DISTRICT OF COLUMBIA

DEPARTMENT OF TRANSPORTATION

GREEN INFRASTRUCTURE STANDARDS

2014

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SUPPLEMENT TO DESIGN AND ENGINEERING MANUAL

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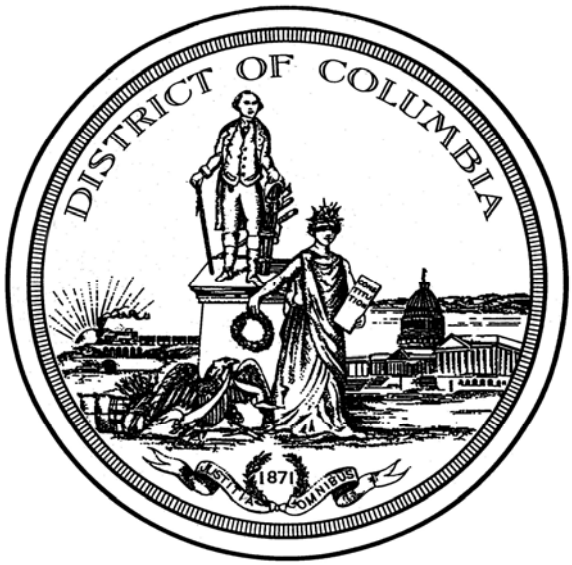

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INTRODUCTION

These Green Infrastructure Standards are standard for all District Department of Transportation contracts awarded by the Mayor of the District of Columbia, the Council of the District of Columbia, and/or the Contracting Officer. The drawings, requirements, and procedures stated herein may be revised or amended from time to time, but only to the extent specified under a supplemental specification or special provision included in the specific contract.

These Standards shall further be the standard drawings and specifications for all the construction activities and material control within the Public Space of the District of Columbia. Reference by date and title shall be made to these specifications with the Plans or other Contract Documents as notification of their application to those documents.

Ronaldo T. Nicholson, P.E.

Chief Engineer

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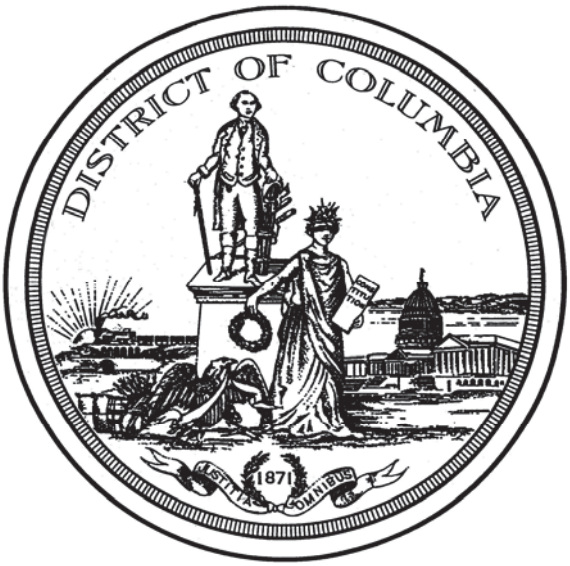


GREEN INFRASTRUCTURE STANDARDS

SUPPLEMENT TO DESIGN AND ENGINEERING MANUAL

2014

District of Columbia Department of Transportation Design and Engineering Manual

The sections provided in this Standards Manual are to supplement the existing Design and Engineering Manual. No sections of the current manual are deleted and no text is modified. All sections herein are to follow any existing sections and text sequentially.

Supplement To: CHAPTER 2

PROJECT DEVELOPMENT

2.3 Project Design Requirements

2.3.10 Soil Erosion and Sediment Control and Stormwater Management

2.3.10.1 Stormwater Management Permit Requirements - Designing to the Maximum Extent Practicable

Projects within the Public Right of Way are required to implement stormwater retention in accordance with District Stormwater regulations to the Maximum Extent Practicable (MEP). This process must be a serious attempt to comply, considering every opportunity to achieve the full retention of the regulated stormwater volume. Construction projects in the Right of Way are faced with a multitude of unique site constraints that vary widely. Limited space outside of the roadway restricts opportunities for infiltration and evapotranspiration, and in many cases the width of the roadway cannot be reduced to create additional space. The specific steps that must be explored for MEP design are stipulated in the DDOE Stormwater Guidebook, and include:

- Identify Drainage Areas and Calculate Stormwater Retention Volume (SWRv)
- Evaluate Infiltration
- Demonstrate Full Consideration of Opportunities with Existing Infrastructure
- Demonstrate Full Consideration of Land Cover Conversions and Optimum BMP Placement
- Size BMPs
- Address Drainage Areas where Zero-Retention Practices are Installed (i.e. no retention is achieved)

The DDOE Stormwater Guidebook defines the applicability of the design steps described below to DDOT Public Right of Way projects, and/or to parcel development projects that reconstruct the adjacent existing Public Right of Way as portion of the project (Type 1 and Type 2 projects, respectively).

2.3.10.2 Stormwater Management Submissions

Stormwater Management Plan (SWMP) submissions will be made with the 30%, 65%, 90%, and Final (100%) Design packages. The SWMP will contain a stormwater management map (SMM), MEP Worksheet, and Project Narrative as further in the Design Process section.

The submissions will include increasingly more detail commensurate with the design stage. The SWMP is first submitted at the DCRA Permit Intake Center with a Building Permit application at 30% design. At DCRA, the SWMP is given to the DDOE technician for further detailed plan review. Each design phase SWMP will be submitted to the DDOE Technician at the DCRA Permit Intake Center. The timing of the submission should be within 2 weeks of the design plan milestone submission to DDOT. The submission will be reviewed by the DDOT project manager prior to submission at the Intake Center. DDOE plan review may take 10-30 business days.

2.3.10.3 Design Process for MEP

Prior to Project Design:

Before the project reaches the design stage, the following items will be identified and incorporated into the Designer's scope of work:

a. *Level of Disturbance:* the level of disturbance will determine whether or not the retention regulation applies to the project.

b. *Ownership of Land Adjacent to Right of Way:* Projects must identify public lands and public rights of way adjacent to the project's limit of disturbance. DDOT will consult with adjacent public property owners and managers to evaluate opportunities to direct stormwater runoff from the project drainage area to adjacent public lands. (This step applies only to DDOT projects, not to parcel projects which include construction within the Right of Way).

c. *Feasibility to Use Public Parking Zone*: DDOT will define whether or not the Public Parking areas (between the sidewalk zone and the right of way line) are feasible for BMP placement or land conversion.

d. *Feasibility to Use "Paper Streets", "paper alleys", and adjacent traffic islands*: Any undeveloped or green space right-of-way within or adjacent to the limits of disturbance of public Right of Way projects will be evaluated for stormwater retention opportunities prior to design.

Planning Phase:

During the planning phase of a project, areas for stormwater retention should be identified to the planning project level of detail. The steps in 30% design phase should be used to accomplish as much advanced planning as the project allows. Steps that may be appropriate in the planning phase are: identifying available space, safe access issues, pedestrian circulation requirements, impervious surface removal, location of existing utilities, existing

trees, soil characteristics, candidate BMP and Land Conversion Areas, and street profile analysis.

2.3.11 Submittals

2.3.11.1 Preliminary Plan Submittal – 30% Review

Stormwater Management MEP Design:

During the 30% design phase, the following steps will be addressed, and incorporated into the submission.

a. *Project Survey*: Full topographic survey for the project is conducted with contour lines at 1 or 2 foot elevations in areas of proposed BMPs.

b. *Available Space for BMP's and Land Conversions:* One of the first steps of the process will be to finalize the dimensions of lane widths, sidewalks, and other zones within the public right of way cross section. This step may occur prior to design during planning, or it may result from an alternatives study during the preliminary design stage. Other spaces to be considered include medians, bump-outs, intersection islands, and cul-de-sacs.

c. *Safe Access Issues:* Maintenance access areas shall be identified for all BMPs. In city streets, this may be the parking lane. A project involving high speed, high volume traffic should include a site assessment to identify vehicle travel lanes and areas of specific safety hazards for maintenance crews. Subsequent steps in the preparation of the stormwater management plan for the project should avoid placing BMPs in these areas.

d. *Pedestrian Circulation Requirements:* The pedestrian circulation requirements of the project, including but not limited to egress zones behind the curb adjacent to on-street parking, will be defined in the 30% design phase. Maximum ponding depth of BMP's near pedestrian facilities should also be defined based on circulation conditions.

e. *Impervious Surface Removal:* As part of the preliminary geometric design, areas of existing pavement which may be candidates for land conversion will be identified.

f. *Drainage Areas, Limits of Disturbance and SWRv:* The drainage boundaries of the project and preliminary limits of disturbance will be determined, plotted and measured. Drainage areas are usually defined by the area draining to a catch basin. Stormwater Retention Volume is to be calculated based on areas of impervious cover, compacted cover and natural cover.

g. *Anacostia Waterfront Development Zone*: If project within AWDZ boundary, calculate treatment volume required.

h. *Location of Existing Utilities and Storm Drains:* Existing utilities and storm drains will be delineated on plan view. BMP locations will be influenced in part by the existence of utilities and storm drains and required offsets.

i. *Existing Trees:* Existing trees to be saved will be identified in the preliminary stage.

j. *Soil Characteristics:* Soils within the limit of disturbance will be identified based on SCS Hydrologic Soil Group – Type A, B, C, D, Urban Land, or Combinations where the Soil Survey designates multiple soil names within a map unit. In Type D soil areas, it is accepted that BMPs will not infiltrate and soil infiltration testing is not required in these areas.

k. *Candidate BMP and Land Conversion Areas:* Based on the available space within the project limits, all potential BMP and land conversion areas will be identified in plan.

l. *Street Profile:* If the initial allocation of candidate BMP areas reveals a probable deficit of BMP sites, a review will be performed to determine if a change in the drainage profile would introduce new candidate BMP locations. Examples include a roadway with a lengthy median sufficient in dimension to handle the size needed for a bio-swale (including necessary freeboards). The facility is not sized at this stage, but is identified as a candidate location.

2.3.11.1.9 Stormwater Management Plan Submission at 30% Design Phase:

- A Stormwater Management Map (SMM) will include:
  i. Full topographic survey including storm drain elevations, and utility designation Level C (minimum)
  ii. Existing Contour lines at 1 or 2 foot spacing - either from survey or GIS
  iii. Drainage area boundaries - either to existing catch basins, or proposed catch basins if designed
  iv. Drainage Area ID #'s (to correspond to worksheet)
  v. Limits of Disturbance
  vi. ROW lines
  vii. Adjacent Public Lands
  viii. Soil boundary lines based on NRCS Hydrologic Soil Group (A, B, C, D, Urban Land)
  ix. Hot spots (gas stations, contamination, etc. as further described in the SW Guidebook)
  x. Existing tree locations to be retained – with a summary chart giving size, species, and condition
  xi. Candidate BMP and Land Conversion areas, with legend

- MEP Worksheet will be completed per the standard template and includes:
  i. Regulated SWRv (regulated volume) calculations based on land uses within the LOD. Can be subdivided into drainage areas, drawing numbers, blocks, or other logical unit at this stage.
  ii. Offsite (beyond LOD) Retention Volumes calculated where it is presumed that onsite SWRv cannot be managed/ treated to meet the regulated volume requirement
  iii. Hydrologic Soil Group (A, B, C, D or Urban Land)

iv. Hot Spot identification, if any
v. Retained Existing Tree Retention volumes
vi. Are BMP candidates identified for each drainage area? Yes or No result

- Narrative will include:
  i. Description of project
  ii. Documentation of extent of impervious area (e.g. lane widths based on design speed/road classification, sidewalk widths based on neighborhood plan or public realm guidance, etc)
  iii. Summary of known hot spots
  iv. Qualitative discussion of available areas for land conversion and BMP placement, including what areas are noted as high probability candidates, and areas that have challenges which may eliminate them as further design is developed. If public lands are adjacent to the project limits of disturbance, include a description of whether or not the lands are available for SWRv (and why/why not). If street profile changes have been considered, these are also described.
  v. Description of known conflicts that prevent placement of a BMP or a land conversion, from the agreed upon conflict list; or if not on the list, rationale of why the site is not deemed viable.
  vi. Optional Attachments to assist reviewers with context of the site:
    - Aerial map depicting adjacent land uses if not fully shown on SMM - limits of project noted
    - Copy of soil survey map from Web Soil Survey – limits of project noted

2.3.11.2 Intermediate (Pre-Final) Plan Submittal – 65% Review

Stormwater Management MEP Design:

When the project reaches the 65% design submission, the BMP locations may be revised based on project changes and detailed design. BMPs size and retention value should be calculated based on the planned depths, infiltration feasibility, and known conflicts. The following steps and refinements to the prior design assessment will take place, and be incorporated into the submission.

a. *Available Space:* The available space for BMP facilities may reduce or expand.
b. *Pedestrian Circulation Requirements:* The layout of pedestrian circulation elements will be more developed, which in turn may inform where BMP and land conversion opportunities can be implemented.
c. *Impervious Surface Removal:* Determination of impervious surface removal and other land conversions will become more defined.

d. *Drainage Areas, Limits of Disturbance and SWRv:* The drainage areas and limits of disturbance, and land cover measurements within these boundaries, will be refined at 65% design stage to match the current design elements.

e. *Location of Existing and Proposed Utilities and Storm Drains:* At 65% design stage, vertical information for existing utilities may be determined though further survey and utility investigation. Utility relocations corridors are also defined, and proposed storm drains are laid out. Utility horizontal and vertical locations within and adjacent to the BMP should be reviewed. These elements will impact the final placement and sizing of BMP's.

f. *Existing Trees:* As design progresses, the existing trees to be preserved may change and new trees will be identified.

g. *Soil Characteristics/Geotechnical Testing:* Soil borings and infiltration tests will be performed at each BMP area per the requirements of the DDOE Stormwater Guidebook. These results will be used in the 65% design to determine infiltration capacity, underdrain placement, and retention value. Designers will review soil boring and infiltration test results to help define whether or not infiltration can be incorporated into the BMP's and if a standard or enhanced BMP design is used. Where soil characteristics permit, infiltration should be used (unless in a hot spot or other area which prohibits infiltration use).

h. *Longitudinal Slopes:* The suite of BMPs which may be installed on steeper road sections is more limited. Any project design grade changes will be determined and effect on BMPs should be addressed.

i. *Select and Size BMPs:* The size of all potential BMP's will be calculated, resulting in a storage volume (Sv) and retention value for each BMP, calculated per the DDOE Guidebook for each BMP type. The allowable retention volume achieved in each practice shall be no more than the 1.7" runoff volume over the surface area reaching the BMP.

2.3.11.2.9 Stormwater Management Plan Submission at 65% Design Phase

- Stormwater Management Map (SMM) will include:
  i. All information from 30% stage, amended to include:
  ii. Proposed catch basin/storm drain system and corresponding drainage area boundaries
  iii. Implementation of drainage profile revisions, if needed and determined to be physically viable
  iv. BMP's carried forward, including those proposed on of adjacent public land (if needed and determined to be viable)
  v. Sub-drainage area boundaries to BMP's
  vi. Proposed trees that can achieve the required soil volume to qualify for retention volume
  vii. Soil boring locations

viii. Vertical information on utilities and storm drain systems – such as proposed storm drain profiles and/or schedules, or test hole locations/results for utilities. (Storm drain profiles and test hole results can be attachments.)

- MEP Worksheet will include:
  i. All information from 30% stage, amended to current design and as described below
  ii. SWRv will be defined by drainage area ID # (typically by catch basin)
  iii. Soil boring test results, including infiltration rates, water table, and bedrock
  iv. Summary of BMP sizing and resultant retained volume in proposed BMP (including proposed trees). Include both Storage volume of practice (Sv-practice) and Retention Value from SW guidebook
  v. Where there is a deficit in any individual drainage area, revisit BMP's where additional volume can be accommodated by capturing offsite contributing area within the BMP, or over-managing LOD area up to ceiling volume. This calculation is only performed when the BMP size is greater than what is needed for the regulated volume.
  vi. Total required retention volume and maximum achievable retention volume, including deficit if applicable.

- Narrative will include:
  i. All information from 30% stage, amended to current design and as follows:
  ii. Description of conflict areas which reduced BMP storage volume or eliminated candidate BMP sites from further consideration
  iii. Description of why public lands were eliminated as candidates for BMP, if applicable
  iv. Supporting narrative of soil boring and infiltration results - if not fully conveyed on the worksheet (eg multiple soil tests per D.A. or practice with varying results). Include Geotechnical Report as an attachment.
  v. Supporting narrative of the BMP sizing results - if not fully conveyed on the worksheet

- Calculations will include:
  i. Individual BMP sizing calculations – Storage volume and retention value achievable based on physical size, depths, infiltration rates, and placement of underdrains; hydraulic sizing such as inflow and overflow velocities, freeboard, conveyance calculations.

2.3.11.3 Final Construction Plans, Specifications, and Cost Estimates – Final Review

Stormwater Management MEP Design:

When the project reaches the final design submission, any updates and refinement to the prior design assessment may take place. The following items may be updated or refined and incorporated into the 90% and 100% submission:

a. *Available Space*.

b. *Impervious Surface Removal*.

c. *Drainage Areas, Limits of Disturbance and SWRv*.

d. *Location of Existing and Proposed Utilities and Storm Drains*.

e. *Existing Trees*.

f. *BMP locations, sizes, SWRv, and retention value*.

g. *Address Drainage Areas Where Zero Retention is Provided:* For drainage areas within the project that cannot achieve any retention practices, that are within the Municipal Separate Storm Sewer System (MS4), water quality catch basins or other treatment technologies must be used to provide water quality treatment for the SWRv.

h. *Stormwater Management Plan Submission at Final Design Phase*

- Provide updates to SMM, narrative, MEP worksheet and calculations to address changes that have occurred since the 65% milestone due to newly determined constraints or newly found opportunities.
- Provide final summary of retention volumes required and achieved.
- Identify areas where Zero Retention is provided and treatment BMP used.

2.4 Preparation of Drawings

2.4.3 Description and Contents of Drawings

2.4.3.16 Landscape and Planting Plans

Additional information for tree space design shall be included with the 65% design submittal and subsequent design submittals to include:

- Plans with the type, locations and dimensions of all tree spaces.
- Plans clearly depicting the locations, dimensions, open and covered soil area, and soil volume method for each tree.
- Details shall be provided which illustrate the overall size, depth, soil composition, and drainage of the planting space.

- Calculations showing contributing drainage area ratios for each facility.
- Calculations of soil rooting volume requirement and volume achieved, per street tree.
- Statement from an engineer or soil scientist relative to anticipated infiltration rates in the subsoil or NRCS Soil Survey Report.

2.4.3.37 Stormwater Management Plan and BMP Design Submittal Requirements

In addition to the submissions described in 2.3.11 for the MEP process, specific BMP facility design information to be included with the 65% design submittal and subsequent design submittals will include:

- Plans with the type, locations and dimensions of all stormwater management facilities and associated planting plans, with key elevations depicted as follows:
    - Inflow elevation
    - Outflow elevation (for online facilities)
    - Invert elevation of bioretention surface
    - Top of ponding elevation
    - Bottom of reservoir/stone layer (bottom of storage)
    - If applicable, underdrain connection point with tie-in invert elevation.
- Sections and profiles to show any steps, underdrains, and utility lines through the facility.
- Maintenance Schedule on plans per DDOE requirements.

Supplement To: CHAPTER 33

ROADWAY DRAINAGE

33.14 Green Infrastructure / Low Impact Development Stormwater Management

33.14.1 General

The purpose of this section is to provide design requirements for low impact development (LID) and green infrastructure (GI) within a public right of way (ROW). The intent is to provide stormwater retention to meet the regulatory requirements while also providing the infrastructure requirements within the public right of way. Standard low impact development techniques to be used in the public ROW shall be permeable pavement, bioretention, and swales. Other Best Management Practice (BMP) types may be used with approval by DDOT and DDOE. In addition, refer to Chapter 47 for street tree, bioretention planting, and associated soil volume requirements.

Signage for public awareness of LID facilities shall be included in the design when directed by DDOT.

33.14.2 Authority

Designs will use the unified approach to sizing stormwater management practices in the City, as described in the "Stormwater Management Guidebook" (Guidebook) by the District Department of the Environment (DDOE). The design requirements herein are in addition to those described in the DDOE Guidebook, and are intended to refine and clarify what design practices are preferred within the public ROW.

33.14.3 Design Guidance

Choice of stormwater facilities should be based on the context of the surrounding streetscape. In addition to the benefits to stormwater quality and quantity, multi-purpose design of stormwater facilities can add aesthetic value to the city by providing varied landscaping, visually appealing pavement design and enhanced community spaces on streets. They can also be combined with traffic calming features.

The process for selecting and designing LID facilities in a roadway project begins with site analysis:

1. Address the street layout – the dimensions of the travel lanes, location of medians, islands and buffer strips, and all elements related to the functionality of the roadway will be established in the design plan.
2. Include other transportation modes – the requirements for pedestrian traffic, cyclists, mass transit, and other possible modes is incorporated into the right of way as well.
3. Choose stormwater locations and types – Implement stormwater facilities that can capture and treat the runoff from impervious surfaces prior to entering the storm drain

system. Consider space between curb and sidewalk, behind sidewalk, in channelized islands and medians for vegetative practices. Consider parking lanes, alleys, sidewalks, and other roadways for permeable pavement. Maximize tree space. LID facilities should be placed to maximize volume capture. Adjacent LID and BMP facilities should be closely reviewed to ensure they will receive water flow from the design storm.

Stormwater practices can add health and value to the urban ecology by enhancing the linkage of existing parkways and parks for improved aesthetics and neighborhood community spaces. In addition, these localized vegetated areas can create new habitat for wildlife, particularly birds and butterflies. The end result of implementing these street improvements is a more sustainable and attractive urban environment.

33.14.4 Permeable Pavement

Permeable pavement is being demonstrated for suitability and durability in the District public ROW. Permeable pavement may be proposed for use in place of impervious pavement, in appropriate locations per section 33.14.4.1. DDOT IPMA must approve any use of permeable pavement at specific locations in District roadways, alleys, and trails.

33.14.4.1 Types of Permeable Pavement Facilities

The types of permeable pavement facilities and appropriate uses are tabulated below. Types subjected to vehicular traffic loads include porous asphalt, pervious concrete, and permeable unit pavers. Other types not subjected to traffic loads, may be allowed on a project by project basis. Designs which differ from the table below may be allowed with DDOT approval.

Type / Application	Alley	Roadway*	Sidewalk	Covered Soil Volume for Plants	Trail
Porous Asphalt	●	●			●
Pervious Concrete	●	●	●	●	●
Permeable Interlocking Unit Pavers	●	●	●	●	
Other Unit Pavers **				●	
Porous Rubber Paving			●	●	●
Porous Bound aggregate			●	●	
Plastic Grid Pavers	●			●	

* Appropriate for low volume roadways & dedicated parking lanes; Not currently allowed for collectors, arterials, and freeways.

** Spaced to allow infiltration

33.14.4.2 Contributing Drainage Area

The maximum contributing drainage area to permeable pavement surface area ratio is 4:1 unless otherwise approved by DDOT. Stormwater runoff from pervious areas often contribute sediment and lead to clogging and increased maintenance requirements for permeable pavement, and should be avoided to the extent possible. Ideally, at least 90% of the area draining to permeable pavement shall be impervious, not including the permeable pavement area itself. Pretreatment, drainage area stabilization, and specific maintenance program are options that DDOT will consider for implementation where contributing drainage area is less than 90% impervious.

33.14.4.3 Permeable Pavement Base Design

All Permeable Pavement Systems:

- The wearing surface is the pavement material plus any required bedding layers under the surface and inside of the joints, in accordance with all applicable standard details, specifications and manufacturer recommendations as applicable. The wearing surface shall meet the latest ADA requirements.

Vehicular Use Permeable Pavement Systems (Roadway, Alleys):

- The choker layer is an open graded stone, typically #8 or #57 stone, between the wearing surface and the reservoir layer, for providing separation and preventing migration between the layers due to the differences in material and void sizes underneath.
- The reservoir layer is an open graded stone, typically #2, #3, or #57 stone, under the choker layer, for meeting the 1.2 inch retention volume requirement (to the maximum extent practicable, where applicable). The depth of the stone shall be determined in part based on the required storage volume for the site and pavement design requirement.

Pedestrian Use Permeable Pavement Systems (Sidewalk, Trail, Covered Soil Volume):

- The aggregate base layer is an open graded stone under the pavement for meeting the 1.2 inch retention volume requirement (to the maximum extent practicable, where applicable). The depth of the stone shall be determined based on the required storage volume for the site, with a minimum of 6” where above tree soil volume, and a minimum of 4” otherwise.
    - Beneath the aggregate base layer in sidewalk and trail areas, the subgrade shall be scarified where feasible, and uncompacted when infiltration is desired. In this case, the stone layer shall be increased to 6” for additional support.
    - Beneath the aggregate base layer in covered soil volume areas, there is layer of structural soils as described in Chapter 47.

Geotextiles and Liners:

- Geotextile meeting requirements of the current DDOT specification for use in stormwater facilities shall be placed on the sides of open graded stone, to prevent migration of adjacent fine material into the permeable pavement stone.
- Impermeable waterproof membranes should be used in permeable pavement systems as follows:
    - Facilities within 10 feet of a structure (e.g. an existing building) shall be lined on the side adjacent to the structure.
    - At the interface between pervious pavement and traditional pavement.
    - In areas where infiltration is not permitted, such as hot spots and for utility protection.
    - Facilities designed for water re-use or harvesting.
    - Where the installation is located on expansive soils, as recommended by the geotechnical engineer.

33.14.4.4 Stormwater Conveyance and Retention

Stormwater conveyance from all impervious areas including standard pavement shall, to the extent feasible, drain to permeable pavement as sheet flow. Otherwise pre-treatment for energy dissipation and sediment control may be required where any concentrated flow is directed onto permeable pavement. Level spreaders may be designed to convert concentrated flow to sheet flow into the permeable pavement facility.

Reservoir and Underdrain - Sizing for Retention Volume

The volume of storage for permeable pavements systems shall be designed to meet the regulatory requirements promulgated by DDOE, including applicable Maximum Extent Practicable (MEP) procedures. Storage design shall meet the following:

- Subsurface drainage will consists of 4 inch to 6 inch diameter perforated underdrain in the reservoir layer or a separate layer of open graded stone below the reservoir layer. Subsurface drainage is recommended beneath all vehicular use permeable pavement installations unless elimination of the underdrain is expressly approved by DDOT. Permeable pavement may be installed in alleys and low volume roads without underdrains if infiltration results are good and underdrain connections are not feasible.
    - For sites where native soil design infiltration rate sufficient to drain the volume below the underdrain within 48 hours, the subsurface pipes may be elevated to provide infiltration sumps of reservoir stone. Use of a raised underdrain is encouraged and provides enhanced retention. An alternative approach to a raised underdrain is an underdrain with an up-turned elbow outlet.

  - For designs with a waterproof membrane on the bottom as required in the Geotextiles and Liners section, the minimum slope of the subsurface drainage pipes is 2% and shall match the bottom (invert) slope of the facility.
  - For designs without a waterproof membrane, the minimum slope of subsurface drainage pipes above the frost line shall be 0.5%. If the pipe is below the frost line, slopes less than 0.5% are allowed.
  - Clean-outs are required for all underdrained permeable pavement facilities. Clean-outs shall be spaced at 100 foot maximum intervals. Where a storm drain structure such as catch basin, manhole, or overflow structure is within 100 feet of a clean-out, it will serve the same function as a clean-out.
  - Observation wells are required for facilities without underdrain and shall be shown on design plans. Observation wells shall be spaced at 100 foot maximum intervals.

- Drawdown time for 1.2 inches of runoff volume over the contributing drainage area shall be 24 hours minimum and 48 hours maximum. Drawdown time is calculated using the DDOE Guidebook equations, based on infiltration rate of native soils at the invert of the facility, and the flow through underdrains.
- The reservoir will be sized so that the runoff associated with the 2 year, 24 hour frequency storm does not surcharge the wearing surface at the low end of the facility. The total hydraulic sizing of the permeable pavement system, consisting of the permeable pavement structure and the adjacent storm drain system, shall meet 33.2 and 33.4.
  - Overflow conveyance for higher storms shall be designed to surface convey into existing or new storm sewer systems adjacent to the permeable pavement.
- To achieve the design volume, the profile of the pavement shall be designed in one of the following scenarios, which shall be selected based on topography of the site, location of utilities and other underground features, project budget, and any other constraints related to specific site:
  - Use of a continuous bottom slope less than or equal to 2%.
  - Use of a terraced invert, with the slope between steps less than or equal to 2%. Vertical drop of terraced invert shall generally be 6” to 12”, but can vary to achieve design requirements.
  - Use of check dams with variable bottom slope, located so that the 2 year, 24 hour runoff volume does not surcharge the low end of the wearing course. Check dam material options include waterproof membrane, PVC sheeting, acrylic sheeting, and concrete. Use of membranes and sheeting are the most cost effective and generally preferred options. A transverse underdrain may be needed in check dam systems if the base of a step does not slope to the

longitudinal underdrain or if needed due to the width of the permeable pavement system.

33.14.4.5 Pavement Structural Design

For alley reconstruction, the DDOT approved standard drawings shall be used for permeable pavement installations.

For other pavements subjected to vehicle traffic loading, pavement design calculations shall be required. Pavement design may result modifications to the pavement cross section in the DDOT approved standard drawings to meet or exceed the pavement strength requirements. AASHTO methods for rigid pavement design shall be used for pervious concrete. AASHTO methods for flexible pavement design shall be used for porous asphalt. AASHTO methods for flexible pavement design, with appropriate layer coefficients as applicable to the interlocking, shape, and thickness of the pavers, shall be used for interlocking permeable unit pavers. Guidance for layer coefficients is provided by the Interlocking Concrete Pavers Institute.

Testing of the bearing capacity for underlying soils shall be required for all permeable pavements for vehicular use, shall be site specific, and shall be in accordance with ASTM D4429-09a, Standard Test for California Bearing Capacity of Soils in Place.

Other considerations for the pavement design include:

- Edge restraints shall be used for all permeable unit pavers. Edge restraints may also be used for porous asphalt and pervious concrete as necessary.
- In soft soils with low bearing capacity where infiltration is planned, geo-grid as the preferred option over removal of the material and placement/compaction of select backfill.

33.14.4.6 Limitations

- Bottom of permeable pavement system must be located at least two feet above the seasonally high water table.
- Permeable pavements with infiltration are not allowed in Hot Spots as defined in the DDOE Guidebook.
- Permeable pavement requires more frequent maintenance if it is installed where sand use is expected, such as in residential areas where adjacent homeowners may treat walkways with sand.

33.14.5 Bioretention

Bioretention shall be placed within vegetated areas of the public ROW and landscaped with a selection of plants from the current DDOT-approved planting lists. Designer will select areas for bioretention using the MEP process as detailed further in the DDOE Guidebook and in section 33.14.7. Possible areas for bioretention include tree space, parking lanes, bumpouts for traffic calming, intersection triangles, open areas, and areas adjacent to sidewalk.

Bioretention design shall be consistent with the DDOE Guidebook with the following additional requirements.

33.14.5.1 Types of Bioretention Facilities

- Bioretention Basins in Open Area: This type is a subset of DDOE's Traditional Bioretention, and is typically a moderate to large-scale bioretention cell with a ponding depths up to 18 inches. Typically these facilities will include shrub and groundcover, and sometimes tree plantings. Basins in open areas will typically have sloped sides. Basins in open area can be online or offline.
- Curb Extension Bioretention: This type is a subset of DDOE's Streetscape Bioretention, and is generally placed in locations where a new curb is constructed into the parking lane to create an opportunity for bioretention, which may or may not incorporate a portion of the street tree space. Curb extensions may have sloped or vertical sides. In most cases, curb extensions will be designed as online facilities.
- Streetscape Bioretention Planter: This type is a subset of DDOE's Streetscape Bioretention, and is typically a small-scale bioretention cell, often located between the curb and sidewalk. These facilities may include tree, shrub and groundcover plantings. Streetscape Bioretention Planters will usually have vertical sides, but may have sloped sides if sufficient space is available. In most cases, bioretention planters will be designed as offline facilities.
- Bioswale: This facility type is consistent with DDOE's Dry Swale/ Bio-swale, and includes drainage channel or linear infiltration basin adjacent to either the roadway or the sidewalk, typically vegetated with trees, shrubs, groundcovers or turf. Bioswales may be designed to convey or retain stormwater. Swales adjacent to roadways that receive stormwater runoff from roadway surfaces shall be designed according to the requirements of the DDOE Stormwater Guidebook as open channels. Bioswales without curbs are online facilities.

33.14.5.2 Bioretention Cross Section

Soil types used in the various bioretention facilities shall be in accordance with the DDOT approved specification.

Soil Profiles

In addition to requirements of DDOE, bioretention facilities shall be designed as follows:

- A layer of 3" triple shredded mulch is placed on the top of the bioretention media.
- The soil profile within Basins, Curb Extensions, Planters and Bioswales shall consist of 18 to 36 inches of Bioretention Soil, sized to meet the retention volume requirements, to the maximum extent practicable (where applicable). Areas with trees shall contain a minimum of 24" inches of soil, 30" preferred.
- See Section 33.14.5.5 for underdrain layer requirements.
- Additional stone may be provided beneath the underdrain layer, or beneath the bioretention soil in cases where no underdrain is present, to enhance the infiltration volume of the facility and to achieve additional stormwater retention volume.
- Impermeable PVC liners are required in bioretention facilities as follows:
    - Facilities within 10 feet of a structure (e.g. an existing building) shall be lined on the side adjacent to the structure.
    - Facilities within 5 feet of the roadway face of curb shall be lined on the side adjacent to the roadway.
    - In areas where infiltration is not permitted, such as hot spots, facilities shall be lined on all sides. In this case, subsurface drainage is required.

33.14.5.3 Contributing Drainage Areas

The impervious cover areas that drain into bioretention facilities should be limited in size to prevent excessive saturation of soils and the consequent development of anaerobic soil conditions. The maximum contributing impervious area to bioretention surface area ratio is recommended as follows:

- for bioretention basins, curb extensions, and streetscape bioretention planters without subsurface drainage: 20:1
- for bioretention basins, curb extensions, and streetscape bioretention planters with subsurface drainage: 33:1
- for other bioswales and open drainage channels: based on engineering design

For ratios above these limits, the runoff inflow to the bioretention must be controlled to not allow excessive water into the facility.

33.14.5.4 Allowable Ponding Depths

- Allowable ponding depth in bioretention facilities shall be selected based on the adjacent land use, expected pedestrian activity, and the associated need for barriers around the facilities as described in section 33.14.5.6 on Safety & Access. The maximum allowed ponding depth in bioretention is 18 inches.

- Bioretention in high-volume pedestrian and residential areas will typically have a 6 inch maximum ponding depth. The ponding depth may vary based on slope conditions.
- Bioretention Basins: May be designed at depths that will require safety barriers or fencing.
- Bioswales: Shall be designed with depths and/or side slopes which do not require barriers.
- Streetscape Bioretention Planter and Curb Extensions: May be designed at depths that will require railings or curb.

33.14.5.5 Bioretention Sizing and Hydraulic Design for Stormwater Retention Volume

Bioretention facilities shall be sized with volumes to meet the regulatory requirements promulgated by DDOE, including applicable Maximum Extent Practicable (MEP) procedures. Storage design shall meet the following:

- Provide maximum bioretention soil depth (filter depth) in accordance with DDOE requirements.
- Design for drawdown time of 72 hours maximum for the 1.2 inches of runoff volume (to the maximum extent practicable) over the contributing drainage. Drawdown time shall be calculated using the DDOE Guidebook equations, based on infiltration rate of native soils at the invert of the facility, and the flow through the underdrains or overdrains.
- Where subsurface drainage is required by DDOE Stormwater Guidebook:
    - A choker layer consisting of a minimum of 3 inches of sand and gravel shall be placed beneath the bioretention soil to prevent the soil from migrating into the underlying stone.
    - A reservoir layer of 10 to 12 inches of open graded #57 stone shall be placed beneath the choker layer, with perforated pipes embedded in the #57 stone. Geotextile shall be placed on the sides of the #57 stone.
    - A minimum of one clean-out is required for basins and curb extensions, and shall be shown on design plans. For other bioretention facilities, a clean-out shall be provided within 10 feet of the underdrain connection to the catch basin or manhole.
    - Connect underdrains to catch basins, manholes, or direct connect to storm sewer pipe. Connection to catch basin is generally the most cost effective option. When directly connected to the Combined Sewer System, place a backflow preventer valve on the underdrain connection.

- For bioretention facilities without underdrains, observation wells are required and shall be shown on the design plans. The maximum spacing of observation wells shall be 100 feet.
- Use curb openings with depressed gutters to convey runoff to bioretention facilities adjacent curbed roadways. Size the openings to deliver the amount of runoff to the facility that the size of the facility can handle, per DDOE requirements:
    - Use the methodology in the DDOE Stormwater Guidebook Appendix H.6 to convert the flow associated with the stormwater retention volume for which the BMP is being designed into peak discharge.
    - Use the methodology of HEC-12 to size the curb opening to achieve 100% interception, while meeting spread requirements of 33.4 for the 15 year storm. Multiple curb openings can be used for each facility to deliver the required volume.

  Curb cuts across sidewalks require trench covers.
- Check dams in bioswales and bioretention curb bump-outs may be necessary to allow ponding volume, achieve the storage volume, to slow velocities, or both. Check dams will be placed in sloped facilities at intervals to maintain ponding depth and facility depth within allowable limits.
- Pre-treatment devices are required to trap coarse sediment. Applicable choices include:
    - Bioretention in Open Area: Stone-filled forebay or spreader, stone diaphragm, or grass filter strip.
    - Curb Extensions: Concrete or stone entry forebay as depicted in DDOT standard drawings.
    - Streetscape Bioretention Planters: Stone forebay/splash block adjacent to curb cut, trash rack or leaf screen across curb cut.
- Overflow devices are required for online facilities and for off-line facilities where the lowest adjacent top of curb or sidewalk is equal to or lower than the inflow point elevation. Typical overflow devices include outflow curb openings to gutter, and overflow structures. Size overflow devices for online bioretention to convey the 15 year storm in accordance with DDOE requirements. Where in the roadway, the overflow device shall be sized to meet the spread requirements per 33.4. For online facilities, provide a minimum of 3” freeboard from overflow structure to overtopping elevation.
- Side slopes of bioswales shall be designed to prevent erosion based on anticipated stormwater flow rates. Jute or coir erosion control mats shall be used to stabilize soils until plant materials have been established.

33.14.5.6 Safety and Access

- Edge conditions around bioretention facilities adjacent to pedestrian areas may be sloped or with a vertical drop.
    - Railings are required around bioretention with a vertical drop adjacent to sidewalks in high-volume pedestrian areas.
        - Top of railing shall be 18" above sidewalk, with vertical and/or horizontal member spacing which meets ADA detection requirements for visually impaired pedestrians.
    - Bioretention with vertical drop adjacent to sidewalks in low-volume pedestrian areas must be surrounded by a curb of minimum 4 inch high and 6 inch wide.
    - Bioretention with vertical drop must have a minimum 4-inch curb or railing between the parking step out zone and the drop.
    - Bioretention with a sloped side must provide a flat (8% maximum slope) 6-inch minimum width buffer of different material to meet flush with adjacent sidewalk. Bioretention with a depth greater than 3-feet must provide a flat (8% maximum slope) 24-inch minimum width buffer. When sides are sloped, the finished grade must be stabilized with plants, sod, seed, mulch, or stone.
    - Bioretention adjacent to a designed shared use path (bicycle facilities) must provide a flat (6:1 maximum slope) 24-inch width buffer of different material to meet flush with adjacent path. A sloped side with maximum 3:1 slope and maximum 5-foot depth or 12-inch maximum drop is allowed. If either of those conditions is exceeded, a 42-inch height guard is required.
- Pedestrian crossings of continuous bioretention facilities adjacent to curb are required as below.
    - One 6' paved crossing between each street tree and 35 foot maximum spacing in high-volume pedestrian areas
    - One 6' crossing every other tree and 70 foot maximum spacing in other areas consistent with surrounding area (paved, grass, or mulched).
- Parking step out zone of a width between 12" and 36", optimally 24" (measured from face of curb) is required for bioretention adjacent to parking lanes. In high-volume pedestrian areas, the step out zone must be 18" minimum, including roadway curb. In low density pedestrian areas, the step out zone may be 12" minimum.
- When placing and designing bioretention facilities adjacent to travel ways, check AASHTO warrants for clear zone and traffic barrier needs. Adjust design to avoid use of traffic barriers whenever possible. The curb serves as a barrier for vehicle safety on most city streets. On streets without curb, provide a 24" minimum graded shoulder between the road and bioretention, with maximum 3:1 side slope beyond the shoulder to a maximum drop of 5 feet.

- Bioretention facilities with sloped sides with a total depth of more than 5 feet shall require a fence of 36-inch height enclosing the entire facility.
- Facilities with a greater than 30" vertical drop require a 42" railing meeting International Building Code 1013 (Guards).
- Access is required to all bioretention areas for maintenance. For facilities off the road, an access road may be needed. For facilities on high speed roads, ensure safe access via a shoulder or designated area. Within the bioretention area, the overflow structure must be accessible to maintenance crews.

33.14.5.7 Limitations

- Bottom of bioretention must be located at least two feet above the seasonally high water table.
- Bioretention with infiltration is not allowed in Hot Spots as defined by DDOE.

33.14.6 Utility Clearances at LID Facilities

Utilities are allowed to collocate in LID facilities subject to acceptance by the utility owner. Individual projects should be coordinated with the utility owners for specific requirements. Current guidelines for clearances of utilities is as follows:

33.14.6.1 Communications/Power

- Communication and electric lines in concrete conduits can run through LID facilities.
- Communication and electric lines not in concrete conduits will have 6" minimum vertical clearance and 2' minimum horizontal clearance.
- Utility poles may be located in permeable pavement facilities, and may not be located within bioretention unless additional stabilization is provided for the pole
- Manholes may be located in permeable pavement facilities, and may not be located within bioretention.

33.14.6.2 Gas

- For gas lines within 6 inches of LID facilities, the contractor must install a protective shield around the pipe. The shield must be made of fiberglass reinforced plastic (frp), or other approved insulating material, in either a 12-inch by 12-inch flattie plate or clip-on configuration. The shield must be placed over the gas pipe and secured in place to provide adequate protection.
- For gas lines that are less than 6-inches from the lid facility or within the lid facility, the contractor must install a combination of a protective shield and sleeve. The protective sleeve must consist of either a grey pvc semi-circular sleeve, which comes in 60-inch lengths, or a larger plastic pipe. This protective sleeve must be installed

over the gas pipe so that the protective sleeve extends at least 9 inches on either side of the area in conflict. The shield shall meet requirements described above.

- Maintain a minimum of 12-inches separation from underdrains to gas facility.
- For excavation within two feet of gas facilities, the contractor shall implement sheeting & shoring protection to protect pipe during construction if directed by the DDOT engineer.
- Four (4) foot minimum clearance is required between the top of gas facilities and finished road surface grade.
- Three (3) foot minimum cover is required over gas facilities in open drainage or road ditches.

33.14.6.3 Water and Sewer

- Reference "DC Water Green Infrastructure Utility Protection Guidelines"
- A minimum of 12" of cover is required between bottom of LID facilities and water main, sewer main, or sewer lateral.
- When less than 5' vertical clearance is provided between bottom of LID facility and sanitary sewer main, an impermeable liner shall be used at the bottom of the LID facility to a horizontal distance at least 3' beyond the sewer main.
- Water service laterals may run through LID facilities.
- Concrete collars shall be provided around surface structures within LID facilities (cleanouts, valve boxes, etc). Top of collar shall be above ponding depth in bioretention.

33.14.6.4 Street Lights

- Street light conduits and poles can run through LID facilities.
- The designer shall ensure that installation of shrubs or plants do not block access to openings of the transformer base. Access to transformer bases can face either the roadway or towards the sidewalk.

33.14.6.5 Fire Hydrants

- On sidewalk side, 3 ft minimum clearance must be provided around hydrants.
- On street side, clearance must be provided for 10 ft in each direction longitudinally along the street, and 4 ft into the street to create a 4 ft by 20 ft access area. This access area may be paved with permeable pavement.

Supplement To: CHAPTER 47

LANDSCAPE DESIGN CRITERIA

47.7 Tree Space Design

Street trees shall be selected from approved lists, and placed in appropriate locations within the public ROW. Surrounding soils, including nearby soils under sidewalks shall comply with the design requirements noted below.

47.7.1 Minimum Soil Volumes

Based on trees selected from the DDOT approved lists, the following are the minimum allowable soil volumes for tree rooting:

- Large Trees: 1,500 cubic feet of soil within a 27 foot radius.
- Medium Trees: 1,000 cubic feet of soil within a 22 foot radius.
- Small Trees: 600 cubic feet of soil within a 16 foot radius.
- Where soil volumes within the maximum allowable radii for adjacent trees overlap, up to 25% of the required soil volume per tree may be shared.
- For trees that are designed to have a covered soil volume which connects to an open area (for example behind the sidewalk), the open area can be considered as part of the required soil volume.
- For existing trees to remain, the root structure of existing tree shall be protected to the extent feasible and provided with additional soil volumes to meet the above requirements.
- Soil Volume Calculation shall be calculated as:
  - (Area of Open Soil x Depth of Soil) plus (Area of Covered Soil x Depth of Soil)
  - All soil types are calculated at full volume.
  - There may be multiple soil volume areas included in the calculation depending on design.

47.7.2 Tree Planting Design in New or Reconstructed Streetscapes

- Maximized open soil area for tree planting is the most cost effective method of achieving the required soil volume.
- Open tree planting space within sidewalks that have soil volume beneath pavement will be a minimum of four feet wide by six feet long. Larger areas may be required to accommodate large root balls or additional plant materials.

- Tree Planting space with continuous open areas adjacent to sidewalk may be one of the following:
    - Turf area between trees, defined as "lawn strip".
    - Mulched area between trees, defined as "plant bed".
- The size of the open tree planting area is influenced by the site as follows:
    - For narrow public space areas equaling 10' or less, the open tree space will typically be set at the minimum opening, with a goal of providing additional paved surface for pedestrian usage.
    - For wider public space areas, the open tree space can be continuous, with pedestrian crossings as required in 47.7.8.
    - In areas where pedestrian activity is not expected to be significant, it is not necessary to follow the above guidance.

47.7.3 Tree Planting Design in Confined Spaces

- Reductions in tree planting space and soil volumes must be justified by physical constraints and approved by DDOT.
- Open tree planting space within existing sidewalk areas that do not have soil volume beneath pavement will be a minimum of six feet wide by nine feet long.
- To the extent feasible, soil rooting volumes shall be expanded by creating grass or planted areas adjacent to trees longitudinally, or by placing soils beneath pavements extending along the sidewalk or across the sidewalk.
- Other soil expansion techniques are reducing compaction, air spading to around roots and addition of planting soil, or other methods as recommended by arborist or landscape architect.

47.7.4 Covered Soil for Meeting Tree Soil Volume Requirements

In order to provide adequate soil volume for street trees, horticulturally appropriate soils must often be placed beneath the adjacent paved surfaces. Acceptable soil systems include suspended pavements, structural cells, and several types of structural soils:

- Suspended pavements include structural slabs that span between structural supports that allow uncompacted growing soil beneath the sidewalk, and commercially-available structural systems. Manufacturer details and certification must be provided for commercial systems. Structural calculations and details must be provided for Suspended Pavement installations. Soil placed beneath Suspended Pavements shall be a minimum of 30 inches of Bioretention Soil or per manufacturer's specifications.
- Structural cells are commercially-available structural systems placed subsurface that support the sidewalk and are filled with soil. Manufacturer details and certification

must be provided for commercial systems. Soil placed within structural cells shall be a minimum of 30 inches of Bioretention Soil or per manufacturer's specifications.

- Sand-Based Structural Soil System (SBSS) is a non-propriety soil system that typically includes a minimum of six inches of open graded crushed stone over a minimum of 30 inches of Sand-Based Structural Soil. Aeration of the overlying stone and a source of water are essential components.
- CU Soil is a patented product and shall be obtained only from licensed facilities. CU Soil shall not be used in conjunction with stormwater infiltration.
- Stalite Structural Soil. is a proprietary product consisting of lightweight aggregate with a horticultural application.

47.7.5 Tree Space Soil Volume Cross Section

Soil Types

Soil types used in the tree space, in accordance with the DDOT approved specification, are generally described as follows:

- Plant Bed Soil: used for the top 12 inches of open planting beds.
- Lawn Soil: used for the top 12 inches in turf or other areas that will experience moderate or heavy foot traffic.
- Bioretention Soil: used in bioretention basins, bioswales, curb extensions, and beneath suspended pavements.
- Sand-Based Structural Soil (SBSS): used to support pavements and as horticultural subsoil beneath Plant Bed and Lawn Soils.
- CU Soil: used to support pavements and obtained only from licensed CU Soil providers.

Soil Profile

- The soil profile of tree space soil volume using SBSS is as follows:
  - For Plant Beds, 12 inches of Plant Bed Soil over a minimum of 24 inches of Sand-Based Structural Soil, or a minimum of 36 inches Plant Bed Soil.
  - For Turf Infiltration Strip, 12 inches of Lawn Soil over a minimum of 24 inches of Sand-Based Structural Soil, or a minimum of 36 inches Lawn Soil.
  - For Covered Soil Volume, a minimum of 12 inches of Plant bed Soil over 24 inches of Sand-Based Structural Soil at open tree areas. In covered areas, 30 inches of Sand-Based Structural Soil, with 6 inches of washed open graded aggregate between SBSS and covered surface.

- Prior to placing bottom layer of the soil profile, the sub-soil shall be loosened by tilling, ripping, trenching or a similar means to maximize infiltration.
- See Section 47.7.7 for sand and/or underdrain requirements underneath structural soil.

47.7.6 Stormwater Retention and Treatment Volume

Tree space with expanded soil volume will serve as a method of capturing and retaining the required 1.2 inches of stormwater in accordance with DDOE requirements. These facilities can be designed to meet the requirements of the DDOE's Bioretention type "Engineered Tree Box" when surface ponding volume is provided, whether designed as an enclosed plant bed with covered soil volume, or a continuous open area (either mulched or with turf) with soil volume under the adjacent sidewalk. The tree space can function as an area for "Disconnected Impervious Surface" per the DDOE Stormwater Guidebook to capture runoff from the sidewalk.

47.7.7 Stormwater Conveyance for Irrigation of Soil

- Soils beneath pavements should receive water flow from no less than 0.5 times, and no more than 4.0 times, the open surface area.
- For tree rooting soils beneath pavements the optimum strategy for providing an even distribution of stormwater for irrigation and infiltration purposes is the use of permeable pavements.
- Where feasible, permeable pavements shall be used over Suspended Pavement, Structural Cell or Structural Soil installations. Approved geogrids shall be placed beneath non-interlocking permeable pavements.
- Where permeable pavements are not used, linear drains with grates discharging directly to structural soil spaced at 6' ft intervals, or small watersheds draining to catch basins with distribution perforated pipes to the soils, shall be provided.
- Where the covered soil volume includes impervious cover of not more than 6 feet in width, the use of linear drains or catch basins is optional.
- An aeration layer shall be created over all suspended pavement soil, structural cell soil or structural soils by using 6" minimum depth of uniformly graded crushed stone materials, such as #8 or #57 stone.
- Subsurface Drainage: Natural Resources Conservation Service (NRCS) Soil Mapping hydrologic units may be used to estimate subsoil infiltration rates or soils may be tested directly by measuring in-place infiltration rates. Where infiltration rates are measured directly tests shall be at a frequency of not less than one test per 1000 square feet. DDOT may require additional testing where variable soil conditions are anticipated.

Infiltration Rate	NRCS Soil Group	Subsurface Requirement
≥ 0.5 in/hr	A or B	None
Between 0.14 and 0.5 in/hr	C	12” of sand beneath street tree soil volume
≤ 0.14 in/hr	D	12” of sand with 4” perforated underdrain, (with geotextile surround) beneath street tree soil volume – connected to the storm drainage system

47.7.8 Access and Safety Barriers

- Pedestrian crossings of continuous open planting strips adjacent to curb are required as below.
    - 6’ paved area between each tree in high-volume pedestrian areas
    - Alternating every other tree in other areas, with surface material appropriate to surrounding area (paved, grass, mulch).
- Parking egress strip of a width between 12” and 36” (measured from face of curb) may be provided adjacent to curb in metered/paid street parking zones where total public space width is at least 12 feet between face of curb and back of sidewalk, using the remaining space available after deducting the required walkway width and minimum open tree space dimension requirements.
- Ornamental fencing meeting DDOT requirements may be required around open tree planting space to protect planting soil from pedestrian foot traffic.
- Bike racks may be combined with ornamental fencing around open tree planting space. Type of rack to be selected in coordination with DDOT project manager.

47.7.9 Structural Support

All structural elements, including pavements and curbs, must be founded over structurally stable soils. Stable soils should extend laterally from the point of support at a slope of 1 horizontal to 2 vertical in the downward direction. Plant Bed, Lawn and Bioretention Soils are not structurally stable. SBSS and CU Soil are structurally stable.

47.8 Planting Guidance for Vegetated Stormwater Systems

Selection of plant species, locations, and spacing within vegetated stormwater management facilities (bioretention) will be based on the following parameters:

- Light - full sun, partial shade, full shade

- Water - Some plants will succeed in areas that are inundated with water frequently while others will only do well when they are located in the driest part of the facility
- Salt - Plants that have a high salt tolerance are the best choice for facilities that will receive a large amount of salt-tainted runoff
- Pollution – Generally, plants that are in areas with higher pollution will require more maintenance and care throughout their lifespan in order to remain aesthetically pleasing
- Maintenance – Areas with low maintenance should be planted with plants that do not require intensive care. Areas that will be maintained several times a year can be planted with plants that require more attention.
- Survivability in urban environment - All of the above factors relate to the plant's ability to survive in an urban ROW LID facility
- Size – plants should be the appropriate mature size for the site. Site viewing lines, pedestrian, and vehicle safety should be considered. Plants, except street trees, between the curb and sidewalk should be less than 18” high above the sidewalk level.

The designer will select the plants for the bioretention facilities from the current DDOT approved plant list. The list is organized in accordance with the above factors, and is grouped into three maintenance categories: low level of care, medium level of care, and high level of care.

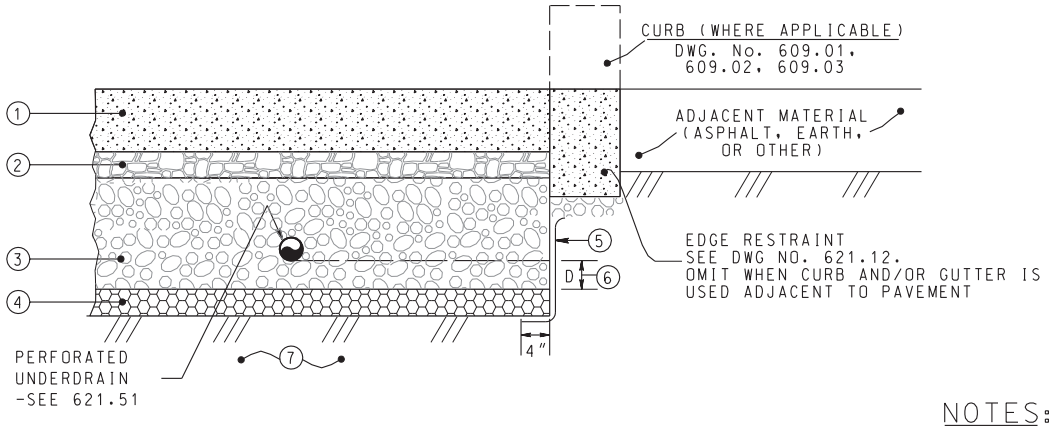
DISTRICT OF COLUMBIA

DEPARTMENT OF TRANSPORTATION

GREEN INFRASTRUCTURE STANDARDS

SUPPLEMENT TO STANDARD DRAWINGS

2014



ROAD / ALLEY SECTION

MINIMUM PAVEMENT THICKNESSES

PAVEMENT ITEM	CLASS A	CLASS B
①	6"	8"
②	4"	4"
③	6", SEE NOTE 5	12", SEE NOTE 5
④	4"	4"

CLASS A: ALLEY, PARKING LANE, LOCAL STREET
CLASS B: COLLECTOR OR ARTERIAL (NOT CURRENTLY ALLOWED)

LEGEND

① PERVIOUS PORTLAND CEMENT CONCRETE

② CHOKER LAYER, AASHTO #57 OR APPROVED EQUIVALENT

③ RESERVOIR LAYER, AASHTO #3, #2, OR #57, OR APPROVED EQUIVALENT*

* AASHTO #57 TO BE USED ONLY WITH MAXIMUM RESERVOIR DEPTH OF 8".

