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Combined Sewer Overflow

Making the case for satellite wastewater treatment systems

By Robert Y.G. Andoh

The Stormwater Pollution Handbook published by the Ontario Ministry of the Environment for municipal offices outlines two options for cleaning up the flows discharging during heavy rainstorms from the many combined sewer overflow (CSO) points in the region. It recommends:

- Partial separation of combined sewers to provide separate storm and sanitary systems.
- Storage of combined sewer flows during rainfall events followed by the treatment of the excess volume during dry periods at the sewage treatment plant.

These are tried-and-true, conventional approaches that have worked with degrees of success ever since engineers started designing sewers to carry both sewage and stormwater in a single pipe. To ensure the highest level of treatment possible, municipalities have strived to increase the capacities of their systems, either by building new, "separated" sewers or by significantly expanding their end-of-the-pipe treatment plants.

These conventional approaches, however, are staggeringly expensive for individual communities already struggling to pay for education, public safety, environmental clean-ups and community programs. Separating sewers also extracts a cost on the community in the form of closed streets for months on end.

There are other options communities are pursuing that not only clean the discharges to government standards, they do so at a significantly lower cost. The implementation of satellite treatment systems within the collection systems – away from the end of the pipe – provides significant benefits from both a process and public health standpoint compared with conventional approaches.

Costs are paramount

Current estimates of the costs required to address these issues are on the rise. In the United States an EPA report in 2006 said utilities have spent $6 billion the past three years to control CSOs, reducing the annual CSO volume from 1 trillion gallons to about 850 billion gallons. The same report estimates an additional $50 billion (US) will be needed to solve CSO problems. Private estimates put the figure much higher, up to $100 billion. Communities bear the brunt of this cost. Many sewer separation projects that wind miles through busy downtown areas run well into the tens of millions of dollars.

Hydrodynamic vortex separators (HDVSs) have been identified as one means of reducing the capital expenditures required to address CSOs. A key advantage is that a single HDVS is capable of both solids separation and disinfection, providing a significant reduction in the capital expenditures required to handle CSOs. Another advantage is that the flow properties of a single HDVS can be optimized to greatly improve the efficiency of both solids separation and contact disinfection compared to conventional technology. This means that HDVSs may be able to handle the same CSO volume as conventional contact tanks that are five times as large. The resulting reduction in tank size and construction costs typically reduces overall project costs by about 50 percent.

Why satellite treatment?

Within extensive sewerage networks conveying foul or combined sewage, the large organic solids typically discharged at the top end of the system, in water closets (WCs), are degraded into smaller sized particles with age and transportation through the sewerage network. This is especially the case where ancillary components such as pumping stations create hydrodynamic regimes with high turbulence and shear. It stands to reason, therefore, that wastewater discharged at the end of an extensive sewerage network will have a higher proportion of smaller sized (less readily settleable)

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solids compared with wastewater at the top end of the system.

The larger solids are, the easier it is to remove them by physical separation processes (such as sedimentation). Fecal solids discharged into water closets (WCs) at the top end of the collection system tend to be larger solids that settle rapidly and are readily removed from wastewater streams using sedimentation as a unit process. These solids also have a propensity to degrade into smaller and smaller sizes as they are transported through collection systems. As fecal solids degrade, they release more and more of their associated pollutants (e.g., fecal coliforms, pathogens and heavy metals) into the surrounding water increasing the public health risks associated with the discharge of untreated portions of the wastewater into the environment.

This would suggest that, with regards to separating solids and their associated pollutants from wastewater, the earlier this separation is implemented in the cycle of collection, conveyance and treatment (i.e., upstream within the collection system), the easier it is to achieve water quality benefits.

Given that one of the main functions and objectives of collection systems and wastewater treatment is to separate contaminants or pollutants from the wastewater, this also suggests that separation of contaminants or pollutants from wastewater should be undertaken at the earliest opportune time in the cycle of Collection, Transport, Treatment and Disposal (CTTD).

These predicate the use of satellite wastewater treatment systems distributed as far upstream as is practicable as this provides the greatest opportunity for achieving high levels of solids and associated pollutant removals without recourse to more complex treatment process stages. It is surmised that the interception and treatment of wastewater at an early stage in the CTTD cycle also enables much more effective utilization of the assimilative capacity of the receiving waters (environment) and provides better scope for community and other stakeholder involvement.

