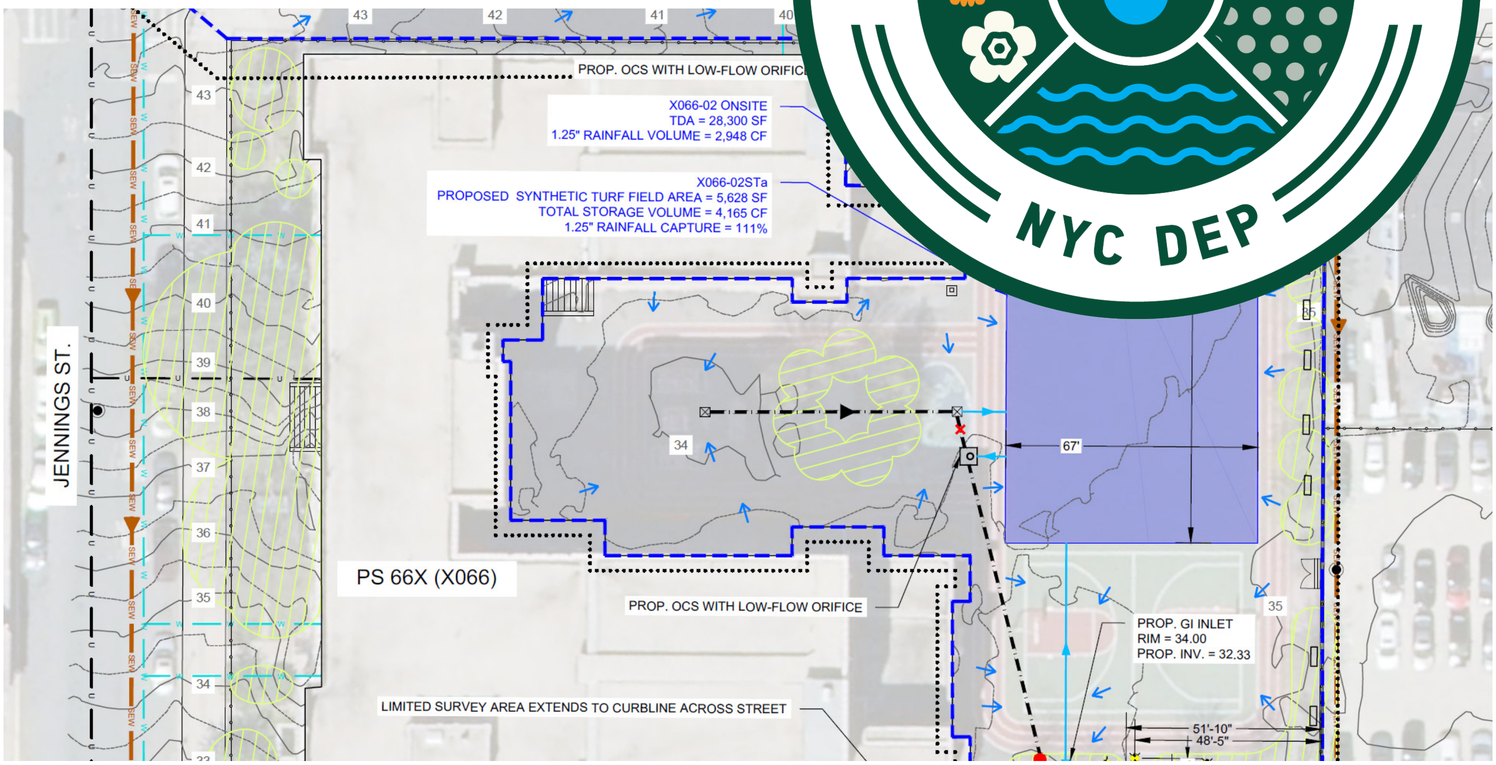
NYC GREEN INFRASTRUCTURE

On-site Design Manual

VERSION NO. 2- JULY 2021

GREEN INFRASTRUCTURE

NYC DEP



NYC Environmental Protection

Onsite Design Manual Version 2-Summary of Revisions

Section	Subsection (if applicable)	Page No.	Description of Change for Onsite Design Manual Version 2
Throughout		N/A	Revised text: "boring location plan" replaced with "boring plan"
Throughout		N/A	Revised text: "draft/final conceptual plan" replaced with "conceptual plan"
1.2 How to Use This Manual	Figure 1-1: Design Process Flowchart	4	Revised graphic: >All projects require DEP and Owner Agency approval to proceed after Boring Plan >Geotechnical and Survey do not proceed concurrently, Survey to begin after suitable conditions for GI confirmed during geotech
2.4 Siting Considerations	Table 2-1: Green Infrastructure Setback Requirements	10	Added text: "Note: Different agencies may have other preferred setback distances."
2.5 Practice Selection		12	Added footnote: "Smaller TDA may be acceptable on case by case basis at the discretion of DEP PM"
2.5 Practice Selection	Stormwater Calculator & Crediting	14	Removed text: "The total capture volume shall not exceed a " maximum design capture volume," which is equivalent to the total volume of runoff generated by 2 inches of rainfall over the impervious surfaces within the tributary area."
2.6 Practice Components	Underdrains	19	Added text: "Other materials may be acceptable with DEP approval."
2.6 Practice Components	Observation Wells and Cleanouts	20	Added text: "Clean-outs shall have a minimum of 8-inch diameter."
2.6 Practice Components	Figure 2-2: Outlet Control Structures	21	Added text to call-outs: >Utility hatch or cleanout cap "(min. 8")" >Manhole cover or utility hatch "(max. 12")"
2.6 Practice Components	Figure 2-3: Outlet Control Structures	22	>Modified diagram to include cleanout cap with call-out "Cleanout cap (min. 8")" >Added text to call-out: "Hatch (max.12")"
2.6 Practice Components	Table 2-5: Minimum Slow Release Thresholds	23	Added footnote: "Smaller TDA may be acceptable on case by case basis at the discretion of DEP PM"

Section 3.5: Site Connection Verification		30	Added text: “DEP’s Bureau of Public Affairs must be notified at least 72 hours in advance of any proposed dye testing. This notification must be submitted by the design consultant to the DEP Project Manager and must include the purpose, date and time, location, downstream extents of dye, and duration of the test.”
4. Design Submittals and Reviews	Figure 4-1: DEP Project Phase Submittal	38	Modified diagram to separate “Boring Location Plan/ Conceptual Plan” to two submittals, “Boring Plan” and “Conceptual Plan Submittal”
Appendix A: TDA and GI Naming Conventions		N/A	Revised text: Naming conventions have stayed the same however clarification has been provided for TDA and GI IDs along with property specific examples.
Appendix G: Conceptual Plan Templates		N/A	Revised graphic: Concept plan example for NYCHA and schools includes boring plan information.

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ACRONYMS

BEPA	DEP Bureau of Environmental Planning & Analysis
CA	Consulting Arborist
CCTV	Closed Circuit Television
cfs	cubic feet per second
CLL	Construction Limit Line
CSO	Combined Sewer Overflow
dbh	diameter at breast height
DEC	New York State Department of Environmental Conservation
DEP	New York City Department of Environmental Protection
DOB	New York City Department of Buildings
DOE	New York City Department of Education
DOT	New York City Department of Transportation
DPR	New York City Department of Parks and Recreation
EHS	Environmental Health and Safety
GILP	Geotechnical Investigation Location Plan
GIS	Geographic Information System
H&H	Hydrologic and Hydraulic
ID	Identification
NAVD 88	North America Vertical Datum of 1988
NYCHA	New York City Housing Authority
OCS	Outlet Control Structure
PE	Licensed Professional Engineer
PT	Permeability Test
PTS	Project Tracking Spreadsheet
PVC	Polyvinyl Chloride
RFI	Request for Information
ROW	Right-of-Way
TDA	Tributary Drainage Area

1. INTRODUCTION

1.1 NYC Green Infrastructure Program

New York City's Green Infrastructure Program (the Program) is a multiagency effort led by the New York City Department of Environmental Protection (DEP) to reduce combined sewer overflows (CSOs) and improve New York Harbor water quality.

One of the City's tools for reducing CSOs is the implementation of stormwater source controls, or green infrastructure. The City published a Green Infrastructure Plan in 2010 and launched the Program in 2011, tasked with implementing green infrastructure within the combined sewer areas. More recently, the City has also been implementing green infrastructure on strategic sites in separately sewered areas as part of other New York City stormwater and resiliency efforts.

The Program implements green infrastructure retrofit projects in the public right-of-way (ROW) as well as on public and private property. For the purposes of this manual, the term "on-site" means within the property line of a City-owned site. On-site green infrastructure projects designed using this manual are retrofits to existing sites, and designs must work with existing site constraints and conditions to incorporate green infrastructure. In addition to water quality benefits, on-site green infrastructure projects can offer co-benefits such as reduced flooding and ponding on paved surfaces, facility upgrades, improved recreational space and aesthetics, and often may result in educational opportunities.

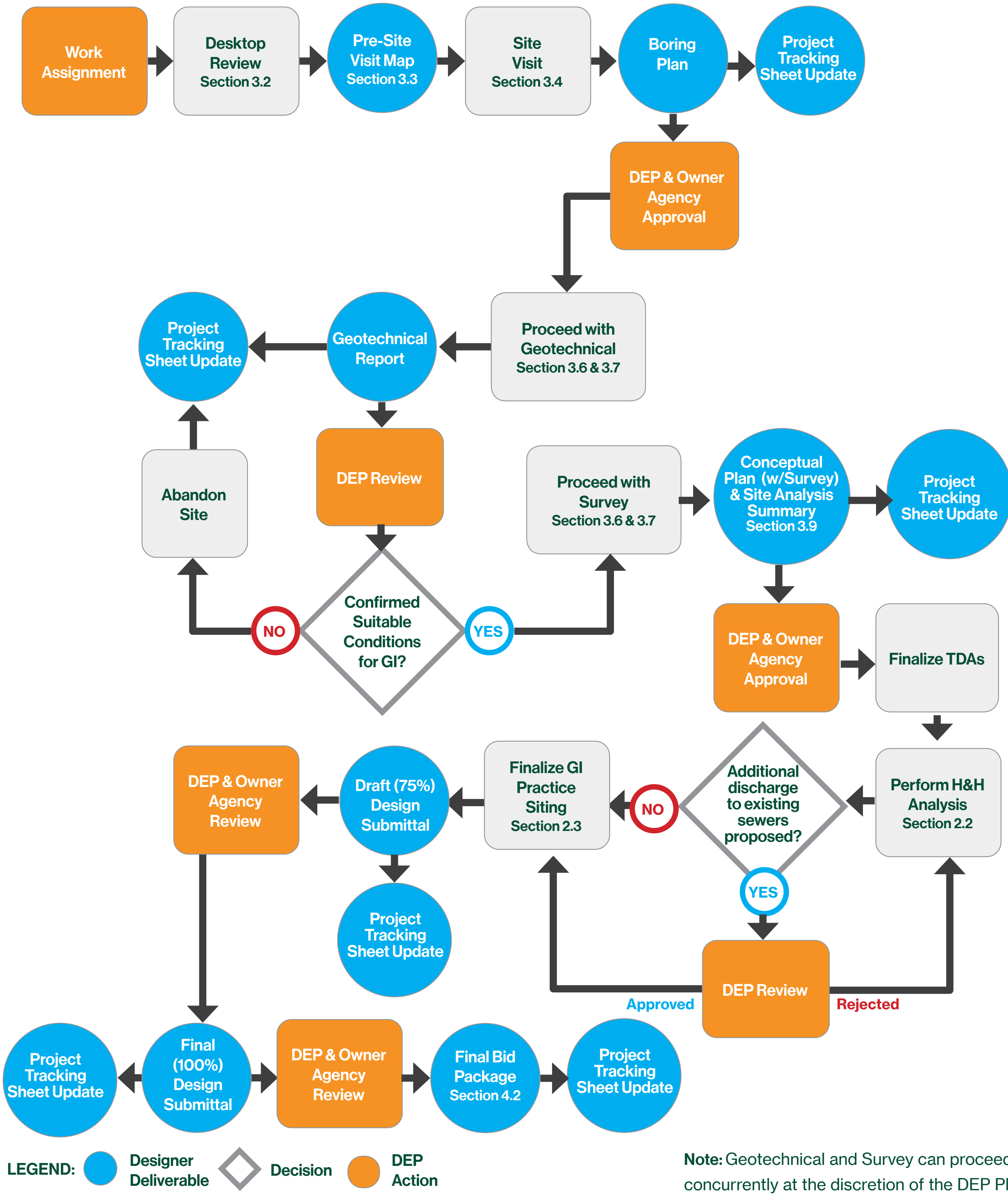
1.2 How to Use This Manual

The primary use of this manual is for DEP-led on-site green infrastructure retrofit projects. This manual may also be used by other agencies for their own green infrastructure retrofit projects with contracted design professionals or in-house design teams, or referenced as general guidance for the design community. DEP can provide guidance to users of this manual as to which sections would apply to specific projects.

For DEP-led projects, this manual is intended to standardize the approach to on-site green infrastructure design. Because specific requirements for the tasks, procedures, and deliverables may vary by Owner Agency, this manual is intended as design process guidance for designers. DEP will serve as the primary coordinator between the various Owner Agencies and the designers as needed.

This manual is organized into four major sections to guide through on-site green infrastructure design criteria as well as the phases of the design process for preparing and submitting on-site green infrastructure designs. Section 2 focuses on design requirements and technical guidance that should be used to site and size green infrastructure practices under DEP's public on-site program, and includes descriptions of green infrastructure practice components. Section 3 describes the first phase of the design process, site analysis and feasibility, which focuses on project initiation, site investigation, and concept development. If the green infrastructure concepts are feasible, the designer will proceed to the process discussed in Section 4. A flow chart of the design process that should be followed is shown in Figure 1-1, which includes key submittals to DEP. Section 5 includes additional components to be considered after the design process as completed, as the on-site green infrastructure practice moves into implementation.

FIGURE 1-1. DESIGN PROCESS FLOW CHART



Note: Geotechnical and Survey can proceed concurrently at the discretion of the DEP PM.

1.3 On-site Green Infrastructure Design Objectives

Greened Acre Definition

As part of New York City water quality goals, the Green Infrastructure Program is working toward a 1.67 billion gallon per year combined sewer overflow reduction goal. Since 2011, DEP has been reporting Program accomplishments as "Greened Acres." A Greened Acre is another way of saying "equivalent impervious acre." It represents the total volume of runoff managed by a green infrastructure practice. This equivalent impervious acre is defined as a "Greened Acre," and represents the total volume of runoff from the impervious area managed by a green infrastructure practice. One Greened Acre is equivalent to a depth of one inch of rainfall spread evenly across one acre of impervious area, or 3,630 cubic feet.

Using Greened Acres instead of impervious acres more accurately represents the targets of the Consent Order between DEP and the Department of Environmental Conservation (DEC) for combined sewer overflows in a volumetric unit and allows for greater design flexibility to maximize the volume of stormwater runoff prevented from entering the combined sewer system.

Greened Acres can be easily computed using the relationship between depth and area and comparing to the volume of stormwater managed in a green infrastructure practice. For example, a green infrastructure practice that is designed to treat 1.25 inches of precipitation from 1 acre of impervious area would treat the equivalent of 1.25 Greened Acres. Greened Acres are important in comparing on-site green infrastructure practices across multiple locations and varying conditions, reporting Consent Order compliance, and assessing the cost-effectiveness of projects.

Practice Prioritization

On-site green infrastructure projects are intended to reduce the volume of stormwater entering the combined sewer system. For this reason, retention practices that keep stormwater on-site and/or infiltrate stormwater back into the ground should be prioritized wherever feasible. Secondary benefits such as site amenities or habitat improvements can help prioritize between different retention techniques. In most cases, vegetated retention practices are preferred over hardscape practices.

