Onsite treatment offers solutions for global wastewater pollution

Water reuse, soil-based treatment, and other decentralized wastewater treatment methods offer low-cost, sustainable solutions for communities faced with water scarcity challenges. Jessica Barringer of Infiltrator Water Technologies explains how onsite systems can reduce local pollution and improve local water supply.

The upcoming Olympic Games in Rio de Janeiro, Brazil, have drawn the world's attention to Brazil and raised awareness of the impaired waters in which competitors will compete. The country's lack of wastewater treatment and its resulting contaminated surface and coastal waters are sources of concern, but the truth remains that much of the world still uses dilution as its primary form of wastewater treatment, including some of the most developed nations. Countless sewer systems have no treatment at their outfall or combined sewer overflow (CSO) locations; many more provide only primary treatment (solids separation).

The first sewers, built between 2000 and 1500 BC, were designed to carry wastewater away from the cities and protect public health by preventing disease outbreaks. These early systems collected raw wastewater and discharged it directly, and without treatment, into surface waters such as lakes, harbors, and oceans across the world. At the time, this practice was considered protective of human health. Now simply sewering, without providing wastewater treatment, is recognized as dangerous to human and environmental health.

Wastewater pollution is toxic to humans, aquatic life, other organisms, and the environment. Exposure to untreated and impaired wastewaters leads to a rise in disease. Sewage contains bacteria, viruses, and other pathogens that can lead to sickness and death when introduced to the human body. More than an estimated 250 million people contract water-borne diseases every year.

In addition to public health concerns, discharging untreated wastewater into surface waters damages the environment. Nutrient overload (eutrophication) causes water bodies to become anaerobic, killing aquatic life and other organisms dependent on that source of fresh water. Discharging untreated wastewater into surface waters can also change the thermal properties of the water source, as wastewater effluent is often warmer than the natural surface waters, which can in turn harm natural eco-systems and aquatic populations.

Together, the lack of wastewater treatment plants and CSO failure during rain events is causing a widespread crisis of wastewater pollution in many countries. In Canada, approximately 150 billion liters of untreated or undertreated wastewater flow into surface waters, making sewers the number one polluter of Canadian surface waters. Eighty percent of the urban wastewater released daily into both the Mediterranean Sea and the Yangtze River in China is also untreated. And according to the US Environmental Protection Agency, 44 percent of stream miles, 64 percent of lakes, and 30 percent of bay and estuarine areas in the United States are too polluted for fishing and swimming. A 2013 study performed by the Water Institute at the University of North Carolina estimated that approximately 1.5 billion people worldwide use sewer systems without treatment, and more than 50 percent of global surface waters are impaired by untreated wastewater. These few examples offer evidence that many communities and countries beyond Brazil are affected by widespread wastewater pollution.

Moving forward

Wastewater treatment is a complex process that requires a combination of solutions rather than a one-size-fits-all approach. Currently, adding a conventional wastewater treatment plant before discharging to surface waters is the most common remedy to untreated sewer flows. These facilities can be designed for varying levels of wastewater treatment, depending on the discharge location and requirements. However, they can be very costly, both in construction costs and infrastructure maintenance required for adequate treatment during stormwater events ranging from low-flow to peak. Additionally, many of the materials required to build treatment plants are not environmentally friendly or sustainable and can have capacity problems during large storm events. While treatment plants are often perceived to be the only – or the best – option available, there are many other more affordable and effective treatment systems that communities can adopt.

For example, water reuse and soil-based treatment offer two viable and sustainable wastewater solutions that can decrease discharges and even recharge local aquifers. Water reuse enables municipalities to decrease discharge into surface waters and thereby decrease demand on the local potable watershed. Centralized sewers and wastewater treatment plants relocate a vast amount of water across watersheds. One way to limit this transfer is to install a water reuse system that provides advanced treatment to produce effluent of sufficient quality to allow reuse for toilet flushing, cooling, irrigating, and even for drinking water, among other uses.

The Port Burwell Sewage Treatment Plant uses Infiltrator chamber technology in an exfiltration bed instead of an outfall as a discharge solution.
Photo by Infiltrator Water Technologies

Table 1. Data from Sydney Water treatment plants show what can be achieved with tertiary filtration.

