Integrating Transportation and Green Infrastructure

SCVURPPP GI Workshop
April 19, 2017

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EOA, Inc.
Outline of Presentation

- Overview & Types of Green Street Systems
- Strategies and Approaches
- Local, State and National Guidance
- Pedestrian Infrastructure Types
- ADA Issues
- Cyclist Infrastructure Types
- Safe Routes to School, Transit & Parks
- Examples of Integrated Systems
The Autozoic Epoch is over!
Green Street System Types

- **Biotreatment:**
  - Curb Extension
  - Sidewalk planter
  - Traffic Circle
  - Tree Trench
  - Rain garden
  - Stormwater CycleTrack
  - Shoulders/Ditches*
  
  *depends on various factors

- **Other Measures:**
  - Pervious Pavement
  - Infiltration trench
  - Cistern/Rain Barrel
  - Proprietary Systems
Complete and Green Street Integration Strategies

- Road Diets
- Safety Improvements
- Complete Streets – Multi-modal
- Stacked Environmental Benefits
- Excess Impervious Surface
Graphic Approaches for Displaying GI Integration

- Roadway Cross Section (Wichita)
- Roadway Cross Section Matrix (San Diego)
- Roadway Types (Philadelphia)
CITY HEIGHTS URBAN GREENING PLAN

A MODULAR APPROACH TO RECLAIMING PUBLIC SPACE WITHIN OUR STREETS

<table>
<thead>
<tr>
<th>STREET ZONES</th>
<th>THRIVING</th>
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BIKE ELEMENTS

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Courtesy of City of San Diego
<table>
<thead>
<tr>
<th>STREET ZONES</th>
<th>Typical Dimensions</th>
<th>Example Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street</td>
<td>10.0 ft</td>
<td>10 ft, 3 inches Width, 10 ft, 3 inches Height</td>
</tr>
<tr>
<td>Avenue</td>
<td>20.0 ft</td>
<td>20 ft, 0 inches Width, 20 ft, 0 inches Height</td>
</tr>
<tr>
<td>Road</td>
<td>30.0 ft</td>
<td>30 ft, 0 inches Width, 30 ft, 0 inches Height</td>
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### URBAN FOREST ELEMENTS

<table>
<thead>
<tr>
<th>COMPONENTS</th>
<th>Description</th>
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<tbody>
<tr>
<td>Street Trees</td>
<td>Provides shade and oxygen</td>
</tr>
<tr>
<td>Sidewalks</td>
<td>Enhances pedestrian comfort</td>
</tr>
<tr>
<td>Street Furniture</td>
<td>Improves visual appeal</td>
</tr>
</tbody>
</table>

*Courtesy of City of San Diego*
# City Heights Urban Greening Plan

A modular approach to reclaiming public space within our streets

## Street Zones

<table>
<thead>
<tr>
<th>Component</th>
<th>Typical Dimensions</th>
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</thead>
<tbody>
<tr>
<td>Building Zone</td>
<td>NA</td>
</tr>
<tr>
<td>Business / Street Activation Zone</td>
<td>4'-12'</td>
</tr>
<tr>
<td>Walking Zone</td>
<td>5'-10'</td>
</tr>
<tr>
<td>Furnishings / Parkway/ Street</td>
<td>2'-10'</td>
</tr>
<tr>
<td>Parking Lane</td>
<td>7'-16'</td>
</tr>
<tr>
<td>1/2 Buffer</td>
<td>4'-6'</td>
</tr>
<tr>
<td>Bike Facility</td>
<td>2'</td>
</tr>
<tr>
<td>1/2 Buffer</td>
<td>2'</td>
</tr>
<tr>
<td>Travel Lane</td>
<td>11'-13'</td>
</tr>
<tr>
<td>Median</td>
<td>4'-18'</td>
</tr>
</tbody>
</table>

