28th Annual Environmental Permitting Summer School

Low Impact Development

(July 23, 2014)

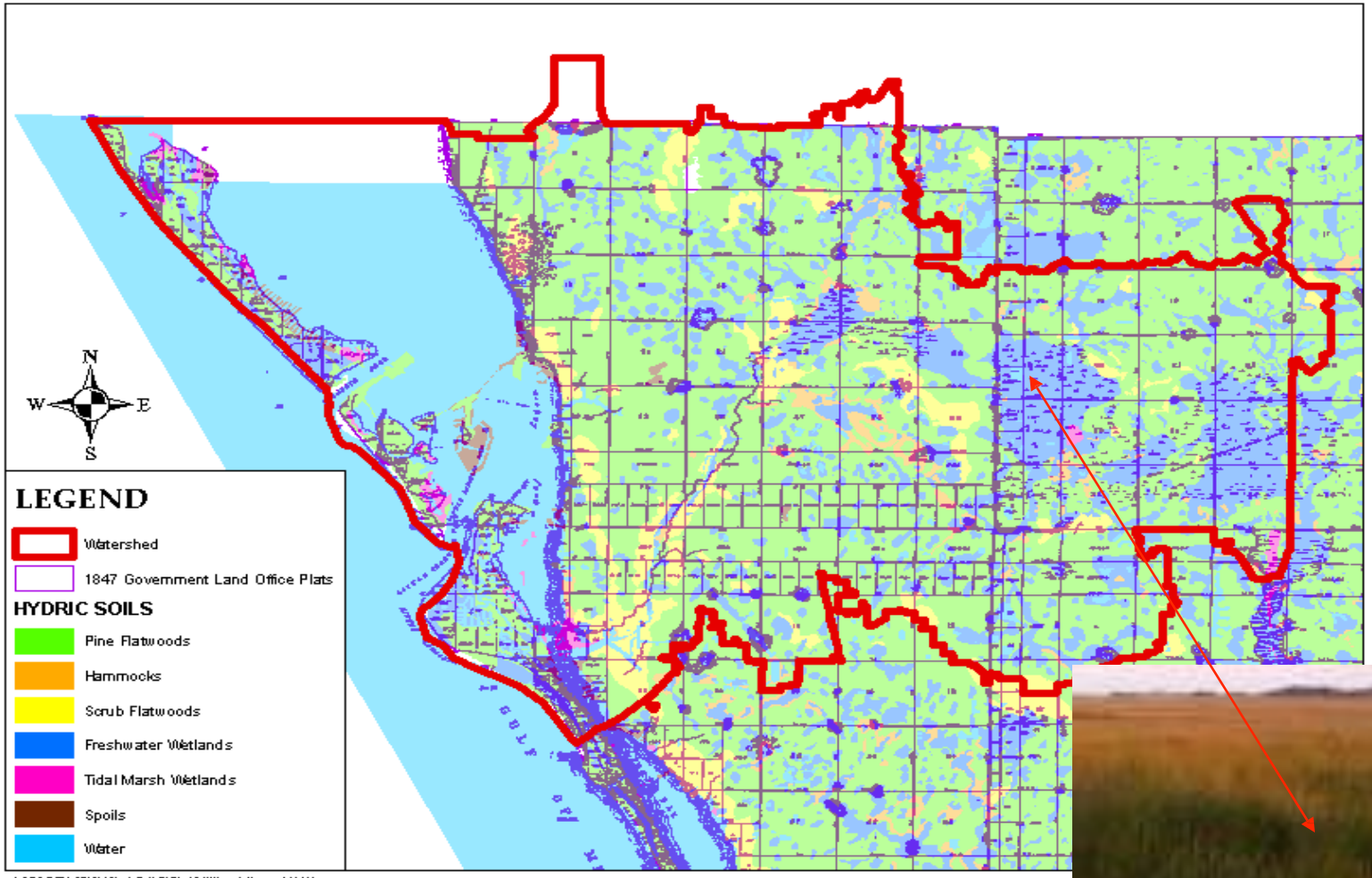
Stephen M. Suau, P.E.

