

## CLEAN WATER ACT'S STORMWATER PROGRAM



Stormwater is a leading cause of water quality impairment and its impact is growing

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- Urban stormwater is a leading source of impairment
- Fast growing water quality concern
  - Approximately 800,000 acres being developed every year, growing to over 1.0 million acres by 2039
- Development increases the amount of impervious cover in the landscape
- Small increase in impervious cover leads to big impacts in receiving waters
- Development upstream can cause downstream impacts in communities





### Stormwater Impacts: Pollution, Flooding, and Property Losses

#### Stormwater pollutants

- Cause beach closures and swimming illnesses through bacterial contamination and algal blooms
- Impact fisheries and shellfish harvesting through excess sedimentation, nutrients, bacteria, metals, and temperature
- Increase the costs of treating drinking water supplies

#### Stream impacts

- Increase stormwater volume and velocity causing flooding, scouring and sewer overflows
- Reduce groundwater recharge impacting water supplies



#### **Existing Program**



#### Current coverage

- •Primarily in urbanized area
- Accounts for much of the population
- Only about 2% of the land area

- Many communities have waterbodies that are already polluted by stormwater discharges from impervious areas
- Communities are working hard to address stormwater and are looking for cost-effective solutions moving forward
- Developers play an important role in finding these costeffective stormwater solutions

#### Changing the Paradigm of Stormwater Management

#### Traditional approach

- Convey stormwater quickly from site to waterbody or detention ponds
- Manage peak flows for flood control, drainage and large scale downstream erosion.
- New approach Integrate green infrastructure in the design of the project
- View stormwater as a resource
- Slow down the flow, allow to infiltrate
- Manage stormwater on-site
- Reduces pollutant loads to waterbodies





#### **New Directions**



Using green infrastructure is a sustainable way to control stormwater.

- Incorporate green infrastructure into sites as they are being developed and redeveloped
  - Provides most cost-effective opportunity to control stormwater at its source
  - Prevents water quality degradation in healthy waters
  - Helps restore impaired waters
- Looking at the problem on a watershed basis will be more cost effective
- Incentives for sustainable practices that provide numerous other economic and quality of life benefits to communities



### If We Don't Take This New Direction – It Will Cost a Lot More





- If sites do not incorporate sustainable stormwater controls in growing communities, waterbodies will become impaired and these communities will face extremely high costs to restore the waters
- If sites do not incorporate sustainable stormwater controls in growing communities, the quality of our urban waters will worsen and the cities will be less appealing places to live
- Communities will not realize the many other benefits of green infrastructure, including:
  - Reduced flooding
  - More liveable communities
  - Increased property values



Potential Focus of a Proposed Stormwater Rule

#### Establish performance standards for discharges from newly developed and redeveloped sites

- Builds upon innovative approaches developed by many communities and developers already
- Helps to revive urban streams
- Creates level playing field
- Prevents pollution
- Avoids costly stream restoration
- Reduces flooding
- Creates local jobs





### Potential Focus of a Proposed Stormwater Rule (Cont'd)

# Encourage watershed approaches for managing municipal stormwater discharges

Helps ensure stormwater controls are properly implemented which could reduce the need for expensive retrofits later





#### **Performance Standards**

- Considering a retention-based performance standard to require that sustainable stormwater controls be incorporated into sites as they are developed and redeveloped
  - Reduce pollutants
  - Reduce volume and velocity of discharges
- Considering a standard that varies according to an area's climate and other location-specific characteristics
  - e.g. certain percentile storm event

About 1/3 of states and many local communities already have some sort of treatment or retentionbased performance standard

- Considering many flexibilities
  - For sites
  - For alternative local programs
- There are cost-effective ways to meet the standard
  - Incorporate controls in the site design by preserving vegetation and/or reducing impervious cover
  - Integrate green infrastructure practices into landscape or other common areas



#### Performance Standards (Cont'd)

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- Considering relaxed standard for redevelopment
  - Recognizes site constraints and benefits to reusing already developed site

Applying the standard nationwide would create a level playing field for developers among municipalities and protect downstream communities from upstream development.

- Encourages redevelopment to revitalize urban communities
- Considering additional incentives for smart growth and brownfields development
- The standard could be directly applied to newly developed and redeveloped sites nationwide or only those sites discharging to regulated MS4s or watersheds including MS4s





#### Performance Standards (Cont'd)

- Could accommodate site constraints (including water rights laws)
  - Managed through treatment
  - Off-site mitigation
  - Payment-in-lieu
  - Banking or trading programs
- Allow sites to do their own analyses based on site-specific information
- Allow phased implementation
- Allow watershed plans that control pollutants/flows
- Would credit alternative programs that are better suited to their needs, but that are as protective as the national standard
- Allow alternative green infrastructure plan in-lieu-of a new and/or redevelopment standard



#### **Encourage Watershed Approaches**

- Encourage MS4s in same watershed to work together
  - Watersheds surrounding existing regulated MS4s
- Encourage sound stormwater programs as growth occurs
- Population threshold 10,000
- MS4 light, watershed permits, guidelines, recognition/certification



#### Benefits of a Proposed Stormwater Rule

#### Water-Based Benefits



Improved recreational, aesthetic and non-use values



Improved air quality and reduced human health impacts

**Vegetation-Based Benefits** 



Lower drinking water treatment costs



Higher off-site property values associated with green infrastructure



Lower dredging costs for navigational channels



Carbon uptake by plants



Reduced siltation of water storage reservoirs



Reduced downstream flooding damage



Groundwater recharge



Small stream erosion and water quality impacts

Reduced energy use by buildings and associated air quality and carbon footprint benefits

> Innovative communities across the U.S. already have on-site retention standards in place and are seeing the benefits.

Green infrastructure stormwater controls like rain gardens and vegetated curb bump-outs can be part of complete street designs



This sustainable, complete street is welcoming for pedestrians, bicyclists, and transit while maintaining plentiful street greenery and managing stormwater. *Photo: Dan Burden, Walkable and Livable Communities Institute.* 

#### **Cost-Effective Solutions in Residential Areas**

- Pervious pavement
- Bioswales, raingardens
- Curb cuts, green streets
- Downspout disconnection
- Narrower streets, driveways, roads



#### **Commercial Cost-Effective Solutions**

- Integrate curb cuts into parking islands to allow water to infiltrate
- Smaller parking lots
- Pervious pavement
- Cisterns



#### US EPA Region 6

Water Quality Protection Division

Division Director:

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### **Green Roads Introduction**

### Nicole Hayes, P.E., LEED AP NHayes@walterpmoore.com

#### WALTER P MOORE

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## What is (does) a Green Road (do)?









## What is (does) a Green Road (do)?

- enhance street function
- target pollutants
- require less
  maintenance
- increase mobility
- reduce material use

- improve safety
- connect modes of transport
- establish identity (place making)
- attract people to local businesses

### Full Life-Cycle Approach





### **Urban Streetscape**





-slide excerpted from Greenroads Master Presentation, the Greenroads Foundation and the University of Washington

### Suburban or Rural







#### **PR-8 Low Impact Development**

Use low-impact development (LID) stormwater management solutions where appropriate to better mimic pre-development hydrological conditions.



Swale with weirs (left) and pervious concrete sidewalk (right) in Seattle, WA









### **Resources and Guidelines**







Logos and Images © The Greenroads Foundation, The Institute for Sustainable Infrastructure, The Ladybird Johnson Wildflower Center, and the iSWM Committee of North Texas

### Questions?

Thank You! Nicole Hayes, P.E., LEED AP NHayes@walterpmoore.com

WALTER P MOORE



# Green Streets and Transportation Planning

September 25, 2013 Arlington, TX

Sponsored by the

Environmental Protection Agency (Region 6) and the

Federal Highway Administration (Texas Division)

Jim Thorne, FHWA

### **Workshop Objectives**



- Describe characteristics and goals of green streets.
- Identify opportunities to improve planning and decision making processes to be more informed on green streets.
- Describe storm water management practices used in green streets.
- Discuss green streets planning, design, operations and maintenance considerations.
- List resources available for green streets.
- Explain tools available for addressing sustainability in planning and project development.