## Stormwater Elements

<table>
<thead>
<tr>
<th>Components</th>
<th>Possible Uses</th>
</tr>
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<tbody>
<tr>
<td>Permeable Pavers</td>
<td>Permeable Pavers</td>
</tr>
<tr>
<td>Permeable Pavers</td>
<td>Permeable Pavers</td>
</tr>
<tr>
<td>Permeable Concrete</td>
<td>Permeable Concrete + Sediment Filtration Bars &amp; Drains</td>
</tr>
<tr>
<td>Permeable Concrete</td>
<td>Permeable Concrete + Sediment Filtration Bars &amp; Drains</td>
</tr>
<tr>
<td>Decomposed Granite</td>
<td>Decomposed Granite</td>
</tr>
<tr>
<td>Decomposed Granite</td>
<td>Decomposed Granite + Sediment Filtration Bars &amp; Drains</td>
</tr>
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</tbody>
</table>

Could result in a street designation of: 1) Green Street or 2) Native Transition Street.
4.4.4 Urban Arterial Street

Figure 4.9 – Urban Arterial Street — Existing Conditions

When evaluating this street segment, the following characteristics are highlighted:

- Urban Arterial street in a mixed residential and commercial neighborhood
- Two-lane cartway with two lanes of parking, two bike lanes, and sidewalks
- High demand for street parking

<table>
<thead>
<tr>
<th>Stormwater Bump-out</th>
<th>Midblock</th>
<th>Corner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stormwater Tree Trench</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stormwater Tree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planter</td>
<td></td>
<td></td>
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<tr>
<td>Permeable Pavement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Gutter</td>
<td></td>
<td></td>
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<tr>
<td>Stormwater Drainage Well</td>
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</tbody>
</table>

- Recommended
- Possible, but there is prob
- Not recommended

Courtesy of City of Philadelphia
Figure 4.9 – Urban Arterial Street — Existing Conditions

Courtesy of City of Philadelphia
Figure 4.10 – Urban Arterial Street — Rendered Visualization of Selected GSI System
Figure 4.10 – Urban Arterial Street — Rendered Visualization of Selected GSI System

Imagining this street retrofitted with green stormwater infrastructure, the Water Department highlights the following points:

- This street type may be an ideal setting for corner bump-outs, as turning radii are often easier to accommodate on wide streets. Corner bump-outs may also improve the pedestrian experience and make street crossings safer. Mid-block bump-outs can be considered if street width and parking demand allows. Refer to the Complete Streets Design Handbook, Section 4.7.1.
- Tree trenches can be used if utility conflicts are limited.
- Stormwater trees may be considered in neighborhoods where many utility laterals make tree trenches infeasible.
- Planters can be considered if a more decorated streetscape is desired.
- Sidewalks may be wide enough to accommodate SMPs without exceptions to the Complete Streets Design Handbook, Section 4.3.2.
Three-Dimensional View of a Stormwater Tree

Tree filters and transpires water while providing shade and enhancing the streetscape.

Courtesy of City of Philadelphia
Figure 2.4: Three-Dimensional View of a Stormwater Tree Trench

Trees take up and transpire water from trench providing shade and enhancing the streetscape.

Stormwater from roadway flows into the stormwater tree trench.

Perforated pipe distributes water into stone or other storage media within the stormwater tree trench.

Courtesy of City of Philadelphia
Corner Stormwater Bump-out

PLANTS FILTER AND TRANSPIRE WATER WHILE ENHANCING THE STREETScape

STORMWATER FROM ROADWAY FLOWS INTO BUMPOUT

WATER INFILTRATES THROUGH SOIL

STONE OR OTHER STORAGE MEDIA PROVIDES ADDITIONAL STORMWATER STORAGE

Courtesy of City of Philadelphia
Local, State and National Roadway Design Standards

- Local Design Standards (such as San Jose DOT’s Geometric Design Guidelines)
- CA Highway Design Manual (HDM)
- CA Manual on Uniform Traffic Control Devices (MUTCD with CA supplement)
- AASHTO (A Policy on Geometric Design of Highways and Streets – “Green Book”)
- NACTO Design Guides
National Association of City Transportation Officials (NACTO)

- Urban Street Design Guide
- Transit Street Design Guide
- Urban Bikeway Design Guide
- Stormwater Guide (coming out in May)
Pedestrian Infrastructure Types

