THE PEARL

FROM GREY TO GREEN

FROM GREY TO GREEN - Tulsa's Pearl District is taking the first step toward sustainable, smart growth. This proposal aims to take what's grey - stormwater - and turn it into green.

OUTDATED INFRASTRUCTURE
UNUSED OPEN SPACE
GREYWATER IS NOT USED AS A RESOURCE
COST OF CONSTRUCTION DISRUPTION
COST OF LAND ACQUISITION
COST OF INFRASTRUCTURE - CONVEYANCE & STORAGE
DAMAGE TO THE WATERSHED
INCREASED AIR POLLUTION
LESS BUILDABLE LAND
TRANSFERS POLLUTANTS DIRECTLY INTO STREAMS & RIVERS
SINGLE PURPOSE
PRONE TO OBSOLESCENCE
DAMAGES NATURAL HABITATS

TREATS WATER AS A RESOURCE
GREATER PROPERTY TAX REVENUE
REDUCES URBAN HEAT ISLAND EFFECT
ALLOWS FOR MORE FLEXIBLE SITE LAYOUTS
PROVIDES A HABITAT FOR PLANTS AND ANIMALS
GREATER DENSITY IN DEVELOPMENT = MORE TAX DOLLARS
MORE LINEAR FEET OF GREEN SPACE = HIGHER PROPERTY
PUBLIC FUNDS INCENTIVIZE PRIVATE INVESTMENT
A VIBRANT, LIVING COMMUNITY
A BETTER QUALITY OF LIFE
LOT YIELD
AESTHETIC VALUE
SUSTAINABLE INFRASTRUCTURE
VALUES

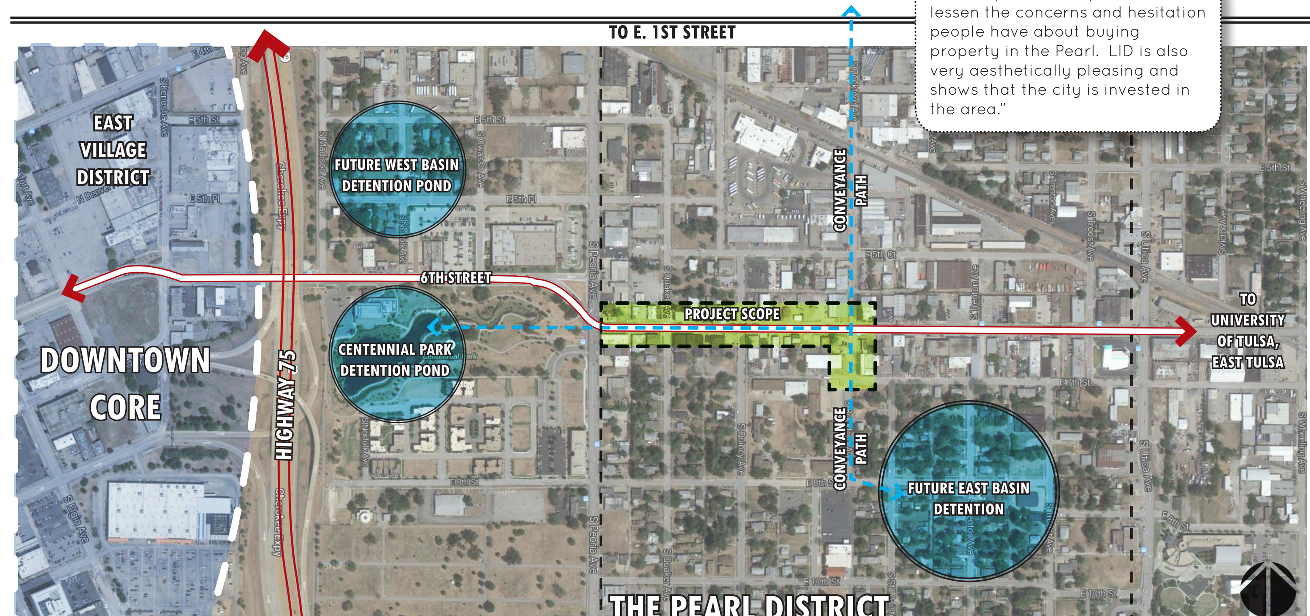
THE CHALLENGE

DELIVER a design that realizes the vision for the neighborhood through the utlization of Low Impact Development strategies to address flooding concerns while stimulating revitalization and reinvestment.

Julian Morgan
Pearl District Association President
Pearl District Business Owner

"Low-impact development can lessen the concerns and hesitation people have about buying property in the Pearl. LID is also very aesthetically pleasing and shows that the city is invested in the area."

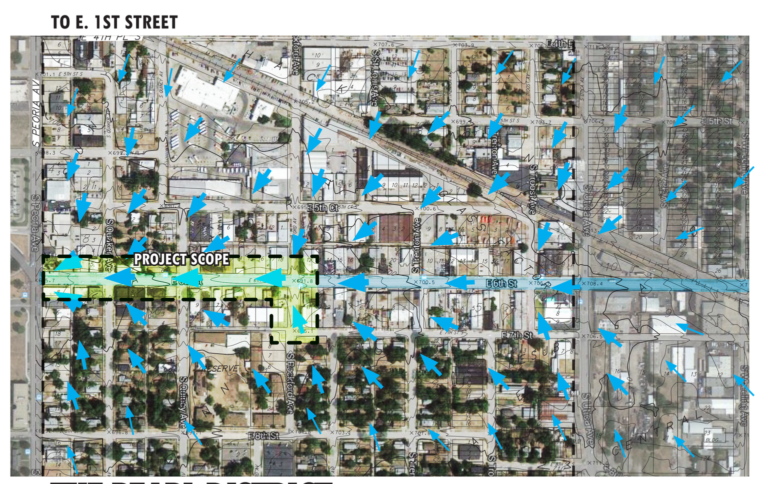
EXISTING CONDITIONS



THE PROJECT SCOPE is from E. Sixth Street between Peoria and Rockford and Rockford between 6th and 7th street. Though the physical area of the project is limited, storm water runoff enters from all directions and has created a need to investigate better water management practices.