#### **Our Agenda**



- 8:00 Welcome and Introductions
- 8:05 EPA's Green Infrastructure Program
- 8:30 Introduction to Green Streets
- 9:00 Addressing Green Streets in the Transportation Planning Process
- 9:30 Break
- 9:40 ASCE's ISI Rating System
- 10:00 Green Streets Planning to O&M Bagby Street, Houston
- 11:45 1:00pm Lunch (on your own)
- 1:00 Green Streets Planning and Design Mesquite Thomasson Square
- 1:45 Green Streets Planning to O&M Dallas Urban Reserve
- 2:30 Break
- 2:45 Green Streets Planning to O&M The Green at College Park
- 3:30 Introduction to FHWA INVEST Tool
- 4:00 NCTCOG's Efforts to Utilize INVEST in the Dallas
- 4:30 Closing Remarks and Adjourn


### **EPA's Green Infrastructure Program**

Bill Honker and Suzanna Perea



### **Introduction to Green Streets**

### Nicole Hayes



# Addressing Green Streets in Transportation Planning



Jim Thorne, FHWA



- Planning Process and Products
- Opportunities to Plan Green
- Example
- Resources



On an average day in the United States, how many people die in traffic crashes?



# **Transportation Planning Process**

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Collaboration with stakeholders and the public

# **Transportation Planning Factors**



- a) Support economic vitality
- b) Increase safety
- c) Increase security
- d) Increase accessibility and mobility
- e) Protect and enhance the environment
- f) Enhance connectivity across and between modes
- g) Promote efficient system management and operation
- h) **Preserve** the existing transportation system



``(E) protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and local planned growth and economic development patterns;

### A Few Key Products of the Transportation Planning Process



- Long Range Transportation Plan (LRTP)
- Transportation Improvement Programs (S/TIPs)
- Unified Planning Work Program (UPWP)
- State Planning and Research Work Program (SPR)

# **Other Planning Efforts**



- Modal planning (freight, transit, ped/bike)
- New Starts project planning
- Corridor or Subarea studies
- Site or community studies
- Congestion Management Process (CMP)
- Collaborative Multi-Agency Planning Efforts
- Linking Transportation and Land Use
- Support of Broader Community Goals and Efforts

### What Do We Want From Our Streets?



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- Roadways that serve all users—vehicle drivers, pedestrians, bicyclists, transit riders
- Interconnected, Multimodal networks
- Safe for all ages and abilities
- Vary by context (e.g., urban/rural)
- Based on community desires
- Outcome of good planning and design

# **Complete Streets May Include:**

- Wider sidewalks
- Narrower travel lanes, traffic calming features
- Crosswalks, curb ramps, accessible pedestrian signals
- Median islands
- Universal design features
- Bike lanes
- Wide paved shoulder
- Bus stops, shelters, bus pull outs
- Curb extensions







## **Connected Streets**





Driving-only transportation pattern

Walkable connected transporation network

Source: www.cnu.org

## **Green Streets are . .**



Natural stormwater management approach that uses plants and soil to slow, filter and cleanse stormwater from streets.

Designed to allow stormwater to penetrate into the ground rather than be diverted to a conveyance system.

Natural systems approach to reduce stormwater flow, improve water quality, reduce urban heating, enhance safety, and beautify neighborhoods.

Some define green streets more broadly, including traffic reduction, narrow widths, encourage multimodal, or complete streets features.

# **Green Street Elements**

- Plants and Soils
- Vegetated curb extensions
- Sidewalk planters
- Landscaped medians
- Vegetated swales
- Permeable pavement
- Street trees







# **Linking Planning**





# Livability

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*Livability* is about using the quality, location, & type of transportation facilities & services available to help achieve broader community goals such as access to good jobs, affordable housing, quality schools, & safe streets.

Livability, sustainability, smart growth, walkable communities, new urbanism, healthy neighborhoods, active living, transit oriented development, complete streets, ...



### **Creating Livable Communities**





#### Creating Livable Communities

How the transportation decision making process can support more livable community outcomes

> Federal Highway Administration October 2011





Photograph of roadway under construction for a green streets project in Arlington, Virginia. Project includes pedestrian intersection improvements and the creation of a bio-retention swale in the median. This project is part of the county's Neighborhood Conservation Program which directly engages citizens in identifying project scope and needs within their neighborhoods and prioritizing projects annually.

### **Chicago DOT**





Green Streets as Community Revitalization Strategy

US EPA Region 5 & FHWA Webinar, 2011

# Photo Montage Urban Advantage







### One source for images: www.urban-advantage.com



# Photo Montage Urban Advantage

### **Making a Greener Complete Street**









- > Are representative of their places
- Allow people to walk comfortably and safely
- Contribute to economic vitality
- Are functionally complete
- Provide mobility and access
- Facilitate placemaking
- > Are green



### **St Louis Great Streets Initiative**





#### Downtown Main Street Mixed-Use District Small Town Downtown Residential Neighborhood Office Employment Area Civic/Educational Corridor Neighborhood Shops Commercial/Service Corridor

#### Resources

Document Library Design Tutorial Related Events Demonstration Projects **East-West Gateway** launched the St. Louis Great Streets Initiative in early 2006 to expand the way communities think of their streets. Rather than viewing a roadway project as solely a way to move more cars and trucks faster, the goal of the St. Louis Great Streets Initiative is to trigger economic and social benefits by centering communities around interesting, lively and attractive streets that serve all modes of transportation. Learn More



#### What is a Place Type? Click Here to Learn More!

#### How to Use this Guide -



#### Design Tutorial -

The Design Tutorial is a Flash based guide to help users understand the many

#### Why Great Streets?



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# Where and How to Plan Green

# Metropolitan Transportation Plan

- a) Goals, Objectives, Performance Measures
- b) Project Evaluation and Selection
  - Sustainability, Livability Criteria
- c) Policy Recommendations
  - Complete, Green, Great Streets, Livability

# **Transportation Improvement Program**

- a) Project Selection Criteria
- b) Program/Project Funding
  - Livable/Sustainable Communities Initiatives
- c) Implement regional policies

### Transportation Outlook 2040 Mid America Regional Council



### **Regional Vision:**

Greater Kansas City is a sustainable region that increases the vitality of our society, economy, and environment for current residents and future generations.

### **Transportation Vision:**

A safe, balanced, regional multimodal transportation system that is coordinated with land-use planning, supports equitable access to opportunities, and protects the environment.



### MARC Transportation Outlook 2040 Transportation System Goals:



**Accessibility** - Maximize mobility and access to opportunity for all area residents

- Climate Change & Energy Use\*\* Decrease the use of fossil fuels through reduced travel demand, technology advancements and a transition to renewable energy sources
- **Economic Vitality** Support an innovative, competitive 21st-century economy
- **Environment** Protect and restore our region's natural resources (land, water and air) through proactive environmental stewardship
- **Place Making\*\*** Coordinate transportation and land-use planning as means to create quality places in existing and developing areas, and strengthen the quality of the region
- Public Health\*\* Facilitate healthy, active living
- Safety & Security Improve safety and security for all transportation users
- System Condition Ensure transportation system is maintained in good condition

System Performance\*\* - Manage the system to achieve reliable and efficient performance

\*\*New plan goals for Transportation Outlook 2040



### **Environmental Goal Strategies - MARC**



### Link environmental and transportation planning.

Natural Resources Inventory

The digital inventory maps valuable natural assets and ecological features in the region to help communities proactively conserve or restore natural resources during development.

### Implement region's Clean Air Action Plan.

**Reduce emissions** 

The region's Clean Air Action Plan contains formal commitments from area governments and businesses to voluntarily reduce ozone-forming emissions.

# Fund and implement the MetroGreen® regional trails and greenways plan.

Fund Metrogreen®

This proposed 1,144-mile interconnected system of public and private open spaces, greenways and trails would link seven counties in the Kansas City metropolitan area.

# MARC Goal Related Performance Measures



# Performance Measures

Progress Report Summary • June 2013

### Environment

Factor	Measure	Data	Goal	Actual	Trend
MetroGreen* network	Completed Metro Green* network miles	2010: 230 miles		1	+5.22%
		2011: 242 miles			
	Source: Mid-America Regional Council Environmental Services, MetroGreen <sup>e</sup> database				
	Note: The network has continued to expand and currently is estimated at 21.2 percent complete to its planned vision of a 1,144-mile system.				