With conventional schemes where treatment plants tend to be "out of sight," there generally is very little scope for stakeholder involvement as an "out-of-sight-out-of-mind"-type mentality may develop with no communal sense of "duty of care." Localized schemes on the other hand provide scope for local community involvement, an awareness of the need for schemes to be sustainable, and increased scope for beneficial reuse and recycling. The satellite approach would appear to have other benefits. This could include potential reductions in the extent of the associated collection systems infrastructure as the wastewater does not have to be carted over long distances. This, in turn, translates into major cost savings.

The usual concerns regarding satellite wastewater treatment schemes often relate to potential increases in maintenance and operational costs and their associated commitments with the proliferation of treatment sites and the possible lack of adequate control to prevent cross-contamination and direct human contact with contaminated sources. In fact, this may be the case where factors such as poorly constructed systems (e.g. septic tanks) are sited in close proximity to groundwater aquifers that are used as primary sources of potable water. This may also be the case for treatment systems, equipment and devices that require external sources of power, sophisticated control, regular inspection, high levels of maintenance and offer inadequate control pathways.

Appropriate systems for implementing a satellite treatment approach are ideally those that require no external sources of power, are simple with no sophisticated control, are robust and reliable, require virtually no maintenance, and provide effective control at relatively minimal costs. Passive robust devices with no moving parts such as vortex flow controls, advanced hydrodynamic vortex separators, filter systems and ecological based wastewater treatment systems are examples of appropriate treatment and control systems which provide scope for the implementation of effective distributed flow control systems with satellite treatment.

Innovative technologies in the upstream parts of highly urbanized catchments provide alternative cost-effective urban water management and control. These systems have been found to be efficient and compact. They also offer more effective treatment and control compared with many conventional systems providing significant cost savings in addition to improved efficacy.

Satellite treatment in action

In Saco, Maine, officials have forged ahead with a project to eliminate seven of the city's eight CSO sites by separating the sewers. For the last of the eight CSO points, the city installed a CSO treatment scheme at the local wastewater treatment plant that uses a hydrodynamic vortex separator to treat the combined flows before they are discharged into the Saco River. Officials opted for this alternative method to solve the CSO issue in a busy downtown area, to avoid having to dig up streets, create traffic congestion and engage in costly land takings.

Saco installed Hydro International Storm King, Grit King and Reg-U-Flo units to meet the Maine Department of Environmental Protection's primary treatment equivalency for wastewater discharge standards. Monitoring results obtained during the spring 2007 wet season of this year showed that the device performed to the state's standards.

Elsewhere, a total CSO treatment scheme including satellite treatment at two sites within the collection system in Columbus, Georgia, was implemented at a cost of $85 million. This saved the community at least $45 million over the previous estimates for the solution based on the conventional approach of a new interceptor sewer that would have necessitated the upgrading of the existing main wastewater treatment facility.

An unconventional approach

Communities with CSO issues may lack adequate funds to undertake the required level of capital and operations and maintenance investments without the potential of perhaps doubling of local rates and fees. Under the current regime of tighter environmental regulations, increasing urbanization coupled with an aging urban drainage and wastewater treatment infrastructure, several communities are faced with the tasks and challenges of rehabilitating or upgrading their collection systems and wastewater treatment plants to provide the requisite levels of service and comply with standards.

Conventional systems are costly and this, coupled with the funding constraints and issues of affordability, clearly highlights the need for innovative, cost-effective and sustainable "alternative approaches" for current collection systems and wastewater treatment needs and challenges.

The use of satellite treatment systems located within collection systems provides the scope for resolving some of the challenges in urban wastewater infrastructure provision in a cost-efficient manner as demonstrated in Saco, Maine, and Columbus, Georgia. Monitoring and operation of these full-scale systems has confirmed that high-rate processes such as a vortex separator, either on its own or followed by compressed media filter, can be used to remove gross solids and the lighter fraction of fine particulates while passively optimizing in-system storage.

Passive high-rate sedimentation and filtration systems that harness the inherent energy within collection system flows have been shown to be very effective for controlling CSOs and other wet-weather impacted discharges. Their use within collection systems in a satellite treatment context provides scope for maximizing the utilization of existing wastewater infrastructure while eliminating or minimizing the large costs associated with transporting wet-weather flows to central wastewater treatment facilities.

Robert Andoh, Hydro International, is a member of the Technical Advisory Board for the University of New Hampshire Stormwater Center. Hydro International is represented in Ontario by ACG Technology.
For more information
E-mail: greg@acgtechnology.com