Under the public on-site program, DEP is targeting practices that treat a minimum of 10,000 square feet of impervious area, or the equivalent of 0.29 Greened Acres. This minimum treatment area is established to ensure projects pursued remain cost-effective, even if changes to the practice are required during the design process. For example, sites that have poor infiltration can be converted to slow release practices by incorporating a low flow orifice (See Section 2 for more details). These slow release practices can still be effective at reducing combined sewer overflows if they treat more than 10,000 square feet of impervious area. Section 2.4 further discusses preferred green infrastructure practices for each Owner Agency.

Cost and Maintenance Considerations

DEP is committed to implementing cost effective and low maintenance green infrastructure and has developed general design guidelines for practices and components, including:

- Porous pavers
- Precast porous concrete
- Rain garden/vegetated bioretention
- Extensive green roof
- Subsurface retention chambers
- Subsurface retention pipe

The goal of these details and specifications is to control costs, reduce maintenance requirements, and expedite the design phase including DEP and Owner Agency reviews. While each design will need to conform these green infrastructure types to the specific circumstances presented on the site, they should be followed as closely as possible. Additionally, in some cases DEP may decide to add small amounts of funding to a project that would provide significant site improvements. These decisions will be made on a case by case basis and in coordination with the Owner Agency. As a general rule, DEP will not fund any site investigation or construction activities not related to green infrastructure unless requested in writing and approved by DEP. By maintaining a focus on optimizing green infrastructure techniques for site treatment, DEP can ensure that the costs per Greened Acre remain low.

2. DESIGN GUIDANCE AND REQUIREMENTS

2.1 Introduction

This section provides guidance for developing on-site green infrastructure designs including:

- Finalizing tributary drainage areas;
- Siting, selecting, and sizing green infrastructure practices; and
- Identifying use of green infrastructure components.

Designers should apply engineering judgment in addition to this guidance to develop sound projects that are consistent with the design objectives stated in the previous section. If at any time professional judgment differs from what is presented in this manual, it should be brought to DEP's attention.

On-site green infrastructure can be generally classified as surface, subsurface, or green roof practices, defined based on where/how stormwater enters the practice. Surface and subsurface practice types can be further defined based on infiltration capacity. Retention practices can be placed in areas where the in-situ soil permeability is greater than 0.5 in/hr. Slow-release practices can be used in areas where the soil permeability coefficient is less than 0.5 in/hr by including a low flow orifice.

Although there is significant variability in green infrastructure types and configurations, in general all practices will include an inlet, a storage area, and an outlet control structure. Schematics of these components, differentiated by practice type, are shown in Figure 2-1.

2.2 Tributary Drainage Area

Delineation Guidelines

Tributary drainage area (TDA) is the amount of surface area that drains to a green infrastructure practice. TDAs are used to size green infrastructure components (Section 2.4) and calculate greened acres.

Preliminary TDA boundaries can be identified using available topography and drainage system information. However, the designer shall utilize the final and approved survey to refine the proposed TDAs. TDAs for each proposed green infrastructure practice shall be delineated based on both existing conditions and any proposed changes to the local contours. This information shall inform the direction of flow, accounting for any curbs, walls, or other barriers and may or may not resemble the drainage patterns associated with existing inlets.

The designer shall seek to refine TDAs and proposed green infrastructure practices such that capture of runoff from impervious areas is maximized throughout the site. This may include consideration of additional off-site areas for capture, such as ROWs or roofs.

When possible, the designer shall consider configuring the site plan such that pervious areas are not included in the TDA. Stormwater runoff from pervious areas often contributes sediment and can lead to clogging and increased maintenance requirements and should be avoided to the greatest extent feasible. Water from sprinklers or fountains shall not be allowed to enter or be directed to a green infrastructure practice.

TDAs shall follow naming conventions outlined in Appendix A.

RAIN GARDEN AT J.H.S 162, BROOKLYN

2.3 Perform Hydrologic & Hydraulic Analysis

A hydrologic and hydraulic (H&H) analysis is performed using the finalized TDAs to ensure that on-site green infrastructure facilities can be optimized to treat impervious areas and avoid impacts to the downstream collection system. The analysis is performed using the Rational Method in accordance with DEP standards, as referenced in DEP's 2012 Guidelines for the Design and Construction of Stormwater Management Systems[1] to determine the following for each TDA:

- Peak flow (Q_p) from TDA (cubic feet per second [cfs]), calculated as follows:

  $Q_p = (C_w \times TDA) / 7{,}320$
  Where:
  Q_p = peak flow (cfs)
  C_w = weighted runoff coefficient
  TDA = tributary drainage area (square feet)

  7,320 = 43,560 square feet per acre divided by the rainfall intensity of 5.95 inches per hour (in/hr) for the event with a 5-year return period and a 6 minute time of concentration

- Existing and proposed flow within existing sewers (cfs).

These results shall be included in the "Summary of H&H Analysis" spreadsheet (Appendix B), utilizing the TDA nomenclature described in Appendix A. A drainage report should also be produced, following the outline presented in Appendix B.

Green infrastructure pipes (i.e. any conveyance, distribution, underdrain, and outlet pipes associated with green infrastructure practices) are designed based on estimated peak runoffs for a given reach of a drainage area. Subsequent pipes should be designed for an estimated peak runoff for a given TDA and should account for all upstream cumulative flows coming into the system. A minimum pipe diameter of 8" shall be used for green infrastructure inlet and outlet pipes. The designer shall verify that the peak flows do not result in erosive velocities into the green infrastructure practice and revise materials or configuration at entrances to minimize erosion, if necessary.

Proposed stormwater runoff that will result in additional discharge to an existing sewer line (e.g. discharging stormwater from one drainage area to another) has the potential to overload the downstream drainage system.

Off-site Runoff

In the case where additional TDAs, such as street runoff, are directed to an on-site green infrastructure facility, designers should ensure there are no potential flooding conditions through the following:

1. Compare existing and proposed runoff at the most downstream collection point. Verify proposed flows do not exceed existing flows, otherwise eliminate off-site runoff from the project.

2. Verify capacity of the existing site sewer exceeds the combined peak flow rates from all TDAs (i.e. $Q_{out} \geq Q_p1 + Q_p2 \ldots + Q_pn$) and does not result in additional impacts to the downstream sewer.

3. If existing site sewer capacity is exceeded, either:

   a. Set the maximum green infrastructure storage elevation at or above the elevation of the street runoff diversion inlet.

   b. For sites where the elevation of the diversion inlet at the street is above the elevation of the maximum storage of the green infrastructure practice or above the site surface elevation, the green infrastructure facility shall be designed with an inflow control device to limit the volume of runoff to the green infrastructure practice. The inflow control device shall be sized to convey the first 1.25-inches of volume runoff to the practice and limit excess flows by bypassing the green infrastructure practice, ensuring that the downstream system capacity is not exceeded, and the site is not flooded. Designer shall provide stormwater calculations and/or system modeling to show inflow control and bypass sizing design.

4. Where these design parameters cannot be achieved the designer should discuss with DEP to determine if modifications to the site sewer infrastructure, diversion of off-site flow in an alternate location, or elimination of off-site flow from the project are warranted..

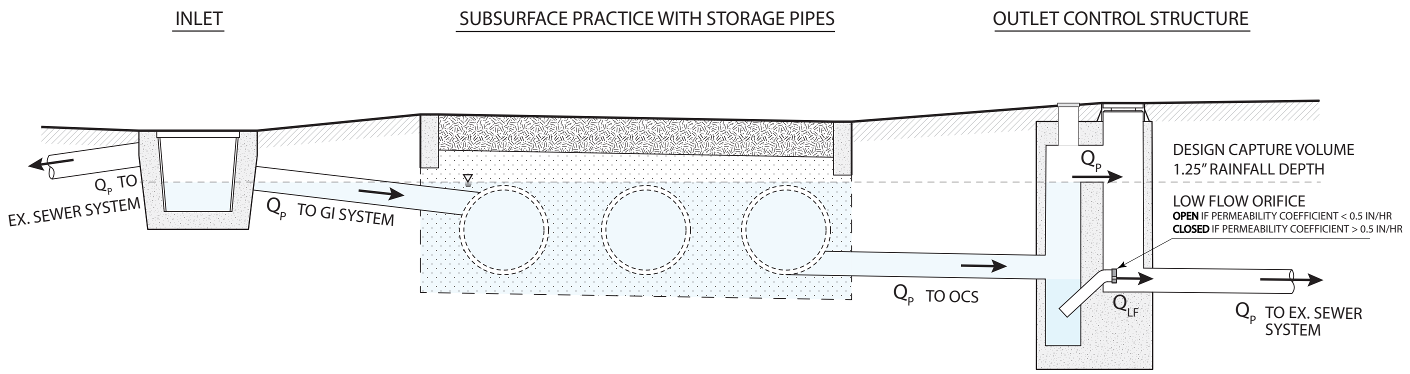
Designers should immediately begin pipe capacity calculation changes to obtain approval to avoid project delays. A completed Hydrology and Hydraulics Analysis Summary form shall be submitted to DEP for review with the Concept Plan

[1] *Release rates specified in this manual differ from the 2012 Guidelines. On-site green infrastructure practices have different release rate requirements to maximize CSO benefits.*

FIGURE 2-1. GREEN INFRASTRUCTURE TYPES AND CONFIGURATIONS

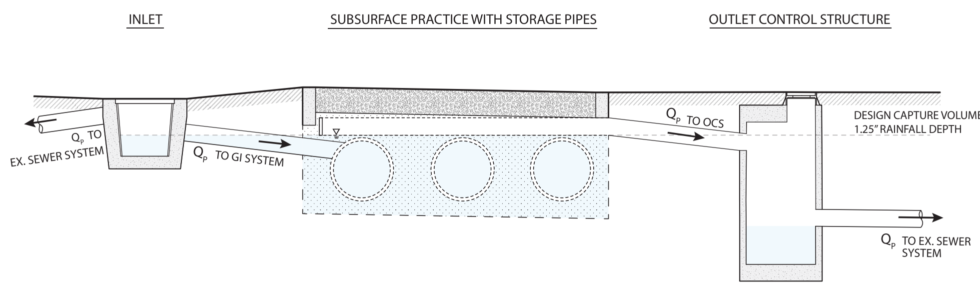
Note: Schematics are not to scale

SUBSURFACE GREEN INFRASTRUCTURE PRACTICE
PREFERRED EXAMPLE 2-1A.

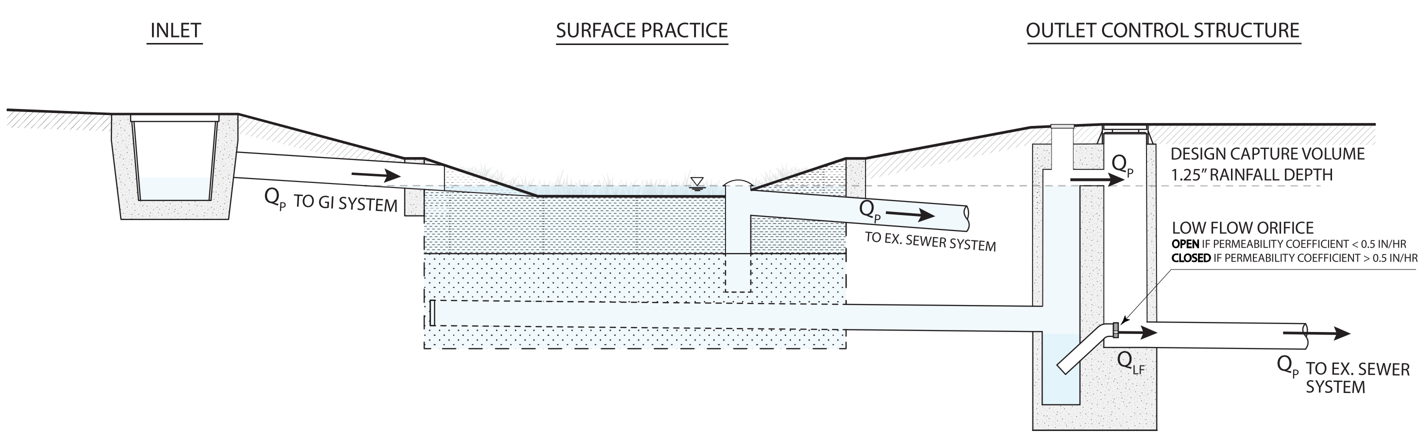


Key Map for Components	
Inlet	See "Inlets" on p. 18
Conveyance Piping	See "Conveyance Pipes" on p. 19
Distribution Piping	See "Distribution Pipes" on p. 19
Underdrains	See "Underdrains" on p. 19
Outlet Control Structure	See "Outlet Control Structures" on p. 20-22
Overflow	See "Outlet Control Structures" on p. 20-22
Low Flow Orifice	See "Low Flow Orifice" on p. 23

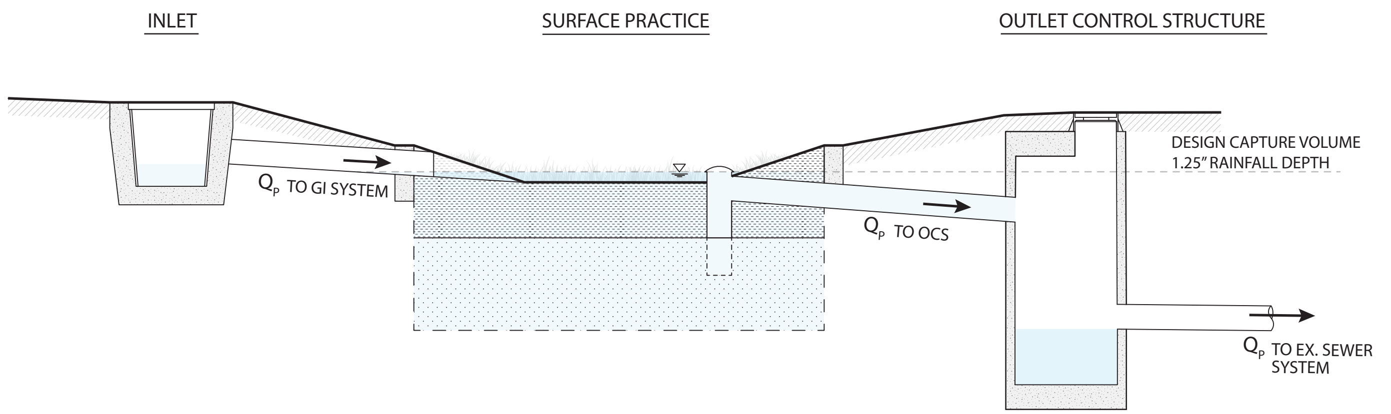
SUBSURFACE GREEN INFRASTRUCTURE PRACTICE (WITHOUT UNDERDRAIN)
ALTERNATE EXAMPLE 2-1B.



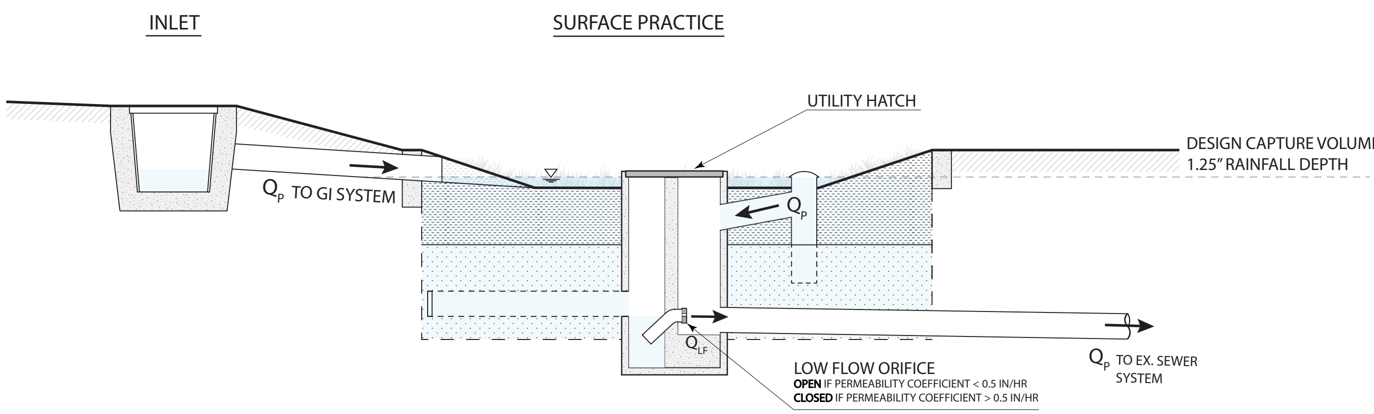
SURFACE GREEN INFRASTRUCTURE PRACTICE
PREFERRED EXAMPLE 2-1C.



