MCL of 0.15 mg/L can easily be attained following conventional treatment of surface waters containing greater than 0.15 mg/L manganese. Because manganese often occurs in Illinois at concentrations above the existing water quality standards, the Public and Food

Processing Water Supply standard is exceeded in many surface waters with public water supply intakes and Illinois EPA has been forced to list these waters on the Clean Water Act Section 303(d) list and establish Total Maximum Daily Loads ("TMDL") unnecessarily for waters with naturally occurring sources of manganese that will be adequately addressed by conventional drinking water treatment. By conservatively estimating that 90% of manganese can be removed at conventional utilities in Illinois, and back-calculating the amount of manganese in surface waters that would still allow for attainment of the 0.15 mg/L finished MCL, it is apparent that a maximum surface water concentration of 1.5 mg/L would be sufficiently protective of the Public and Food Processing Water Supply use designation. However, in order to provide an additional measure of conservancy, the Agency is proposing to set the new manganese Public and Food Processing Water Supply standard at 1 mg/L (total manganese). The standard would be applied at the point of surface water intake and would be regulated as a one-number, not to be exceeded standard.

The proposed updates to the General Use and Lake Michigan Basin water quality standards for boron, fluoride and manganese were developed using U.S. EPA guidelines for deriving numerical water quality criteria. *See*, Attachment 1, Exhibit F. The U.S. EPA "1985 Guidelines" methodology is commonly used to derive state standards and U.S. EPA national criteria documents for substances that are toxic to aquatic life. This conventional methodology was used in deriving acute and chronic standards for boron, fluoride, and manganese. Given that fluoride and manganese toxicity is known to be influenced by the hardness of test water, standards for these substances were developed to account for hardness-dependent relationships. Literature reviews and additional laboratory tests studying the influence of water chemistry on

boron toxicity had confounding results, therefore boron standards were developed independent of water chemistry.

The newly derived boron, fluoride and manganese standards were the result of collaborative work between the Agency, U.S. EPA and Dr. David Soucek of Illinois Natural History Survey (INHS). A literature review compiled by the Agency determined that insufficient data was available to derive Tier I acute and chronic standards for each substance, therefore it was necessary to conduct toxicity tests to supplement the dataset for each parameter. The Agency consulted with U.S. EPA to determine which test organisms would best fill the data gaps in order to derive fully protective aquatic life standards. U.S. EPA then contracted Great Lakes Environmental Commission (GLEC) and INHS to conduct toxicity tests on boron (acute tests using the fathead minnow *Pimephales promelas* (variable pH), *Ceriodaphnia dubia*, and the freshwater mussels *Lampsilis siliquoidea*, *Ligumia recta*, and *Megalonaias nervosa*; chronic test using *Pimephales promelas*), fluoride (acute tests using the fingernail clam *Sphaerium simile* and the amphipod *Hyalella azteca*) and manganese (acute tests using *Lampsilis siliquoidea* and *Megalonaias nervosa*). *See* Attachment 6. The Agency additionally contracted INHS to conduct additional toxicity tests on boron (acute tests using the stonefly *Allocapnia vivipara*, *Sphaerium simile*, *Pimephales promelas*, the waterflea *Ceriodaphnia dubia* (variable hardness and pH) and *Hyalella azteca* (variable hardness and pH); chronic tests using *Pimephales promelas* and *Hyalella azteca*), fluoride (acute and chronic tests using *Hyalella azteca*), and manganese (acute and chronic tests using *Hyalella azteca*). *See,* Attachment 1, Exhibit U.

Standards for each substance were then developed in accordance with 1985 Guidelines methodology. The following is a general overview of the 1985 Guidelines procedures used in

deriving the proposed standards. Further detail regarding the additional procedures required for deriving the hardness-based fluoride and manganese standards is provided in Attachment 1.

Only data from toxicity tests conducted on appropriate organisms using valid test methods, appropriate laboratory waters, and proper endpoints were used in deriving the proposed standards. For each substance, acute data expressed as an LC50 (concentration lethal to 50 percent of the tested organisms) was compiled for each species and was used to develop a Genus Mean Acute Value (GMAV) for each genus. The GMAVs were ranked by sensitivity and were used to develop the Final Acute Value (FAV). The FAV is the value protective of at least 95% of species at the LC50 level of effect. The FAV was then divided by 2 in order to convert the acute value from an LC50 level of protection to a level that is protective at the no observable adverse effect level.

Chronic standards for boron and fluoride were developed using the Acute-Chronic Ratio (ACR) approach, which requires ACRs from animals in at least three different families of which one species is a fish, one species is an invertebrate, and one is an acutely sensitive freshwater species. An ACR is calculated by dividing the acute LC50 of a species by the Maximum Acceptable Toxicant Concentration (MATC) of the same species derived from a test conducted in the same laboratory under test conditions identical to the acute test. The Final Acute-Chronic Ratio (FACR) was then calculated by taking the geometric mean of all available ACRs for each species. Chronic standards were then obtained by dividing the FAV of each substance by the FACR. The chronic manganese standard was not developed using the ACR approach because the resulting standard was not protective of *Hyalella azteca*, the most sensitive species. Rather, the chronic manganese standard was based off the *Hyalella azteca* MATC to afford proper protection for this organism and other untested, closely related organisms.

The procedures used by Illinois EPA in deriving acute and chronic standards for all three parameters are described in more detail in Attachment 1.

2. Other Proposed Changes to Part 302 and 303

In addition to the updated water quality standards, the Agency is proposing a handful of minor amendments to Part 302.

a. Derived Water Quality Criteria publication requirement

In R88-21(A) the procedures in Subpart F of Part 302 for deriving site-specific water quality criteria for toxic parameters were adopted by the Board. One important procedural component of this method for establishing criteria was to require periodic public notice of the criteria that have been developed. In R97-25, parallel procedures were included in Subpart E for publication of derived criteria developed for the Lake Michigan Basin.

The Agency is required to and does publish notice of derived water quality criteria in the Illinois Register every quarter pursuant to 302.595 for Lake Michigan Basin criteria for bioaccumulative chemicals of concern and pursuant to 302.669 for all other toxicity criteria derived pursuant to Subpart F. The Agency has also maintained a list of derived criteria on its website. The Agency is proposing to simply change the required method of public notice to updating the list on its website not less frequently than quarterly, rather than requiring publication in the Illinois Register.

b. Correction to Error in Zinc General Use water quality standard derivation

The existing General Use chronic water quality standard for zinc is hardness-based and was adopted by the Board in the R02-11 rulemaking. *See, In the Matter of Water Quality Triennial Review: Amendments to 35 Ill. Adm. Code 302.105, 302.208(e)-(g), 302.504(a),*

302.575(d), 309.141(h); and Proposed 35 Ill. Adm. Code 301.267, 301.313, 301.413, 304.120, and 309.157, R02-11 (December 19, 2002). During the R02-11 proceeding, the Agency identified a number of mathematical and clerical errors in its proposal to the Board by submittal of three different Errata Sheets. *See*, Attachment 8. In Errata Sheet Number 3, the Agency addressed corrections to the zinc values in its original proposal that were eventually adopted by the Board. The Agency has discovered an additional error in the chronic water quality standard for zinc that was not identified in the R02-11 proceeding.

