CREATING GREEN BUFFERS IN THE GREENPOINT INDUSTRIAL AREA

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BROOKLYN, NY

MARCH 2018

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Purpose

The purpose of the "Creating Green Buffers in the Greenpoint Industrial Area" (Green Buffers) project is to generate a green infrastructure (GI) plan for a five-block industrial area in the Greenpoint neighborhood of Brooklyn. The GI plan is to be developed through a collaborative and community-driven process and to identify potential sites for GI installations with the intent that property owners and/or public agencies will implement the GI plan in the future.

This document is the resultant GI Plan that discusses the green infrastructure practices considered for the Green Buffers project (Part 1) and proposes GI practices for the project area (Part 2). This GI Plan contains background information and desktop assessments that explore the various GI alternatives and their feasibility in the project area. This document informs future actions for the project, including outreach and field work, which will help make Green Buffers in the Greenpoint industrial area a reality.

Background

Industrial areas in a dense urban center are often perceived negatively by residents immediately outside of the area even if industrial areas provide economic benefits to the neighborhood as well as to the entire city. One of the reasons for the negative perception is the physical environment found in many industrial areas. Large industrial buildings, machineries, noisy or dusty activities, truck traffic, and lack of greeneries are common features that are not particularly inviting for local residents. However, preserving industrial activities is important to many urban residents for jobs and related economic activities. Although seemingly contradictory, preserving industrial activities may also preserve the neighborhood character of the surrounding areas by stemming the tide of gentrification. The tension between the need to preserve an industrial area and the desire for a "green" neighborhood is nothing new. However, with the establishment of green infrastructure in urban planning as well as stormwater management, there are now opportunities to create a green industrial area that serves the businesses as well as the residents.

McGolrick Park Neighborhood Alliance (MPNA) is a grassroots volunteer organization, which saw an opportunity to transform the industrial area of Greenpoint through green infrastructure. On behalf of the MPNA, New York City Soil & Water Conservation District (SWCD) received grant funding from the New York State Office of the Attorney General and the New York State Department of Environmental Conservation through the Greenpoint Community Environmental Fund to engage the community in developing a greening plan for the industrial area. As part of the greening plan development, SWCD issued a request for proposals (RFP) from consultant teams to complete the technical aspects of the project. The contract was awarded to the Evergreen Exchange team that included eDesign Dynamics, LLC, in partnership with NYC Audubon, and MPCA. In May 2016, SWCD with assistance from the Evergreen Exchange team initiated a community-driven

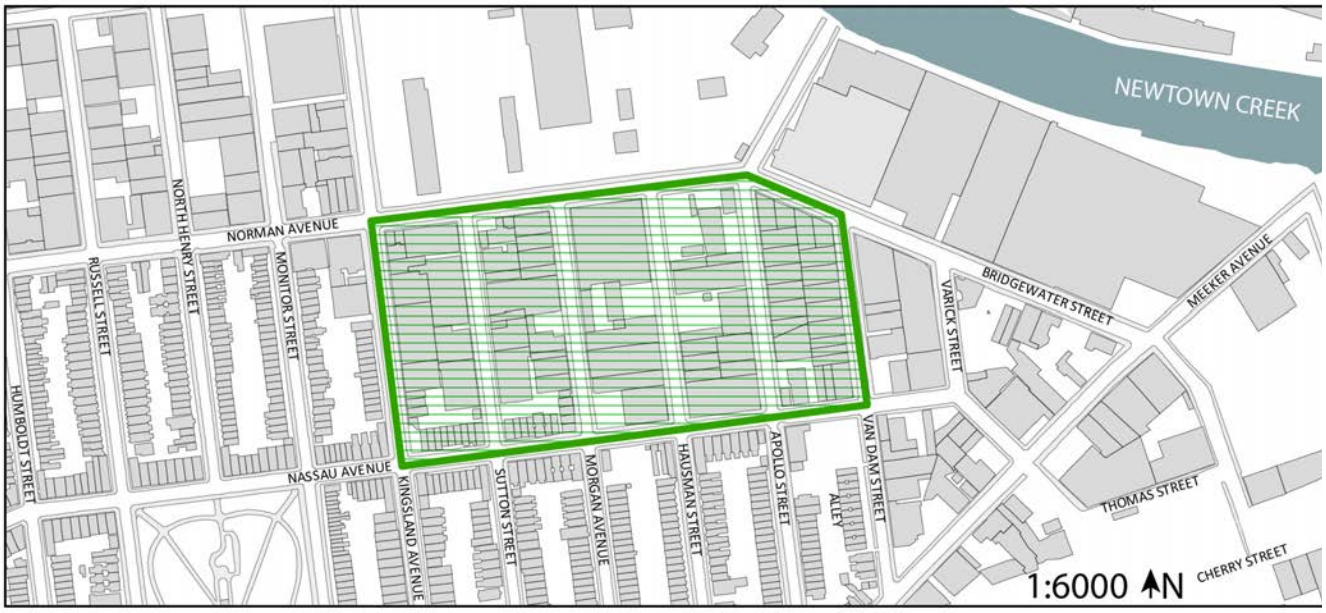


FIGURE 1 - PROJECT AREA MAP
Location of 'Green Buffers' Project area in Greenpoint, Brooklyn, NY.

planning process with the goal of enhancing its stormwater management, reducing its thermal pollution, improving its aesthetics, uniting its commercial and residential sectors, and acting as a model for other mixed industrial and residential communities.

The project area consists of five blocks in the Greenpoint neighborhood of Brooklyn, bounded by Norman Ave. and Bridgewater St. to the north, Nassau Ave. to the south, Kingsland Ave. to the west, and Van Dam St. to the east. (See Figure 1.) The area is primarily zoned as industrial with a small portion being commercial, residential, and mixed-use. However, the west and south borders of the project area abuts predominantly residential areas. The majority of the project area is privately owned. The total project area is approximately 875,500 square feet. From GIS data, it is estimated that 57% of the project area is covered by buildings, 17% by roadways, 15% by sidewalks, and 11% by trees and courtyards. The prevalence of existing infrastructure was an important factor in evaluating the feasibility of installing green infrastructure practices in the project area; another important factor was the presence of the contamination plume (described below) underlying the project area.

The project area falls within the Combined Sewer Overflow (CSO) Drainage Area NCB-027. Combined sewer overflow in New York City has been an environmental concern for decades. During a combined sewer overflow event, the sewer system receives high flows from heavy rain or snow melt which lead to a mixture of stormwater and untreated sewage being discharged into the city's waterways. New York City has invested over $2 billion in reducing CSO discharges to date and has committed to spending $1.5 billion in public funds to utilize green

infrastructure (NYC DEP, 2016) to further reduce CSOs. The green infrastructure projects discussed within this report reduce stress on downstream combined sewer systems by capturing stormwater runoff and thereby reduce the volume of overflows within NCB-027.

The project area sits directly above an ExxonMobil oil spill, which originated from the oil refineries that extended between present-day North Henry St., Greenpoint Ave., Norman Ave., Apollo St., and Newtown Creek. The oil spill was first detected in 1978 by a film that appeared on the surface of Newtown Creek. 14 million gallons of petroleum product is estimated to have spilled along the 52 acres of shorefront property between the Greenpoint Avenue Bridge and Kosciusko Bridge (Ecology and Environment Engineering, 2009). Although remediation efforts commenced after discovery of the spill, they are still ongoing and a plume remains under and around the area near the refineries, which includes the project area for Green Buffers (see Appendix 1 for a map of the plume.)

This plan assesses the feasibility of installing the following green infrastructure practices for the Green Buffers project area: Bioswales, stormwater greenstreets, porous paving systems, green walls, green roofs, and rainwater harvesting/reuse systems. Retention-based GI practices, such as bioswales and porous paving systems, are designed to manage stormwater runoff by promoting infiltration and evapotranspiration. Infiltration contributes to groundwater recharge and has the potential to improve the stormwater quality via biogeochemical processes. Storage and detention based GI reduce contributions to combined sewer systems by detaining rainwater temporarily and releasing it slowly. Water harvesting systems, such as cisterns and rain barrels, also reduce contribution to combined sewer systems by diverting rainwater that falls on rooftops and other exposed surfaces into storage containers. The harvested water can be reused in numerous ways, such as for watering plants or other landscaping purposes, or if the water is configured for reuse inside a building, the harvested water can be used for flushing toilets, laundering clothes, or other grey water uses. Alternatively, storage containers or cisterns can be configured to detain the runoff for slow release over several days, thus helping to reduce wet weather contributions to the combined sewers.

This conceptual plan expands on the GI practices being considered for the Green Buffers project and discusses the New York City technical and regulatory considerations that need to be taken into account prior to their installation in the Green Buffers project area. The plan recommends the green infrastructure technologies most suited to the project area, sites potential installation locations, and outlines the next steps needed for implementation.

SECTION ONE

GENERAL GREEN INFRASTRUCTURE FRAMEWORK & CONSIDERATIONS

1.1 Bioswales and Stormwater Greenstreets

1.1.1 Introduction to Bioswales and Stormwater Greenstreets

One of the most standardized and common forms of green infrastructure in New York City is the right-of-way bioswale (ROWB). Right-of-way bioswales are designed to capture and manage stormwater runoff from upstream impervious areas. ROWBs look much like a standard sidewalk planted area or tree pit, but lie below the roadway grade and include layers of soil and gravel that allow for storage and infiltration of stormwater. ROWBs are located on the sidewalk, and stormwater is conveyed through an engineered curb-cut inlet. Rainwater flowing along the curb enters the ROWB basin through the curb-cut inlet. After entering the ROWB, stormwater accumulates in a depressed, vegetated area to allow for infiltration into engineered soil and coarse gravel layers within the ROWB. The collected water stored in the soil and gravel layers infiltrates vertically and laterally into in-situ soils. Any runoff that surpasses the collection capacity of the bioswale bypasses the bioswale and is subsequently captured at a conventional stormwater inlet and directed to the sewer system. A typical New York City bioswale can be seen in Figure 2.

Like ROWBs, stormwater greenstreets ("greenstreets") are designed to capture and manage stormwater runoff from upstream impervious areas. Rather than being located on the sidewalks, however, greenstreets are located in "bump outs" adjacent to the sidewalk on the roadway or at traffic triangles and are typically larger in size than ROWB. Greenstreets may or may not contain trees, but are vegetated to maintain infiltration rates and provide water quality improvements and habitat value. An example of a greenstreet can be seen in Figure 3. (next page)

FIGURE 2 - NYC DEP BIOSWALE DIAGRAM
Typical NYC Bioswale (NYC DEP, 2017)

FIGURE 3 - NYC GREENSTREET
Typical NYC Greenstreet extending from sidewalk into the right of way as a bump-out. (NYC Parks/ localecology.org, 2017)

1.1.2 Technical and Regulatory Considerations for Bioswales and Stormwater Greenstreets

The NYC Department of Environmental Protection (DEP), the NYC Department of Transportation (DOT), and the NYC Department of Parks and Recreation (DPR), have developed design standards, procedures, and guidelines for GI within the public right-of-way. Any right-of-way installation of bioswales and stormwater greenstreets follow these guidelines. The site selection and design procedure, published by NYC DEP, includes a tributary drainage area analysis, agency walkthroughs, and geotechnical evaluations. Both city agencies and contractors are required to strictly adhere to these standards.

Along with NYC DEP's siting and design standards, DOT has issued siting guidelines outlining where ROWBs can be placed on the sidewalk and where greenstreets can be placed within the roadway. DOT's siting guidelines can be found in Appendix 2. The stormwater management capacity for each potential ROWB and greenstreet is determined through NYC DEP's tributary drainage area analysis (TDA). The TDA process prioritizes GI sites based on rainfall captured and provides a criterion for preliminary sites to move on to the geotechnical investigation. Once preliminary sites have been selected through the TDA analysis, representatives from DOT and DEP conduct a walkthrough to ensure that all siting guidelines are satisfied including: distances from building foundations, trees, hydrants, curb cuts, entrances, stop signs, light and electrical poles, and other street features.

After the preliminary sites have been approved, the sites undergo a geotechnical investigation to determine the soil characteristics and permeability rates at the preliminary sites. A geotechnical investigation is required to determine if a proposed GI location has adequate soil characteristics for an infiltration-based GI practice. Upon completion of the geotechnical investigation, and acceptance of the geotechnical results by DEP, sites proposed for ROWBs and greenstreets will undergo a limited survey to document the topography, surface/ subsurface features, trees, utilities, and vaults within the defined survey area for the project.

1.2 Permeable Pavement and Paver Systems

1.2.1 Introduction to Permeable Pavement and Paver Systems

Permeable paving systems allow water to infiltrate through engineered macropores, thereby reducing flooding, excess runoff, and pooling. Permeable paving alternatives include asphalt and concrete with large void spaces and are pre-mixed but poured/installed in place. Permeable pavers are pre-fabricated and installed in interlocking patterns. All permeable paving technologies are placed above sand and/or gravel subsurface storage layers. Examples of permeable pavement and permeable pavers can be seen in Figure 4 and Figure 5 respectively.

FIGURE 4 - PERMEABLE PAVEMENT
Permeable surfaces, like this pervious concrete, allow for stormwater to easily drain into a stormwater management system. (CivilTech, 2016)

FIGURE 5 - PERMEABLE PAVERS
Permeable Pavers used for public walkways and plaza space. (NYC DEP, 2017)

1.2.2 Technical and Regulatory Considerations for Permeable Pavement and Pavers

Permeable pavements and pavers are typically installed over porous sand/gravel beds that provide storage for the water passing through the pavement. A review of site conditions is necessary to determine the permeable pavement design options and preliminary features. The soil conditions and infiltration should be determined by a geotechnical evaluation as described in the above sections. The soil test should be completed at the elevation for which natural soil subgrade infiltration is being proposed. Permeable pavements can be used over low permeability soils, but alternative design features such as underdrains or a raised drain/outlet structure with greater reservoir storage would need to be included for proper system functionality (Eisenberg et al., 2013).

In addition to soil conditions and other geotechnical factors, existing and proposed slopes of the project should be evaluated when considering a permeable pavement system.

Contributing area run-on and land use will factor into the design of the permeable pavement system. Existing, proposed, and neighboring land use may create an increased risk for surface clogging and soil and groundwater contamination. Permeable pavement should not be used to treat stormwater hotspot areas where concentration of pollutants such as oils and grease, heavy metals, and toxic chemicals are likely to be significantly higher than in typical stormwater runoff (NCDENR, 2012). Generally, permeable pavements are intended for capture of precipitation falling directly on the surface only, avoiding run-on carrying fine sediments that will clog pores and reduce overall infiltration capacity.

1.3 Street Trees and Street Planters

1.3.1 Introduction to Street Trees and Street Planters

Street trees are planted by the New York City Department of Parks and Recreation (DPR) and are located in the public right-of-way. Tree species are determined based on sidewalk width, soil conditions, surrounding tree canopy, flood/drought vulnerabilities, nearby infrastructure, and sewers. Street planters are large potted plants (usually a total planter footprint of over four square feet) planted by property owners and placed within the right-of-way. Street trees and street planters reduce stormwater runoff by leaf interception and direct capture.

FIGURE 6 - STREET TREES
Street Trees along a sidewalk in residential blocks (Welcom-e2TheBronx)

FIGURE 7 - STREET PLANTERS
Street Planters used in a street median to create public space and provide safety from road traffic. (TerraCast, 2014)

1.3.2 Technical and Regulatory Considerations for Street Trees and Street Planters

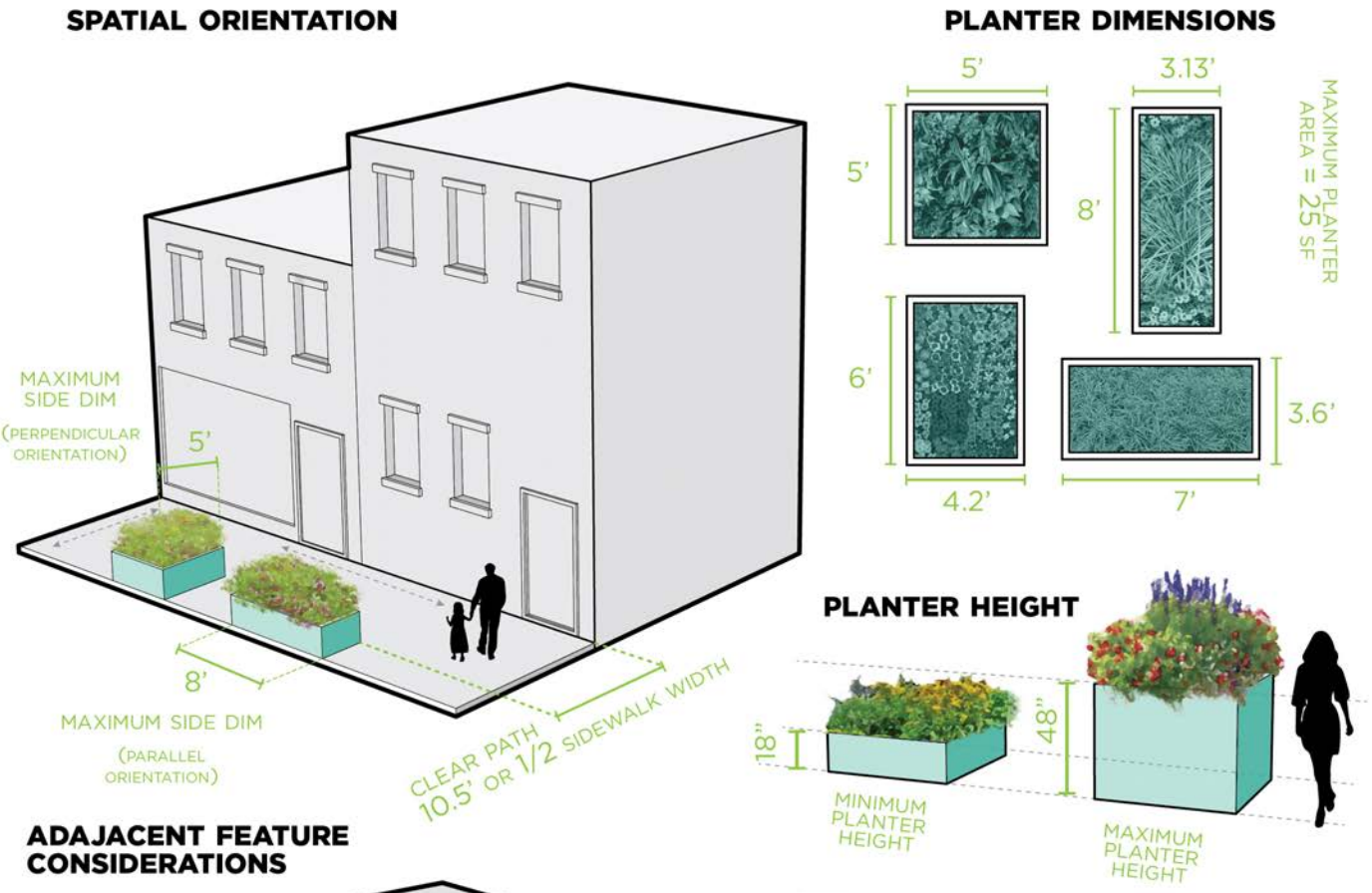
Street tree and street planter locations are determined by the clearances and dimensions regulated by the New York City Department of Parks and Recreation (DPR). DPR lays out its requirements for planting street trees in its Tree Planting Standards (2016). DPR's Tree Planting Standards outline the spacing requirements, tree pit dimensions, tree species and group plantings selection, planting and materials specifications, seasonal maintenance, guarantee period, and finishing requirements. To illustrate the spacing requirements between a proposed street planting location and existing utilities, structures, or other trees, DPR has also generated a Street Tree Planting Standard which follows regulations of other agencies with street jurisdiction such as Fire, DOT, and MTA. DPR's Tree Planting Standard is shown in Appendix 3 and DPR's Street Tree Planting Guidelines are shown in Appendix 4.

In addition to the DPR Tree Planting Standards, DOT outlines rules for where larger planter boxes can be placed on city sidewalks. The specific allowable clearances for street planters can be found in DOT's "Revocable Consent Rules," which can be viewed in Appendix 5. DOT states that street planters, along with benches, information kiosks, litter receptacles, mail boxes, and public telephones may be aligned with a minimum of three feet clearance between them for up to 30 feet, or may be grouped together without separation but extend no more than 15 feet long (NYC DOT, 2016). Also, in the "Revocable Consent Rules," DOT specifies dimensions for street planters.

Sizing for the street planters is also outlined in the DOT rules; they can be 18 to 48 inches high and must be maximum five feet along the side that is perpendicular to the curb, or maximum eight feet along the side that is parallel to the curb. If a street planter is located against a building, it may be continuous. Street planters can have a maximum area of 25 square feet, with dimensions measured at the planter's widest point. Community Board and Public Design Commission (PDC) approval for street planters may also be required at DOT's discretion.

FIGURE 8 - STREET PLANTER DESIGN GUIDELINES

Various selected clearances and dimensions for street planter design, complete list found in the DOT "Revocable Consent Rules," which can be viewed in Appendix 5



1.4 Green Walls

1.4.1 Introduction to Green Walls

Located on the sides of buildings, green walls add green space at eye-level to communities. Green walls include two categories: living walls and green facades. Green facades are created by planting climbing plants at ground level in garden beds or containers. Climbing plants can attach directly to the surface of the building or they can be supported on a structure, such as a modular trellis, independent of the building.

Living walls are vertical gardens that are attached to the exterior of a building. They differ from green facades in that planting substrate is fastened to the wall itself. The plants receive water and nutrients from within the vertical support instead of from the ground. Living walls typically include a modular panel system to support roots and growing medium, a drip irrigation system, and a catch basin to capture runoff.

Green walls provide retention of stormwater through percolation of rainfall and direct interception (Loh, 2008). Examples of living walls and green facades can be seen in Figure 9 and Figure 10, respectively.

FIGURE 9 - LIVING WALL
Living Walls allow for vegetation to grow directly on the exterior of the building. (BlueBrick, 2017)

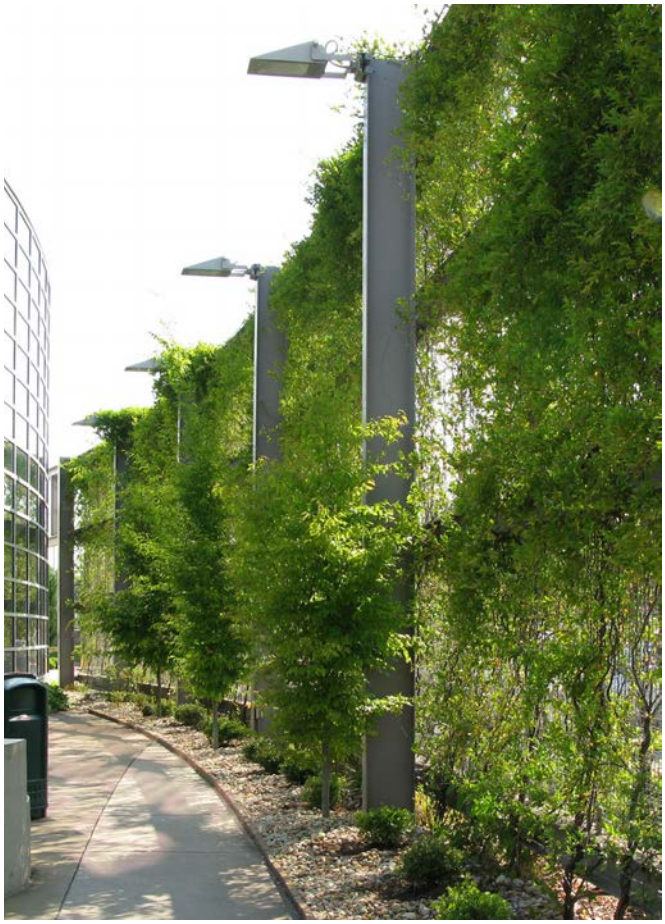


FIGURE 10 - GREEN FACADE
Example of a Green Facade with climbing plants which grow up the trellis structure. (Greenscreen)

1.4.2 Technical and Regulatory Considerations for Green Walls

Architectural, engineering, and structural considerations should be evaluated when designing a living wall or green facade.

Attachment to the building and how the system will be secured to the building or freestanding structure are key in determining the suitability of a green wall. A structural engineer should be included in the siting and design of living walls and green facades to verify the required loads and that the system is compatible with the building construction and materials.

NYC building codes regarding right-of-way, landscape ordinances and easements need to be consulted when locating a green wall. Depending on building placement, a green wall may protrude from the building and extend into public space. If not approved by City agencies, planter type and size may need to be reduced to remain on private property.

When designing a green wall, selection of plant species that will thrive under the given conditions is key. Preference should be given to native plants, as they are more suited for the site environment and more likely to thrive. Plant selection should be based on wind and light exposure, hardiness zones, moisture needs and amenity context.

Living wall systems have recently become available as modular kits that can be installed inside or out. Because planting medium is limited, irrigation is typically a required component to maintain good plant health. Generally, the living walls are fitted with drip irrigation systems with an emitter placed in each cell or plant box. Drip irrigation is efficient and effective, but requires pumping and a reliable source of irrigation water. Sometimes the water source can be a tank or cistern filled with stormwater, but it is more common to use potable water because of its ease of use. According to one manufacturer, approximately 20 square feet of living wall receives on the order of one gallon per day of irrigation water.

Green facades, which consist of climbing plants with roots in the ground, do not generally require irrigation but may need supplemental moisture during dry spells. Perennial plants will endure longer dry periods than annuals because of root depth. Irrigation water is typically added to the planting area by garden hose.

1.5 Green Roofs

1.5.1 Introduction to Green Roofs

Green roofs are planted areas constructed on building rooftops that are designed to have a vegetated, light-weight soil medium lying above a drainage and water storage layer and roofing membrane. The rainwater absorbed and stored by the green roof system helps prevent stormwater runoff from entering combined sewers and the occurrence of flooding after major rain events. Because of the additional burden on the roof structure from green roofs, it is necessary to employ a structural engineer to inspect and assess the condition of the roof below the membrane, and confirm that it is capable of bearing the additional load.

Green roofs can be categorized into three typologies: Extensive, intensive, or semi-intensive. Selection of a particular typology depends both on the structural capacity of the roof and the costs for installation. Extensive green roofs consist of a shallow planting medium and short vegetation (often sedum). Primarily installed for environmental and visual benefits, extensive green roofs are lightweight and often require little maintenance. Intensive green roofs are often designed for human use and/or enjoyment and typically incorporate a variety of plants, including shrubs and trees. These more complex roofing systems typically require landscape maintenance and/or fertilization, water collection systems, and enhanced roofing structure, and are therefore significantly more expensive than extensive rooftops. Semi-intensive green roofs are a mixture of extensive and intensive green roofs. They have a greater diversity of plants than extensive green roofs, incorporating plants such as perennials or small shrubs, but cannot support deep root systems due to its shallower growing medium depth. The cost of semi-intensive rooftops are in-between extensive and intensive green roofs. Generally speaking, deeper the growing medium, the greater the environmental benefits. In addition to conventional benefits of green infrastructure, such as air quality improvement and habitat enhancement, green roofs can reduce the cooling costs for buildings.

Where there are multiple roof levels, green roof systems can be organized in a manner that allows for conventional roof areas to drain to lower green roof areas, thus reducing the total area required for green roof installation. The green roof design provides for some retention of moisture held in the planting medium and gradual release of the detained volume as the planting medium drains to its field capacity. Green roofs can be designed to retain 1” of rainfall depending on the structural capacity of the roof.

1.5.2 Technical and Regulatory Considerations for Green Roofs

The building's structure, existing use of the rooftop, and rooftop accessibility must be evaluated when considering green roofs. The saturated weight of the green roof adds a significant load to the roof structure. In a retrofit scenario, the loading capacity of the roof may be limited, and structural reinforcements are generally costly and difficult. New structures can be designed to bear the additional load at a more reasonable cost.

Green roofs are typically discussed in terms of the depth of the planting medium. Extensive rooftops have a growing medium depth of 2-6 inches with a saturated weight of 16-35 pounds per square foot; and, extensive rooftops can be installed on surfaces with slopes up to 30%. Intensive rooftops have a growing medium depth greater than 12 inches with a saturated weight load of 60-200 pounds per square foot, and can be installed on surfaces with slopes up to approximately 3%. Use of large woody plants like trees and shrubs can add substantial weight over time, and must be evaluated structurally. Semi-intensive rooftops have a growing medium depth of 6-12 inches with a saturated weight load of 35-60 pounds per square foot (NYC DDC, 2007).

Regardless of the type of green roof selected, five layers should be incorporated in a green roof's design: the waterproof membrane (which may already be installed over the roof), the drainage layer, the filter cloth, the growing medium, and the plants. Below, the typical sections for extensive and intensive green roofs are shown. Green roofs add significant weight on top of a building, and property owners looking to add a green roof to their building are required by New York City Department of Buildings (DOB) to hire a professional engineer (P.E.), a registered architect (R.A.), or a registered landscape architect (R.L.A.) to perform a structural analysis.

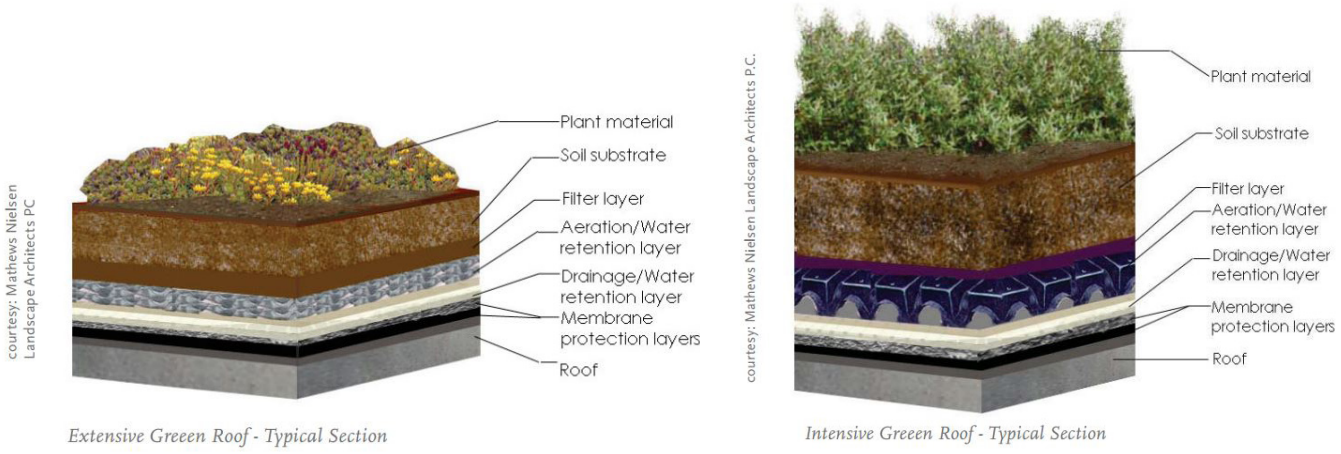


FIGURE 11 - EXTENSIVE VERSUS INTENSIVE GREEN ROOFS
Typical Green Roof Sections (NYC DDC, 2007/MNLA)

The analysis will determine if the existing roof will be able to support the proposed green roof system along with existing loading. After verifying the structural integrity of the roof, the P.E. or R.A. can apply for the construction permit. The P.E. or R.A. will need to certify specific technical elements, submit the structural analysis, and confirm that the existing roof will support the green roof when saturated by providing additional drawings, calculations, and construction documents if necessary. The P.E., R.A., or R.L.A. must also ensure that the green roof is in compliance with the New York State law and the New York City Department of Buildings implementation rule (NYC DOB, 2010). These procedures, however, are only required if the green roof installation is greater than four inches in depth. DOB states that "green roof systems, not more than four inches in depth measured from the upper surface of the roof covering to the top of the growth medium, located on buildings of noncombustible construction or buildings greater than 100 feet in height" do not require permits (NYC DOB, 2010).

1.6 Detention Bioswales

1.6.1 Introduction to Detention Bioswales

At the surface, detention bioswales operate similarly to the standard retention-based ROWB discussed previously. Detention bioswales capture and manage stormwater runoff from upland areas through a depressed planted area with curb-cut (or catch basin) inlet. Beneath the surface, detention bioswales have a soil and gravel layer, like those found in the retention-based bioswales, however, the detention-based bioswales are lined to prevent infiltration into the surrounding earth. Detention bioswales typically possess an underdrain that connects to the sewer system which allows the stored volume to slowly discharge to the sewer system.

Detention bioswales are best suited for areas where a standard (retention-based) bioswale is not possible due to low infiltration rates, contaminated soils, or proximity to other limiting structures such as building foundations or shallow bedrock.

1.6.2 Technical and Regulatory Considerations for Detention Bioswales

Currently, NYC DEP does not allow detention bioswales to be constructed within the right-of-way, thus there is no governing procedure or technical guidance for this technology. However, this practice is currently being used in other cities and on private land. It is expected that in the future, NYC DEP will adopt this technology for areas that are otherwise unsuitable for infiltration, and publish governing documents to guide the process. Likely, the construction of detention-based bioswales will follow a similar process to that outlined previously for detention-based bioswales.

1.7 Rainwater Harvesting

1.7.1 Introduction to Rainwater Harvesting

Water harvesting GI practices capture and store rainwater from roofs or other raised surfaces for later use. The captured rainwater can be used by property owners for irrigation or other greywater purposes, such as cooling water, toilet flushing, or cleaning. The use of harvested water reduces the property's dependence on municipal water and its utility bills.

1.7.2 Technical and Regulatory Considerations for Rainwater Harvesting

Water quality plays a large role in rainwater harvesting systems. In less urban environments or where there is irrigation demand, it is technically straightforward to store and redistribute stormwater to green areas. Other uses, such as toilet flushing or cleaning, require treatment to prevent the potential spread of pathogens and to limit the growth of bacteria in storage tanks. Green roofs can provide effective pre-treatment of runoff and supply a cleaner source of harvested water than standard roof areas. A number of mechanical, biological and chemical treatment options exist to meet the water quality goals of the specific uses.

The first condition to consider when evaluating a rainwater harvesting system is potential demand. If there is no irrigation demand, potential uses are limited to toilets, cleaning, cooling water or other industrial processing (e.g., dust control). If the average daily demand is low (compared to the proposed management area), then a rainwater harvesting system will likely not be cost effective. Other factors influencing use decisions include ease of routing and collecting from multiple sources and storage availability, as well as public perception and acceptance.

According to the Rainwater Harvesting State Regulations and Technical Resources report prepared by the United States Department of Energy (DOE) in June 2015, there are no statewide rainwater harvesting regulations for New York. The DOE advises that reuse scenarios follow the New York State Rainwater Harvesting Guide developed by the Environmental Finance Center of Syracuse University in 2015 and the Rainwater Harvesting 101 report prepared by GrowNYC in August 2008. The New York State Rainwater Harvesting Guide can be viewed in Appendix 6 and the Rainwater Harvesting 101 report can be viewed in Appendix 7. Both documents provide useful background information on rainwater harvesting systems, but the Rainwater Harvesting 101 report provides a more in-depth description for installing a system for a given location. The Rainwater Harvesting 101 report outlines the typical materials and devices needed for rainwater harvesting systems and where they can be obtained, cost estimates, and formulas for calculating the potential rainwater capture volume as well as the size and quantity of pipes and tanks needed. There may also be additional water quality requirements from NYC Department of Health and Mental Hygiene when stormwater is used within a building's interior.

SECTION TWO

GREEN INFRASTRUCTURE PROPOSED FOR THE GREEN BUFFERS PROJECT AREA

2.1 Bioswales and Stormwater Greenstreets

After assessing the existing conditions of the project area, infiltration-based GI practices are not suitable for the Green Buffers project area because of the known ExxonMobil petroleum-based contaminant plume underlying the project area. Installing infiltration-based GI in areas of known contamination presents environmental and health risks, and is thereby prohibited by DEP. DEP's Procedure Governing Limited Geotechnical Investigation for Green Infrastructure Practices states that "if soil and/or groundwater contamination is observed or suspected during the investigation, drilling shall be terminated immediately. The borehole shall be filled and the proposed location shall be abandoned." (See Appendix 8)

When infiltration practices in the right-of-way are not DEP-funded, NYCDOT sets forth guidelines for siting bioswales and greenstreets. Both Phase 1-like (desktop evaluations) and Phase 2-like (field investigations) studies must be conducted prior to siting infiltration bases GI practices in right-of-way (ROW). NYCDOT uses the Phase 1-like study to determine if a location is appropriate for infiltration by examining historical records and regulatory databases for spill records and plume extents. If there is any record of existing contamination below a site, NYCDOT prohibits the siting of an infiltration-based practice. If no known contamination is found during the Phase 1-like study, the Phase 2-like investigation includes toxicity tests on soil and groundwater samples at each site. If any contamination is found above regulatory levels during the Phase 2-like investigation, the site is eliminated from consideration for an infiltration practice. Based on previous experience within Greenpoint, Brooklyn the entirety of the project area covered in this report would be rejected based on Phase 1-like findings.

Therefore, no infiltration-based GI practices are recommended for the Green Buffers project.

2.2 Permeable Pavement and Paver Systems

Permeable pavement systems function by allowing stormwater to infiltrate through the underlying soil. As described above, infiltration within the ExxonMobil plume presents an environmental and human health risk. For this reason, permeable pavement systems are not recommended for the Green Buffers project area.

2.3 Street Trees and Street Planters

With long stretches of sidewalk and numerous lengths of fences, the Green Buffers project area is well suited for street trees and planters. There are currently a few stretches that include a grouping of street trees most notably on Nassau Avenue, Kingsland Avenue, and Apollo Street. Street trees and planters are a very visible and aesthetically pleasing GI option. Installation of street trees would be lead and facilitated by NYC DPR. Street planters are low cost and easily installed while still providing visible greening to the community. A desktop assessment, described in the following section, determined approximately 34 street trees and 19 planters are feasible for the Green Buffers project area.

2.3.1 Siting and Proposed Locations for Street Trees and Street Planters

Using Google Earth, a desktop assessment was performed to site street trees and planters in the project area. As outlined previously, street trees sites are selected according to the clearances and dimensions regulated by the New York City DPR and DOT. When a location was deemed unsuitable for a street tree, the location was evaluated for a street planter using the "Revocable Consent Rules" from DOT.

The proposed locations for street trees and street planters are shown in Figure 12. Within the Green Buffers project site there are 34 potential street tree locations and 19 street planter locations. One of the 34 potential street tree locations is an already constructed, empty tree pit.

FIGURE 12 - SITING MAP: STREET TREES & STREET PLANTERS
Potential Street Tree and Planter Locations in the Project Area, chosen based on various design guidelines and limitations

2.3.2 Value and Co-benefits of Street Trees and Street Planters

Street trees and planters act as stormwater management practices by reducing the amount of runoff that enters the combined sewer system. Trees and planters, acting as mini-reservoirs, control stormwater at the source. Street trees reduce runoff through evapotranspiration, interception, reduced throughfall, and increased infiltration (US EPA, 2013). Unlike ROWBs and greenstreets, street tree pits are not generally designed to capture large volumes of runoff from adjacent impervious areas. The volume of water entering the tree pit and subsequent infiltration is at a much smaller scale than ROWBs or greenstreets, which typically receive runoff directed from a minimum of 20 times the surface area of the ROWB or greenstreet itself. The stormwater that reaches the tree pit is either direct rainfall or incidental runoff from adjacent sidewalk areas; street trees achieve much of their runoff reduction through interception, rainfall that lands on tree leaves and is stored or evaporated back into the atmosphere and never reaches the ground. Estimates for water a typical tree can intercept in its crown range from 760 to 4,000 gallon/tree/year (CRWA, 2009). Similarly, street planters control stormwater runoff through direct interception alone because no vegetation is rooted in the ground. Street trees are recommended for the study area because the benefits (stormwater management, air quality improvements, head island reduction, habitat, shade and beautification) are assumed to well exceed the risks associated with soil contamination. Currently, New York street trees are estimated to reduce runoff by 890.6 million gallons annually (NYC Parks, 2016).

The number of trees and planters sited in the project area was used to determine the potential annual capture of stormwater. The capture was analyzed from the year of planting to year 30, when the trees are expected to reach maturity. As street trees mature, the canopy width increases thereby increasing the amount of stormwater captured through interception. The planters were assumed to have the maximum allowable surface are of 25 square feet. The analysis assumed average New York City annual rainfall. According to the analysis, if all sited planters (19) and street trees (34) were planted in the project area, total annual capture of stormwater would exceed 43,000 gallons.

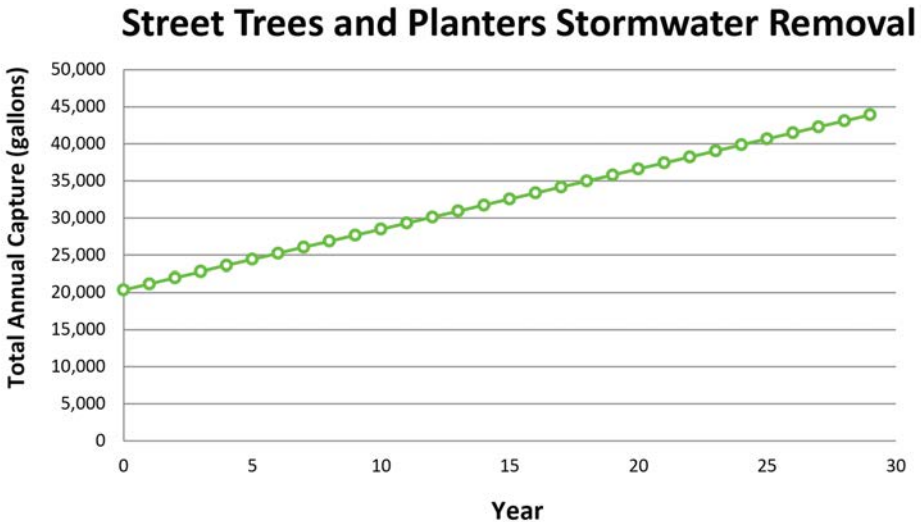


FIGURE 13 - GI TECHNOLOGY PERFORMANCE: STREET TREES & STREET PLANTERS
Stormwater Removal by Street Trees and Street Planters

Street trees and planters provide other numerous social and environmental benefits apart from stormwater management. Urban trees and plantings help offset climate change by capturing atmospheric carbon dioxide through photosynthesis, and decreasing energy used by buildings through evapotranspirative cooling. Trees remove gaseous air pollution by uptake via leaf stomata and also intercept airborne particles. Pollution removal rates differ among cities according to the amount of air pollution, length of in-leaf season, precipitation, and other meteorological variables. In 1994, trees in New York City removed an estimated 1,821 metric tons of air pollution (Nowak, 2002).

The discussed benefits of street trees are quantified in the table below. Numerical values for urban planters are not well defined in the literature.

A further stormwater benefit of street trees, particularly when planted within properly constructed tree pits, is their ability to improve and sustain soil permeability and the infiltration of captured runoff through the soil profile. The extensive root area of mature trees helps to assure that infiltration zones do not become clogged or compacted over time.

Urban heat island effect, defined as the increase in ambient temperature in cities due to modification of land surfaces and waste heat generated, can be decreased through street tree plantings. Leaves and branches reduce the amount of solar radiation that reaches below the tree canopy or plant. Trees also cool through evapotranspiration, which uses the heat from the air to evaporate water. Studies have found that evapotranspiration and shading effects can reduce air temperature by 1°C to 5°C (Brown et al. 2013). Street trees and plants help create New York City's urban forest that provides habitat- including food and shelter for many species of birds, insects, and other wildlife.

The environmental benefits of street trees and plantings lead to human health and social benefits as well. Street trees have been found to increase property values, reduce crime, and enhance quality of life. (US EPA, 2014). By reducing air pollution, trees and vegetation lower the negative health consequences of poor air quality. Shade from trees can reduce heat gain in buildings, which can lower indoor air temperatures and minimize the health impacts of heat waves. The shade provided by tree's canopies can help lower UV exposure. Trees also act as wind breakers, including during winter months, thus helping to reduce the cost of winter heating.

STREET TREE ENVIRONMENTAL BENEFITS

	PER MATURE TREE	WITH 34 TREES PLANTED IN PROJECT AREA
CARBON REDUCTION (TONS/YR) *(NOWAK, 1992)*	3.63	123.42
AIR POLLUTION REMOVAL (KG/YR) *(NOWAK, 2002)*	0.71	24.14

2.3.3 Maintenance of Street Trees and Street Planters

Maintenance for street trees and planters is minimal. NYC DPR provides all maintenance and pruning for street trees. Every year, DPR conducts a routine pruning on a portion of the city trees in each community board to keep the mature trees healthy. Residents and property owners can contribute to the health of the street trees by keeping the tree pits free of garbage, road and sidewalk salt and dog waste, which can contaminate the soil. Residents and property owners can also request maintenance for a tree that is dead, blocking streets signs, or other hazards by contacting DPR.

Street planters are owned, and therefore maintained, by property owners. Property owners agree to maintain the structure and indemnify the City for any resulting damages. Street planter maintenance is that of any outdoor potted plant. During times of drought, watering may be necessary. If overgrowth occurs, the plants may need to be pruned. To retain the aesthetics of the planter, weeds and trash should be removed, if found.

2.3.4 Data Gaps and Next Steps for Street Trees and Street Planters

A walkthrough of the project area should be conducted to investigate the proposed street tree and street planter locations shown in Figure 12 and listed in Appendix 4. While conducting the walkthrough, DPR's Tree Planting Standards and Street Tree Planting Guidelines as well as DOT's clearances for street planters should be kept in mind to ensure spacing and setback requirements are met. Sites in front of commercial properties warrant communication with the business owner or manager to ensure placement of a tree or a planter does not interfere with the operation of the business.

If proposed street tree locations are confirmed during the site walkthrough, planting requests should be made through DPR.

For all planter locations that are confirmed, property owners should initiate the DOT approval process through a revocable consent. The application process begins with the Petition Form for a New Revocable Consent Petition, available on the NYCDOT website. The application process requires a plan prepared by a licensed architect or engineer that conforms to DOT standards. A pre-submission conference can be scheduled to ensure all application requirements are fulfilled and in order.

Upon receiving a complete petition for revocable consent, DOT distributes the material to the appropriate City agencies for review. Upon review, DOT will make a determination on whether the designs must by reviewed by the Public Design Commission (PDC) or the local Community Board.

2.4 Green Walls

The Green Buffers Project Area provides a great opportunity for green walls due to the prevalence of non-residential buildings with large, plain facades that have minimal windows and other adornments. Green walls offer a street-level greening opportunity that is visible and aesthetically pleasing to the public.

2.4.1 Siting and Proposed Locations for Green Walls

Since green walls are on building facades or private property fences, no New York City agency has siting guidelines and the choice of installation and location is up to the property owner. However, if the planter is placed on the ground (as opposed to fastened to the wall), street planter permit may be necessary even if the planter is placed inside the property line. The green wall locations that were sited in the Green Buffers project area were sited in a desktop assessment based on building facade surface area, prevalence of windows, and entry ways.

There are two general types of green walls: planting medium in a planter on the ground with a trellis or fence for climbing plants or panting medium in containers fastened to the walls at various heights. The former is minimally invasive to the building structure while the latter requires an engineering analysis . Siting locations should be conducive to sunlight and rainfall for the health of the plants. Local community members should be able to see the green walls easily to obtain all the benefits of the added green space. When green walls are planted directly in soils below grade, the designer/installer should consider the volume (depth and area) for planting bed so as to assure that the root structure can fully develop. Designers should also make an effort to assure that some runoff from adjacent impervious areas is directed toward the planting bed for irrigation and for greater stormwater volume benefits.

The proposed green wall locations for the project area are shown in Figure 14.

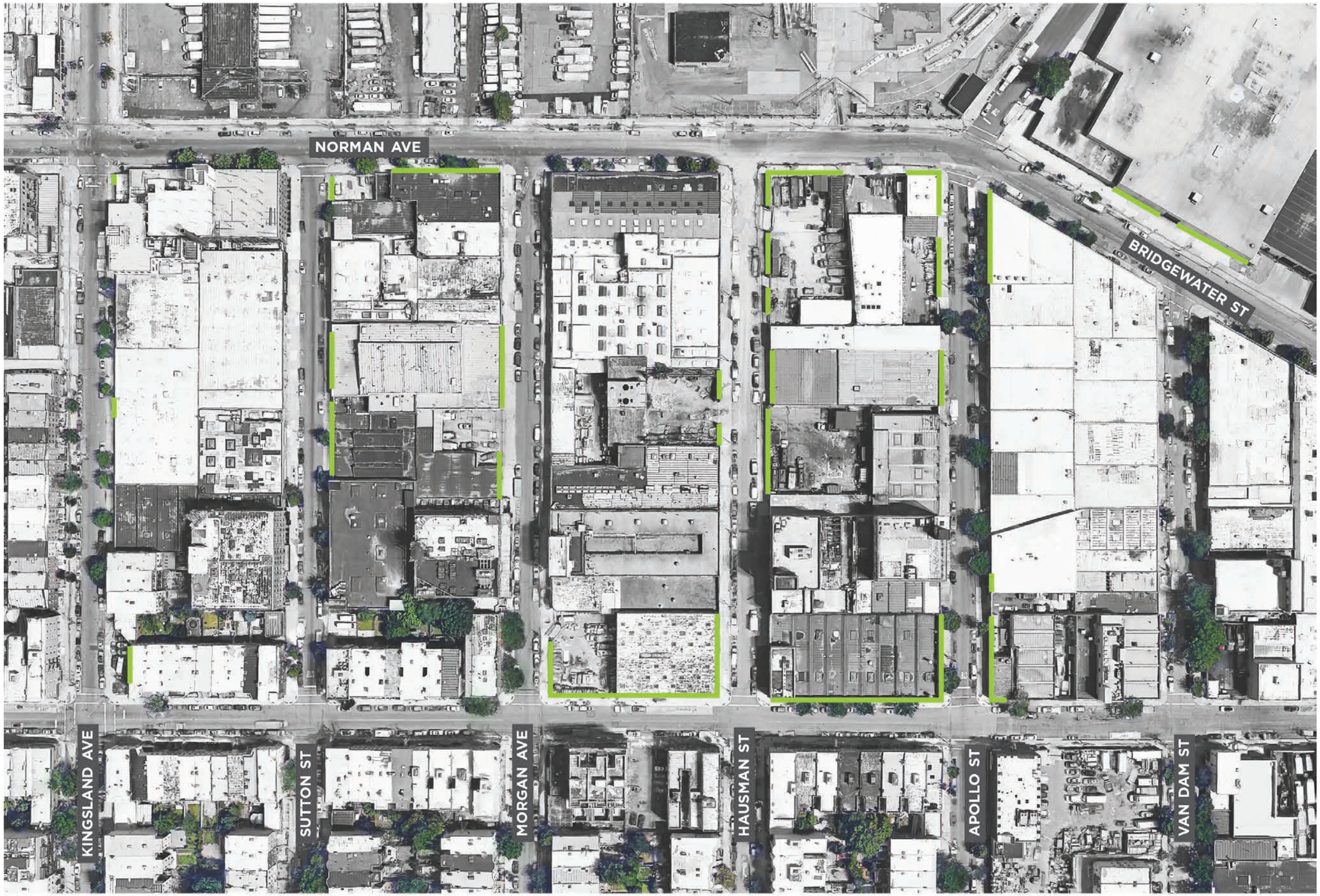


FIGURE 14 - SITING MAP: GREEN WALLS
Potential Green Wall Locations in the Project Area, chosen based on various design guidelines and limitations

2.4.2 Value and Co-Benefits of Green Walls

Green walls create a small, but measurable reduction of runoff to combined sewers. The plants and media in green wall systems promote interception, infiltration and evapotranspiration. Some green walls use collected rain water or recycled grey water for irrigation, further reducing the building's contribution to the combined sewer system. An analysis was conducted to determine the removal from the system with non-irrigated green wall systems. For the purpose of the analysis, green wall systems were assumed to possess a planting bed of 10 square feet and cover a wall area of 200 square feet after 9 years of maturation. The model used historical annual precipitation of New York City.

In addition to stormwater management, green walls provide other environmental benefits including urban temperature reduction and decreased energy usage. Studies have shown that a vine sunscreen such as ivy, growing directly on a west wall, provides effective shading of the wall - thus contributing to lower heat absorption of the wall and therefore lower indoor temperatures (Hoyano, 1988). Temperature differences up to 10°C was recorded between exposed wall surfaces with and without the plant screening. The effect of air movement increasing convective heat gain/loss through building facades can also be mitigated by green walls, thus helping in the lowering of building energy usage. The increased thermal performance can lower energy requirements for the heating or cooling of a building, and thus lower greenhouse gas emissions (Loh, 2008). The evapotranspiration from green walls also contributes to the lowering of temperatures around the planting, an affect that can help lower the urban heat island effect.

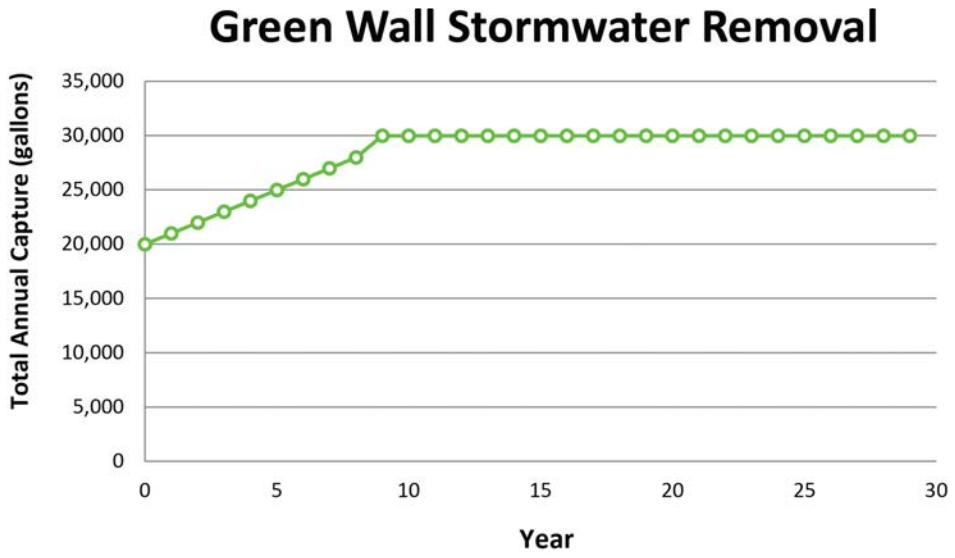


FIGURE 15 - GI TECHNOLOGY PERFORMANCE: GREEN WALLS
Stormwater Removal by Green Walls

Green wall systems can be of benefit to reduce sound reflection from the hard surfaces of roads and buildings. Studies have shown that green walls show better acoustic absorption than other common building materials (Azkorra et al., 2015). Green walls can be a means to increasing biodiversity in urban environments where much ecology has been lost to development. Increased native flora and fauna species have been documented by green roof projects and it is not unreasonable to expect similar results for vertical landscapes.

2.4.3 Maintenance of Green Walls

Maintenance needs of green walls are similar to that of regular landscape plants. Plant growth must be maintained through routine weeding, pruning, and mulching. The substrate must be maintained if it is disturbed by wind, rain, or animal activity. If being used, waterproofing membranes need to be inspected for any damage from water or plants.

If the wall uses an irrigation or pumping system, they must be tested and inspected. Most walls are dormant in the winter when irrigation systems should be shut down. Plant selection will determine the extent of any annual pruning or plant replacement needed, which will be described by the green wall vendor or designer. If drainage features are a part of the system, ensure that they are clear and functioning by removing dirt and litter.

2.4.4 Data Gaps and Next Steps for Green Walls

Little research has been done to quantify the potential for green walls to capture rainfall through leaf interception. Better analysis could demonstrate a marked increase in the expected management volume for the installation. Additionally, irrigation of green or living walls using stored rain water would similarly increase the management volume through evapotranspiration. The research on this practice is also lacking.

2.5 Green Roofs

The Green Buffers project area is well suited for green roofs due to the large number of industrial buildings that have flat, open roofs with expansive surface areas. The popularity of green roofs in industrial areas is growing in New York City. Green roofs are a desirable option for industrial properties because these sites often maximize their property footprint with built structures and, the remaining ground-level space is heavily used for their business practices, making it unsuitable for grade-level green infrastructure installation. A green roof is an option that does not interfere with any daily operations. Green roof systems, because they protect the roofing membrane from exposure to sun and climate, are expected to increase the life-expectancy of the roofing membrane by two to four times (NPS, 2017). Some green roof installations in Germany have been operating for over a hundred years without roof replacement. These features, coupled with the tax abatements from green roof installation, make green roofs a good choice for the project area.

2.5.1 Siting and Proposed Locations of Green Roofs

As mentioned in previous sections, the most important factor in siting a green roof is ensuring the building can support the additional weight added by the green roof. A structural assessment must be conducted by a licensed engineer to verify that the roof and its support system are adequate. A structural assessment of each building within the project area was not plausible; thus other factors, such as roof slope, sizes, and complexity, were considered during the desktop assessment of potential green roof locations within the project area.

Green roofs siting must consider roof slope. Roof slopes under 10 degrees are best suited for green roofs although it is possible to install a green roof on a slope up to 30 degrees. Size is also a factor in green roof siting. A smaller green roof will be less cost efficient, since they require more detailed work per square foot when installing the membrane. Similarly, roofs with many protrusions, such as skylights, vents, or mechanical systems can become more costly. Naturally, cost structures change when green roofs are installed as part of a needed roof replacement, or when new buildings are constructed. Structurally enhancing existing roofs so that they can bear the additional load is generally not a cost-effective measure. In some instances, it may be possible to provide an intensive (deep) green roof that receives runoff directed from a higher roof area.

Using Google Earth, a desktop assessment was performed to determine potential green roofs within the project area. Roofs were chosen based on the guidelines above, but with no actual inspection or field verification. All potential green roof locations are shown in Figure 16.

FIGURE 16 - SITING MAP: GREEN ROOFS
Potential Green Roof Locations in the Project Area, chosen based on various design guidelines and limitations

2.5.2 Value and Co-Benefits of Green Roofs

Green roofs help reduce stress on New York City's aging wastewater infrastructure by diverting rainwater from directly entering the storm sewer networks. Using green roof vendor publications and research papers, a model was created to determine the total annual capture of stormwater within the Green Buffers project area as a function of the adoption of the green roof locations proposed in Figure 16. The model used historical annual precipitation of New York City, an average capture depth, and a conservative porosity value (35%). For extensive green roofs, a 3-inch growing medium was used and for intensive, a 6-inch growing medium was used (Young, 2008).

