BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

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

NOTICE OF FILING

To: John Therriault, Clerk
Illinois Pollution Control Board
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Persons included on the attached
SERVICE LIST

Please take notice that on November 22, 2013, we filed electronically with the Office of the Clerk of the Illinois Pollution Control Board the attached **Pre-Filed Testimony of: Larry Tyler, Bruce Nelson, Roger Klocek and James Huff**, a copy of which is served upon you.

CITGO PETROLEUM CORPORATION and
PDV MIDWEST, LLC, Petitioners

By: ______________________

Jeffrey C. Fort
Irina Dashevsky
Dentons US LLP
233 S. Wacker Drive
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Chicago, IL 60606-6404

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PRE-FILED TESTIMONY OF ROGER KLOCEK

Introduction

My name is Roger Klocek and I am a senior biologist at Huff & Huff, Inc. an environmental consulting firm founded in 1979. I received a Bachelor's degree in 1971 from University of Illinois, Chicago, and have been a practicing aquatic biologist since then.

My work experience includes 36 years at the Shedd Aquarium in Chicago where I was most recently a biologist in the Conservation Department. I was also an aquatic biologist with Openlands, Chicago for three years. I have been involved in a variety of marine and freshwater fisheries projects, conservation surveys and aquatic species projects. Currently I conduct freshwater fishery surveys, macroinvertebrate surveys, and mussel surveys in various water bodies within the Midwest.

I have been involved in conducting approximately 18 environmental impact studies during the last four years. Most of these studies have involved stream surveys, including one on the Chicago Sanitary & Ship Canal, (CSSC) for the Lemont Refinery which is described here. A copy of my resume is provided in Exhibit A.

Huff & Huff, Inc. has been retained by the Lemont Refinery to develop winter chloride water quality limits for the CSSC. As part of this effort, I collected both plankton and macro-invertebrate samples from the CSSC during 2013. Exhibit B is a report I prepared which derives alternative winter chloride water quality criteria.

A structure unique to the CSSC is the electric fish barrier, a permanent installation located near Lemont, Illinois to prevent aquatic invasive species (especially Asian carp species) from migrating into the Great Lakes. To address some of the human safety concerns associated with the electric barrier, the Coast Guard enacted a *Regulated Navigation Zone in* the vicinity of the barriers, which includes safety requirements for the vessels transiting the CSSC and for the industries bordering the CSSC within the Regulated safety zones. The electric barrier array was authorized by Congress, with the recognition on the part of federal and state biologists that any fish migration in the CSSC would be prevented in order to protect the Great Lakes from invasive species.

The electric barriers not only prevent the aquatic invasive species from migrating, but also prevent all other fish from migrating up or down the CSSC at Lemont, effectively terminating the water body at this point from a fishery perspective. Normally, preventing migration is not a desirable outcome, but it is necessary in view of the greater goal of protecting the biological integrity of the Great Lakes.

The Board has designated the CSSC as a "Aquatic Life Use B" water. It has identified the species likely to inhabit the CSSC as "tolerant" species, and has listed several examples of tolerant fish species. Based on my knowledge and investigation of the CSSC in the vicinity of the Lemont Refinery, that description is accurate.

The purpose of my testimony today is to take the available information on the aquatic life in the CSSC and to derive water quality criteria for chlorides, both acute and chronic. The basis for the recommended criteria are summarized herein.

Analysis of Data with respect to Fish in the CSSC

There are three separate recent data bases for fish species in the CSSC: the rotenone event from 2009, the multi-task force sampling in 2012, and the periodic sample collections conducted from 2001 to 2009 by MWRDGC. The details and data from these events are presented in Exhibit B, Table 2. Were one to compute the Index of Biotic Integrity (IBI), an IEPA designed method of evaluating stream health using fish community structure, the IBI for the rotenone fish collection near Lockport Illinois, would tally a score of 22 (out of a possible 60 points). The Illinois Department of Natural Resources narratively describes this score as a *Limited Aquatic Resource*.

The 2009 rotenone collection showed that seven species alone accounted for 93% of the total catch. The rotenone collection event of December 2009 depicts a limited fish community that is comprised of widespread and tolerant species. The most abundant fish in the CSSC was the common carp, a non-native species and arguably the most tolerant species in Illinois. No intolerant species as defined by the IEPA, IBI calculation methodology, were found during the rotenone collection. The fish community in the CSSC is abnormally skewed toward fish that can be considered as generalists at this time.

Fish collected from the rotenone event exclusively at the Lockport Controlling Structure site, which is the closet station to the Lemont Refinery, and collections from the two other sources (Exhibit B, Table 3) showed the same condition: six species accounted for 98 percent of the total numbers of fish captured during the rotenone collection, 94 percent during the MRRWG collection, and 90 percent during the MWRDGC collections. Four of those six species were present in all three sets of data: common carp, emerald shiner, bluntnose minnow and gizzard shad.

The most sensitive fish in the CSSC, for which chloride data are available, is the bluntnose minnow with a Genus Mean Acute value (GMAV) of 6,515 mg/L of chloride. Table 3 of Exhibit B presents the results and IBI score for the 2012 fish collection.

Analysis with Respect to Macroinvertebrates in CSSC

Historic macroinvertebrate data are available from samples collected by the MWRDGC for the years 2001-2009. We supplemented that data with our own sampling efforts in the summer of 2013. None of the taxa collected are considered to be intolerant organisms on the macroinvertebrate list for MBI calculations. Tables 5 and 6 of Exhibit B provide the detailed results.

Macroinvertebrate samples of aquatic species can give information about stream health based on the type, tolerance, and abundance of aquatic invertebrates. Some macroinvertebrates are protected from biotic and abiotic changes during winter because they burrow into the substrate and become less active. Invertebrates such as crayfish, fingernail clams, and aquatic worms regularly burrow while others such as Asiatic clams become dormant, where feeding ceases below a given temperature range, which can vary between 44 to 50 degrees F, (Thorp and Covich, 2001).

The CSSC at Lockport has the highest diversity of organisms from any CSSC location collected by Hester-Dendy samplers. MWRDGC collected a limited number of Ephemoptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), collectively known as EPT taxa using Hester-Dendy samplers. EPT taxa are known to be among the more sensitive organisms to pollution, and their presence or absence is a general signal of stream health. No stoneflies, the most sensitive of the EPT taxa have been collected in the CSSC. Caddisflies as a group are the most tolerant of the EPT taxa.

During 2001 trough 2003, no EPT taxa were collected. Remaining years had less than 1% of the collection containing EPT with the majority of the collections as caddisflies. The exception was during 2005, which had 2% of the collection composed of EPT taxa and during 2008 which had 4.5% of the collection composed of EPT due to an abundance of caddisfly larvae.

Mayflies (*Stenonema* sp. and *Sternacron* sp.) were taken in the combined 2001-2009 catch at mean of 0.1%. *Sternacron* mayflies were seen again in 2005 at 0.6% of the catch. No mayflies were collected in 2006 and 2007. *Sternacron* and *Maccaffertium* mayflies appeared again in 2008 at 0.05% of the catch, and no mayflies were collected during 2009. The Illinois EPA ranks *Sternacron, Stenonema* and *Maccaffertium* (all belonging to family Heptageniidae), as moderately intolerant organisms with a rank value of 4 out of 11 when used to calculate an MBI (Macroinvertebrate Biotic Index) to judge stream health. Habitat limitations for mayflies may help to explain the scarcity of this group on the CSSC. A Limnotech, Inc. study (2009b) incorporates these MWRDGC data.

USEPA is currently evaluating another mayfly, *Centroptilum* sp. for chloride tolerance. *Centroptilum* is rarely found in Illinois and has an MBI value of 2, making it an intolerant organism under IEPA macroinvertebrate guidelines. *Centroptilum* frequents fast flowing water of streams and brooks in Illinois, with hard bottoms of gravel and cobble. Illinois Natural History Survey records of *Centroptilum* reveal 18 records of the genus in Illinois spanning a period between 1946 and 1997. The closest occurrence of *Centroptilum* to the CSSC was from Black Partridge Creek in a Will County Forest Preserve. The remaining 17 records for *Centroptilum* are for downstate county occurrences. *Centroptilum* would not make a good surrogate for the more tolerant mayflies that are occasionally found in the CSSC. *Centroptilum* would not be expected to colonize a habitat such as the CSSC which lacks the proper bottom habitat and current regime to support *Centroptilum* colonization, no matter what water chemistry conditions are at present. Chadwick and Feminella (2001) found that a Heptageniid mayfly tolerated increased salinities (6,800 mg/L) at lower temperatures of 18 degrees C compared to 2,400 mg/L at 28 degrees C, indicating that lower temperatures are more protective than higher temperatures to specific mayflies exposed to increasing salinity. Low winter temperatures in the CSSC would be expected to protect the mayflies presently found occasionally in the CSSC from winter chloride spikes.

On August 20, 2013 downstream of the Lemont Refinery, Hester-Dendy samples yielded a total of nine common taxa. The surface collection yielded individuals of six taxa with no EPT (Ephemoptera, Plecoptera, Trichoptera) species and no intolerant taxa. Dominant taxa were *Hyalella* amphipods. The deeper samplers yielded four taxa dominated by amphipods. No EPT or intolerant taxa were present. The high proportion of amphipods present allowed the deeper sample to rank higher than the surface sample; however, the total of four taxa present is considered to be low. Table 6 of Exhibit 2 presents the data and results of the 2013 multi plate samplers.

Analysis with respect to Plankton in the CSSC

Historical plankton samples were taken during 1978 by members of the Illinois Natural History Survey (INHS) in July, August and September at thirteen sites extending from the North Branch Chicago River and proceeding downstream through the Illinois River waterway to the Mississippi River. One site was located on the CSSC at the Lockport Lock and Dam. Five species of cladocerans ("water fleas" including *Daphnia* spp.) were found during July through September sampling at Lockport, Illinois during 1978 as presented in Table 7 of Exhibit B.

During June 2013, plankton samples were collected by Huff & Huff, Inc. both upstream and downstream of the RNZ. Upstream and downstream samples differed little in their composition and structure. Of the plankton contents, the crustacea were examined and three taxa emerged as present in the CSSC. *Bosmina,* Diaphanosoma, and Cyclopoid copepods comprised the total catch of planktonic crustacea. During November of 2013 a second plankton collection was made at Lockport, Illinois. Bosmina was the only crustacean found at much lower densities than the June samples. Table 8 of Exhibit B presents the 2013 Plankton results.

