City of Aurora – Fox Metro Water Reclamation District – Valley of the Fox Sierra Club

Green Infrastructure for CSO Control

Final Report

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1.0 Introduction

The City of Aurora lies within Kane, Kendall, DuPage, and Will Counties and encompasses over 45 square miles. Approximately 24%, or 11 square miles, of the City is served by combined sewers. Around 10.7 square miles of the combined sewer system (CSS) area drains directly to the main stem of the Fox River via surface flow, storm sewers, and combined sewer overflows. The remaining 0.3 square miles of the CSS drains to Indian Creek, and ultimately enters the Fox River about 0.6 miles upstream of the City's downtown. The Fox Metro Water Reclamation District (FMWRD) treats the sewage from the City's separate sanitary sewer system, and the dry weather flows from the combined system. The FMWRD also treats a portion of the stormwater that drains into Aurora's combined sewer system.

Some of the problems associated with Aurora's combined sewers include basement sewer backups, street flooding, and combined sewer overflows (CSO's) into the Fox River and Indian Creek. A CSO consists of the discharge of raw sewage mixed with stormwater runoff. The City has a total of 15 permitted CSO's.

The Fox River Watershed is on the State's 303(d) list of impaired waters. The 303(d) list indicates that potential causes of impairment include pH, phosphorous, sedimentation/siltation, dissolved oxygen, suspended solids, mercury, PCBs, and fecal coliform. Water quality sampling performed by the Fox Metro Water Reclamation District (FMWRD) from 2008 through 2010 shows that discharges from FMWRD's and Aurora's CSOs and separate storm outfalls contain high concentrations of phosphorous, suspended solids, fecal coliform, BOD and other nutrients that contribute to low dissolved oxygen.

To date the City and FMWRD have invested over $250M in improvements to the combined sewer system. Over $100M has been invested in constructing new separate storm sewers which remove surface water sources from the combined system. Considering the pollutant concentrations found in the City's separate storm discharges, it is unlikely that conventional sewer separation alone will eliminate Aurora's contribution to violations of water quality standards in the Fox River.

Recognizing the need to remove pollutants from stormwater runoff in conjunction with reducing the negative impacts caused by Aurora's combined sewer system, the City, in partnership with FMWRD and the Valley of the Fox Group of the Illinois Chapter of the Sierra Club, undertook the construction of raingardens within Aurora's combined sewer system. These raingardens are funded in part by an Illinois Environmental Protection Agency Illinois Green Infrastructure Grant (IGIG). The original IGIG financial agreement included the construction of raingardens at 28 locations throughout the City's combined sewer system. However, the total number of intersections being funded by the IGIG was reduced to 17. With assistance from its grant partners and the IEPA, Aurora is in the process of implementing additional raingardens independent of the IGIG program.

1.0 Practice type and Site Selection

The constructed water quality improvements consist of bioinfiltration basins commonly known as raingardens. The raingardens consist of shallow depressions that receive stormwater runoff from surrounding impervious roadway pavement, sidewalks, and buildings, as well as from pervious lawns. The raingardens are covered with approximately 18" thick layer of engineered soil and planted with vegetation. The stormwater that enters the basins is treated by plants, engineered soil, as well as the porous existing soils that underlie the area.

The intent for these improvements is to reduce storm flows into the combined sewer system in lieu of constructing separate storm sewers. The site selection process consisted of the following steps:

- Conceptual layout of potential future separate storm sewer networks within the combined system.
- Identification of locations at the upstream ends of the future storm sewer networks that have the following characteristics:
    - High probability of encountering naturally occurring permeable soils.
    - Adequate right-of-way width.
    - On street parking on at least one side of the roadway.
    - Tributary areas preferably in the 1 to 3 acre range.
    - Relatively flat slopes for the area between the sidewalk and curb.
    - Horizontal and vertical proximity of basement foundations to the proposed raingardens.
        - Nearby Basement foundation material type and condition.
    - Ability to incorporate an overflow device into the raingarden design.
    - Need to provide traffic calming and pedestrian safety improvements.
    - Public support for the project.

