

# Low Impact Development Toolkit

Presented to:  
Sustainable Cities Network  
*Green Infrastructure Workgroup*  
April 16, 2015



**mesa·az**

BUILDING A SUSTAINABLE  
COMMUNITY

[mesaaz.gov/sustainability](http://mesaaz.gov/sustainability)

**Jeff McVay**

Manager of Downtown Transformation  
City Manager's Office

# Traditional Stormwater System



1968, 84" pipe



# Storms Happen





# Storms Happen



# Storms Happen





# Storms Happen





# Development Advisory Forum

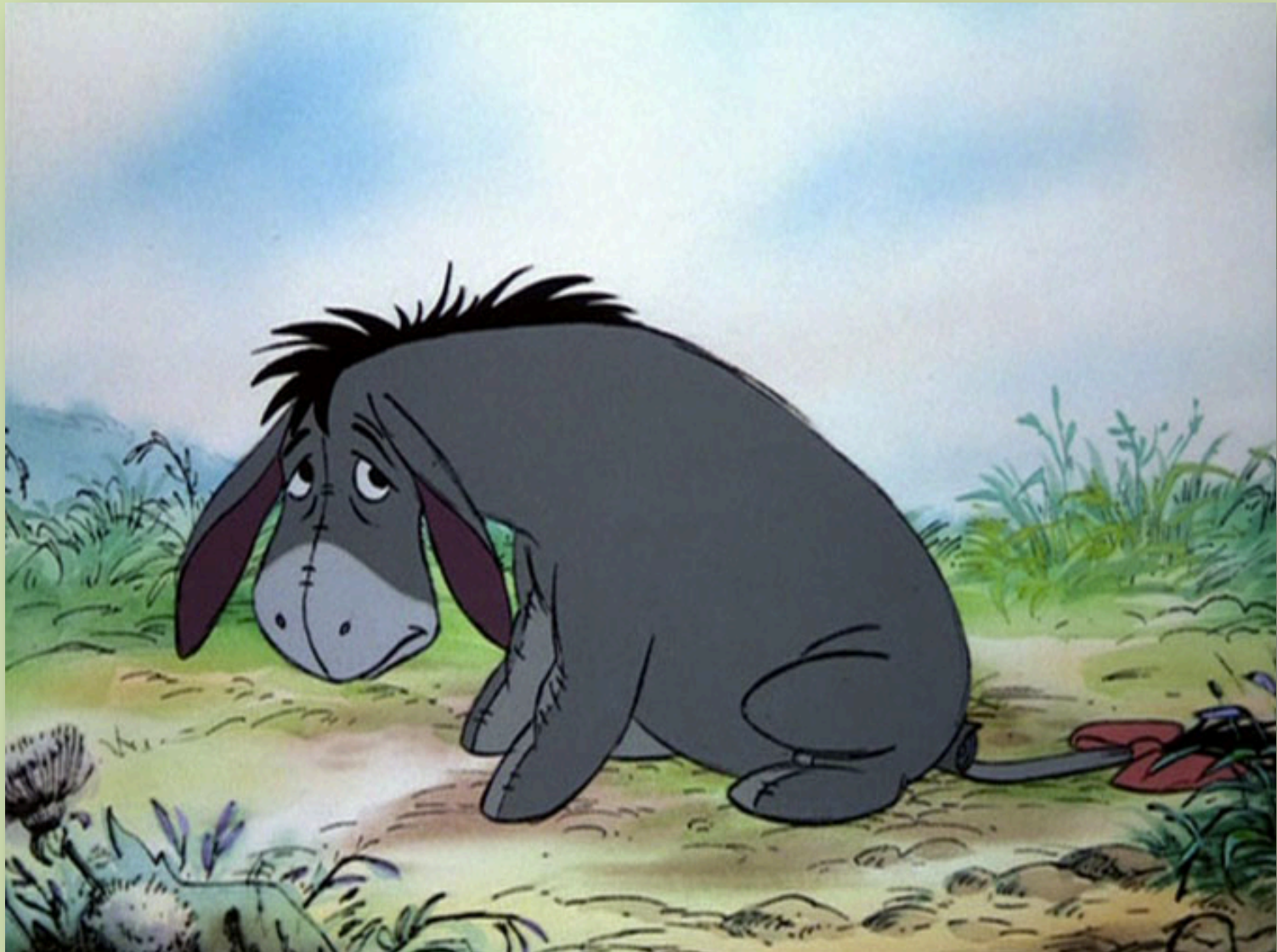


February 25





# Eeyores





# Champions



# LOW IMPACT DEVELOPMENT TOOLKIT

PREPARED FOR THE CITY OF MESA, ARIZONA



# Development Impacts and Challenges

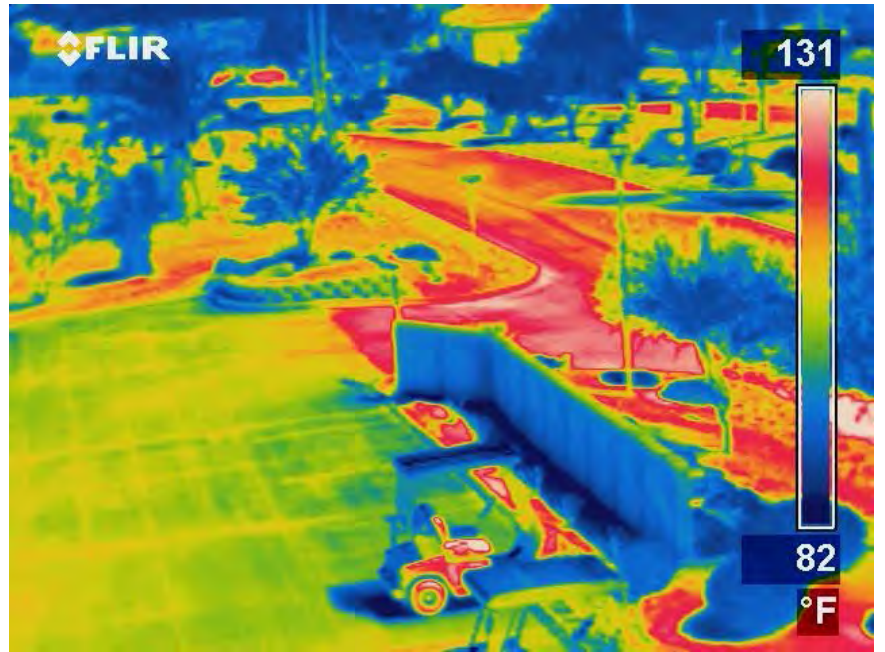
FLOODING

HEAT-ISLAND EFFECT

INCREASE POLLUTANT AND SEDIMENT LOADS

INCREASED COSTS OF STORM WATER INFRASTRUCTURE

INCREASED PRESSURE ON EXISTING STORM WATER INFRASTRUCTURE



# Benefits of LID

REDUCES FLOODING

MITIGATES HEAT-ISLAND EFFECT

REDUCES SEDIMENT AND POLLUTANT LOADS

REDUCES COSTS OF STORM WATER INFRASTRUCTURE

IMPROVES LIVABILITY AND ADDS VALUE TO THE COMMUNITY

# A Systems Approach

VISIBLE and USEFUL

IMPACTS DEVELOPABLE AREA ON-SITE

ECONOMIC VALUE and SAVINGS

# LID TOOLKIT DIAGRAM

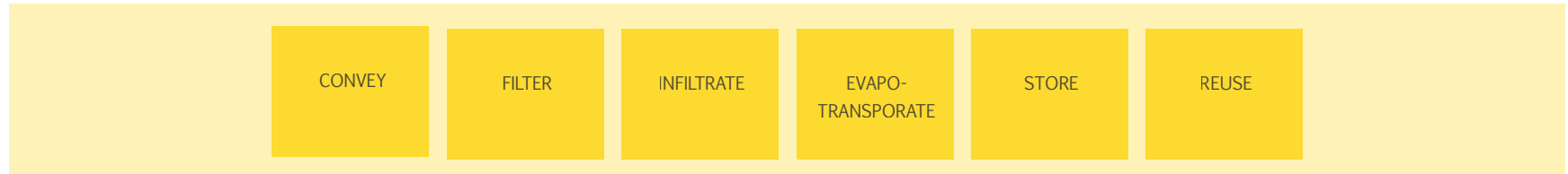
ORIGIN OF MAN-MADE STORMWATER RUNOFF

SOURCE












METHOD OF MANAGING STORMWATER RUNOFF

ACTION



MEANS TO ACCOMPLISH ACTIONS

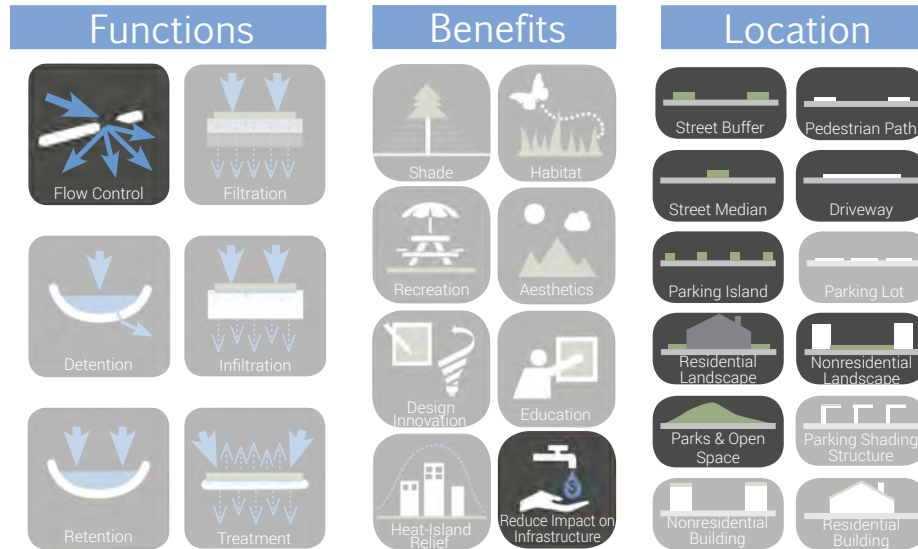
TECHNICAL VARIATIONS TOOLS

	GREEN STREET	VEGETATED SWALE	BIORETENTION	PERMEABLE PAVING	CONSTRUCTED WETLANDS	INFILTRATION & UNDERDRAINS	GREEN ROOF	RAINWATER HARVESTING	LANDSCAPE*
	Standard Curb Cut Curb Cut with Sidewing Concrete Flush Curb Grated Curb Cut Curb Cut with Sediment Capture Wheelstop Curb	Meandering or Linear Restored Wash	Vegetated Retention Basin Bioretention Cell Planter	Stabilized Aggregate Porous Asphalt Porous Concrete Structural Grids Permeable Pavers	Constructed Wetlands	Infiltration & Underdrains	Rooftop Garden Downspout Disconnection	Cisterns Above Ground Cisterns Below Ground	Tree Preservation Soil Amendment Impervious Surface Reduction Plant Selection
									

\* Not in toolkit because it is applicable to all other tools



# GREEN STREET – STANDARD CURB CUT



Curb cuts control stormwater flow from streets to LID facilities.

