Navigating the Regulatory and Design Challenges of the Gowanus CSO Facilities

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Introduction

The Gowanus Canal, located in the borough of Brooklyn (Figure 1), has been an industrial center for New York City since the mid-1800s when the tidal marshes were filled in and the canal was channelized. The canal promoted the movement of goods and materials to and from the heavy industry that developed along it, including manufactured gas plants, coal yards, cement makers, soap makers, tanneries, paint and ink factories, machine shops, chemical plants and oil refineries.

Over time, these industrial operations contributed to the extensive contamination found in and around the canal. This was the primary reason why the United States Environmental Protection Agency (USEPA) added the Gowanus Canal to the Superfund Program’s National Priorities List on March 2, 2010. The Superfund-designated remedy focused on the contamination associated with the manufactured gas plant (MGP), which was located near the head end of the canal, under the present-day Thomas Greene Park and Douglas-Degraw Pool.

Figure 1. Orthoimage of the Gowanus Canal and surrounding terrain in the borough of Brooklyn, New York.

Ortho Image courtesy of the New York State GIS Clearinghouse

Record of Decision (ROD)

Following the addition of the Gowanus Canal to the National Priorities List, the USEPA issued its ROD in September 2013, which described the selected remedy for “in-canal” work associated with the Gowanus Canal Superfund Site. The ROD included:

• Implementation of institutional controls to protect the integrity of the cap.
• Periodic maintenance of the cap and long-term monitoring to ensure that the remedy continues to function effectively.
• Combined sewer overflow (CSO) controls to reduce solids loading to the canal, which is intended to prevent the re-contamination of the canal following the implementation of the remedy.

Responsibility for the implementation of the selected remedy was mostly borne by other potentially responsible parties (PRPs). However, under the ROD, New York City is required to construct two CSO facilities to reduce solids loading from CSOs to the canal.

In May 2014, USEPA issued an Administrative Order for Remedial Design to New York City (the Order) that contained a Scope of Work (SOW) further defining the portion of the selected remedy which requires the city to construct CSO tanks to control CSOs that currently discharge through outfalls RH-034 and OH-007 (Figure 2). The ROD preliminarily estimated that the CSO retention solution will need to provide a 58 to 74 percent reduction in CSO solids loading to the canal from the RH-034 and OH-007 outfalls in order to meet the ROD’s preliminary remediation goals. A tank size of 8 million gallons (MG) and 4 MG were estimated to be required to reach the solids-load reduction targets at RH-034 and OH-007, respectively.

Siting Study

In response to the ROD and subsequent Order, the New York City Department of Environmental Protection (DEP), as the city’s designated agent, conducted a series of technical evaluations to site and size the CSO facilities and coordinate planned work activities with the other parties involved with implementing the ROD.

The city retained an engineering consultant, Brown and Caldwell, to conduct a “Siting Study” to evaluate the requirements stipulated in the Order. The goals of this study were to:

• Identify appropriate storage volumes to attain the targeted solids-load reduction required by the ROD.

Figure 2. Present-day Gowanus Canal and CSO outfalls RH-034 and OH-007 to be addressed per the Record of Decision (ROD).

Brown and Caldwell
Typical-Year CSO Volume

During wet weather, the Gowanus Canal receives CSO discharges from two distinct wastewater treatment plant (WWTP) sewershed areas (collection systems): the Red Hook and Owls Head WWTP sewershed areas (Figure 3). The collection systems serving each of these two WWTPs are represented by two distinct models, referred to as the Red Hook and Owls Head models. These models, developed using the InfoWorks CS software package, allow for robust representation of complex real-world systems in a mathematical framework that can be used for planning and design evaluations. To estimate flow conditions at two CSO discharge points - RH-034 and OH-007 - the study used predicted CSO volume data, calculated by both the Red Hook and the Owls Head models.