Green roofs also provide additional benefits, such as energy conservation, noise reduction, urban heat island effect reduction, a potential for urban agriculture expansion, economic growth, and an overall improvement in a building's aesthetics. The insulation value and thermal mass of the green roof reduces heating/cooling loads by insulating the building during winter and reducing the building's surface temperature during summer. The insulated nature of the green roof also aids in dampening surrounding city noise, which creates a better living/working environment for the building's occupants.

The plantings on green roofs also aid in lowering the urban heat island effect by deflecting the sun's radiation, absorbing carbon dioxide, and releasing moisture into the atmosphere. Green roofs typically incorporate low-maintenance plants with high water holding capacity, such as sedums, into their design, but additional planting should be considered to promote biodiversity. One possibility is to incorporate vegetables and/or other produce on the rooftops. The produce could be used by the building's tenants or donated to those in need.

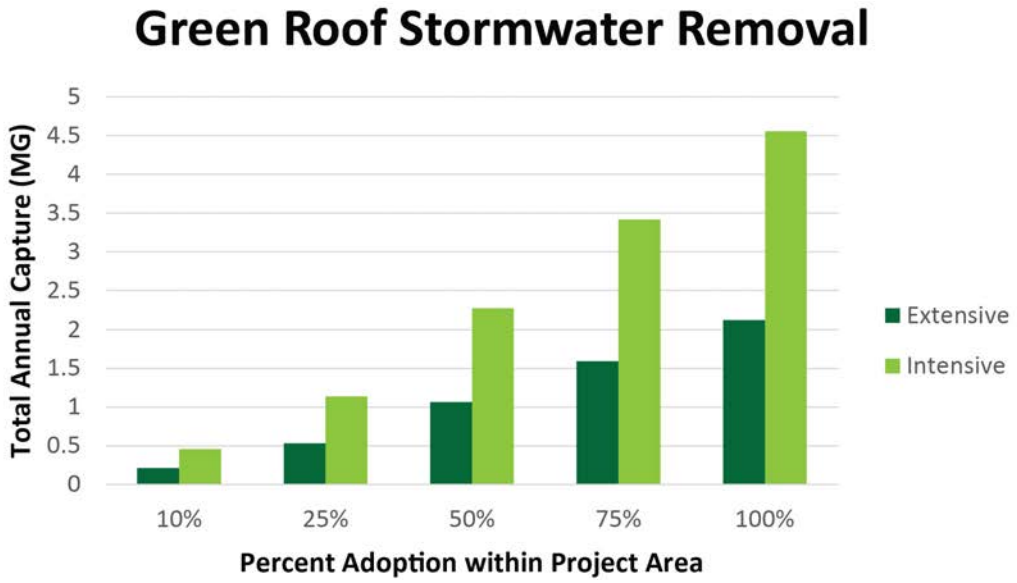


FIGURE 17 - GI TECHNOLOGY PERFORMANCE: GREEN ROOFS
Stormwater Reduction by Green Roofs

In addition to the potential revenue, the local economy is improved by new job opportunities generated from the construction and maintenance of the green roof. The increase of green space may also lead to increased property value of the building.

2.5.3 Maintenance of Green Roofs

The primary maintenance requirements for green roofs have to do with plant maintenance and debris removal to prevent clogging. De-clogging of overflows or drainage outlets may sometimes be required after a large storm, but periodic inspection should be performed several times annually, especially during the first years after installation and until the specific behavior of the green roof system is better understood.

Plant maintenance requirements will depend on whether the green roof is intensive or extensive as well as the planting regime chosen. Extensive green roofs typically support only a small variety of plants, mostly sedums, which are well adapted to the wet/dry environment, although they require irrigation during summer dry spells, especially during the establishment period. Intensive systems generally retain more moisture and require less (or no) irrigation. Due to the larger variety of plant species, intensive green roofs may require greater attention to assure that the plant communities are able to remain healthy and to prevent a flush of undesirable weeds. Plant care on any green roof is most critical during establishment, which lasts 18 to 24 months (Tolderlund, 2010). The general plant maintenance tasks include weeding, watering, thinning, pruning, fertilizing and occasional plant replacement, instructions for which are customarily provided by the installer. Most plant maintenance can be performed by the roof owners or interested tenants. Maintenance contracts are often negotiated with the green roof installer for the first one to three years after installation.

Maintenance and visual inspection of the waterproofing membrane is necessary as leaks can occur at joints, penetrations, and flashings due to poor installation or material failure. Alternatively, electronic leak detection systems between or underneath the membranes can pinpoint exact locations of water leaks. In addition, any areas or joints where the roof is penetrated, such as vents, ducts, drains, and expansion joints should be regularly inspected and kept free of roots, leaves, and debris.

2.5.4 Data Gaps and Next Steps for Green Roofs

Rooftops that have large catchment areas and maximum rainfall exposure should be investigated in the Green Buffers project area for green roof installations. While surveying the rooftops in the project area, the rooftop gradients should also be investigated to assess the type of green roof that can be proposed on the rooftop.

The structural analysis of a rooftop determines if the existing rooftop can support the installation of a green roof. The structural analysis for a green roof is critical because of the additional loading from the stored water, growing medium and planting layers. A structural analysis must be carried out by a P.E. or R.A. in order to file for a construction permit from the DOB; however, even before the structural analysis is conducted the rooftop's exposure to rainfall, as well as its size, should be assessed. The assessment should also include consideration of combining roof areas into a single "catchment" that is managed by one or more intensive green roof areas, allowing higher roofs to drain freely to lower green roofs, thus reducing the overall cost of installation on a per square foot of catchment basis. Additionally, since green roofs offer substantial cooling benefits during summer months, roof areas should be selected that cover interior spaces that require cooling for maximum energy benefit.

2.6 Detention Bioswales

2.6.1 Siting and Proposed Locations of Detention Bioswales

Detention bioswales could prove to be a promising practice for the project area in the future. Currently, detention bioswales are not being sited or constructed in the right-of-way in New York City. Detention bioswales should be considered for the project area if they are adopted by the City.

Due to the fact that the detention bioswale is not currently an accepted technology for the right-of-way in NYC, exact bioswale locations were not determined. New York City Economic Development Corporation (NYC EDC) and DEP estimate future construction of bioswales at one bioswale per acre (NYC EDC, 2017). Applying this estimation to the project area, which is approximately 23 acres, 23 bioswales could potentially be sited. If this technology is approved, the siting process will follow any published NYC DEP site selection and guidelines.

2.6.2 Value and Co-Benefits of Detention Bioswales

Based on an assumed adoption of 23 bioswales, and the average annual rain events in New York City, an analysis was performed to determine the average annual capture for the project area. The annual capture is shown as a function of adoption rate. In addition, annual capture for two bioswale configurations, with and without a stormwater chamber is shown.

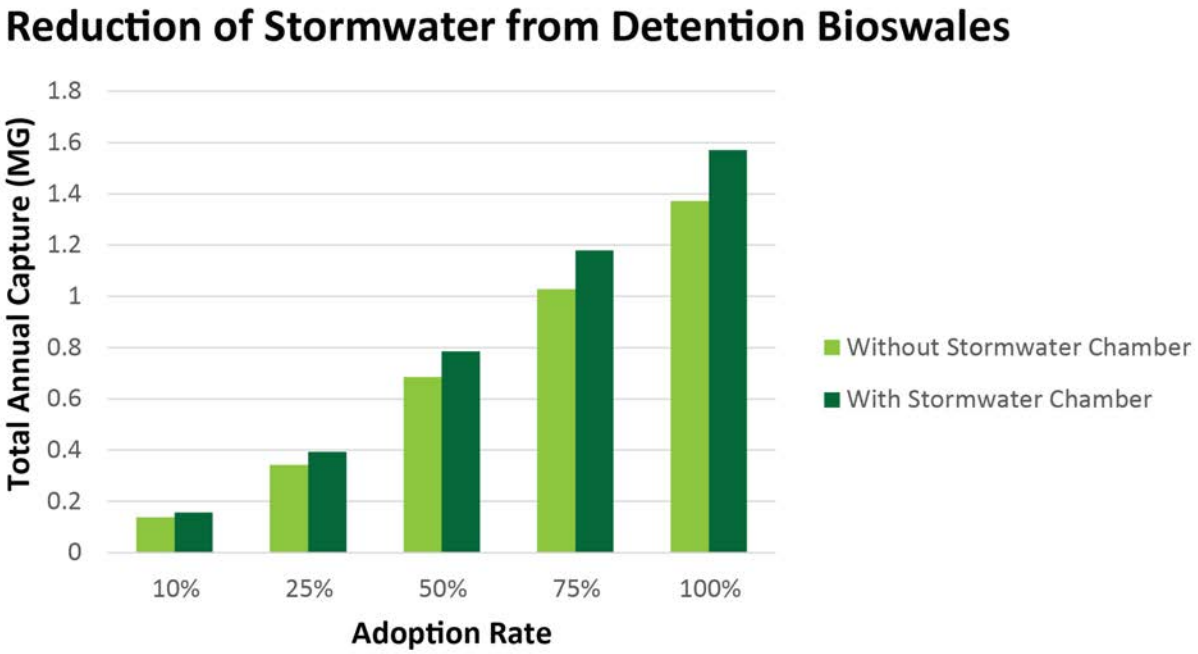


FIGURE 18 - GI TECHNOLOGY PERFORMANCE: DETENTION BIOSWALES
Stormwater Reduction by Detention Bioswales

Along with stormwater management, bioswales provide numerous public health benefits including reduction in urban heat island effect and improvement in air quality. According to a study conducted by NYC DEP, an individual bioswale can remove 0.15 lbs of ozone, 0.1 lbs of PM10 and nitrogen dioxide, and 0.06 lbs of sulfur dioxide annually. In this study, individual bioswales showed temperatures 15% lower than the average sidewalk or street temperature (NYC DEP, 2016).

Bioswales also improve ecosystems in the urban area. The increase in green space adds to the wellbeing for residents and desirability of the neighborhood. Construction of bioswales in right-of-way support green jobs in the metropolitan region through design, construction, and maintenance.

2.6.3 Maintenance of Detention Bioswales

New York City has an established Green Infrastructure Task Force, formed by all relevant City agencies, with the goal of efficient maintenance to upkeep all green infrastructure in the right-of-way. Crews manage the vegetation within the bioswale, including weeding and trash removal. If detention bioswales were approved and constructed in the project area, following all City guidelines, the maintenance would be performed by the Green Infrastructure Task Force, relieving the property owner of any effort or responsibility.

2.6.4 Data Gaps and Next Steps for Detention Bioswales

Detention bioswales are not an accepted form of green infrastructure in the New York City right-of-way. Prior to any siting or construction of detention bioswales, NYC DEP must approve this technology. If the detention bioswale becomes a standard practice in New York City, NYC DEP will publish siting guidelines and design standards.

2.7 Rainwater Harvesting

Rainwater harvesting is difficult to site in a largely industrial urban area. Due to the overwhelmingly industrial land-use within the project area, many of the properties do not have a needed end use for harvested rainwater. Those businesses that do use water in their operations have stringent quality standards that may require filtration and treatment. Rainwater harvesting is not recommended for the project area, except in conjunction with a green wall project.

Financial Feasibility

When assessing the financial feasibility of a GI practice, the cost of installation should be compared to the volume of stormwater managed and co-benefits to determine if the environmental benefits are significant enough to justify the cost of the project. One way to assess GI projects is through the "dollar per gallon" metric, assessing the cost of installation versus the number of gallons removed from the combined sewer system on an annual basis. The dollar per gallon of stormwater managed metric ($/gallon) standardizes projects to help evaluate a project's financial feasibility. By evaluating GI projects in a single metric, various GI installations can be compared and ranked according to which project manages a gallon of stormwater at a lower cost. However it is important to note that this metric only evaluates the cost effectiveness with respect to stormwater management and does not take into consideration any of the co-benefits.

A model was created to evaluate the proposed green infrastructure practices that determined the cost per gallon of stormwater managed annually. Below is a graph depicting these costs for the GI practices proposed for the Green Buffers project. The results are shown as a high and low estimate as the cost of each practice can range based on local conditions, materials and other factors. Each practice was sized to manage the one-inch rainfall event from its contributing area. The calculations assume the events of one-inch or less represent 85% of annual rainfall in New York City and that 44 inches of rainfall is received annually.

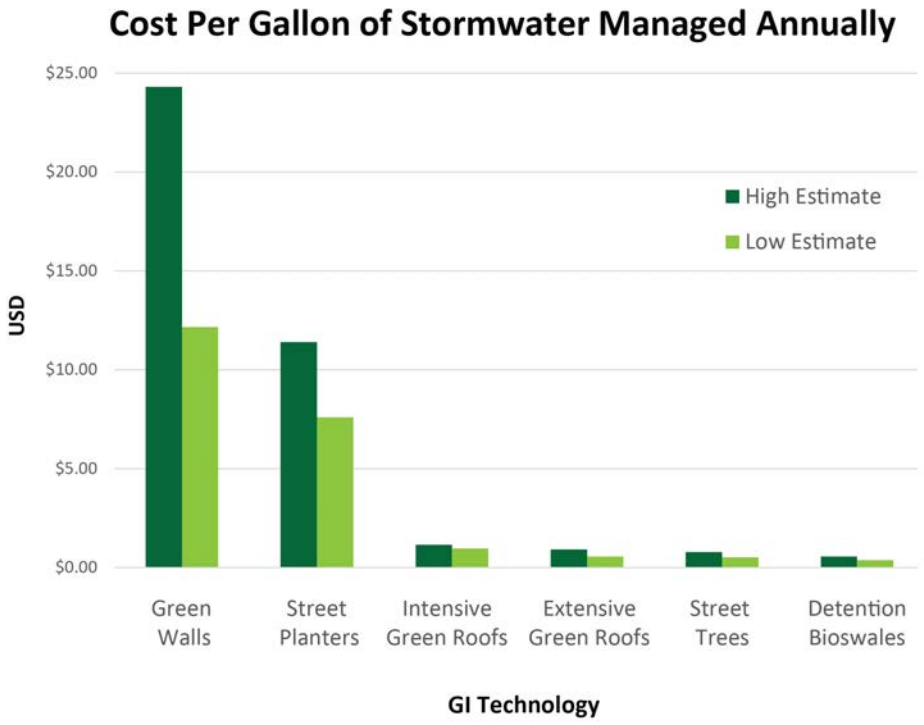


FIGURE 19 - GI TECHNOLOGY PERFORMANCE: TECHNOLOGY COMPARISON
Cost for proposed GI Practices for the project area shown as a function of their ability to manage stormwater

Although the dollar per gallon value helps maximize stormwater management while being cognizant of funds, these values should be evaluated in conjunction with the technical feasibility and co-benefits. The relative value of co-benefits for the proposed GI practices is summarized in the following table.

The annual dollar per gallon values, technical feasibility, and co-benefits are useful for making an informed decision about which GI practices to install and at what locations; additionally, some GI practices qualify for DEP's green infrastructure grant program or DOB's tax abatement for green roofs.

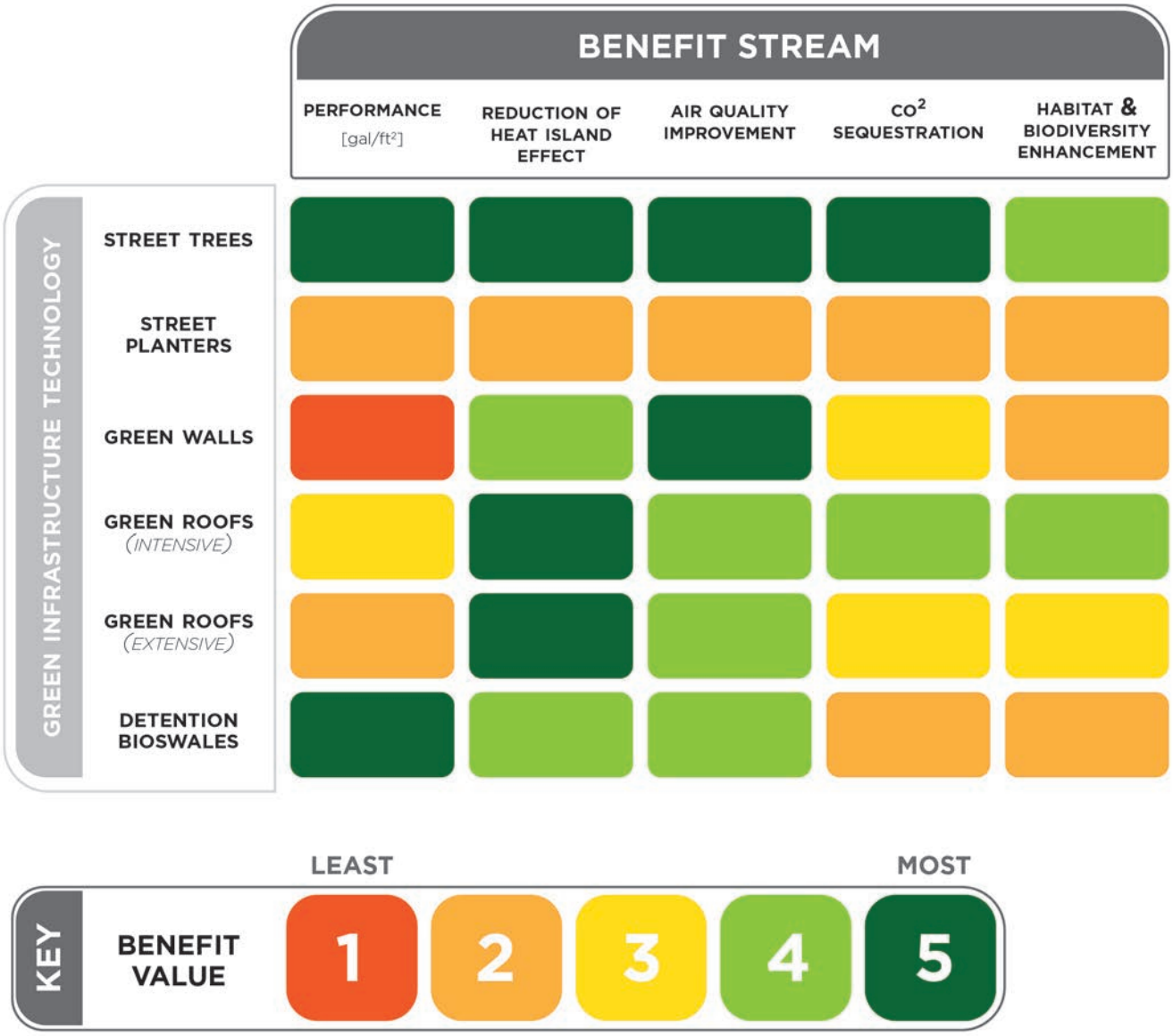


FIGURE 19 - GI TECHNOLOGY COMPARISON: CO-BENEFITS
Comparison of positive secondary effects, or co-benefits, among various proposed GI technologies for the project area

DEP GI Grant Program

To meet the goals of the CSO Consent Order, DEP developed a GI Grant Program to provide funding for the design and construction of GI projects on non-City owned properties. GI projects eligible for the program include: Rooftops (green roofs, blue roofs, or roof leader diversion to rain gardens), infiltration (rain gardens or vegetated swales), rainwater harvesting (cisterns or rainwater reuse systems), subsurface systems with infiltration capacities, and porous paving systems. For a property to be eligible for the program, it must lie within a combined sewer area of New York City, be privately owned (City-owned properties leased to private parties or other government entities are reviewed on a case-by-case basis), and property owners must execute a Declaration of Restrictive Covenant, Funding Agreement, and a Statement of Agreement. The Declaration of Restrictive Covenant ensures the project will be kept in place and maintained for a period of at least 20 years.

The Green Buffers project area falls within the NCB-027 combined sewer area and does not contain any City-owned properties. Appendix 9 has a map of the combined sewer areas in and near the project area, and Appendix 10 shows the land use in and around the project area as well as the properties near the project area that are City-owned.

To receive funding, GI practices are required to manage the volume of stormwater equivalent to one inch of rainfall over the total impervious area that is contributing to the proposed GI practice. Additionally, the funds requested for the proposed design must exceed $35,000. For rooftop projects, applicants are also required to have a P.E. or R.A. inspect the loading capacity of the roof and verify it can support the proposed rooftop project. A P.E. or R.A.-stamped structural analysis will have to be submitted with the Grant application.

The Grant program evaluates GI projects based on a cost/benefit ratio, feasibility, application completeness, and other factors that have to do with community engagement, monitoring, projected timeline, and if applicants are willing to pay in-kind costs. The Grant program looks favorably on projects that can be completed in shorter time frames, are innovative, submit monitoring plans, aid community involvement, support economic/workforce development, and/or match the funding request with in-kind or cash costs.

DOB Tax Abatement: Green Roofs

DOB provides a one-year tax abatement of $5.23 per square foot of green roof to buildings that have at least 50% of their eligible roof space coved by a green roof. The tax abatement is capped at $200,000 for a single property. To qualify for the tax abatement, the green roof must have a vegetated layer, a growing medium layer, a weather and waterproof roofing membrane, a root barrier layer, an insulation layer, and a drainage layer. The vegetated layer must have at least 80% of live plants, either native and agricultural plant species or plants that have high water storage capacity, such as *sedums*, and should be spaced out to cover 80% of the layer. The growing medium should be a mixture of natural or engineered soil that is at least two inches in depth. If the growing medium layer is less than three inches, a layer for water storage should be included to prevent the growth medium layer from drying out (NYC DOB, 2010).

Stakeholder Engagement

One of the main tenets of green infrastructure planning is stakeholder and community engagement. The goal of this engagement is to build community awareness of and support for green infrastructure projects and initiatives that can result in the implementation of proposed projects and initiatives. The previously outlined feasibility analysis was intended to engage diverse stakeholders in the process of siting, designing, and evaluating the potential of GI typologies to become integrated within the project area's existing infrastructure, function, and community. The project team has performed community and business owner outreach through open community meetings and individual meetings.

Community Meeting

A community meeting was held on May 15, 2017 to present the types of GI practices feasible for the Green Buffers area and engage stakeholders in identifying potential locations for those practices. Maps of the project area, depicting parcel building footprints and land use, were distributed to groups of community members along with stickers depicting GI practices. Each group indicated where they would like to see different practices sited and investigated. This exercise resulted in several projects and locations for the project team to further investigate:

- Install a green roof on Broadway Stages building (located at 359 Kingsland Avenue). Broadway Stages is a good community partner and has installed a green roof on another of its property.
- Use the private properties and empty tree pits on Norman Avenue to create a "landscape buffer."
- Determine if a repair is scheduled for the flooding at Kingsland Ave and tack on a greening element to a capital project.
- Consider green roofs on bus stops along Nassau Avenue

•Approach the business located in Empire Merchant Building (16 Bridgewater Street) for a potential green roof.

•Create a "green corridor" from McGolrick Park to 520 Kingsland using green walls, street trees, and planters.

•Strategically plan green infrastructure downstream of the Nassau Avenue and Apollo Avenue corner (the highest point in the project area).

Business Outreach

Based on the technical and regulatory feasibility and integrating the stakeholders' feedback from the community meetings, an outreach plan was developed for businesses within the project area. The goals for the business outreach were: 1) to inform and engage the business owners in the project area and 2) to notate any concerns, restrictions or considerations for siting a GI practice in the vicinity of their facilities. The outreach plan involved initiating contact with all businesses in the area and focusing on those whose location was chosen as a potential site for green infrastructure. Every effort was made to reach the business owner or operator to explain the green infrastructure projects and the steps necessary for implementation.

There are more than 100 businesses within the 5 block project area and the immediately adjacent area. Of the total 119 businesses, the outreach coordinator called 81 businesses and met or spoke with representatives from 41 businesses. Priority for further consideration was given to the 41 businesses that responded to the initial outreach effort. Out of this cohort of businesses, the outreach coordinator was able to engage in in-person meetings with 18 businesses, some with multiple visits, to solicit their concerns and gauge their interest level.

The 18 businesses were generally categorized as "high priority," "medium priority," and "low priority" based on a combination of factors, such as the business representative who met with the outreach coordinator (business owner vs manager); expression of interest and/or enthusiasm; nature of the site and the business; and other factors. The table on the following page summarizes the meetings with the 18 businesses.

In general even those businesses with an interest in the project want participation to be convenient with minimal commitment of time and human resources. They will not send a representative to a community meeting but are willing to meet with the project team at their convenience. Many were also reluctant to engage until there is a more specific plan for them to review. Those identified as high priority also shared useful information regarding their operation and potential concerns in siting GI practices in the vicinity of their businesses.

In addition to business outreach, property ownership was researched. Letters were sent to all 65 property owners in the project area informing them of the project. Because telephone numbers were not readily available, no property owner was contacted by telephone. Most of the properties are owned by companies (e.g., LLCs) rather than individuals, making it difficult to establish a personal connection.

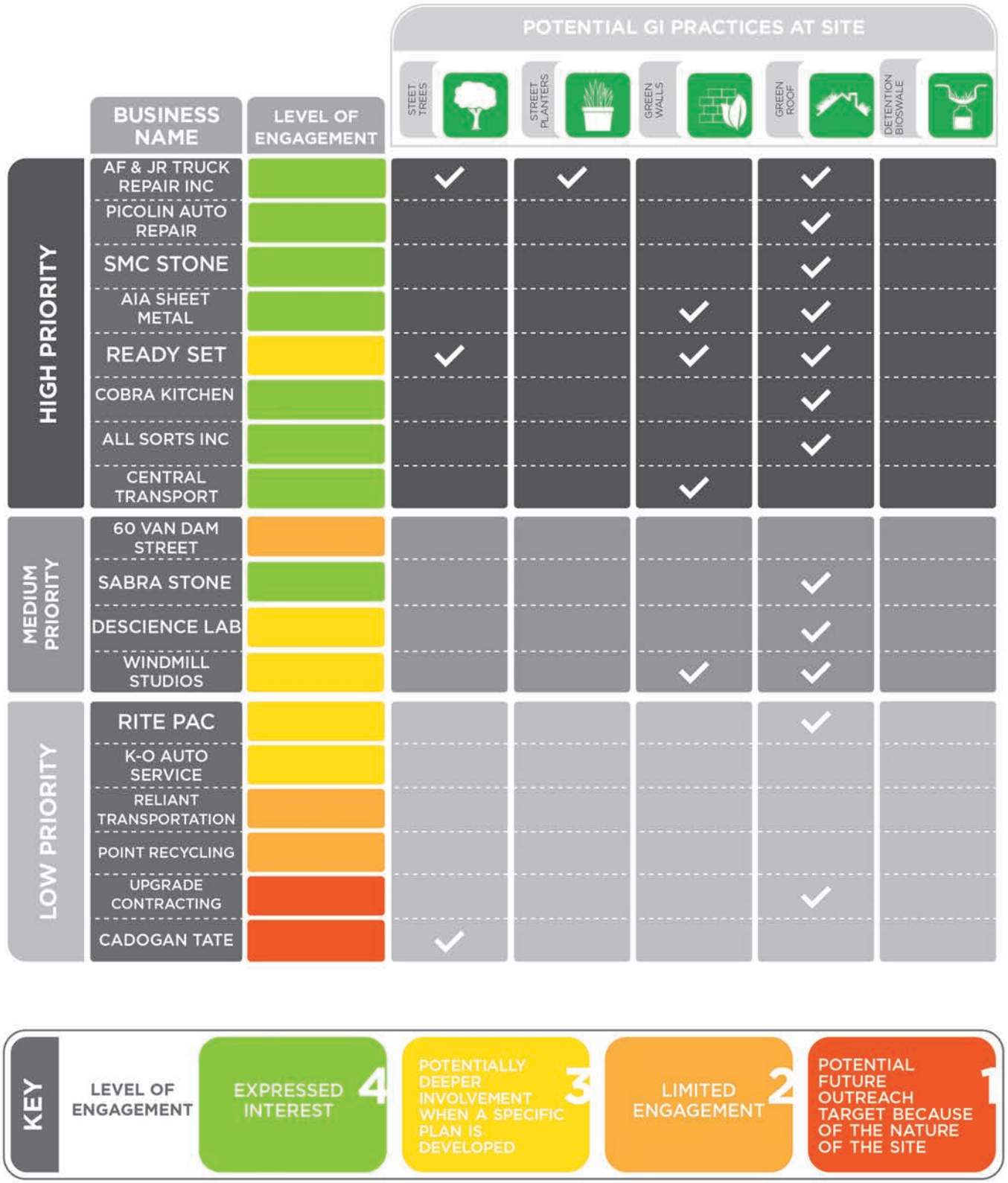


FIGURE 20 - BUSINESS OUTREACH COMPARISON TABLE
Prioritized list of businesses within the project area, their level of engagement, and possible GI technologies to be installed

Community Feedback

After the initial community workshop, residents identified some potential sites for green infrastructure practices that are feasible in the project area (see page 51). These potential sites were confirmed through a desktop analysis and a walkthrough of the project area was organized as a public event on October 14th, 2017. The goal of the event was to evaluate locations for street trees, street planters, green roofs and green walls based on the maps shown in Figures 12, 14 and 16.

Although the turnout was low, some sites were identified as desirable from a resident's perspective. A more technical walkthrough is needed to determine what is theoretically feasible due to spacing and set back requirements. In addition, a second community workshop was held on January 30th, 2018, to develop strategies for moving this project to the implementation phase. Representatives from the NYC Department of Transportation and DPR participated as well as members of the community. There was a strong desire to focus on Norman Avenue as a green corridor. DPR is interested in planting trees in existing tree pits that are empty. Newtown Creek Alliance, a community-based organization, is interested in supporting efforts to build stormwater planters along Norman Avenue. The NCA is currently working on creating a street-end planters at the end of Apollo Street, which merges Norman Avenue. Focusing on Norman Avenue will serve as an extension of the NCA's existing greening efforts, and thus improves the potential for implementation.

Next Steps/Conclusions

The next phase of the project requires a local organization which can serve as the project lead. Additional financial resources are also warranted. Another walkthrough with members of the community would be beneficial in identifying additional potential sites for GI practices. Such a walkthrough should be followed by a more technical walkthrough for preliminary feasibility assessment.

Following the preliminary feasibility assessment, rough conceptual design for each potential site for a green roof, a green wall or street planters would be useful in approaching the business and property owners. In addition to the conceptual designs, potential financing resources should be prepared, particularly for structural analysis needed to fully evaluate each project site. Aggregating multiple sites for structural analysis should be considered for applying for potential funding.

For tree pits that are currently empty, businesses that front the tree pit should be contacted to evaluate whether a tree would interfere with their operation. If a tree does not pose a nuisance for the business, a request for a tree should be placed with DPR. If a tree is a concern for the operation of the business, replanting the tree pit with herbaceous native plants might be investigated.

For potential funding, New York City Council Resolution A Capital Funding should be pursued for installing new

tree pits. The project area is within the City Council District 33 (Councilman Stephen T. Levin), which currently offers participatory budgeting. In addition to new tree pits along Norman Avenue, the Reso A funding might be appropriate for other potential projects such as a bus stop green roof on Nassau Avenue. For green roofs, outreach to business and property owners to inform them of the DEP Green Infrastructure Grants Program and the Green Roof Tax Abatement Program is warranted.

Continued community engagement is also needed to sustain the project. One of the goals of this project is to make the industrial area of Greenpoint a more pleasant environment for area residents and the workers. By doing so, the rift between residents and businesses can be narrowed and the support for local businesses in the project area, many of them small businesses, can be nurtured. A leadership by a local organization is thus critical to move the project into the implementation phase.

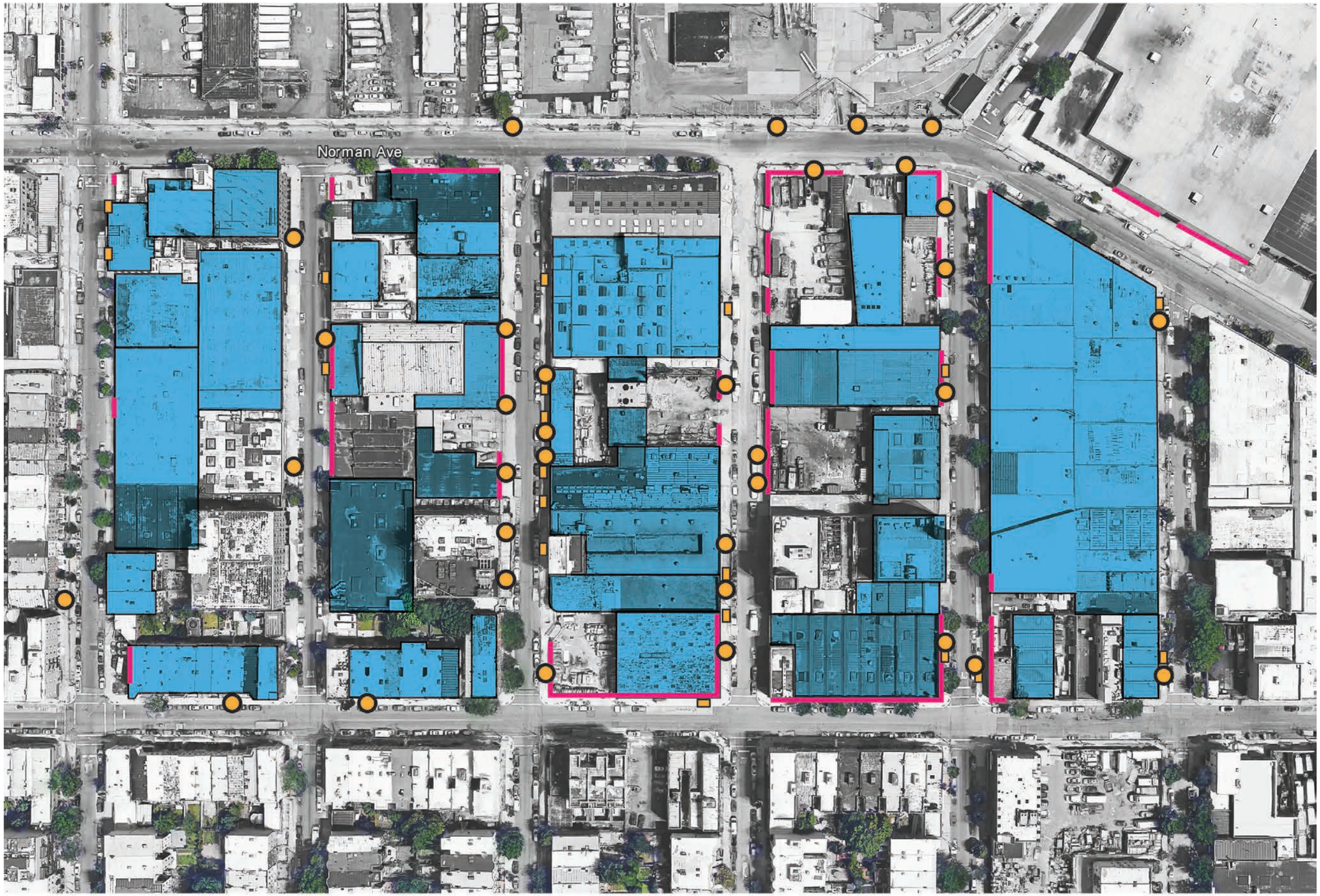


FIGURE 21 - SITING MAP: COMBINED POTENTIAL GI
Potential sites for Green Infrastructure in the Project Area, based on community inpout and desktop analysis

GLOSSARY
OF TERMS

Glossary of Terms

Blue Roof
Blue roofs are designed without vegetation for the primary purpose of temporarily detaining stormwater. Weirs at the roof drain inlets create temporary ponding and gradual release of stormwater.

Co-Benefits
(In reference to Green Infrastructure) The subsequent positive effects of installing Green Infrastructure in urban settings, including but not limited to the secondary improvements to urban life such as recreational benefits, community benefits, educational opportunities, stewardship possibilities, and reduction in Urban Heat Island Effect.

Combined Sewer Overflow (CSO)
Discharge of untreated wastewater, mixture of stormwater and domestic waste, when the flow capacity of a sewer system is exceeded during rainstorms.

Detention
The act of holding stormwater temporarily and discharging the stormwater over an extended period of time (hours to days), generally by controlling the size of the discharge volume and flow rate.

Direct Capture
In hydrology, the component of the water cycle which has been directly absorbed by vegetation, including plant and tree leaves.

Evapotranspiration
The release of water vapor into the atmosphere by the combination of direct evaporation from soil media and transpiration by plants.

Extensive Green Roof
Vegetated Roof system with a typical soil depth of 3-6 in, with lightweight soil containing relatively low organic matter. Extensive Green Roof systems typically have a limited variety of plant species and have, on average, lower maintenance, nutrition and irrigation requirements. (Compare to Intensive Green Roofs)

Green Infrastructure (GI)
Infrastructure associated with stormwater management and low impact development that encompasses approaches and technologies to infiltrate, evapotranspire, capture, and reuse stormwater to maintain or restore natural hydrologies.

Hardiness Zones
Zones based on the average annual minimum winter temperature, divided into 10-degree F zones.

Infiltration
The movement of water through the ground surface into the unsaturated zone.

Intensive Green Roof
Vegetated Roof system with a typical soil depth of 6 in or greater, with heavier weight soil (up to 150 lbs/in2). Intensive Green Roof systems typically have a greater diversity of plant species including shrubs and small trees, and typically require more maintenance, nutrition and irrigation regimes. (Compare to Extensive Green Roofs)

Interception
In hydrology, the accumulation of precipitation on vegetation and other above-ground surfaces and its evaporation during and after a storm event.

Macropores
Macropores are large soil pores, usually between aggregates, that are generally greater than 0.08 mm in diameter. Macropores drain freely by gravity and allow easy movement of water and air. They provide habitat for soil organisms and plant roots can grow into them.

MPNA
McGolrick Park Neighborhood Alliance, a group of organized community leaders and residents working to improve McGolrick Park and surrounding neighborhood.

NYC DEP
New York City Department of Environmental Protection, , the department of the government of New York City which protects public health and the environment by supplying clean drinking water, collecting and treating wastewater, and reducing air, noise, and hazardous materials pollution.

NYS DEC
New York State Department of Environmental Conservation, department of the New York state government which guides and regulates the conservation, improvement, and protection of New York's natural resources; manages Forest Preserve lands in the Adirondack and Catskill parks, state forest lands, and wildlife management areas; regulates sport fishing, hunting and trapping; and enforces the state's environmental laws and regulations.

NYC DOB
NYC Department of Buildings, the department of the government of New York City which promotes the safety of all people that build, work, and live in New York City by regulating the lawful use of over one million buildings and construction sites across the five boroughs.

NYC DPR
NYC Department of Parks & Recreation, the department of the government of New York City responsible for maintaining the city's parks system, preserving and maintaining the ecological diversity of the city's natural areas, and furnishing recreational opportunities for city's residents and visitors.

NYC DOT
NYC Department of Transportation, the department of New York City which provides for the safe, efficient, and environmentally responsible movement of people and goods in the City of New York and maintains and enhances the transportation infrastructure crucial to the economic vitality and quality of life of City residents.

NYC SWCD
New York City Soil & Water Conservation District, subdivision of the state government, is part of a nationwide system of 3000 districts, assists New Yorkers and local decision-makers in making wise use of the City's soil, water and related resources.

Photosynthesis
The manufacture by plants of carbohydrates and oxygen from carbon dioxide mediated by chlorophyll in the presence of sunlight.

PM10
Inhalable particles, with diameters that are 10 micrometers and smaller; an air pollutant.

Porosity
The volume fraction of a rock or unconsolidated sediment not occupied by solid material but usually occupied by water and/or air.

Retention
The act of managing stormwater by maintaining a permanent pool of water between storm events. A retention system differs from a detention system, which is designed to empty between storm events and does not maintain a permanent pool.

Right-Of-Way Bioswales (ROWBS)
Planted areas in the sidewalk that are designed to collect and manage stormwater.

Semi-Intensive
A combination of an extensive greenroof with areas of higher plant depths, the semi-intensive living roof will have both areas of lower than 6" of growing media and higher, ranging from 8-12" or 20 – 30 cm.

Stormwater Greenstreets
Stormwater Greenstreets, like Right-of-way Bioswales (ROWB), are planted areas designed to collect and manage stormwater that runs off the streets and sidewalks. However Stormwater Greenstreets are typically constructed in the roadway as a "bump out", are usually larger than ROW Bioswales, and have varying lengths, widths and soil depths based on the characteristics of the existing roadway.

Substrate
The material on which another material is coated or fabricated; in a natural water system, the bottom sediment material or the rock underlying surface soils.

Thermal Pollution
A reduction in water quality caused by increasing its temperature, often due to disposal of waste heat from industrial or power generation processes. Thermally polluted water can harm the environment because it has less dissolved oxygen holding capacity, and plants and animals can have a hard time adapting to it.

Throughfall
The precipitation that penetrates through the canopy and reaches the soil surface by canopy drip.

Transpiration
A part of the hydrologic cycle in which water vapor passes out of living organisms through a membrane or pores.

Tributary Drainage Area (TDA)
The total impervious surfaces that drain downhill and transport stormwater towards a specific point or feature.

USDOE
United States Department of Energy

Urban Heat Island Effect
The measurable increase in ambient urban air temperatures resulting primarily from the replacement of vegetation with buildings, roads, and other heat-absorbing infrastructure. The heat island effect can result in significant temperature differences between rural and urban areas.

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APPENDICES

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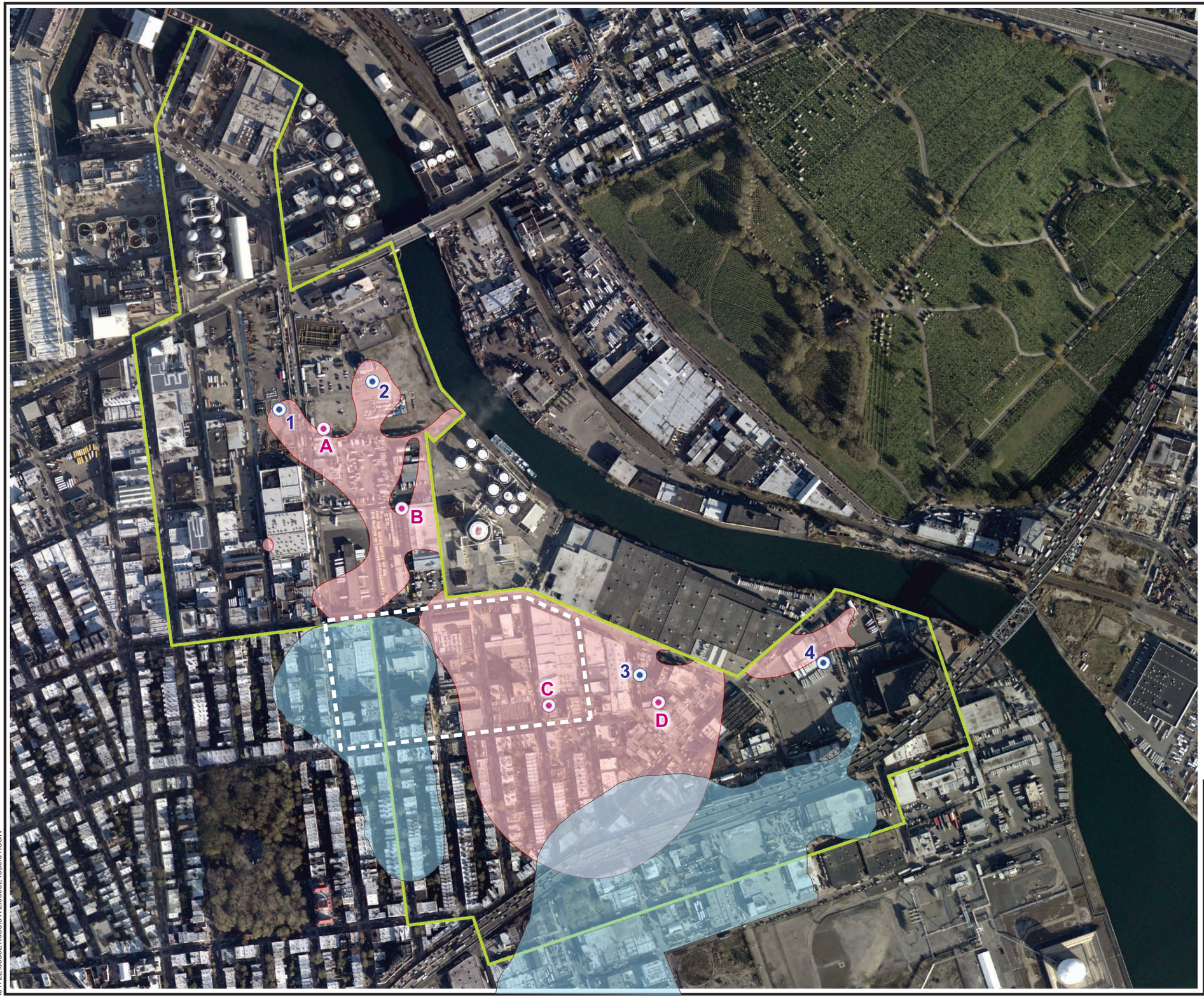
8. NYC DEP GEOTECHNICAL INVESTIGATION PROCEDURE
9. PROJECT AREA CSO MAP PROJECT AREA
10. ZONING & LAND USE MAP

APPENDIX one

MAP OF
POLLUTION PLUME



LEGEND

1 LOCATION AND DESIGNATION OF CO2 TRAP AND LI-COR SURVEY MEASUREMENT

A LOCATION AND DESIGNATION OF ADDITIONAL LI-COR SURVEY MEASUREMENT

FREE PRODUCT EXTENT (SEPTEMBER 2015)

EMGPRP BOUNDARY

PROJECT AREA

MEEKER AVE PLUME AREA

ADDITIONAL INFORMATION REGARDING THE MEEKER AVE PLUME WAS PROVIDED BY THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION ENVIRONMENTAL SITE REMEDIATION DATABASE. SPATIAL DATA WAS PROVIDED BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AND THE GREENPOINT-WILLIAMSBURG NEIGHBORS ALLIED FOR GOOD GROWTH

N

500 0 500 1,000 Feet

Title:

CO2 FLUX MEASUREMENT LOCATIONS

EXXONMOBIL
GREENPOINT PETROLEUM REMEDIATION PROJECT
GREENPOINT, BROOKLYN, NEW YORK

Prepared for: EXXONMOBIL OIL CORPORATION
BROOKLYN, NEW YORK

ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: B.P.	Date: 10MAR17	FIGURE
Prepared by: B.H.C.	Scale: AS SHOWN	1
Project Mgr.: I.H.	Project No.: 0172.0030Y040	
File: 0172.0030E4086.01.CDR		

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APPENDIX two

NYC DOT SITING GUIDELINES

Right-of-Way Bioswale Siting Guidelines

Commissioner Janette Sadik-Khan New York City Department of Transportation

These guidelines are not intended as criteria but minimum standards and first steps in the siting process. Every location which meets these standards will be reviewed individually by DOT.

NEW YORK CITY DOT

ROWB Site Selection Guidelines

ROWBs shall preferably be located in low to moderate density areas

ROWB Site Selection Guidelines

ROWBs proposed for areas of high pedestrian volume must be reviewed by DOT.

ROWB Site Selection Guidelines

ROWBs should maintain a minimum **8’** clear path in moderate density residential (R6-R10), manufacturing, and all commercial areas while a **5’** clear path must be maintained in low density residential settings (R1-R5)*.

*Refer to New York City Department of City Planning Zoning Districts

For locations where this requirement can’t be met, DOT will evaluate on a case-by-case basis**. The 8’ or 5’ clear path is offset from the lot-line of the property; this may or may not be the same as the building line

**ROWBs exceeding standard lengths and widths must be reviewed by DOT for approval. All minimum requirements should still be maintained.

ROWB Site Selection Guidelines

ROWBs are to maintain a minimum **5’** distance from driveways or legal curb cuts*.

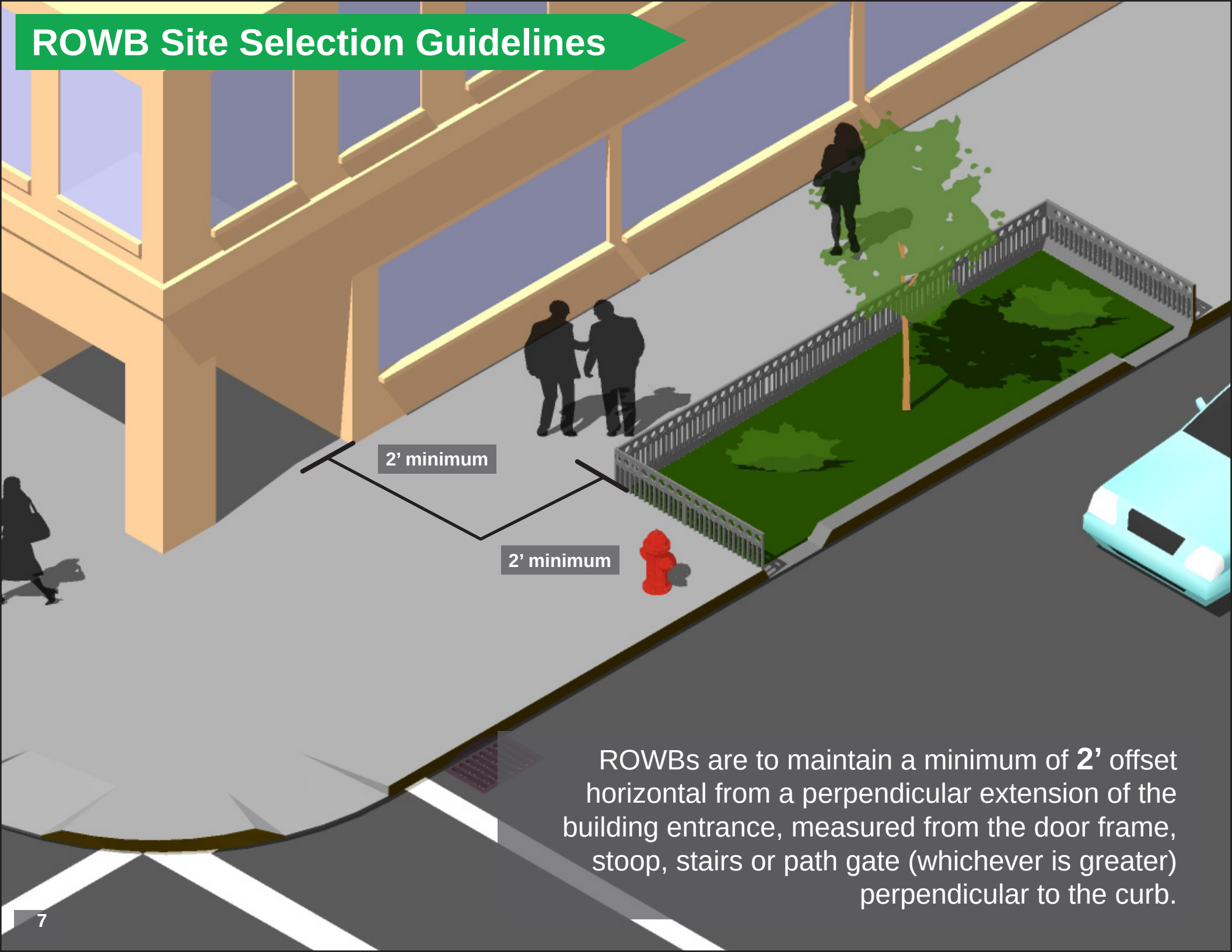
*Curb cuts not immediately perceived as legal and conflict with proposed siting of ROWBs should be verified in writing with the Department of Buildings

ROWB Site Selection Guidelines

ROWBs are to maintain a minimum **5’** from any marked or unmarked crosswalk

ROWBs are to maintain a minimum **5’** from any pedestrian ramp

ROWB Site Selection Guidelines



ROWBs are to maintain a minimum of **2’** offset horizontal from a perpendicular extension of the building entrance, measured from the door frame, stoop, stairs or path gate (whichever is greater) perpendicular to the curb.

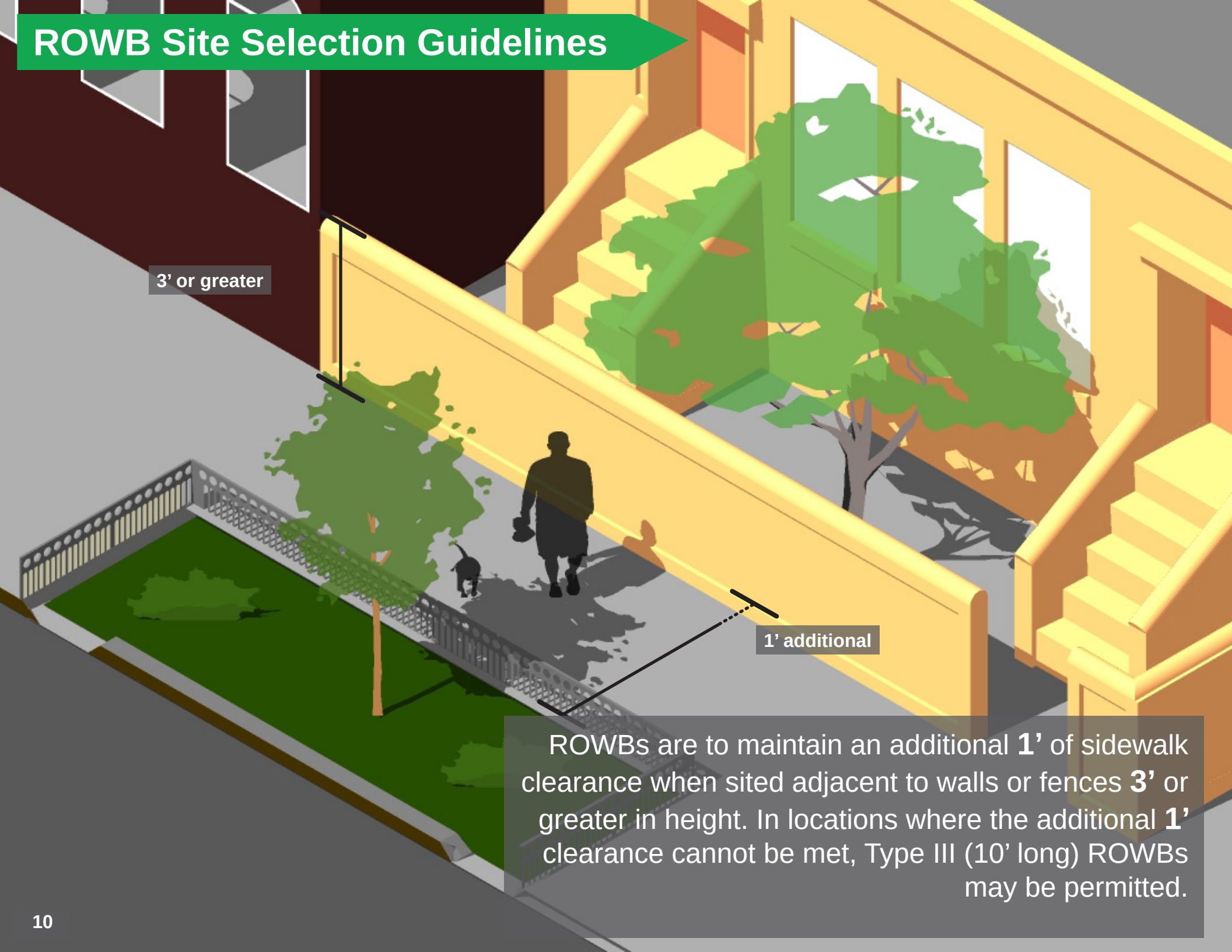
ROWB Site Selection Guidelines

ROWBs shall not violate any building code requirements

ROWB Site Selection Guidelines

Sidewalk corners must be kept clear.

ROWB Site Selection Guidelines



ROWBs are to maintain an additional **1’** of sidewalk clearance when sited adjacent to walls or fences **3’** or greater in height. In locations where the additional **1’** clearance cannot be met, Type III (10’ long) ROWBs may be permitted.

ROWB Site Selection Guidelines

ROWBs must not be sited within **100’** of either side of a posted bus stop.

ROWB Site Selection Guidelines

ROWBs must not be sited within a **10’** radius of subway entrances and exits. ROWBs sited within the vicinity of underground subway structures, sites are to be coordinated with NYCTA.

ROWB Site Selection Guidelines

ROWBs are to maintain a minimum **5’** from any revocable consent structure.

ROWB Site Selection Guidelines

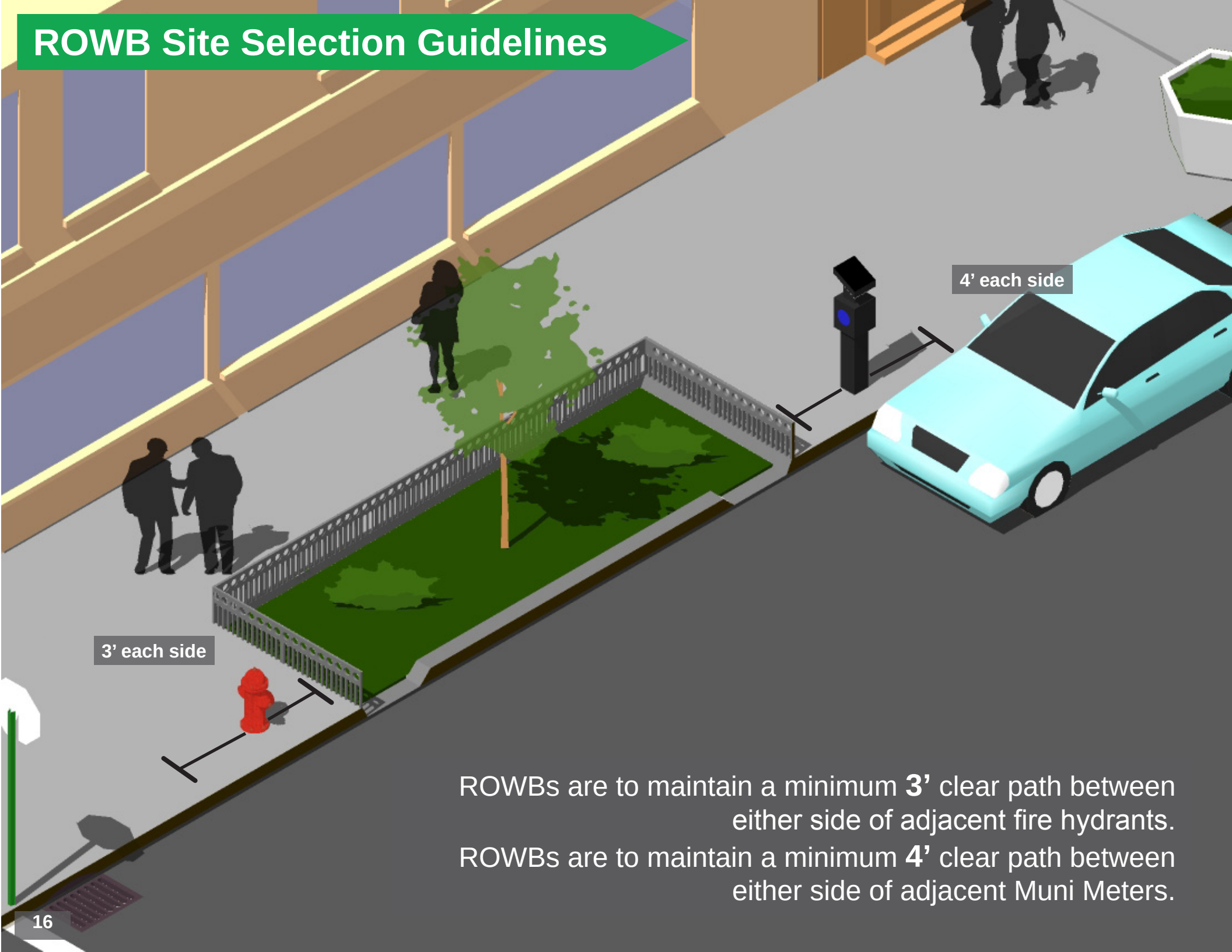
ROWBs are to maintain a minimum **5’** from building vaults.