## Description

- Curb cuts are openings created in a curb to allow stormwater from an impervious surface, such as roads, parking lots, or hardscape areas, to flow into a lower landscaped storage and infiltration area (LID facility).
- The curb cut is a useful tool for retrofitting existing development with green infrastructure practices without major reconstruction.
- Since curb cut openings are perpendicular to the flow of stormwater on the street, they will usually collect only a portion of the water flowing along the gutter. If attenuating stormwater flows along the street is the goal, place multiple curb cuts at intervals along the street.

## Installation


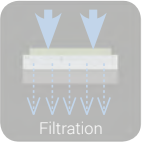










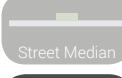
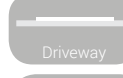
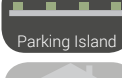



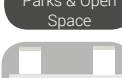



- Openings should be at least 18 inches wide, but up to 36 inches is preferred for ease of maintenance.
- Locate curb cut openings at low points and space them based upon stormwater velocity and volume, and the capacity of the area behind curb for detention, infiltration and access to overflow systems.
- The curb cut can either have vertical or angled sides. The design intent is to create a smooth transition from the paved surface to full curb height.

## Maintenance

- Regularly clear curb cuts of any debris and sediment that prevents the free flow of stormwater into LID facility (1-2 times per year and after storm events).
- Periodically check rip rap areas for signs of erosion damage. Repair and reinforce as necessary (annually and after storm events).

Footnote: #1

# GREEN STREET – WHEELSTOP CURB

Functions	Benefits	Location
 Flow Control  Filtration	 Shade  Habitat  Recreation  Aesthetics  Design Innovation  Education  Heat-Island Relief  Reduce Impact on Infrastructure	 Street Buffer  Pedestrian Path  Street Median  Driveway  Parking Island  Parking Lot  Residential Landscape  Nonresidential Landscape  Parks & Open Space  Parking Shading  Nonresidential Building  Residential Building



Wheelstops allow sheet drainage to pass into landscape areas.

## Description

- Wheelstop Curbs are formed sections of curb with gaps between them. They allow stormwater from adjacent impervious surfaces, like parking lots, to flow into adjacent planting areas.
- In flush, or no curb parking areas, poured-in-place wheelstop curbs can be used to define openings and protect infiltration and planting areas.

## Installation

- Space poured-in-place wheel stop curbs as needed for parking/traffic conditions while allowing water to flow into vegetated areas.
- Poured-in-place wheel stop curbs are most common in parking lot applications, but they can also be applied in certain street conditions.
- Provide a minimum of 6 inches of space between the poured-in-place wheelstop curb edge and edge of asphalt paving to provide structural support for the wheel stop.
- Securely anchor poured-in-place wheelstop curbs using foundations or other support to ensure that they resist vehicle impact and overturning.
- A concrete flush curb is advised along the edge of pavement for structural support of poured-in-place wheel stop curbs and visual demarcation of parking area or driveway edge.

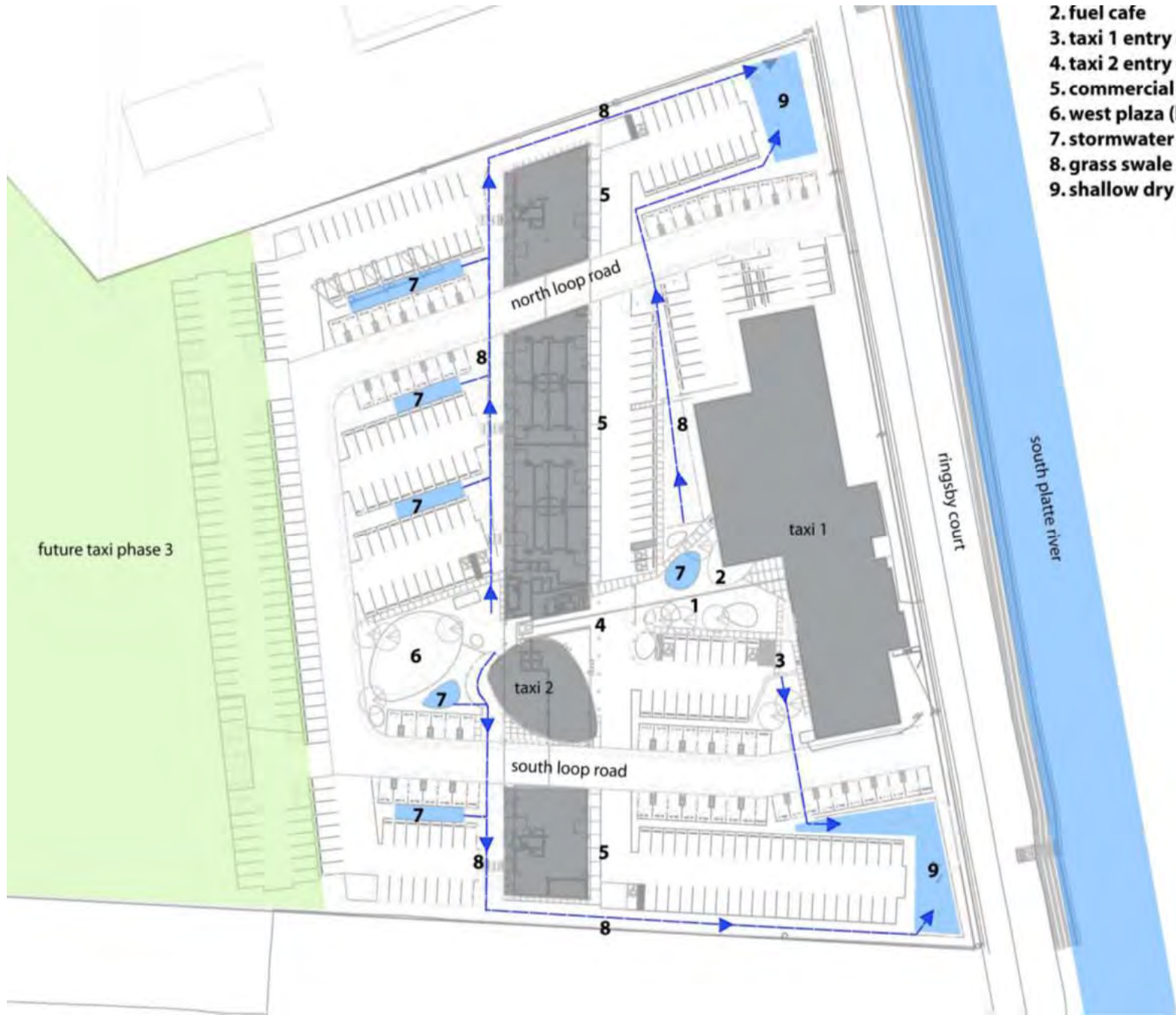
## Maintenance

- Poured-in-place wheelstop curbs have similar maintenance requirements as other poured concrete curbs. Unless they are firmly anchored they can be dislodged creating unsightly and dangerous conditions. They should be checked regularly for cracking and settlement and repaired or replaced as necessary.

Footnote: #3



Case Study – Taxi Mixed Use Development, Denver, CO



- 2. fuel cafe
- 3. taxi 1 entry c
- 4. taxi 2 entry c
- 5. commercial fl
- 6. west plaza (ki
- 7. stormwater g
- 8. grass swale
- 9. shallow dry p

future taxi phase 3

ringsby court

south platte river

north loop road

south loop road

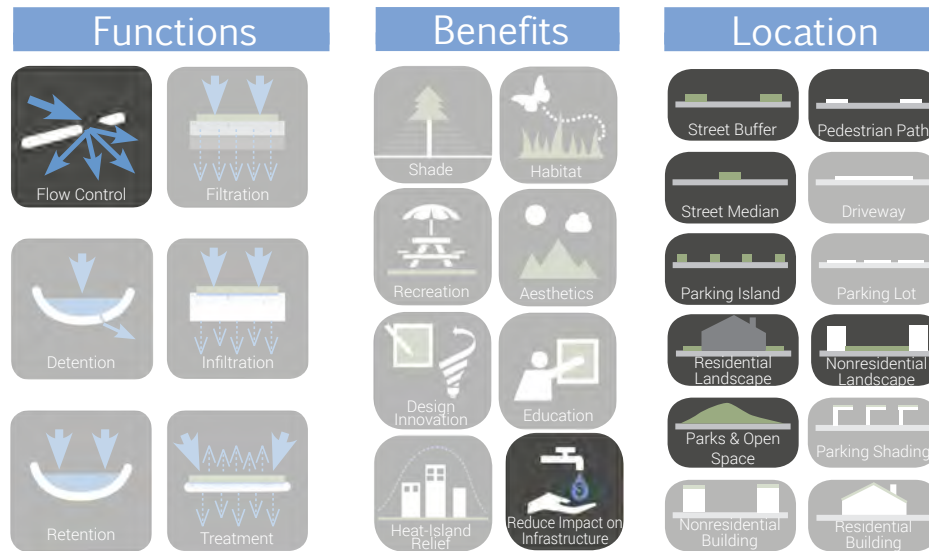
taxi 1

taxi 2





# GREEN STREET – GRATED CURB CUT



Grates allow stormwater to pass through while providing an accessible pedestrian route.

## Description

- Grated curb cuts allow stormwater to be conveyed under a pedestrian walkway. Curb-cut openings are described in previous sections to allow stormwater from impervious surfaces to flow into a landscaped area.
- The grated curb cut is a useful tool for urban areas where there is heavy pedestrian traffic and the need for handicap accessible routes adjacent to streets and parking areas.
- Grated curb cuts should only be used where there is not enough vertical distance to install a scupper. Where they are used, only decorative heavy duty, accessible, precast gratings should be permitted.

