

ENVIRON

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STATE OF ILLINOIS
Pollution Control Board

September 23, 2009

Marie E. Tipsord
Hearing Officer
Illinois Pollution Control Board
100 West Randolph, Suite 11-500
Chicago, Illinois 60601

Pct# 247

ORIGINAL

Re: **R2008-009, In The Matter of: Water Quality Standards and Effluent Limitations for the Chicago Area Waterway System and the Lower Des Plaines River: Proposed Amendments to 35 Ill. Adm. Code 301, 302, 303 and 304**

Dear Madam Hearing Officer,

This letter serves as ENVIRON's response on behalf of Stepan Company to Board Member Dr. Shundar Lin's question at the August 13 hearing regarding the dosage of chlorine necessary to meet the proposed effluent bacteria standards at end of pipe. The dosage of chlorine determined by ENVIRON was 70 mg Cl₂/ L of wastewater. In addition to providing the exact chlorine dose, the following comments summarize ENVIRON's general approach to chlorine disinfection.

First, the concept of chlorine consumption must be considered. In typical wastewater, there are four sources of chlorine or hypochlorite consumption, three of which compete with chlorine availability for disinfection. Consequently, adequate chlorine must be added to satisfy these sources of chlorine consumption and provide sufficient residual chlorine to kill fecal coliform. These sources are:

1. Ammonia-N, which reacts with chlorine to form nitrogen gas;
2. Oxidizable organics, such as phenols, which are converted to simpler organic constituents and, hopefully, not converted into chlorinated-organics;
3. Oxidizable inorganics, such as cyanides, or sulfides, which are reduced to lower state compounds; and,
4. Biological organisms, including fecal coliforms, which are killed in the presence of sufficient residual chlorine.

Upon that foundation, the calculation of the chlorine dose was arrived in the following manner. Stepan's wastewater averages about 2.1 mg/L of ammonia-N, which is a chlorine consumer, and it can range as high as 3.0 mg/L of ammonia-N. This will result in "breakpoint chlorination" to convert the ammonia to harmless nitrogen gas, requiring about 15:1 Cl₂ to N (See *Design Manual Municipal Wastewater Disinfection*. Cincinnati: US EPA Office of Research and Development, 1986. Print). The theoretical dosage of chlorine to convert ammonia to nitrogen gas is 47.25 mg/L [2.1 x 15 x 1.5 (roughly ratio of maximum to average ammonia-N concentration)]. This leaves approximately 20 mg of Cl₂/L of wastewater for disinfection. From the *Design of Municipal Wastewater Treatment Plants, WEF Manual of Practice No. 8 / ASCE Manual and Report on Engineering Practice No. 76*. Alexandria, VA: Water Environment Federation, 1991. Print, Chapter 14, Table 14.1: Typical Chlorine Dosages, the required dosage of chlorine for disinfecting municipal activated sludge effluent can be up to 9 mg/L. Because of

the industrial nature of the Stepan wastewater, there will most likely be constituents that exert an additional chlorine demand (residual organics, surfactants, etc). Because this additional chlorine demand has not been quantified, a 100% safety factor was applied, rounding the required dosage of chlorine for disinfection to 20 mg/L. Adding that amount of chlorine to the amount necessary to address the presence of ammonia-N, which consumes chlorine, and rounding off the calculations, we arrived at 70 mg of Cl_2/L of wastewater to achieve disinfection.

This dosage of chlorine is also what was implicitly reflected in our cost calculations, as the following calculations demonstrate:

- Design Flow = 1,100,000 gal/day
- The gallons of bleach solution projected for disinfection = 235,883 gal/yr (see Table 8 of Exhibit 321), which is roughly 646 gallons/day [235,883/365].
- The bleach solution is 12.5% bleach (NaOCl), so the bleach/liter of wastewater is approximately 73 mg of NaOCl/L of wastewater [646 gals/day x 12.5% $\text{NaOCl}/1,100,646$ (gallons of wastewater plus bleach solution in a day)].
- Using the molecular weights of sodium (Na), oxygen (O) and chlorine (Cl), the 73 mg of NaOCl/L of wastewater is equivalent to 51 mg of OCl^-/L of wastewater and to 70 mg of Cl_2/L of wastewater.

Consequently, the dosage of approximately 70 mg of Cl_2/L of wastewater accounts for the presence of ammonia, susceptible organics/inorganics, and a safe residual for disinfection and served as the basis for our cost estimate.

Sincerely,

ENVIRON International Corporation



Carl E. Adams Jr., PhD, PE
Principal