ROWB Site Selection Guidelines

ROWB tree guards must not exceed **18-24”** in height.

ROWB tree guards should be no closer than **18”**to face of curb.

ROWB Site Selection Guidelines



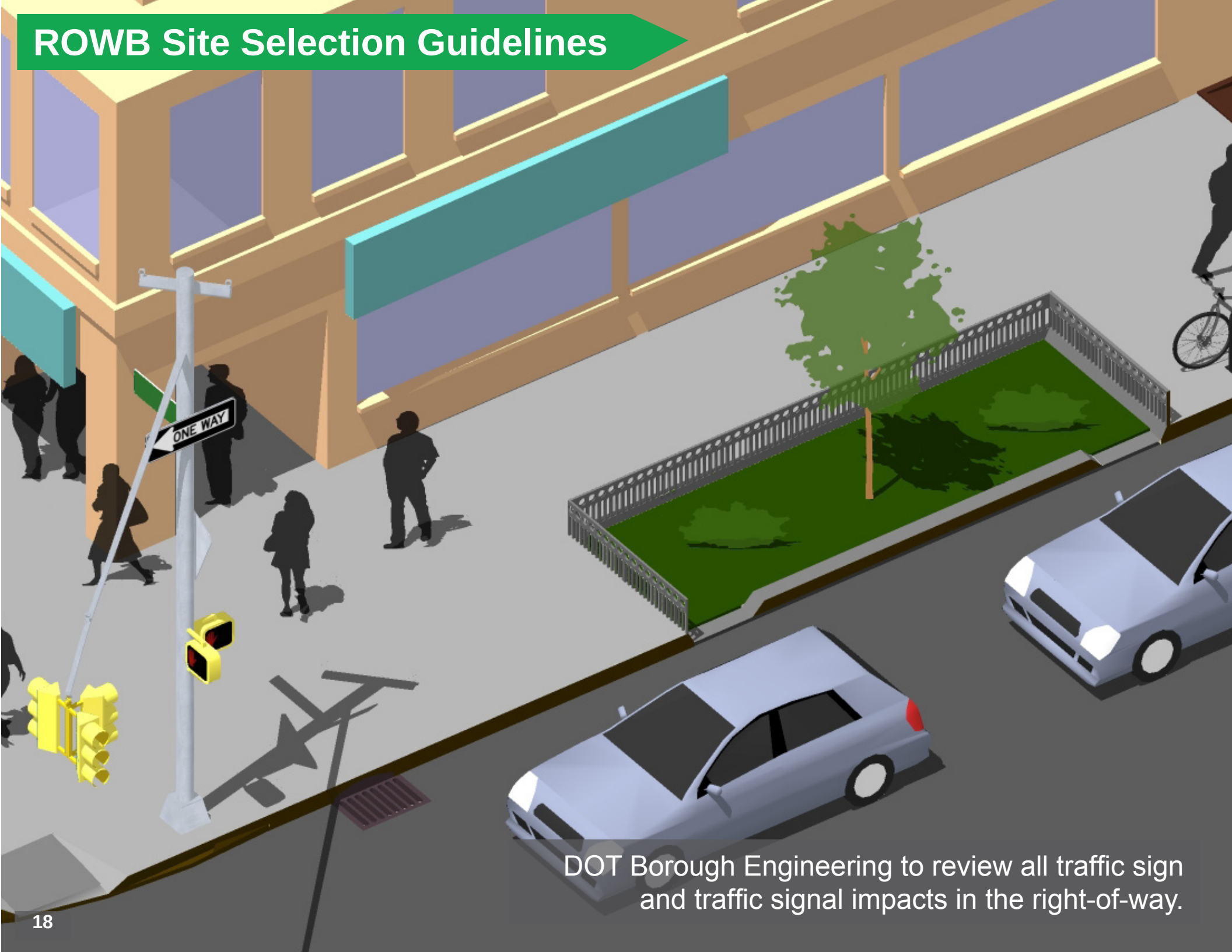
ROWBs are to maintain a minimum **3’** clear path between either side of adjacent fire hydrants.

ROWBs are to maintain a minimum **4’** clear path between either side of adjacent Muni Meters.

ROWB Site Selection Guidelines

ROWBs are to maintain a minimum **5’** clear path between the outer edge of any other street furnishings not included in the Revocable Consents list.

ROWB Site Selection Guidelines



DOT Borough Engineering to review all traffic sign and traffic signal impacts in the right-of-way.

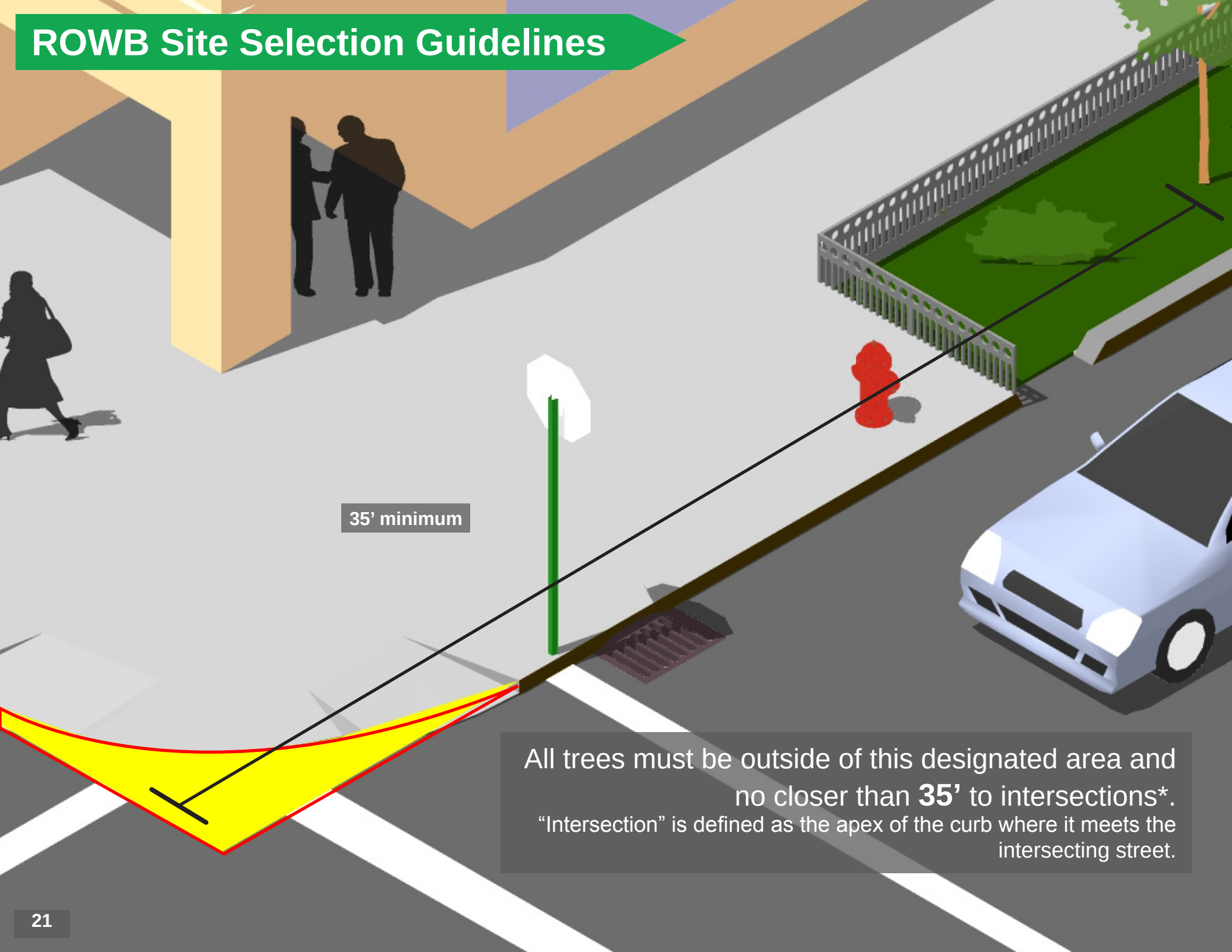
ROWB Site Selection Guidelines

Relocation of street furniture such as bike racks and benches must be coordinated with DOT.

ROWB Site Selection Guidelines

The distance of the trees to the apex of the intersection must be a function of street geometry. Sight line area must meet AASHTO Geometric Design of Highways and Streets sight triangle minimums.

ROWB Site Selection Guidelines



All trees must be outside of this designated area and no closer than **35’** to intersections*.

“Intersection” is defined as the apex of the curb where it meets the intersecting street.

ROWB Site Selection Guidelines

Trunks of trees in ROWBs must maintain a minimum **30’** distance to Stop Signs.

ROWB Site Selection Guidelines

Trunks of trees in ROWBs must maintain a minimum **25’** distance to street lights and traffic signals per DPR Tree Planting guidelines. A minimum of **5’** clearance between pit edge of ROWB and street light footing must be maintained.

Trunks of trees in ROWBs must maintain a minimum **10’** distance to utility poles. A minimum of **5’** clearance between pit edge of ROWB and utility pole must be maintained.

DPR discretion may be used when siting trees closer than 25’ to a light pole.

25’ minimum street lights & traffic signals
10’ minimum utilty poles

ROWB Site Selection Guidelines

Height of shrubs must not exceed **2’6”**.

ROWB Site Selection Guidelines

A minimum **25’** distance must be maintained between the trunk centerline of ROWB trees and the trunk centerline of any existing trees. A minimum **5’** distance is required between the edge of a ROWB and an existing tree pit or bioswale.

*DPR discretion may be used when siting trees closer than 25’.

ROWB Site Selection Guidelines

All trees in bioswales must adhere to DPR's tree planting guidelines as well as the ROWB siting guidelines.

ROWB Site Selection Guidelines

Prior to DOT field review contractor must inform DOT if any ROWBs are proposed within planned or existing historic or landmarked districts.

APPENDIX three

NYC DPR TREE PLANTING STANDARDS I

NYC Parks

Tree Planting Standards

City of New York
Parks & Recreation

February 2014

TREE PLANTING STANDARDS

Street trees are important to our quality of life in the city. They are living elements of our street infrastructure. Located in the public right-of-way, they provide cooling shade, cleaner air, and more beautiful urban streetscapes. Trees confer important esthetic and ecological benefits to City residents as well. Yet plants in the urban landscape face a variety of environmental and physical stresses, including pedestrian and vehicular traffic, soil compaction, air pollution, and drought. Some of the key factors to maximize long-term plant survival are proper handling, careful planting, and immediate and continued aftercare.

All approved tree planting permit applicants **must** follow these standards. Any tree work improperly performed or otherwise not in accordance with these specifications will be subject to restitution and penalty at the direction of Parks & Recreation and at the expense of the property owner.

1. Design

A. Spacing Requirements

The following requirements shall be followed when siting tree pits along sidewalks. These guidelines generally follow regulations of other agencies with right-of-way jurisdictions or infrastructure. These requirements are design and tree species dependent. The Americans with Disabilities Act (ADA) guidelines must be followed.

a. Do not plant in front of building entrances in order to permit easy access by the Fire Department.

b. Do not plant within bus stops.

c. Do not plant directly over DEP water mains less than 20 inches in diameter.

d. Minimum horizontal distance from DEP water main to tree trunk is 6 feet.

e. Minimum distance between trees (trunk to trunk) shall be 20' to 30', depending upon the tree species and other local conditions.

f. Minimum distance from a streetlight to the tree trunk is 25 feet (this may vary with tree species).

g. Minimum distance from a stop sign to the tree trunk is 30 feet.

h. Minimum distance from other traffic signs to the tree trunk is 6 feet.

i. Suggested distance from a parking meter back to tree trunk shall be no more than 5 feet, to allow for the swing of car doors.

j. Minimum distance from a gas or water valve to the edge of the pit is 2 feet.

k. Minimum distance from an oil fill pipe to the edge of the pit is 4 feet.

l. Minimum distance from the edge of a coal chute to the edge of the pit is 2 feet.

m. Minimum distance from a fire hydrant to the edge of the pit is 3 feet.

n. Minimum distance from a curb cut or driveway to the edge of the pit is 2 feet and to the tree trunk is 7 feet.

o. Minimum distance from the corner of a street intersection to the tree trunk is 40 feet.

p. Minimum distance from the edge of the pit to any opposite obstruction (building wall, stoop, railing, property line etc) is from 4 to 6 feet, depending upon local conditions and the amount of sidewalk traffic.

q. All tree pits must be contiguous to the street curb (except as noted below, or with the permission of the Agency representative).

r. Trees may be planted on either side of sidewalks (if any exist) in lawn areas where there is sufficient room between the property line and the street curb.

The locations of all trees shown on plans may be relocated as required by site conditions and as directed by the Agency representative.

B. TREE PIT DIMENSIONS

Tree pits should be as large as possible to allow for ample growing space for tree roots and crown, and to prevent future sidewalk lifting. Optimal tree pit size would be 4 feet by 10 feet or 5 feet by 10 feet. The overall width of a sidewalk can limit the size of a tree pit. Please refer to the Sample Tree Pit Configuration Sheet on page 19 for a range of possible tree pit sizes.

Parks encourages continuous tree pits whenever possible, and designs that call for continuous pits may be given more flexible spacing requirements by the Agency representative.

If the recommended tree pit size does not match the approved site plan, the plan must be revised.

C. GROUPED PLANTINGS

Grouped plantings provide a number of environmental benefits. These benefits include increased shading, reduced evapotranspiration, less soil compaction, greater available soil volume, and reduced exposure to reflective heat for an individual tree. A grouped planting can be achieved in several types of sites: (1) a greenstreet, such as a median or traffic triangle, with opportunity for a large planting bed; (2) a continuous tree pit, where two or more trees are planted in a single trench in the sidewalk (at least 30 feet long); or (3) a raised planting bed as within a plaza or alongside a pedestrian passageway.

D. SPECIES SELECTION

Growing conditions and microclimates can vary from location to location within a borough and across the City. Species selection should take into account site conditions, design goals, and diversity goals. In choosing a tree, the mature height and spread shall be considered to ensure that it will not interfere with existing or proposed structures and overhead utilities. Parks will not allow large to be planted under primary wires. The species characteristics shall be considered to ensure that they will not cause interference with walls, walks, drives, and other paved surfaces, or affect water and sewer lines, underground drainage systems or utilities.

See the attached list of approved street trees for New York City for information on each species shape, growth rate, visual interest, environmental tolerances and sensitivities (including Asian Longhorned beetle hosts), and special needs. Additional species will be considered.

*Final approval of species choice will be made by a New York City Parks & Recreation Representative.

E. CU STRUCTURAL SOIL

Trees are not to be planted directly in CU Structural Soil. CU Structural Soil is only to be used as a base material under impermeable surfaces. Exposed or permeable surfaces should be excavated and replaced with fresh topsoil meeting tree planting specifications. All Structural Soil Installations need approved prior by a New York City Parks forester.

e. Installation:

The Contractor shall notify the Forester of any subsurface conditions which will affect the Contractor's ability to complete the work, and shall locate and confirm the locations of all underground utility lines and structures prior to starting any excavation in the area to receive Structural Soil by calling New York City/Long Island Call One Center, (800) 272-4480. The Contractor shall be liable to repair any damage to underground utilities or structures caused by their activity during the progress of this work, at their own expense. Where tree roots larger than one inch (1") diameter are damaged , the Contractor shall ensure that damaged root sections are cleanly cut with sterilized pruning equipment.

Prior to placing pavement, the licensed CU-Soil™ provider and the Forester shall check the Structural Soil material for consistency with the color and texture of the approved sample supplied by the Contractor. In the event that the material supplied varies significantly from the approved sample, the Forester may request that the Contractor test the installed Structural Soil. Any mix which varies significantly from the approved testing results, as determined by the Forester, shall be removed and new Structural Soil installed that meets the specifications.

License: You are required to use a licensed CU Structural Soil manufacturer.

2. Plant Pest Control Requirements

You are reminded to comply with Federal and State Department of Agriculture regulations for plant pest control. Full information can be obtained from Federal and State Pest Control personnel.

A. ASIAN LONGHORNED BEETLE

Quarantine zones for the Asian Longhorned Beetle currently cover large areas of Brooklyn, Manhattan, Queens, and part of Staten Island. You must read and understand the nature and area of the quarantine as presented in Rule Making Activities, New York State, Department of Agriculture & Markets, Emergency Rule Making (Asian Longhorned Beetle; I.D. No. AAM - 53

96 00016 - E). You shall become familiar with restrictions and regulations established by all authorities having jurisdiction.

Anyone working within the Quarantine Zone must have certification from the New York State Department of Agriculture and Markets to do so. In general, State Department of Agriculture regulations requires contractors operating in infested areas to thoroughly clean all equipment units before moving them to non-infested areas.

Tree species listed as hosts for the Asian Longhorned Beetle are generally prohibited from planting within all of Brooklyn, Manhattan, Queens, and parts of Staten Island. Exceptions will be made on a case-by-case basis with the approval of the Parks Forester.

3. Materials

A. PLANTS

a. *Digging*. All trees shall be dug immediately before moving unless otherwise specified. All trees shall be dug to retain as many fibrous roots as possible. Balled and burlapped trees shall have a solid ball of earth of the minimum specified size (28"), securely held in place by untreated burlap and stout rope (nylon rope is NOT acceptable). Oversize or exceptionally heavy trees are acceptable if the size of the ball or spread of roots is proportionally increased. Loose, broken, or manufactured balls are unacceptable. Size and grading standards shall conform to those of the American Association of Nurserymen American Standards for Nursery Stock, 1996 Edition, unless otherwise specified.

b. *Form and structure*. All trees shall be typical of their species or cultivar. They shall have normal, well developed branches and a fibrous root system. They shall be sound, healthy, vigorous trees, free from defects, disfiguring knots, sunscald, injuries, abrasions of the bark, plant diseases, insect eggs, borers and all forms of infestations. All trees shall have a single, straight trunk, with leader intact (not all species have a leader but one must be present in those that do) and be branched at least five feet from the ground.

c. *Provenance and tree size*. All trees shall be nursery grown in a USDA hardiness zone of 7B or lower (material collected from the wild is unacceptable), except with permission from Parks. Tree size shall be at least 2.5 inch calipar measured at six inches from the ground and no larger than 3.5 inches in caliper unless otherwise authorized by Parks & Recreation.

d. *Plant names*. Plant names shall agree with the nomenclature of "Standardized Plant Names" as adopted by the American Joint Committee on Horticultural Nomenclature 1942 edition. All tree cultivars, patented or otherwise must be certified by the supplying nursery. All nurseries shall be required to have a registration certificate from the Department of Agriculture & Markets, Division of Plant Industry, New York State certifying that plant material is apparently free from injurious insect and plant diseases. A similar certificate shall be required from other states where plant material is obtained.

e. *Species selection*. Species shall be selected from the list of approved Street Trees for New York City. Guidelines on this chart must be followed, as well as any conditions described on the permit. Restrictions may include species recommended for specific planting seasons and locations. Ultimately, it is Parks decision what species of tree will be planted. Take special note of species prohibited from planting in Brooklyn, Manhattan, Queens, and parts of Staten Island due to the Asian Longhorned Beetle.

B. BACKFILL

Material shall consist of natural loam topsoil with the addition of humus only, and no other soil type, such as a sand or clay soil type, shall be accepted. Topsoil must be free from subsoil, obtained from an area which has never been stripped. It shall be removed to a depth of one (1) foot, or less if subsoil is encountered. Topsoil shall be of uniform quality, free from hard clods, stiff clay, hardpan, sods, partially disintegrated stone, lime, cement, ashes, slag, concrete, tar residues, tarred paper, boards, chips, sticks or any other undesirable material. If a truckload of topsoil is considered by the Agency to contain too much undesirable material to be corrected on the site, the entire truck load shall be rejected. No topsoil shall be delivered in a frozen or muddy condition. Topsoil shall comply with the following requirements:

a. *Organic Matter*. Must be between seven (7) and twelve (12) percent (not to exceed 14 percent) by weight, as determined by the Dry Combustion Method for Total Carbon and Organic Carbon (using a multiplying factor of 2) as described in Methods of Soil Analysis, #9, Part 2, 2nd ed. published by the American Society of Agronomy. The organic content shall not exceed fourteen percent (14%).

b. pH range. Shall be 6.0 to 7.0 inclusive.

c. *Sieve Analysis* (by Wash Test, ASTM Designation C-117). Passing 2" sieve (100%); Passing 1" sieve (95% to 100%); Passing #4 sieve (90% to 100%); Passing #100 sieve (30% to 60%).

d. *Clay*. The test method to measure the clay content of the soil shall be ASTM D 422.

The Parks Forester reserves the right to reject topsoil in which more than 60% of the material passing the No. 100 U.S.S. Mesh sieve consists of clay as determined by the Buoyoucous Hydrometer or by the decantation method. All percentages are to be based on dry weight of sample. When the topsoil otherwise complies with the requirements of the specification but show a deficiency of not more than one (1) percent in organic matter, it may be incorporated when and as permitted by the Forester. Electrical Conductivity shall be less than 0.5 mhos/cm. A higher level would indicate excessive salt content.

At final inspection if soil does not appear to meet specifications you will not receive a final sign-off of your permit. If directed, topsoil which varies only slightly from the specifications may be made acceptable by such corrections as the Inspector deems necessary.

C. MULCH

Shredded bark mulch shall be a natural forest product of 98% bark containing less than 2% wood or other debris. It shall be of White or Red Fir and/or Pine bark of a uniform grade with no additives or any other treatment. Size of bark shall be from 5/8" to 1-1/4".The pH factor should range from 5.8 to 6.2. Shredded bark may also be used.

D. WATER

If conditions do not allow the use of New York City water sources, you must obtain your own source of water.

4. Planting Specifications

Planting shall consist of excavating all tree pits, planting, and maintaining new trees of the type and size designated on the approved list. All work shall be in accordance with these specifications and to the satisfaction of the Parks representative.

If any new tree pits have to be cut, a permit must first be obtained from the Department of Transportation. A permit shall be required for each block where the pavement is broken for a new pit. It is your responsibility to notify all owners/operators of underground facilities (code 753). Owners/operators of underground facilities include but are not limited to Keyspan, Con Edison and telephone authorities. Code 753 notifications are to be made to the NYC/LI One Call Center, Briarwood Plaza, Suite 202, 36-35 Bell Boulevard, Bayside, NY 11361. Telephone No. 1-800-272-4480. A code 753 number must be obtained before any work can begin.

No pits shall be dug until proposed locations have been marked on the ground with a white 'P' by Parks & Recreation staff. Once work begins you take full responsibility for the tree pit locations. All excavated materials shall be removed from the site and disposed of. The area is to be made safe and secure at the end of the workday.

Site characteristics, such as overhead power lines, existing vegetation, and infrastructure items, such as curbs and sidewalks, shall be considered. Trees that grow taller than 25 feet should not be planted directly under power lines. When possible the tree leader shall be offset from power lines.

Where subsurface obstructions (vaults, utilities, sprinklers) are encountered during excavation, and restrict the planting of a tree you shall restore the disturbed area to its original condition. If damage is done to an underground obstruction it is the responsibility of the contractor to restore the site to its original condition. A new planting location will be designated if conditions permit.

Trees shall be transported and handled with utmost care to insure adequate protection against injury and desiccation. When transported in closed vehicles, plants shall receive adequate ventilation to prevent sweating. When transported in open vehicles, plants shall be protected by tarpaulins or other suitable cover material. Balled and burlapped trees shall be set on the ground and balls covered with soil. Until planted, all materials shall be properly maintained and kept adequately watered. You are liable for any damage to property caused by planting operations and related work. **All disturbed areas shall be restored to their original condition.**

You are only permitted to occupy an eight-foot lane adjacent to the curb. Traffic shall not be blocked off at any time during planting operations. Work shall not be performed on opposite sides of the street at the same time. Existing parking regulations shall be complied within so far as "No Standing" rules apply for the time limits specified.

A. Planting Seasons

Trees may be planted in the fall from October 1st through December 31st and in the spring from March 1st through May 31st. No planting is permitted in the summer. Please be aware of the DOT Construction Embargo from November 21st thru January 2nd (Street my vary from year to year, please check DOT's website).

B. Installation

Remove all materials from the tree pit for the full length and width of the tree pit to the depth of the tree's root ball (see diagram pg. 13 Tree Planting and Stake Detail). For excavation of a tree lawn, excavate an area at least three times the diameter of the root ball in length by the width of the lawn strip (up to three (3) times the diameter of the rootball), to the dimensions listed on the permit. Extreme care shall be taken not to excavate to a depth greater than required. The subgrade below the root ball shall be tamped slightly to prevent settlement. All ropes, stones, etc. shall be removed from the planting site before backfilling. All excavated materials shall be removed from the site and disposed of.

Place balled and burlapped material in the prepared planting pit by lifting, and carrying it by the rootball so that the ball will not be loosened. Set the tree straight and in the **center of the pit**. All trees shall sit, after settlement, with the base of the trunk and the beginning of the roots known as the "trunk flare" level with the sidewalk grade. If the top of the rootball is not consistent with this area, soil will be added or removed below the rootball to make it so, and the depth of the planting site adjusted accordingly.

Cut and remove rope and wire from the top 2/3 of the rootball. At least 2/3 of the burlap shall be removed from the tree pit. The remaining wires should be pulled back and the burlap adjusted to prevent the formation of air pockets. Backfilling mixture shall be loose and friable, and not frozen. Soil shall be firmed at six to eight inch intervals. All tree pits are to be filled with topsoil or backfill and made level with existing conditions.

Cultivate and rake over finished planting areas leaving them in an orderly condition. On level ground or slight slopes, a shallow basin a little larger than the diameter of the tree ball shall be left around each tree. At no time should topsoil be mounded to cover the trunk of the tree. **The trunk flare shall always be visible**. Final soil level, except for the shallow basin, shall be flush with the surrounding sidewalk grade to prevent potential tripping hazard.

C. Tree Wrap

No tree trunks shall be wrapped. Remove all nursery tags and protective wrapping.

D. Staking

All staking shall be done during planting operation and shall be maintained throughout the first year of the two (2) year guarantee period.

Stakes shall be of white cedar with bark attached and shall show no sign of cracking or decay. They shall have a maximum allowable deflection of ten percent (10%). Stakes shall be cut even so they are the same height. All trees shall be supported by two (2) stakes, they shall be eight (8) feet long; the diameter at the middle shall be not less than (2) inches nor more than two and three quarters (2-3/4) inches and the diameter at the butt shall not exceed three (3) inches. Stakes shall be placed outside of the rootball, driven thirty (30) inches into the ground, and shall be fastened to the tree with a suitable length of ¾" wide, flat, woven polypropylene material such as Arbortie™ as manufactured by DeepRoot®, San Francisco, CA or approved equal that is knotted around the tree stakes.

Unless otherwise directed, trees shall be staked as shown on the plans and in accordance with these specifications. Stakes shall be set parallel to curbs. Trees shall stand plumb after staking. Stakes and Arbortie™ shall be removed at the end of the first year of the two (2) year guarantee period, unless directed otherwise by the Project Manager. At the time the stakes are removed any holes left by the stake shall be filled with topsoil of the same quality as that specified in Section B- Backfill.

E. PRUNING

Only crossing, dead, broken or badly bruised branches shall be removed. These shall be pruned with a clean cut. All pruning shall be done with sharp pruning tools. At the time of planting, pruning cuts shall be made at the base of the branch at such a point and angle that neither the branch collar nor the bark of the stem is damaged, and that no branch stub extends from the collar. Crowns of young trees shall <u>not</u> be cut back to compensate for root loss. No leaders shall be cut.

F. WATERING

At the time of planting, the soil around each tree shall be thoroughly saturated with at least twenty gallons of water. Soil shall be firmed at six to eight inch intervals and thoroughly settled with water. Water shall be free from oil, have a pH not less than 6.0 nor greater than 8.0 and shall be free from impurities injurious to vegetation. Water may be drawn from mains owned by or supplying water to the City of New York. Please contact DEP for an access permit.

Water shall not be applied in a manner which damages plants, plant saucers, stakes or adjacent areas. Each plant saucer shall be carefully filled with water in a manner which does not erode the soil or the plant saucer. Watering shall not cause uprooting or exposure of plant's roots to the air.

G. MULCHING

Bark Mulch shall be applied as a ground cover to the surface of all planting beds at the time of planting and again after the tree stakes have been removed, one year after planting. (See Section 3 C for Mulch specifications).

Mulch shall be applied to a uniform depth of three (3) inches and shall be so distributed as to create a smooth, level cover over the exposed soil. A gap of approximately 2" should be left between the mulch and the trunk of the tree to avoid mounding above the trunk flare.

5. Seasonal Maintenance

A. WATERING

Watering shall also take place throughout the two (2) year guarantee period, at least 20 gallons at approximately two week intervals from May 15 to October 31. You may need to increase or reduce the frequency of watering based on weather conditions, resulting soil water content or other factors.

Water shall not be applied in a manner that damages plants, plant saucers, stakes or adjacent areas. Each plant saucer shall be carefully filled with water in a manner that does not erode the soil or the plant saucer. Watering shall not cause uprooting or exposure of plant's roots to the air. Damages resulting from these operations shall be immediately repaired at your expense.

B. OTHER MAINTENANCE ACTIVITIES

All newly planted trees shall be maintained until two (2) years after the final inspection of permitted planting.

Maintenance shall include weeding, cultivating, edging, pruning, adjustment and timely removal of stakes, and Arbortie™ (these must be removed after one year), repair of minor washouts, mulching, soil replacement and other horticultural operations necessary for the proper growth of all trees, and for keeping the entire area within the planting area neat in appearance.

All planting areas shall be cultivated and weeded with hoes or other approved tools within the period from May 15th to October 31st, and such cultivating and weeding shall be repeated at least every three (3) weeks. Under no conditions shall weeds be allowed to attain more than six (6) inches of growth.

Pit pavement shall be maintained flush with adjacent pavement during the two (2) year guarantee period. At the expiration of the guarantee period the area around the tree shall be cultivated and weed free.

6. Guarantee Period

All trees must be guaranteed for two (2) years. All legitimate contractors and nurseries provide a guarantee for their trees. Make sure to confirm the two (2) year guarantee, and beware of suppliers who claim not to provide this service.

A. TREE REPLACEMENT

Any planted tree that is dead or, in the opinion of the Parks Department, is in an unhealthy or unsightly condition, and/or has lost its natural shape due to dead branches, excessive pruning, inadequate or improper maintenance, or other causes including vandalism, prior to final acceptance, shall be replaced in the next planting season. There shall be a two (2) year guarantee on trees commencing after the final inspection of the permitted planting. The topsoil in the tree pit shall be changed when any replacement tree is planted.

Where dead trees have been identified, whether due to natural causes or vandalism, the dead material shall be removed, including stakes, and Arbortie™ **within 30 days of notification**. When necessary, topsoil, grass seed or appropriate paving material shall be added to the pit to eliminate potential tripping hazards at the time of removal. You must submit photos to Parks showing the proper removal of trees. You must then obtain a permit to replant during the planting season.

B. VANDALISM

Where vandalism or related causes are agreed as the cause for tree replacement, you shall be responsible for one replacement during the two (2) year guarantee period after final inspection of the permitted planting. It will be necessary to prove that the tree was vandalized using photo-documentation.

7. Finishing

Paving blocks, installed in the manner described below are required within each sidewalk tree pit when specified by Parks. Exceptions to this requirement are allowed on a case by case basis. Examples include adequate tree pit guards or non-invasive or competitive under plantings. Please note that Parks will take action if the tree guard, under planting, or paving endangers the long-term health and survival of city-owned trees. Parks does not allow tree grates to be installed around newly planted or existing trees.

A. PAVING BLOCKS

a. Materials

Granite Block Pavers: Granite blocks shall be new or used and shall be cut from fine to medium grained sound and durable granite. The granite shall be reasonably uniform in quality and texture throughout and shall be free from an excess of mica and feldspar and from seams, scales or evidence of disintegration. If used blocks are utilized they shall be clean, free from mortar, asphalt, etc.

Blocks shall be fairly rectangular in shape and shall be not less than four (4) inches nor more than twelve (12) inches in length; not less than three (3) nor more than five (5) inches in width; not less than three (3) nor more than five (5) inches in depth. The blocks shall be cut so that opposite faces will be approximately parallel and adjoining

faces approximately at right angles to each other. Granite blocks shall be so dressed that they may be laid with one (1) inch joints. All blocks shall have one reasonably smooth split head.

b. Installation

Paving blocks shall be installed using a sand cushion. The sand shall consist of clean, hard, durable, uncoated stone particles, free of lumps of clay and all deleterious substances and shall be so graded when dry, one hundred percent shall pass a ¼ inch square opening sieve; not more than thirty-five percent by weight shall pass a No. 50 sieve. Sand shall conform to ASTM C-33.

Trim and tamp the subgrade to smooth, uniform lines prior to placing the pavers. The pavers shall be laid on a sand cushion with a minimum thickness of one inch. The sand cushion shall be compacted by hand tamping, or as directed by the Forester. Joints between pavers shall be a maximum of one inch and a minimum of three quarters inch in width. All joints (inner and outer) shall be mortared in place with a cement mortar of a wet mixture of one part Portland cement and two parts sand. (see drawing page 21-22)

Care should be taken to leave a maximum amount of tree pit surface area uncovered, without pavers (see drawing pg 20 & 21). The installation of tree guards shall not interfere with the proper grade of the tree; trees cannot be planted deeper to accommodate pavers and root balls cannot be damaged during installation.

B. TREE PIT GUARDS

Tree pit guards are not required by Parks. A tree pit guard is a device, usually a cast-iron fence or wrought-iron wickets, installed around a tree pit for protection. Parks recommends a low cast-iron fence or wrought-iron wickets that is 18" high. Tree guard posts shall be solid steel. Tree guards should be three sided leaving the street side open and should **not** be embedded into concrete. This will protect the tree from dogs and pedestrians and give it enough space to grow for many years to come. New York City Parks has four standardized and approved designs which are encouraged for all tree guard installations. See Appendix for specifications. Please also note that the permitee takes full responsibility for maintaining the tree guard in a safe condition. If the condition of the tree guard is not maintained in a safe condition the tree guard will be removed by NYC Parks.

Interested parties should apply for a permit to work on or near a tree before installing a tree guard. The permit is to 'Install Tree Guard'. Guards should not be installed close to tree trunks, and should be installed along the perimeter of three sides of the tree bed. They strangle the tree as it grows and fail to protect the root zone.

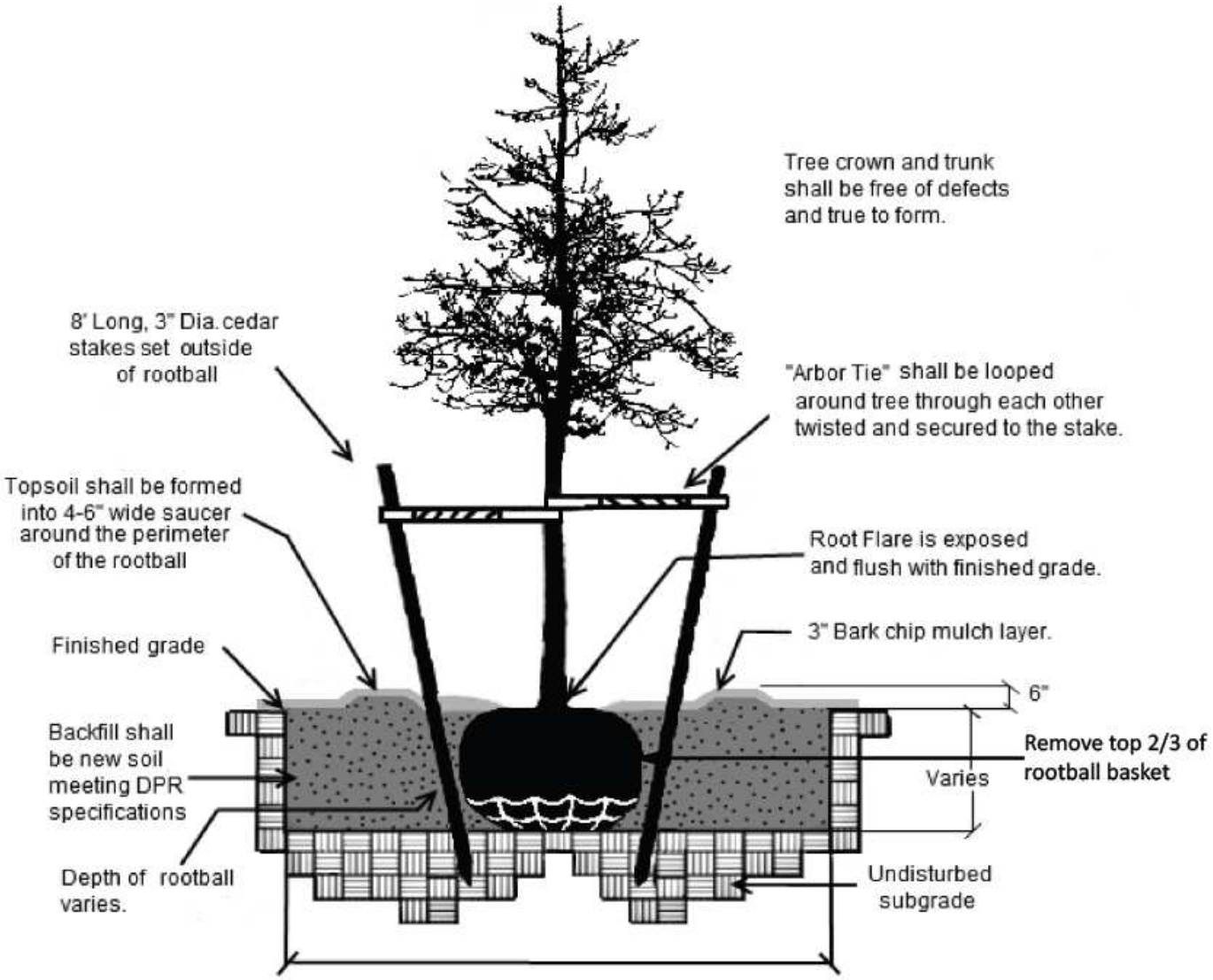
Sidewalk-level tree grates are not permitted; granite paving should be used as an alternative. Grates do not protect the tree trunk and the tree will grow into them and die if the openings are

not periodically widened. They also serve as receptacles for litter and if raised by the tree's growth will cause a trip hazard.

Do not install brick or concrete walls around the tree pits. The interior space created by the solid wall encourages property owners to add soil over the root zone for plantings, unwittingly suffocating tree roots.

Never plant Ivy or woody shrubs/plants in the tree pit as they compete with the tree for vital nutrients.

APPENDIX



Tree Planting & Stake Detail

Not to Scale

SAMPLE TREE PIT CONFIGURATIONS

TREE PIT DIMENSIONS*			
	Length (ft)	Surface Area (sf)	Soil Volume (cu ft)
Width: 7 ft			
	6	42	84
	7	49	98
	8	56	112
	9	63	126
	10	70	140
	⋮	⋮	⋮
	25	175	350
	⋮	⋮	⋮
	50	350	700
	⋮	⋮	⋮
	100	700	1400
Width: 6 ft			
	6	36	72
	8	48	96
	9	54	108
	10	60	120
	⋮	⋮	⋮
	25	150	300
	⋮	⋮	⋮
	50	300	600
	⋮	⋮	⋮
	100	600	1200
Width: 5 ft			
	6	30	60
	7	35	70
	8	40	80
	9	45	90
	10	50	100
	⋮	⋮	⋮
	25	125	250
	⋮	⋮	⋮
	50	250	500
	⋮	⋮	⋮
	100	500	1000
Width: 4 ft			
	7	28	56
	8	32	64
	9	36	72
	10	40	80
	⋮	⋮	⋮
	25	100	200
	⋮	⋮	⋮
	50	200	400
	⋮	⋮	⋮
	100	400	800

*all calculations based on a tree pit depth of 2 feet. In general, tree pit depth should match root ball height. In the case of structural soil, pit can be deeper.

Notes:

These dimensions illustrate the variety of tree pit sizes and configurations that are possible. They are not meant to be fixed. Tree pits should always be as large as possible. The larger the soil volume the larger the tree size will be at maturity and the better chance it has for long-term survival.

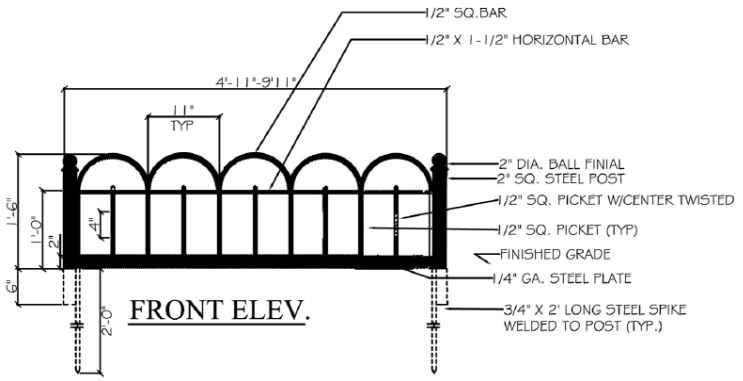
The longer tree pit lengths on the chart at left show the soil volumes achieved in continuous tree pits, which are underground trenches that are generally treated with structural soil belowground and sidewalk pavement aboveground, except for the area around the tree which resembles the open area of a traditional tree pit.

General rules for proximity to built infrastructure:

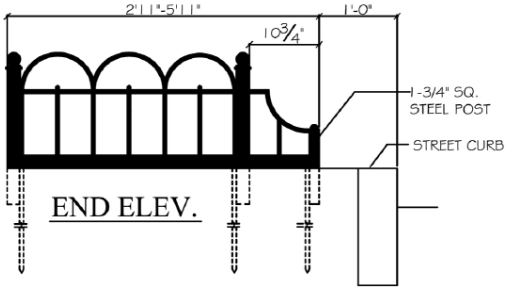
--20 feet from light poles
--30 feet from stop signs
--6 feet from traffic signs
--5 feet from parking meters
--2 feet from water drains
--2 feet from utilities
--5 feet from hydrants
--7 feet from driveways
--39 inches minimum passage for ADA considerations
--5 feet passage general requirement NYC DOT
--15 to 25 feet from other trees

Note: these are general infeasibility criteria meant to guide designers. Specific rules and allowances will be established during the DPR permitting process, since exact tree siting varies by tree species selection, local site conditions, and other agency requirements .

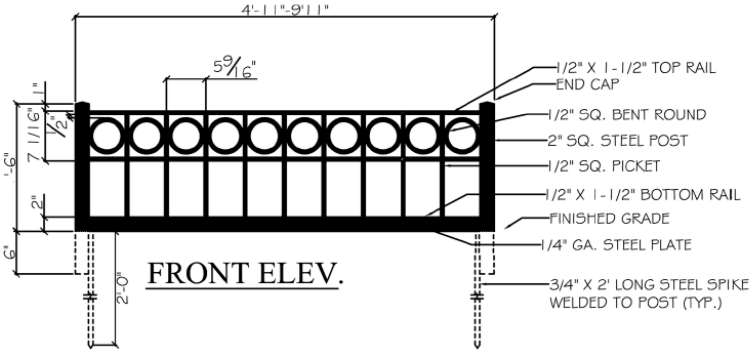
Prepared by DPR, Central Forestry & Horticulture, May 2008



TREE PIT GUARD TYPE 'A'



TYPE 'A' THREE SIDED DESIGN



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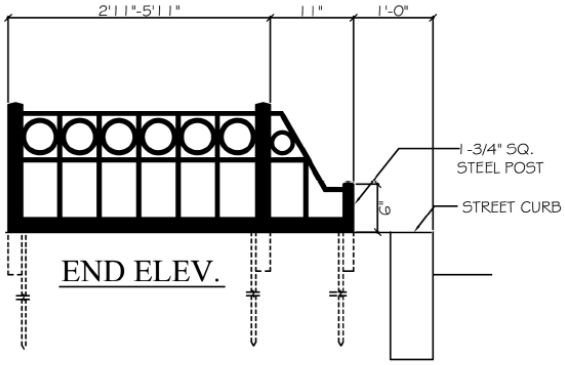

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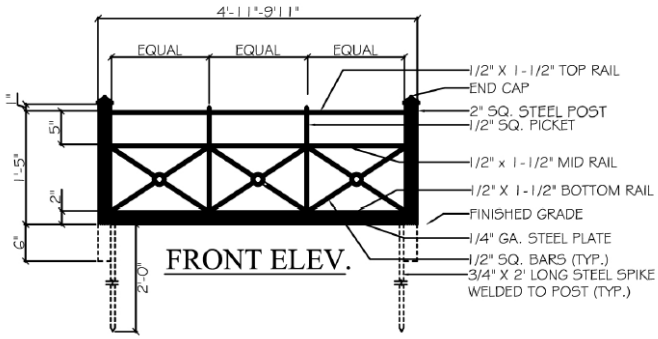

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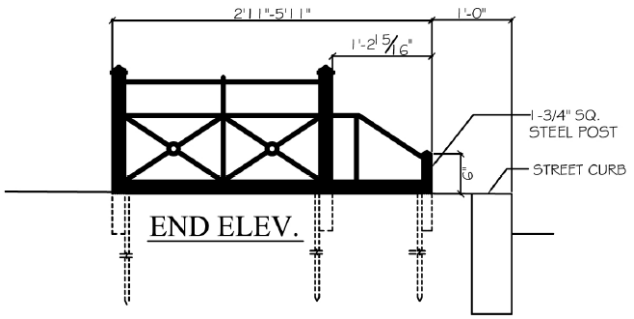

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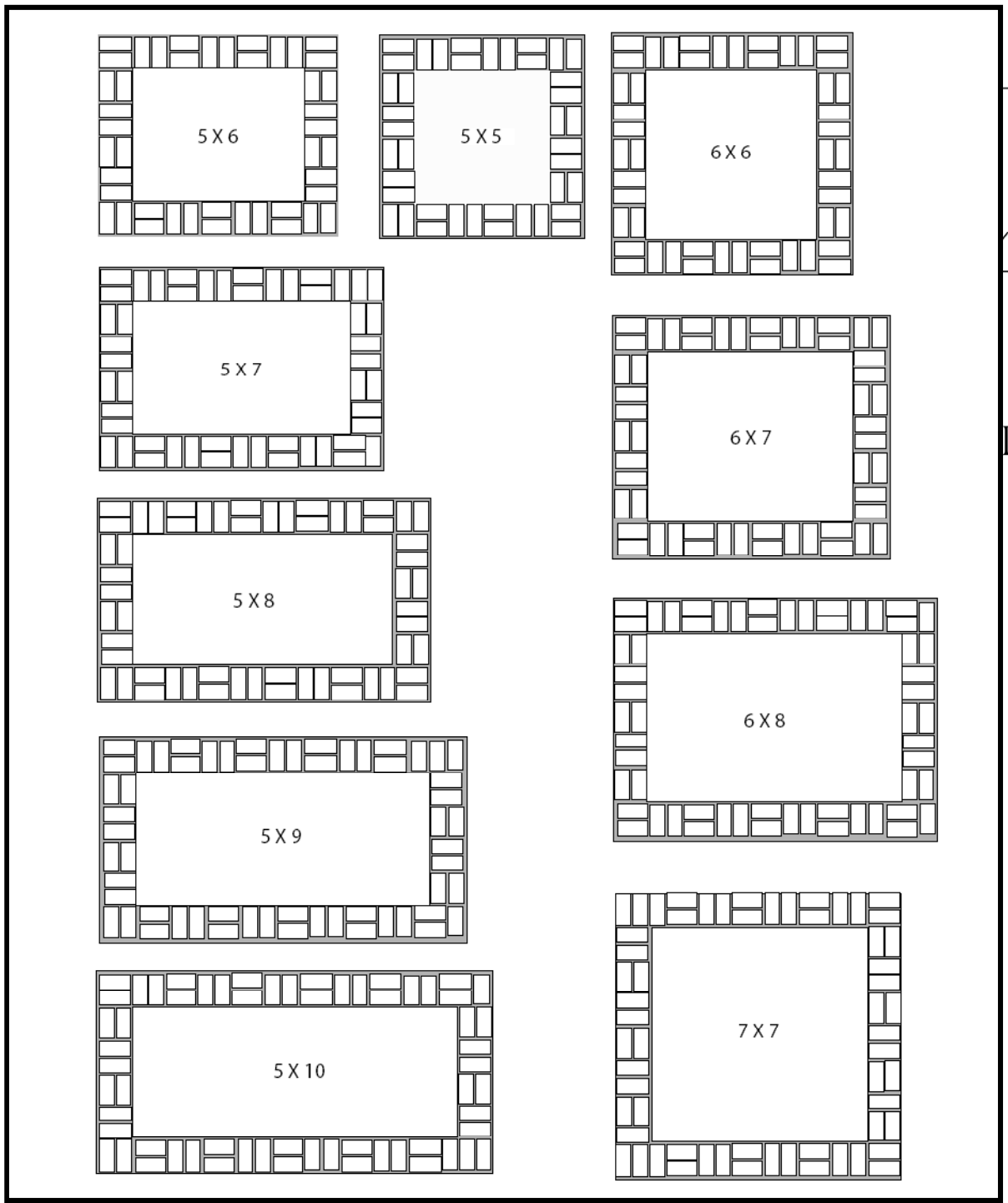
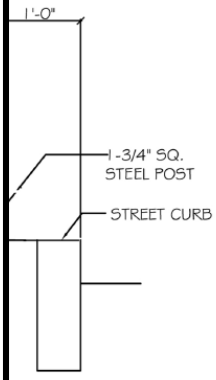




D"

Tree Pit Dimensions and Paving Standards

APPENDIX four

NYC DPR TREE PLANTING STANDARDS II

Street Tree Planting Standards for New York City

2016

City of New York
Parks and Recreation

NYC Parks

Table of Contents

Important Note: All permit holders are expected to be familiar with and to plant in accordance with NYC Parks Standards. Detailed Parks approved specifications may be available. Ask your NYC Parks Forester for further details when applying for or requesting a permit. All permit request must be made using the new *Tree Work Permit and Plan Review Application* found at the following link:
https://www.nycgovparks.org/services/forestry/forestry-application

Introduction

The mission of Forestry, Horticulture, and Natural Resources is to protect, restore, expand and manage New York City's green spaces and natural areas to maximize the benefits for environmental and community health and resilience.

Overview

Street trees are important to our quality of life in the city. They are living elements of our street infrastructure. Located on the public right-of-way, they provide cooling shade, cleaner air, and more beautiful urban streetscapes. Trees confer important aesthetic and ecological benefits to city residents as well. Plants in the urban landscape, however, face a variety of environmental and physical stresses including pedestrian and vehicular traffic, soil compaction, air pollution, and drought. Some of the key factors to maximize long-term plant survival are proper handling, careful planting, and immediate and continued aftercare.

All trees planted on the public right-of-way are under the jurisdiction of the Department of Parks & Recreation as property of the City of New York. A valid tree planting permit must be obtained in order to plant on the public right-of-way, and plantings must be done in accordance with the agency's current street tree planting standards. Any tree work improperly performed or otherwise not in accordance with these specifications may be subject to remedial work at the tree work entity's expense, and/or additional penalties.

Street Tree Planting Requirements for New Buildings

All new buildings and all enlargements exceeding 20 percent of the floor area must provide one new street tree for every 25 feet of building road frontage. These requirements must be satisfied for the builder to obtain a Certificate of Occupancy from the Department of Buildings (DOB). All jobs pre-filed with DOB after May 3, 2010 are required to undergo a Parks Plan Review before any permits or tree fund invoice can be issued.

Design Requirements

Spacing Requirements

The following requirements shall be followed when siting tree pits along sidewalks. These guidelines generally follow regulations of other agencies with jurisdiction or infrastructure on the right-of-way. These requirements are design and tree species dependent. The *American with Disabilities Act* (ADA) guidelines must also be followed.

a. Do not plant in front of building entrances in order to permit easy access by the Fire Department.
b. Do not plant within bus stops.
c. Do not plant within no standing zones
d. Do not plant directly over DEP water mains less than 20 inches in diameter.
e. Minimum horizontal distance from DEP water main to tree trunk is 6 feet.
f. Minimum distance between trees (trunk to trunk) shall be 20 feet to 30 feet, depending upon the tree species and other local conditions.
g. Minimum distance from a streetlight or utility pole to the tree trunk is 25 feet (this may vary with tree species).
h. Minimum distance from a stop sign to the tree trunk is 30 feet.
i. Minimum distance from other traffic signs to the tree trunk is 6 feet.
j. Suggested distance from a parking meter back to tree trunk shall be no more than 5 feet, to allow for the swing of car doors.
k. Minimum distance from a gas or water valve to the edge of the pit is 2 feet.
l. Minimum distance from an oil fill pipe to the edge of the pit is 4 feet.
m. Minimum distance from the edge of a coal chute to the edge of the pit is 2 feet.
n. Minimum distance from a fire hydrant to the edge of the pit is 3 feet.
o. Minimum distance from a curb cut or driveway to the edge of the pit is 2 feet and to the tree trunk is 7 feet.
p. Minimum distance from the corner of a street intersection to the tree trunk is 40 feet.
q. Minimum distance from the edge of the pit to any opposite obstruction (building wall, stoop, railing, property line etc.) is from 4 to 6 feet, depending upon local conditions and the amount of sidewalk traffic.
r. All tree pits must be contiguous to the street curb (except as noted below, or with the permission of the Forester).
s. Trees may be planted on either side of sidewalks (if any exist) in lawn areas where there is sufficient room between the property line and the street curb.

Additional design or spacing requirements may be imposed at the discretion of the Parks Forester reviewing your application depending on the location and site conditions.

Tree Pit Dimensions

Tree pits should be as large as possible to allow for ample growing space for the tree's roots and to reduce the likelihood of future sidewalk lifting. The standard street tree pit size is 5 feet by 10 feet. The overall width of a sidewalk can limit the size of a tree pit. Where a 5 feet by 10 feet tree pit is not possible, alternate dimensions must be approved by the Forester.

The installation of continuous tree pits is encouraged whenever possible, and design proposals that call for continuous tree pits may be given more flexible spacing requirements by the Forester.

Grouped Plantings

Grouped plantings are sites where trees are planted closer than 20 feet from each other (trunk to trunk). Grouped plantings provide a number of environmental benefits which include: increased shading, reduced evapotranspiration, reduced soil compaction, greater available soil volume, and reduced exposure to reflective heat for an individual tree. A grouped planting can be achieved in several types of sites: (1) a GreenStreet, such as a median or traffic triangle, with opportunity for a large planting bed; (2) a continuous tree pit, where two or more trees are planted in a single trench in the sidewalk (at least 30 feet long); or (3) a raised planting bed within a plaza or alongside a pedestrian passageway. Grouped plantings are not often the preferred method of planting and are subject to approval at the discretion of the Forester reviewing your proposal.

Species Selection

Growing conditions and microclimates can vary from location to location within a borough and across the City. Species selection should take into account site conditions, design goals, and diversity goals. In choosing a species, the mature height and spread shall be considered to ensure that it will not interfere with existing or proposed structures and overhead utilities. The final selection of the species is made by the Forester. Parks will not allow large trees to be planted under primary wires and discourages small trees in large open spaces.
NYC Parks publishes a list of approved species for planting on the right-of-way. (Appendix A). Alternate species not found on the approved list may be considered on a case by case basis, however, NYC Parks retains the right to determine what species is planted on the right-of-way.

Structural Soils

NYC Parks encourages the use of structural soils where appropriate, and may require its use where it is deemed necessary. Trees are not to be planted directly in structural soil, and structural soil is only to be used as a base material under hard surfaces such as concrete, permeable pavement, or permeable pavers. Exposed soil or grass covered surfaces should be excavated and replaced with fresh topsoil meeting DPR street tree planting specifications. NYC Parks has approved the use of CU and Swedish Structural Soils, and they must be installed in accordance with Parks' specifications (Appendix B). Structural soils can only be installed with the prior consent of the Parks Forester reviewing your application and the use of a licensed structural soil manufacturer is required.

Soil Cells (Silva Cells)

Soil cells such as Silva Cells, may be used where appropriate. They can only be installed with the prior consent of the Parks Forester reviewing your application, and must be installed in accordance with Parks' specification (Appendix C).

Permeable Pavement or Pavers

NYC Parks encourages the use of permeable pavement or pavers where appropriate to increase the amount of water available to trees and to assist in storm water capture and management. All pavement or pavers must conform to Department of Transportation (DOT) standards (Refer to DOT for materials and specifications). Parks may approve or require the placement and use of

permeable pavers or pavement around new and existing trees. The proposed use of permeable pavers or pavement should be noted in the permit application.

Bioswales / Green Infrastructure

Bioswales installed on the right-of-way help collect and manage storm water runoff from streets and sidewalks by directing storm water to engineered systems that typically feature soils, stones, and vegetation. At this time, Parks does not issue permits for private installations of bioswales on the right-of-way without the consent of appropriate city agencies, and provisions for maintenance in place.

Plant Pest Control Requirements

Any planting on the public right-of-way is required to comply with all state and federal regulations for plant pest control. More information can be obtained from the appropriate state and federal pest control agencies.

