Basis of Design Report Harbor Brook CSO 018 Constructed Wetlands Pilot Treatment System

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Save the Rain

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SECTION 1

Introduction

1.1 Background

Onondaga County entered into an Amended Consent Judgment (ACJ) with the State of New York, New York State Department of Environmental Conservation (NYSDEC), and Atlantic States Legal Foundation (ASLF) on January 20, 1998 pertaining to pollutant loadings from the Metropolitan Syracuse Wastewater Treatment Plant ("METRO") and the combined sewer overflows (CSOs) that discharge into Onondaga Lake. The combined sewer service area is entirely within the City of Syracuse limits and drains to the southeastern end of Onondaga Lake. Figure 1 is a location map of the project area.

On November 16, 2009, the Fourth Stipulation and Order to the 1998 ACJ was adopted, which revised the ACJ to include provisions for the addition of green infrastructure projects into the previously approved grey infrastructure program. The County has proposed to implement a green infrastructure program to reduce the volume of rainwater that presently enters the combined sewer system in an effort to reduce the frequency and volume of CSO discharges to the receiving waters tributary to Onondaga Lake.

CSO discharges to Harbor Brook are a health concern and represent a nutrient loading that contributes to the degradation of water quality in Onondaga Lake. CSO 018, located near the intersection of Velasko Road and West Onondaga Street (see Figure 2), is one of these overflows that discharges combined sewage (i.e., sewage combined with stormwater) into Harbor Brook during severe wet-weather events. Since there is a significant amount of open space available in close proximity to this overflow, Onondaga County has expressed an interest in pursuing construction of a passive, sustainable natural treatment system (constructed treatment wetland) to treat the combined sewage overflow at this location before discharge into Harbor Brook. Figure 3 is a property ownership map which shows the extent of County owned property within the project area.

To accommodate this goal, the CH2M HILL and CHA team is completing the design of a full scale constructed wetland pilot treatment system at CSO 018. This Basis of Design Report is the second phase of design, intended to provide design drawings and information to a 50 percent level of completion for County, community, and regulatory review. Prior to this, the first phase of design confirmed the technical, regulatory, and economic feasibility of constructing a full-scale wetland pilot treatment facility and included a 10 percent design concept and cost opinion. Documents from the first phase included:

1. Engineering Report (dated December, 2010), submitted with the Green Innovation Grant Program 2010 application to the New York State Environmental Facilities Corporation (NYSEFC).
2. Project Definition Report (dated January 2011), provided documentation of concept design including theoretical removal efficiencies for the available footprint of land.

1.2 Purpose and Objective

The long term goal is to use the data generated from the full scale pilot system to design a permanent wetland treatment system at CSO 018 (with potential expansion to include CSO 078 or the application of treatment wetlands technology at other CSOs). This project will be part of a larger scale project to restore the site (from west of Velasko Road where Harbor Brook crosses under Grand Avenue to about Holden Street or some portion of this area) and to improve the water quality of the entire Harbor Brook flow. A community park and educational resource is envisioned to complement the long-term wetland treatment system. These concepts will be discussed and developed concurrently with the CSO 018 wetland pilot project development and during the approximately 2-year monitoring program in cooperation with the County.

This Basis of Design Report builds upon the two (2) previously prepared reports and progresses the concept of constructing a full-scale constructed wetlands pilot treatment system at CSO 018 into the final design phase. This report specifically includes the following:

- Project description.
- Layout of proposed facilities on the selected project site.
- Stormwater Management Model (SWMM) results for the 1 year, 2 hour storm event conveyed through the grit and floatables removal unit, conveyance pipes, and constructed wetlands pilot treatment facilities.
- Floatables and grit removal facilities design criteria, including an evaluation of several alternatives.
- Sizing criteria for the constructed wetland cells.
- Cut sheets of selected equipment.
- Geotechnical investigation memo.
- Evaluation of compensatory storage requirements for the Velasko Road Detention Basin (see approximate outline of the basin in Figure 2) and incorporation of required storage into the project site design.
- Flow monitoring at the relocated CSO 018 outfall to identify CSO discharge events to Harbor Brook.
- Preparation of 50 percent complete design drawings.
- Confirmation of permitting requirements.
- Operation, maintenance and monitoring requirements.
- Project schedule.
- Updated Engineer's Opinion of Probable Construction Costs.

SECTION 2

Project Site Conditions

2.1 Existing Project Site

The existing project site at CSO 018 (Figures 1 and 2), located in Onondaga County within the City of Syracuse, is bordered generally by West Onondaga Street to the south, Harbor Brook to the north, and Velasko Road to the west. The drainage area tributary to CSO 018 is approximately 145 acres in size (Figure 4).

2.1.1 Current CSO and HBIS Operations

An existing 48-inch reinforced concrete pipe (RCP) conveys combined sewage from West Onondaga Street in a northerly direction towards CSO 018, located along Harbor Brook (see Progress Print D-3001). Flow is conveyed through an existing CSO regulator which splits the flow into an interceptor flow component and an overflow component. Dry weather flows are currently conveyed through a 10-inch vitrified clay pipe (VCP) interceptor-connect pipe, through a grit removal chamber discharging into the 21-inch Harbor Brook Interceptor Sewer (HBIS), which is tributary to the METRO wastewater treatment plant. Flow over the capacity of the 10-inch interceptor-connect pipe is conveyed through the CSO 018 outfall pipe and discharged to Harbor Brook.

2.1.2 Newly Constructed HBIS Modifications

The Onondaga County Department of Water Environment Protection (OCDWEP) has recently constructed a new HBIS along the Rowland Street extension (D&S Service Access) which consists of an 18-inch & 21-inch polyvinyl chloride (PVC) pipe through the CSO 018 project site. Combined sewage flowing down the existing 48-inch RCP from West Onondaga Street will be conveyed through a new flow diversion manhole which will split the flow into an interceptor flow component and an overflow component. Dry weather flows will be conveyed through a new 12-inch interceptor–connect pipe that discharges into the new 21-inch HBIS, which is tributary to the METRO wastewater treatment plant. Flows over the capacity of the 12-inch interceptor-connect pipe will be conveyed through a new 30-inch HDPE overflow pipe to CSO 018 and will be discharged into Harbor Brook. The existing grit removal facility will be abandoned. This work is scheduled to be completed by June of 2011.

Since the old 21-inch HBIS is located within the area proposed for construction of the wetland treatment cells, it is required that the old HBIS be abandoned and the new HBIS be commissioned and made active before construction of the wetland treatment cells commences.

2.1.3 Other Considerations

2.1.3.1 Potential Combining and Treatment of CSO 078 with CSO 018

The CSO 078 drainage basin is located immediately to the west of the CSO 018 drainage basin (see Figure 4). Recognizing the usual cost-effective advantage of combining CSO flows for treatment, preliminary consideration was given to combining the flow from CSO 078 with the flow from CSO 018 and treating this combined flow in a constructed wetlands treatment facility located in the vicinity of CSO 018.