## **Project Funding and Programming**

### **Complete Streets Efforts**

- Regional Plan agreement on concepts
- Collaboration with local government partners
- Good Practice/Guidance documents
- Funding and programming eligibility and criteria



# www.fhwa.dot.gov/map21/



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# Planning.dot.gov





#### METROPOLITAN AREA ISPORTATION PLANNING FOR HEALTHY COMMUNITIES



December 2012

U.S. Department of Transportation

U.S. Department of Transportation Office of Planning, Environment, and Realty Federal Highway Administration

Prepared for

of Transportation Federal Highway Administration

Prepared by: U.S. Department of Transportation Research and Innovative Technology Administration John A. Volpe National Transportation Systems Center



# **Context Sensitive Solutions**

- Integrate land use, transportation, etc.
- Meaningful stakeholder participation
- Keep human and natural context foremost in mind
- Produce a plan for a transportation system that will be an asset to the community



Designing Walkable Urban Thoroughfares: A Context Sensitive Approach





Institute of Transportation Engineers

http://www.contextsensitivesolutions.org/

# **FHWA Livability Website**



### http://www.fhwa.dot.gov/livability/



### www.sustainablecommunities.gov/





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## **Good Things to Do?**



Consider complete, green streets in one planning process

- Connected street networks
- Connect transportation projects with broader community objectives
- Adopt context sensitive approach



Jim Thorne Community Planner FHWA Resource Center Jim.Thorne@dot.gov 708-283-3538



Construction Ecoservices. Walter P Moore . Design Workshop Green Streets Planning to O&M- Bagby Street, Houston:

#### PRESENTERS

- Charlie Penland, PE, LEED AP Principal, Walter P Moore
- Philip Koske, PLA, LEED AP Associate, Design Workshop
- David Batts, LEED AP Director of System Solutions, Construction Ecoservices



## PRESENTATION OVERVIEW

- I. General Information
- II. Planning
- III. Design
- IV. Construction
- V. Operations and Maintenance
- VI. Greenroads<sup>™</sup> Certification Process



## I. GENERAL INFORMATION

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- Pedestrian-oriented urban community
- Centrally located in heart of Houston
- Vibrant, densely populated mixed use neighborhood
- Popular restaurants and dynamic nightlife
- State of Texas Cultural Arts and Entertainment District





- Midtown Redevelopment Authority / Tax Increment Reinvestment Zone (TIRZ) created in 1995
- Abandoned and blighted area with insufficient infrastructure
- TIRZ formed to foster economic development and eliminate blight
- Funding provided through incremental taxes generated in Zone
- Initial focused on multi-family developer agreements to increase number of residents
- Currently administers proactive Capital Improvements Program (CIP) to stimulate development





- Blighted areas transformed into thriving, pedestrian-friendly mixed use neighborhoods
- Vibrant, culturally diverse community
- Active lifestyle
- Increase in Population
  - 1995 under 1000 residents
  - 2012 ~ 9500 residents
- Increase in Property Tax Base
  - 1995 \$157 million
  - 2012 \$1.2 billion





Scope of work:

- Traffic Impact and Physical Analysis
- Public engagement throughout the design and implementation process
- Full street paving replacement
- Consolidation of overhead utilities
- Upgrades to sewer, storm sewer and water lines
- New sidewalks, intersection treatments, lighting, planting, and irrigation system
- Greenroads<sup>™</sup> Certification



## II. PLANNING

#### PLANNING OBJECTIVES:

Redefine the role of a public space in the lives of its user base.

Quality of life is the central driver for return on investment for our projects; Our clients expect us to maximize all potential to improve quality of life for residents and visitors.



#### PLANNING METHODOLOGY:

We quickly understood that there is no single street section or standard approach for this project.

Context Sensitive Design- We understood that the corridor as a whole had several common traits, but each block had a unique relationship with the street.

To do this, the project team must measure existing conditions and test assumptions:

- 1. Understand and Embrace Stakeholders
- 2. Thorough Analysis
- 3. Budgeting and Management Capacity
- 4. Policy vs. Process

## 1.STAKEHOLDER ENGAGEMENT

- Stakeholders can be partners or adversaries; you get to choose at the outset of a project.
- Stakeholders often have a better idea of how activity along corridors works then you do.
- Commerce and daily life will be greatly impacted during construction. Your engagement of the public should not stop after the planning phase.
- Greenroads<sup>™</sup> requires a public meeting as a prerequisite. Many third party validation systems consider engagement as part of sustainable planning.



South Grand Boulevard, St. Louis MO



#### 2. PROJECT ANALYSIS

- Pedestrian, Automobile and Transit Circulation and Safety
- Traffic Analysis (speed, counts, etc.)
- Existing Land Use Analysis
- Overhead Utility Analysis
- Lighting (footcandle) Analysis
- Tree Analysis (health, shade, etc.)
- Existing Parking
- Walking Distance
- Heat Island Effect
- Opportunity for Redevelopment/Reinvestment
- Existing Public and Private Irrigation





## CIRCULATION AND TRAFFIC

• All aspects of the design have an impact on quality of life and usability.





### LAND USE

- Analysis of underdeveloped blocks and potential land use changes
- Opportunities for redevelopment and streetscape design



Commercial

## EXISTING TREES AND PEDESTRIAN FEATURES

- Trees were evaluated to determine their value to the community and human comfort
- Tree health, root growth conditions, soils, canopy disturbance, species
- Expanded rapid taper root zone area and advanced soil amendments ....42% increase in tree growth area



Tree canopy has a direct impact on both water quantity and air quality.

## HUMAN COMFORT AND WALKABILITY

- The Texas Summer Problem : high humidity, high temperatures, low winds
- How to create summer disruption : value of shade and breezes



## HUMAN COMFORT AND HEAT ISLAND

- Understanding surface temperatures in July
- Choice of hardscape materials
- Increase in softscape materials



Heat Island - Temperature of Various Materials on Site

Measurements were taken using a hand-held infrared thermometer at 12" above the surface. All measurements were taken in the sun on the same day with the same ambient temperature.

### ON STREET PARKING VALUE

- Mapping existing parking opportunities
- Designing in additional on street parking facilities : convenience and revenue



- 3. Budgeting and Management Capacity
- Utilize cost modeling so that you do not over-promise.
- Use public feedback and/or previous planning efforts to prioritize improvements.
- Develop a plan for understanding staff and budget demands related to maintenance; reach out to installers or municipal groups that have installed similar features.
- Plan for dog waste and circulation through/around linear features.

"Lack of maintenance of infiltration systems has a considerably high impact on (perception of) aesthetic qualities."

Frank Sleegers, Potentials and Limitations of Implementing Linear Infiltration Systems on Urban Streets

## 4. POLICY VS. PROCESS

- Unless you are in Portland, "Green Streets" generally represents change.
- Policy is generally not good at adapting to change quickly.
- Fire, EMS and other public safety often have heavy influence in the function of our street network...which also means they greatly influence the overall quality of those spaces for the public.
- Houston is remarkably flexible regarding back of curb improvements; Approval of improvements within the right of way can be very complex depending on regulations.

### TRAFFIC PLANNING ISSUES

- Number of lanes (traffic impact analysis)
- Pedestrian friendly, but traffic effective
- Accommodating on street parking
- Intersection design for high turning movements
- Freeway off ramp impacts





#### TRAFFIC STUDY AREA



#### EXISTING STREET SECTIONS





#### 2010 MAJOR THOROUGHFARE PLAN, CITY OF HOUSTON





#### **New Street Section**



Additional right turn lanes up to Webster Street.

#### **Overall Configuration**



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# Background LOS (2035) – AM 1% Growth Rate



## Proposed LOS (2035) – AM Improved Timings - 1% Growth Rate



# Background LOS (2035) – PM 1% Growth Rate



## Proposed LOS (2035) – PM Improved Timings -1% Growth Rate



Improved traffic flow has a direct impact on air quality and the quality of the pedestrian experience.

#### I-45 OFF RAMP



#### I-45 OFF RAMP- PLAN


### **ON-STREET PARKING**

- Preservation of parking was critical to both the Client and local stakeholders.
- As constructed, the project has an 8% net decrease in parking assuming cars in the existing condition scenario were parked efficiently.
- Adequate and convenient crossings of liner features is critical.



### INTERSECTIONS

• The new design reduces crossing distances by 30-50%.



Bagby Street was defined by broad intersections and wide paving areas.

### UTILIES

- Water and Sewer
- OH Utilities
  - Strategic rerouting
  - UG routing options
- Service interruptions



## **Existing Waterline**



# **Existing Wastewater Collection**



## Franchise Utility Clean Up Options



### DRAINAGE ISSUES

- Large 60" offsite pass through storm line
- City Standards potential conflicts
  - 24" minimum storm line
  - Inlet standards
- Impact mitigation
- Water Quality



# **Existing Drainage**



Residents are interested in the function of LID features but more interested In positive impacts on downstream recreational amenities.