Progressive Water Resources
Integrated Water Resource Consultants

Fruitville @ i75 – Infill Project

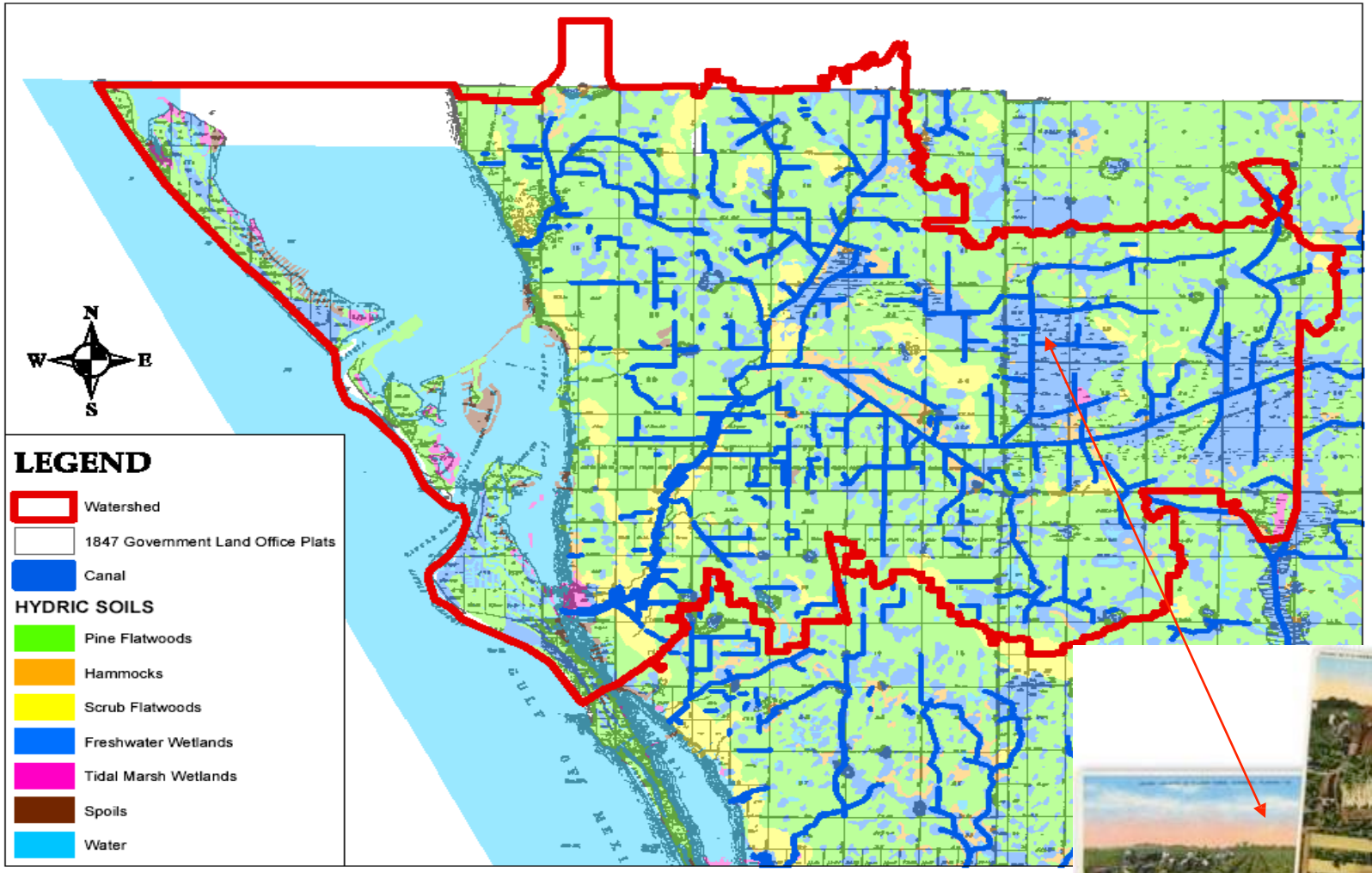
Fruitville @ i75 – Infill Project

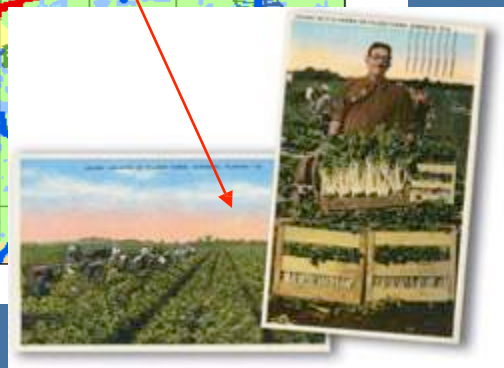
Sarasota Bay Watershed



Fruitville @ i75 – Infill Project

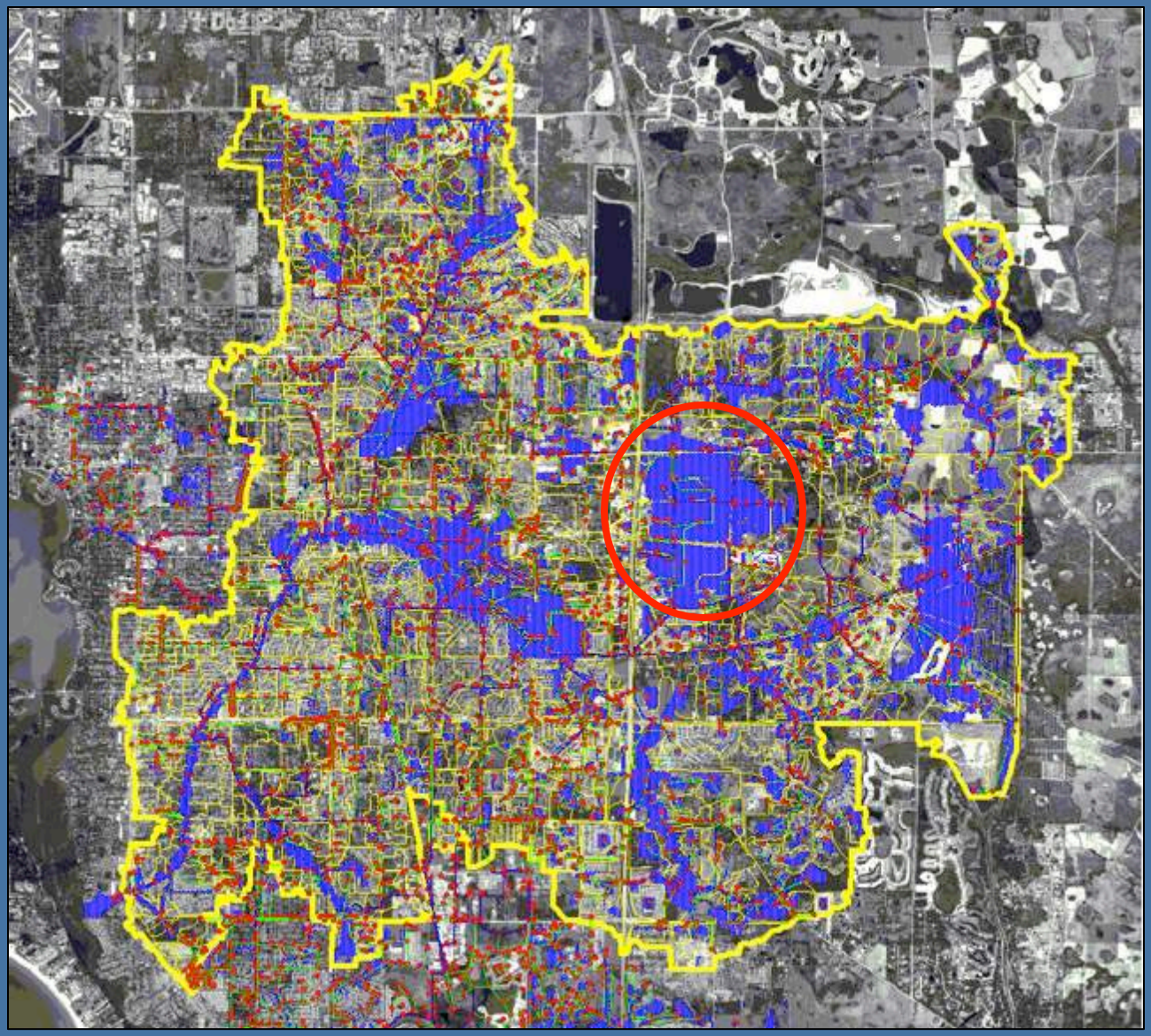
Sarasota Bay Watershed





Fruitville @ i75 – Infill Project

Fruitville @ i75 – Infill Project



Celery Fields

Diversion Structure 1

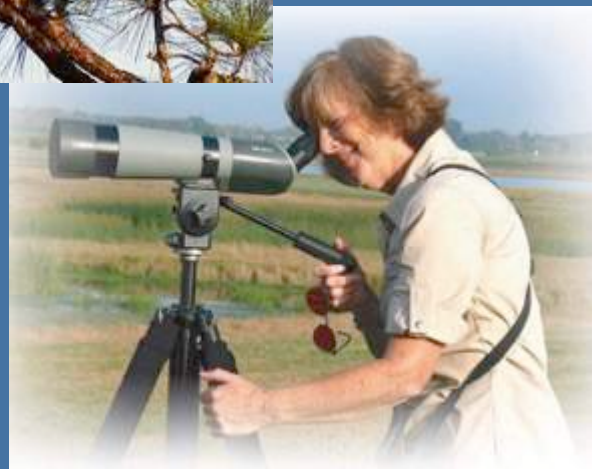
Discharge Structure 1

Discharge Structure 2

Fruitville @ i75 – Celery Fields

Return of Wildlife Resources

- Listed of the Florida birding trail
- Over 200 species have been counted
- 14 breeding species - including 2 endangered - Bald Eagles and Least Terns



Fruitville @ i75 – Celery Fields

Historical Resources

- Fossils
- Indian canoes

Fruitville @ i75 – Celery Fields

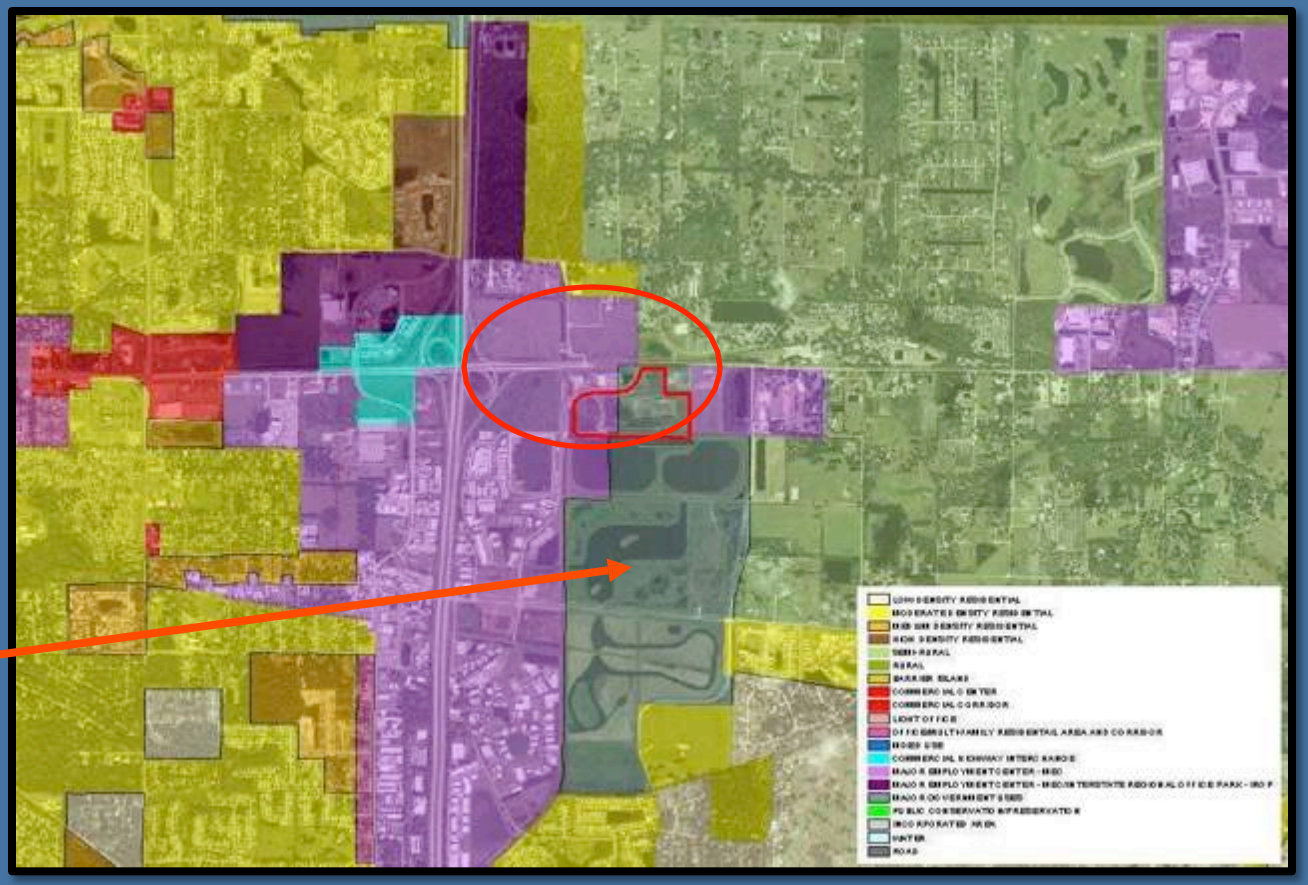
Approved 400 Acre Park

Wide support for
Celery Fields
Natural Area
Passive
Recreational Plan

Fruitville @ i75 – Infill Project

Existing Land Use Designation – Major Employment Center

Celery Fields is also a Regional Floodplain Storage Area



Fruitville @ i75 – Planning

- Six MEC property owners including County
- Celery Fields public asset (Regional Floodplain Compensation) leveraged to coordinate planning with private MEC properties
- Public & private MEC property owners have been working together for 5 years

Fruitville @ i75 – Water Goals

- ✓ Showcase LID at the site level
- ✓ Utilize regional stormwater to meet floodplain management needs
- ✓ Provide for state of the art water conservation and efficiency
- ✓ Harvest stormwater to offset water demands (and reduce pollutant loads)

Fruitville @ i75 – Water Quality

- EPA TMDLs:
  70% reduction for TN & TP

- FDEP: Unable to link low DO violations to nutrients
  Delisted for nutrients.

- EPA Numeric Nutrient Criteria (NNC):
  TN = 1.65 mg/L
  TP = 0.49 mg/L

Fruitville @ i75 – Water Quality

Existing Land Use = Pasture
Area = ±200 acres
Average annual runoff = 18”

TN conc. = 2.48 mg/L
TP conc. = 0.70 mg/L

Est. Average Annual TN Load = 2068 lbs/yr
Est. Average Annual TP Load = 571 lbs/yr

Fruitville @ i75 – Water Quality

Proposed Land Use = HIC
Area = ±200 acres
Average annual runoff = 42''

TN conc. = 2.48 mg/L
TP conc. = 0.23 mg/L

Est. Average Annual TN Load = 4721 lbs/yr
Est. Average Annual TP Load = 438 lbs/yr