An error was made in regards to the chronic toxicity value reported by the Agency for *Hyalella azteca*. This value was taken from Table 2 of Borgmann et al. 1993 which is included as Attachment 1, Exhibit W to this Statement of Reasons. A transcription error resulted in the Agency using an incorrect value from that Table in its derivation of the chronic zinc water quality standard. An explanation of the error is provided on page 22 of Attachment 1 and both the incorrect and corrected values and equations are provided in Attachment 1, Exhibit X. Due to this change, the intercept value in the equation representing the chronic zinc standard must be modified from A = -0.8165 to A = -0.4456. The adopted chronic value for *Hyalella azteca* was erroneously calculated and resulted in a chronic zinc standard that was not representative of the true dataset and the Agency is proposing that the Board correct this error.

c. Elimination of STORET references

STORET is defined in Section 301.405 as "the national water quality data system of the federal Environmental Protection Agency." STORET codes, as they appear in current Board water quality standards, are no longer maintained and updated by U.S. EPA, therefore they are of little use in instructing the reader on what form of the substance is regulated. Because the STORET database is no longer being supported by U.S. EPA, the Agency is proposing to drop

STORET codes from throughout the regulations when those regulations are opened for other amendments.

d. Corrected cross-references

In developing these amendments, the Agency discovered a handful of typographical errors in cross references. Those incorrect or outdated cross-references were found in Sections 302.303, 302.553, 302.648, 302.657.

e. Language Clarification in 302.208

In addition to changes to the water quality standards in 302.208, the Agency is proposing to reorganize the language in each paragraph to more clearly identify how the acute, chronic, human health and single-value standards are interpreted. These changes generally involve splitting up the language in existing subsection (d) into the applicable language in subsections (a) through (c). In addition, language is added to subsection (d) to clarify the interpretation of the single-value standards in subsections (g) and (h). *See* below for the specific changes proposed.

f. Clarifications of references to Cyanide, Mercury, Chloride and Toluene in Tables

The Agency is proposing a handful of amendments to clarify the applicability of the water quality standards for toxic parameters. In 302.208, the Agency has proposed changing the term "metal" to "chemical constituent" to make clear that not all of the parameters regulated in that Section are metals.

For mercury and chloride, the Agency has proposed adding the phrase "(total)" following the parameter in the tables to clarify that the substance is regulated in its total form, rather than dissolved forms. For chloride, this is done to create consistency throughout the Board's water quality standard regulations. For mercury, it is done to clarify that, unlike the aquatic life standards which are based on dissolved mercury, the human health standard for mercury relies

on total mercury given the potential for total mercury to become methylated and subsequently bioaccumulate in aquatic life.

The current General Use standard does not specify the form of cyanide, but it is interpreted as allowing either of two test methods for cyanide: the weak acid dissociable (WAD) form or the available form. Currently, the Lake Michigan Basin standards in Subpart E of Part 302 refer to the weak acid dissociable (WAD) form, while the total form is used in the existing Secondary Contact and Indigenous Aquatic Life standard and the effluent standard of 0.10 mg/L. Total Cyanide refers to all of the CN groups in cyanide compounds that can be determined as the cyanide ion (CN^-). Available cyanide consists of cyanide ion (CN^-), hydrogen cyanide in water (HCN_{aq}) and the cyano-complexes of zinc, copper, cadmium, mercury, nickel, and silver. Cyanide (WAD) is the hydrogen cyanide (HCN) that is liberated from a slightly acidified (pH 4.5 to 6.0) sample under the prescribed distillation conditions. Total cyanide and cyanide (WAD) are determined using standard methods, while available cyanide methods are taken from EPA-821-R-99-013 (August 1999). The Agency is proposing clarifications in both the Lake Michigan and General Use standards that clarify that the WAD and available cyanide are the two forms of cyanide tests that may be used in assessing attainment with the General Use cyanide water quality standard.

Two minor changes are proposed to the toluene standards in Part 302.Subpart E. In 302.504(a), the table mistakenly identifies the toluene standard in milligrams per liter, rather than micrograms per liter. In addition, the toluene standard in 302.504(d) is proposed for deletion because it is less stringent than the acute standard in 302.504(a) and therefore unnecessary. In R02-11, the Board updated the toluene standard in 302.504(a) to include the acute and chronic standards of 2,000 and 610 respectively. This standard was published and adopted in error in

milligrams per liter units instead of micrograms per liter. To demonstrate that this was merely a typographical error, the Agency directs the Board to the transcript of the March 6, 2002 hearing in R02-11 where the Board questions for the Agency witnesses correctly identified the toluene standard proposed as being measured in micrograms per liter. *See*, R02-11, Hearing Transcript, March 6, 2002, pp. 104-105.

g. Repeal of Section 303.312

As explained in more detail below, the Agency has proposed repeal of a site-specific fluoride standard in 303.312 as obsolete and inconsistent with the new water quality standards.

III. REGULATORY PROPOSAL: REGULATORY LANGUAGE

The Agency is proposing additions and changes to 35 Ill. Adm. Code Part 302 and one change to Part 303. The specific Sections affected are Sections 302.208, 302.303, 302.304, 302.504, 302.553, 302.595, 302.648, 302.657, 302.669 and 303.312.

SUBPART B: GENERAL USE WATER QUALITY STANDARDS

All of the proposed language changes in Part 302, Subpart B are contained in Section 302.208. The relevant amendments are included below for reference with the exception of the deletion of STORET numbers in the Tables.

Section 302.208 Numeric Standards for Chemical Constituents

a) The acute standard (AS) for the chemical constituents listed in subsection (e) shall not be exceeded at any time except for those waters for which a zone of initial dilution (ZID) applies pursuant to Section 302.102~~as provided in subsection (d)~~.

b) The chronic standard (CS) for the chemical constituents listed in subsection (e) shall not be exceeded by the arithmetic average of at least four consecutive samples collected over any period of at least four days, except for those waters

in which the Agency has approved a mixing zone or allowed mixing pursuant to Section 302.102~~as provided in subsection (d)~~. The samples used to demonstrate attainment or lack of attainment with a CS must be collected in a manner that assures an average representative of the sampling period. For the chemical constituents ~~metals~~ that have water quality based standards dependent upon hardness, the chronic water quality standard will be calculated according to subsection (e) using the hardness of the water body at the time the ~~metals~~ sample was collected. To calculate attainment status of chronic ~~metals~~ standards, the concentration of the chemical constituent ~~metal~~ in each sample is divided by the calculated water quality standard for the sample to determine a quotient. The water quality standard is attained if the mean of the sample quotients is less than or equal to one for the duration of the averaging period.

c) The human health standard (HHS) for the chemical constituents listed in subsection (f) shall not be exceeded when the stream flow is at or above the harmonic mean flow pursuant to Section 302.658 nor shall an annual average, based on at least eight samples, collected in a manner representative of the sampling period, exceed the HHS except for those waters in which the Agency has approved a mixing zone or allowed mixing pursuant to Section 302.102~~as provided in subsection (d)~~.

d) The standard for the chemical constituents of subsections (g) and (h) shall not be exceeded at any time except for those waters in which the Agency has approved a mixing zone or allowed mixing pursuant to Section 302.102. ~~In waters where mixing is allowed pursuant to Section 302.102, the following apply:~~

~~1) The AS shall not be exceeded in any waters except for those waters for which the Agency has approved a zone of initial dilutions (ZID) pursuant to Section 302.102.~~

~~2) The CS shall not be exceeded outside of waters in which mixing is allowed pursuant to Section 302.102.~~

~~3) The HHS shall not be exceeded outside of waters in which mixing is allowed pursuant to Section 302.102.~~

e) Numeric Water Quality Standards for the Protection of Aquatic Organisms

Constituent	~~STORET Number~~	AS (μg/L)	CS (μg/L)
***			
Boron (total)		40,100	7,600