④ FILTER LAYER (SEE NOTE 7), AASHTO #8 OR APPROVED EQUIVALENT

⑤ GEOTEXTILE CLASS 2, LOCATED ON SIDES OF PRACTICES ONLY

⑥ INFILTRATION SUMP. FOR STANDARD DESIGN, D = 0"
FOR ENHANCED DESIGN, SEE NOTE 6

⑦ UNCOMPACTED SUBGRADE FOR AREAS DESIGNED FOR INFILTRATION PRACTICES. FOR OTHER AREAS, COMPACT AS SPECIFIED IN SPECIFICATION CITED IN NOTE 2. FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.

NOTES:

1. DETAIL TO BE USED ONLY WHEN APPROVED BY DDOT IPMA AND SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "PERVIOUS PORTLAND CEMENT CONCRETE PAVEMENT".
2. AGGREGATE LAYERS SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "AGGREGATES FOR PERMEABLE PAVEMENT AND BIORETENTION".
3. SEE DWG. NO. 621.10 FOR LONGITUDINAL AND CROSS SLOPE REQUIREMENTS.
4. WATERPROOF MEMBRANE TO BE USED TO PROMOTE WATER RE-USE, PROTECT NEARBY BUILDING FOUNDATIONS AND AVOID INFILTRATION AROUND UTILITIES. SEE DESIGN PLANS.
5. DEPTH OF RESERVOIR LAYER AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT AND CONVEYANCE REQUIREMENTS, AND PAVEMENT STRUCTURAL DESIGN.
6. ENHANCED DESIGN CONTAINS A WATER STORAGE LAYER AND AN INFILTRATION SUMP BENEATH THE UNDERDRAIN SIZED TO DRAIN THE DESIGN STORM WITHIN 48 HOURS.
7. WHEN FILTER LAYER IS OMITTED, PROVIDE GEOTEXTILE CLASS I MATERIAL BENEATH RESERVOIR LAYER MEETING CURRENT APPROVED DDOT SPECIFICATION FOR "GEOSYNTHETICS FOR STORMWATER FACILITIES".
8. BOTTOM OF PERMEABLE PAVEMENT STRUCTURE SHALL BE AT LEAST 2' ABOVE THE SEASONAL HIGH WATER TABLE OR BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
9. TOP OF PAVEMENT SHOULD BE DESIGNED TO ACHIEVE 1% MINIMUM SLOPE IN ANY DIRECTION.
10. FOR ROADWAY JOINT LAYOUT, REFER TO DDOT DWG. NO. 501.01. FOR ALLEY JOINT LAYOUT, REFER TO DDOT DWG. NO. 503.01.

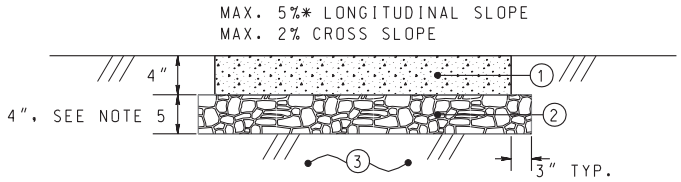
			RECOMMENDED: Ravindra D Ganik DEPUTY CHIEF ENGINEER
DATE	APPR.		
REVISED			APPROVED: CHIEF TRANSPORTATION ENGINEER
ISSUED:			
		REFERENCE	

PERVIOUS CONCRETE PAVEMENT

(ROADWAY AND ALLEY)

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.01



SIDEWALK SECTION

*STEEPER SLOPE ALLOWED IF APPROVED BY DDOT IPMA.

LEGEND

(1) *PERVIOUS PORTLAND CEMENT CONCRETE*

(2) *BASE COURSE, AASHTO #57 OR APPROVED EQUIVALENT*

(3) *UNCOMPACTED SUBGRADE FOR AREAS DESIGNED AS INFILTRATION PRACTICES. FOR OTHER AREAS, COMPACT AS SPECIFIED IN SPECIFICATION CITED IN NOTE 2. FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.*

NOTES:

1. DETAIL TO BE USED ONLY WHEN APPROVED BY DDOT IPMA AND SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "PERVIOUS PORTLAND CEMENT CONCRETE PAVEMENT".
2. AGGREGATE LAYERS SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "AGGREGATES FOR PERMEABLE PAVEMENT AND BIORETENTION".
3. WHERE INSITU SOILS ARE NOT CONDUCIVE TO INFILTRATION OF 1.2" RETENTION VOLUME WITHIN 72 HOURS, UNDERDRAIN SHOULD BE CONSIDERED THROUGH COORDINATION WITH DDOT IPMA.
4. WATERPROOF MEMBRANCE TO BE USED TO PROMOTE WATER RE-USE, PROTECT NEARBY BUILDING FOUNDATIONS AND AVOID INFILTRATION AROUND UTILITIES. SEE DESIGN PLANS.
5. AGGREGATE DEPTH MAY BE GREATER THAN MINIMUM, AS SHOWN IN DESIGN PLANS TO ACHIEVE ADDITIONAL STORMWATER STORAGE.
6. BOTTOM OF PERMEABLE PAVEMENT STRUCTURE SHALL BE AT LEAST 2' ABOVE THE SEASONAL HIGH WATER TABLE OR BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
7. TOP OF PAVEMENT SHOULD BE DESIGNED TO ACHIEVE 1% MINIMUM SLOPE IN ANY DIRECTION.
8. FOR SIDEWALK JOINT LAYOUT, REFER TO DDOT DWG. NO. 608.01. FOR TRAIL JOINT LAYOUT, REFER TO DDOT DWG. NO. 501.01.

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

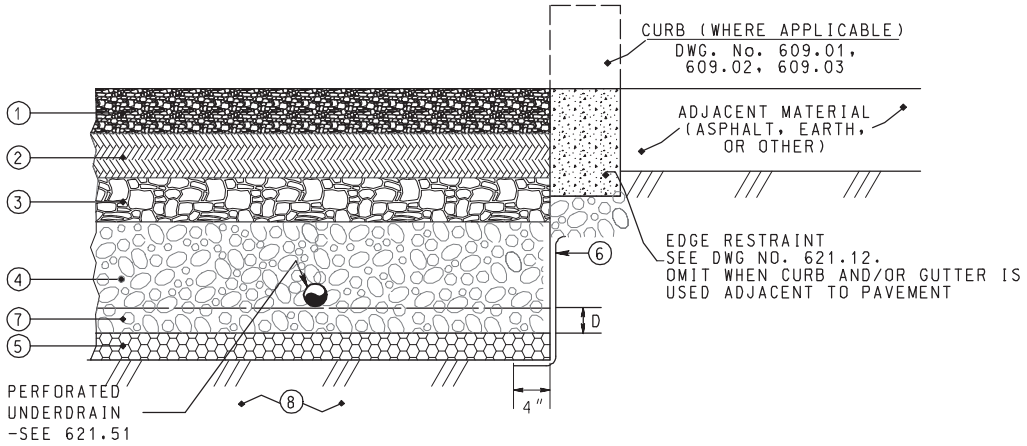
RECOMMENDED: Ravindra D Ganiti
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

PERVIOUS CONCRETE SIDEWALK

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.02



ROAD / ALLEY SECTION

MINIMUM PAVEMENT THICKNESSES

PAVEMENT ITEM	CLASS A	CLASS B
①	1.5"	3"
②	3"	6"
③	4"	4"
④	6", SEE NOTE 5	12", SEE NOTE 5
⑤	4"	4"

CLASS A: ALLEY, PARKING LANE, LOCAL STREET
CLASS B: COLLECTOR OR ARTERIAL (NOT CURRENTLY ALLOWED)

LEGEND

① POROUS ASPHALT SURFACE COURSE - HMA 12.5 mm

② POROUS ASPHALT BASE COURSE - HMA 25 mm

③ CHOKER LAYER, AASHTO #57 OR APPROVED EQUIVALENT

④ RESERVOIR LAYER, AASHTO #3, #2, OR #57, OR APPROVED EQUIVALENT*

* AASHTO #57 TO BE USED ONLY WITH MAXIMUM RESERVOIR DEPTH OF 8".

⑤ FILTER LAYER (SEE NOTE 7), AASHTO #8 OR APPROVED EQUIVALENT

⑥ GEOTEXTILE CLASS 2, LOCATED ON SIDES OF PRACTICES ONLY

⑦ INFILTRATION SUMP. FOR STANDARD DESIGN, D = 0"
FOR ENHANCED DESIGN, SEE NOTE 6

⑧ UNCOMPACTED SUBGRADE FOR AREAS DESIGNED FOR INFILTRATION PRACTICES.
FOR OTHER AREAS, COMPACT AS SPECIFIED IN SPECIFICATION CITED IN NOTE 2.
FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.

NOTES:

1. DETAIL TO BE USED ONLY WHEN APPROVED BY DDOT IPMA AND SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR 'POROUS ASPHALT PAVEMENT'.
2. AGGREGATE LAYERS SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR 'AGGREGATES FOR PERMEABLE PAVEMENT AND BIORETENTION".
3. SEE DWG. NO. 621.10 FOR LONGITUDINAL AND CROSS SLOPE REQUIREMENTS.
4. WATERPROOF MEMBRANE TO BE USED TO PROMOTE WATER RE-USE, PROTECT NEARBY BUILDING FOUNDATIONS AND AVOID INFILTRATION AROUND UTILITIES. SEE DESIGN PLANS.
5. DEPTH OF RESERVOIR LAYER AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT AND CONVEYANCE REQUIREMENTS, AND PAVEMENT STRUCTURAL DESIGN.
6. ENHANCED DESIGN CONTAINS A WATER STORAGE LAYER AND AN INFILTRATION SUMP BENEATH THE UNDERDRAIN SIZED TO DRAIN THE DESIGN STORM WITHIN 48 HOURS.
7. WHEN FILTER LAYER IS OMITTED, PROVIDE GEOTEXTILE CLASS I MATERIAL BENEATH RESERVOIR LAYER MEETING CURRENT APPROVED DDOT SPECIFICATION FOR 'GEOSYNTHETICS FOR STORMWATER FACILITIES'.
8. BOTTOM OF PERMEABLE PAVEMENT STRUCTURE SHALL BE AT LEAST 2' ABOVE THE SEASONAL HIGH WATER TABLE OR BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
9. TOP OF PAVEMENT SHOULD BE DESIGNED TO ACHIEVE 1% MINIMUM SLOPE IN ANY DIRECTION.

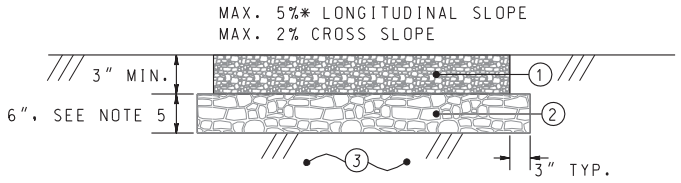
			RECOMMENDED: Ravindra D. Gonit DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED: CHIEF TRANSPORTATION ENGINEER
REVISED			
ISSUED:		REFERENCE	

POROUS ASPHALT PAVEMENT

(ROADWAY AND ALLEY)

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.03



SIDEWALK SECTION

*STEEPER SLOPE ALLOWED IF APPROVED BY DDOT IPMA.

LEGEND

(1) POROUS ASPHALT SURFACE COURSE

(2) AGGREGATE BASE, AASHTO #57 OR APPROVED EQUIVALENT

(3) UNCOMPACTED SUBGRADE FOR AREAS DESIGNED FOR INFILTRATION PRACTICES. FOR OTHER AREAS, COMPACT AS SPECIFIED IN SPECIFICATION CITED IN NOTE 2. FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.

NOTES:

1. DETAIL TO BE USED ONLY WHEN APPROVED BY DDOT IPMA AND SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "POROUS ASPHALT PAVEMENT".
2. AGGREGATE LAYERS SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "AGGREGATES FOR PERMEABLE PAVEMENT AND BIORETENTION".
3. WHERE INSITU SOILS ARE NOT CONDUCIVE TO INFILTRATION OF 1.2" RETENTION VOLUME WITHIN 72 HOURS, UNDERDRAIN SHOULD BE CONSIDERED THROUGH COORDINATION WITH DDOT IPMA.
4. WATERPROOF MEMBRANCE TO BE USED TO PROMOTE WATER RE-USE, PROTECT NEARBY BUILDING FOUNDATIONS AND AVOID INFILTRATION AROUND UTILITIES. SEE DESIGN PLANS.
5. AGGREGATE DEPTH MAY BE GREATER THAN MINIMUM, AS SHOWN IN DESIGN PLANS TO ACHIEVE ADDITIONAL STORMWATER STORAGE.
6. BOTTOM OF PERMEABLE PAVEMENT STRUCTURE SHALL BE AT LEAST 2' ABOVE THE SEASONAL HIGH WATER TABLE OR BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
7. TOP OF PAVEMENT SHOULD BE DESIGNED TO ACHIEVE 1% MINIMUM SLOPE IN ANY DIRECTION.

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

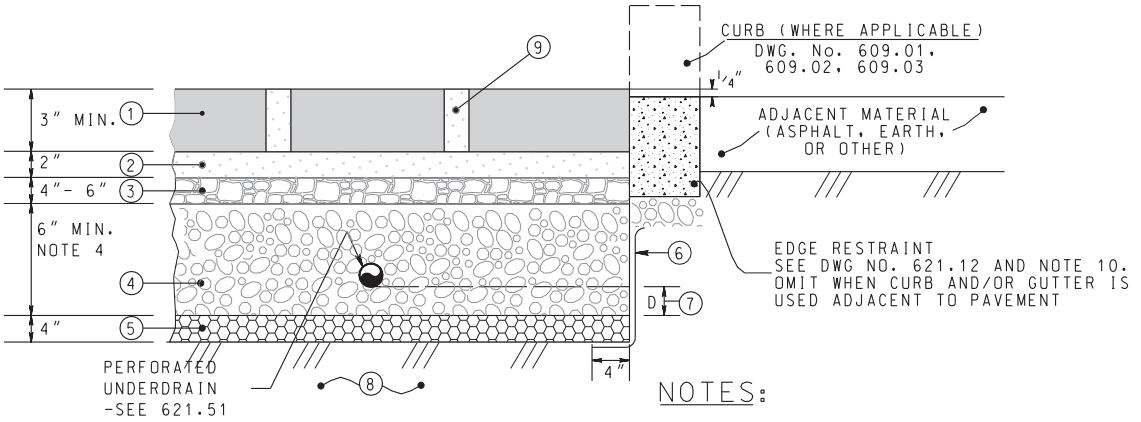
RECOMMENDED: Ravindra D. Ganvir
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

POROUS ASPHALT SIDEWALK

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.04



ROAD / ALLEY SECTION

LEGEND

(1) PERMEABLE INTERLOCKING CONCRETE PAVERS (PICP) OR SIMILAR

(2) BEDDING LAYER, AASHTO #8 OR APPROVED EQUIVALENT

(3) CHOKER LAYER, AASHTO #57 OR APPROVED EQUIVALENT

(4) RESERVOIR LAYER, AASHTO #3, #2, OR APPROVED EQUIVALENT

(5) FILTER LAYER (SEE NOTE 7), AASHTO #8 OR APPROVED EQUIVALENT

(6) GEOTEXTILE CLASS 2, LOCATED ON SIDES OF PRACTICES ONLY

(7) INFILTRATION SUMP. FOR STANDARD DESIGN, D = 0"
FOR ENHANCED DESIGN, SEE NOTE 6

(8) UNCOMPACTED SUBGRADE FOR AREAS DESIGNED FOR INFILTRATION PRACTICES
FOR OTHER AREAS, COMPACT AS SPECIFIED IN SPECIFICATION CITED IN NOTE 2
FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS

(9) JOINT TO HAVE ½ INCH MAXIMUM GAP IN ACCORDANCE WITH THE LATEST ADA REQUIREMENTS AND TO BE FILLED WITH AASHTO #8 OR APPROVED EQUIVALENT. MINIMUM GAP SHALL BE ¼" OR PER MANUFACTURERS RECOMMENDATIONS FOR INTERLOCKING CONCRETE PAVERS.

NOTES:

1. DETAIL TO BE USED ONLY WHEN APPROVED BY DDOT IPMA AND SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "PERMEABLE UNIT PAVERS" (NOT CURRENTLY ALLOWED ON COLLECTOR AND ARTERIAL)
2. AGGREGATE LAYERS SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "AGGREGATES FOR PERMEABLE PAVEMENT AND BIORETENTION".
3. SEE DWG. NO. 621.10 FOR LONGITUDINAL AND CROSS SLOPE REQUIREMENTS.
4. WATERPROOF MEMBRANE TO BE USED TO PROMOTE WATER RE-USE, PROTECT NEARBY BUILDING FOUNDATIONS AND AVOID INFILTRATION AROUND UTILITIES. SEE DESIGN PLANS.
5. DEPTH OF RESERVOIR LAYER AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT AND CONVEYANCE REQUIREMENTS, AND PAVEMENT STRUCTURAL DESIGN.
6. ENHANCED DESIGN CONTAINS A WATER STORAGE LAYER AND AN INFILTRATION SUMP BENEATH THE UNDERDRAIN SIZED TO DRAIN THE DESIGN STORM WITHIN 48 HOURS.
7. WHEN FILTER LAYER IS OMITTED, PROVIDE GEOTEXTILE CLASS I MATERIAL BENEATH RESERVOIR LAYER MEETING CURRENT APPROVED DDOT SPECIFICATION FOR "GEOSYNTHETICS FOR STORMWATER FACILITIES".
8. BOTTOM OF PERMEABLE PAVEMENT STRUCTURE SHALL BE AT LEAST 2' ABOVE THE SEASONAL HIGH WATER TABLE OR BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
9. TOP OF PAVEMENT SHOULD BE DESIGNED TO ACHIEVE 1% MINIMUM SLOPE IN ANY DIRECTION.
10. OTHER TYPES OF EDGE RESTRAINTS SUCH AS STEEL OR PLASTIC SHALL BE ALLOWED AS APPROVED BY THE ENGINEER AND BASED ON MANUFACTURER'S RECOMMENDATIONS.

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

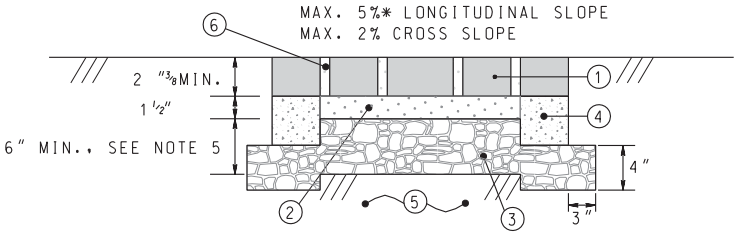
RECOMMENDED: Ravindra D. Gonis
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

PERMEABLE INTERLOCKING UNIT PAVER PAVEMENT
(ROADWAY AND ALLEY)

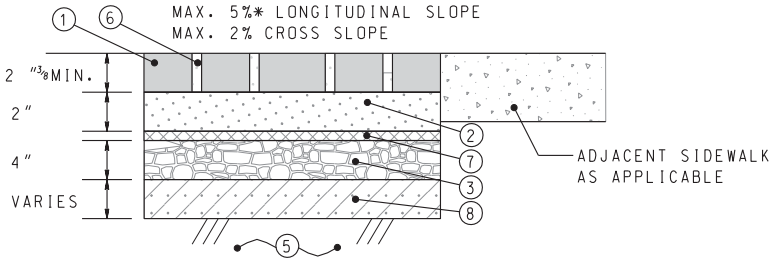
DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.05



SIDEWALK SECTION

* STEEPER SLOPE ALLOWED IF APPROVED BY DDOT IPMA.



NON-INTERLOCKING PAVERS OVER SAND-BASED STRUCTURAL SOIL

* STEEPER SLOPE ALLOWED IF APPROVED BY DDOT IPMA.

LEGEND

(1) PERMEABLE INTERLOCKING CONCRETE PAVERS (PICP) OR SIMILAR, OR NON-INTERLOCKING PAVERS, AS NOTED.

(2) BEDDING LAYER, AASHTO #8 OR APPROVED EQUIVALENT

(3) DOUBLE WASHED AGGREGATE, AASHTO #57 OR APPROVED EQUIVALENT

(4) CONCRETE EDGE RESTRAINT, MIN. 4" WIDE AND 7½" DEEP; MORTAR OR POLYMER ADHERED PAVERS TO TOP; ALTERNATIVELY, EXTEND EDGE RESTRAINT TO SURFACE. OTHER TYPES OF EDGE RESTRAINTS SUCH AS STEEL OR PLASTIC SHALL BE ALLOWED AS APPROVED BY THE ENGINEER AND BASED ON MANUFACTURER'S RECOMMENDATIONS.

(5) UNCOMPACTED SUBGRADE FOR AREAS DESIGNED FOR INFILTRATION PRACTICES. FOR OTHER AREAS, COMPACT AS SPECIFIED IN SPECIFICATION CITED IN NOTE 2. FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS. SEE NOTE 8 FOR ALTERNATE DESIGN.

(6) JOINT TO HAVE 1/2 INCH MAXIMUM GAP IN ACCORDANCE WITH THE LATEST ADA REQUIREMENTS AND TO BE FILLED WITH AASHTO #8 OR APPROVED EQUIVALENT. MINIMUM GAP SHALL BE 1/4" OR PER MANUFACTURERS RECOMMENDATIONS FOR INTERLOCKING CONCRETE PAVERS.

(7) GEOGRID, AS APPROVED BY DDOT

(8) SAND-BASED STRUCTURAL SOIL (SBSS)

NOTES:

1. DETAIL TO BE USED ONLY WHEN APPROVED BY DDOT IPMA AND SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "PERMEABLE UNIT PAVERS".
2. AGGREGATE LAYERS SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "AGGREGATES FOR PERMEABLE PAVEMENT AND BIORETENTION".
3. WHERE INSITU SOILS ARE NOT CONDUCIVE TO INFILTRATION OF 1.2" OF RETENTION VOLUME WITHIN 72 HOURS, UNDERDRAINS SHOULD BE CONSIDERED THROUGH COORDINATION WITH DDOT IPMA .
4. WATERPROOF MEMBRANE TO BE USED TO PROMOTE WATER RE-USE, PROTECT NEARBY BUILDING FOUNDATIONS AND AVOID INFILTRATION AROUND UTILITIES. SEE DESIGN PLANS.
5. AGGREGATE DEPTH MAY BE GREATER THAN MINIMUM, AS SHOWN IN DESIGN PLANS TO ACHIEVE ADDITIONAL STORMWATER STORAGE.
6. BOTTOM OF PERNMEABLE PAVEMENT STRUCTURE SHALL BE AT LEAST 2' ABOVE THE SEASONAL HIGH WATER TABLE OR TO BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
7. TOP OF PAVEMENT SHOULD BE DESIGNED TO ACHIEVE 1% MINIMUM SLOPE IN ANY DIRECTION.
8. IN AREAS OF TREE PLANTINGS WHICH CALL FOR SAND-BASED STRUCTURAL SOIL (SSBS), THE SBSS MAY EXTEND UNDER THE AGGREGATE BASE LAYER OF THE SIDEWALK.

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

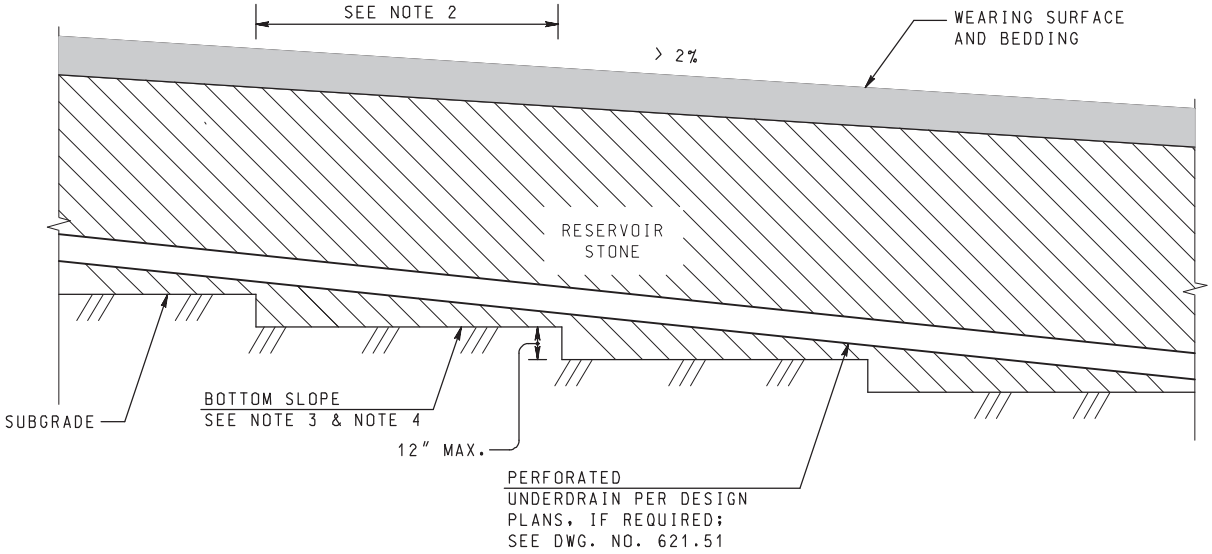
RECOMMENDED: Ravindra D Gonit
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

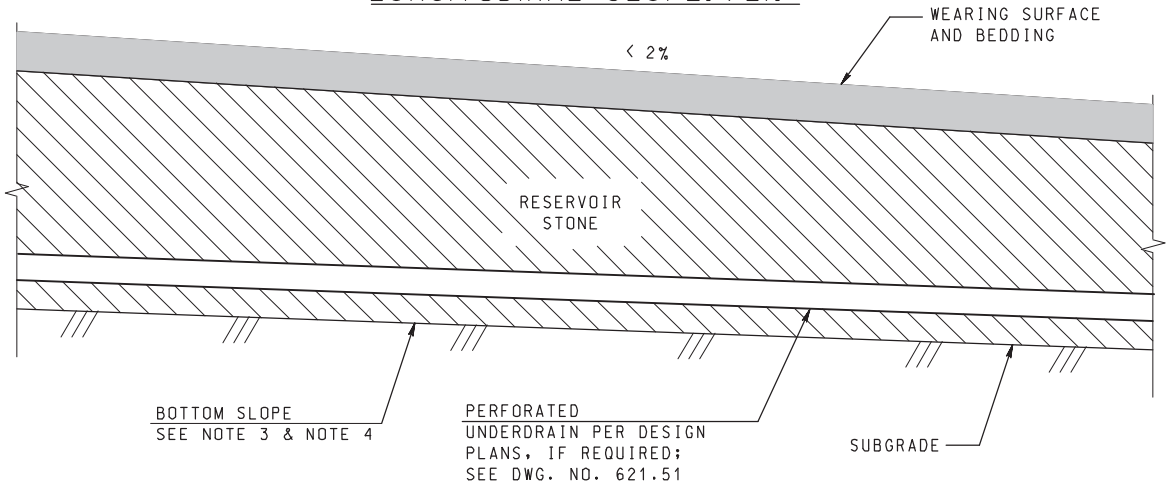
PERMEABLE PAVER SIDEWALK

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.06



TERRACED SLOPE
LONGITUDINAL SLOPE: >2%



CONTINUOUS BOTTOM SLOPE
LONGITUDINAL SLOPE: < 2%

NOTES:

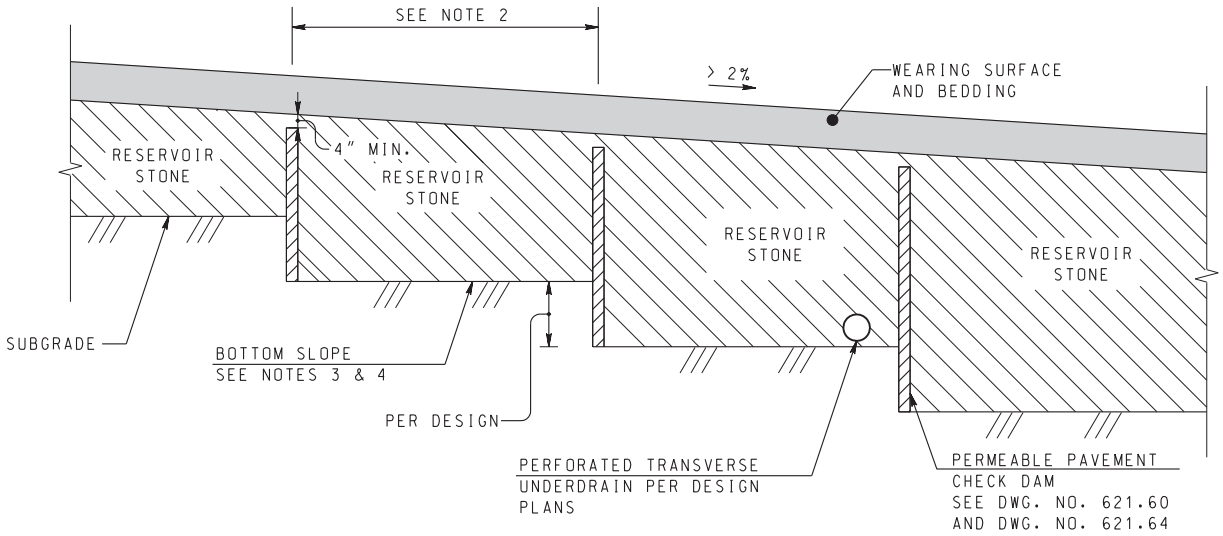
1. CHECK DAMS TO BE USED FOR INSTALLATION WITH BOTTOM SLOPES GREATER THAN 2% LONGITUDINALLY, OR AS DIRECTED BY THE CONTRACT DOCUMENTS.
2. DISTANCE BETWEEN STEPS IS DETERMINED BY THE SLOPE OF THE PAVEMENT TO ACHIEVE A STEP NO MORE THAN 12' TALL.
3. BOTTOM SLOPE = 0% TO 5% BUT NO STEEPER THAN TOP SLOPE, PER DESIGN PLANS. ENGINEER TO DESIGN SYSTEM TO ACHIEVE STORAGE, DRAW-DOWN, AND STRUCTURAL REQUIREMENTS. BOTTOM SLOPE DOES NOT HAVE TO BE PARALLEL TO TOP SLOPE.
4. FOR FACILITIES WITH WATERPROOF MEMBRANE, MINIMUM BOTTOM SLOPE SHALL BE 2% TO DRAIN DRY.
5. TRANSVERSE BOTTOM SLOPES AND CROSS SLOPES SHALL BE <3%.

			RECOMMENDED: Ravindra D Gonit DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED:
REVISED			
ISSUED:			CHIEF TRANSPORTATION ENGINEER
		REFERENCE	

PERMEABLE PAVEMENT ELEVATION–1

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.10



LONGITUDINAL SLOPE: > 2%

NOT TO SCALE

NOTES:

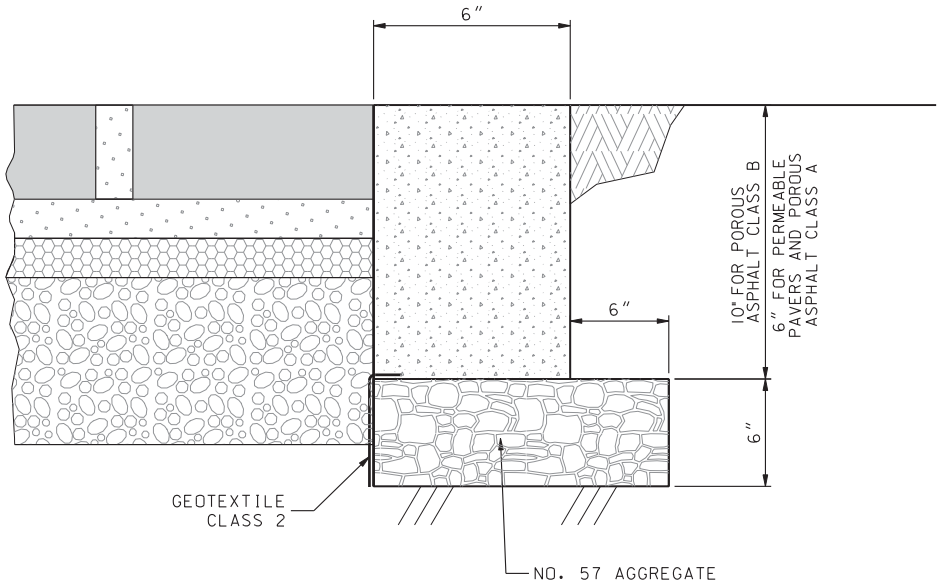
1. CHECK DAMS TO BE USED FOR INSTALLATION WITH BOTTOM SLOPES GREATER THAN 2% LONGITUDINALLY AS SHOWN IN THE CONTRACT DOCUMENTS.
2. DISTANCE BETWEEN STEPS IS DETERMINED BY THE SLOPE OF THE PAVEMENT TO ACHIEVE A STEP NO MORE THAN 12" TALL.
3. BOTTOM SLOPE = 0% TO 5% BUT NO STEEPER THAN TOP SLOPE, PER DESIGN PLANS. ENGINEER TO DESIGN SYSTEM TO ACHIEVE STORAGE, DRAW-DOWN, AND STRUCTURAL REQUIREMENTS. BOTTOM SLOPE DOES NOT HAVE TO BE PARALLEL TO TOP SLOPE.
4. FOR FACILITIES WITH WATERPROOF MEMBRANE, MINIMUM BOTTOM SLOPE SHALL BE 2% TO DRAIN DRY.
5. TRANSVERSE BOTTOM SLOPES AND CROSS SLOPES SHALL BE <3%.

			RECOMMENDED: Ravindra D Ganvir DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED: CHIEF TRANSPORTATION ENGINEER
REVISED			
ISSUED:		REFERENCE	

PERMEABLE PAVEMENT ELEVATION–2

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.11



NOTES:

1. PERIMETER RESTRAINTS ARE REQUIRED FOR PERMEABLE INTERLOCKING UNIT PAVEMENT SYSTEMS. ENGINEER TO DETERMINE IF EDGE RESTRAINTS ARE NECESSARY FOR POROUS ASPHALT AND PERVIOUS CONCRETE INSTALLATIONS.

2. MATERIALS: TYPE F, 3,500 PSI CONCRETE; OTHER TYPES OF EDGE RESTRAINTS, SUCH AS STEEL OR PLASTIC SHALL BE ALLOWED AS APPROVED BY THE ENGINEER, AND BASED ON MANUFACTURER'S RECOMMENDATIONS.

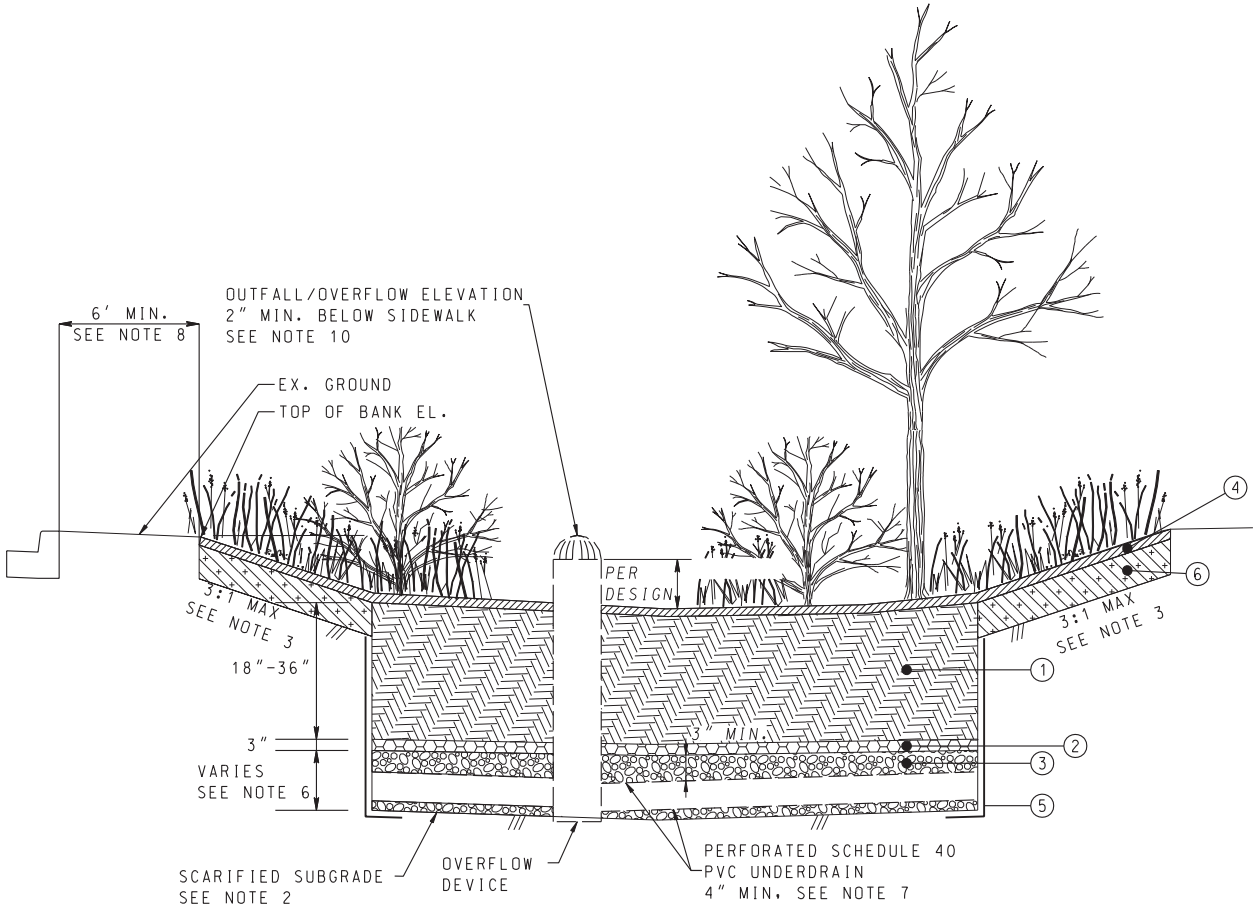
			RECOMMENDED: Ravindra D. Ganvir DEPUTY CHIEF ENGINEER	**PERMEABLE PAVEMENT EDGE RESTRAINT**
DATE	APPR.		APPROVED:	
REVISED				
ISSUED:			CHIEF TRANSPORTATION ENGINEER	
		REFERENCE		

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.12

NOTES:

1. BIORETENTION MATERIALS AND CONSTRUCTION SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "BIORETENTION, PLANTING, AND STRUCTURAL SOILS".
2. SCARIFY SUBGRADE 3" MIN. BEFORE INSTALLATION.
3. SIDE SLOPES STEEPER THAN 3:1 MAY BE ALLOWED; HOWEVER, MUST BE STABILIZED IN ACCORDANCE WITH DDOT DESIGN REQUIREMENTS.
4. FOR ALTERNATIVE EDGE TREATMENT CONDITIONS, SEE DWG. NOS. 621.30 TO 621.32
5. BOTTOM OF BIOSWALE SHALL BE AT LEAST 2' ABOVE THE SEASONAL HIGH WATER TABLE AND BEDROCK AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
6. STONE DEPTH SHALL VARY PER DESIGN PLANS, TO ACHIEVE A WATER STORAGE LAYER/ INFILTRATION SUMP, WHEN APPLICABLE.
7. PROVIDE UNDERDRAIN WHEN CALLED FOR PER DESIGN PLANS. SEE DWG. 603.01 FOR MIN. BEDDING REQUIREMENT.
8. DISTANCE TO ROADWAY MAY BE REDUCED WHEN SIDE OF PRACTICE IS LINED WITH WATERPROOF MEMBRANE, PER DESIGN PLANS.
9. SEE DWG. NO. 603.01 FOR CLEAN OUT AND OBSERVATION WELL DETAIL.
10. BIORETENTION FACILITY DEPICTED IS ONE WITH AN OVERFLOW STRUCTURE. "OFF-LINE" FACILITIES DESIGNED TO LIMIT INFLOW SO THAT OVERFLOW STRUCTURES ARE NOT REQUIRED ARE ALSO PERMISSIBLE, AS SHOWN ON DESIGN PLANS.
11. IF DEPTH FROM SURROUNDING GRADE TO LOW POINT OF FACILITY EXCEEDS 5 FEET, A FENCE IS REQUIRED AROUND ENTIRE FACILITY.



ELEVATION

LEGEND:

1. BIORETENTION SOIL
2. CHOKER LAYER, SAND & GRAVEL
3. AASHTO #57 STONE, DOUBLE WASHED
4. MULCH, PER PLANTING PLAN
5. GEOTEXTILE, CLASS 2
6. PLANT BED SOIL

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

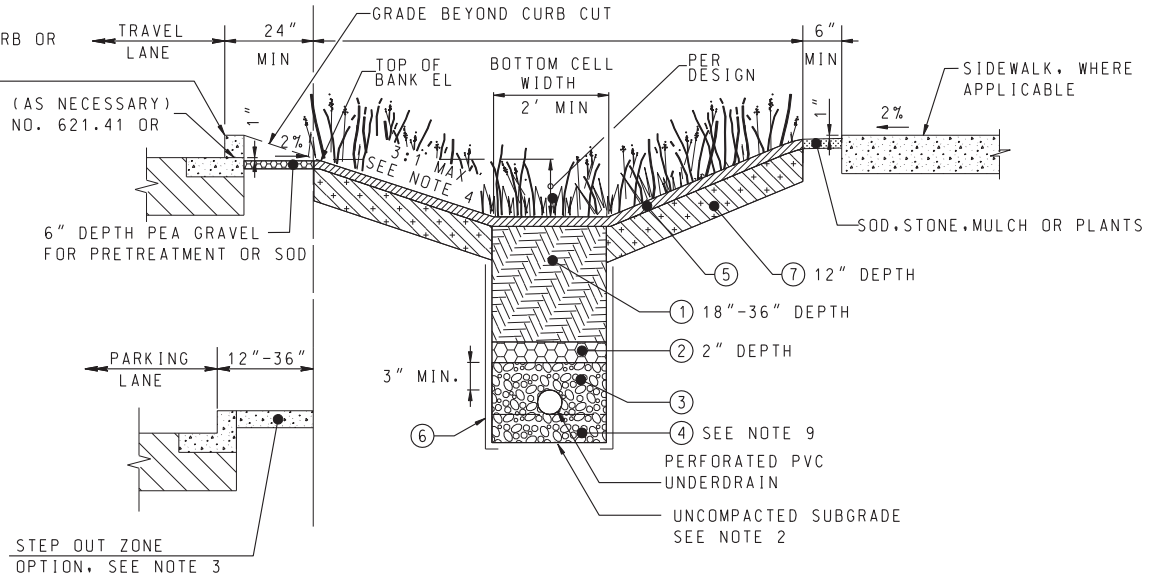
RECOMMENDED: Ravindra D Gavvala
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

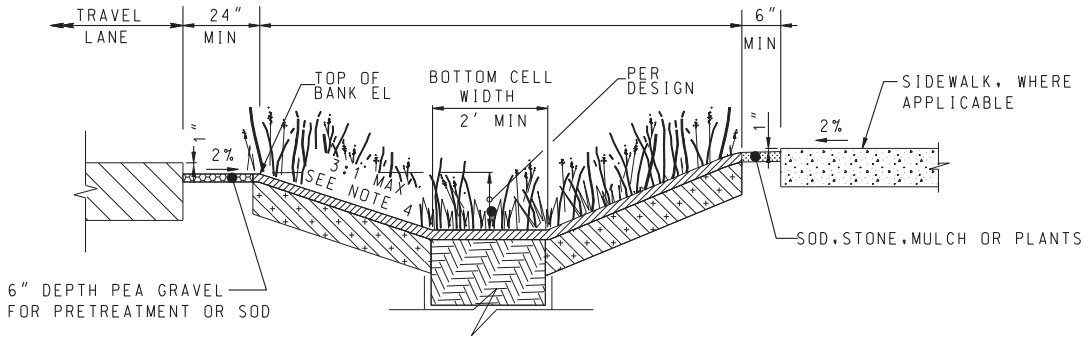
BIORETENTION IN OPEN AREA

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.20



CLOSED SECTION



OPEN SECTION

NOTES:

1. BIORETENTION MATERIALS AND CONSTRUCTION SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "BIORETENTION, PLANTING, AND STRUCTURAL SOILS".
2. SCARIFY SUBGRADE 3" MIN. BEFORE INSTALLATION.
3. STEP OUT ZONE REQUIRED WHEN PARALLEL PARKING IS PROVIDED. INSTALLATION MAY BE STANDARD CONCRETE SIDEWALK, SOD, MULCH OR PAVEMENT BASED ON SURROUNDING CONDITIONS.
4. SIDE SLOPES STEEPER THAN 3:1, MAY BE ALLOWED; HOWEVER, MUST BE INSTALLED IN ACCORDANCE WITH DDOT SPECIFICATIONS.
5. TREES AND PLANTINGS SHALL BE INSTALLED IN ACCORDANCE WITH DESIGN PLANS.
6. BOTTOM OF BIOSWALE SHALL BE AT LEAST 2' ABOVE THE SEASONAL HIGH WATER TABLE AND BEDROCK AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
7. INSTALL TRAFFIC BARRIER PER DWG. NO. 605.04, AS NECESSARY BASED ON ROADWAY DESIGN.
8. OFFSET TO SWALE MAY BE REDUCED IF ALTERNATE EDGE TREATMENT IS USED. SEE DWG. NOS. 621.30 TO 621.32.
9. DEPTH OF INFILTRATION SUMP AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT REQUIREMENTS.

LEGEND:

1. BIORETENTION SOIL
2. CHOKER LAYER, SAND & GRAVEL
3. AASHTO #57 STONE, DOUBLE WASHED
4. INFILTRATION SUMP, AASHTO #57 STONE, DOUBLE WASHED
5. MULCH, PER PLANTING PLAN
6. GEOTEXTILE, CLASS 2
7. PLANT BED SOIL

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

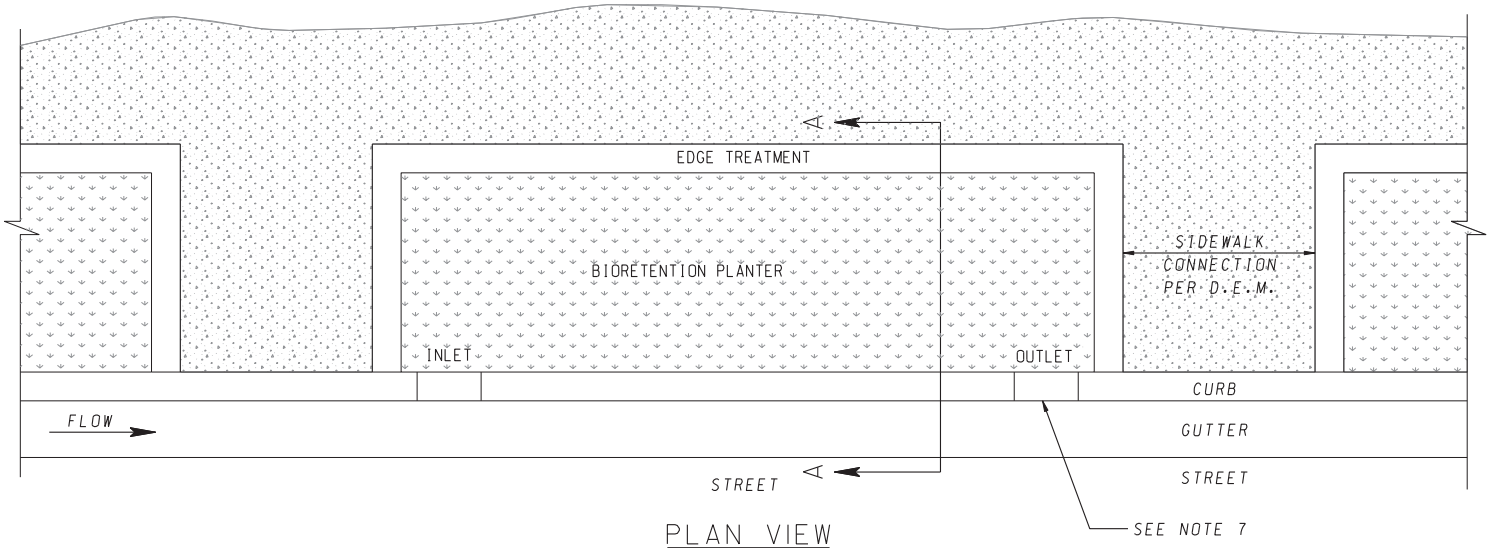
RECOMMENDED: Ravindra D. Gonik
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

BIOSWALE ADJACENT TO ROADWAY

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

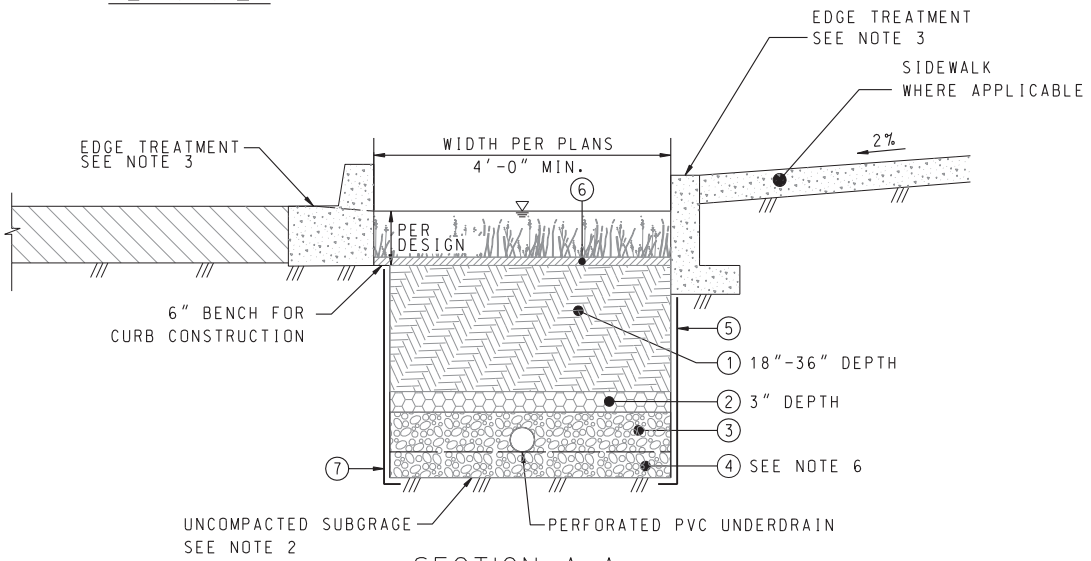
DWG. NO. 621.21



PLAN VIEW

NOTES:

1. BIORETENTION MATERIALS AND CONSTRUCTION SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "BIORETENTION, PLANTING, AND STRUCTURAL SOILS".
2. SCARIFY SUBGRADE 3" MIN. BEFORE INSTALLATION.
3. FOR EDGE TREATMENT OPTIONS, SEE DWG. NOS. 621.30 TO 621.32.
4. TREES AND PLANTINGS SHALL BE INSTALLED IN ACCORDANCE WITH DESIGN PLANS.
5. BOTTOM OF BIORETENTION SHALL BE AT LEAST 2' ABOVE THE SEASONAL HIGH WATER TABLE AND BEDROCK AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
6. DEPTH OF INFILTRATION SUMP AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT REQUIREMENTS.
7. OUTLET REQUIRED AS SPECIFIED BY PLANS.



SECTION A-A

LEGEND:

1. BIORETENTION SOIL
2. CHOKER LAYER, SAND & GRAVEL
3. AASHTO #57 STONE, DOUBLE WASHED
4. INFILTRATION SUMP, AASHTO #57 STONE, DOUBLE WASHED
5. GEOTEXTILE, CLASS 2
6. MULCH, PER PLANTING PLANS
7. WATERPROOF MEMBRANE

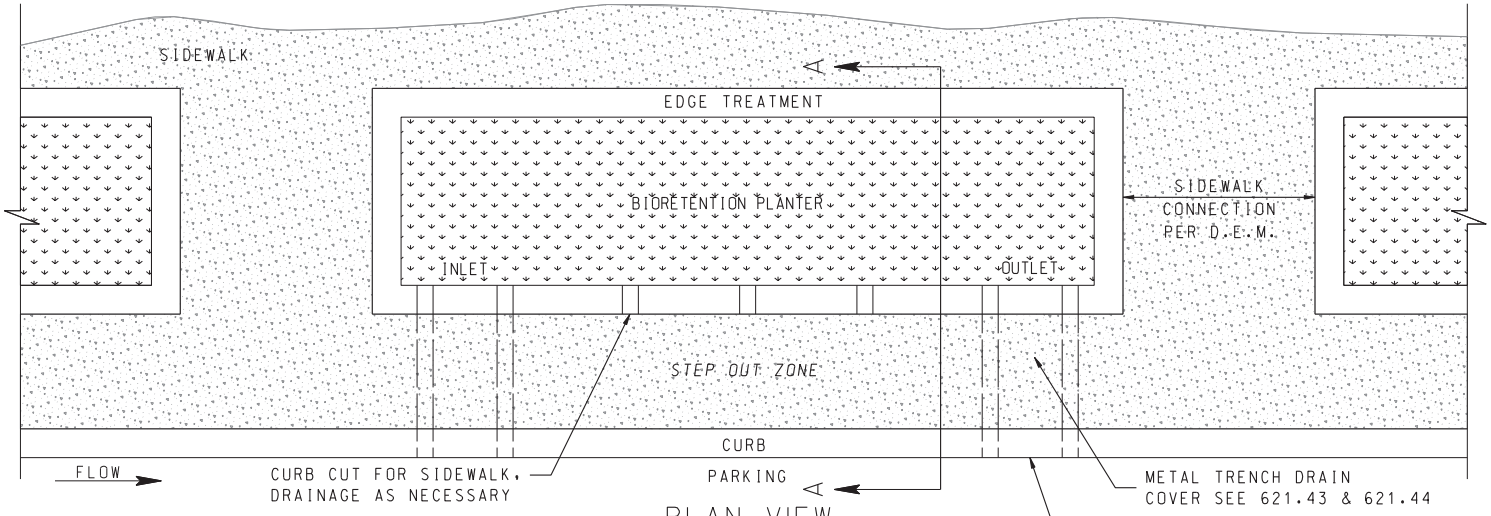
			RECOMMENDED: Ravindra P. Gonit DEPUTY CHIEF ENGINEER
DATE	APPR.		
REVISED			APPROVED:
ISSUED:			CHIEF TRANSPORTATION ENGINEER
		REFERENCE	

BIORETENTION PLANTER ADJACENT TO ROADWAY-1

(NO STEP OUT ZONE)

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

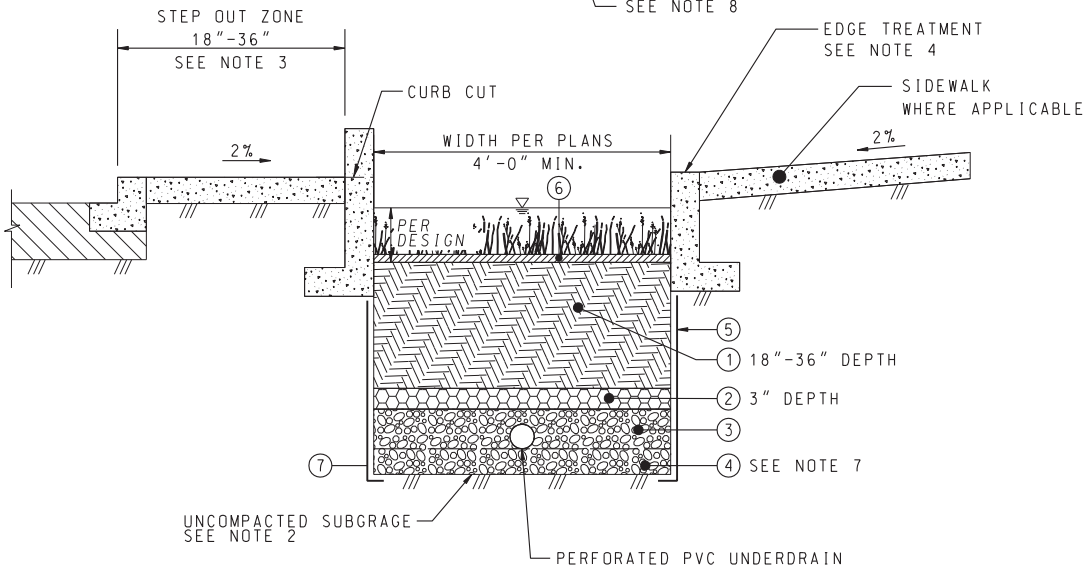
DWG. NO. 621.22



PLAN VIEW

NOTES:

1. BIORETENTION MATERIALS AND CONSTRUCTION SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "BIORETENTION, PLANTING, AND STRUCTURAL SOILS".
2. SCARIFY SUBGRADE 3" MIN. BEFORE INSTALLATION.
3. STEP OUT ZONE REQUIRED WHEN PARALLEL PARKING IS PROVIDED. INSTALLATION MAY BE STANDARD CONCRETE SIDEWALK, SOD, MULCH OR PAVEMENT BASED ON SURROUNDING CONDITIONS.
4. FOR EDGE TREATMENT OPTIONS, SEE DWG. NOS. 621.30 TO 621.32.
5. TREES AND PLANTINGS SHALL BE INSTALLED IN ACCORDANCE WITH DESIGN PLANS.
6. BOTTOM OF BIORETENTION SHALL BE AT LEAST 2' ABOVE THE SEASONAL HIGH WATER TABLE AND BEDROCK AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
7. DEPTH OF INFILTRATION SUMP AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT REQUIREMENTS.
8. OUTLET REQUIRED AS SPECIFIED BY PLANS.