While the potential advantages were recognized, there are no definite plans by OCDWEP to combine these CSOs into one CSO treatment facility in the near future. Due to the potential advantages of combining flows in the future after construction of the pilot facility to treat the CSO 018 flows, this option remains viable and has been given consideration. While a grit and floatables removal facility is proposed at the present time just for CSO 018, an area immediately adjacent to this facility is available for construction of a similar grit and floatables removal facility to treat the flows from CSO 078, if the OCDWEP decides to pursue this option in the future. Therefore, the option of having two (2) adjacent grit and floatables removal units constructed immediately north of West Onondaga Street with conveyance of flows to a constructed wetlands treatment facility sized to treat both CSO 018 and CSO 078 flows remains a future possibility and has not been precluded. The current wetland treatment facility could be expanded to the south into the adjacent wetland created as part of the 1998 expansion of the stormwater management area.

The results of the pilot study will define the design criteria for the development of future wetland treatment facilities within Onondaga County and beyond, and will be the basis for determining how a potential wetland treatment facility to include CSO 078 flow could be constructed within the lands available adjacent to Harbor Brook.

2.1.3.2 Bellevue Country Club Stormwater Pond Discharge

There are two (2) stormwater detention ponds located on the Bellevue Country Club property that are believed to contribute a significant amount of snowmelt and stormwater to CSO 018 during the early spring months (shown on Figure 4). Stormwater flows are discharged over a weir structure located at the outlet of the most downstream (west) pond and into a drop manhole located at the intersection of Sunhill Terrace and Glenwood Avenue. From here, the flow is conveyed through the combined sewers in a northerly direction along Sunhill Terrace and then in an easterly direction along Bellevue Avenue to the intersection of Bellevue Avenue and Velasko Road. At this location, the regulated flow is conveyed through a 15″ combined sewer along Bellevue Avenue to the intersection of Bellevue Avenue and Upland Road (with the overflow being conveyed through the 27″ sewer along Velasko Road which flows in a northerly direction to Harbor Brook), then through a 24″ sewer in a northerly direction toward W. Onondaga Street, and finally tributary to the 48″ Rowland Trunk Sewer at W. Onondaga Street.

The estimated combined sewage discharge from CSO 018 to Harbor Brook (derived from SWMM modeling of the combined sewer system by other OCDWEP engineering consultants) includes the stormwater contribution from the Country Club ponds. Therefore, the potential future elimination of this flow contribution from CSO 018 may result in a reduction of the existing 1 year, 2 hour storm event CSO flows. However, this reduction is not believed to be significant enough (in volume or nutrient loading) to substantially impact the current sizing of the constructed wetlands facilities.

2.1.3.3 Geotechnical Investigation

A subsurface investigation was completed on the site in February 2011. A technical memorandum of our findings is included in Appendix A. The investigation revealed a varying layer of peat across the site that will impact construction of the proposed facilities. See Section 3.3.5.4 for design considerations.

2.1.3.4 Impact of Flood Levels

The Velasko Road Detention Basin has historically experienced regular flooding prior to 1980, due to lack of attenuation of stormwater flows. In 1980, a dam and a flood control structure were constructed just upstream of Holden Street which formed the Velasko Road Detention Basin (see approximate outline of the basin in Figure 4). These facilities addressed flooding issues up to a 25-year storm, with a maximum design outflow rate of 300 cubic feet per second (cfs). To provide sufficient stormwater storage within the detention basin, three (3) houses that existed along the south side of Rowland Street between Velasko Road and Holden Street were demolished. This section of Rowland Street was removed, with the exception of a gravel access driveway to the current grit removal system.

As the community grew and storm flows increased, there was a need to increase the discharge rate from the control structure to continue to protect the area from flooding up to the 25-year storm event. In about 1998, the dam was modified to include an orifice (approximately 2 ft x 2 ft in size) that allows additional flow to exit the detention pond to a design rate of about 480 cfs. Flow was directed to the orifice by excavating a channel adjacent to the Avio flood control gate. The increased flow required that the Holden, Hoeffler, and Lydell Street (east of Hoeffler Street) culverts be replaced with larger culverts and the channel from Hoeffler Street upstream to the control gate be modified. About 93,000 cubic yards of soil were excavated from the floodplain to provide additional storage capacity (about 41 acre-ft).

The highest 15 minute interval flow recorded at the structure since 1999 is 331 cfs which occurred on January 23, 2007. The highest recorded daily average flow is 177 cfs which occurred on January 19, 1996. These high flows suggest that the existing capacity of the basin has not yet been reached. The preliminary FEMA flood study dated June 2008 indicates that the 100 year storm event would result in a water elevation of +/- 402.00 (NAVD 88).

Construction of the wetland treatment system within the Velasko Road Detention Basin will require mitigation by creating compensatory storage. This is discussed further in Section 3.3.4.

2.1.3.5 Phase 1 Environmental Site Assessment

A Phase I Environmental Site Assessment is being completed for the Velasko Road Detention Basin. The preliminary findings and recommendations are not considered unusual for the current and historical uses of the area within the City of Syracuse. The preliminary results indicate that a site soil management plan should be developed for staging and disposal of site soils during construction activities. Additionally, recommendations may include a subsurface investigation to obtain a more complete understanding of adjacent or site subsurface materials identified as recognized or historic recognized environmental concerns. This will be further discussed with the County. The final Phase I Environmental Site Assessment will be provided to the County under separate cover.

2.2 Existing CSO 018 Flow Characteristics

Flow attributes of CSO 018, based on Stormwater Management Modeling (SWMM), are provided in Table 2-1 below. Brown and Caldwell created the SWMM combined sewer model, prepared under a separate contract with Onondaga County, that models combined sanitary and storm flows for the entire county. The B&C model results which incorporated the new Harbor Brook Interceptor Sewer establish the design flows for this project. A copy of the hydrograph for the 1 year, 2 hour storm event developed from this model and the associated technical memo is included in Appendix B.

TABLE 2-1
CSO 018 Attributes (Based on 2011 Stormwater Management Modeling (SWMM) Results)

Parameter	Value
Basin (Catchment) Area	145 acres
Annual CSO Flow	13.6 million gallons/year
Number of Overflow Events/Year	42
CSO Volume for 1 year, 2 hour storm event	0.70 million gallons
CSO Peak Flow Rate for1 year, 2 hour storm event	40 cfs

SECTION 3

Basis of Design

3.1 Proposed Pilot Treatment System Overview

The use of wetlands for treatment of stormwater and wastewater is an accepted practice worldwide, supported by more than fifty years of design and operational experience. Virtually all types of water have been treated with wetlands, including many applications for domestic wastewater. Constructed treatment wetland systems are typically designed based on the performance of a pilot wetland system.

The proposed pilot treatment system has been sized to treat the combined sewage flow generated at CSO 018 during the 1 year, 2 hour storm event, which is presently discharged to Harbor Brook without treatment. The system will consist of grit and floatables removal followed by constructed wetlands treatment.

Grit and floatables removal is required upstream of the wetlands treatment system to protect the constructed wetland treatment system from an influx of inorganic materials. Grit removal is required to prevent filling in of the wetland treatment cells with inert solids, thereby reducing the treatment capacity of the constructed wetlands system. Floatables removal is required to prevent clogging of the wetland cell media, prevent danger to wildlife attracted to the facility, and ensure an aesthetically pleasing and attractive area is maintained.

The constructed treatment wetlands system will provide reduction of bacteria, nutrients (nitrogen and phosphorus), total suspended solids (TSS), and 5-day biochemical oxygen demand (BOD_5).