***

Cyanide (Weak acid dissociable or available)	~~00718~~	22	5.2
Fluoride (total)		$e^{A+B\ln(H)}$ where $A = 6.7319$ and $B = 0.5394$	$e^{A+B\ln(H)}$, but shall not exceed 4.0 mg/L where $A = 6.0445$ and $B = 0.5394$

***

Manganese (dissolved)		$e^{A+B\ln(H)}$ X 0.9812* where $A = 4.9187$ and $B = 0.7467$	$e^{A+B\ln(H)}$ X 0.9812* where $A = 4.0635$ and $B = 0.7467$

***

Zinc (dissolved)	~~01090~~	$e^{A+B\ln(H)}$ X 0.978*, where $A = 0.9035$ and $B = 0.8473$	$e^{A+B\ln(H)}$ X 0.986*, where ~~$A = -0.8165$~~ $A = -0.4456$ and $B = 0.8473$

***

where: $\mu g/L$ = micrograms per liter
e^x = base of natural logarithms raised to the x- power
$\ln(H)$ = natural logarithm of Hardness ~~(STORET 00900)~~
* = conversion factor multiplier for dissolved metals

f) Numeric Water Quality Standard for the Protection of Human Health

Constituent	~~STORET Number~~	($\mu g/L$)
Mercury (total)	~~71900~~	0.012

****

g) Single-value standards apply at the following concentrations for these substances: ~~Concentrations of the following chemical constituents shall not be exceeded except in waters for which mixing is allowed pursuant to Section 302.102.~~

Constituent	Unit	~~STORET Number~~	Standard
Barium (total)	mg/L	~~01007~~	5.0
~~Boron (total)~~	~~mg/L~~	~~01022~~	~~1.0~~
Chloride (total)	mg/L	~~00940~~	500
~~Fluoride~~	~~mg/L~~	~~00951~~	~~1.4~~
Iron (dissolved)	mg/L	~~01046~~	1.0
~~Manganese (total)~~	~~mg/L~~	~~01055~~	~~1.0~~

***

where: mg/L = milligrams per liter and
μg/L = micrograms per liter

h) Water quality standards for sulfate are as follows: ~~The following concentrations for sulfate must not be exceeded except in receiving waters for which mixing is allowed pursuant to Section 302.102:~~

***

***

As explained above, the Agency is proposing to amend the language in Subsection 302.208(a), (b) and (c) to include the language from existing subsection 302.208(d) that addresses how each type of standard is applied. Subsection (d) is replaced with language from subsections (g) and (h) describing how the single-value standards are applied. This change is intended to assist the reader in understanding how each type of standard (acute, chronic, human health and single-value) will be applied.

Also in Section 302.208, the Agency is proposing to delete references to STORET numbers and to change the term "metal" to "chemical constituent" in subsection (b) for accuracy and for consistency with the other subsections. The Agency is proposing to add an "s" to milligram and microgram in the equation keys in subsections (e) and (g) and adding "of" between base and natural in the key in subsection (e). In subsection (e) the phrase "(Weak acid

dissociable or available)" to the table after cyanide and "(total)" is added to mercury in subsection (f).

The Agency's proposal in Section 302.208 also corrects the error to the derivation of the chronic zinc water quality standard that was explained above. This correction of the error in the existing formula for the General Use chronic water quality standard for zinc results in a change in the equation in the Table in Section 302.208(e) from A = -0.8165 to A = -0.4456.

Finally, the outdated boron, fluoride and manganese standards are deleted from subsection (g) and the new proposed standards are added to subsection (e).

SUBPART C: PUBLIC AND FOOD PROCESSING WATER SUPPLY STANDARDS

The following amendments (in addition to the deletion of all STORET numbers in the Table) are proposed for 35 Ill. Adm. Code Part 302, Subpart C, Sections 302.303 and 302.304:

Section 302.303 Finished Water Standards

Water shall be of such quality that with treatment consisting of coagulation, sedimentation, filtration, storage and chlorination, or other equivalent treatment processes, the treated water shall meet in all respects the requirements of Part 611~~604~~.
(Note: Prior to codification, Table 1, Rule 304 of Ch 6: Public Water Supplies.)

Section 302.304 Chemical Constituents

The following levels of chemical constituents shall not be exceeded:

CONSTITUENT	~~STORET NUMBER~~	CONCENTRATION (mg/l)
***		
Boron (total)		1.0
***		
Chloride (total)	~~00940~~	~~250.~~
***		1.4
Fluoride (total)		
***		
Manganese (total)	~~01055~~	1.0~~0.15~~

Nitrate-Nitrogen	~~00620~~	~~10.~~
***		
Sulfates	~~00945~~	~~250.~~
Total Dissolved Solids	~~70300~~	~~500.~~

In Section 303.303 the Agency is deleting a cross-reference to Part 604, which has been repealed, and replacing it with the appropriate cross-reference to the drinking water standards in Part 611. In Section 303.304, the Agency is proposing to delete all STORET numbers (even those not repeated above) and a handful of misplaced periods or decimal points. The term "(total)" is added after chloride in the table and the current General Use water quality standards for boron and fluoride are moved to this Section applicable at Public Water Supply intakes. The amended Public and Food Processing Water Supply standard for manganese of 1 mg/liter is also included.

SUBPART E: LAKE MICHIGAN BASIN WATER QUALITY STANDARDS

The proposed changes to Subpart E are being made to 35 Ill. Adm. Code 302.504, 302.553 and 302.595. In addition to the deletion of all STORET numbers from the Tables, in Section 302.504 the Agency proposal contains the following language:

Section 302.504 Chemical Constituents

The following concentrations of chemical constituents must not be exceeded, except as provided in Sections 302.102 and 302.530:

a) The following standards must be met in all waters of the Lake Michigan Basin. Acute aquatic life standards (AS) must not be exceeded at any time except for those waters for which the Agency has approved a zone of initial dilution (ZID) pursuant to Sections 302.102 and 302.530. Chronic aquatic life standards (CS) and human health standards (HHS) must not be exceeded outside of waters in which mixing is allowed pursuant to Section 302.102 and 302.530 by the arithmetic average of at least four consecutive samples collected over a period of at least four days. The samples used to demonstrate compliance with the CS or HHS must be collected in a manner which assures an average representation of the sampling period.

Constituent	~~STORET Number~~	Unit	AS	CS	HHS
***					
Boron (total)		mg/L	40.1	7.6	NA
***					
Cyanide (Weak acid dissociable or available)	~~00718~~	µg/L	22	5.2	NA
Fluoride (total)		µg/L	exp[A +Bln(H)] where A = 6.7319 and B = 0.5394	exp[A +Bln(H)], but shall not exceed 4.0 mg/L where A = 6.0445 and B = 0.5394	NA
***					
Manganese (dissolved)		µg/L	exp[A +Bln(H)] X 0.9812* where A = 4.9187 and B = 0.7467	exp[A +Bln(H)] X 0.9812* where A = 4.0635 and B = 0.7467	NA
***					
Toluene	~~78131~~	µg/L~~mg/L~~	2000	610	51.0
***					

Where:

NA = Not Applied
Exp[x] = base of natural logarithms raised to the x-power

ln(H) = natural logarithm of Hardness
~~(STORET 00900)~~
* = conversion factor multiplier for dissolved metals

b) The following water quality standards must not be exceeded at any time in any waters of the Lake Michigan Basin, unless a different standard is specified under subsection (c) of this Section.

Constituent	~~STORET Number~~	Unit	Water Quality Standard
***			
~~Boron (total)~~	~~01022~~	~~mg/L~~	~~1.0~~
***			
~~Fluoride~~	~~00951~~	~~mg/L~~	~~1.4~~
***			
~~Manganese (total)~~	~~01055~~	~~mg/L~~	~~1.0~~
***			

c) In addition to the standards specified in subsections (a) and (b) of this Section, the following standards must not be exceeded at any time in the Open Waters of Lake Michigan as defined in Section 302.501.