CONTRIBUTING DRAINAGE AREA	26.8 ACRES
PROJECT DRAINAGE AREA	11.8 ACRES
RUNOFF COEFFICIENT	0.8Z
RUNOFF FROM 1% STORM	167 CFS

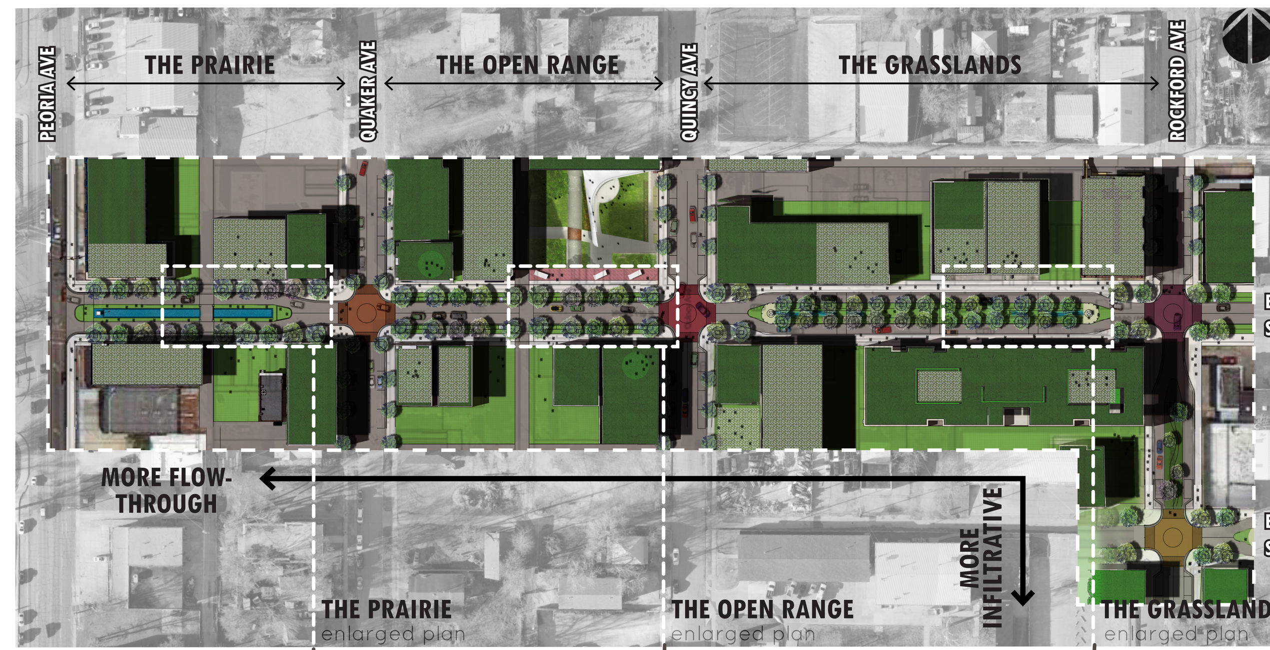
Contributing drainage area is that portion of the Elm Creek Basin which directly impacts stormwater management in the project area.



The Elm Creek drainage basin consists of 3.4 square miles of fully urbanized inner city, which is generally located east of the downtown Tulsa area. The basin is totally developed with urban land uses, consisting primarily of older single family residences, with retail and service commercial uses along the major streets.

The Elm Creek basin includes the Pearl District, as well as parts of other neighborhoods including Kendall-Whittier. The watershed is identified by the name of the creek that formerly drained it. The creek was replaced by a network of storm sewers which now drain into the "Elm Park Relief Sewer", designed in 1922. Urbanization in the watershed over the 87 year period since that time has served to overload the main sewer system as well as its contributing conduits.[1]

[1]taken from the Elm Creek 6th Street Drainage Project by Guy Engineering



OVERALL SITE PLAN

THE SOLUTION

6th Street in the Pearl District has the potential to be regarded as the greenest street in Tulsa. This proposal demonstrates this potential and the ways in which it may be achieved. As envisioned, this project will not only manage storm water effectively, but in doing so, will create a vibrant, multi-modal, pedestrian-oriented street that enables the surrounding community to thrive.

This proposal seeks to capitalize on the challenges of the site to accomplish the following:

- **EDUCATE** stakeholders on the value and importance of incorporating LID strategies into public infrastructure projects. Educate the general public about sustainable design.
- Improve the **ENVIRONMENT** through a reduction in urban heat island effect, reduced energy use, added green space, and improved quality of stormwater runoff.
- Foster **COMMUNITY** by providing dynamic public spaces that encourage social interaction.
- Advance the **ARTS** by providing multiple venues for the display and performance of a diverse variety of public art.
- Identify the **ECONOMIC** benefits of the design in terms of its financial, social, and environmental impact on the area.

A PHASED APPROACH

PHASE I

- Public Investment in ROW infrastructure – partially complete, already necessary
- Public improvements instill confidence in developers/residents – supplies catalyst for private investment
- Benefits – catalyst for development, safer realm for pedestrians with street design/activity/visual tree corridor, reduced load on storm infrastructure, lowered urban heat island effect, urban habitats created, confidence in the District

PUBLIC

PHASE II

- City incentivizes properties or works with private owners to develop and maintain pocket parks/infiltration zones – TIF district based upon increased property values/sales
- Shared cost – maintenance by adjacent property owners
- Benefits – reduced load on storm infrastructure, lowered urban heat island effect, urban habitats created, social nodes created, more property frontage on green space increasing property value, bettering views, allowing for exterior seating/dining

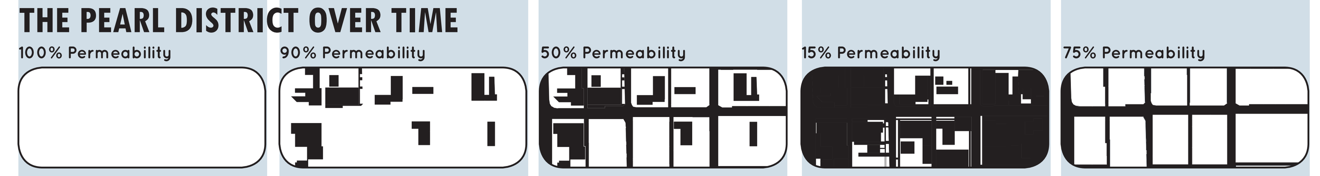
PUBLIC
PRIVATE

PHASE III

- Requirements and incentives for green roofs, private permeable spaces and grey water use
- Cost minimal – incentives only – maintained by private property owners
- Benefits – reduced load on storm infrastructure, lowered urban heat island effect, urban habitats created, more use of water prior to treatment