Asian Longhorned Beetle

Quarantine zones for the Asian Longhorned Beetle currently cover areas of Brooklyn and Queens. Applicants must read and understand the nature and area of the quarantine as presented in *Rule Making Activities, New York State, Department of Agriculture & Markets, Emergency Rule Making* (Asian Longhorned Beetle; I.D. No. AAM - 53 96 00016 - E). The applicant shall become familiar with restrictions and regulations established by all authorities having jurisdiction.

Anyone working within the Quarantine Zone must have certification from the New York State Department of Agriculture and Markets to do so. State Department of Agriculture regulations requires that applicants operating in infested areas to thoroughly clean all equipment units before relocation to non-infested areas.

Parks imposes restrictions on the planting of tree species listed as hosts for the Asian Longhorned Beetle in parts of Brooklyn and Queens. Exceptions may be considered on a case-by-case basis.

Materials

Plants

Digging. All trees shall be dug immediately before moving unless otherwise specified. All trees shall be dug to retain as many fibrous roots as possible. Balled and burlapped trees shall have a solid ball of earth of the minimum specified size (32 inches), securely held in place by untreated burlap and stout rope (nylon rope is NOT acceptable). Oversize or exceptionally heavy trees are acceptable if the size of the ball or spread of roots is proportionally increased. Loose, broken, or manufactured balls are unacceptable. Size and grading standards shall conform to those of the *American Association of Nurserymen American Standards for Nursery Stock, 1996 Edition*, unless otherwise specified.

Form and structure. All trees shall be typical of their species or cultivar. They shall have

normal, well developed branches and a fibrous root system. They shall be sound, healthy, vigorous trees, free from defects, disfiguring knots, sunscald, injuries, abrasions of the bark, plant diseases, insect eggs, borers and all forms of infestations. All trees shall have a single, straight trunk, with leader intact (not all species have a leader but one must be present in those that do) and be branched at least five feet from the ground unless otherwise specified or approved by the Forester.

Provenance and tree size. All trees shall be nursery grown in a USDA hardiness zone of 7B or lower (material collected from the wild is unacceptable), except with permission from Parks. Tree size shall be at least 2.5 inch caliper measured at 6 inches from the ground and no larger than 3.5 inches in caliper unless otherwise authorized by NYC Parks.

Plant names. Plant names shall agree with the nomenclature of "Standardized Plant Names" as adopted by the American Joint Committee on Horticultural Nomenclature 1942 edition. All tree cultivars, patented or otherwise, must be certified by the supplying nursery. All nurseries shall be required to have a registration certificate from the Division of Plant Industry of the New York State Department of Agriculture & Markets certifying that plant material is apparently free from injurious insect and plant diseases. A similar certificate shall be required from other states where plant material is obtained.

Species selection. Species shall be selected by Parks from the list of approved street trees for New York City (Appendix A). You may only plant the species indicated on the permit and must follow any terms and conditions described on the permit. Season, site conditions, and location will affect what species may be planted.

Backfill

Material shall consist of natural loam topsoil with the addition of humus only, and no other soil type, such as a sand or clay soil type, shall be accepted. Topsoil must be free from subsoil, obtained from an area which has never been stripped. It shall be removed to a depth of one foot or less if subsoil is encountered. Topsoil shall be of uniform quality, free from hard clods, stiff clay, hardpan, sods, particularly disintegrated stone, lime, cement, ashes, slag, concrete, tar residues, tarred paper, boards, chips, sticks or any other undesirable material. Topsoil shall meet the following requirements:

a. *Organic Matter.* Backfill shall contain between 5%-9% organic matter.
b. The pH shall be in the range of 6.0 to 7.5 inclusive, unless otherwise approved or specified by the Forester.
c. *Soil Textural Analysis*. Topsoil shall consist of the following percentages of sand, silt and clay. Any soil that does not meet the requirements below will be rejected and removed from the site.

Rocks, Stone and Gravel (>2.0 mm)	<25%
Sand (0.05-2 mm)	40%-70%
Silt (0.002-0.05 mm)	10%-50%
Clay (<0.002 mm)	20% maximum

d. When the topsoil complies with the requirements of the specification but show a deficiency of not more than one percent in organic matter, it may be incorporated when and as permitted by the Forester.
e. Electrical conductivity shall be a maximum of 1.0. mmhos/cm. A higher level would indicate that the salt content is too high to be acceptable, and the soil must be removed from the site by the permit holder.

NYC Parks may require that soil be changed at the expense of the applicant and/or the tree work entity if the soil does not appear to meet Parks specifications. It is the applicant's responsibility to prove that the soil used meets Parks specifications. The applicant may provide a report from an approved lab showing a passing soil sample if they wish to show that their soil meets Parks specifications. The soil should be tested for the following: nutrients, pH, soluble salt level, organic matter content, percentages of sand/silt/clay, soil textural class, gravel content, + Extra Sieve ¼. The choice of lab must be approved in advance by the appropriate Parks Forester, and soil samples must be taken by a Parks Forester or their designate, and delivered to the lab by the Forester or their designate. Only a passing sample acceptable to the Parks Forester will exempt the applicant from having to replace the soil.

Mulch

The applicant shall furnish and place Shredded Bark Mulch in accordance with the plans, specifications and directions of the Forester. All mulching shall be done during planting operation.

Shredded Bark Mulch shall be a natural forest product composed of shredded bark or wood not exceeding 3 inches in length and 1 inch width. Mulch shall be derived from tree material, not from wood waste or by-products like sawdust, shredded palettes, or other debris. Mulch shall be natural in color and not dyed. It shall be of a uniform grade with no additives or any other treatment. Mulch with leaves, twigs, and/or debris shall not be acceptable.

Shredded Bark Mulch shall be applied as a ground cover to the surface of all planting beds at the time of planting, one year after planting when the tree stakes are removed, at the start of each watering season during the 2 year guarantee period and when the tree is watered when directed by the Forester. Shredded Bark Mulch shall be applied to a uniform depth of 3 inches and shall be so distributed as to create a smooth, level cover over the exposed soil. A gap of approximately 2 inches should be left between the Shredded Bark Mulch and the trunk of the tree to avoid mounding above the trunk flare.

Water

If conditions do not allow the use of New York City water sources, the applicant must obtain their own source of water.

Planting Specifications

Planting shall consist of excavating all tree pits, planting, and maintaining new trees of the type and size designated on the approved list. All work shall be in accordance with these specifications (Appendix E) and to the satisfaction of the Parks Forester.

If any new tree pits have to be cut, a permit must first be obtained from DOT. A permit shall be required for each block where the pavement is broken for a new pit. It is the responsibility of the applicant to notify all owners/operators of underground facilities (code 753). Owners/operators of underground facilities include but are not limited to Keyspan, Con Edison and telephone authorities. Code 753 notifications are to be made to the NYC/LI One Call Center, Briarwood Plaza, Suite 202, 36-35 Bell Boulevard, Bayside, NY 11361. Telephone No. 1-800-272-4480. A code 753 number must be obtained before any work can begin.

No pits shall be dug until proposed locations have been marked on the ground with a white ‘P’ by a Parks Forester. Once work begins, the applicant takes full responsibility for the tree pit locations. All excavated materials shall be removed from the site and disposed of properly. The area is to be made safe and secure at the end of the workday.

Site characteristics, such as overhead power lines, existing vegetation, and infrastructure items, such as curbs and sidewalks, shall be considered. Trees that grow taller than 25 feet should not be planted directly under power lines. When possible the tree leader shall be offset from power lines.

Where subsurface obstructions (vaults, utilities, sprinklers) are encountered during excavation and restrict the planting of a tree, the applicant shall restore the disturbed area to its original condition. If damage is done to an underground obstruction, it is the responsibility of the applicant to restore the site to its original condition. A new planting location will be designated if conditions permit.

Trees shall be transported and handled with utmost care to ensure adequate protection against injury and desiccation. When transported in closed vehicles, plants shall receive adequate ventilation to prevent sweating. When transported in open vehicles, plants shall be protected by tarpaulins or other suitable cover material. Balled and burlapped trees shall be set on the ground and balls covered with soil. Until planted, all materials shall be properly maintained and kept adequately watered. Applicants are liable for any damage to property caused by planting operations and related work. All disturbed areas shall be restored to their original condition.

Applicants are only permitted to occupy an 8 foot lane adjacent to the curb. Traffic shall not be blocked off at any time during planting operations. Work shall not be performed on opposite sides of the street at the same time. Existing parking regulations shall be complied within so far as "No Standing" rules apply for the time limits specified.

Planting Seasons

Trees may be planted in the fall from October 1 through December 15, and in the spring from March 1 through May 15. No planting is permitted in the summer. Please be aware of the DOT Construction Embargo from November 21 through January 2 and any other restrictions (streets may vary from year to year, please check DOT’s website).

Installation

Remove all materials from the tree pit for the full length and width of the tree pit to the depth of the tree’s root ball (Appendix E). For excavation of a lawn strip, excavate an area at least three times the diameter of the root ball in length by the width of the lawn strip (up to 3 times the diameter of the root ball), to the dimensions listed on the permit. Extreme care shall be taken to avoid excavation to a depth greater than required. The subgrade below the root ball shall be tamped slightly to prevent settlement. All ropes, stones, etc. shall be removed from the planting site before backfilling. All excavated materials shall be removed from the site and disposed of in an acceptable manner.

Place balled and burlapped material in the prepared planting pit by lifting and carrying it by the root ball so that the ball will not be loosened. Set the tree straight and in the center of the pit. All trees shall sit, after settlement, with the base of the trunk and the beginning of the roots, known

as the “trunk flare”, level with the sidewalk grade. If the top of the root ball is not consistent with this area, the depth of the planting site should be adjusted by adding or removing soil below the root ball to make the trunk flare level with the sidewalk grade.

Cut and remove rope and wire from the top 2/3 of the root ball. At least 2/3 of the burlap shall be removed from the tree pit. The remaining wires should be pulled back and the burlap adjusted to prevent the formation of air pockets. Backfilling mixture shall be loose and friable and not frozen. Soil shall be firmed at 6 to 8 inch intervals. All tree pits are to be filled with topsoil and made level with existing conditions.

Cultivate and rake over finished planting areas leaving them in an orderly condition. At no time should topsoil be mounded to cover the trunk of the tree. The trunk flare shall always be visible. Final soil level shall be flush with the surrounding sidewalk grade to prevent potential tripping hazard.

Tree Wrap

No tree trunks shall be wrapped. Remove all nursery tags and protective wrapping.

Staking

All staking shall be done during the planting operation and shall be maintained throughout the first year of the 2 year guarantee period. After the first year, the stakes must be removed.

Stakes shall be of white cedar with bark attached and shall show no sign of cracking or decay. They shall have a maximum allowable deflection of ten percent (10%). Stakes shall be cut even so they are the same height. All trees shall be supported by 2 stakes, they shall be 8 feet long; the diameter at the middle shall be not less than 2 inches nor more than 2 ¾ inches and the diameter at the butt shall not exceed 3 inches. Stakes shall be placed outside of the rootball, driven 30 inches into the ground, and shall be fastened to the tree with a suitable length of ¾” wide, flat, woven polypropylene material such as Arbortie™ as manufactured by DeepRoot®, San Francisco, CA or approved equal that is knotted around the tree stakes (Appendix E).

Unless otherwise directed, trees shall be staked as shown on the plans and in accordance with these specifications. Stakes shall be set parallel to curbs. Trees shall stand plumb after staking. Stakes and Arbortie™ shall be removed at the end of the first year of the 2 year guarantee period, unless directed otherwise by the Forester. At the time the stakes are removed any holes left by the stake shall be filled with topsoil of the same quality as that specified in Section B-Backfill.

Pruning

Pruning shall be done in accordance with ANSI A300 Part 1 Standard Practices for structural pruning. When directed by the Forester, trees shall be pruned so the resulting crown retains the growth habit of the tree species. Any and all branches interfering with or hindering the healthy growth of the tree shall be removed. All diseased branches and all dead branches shall be removed. Any branch which may be partly dead, yet has a healthy lateral branch at least one-third the diameter of the parent branch shall be removed beyond the healthy branch. All stubs or improper cuts resulting from former pruning shall be removed. All cuts shall be cleanly made with sharp tools as close to the parent trunk or limb as possible without disturbing the branch

bark ridge or callus collar. Any existing nails, spikes, wire, plastic or other materials found driven into or fastened to the trunk or branches shall be removed or if approved they shall be cut flush in a manner to permit complete healing over.

Watering

At the time of planting, the soil around each tree shall be thoroughly saturated with at least 20 gallons (20 gal) of water. Soil shall be firmed at 6-8 inch intervals and thoroughly settled with water. Water shall be free from oil, have a pH not less than 6.0 nor greater than 8.0 and shall be free from impurities injurious to vegetation. Water may be drawn from mains owned by or supplying water to the City of New York. Please contact DEP for an access permit.

Water shall not be applied in a manner which damages plants, stakes, or adjacent areas. Each tree bed shall be watered evenly in a manner which does not erode the soil or mulch. Watering shall not cause uprooting or exposure of plant roots to the air.

Mulching

Bark Mulch shall be applied as a ground cover to the surface of all planting beds at the time of planting and again after the tree stakes have been removed, one year after planting. (See p.9 for Mulch specifications).

Mulch shall be applied to a uniform depth of 3 inches and shall be so distributed as to create a smooth, level cover over the exposed soil. A gap of approximately 2 inches should be left between the mulch and the trunk of the tree to avoid mounding above the trunk flare.

Seasonal Maintenance

Watering

Watering must take place throughout the 2 year guarantee period, at least 20 gallons at approximately two week intervals from May 15 to October 31. You may need to increase or reduce the frequency of watering based on weather conditions, resulting soil water content or other factors.

Water shall not be applied in a manner which damages plants, stakes, or adjacent areas. Each tree bed shall be watered evenly in a manner which does not erode soil or mulch. Watering shall not cause uprooting or exposure of plant’s roots to the air.

Damages resulting from these operations shall be immediately repaired at the expense of the applicant.

Other Maintenance Activities

All newly planted trees shall be maintained by the tree work entity and/or applicant until 2 years after the final inspection of permitted planting (sign-off date).

Maintenance shall include weeding, cultivating, edging, pruning, adjustment and timely removal of stakes, and Arbortie™ (these must be removed after one year), repair of minor washouts,

mulching, soil replacement and other horticultural operations necessary for the proper growth of all trees, and for keeping the entire area within the planting area neat in appearance.

All planting areas shall be cultivated and weeded with hoes or other approved tools within the period from May 15 to October 31, and such cultivating and weeding shall be repeated at least every 3 weeks. Under no conditions shall weeds be allowed to attain more than 6 inches of growth.

Pit pavement shall be maintained flush with adjacent pavement during the 2 year guarantee period. At the expiration of the guarantee period, the area around the tree shall be cultivated and weed free.

Guarantee Period

All trees must be guaranteed for 2 years. All applicants and tree work entities listed on a permit shall provide a guarantee for the trees planted. Applicants are advised to ensure that their tree work entity provides a guarantee otherwise they will may be held liable under the permit for replacing the tree.

Tree Replacement

Any tree planted that is dead or, in the opinion of Parks, in an unhealthy or unsightly condition, and/or has lost its natural shape due to dead branches, excessive pruning, inadequate or improper maintenance, or other causes including vandalism, prior to final acceptance, shall be replaced in the next planting season. There shall be a 2 year guarantee on trees commencing after the final inspection of the permitted planting (sign-off date). The topsoil in the tree pit shall be changed when any replacement tree is planted.

Where dead trees have been identified, whether due to natural causes or vandalism, the dead material shall be removed, including stakes, and Arbortie™ within 30 days of notification. When necessary, topsoil, grass seed or appropriate paving material shall be added to the pit to eliminate potential tripping hazards at the time of removal. Photos must be submitted to Parks showing the proper removal of trees. A renewed permit must be obtained to replant during the planting season.

Vandalism

Where vandalism or related causes are agreed as the cause for tree replacement, the applicant shall be responsible for all necessary replacements during the 2 year guarantee period as determined by the Forester.

Finishing

Tree Pit Guards

Tree pit guards may be required by Parks. A tree pit guard is usually a cast-iron fence or wrought iron wickets, installed around a tree pit for protection. Parks recommends a low cast-iron fence or wrought-iron wickets that is 18 inches high. Tree guard posts shall be solid steel or reinforced aluminum. Tree guards must be three sided leaving the street side open and should

not be embedded into concrete. This will protect the tree from dogs and pedestrians and give it enough space to grow for many years to come.

NYC Parks has standardized and approved designs which are encouraged for all tree guard installations (Appendix D). Alternative designs may be approved on a case-by-case basis and must be three-sided, approximately 18 inches tall, with no sharp points, installed on the outer perimeter of the tree bed, and positioned at least one foot short of the curb with the curbside open. Solid walls are not permissible. Water must be able to flow into the tree bed on all sides. The applicant takes full responsibility for maintaining the tree guard in a safe condition. If the condition of the tree guard is not maintained in a safe condition the tree guard will be removed by NYC Parks. Interested parties should apply for a permit to 'Install Tree Guard' before installing a tree guard. The permit is to 'Install Tree Guard'.

Tree Grates

Sidewalk-level tree grates are not permitted.

Pavers

Pavers are also not to be used without express written permission from Parks.

Other

Never plant Ivy or woody shrubs/plants in the tree pit as they compete with the tree for vital nutrients.

APPENDICES

Appendix A

LIST OF APPROVED SPECIES

1 *Abies concolor*
2 *Acer buergerianum*
3 *Acer campestre*
4 *Acer campestre* 'Evelyn'
5 *Acer campestre* 'Metro Gold'
6 *Acer campestre* 'Queen Elizabeth'
7 *Acer ginnala*
8 *Acer ginnala* 'Flame'
9 *Acer ginnala* 'Ruby Slippers'
10 *Acer griseum*
11 *Acer palmatum*
12 *Acer pennsylvanicum*
13 *Acer pseudoplatanus* 'Atropurpureum'
14 *Acer maximowiczianum*
15 *Acer miyabe* 'State Street'
16 *Acer x freemanii* 'Armstrong'
17 *Acer x freemanii* 'Autumn Blaze'
18 *Acer rubrum* 'Bowhall'
19 *Acer rubrum* 'Frank Jr.'
20 *Acer rubrum* 'Franksred'
21 *Acer rubrum* 'Karpick'
22 *Acer rubrum* 'October Glory'
23 *Acer rubrum* 'Red Sunset'
24 *Acer rubrum* 'Redpointe'
25 *Acer x freemanii* 'Scarsen'
26 *Acer saccharinum*
27 *Acer tataricum* 'Rugged Charm'
28 *Acer tataricum* 'Pacific Sunset'
29 *Acer tataricum* 'Pattern Perfect'
30 *Acer tataricum* 'Hot Wings'
31 *Acer truncatum* 'Norwegian Sunset'
32 *Aesculus* 'Autumn Splender'
33 *Aesculus glabra*
34 *Aesculus hippocastanum* 'Baumanni'
35 *Aesculus octandra*
36 *Aesculus x carnea* 'Briotii'
37 *Aesculus x carnea* 'Fort Mcnair'
38 *Amelanchier canadensis* 'Robin Hill'
39 *Amelanchier laevis*
40 *Amelanchier laevis* 'Spring Flurry'
41 *Amelanchier lamarkii*
42 *Amelanchier x grandiflora* 'Autumn Brilliance'
43 *Amelancher x grandiflora* 'Princess Diana'
44 *Betula nigra* 'Heritage'
45 *Betula nigra* 'Duraheat'
46 *Carpinus betulus*
47 *Carpinus betulus* 'Emerald Avenue'
48 *Carpinus betulus* 'Fastigiata'
49 *Carpinus caroliniana*
50 *Carpinus caroliniana* 'Native Flame'
51 *Carpinus japonica*
52 *Catalpa ovata*
53 *Catalpa speciosa*
54 *Celtis laevigata*
55 *Celtis occidentalis*
56 *Celtis occidentalis* 'Magnifica'
57 *Celtis occidentalis* 'Chicagoland'
58 *Celtis occidentalis* 'Praire Sentinal'
59 *Cercidiphyllum japonicum*
60 *Cercis canadensis*
61 *Cercis canadensis* 'Crosswicks Red'
62 *Cercis canadensis* 'Appalachain Red'
63 *Cercis canadensis* 'Forest Pansy'
64 *Cercis canadensis* 'Hearts of Gold'
65 *Cercis canadensis* 'Royal White'
66 *Cercis canadensis* var. Alba
67 *Cercis chinensis* 'Avondale'
68 *Cercis reniformis* 'Oklahoma'
69 *Chamaecyparis obtusa* 'Crippsii'
70 *Chionanthus retusus*
71 *Chionanthus virginicus*
72 *Cladrastis kentukea*
73 *Cladrastis kentukea* 'Sweetshade'
74 *Cladrastis kentukea* 'Perkins Pink'
75 *Cornus* 'June Snow'
76 *Cornus* 'Venus'
77 *Cornus* 'Constellation'
78 *Cornus florida* 'Cherokee Sunset'
79 *Cornus florida* 'Cherokee Brave'
80 *Cornus florida* 'Cherokee Princess'
81 *Cornus kousa* 'Summer Stars'
82 *Cornus mas*
83 *Cornus mas* 'Spring Sun'
84 *Corylus colurna*
85 *Cotinus coggygria*
86 *Cotinus* 'Grace'
87 *Crataegus* 'Crimson Cloud'
88 *Crataegus crusgalli* var. inermis

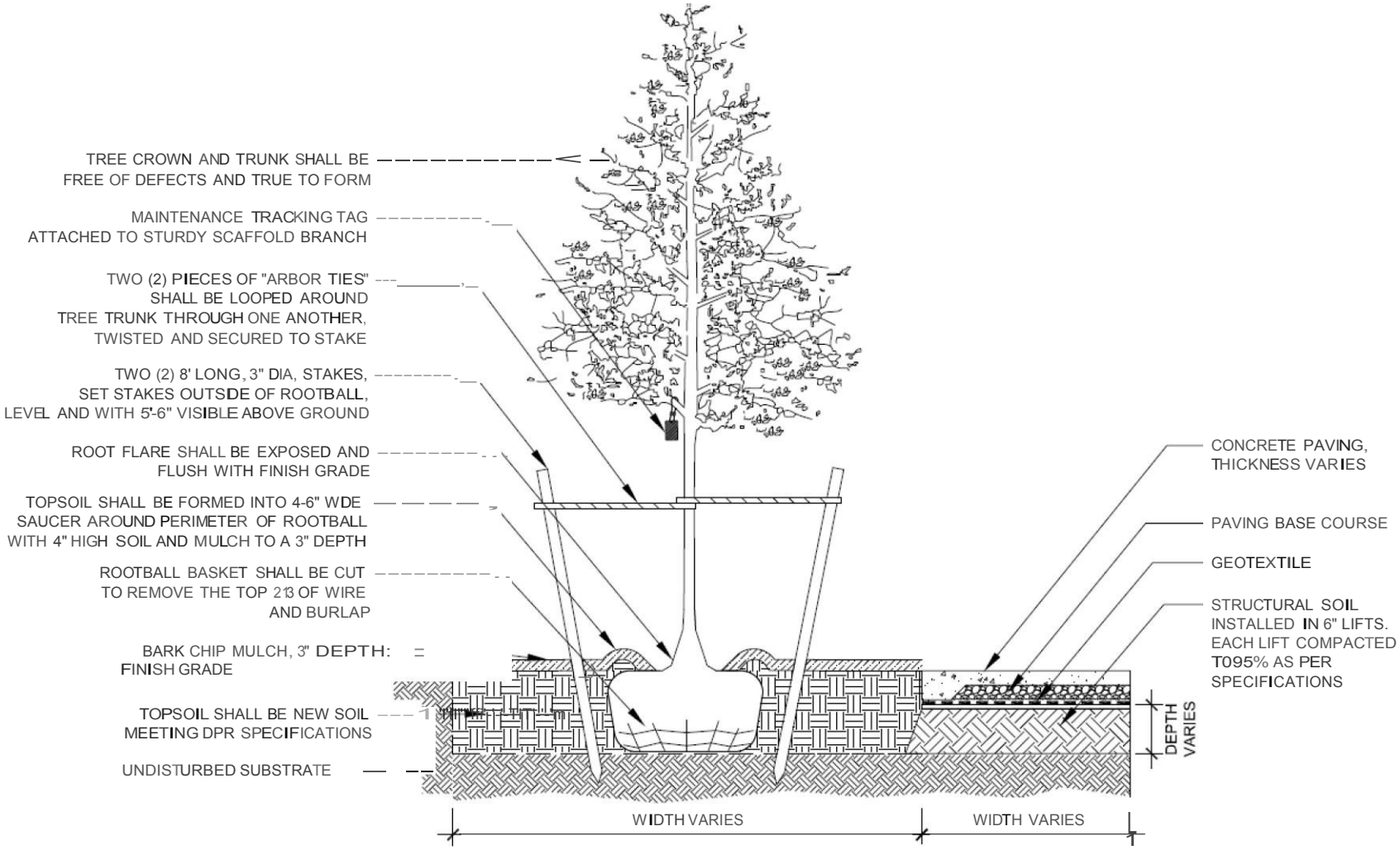
89 *Crataegus* 'Lavellus'
90 *Crataegus phaenopyrum* 'Washington'
91 *Crataegus viridis* 'Winter King'
92 *Cryptomeria japonica* 'Angelica'
93 *Cryptomeria japonica* 'Black Dragon'
94 *Cryptomeria japonica* 'Yoshino'
95 *Eucommia ulmoides*
96 *Eucommia ulmoides* 'Emerald Pointe'
97 *Eucommia ulmoides* 'Emerald Sunshine'
98 *Fagus sylvatica* 'Dawyckii Purple'
99 *Fagus sylvatica* 'Riversii'
100 *Fraxinus americana*
101 *Fraxinus pennsylvanica* 'Leprechaun'
102 *Fraxinus pennsylvanica* 'Patmore'
103 *Gingko biloba*
104 *Gingko biloba* 'Autumn Gold'
105 *Gingko biloba* 'Columnaris'
106 *Gingko biloba* 'Fairmont'
107 *Gingko biloba* 'Fastigiate'
108 *Gingko biloba* 'Magyar'
109 *Gingko biloba* 'Princeton Sentry'
110 *Gingko biloba* 'Shangri-la'
111 *Gleditsia triacanthos* var. inermis 'Draves'
112 *Gleditsia triacanthos* var. inermis 'Halka'
113 *Gleditsia triacanthos* var. inermis 'Shademaster'
114 *Gleditsia triacanthos* var. inermis 'Imperial'
115 *Gleditsia triacanthos* var. inermis 'Skyline'
116 *Gleditsia triacanthos* var. inermis 'Streetkeeper'`
117 *Gymnocladus dioicus*
118 *Gymnocladus dioicus* 'Espresso'
119 *Gymnocladus dioicus* 'Prairie Titan'
120 *Halesia carolina*
121 *Halesia carolina* 'Arnold Pink'
122 *Halesia diptera* 'Magniflora'
123 *Halesia* 'Jersey Belle'
124 *Halesia monticola*
125 *Juniperus chinensis* 'Hetzii'
126 *Juniperus chinensis* 'Ketleri'
127 *Juniperus virginiana*
128 *Koelreuteria paniculata*
129 *Koelreuteria paniculata* 'Fastigiata'
130 *Koelreuteria paniculata* 'Gold Candle'
131 *Koelreuteria paniculata* 'Rose Lanterns'
132 *Laburnum x watereri*
133 *Lagerstroemia* 'Muskogee'
134 *Lagerstroemia* 'Natchez'
135 *Lagerstroemia* 'Tuskogee'
136 *Liquidambar formosana*
137 *Liquidambar styraciflua*
138 *Liquidambar styraciflua* 'Cherokee'
139 *Liquidambar styraciflua* 'Happidaze'
140 *Liquidambar styraciflua* 'Moraine'
141 *Liquidambar styraciflua* 'Slender Sliouette'
142 *Liquidambar styraciflua* 'Worplesdon'
143 *Liriodendron tulipifera* 'Arnold'
144 *Liriodendron tulipifera* 'Emerald City'
145 *Maackia amurensis*
146 *Maackia amurensis* 'Starburst'
147 *Magnolia* 'Butterflies'
148 *Magnolia* 'Elizabeth'
149 *Magnolia macrophylla*
150 *Magnolia soulangiana*
151 *Magnolia soulangiana* 'Rustica Rubra'
152 *Magnolia* 'Wades Memory'
153 *Malus* 'Adams'
154 *Malus* 'Cardinal'
155 *Malus* 'Centurion'
156 *Malus* 'Coralburst'
157 *Malus* 'Dolgo'
158 *Malus* 'Donald Wyman'
159 *Malus* 'Harvest Gold'
160 *Malus* 'Sugartyme'
161 *Malus* 'Prariefire'
162 *Malus* 'Pink Spire'
163 *Malus* 'Robinson'
164 *Malus* 'Spring Snow'
165 *Malus* 'Sugartyme'
166 *Metasequoia glyptostroboides*
167 *Metasequoia glyptostroboides* 'Gold Rush'
168 *Nyssa sylvatica*
169 *Nyssa sylvatica* 'Forum'
170 *Nyssa sylvatica* 'Red Rage'
171 *Nyssa sylvatica* 'Wildfire'
172 *Ostrya virginiana*
173 *Parrotia persica*
174 *Parrotia persica* 'Vanessa'
175 *Parrotia persica* 'Ruby Vase'
176 *Pistache chinensis*
177 *Pistache chinensis* 'Pairs Choice'
178 *Platanus x acerifolia* 'Bloodgood'
179 *Platanus x acerifolia* 'Columbia'
180 *Platanus x acerifolia* 'Exclamation'
181 *Prunus* 'Amanowagawa'

182 *Prunus blireana*
183 *Prunus cerasifera* 'Crimson Point'
184 *Prunus cerasifera* 'Krauter Vesuvius'
185 *Prunus cerasifera* 'Mt. St. Helens'
186 *Prunus cerasifera* 'Newport'
187 *Prunus cerasifera* 'Thundercloud'
188 *Prunus cistena* 'Schmidtcis'
189 *Prunus* 'Dreamcatcher'
190 *Prunus* 'Holly Jolivette'
191 *Prunus* 'Mount St. Helens'
192 *Prunus* 'Mt Fuji'
193 *Prunus* 'Okame'
194 *Prunus padus*
195 *Prunus padus* 'Merlot'
196 *Prunus padus* 'Summer Glow'
197 *Prunus* 'Princeton Snowcloud'
198 *Prunus* 'Royal Burgundy'
199 *Prunus sargentii*
200 *Prunus sargentii* 'Columnaris'
201 *Prunus sargentii* 'Rancho'
202 *Prunus serotina*
203 *Prunus serrulata* 'Kwanzan'
204 *Prunus serrulata* 'Shirotae'
205 *Prunus* 'Snow Goose'
206 *Prunus* 'Snow Goose x copper graft'
207 *Prunus subhirtella* 'Autumnalis'
208 *Prunus virginiana* 'Canada Red'
209 *Prunus x hillieri* 'Spires'
210 *Prunus x yedoensis*
211 *Prunus x yedoensis* 'Akebono'
212 *Prunus x yedoensis* 'Cascade Snow'
213 *Quercus acutissima*
214 *Quercus alba*
215 *Quercus bicolor*
216 *Quercus coccinea*
217 *Quercus* 'Crimson Spire'
218 *Quercus dentata*
219 *Quercus ellipsodalis*
220 *Quercus frainetto*
221 *Quercus garryana*
222 *Quercus imbricaria*
223 *Quercus lyrata*
224 *Quercus macrocarpa*
225 *Quercus muehlenbergii*
226 *Quercus nuttali*
227 *Quercus palustris*
228 *Quercus palustris* 'Green Pillar'
229 *Quercus phellos*
230 *Quercus phellos* 'Hightower'
231 *Quercus prinus*
232 *Quercus* 'Regal Prince'
233 *Quercus robur*
234 *Quercus robur x bicolor* 'Kindred Spirit'
235 *Quercus robur* 'Skyrocket'
236 *Quercus robur* var. Fastigiata
237 *Quercus rubra*
238 *Quercus x comptoniae*
239 *Quercus sargentii*
240 *Quercus shumardii*
241 *Quercus texana*
242 *Quercus velutina*
243 *Robinia pseudoacacia* 'Frisia'
244 *Robinia pseudoacacia* 'Purple Robe'
245 *Sequoiadendron gigantum*
246 *Stewartia pseudocamellia*
247 *Styphnolobium japonicum* 'Millstone'
248 *Styphnolobium japonicum* 'Regent'
249 *Styrax japonica*
250 *Styrax japonica* 'Emerald Pagoda'
251 *Styrax japonica* 'Snowcone'
252 *Styrax obbasia*
253 *Syringa pekinensis* 'Beijing Gold'
254 *Syringa pekinensis* 'China Snow'
255 *Syringa pekinensis* 'Summer charm'
256 *Syringa reticulata*
257 *Syringa reticulata* 'Snowcap'
258 *Syringa reticulata* 'Ivory Silk'
259 *Taxodium ascendens* 'Nutans'
260 *Taxodium distichum*
261 *Taxodium distichum* 'Shawnee Brave'
262 *Tilia americana* 'Continental Appeal'
263 *Tilia americana* 'Legend'
264 *Tilia americana* 'McSentry'
265 *Tilia americana* 'Redmond'
266 *Tilia cordata* 'Corinthian'
267 *Tilia cordata* 'Corizam'
268 *Tilia cordata* 'Glenlevyn'
269 *Tilia cordata* 'Greenspire'
270 *Tilia cordata* 'Prestige'
271 *Tilia cordata* 'Shamrock'
272 *Tilia cordata* 'Unizam'
273 *Tilia mongolica* 'Harvest Gold'
274 *Tilia tomentosa* 'Green Mountain'
275 *Tilia tomentosa* 'Satin Shadow'
276 *Tilia tomentosa* 'Sterling'
277 *Tilia tomentosa* 'Szeleste'
278 *Tilia x euchlora*
279 *Tilia x euchlora* 'Laurelhurst'
280 *Ulmus* 'Accolade'
281 *Ulmus americana* 'Princeton'
282 *Ulmus americana* 'Valley Forge'
283 *Ulmus* 'Athena'

284 Ulmus 'Emerald Sunshine'
285 Ulmus 'Frontier'
286 Ulmus 'Homestead'
287 Ulmus 'Jefferson'
288 Ulmus 'Morton Glossy'
289 Ulmus 'New Harmony'
290 Ulmus 'New Horizon'
291 Ulmus parvifolia 'Everclear'
292 Ulmus parvifolia 'Allee'
293 Ulmus parvifolia 'Bosque'
294 Ulmus parvifolia 'Dynasty'
295 Ulmus 'Patriot'
296 Ulmus 'Pioneer'
297 Ulmus 'Prospector'
298 Ulmus 'Triumph'
299 Zelkova serrata 'City Sprite'
300 Zelkova serrata 'Green Vase'
301 Zelkova serrata 'Halka'
302 Zelkova serrata 'Mushashino'
303 Zelkova serrata 'Variegata'
304 Zelkova serrata 'Village Green'
305 Zelkova serrate 'Wireless'

Appendix B

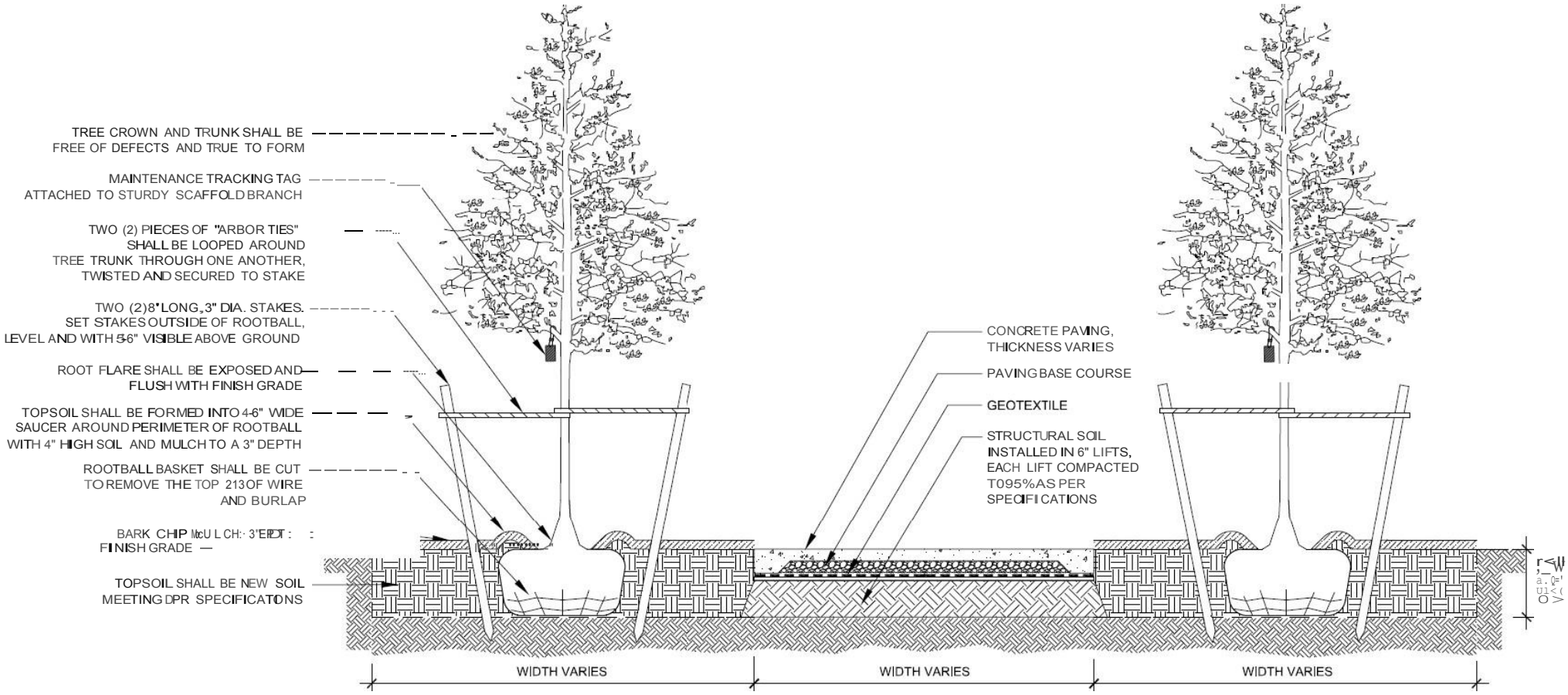
STRUCTURAL SOIL



TREE PLANTING & STRUCTURAL SOIL DETAIL

NOT TO SCALE

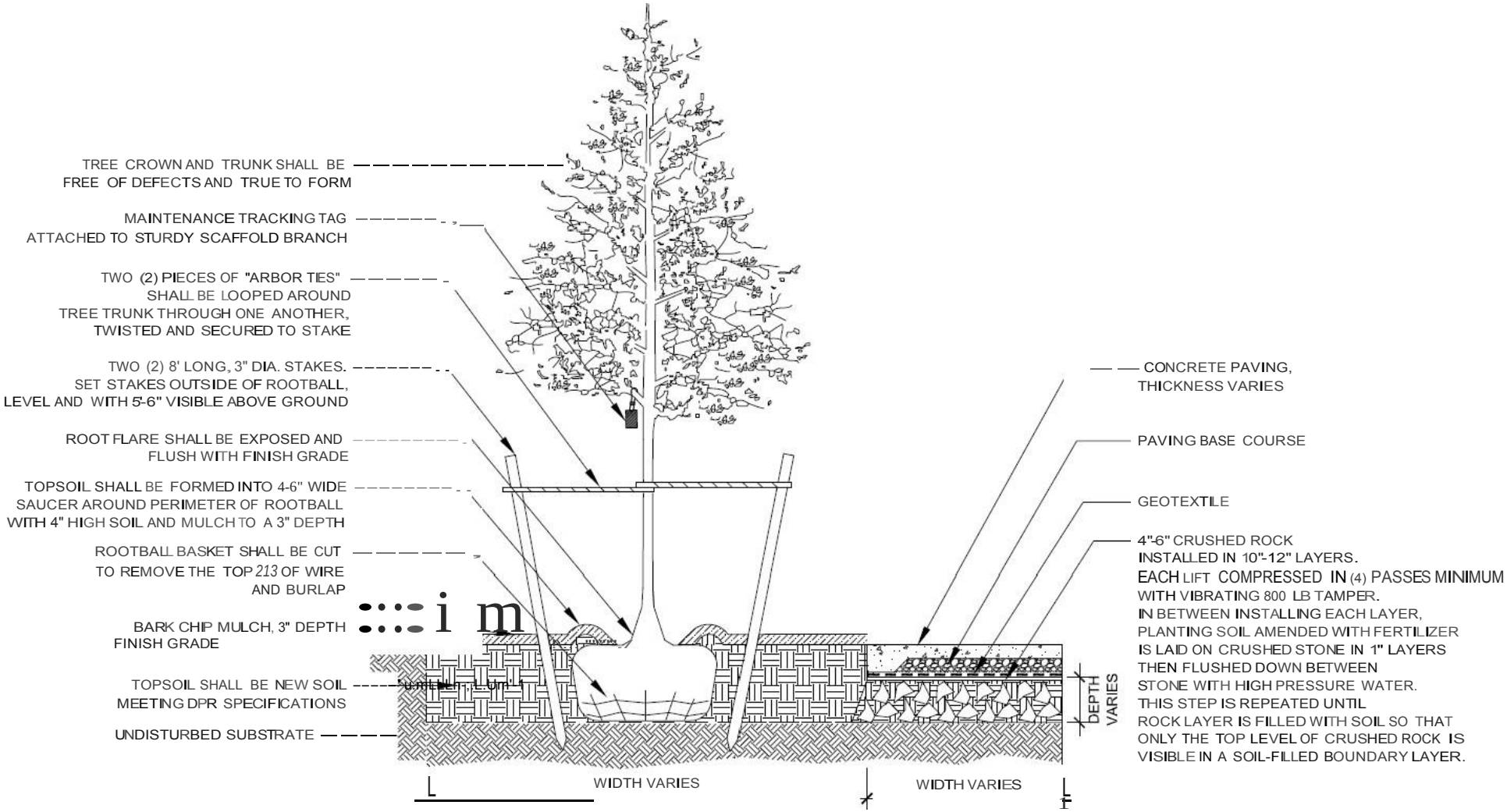
CONTINUOUS STRUCTURAL SOIL



TREE PLANTING & CONTINUOUS STRUCTURAL SOIL DETAIL

NOT TO SCALE

SWEDISH STRUCTURAL SOIL

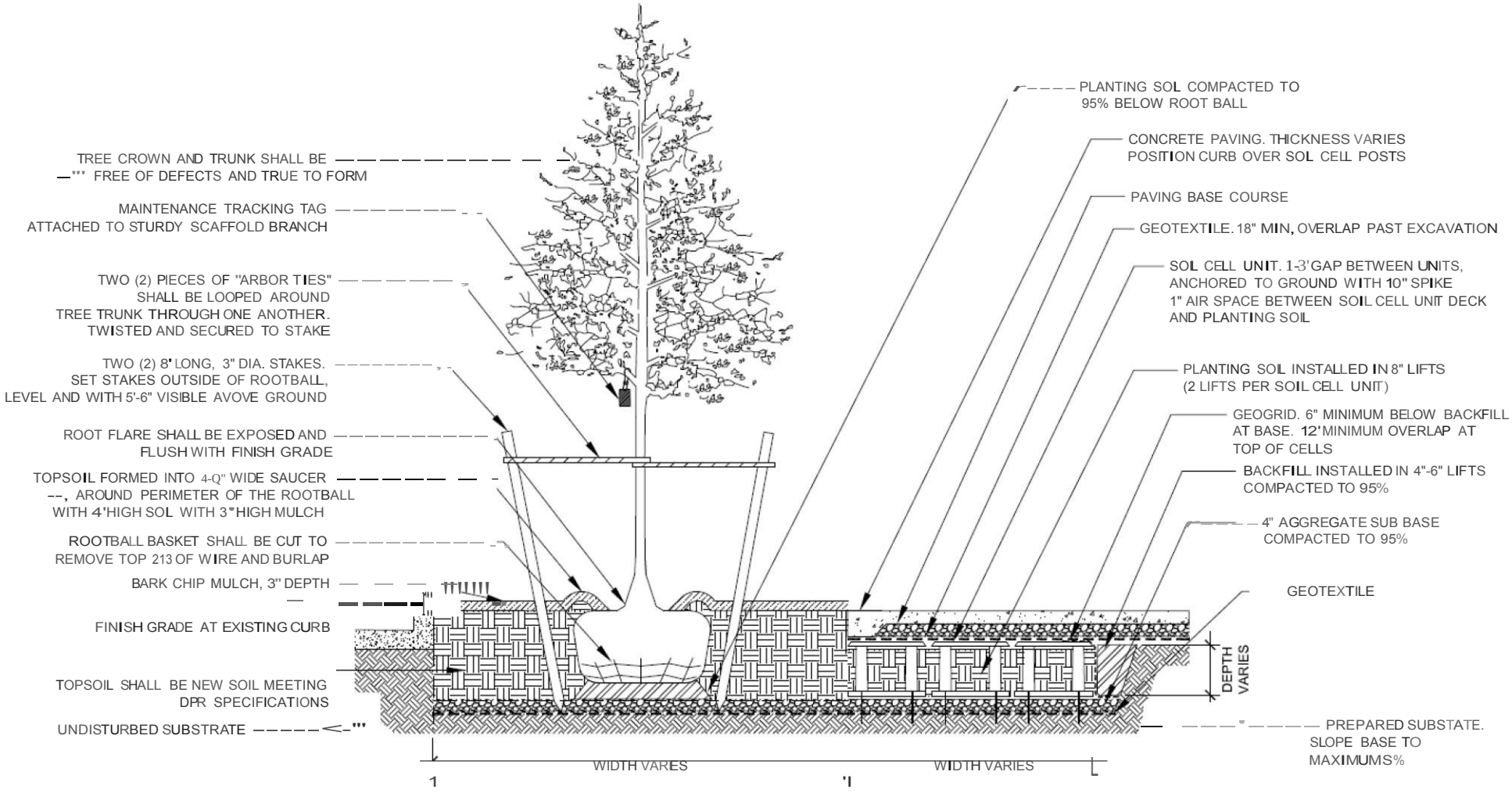


TREE PLANTING & SWEDISH STRUCTURAL SOIL DETAIL

NOT TO SCALE

Appendix C

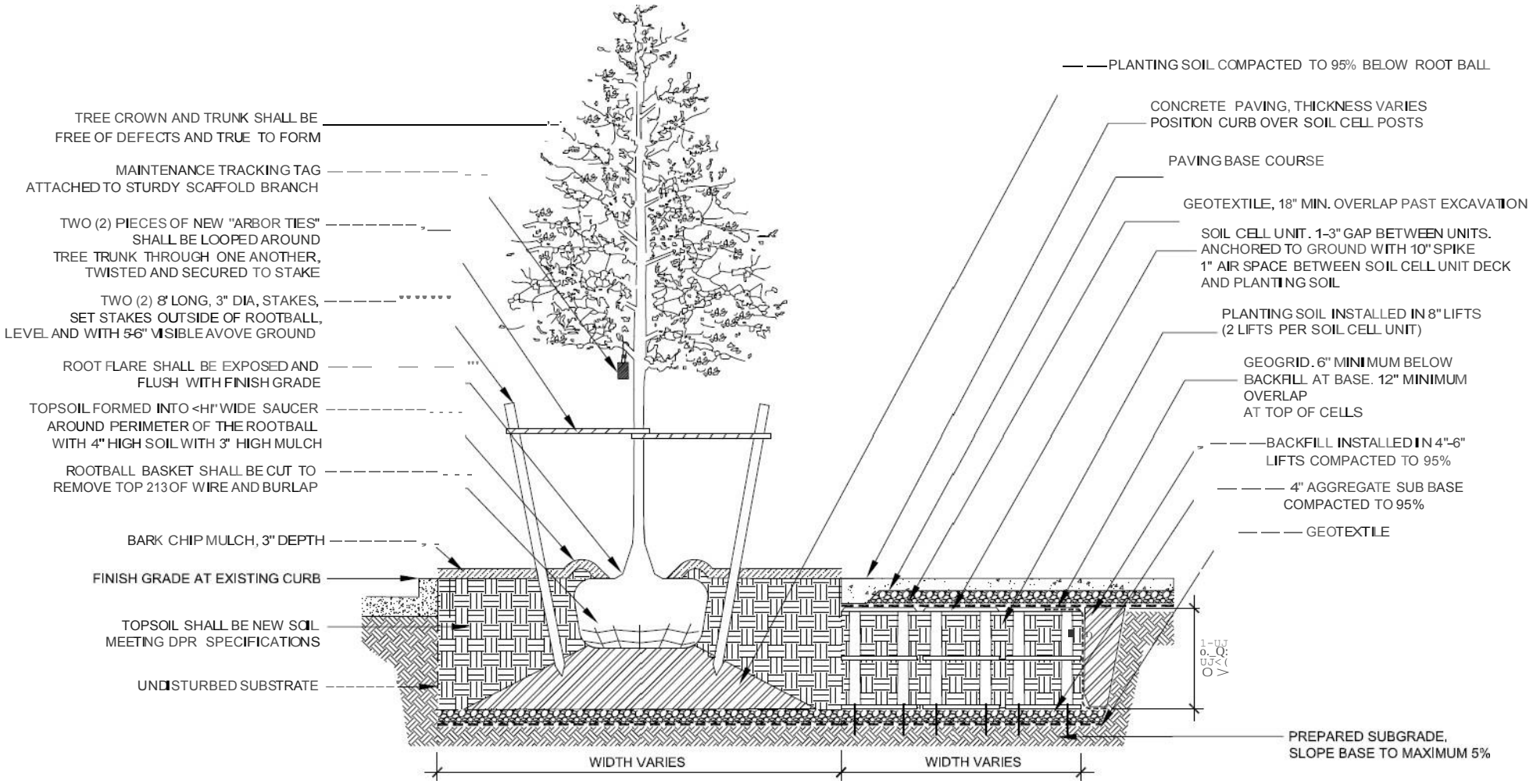
SOIL CELL UNIT IN SINGLE LAYER



TREE PLANTING & SOIL CELL UNIT IN SINGLE LAYER DETAIL

NOT TO SCALE

SOIL CELL UNIT IN DOUBLE LAYER

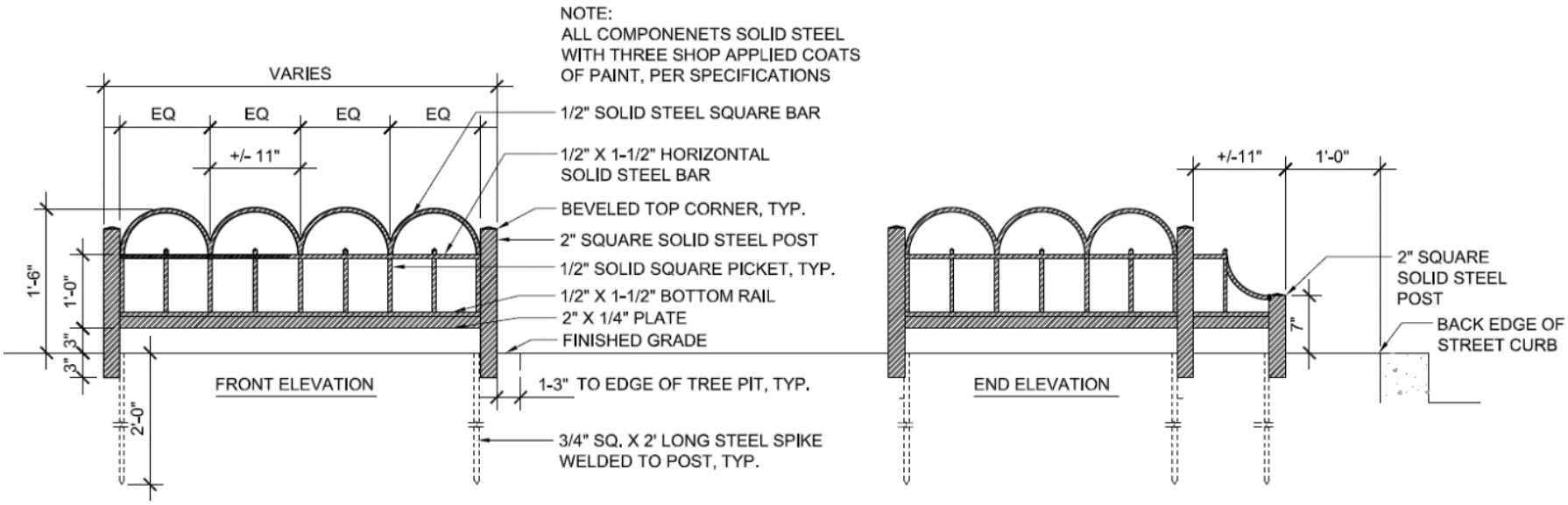


TREE PLANTING & SOIL CELL UNIT IN DOUBLE LAYER DETAIL

NOT TO SCALE

Appendix D

TREE GUARDS

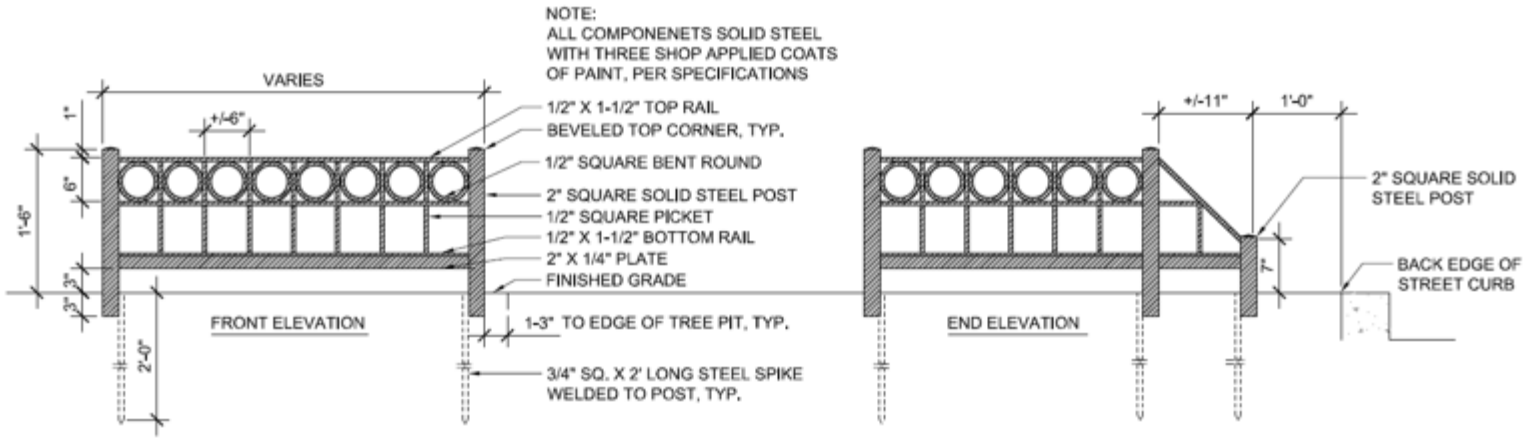


TREE PIT GUARD TYPE 'A'

NOT TO SCALE

TYPE 'A' THREE-SIDED DESIGN

NOT TO SCALE

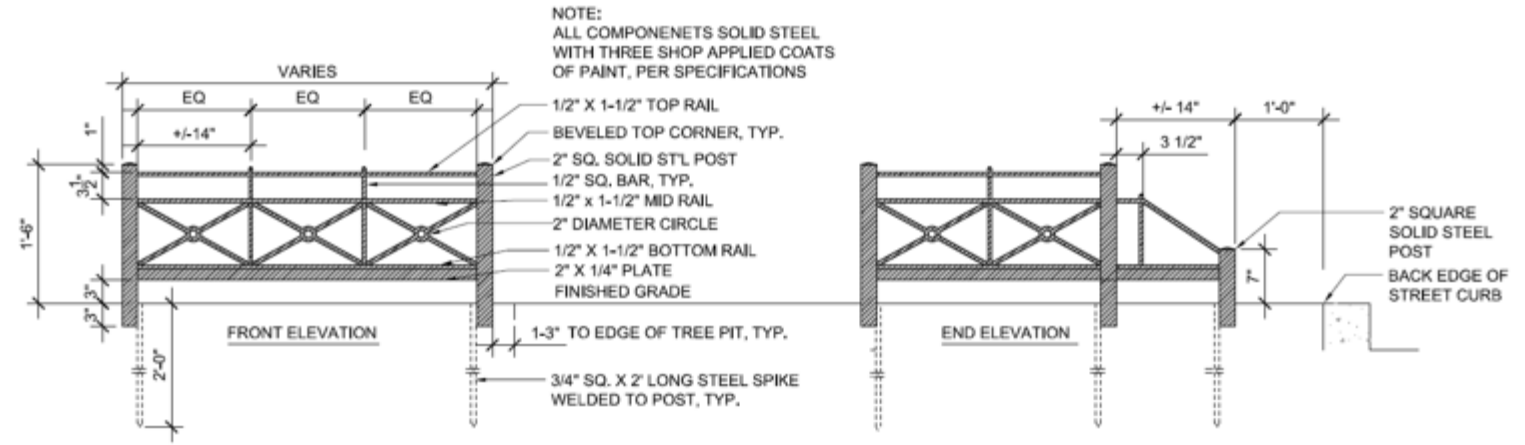


TREE PIT GUARD TYPE 'B'

NOT TO SCALE

TYPE 'B' THREE-SIDED DESIGN

NOT TO SCALE

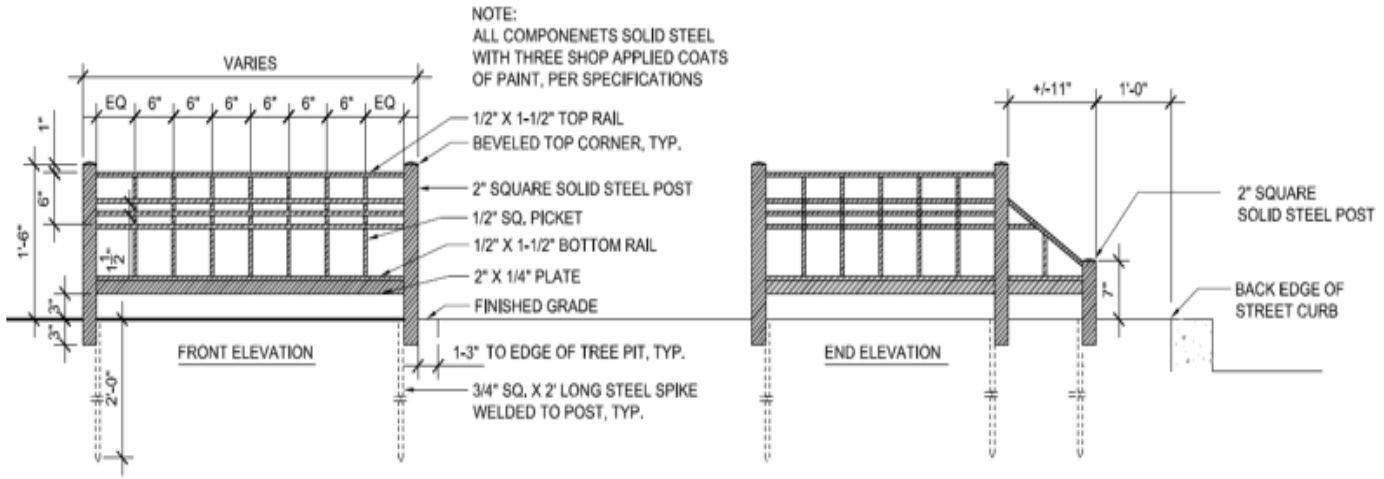


TREE PIT GUARD TYPE 'C'