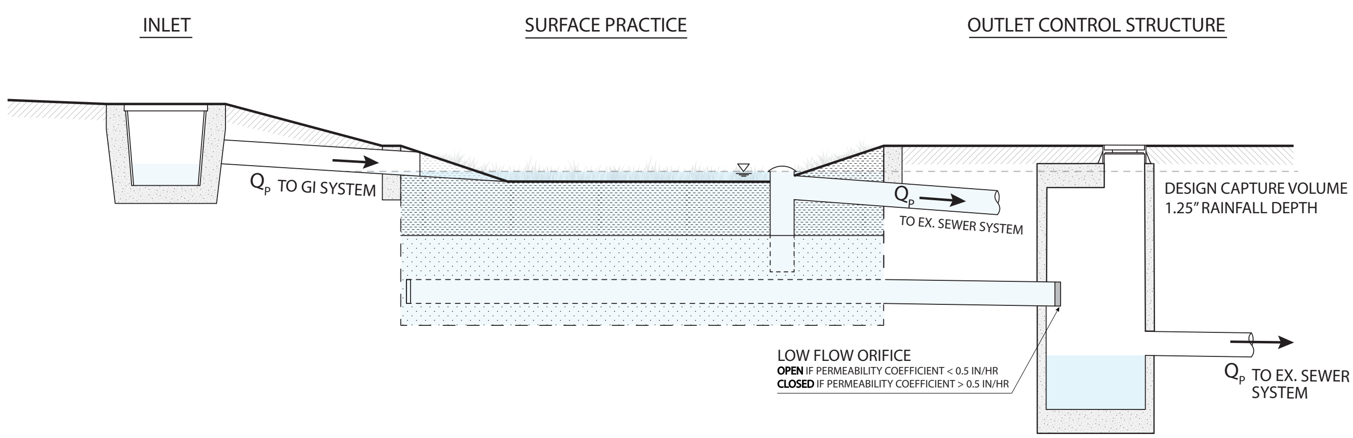
2-1D. SURFACE GREEN INFRASTRUCTURE PRACTICE (WITHOUT UNDERDRAIN)
ALTERNATE EXAMPLE



SURFACE GREEN INFRASTRUCTURE PRACTICE
ALTERNATE EXAMPLE 2-1E.



SURFACE GREEN INFRASTRUCTURE PRACTICE
ALTERNATE EXAMPLE 2-1F.



2.4 Siting Considerations

In designing and siting green infrastructure practices, the designer should be aware of the site's programming priorities, as identified during the site visit with the Owner Agency. The designer should incorporate feedback received from the site analysis phase as well as any other concerns voiced by the Owner Agency. Other siting concerns include the presence of existing vegetation; ease of maintenance and access to planted areas and cleanouts; underlying soil permeability and load-bearing capacity; and cost/greened acre.

To provide efficient capture, green infrastructure practices must be sited at the lowest point feasible and manage site runoff from surrounding impervious areas within its tributary. This can be facilitated by identifying existing stormwater inlets and infrastructure within the site. As a general rule, green infrastructure practices may not manage any sanitary flow from drinking fountains, spray play areas, etc., and must be located outside of the dripline of existing trees.

Setback requirements for all green infrastructure system components are summarized in Table 2-1. Any deviation from setbacks will require special approval from DEP and the Owner Agency and may require the use of an impermeable liner.

GREEN INFRASTRUCTURE SCHOOL PLAYGROUND P.S. 33

TABLE 2-1: GREEN INFRASTRUCTURE SETBACK REQUIREMENTS

HORIZONTAL SETBACKS	Minimum Setback Distance (feet)
Building Foundations, Vaults and Protruded Basements	10
Flagpoles and Light Poles	10
Retaining Walls	10
Transit Structures	25
Highway/Roadway Structures	25
Monitoring Wells	50
DEP Infrastructure (e.g. water and/or sewer mains, etc.)	15
Property Line	5
Slopes 10% below practice **Slopes 10% - 30% below the practice** **Note: avoid installing an infiltration facility near slopes greater than 30%.**	100 100 + 5 feet for every 1% slope
VERTICAL SEPARATION	
Bottom of practice to the top of the high groundwater table	3 (2 with DEP PM approval)
Bottom of practice to the top of bedrock or other impermeable material or subsurface layer	3 (2 with DEP PM approval)

Note: Different agencies may have other preferred setback distances.

THE TRUST FOR PUBLIC LAND

P.S. 33 Chelsea Prep School
Community Playground
Chelsea, N.Y

666 Broadway, 9th Floor
New York, NY 10012
212-677-7171


SUBSURFACE DETENTION SYSTEM CONSTRUCTION AT P.S.932, BROOKLYN

2.5 Practice Selection

All green infrastructure practices shall:

1. Treat a minimum of 10,000 square feet of impervious area[1].

2. Have a maximum depth of 5 feet below the ground surface to avoid additional sheeting costs. If a green infrastructure practice is proposed to be deeper than 5 feet, DEP shall be notified immediately for review and approval prior to continuing with the design.

3. Possess sufficient load bearing capacity to support any vehicles, machinery, or structures that may utilize the location.

DEP has established a preferential hierarchy for green infrastructure practices. The general order of preference is shown in Table 2-2. Note that retention practices are prioritized over slow-release practices, and surface practices are preferred over subsurface practices. This hierarchy will be subject to certain exceptions dependent upon Owner Agency and individual site uses, based on site-specific discussions during the planning and design process. General design guidelines for each practice can be found in Appendix C.

TABLE 2-2: GREEN INFRASTRUCTURE PRACTICE HIERARCHY

Order of Preference	Green Infrastructure Practice Type
1	Vegetated Surface Retention (rain gardens, bioretention)
2	Subsurface Retention (subsurface retention, permeable pavement)
3	Vegetated Surface Retention/Slow-release (green roofs, retention techniques with open underdrains)
4	Slow-release (subsurface detention)

Retention (Infiltration) v. Slow-Release

Permeability test results will inform the decision to provide a retention-based practice (which results in complete infiltration of the captured volume) or a slow-release practice (which relies on slow release of the captured volume back to the combined sewers). Table 2-3 summarizes when green infrastructure practices shall be designed for retention or slow-release.

TABLE 2-3: RETENTION V. SLOW-RELEASE

Permeability Coefficient (in/hr)	Green Infrastructure Practice
<0.5	Slow-release
>0.5	Retention

[1] *Smaller TDA may be acceptable on case by case basis at the discretion of DEP PM*

In both instances, an underdrain connected to an outlet control structure should be included in the design (see Section 2.5). This will allow slow-release practices to be easily converted to retention practices if infiltration testing during construction shows favorable permeability coefficients and will allow retention practices to be converted to slow-release if infiltration becomes insufficient after some years of operation. Adjustment between a slow-release and retention practice will be accomplished by opening or closing the low flow orifice. Possible adjustments will be initially evaluated based on the results of infiltration testing during construction (see Section 5.2). Retention practices should always be prioritized over slow-release practices.

All practices should drain completely within 48 to 72 hours. To confirm drain down time for infiltration practices, determine the effective infiltration depth by dividing the static storage volume by the horizontal surface area (footprint) of the storage practice. The drain down time can be calculated by dividing the effective depth by the design infiltration rate.

$d_{infiltration} = (V_{GI}/A_{footprint}) \times 12$

$t = d_{infiltration}/IR$

Where:

t = drain down time (hrs)

V_{GI} = static storage volume of practice (cubic feet)

$A_{footprint}$ = horizontal surface area of practice (square feet)

$d_{infiltration}$ = effective infiltration depth (inch)

IR = infiltration rate (inch/hr)

When low permeability coefficients dictate the use of a slow-release practice, a low flow orifice shall be sized to drain the practice within 72 hours at a rate of 0.1 cfs/acre (see Section 2.5 for further information on sizing low flow orifices). The drain down time for practices with low flow orifices can be calculated by dividing the static storage volume of the practice by the time-variable orifice flow equation, which can be simplified using the following equation.

$t = (2V_{GI})/(C \times A_o \times \sqrt{(2 \times g \times h)} \times 3600)$

Where:

t = drain down time (hrs)

V_{GI} =static storage volume of practice (cubic feet)

C = orifice discharge coefficient (0.6)

g = gravity (32.2 feet per second squared)

h = hydraulic head above centerline of orifice diameter (feet)

A_o = area of orifice (square feet)

Additionally, it is recommended that slow-release practices NOT include impermeable liners, unless proximity to another structure or limiting layer (e.g., bedrock, water table) requires it.

Sizing

The "design capture volume" is defined as the total volume of runoff generated by 1.25 inches of rainfall over the impervious surfaces within the tributary drainage area. This volume is obtained by taking the product of design rainfall depth and the contributing impervious area. A design rainfall depth of 1.25 inches is selected to optimize the effectiveness of the green infrastructure practice.

$V_{capture} = (1.25/12) \times TDA$

Where:

$V_{capture}$ = design capture volume (cubic feet)

TDA = tributary drainage area (square feet)

The "static storage volume" of the green infrastructure practice is defined as the volume of water that can be held by the practice, which is determined as the sum of surface (ponding) storage volume, volume within the planting medium, volume within the gravel medium, and volume found in subsurface structures (e.g., stormwater chambers, pipes, tanks, etc.), up to the design storage elevation. Green infrastructure practices should be designed such that the static storage volume is equal to or greater than the design capture volume draining to the green infrastructure practice. In general, any additional losses from a green infrastructure practice that increase the capacity of the practice (i.e., infiltration occurring during a runoff event, if feasible) should be credited to the performance of the practice as further described in the next section.

$V_{GI} = V_{surface} + \Sigma\ V_{subsurface}$

Where:

V_{GI} = static storage volume of practice (cubic feet)

$V_{surface}$ = surface (ponding) storage volume (cubic feet)

$V_{subsurface}$ = subsurface (i.e. soil media, gravel, tanks, etc.) storage volume (cubic feet)

PERMEABLE CONCRETE AT NYCHA SETH LOW HOUSES, BROOKLYN

PERMEABLE PAVEMENT CONSTRUCTION AT P.S. 12, QUEENS

Stormwater Calculator & Crediting

Key dimensions and performance metrics are recorded and calculated in DEP's Stormwater Calculation Table for On-Site GI Practices (Appendix D), which requires inputs of tributary area as well as depth and area of the various storage media (ponding, soil, subsurface storage).

Since 2011, DEP has reported and will continue to report on the equivalent impervious acres as outlined in the Consent Order between DEP and DEC for CSOs. DEP reports equivalent impervious acres as "Greened Acres". One Greened Acre is equivalent to one inch of rainfall depth over one acre of impervious area, resulting in a volume of 3,630 cubic feet. Section 1.3 further describes the calculation of Greened Acres.

Crediting for green infrastructure practices is performed by calculating the number of Greened Acres for the "total capture volume." The total capture volume is defined as the sum of the static storage volume and any additional volume that the green infrastructure facility manages over an 8-hour period (this does not include stormwater that bypasses the green infrastructure facility through inlet or outlet controls). For retention practices, this additional treatment volume is a result of the water that infiltrates through the bottom and sides of the green infrastructure practice in eight hours and is a function of the permeability coefficient.

The stormwater calculation table calculates the design capture volume of each tributary drainage area, the static storage volume of each green infrastructure practice, the infiltration volume (for retention practices), and the percent of the design capture volume managed by the practice.

Runoff Conveyance Systems

Green infrastructure related runoff conveyance systems collect and convey surface runoff from tributary areas to green infrastructure practices. These systems include inlets, curb cuts, pipes, and manholes.

Runoff from on-site surfaces can be directed to green infrastructure practices by means of sheet flow (unchannelized flow directly over the surface), which is regulated by surface topography, or with the use of inlet and pipe networks. Inlet systems are generally preferred for their ability to collect sediment or debris carried from the contributing area. Capture mechanisms that rely on sheet flow may require frequent cleanup of the area as grit and fines are carried from across the site.

In some cases, the green infrastructure practices can be designed to have the capacity to also receive runoff contributions from off-site, such as from adjacent roadways.

The designer should include all additional flow from off-site in the H&H analysis (see Section 2.2), ensuring green infrastructure practices have the capacity to manage the additional off-site runoff.

Flow into green infrastructure practices should be designed to limit inflow based on the static storage volume of the practices and be able to bypass or re-direct runoff when the practice has reached capacity (see Section 2.5 for additional information).

GREEN INFRASTRUCTURE AT P.S. 221, QUEENS

2.6 Practice Components

This section provides guidance for the design of green infrastructure components. On-site green infrastructure practices are designed as systems with several components that are configured to ensure the functionality of the practice. Very often it is possible to accomplish the same management goals using different configurations or materials, therefore the components below are described through their functions within the larger system. The designer may propose systems with components that are not mentioned here, as long as the parameters described below are met and the runoff management goals are achieved. For further detail and other general guidance on green infrastructure components, refer to DEP's Standard Details for On-site GI Practices, included in Appendix C.

Ponding Depth

Allowable ponding depth in green infrastructure facilities should be selected based on the adjacent land use, site constraints, ability to drain surface water within 48 hours (i.e., underlying soil permeability) and the associated need for barriers around the facilities. Ponding depth above a rain garden bed shall be 3 inches minimum but should not exceed 6 inches. In all instances, a minimum 3 inches of freeboard (i.e., depth between maximum surface ponding and adjacent grade) will be required. The actual ponding depth may vary based on slope conditions.

Overflow devices shall be used to control maximum surface ponding depth. Typical overflows consist of a riser pipe and domed grate (see details in Appendix C).

Engineered Soil

Soil depth must provide enough space for vegetation root establishment. Vegetated practices with trees should have a minimum soil depth of 2 feet 6 inches. Vegetated practices without trees should have a minimum soil depth of 1 foot 6 inches, with a depth of 2 feet being preferred.

Stone Reservoir

The stone reservoir volume is determined by physical constraints such as the need to provide sufficient soil medium, ponding depth, and freeboard while maintaining a maximum 5-foot depth practice. Because of the significant pore spaces, designers should use stone reservoirs to meet the target management volume, sometimes extending the reservoir under pavement and beyond the extent of the practice's surface expression.

GRAVEL RESERVOIR

GREEN INFRASTRUCTURE CONSTRUCTION
ON QUEENS COLLEGE CAMPUS, QUEENS

Subsurface Stormwater Systems

Subsurface stormwater systems, such as stormwater chambers or storage pipes, are perforated high density polyethylene (HDPE) structures surrounded by gravel that allow for additional storage volume.

Maximum Side Slopes

When graded slopes are used to create storage depressions and match surface grades, a maximum side slope of 1V: 3H shall be used. Slopes shall be planted in a manner that limits erosion.

Energy Dissipation

Any condition where runoff flows to a vegetated surface requires energy dissipation. This can be accomplished with use of a hard structure such as an inlet or in the manner of a spillway with appropriately sized stone, geogrid, or other method that will prevent scour and plant loss.

Vegetation

Establishing vegetation is essential to the functionality of a vegetated practice. Plants should be chosen based on their hardiness, soil and light conditions, root structure, and ability to adapt to wet and dry conditions. The vegetative cover and root systems should promote infiltration within the engineered soil, provide an aesthetic benefit, and help prevent erosion, particularly on surface side slopes.