The proposed pilot treatment system will operate as follows:

1. When a rain event occurs, the existing 48-inch combined sewer (labeled as sanitary on provided base mapping) at West Onondaga Street will begin to surcharge within the proposed grit and floatables facility.
2. The grit and floatables facility will remove the majority of grit and floatables before overflowing through an automatic siphon, where flow will be conveyed to the constructed wetlands treatment system.
3. The constructed wetlands treatment system will consist of three (3) separate and distinct cells of different types of wetlands (i.e., floating wetland island, vertical downflow wetland, and surface flow wetland), which can be operated in either series or parallel flow patterns. The variety of flow patterns will allow for flexibility to monitor the removal efficiency of key contaminants in each wetland cell.
4. Once the storm event flows have passed through the constructed wetlands, the flow will be discharged through one outfall to Harbor Brook.

Storm event flows in excess of the 40 cfs peak design flow from a 1 year, 2 hour storm will discharge from the grit and floatables facility through an overflow weir, back to the 48”

Rowland Trunk Sewer for conveyance into the new HBIS (if excess capacity exists) or routed around the treatment wetland facility for direct discharge to Harbor Brook via the facility outlet pipe. The following sections provide greater detail on the grit and floatables facility and the constructed wetlands pilot treatment system.

3.2 Grit and Floatables Facility

For the purposes of providing a design prototype, several grit and floatables systems were reviewed for this application. The proposed grit and floatables prototype system was chosen based on a technical feasibility evaluation of several types of grit and floatables removal systems. Each of the removal alternatives were evaluated based on the following criteria (listed in no particular order):

- Operational reliability
- Electrical power requirements
- Solids handling requirements
- Required maintenance
- Grit and floatables removal efficiency
- Equipment lead time
- Construction cost
- Operation and maintenance costs
- Maximizing flow diverted to wetland treatment system

Based on results of the evaluation, the Storm King with Swirl Cleanse screen was recommended as the design prototype. A copy of the technical memorandum prepared for the feasibility evaluation of alternatives has been included as Appendix C.

3.2.1 Removal Efficiencies, Sizing and System Operation

3.2.1.1 Optimizing Unit Sizing and Removal Efficiencies

Based on the design flow of 40 cfs, two (2) 28 foot diameter Storm King units would be required to remove 95 percent of all grit, sand and sediment with specific gravity of 2.65, greater than or equal to 106 microns.

Recognizing that grit concentrations are higher during wet weather events and that the grit gradation has a tendency to migrate to the coarser part of the grading curve during significant wet weather flows, a smaller unit may also be considered. Based on this assumption the unit can be alternatively sized to remove 95 percent of all grit particles that are 106 microns for smaller more frequent storm events, but target coarser material at the peak wet weather flows.

This unit would be a single 26-foot diameter structure, designed to achieve 95 percent removal of all grit, sand and sediment with specific gravity of 2.65 greater than or equal to 300 microns at the design flow of 40 cfs. The volume of the vessel would be reduced to 33,700 gallons (from 82,260 gallons in the design above) with an underflow rate (flow back to the HBIS) of 4 cfs.

This separator size will maximize flow to the wetland, provide the wetlands with appropriate preliminary treatment, while also emphasizing the treatment capabilities of the constructed wetlands. The estimated construction cost is also considerably lower than the 2 unit option and is consistent with the alternatives considered in Appendix C.

3.2.1.2 Inline/Offline Operation Options

Two alternative operation scenarios were evaluated. The alternatives include an "offline" option and "inline"option. Based on conversations with the County and modeling data received from Brown and Caldwell, 1991 is considered an average year for rainfall events and as such was used as the basis of the evaluation.

The offline option allows dry weather flow (+/- 4 cfs) to continue through the existing Rowland Street Trunk sewer and diverts wet weather flows through the grit and floatables unit to the constructed wetlands. In addition to the dry weather flow, the grit and floatables unit discharges +/- 1.33 cfs of underflow returned to the HBIS. Therefore, under this option a total of +/- 5.33 cfs would be returned to the HBIS. With offline operation, 68 percent of CSO volume and 55 percent of CSO events are diverted to the wetland.

Under the inline option, all flows (including dry weather flows) would pass through the grit and floatables unit. As such, flows returning to the HBIS will be reduced to +/- 4 cfs. With inline operation, 91.0 percent of CSO volume and 78.5 percent of CSO events are diverted to the wetland. The disadvantage of this option is that it may result in increased life-cycle costs due to increased operations and maintenance (floatables may not be flushed out of unit between CSO events due to dry weather flow configuration).

Figure 5 shows the volume of overflows that will reach the constructed wetlands under each operation scenario described above. Based on this data, the inline option will allow approximately 10 more storm events and 3.08 million gallons more CSO water to the constructed wetlands for the average year when compared to the offline option. The inline option is shown in the 50 percent design drawings as the design prototype.

3.2.1.3 Proposed System Description

Based on the evaluations described in Appendix C, and further refined as described above, the proposed grit and floatables removal system is sized to treat flow rates up to 40 cfs, as produced by the 1 year, 2 hour storm event at CSO 018, and remove 95 percent of grit, 300 microns and greater in size. The design prototype as shown in the 50 percent drawings, a Storm King with Swirl Cleanse in an "in line" configuration, is a stainless steel unit that will be installed within a 26 foot diameter cast-in place concrete chamber. A copy of the equipment cut sheets is included in Appendix D.

The design prototype uses vortex separation technology, and consists of a circular vortex chamber, with an automatic discharge siphon, and sanitary sewer return piping. When the flow in the sanitary sewer system reaches the designed level, the water will overflow to the circular vortex chamber. Floatables and water will be collected on a conical screen and returned to the sanitary system through the return piping; grit will be removed through a separate return pipe off the bottom of the vortex chamber. (Based on discussions with the County at completion of 50 percent design, final design will include the collection of grit rather than conveying it to the HBIS.) As the water level continues to rise within the chamber, the treated water will be discharged through the automatic siphon to the constructed wetlands.

The system will be equipped with an emergency overflow weir that will function and discharge any flows in excess of the 40 cfs design flow rate back into the existing 48" Rowland Trunk Sewer for conveyance into the new HBIS (if excess capacity exists) or routed around the treatment wetland facility for direct discharge to Harbor Brook via the facility outlet pipe.

3.2.2 Hydraulic Modeling

To assess the potential impacts the grit and floatables facility and associated diversion structures would have on the capacity of the upstream sewer system under high flows, CHA developed two EPA SWMM models (version 5.0) for impacted parts of the system. Both models extended from the manhole at the intersection of Bellevue Avenue and Upland Road to the existing interceptor sewer and the proposed treatment wetlands. The first model was an existing conditions model which was used to determine the depth of flow in the sewer system under the existing condition with the newly constructed HBIS. The second model was a proposed conditions model which includes the design prototype unit and associated diversion structures.

Figure 6 shows the system hydraulic gradeline in the existing sewer system from the 1 year, 2 hour storm event. The 48-inch pipe is flowing approximately half full and the upstream 24-inch pipe, between Bellevue Avenue and West Onondaga Street, is flowing full but the system is not surcharged.

Figure 6 also shows the system hydraulic gradeline for the 1 year, 2 hour storm event with the inline design prototype. The results indicated the 48" pipe is surcharged to Elevation 411.3 (NAVD 88) at the West Onondaga Street manhole which is above the 2 existing service laterals. Therefore, it is recommended that these two services be converted to grinder pumps to protect the buildings from surcharging. This is based on a limited SWMM model completed for the Basis of Design report. Brown & Caldwell will run the full CSO 018 model with the addition of the inline Storm King unit to verify these hydraulic gradeline elevations during final design.

