The Green and In-Between: Incorporating Green Infrastructure in Municipal Design

Development of LID Standard Details for the City of Dallas

Tricia Hatley, P.E. – Freese and Nichols
Boris Minot, EIT, CFM – Freese and Nichols
LID Design Components

1. Quantity Control
   - Peak Flow Attenuation
   - Runoff Volume Reduction

2. Quality Control
   - Sedimentation
   - Flotation
   - Filtration
   - Biological Processes

3. Pollutant Removal
   - TSS
   - Nutrients
   - Bacteria

MINIMIZE THE QUANTITY OF RUNOFF

MAXIMIZE THE QUALITY OF RUNOFF

LESS FLOODING

LID DRAINAGE CONCEPT
Additional Benefits of LID

Reduced Construction Costs


Increased Property Values

- A 2008 study in Seattle found neighborhoods with LID practices increased property values by 3.5-5% (The Effect of LOD on Property Values, Water Environment Federation)
Challenges

- High Intensity Rainfall
- Dual Function Performance
- Poor Soils
- Poor Construction Practices
- Poor Design Practices
- Lack of Available Space
- Poor O&M Practices
- Vegetation Failure
- BMP Failure
Keys to Success

- Constructible
- Durable
- Maintainable
- Compatible
- Visible
- Context Sensitive
• Adoption and inclusion of LID Standard Details into design standards

• Updated Drainage and Paving Manuals

• LID Training and Maintenance Presentations for City staff

• LID becomes the accepted and preferred design approach
Creating Standard Details
Objectives

Research LID Programs Nationwide

Determine appropriateness for Dallas

Input from stakeholders
Curb Extension
  - Corner
  - Mid-block

Tree Box Filter
  - Single
  - In Series

Bioretention Planter
  - With Parking
  - Without Parking

Enhanced/Vegetated Swale

Bioswale

Placement Diagram

Low Impact Development
Standard Details

Department of Public Works

City of Dallas, Texas
Bioretention Planters

California Department of Transportation
Bioretention Planters
Curb Extensions

STORMWATER FROM ROADWAY FLOWS INTO TROUGH OUT
DOWER RIDER TRANSFERS EXCESS WATER TO UNDERGROUND
PLANTS FILTER AND TRANSPIRE WATER WHILE ENHANCING THE STREETScape
WATER INFILTRATES THROUGH SOIL
STONE OR OTHER STORAG MEDIA PROVIDES ADDITIONAL STORMWATER STORAGE
UNDERGROUND CARRIES EXCESS WATER TO SEWER THROUGH OVERFLOW INLET
SPLASH PAD
Curb Extensions
Curb Extensions
Enhanced/Vegetated Swale

City of Philadelphia Green Streets Design Manual, 2014
Enhanced/Vegetated Swale
Enhanced/Vegetated Swale
Tree Box Filter
Tree Box Filter

Grande Dunes Marina, Contech Engineered Solutions
Tree Box Filter - Single
BIORETENTION PLANTERS CONTROL PEAK FLOWS AND VOLUMES OF STORMWATER RUN-OFF BY PROVIDING SURFACE AND SUBSURFACE STORAGE AND INFILTRATION INTO NATIVE SOIL. WATER IS ALSO TREATED AS IT FILTERS THROUGH THE BIORETENTION SOIL.

DESIGNER GUIDELINES:

