TESTIMONY of

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BEFORE THE SUBCOMMITTEE ON
WATER RESOURCES AND ENVIRONMENT
COMMITTEE ON
TRANSPORTATION AND INFRASTRUCTURE
U.S. HOUSE OF REPRESNTATIVES

April 13, 2005

Mr. Chairman and members of the committee, thank you for inviting me here this morning. My name is Joan Rose, I am a professor at Michigan State University and hold the Nowlin Chair in Water Research. I am a public health water microbiologist and have studied bacteria, parasites and viruses that make people sick and are found in sewage and polluted waters, for over 20 years. I was involved in the investigation of the *Cryptosporidium* waterborne disease outbreak in Milwaukee in 1993 that sickened 400,000 and killed those with weakened immune systems. I am very familiar with that parasite. The genotyping (genetic evaluation) data now show that sewage was the likely source of the outbreak. I have studied the contamination of beaches and recreational waters where people have gotten sick. From the Florida Keys to the beaches of Lake Michigan I have been sampling for viruses and bacteria and we have found evidence of human viruses in these waters. We know that young children are particularly at risk as they play in the water, turning a day of fun at the beach into a day of illness.

I have been collecting and sampling wastewater, untreated, treated and highly treated wastewater since the 1980s. I recently finished a study of six wastewater reclamation facilities where we looked for the pathogens, *Cryptosporidium*, *Giardia* and enteric viruses (as well as bacteria) [Funded By WERF# 00-PUM-2T REDUCTION OF PATHOGENS, INDICATOR BACTERIA, AND ALTERNATIVE INDICATORS BY WASTEWATER TREATMENT AND RECLAMATION PROCESSES]. I developed with my colleagues a method and have detected "live" and infectious *Cryptosporidium* in sewage. The results of that study show that untreated sewage contains large concentrations of pathogens, secondary treatment reduced the bacteria, viruses and parasites from 89 to 99.9% and upstream treatment affected the disinfection step. Chlorination did not kill any of the *Cryptosporidium*.

The 1972 *Clean Water Act* is about health. The U.S. led the way for protection of waters by mandating secondary treatment long before Europe caught on, recognizing that "dilution" wasn't sufficient to protect waters and public health from waterborne pathogens. I learned a lot about how Congress took a leadership role as I listened to Honorable Paul G. Rogers at a National Academy, National Institute of Health meeting in 2003 talk about the development of that important legislation (Reiter, 2004). The goal: prevent the discharge of constituents to surface waters from sewage treatment plants that pose a threat to public and aquatic health. Even very large dilution, in marine waters with an outfall which blended the sewage with the marine waters, was not seen as acceptable as studies in Mamala Bay, Honolulu, Hawaii showed that primary treatment was not sufficient, with bacteria, viruses and parasites found on the beaches and evidence that the outfall was contributing to this.

Sewage contains pathogens that have come directly from the infected people in the community. Hundreds of pathogens (human viruses and parasites), that number in the millions in concentrations, are found in sewage and are "young," that is having been in water prior to discharge in the environment less than 24 hours. There is plenty of documentation that these pathogens make others sick when they get into waterways. These pathogens can impact both drinking water facilities and recreational waters. *Cryptosporidium* is completely resistant to chlorination, the most common disinfection used in wastewater and drinking water treatment. I have heard some in the water industry and engineering fields say that we can kill the oocysts with water chlorination, **but that is**

simply not true. Physical removal through primary and secondary treatment and filtration are the most common way that we reduce the parasite risk for both *Cryptosporidium* and *Giardia* parasites. As explained in more detail below, primary treatment removes approximately 50% of the parasites in sewage. That is not good enough to protect public health. It means that 1000 parasites in 100L are reduced to 500 parasites, and it takes only **one** to start an infection.

While other animals can excrete parasites and bacteria, sewage contains not only these organisms but also human viruses which are not found in animal waste. There are special genetic types of parasites that are found only in animals or humans and do not cross over (from animal to human) to cause infection. For example, the studies done on the Milwaukee outbreak of *Cryptosporidium* showed that it was due to the human type coming from human fecal material and human-associated wastewater (Rose et al., 2002).

We have learned a lot about pathogens in sewage in the last 30 years that we did not know before.

- We have identified new microbes/pathogens of concern. We have new methods which can detect these. (We did not know about *Cryptosporidium* when the CWA was first written.)

- We know that if we drink, ingest, contaminate our hands even with very small concentrations (numbers of pathogens) this can still cause an infection (Haas et. 1999).

- We know that our young children and elderly, the immunocompromised (those on cancer therapy, transplant patients, with AIDS, diabetes) are at the highest risk of ending up in the hospital or even dying when exposed to these pathogens (Gerba et al., 1996).

- We now are particularly aware that the bacterial indicator system we use to judge water quality, water and wastewater treatment in particular is not adequate to understand or protect against viruses and parasites (NRC, 2004).

We also know that we have a lot more people, a lot more sewage, aging infrastructure, and more infiltration and inflow. These are some of the many challenges facing the industry.

