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

PARKING & STREETS
HARDSCAPE AREAS
STRUCTURE RUNOFF
LANDSCAPE AREAS
ALTERNATIVE SOURCES

METHOD OF MANAGING STORMWATER RUNOFF

ACTION

CONVEY
FILTER
INfiltrate
EVAPORATE-TRANSPORATE
STORE
REUSE

MEANS TO ACCOMPLISH ACTIONS

TECHNICAL TOOLS

GREEN STREET
VEGETATED SWALE
BIORETENTION
PERMEABLE PAVING
CONSTRUCTED WETLANDS
INfiltration & UNDERDrains
GREEN ROOF
RAINWATER HARVESTING
LANDSCAPE*

TECHNICAL VARIATIONS

Standard Curb Cut
Curb Cut with Sidewing
Concrete Flush Curb
Grated Curb Cut
Curb Cut with Sediment Capture
Wheelstop Curb

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**

### Functions
- Flow Control
- Filtration
- Detention
- Infiltration
- Retention
- Treatment
- Design Innovation
- Education
- Shade
- Habitat
- Recreation
- Aesthetics
- Heat Island Relief
- Reduce Impact on Infrastructure

### Benefits
- Shade
- Habitat
- Recreation
- Aesthetics
- Design Innovation
- Education
- Heat Island Relief
- Reduce Impact on Infrastructure

### Location
- Street Buffer
- Pedestrian Path
- Street Median
- driveway
- Parking Island
- Parking Lot
- Residential Landscape
- Nonresidential Landscape
- Parks & Open Space
- Parking Shading Structure
- Nonresidential Building
- Residential Building

### 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
- Curb cuts work well with relatively shallow stormwater facilities that do not have steep side slopes that might erode.
- Set the elevation of the bottom of the curb cut to maximize flow into the landscape area.
- A drop in grade should occur between the curb cut entry point and the finish grade of the landscape area to allow for passage of sediment.
- Small amounts of hand placed rip-rap can be used on the LID facility side of the curb cut opening to reduce the potential for erosion in landscaped areas.
- Example of standard curb cut detail in Best Practice chapter, page 39.

### Footnote: #1
- Curb cuts control stormwater flow from streets to LID facilities.
**Green Street - Wheelstop Curb**

<table>
<thead>
<tr>
<th>Functions</th>
<th>Benefits</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Control</td>
<td>Filtration</td>
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<td>Nonresidential Landscape</td>
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<tr>
<td>Heat Island Relief</td>
<td>Reduce Impact on Infrastructure</td>
<td>Parking Shading</td>
</tr>
<tr>
<td>Residential Building</td>
<td>Parks &amp; Open Space</td>
<td>Residential Building</td>
</tr>
</tbody>
</table>

**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 check regularly for cracking and settlement and repaired or replaced as necessary.

Footnote: #3
Case Study – Taxi Mixed Use Development, Denver, CO
### Green Street - Grated Curb Cut

<table>
<thead>
<tr>
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</thead>
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<tr>
<td>Flow Control</td>
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</tr>
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<td>Filtration</td>
<td>Habitat</td>
<td>Pedestrian Path</td>
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<tr>
<td>Detention</td>
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<td>Street Median</td>
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<tr>
<td>Infiltration</td>
<td>Aesthetics</td>
<td>Driveway</td>
</tr>
<tr>
<td>Retention</td>
<td>Design</td>
<td>Parking Island</td>
</tr>
<tr>
<td>Treatment</td>
<td>Education</td>
<td>Parking Lot</td>
</tr>
<tr>
<td>Heat-Island Relief</td>
<td>Reduce Impact on Infrastructure</td>
<td>Nonresidential Building</td>
</tr>
</tbody>
</table>

#### 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.

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Footnote: #4
Grates allow stormwater to pass through while proving an accrossing pedestrian route.
Water features can harvest rainfall, making water visible and celebrating its importance in an arid climate.

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

Grated curb cuts convey stormwater from pavement into planting areas.