1. THIS DESIGN DETAIL MUST BE ADAPTED TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. LAYOUT REQUIREMENTS: REFER TO THE CITY OF DALLAS PAVING DESIGN MANUAL AND STANDARD CONSTRUCTION DETAILS. DS-2-0 FOR COURTYARD STRIPWAY, PARKING SPACE AND ACCESSIBLE PATH REQUIREMENTS.
4. SURFACE POOL DRAWDOWN TIME IS TIME FOR MAXIMUM SURFACE POOLING TO INFILTRATE INTO THE BIORETENTION SOIL AFTER THE END OF A STORM. RECOMMENDATIONS:
   - 3-12 HOUR DRAWDOWN IS OPTIMAL
   - 24 HOUR MAXIMUM DRAWDOWN RECOMMENDED
5. A CURABLE RESPIRATOR COURSE IS TYPICALLY REQUIRED UNTIL THE BIORETENTION SOIL TO PROVIDE ADDITIONAL STORAGE.
6. AVOID COMPACTION OF EXISTING SUBGRADE BELOW THE PLANTER DURING CONSTRUCTION. THE SUBGRADE MUST BE SCARIFIED TO MINIMUM BEFORE INSTALLATION.
7. IN THE EVENT THE PLANTER OUTLET IS BURIED OR COVERED, PLANTERS SHALL BE DESIGNED TO AVOID INFILTRATION TO THE STOREDLEVEY TO THE STREET.
8. NOTCHES IN THE PLANTER WALL SHALL BE SIZED AND SPACED AS REQUIRED TO AVOID INFILTRATION ON THE SIDEWALK ALONGSIDE THE PLANTER. IT IS RECOMMENDED THAT NOTCHES BE CAST IN PLACE RATHER THAN SAW CUT
9. ALL EXPOSED CONCRETE EDGES SHALL BE REVELED.
10. THE PLANTING MEDIA SURFACE IN STORMWATER PLANTERS SHALL BE LEVEL ALONG THE ALIGNMENT OF THE STREET. A SUCTION NO GREATER THAN 1% PERCENT IS ACCEPTABLE BUT A LEVEL SURFACE IS RECOMMENDED. CHECK DAMS MAY BE USED TO TERMINATE FACILITIES TO PROVIDE SUFICIENT PENETRATION FOR LOWER-LEVEL INSTALLATIONS. NOTE: THIS DOES NOT APPLY TO THE CROSS-GRAINING IF USED FROM THE PERIMETER OF THE PLANTER DOWN TO THE LOWEST PLANTING MEDIA SURFACE.
11. DESIGNER SHALL CONSIDER THE HEIGHT OF VEGETATION BOTH AT INSTALLATION AND ANTICIPATED MATURITY. BOTH HEIGHTS SHALL BE CONSIDERED IN THE CONTEXT OF THE STORMWATER PLANTER’S PLAN DIMENSIONS, DEPTH, AND SURROUNDING AREA PROTECTION AND VEGETATION SELECTED ACCORDINGLY. IF IT HAS BEEN FOUND THAT A PLANTER SIDE AND/OR HAS HIGH AREA PROTECTION, VERY LOW VEGETATION AT INSTALLATION TENDS TO GIVE A STORMWATER PLANTER AN EXCESSIVELY DEEP APPEARANCE, NOTE THAT WITH THE EXCEPTION OF TREES, MAXIMUM VEGETATION HEIGHT AT MATURITY SHALL BE NO GREATER THAN 18 INCHES ABOVE THE SURROUNDING SIDEWALK ELEVATION. ALSO, PLANT SELECTION AND PLACEMENT SHALL BE DONE TO PREVENT ENCROACHMENT OF PLANTS OUTSIDE OF THE LIMITS OF THE STORMWATER PLANTER AND CONSIDERATION OF MAINTAINING ACCURATE HEIGHTS BASED ON THE PLACEMENT OF THE STORMWATER PLANTER.
12. MAXIMUM DROP FROM TOP OF GRADING TO TOP OF BIORETENTION SOIL SHALL INCLUDE CONSIDERATIONS FOR THE BIORETENTION SOIL SETTLEMENT.
13. UP TO TWO PLANTERS MAY BE CONNECTED IN SERIES, IN LINE OF MULTIPLE INLETS. PROVIDED THE CONNECTION IS A TRENCH DRAIN OR EQUAL SURFACE CONVEYANCE AND IS ADEQUATELY SIZED TO CONVEY FLOWS.
**Landscaping Planting Media**

**PLANTING NOTES**

1. CONTRACTOR WILL BE RESPONSIBLE FOR REFINISHING THE VARIOUS LANDSCAPING RELATED ITEMS IN THE PROPOSAL FOR SPECIFIED DIMENSIONS, VOLUMES AND MEASUREMENTS THAT HAVE BEEN MODIFIED OR NOT SHOWN.

2. ALL PLANTS WILL BE NURSERY-GROWN IN CONTAINERS UNLESS OTHERWISE SHOWN ON PLANS.

3. LOCATION OF PLANTS WILL BE IN ACCORDANCE WITH THE GENERAL PLANTING ITEM. PARAGRAPH 2.1.3.7 PLANT SELECTIONS ITEM 2.1.3. REJECTION OF PLANTS.