- Sidewalks, Shoulders & Curbwalks/Stepouts
- Paseos, Plazas and Parklets
- Mass Transit Boarding Areas
- Intersection Treatments
- Mid-block Crossings
- Alleys, Trails and Multi-use Paths
- Pedestrian Priority Zones and Woonerfs
- Bridges, Stairs, Ramps and Elevators
- Building Entrances, Parking Lots & Driveways
Pedestrian and Cyclist Benefits of Stormwater Curb Extensions

- Physical separation of pedestrians from street
- Does not reduce sidewalk area
- Shortens unprotected crossing distances at intersections
- Traffic calming measure – slows motor vehicles
- Curb extensions should not impede on bicycle facilities
Ped Safety: SW Curb Extension

Campbell
NACTO Lane Width Recommendations

- 10 foot lane widths in urban areas improve street safety without impacting traffic operations
- Truck or transit routes can use one travel lane of 11 feet in each direction
- Narrower travel lanes (9–9.5 feet) can be effective as through lanes in conjunction with a turn lane
- Wider lanes correlate with higher speeds
Traffic Speed Reduction: Curb Extensions and GI

- Stormwater Curb Extension
- Bus Curb Extension
- Chicane
- Pinchpoint
- Gateway
Stormwater Curb Extension
Bus Curb Extension
Portland
Chicane
Pinchpoint
Gateway
Crossings

- Raised Intersection
- Raised Crosswalk
- Speed Table*

(*not always used for a crossing)
Speed Table
Traffic Volume Reduction Guidance

**Required Features**
- Where emergency vehicle access is provided, an alternate minimum of 7 feet of clear width space shall be maintained between objects or features. The presence ofmovable objects, flexible or collapsible objects, or extra space may reduce vehicle requirements.
- Volume Management: Movements should provide bicycle access, either through a 4-foot minimum cross-frame bike lane or a 4-foot bike lane opening between vertical barriers.

**Recommended Features**
- Appropriate signage should be installed in areas where land use changes or are accessible by bicycle access.
- For a partial closure, the signed extension or edge island should be visible to the emergency vehicle operators.

**Volume Control**
- For a partial closure, the road extension or edge island should be visible to the emergency vehicle operators.
- Appropriate signage should be installed in areas where land use changes or are accessible by bicycle access.

**Optional Features**
- The partial closure should allow for long-term bicycle access. This may include the installation of bike racks.
- Appropriate signage should be installed in areas where land use changes or are accessible by bicycle access.
- For a partial closure, the road extension or edge island should be visible to the emergency vehicle operators.

**Measures**
- Measures may be implemented for a 30-day period to assess the effects of the partial closure. If no significant issues arise, the partial closure may be extended.

**Conclusion**
- The partial closure should allow for long-term bicycle access. This may include the installation of bike racks.
- Appropriate signage should be installed in areas where land use changes or are accessible by bicycle access.
- For a partial closure, the road extension or edge island should be visible to the emergency vehicle operators.

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*Note: The text is adapted from the image and represents a comprehensive guide on traffic volume reduction and its guidance.*
Diverters/Closures

- Partial Closure
- Full Closure
Partial
Full Closure
ADA Issues in GI Design

- Curb ramp grades, length & interface with street
- Paving roughness and joint gaps/spaces
- Sidewalk clear path of travel and width minimum
- Path of travel from on-street parking lane to sidewalk with bioretention blocking path
- Trip and fall hazards
- Excessive system and ponding depth
- Vision impaired community issues
  - Grade changes around bioretention areas
  - Grade changes within bioretention areas
  - Fencing and curbing around bioretention
Bioretention Planter with Step-Out Zone

WHERE TO USE?
- Wide sidewalk area with adjacent on-street parking.
- High-volume pedestrian areas.
- Areas with other streetscape features (lights, bike racks, bus stops, etc).

LIMITATIONS
- Do not disturb existing, mature trees.
- Provide low fence or curb for pedestrian safety.

