

## Transmittal Letter For Board Meeting

April 7, 2006  
(For Board Meeting of April 20, 2006)  
(Revised April 25, 2006)  
COMMITTEE ON RESEARCH AND DEVELOPMENT

Mr. John C. Farnan  
General Superintendent  
O F F I C E

AGENDA SUMMARY: Endocrine Disrupting Compounds, Antibiotics, and Other  
Pharmaceuticals in the Water Environment

Dear Sir:

The purpose of this letter is to provide you with an update on Metropolitan Water Reclamation District of Greater Chicago (District) activities to evaluate the issue of endocrine disrupting compounds, antibiotics, and other pharmaceuticals in the water environment. This issue continues to receive increasing attention by the United States Environmental Protection Agency (USEPA), environmental groups, and the press, both nationally and internationally. The news media have reported on the environmental impacts of this problem in many states in our Nation and in many countries around the world. We last reported to you on this matter in our December 19, 2003 transmittal letter, submitted for the January 8, 2004 Board Meeting. This letter is posted on the District's web site.

### I. Endocrine Disrupting Compounds

#### A. The Issue

The USEPA has defined an endocrine disrupting compound as " an exogenous agent that interferes with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis, reproduction, development, and/or behavior."

Over 100 compounds are now considered to be endocrine disruptors. These can be divided into five categories.

- steroid compounds (estrogens)
- surfactants (which will be referred to herein as alkylphenol ethoxylates or APES)
- pesticides, herbicides, and fungicides (e.g., DDT, dieldrin, 2,4-D)
- polyaromatic compounds (e.g., PAHs, PCBs, brominated flame retardants)
- organic oxygen compounds (e.g., phthalates, dioxins, bisphenol A)

The scientific community is currently divided on the magnitude and importance of the endocrine disruptor problem because of a lack of scientific

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research and studies. However, some research indicates that these types of endocrine disrupting compounds can have adverse effects, especially on aquatic organisms, even at extremely low concentrations.

All five categories of endocrine disrupting compounds previously listed enter District water reclamation plants (WRPs) in the raw sewage. Detailed knowledge of which endocrine disrupting chemical compounds are entering District WRPs as well as their concentrations in WRP influent is currently lacking. Likewise, little is known as to which endocrine disrupting chemical compounds and their concentrations are present in District biosolids and final effluents.

These compounds are present at extremely low concentrations that are often in the parts per billion or parts per trillion range. At these low levels, the District laboratories do not have the sophisticated instrumentation required to detect and quantify many of the important endocrine disrupting compounds. For many of the compounds, analytical methodologies are still being developed to provide the necessary sensitivity for detection at the low levels, at which the compounds occur and to accurately quantify the compounds in complex matrices such as biosolids and soil. Thus, for a large number of these compounds, it is difficult to generate data and information quickly.

B. District Action to Evaluate the Endocrine Disrupting Compounds Issue

1. District staff continue to follow developments on this issue both through reviewing the scientific literature and through their participation at technical meetings and conferences. This is allowing us to learn more about the problem of endocrine disruptors in the water environment, about new analytical techniques for measuring endocrine disruptors, and about technologies for removing endocrine disruptors during the wastewater treatment process.
2. District laboratories are collaborating with USEPA laboratories to survey the raw sewage, final effluent, sludge, and biosolids samples from the District's seven WRPs for some of the APEs. Samples are being collected twice annually and are being split with District laboratories analyzing raw sewage, sludges, and biosolids; and USEPA laboratories analyzing final effluents using more sensitive analytical methods that these samples require. Results to date indicate that APEs are present in the effluents of the District's seven WRPs at very low levels that cannot be accurately quantified.
3. District laboratories are surveying raw sewage, final effluent, sludges, and biosolids for some of the pesticides, herbicides, and fungicides; polyaromatic compounds; and organic oxygen compounds twice annually. The concentrations of nearly every compound being analyzed are below District laboratory detection limits.
4. The District is collaborating with USEPA to evaluate industrial sources of APEs in the North Side WRP service area. Manufacturing facilities that were sampled included manufacturers of paint, pesticides, detergents, emulsifiers, and emulsifiers for food products. The APEs that were analyzed were almost universally not detected in

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the manufacturing facility effluents, but were detected in various combinations in the interceptors at parts per billion levels. More work is needed to provide a clearer picture of the magnitude of commercial, industrial, and residential sources of APEs and of compound occurrence and concentrations in WRP influents.