### BACK OF CURB IMPROVEMENTS

- Street furnishings
- Sidewalks and pathways
- Lighting and electric service
- Curb ramps
- Wayfinding and signage
- Crosswalk equipment
- Irrigation
- Plantings
- Street trees
- Existing trees
- Rain Gardens





### RAIN GARDEN DESIGN

- Use the largest trees you can afford
- If detention is not a goal, consider stepping interior elevations
- Be sure proposed plant material will grow to heights that complement the depth of the feature
- Spend as much as you can on soils within the rain garden. This is particularly important if you have an impervious liner at the bottom of the feature. At best, 1 tree = 1,000cf of soil!
- When surveyed, observers rank trees highest and standing water lowest
- Understand the requirements and limitations of building features around utilities
- Provide edge protections and adequate crossings







### EPHEMERAL INTERPRETATION





## IV. CONSTRUCTION

**STX** 

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# Street Trees Were Integral



- Typical Biofiltration Wasn't an Option
- Needed an Efficient Approach
- High Performance Soils Allowed for Smaller Solution

# Street Trees Were Integral



 Typical biofiltration would have required biofiltration soils and underdrain along the entire planter box

# Street Trees Were Integral



 High Performance Modular Biofiltration
 System's footprint was small enough to remain outside the rootzone of street trees.

# Rain Garden Design

- Learning From Past Mistakes
- How Engineered Soils Drain
- Understanding "Bridging"
- Flow Dissipation



# Learning From Past Mistakes

# Learning From Past Mistakes



## **Understanding Engineered Soils**

Hydraulic Conductivity





# "Bridge" Aggregates

Y

# "Bridge" Aggregates



# "Bridging" Prevents Clogging

# Flow Dissipation is Critical

# Rain Garden Construction

- Quality Assurance / Quality Control
- Working Around Utilities
- Protecting the Systems
- Signage

## Performance Verification

## **Quality Assurance**





# Working Around Utilities



### Modularity Aids in Field Modifications

### Flexibility is Essential to success



# **Protection During Construction**



Protecting the System is Imperative
Prevents Premature Sedimentation
Simple "Activation" Protocol

# Signage



Use Signage When Possible
Communicate Message in English and Spanish
Action Items Must be Complete Prior to Activation

# **Measuring Performance**



- Hydraulic Conductivity Test
- Pass / Fail
- Manufacturer / Contractor Must Prove It Works

### V. OPERATIONS AND MAINTENACE

- Staff training vs. contracted maintenance
- Indicators of system problems/failure
- Like typical planting areas, LID features require regular cleaning
- Plantings should be simple enough to intuitively maintain
- Re-application of mulch
- Keep water entry points clean and clear



VI.

### EVIDENCE

#### ENVIRONMENT

- First GreenRoads certified project in the State of Texas (final stages)
- 300 tons of CO2 saved through fly ash in concrete
- 33% of right of way stormwater enters into rain gardens
- 70% tree canopy throughout corridor (32% existing)
- 16% decrease in noise decibel levels (peak) in key pedestrian areas (50 db to 42 db)
- 14% decrease in surface temperatures (108 degrees to 95 degrees avg)

### EVIDENCE

#### COMMUNITY

- 4 lanes to 2 lanes (with periodic turn lanes) without reducing LOC below standard
- Pedestrian crossing distance reduced by nearly 45% (42' to 24' avg)
- 88% of the sidewalks are in shade (compared to 49%)
- Foot candle increase from .1 avg. to .45 average
- 15% more on street parking throughout the corridor
- 276% increase in pedestrian areas (16,291 SF to 44,983 SF)
- 350% Increase of bicycle facilities (12 to 42)
- 38% increase in seating and social gathering areas

### EVIDENCE

### ECONOMICS

- Approximately \$25m in private development since project was announced
- 20% Rental market increase (\$1.40 to \$1.75 avg p/SF p/month)
- Project has remained in acceptable construction budget
- 218% increase in tree canopy throughout corridor (32% to 70%)
- Water quality credit for rain gardens that can be transferred to development (PER)
   ART
- Custom furniture, signage, lighting and paving
- Custom interpretive rain gardens
- Enhanced planting design based on color, texture, form, structure, seasonality





- Rating system
- Similar to LEED system
- Includes, but not limited to sustainable design / LID
- Nonprofit Organization focused on Education and the advancement of roadway and bridge initiatives
- Bagby expecting Certified or Silver certification



## Credits

- 11 Project Requirements
- Optional Credits
  - Environmental and Water
  - Access and Equity
  - Construction Activities
  - Materials
  - Pavement
  - Custom


### **Construction activities**



# Lessons Learned

- Starts with planning (commit early)
  - Determine the benefits to be achieved
  - Requires owner buy in
  - Plan with the end results in mind
- Important as a design tool
- Important to track progress throughout
- Construction contract must address requirements
- Should be a major part of the pre-bid and pre-con meetings



# **Discussion and Questions**



# <u>Manteserve</u>

















Stormwater that percolates through the filtration layers of the reed and cypress rain gardens, is conducted via a storm pipe into a filtration pond. The pond serves as a water source in the summer and the home lots are connected to the street space via individual bridges seen in the photo above.



(Left) To establish spatial definition to the eastern street edge, bald and pond cypress trees are organized in parallel layers to the street. These species are resilient to deluge and the extreme heat and drought of central Texas summers. (Middle) *Equisetum sp.* establish a vigorous fabric under the cypress. Slotted curbs communicate rainwater into the biofiltration gardens. (Right) The asymmetrically sloped street produces a low or "wet side" and a high or "dry side," seen in this photo. The dry side contains a single row of un-irrigated desert willows set in a continuous surface of decomposed granite dust.



#### Zone A The Entrance and Ecological Field

- 1. Entrance
- 2. Existing Volunteer Tree Canopy
- 3. Italian Cypress Field
- 4. Filtration Pond
- 5. Street "Vanguard Way"

#### Zone B The System Landscape and Biofiltration Street

- 6. "Dry Side", Desert Willow
- 7. "Wet Side", Bald and Pond Cypress
- 8. Rain Garden Biofilters
- 9. Bridges
- 10. Filtration Pond

#### Zone C The Broadmead Connection at the Public Park

- 11. Buffalo Grass
- 12. White Rock Creek Park, Existing

#### Project Context Public and Private Landscape

- 13. Existing 1950s Subdivision
- 14. DART Transit Rail
- 15. White Rock Creek



#### ZONE A

The Entrance and Ecological Field

In lieu of the expected features and walls, entrance is established with a transitional field of ecological plantings that legitimates the volunteer and itinerant species of the site, which propagated to its location from the adjacent subdivisions.

# B



#### ZONE B The System Landscape and Biofiltration Street

The central length of the street is designed as a repetitive system of elements that transform the street into a biofilter. This new prototype rethinks the typical residential street of the city by its demonstration at the Urban Reserve.

#### ZONE C The Broadmead Connection at the Public Park

The area at the terminus of the street visually merges with the riparian landscape of a public linear park system – White Rock Creek Linear Park – by means of an alternative set of grasses added to the system landscape.



#### PROJECT CONTEXT Public and Private Landscape

The context east of the Urban Reserve is a socially diverse 1950's subdivision typified by one half and one-quarter acre detached lots.



photo courtesy Kevin Sloan Studio









### **Innovative Green Projects 2009**



#### **URBAN RESERVE, DALLAS**

Green Points: Urban Reserve is a modern Dallas neighborhood with specially created landscaping suitable for Dallas' hot, dry summers. The neighborhood is about 10 acres (4 hectares) and is organized along a single street approximately 1,000 feet (305 m) long. Landscape architect Kevin Sloan tilted the street 2 percent asymmetrically so all the water flows to one side. This "wet" side has cypress trees and other plants that can sustain flooding. The other side of the street—the "dry" side—uses a xeriscaping strategy. No irrigation is needed and the trees are hardy species that can exist in places where there isn't a lot of rain. The ground plane consists of decomposed granite, a paving material that creates a fine gravel that is comfortable walk on, similar to what is found in the Luxembourg Gardens in Paris. Before being developed, the land had been used as a dumping ground; it was littered with debris, earthfill, concrete slabs, and broken-up masonry. The team reused that waste to build walks, make pavement and prevent erosion around detention facilities.