## Installation

- The grated curb cut opening should ideally be 18 inches wide; enough to minimize the potential for clogging.
- Grates should be compliant with the Americans with Disabilities Act (ADA) and have adequate slip resistance.
- Grates should be anchored in a way that deters removal or theft.
- A drop in grade should occur between the grated curb cut channel and the finish grade of the landscaped area to allow for the passage of sediment. Permanent or temporary erosion control may be necessary where concentrated runoff from the channel is deposited into the landscaped area.

## Maintenance

- Regularly clear grated curb cuts of debris and sediment that may prevent the free flow of stormwater (1-2 times per year and after storm events).
- Periodically check for damage to grate and structural support system that may cause ponding of water or impede accessible pedestrian routes.
- It may be necessary to remove grates to clear sediment and debris.

Footnote: #4



Water features can harvest rainfall, making water visible and celebrating its importance in an arid climate.



Grated curb cuts convey stormwater from pavement into planting areas.



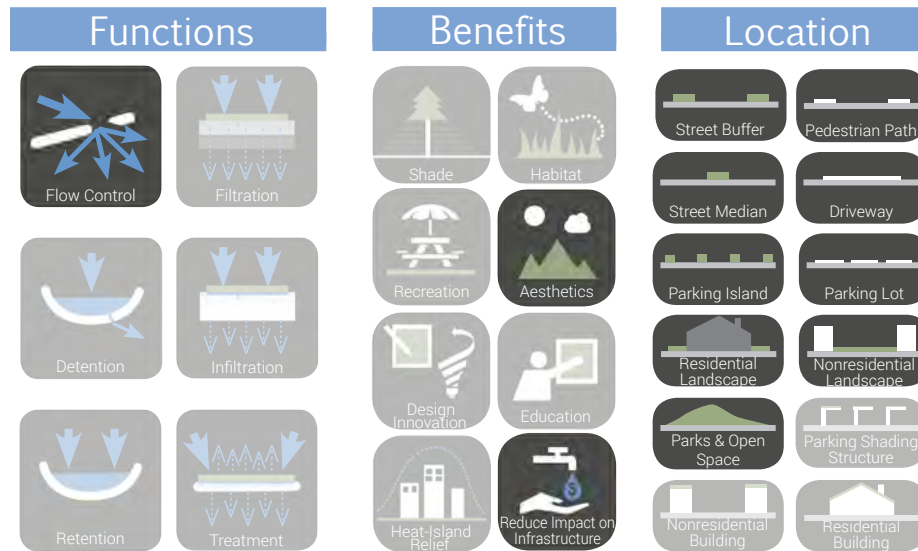
Porous pavers and permeable pavement at the pedestrian walkway allows infiltration and reduces off-site runoff.



Standard curb cuts open up planting areas to receive stormwater flow.



# GREEN STREET – CONCRETE FLUSH CURB



Flush curbs allow stormwater to sheet drain to landscape areas.

## Description

- Concrete flush curbs allow stormwater to runoff impervious surfaces directly into landscaped areas and stormwater facilities. Stormwater flow is distributed more evenly which reduces the potential for erosion and clogging along a pavement edge.

## Installation

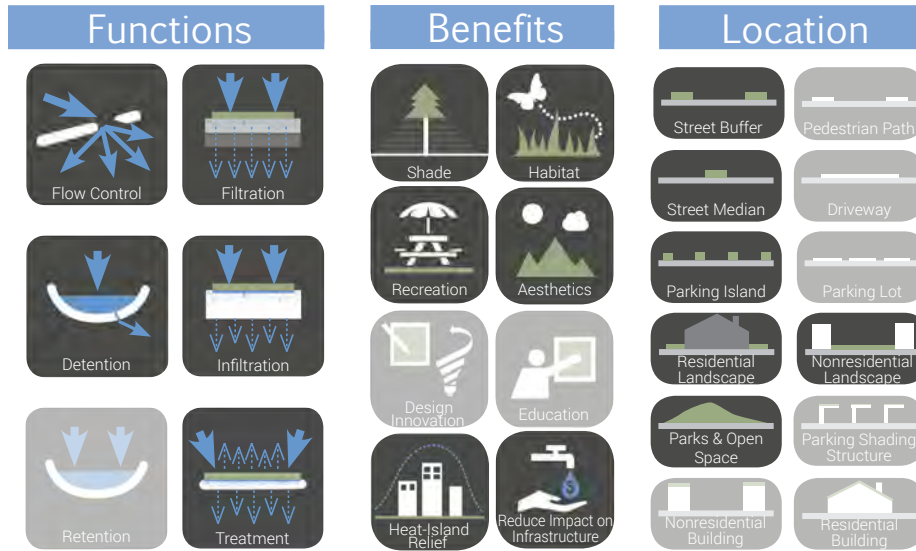
- Top of concrete curb should be installed flush with the pavement surface, with allowances for subgrade compaction and future settlement.
- A drop in grade should occur between the top of the flush curb and the finished grade of the landscaped area to allow for passage of sediment and debris to drop out.
- Utilize temporary erosion control measures when seeding or planting adjacent areas to reduce the potential for erosion.
- A wider surface area and contrasting color for the flush curb provides an important visual cue when used on roads, driveways and bicycle paths.
- This tool will be considered on a case by case basis for street rights-of-way, per Mesa's Suburban Ranch Street Detail.

## Maintenance

- Check the flush curb for signs of damage or settlement causing ponding or concentration of stormwater runoff.
- Check landscape edge condition for signs of rilling or erosion and repair or reinforce as needed (annually).
- Remove sediment and debris from landscape area outside of flush curb that may cause water to pond or backup.

Footnote: #6

# VEGETATED SWALE – MEANDERING OR LINEAR



Vegetated swales accept stormwater for conveyance, storage and infiltration.

## Description

- Vegetated swales are stormwater runoff conveyance systems that provide an alternative to piped storm sewers.
- They can absorb low flows and direct runoff from heavy rains to storm sewer inlets or directly to surface waters.
- Vegetated swales improve water quality by enhancing infiltration of the first flush of stormwater runoff and promoting infiltration of storm flows they convey.
- Costs vary greatly depending on size, plant materials, and site considerations. Vegetated swales are generally less expensive when used in place of underground piping.

## Installation

- Deep-rooted native plants are preferred to promote water infiltration and reduce erosion and maintenance requirements.
- Evaluate site soil conditions. Ideally soil infiltration rates should be greater than one-half inch per hour. Soil Amendments may be needed to achieve ideal infiltration rates.
- A meandering or linear alignment is preferred, with side slopes that do not exceed 4:1. Slopes adjacent to walkways or accessible hardscape areas should not exceed 6:1. In suburban contexts, a meandering

installation should be used. Linear installations are appropriate in urban contexts.

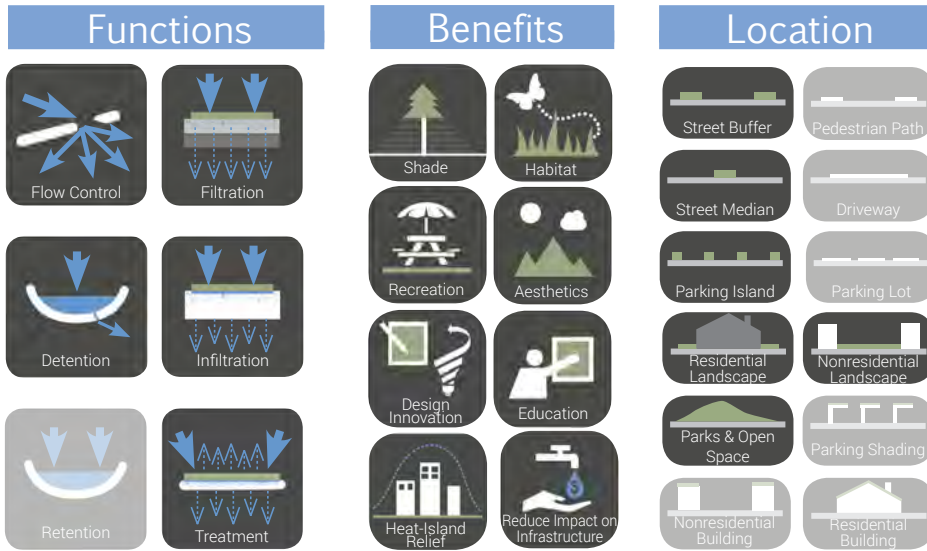
- Refer to building codes for maximum depths allowed without a guard rail requirement. In any case, a vertical drop of more than 30 inches will require a guard rail installation.
- Current engineering standards require all swales that detain stormwater

## Maintenance

- Vegetation in the swale will require regular maintenance such as removal of debris and dead branches, and occasional pruning.
- Supplemental irrigation may be required to maintain healthy landscape plants.
- Removal of sediment and regrading will be necessary to maintain the swale shape and volume over time. As with plant waste, sediment should be removed and disposed of properly.

Footnote: #7

# BIORETENTION – BIORETENTION CELL



Bioretention cells fit into constrained urban site.

## Description

- Bioretention cells are shallow depressions with a designed soil mix and plants adapted to the local climate and soil conditions. These are used in more urban conditions and where subsoils are porous and allow infiltration into the subgrade.
- Bioretention cells capture and infiltrate stormwater into the ground below the cell and have an overflow that carries excess stormwater to a discharge point.
- Bioretention cells that do not infiltrate stormwater into the ground and include an underdrain, are called bioretention planters.

## Installation

- Bioretention cell bottoms should be relatively flat and not lined. The bottom surface should be loosened several inches deep prior to placing the bioretention soil mix. The cell bottom area should be designed based on the ability of the soil to freely drain into the subgrade.
- Stormwater enters the bioretention cell by surface flow or pipe inlet. A pre-settling area can be a rock or vegetated sediment capture area designed to protect the bioretention cell by slowing incoming flows at the point of entry.
- A minimum depth of specially graded soil is necessary for the proper function of a bioretention cell.
- An appropriate surface mulch layer should be selected to reduce weed establishment, regulate soil moisture and temperature, and add organic matter to the soil.

- Stormwater ponding above the cell provides storage for storm flows, settles out particulates such as sediment, and provides for uptake and filtering of pollutants within the cell.
- Plants used must be drought tolerant, and suitable for occasional saturation.
- Overflow for the bioretention cell should transport excess stormwater to an approved discharge point.

