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Great Swamp Controls CSOs

Spirit of cooperation colors the infrastructure green.

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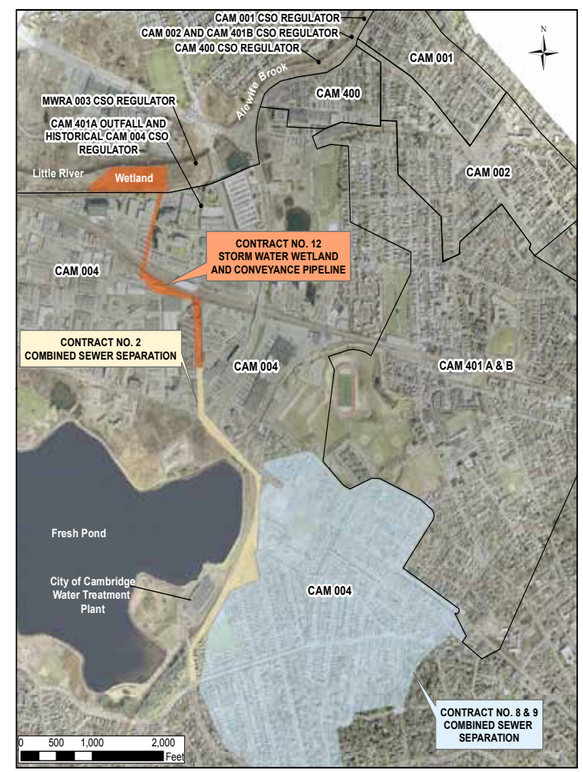
In the 1980s, the EPA initiated a court order to reduce the incidence of combined sewer overflows (CSOs) caused by wet weather to the Alewife Brook, as part of regional efforts to clean up the Boston Harbor. The headwaters of the brook lay partially within the City of Cambridge, a 400-acre area served by the city's "CAM 004" CSO Regulator. The CAM 004 area presented such complexity that separation of sewer systems required 25 years of adaptive planning and sustainable engineering to gain approval.



The CAM 004 area is situated in a region noted by 19th century naturalist William Brewster as "The Great Swamp." Wetlands originally spanned from the Mystic River to a glacial kettle pond named Fresh Pond. The city developed Fresh Pond for potable water use in 1856 and it now serves as the terminal raw water reservoir (1.5 billion gallons) for the city's 24-mgd water treatment plant. Commercial/residential complexes and light industry now dominate the historical wetland terrain, while affluent residences line adjacent hillsides. It is a dense and wealthy mix of urban development.

To protect the reservoir, city forefathers installed a mix of sewers and drains (primarily combined sewers) and routed flow towards the Alewife Brook, where trunk sewers owned by the Massachusetts Water Resource

The CAM 004 area is a dense mix of urban development amongst sensitive environmental resources.

The Alewife Brook suffers considerable flooding due to urban development.

Authority (MWRA) intercepted combined flows from the surrounding region. Much of this infrastructure predates the 1920s and has become overwhelmed by urbanization. In the 1980s, the area was typified by 63 CSO discharges to the Alewife Brook each year (53 MG annually). Beyond CSOs, the impact of stormwater was significant. Comparatively small (two-year) storms flooded CAM 004 roadways and produced objectionable sanitary sewer overflows (SSOs). The impacts to CAM 004 were amplified during larger (five-year) storms when damaging flooding in the Alewife Brook occurred due to regional development. During major storms, the reservation surrounding

Fresh Pond Reservoir was breached.

Seeking to meet a federal court deadline for CSO control by the year 2015, the MWRA developed a CSO Facilities Plan in partnership with member communities. The plan adopted complete

The city's engineered wetland was integrated into state conservation land and sensitive habitat.

separation of the CAM 004 combined sewer system along with partial separation of adjacent CSO areas. Several phases of conventional infrastructure projects were envisioned over a 20-year span, but the plan did not mitigate existing flooding in CAM 004 and had the potential to exacerbate flooding in the Alewife Brook with newly separated stormwater.

In 1998, Cambridge began detailed studies for combined sewer separation of the CAM 004 area. The city engaged a team of engineers including wet infrastructure leader MWH Global (www.mwhglobal.com) to develop the city's first hydraulic stormwater model. MWH staff initially used EPA's SWMM EXTRAN software, but then adopted HydroWorks by Wallingford Software (www.wallingfordsoftware.com) in the

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UK, now a subsidiary of MWH Global. This critical tool allowed an integrated analysis of the watershed's natural and piped systems.