LID Best Management Strategies

Stormwater Landscapes

Pervious Pavement

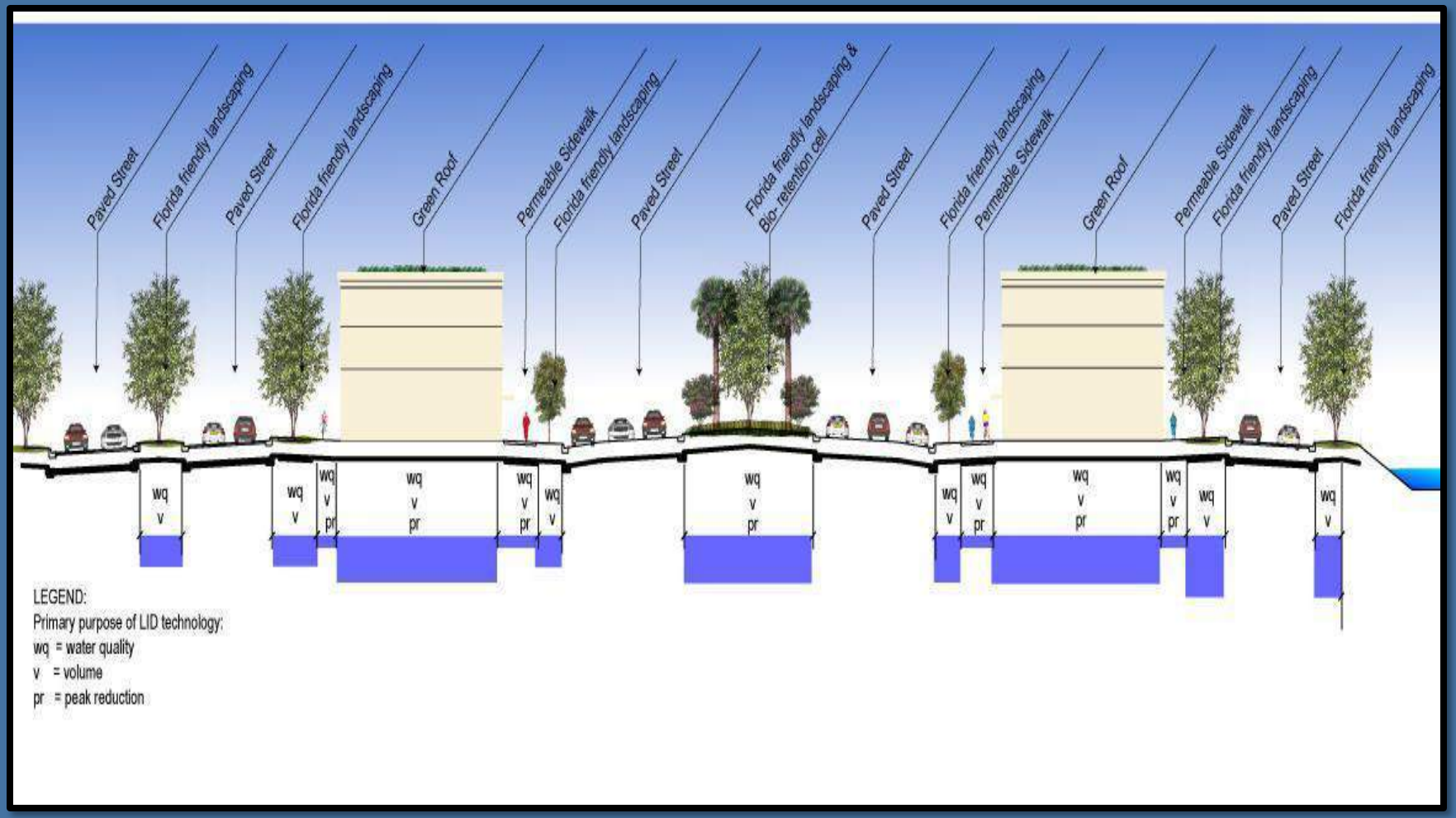
Stormwater Harvesting

Green Roof

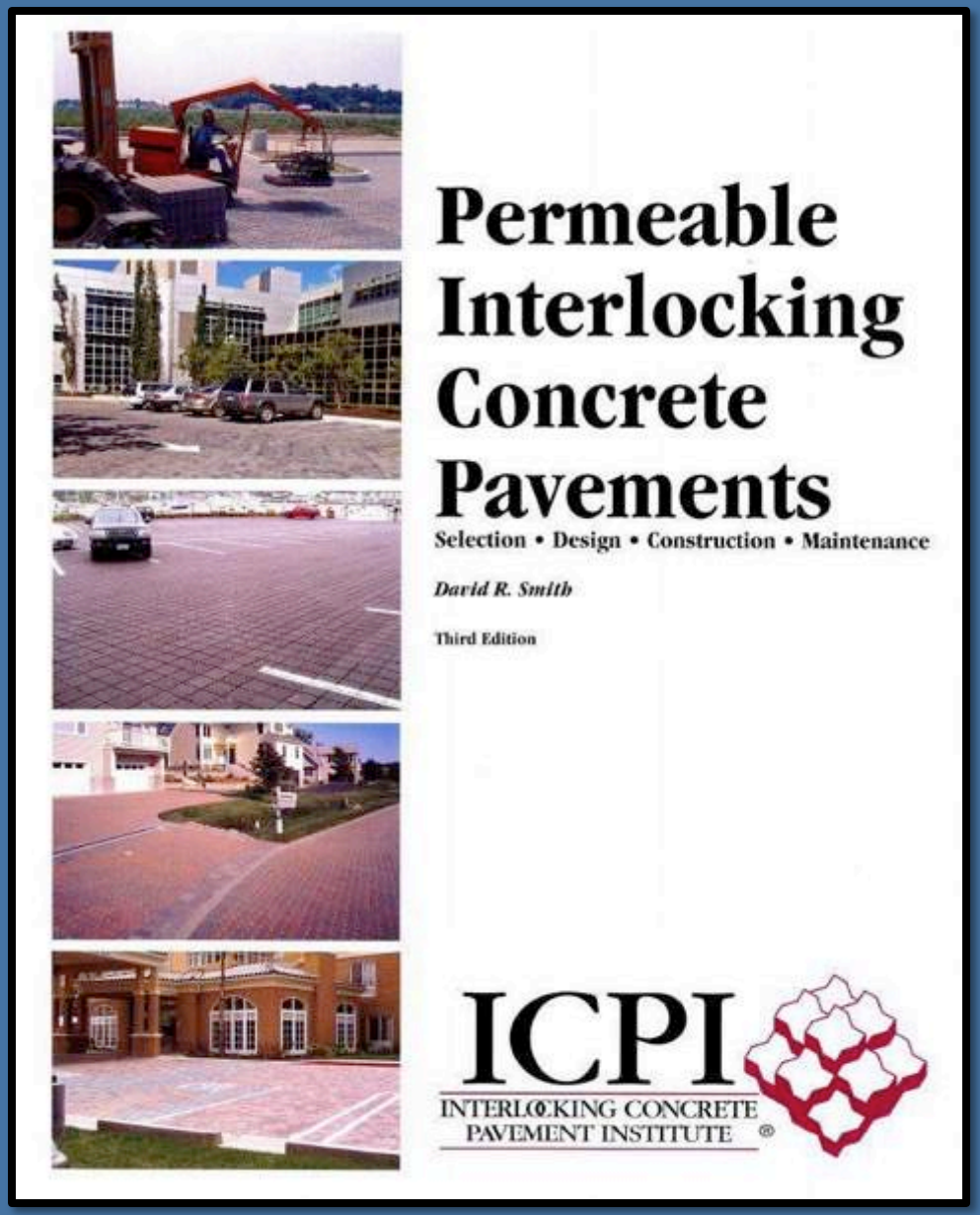
Fruitville @ i75 – LID Opportunities

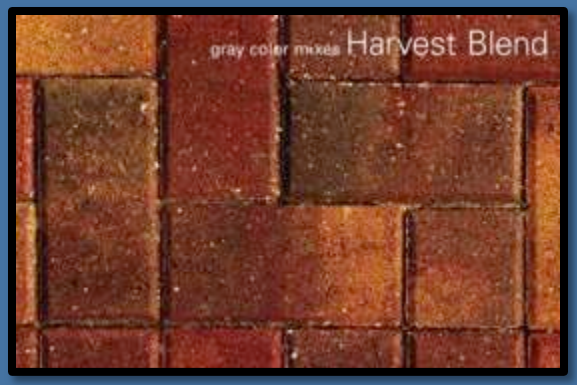
- Only need to provide for stormwater treatment - Floodplain/attenuation provided in regional facility
- Elevation - Sites will have 7.5 ft. from finished grade to Control Water Level
- No wetlands/high water table restrictions
- Land Use – Urban land use designation and form provides value proposition

LID – Across the Transect



LID Streets - Pervious Pavers

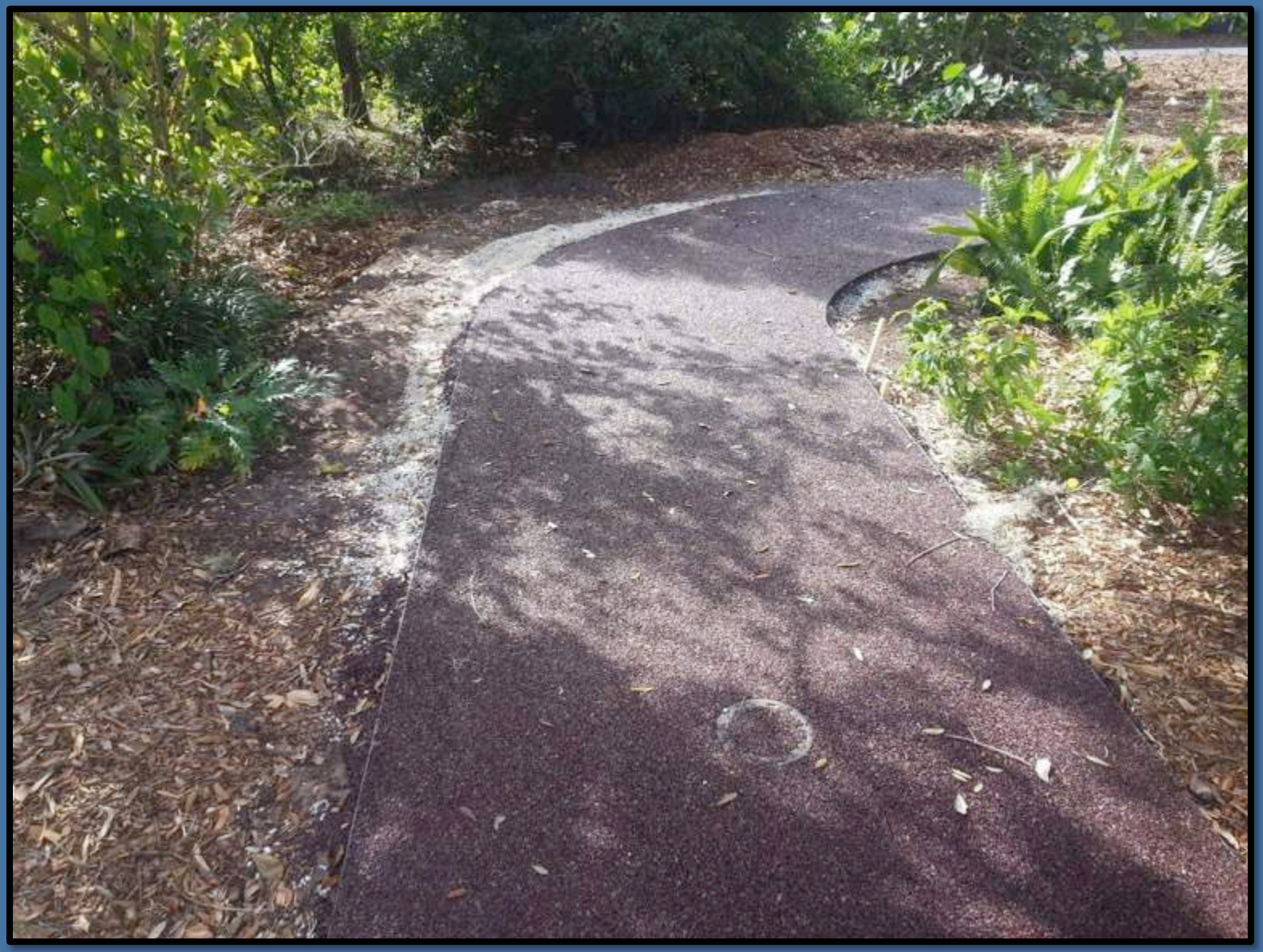




LID Streets – Pervious Pavers

LID Walkway – Pervious Pavers

LID Walkway – Pervious Pavers



LID Walkway – Pervious Pavers

LID - Stormwater Harvesting

LID Buildings - Green Roof

Fruitville @ i75 – Water Quality

Gross Load = 4,721 lbs/yr
Reduction = 3,008 lbs/yr
Net Load = 1,712 lbs/yr

Exist. Load = 2,023 lbs/yr

Estimated TN Load Reductions from:
Stormwater Harvesting = 1,511 lbs/yr
Green Roofs @ 10% = 441 lbs/yr
Pervious Pavement @ 20% = 1,057 lbs/yr