5. We are conducting studies to evaluate the occurrence of some APEs in biosolids that are being applied to farmland, including their fate in sludge processing trains and environmental fate following land application including the following.
  - a. Plans have been completed with USEPA personnel from the National Risk Management Research Laboratory in Cincinnati to begin a study of the fate of APEs in anaerobic digesters at the Calumet WRP. The study will begin in December 2005, and will be conducted at no cost to the District.
  - b. We have worked with researchers at the University of Georgia, at no cost to the District, to analyze a limited number of centrifuge cake biosolids samples from the Calumet and Stickney WRPs for one APE, which was detected in parts per million concentrations. The environmental significance of these results has not yet been determined (see Item 5c).
  - c. We are also following the fate of APEs in land-applied biosolids at the research sites that were established on farms in Kankakee and Will Counties in 2005. This work is in progress.
6. We are working with researchers in the School of Public Health at the University of Illinois at Chicago to characterize levels of polybrominated diphenyl ethers (PBDEs) in biosolids. While these fire-retardant compounds are being detected in our biosolids, little is yet known about their environmental fate following land application. More data and information are required to accurately assess the environmental significance of PBDEs in biosolids.
7. We are participating in the USEPA's Regional Applied Research Effort study, which includes collaboration of the United States Geological Survey (USGS). This project was initiated in November of 2004 to learn more about potential sources of endocrine disrupting compounds in the District's Calumet WRP service area, to determine their fate throughout the solids and liquid process trains at the Calumet WRP and also to learn more about the effects that endocrine disrupting compounds are having on the Calumet WRP's receiving waters. Following is a brief summary of what has been accomplished to date.
  - a. Comprehensive samplings of the Calumet WRP solids and liquid process trains were conducted in March and August 2005. These samples are being analyzed for various classes of endocrine disrupting compounds by USEPA and USGS laboratories. Results are not yet available.

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- b. The Calumet River system will also be sampled and the samples will be analyzed for endocrine disrupting compounds. This is anticipated to occur in 2006.
  - c. Sewers in the Calumet WRP service area, serving commercial, industrial, and residential areas were sampled in May and August and were analyzed by USEPA for some APEs. Many APEs were found to be present in parts per billion concentrations from all three sources. More data and information are needed to better understand the significance of these sources of APEs in the Calumet WRP service area.
8. We are investigating impacts of endocrine disrupting chemicals in the District waterways. District activities include the following:
- a. Collecting and analyzing samples from the ambient water quality monitoring network twice annually and analyzing them for various classes of endocrine disrupting compounds. Nearly all compounds being analyzed are not detected.
  - b. Preparing to survey aquatic organisms from District waterways on a limited basis for biochemical markers of endocrine disruption. We are also preparing to test a limited number of samples for hormonal activity. This is done using bioassays that detect estrogenic and androgenic activity in water samples. Estrogenic activity is produced by natural or synthetic compounds that function as female sex hormones promoting the development of female sexual characteristics, while androgenic activity is produced by natural or synthetic compounds, including steroid hormones, that stimulate or control the development or maintenance of masculine characteristics in vertebrate animals. This work is anticipated to begin in 2006. These tests, in addition to regular chemical testing that is being conducted by the District and collaborative agencies, will begin to give us an indication of whether there is a detectable presence of endocrine disrupting compounds in District waterways.
9. We are supporting Water Environment Research Foundation (WERF) projects on this subject through our annual membership subscription.

## II. Antibiotics, Antibacterial Agents, and Pharmaceuticals

### A. The Issue

Antibiotics are chemical or biological compounds given to humans and animals to treat or prevent bacterial infections. Antibacterial agents are chemicals with disinfecting properties that are constituents of soaps and other cleaning products. Pharmaceuticals encompass drugs and medications that are taken to treat a wide array of diseases and symptoms of illness.

Research has indicated that bacteria have the ability to gain resistance to certain antibiotics and that this resistance is then passed along to succeeding generations of these same bacteria. This leads to the creation of

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so-called "antibiotic resistant strains" of bacteria, which are considered very dangerous as people infected with them do not respond to conventional medical treatment.

At present, it is unknown the degree to which these antibiotic resistant bacteria are entering wastewater treatment plants or the degree to which they are being generated or proliferated in these treatment plants. Antibiotic resistant bacteria have also been commonly detected in the water and soil environment but it is unclear the extent to which they occur naturally, as opposed to resulting from adaptation due to continuous low level exposure to antibiotics introduced into the environment from wastewater treatment plant effluents and biosolids.