People: Landscape architect, Kevin Sloan Studio, Dallas

Photos: Courtesy of Charles Davis Smith, AIA

# The Numbers

Development costs:								
Rain gardens						\$	224,952	
Street paving	\$	88,467						
Additional cost of rain gardens	\$	136,485						
Development costs minimized:		<u> </u>						
Rain gardens with fewer trees and I	\$	188,546						
Street paving		\$	88,467					
Additional cost of rain garder		\$	100,079					
Utility cost:	tv cost: Water Electric						Total	
	2007	\$	4.420	\$	364	\$	4,784	
	2008	\$	4.841	\$	862	\$	5,703	
	2009	\$	1.438	\$	1.490	\$	2.928	
	2010	\$	2,743	\$	1.369	\$	4,112	
	2011	\$	5,568	\$	1,789	\$	7.357	
	2012	\$	7.812	\$	2.063	\$	9.875	
	2013	\$	3.298	\$	1,158	\$	4,456	
	<b>T</b> ( )		,		,		,	
	lotal	\$	30,121	\$	9,095	\$	39,216	
		Average annual utility cost					5,602	
					-			
Area irrigated:								
Common areas							75,779	SF
Front yards of built homes							10,920	SF
Total area							86,699	SF
	•							
Average annual cost of water +	\$	0.06						
	•	0.01						
Average annual cost of water +	\$	9.34						



### Goals

- 1. Architecture of its time and of its place
- 2. Energy and water conservation
- 3. LEED certified homes to guarantee conservation
- 4. Create a neighborhood based on what people love in life...nature, exercise, modern architecture and modern art
- 5. Exterior materials of a naturally weathering nature with limited painted surfaces so the neighborhood ages gracefully
- 6. Control public landscape for a cohesive look and reasonable maintenance

### Landscape Concept

- 1. Recycle rain water via ponds and rain gardens
- Create ribbons of landscape...west/dry side with crushed green granite and desert willows, street, rain gardens with pond and bald cypress and horsetail reeds, east/west side with live oaks and purple winter creeper
- 3. Rain gardens hold several inches of water rather than several feet of water





### **Successes**

- We filter dirty water from our site plus upstream...we are a net positive on the environment
- 2. The streetscape is human scale creating more interaction with neighbors
- 3. The street is 22' wide rather than the standard of 36'...less concrete reduces heat island effect and encourages slower driving with the benefit of less runoff from hardscape

# **Consider Changes for the Future**

- Different plant material than horsetail reed...perhaps love grass or buffalo grass... need to lessen the purchase of City water in the hot summer
- 2. Consider aesthetics of pond edges as water level drops during minimal rain periods
- 3. Grade rain gardens to hold up to 12" of storm water at the deepest point





# LEADING PEDESTRIAN INTERVAL (LPI)

**DPS 201** 

# WHY – GETS PEDESTRIANS ESTABLISHED IN CROSSWALK

# STREETFILMS

# CASE STUDY: LPI (ST. PETERSBURG, FL)

# **Problem/Background**

- High rate of collisions between left-turning motorists and pedestrians during WALK interval
- LPI 3 intersections
- Pedestrian crossings averaged
  60 per hour
- No public outreach / awareness to ensure unbiased results



# CASE STUDY: LPI (ST. PETERSBURG, FL)

### **Details**

- Installed 3-second LPI
- Studies pedestrian behavior and conflicts with turning vehicles
- Each street had four lanes & high traffic volume
- 30 mph posted speed
- Data collected for:
  - pedestrian/motor vehicle conflicts
  - pedestrians beginning to cross during the 5-second period at the start of the WALK interval
  - pedestrians starting to cross during the remainder of the WALK interval



# CASE STUDY: LPI (ST. PETERSBURG, FL)

# Results

- Conflicts virtually eliminated for pedestrians departing during start of the WALK interval
  - Before: average of 2-3 conflicts per 100 pedestrians
  - After: no observation period had more than 2 conflicts per 100 pedestrians & 34 of the 41 periods had no conflicts
- Smaller reduction in conflicts during the remainder of the WALK interval
- Four months after installation, no reduction in effectiveness

# LEADING PEDESTRIAN INTERVAL -SAFETY



ITE Toolbox: Modify signal phasing to implement LPI - associated with a 5% decrease in pedestrian crashes.

#### Reference

- Institute of Transportation Engineers (2004). Toolbox of Countermeasures and Their Potential Effectiveness to Make Intersections Safer, Briefing Sheet 8, FHWA.
- Orlando, Florida study (2000)
- CMF Star Rating: Cannot be rated Insufficient information about study

# CMF (CRF)

### CRF 37% pedestrian crashes

 <u>Study Citation</u>: Fayish, and Gross, "Safety Effectiveness of Leading Pedestrian Intervals Using the Empirical Bayes Method." TRB 88th Annual Meeting Compendium of Papers CD-ROM. Washington, DC (2009).



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#### Countermeasure: Modify signal phasing (implement a leading pedestrian interval)

CMF	CRF (%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
0.63	37	*****	Vehicle/bicycle,Vehicl e/pedestrian	All	Urban	Fayish and Gross, 2009	
0.554	44.6	*****	Vehicle/bicycle,Vehicl e/pedestrian	All	Urban	Fayish and Gross, 2009	
0.577	42.3	*****	Vehicle/bicycle,Vehicl e/pedestrian	All	Urban	Fayish and Gross, 2009	
0.639	36.1	*****	Vehicle/bicycle,Vehicl e/pedestrian	All	Urban	Fayish and Gross, 2009	
0.608	39.2	*****	Vehicle/bicycle,Vehicl e/pedestrian	All	Urban	Fayish and Gross, 2009	
0.63	37	*****	Vehicle/bicycle,Vehicl e/pedestrian	All	Urban	Fayish and Gross, 2009	
0.711	28.9	*****	Vehicle/bicycle,Vehicl e/pedestrian	All	Urban	Fayish and Gross, 2009	



# MUTCD

Section 4E.06 Pedestrian Intervals and Signal Phases

### **MUTCD OPTION**

At intersections with high pedestrian volumes and high conflicting turning vehicle volumes, a brief leading pedestrian interval, during which an advance WALKING PERSON (symbolizing WALK) indication is displayed for the crosswalk while red indications continue to be displayed to parallel through and/or turning traffic, may be used to reduce conflicts between pedestrians and turning vehicles.





Section 4E.06, Paragraph 19

# MUTCD GUIDANCE ACCESSIBLE PEDESTRIAN SIGNALS

#### Guidance:

If a leading pedestrian interval is used, the use of accessible pedestrian signals (see Sections 4E.09 through 4E.13) <u>should</u> <u>be considered</u>.

Vision-impaired pedestrians use the sound of moving traffic to start crossing

If No APS, How do Vision Impaired Pedestrians Know When to Cross?



## **MUTCD GUIDANCE**

- If a leading pedestrian interval is used, it should be at least 3 seconds in duration and should be timed to allow pedestrians to cross at least one lane of traffic or, in the case of a large corner radius, to travel far enough for pedestrians to establish their position ahead of the turning traffic before the turning traffic is released.
- If a leading pedestrian interval is used, <u>consideration should</u> <u>be given</u> to prohibiting turns across the crosswalk during the leading pedestrian interval



## HOW MANY SECONDS TO LEAD WITH?

MUTCD minimum is 3 seconds - but is there good guidance to determine other values?

- D.C. has 117 intersections with LPI
  - Most of these intersections have LPI on all four approaches
  - Typically use 3 sec
  - Rare occasions 7 or 8 sec used for unusual geometrics.
  - No chart or diagram for calculating time
- Philadelphia has about 24 LPI intersections
  - Use 3 sec
- Phoenix has 3 LPI intersections
  - Use 5 sec
  - Intersections have time of day LPI



### LPI INTERSECTION - PHOENIX



- Two one-way streets
- 5 sec LPI
- Heavy left-turn movement conflicts with heavy crossing
- Outside City Hall & City Court and main marking structure for both
## LPI SIGNAL PHASING DIAGRAM 3<sup>RD</sup> AVE AND WASHINGTON ST



- Heavy northbound left-turn conflicts
- 5 Sec LPI provided for north/south pedestrians crossing with 3<sup>rd</sup> Ave traffic



### LPI CAN BE FIXED-TIME OR ACTUATED



- Fixed-time:
  - 24-hours
  - Time-of-day
- Push-button actuated



### NO RIGHT TURN ON RED

"NO RIGHT TURN ON RED" sign highly recommended
What NTOR sign works best for various circumstances?