SECTION A-A

LEGEND:

1. BIORETENTION SOIL
2. CHOKER LAYER, SAND & GRAVEL
3. AASHTO #57 STONE, DOUBLE WASHED
4. INFILTRATION SUMP, AASHTO #57 STONE, DOUBLE WASHED
5. GEOTEXTILE, CLASS 2
6. MULCH, PER PLANTING PLANS
7. WATERPROOF MEMBRANE

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

RECOMMENDED: Ravindra D. Gonit
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

BIORETENTION PLANTER ADJACENT TO ROADWAY-2

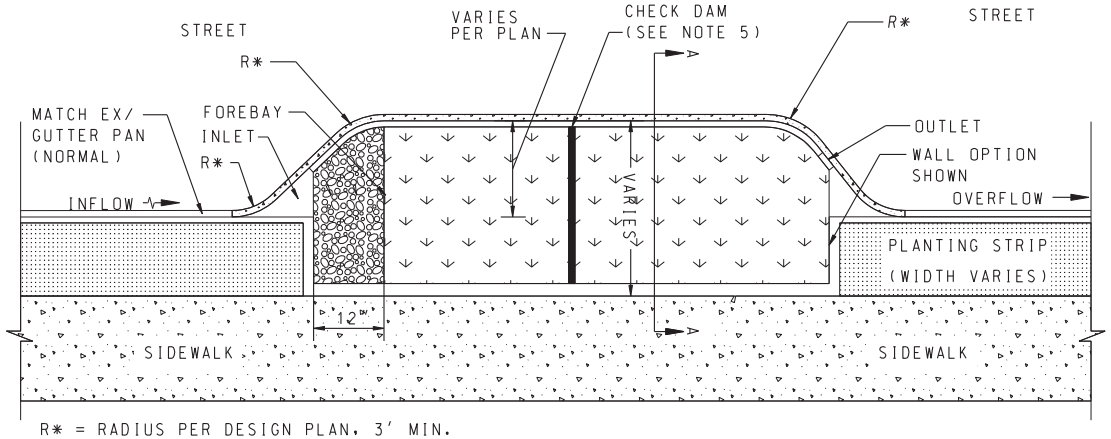
(WITH STEP OUT ZONE)

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.23

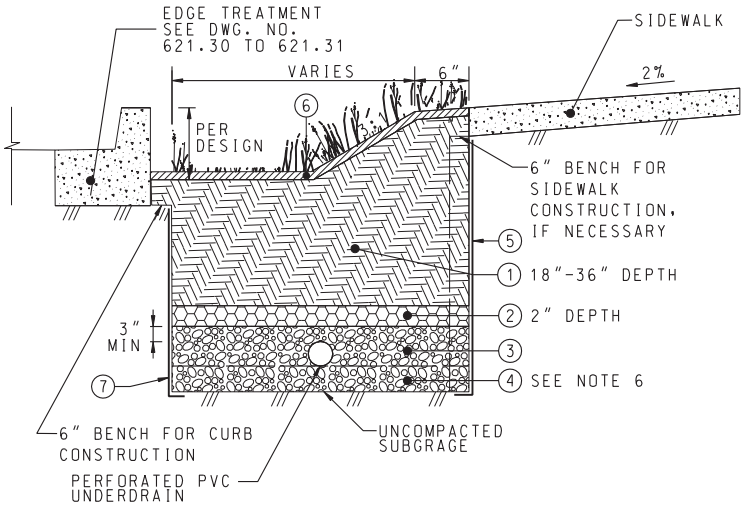
NOTES:

1. BIORETENTION MATERIALS AND CONSTRUCTION SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "BIORETENTION, PLANTING, AND STRUCTURAL SOILS".
2. LONGITUDINAL SLOPE OF PLANTER MATCHES ROAD, OR FLATTER AS REQUIRED PER DESIGN PLAN.
3. SIDEWALK ELEVATION MUST BE SET ABOVE INLET AND OUTLET ELEVATIONS TO ALLOW OVERFLOW TO DRAIN TO STREET BEFORE PONDING LEVEL REACHES SIDEWALK.
4. SEE DWG. NO. 621.40 FOR INLET / OUTLET AND FOREBAY DETAILS.
5. CHECK DAMS REQUIRED AS PER DESIGN PLANS. SEE DWG. NOS. 621.60 TO 621.63.
6. DEPTH OF INFILTRATION SUMP AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT REQUIREMENTS.
7. SCARIFY SUBGRADE 3" MIN. BEFORE INSTALLATION.

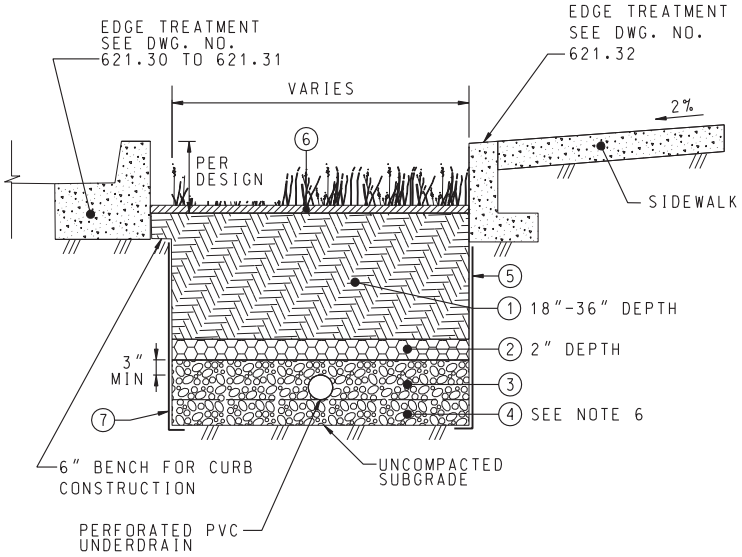


R* = RADIUS PER DESIGN PLAN, 3' MIN.

PLAN VIEW



SECTION A-A (SLOPE OPTION)



SECTION A-A (WALL OPTION)

LEGEND:

1. BIORETENTION SOIL
2. CHOKER LAYER, SAND & GRAVEL
3. AASHTO #57 STONE, DOUBLE WASHED
4. INFILTRATION SUMP, AASHTO #57 STONE, DOUBLE WASHED
5. GEOTEXTILE, CLASS 2
6. MULCH, PER PLANTING PLANS
7. WATERPROOF MEMBRANE

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

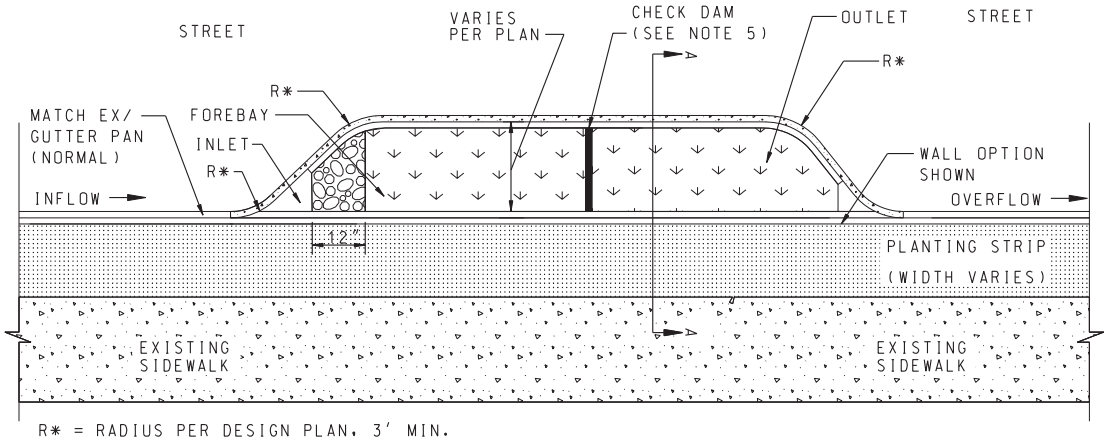
RECOMMENDED: Ravindra D. Gonit
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

CURB EXTENSION IN-PLANTING STRIP BIORETENTION

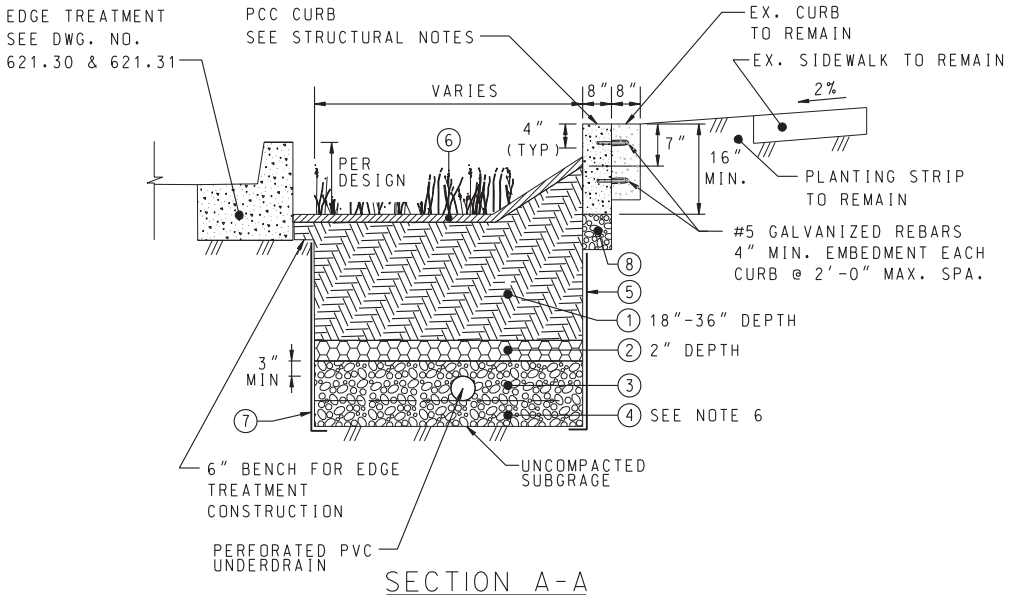
DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.24



R* = RADIUS PER DESIGN PLAN, 3' MIN.

PLAN VIEW



SECTION A-A

NOTES:

1. BIORETENTION MATERIALS AND CONSTRUCTION SHALL MEET CURRENT APPROVED DDOT SPECIFICATION FOR "BIORETENTION, PLANTING, AND STRUCTURAL SOILS".
2. LONGITUDINAL SLOPE OF PLANTER MATCHES ROAD, OR FLATTER AS REQUIRED PER DESIGN PLAN.
3. SIDEWALK ELEVATION MUST BE SET ABOVE INLET AND OUTLET ELEVATIONS TO ALLOW OVERFLOW TO DRAIN TO STREET BEFORE PONDING LEVEL REACHES SIDEWALK.
4. SEE DWG. NO. 621.40 FOR INLET / OUTLET AND FOREBAY DETAILS.
5. CHECK DAMS REQUIRED AS PER DESIGN PLANS. SEE DWG. NO. 621.60 TO 621.63.
6. DEPTH OF INFILTRATION SUMP AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT REQUIREMENTS.
7. SCARIFY SUBGRADE 3" MIN. BEFORE INSTALLATION.

STRUCTURAL NOTES:

1. DRILL HOLES IN EXISTING CURB TO ALLOW FOR DOWEL INSTALLATION. REMOVE LOOSE PART AT EXISTING CURB VERTICAL SURFACE.
2. REPAIR SURFACE AS REQUIRED, INSTALL DOWEL AND APPLY NON-SHRINK MORTAR IN THE EXISITNG CURB.
3. DOWELS SHALL BE #5 GALVANIZED REBAR OR APPROVED EQUAL WITH MIN. 4" EMBEDMENT IN EXISITNG AND NEW CURBS.
4. CIP CONCRETE SHALL BE f'c = 3 ksi.
5. DO NOT DISTURB EXISTING SOIL UNDER EXISITNG CURB.
6. SEE DWG. NO. 609.01 FOR ADDITIONAL DETAILS.

LEGEND:

1. BIORETENTION SOIL
2. CHOKER LAYER, SAND & GRAVEL
3. AASHTO #57 STONE, DOUBLE WASHED
4. INFILTRATION SUMP, AASHTO #57 STONE, DOUBLE WASHED
5. GEOTEXTILE, CLASS 2
6. MULCH, PER PLANTING PLANS
7. WATERPROOF MEMBRANE
8. 6" MIN. GRADED AGGREGRATE BASE

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

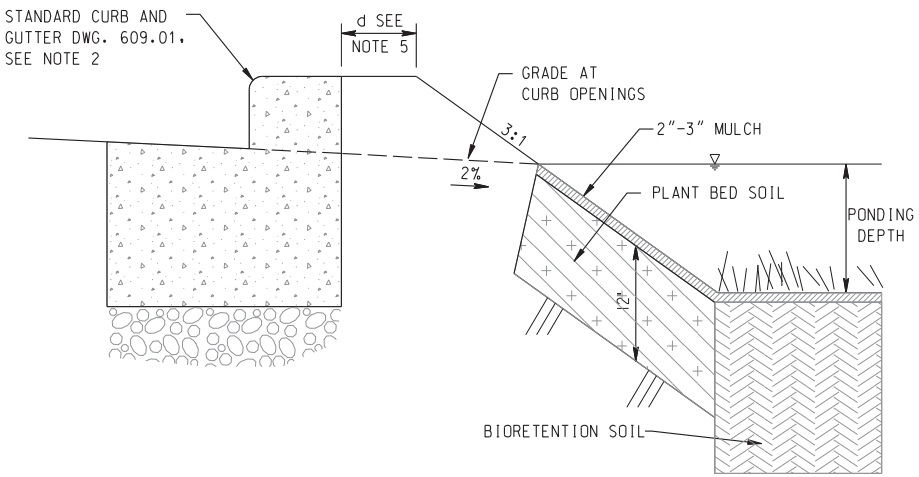
RECOMMENDED: Ravindra D Ganvir
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

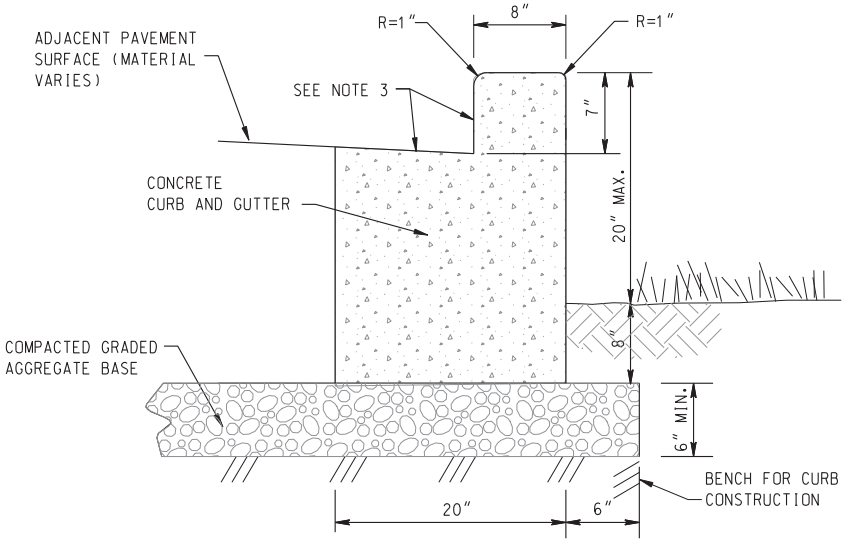
CURB EXTENSION IN-STREET BIORETENTION

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.25



CURB WITH SLOPE



THICKENED CONCRETE CURB AND GUTTER

NOTES:

1. CONCRETE SHALL BE CLASS E; FINISH ALL EXPOSED CONCRETE SURFACES.
2. CURB TYPE AND MATERIAL TO MATCH PLANS.
3. SLOPE OF GUTTER AND CURB REVEAL TO MATCH STANDARD CURB AND GUTTER, PER DWG. 609.01.
4. REFER TO DESIGN AND ENGINEERING MANUAL SECTION "33.14.5.6 SAFETY AND ACCESS" FOR PEDESTRIAN SAFETY DESIGN REQUIREMENTS.
5. 0" TO 28" STEP OUT ZONE, PER PLAN.
6. EXPANSION AND CONTRACTION JOINTS SHALL BE PLACED IN ACCORDANCE WITH STANDARD DDOT CONCRETE CURB REQUIREMENTS.

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

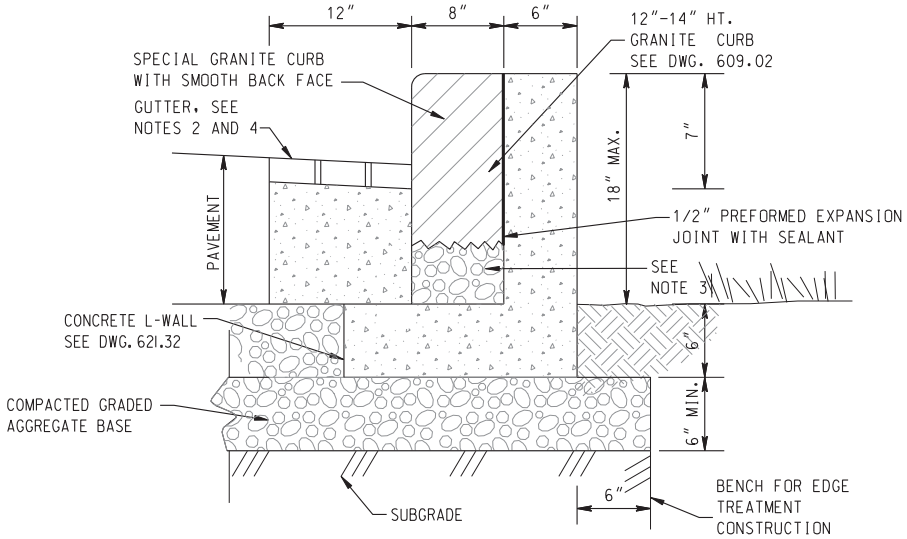
RECOMMENDED: Ravindra D Ganik
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

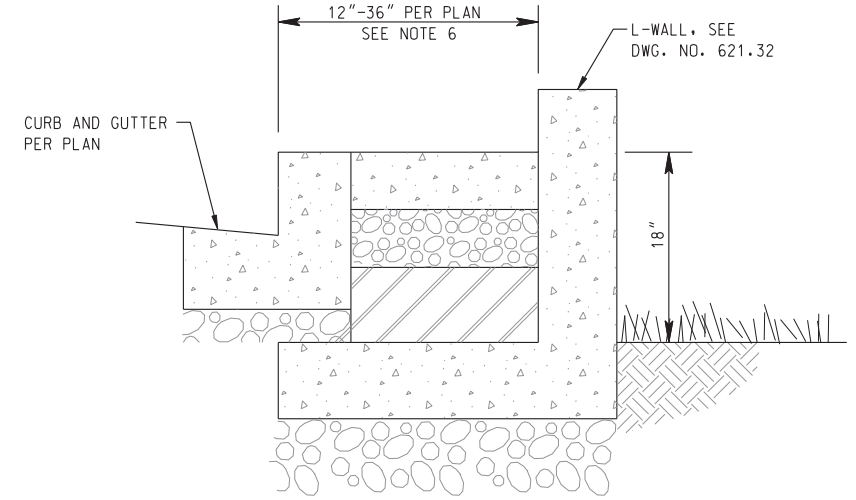
BIORETENTION FACILITY STREET SIDE EDGE TREATMENT– 1

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.30



GRANITE CURB WITH L-WALL CRADLE



L-WALL AND STEP OUT ZONE

NOTES:

1. AT CATCH BASINS AND OTHER STORM OR UTILITY STRUCTURES, PROVIDE REDUCED BASE DIMENSION TO CLEAR THE STRUCTURE.

2. GUTTER MATERIAL TO MATCH PLANS (CONCRETE OR BRICK).

3. PROVIDE NO. 57 STONE BENEATH GRANITE CURB.

4. PROVIDE MIX "E" CONCRETE BETWEEN BOTTOM OF GUTTER AND WALL BASE. REMOVE CONFLICTING PCC DRY MIX PRIOR TO CONSTRUCTING CONCRETE GUTTER.

5. FINISH ALL EXPOSED CONCRETE SURFACES.

6. STEP OUT ZONE INSTALLATION MAY BE STANDARD CONCRETE SIDEWALK, SOD, MULCH OR PAVEMENT BASED ON SURROUNDING CONDITIONS, AS SHOWN ON PLANS.

7. REFER TO DESIGN AND ENGINEERING MANUAL SECTION "33.14.5.6 Safety and Access" FOR PEDESTRIAN SAFETY DESIGN REQUIREMENTS.

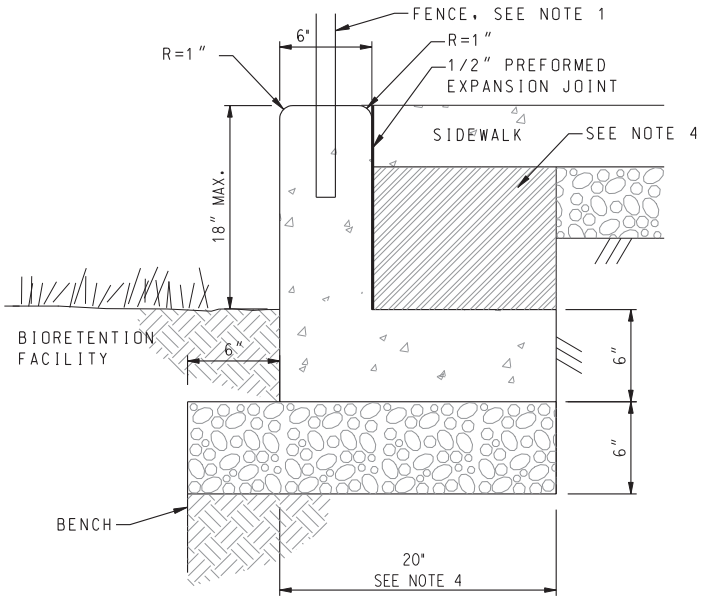
8. EXPANSION JOINTS SHALL BE PLACED AT MAXIMUM 90 FOOT INTERVAL. CONTRACTION JOINTS SHALL BE FORMED OR SAWED AT 30 FOOT MAXIMUM INTERVAL BETWEEN EXPANSION JOINTS. WHERE ADJACENT TO CURB, SIDEWALK OR CONCRETE PAVEMENT, JOINTS SHALL LINE UP.

			RECOMMENDED: Ravindra D. Gonit DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED:
REVISED			
ISSUED:			CHIEF TRANSPORTATION ENGINEER
		REFERENCE	

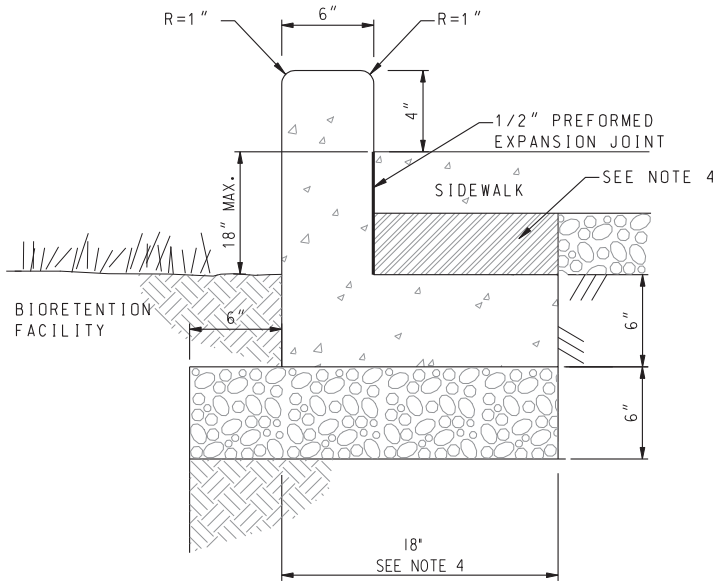
BIORETENTION FACILITY STREET SIDE EDGE TREATMENT-2

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.31



L-WALL (FLUSH)



L-WALL (WITH REVEAL)

NOTES:

1. WHEN FLUSH WALLS ARE SELECTED, TYPICALLY IN HIGH-VOLUME PEDESTRIAN AREAS, PROVIDE RAILING OR FENCE PER PLAN.
2. WHEN WALLS WITH REVEALS ARE USED, TYPICALLY IN LOV-VOLUME PEDESTRIAN AREAS, PROVIDE BREAKS IN REVEAL AS SHOWN ON PLANS TO ALLOW FOR SIDEWALK RUNOFF INTO STORMWATER MANAGEMENT FACILITY.
3. CONCRETE SHALL BE CLASS E; FINISH ALL EXPOSED CONCRETE SURFACES.
4. BASE MAY BE REDUCED TO 15" WIDTH IF CONCRETE IS USED IN THE HATCHED AREA.
5. REFER TO DESIGN AND ENGINEERING MANUAL SECTION "33.14.5.6 SAFETY AND ACCESS" FOR PEDESTRIAN SAFETY DESIGN REQUIREMENTS.
6. EXPANSION JOINTS SHALL BE PLACED AT MAXIMUM 90 FOOT INTERVAL. CONTRACTION JOINTS SHALL BE FORMED OR SAWED AT 30 FOOT MAXIMUM INTERVAL BETWEEN EXPANSION JOINTS. WHERE ADJACENT TO CURB, SIDEWALK OR CONCRETE PAVEMENT, JOINTS SHALL LINE UP.

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

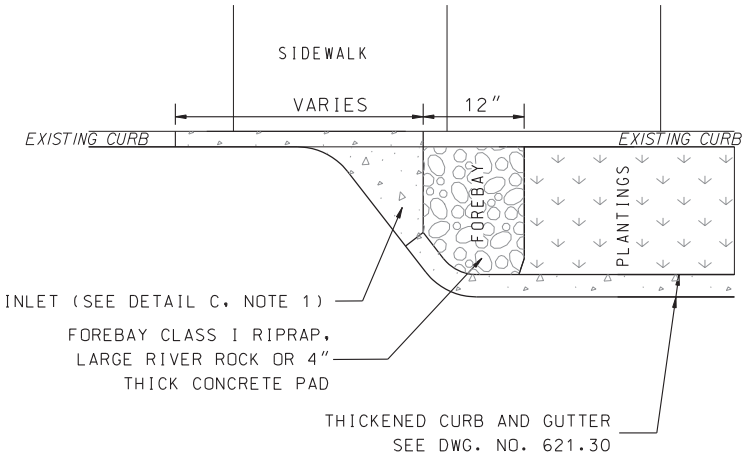
RECOMMENDED: Ravindra D. Gonit
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

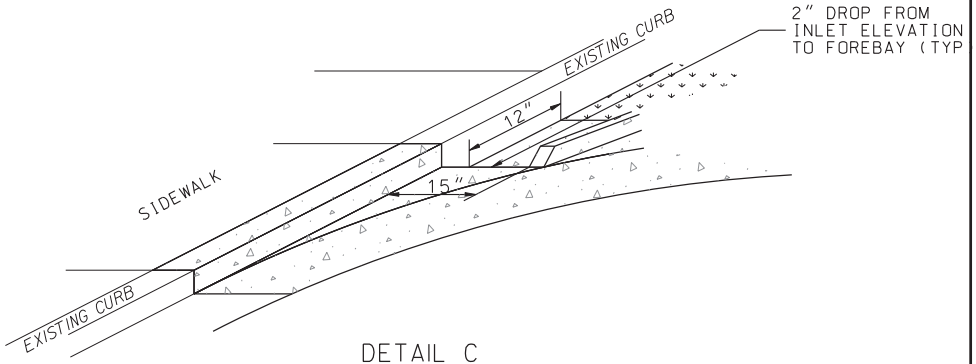
BIORETENTION FACILITY SIDEWALK SIDE EDGE TREATMENT

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

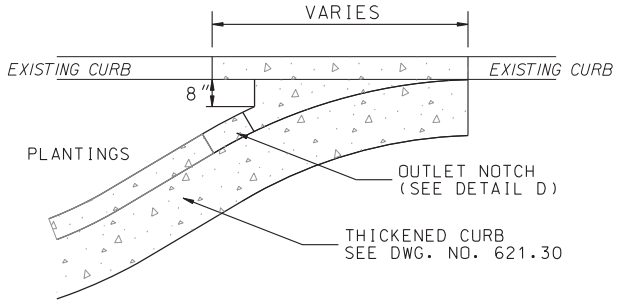
DWG. NO. 621.32



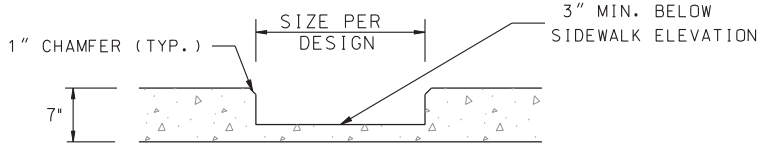
DETAIL A
INLET PLAN VIEW



DETAIL C
INLET ISOMETRIC VIEW



DETAIL B
OUTLET CURB PLAN



DETAIL D
OUTLET NOTCH

NOTES

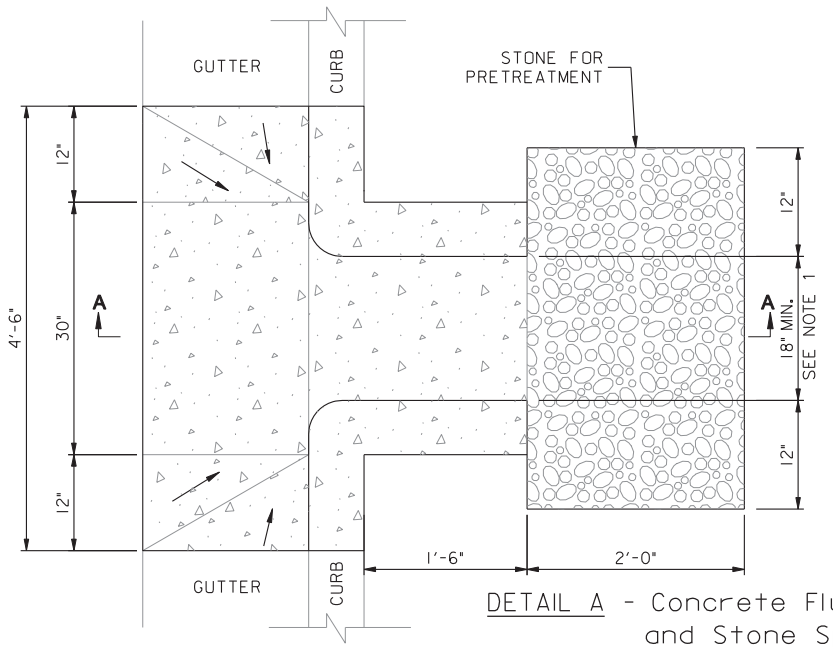
1. INLET MAY BE MODIFIED TO METER THE AMOUNT OF FLOW ENTRY TO STORMWATER FACILITY

			RECOMMENDED: Ravindra D Gavit DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED: CHIEF TRANSPORTATION ENGINEER
REVISED			
ISSUED:			
		REFERENCE	

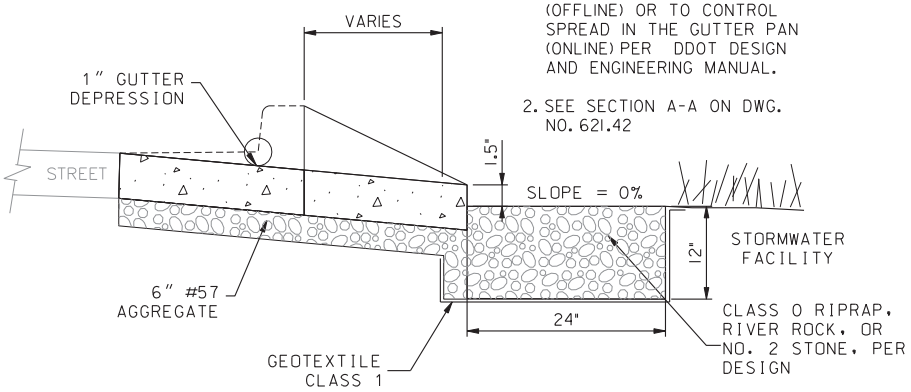
INLET AND OUTLET FOR CURB EXTENSION BIORETENTION

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.40



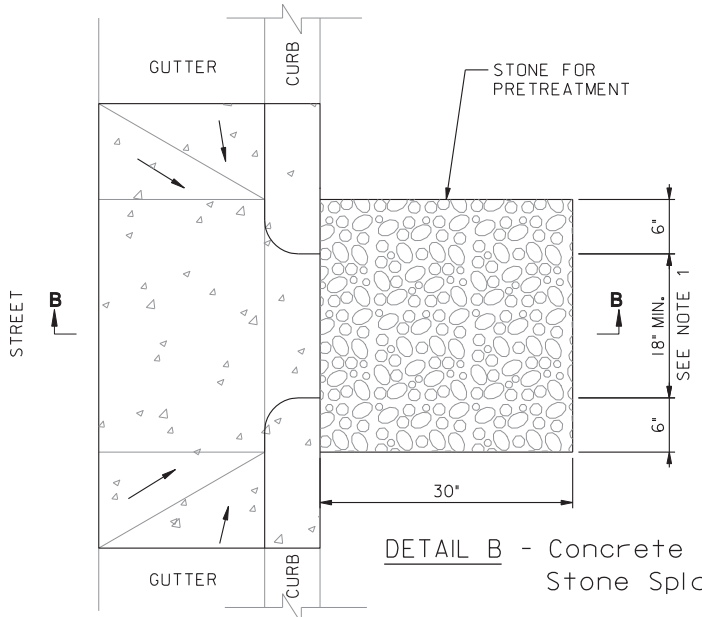
DETAIL A - Concrete Flume with Wingwalls and Stone Splash Pad



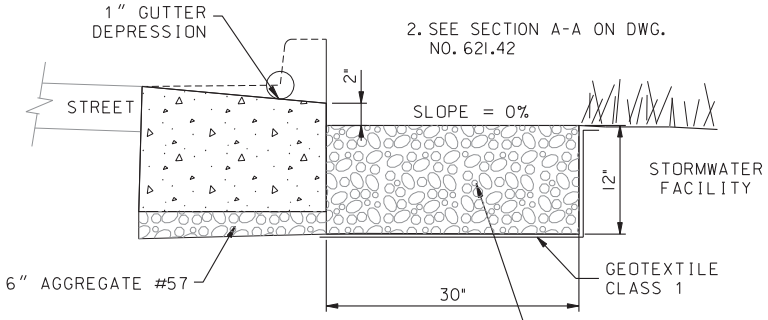
SECTION A-A

NOTES:

1. CURB OPENING DIMENSION SHOWN IS A MINIMUM. CURB CUT SHALL BE SIZED TO CONVEY 1.2" RAINFALL (OFFLINE) OR TO CONTROL SPREAD IN THE GUTTER PAN (ONLINE) PER DDOT DESIGN AND ENGINEERING MANUAL.
2. SEE SECTION A-A ON DWG. NO. 621.42



DETAIL B - Concrete Flume with Stone Splash Pad



SECTION B-B

NOTES:

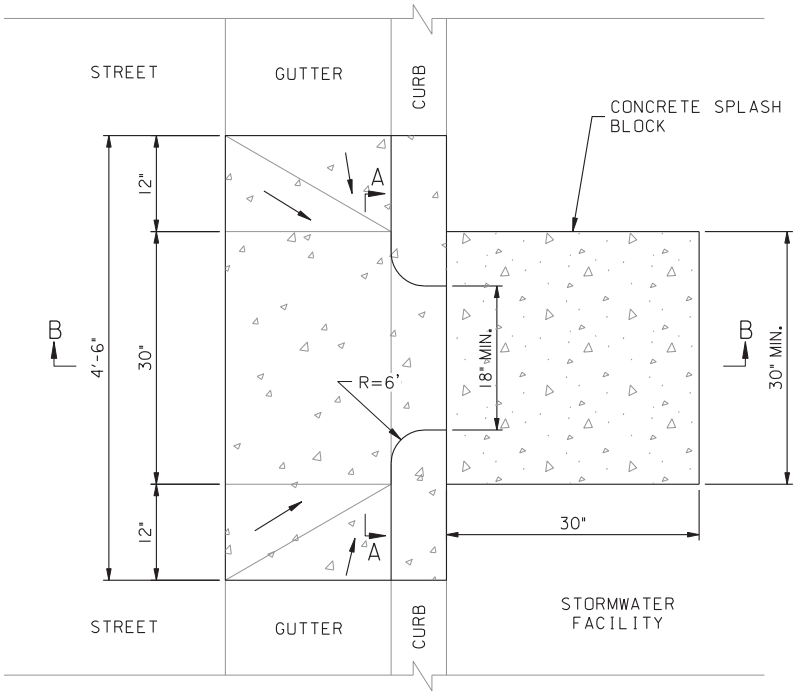
1. CURB OPENING DIMENSION SHOWN IS A MINIMUM. CURB CUT SHALL BE SIZED TO CONVEY 1.2" RAINFALL (OFFLINE) OR TO CONTROL SPREAD IN THE GUTTER PAN (ONLINE) PER DDOT DESIGN AND ENGINEERING MANUAL.
2. SEE SECTION A-A ON DWG. NO. 621.42

			RECOMMENDED: Ravindra D. Ganis DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED: CHIEF TRANSPORTATION ENGINEER
REVISED			
ISSUED:		REFERENCE	

CURB CUT WITH SPLASH PAD – 1

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

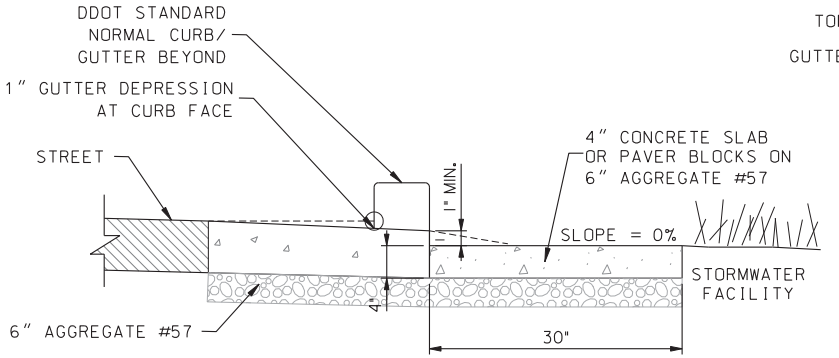
DWG. NO. 621.41



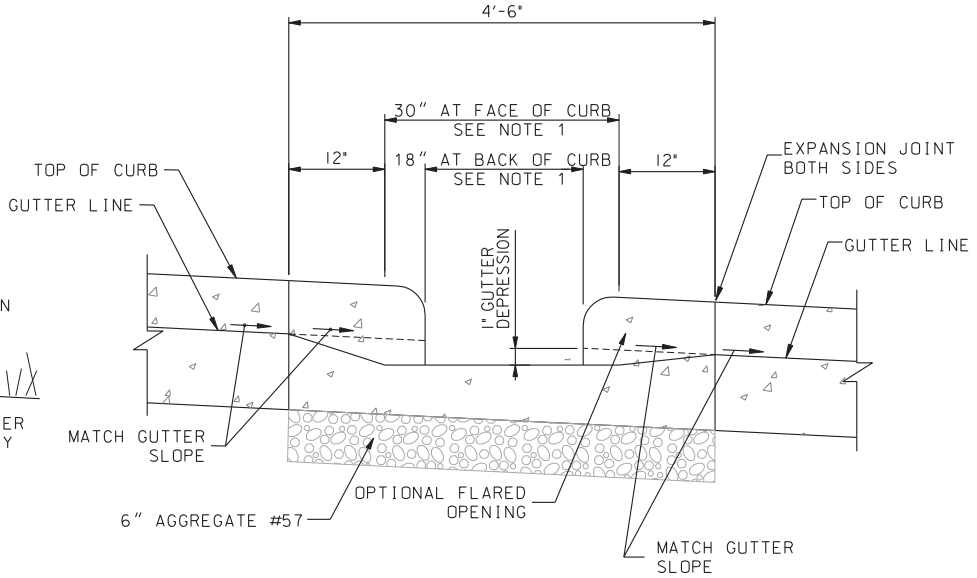
PLAN VIEW

NOTES:

1. CURB OPENING DIMENSION SHOWN IS A MINIMUM. CURB CUT SHALL BE SIZED TO CONVEY 1.2" RAINFALL (OFFLINE) OR TO CONTROL SPREAD IN THE GUTTER PAN (ONLINE) PER DDOT DESIGN AND ENGINEERING MANUAL.



SECTION B-B



SECTION A-A

			RECOMMENDED: Ravindra D Gonit DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED: CHIEF TRANSPORTATION ENGINEER
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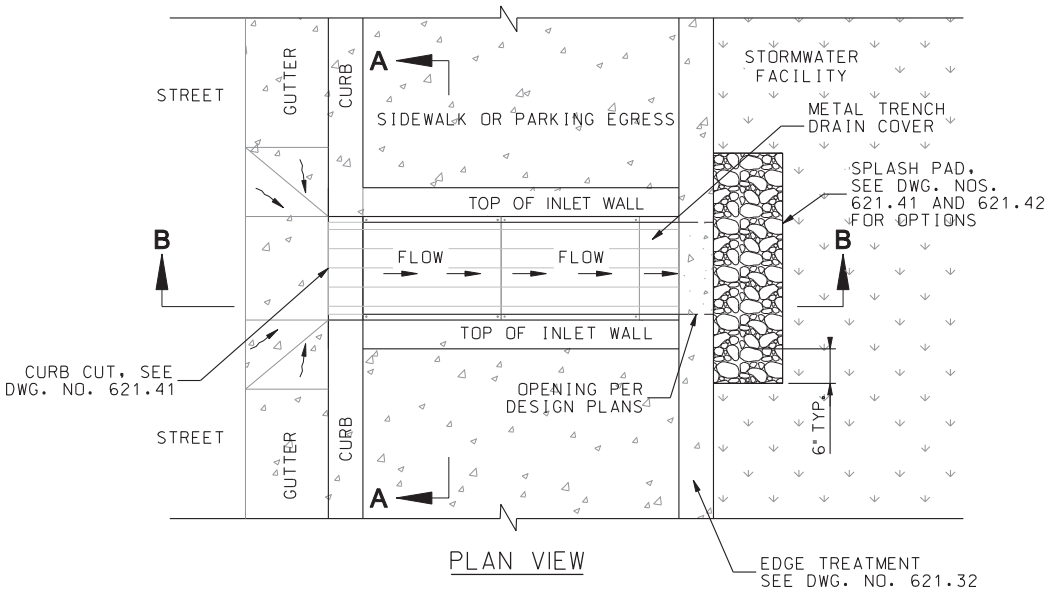
ISSUED:			
		REFERENCE	

CURB CUT WITH SPLASH PAD – 2

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

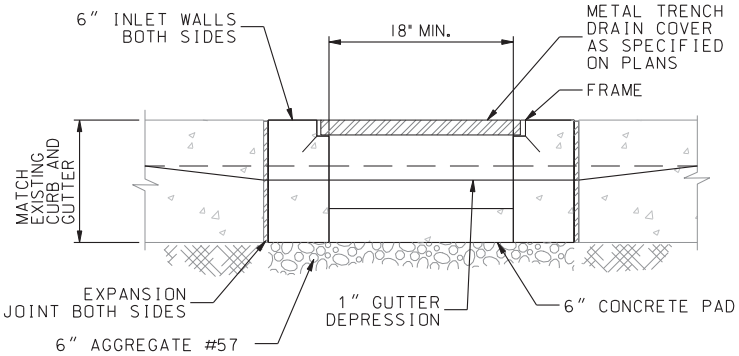
DWG. NO. 621.42



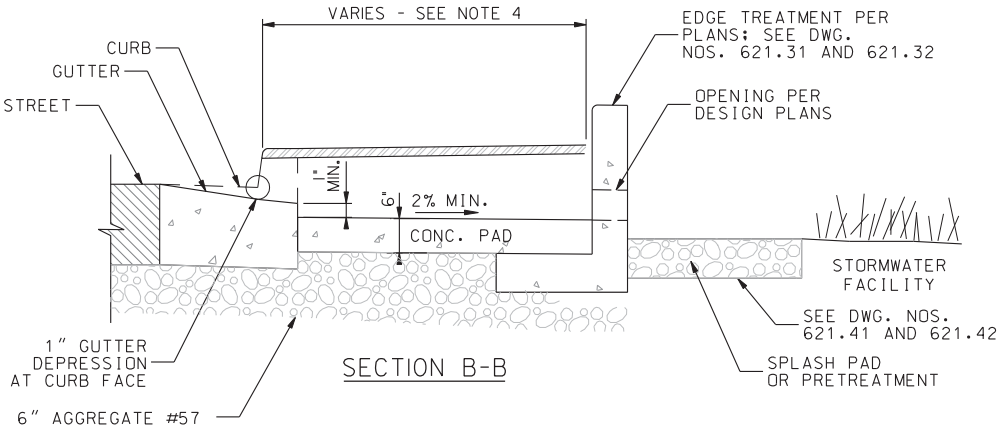
PLAN VIEW

NOTES:

1. CURB OPENING DIMENSION SHOWN IS A MINIMUM. CURB CUTS SHALL BE SIZED TO CONVEY 1.2" RAINFALL (OFFLINE) OR TO CONTROL SPREAD IN THE GUTTER PAN (ONLINE) PER DDOT DESIGN AND ENGINEERING MANUAL.
2. REFER TO DESIGN PLANS FOR SIZE AND TYPE OF GRATE.
3. METAL TRENCH DRAIN COVER TO BE BOLTED DOWN (THEFT PROTECTED) BUT REMOVABLE.
4. FOR DIMENSIONS AND SLOPES, SEE DESIGN PLANS.



SECTION A-A



SECTION B-B

			RECOMMENDED: Ravindra D. Ganiti DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED: CHIEF TRANSPORTATION ENGINEER
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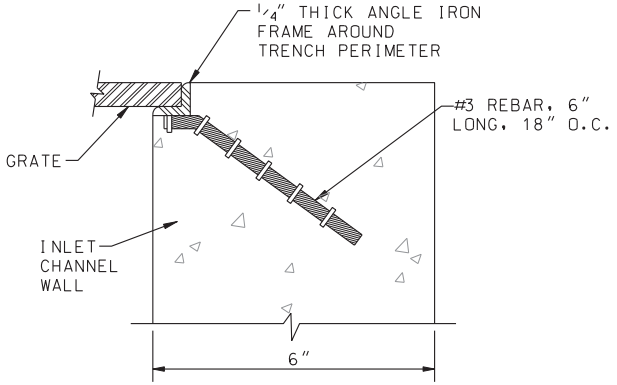
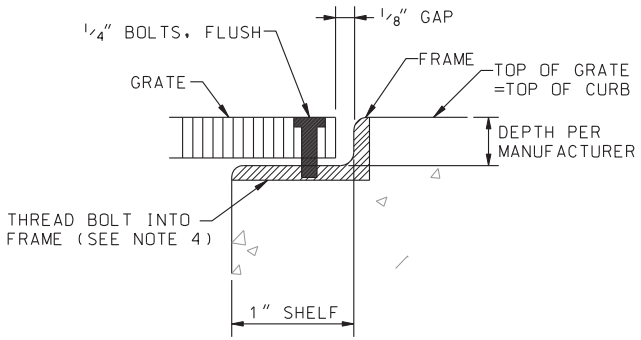
CURB CUT METAL TRENCH DRAIN COVER-1

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.43



FRAME DETAIL



GRATE ATTACHMENT DETAIL

CONSTRUCTION NOTES:

1. CAST IRON, NATURAL FINISH.
2. NO OPENING GREATER THAN 3/8".
3. PROTECT THREADED HOLES IN FRAME FROM CLOGGING DURING FRAME INSTALLATION.
4. GRATE TO BE RATED FOR H-20 LOADING, WITH A NON-SLIP SURFACE HAVING A STATIC COEFFICIENT OF FRICTION BETWEEN 0.60 AND 1.0 PER ASTM C1020. GRATES ON INCLINES GREATER THAN 4% SHALL HAVE A COEFFICIENT OF 0.80 TO 1.0.
5. WAVY GRATE AS SHOWN OR APPROVED ADA COMPLIANT EQUIVALENT.

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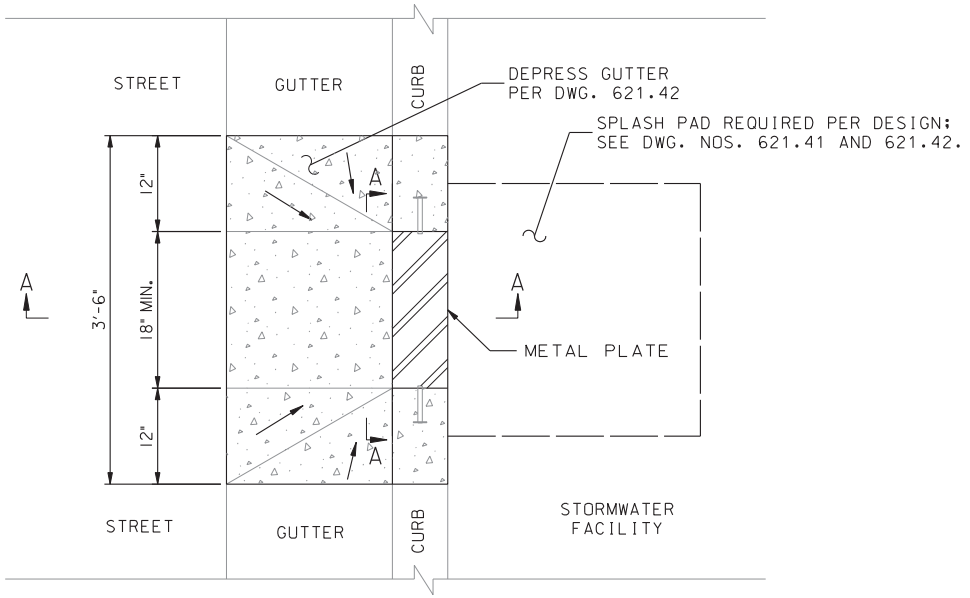
RECOMMENDED: Ravindra D. Ganvir
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

CURB CUT METAL TRENCH DRAIN COVER-2

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

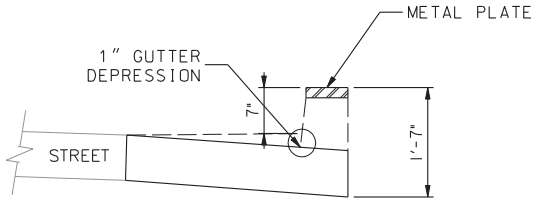
DWG. NO. 621.44



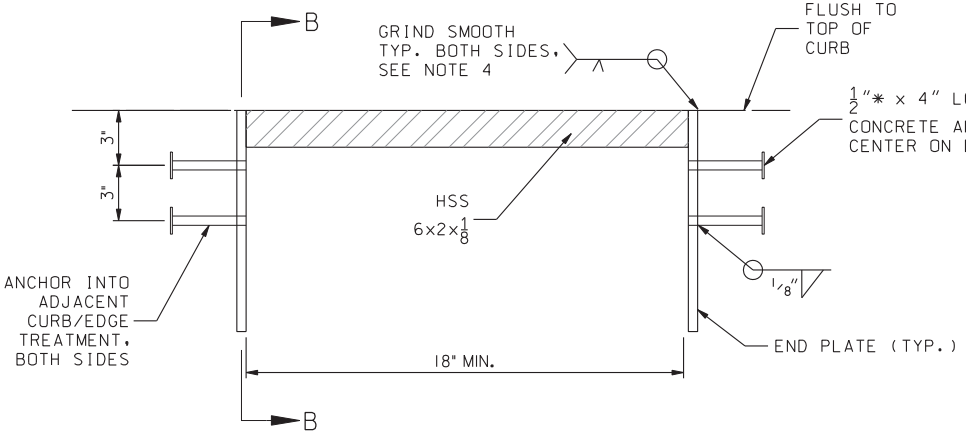
PLAN VIEW

NOTES:

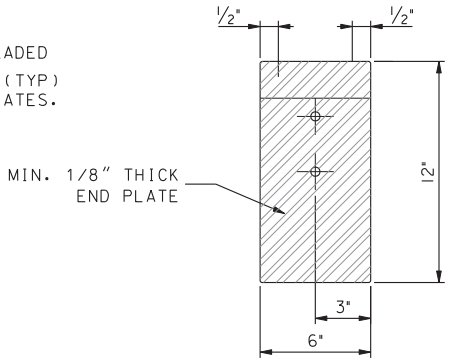
1. PLATE OVER CURB CUT MAY BE OMITTED WITH DDOT APPROVAL.
2. HEADED CONCRETE ANCHORS SHALL MEET THE REQUIREMENTS OF ASTM A-108.
3. HSS 6 x 2 x 1/8 CHANNEL SHALL MEET THE REQUIREMENTS OF ASTM A-500 GRADE B.
4. END PLATES SHALL MEET THE REQUIREMENTS OF ASTM A-36.
5. ENTIRE ASSEMBLY SHALL BE HOT DIP GALVANIZED IN ACCORDANCE WITH ASTM A-123.
6. DESIGN VERTICAL WHEEL LOAD IS 8.5 KIPS (1/2 OF TANDEM AXLE WEIGHT SPECIFIED IN FHWA-HOP-06-105).
7. SINGLE BEVEL GROOVE WELD.
8. ALTERNATE MATERIAL FOR ASSEMBLY (E.G. CAST IRON, GRAY IRON) MAY BE USED PER DESIGN PLANS.



SECTION A-A



ELEVATION



SECTION B-B

			RECOMMENDED: Ravindra D. Ganiti DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED: CHIEF TRANSPORTATION ENGINEER
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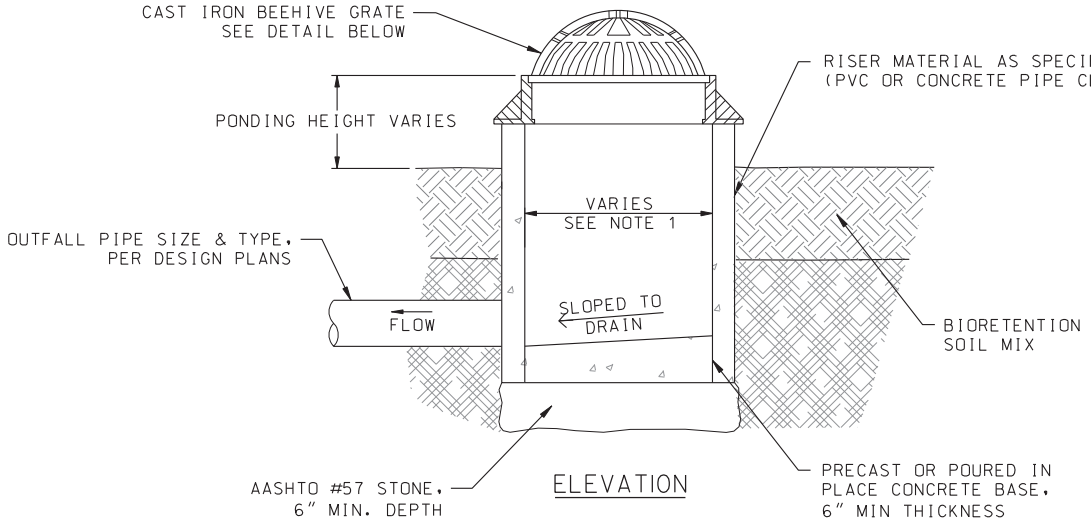
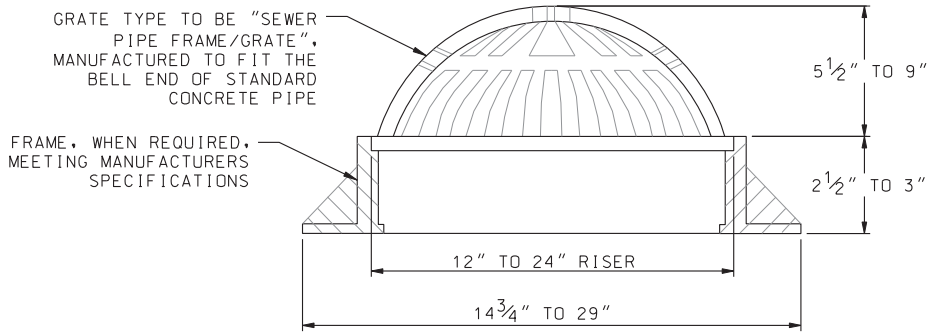
ISSUED:		REFERENCE	

METAL PLATE OVER CURB CUT

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.45





CAST IRON BEEHIVE GRATE DETAIL

SEE NOTE 1

NOTES:

1. MINIMUM OPENING SIZE IN GRATE SHALL BE 1 1/4" INCHES.

2. SIZE OF GRATE SHALL MATCH SIZE OF THE RISER, PER PLANS, SHALL FIT SNUG AND WATERTIGHT, AND SHALL BE REMOVABLE FOR MAINTENANCE PURPOSES.