Geotextile

Geotextile barriers should be used to separate engineered soil media and gravel reservoirs. Geotextile barriers are not recommended to line the bottom of the green infrastructure practice. Non-woven geotextile fabrics are the most appropriate type for permitting and sustaining infiltration. Heat-bonded nonwoven fabrics are not recommended, because they tend to clog very quickly. Designers should review manufacturer's recommendations to avoid placement that would void the warranty.

Inlets

Inlets are intended to collect sediment and debris, dissipate energy, and control inflow to the green infrastructure practice. For subsurface practices, inlets are the preferred method for collecting runoff. Surface/vegetated practices do not require inlets if the following conditions are met:

- Inflow locations contain a sediment collection component, such as a fore-bay.
- Inflow locations contain proper erosion control measures, such as rip rap apron or overflow device.

All inlets must include:

- A minimum 1-foot sump to allow for sediment collection and removal.
- ADA (Americans with Disabilities Act) compliant grates, if placed over pedestrian surfaces.
- H-20 loading grates where vehicular traffic will take place.
- Hood and/or screens to prevent debris from entering the practice.

If feasible, existing inlets with a minimum 1-foot sump can be retrofitted for inflow to green infrastructure practices.

To prevent flooding, inlets shall include an overflow outlet that connects to the existing on-site drainage system. The invert of the overflow outlet shall match or exceed the maximum storage elevation of the stormwater management practice.

Designers must confirm that both the overflow and distribution pipe have the capacity to manage the peak flowrate as determined in Section 2.2.

When street capture is feasible, inlet openings with depressed curbs should be used to convey off-site capture runoff into green infrastructure facilities adjacent to curbed roadways as the priority inlet type. See Appendix E for inlet details for directing street runoff to Parks. Interior site inlets may vary based on owner agency preferences.

SUBSURFACE DETENTION SYSTEM CONSTRUCTION AT P.S. 932, BROOKLYN

PERMEABLE PAVEMENT INSTALLATION

Conveyance Pipes

Conveyance pipes are used to convey stormwater to and from green infrastructure practices. Conveyance piping provides connections to existing site drainage infrastructure and to the combined sewer system through existing site connections.

Conveyance pipes shall:

- Be 8-inch diameter or greater and use materials that can be joined to existing site infrastructure and consistent with NYC Plumbing Code.
- Have a minimum 0.5% slope, a minimum flow velocity of 2.5 feet per second and a maximum slope of 10%
- Be designed based on estimated peak runoffs for a given reach of a drainage area (see Section 2.2); subsequent pipes shall be designed for an estimated peak runoff for a given drainage area and should account for all upstream cumulative flows coming into the system.
- Use 1/8 (45 degree) elbows for bends – 90 degree bends should be made using two 1/8 (45 degree) elbows and separated by at least 1 foot of straight pipe.

Distribution Pipes

Distribution pipes are used to evenly distribute flow from inlets or manhole structures throughout subsurface practices. The use of one pipe to serve as both inflow and outflow is not permitted, meaning distribution pipes cannot also function as underdrains.

Distribution pipes shall:

- Be 8-inch diameter or greater high-density polyethylene (HDPE) meeting the requirements of ASTM D3350; when installed within the gravel reservoir layer, distribution pipes shall be perforated within the subsurface practice with perforations meeting AASHTO Class II specifications.
- Be designed based on estimated peak runoffs for a given reach of a drainage area (see Section 2.2).
- Have cleanouts (see this section) and endcaps.
- Use 1/8 (45 degree) elbows for bends – 90 degree bends should be made using two 1/8 (45 degree) elbows and separated by at least 1 foot of straight pipe.
- Be accessible from at least two points, either by a cleanout or drainage structure (e.g., inlet).
- Have a minimum of 3 inches of stone on all sides.

Underdrains

Underdrains shall be installed in green infrastructure practices to facilitate drainage, unless directed otherwise by DEP. Underdrains shall:

- Be 8-inch diameter or greater HDPE meeting the requirements of ASTM D2729 with perforations meeting AASHTO Class II specifications. Other materials may be acceptable with DEP approval.
- Be perforated on all sides only within the green infrastructure practice gravel reservoir – the final 5 feet of pipe connecting with the drainage structure shall be solid (non-perforated) to avoid potential performance issues.
- Be wrapped in geotextile fabric or filter sock along the entire perforated length.
- Connect to an outlet control structure that includes a weir set to the elevation of the design storage volume.
- Not be allowed to discharge uncontrolled back into the existing sewer system (see Low Flow Orifice section).
- Have 0.5% minimum slope with cleanouts and endcaps.
- Use 1/8 (45 degree) elbows for bends – 90 degree bends should be made using two 1/8 (45 degree) elbows and separated by at least one foot of straight pipe.
- Be accessible from at least two points, either by a cleanout or drainage structure (e.g., outlet control structure).
- Not have an open connection to surface features to prevent entry of sedimentation and trash.
- Have a minimum of six inches of stone on all sides.

Underdrains are required in all green infrastructure practices. In certain retention projects an underdrain is not necessary or effective and can be removed at the direction of DEP. If an underdrain is not included, a weir or riser is not needed as long as a separate overflow structure is provided.


RIP RAP INLET

Observation Wells and Cleanouts

Observation wells are structures that are used to monitor the function of the subsurface green infrastructure components. Two observation wells shall be included for all practices that include a stone storage layer.

Observation wells shall be:

- Located near the longitudinal center of the system
- Flush with the ground surface
- Anchored to the subsurface system, secured, and capped.
- Spaced appropriately to represent the entire practice

Cleanouts are structures that allow access to subsurface pipes (including distribution pipes and underdrains) for cleaning. Cleanouts shall have a minimum 8-inch diameter.

Cleanouts shall be placed:

- Evenly at a minimum of every 75 feet of straight pipe runs
- Upstream of pipe bends
- Within 10 feet of the underdrain connection to the drainage structure (catch basin, manhole, or flow control structure).
- Outside of any play fields or high traffic areas
- Considerate of site constraints and maintenance equipment access

Outlet Control Structures

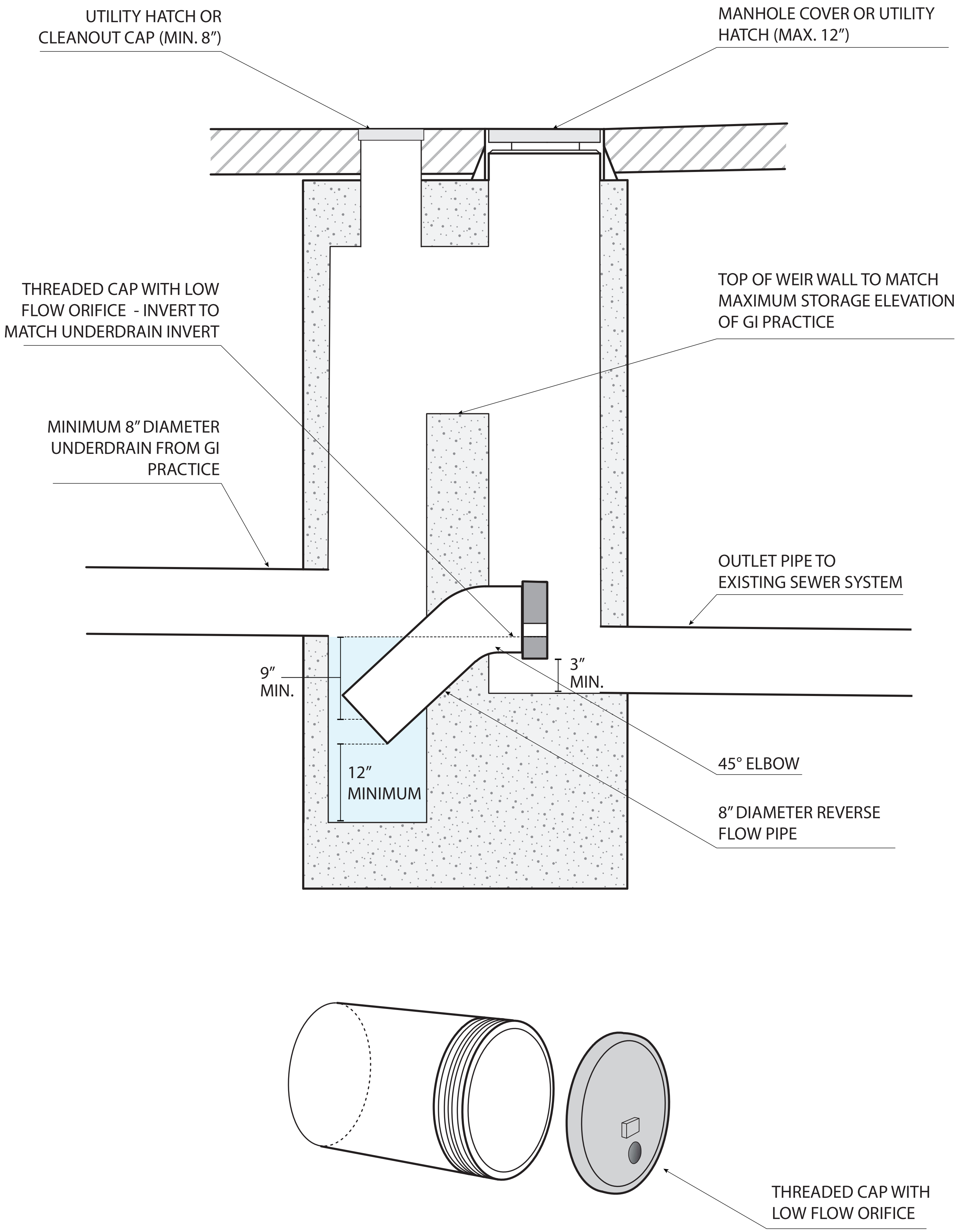
Each green infrastructure practice with an underdrain shall include an Outlet Control Structure (OCS) between the practice and the connection to the existing on-site drainage system. The purpose of the OCS is to regulate flow between the green infrastructure practice and the existing sewer system. Several OCS configurations are acceptable if the following requirements are met:

- Provide connection with underdrain systems
- Provide for overflow and discharge of captured runoff in excess of the peak design volume, either with a weir or riser.
- Provide a low flow orifice for the slow release of the stored volume to the sewer system (see Low Flow Orifice this section).
- Provide a 24-inch minimum sump below the invert of the underdrain or low flow orifice, whichever is lower, for the collection of debris that must accessible for cleaning.
- Discharge to on-site drainage infrastructure only (e.g., existing drainage pipe or inlet); the invert of the connection to on-site drainage infrastructure shall never be higher than the design storage elevation.

A minimum 3-inch drop from the low flow orifice into the on-site drainage system is preferred. If the connection to the existing on-site drainage system is shallower than the low flow orifice, the low flow orifice can be raised to the invert of this connection pipe. This should only be considered for retention practices.

Two potential OCS configurations are shown in Figures 2-2 and 2-3. Certain elements, such as the weir set at the maximum storage elevation or the reverse flow pipe set in a deep sump, should be included in all potential OCS configurations. Other elements, such as the low flow orifice, should be determined based on the site-

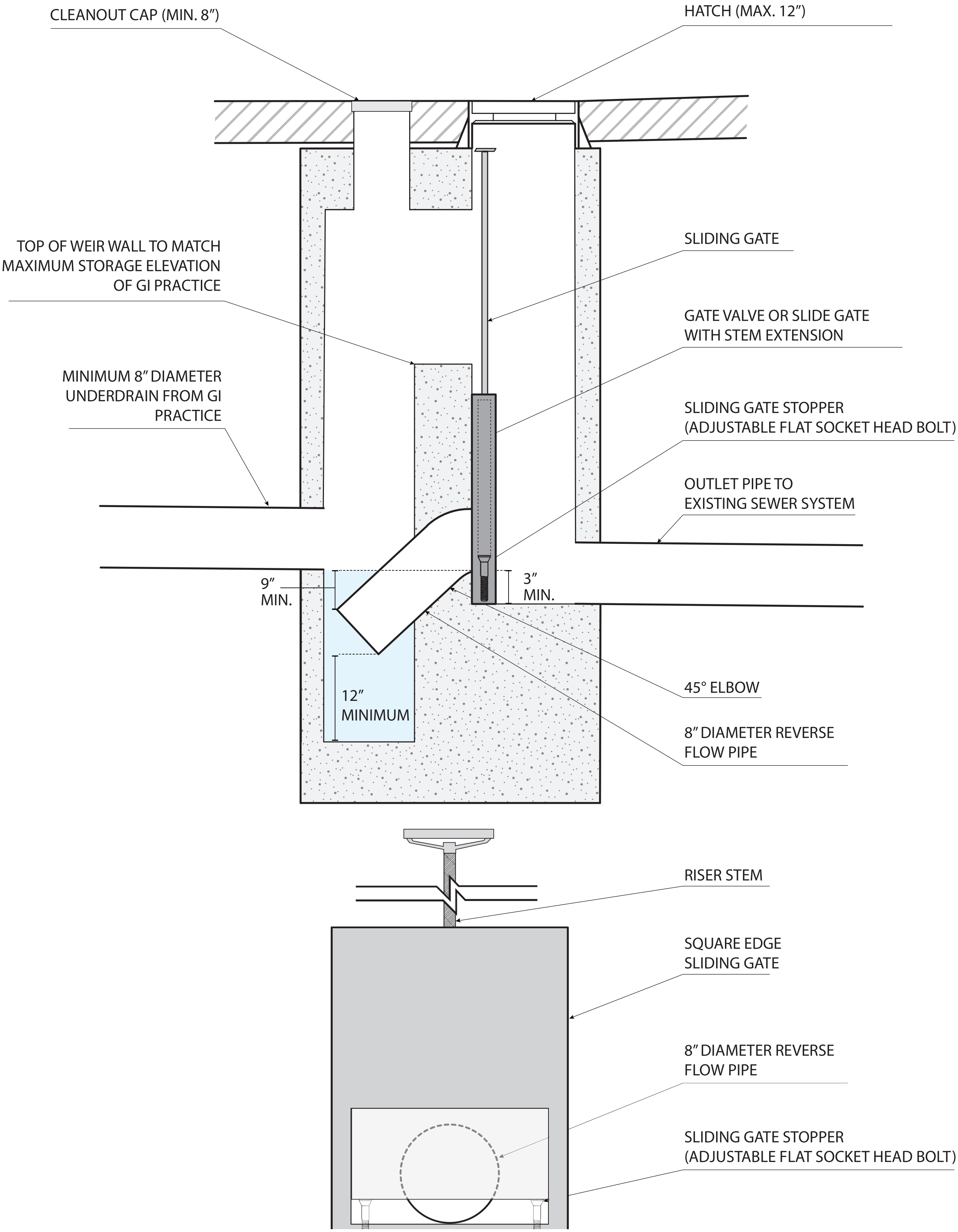
FIGURE 2-2. OUTLET CONTROL STRUCTURES



NOTE

ALTERNATIVE INNOVATIVE OUTLET CONTROL STRUCTURES OR COMPONENTS CAN BE IMPLEMENTED WITH THE APPROVAL OF DEP.