### SIGNAL CONTROLLER COMPATIBILITY OLDER SIGNAL CONTROLLERS

- Too many to list but two are: TCT8000, TMP390
- Older signal controllers may need to utilize a new/additional phase for LPI interval, allowing the WALK to occur before the green interval and holding all of the other movements in red. Typically requires creation of a dummy phase to link the LPI with the rest of the WALK and pedestrian clearance interval
  - Can be done with concurrent operating phases or controllers capable of pedestrian overlaps
  - Can be more complex to establish left-turn phases with LPI because of increased number of phases utilized & limitations of older controllers



### SIGNAL CONTROLLER COMPATIBILITY NEWER SIGNAL CONTROLLERS

- Examples: ASC/2 or ASC/3
- Use Delayed Green feature (DLY GRN)



- Defined (per the ASC/3 Programming Manual) as: "The time that the vehicle green indication will be delayed from the start of the WALK interval. The delay is ignored if there is no pedestrian service call when the phase is started (actuated mode). If the delay time is greater than the WALK time, the WALK is extended to the end of the delay green."
- For fixed-time or non-actuated operation, delayed green (for LPI) will be provided for every signal cycle.
- Per the ASC/3 Programming Manual, the delayed green can be set from 0 to 255 seconds
- Can be push-button, automated detection, or time-of-day
- D.C. DOT implements LPI through a central controller

### ISSUES

- Left Turn Arrows Best with lagging protected arrows
- Synchronization with other signals should not be an issue
- One-Way Streets Treat left-turn LPI same as right-turn May want to add a few more seconds in some instances
- NTOR RTOR prohibitions highly recommended for LPI to work for pedestrians
- Congestion separating pedestrians from turns should help reduce congestion

### HOW TO INCREASE LPI EFFECTIVENESS

- Provide enough LPI time for pedestrians to occupy crosswalk
- Prohibit turns on red
- Provide APS for vision-impaired pedestrians







### COST

Low (if new controller not needed)

Time & effort to program & implement

NTOR signs

APS push buttons (Highly Desirable)





## CASE STUDIES



## CASE STUDY: LPI (STATE COLLEGE, PA)

## **Details**

- High pedestrian-vehicle crash rates, especially in central business district
- LPIs installed at 10 intersections downtown
- Each street had two through lanes
- **12,000 13,500 ADTs**



## CASE STUDY: LPI (STATE COLLEGE, PA)

## **Details**

- 25 mph speed limit
- Pedestrians: 100 to 1,000 per hour
  - Fluctuation due to university class schedules
- LPI 3 seconds



## CASE STUDY: LPI (STATE COLLEGE, PA)

## Results

- Study in 2010 compared the 10 sites with LPIs to other STOPcontrolled intersections in the borough\*
- Crash counts for 4-year before and 3-year after period: LPIs resulted in a 46.2 - 71.3% reduction in crashes
- LPIs resulted in cost savings of \$92,130 per intersection per year

\*Fayish, Aaron C; Gross, Frank. "Safety Effectiveness of Leading Pedestrian Intervals Evaluated by a Before–After Study with Comparison Groups." TRB, Issue 2198, 2010, pp 15-22.

Period	Time (year)	Treatment Group	Comparison Group
Before	4	24	13
After	3	14	17

#### **Before and After Crash Counts**



## NYC LPI LOCATIONS **BRONX MANHATTAN QUEENS**

#### Listing of LPI Signals

<u>http://www.nyc.gov/html/dot/ht</u> ml/infrastructure/leading-pedintervals.shtml

Broadway at West 225th Street	the Bro	
East 147th Street at Willis Avenue	the Bro	
East 149th Street at Morris Avenue	the Bro	
East 161st Street at Gerard Avenue	the Bro	
East 233rd Street at Carpenter Avenue	the Bro	
East Tremont Avenue at Ericson Place/Hutchinson		
River Parkway exit ramp	the bio	
River Avenue at East 162nd Street	the Bro	
Sedgwick Avenue at Dickinson Avenue	the Bro	
West Fordham Road at University Avenue	the Bro	

nx nx nx nx nx nx nx nx nx

108th Street at Otis & Van Cleef Streets	Queens
178th Street at Hillside Avenue	Queens
188th Street at Grand Central Parkway Service Road North	Queens
73rd Avenue at Bell Boulevard	Queens
99th Street at Horace Harding Expressway Service Road North	Queens
Archer Avenue at Parsons Boulevard	Queens
Archer Avenue at Sutphin Boulevard	Queens
Broadway at 21st Street	Queens
Corporal Kennedy Street at 26th Avenue	Queens
Cross Bay Boulevard at 157th Avenue	Queens
Eliot Avenue at 71st Street	Queens
Grand Avenue at 69th Street	Queens
Grand Avenue at Long Island Expressway North	Queens
Grand Avenue at Long Island Expressway South	Queens
Hempstead Avenue at Springfield Boulevard	Queens
Jamaica Avenue at 162nd Street	Queens
Jamaica Avenue at Parsons Boulevard	Queens
Junction Boulevard at Long Island Expressway South Service Road	Queens
Kissena Boulevard at Elder Avenue	Queens
Kissena Boulevard at Sanford Avenue	Queens
Main Street at 40th Road	Queens
Main Street at 41st Road	Queens
Merrick Boulevard at Hillside Avenue	Queens
Northern Boulevard at Main Street	Queens
Northern Boulevard at Parsons Boulevard	Queens
Queens Boulevard at 32nd Place	Queens
Queens Boulevard at 33rd Street	Queens
Queens Boulevard at 34th Street	Queens
Queens Boulevard at 35th Street	Queens
Queens Boulevard at 36th Street	Queens
Queens Boulevard at 37th Street	Queens
Queens Boulevard at 38th Street	Queens
Queens Boulevard at 39th Place	Queens
Queens Boulevard at 39th Street	Queens
Queens Boulevard at 40th Street	Queens
Queens Boulevard at 41st Street	Queens
Queens Boulevard at 42nd Street	Queens
Queens Boulevard at 43rd Street	Queens
Queens Boulevard at 44th Street	Queens
Queens Boulevard at 45th Street	Queens
Queens Boulevard at 46th Street	Queens
Queens Boulevard at 47th Street	Queens
Roosevelt Avenue at Main Street	Queens
Union Turnpike at Springfield Boulevard	Queens
Whitestone Expressway Service Road at 20th Avenue	Queens

### **QUESTIONS / RESOURCES**

#### MUTCD Section 4E.06 Pedestrian Intervals and Signal Phases

- <u>http://mutcd.fhwa.dot.gov/htm/2009r1r2/part4/part4e.htm</u>
- "Safety Effectiveness of Leading Pedestrian Intervals Using the Empirical Bayes Method." TRB 88th Annual Meeting Compendium of Papers CD-ROM. Washington, DC (2009).
   <u>Study Citation</u>: Fayish, and Gross
  - http://nacto.org/docs/usdg/safety\_effectiveness\_of\_lpi\_fayish.pdf

## THE GREEN AT COLLEGE PARK UNIVERSITY OF TEXAS ARLINGTON













Drainage Area Boundry

Acres

#### The Green at College Park, UTA



PROJECT ADDRESS: 601 SOUTH PECAN STREET, ARLINGTON TX 76019, USA SCALE:

> Sheet No: Credit 2.1 HYDROLOGY MAP

SEPTEMBER 2010

NTS



# THE GREEN AT COLLEGE PARK

#### The University of Texas Arlington



# THE GREEN AT COLLEGE PARK

### HIERARCHY OF STORM WATER MANAGEMENT

- Priority One Design the site to be a green sponge
  - Encourage infiltration of storm water into the soil
  - Drain storm water from grey to green
  - Sheet flow storm water across the landscape
  - Reduce impervious surfaces
  - Slow down the flow of water
  - Create micro-depressions in the landscape to capture storm water
  - Amend soil with organic matter to encourage soil to function more like pre-development infiltration rates

# THE GREEN AT COLLEGE PARK

The University of Texas Arlington

### HIERARCHY OF STORM WATER MANAGEMENT

Priority Two – Improve quality of storm water

- Filter water through vegetated areas
- Filter water through soil
- Slow down flow of water to allow sediment to settle
- Select plants that break down pollutants in water
- Slow down the flow of water
- Provide a highly organic soil so microorganisms can break down pollutants

#### **Expected Pollutants:**

- Sediment,
- heavy metals and
- Petroleum compounds from adjacent parking

BMP's

#### BMP's:

#### . <u>Rain Planters:</u>

- Designed to store and convey run-off and filter contaminants
   <u>Biofilters</u>:
- •Located between parking areas and rain garden
- Saw tooth curb added to allow stormwater to drain through biofilters
- biofilters contain native vegetation

#### Rain Garden:

- connects and flows into the Rain Garden.
- Water infiltrated into the rich planting media in the rain planters flows through the soil into the rain garden.