Winter Chloride Limit and Recalculation Procedure

To calculate recommended criteria (acute and chronic) for chlorides with respect to the Lower Ship Canal, and with a particular focus to the CSSC near Lockport and the Regulated Navigation Area and Safety Zone, we utilized USEPA's procedures. The Recalculation Procedure was revised by USEPA in 2013 (Delos, 2013) and is used to edit the taxonomic composition of the national toxicity dataset to reflect a more representative site-specific data set and better match the faunal assemblage that resides at the site. This requires attention to the actual species in the stream segment; here the Lower Ship Canal.

The USEPA states that the underlying premise of the Recalculation Procedure is that taxonomy has value in predicting sensitivity, such that the national dataset can be adjusted to reflect the taxonomy of species that reside at the site. The core of the procedure is the Deletion Process, which involves removing tested species that do not reside at the site from the national data set. The recommended procedure allows deletion of non-resident tested species, if and only if, they are not appropriate surrogates of resident untested species based on taxonomy.

The goal of this analysis is to develop a winter chloride water quality re-calculation based on the species present in the CSSC during the winter season.

When an exact species match is not present from the national criteria dataset, but a surrogate genus, family, order, class or phylum is present in the dataset and represents a species found as a resident species in the waterbody of interest, then the dataset representing that surrogate species can be retained for calculations. Inclusion of new and appropriately conducted laboratory data sets is also allowed. Nine of the 29 species in the Iowa dataset are present as species in the CSSC. Six other species in the data set are present as genera in the CSSC. Eight additional species in the dataset are present at the family, order or class level of classification in the CSSC. Table 9 of Exhibit B presents the list of 23 species present in the CSSC.

Fish and invertebrate data sets for organisms found in the CSSC were examined from reports and web based sources such as INHS collections and reports, MWRDGC collections, USACE collections, USEPA reports, Limnotech reports, and Huff & Huff collections.

Twenty-three (23) of the twenty-nine (29) species in the Iowa list were included in the data set for the CSSC. Three fish species, one amphibian, and two invertebrate species were dropped from the CSSC list:

1. American eel, threespine stickleback and guppy were not included in the CSSC list because these fish are not reported from the CSSC and other fish species of lower chloride tolerance were retained on the list.
2. The chorus frog was not retained because it has not been reported in the CSSC and typically metamorphoses tadpoles to frogs in wetlands and not large rivers. The bullfrog was retained on the CSSC list as present because tadpoles of either the bullfrog or northern leopard frog, a relative of the same genus, were seen near 2013 sample sites, but no specimens were vouchered.

3. *Ceriodaphnia* was not retained because it is not present during the winter season and has only been observed once during the month of July in the CSSC in 1978.
4. *Sphaerium* was not retained because it is not present in the CSSC. However, *Musculium* a closely related genus of fingernail clam was added to the dataset because it is present in the CSSC and has been recorded from the Lockport sample site several times during the last nine years. (MWRDGC 2001-2009).

The water flea genus *Daphnia* on the USEPA national dataset was used as a surrogate for the dominant water flea *Bosmina longirostris* present in the CSSC. *Daphnia* were chosen because the genus is protective of the fifth percentile for the 23 species in the CSSC. *Daphnia* were among the least tolerant invertebrates with a GMAV of 2,326 mg/L for chloride. *Musculium* fingernail clams were the least tolerant of any organism to chloride with a GMAV of 1,930 mg/L. Table 9 of Exhibit 2 presents the list of taxa used for the recalculation. Table 10 of Exhibit 2 presents the recalculation data sheet and results.

Using *Musculium* for the recalculation of site specific chloride criteria for the CSSC, and the USEPA calculation method (Stephen et al. 1985), a winter FAV of 1,983 mg/L chloride was calculated. A *Final Chronic Value* (FCV) was derived by dividing the *Final Acute Value* (FAV) with an appropriate *Acute to Chronic Ratio* (ACR). Stevens, 2009 recommended an Acute to Chronic Ratio of 7.308 be used for vertebrate species and an Acute to Chronic Ratio of 3.178 be used for invertebrate species. We used the invertebrate ACR for our calculations because the four most acutely sensitive genera used for the FAV calculations were all invertebrates. Therefore,

Criterion Maximum Concentration (acute value) of 991 mg/L

Criterion Continuous Concentration (chronic value) of 624 mg/L

The calculations to establish these acute and chronic criteria are shown in Table 10 of Exhibit 2.

Conclusion and Recommendation

A winter chloride criteria is proposed (November through April), on a site specific basis for the CSSC that is based on a limited aquatic fauna present in the Lower Ship Canal. A Criterion Maximum Concentration (acute value) of 990 mg/L and a Criterion Maximum Concentration (chronic value) of 620 mg/L would be protective to the more sensitive fauna present.

/s/ Roger Klocek

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Exhibit A

ROGER KLOCEK
Senior Biologist

Expertise: Environmental Assessment, Fish Assessment, Mussel Relocation, Sensitive Species Studies, Mollusk Assessment, Water Intake Studies

Huff & Huff, Inc. 2009 - Present
Openlands 2008 - 2011
Shedd Aquarium 1971 - 2007

Recent Aquatic Assessments:

- Relocate sensitive species and mussel beds Winnebago Co., IL 2012
- Prepare update for water intake bio studies, Lake Co., IN, 2012
- Assess mussels, Clinton Iowa and DeKalb Co. IL 2012
- Assess fish (IBI), macroinvertebrates (MIBI), mussels (MCI), Cook Co., LaSalle Co, IL, 2012
- Assess Spring Creek, for 3 years for; mussels, fish (IBI), benthics (MIBI), Will Co., IL 2009-2011.
- Assist with Loggerhead Shrike surveys, Will County, IL 2011.
- Assess mussels Manhattan Creek, Will Co., IL 2011
- Assess mussels, fish, (IBI), macroinvertebrates, (MIBI) Hampshire Creek, Hampshire, IL, 2009, 2011
- Assist with Hines Dragonfly Survey, Will Co., IL
- Assess mussels, fish, (IBI), invertebrates (MBI) in Kishwaukee River at Huntley IL, Kane Co., 2010
- Assess mussels including state listed species in Fox River, Elgin, IL 2010
- Conduct Scuba assessment of mussels at St. Charles, IL, sensitive species survey. 2010
- Assess protected mussels at Brewster Creek, Elgin IL 2009
- Monitor relocated mussels on a quarter- mile section of the Fox River at Dundee, IL, 2006
- Relocate mussels at the Sullivan Bridge construction site in Aurora, IL in association with the IDNR. 2004
- Relocate mussels inside coffer dams at bank stabilization project, Batavia, IL, 2000
- Assess and relocate all mussels including IL State T&E species, on one mile of the Fox River for Kane Co. 2002
- Assist with Scuba procurement of breeding stock for endangered Higgins Eye mussel, Cordoba, IL 2002-05
- Project Manager for survey and relocation of all mussels on approximately 4000 feet of Eakin Creek, Kane Co. 2000
- Assess mussels in the Fox River Basin at twenty-five stations in partnership with the IDNR. (1999-2001)
- Conduct mussel assessments on 35 stations of Kishwaukee River 2009-2011
- Conduct mussel assessments Midewin Tallgrass Prairie on three watersheds, 2008-09
- Conduct mussels assessments Kankakee River and tributaries for protected species, 2006–2009
- Conduct cave salamander population assessments, multiple caves, Ava, MO. 2001-2005.
- Conduct freshwater spring and cave faunal assessments for Dominican National Parks Service, 2000.
- Conduct juvenile and larval reef fish and queen conch faunal assessments, Dominican Republic, 1995-2000.

Educational Experience:
B.S. Biology/Anthropology, 1966 to 1971, University of Illinois, Chicago, IL

Certifications:
Rescue Diver, 1982, Divemaster, 1990

Publications:

- 2011. Klocek, R. and Laura Barghusen Aquatic Faunal Surveys Before and After Restoration of the Will County Forest Preserve's Spring Creek at Hadley Valley Forest Preserve, Will County, Illinois, 2009 through 2011.
- 2009. Klocek, Roger. Bland, James, Barghusen, Laura. Key to the mussels of Northern Illinois. Online key posted by the Field Museum, Chicago. http://fm1.fieldmuseum.org/keystonature/mussels/
- 2008. Klocek, Roger, Bland, James, Barghusen, Laura. Guide to Mussels of Northern Illinois. Chicago Wilderness Publications. P iii-84. and online at: http://fm2.fieldmuseum.org/plantguides/guide_pdfs/CW6_mussel_guide.pdf

Exhibit B
WINTER CHLORIDE TOXICITY CRITERIA
on the CHICAGO SANITARY & SHIP CANAL,
A Re-Evaluation Based on Current Species Present

The purpose of this document is to use the existing biological information relating to the Chicago Sanitary & Ship Canal ("CSSC") to derive recommended water quality criteria for chlorides in this segment of the CSSC. The CSSC has been designated an Aquatic Life Use B water, and the species resident in this stream segment are tolerant species. More specific information on the species found and their tolerance is included below.

Chlorides

The existing chloride water quality criteria were published by the U.S. Environmental Protection Agency (USEPA) in 1988. Increased chloride concentrations in natural waters are a common problem during winter de-icing practices due to the use of road salts, primarily sodium chloride. A 2010 study in southeastern Wisconsin (Milwaukee area), examined 11 watersheds during winter and found that chloride concentrations exceeded the U.S. Environmental Protection Agency (USEPA) acute (860 mg/L) criterion at 55 percent of the stations, and the chronic (230 mg/L) water-quality criterion at 100% of monitored sites. On a national scale, historic U.S. Geological Survey chloride data from 168 northern metropolitan stations were examined, with 55 percent of stations exceeding the chronic standard and 25 percent exceeding acute criterion from November through April, (Corsi et al., 2010).

The Iowa Department of Natural Resources (Iowa DNR, 2009), compiled updated toxicity information from the literature and from studies commissioned by the USEPA. The result of this effort by the Iowa DNR demonstrates that water chemistry such as hardness and sulfate influence the toxicity of chloride to aquatic life. These studies resulted in the development of chloride criteria that are based on the concentrations of hardness and sulfate levels that can be site specific, and are more consistent with the current scientific understanding about toxicity of chloride to aquatic organisms. Iowa adopted new chloride standards in 2009 (USEPA approved 2010), with Pennsylvania, Missouri, and Wisconsin currently in the process of adopting similar standards as Iowa. Indiana adopted new chloride standards in 2012.

Testing Procedures

National Criteria for Chloride were published by the USEPA in 1988. Test results used to derive water quality standards for chloride toxicity were based on species including rainbow trout, American eel, bluegill, fathead minnow, daphnia, midges, caddisfly, mosquito larvae, fingernail clam, and tubifex worms. Fish are generally more tolerant to chlorides and invertebrates less tolerant, with fingernail clams being among the least tolerant organisms identified in 1988.