Two objectives were then added to the Plan: 1) eliminate flooding in the CAM 004 area for the ten-year storm, and 2), restrict the peak discharge of stormwater to the Alewife Brook to not exceed existing conditions. These objectives were radical and appeared impractical—model results identified the need to store over three MG (ten acre-feet) of runoff. The lack of municipal land and density of the built environment made "grey infrastructure" schemes such as underground tanks prohibitively expensive. The only option was to integrate with the natural environment, requiring a shift in thinking.

The city and MWRA partnered with the Massachusetts Department of Conservation and Recreation (DCR), the Massachusetts Department of Environmental Protection, and various legislators with the vision of constructing 3.5-acres of storage in the DCR's Alewife Reservation. The site featured scrub/shrub wetland and bottomland hardwoods suffering from a century of urban impact and also bordered the Little River, a tributary of the brook. Conveyance pipelines necessary to access the site required easements across six commercial complexes and a major rail corridor. These unique site conditions would introduce myriad requirements.

Though the impetus for the project was CSO and flood control, its environmental impact and potential benefit quickly became the focus of project stakeholders and the engineering team. The DCR would not approve a common detention basin. This led to the concept of an engineered stormwater wetland and resurrection of The Great Swamp.

Environmental Benefit to the Alewife Brook

The wetland quickly took on the identity of a "green infrastructure" project, and MWH optimized the hydraulics of the wetland and CAM 004 stormwater system to achieve substantial benefit to the Alewife Brook. Primary features include:

1. A passive bending weir that strategically directs dirty stormwater into wetland biota to consume suspended solids and nutrients, while also retaining flood volumes in the upstream system to not exacerbate damaging flooding in the brook.
2. A forebay that functions as a settling basin to remove fine sediment.
3. Best management practice catch basins that capture floatables and grit.
4. A passive vortex valve that strategically passes groundwater base flow to the brook for drought resistance.

The project also improved the brook's hydrology through the construction of a man-made oxbow. This feature introduced new open water habitat, an increase in available floodplain, and an increase in compensatory flood storage volumes.

Environmental Benefit to the Alewife Reservation

Construction of the stormwater wetland required a massive grading operation within state conservation land. This short-term disruption was offset with long-term enhancements. Poor quality wetland was replaced with 120,000 native plant species to recreate rich and diverse habitats that would encourage re-population of native fauna. The project also targeted removal of invasive plant species, which are prevalent in the Alewife Reservation, followed by monitoring and maintenance by the city to prevent re-population.

An additional feature engineered by MWH was the installation of a passive level control device between the wetland and oxbow. This device functions to maintain open water levels in the wetland for drought resistance, while preserving flood storage volume in the wetland for storm events.

Environmental Benefit to the Urban Environment

The value of the wetland and associated infrastructure is felt by Cambridge's citizens. Public health is improved through reduced SSOs and sewer backups into basements. Nuisance flooding in the public right of way is reduced. A considerable volume of contaminated soil has been excavated from the site.

Citizens are also recognizing an increase in their quality of life. City infrastructure that is often "out of sight, out of mind" is now prominently featured and integrated with conservation land to increase awareness. The wetland features walking paths, boardwalks, disabled access, an amphitheater, and educational signage. Air quality and physical health is improved through installation of a new multi-use bike path that provides access to mass transit.

In October 2013, the city hosted a ribbon cutting ceremony that placed the wetland into service and acknowledged the final phases of combined sewer separation that are underway. All told, the construction cost of the wetland, large conveyance pipelines, and ongoing sewer separation is about $100 million.

Stormwater infrastructure projects such as this are best initiated by embracing the concept of a multi-use project in the planning phase. Owners that proactively gain stakeholder support will discover that perceived limitations are in fact opportunities. Moreover, detailed and creative hydraulic modeling must be undertaken to integrate this type of mass infrastructure with the environment. By adopting this mentality, sustainable engineering will naturally take place and projects will reach their full potential.

Mr. Olander, Supervising Engineer, and Mr. Pisano, Principal, are engineers with MWH Global, and partnered with Kleinfelder and The Bioengineering Group for the project.

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