## Maintenance

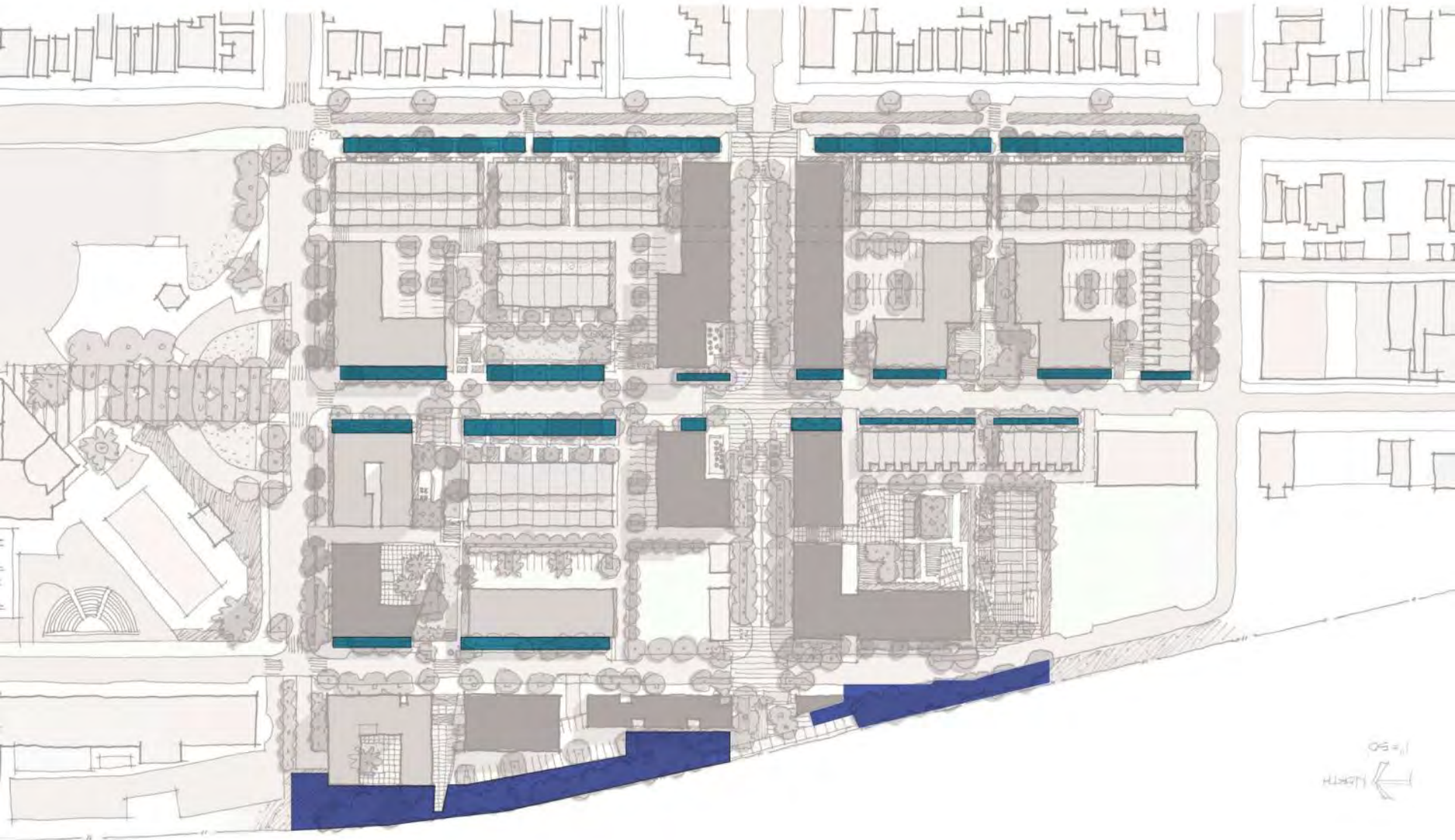
- Regularly check bioretention cells for blockages from debris and sediment. Remove sediment and debris and dispose of properly.
- Maintain landscape by replacing dead vegetation, pruning healthy vegetation and removing weeds regularly. Do not use herbicides in stormwater facilities.
- Bioretention soil may need to be replaced if soil percolation rates fall below the design flow capacity, Check percolation rates if bioretention cells are not draining within 36 hours, or have been contaminated by sediment inflows.

Footnote: #10

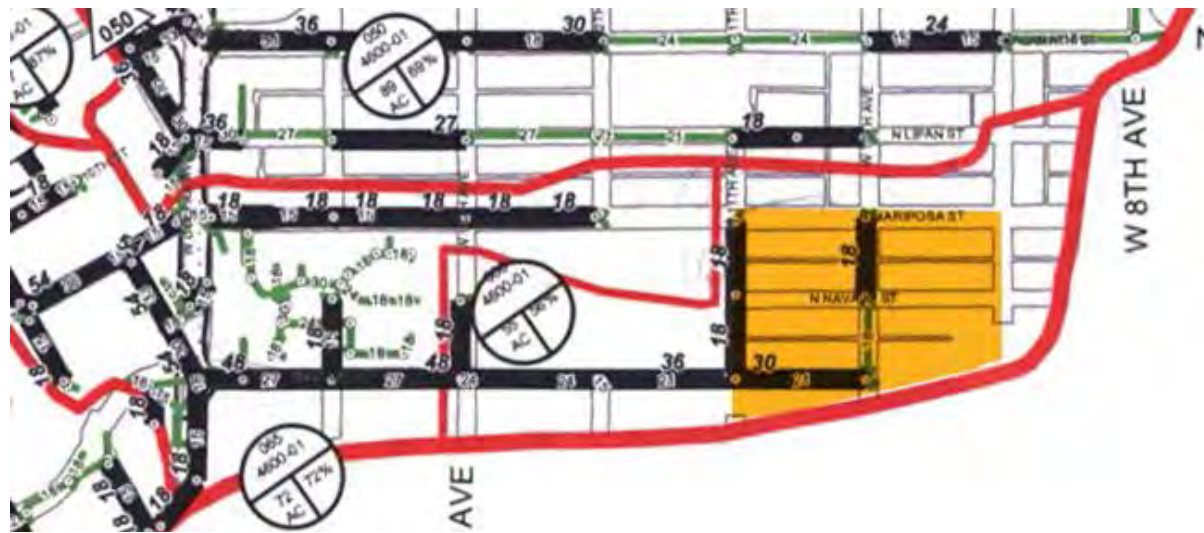


Case Study – Lincoln Ave. Redevelopment – Denver, CO





1" = 50'  
NORTH

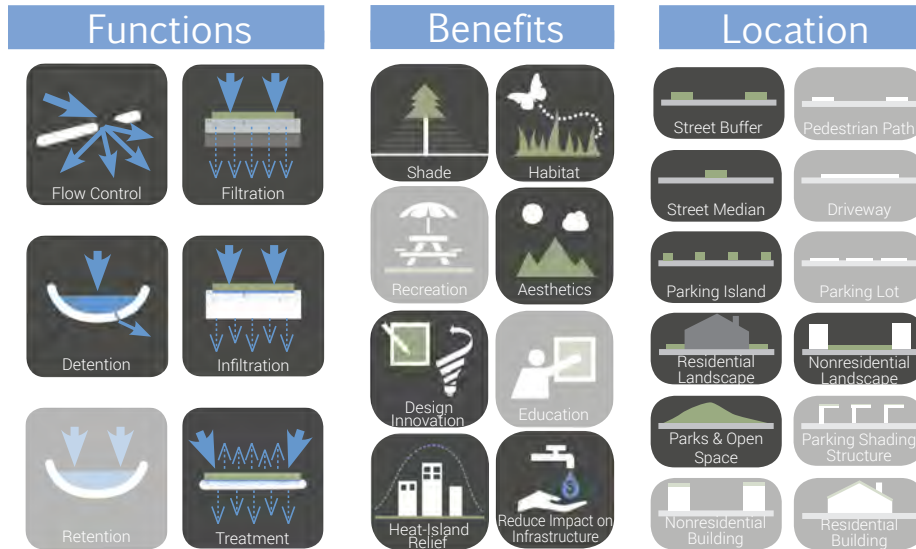


Conventional Stormwater Pipe System



Reduced Stormwater Pipe System

# BIORETENTION – PLANTERS



Bioretention planters provide stormwater storage and promote healthy growth of trees and plants.

## Description

- Bioretention planters are landscape planters that also store stormwater in porous planting soils and above the soil surface. Planters may be raised above ground or can be set flush with or even below the ground surface. They capture runoff from downspouts or overflow from rain barrels.
- There are several types of bioretention planters including:
  - Structural soils or Silva Cells.
  - Raised flow-through planter boxes.
  - In-ground planter boxes.
- Like bioretention swales and rain gardens, planter boxes sustain healthy plants with a minimum of supplemental irrigation, while improving the quality of stormwater runoff and reducing runoff volume.

## Installation

- Calculate stormwater volume capacity by using the soil volume and pore space in each planter.
- Planters should be installed on a flat subgrade and surface grade to maximize storage.
- Planting mix soil should be carefully selected and tested to provide proper physical composition, adequate drainage and organic matter to support designated plantings. Planting soil should be at least 18" deep; contain no more than 20% compost, and be a desert-appropriate mix.

- Soils should be placed at a width and depth to accommodate the mature size of specified plantings. A subgrade gravel layer can be used to add storage capacity.