Constituent	~~STORET Number~~	Unit	Water Quality Standard
***			
Boron (total)		mg/L	1.0
***			
Chloride (total)	~~00940~~	mg/L	12.0
Fluoride (total)		mg/L	1.4
***			
Manganese (total)	~~01055~~	mg/L	0.15
***			

d) In addition to the standards specified in subsections (a), (b) and (c) of this Section, the following human health standards (HHS) must not be exceeded in the Open Waters of Lake Michigan as defined in Section 302.501 by the arithmetic average of at least four consecutive samples collected over a period of at least four days. The samples used to demonstrate compliance with the HHS must be collected in a manner which assures an average representation of the sampling period.

Constituent	~~STORET Number~~	Unit	Water Quality Standard
***			
~~Toluene~~	~~78131~~	~~mg/L~~	~~5.60~~
***			

The Agency has proposed elimination of STORET numbers throughout this Section. Subsection (a) contains the new boron, fluoride and manganese water quality standards which are in line with those proposed for General Use waters. The phrase "or available" is added after "weak acid dissociable" following the cyanide standard in subsection (a). An error in the toluene units is corrected from milligrams to micrograms in subsection (a). The outdated boron, fluoride and manganese standards are deleted from subsections (b), while the same standards for boron and fluoride are added to the Open Waters of Lake Michigan language in subsection (c). The term "(total)" is added after "chloride" in subsection (c). Finally, the duplicative and unnecessary toluene standard is deleted from subsection (d). No changes are proposed to subsection (e).

The following amendments are proposed for Section 302.553(d) and 302.595(a):

Section 302.553 Determining the Lake Michigan Aquatic Toxicity Criteria or Values - General Procedures

The Lake Michigan Aquatic Life Criteria and Values are those concentrations or levels of a substance at which aquatic life is protected from adverse effects resulting from short or long term exposure in water.

****

d) If data for acute effects are not available for all the eight families listed above, but are available for the family Daphnidae, a Tier II value shall be derived according to procedures in Section 302.563. If data for chronic effects are not available for all the eight families, but there are acute and chronic data available according to Section 302.565(b) so that three acute to chronic ratios (ACRs) can

be calculated, then a Tier I chronic criterion can be derived according to procedures in Section 302.565. If three ACRs are not available, then a Tier II chronic value can be derived according to procedures in Section 302.565(be).

The cross-reference to Section 302.565(e) found in Section 302.553(d) is incorrect, because that subsection does not exist in the Board's rules. It is being replaced with the correct cross-reference to Section 302.565(b).

Section 302.595 Listing of Bioaccumulative Chemicals of Concern, Derived Criteria and Values

a) The Agency shall maintain a listing of toxicity criteria and values derived pursuant to this Subpart. This list shall be made available to the public and updated periodically but no less frequently than quarterly, and when updated shall be published on the Agency's website ~~when updated in the Illinois Register~~.

****

The amendment to this subsection is designed to replace the duplicative effort of making the list of derived water quality criteria available on both the Illinois EPA website and in the Illinois Register as discussed above.

SUBPART F: PROCEDURES FOR DETERMINING WATER QUALITY CRITERIA

In Subpart F of Part 302, the Agency is proposing changes to Sections 302.648, 302.657 and 302.669. The following changes are proposed to Section 302.648 and 302.657:

Section 302.648 Determining the Human Threshold Criterion

The HTC is calculated according to the equation:

***

W = Per capita daily water consumption equal to 2 liters per day (L/d) for surface waters at the point of intake of a public or food processing water supply, or equal to 0.01 liters per day (L/d) which represents incidental exposure through contact or ingestion of small volumes of water while swimming or during other recreational activities for areas which are determined to be public

access areas pursuant to Section 302.102~~302.201~~(b)(3), or 0.001 liters per day (L/d) for other General Use waters;

***

Section 302.657 Determining the Human Nonthreshold Criterion

The HNC is calculated according to the equation:

***

W = Per capita daily water consumption equal to 2 liters per day (L/d) for surface waters at the point of intake of a public or food processing water supply, or equal to 0.01 liters per day (L/d) which represents incidental exposure through contact or ingestion of small volumes of water while swimming or during other recreational activities for areas which are determined to be public access areas pursuant to Section 302.102~~302.201~~(b)(3), or 0.001 liters per day (L/d) for other General Use waters;

***

Both of these Sections contain a cross-reference to Section 302.201(b)(3). That referenced provision does not exist and is being amended to the reference the correct and existing Section 302.102(b)(3). This was likely simply a typographical error in the existing rules.

The following language is proposed for Section 302.669:

Section 302.669 Listing of Derived Criteria

a) The Agency shall develop and maintain a listing of toxicity criteria pursuant to this Subpart. This list shall be made available to the public and updated periodically but no less frequently than quarterly, and when updated shall be published on the Agency's website ~~when updated in the Illinois Register~~.

The Agency is proposing one final amendment to Part 302, which is to eliminate the requirement in Section 302.669 to publish derived criteria quarterly in the Illinois Register and to instead publish quarterly updates on the Illinois EPA website.

PART 303, SUBPART C: SPECIFIC USE DESIGNATIONS AND SITE SPECIFIC WATER QUALITY STANDARDS

The Agency is also proposing one change at this time to 35 Ill. Adm. Code Part 303. This change is a repeal of Section 303.312:

Section 303.312 Waters Receiving Fluorspar Mine Drainage (Repealed)

~~a) The fluoride standard of Section 302.208 shall not apply to waters which:~~

~~1) receive effluent from the mines and mills of the fluorspar mining and concentrating industry, and~~

~~2) have been designated by the Illinois State Water Survey as streams which once in ten years have an average minimum seven day low flow of zero.~~

~~b) Such waters shall meet the following standard with regard to fluoride:~~

~~CONSTITUENT~~	~~STORET NUMBER~~	~~CONCENTRATION mg/l~~
~~Fluoride~~	~~00950~~	~~5~~

This provision provided site-specific relief from the fluoride standard to two companies: Ozark-Mahoning and Minerva Oil who performed Fluorspar mining in Pope and Hardin Counties in southern Illinois. *See*, In the Matter of: Proposed Amendments to Rules 203 and 408 of the Illinois Water Pollution Control Regulations, R73-15 (March 6, 1975) (Attachment 4). The receiving streams impacted by discharges from these two companies are outlined in pages 3 and 4 of the Board's March 6, 1975 Opinion and Order. Both companies have ceased production and terminated their discharge permits. In fact, according to the Illinois State Geologic Survey there are currently no companies conducting fluorspar in Illinois or anywhere in the United States. *See*, Attachment 5. If fluorspar mining were to resume in Illinois, it is likely that such activity could comply with the new, less stringent, General Use fluoride water quality standards. If additional relief would be necessary, the Agency believes that the affected party should justify such future relief to the Board under the current science and the new, updated fluoride water quality standards.

IV. FACTS IN SUPPORT

The proposal before the Board relies on the technical support document prepared by Bureau of Water staff at the Illinois EPA and a variety of studies and papers cited in that report. The facts in support of this proposal are outlined in detail in Attachment 1. In particular, the Agency relied extensively on the results of tests conducted by Dr. Soucek of the Illinois Natural History Survey. Dr. Soucek's Report of the studies conducted is included this rulemaking submittal as Exhibit U to Attachment 1. The documents relied on and methods for obtaining underlying data are explained below and a comprehensive list of Exhibits and documents relied upon in developing this rulemaking proposal is provided at the end of this Statement of Reasons.