FIGURE 2-3. OUTLET CONTROL STRUCTURES



Low Flow Orifice

A low flow orifice shall be installed within the outlet control structure for all practices with underdrains. Low flow orifices shall:

- Be sized to drain the slow-release practice at a rate of 0.1 cfs per acre of tributary impervious area managed, using the following equation:

  $Q = C \times A_o \times \sqrt{(2 \times g \times h)}$

  Where:

  Q = release flow rate, cfs

  C = 0.6 (discharge coefficient)

  A_o = area of orifice, square feet

  g = 32.2 feet per second squared (gravity acceleration)

  h = hydraulic head above centerline of orifice diameter, feet

- Be easily accessible and have appropriate protection to prevent clogging.
- Allow for draining the entire storage volume in 72 hours
- Be set at or above the connection to the on-site drainage system (minimum 3-inch drop preferred)
- Be set to an open position only for slow-release practices (see Section 2.4)

Maintenance considerations and green infrastructure effectiveness set the limitations for when slow-release practices with low flow orifices can be used and were taken into consideration while developing the thresholds in Table 2-5. Low flow orifice size should never be smaller than 1-inch diameter for practices loaded from the surface or 2-inch diameter for practices where stormwater enters below the surface. Although the performance criteria of 0.1 cfs per acre is desired for all slow-release practices, designers can proceed with the minimum orifice sizes regardless of the calculated discharge, assuming the specified minimum tributary drainage areas are met as presented in Table 2-5.

Low flow orifices within outlet control structures provide DEP with the flexibility to modify green infrastructure practices in the future with minimal changes to the practice. Adjustments to the system can be made to account for actual performance by either opening or closing the orifice. If a drilled cap orifice is used, the designer might be required to specify multiple replacement caps in the bid package to facilitate future field adjustments.

TABLE 2-5- MINIMUM SLOW RELEASE THRESHOLDS

	Minimum Low Flow Orifice Size	Minimum Tributary Drainage Area[1]
Surface Loaded Practices	1”	10,000 SF
Subsurface Loaded Practices	2”	20,000 SF

Manhole Structures

Manhole structures can be used for energy dissipation, inflow control, and upstream bypass. Whenever feasible, manholes should be designed so that they do not require confined space entry, but can easily be accessed by a vactor truck attachment. Generally, manholes:

- With two or more inlet pipes and one outlet shall be a minimum of 4 feet in diameter.
- Shall not have more than three pipe connections at the same elevation; additional connections shall be separated at least 1 foot vertically.
- Shall be located at least 3 feet above the groundwater table to prevent potential groundwater infiltration into the system.
- Require a minimum concrete leg of 6 inches between the manhole block-outs for adjacent pipes.

High Density Polyethylene Liners

When green infrastructure practices are proposed within 10 feet of a structural foundation and have received DEP’s approval, the side of the excavation closest to the foundation shall be lined to prevent intrusion. The impervious liner shall extend from the top of the freeboard to 12 inches beneath the bottom of the practice and shall cover the full width of the excavation. Liners shall be sufficiently anchored along the upper edge to prevent slipping and shall not extend to the surface where it would be visible.

[1] Smaller TDA may be acceptable on case by case basis at the discretion of DEP PM

3. SITE ANALYSIS AND FEASIBILITY

3.1 Project Initiation

Prior to initiating the site analysis process, the designer will have reviewed potential sites with DEP and/or the Owner Agency to identify any potential conflicts or constraints that would eliminate the site from green infrastructure implementation. When a potential site is assigned, the designer shall investigate any such conflicts or constraints and identify other potential issues during the desktop review and site investigations in the site analysis phase (e.g., subsurface contamination, high bedrock, high groundwater, etc.) and notify DEP if any additional constraints exist and would deem the site infeasible.

Project Kickoff Meeting

The kickoff meeting shall occur before or during the project site visit. The meeting, at a minimum, should discuss the following:

- Project scope, including:
  - Site-specific opportunities and goals for green infrastructure retrofits
  - Considerations of the Owner Agencies' current use/programming
  - Potential to mitigate historic flooding issues, as applicable
  - Potential to manage off-site stormwater, as applicable
  - Considerations of maintenance for various green infrastructure types (DPR/DOE)
- Roles and responsibilities of each party and key personnel involved
- Project schedule
- Project deliverables and workshops
- Site-specific permits and approvals
- Other Agency approvals.

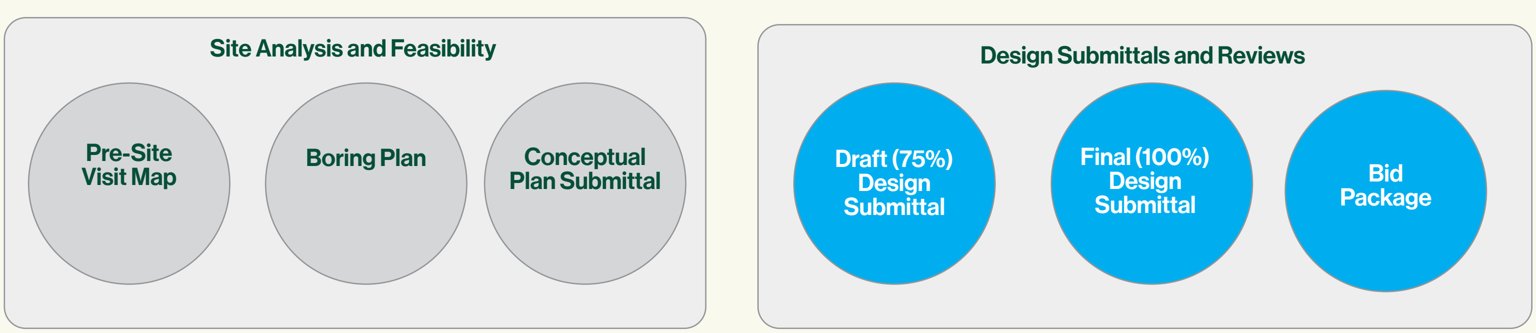
The designer should provide an attendee sign-in sheet for the kickoff meeting and submit meeting minutes to DEP within 10 business days after the meeting.

Owner / Site Coordination

Each Owner Agency has designated key personnel as the point of contact for DEP's on-site green infrastructure projects throughout the site selection and design process to facilitate site coordination, permitting, and review of design submittals. DEP will provide the designer with a list of the key personnel for each Owner Agency.

The site-specific permits and approvals needed for the project shall be communicated in the kickoff meeting as they will vary by Owner Agency. Permits needed for the geotechnical investigation are detailed in DEP's Limited Geotechnical Investigation Procedures For New York City On-Site Green Infrastructure Practices, included in Appendix F.

FIGURE 3-1. DEP PROJECT PHASE SUBMITTALS



3.2 Desktop Review

The designer shall review existing Owner Agency and DEP records to identify the site characteristics that will affect the design of on-site green infrastructure practices. A review of available geographic information system (GIS) data related to the site should also be performed prior to the site visit to delineate initial TDAs. Existing records and GIS information include, but are not limited to:

Provided by DEP, if available:

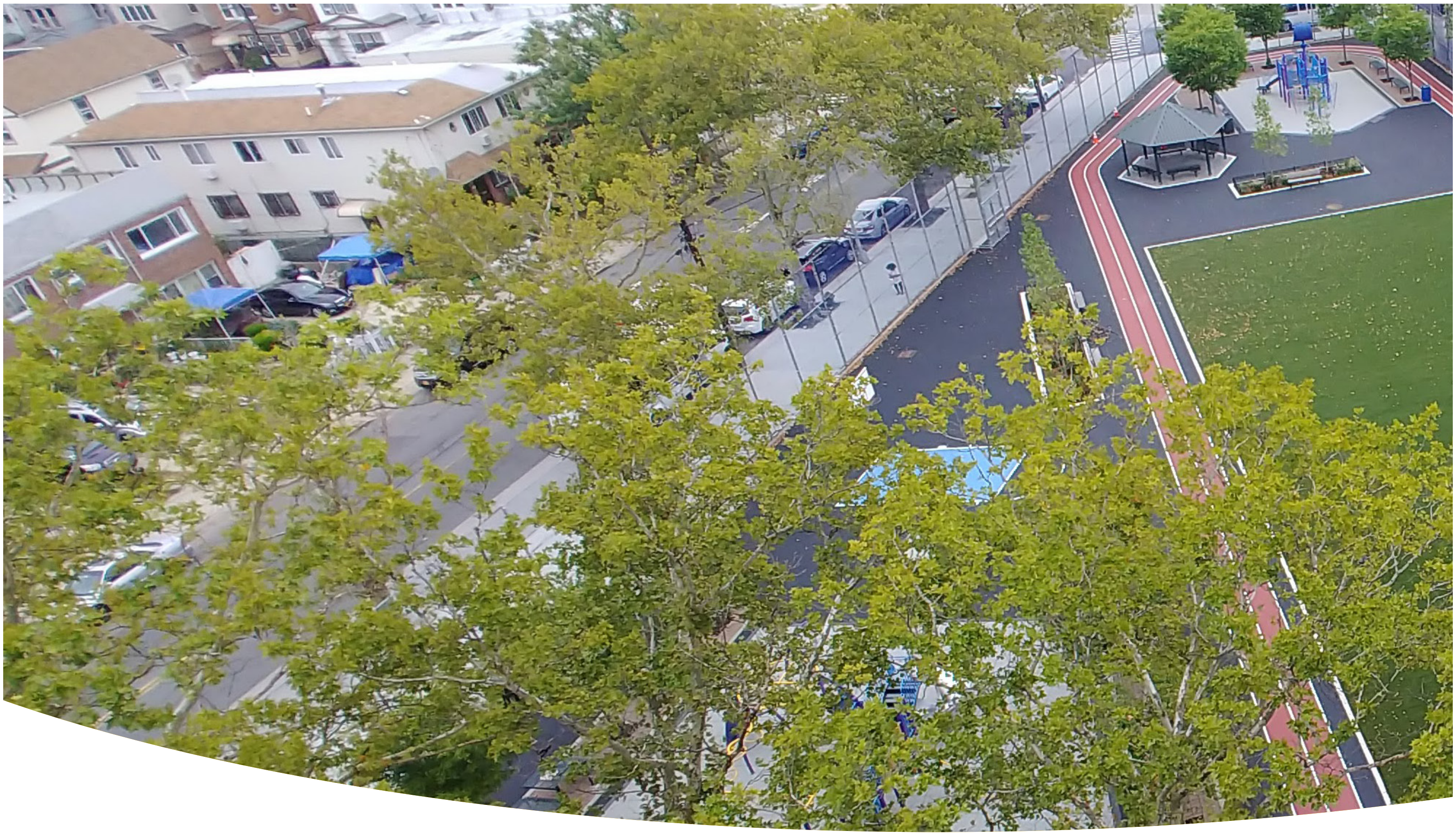
- Surveys
- Aerial photographs / pictometry
- LIDAR
- DEP site connection records and/or tap cards
- Historic boring records
- Sewer record maps / GIS information for abutting streets
- Bedrock and soil map, if relevant
- Hazardous materials investigations from Owner Agency, where available.

To be gathered by designer (if applicable):

- Environmental reports
- Historic fire insurance maps
- Land use history
- As-built drawings, including nearby MTA infrastructure if appropriate
- Site / utility plans
- Department of Buildings (DOB) and New York Fire Department (FDNY) permits (for Green Roofs)
- Updated capital and master plans or community development plans

RAIN GARDEN AT J.H.S 162, BROOKLYN

DEP will facilitate coordination with Owner Agencies to gather existing information. If needed, DEP's Request for Records form (for records such as sewer drainage plans, water and sewer maps, sewer as-built drawings, tap and sewer cards, etc.) can be found online at http://www.nyc.gov/html/dep/html/forms_and_permits/locations.shtml and must be submitted via email to wsrecordscentral@dep.nyc.gov. If there are ROW green infrastructure practices adjacent to the site, DEP can provide historic boring and permeability test (PT) information associated with those nearby green infrastructure practices.



3.3 Pre-Site Visit Map

In preparation for the site visit with DEP and the Owner Agency, the designer should create a pre-site visit map to present information found in the desktop review and propose locations for potential green infrastructure practices. To the greatest extent possible, the following information shall be included on the site visit map:

- Recent survey drawings / site plans, with source and date labeled (high resolution aerial photo showing current conditions may be used in addition to survey drawings, or if existing site plans are not available or not representative of current conditions)
- Property line / site boundaries
- Existing grading information, including:
  - Legible spot elevations and/or contours
  - Surface flow direction arrows
- Existing on-site drainage system, including:
  - Drain inlets and manholes with corresponding rim and invert elevations (give unique labels (e.g., CB1 [catch basin1], MH1 [manhole 1], etc.) to all structures for ease of identification)
  - Drainage piping
  - Location(s) of connection(s) to DEP combined sewer
- Major site features (spray shower, play equipment, flagpole, truck entrance, trash compactor, retaining wall, etc.) and any key site constraints observed during desktop analysis (label features with callouts wherever necessary).
- Historical boring identifications (IDs) and locations inside the property line or within 30 feet of potential green infrastructure practices, and from historic ROW green infrastructure geotechnical tests adjacent to the property.
- Areas with shallow bedrock, high groundwater, or potential contamination
- Approximate extent of existing tree canopy and critical root zones
- Building lines
- Utility lines and nearby NYCT infrastructure
- Existing ROW catch basins

GREEN INFRASTRUCTURE AT P.S.50, QUEENS

- Nearby ROW green infrastructure locations (including all GreenHUB statuses)
- Location, size (area in square feet), and IDs of proposed green infrastructure practices and their associated impervious TDAs, based on desktop analyses (more than one combination of green infrastructure practices may be proposed for the same TDA).
- Boundaries and calculated areas of impervious TDAs managed by each proposed green infrastructure practice (including ROW impervious areas, if feasible).
- Proposed boring and PT locations and proposed site access for geotechnical investigation
- Proposed survey limit
- DEP's Stormwater Calculation Table for On-Site GI Practices (Appendix D), listing each proposed green infrastructure practice. See Section 2.4 for more information on the table.
- On-site sewer connection options for each proposed green infrastructure practice

The purpose of the preliminary TDA delineation is to provide a first-pass boundary for understanding site conditions and for recording observations during the field visit. The delineation plan shall be developed with use of existing information only, such as aerial photos, pictometry, and site as-builts. If the Owner Agency allows runoff from off-site to be considered, the surrounding impervious ROW TDAs should be evaluated as well. Proposed green infrastructure practices should be compatible with apparent site uses and be sized according to the available TDA. More than one combination of green infrastructure practice may be proposed for a given TDA.

For more information on criteria for green infrastructure practice siting to assist with TDA delineation, refer to Section 2.3. TDAs must follow the naming convention outlined in Appendix A.

The designer needs to provide the pre-site visit map to DEP one week prior to the site visit. The map will be used during the site visit to field verify and document existing field conditions. The map scale should be such that surface features are identifiable on 11-inch x 17-inch plans. More than one map may be necessary to cover the boundaries of the entire site or show all of the required information.


TPL GREEN PLAYGROUND AT J.H.S 218, BROOKLYN (AFTER)


TPL GREEN PLAYGROUND AT J.H.S 218, BROOKLYN (BEFORE)

3.4 Site Visit

DEP will schedule the site visit with the designer and Owner Agency to document existing conditions, discuss site constraints and opportunities, and further investigate suitable locations for potential green infrastructure practices. The designer should provide an attendee sign in sheet for the site visit as well as any map mark-ups with potential green infrastructure locations identified.

Existing Conditions Documentation

Existing conditions to note during the site visit are listed below.

Site Drainage Details:

- Note obvious slopes, flow direction, and approximate TDA boundaries
  - Identify any visible barriers or obstructions affecting flow paths (curbs, ditches, walls, etc.)
  - Observe and compare elevation of site to street
  - Identify any localized low points (ponding locations) or high points (unsuitable for green infrastructure)
- Identify and assess working condition of existing drainage structures, active dry wells, and catch basins through visual inspection. If additional inspection is needed to identify pipe conditions, see Section 3.5 for inspection procedures.
- Identify locations for overflow of runoff
- Verify opportunities to capture street runoff.