A species is defined as a group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding. The species is the lowest principal natural classification unit, ranking below a genus and always denoted by a Latin binomial, the genus and species, e.g., *Felis catus* (house cat), *Felis margarita* (black-footed cat).

The calculations used to set the water quality criteria are based on the *Final Acute Value* (FAV) that is calculated using a method that gives approximately equal weight to the four lowest genus values. Toxicity testing conducted on respective species is used to develop the combined toxicity for the genus (Stephens et al. 1985).

A *Genus Mean Acute Value* (GMAV) is the geometric mean of all the *Species Mean Acute Values* (SMAVs) available for species in the genus. Species within a genus are toxicologically similar, so the use of Genus Mean Acute Values prevents data sets from being biased by an overabundance of species in one or a few genera.

The FAV is divided by two to calculate the *Criterion Maximum Concentration* (CMC) also known as the *acute value*. The CMC is intended to protect 95 percent of a group of diverse genera, unless there is a commercially or recreationally important species which needs to be taken into account with a lower sensitivity. The *Criterion Continuous Concentration* (CCC), or chronic value, is equal to the Final Acute Value, divided by the Acute-to-Chronic Ratio (ACR). When laboratory data are lacking for chronic tolerance values, the chronic tolerance can be computed by using an ACR for vertebrates (7.308) and an ACR for invertebrates (3.178) as proposed by Stephens (USEPA, 2009). The 1988 USEPA list used 12 species for calculations while the 2009 list used by Iowa to calculate its recent chloride standards contains 29 species, as presented in Table 1.

<u>Fish Collected from the CSSC</u>

The Chicago Sanitary & Ship Canal extends approximately 30 miles from Damen Avenue, Chicago to the confluence of the Des Plaines River in Joliet, Illinois.

<u>Rotenone Event</u>

A Rotenone collection was made of the CSSC during December 3 and 4, 2009 to determine Asian Carp presence. Multiple agencies cooperated to ensure thorough coverage of the areas, including the Illinois Department Natural Resources, U.S. Fish and Wildlife service, U.S. Army Corps of Engineers (USACE), and others. This effort represented the most comprehensive fish collection documented for the CSSC and had stations at Cargill grain elevators (River Mile 292.7), at the Lockport Controlling Structure (River Mile 293.1) and at Ruby Street in Joliet, Illinois (River Mile 288.7).

The rotenone event was monitored and dead fish were identified and counted by fisheries biologists over the two-day period. A total of 17,771 fish of 36 species were recorded from the vicinity of Lockport and Joliet, Illinois, allowing a snapshot view of the composition of the total fish community that has never been equaled during other fish sampling events.

Table 2 provides the common, scientific names, numbers and percentage of each species taken during the 2009 collection. Were one to compute the Index of Biotic Integrity, an IEPA designed method of evaluating stream health using fish community structure, the IBI for the rotenone fish collection near Lockport Illinois, would tally a total of 22 (out of a possible 60 points). The IEPA narrative describing an IBI score of 22 is given as follows:

"**IBI 16-30 scores.** Rated as a Class 4 stream. Biotic integrity is much lower than that expected in Illinois streams that reflect the typical reference conditions, as currently defined. Number of native species is reduced further from reference conditions due to near-complete loss of intolerant species and further pronounced loss of sucker species and benthic-invertivore species. Imbalance of fish-community structure is evidenced as indiscriminate loss of species across major families (minnows, suckers, and sunfish). Further reductions in abundances of specialist benthic invertivores and mineral-substrate spawners indicate moderate to extreme imbalance in trophic and reproductive functional structure" (2005, Interpreting Illinois Fish-IBI Scores, Draft, Illinois Environmental Protection Agency.)

While the IBI is specifically meant for application to wadeable streams, the IBI can be applied to a rotenone collection because a reasonably complete picture of the total fish community structure is provided by rotenone collection methods. The IDNR narratively describes an IBI of 22 as a *Limited Aquatic Resource*. The 2009 Rotenone collection showed the following composition of species:

- common carp at 40% of the catch,
- Emerald shiner 16%,
- yellow bullhead 11%,
- bluntnose minnow 7%,
- goldfish 7%,
- channel catfish 6%, and
- gizzard shad 6%.

These seven species alone accounted for 93% of the total catch. The rotenone collection event of December 2009 depicts a limited fish community that is comprised of widespread and tolerant species. The most abundant fish in the CSSC was the common carp, a non-native species and arguably the most tolerant species in Illinois. No intolerant species were found during the Rotenone collection. The fish community in the CSSC is abnormally skewed toward fish that can be considered as generalists.

Fish collected exclusively near the Lockport Controlling Structure, which is the closet station to the Lemont Refinery, captured 5,741 total fish of 24 species during the 2009 Rotenone collection. Of the 24 species collected in 2009, six species accounted for 98 percent of the total numbers of fish captured:

- common carp 71.1%, of the catch,
- yellow bullhead 11.8%,
- channel catfish 5%,
- gizzard shad 4.8%,
- emerald shiner 2.8%,
- bluegill 1.7%, and
- bluntnose minnow 0.9%.

Other Fish Collection Events

A multiple agency task force, the *Monitoring and Rapid Response Working Group* (MRRWG) made a fish collection near Lockport Illinois during 2012. Twenty-seven (27) species of fish were collected:

- gizzard shad (73%) of the catch,
- emerald shiner (9%),
- green sunfish (5%),
- bluntnose minnow (3%),
- largemouth bass (2%), and
- oriental weatherfish (2%).

Together, these six species accounted for 94% of the catch. The computed IBI score for the 2012 MRRWG collection was 28, ranked as a *Limited Aquatic Resource*. Table 3 presents the results and IBI score for the 2012 fish collection.

While IBI calculations are not recommended for application to electro-shocking boat collections, the IBI was calculated in order to provide a comparison to the rotenone collection results. Shocking boat collections often have a limited electrical field range of 6 to 10 feet, and can miss collecting fish in deeper water, thus a total picture of the complete fish community can be lacking. The metrics used to calculate the IBI provide a snapshot of the collected fish community and provide important information on feeding guild structure, intolerant species, community structure and composition of specialized spawning groups of fishes. The metrics alone can be used to gauge community structure whether an IBI score is calculated or not.

Fish collections were made by the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) at Lockport, IL from 2001-2005. The Lockport site produced 12 species of fish. Table 4 presents the MWRDGC data. Ninety percent of the fish collected by MWRDGC at Lockport were represented by 6 species. The six species and their total percent of the collections during 2001-2005 were,

- gizzard shad at 54% of the catch,
- common carp 17%,
- bluntnose minnow 8%,
- pumpkinseed sunfish 6%,
- emerald shiner 6%, and
- mosquitofish 2%.

Of the total fish species from all reported sources of collection captured at Lockport, Illinois between 2001 to 2012, seven species: the bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), yellow bullhead (*Ameiurus natalis*), emerald shiner (Notropis atherinoides), golden shiner, (Notemigonus crysoleucas), mosquitofish, (Gambusia affinis), and fathead minnow (*Pimephales promelas*) are present on the USEPA chloride tolerance list. The most sensitive fish in CSSC, for which data are available, is the fathead minnow with a GMAV of 6,515 mg/L of chloride.

Macroinvertebrate Collection Events in the CSSC

MWRDGC sampling

Macroinvertebrate collections were made by Ponar dredge and modified Hester-Dendy multiple substrate samplers during 2001-2009 by the MWRDGC in the CSSC. Limnotech (2009a) used a subset of this data when compiling their habitat evaluation on the Chicago Area Waterways. Ponar dredges collect bottom substrates that are usually colonized by extremely tolerant organisms. Hester-Dendy samplers are colonized by organisms in the water column, and may be colonized by intolerant organisms. The Lockport, Illinois site returned the most extensive species list collected by Hester-Dendy samplers compared to the three other MWRDGC sample sites (Harlem Avenue, Route 83, and Stephens Street, Joliet, IL). Sixty-seven (67) types (also called taxa), of invertebrates were collected over a nine -year period at Lockport, Illinois. Of the 67 taxa, one species (*Hyalella azteca*, an amphipod) was represented on the USEPA chloride tolerance list. Two genera of invertebrates (*Physa sp*., a snail and *Chironomus* sp., a midge) were collected from 2001-2009 at Lockport and were represented on the USEPA Chloride list. Other taxa of invertebrates were collected at the Lockport site that are represented at the family order or class level on the USEPA chloride list. Of the macroinvertebrates collected at the Lockport site from 2001- 2009, the fingernail clam, *Musculium sp.* is the least tolerant invertebrate having a SMAV of 1,930 mg/L of chloride. *Musculium* is not present on the USEPA chloride list, but has a representative on the list as the fingernail clam, *Sphaerium simile*. Table 5 presents the invertebrates collected by the MWRDGC from 2001-2009 at Lockport, Illinois.

Huff & Huff Sampling Upstream and Downstream of the Regulated Navigation Zone

The CSSC provided special challenges in sampling due to the presence of the Electric Fish Barriers, located in the CSSC at the Citgo Lemont Refinery, that prevent the spread of Asiatic carp species upstream to Lake Michigan. The U.S. Coast Guard also established a *Regulated Navigation Area* (RNA) that extends for approximately 1.4 miles upstream (northerly) of the 135^{th} Street Bridge and for 1.1 miles downstream of the bridge. Sampling is forbidden by the U.S. Coast Guard within the RNA and samples were taken starting just outside the boundaries of the RNZ.

The methodology Huff & Huff, Inc. used to collect organisms in 2013 was in accordance with the methods given in the *Standard Operating Procedure for Method to Collect Aquatic Macroinvertebrates with Multi-Plate Artificial Substrate Samplers, IEPA 2011.* The artificial substrate sampler used is a modified form of a typical Hester-Dendy sampler consisting of nine fiberboard plates that are separated from each other by nylon washers. The sampler is suspended off the bottom and left in place for four to six weeks in order to colonize macroinvertebrates.

Samplers were tied off above the water line of the CSSC such that one set of three samplers were suspended approximately 5 feet below the water and another set was suspended approximately 11 feet below the water surface. A duplicate set of samplers was suspended at 11-12 feet below the surface. Samplers were able to follow the abrupt drop- off of the limestone walls. Retrieved samplers from each depth were placed into separate buckets then individually bagged upon retrieval.

Samples were processed using the Standard Operating Procedure for Sample Processing for the Macroinvertebrate Biotic Index (MBI), [IEPA 2011]. Samples were rated using the Standard

Operating Procedure for Calculation of the Macroinvertebrate Biotic Index (MBI), [IEPA 2011]. The MBI compares the abundance and tolerance values of different aquatic organisms that then produces a numeric value which rates stream health.

