Clean Water
State Revolving Fund

METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI, OHIO
REDUCING ANTIMICROBIAL RESISTANCE FROM HOSPITAL WASTEWATER

Emerging Contaminants:
Antibiotic resistant bacteria (ARB), antibiotic resistance genes (ARGs)

Project Type:
Technology pilot

Antimicrobial resistance (AMR) continues to be a growing public health concern worldwide. AMR is considered an emerging contaminant (EC) because resistant microorganisms are increasingly found in the environment and may pose emerging ecological and human health risks. AMR occurs when microorganisms such as bacteria, viruses, fungi, or parasites change and adapt over time to withstand drugs that once destroyed them. The resulting drug-resistant microorganisms, or superbugs, lead to infections that are harder to treat. These superbugs cause 2.8 million infections and 35,000 deaths annually in the United States and make many routine procedures that rely on antibiotics to control infections (e.g., knee or hip replacement) riskier.[1] While AMR is natural, using antibiotics, antifungals, and other antimicrobial drugs in humans, animals, and plants speeds up the process. Once superbugs develop, they can spread between communities through the food supply and the environment. Drug-resistant infections can affect anyone, anywhere, and are occurring more frequently.

Wastewater treatment facilities (WWTFs) could play an important role in managing ECs, such as AMR, because they collect wastewater from many sources, including homes, businesses, and hospitals. Hospitals are considered a hotspot for antibiotic use, and many studies have shown relatively higher concentrations of antibiotic-resistant bacteria (ARB) and antibiotic resistance genes (ARGs) in hospital wastewater compared to typical domestic wastewater.[2,3] Many hospitals currently send their raw wastewater to municipal WWTFs without pretreatment. Pretreating hospital wastewater before it enters the sewer system could help reduce the spread of AMR by reducing the load of ARB and ARGs that WWTFs receive. Additionally, pretreatment has the potential to more effectively destroy these ECs and improve overall removal of ECs through wastewater treatment.

To explore this opportunity, in 2024, EPA approached the Metropolitan Sewer District of Greater Cincinnati (MSDGC) in Ohio to collaborate on a project to evaluate whether treating hospital wastewater at its source can reduce AMR in the broader collection system and sewershed. The EPA facility located near MSDGC provides expertise and laboratory capabilities, including culture-based methods to grow and count ARB and molecular techniques (such as high-throughput polymerase chain reaction) to detect and measure ARGs in wastewater. These analyses are complex and resource intensive, requiring advanced instrumentation and specialized expertise to interpret complicated biological data. This collaboration with EPA provides MSDGC access to deeper, more comprehensive analysis of AMR than previously available to them.

Mercy Health – West Hospital (Mercy West) was selected for this project because it is the only hospital in MSDGC's Taylor Creek WWTF sewershed, making it an ideal setting to investigate and measure the direct impact of pretreating hospital wastewater on AMR in the sewershed. The Taylor Creek WWTF is a conventional activated sludge system with seasonal ultraviolet (UV) disinfection, but these technologies are not specifically designed to remove ARB and ARGs. To address this gap, MSDGC will design, construct, and operate the Mercy West Advanced Treatment System (MWATS) at the hospital to pretreat the concentrated waste stream before it enters the sewer system. The treatment process will include a membrane bioreactor to separate and reduce ARB and ARGs, followed by UV/advanced oxidation process (AOP) to destroy any remaining AMR contaminants. MSDGC selected

[1] https://www.cdc.gov/antimicrobial-resistance/about/
[2] https://pmc.ncbi.nlm.nih.gov/articles/PMC12031161/
[3] https://www.sciencedirect.com/science/article/abs/pii/S004896972307081X

these technologies because they have proven effective in removing contaminants from wastewater in water reuse applications.

The MWATS will be built as modular system using skid-mounted units. This approach allows flexibility for future opportunities by implementing the same membrane bioreactor and UV/AOP treatment at other high-strength wastewater sources, such as industrial facilities and landfills. This project may also expand to study additional analytes, such as metals (which can contribute to AMR), per- and polyfluoroalkyl substances (PFAS), and microplastics (which are possible substrates for AMR).

To evaluate the effectiveness of the MWATS, MSDGC and EPA will collect wastewater samples from multiple points throughout the sewershed, including before and after treatment through the MWATS and at the influent and effluent of the Taylor Creek WWTF. This method will allow MSDGC and EPA to assess both the performance of the MWATS and its broader impact on the wastewater system and surrounding environment.

This project is a collaborative effort among MSDGC, EPA, the U.S. Geological Survey (USGS), Mercy West, and Ohio Environmental Protection Agency (Ohio EPA). MSDGC will lead overall project management, facilities coordination, and support sampling and analysis efforts. EPA will collect wastewater samples, conduct detailed AMR testing for ARB and ARGs, and coordinate additional testing. Through an interagency agreement, EPA will ship wastewater samples to the USGS lab in Lawrence, Kansas, for analysis of various classes of antibiotics and pharmaceutical compounds. Mercy West will serve as a community partner and stakeholder and participate in discussions regarding study design, implementation, and interpretation. The Ohio EPA will provide Clean Water State Revolving Fund (CWSRF) EC funds to support the planning and the installation of the pilot treatment system of this project. By combining advanced science, targeted treatment technologies, and strong collaboration, this effort presents a remarkable opportunity to better understand and reduce AMR in wastewater systems.

The project is expected to span two to three years, with initial sampling in the first year while the MWATS is designed, constructed, and installed, as well as follow-up sampling after the MWATS becomes operational. The partnership between EPA and MSDGC provides a unique opportunity to study ECs with specialized analysis requirements in a full-scale municipal sewershed and is the first direct assessment of the impacts of hospital wastewater pretreatment on AMR anywhere in the world.

Eligibilities:

Per Section 603(c)(1) of the Clean Water Act (CWA), the construction of a capital project at a publicly owned treatment works is eligible for CWSRF funding. The proposed project includes pilot testing activities and analysis that are working toward the construction of a new WWTF treatment process.

To be eligible for the CWSRF emerging contaminants funds:

1. *The presence of an EC(s) needs to be confirmed.* MSDGC and EPA have conducted previous monitoring of Mercy West effluent and have identified ARB and ARGs.

2. *A capital project needs to be identified.* The proposed pilot project will inform the potential development and implementation of a capital project at Mercy West as part of the Taylor Creek WWTF's pretreatment process.

Based on the points outlined above, the proposed project is eligible for CWSRF EC funds.