3.3 Constructed Wetlands Pilot Treatment System

3.3.1 General Wetlands Description

3.3.1.1 Target Flows

The intent of the constructed pilot treatment wetland is to capture and treat the CSO 018 discharge resulting from up to the 1-year, 2-hour storm event. Flows in excess of the 40 cfs peak flow associated with the design storm will discharge from the grit and floatables facility through an overflow weir, back to the 48" Rowland Trunk Sewer for conveyance into the new HBIS (if excess capacity exists) or routed around the treatment wetland facility for direct discharge to Harbor Brook via the facility outlet pipe.

Due to the nature of the open wetland system, CSO volumes (from longer duration storms) in excess of the design storm volume can be accepted; however, treatment performance will be variable from event to event, with higher removal efficiencies during shorter duration storm events, and lower efficiencies during longer duration storm events due to greater dilution from rainfall. During extreme storm events, manually operated valves will allow flexibility in directing flows. The options that will be considered are allowing excess flow to travel through the wetland or bypassing flow around the wetland if required to maintain the integrity of the wetland plantings and berms.

3.3.1.2 Wetland Performance Objectives

As stated previously, the goal of the constructed treatment wetland is to sufficiently reduce contaminant levels in the CSO 018 flow resulting from the 1 year, 2 hour storm event. Since flows will be episodic with higher and lower flows over a 24 hr period, the discharge quality will be somewhat variable but on average will achieve the goal of improving the CSO water quality. The pilot testing program will define the actual treatment efficiency of the wetland system and will help determine modifications required, if any, to improve the performance.

As previously presented in the Project Definition Report, a summary of average annual contaminant reductions that are expected for the wetland treatment system and the reduced load to Harbor Brook is presented in Table 3-1. These data do not incorporate the addition of the grit and floatables removal system. The removal of grit and floatables prior to the constructed treatment wetlands will contribute to optimal performance and lead to better overall water quality discharged to Harbor Brook, and it will minimize the maintenance required for the treatment wetlands to achieve removal efficiencies as shown in Table 3-1.

TABLE 3-1
Potential Contaminant Reductions to Harbor Brook from the Proposed CSO 018 Treatment Wetland

Constituent	Inflow Concentration (mg/L)[1]	Annual Average Reduction Range (%)[2]	Annual Average Outflow Concentration Range (mg/L)	Annual Load Reduction (Tons/yr)[3]
BOD_5	30.38	50 – 80	6 – 15	1.1 – 1.7
TSS	100.25	50 – 90	10 – 50	3.5 – 6.3
TKN[4]	4.14	20 – 40[5]	2.5 – 3.3	0.06 – 0.11
P	0.78	20 – 40[5]	0.5 – 0.6	0.013 – 0.020
Fecal Coliform	430,000	3 orders of magnitude	430	
Total Load Reduction				4.7 – 9.1[6]

Notes:

[1] Based on SUNY ESF report “Creating Stormwater Treatment Wetlands for Harbor Brook, Syracuse, New York: An Urban Ecosystem Educational Partnership – Part II of the CNY Watershed Project, Smardon and Wu

[2] Annual average concentration reductions are based on literature including the North American Wetland database, USEPA (1996), Treatment Wetland – Second Edition, Kadlec and Wallace (2009), and experience by CH2M HILL treatment wetland technologists.

[3] Based on 18.6 MG/yr CSO 018 discharge flow

[4] TKN = Total Kjeldahl Nitrogen

[5] Higher reductions may be achieved during warmer temperatures (i.e., summer season) of up to 90% depending on flow rate and concentration

[6] Sum of BOD_5, TSS, TKN, and P loading values

3.3.2 Seasonal Effectiveness

Seasonal effectiveness of constructed wetland systems is well documented in Kadlec and Wallace (for reference, see footnote 2 of Table 3-1). Each constituent has a rate constant (theta) value assigned to it that indicates the degree to which the fluctuation in water temperature will affect the removal efficiency. For example, total suspended solids, BOD_5 and total phosphorus reduction are temperature independent and have theta values of 1. In other words, performance in summer and winter is expected to remain unchanged on an average seasonal basis. Nitrogen reduction is very dependent on temperature with a theta value of 1.04, and as the temperature falls, nitrogen reduction becomes less efficient. When the water temperature falls below about 40°F, nitrification and denitrification are reduced to close to zero.

Wetlands for water quality improvement of wastewater flows have been documented in North America since the early 1900s. Examples of northern wetlands with starting dates include: Lexington, Massachusetts (1912), Brillion Marsh, Wisconsin (1923), and Cootes Paradise, Hamilton, Ontario (1919). Wetlands for treating leachate and wastewater have been reported on in Alaska, Yukon, and Northwest Territories from the mid-1960s on. CSO flows have been treated in Europe since the mid 1980s.

3.3.3 Proposed Types of Constructed Wetland Cells

Three (3) types of wetland cells have been selected for inclusion in this full scale pilot project to determine the optimal CSO treatment potential and configuration (in series, in parallel, and in series/parallel). These include:

- Floating Wetland Island (FWI)
- Vertical Down Flow (VDF)
- Surface Flow (SF) wetlands

Flow control structures will be configured to allow discharge from CSO 018 to enter each wetland cell directly and then be discharged directly to Harbor Brook (parallel operation). In addition, the wetlands will be able to operate in series, flowing from the FWI to the VDF and then finally to the SF cell or in a combination of parallel and series with flow discharge from the FWI being split between the VDF and the SF wetlands before combining and discharging to Harbor Brook. A summary describing each wetland component is presented in the Table 3-2. A brief description of each wetland type follows.

TABLE 3-2
Wetland Treatment Components

Component	FWI	VDF	SF
Area (ft^2)	12,217	10,562	11,012
Normal Depth (NWL) (ft)	1	0	0.5
Max Event Depth (EWL) (ft)	4.0	1.5	1.5
Side slopes	3:1	3:1	3:1

3.3.3.1 Floating Wetland Island

The Floating Wetland Island (FWI) is a man-made floating island of wetland vegetation with roots that extend down into the water column below the island mat. The use of FWI for domestic wastewater treatment is a relatively recent application of a process that has been used in the mining industry for many years. It is somewhat similar to the floating aquatic vegetation type of wetland technology that typically used duckweed or water hyacinth plants, which naturally have the leaves floating on the water surface, to vegetate the wetland. While these latter plants needed to be harvested to remove the contaminants, the FWI vegetation does not need to be removed in order to provide water quality improvement. Native species will be used for FWI vegetation.

This cell will be drained to a low water elevation of about 1 foot of water depth between CSO events and will fill to about 5 feet of water depth before overtopping to the next cell. This expected changing water level is another good reason for using this type of wetland for this application; the cell can provide a high storage volume for storm flows, but plants will not become flooded for long periods of time as they would if planted into the wetland bottom soils.

The FWI cell will have greater diversity of vegetation, since the depth of water over the root portion of the plants will be consistently low, with the roots themselves always submerged. The combination of open water and diverse plant species will provide pleasing aesthetics and high habitat value but low mosquito productivity when compared with a natural wetland, since mosquito predators will be maintained in this environment.