PUBLIC
PRIVATE

THE PEARL DISTRICT OVER TIME



100% Permeability	90% Permeability	50% Permeability	15% Permeability	75% Permeability
Prior to urban growth, Tulsa was part of the largest ecosystem in North America. The Tallgrass Prairie, originally covering over 142 million acres, is now only found in Kansas and Oklahoma. During this time, rainwater moved naturally over the course and sandy soils, and a diverse group of plants and animals could be found among the post oak and blackjack oaks that dotted the prairie.	Tulsa's early history is aligned with the displaced Muscogee (Creek) Indians who arrived in the area from eastern states in the 1830s. With the arrival the railroad in 1882, Tulsa began to grow as a ranching community. Tulsans shipped thousands of cattle from the surrounding areas eastward on the Frisco Railroad. As land ownership changed hands from the Creeks to others, large ranches were broken up and previous owners turned to opening businesses or farming, and the cow town days of Tulsa were over.	Tulsa changed from a small frontier town to a boomtown with the discovery of oil in 1901 at Red Fork. Development in the 6th Street Neighborhood reflects this initial explosion of growth. The "platting" of land in the 6th Street Neighborhood began in 1909. In 1922 the original stormwater system still serving the area was built. By 1923, the area was firmly established as a diverse, mixed-use urban neighborhood. By the end of the century this pattern of urbanization had covered the entire Elm Creek Basin.	At the close of the 1900's, the area had seen several decades of decline due to the trend of suburbanization. In 2006 the first phase of a flood mitigation plan was constructed in Centennial Park not using the traditional gray Infrastructure approach but a context sensitive design solution. The public investment helped spur what has become a neighborhood wide revitalization. Millions of dollars in private funds have been reinvested in new homes and businesses opening throughout the district.	**Sustainable, Low-Impact Development** In the late 2010s, the Pearl District underwent an infrastructural revitalization that spurred rapid new development along 6th street. The low-impact methods that were implemented not only promoted a more walkable, livable, living district, but it also educated the public on how to successfully implement LID strategies in an existing situation. Now the Pearl District is known throughout the country as an exemplary LID project, and has gained notoriety for its celebration of the arts and sustainability.

A Vision for 6th Street
Located directly east of Downtown in the historic section of the Pearl District, this project provides an opportunity to create vital public spaces that will have tremendous potential to revitalize the surrounding neighborhood while helping to educate the community on Low Impact Development stragtegies.

Meet the Pearl District!

Pearl District residents care about the future of their community. That's why they support Low-Impact Design development – to improve the quality, safety, and overall well-being of the district.

"The Pearl District should strive to be an example of how a city can turn a neglected area into a home for thriving mixed-use development that has not only repurposed buildings, but has infilled with water, trees & green spaces and low-impact new construction."

Mary Jones, Architect
Jonesplan, LLC
Pearl District Business Owner

"I'd like to see someone champion a storm sewer credit for properties that collect all rainwater."

Jonathan Bolzle
Broker/developer for KMO Development Group and member of Tulsa's Young Professionals

Amber Whitlatch
Owner, Marketing Director
Nightingale Theater
Pearl District Business Owner

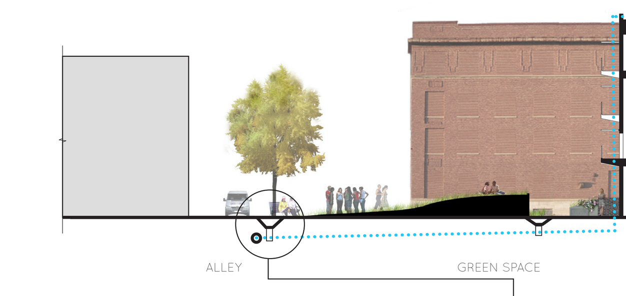
"Flooding is a concern for everyone in the flood zone. My fear would be damage to my business in case of a flood."

"I would absolutely be more apt to purchase property in the Pearl if I knew that future low-impact development would alleviate many storm water issues."

Shagah Zakerion
Executive Director,
Tulsa's Young Professionals

Joe Picorale
Owner, Be Love Yoga Studio
1310 E 6th Street

"We could hold workshops at the studio to engage stakeholders and brainstorm ideas as well as to learn more about Low Impact Development"



SECTION THROUGH BUILDING AND SECONDARY GREEN SPACE

TYPICA

THE SOLUTION

Each section of street contains a different combination of low-impact techniques to provide the most context specific solution. From West to East, more infiltrative methods are used to store rainwater and restore the natural hydrology of the site as much as possible. **As stormwater moves eastward, it is first collected by methods that do not add volume or increase the flow rate into the main conveyance.** Each block has a distinct character and street section, creating a dynamic experience for all modes of travel.

The Prairie is the main entrance to the Pearl District and features a canal that represents the predevelopment conditions on the site. The street trees are set back near the building face to frame the incredible vista looking west to Downtown.

The Open Range features an urban park as the core of the district - it facilitates new economic development, social interactions, places for learning and art, and exemplary LID methods.

In **The Grasslands**, the center median can host a variety of activities, ranging from street festivals to stargazing. Beneath this center median, water is stored for reuse by neighboring businesses.