Fruitville Urban Infill Plan

Fruitville Urban Infill Plan w/LID Overlay

Fruitville @ i75 – LID Next Steps

- Develop LID Design (Public Works) Standards
- Link Design Standards to Science
- Create Dashboard Menu
- Establish Permit Criteria w/WMD

LID Design (Public Works) Standards

DISTRICT OF COLUMBIA

DEPARTMENT OF TRANSPORTATION

GREEN INFRASTRUCTURE STANDARDS

2014

DISTRICT OF COLUMBIA

DEPARTMENT OF TRANSPORTATION

TERRY BELLAMY, DIRECTOR

RONALDO T. NICHOLSON, P.E., CHIEF ENGINEER

MUHAMMED KHALID, P.E., DEPUTY CHIEF ENGINEER

RAVINDRA GANVIR, P.E., DEPUTY CHIEF ENGINEER

WASI KHAN, P.E., CHIEF QA/QC DIVISION

Green Infrastructure Standards Development Team

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DDOT/IPMA
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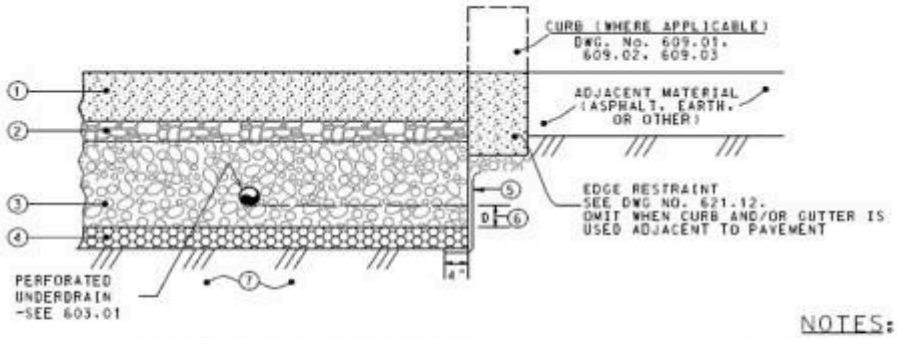
Steve Saari
Greg Hoffmann, P.E., Center for Watershed Protection
A. Morton Thomas & Associates, Inc.
Laura Mehiel, P.E.
Don Rissmeyer, P.E.
Steve Torgerson, ASLA
Larry G. Trout, Jr., P.E.
Robert Pine, FASLA, Pine & Swallow

LID Design (Public Works) Standards



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.

DATE	APPR.	
REVISED		
ISSUED:		REFERENCE

RECOMMENDED: _____ DEPUTY CHIEF ENGINEER

APPROVED: _____ CHIEF TRANSPORTATION ENGINEER

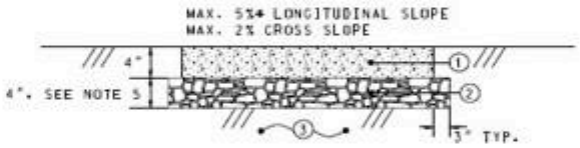
PERVIOUS CONCRETE PAVEMENT

(ROADWAY AND ALLEY)

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.01

LID Design (Public Works) Standards



SIDEWALK SECTION

*STEEPER SLOPE ALLOWED IF APPROVED BY DDOT IPMA.

LEGEND

① PERVIOUS PORTLAND CEMENT CONCRETE

② BASE COURSE, AASHTO #57 OR APPROVED EQUIVALENT

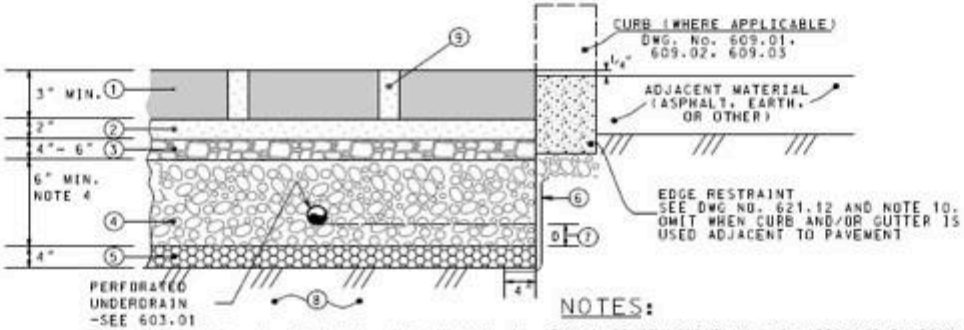
③ UNCOMPACTED SUBGRADE FOR AREAS DESIGNED AS INFILTRATION PRACTICES. FOR OTHER AREAS, COMPACT AS SPECIFIED IN SPECIFICATION CITED IN NOTE 2. FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.

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.

			RECOMMENDED: DEPUTY CHIEF ENGINEER	PERVIOUS CONCRETE SIDEWALK	d. DISTRICT OF COLUMBIA DEPARTMENT OF TRANSPORTATION
DATE	APPR.		APPROVED: CHIEF TRANSPORTATION ENGINEER		DWG. NO. 621.02
REVISED					
ISSUED:		REFERENCE			

LID Design (Public Works) Standards



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 (PMA 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.

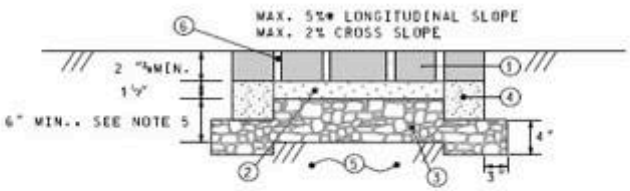
DATE	APPR.		RECOMMENDED: DEPUTY CHIEF ENGINEER
REVISED			
ISSUED:		REFERENCE	APPROVED: CHIEF TRANSPORTATION ENGINEER

PERMEABLE INTERLOCKING UNIT PAVER PAVEMENT
(ROADWAY AND ALLEY)

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

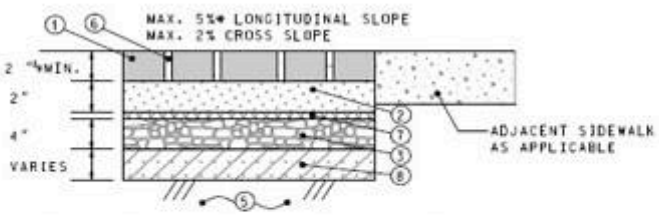
DWG. NO. 621.05

LID Design (Public Works) Standards



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 PERMEABLE 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.	REFERENCE
REVISED		
ISSUED:		

RECOMMENDED: DEPUTY CHIEF ENGINEER

APPROVED: CHIEF TRANSPORTATION ENGINEER

PERMEABLE PAVER SIDEWALK

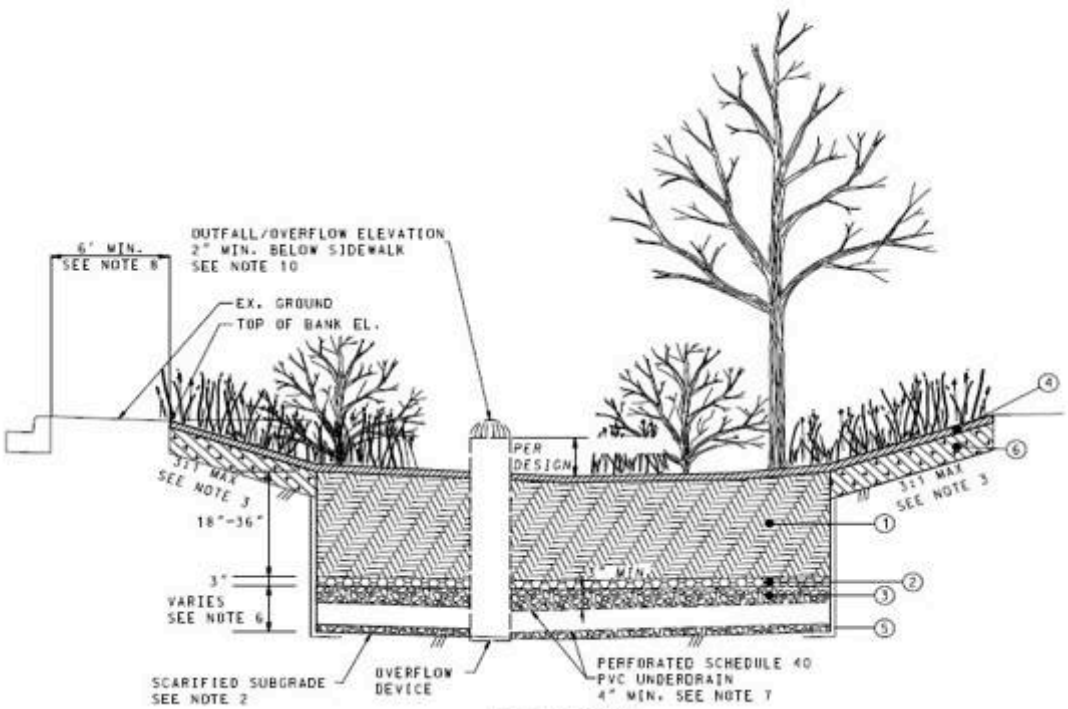
DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.06

LID Design (Public Works) Standards

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.	REFERENCE
REVISED		
ISSUED:		

RECOMMENDED: _____ DEPUTY CHIEF ENGINEER

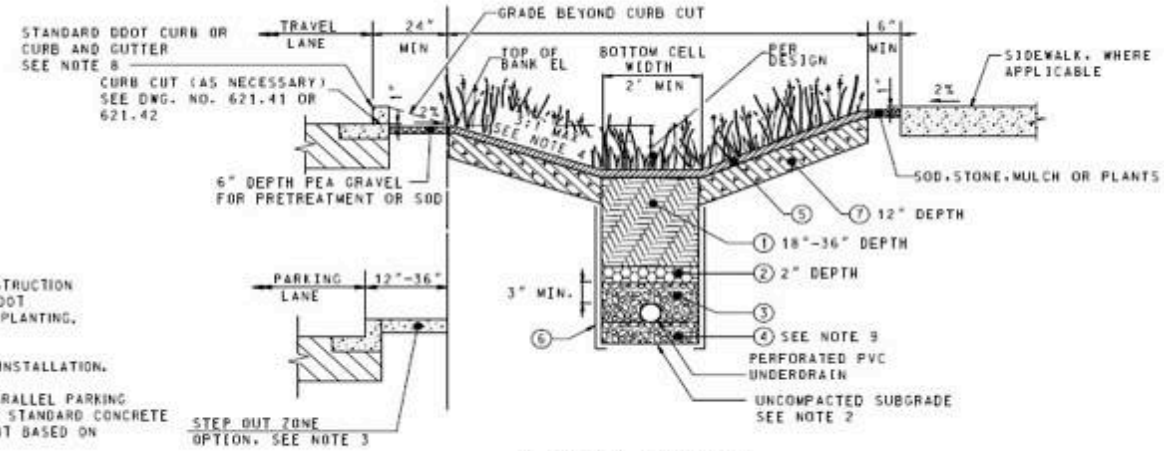
APPROVED: _____ CHIEF TRANSPORTATION ENGINEER