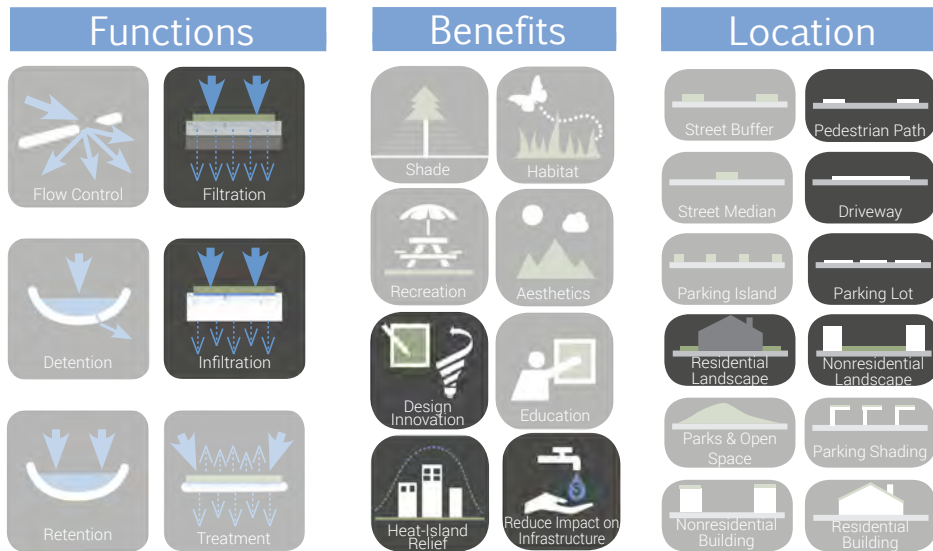
## Maintenance

- Bioretention planters should be checked annually to maintain optimum storage, and drainage functions.
- Following storm events, planters should be inspected to ensure that standing water is not present in the planter for more than 36 hours.
- Monitor health of vegetation and maintain them using best landscape maintenance practices. Prune and replace plants as necessary.
- Herbicides should not be used in bioretention planters.
- Special consideration should be taken when replanting in bioretention planters that have structured soils or Silva Cells.

Footnote: #11



# PERMEABLE PAVING – POROUS CONCRETE



Porous concrete can reduce runoff sustaining in sidewalks and plaza areas.

## Description

- Single size aggregate, also know as porous concrete, consists of a special mix design with void spaces that make it highly permeable.
- Aggregates are normally screened to provide particles that can fall within narrow limits to ensure porosity.
- About 30% to 40% of the material is void space, and its permeability is often measured in hundreds of inches per hour.
- Porous concrete reduces the velocity and volume of stormwater runoff delivered into storm sewer system and can reduce contaminants in runoff prior to its discharge to the storm sewer system

## Installation

- The porous concrete mix must be designed and installed by an experienced contractor. Poor materials and/or installation can result in a higher risk of failure.
- The design for porous concrete consists of several layers, including a compacted sub-base, geotextile, a reservoir stone aggregate, and poured surfacing layer, formed with a screed finish.
- Porous concrete is normally set flush with adjacent pavements or grades.
- The subgrade reservoir should allow for drainage to the stormwater system through underdrain tile or piping, especially if the subgrade does

not allow adequate infiltration. Underdrain tile or piping is sometimes necessary to achieve proper drainage.

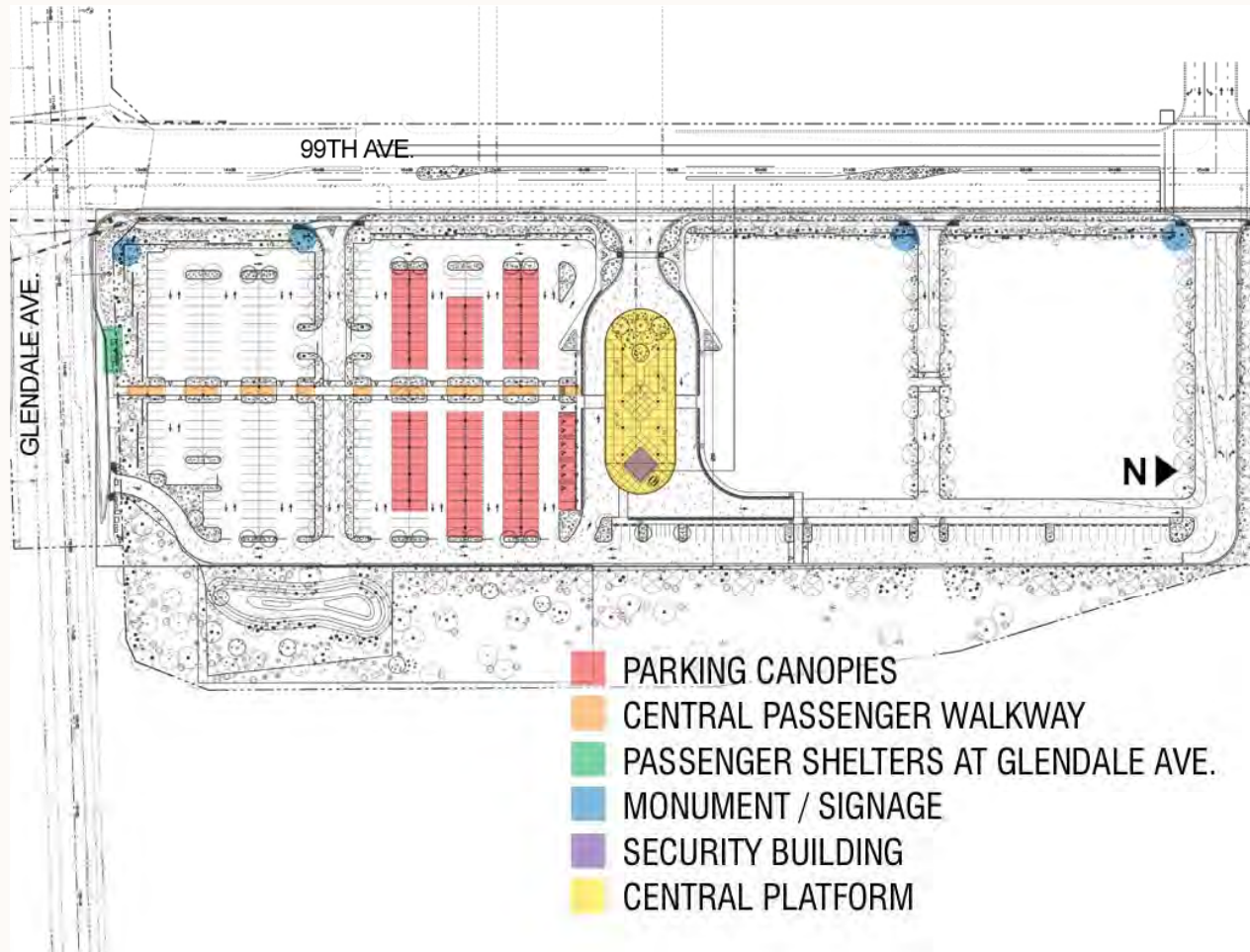
## Maintenance

- Maintenance includes the regular vacuuming of surface areas to remove sediment and minimize clogging. With regular maintenance, porous concrete can have a service life of at least 20 years.
- Porous concrete should be checked periodically for settlement and cracking, and damaged areas repaired to match the original pavement design.

Footnote: #14



## Glendale Park & Ride



99<sup>th</sup> Avenue & Glendale

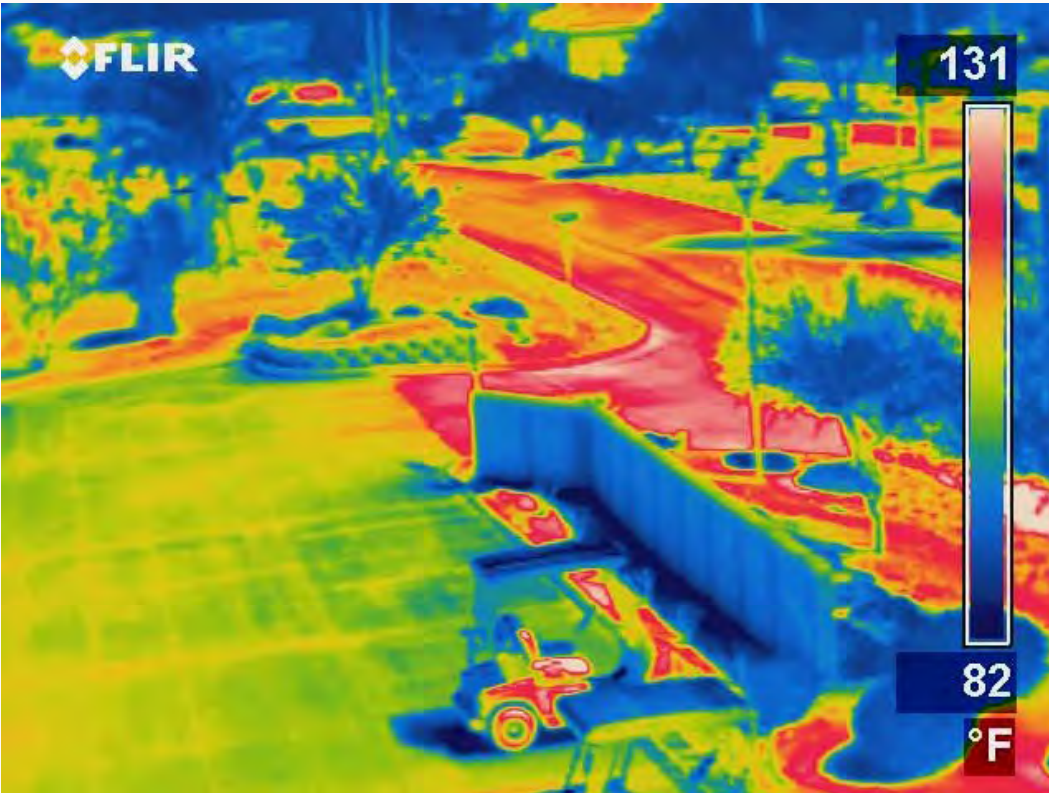
- Phase 1 Completed
  - January 2007
  - 388 spaces
- Phase 2
  - 254 spaces
- 642 at build out
- Costs
  - HMA = \$693,570
  - Pervious = \$844,070
    - 20 yr. HMA more than pervious

## City of Glendale Park and Ride Facility –

BMP Type	Typical Pollutant Removal (percent)				
	Suspended Solids	Nitrogen	Phosphorus	Pathogens	Metals
Dry Detention Basins	30 - 65	15 - 45	15 - 45	< 30	15 - 45
Retention Basins	50 - 80	30 - 65	30 - 65	< 30	50 - 80
Constructed Wetlands	50 - 80	< 30	15 - 45	< 30	50 - 80
Infiltration Basins	50 - 80	50 - 80	50 - 80	65 - 100	50 - 80
Infiltration Trenches/ Dry Wells	50 - 80	50 - 80	15 - 45	65 - 100	50 - 80
Porous Pavement	65 - 100	65 - 100	30 - 65	65 - 100	65 - 100
Grassed Swales	30 - 65	15 - 45	15 - 45	< 30	15 - 45
Vegetated Filter Strips	50 - 80	50 - 80	50 - 80	< 30	30 - 65
Surface Sand Filters	50 - 80	< 30	50 - 80	< 30	50 - 80
Other Media Filters	65 - 100	15 - 45	< 30	< 30	50 - 80

Pollutant removal – one benefit

HEAT ISLAND MITIGATION Comparing surface temperatures between and Asphalt Road and Concrete Parking Lot in Rio Verde, Arizona. Max air temperature that day was 100F.