3. ALTERNATE MATERIAL TO CAST IRON SHALL BE ALLOWED AS APPROVED BY DDOT IPMA.

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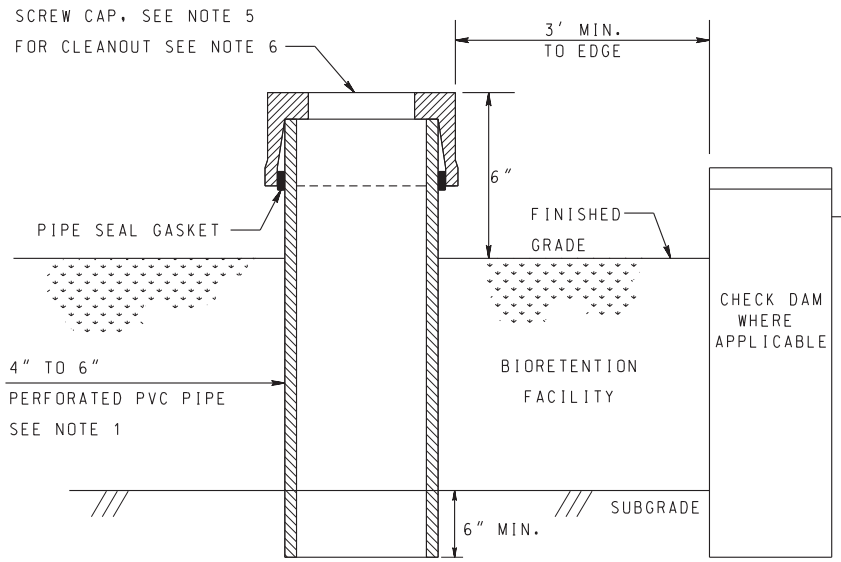
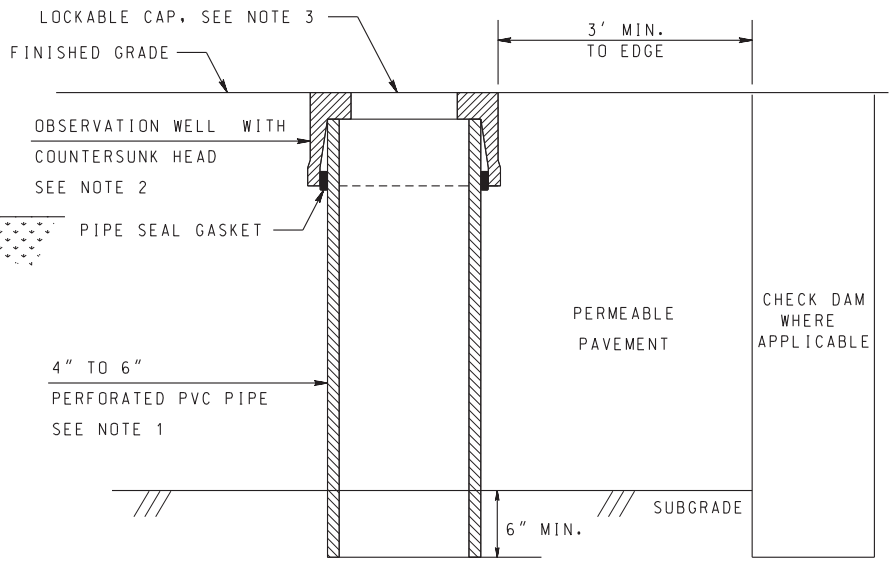
OVERFLOW RISER WITH BEEHIVE GRATE

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.50



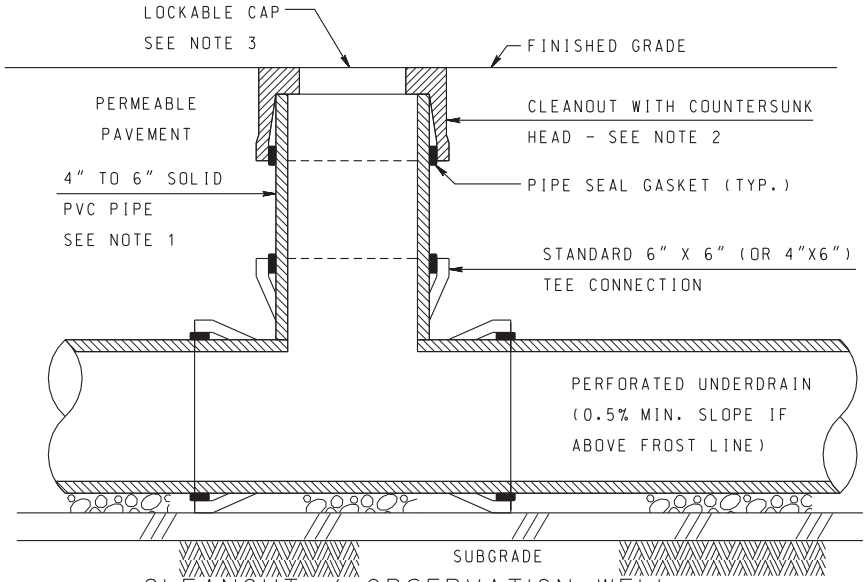
OBSERVATION WELL IN BIORETENTION



OBSERVATION WELL IN PERMEABLE PAVEMENT

NOTES:

1. PROVIDE A TUBE MADE OF NON-CORROSIVE MATERIAL, SCHEDULE 40 PVC OR EQUAL, AT LEAST 3 FEET LONG WITH AN INSIDE DIAMETER OF 4 TO 6 INCHES. PERFORATED PIPE IS REQUIRED FOR ALL OBSERVATION WELLS, OR CLEANOUTS USED AS OBSERVATION WELLS.
2. FACTORY ATTACHED BRASS OR HIGH IMPACT PLASTIC HEAD WITH RIBS TO PREVENT ROTATION WHEN REMOVING LOCKABLE CAP.
3. LOCKABLE CAP SHALL BE BRASS AND RATED FOR HS-20 LOADING IN VEHICULAR AREAS, MOUNTED FLUSH TO GRADE. LOCKABLE CAP MAY BE HIGH IMPACT PLASTIC THAT IS UV STABLE IN NON-VEHICULAR LOADING AREA, AT LEAST 6 INCHES ABOVE GRADE.
4. IN FACILITIES SUBJECT TO VEHICULAR TRAFFIC, CONCRETE APRONS AROUND CLEANOUTS ARE AN OPTION, AS SHOWN IN DESIGN PLANS.
5. CAP ON RISERS IN BIORETENTION FACILITY SHALL BE PVC SCREW IN PLUG.
6. FOR CLEANOUT IN BIORETENTION (NOT SHOWN), USE SIMILIAR DETAIL, BUT USE PVC SCREW CAP SET 6" ABOVE FINISHED GRADE.



CLEANOUT / OBSERVATION WELL
IN PERMEABLE PAVEMENT (SEE NOTE 6)

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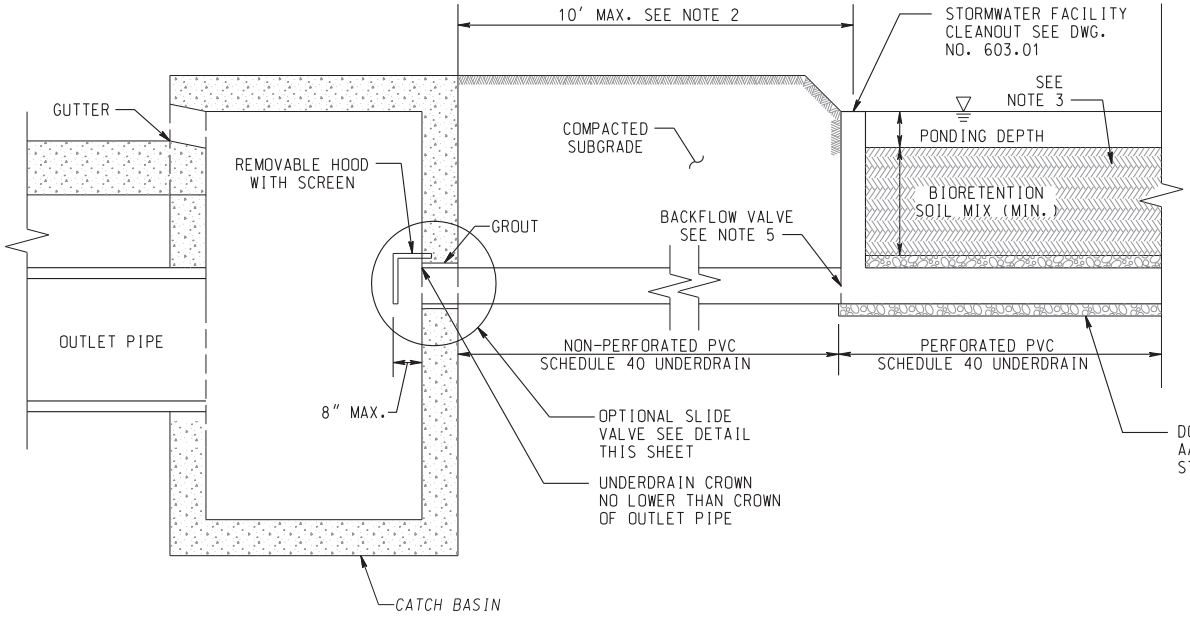
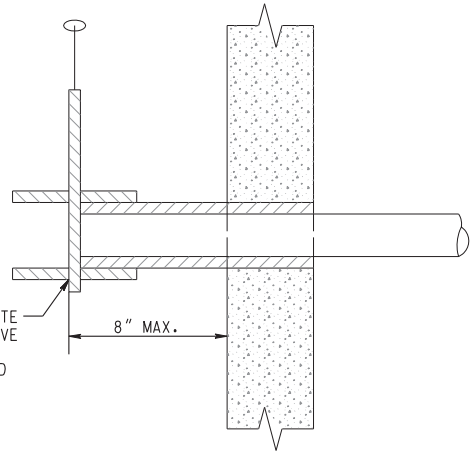
STORMWATER FACILITY UNDERDRAIN PIPE RISERS

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.51



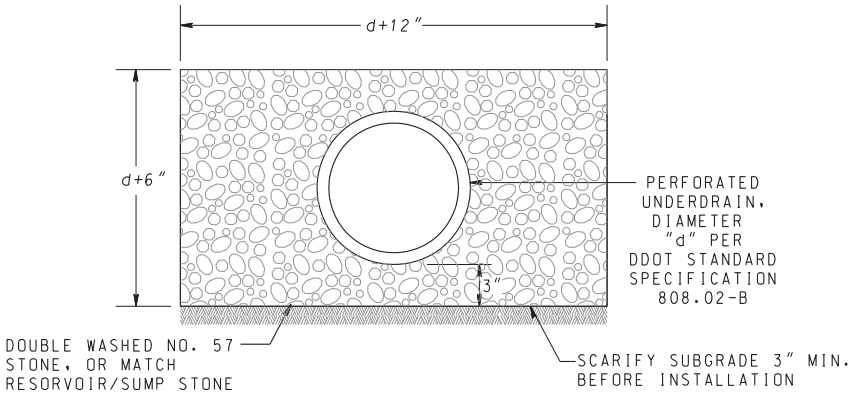
LID UNDERDRAIN CONNECTION TO CATCH BASINS



OPTIONAL SLIDE VALVE

NOTES:

1. CATCH BASIN CONNECTIONS FROM UNDERDRAINS SERVICING PRIVATE PROPERTY ARE PROHIBITED.
2. WHEN STORMWATER FACILITY IS LOCATED > 10 FEET FROM CATCH BASIN, PROVIDE ADDITIONAL CLEANOUT OUTSIDE OF STORMWATER FACILITY WITHIN 10' OF CATCH BASIN.
3. STORMWATER FACILITY DEPICTED IS BIORETENTION PRACTICE. CONNECTIONS TO CATCH BASIN WILL ALSO APPLY TO PERMEABLE PAVEMENTS AND BIOSWALES WITH UNDERDRAINS.
4. OPTIONAL PVC GATE VALVE TO BE USED TO REGULATE FLOW IN UNDERDRAIN PIPE AS INDICATED IN PLANS. VALVE MAY ALSO BE USED IN OVERFLOW RISER AS DIRECTED.
5. WHEN CONNECTING TO A COMBINED SEWER SYSTEM, A BACKFLOW VALVE WITH SERVICE ACCESS EXTENSION IS REQUIRED AT CONNECTION BETWEEN PERFORATED AND NON-PERFORATED PIPE.
6. PVC SLOPE SHALL BE PER DESIGN MANUAL SECTION 33.14.4.4.



UNDERDRAIN AND BEDDING SECTION

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DATE	APPR.		APPROVED: CHIEF TRANSPORTATION ENGINEER
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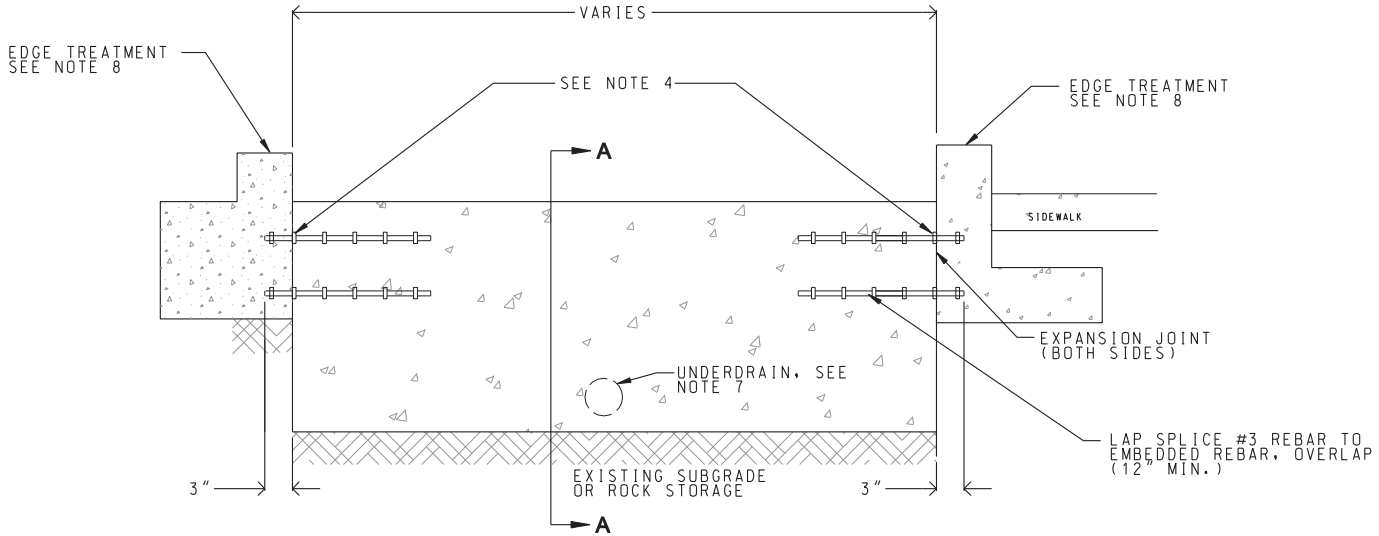
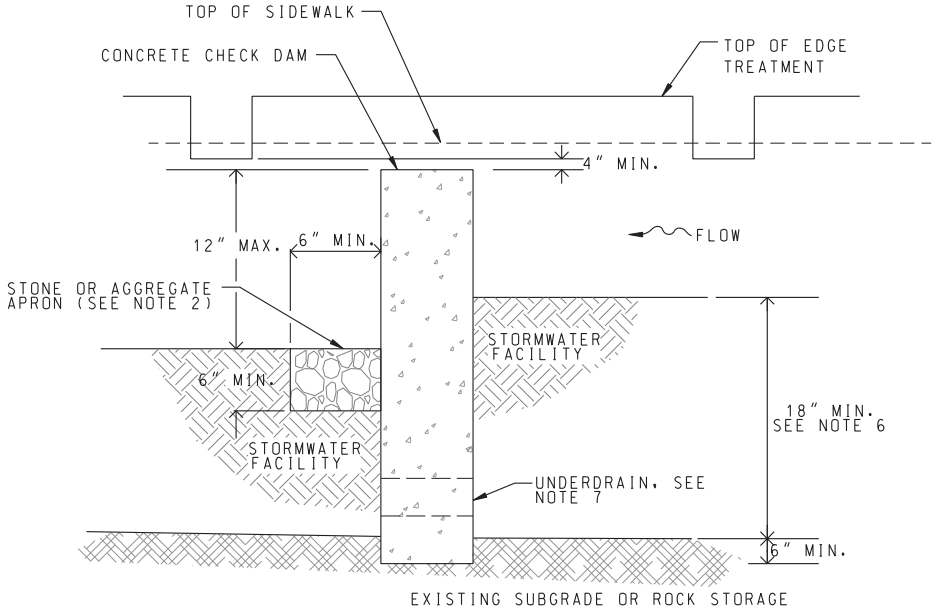
STORMWATER FACILITY UNDERDRAIN BEDDING AND CATCH BASIN CONNECTION

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.52



ELEVATION



SECTION A-A

NOTES:

1. LOCATIONS, HEIGHTS, AND WIDTHS OF CHECK DAMS TO BE SPECIFIED IN THE DESIGN PLANS.
2. SIZE OF STONE OR AGGREGATE APRON TO BE SPECIFIED IN THE DESIGN PLANS.
3. CONCRETE CHECK DAM SHALL BE CONTINUOUS (NO JOINTS).
4. EMBED #3 REBAR 3" MIN. INTO EDGE TREATMENT ON BOTH SIDES (2 PER SIDE).
5. THIS CHECK DAM MAY BE USED IN PLANTERS OR CURB EXTENSIONS.
6. DEPTH OF CHECK DAM VARIES DEPENDING ON THE DEPTH OF THE FACILITY.
7. IF PRESENT, UNDERDRAIN TO PASS THROUGH CHECK DAM IN A NON-PERFORATED PVC PIPE.
8. FOR EDGE TREATMENT OPTIONS, SEE DWG. NOS. 621.30 TO 621.32.

DATE	APPR.	
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RECOMMENDED: Ravindra D. Ganvir
DEPUTY CHIEF ENGINEER

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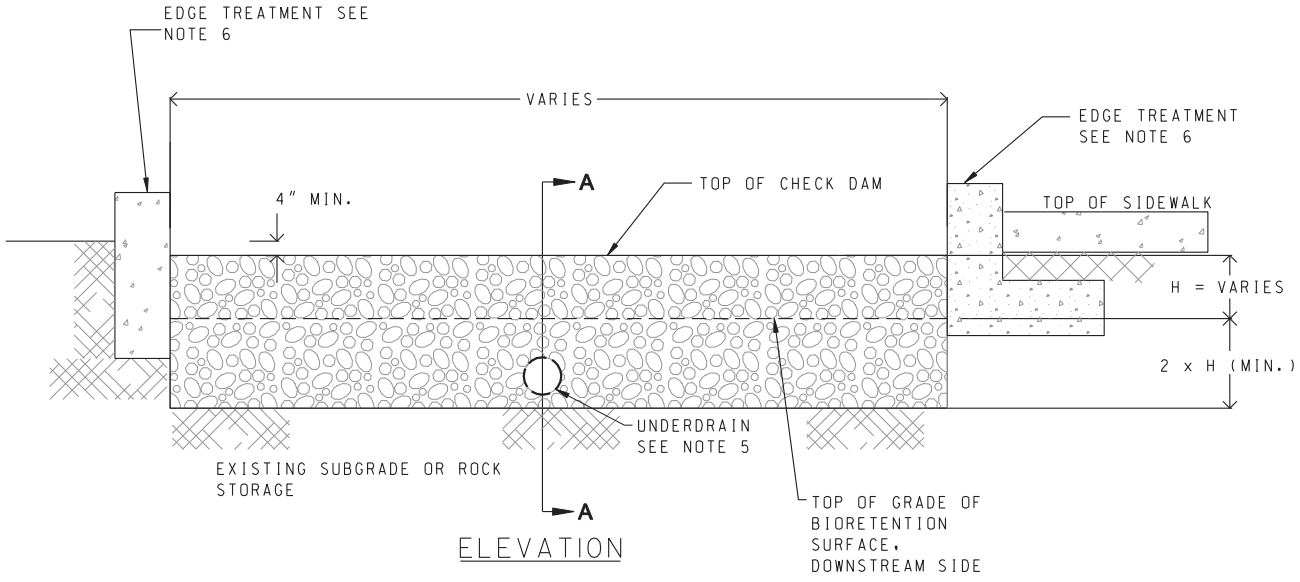
CHIEF TRANSPORTATION ENGINEER

CONCRETE CHECK DAM

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

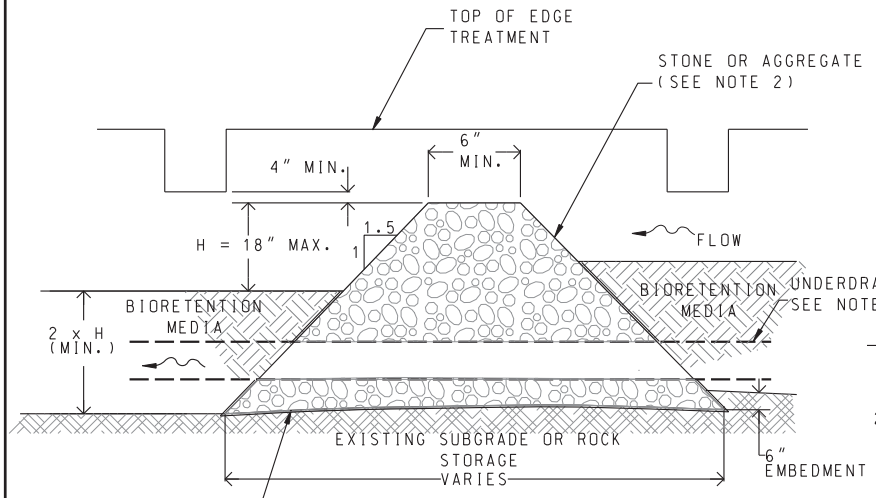
DWG. NO. 621.60



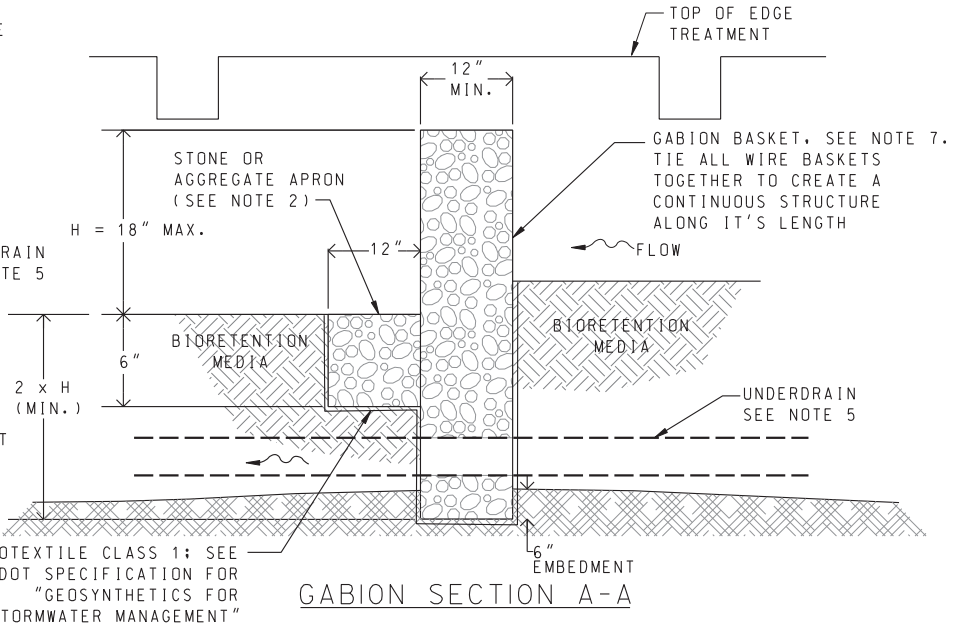
ELEVATION

NOTES:

1. LOCATIONS, HEIGHTS, AND WIDTHS OF CHECK DAMS TO BE SPECIFIED IN THE DESIGN PLANS
2. SIZE OF STONE OR AGGREGATE APRON TO BE SPECIFIED IN THE DESIGN PLANS.
3. THIS CHECK DAM MAY BE USED IN SWALES, PLANTERS, AND CURB EXTENSIONS.
4. DEPTH OF CHECK DAM VARIES DEPENDING ON DEPTH OF FACILITY.
5. IF PRESENT, UNDERDRAIN TO PASS THROUGH CHECK DAM IN A NON-PERFORATED PVC PIPE.
6. FOR EDGE TREATMENT OPTIONS, SEE DWGS NOS. 621.30 TO 621.32.
7. PROVIDE GABION BASKET, WELDED MESH TYPE WHEN UNDERDRAIN IS USED.



SLOPED SECTION A-A



GABION SECTION A-A

			RECOMMENDED: Ravindra D. Ganik DEPUTY CHIEF ENGINEER
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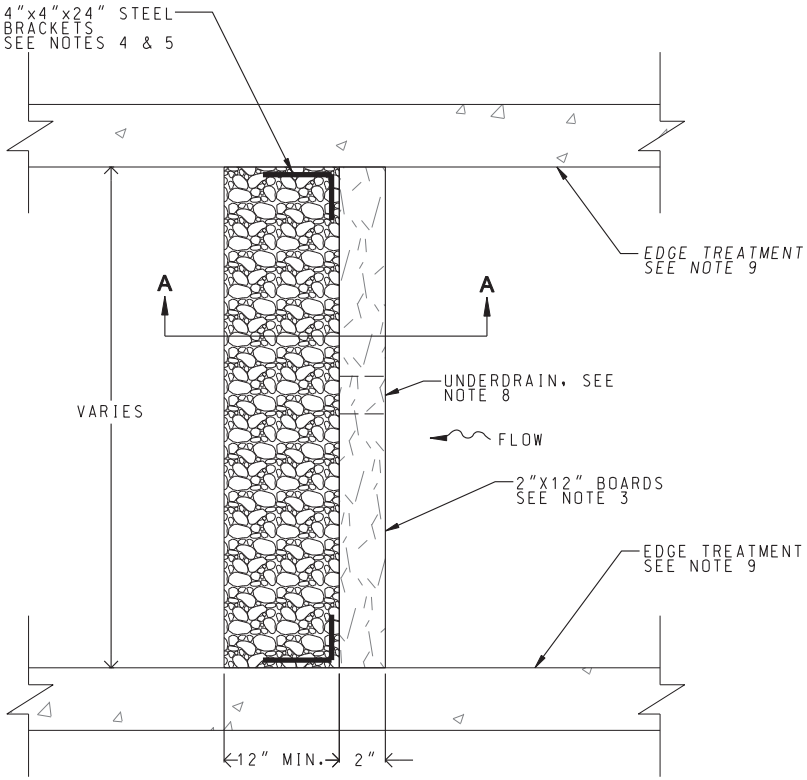
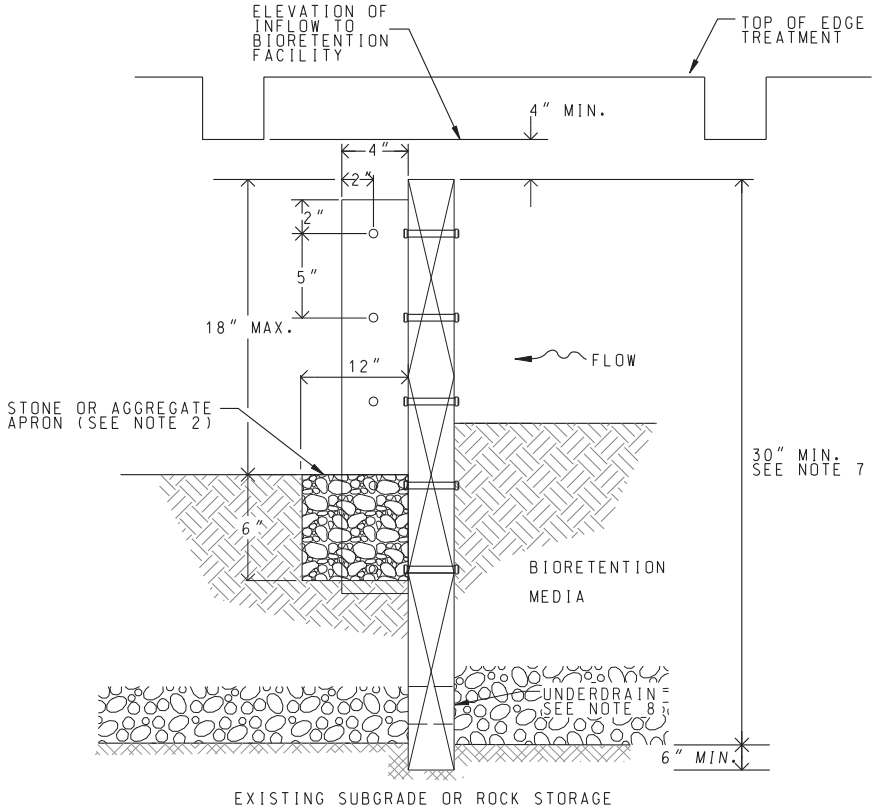
ROCK CHECK DAMS

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.61



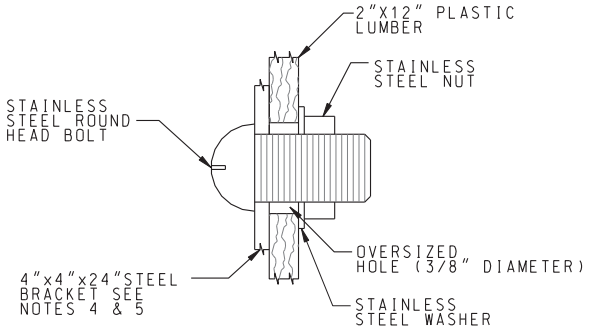
PLAN



SECTION A-A

NOTES:

1. LOCATIONS, HEIGHTS, AND WIDTHS OF CHECK DAMS TO BE SPECIFIED IN THE DESIGN PLANS.
2. SIZE OF STONE OR AGGREGATE APRON TO BE SPECIFIED IN THE DESIGN PLANS.
3. BOARDS TO BE PLASTIC LUMBER AND CONTINUOUS ALONG ITS LENGTH. OTHER MANUFACTURED PRODUCTS MAY BE USED WITH DDOT APPROVAL.
4. ALL FASTENERS TO BE STAINLESS STEEL OR GALVANIZED. BOLTS TO BE 5/16 "DIAMETER.
5. BRACKET TO BE MADE OF 3/16 " MIN. STEEL.
6. THIS CHECK DAM MAY BE USED IN BIORETENTION PLANTERS OR CURB EXTENSIONS.
7. DEPTH OF CHECK DAM VARIES DEPENDING ON THE DEPTH OF THE FACILITY.
8. IF PRESENT, UNDERDRAIN TO PASS THROUGH CHECK DAM IN A NON-PERFORATED PVC PIPE. GAPS AROUND PIPE TO BE FILLED WITH POLYURETHANE FOAM.
9. FOR EDGE TREATMENT OPTIONS, SEE DWG. NOS. 621.30 TO 621.32.



PLASTIC LUMBER BOLTING DETAIL

			RECOMMENDED: Ravindra D Gavvis DEPUTY CHIEF ENGINEER
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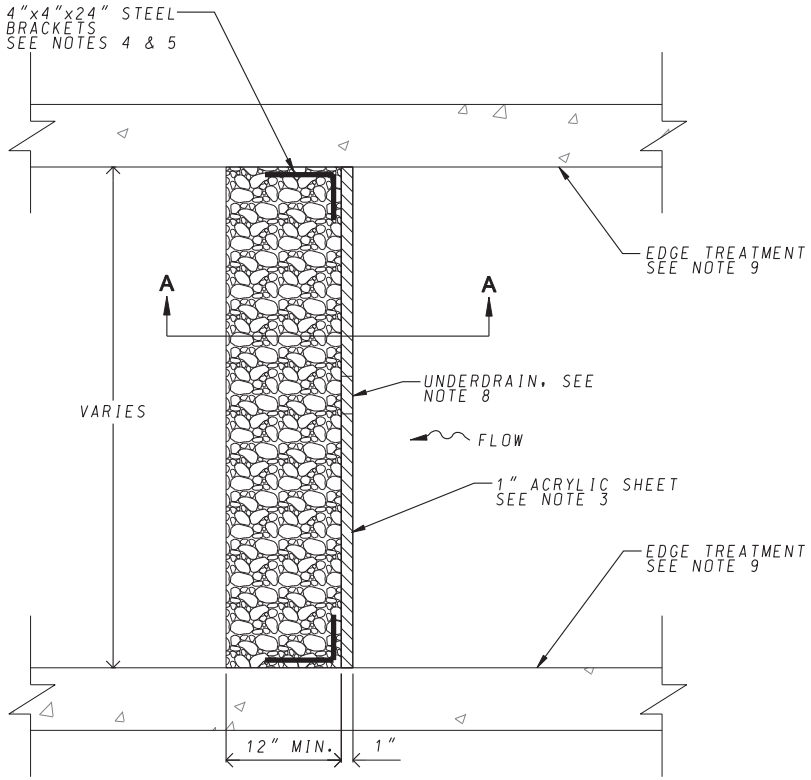
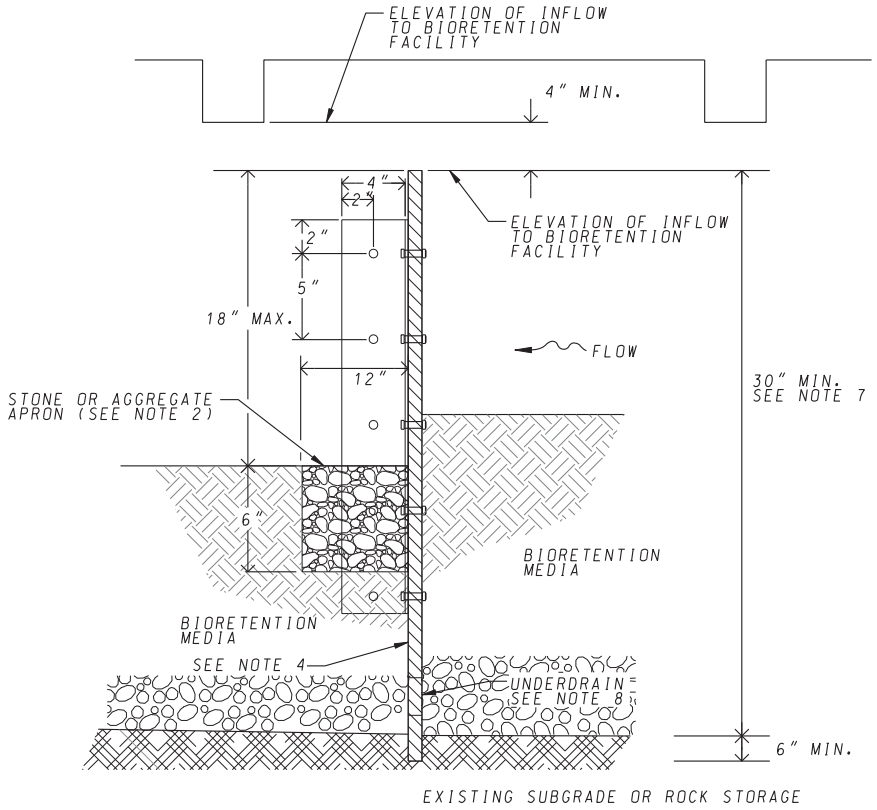
PLASTIC LUMBER CHECK DAM

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.62



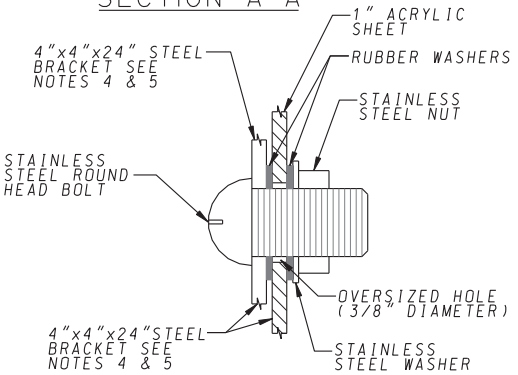
PLAN



SECTION A-A

NOTES:

1. LOCATIONS, HEIGHTS, AND WIDTHS OF CHECK DAMS TO BE SPECIFIED IN THE DESIGN PLANS.
2. SIZE OF STONE OR AGGREGATE APRON TO BE SPECIFIED IN THE DESIGN PLANS.
3. SHEETS TO BE CELL-CAST AND CONTINUOUS ALONG THEIR LENGTH. OTHER MANUFACTURED PRODUCTS MAY BE USED WITH DDOT APPROVAL.
4. ALL FASTENERS TO BE STAINLESS STEEL OR GALVANIZED. BOLTS TO BE 5/16 " DIAMETER.
5. BRACKET TO BE MADE OF 3/16 " MIN. STEEL.
6. THIS CHECK DAM MAY BE USED IN BIORETENTION PLANTERS OR CURB EXTENSIONS.
7. DEPTH OF CHECK DAM VARIES DEPENDING ON THE DEPTH OF THE FACILITY.
8. IF PRESENT, UNDERDRAIN TO PASS THROUGH CHECK DAM IN A NON-PERFORATED PVC PIPE. GAPS AROUND PVC PIPE TO BE FILLED WITH POLYURETHANE FOAM.
9. FOR EDGE TREATMENT OPTIONS, SEE DWG. NOS. 621.30 TO 621.32.



ACRYLIC SHEET BOLTING DETAIL

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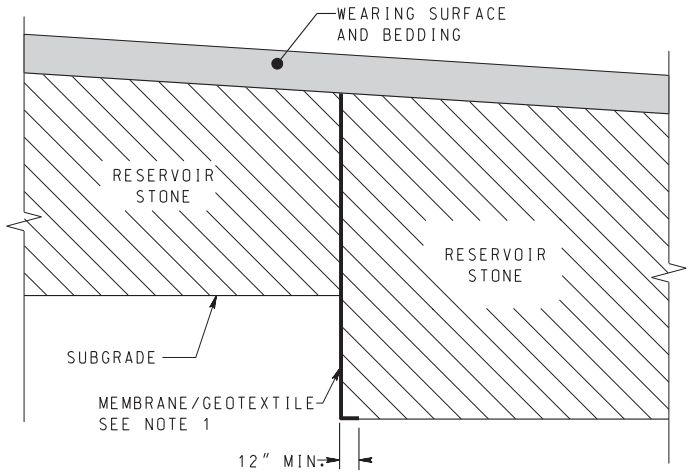
		REFERENCE	

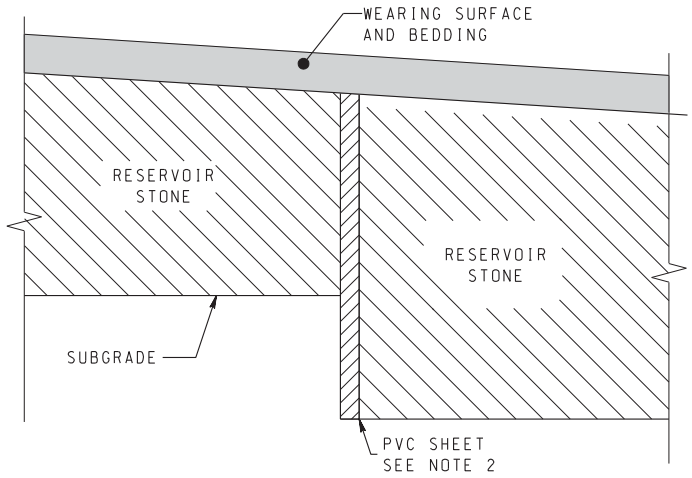
ACRYLIC SHEET CHECK DAM

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.63



MEMBRANE/GEOTEXTILE CHECK DAM
NOT TO SCALE



PVC SHEET CHECK DAM
NOT TO SCALE

NOTES:

1. WATERPROOF MEMBRANE OR LOW PERMEABILITY GEOTEXTILE (PERMITTIVITY OF 0.05 SEC^{-1} OR LESS)
2. SHEET TO BE 3/8" PVC SHEET TYPE I, GRAY.

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

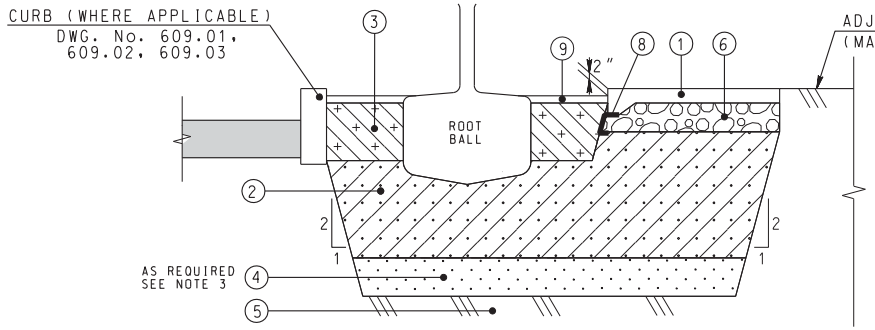
RECOMMENDED: Ravindra D. Gonsi
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

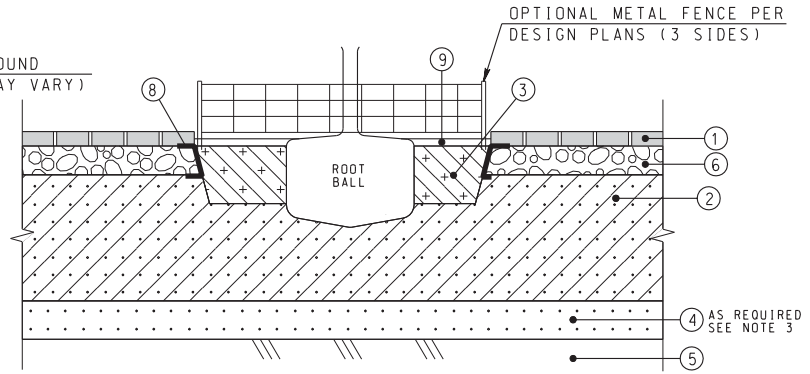
ALTERNATE PERMEABLE PAVEMENT CHECK DAMS

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.64



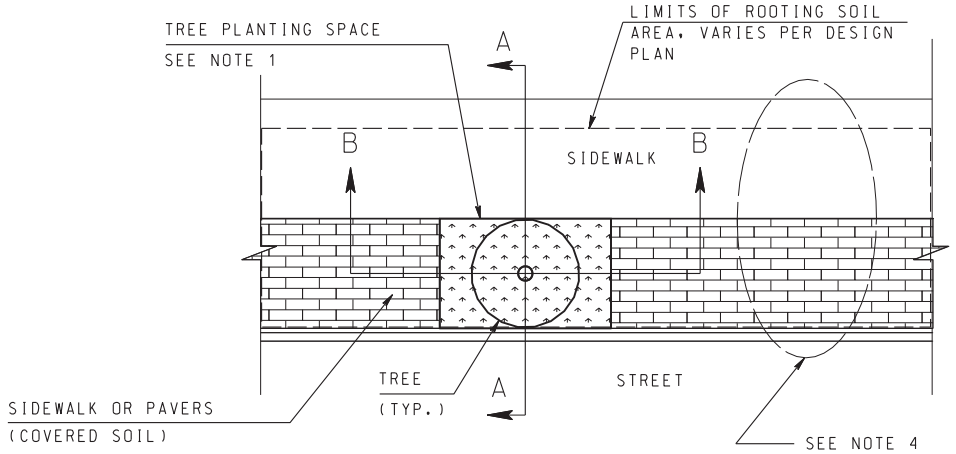
SECTION A-A



SECTION B-B

NOTES:

1. MINIMUM OPEN TREE PLANTING SPACE DIMENSIONS: 4'x6'.
2. MAXIMUM WATERSHED AREA: 6.0 TIMES AREA OF THE OPEN TREE PLANTING AREA.
3. SEE DWG NO. 621.74 FOR BOTTOM SAND LAYER AND SUBSURFACE DRAINAGE REQUIREMENTS.
4. FOR SIDEWALK OVER STRUCTURAL SOIL DETAIL OPTIONS, SEE DWG. NOS. 621.75 AND 621.76.
5. SEE DWG. NOS. 611.10 TO 611.13 FOR TREE INSTALLATION REQUIREMENTS.



PLAN VIEW

LEGEND:

1. SIDEWALK / PAVERS
2. DDOT APPROVED STRUCTURAL SOIL - 30" MIN.
3. PLANTING SOIL - 12"
4. SAND - 0" TO 12" (AS REQUIRED)
5. SCARIFIED SUBSOIL - 4"
6. CRUSHED STONE, DOUBLE WASHED NO. 57 - 6"
7. CHOKER LAYER
8. GEOTEXTILE
9. MULCH - 3"

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

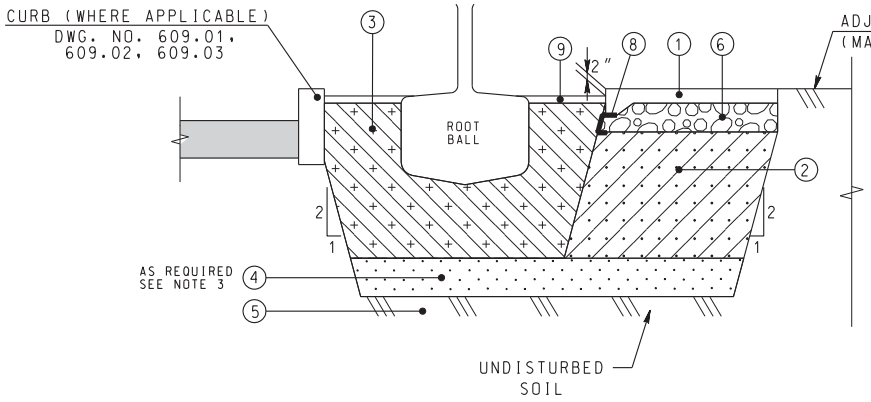
RECOMMENDED: Ravindra D Ganik
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

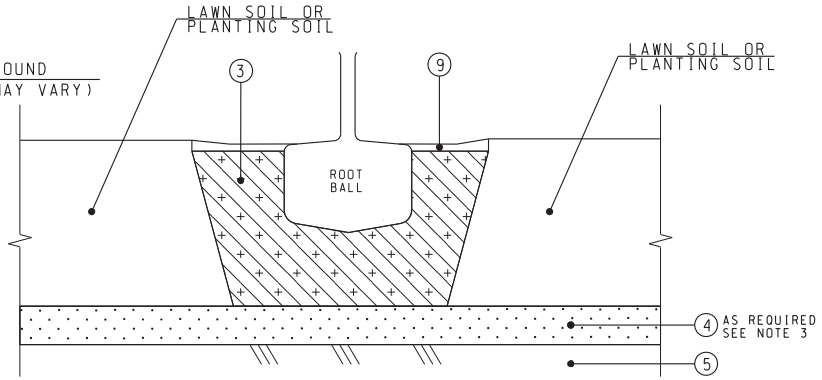
STRUCTURAL SOIL UNDER SIDEWALK – COVERED TREE SPACE

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

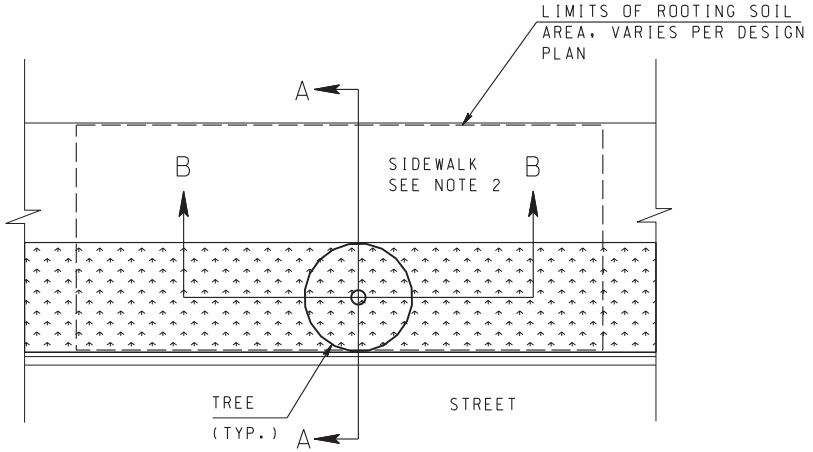
DWG. NO. 621.70



SECTION A-A



SECTION B-B



PLAN VIEW

NOTES:

1. MAXIMUM WATERSHED AREA: 6.0 TIMES AREA OF THE CONTINUOUS PLANTING STRIP.
2. WHERE IMPERVIOUS SIDEWALK WIDTH IS GREATER THAN 8', LINEAR GRATES OR SIDEWALK CATCH BASINS ARE REQUIRED FOR REDISTRIBUTION OF RAIN WATER. SEE DWGS NOS. 621.75 AND 621.76.
3. SEE DWG NO. 621.74 FOR BOTTOM SAND LAYER AND SUBSURFACE DRAINAGE REQUIREMENTS.
4. SEE DWGS. NO. 611.10 TO 611.13 FOR TREE INSTALLATION REQUIREMENTS.

LEGEND:

1. SIDEWALK / PAVERS
2. DDOT APPROVED STRUCTURAL SOIL - 30" MIN.
3. PLANTING SOIL - 36"
4. SAND - 0" TO 12" (AS REQUIRED)
5. SCARIFIED SUBSOIL - 4"
6. CRUSHED STONE, DOUBLE WASHED NO. 57 - 6"
7. CHOKER LAYER
8. GEOTEXTILE
9. MULCH - 3"

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

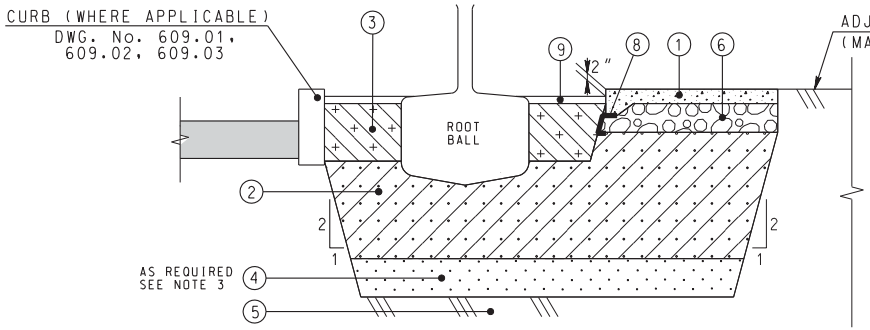
RECOMMENDED: Ravindra D. Ganvir
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

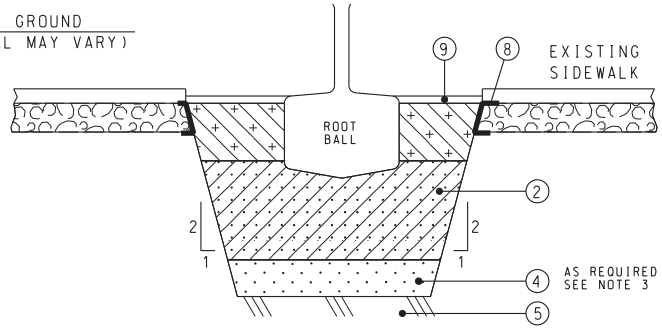
STRUCTURAL SOIL UNDER SIDEWALK – CONTINUOUS OPEN TREE SPACE

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.71



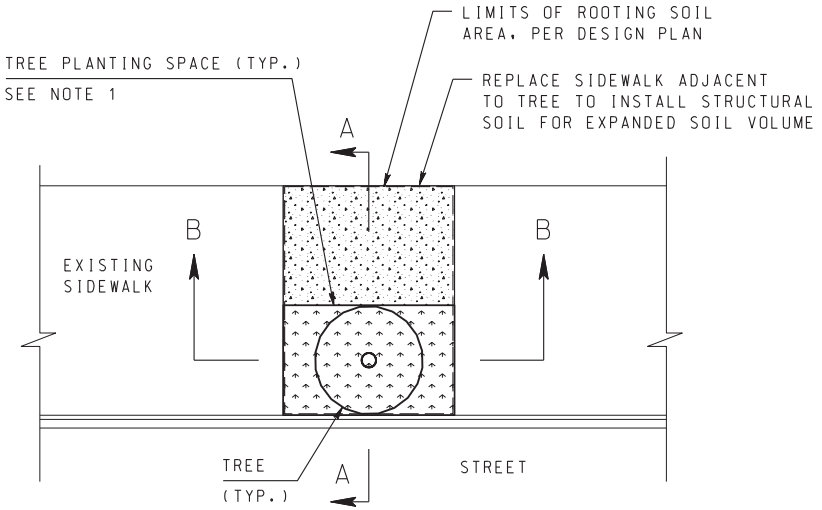
SECTION A-A



SECTION B-B

NOTES:

1. MINIMUM OPEN TREE PLANTING SPACE DIMENSIONS: 6'x9'.
2. MAXIMUM WATERSHED AREA: 6.0 TIMES AREA OF THE OPEN TREE PLANTING AREA.
3. SEE DWG NO. 621.74 FOR BOTTOM SAND LAYER AND SUBSURFACE DRAINAGE REQUIREMENTS.
4. DETAIL INTENDED FOR NEW TREE PLANTINGS ON SITES WITH CONSTRAINTS TO ACHIEVING FULL SOIL VOLUME.
5. TO ADAPT DETAIL TO EXISTING TREE LOCATIONS, PROVIDE EXPANDED SOIL VOLUMES BEYOND EXISTING TREE ROOTING AREA; DO NOT DISTURB AROUND EXISTING TREE ROOTS.
6. SEE DWGS. NO. 611.10 TO 611.13 FOR TREE INSTALLATION REQUIREMENTS.



PLAN VIEW

LEGEND:

1. REPLACED SIDEWALK - TYPE PER DESIGN PLANS
2. DDOT APPROVED STRUCTURAL SOIL - 30" MIN.
3. PLANTING SOIL - 12"
4. SAND - 0" TO 12" (AS REQUIRED)
5. SCARIFIED SUBSOIL - 4"
6. CRUSHED STONE, DOUBLE WASHED NO. 57 - 6"
7. CHOKER LAYER
8. GEOTEXTILE
9. MULCH - 3"

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

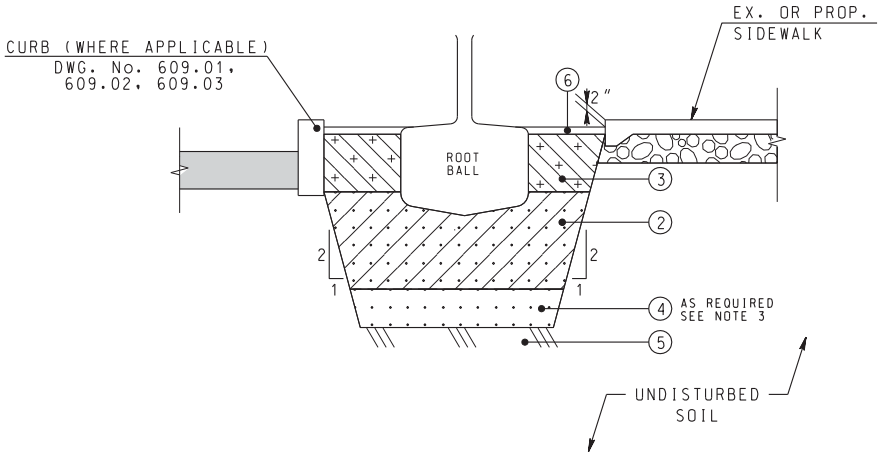
RECOMMENDED: Ravindra D. Gavis
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

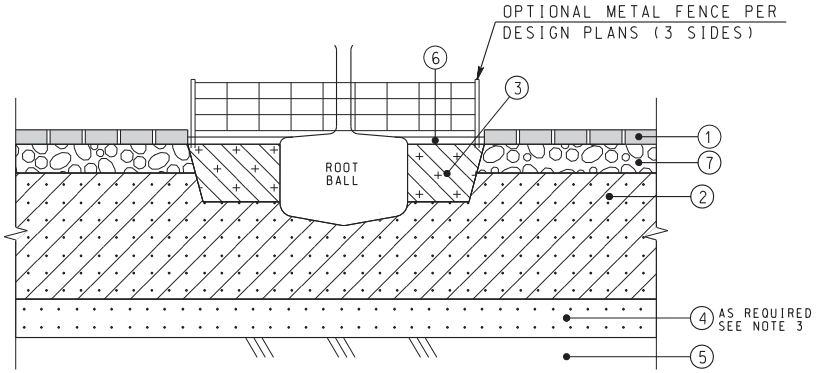
STRUCTURAL SOIL UNDER SIDEWALK – CONFINED OPEN TREE SPACE

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.72



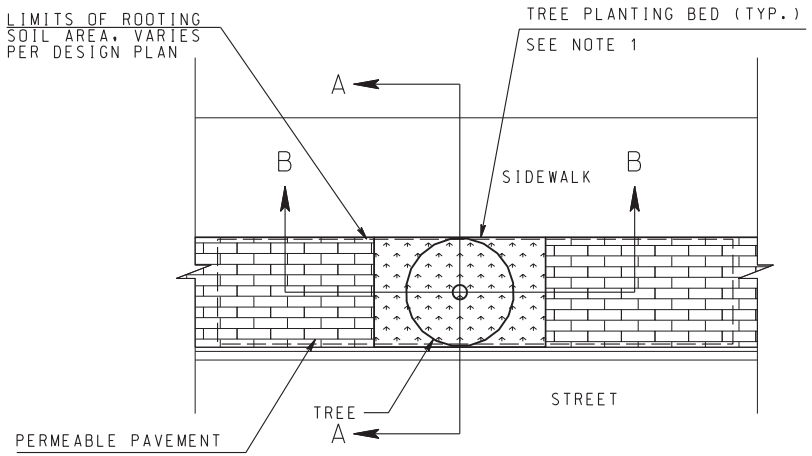
SECTION A-A



SECTION B-B

NOTES:

1. MINIMUM TREE PLANTING BED DIMENSIONS: 4' x 6'.
2. MAXIMUM WATERSHED AREA: 6.0 TIMES AREA OF THE TREE PLANTING BED.
3. IF SUBGRADE INFILTRATION RATE IS LESS THAN 0.5 INCH PER HOUR, OR IF THE SOILS ARE MAPPED BY USGS AS GROUP C OR D, SAND LAYER IS REQUIRED.
4. SEE DWG NOS. 621.02, 621.04, OR 621.06 FOR PERMEABLE PAVEMENT DETAIL OPTIONS.
5. DETAIL INTENDED FOR NEW TREE PLANTINGS ON SITES WITH CONSTRAINTS TO ACHIEVING FULL SOIL VOLUME.
6. TO ADAPT DETAIL TO EXISTING TREE LOCATIONS, PROVIDE EXPANDED SOIL VOLUMES BEYOND EXISTING TREE ROOTING AREA; DO NOT DISTURB AROUND EXISTING TREE ROOTS.