BIORETENTION IN OPEN AREA

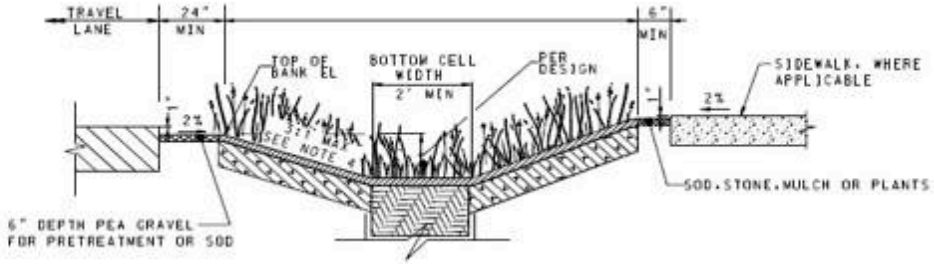
DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.20

LID Design (Public Works) Standards



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.	REFERENCE
REVISED		
ISSUED:		

RECOMMENDED: _____ DEPUTY CHIEF ENGINEER

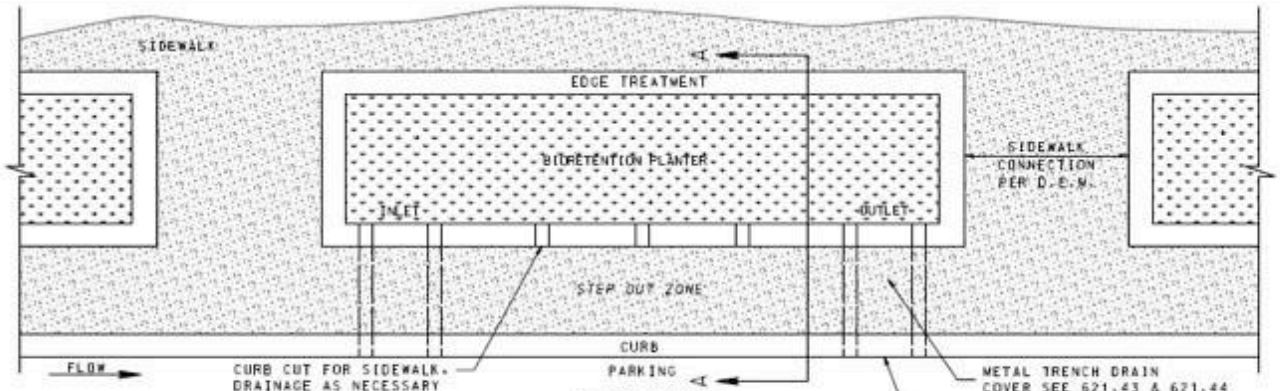
APPROVED: _____ CHIEF TRANSPORTATION ENGINEER

BIOSWALE ADJACENT TO ROADWAY

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.21

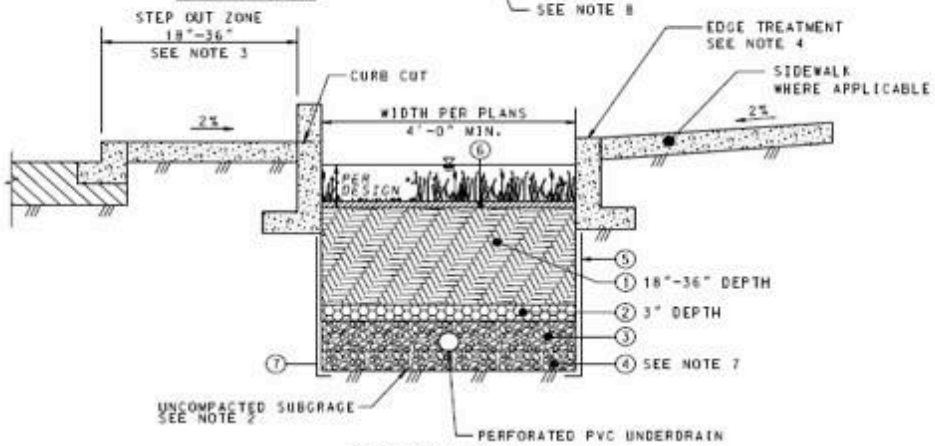
LID Design (Public Works) Standards



PLAN VIEW

NOTES:

1. BIORETENTION MATERIALS AND CONSTRUCTION SHALL MEET CURRENT APPROVED ODOT 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.	REFERENCE
REVISED		
ISSUED:		

RECOMMENDED: _____ DEPUTY CHIEF ENGINEER

APPROVED: _____ CHIEF TRANSPORTATION ENGINEER

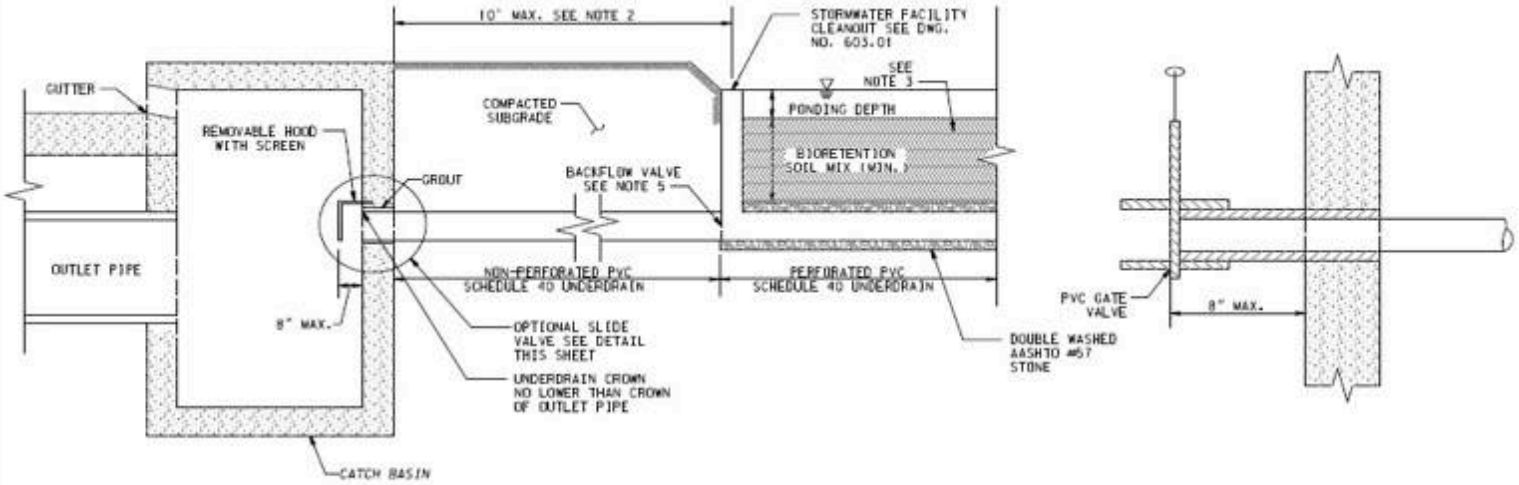
BIORETENTION PLANTER ADJACENT TO ROADWAY–2

(WITH STEP OUT ZONE)

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.23

LID Design (Public Works) Standards

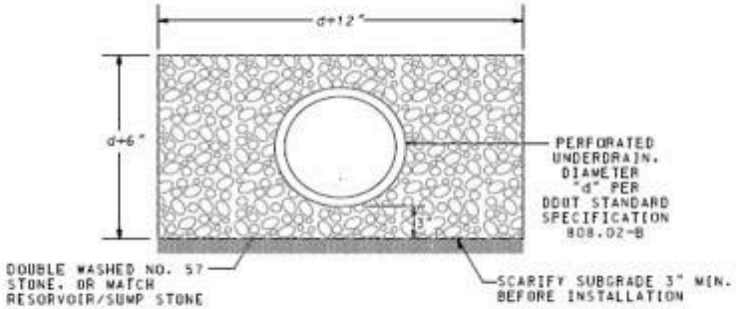


LID UNDERDRAIN CONNECTION TO CATCH BASINS

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

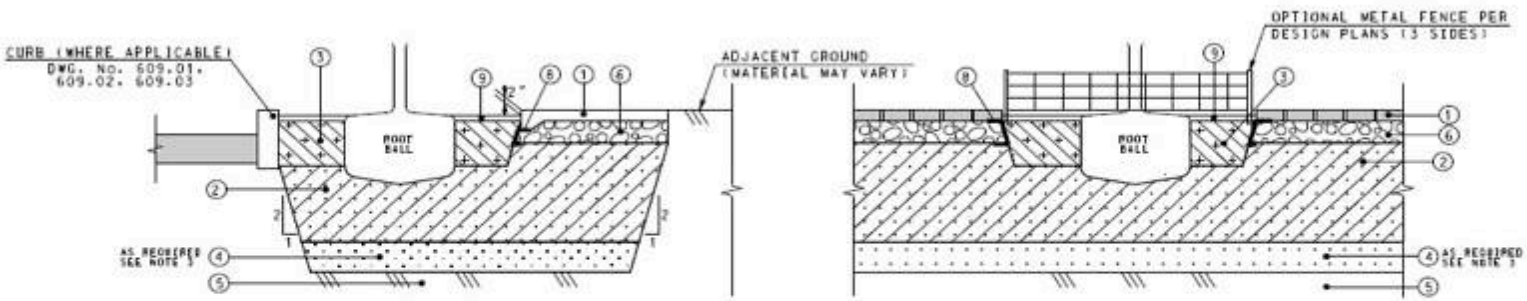
DATE	APPR.		RECOMMENDED: DEPUTY CHIEF ENGINEER
REVISED			
ISSUED:		REFERENCE	APPROVED: CHIEF TRANSPORTATION ENGINEER

STORMWATER FACILITY UNDERDRAIN BEDDING AND CATCH BASIN CONNECTION

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

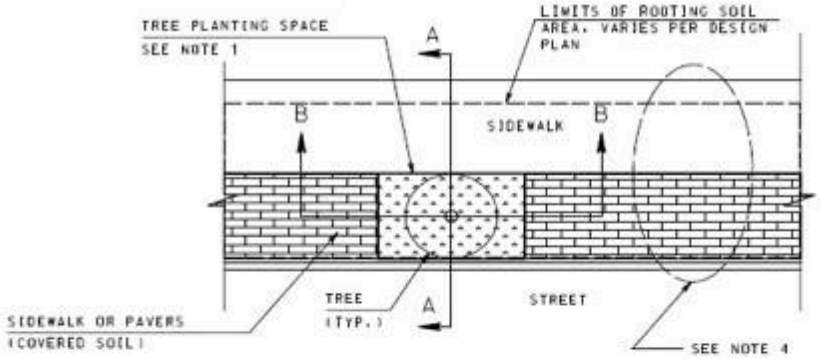
DWG. NO. 621.52

LID Design (Public Works) Standards



SECTION A-A

SECTION B-B



PLAN VIEW

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.