Apart from the Superfund ROD and the Order requirements, DEP is already implementing a series of projects to reduce wet-weather overflows from CSOs that discharge to the Gowanus Canal. These projects, implemented under the Waterbody Watershed Infrastructure, and the High-Level Storm Sewer improvements. These projects are anticipated to reduce total CSO volume to the Gowanus Canal by 44 percent. In addition, the Gowanus Flushing Tunnel and Pump Station reactivation reduces pathogen concentrations and increases dissolved oxygen in the canal, resulting in full compliance with designated state water-quality standards. Given the significant anticipated CSO reduction impact of these projects and associated reduction in solids loading, they are being considered as part of the remedial solution toward meeting the 58 to 74 percent estimated reduction in solids loading set forth in the ROD.

Typical-Year CSO Design Flow Rate

While the CSO volumes aided in sizing the tanks to achieve the solids-load reduction, the model-predicted peak-flow rates associated with the CSO events were used to size conveyance infrastructure. Additionally, the peak-flow rates were used to estimate head losses through the influent and effluent conduits and the basin. Understanding the head loss was critical to developing the hydraulic profile and confirming that the CSO facility would not adversely impact the hydraulic grade in the upstream collection system.

The peak typical-year flow rates of 306 million gallons per day (mgd) and 146 mgd for RH-034 and OH-007, respectively, were used as the basis of design. This conservative approach enables all typical-year CSO to be directed to the facility.

Aside from directing 306 mgd and 146 mgd to the RH-034 and OH-007 storage basins, the CSO regulator must still be able to
to bypass the five-year/two-hour storm to the canal to prevent adverse impacts in the upstream system, which include sewer backups, flooding, and surcharge. This was estimated to be 750 mgd for RH-034 and 250 mgd for OH-007. To accommodate these flow rates, the CSO structures need to be reconfigured to allow complete diversion of typical-year flows to the CSO facility to meet solids-load reduction requirements, as well as the ability to bypass excess flows to avoid upstream surcharge and flooding.

2. Facility Sizing and Performance Evaluation

The purpose of the CSO facilities is to reduce solids loading to the canal from CSO sources by capturing CSO volume, prior to discharge to the canal, and storing it until after the event so it can be sent to the treatment facilities. By intercepting CSO volume prior to discharge, solids loading to the canal will be reduced. To estimate the required size of the tank, both volumetric and pollutant-load reduction bases were used to calculate the required tank size to meet the solids-load reduction requirement.

The volume basis approach assumes that the solids-load reduction is equal to the reduction in typical-year CSO volume, a 1:1 ratio. By reducing the typical-year CSO volume by 58 to 74 percent, it is expected that the solids loading to the canal will be reduced by the same percentage. Considering that a significant portion of the solids loading typically occurs during the beginning of a wet-weather event and is either carried to the WWTP or contained in the storage tank, this approach likely results in a more conservative estimate of the required tank volume than other methodologies.

In parallel, a pollutant-load reduction calculation was also completed. Since the tank is designed to be a flow-through facility, whereby CSO volume that exceeds the storage volume of the tank is discharged from the facility, some degree of primary (Type I) settling is expected to occur as the flow passes through the tank. The settling of solids, considered in this approach, resulted in higher solids capture for the tank than the volume basis approach.

The 8 MG and 4 MG facilities for RH-034 and OH-007, noted in the ROD, exceed the higher end of the required solids-loading reduction (Table 1). To achieve the targeted range of solids-load reduction of 58 to 74 percent, the required storage volume could be reduced to either 3.1 or 5.7 MG for RH-034 and either 1.4 or 2.5 MG for OH-007.

<table>
<thead>
<tr>
<th>RH-034</th>
<th>Reduction in Typical Year Volume</th>
<th>OH-007</th>
<th>Reduction in Typical Year Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tank Volume</td>
<td>8.0 MG</td>
<td>74%</td>
<td>4.0 MG</td>
</tr>
<tr>
<td></td>
<td>5.7 MG</td>
<td>74%</td>
<td>2.5 MG</td>
</tr>
<tr>
<td></td>
<td>3.1 MG</td>
<td>58%</td>
<td>1.4 MG</td>
</tr>
</tbody>
</table>

Under the pollutant-load reduction calculation, the solids-load reduction for an 8 MG and 4 MG basin exceeded 90%.