PLAN VIEW

LEGEND:

1. PERMEABLE PAVEMENT
2. DDOT APPROVED STRUCTURAL SOIL - 30" MIN.
3. PLANTING SOIL - 12"
4. SAND - 12" (AS REQUIRED)
5. SCARIFIED SUBSOIL - 4"
6. MULCH - 3"
7. PERMEABLE PAVEMENT BASE

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

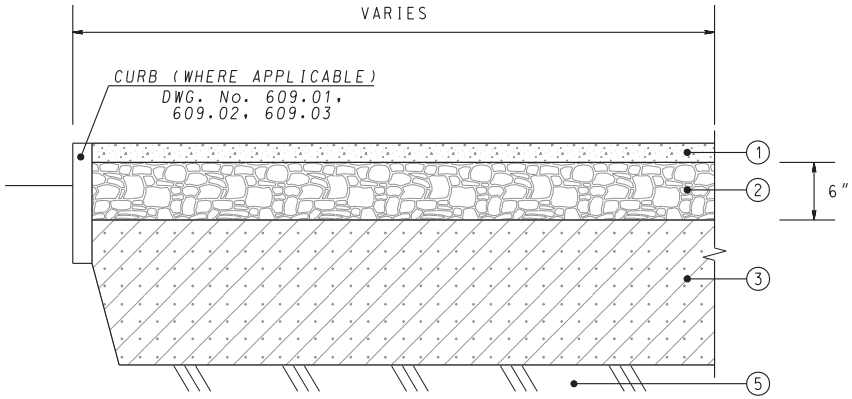
RECOMMENDED: Ravindra D Gavit
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

STRUCTURAL SOIL UNDER COVERED TREE SPACE ONLY

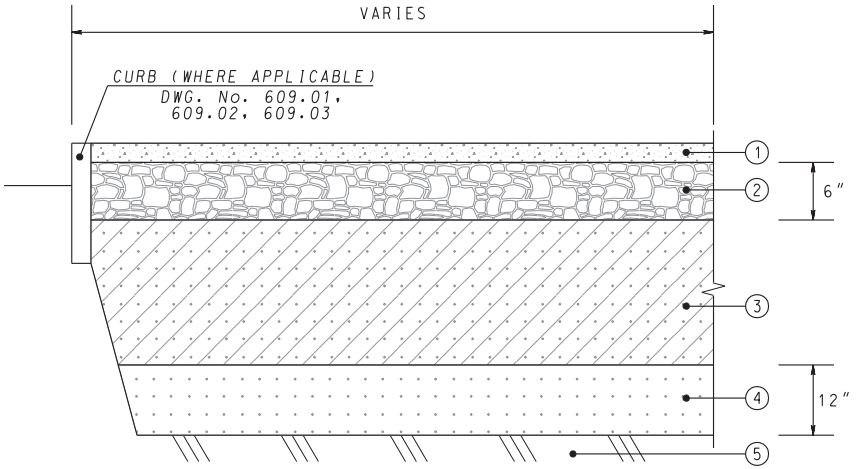
DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.73



STRUCTURAL SOIL OVER SCARIFIED SOIL

NRCS HYDROLOGIC SOIL GROUP A OR B



STRUCTURAL SOIL OVER SAND OVER SCARIFIED SOIL

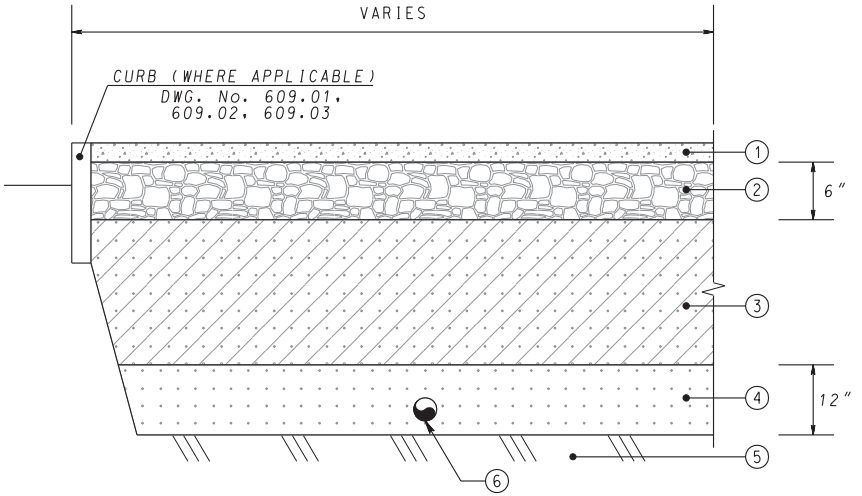
NRCS HYDROLOGIC SOIL GROUP C

NOTES:

1. IF NRCS HYDROLOGIC SOIL GROUP IS A OR B, OR MEASURED SUSBOIL INFILTRATION RATE IS 0.5 IN/HR OR GREATER, SBSS MAY BE PLACED OVER SCARIFIED SUBSOIL.

2. IF NRCS HYDROLOGIC SOIL GROUP IS C, OR MEASURED SUSBOIL INFILTRATION RATE IS BETWEEN THAN 0.14 AND 0.5 IN/HR, SBSS SHALL BE PLACED OVER 12 INCHES OF SAND OVER SCARIFIED SUBSOIL.

3. IF NRCS HYDROLOGIC SOIL GROUP IS D, OR MEASURED SUBSOIL INFILTRATION RATE IS LESS THAN 0.14 IN/HR, PERFORATED 4" PVC UNDERDRAIN WRAPPED IN GEOTEXTILE SHALL BE EMBEDDED IN SAND AND CONNECTED TO THE STORM DRAINAGE SYSTEM.



STRUCTURAL SOIL OVER SAND WITH DRAIN OVER SCARIFIED SOIL

NRCS HYDROLOGIC SOIL GROUP D

LEGEND:

1. SIDEWALK OR PAVERS
2. CRUSHED STONE - DOUBLE WASHED NO. 57
3. DDOT APPROVED STRUCTURAL SOIL - 30" MIN.
4. SAND
5. SCARIFIED SUBSOIL - 4"
6. 4" PERFORATED PVC UNDERDRAIN (SCHEDULE 40) WITH GEOTEXTILE WRAP

DATE	APPR.	
REVISED		
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		REFERENCE

RECOMMENDED: Ravindra D. Gonit
DEPUTY CHIEF ENGINEER

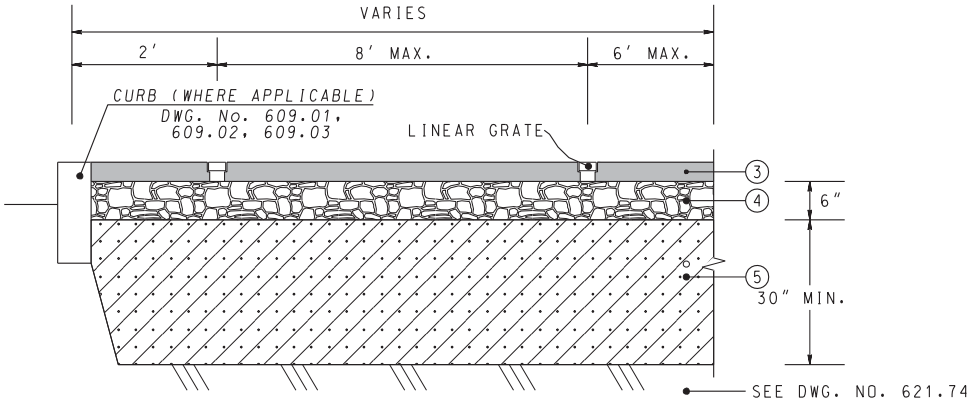
APPROVED:
CHIEF TRANSPORTATION ENGINEER

TREE SPACE COVERED SOIL VOLUME SUBSURFACE DRAINAGE OPTIONS

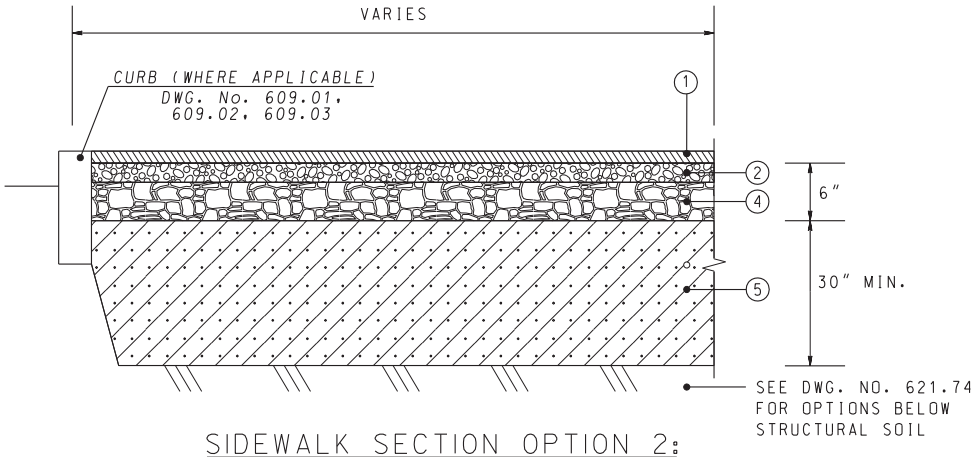
DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.74

NOTE:
FOR PLAN VIEW AND ADDITIONAL DETAIL, SEE DWG. NO. 621.70



SIDEWALK SECTION OPTION 1:
IMPERVIOUS PAVEMENT COVER
WITH LINEAR GRATES



SIDEWALK SECTION OPTION 2:
PERVIOUS PAVEMENT COVER

LEGEND:

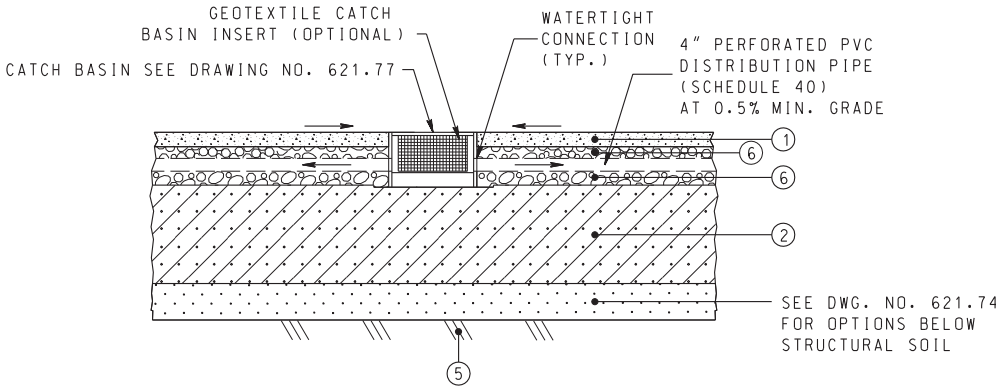
1. PERVIOUS PAVEMENT SURFACE/WEARING COURSE
2. PERVIOUS PAVEMENT BEDDING / AGGREGATE BASE
3. IMPERVIOUS SIDEWALK
4. CRUSHED STONE - NO. 57 DOUBLE WASHED AGGREGATE
5. DDOT APPROVED STRUCTURAL SOIL

			RECOMMENDED: Ravindra D. Ganvir DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED:
REVISED			
ISSUED:			CHIEF TRANSPORTATION ENGINEER
		REFERENCE	

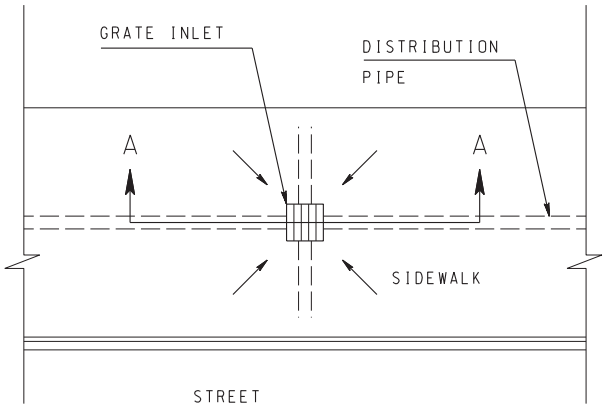
COVERED SOIL VOLUME-1 PERVIOUS COVER OR IMPERVIOUS COVER WITH LINEAR GRATES

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.75



SECTION A-A



PLAN VIEW

LEGEND:

1. SIDEWALK
2. DDOT APPROVED STRUCTURAL SOIL - 30" MIN.
3. BIORETENTION SOIL
4. PLANTING SOIL
5. SCARIFIED SUBSOIL - 4"
6. CRUSHED STONE, DOUBLE WASHED NO. 57 - 3"
7. CHOKER LAYER
8. GEOTEXTILE
9. MULCH - 3"

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

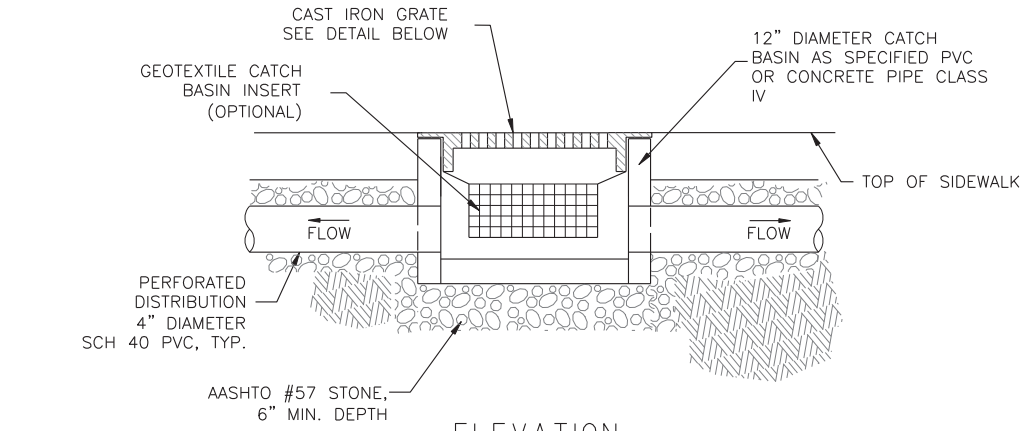
RECOMMENDED: Ravindra D Gavit
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

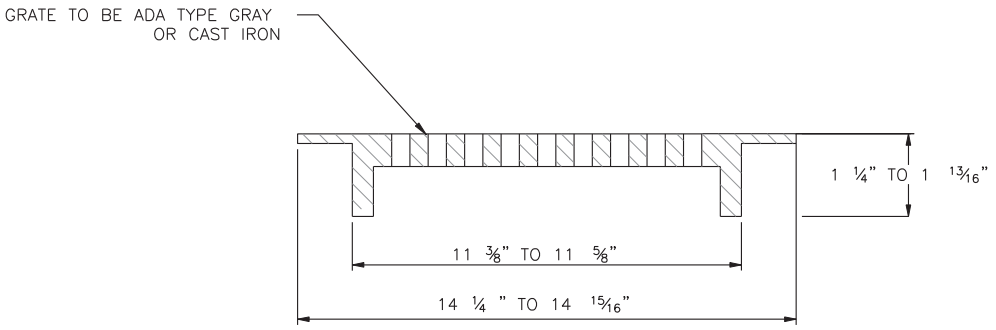
COVERED SOIL VOLUME-2 IMPERVIOUS COVER WITH CATCH BASIN

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.76



ELEVATION



CAST IRON GRATE DETAIL

SEE NOTE 1

NOTES:

1. MAXIMUM OPENING SIZE IN GRATE SHALL BE 1/2 INCHES.
2. SIZE OF GRATE SHALL MATCH SIZE OF THE RISER, PER PLANS, SHALL FIT SNUG, AND SHALL BE REMOVEABLE FOR MAINTENANCE PURPOSES.
3. ALTERNATE MATERIAL TO CAST IRON SHALL BE ALLOWED AS APPROVED BY DDOT IPMA.

			RECOMMENDED: Ravindra P. Gonit DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED:
REVISED			
ISSUED:			CHIEF TRANSPORTATION ENGINEER
		REFERENCE	

TREE SPACE GRATE CATCH BASIN

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.77

DISTRICT OF COLUMBIA

DEPARTMENT OF TRANSPORTATION

GREEN INFRASTRUCTURE STANDARDS

SUPPLEMENT TO STANDARD SPECIFICATION FOR HIGHWAYS AND STRUCTURES

2014

621.01 AGGREGATES FOR STORMWATER MANAGEMENT

(A) DESCRIPTION

This item shall consist of constructing base courses for permeable pavements and bioretention facilities to the specified depths on a prepared foundation conforming to the lines, grades and cross sections shown in the contract documents. Base courses may include reservoir layer, storage layer, choker layer, filter layer, and other layers included in the Contract Documents. Except as herein stated, the requirements for control of materials, submittals, sampling, and testing items specified in DDOT Standard Specification 106 not described in sections below, are applicable to this specification.

(B) SUBMITTALS

Source Approval: Submit documentation of materials to the DDOT Lab prior to construction as follows:

1. Material Source - Certificate
2. Cleanliness – Certification that stone is double-washed per this provision.
3. Properties - Certified Test Results for:
    a. Gradation
    b. Smoothness
    c. Percentage of Wear
4. Sample: Prior to production and delivery of aggregates, take at least one (1) initial sample in accordance with ASTM D75. Collect each sample by taking three (3) incremental samples at random locations from source material to make a composite sample. See Table 106.02 in the Standard Specifications for minimum sampling requirements. Repeat sampling procedure when source of material is changed or when deficiencies or variations from specified grading of materials are found in testing.

(C) MATERIALS

1. Coarse aggregate shall be of the types designated in the Contract Documents, and shall consist of clean, tough, durable fragments of crushed stone, or crushed gravel, conforming to the gradations in Table 1 and shall also meet the following:
    a. Be double-washed, sufficient to remove dust and other coatings; and
    b. Be free from clay balls, organic matter, and other deleterious substances
2. Reservoir/storage layer for permeable pavements shall also meet the following:
    a. Maximum percentage of wear per DDOT Standard Specification 803.02

b. Minimum 75% by mass (weight) of the material coarser than the No. 4 sieve with at least two (2) fractured faces, and 90% shall have one or more fractured faces as determined by ASTM D5821;

c. Have not more than 5% of flat or elongated pieces (>5:1) as specified in ASTM D4791;

d. Material shall have a California bearing ratio (CBR) of at least thirty (30) as determined by laboratory test on a four (4) day soaked sample in accordance with ASTM D1883.

Table 1: Gradation for Base Courses

Pavement Reservoir Layer	Choker Layer for Permeable Pavements	Filter Layer	Bioretention Storage/Drainage Layer
AASHTO No. 2 or No. 3 Stone	AASHTO No. 57 Stone	AASHTO No. 8 Stone	AASHTO No. 57 Stone

3. Choker Course for bioretention shall be a free-draining sand and gravel borrow shall consist of inert, hard, durable stone and coarse sand, free from loam, clay, mica, surface coatings and deleterious materials and shall conform with the following gradation:

U.S. Sieve No.	% Passing by Weight	
	Minimum	Maximum
3 inch	100	-
1/2 inch	60	-
# 4	40	100
# 50	8	28
# 200	0	8

Saturated hydraulic conductivity of the sand and gravel shall be not less than 10 inches per hour according to ASTM D5856-95 (2000) when compacted to a minimum of 95% Standard Proctor, ASTM 698.

(D) PREPARATION OF GRADE

Excavation and sub-grade preparation to the lines and grades shown on the Contract Documents shall follow the following steps:

1. Sub-grade shall not be compacted for installations where contract documents specify a minimum infiltration rate for the sub-grade.
2. For permeable pavements with soft or yielding soils in locations specifying a minimum infiltration rate for the sub-grade, Contractor shall install geogrid in accordance with contract documents. Geotextile fabric shall not be used.
3. For permeable pavements where no minimum infiltration rate is specified for the sub-grade, Contractor shall be allowed to perform subgrade compaction, and can utilize geotextile fabric or impermeable liners as specified in the Contract Documents.
4. Where erosion of sub-grade has caused accumulation of fine materials and/or surface ponding, this material shall be removed with light equipment and the underlying soils scarified to a minimum additional depth of 6 inches with a rake and a tracked vehicle used in combination, or equivalent.
5. Construction equipment shall not be allowed on the subgrade, except as noted above.

(E) HAULING

Trucks meeting the same cleanliness requirements of the double washed materials shall be used during hauling. Trucks shall be inspected and cleaned prior to each use.

(F) LIMITATIONS ON PLACING

Do not install aggregate base course when rainfall or other weather conditions will detrimentally affect the quality of the work.

(G) PLACING, SHAPING AND COMPACTING

1. Upon completion of sub-grade work, the Engineer shall be notified and shall inspect the sub-grade before the Contractor continues installation. Owner or Engineer shall have the option to perform infiltration testing on the subgrade to verify minimum infiltration rates, at the Contractor’s expense where specified on the contract documents.
2. Any accumulation of debris or sediment which takes place after approval of sub-grade shall be removed prior to installation continuing at no extra cost.
3. Place geosynthetics, impermeable liner, pipe, and aggregate as required on the contract documents immediately after approval of sub-grade in accordance with the standards specifications and the DDOT specification “Geosynthetics for Stormwater Management”.
4. Do not dump aggregate base course in piles, but evenly spread and place aggregate on the prepared sub-grade in layers of uniform thickness without segregation. Where the base course is constructed in more than one layer, clean previously constructed layers of loose and foreign matter prior to placing subsequent layers.

5. Moisten and roll each lift of aggregate with a 10-ton roller, keeping equipment movement over exposed sub-grades to a minimum. Roll each lift between 4 and 6 passes. If a required depth of aggregate in a lift exceeds ten (10) inches, the aggregate layer shall be rolled in ten (10) inch lifts.
6. Make adjustments in placing procedures or equipment to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to insure a satisfactory aggregate base course.

(H) FINISHING

1. **Geosynthetics along Edges** – Geotextile fabric or impermeable liners, or both, shall be used along the edges or sides of aggregate base course materials for permeable pavement and bioretention as specified in the contract documents. Following placement of an aggregate base course, and at the conclusion of each day's work, the geotextile or impermeable liner, or both, shall be folded back and secured to protect from sediment washout along all bed edges. At least a two foot (2') strip shall be used to protect stone from adjacent bare soil. This edge strip shall remain in place until all bare soils contiguous to beds are stabilized and fully vegetated or until the wearing surface for the permeable pavement has been placed.
2. **Unfinished Edges Of Base Course** – In fill conditions, place earth or other approved materials along any unfinished edges of the base course in such quantity that it will compact to the thickness of the aggregate base course being constructed. In each operation, allow at least a two (2) foot width of the shoulder along all unfinished edges to be rolled and compacted simultaneously with the rolling and compacting of each layer of aggregate.

(I) SAMPLING

1. **Aggregates at the Source** – See section (B).
2. **During Construction -** Take at least one (1) random sample during construction within the first 500 tons of placed aggregate material, in accordance with ASTM D 75. Collect each sample by taking three (3) incremental samples at random locations from the placed material to make a composite sample by weight of not less than 75 pounds.
3. **Sample Identification** - Place each sample in a clean container, securely fastened to prevent loss of material. Tag each sample for identification and with the following information:

Contract No._____

Sample No._____ Quality _____

Date of Sample_____

Sampler_____

Source_____

Intended Use_____

For Testing_____

4. **Repeat Sampling –** Repeat the above sampling when a material source is changed or when unacceptable deficiencies or variations from a specified gradation of materials is found in testing.

(J) ACCEPTANCE TESTING

Testing responsibilities will be performed by the Contractor's testing agency at the Contractor's expense. Materials approval testing may be performed by DDOT. Failure to detect defective work or materials early will not prevent rejection if a defect is discovered nor shall it obligate the owner for final acceptance at any time. Submit all Test Reports to the Engineer.

1. **Gradation** - Test each sample of aggregate base course material for gradation in accordance with ASTM C 136 and with the sampling described in Section (I).
2. **Thickness**– Measure each 100 square yards of each layer of aggregate base course placement. Make depth measurements by test holes, at least 3 inches in diameter, through the base course. Where base course deficiency is more than ½ inch, correct by scarifying, adding mixture of proper gradation, re-blading, and re-compacting. Where the measured thickness is more than ½ inch thicker than indicated, consider it as the indicated thickness plus ½ inch for determining the average. The average thickness is the average of the depth measurements for the entire area, and shall not under-run the thickness indicated in the Contract Documents without written approval from the Engineer.

(K) PROTECTION

Protection work will be performed by the Contractor at the Contractor's expense.

1. As construction is completed, maintain and protect the aggregate base course, except where a portion of the succeeding course is under construction thereon. Maintenance includes drainage, rolling, shaping, and watering, as necessary, to maintain the course in proper condition. Correct deficiencies in thickness, composition, and construction which develop during the maintenance, to conform to the requirements specified herein. Maintain sufficient moisture by light sprinkling with water at the surface to prevent a dusty condition.

2. Finishing along the edges of the permeable pavement for protection during construction shall be as described in Section (H) until the site is fully stabilized, at which time excess geotextile fabrics and impermeable liners can be cut back to the pavement edges.

3. In addition, runoff onto an aggregate base course shall be minimized until the site is fully stabilized. Diversion ditches or other approved types of erosion and sediment control measures shall be placed at the toe of slopes which are adjacent to permeable pavement and bioretention areas, to prevent sediment from washing into areas aggregate base course at all times during and after construction. Any sediment accumulation into the aggregate base course shall be removed immediately by cleaning or replacement of the aggregate by the Contractor at no cost to the owner.

(L) MEASURE AND PAYMENT

The unit of measure for Aggregates for Stormwater Management will be the cubic yard for each course/type of material. The actual number of cubic yards measured complete in place will be paid for the contract unit price per cubic yard, which payment will include all labor, materials, tools, equipment and incidentals necessary to complete the work as specified herein. Payment will also include all subgrade preparation and testing necessary to achieve the required placement.

621.02 GEOSYNTHETICS FOR STORMWATER MANAGEMENT

(A) DESCRIPTION

This work consists of supplying and installing various geosynthetics for use in stormwater management, including the following:

1. Geotextile, Class 1: a geotextile fabric for use in applications where there is a high risk of damage during construction due to construction equipment or dumped aggregates, including due to its use at the bottom of stormwater management facilities.
2. Geotextile, Class 2: a geotextile fabric for use in applications where there is little to average risk of damage during construction due to construction equipment or dumped aggregates, including use on the sides of stormwater management facilities.
3. Geogrid: a geosynthetic with woven bands of synthetic material with large apertures for use in applications where the underlying soils are weak or yielding.

   i. If the following soil conditions are encountered when installing permeable pavement facilities, geogrid in accordance with this provision may be utilized in lieu of removal of soil and replacement with select backfill, as approved by DDOT:

   - unstable or highly erodible soils,
   - weak soils,
   - gap graded soils,
   - alternative sand / silt laminated soils,
   - dispersive clays, and / or rock flour

4. Waterproofing Membrane: material that is used to prevent infiltration and contain stormwater within the facility by lining the sides and bottom.

   Except as herein stated, the requirements specified by DDOT Standard Specifications are applicable to this specification.

(B) MATERIALS

1. Geotextile: Class 1 and Class 2 geotextiles for stormwater management shall meet the requirements of AASHTO M-288 and Sections 213.02 and 822.09 of the DDOT specifications, as applicable.

   - The permeability of the geotextile fabric should also be at least an order of magnitude higher (10x) the soil sub-grade permeability for stormwater management facilities used as infiltration practices.

2. Geogrid: Shall meet the requirements of AASHTO M-288 and Section 213.02 of the DDOT specifications, unless otherwise specified in the contract documents.

3. Waterproofing Membrane: shall have a thickness of 30 mil and conform to the following requirements.

Table 1: Test Properties for Waterproofing Membrane

Test Property	Test Method	Specifications Limits
Thickness	D5199	+/-5%
Specific Gravity (min.)	D 792	1.20
100% Modulus (psi, min.) (lb. force/in width, min.)	D 882	1000 30
Tensile (psi, min.) (lb. force/in width, min.)	D 882	2300 73
Elongation at Break (%, min.)	D 882	380
Graves Tear (lb./in., min.) (lb. force/in. width, min.)	D 1004	325 8
Resistance to Soil Burial (% change, max.) (a) Break Strength (b) Elongation (c) Modulus at 100%	G 160	 5 20 20
Low Temperature Impact (Pass/F)	D 1790	-20
Dimensional Stability (% change/max.)	D 1204 (212/F/15 min.)	3
Water Extraction (%, Max. Loss)	D 1239	0.15
Volatile Loss (%, max.)	D 1203	0.70
Hydrostatic Resistance (psi, min.)	D 751	100

(C) **SUBMITTALS AND TESTING**

1. Product Data: Submit most recent printed information from manufacturer for:
   a. Type and Source of Materials
   b. Qualifications of Manufacturer
      - Manufacturer shall have a minimum of five (5) years of experience supplying geotextile materials for stormwater applications.
      - Submit Manufacturer name, address, telephone and fax numbers, and contact name.
      - Submit certification that Manufacturer is able to provide sufficient quantities of materials for the entire project.

c. Geotextile Material per Table 213.02 (A)
   - Weight, ounces per square foot
   - Grab Strength, pounds force
   - Puncture Strength, pounds force
   - Trapezoidal Tear Strength, pounds force
   - Permittivity, as a function of permeability, /sec
   - Minimum Apparent Opening Size, millimeters
   - Elongation at Failure, %
   - Ultraviolet stability, % strength retained after 500 hours

d. Geogrid Material per Table 213.02 (B)
   - Weight, ounces per square foot
   - Strength at 5% Strain, pounds per foot
   - Minimum Opening Size, inches
   - Maximum Opening Size, inches
   - Ultimate Tensile Strength, pounds per foot
   - Junction Strength, pounds force
   - Ultraviolet stability, % strength retained after 500 hours

e. Waterproofing Membrane per Table 1.
   - Thickness, mils
   - Specific Gravity
   - 100% Modulus, psi, pounds force/inch width
   - Tensile Strength, psi, pounds force/inch width
   - Elongation at Break, percent
   - Graves Tear, pounds/in, pounds force/inch width
   - Resistance to Soil Burial, % change
   - Low Temperature Impact, pass/degree Fahrenheit
   - Dimensional Stability, % change
   - Water Extraction, %, maximum loss
   - Volatile Loss, %
   - Hydrostatic Resistance, psi

2. Product Samples: Along with product data, submit representative samples to DDOT for review and approval. Do not order materials until DDOT has approved. Delivered materials shall match the approved samples.

3. Soil Tests: Submit certification that the geotextile has at least an order of magnitude (10x) higher permeability than the soil subgrade permeability as specified in the Contract Documents for infiltration practices.

(D) DELIVERY, STORAGE AND HANDLING

1. Deliver, store and handle packaged materials in strict compliance with all manufacturer's instructions and recommendations. Keep a record of all deliveries along with corresponding package labels.

2. Minimize exposure to ultraviolet (UV) degradation by keeping geotextile materials out of direct sunlight at all times. Protect all materials from weather, damage, injury and theft.

3. Sequence deliveries to avoid delays and UV exposure.

(E) PRE-INSTALLATION EXAMINATION AND PREPARATION

1. Pre-Installation Examination: Prior to beginning work, the Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify DDOT in writing of all deficiencies and conditions detrimental to the proper completion of this work. This includes:

   a. The subgrade is at incorrect depths, lines, and dimensions for installing the geotextile fabrics.

   b. Overly wet conditions exist or are anticipated to occur during installation, as they will contaminate the geotextiles.

   c. Construction debris is present within the placement area which may damage the geotextiles; work is to be sequenced to avoid construction traffic on the exposed geotextiles at any time.

2. By beginning work, the Contractor accepts the previous work and site conditions.

(F) PLACEMENT

1. The Contractor shall not place any geotextile, geogrid or waterproofing membrane until all work in adjacent areas is complete and approved by DDOT.

2. Material shall be cut and fit to the dimensions shown on the plans with a minimal amount of seams, and with excess materials removed and disposed of properly. Clean and straight cuts are required to the line and grade of the plans.

3. Geosynthetics shall be placed on the prepared surface of the stormwater practice parallel to the longest side of the practice, and without dragging it across the grade. Wrinkles and folds shall be removed by stretching and pinning.
4. Securing pins or staples for geotextile fabric shall have a minimum length of 10 inches and shall be designed to securely hold the geotextile fabric in place during construction. Waterproofing membrane shall be held in place by backfilling or other means without puncturing the material. Other methods of pinning can also be used as allowed by the Chief Engineer.
5. Geotextiles shall be overlapped by a minimum of 3 feet at roll edges and ends. Roll edges, ends and overlaps shall be secured a minimum of 5 feet on center or sewed in accordance with Section 213.02 (C).
6. Geotextiles shall be folded or cut and overlapped in the direction of the turn for all curves. Folds, as well as edges, ends, and overlaps shall be pinned a minimum of 5 feet on center or sewed in accordance with Section 213.02 (C).
7. Waterproofing membrane shall be glued continuously at seams in accordance with all manufacturers' recommendations including any required overlap. Folds shall also be secured and pulled taught.

(G) PROTECTION

1. Protect newly placed geosynthetics from damage during construction, and protect them from ultraviolet (UV) degradation at all times.
2. Construction traffic on exposed geosynthetic materials is strictly prohibited.
3. After beginning work, coordinate activities with other work so that there is no disturbance or damage from traffic or other construction activities subsequent to placement.
4. Any damaged geotextile, geogrid, or waterproofing membrane shall be repaired or replaced immediately upon discovery of the damage, to the satisfaction of the Engineer, at the Contractor's expense.

(H) EXCESS MATERIALS

Unused material exposed to ultraviolet (UV) degradation or otherwise damaged shall also be disposed of properly.

(I) MEASURE AND PAYMENT

The unit of measure for geosynthetics will be square yards of the type of geosynthetic specified. The number of square yards will be the actual number of square yards complete in place, which will include furnishing, transporting, handling, installing, and testing the geosynthetics as well as all seams, overlaps, staking, embedment, and protection measures.

621.03 UNDERDRAINS FOR STORMWATER FACILITIES

(A) DESCRIPTION - This work shall consist of furnishing and placing the items specified to construct perforated PVC pipe for underdrains, cleanouts, observation wells, field connections to existing storm and/or combined sewer pipe or existing structures, and gate valves and backflow preventers as shown in the Drawings and in accordance with DC WASA Standards, where applicable. Except as herein stated, the requirements specified in DDOT Standard Specifications 601 and 310 are applicable to this specification.

Related Items: Trench excavation and backfill and non-perforated underdrain pipe will be constructed and installed per the standard specifications and special provisions and paid separately.

(B) REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AASHTO M 105 Gray Iron Castings
ASTM D 2729 Polyvinyl Chloride (PVC) Sewer pipe and Fittings
ASTM D 3034. Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings

(C) MATERIALS - All materials shall meet the requirements set forth in the Standard Specifications or modified in the Special Provisions.

1. PVC (perforated or non-perforated as specified in the Contract Drawings): Shall be schedule 40 for underdrains and pipe risers, and shall conform to Section 808.02 of the Standard Specifications.
2. HDPE for underdrain pipe along curves, as indicated in the Contract Drawings.
3. Frame and Cover: Shall be Neenah – R-1792-AL or approved equal.
4. Screw Cap: Shall be threaded PVC with 2-inch square lug.
5. Concrete Encasement: Concrete encasement shall have a minimum compressive strength of 3000 psi and shall conform to Section 817 of the Standard Specifications.
6. Fittings: Fittings shall be PVC and used as indicated on the design drawings.
7. Cleanout: The cleanout cover assembly in pavement shall be cast iron and have an adjustable housing with a scoriated cast iron cover as indicated in the design drawings and as referenced in DDOT Specification Section 815.04.
8. Observation Well: 2-inch well test plug using EnviroTech ErgoGrip or approved equal with tethering eyelet.
9. Field Connections: All materials shall meet the requirements set forth in Standard Specifications 310.03, 314.03, 316.03, or modified in the Special Provisions.
10. Backflow Valve – Shall be a backflow flapper valve (6-inch), Flex PVC ™ Item No. S675P or approved equal.

11. Gate Valve: Shall be manual slide valve, PVC plastic body and hubs with 304 stainless steel shaft and paddle (4-inch or 6-inch) and die cast aluminum handle, Valterra or approved equal.

(D) CONSTRUCTION REQUIREMENTS

1. UNDERDRAIN PIPES

   Perforated pipes shall be placed with perforations down. Pipe shall be placed with the bell end up grade. Pipe sections shall be joined with appropriate couplings. The ends of underdrain pipe shall be plugged up grade as directed by the Engineer.

2. RISERS FOR CLEANOUTS/OBSERVATION WELLS

   a. Observation Well: Provide 2-inch PVC slotted well casing, with well point, extending twelve-inches into subgrade. Set casing approximately 2-inches below finished pavement elevation to allow clearance for test plug and cleanout cap. Provide 4-inch diameter PVC outer casing extending through pervious concrete into subbase and install 4-inch flush mounted cast iron cleanout with brass cap solvent welded to outer casing. Provide 2-inch well test plug with tethering eyelet.

   b. In paved areas: Provide frame and cover over cleanout and observation well riser pipes as indicated in the Drawings. For locations in permeable pavement, frames and covers shall be located within the permeable pavement area surrounded by PCC edge curb. Cleanouts and Observation Wells shall be encased in concrete as shown in the Drawings. Connect riser to underdrain piping.

   c. In non-paved areas: Provide screw cap covers. Covers shall be set 6-inches above final grade. Connect riser to underdrain pipe.

3. Field Connection at Existing Structure construction shall meet the requirements set forth in Standard Specifications 316.04, DC WASA Standards, and in the contract Drawings.

4. Field Connection at Sewer construction shall meet the requirements set forth in Standard Specifications 310.04, 314.04(E), 603.03, and in the contract Drawings.

5. Backflow preventer assembly to be located per the plans and as directed by the Engineer at a location upstream of proposed sewer field connection yet downstream of perforated underdrain pipe. Provide PVC riser pipe to protect PVC access sleeve pipe. Connect assembly to underdrain piping, using the appropriate reducer and tee fittings.

6. Gate valve to be located per the plans and as directed by the Engineer within an accessible catch basin or overflow riser and upstream of proposed sewer field connection yet downstream of perforated underdrain pipe. The incoming non-perforated PVC pipe shall extend into the catch basin or overflow riser a sufficient distance to allow for connection of the valve as well as sufficient operation of the valve handle but not more than a distance of 8 inches. Valves may also be placed within valve boxes as per plans and specifications and as directed by the Engineer. Catch basins, overflow risers and/or valve boxes must have sufficient depth to allow for the height of the valve when in its fully open position plus at least 3 inches at the top.

(E) TESTING AND ACCEPTANCE

When construction is complete, the contractor shall test all completed underdrain systems for continuous, unimpeded flow.

a. Suggested test methods for each pipe run are as follows:
   i. At highpoint or upstream end of underdrain pipe, open cleanout and insert hose from water source.
   ii. Turn on water
   iii. Acceptance of pipe run consists of free flow of water through drain outlet into the existing storm sewer structure.

b. Any sections of the underdrain that are clogged or crushed shall be repaired at the contractor's expense.

(F) MEASURE AND PAYMENT

a. UNDERDRAIN PIPE

Payment for Underdrain Pipe will include all costs for furnishing all materials, labor, tools, equipment and incidentals (including pipe risers, caps, and fittings) to complete the work. The unit of measurement will be linear feet.

b. CLEANOUTS/OBSERVATION WELLS

The unit of measure for Underdrain Cleanout and Observation Well will be each. Payment for Underdrain Cleanout or Underdrain Observation Well will be made at the Contract unit price per each which will include excavation, shoring, backfill, compaction, installation of cleanout including wye and jointing, pipe riser, gaskets, frame and cover or screw cap, concrete encasement, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

c. FIELD CONNECTION

Field connection at existing structure will be measured and paid for at the contract unit price per each and will include furnishing, installing, excavation, backfill, and all labor, materials, tools, equipment, and incidentals necessary to complete the work.

The unit of measure for field connection at sewer will beeach. Payment will be made at the Contract unit price per each, which payment will include, but not limited to, furnishing and installing wye branch connections, straight thimbles, maintaining sewer service, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

d. BACKFLOW PREVENTER

The unit of measure for Backflow Preventers will be each. Payment for Backflow Preventers will be made at the Contract unit price per each which will include excavation, shoring, backfill, compaction, installation of pipe riser, connections, gaskets, backflow

preventer (flapper valve), frame and cover or screw cap, concrete encasement, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

e. GATE VALVE

The unit of measure for Gate Valves will be each. Payment for Gate Valves will be made at the Contract unit price per each which will include connections, gate valve (slide valve), and all labor, materials, tools, equipment and incidentals needed to complete work specified.

621.04 PERVIOUS CONCRETE PAVEMENT

(A) DESCRIPTION

This work shall consist of constructing pervious Portland cement concrete roadway pavements, alleys, sidewalks, or trails on a prepared sub-grade in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical sections shown in the contract documents or as directed by the Chief Engineer.

The pervious concrete pavements and sidewalks shall consist of a mixture of Portland cement, aggregate, water, admixtures and other ingredients as may be specified. Except as herein stated, the requirements specified for DDOT Standard Specifications 501 Portland Cement Concrete Pavement and 608.01 Portland Cement Concrete Sidewalk and Driveway are applicable to this specification.

(B) REFERENCES

ACI 522R-10 Report on Pervious Concrete

ACI 522.1-08 Specifications for Pervious Concrete Pavement

ACI 211.3R - Guide for Selecting Proportions for No-Slump Concrete

ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

ASTM C94 - Standard Specification for Ready-Mixed Concrete

ASTM C150 – Standard Specification for Portland Cement

ASTM C595 - Standard Specification for Blended Hydraulic Cements

ASTM C979 – Standard Specification for Pigments for Integrally Colored Concrete

ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction

ASTM C1116 – Standard Specification for Fiber Reinforced Concrete

ASTM C1688 - Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete

ASTM C1701 - Standard Test Method for Infiltration Rate of In Place Pervious Concrete

ASTM C1754 - Standard Test Method for Density and Void Content of Hardened Pervious Concrete

ASTM D994 - Standard Specification for Preformed Expansion Joint Filler for Concrete

ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction

ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

NRMCA – National Ready Mix Concrete Association

(C) MATERIALS

1. Portland Cement shall be:
   a. Type I or II conforming to AASHTO M85 or ASTM C150; or
   b. Type IP or IS conforming to ASTM C595.
2. Aggregate
3. Maximum coarse aggregate size shall be No. 8.
4. Coarse and fine aggregate conforming to Sections 803.02 and 803.01 of the DDOT Standard Specifications shall be double-washed. Washing shall be sufficient to remove dust and other coatings.
5. Admixtures – Water reducing, hydration stabilizers, air entrainment, and other admixtures conforming to DDOT Specifications shall be allowed in the mix design.
6. Fibers – Reinforcing fibers conforming to DDOT Specifications and ASTM C1116 shall be allowed in the mix design.
7. Pigments – Pigments conforming to ASTM C979 shall be allowed in the mix design.
8. Joint Material – Filler for expansion joints shall be in accordance with Section 807.01 of the DDOT Standard Specifications.

(D) PROPORTIONING

Comply with ASTM C94 and develop a concrete mix design meeting the following requirements in accordance with ACI 211.3R, Appendix 6:

1. Concrete shall achieve a minimum infiltration rate of 60 inches/hour (30 gallons/hour in a 12 inch diameter cylinder). Testing shall be in accordance with ASTM 1701.
2. Concrete shall meet a minimum compressive strength when specified in the Contract Documents.
3. A combined coarse and fine aggregates gradation shall be provided and material passing the #4 sieve shall be between 4% and 7%.
4. Mix Water: Mix water quantity shall be such that the cement paste displays a wet metallic sheen without causing the paste to flow from the aggregate. Mix water yielding a cement paste with a dull-dry appearance has insufficient water for hydration. Insufficient water results in inconsistency in the mix and poor bond strength between aggregate particles. High water content results in the paste reducing or eliminating the void system required for porosity.

(E) SUBMITTALS

1. **Contractor Qualifications**

   a. At the time of bid submission, Contractor shall submit the name and qualifications of the pervious concrete installer, providing written evidence of the following:

   (i) Employment of one (1) NRMCA certified Pervious Concrete Craftsman who shall be on site, overseeing each placement crew, during all concrete placement; or

   (ii) Employment of at least two (2) NRMCA certified Pervious Concrete Installers who shall be on site, overseeing each placement crew, during all concrete placement.

   b. Not later than fourteen (14) days before construction of pervious concrete, Contractor shall furnish evidence of employment of at least three (3) certified Pervious Concrete Technicians who will perform the pervious concrete construction.

2. **Testing Agency** – Within seven (7) days after notice to proceed, Contractor shall furnish the name and location of the proposed testing agency meeting the requirements of Section O of this specification.

3. **Concrete Producer Qualifications** – Within seven (7) working days after notice to proceed, Contractor shall furnish the name and location of an NRMCA certified plant that will produce and provide pervious concrete.

4. **Concrete Mix Design** – Not later than thirty-five (35) days before construction of pervious concrete, Contractor shall furnish:

   a. A proposed mix design with proportions of materials for acceptance as described in section D of this specification or otherwise specified in Contract Documents. The data shall include unit weight, void ratio, and strength.

   b. Samples of individual concrete materials contained in the mix design for sampling and testing of material prior to use, in accordance with Section 106.02 of the DDOT Standard Specifications.

5. **Product Sample (Test Panel)** – At least fifteen (15) working days before construction of pervious concrete, and following the Chief Engineer's acceptance of the mix design, Contractor shall provide a sample of the product (test panel) in accordance with section F of this specification.

(F) TEST PANEL

1. Contractor shall provide a minimum of one (1) test panel for acceptance. Place, joint and cure the test panel, a minimum of 275 square feet in size or as specified in the Contract Documents, at the required project thickness to demonstrate that in-place void contents, unit weights, and infiltration rates can be met and to demonstrate effective jointing that does not compromise the cured concrete integrity.

2. **Test Panel Infiltration:** Test panels shall be tested for infiltration in accordance with ASTM C1701.
3. **Test Panel Cores:** Test panels shall have three (3) cores, each six (6) inches in diameter, taken from the panel a minimum of seven (7) days after placement of the pervious concrete. At least one core shall be taken within six (6) inches of a contraction joint. The cores shall be measured for thickness, void structure, and unit weight. Untrimmed, hardened core samples shall be used to determine thickness in accordance with ASTM C42. After thickness determination, the cores shall be trimmed and measured for unit weight in a saturated condition and void content in accordance with ASTM C1754.
4. **Test Panel Acceptance**: Satisfactory test panels will be determined by:
   a. Infiltration rate of at least 60 inches per hour.
   b. Compacted thickness within 1/4" of the specified thickness.
   c. Void Content ± three (3) percent of the design void content.
   d. Unit weight ± five (5) pounds per cubic foot of the design unit weight.

   If test panels meet the above mentioned requirements, they can be left in-place and included in the completed work. If test panels do not meet the above mentioned requirements, they shall be removed and disposed of in an approved manner, and replaced with an acceptable test panel at the contractor's expense.

(G) PREPARATION OF GRADE

1. Sub-Grade Preparation – Shall be in accordance with Specification "Aggregates for Stormwater Management".
2. Base Materials – Shall be in accordance with Specification "Aggregates for Stormwater Management".

(H) HANDLING, MEASURING AND BATCHING MATERIALS

Pervious concrete shall be transported from batching plant to the location of placement by a rolling drum mixer truck with current (within 12 months) certification by the NRMCA. Non-agitating trucks shall not be used. Each truck should not haul more than two (2) loads before being cycled to another type of concrete, unless a stabilizing hydration agent is used in the pervious concrete mix design or if DDOT determines that there is no significant concrete build-up in the concrete mixer after delivery of each load.

(I) MIXING CONCRETE

1. Concrete shall be mixed for a minimum of one (1) minute after introduction of all materials into the mixer. Truck mixers shall be operated at the speed designated by the concrete producer for at least 75 to 100 revolutions of the drum.

2. Concrete mixing shall comply with ASTM C94 except that discharge shall be completed within sixty (60) minutes after the introduction of mix water to the cement. This time can be increased to ninety (90) minutes when utilizing a hydration stabilizer. Further water addition is permitted at the point of discharge provided the design water/cement ratio is not exceeded.

(J) LIMITATIONS ON MIXING AND PLACING

Do not install pervious concrete when ambient temperature is below 40°F or above 90°F, or when ambient temperature is forecasted to be below 40°F or above 90°F at any time during the seven (7) days following placement, unless otherwise permitted in writing by the Chief Engineer.

(K) PLACING AND CONSOLIDATING CONCRETE

1. **Pre-Placement Conference** - A mandatory pre-placement conference will take place at least seven (7) days prior to installation of work and shall include at a minimum engineer, inspector, general contractor, pervious concrete contractor, concrete supplier, and field testing agency.
2. Wet the base materials or sub-grade immediately prior to concrete placement.
3. Deposit concrete directly from the transporting equipment onto the base materials or sub-grade, as appropriate.
4. **Discharge**: Each truckload shall be visually inspected for moisture consistency prior to discharge. Water addition shall not be permitted at the point of discharge to obtain the required mixture consistency and truckloads lacking the required moisture consistency shall be rejected as determined by the inspector. Discharge shall be a continuous operation and shall be completed as quickly as possible. Concrete shall be deposited as close to its final position as practical and such that discharged concrete is incorporated into previously placed and plastic concrete. If consolidation occurs during concrete discharge, placement shall be halted, the mixture shall be addressed, and the consolidated portion removed and replaced immediately.
5. Other methods of discharging the concrete may be used when specified in the Contract Documents or as allowed by the Chief Engineer.
6. Spread the concrete using a come-along, short-handle square ended shovel or rake, or similar equipment.
7. Rolling compaction shall be achieved using a motorized or hydraulically actuated, rotating, weighted tube screed that spans the width of the section placed and exerts a minimum vertical pressure of 10 psi on the concrete. Alternatively a steel pipe roller meeting the same criteria may be used.

8. Plate compaction is not recommended, but may be necessary in small areas. When necessary, a standard soil plate compactor with a base area of at least two square feet that exerts a minimum pressure of 10 psi on the concrete through a ¾ inch minimum plywood cover shall be used.
9. Cross rolling shall be performed using a roller specifically designed to smooth and compact pervious concrete. Lawn rollers are not allowed.
10. Foot-traffic shall not be allowed on fresh concrete.

(L) STRIKE-OFF, CONSOLIDATION AND FINISHING

1. Strike off concrete between forms using a form riding paving machine, vibrating screed, or roller screed.
2. Do not use steel trowels or power finishing equipment.
3. Final surface texture shall be achieved by finishing the fresh concrete using a full-width steel roller that provides a minimum compactive pressure to achieve the required tolerances.
4. Hand tools shall be used to finish the concrete along the slab edges immediately adjacent to forms.
5. Other methods of producing final surface texture may be permitted when specified in the Contract Documents or approved by the engineer.

(M) CURING

1. Begin curing within twenty (20) minutes of concrete discharge unless longer working time is approved by the Chief Engineer.
2. **Curing Material**:
   a. The pavement surface shall be entirely covered with a minimum six (6) mil thick polyethylene sheet in accordance with Section 501.17(C) of the DDOT Standard Specifications. Sheeting shall be cut to a minimum of the full lane width and pavement shall remain covered for at least seven (7) uninterrupted days.
   b. Alternate curing materials may be used as approved by the Chief Engineer.
3. Curing sheets shall be secured and kept secure at all times without using dirt.
4. **Hot Weather Curing:** A fog shall be sprayed above the surface, before covering, when required due to hot weather conditions. Equipment must include fog nozzles that atomize water using air pressure to create a fog blanket over the slab.
5. **Cold Weather Curing:** Curing shall be in accordance with DDOT Standard Specification.

(N) JOINTS

1. Contraction joints shall be installed at locations and spacing shown in the Contract Documents at one-quarter (¼) the depth of the thickness or a maximum of one and a half (1½) inches for roadway and alley pavements, and at one-half inch (½") for sidewalks and trails. Allowable methods for joint placement, as directed by the Chief Engineer, include:

    a. **Rolled Joints** - shall be formed in plastic concrete using a steel pipe roller to which a beveled fin with the required diameter to achieve the joint depth has been attached around the circumference of the roller. Rolled joints are formed immediately after roller compaction and before curing. Sidewalks and trails shall have rolled joints.

    b. **Sawed joints** - shall be constructed as soon as the pervious pavement can be sawed without raveling the sawed edge and before initial cracking occurs, using a wet saw or an early-entry saw. Sawed joints shall typically be constructed between 24 hours and 48 hours after concrete placement, depending on site conditions. At no time during the sawing process shall more pavement surface be exposed than that needed for sawing. Any dust or slurry generated during sawing shall be immediately removed during the sawing operation.

2. Construction joints shall be installed at locations and spacing shown in the Contract Documents and whenever concrete placement is suspended for a sufficient length of time that concrete may begin to harden.

3. Expansion joints shall be installed when pervious concrete will abut existing concrete slabs or other structures such as walls, footings, columns, catch basins, stairs, light poles, and other points of restraint.

4. To reduce raveling at joints, or where pervious concrete meets impervious pavement, finishing may be necessary in accordance with Section L, Item 4 of this specification.

(O) TESTING

Testing responsibilities will be performed by the testing agency at the Contractor's expense. Concrete materials and operations may also be tested and inspected by the owner as work progresses. Use of testing services will not relieve Contractor of the responsibility to furnish materials and construction in full compliance with the Contract Documents. Failure to detect defective work or materials early will not prevent rejection if a defect is discovered later nor shall it obligate the Engineer for final acceptance at any time.

1. **Testing Agency:** Agencies that perform testing services on concrete shall be AASHTO accredited per AASHTO R18 and meet the requirements of ASTM C1077. Testing agencies performing the testing shall also have experience in testing pervious concrete and shall be accepted by the Engineer before performing any work. Field tests of concrete shall be made by an individual certified as an NRMCA Certified Pervious

Concrete Technician, who is also an ACI Concrete Field Testing Technician, Grade 1 in accordance with ACI CPI.