"Truly sustainable growth would include new jobs, lower-income housing and some fundamental services (grocery store, hair salon,

Amber Whitlatch
Owner, Marketing Director
Nightingale Theater
Tulsa Pearl District

THE PRAIRIE
ENLARGED PLAN

- outdoor music venue, public art, street art, craft festivals
- cellular storage beneath pavers, narrow streets, bioswales, planter boxes, animal & plant habitats recreated
- shared green space, food trucks, music events, festivals, community garden, farmer's markets, street benches, decreased vehicular speed
- A reference perspective
- plant & animal species information, community gardening, info about LID
- reduced maintenance, increased property values next to green space

FLOW-THRU
FLOW-THRU & INFILTRATIVE
INFILTRATIVE

ARTS	ENVIRONMENT	COMMUNITY	EDUCATION	ECONOMIC
outdoor music facilities	narrower streets	shared green spaces	informational plaques about LID	greater lifespan of materials
spaces for public art	permeable pavement	food truck facilities	plant species information	increased green space increases property values
encouragement of street art	bioretention / cellular stormwater storage beneath road & sidewalk	street benches	animal species information	less volume of stormwater on existing infrastructure
chalk art festivals	planter boxes	nodes for greater social interactions	community gardens	incentivized green initiatives
I AM YOGA Festival	bioswales	encouraged diverse demographic	water harvesting information	reduced maintenance
foster monthly art openings	greenroofs	community gardens	historic information	reduced stormwater treatment costs
	rainwater harvesting	off-street centralized parking emphasizes the street as a pedestrian zone		less land in the flood plain
	more surface area of swales increases greater evapotranspiration and infiltration	raised intersections for slower traffic		
	facilitate animal habitats	farmer's markets		
	organic edible gardens	sense of pride and uniqueness		
	reduction of urban heat island effect			
	bike racks			
	multi-modal transportation encouraged			
	Parking Lot Islands			

LEVEL

FLOW-THROUGH
Flow-through cells have impervious bottoms with porous pipes that connect with the existing infrastructure.

Methods of stormwater management such as flow-through tree boxes and planters are the first line of defense to surface runoff and pollutants. Plants and soils retain water and retain some negative additives before it reaches the underground structures. Stormwater that encounters a series of flow-through features is significantly slowed.

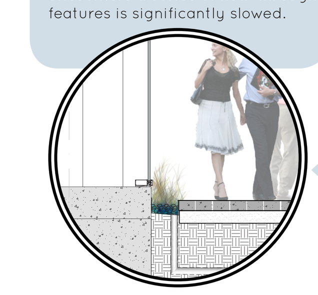
LEVEL

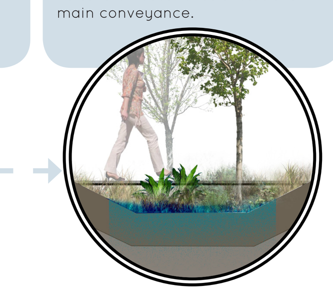
FLOW-THROUGH AND INFILTRATIVE
Both flow-through and infiltrative methods can be used together to create a context-specific solution to managing stormwater.

LEVEL

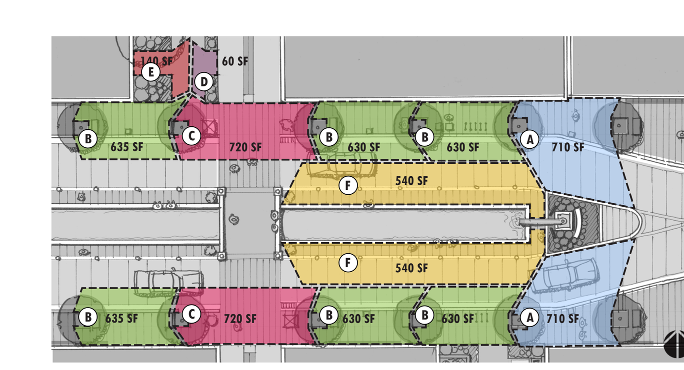
INFILTRATIVE & STORAGE
Infiltrative methods retain water and slowly release it back into the ground. Stormwater can also be stored in tanks or cells beneath the road and sidewalk.

Methods of stormwater management such as infiltrative planters and drybeds have the least impact on modern infrastructural systems. Plants intercept water and the subsurface soils filter out pollutants. Infiltrative systems and storage reduce the volume of water that enters the main conveyance.

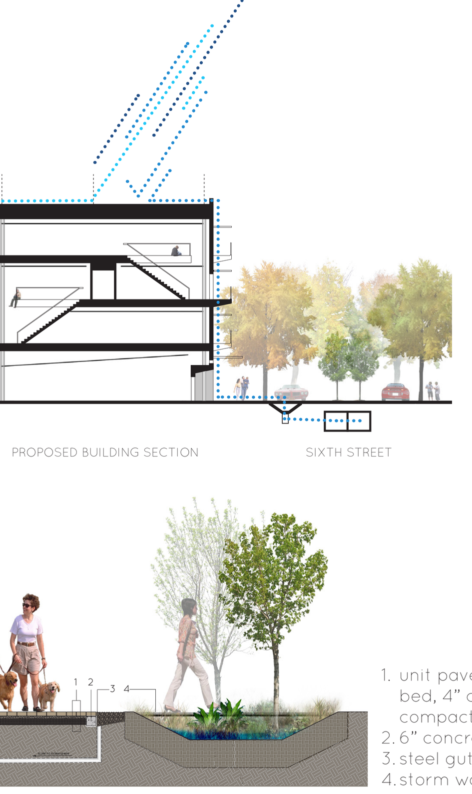




PERSPECTIVE B
LOOKING DOWN 6TH STREET
TOWARDS DOWNTOWN

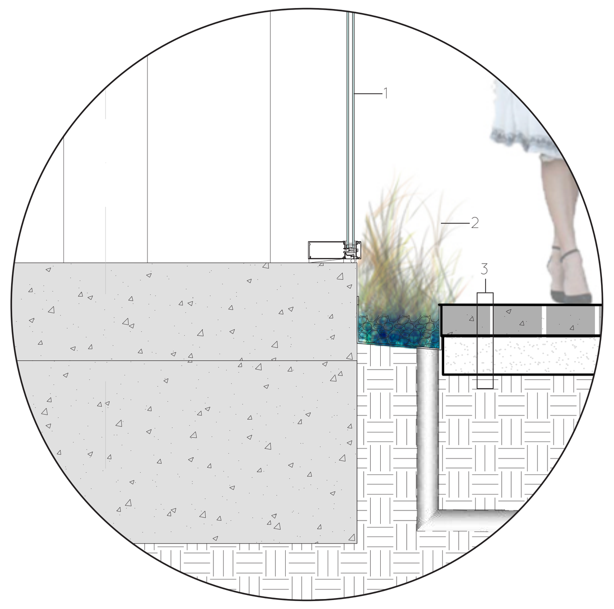


PLANTER CAPACITIES
The above diagrams illustrate the contri
planters and bioswales are designed to