The upstream site relative to Lemont had no sample retrieved as the anchoring line was cut by barges/towboats scraping along the bank wall. The downstream site yielded a total of 800 organisms (including duplicate samplers) from nine taxa. The surface (5 feet deep), collection yielded 215 individuals of six taxa with no EPT (Ephemoptera, Plecoptera, Trichoptera) species and no intolerant taxa. Dominant taxa were amphipods at 47% of the collection. The MBI was 6.7. The deeper samplers yielded 336 organisms of four taxa dominated by amphipods at 88% of the collection. No EPT taxa were present. The MBI was 5.5. The high proportion of amphipods present allowed the sample to rank a better score than surface sample; however, the total of four taxa present is considered to be a low numbers of species present. Table 6 presents the data and results of the multi plate samplers.

Analysis with Respect to Macroinvertebrates in CSSC

Macroinvertebrate samples of aquatic species can give information about stream health based on the type, tolerance, and abundance of aquatic invertebrates. Some macroinvertebrates are protected from biotic and abiotic changes during winter because they burrow into the substrate and become less active. Invertebrates such as crayfish, fingernail clams, and aquatic worms regularly burrow while others such as Asiatic clams become dormant, where feeding ceases below a given temperature range, which can vary between 7 to 10 degrees C, (Thorp and Covich, 2001).

Historic macroinvertebrate data are available from samples collected by the MWRDGC. A four-year mean of macroinvertebrate species from MWRDGC samples (2001-2004) collected by petite Ponar dredges captured up to 63,897 organisms per square meter representing 14 total taxa, comprised of 98% aquatic worms and 1% midges. The modified Hester-Dendy multi-plate samplers captured up to 8,603 organisms per square meter of 14 taxa, comprised of 68% aquatic worms, 10% amphipods, and 10% midges. All of the taxa collected were tolerant organisms. Table 5 of Exhibit B presents MWRDGC data for these macroinvertebrate collections.

MWRDGC collected a limited number of Ephemoptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), collectively known as EPT taxa using Hester-Dendy samplers from 2001-2009 EPT taxa are known to be among the more sensitive organisms to pollution, and their presence or absence is a general signal of stream health. No stoneflies, the most sensitive of the EPT taxa have been collected in the CSSC. Caddisflies, as a group, are considered to be among the most tolerant of the EPT taxa.

Mayflies (*Stenonema* sp. and *Sternacron* sp.) were taken in the combined 2001-2004 catch at mean of 0.1% of the catch. *Sternacron* mayflies were seen again in 2005 at 0.6% of the catch. No mayflies were collected in 2006 and 2007. *Sternacron* and *Maccaffertium* mayflies appeared again in 2008 at 0.05% of the catch, and no mayflies were collected during 2009. The Illinois EPA ranks *Sternacron*, *Stenonema* and *Maccaffertium* (all belonging to family Heptageniidae), as moderately intolerant organisms with a rank value of 4 out of 11 when used to calculate an MBI (Macroinvertebrate Biotic Index) to judge stream health. Lower values for organisms indicate less tolerance to pollution and higher numbers indicate more tolerance to pollution. Habitat limitations for mayflies may help to explain the scarcity of this group on the CSSC. A Limnotech, Inc. study (2009b) incorporates this MWRDGC data.

USEPA is currently evaluating another mayfly, *Centroptilum* sp. for chloride tolerance. *Centroptilum* is rarely found in Illinois and has an MBI value of 2, making it an intolerant organism under IEPA macroinvertebrate guidelines. *Centroptilum* frequents fast flowing water of streams and brooks in Illinois, with hard bottoms of gravel and cobble. Illinois Natural History Survey records of *Centroptilum* reveal 18 records of the genus in Illinois spanning a period between 1946 and 1997. The closest occurrence of *Centroptilum* to the CSSC was from Black Partridge Creek in a Will County Forest Preserve. The remaining 17 records for *Centroptilum* are for downstate county occurrences. *Centroptilum* would not make a good surrogate for the more tolerant mayflies that are occasionally found in the CSSC. *Centroptilum* would not be expected to colonize a habitat such as the CSSC which lacks the proper bottom habitat and current regime to support *Centroptilum* colonization, no matter what water chemistry conditions are at present. Chadwick and Feminella (2001) found that a Heptageniid mayfly tolerated increased salinities (6,800 mg/L) at lower temperatures of 18 degrees C compared to 2,400 mg/L at 28 degrees C, indicating that lower temperatures are more protective than higher temperatures to specific mayflies exposed to increasing salinity. Low winter temperatures in the CSSC would be expected to protect the mayflies presently found occasionally in the CSSC from winter chloride spikes.

The CSSC at Lockport has the highest diversity of organisms from any CSSC location collected by Hester-Dendy samplers, yet has a relatively poor representation of EPT taxa during 2001- 2009 MWRDGC collections. During 2002 and 2003, no EPT taxa were collected. Remaining years had less than 1% of the collection comprised of EPT with the majority as caddisflies. The exception was during 2005, which had 2% of the collection composed of EPT taxa and during 2008 which had 4.5% of the collection composed of EPT due to an abundance of caddisfly larvae.

An August 20, 2013 upstream Hester-Dendy sample site, relative to Lemont had no sample retrieved as the anchoring line was cut by barges/towboats. The downstream site yielded a total of 800 organisms (including duplicate samplers) of nine taxa. The surface (5 feet deep), collection yielded 215 individuals of six taxa with no EPT (Ephemoptera, Plecoptera, Trichoptera) species and no intolerant taxa. Dominant taxa were Hyalella amphipods at 47% of the collection. The calculated MBI was 6.7. The deeper samplers yielded 336 organisms of four taxa dominated by amphipods at 88% of the collection. No EPT taxa were present. The MBI was 5.5 and returned a better score than the surface sample. The high proportion of amphipods present allowed the sample to rank higher than the surface sample; however, the total of four taxa present is considered to be low. Table 6 of Exhibit B presents the data and results of the 2013 multi plate samplers.

<u>Plankton Sampling in the CSSC</u>

<u>Sampling in 1978</u>

Plankton samples were taken during 1978 by members of the Illinois Natural History Survey INHS in July, August, and September at thirteen sites including the North Branch Chicago River and extending downstream through the Illinois River waterway to the Mississippi River. One site was located on the CSSC at the Lockport Lock and Dam. Five species of cladocerans (water fleas) were found during July through September sampling at Lockport as presented below, with numbers recorded as abundance per cubic meter. Table 7 presents the results of the cladoceran collection in 1978.

Bosmina longirostris was the only cladoceran present during July, August, and September. *Moina micura* another water flea was present in August and September. *Daphnia retrocurva a* water flea was only present in September. *Chydoris sphaericus* and *Ceriodaphnia quadrangula other* types of water fleas were only present in July (Havera et al. 1980). All cladocerans mentioned produce overwintering eggs that are protected by a specialized hardened shell termed the *ephippium.* The ephippium can withstand periods of extreme cold, or complete drying then hatch when conditions favorably change in the spring (Windsor and Innes 2002).

<u>Sampling in 2013</u>

During July 12, 2013, Huff & Huff, Inc. collected plankton samples at the two sites where the multi-plate samplers were installed. Plankton tows started in mid river upstream and downstream of the Lemont Refinery Outfall and outside the Regulated Navigation Zone (RNZ). Plankton tows were accomplished using a plankton net with a 30-centimeter (cm) mouth, 91 cm length and 153-micron mesh. Plankton tows were done at slow speed, approximately 1 mile per hour for a distance of about 0.8 miles (1,300 meters), in three-fifteen-minute tows. Tows were conducted so the net was submerged from one to 3 feet below the surface. Approximately 117 cubic meters of water were filtered through the plankton net during each tow. Major plankton types were identified to the lowest possible taxonomic unit, and abundance estimates were made depending upon concentration of taxa.

The June 2013 plankton samples were collected both upstream and downstream of the RNZ. Upstream and downstream samples differed little in their composition and structure. Each site represents approximately 116 cubic meters of water sampled. Of the plankton contents, the crustacea were examined and three taxa emerged as dominant in the CSSC. *Bosmina* at 87%, *Diaphanosoma* at 2% and Cyclopoid copepods at 11% comprised the total catch of planktonic crustacea.

During November 18, 2013 a second plankton collection was made at one location at Lockport, Illinois (River Mile 292.7). The plankton net was towed for 500 meters, filtering approximately 45 cubic meters of water. *Bosmina longirostris* was the only crustacean found at approximately five Bosmina per cubic meter, a much lower densities than the June samples. Table 8 of Exhibit B presents the 2013 Plankton results.

Bosmina longirostris has a worldwide distribution and is a common water flea (order Cladocera) in Lake Michigan. *Bosmina* is related to *Daphnia* though both are classified in different families. *Bosmina* is the most abundant water flea in the CSSC and comprises approximately 87% of the catch. *Bosmina longirostris* varied in size from 200 to 450 microns in length with the majority at approximately 300 microns long. Many *Bosmina* carried eggs, showing that there is active reproduction occurring. Balcer et al. (1984) cite studies showing *Bosmina longirostris* lives 20-25 days, producing 5-8 clutches of 2-4 eggs each. Embryonic development takes 2-3 days with sexual maturity achieved in 3-4 days. Brucet et al. (2009), describes the salinity tolerance of the common crustacean species to their occurrence within salt gradients within 35 shallow, estuarine lagoons in Spain and Denmark. *B. longirostris* varied in seawater salinity tolerance from 1,000 to 2,000 mg/L in Spanish and Danish lagoons.

Diaphanosoma sp. is a common water flea in Lake Michigan and varied in size in the CSSC from 800-900 microns. Both *Diaphanosoma* and *Bosmina* probably originated from Lake Michigan inputs in the CSSC, and established reproductive populations in the CSSC. *Diaphanosoma* is commonly collected in Lake Michigan from May through October, with peak abundance during the fall season. Two species of *Diaphanosoma* are known from Lake Michigan, *D. brachyurum* and *D. birgei*.

Diacyclops thomasi (formerly known as *D. bicuspidatus thomasi*), is a copepod with worldwide distribution and is a common crustacean in midwestern freshwaters. It is the most abundant cyclopoid copepod in Lake Michigan. D. thomasi produces a clutch of 10-40 eggs, which hatch and reach sexual maturity 28-35 days at approximately 20 degrees C. Females can produce a second clutch of eggs four days after the first eggs hatch. *D. thomasi* has adult forms as well as eggs, which overwinter.