2. **Testing Procedure:**
   a. Conduct tests in accordance with ASTM C1688 at the beginning of each pervious concrete placement operation for each batch, or for every 50 cubic yards (maximum), or a minimum of one test for each day's placement, to verify fresh density and void content.
   b. A minimum of seven (7) days following each placement, three (3) cores, six (6) inches in diameter, shall be taken. The cores shall be measured for thickness, void content and unit weight determined using the methods described in section F of this specification Test Panels. Satisfactory test panels will be determined by:
      i. Compacted thickness +3/4", -1/4" of the specified thickness.
      ii. Void Content ± three (3) percent of the design void content.
      iii. Unit weight ± five (5) pounds per cubic foot of the design unit weight.
   c. If pervious concrete fails to meet the above requirements, the Chief Engineer shall make a determination of acceptance, rejection, or acceptance at a reduced price, per Section 501.15 paragraph (A) of the DDOT Standard Specifications.
3. The infiltration of the pavement surface shall be tested in accordance with ASTM C1701. All applied water shall infiltrate directly without puddle formation or surface runoff, and the testing shall be observed by DDOT. A minimum infiltration rate of 60 inches per hour shall be achieved.
4. Submit all test results to the Chief Engineer.
5. Cores holes shall be filled with standard concrete.

(P) OPENING TO TRAFFIC

Both vehicular traffic and pedestrian traffic shall be excluded from pervious concrete pavement after the placement of curing materials as follows:

- 7 days for pedestrian traffic on sidewalks or pavements
- 14 days for vehicular traffic on alleys
- As determined by Chief Engineer for vehicular traffic on roadways, but not less than 14 days.

(Q) TOLERANCES

Pavement must be mechanically swept and finished before testing for compliance with tolerances. Construct pavement to comply with the tolerances of Section 501.23 of the DDOT Standard Specifications and the following:

- Thicknesses: + 3/4 inch; - 1/4 inch; refer to Section 501.23 of the DDOT Standard Specification for disposition on pavement with average thickness which is less than the thickness by more than 1/8 inch.
- Elevation: + or - 1/2 inch
- Contraction joint depth: +1/4 inch, -0 inch

(R) MEASURE AND PAYMENT

The unit of measure for Pervious Concrete Pavement will be the square yard at the specified thickness. The actual number of square yards, complete in place measured along the surface, will be paid for at the contract unit price per square yard, or adjusted unit price per square yard if required under Section 501.23 of the DDOT Standard Specifications, which payment will be full compensation for furnishing, hauling, and placing all materials, including formwork, concrete work, joints, expansion joint materials, waterproofing, load transfer devices, impervious material, sealing of joints and curing. Payment for will include all costs for furnishing all materials, labor, tools, equipment and incidentals to complete the work.

621.05. POROUS ASPHALT PAVEMENT

(A) DESCRIPTION

This work shall consist of constructing a porous asphalt pavement on a prepared sub-grade in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical sections shown in the contract documents or as directed by the Chief Engineer.

The porous asphalt pavement shall consist of a mixture of aggregates, bituminous binder material including polymer modified asphalt, fibers, mineral filler, anti-strip additives, and other optional additives as may be specified. Except as herein stated, the requirements specified for 401 and 818 are applicable to this specification.

(B) REFERENCES

AASHTO T96 - Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact

AASHTO T209 - Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

AASHTO T275 - Standard Method of Test for Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

AASHTO T283 - Standard Method of Test for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage

ASTM D3203 - Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

ASTM D4791 - Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

ASTM D5821 - Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate

ASTM D6390 - Standard Test Method for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures

ASTM D6752 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

NAPA IS-115 - Open-Graded Asphalt Friction Courses, Design, Construction & Maintenance

NAPA IS-131 - Porous Asphalt Pavements for Stormwater Management

NAPA – National Asphalt Pavement Association

(C) MATERIALS

The materials for porous asphalt pavement shall meet the requirements of DDOT Standard Specification Section 802 and 803, and the following:

1. Performance graded asphalt binder (PGAB) for base and surface course shall meet the requirements of the 2013 DDOT Standard Specifications, Section 802.09.
2. Coarse aggregate shall be that part of the aggregate retained on the No. 8 sieve and shall consist of clean, tough, durable fragments of crushed stone, or crushed gravel of uniform quality. Coarse aggregate shall:
    a. Have a percentage of wear as determined by AASHTO T96 of not more than 30 percent;
    b. Have at least 75% by mass (weight) of the material coarser than the No. 4 sieve with at least two (2) fractured faces, and 90% shall have one or more fractured faces as determined by ASTM D5821;
    c. Have not more than 5% of flat or elongated pieces (>5:1) as specified in ASTM D4791;
    d. Be double-washed, sufficient to remove dust and other coatings; and
    e. Be free from clay balls, organic matter, and other deleterious substances.
3. Additives such as cellulose or mineral filler, or anti-strip additives, shall be included when stipulated in the Contract Documents or as allowed by the Chief Engineer.

(D) COMPOSITION OF THE MIXTURES

The Contractor shall develop for approval a job mix formula for proportioning of each type of porous asphalt pavement proposed for use as specified in the Contract Documents (surface, leveling, base, or other) in accordance with DDOT Standard Specification Section 818 and the following:

1. The recommended percent of bituminous material is 6% minimum based on the total weight of the mix, to assure adequately thick layers of asphalt around the aggregate.
2. Fines in the job mix formula shall have no more than 5% passing the ¼" sieve, and no more than 1% passing the #200 sieve.
3. Retained Tensile Strength (AASHTO T283) shall be > 80 %.
4. Mix design shall result in pavement that accepts 60 inches/hour (30 gallons per hour in a 12 inch diameter ring). Testing shall be in accordance with ASTM D6390.

(E) SUBMITTALS

1. **Contractor Qualifications -** At the time of bid submission, Contractor shall submit the name and qualifications of the porous asphalt installer, providing written evidence of

project experience and proficiency in successfully completing porous asphalt pavement construction including a minimum of three (3) completed projects, total square footage to exceed the project quantities with owner information, addresses of each project, and the following:

(i) Job mix designs used;

(ii) In-Situ pavement test results; and

2. **Testing Agency** – Within 7 days of notice to proceed, Contractor shall furnish the name and location of a third-party QA Inspection Agency with experience in testing porous asphalt, who will oversee and document mix production. Use of testing services will not relieve the contractor of the responsibility to furnish materials and construction in full compliance with the Contract.

3. **Producer Qualifications** – Within seven (7) days after notice to proceed, the Contractor shall furnish the name and location of an asphalt plant that is DDOT certified and will produce and provide porous asphalt.

   a. Job Mix Designs – At least thirty (30) working days before construction, Contractor shall furnish job mix designs for the porous asphalt, which shall include at a minimum all mix design described in this specification.

   b. Material Sources: Submit a list of materials proposed for work under this Section including the name and address of all material sources and all bituminous mixing plants.

   c. Certificates: Submit certificates, signed by the material sources and the relevant subcontractors, stating that the materials meet or exceed the specified requirements.

   d. Samples: Submit samples of all materials and all current test results of the mix for review and approval by the Engineer and test results to the DDOT lab.

4. **Test Results** – Testing agency shall provide pavement test result:

   a. Air void content shall be calculated from the bulk SG and maximum theoretical SG (AASHTO T209) using ASTM D3203. Bulk specific gravity (SG) shall be calculated using AASHTO T275 (paraffin wax) or ASTM D6752 (automatic vacuum sealing).

   b. Test results per Table 1

Table 1 – Certification Requirements

Material*	**Properties to be reported on Certificate****
binder PGAB	Certification
coarse aggregate	gradation, wear, fracture faces (fractured and elongated)
fine aggregate	Gradation
Silicone, when applicable	manufacturer's certification
Fibers, when applicable	manufacturer's certification
Mineral filler, when applicable	manufacturer's certification

* Samples of each material shall be submitted to the Chief Engineer. Samples must be in sufficient quantity to perform tests for each material per Section 106 of the DDOT Standard Specifications.

** At a minimum; more material properties may be required per Contract Documents.

(F) WEATHER AND SEASONAL RESTRICTIONS

Comply with Section 401.04 and the following:

1. The ambient air temperature during the past 24 hours shall be above 50°F
2. The asphalt laying temperature should be within 10°F of the compactive temperature in the approved job mix design.

(G) HAULING OF ASPHALTIC MATERIALS

1. The asphalt shall be transported in clean vehicles with tight, smooth dump beds that have been sprayed with a non-petroleum release agent or soap solution to prevent the mixture from adhering to the dump beds. Mineral filler, fine aggregate, slag dust, and similar materials shall not be used to dust truck beds.
2. The open graded mix shall be covered during transport to protect the mix from weather and to minimize mix cooling and prevent lumps. Long hauls, particularly those in excess of 25 miles may result in separation of the mix and its rejection, and are not recommended.

(H) PREPARATION OF GRADE

1. **Sub-Grade Preparation** – Shall be in accordance with the specification “Aggregates for Stormwater Management”.

2. **Base Materials –** Shall be in accordance with the specification "Aggregates for Stormwater Management".

(I) SPREADING AND FINISHING

1. **Pre-Placement Conference** - A mandatory pre-placement conference will take place at least seven (7) days prior to installation of work and shall include at a minimum engineer, inspector, superintendent, asphalt installer, and QA inspector.
2. Contact surfaces such as curbing, gutters, and manholes shall be painted with a thin, uniform coat of Type RS-1 emulsified asphalt immediately before the asphalt mixture is placed against them.
3. Place the asphalt using self-propelled paving equipment meeting Section 904, with an activated screed or strike-off assembly capable of being heated if necessary, and capable of spreading and finishing the mixture without segregation. Track pavers are recommended.
4. The use of water to cool the pavement is prohibited.
5. Place lifts no more than 24 hours after each previous lift to minimize the use of tack coats. Tack coats will only be allowed if required by the Contract Documents or approved by the Engineer.
6. The finished surface shall be of a uniform texture and evenness, and shall not show any indication of tearing, shoving, or pulling of the pavement during placement.

(J) COMPACTION OF POROUS ASPHALT

1. Roll the asphalt using a two-axle tandem roller when it is cool enough to withstand the roller without displacement of the asphalt, and using rollers sufficient to compact the asphalt without crushing the aggregate or compromising the required void content and infiltration rates.
2. The number, mass (weight), and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. Generally one breakdown roller will be needed for each paver used in the spreading operation.
   a) Breakdown rolling shall occur when the mix temperature is between 275 and 325°F.
   b) Intermediate rolling shall occur when the mix temperature is between 200 and 275°F.
   c) Finish rolling shall occur when the mix temperature is between 150 and 200°F.
3. Unless otherwise specified, the longitudinal joints shall be rolled first. Next, the Contractor shall begin rolling at the low side of the pavement and shall proceed toward the center or high side with lapped rolling parallel to the centerline.
4. Roll until all roller marks are gone however avoid excessive rolling which could reduce the infiltration capabilities of the asphalt.

5. To prevent adhesion of the mixture to the rolls, rolls shall be kept moist with clean water or water mixed with very small quantities of detergent or other approved materials. Excess liquid will not be permitted.
6. Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hot or lightly oiled hand tampers, smoothing irons or with mechanical tampers. On depressed areas, either a trench roller or cleated compression strips may be used under the roller to transmit compression to the depressed area.
7. Rollers will not be stopped or parked on the freshly placed mixture; Foot-traffic shall not be allowed on fresh asphalt for at least 24-hours.
8. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture. The mixture shall be compacted to conform to the surrounding area with segregation. Any area showing deficiencies shall be replaced at the Contractor's expense.

(K) JOINTS

1. Joints between old and new pavements or between successive days work shall be made to ensure a thorough and continuous bond between the old and new mixtures. Whenever the spreading process is interrupted long enough for the mixture to attain its initial stability, the paver shall be removed from the mat and a joint constructed.
2. Butt joints shall be formed by cutting the pavement in a vertical plane at right angles to the centerline, at locations approved by the Engineer. The Engineer will determine locations by using a straightedge at least 16 feet long. The butt joint shall be thoroughly coated with Type RS-1 emulsified asphalt just prior to depositing the pavement mixture when paving resumes.
3. Tapered joints shall not be allowed. Longitudinal joints that have become cold shall be coated with Type RS-1 emulsified asphalt before the adjacent mat is placed. If directed by the Engineer, joints shall be cut back to a clean vertical edge prior to applying the Type RS-1 emulsified asphalt.

(L) PAVEMENT SAMPLES

The Contractor shall cut 4" minimum diameter core samples for air voids and thickness plus box samples from the compacted pavement for testing within 24 hours of placement. Samples of the mixture shall be taken for the full depth of the pavement every 200 tons of placement or 1 sample per day, whichever is greater, or as directed by the Engineer.

(M) TESTING

1. **Quality Assurance (QA) Inspector**

a. The Contractor shall provide at the Contractors' sole expense and the Engineer's approval a third-party QA Inspector to oversee and document mix production. All mix testing results during production shall be submitted to the QA Inspector.

b. The QC plan may be altered at the discretion of the Engineer and based on written recommendations from the QA Inspector.

c. For small batch production, the Engineer may also modify or eliminate some testing requirements in the QC plan.

2. **During Production**

a. The Contractor shall sample, test and evaluate the mix in accordance with the methods and minimum frequencies in the Table 2. Test results shall be delivered to the Chief Engineer.

Table 2: QC/QA testing requirements during production

Test	Minimum Frequency	Test Method
Temperature in Trucks Prior to leaving Plant	Six times per day	--
Gradation	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	AASHTO T30
Binder Content	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	AASHTO T164
Air Void Content	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	ASTM D6752

b. Testing of the temperature, binder content, and air void content shall be within the limits set by this specification.

c. Testing of the gradation shall not vary from the approved design mix by more than the tolerances in Table 3.

Table 3: QC/QA testing tolerances during production

Sieve Size	Percent Passing
0.75	---
0.50	$\pm$ 6.0
0.375	$\pm$ 6.0
No. 4	$\pm$ 5.0

No. 8	± 4.0
No. 200	± 2.0
% PGAB	+ 0.4, - 0.2

d. Should the asphalt fail to meet all testing requirements initially, production modifications shall be made until the porous asphalt mix is within required tolerances. After the corrective action has been taken the resulting mix will be sampled and tested again at the Contractor's expense.

e. If the re-sampled asphalt fails to meet all testing requirements again, the Engineer will be immediately informed and provided with the test results. The Engineer may determine that it is in the best interest of project that production is ceased at that time. The Contractor will be responsible for all costs associated with the inability of the asphalt plant to meet all testing requirements.

3. **Following Placement**

a. The full permeability of the pavement surface shall be tested prior to final acceptance in accordance with ASTM D6390.

b. Test in-place base and surface course for compliance with requirements for thickness, void content and unit weight as described above by using 1' x 1' slab samples. Repair or remove and replace unacceptable work as directed by the Engineer at the Contractor's cost.

c. Surface Smoothness: Test finished surface for smoothness using a 10 foot straightedge applied parallel with and at right angles to the centerline of the paved area. Surface will not be accepted if gaps or ridges exceed 3/16 of an inch. The smoothness requirements specified herein apply only to the top lift of each layer, when asphalt is constructed in more than one lift.

d. QC/QA requirements during paving are summarized in Table 4.

Table 4. QC/QA requirements during paving.

Activity Schedule	Frequency	Tolerance
Inspect truck beds for pooling (draindown)	every truck	NA
Take surface temp. behind joint heater	each pull	6°C (10°F) of compaction temp
Test surface smoothness & positive drainage with a 10 ft straight edge	After compaction	4.5 mm (3/16")

Hose test with at least 5 gpm water	after compaction	immediate infiltration, no puddling

(N) PROTECTION OF ASPHALTIC PAVEMENT

Minimum times prior to opening pavement to traffic are as follows:

- After pavement has been permitted to cool to below 100 °F for all traffic, and;
- 24 hours for pedestrian traffic, and;
- 48 hours for vehicular traffic.

The Contractor shall protect the porous asphalt from severe weather conditions and contamination by dust, dirt, mud or other fine grained material or sediment. The asphalt shall be protected by an approved method from the time of placement until final acceptance of the project. Any damage to the porous asphalt caused by the contractor's equipment shall be repaired by the contractor at no cost to the owner. Any portion of the porous asphalt that becomes contaminated to the extent that drainage is reduced or inhibited shall be removed and replaced at no expense to the owner.

(O) MEASURE AND PAYMENT

The unit of measure for Porous Asphalt Pavement will be tons. The number of tons will be the actual number of tons complete in place, as weighed on approved truck scales. The Chief Engineer will deduct the weight of all material lost, wasted, damaged, rejected or applied in excess of the Engineer's direction or contrary to these specifications. The number of tons of Porous Asphalt Pavement type specified, as measured, will be paid at the contract unit price per ton, which payment will be full compensation for furnishing, hauling, and placing all materials and for furnishing all equipment, tools, labor and incidentals necessary to complete the work as specified herein.

621.06. PERMEABLE UNIT PAVER PAVEMENT

(A) DESCRIPTION

This work shall consist of constructing permeable unit pavers on a prepared sub-grade in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical sections shown in the contract documents or as directed by the Chief Engineer.

The permeable unit pavers shall consist of a combination of unit pavers and aggregate for the joints and bedding layer, to form an integrated, structural wearing surface when compacted.

(B) REFERENCES

ASTM C67 – Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile

ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

ASTM C150 – Standard Specification for Portland Cement

ASTM C418 - Standard Test Method for Abrasion Resistance of Concrete by Sandblasting

ASTM C595 - Standard Specification for Blended Hydraulic Cements

ASTM C936 – Solid Concrete Interlocking Paving Units

ASTM C979 – Standard Specification for Pigments for Integrally Colored Concrete

(C) MATERIALS

Materials shall be approved in accordance with Section 106 requirements, and as described below.

1. All unit pavers shall meet surface requirements of the latest Americans with Disabilities Act (ADA) requirements and accessibility guidelines.
2. Unit pavers shall be of the type, style, color, and other details as described in the Contract Documents and in accordance with all manufacturer's recommendations for the selected unit paver system.
    a. Shapes: rectangular, L-shaped, hexagonal, square as specified in design plans
    b. Thickness: 3 1/8 in. for vehicular use, 2 3/8 in. for pedestrian use.
    c. Colors will match surrounding conditions as specified in design plans: Light gray, brick
    d. **Concrete Unit Pavers**: The material and fabrication for the unit pavers shall meet or exceed the requirements of ASTM C936 "Solid Concrete Interlocking Paving

Units" and must allow a minimum infiltration rate of 60 in/hr through the pavement upon installation.

i. Portland cement: ASTM C150, Type 1.

ii. Aggregate: Normal weight ASTM C33.

iii. Pigments: ASTM C979 and as specified in the Contract Documents.

iv. Other constituents: Previously established by test or experience as suitable for use in concrete, in compliance with applicable ASTM standards or as otherwise approved by the Engineer

v. Paver physical properties:

(a) Provide only sound units free of defects that would allow proper placing of units to achieve the specified pavement strength and performance.

(b) Compressive strength: ASTM C140, when delivered to the project site, average compressive strength of not less than 8,000 psi, with no individual unit less than 7,200 psi.

(c) Absorption: ASTM C140, average absorption not greater than 5%, with no individual unit greater than 7%.

(d) Resistance to freezing and thawing: ASTM C67, with no breakage and not greater than 1% loss in dry mass of any individual unit after 50 cycles of freezing and thawing.

(e) Abrasion resistance: ASTM C418, maximum volume loss of 0.915 cubic inches / 7.75 sq. in. Average thickness loss of no more than 0.118" (3 mm) due to abrasion testing.

(f) Dimension tolerances: Length +/- 1/16", Height +/- 1/8"

e. **Other Material Unit Pavers**: Clay, brick, or other alternate materials shall be utilized as called for in the Contract Documents and shall meet physical properties described above in 2.d., unless otherwise specified in Contract Documents.

3. **Bedding and Joints**: AASHTO #8 aggregate or similar, as directed by the Contract Documents and in accordance with DDOT Specification for Aggregates for Stormwater Management.

(D) SUBMITTALS

Contractor shall submit drawings and documentation as required in this specification and obtain written acceptance of submittals before using the materials or methods requiring approval.

1. **Contractor Qualifications** – At the time of bid submission, Contractor shall:

a. Submit the name and qualifications of the installer, providing written evidence of project experience and proficiency in successfully completing permeable unit paver

construction including a minimum of three (3) completed projects, total square footage to exceed the project quantities with owner information, address and a sample of the product used, or photographs thereof, and the following: complete description of the product type and style; and details of the manufacturer's mold assembly with patterns, dimensions, all edge details and radii, spacer bars, and the mold head or shoe; and

b. Submit written evidence of an Installer who will be onsite at all times during the unit paver installation, with a current certificate from the Interlocking Concrete Pavement Institute (ICPI) Installer Certification Program and a record of completion from the Permeable Interlocking Concrete Pavers (PICP) Specialist Course, or

c. Submit written evidence that the Contractor will obtain the service of a consultant who has the required certifications and who will be on site at all times during the unit paver installation, acting as the installer for the project.

2. **Testing Agency** – Within seven (7) days after notice to proceed, the Contractor shall submit the name and location of a third party QA testing agency with experience in testing permeable interlocking unit pavements, who will oversee and document production and assembly. Use of testing services will not relieve contractor of the responsibility to furnish materials and construction in full compliance with the Contract Documents.

3. **Producer Qualifications** – Within seven (7) days after notice to proceed, the Contractor shall furnish the name and location of the plant that will produce the unit pavers.

   a. Product Information: The plant shall provide product information including all material sources and all manufacturers' recommendations that are relevant to the project.

   b. Certifications: The plant shall provide current certifications, signed by the material sources as relevant, stating that the materials will meet or exceed all specified requirements.

   c. Samples: The plant shall provide three (3) samples of unit pavers.

4. **Test Panels –** At least fifteen (15) days before construction of permeable interlocking unit pavers, and following the engineer's acceptance of the qualifications described above, the Contractor shall provide a minimum of one (1) test panel for acceptance. Place, joint and cure the test panel, to be a minimum of 275 square feet in size or as specified in the Contract Documents, at the required project thickness to demonstrate to the engineer's satisfaction that the unit pavers and design flow rates are acceptable, and that a satisfactory pavement can be installed at the site location. Testing shall be in accordance with Section (G).

5. **Test Reports** - Submit test reports certifying compliance with all material and physical requirements stated herein. All tests shall have been conducted not more than twelve (12) months before manufacturing of the unit pavers.

(E) PREPARATION OF GRADE

1. **Sub-Grade Preparation** – Shall be in accordance with DDOT Specification for Aggregates for Stormwater Management.
2. **Base Materials** – Shall be in accordance with DDOT Specification for Aggregates for Stormwater Management.
3. **Edge Restraints** - Install all edge restraints of the types, locations and dimensions shown on the Contract Documents and at the lines and grades required. Permeable pavement shall not be allowed without edge restraints around the entire perimeter without the written approval of the Engineer.
4. **Protection** - Shall be in accordance with DDOT Specification for Aggregates for Stormwater Management.

(F) INSTALLATION

1. Pre-Placement Conference - A mandatory pre-installation conference will take place at least two (2) weeks prior to installation of the unit pavers and shall include at a minimum engineer, inspector, general contractor, permeable unit paver installer, manufacturer, and field testing agency.
2. Install base materials in accordance with the DDOT Specification for Aggregates for Stormwater Management.
3. Moisten, spread and screed aggregate bedding material and fill any voids left by screed rails. Do not roll or compact the bedding material prior to placing unit pavers.
4. Lay the unit pavers in the type, style, pattern, dimensions, and locations with joint widths as recommended by the Manufacturer and shown on the Contract Documents. Maintain consistent and uniform patterns for the entire pavement area.
5. Fill gaps at the edges of the paved area with cut units. Cut pavers subject to vehicular traffic shall be no smaller than 1/3 of a whole unit and shall have no sharp edges. Patterns shall be maintained to the extent possible in placing cut units to fill gaps in the pattern. Stagger blocks to avoid running bond or other straight joints or seams in the pattern.
6. Fill the openings and joints with washed ASTM No. 8 aggregate. Some paver joint widths may be too narrow to accept most No. 8 stone. In such case, use joint material that will fill joints such as washed ASTM No. 89 or No. 9 stone. Sweep excess aggregate from the surface.

7. Compact and seat the unit pavers into the bedding material using a low amplitude, 75-90 Hz plate compactor capable of at least 5,000 lbf centrifugal compaction force. This will require at least two (2) passes with the plate compactor over the entire surface.
8. Apply additional ASTM #8, #9 or #89 aggregate to the openings and joints as needed, filling them in completely, then remove excess aggregate by sweeping, and make at least two (2) more passes with the plate compactor over the entire surface.
9. All unit pavers within six (6) feet of the laying face must be fully compacted at the completion of each day's work.

(G) TESTING

Testing responsibilities will be performed by the Contractor's testing agency or the Manufacturer at the Contractor's expense, as described below. Materials approval testing will be performed by DDOT. Failure to detect defective work or materials early will not prevent rejection if a defect is discovered nor shall it obligate the owner for final acceptance at any time.

1. **Manufacturer's Testing** – Testing of the materials to demonstrate compliance with the requirements of Section (C) of this specification shall be the combined responsibility of the Contractor and the manufacturer. Test results shall be approved by the Engineer in advance of the construction work.
2. **Smoothness Testing** - Test finished unit paver system with a 10 foot straightedge, applied parallel with and at right angles to the center line of the paved area. Correct deviations in the surface in excess of one-half (1/2) inch by removing the unit pavers as necessary and then loosening, adding or removing material, re-shaping, watering, and re-compacting. The smoothness requirements specified herein apply only to the top lift of each layer, when base course is constructed in more than one lift.
3. **Infiltration Testing** - The full permeability of the pavement surface shall be tested prior to final acceptance by application of clean water at least 5 gallons per minute, using a hose or other distribution device. Water used for the test shall be clean, free of suspended solids and deleterious liquids. All applied water shall infiltrate directly without large puddle formation or surface runoff, and the testing shall be observed by the Engineer. A minimum flow rate of 60 inches per hour is required.

(H) PROTECTION

1. As construction is completed, maintain and protect the permeable pavement. Correct deficiencies in thickness, composition, construction, and smoothness, which develop during the maintenance, to conform to the requirements specified herein.
2. Finishing along the edges of the permeable pavement for protection during construction shall be until the site is fully stabilized, at which time excess filter fabric and impermeable liners can be cut back to the pavement edges.

3. In addition, runoff onto permeable pavement shall be minimized until the site is fully stabilized as described in the Contract Documents. Diversion ditches or other approved types of erosion and sediment control measures shall be placed at the toe of slopes which are adjacent to permeable pavement, to prevent sediment from washing into pavement areas at all times during and after construction. Any sediment accumulation onto the permeable pavement shall be removed immediately by cleaning or replacement of the aggregate by the Contractor at no cost to the owner.

(I) MEASURE AND PAYMENT

The unit of measure for Permeable Unit Paver Pavement will be in square yards for the type(s) specified in the Contract Documents. The actual number of square yards complete in place will be paid for at the contract unit price per square yard, or adjusted unit price per square yard, which payment includes unit pavers, bedding material, and joint filler, complete and in place. Payment will include costs for furnishing all materials, labor, tools, equipment and incidentals to complete the work.

621.07. POROUS FLEXIBLE PAVEMENT

(A) DESCRIPTION

This work shall consist of furnishing and placing the items specified to construct porous flexible pavement, as shown in the contract documents, or as directed by the Engineer. Except as herein stated, the requirements specified in the Standard Specifications are applicable to this specification.

(B) REFERENCES

ASTM C 33 - Standard Specification for Concrete Aggregates

ASTM D3385 - Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer

AASHTO T-180 - Standard Method of Test for Moisture-Density Relations of Soils

(C) MATERIALS

All materials shall meet the requirements set forth in the Standard Specifications or modified in the contract documents.

1. SUBBASE
   a. Base aggregates shall be #57 coarse aggregate (3/4” to 1 1/2”) with no fines and shall meet the durability requirements of ASTM C 33.

2. POROUS FLEXIBLE PAVEMENT
   a. Bonding: Have the capacity to bind with: wood; steel; concrete; aluminum; compacted aggregate; enamel tile, or; fiberglass.
   b. Resistance to degradation: Resistant to: chlorine; ozone; bromine; muriatic acid; salt water; oil; transmission oil, and; hydraulic oil.
   c. Aggregate: Triple-washed coarse chipped granite aggregate (3/8 to 1/2 inch) per ASTM C 33.
      i. Nominal maximum aggregate size shall not exceed 1/3 of the specified paving thickness.
   d. Rubber: Recycled passenger tires ground to 3/8” nominal with the wire remnants removed. Colorizing performed at the factory as tested and certified by Manufacturer.
   e. Binding agent: urethane liquid prepolymer based upon Diphenylmethane-Diisocyanate as tested and certified by the Porous Flexible Pavement Manufacturer.
   f. Air Entraining Agents: Prohibited.

g. Mix Design: Using materials acceptable to the Manufacturer design a tentative mix and test for the consistency intended for use on the work and specified.

i. The volume by weight of aggregate per cu. yd. shall be 50% of the total dry mix.

ii. The volume by weight of the rubber product per cu. yd. shall be 50% of the total dry mix.

iii. Permeability: Pervious infiltration rate of 2,000 gallons/square foot/hour.

h. Color: As specified in Contract Documents.

3. ROOT BARRIER FABRIC: material that is used to prevent infiltration of plant and tree roots into porous flexible pavement.

(D) SUBMITTALS

1. Manufacturer Qualifications - Within seven (7) days after notice to proceed, the Contractor shall furnish the name and location of the manufacturer, and:

a. Submit a list of materials proposed for work under this Section including the name and address of all material sources and all bituminous mixing plants.

b. Submit certificates, signed by the material sources and the relevant subcontractors, stating that the materials meet or exceed the specified requirements.

2. Installer Qualifications

a. Porous Flexible Pavement installer shall be currently certified by the Manufacturer and have successfully installed a minimum of 10,000 square feet.

b. Porous Flexible Pavement installer shall employ no less than two Manufacturer-certified Porous Flexible Pavement technicians on staff who directly oversee and perform the installations during all Porous Rubber Pavement placement, unless otherwise specified.

c. Installer must provide a list of successful Porous Flexible Pavement projects, including the address, square footage and photographs for each project. Manufacturer’s certifications must be presented.

3. Proposed Mix Design

4. Samples for Verification: Provide two 6” diameter samples, in specified color, full thickness

5. Root barrier fabric manufacturer and properties

(E) CONSTRUCTION REQUIREMENTS

1. PROJECT SITE CONDITIONS

a. Minimize exposure to wind and heat before curing materials are applied.

b. Avoid placing if rain, snow, or frost is forecast within 24 hours unless measures are taken as described later. Always protect fresh paving from moisture and freezing.

2. SUBGRADE PREPARATION

   a. Prepare subgrade as specified in the contract documents.

   b. Construct subgrade to ensure that the required paving thickness is obtained in all locations.

   c. Keep all traffic off of the subgrade during construction to the maximum extent practical. Regrade subgrade disturbed by delivery vehicles or other construction traffic, as needed.

   d. Compact the material added to obtain final subgrade elevation.

   e. Determine subgrade permeability in accordance with ASTM D3385 before porous paving placement. Confirm that subgrade permeability meets requirements of Contract Documents.

3. SUBBASE

   a. Prepare subbase in accordance with contract documents, with 95% compaction per AASHTO T-180, installed over a Type 1 Geotextile.

   b. Install root barrier fabric where called for on Contract Documents.

4. SETTING FORMWORK

   a. Set, align, and brace forms so that the hardened paving meets the tolerances specified herein. Forms shall be clean and free of debris of any kind, rust, and hardened concrete.

   b. Apply form release agent, either bio-diesel or vegetable oil coating to the form face which will be in contact with porous paving, immediately before placing paving.

   c. The vertical face of previously placed concrete may be used as a form.

      1. Protect previously placed paving from damage.

      2. Do not apply form release agent to previously placed concrete.

      3. Apply bonding agent to face of surfaces when adhesion is desired.

5. BATCHING, MIXING, AND DELIVERY

   a. Batch and mix on site in compliance with Manufacturer’s written specifications, except that discharge shall be completed within 5 minutes of the introduction of urethane to the dry products.

6. PLACING AND FINISHING PAVING

   a. Do not place porous paving on frozen or wet subgrade or subbase.

   b. Deposit porous paving either directly onto the subgrade or subbase by wheelbarrow or by material handler onto the subgrade or subbase, unless otherwise specified.

   c. Porous paving has a thickness of 2”, over Clean Coarse Aggregate (#57 stone) with 95% compaction per AASHTO T-180, with a minimum thickness of 4 inches or over other approved types of structural soil, over stabilized sub-base.

d. Deposit porous paving between the forms to an approximately uniform height.

e. Spread the porous paving using a come-along, short-handle, square-ended shovel or rake.

f. Use steel trowels to finish to the elevations and thickness specified in Contract Documents.

7. FINAL SURFACE TEXTURE

a. Final surface of porous paving shall be smoothed with bull float and magnesium trowels.

8. EDGING

a. When forms are not used, bevel the edge of the top surface to a 45° slope.

9. CURING

a. Begin curing within 20 minutes of paving discharge, unless longer working time is accepted by the Manufacturer.

b. Completely cover the paving surface with a minimum 4 mil thick polyethylene sheet only if rain or sprinklers are imminent within 20 minutes. Cut sheeting to a minimum of a full placement width.

1. Cover all exposed edges of paving with polyethylene sheet.

2. Secure curing cover material without using dirt.

c. Cure paving for a minimum of 24 uninterrupted hours, unless otherwise specified.

10. HOT AND COLD-WEATHER CONSTRUCTION

a. In cold weather when temperatures may fall below freezing just after an installation, utilize a fan to maintain airflow over porous paving during the curing process.

b. Porous flexible pavement may be installed in warm weather with temperatures up to 95 degrees Fahrenheit without any special procedures.

c. Do not open the paving to light vehicular or pedestrian traffic until the porous flexible pavement has cured for at least 24 hours during warm weather, and 48 hours during very cold temperatures at or near freezing.

(F) MEASURE AND PAYMENT

The unit of measure for porous flexible pavement will be the square yard. Payment for porous flexible pavement will be made at the Contract unit price per square yard which will include, backfill, compaction, porous flexible pavement, root barrier fabric and all labor, materials, tools, equipment and incidentals needed to complete work specified.

Geotextile and aggregate subbase will be measured and paid for separately.

621.08. POROUS GRASS PAVEMENT

(A) DESCRIPTION

The work consists of furnishing and installing porous grass pavement in accordance with the lines, grades, design and dimensions shown on the Contract Drawings and as specified herein. The porous grass pavement includes grass pavement rings, turf conditioner, and concrete sand. Except as herein stated, the requirements specified for DDOT Standard Specifications 609 are applicable to this specification.

(B) MATERIALS

1. POROUS GRASS PAVEMENT UNITS:
    a. High density polyethylene (HDPE)
    b. Color: black
    c. Color Uniformity: Uniform color throughout all units rolls.
    d. Ultraviolet light stable.
    e. Required Loading Capability: 4000 psi (when filled with sand)
    f. Wheelchair Access testing for ADA Compliance: Passing ASTM F 1951-08.
    g. Wheelchair Access testing for ADA Compliance: Passing Rotational Penetrometer testing.
    h. Tensile strength, pull-apart testing: Minimum 400 lbf/in per ASTM D638 Modified.
    i. System Permeability: Minimum 2.5 inches of water per hour.
2. TURF CONDITIONER: A natural humate-based soil additive which absorbs water and dissolved nutrients. Ingredients should include gypsum, sulfur, and oxidized lignate carbonaceous shale. Provide as recommended by and supplied by manufacturer.
3. SAND: coarse, well-draining sand (washed concrete sand- AASHTO M6 or ASTM C-33), as required by the manufacturer of the porous grass pavement system.
4. AGGREGATE SUBBASE: A free draining material of double-washed No. 57 stone meeting the gradation requirements of "Bioretention Storage/Drainage Layer" per section (C) of the DDOT Specification for "Aggregates for Stormwater Management".
5. AGGREGATE BASE:
    a. A free-draining sand and gravel borrow material meeting the gradation requirements of "Choker Course for Bioretention" per section (C) 3 of the DDOT Specification for "Aggregates for Stormwater Management".
    b. pH range from 6.5 to 7.2 to provide adequate root zone development for turf.
6. SOD: Per 823.05.

(C) CONSTRUCTION REQUIREMENT

1. Place aggregate subbase course material over prepared subgrade to grades shown on plans, in lifts not to exceed 6", compacting each lift separately to 95% Modified Proctor.
2. Place aggregate base course material over prepared subbase to grades shown on plans, in lifts not to exceed 6", compacting each lift separately to 95% Modified Proctor. Leave minimum 1” to 1.5" for porous grass pavement unit and sand/sod fill to Final Grade.
3. Spread all turf conditioner (spreader rate = 10 lbs per 1076 ft2) evenly over the surface of the base course with a hand-held, or wheeled, rotary spreader. The mix should be placed immediately before installing the porous grass pavement units to assure that the polymer does not become wet and expanded when installing the units.
4. Install the porous grass pavement units by placing units with rings facing up, and using pegs and holes provided to maintain proper spacing and interlock the units. Units can be easily shaped with pruning shears or knife. Units placed on curves and slopes shall be anchored to the base course, using 40d Common nails with fender washer, as required to secure units in place. Tops of rings shall be between 0.25" to 0.5" below the surface of adjacent hard-surface pavements.
5. Install sand in rings as they are laid in sections by “back-dumping” directly from a dump truck, or from buckets mounted on tractors, which then exit the site by driving over rings already filled with sand. The sand is then spread laterally from the pile using flat bottomed shovels and/or wide “asphalt rakes” to fill the rings. A stiff bristled broom should be used for final “finishing” of the sand. The sand must be “compacted” by using water from hose, irrigation heads, or rainfall, with the finish grade no less than the top of rings and no more than 0.25” above top of rings.
6. Install thin sod directly over sand filled rings, filled no higher than the top of the rings. Sod strips should be placed with very tight joints. Sodded areas must be fertilized and kept moist during root establishment (minimum of 3 weeks). Sodded areas must be protected from any traffic, other than emergency vehicles, for a period of 3 to 4 weeks, or until the root system has penetrated and established well below the porous grass pavement units.
7. Remove and replace segments of porous grass pavement units where three or more adjacent rings are broken or damaged, reinstalling as specified, so no evidence of replacement is apparent. Perform cleaning during the installation of work and upon completion of the work. Remove all excess materials, debris, and equipment from site. Repair any damage to adjacent materials and surfaces resulting from installation of this work.

(D) MEASURE AND PAYMENT

The unit of measure for Porous Grass Pavement will be square yards. The number will be the actual area installed. Payment will be made at the respective contract unit price per square yard, which payment will include furnishing and placing turf conditioner, porous grass pavement rings, sand filler material, and all labor, tools, equipment and incidentals necessary to complete the work.

Aggregate subbase layer, base layer and sod will be paid for separately.

621.09. BIORETENTION, PLANT BED, LAWN AND SAND BASED STRUCTURAL SOILS

(A) DESCRIPTION

This work consists of supplying, testing, amending, mixing and installing various planting soil categories for use in stormwater management and horticultural plantings, covering the following:

1. Planting Soil shall refer to Bioretention Soil, Plant Bed Soil, Lawn Soil and/or Sand-Based Structural Soil.
2. Bioretention Soil: soil blend for use in stormwater bioretention facilities.
3. Plant Bed Soil: planting medium for trees, shrubs, and groundcovers in Plant Beds
4. Lawn Soil: planting medium for lawn areas
5. Sand Based Structural Soil: soil blend for trees where planting soils are beneath paved surfaces and horticultural subsoil.
6. Compost: a soil amendment to be used with existing soil
7. Sand: for beneath structural soils as required in Contract Documents

Except as herein stated, the requirements specified for DDOT Standard Specifications are applicable to this specification.

(B) MATERIALS

1. GENERAL – Bioretention, Plant Bed, Lawn, and Sand Based Structural Soil Mixtures
   a. Soils mixtures are composed of a blend of three base components: base loam, organic material and sand. The Soil Supplier is responsible for locating and obtaining approval of sources for base loam, organic material and sand that meet the Specification requirements. The Soil Supplier is responsible for mixing the components. Approximate mixing ratios are as specified herein, but may require adjustment, depending on the characteristics of the final base materials.
   b. Base Components
      (i) Base Loam: a natural A-horizon growing medium free from admixtures.
      (ii) Organic Material or Compost: a fully decomposed yard waste organic material.
      (iii) Sand: uniformly-graded medium to coarse sand.
   c. Soil medium materials shall fulfill the requirements as specified and be tested to confirm the specified characteristics.
2. BASE LOAM
   a. Base Loam shall be natural A-horizon topsoil free of subsoil, large stones, earth clods, sticks, stumps, clay lumps, roots or other objectionable, extraneous matter or debris. Base Loam shall also be free of quack-grass rhizomes, Agropyron Repens, and the nut-

like tubers of nutgrass, Cyperus Esculentus, and all other primary noxious weeds. Base Loam shall not be delivered or used for planting while in a frozen or muddy condition. Base Loam for mixing shall conform to the following grain size distribution for material passing the #10 sieve by weight:

	Percent Passing	
U.S. Sieve Size Number	Minimum	Maximum
10	100	---
18	85	100
35	70	95
60	54	85
140	42	68
270	36	60
0.002mm	3	12

b. Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 20% by weight of the total sample. Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422 after burning off organic matter by ignition. The organic content shall be between 3.0 and 6.0 percent by weight. Base Loam shall have a well-developed and stable crumb structure.

c. Unless otherwise recommended by the Soil Supplier's Soil Scientist: Cation Exchange Capacity shall be not less than 12 and Soluble Salts shall be not more than 2,000 ppm/2.0 mmhos/cm.

3. COARSE SAND FOR SOIL MIXTURES

a. Sand for blending, protection layer above filter fabrics, and drainage below planting soils shall be uniformly graded medium to coarse sand consisting of clean, inert, rounded to sub-angular grains of quartz or other durable rock free from loam or clay, surface coatings and deleterious materials, include no more than 0.5% mica, and have the following gradation for material passing the #10 sieve by weight.

	Percent Passing	
U.S. Sieve Size Number	Minimum	Maximum
10	100	--
18	60	80
35	25	45
60	8	20
140	0	8
270	0	3
0.002mm	0	0.5

b. Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample. The ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 3.0 or less (D70/D20 <3.0). Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422 after burning off organic matter by ignition.

c. Coarse sand shall be non-calcite and shall not be derived from serpentine. pH shall be less than 7.5.

4. ORGANIC AMENDMENT (COMPOST)

a. Organic Matter for amending planting soils shall be a stable, humus-like material produced from the aerobic decomposition and curing of leaf and yard waste composted for a minimum of one year (12 months). The leaf and yard waste compost shall be free of debris such as plastics, metal, concrete or other debris. The leaf and yard waste compost shall be free of stones larger than 1/2", larger branches and roots. Wood chips over 1" in length or diameter shall be removed by screening. The compost shall be a dark brown to black color and be capable of supporting plant growth with appropriate management practices in conjunction with addition of fertilizer and other amendments as applicable, with no visible free water or dust, with no unpleasant odor, and meeting the following criteria as reported by laboratory tests.

(i) The ratio of carbon to nitrogen shall be in the range of 12:1 to 25:1.

(ii) Stability shall be assessed by the Solvita procedure. Protocols are specified by the Solvita manual (latest version). The compost must achieve a maturity index of 6 or more as measured by the Solvita scale. Stability tests shall be conducted by a DDOT approved lab.

(iii) Pathogens/Metals/Vector Attraction reduction for compost material derived from biosolids shall meet 40 CFR Part 503 rule, Table 3, page 9392, Vol. 58 No. 32, (for applications to soils with human activity).

(iv) Organic Content shall be at least 20 percent (dry weight). One hundred percent of the material shall pass a 3/8-inch (or smaller) screen. Debris such as metal, glass, plastic, wood (other than residual chips), asphalt or masonry shall not be visible and shall not exceed one percent dry weight. Organic content shall be determined by weight loss on ignition for particles passing a number 10 sieve.

(v) pH: The pH shall be between 6.5 to 7.2 as determined from a 1:1 soil-distilled water suspension using a glass electrode pH meter American Society of Agronomy Methods of Soil Analysis.

(vi) Salinity: Electrical conductivity of a one to five soil to water ratio extract shall not exceed 2.5 mmhos/cm (dS/m).

(vii) The compost shall be screened to 1/2 inch maximum particle size and shall contain no more than 3 percent material finer than 0.002mm as determined by hydrometer test on ashed material.

(viii) Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Aluminum, Magnesium, Iron, Manganese, Lead, Soluble Salts, Cation Exchange Capacity, soil reaction (pH), and buffer pH. The Soil Supplier's Soil Scientist shall provide a recommendation as to the suitability of the compost based on review of the test results.

5. SOIL ADDITIVES

   a. Ground Limestone: dolomitic limestone and contain not less than 50 percent of total carbonates and 25 percent total magnesium with a neutralizing value of at least 100 percent. Material shall be ground to such fineness that 40 percent will pass through the 100 mesh U.S. standard sieve and 98 percent will pass through the 20 mesh U.S. standard sieve.

   b. Acidulant for adjustment of planting soils pH shall be commercial grade sulfur, ferrous sulfate, or aluminum sulfate for horticultural use that are unadulterated. Acidulants shall be delivered in unopened containers with the name of the manufacturer, material, analysis and net weight appearing on each container.

   c. Fertilizer: slow-release granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in a composition as recommended by the Soil Testing Laboratory.

   d. Use of peat moss is prohibited.

6. Sand – for the layer underneath structural soil as called for in the Contract Documents shall meet the gradation requirements of Section (B), Subsection 3 of this provision.

(C) SUBMITTALS AND TESTING

1. Critical Path Processing - Soils Testing Report Submittals.

   The Contractor is responsible for recognizing that these project materials warrant timely and serious attention, that the testing process to achieve approved materials shall be considered a lead time item, and that under no circumstance shall failure to comply with all

specification requirements be an excuse for a delay or for expedient substitution of unacceptable material(s).

2. Sources for Soil Components and Soil Mixes: Within seven (7) days after notice to proceed, submit information identifying sources for soil components and the firm responsible for mixing of soil mixes:

   a. Soil mix supplier shall have a minimum of five years of experience supplying custom planting soil mixes.

   b. Submit supplier name, address, telephone and fax numbers and contact name.

   c. Submit certification that accepted supplier is able to provide sufficient quantities of materials and mixes for the entire project.

3. Testing Agency**:** Within seven (7) days after notice to proceed, Contractor shall furnish the name and location of the proposed testing agency. Agency proposed for testing of horticultural soils shall be an approved member of the Performance Assessment Program (PAP) administered by the North American Proficiency Testing (NAPT) Oversight Committee. The Testing agency shall be accepted by the Chief Engineer.

4. Product Data: No later than 30 days prior to planned soil construction, submit most recent printed information from manufacturer for:

   a. Organic Material: identify the material(s) from of which is it composed and identify the location where material was composted.

   b. Fertilizers

   c. Ground Limestone

   d. Sulfur

5. Samples and Test Reports: Submit representative samples and reports to the Chief Engineer and the Testing Agency as described herein for approval. Delivered materials shall closely match the approved samples.

   a. Submit 1 gallon soil samples and horticultural soil test reports in two phases.

      (i) Planting Soil Base Components:

         - Base Loam
         - Organic Amendment (Compost)
         - Sand

         Submit samples of above to the Testing Agency. Submit soil testing reports to Chief Engineer no later than 21 days prior to planned soil construction.

      (ii) Only after approval of base components, submit soil blend mixes / mediums for approval. Mixing and batching of soil mediums in the same manner as bulk soils will be prepared for delivery to site, and shall include:

         - Bioretention Soil

- Plant Bed Soil
- Lawn Soil
- Sand-Based Structural Soil

Submit samples of above to the Testing Agency. Submit duplicate samples and soil testing reports to Chief Engineer no later than 14 days prior to planned soil construction.

(iii) Samples of each soil type delivered to the site shall taken and tested for conformance with the Specification Requirements. Submit duplicate samples and soil testing reports to Chief Engineer.

b. Soil Sampling: Sampling shall be done by the Soil Supplier. Samples shall be representative of the material to be brought to the site. Each sample shall be a Composite Sample, which consists of 5 separate sub-samples taken from a minimum of (5) different locations at each source and mixed together to make the test sample.

c. Test Reports shall be certified and shall cover the items below. <u>All reports must be from recent analyses, less than 90 days old, and represent materials that are available for delivery to the site.</u>

(i) Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Soil Classification System.

(ii) The silt and clay content shall be determined by a Hydrometer Test of soil passing the #270 sieve. Percent clay (0.002 mm) shall be reported separately in addition to silt (ASTM D-422-63, hydrometer method).

(iii) Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium Magnesium, Aluminum, Manganese, Cation Exchange Capacity, Soluble Salts, acidity (pH) and buffer pH.

Tests shall be conducted in accordance with Recommended Soil Testing Procedures for the Northeastern United States, Current Edition, Northeastern Regional Publication No. 493; Agricultural Experiment Stations of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and West Virginia. Tests include the following:

(a) Test for soil Organic Matter by loss of weight on ignition, as described in Northeastern Regional Publication No. 493.

(b) Test for soil CEC by exchangeable acidity method as described in Northeastern Regional Publication No. 493.

(c) Test for soil Soluble Salts shall be by the 1:2 (v:v) soil:water Extract Method as described in Northeastern Regional Publication No. 493.

(d) Test for Buffer pH by the SMP method as described in Northeastern Regional Publication No. 493.

(e) Certified reports on analyses from producers of composted organic materials are required. Analyses will include all tests for criteria specified herein.

(f) Density Tests: In-place density testing is required in all areas. Placed planting soils must be inspected for compaction level by the soil scientist or by the following: ASTM D1556 Density of Soil and Rock In Place Using Sand Cone Method, ASTM D6398-10 Nuclear Methods or ASTM D2167-08 Rubber Balloon method. AASHTO T-99 (Standard Effort) in accordance with DDOT specifications shall be used for Laboratory Compaction Characteristics of Soil unless otherwise directed.

- Contractor shall perform In-place density tests at a rate of one test per 2,000 square feet for each type of material placed.

(g) Test data and recommendations for soil amendments including but not limited to: nitrogen, phosphorus, potassium and limestone

6. Certificates: No later than 7 days prior to planned soil construction, submit certification that soil blend components and soil mediums meet applicable environmental standards of the District of Columbia.

(D) PROPORTIONING

Soil Supplier shall uniformly mix ingredients on an approved hard surface area or with soil blending equipment. Soils and Organic Amendment shall be maintained moist, not wet, during mixing. Amendments shall not be added unless approved to extent and quantity by the owner and additional tests have been conducted to verify type and quantity of amendment is acceptable. Percentages of components, unless otherwise noted, will be established upon completion of individual test results for components of the various mixes.

After component percentages are determined by the Soil Supplier's Soil Scientist, each planting soil medium shall be tested for physical and chemical analysis.

1. Bioretention Soil

Bioretention Soil shall consist of a blend of approximately 55% by volume Coarse Sand, 20% by volume Base Loam and 25% by volume of Organic Amendment. This blend will comply with the bioretention soil requirement in the District Department of Environment Stormwater Guidebook, in which soil components are given by weight. The components shall be blended to create a uniform mixture that meets the following criteria. Percentages will be adjusted as necessary to achieve the following grain size distribution and criteria below for material passing the #10 sieve by weight:

	Percent Passing		
U.S. Sieve Size Number	Minimum	Maximum	
10	100	-	(Coarse Sand)
18	68	95	(Coarse Sand)
35	38	65	(Coarse Sand)
60	22	37	(Fine Sand)
140	15	22	(Fine Sand)
270	12	14	(Silt)
0.002mm	1	4	(Clay)

a. Maximum size shall be one inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.

b. The ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 4.5 or less (D70/D20 <4.5).

c. The final mix shall have a saturated hydraulic conductivity of not less that 4.0 inches per hour according to test procedure ASTM D5856-95 (2000) when compacted to a minimum of 86 percent of the maximum density as determined by AASHTO T-99. The mix shall be compacted at 60% to 80% optimum moisture content.

d. Organic content shall be between 3.0 and 4.0 percent by weight.

e. Unless otherwise specified or recommended by the Soil Supplier's Soil Scientist: pH shall be between 6.5 and 7.2; CEC shall be a minimum of 7; P-Index shall be between 10 and 30; and Soluble Salts shall be less than 500 ppm/0.5 mmhos/cm.

2. PLANT BED SOIL

Base Loam, Sand and Compost, each as specified above, shall be combined in approximately equal parts by volume Sand, Base Loam and Compost to create a uniform blend which meets the following requirements. Percentages will be adjusted as necessary to achieve the following grain size distribution and criteria below for material passing the #10 sieve by weight:

U.S. Sieve Size Number	Percent Passing Minimum	Maximum	
10	100	-	(Coarse Sand)
18	80	95	(Coarse Sand)
35	56	80	(Coarse Sand)
60	32	56	(Fine Sand)
140	23	32	(Fine Sand)
270	19	23	(Silt)
0.002mm	2.5	8	(Clay)

a. Maximum size shall be one inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.

b. Saturated hydraulic conductivity of the mix: not less than 3 inches per hour according to ASTM D5856-95 (2000) when compacted to a minimum of 84% of the maximum density as determined by AASHTO T99. The mix shall be compacted at 60% to 80% optimum moisture content.

c. Organic content: between 5.0 and 6.5 percent by weight.

d. Unless otherwise specified or recommended by the Soil Supplier's Soil Scientist: pH shall be between 6.5 and 7.2; CEC shall be a minimum of 10; and Soluble Salts shall be less than 2,000 ppm/2.0 mmhos/cm.

3. Lawn Soil

Base Loam, Sand and Compost, each as specified above, shall be combined in an approximate mix ratio of 45% by volume Sand to 30 % by volume Base Loam to 25% by volume Compost to create a uniform blend which meets the following requirements. Percentages will be adjusted as necessary to achieve the following grain size distribution and criteria below for material passing the #10 sieve by weight:

U.S. Sieve Size Number	Percent Passing Minimum	Maximum	
10	100	-	(Coarse Sand)
18	80	95	(Coarse Sand)
35	56	80	(Coarse Sand)
60	30	56	(Fine Sand)
140	18	30	(Fine Sand)
270	15	18	(Silt)
0.002mm	2.5	6	(Clay)

a. Maximum size shall be one inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.

b. The ratio of the particle size for 80% passing (D80) to the particle size for 30% passing (D30) shall be 6.0 or less (D80/D30 <6.0).

c. Saturated hydraulic conductivity of the mix: not less than 4 inches per hour according to ASTM D5856-95 (2000) when compacted to a minimum of 86% of the maximum density as determined by AASHTO T-99. The mix shall be compacted at 60% to 80% optimum moisture content.

d. Organic content: between 4.0 and 5.0 percent by weight. Compost shall be added as necessary to meet minimum organic content requirement.

e. Unless otherwise specified or recommended by the Soil Supplier's Soil Scientist: pH shall be between 6.5 and 7.2; CEC shall be a minimum of 8; and Soluble Salts shall be less than 1,000 ppm/1.0 mmhos/cm

4. SAND-BASED STRUCTURAL SOIL

Sand-Based Structural Soil shall consist of a blend of approximately 60% by volume Coarse Sand, 15% by volume Base Loam and 25% by volume Organic Amendment. The components shall be blended to create a uniform mixture. Percentages will be adjusted as necessary to achieve the following grain size distribution and criteria below for material passing the #10 sieve by weight:

	Percent Passing		
U.S. Sieve Size Number	Minimum	Maximum	
10	100	-	(Coarse Sand)
18	68	90	(Coarse Sand)
35	38	63	(Coarse Sand)
60	18	39	(Fine Sand)
140	10	18	(Fine Sand)
270	8	10	(Silt)
0.002mm	1	4	(Clay)

a. Maximum size shall be one inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.

b. The ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 3.0 or less (D70/D20 <3.0).

c. The final mix shall have a saturated hydraulic conductivity of no less than 6.0 inches per hour according to test procedure ASTM D5856-95 (2000) when compacted to a minimum of 88 percent of the maximum density as determined by AASHTO T-99, unless the soil will be placed in an area that experiences loading. If the soil will be placed under sidewalk, curbs or gutter, the density shall be a minimum of 93 percent maximum dry density as determined by AASHTO T-180. The mixes shall be compacted at 60% to 80% optimum moisture content.

d. Organic content shall be between 2.5 and 3.5 percent by weight.

e. Unless otherwise specified or recommended by the Soil Supplier's Soil Scientist: pH shall be between 6.5 and 7.2; CEC shall be a minimum of 6; and Soluble Salts shall be less than 500 ppm/0.5 mmhos/cm.

(E) PREPARATION AND MIXING OF PLANTING SOIL MIXES

Preparation, amendment, and mixing of the planting soil shall be performed at the Soil Supplier location. The following procedure shall be followed:

1. Soil shall be amended to meet pH requirements and horticultural deficiencies as determined by the Testing Agency.
2. Examine soil and remove foreign materials, stones and organic debris over 1/2” in size.
3. Correct deficiencies in soil as directed by horticultural soil test results. If lime is to be added, it shall be mixed with dry soil before fertilizer is added and mixed.