#### Oval Lawn:

- During large storm events run-off backs up and is stored in the oval lawn area.
- Drainage across the lawn sheet flows into the Rain Garden.

# STORM PLANTER





# CONDENSATE FOUNTAIN





## DRY STREAMBED



## RAIN GARDEN



## **RAIN CHANNEL**





SCALE: I" = I'-0"

Rain Planter.dwg

## RAIN GARDEN





## **DETENTION LAWN**







# **BIO FILTER**

## OVER FLOW


### WATER WISE A GREEN SOLUTION TO WATER POLLUTION

INTER STREET

College Park Center Drainage consists of surface runoff, storm water from roof drains and condensate from the air conditioning system.

The **Rain Channel** is a conveyance system that consists of a porous soil structure protected by a layer of rock mulch. This channel increases infiltration of runoff into the soil and filters total suspended solids.

The **Storm Spring** relieves pressure from the underground campus storm drainage system. During large storm events, it functions as a reverse inlet, allowing storm drainage from underground pipes to overflow into the oval lawn area for detention.

The **Detention Lawn** temporarily holds water during large storm events and gradually allows it to drain into the Rill Garden.

The **Rill Garden** is a complex system of vegetation that thrives in drought and flood conditions. Below the surface layer of the rock mulch is a porous soil structure that increases infiltration. The soil system, rock mulch and vegetation work together to remove pollutants from storm run-off. This garden replaces an eroded drainage channel, )or rill) that existed on the site.

ADDITIONAL INFORMATION:



The Check Dam helps to filter storm water and encourages infiltration by reducing velocity and increasing the amount of time storm water is detained on site.

The **Overflow Structure** controls the amount of water that leaves the garden and drains to Johnson Creek. The controlled release also alleviates potential flooding of adjacent streets.

The Biofilter is a vegetated system that removes total suspended solids from parking lot run-off before eventually draining into the rill garden.

The **Microdepressions** are shallow depressions in the landscape that are sculpted to retain irrigation and storm runoff. Below the depressions are large rock sumps that store water and release it into the soil to be used by surrounding vegetation. Planted in the shallow areas are native plants that grow in wet soil conditions.



### SIMPLE ADJUSTMENTS TO ACHIEVE SUSTAINABILITY

#### LIMIT TURF PLANTING

 More than 50% of municipal water use goes to irrigate residential lawns

#### **USE THE SOIL AS A WATER BANK**

#### PLANT NATIVE GRASSES AND PERENNIALS

#### **IMPROVE ORGANIC CONTENT OF SOIL**

#### **DRAIN FROM GREY TO GREEN**



### THE SUSTAINABLE SITES INITIATIVE

"The Sustainable Sites Initiative™ (SITES™) is an interdisciplinary effort by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at The University of Texas at Austin and the United States Botanic Garden to create voluntary national guidelines and performance benchmarks for sustainable land design, construction and maintenance practices"

www.sustainablesites.org

### **SITES vs. LEED**

SITES – Sustainable
 Sites Initiative (SITES)

### Site based

- Certification is on a 1,2,3,4 Star rating system
- Just finished the pilot program phase
- Only one form of SITES is available
- 2009 Guidelines & Performance Benchmarks

- LEED Leadership in Energy and Environmental Design
- Building Based
- Certification is on a Silver, Gold & Platinum rating system
- Is an established rating system
- Is available in several forms

### **SITES PILOT PROGRAM**



### **SITES CERTIFICATIONS**



Novus Headquarters St Charles, MI





Woodland Discovery Playground Memphis, TN



#### How INVEST Can Help You

The Infrastructure Voluntary Evaluation Sustainability Tool U.S. DOT Federal Highway Administration

Green Streets and Transportation Planning Workshop Arlington, Texas September 25, 2013





#### What is Sustainability?





#### The Sustainability Triple Bottom Line



NCHRP 708: Guidebook for Sustainability Performance Measurement for Transportation Agencies



- Sustainability entails meeting human needs for the present and future, while:
- Preserving and restoring environmental and ecological systems;
- Fostering community health and vitality
- Promoting economic development and prosperity; and
- Ensuring equity between and among population groups and over generations.





- Transportation system enhances quality of life through access to health care, education, employment, recreation, etc.
- Supports community, economic development.
- Negative impacts from congestion, fatalities and injuries, noise, air and water pollution, GHG, diminishing energy resources, and biological and ecosystem damage.
- Maximize benefits, minimize costs.

#### **FHWA Sustainable Highways Initiative**



The Sustainable **Highways Initiative** supports programs and activities conducted across the Federal **Highway Administration** to facilitate balanced decision-making among environmental, economic and social values the triple bottom line of sustainability.







- Connects sustainability principles with action
- Measures sustainability specifically for transportation
- Helps stakeholders in the industry go above and beyond



#### **Built for the Real World**



- Voluntary Use it how and where the agency wants
- Private Data belongs to the user
- Practical Relates to projects and planning the agency does every day
- Free No licenses and no limits



#### **Supporting the Entire Life Cycle**







#### **About INVEST**







#### **INVEST User Workspace**



						My Workspac	e Logged In as FHWA Demos	
							Logout	
	ST						Version 1.0	
lome Learn Brows	se Score <u>H</u>	lome >My Wo	orkspace				search g	
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Scoring Tutorial							Learn	
							Browse	
Start a new Project or Pro	ogram						Score	
							Glossary	
Continue Working on an Ex	xisting Project or	Program:					FAQ	
System Planning an	nd Processes	6					Case Studies	
<u>Test 1</u> Project Developme	<u>Edit</u> nt	Duplicate	Print-View	Score	<u>Delete</u>	Collaborate	FHWA's Sustainable Highways Initiative	
Test 2	Edit	<u>Duplicate</u>	Print-View	Score	Delete	Collaborate	Provide Comments	
							Register	
Operations and Ma	intenance			_			Privacy	
Test 3	Edit	Duplicate	Print-View	Score	Delete	Collaborate		



#### Scoring in INVEST



	My Workspace Logged						
		Logout Version 1.0					
iterion Number and Title	Home Learn Browse Score Home > Score > Scorecard > View	Criterion	search	go			
ning: Economic Development and Land Use ning: Natural Environment ning: Social ning: Bonus bility	Criterion Details SP-1 Integrated Planning: Economic Development and Land Use	Criterion Scoring Test 1 Has the agency developed goals and objectives for the integration of metropolitan and/or statewide	Home Learn Browse Score				
sportation and Public Health ds Movement Management	Goal Integrate statewide and metropolitan Long Range Transportation Plans (LRTP) with statewide, regional, and/or local land use plans and economic development forecasts and goals. Proactively encourage and facilitate sustainability through the coordination of transportation, land use, and economic development planning.	transportation planning with economic development and land use planning above and beyond current requirements? (a) Yes (1 point)	Glossary FAQ Case Studies				
ls inability ds Systems Management & Operations Ianagement and Planning	Sustainability Linkage Integrating transportation planning with economic development and land use supports the economic triple bottom line principle by creating opportunities to improve access and mobility, and increase the social, environmental, and economic returns on both public and private investments in transportation projects	<ul> <li>No</li> <li>Are the goals and objectives consistent with applicable economic development and land use plans above and beyond current requirements?</li> <li>Yes (1 point)</li> </ul>	FHWA's Sustainable Highways Initiative Provide Comments Register				
Resiliency 1g and NEPA	and programs.  Attend Tiple Battom Lise Principles  Scoring Requirements Background  This criterion recognizes that each state and MPO has different land use and economic development regulatory, policy, and institutional frameworks, plans, and goals, and allows for flexibility in the activities and types of plans agencies use to measure integration. The intent of this	<ul> <li>No</li> <li>Does the agency regularly engage land use and economic development agencies in its jurisdiction throughout the transportation planning process?</li> <li>Yes (2 points)</li> </ul>	Privacy				

criterion is to encourage agencies to integrate sustainability into

transportation, land use, and economic development planning.