Facility location	Design Flow
Foxboro, Massachusetts	1.2 mgd
City of Gold Beach, Oregon	2.2 mgd
Town of Los Osos, California	1.6 mgd
Village of Omemee, Ontario	350,000 gpd
Bozeman, Montana	200,000 gpd
Port Burwell Ontario	280,000 gpd
Manistee, Michigan	180,000 gpd
Breckenridge, Colorado	500,000 gpd
Plymouth, Massachusetts	300,000 gpd
Yolo County, California	225,000 gpd

mgd: millions of gallons per day
gpd: gallons per day
1 gallon = 3.7854 liters

A few of the challenges encountered with the implementation of water reuse systems include the difficulty in retrofitting existing infrastructure, cost, and public perception. Water reuse is most easily implemented in new developments, where additional plumbing and fixtures can be installed up front, rather than be retrofitted. Both public stigma and regulations can be barriers to the acceptance of water reuse. The perception of using wastewater as a potable water source seems unnerving and dangerous without proper education; however, in reality, we are continuously reusing water and wastewater. In fact, all municipal water systems that draw water downstream from a wastewater treatment plant are implementing de-facto water reuse. Water reuse infrastructure simply offers a more direct and sustainable form of water reuse.

Soil-based treatment systems, such as individual septic systems and larger decentralized systems or cluster systems, can also be used to treat wastewater. Soil is often overlooked as a low-cost, environmentally friendly treatment device simply because it feels archaic, but soil provides a rich microbial community that quickly treats wastewater using no added energy. Furthermore, design options within the decentralized industry continue to increase, making technologies available to provide all levels of treatment. Decentralized systems keep treatment and groundwater recharge localized and in coastal areas help to prevent saltwater intrusion. Clustered systems provide the option of third-party operation, maintenance, and management.

The biggest limiting factors in the widespread use of soil-based treatment are zoning, land availability, and regulations. Homeowners and developers need to educate the public and lobby for the implementation of decentralized solutions in order to move beyond the stigma of onsite systems and focus on the environmental and fiscal sustainability of decentralized wastewater management.

Exfiltration bed reduces phosphorus

In Bayham, Ontario, Canada, the Port Burwell Sewage Treatment Plant opted to rely on an exfiltration bed using Infiltrator chamber technology instead of an outfall as a discharge solution. Located on the shore of Big Otter Creek near Lake Erie in Bayham, the plant was upgraded to accommodate steady growth in the surrounding area. The plant needed to expand wastewater treatment services and protect water quality in the lake. To accommodate the growth, the decision was made by the City of Bayham to connect the surrounding communities to the area's Port Burwell Sewage Treatment Plant and to explore how this facility could be modified for future efficiency, added capacity, and environmental stability.

Engineers created a conceptual design report for the plant. Based on projected population growth in and around the Big Otter Creek area, it was determined that the treatment capacity of the existing Port Burwell plant would have to be expanded from 528 cubic meters per day (m^3/d) to 1,060 m^3/d. The solution to convert the originally designed outfall to an exfiltration bed using Infiltrator chamber technology saved considerable cost and also provided additional pollutant removal. Key benefits included expansion of the overall plant capacity and a

reduction in phosphorous. With the exfiltration chamber system solution, phosphorous is naturally removed by the soil, thereby reducing the impact to the sensitive lake environment.

The chamber gallery is located in the existing plant outfall easement adjacent to the treatment facility. It provides sufficient capacity to discharge the effluent from the sequenced batch reactors (SBRs) on a sequential basis including a 25-percent surcharge. The design also includes inspection ports and manholes so that the bed can be physically inspected.

The Port Burwell exfiltration system has met all of the original capacity projections and environmental requirements. Fluctuating groundwater levels continue to challenge the project but have been managed through the addition of tiling to control the flow to the exfiltration galleries. Additionally, vegetation has grown above the system as planned so that it is nearly invisible to the eye and does not obscure the landscape.

Conclusion

Wastewater management has historically shifted toward a centralized scheme, and the public perception is that centralized sewer best protects the public and environmental health. Public sewer is considered a desirable commodity among designers and consumers alike. However, water tables are dropping at drastic rates, and sewers continue to discharge trillions of liters of untreated sewage into surface waters worldwide every year. The environmental and health effects of this political negligence are not acceptable.

Engineers and regulators in the wastewater industry need to protect both public and environmental health in the most effective and sustainable manner. For this to happen, many in the water sector need to consider alternative approaches that could be implemented in both new development and in infrastructure upgrade projects. Water reuse and soil-based wastewater treatment systems are only two of the many options available to provide communities with flexible and sustainable solutions.

It is imperative that wastewater treatment is required before discharging to surface waters, and discharge should be minimized to protect the surrounding ecosystems. All options need to be evaluated, especially when considering systems that provide greater protection of public and environmental health.

Author's Note

Jessica Barringer is a project engineer at Infiltrator Water Technologies and works with the research and development and science and government departments. She holds a masters of science degree in civil and environmental engineering from the Colorado School of Mines, Golden, Colorado, United States.

For further information please see the Advertiser Contact List on page 50