3.3.3.2 Vertical Down Flow Wetland

The Vertical Down Flow (VDF) wetland cell will have water entering either directly from CSO 018 or from the FWI cell. CSO water will be dosed into Cell 2 from Cell 1 using an automated control valve to the top of the wetland through riser pipes onto splash pads that distribute the flow across the wetland surface. When flow is added directly to Cell 2 from the grit/floatables removal system in the parallel flow mode, the flow will be added continuously to the gravel bed. The water will percolate down through the wetland sand and gravel bed, where the water will be collected in a perforated header piping system and then directed to either the Surface Flow Wetland or Harbor Brook. The VDF wetland will be dosed at a rate of +/- 55,000 gallons per dose. Once the initial dose has run through the gravel and discharged through the under drain, the cell will be dosed again. This process will continue until the water volume in the FWI (Cell 1) returns to its normal water level (NWL) of 396.50 (NAVD 88).

The VDF wetland cell is expected to have a more robust range of vegetation, since this cell will be flooded and drained regularly. Native species such as cattail and bulrush are the most likely candidate species for planting.

Benefits of VDF cells are that there is no open water and therefore no mosquito productivity, and there is limited CSO water exposure potential to the public.

3.3.3.3 Surface Flow Wetland

The Surface Flow (SF) wetland most closely resembles a natural wetland, and is also generally the lowest cost per unit area to build and maintain. It will have a vegetated shelf that will be about one-half to one foot deep under dry-weather water level conditions and three feet deep water areas (deep zones) that will help with redistributing flow to reduce the potential for short-circuiting. They will provide re-aeration, as well as a refuge for wildlife. The SF cell will have the potential for increased water depth for greater CSO water storage and treatment prior to overflowing to Harbor Brook. The SF wetland outfall is a 30-inch pipe with an invert of 392.5 (NAVD 88). Stop logs in the outlet structure will set the discharge elevation at 393.00 (NAVD 88) allowing 6 inches of standing water within the wetland.

The SF wetland with constant standing water and regular flooding will also require a robust plant, but will likely be most favorable for native species such as cattail and bulrush. Volunteer

Phragmites from seeds carried in by wind and water will tend to have a more difficult time germinating and becoming established in standing water.

As with the FWI, the combination of open water and plantings will provide high habitat value but low mosquito productivity when compared with a natural wetland, since mosquito predators will be maintained in this environment.

Benefits of SF wetlands are that it provides high storage volume to contain CSO storm flows, it is aesthetically pleasing with open water and wetland vegetation, it has low mosquito productivity due to high predator populations, and the relative cost compared to the other wetlands is low.

3.3.4 Wetlands Hydraulic Modeling

To assess the hydraulic capacity and performance of the treatment wetlands system for the 1 year, 2 hour storm event, a SWMM (EPA SWMM version 5.0) model was developed of the wetlands and the associated hydraulic control structures. The wetlands SWMM extends from the outlet of the grit and floatables removal system and through the treatment wetlands where it discharges into the relocated stream at the east end of the wetlands. The model includes all of the wetland treatment cells (floating wetlands, vertical down-flow, and surface flow), culverts, manholes, gates, valves, diversion structures, and valve control rules required to operate the treatment wetlands. Using the SWMM, three hydraulic operational flow scenarios were modeled; these include the Series, Series-Parallel and Parallel Flow scenarios.

Due to EPA SWMM limitations, the infiltration/underdrain flow response resulting from the dosing of Cell 2 was modeled in a separate model using the Low Impact Development functionality built into EPA SWMM. This modeled response was then replicated in the wetlands model using a custom drainage rating curve. A hydraulic conductivity of 10 in/hr was used for this part of the analysis. While the actual hydraulic conductivity is expected to be slightly higher, this rate is conservative from a capacity perspective and allows for some loss of conductivity over the life of the wetland.

The following sections provide a brief summary of how the treatment wetlands are expected to function under each scenario.

3.3.4.1 Series Flow Scenario

Under the Series Flow scenario the model shows that Cell 1 can contain the entire 700,000 gallon (93,600 ft^3) 1 year, 2 hour storm event from the CSO without overtopping the Cell 1 embankments. Under this scenario, the 1 year, 2 hour storm event is held in Cell 1 and dosed by gravity into Cell 2 using a dose volume of 55,000 gallons/dose (7,350 ft^3/dose) which is equivalent to a depth of 6 inches over the surface area of Cell 2. After Cell 2 is dosed, the water is allowed to infiltrate and drain completely before the cell is dosed again. It takes about 6 hours for the water to infiltrate into the Cell 2 media and pass though Cell 3 and for Cell 3 to return back to the normal water level of 393.0 feet (NAVD 88). This dosing and infiltrating cycle occurs 12 times following the 1 year, 2 hour storm event. Under this scenario it takes about 88 hours for the design storm to pass though the treatment wetlands and for the wetlands to return to the initial condition water levels. The volume hydrographs in each of the cells under this scenario are included in Figure 7.

3.3.4.2 Series-Parallel Flow Scenario

Under the Series-Parallel Flow Scenario the entire 1 year, 2 hour storm event is sent directly into Cell 1 and contained. The "top half" of the Cell 1 storage is sent to Cell 3 and allowed to drain into Harbor Brook before the dosing of Cell 2 is started. In order for the Cell 2 infiltration to function as designed, Cell 3 needs to be at or below elevation 393.1 feet (NAVD 88) before Cell 2 is dosed. Cell 2 is dosed at a rate of 55,000 gallons/dose. The parallel portions of this treatment scenario are run one after the other so that the water going from Cell 1 to Cell 3 does not prevent Cell 2 from functioning properly. Under this scenario it takes about 58 hours for the design storm to pass though the treatment wetlands and for the wetlands to return to the initial condition water levels. The volume hydrographs in each of the cells under this scenario are included in Figure 8.

3.3.4.3 Parallel Flow Scenario

Under the Parallel Flow Scenario, one third of the 700,000 gallon (93,600 ft^3) 1 year, 2 hour storm event is sent directly to each of the wetlands cells. The flow is split in flow diversion structures #6 and #8. The volume sent to each cell ranges from 180,000 to 248,000 gallons (24,000 to 33,400 ft^3). Discharges from each wetland cell are directed via flow control structures to a common structure to a single pipe discharge to Harbor Brook. Under this scenario it takes about 14 hours for the design storm to pass though the treatment wetlands and for the wetlands to return to the initial condition water levels. The volume hydrographs in each of the cells under this scenario are included in Figure 9.

3.3.4.4 Potential Impacts of High Water Levels in Harbor Brook

The impact of high water levels in Harbor Brook was considered while modeling the hydraulics and operations of the treatment wetlands, but not explicitly modeled. Under each of the operational scenarios modeled, the primary factor that controls how long it takes the wetlands to return back to the initial condition water levels is the water level in Cell 3. When water levels are below 393.0 feet (NAVD 88) in Harbor Brook they have little or no effect on the time it takes for flows to pass though the treatment wetlands. When water levels in Harbor Brook (and as a result in Cell 3) are above 393.0 feet (NAVD 88), the dosing system does not activate. This means that under the Series and Series-Parallel scenarios the dosing portion of the treatment doesn't begin until the water levels in Harbor Brook have receded to below 393.0 feet (NAVD 88). Under the Parallel scenario regardless of the water levels in Harbor Brook the wetland inflows are allowed to flow freely; the water levels in Cells 2 and 3 will recede at approximately the same rate as the water levels in Harbor Brook.

