Green Stormwater Infrastructure at Wissinoming Park, Part 2: Construction Considerations and Lessons Learned

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Highlights

- The presentation will review challenges and lessons learned throughout the planning/design phase.
- The innovative GSI design approach will be explored to highlight the triple bottom line benefits.
- Primary focus will be design/implementation considerations and lessons learned during construction.

Introduction

The Green Stormwater Infrastructure (GSI) at Wissinoming Park project is a marquee project for the City of Philadelphia Water Department (PWD), providing over 40 Greened Acres (GAs) to help advance the objectives of the *Green City, Clean Waters* program. Johnson, Mirmiran & Thompson (JMT), in conjunction with PWD, designed and implemented three (3) Stormwater Management Practices (SMPs) within the park, including: two underground slow-release detention systems beneath athletic fields, and one interconnected surface treatment chain consisting of an upland rain garden and a sloping wetland complex within a legacy stream corridor. The sloping wetland system brings a unique look to the park, increases biodiversity, provides an exceptional educational/recreational opportunity for the public, and restores functions and values of the historic stream valley which were removed through urbanization of the area. Other improvements constructed for this project include over 100 GSI sewer inlets, 10,000 LF of GSI sewer, over 50 GSI sewer manholes, and over 30 ADA ramps. JMT will review the history of the site, discuss site constraints and our project design approach. The primary focus of the presentation will be to provide a detailed review of adaptive management techniques employed in the project development and during construction. Construction of the project was substantially completed in Winter 2020, with final landscaping installation occurring during Spring and Fall 2021. Lessons learned and a discussion of construction-phase oversight activities will be explored in detail for the presentation.

Methodology or Background (for case study)

The presentation will highlight challenges and lessons learned throughout the planning, design, and construction-phases of this unique green stormwater infrastructure project. The presentation will open with a trip into the past - a brief history of the park and unique look at how the project setting helped shape the project design and overall goals. A review of the project location, site constraints and considerations, design approach, and stakeholder/local coordination will be highlighted to give the listener perspective on the project. A major focus of the presentation will be the unique design approach to maximize stormwater treatment- including the sloping stormwater wetland complex used to temporarily store, filter, and allow for evapotranspiration of neighborhood runoff within this highly urbanized, combined sewer area. Construction issues and lessons learned during installation will be explored in detail, with commentary on how cost savings were realized, and materials were utilized to expedite project implementation.

Key Findings

Figure 1. Substantially Complete Sloping Wetland System following 4-inches of rainfall in less than 4 hours on July 12, 2021 (~100-year storm).

The presentation will highlight the City of Philadelphia's *Green City, Clean Waters* program to set the stage for the project. Learning objectives include design adaptive management – how site conditions and constraints were taken into consideration during design. The urban park setting provided numerous opportunities for community enhancement and aesthetic improvements to the setting (i.e., social trails formalized, safety considerations of walking trails, sight line improvement through vegetative removal). We will explore how construction project changes were managed due to field conditions by highlighting problems encountered and how JMT/PWD was able to expeditiously address to minimize delays and contractor change orders. We will share how project issues were resolved and lessons learned throughout the planning, design, coordination, and construction process.

Recommendations

The presentation will highlight the following lessons learned to be considered by attendees for any future work:

- A thorough understanding of historical impacts and site conditions/constraints is critical to developing sustainable design solutions in a cost-effective manner.
- A direct line of communication between the client/owner, designer and contractor through planning/design and construction is recommended to minimize construction delays and change orders.
- Processes to document, communicate and incorporate construction considerations and lessons learned are recommended to inform future designs.

Lessons Learned: Stormwater BMP Construction Challenges & Issues

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Highlights

- BMP issues encountered during construction
- Construction observations
- BMP modification and construction change due to unforeseen existing conditions

Introduction

Over the past two decades, stormwater management design guidelines and regulations for land development have been revised and updated multiple times. Along the way, research has improved our knowledge and understanding of the functions and performances of stormwater BMPs. Many lessons were learned during and after construction when stormwater management systems were challenged by more frequent, intense rain events. These lessons include, but are not limited to, constructability, site testing evaluation, and pre-treatment design and have helped to further increase efficacy and efficiency of stormwater BMPs.