All cladocerans and copepods are important food items for larval or small fish. The July 2013 plankton samples from upstream and downstream sites differed little in composition and structure. Approximately 25 milliliters (ml) of concentrated plankton was collected upstream at site A-1 and 28 ml of concentrated sample was collected downstream at site C-1. Each site represents approximately 116 cubic meters of water sampled. Of the plankton contents, the crustacea were examined and three species emerged as dominant in the CSSC during June, *Bosmina* at 87%, *Diaphanosoma* at 2%, and Cyclopoid copepods at 11% comprised the catch of planktonic crustacea. Comparison of results to 1978 plankton collections show a lack of *Daphnia retrocurva, Moina,* and *Ceriodaphnia*, and these organisms may no longer be present near Lemont or may be present on a limited basis seasonally.

Recalculation Procedure Applied to the CSSC

In light of the above analyses with respect to the available data, we proceeded to calculate the appropriate chloride toxicity criteria, both chronic and acute, using USEPA procedures. For that we chose the Recalculation Procedure.

The Recalculation Procedure was revised by USEPA in 2013 (Delos, 2013) and is used to edit the taxonomic composition of the toxicity dataset used for the Species Sensitivity Distribution (SSD) upon which a site-specific criterion is based, in order to better match the assemblage that resides at the site. The Recalculation Procedure is intended to provide flexibility to States to derive site-specific criteria that best reflect the species that reside at a site.

The USEPA notes that the underlying premise of the Recalculation Procedure is that taxonomy has value in predicting sensitivity, such that the national dataset can be adjusted to reflect the taxonomy of species that **reside at the site**. The core of the procedure is the Deletion Process, which involves removing tested species that do not reside at the site from the national data set. The recommended procedure allows deletion of nonresident tested species, if and only if, they are not appropriate surrogates of resident untested species based on taxonomy.

The goal of this analysis is to develop a winter chloride water quality re-calculation based on the species present in the CSSC during the winter season.

When an exact species match is not present from the national criteria dataset, but a surrogate genus, family, order, class or phylum is present in the dataset and represents a species found as a resident species in the waterbody of interest, then the dataset representing that surrogate species can be retained for calculations. When appropriate laboratory results are available for taxa, that are not present among the 29 taxa on the national data set used for chloride calculations, they may be added to the data set. Nine of the 29 taxa in the Iowa dataset are present as species in the CSSC. Six other species in the data set are present as genera in the CSSC. Eight additional species in the dataset are present at the family, order or class level of classification in the CSSC. Table 8 presents the list of 23 species present in the CSSC.

Twenty-three (23) of the twenty-nine (29) species in the Iowa list were included in the data set for the CSSC. Three fish species, one amphibian, and two invertebrate species were deleted from the CSSC list:

1. American eel, threespine stickleback and guppy were not included in the CSSC list because these fish are not reported from the CSSC and other fish species of lower chloride tolerance were retained on the list.
2. The chorus frog was not retained because it has not been reported in the CSSC and typically metamorphoses in wetlands, not in large streams or rivers. The bullfrog was retained on the CSSC list as present because tadpoles of either the bullfrog or northern leopard frog were seen near 2013 sample sites, but no specimens were vouchered.
3. *Ceriodaphnia* was not retained because it is not present during the winter season and has only been observed once during the month of July in the CSSC in 1978.
4. *Sphaerium* was not retained because it is not present in the CSSC. However, *Musculium* a closely related genus of fingernail clam was added to the dataset because it is present in the CSSC and has been recorded from the Lockport sample site several times during the last nine years (MWRDGC 2001-2009). *Musculium* has recent chloride toxicity data calculated (USEPA, 2010).

The water flea genus *Daphnia* on the USEPA national dataset was used as a surrogate for the dominant water flea *Bosmina longirostris* present in the CSSC. *Daphnia* were chosen because the genus is protective of the fifth percentile for the 23 species in the CSSC. *Daphnia are* among the least tolerant invertebrates with a GMAV of 2,326 mg/L for chloride. *Musculium* fingernail clams were the least tolerant organism in the CSSC to chloride with a GMAV of 1,930 mg/L. Table 9 presents the list of taxa used for the recalculation. Table 10 presents the recalculation data sheet and results.

Using *Musculium* for the recalculation of site specific chloride criteria for the CSSC and the USEPA calculation method (Stephen et al. 1985), a winter FAV of 2,422 mg/L chloride was calculated. Therefore,

Criterion Maximum Concentration (acute value) of 991 mg/L
Criterion Continuous Concentration (chronic value) of 620 mg/L

Soucek, (2005) demonstrated that hardness and sulfate ameliorate chloride toxicity to sensitive invertebrates. The Iowa Chloride standards (2009b) incorporate the hardness and sulfate concentrations into formulae for calculating chloride concentrations for varying hardness or sulfate concentrations. The critical hardness in the CSSC is similar to the test waters used for calculating the chloride and sulfate ratios, and therefore, no adjustment for hardness in the CSSC is necessary. However, the median sulfate concentration in the CSSC (92 mg/L) is higher than used in deriving the formulae from baseline tests. Factoring in sulfate differences would yield slightly higher values for the CMC and CCC.

Conclusion:

A winter chloride criteria is proposed (November through April), on a site specific basis for the CSSC that is based on a limited aquatic fauna where the Criterion Maximum Concentration (acute value) is 990 mg/L and the Criterion Maximum Concentration (chronic value) is 620 mg/L. The calculations presented herein demonstrate that such is protective of the species present in the CSSC.

Works Consulted

Balcer, Mary D., Nancy L. Korda, and Stanley I. Dodson. Zooplankton of the Great Lakes: a guide to the identification and ecology of the common crustacean species. Univ. of Wisconsin Press, 1984.

Benoit, Duane A. 1988. *Ambient Water Quality Criteria for Chloride*. United States Environmental Protection Agency. EPA 440/5 8801.

Brucet, Sandra, Dani Boix, Stéphanie Gascón, Jordi Sala, Xavier D. Quintana, Anna Badosa, Martin Søndergaard, Torben L. Lauridsen, and Erik Jeppesen. *Species richness of crustacean zooplankton and trophic structure of brackish lagoons in contrasting climate zones: north temperate Denmark and Mediterranean Catalonia (Spain). Ecography* 32, no. 4 (2009): 692-702.

Chadwick, Michael A. and Jack W. Feminella. 2001. Influence of salinity and temperature on the growth and production of a freshwater mayfly in the Lower Mobile River, Alabama. Limnol. Oceanogr., 46(3), 2001, 532–542

Corsi, Stephen. David Graczyk, Stephen Gies, Nathaniel Booth, and Kevin Richards. 2010. A Fresh Look at Road Salt: Aquatic Toxicity and Water Quality Impacts on a Local, Regional and National Scale. *Enviro. Sci. and Technology*. V 44. pp 7376-7382.

Delos, Charles G. 2013. Revised Deletion Process for the Site-Specific Recalculation Procedure for Aquatic Life Criteria. United States Environmental Protection Agency. EPA-823-R-13-001

Eldridge, William H, David B. Arscott and S John K. Jackson 2010. Stroud Water Research Center Expert Report on the Proposed Rulemaking by the Pennsylvania Environmental Quality Board [25 PA. CODE CH. 93] for Ambient Water Quality Criterion; Chloride (Ch) [40 Pa.B. 2264] [Saturday, May 1 2010]

Erickson, R. and C. Stephan. 1988. Calculation of the Final Acute Value for water Quality Criteria for Aquatic Organisms. U.S. Environmental Protection Agency, Washington, D.C., EPA/600/3-88/018 (NTIS PB88214994), 1988.

Havera, Stephen P. Frank C. Bellrose, H. Kathleen Archer, Fred Paveglio, Jr., Donald W. Steffeck, Kenneth S. Lubinski, Richard E. Sparks, Warren U. Brigham, Larry Coutant, Stephen Waite, Dee McCormick. 1980. Projected Effects of Increased Diversion of Lake Michigan Water on the Environment of the Illinois River Valley. Illinois Natural History Survey. Urbana, IL.

Illinois Environmental Protection Agency. 2011. Standard Operating Procedure for Sample Processing for the Macroinvertebrate Index of Biotic Integrity (mIBI). Document Control No. 167. IEPA BOW SOP001-00-1111. Revision No. 0. Springfield, Illinois

Illinois Environmental Protection Agency. 2011. Standard Operating Procedure for Methods to Collect Aquatic Macroinvertebrates with Multi-plate Artificial Substrate Samplers. Document Number 169.

Illinois Environmental Protection Agency. 2011. Standard Operating Procedure for Calculation of the Macroinvertebrate Index of Biotic Integrity (mIBI). Document Control No. 170. IEPA BOW SOP004-00-111. Revision No. 0. Springfield, Illinois.

Illinois Environmental Protection Agency. 2011. Macroinvertebrate Tolerance List and Functional Feeding Group Classification. Document Control No. 176. IEPA BOW ID002-00-1111 Revision No. 0. Springfield, Illinois.

Illinois Natural History Survey. Ephemoptera Database. Accessed October 30, 2013. http://ellipse.inhs.uiuc.edu:591/INHSCollections/FMPro

Illinois Natural History Survey. Mussel Database. Accessed October 11, 2013. http://ellipse.inhs.uiuc.edu:591/INHSCollections/

Iowa DNR. 2009. Water Quality Standards Review: Chloride, Sulfate and Total Dissolved Solids Iowa Department of Natural Resources Consultation Package. February 9, 2009.

Iowa DNR. 2009b. Water Quality Standards Fact Sheet. Chloride. Iowa Department of Natural Resources. March 3, 2009.

Kelly, Walton R., Samuel V. Panno, and Keith Hackley. 2012. The Sources, Distribution, and Trends of Chloride in the Waters of Illinois. Illinois State Water Survey. Prairie Research Institute University of Illinois at Urbana-Champaign. Bulletin B-74.

Lee, Jin-Yong and Sung-Ho Song. 2007. Groundwater Chemistry and Ionic Ratios in a Western Coastal Aquifer of Buan, Korea: Implication for Seawater Intrusion. *Geosciences Journal*. Vol. 11, No. 3, p. 259 – 270.

Limnotech. 2009a. Review and Selection of Fish Metrics for the Chicago Area Waterway System Habitat Evaluation and Improvement Study. Prepared for The Metropolitan Water Reclamation District Of Greater Chicago. April 21, 2009.

Limnotech 2009b. Technical Memorandum No. 1. Characterization of the Macroinvertebrate Community, Chicago Area Waterway System Habitat Restoration Evaluation and Improvement Study. Prepared by Baetis Environmental Services, Inc. for LimnoTech, Inc.

Miguntanna, Nadeeka S., Prasanna Egodawatta, Serge Koko, and Ashantha Goonetilleke. 2010. Determination of a Set of Surrogate Parameters to Assess Urban Stormwater Quality. *Sci. Tot. Environ*. Vol. 408, pp. 6251-6259.