A rising Harbor Brook will be isolated from the constructed wetlands by an inline check valve on the wetland discharge pipe. As water levels in the Velasko Road Detention Basin rise above the wetland controlled berm spillways, stormwater flows will enter and flood the wetland facility.

3.3.5 Other Considerations

3.3.5.1 Water Table Elevation

As part of the geotechnical investigation, six piezometers were installed across the site to monitor the water table elevation during the pilot study monitoring period (see Figure 1 of Appendix A "well locations"and Plan Sheet C-1001). Table 3-2 shows the recorded water table elevations for measurements taken to date. It is expected that the level will fluctuate depending on season, rainfall, frost, etc.

TABLE 3-3
Groundwater monitoring data

Date	Well #	Boring #	Ground Elevation	Surface to Groundwater (ft)	Ground water Elevation
1.20.2011	1	B-15*	396.0	5.31’	390.2
	2	B-9	395.5	3.50’	392.8
	3	B-11	396.3	3.15’	392.7
	4	B-5	396.8	3.81’	391.7
	5	B-2	395.8	1.30’	394.7
	6	B-10	395.5	1.49’	395.3
4.8.2011	1	B-15	396.0	1.38’	394.12
	2	B-9	395.5	2.07’	394.23
	3	B-11	396.3	1.84’	393.96
	4	B-5	396.8	2.74’	392.76
	5	B-2	395.8	1.21’	394.79
	6	B-10	395.5	1.16’	395.64
4.29.2011	1	B-15	396.0	0.46’	395.04
	2	B-9	395.5	1.1’	395.20
	3	B-11	396.3	0.45’	395.35
	4	B-5	396.8	0.65’	394.85
	5	B-2	395.8	0.02’	395.98
	6	B-10	395.5	0.55’	397.35

* Refers to the boring/well locations indicated on Boring Location Plan.

3.3.5.2 Discharge Location to Harbor Brook

In order to maintain good flow through the wetland system without pumping, a reasonable grade is required. The proposed discharge location is to an existing drainage ditch that discharges to Harbor Brook just up-gradient of the flow control structure of the Velasko Road Detention Basin. Note that the water level of Harbor Brook under base flow conditions has averaged about 392.3 NGVD 29 (approximately 391.7 NAVD 88) feet based on flow and level measurements recorded by US Geological Survey since about 1998 when modifications were made to the outlet structure. This establishes the surface flow wetland bottom elevation.

The normal water elevation in the surface flow (Cell 3) wetland will be 393.0 NAVD 88 and the outfall to Harbor Brook will be set at this elevation. As noted above, water levels in Harbor Brook will impact the discharge rate from the constructed wetland facility. However, since the proposed wetlands will accommodate the CSO volume from the design storm, treatment will be delayed until the storm runoff in Harbor Brook recedes below 393.0 (NAVD 88).

Discharge to Harbor Brook will be through 36-inch HDPE piping combined from the discharge from Cells 1, 2, and 3 and the bypass piping north of the proposed wetlands. The flow rate will be metered by a pressure transducer or radar flow meter and pass through an inline check valve prior to being discharged through an outfall structure to Harbor Brook.

3.3.5.3 Berms and Maximum Water Depths

In order to accommodate the CSO volume associated with the 1 year, 2 hour storm event, and provide 1 foot of freeboard, the berm height required around Cell 1 – Floating Wetland Island is Elev. 402.00 (NAVD 88). Berm heights associated with the Cell 2 - Vertical Down Flow Wetland and Cell 3 – Surface Wetland are dictated by the desire to isolate the treatment wetlands from the stormwater within the Velasko Road Detention Basin area. Based on the preliminary FEMA flood study dated June 2008 (which provides information related to a maximum 100-year storm event), the 10 year storm event would result in a water elevation of +/-399.5 (NAVD 88). As such, the lower wetland cells would be protected for storm events smaller than the 10 year storm. The berms have been designed with emergency spillways to allow w the free flow of flood waters into and out of the wetland cells. During storm events where the water storage required in the Velasko Road Detention Basin exceeds the spillway elevation of the lower wetland cells (Elev. 396.00 NAVD 88), the wetland cells will be flooded with stormwater. As the storage volume recedes, storm water will be released through the emergency spillway until it reaches the spillway elevation. Water in the cells below the spillway elevation will be stored until the Velasko Road Detention Basin recedes to an elevation which allows the remaining water in the cells to flow through the wetlands to the Harbor Book outfall.

3.3.5.4 Geotechnical Recommendations

The technical memo in Appendix A recommends that, for larger structures and loadings, the layer of peat be removed from below the structures and replaced with structural fill. It also recommends that depending on the bury depth of various pipes, restrained joints be considered to provide additional protection from joint separation.

The wetland cell berms should be constructed with silty clay and clayey silt soils, classified as MH or CL in the Unified Soil Classification System, with no sizes larger than 3 inches and at least 75 percent by dry weight of fines passing the No. 200 standard sieve size. The plasticity index of the soil should be at least 15. The coefficient of permeability of the soil should be less than 1×10^{-5} centimeters per second when compacted to a minimum of 90 percent of standard Proctor maximum dry density at a moisture content wet of optimum. Note that these soils are not available on-site and will need to be imported. There is also peat at the location of the wetlands and it is recommended that a stabilization fabric (Mirafi 600x, or equal) be installed on top of the native soil. Removal of the peat at the location of the berms will not be required.

3.3.5.5 Cell Lining

Cells 1 and 2 will have HDPE liners as they will be required for these types of systems, and since these cells will not benefit from groundwater to keep plants viable during drought conditions. If Cell 3 remains unlined, it will benefit from shallow groundwater as a source of water for the deep zones. This will provide shallow groundwater for Cell 3 and will be used for watering Cells 1 and 2 to keep all plants viable during drought conditions. As is typical for wetland systems that are unlined, the bottom of the wetland will self seal over time due to sedimentation that blinds the bottom pores. Negative impact to groundwater from CSO flows is expected to be minimal; during most flow conditions, Cell 3 receives pretreated water from either Cell 1 or 2. Monitoring wells around the unlined Cell 3 will be a part of the experimental program to determine if groundwater becomes impacted by infiltration from Cell 3.

3.3.5.6 Compensatory Storage – Velasko Road Detention Basin

Since the proposed project is located within the Velasko Road Detention Basin, construction of the wetland treatment system will reduce the storage volume available in the basin. As such it will be necessary to make up that storage volume lost to the wetlands by constructing compensatory storage within the existing basin. In order to account for potential back to back storm events, compensatory storage will be required for the berm volumes plus the storage volume in the wetland cells. Based on the proposed wetland grading plan, the berm volume is 2.07 Acre-Feet (AF) and the cell volumes are 2.55 AF (Cell 1), 1.63 AF (Cell 2), and 0.63 AF (Cell 3). The total required compensatory storage is 6.88 AF.

Figure 10 shows areas within the basin where the required compensatory storage will be provided. The current plan is to stay within County owned property and not impact existing wetlands on site. A topographic survey of the area was underway during the preparation of this report. Based on the County LiDAR mapping the areas identified are estimated to provide up to 7.95 Acre Feet for storage.

3.3.5.7 Wetland Level Control

Flow control through the constructed wetlands will consist of a series of flow diversion structures (FDS) combined with pressure transducers located in each wetland cell. Please refer to the Basis-of-Design drawings for the locations of the diversion structures within the constructed wetlands system.