The ultimate goal for the selection process was to choose sites that would function as desired, be well received by the public, and eliminate the need to install storm sewer to drain the site. The sites chosen for this project are located in predominately residential neighborhoods. Appendix A includes a map of the raingarden sites.

2.0 Education and Outreach

3.10 Active Outreach

As mentioned above, public support was an important aspect of the site selection process. Public meetings were conducted for the purpose of educating interested stakeholders and obtaining support for the program. The meetings were held on the following dates:

- October 13, 2012
- October 20, 2012
- November 29th, 2012
- September 11, 2013
- October 2, 2013
- November 25, 2013
- May 28th, 2014

The meetings were advertised via mailers, press releases, and email notification to Citizen Ward Committees. Appendix B includes a representative press release, power point presentation, and a graphic layout of the project signage.

3.20 Passive Outreach

Ongoing passive outreach for this project consists of signage placed at the largest raingarden site located immediately adjacent to Bardwell Grade School near the intersection of Marion Avenue and Sexton Street. This site was chosen due to the very high volume of pedestrian traffic. The sidewalks adjacent to the signage are frequented by both parents and students on a daily basis.

4.0 Design

Stormwater enters the raingardens through either catch basins with modified curb castings, or through cast in place curb openings. The catch basins are constructed without bottoms and are partially filled with CA-16 filter media. The catch basins provide some pretreatment to the stormwater prior to entering the bioinfiltration basins by screening out larger objects and give some opportunity for heavier sediment to settle out of the influent.

The raingardens were constructed with overflow structures that will allow stormwater to discharge into an existing storm sewer during rainfall events that exceed the capacity of the basins. The overflow elevations were set just below the elevation of the adjacent roadway gutter in order to avoid water ponding within the street during larger storm events.

The performance of the raingardens was estimated using HydroCad software. The goal for the raingardens is to infiltrate 100% of the runoff from a 1 year 1 hour storm event. Based on statistical rainfall data published in Bulletin 70/71 by the Illinois State Water Survey, the 1 year, 1 hour storm event for the City of Aurora is 1.19”. The 1.19” 1 hour storm was chosen since roughly 90% of the rain fall events will be equal to or less than the design storm. In other words, if the 1 year storm event is infiltrated by the raingarden, then zero discharge would be expected for approximately 90% of all of the rainfall events that occur on an annual average.

The basis for the hydraulic design of the Bioinfiltration basins is as follows:

1. Infiltrate 100% of the runoff from the 1 year, 1 hour storm event (1.19” rainfall over 1 hour). HydroCAD 10.0 was utilized to model the Bioinfiltration basins. Exfiltration was modeled as the primary outlet device for the basins. The following assumptions were applied to the modeling exercise:
    - 3.8” per hour infiltration rate
    - SCS Type III rainfall distribution
    - 30% void ratio for the proposed CA-16 washed gravel backfill
    - 0% void ratio for the engineered top soil and existing native soils
    - Zero storage within the proposed catch basins and underdrain
    - 0% evapotranspiration due to native plantings
    - Cn is site specific and varies from 76 to 85

    Based on the modeling, all the raingardens except for those at intersections 14, 22, and 28 infiltrate 100% of the runoff generated by the 1 year, 1 hour storm event. The model estimates that the

raingardens at 14, 22, and 28 infiltrate 60%, 74%, and 70% of the 1 year storm respectfully. Overall the raingardens are estimated to infiltrate 87% of the design storm for a total volume reduction of 25,500 cubic feet or 199,150 gallons.
It should be noted that native sands and gravels at intersections 22 and 28 seem to convey water at a much higher rate than the 3.8" per hour assumption. Site 28 is across the street from the McCarty Park Bioinfiltration Basins. The McCarty Park improvements were constructed in 2010 as part of an ARRA funded project. The post construction infiltration rate for McCarty Park was estimated to be 16" per hour.