V. TECHNICAL FEASIBILITY AND ECONOMIC JUSTIFICATION

Section 27 of the Act requires the Board to consider the technical feasibility and economic reasonableness of all rulemaking proposals.

A. Technical Feasibility

Illinois EPA has investigated the treatment options for boron and fluoride as a result of the Agency's obligation to provide recommendations to the Board in response to petitions for site specific regulatory relief from these water quality standards. Both substances are highly soluble and this characteristic generally confounds attempts at treatment. Boron does not respond to the usual method of treating metals by raising pH and precipitating the metal to sludge. Fluoride likewise does not respond to this manner of treatment. The only methods of treatment identified have been reverse osmosis, which is seldom acceptable as it results in a high concentration wastewater that still must be disposed of, and various non-conventional treatment processes that are very expensive and have not seen routine use. In every case for site-specific water quality standards or adjusted standards brought before the Board, Illinois EPA has

concluded that no reasonable treatment exists for boron and fluoride to reduce effluent concentrations. *See*, Attachment 1, Exhibit D.

Unlike boron and fluoride, manganese does respond to treatment by raising pH and thereby forcing precipitation. A chemical is added to a basin which raises effluent pH causing manganese to precipitate. The proposed change in the manganese water quality standard may relieve future mine outfalls from manganese treatment, however, manganese permit limits may still be dictated by 35 Ill. Adm. Code Subtitle D: Mine Related Water Pollution. Other than some coal mines, the only facilities known to treat for manganese are public water supply treatment plants that remove manganese from surface water to meet drinking water standards and then must filter or settle suspended manganese particles from the wastewater. The Agency does believe this rulemaking will result in the need to implement additional treatment technologies beyond those required by the existing regulations.

B. Economic Justification

In addition to technical feasibility, the Board is required to examine the economic impacts of any new technology required by this rulemaking proposal. The Agency does not expect that any of these water quality standards changes will require any new technology upgrades to achieve compliance. Although the proposal makes a number of changes to the boron, fluoride, and manganese standards applicable to the Lake Michigan Basin, Public and Food Processing and General Use water quality standards, these standards should not become more stringent than the existing standards in any waters of the State of Illinois. The only water quality standard that could become more stringent than the existing standard is in General Use waters where the ambient hardness is less than 45 milligrams per liter which would result in a chronic manganese standard of less than 1 milligram per liter. The Agency is not aware of any

facilities that will be required to install upgrades to achieve compliance with this proposal. The only foreseeable exception to this will be if any of the facilities currently granted regulatory relief that is not moot as a result of this standard are unable to demonstrate that they can either meet the new standard or are no longer able to meet the standards for the grant of regulatory relief by the Board. As explained below, this is expected to be a small group of sources and the Agency hopes these sources will come forward and address their concerns as part of the rulemaking proceeding. For these reasons, the Agency's proposed changes are clearly technically feasible and economically reasonable.

VI. AFFECTED FACILITIES AND OUTREACH

A. Affected Facilities

This rulemaking proposal would establish revised ambient water quality standards and does not seek to establish any specific effluent standards or other requirements targeted at specific facilities or classes of facilities. However, if a discharger in the State of Illinois has permit limits driven by water quality standards rather than or in addition to technology based limits, they could potentially be affected by one or more of the various standards being proposed.

In the case of dischargers who are currently in compliance with the existing water quality standards for boron, fluoride and manganese, there should be no impact. Illinois EPA expects that for those facilities, the applicable water quality standard is either staying the same or becoming less stringent, so there will be no impact. The only classes of facilities the Agency considers to be potentially impacted negatively by this proposal are those facilities with existing regulatory relief from the current standard or facilities that discharge to receiving waters with less than 45 mg/L hardness and have a reasonable potential to discharge greater than 1.0 milligrams per liter of manganese as a long term average. As further detailed on page 19 of

Attachment 1, critical hardness concentrations in Illinois waters are rarely less than 90 milligrams per liter and no ambient water quality monitoring network stations are known to possess a critical hardness of less than 45 milligrams per liter. *See also*, Attachment 1, Exhibit S.

A complete list of potentially affected facilities with existing regulatory relief from the current water quality standards is provided as Exhibit D to Attachment 1. This list of affected facilities and stream segments includes four facilities with fluoride relief and eight facilities with boron relief. There is also currently a site-specific rule that sets a water quality standard of 5 mg/L in waters receiving discharges from fluorspar mining activities in 303.312. That relief was originally adopted to impact two companies - Ozark-Mahoning and Minerva Oil. *See*, R73-15 (March 6, 1975). Since there is no longer any fluorspar mining in the United States and since this relief was granted thirty-five years ago, the Agency is proposing to repeal that provision at this time.

In the Board Opinion in *In the Matter of: City of Galva Site Specific Water Quality Standard for Boron Discharges to Edwards River and Mud Run Creek: 35 Ill. Adm. Code 303.447 and 303.448* the Board found:

> The Board notes that the record indicates the Agency is cooperating with the Illinois Natural History Survey (INHS) to generate additional boron toxicity studies to supplement the current database. Such data would help to ensure that boron general use standards proposed in the future would be protective of aquatic life. The results of the Agency/INHS study is expected to bolster the scientific justification for the revision of the general use boron water quality standard. If the Agency/INHS study results in new boron toxicity information that raises any concerns with the site specific standards or renders such standards as moot, the Board expects the Agency to address those concerns as part of its proposal to revise the general use standards. The Board notes that in the past, the Board has revised existing site specific rules to make them consistent with the adopted revisions to the rule of general applicability. See Proposed New and Updated Rules for Measurement and Numerical Sound Emissions Standards Amendments to 35 Ill. Adm. Code 901 and 910, (R03-9) March 2, 2006.

See, R09-11 (August 6, 2009). *See also*, *In the Matter of: Proposed Site Specific Rule for City of Springfield, Illinois, Office of Public Utilities, City, Water, Light and Power and Springfield Metro Sanitary District from 35 Ill. Adm. Code 302.208(g): New 35 Ill. Adm. Code 303.446*, R09-8 (May 21, 2009).

Of the facilities with fluoride regulatory relief granted by the Board, there are none that have relief that would exceed the proposed acute standard. However, the Agency also had to consider whether any of the affected facilities would exceed the proposed chronic standard.

The relief granted to Granite City Steel in *In the Matter of: Granite City Division of National Steel Petition for Adjusted Standard from 35 Ill. Adm. Code 302.208: Numeric Standard for Fluoride*, AS 90-4 (April 8, 1993) should become moot because the chronic fluoride standard will be the same as the never to be exceeded standard granted in Horseshoe Lake. Based information contained in Discharge Monitoring Reports, it appears that the fluoride relief granted to Modine Manufacturing in *In the Matter of: Site-Specific Limitation for the Modine Manufacturing Company Facility, Ringwood, Illinois*, R87-36 (May 24, 1990) and to the City of Effingham in *In the Matter of Site Specific Rule for City of Effingham Treatment Plant Fluoride Discharge, 35 Ill. Adm. Code 304.233*, R03-11 (December 18, 2003) should no longer be necessary.[1] For Modine Manufacturing, the company's Discharge Monitoring Reports show that the facility no longer has elevated fluoride levels in its discharge, so the relief granted by the Board in R87-36 may no longer be necessary. For the City of Effingham, the Discharge Monitoring Reports show that the highest fluoride value reported since July of 2005 is 4.0 mg/L.