1. unit pavers, 1.5" sand setting bed, 4" compacted aggregate, compacted subgrade
2. 6" concrete footing
3. steel gutter with filter gravel
4. storm water bridge beyond

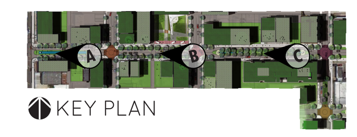
L INFILTRATIVE / FLOW THROUGH BIOSWALE CONDITION

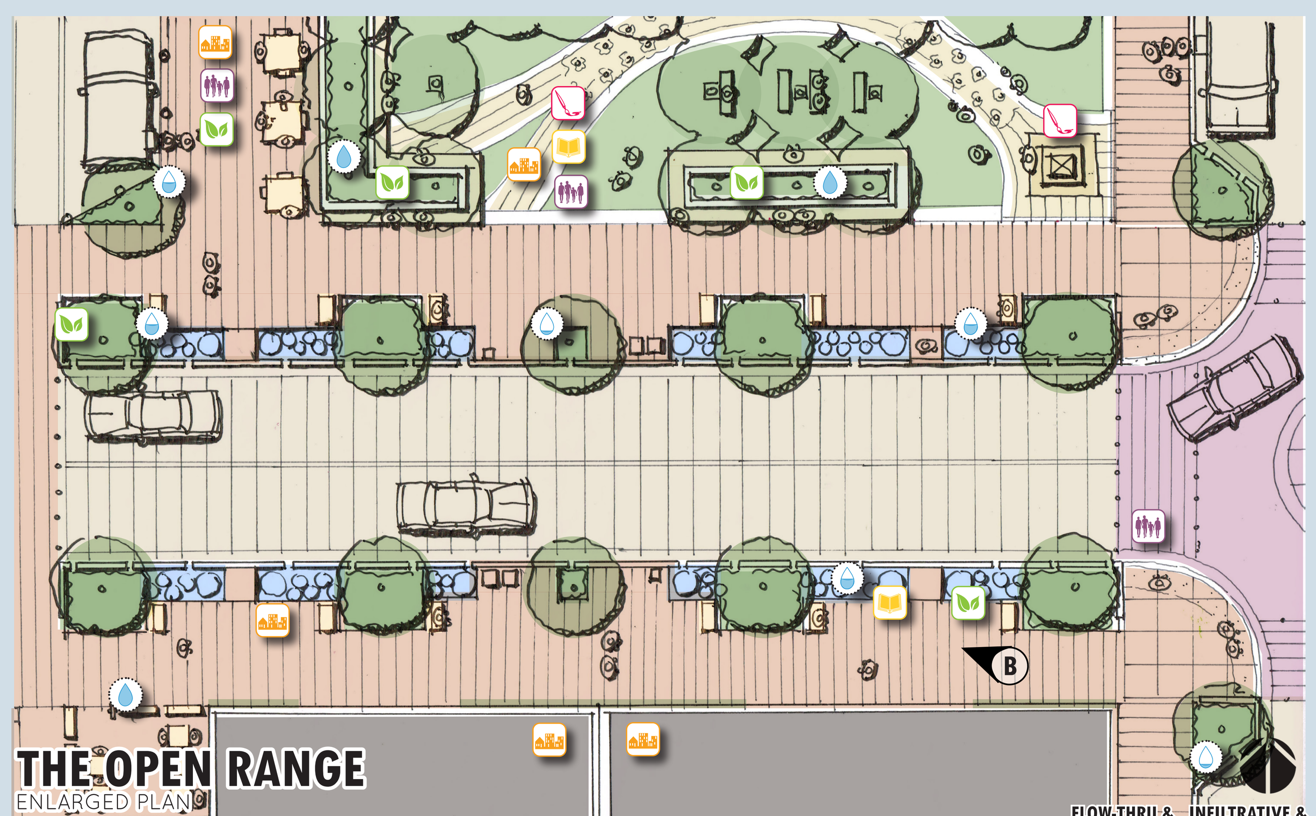


TYPICAL GROUND FLOOR FLOW-THROUGH FILTRATION DETAIL
SCALE 3/4" = 1'-0"

1. proposed building storefront
2. biofiltration grasses in a steel gutter with filter gravel, 8" min below finish floor
3. pervious pavers at sidewalk (slope to bioswale and retain in cells below)