3. CSO Facility Requirements

As a preliminary step in developing the conceptual requirements and layouts of storage solutions for the CSO facilities, the team conducted a desktop benchmarking evaluation of wet-weather storage facilities installed in other cities across the United States. The purpose of this high-level assessment was to identify common features of storage facilities, as well as to identify innovative layouts or unit processes that were either proven or believed to enhance performance, reduce operations and maintenance challenges, and provide abatement of noise and odors. Information was collected from a variety of sources, including conversations with engineers who were involved with the planning, design, or construction of the facilities; Internet research; and informal discussions with utility staff that own or operate the storage facilities. In addition to this high-level benchmarking exercise, two of DEP’s CSO storage facilities were toured to study the layout, understand operational challenges with the existing facilities, and identify improvements that the operations staff would recommend for future installations.

After collecting information from the review of wet-weather facilities, the project team developed a series of recommendations for preferred unit processes and sizing criteria based on the design flow rate conditions and required storage volumes. These recommendations enabled selection and sizing of the mechanical and electrical equipment, based on the targeted flow rates and tank volumes. Collectively, this information was used to develop a workable facility layout that considered DEP’s operational preferences, redundancy requirements, and requirements for setbacks and clear space for safe operation of a CSO facility.

An outcome of developing the site plan layout was a better understanding of the footprint required for the facility. This analysis indicated that a 4 MG tank at OH-007 will require approximately 60,000 square feet and an 8 MG tank at RH-034 will require approximately 100,000 square feet.

4. Land Search and Facility Siting

After the conceptual facility layouts were developed and the foot-print requirements were defined, the team embarked on a review of property near the RH-034 and OH-007 regulators that were of suitable size to construct and operate a CSO storage facility.

A two-step process was used to identify potential locations for the CSO facility. An initial screening was conducted on available properties that were of a suitable size and were within a quarter-mile radius around RH-034 and OH-007. Short-listed sites that resulted from the initial screening were then subject to a more detailed short-list evaluation.

Initial Identification and Screening

A total of 86 sites were initially identified. These properties were scored against three main screening criteria, effectively considered “fatal flaw” analysis. The criteria included:

- **Size of Properties.** Evaluated the sites to determine if a 100,000 square-foot 8 MG facility or a 60,000 square-foot 4 MG facility could fit on the property or a combination of adjacent properties. If not, the location was dropped from the list.
- **Hydraulic Analyses and Effective Capture of the CSOs.** Hydraulic analyses conducted during the conceptual layout phase determined that diverting flow to storage downstream of the CSO weir resulted in a better level of control than diverting CSO to storage upstream of the tank, within the tributary collection system. Sites that were located upstream of the CSO regulators or sites that were not within close proximity to the CSO regulator were eliminated from the list.
- **Current or Planned Land Use.** Because there is significant development occurring around the Gowanus Canal, research was conducted to identify properties among the 86 sites which had planned or permitted development. These sites, as well as sites under construction or slated for redevelopment, were eliminated from the list.

Because very few properties met the minimum size requirements on their own, several properties were combined into potential sites.
meeting the square footage requirements for the CSO facilities. The remaining 14 sites met the minimum size needed for the tanks and facilities; the availability of construction set-back and staging areas was evaluated in more detail in the next step of the screening process.

Evaluation of Short-listed Sites

The 14 sites identified from the preliminary screening were further evaluated and ranked using a multi-criteria analysis that allowed for the application of numerous qualitative screening factors to each potential site, resulting in a quantitative ranking. The screening factors consisted of both engineering criteria and land use/environmental criteria. The initial screening for land use and environmental considerations was based on the analysis categories in the City Environmental Quality Review (CEQR) Technical Manual.

