Summary of Lake Michigan Nearshore Water Quality

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This technical memorandum presents the response to the following Wisconsin Department of Natural Resources (WDNR) request for additional information in the Waukesha Water Supply Environmental Report:

> *"Provide information about nearshore water quality and environmental conditions in the areas south of Milwaukee, and near Oak Creek and Racine in addition to the information already provided about the Milwaukee Area of Concern. This should include the anticipated environmental effects of each water supply and return flow alternative."*

The proposed project and alternatives to the proposed project that have Lake Michigan water supply and return flow would have no significant adverse impact to Lake Michigan nearshore water quality as described below. The groundwater supply alternatives would not have any impact upon Lake Michigan nearshore water quality.

Lake Michigan

Water Quality—Existing Conditions

Southeastern Wisconsin's Lake Michigan shoreline water quality has been influenced by both indirect (non-point) and direct (point) sources as well as changes caused by invasive species (notably zebra and quagga dreissenid mussels). Non-point sources have included impervious and pervious surface runoff, boating wastes, bacteria contamination from community swimming, bacterial transport in shoreline algae accumulation, and direct input from animals, such as seagulls. Point sources generally result from combined sewer overflows (CSOs), sanitary sewer overflows (SSOs), or from stormwater outfalls (Kinzelman, 2007). In recent decades invasive dreissenid mussels which have covered the lake bottom have resulted in clearer water which in turn has led to algae growth, including the spread of *Cladophora* at deeper water levels than prior to mussel colonization. Research at the Great Lakes Water Institute and elsewhere continues on the interaction between invasive mussels, nutrient cycling in Lake Michigan, and the growth of *Cladophora* (Bootsma, 2009).

Water Quality Data—Milwaukee Metropolitan Sewerage District/University of Wisconsin-Milwaukee

Potential discharge locations for the City of Waukesha's return flow have been identified near the lakeshore cities of Oak Creek or Racine via the Menomonee River or the Root River, respectively. A summary of nearshore water quality data for samples collected from Lake Michigan near the cities of Oak Creek and Racine are provided in Tables 1 and 2. Table 1 provides average water quality data ranges collected from nearshore locations. Data collected closest to the Milwaukee Metropolitan Sewerage District (MMSD) South Shore (SS) Water Reclamation Facility measurements are closer to the submerged treatment plant outfall. Nearshore (NS) data are expected to be more characteristic of overall Lake Michigan water quality than SS data because they are further away from a discharge location.

TABLE 1
Lake Michigan Water Quality Data [a]
Collected 1979 to 2010 [b]

Parameter	South Shore (SS-01 through SS-12)	Nearshore (NS-01 through NS-03)	Nearshore (NS-10)
Total Phosphorus (mg/L as P)	0.015 – 0.111	0.011 – 0.013	0.014

TABLE 1
Lake Michigan Water Quality Data [a]
Collected 1979 to 2010 [b]

Parameter	South Shore (SS-01 through SS-12)	Nearshore (NS-01 through NS-03)	Nearshore (NS-10)
Total Suspended Solids (mg/L)	3.8 – 7.2	ND	ND
Chloride (mg/L	11.2 – 46.6	10.0 – 10.7	9.8
Fecal Coliform (MPN/100 mL)	4 – 561	0 – 1	1