MWRDGC 2011. A Study of the Benthic Macroinvertebrate Community in Selected Chicago Metropolitan Area Waterways During 2009. Prepared for the Metropolitan Water Reclamation District of Greater Chicago by EA Engineering, Science, and Technology, Inc.

MWRDGC 2010. A Study of the Benthic Macroinvertebrate Community in Selected Chicago Metropolitan Area Waterways 2006 – 2008. Prepared for the Metropolitan Water Reclamation District of Greater Chicago by EA Engineering, Science, and Technology, Inc.

MWRDGC. 2010. Metropolitan Water Reclamation District of Greater Chicago: Technical Data and Reports. http://www.mwrdgc.dst.il.us/.

MWRDGC 2009. A Study of the Benthic Macroinvertebrate Community in Selected Chicago Metropolitan Area Waterways 2005. Prepared for the Metropolitan Water Reclamation District of Greater Chicago by EA Engineering, Science, and Technology, Inc.

MWRDGC 2001-2005. Fish Data Chicago Area Waterways. Excel Workbook. Benthic Invertebrate Data Chicago and Calumet River Systems and Tributaries. http://www.mwrd.org/irj/portal/anonymous/WQM

MWRDGC 2001-2004. Benthic Invertebrate Data Chicago Area Waterways. Excel Workbook. http://www.mwrd.org/irj/portal/anonymous/WQM

MWRDGC. 2004. A Study of the Benthic Macroinvertebrate Community in Selected Chicago Metropolitan Area Waterways 2001-2002. Metropolitan Water Reclamation District of Greater Chicago. Prepared by: EA Engineering, Science, and Technology, Inc.

.NOAA. 2010. National Weather Service Weather Forecast Office, Chicago monthly snowfall amounts, http://www.crh.noaa.gov/lot/?n=chi Jan snow rankings.

Ozcalkap, Songul and Mustafa Temel. 2011. Seasonal changes in zooplankton community structure in Lake Kucukcekmece, Istanbul, Turkey. Turk J Zool. 2011; 35(5): 689-700

Sindt, Gregory L. 2008. Chloride and TDS Water Quality Standards Update. Technical Advisory Committee, Iowa Depart Natural Resources. January 15, 2008.

Soucek, D. J. and Kennedy, A. J. (2005), Effects of hardness, chloride, and acclimation on the acute toxicity of sulfate to freshwater invertebrates. *Environmental Toxicology and Chemistry*, 24: 1204–1210. DOI: 10.1897/04-142.1 Abstract and Power Point Presentation.

Smogor, R. 2000 (draft, annotated 2006). Draft manual for calculating Index of Biotic Integrity scores for streams in Illinois. Illinois Environmental Protection Agency, Bureau of Water, Division of Water Pollution Control. Springfield, Illinois.

Smogor, R. 2005 (draft). Interpreting Illinois fish-IBI scores. Illinois Environmental Protection Agency, Bureau of Water, Division of Water Pollution Control. Springfield, Illinois.

Stephan, C. E. 2009. (In Etheridge et al. 2010). Calculation of aquatic life criteria for chloride. 9FebChlorideCriteria.wpd, U.S. Environmental Protection Agency, Duluth, MN.

Stephen, Charles E., Donald I. Mount, David J. Hansen, John R. Gentile, Gary A. Chapman, and William A. Brungs. 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. PB85-227049. Washington, D.C.

Thorp, James H. and Alan P. Covich. 2001. Ecology and Classification of North American Invertebrates. Academic press. New York. pp vii-1056.

Twait, Scott. 2011. Illinois Environmental Protection Agency. Personal Communication. Critical Hardness and sulfate CSSC. 1-28-2011.

USACE. 2013. Permanent Barrier I, Lockport Pool, Chicago Ship and Sand Sanitary Canal, Will County, Illinois, Environmental Assessment. U.S. Army Corps of Engineers.

USACE, 2009. Chicago Sanitary and Ship Canal Fish List for 2009 Asian Carp rapid response. U.S. Army Corps of Engineers

USEPA 2010. Final Report on Acute and Chronic Toxicity of Nitrate, Nitrite, Boron, Manganese, Fluoride, Chloride and Sulfate to Several Aquatic Animal Species. Region 5 EPA 905-R-10-002. November 2010.

USEPA 2009. Approval letter for changes to water quality criteria for Illinois.

USEPA. September 26, 2008. Acute Toxicity of Chloride to Select Freshwater Invertebrates. EPA Contract Number: 68-C-04-006, Work Assignment 4-34 Sub-task. Data table in Sindt 2008.

USEPA. 2005. Standard Operating Procedure for Zooplankton Sample Collection and Preservation and Secchi Depth Measurement Field Procedures. 2005. U.S. Environmental protection Agency. LP402

USEPA. 2003. Standard Operating Procedure for Zooplankton Analysis. U.S. Environmental protection Agency. LP403.

Table 1.
CHLORIDE TAXA, TAXA RANKS, GENUS MEAN ACUTE VALUES(GMAV) And SPECIES MEAN ACUTE VALUES (SMAV)

Rank	**GMAV**	**Common Name Genus species**	**SMAV**
29	17,161	American eel *Anguilla rostrata*	17,161
28	16,203	Crayfish *Cambarus sp.*	16,203
27	14,897	Plains killifish *Fundulus kansae*	14,897
26	14,843	Dragonfly *Libellulidae (*family*)*	14,843
25	13,453	Threespine stickleback *Gasterosteus aculeatus*	13,453
24	>11,860	Guppy *Poecilia reticulata*	>11,860
23	9,933	Mosquitofish *Gambusia affinis*	9,933
22a	9,157	Green sunfish *Lepomis cyanellus*	9,975
22b	9,157	Bluegill *Lepomis macrochirus*	8,407
21	8,971	Red shiner *Notropis lutrensis*	8,971
20	8,043	Rainbow trout *Oncorhynchus mykiss*	8,043
19	7,442	Black bullhead *Ameiurus melas*	7,442
18	6,515	Fathead minnow *Pimephales promelas*	6,515
17	6,219	Tubificid worm *Tubifex tubifex*	6,219
16	6,111	Bannerfin shiner *Cyprinella leedsi*	6,111
15	6,072	Midge *Chironomus dilutus*	6,072
14	5,897	Bullfrog (tadpole) *Rana catesbeiana*	5,897
13	5,444	Aquatic worm *Lumbriculus variegatus*	5,444
12	5,078	Amphipod *Hyalella azteca*	5,078
11	4,686	Chorus frog *Pseudacris sp.*	4,686
10	4,369	Leech *Nephelopsis obscura*	4,369
9	3,946	Copepod *Diaptomus clavipes*	3,946
8	3,891	Isopod *Lirceus fontinalis*	3,891
7	3,728	Snail *Gyraulus parvus*	3,728
6	3,350	Snail *Physa gyrina*	3,350
5a	3,086	Mussel *Villosa delumbis*	3,821
5b	3,086	Mussel *Villosa iris*	2,492
4a	2,835	Mussel *Lampsilis fasciola*	2,907
4b	2,835	Mussel *Lampsilis siliquoidea*	2,764
3a	2,326	Cladoceran *Daphnia ambigua*	1,650
3b	2,326	Cladoceran *Daphnia magna*	3,773
3c	2,326	Cladoceran *Daphnia pulex*	2,020
2	1542	Cladoceran *Ceriodaphnia dubia*	1,542
1	1128	Fingernail clam *Sphaerium simile*	1,128

Source: Stephan 2009.

TABLE 2
CHICAGO SANITARY & SHIP CANAL FISH COMMUNITY
ROTENONE COLLECTION, DECEMBER 2009

		12/03/09		12/04/09				Percent
Species		Cargill	Lockport	Cargill	Lockport	Ruby St	TOTAL	of Catch
common carp	*Cyprinus carpio*	2288	3364	200	715	527	7094	39.9
emerald shiner	*Notropis atherinoides*	2622	103	50	60	65	2900	16.3
yellow bullhead	*Ameiurus natalis*	633	77	50	602	220	1582	11.2
bluntnose minnow	*Pimephales notatus*	1251	10	...	40	15	1316	7.4
goldfish	*Carassius auratus*	1091	15	30	22	107	1265	7.1
channel catfish	*Ictalurus punctatus*	629	178	30	107	131	1075	6.0
gizzard shad	*Dorosoma cepedianum*	652	263	50	11	44	1020	5.7
freshwater drum	*Aplodinotus grunniens*	361	31	...	16	97	505	2.8
bluegill sunfish	*Lepomis macrochirus*	235	90	20	5	2	352	2.0
pumpkinseed sunfish	*Lepomis gibbosus*	189	...	...	5	3	197	1.1
white perch	*Morone americana*	185	1	...	...	1	187	1.1
threadfin shad	*Dorosoma petenense*	57	1	...	...	3	61	0.3
round goby	*Neogobius melanostomus*	3	5	...	...	42	50	0.3
hybrid sunfish	*Lepomis sp.*	22	...	...	5	1	28	0.2
black crappie	*Pomoxis nigromaculatus*	22	1	...	...	4	27	0.2
white bass	*Morone chrysops*	11	...	...	...	3	14	<0.1
sauger	*Stizostedion canadense*	1	...	...	...	13	14	<0.1
largemouth bass	*Micropterus salmoides*	5	1	5	...	2	13	<0.1
flathead catfish	*Pylodictis olivaris*	2	3	...		6	11	<0.1
golden shiner	*Notemigonus crysoleucas*	3	...	...	...	7	10	<0.1
green sunfish	*Lepomis cyanellus*	6	1	...	1	2	10	<0.1
yellow bass	*Morone mississippiensis*	3	3	...	...	2	8	<0.1
white sucker	*Catostomus commersoni*	3	1	...	...	1	5	<0.1
longnose gar	*Lepisosteus osseus*	5	...	...	...	...	5	<0.1
northern pike	*Esox lucius*	...	...	...	...	4	4	<0.1
orange-spotted sunfish	*Lepomis humilis*	1	...	...	...	2	3	<0.1
tadpole madtom	*Noturus gyrinus*	2	1	...	...	...	3	<0.1
small mouth buffalo	*Ictiobus bubalus*	...	...	...	...	2	2	<0.1
redear sunfish	*Lepomis microlophus*	...	1	...	...	1	2	<0.1
white crappie	*Pomoxis annularis*	...	...	...	1	1	2	<0.1
walleye	*Stizostedion vitreum*	2	...	...	...	...	2	<0.1
grass carp	*Ctenopharyngodon idella*	1	...	...	...	...	1	<0.1
bighead carp	*Hypophthalmichthys nobilis*	...	...	...	1	...	1	<0.1
alewife	*Alosa pseudoharengus*	1	...	...	...	...	1	<0.1
yellow perch	*Perca flavescens*	...	...	...	...	1	1	<0.1
silver carp	*Hypophthalmichthys molitrix*	...	...	...	...	...	0	0.0
TOTAL (May not equal 100% due to rounding)							17,771	101.6