The final list of eight screening factors used for this analysis was selected as follows:

A. Engineering Criteria
1. Size.
2. Proximity to existing infrastructure.
3. Utility relocation.

B. Land Use and Environmental Criteria
1. Current/planned surrounding land uses (applicable to land use, air quality, noise, construction and neighborhood character considerations), including community disruption.
2. Historic and cultural resources.
4. Property acquisition.
5. Proximity to potential staging areas.

Assigning impact scores for each of the eight criteria were completed through workshops and meetings between the Siting Study team and DEP. The outcome of the effort was a prioritized list of available sites in which the highest-ranked sites (two sites for RH-034 and two sites for OH-007) were advanced in the study. Detailed facility layouts were developed for the highest-ranked sites so cost estimates and construction schedules could be developed.

Outcomes of the Siting Study

The Siting Study helped DEP better quantify the size of the facility required to meet the obligations outlined in the ROD, as well as help determine a site for the facility, based on the estimated footprint. The information obtained through the Siting Study was used to develop an AACE Class IV cost estimate which determined the total program (RH and OH tanks) to cost more than $1 billion in 2015 dollars, significantly greater than the $77 million estimated by USEPA in the ROD.

Settlement Agreement

In June 2016, USEPA and New York City entered into an “Administrative Settlement Agreement and Order for Remedial Design, Removal Action, and Cost Recovery” which uses findings from the Siting Study to establish DEP’s requirements to complete two parallel designs of an 8 MG CSO retention tank at the RH-034 CSO overflow. The Owl’s Head obligations remain under the 2014 Order. The city is proceeding with the project and has retained a consultant team (Hazen and Sawyer with Brown and Caldwell) to complete the design of the CSO facilities.

Detailed Design

Detailed design of the CSO facilities began in July of 2016, initially with a series of design workshops culminating with the Facility Plan and Basis of Design Report, which was completed in December 2017. This preliminary design work built off the findings from the Siting Study and advanced key design alternatives, such as fine influent screening, degritting the pumped effluent to prevent redeposition in the collection system, and a robust odor control system to address the proximity of the facility to residential areas.

The detailed design of a CSO facility in a congested neighborhood in Brooklyn presents many challenges, many of which continue to be evaluated as part of the design. One of the more complex considerations is the requirement that the city complete the removal action of contaminated sediments within the footprint of the facility within 24 months. Per the Settlement Agreement, the city must remove and handle all the soil within the footprint of the tank, while other PRPs will handle hot spot contamination outside of the tank footprint.

Based on the facility footprint at the head-end site RH-034, an estimated 71,000 cubic yards of material needs to be handled during excavation. Site characterization identified soils with a high moisture content and chemical impacts, primarily attributed to the MGP waste found on the site. These conditions suggested that the soil needs to be stabilized after excavation. To work within the 24-month removal action requirement, the design team endeavored to optimize the time needed to construct a robust support of excavation (SOE), while still providing sufficient time to remove and handle the spoils. A range of SOE options were evaluated by the design team that considered cost and time to construct. The outcome of the analysis was a deep SOE to bedrock, with minimal bracing. This option provides an SOE that minimizes cross-lot bracing and creates minimal conflicts with excavation equipment, leading to a more efficient process of removing the soil. In addition, a deep SOE eliminated the risk of a weak jet grout plug, caused by the MGP waste reacting with the grout. Construction of the plug was anticipated to take a long time to overcome the reaction with the MGP waste, potentially leading to an overrun on the 24-month schedule.

This is one of many examples of the complexities of designing a CSO facility that is located in the middle of a Superfund site.

Summary

CSO facilities are typically constructed in response to Clean Water Act requirements – and even under these circumstances, there are regulatory and design challenges that need to be addressed and overcome. The overlay of Superfund has created new challenges that need to be effectively managed, namely the requirements stipulated in the ROD and Settlement Agreement, and the specific requirements for remediation of the soil under and around the proposed CSO facility. DEP continues to advance this design, balancing technical needs for an operable facility and sensitivity to the community during construction, with the aggressive remediation schedule dictated by USEPA. In addition, DEP is exploring opportunities to make the Gowanus program synergistic with other needs in the draining area, including climate change, resiliency, growth, and quality of life.

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