The constructed wetland treatment system will operate as follows: When the system is operating in series, the pressure transducer in FDS #11 will activate (open) a 12-inch butterfly valve when the desired elevation is reached such that wetland Cell 2 will be dosed approximately 55,000 gallons of water (6 inch depth equivalent over the area of Cell 2). The valve will close based on a predetermined duration of discharge. A second pressure transducer in FDS #13 will determine when wetland Cell 3 can accept additional flow and will not allow the valve to open until the predetermined water level has been reached. The dosing process will continue until the water level within Cell 1 drops below the valve-off elevation indicated by the pressure transducer. A copy of the equipment cut sheets for the pressure transducer and butterfly valve have been included as Appendix E.

3.3.5.8 Site Security

The grit and floatables removal facility and the constructed pilot wetlands area will each be secured by a fence to prevent trespass and access to the control valves and monitoring equipment. Gates will be provided at appropriate locations to allow access for operation and maintenance of the facility. A chain link fence is assumed for the Basis of Design, but the final fence selection will occur during final design.

SECTION 4

Permitting

Investigations for State and federally regulated environmental resources were conducted at the project site, identifying that the project area contains federally regulated wetlands and a state and federally regulated stream (Harbor Brook). A copy of Wetland Delineation Report is included as Appendix F. It was also determined that the project site is within a stormwater management basin used to protect downstream residents from flooding up to the 25-year storm event. The pilot project will result in the relocation of the existing CSO 18 outfall to Harbor Brook, allowing the majority of the flow from this CSO to enter the pilot wetlands for treatment before discharging to Harbor Brook. Construction of the wetland pilot treatment system will also require the relocation of a ditch with wetland vegetation. As a result, the following permits and approvals will be required:

- State Pollutant Discharge Elimination System (SPDES) permit modification from NYS Department of Environmental Conservation (NYSDEC) for CSO 18 to address relocation and treatment.
- State Environmental Quality Review (SEQR). The project will require review under the State Environmental Quality Review Act (SEQR). It has been identified as a Type 1 action and is undergoing coordinated review with the involved agencies. Onondaga County intends to serve as Lead Agency. A full environmental assessment form (FEAF) has been prepared and will provide the basis for a determination of significance. Since the project is intended to improve water quality from CSO 18 and the project impacts are occurring on previously disturbed lands, it is anticipated that a Negative Declaration will be issued.
- U.S. Army Corps of Engineers (USACE) Nationwide Permit (NWP) No. 43 – Stormwater Management Facilities to relocate the outfall and impacts to the wetland ditch that will be relocated to facilitate treatment facility design.
- Article 15 Protection of Waters permit modification from NYSDEC for impacts to Harbor Brook (Class B waters) associated with the relocated outfall. It is assumed that the existing permit for the interceptor sewer project associated with the Harbor Brook watershed can be modified.
- Section 401 Water Quality Certification from NYSDEC, required in conjunction with the authorization of the NWPs and the Article 15 permit. This certification addresses the placement of clean fill and proper erosion and sedimentation controls.
- SPDES General Construction Permit for land disturbance in excess of one acre. A Stormwater Pollution Prevention Plan will be prepared and a Notice of Intent submitted to NYSDEC. Depending on how much land is disturbed at any one time, a 5-acre waiver may be required.
- Coordination with the NYS Natural Heritage Program, U.S. Fish and Wildlife Service, and NYS Office of Parks, Recreation and Historic Preservation to ensure no impacts to protected

species and cultural resources. This coordination is required as part of the general permit conditions for the Nationwide Permits, Water Quality Certification, and the Article 15 Permit.

- The placement of fill within the stormwater management basin associated with Harbor Brook will require compensatory storage. Approval for the fill and associated compensatory storage will be required from Onondaga County Department of Water Environment Protection.
- City of Syracuse curb cut permit for access road to grit and floatables facility

A Joint Application for Permit will be prepared and submitted to NYSDEC and USACE to obtain the permits identified above. Wetland impacts will include approximately 0.20 acre of wetland ditch that will be mitigated by replacement in kind.

SECTION 5

Operations, Maintenance, and Monitoring

5.1 Operations and Maintenance

The constructed wetlands pilot treatment system has been designed to minimize the operations and maintenance required to run the system. The grit and floatables system does not have any moving parts or require power. The only electrical components of the system are the pressure transducers and actuated butterfly valves located within the constructed wetland cells as well as the level sensing devices for flow measurement and automatic sampling equipment. A summary of the specific operations and maintenance required for each system is outlined below.

5.1.1 Grit and Floatables Removal System

Since there are no moving parts associated with the design prototype, operations and maintenance of the system will be relatively simple. After the unit is used to treat a wet-weather event, the equipment should be checked to make sure all residual floatables have been removed from the top screen. This can be accomplished by spraying down the screen with a high pressure hose. Floatables not removed from the screen following a rain event should be manually removed to prevent odors from building up in and around the system and maintaining an aesthetically pleasing environment.

5.1.2 Wetlands Treatment System

5.1.2.1 Operations

Design of the wetland treatment area includes a number of flow control structures with weirs and gates to direct and control flows under various flow scenarios. Gates and weirs in these structures will require adjustments as different treatment alternatives are evaluated. Gates in the flow diversion structures and manholes will be operated from the surface by a pull chain during dry weather when not in operation. The gates in manhole 5 are the only gates that may require operation under flow conditions; as such these gates will have manual gate operators and floor stands mounted on the top of the structure. Table 5-1 below identifies the various gate positions to achieve the three flow scenarios; Series, Parallel, and Series + Parallel. A summary of the various flow scenarios is included in Appendix G.

TABLE 5-1
Wetland System Diversion Gate Configurations

Gate	Series	Parallel	Series & Parallel
5A	Open	Open	Open
5B	Closed	Closed	Closed
6A	Closed	Open	Closed
7A	Closed	Closed	Open

TABLE 5-1
Wetland System Diversion Gate Configurations

Gate	Series	Parallel	Series & Parallel
8B	Closed	Open	Closed
11A	Closed	Open	Open
12 Dosing Valve	Open	Closed	Closed
13A	Open	Closed	Closed
13B	Closed	Open	Open

5.1.2.2 Make-up Flow to Wetland (Low Flow Conditions)

During prolonged periods between storm events it may be necessary to provide supplemental water to the wetlands Cells 1 and 2 to keep plants viable. Groundwater levels are anticipated to be sufficient to provide this required moisture for Cell 3 since it is expected to be unlined. The current design includes a wet well (MH # 19) which is supplied with water from the Cell 3 deep zone. During low CSO flows to the wetlands, a temporary pump will be set up to pump water into the wetland Cell 1 and Cell 2 from the Cell 3 deep zone, via MH #19. As groundwater data is collected through this spring and through the pilot study, the design will be modified accordingly. As a secondary source of water, the temporary pump could be set up to draw water from Harbor Brook or from the stormwater box culvert adjacent to Velasko Road. Water that is pumped into the constructed wetlands will flow through the system back to Harbor Brook.

5.1.2.3 Vector Control

Natural wetlands are subject to wide variations in water level as flood waters inundate a wetland area and recede, and this variation allows mosquito populations to expand rapidly as the fast-growing mosquitoes mature before populations of predator species are established. In contrast, Cells 1 and 3 will be designed to maintain a minimum water level, so that the populations of aquatic predators which feed upon mosquito larvae (including minnows and aquatic insects) are sustained. Cell 2 will not produce mosquitoes since there will be no standing water. Thus, mosquito populations are not expected to increase as a result of the project, but if necessary, additional measures such as erecting bat roosting boxes and bird nesting boxes (particularly for swallows) will also help to keep the mosquito population lower. Mosquito specific larvacides can be used for mosquito control if required. This addresses the problem before they emerge.