Pharmaceuticals and antimicrobial agents are introduced into the sewer systems of District WRPs and enter the treatment plants. The effect that antimicrobial agents have on the District WRP liquid and solids process trains is not known, nor is it known whether these compounds survive the treatment process to be introduced into the environment in the WRP effluents or biosolids. Regarding pharmaceuticals, little is known concerning the fate of these compounds that enter the sewer system of District WRPs. These compounds may be capable of effecting animal health and behavior and microbial ecology if they are introduced into the environment via WRP effluent or biosolids.

B. District Action to Evaluate the Antibiotic Resistant Bacteria, Pharmaceutical Compounds, and Antimicrobial Agent Issue

1. District staff is following this issue in the scientific literature and through participation at scientific conferences. This will allow us to understand the extent of the problem relative to the wastewater treatment industry.
2. We have entered into a cooperative agreement with researchers at Purdue University in 2003 to analyze District biosolids for antibiotics, and also to track the fate of these antibiotics, if found, at land-application sites receiving biosolids. Purdue University has obtained a research grant to do this work, and it is being done at no cost to the District. Unfortunately, Purdue University has not yet developed acceptable analytical methods for biosolids and soils. We are continuing to work with Purdue University and are also surveying other potential collaborators.
3. We have initiated a program of research to understand the fate of antibiotic resistant bacteria in the wastewater treatment process and receiving streams. Bacteria resistance is being investigated for three antibiotics: ampicillin, tetracycline, and gentamycin. Following is a summary of the progress that has been made on this project.
  - a. We have completed a round of testing of WRP influent and effluent samples for presence of antibiotic resistant fecal coliform at all seven WRPs in both winter and summer months, including the three plants that disinfect their effluent in the summer. Preliminary results indicate that antibiotic resistant bacteria are not proliferated in our WRPs.

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- b. We have completed a work plan for the next phase of the study, which will include characterization of antibiotic resistant bacteria in final effluents and receiving waterways. This work will begin in 2006.
4. We participated at the invitation of the USEPA in their "Meeting on Pharmaceuticals in the Environment" in August 2005 to present a summary of our initiatives to limit introduction of pharmaceuticals into the environment in the District's service area.
5. We are collaborating with researchers in the Department of Environmental Health Sciences Laboratory at Johns Hopkins University to analyze the occurrence of two common antimicrobial agents (triclosan and triclocarban) in District WRP influent, effluent, and sludge/biosolids. Preliminary results indicate that these compounds are present at parts per billion levels in influents and are reduced to parts per trillion levels in effluents. The compounds were found to be present at parts per million concentrations in sludge and biosolids suggesting that they accumulate in the solid phase of the treatment process. More data and information are necessary to understand the fate of these compounds in the treatment process more clearly and to determine their environmental significance. This class of compounds is of concern because of the effects that they can potentially have on the balance of microbial ecology in the wastewater treatment process, anaerobic sludge digesters, soils receiving biosolids applications, and waters receiving WRP final effluents.
6. The District participated in the Cook County Sheriff's Office, Unwanted Medication Disposal Day on May 11, 2005, for the safe disposal of unused medications by the public. This program was executed at 22 locations across the county and collected 3,400 pounds of unused medications. The medications turned in were properly destroyed.
7. We invited Dr. Marsha Black, University of Georgia, Department of Environmental Health Sciences, to meet with District staff and present a seminar summarizing the findings of her research on endocrine disruption in aquatic organisms exposed to fluoxetine (Prozac). This research examined the effects of acute and chronic exposure of two frog species and one fish species to Prozac. Prozac was found to be acutely toxic to western mosquito fish at concentrations that are two to three orders of magnitude above the concentration at which Prozac is currently detected in water bodies across the United States.

Chronic exposure to Prozac resulted in delayed development of adult sexual morphology in the fish and one of the frog species, however, these effects were also induced at Prozac concentrations significantly greater than those currently detected in waters of the United States.

We will continue to pursue these investigations through 2006 and beyond in order to generate the data and information necessary to make informed decisions concerning the level of control and treatment of these chemical compounds that is necessary to provide adequate protection of human health and the water and soil environments that may be impacted by discharge of District WRP final effluents or land application of District biosolids.

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The District's own monitoring and participation in the cooperative studies with the USEPA, WERF and other academic institutions, demonstrates the District's leadership in the wastewater treatment industry in investigation of these emerging issues that impact water and biosolids quality throughout the world and is an indication of the depth of the District's commitment in protecting our water environment.

Respectfully submitted,

Richard Lanyon  
Director of Research and Development

RL:TG:dm/dl