[1] The fluoride relief granted to the City of Effingham required compliance with a 2.0 mg/L water quality standard at the City of Flora's public water supply intake. That relief, as written, would have caused the Agency's proposed Public and Food Processing Water Supply standard to be exceeded. However, since the Board opinion was issued in R03-11, the City of Flora has connected to the Gateway Regional Water Supply System and no longer has a surface water intake in the Little Wabash River so compliance with the proposed new Public and Food Processing Water Supply fluoride water quality standard of 1.4 mg/L will not be a problem.

Based on this information, it appears that Effingham would not need regulatory relief in order to comply with the proposed chronic fluoride standard of 4.0 mg/L as a monthly average.

General Motors is the only facility granted regulatory relief by the Board from the fluoride water quality standard that the Agency has identified will still need the Board relief upon adoption of the Agency's fluoride proposal. *See, In the Matter of: Petition of General Motors Corporation to Amend 35 Ill. Adm. Code 303.222* (Site Specific Regulation for Fluoride), R93-13 (January 11, 1995) and Attachment 1, Exhibit D.

For the site-specific regulatory relief from the boron water quality standards, none of the dischargers would cause an exceedance of the proposed acute boron standard of 40.1 mg/L. As with fluoride, the Agency investigated whether the chronic standard of 7.6 mg/L would be met in all cases.

The following three facilities have relief from the boron standard that will clearly become moot upon adoption of the Agency's proposal: City of Galva (Northeast STP)(*In the Matter of: City of Galva Site Specific Water Quality Standard for Boron Discharges to Edwards River and Mud Run Creek: 35 Ill. Adm. Code 303.447 and 303.448*, R09-11 (August 6, 2009)), Akzo Nobel (*In the Matter of: Petition of Akzo Chemicals, Inc. for an Adjusted Standard from 35 Ill. Adm. Code 304.105 and 302.208*, AS93-8 (September 1, 1994)) and CILCO (Duck Creek)(*In the Matter of: Petition of Central Illinois Light Company (Duck Creek Station) for Adjusted Standard from 35 Ill. Adm. Code 302.208 and 35 Ill. Adm. Code 304.105 Regarding the Parameter Boron*, AS96-8 (June 20, 1996)). These standards will become moot because the never-to-be-exceeded relief granted by the Board in these proceedings is lower than the new chronic standards proposed by the Agency.

Review of the relief granted and the Discharge Monitoring Reports and discussions with interested parties has led the Agency to conclude that the chronic standard will be consistently met and therefore the boron relief granted by the Board should no longer be needed for four of the remaining five facilities. These facilities are City of Springfield, Spring Creek STP; Dynegy Baldwin Station (Illinois Power); Southern Illinois Power Cooperative (SIPC); and Dynegy Midwest Generation – Wood River Station (Illinois Power). *See, In the Matter of: Proposed Site Specific Rule for City of Springfield, Illinois, Office of Public Utilities, City, Water, Light and Power and Springfield Metro Sanitary District from 35 Ill. Adm. Code 302.208(g): New 35 Ill. Adm.Code 303.446*, R09-8 (May 21, 2009); *In the Matter of: Petition of Illinois Power Company (Baldwin Power Plant) for Adjusted Standard from 35 Ill. Adm. Code 302.208 and 35 Ill. Adm. Code 304.105 Regarding the Parameter Boron*, AS96-1 (Mary 2, 1996); *In the Matter of: Petition of South Illinois Power Cooperative (Marion Power) for Adjusted Standard from 35 Ill. Adm. Code 302.208(e),* AS92-10 (July 1, 1993); and *In the Matter of: The Proposed Amendment to Rule 203 of the Water Pollution Regulations* (R76-18)(May 25, 1978). While there was initially a potential that relief granted to these facilities could have resulted in exceedance of the chronic boron water quality standard in one of the impacted stream segments, further investigation revealed that Board relief from the new chronic standard would no longer be necessary for these facilities.

Based on the Agency's initial investigations, it appears that the boron relief granted by the Board will still be necessary for at least one of the identified segments for one of the affected facilities. This facility is Springfield City Water Light and Power and the impacted segment is Sugar Creek from Spaulding Dam to Sewage Treatment Plant only. See, *In the Matter of:*

Petition of the City of Springfield, Office of Public Utilities for an Adjusted Standard from 35 Ill. Adm. Code 302.208(e), AS94-9 (December 1, 1994).

In addition, there are several classes of facilities that have the potential to benefit from this proposal. Dischargers to streams with Public and Food Processing Water Supply intakes may benefit from removal of some streams from the 303(d) List for manganese. It is also possible that coal mines and other industrial or municipal dischargers with water quality based effluent limits may benefit from the new General Use standards for boron, fluoride and manganese. With regard to the proposed correction to the zinc water quality standard, it is possible that correction of this error will benefit some facilities that are currently having difficulty meeting their permit limits. The Agency has identified all facilities in the State with permit limits for zinc and has included that list of potentially impacted facilities at Attachment 7 to this Statement of Reasons.

B. Outreach

Illinois EPA shared a draft rulemaking proposal with approximately 120 stakeholders on September 17, 2009. These stakeholders included representatives of state and federal government agencies, universities, environmental groups, industrial dischargers, municipal dischargers, trade associations and consulting engineers.

A meeting was held on October 19, 2009 at the Illinois EPA Headquarters in Springfield to explain the draft proposal and respond to any questions or comments. Approximately 25 stakeholder representatives attended. The Agency made presentations on the different components of the draft proposal and answered questions on the presentations. The Agency also distributed copies of the various presentations following the meeting. The Agenda and Sign In

list from the stakeholder meeting are included as Attachments 2 and 3 to this Statement of Reasons.

The Agency accepted written comments from the stakeholders following the meeting. Comments were received from the Springfield Metropolitan Sanitary District and the Illinois Environmental Regulatory Group.

Follow-up emails were sent to the stakeholders on July 8, 2010 and November 10, 2010. These emails updated the stakeholders on changes to the proposal as a result of additional tests and information becoming available and the Agency's progress and timeline towards filing this proposal with the Board.

VII. SYNOPSIS OF TESTIMONY

Pre-filed Testimony will be submitted by two Illinois EPA witnesses, Bob Mosher and Brian Koch.

A. Bob Mosher, Manager, Water Quality Standards Unit, Division of Water Pollution Control, Bureau of Water, Illinois EPA

Mr. Mosher will present testimony on the background and history of the current General Use, Lake Michigan Basin and Public and Food Processing Water Supply water quality standards for boron, fluoride and manganese. He will also present testimony on the proposed change to the derived water quality criteria publication provision and the additional non-substantive updates to the regulatory language in Part 302. Mr. Mosher will also be available to answer general questions on the water quality standards program and the triennial review process.

B. Brian Koch, Environmental Protection Specialist, Water Quality Standards Unit, Division of Water Pollution Control, Bureau of Water, Illinois EPA

Mr. Koch will present technical testimony regarding the development of the proposed changes to the boron, fluoride and manganese General Use, Lake Michigan Basin and Public and Food Processing Water Supply water quality standards. He will testify about the literature surveyed and new toxicity tests performed in support of this water quality standard proposal to the Board. He will be available to answer technical questions regarding the toxicity of boron, fluoride and manganese to aquatic life and the water quality standard derivation process for these parameters. Mr. Koch will also explain and answer questions related to the error discovered by the Agency in the derivation of the zinc water quality standard and the correction of that error in this proceeding.

C. Testimony in Support of the Agency's proposal

At this time, Mr. Mosher and Mr. Koch are the only anticipated witnesses in support of this rulemaking proposal that Illinois EPA intends to call to provide testimony. Both witnesses are expected to submit Pre-filed Testimony to the Board as directed by the Hearing Officer. The Agency also reserves the right to submit testimony from additional witnesses if necessary to address any questions or concerns raised by the public or the Board with respect to this proposal and to have additional Agency staff present at the Board hearings on this proposal to answer unforeseen questions that may arise.