Source: IDNR, 2009

Conversion of Numbers to Metric Attributes for IBI Calculation

Species-richness	Number	Metric
# Native Species (NFSH)	27	5
# Sucker Species (NSUC)	1	1
# Sunfish Species (NSUN)	5	4
# Intolerant Species (INTOL)	0	0
# Minnow Species (NMIN)	3	2
# Benthic Invertivore Species (NBINV)	2	2
Trophic- or Reproductive-structure		
% Individuals Specialist Benthic Invertivores (SBI)	< 0.1	1
% Individuals Generalist Feeders (GEN)	77	3
% Individuals Mineral Substrate Spawners (LITOT)	< .1	1
Tolerance		
% Tolerant Species (PTOL)	63.5	3
Overall IBI Score		22
IBI Narrative Value		Limited Aquatic Resource

Source IBI: IEPA 2005

TABLE 3
CHICAGO SANITARY & SHIP CANAL FISH COMMUNITY
MRRWG 2012 COLLECTION, NEAR LOCKPORT, ILLINOIS

Common Name	Genus species	Number	Percent of Catch
gizzard shad	*Dorosoma cepedianum*	3,190	72.5
emerald shiner	*Notropis atherinoides*	382	8.7
green sunfish	*Lepomis cyanellus*	222	5.0
bluntnose minnow	*Pimephales notatus*	134	3.0
largemouth bass	*Micropterus salmoides*	88	2.0
oriental weatherfish	*Misgurnus anguillacaudatus*	75	1.7
bluegill sunfish	*Lepomis macrochirus*	70	1.6
common carp	*Cyprinus carpio*	67	1.5
pumpkinseed sunfish	*Lepomis gibbosus*	39	0.9
golden shiner	*Notemigonus crysoleucas*	32	0.7
mosquitofish	*Gambusia affinis*	28	0.6
yellow bullhead	*Ameiurus natalis*	21	0.5
threadfin shad	*Dorosoma petenense*	14	0.3
hybrid sunfish	*Lepomis sp.*	7	0.2
Spotfin shiner	*Cyprinella spiloptera*	7	0.2
channel catfish	*Ictalurus punctatus*	5	0.1
smallmouth bass	*Micropterus dolomieu*	3	0.1
banded killifish	*Fundulus diaphanus*	3	0.1
brown bullhead	*Ameiurus nebulosus*	2	0.1
freshwater drum	*Aplodinotus grunniens*	2	0.1
goldfish	*Carassius auratus*	2	0.1
longnose gar	*Lepisosteus osseus*	2	0.1
Spottail shiner	*Notropis hudsonius*	2	0.1
white sucker	*Catostomus commersoni*	2	0.1
black bullhead	*Ameiurus melas*	1	<0.1
northern pike	*Esox lucius*	1	<0.1
muskellunge	*Esox masquinogy*	1	<0.1
TOTAL (May not equal 100% due to rounding)		4,402	100.3

Source: USACE 2012

*MRRWG = Monitoring and Rapid Response Working Group, a multi-agency task force

Conversion of Numbers to Metric Attributes for IBI Calculation		
Species-richness	Number	Metric
# Native Species (NFSH)	21	4
# Sucker Species (NSUC)	1	1
# Sunfish Species (NSUN)	5	4
# Intolerant Species (INTOL)	1	1
# Minnow Species (NMIN)	5	4
# Benthic Invertivore Species (NBINV)	0	0
Trophic- or Reproductive-structure		
% Individuals Specialist Benthic Invertivores (SBI)	0	0
% Individuals Generalist Feeders (GEN)	13.2	6
% Individuals Mineral Substrate Spawners (LITOT)	2.1	2
Tolerance		
% Tolerant Species (PTOL)	10.2	6
Overall IBI Score		28
IBI Narrative Value		Limited Aquatic Resource

Source: IBI-IEPA 2005

TABLE 4
FISH OF THE CHICAGO SANITARY AND SHIP CANAL, 2001-2005
COLLECTED BY METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
AT SEVEN SITES FROM DAMEN AVENUE, CHICAGO TO LOCKPORT, ILLINOIS

Common name	**Genus species**	2001	2002	2003	2004	2005	Total	% of Total*
Gizzard shad	*Dorosoma cepedianum*	157	188	252	180	1048	1825	53.6
Carp	*Cyprinus carpio*	135	191	75	101	89	591	17.3
Bluntnose minnow	*Pimephales notatus*	14	40	114	68	33	269	7.9
Pumpkinseed	*Lepomis gibbosus*	23	46	48	48	51	216	6.3
Emerald shiner	*Notropis atherinoides*	3	15	5	8	161	192	5.6
Mosquitofish	*Gambusia affinis*	2	52	1	2	2	59	1.7
Golden shiner	*Notemigonus crysoleucas*	0	22	2	13	15	52	1.5
Green sunfish	*Lepomis cyanellus*	5	5	10	8	3	31	1.1
Largemouth bass	*Micropterus salmoides*	2	6	4	14	13	39	1.1
Spotfin shiner	*Cyprinella spiloptera*	1	6	5	7	5	24	0.7
Yellow bullhead	*Ameiurus natalis*	1	6	10	5	5	27	0.7
Channel catfish	*Ictalurus punctatus*	1	4	3	4	5	17	0.5
Goldfish	*Carassius auratus*	2	5	4	2	6	19	0.5
Bluegill	*Lepomis macrochirus*	4	7	1	5	1	18	0.5
Carp x Goldfish	*Cyprinus hybrid*	3	1	2	2	0	8	0.2
Freshwater drum	*Aplodinotus grunniens*	0	1	0	1	2	4	0.1
Round goby	*Neogobius melanostomus*	0	0	1	1	1	3	0.1
Skipjack herring	*Alosa chrysochloris*	0	0	0	0	3	3	0.1
Yellow bass	*Morone mississippiensis*	0	0	0	0	3	3	0.1
Chinook salmon	*Oncorhynchus tshawytscha*	0	0	0	0	1	1	>0.1
Fathead minnow	*Pimephales promelas*	0	0	0	1	1	2	>0.1
Pumpkinseed x bluegill	*Lepomis hybrid*	0	0	0	0	1	1	>0.1
White bass	*Morone chrysops*	0	0	0	1	0	1	>0.1
White perch	*Morone americana*	0	0	0	0	2	2	>0.1
Total		353	595	537	471	1451	3407	99.6

Source: *Fish Data Chicago Area Waterways 2001-2005.* MWRDGC Data Portal Online accessed 11-6-13

TABLE 5.
BENTHIC INVERTEBRATES OF THE CHICAGO SANITARY AND SHIP CANAL
AT LOCKPORT, ILLINOIS 2001-2009

	Station Number and Name:	92 - Lockport						
	Year(s) of Collection:	2001 - 2004 Mean Numbers		2005	2006	2007	2008	2009
	Sampling Device Used:	Petite-Ponar	Hester-Dendy					
Phylum and (Common Name)	***Taxa***	Mean N/m²	Mean N/m²	N/meter²				
Coelenterata (Hydroids)	*Hydra*		364	95.1	909.6	324.7	4,406.20	...
Platyhelminthes (Flat Worms)	*Turbellaria*	23	903	656.6	895.2	1,194.80	703.3	197.3
Nemertea (ribbon worms)	*Nemertea*				1.8			...
Entoprocta (colonial zooids)	*Urnatella gracilis*						1.8	...
Ectoprocta (Bryozoans)	*Plumatella*		1	1.8				...
Annelida-Oligochaeta (Aquatic Worms)	*Oligochaeta*	62,365	4,923	46.60	688.9	475.4	297.8	1,609.30
Annelida-Hirudinea (Leeches)	*Glossiphoniidae*	36	43					...
leech	*Helobdella stagnalis*				78.9	23.3	5.4	...
leech	*Helobdella triserialis*					7.2		...
leech	*Mooreobdella microstoma*				3.6			...
leech	*Placobdella papillifera*						14.4	...
Isopoda (Sow Bugs)	*Caecidotea sp.*		3			1.8		46.6
Amphipoda (Amphipods), scuds	*Gammarus fasciatus*	334	830					260.1
amphipod	*Gammarus sp.*			16.1	340.9	769.6	428.8	434.2
amphipod	*Hyalella azteca*			267.3	206.3	1,065.70	245.8	...
Ephemoptera (Mayflies Heptageniidae))	*Stenacron sp.*	0.0	3.6	21.5	0.0	0.0	1.8	0.0
clinging mayfly	*Stenonema integrum*	0.0	3.6	0.0	0.0	0.0	0.0	0.0
clinging mayfly	*Maccaffertium integrum*	0.0		0.0	0.0	0.0	1.8	0.0
Trichoptera (Caddisflies)	*Cyrnellus fraternus*		5	48.8	39.5	14.4	346.3	21.5
caddisfly	*Cheumatopsyche*	18	1		1.8			5.4
caddisfly	*Hydropsyche bidens*					3.6		...
caddisfly	*Hydropsyche sp.*		2					...
silk case caddisfly	*Hydroptila sp.*			1.8				...
Riffle beetle	*Stenelmis crenata*				1.8			...
Riffle beetle	*Stenelmis sp.*					1.8		...
water scavenger beetle	*Berosus sp.*		1					...
Diptera (two-winged flies)	*Pericoma sp. (diptera)*	4	....					5.4
Chironomidae (midges)	*Chironomus sp.*	18	2				9	...
midge	*Ablabesmyia sp.*		53					...
midge	*Ablabesmyia janta*			26.9	2.58	102.3	96.9	12.6
midge	*Ablabesmyia mallochi*				86.1			28.7
midge	*Procladius sp.*	700	....	1.8				...
midge	*Tanypus sp.*	18	....					...
midge	*Cricotopus sylvestris group*			3.6				23.3
midge	*Cricotopus bicinctus group*			5.4				...