PERSPECTIVE C
LOOKING DOWN 6TH STREET TOWARDS DOWNTOWN

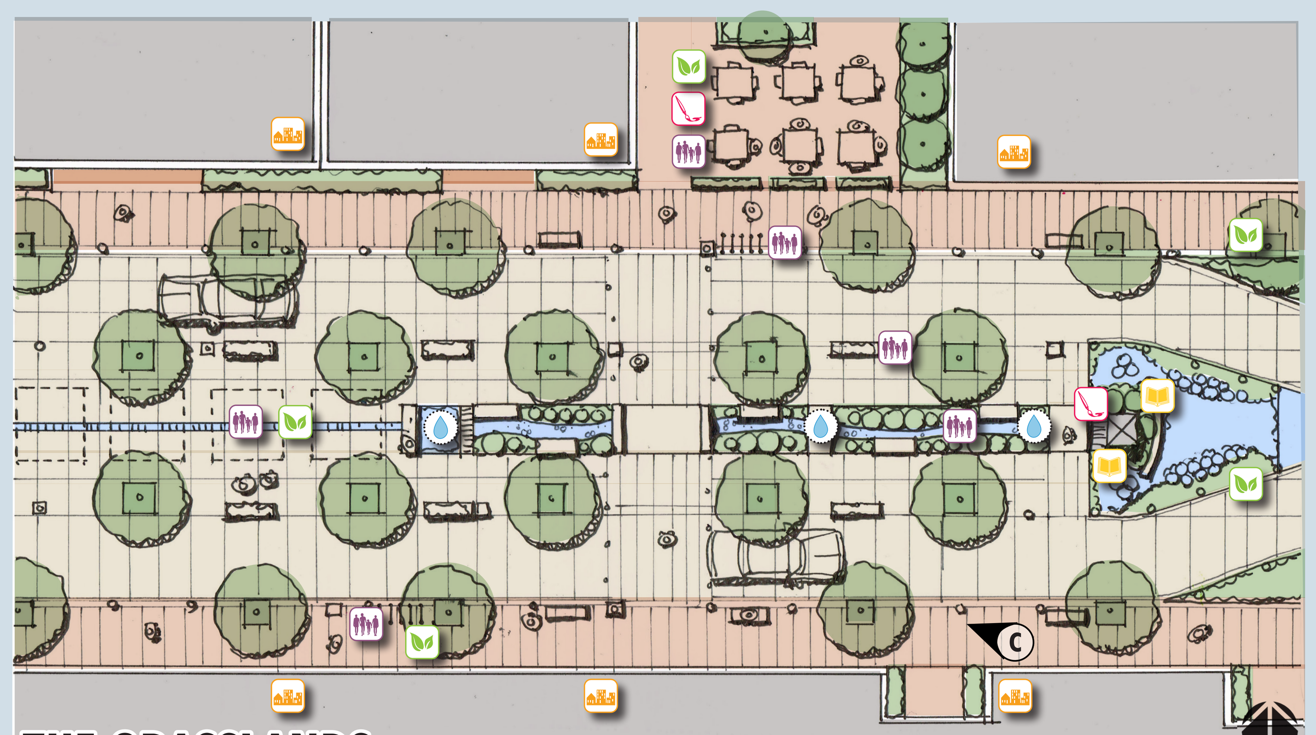

KEY PLAN



THE OPEN RANGE
ENLARGED PLAN

- outdoor music venue, public art, street art, craft festivals
- cellular storage beneath pavers, narrow streets, bioswales, planter boxes, animal & plant habitats recreated, street tree, underground water storage, native plants, pocket park
- shared green space, food trucks, music events, festivals, community garden, farmer's markets, pedestrian bridges, street benches, decreased
- B reference perspective
- signage, plant & animal species information, community gardening, info about LID
- reduced maintenance, increased property values next to green space, cafe seating,

FLOW-THRU | FLOW-THRU & INFILTRATIVE | INFILTRATIVE & STORAGE



THE GRASSLANDS
ENLARGED PLAN

- outdoor music venue, public art, street art, craft festivals
- cellular storage beneath pavers, narrow streets, bioswales, planter boxes, animal & plant habitats recreated, street tree, underground water storage, native plants, pocket park
- shared green space, food trucks, music events, festivals, community garden, farmer's markets, pedestrian bridges, street benches, decreased vehicular speed, curbless streets ensure ADA compliance, lighting, bollards, bike racks,
- C reference perspective
- signage, plant & animal species information, community gardening, info about LID
- reduced maintenance, increased property values next to green space, cafe seating,

FLOW-THRU | FLOW-THRU & INFILTRATIVE | INFILTRATIVE & STORAGE

BIOSWALES
A bioswale is a shallow depression created in the earth to accept and convey stormwater runoff. A bioswale uses natural means, including vegetation and soil, to treat stormwater by filtering out contaminants being conveyed in the water.

- Natural water detention feature - water is absorbed into soil (LEVEL III: infiltrative)
- Reduces runoff reaching the subsurface infrastructure
- Cleanses water by removing pollutants
- Reduces the need for subsurface infrastructure

$ Costs vary greatly depending on size, plant material, and site considerations. Bioswales are generally less expensive when used in place of underground piping.

GREENROOFS
Greenroofs generate significant public and environmental benefits, as well as benefits to developers and building owndersdue to extended life compared to traditional roofs.

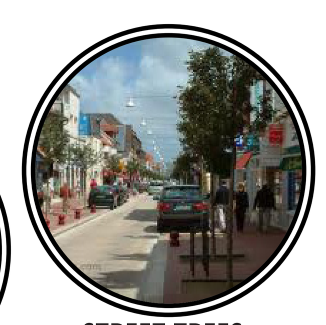
- Saves significant fossil-fuel energy use through insulation
- Reduces stormwater flow by 50% to 90%
- Increases water use efficiency through building storage for rain-water, and recycling of grey water
- Reduces air pollution
- Greatly reduces "heat island" effects in cities
- Reduces noise pollution from outside sources

$ Benefits to building owners were found to be significant, but they do not accrue until sometime after year 20. By year 40 the city estimated that the owner of a building with an ecoroof would save a total of $400,000

PERVIOUS PAVERS
Permeable paving provides a 100% pervious surface by runoff passing through small, aggregate-filled openings between solid high-strength durableconcrete pavers.

- Infiltrates, filters and decreases stormwater runoff rate and reduces Total Maximum Daily Loads (TMDLs)
- Reduces or eliminates stormwater detention and retention ponds, storm sewers, drainage appurtenances and related costs
- Processes and reduces pollutants from vehicular oil drippings

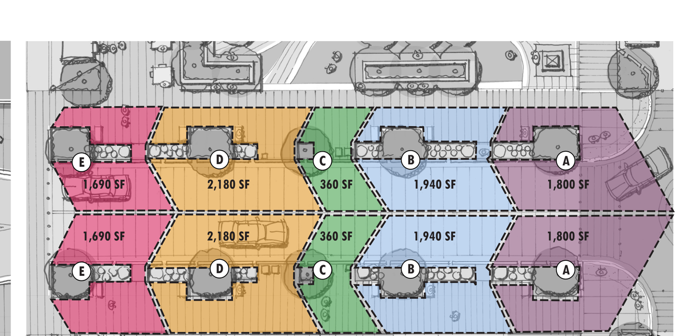
$ Cost: $10-$15 per square foot

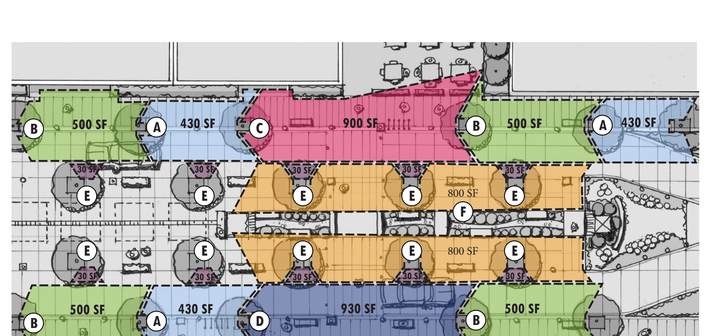


STREET TREES
Once seen as highly problematic for many reasons, street trees are proving to be a great value to people living, working, shopping, sharing, walking and motoring in and through urban places.