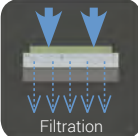

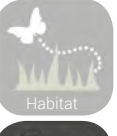




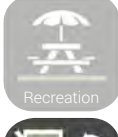
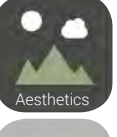

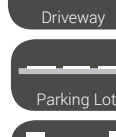



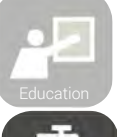




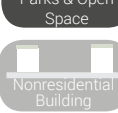







Additional benefit of pervious pavements –  
Mitigating heat island effect

- ASU pavement – NO discernible maintenance to date.
  - Very satisfied with performance to date
- COG Park and Ride
  - 6 mos. hire contractor for vacuumed or brush work
  - Flush pavement - pores appear to be self cleaning due to dust size
  - Extremely satisfied to date with performance

## The Maintenance Question

# PERMEABLE PAVING – PERMEABLE PAVERS

Functions	Benefits	Location			
 Flow Control	 Filtration	 Shade	 Habitat	 Street Buffer	 Pedestrian Path
 Detention	 Infiltration	 Recreation	 Aesthetics	 Street Median	 Driveway
 Retention	 Treatment	 Design Innovation	 Education	 Parking Island	 Parking Lot
		 Heat-Island Relief	 Reduce Impact on Infrastructure	 Residential Landscape	 Nonresidential Landscape
		 Parks & Open Space	 Parking Shading	 Nonresidential Building	 Residential Building



Permeable paving is an attractive way to provide runoff reduction in paving and pedestrian areas.

## Description

- Permeable pavers are comprised of precast concrete unit pavers designed to be set on a compacted base and highly permeable setting bed with joints filled with sand or fine gravel.
- Water enters the joints between the unit pavers and flows through an open-graded base, to infiltrate into the subgrade or be carried out into the storm system via underdrain piping.
- The void spaces in the subbase store water and infiltrate it back into the subgrade, or allow it to evaporate providing local air cooling.
- The sand joints provide surface permeability and helps filter stormwater sediments and pollutants.

## Installation

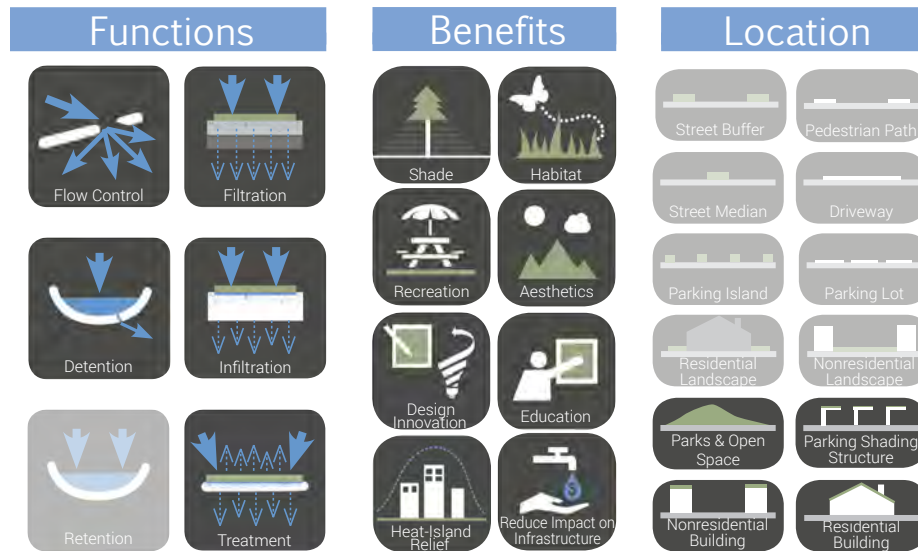
- A stable compacted subbase is essential for any flexible pavement such as porous pavers. The depth of rock and gravel must be capable of holding rainwater long enough for the soil underneath to absorb it.
- Excavate to required subgrade depth, compact subsoil using a roller or vibratory compactor, and install geotextile fabric.
- Prepare base material and compact using a roller or compactor. Install the crushed rock in separate layers and recompact. Install bedding layer and then paving stones with edge restraints.

## Maintenance

- Inspect pavers regularly for settlement and broken pavers. Replace broken pavers immediately to prevent structural instability. Pavers can be removed individually and replaced during utility work.
- Do not pressure wash concrete unit pavers. Sweeping and vacuuming should be performed when paver areas are dry.
- Although a more expensive option for permeable pavement, concrete unit pavers are the most effective at reducing runoff and are often the most aesthetically pleasing option.

Footnote: #16

# GREEN ROOFS – ROOFTOP GARDEN



Green roofs store and utilize stormwater to reduce runoff from building sites.

## Description

- A green roof or Xeriscape living roof is when the roof of a building or structure is at least partially covered with a growing medium and vegetation planted over a waterproofing membrane. It may also include a root barrier, drainage mat and irrigation system.
- There are two types of green roofs: Intensive and Extensive. The difference is in the depth of soil and the ability to support simple groundcover planting (intensive) versus larger materials such as trees and shrubs (extensive).
- Green roofs provide stormwater storage and absorption, reduce runoff from buildings, and insulate buildings from solar gain and heat loss.

## Installation

- The intended function of a green roof will have a significant effect on its design.
- The height of the roof above grade, its exposure to wind, orientation to the sun and shading by surrounding buildings will all impact types of materials used and maintenance requirements. Views to and from the roof will also determine where elements are located for maximum effect.
- Professionals must be consulted for the design and construction of the green roof. A qualified architect, structural engineer, landscape architect and facility maintenance personnel are critical to the success of a green roof project.

- Access to the green roof site is crucial - not only for installation and maintenance, but also for delivery of materials, soil and plants.

## Maintenance

- Vegetation will require supplemental irrigation and only very hardy plants should be used in our desert environment. Depending on whether the green roof is extensive or intensive, required plant maintenance will range from two to three yearly inspections to check for weeds or damage, to weekly visits for irrigation, pruning, and replanting.
- Both plant maintenance and maintenance of the waterproofing membrane are required.
- To ensure continuity in the warranty and the maintenance requirements, the building architect, structural engineer and/or owner should specify and maintain everything up to and including the waterproof membrane. The greenroof designer and installer is only responsible for those items above the waterproof membrane, including soils, drainage and plantings.

Footnote: #19

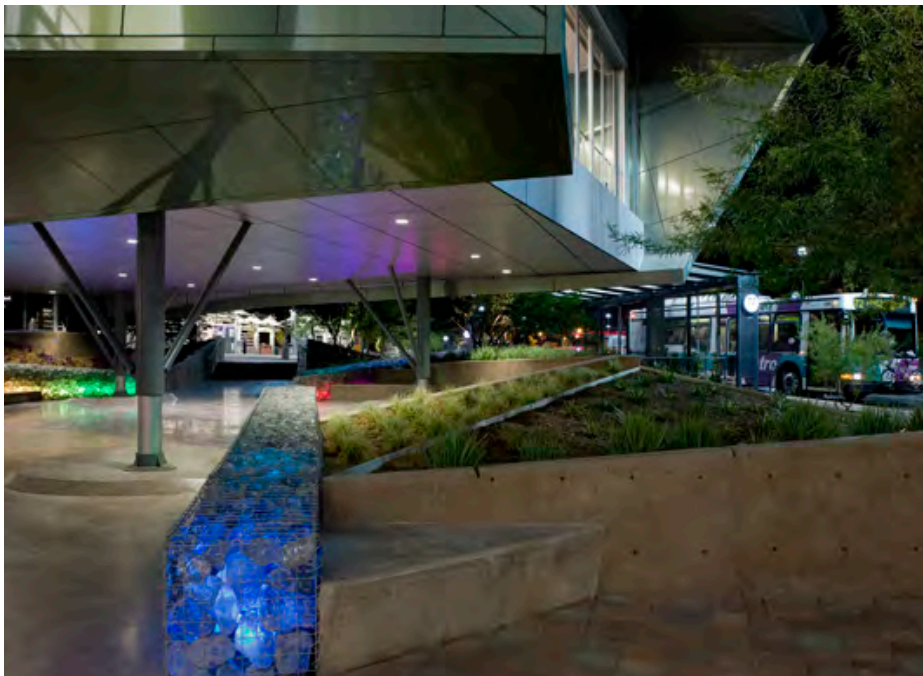




Green roof absorbs rainwater, provides insulation and creates a habitat for birds. It also helps to lower adjacent air temperature mitigating the heat island effect.



Native tree canopies provide cooling in the plaza area.

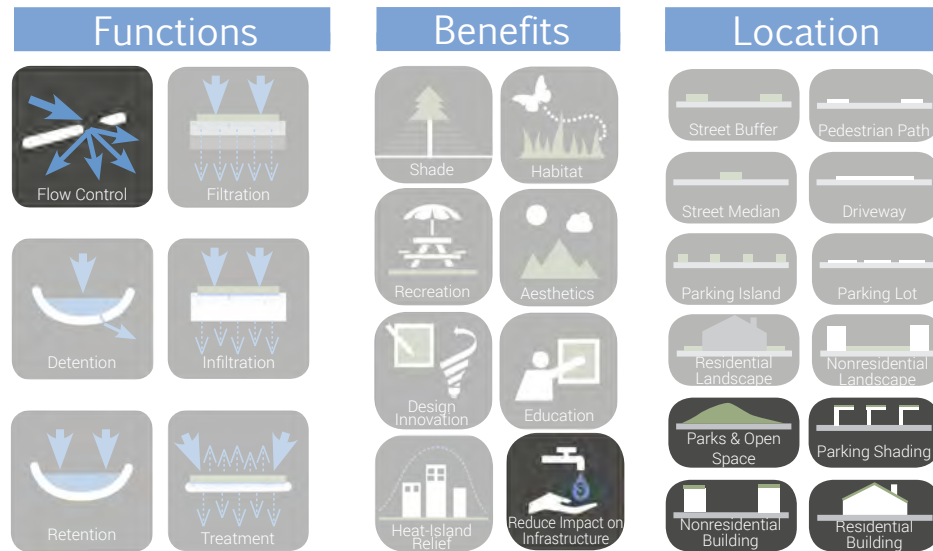


Native materials, used in urban forms, help create a gathering area for people using the Tempe Transit Center.