NOT TO SCALE

TYPE 'C' THREE-SIDED DESIGN

NOT TO SCALE

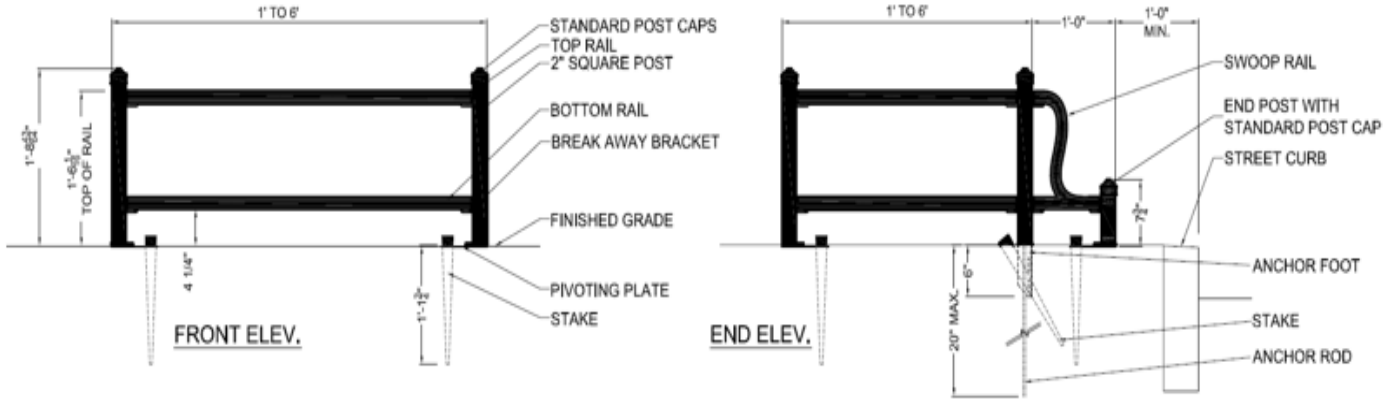


TREE PIT GUARD TYPE 'D'

NOT TO SCALE

TYPE 'D' THREE-SIDED DESIGN

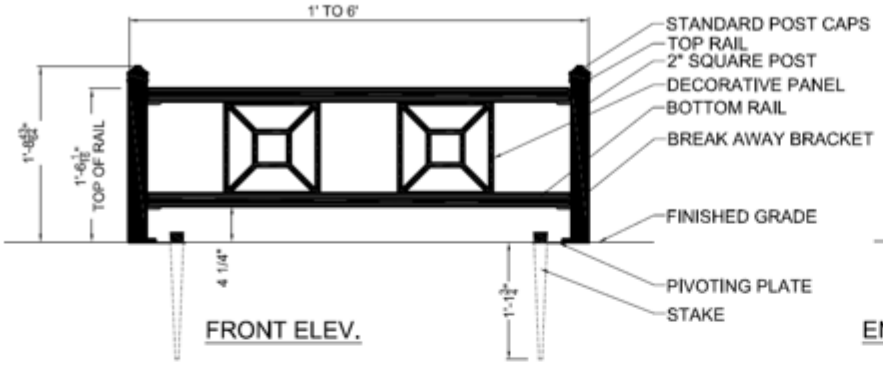
NOT TO SCALE

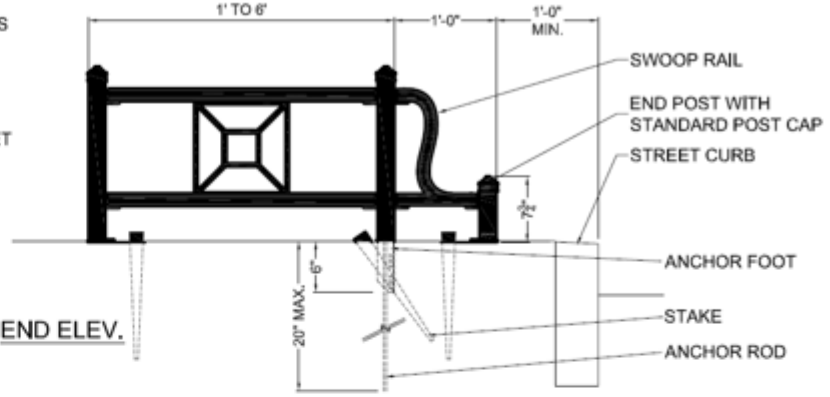


TREE PIT GUARD TYPE 'E'

SCALE: NTS

TYPE 'E' THREE SIDED DESIGN

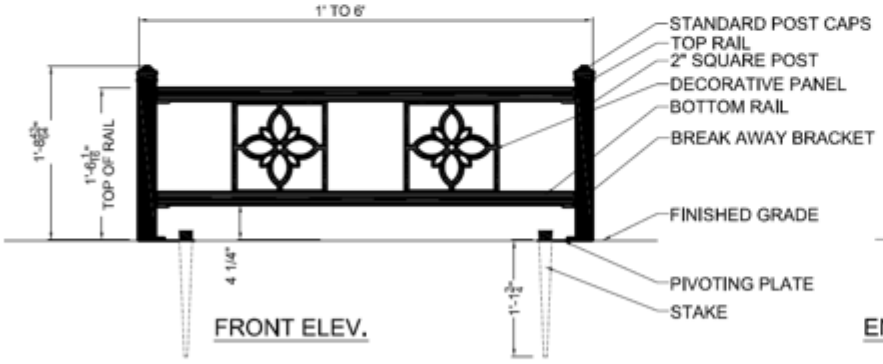


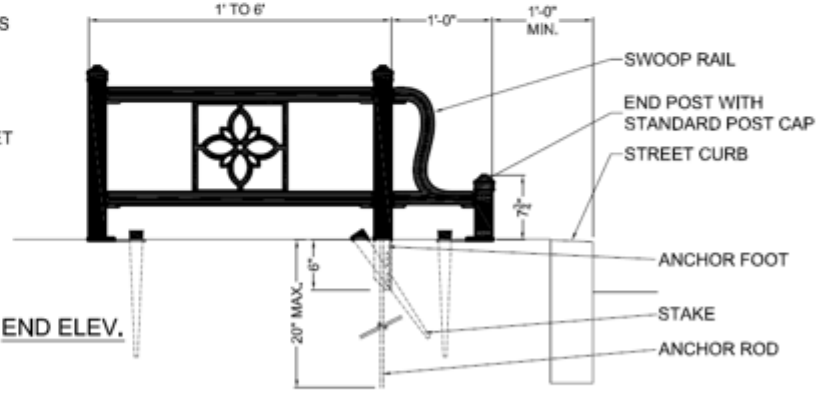


TREE PIT GUARD TYPE 'F'

SCALE: NTS

TYPE 'F' THREE SIDED DESIGN

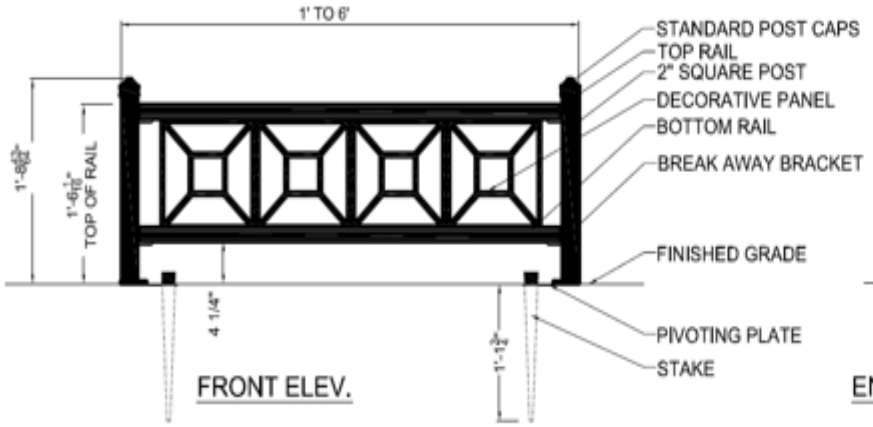


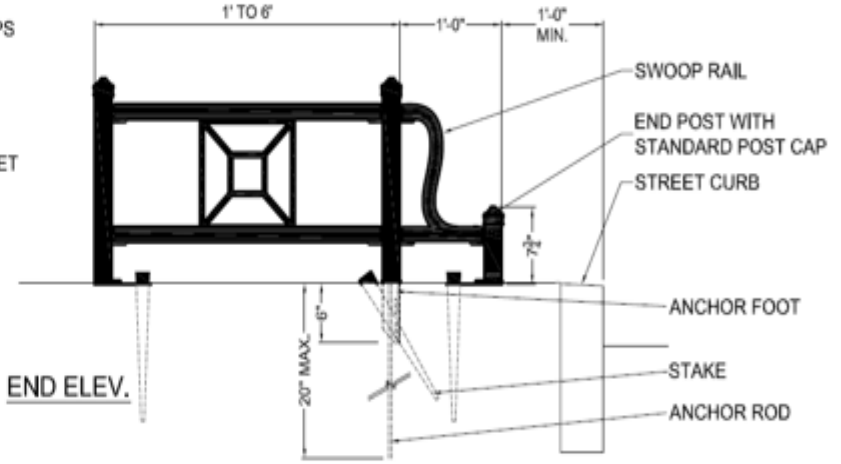


TREE PIT GUARD TYPE 'G'

SCALE: NTS

TYPE 'G' THREE SIDED DESIGN

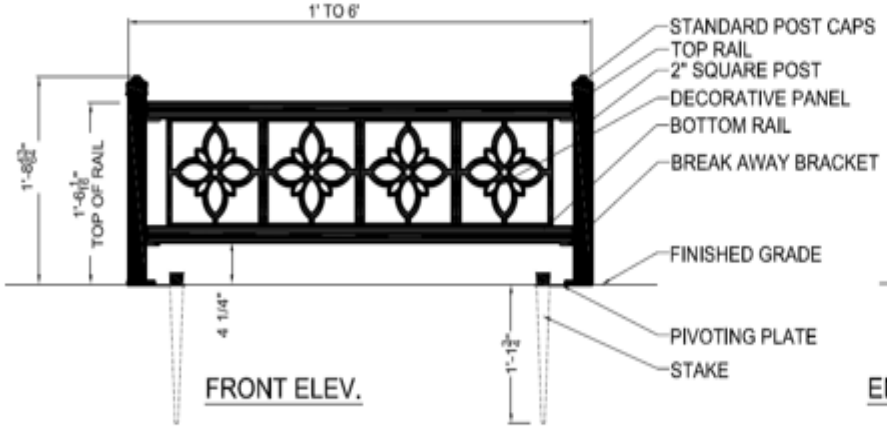


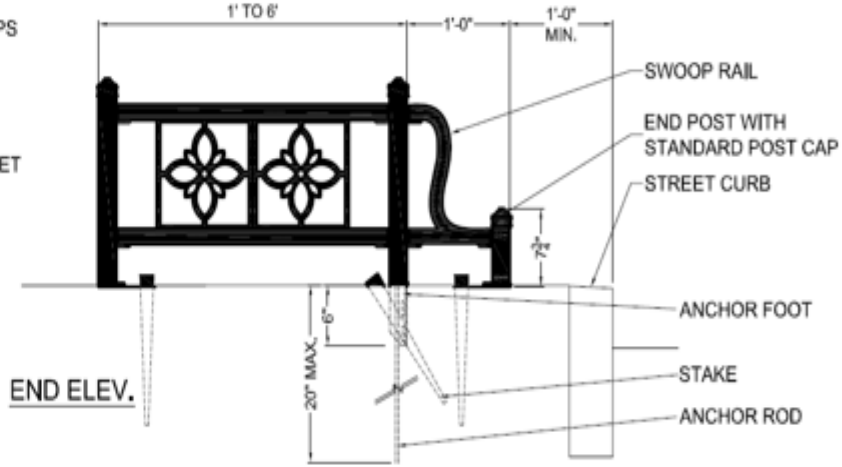


TREE PIT GUARD TYPE 'H'

TYPE 'H' THREE SIDED DESIGN

SCALE: NTS



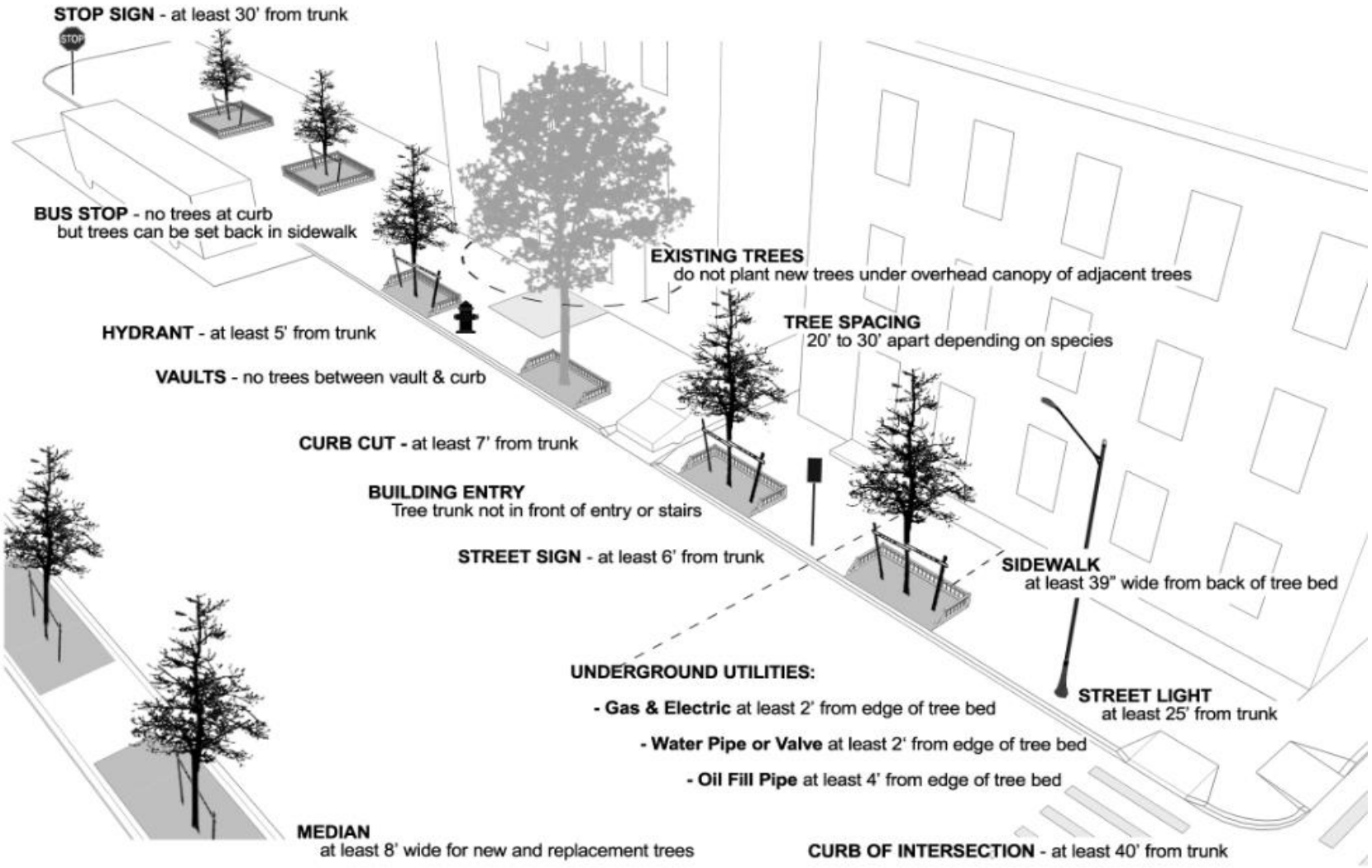


TREE PIT GUARD TYPE 'J'

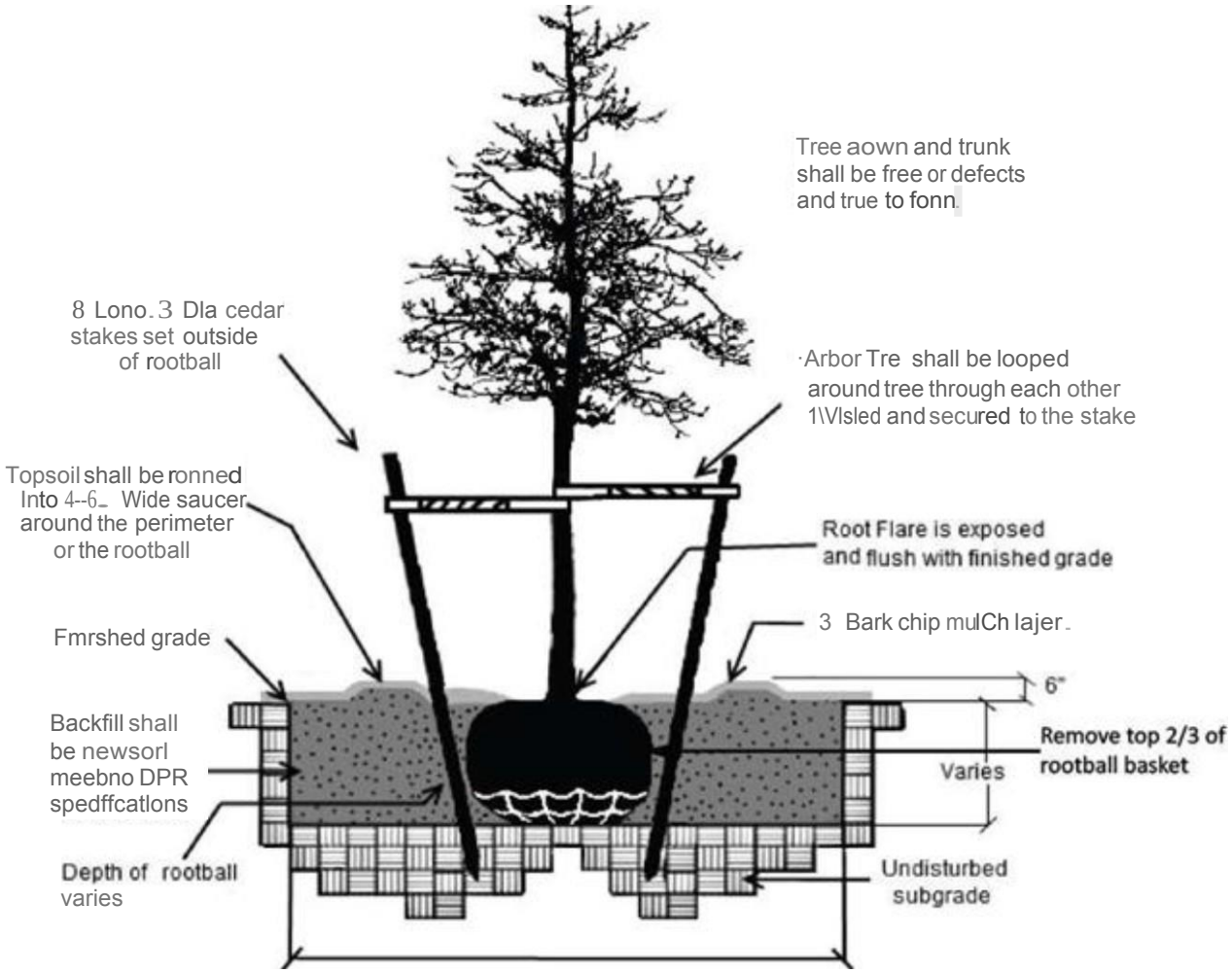
TYPE 'J' THREE SIDED DESIGN

SCALE: NTS

Appendix E


STOP SIGN - at least 30' from trunk
BUS STOP - no trees at curb
but trees can be set back in sidewalk
EXISTING TREES
do not plant new trees under overhead canopy of adjacent trees
HYDRANT - at least 5' from trunk
TREE SPACING
20' to 30' apart depending on species
VAULTS - no trees between vault & curb
CURB CUT - at least 7' from trunk
BUILDING ENTRY
Tree trunk not in front of entry or stairs
STREET SIGN - at least 6' from trunk
SIDEWALK
at least 39" wide from back of tree bed
UNDERGROUND UTILITIES:
- Gas & Electric at least 2' from edge of tree bed
- Water Pipe or Valve at least 2' from edge of tree bed
- Oil Fill Pipe at least 4' from edge of tree bed
STREET LIGHT
at least 25' from trunk
MEDIAN
at least 8' wide for new and replacement trees
CURB OF INTERSECTION - at least 40' from trunk

Appendix F



Tree Planting & Stake Detail

Not to Scale

APPENDIX five

NYC DOT REVOCABLE CONSENT RULES

New York City

Department of Transportation

REVOCABLE CONSENT RULES

Title 34
Chapter 7
Rules of the City of New York

March 7, 2016

Due to recent legislative changes, certain cross references to the Administrative Code contained in these Rules may be inaccurate.

Title 34 **3/7/2016**
Department of Transportation
Chapter 7
Revocable Consent Rules

CONTENTS

Section 7-01
Definitions

Administrative Code. “Administrative Code” means the Administrative Code of the City of New York.

Charter. “Charter” means the New York City Charter.

Commissioner. "Commissioner" means the Commissioner of the Department of Transportation of the City of New York or his or her designee.

Department. "Department" means the Department of Transportation of the City of New York.

DCP. “DCP” means the Department of City Planning of the City of New York.

DoITT. “DoITT" means the Department of Information Technology and Telecommunications of the City of New York.

Improvement. "Improvement" means a tangible thing or object which may be installed on, over or under a street, or any private use of a street.

Public Service Corporation. "Public Service Corporation" means an entity subject to the jurisdiction of the Public Service Commission under the Public Service Law.

Revocable Consent. "Revocable consent" means a grant of a right, revocable at will, (1) to any person to construct and use for private use pipes, conduits and tunnels under, railroad tracks upon, and connecting bridges over inalienable property, (2) to an owner of real property or, with the consent of the owner, to a tenant of real property to use adjacent inalienable property for the purposes stated in section 7-04 hereof or as may be permitted by rules of DoITT, or (3) to a public service corporation for facilities ancillary to, but not within, a franchise granted prior to July 1, 1990.

ULURP. “ULURP” means the Uniform Land Use Review Procedure as set out in sections 197-c and 197-d of the Charter.

Section 7-02
Requirement to Obtain a Revocable Consent

With the exception of the city of New York and/or its agents, no person or entity shall install or maintain any of the improvements listed in section 7-04 of these rules without first obtaining a revocable consent from the Department. The Department shall not issue a revocable consent for any improvement which, in the judgment of DCP, has land use impacts or implications, unless such revocable consent has been reviewed and approved pursuant to ULURP. Revocable consents may not be assigned, transferred or otherwise conveyed without the prior written approval of the Commissioner.

Section 7-03
DCP Review

(a) The Department shall submit to DCP petitions for those improvements listed in §7-04(a) of these rules that do not meet the locational or dimensional standards in such section 7-04(a). The Department shall also submit to DCP all petitions for the following improvements: bridge, above-ground cable, guard booth, information sign/kiosk, parking area for private use, and above-ground pipe/fuel line.

(b) DCP shall review each petition submitted by the Department to determine whether or not a proposed revocable consent has land use impacts or implications and whether, as a result, ULURP applies, and shall notify the Department of its determination. The Department shall notify the petitioner of the determination by DCP regarding the applicability of ULURP and shall stay its final decision pending ULURP approval.

(c) If ULURP is required, the petitioner shall obtain information and application forms pertaining to ULURP from DCP and file a ULURP application with DCP in accordance with the rules governing ULURP.

(d) No revocable consent shall be granted by the Department if the application for such consent has been disapproved pursuant to ULURP. A revocable consent may be granted by the Department if the application for such consent has been approved pursuant to ULURP or if DCP determines the proposed improvement has no land use impacts.

(e) The Department shall submit to DCP for review any petition for a renewal or amendment for an improvement listed in section 7-04(a) of these rules where:

(1) such renewal or amendment includes a modification that does not meet a locational or dimensional standard in section 7-04(a) or increases the degree of non-compliance with such locational or dimensional standard; or

(2) such petition is for a bridge, above-ground cable, guard booth, information sign/kiosk, parking area for private use, above-ground pipe/fuel line, and the renewal or amendment includes a modification to the location or an increase in the dimension of such improvement; or

(3) such petition is for a renewal or amendment of a consent that was approved by the City Planning Commission for a specific term, and the renewal or amendment would extend the consent beyond the term approved by the Commission.

Section 7-04
Eligible Improvements; Standards; Annual Rates.

(a) The Commissioner may, in his or her discretion, grant, renew, modify, or rescind revocable consents for any of the improvements listed in this subdivision to be constructed or maintained on, over, or under City streets, in accordance with the requirements set forth in section 364 of the Charter. Except as otherwise provided, annual compensation for the improvements listed in this subdivision shall be as set forth herein and, unless otherwise provided, shall not increase during the term of the revocable consent.

(1) **Accessibility Lift to Provide Access for People with Disabilities**

(i) Standard.
The lift shall be stored at the building end of its run and shall include appropriate safety devices. The lift shall not extend more than five and one half feet in the direction of the curb from the base of the steps when in use. In no instance shall the lift or any portion thereof extend beyond the curbline when in use.

(ii) Annual rate. $25. The annual fee for an accessibility lift shall be in addition to the normal fee for a stoop or stairway.

(2) **Bench**

(i) Standard.
No bench shall be greater than six feet in length. Benches greater than four feet in length shall be designed to discourage people from reclining. Benches adjacent and parallel to the building shall be installed no more than six inches from the building face and, if multiple benches are installed, they shall be at least three feet apart. A bench which is not anchored to the sidewalk shall be placed against the building face during hours that the benefited property is open to the public and shall be stored inside the building when the building is closed.

(ii) Annual rate. $150

(3) **Bridge**

(i) To be referred to DCP to determine whether the improvement has land use impacts.

(ii) Annual rate. See section 7-10. If the structure is not in use, the rate shall be 10% of the rate in effect pursuant to the formulas described in section 7-10.

(4) **Cable, above-ground**

(i) To be referred to DCP to determine whether the improvement has land use

impacts.

(ii) Annual rate. See section 7-10.

(5) **Cellar door, including stair**

(i) Standard. All cellar doors required by section 27-292(b) (4) of the Administrative Code shall be constructed pursuant to the requirements of the Administrative Code.

(ii) Annual rate. See section 7-10.

(6) **Clock**

(i) Standard. The base shall be no more than 18 inches in diameter. The lowest portion of the clock face shall be at least eight feet above the sidewalk. The overall height of the clock shall not exceed 15 feet. The clockface shall be no more than two feet in diameter. Time shall be maintained accurately. The name or logo and address of the adjacent premises may be displayed on the clockface; however, the total display space shall be no greater than one third of the square footage of the clockface.

(ii) Annual rate. $300

(7) **Conduit and underground cable**

(i) Standard. All conduits shall be underground.

(ii) Annual rate. See section 7-10.

(8) **Electrical socket**

(i) Standard. All electrical sockets shall be installed pursuant to the requirements of the New York City Department of Buildings.

(ii) Annual rate. $25

(9) **Enclosure for trash receptacle, adjoining a building, for private use**

(i) Standard. The enclosure shall be of non-flammable construction and shall be rodent proof. The enclosure shall be between three feet and five feet high, except in areas in the Bronx, Queens, Brooklyn and Staten Island zoned for manufacturing, mixed-use (MX), special purpose districts which allow manufacturing, or for automotive or other heavy commercial uses (C8), where the enclosure shall be between three feet and ten feet high, and shall be securely

affixed to the sidewalk, fence, building, or other appropriate fixture.

(ii) Annual rate. The greater of $5 per square foot of area, as projected onto a horizontal plane or $25, except in areas zoned for manufacturing, where the annual rate shall be $1 per square foot of area, as projected onto a horizontal plane.

(10) **Fenced or walled-in area, including the enclosing structure, not used for planting or parking, including a fenced or walled-in area containing a drainage basin or a shopping cart storage area.**

An area enclosed by a privately installed guard rail shall be deemed a fenced-in area and shall be subject to the standards below. Fences may be approved for no more than one year pursuant to the provisions in section 2-10(j) of Chapter 2 of this Title 34, provided the placement of such fences is for temporary security purposes.

(i) Standard.

(A) The fence shall be no fewer than three and no greater than four feet high in residential and commercial zoning districts and shall be no fewer than three and no greater than ten feet high in manufacturing zoning districts, as such zoning districts are set forth in the Zoning Resolution, except that athletic play field fences may extend as high as 15 feet. Smooth edged finials may be attached to fence posts up to a maximum height of four feet, six inches in residential or commercial zoning districts. No chisel points or spikes shall be included on fences shorter than eight feet, except as approved by the Landmarks Preservation Commission.

(B) The fence shall be constructed of non-flammable, non-wood material. The use of opaque material (such as masonry) is limited to the base of the fence up to 21 inches in height and to vertical columns spaced at least five feet apart. Solid or opaque materials may comprise no more than 35 percent of the total vertical area of the fence above any opaque base. For metal fences, picket interspaces shall measure between four and five and three quarters inches, and picket width may measure up to one inch wide. Chain-link, where approved, shall have a two inch mesh and shall not include screening. Barbed wire is permitted in manufacturing zoning districts only. Razor wire is prohibited.

(C) No sign shall be attached to a fence.

(ii) Annual rate.

(A) Except as provided in section 7-04(a)(10)(ii)(B), below, the first year's annual rate shall be the greater of $1,500 or (C x L x 0.16 x A), as defined in section 7-10(a) of these rules, and subsequent years' rates shall be determined in accordance with section 7-10(c) of these rules.

(B) For non-commercial use connected to a residential building of six or fewer units, the greater of $100 or (C x L x 0.01 x A), as defined in section 7-10(a) of these rules.

(11) **Flagpole**

(i) Standard. The base shall be no larger than 18 inches in diameter and no fewer than 30 inches in height.

(ii) Annual rate. None (pursuant to section 19-125(e) of the Administrative Code).

(12) **Guard booth**

(i) To be referred to DCP to determine whether the improvement has land use impacts.

(ii) Annual rate. See section 7-10.

(13) **Information sign or kiosk**

(i) To be referred to DCP to determine whether the improvement has land use impacts.

(ii) Annual rate. See section 7-10.

(14) **Litter receptacle for public use**

(i) Standard. The litter receptacle shall be constructed of non-flammable, non-wood material and shall be securely affixed to the sidewalk or sufficiently heavy to prevent movement without considerable force. The minimum height of the receptacle shall be two feet, six inches, the maximum height shall be four feet and the maximum width shall be three feet, with an overall area not to exceed nine square feet. No side of the receptacle shall exceed three feet in width. The litter receptacle may include the grantee's logo and/or building or institution name no greater than one square foot in size, if the receptacle is adjacent to the named property.

(ii) Annual rate. $25

(15) **Overhead Building Projection in excess of that allowed by the Administrative Code**

(i) Standard. Overhead building projections shall be permitted over the street provided the minimum height above the sidewalk is ten feet and the depth of the projection does not exceed three feet, ten inches, inclusive of any depth permitted by section 27-313(a) of the Administrative Code, to a height 30 feet above the sidewalk. Above 30 vertical feet the permitted depth shall be four feet ten inches, inclusive of any depth permitted by the Administrative Code. Except for architectural details such as cornices, brackets and belt courses, which may extend

across the full street frontage of a building, projections shall not have an aggregate width at any level of the building greater than 50 percent of the building frontage. Projections containing floor area shall be referred to DCP.

(ii) Annual rate. See section 7-10.

(16) **Parking area for private use for non-residential property (if there is no charge to vehicle operator)**

(i) To be referred to DCP to determine whether the improvement has land use impacts.

(ii) Annual rate. The first year's annual rate shall be the greater of $600 or (C x L x 0.36 x A), as defined in section 7-10(a) of these rules, and subsequent years' rates shall be determined in accordance with section 7-10(c).

(17) **Pipe or fuel pipeline, above-ground**

(i) To be referred to DCP to determine whether the improvement has land use impacts.

(ii) Annual rate. See section 7-10. If the grantee is not using the structure, the Department may set rates without reference to the formulas described in section 7-10.

(18) **Planted area, including any surrounding fence or wall**

(i) Standard. Live vegetation shall occupy 80 percent of the area. No vegetation may overhang a sidewalk beyond the boundary of the planted area, including any fence, unless the overhanging vegetation is at least eight feet above the adjacent sidewalk area. No rocks, timbers, wickets (hoops) or other trip hazards shall serve as a border. Any surrounding fence or wall shall conform to the standards provided in item (10), above.

(ii) Annual rate. The greater of $2 per square foot of area, as projected onto a horizontal plane, or $25

(19) **Planters.**

(i) Standard.

(A) The planter shall be no fewer than 18 and no greater than 48 inches high. The maximum area, measured at the planter's widest point, shall be 25 square feet, and the maximum dimension of the planter shall be five feet along the side which is perpendicular to the curb or eight feet along the side which is parallel to the curb. (Planters installed against the building face may be continuous.)

(B) If a planter is proposed to be placed above a sidewalk vault, a professional engineer shall certify that the sidewalk can support a 600-pound per square foot live load.

(C) No planter shall be constructed of wood. Wood cladding of other planter types is permitted if such cladding is fireproof and graffiti resistant. Concrete tubs, two inches thick, are recommended.

(D) The Department recommends the planting of small shrubs and flowers as they require less maintenance and are hardier than small trees. No woody growth shall overhang the edge of the planter. Suggested tree species for planters are: Crab Apples - (Florida Snow Drift); Euonymus Pateris (Shrub); Taxus O. Densifornius (Japanese Yew); Scotch Pine; Austrian Pine; Ilex Meserva; Cornus Mass (Corneliean Dogwood); Syringia Reticulata (Japanese Tree Lilac); Prunus Sargentii (Columnaris); Acer Ginnala (Amur Maple); Acer Truncatum; Viburnum Sieboldii (Tree Form Viburnum).

(E) Planters shall be maintained, shall contain live plants at all times and shall be kept free of debris and graffiti.

(ii) Annual rate. The greater of $2 per square foot of area as projected onto a horizontal plane, or $25 per planter.

(20) **Post, pole or bollard not otherwise governed by permit procedures contained in section 19-125 of the Administrative Code**

(i) Standard. The post, pole or bollard shall be no fewer than 30 inches high, no greater than 48 inches high, and no greater than 18 inches in diameter. If more than one post, pole or bollard is to be installed, they shall be at least four feet apart and shall not be joined with horizontal members. If a concrete-filled pipe design is used, it shall be capped or smoothed.

(ii) Annual rate.

(A) $125 each, minimum of $500 per consent.

(B) Post, pole or bollard adjacent to a building containing a marquee pursuant to a permit granted by the Department of Buildings, $25 each, minimum of $100 per consent.

(21) **Public service corporation facility ancillary to, but not within, a franchise granted prior to July 1, 1990**

(i) Standard. Refer to standards in this section for individual structures.

(ii) Annual rate. See section 7-10. When calculating the annual rate pursuant to this paragraph, “E” will be reduced by 15%. This rate shall not apply to revocable consents approved as provided in subdivision (b) of this section.

(22) **Railroad tracks for private use**

(i) Standard. Railroad tracks shall be located in an M or C8 zoning district outside any area improved for vehicular or pedestrian use, except that tracks may cross an existing or future driveway with the permission of the property owner served by such driveway.

(ii) Annual rate. The first year's annual rate shall be the greater of $500 or (C x L x 0.04 x A), as defined in section 7-10(a) of these rules, and subsequent years' rates shall be determined in accordance with section 7-10(c).

(23) **Ramp intended to provide access for people with disabilities**

(i) Standard.

(A) The Department may grant a revocable consent for a ramp which extends more than 44 inches from the building line for buildings erected prior to December 6, 1969, including any additional steps attached or ancillary to the ramp structure made necessary by the creation of the ramp. (Section 27-308 of the Administrative Code permits ramps to extend up to 44 inches from the building line for such buildings.) (Buildings erected after December 6, 1969 must contain ramps within the property line.)

(B) In the case of buildings erected between December 6, 1969 and September 5, 1987, the Department may grant a revocable consent for a ramp which extends more than 44 inches from the building line if the ramp will make a primary entrance to the building accessible.

(C) The ramp shall conform to the standards of the Americans with Disabilities Act, 36 CFR Part 1191, and section 27-308 of the Administrative Code. A canopy may be erected above the ramp provided such canopy does not fully enclose the ramp and provided such ramp is adequately illuminated and complies with all other applicable regulations.

(ii) Annual rate. $25

(24) **Retaining Walls**

(i) Standard. Retaining walls may be constructed only where warranted by existing grade or by a change in grade undertaken with prior approval by the Department of Buildings.

(ii) Annual rate. See section 7-10.

(25) **Sidewalk plaque or logo**

(i) Standard. The size of the logo or plaque shall not exceed nine square feet with a maximum dimension of three feet along any side. The plaque or logo shall be limited in design and content to a symbol or other element referring to or naming the adjoining property owner, a district organization, the district/neighborhood character, or consistent with an area-wide way-finding

graphic design system. The plaque or logo shall consist of material that provides a stable, firm and slip-resistant surface and shall be installed flush with the sidewalk surface.

(ii) Annual rate. $300 per plaque or logo.

(26) **Socket with removable poles, posts, or similar devices, including any connecting devices such as ropes, ribbons, horizontal poles, and the area thereby enclosed**

(i) Standard. Sockets shall be flush with the sidewalk and fitted with spring-mounted flush covers. Posts or poles shall be no fewer than 30 inches and no greater than 48 inches high, including any connecting devices.

(ii) Annual rate. The first year's annual rate shall be the greater of $750 or (C x L x 0.16 x A), as defined in Section 7-10(a) of these rules, where A is the area of the enclosed area, and subsequent years' rates shall be determined in accordance with section 7-10(c).

(27) **Stoop, step, ramp, vestibule or other entrance detail extending beyond limits set in Articles 8 and 9 of Subchapter 4 of Chapter 1 of Title 27 of the Administrative Code, other than a ramp described in section 7-04(a)(23) hereof or a stoop or other improvement described in section 7-04(a)(29) hereof**

(i) Standard. Such structures shall be constructed pursuant to the requirements of the New York City Department of Buildings and shall have a maximum width of eight feet and shall extend as far as such structures on adjacent buildings.

(ii) Annual rate. See section 7-10.

(28) **Stoop or any other improvement eligible for a revocable consent pursuant to these rules and adjacent to a building which is located within a designated New York City historic district or which is a designated New York City Landmark.**

(i) Standard. No revocable consent shall be granted for such a structure located in a designated New York City historic district or attached to a designated New York City landmark building without the prior written approval of the Landmarks Preservation Commission pursuant to Chapter 3 of Title 25 of the Administrative Code. Refer to standards in this section for individual structures.

(ii) Annual rate. $25 for residential buildings with fewer than six units. For all other buildings, see the appropriate paragraph of this subdivision.

(29) **Street lamp or light fixture**

(i) Standard. Street lamps or light fixtures which replace or augment existing lighting shall be placed and illuminated as approved by the Department's Division of Street Lighting. The base shall be no greater than 18 inches in diameter. Hours of illumination shall coincide with those of the City's street lights.

(ii) Annual rate. $150

(30) **Tunnel**

(i) Standard. All tunnels and related structures shall be constructed underground or within the adjacent building pursuant to the requirements of the New York City Department of Buildings.

(ii) Annual rate. See section 7-10. If the structure is not in use, the rate shall be 10% of the rate in effect pursuant to the formulas described in section 7-10.

(31) **Vault extending beyond the curbline or underground improvement not otherwise governed by license procedures contained in section 19-117 of the Administrative Code**

(i) Standard. All vaults shall be constructed underground pursuant to the requirements of the New York City Department of Buildings.

(ii) Annual rate. See section 7-10.

(32) **Any improvement listed in section 7-04 for which a consent is proposed to be granted where the grantee has filed an application concerning the subject property pursuant to section 4-105 of the Administrative Code, or any improvement listed in section 7-04 of these rules where the construction of such improvement was funded 50 percent or more by a City agency.**

(i) Standard. Refer to standards listed above for individual structures.

(ii) Annual rate. The Department may set rates for such consents without reference to the formulas described in § 7-10; such rates shall be set forth in the agreements memorializing the consents.

(33) **Any improvement listed in section 7-04 which has been approved for use for security purposes by the New York City Police Department.**

(i) Standard. Refer to standards listed above for individual structures.

(ii) Annual rate. None.

(iii) This paragraph shall not be construed to apply to any improvement(s) listed in paragraph 35 of subdivision (a) of Section 7-04 of Title 34 of these

Rules.

(34) **Upon approval by the Public Design Commission, any work of art that is fully integrated into an improvement listed in section 7-04.**

(i) Standard. Such an improvement with an integrated art element must adhere to the standards listed in this section for individual structures.

(ii) Annual rate. 50% reduction to the annual rate listed in this section for individual structures.

(35) **Portions of the street used in connection with loading docks, bays or other like facilities for loading and unloading of goods and materials of or for the use of foreign, domestic or multinational governmental entities, where, in the judgment of the New York City Police Department, the location of such facility is necessary due to security concerns applicable to such entity.**

(i) To be referred to DCP to determine whether the improvement has land use impacts.

(ii) Annual rate. An amount determined by the Department to be adequate compensation.

(36) **Bicycle racks.**

(i) Standard. All bicycle racks shall be installed in compliance with the general conditions in Section 7-06 of this title. A request that adheres to minimum clearances may nonetheless be denied by the department if the bicycle rack would interfere with the safe passage of pedestrians.

(ii) Annual rate. $25

(37) **Any improvement that has been certified by a New York State Licensed Professional Engineer as a component of a flood mitigation system as defined in Section 2-10 of this title.**

(i) Standard.

(A) The Department may grant a revocable consent for flood mitigation system components. Except in the case of a public service corporation facility, a revocable consent will only be granted to a petitioner:

(a) for the protection of a building or portion of a building under this paragraph where such building or portion of a building was erected prior to January 8, 2015 or where a lawful building permit was issued by the Department of Buildings for the erection of such

building prior to January 8, 2016; or
(b) for the protection of a building or portion of a building located within an area of special flood hazard, as such term is defined in section G201.2 of Appendix G of the New York City Building Code.

(B) Such improvements shall be designed and constructed in compliance with the requirements of the New York City Department of Buildings and any other applicable requirements of or terms and conditions of approvals issued by other City entities. The Department will consult with the New York City Department of Environmental Protection and any other agency the Department deems necessary or desirable regarding an application for a revocable consent for flood mitigation system components prior to its approval of such application.

(ii)Fee. $2,000. This fee shall apply to the initial revocable consent application and shall not apply to renewal applications so long as the design of the improvement has not changed.

(b) Other improvements approved by the Board of Estimate. Revocable consents that were granted by the Board of Estimate prior to July 1, 1990 for private improvements which are not listed in subdivision (a) above may be renewed, amended, or revoked by the Commissioner in his or her sole discretion, provided that any renewal or amendment shall be submitted to DCP when required pursuant to section 7-03 of these rules. In each year of such consent, the annual rate shall increase by the average of the Consumer Price Index for All Urban Consumers in New York and New Jersey published by the U.S. Department of Labor's Bureau of Labor Statistics ("CPI") increase for the ten years prior to the date of the renewal of the consent. For consents granted pursuant to this subdivision to public service corporations, their annual rate increase shall be reduced by 15%.

(c) Compliance with requirements. All improvements for which a revocable consent is granted shall comply with the general conditions in section 7-06 of these rules.

Section 7-05

Revocable Consents for Telecommunications Purposes

Petitions for revocable consents for telecommunications purposes shall be reviewed and may be granted by DoITT, subject to approval by the Department and review by DCP, where appropriate. Petitions for such consents shall be filed with the Department and shall be forwarded by the Department to DoITT for processing. Petitioners shall submit any additional information which may be required by DoITT.

Section 7-06

General Conditions

(a) Advertising Prohibited. No advertising shall appear on any improvement which is the subject of a revocable consent agreement.

(b) Maintenance. Graffiti shall be removed within seven days of appearance. Art Commission approved colors shall be used and maintained. Sidewalks fronting the entire property must be in good condition, without violations or illegal encroachments.

(c) Clearances for Above-Ground Structures.

(1) Corner Clearance Policy. No revocable consent will be granted for above-ground structures located within the corner quadrant (the area ten feet from either side of the area created by extending the building line to the curb) pursuant to Executive Order #22 of 4/13/95, as amended.

(2) Improvements shall be at least 18 inches from the curb line (front face of curb).

(3) Clear path. A straight unobstructed path ("clear path") for pedestrian circulation on the sidewalk shall remain after the installation of the improvement. The minimum width of the clear path shall be the greater of eight feet or one-half of the sidewalk width. The minimum width of the clear path shall be the greater of ten and one-half feet or one-half of the sidewalk width where a bench, information kiosk or bicycle rack with bicycles parallel to the curb or a queuing area enclosed by poles abuts the clear path. The minimum width of the clear path shall be the greater of 12 1/2 feet or one-half of the sidewalk width where a bicycle rack with bicycles perpendicular to the curb abuts the clear path. The clear path shall be maintained for 15 feet to either side of the improvement. When possible, the improvement shall abut, be aligned with, or be located between other major obstructions such as subway entrances, bus stop shelters, newsstands, and sidewalk cafés.

(4) Improvements shall not be located under fire escapes.

(5) (i) The following minimum distances shall be required between the revocable consent improvement and the specified element or object, except as otherwise specified herein:

Subway Entrance (open side)	15'
Sidewalk Cafés	15'
Newsstand	15'
Bus Stop (with/without shelter)	15'

Fire Hydrant/Standpipe	10'
Driveway	10'
Bicycle Rack (including all bicycles)	8'
Street Tree	5'
Bench	5'
Principal Building Entrance	5'
Ramp intended to provide access for people with disabilities	5'
Subway Entrance (closed end or side)	5'
Public Telephone	5'
Planters on the sidewalk not adjacent to the building façade	5'
Mail Box	4'
Street Lights	4'
Parking Meters	4'
Edge of Tree Pit	3'
Street Signs	3'
Utility Hole Covers, Cellar Doors, Areaways	3'
Transformer Vault, Sidewalk Grates	3'
All Other Legal Street Furniture	5'

(ii) Benches, information kiosks, litter receptacles, mail boxes, planters and public telephones may be located in an aligned grouping with a reduced minimum clearance between them of three feet. Other structures may be incorporated into such groupings provided the minimum clearances in subparagraph (i) above are provided. In no case shall such groupings extend for a length greater than 30 feet along the sidewalk. The listed elements may also be combined, without separation, into a single structure provided the overall length of such unitary structure and any other of the listed elements outside the grouping or unitary structure shall be no more than 15 feet. In no case shall a grouping or unitary structure be less than 15 feet from another grouping or unitary structure.

(d) Waiver.

(1) Where strict compliance with these rules shall create undue hardship, the Commissioner may waive or modify these rules, in specific cases, except where prohibited by law, if in his/her opinion, the public health, safety and general welfare will not be endangered thereby. The petitioner shall request such waiver in writing and shall provide any information requested by the Department which may assist the Commissioner in his or her determination.

(2) Notwithstanding the above provisions, prior to waiving the standards rules related to the location or dimensions of improvements, the Department shall refer the proposed change to DCP for review.

Section 7-07

Application Requirements

(a) Petition form. An application for a new revocable consent or for a renewal, modification, assignment or rescission of an existing revocable consent shall be made on a petition form obtained from the Department, and shall be signed by the petitioner or a person authorized to enter into binding agreements on behalf of the petitioner. In the case of a new consent, the petitioner shall submit the original plus ten copies of the completed form; in the case of a renewal, modification, assignment or rescission, petitioner shall submit the original plus five copies.

(b) Business Certificates. The petitioner shall submit a copy of any applicable business certificate, such as a certificate of incorporation or partnership certificate. With respect to petitions for an assignment or transfer of a revocable consent, the petitioner shall submit a copy of the business certificate of the assignee or transferee.

(c) Plans.

(1) Paper or mylar prints of a plan shall be submitted in the equivalent number of prints as are required for the petition form. Each plan print shall measure 18 by 24 inches unless otherwise authorized by the Department.

(2) The plan shall bear the seal of a Professional Engineer or Registered Architect licensed by the State of New York.

(3) The plan shall be drawn to scale and shall indicate the block and lot number of the property of the petitioner. The plan shall indicate in detail the method of construction, applicable technical information, and the materials to be used. A title box shall be placed on the right hand side of each sheet containing the words “Plan Showing Location of Proposed (structure type) to be Constructed in (name of street), Borough of (borough), to Accompany Application of (petitioner’s name), dated (petition date), to the Department of Transportation of the City of New York” and shall indicate the date it was prepared and any subsequent revisions.

(4) All details of existing structures shall be shown in standard line thickness. All proposed new construction and existing structures which are the subject of the petition shall be plainly shown in red. Proposed removals or relocations, if any, of existing conduits, pipes lines, or other structures shall be clearly indicated by red dashed lines.

(5) The plan shall show the building lines and curb lines, railroad tracks, and, if applicable, any electrical conduits, sewers and other substructures in the street which may be affected in any manner by the proposed construction. All such information shall be obtained and verified by the petitioner. The location, character and dimensions of all such structures and substructures shall be accurately shown and indicated by dimensions on the plan.

(6) The plan shall include longitudinal and transverse sections to show the relative position of the existing structures in the street and the proposed new construction.

(7) The applicant shall provide photographs of the existing conditions and may be required to provide photo simulations of the proposed structure and its surroundings as they would appear after installation.

(8) The plan shall also include the Professional Engineer's or Registered Architect's estimate of the current cost to remove or deactivate the proposed improvement and restore all sidewalks and pavements to current Department standards for new construction. Alternatively, the cost of removal may be provided on a separate sheet of paper provided that it is signed and sealed by a Professional Engineer or Registered Architect.

(9) Following the installation of any improvement for which a consent has been granted, the petitioner shall submit to the Department two copies of a plan indicating the "as built" condition. Such plan shall include any changes approved by the Department, with any deviations from the original plan shown by a double red line. Such plan shall be signed, sealed and dated by a Professional Engineer, Registered Architect or a Licensed Land Surveyor and shall include a certification which reads: "This drawing represents the as-built condition and shows the actual location of all subsurface conditions uncovered during this installation."

(d) Pedestrian Congestion. The Department may require a petitioner to submit additional information concerning pedestrian density and volume as well as the width of the usable pedestrian path at the site of a proposed revocable consent structure. The Department may require that such information include a pedestrian flow analysis conducted according to the performance standards described in the Transportation Research Board's Highway Capacity Manual chapter on pedestrian flow.

(e) Additional Copies and Information. Upon the request of the Department, the petitioner shall provide additional copies of the petition and/or plan. The petitioner shall also provide any additional supporting information requested by the Department or by DCP, where referral has been made to DCP.

(f) Waiver of Plan Requirements. For petitions concerning minor improvements, such as planters, trash and litter receptacles, or benches, the Department may waive the requirement that the plan be prepared by a Professional Engineer or Registered Architect where such submission is not otherwise required by law, and where the petitioner has requested a waiver in writing.

(g) Exception. The requirements of this section shall not apply to revocable consents for public service corporation facilities ancillary to, but not within, a franchise, if the revocable consent covers multiple structures whose locations are not known at the time of the granting of the consent. Plans for each such structure shall be submitted prior to construction and shall meet the requirements of Chapter 2 of Title 34 of the Rules of the City of New York.

Section 7-08

Filing Fees

(a) General Information. Filing fees for petitions shall be submitted with the petition form and any required plans or supporting documents. Filing fees shall be non-refundable.

(b) Specified Improvements. The filing fees listed in this paragraph shall apply to petitions for the following specified types of improvement: accessibility lift; bench; enclosure for trash receptacle; litter receptacle; planted area; planter; ramp intended to provide access for people with disabilities; stoop or step; or any improvement which has been approved by the Landmarks Preservation Commission:

(1) initial petition	$100.00
(2) renewal	100.00
(3) modification	100.00
(4) assignment or transfer	100.00
(5) rescission	100.00

(c) All other improvements, except for improvements approved for use for security purposes by the New York City Police Department.

(1)	initial petition	750.00
(i)	initial petition with a Special Street Plan Type F application with proof of payment of a fee in excess of $650.00	100.00
(2)	renewal	500.00
(3)	modification	
(i)	contractual	375.00
(ii)	structural	550.00
(4)	assignment or transfer	200.00
(5)	rescission	375.00

(d) Improvements approved for use for security purposes by the New York City Police Department. Filing fees shall not apply to any improvements approved for use for security purposes by the New York City Police Department.

Section 7-09

Action by the Department

(a) The Department shall, within 30 calendar days of receipt of a complete petition for a revocable consent, forward a copy of such petition to: the Borough President for the borough in which the proposed improvement is to be located; all Community Boards in whose districts the proposed improvement is to be located; DCP, if required to do so pursuant to section 7-03; and all other City agencies affected by the proposed consent. The Department shall allow 30 calendar days for the Borough President, Community Board, and other affected agencies to comment on the petition.

(b) The Department shall inform the petitioner in writing of all objections. Review of the petition shall be stayed until all objections are resolved. The petitioner shall be given the opportunity to revise the petition or plan in order to resolve the objection(s). If any objection has not been resolved within 90 days from the date the petitioner was informed of the latest objection, such petition may, in the discretion of the Department, be deemed to have been withdrawn.

(c) Prior to granting any revocable consent or renewal or modification to the location or an increase in the dimension of an improvement, the Department shall hold a public hearing on the terms and conditions of the proposed revocable consent agreement. Notice of such hearing shall be published by the Department at the expense of the petitioner in accordance with section 371 of the Charter.

(d) Notwithstanding the foregoing, the Department may deny a petition for a revocable consent without a hearing if, in the sole judgment of the Commissioner, the grant of such consent would interfere with the use of the inalienable property of the City (including streets and sidewalks) for public purpose or would otherwise not be in the best interest of the City.

(e) The revocable consent agreement shall be filed by the Department with the appropriate County Clerk.

Section 7-10

Annual Rate Schedule for Revocable Consent Improvements

For all improvements that do not have an annual rate set forth in section 7-04(a), the annual rate of compensation for the first year of the term of each revocable consent shall be calculated in accordance with the following:

(a) Definitions and Variables.

"A" means the maximum area of the improvement for which a consent has been or is proposed to be granted, as projected onto a horizontal plane (the "footprint").

"Benefited Property" means the real property which is adjacent to the improvement for which a revocable consent has been or is proposed to be granted, and which is benefited by the improvement.

"C" means 100 percent plus the percent change (plus or minus) in the Consumer Price Index for All Urban Consumers in New York and New Jersey published by the U.S. Department of Labor's Bureau of Labor Statistics ("CPI") on July 1 of the year for which the revocable consent annual rate is being calculated, compared to the CPI on July 1, 2003.

"E" means the standard escalating factor, which shall be a percentage equal to the average annual percentage increase in the CPI for the ten years immediately preceding the year for which the standard escalating factor is being determined; the Department shall determine the standard escalating factor on July 1 of the year to be applied to all consents granted or renewed between that July 1 and the next succeeding June 30, inclusive.

"L" means the Current Transitional Assessed Value[1] or the Actual Assessed Value, whichever is lower, of the Benefited Property, in its unimproved state (in dollars and cents per square foot); provided, however, that if there is more than one Benefited Property, "L" shall be equal to the average of the Current Transitional Assessed Values of all the Benefited Properties in their unimproved states (in dollars and cents per square foot). Note: For cables contained within conduit owned by another entity, L=0.

"M" means the applicable multiplier. For pipes and conduits with up to 25 square feet in cross-sectional area, the applicable multiplier is 0.04. For all other improvements, the applicable multiplier is 0.08.

"Minimum Annual Charge" shall be assessed as follows: For improvements having a maximum cross-sectional area greater than four square feet, the Minimum Annual Charge shall be $3,000. For improvements having a maximum cross-sectional area of four square feet or less, the Minimum Annual Charge is $1,500, except that pipes and conduits having an outside diameter of

[1] Current Actual or Transitional Value, whichever is less.

three inches or less (inclusive of any protective sheath or casing) shall be assessed a Minimum Annual Charge of $750.

“R1” means the rate of compensation for the first year of the revocable consent agreement which shall be determined in accordance with section 7-10(b), below.

“V” means the rate (in dollars and cents) obtained from Table A relating to the volume occupied by the improvement. For improvements exceeding nine feet in height, the computation will be made in units up to nine feet in height and then added together.

(b) Rate for First Year. R1 shall equal C [V + (L x M x A)], or the Minimum Annual Charge, whichever is greater.

(c) Rate for Each Subsequent Year.

second year = R1 + (E x R1)

third year = R1 + (2E x R1)

fourth year = R1 + (3E x R1)

fifth year = R1 + (4E x R1)

sixth year = R1 + (5E x R1)

seventh year = R1 + (6E x R1)

eighth year = R1 + (7E x R1)

ninth year = R1 + (8E x R1)

tenth year = R1 + (9E x R1)

(d) Consents granted on or prior to June 30, 1991. For those consents granted on or before June 30, 1991 which provide for annual fees to be computed based upon the rate schedule currently in effect, annual compensation shall equal R1 as calculated pursuant to section 7-10(b).

(e) Revenue. All revocable consent revenue shall be collected by the Department.