2. Limit ponding within the basins to a maximum of 12 hours after a rain event in order to minimize complaints and avoid damaging the vegetation.

The draw down time (Dt) for the basins was estimated as follows:
Dt = maximum depth/infiltration rate
Dt = 12"/2"per hour
Dt = 6 hours

Pollutant removal was estimated using the IEPA Urban Runoff BMP Pollutant Load Reduction Worksheet. Based on the worksheet, the raingardens will remove 75% of the Total Suspended Solids (TSS), which equates to an annual reduction of approximately 13,683 lbs of TSS. The worksheet estimates that the improvements will reduce phosphorous loadings by approximately 70% for a total annual load reduction of 31 lbs. See Appendix C for a summary of the hydrologic and pollutant removal estimations.

5.0 Construction

The tasks associated with constructing the water quality improvements were similar to a typical roadway and underground utility reconstruction project. One notable difference with this project was that the contractor could not position excavation equipment within the infiltration basins. The purpose for this prohibition was to avoid over compacting the existing and proposed soils. The sequence of tasks was as follows:

- Relocation of utilities.
    - Relocation of gas mains by NICOR
    - Relocation and or bracing of power poles by ComEd
- Installation of sediment controls.
- Exploratory excavations to determine exact locations of some critical existing improvements.
- Adjustments to the proposed improvements based on information obtained during the exploratory excavations.
- Removal of pavement, curb and gutter, and sidewalk.
- Installation of underground utilities and porous granular embankment.
- Excavation for bioinfiltration basins.
- Placement of curb and gutter, sidewalk, and pavement.
- Final excavation/grading for bioinfiltration basins and placement of engineered top soil.
- Placement of river rock and limestone retaining walls.
- Installation of plants and hardwood mulch.

6.0 Costs

Design	
Survey/Drafting	$70,873.23
Civil Design/plan preparation	$129,360.00
Landscape Architecture/Public Outreach	$35,670.00
Total Design	**$235,903.23**
Construction	
Installation of Improvements	**$1,465,556.32**
Construction oversight	
Inspection of landscape related improvements	$24,478.75
Resident Engineering for overall project	$140,731.74
Total Construction Oversight	$165,210.49
Total Costs	**$1,866,670.04**
IEPA Funding (78%)	$1,451,666.00
Recipient Match (22%)	$415,004.04

The original financial assistance agreement was intended to fund the construction of raingardens at 28 intersections for an estimated total cost of $1,707,842. Due to delays associated with finding suitable sites, the project was truncated from 28 intersections down to 17.

As discussed in the Design section, one of the goals for these improvements is to eliminate the need to construct storm sewers to serve these intersections. The cost to install the storm sewer alternative is estimated to be approximately $2,800,000.

7.0 Evaluation

Since the basins have just recently been completed, an objective analysis of the hydrologic performance of the basins has yet to be performed. Based on observations made during rainfall events, some of the bioinfiltration basins appear to be infiltrating water at a much greater rate than the hydrologic and hydraulic calculations predict. During the month of June Aurora received 10.3 inches of rain. On June 30th 2.3 inches of rain fell, with a maximum 15 minute intensity of 0.65 inches. At this time the top soil had been installed within all of the raingardens along Simms. Plants and mulch had not been installed. Ponding was not observed in most of the raingardens within an hour after the rain stopped. A few did display ponding of one inch or less for a few hours longer. It is unknown if the capacity of any of the raingardens gardens was exceeded during this rain event. Since the plants and mulch have been installed, no ponding has been observed for longer than one hour after rainfall events. Aurora intends on installing flow meters within the raingardens in early spring of 2015 in order to accurately assess their performance. Overall the improvements seem to be performing effectively, and are well received by the public.