Site Design / Construction / Maintenance Details:

- Identify potential conflicts with existing trees/drip lines (e.g., critical root zone)
- Identify existing utilities or subsurface structures to the greatest extent possible
- Identify possible site usage conflicts or community issues (e.g., community garden in park)
  - Consider how construction timing, duration, and phasing integrates with site programming
  - Consider potential conflicts with the site's operation
- Identify NYCT infrastructure boundaries. If geotechnical borings or construction is proposed within 200 feet of NYCT infrastructure, a Letter of No Impact will need to be prepared.
- Consider maintenance access and issues (current maintenance procedures, access considerations, etc.) and record feedback from Owner Agency representatives on operational issues and concerns
- Consider site access for geotechnical investigations (driller may need small rig)
- Identify other construction or maintenance challenges (e.g., will sediment transport or piling of leaves from trees affect permeable pavement locations?)

Photo Documentation

The designer should document the site visit with photos of relevant features and at least two photos of each potential green infrastructure practice location. These photos and a photo location map shall be incorporated into the conceptual plan document.

Boring Plan

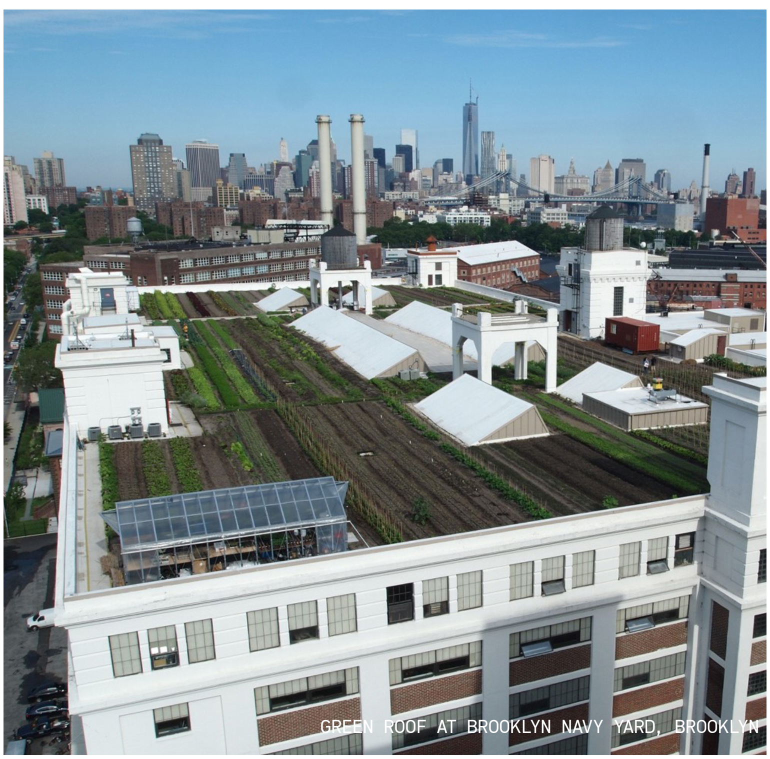
The boring locations proposed on the pre-site visit map will be reviewed during the site visit. These boring locations and proposed PT locations will be further refined and submitted as the Boring Location Plan to DEP for review and approval prior to starting the geotechnical investigation. See Section 3.6 for more information on the geotechnical investigation and Appendix F for DEP's Limited Geotechnical Investigation Procedures For New York City On-Site Green Infrastructure Practices. The Project Tracking Spreadsheet (PTS) should be initiated with the development of the Boring Plan. See Section 3.9 for more details on the PTS.

Green Roof Analysis

Where a green roof is proposed, additional site analysis is required. This additional analysis includes an assessment of the existing building (structural analysis) and roof integrity (roof membrane assessment) necessary to support the implementation of a green roof.

The designer must conduct a structural analysis to determine if the roof can accommodate additional loading capacity. The structural analysis report must be subjected to quality assurance / quality control by the designer and include recommendations regarding the suitability of the roof for proposed green roof(s). In order for the roof to be considered viable for green roof installation, the structural analysis must indicate that the roof structure is capable of supporting the additional load from the proposed green roof(s) when saturated in addition to any other live loads expected as part of the project. This report is required to be signed and sealed by a structural engineer licensed in the State of New York.

A roof membrane assessment must be conducted to evaluate the condition of the existing roof membrane and confirm the remaining years on its warranty, if any. If there are remaining year(s) on the warranty, the designer must contact the roof membrane manufacturer and confirm the necessary steps required to protect the membrane before installing the proposed green roof(s). The designer should also confirm if the manufacturer cannot continue to honor the warranty if a green roof is installed. The designer should also note major or numerous roof penetrations by pipes, ducts, equipment, or other features.



GREEN ROOF AT BROOKLYN NAVY YARD, BROOKLYN

3.5 Site Connection Verification

Site connection verification using dye testing or CCTV may be needed if site connection record searches have been inconclusive or there is reason to believe that an existing drainage structure does not discharge to the combined sewer system.

DEP will decide which method will be appropriate for the site based on the time necessary to perform the test and other case by case constraints.

DEP's Bureau of Public Affairs must be notified at least 72 hours in advance of any proposed dye testing. This notification must be submitted by the design consultant to the DEP Project Manager and must include the purpose, date and time, location, downstream extents of dye, and duration of the test.

RAIN GARDEN AT ASTORIA HEIGHTS PLAYGROUND, QUEENS

GEOTECHNICAL INVESTIGATION

3.6 Geotechnical Investigation

Unless otherwise directed by DEP, a Limited Geotechnical Investigation is required within or near the footprint of each proposed on-site green infrastructure installation prior to the design phase. The Limited Geotechnical Investigation at a minimum shall determine the following:

- Subsurface soil characteristics and texture
- Depth to groundwater
- Depth to bedrock
- Any hydraulically limiting layer(s) that would potentially inhibit vertical infiltration
- Hydraulic conductivity using permeability tests (PT).

A Geotechnical Investigation Location Plan (GILP or Boring Plan) shall be submitted to DEP for review and approval prior to commencing the geotechnical investigation.

If contamination (soil and/or groundwater) is discovered during the geotechnical investigation, drilling shall be terminated immediately. The borehole shall be filled, and the proposed location shall be abandoned. Indications of suspected contamination during geotechnical investigations must be reported to DEP and the Owner Agency.

DEP's Limited Geotechnical Investigation Procedures For New York City On-Site Green Infrastructure Practices is included in Appendix F. In addition, all applicable permits and approvals must be obtained. Each Owner Agency has an individualized process for site coordination and permit approvals regarding geotechnical testing, which is detailed in the attachments of Appendix F.

3.7 Site Survey Requirements

Prior to commencing detailed design for green infrastructure, a Limited On-site Survey is required. The survey shall include establishing project control field survey operations to extend primary horizontal or vertical control baselines and other control points (with ties) at the project site. This work includes, but is not limited to, the data collection, processing, reporting and CAD drawing production of digital terrain models, base mapping, site surveys, drainage surveys, utility features, or supplemental field surveys in areas of dense vegetation.

The Limited On-site Survey may take place concurrently with the Limited Geotechnical Investigation at the discretion of the DEP PM. A licensed New York State Land Surveyor shall carry out the survey and prepare, stamp, and sign the survey drawings for submittal to DEP.

For sites under DPR jurisdiction, the designer must also perform a Tree Survey conducted by an International Society of Arboriculture Certified Arborist. (see Section 3.8).

Before commencing any field survey, every attempt should be made to contact all owners of property adjoining the parcel to be surveyed. The nature of the survey should be explained

Survey Limits

At a minimum, survey extents shall include the preliminary Construction Limit Line (CLL), the entire TDA for each proposed green infrastructure practice, plus an additional 10 foot buffer beyond the TDA boundary. The survey limits shall also include a 10-foot buffer around any impervious TDAs to account for off-site drainage areas being considered.

At the discretion of the designer and approved by DEP, the survey limits can be expanded to capture all construction access and staging areas or reduced if large off-site TDAs are directed to the practice and TDA boundaries can be established using available LiDAR data.

Topographic Information

Topographic surveys and subsequent maps prepared from the collection of field data provides the designer with existing conditions and features of the land, identifying the location of property lines, existing structures, streets, curbs, other drainage facilities, sidewalks, above ground utilities and related facilities, manholes/inlets/catch basins, trees, and other features present on-site. Contour lines identify the slope of the land and drainage patterns.

The survey must collect and show the required following information:

- All existing elevations necessary to characterize the topography of the site, including high and low points, within the defined survey area (all elevations shall be shown in feet and referenced as per NAVD 88 data requirement for survey drawings)
- Contours lines, drawn at 0.5-foot intervals.

Drainage Information

The drainage survey work includes, but is not limited to, collecting information of all drainage structures (e.g., size, material, type, rim/grate elevation, and invert elevations at the inlet and outlet) and cleaning manholes, catch basins, and pipes if filled with sediments that preclude the taking of the invert elevations.

Surface Features

The survey shall identify and show the following features within the survey area:

- North direction
- Site name
- Property line
- Street names
- Common surface features:
  - Utility castings and overhead utility lines (including but not limited to manholes, fire hydrants, catch basins, etc.)
  - Existing site furniture (including but not limited to fences, sign poles, benches, tables, light and utility poles, etc.)
  - Tree centerline, diameter at breast height (DBH) and drip line locations
  - Tree stump centerline and diameter
  - Tree pit extents
  - Driveways, curb cuts, crosswalks, ramps, and stairwells
  - Curb reveal (top of curb/bottom of curb elevations), material, and condition
  - Existing buildings and structures

- Building doors, doorways, gates, and building/property entrances
- Sidewalk and roadway surface materials
- Pavement markings.

Unless otherwise directed by DEP, if the green infrastructure practice(s) are being designed to capture street runoff, the survey extents shall also include the entire off-site TDA limit and identify the following:

- Legal ROW width of the street
- Roadway width (curb to curb)
- Distances to intersections
- Elevations and street grades
- Bus stops, bus stop shelters and signs
- Subway entrances
- ROW green infrastructure, if present.

Subsurface Features

The survey shall provide subsurface information to the maximum extent practicable. This information shall include vertical alignment, horizontal alignment, dimensions, type, and cover for utilities, including but not limited to gas lines, electric lines, material communication lines, etc.

For green infrastructure practices sited within 10 feet from a protruded basement or utility vault, a vault investigation must be performed. Vault investigation shall consist of a visual inspection and at a minimum capture the following information:

- Basement information (width, depth of slab below street or sidewalk grade, extension into sidewalk beyond building line, etc.)
- Visual signs on walls and slab of existing water damage (especially on the wall adjacent to the street/sidewalk)
- Note regarding presence of and location of a sump pump
- Location of where service lines enter/exit (includes but not limited to water service, house connection, gas, electrical, etc.).

Survey Drawings

The survey drawings must:

- Include, but not be limited to, all information detailed in this section

Display all information using the symbols in Appendix H: Green Infrastructure Drawing Legend

- Use North America Vertical Datum of 1988 (NAVD 88) for vertical data
- Use North American Datum of 1983 (NAD 83) State Plane New York, Long Island FIPS 3104 Feet for horizontal data
- Clearly indicate the datum used and provide a conversion to the local Borough Sewer datum on the contract plans.

All survey drawings must be stamped and signed by a licensed New York State Land Surveyor and submitted to DEP in the following format:

- AutoCAD 2018 or higher

PERMEABLE PAVERS AT P.S. 261, BROOKLYN

3.8 Tree Survey and Inventory (DPR only)

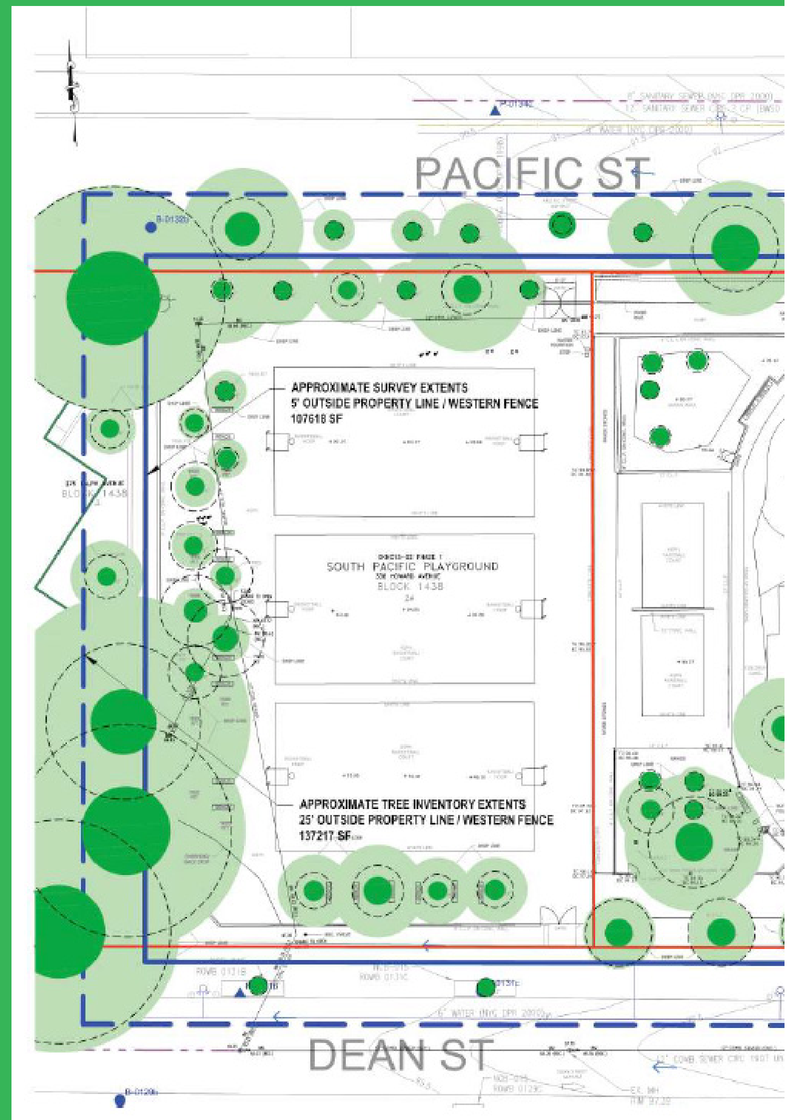
For DPR projects only, the designer shall engage the services of an approved Consulting Arborist (CA) who shall perform an inventory and limited visual assessment of all trees potentially impacted by green infrastructure construction on parkland.

Procedure

The designer should prepare a CLL drawing for each proposed green infrastructure practice location for review and approval by DEP. This line shall generally contain the footprint of each green infrastructure practice and reasonable work zones and access routes. The tree survey limits shall generally include all trees and stumps within 25 feet of the CLL. Any trees and stumps within the 25-foot radius that are the located outside the park property line shall be included in the survey. After review by DEP, the designer will provide the CA with a site survey or similar document showing the CLL and tree survey limits.