Table A

Length in Feet	Cross-Section Area						
	Up to 1.4 Sq. ft.	1.4 to 4 Sq. ft.	4 to 20 Sq. ft.	20 to 81 Sq. ft.	81 to 162 Sq. ft.	162 to 243 Sq. ft.	Smaller Pipes up to 3"
Up to 100'	$13.90 Per Ft.	$27.83 Per Ft.	$34.78 Per Ft.	$41.72 Per Ft.	$69.56 Per Ft.	$83.48 Per Ft.	$7.26 Per Ft.
100' - 150'	$1,390 + $8.17 Per Ft. Over 100 ft.	$2,783 + $16.35 Per Ft. Over 100 ft.	$3,478 + $20.43 Per Ft. Over 100 ft.	$4,172 + $24.51 Per Ft. Over 100 ft.	$6,956 + $40.87 Per Ft. Over 100 ft.	$8,348 + $49.04 Per Ft. Over 100 ft.	$726 + $4.26 Per Ft. Over 100 ft.
150' - 200'	$1,799 + $7.72 Per Ft. Over 150 ft.	$3,600 + $15.45 Per Ft. Over 150 ft.	$4,499 + $19.30 Per Ft. Over 150 ft.	$5,397 + $23.16 Per Ft. Over 150 ft.	$9,000 + $38.62 Per Ft. Over 150 ft.	$10,800 + $46.34 Per Ft. Over 150 ft.	$939 + $4.03 Per Ft. Over 150 ft.
200' - 250'	$2,185 + $7.29 Per Ft. Over 200 ft.	$4,373 + $14.59 Per Ft. Over 200 ft.	$5,464 + $18.23 Per Ft. Over 200 ft.	$6,555 + $21.87 Per Ft. Over 200 ft.	$10,931 + $36.46 Per Ft. Over 200 ft.	$13,117 + $43.76 Per Ft. Over 200 ft.	$1,140 + $3.80 Per Ft. Over 200 ft.
250' - 300'	$2,549 + $6.83 Per Ft. Over 250 ft.	$5,102 + $13.67 Per Ft. Over 250 ft.	$6,376 + $17.08 Per Ft. Over 250 ft.	$7,649 + $20.49 Per Ft. Over 250 ft.	$12,754 + $34.16 Per Ft. Over 250 ft.	$15,305 + $41.00 Per Ft. Over 250 ft.	$1,330 + $3.56 Per Ft. Over 250 ft.
300' - 350'	$2,891 + $6.40 Per Ft. Over 300 ft.	$5,786 + $12.81 Per Ft. Over 300 ft.	$7,230 + $16.00 Per Ft. Over 300 ft.	$8,673 + $19.20 Per Ft. Over 300 ft.	$14,462 + $32.01 Per Ft. Over 300 ft.	$17,355 + $38.42 Per Ft. Over 300 ft.	$1,508 + $3.34 Per Ft. Over 300 ft.
350' - 400'	$3,211 + $5.94 Per Ft. Over 350 ft.	$6,426 + $11.89 Per Ft. Over 350 ft.	$8,030 + $14.85 Per Ft. Over 350 ft.	$9,633 + $17.82 Per Ft. Over 350 ft.	$16,062 + $29.71 Per Ft. Over 350 ft.	$19,276 + $35.66 Per Ft. Over 350 ft.	$1,675 + $3.10 Per Ft. Over 350 ft.
400' - 450'	$3,508 + $5.70 Per Ft. Over 400 ft.	$7,021 + $11.41 Per Ft. Over 400 ft.	$8,772 + $14.25 Per Ft. Over 400 ft.	$10,524 + $17.10 Per Ft. Over 400 ft.	$17,548 + $28.51 Per Ft. Over 400 ft.	$21,059 + $34.22 Per Ft. Over 400 ft.	$1,830 + $2.97 Per Ft. Over 400
450' - 525'	$3,793 + $5.21 Per Ft. Over 450 ft.	$7,591 + $10.43 Per Ft. Over 450 ft.	$9,485 + $13.03 Per Ft. Over 450 ft.	$11,379 + $15.63 Per Ft. Over 450 ft.	$18,973 + $26.06 Per Ft. Over 450 ft.	$22,770 + $31.28 Per Ft. Over 450 ft.	$1,979 + $2.72 Per Ft. Over 450 ft.
525' - 600'	$4,183 + $4.75 Per Ft. Over 525 ft.	$8,373 + $9.48 Per Ft. Over 525 ft.	$10,462 + $11.85 Per Ft. Over 525 ft.	$12,551 + $14.22 Per Ft. Over 525 ft.	$20,928 + $23.71 Per Ft. Over 525 ft.	$25,116 + $28.45 Per Ft. Over 525 ft.	$2,183 + $2.47 Per Ft. Over 525 ft.
600' - 30,000'	$4,540 + $4.33 Per Ft. Over 600 ft.	$9,084 + $8.66 Per Ft. Over 600 ft.	$11,351 + $10.83 Per Ft. Over 600 ft.	$13,618 + $12.99 Per Ft. Over 600 ft.	$22,706 + $21.66 Per Ft. Over 600 ft.	$27,249 + $25.99 Per Ft. Over 600 ft.	$2,368 + $2.26 Per Ft. Over 600 ft.
For More Than 30,000'	$134,440 + $2.82 Per Ft. Over 30,000 ft.	$268,884 + $5.64 Per Ft. Over 30,000 ft.	$336,251 + $7.05 Per Ft. Over 30,000 ft.	$403,318 + $8.46 Per Ft. Over 30,000 ft.	$672,506 + $14.11 Per Ft. Over 30,000 ft.	$806,949 + $16.93 Per Ft. Over 30,000 ft.	$70,168 + $1.47 Per Ft. Over 30,000 ft.

APPENDIX SIX

NYS RAINWATER HARVESTING GUIDELINES

New York State
Rainwater Harvesting Guide

2015

Environmental
Finance
Center
Syracuse University

New York State Rainwater Harvesting Guide 2015

Information for the development of this guide was primarily sourced, with permission, from “Rainwater Harvesting” by Dana O. Porter, Russell A Persyn, and Valeen A. Silvy of Texas A&M AgriLife Extension Service Information presented in this guide is from the Texas A&M publication unless otherwise cited.

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What is Rainwater Harvesting?

According to the National Conference of State Legislatures, rainwater harvesting is “the act of utilizing a collection system to use rainwater for outdoor uses, plumbing, and in some cases, consumption” (NCSL 2013). While there are laws pertaining to rainwater harvesting in some states, New York is not one of them. Rainwater harvesting captures, diverts, and stores rainwater for later use. The method of harvesting rainwater is an innovative approach to use water more efficiently, resulting in monetary savings.

Why Participate in Rainwater Harvesting?

Even with low rainfall averages, one can save money by efficiently collecting and storing rainwater for irrigation for many aspects of the landscape. Rainwater harvesting can also be an easy solution to minimize harmful environmental effects that could be occurring on a property.

Benefits of Rainwater Harvesting

- Decreased erosion from rainwater runoff, which can decrease agricultural productivity.
- Reduced charges on utility bills.
- Reduced runoff that could be carrying harmful contaminants such as fertilizer, sediments, or pesticides. This becomes especially important when on a farm or near a body of water.
- Rainwater can be used to clean machinery, provide drinking water for animals, wash out of pens and parlors, and supply water to irrigation systems.

Did you know? Many areas of New York State use salt to keep roads safe in the winter. However, this salt can infiltrate soil on a property and inhibit vegetation growth. Rainwater, however, is free of salts and minerals. When rainwater percolates into the soil it pushes the salt away from the root zones, promoting healthy root growth.

Rainwater harvesting systems can be very easy to create. This guide helps homeowners, farmers, and other users design and utilize a rainwater harvesting system that is right for them and their property.

Water Use and Supply Nationwide and in NYS

Water uses such as irrigation, public supply, and thermoelectric power account for 90 percent of the nation’s total water consumption (USGS,

2015). According to the U.S. Geological Survey, the estimated total water use for New York State in 2010 was 10.6 billion gallons per day.

New York State is rich in freshwater sources, as normal annual precipitation in most of state ranges from 30 to 50 inches (NOAA 2015). These sources provide drinking water, flood protection, and support "recreation, tourism, agriculture, fishing, power generation, and manufacturing" (NYSDEC, 2015). However, freshwater is not an unlimited resource, and water users are only increasing in New York (NYSDEC, 2015). Since water is so valuable, water conservation efforts and conservation programs have been developed throughout the state.

Before Installation

There are many factors to consider when choosing the right rainwater harvesting system that caters to a property owner's demands. Determining the right system in the beginning will save money and increase efficiency.

What Is the Primary Use of the Rainwater Harvesting System?

Collected rainwater may serve in various applications, including landscaping, in-home use, livestock, fire protection, stormwater management, and facility/equipment washing. Identifying water applications will guide system size and installation needs.

Consider the Following:

- Will the harvested rainwater be used immediately, or stored for later use?
- Will the system need to have high pressure to spray crops, or will a low pressure, dripping system be used to water the crops?
- Are the crops for consumption? If so, what water treatment system options are available?

How Much Rainwater Is Required?

Knowing how much water is currently used to water plants, clean, or provide drinking water for animals is important. Based on of a farm's water needs, a property owner can build an appropriate system. Annual water needs can be difficult to determine. However, the Penn State College of Agricultural Sciences has designed a guide that will assist in this analysis. The guide focuses on water uses for animals, irrigation systems, milk houses, and parlor and holding areas (Penn State Extension 2015).

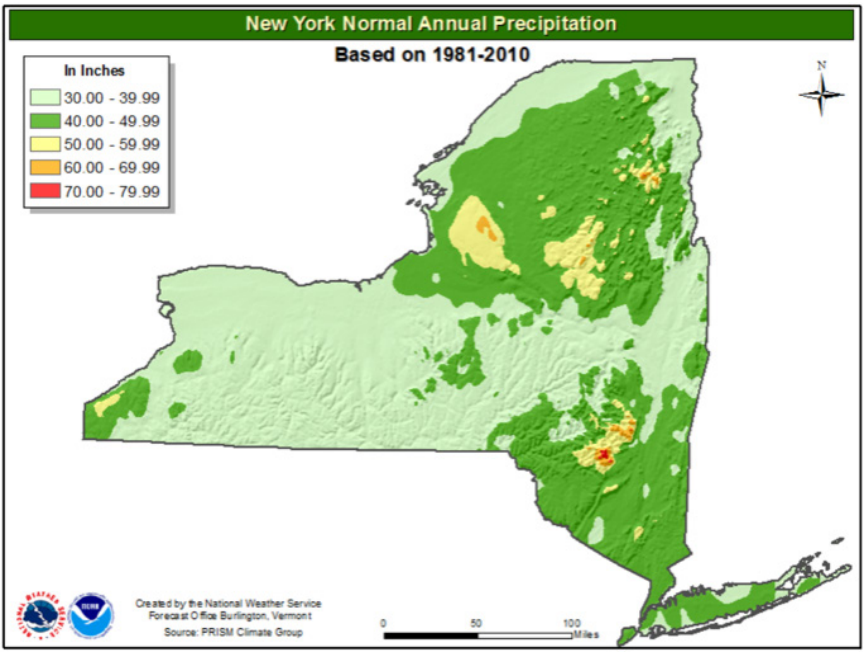
Estimated on-farm water use: _____ gallons

How Much Rainwater Can Be Collected?

Determining how much rainwater can be collected will give the user an idea of how to utilize it. The amount of rainwater that is available for use may affect the type and size of the system that a homeowner or farmer puts in place. Following these easy steps can help determine the amount of rainwater available for use in gallons.

Step 1

Locate the property where the rainwater harvesting system will be installed on the map below, created by the National Weather Service. Use the key to determine annual precipitation levels in that area.



Step 2

Next, determine the property's catchment area. For example, a roof with 30ft by 40ft dimensions will yield a catchment area of 1,200 square feet.

Step 3

Determine the runoff coefficient. Different types of materials allow for better runoff than others. If there are multiple locations on the property, different roof types will have an affect on the system. The roof's coefficient can be found in the table below.

Runoff Coefficients*		
Surface Type	**High**	**Low**
Roof		
Metal, gravel, asphalt shingle	0.95	0.75
Paving		
Concrete, ashpalt	0.95	0.70
Brick	0.85	0.70
Gravel	0.70	0.25
Soil		
Flat (2% or less), bare	0.75	0.20
Flat (2% or less), with vegetation	0.60	0.10
Lawns, Sandy Soil		
Flat (2% or less)	0.10	0.05
Average (2% to 7%)	0.15	0.10
Lawns, Heavy Soil		
Flat (2% or less)	0.17	0.13
Average (2% to 7%)	0.22	0.18

*Data obtained from: Haan, C.T., B.J. Barfield and J.C. Hayes, *Design Hydrology and Sedimentology for Small Catchments*, Academic Press; and Waterfall, P.H., 1998, *Harvesting Rainwater for Landscape Use*, Arizona Department of Water Resources.

Step 4

Calculate how much rainwater can be harvested on the property.

Rainwater Harvested (Gallons)	=	Average Inches of Rainfall Annually	x	0.623 Constant	x	Catchment Area (Square Feet)	x	Runoff Coefficient

Annual rainwater harvesting potential: _____ gallons

Efficiently Using Rainwater:

Investing in a rainwater harvesting system may not provide returns if there are leaking faucets and pipes. Leaks will result in unnecessary costs as homeowners end up buying or pumping more water. Homeowners and farmers should take precautions to prevent any water collected through the harvesting system from being wasted.

Follow These Steps to Increase Efficiency:

- Replace leaking hoses and faucets.
- Water crops in the morning or at night to reduce evaporation.
- When washing equipment or pens, use only as much as needed.
- Improve irrigation water use efficiency.

Components of a Rainwater Harvesting System

Source: Texas A&M Agrilife Extension Service

There are many parts that are crucial to a rainwater harvesting system. It is important that each part is constructed and placed appropriately to get the most out of the system. All rainwater harvesting systems need a catchment area, conveyance system, filter, storage, and distribution system (Innovative Water Solutions 2015).

Catchments

The catchment system makes first contact with the rainwater and directs it to the conveyance system. Catchments are most commonly roofs as they have a large surface area available with an adequate pitch to provide runoff. The catchment system will provide a "yield," or an amount of water per rainfall. Using materials that have a high yield will increase the system's ability to harvest.

Materials: Roofs are made from various materials, which affects the properties of the catchment area. Considering the material of the roof is most important when the rainwater harvesting system will be used for potable water. Metal roofs are best for this application as they easily shed contaminants. Additionally, metal roofs have one of the highest yields due to high runoff coefficient and low permeability. Less debris will build up, keeping the water cleaner (Pickett 2015).

*Important: Make sure to avoid wood shingles or metal flashing that contains lead. Harvest rainwater in this application can be harmful to crops and inappropriate as a potable water source.

Slope: A steeper slope on the roof will allow water to run off more quickly, cleaning the roof of containments. Less steep roofs will allow contaminants to sit on the roof longer, possibly causing problems for the

system (Texas A&M Agrilife Extension 2015a).

Conveyance Systems

From the catchment area, the water needs to make its way to the storage tank. This is done through the conveyance part of the rainwater harvesting system. The conveyance system is usually made up of a series of downspouts and gutters that divert the rainwater to the storage tank. There are two types of conveyance systems, dry and wet. Both dry and wet systems have two main factors to take into consideration, sizing and proper installation of gutters and downspouts.

Dry Systems: These systems are designed for the water to run directly from the catchment to the conveyance system, and then into the storage tank. The only time there is water in the dry conveyance system is when it is raining, avoiding the problem of stagnant water (Rain Harvesting 2015a).

Wet Systems: Wet systems have piping that runs from the catchment to below ground. The piping resurfaces when it reaches the storage tank above ground. This is a more popular solution in applications where the storage tank is not located next to the catchment area and/or the catchment area is relatively large. Farmers or property owners that wish to irrigate land that isn't adjacent to the catchment area would benefit from using this option. Stagnant water in the piping between rainfall occurrences is one disadvantage of this system (Rain Harvesting 2015b).

The Fix for Wet Systems

An in ground water diverter makes sure that the water is flushed out of the underground wet system, therefore converting the wet system to a dry system. This improves water quality by not allowing water to sit, and reduces the possibility of contaminates from entering the tank. Diverters are built underground and are out of sight. http://rainharvesting.com.au/product/in-ground-diverters/

Sizing: According to the Texas A&M Agrilife Extension, gutters should be sized to be able to handle a 100-year storm event, meaning that a storm of that magnitude will have a one percent chance of happening every year. A gutter used as part of a conveyance system should be no smaller than five inches wide. Downspout size must be calculated. One square inch of a downspout should be provided for every hundred feet of catchment area supplying that downspout. The formula to calculate downspout size is below (Texas A&M Agrilife Extension 2015).

Downspout Size = (Length (feet) x Width (feet) of catchment area)/100

Proper Installation: This is important in order to make sure that the conveyance system is safe and functions properly.

Take the following steps to ensure that the conveyence system functions properly (Texas A&M Agrilife Extension 2015a):
- Paint PVC pipe to avoid UV breakdown. This can improve to the aesthetic of the system if this is a concern.
- Make sure the gutters are sloped at least 1/16" per foot to allow for proper drainage. This is especially important during freezing New York winters to avoid ice buildup.
- Provide gutter hangers every foot to help resist snow weight.
- Use rounded gutter outlets to reduce the amount of debris buildup.
- The front of the gutter should be a ½ inch lower than the back. When collecting rainwater, there is a possibility for debris to splash against the building.

Filtration

Debris is likely to enter the conveyance system as a result of rainwater collection. There are ways to help prevent this, resulting in a cleaner, more efficient system. The first step is to install a leaf screen over the top of the downspout, preventing any large debris from entering. After the leaf filter is installed, the rainwater should pass through a device called a first flush diverter. The diverter stops contaminants from entering the rainwater tank. One 10-gallon diverter should be installed for every 1,000 square feet of catchment area. An inline sediment filter removes any sediment after the water exits the tank and before it reaches the outlet. Inline sediment filters are important when using drip line irrigation systems. If not removed, the sediment will clog the holes in the drip line (Rain Harvesting 2015c).

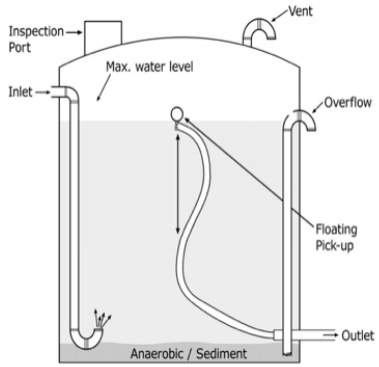
Storage

This is one of the most complicated but important steps when building a rainwater harvesting system. There are many factors to consider, such as safety, connections, above or below-ground, and tank material. Storage can be the most expensive part of a system, and so it is important to consider potential problems beforehand.

Safety: The goal of rainwater harvesting is to collect quality water that can be used for a multitude of agricultural practices and potentially for potable water. While the tank is holding water waiting to be used, steps should be taken to retain the quality of that water. The tank should not allow for light penetration, which will cause the growth of algae, thus tainting the water supply. The tank should be sealed except for any necessary inlets or outlets. This is important in keeping any insects or animals from entering the storage tank.

Connections: Every storage tank requires inlets and outlets in order to take in water, discharge water, and breathe (Texas A&M Agrilife Extension 2015b).

Inlet: The inlet is where rainwater enters the tank. It is important to have a calming inlet connected to the end of the inlet inside the tank. This is done to avoid any disruption of possible sediments on the bottom of the tank.



Source: Texas A&M Agrilife Extension Service

Outlet: The outlet is where the water drains from the tank. The outlet is connected to a floating object attached to a flexible tube off of the bottom of the tank. The bottom four inches of the tank should not be drained to avoid sediment drainage.

Overflow: Overflow releases excess water during a heavy rain.

Vent: The vent is important to stop a vacuum effect from occurring inside of the storage tank. Cover any openings with mesh so insects and other contaminants cannot enter the tank.

Inspection Port: Located at the top of the tank, the port allows for maintenance and inspection by the user.

Tank Materials: There are many different types of materials that can be used in tank construction. Each material has its advantages and disadvantages in cost, construction, and durability.

Above-Ground or Below-Ground: There is much to consider when deciding to place a tank above or below-ground. The advantages and disadvantages of each installation should be considered case-by-case based on the user's goals for rainwater harvesting.

Above-Ground: On a farm, there is usually not a problem with restricted space allowing for the placement of large storage tanks on the property. Many farms have multi-story buildings in the form of barns, garages, and holding areas. This allows for large tanks to be gravity fed to the tank from the catchment area. However, it is important to remember that in New York's winter climate, above-ground tanks need to be insulated and often drained for several months.

Advantages:
- Installation is less expensive.
- Maintenance and repair are much easier because of accessibility.
- It is easy to add another tank if necessary.
- Gravity fed tank.

Disadvantages:
- Subject to freeze-thaw cycles that make the system possibly unusable in the winter months.
- Heavy equipment, which can easily damage an above-ground tank.
- Sunlight can cause algal growth.
- May be considered an eyesore.

Below-Ground: This type of tank installation is often more common in large-scale operations. Underground tanks will be able to better handle the freeze-thaw cycles that New York experiences every year, thus allowing for possible year round use. An underground tank requires installment of pumps to get the water in the storage tank.

Advantages:
- Algal growth will not occur due to the absence of sunlight.
- The tank avoids weather conditions including freezing, as long as the tank is below the frost line.
- The ground temperature has a stable, cool temperature throughout the year, limiting bacterial growth.

Disadvantages:
- More expensive.
- Less accessible for maintenance.
- Soil shifts may cause a fracture to occur.
- The system will require a pump to move the water into the tank.

Distribution
The distribution system depends entirely on what the user wants to do with the water. Common applications for the rainwater include irrigation, washing of machinery and pens, drinking water for livestock, as well as any other application for water on the property. Distribution systems are designed case-by-case, as each farm will need the system to fulfill different requirements. Pumps, pressurized tanks, and control boxes are all optional, but will make the rainwater harvesting system more useful.

Pumps
When deciding on the type of distribution, pressure is an important factor to consider. Most rainwater harvesting systems present on farms need to be pressurized in order to perform at the level needed. Gravity

flow systems will not suffice for farming applications, unless only low pressure is needed for all water demands that have to be located at a lower level than the tank. Pumps will pressurize the system, expanding the potential rainwater usage, but for an increased price. When a system is pressurized, hoses, faucets, and irrigation systems can be used at any location on the farm, at any point. Pumps can either be located in-line with the discharge pipe, or submersed within the tank. Determining the size of the pump is based on the pressure and volume a user wants from the system. A good reference is that a typical indoor showerhead operates at 30psi and 2.5 gallons. A pump technician can advise users on the type of pump needed to meet agricultural needs.

Pressurized Tank

A pressurized tank is used to relieve the pump of a constant on/off cycle when using pressurized water from the system. Having a pump turn on and off repeatedly will reduce the lifespan of the pump. Pressurized tanks store water at pressure, and are refilled when depleted. These are useful when using only small amounts of water for jobs on the farm or at a residence.

Control Panels

The use of control panels will help monitor the system. There are many companies that sell control panels for rainwater harvesting (Texas A&M Agrilife Extension 2015b).

Making Rainwater Safe to Consume

If a user wants to use the system for drinking water or watering ready-to-eat crops, then ultraviolet (UV) sterilization is required. A UV unit will kill bacteria, pathogens, and viruses that could harm the consumer. Modern units work by allowing water to flow in between a UV light and a stainless steel tube. The UV light is wrapped in a quartz sleeve to protect the bulb from water, but still allows all of the UV energy to be transferred to the water. The water has to be free of sediments so shadowing of the UV light can be avoided. Shadowing could potentially cause the UV light to miss some of the contaminants. Using a carbon filter before the UV treatment will get rid of unfavorable smells and tastes. Using UV is only necessary if the water is going to be used for consumption or irrigation of ready-to-eat crops. There are many of applications for rainwater harvesting that don't require the use of a UV light (Conservation Technology 2015).

Freezing Conditions and Rainwater Harvesting

New York State has a wide range of temperatures throughout its four seasons. Even during the freezing winter months, rainwater harvesting systems still collect enough water to benefit system owners. When freezing temperatures do occur, certain precautions need to be taken in order to protect the system (The Watershed 2015).

Tanks: The tank should be emptied unless it is installed in a way to stop freezing from occurring. The tank can be placed underground below the frost line, reducing the risk of freezing. An aerator can be added to the tank to make sure there is movement in the water, preventing the water from settling or freezing. A heat pump can also be used to deter freezing as well.

Conveyance System: Make sure that the conveyance system has the proper slope to ensure there is never any sitting water in the gutters. This will cause a buildup of ice and place strain on the system.

Pump: Like the tank, the pump must either be winterized or placed below the frost line like the tank. Having an in-tank, submersible pump, is an advantage when freezing occurs. The water in the tank should not freeze, thus acting as protection for the pump.

Distribution: All distribution systems need to be insulated from freezing temperatures if not placed underground and below the frost line. If this is not possible, the distribution system should be drained during the freezing months to avoid damage.

Maintenance

It is important to take care of the rainwater harvesting system to maintain its efficiency and effectiveness. This is easy to do, and should be done before each rain season and after periods of heavy rainfall. Proper maintenance will ensure that the user is harvesting the most rain per rainfall.

Maintenance List

- Removal of any debris build up in the gutters and downspouts.
- Clean out all of filters periodically. This is important for systems using drip irrigation and/or rainwater for potable water.
- Flushing of the storage tank bottom to get rid of sediment buildup.
- Checking for leaks throughout the system and repair accordingly.

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Syracuse University Environmental Finance Center programs and projects are supported in part by funding from USDA-RD and EPA.

APPENDIX seven

GROWNYC RAINWATER HARVESTING 101

Rainwater Harvesting 101

GARDEN · TEACH · RECYCLE · GREENMARKET

grow NYC

RAINWATER HARVESTING 101

GROWNYC

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PREFACE

GrowNYC is a hands-on non-profit that has been improving New York City's environment for over thirty years. GrowNYC's dedicated staff green our neighborhoods, create the environmental leaders of the future, promote waste prevention and recycling, and run the largest farmers market program in the country. GrowNYC achieves its mission through the following projects and programs: The Open Space Greening Program, Greenmarket, The New Farmer Development Project, Environmental Education Training Student Organizers, Learn It, Grow It, Eat It and Office of Recycling Outreach and Education.

The Open Space Greening Program (OSG) empowers people in neighborhoods throughout the city to create, manage and sustain community gardens and park/playgrounds. OSG provides best practices workshops, services, tools, donated plant material, and open space planning/mapping information and other services. Grow Truck provides tools, donated supplies, plants and horticultural advice and assistance to gardening groups all over New York City. The Plant-A-Lot Project gives substantial material and technical assistance to several new gardens each year and helps the 45 existing gardens created in prior years.

Since 2002, OSG staff has taken the lead in building and maintaining rainwater harvesting systems in community gardens across the five boroughs, leading educational workshops, assisting community gardeners in identifying alternate water resources and building low cost systems. GrowNYC is an active member of the Water Resources Group, a network of NYC greening and environmental organizations promoting sustainable water conservation practices in NYC. The New York State Department of Environmental Conservation (DEC) recognized GrowNYC's efforts with The Environmental Excellence Award in 2006. This manual was created to disseminate to a wide audience the design parameters and building techniques used by GrowNYC staff.

Summer intern was able to prepare this document thanks to a grant from The New York State Department of Environmental Conservation in 2008 for Pollution Prevention. Ms. Leung provided many of the photos, charts, and drawings used. OSG staff, Lars Chellberg, and Lenny Librizzi provided invaluable guidance, advice, and editing of the manual. GrowNYC Executive Director Marcel Van Ooyen and Assistant Executive Director Julie Walsh edited the text. Additional information and assistance was provided by NYC community gardeners and members of the Water Resources Group.

Table of Contents

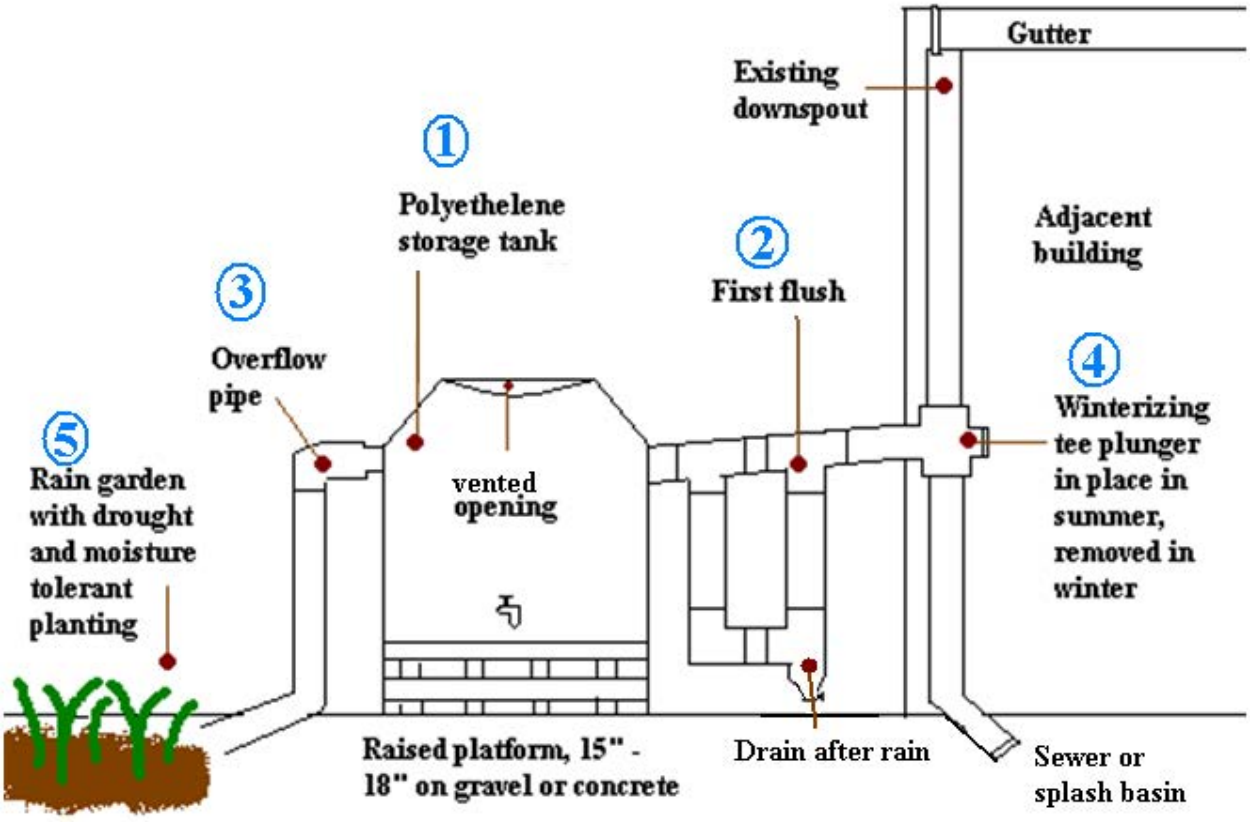
Introduction

"It isn't easy to come up with 'one size fits all' instructions for building rainwater harvesting systems because of variations in styles of roofs, downspouts, storage tanks, and garden layouts. You have to use a combination of research, common sense, ingenuity, and dumb luck to design and build your system."

-Lenny Librizzi, Assistant Director of Open Space Greening at GrowNYC

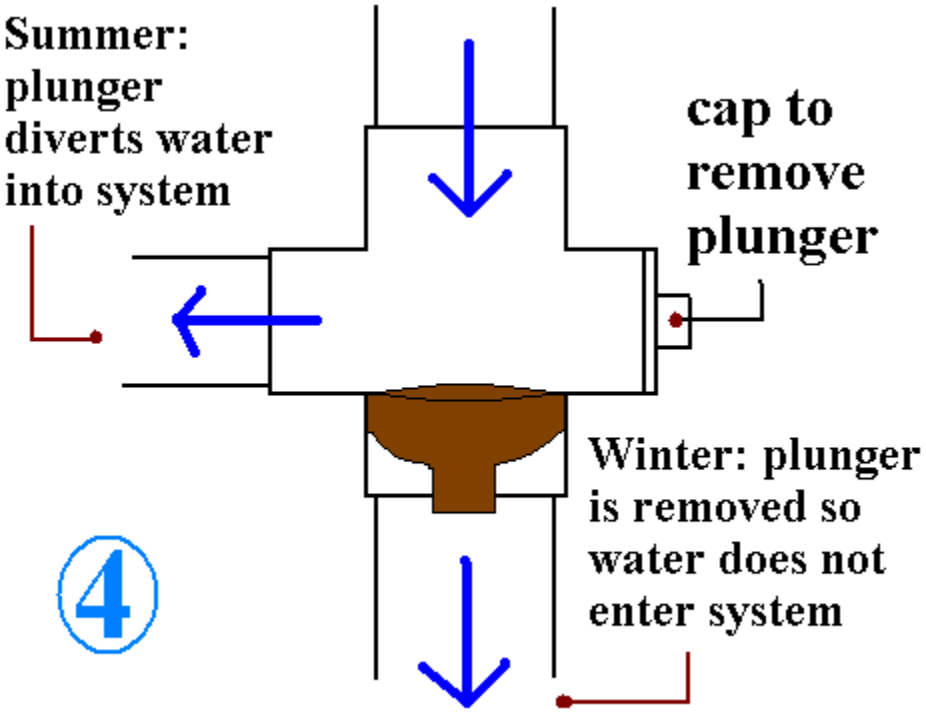
Rain water harvesting (RWH) is the means of collecting and storing rain water in large, durable containers, usually, collecting from rooftop gutters. RWH systems come in a variety of shapes and sizes (see pictures below).

Rain water harvesting systems are fairly easy to construct. Tanks in NYC community gardens range in size from 300 to 1000 gallons but can be as small as 55 gallons and as big as 10,000 gallons. Rain water collected from the downspout of an adjacent building or shed in the garden is redirected to the water storage area in the garden. The RWH system includes 3 parts (see drawing): the tank **(1),** the first flush **(2)** and the overflow pipe **(3).**



During a rainfall event water from the gutter flows into the downspout. Instead of the water going into the sewer system, the rainwater harvesting system diverts the water into pipes. This diverter consists of a 3 way tee with a plunger in place during the summer. This plunger keeps the water from entering the downspout and forces it to flow into the harvesting system. It is taken out in the winter when rainwater is no longer collected **(4).**

Here is a closer view of how the plunger works.



The pipes lead to a roof washer system which is a containment area for the first few gallons of water. Since the initial flushes of water contain rooftop debris and leaves, the roof washer acts as a filtering system by separating the dirty water from the cleaner water. Once the roof washer is full, the cleaner water enters the rain tank. As soon as the tank is full, excess water flows into the overflow pipe which leads to an adjacent rain garden **(5),** is directed back to where it originally flowed or piped underground. A rain garden is a plot containing hardy plants that can survive with both saturated and dry soil.

History of rainwater harvesting

Rainwater harvesting is an ancient practice. Many different cultures have used this technology for agricultural purposes. The Philippines have been using rain water for rice terraces for thousands of years now. Indian history indicates that rain water systems have been in use since 3000 BC. Usage can also be traced back 2000 years ago in Thailand and other parts of Southeast Asia, where simple gutters were used to fill jars and pots. The earth dams of ancient Egypt were used to control runoff. Ancient rain water cisterns can still be seen on the islands of Capri and Malta.

In addition to rainwater harvesting, the Romans also used their systems as air conditioners. When the water evaporated, it created a cooling effect in the microclimate. As their populations started to increase, the Romans developed underground cisterns. This way, less water would be lost due to evaporation. They connected these cisterns to above ground pools as a means of water filtration. When these pools overflowed, the cleaner water would enter the cisterns. This design was an inspiration for modern day rain barrels. The Roman's shallow pool mirrors the modern day roof washer or first flush system.

The world's largest cistern is the Yerebatan Sarayi, built by Caesar Justinian in 527 AD. It is located in modern day Turkey and is a popular tourist attraction. It is 140 meters by 70 meters big and can store up to 80,000 meters^3 of water. This huge structure is completely underground and involves a series of intersecting vaults. Binbirdik is another cistern in Istanbul, created by Caesar Constantine in 389 AD that can store 80,000 meters^3. However construction of these cisterns stopped due to the difficulty of building underground and the outbreak of human fecal contamination in large cities. [1]

In the 1970's, a new technology of rain water harvesting was developed where storm water was stored in well storage tanks in the form of different sized ponds. A thin layer of red clay was used to line the bottom of the pond to prevent seepage and trees were planted around the pond to prevent excessive evaporation. Over 40,000 of these systems were built in the Loess Plateaus of China. [2]

Although rain water harvesting was a significant and successful design in the past, its popularity has declined over the centuries. Urbanization demanded a more centralized water supply system. Watersheds and pipelines came into use and running water became one of the world's greatest inventions. However, due to modern day water pollution and drought, rainwater harvesting techniques have come back into practice again.

Benefits of rainwater harvesting in urban areas

By keeping storm water out of the sewage system, gardeners help keep their local water bodies clean. Because most of NYC is paved over, rainwater can't be absorbed by the ground. Instead, it runs across the pavement, picking up oil, street debris, animal feces and other waste as it moves. This runoff then enters the sewer system.

Unfortunately, not all runoff makes it to a treatment plant before entering the city's rivers and harbor. This is because most of NYC is on a combined sewer system, whereby the same pipes are used to transport both storm water runoff and household waste to sewage treatment plants. If these treatment plants overflow, the contaminated water then enters the water bodies surrounding NYC.

During dry weather the sewage treatment system generally works well, but these treatment plants can only handle about twice their dry weather volume. This means that heavy rains often result in combined sewer overflows (CSOs), which release untreated wastewater, storm water and street debris into local waterways. Untreated sewage can carry disease causing pathogens and nutrient rich organic material, which can choke the Harbor's ecosystem.

Not only can rainwater harvesting prevent water pollution, it also conserves water. Typical systems can store up to 1000 gallons of water. Harvesting during rainy days in spring and summer provides a source of water for the dry spells between rain events. Instead of running the hose to water your garden, you can use the rainwater stored in your tank. This will relieve the strain on our reservoirs and also save you money on your water bill. Forty percent of household water consumption is used on domestic irrigation! [3]

Rainwater harvesting has proven to be successful. The 35 rain water harvesting systems working in NYC's community gardens collect 422,900 gallons of water every year. That's enough for 264,313 toilet flushes!

Of course small scale construction of rainwater systems is not enough to significantly impact our environment. However, if rain barrels were used more extensively and rain gardens became a larger part of city landscape planning, water conservation would have a greater environmental impact. We would experience cleaner water bodies, less flooding and lower water costs.

Rain water harvesting has great potential to reduce rainwater flow into storm drains by collecting rainwater in gardens and can reduce the dependence on the NYC watershed. Every drop of water counts and conservation is the most sustainable, cost-effective source of water supply for our region.

Current efforts

Community gardeners across North America and around the world have revived the practice of using rain barrels in their gardens out of necessity.

In **Seattle**, budget constraints and rising water prices spawned the construction of rainwater harvesting systems. Some of Seattle's rainwater harvesting systems are works of art. Here gate pillars support the flow of rainwater from the building on the right into the cistern on the left. Seattle Public Utilities have recommended changes to the land use and building codes that encourage water conservation. SPU has also sponsored some wildly successful sales of rain barrels to Seattle residents.

The special curves on this gate represent the monthly rain fall in Seattle and the amount of water collected year round.

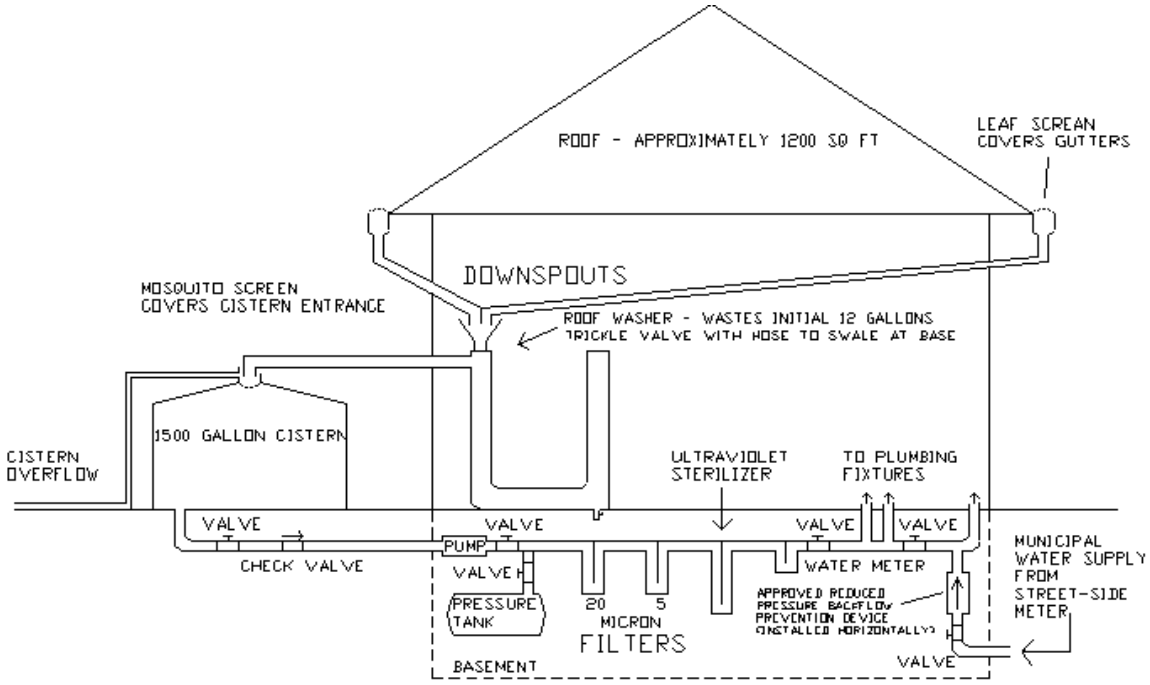
The overflow pipe of this Seattle cistern creates a mini waterfall.

A cat enjoying the rain garden in Kansas City.

The 10,000 Rain Gardens Program in **Kansas City** is an example of regional efforts to educate and introduce water conservation to the Kansas City community. Rain gardens are areas of vegetation on porous ground that can filter and drain excess storm water. Kansas City officials encourage their residents to plant these gardens on their own property.

The City of **Vancouver** designs and manufactures rain barrels for residents to use for irrigation (see picture on right). Vancouver subsidizes the cost of the rain barrels by 50%. Over 2000 barrels have already been sold.

Portland, Oregon, granted a permit for a household to harvest rainwater for use indoors during all but the dry summer months (see sketch and picture below). The water undergoes enough filtering to meet EPA's standards for drinking water. In 1998 this system cost less than $1,500 to install.



Maplewood, Minnesota has forged a coalition between its water and sanitation departments and residential landowners to plant large-scale curbside rain gardens that reduce storm-water sewage (see picture on left).

The Minnesota Arboretum uses its parking lots to demonstrate best landscape practices such as planting rain gardens and using permeable pavers to reduce contamination caused by storm water runoff (see picture on right).

The City of **Toronto** Downspout Disconnection Program offers a free service to homeowners to disconnect downspouts from the sewer system and install rain barrels which are available at a discount.

Chicago also encourages its citizens to disconnect downspouts. In addition, Chicago's Water Agenda 2003 included a rooftop garden initiative, a pilot program for permeable alleys, and rain gardens planted in the City's rights-of-way.

Austin offers rebates of up to $30 for newly installed rain barrels and of up to $500 for installation of rainwater harvesting systems, following design approval by the City.

In 2001, the first Drought Emergency to be announced since 1989 was declared in **New York City**. The reservoir levels were 40% below normal which resulted in mandatory water use restrictions. The Water Resources Group (WRG) was founded as a response to this single drought year. Since then WRG and GrowNYC have built 35 rainwater harvesting systems in New York City, collecting over 422, 900 gallons of storm water per year.

"New York City currently lags behind other cities like Boston and Chicago, which capture 90% of their combined sewage overflow; New York City only captures about 70%, according to the city"[4]

Materials

Every rain water harvesting system is different but they do have similarities. Here is a comprehensive list of tools and supplies. Your system will use many of these but may not require all of them.

Tools:

- Drill
- Hole saw attachment or jigsaw
- Screw drivers
- Hammer
- Level
- PVC saw (see top saw in picture) and metal hacksaw (bottom saw)
- Tin snips or sheet metal shears
- Crimping tool (see picture on right) and cable cutting tools

Gutters:

- Gutter lengths
- Leaders and bends
- Pre-fabricated gutter hangers
- Plumbing strap (for securing pipes to wall)
- Flexible, accordion style expandable plastic pipe
- Tube of gutter sealant and caulk gun to apply it
- PVC cleaner and cement
- Teflon tape (for creating a water tight seal on threaded bushings)

Barrel storage system:

- Tanks and PVC parts or other materials to construct the manifold. Here we have a capped 4 way tee (see leftmost picture) and a 90° and 45° elbow respectively (see rightmost picture)
- Window screen or screened vents for mosquito proof vent
- Bulk head fittings (An elongated compression fitting, which will allow pipe, to run through a bulkhead)
- Platform material such as treated lumber, plastic lumber or concrete blocks
- Eyebolts (for securing tank)
- Spigot
- Metal flanges of corresponding size to spigot and hardware
- Rope or cabling supplies to secure the tank

Where to obtain supplies

Polyethylene tanks are best purchased locally because of high shipping costs. Search online for local suppliers. You can personally ship smaller tanks and save on extra expenses. Here are some websites that sell tanks:

- http://www.liquidlogictanks.com/index.html
- http://www.tank-depot.com/
- http://www.rainbarrelsource.com/
- http://www.rainbarrelsandmore.com/
- http://www.aquabarrel.com/

Drip irrigation suppliers include:

- http://www.dripdepot.com/
- http://www.dripirrigation.com/
- http://www.rainbird.com/drip/index.htm
- http://www.dripworksusa.com/
- http://www.netafim.com/
- http://www.chapindrip.com/
- http://www.farmtek.com

Downspout filters and a variety of other specialized parts for systems can be purchased from:

- http://www.starkenvironmental.com/a-1-filtration.html
- http://www.braewater.com/
- http://www.rainharvesting.com.au/default.asp
- http://downspoutfilter.com/index.php
- http://rainharvest.com/shop/default.asp

Tools and PVC gutter pieces can be purchased at your local hardware stores. Lowes or Home Depot also sells these items. For locations near you, visit their websites at http://www.lowes.com/ or http://www.homedepot.com.

Cost Estimates

Note that the prices listed indicate the values in 2008. Adjust for a 15% – 20% annual increase.

Polyethylene tanks: Generally, tanks cost $1 per gallon but it can sometimes be too big to transport on your own. Shipping costs are about an additional $1 per gallon.

Leaders and Gutters: The number of leaders and gutters needed per site will vary depending on the roof configuration. A 10-foot long gutter is $15.00, a 10 foot long 2”x 3” leader is $9.00, and a 10 foot long 3”x 4” leader is $16.00. Connecting parts, corners and bends are anywhere from $2.00 to $10.00.

Platforms: Platforms for containers can be made out of cinder blocks, plywood or any other sturdy material. While the tank is light when it is empty, remember that a full tank of water can weigh thousands of pounds. A small 55 gallon tank weighs over 400 pounds when full! Be sure that your platform is strong enough to withstand large weights. Cement blocks can be scavenged from construction sites. Should you have to purchase them, 8” x16” cement blocks are $ 1.50 each. The lumber prices are $16.00 for a pressure treated 8 foot long 2”x 10” piece or $13.00 for a pine or fir 8-foot long 2”x 10” piece. An 8 foot long 4” x 4” piece costs $12.00. 4” x 4” lumber laid lengthwise in alternating directions placed on a gravel base makes a sturdy platform (see picture on page 25). Using poured concrete pilings and a built wooden deck for a platform may cost about $500.

Miscellaneous Hardware and specialized parts: This category includes accordion connector pieces, screens, sealants, sheet metal, screws, nuts, bolts, gravel, filtering parts and supplies, roof washers, weed fabric and other specialized parts. These parts will vary by site and type of barrel.

Plumbing Supplies: The amount of plumbing you need varies depending on the system you are making. This category includes overflow pieces, PVC pipes, connector pieces, rubber fittings, spigots, bulkhead fittings and the piping needed to draw the water away from the system. Upgrades will include soaker hoses or other type of overflow disperser and roof washers. A sophisticated drip irrigation system could add $500 – 1000 to the cost.

Tool Kit: Some specialty tools are needed such as drill bits, screw bits, hacksaw blades, tin snips, hole saws, caulk gun, caulking or silicon, jig saw, pliers and tape measures.

Cost analysis for a 300 gallon rainwater system in 2008

Tank	$300
Shipping of Tank	$300
Leaders and Gutters	$100
Platform	$300
Hardware	$100
Plumbing	$100
Tool Kit	$50
Total Cost	$1250

Cost analysis for a 1000 gallon rainwater system in 2008

Tank	$1000
Shipping of Tank	$1000
Leaders and Gutters	$200
Platform	$600
Hardware	$200
Plumbing	$200
Tool Kit	$50
Total Cost	$3250

If there is not already an existing roof or shed nearby, a shade structure can be constructed. One possible design is the winged structure seen here:

Cost analysis for a 300 gallon rainwater system with winged structure in 2008

Tank	$300
Shipping of Tank	$300
Leaders and Gutters	$100
Platform	$300
Hardware	$100
Plumbing	$100
Tool Kit	$50
Materials for Shade Structure	$2500
Total Cost	$3750

PVC Applications

Up to now PVC or polyvinyl chloride has been the key piping material in the rainwater harvesting systems in NYC community gardens. This hard plastic is inexpensive, durable, easy to use and readily available. Tees, elbows, bushings and couplings are all made out of PVC. Although PVC is fairly stable, there are environmental hazards in manufacturing and burning PVC. We are currently looking for other sources that are more environmentally benign but also having the same flexibility with parts as PVC does. Although metal can be an alternative, it can be costly. If there is a material that you think can be a replacement for PVC, please add your information or comment to this wiki: http://www.waterresourcesgroup.org/wiki/index.php?title=Main_Page.

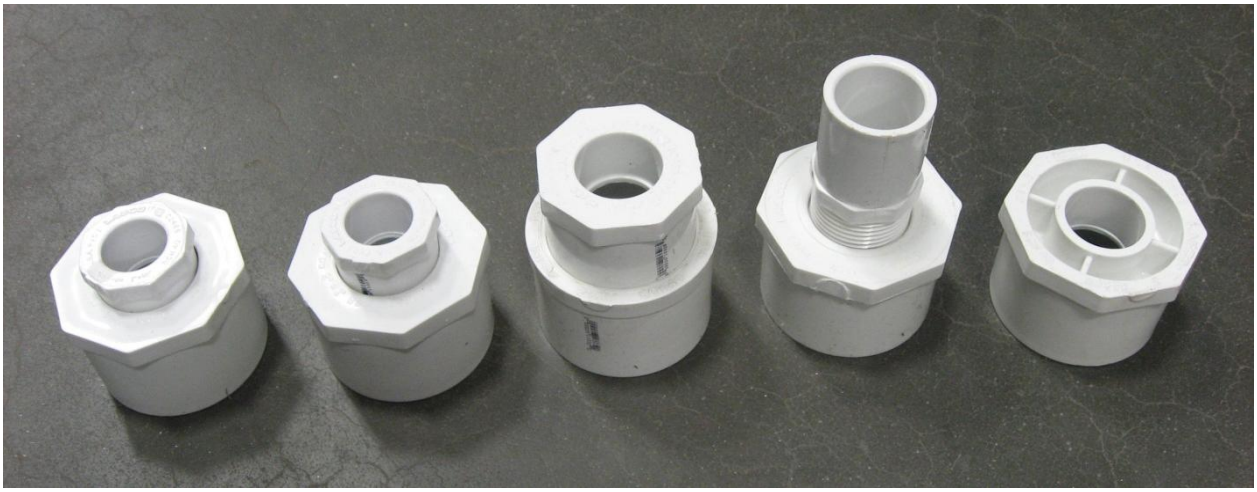
In order to join PVC pipes together, use PVC specific cleaner primer and cement. PVC cleaner primer removes dirt and melts the surface for ultimate adhesion. After the pipe is clean, you can use cement to join the two pieces together. Only apply cleaner and cement to the outside part of the male piece (see picture on left) and the inside part of the female piece (see picture on right). It is important to hold the two pieces together for 20 seconds after applying the cement because they may move apart. After 20 seconds, the two pieces are permanently joined (see bottommost picture). Wipe off excess glue.

Use bushings and reducer fittings when it is necessary to change the size of your pipes. These come in a wide variety of glue (slip) and threaded designs.

This 2”x 1 ¼” slip bushing connects a 2” (diameter) piece of pipe with a 1 ¼ “pipe. Slip bushings can be adhered using the cleaner and cement method mentioned above.

This 2”x 1” slip and thread bushing connects a 2” slip pipe with a 1” threaded pipe. Thread bushings can be adhered tightly using Teflon tape. Roll the tape starting at the end of the male thread bushing towards the middle. Two or three wraps are sufficient.

PVC parts are very versatile since no two rainwater harvesting systems are alike. Many different combinations of PVC parts can be used for the same function. Here are 5 different ways to connect a 2” pipe with a ¾ “pipe.



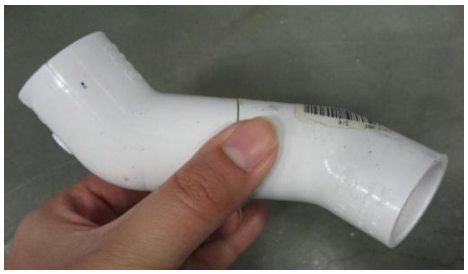
It is very important to align adjacent pipes. The two tees in the first picture (see picture below) must align exactly in order to connect to the same wall. Careless glueing will lead to problems. Use a hard, level surface such as a concrete floor to help you align pipes.

The pipes in the second picture (see picture on left) must be exactly perpendicular to each other. The tee on the left will connect to the barrel. The tee on the right will connect to existing pipes. Use a marker to indicate the points where the one pipe must meet the other.

The pictures above also point out the use of piping. Notice how the two tees are joined in each picture. In the second picture, the two tees are joined by using a small piece of pipe in between them, called a sleeve. The interior coupling is too short to be seen in this picture. In a situation where you want the tees to be further apart, such as in the first picture, just extend the size of the pipe to the desired length.

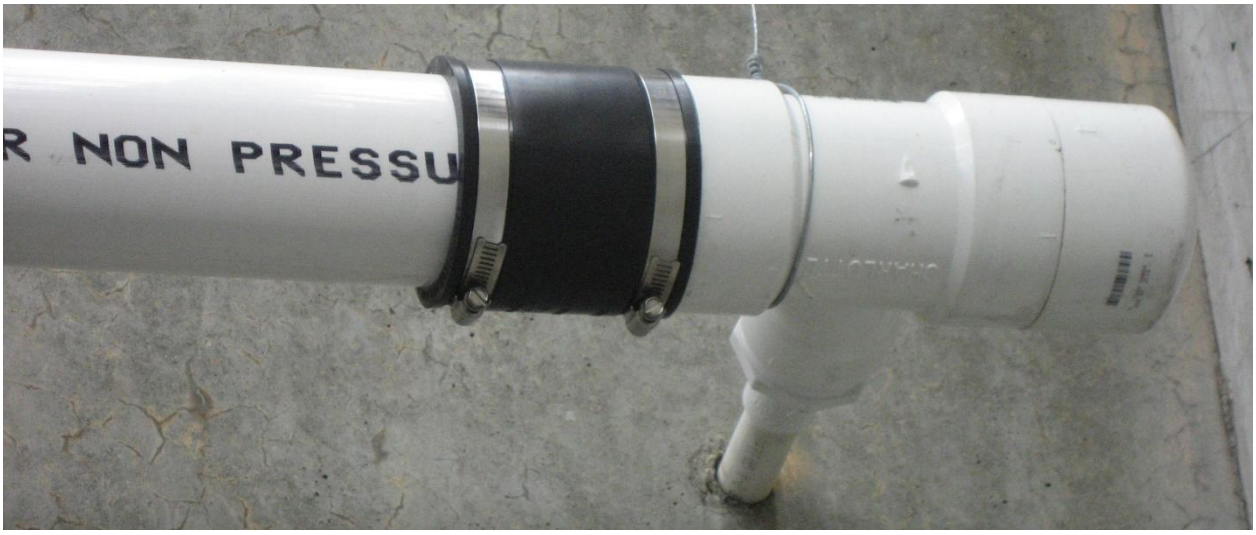
Although every rainwater system must be carefully planned before actual construction begins, it is very easy to miscalculate or measure incorrectly. Often times, errors are not realized at first. To fix a measurement or connection problem where the 2 pipes that were intended to connect do not match up, use two 45° degree elbows. A combination of two 45° elbows will produce almost any twist or angle desired.

Two 45° elbows can make a 90° degree twist or a 180° degree twist.



Two pipes that did not connect before can now be connected with the help of two 45° elbows.

It is also possible to shorten the PVC pipe by cutting and reconnecting it with a rubber coupling. Notice that the pipe below is too long to connect with the smaller pipes attached to the wall (see top picture). It was shortened and reconnected using a rubber coupling (see bottom picture).



Sizing of the tank and roof washer

A variety of rainwater systems can be constructed for the same downspout and roof. Here are two different systems that have been installed over the years at the 1100 Block Bergen Garden in Brooklyn. It is generally better to have a single barrel rather than multiple barrels because of possible leakage from the numerous connections. The 9 barrels in the original system had 17 connections. There were 17 locations where leakage could occur as opposed to 1 location in the current system.

The capacity of the system should be determined by two factors: the size of the roof, which determines how much water can be collected and the size of the garden, which measures how

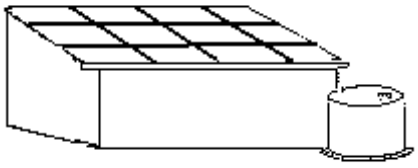
much water is needed. A 300 gallon vertical cylindrical storage tank is approximately 42 inches in diameter and 51 inches tall. A 1000 gallon polyethylene tank is approximately 92 inches in diameter by 60 inches tall or 61 inches in diameter by 100 inches tall.

The amount of water you can harvest varies depending on the size of your roof. You will be surprised how much water you will be able to collect from even the smallest roof. **The rule of thumb is 600 gallons of water per inch of rain per thousand square feet of catchment area.** Not all the rain that falls can actually be collected. Efficiency is usually presumed to be 75% depending on system design and capacity. Here is the basic formula for calculating the potential amount that can be collected:

$$\frac{\textit{(Catchment area) x (inches of rain) x (600 gallons) x (.75)}}{\textit{1000 square feet}}$$

Remember that a roof can have several downspouts. Your catchment area only consists of the region where the downspout that is connected to the rain barrel collects from. Pay attention to the gutter and slope of the roof to determine which part is your catchment area. In order to calculate the catchment area, use measuring tape to determine the width and length of your roof in square feet. Multiply the length and width of your catchment area for the area of your roof.