4. Planting soil mixtures shall be produced with equipment that blends together each component in a thorough and uniform manner.
5. Preparation and mixing shall be accomplished when the soil moisture content is less than field capacity and at a moisture content approved by DDOT and the Soil Scientist.
6. Incorporate pre-plant fertilizer as directed.

(F) DELIVERY, STORAGE AND HANDLING

1. Material shall not be handled or hauled when it is wet or frozen. Soil shall be hauled only when the moisture content is between 60% and 100% of optimum moisture content as determined by AASHTO T-99 for all planting soils except Sand-Based Structural Soil which shall be determined by AASTO T-180. Stockpiles shall be covered during wet weather. The Soil Supplier is responsible for meeting these requirements until the soil is delivered to the site. Soil which is delivered that exceeds the allowable maximum moisture content shall be replaced with new soil that meets the requirements.
2. Contractor shall store and handle packaged materials in strict compliance with manufacturer's instructions and recommendations. Protect all materials from weather, damage, injury and theft.

(G)PRE-INSTALLATION EXAMINATION AND PREPARATION

1. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.
2. Pre-Installation Examination Required: The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify DDOT in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means Contractor accepts substrates, previous work, and conditions. The Contractor shall not place any planting soil until all work in adjacent areas is complete and approved by DDOT and the Soil Scientist.
3. Examination of Conditions: Prior to the start of soil placement existing conditions shall be reviewed. Any deficiencies shall be noted and related to DDOT in writing prior to acceptance of the subgrade by the Landscape Contractor. Deficiencies include, but shall not be limited to the following:
   a. Construction debris present within the planting areas.
   b. The subgrade is at incorrect depths for installing the designed soil profile and/or drainage layer.
   c. Incomplete irrigation and/or subsurface drainage installation.

(H)SUBGRADE PREPARATION

1. Coordinate the following scarification work to eliminate subgrade compaction resultant from Construction Operations when located in lawn and planting areas.

a. General Site Subgrade Compaction Mitigation for all planting areas that are not heavily compacted:

(i) Immediately prior to placing any Planting Soil or any drainage materials beneath planting soils, the entire subgrade shall be loosened to a minimum depth of 3-inches using the teeth of a backhoe or other suitable equipment.

(ii) After the subgrade soils have been loosened, re-compressed and inspected, remove any stones or debris 6" or greater and dispose off of the project site. Do not bury large stones or debris.

(I) PREPARATION OF SOILS

The contractor or soil supplier shall not work soil when the moisture content is less than 60% nor more than 100% of optimum moisture content as determined by AASHTO T-99 for all planting soils except Sand-Based Structural Soil which shall be determined by AASTO T-180 or when it is frozen. Apply water, if necessary, or dry the soil to bring soil within the acceptable moisture content range.

(J) PLACEMENT OF DRAINAGE MATERIALS AND SOIL LAYERS

1. Preparation for Placement of Planting Soils
   a. Notify DDOT of soil placement operations at least seven calendar days prior to the beginning of work.
   b. Prevent compacting soils by beginning work in corner, against walls, or the center of isolated beds, and progressing outwards towards borders.
   c. Never move or work Planting Soils when wet or frozen.
   d. Place barricades as required to prevent compaction of planting soil from vehicles, equipment, or pedestrian traffic.
2. In accordance with the Contract Document and Detail Drawings, proceed with placement of base materials as follows:
   a. Where geosynthetics are required per the contract plans, place geosynthetic layers in accordance with DDOT approved specification for Geosynthetics for Stormwater Management.
   b. Where subsurface storage is required, place sand or stone layer as shown on the drawings in accordance with DDOT approved specification for Aggregates for Stormwater Management.
   c. Where subsurface drainage is required, install in accordance with DDOT specifications.
3. General Placement Requirements
   a. No rubber-tired equipment or heavy equipment except for a small bulldozer shall pass over the subsoils (subgrade) after they have been loosened and recompressed. If the

Contractor plans to utilize such areas for any use of heavy equipment, this work should be carried out prior to beginning the process of loosening soils or filling in that area.

b. Place and spread Planting Soils in layers as specified to a thickness greater than required such that after settlement,

c. The surface area of each lift, including the subgrade after it has been compacted, shall be scarified by raking immediately prior to placing the next lift.

d. Place and spread topmost layers of planting medium to the thickness such that, after settlement, finished grades conform to the lines, grades and elevations shown on the Drawings. Ensure proper drainage in an uninterrupted pattern free of hollows and pockets.

e. All planting soils shall be placed at a moisture content between 60% and 100% of optimum moisture content as determined by AASHTO T-99 for all planting soils except Sand-Based Structural Soil which shall be determined by AASTO T-180.

4. Place Bioretention Soil as follows:

a. Bioswales: Place and spread in lifts not greater than twelve inches and compact each layer to a density of 85% plus or minus 2% of maximum density as determined by AASHTO T-99.

b. Other Bioretention: Place and spread in lifts not greater than twelve inches and compact each layer to a density of 83% plus or minus 2% of maximum density as determined by AASHTO T-99.

5. Place and spread Planting Bed Soil in lifts not greater than twelve inches and compact to a density of 82% plus or minus 2% of maximum density as determined by AASHTO T-99.

6. Place and spread Lawn Soil in lifts not greater than twelve inches and compact to a density of 86% plus or minus 2% of maximum density as determined by AASHTO T-99.

7. Place Sand Based Structural Soil as follows:

a. Beneath Pavements: Spread in lifts not greater than eight inches and compact with a minimum of two passes of vibratory compaction equipment to a density of 93% plus or minus 1% of maximum density as determined by AASHTO T180.

b. As Horticultural Subsoil: Spread in lifts not greater than twelve inches and compact to a density of 85% plus or minus 1% of maximum density as determined by AASHTO T-99.

c. The Contractor shall construct a Mock Up of the initial installation of Sand Based Structural Soil in the presence of DDOT or its representative. The Mock Up may be part of the permanent installation. The Mock Up shall be conducted with the same equipment that will be used for the duration of the Sand Based Structural Soil installation. Mock Up must be conducted with compliant soil moisture conditions. A geotechnical testing agency shall be on site to conduct soil moisture and compaction/density tests for each lift installed during the Mock Up.

(K) PROTECTION

1. Protect newly graded areas from traffic, freezing and erosion. Keep free of trash, debris or construction materials from other work.
2. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or compaction due to subsequent construction operations or weather conditions. Scarify or remove and replace material to a depth as directed by DDOT and the Soil Scientist; reshape and re-compact at optimum moisture content to the required density.
3. Where settling occurs, before final acceptance or during the warranty period, remove finish surfacing, backfill with additional approved soil, compact to specified rates, and restore any disturbed areas to a condition acceptable to the Owner.

(L) COORDINATION AND EXCESS MATERIALS

1. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.
2. Excess Planting Soil Mixtures and Materials: Remove excess planting mediums and materials from the site.

(M) POST-INSTALLATION TESTING

In-place density testing shall be performed by the Contractor at a rate of 1 per 2000 square feet for each type of material placed. The standard test for surface and subsurface density shall be ASTM D 2922-01: Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

(N) MEASURE AND PAYMENT

1. Bioretention Soil, planting bed soil, lawn soil, sand-based structural soil, compost, and sand each will be measured in cubic yards complete in place.
2. Payment will be made at the respective contract unit price per cubic yard, which payment will include preparing areas to receive the soil, furnishing, transporting, installing and testing the soil mixtures including all amendments, and all labor, tools, equipment and incidentals necessary to complete the work.

621.10. TRIPLE SHREDDED HARDWOOD MULCH

(A) DESCRIPTION

Work under this item includes the installation of triple shredded hardwood bark mulch in landscape areas as specified in the Contract Documents. Except as herein stated, the requirements specified in DDOT Standard Specification 823.04(C) are applicable to this specification.

(B) MATERIALS

Triple-shredded hardwood bark mulch shall be free from deleterious materials and suitable as a top dressing of trees and shrubs, passing through a #3 sieve and sized between 3/8"-1/2", dark tan and brown in color.

(C) CONSTRUCTION REQUIREMENT

Prior to construction, Contractor shall provide 1 gallon sample of mulch to the Engineer for approval.

(D) MEASURE AND PAYMENT

Payment for triple shredded hardwood mulch will be made at the respective contract unit price per square yard, which payment will include furnishing, transporting, and installing mulch including all labor, tools, equipment and incidentals necessary to complete the work.

621.11. CURB CUT METAL TRENCH DRAIN COVER

(A) DESCRIPTION

This work shall consist of furnishing and placing solid trench drain covers above curb cuts into bioretention facilities as shown in the contract documents, or as directed by the Engineer. Except as herein stated, the requirements specified in DDOT Standard Specification 327 are applicable to this specification

(B) MATERIALS

Per Standard Specification 327.

(C) CONSTRUCTION REQUIREMENT

Provide covering over curb cut in accordance with the dimensions and pattern shown in the Contract Documents.

(D) MEASURE AND PAYMENT

The unit of measure for Curb Cut Metal Trench Drain Cover will be per linear foot for the size specified. Payment for Curb Cut Metal Trench Drain Cover will be made at the Contract unit price per linear foot which will include frame, cover, fasteners, grout, installation, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

621.12. DOMED OVERFLOW RISER

(A) DESCRIPTION

This work shall consist of furnishing and placing domed overflow risers in bioretention facilities as shown in the contract documents, or as directed by the Engineer. Except as herein stated, the requirements specified for DDOT Standard Specifications 310 and 808 are applicable to this specification.

(B) MATERIALS

1. PVC Riser Structure: Schedule 40 bell and spigot and conform to Section 808.02 of the Standard Specifications.
2. Concrete Pipe Riser: PCC Pipe per Standard Specification 808.01 (B)
3. Concrete for Riser or Catch Basin: PCC Class F per Standard Specification 817
4. Domed/Beehive Grate: 12” to 30” diameter domed grate using Cast Iron. Ductile Iron, or High Density Polyethylene as shown on the plans.

(C) CONSTRUCTION REQUIREMENT

Provide domed risers for bioretention facilities placed on aggregate stone as indicated in the Drawings. Top of riser shall be set as specified in the contract plans for ponding depth and a minimum 3 inches below adjacent sidewalk or top of curb. Connect riser to underdrain piping using the appropriate reducer fittings, tees, and/or elbows.

(D) MEASURE AND PAYMENT

The unit of measure for Domed Overflow Risers will be each. Payment for Domed Overflow Risers will be made at the Contract unit price per each for the diameter specified, which will include excavation, shoring, backfill, compaction, installation of pipe riser and stone base including connections, gaskets, domed/beehive grate, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

621.13. CHECK DAMS FOR STORMWATER FACILITIES

(A) DESCRIPTION

Work under this item includes the installation of check dams to slow and hold water flow in the stormwater facilities. Except as herein stated, the requirements specified for DDOT Standard Specifications 208, 507.02, and 822.09 are applicable to this specification.

(B) MATERIALS

1. Stone: shall meet the requirements set forth in the Standard Specifications, design plans, or modified in the Special Provisions.
2. Concrete: PCC Class F per Standard Specification 817
3. Reinforcement: Reinforcing Steel, Grade 60 Per Standard Specification 812.02:
4. Gabion:

   All wire including tie and connecting wire shall have a tensile strength of at least 60 000 psi when tested per A 370. All wire sizes and mesh spacing shall be as recommended by the manufacturer. Stainless steel interlocking fasteners meeting A 313 may be substituted for wire ties. When subjected to directional tension along its axis, the fastener shall remain in a closed and locked condition for a minimum force of 900 lb.

   Galvanized coating for fabric, ties, and connecting wire shall not be at least 0.8 oz/ft2 when tested per A 90.

   PVC coating for fabric, ties, and connecting wires shall exhibit no weight loss when tested per MSMT 508. Color shall meet Federal Standard 595, gray color No. 26440 or green color No. 24533, and match throughout the project.
5. Recycled Plastic Lumber: shall meet ASTM D6662-13.
6. Acrylic Sheeting: Cyro Industries ACRYLITE® DP-9, translucent or transparent, or approved equal.
7. PVC Sheeting: PVC Type 1, Gray
8. Polyurethane Foam: Dow Chemical Company ENERFOAM™ Professional Foam Sealant or approved equal.

(C) CONSTRUCTION REQUIREMENT

Construction shall be as follows:

1. Prepare bioretention or permeable pavement areas in accordance with the construction plans and specifications.
2. Stone Check Dam: Place class 1 geotextile on prepared subgrade. Construct the check dam with washed #2 stone or river rock with side slopes of 1:1 and a minimum top width of 6 inches. Place the stone so that it completely covers the width of the bioretention area and sides per the detail on the drawings. Form the weir so that top of the outlet crest is approximately 4 inches lower than the outer edges.
3. Gabion Check Dam: Place class 1 geotextile on the prepared subgrade. Overlap adjacent strips at least 12 inches. Replace or repair geotextile damaged during placement of the wire baskets.
4. Set the empty units on the geotextile and bind the vertical ends together with wire ties or interlocking fasteners spaced to permit stretching of the units to remove kinks. Use stretching methods that do not damage the baskets. Use stakes, pins, or other approved methods to ensure proper alignment.
5. Carefully fill the basket units with stone placed by hand or machine to ensure good alignment with a minimum of voids between stones. Avoid bulging of the mesh. Do not drop the stone from a height greater than 36 in. Place the stone to provide a minimum of two courses. Place the top layer of stone to a uniform surface. Avoid any bulging of the lid mesh. After a basket unit is filled, bend the lid over until it meets the ends of the unit. Secure the lid to the sides and ends with wire ties or interlocking fasteners. When a complete basket unit cannot be installed because of space limitations, cut the basket unit to fit as directed.
6. Concrete Dam: Construct following the requirements of 507.02 or as specified in the Contract Documents or directed by the Engineer.
7. Acrylic or PVC Sheeting: Place in accordance with Contract Documents.
8. Set the height for the weir crest per details in the construction drawings.

(D) MEASURE AND PAYMENT

The unit of measure and payment for stone check dam will be made per cubic yard and include installation, setting, and leveling of stone and all labor, materials, tools, equipment and incidentals needed to complete work specified.

The unit of measure and payment for gabion check dam will be made per cubic yard and include installation, setting, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

The unit of measure and payment for concrete check dam will be made per cubic yard and include installation, setting, reinforcement, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

The unit of measure and payment for acrylic or PVC sheet check dams will be made per square yard and include installation, setting, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

The unit of measure and payment for recycled lumber check dam will be made per square foot for the thickness specified in the plans, and include installation, setting, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

Geotextiles will be measured and paid for separately.

621.14. SIDEWALK LINEAR SLOT DRAIN

(A) DESCRIPTION

This work shall consist of furnishing and placing linear slot drains or linear grates in sidewalks above structural soil, as shown in the contract documents, or as directed by the Engineer. Except as herein stated, the requirements specified in DDOT Standard Specification 327 are applicable to this specification.

(B) MATERIALS

In addition to materials in DDOT Specification Section 327:

- Prefabricated Polypropylene Linear Slot Drain with UV Inhibitor, 2” maximum in width unless otherwise shown on Plans, with ADA Compliant Slot Openings.
- Anchors and hold-down clips in accordance with Manufacturer’s recommendations.

(C) CONSTRUCTION REQUIREMENT

1. Prefabricated Polypropylene linear slot drain may be open or solid bottom channel.
   a. Solid bottom need not be sloped.
   b. If solid bottom, prior to installation construct 2 row perforation pattern at 6” intervals in the invert of the drain to allow distribution of rainwater into the soil underneath the drain. Rows shall be parallel to the axis of the pipe and 120 degrees plus or minus 5 degrees apart. Perforations shall be 1/2” to 5/8” diameter.
2. Iron slot drains or linear grates shall be constructed in accordance with the details in the plans.
3. Geotextile class 2 shall be placed beneath slot drain prior to installation.

(D) MEASURE AND PAYMENT

The unit of measure for Sidewalk Linear Slot Drain will be linear foot for the material specified – Ductile Iron, Gray Iron, or Polypropylene. Payment will be made at the Contract unit price per linear foot which will include excavation, backfill, perforations, geotextile and all labor, materials, tools, equipment and incidentals needed to complete work specified.

621.15. TREE SPACE GRATE CATCH BASIN

(A) DESCRIPTION

This work shall consist of furnishing and placing sidewalk catch basins in tree space with structural soil, as shown in the contract documents, or as directed by the Engineer. Except as herein stated, the requirements specified for DDOT Standard Specifications 310 and 327 are applicable to this specification.

(B) MATERIALS

1. Concrete for Catch Basin: PCC Class F per Standard Specification 817
2. Catch Basin Grate: ADA compliant using Cast Iron, Ductile Iron, or High Density Polyethylene as shown on the plans.
3. Geotextile Catch Basin Insert: Removable round geotextile bag supported by a galvanized metal cage, sediment basket, or approved equivalent installed in accordance with manufacturer's specifications.

(C) CONSTRUCTION REQUIREMENT

Provide sidewalk catch basin placed on aggregate stone in covered tree space areas as indicated in the Drawings. As specified in plans, provide removable geosynthetic bag catch basin insert for collection and removal of silt, debris and trash. Connect basin to distribution piping using the appropriate reducer fittings, tees, and/or elbows.

(D) MEASURE AND PAYMENT

The unit of measure Tree Space Grate Catch Basin will be each. Payment for Tree Space Grate Catch Basin will be made at the Contract unit price per each which will include excavation, shoring, backfill, compaction, installation of structure and stone base including connections, gaskets, grate, geotextile catch basin insert (when specified), and all labor, materials, tools, equipment and incidentals needed to complete work specified.

621.16. CU SOIL

(A) DESCRIPTION

The work consists of furnishing and installing structural soil under sidewalks as a means to provide expanded soil rooting volume for trees, while providing support for the sidewalk loads, as shown in the Contract Drawings and as specified herein. Except as herein stated, the requirements specified in DDOT Standard Specifications are applicable to this specification.

(B) MATERIALS

1. CU™ Soil, a patented soil mix, obtained from a producer licensed by AMEREQ INC./CU-Soil™ Division or approved equal.

(C) CONSTRUCTION REQUIREMENT

1. At least 30 days prior to ordering materials, the Contractor shall submit to the DDOT Lab certificates, manufacturer's literature, certified tests, and/or proof of licensure for materials to be supplied. No materials shall be ordered until the required certificates, manufacturer's literature, test results, or proof of licensure have been reviewed and approved by the Engineer. Approval shall not constitute final acceptance. The engineer reserves the right to reject, on or after delivery, any material that does not meet the manufacturer's or supplier's specifications.
2. Installation and testing of the CU soils shall fully comply with all requirements of the licensed supplier, unless otherwise shown on Contract Plans.

(D) MEASURE AND PAYMENT

The unit of measure for CU soil is cubic yard. Payment will be made for the actual quantity installed. Payment will be made at the respective contract unit price, which payment will include furnishing and placing the product, and all labor, tools, equipment and incidentals necessary to complete the work.

621.17. LIGHTWEIGHT AGGREGATE

(A) DESCRIPTION

The work consists of furnishing and installing material under sidewalks as a means to provide expanded soil rooting volume for trees, while providing support for the sidewalk loads, as shown in the Contract Drawings and as specified herein. Except as herein stated, the requirements specified in DDOT Standard Specifications are applicable to this specification.

(B) MATERIALS

1. Stalite, a proprietary lightweight aggregate by Carolina Stalite Company, 205 Klumac Road, Salisbury, NC 28145 or approved equal.

(C) CONSTRUCTION REQUIREMENT

1. At least 30 days prior to ordering materials, the Contractor shall submit to the DDOT Lab certificates, manufacturer's literature, certified tests, and/or proof of licensure for materials to be supplied. No materials shall be ordered until the required certificates, manufacturer's literature, test results, or proof of licensure have been reviewed and approved by the Engineer. Approval shall not constitute final acceptance. The engineer reserves the right to reject, on or after delivery, any material that does not meet the manufacturer's or supplier's specifications.
2. Installation and testing of the Lightweight Aggregate shall fully comply with all requirements of the manufacturer, unless otherwise shown on Contract Plans.

(D) MEASURE AND PAYMENT

The unit of measure for Lightweight Aggregate is cubic yard. Payment will be made for the actual quantity installed. Payment will be made at the respective contract unit price, which payment will include furnishing and placing the product, and all labor, tools, equipment and incidentals necessary to complete the work.

621.18. STRUCTURAL CELLS FOR SOIL ROOTING VOLUME

(A) DESCRIPTION

The work consists of furnishing and installing materials under sidewalks as a means to provide expanded soil rooting volume for trees, while providing support for the sidewalk loads, as shown in the Contract Drawings and as specified herein. Except as herein stated, the requirements specified in DDOT Standard Specifications are applicable to this specification.

(B) MATERIALS

1. STRUCTURAL CELLS:

   Provide specific product called for in the Contract Plans, which may include:

   a. Silva Cell by Deep Root Partners, LLC, 530 Washington Street, San Francisco, CA 94111

   b. StrattaCell by CityGreen, 200-1920 Yonge Street, Toronto, Ontario M4S 3ES

   c. Approved equal.

(C) CONSTRUCTION REQUIREMENT

1. At least 30 days prior to ordering materials, the Contractor shall submit to the DDOT Lab certificates, manufacturer's literature, and certified tests for materials to be supplied. No materials shall be ordered until the required certificates, manufacturer's literature, or test results, have been reviewed and approved by the Engineer. Approval shall not constitute final acceptance. The Engineer reserves the right to reject, on or after delivery, any material that does not meet the manufacturer's or supplier's specifications.
2. Installation and testing of the structural cells shall fully comply with all requirements of the manufacturer and/or licensed supplier, unless otherwise shown on Contract Plans.

(D) MEASURE AND PAYMENT

The unit of measure for Structural Cells for Soil Rooting Volume shall be per cubic yard, for the type specified. Payment will be made for the actual quantity installed. Payment will be made at the respective contract unit price, which payment will include furnishing and placing the product, and all labor, tools, equipment and incidentals necessary to complete the work.

Separate pay items are established for planting soil, underdrain, geosynthetics, and aggregate base, as shown in the Contract Documents.

DISTRICT OF COLUMBIA

DEPARTMENT OF TRANSPORTATION

GREEN INFRASTRUCTURE STANDARDS

GREEN INFRASTRUCTURE PLANT LIST

Guide for Green Infrastructure Planting

Introduction

The following plant list includes plants that are native to or have adapted to the climate and habitat of the District. Some plants have different varieties - or cultivars - that are also acceptable for use within bioretention planting. Other cultivars not included on the list may be used, but they must be approved by DDOT before being planted in the bioretention facility.

The list also includes information about the characteristics of the plants as well as growing requirements. The type of plant is also included to help increase diversity within the planting area. Other categories included in the plant list are requirements by DDOT or include characteristics that could impact the use of the plant on a site-to-site basis (see Table 2).

Overall Survivability

Overall survivability is determined by numerous factors including salt, pollution, and drought tolerances (see Table 1). Ultimately, water needs and drought tolerance are very important factors when considering the overall survivability of a specific plant. It is also very important to ensure the plants are properly spaced to prevent overcrowding the root systems. Early maintenance is also extremely important to ensure the plants will thrive.

Light	Sun is necessary for plants to grow, but different plants require varying levels of sun exposure.
Water	Some plants grow better in wet conditions while others will only survive in dry areas.
Salt	Salt can cause soil to more easily compact and can make it more difficult for plants to access oxygen, water, and nutrients.
Pollution	Urban environments are home to numerous pollutants in the air, stormwater, and even the soil.
Maintenance	Mulch should be applied yearly to the planting areas. The plants should be watered until they are fully established (about 1 year) and weeding should occur to prevent overcrowding by nuisance species.

Table 1

Bioretention Planting

Similar to regular plant beds, the vegetation for each Low Impact Development (LID) facility must be carefully selected for the specific conditions found on site. Each LID facility has unique requirements from one another. The design of the facility must also be considered when selecting plants since some facilities hold water for longer periods of time than others.

Level of Care

Level of care correlates with the plant's ability to survive in a specific environment. In many cases, the plants selected for the various LID facilities can survive very well with little intervention once established. These are, typically, plants that have adapted to the urban conditions and all the seasons that occur in the District. Some ornamental plants can do just as well and are included in the list, but they may need a little more attention to look great. The level of care scale takes into consideration the plant's needs, the plant's aesthetic requirements, and any challenges that may arise from growing in an urban environment.

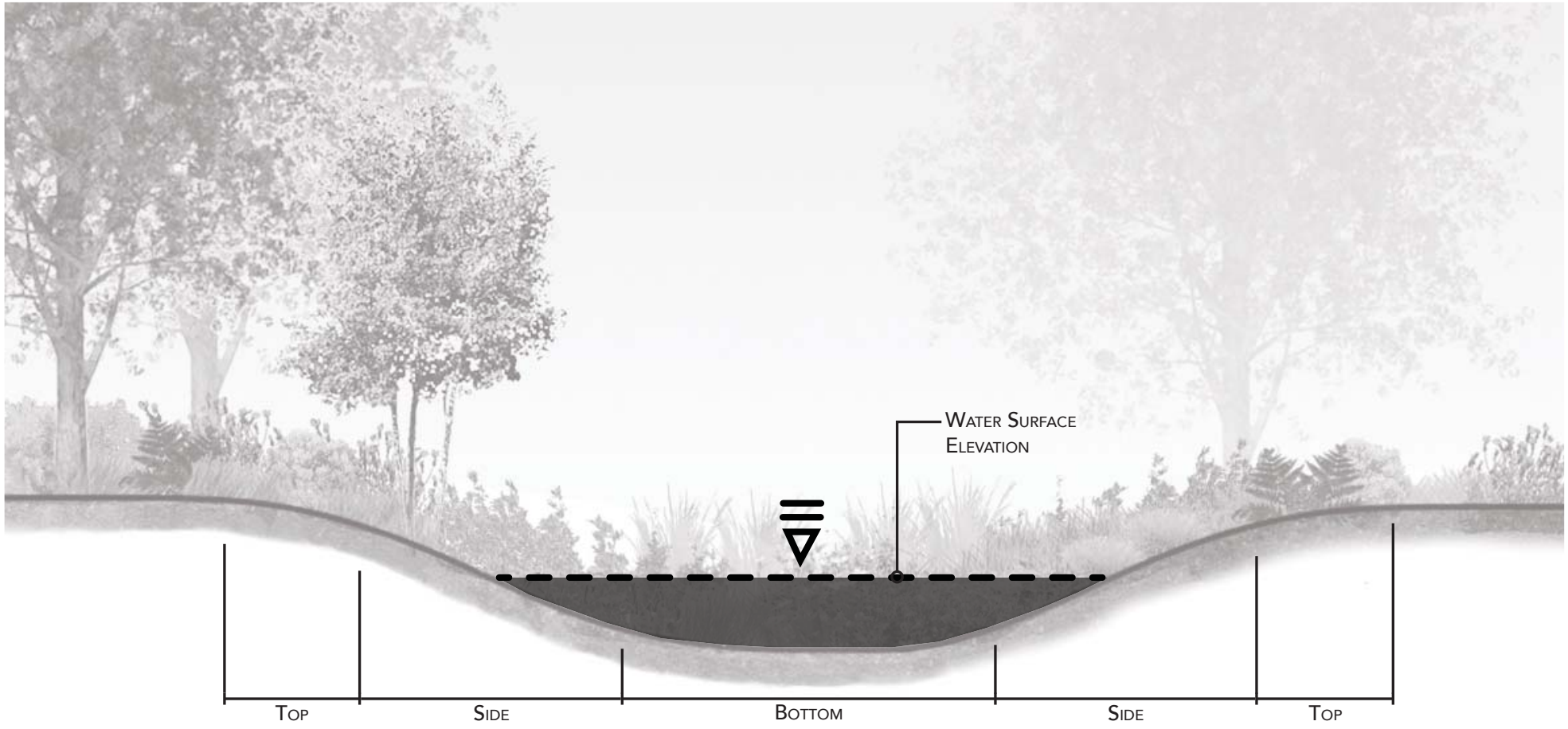
Low: Plant materials are well suited for the urban environment (can survive through drought, road salt use in winter, pollution, etc.) and require little to no pruning or aesthetic maintenance throughout the year. The plants can survive on typical rainfall once established. Low level of care areas are often in edges of the District and along busy collector roads where maintenance is completed once or twice a year.

Medium: Plant materials are suited for the urban environment but require a moderate amount of pruning or aesthetic maintenance throughout the year. The plants require some additional watering in order to survive. Medium level of care areas are often in the neighborhoods where maintenance is completed quarterly and by homeowners that may take care of the public space while completing their own yard work.

High: Plant materials are suited for the urban environment but may require significant pruning or aesthetic maintenance throughout the year. The plants may require additional watering to survive. High level of care areas are usually in the urban center or commercial zones where maintenance is routinely completed monthly within the public space.

Spacing	Ensure plants have enough room to grow to their mature height and spread without overcrowding one another's foliage or roots. The spacing has been approved by DDOT with the mature plant size and root system needs in mind.
Minimum Container Size	Trees must meet a specific caliper so they can withstand wind and potential pedestrian contact. Similar to trees, shrubs and perennials should be a specific container size to be able to withstand pedestrian contact and also help shade out weeds. The container and plant material sizes have been selected and approved by DDOT.
Other Plant Characteristics	Because each site is different, it is important to consider other possible stressors that may be unique to the location (besides drought and salt). These can include, but are not limited to, animal browsing, extreme soil conditions, surrounding vegetation, extreme water requirements, extreme light requirements, and life cycle lengths.

TABLE 2



BIORETENTION ZONES

FIGURE 1

BIORETENTION - LOW LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Annual maintenance; no irrigation

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
TREES													
Amelanchier canadensis *Shadblow Serviceberry*	6-20	10-20	White	Apr-May	○ ◑	M	♦♦♦	Small Tree	X	Bottom Side	Per Plan	2" cal. OR Multi-stem by height: 8'-10'	Tolerates clay soil, wind, dry soil; fragrant flowers
Amelanchier x grandiflora Apple Serviceberry* *'Autumn Brilliance'*	25-30	15-20	White	April	○ ◑	M	♦♦	Small Tree	X	Top Side	Per Plan	2" cal. OR Multi-stem by height: 8'-10'	Tolerates clay soil
Betula nigra *River Birch** *'Heritage'* † *'BNMTF' Dura Heat* †	40-70	40-60	Brown, Green	Apr-May	○ ◑	M	♦♦	Med. Tree	X	Bottom Side	Per Plan	2" cal. OR by height: 8'-10'	Tolerates deer, drought, clay soil, wet soil, air pollution
Celtis occidentalis *Hackberry*	40-60	40-60	Green	Apr-May	○ ◑	H M	♦	Large Tree	X	Bottom Side	Per Plan	2" cal.	Tolerates drought, clay soil, wet soil, air pollution, wind, extended flooding
Crataegus viridis *Green Hawthorne** *'Winter King'*	25-35	25-35	White	May	○	L	♦♦	Med. Tree	X	Top Side	Per Plan	2" cal.	Tolerates drought, clay soil, dry soil; install away from sidewalks & walkways
Diospyros virginiana *Persimmon*†	35-60	25-35	White, Yellow	May-June	○ ◑	M	♦	Large Tree	X	Top Side	Per Plan	2" cal.	Tolerates drought, clay soil, dry soil, shallow rocky soil, air pollution; dioecious, install away from sidewalks & walkways
Ginkgo biloba *Ginkgo (male only)*†	50-80	30-40	Green	Mar-Apr	○	M	♦	Large Tree		Bottom Side	Per Plan	2" cal.	Fruitless, tolerates deer, clay soil, air pollution

BIORETENTION - LOW LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Annual maintenance; no irrigation

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
Gleditsia triacanthos *Honeylocust** *'Shademaster'* †	35-45	25-35	Yellow-Green	May-June	○	M	♦	Med. Tree	X	Bottom Side	Per Plan	2" cal.	Thornless and fruitless, tolerates deer, drought, clay soil, black walnut, air pollution
Gymnocladus dioicus Kentucky Coffee Tree* *'Stately Manor'* †	40-50	20-25	White	May-June	○	H M	♦♦	Med. Tree	X	Bottom Side	Per Plan	2" cal.	Fruitless, tolerates drought, air pollution
Juniperus virginiana *Eastern Red Cedar*	30-65	8-25	Non-flowering	Non-flowering	○	M	♦	Med. Tree	X	Top Side	Per Plan	2" cal. OR by height: 8'-10'	Tolerates deer, erosion, dry soil, shallow rocky soil, black walnut, air pollution
Koelreuteria paniculata *Goldenraintree*	30-40	30-40	Yellow	June-July	○	M	♦	Med. Tree		Top Side	Per Plan	2" cal.	Sometimes weak-wooded, tolerates drought, clay soil, air pollution
Lagerstroemia indica *Crapemyrtle**			Various	July-Sept	○	L	♦	Small Tree		Top Side	Per Plan	8-10' height	Tolerates drought, clay soil, air pollution
'Biloxi'	15-25	15-25	Pink										Exfoliating bark
'Muskogee'	10-12	10-12	Pink, Purple										
'Natchez'	15-20	15-20	White										Exfoliating bark
'Tuscarora'	10-16	10-16	Dark Pink										
Liquidambar styraciflua *Sweetgum**			Yellow, Green	Apr-May	○	M	♦♦	Med. Tree	X	Bottom Side	Per Plan	2" cal.	Tolerates rabbit, deer, wet soil, clay soil; sterile
'Ward' Cherokee †	40-50	25-30											
'Hapdell' Happidaze †	60-80	40-60						Large Tree					
'Rotundaloba' †	60-70	20-30	Greenish										
Nyssa sylvatica *Blackgum** *'Wildfire'*	30-50	20-30	Green, White	May-June	○ ◑	L	♦	Med. Tree	X	Bottom Side	Per Plan	2" cal.	
Platanus occidentalis *American Sycamore*	75-100	75-100	Red, Yellow	April	○	L	♦	Large Tree	X	Bottom Side	Per Plan	2" cal.	Tolerates deer, air pollution
Quercus imbricaria *Shingle Oak†*	40-60	40-60	Yellow, Green	Apr	○ ◑	H	♦♦	Large Tree	X	Bottom Side	Per Plan	2" cal.	Tolerates drought, clay soil, dry soil, black walnut
Quercus macrocarpa *Bur Oak†*	70-80	70-80	Yellow, Green	Apr	○	H	♦	Large Tree	X	Top Side	Per Plan	2" cal.	Tolerates drought, clay soil, dry soil, extended flooding

BIORETENTION - LOW LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Annual maintenance; no irrigation

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
Quercus phellos *Willow Oak†*	40-75	25-50	Yellow, Green	Apr	○	H	♦	Large Tree	X	Bottom Side	Per Plan	2" cal.	Tolerates clay soil, wet soil, air pollution
Sophora japonica *Japanese Pagoda Tree†*	40-60	40-60	White	July-Aug	○	L	♦♦♦	Large Tree		Bottom Side	Per Plan	2" cal.	Tolerates drought, air pollution, heat
Syringa reticulata *Japanese Tree Lilac*	20-30	15-20	White	June	○	M	♦♦	Small Tree		Bottom Side	Per Plan	2" cal.	Tolerates deer, clay soil, alkaline soil; fragrant
Taxodium distichum *Bald Cypress†*	50-70	20-45	No flower	No flower	○	M L	♦	Large Tree	X	Bottom Side	Per Plan	8-10' height	Tolerates deer, clay soil, wet soil, air pollution, strong winds
Ulmus americana *American Elm** *'Princeton'* † *'Jefferson'* † *'New Harmony'* †	 60-80 40-50 60-70	 40-70 40-50 40-70	 Green, Red Green Green	March-Apr	○	H	♦	 Large Tree Med. Tree Large Tree	X	Bottom Side	Per Plan	2" cal.	Good street tree, tolerates drought, black walnut, air pollution, good resistance to Dutch Elm Disease
Ulmus parvifolia *Chinese Elm†*	60-70	35-55	Green	Sept.	○	M	♦♦	Large Tree		Bottom Side	Per Plan	2" cal.	Tolerates drought, clay soil, air pollution
Zelkova serrata *Zelkova** *'Green Vase'* † *'Village Green'* †	 60-80 40-60	 40-50 30-50	 Green	 Mar-Apr	 ○	 M	 ♦♦	 Large Tree		 Top Side	 Per Plan	 2" cal.	 Tolerates air pollution, wind
SHRUBS													
Aronia melanocarpa *Black Chokeberry** *'Autumn Magic'* *'Morton'*	 3-6 2-3	 4-7 4-5	 White	 May	 ○ ◑	 H	 ♦♦	 Deciduous Shrub	 X	 Bottom Side	 4	 5 gal.	 Tolerates drought
Baccharis halimifolia Eastern Baccharis	5-10	5-7	White	July-Sept	○ ◑	H	♦♦	Deciduous Shrub	X	Bottom	3	3 gal.	
Cornus alba Tatarian Dogwood* *'Ivory Halo'*	 4-6	 4-6	 White	 May-June	 ○ ◑	 M	 ♦♦	 Deciduous Shrub	 X	 Top Side	 4	 3 gal.	 Tolerates rabbit, deer, erosion
Cornus sericea *Red Twig Dogwood** *'Farrow'* *'Flaviramea'*	 3-4 5-6	 3-4 5-6	 White	 May-June	 ○ ◑	 L	 ♦♦	 Deciduous Shrub	 X	 Bottom Side	 3	 5 gal.	 Tolerates deer, erosion, clay soil, wet soil, drought, air pollution

BIORETENTION - LOW LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Annual maintenance; no irrigation

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
Ilex glabra *Inkberry Holly** *'Compacta'*	3-4	4-6	White	May-June	○ ◑	M	♦♦	Evergreen Shrub	X	Bottom Side	4	3 gal.	Tolerates rabbit, deer, erosion, wet soil, air pollution
Juniperus conferta *Shore Juniper** *'Blue Shore'* *'Emerald Sea'*	0.5-1 1-2	4-6 6-9	N A	N A	○	H	♦♦	Evergreen Shrub		Top Side	4	3 gal.	Tolerates deer, drought, erosion, dry soil, shallow rocky soil, air pollution; Intolerant of wet soils standing water
Juniperus horizontalis *Creeping Juniper** *'Blue Chip'*	0.5-0.75	8-10	N A	N A	○	H	♦♦	Evergreen Shrub	X	Top Side	4	5 gal.	Tolerates deer, drought, erosion, dry soil, shallow rocky soil, air pollution; Intolerant of wet soils standing water
Myrica pensylvanica *Bayberry*	5-10	5-10	Yellow	May	○ ◑	H	♦	Deciduous Shrub	X	Top Side	6	5 gal.	Tolerates drought, erosion, wet soil
Nandina domestica *Heavenly Bamboo** *'Compacta'*	3-5	1-3	White	May-June	○ ◑	L	♦♦	Deciduous Shrub		Bottom Side	3	3 gal.	Tolerates drought, heavy shade
Viburnum dentatum Arrowwood Viburnum* *'Christom' Blue Muffin*	6-10 3-5	6-10 3-4	White	May-June	○ ◑	H M	♦♦	Deciduous Shrub	X	Top Side	4 3	5 gal.	Tolerates clay soil, black walnut, drought, air pollution

BIORETENTION - LOW LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Annual maintenance; no irrigation

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
PERENNIALS													
Amsonia hubrichtii *Blue Star*	2-3	2-3	Blue	Apr-May	○ ◑	M L	♦♦	Perennial	X	Bottom Side	1.5	1 gal.	Tolerates deer
Amsonia tabernaemontana Blue Star	2-3	2-3	Blue	May	○ ◑	M L	♦♦	Perennial	X	Bottom Side	1.5	1 gal.	Tolerates deer, drought, clay soil
Asclepias incarnata Swamp Milkweed	4-5	2-3	White, Pink	July-Aug	○	L	♦♦	Perennial	X	Bottom Side	1.5	1 gal.	Tolerates deer, clay soil, wet soil
*Dianthus Cheddar Pink** *'Feuerhexe'*	0.25-0.5	0.5-1	Magenta	May-June	○	H	♦♦	Perennial	X	Top Side	1.5	3 gal.	Tolerates deer
Hypericum calycinum *St. Johnswort*	1-1.5	1.5-2	Yellow	July-Aug	○ ◑	M	♦♦	Deciduous Shrub		Top Side		3 gal.	Tolerates drought, erosion, dry soil
Liriope muscari *Lily Turf**			Lavender	Aug-Sept	○ ◑	M	♦	Perennial		Top Side	1	1 gal.	Tolerates rabbit, deer, drought, erosion, air pollution; Intolerant of standing water
'Big Blue'	1-2	1-2	Lavender	Aug-Sept									
'Evergreen Giant'	1-2	1-2	Purple	Aug									
'Variegata'	1-1.5	1-2	Purple	Aug									
Pycnanthemum muticum Smooth Toothed Mountain Mint	2-3	2	White	July-Sept	○ ◑	M	♦♦	Perennial	X	Top Side	1.5	1 gal.	Tolerates deer
Solidago sphacelata *Goldenrod**													Tolerates deer, drought, erosion, clay soil, dry soil, shallow rocky soil
'Golden Fleece'	1-1.5	1-1.5	Yellow	Aug-Sept	○	H	♦♦	Perennial	X	Top Side	1	1 gal.	
FERNS													
Adiantum pedatum Northern Maidenhair Fern	1-2.5	1-1.5	N A	N A	◑ ●	M	♦♦	Perennial	X	Bottom Side	1	1 gal.	Tolerates heavy shade
Diplazium pycnocarpon Glade Fern	2-3	2-3	N A	N A	◑ ●	M	♦♦	Perennial	X	Bottom Side	1	1 gal.	Tolerates rabbit, deer, heavy shade, dry soil
Polystichum acrostichoides Christmas Fern	1-2	1-2	N A	N A	◑ ●	M	♦♦	Perennial	X	Top Side	1	1 gal.	Tolerates rabbit, deer, drought, heavy shade, erosion, dry soil, shallow rocky soil

BIORETENTION - LOW LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Annual maintenance; no irrigation

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
GRASSES													
Carex eburnea Bristle-leaf Sedge	0.5-1	0.5-1	Green	April	◑ ●	L	♦♦	Perennial Grass	X	Top Side	1	1 gal.	Tolerates deer, heavy shade
Carex morrowii *Japanese Sedge** *'Silver Sceptre'*	1-1.5	1.5-2	N A	N A	◑ ●	M	♦♦	Perennial Grass		Bottom Side	1	1 gal.	Drought tolerant once established, otherwise needs constant watering; tolerates deer, heavy shade, erosion, wet soil
Carex pensylvanica *Pennsylvania Sedge*	0.5-1	0.5-1	Green	May	◑ ●	M	♦	Perennial Grass	X	Top Side	0.5	1 gal.	Tolerates heavy shade, wet soil
Carex stricta Tussock Sedge	1-3	1-2	Red, Brown	May-June	○ ◑	L	♦♦♦	Perennial Grass	X	Bottom Side	2	1 gal.	Tolerates deer, erosion
Chasmanthium latifolium *Northern Sea Oats*	2-5	1-2.5	Green	Aug-Sept	○ ◑	M	♦♦	Perennial Grass	X	Bottom Side	3	1 gal.	Tolerates black walnut
Hakonechloa macra Japanese Forest Grass	1-1.5	1-2	Yellow-Green	July-Aug	◑	M	♦♦	Perennial Grass		Top Side	1.5	1 gal.	Tolerates black walnut, air pollution
Juncus inflexus *European Meadow Rush** *'Blue Arrows'*	1-3	1-3	Yellow, Red	May-July	○	L	♦♦	Perennial Grass	X	Bottom	1	1 gal.	Tolerates erosion, wet soil
Juncus patens *Grey Rush** *'Carmen's Grey'* *'Elk Blue'*	1-2	1-2	Brown	May-Aug	○ ◑	L	♦♦	Perennial Grass		Bottom Side	1	1 gal.	Tolerates drought once established

BIORETENTION - LOW LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Annual maintenance; no irrigation

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
Muhlenbergia capillaris Pink Muhlygrass	2-3	2-3	Pink	Sept-Nov	○ ◑	M	♦	Perennial Grass		Top Side	3	1 gal.	Tolerates drought, black walnut, air pollution
Panicum virgatum *Switchgrass**			Pink	July-Feb	○ ◑	H M	♦♦	Perennial Grass	X	Bottom Side	3	1 gal.	
'Cheyenne Sky'	2-3	1.5-2	Red	July-Feb									
'Heavy Metal'	4-5	1-2	Pink	July-Feb									Tolerates drought, erosion, dry soil, wet soil, black walnut, air pollution
'Prairie Sky'	4-6	2-3	Red	Aug-Feb									
'Ruby Ribbons'	3-4	2-2.5	Purple	July-Feb									
'Shenandoah'	3-6	2-3	Pink	July-Feb									
'Squaw'	3-4	1.5-2	Red	July-Feb									
Schizachyrium scoparium *Little Bluestem**								Perennial Grass					Tolerates deer, drought, erosion, dry soil, shallow rocky soil, black walnut, air pollution
'MinnblueA'	2-4	1.5-2.5	Red, Brown	Aug-Feb	○	M	♦♦		X	Top Side	3	1 gal.	
Sorghastrum nutans *Indian Grass*	3-5	1-2	Brown, Yellow	Sept-Feb	○	M	♦♦	Perennial Grass	X	Top Side	3	1 gal.	Tolerates drought, erosion, dry soil, shallow rocky soil, black walnut, air pollution

* The listed cultivars are recommended for use in ROW LID facilities. Others may be used with approval from DDOT.

† DDOE Stormwater Credits (counts toward credits if average spread at maturity >35').

BIORETENTION - MEDIUM LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Quarterly maintenance; some water available

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
TREES													
Asimina triloba *Pawpaw*	15-30	15-30	Purple	Apr-May	○ ◑	L	♦♦♦	Small Tree	X	Bottom Side	Per Plan	2" cal.	Tolerates wet soil
Cercis canadensis *Eastern Redbud (single stem)** *'Forest Pansy'*	20-30	25-35	Red-Purple, Rosy Pink Rose-Purple	Mar-Apr Apr-May	○ ◑	L	♦ ♦♦♦	Small Tree	X	Side	Per Plan	2" cal. OR Multi-stem by height: 8'-10'	Tolerates deer, clay soil, black walnut
Magnolia x *'Galaxy'*	25-40	20-25	Red-Purple, Pink	May-June	○ ◑	L	♦	Med. Tree		Botom Side	Per Plan	2" cal. OR Multi-stem by height: 8'-10'	Tolerates clay soil, wet soil, air pollution; fragrant
Magnolia virginiana *Magnolia** *'Jim Wilson'* *Moonglow* †	35-40	15-18	White White	May-June	○ ◑	L	♦	Med. Tree	X X	Bottom Side	Per Plan	2" cal. OR Multi-stem by height: 8'-10'	Tolerates clay soil, wet soil, air pollution
Metasequoia glyptostroboides *Dawn Redwood*†	70-100	12-25	N A	N A	○	L	♦♦♦	Large Tree		Bottom Side	Per Plan	8-10' height	Tolerates deer, clay soil, wet soil, air pollution
Quercus bicolor *Swamp White Oak*†	50-60	50-60	Yellow, Green	April	○	H	♦	Large Tree	X	Bottom Side	Per Plan	2" cal.	Tolerates wet soil, drought
Quercus lyrata *Overcup Oak*†	40-60	40-60	Yellow, Red	March-Apr	○	H	♦♦♦	Large Tree	X	Bottom Side	Per Plan	2" cal.	Tolerates erosion, clay soil, wet soil
SHRUBS													
Buddleja davidii *Butterfly bush** *'Blue Chip'*	1-2	1-2	Blue	June-Sept	○	H	♦♦♦	Deciduous Shrub		Top Side	1	3 gal.	Tolerates rabbit, clay soil
Callicarpa americana *Beautyberry*	3-6	3-6	Lavender, Pink	June-Aug	○ ◑	L	♦♦♦	Deciduous Shrub	X	Bottom Side	3	3 gal.	Tolerates clay soil
Callicarpa dichotoma *Beautyberry** *'Early Amethyst'*	3-4	4-5	Lavender, Pink	June-Aug	○ ◑	L	♦♦♦	Deciduous Shrub		Top Side	4	3 gal.	Tolerates drought
Cephalanthus occidentalis *Buttonbush*	5-12	4-8	White	June	○ ◑	M L	♦♦♦	Deciduous Shrub	X	Bottom Side	4	3 gal.	Tolerates erosion, wet soil

BIORETENTION - MEDIUM LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Quarterly maintenance; some water available

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
*Clethra alnifolia Clethra**			White	July-Aug	○ ◑	M L	♦♦♦	Deciduous Shrub	X	Bottom Side	3	3 gal.	
'Compacta'	3-4	3-4											Tolerates heavy shade, erosion, clay soil, wet soil
'Hummingbird'	2-4	3-5											
'September Beauty'	4-6	3-4	White										
'Ruby Spice'	4-6	3-5	Pink										
Fothergilla gardenii *Dwarf Fothergilla*	1.5-3	2-4	White	Apr-May	○ ◑	M	♦♦♦♦	Deciduous Shrub	X	Bottom Side	3	3 gal.	
Hydrangea aborescens *Smooth Hydrangea*	3-5	3-5	White	June-Sept	●	M	♦♦	Deciduous Shrub	X	Top Side	3	5 gal.	Tolerates rabbit, drought, erosion, clay soil, dry soil, wet soil, shallow rocky soil
Hydrangea quercifolia *Oakleaf Hydrangea**	6-8	6-8	White, Pink	May-July	○ ◑	M	♦♦♦	Deciduous Shrub	X	Bottom Side	5	3 gal.	
'Sike's Dwarf'	2-3	3-4	White								3		
Ilex verticillata *Winterberry**													Female cultivar, needs male cultivar for berries, tolerates erosion, clay soil, wet soil, air
'Afterglow'	3-6	3-6	N A	Minimal	○ ◑	M L	♦♦♦	Evergreen Shrub	X	Bottom Side	3	5 gal.	
'Jim Dandy'	3-6	4-8	White								4		Male cultivar
'Nana' Red Sprite	2.5-3	2.5-3	White								2		Female cultivar
Ilex vomitoria *Yaupon Holly**								Evergreen Shrub					Tolerates air pollution
'Condeaux'	3	3	White	April	○ ◑	H	♦♦♦		X	Top Side	2.5	3 gal.	
Itea virginica *Virginia Sweetspire**													Tolerates erosion, clay soil, wet soil
'Henry's Garnet'	3-4	4-6	White	May-June	○ ◑	L	♦♦	Deciduous Shrub	X	Bottom Side	3	5 gal.	
'Little Henry'	1.5-2	2-2.5											
Myrica cerifera *Wax Myrtle*	6-12	6-12	Green	Mar-Apr	○ ◑	M	♦♦♦	Evergreen Shrub	X	Bottom Side	5	5 gal.	Drought tolerant once established; dioecious
Rhus aromatica *Fragrant Sumac**								Deciduous Shrub		Bottom Side			Tolerates rabbit, drought, erosion, clay soil, dry soil, shallow rocky soil
'Gro-Low'	1.5-2	6-8	Yellow	Apr-May	○ ◑	L	♦♦		X		5	5 gal.	
*Rosa x Rose**								Deciduous Shrub		Top Side			Tolerate air pollution; many cultivars
'Knockout'	3-4	3-4	Varies	May-frost	○ ◑		♦♦				3	3 gal.	