4. LOCATIONS OF TREES, SHRUBS, AND BUSH WILL BE STATED IN THE FIELD BY THE CONTRACTOR FOR APPROVAL BY LANDSCAPE ARCHITECT PRIOR TO PLANTING.

5. THE CONTRACTOR WILL BE RESPONSIBLE FOR THE SAFE TRANSPORTATION OF PLANTS TO THE PROJECT SITE AND THEIR CONDITION UPON ARRIVAL.

6. PLANT MATERIALS WILL NOT BE STORED ON HARD SURFACE OR LEFT EXPOSED TO THE SUN.

7. PROTECT THE ROOT BALLS AND WATER REGULARLY UNTIL PLANTING.

8. IF PLANTS ARE LEFT IN STORAGE OVER THE WINTER OR HOURLY, A MEANS OF PERIODICALLY WATERING AND INSPECTION CONTAINER MOISTURE WILL BE PROVIDED.

9. ALL PLANTS WILL BE HARDY, SYMMETRICAL, TIGHT KNOT, AND SO TRAINED OR FAVORABLE DEVELOPMENT AND APPEARANCE AS TO BE SUPERIOR IN FORM, SHAPE OR BRANCHES, AND COMPACTNESS. PLANTS WILL BE SOURCED FROM THE CONTRACTOR'S LOCAL SUPPLIERS, PARTICIPATING OR VENDOR, AND WILL BE HANDLED IN A PROFESSIONAL MANNER.

10. ALL SHRUB AND FREE PLANTINGS WILL BE MULCHED AFTER PLANTING TO THE DEPTH INDICATED IN THE DETAILS. MULCH WILL BE HARDWOOD-LANDSCAPED WITH A MINIMUM OF 4 INCHES (100 MM) OF HARDWOOD, AND OTHERS, WHICH WILL BE PART OF AN APPROPRIATE MIX WITH OR WITHOUT THEIR CONTAMINANTS (STONES, STICKS, CLAY, OR OTHER MATERIALS).

**PLANTING BED PREPARATION**

11. ONCE PLANTING LOCATIONS HAVE BEEN APPROVED IN THE FIELD, APPLY A SUPERIOR MIXTURE WITHIN THE AREAS TO QUIT EXISTING VEGETATION AND WEEDS. IMPLANT TO OBTAIN COMPLETE VEGETATION CONTROL, REAPPLY AS NECESSARY BEFORE APPLYING COMPOST.

APPLY THREE INCHES (75 MM) OF COMPOST (See General Planting Item Part 2.2.4 FOR COMPOST SPECIFICATIONS) TO ALL PLANTING AREAS. THOROUGHLY TILL TO A DEPTH OF 12 INCHES (300 MM), COMPOST AND HIERBIDE APPLICATIONS WILL NOT BE PAID FOR SEPARATELY BUT WILL BE CONSIDERED SUBSIDARY TO THE GENERAL PLANTING ITEM.

**ENGINEERED SOIL: L-5.1**

**MULCH: L-5.2**

**LIST OF PLANTS ACCEPTABLE FOR LID FACILITIES: L-5.3**

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<td>CREPE MYRTLE</td>
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**THE FOLLOWING GRASS SPECIES PERFORM WELL IN THE STRESSFUL ENVIRONMENT OF AN OPEN CHANNEL AND ARE THERFORE RECOMMENDED FOR BIODRAINS AND MANHOLE-VEGETATION CHANNELS:**

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<td>INDIAN SUMMER</td>
<td>BLADDERGRASS</td>
<td>PRAIRIE GRASS</td>
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<td>CRAB GRASS</td>
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**LANDSCAPE NOTES**

**LOW IMPACT DEVELOPMENT**

**STANDARD DETAILS**

**DISTANCE OF ITEMS**

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<th>CITY OF DALLAS, TEXAS</th>
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28
Public Signage