The sample roof shown below (see picture below[5]) has a catchment area that is 40 feet wide and 30 feet long. Hence, it has a 1200 square feet roof (40 feet wide x 30 feet long). Assume that it rains 2 inches. We can now plug this information into our general formula (see equation above).



Catchment Area = 1200 square feet
Amount of Rain = 2 inches
Gallons of water collected per inch of rain per 1000 square feet = 600 gallons
Percent Efficiency = 75% or .75

$$\frac{\textit{(1200 square feet) x (2 inches of rain) x (600 gallons) x (.75)}}{\textit{1000 square feet}} = \textit{1080 gallons}$$

Therefore a 1200 square foot roof will collect 1080 gallons of water on a day with 2 inches of rainfall. Using this formula and your region's average rainfall numbers combined with an estimated water need, you should be able to calculate the approximate size of your tank or barrel system.

Roof washer sizes also differ according to the size of the roof. **The rule of thumb is one to two gallons of roof washer capacity for every 100 square feet of catchment area.** A 1 foot length of 6 inch diameter PVC pipe holds 1.5 gallons. A 1 foot length of 4 inch diameter PVC pipe holds .66 gallons.

We will use the same 1200 square foot roof shown above as an example. Since the rule of thumb suggests one gallon of roof washer capacity for every 100 square feet of catchment area, the sample roof will need 12 gallons of roof washer capacity.

If you are using 6 inch diameter pipe, use the following formula:

$$\frac{\textit{Number of gallons of roof washer capacity}}{\textit{1.5 gallons/ feet}}$$

The size of our roof washer on our sample roof can be calculated by:

$$\frac{\textit{12 gallons of roof washer capacity}}{\textit{1.5 gallons / feet}} = \textit{8 feet of 6" pipe}$$

If you are using 4 inch diameter pipe, use the following formula:

$$\frac{\textit{Number of gallons of roof washer capacity}}{\textit{.66 gallons / feet}} = \frac{\textit{12 gallons}}{\textit{.66 gallons/ feet}} = \textit{18 feet of 4" pipe}$$

Therefore a 1200 square foot roof will need 8 feet of 6" diameter pipe or 18 feet of 4" diameter pipe. Remember it is possible to separate long lengths of roof washers into several, continuous pipes instead of just one long pipe.

Construction

The first step of the construction project is to make a plan drawing. The plan drawing considers the location of the downspout and the amount of space available. Each system must include the tank, the first flush and the overflow. Here are some issues that should be considered in your planning:

• The most stable place to position your barrel is against a stable wall on level ground as close to the downspout as possible.
• Gravity moves water downhill. Be sure there is available space for a downward pitch in all pipes.
• The barrel on its platform is the highest point of the garden but the lowest point of the system.
• The overflow pipe should be directed toward a rain garden not toward pathways or structures.
• The overflow pipe should flow from the barrel's highest point.
• The spigot should be at the barrel's lowest point.


overflow pipe
roof washer
system


roof washer
system
overflow pipe

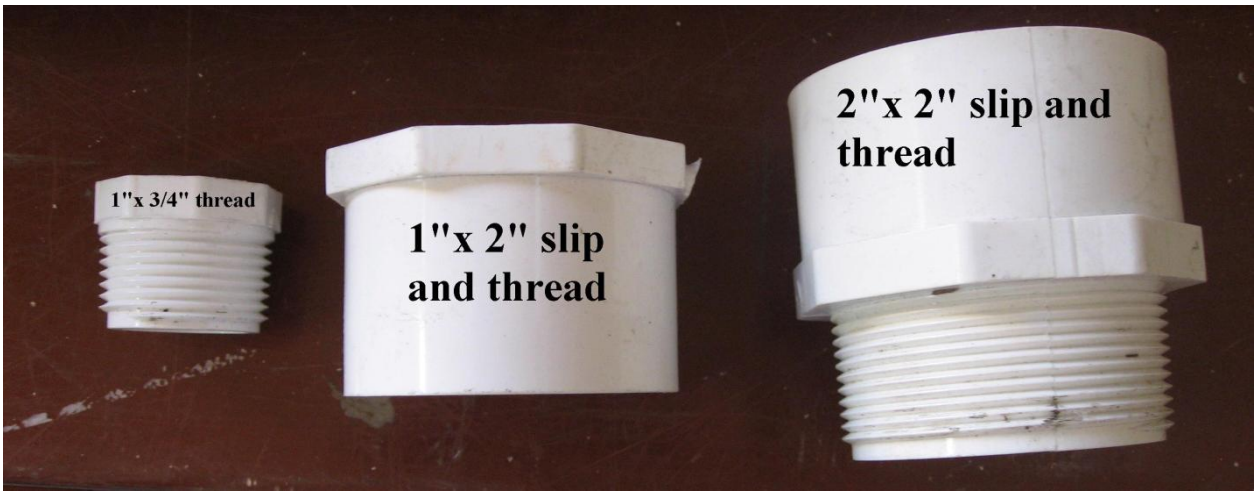
Tanks

Tanks can be made from all sorts of materials such as cement (see picture on left[6]), metal, ceramic and wood (see picture on right[7]). In tropical countries, a terra cotta tank can be used. No wintering tee is necessary for these tanks because there is no danger of freezing.

For design purposes, bladders can also be used to store water instead of tanks. Bladders are large, flexible bags functioning in a way similar to the water balloon (see picture on left[8]). This way, engineers can create storage tanks in a variety of shapes instead of the traditional cylinder.

The tank system includes the spigot, the inflow pipe, the overflow pipe, the lid and the platform it rests on.

Spigot: A variety of bushings can be used to connect the spigot. It is preferable to use a single reducer bushing but that is often not possible. For example, the tank's spigot hole is 2 inches in diameter. The spigot pictured here is a ¾ "ball valve hose bib. In order to reduce the 2" opening to the ¾"spigot, the following 3 bushings were used:



Lid: The lid should remain closed at all times. Still water is a haven for mosquito larvae. Inspect the lid and any vents annually and clean as necessary

Inflow and Overflow pipes: Some tanks come with bulkhead fittings installed for the inflow and overflow pipes. For those that don't, a hole saw is used to drill a large hole in the barrel. Two bushing pieces, like the ones pictured below, are used to fashion a bulkhead fitting.

Use a marker to trace the hole you will cut for the threaded bushings. Make the hole tight to the threads. Once the hole is prepared, thread the first piece in from the outside.

Thread the second piece from the inside of the tank using a flexible wrench. Use gutter sealant to create a watertight seal.

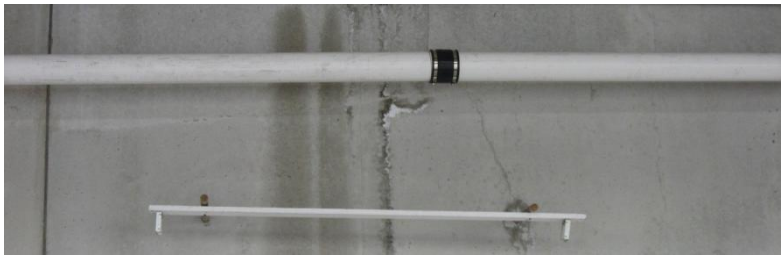
Platform: The purpose of the platform is to raise the tank enough to get your watering can under the spigot and to create pressure flow for a hose. Spread a thick gravel base over an area slightly larger than the platform. This will promote good drainage and allow for final leveling once the platform is built.

A stable arrangement of cement cinder blocks, like this one, makes a great platform for small 55 gallon tanks but is not ideal for larger tanks. Since the blocks easily shift, rot resistant 4”X 4” or 6”X 6” lumber laid out in alternating rows is the best option for a platform. Steel platforms are also a possibility but are more costly. Be sure to level and compact the ground well where the tank will sit.

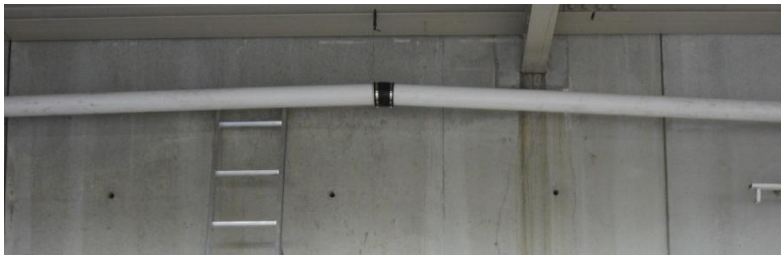
Warning Signs: Do not drink the water collected. Only use it to irrigate your garden. Installed PVC is inert and it is used as a water supply pipe for house trailers and other homes. The possible contamination is almost exclusively from harmful bacteria. For water to meet drinking water standards it must be treated, usually with chlorine, often filtered and sometimes treated with ultraviolet light. A warning sticker or sign should be placed on your rain barrel to avoid the possibility of anyone mistakenly drinking the water.

Leaders

The leaders of the rain water harvesting system refer to the series of pipes that lead to the tank. This includes the pipe that connects the downspout, the wintering tee, the roof washer system and the pipe that connects the barrel. Gravity keeps the water flowing. Remember to put a downward pitch on all pipes. A quarter inch down for every linear foot will create an adequate pitch. Use a level (see picture below). It may be useful for someone to stand back to visually check the pitch and help you adjust the pipes as you are pitching them.



Keep pipes pitched downward.



DO NOT pitch pipes upward.

Keep the pitch of your pipes even and downhill. The picture on top is correct. The picture on the bottom has an upward pitch and will create problems.

Connecting the downspout: Our intent with rain water harvesting is to divert storm water, store it for future use and keep it out of the sewers. There are several options to divert the rain water: insert a 3 way tee into the downspout (see picture on left) or connect the existing downspout directly to the rain barrel (see picture on right). You can design your own custom diverter as well.

Another possibility is to replace the downspout entirely with pipes leading to your rain water harvesing system (see picture below and on the next page).

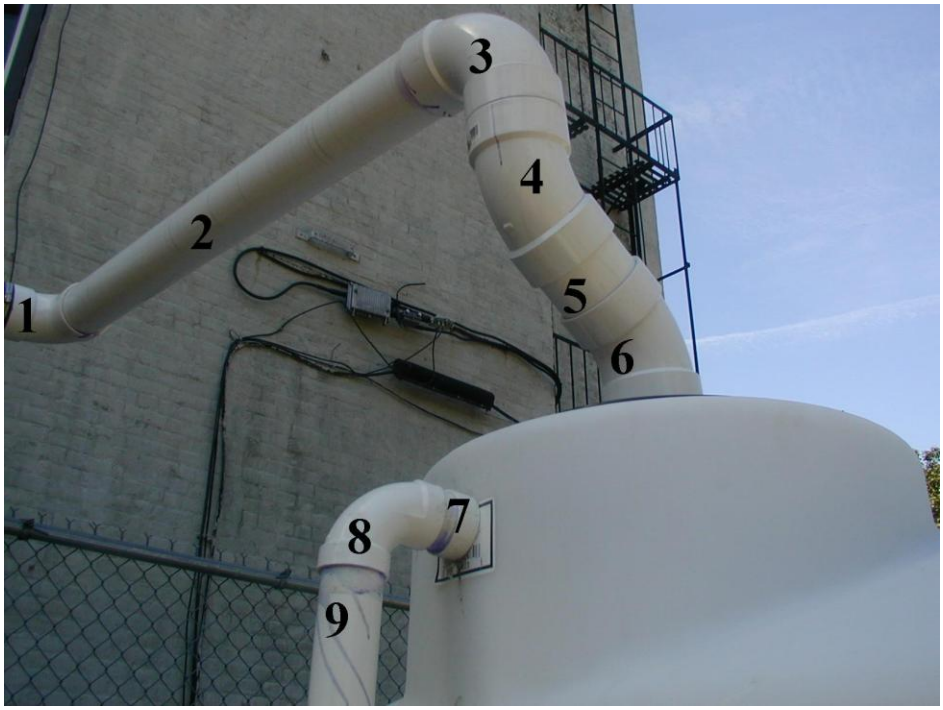
Connecting to the downspout is one of the last steps in construction of your system. You do not want to disconnect your downspout and start collecting rainwater with an unfinished system.

Wintering tee: The purpose of the wintering tee is to allow the water to be directed back into the sewers during freezing temperatures. Rain water should not be collected at that time because it may freeze and cause breaks in the system. A simple wintering tee utilizes a removable plunger head. The plunger head blocks water flow into the sewer and forces it to enter the system. It is removed during the winter and rain water will just flow straight down into the sewer (see picture on left and diagram on page 4). Complicated wintering tees include a filtering system. It operates with the same principle but instead of a removable plunger head, there is a removable filter which catches debris (see picture on right).

Roof washer system: Refer to ‘Roof washers’ on page 30.

Connecting the barrel: Refer to ‘Tanks’ on page 23.

Here are some ideas to help you with the design of your leader.



INFLOW
1: 90° elbow
2: 4"pipe
3: 90° elbow
4: 45° elbow
5: 4"pipe
6: 45° elbow

OVERFLOW
7: 2"bushing
8: 90° elbow
9: 2"pipe

This design uses a separate inflow and overflow pipe.

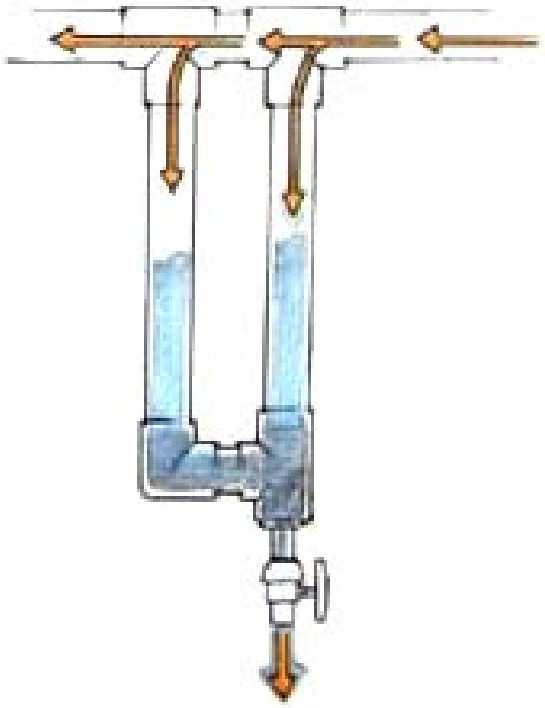
INFLOW
1: downspout
2: 4"rubber coupling
3: cap
4: 4 way tee
5: rubber coupling
6: 90° elbow
7: 4"sleeve
8: 4"rubber coupling
9: 3 way tee

OVERFLOW
10: 45° elbow
11: 90° elbow
12: 4"pipe

This design uses the same tank opening for both the inflow and overflow.

Roof Washers

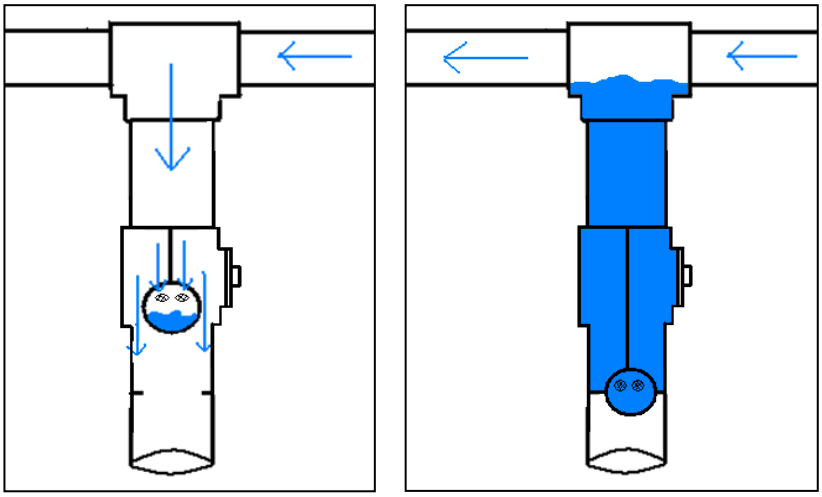
Roof tops are prone to collect leaves and dirt. The rain carries all this debris with it as it enters the gutter and downspout. The roof washer or first flush system is a simple way to filter the water you collect. It is a series of pipes that storm water flows into before entering the rain barrel. Once the roof washer is full, water will begin to fill the rain barrel without mixing with the dirty water contained in the first flush. The appropriate size of the roof washer varies depending on the size of the roof. Refer to 'Sizing of the tank and roof washer system' on page 18 for details on how to calculate roof washer size. Small first flush systems can be a single downward pipe. However, to accommodate larger roofs, first flush systems can be constructed of multiple downward pipes.



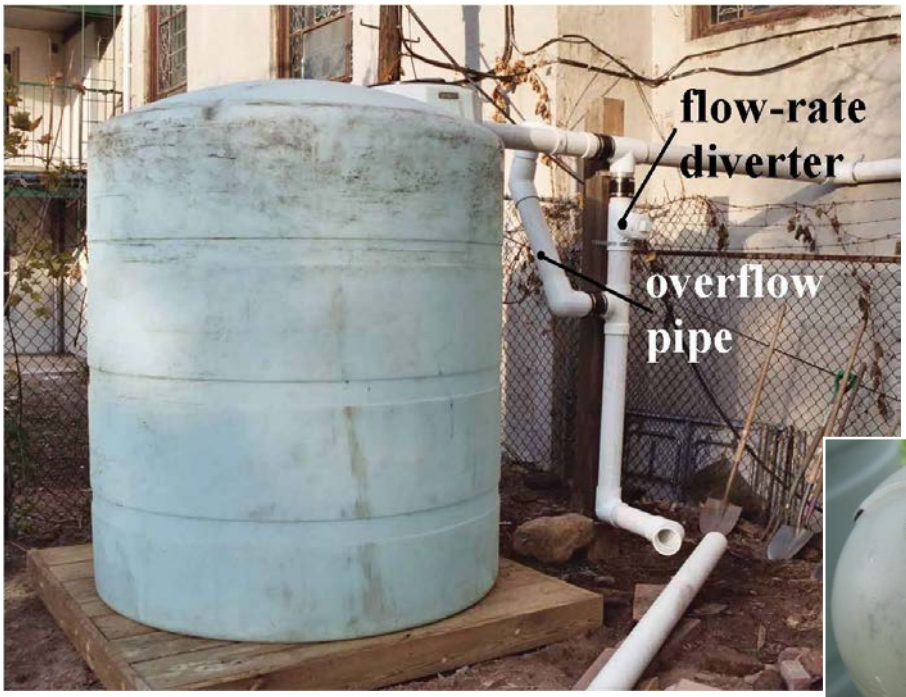
The roof washer must be emptied promptly after a rain event and valve reset in the closed position to be ready for the next rain. Drain the roof washer to a safe location. Include another spigot or valve in your design to drain the first flush.

An alternative to the container method of the roof washer is a device like the Flow-Rate Diverter by Safe Rain. It consists of a plastic ball attached to a spring. The top of the ball contains a screen and a movable tab. During a rainfall event, water that enters the pipe will either flow into the ball or on its sides (see picture on left). The purpose of the screen on top is to gradually allow water to enter the ball. Once the ball is filled, it will sink down and block the drain (see picture on right). Water can then start filling up the pipe and start entering the tank. The moveable tab controls the amount of water that enters the ball by covering or exposing the screen as desired. For example, larger barrels that require larger roof washers require a screen that is less exposed. Larger amounts of water will have to pass through the pipe before the ball can be filled. The ball will have a small drip hole to slowly empty once the rain has ended to then return to its original position to be ready for the next rainfall.

Entering rainwater will flow into this pipe. Some will enter the ball, making it heavier and some will flow past the ball and out of the pipe.



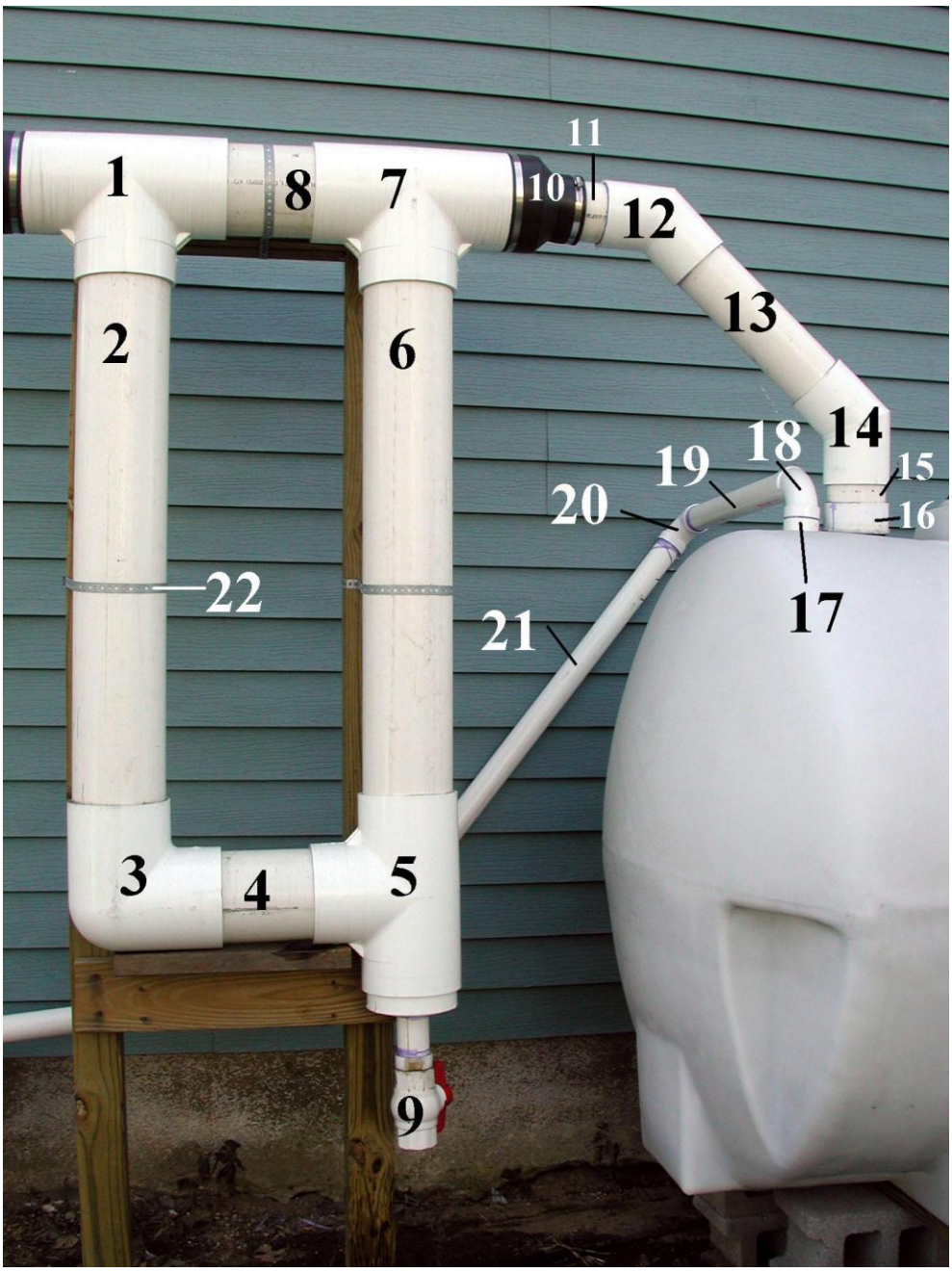
Once the ball is saturated with water, it will sink down and block the pipe. Water will fill up the pipe and finally enter the tank.



This device allows the overflow pipe to be connected to the roof washer pipe.

Water gradually enters the ball through this screen.

Here is an idea to help you design a roof washer of your own.



ROOF WASHER
1: 3 way tee
2: 6”pipe
3: 90° elbow
4: 6”pipe
5: 3 way tee
6: 6”pipe
7: 3 way tee
8: 6” pipe
9: drain valve

INFLOW
10: 6”x4” rubber coupling
11: 4” pipe
12: 45° elbow
13: 4”pipe
14: 45° elbow
15: 4”pipe
16: bushing

OVERFLOW
17: bushing
18: 90° elbow
19: 2”pipe
20: 90° elbow
21: 2” pipe

ANCHORING
22: plumber’s strap

Although this rainwater harvesting system has a good roof washer design, it does not have a good overflow design. Excess water will back up into the inflow pipe before the overflow pipe starts working. The overflow pipe should also be the same diameter as the inflow pipe to avoid a bottleneck situation.

Overflow pipes

When the rain barrel reaches its capacity, the overflow pipe discharges the excess water so that water won't start spilling out from around the lid. Cut a hole near the top of the barrel and connect an overflow pipe there. Be sure that the overflow pipe is not directed toward water-sensitive structures or areas where water can collect and do damage. The overflow pipe should be the same size as the inflow pipe so that a bottleneck situation is avoided during heavy rainfalls.

Here are some ideas to help you design an overflow pipe of your own.

OVERFLOW
1: bushing
2: 2"pipe
3: 45° elbow
4: 45° elbow
5: 2" pipe

The overflow pipe is connected back to the sewer. Building systems close to the downspout requires less piping.

OVERFLOW
1: 2” pipe
2: 90° elbow
3: 2” pipe

Instead of directing water back into the sewer, you can direct the water into a rain garden, gravel filled trench or connect it to a drip irrigation system. Overflow can be turned into works of art. Here the overflow is turned into a small water course (see picture on below), which ultimately ends in a rain garden.

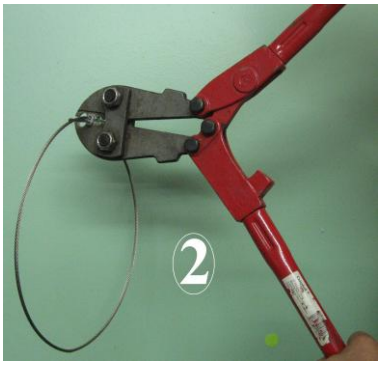
Rain gardens are depressed plots of land (see pictures below). It should be at the lowest point in the garden so that water can flow there easily. Dig a deep trench and fill it with 5 inches of gravel for seepage. Cover this area with burlap netting so that the soil will not sink down into the gravel. Place a couple of inches of soil on top and start planting. Only plants able to survive both dry and saturated soil should be grown. Native plants are also encouraged because they are more tolerant of local climate and soil conditions. These plants include wildflowers, ferns, shrubs and small trees. [9] Brooklyn Botanic Garden provides a thorough list of rain garden plants for different regions on their website at:
http://www.bbg.org/gar2/topics/design/2004sp_raingardens.html

Bioswales are alternatives to rain gardens. They are depressions in the landscape with collections of rock, gravel and vegetation that act as a filter for water. They effectively strain silt, inorganic contaminants, organic chemicals and pathogens. The longer the water is trapped inside the bioswale, the easier it is for pollutants to be trapped. They are most commonly found surrounding a parking lot so that oil runoff can be filtered before entering the sewer system.[10]

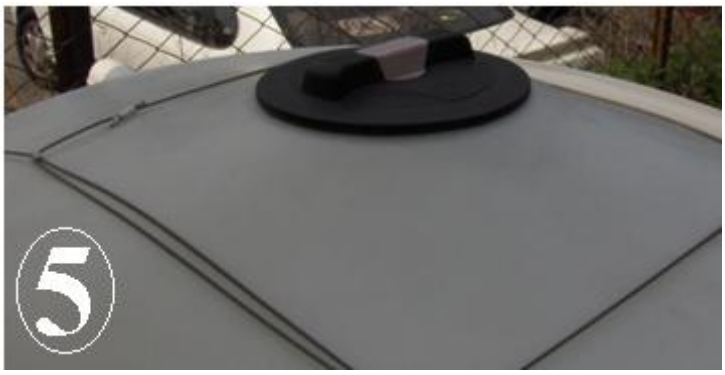
Anchoring

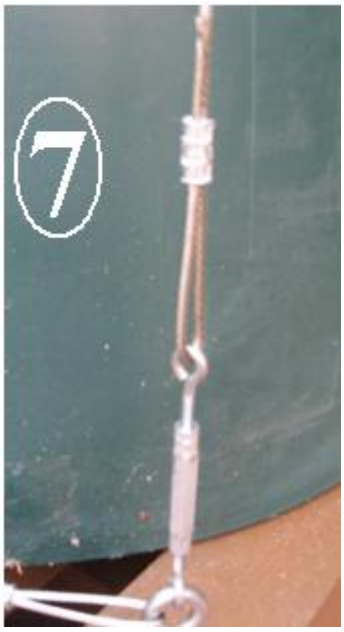
Because the rain barrel is fairly light and may tip or fall when it is empty, it is important to anchor the system to the platform or a structure. The easiest method to tie down your system is to use nylon rope. Steel cable is also a solution. Since cabling is more complicated, we will illustrate these steps.

Cut a piece of steel aircraft cable and slip 5 cable swedges in it Use the first piece of cable swedge **(see picture 1)** and a crimping tool to connect it into a circle **(2).** Its circumference should be a less than the circumference of the rain barrel but more than that of the lid. Cut two more long pieces of steel cable. They should be at least twice the height of the rain barrel. Use one cable and slip it through two of the metal cable swedges that are already on the circle. Making sure both lengths of cable are even; use the crimping tool to secure the metal swedges in place. Do the same with the other cable and two metal swedges **(3).**



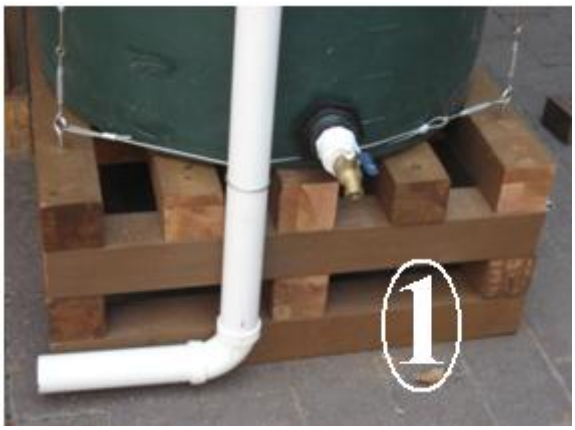
Screw a metal eyebolt into each of the four corners of your platform. Connect a turn buckle to each metal eyebolt **(4).** Place the series of cables onto your rain barrel. The circle should be on top of the rain barrel **(5).** The four hanging ends should be facing each corner of the platform. Loop the ends of the cables into the turn buckle **(6).** Use a metal swedge to secure the loop. Do this for all four corners. Finally, twist the turn buckles until the metal cables are taut **(7)** to finish securing your rain barrel **(8).**



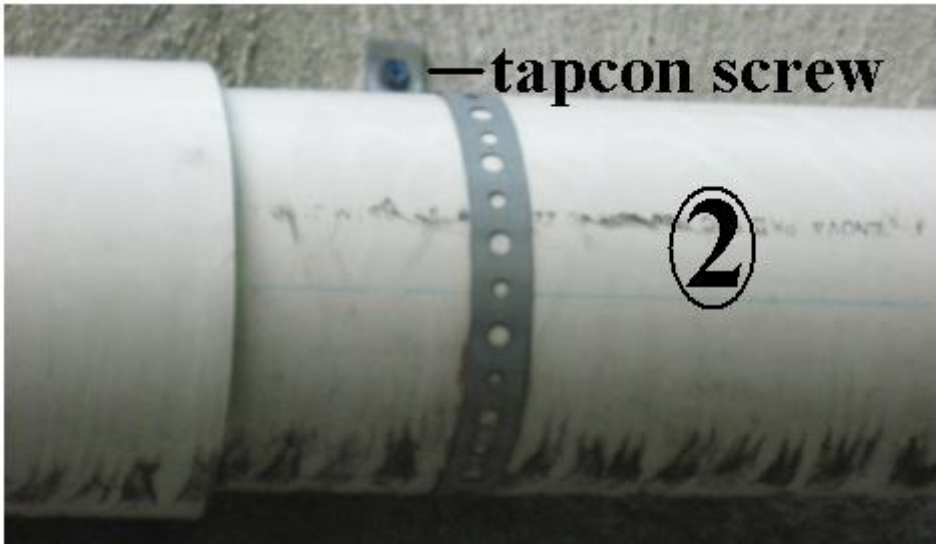


For cinder block platforms, nail a thick wooden plank on top and use the eyebolt method mentioned above.
Pre-fabricated steel brackets are generally used to anchor horizontal tanks.

It is a good idea to anchor pipes as well. If the pipe is hugging the rain barrel, anchor the pipe to that platform using cable **(see picture 1),** perforated plumber's strap **(2)** or other methods.



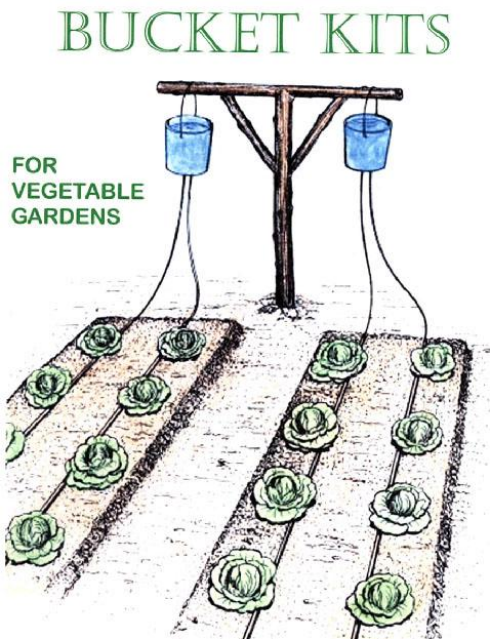
Pipes that are directly against the wall of a building can be secured to the wall using plumber's strap attached with tapcon screws, which seal the hole drilled in the wall to avoid leaks **(2).**

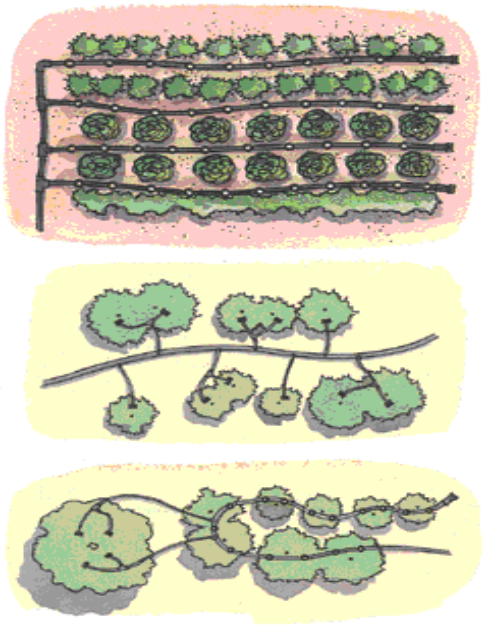


Drip Irrigation

Drip irrigation systems reduce water use. Small amounts of water are supplied to the base of plants. Since the water is applied directly to the soil, rather than onto the plant, evaporation from leaf surfaces is eliminated. The water is also placed where it is needed rather than sprayed over the entire garden.

With a drip system, water flows into a series of thin flexible hose lines. These irrigation hoses have tiny holes at even intervals. These hoses are placed on the surface or beneath a layer of mulch. When water enters the system, it slowly trickles out of these holes and waters the roots of plants (see pictures below[11]). The overflow of rain water harvesting systems is sometimes connected to these smaller pipes.





Tubing comes in many sizes (see pictures below[12]). It is used to get the water from the source to the garden. A variety of fittings are available to go around corners and to connect pieces.

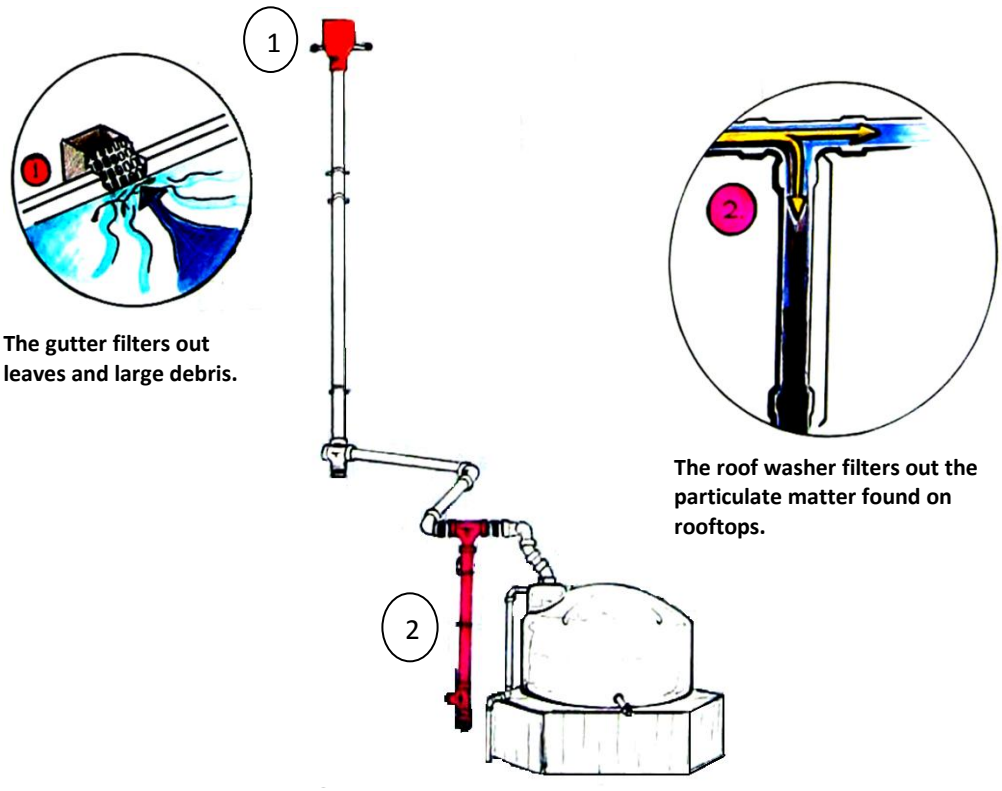
In most cases, no special tools or skills are needed. Plastic pipe is punched with an inexpensive tube punch that assures the proper hole size. Spaghetti tubes snap into the hole. No gluing is required. Because the holes are small, they can easily be plugged if you put one in the wrong place.

Gravity Feed Drip Irrigation Kits are used to connect to rain barrels and rainwater harvesting systems where the water pressure is low (see picture below[13]). This system uses small ¼ inch valves instead of emitters to avoid the problem of clogged emitters

Drip Irrigation systems need planning, but are neither expensive nor difficult to install. Most drip irrigation suppliers will help you design a system to best meet your gardening needs. Drip systems require periodic maintenance. Check regularly for leaks and broken connections.

Filtration Systems

This rain water harvesting system already has two means of filtration, one at the gutter **(see picture 1)** and the other at the roof washer **(2).**



The gutter filters out leaves and large debris.

The roof washer filters out the particulate matter found on rooftops.

This gutter screen that is put at the mouth of the downspout (see picture on right) prevents leaves and other large debris from entering the system. If you want to buy a filter, two choices are Rain Keeper Downspout filter for smaller roofs and the Rain Keeper Downspout collection filter for smaller systems. Refer to “Where to obtain supplies” on page 11 for more information.

Treatment

During warm weather, bacteria may grow inside the storage tank. Organic matter also poses a problem as algae or other contaminants may grow in storage tanks.WRG recommends adding a small amount of chlorine, in the form of unscented household bleach, to your water storage tank. Do not use bleach with any additives like fragrances or softeners. A log should be kept to ensure the proper addition of the chemical. Store log with bleach container. Please remember to wear gloves when handling bleach, to store bleach in a cool, dry place and to label bottle clearly to avoid improper use. On the 1st of each month, add a small amount of bleach to *each* water storage container. If the tank is emptied and refilled in less than one month's time, an application of bleach should be added to the tank when it refills

Tank Size	Amount of Bleach to Add
1000 gallons	1/3 cup
750 gallons	1/4 cup
500 gallons	3 tablespoons
50 gallons	2 teaspoons

Regularly emptying the roof washer and the addition of a small amount of bleach to your tank will ensure the water is safe for watering vegetables. The water stored in the tanks is for ***irrigation purposes only*****.** It is safe to use on vegetables and other plants in the garden, but it is not safe to drink. The quality of this water does not comply with local and national drinking water standards.

Aesthetics

“The most beautiful system is carefully constructed and incorporates a carefully thought out, well designed and installed plumbing system.”

-Lars Chellberg, GrowNYC staff member

Although a rain barrel is considered by some to be unsightly, it is easy to beautify your rain water harvesting system. PVC pipes and tanks can be covered by plants or painted (see pictures below).

A gazebo at this Seattle community garden covers an underground cistern that stores 5,000 gallons of collected rainwater (see picture below).

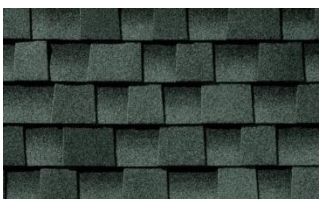
Promoting the sustainable practice of rain water harvesting is also important. For example, NYC community gardens use a “This garden harvests rain water” sign (see picture on right), a good idea to put in front of your system. Have printed information for people to learn more about rain water harvesting like this Water Resources Group brochure (see picture on left).

Sometimes it is necessary to break some basic RWH rules for aesthetic reasons. This rain water harvesting system has an inflow pipe that is pitched upward which means that it must rain enough for the water to fill up the roof washer and the inflow pipe before it can enter the tank. This was done so that the roof washer could be positioned below the brick wall and not interfere with the tree limb or the neighbor’s views.

Roofing Material

Roof tops are essential to any rain water harvesting system. Popular types of roofing include corrugated metal decking, shingles, rolled asphalt and cedar shake.

Corrugated metal decking can come in two forms- zinc coated or hot dipped galvanized. Because, zinc coated roofs rust easily, hot dipped galvanized roofs are more popular. These roofs are constructed simply by nailing down with sealing washers to your structure or screwing. Apply gutter sealant on any nail or screw to make sure water doesn't leak from these spots. Metal roofs provide great structural support for long amounts of time. It has the highest efficiency rate when it comes to rain water harvesting because of its waterproof surface. Its only downfall is the noise factor. It gets very loud when rain water clashes with the rooftop. It is an ideal roofing material for non residential structures.



Shingles are small pieces of overlapping wood or slate. Place a ½ inch wide piece of plywood on top of the structure. Start nailing shingles in a horizontal, overlapping fashion starting from the gutter line.

Work your way up to the top of your roof, making sure your next row overlaps the previous row (see picture on left[14]).

Rolled asphalt or modified bitumen roofs occur most commonly on flatter rooftops. A large sheet of asphalt is simply glued down with tar or plastic. Asphalt roofs can either have a granular surface or a smooth surface. Although granular surfaces are slightly less efficient in catching rain water because it is easily trapped in the pieces of ground glass, it is preferred over smoother roofs. Granular roofs wear slowly, resist cutting and keep UV rays from degrading it. Typically, a few years after the granular roof is installed, it is painted with aluminum to lock in grains that may have fallen loose (see picture on right[15]).

Cedar shake or wooden roofs are installed in a vertically overlapping fashion. Wood is the least efficient in catching rain water because it is porous. However, once the wood is saturated, it will no longer absorb water (see picture on left[16]).

Seasonal Maintenance

To ensure your health and safety the Water Resources Group recommends the following seasonal maintenance schedule for keeping your rainwater free of contaminants.

Spring

- Close spigot
- Re-direct roof water from the drain pipe back into tank storage system by replacing the in-line plunger or changing the position of the valve
- Clean any winter debris from gutters, leader inlets and roof
- Repair any leaks in barrel or tanks
- Inspect and clean barrel tops
- Fill system with a few inches of water to check hose connections for leaks
- Inspect rope/cable retainers to assure that barrels are secure
- Be sure that your tank is labeled with a “do not drink the water” sign in all appropriate languages
- To help ensure that children do not drink the water remove the valve from spigot and store with tools

Summer

- Keep the roof, gutters and leader inlets clear of debris, check monthly

- Inspect vents at top of each barrel to insure that they are clean and intact
- Visit your system during a heavy rain or shortly after to check for leaks and overflow problems.
- Any water from the overflow system should drain within 24 hours of a rainfall; if puddles form, you should move the outflow pipe to a more porous site or consider installing a small rain garden
- Inspect pipes and connectors regularly for any damage or disrepair
- Check man-way hatch on top of your tank to make sure it is securely closed

Fall

- Remove plunger from the PVC joint to redirect water into the drain pipe to the sewer
- **Empty water from the entire system- roof washer and tank**
- Open main valve of storage tank and rain barrels
- Open valve on roof washer. Valves should remain open all winter to keep water from freezing in system
- Disconnect leader from system and re-route water as necessary for particular system
- Cover any openings in leaders

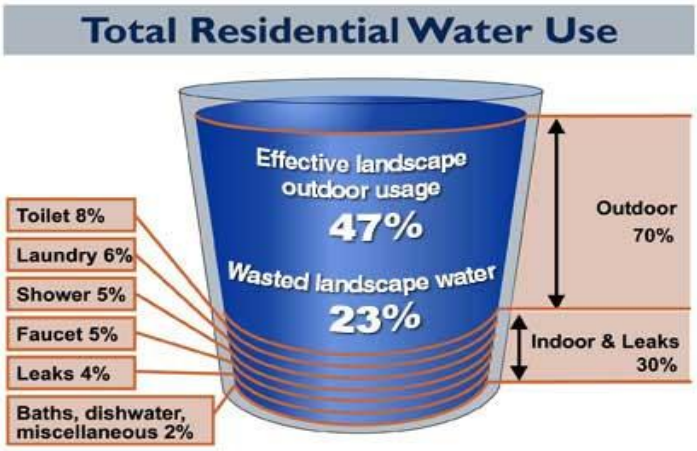
Living with the RWH System

Now that you have built your rain water harvesting system, you have helped to conserve one of the Earth's most valuable resources. A rain barrel is not something you build and walk away from. It is important to make sure there are no leaks in your barrel and to drain the first flush after every storm.

Remember to drain your roof washer and tank during the winter and to take out your wintering tee! Freezing water will BREAK the system. The cracks seen in the two pictures below are from left over water freezing and expanding.

If properly built and maintained, your rain water harvesting system will last many years. Even the smallest tanks will save thousands of gallons of water.

It is essential to learn how to manage your water usage. Seventy percent of residential water use goes to outdoor activities. One third of that water is wasted (see diagram on right[17]). Using pumps or sprinklers to water plants are one of the most inefficient ways to irrigate. Plants only need to be watered at the roots. Sprinklers relentlessly waste water by randomly shooting out water to tree branches or leaves. Drip irrigation systems with outlets placed strategically next to plant roots are the most efficient ways to irrigate.



Existing RWH Systems

Organic Gardening Magazine has been sponsoring construction of rain water harvesting systems in community gardens since 2007. Their Waterworks Project funded 30 systems in the past 2 years. Looking at existing rain water harvesting systems and talking to community gardeners may assist you in building your own. Locations in the USA and Canada include:

Alemany Farm - San Francisco, CA
Ashview Community Garden - Atlanta, GA
Aspen Farms - Philadelphia, PA
Boyd Street Urban Farm - Portland, ME
Bradner Gardens Park – Seattle, WA
Brentwood Community Garden - Portland, OR
Children Garden - Camden, NJ
City Seeds Urban Farm - St. Louis, MO
Dias y Flores – New York, NY
The Farm Garden at the Early Childhood Education Center - Columbus, OH
Fremont Community Garden - Sacramento, CA
The Garden of Dreams - New York, NY
Global Gardens - Tulsa, OK
Gloryland Community Garden, Detroit, MI
Growing Green Youth Garden, Buffalo, NY
Guadalupe Montessori School, Silver City, NM
Hope Community Garden - Toronto, ON Canada
Marigold Meadows - Phoenix, AZ
Master Peace Youth and Community Garden - Riverdale, MD
Our Saviour Community Garden - Dallas, TX
The 1100 Block Bergen Street Garden - Brooklyn, NY
Urban Ministry Center - Charlotte, NC
Wasatch Community Gardens - Salt Lake City, UT
Woodlawn Garden - Portland, OR
Xochiquetzal Peace Garden - Chicago, IL

For more information on these gardens, visit their website at:
http://www.organicgardening.com/feature/0,7518,s1-2-10-1531-1-1X2X3-4,00.html

This guide can be found on GrowNYC's website at:
http://www.GrowNYC.org/openspace/rainwater

10 Ways to Conserve Water

1. Turn off the faucet when brushing your teeth, washing your face and shaving.

2. Fix any leaky sinks, toilets or showerheads.

3. Wash only full loads- for clothing and dishes.

4. Do not run water to thaw meats.

5. Water plants at the roots.

6. Take showers instead of baths.

7. Replace showerheads and sink aerators with low flow ones.

8. Use a pitcher to store cold water in the refrigerator instead of running the tap every time.

9. Water plants during early mornings and late afternoons to reduce evaporation.

10. Do not flush the toilet unnecessarily. Dispose of bugs, cigarette butts and tissues another way. [18] [19] [20]

The Water Resources Group (WRG), a coalition of NYC greening & community garden groups is dedicated to the preservation of NYC water resources through gardening, ecological design and education programs. WRG is installing rainwater harvesting systems in gardens across NYC to conserve water and prevent pollution. For more information on how you can help conserve water in New York City, visit the Water Resources Group website at www.waterresourcesgroup.org.

If you have any questions regarding the construction of your rain water harvesting system e-mail Lenny Librizzi, Assistant Director of Open Space Greening at GrowNYC at llibrizzi@GrowNYC.org.

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This manual was put together by Julia Leung, Lenny Librizzi, Assistant Director of Open Space Greening at GrowNYC and Lars Chellberg.

After reading this manual, please fill out this feedback form and mail it to:

GrowNYC
51 Chambers Street, Room 228
New York, NY 10007

On a scale of 1 – 10, 10 being the most agreeable, 1 being the least, assess the following statements:

This manual is easy to understand.
1 2 3 4 5 6 7 8 9 10

This manual contains clear instructions.
1 2 3 4 5 6 7 8 9 10

This manual helped you make your rain water harvesting system.
1 2 3 4 5 6 7 8 9 10

You understand how a rain water harvesting system works.
1 2 3 4 5 6 7 8 9 10

You are no longer interested in rain water harvesting.
1 2 3 4 5 6 7 8 9 10

You would recommend this manual to your friends.
1 2 3 4 5 6 7 8 9 10

You know the importance of water conservation.
1 2 3 4 5 6 7 8 9 10

What are the strong points of this manual?

What are the weak points of this manual?

APPENDIX eight

NYC DEP PROCEDURE GOVERNING LIMITED GEOTECHNICAL INVESTIGATION

NYC DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF ENGINEERING DESIGN AND CONSTRUCTION

GREEN INFRASTRUCTURE

PROCEDURE GOVERNING

LIMITED GEOTECHNICAL INVESTIGATION

FOR

RIGHT-OF-WAY GREEN INFRASTRUCTURE PRACTICES

July 2017

Table of Contents

Appendix:

Limited Geotechnical Investigation

1 General

Limited Geotechnical Investigation is required prior to the design of these Right-of-way Green Infrastructure (GI) practices to determine soil characteristics, soil permeability rates, and depths to groundwater table and bedrock when encountered.

A Geotechnical Report including the above information, stamped and signed by a NYS Licensed Professional Engineer (P.E.), shall be submitted to BEDC-GI. The following sections provide details of the geotechnical investigation and reporting procedure.

2 Geotechnical Investigation

The Limited Geotechnical Investigation consists primarily of:

a) Soil borings to determine the soil characteristics (field observation and laboratory testing) as well as the depths to groundwater table and bedrock where encountered.
b) Falling-head in-situ permeability tests (PTs) to determine soil permeability rates.

In general, one soil boring and one PT (collectively referred to as B/PT) shall be performed at every Preliminary ROW GI practice considered for design. However, soil and PT data can be inferred from existing soil borings and PTs in the vicinity of GI practice locations.

For ROW Permeable Pavement, B/PTs are required at every street segment near the downstream end. Additional B/PTs may be proposed for longer streets at 150-ft spacing. For areas with permeable pavement planned for both sides of a street, the B/PTs shall be staggered on alternate sides of the street.

The following sections provide more detail on the soil borings and PTs.

2.1 Pre-Investigation and Planning

2.1.1 Boring Plan

Soil boring and PT locations shall be proposed in a Boring Plan and submitted to BEDC-GI for approval. At a minimum, the Boring Plan shall be comprised of the following: Boring Plan Map and Boring Plan Table with all pertinent information, including but not limited to all GI practices with correct GI IDs and GI Types where applicable (see attachments A); all soil boring and PT locations, existing historical data (see attachments B); and a summary of proposed borings and PTs.

Spacing analysis shall be performed for green infrastructure practices sited during the walkthrough to determine status of the GI practice. The Boring Plan shall show proposed GI practices as either “Preliminary” (GI practices which fulfill siting criteria and may proceed to

geotechnical investigations), or "Reserved" (possible alternative GI practices recommended wherever Preliminary sites are deemed unfeasible or insufficient to manage the TDA).

2.1.2 Historical Borings

Historical soil borings and PT data in proximity of proposed GI practices may be obtained from DEP or from the Department of Design and Construction (DDC).

Soil data for Preliminary GI practices may be represented by historical soil boring(s) within 50 ft of the practice in place of an intended soil boring, provided that the available information is sufficient. For example, if the boring log for such a historical boring location shows the soil characteristics up to 20 ft below ground surface (bgs) as well as depths to the groundwater table and bedrock (if encountered), then only PTs will be necessary for that location.

All historical boring data in the vicinity of the GI practice(s) along with distance from GI practice shall be included in the Boring Plan Table. The actual historical boring data in its entirety shall be submitted with the Boring Plan and as a part of the Geotechnical Report.

2.1.3 Pre-Drilling Site Checklist

Prior to any drilling work, the on-site Professional Engineer (P.E.) or representative of the P.E. (Rep.) must complete and sign BEDC-GI's latest Pre-Drilling Site Checklist (Checklist). The Checklist covers all required utility mark-outs, investigation tasks, Health and Safety Plan (HASP), and necessary documentation for each soil boring and/or PT location.

The Checklist must be kept on-site at all times during drilling operations, along with all associated documentation, and available to DEP personnel upon request. If, upon a site inspection, the Checklist is not found on-site, drilling operations shall cease immediately and permission to resume must be requested from and granted by BEDC-GI before any drilling operation resumes.

The P.E. or Rep. shall be on-site to observe the geotechnical investigation and is responsible for ensuring all geotechnical sub-consultants, drilling contractors, and other field representatives are following BEDC-GI standard procedures and protocol when performing geotechnical work.

The P.E. or Rep. shall document any pre-existing conditions at the site. The P.E. is responsible for any damages and injuries that occurs in the field. In the event of such incidents, BEDC-GI must be notified promptly.

2.2 Geotechnical Investigation Locations

2.2.1 Identifying Boring Locations on the Field

Soil borings and permeability tests shall be conducted in separate boreholes no closer than 5 ft apart. If a boulder or other obstruction is encountered during drilling for any GI practice, another attempt shall be made within 5 ft - 10 ft of the original borehole. Each borehole should be given a name corresponding to the GI ID and the test (B/PT) and the x,y coordinate of each borehole should be recorded.

For all Right-of-way GI practices excluding Permeable Pavement, soil borings and PTs must be performed within the footprint of the GI practice. In the event that drilling cannot be conducted within the footprint area, drilling should be done no more than 5 ft beyond the footprint of the Preliminary GI practice. If the prior two options are not possible, the B/PTs may be relocated to a Reserved site within 30 ft on the same side of the right-of-way as the original Preliminary site. If Drilling cannot be relocated to a Reserved location, an attempt to perform B/PTs shall be made a safe location within 30 ft of the original Preliminary location, and BEDC-GI shall be notified prior to drilling.

For permeable pavement, the B/PTs must be conducted within 20 ft of the proposed drilling location according to the approved Boring Map, and if possible, within the permeable pavement footprint.

No drilling is permitted in a location which blocks a driveway.

If drilling cannot be conducted at the planned location and no relocation options are feasible, consultant shall submit a recommended action (e.g. provide alternative drilling options, recommend rejection of the GI practice, etc.) pending BEDC-GI approval.

2.2.2 Field Measurements

All GI practices, soil borings, and PT locations represented on the Boring Plan Map shall be accurately laid, and obscuring of crucial elements must be avoided.

The Boring Plan Map shall be updated in a timely manner to reflect any deviations noted between the Boring Plan Map and actual field measurements.

2.3 Geotechnical Investigation Methodology

2.3.1 Drilling Procedure and Equipment

Upon approval by the P.E., geotechnical investigations are to be conducted using the following drilling methods:

- Direct Push Method with a 4-inch inner diameter casing
- Hollow-stem auger (HSA) with a 4-inch inner diameter hollow-stem
- Rotary Tri-cone Roller Bit cased by 4-inch inner diameter casing

Only water from a hydrant or any clean potable water source shall be used as drilling fluid. It is not acceptable to recycle the drilling fluid or to use drilling mud. Proper sediment control must be used at all times to control both coarse and fine particles in runoffs.

The P.E. should approve the drilling method that will minimize disturbance to the soil tested.

The P.E. or Rep. shall be on-site to observe the boring operation and keep a continuous and accurate Boring Log for each location recording all pertinent data. Refer to **Section 3.1.2** for details on the Boring Log.

In the event that no water or sewer records were obtainable for drilling, the P.E. or Rep. may direct drillers to excavate via air vacuum or hand auger up to the depth of the first soil sample or

PT (see **Section 2.3.4**. for soil sampling and PT depths). The reason for conducting this procedure must be properly documented and reported to BEDC-GI.

2.3.1.1 Standard Penetration Test

In each soil boring location, a Standard Penetration Test (SPT) shall be conducted continuously in accordance with **ASTM D1586** (i.e. a 24-inch long, 2-inch outside diameter split-barrel- sampler driven by blows from a 140-pound hammer falling freely from a height of 30 inches) to the depth detailed in **Section 2.3.4**.

The number of blows required to drive the 24-inch split-barrel sampler every 6-inch increment will be recorded. The Standard Penetration Resistance (N-value) shall be determined as the sum of the blows required to drive the sampler to the second and third 6-inch increments.

2.3.1.2 Soil Sampling

The P.E. or Rep. shall make visual observations for the soil at all depths at the time of the SPT, and record all pertinent observations as soil descriptions in the Boring Logs.

Soil samples that are representative of the actual recovered soil core shall be collected at specific depth intervals for laboratory analysis. Collected samples shall be stored in labeled jars, to be delivered to an approved AASHTO-certified laboratory for subsequent examination and testing. Within a soil sampling depth if different soil stratums are encountered, a sample should be recovered for each stratum, labeled and stored separately. Samples shall be taken and tested as outlined in **Section 2.5**.