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.	REFERENCE
REVISED		
ISSUED:		

RECOMMENDED: _____ DEPUTY CHIEF ENGINEER

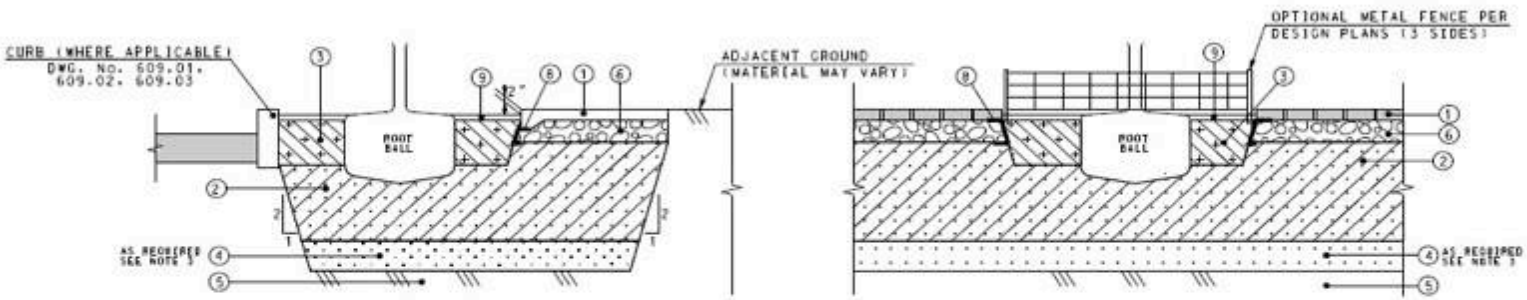
APPROVED: _____ CHIEF TRANSPORTATION ENGINEER

STRUCTURAL SOIL UNDER SIDEWALK – COVERED TREE SPACE

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

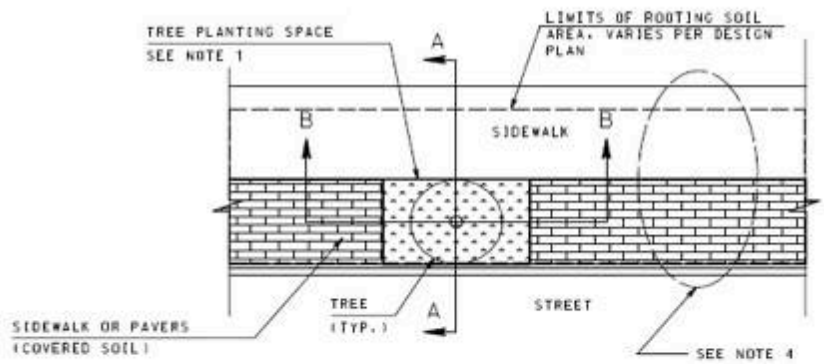
DWG. NO. 621.70

LID Design (Public Works) Standards



SECTION A-A

SECTION B-B



PLAN VIEW

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.

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.	REFERENCE
REVISED		
ISSUED:		

RECOMMENDED: DEPUTY CHIEF ENGINEER

APPROVED: CHIEF TRANSPORTATION ENGINEER

STRUCTURAL SOIL UNDER SIDEWALK – COVERED TREE SPACE

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.70

Design Standards – Specifications

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.

LID Design Standards - Plants

BIORETENTION - LOW LEVEL OF CARE

DDOT GREEN INFRASTRUCTURE STANDARDS

PLANTS FOR USE IN BIORETENTION

Annual maintenance; no irrigation

○ Full Sun ◑ Part Shade ● Full Shade

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

💧 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
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** *'Big Blue'* *'Evergreen Giant'* *'Variegata'*	 1-2 1-2 1-1.5	 1-2 1-2 1-2	Lavender Lavender Purple Purple	Aug-Sept Aug-Sept Aug Aug	○ ◑	M	💧	Perennial		Top Side	1	1 gal.	Tolerates rabbit, deer, drought, erosion, air pollution; Intolerant of standing water
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** *'Golden Fleece'*	1-1.5	1-1.5	Yellow	Aug-Sept	○	H	💧💧	Perennial	X	Top Side	1	1 gal.	Tolerates deer, drought, erosion, clay soil, dry soil, shallow rocky soil
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

LID Design Standards - Plants

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

LID Design Standards - Plants

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

LID Design Standards - Trees

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

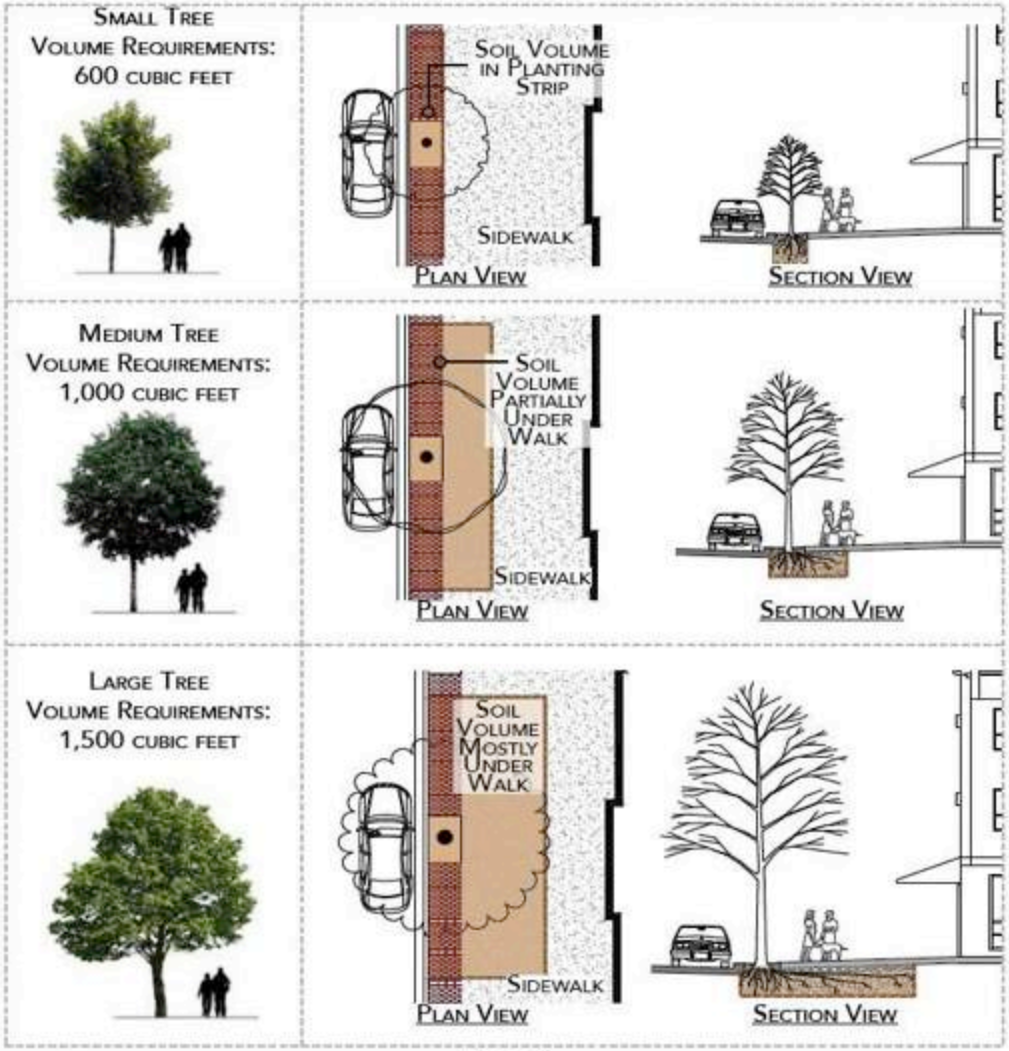


Figure 2

LID Design Standards - Trees

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

LID Design Standards - Trees

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

LID Design Standards - Trees

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

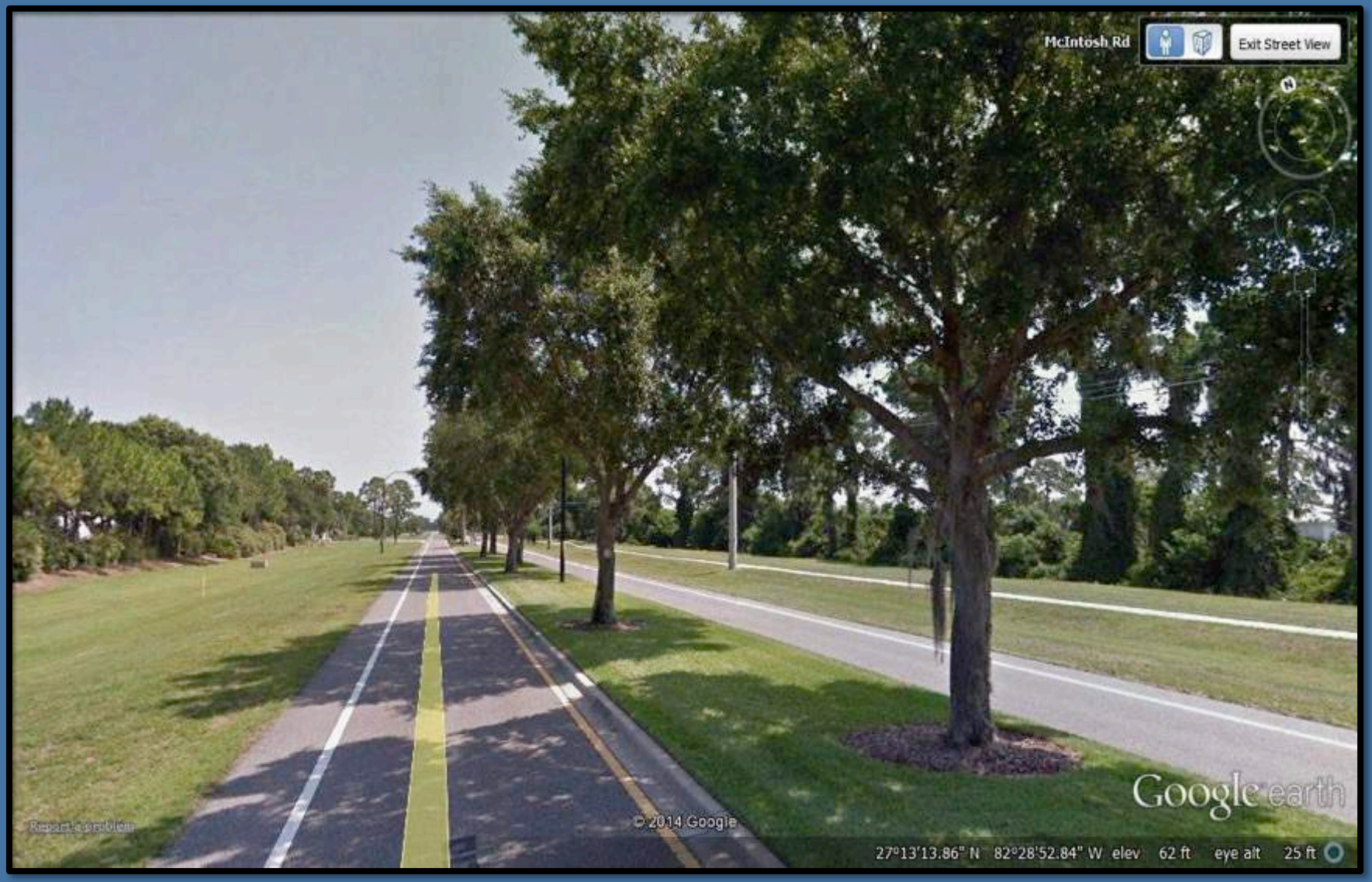
L Low Salt Tolerance M Moderate Salt Tolerance H High Salt Tolerance