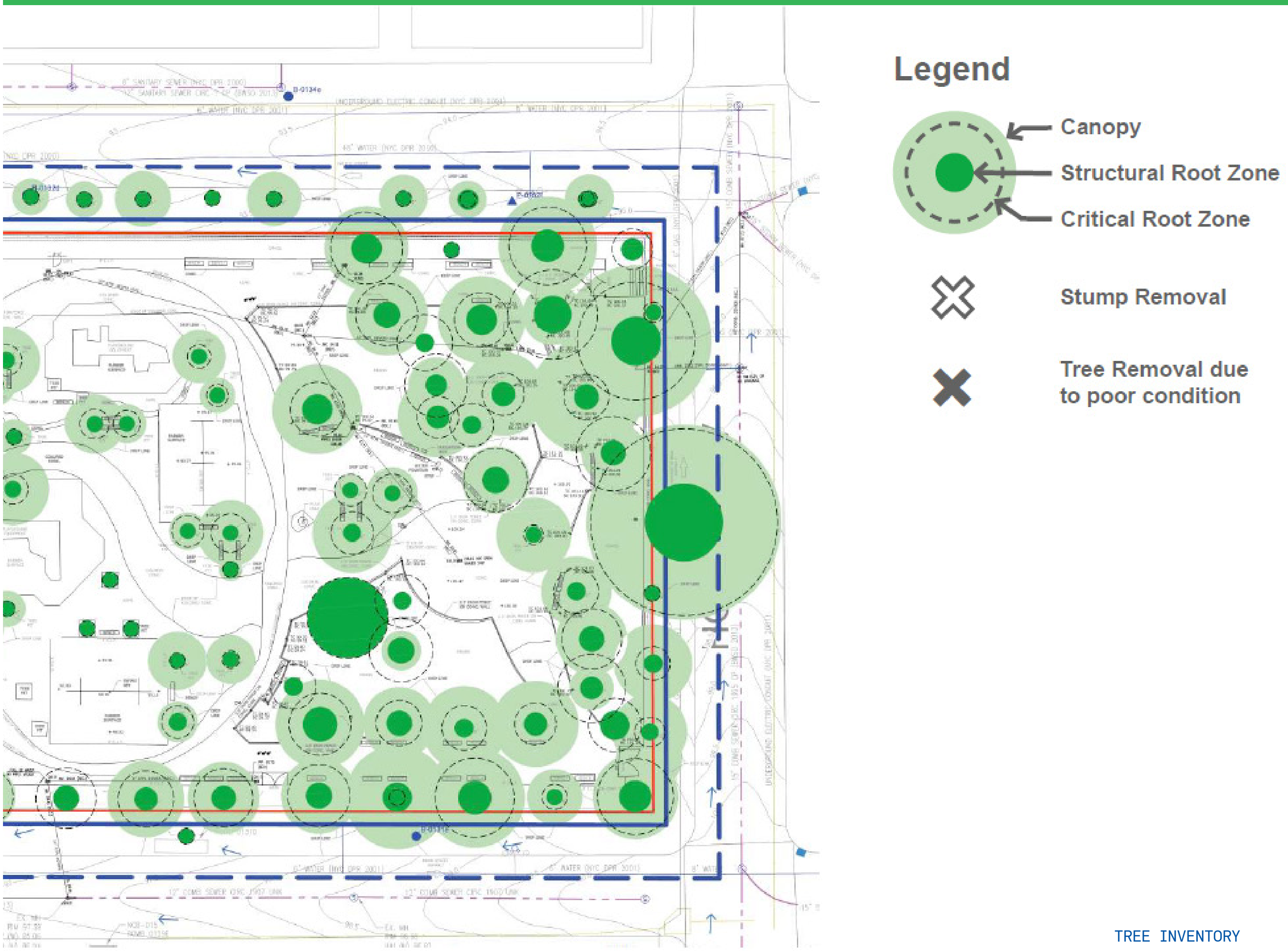
The tree inventory shall include, but not be limited to:

- Tree number
- Species
- Diameter at breast height (dbh)
- Condition
- Proposed pruning type(s)
- Recommendations for transplant or more advanced assessment by DPR
- Recommendation for removal if deemed by the CA to be dead, irreversibly diseased, or hazardous.



The CA shall enter the tree inventory into the DPR Tree Inventory Microsoft Excel spreadsheet, included as Appendix I, and submit it to the designer. In addition, the CA shall submit a field-annotated site survey indicating the location of each tree, its dripline, critical root zone, and corresponding tree number to the designer. The tree survey information shall be added to the site survey drawing in the conceptual plan submittal.

In consultation with DPR, DEP may assign additional trees to be inventoried at a later date by the contractor if deemed necessary due to the contractor's choice of means and methods, to a change in either CLL or access route, based on site conditions, or an assessment of potential impacts.



Consulting Arborist Qualifications and Approval

All CAs must be approved by the DPR Landscape Construction Unit. The designer must submit the prospective CA's resume, including educational background, employment history, and relevant certifications, to the DPR Green Infrastructure Unit with a copy to the DEP Office of Green Infrastructure Project Manager. DPR will respond within one week of credentials submittal. DPR reserves the right to periodically evaluate the performance of any previously approved CA. If the CA is not performing to DPR standards, his or her approval status may be revoked.

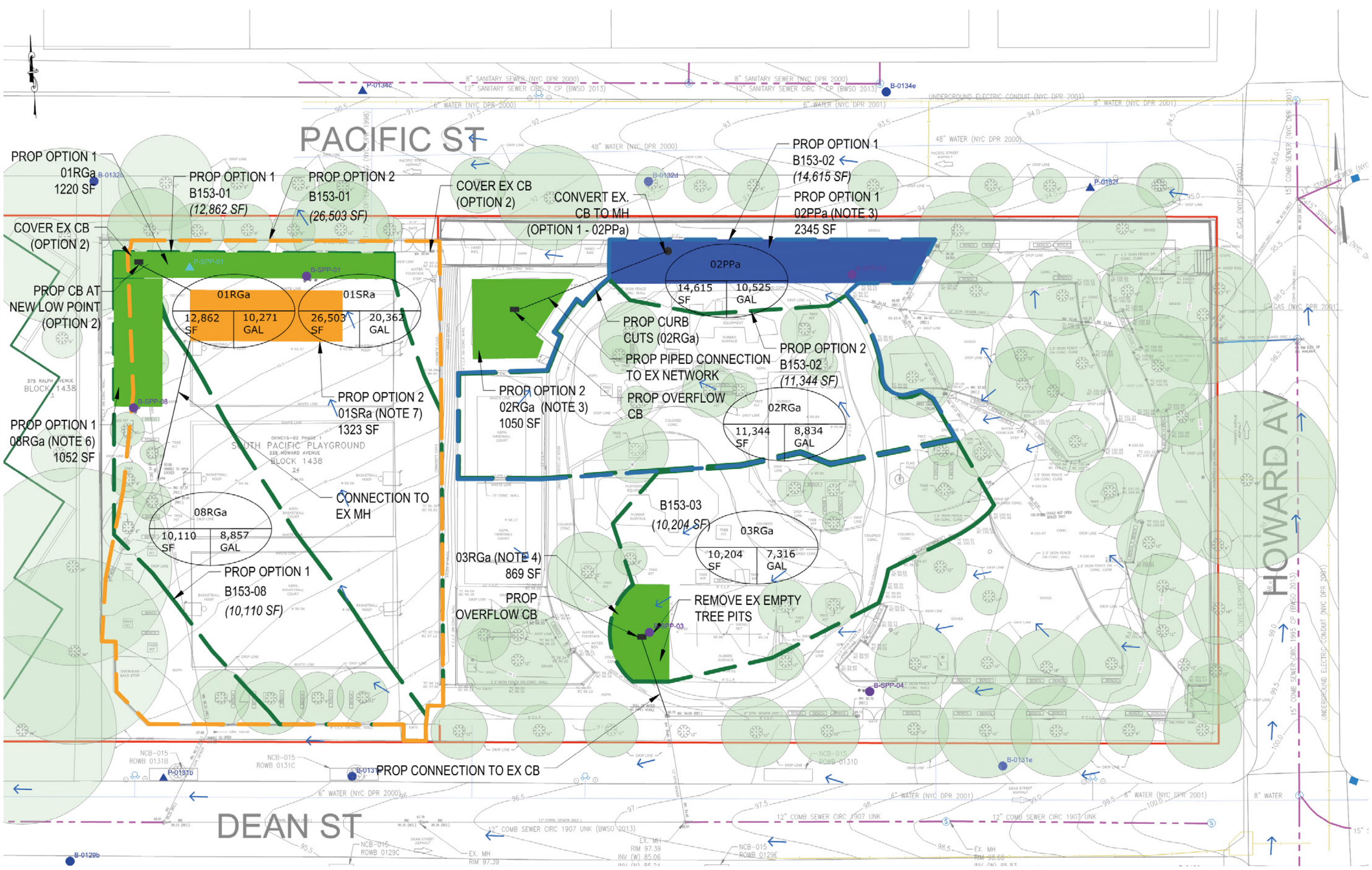
All persons desiring approval as CAs shall possess, for a minimum of three years prior to the date of work assignment, certification from the International Society of Arboriculture (I.S.A.) as a "Certified Arborist" or "Board Certified Master Arborist," or from the American Society of Consulting Arborists (A.S.C.A) as a "Registered Consulting Arborist;" and a minimum of three years of full-time professional experience in the practical use of knowledge involved in tree protection, pruning, installation and establishment, diagnosis and treatment of tree problems, cabling and bracing, climbing, fertilization, or other services that directly relate to arboriculture.

3.9 Conceptual Plan and Site Analysis Summary

Following the site survey, the designer will prepare and submit a Conceptual Plan and Site Analysis Summary for DEP review. The site analysis summary will present the information identified in the desktop analysis and important features verified by the designer and collected by the surveyor, including any comments from DEP and the Owner Agency, and recommended green infrastructure practice types and locations. DEP will provide a template for the conceptual plan, an example of which is included in Appendix G.

The Conceptual Plan and Site Analysis Summary must incorporate the survey and results from the geotechnical investigation (must be submitted after the investigations are completed). Concept plans should only include proposed green infrastructure practices that treat a minimum of 10,000 square feet of impervious area. Practices that do not treat 10,000 square feet should look to increase the treatment area by piping from other on- or off-site areas, or these practices should be removed at the concept plan stage.

The following sections detail the components to be included in the conceptual plan and site analysis summary submittal.




CONSTRUCTION AT P.S. 139, QUEENS

Submittal Components

Following the DEP template, the conceptual plan document must provide, at a minimum, the project location, project goals, existing conditions plan(s), proposed conceptual green infrastructure plan(s), photos from the site visit, and a photo location map. The conceptual green infrastructure plan will include, but not be limited to, the following:

- Field verified conditions (updated from the pre-site visit map)
- Locations for geotechnical investigations (performed and/or proposed)
- Limits of survey
- TDAs
- Preliminary green infrastructure practice(s) and location(s)
- Clearances of green infrastructure practices from existing surface and subsurface site features (buildings, light poles, retaining walls, DEP infrastructure, etc.)
- Construction Limit Line (CLL) (footprint of each green infrastructure practice and reasonable work zones, access routes, and area of site restoration).
- Invert elevations for GI and proposed and/or existing drainage structures

In addition, the following documents must be included as a site analysis summary:

- Cover letter including a short summary of the site analysis work performed, highlighting findings from the desktop analysis and site visit, photos of potential green infrastructure sites, Owner Agency input, and potential maintenance issues and mitigation options
- Copy of the site visit attendee sign in sheet
- Completed Field Checklist Form
- Updated DEP's Stormwater Calculation Table for On-Site GI Practices
- Existing drawings and reports from records search, with summary list
- Structural Analysis Report (green roofs only).

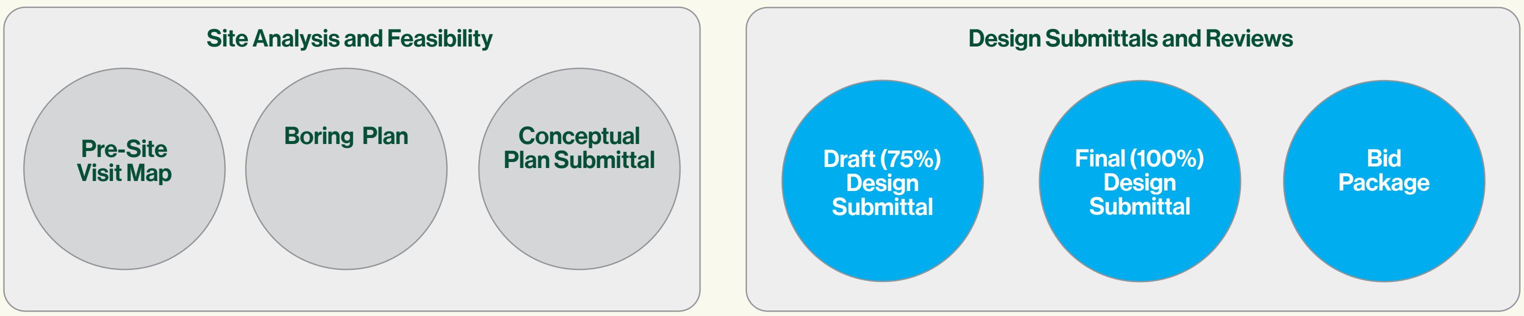
Project Tracking Spreadsheet (PTS)

The designer shall complete the PTS in the standard format provided by DEP (designers should always use the template available in GreenHUB to ensure use of the latest version) for each green infrastructure practice (asset) proposed during the site analysis phase. The PTS will serve as a record for impervious TDAs for each green infrastructure practice and is critical to the DEP's reporting capability. The designer shall update and revise the PTS with each design submission and submit the spreadsheet directly to DEP or through GreenHUB, a web-based application with data management capabilities that provides asset management for the green infrastructure practices citywide. DEP will provide the designer with instructions for login into GreenHUB.

4. DESIGN SUBMITTALS AND REVIEWS

Following the conceptual plan and site analysis summary submittal, designers will prepare two design submittals prior to submitting a final bid package, as depicted in Figure 4-1. Each design submittal will include a cover letter summarizing changes from the previous submittal and include a checklist that clearly identifies the submittal's required drawings, specifications, cost estimates, and calculations. Certain requirements will vary by Owner Agency, as discussed in this section. All design submittals shall be reviewed by DEP and the Owner Agency.

FIGURE 4-1. DEP PROJECT PHASE SUBMITTALS



4.1 General Drawing Requirements

The designer should implement rigorous quality assurance protocols before any submittal to DEP. All design drawings must be checked by the designer to ensure that all documents are correct and consistent. At a minimum, the following items should be checked:

- Control points, baselines, centerlines are drawn correctly. Survey and control information should be checked independently by the engineer
- Elevations, distances, dimensions, scale, and angles are represented correctly
- Drafting standards (line types, line weights, symbols, etc.) are applied correctly
- Generally, for plans 1 inch = 20 feet scale is most preferable to show sufficient plan details, however 1 inch = 40 feet may also be used
- All profiles should be plotted at a vertical scale of 1 inch = 5 feet with horizontal scale of 1 inch = 10 feet and/or to the same horizontal scale as the plan view
- Provide pipe size, slope, material, and flow rate on all profiles
- Match lines shall be easily distinguishable with bold lines, lettering, and proper station reference
- Proposed work shown in black and existing conditions, including text, screened at 50% black ink.

All drawings shall include the following elements:

- DEP/Owner Agency appropriate title blocks, North arrow, graphic and written scales
- Dimensions, symbols and legend
- Drawing annotations and abbreviations
- Reference drawings (documentation of existing structures, site surveys)

This list is not inclusive of all quality assurance checks to be made; it is the responsibility of the designer to submit drawings that are free of errors as part of the effort to limit costs per Greened Acre. Appropriate owner agency drawing templates will be provided to the designer.

4.2 Design Submittals

The designer will prepare each stand-alone design submittal to include drawings and other supporting documents that meet all requirements, with a focus on minimizing change orders during construction. When references are made, or assumptions are based on previously submitted studies or reports, the design submittal must include the referenced information as an attachment. Assumptions made in previous submittals must be verified and substantiated in all new reports. Maintenance should be considered in each design submittal, and any issues or mitigation measures should be discussed with DEP and potentially owner agencies as well.

All submitted documents shall be legible. If submittals are unreadable, resubmittal of readable copies shall be required. These will be reviewed concurrently with the various design stage submittals.

Submittals with incomplete or absent information may result in the document being returned without review and potentially causing project delays. DEP may require additional information with any submittal that is unclear, does not provide sufficient information to make a decision, or is missing required elements as specified under these guidelines.

Comments received from DEP and the Owner Agency will be addressed by the designer on the next submittal.

Review Time

In scheduling the design of a project, the designer should allow a maximum of 15 business days for DEP and the Owner Agency to review each phase of design and provide comments. The actual time required by DEP to review and return drawings may be less than 15 days. Plans will be reviewed in the order they are received.