Educate the public about LID goals, functions and importance

Identifies lid facility for maintenance crews
# Maintenance and Inspections

## Bioretention Planter/Curb Extension/Bioswale/Vegetated Swale Inspection and Maintenance Checklist

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>Inspection Performed</th>
<th>Maintenance Performed</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monthly Inspections/Maintenance</strong></td>
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<tr>
<td>Remove trash, sediment, and debris</td>
<td>Remove trash, sediment, and debris within and around the BMP. Note depth of sediment in trench drains or splash pads and remove.</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
<td></td>
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<tr>
<td>Wipe down signage</td>
<td>Wipe down signage using an all-purpose cleaner and soft rag.</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
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<tr>
<td>Remove non-target/invasive vegetation (March to November)</td>
<td>Remove non-target/invasive plants using applicable mechanical or chemical methods.</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
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<tr>
<td>Inspect structural components</td>
<td>Document damage to any structural components including curbs, grate, splash pads, clean outs, check dams, or overflow structures.</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
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<tr>
<td>Check for evidence of standing water</td>
<td>Document the depth of standing water and estimated date and time of last storm event.</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
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<tr>
<td>Check for evidence of erosion or scouring</td>
<td>Document location and severity of scouring, rutting or erosion, specifically around entrance and exit points.</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
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<tr>
<td><strong>Annual Inspections/Maintenance</strong></td>
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<tr>
<td>Apply mulch</td>
<td>If applicable, apply mulch to landscaped beds as needed.</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
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<tr>
<td>Streambed cobbles</td>
<td>Replace streambed cobbles and entrance and exit locations as needed.</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
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<td>Cut back target perennials (March)</td>
<td>Manually cut detrimental herbaceous vegetation from the previous growing season to 4-6 in. above the ground.</td>
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<td>Prune trees and shrubs (b/y Sept. and Dec.)</td>
<td>Elevate lower limbs and remove dead, rubbing, or crossing limbs</td>
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<tr>
<td>Vacuum subsurface structures</td>
<td>Remove trash/sediment/organic debris from subsurface structures</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
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<td>Jet-rod pipes</td>
<td>Jet-rod conveyance, distribution, and underdrain pipes</td>
<td>☐ Y ☐ N ☐ Y ☐ N</td>
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*Add any additional notes and summary on the back of this page.*
## Maintenance and Inspections

### Bioretention Planter/Curb Extension/Bioswale/Vegetated Swale Inspection and Maintenance Checklist

**Inspection Notes/Summary:**

<table>
<thead>
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<th>Sketch of Facility (note problem areas):</th>
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**Photographs:**

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Maintenance Protocol

**MATERIALS AND EQUIPMENT**

**Tools and Equipment**
- General hand tools
- Screwdrivers
- Wrenches
- Pliers
- Level
- Tape measure
- Power tools (drill, sander, etc.)

**Materials**
- Wood
- Metal
- Insulating material
- Adhesives
- Sealants
- Paint
- Protective coatings

**Safety Equipment**
- Personal protective equipment (PPE)
- Respirators
- Safety glasses
- Hard hats

**PROCEDURE**

1. **Preparation**
   - Ensure the area is clear and free from obstacles.
   - Identify the materials and equipment needed for the task.
   - Check the condition of all tools and equipment.

2. **Assessment**
   - Evaluate the condition of the materials.
   - Inspect for any signs of wear, damage, or deterioration.
   - Verify that all materials are suitable for the application.

3. **Application**
   - Apply the chosen materials according to the manufacturer's instructions.
   - Ensure that the application is even and consistent.
   - Monitor the materials for any signs of failure or issues.

4. **Cure and Maintenance**
   - Allow the applied materials to cure according to the manufacturer's recommendations.
   - Perform regular checks on the materials to ensure they are performing as expected.
   - Address any issues or concerns promptly.

**QUALITY ASSURANCE**

- Regularly inspect all materials and equipment for proper functioning.
- Use certified personnel for all applications.
- Document all work performed and maintenance activities.

**SAFETY GUIDELINES**

- Wear appropriate PPE at all times.
- Follow all safety protocols and guidelines.
- Conduct safety training for all personnel.
- Maintain a clean and safe work environment.

**RECORD KEEPING**

- Maintain detailed records of all maintenance activities.
- Update all relevant documents with the latest information.
- Use an asset tracking system to monitor the condition of all materials and equipment.
Training for City of Dallas Staff

1st Session: September 2016
- Introduction of LID and the details

2nd Session: August 2017
- Maintenance
Questions?

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• Boris Minot, EIT, CFM – Freese and Nichols – boris.minot@freese.com