VIII. SUPPORTING DOCUMENTATION

A. Statement Regarding Compliance with 5 ILCS 100/5-40(3.5)

Pursuant to the Illinois Administrative Procedure Act, the Board's procedural rules provide that rulemaking proponents must submit to the Board "*A descriptive title or other description of any published study or research report used in developing the rule, the identity of the person who performed such study, and a description of where the public may obtain a copy*

of any such study or research report. If the study was performed by an agency or by a person or entity that contracted with the agency for the performance of the study, the agency shall also make copies of the underlying data available to members of the public upon request if the data are not protected from disclosure under the Freedom of Information Act [5ILCS 140]. [5 ILCS 100/5-40(3.5)]." 35 Ill. Adm. Code 102.202(e).

To assist the Board in compliance with these requirements, the Agency has attempted to file as Attachments to this proposal the bulk of the information relied on in developing this proposal to the Board. See Section B below for the List of Attachments that provides the relevant identifying information for these Attachments. In addition, the Agency has provided a second list in Section C below of documents relied upon, but not submitted to the Board as Attachments to this rulemaking proposal. Many of these documents are U.S. EPA guidance documents and Board opinions that are readily accessible by the Board and the public.

With regard to studies conducted by the Agency or by an entity that contracted with the Agency for performance of the study, the Agency has provided summaries of the underlying data from those studies as Attachments to the Statement of Reasons and Technical Support Document. To the extent that the Agency relied on studies with voluminous amounts of raw data or documents that are subject to copyright protection, the Agency will make such underlying data and supporting documents available to members of the public at the Illinois EPA Library which is located at the Agency Headquarters at the following address:

Illinois Environmental Protection Agency
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

The studies relied on in developing these proposals which are summarized, but not attached are identified both in the list of references in Attachment 1 and in Subsection C below.

B. List of Attachments

Attachment 1 – Facts in Support of Changing Water Quality Standards for Boron, Fluoride, and Manganese (Illinois EPA, Bureau of Water, 2010)

Exhibit A – Water Quality Criteria (Boron), McKee and Wolf (1963)
Exhibit B – Water Quality Criteria (Fluoride) McKee and Wolf (1963)
Exhibit C – Water Quality Criteria (Manganese) McKee and Wolf (1963)
Exhibit D – Site-specific relief granted by the IPCB for boron and fluoride to date
Exhibit E – Manganese removal estimations at conventional utilities located on impaired Public and Food Processing water Supply waters with Mn exceeding 150 ug/L
Exhibit F – Guidelines for deriving numerical National Water Quality Criteria for the protection of aquatic organisms and their uses
Exhibit G – Acute Toxicity Data used in Boron Standard Derivation
Exhibit H – Chronic Toxicity in Boron Standard Derivation
Exhibit I – Boron Standard Derivation using 1985 Guidelines Methodology
Exhibit J – Influence of hardness and pH on boron toxicity
Exhibit K – Fluoride Standard Derivation Using 1985 Guidelines Methodology
Exhibit L – Manganese Standard Derivation Using 1985 Guidelines Methodology
Exhibit M – Acute and chronic fluoride standards at variable hardness using 1985 Guidelines Methodology
Exhibit N – Acute and chronic manganese standards at variable hardness using 1985 Guidelines Methodology
Exhibit O – Acute toxicity data used in fluoride Standard Derivation
Exhibit P – Chronic toxicity data used in fluoride Standard Derivation
Exhibit Q – Acute toxicity used in manganese Standards Derivation
Exhibit R – Chronic toxicity data used in manganese Standard Derivation
Exhibit S – Ambient Water Quality Monitoring Network (AWQMN)
Exhibit T – Calculation of the conversion factor multiplier for manganese standards derived from total and dissolved manganese data collected during the chronic *Hyalella azteca* test. For each treatment, the filtered (dissolved) results were divided by the unfiltered (total) results to calculate the percent of dissolved manganese
Exhibit U – Final Report, Acute and Chronic Toxicity of Boron, Fluoride, and Manganese to Freshwater Organisms, by David J. Soucek and Amy Dickinson, Illinois Natural History Survey, University of Illinois, October 14, 2010
Exhibit V – Excerpts from Exhibit S to Agency Rulemaking Proposal in R02-11
Exhibit W – Accumulation, regulation and toxicity of copper, zinc, lead and mercury in *Hyalella azteca*, U. Borgmann, W.P. Norwood & C. Clarke, *Hydrobiologia*, 259: 79 – 89 (1993)
Exhibit X: Revised chronic zinc standard using the corrected *Hyalella azteca* MATC

Attachment 2 – Water Quality Standards Stakeholders Meeting Agenda, dated October 19, 2009

Attachment 3 – Water Quality Standards Stakeholders Meeting Sign in list, dated October 19, 2009

Attachment 4 – Opinion and Order of the Illinois Pollution Control Board, In the Matter of: Proposed Amendments to Rules 203 and 408 of the Illinois Water Pollution Control Regulations, R73-15 (March 6, 1975)

Attachment 5 – Information from the Illinois State Geological Survey

Attachment 6 – Great Lakes Environmental Commission Final Report (October 22, 2010) (excerpts pertaining to boron, manganese and fluoride tests only)

Attachment 7 – Facilities with NPDES Permit Limits Based on the Incorrect Chronic Standard for Zinc

Attachment 8 – Agency Errata Sheets 1, 2 and 3 from R02-11

C. List of Documents Relied Upon But Not Attached

Guidance Documents

Method OIA-1677 Available Cyanide by Flow Injection, Ligand Exchange, and Amperometry, 821-R-99-013, United States Environmental Protection Agency (August, 1999).

Standard Methods for the Examination of Water and Wastewater: Centennial Edition. 21st Edition. Eaton, AD, LS Clesceri, EW Rice, AE Greenberg, and MAH Franson (editors). ISBN: 0875530478. American Public Health Association. 2005. Washington, D.C.

Pollution Control Board Opinions: Rulemakings of General Applicability

In the Matter of: Water Quality Triennial Review: Amendments to 35 Adm. Code 302.105, 302.208(e)-(g), 302.504(a), 302.575(d), 309.141(h); and Proposed 35 Ill. Adm. Code 301.267, 301.313, 301.413, 304.120, and 309.157, R02-11 (December 19, 2002).

In the Matter of: Conforming Amendments for the Great Lakes Initiative: 35 Ill. Adm. Code Part 302.101; 302.105; 302.Subpart E; 303.443, and 304.222, R97-25 (

In the Matter of: Proposed Amendments to Title 35, Subtitle C (Toxins Control), R88-21 – Docket A (January 25, 1990).

In the Matter of: Water Quality Standards Revisions, R71-14 (Consolidated with R70-8 and R71-20) (March 7, 1972).

Pollution Control Board Opinions: Site Specific Rulemakings and Adjusted Standards

Boron

In the Matter of: City of Galva Site Specific Water Quality Standard for Boron Discharges to Edwards River and Mud Run Creek: 35 Ill. Adm. Code 303.447 and 303.448, R09-11 (August 6, 2009).

In the Matter of: Proposed Site Specific Rule for City of Springfield, Illinois, Office of Public Utilities, City, Water, Light and Power and Springfield Metro Sanitary District from 35 Ill. Adm. Code 302.208(g): New 35 Ill. Adm. Code 303.446, R09-8 (May 21, 2009).