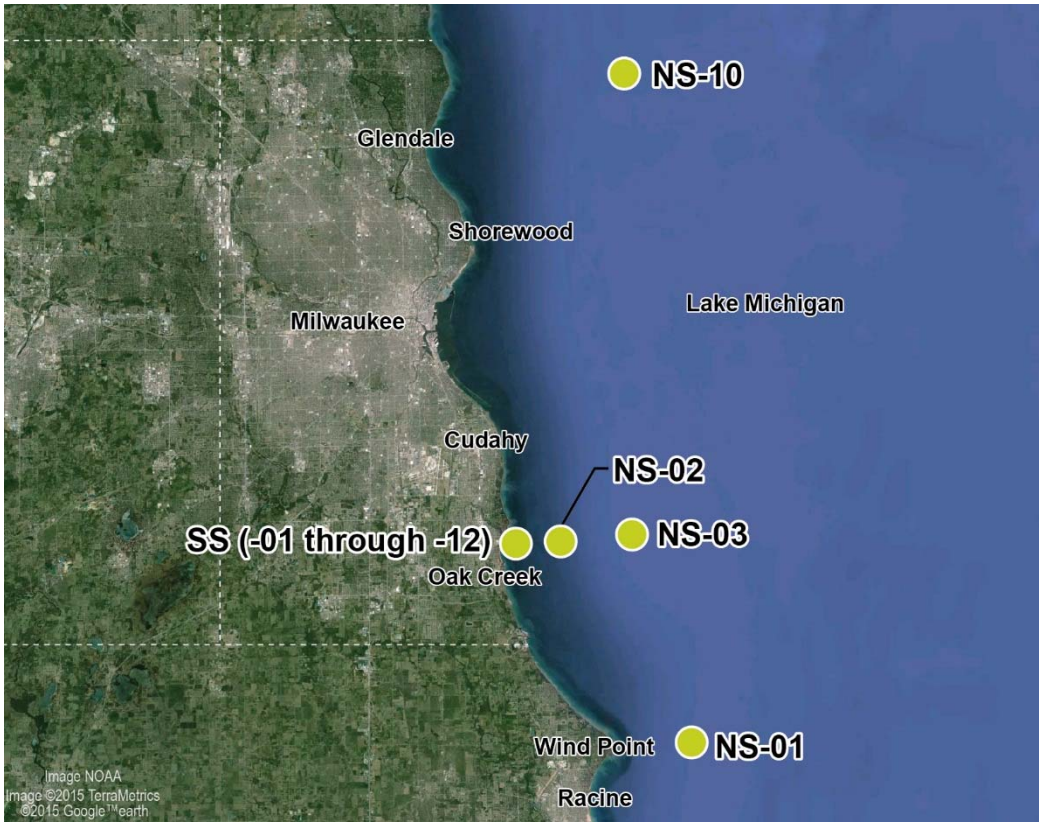
[a] Data collected from WATERBase database, maintained by the University of Wisconsin-Milwaukee, School of Freshwater Sciences. South Shore area and nearshore NS-01 through NS-03, and NS-10 reported data represent ranges in the averages.
[b] Sampling at some locations began in 1980.
ND = No data. Various data may have been excluded based on invalid inputs.

The WATERBase database contains information on additional water quality parameters. Those contained in Table 1 were selected because they are included in preliminary return flow effluent limits provided by the WDNR and consistent with other regional water quality analysis and provided for the project.

The NS-01 through NS-03 data collection points were selected because they are located between the City of Oak Creek and the City of Racine. The NS-10 data collection point was selected because it is further from the nearshore data points near the MMSD South Shore Water Reclamation Facility (SS data points) and the Milwaukee River. It is consequently less under the influence of these inflows to Lake Michigan. The SS data collection points were selected to see how mixing occurs within Lake Michigan from a treated effluent discharge compared to other nearshore data. Other data points in Lake Michigan were not summarized because they are outside the area where the WDNR requested information.

Figure 1 shows the locations of nearshore and South Shore area sampling sites near the cities of Oak Creek and Racine. Nearshore sampling point NS-10 is located north of the Menomonee River. Along the western shoreline of Lake Michigan, currents predominantly follow a north-to-south direction (or lake-wide, a counterclockwise rotation). Therefore, NS-10 is expected to represent water quality without the immediate effects of various discharges to the lake south of the City of Milwaukee. These discharges may include the Menomonee, Milwaukee, and Root Rivers, MMSD Jones Island and South Shore Water Reclamation Facilities, Oak Creek Power Plant, and various stormwater outfalls or direct runoff.