2.3.2 Permeability Test Procedure and Equipment

Please see 2.3.1 for allowable drilling equipment.

Prior to conducting the permeability test, the following conditions should be checked:

- If a soil boring was conducted within 20 ft. of a planned PT location, the borehole from the soil boring must be completely backfilled before the PT is commenced.
- Clean water must be used in conducting PTs. PTs conducted using “dirty water” creates faulty results, which shall be rejected, and retest will be required.
- Proper sediment control shall be deployed to protect the catch basin and cleanliness of the street.
- Permeability tests shall not be performed when the ambient temperature is below 0°C.

The permeability test procedure is as follows:

- The 4-inch inner diameter casing shall be driven to the required test depth (refer to soil boring procedure for allowable equipment). The space (annulus) between the casing and borehole must be kept at a minimum.
    - If the casing cannot be driven and a larger hole is first bored to allow for the casing, the annulus must be backfilled and packed with drill cuttings before any water is introduced for testing into the casing.

- Measure the depth to the bottom of the hole to the nearest inch.
- Ensure that the depth to the bottom of the hole is within 1 inch of the depth to the bottom of the casing.
- Place approximately 6 - 8 inches of coarse sand (4.75mm – 2mm) at the bottom of the casing.
- Wash out casing using a continuous flow of clean water at low water pressure (the water shall not disturb the coarse sand layer at the bottom of the casing) until the water exiting the casing runs clear with no discoloration.
- Saturate the soil beneath the bottom of the casing for at least thirty (30) minutes using clean water.
- Fill casing to the top with clean water and record the temperature of the water (see **Section 2.3.3** for details on temperature measurement).
- Record the time at the beginning of the test.
- Record the falling water level in the casing at 1, 2, 3, 4, 5, 10, and 15 minutes after the beginning of the test or until the water level in the casing has stopped falling.
- At the conclusion of the test, fill the casing to the top with clean water and maintain the water at this level for five (5) minutes.
- Repeat the test once for each PT depth using the same procedure.

The P.E. or Rep. must maintain continuous data of PTs and report them accurately in Permeability Test Logs (PT Logs). Refer to **Section 3.1.3** for details on the PT Log.

2.3.3 Temperature Measurement

Temperatures shall be measured in °C using equipment meeting the specifications as shown in Table 1 and calibrated against a National Institute of Standards and Technology (NIST) Standard or with certified calibration traceable to NIST.

Table 1 – Acceptable Temperature Measurement Equipment

Equipment	Specifications
Liquid-in-glass thermometer (nonmercury)	• Temperature range, at least -5 to +45°C • 0.5°C gradations or smaller • Calibrated accuracy within 1 percent of full scale or 0.5°C, whichever is less
Thermistor	• Calibrated accuracy within 0.1 to 0.2°C • Digital readout to at least 0.1°C

2.3.4 Geotechnical Investigation Depths

The depth at which all Geotechnical Investigation procedures are to be conducted shall be determined by the depth of the undisturbed soil below the base of the Preliminary GI practice.

Table 2 shows the total soil boring (and SPT) depths, soil sampling (for laboratory testing) depths, and PT depths for various types of GI practices.

Table 2 – Depth of Soil Boring and PT for Various GI Practices

Group	Type of GI Practice	Total Soil Boring Depth	Lab Sample Depths[1]	PT Depths[2]
A	ROWB, ROWSGS with tree and/or typical stone reservoir depth, ROWGS, ROWIB	20 ft bgs	5-7 ft bgs 7-9 ft bgs 11-13 ft bgs 18-20 ft bgs	5 ft bgs 10 ft bgs
B	ROWRG, ROWSGS with shallow stone reservoir and no tree, ROW Permeable Pavement	9 ft bgs	3-5 ft bgs 5-7 ft bgs	3 ft bgs 6 ft bgs
C	ROWSB	20 ft bgs	5-7 ft bgs 9-11 ft bgs 11-13 ft bgs 13-15 ft bgs 15-17 ft bgs	5 ft bgs 10 ft bgs 15 ft bgs

[1] Acceptable deviations from the sampling depth, without prior approval by BEDC-GI:

- Two samples may be taken from an interval if there is a significant change in soil layer (e.g. differences in consistency, color or major component). The sampling depths should be labeled and the samples stored separately.
- If a sample cannot be retrieved or the recovery length is extremely low (less than 2 in) and additional soil cannot be obtained, soil from the immediately following interval shall be collected.

[2] If the bottom of the casing cannot be properly sealed due to soil conditions or obstructions, the casing may be drilled up to an additional foot below ground surface.

2.3.5 Termination and Cancellation of Soil Borings and Permeability Tests

Various conditions at the drilling site may prevent completion of the geotechnical investigation. Soil borings and/or PTs are referred to as “terminated” if the drilling was commenced but could not be completed to the intended depth. “Cancellation” refers to situations where drilling for the soil boring and/or PT did not commence. In general, soil borings and PTs shall not be cancelled without prior approval by BEDC-GI.

The following list provides general guidance on when drilling may be terminated without prior approval by BEDC-GI:

a) If soil and/or groundwater contamination is suspected during the 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 BEDC-GI.
b) If an obstruction (e.g. boulder, abandoned utility, large debris, etc.) is encountered at or less than 15 ft bgs, another drilling location shall be identified according to **Section 2.2.1**. If the obstruction is confirmed at the reattempted location, the soil boring or PT shall be terminated. If the obstruction is encountered at a depth greater than 15 ft bgs, drilling may be terminated without a reattempt.
c) If an obstruction (e.g. boulder, abandoned utility, large debris, etc.) is encountered at or less than 5 ft bgs, another drilling location shall be identified according to **Section 2.2.1**. If the obstruction is confirmed at the reattempted location, at or less than 5 ft bgs, the soil boring or PT shall be terminated and the remaining test, if not yet performed, shall be canceled. The location shall be rejected.
d) If bedrock is encountered, drilling shall be terminated and the depth to bedrock and rock classification (based on visual observation) recorded. Where possible, drilling shall proceed through weathered or decomposed bedrock.

If obstructions and/or bedrock are encountered at less than 9 ft bgs at three or more sites within a 100-ft radius, drilling operations shall cease and BEDC-GI must be contacted to obtain approval to proceed with subsequent drillings within the 100-ft radius.

If a water table is encountered, the depth to the water table shall be recorded and the boring shall proceed to the intended depth. The water table shall be identified as either perched water or the groundwater table.

2.3.5.1 Termination of Permeability Tests after the Saturation Period

PTs may be terminated after the 30-minute saturation period and reported accordingly for the following conditions:

- If the casing is completely filled during the saturation period and there is no visible drop in water level after 30 minutes, the PT shall be reattempted for the same depth at another location between 5 ft to 10 ft away. If there is no visible drop in water level after 30 minutes at the reattempted location, the PT shall be terminated for that depth only and the permeability coefficient reported as “0.000 in/hr”.
- If the casing cannot be filled due to rapid infiltration (RI) during the saturation period and no water is retained in the casing after 30 minutes, the PT shall be reattempted for the same depth at another location between 5 ft to 10 ft away. If rapid infiltration is observed during the saturation period for the reattempt, the PT shall be terminated for that depth only and the permeability coefficient reported as “RI”.
- For PT at 10ft, if groundwater is observed between 9 ft - 10 ft and there is no visible drop in water level during the saturation period, the PT need not be reattempted for the 10 ft

depth. The PT shall be terminated and the permeability coefficient reported as "0.000 in/hr" for that depth only.

2.3.5.2 Modification of Soil Borings and/or Permeability Test Depths

For Preliminary GI practices in Group A (refer to Table 2), if the groundwater table and/or bedrock is confirmed between 7-9 ft bgs during drilling for either the soil boring or PT, drilling shall be terminated. New offset locations shall be identified according to **Section 2.2.1**, to conduct soil sampling and PTs at the depths specified for Group B practices instead. Soil samples at 3'-5' and 5'-7' must be collected for group B practices.

For example, if bedrock is encountered at 8 ft bgs during drilling for the 10-ft PT at a Preliminary ROWB site, the 10-ft PT shall be cancelled and a new borehole shall be identified to conduct PTs at 3 ft and 6 ft. Additionally, the 20-ft soil boring will also be cancelled (if it had not been conducted yet), and a 9-ft soil boring with the corresponding soil sampling depths shall be conducted instead.

2.4 Cleanup

The P.E. or Rep. on site shall ensure drillers maintain proper housekeeping at all times, and clean up any remaining debris and sediment post drilling operation.

Upon termination or completion of any soil boring or PT, all boreholes are to be backfilled with soil cuttings to the ground surface level and sealed with an asphalt or concrete patch to restore the surface to its original condition. All other holes, depressions, cracks, surface inconsistencies, and other hazards resulting from the work must be properly mitigated. The contractor will return to the site two weeks following the work, one month following the work, and as necessary to make repairs to backfilled holes.

Photographs shall be taken documenting the condition in which the drilling locations are abandoned.

If any damage results due to drilling operations, the PE or Rep. must properly document, inform BEDC – GI and direct the driller to repair.

2.5 Geotechnical Laboratory Testing

Laboratory tests shall be conducted by an AASHTO-certified laboratory to determine the distribution of particle sizes of the soil – particularly the fines (silts and clays) content – in accordance with ASTM D422.

3 Geotechnical Report

3.1 Geotechnical Investigation Data

3.1.1 Boring Plan Maps and Shapefiles

Field-measured locations of all GI practices and geotechnical investigations must be accurately recorded. This location data shall be submitted as a finalized Boring Plan Map and shapefile (**Section 3.3.2** contains additional details on shapefile requirements).

3.1.2 Boring Logs

Boring Logs must be submitted for all soil borings, including those which were terminated. At a minimum, Boring Logs must include the following:

- Identification number (ID No.) and location of the soil boring (nearest building address or cross streets)
- Number of blows per 6-inch intervals of continuous penetration
- Length of sample recovery (inches) for each 2-ft interval
- Thickness of each soil stratum encountered (including pavement, fill or topsoil layers).
- Characteristics of the soil (based on field observations) for all depths, including:
    1. Soil description per Modified Burmister
    2. Soil classification per Unified Soil Classification System (USCS), in parentheses
    3. Color
    4. Soil moisture (dry, moist, or wet)
    5. Soil compaction: Loose, moderately compacted, or very compacted
    6. If present:
        a. Debris (brick, concrete, wood, glass, etc.)
        b. Cobbles, boulders, etc.
        c. Odor (organic, chemical, etc.)
        d. Notable soil formations which may affect permeability (e.g. "bull's liver", glacial till, etc.)
        e. Indication of possible contamination (ash, petroleum, slag, etc.)
        f. Decomposed vegetation
- Notes of subsurface conditions encountered during drilling (e.g. utilities, structures, etc.)
- Additional notes (e.g. interaction with community, etc.)

3.1.3 Permeability Test Logs

Permeability Test Logs (PT Logs) must be submitted for all PTs, including those that were terminated. At a minimum, PT Logs must include PT ID number, ambient temperature, test location, test depth, depth to groundwater table and/or bedrock (if encountered), water temperature at the start of the test, and all water depth readings, results, and calculations.

Average permeability values shall be calculated based on a modification of ASTM D6391 using the following formula. The PT Log template with the formula and associated calculation methods is included in the Appendix. In general, no permeability calculations are necessary at the time of drilling since permeability values (and other variables used to calculate permeability values) are automatically calculated in the PT Log once all the data recorded during the PT (see **Section 2.3.2**) are inputted into the template.

$$K_m = \pi \cdot R_t \cdot \frac{D \cdot \left(\ln \frac{h_1}{h_2}\right)}{11 \cdot (t_2 - t_1)}$$

$$R_t = \frac{2.2902(0.9842^{\mathrm{T}})}{\mathrm{T}^{0.1702}}$$

Where:

- K_m = Mean permeability [in/hr], and $K_m = \sqrt{k_h \cdot k_v}$
- k_h = Horizontal permeability [in/hr]
- k_v = Vertical permeability [in/hr]
- D = Inner diameter of casing [in]
- h = Height of water above bottom of casing at time t [in]
- t = Time [hr]
- R_t = Ratio of viscosity of water at test temperature to the viscosity of water at 20 °C
- T = temperature [°C]

- Early termination of PTs (see **Section 2.3.5.1**) shall be noted in the "Inspectors Remarks" section of the PT Logs and in Geotech Report Summary Table as general geotech notes. No field data shall be reported as "Depth (in)", and no permeability values shall be calculated for terminated PTs.
- PT Logs (and Geotechnical Report Summary Tables) must accurately reflect the actual depths the PTs were performed.
- The PT Log template contains default time values of 1, 2, 3, 4, 5, 10, and 15 minutes after the start of the test. If the water level drops below the casing before the 15-minute measurement period, these default values must be modified to the actual time values for which water depth measurements were recorded.
- If the PT cannot be calculated (for example, due to RI), the PT Log shall clearly indicate that PT calculations are not valid.

3.1.4 Laboratory Test Results

Laboratory testing and reporting must include a sieve analysis of soil samples and plotting of gradation curves, as well as soil classification based on the USCS.

The following USCS-classified sieve sizes are to be included with data points for all sampled depths overlaid on the same gradation curve:

4"
3"
1-1/2”
3/4"
3/8”
#4
#10
#20
#40
#60
#100
#200

The sample for Laboratory Test Results showing sieve analyses and gradation curves is included in the Appendix.

3.1.5 Geotechnical Report Summary Table

Pertinent data from the soil borings (including data available from historical boring logs), PTs, laboratory test results, and any other information acquired during the Geotechnical Investigation shall be summarized in all Geotechnical Report Summary Table submittals.

3.2 Interim Geotechnical Report Submission

Interim Geotechnical Reports for subsets of the contract area shall be submitted prior to the completion and subsequent submittal of the Geotechnical Report.

The Interim Geotechnical Reports must include the following attachments:

- Attachment A – Boring Plan Map
- Attachment B – Historical Boring Logs
- Attachment C_1 – Interim Geotechnical Report Summary Table
- Attachment D – Soil Boring Logs
- Attachment E – Laboratory Test Results
- Attachment F – Permeability Test Logs

Interim Geotechnical Summary Tables shall be submitted as Excel worksheets following the sample provided by BEDC-GI (see the Appendix for sample). Each submission shall also include all previously submitted Interim Geotechnical Summary Table worksheets for the contract area as part of the same workbook.

Boring Plan Maps (and Boring Plan Tables, if applicable) shall be updated accordingly and submitted with the Interim Geotechnical Summary Table to reflect any changes to the Boring Plan.

3.3 Geotechnical Report Submission

3.3.1 Draft Geotechnical Report

The Draft Geotechnical Report must include the following as a minimum:

- Project Description
- Site Conditions (Topographic, Geological, Hydrogeological Setting)
- Geotechnical Investigation Results
- Summary and Conclusion
- Attachments (samples and templates in Appendix)
    - Attachment A – Boring Plan Map
    - Attachment B – Historical Boring Logs
    - Attachment C_2 – Draft Geotechnical Report Summary Table
    - Attachment D – Soil Boring Logs
    - Attachment E – Laboratory Test Results
    - Attachment F – Permeability Test Logs

Draft Geotechnical Report shall be submitted only electronically in pdf format, along with the Excel versions of Attachment C_2. Please refer to Geotechnical Investigation Reporting Procedure for additional details.

3.3.2 Geospatial Data Requirement

Geospatial data of all GI practices and geotechnical investigation locations in shapefile format, conforming to the following BEDC-GI GIS requirements:

- Coordinate System: NAD_1983_StatePlane_New_York_Long_Island_FIPS_3104_Feet
- Projection: Lambert_Conformal_Conic
- Coordinates for ROWB, ROWRG, ROWIB, ROWGS, and ROWSGS shall be the upstream curb-side corner of the practice
- Coordinates for ROWSB shall be the center of the ROWSB.
- Points representing all soil boring and PT locations shall have the following attribute fields: ‘Contract_No’, ‘Phase_No’, ‘GI_ID’, ‘B_ID’ and ‘PT_ID’

All pertinent data submitted in the Geotechnical Report must be transferred to the Project Tracking Spreadsheet and submitted with the Geotechnical Report.

3.3.3 Final Geotechnical Report

Refer to 3.3.1 Draft Geotechnical Report for minimum requirements. An updated Geotechnical Report Summary Table shall be submitted according to any final changes and comments from design.

Electronic and printed copy of complete Geotechnical Report, stamped and signed by a Professional Engineer, must be submitted upon DEP request.

Appendix:

Relevant Documents Prior to Geotechnical Investigations:

- Boring Plan Table (Sample) for:
  - ROW GI Practices Excluding Permeable Pavement
  - Permeable Pavement
- Pre-Drilling Site Checklist

Samples and Templates for Geotechnical Report Attachments:

- Attachment A – Boring Plan Map (Sample)
  - Boring Plan Map for ROW GI practices
- Attachment C_1 – Interim Geotechnical Report Summary Table (Sample)
- Attachment C_2 – Geotechnical Report Summary Table (Sample)
- Attachment D – Soil Boring Logs (Templates) for:
  - 20-ft Boring
  - 9-ft Boring
  - 20-ft Boring for ROWSB
- Attachment E – Laboratory Test Results (Sample)
- Attachment F – Permeability Test Log (Templates)

DEP Contract ID: [Contract]
DEP Project: [Project Description]
Prepared By: [Consultant/Sub Name]

NYC Department of Environmental Protection
Bureau of Engineering Design and Construction - Green Infrastructure
Borough of X, New York

Boring Plan Table for ROW GI Practices (Excluding Permeable Pavement)

GI ID No.	GI Length/ Diameter	GI Width	Available Upstream Distance - Sited* (ft)	Consultant Recommendation [date]		
				Status (Preliminary/ Reserved)	Available Upstream Distance - Design** (ft)	Notes (Historical Borings***, etc.)
1255a	20	6.00	100	Preliminary	100	
1256a	10	4.50	110	Preliminary	110	
1257a	17	5.00	280	Preliminary	280	
1259a	12	4.00	95	Preliminary	95	
1259b	12	4.50	265	Preliminary	265	
1260a	10	5.00	90	Preliminary	90	
1260b	12	5.00	145	Preliminary	145	
1260c	12	5.00	205	Preliminary	205	
1260d	10	4.50	140	Preliminary	140	
GS1260e	15	3.00	-	Rejected	-	Conflict with 12" LCP WM
1262a	18	5.00	145	Preliminary	145	
GS1262b	15	3.00	245	Preliminary	245	
1262c	16	5.00	40	Preliminary	185	
1262d	11	5.00	145	Reserved	-	
1263a	18	4.50	40	Preliminary	285	
1263b	17	4.50	245	Reserved	-	
1263c	11	4.50	125	Preliminary	125	
1263d	12	4.50	95	Preliminary	95	
1264a	18	4.00	40	Preliminary	270	
1264b	15	4.00	230	Reserved	-	
1264c	19	4.00	220	Preliminary	220	
1264d	12	4.00	125	Preliminary	125	
1264e	14	4.50	190	Preliminary	190	
1266a	15	4.00	145	Preliminary	145	
1267a	10	5.00	150	Preliminary	150	
1267b	20	5.00	40	Preliminary	260	
1267c	18	5.00	60	Reserved	-	
1267d	18	5.00	160	Reserved	-	
1267e	12	5.00	135	Preliminary	135	
1268a	10	4.00	200	Preliminary	200	
1268b	19	4.00	75	Preliminary	75	
GS1268-1a	15	3.50	70	Preliminary	170	
GS1268-1b	14	3.50	100	Reserved	-	
1269a	20	5.00	150	Preliminary	150	
IB1269b	13	4.00	-	Rejected	-	Conflict with 8" LCP WM
1270a	10	6.00	210	Preliminary	210	
1271a	20	5.00	55	Preliminary	165	
1271b	10	5.00	110	Reserved	-	
1271c	15	4.00	165	Preliminary	165	
1272a	20	4.50	145	Preliminary	145	
1273a	10	4.50	30	Preliminary	440	
1273b	15	4.50	410	Reserved	-	
1273c	10	4.00	140	Preliminary	140	
1274a	20	5.00	360	Preliminary	360	
1274b	12	5.00	415	Preliminary	415	
1274c	12	5.00	-	Rejected	-	Conflict with 10" VCP Sewer
GS1275a	20	3.00	30	Preliminary	350	
GS1275b	15	3.00	320	Reserved	-	
GS1275c	10	3.00	110	Preliminary	110	
GS1275d	15	3.00	110	Preliminary	110	
SGS1279a	40	6.00	150	Preliminary	150	
1357a	10	4.00	220	Preliminary	220	
1357b	12	4.00	65	Preliminary	65	
1357-1a	11	5.00	120	Preliminary	120	
1358a	10	5.00	175	Preliminary	175	
1359a	18	5.00	195	Preliminary	195	
1360a	15	5.00	110	Preliminary	110	
1361a	13	5.00	160	Preliminary	160	
1361b	13	4.50	30	Preliminary	90	
1361c	13	4.50	60	Reserved	-	
1361-1a	12	4.50	150	Preliminary	150	
1364a	13	5.00	235	Preliminary	235	HB SES 1276-1 (pg ##) appx 35' away, PT Only
1364b	10	5.00	315	Preliminary	315	
SGS1365a	45	6.00	155	Preliminary	155	
1366a	13	4.00	100	Preliminary	100	
1366b	20	4.00	40	Preliminary	290	HB SES 1276-1 (pg ##) appx 70' away (soil data not inferred)
1366c	13	4.00	250	Reserved	-	HB SES 1276-2 (pg ##) appx 75' away (soil data not inferred)
1366d	20	5.00	250	Preliminary	250	
IB1366e	12	5.00	-	Rejected	-	Conflict with 8" VCP Sewer
1367a	12	4.00	300	Preliminary	300	
IB1367b	13	4.00	180	Preliminary	180	
IB1369a	20	5.00	170	Preliminary	170	
IB1369b	16	5.00	185	Preliminary	185	

1383a	12	5.00	255	Preliminary	255	
1383b	20	5.00	240	Preliminary	240	
SGS1379a	45	6.00	255	Preliminary	255	
SB1384a	-	-	340	Preliminary	340	
SB1400a	-	-	240	Preliminary	240	

*The distance between the inlet of the GI practice and either the inlet of an upstream GI practice (either Preliminary or Reserved) or the top of the tributary area

**The distance between the inlet of the Preliminary GI practice and either the inlet of an upstream Preliminary GI practice or the top of the tributary area

***References to historical boring data must include the boring ID and the page number in the historical boring log attachment. Indicate if PT only is appropriate for location.

Note: All Preliminary sites shall have both a soil boring and PTs, unless the pertinent soil data can be inferred from a historical boring or a nearby proposed boring.

Total submitted

78

Summary of planned geotechnical investigation:

B&PT locations	62
PT only locations	1
Reserved sites	11
Total	74

DEP Contract ID: [Contract]
DEP Project: [Project Description]
Prepared By: [Consultant/Sub Name]

NYC Department of Environmental Protection
BEDC - Green Infrastructure
Borough of X, New York

ROW Porous Pavement Boring Plan Table

Submission 1

Location	GI ID No. (PP ID)	Laboratory Testing Data/ Historical Boring Soil Description					Permeability Analysis				Groundwater Table Depth (ft)	Bedrock Depth (ft)	General Geotechnical Notes	Consultant Recommendation [date]		
		New Boring ID No.	Nearest Existing/Historical Boring ID No.	Depth (ft)	USCS Symbol	% Passing No. 200	New Permeability Test ID No.	Nearest Historical PT ID No.	Permeability Test Depth (ft)	Avg. Permeability Coef. (in/hr)				Soil Boring (Yes/No)	Permeability Test (Yes/No)	Additional Notes
Wilson Ave in between Himrod St and Harman St	PP1265.1	B-PP1265.1a					P-PP1265.1a							YES	YES	
	PP1371.1	B-PP1371.1a					P-PP1371.1a							YES	YES	
Greene Ave in between Wilson Ave and Central Ave	PP1270-1.1		B-GS1268-1a	5-7	SM	27.4%		P-GS1268-1a	5	0.00						
				7-9	NR	NR			10	0.01						
				11-13	ML	50.0%										
				18-20	SM	17.5%										
		B-PP1270-1.1a					P-PP1270-1.1a							YES	YES	
Wilson Ave in between Greene Ave and Bleecker St	PP1270.1	B-PP1270.1a					P-PP1270.1a							YES	YES	
			B-SGS1365a	5-7	SM	26.3%		P-SGS1365a	5	0.13						
				7-9	SM	28.3%			10	0.02						
				11-13	SP	30.0%										
				18-20	SM	14.2%										
Bleecker St in between Wilson Ave and Central Ave	PP1271.1	B-PP1271.1a					P-PP1271.1a							NO	YES	
			B-1273c	5-7	SP-SM	18.7%		P-1273c	5	0.90						
				7-9	SP-SM	8.9%			10	0.19						
				11-13	SW-SM	5.0%										
				18-20	SP-SM	8.2%										

See 'Notes' for specific instructions on using template

Department of Environmental Protection
Bureau of Engineering Design & Construction - Green Infrastructure

Boring/Permeability Test No(s).

Limited Geotechnical Investigation Pre-Drilling Site Checklist

GI Contract No: _____ Consultant: _____

Managing Agency: _____ Site Supervisor: _____

Project Location: _____ Drilling Contractor: _____

The following investigation activities must be completed prior to commencement of drilling:

- ☐ One-Call utility mark-out
- ☐ Water and sewer mark-out based on available maps, tap cards, and service connection information
- ☐ Subsurface preliminary investigation with Ground Penetrating Radar (GPR) or other subsurface utility detection equipment
- ☐ Manual investigation of underground structures
- ☐ Manual investigation of overhead utilities
- ☐ Mark-out cleared drilling location
- ☐ Take photos of sidewalk, making note of any existing cracks or damages
- ☐ Ensure that sediment controls are deployed appropriately.
- ☐ Ensure that construction materials, equipment, debris, etc. are not blocking driveways

The following documentation must be obtained and kept <u>on-site</u> during all drilling activities:

- ☐ Water maps and service line information
- ☐ Sewer maps
- ☐ Health and Safety Plan (HASP)
- ☐ One-Call Ticket stating utilities cleared and/or marked

  Confirmation No._____ Expiration Date: _____
- ☐ Other agency permits (DOT, DPR, and other permits as required)
- ☐ Approval from MTA, LIRR, bridges, tunnels, AMTRAK, PATH, etc. (as required)
- ☐ Hydrant permit for clean water to conduct Permeability Tests (unless using water truck)
- ☐ DEP-reviewed Boring Location Plan

I, _____, (P.E. or Representative) attest that all the above have been completed and that this checklist along with the pertinent documentation mentioned above will be maintained on-site.

_____ _____

Date Signature of On-site P.E. or Representative

<u>NOTES:</u>

1. This checklist must be kept on-site with <u>all mentioned documentation</u> and produced upon request for DEP Reference and Review.
2. <u>The on-site P.E. or Representative is responsible for observing the geotechnical investigation, confirming the drilling locations, and ensuring that the locations of soil borings and permeability tests do not interfere with DEP infrastructure</u>.
3. Drilling activities shall not interfere with or impact utilities (e.g. water mains, sewers, property service lines, etc.).

BEDC - GREEN INFRASTRUCTURE

[CSO, Tributary Area] Boring Plan Map For ROW GI Practices

GXXXX-XX PHASE [#] STAGE[#]

LEGEND

- ## (WB) — Preliminary Right-of-Way Bioswale (ROWB), Greenstrip (ROWGS) or Infiltration Basin (ROWIB) ID
- ## — Preliminary Right-of-Way Permeable Pavement (ROWPP) ID
- ## — Preliminary Right-of-Way Stormwater Greenstreet (ROWSGS) or Seepage Basin (ROWSB) ID
- ## (WB) — Reserved Green Infrastucture ID
- Contract Area Boundary
- Matchline
- Preliminary ROWB, ROWGS or ROWIB
- Reserved ROWB or ROWGS
- ROWSGS Outline
- ROWPP Footprint
- ROWSB
- DDC-0019-5 — Historical Boring
- 75B — Proposed Boring and Permeability Test
- 250A — Proposed Permeability Test Only
- B-361C — Existing ROW Boring & Permeability Test
- P-84D — Existing Permeability Test Only
- B-300E — Existing Boring Test Only
- Catch Basin
- Field Observed Catch Basin
- Non-Existent Catch Basin
- Surface Flow Direction

KEY MAP:

RIGHT OF WAY GREEN INFRASTRUCTURE
[CSO],[WATER BODY]
[BOROUGH], NY

MANAGING/PARTNER AGENCY:
[LOGO]

CONSULTANT ENGINEER:
[LOGO]

BEDC - GI PROJECT ENGINEER:
[NAME]

CONTRACT NO:
GXXXX-XX PHASE [#] STAGE[#]

SCALE [1" = 100']	DATE	SHEET
0' 100' 200' 300'	7/11/2017	# OF #

DEP Contract [Contract]
DEP Project: [Project Description]
Prepared By: [Consultant/Sub Name]

NYC Department of Environmental Protection
Bureau of Engineering Design and Construction -- Green Infrastructure
Borough of X, New York

Interim Geotechnical Report Summary Table **Submission ##**

GI ID No.	Soil Data (Laboratory Results or Historical Boring Soil Description)				Permeability Analysis			Groundwater Table Depth (ft)	Bedrock Depth (ft)	General Geotechnical Notes	Siting Analysis					Consultant Recommendation [Date]		
	Nearest Boring ID No.	Depth (ft)	USCS Symbol	% Passing No 200 Sieve	Nearest Permeability Test ID No.	Permeability Test Depth (ft)	Average Permeability Coef. (in/hr)				ROWGI Length (ft)	ROWGI Width(ft)	Calculated Stormwater Mgmt Capacity (CF)	Available Upstream Distance - Sited* (ft)	Minimum Required Upstream Distance** (ft)	Recommendation for Survey	Stone Column Depth (ft) , if applicable	Additional Notes
2022a	B-2022a	5-7	SP-SM	5.5%	PT-2022a	5	0.23											
		7-9	SP-SM	6.4%		10	0.09	NE	NE		13	5	190.27	18	72	Proceed	-	Hydraulically Connected to 2022b
		11-13	SP	2.7%														
		18-20	SP	4.2%														
2022b	B-2022a	5-7	SP-SM	5.5%	PT-2022a	5	0.23											
		7-9	SP-SM	6.4%		10	0.09	NE	NE		13	5	190.27	225	72	Proceed	-	Hydraulically Connected to 2022a
		11-13	SP	2.7%														
		18-20	SP	4.2%														
2022c	B-2022c	5-7	SP	4.5%	PT-2022c	5	0.07											
		7-9	SP	1.9%		10	2.32	NE	NE	Organic clay was encountered at 9'	13	4	116.58	150	44	Rejected	-	
		11-13	SP	1.3%														
		18-20	SP	1.7%														
2199b	B-2199b	3-5	SP	3.5%	PT-2199b	3	1.29											
		5-7	SP	1.3%		6	2.61	8	NE	Shallow GWT was encountered at 8ft and shallow Geotechnical procedure was followed	13	5	311.09	30	109	Proceed		ROWRG Recommended
		7-9	SP	2.9%														
2199c	(Reserved)				(Reserved)													
											20	5		170		Reserved		
IB2221a	B-IB2221a(1)	5-7	SP	1.5%	PT-IB2221a	5	0.28											
		7-9	SP	1.7%		10	1.47	NE	NE	Refusal at 9' in boring. Moved to offset location.	13	4	142.83	330	62	Proceed	-	Clearance to building = 8 ft
	B-IB2221a(2)	11-13	SP	1.8%														Vault survey will be conducted
		18-20	SP	1.9%														HDPE recommended
2210a	B-2210a	5-7	SC	28.0%	PT-2210a	5	4.23											
		7-9	SP	1.9%		10	0.43	NE	NE		10	5	558.22	70	203	Proceed	15	
		11-13	SP	3.3%														
		18-20	SP	2.2%														
2210b	B-2210b	5-7	SC	10.0%	PT-2110b(1)	5	0.00											
		7-9	SP	15.0%		10	2.82	NE	NE		11	5	110.61	100	40	Do Not Proceed		
		11-13	SP	3.1%	PT-2110b(2)	5	0.05											
		18-20	SP	2.5%														
2222a	B-2222a	5-7	SP	3.4%	PT-2222a	5	1.10											
		7-9	SP	5.0%		10	0.18	NE	NE		10	5	219.13	120	96	Proceed	-	Clearance to building >10 ft
		11-13	SP	2.3%														Vault survey not necessary
		18-20	SP	1.0%														
2177a	B-2177a	5-7	SP	5.0%	PT-2177a(1)	5	RI											
		7-9	SP	1.2%		10	1.46	NE	NE		20	5	1212.13	25	472	Proceed		
		11-13	SP	1.1%	PT-2177a(2)	5	5.40											
		18-20	SP	1.2%														
2177b	(Reserved)				(Reserved)													
											20	5		65		Reserved		

2177c	(Reserved)				(Reserved)													
											10	5		115		Reserved		
GS2216a	B-GS2216a	5-7	SM	21.8%	PT-GS2216a	5	NP											
		7-9	SP	1.4%		10	3.91	NE	NE	Refusal at 5' PT test both at original and offset location	13	3	110.48	28	48	Do Not Proceed		
		11-13	SP	3.9%														
		18-20	SP	3.5%														
GS2216b	(Reserved)				(Reserved)													
											13	3		140		Preliminary		Recommendation is to make GS2216b Preliminary and do new boring and PT test

See 'Notes' for specific instructions on using template

*The distance between the inlet of the GI practice and either the inlet of an upstream GI practice (either Preliminary or Reserved) or the top of the tributary area

**Minimum required length of upstream distance, D, determined by the following formula: D = (12*[Calculated Stormwater Mgmt Capacity])/(1.1*[TDA width])

Proceed	7
Do not proceed/reject	3
Pending	0
Reserved	3
Preliminary	1
	14

# of sites submitted:

14

DEP Contract [Contract]
DEP Project: [Project Description]
Prepared By: [Consultant/Sub Name]

NYC Department of Environmental Protection
Bureau of Engineering Design and Construction -- Green Infrastructure
Borough of X, New York

Draft/ Final Geotechnical Report Summary Table **Package ##**

GI ID No.	Soil Data (Laboratory Results or Historical Boring Soil Description)				Permeability Analysis			Groundwater Table Depth (ft)	Bedrock Depth (ft)	General Geotechnical Notes	Siting Analysis					Interim Report Review			Consultant Recommendation [Date]		
	Nearest Boring ID No.	Depth (ft)	USCS Symbol	% Passing No 200 Sieve	Nearest Permeability Test ID No.	Permeability Test Depth (ft)	Average Permeability Coef. (in/hr)				Final ROWGI Length (ft)	Final ROWGI Width(ft)	Calculated Stormwater Mgmt Capacity (CF)	Available Upstream Distance - Sited* (ft)	Minimum Required Upstream Distance** (ft)	Submission No.	DEP Recommendation for Survey	Stone Column Depth (ft) , if applicable	Recommendation for Contract Plan	Stone Column Depth (ft) , if applicable	Additional Notes
2022a	B-2022a	5-7	SP-SM	5.5%	PT-2022a	5	0.23														
		7-9	SP-SM	6.4%		10	0.09	NE	NE		13	5	190.27	18	72	1	YES		Proceed	-	Hydraulically Connected to 2022b
		11-13	SP	2.7%																	
		18-20	SP	4.2%																	
2022b	B-2022a	5-7	SP-SM	5.5%	PT-2022a	5	0.23														
		7-9	SP-SM	6.4%		10	0.09	NE	NE		13	5	190.27	225	72	1	YES		Proceed	-	Hydraulically Connected to 2022a
		11-13	SP	2.7%																	
		18-20	SP	4.2%																	
2022c	B-2022c	5-7	SP	4.5%	PT-2022c	5	0.07														
		7-9	SP	1.9%		10	2.32	NE	NE	Organic clay was encountered at 9'	13	4	116.58	150	44	1	NO		Rejected	-	
		11-13	SP	1.3%																	
		18-20	SP	1.7%																	
2199b	B-2199b	3-5	SP	3.5%	PT-2199b	3	1.29														
		5-7	SP	1.3%		6	2.61	8	NE	Shallow GWT was encountered at 8ft and shallow Geotechnical procedure was followed	13	5	311.09	30	109	2	YES		Proceed		ROWRG Recommended
		7-9	SP	2.9%																	
2199c	(Reserved)				(Reserved)																
											20	5		50		2	Reserved		Reserved		
IB2221a	B-IB2221a(1)	5-7	SP	1.5%	PT-IB2221a	5	0.28														
		7-9	SP	1.7%		10	1.47	NE	NE	Refusal at 9' in boring. Moved to offset location.	13	4	142.83	330	62	2	YES		Proceed	-	Clearance to building = 8 ft
	B-IB2221a(2)	11-13	SP	1.8%																	Vault survey was conducted
		18-20	SP	1.9%																	HDPE recommended
2210a	B-2210a	5-7	SC	28.0%	PT-2210a	5	4.23														
		7-9	SP	1.9%		10	0.43	NE	NE		10	4	490.12	70	178	3	YES	15	Proceed	15	
		11-13	SP	3.3%																	
		18-20	SP	2.2%																	
2210b	B-2210b	5-7	SC	10.0%	PT-2110b(1)	5	0.00														
		7-9	SP	15.0%		10	2.82	NE	NE		11	5	110.61	100	40	3	NO		Do Not Proceed		
		11-13	SP	3.1%	PT-2110b(2)	5	0.05														
		18-20	SP	2.5%																	
2222a	B-2222a	5-7	SP	3.4%	PT-2222a	5	1.10														
		7-9	SP	5.0%		10	0.18	NE	NE		10	5	219.13	120	96	4	YES		Proceed	-	Clearance to building >10 ft
		11-13	SP	2.3%																	Vault survey not necessary
		18-20	SP	1.0%																	
2177a	B-2177a	5-7	SP	5.0%	PT-2177a(1)	5	RI														
		7-9	SP	1.2%		10	1.46	NE	NE		10	4	564.55	25	220	4	YES		Proceed		
		11-13	SP	1.1%	PT-2177a(2)	5	5.40														
		18-20	SP	1.2%																	
2177b	(Reserved)				(Reserved)																
											20	5		65		4	Reserved		Reserved		
2177c	(Reserved)				(Reserved)																
											10	5		115		4	Reserved		Reserved		

GS2216a	B-GS2216a	5-7	SM	21.8%	PT-GS2216a	5	NP														
		7-9	SP	1.4%		10	3.91	NE	NE	Refusal at 5' PT test both at original and offset location	13	3	87.43	28	40	5	NO		Do Not Proceed		
		11-13	SP	3.9%																	
		18-20	SP	3.5%																	
GS2216b	B-GS2216a	5-7	SM	21.8%	PT-GS2216b	5	0.15														
		7-9	SP	1.4%		10	2.50				13	3	104.08	140	48	5	YES		Proceed		
		11-13	SP	3.9%																	
		18-20	SP	3.5%																	

See 'Notes' for specific instructions on using template

*The distance between the inlet of the GI practice and either the inlet of an upstream GI practice (either Preliminary or Reserved) or the top of the tributary area

**Minimum required length of upstream distance, D, determined by the following formula: D = (12*[Calculated Stormwater Mgmt Capacity])/(1.1*[TDA width])

# of sites submitted:

14

Proceed	8
Do not proceed/reject	3
Pending	0
Reserved	3
	14

COMPANY NAME/LOGO				Boring ID No.	B- XXXX
Prepared for: AGENCY NAME / LOGO				PROJECT:	<contract area or project description>
				LOCATION / BOROUGH :	<borough>
INSPECTOR: <name>	DRILLER: <name>			Start Date: <date>	Weather: <weather>
CONTRACTOR: <name>	HELPER: <name>			Start Time: <time>	
P.E./REP.: <name>					
Total Boring Depth: <##> ft	Drill Bit Type: <type>			Weight of Hammer for casing: <##> lbs	
Rig Type: <type>	Casing Inner Diameter: 4 in			Weight of Hammer for spoon: <##> lbs	
	Depth of Casing: ft			Type of Hammer: <type>	
Depth to Groundwater Table (bgs): <##> ft				Drop: 30 in	
Depth to Bedrock (bgs): <##> ft				Split Spoon Diameter: 2 in	

B- XXXX BORING LOG

Depth Below Ground Surface (ft)	Soil Description (Field Observations)	SPT Blows per 6"	N Value	Recovery Length (inches)	Remarks
0					
5	Bulk Sample 1 (S1)				
	Bulk Sample 2 (S2)				
10	Bulk Sample 3 (S3)				
15					
20	Bulk Sample 4 (S4)				

Boring terminated at 20 feet below ground surface unless otherwise instructed.

Inspector's Remarks:

COMPANY NAME/LOGO				Boring ID No.	B- XXXX
Prepared for: AGENCY NAME / LOGO				PROJECT:	<contract area or project description>
				LOCATION / BOROUGH :	<borough>
INSPECTOR:	<name>	DRILLER:	<name>	Start Date: <date>	Weather: <weather>
CONTRACTOR:	<name>	HELPER:	<name>	Start Time: <time>	
P.E./REP.:	<name>				
Total Boring Depth:	<##> ft	Drill Bit Type:	<type>	Weight of Hammer for casing:	<##> lbs
Rig Type:	<type>	Casing Inner Diameter:	4 in	Weight of Hammer for spoon:	<##> lbs
		Depth of Casing:	ft	Type of Hammer:	<type>
Depth to Groundwater Table (bgs):	<##> ft			Drop:	30 in
Depth to Bedrock (bgs):	<##> ft			Split Spoon Diameter:	2 in

B- XXXX BORING LOG

Depth Below Ground Surface (ft)	Soil Description (Field Observations)	SPT Blows per 6"	N Value	Recovery Length (inches)	Remarks
0					
3	Bulk Sample 1 (S1)				
6	Bulk Sample 2 (S2)				
9					

Boring terminated at 9 feet below ground surface unless otherwise instructed.

Inspector's Remarks:

COMPANY NAME/LOGO				Boring ID No.	B- XXXX
Prepared for: AGENCY NAME / LOGO				PROJECT: <contract area or project description>	
				LOCATION / BOROUGH : <borough>	
INSPECTOR: <name>	DRILLER: <name>			Start Date: <date>	Weather: <weather>
CONTRACTOR: <name>	HELPER: <name>			Start Time: <time>	
P.E./REP.: <name>					
Total Boring Depth: <##> ft	Drill Bit Type: <type>			Weight of Hammer for casing: <##> lbs	
Rig Type: <type>	Casing Inner Diameter: 4 in			Weight of Hammer for spoon: <##> lbs	
	Depth of Casing: ft			Type of Hammer: <type>	
Depth to Groundwater Table (bgs): <##> ft				Drop: 30 in	
Depth to Bedrock (bgs): <##> ft				Split Spoon Diameter: 2 in	

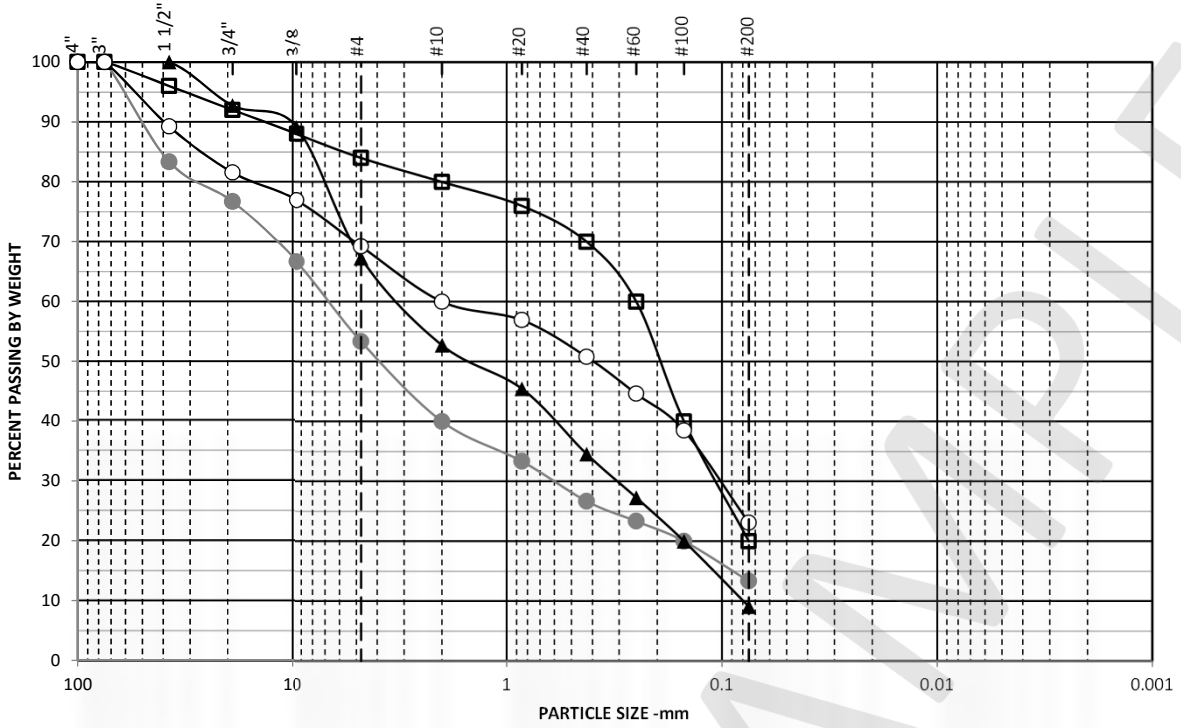
B- XXXX BORING LOG

Depth Below Ground Surface (ft)	Soil Description (Field Observations)	SPT Blows per 6"	N Value	Recovery Length (inches)	Remarks
0					
5	Bulk Sample 1 (S1)				
10	Bulk Sample 2 (S2)				
	Bulk Sample 3 (S3)				
	Bulk Sample 2 (S4)				
15	Bulk Sample 4 (S5)				
20					

Boring terminated at 20 feet below ground surface unless otherwise instructed.

Inspector's Remarks:

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Boring ID No. B-1054

Symbol	●	□	▲	○	◆
Depth	5-7	7-9	11-13	18-20	-
% Gravel	46.67	16.00	32.73	30.77	-
% Sand	40.00	64.00	58.18	46.15	-
% Fines	13.33	20.00	9.09	23.08	-
% -2μ	-	-	-	-	-
Cc	-	-	0.36	-	-
Cu	-	-	41.54	-	-
D_{100} (mm)	75.00	75.00	37.50	75.00	-
D_{60} (mm)	7.13	0.25	3.38	2.00	-
D_{30} (mm)	0.64	0.11	0.32	0.11	-
D_{10} (mm)	-	-	0.08	-	-
USCS	SP-SM	SM	SP	SM-ML	-
w (%)	-	-	-	-	-

Particle Size (Sieve #)	Percent Finer				
	●	□	▲	○	◆
4"	100.0	100.0	100.0	100.0	-
3"	100.0	100.0	100.0	100.0	-
1 1/2"	83.3	96.0	100.0	89.2	-
3/4"	76.7	92.0	92.7	81.5	-
3/8"	66.7	88.0	89.1	76.9	-
4	53.3	84.0	67.3	69.2	-
10	40.0	80.0	52.7	60.0	-
20	33.3	76.0	45.5	56.9	-
40	26.7	70.0	34.5	50.8	-
60	23.3	60.0	27.3	44.6	-
100	20.0	40.0	20.0	38.5	-
200	13.3	20.0	9.1	23.1	-

Depth (ft bgs)	Symbol	DESCRIPTION AND REMARKS
5-7	●	sandy silt
		Color/Odor/Impurities: brown
7-9	□	silt and sand
		Color/Odor/Impurities: dark brown - brown
11-13	▲	poorly graded sand, little silt
		Color/Odor/Impurities: light brown
18-20	○	silt and clay, some sand
		Color/Odor/Impurities: brown/gray
-	◆	-

PARTICLE SIZE DISTRIBUTION

Consultant Name

Prepared for: Agency Name / Logo

Contract Area / Project Description

Borough

Laboratory Name

Comments:

COMPANY NAME/LOGO

PT ID No. PT- <ID>

Sheet <#> of 2

Prepared for: AGENCY NAME / LOGO

PROJECT: <contract area or project description>

LOCATION / BOROUGH : <borough>

INSPECTOR:	<name>	DRILLER:	<name>	Start Date:	<date>	Weather:	<weather and ambient temperature>
CONTRACTOR:	<name>	HELPER:	<name>	Start Time:	<time>		
P.E./REP.:	<name>						

Depth of PT:	<depth>	ft	Drill Bit Type:	<type>		Weight of Hammer for casing:	140 lbs
Rig Type:	<type>		Casing Internal Diameter:	4	in	Type of Hammer:	<type>
			Casing Length:	<length>	in		

ASTM D-6391 – 11
PERMEABILITY COEFFICIENT (Km) FORMULA:

General Formula:

$$K_m = \pi R_t \times \frac{\left[D\left\{Ln\left(\frac{h_1}{h_2}\right)\right\}\right]}{11 \times (t_2 - t_1)}$$

Formula for 4" internal diameter casing (in/hr):

$$K_m = 1.142 R_t \times \frac{\left[Ln\left(\frac{h_1}{h_2}\right)\right]}{(t_2 - t_1)}$$

where:

$$R_t = {2.2902(0.9842^T)}/{T^{0.1702}}$$

PT-<ID> @ <depth> ft

TEST 1

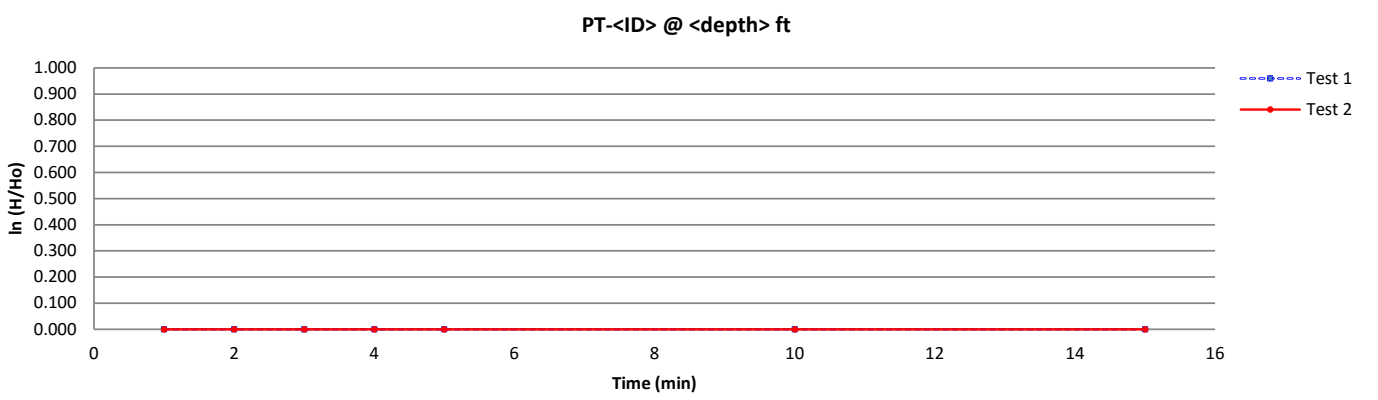
Water temperature (°C), T: Rt= -

FIELD DATA		CALCULATED DATA			
Time (min)	Depth (in)	Height (in)	Ln (H/Ho)	(t_1-t_2)	*Kv (in/hr)
1		-	-	0.017	-
2		-	-	0.017	-
3		-	-	0.017	-
4		-	-	0.017	-
5		-	-	0.017	-
10		-	-	0.083	-
15		-	-	0.083	-

TEST 2

Water temperature (°C), T: Rt= -

FIELD DATA		CALCULATED DATA			
Time (min)	Depth (in)	Height (in)	Ln (H/Ho)	(t_1-t_2)	*Kv (in/hr)
1		-	-	0.017	-
2		-	-	0.017	-
3		-	-	0.017	-
4		-	-	0.017	-
5		-	-	0.017	-
10		-	-	0.083	-
15		-	-	0.083	-



TEST 1 FINAL RESULTS

Time Weighted Average Permeability Coefficient **Km=** 0.0000 in/hr

TEST 2 FINAL RESULTS

Time Weighted Average Permeability Coefficient **Km=** 0.0000 in/hr

AVERAGE PT-<ID> @ <depth> ft

Time Weighted Average Permeability Coefficient **Km=** 0.0000 in/hr

Inspectors Remarks:

DEFINITION OF VARIABLES

*Km= Mean permeability

T = Temperature of permeant (water), in °C

Ln = Natural Logarithmic

t1 = Time at the start of the test in the same units selected for Km

t2= Time at the end of the test in the units selected for Km

h1= Height of the water above the bottom of the casing at the start of the test in the same units selected for Km

h2= Height of the water above the bottom of the casing at the end of the test in the same units selected for Km

Rt = Ratio of viscosity of water at test temperature to the viscositye of water at 20°C

COMPANY NAME/LOGO

PT ID No. PT- <ID>

Sheet <#> of 2

Prepared for: AGENCY NAME / LOGO

PROJECT: <contract area or project description>

LOCATION / BOROUGH : <borough>

INSPECTOR:	<name>	DRILLER:	<name>	Start Date:	<date>	Weather:	<weather and ambient temperature>
CONTRACTOR:	<name>	HELPER:	<name>	Start Time:	<time>		
P.E./REP.:	<name>						

Depth of PT:	<depth>	ft	Drill Bit Type:	<type>		Weight of Hammer for casing:	140 lbs
Rig Type:	<type>		Casing Internal Diameter:	4	in	Type of Hammer:	<type>
			Casing Length:	<length>	in		

ASTM D-6391 – 11
PERMEABILITY COEFFICIENT (Km) FORMULA:

General Formula:

$$K_m = \pi R_t \times \frac{\left[D\left\{Ln\left(\frac{h_1}{h_2}\right)\right\}\right]}{11 \times (t_2 - t_1)}$$

Formula for 4" internal diameter casing (in/hr):

$$K_m = 1.142 R_t \times \frac{\left[Ln\left(\frac{h_1}{h_2}\right)\right]}{(t_2 - t_1)}$$

where:

$$R_t = {2.2902(0.9842^T)}/{T^{0.1702}}$$

PT-<ID> @ <depth> ft

TEST 1

Water temperature (°C), T: Rt= -

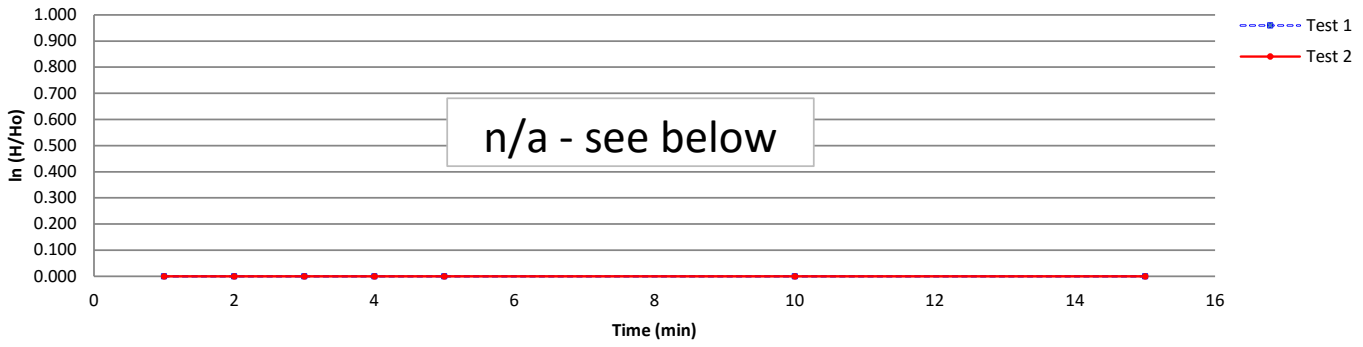
FIELD DATA		CALCULATED DATA			
Time (min)	Depth (in)	Height (in)	Ln (H/Ho)	(t_1-t_2)	*Kv (in/hr)
1		-	-	0.017	-
2		-	-	0.017	-
3		-	-	0.017	-
4		-	-	0.017	-
5		-	-	0.017	-
10		-	-	0.083	-
15		-	-	0.083	-

TEST 2

Water temperature (°C), T: Rt= -

FIELD DATA		CALCULATED DATA			
Time (min)	Depth (in)	Height (in)	Ln (H/Ho)	(t_1-t_2)	*Kv (in/hr)
1		-	-	0.017	-
2		-	-	0.017	-
3		-	-	0.017	-
4		-	-	0.017	-
5		-	-	0.017	-
10		-	-	0.083	-
15		-	-	0.083	-

PT-<ID> @ <depth> ft



TEST 1 FINAL RESULTS

Time Weighted Average Permeability Coefficient **Km=** in/hr

TEST 2 FINAL RESULTS

Time Weighted Average Permeability Coefficient **Km=** in/hr

AVERAGE PT-<ID> @ <depth> ft

Time Weighted Average Permeability Coefficient **Km=** in/hr

Inspectors Remarks:

<Insert reason for PT termination here>

DEFINITION OF VARIABLES

*Km= Mean permeability
T = Temperature of permeant (water), in °C
Ln = Natural Logarithmic
t1 = Time at the start of the test in the same units selected for Km
Rt = Ratio of viscosity of water at test temperature to the viscositye of water at 20°C
t2= Time at the end of the test in the units selected for Km
h1= Height of the water above the bottom of the casing at the start of the test in the same units selected for Km
h2= Height of the water above the bottom of the casing at the end of the test in the same units selected for Km

APPENDIX nine

PROJECT AREA CSO MAP

Courtesy of: NYC OpenData, State of New Jersey, Esri, HERE, DeLorme, INCREMENT P, Intermap, USGS, METI/NASA, EPA, USDA

APPENDIX ten

PROJECT AREA ZONING & LAND USE MAP

Green Buffer Project: Land Use Map

Primary Land Use

- One & Two Family Residence
- Multi-Family Residence (Walkup)
- Multi-Family Residence (Elevator)
- Mixed Residential & Commercial
- Commercial Use
- Industrial / Manufacturing
- Transportation / Utility
- Public Facilities and Institutions
- Open Space & Recreation
- Parking
- Vacant Land

FUNDING FOR THIS PROJECT WAS PROVIDED BY THE NEW YORK STATE OFFICE OF THE ATTORNEY GENERAL AND THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION THROUGH THE GREENPOINT COMMUNITY ENVIRONMENTAL FUND.

GREENPOINT COMMUNITY ENVIRONMENTAL FUND

NEW YORK CITY SOIL AND WATER CONSERVATION DISTRICT

EVERGREEN

eDESIGN DYNAMICS