BIORETENTION - MEDIUM LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Quarterly maintenance; some water available

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
PERENNIALS													
Aruncus dioicus *Goat's Beard*	4-6	2-4	White	Apr-May	○ ◑	M L	♦♦♦	Perennial	X	Bottom Side	2	1 gal.	Tolerates rabbit
Asclepias tuberosa *Butterfly Weed*	1-2.5	1-1.5	Orange, Yellow	June-Aug	○	L	♦♦♦	Perennial	X	Bottom Side	1	1 gal.	Tolerates deer, drought, erosion, dry soil, shallow rocky soil
Aster novae angliae New England Aster* *'Alma Potschke'*	2.5-4	2.5-4	Pink	June-Sept	○	L	♦♦♦	Perennial	X	Bottom Side	2	1 gal.	Tolerates clay soil
Aster novi belgii New York Aster* *'Wood's Purple'*	1-1.5	1-1.5	Purple	Aug-Sept	○	L	♦♦♦	Perennial	X	Bottom Side	1	1 gal.	Tolerates drought, clay soil
Baptisia australis *Blue False Indigo*	3-4	3-4	Blue	May-June	○ ◑	H	♦♦	Perennial	X	Bottom Side	2	1 gal.	Tolerates rabbit, drought, erosion, clay soil, dry soil, shallow rocky soil
Baptisia sphaerocarpa *Yellow Wild Indigo*	2-3	2-3	Yellow	May-June	○ ◑	H	♦♦	Perennial		Top Side	1.5	1 gal.	Tolerates drought, erosion, dry soil
Brunnera macrophylla Siberian Bugloss* *'Jack Frost'*	1-1.5	1.5-2.5	Blue	Apr-May	◑	L	♦♦♦	Perennial		Bottom Side	1	1 gal.	Tolerates rabbit
Callirhoe involucrata *Purple Poppy Mallow*	0.5-1	0.5-3	Purple, Pink	May-June	○	L	♦♦	Perennial		Top Side	0.5	1 gal.	Does not transplant well, tolerates drought, dry soil, shallow rocky soil
Ceratostigma plumbaginoides *Plumbago*	0.75-1	1-1.5	Blue	July-Sept	○ ◑	M	♦♦♦	Perennial		Top Side	0.5	1 gal.	Tolerates erosion, clay soil
Chrysogonum virginianum *Golden Knee*	0.5-1 ft	1-2	Yellow	May-Oct	◑ ●	L	♦♦♦	Perennial	X	Bottom	0.5	1 gal.	Tolerates heavy shade
Echinacea purpurea sp. *Coneflower sp.*	2-5	1.5-2	Purple, Red, White, Orange	June-Aug	○ ◑	H M	♦♦	Perennial	X	Top Side	1	1 gal.	Tolerates deer, drought, clay soil, dry soil, shallow rocky soil
Epimedium grandiflorum Bishop's Hat	0.75-1.5	1-2	Pink, Purple, White	April-May	◑ ●	L	♦	Perennial	X	Top Side	0.5	1 gal.	Tolerates rabbit, deer, drought, heavy shade, erosion, dry soil, shallow rocky soil

BIORETENTION - MEDIUM LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Quarterly maintenance; some water available

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
Epimedium x veriscolor *Bishop's Hat** *'Sulphureum'*	0.75-1	0.75-1.5	Yellow	April	○ ◑	L	♦♦	Perennial		Top Side	0.5	1 gal.	Tolerates rabbit, deer, drought, heavy shade, erosion, dry soil, shallow rocky soil
Eupatorium dubium *Joe Pye Weed** *'Little Joe'*	3-4	2-3	Purple	July-Sept	○ ◑	L	♦♦♦	Perennial	X	Bottom Side	1.5	1 gal.	Tolerates deer, clay soil, wet soil
Gernanium maculatum Cranesbill	1-1.5	1-2	Blue, Purple	May-July	○ ◑	H	♦♦	Perennial		Bottom Side	0.5	1 gal.	Tolerates rabbit, deer
*Geranium Cranesbill** *'Rozanne'*	1-1.5	1.5-2	Violet	Aug-Sept	○ ◑	H M	♦♦♦	Perennial	X	Bottom Side	0.5	1 gal.	Tolerates deer
Helianthus angustifolius *Swamp Sunflower** *'Gold Lace'*	6-8	5-8	Yellow	Sept	○	M	♦♦♦	Perennial	X	Bottom Side	4	1 gal.	Drought tolerant once established
Helianthus salicifolius *Willowleaf Sunflower** *'Low Down'*	1.5-2	2-3	Yellow	Sept	○	M L	♦♦♦	Perennial	X	Bottom Side	1.5	3 gal.	Drought tolerant once established
Heliopsis helianthoides *Oxeye Sunflower** *'Summer Nights'* *'Sommersonne'*	3-6 2-3	2-4 1.5-2	Orange, Yellow Yellow	June-Aug	○	L	♦	Perennial	X	Top Side	1 1	1 gal.	Tolerates drought, erosion, clay soil, dry soil, shallow rocky soil
*Hemerocallis Daylilly** *'Happy Returns'* *'Stella d'Oro'*	1-1.5 0.75-1	1-1.5 0.75-1	Yellow	June-Oct May-Aug	○ ◑	H M	♦♦♦	Perennial		Top Side	1 0.5	1 gal.	Tolerates rabbit, erosion, air pollution
Hibiscus moscheutos *Hibiscus** *'Lord Baltimore'*	4-5	2-3	Red	July-Sept	○	M	♦♦	Perennial	X	Bottom Side	1.5	1 gal.	Tolerates deer, wet soil
*Iris Siberian Iris** *'Caeser's Brother'*	3-4	2.5-3	Purple	May	○ ◑	M	♦♦	Perennial		Bottom Side	1	1 gal.	Tolerates rabbit, deer, drought, erosion, clay soil, wet soil
Iris germanica Bearded Iris	2-3	1-2	Purple	May	○	M	♦♦	Perennial		Bottom Side	0.5	1 gal.	Tolerates deer, drought

BIORETENTION - MEDIUM LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Quarterly maintenance; some water available

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
Leucanthemum x superbum Shasta Daisy* *'Becky'*	3-4	2-3	White, Yellow	July-Sept	○	M L	♦♦	Perennial		Top Side	1.5	1 gal.	Tolerates rabbit, deer, drought, dry soil
Monarda bradburiana Eastern Beebalm	1-2	1-2 ft	Pink, White	May	● ◑	M L	♦♦	Perennial	X	Top Side	0.5	1 gal.	Tolerates deer, drought, dry soil, shallow rocky soil
Nepeta racemosa Catmint* *'Blue Wonder'*	0.75-1.5	1-1.5	Blue	May-Sept	○ ◑	M	♦♦	Perennial		Top Side	0.5	1 gal.	Tolerates deer, drought, dry soil, shallow rocky soil, air pollution
Oenothera fruticosa Narrow-Leaved Full Sundrops	1-1.5	1-2	Yellow	May-June	○	H	♦♦	Perennial	X	Top Side	0.5	1 gal.	Tolerates drought, erosion, dry soil, shallow rocky soil
Phlox subulata Moss Phlox	.25-.5	1-2	Pink, Purple, White, Lavender	Mar-May	○	None	♦♦	Perennial	X	Bottom Side	0.5	1 gal.	Tolerates deer, drought, erosion, air pollution
Penstemon digitalis Beardtongue 'Huskers Red'*	2-3	1-2	Red	Apr-June	○	M	♦♦	Perennial	X	Top Side	0.5	1 gal.	Tolerates deer, drought, clay soil, dry soil
Perovskia atriplicifolia Russian Sage	3-5	2-4	Lavender, Blue	July-Oct	○	H	♦♦	Perennial		Top Side	1	1 gal.	Tolerates rabbit, deer, drought, clay soil, dry soil, air pollution
Physostegia virginiana Obedient Plant	3-4	2-3	Pink, White	June-Sept	○	L	♦♦♦	Perennial	X	Bottom Side	1	1 gal.	Tolerates deer, clay soil
Polygonatum odoratum var. pluriflorum Solomon's Seal 'Variegatum'*	2-3	0.75-1	White	Apr-May	○ ◑	L	♦♦	Perennial		Bottom Side	0.5	1 gal.	Tolerates drought, heavy shade, erosion, dry soil, wet soil
Rudbeckia fulgida Black-Eyed Susan 'Fulgida' 'Goldsturm'*	2-3 1-2	2-2.5	Orange, Yellow Yellow	June-Oct June-Sept	○	M	♦♦♦	Perennial	X	Top Side	1	1 gal.	Tolerates deer, drought, clay soil, dry soil, shallow rocky soil, air pollution
Rudbeckia hirta Black-Eyed Susan 'Indian Summer'*	2-3	1-2	Yellow	June to frost	○	L	♦♦	Perennial	X	Top Side	0.5	1 gal.	Short lived, tolerates deer, drought, clay soil

BIORETENTION - MEDIUM LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Quarterly maintenance; some water available

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
Salvia x sylvestris *Purple Salvia** *'May Night'*	1.5-2	1-1.5	Purple, Blue	May-June	○	H M	♦♦	Perennial		Top Side	0.5	1 gal.	Tolerates deer, drought, dry soil
Sedum kamtschaticum var. floriferum *Orange Stonecrop** *'Weihenstephaner Gold'*	0.25-0.5	0.25-1	Yellow	June-Aug	○	H	♦♦	Perennial		Top Side	0.5	1 gal.	Tolerates rabbit, deer, drought, erosion, dry soil, shallow rocky soil, air pollution
Sedum rupestre *Stonecrop** *'Angelina'*	0.25-0.5	1-2	Yellow	June-Aug	○	H	♦♦	Perennial		Top Side	0.5	1 gal.	Tolerates rabbit, deer, drought, dry soil, shallow rocky soil, air pollution
Sisyrinchium graminoides *Blue-eyed Grass*	1.5-2 ft	0.5-1	Blue, Purple,	May-June	○	M L	♦♦	Perennial	X	Top Side	0.5	1 gal.	
Stachys byzantina Lamb's Ear* *'Big Ears'*	0.5-1	1-2	Purple	Rarely flowers	○	L	♦♦	Perennial		Top Side	0.5	1 gal.	Tolerates rabbit, deer, drought, dry soil, shallow rocky soil, black walnut, air pollution

BIORETENTION - MEDIUM LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Quarterly maintenance; some water available

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
GRASSES													
Calamagrostis x acutiflora *Feather Reed Grass** *'Karl Foerster'*	3-5	1.5-2.5	Purple	May-Feb	○	H	♦♦♦	Perennial Grass		Bottom Side	1	1 gal.	Tolerates erosion, wet soil, black walnut, air pollution
Carex muskingumensis *Palm Sedge*	2-3	2-3	Yellow	May-Sept	○ ◑	L	♦♦	Perennial Grass		Bottom Side	1	1 gal.	Tolerates deer, drought
Juncus effusus *Soft Rush*	2-4	2-4	Green, Yellow	June-Aug	○	L	♦♦♦♦	Perennial Grass	X	Bottom	1	1 gal.	Tolerates erosion, wet soil
Pennisetum alopecuroides *Fountain Grass** *'Hameln'*	1.5-2.5	1.5-2.5	Pink, White	Aug-Oct	○ ◑	H M	♦♦♦	Perennial Grass		Bottom Side	1	1 gal.	Tolerates drought, erosion, wet soil, black walnut, air pollution
Spartina patens *Saltmeadow Cordgrass*	4-6	1-2	Green	Evergreen	○ ◑	H	♦♦♦	Perennial Grass	X	Bottom	0.5	1 gal.	
Sporobolus heterolepis *Prairie Dropseed*	2-3	2-3	Pink	Aug-Oct	○	H	♦♦	Perennial Grass	X	Top Side	1	1 gal.	Tolerates deer, drought, erosion, dry soil, shallow rocky soil, black walnut, air pollution

* The listed cultivars are recommended for use in ROW LID facilities. Others may be used with approval from DDOT.

† DDOE Stormwater Credits (counts toward credits if average spread at maturity >35').

BIORETENTION - HIGH LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Monthly maintenance; site is routinely watered

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR:	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
TREES													
Aesculus flava Yellow Buckeye†	50-75	30-50	Yellow	Apr-May	○	M	♦♦♦	Large Tree	X	Top Side	Per Plan	2" cal.	Messy, install away from sidewalks & walkways, best when planted in large areas
Chionanthus virginicus Fringe Tree	12-20	10-20	White	May-June	○ ◑	L	♦	Small Tree	X	Bottom Side	Per Plan	8-10' height	Tolerates clay soil, air pollution; slightly fragrant
Ilex decidua Possumhaw	7-15	5-12	White	May	○ ◑	M	♦♦♦	Small Tree	X	Bottom Side	Per Plan	2" cal.	Tolerates wet soil, clay soil, air pollution
Liquidambar styraciflua *Sweetgum†*	60-80	40-60	Yellow, Green	Apr-May	○	M	♦♦	Large Tree	X	Bottom Side	Per Plan	2" cal.	Tolerates rabbit, deer, clay soil, extended flooding; messy
Oxydendrum arboreum Sourwood	20-50	10-25	White	June-July	○ ◑	M	♦♦♦	Small Tree	X	Bottom Side	Per Plan	2" cal.	Tolerates deer, dry soil; fragrant
Quercus falcata Southern Red Oak†	60-80	40-50	Green (female), Red (male)	Apr-May	○	M	♦	Large Tree	X	Top Side	Per Plan	2" cal.	Tolerates drought, air pollution, brief flooding, intolerant of root disturbance
Tilia americana *Linden** *'Redmond'* †	50-70	30-45	Yellow	June	○ ◑	L	♦♦	Large Tree	X	Top Side	Per Plan	2" cal.	Tolerates drought, clay soil; fragrant, attractive to bees
Tilia cordata *Littleleaf Linden** *'Greenspire'* †	50-70	35-50	Yellow	June	○ ◑	L	♦♦	Large Tree	X	Bottom Side	Per Plan	2" cal.	Tolerates drought, wet soil, dry soil, air pollution; fragrant, attractive to bees
SHRUBS													
Forsythia x intermedia Forsythia* *'Courtasol'*	1-2	1-4	Yellow	Mar-Apr	○ ◑	M	♦♦	Deciduous Shrub		Top Side	0.5	3 gal.	Tolerates deer, clay soil, black walnut
Vaccinium angustifolium Lowbush Blueberry	.5-2	2-4	White	May-June	○ ◑	L	♦♦♦	Deciduous Shrub	X	Bottom Side	1	3 gal.	
Vaccinium corymbosum Highbush Blueberry	6-12	8-12	White, Pink	May	○ ◑	H	♦♦♦	Deciduous Shrub	X	Bottom Side	6	5 gal.	Tolerates wet soil
Viburnum trilobum American Cranberrybush* *'Bailey Compact'*	3-6	3-6	White	Mar-May	○ ◑	M	♦♦♦	Deciduous Shrub	X	Top Side	2	4 gal.	Tolerates black walnut, shade, air pollution

BIORETENTION - HIGH LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

PLANTS FOR USE IN BIORETENTION

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

Monthly maintenance; site is routinely watered

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

BOTANICAL NAME COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	BLOOM COLOR:	BLOOM TIME	SUN SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	ZONE	SPACING (FT.)	MINIMUM CONTAINER SIZE	OTHER NOTES
PERENNIALS													
Astilbe chinensis var. pumila Chinese Astilbe	0.75-1	0.75-1	Pink	May-Aug	◑ ●	M	♦♦	Perennial		Top Side	0.5	1 gal.	Tolerates rabbit, deer, heavy shade, black walnut
Chelone glabra Turtlehead	2-3	1.5-2.5	Pink, White	Aug-Oct	◑	L	♦♦♦	Perennial	X	Bottom Side	1	1 gal.	Tolerates erosion, wet soil
Helleborus *Lenten Rose** *'Walhelivor'*	1-1.5	1-1.5	White	Mar-May	◑ ●	M	♦♦♦	Perennial		Bottom Side	0.5	1 gal.	Toxic, tolerates deer, heavy shade, dry soil
Hosta sp. Hosta	0.75-1	2-2.5	Lavender	July-Aug	◑ ●	M	♦♦♦	Perennial		Bottom Side	1	1 gal.	Tolerates heavy shade, black walnut
BULBS													
Narcissus sp. Daffodil sp.	1-1.5	0.75-1	Yellow, Orange, White	Apr	○ ◑	M L	♦♦	Bulbous Perennial		Bottom Side	0.5	bulb	Tolerates rabbit, deer, drought
Tradescantia virginiana Spider Lily	1.5-3	1-1.5	Blue, Pink, Purple, White	May-July	◑ ●	L	♦♦♦	Bulbous Perennial	X	Bottom Side	0.5	bulb	Tolerates clay soil, black walnut
GRASSES													
Carex glauca Blue Sedge* *'Blue Zinger'*	1-1.5	1-1.5	Green, White	July-Aug	◑ ●	M	♦♦♦	Perennial Grass		Bottom Side	0.5	1 gal.	Tolerates deer, heavy shade
Deschampsia cespitosa *Tufted Hair Grass** *'Goldtau'*	2-3	1-2	Silver, Purple, Green	July-Sept	◑	M	♦♦	Perennial Grass	X	Bottom Side	0.5	1 gal.	Tolerates black walnut, air pollution

* The listed cultivars are recommended for use in ROW LID facilities. Others may be used with approval from DDOT.

† DDOE Stormwater Credits (counts toward credits if average spread at maturity >35').

Green Infrastructure Standards

Trees for Use in Public Space

Tree Space Design

Adequate soil space provides the nutrients, water, air, and root space that trees need to have a long, successful life. The soil volume required depends on the fully-grown tree size (generally two cubic feet of soil per one square foot of the tree's mature drip line area). There are other categories that must be considered when selecting a location and species of tree (see Table 3 and Figure 2).

Soil Dimensions	Soil for the trees should be three feet deep. The length and width must ensure appropriate volume for the tree species and size.
Open space	Provide as much open space as possible to allow the tree to grow and access water.
Soil Extents	Structural soil, suspended sidewalks, or structural slabs should be provided to the edges of paved areas to encourage tree roots to extend further and into adjacent green areas (lawns, planting beds, etc.).
Overhead Utilities	When overhead utilities are present, only small trees can be planted to avoid interference in the future.

Table 3

UFA Minimum Tree Sizes	
Single Stem	2" cal.
Multi-Stem	8-10' height

Table 4

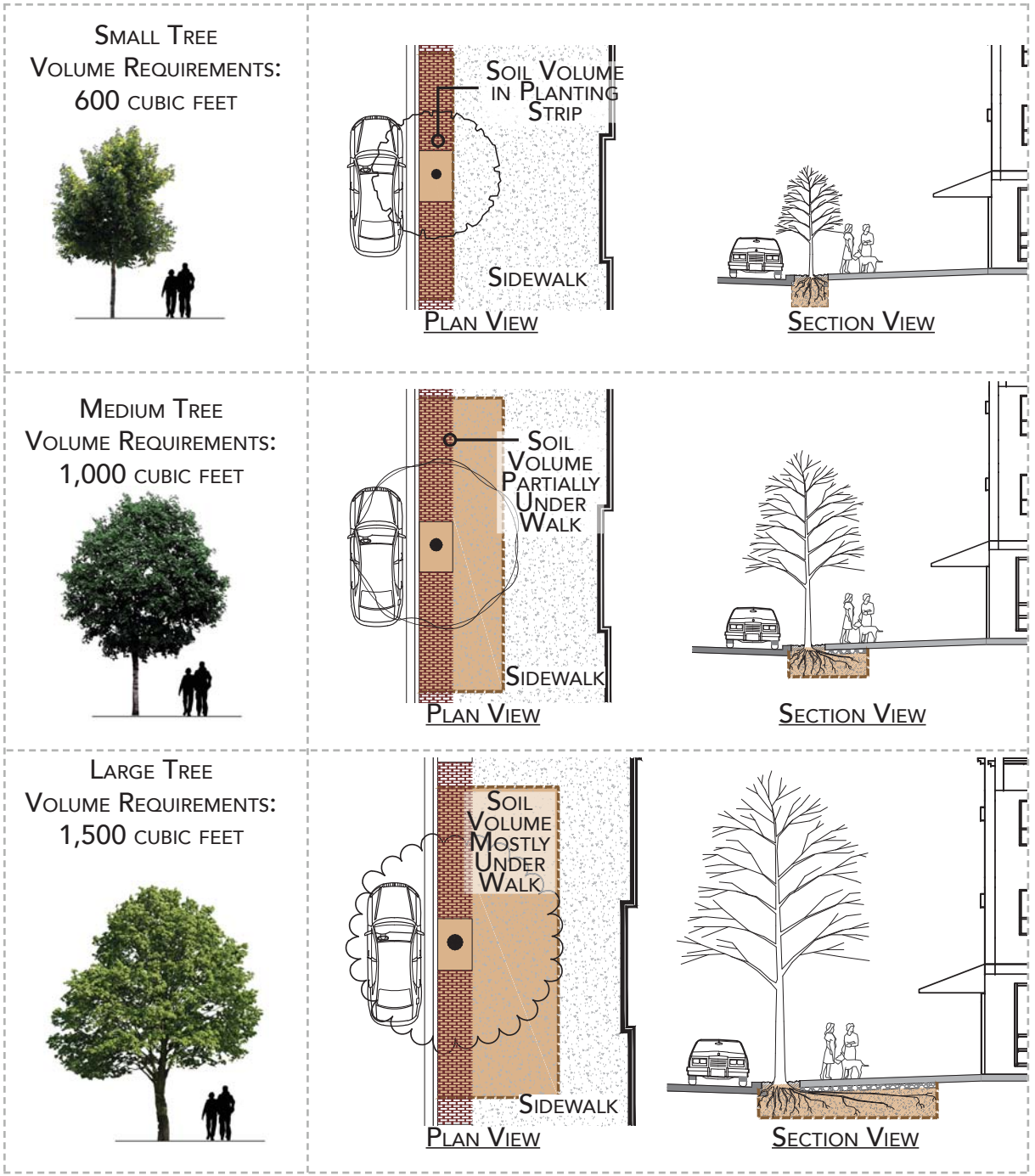


Figure 2

TREES USED IN PUBLIC SPACE - SMALL TREES

DDOT GREEN INFRASTRUCTURE STANDARDS

TREES FOR USE IN PUBLIC SPACE

SMALL TREES

<35' tall, minimum soil volume = 600 cubic feet

○ Full Sun ◑ Part Shade ● Full Shade

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

SS Single Stem **MS** Multi-Stem

BOTANICAL NAME	COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	TRUE FLOWER	BLOOM TIME	FALL COLOR	GROWTH RATE	SUN/ SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	OTHER NOTES
Acer buergerianum	Trident Maple	20-25	20-25	Greenish-Yellow	Apr-May	Yellow, Orange, Red	Slow-Moderate	○	M	♦♦♦	Deciduous		Tolerates air pollution, wind, soil compaction; exfoliating bark
Acer campestre	Hedge Maple	25-35	25-35	Green	May	Yellow	Slow	○ ◑	H	♦	Deciduous		Tolerates high pH soils, dry soils, compaction, air pollution
Acer griseum	Paperbark Maple	20-30	40-50	Green	Apr	Bronze, Russet-Red, Red	Slow	○	M	♦♦	Deciduous		Tolerates heat, clay soil; exfoliating bark
Acer truncatum	Shantung Maple	20-25	15-20	Greenish-Yellow	Apr	Yellow-Orange, Purple-Red	Slow	○ ◑	M	♦	Deciduous		Tolerates drought
Amelanchier canadensis	Shadblow Serviceberry	6-20	10-20	White	Apr-May	Yellow-Gold, Orange-Red	Moderate	○ ◑	M	♦♦♦	Deciduous; SS/MS	X	Tolerates clay soil, dry soil; slightly fragrant
Amelanchier x grandiflora 'Autumn Brilliance'	Apple Serviceberry	15-25	15-25	White	Apr	Orange-Red	Slow-Moderate	○ ◑	M	♦♦		X	Tolerates clay soil
Amelanchier laevis	Allegheny Serviceberry	15-25	5-10	White	May	Orange-Red	Moderate	○ ◑	M	♦♦♦	Deciduous; MS	X	Tolerates wet soil, air pollution
Carpinus caroliniana	American Hornbeam	20-30	20-30	White (female), Green (male)	Feb	Yellow, Orange, Scarlet	Slow	○ ◑	L	♦♦	Deciduous; SS/MS	X	Tolerates dry soil, heavy shade, wet soil
Cercis canadensis	Eastern Redbud *	20-30	25-35	Reddish-Purple, Rosy-Pink	Mar-Apr	Yellow-Green, Yellow	Slow-Moderate	○ ◑	L	♦	Deciduous	X	Tolerates deer, clay soil, black walnut
'Forest Pansy'	Forest Pansy Redbud			Rose-Purple	Apr-May	Red-Purple	Moderate			♦♦♦			
'Oklahoma'	Oklahoma Redbud	15-25	15-25	Dark Pink-Red	Apr	Yellow	Fast			♦♦			
Chionanthus virginicus	White Fringetree	12-20	10-20	White	May-June	Yellowish-Green, Brown, Bright to Golden Yellow	Slow	○ ◑	L	♦	Deciduous; SS/MS	X	Tolerates clay soil, air pollution; slightly fragrant

TREES USED IN PUBLIC SPACE - SMALL TREES

DDOT GREEN INFRASTRUCTURE STANDARDS

TREES FOR USE IN PUBLIC SPACE

SMALL TREES

<35' tall, minimum soil volume = 600 cubic feet

○ Full Sun ◑ Part Shade ● Full Shade

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

SS Single Stem **MS** Multi-Stem

BOTANICAL NAME	COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	TRUE FLOWER	BLOOM TIME	FALL COLOR	GROWTH RATE	SUN/ SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	OTHER NOTES
Chionanthus retusus	Chinese Fringetree	15-25	15-25	White	May-June	Yellow	Slow-Moderate	○ ◑	Un-known	♦♦♦	Deciduous; MS		Tolerates air pollution, wet soil; exfoliating bark, fragrant
Cornus florida 'Cherokee Princess'	Cherokee Princess Flowering Dogwood	15-30	15-30	Yellowish-Green	May-June	Red-Reddish Purple	Slow-Moderate	○ ◑	L	♦♦♦	Deciduous	X	Tolerates wet soil, shade, deer, black walnut
Cornus florida x kousa 'Rutgan'	Stellar Pink Hybrid Dogwood	18-20	18-20	Yellowish-Green	Apr-May	Purple-Red	Fast	○ ◑	Un-known	♦♦♦	Deciduous	X	Sterile, good resistance to anthracnose and dogwood borer, highly resistant to powdery mildew
Cornus kousa	Kousa Dogwood	20-30	20-30	Yellowish-Green	May-June	Reddish-Purple to Scarlet	Slow-Moderate	○	M	♦♦	Deciduous		Tolerates deer, clay soil, and hot, dry, gravelly soils and sites
Cotinus obovatus	American Smoketree	20-30	20-30	Yellowish-Green	May-June	Yellow, Orange, Red, Reddish Purple	Moderate	○ ◑	L	♦♦	Deciduous; SS/MS	X	Tolerates deer, dry soil, compacted soils
Halesia tetraptera	Carolina Silverbell	30-40	25-35	White	Apr-May	Yellow, Yellowish-Green	Moderate	○ ◑	L	♦♦♦	Deciduous; SS/MS	X	Tolerates wet soil
Ilex decidua	Possumhaw	7-15	5-12	White	May	Yellow	Moderate	○ ◑	M	♦♦♦	Deciduous; SS/MS	X	Tolerates wet soil, clay soil, air pollution
Laburnum anagyroides	Columnar Goldenchain Tree	20-30	10-12	Golden Yellow	May-June	Not Showy	Slow-Moderate	○ ◑	L	♦♦♦	Deciduous; SS/MS		Tolerates clay soil, dry soil, wet soil, wind
Laburnum x watereri	Goldenchain Tree	12-15	9-12	Yellow	May	Not Showy	Moderate	○ ◑	L	♦♦♦	Deciduous; SS/MS		Heat intolerant, susceptible to twig blight, leaf spot, aphids, grape mealy bugs

TREES USED IN PUBLIC SPACE - SMALL TREES

DDOT GREEN INFRASTRUCTURE STANDARDS

TREES FOR USE IN PUBLIC SPACE

SMALL TREES

<35' tall, minimum soil volume = 600 cubic feet

○ Full Sun ◑ Part Shade ● Full Shade

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

SS Single Stem **MS** Multi-Stem

BOTANICAL NAME	COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	TRUE FLOWER	BLOOM TIME	FALL COLOR	GROWTH RATE	SUN/ SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	OTHER NOTES
Lagerstroemia indica	Crapemyrtle*			Various	July-Sept		Fast	○	L	♦	Deciduous; SS/MS		Tolerates drought, clay soil, air pollution
'Biloxi'	Biloxi Crapemyrtle	15-25	15-25	Pale Pink		Dark Yellow-Orange, Orange-Red, Red							Exfoliating bark
'Muskogee'	Muskogee Crapemyrtle	10-12	10-12	Lavender Pink		Red							
'Natchez'	Natchez Crapemyrtle	15-20	15-20	White		Orange, Red							Exfoliating bark
'Tuscarora'	Tuscarora Crapemyrtle	10-16	10-16	Dark Coral Pink, Red		Orange-Red							
Maackia amurensis	Amur Maackia	20-30	20-30	White	June-July	Not Showy	Slow	○	Un-known	♦♦	Deciduous		Tolerates clay soil; fragrant, exfoliating bark
Magnolia x 'Butterflies'	Hybrid Magnolia	18-20	18-20	White	June-July	Not Showy	Moderate	○ ◑	L	♦♦♦	Deciduous; SS/MS		Tolerates deer, air pollution; fragrant, pyramidal form
Magnolia denudata	Yulan Magnolia	30-40	30-40	Yellow	Apr	Not Showy	Moderate	○ ◑	Un-known	♦♦♦	Deciduous		Tolerates air pollution, clay soil
Magnolia x soulangiana	Saucer Magnolia	20-30	20-30	White	Mar-Apr	Yellow-Brown	Moderate	○ ◑	Un-known	♦♦	Deciduous; SS/MS		Tolerates clay soil; fragrant
Malus	Crabapple*				Apr-June								Tolerates air pollution
'Adirondack'	Adirondack Crabapple	12-16	12-16	White, Red		Not Showy	Slow	○	M	♦♦	Deciduous		Tolerates frost; resistant to scab, fireblight, rust, mildew, columnar form
'Donald Wyman'	Donald Wyman Crabapple	15-20	20-25	White		Amber-Gold	Moderate	○	L	♦♦	Deciduous; SS/MS		Fragrant, slightly susceptible to powdery mildew
Oxydendrum arboreum	Sourwood	20-50	10-25	White	June-July	Yellow, Red, Purple	Slow	○ ◑	M	♦♦♦	Deciduous	X	Tolerates deer, dry soil; fragrant, pyramidal form
Parrotia persica	Persian Ironwood	20-40	15-30	Crimson	Mar-Apr	Yellow, Orange, Scarlet	Moderate	○ ◑	L	♦	Deciduous; SS/MS		Tolerates clay soil, air pollution

TREES USED IN PUBLIC SPACE - SMALL TREES

DDOT GREEN INFRASTRUCTURE STANDARDS

TREES FOR USE IN PUBLIC SPACE

SMALL TREES

<35' tall, minimum soil volume = 600 cubic feet

○ Full Sun ◑ Part Shade ● Full Shade

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

SS Single Stem **MS** Multi-Stem

BOTANICAL NAME	COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	TRUE FLOWER	BLOOM TIME	FALL COLOR	GROWTH RATE	SUN/ SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	OTHER NOTES
Pistacia chinensis	Chinese Pistachio	30-35	25-35	Greenish-Yellow	Apr	Orange, Orange-Red	Moderate	○	L	♦	Deciduous		Tolerates heat, dry soil, clay soil; excellent pest resistance
Prunus mume 'Peggy Clark'	Japanese Apricot	15-20	15-20	Double Deep Rose	Mar	Not Showy	Fast	○	Un-known	♦♦	Deciduous; SS/MS		Tolerates clay soil; fragrant, messy
Prunus x 'Okame'	Okame Cherry	15-30	20-30	Rosy Pink	Mar-Apr	Yellow, Orange, Red, Copper	Moderate-Fast	○ ◑	Un-known	♦♦	Deciduous		Tolerates clay soil, acidic soil, slightly alkaline soil; slightly fragrant
Prunus virginiana 'Shubert'	Canada Red Chokecherry	20-30	20-25	White	Apr-May	Orange, Red	Moderate-Fast	○ ◑	L	♦♦♦	Deciduous; SS/MS		Fragrant, attractive to bees, susceptible to aphids, leaf spot, black knot, shot hole fungus
Pyrus calleryana 'Autumn Blaze'	Autumn Blaze Pear	30-40	10-15	White	Mar-Apr	Reddish-Purple	Fast	○	M	♦♦	Deciduous		Tolerates dry soil, air pollution; highly susceptible to fireblight, has thorns on branches

TREES USED IN PUBLIC SPACE - SMALL TREES

DDOT GREEN INFRASTRUCTURE STANDARDS

TREES FOR USE IN PUBLIC SPACE

SMALL TREES

<35' tall, minimum soil volume = 600 cubic feet

○ Full Sun ◑ Part Shade ● Full Shade

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

SS Single Stem **MS** Multi-Stem

BOTANICAL NAME	COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	TRUE FLOWER	BLOOM TIME	FALL COLOR	GROWTH RATE	SUN/ SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	OTHER NOTES
Quercus myrsinifolia	Chinese Evergreen Oak	20-30	20-30	Non-Flowering	N/A	N/A	Slow	○	M	♦♦	Evergreen		Tolerates deer, heat, humidity, rabbits
Rhus typina	Staghorn Sumac	15-25	20-30	Greenish-Yellow	June-July	Yellow, Orange, Scarlet	Fast	○ ◑	H	♦♦	Deciduous; SS/MS	X	Tolerates dry soil, rabbits, erosion, shallow/rocky soil, black walnut
Styrax japonicus	Japanese Snowbell	20-30	20-30	White	June-July	Yellowish, Reddish	Moderate	○ ◑	M/H	♦♦	Deciduous		Tolerates air pollution, heat; slightly fragrant
Syringa reticulata	Japanese Tree Lilac	20-30	15-20	White	June	Not Showy	Moderate	○	M	♦♦	Deciduous; SS/MS		Tolerates deer, clay soil, alkaline soil; fragrant
Syringa pekinensis	Chinese Tree Lilac*						Slow				Deciduous; SS/MS		
'Zhang Zhiming'	Beijing Gold Lilac	20-25	20-25	Yellow	May-Aug	Copper		○	M	♦♦			Tolerates deer, clay soil; fragrant, exfoliating bark
'Morton'	China Snow Lilac			White	June	Not Showy		○	M	♦♦♦			
Tetradium daniellii	Bee Bee Tree	25-30	25-30	White	July-Aug	Not Showy	Moderate-Fast	○ ◑	M	♦	Deciduous		Tolerates wind; fragrant, weak wooded, invasive in PA
Zelkova serrata	Zelkova*			Not Showy	N/A			○	Un-known		Deciduous		Tolerates air pollution, vase-shaped
'JFS-KW1'	City Sprite Zelkova	20-25	15-20			Yellow	Moderate			♦♦♦			Good for planting under power lines, semi-dwarf
'Schmidtlow'	Wireless Zelkova	20-25	35-40			Red	Moderate-Fast			♦♦♦♦			Tolerates frost; good for planting under power lines, broad form

* The listed cultivars are recommended for use in Public Space Planting. Others may be used with approval from DDOT. All Trees on this list are subject to change at the review of UFA.

† DDOE Stormwater Credits (counts toward credits if average spread at maturity >35').

TREES USED IN PUBLIC SPACE - MEDIUM TREES

DDOT GREEN INFRASTRUCTURE STANDARDS

TREES FOR USE IN PUBLIC SPACE

MEDIUM TREES

35-50' tall, minimum soil volume = 1000 cubic feet

○ Full Sun ◑ Part Shade ● Full Shade

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

SS Single Stem **MS** Multi-Stem

BOTANICAL NAME	COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	TRUE FLOWER	BLOOM TIME	FALL COLOR	GROWTH RATE	SUN/ SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	OTHER NOTES
Acer rubrum 'Franksred' †	Red Sunset Maple	40-50	35-40	Red	Mar	Orange, Red	Moderate-Fast	○ ◑	L	♦♦♦	Deciduous	X	Tolerates wet soil, air pollution
Aesculus x carnea †	Red Horsechestnut	40-50	40-50	Rose-Red, Yellowish	May	Not Showy	Slow	○ ◑	M	♦♦♦	Deciduous		Messy (install away from sidewalks & walkways)
Betula nigra 'BNMTF' †	Dura-Heat River Birch	30-40	25-35	Brownish-Green	Apr-May	Yellow	Fast	○ ◑	M	♦♦	Deciduous; SS	X	Tolerates deer, drought, clay soil, wet soil, air pollution
Carpinus betulus 'Fastigiata'	European Hornbeam	30-40	20-30	Yellow (male), Green (female)	Mar	Yellow-Orange	Slow	○ ◑	L	♦♦	Deciduous		Tolerates pollution; columnar
Cercidiphyllum japonicum †	Katsuratree	40-60	25-60	Green-Reddish Green	Mar-Apr	Gold, Orange-Red	Moderate-Fast	○ ◑	M	♦♦♦♦	Deciduous; SS/MS		Susceptible to leaf scorch from hot, dry, and/or windy conditions
Cladrastis kentukea	American Yellowwood	30-50	40-55	White	May-June	Yellow	Moderate	○	M	♦♦♦	Deciduous	X	Tolerates alkaline soils, acidic soils, urban conditions; fragrant
Corylus colurna †	Turkish Filbert	40-50	20-35	Yellow	Mar	Yellow	Moderate	○	L	♦♦	Deciduous		Generally tolerant of urban conditions
Ginkgo biloba 'Princeton Sentry'	Princeton Sentry Maidenhair Tree	40-50	20-30	Green	Apr	Golden Yellow	Fast	○	L/M	♦	Deciduous		Tolerates deer, clay soil, heat, air pollution; male certified (fruitless), columnar
Gleditsia triacanthos 'Shademaster' †	Shademaster Honeylocust	35-45	25-35	Golden Green	May-June	Yellow	Fast	○	M	♦	Deciduous; SS/MS	X	Thornless and fruitless, tolerates deer, drought, clay soil, black walnut, air pollution
Gymnocladus dioicus 'Stately Manor' †	Fruitless Kentucky Coffeetree	40-50	20-25	White	May-June	Yellow	Slow-Moderate	○	H/M	♦	Deciduous	X	Fruitless, tolerates drought, air pollution

TREES USED IN PUBLIC SPACE - MEDIUM TREES

DDOT GREEN INFRASTRUCTURE STANDARDS

TREES FOR USE IN PUBLIC SPACE

MEDIUM TREES

35-50' tall, minimum soil volume = 1000 cubic feet

○ Full Sun ◑ Part Shade ● Full Shade

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

SS Single Stem **MS** Multi-Stem

BOTANICAL NAME	COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	TRUE FLOWER	BLOOM TIME	FALL COLOR	GROWTH RATE	SUN/ SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	OTHER NOTES
Juniperus virginiana	Eastern Red Cedar	30-65	8-25	Non-Flowering	N/A	N/A	Moderate	○	M	♦	Evergreen	X	Tolerates deer, erosion, dry soil, shallow/rocky soil, black walnut, air pollution; columnar to pyramidal
Koelreuteria bipinnata	Chinese Flametree	20-35	15-30	Yellow	Aug-Sept	Gold-Bronze	Fast	○	M	♦♦	Deciduous; SS/MS		Tolerates drought and smog conditions
Koelreuteria paniculata †	Goldenraintree	30-40	30-40	Yellow	June-July	Yellow	Moderate-Fast	○	M	♦	Deciduous		Sometimes weak-wooded, tolerates drought, clay soil, air pollution
Liquidambar styraciflua					Apr-May	Yellow, Red					Deciduous	X	Tolerates wet soil
'Ward' Cherokee †	Cherokee Sweetgum	40-50	25-30	Yellow			Slow	○	M	♦♦			Tolerates deer, clay soil; fruitless
'Slender Silhouette'	Columnar Sweetgum	35-50	4-8	White			Moderate-Fast	○	H/M	♦♦			Tolerates air pollution; fruitless, columnar
Liriodendron tulipifera 'Compactum'	Compactum Tuliptree	30-40	15-30	Yellow-Green	May-June	Yellow	Fast	○	L	♦♦	Deciduous	X	Intolerant of very hot, dry sites; dwarf
Maclura pomifera 'White Shield'	White Shield Osage Orange	20-40	20-40	Greenish-White	June	Yellow	Fast	○	M	♦	Deciduous	X	Tolerates heat, deer; fruitless, thornless
Magnolia 'Galaxy'	Galaxy Magnolia	30-40	20-25	Red-Purple, Pink	May-June	Coppery Bronze	Moderate	○ ◑	L	♦	Deciduous		Tolerates clay soi, wet soil, air pollution; fragrant
Magnolia acuminata 'Elizabeth'	Elizabeth Magnolia	20-45	15-25	Yellow	Apr-May	Yellow Bronze	Moderate-Fast	○ ◑		♦♦	Deciduous	X	Tolerates deer; intolerant of soil extremes (dry and wet); fragrant, pyramidal form
Magnolia grandiflora 'Bracken's Brown Beauty'	Bracken's Brown Beauty Southern Magnolia	20-40	15-25	White	May-June	Not Showy	Moderate	○ ◑	M	♦♦	Evergreen	X	Tolerates air pollution; fragrant, generally intolerant of soil extremes (dry and wet)

TREES USED IN PUBLIC SPACE - MEDIUM TREES

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

TREES FOR USE IN PUBLIC SPACE

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

MEDIUM TREES

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

35-50' tall, minimum soil volume = 1000 cubic feet

SS Single Stem **MS** Multi-Stem

BOTANICAL NAME	COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	TRUE FLOWER	BLOOM TIME	FALL COLOR	GROWTH RATE	SUN/ SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	OTHER NOTES
Magnolia virginiana 'Jim Wilson' Moonglow †	Moonglow Magnolia	10-35	10-35	White	May-June	Not Showy	Moderate-Fast	○ ◑	L	♦	Semi-evergreen	X	Tolerates clay soil, wet soil, air pollution, vase shaped
Nyssa sylvatica 'Wildfire'	Wildfire Black Gum	30-50	20-30	Green, White	May-June	Orange-Yellow to Purple-Red	Slow-Moderate	○ ◑	L	♦	Deciduous	X	Tolerates clay soil, wet soil
Ostraya virginiana	Hophornbeam	25-40	15-30	Red-Brown (male), Light Green (female)	Apr	Yellow	Slow	○ ◑	L	♦	Deciduous	X	Tolerates deer, clay soil, dry/gravelly soils (in partial shade)
Pinus virginiana	Virginia Pine	15-40	10-30	Pale Green, Yellow	Apr-May	N/A	Slow	○	L	♦	Evergreen	X	Tolerates dry soil, clay soil
Prunus x yeodensis †	Yoshino Cherry	35-45	35-45	Pink, White	Mar-Apr	Yellow, Bronze	Moderate	○ ◑	Un-known	♦♦♦♦	Deciduous		Tolerates humidity; susceptible to a large number of insects and disease pests, slightly fragrant
Quercus muehlenbergii †	Chinkapin Oak	40-60	50-70	Yellowish Green	Apr	Yellow, Golden, Brown	Moderate	○	L	♦♦	Deciduous	X	Tolerates dry soil, shallow/rocky soil, drought
Quercus stellata †	Post Oak	35-45	35-45	Yellowish Green	Apr	Golden Brown	Moderate	○	M	♦	Deciduous	X	Tolerates dry soil, shallow/rocky soil, drought
Quercus x warei 'Nadler'	Kindred Spirit Oak*	35-40	4-10	Yellowish Green	Apr	Yellow, Yellow-Brown	Fast	○	L	♦♦	Deciduous		Tolerates dry soil, wet soil; resistant to wind and ice, highly resistant to powdery mildew
Robinia pseudoacacia 'Frisia'	Frisia Black Locust	30-50	25-40	White	May-June	Yellow	Fast	○ ◑	H	♦	Deciduous	X	Tolerates deer, clay soil, air pollution; extremely fragrant, attractive to bees
Sassafras albidum	Sassafras	30-60	25-40	Greenish-Yellow	Apr-May	Yellow, Orange, Scarlet, Purple	Moderate-Fast	○ ◑	Un-known	♦	Deciduous	X	Tolerates deer, clay soil; fragrant

TREES USED IN PUBLIC SPACE - MEDIUM TREES

DDOT GREEN INFRASTRUCTURE STANDARDS

○ Full Sun ◑ Part Shade ● Full Shade

TREES FOR USE IN PUBLIC SPACE

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

MEDIUM TREES

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

35-50' tall, minimum soil volume = 1000 cubic feet

SS Single Stem **MS** Multi-Stem

BOTANICAL NAME	COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	TRUE FLOWER	BLOOM TIME	FALL COLOR	GROWTH RATE	SUN/ SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	OTHER NOTES
Stewartia pseudocamellia	Japanese Stewartia	15-40	15-30	White	June-July	Yellow, Red, Dark Reddish Purple	Slow	○	Un-known	♦♦	Deciduous; SS/MS		Intolerant of intense heat; exfoliating bark
Ulmus americana 'Jefferson' †	Jefferson Elm	40-50	40-50	Green	March-Apr	Yellow	Moderate-Fast	○	H	♦	Deciduous		Good street tree, tolerates drought, black walnut, air pollution; vase shaped, arching,
Ulmus parvifolia †	Chinese Elm	60-70	35-55	Green	Sept.	Yellowish-Reddish Purple	Moderate-Fast	○ ◑	M	♦	Deciduous		Tolerates drought, clay soil, air pollution; exfoliating bark, good resistance to Dutch Elm Disease

* The listed cultivars are recommended for use in Public Space Planting. Others may be used with approval from DDOT. All Trees on this list are subject to change at the review of UFA.

† DDOE Stormwater Credits (counts toward credits if average spread at maturity >35').

TREES USED IN PUBLIC SPACE - LARGE TREES

DDOT GREEN INFRASTRUCTURE STANDARDS

TREES FOR USE IN PUBLIC SPACE

LARGE TREES

>50' tall, minimum soil volume = 1500 cubic feet

○ Full Sun ◑ Part Shade ● Full Shade

L Low Salt Tolerance **M** Moderate Salt Tolerance **H** High Salt Tolerance

♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

SS Single Stem **MS** Multi-Stem

BOTANICAL NAME	COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	TRUE FLOWER	BLOOM TIME	FALL COLOR	GROWTH RATE	SUN/ SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	OTHER NOTES
Acer x freemani †	Freeman Maple	40-60	20-40	Green-Red	Apr-May	Yellow or Red	Moderate-Fast	○ ◑	L	♦♦	Deciduous	X	Tolerates clay soil, dry soil, wet soil
Aesculus flava †	Yellow Buckeye	50-75	30-50	Yellow	Apr-May	Yellow-Orange	Moderate	○	M	♦♦♦	Deciduous	X	Messy (install away from sidewalks & walkways), best when planted in large areas
Cedrus deodara †	Deodar Cedar	40-60	30-40	Non-Flowering	N/A	N/A	Moderate	○	M	♦♦	Evergreen		Tolerates clay soil, humidity, drought; must be limbed up when used as a street tree
Celtis laevigata †	Sugarberry	60-80	60-80	Green	Apr-May	Yellow	Fast	○ ◑	H/M	♦	Deciduous	X	Tolerates clay soil, wet soil, air pollution, wind, extended flooding; can form large surface roots
Celtis occidentalis †	Hackberry	40-60	40-60	Green	Apr-May	Yellow, Yellow-Green	Moderate-Fast	○ ◑	H/M	♦	Deciduous	X	Tolerates clay soil, wet soil, air pollution, drought, wind, extended flooding
Diospyros virginiana †	Persimmon	35-60	25-35	White, Yellow	May-June	Yellow-Green, Yellow Reddish Purple	Slow-Moderate	○ ◑	M	♦	Deciduous	X	Tolerates drought, clay soil, dry soil, shallow/rocky soil, air pollution; dioecious, install away from sidewalks & walkways
Fagus sylvatica	European Beech*			Yellowish-Green	Apr-May	Reddish-Bronze	Slow-Moderate	○	L	♦♦	Deciduous		Tolerates deer; intolerant of wet soils, compaction, heat; messy fruit
'Atropunicea' †	Purple European Beech	50-75	40-60	Not Showy	N/A	Copper	Slow						Tolerates clay soil, heat, dry soil
'Riversii' †	Rivers Purple Beech	50-60	40-50	Yellowish-Green	Apr-May			○ ◑					Tolerates deer; intolerant of wet soils; do not always grow well in urban settings
Ginkgo biloba †	Ginkgo (male only)*	50-80	30-40	Green	Mar-Apr	Yellow	Slow-Moderate	○	M	♦	Deciduous		Fruitless, tolerates deer, clay soil, air pollution
Gleditsia triacanthos var. *inermis* 'Skycole' †	Skyline Honeylocust	35-45	35-50	Greenish-White	May-June	Yellow	Fast	○	H	♦♦	Deciduous	X	Tolerates deer, clay soil, black walnut, air pollution, wind, high summer heat

TREES USED IN PUBLIC SPACE - LARGE TREES

DDOT GREEN INFRASTRUCTURE STANDARDS

TREES FOR USE IN PUBLIC SPACE

LARGE TREES

>50' tall, minimum soil volume = 1500 cubic feet

○ Full Sun ◑ Part Shade ● Full Shade

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♦ Highly Tolerant ♦♦ Tolerant ♦♦♦ Somewhat Tolerant ♦♦♦♦ Intolerant

SS Single Stem **MS** Multi-Stem

BOTANICAL NAME	COMMON NAME	HEIGHT (FT.)	SPREAD (FT.)	TRUE FLOWER	BLOOM TIME	FALL COLOR	GROWTH RATE	SUN/ SHADE	SALT TOL.	DROUGHT TOL.	TYPE	NATIVE	OTHER NOTES
Liquidambar styraciflua	Sweetgum*			Green	Apr-May	Yellow, Purple, Red	Moderate-Fast	○	M	♦♦♦	Deciduous	X	Tolerates rabbit, deer, clay soil, extended flooding; messy
'Hapdell' Happidaze †	Happidaze Sweetgum	60-80	40-60	Yellowish Green		Marroon	Fast						Tolerates rabbit, deer, clay soil, wet soil, air pollution; sterile
'Rotundiloba' †	Rotundiloba Sweetgum	60-70	20-30	Greenish		Yellow, Burgandy	Moderate						Tolerates rabbit, deer, clay soil, extended flooding; sterile
Liriodendron tulipifera †	Tulip tree*	60-90	30-50	Yellow	May-June	Yellow, Golden Yellow	Fast	○ ◑	L	♦♦♦♦	Deciduous	X	Tolerates rabbit, deer, clay soil; intolerant of hot, dry sites
'Arnold' †	Arnold Tulip tree	50-60	15-25	Yellow-Green, Orange	Mar-Apr	Yellow		○		♦♦			Tolerates rabbit, deer, air pollution, heat, humidity, erosion; columnar
Magnolia grandiflora 'Edith Bogue' †	Edith Brogue Southern Magnolia	40-60	20-30	White	May-June	Coppery-Bronze		○ ◑	M	♦♦	Evergreen	X	Tolerates air pollution; intolerant of many urban pollutants and soil extremes (dry or wet); fragrant, pyramidal
Metasequoia glyptostroboides †	Dawn Redwood	70-100	15-25	No Flower	N/A	Orange-Brown, Red-Brown	Fast	○	L	♦♦♦	Deciduous		Tolerates deer, clay soil, wet soil, air pollution
Platanus x acerifolia 'Bloodgood' †	Bloodgood London Planetree	70-85	50-70	Red	Apr	Yellow-Brown	Fast	○	M	♦	Deciduous		Tolerates soil compaction, heat, extended flooding; good resistance to sycamore anthracnose

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Quercus acutissima †	Sawtooth Oak	40-60	35-50	Yellowish-Green	Mar-Apr	Yellow, Golden-Brown	Moderate	○	M	♦	Deciduous		Tolerates wind, dry and compacted soil, heat, humidity, drought; reported invasive in MD and VA
Quercus alba †	White Oak	50-80	50-80	Yellowish-Green	Apr-May	Red	Slow-Moderate	○	H	♦♦	Deciduous	X	Tolerates drought, clay soil, dry soil, shallow/rocky soil, black walnut
Quercus bicolor †	Swamp White Oak	50-60	50-60	Yellowish-Green	Apr	Yellow, Reddish-Purple	Slow-Moderate	○	H	♦	Deciduous	X	Tolerates wet soil
Quercus coccinea †	Scarlet Oak	60-75	40-50	Yellowish-Green	Apr-May	Red	Moderate	○	M	♦♦	Deciduous	X	Tolerates drought, clay soil, dry soil, black walnut
Quercus falcata †	Southern Red Oak	60-80	40-50	Green (female), Red (male)	Apr-May	Reddish-Brown	Moderate	○	M	♦	Deciduous	X	Tolerates drought, air pollution, brief flooding; intolerant of root disturbance
Quercus imbricaria †	Shingle Oak	40-60	40-60	Yellow, Green	Apr	Yellow-Brown, Russet-Red	Slow-Moderate	○ ◑	H	♦♦	Deciduous	X	Tolerates clay soil, dry soil, drought, black walnut
Quercus lyrata †	Overcup Oak	40-60	40-60	Yellow (male), Red (female)	March-Apr	Brown	Moderate	○	H	♦♦♦	Deciduous	X	Tolerates erosion, clay soil, wet soil
Quercus macrocarpa †	Bur Oak	60-80	60-80	Yellow, Green	Apr	Yellow-Green, Yellow, Yellow-Brown	Slow-Moderate	○	H	♦	Deciduous	X	Tolerates drought, clay soil, dry soil, extended flooding
Quercus nuttallii †	Nuttall Oak	60-80	35-50	Brown	Mar-Apr	Red	Moderate	○	Un-known	♦♦	Deciduous	X	Tolerates clay soil, wet soil

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Quercus palustris †	Pin Oak	60-70	25-40	Yellowish-Green	Apr	Russet, Brown, Red	Moderate-Fast	○	L	♦♦	Deciduous	X	Tolerates wet soil, clay soil, extended flooding
'Pringreen'	Green Pillar Oak	50-60	15-25			Red	Fast			♦♦♦			Tolerates wet soil, dry soil; columnar
Quercus phellos †	Willow Oak	40-75	25-50	Yellow, Green	May	Yellow, Yellow-Brown, Russet-Red	Moderate-Fast	○	H	♦	Deciduous	X	Tolerates clay soil, wet soil, air pollution
Quercus prinus †	Chestnut Oak	50-65	40-65	Yellowish-Green	Apr	Yellowish-Brown	Moderate	○	Un-known	♦	Deciduous	X	Tolerates dry soil, rocky soil
Quercus robur 'Fastigiata'	Columnar English Oak	50-60	15-25	Yellowish-Green	Apr	Not Showy	Slow-Moderate	○	H	♦	Deciduous	X	Tolerates air pollution; susceptible to powdery mildew; columnar
Quercus rubra †	Red Oak	55-75	55-75	Yellowish-Green	May	Russet-Bright Red	Fast	○	H	♦	Deciduous	X	Tolerates drought, dry soil, black walnut, air pollution
Quercus shumardii †	Shumard Oak	40-60	35-55	Yellowish-Green	Apr	Russet-Red, Red	Fast	○	M	♦♦	Deciduous	X	Tolerates drought, dry soil, air pollution
Quercus x warei 'Long'	Regal Prince Oak	40-60	20-25	Yellowish-Green	Apr	Yellow-Brown	Moderate	○	L	♦♦	Deciduous	X	Tolerates drought; excellent resistence to powdery mildew and borers; columnar
Sophora japonica †	Japanese Pagoda Tree	40-65	40-65	White	July-Aug	Not Showy	Moderate-Fast	○ ◑	H / M	♦♦	Deciduous		Tolerates drought, air pollution, heat
Taxodium distichum †	Bald Cypress	50-70	20-45	Non-Flowering	N/A	Reddish-Brown	Moderate-Fast	○	M / L	♦♦	Deciduous	X	Tolerates deer, clay soil, wet soil, air pollution
Tilia americana	Redmond Linden	50-70	30-45	Yellow	June	Pale Green,	Moderate	○ ◑	L	♦	Deciduous	X	Tolerates drought, clay soil;
Tilia cordata 'Greenspire' †	Greenspire Littleleaf Linden	50-70	35-50	Yellow	June	Yellow	Moderate	○ ◑	L	♦♦	Deciduous		Tolerates wet soil, dry soil, air pollution; fragrant, attractive to bees
Tilia tomentosa †	Silver Linden	50-70	30-45	Yellow	June-July	Yellow	Moderate	○ ◑	M	♦	Deciduous		Tolerates heat, air pollution; fragrant, attractive to bees

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Ulmus americana	American Elm Cultivars *				Mar-Apr	Yellow	Moderate-Fast	○	H	♦	Deciduous	X	Tolerates drought, black walnut, air pollution; good resistance to Dutch Elm Disease
'New Harmony' †	New Harmony Elm	60-70	40-70	Green									
'Princeton' †	Princeton Elm	60-80	40-70	Green, Red									
Ulmus 'Morton' Accolade †	Accolade Elm	50-60	25-40	Green	Mar-Apr	Yellow	Moderate-Fast	○ ◑	M	♦	Deciduous		Tolerates wet soil, dry soil, heat, wind, air pollution; excellent resistance to Dutch Elm Disease.
Ulmus x hollandica 'Groeneveld' †	Groeneveld Elm	45-65	9-13	Green	Mar	Not Showy	Fast	○	M	♦♦	Deciduous		Marginal resistance to Dutch Elm Disease
Zelkova serrata	Japanese Zelkova*												Tolerates air pollution, wind
'Green Vase' †	Green Vase Zelkova	60-80	40-50	Green	Mar-Apr	Bronze-Red	Moderate	○	M	♦♦	Deciduous		Vase-shaped
'Halka' †	Halka Zelkova	45-55	25-35			Yellow	Fast			♦			Open and loose
'Village Green' †	Village Green Zelkova	40-60	30-50							♦♦			Vase-shaped

* The listed cultivars are recommended for use in Public Space Planting. Others may be used with approval from DDOT. All Trees on this list are subject to change at the review of UFA.

† DDOE Stormwater Credits (counts toward credits if average spread at maturity >35').

DISTRICT OF COLUMBIA

DEPARTMENT OF TRANSPORTATION

GREEN INFRASTRUCTURE STANDARDS

GREEN INFRASTRUCTURE MAINTENANCE SCHEDULES

Maintenance Schedule for Permeable Pavement Practices

Maintenance Tasks	Frequency	Time of Year / Timing
In the first year following construction, inspect the practice and contributing drainage area twice , within 24 hours after storm events that exceed 1/2 inch of rainfall. Conduct any needed repairs or stabilization.	Twice after installation	Within 24 hours after storm events that exceed 1/2 inch of rainfall
Conduct a maintenance inspection	Annually	
Mechanically sweep pavement with a regenerative street sweeper, or a vacuum sweeper to remove sediment	4 times per year in potential high sediment load areas 2 times per year otherwise	During Spring clean-up following final snow storm; During Fall clean-up following leaf fall
Remove any accumulated sediment in pretreatment cells and inflow points	Once a year	
• Stabilize contributing drainage area within public land to prevent siltation of practice • Remove any soil or sediment deposited on pavement. • Replace or repair any pavement surfaces that are degenerating or spalling • Blow-out cleanouts using compressed air, high pressure water hose, or drain snake in practices that show evidence of clogged underdrain	As needed following Annual Inspection	
• Conduct maintenance using a regenerative street sweeper, a vacuum sweeper, or power washing (< 500 psi, at an angle 30 degrees or less). • Replace any necessary joint material	If clogged	
• Mow grass in grid paver applications • Spot weed for grass applications	Once every 6 weeks during the growing season Annually	April through October

Maintenance Schedule for Bioretention Practices

	Maintenance Tasks	Frequency	Time of Year / Timing
Initial Tasks during Establishment (first three years)	Within 6 months following construction, the practice and drainage area should be inspected after storm events that exceed 1/2 inch of rainfall.	Twice after installation	Following storm events that exceed 1/2 inch of rainfall
	Remove stakes, wires, and tags	One time	6 months after planting
	Water plants – initial three years	Weekly during first 2-3 months after installation, and when rainfall is less than 1 inch per week	April-October
	Spot fertilization	One time as needed in First-second year of installation	Early spring
Routine Inspection	• Conduct a maintenance inspection • Check curb cuts and inlets for accumulated grit, leaves, and debris that may block inflow • Identify maintenance tasks needed • Look for erosion, bare areas, and where mulch needs to be applied	Quarterly	
Routine Maintenance	• Spot weed • Adjust mulch as needed to ensure full cover • Remove trash and animal waste • Remove any dead or diseased plants • Remove sediment in pretreatment cells and inflow points • Mow grass filter strips and bioretention with turf cover	Quarterly	March - November
	Mulch with 3 inches shredded hardwood mulch	Annually	February - April
As-Needed Maintenance	Prune trees and shrubs	As-needed	Feb-April and Sept-Nov as appropriate
	Water plants – after three years	Weekly during droughts (more than 2 weeks of no rain)	April-October
	• Remove invasive plants using recommended control methods. • Add planting to maintain desired vegetation density. • Replace stone at curb cuts, inflow, weirs, & check dams • Blow-off cleanouts using compressed air, high pressure water hose, or drain snake in practices that show evidence of clogged underdrain • Stabilize the surrounding drainage area to prevent erosion	As needed following Inspection	At appropriate time for disease or pest treatment. October-April per DDOT Std Specs November-March As-needed As-needed
	Remove and replace the mulch layer	Once every 3 years	Feb-April

Maintenance Schedule for Street Tree Space

Maintenance Tasks	Frequency	Time of Year / Timing
Inspect tree for health and establishment and report any changes to UFA via 311 or 311.dc.gov.	Three times during establishment; Every five years for life of tree	Spring 1st season Fall 1st season Fall 2nd season
Remove stakes and wires.	One time	One year after planting
Water tree – first year	25 gallons Weekly via slow release device	April-October
Water tree – second & third year	25 gallons Bi-Monthly via slow release device	April-October
Remove weeds and trash	Quarterly	March-November
Mulch with 3 inches double ground shredded hardwood mulch. Place much in a ring to capture rain water. Mulch shall not be mounded around tree.	Annually or as needed.	Feb-April
If tree pruning is needed, call 311 or 311.dc.gov to request an inspection by UFA.	As-needed	
Remove sediment and trash from any inlets and slot drains	Annually	