Shade structures at transit stations can harvest rainwater and use it to nourish a green wall.

# GREEN ROOFS – DOWNSPOUT DISCONNECTION



Disconnecting a downspout allows rainwater to supplement irrigation in the landscapes.

## Description

- Downspout disconnection is the practice of directing rainwater from the rooftop into a landscaped yard instead of into a piped system or into the street.
- Downspouts can direct stormwater to landscape areas where it is stored and used to irrigate landscape plants or infiltrate into the ground.

## Installation

- Direct downspout extensions away from building foundations or adjacent properties to avoid structural damage or nuisance flooding.
- Firmly anchored splash blocks or hand placed rock can be installed to direct downspout drainage to landscaped areas.
- Ensure that the offsite overflow is sufficiently lower than the building floor elevation to reduce the potential for building flooding.

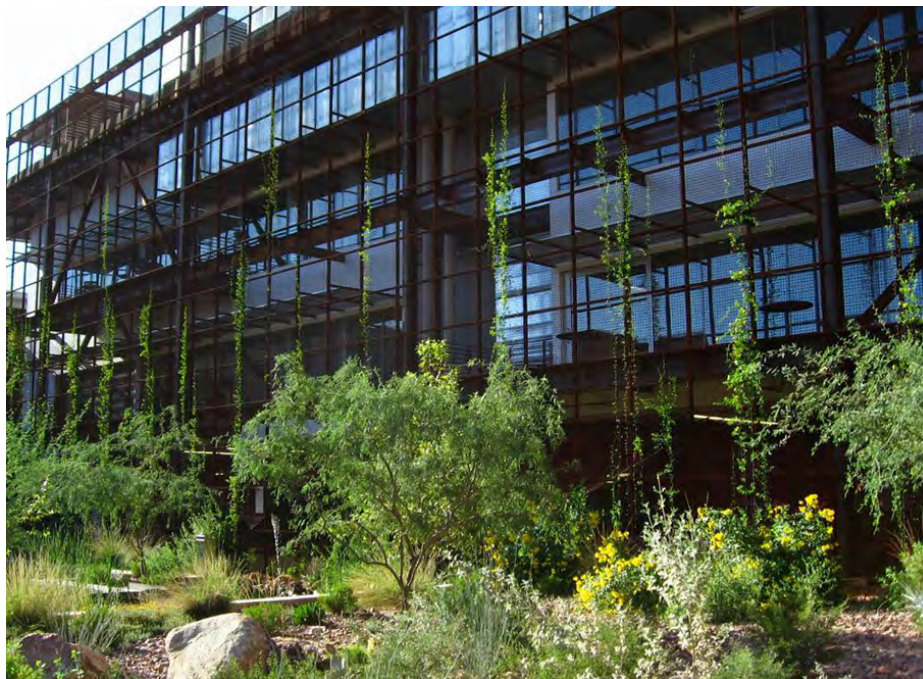
## Maintenance

- Clean gutter at least twice a year, and more often if there are overhanging trees. Make sure gutters are pitched to direct water to downspouts.
- Caulk leaks and holes. Make sure roof flashing directs water into the gutters. Look for low spots or sagging areas along the gutter line and repair with spikes or place new hangers as needed.
- Check and clear elbows or bends in downspouts to prevent clogging. Each elbow or section of the downspout should funnel into the one below it. All parts should be securely fastened together.
- Maintain landscaping so that there is positive drainage away from all structures. Don't build up grade, soils, groundcover mulches, or other materials near the building that might inhibit positive drainage.

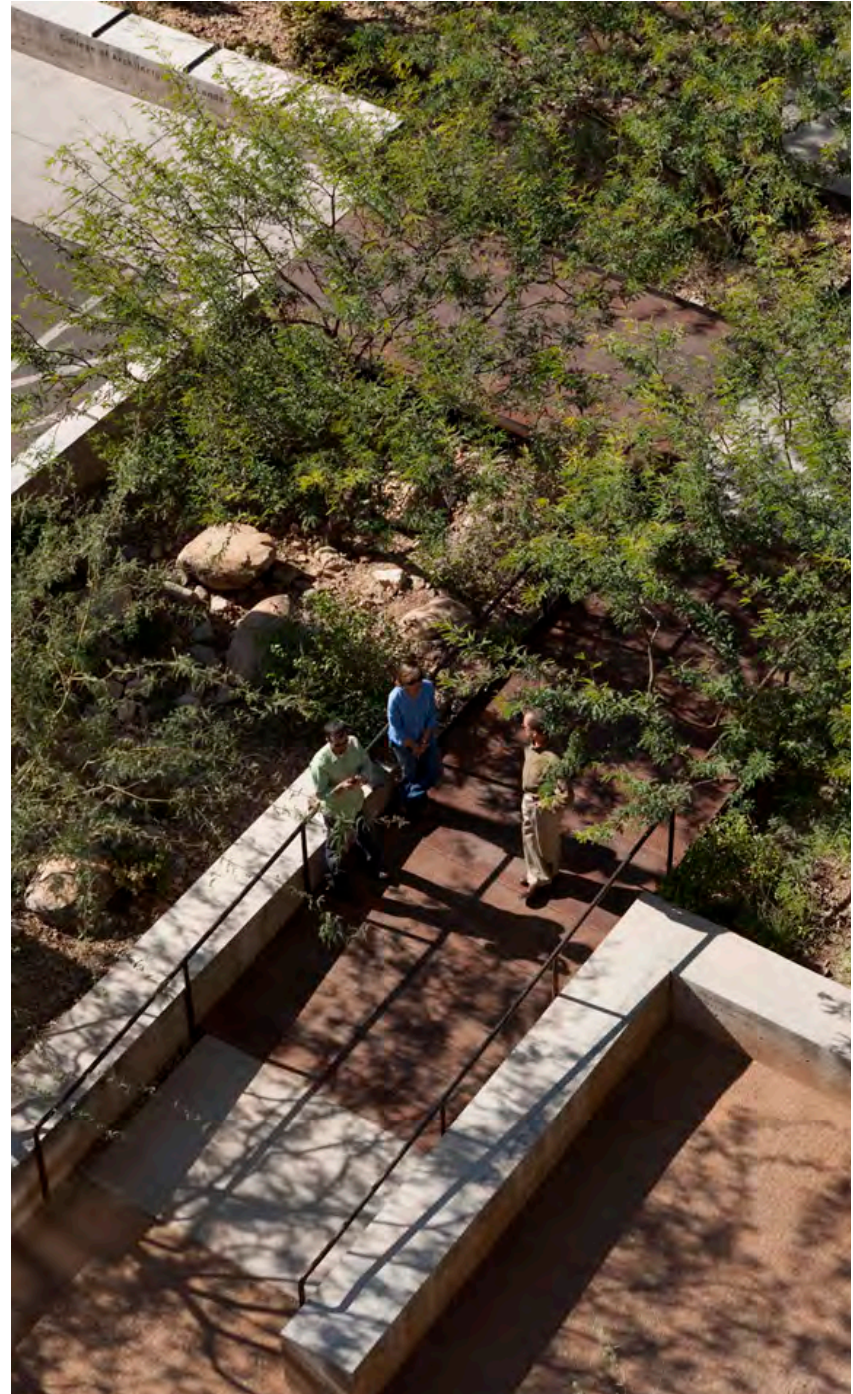
Footnote: #20



A new entry and garden/outdoor classroom provide cleansing garden for adjacent building and pavement runoff.

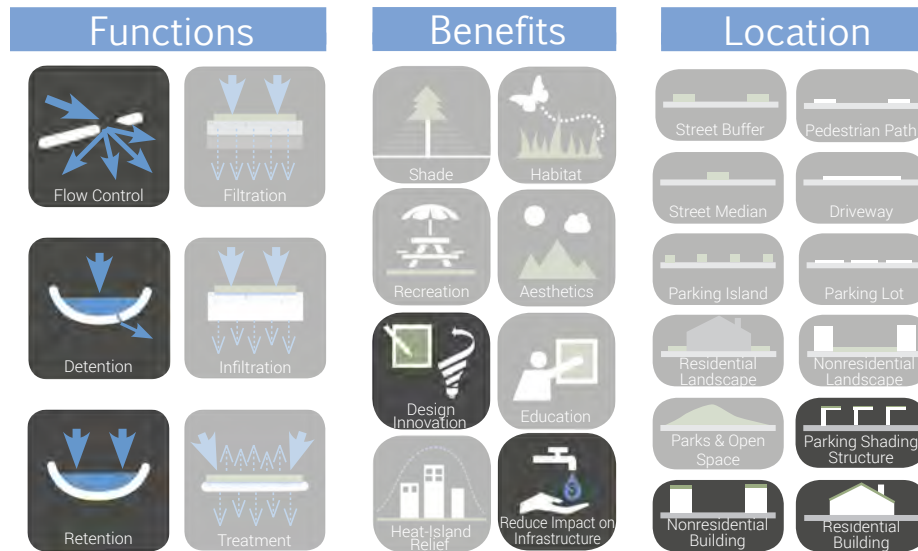


Stormwater runoff is reduced significantly in the landscape and fully integrated with building mechanical systems.



Pedestrian walkways provide shady comfort.

# RAINWATER HARVESTING – CISTERNS ABOVE GROUND



Cisterns can store rainwater to be re-used for future landscape irrigation.

## Description

- An aboveground rainwater harvesting system captures stormwater runoff, often from a rooftop, and stores the water for later use.
- A rainwater harvesting system consists of four main components including a gutter system that collects runoff from the rooftop and directs it into the cistern, a cistern that stores runoff for later use, an overflow pipe that allows excess runoff to leave the cistern in a controlled manner, and an outlet pipe, sometimes connected to a pump, that draws water from the bottom of the cistern for irrigation use.

## Installation

- The most commonly available cisterns are made of plastic, fiberglass, or galvanized metal. The size of the rainwater cistern can have the greatest impact on system cost and performance. Several factors must be considered, including contributing rooftop area, rainfall patterns and anticipated usage.
- The primary constraint in selecting a cistern location is the position of the gutter downspouts. It is generally easiest and most cost effective to place the cistern near an existing downspout. When possible, locate the cistern near the site where water will be used.
- A building, stone or gravel backfill or a poured concrete pad, may be required to provide structural support to an aboveground cistern.