5.1.2.4 Nuisance Wildlife Control

While one intention of creating wetlands is to encourage wildlife use, overuse of the wetland by certain species can cause damage that can be costly to repair or take a long time to naturally regenerate. During the start-up of wetland systems, the young wetland plants are vulnerable to grazing by waterfowl. Controls, which may include overhead filament wires and bird scare tape and perimeter snow fencing, may be required. Once the vegetation is established, concern is shifted to nuisance wildlife such as muskrats that can completely eat out wetlands if they do not have natural predators to keep their populations under control. They can also negatively impact the integrity of the berms. Construction of a nuisance wildlife exclusion fence around the perimeter of the wetland at the start of the project is the best way to keep nuisance wildlife from migrating into the wetland.

5.1.2.5 Odor Control

Constructed treatment wetlands, once fully vegetated, are designed to minimize odor potential. Odors will be addressed by maintaining an appropriate water level in the wetlands and keeping the cells flooded with 6″ to 1′ of water above the anoxic wetland soils that are a critical component for retaining bound metals and phosphorous and for reducing the nitrite and nitrate concentrations through denitrification. Wetland systems with odorous conditions are rare, and these are typically systems that are not properly operated or are poorly designed. With proper operation, odor problems from the grit and floatables and wetland are not anticipated. If there are fugitive odors, the intent of the pilot program will be to determine the source and solution.

5.2 Monitoring

The State University of New York, College of Environmental Science and Forestry (SUNY ESF) under the guidance of CH2M HILL will be responsible for monitoring the system during the pilot phase. The monitoring will include sampling of stormwater quality into and out of the grit and floatables systems as well as each wetland cell during at least three CSO events per season over a two year period (i.e., 24 sampling events). The data will be compiled and evaluated and then reports prepared summarizing the data and the system performance. SUNY ESF will also visually monitor the berms to determine if there are obvious integrity issues, record vegetation health and density, inventory wildlife seen on the site, measure water levels in each cell, and other activities. They will be on the site at least once per week for the duration of the monitoring program.

Wetland sampling and flow metering points will be located throughout the constructed wetland cells as well as the bypass manholes such that a complete mass balance can be performed on the system. Table 5-2 identifies flow metering and sampling locations to monitor the three flow scenarios; Series, Parallel, and Series + Parallel.

Grab samples will be collected by SUNY ESF in addition to samples taken by automatic sampling units. The locations of the automatic sampling units will be shown on the final design drawings. Automatic sampling protocols will be determined as part of the final design. Flow metering will be accomplished by in-pipe flow meters that will be capable of being transferred to different locations within the constructed wetlands based on the flow scenario operation.

TABLE 5-2
Sampling and Flow Metering Locations

Locations	Series	Parallel	Series & Parallel
Sampling (structures)	MH’s: 5, 11, 13, 18	MH’s: 5, 11, 13, 18, 19	MH’s: 5, 11, 13, 18, 19
Flow Metering	MH’s: 5, 18	MH’s: 5, 6, 8, 10, 18	MH’s: 5, 7, 8, 11, 18

In addition, as required in the County's Proposed Modifications to the Ambient Monitoring Program Work Plan (AMP) dated May 14, 2010, a water level sensor will be installed in the outlet pipe discharge to Harbor Brook. This sensor will measure water level and CSO activation duration resulting from the combined flows discharged from the constructed treatment wetland facility and flows routed from the existing CSO 018 structure.

SECTION 6
Project Schedule

The following schedule in Table 6-1 was set for the project in order to begin the pilot program as quickly as possible. Several work items such as permit review and pre-ordering equipment and plants could delay or accelerate this schedule. In addition, phasing of work to allow for earlier construction start dates is under consideration.

TABLE 6-1
Proposed Project Schedule

Work Item	Start	Completion
Basis of Design Report (30 - 50%)	February 2011	May 2011
Final Design (50 - 90%)	May 2011	June 2011
Permit Submittal and Review	July 2011	August 2011
NYSDEC Public Notice and Permit Issue	August 2011	September 2011
Construction Tender Documents	July 2011	July 2011
Procurement (Bidding)	August 2011	September 2011
Construction	September 2011	November 2011
Planting	Spring 2012	Spring 2012
Evaluation	2012	2015

SECTION 7

Project Cost Opinion

A conceptual planning-level construction cost opinion was prepared for the full scale constructed wetland pilot treatment system for preliminary budget planning and is presented in Table 7-1.

TABLE 7-1
Construction Cost Opinion

Item	Cost Basis	Totals
Grit and Floatables Removal System		$1,786,000
Grit & Floatables and Wetlands Electrical		$89,000
Wetland Cells		
Cell 1 FWI		$540,000
Cell 2 VDF		$417,000
Cell 3 SF		$205,000
Subtotal		$3,037,000
Contractor Overhead (10%)	$3,037,000	$304,000
		$3,341,000
Profit (5%)	$3,341,000	$168,000
		$3,509,000
Mobilization/Bonds/Insurances (5%)	$3,509,000	$176,000
		$3,685,000
Contingency (20%)	$3,685,000	$737,000
		$4,422,000
Escalation (to mid-point of construction) (7.9%)	$4,422,000	$350,000
		$4,772,000
Local Adjustment Factor (96.5%)	$4,772,000	$4,605,000
Market Adjustment Factor (5%)	$4,605,000	$4,836,000
Total Construction Cost Opinion		**$4,836,000**
Engineering, Legal and Administrative Costs		
Permitting (1%)	$4,836,000	$49,000
Engineering (20%)	$4,836,000	$968,000

TABLE 7-1
Construction Cost Opinion

Item	Cost Basis	Totals
Services During Construction (4%)	$4,836,000	$194,000
Startup Services (1%)	$4,836,000	$49,000
Legal and Admin (5%)	$4,836,000	$242,000
Subtotal		$1,502,000
Total Project Cost Opinion		**$6,338,000**

The cost estimates presented in this engineering report are "order-of-magnitude" (Level 3) estimates, as defined by the American National Standards Institute (ANSI) and The Association for the Advancement of Cost Engineering International (AACE International) as "approximate estimates made without detailed engineering data. It is normally expected that estimates of this type will be accurate within plus 30 percent or minus 20 percent." This range implies that there is a high probability that the final project cost will fall within the range.

A 20% contingency has been included in these cost estimates as a provision for unforeseeable, additional costs within the general bounds of the project scope; particularly where previous experience has shown that unforeseeable events that will increase costs are likely to occur. The contingency in these estimates consists of two components: 1) Bid Contingency covers the unknown costs associated with constructing a given project scope, such as adverse weather conditions, strikes by material suppliers, geotechnical unknowns, and unfavorable market conditions for a particular project scope; and 2) Scope Contingency covers scope changes that may occur during final design and implementation.

The cost estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimates. The final cost for the project will depend on such criteria as actual labor and material costs, competitive market conditions, actual site conditions, final project scope, and other variables. As a result, the final project cost will vary from this estimate. The proximity to actual costs will depend on how close the assumptions of this estimate match final project conditions. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help assure proper project evaluation and adequate funding.