COMMON DESIGN ISSUES
Pedestrian Safety: Bioretention areas in the streetscape can have dropped or sloped sides. Short fences or curbs prevent pedestrians from slipping into a recessed area. Bioretention with side slopes can use a small step-out area in place of a fence or curb. When bioretention is next to street parking areas, a step-out zone of 12-36 inches must be provided to allow access from vehicle to sidewalk. Crossing areas must be provided between street parking and the sidewalk.

Greening DC Streets • Chapter 2
GREENING THE PUBLIC SPACE

PERMEABLE PAVEMENT IN PEDESTRIAN CROSSING Curb

BIORETENTION PLANTING

STEP OUT ZONE

CURB CUT WITH METAL TRENCH DRAIN COVER
Cyclist Infrastructure Types

- Class 1 – Paths
- Class 2 – Lanes
- Class 3+ – Bike Boulevards (Enhanced Rts.)
- Class 3 – Routes
- Class 4 – Protected Bikeway (Separated)
- Intersection Treatments
- Sidewalks (Where Allowed)
- Bridges and Ramps
- Cycle Parking Areas
Road Diet: Bike Lane & SW Planter
Bike Safety: CycleTrack Planter

Emeryville
Bike Safety: CycleTrack Tree Filter

Seattle
Caltrans Grants: Active Transportation Program

- Functional Landscaping
  - Stormwater curb extensions for SRTS
  - Filter strips used as cycletrack protection?

- Non-Functional Landscaping
  - Parking areas used for cycletrack protection
  - Decorative landscaping

- 5% allowed for non-functional landscaping
- Pervious paving?
Safe Routes to Schools, Transit and Parks

- **SRTS** – Intersection curb extensions, mid-block crossings and traffic calming measures such as chicanes and diverters.
- **SRTT** – Curb extensions, pervious pavement and tree filters at improved transit stops.
- **SRTP** – Traffic circles, Tree filters and rain gardens in park land near crosswalks.
Designs for Sloped Streets

- Underground check dams
- Above ground check dams
- Modular systems
- Non-infiltrating systems
- Terraced systems
“Mr. Osborne, may I be excused?  
My brain is full.”
Other Examples of Integrated Systems
Green Railways

New Orleans
SRTP: Path-Rain Garden

El Cerrito
Improved Curb Ramp with Pervious Paving in Parking Lane

Berkeley
Improved Walk and Bike-ability with Infiltration Trench

San Jose
Bay Area Case Studies of Integrated Systems in Retrofit Projects
Retrofit Example #1 - Colma

- Road Diet
- Stormwater Curb Extensions
- Bike Lanes
- New Sidewalk on one side
- On-Street Parking added
- Pedestrian Safety - Mid-block crossings
- 2014
Before: two vehicle travel lanes in each direction, sidewalk only on south side, no on-street parking and no cross-walks.
After: one vehicle travel lane in each direction, new bike & parking lanes, new sidewalk on north side, protected mid-block crossing with rectangular rapid flashing beacon (RRFB) & stormwater curb extensions with trees.
Example #2 - Emeryville

- Phased Project:
  - First - a Road Diet for Cyclists
  - Then - a Pedestrian Safety Project
  - Finally - a Green Street
- Bay-Friendly Landscaping
- No irrigation
- Many Lessons Learned (aka mistakes)
- 2011
Complete and Green
Example #3 - Campbell

- Road Reconstruction Project
- Stormwater sidewalk planters, curb extensions and tree filters
- Bike lanes
- Bay-Friendly rated landscape
- 1st Bay Area GI GreenRoads certified project: silver
- 2016
Example #4 – Palo Alto

- Neighborhood Infrastructure Project
- Localized Flooding Issues
- Stormwater curb extensions
- Permeable Paver Crosswalks and Path
- No Stormdrain for underdrain connection
- Drywell Drainage Columns
Example #5 - Emeryville

- Bike-Ped Grant Project
- Road Diet with Raised 2-way Cycle Track
- Added Stormwater Planter
- Bay-Friendly Landscaping
- Bay Trail Gap Closure
- Funded by $500k Countywide Bicycle Grant
- 2016
Thank you!

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