FIGURE 1
Water Quality Data Collection Locations [a]
Locations near Oak Creek, WI, and Racine, WI



[a] Screenshot of WATERBase interface. Nearshore sample locations are individually identified as NS-01, NS-02, NS-03 and NS-10. Clustered samples taken close to the South Shore (SS) Water Reclamation Facility are also indicated.

Water Quality Data—City of Racine

From 2000 to 2006, water and sediment quality measurements taken at North Beach and Zoo Beach, both located in the City of Racine, exceeded United States Environmental Protection Agency (US EPA) Standards for Recreational Water an average of 90 days per year. Research conducted at North Beach documented elevated concentrations of microbial indicators from numerous sources that contribute or harbor potentially pathogenic microorganisms. These included beach sands, algae (*Cladophora*), and the Root River. The foreshore is highly impacted by bacteria sources from swimming and animals, accumulated stranded algae, and runoff. It also sees much recreational activity, increasing health risk when high bacteria concentrations occur. From 172 North Beach foreshore samples collected in 2002, the average *E. coli* concentration was 33.3 colony forming units (CFU)/gram (dry weight) of sand. Data also suggest that *E. coli* concentrations were found to be twice as high at the berm crest after rainfall events as before. By comparison, concentrations were significantly less for submerged sediments (Kinzelman, 2005).

Algae can also harbor elevated concentration of bacterial indicators. Stranded mats have higher concentrations of bacterial indicators than submerged mats. Average concentrations of *E. coli* measured in June 2004 ranged from 333 to 25,000 CFU/gram for stranded mats versus 400 to 1,700 CFU/gram for submerged mats (Kinzelman, 2005). Stranded mats are typically found along the water's edge at Lake Michigan beaches, where foreshore recreational activities occur. The presence of *Cladophora* along the shoreline has been augmented from a variety of environmental factors, including nutrient loading and greater sunlight penetration due to the improved water clarity from the filter feeding by invasive zebra and quagga mussels (Bootsma, 2009).

The Root River itself is also a source of bacteria to City of Racine beaches and Lake Michigan. The City of Racine operates seven monitoring stations along the Root River. Average *E. coli* concentrations measured in 2004 ranged from about 1,000 to 39,000 most probably number (MPN)/100 milliliters (mL) as a result of non-point and point source contributions to the Root River (Kinzelman, 2005).

Impacts of Alternatives on Water Quality

The return flow will meet Wisconsin Pollution Discharge Elimination System (WPDES) discharge requirements protecting Lake Michigan water quality and City of Racine beach quality.

Lake Michigan

For all Lake Michigan water supply and return flow alternatives, the high quality water from Waukesha return flow would be expected to have no significant adverse impacts on nearshore Lake Michigan water quality. WPDES permitted effluent limits for the Waukesha Wastewater Treatment Plant will be met, resulting in very low concentrations to the receiving stream.

With return flow having a high quality, the concentration of bacteria will meet water quality standards with historical operations having less than 100 CFU/100 mL during the recreational season. (See Appendix M of the Return Flow Plan). As documented in the Environmental Report Section 6.4.1.2.2, return flow, even under the most conservative conditions, would contribute less than 0.2 percent of all fecal coliform loading, less than 0.2 percent of all total suspended solids loading, and less than 0.35 percent of total phosphorus loading from the greater Milwaukee area watersheds to Lake Michigan. Discharge of chlorides would meet WPDES permit requirements.

Comparison of South Shore area to nearshore data may also suggest a dispersion effect of the listed parameters at a greater distance from the lakeshore which shows quick mixing within the nearshore area. This will further lower return flow concentrations whether in the Root River or through a direct to Lake Michigan discharge. Based upon these small contributions, return flow would have no significant adverse impacts to Lake Michigan water quality.

With a Lake Michigan drinking water source, background concentrations of constituents in the lake will naturally be in Waukesha's water source. If not removed or altered during the treatment processes, natural background concentrations will remain in Waukesha's return flow, resulting in no net increase in loading to the lake and no change in the Great Lakes system. Changes in lake concentration will be managed to meet WPDES requirements, designed to be protective of the physical, chemical, and biological integrity of Lake Michigan and the Great Lakes system.

