Winnipeg's low-cost solution to improving water quality

City of Winnipeg, Manitoba

water

Green Municipal Fund Case Study

UV reactors disinfect water in the City of Winnipeg UV pilot testing facility (Photo: City of Winnipeg/Duane Griffin).

Water Treatment Ultra-Violet Disinfection and Disinfection By-product Study (GMEF 0796)

Date project completed: January 2004
Total project value: $780,000
GMF grant: $90,000

- **Ultra-violet (UV) disinfection of unfiltered water tested**
- **UV disinfection identified as a cost-effective barrier for pathogen control**
- **Facility constructed in 2004; UV disinfection now in operation**
- **Future water filtration plant to incorporate UV disinfection technology**

OVERVIEW The City of Winnipeg partnered with CH2M HILL to test how effectively new ultra-violet (UV) disinfection technology eliminates pathogens from unfiltered water. Although UV disinfection had shown promise in recent studies as a cost-effective way to inactivate bacteria such as *Giardia* and *Cryptosporidium*, these studies had concentrated only on filtered water. Winnipeg's goal was to incorporate UV disinfection into its existing water treatment system, which did not include filtration. The 14-month study assessed UV disinfection of unfiltered water and anticipated changes in disinfection by-products that might be produced. As a result of the study, the city was able to include UV disinfection in its water treatment plans. Winnipeg built a UV disinfection facility in 2004 as a result of the study. The facility now provides the city with an added barrier against pathogens and significantly improves public health protection.

PROJECT TEAM
Awwa Research Foundation (AwwaRF)
University of Massachusetts
University of New Hampshire
CH2M HILL

CONTEXT The water supply for the City of Winnipeg (population 650,000) originates in Shoal Lake, located on the border between Manitoba, Ontario and Minnesota. At the time of the study, water treatment before distribution consisted of chlorination, fluoridation and corrosion control. However, chlorine disinfection may not have protected sufficiently against all potentially dangerous pathogens. This study provided an opportunity to test a relatively simple technology that could guard against pathogens resistant to chlorine disinfection. The combination of water cloudiness, total organic carbon (TOC) and algae in Winnipeg's water supply was ideal for the study because it allowed researchers to study their effects on the UV disinfection process.

APPROACH The team pilot-tested UV disinfection technology and studied disinfection by-products over a one-year period. The City of Winnipeg constructed the UV pilot plant inside a construction trailer. Both low-pressure and medium-pressure UV pilot units were included in the pilot facility.

One key area of the study involved assessing the effectiveness of UV disinfection in unfiltered water of variable quality. Specifically, the team looked at the impact of water cloudiness (turbidity), TOC and algae on the effectiveness of UV disinfection. In addition to the disinfection process, researchers studied the by-products resulting from it. One of the goals was to determine whether UV disinfection would reduce the levels of by-products normally associated with the use of chlorine for water disinfection. Researchers tested for a number of disinfection by-products, including trihalomethane (THM), haloacetic acid (HAA), aldehydes, ketoacids, biodegradable organic matter, nitrosodimethylamine (NDMA) and total organic halides (TOX). Small-scale tests were conducted in the city's laboratory, as well as at the University of Massachusetts and the University of New Hampshire. The team also identified the operation and maintenance requirements of UV disinfection technologies when they are used for unfiltered waters.

RESULTS The study proved that UV disinfection is a practical and affordable way to inactivate pathogens in drinking water. In particular, it demonstrated that UV disinfection can be used to meet *Cryptosporidium* and *Giardia* disinfection requirements for unfiltered drinking water systems.

The study showed that the technology can work effectively in unfiltered, relatively clear water supplies. UV disinfection can also work in waters with heavy plankton, although UV reactors will likely need more energy and more frequent cleaning in these cases. Testing confirmed that UV disinfection should take place after filtration, if there is a water filtration system, and prior to chlorination, to maximize effectiveness and minimize chlorine decay and other impacts of the UV treatment process. While UV intensity sensors can be a valuable tool in monitoring system performance, the study showed that they can fail to describe fully what is happening in the system. Sensors should be tested periodically.

Analysis of the disinfection by-products suggested that by converting to UV disinfection and using chlorine in the water distribution system, the city could meet its water quality goals and regulatory requirements.

As a result of the study, the City of Winnipeg implemented UV disinfection to supplement its chlorination process, years in advance of completing construction of its water treatment facility. The city was able to better protect public health by implementing a simple, cost-effective barrier for pathogen control.

The study also resulted in a number of recommendations to utilities in general on the technical requirements for UV disinfection processes.

LESSONS LEARNED Pilot testing the technology with Winnipeg's source water proved to be a valuable process. "I'd recommend that utilities validate the results on their own source of water," said Duane Griffin, head of the water planning branch. Water from different sources can have different features, such as varying levels of cloudiness, iron and algae, which may call for changes in technical and operating requirements.

Through its pilot testing, the city also learned that UV disinfection can be built into existing water treatment facilities: the technology is relatively compact and does not require a new building.

NEXT STEPS The city built a UV disinfection facility in 2004. Adding UV treatment to the existing chlorination system has provided the city with a simple, cost-effective way to protect public health while its water treatment plant is still in development. Detailed design of a new water treatment plant began in 2005. The plant will be completed in 2008. UV disinfection will be fully integrated into the water treatment system as an added protection against pathogens.

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