Standard curb cuts open up planting areas to receive stormwater flow.
**GREEN STREET - CONCRETE FLUSH CURB**

**Functions**
- Flow Control
- Filtration
- Detention
- Infiltration
- Retention
- Treatment

**Benefits**
- Shade
- Habitat
- Recreation
- Aesthetics
- Education
- Heat-Island Relief
- Reduce Impact on Infrastructure

**Location**
- Street Buffer
- Street Median
- Driveway
- Parking Island
- Parking Lot
- Residential Landscape
- Nonresidential Landscape
- Parks & Open Space
- Parking Shading Structure
- Residential Building
- Nonresidential Building

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 alongside 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

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**

### 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.

### 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.

- 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.

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**Footnote: #10**

- 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.
Case Study – Lincoln Ave. Redevelopment – Denver, CO
Conventional Stormwater Pipe System

Reduced Stormwater Pipe System
**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.
PERMEABLE PAVING - POROUS CONCRETE

Functions
- Flow Control
- Filtration
- Detention
- Infiltration
- Treatment

Benefits
- Shade
- Habitat
- Recreation
- Aesthetics
- Design Innovation
- Education
- Heat-Island Relief
- Reduce Impact on Infrastructure
- Shade
- Habitat
- Recreation
- Aesthetics
- Design Innovation
- Education
- Heat-Island Relief
- Reduce Impact on Infrastructure

Location
- Street Buffer
- Pedestrian Path
- Street Median
- Driveway
- Parking Island
- Parking Lot
- Residential Landscape
- Parking Shading
- Nonresidential Landscape
- Parking Shading
- Residential Building
- Parking Shading
- Nonresidential Building

Description
- Single size aggregate, also known 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 systems 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 may be 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

Porous concrete can reduce runoff sustaining in sidewalks and plaza areas.
Glendale Park & Ride
99th Avenue & Glendale

City of Glendale Park and Ride Facility –

- 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
<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Typical Pollutant Removal (percent)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Suspended Solids</td>
</tr>
<tr>
<td>Dry Detention Basins</td>
<td>30 - 65</td>
</tr>
<tr>
<td>Retention Basins</td>
<td>50 - 80</td>
</tr>
<tr>
<td>Constructed Wetlands</td>
<td>50 - 80</td>
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<tr>
<td>Infiltration Basins</td>
<td>50 - 80</td>
</tr>
<tr>
<td>Infiltration Trenches/Dry Wells</td>
<td>50 - 80</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>65 - 100</td>
</tr>
<tr>
<td>Grassed Swales</td>
<td>30 - 65</td>
</tr>
<tr>
<td>Vegetated Filter Strips</td>
<td>50 - 80</td>
</tr>
<tr>
<td>Surface Sand Filters</td>
<td>50 - 80</td>
</tr>
<tr>
<td>Other Media Filters</td>
<td>65 - 100</td>
</tr>
</tbody>
</table>

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 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 help filter stormwater sediments and pollutants.

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.

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

• 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

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.

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.

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.

Footnote: #19

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

### Functions
- Flow Control
- Filtration
- Detention
- Infiltration
- Retention
- Treatment

### Benefits
- Shade
- Habitat
- Recreation
- Aesthetics
- Education
- Heat-Island Relief

### Location
- Street Buffer
- Pedestrian Path
- Street Median
- Driveway
- Parking Island
- Parking Lot
- Residential Landscape
- Nonresidential Landscape
- Parks & Open Space

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**Disconnection**

- 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.

**Description**

**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.

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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.
### Functions
- Flow Control
- Detention
- Retention
- Treatment
- Filtration
- Infiltration
- Shade
- Habitat
- Recreation
- Aesthetics
- Design Innovation
- Education
- Heat-Island Relief
- Reduction of Heat Island

### Benefits
- Street Buffer
- Pedestrian Path
- Street Median
- Driveway
- Parking Island
- Parking Lot
- Residential Landscape
- Nonresidential Landscape
- Parks & Open Space
- Parking Shading Structure

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

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### 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