💧 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

Stormwater Swale



Landscape

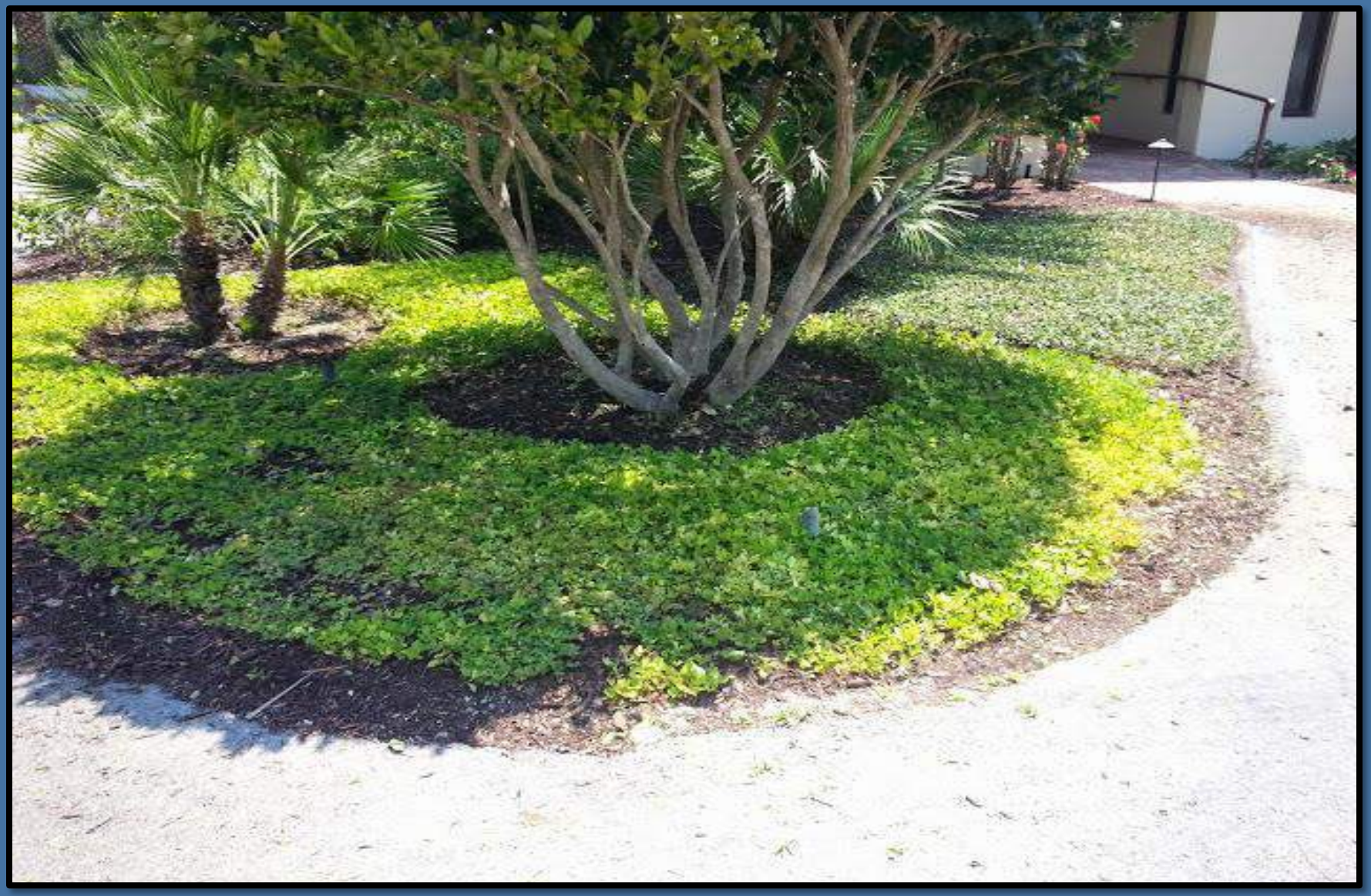
Landscaping with Stormwater Swale

Landscaping in Stormwater Swales

Conventional Landscapes

Florida Friendly Landscapes

Florida Friendly Landscapes



Florida Friendly Landscapes

Landscaping w/Stormwater

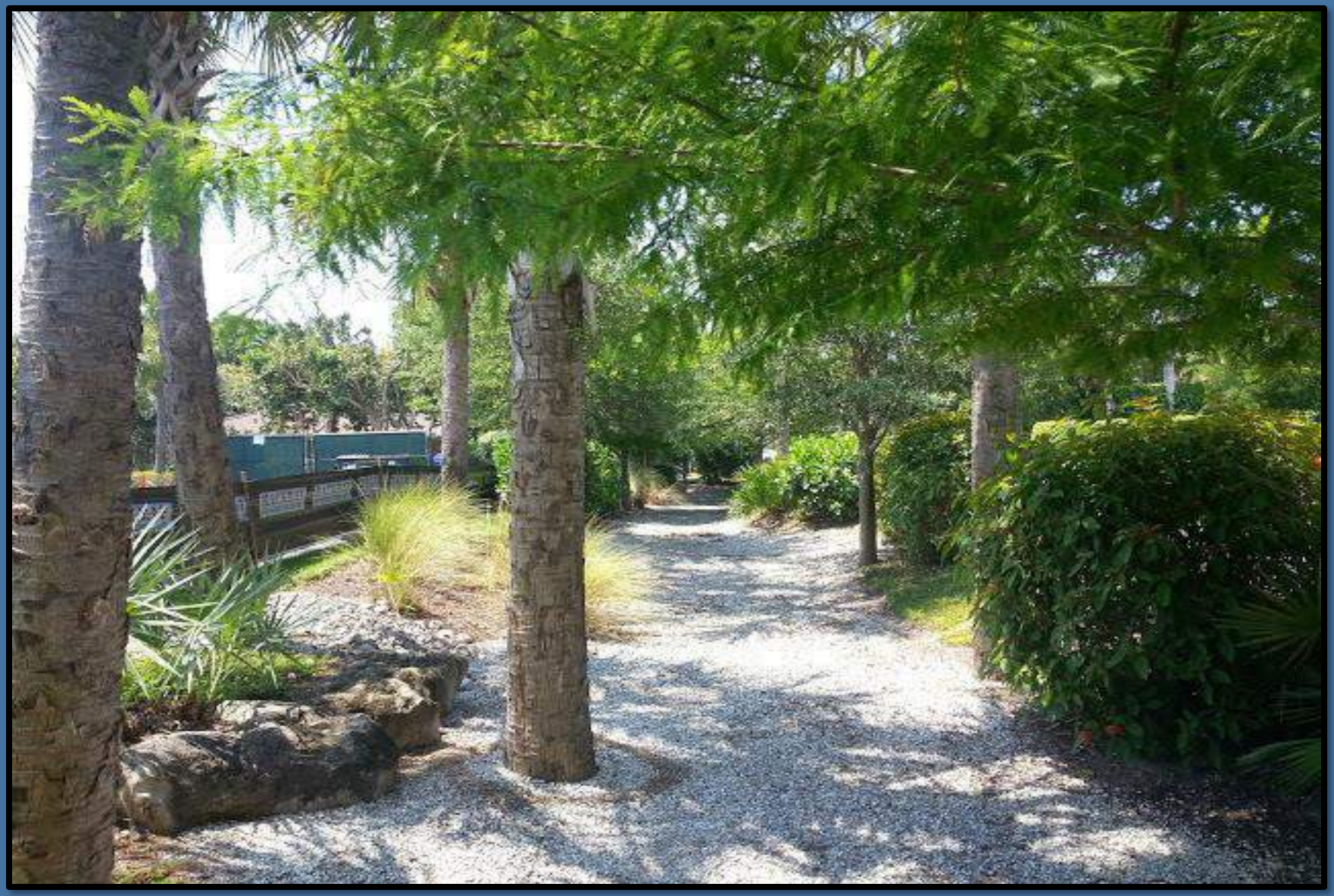
Landscaping w/Stormwater

Landscaping w/Stormwater

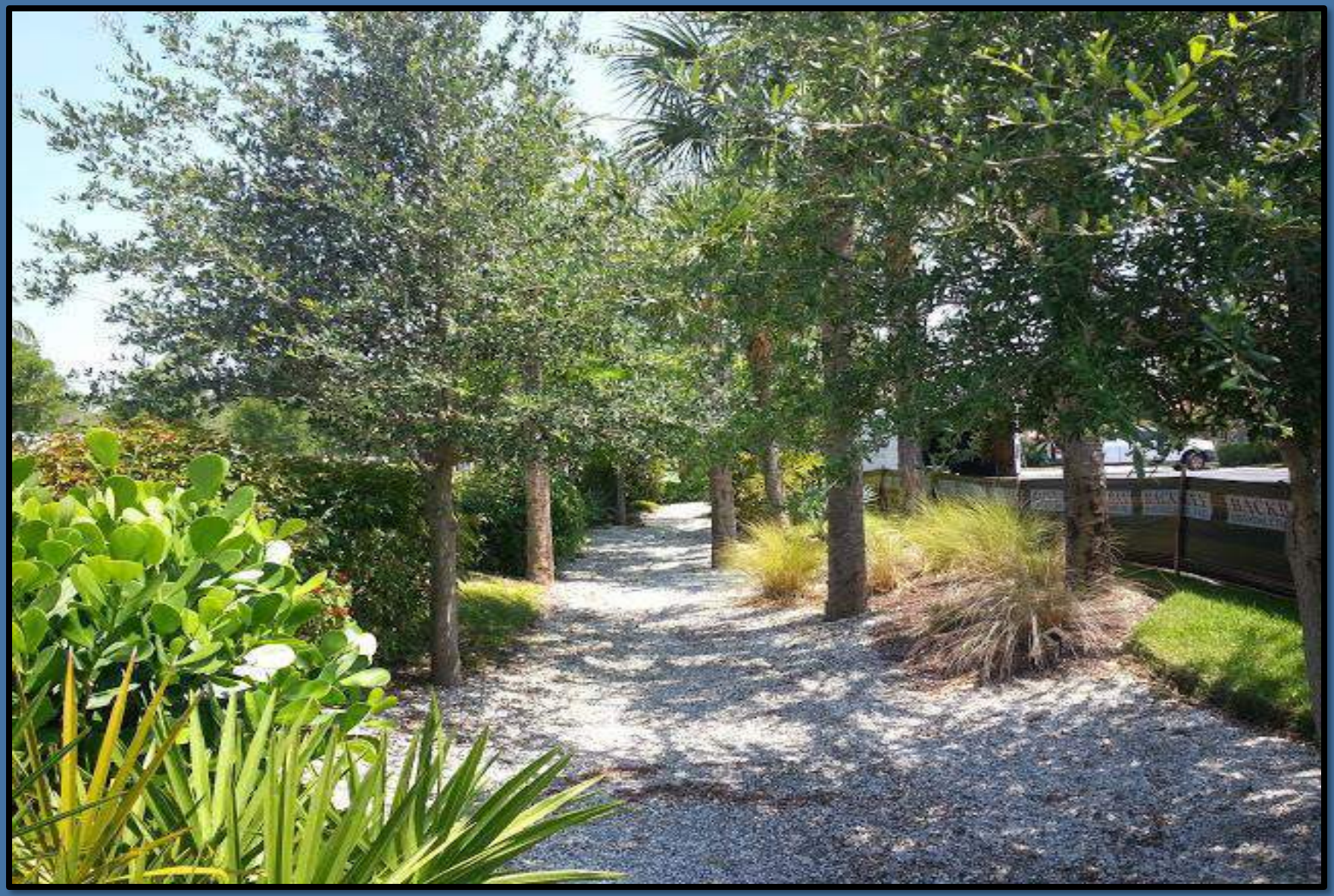
Landscaping w/Stormwater

Stormwater Swale + Landscape

Stormwater Swale + Landscape + Trail

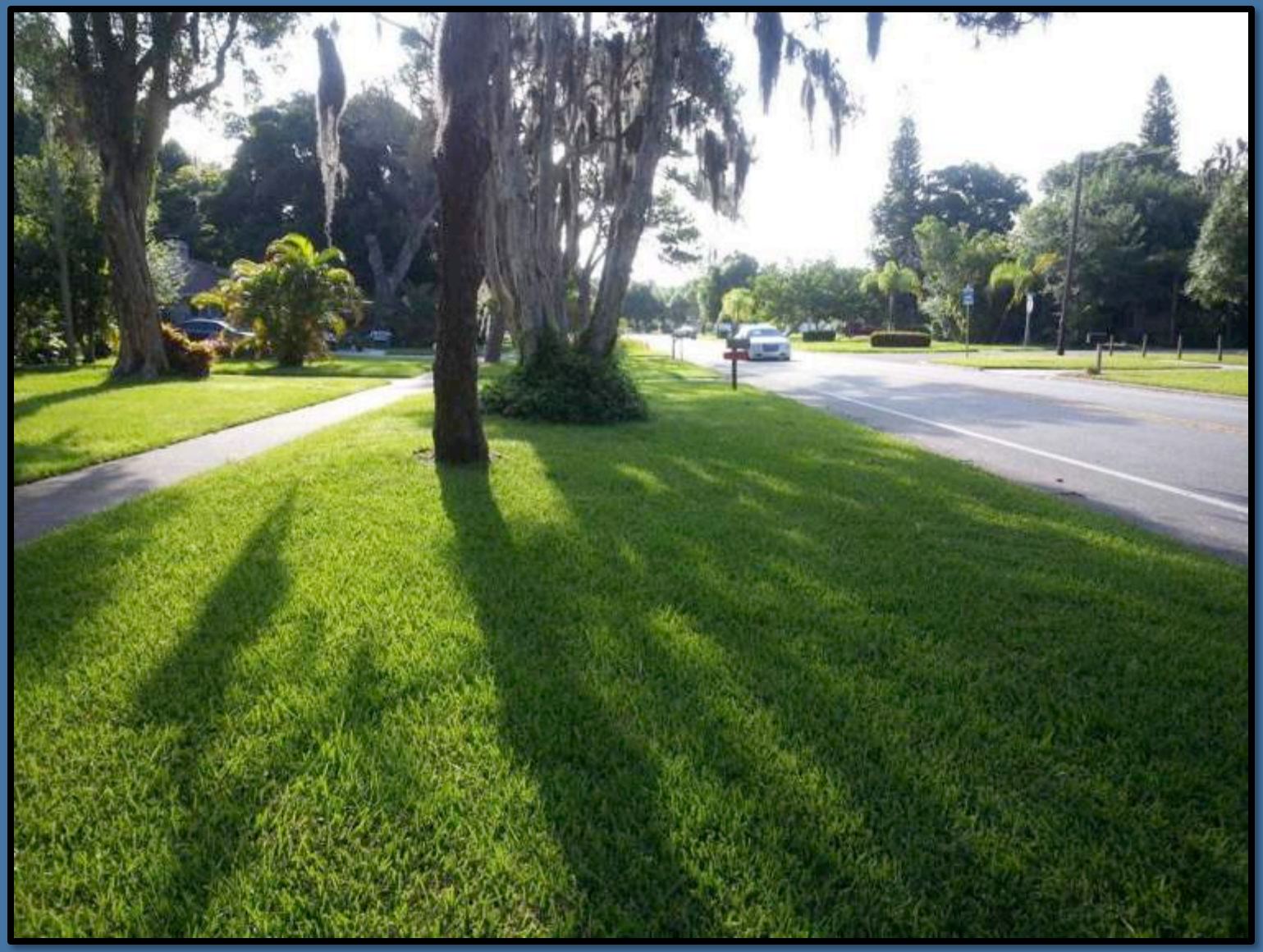


Stormwater Swale + Landscape + Trail