O No

#### G

SP-1: Integrated Plann

- SP-2: Integrated Plann
- SP-3: Integrated Plann
- SP-4: Integrated Plann
- SP-5: Access & Affordal
- SP-6: Safety Planning
- SP-7: Multimodal Tran
- SP-8: Freight and Good
- SP-9: Travel Demand N
- SP-10: Air Quality
- SP-11: Energy and Fue
- SP-12: Financial Susta
- SP-13: Analysis Methor
- SP-14: Transportation
- SP-15: Linking Asset M
- SP-16: Infrastructure
- SP-17: Linking Plannin



#### **How INVEST Measures Sustainability**





#### **Evaluate – Score – Improve**



- Evaluate Using the collaborative process can provide the most important outcome
- Score Provides recognition for implementing sustainability best practices and identifying gaps
- Improve Using the process to improve in practice and identify cost effective measures



#### **INVEST Pilot Sites**







#### **INVEST Pilot Success Stories**







## North Central Texas Council of Governments (NCTCOG)



Large Multi-Modal Transportation Plan INVEST Role: System Planning & Processes

- Rapid regional growth: 6.5M to 10M
- Projected funding shortfall of \$45B
- Need to increase mobility, cut some improvements & reprioritize others
- Influence travel behavior & demand, improve transportation / land use links
- Extend life of existing assets, increase spending on O&M
- Used INVEST to validate assumptions, ID improvements in asset management and infrastructure resiliency



## North Central Texas Council of Governments (NCTCOG)







#### Watch Video Case Study Here



# Ohio Department of Transportation (ODOT)



Complex, Urban Project INVEST Role: Project Development

- Largest project in ODOT history replace bridge spans / expand lanes
- Involves coast-to-coast Interstate
- Affects historic district and hightraffic sports complex
- Targeted major savings in diesel fuel, steel, water and landfill
- Used INVEST to validate those savings assumptions





## Ohio Department of Transportation (ODOT)







#### Watch Video Case Study Here



#### **Western Federal Lands**



National Scenic Parkway INVEST Role: Project Development

- 70 years of traffic, weather, avalanches & rockslides
- Aggressive 20-year seasonal rehab program keeps road open but work moving ahead
- Reusing all existing stonework, reseeding disturbed roadsides
- INVEST helped validate context sensitivity but also improve their documentation & communications



#### **Western Federal Lands**







#### Watch Video Case Study Here



# Utah Department of Transportation (UDOT)



Maintaining a State-Wide Highway System INVEST Role: Operations & Maintenance

- Traffic monitoring & coordination across
   6K+ center-line miles of highways
- Key goals: preserve infrastructure, optimize mobility, improve safety, strengthen the economy
- Budget pressures driving need for more sustainable practices
- Used INVEST to ID inexpensive ways to promote sustainability, like better data about pavement conditions



## Utah Department of Transportation (UDOT)







#### Watch Video Case Study Here



#### **INVEST Implementation Sites**





## **INVEST:** Sustainability throughout the Transportation Lifecycle





Voluntary • Private • Free • Flexible • Practical



#### **Appendix: System Planning Criteria**



- SP-1 Integrated Planning: Economic Development and Land Use
- SP-2 Integrated Planning: Natural Environment
- SP-3 Integrated Planning: Social
- SP-4 Integrated Planning: Bonus
- SP-5 Access & Affordability
- SP-6 Safety Planning
- SP-7 Multimodal Transportation and Public Health
- SP-8 Freight and Goods Movement

- SP-9 Travel Demand Management
- SP-10 Air Quality
- SP-11 Energy and Fuels
- SP-12 Financial Sustainability
- SP-13 Analysis Methods
- SP-14 Transportation Systems Management & Operations
- SP-15 Linking Asset Management and Planning
- SP-16 Infrastructure Resiliency
- SP-17 Linking Planning and NEPA

#### **Appendix: Project Development Criteria**



- PD-1 Economic Analyses
- PD-2 Lifecycle Cost Analysis
- PD-3 Context Sensitive Project Development
- PD-4 Highway and Traffic Safety
- PD-5 Educational Outreach
- PD-6 Tracking Environmental Commitments
- PD-7 Habitat Restoration
- PD-8 Stormwater
- PD-9 Ecological Connectivity

- PD-10 Pedestrian Access
- PD-11 Bicycle Access
- PD-12 Transit & HOV Access
- PD-13 Freight Mobility
- PD-14 ITS for System Operations
- PD-15 Historical, Archaeological, and Cultural Preservation
- PD-16 Scenic, Natural, or Recreational Qualities
- PD-17 Energy Efficiency
- PD-18 Site Vegetation

#### **Appendix: Project Development Criteria**



- PD-19 Reduce and Reuse Materials
- PD-20 Recycle Materials
- PD-21 Earthwork Balance
- PD-22 Long-Life Pavement Design
- PD-23 Reduced Energy and Emissions in Pavement Materials
- PD-24 Contractor Warranty
- PD-25 Construction Environmental Training
- PD-26 Construction Equipment Emission Reduction

- PD-27 Construction Noise Mitigation
- PD-28 Construction Quality Control Plan
- PD-29 Construction Waste Management

## Appendix: Operations & Maintenance Criteria



OM-1 Internal Sustainability Plan

- OM-2 Electrical Energy Efficiency and Use
- OM-3 Vehicle Fuel Efficiency and Use
- OM-4 Reuse and Recycle
- OM-5 Safety Management
- OM-6 Environmental Commitments Tracking System
- OM-7 Pavement Management System

OM-8 Bridge Management System

- OM-9 Maintenance Management System
- OM-10 Highway Infrastructure Preservation and Maintenance
- OM-11 Traffic Control Infrastructure Maintenance
- OM-12 Road Weather Management Program
- OM-13 Transportation Management and Operations
- OM-14 Work Zone Traffic Control


### FHWA Needs Feedback to Make it Even Better

To help FHWA make the next version of INVEST even better, click on the "Provide Comments" link at:

www.sustainablehighways.org









# Try INVEST at: www.sustainablehighways.org

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# Transportation Sustainability in North Central Texas: Using INVEST to Evaluate the Dallas-Fort Worth Metropolitan Transportation Plan

### FHWA Green Streets and Transportation Workshop September 25, 2013



Dan Lamers

Senior Program Manager, Transportation Planning North Central Texas Council of Governments



### **Regional Perspective**

- Big and getting bigger
- Major economic player

### Population

- 2012: 6.7 million
- 2035: 9.8 million
- 4<sup>th</sup> Largest Metropolitan Area by Population

#### Area

- 12 county Metropolitan Planning Area
- 9,441 square miles (larger than New Hampshire)
- 2<sup>nd</sup> Largest Metropolitan Planning Area

#### Economy

- Home to 18 Fortune 500 Firms
- Ranked 6<sup>th</sup> in Gross Metropolitan Product



# A New Planning Reality

- Mobility 2035 and Mobility 2035 2013 Update
  - Continued growth
  - Funding shortfalls
  - Air quality nonattainment
- A new approach was needed
  - Needs exceed available revenue
  - Can't build our way out of congestion
  - Invest strategically in infrastructure
  - Maximize existing system
  - Use sustainable development strategies to reduce demand and provide multi-modal options
  - Emphasize environmental aspects and quality of life



Mobility 2035 - Adopted March 2011



Mobility 2035 – 2013 Update - Adopted June 2013



### What Did We Do?

- 2012 INVEST Pilot Study Participant
  - Evaluated all triple bottom line elements relative to our planning process and MTP
    - Brought together all relevant program areas
    - Many discussions as we attempted to score ourselves on each criteria
    - Found it difficult to fit our efforts into scoring options
      - Met vs Not Met, partial credit

### -<u>Video</u>

• Realized we had done a lot, but still had some work to do



## Where Are We Now?

- Current Sustainability Initiatives
  - -Environment
    - Air quality
    - Regional Ecosystem Framework
  - Land-Use and TransportationConnection
    - Sustainable development funding programs
  - Economic Development
    - Infrastructure investment

Current efforts focus on localized/project level implementation. Future efforts aim to address sustainability throughout the region at the system level.



Southlake Town Square

Source: NCTCOG



## How Can We Get There?

- Incorporate concepts from INVEST throughout plan development
- Mobility 2040 the next metropolitan transportation plan
  - Received FHWA funds to focus on specific INVEST System Planning Criteria
    - Sustainability Performance Measure Development for about 10 measures
    - Planning and Environment Linkages (Landscape-scale analysis techniques and mitigation)
    - Linking Asset Management and Planning
    - Infrastructure Resiliency (Adaptation Strategies)
  - Coordinate with SHRP2 grant to update Regional Ecosystem Framework
  - Evaluate before and after
- Incorporate performance based planning efforts
- Understand "Texas Version" of context sensitive solutions



### **Contact Information**

- To find out more about the Mobility 2035 2013 Update, please visit <u>www.nctcog.org/mobility2035</u> or contact:
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