In the Matter of: Petition of Central Illinois Light Company (Duck Creek Station) for Adjusted Standard from 35 Ill. Adm. Code 302.208 and 35 Ill. Adm. Code 304.105 Regarding the Parameter Boron, AS96-8 (June 20, 1996).

In the Matter of: Petition of Illinois Power Company (Baldwin Power Plant) for Adjusted Standard from 35 Ill. Adm. Code 302.208 and 35 Ill. Adm. Code 304.105 Regarding the Parameter Boron, AS96-1 (May 2, 1996)).

In the Matter of: Petition of the City of Springfield, Office of Public Utilities for an Adjusted Standard from 35 Ill. Adm. Code 302.208(e), AS94-9 (December 1, 1994).

In the Matter of: Petition of Akzo Chemicals, Inc. for an Adjusted Standard from 35 Ill. Adm. Code 304.105 and 302.208, AS93-8 (September 1, 1994).

In the Matter of: Petition of South Illinois Power Cooperative (Marion Power) for Adjusted Standard from 35 Ill. Adm. Code 302.208(e), AS92-10 (July 1, 1993).

In the Matter of: The Proposed Amendment to Rule 203 of the Water Pollution Regulations, R76-18 (May 25, 1978)(Illinois Power Wood River Station).

Fluoride

In the Matter of: Granite City Division of National Steel Petition for Adjusted Standard from 35 Ill. Adm. Code 302.208: Numeric Standard for Fluoride, AS 90-4 (April 8, 1993).

In the Matter of: Petition of General Motors Corporation to Amend 35 Ill. Adm. Code 303.222 (Site Specific Regulation for Fluoride), R93-13 (January 11, 1995).

In the Matter of: Site-Specific Limitation for the Modine Manufacturing Company Facility, Ringwood, Illinois, R87-36 (May 24, 1990)

In the Matter of Site Specific Rule for City of Effingham Treatment Plant Fluoride Discharge, 35 Ill. Adm. Code 304.233, R03-11 (December 18, 2003).

Toxicity Studies and Data used in Derivation of Proposed Water Quality standards and summarized in Attachment 1, Exhibits G, H, O, P, Q and R:

Beleau, MH and JA Bartosz. 1982. Acute toxicity of selected chemicals: data base. U.S. Fish and Wildlife Service, Colorado River Fishery Project, Report No. 6. Salt Lake City, Utah. 3:242-254.

Biesinger, KE and GM Christensen. 1972. Effects of various metals on survival, growth, reproduction, and metabolism of *Daphnia magna*. Journal of the Fisheries Research Board of Canada 29:1691–1700.

Buikema, AL, CL See, and J Cairns, Jr. 1977. Rotifer sensitivity to combinations of inorganic water pollutants. OWRT Project A-071-VA. Virginia Water Resources Research Center Bulletin No. 92. Blackburg, VA; 42 p.

Calleja, MC, G Persoone, and P Geladi. 1994. Comparative acute toxicity of the first 50 multicentre evaluation of *in vitro* cytotoxicity chemicals to aquatic non-vertebrates. Archives of Environmental Contamination and Toxicology 26:69-78.

Camargo, JA and JV Tarazona. 1990. Acute toxicity to freshwater benthic macroinvertebrates of fluoride ion (F-) in soft water. Bulletin of Environmental Contamination and Toxicology 45:883-887.

Camargo, JA and JV Tarazona. 1991. Short-term toxicity of fluoride ion (F-) in soft water to rainbow trout (Salmo gairdneri) and brown trout (Salmo trutta fario). Fluoride 24(2):76-83.

Camargo, JA, JV Ward, and KL Martin. 1992. The relative sensitivity of competing hydropsychid species to fluoride toxicity in the Cache la Poudre River (Colorado). Archives of Environmental Contamination and Toxicology 22:107-113.

Couillard Y, P Ross, and B Pinel-Alloul. 1989. Acute toxicity of six metals to the rotifer *Brachionus calyciflorus*, with comparisons to other freshwater organisms. Toxicity Assessment 4:451-462.

Davies, PH and SF Brinkman. 1994. Acute and chronic toxicity of manganese to exposed and unexposed rainbow and brown trout. Federal Aid in Fish and Wildlife Restoration Job Progress Report, Colorado Division of Wildlife, Fish Research Section. Fort Collins, CO, USA. Federal Aid Project #F-243R-1.

Davies, PH and SF Brinkman. 1995. Acute and chronic toxicity of manganese to brown trout (*Salmo trutta*) in hard water. Federal Aid in Fish and Wildlife Restoration Job Progress Report, Colorado Division of Wildlife, Fish Research Section. Fort Collins, CO, USA. Federal Aid Project #F-243R-2.

Davies, PH, SF Brinkman, and M McIntyre. 1998a. Toxicity of manganese and zinc to Boreal toad tadpoles (*Bufo boreas*). In: Federal Aid in Fish and Wildlife Restoration Job Progress Final

Report, Colorado Division of Wildlife, Fish Research Section. Fort Collins, CO, USA. Federal Aid Project #F-243R-5.

Davies, PH, SF Brinkman, and M McIntyre. 1998b. Toxicity of manganese to early-life stage and fry of brook trout (*Salvelinus fontinalis*) and rainbow trout (*Oncorhynchus mykiss*) in water hardnesses of 30 and 150 mg/L. In: Federal Aid in Fish and Wildlife Restoration Job Progress Final Report, Colorado Division of Wildlife, Fish Research Section. Fort Collins, CO, USA. Federal Aid Project #F-243R-5.

Dethloff, GM, WA Stubblefield, and CE Schlekat. 2009. Effects of water quality parameters on boron toxicity to *Ceriodaphnia dubia*. Archives of Environmental Contamination and Toxicology 57:60-67.

ENSR. 1990. Unpublished in-house data.

ENSR. 1992a. Acute toxicity of manganese to *Pimephales promelas* under static-renewal test conditions at four levels of water hardness. June 1992.

ENSR. 1992b. Acute toxicity of manganese to *Ceriodaphnia dubia* under static-renewal test conditions at four levels of water hardness. June 1992.

ENSR. 1992c. Chronic toxicity of manganese to *Ceriodaphnia dubia* under static-renewal test conditions at four levels of water hardness. July 1992.

ENSR. 1996e. Early life stage toxicity of manganese to the fathead minnow (*Pimephales promelas*) under flow-through test conditions. March 1996.

Fieser, AH. 1985. Toxicity of fluorides to aquatic organisms: modeling for water hardness and temperature. Dissertation. University of Pittsburgh.

Gersich, FM. 1984. Evaluation of a static renewal chronic toxicity test method for *Daphnia magna* Straus using boric acid. Environmental Toxicology and Chemistry 3:89-94.

Great Lakes Environmental Center. October 22, 2010. Final Report on Acute and Chronic Toxicity of Nitrate, Nitrite, Boron, Manganese, Fluoride, Chloride and Sulfate to Several Aquatic Animal Species.

Hamilton, SJ. 1995. Hazard assessment of inorganics to three endangered fish in the Green River, Utah. Ecotoxicology and Environmental Safety 30:134-142.

Hamilton, SJ and KJ Buhl. 1990. Acute toxicity of boron, molybdenum and selenium to fry of chinook salmon and coho salmon. Archives of Environmental Contamination and Toxicology 19(6):366-373.

Hamilton, SJ and KJ Buhl. 1997. Hazard evaluation of inorganics, singly and in mixtures to Flannelmouth Sucker, *Catostomus latipinnis*, in the San Juan River, New Mexico. Ecotoxicology and Environmental Safety 38:296-308.

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Respectfully Submitted,

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