Primary treatment is not effective in the significant removal of microbial pollutants. It may settle out some protozoa and parasite ova and cysts. A few microorganisms may be reduced due to partial particulate removal. A Canadian study of a primary wastewater treatment plant (Payment, Plante, and Cejka, 2001) showed that fecal coliforms were the most numerous of the indicator bacteria and their removal averaged 25%. Fecal streptococci removal was 29%, while *Escherichia coli* removal was 12%. *Clostridium perfringens* removal averaged 51%. There was a 76% removal for *Giardia* cysts and *Cryptosporidium* oocysts removal averaged 27%. There was no removal of human enteric viruses (Payment, Plante, and Cejka, 2001). The Canadian study concluded that primary treatment alone is insufficient to allow recreational contact in the waters affected by the plant's outfall.

In secondary aerobic wastewater treatment, several specific studies including my own show that parasites *Cryptosporidium* and *Giardia* were reduced 92 to 99.9%. *Clostridium perfringens* spores, *Clostridium perfringens* total counts, somatic coliphages, and heterotrophic bacteria were reduced by approximately 85 - 99%. All of the other microorganisms were reduced by at least ~99.97%

Disinfection of wastewater with chlorine is critical to the control of viruses and bacteria and is influenced by many things. There are a number of important points to be made about disinfection.

- *Cryptosporidium* is completely resistant to chlorination, *Giardia* is the next most resistant, then viruses. Bacteria are the easiest to kill.
- Neither *E. coli* nor enterococci are sufficient indicators of virus reductions during primary or secondary sewage disinfection.
- Solids and the amount of ammonia in the water influence how well we can kill the viruses and bacteria with disinfection (and primary sewage has more solids and more ammonia than secondary sewage).
- When 10% of secondary sewage was added to tap water, chlorination was almost completely ineffective in killing Poliovirus. (24^{o}C, 0.5 mg/l, 15 minutes contact time.) (Sobsey, 1989.) Poliovirus is one of the most susceptible viruses to chlorination generally.
- Recent studies by scientists at Duke University and University of North Carolina (FATE AND PERSISTENCE OF PATHOGENS SUBJECTED TO ULTRAVIOLET LIGHT AND CHLORINE DISINFECTION, LINDEN ET AL., 98-HHE-02; WERF) have found that disinfection efficiency is reduced when particles are in wastewater. In fact, coliform bacteria and viruses were reduced by only about 90 to 99%, where >99.9% to 99.99% was achieved using chlorination and ultraviolet radiation with virtually no particles in the wastewater.

The blending or dilution of untreated or partially treated sewage with the treated flow has been an issue for many communities. I began looking for data on pathogens in blended effluents in an attempt to answer the question about how many pathogens would be found in the sewage effluent if one were to blend. In fact, there is very little information available. Initially, I undertook just a mathematical approach to examine the concentrations that might be in blended effluents as compared to fully treated effluents. Using real monitoring data on **average concentrations** of viruses and parasites that were found in untreated, primary treated and secondary treated wastewater, I took a look at one facility's design and flows and added up the numbers. Using human probability of infection models I calculated the risk if one were to swim near this discharge. Obviously there is a wide array of facility treatment designs and a wide array of practices in blending that would need to be examined and could be examined in a similar fashion.

I also looked at some data from Milwaukee which, to their credit, did some monitoring, and I must say I applaud their efforts to monitor the parasites in their wastewater.

I would like to summarize what I found.

- Greater than 99% of the loading of pathogenic viruses and protozoa resulted from the untreated/partially treated portion of the blended effluent. The risks associated with swimming in waters receiving the blended flows were found to be 100 times greater than if the wastewater were fully treated and were high for viruses and *Giardia* (1/100 risk).
- There were 13 times more viruses in the primary then the secondary, 4 times more *Cryptosporidium* oocysts in the primary then the secondary and 4.8 times more *Giardia* cysts in the primary then the secondary.
- The Milwaukee data was examined and showed that *Giardia* cysts were high in blended effluent (378/L compared to the average in untreated sewage 505/L). When the water was not blended the averages were 0.2/L. This represents a 1000 times increase in risk compared to the mathematical calculation given previously, and risks were 1/10 of contracting giardiasis from swimming near this outfall.

We should keep in mind that just meeting the NPDES discharge standards is not the only consideration.

- The bacteria standards were developed with the consideration that secondary treatment was going to be employed.
- The science tells us that these standards do not address all of the "constituents of concern" that can cause harm to humans.
- We are misleading the public if we say that blending protects public health, relative to treating our sewage flows, which is what most citizens believe the industry is doing. We are adding back a larger concentration of contaminants from the untreated or partially treated flow, and we are reducing the efficiency of the treatment.

Finally I would like to state that I believe:

- The wastewater industry is one of the unsung heroes of public health and with our new science knowledge we recognize that much more effort needs to be focused on wastewater treatment. We need to examine advances in treatment, better disinfection, and emerging contaminants.
- More monitoring data are needed. The diversity of treatment and blending scenarios under various types of rainfall events need to be examined carefully. Communities should be aware of public health benefits that wastewater treatment provides and decisions on investments in our wastewater infrastructure should be based on water quality and health protection.
- Federal and State Leadership will be necessary to address the future challenges.
- The use of science-based risk assessment methods for addressing contaminants in water by EPA is an appropriate approach for developing rules that will ultimately protect public health.
- EPA needs to develop treatment standards and ambient water quality criteria for the full range of pathogens that threaten public health.

References

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