Draft (75%) Design Submittal

The draft design submittal will include the green infrastructure practices proposed in the Conceptual Plan and Site Analysis Summary and all supporting documentation on the site's feasibility and constraints. The documents to be submitted as part of the draft design submittal are:

- Cover Letter: The Cover Letter must:
  - State the design phase being submitted
  - List any new work not included in previous submittal
  - Describe any design changes from previous submittal and justification for such changes
  - State any assumptions being made and verify any assumptions made in previous submittal
  - Summarize methodology and results for all calculations including: peak flow rates, storage volumes, critical water surface elevations, orifice sizing, green infrastructures facility sizes, and drainage times
  - Describe any H&H methods different than those identified in this manual and justification for using them
  - Include a narrative of potential maintenance or access issues considered and potential mitigation measures
- Comment tracking table with responses to conceptual plan comments
- Draft Design Submittal Checklist
- Draft Design Submittal Drawings
  - Title Sheet: including list of drawings, site location map, property lot and block number, contract number as shown in GreenHUB, and list of any standard Owner Agency drawings
  - General Notes: including symbols and legends, abbreviations, etc.
  - Topographic Survey: including survey control points, North arrow, scale, block and lot number, gross lot size, location and critical elevations of utilities, wells, drainage pipes, etc. See Section 3.7 for full description of survey requirements.
  - Utility Coordination Plan: including existing drainage, water, sewer, electricity, gas utilities, etc.)
  - Boring Plan: identify boring locations and include both boring, soil, and/or permeability logs, etc.
  - Tree Protection and Staging Plan: including tree protection schedule, site access, and construction fencing / gates
  - Removal / Demolition Plans: include specific items requiring demolition, relocation, etc., extent of removal, if any utilities are to be capped and abandoned in place, any hazardous material removal, and callouts for specific items not to disturbed

TABLE 4-1: ASSET INFORMATION REQUIRED ON PLAN SUBMITTAL

Tributary Area ID	Ponding Volume (CF)
Impervious Tributary Area (SF)	Soil Volume (CF)
Static Storage Volume (CF)	Stone / Drainage Layer Volume (CF)
Green Infrastructure Type	SW Chambers, Pipes, etc. Volume (CF)
Green Infrastructure ID	Infiltration Volume (CF)
Asset Area (SF)	Calculated Volume of Rainfall Managed (CF)
Ponding Depth (IN)	Calculated Volume of Rainfall Managed (GAL)
Soil Depth (FT)	Impervious Surface Managed (%)
Stone / Drainage Layer Depth (FT)	

- Erosion Control Plan
- Materials Plan: identify all critical materials and primary features
- Grading Plan: include significant spot grades and major contours for all critical materials and primary features, elevations of proposed and existing green infrastructure practices
- Proposed Green Infrastructure Layout Plan: identify all primary existing features and proposed work with locations shown by dimensions from existing reference points, including:
    - Table of tributary drainage areas and green infrastructure assets with the information in Table 4-1.
    - Existing storm sewer infrastructure including pipes and inlets
    - Green infrastructure practices with dimensions and inverts
    - Sizes, slopes, and flow arrows for all piping and inflow channels
    - Inverts for all drainage structures including inlets, manhole structures, cleanouts, outlet structures etc.
    - Peak flow rates at all inflow/outflow points including inlets, manholes, and outlet structures
    - Stormwater calculation table for all green infrastructure practices
    - Critical water surface elevations
- Planting Plan: identify planting areas and species with general quantities
- Sections, Profiles, and Details: identify all critical materials and primary features
- Site Details: custom details illustrating design intent and materials

- Preliminary Engineering Cost Estimate (including cost per Greened Acre)
- List of Specifications
- DEP Project Tracking Spreadsheet
- Appendices, including:
    - Appendix D:Stormwater Calculation Table for On-site GI Practices
    - Detailed H&H Analysis for each TDA and DEP's Summary Table: Determination of runoff coefficients, times of concentration, rainfall intensity used, and peak flow rate calculations
    - Hydraulic Capacity Calculations for green infrastructure conveyance systems
    - Geotechnical Report


SUBSURFACE DETENTION SYSTEM CONSTRUCTION AT P.S. 89, BRONX

Final (100%) Design Submittal

The final design submittal will advance the project design to completion, complying with and incorporating prior comments received and submit the final "ready to bid" set of drawings and specifications to be reviewed. The following is an outline of the final design submittal requirements.

- Cover Letter
  - Update of information from the previous submittal
- Comment Tracking Table with responses to draft design submittal comments
- Final Design Submittal Checklist
- Final Design Drawings
  - Address all comments from previous submittals. Ensure correct cross referencing between site plans drawings for appropriate details, sections, match lines, other design disciplines, etc.
  - Include drawings complete with final design intent, materials, callouts, and calculations.
  - Eliminate any possible conflicts (horizontal and vertical) between site development and proposed green infrastructure practices and existing utilities drawings by coordinating with other design disciplines.
- Final Engineering Cost Estimate (including cost per Greened Acre)
- Final Specifications (as discussed with DEP)
- DEP Project Tracking Spreadsheet
- Preliminary Construction Schedule
- Appendices with appropriate backup information, calculations, and analyses, including but not limited to:
  - Updated Stormwater Calculator Spreadsheet
  - Updated Detailed H&H Analysis
  - Updated Hydraulic Capacity Calculations
  - Geotechnical Report

Bid Package Submittal

The designer shall address all comments received during the final design submittal and resubmit the final documents outlined in the previous sections. The final bid package will consist of 100% Construction Drawings signed and stamped by a New York State Professional Engineer and all final specifications necessary for a complete construction bid package. The documents included in the final bid package are:

- Cover Letter
  - The Cover Letter must confirm that all comments from the final design submittal have been addressed and confirm all documents required for construction are included with the bid package.
- Comment Tracking Table with responses to final design submittal comments
- Bid Package Checklist
- 100% Construction Drawings
- Final Cost Estimate
- Final Specifications
- Updated DEP Project Tracking Spreadsheet
- Bid Booklet
- DEP Procurement
  - For contracts procured through DEP, the designer shall prepare a complete bid book, including the City Standard Construction Contract, the Invitation to Bid, Prevailing Wage Rates, and all other requisite documents that will be provided by DEP as appropriate, as well as final specifications.
- DOE Procurement
  - For DOE procured contracts, the designer shall transmit detailed specifications and drawings only. The designer shall address comments made by DEP/DOE legal offices (as applicable) and the Corporation Counsel and make revisions as required prior to bid. Sites to be included under DOE JOC contracts will include the same information as required for DEP procured construction contracts but shall be coordinated with DOE and packaged according to existing DOE JOC contracts.

WINTHROP CAMPUS, BROOKLYN

5. POST-DESIGN

5.1 Bid Phase Services

For the sites where DEP is facilitating the construction, design consultants will provide support to DEP through bidding and award. The DEP Project Manager will provide specifications for the design consultant to modify accordingly to satisfy necessary contract requirements. A representative of the design consultant is present at the pre-bid conference and site visit to answer any questions. The design consultant shall answer all questions from prospective bidders that require design-related clarification through addenda and, upon conclusion of the bid period, incorporate all modifications from addenda into the construction contract documents.

5.2 Construction Activities

Submittal Review and Approval

All submittals provided by the construction contractor are reviewed by the design consultant to ensure compliance with the construction contract documents. The design consultant shall return all shop drawings to the construction contractor as "Furnish as Corrected" or "Furnish as Submitted." If the design consultant identifies issues with the quality of the drawings, the design consultant is required to bring it to DEP's attention to take corrective action with the construction contractor.

On occasion, the construction contractor may propose an item that is materially different from what is required in the construction contract documents. The design consultant is responsible for evaluating contractor-initiated construction deviations. The evaluation must consider compliance with design objectives, cost, and technical feasibility. If the substitution is considered acceptable, the design consultant would prepare a cost estimate for the substitution.

If necessary, the design consultant will evaluate and respond to Requests for Information ("RFI") prepared by the contractor.

Site Visits

The design consultant should be present at the pre-construction meeting with the construction manager to communicate key aspects of the design and installation and conduct periodic site visits to ensure that the work is progressing in accordance with the construction contract documents and design intent. The design consultant is also responsible for conducting site visits and providing appropriate technical expertise based on work progress.

Notes prepared by the design consultant after each site visit must include observations on the quality of progressed work and identify any areas that require closer oversight attention or upcoming work that requires specific instruction.

Construction checklist may be provided by DEP project manager.

Geotechnical Testing During Construction

Infiltration testing of the native soils at the bottom of the green infrastructure practice shall be performed by the contractor during construction of each green infrastructure practice. The test shall be performed per ASTM D3385-18 "Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer" with a minimum of one test completed for every 100 square feet of green infrastructure practice area (with a minimum of 2 tests per practice). The testing results shall be provided by the construction contractor to the design consultant. The results of the test will be used to determine whether the green infrastructure practice should operate as a retention or slow-release practice (whether the configuration of the valve in the outlet control structure is open or closed).

As-built Drawings Review and Approval

The design consultant will review as-built drawings provided by the construction contractor to ensure consistency with the final construction of the green infrastructure practices in the field. The PTS shall be finalized and resubmitted based on the as-built information.


DOOSAN

6. DEFINITIONS

Cleanout: structure to allow access to subsurface pipes for cleaning.

Conveyance Systems: structures that are used to capture and convey stormwater runoff, such as inlets, channels, or pipe sections.

Design Capture Volume: total volume of runoff generated by 1.25 inches of rainfall over the impervious surfaces within the tributary drainage area. This volume is obtained by taking the product of design rainfall depth and the contributing impervious area.

Distribution Pipes: pipes used in subsurface practices to even distribute flow from inlets or manhole structures throughout the facility.

Fore-bay: a separate segment within a stormwater basin used to trap sediment, chosen to facilitate maintenance and removal of the sediment. Use of a fore-bay is intended to facilitate sedimentation and thus protect other unit treatment processes.

Grade: Grade or Slope is the vertical change in elevation divided by the horizontal distance between the same two points. Slope is usually expressed in feet per foot (rise over run). Grade is often expressed as a percentage (rise divided by run X 100).

Greened Acre: volume of stormwater managed by a green infrastructure practice equivalent to 1 inch of stormwater over 1 acre of impervious area, or 1 acre-inch of volume.

GreenHUB: DEP's web-based application with data management capabilities that provides asset management for the green infrastructure practices citywide over their lifecycle, where designers upload the Project Tracking Spreadsheet.

Head (Hydraulic Head): Energy represented as a difference in elevation. In slow-flowing open systems, the difference in water surface elevation, e.g., between an inlet and outlet.

Impervious Surface: surfaces in the urban landscape that cannot effectively infiltrate rainfall and generally consisting of rooftops, pavements, sidewalks, and driveways.

Infiltration: the downward entry of water into the surface of the soil. Infiltration rate (or infiltration capacity) is the maximum rate at which a soil in a given condition will absorb water.

Inlet: structure to collect sediment and debris, dissipate energy, and control stormwater flow into a facility.

Invert: the bottom elevation of a channel, pipe, or manhole.

Low Flow Orifice: orifice located within the outlet control structure used to reduce the flow rate out of a green infrastructure practice with an underdrain.

Maximum Design Capture Volume: total volume of runoff generated by 2 inches of rainfall over the impervious surfaces within the tributary drainage area.

Native Vegetation: Vegetation comprised of plant species indigenous to the region and which reasonably could have been expected to naturally occur on the site.

Observation Well: structure located near the center of a subsurface practice used to monitor the facility.

Outlet Control Structure: below-grade structure used to regulate flow out of a green infrastructure practice with an underdrain, prior to connecting to existing on-site drainage system.

Peak Runoff: the maximum stormwater runoff rate (cfs) determined for the design storm, or design rainfall intensity.

Permeable or Porous Pavements: pavements for roadways, sidewalks, parking lots or plazas that are designed to infiltrate runoff, such as: permeable concrete, permeable asphalt, unit pavers- on-sand, and crushed gravel.

Ponding Depth: the depth of surface water within a green infrastructure practice.

Project Tracking Spreadsheet: a spreadsheet filled out by designers or project managers to record key information about green infrastructure practices, submitted through the GreenHUB website.

Rational Method: a method of calculating runoff flows based on rainfall intensity, and tributary area, and a factor representing the proportion of rainfall that runs off.

Retention: the process of holding or retaining runoff close to the source for infiltration, evapotranspiration, or reuse.

Retention Practices: facilities designed to hold water for a considerable period of time, with the intention that the water will be dissipated by evaporation, plant transpiration and/or infiltration into the soil. Note the relation to "Slow-Release Practices".

Runoff Coefficient: a measure of the permeability that is used to estimate the portion of the rainfall that will run off the watershed.

Sheet Flow: a flow condition during a storm where the depth of stormwater runoff is shallow and informally spread over the land surface.

Slope: Land gradient described as the vertical rise divided by the horizontal run expressed in percent.

Slow-Release Practices: Facilities design to hold runoff for a short period of time and then releasing it at a controlled rate into the area storm drain system. Note the relation to "Retention Practices".

Static Storage Volume: the volume of water that can be held by the green infrastructure practice, which is determined as the sum of surface (ponding) storage volume, volume within the planting medium, volume within the gravel medium, and volume found in subsurface structures (e.g. stormwater chambers, pipes, tanks, etc.).

Storm Runoff: Surplus surface water generated by rainfall that does not seep into the earth and flows overland to flowing or stagnant bodies of water.

Subsurface Practices: green infrastructure practices designed to have stormwater enter the facility below-grade from a connection to an inlet.

Surface Practices: green infrastructure practices designed to have stormwater enter the facility through surface loading.

Time of Concentration (Tc): the time for runoff to travel from the hydraulically most distant point of the drainage area to the watershed outlet or study point.

Total Capture Volume: the sum of the static storage volume and any additional volume that the green infrastructure practice manages over an 8-hour period (i.e. infiltration or slow release from an underdrain). It does not include stormwater that bypasses the green infrastructure practice through inlet or outlet controls.

Tributary Drainage Area: the amount of surface area that drains to a green infrastructure practice.

Underdrain: drainage pipe connecting the facility to an outlet control structure prior to the existing on-site drainage system.

Velocity: the velocity in a pipe that is flowing full, but not under pressure. This condition is sometimes called gravity full flow and the velocity is determined from Manning's equation.

7. APPENDIX

Appendix A: TDA and Green Infrastructure Asset ID Naming Conventions

Appendix B: Summary of H&H Analysis Spreadsheet and Drainage Report Outline

Appendix C: Green Infrastructure Practice Standards (Descriptions and Typical Details)

Appendix D: DEP's Stormwater Calculation Table for On-Site GI Practices

Appendix E: Modified Parks Inlet Detail for Off-site Runoff

Appendix F: DEP's Limited Geotechnical Investigation Procedures For New York City On-Site Green Infrastructure Practices

Appendix G: Conceptual Plan Templates

Appendix H: Green Infrastructure Survey Drawing Legend

Appendix I: DPR Tree Inventory Spreadsheet

Note: All Appendicies are available for download as either PDF of Excel templates on DEP's Green Infrastructure Website

APPENDIX A

TDA AND GREEN INFRASTRUCTURE ASSET ID NAMING CONVENTIONS

APPENDIX B

SUMMARY OF H&H ANALYSIS SPREADSHEET AND DRAINAGE REPORT OUTLINE

APPENDIX C

GREEN INFRASTRUCTURE PRACTICE STANDARDS
(DESCRIPTIONS AND TYPICAL DETAILS)

APPENDIX D

DEP'S STORMWATER CALCULATION TABLE FOR ON-SITE GI PRACTICES

APPENDIX E

MODIFIED PARKS INLET DETAIL FOR OFF-SITE RUNOFF

APPENDIX F

DEP'S LIMITED GEOTECHNICAL INVESTIGATION PROCEDURES FOR NEW YORK CITY ON-SITE GREEN INFRASTRUCTURE PRACTICES

APPENDIX G

CONCEPTUAL PLAN TEMPLATES

APPENDIX H

GREEN INFRASTRUCTURE SURVEY DRAWING LEGEND

APPENDIX I

DPR TREE INVENTORY SPREADSHEET