City of Racine

The Waukesha return flow would also be expected to have no significant adverse impacts on the City of Racine's shoreline water quality. The City of Racine has tested beach quality data for many years to understand the sources and control methods to maintain and improve beach quality. The City has Racine has determined that beach management practices, user behaviors, and monitoring of pathogen indicators can reduce shoreline pollution and the likelihood of public health concerns (Kinzelman, 2005). The City of Racine and others have undertaken numerous management initiatives that have improved the water quality at Racine beaches by targeting bacterial sources. These projects have included providing additional trash cans, preventing birds from congregating on public beaches, managing detached algae mats, and re-grading beaches (Kinzelman, 2007). The City of Racine has also implemented projects to further improve near-shore water quality by installing bioswales and bioretention basins to capture polluted stormwater at outfalls prior to discharge into Lake Michigan (US EPA, 2014). Return flow does not adversely affect any of the primary bacterial sources or the efforts undertaken to improve beach quality. With return flow having a high quality from disinfection, the concentration of bacteria in the Root River significantly improves at the return flow location and improves at all simulated locations documented in a Root River water quality model (see Appendix M of the Return Flow Plan).

As documented in the Environmental Report Section 6.4.1.2.2, return flow, even under the worst case conditions, would contribute less than 0.2 percent of all fecal coliform loading from the greater Milwaukee watersheds to Lake Michigan. The return flow pump station would be designed so that the return flow would not be subject to SSOs. Return flow does not contribute to stormwater runoff, separate sewer overflows, or other sources that are the primary bacteria sources on Racine beaches. As a result, return flow would have no significant adverse impact to Racine beach quality.

Lake Michigan Sediment

Sediment quality was reviewed in the vicinity of the Wisconsin Electric Power Company (WEPCO, or We Energies) Oak Creek, Wisconsin power plant. Two sediment quality studies were undertaken to investigate lakebed sediment on behalf of We Energies as a requirement for dredging operations. The first study, conducted in 1998, reported low to undetectable amounts of chlorinated organic compounds, such as polychlorinated biphenyls (PCBs) and pesticides (WDNR, 2003). Metals, which are naturally present at trace levels in Lake Michigan sediment, were also present at or below mean concentrations at other locations on Lake Michigan (WDNR, 2003). The second study, conducted in 2002, detected no PCBs at the selected sample sites, and metals were again detected at or below mean background concentrations. Polycyclic aromatic hydrocarbons (PAHs), which are compounds resulting primarily from industrial oil and coal activities, were detected at three of eleven sample locations at concentrations high enough to negatively affect benthic macroinvertebrates. However, elevated levels were expected based on close proximity to the power plant's coal dock.

Locations elsewhere in the lake would be expected to vary in sediment quality, however, return flow to Lake Michigan is not expected to have any significant adverse impacts to sediment quality. The return flow does not have a source of PCBs and only metal concentrations within allowable discharge limits. Consequently, return flow would have no significant adverse impact on Lake Michigan substrate quality.

References

Wisconsin Department of Natural Resources and Public Service Commission of Wisconsin. "Final Environmental Impact Statement: Elm Road Generating Station – Volume 1." *Docket 05-CE-130.* July, 2003, p. 210-211.

United States Environmental Protection Agency (US EPA). "Racine Receives EPA Great Lakes Shoreline Cities Green Infrastructure Grant." *EPA News Release*. March, 2014.

Kinzelman, Julie. "Beach Pollution Source Identification Field Cases: Racine, WI." *Beach Management Workshop*. Egg Harbor, WI. April, 2005.

Kinzelman, Julie. "Using spatial distribution studies & source tracking to target beach remediation – the Racine, WI approach (oral presentation)." *Presque Isle Beach Sanitary Workshop*. Erie, PA. 2007.