(Continued On Next Page)

TABLE 5. **(Continued From Preceding Page)**
BENTHIC INVERTEBRATES OF THE CHICAGO SANITARY AND SHIP CANAL

midge	*Cricotopus sp.*		18					...
midge	*Chironomus sp.*							1.8
midge	*Cryptochironomus*	45	....					...
midge	*Dicrotendipes sp.*	99	854					...
midge	*Dicrotendipes modestus*							1.8
midge	*Dicrotendipes neomodestus.*			7.2	5.4	12.6		12.6
midge	*Dicrotendipes lucifer*				543.6	1,352.70	419.8	644.1
midge	*Dicrotendipes simpsoni*			242.2	296	342.7	120.2	366
midge	*Glyptotendipes sp.*		5	12.6	10.8	12.6	5.4	100.5
midge	*Nanocladius distinctus*			3.6	193.8	26.9	57.4	122
midge	*Nanocladius sp.*	117	224					...
midge	*Parachironomus*			3.6				...
midge	*Phaenopsectra flavipes*							12.6
midge	*Polypedilum spp.*		4					...
midge	*Polypedilum fallax grp.*							12.6
midge	*Polypedium flavum*			5.6			3.6	
midge	*Polypedilum illinoensis*							12.6
midge	*Polypedium scalaenum*			5.4		12.6		...
midge	*Rheotanytarsus sp.*							12.6
midge	*Stenochironomus sp.*		1	48.8				12.6
midge	*Thienemannimyia grp.*			1.8			17.9	37.7
midge	*Thienemannimyia similis*			5.4				...
midge	*Xenochironomus xenolabis*			44.9	5.4			...
midge	*Xenochironomus sp.*		16					...
Gastropoda (Snails)	*Ferrissia sp.*	54	246	1706.1	1.8	9	123.8	35.9
ramshorn snail	*Helisoma sp.*			14.4	1.8		215.3	...
ubiquitous pond snail	*Physa sp.*		2	25.1	5.4	5.4		...
sprite snail	*Menetus sp.*		1					...
Bivalvia (Mussels and Clams), Asiatic	*Corbicula fluminea*	65	78	53.8	61	10.8	53.8	...
zebra mussel	*Dreissena polymorpha*		17				3.6	...
mottled pea clam	*Eupera cubensis*					9	9	...
fingernail clam	*Musculium sp.*		1	39.5			43.1	...
	Total Number Per Square Meter:	63897	8608	3413	4382	5779	7632	4024
	Total Taxa:	14	28	29		23	25	25
	Total EPT Taxa:	1	5	3	2	2	3	2
	Total % EPT Taxa	0.03 %	0.20%	2.10%	0.90%	0.30%	4.60%	0.60%
	Total Ephemoptera (Mayfly) Taxa	zero	0.08%	0.60%	zero	zero	0.05%	zero

Source: MWRDGC 2001-2004, 2009

TABLE 6
MACROINVERTEBRATES FROM HESTER-DENDY MULTIPLATE SAMPLERS
CHICAGO SANITARY & SHIP CANAL, DOWNSTREAM OF 135 TH STREET
August 20, 2013

CLASS/ORDER Family Genus/sp	Common Name	Ti Value	Feeding Group	.... Numbers per Station Number .... Station 5 FEET	Ni * Ti	Station 11 FEET	Ni * Ti	Station 11 DUP	Ni * Ti
TURBELLARIA	Flatworms								
Dugesia/Planaria	flatworm	6	...	5	30	10	60	16	96
Oligochaeta	Aquatic Worms								
HIRUDINIA	Leeches	8	PR	33	264	1	8	0	0
AMPHIPODA	Scuds								
Gammarus sp.	amphipod	3	CG	6	18	7	21	6	18
Hyalella azteca	amphipod	5	CG	122	610	290	1,450	165	825
DIPTERA	Two Winged Flies								
Chironomidae	Midges	6	CG	47		28		48	
Chironomus sp.	red Midge	11	CG		517		308		528
ODONATA	Dragon/Damselflies								
Enallagma sp.	bluet damselfly	6	PR	1	6	0	0	0	0
PELECYPODA	Clams/Mussels								
Dreissena sp.	zebra/quagga mussel	99.9	CF	0	0	1	0	1	0
GASTROPODA	Snails/Limpets								
Bithynia sp.	mud bithynia	6	CF	1	6	0	0	0	0
Physella sp.	ubiquitous physa	9	SC	0	0	0	0	14	126
Number Individuals (N)				215		336		249	
Number per meter^2				21		33		24	
Number Taxa for MBI				6		4		5	
Number Ti x Ni				457		710		528	
Number EPT Taxa				0		0		0	
Number Intolerant Taxa				0		0		0	
MBI = Σ(ni*ti/N)				6.7		5.5		6.4	

TABLE 7
PLANKTON DATA LOCKPORT, ILLINOIS, 1978
ILLINOIS NATURAL HISTORY SURVEY

Water Flea Type	Numbers Per Cubic Meter	% of Catch*	Months Collected
Bosmina longirostris	31,083	52.5%	July, August September
Moina micura	27,743	47.0%	August, September
Daphnia retrocurva	186	0.3%	September
Chydoris sphaericus	100	0.2%	July
Ceriodaphnia quadrangula	100	0.2%	July

Source: INHS 1978 *May not equal 100% due to rounding

TABLE 8a.
PLANKTONIC CRUSTACEA COMPOSITION
CHICAGO SANITARY & SHIP CANAL NEAR LEMONT, ILLINOIS
JUNE 12, 2013

Common Name	Genus Species	Upstream # per m^3	Upstream %	Downstream # per m^3	Downstream %	Total # per m^3	Total %
Water flea, cladoceran	*Bosmina longirostris*	152.6	87%	172.6	87%	325.2	87%
Copepod	*Diacyclops thomasi*	17.5	10%	22.0	11%	39.5	11%
Water flea, cladoceran	*Diaphanosoma sp.*	5.1	3%	3.5	2%	8.6	2%
Total		175	100%	198	100%	373	100%*

* May not equal 100% due to rounding

TABLE 8b.
PLANKTONIC CRUSTACEA COMPOSITION
CHICAGO SANITARY & SHIP CANAL AT LOCKPORT, ILLINOIS
NOVEMBER 18, 2013

Common Name	Genus Species	*Numbers per m^3	Total # per m^3	Total %	Water Temperature °C	Dissolved Oxygen mg/L
Water flea, cladoceran	*Bosmina longirostris*	5	5	100	11.9	7.5
Copepod	*Diacyclops thomasi*	0	0	0	.....	.....
Water flea, cladoceran	*Diaphanosoma sp.*	0	0	0	.....	.....
Total						

*Based on 500 meter long tow

TABLE 9
CHLORIDE GENUS and SPECIES MEAN ACUTE VALUES (GMAV, SMAV) IN MG/L
FOR TAXA WITH PRESENCE IN CHICAGO SANITARY & SHIP CANAL
NEAR LOCKPORT, ILLINOIS

Rank, R	**Genus species**	SMAV	GMAV	Cumulative Probability, P
23	Crayfish, *Cambarus sp.*	16,203	16,203	0.9583
22	Plains killifish *Fundulus kansae*	14,897	14,897	0.9167
21	Dragonfly, *Libellulidae*	14,843	14,843	0.8750
20	Mosquitofish, *Gambusia affinis*	9,933	9,933	0.8333
19	Green sunfish, *Lepomis cyanellus*	9,975	9,157	0.7917
18	Red shiner, *Notropis lutrensis*	8,971	8,971	0.7500
17	Rainbow trout, *Oncorhynchus mykiss*	8,043	8,043	0.7083
16	Black bullhead, *Ameiurus melas*	7,442	7,442	0.6667
15	Fathead minnow, *Pimephales promelas*	6,515	6,515	0.6250
14	Tubificid worm, *Tubifex tubifex*	6,219	6,219	0.5833
13	Bannerfin shiner, *Cyprinella leedsi*	6,111	6,111	0.5417
12	Midge, *Chironomus dilutus*	6,072	6,072	0.5000
11	Bullfrog (tadpole), *Lithobates (Rana) catesbeiana*	5,897	5,897	0.4583
10	Aquatic worm, *Lumbriculus variegatus*	5,444	5,444	0.4167
9	Amphipod, *Hyalella azteca*	5,078	5,078	0.3750
8	Leech, *Nephelopsis obscura*	4,369	4,369	0.3333
7	Copepod, *Diaptomus clavipes*	3,946	3,946	0.2917
6	Isopod, *Lirceus fontinalis*	3,891	3,891	0.2500
5	Snail, *Gyraulus parvus*	3,728	3,728	0.2083
4	Snail, *Physa gyrina*	3,350	3,350	0.1667
3	Mussel, *Villosa delumbis*	3,821	3,086	0.1250
2	Cladoceran *Daphnia ambigua*	1,650	2,326	0.0833
1	Fingernail clam, *Musculium* sp.	1,930	1,930	0.0417

Source; Stephens, 2009

GMAV = Genus Mean Acute Value, SMAV = Species Mean Acute Value

Number of Data Points, N = 23

TABLE 10
RECALCULTION VALUES FOR
CHICAGO SANITARY AND SHIP CANAL

Rank	GMAV	Type, Genus species	Cumulative Probability, P	$Ln(GMAV)^2$	Ln(GMAV)	$P^{1/2}$
4	3,350	Snail, *Physa*	0.1739	65.881	8.117	0.417
3	3,086	Mussel, *Villosa spp.*	0.1304	64.555	8.035	0.361
2	2,326	Cladoceran *Daphnia spp.*	0.0870	60.092	7.752	0.295
1	1,930	Fingernail clam, *Musculium sp.*	0.0435	57.233	7.565	0.209

Σ P	**$\Sigma (\ln(GMAV)^2)$**	**Σ ln(GMAV)**	**$\Sigma P^{1/2}$**
0.435	**247.762**	**31.469**	**1.282**

$(\Sigma \ln(GMAV))^2/4$	**$(\Sigma P^{1/2})^2/4$**
247.567	**0.411**

$S^2 = [\Sigma (\ln(GMAV)^2) - (\Sigma \ln(GMAV))^2/4] / [\Sigma P - (\Sigma P^{1/2})^2/4]$

$S^2 = [S(\Sigma P^{1/2})]^2 = [247.762 - 247.567] / [0.435 - 0.411]$

$S^2 = [S(\Sigma P^{1/2})]^2 = 8.065$

$S = S(\Sigma P^{1/2}) = 2.840$

L = [Σ ln(GMAV) - S*(Σ P1/2)] / 4

L = [31.469 - 2.84*1.282] / 4

L = 6.957

$A = S*(0.05)^{1/2} + L$

A = 2.84*0.05^(1/2) + 6.957

A = 7.592

$FAV = e^A = \exp(A)$

FAV = exp(7.592)

FAV = 1,983

FCV = Chronic Toxicity =FAV / ACR

ACR for invertebrates is 3.178

FCV = 624

	Rounded Values
Criterion Max Concentration (CMC) = FAV/2= 991 mg/L	**990 mg/L**
Criterion Chronic Concentration (CCC) = FCV= 624 mg/L	**620 mg/L**

CERTIFICATE OF SERVICE

I, the undersigned, certify that on November 22, 2013, I served electronically the attached **Pre-Filed Testimony of: Larry Tyler, Bruce Nelson, Roger Klocek and James Huff**, upon the following:

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and by U.S. Mail, first class postage prepaid, to the following persons:

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