- Safer walking environment
- Businesses on treescaped streets show 12% higher income streems
- Absorb the first 30% of most precipitation through their leaf system reducing the amount of stormwater
- Improved air quality
- Mitigate urban heat island effect

$ Cost: $250-600
Return: $90,000 over the lifetime of the tree (not including aesthetic, social and natural)



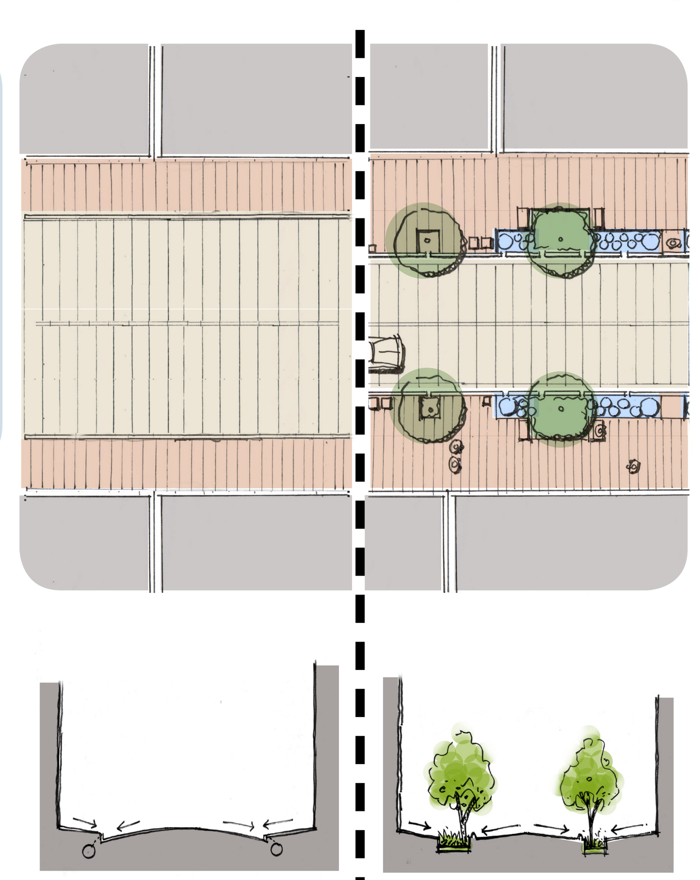


...buting area of runoff to each planter, as well as the general slope of 6th Street. The ...retain additional square footage of runoff.

CONVENTIONAL DESIGN vs. LOW-IMPACT DESIGN

COMMON PRACTICES:
- treating stormwater as a problem on the site
- stormwater must be removed from the site as quickly as possible
- central management of stormwater
- natural ecosystem are not considered in design
- typical elements are
  - impervious roadways,
  - impearmeable surfaces on roofs,
  - gutters/downspouts,
  - curbs with inlets to main conveyance
  - impearmeable paved areas

WHICH YIELD:
- larger and more impervious surfaces
- decreased time of concentration
- higher speed and volume of runoff
- devistation of our natural watershed & ecosystems
- negative effect on water quality



COMMON PRACTICES:
- treating stormwater as a resource
- collecting water as close to its source as possible
- localized management of stormwater
- emulation of predevelopment hydrology
- facilitation of natural ecosystem to thrive
- typical elements are
  - roadways draining to infiltration basins
  - greenroofs
  - rainwater collection on-site
  - curb cuts to infiltration basins
  - permeable paving

WHICH YIELD:
- more pervious surfaces to capture rainwater
- increased time of concentration on pervious surfaces
- lower speed and volume of runoff
- positive effects on stream stability and natural habitats devastation of our natural watershed & ecosystems
- positive effect on water quality

BARRIERS AND STRATEGIES

The following table lists a few of the limitations of current codes and regulations that prevent LID strategies from being implemented. (full list provided in digital version)

Identified Barriers	Conceptual Strategies
"Mixed messages" from different governmental departments about LID implementation (planning, public works, parks, engineering, City leaders, etc...)	Create an LID Manual that exaplains the installation procedure, mainternace requirments, and associated costs. Provide to all necessary City Departments.
Americans with Disabilities Act considerations	Provide alternate surfaces for disabled access if there is potential for pervious surface to impede mobility.
Compatibility with existing developments that do not use LID practices	Involvement of Landscape Architects and Planners to better define "community identity and character."

HOW?

Seventeen case studies evaluated by the EPA demonstrated in general that LID practices can reduce project costs and improve environmental performance.

In sixteen of the seventeen cases, significant savings were realized due to reduced costs for site grading and preparation, stormwater infrastructure, site paving, and landscaping.

In all cases, LID provided other benefits that were not monetized and factored into the project bottom line. These benefits include:
- improved aesthetics
- expanded recreational opportunities
- increased property values due to the desirability of the lots and their proximity to open space,
- increased total number of units developed,
- increased marketing potential, and
- faster sales.

The case studies also provided other environmental benefits such as reduced runoff volumes and pollutant loadings to downstream waters, and reduced incidences of combined sewer overflows

The studies found that total capital cost savings ranged from 15 to 80 percent when LID methods were used.