Swale + Landscape + Trail + Playground

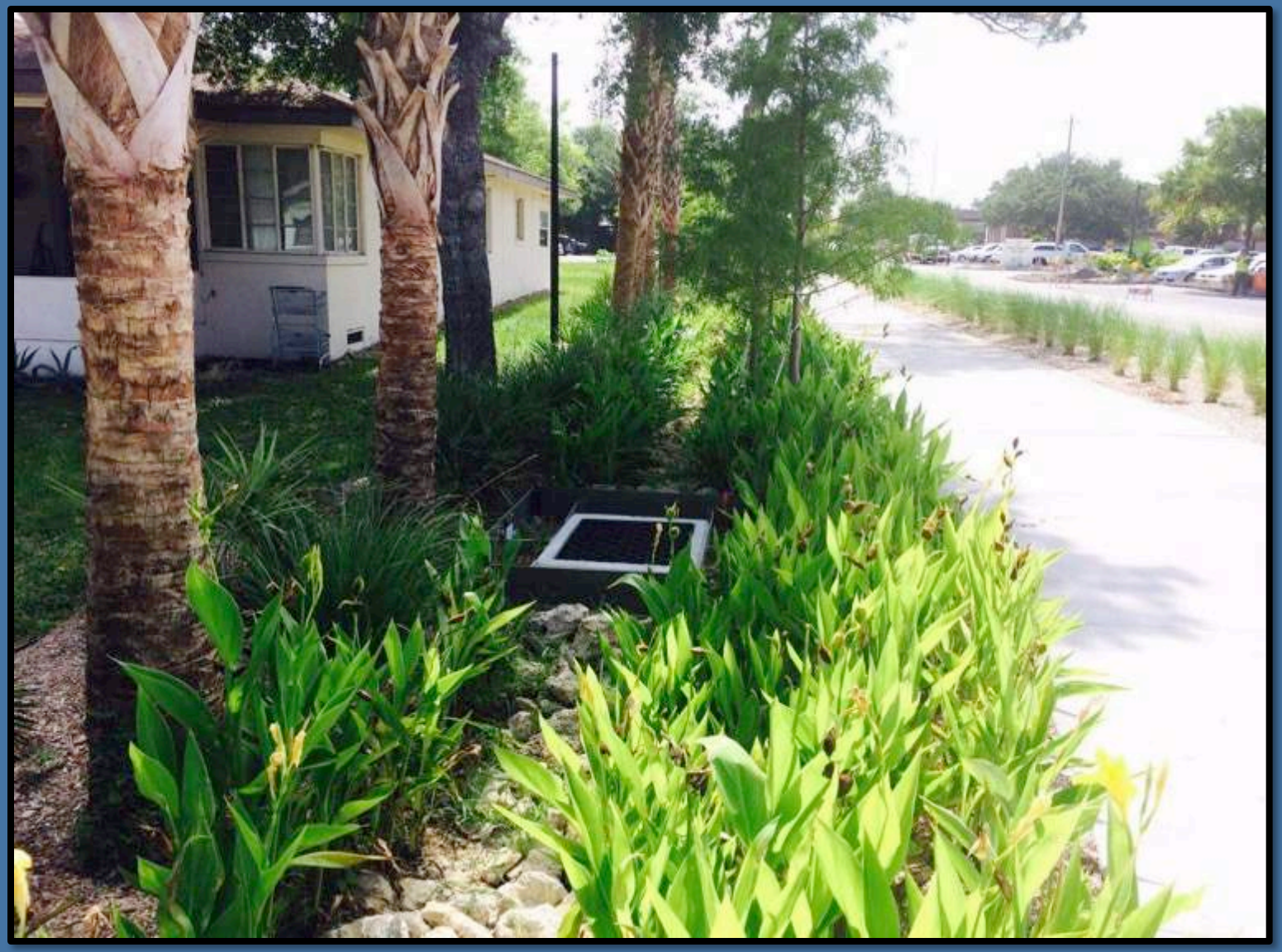
Pre LID



Post LID

LID still requires basic Engineering

LID Stormwater Landscape "Framing"



LID Stormwater Landscape "Framing"

Bioswales - Lessons Learned

- Understand Potential Commitment to Maintenance
- Look for Multiple Use/Benefits
- Keep it Simple
- Engage people who will be directly affected
- Locate utilities, especially in urban areas
- Engage geotech for infiltration and water table
- Requires Stormwater Engineering
- Eye for Design
- Need landscape experience
- Right Vegetation in the Right Place
- Picture frame

The End