Background

Stormwater BMP design and construction are challenging for all parties involved. Unforeseen circumstances in the field can require design changes or even minor and major amendments to land development permits in order to construct basins that function in the manner they are designed. Common issues include ponding water due to high groundwater table and compacted infiltration media, significant erosion due to heavy rainfall and unstable soil conditions, and the clogging and eventual failure of pre-treatment devices. The level of adversity encountered during the construction phase is uncertain and, in the case of many recent projects, unprecedented as it involved a global pandemic which resulted in a postponed construction schedule.

Key Findings

Stormwater BMP issues encountered during construction

- Improper construction sequencing leading to BMPs eroding and clogging with sediment
- Subsurface soil becoming compacted by heavy equipment during construction and excessive foot traffic
- BMPs not infiltrating due to high ground water or insufficient subsurface information available during the design
- Forebays not being cleaned out after storm events causing backwater and storage capacity issues
- Routine maintenance not considered during design
- Vegetation unable to establish due to seasonal weather

BMP Construction observations can help detect these issues during the construction to mitigate the risk of BMP failure early in the BMP's lifespan. Furthermore, it gives designers an opportunity to see the site otherwise known only from drawings and pictures. This can help to detect issues and challenges and improve the design for the current as well as future stormwater BMPs.

EXAMPLE 1:

Construction Sequencing

Stormwater BMPs are vulnerable to erosion during the construction, thus detailed proper construction sequencing and stabilization is crucial for the long-term success of the facility. Stabilization of the drainage area flowing to the BMP is critical in preventing sediment from clogging the infiltration area. Investigation revealed that amended soils

and plants were installed while the basin was being used as a sediment treatment facility. Construction sequencing should emphasize the order of construction activities and the timing for conversion of temporary sediment treatment facilities into permanent stormwater treatment BMPs.

EXAMPLE 2:

Subsurface Investigation

Figure 1 shows an existing site where a higher-than-expected groundwater table was encountered. The challenge in this case was to minimize changes to the basin design because construction around the perimeter had already begun, while still complying with all local and state requirements.

Figure 1. Site of a stormwater basin which encountered a high groundwater table prior to construction.

Opportunities for Improvement when Severe Weather Complicates Construction

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Highlights

- General weather observations over multiple seasons of construction, including GSI and work in waterways.
- Project examples demonstrating consequences of extreme storm events.
- Construction response to unforeseen damages caused by erosion and destabilization.

Introduction

Weather conditions have always been an obstacle for the construction and maintenance of infrastructure. Policies have been put in place to protect the environment and public safety both during and after construction, for example by protecting waterways from pollution generated by development. Depending on the project, such as bridge replacements and stream restorations, developers may also be required to consider potential flood risk and mitigation. Despite this, not all situations can be accounted for. While designing for severe weather events is not always practical or economical, there are other ways to prepare for the possibility of complications to construction imposed by severe weather. This presentation will explore some challenges faced by design and construction teams because of unforeseen conditions during construction. It will also highlight some lessons learned and provide recommendations of how to improve response time and the effectiveness of solutions.

Background

One of the most significant environmental challenges associated with construction activities is how to stabilize soils and earthwork during construction. Regulations can require developers to prepare plans for erosion and sedimentation control and post-construction stormwater management, to prevent undue sediment burden on nearby waterways and storm sewer systems which lead to the waterways. Some construction activities that have the highest risk for erosion complications include excavation, work in and around waterways, and development in historically undeveloped areas. Preventative measures include detailed construction sequencing and the design, installation, and maintenance of sufficient erosion and sediment control devices. Maintenance during the post-construction establishment period and during the lifespan of infrastructure is also essential to reducing potential risk from fluctuating weather conditions.

Key Findings

In the Northeast, many construction activities are scheduled during months that may also see the greatest amounts of rainfall. Philadelphia experienced several rain events in 2021 alone with total precipitation equaling or exceeding 1.5 inches. Our team has been involved in several projects in which construction coincided with some of these extreme storm events. Some cases required corrective actions to ensure the proposed infrastructure could function as the design intended. A few of these projects involved long-term construction which required work to be completed almost continuously throughout the year. Multiple severe weather events throughout the project timeline resulted in unforeseen challenges as well, such as modifications to design to stabilize an area and reconstruction of damaged infrastructure. The presentation will explore these findings in more detail and provide lessons learned by the design team through the response to these unexpected challenges.

Recommendations

- Account for unforeseen items in construction contract documents.
- Look at projected and historical storm events at the site during E&S design to consider potential risk.
- Designers, the client, construction managers, and contractors should establish and maintain pathways for effective communication about how to plan for and react to severe weather events.