- Some type of overflow or bypass is required to release water when the cistern has reached its capacity.
- To draw water from the cistern, some type of faucet or outlet pipe must be installed.
- An existing gutter system can be easily modified to direct rainwater into a cistern.

## Maintenance

- Regularly check the gutters to make sure debris is not entering the rainwater harvesting system.
- Inspect the screens annually to make sure debris is not collecting on the surface and that there are not holes allowing mosquitoes or other insects to enter the cistern.
- Clean the inside of the cistern twice a year to prevent buildup of debris. Clean out debris twice a year, preferably prior to the beginning of each rainy season.
- Cisterns should be fully enclosed or have screens to prevent mosquito breeding.

# BEST PRACTICES

# BEST PRACTICE

## Current Practice

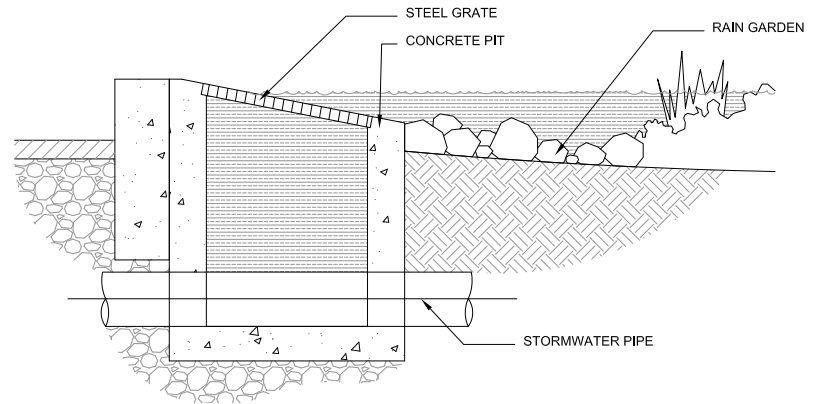


Existing Stormwater Catchment

## Recommended LID Option



Sloped Grated Stormwater Sediment Capture and Bioretention



Sloped Grated Stormwater Sediment Capture and Bioretention Section Details

# BEST PRACTICE

## Current Practice

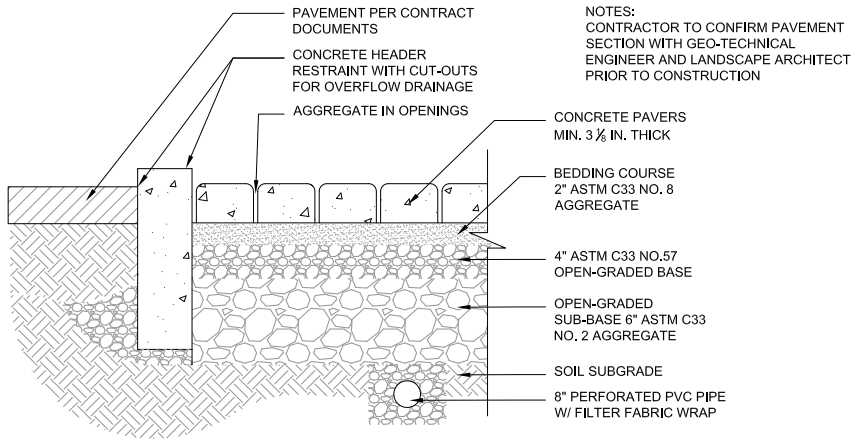


Existing Concrete Paving

## Recommended LID Option



Permeable Pavement



Permeable Pavement Section Details

# BEST PRACTICE

Current Practice

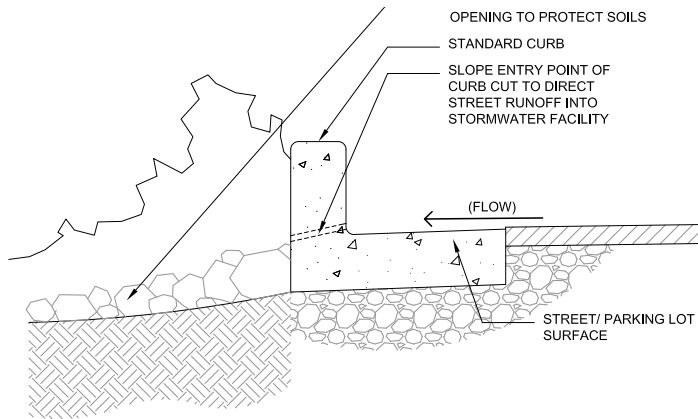


Existing Standard Curb

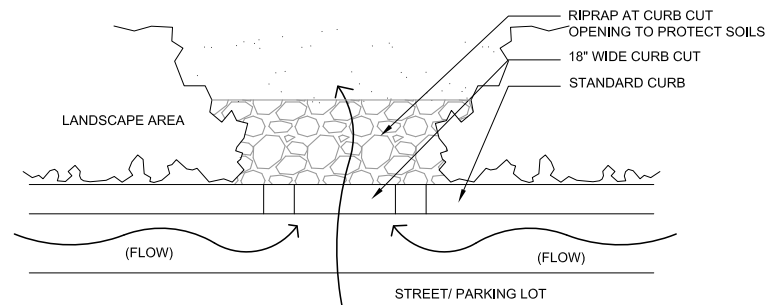
Recommended LID Option



Standard Curb Cut



Standard Curb Cut Section Details



Standard Curb Cut Plan Details



## Current LID in Mesa



BEFORE - SOUTHERN AVENUE

## Current LID in Mesa



AFTER - SOUTHERN AVENUE

## Current LID in Mesa



BEFORE - MESA URBAN GARDEN

## Current LID in Mesa



AFTER - MESA URBAN GARDEN

# LOW IMPACT DEVELOPMENT TOOLKIT

PREPARED FOR THE CITIES OF MESA AND GLENDALE



BY THE TEAM OF:



L O G A N S I M P S O N



WITH FUNDING FROM:



WATER INFRASTRUCTURE  
FINANCE AUTHORITY

FEBRUARY 2015



# Lessons Learned

City of Glendale

# Lessons Learned

- \* Identify your audience
- \* Competing functions





# Tip #1

There's  
got to be  
a better  
way...

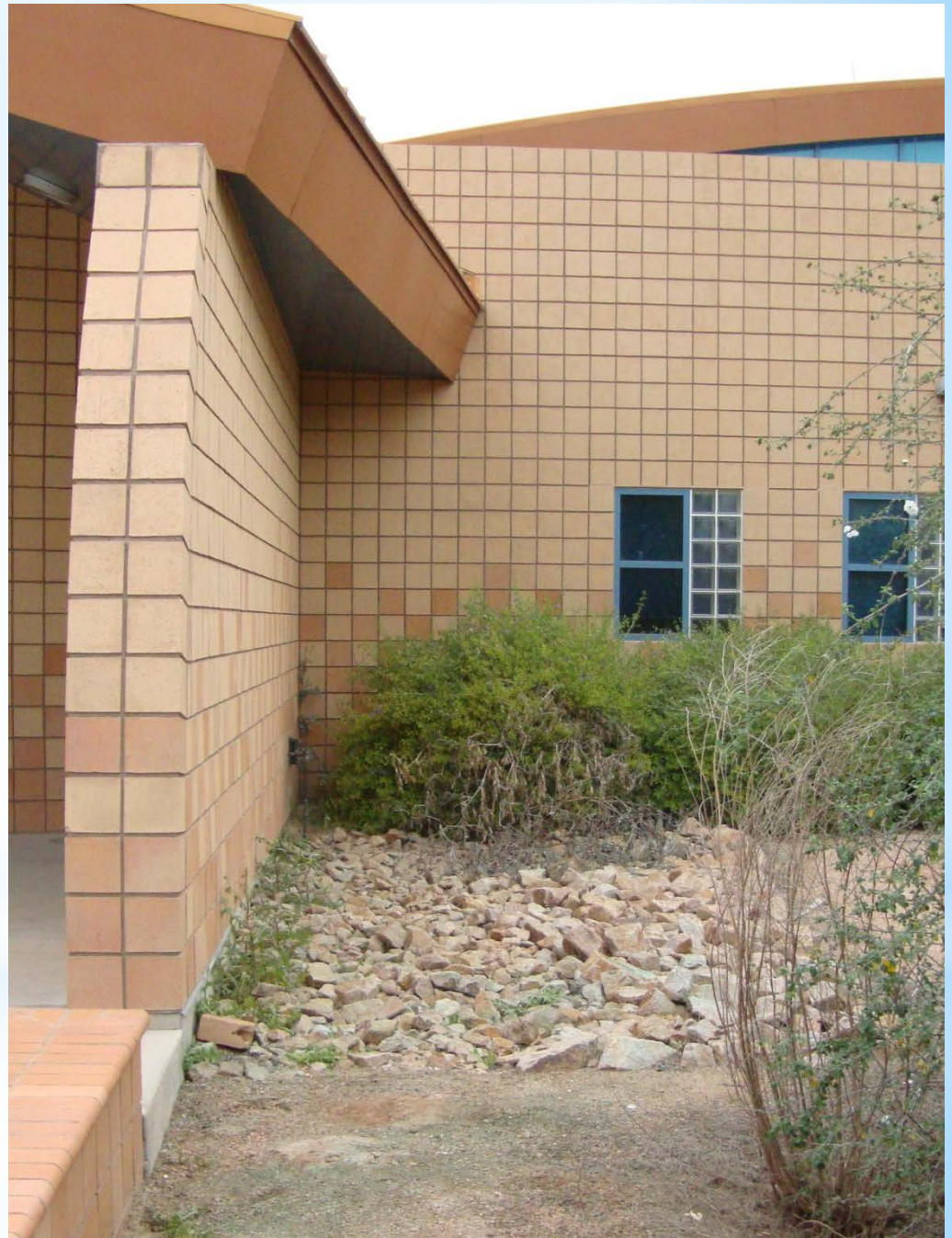


# Permeable Pavement at Park and Ride (NE Corner of 99<sup>th</sup> Ave and Glendale Ave)



# Tip #2

Site-specific  
conditions  
dictate  
what  
will work...



# Rain Garden at Glendale's Main Library