Crown Street
Vancouver, Canada

CASE STUDY 1 Crown Street Vancouver, Canada
The Crown Street redevelopment project, completed in 2005, retrofitted a 1,100-foot block of traditional curb-and-gutter street with a naturalized streetscape modeled after the Seattle SEA Street design. Several LID features were incorporated into the design. The total imperviousness of the street was decreased by reducing the street width from 28 feet to 21 feet with one-way sections of the road narrowed to 10 feet.

Roadside swales that use vegetation and structural grass (grass supported by a grid and soil structure that prevents soil compaction and root damage) were installed to collect and treat stormwater through infiltration.26
Modeling predicts that the redesigned street will retain 90 percent of the annual rainfall volume on-site; the remaining 10 percent of runoff will be treated by the system of vegetated swales before discharging.

LID Cost	$396,000
Conventional Cost	$364,000
Additional Cost	$32,000

CASE STUDY 2 The 2nd Avenue Street Edge Alternative (SEA) Seattle, Washington
Seattle's pilot Street Edge Alternatives Project (SEA Streets) was completed in the spring of 2001. It was designed to provide drainage that more closely mimics the natural landscape prior to development than traditional piped systems. To accomplish this, they reduced impervious surfaces to 11 percent less than a traditional street, provided surface detention in swales, and added over 100 evergreen trees and 1100 shrubs.

Two years of monitoring show that SEA Street has reduced the total volume of stormwater leaving the street by 99 percent.

LID Cost	$651,548
Conventional Cost	$868,803
Additional Savings	$217,255

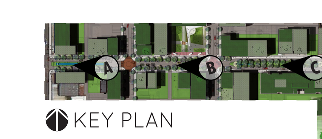
The 2nd Avenue Street Edge Alternative (SEA)
Seattle, Washington

CASE STUDY 3 Gap Creek Sherwood, Arkansas

LID Cost	$3,942,100
Conventional Cost	$4,650,600
Additional Savings	$ 678,500

Gap Creek's revitalization included LID concepts. The revised design increased open space from the originally planned Gap Creek 1.5 acres to 23.5 acres. Natural drainage areas in the subdivision were preserved and buffered by greenbelts. Traffic-calming circles were used, allowing the developer to reduce street widths from 36 to 27 feet. In addition, trees were kept close to the curb line. These design techniques allowed the development of 17 additional lots.

PERSPECTIVE A
LOOKING DOWN THE CANAL TOWARDS DOWNTOWN


KEY PLAN

HYDROLOGIC DATA

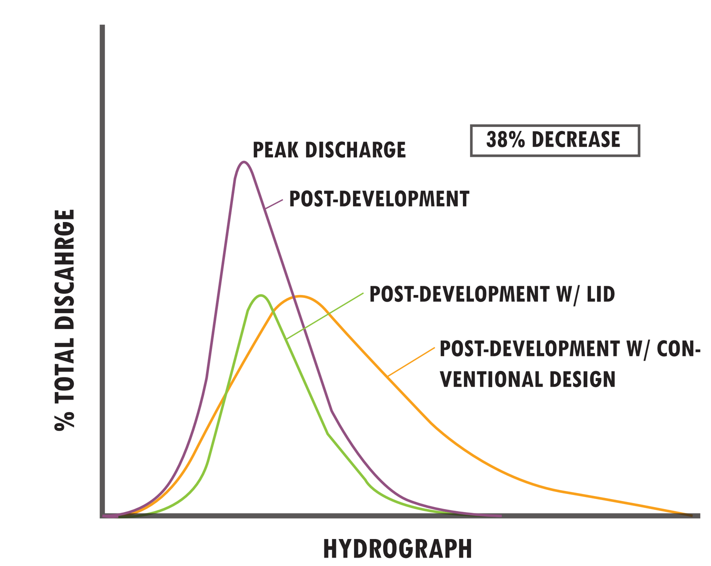
				Public Phase 1	Public/Private Phase 2	Phase 3
Streets & Alleyways	106,842.00	SF	20.8%	106,842		
Single-Story Parking	35,356.00	SF	6.9%		35,356	
Sidewalks	51,872.00	SF	10.1%	51,872		
Green Roofs/cisterns	186,075.00	SF	36.3%			186,075
Green Areas	132,730.00	SF	25.9%	112,821	19,910	
Total Project Footprint	512,875.00			271,535	55,266	186,075
Percent of Total Project				52.9%	10.8%	36.3%
Contributing Drainage Area	1,167,400.00	SF	26.80	Acres		

Rational Equation Q = CIA		Area, A	Length	Velocity	Tc	Intensity, I		"C"	Q_5	Q_{100}
EXISTING CONDITIONS		acres	feet	fps	minutes	I_5, in/hr	I_{100}, in/hr		cfs	cfs
Total Area Runoff	100%	26.80	1875	2.00	15.63	4.6	7.60	0.82	101.09	167.02
Project Drainage Area	43.9%	11.77							44.41	73.38
Drainage Area Outside of Project	56.1%	15.03							56.68	93.64

	Area, A	Length	Velocity	Tc	Intensity, I		"C"	Q_5	Q_{100}
PROPOSED LID PROJECT CONDITIONS	acres	feet	fps	minutes	I_5, in/hr	I_{100}, in/hr		cfs	cfs
Project Drainage Area	11.77	1500	1.5	16.67	4.6	7.6	0.51	27.61	45.62
Drainage Area Outside of Project	15.03							56.68	93.64
Total Area Runoff	26.80							84.29	139.26

Reduction in runoff from project =	27.75	cfs	38%
Reduction in total area runoff due to project =	27.76	cfs	17%

The reductions in stormwater runoff shown herein are accomplished with the Publicly constructed green areas in Phase 1 and the Private efforts in Phases 2 and 3.
No reduction is accounted for Public construction of streets, alleyways or sidewalks



HYDROGRAPH

LET'S MAKE IT HAPPEN

"I'd like to see someone champion a storm sewer credit for properties that collect all rainwater."

Jonathan Bolzle
Broker/developer for KMO Development Group and member of Tulsa's Young Professionals

1. define realistic goals for implementation (consider phasing)
2. establish guidelines that marry the public and private responsibilities to uphold LID
3. update development / redevelopment standards and pass ordinances
4. educate stakeholders and get buy-in