Development and other changes to land cover can increase the amount of impervious surfaces, alter the density of arroyo channels, increase the volume and velocity of stormwater, and change the amount and type of material that arroyos convey. Ultimately, these changes can divert much of the surface drainage to underground storm sewers. Stormwater events and resulting floods can strike with little warning, can travel at extremely high velocities, and carry a tremendous amount of sediment and debris. Changes in land cover can also alters the physical configuration and stability of stream channels, changing vegetation patterns and potentially reducing their value as wildlife habitats.

Enhancing and improving existing channels and arroyo systems can allow them to withstand erosion caused by turbulent flood and debris flows. Such enhancements and improvements require careful design, proper implementation and sufficient maintenance in some cases. Development on or near an arroyo should not increase downstream peak flows. Studies can be performed for such development to ensure it does not change the direction of an arroyo or have negative downstream effects. Erosion control techniques like culverts and arches can maintain flow path and protect from erosion. The location of erosion control structures is important: constructing them where a flow path has been or is likely to be altered, or downstream of a road crossing (where increased flow velocity is likely) can assist in maintaining a healthy arroyo system where development has already occurred.

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Floodwaters may pass safely through an alluvial fan system if the existing channels and banks are protected. Because alluvial fans represent critical sites of sediment routing in mountainous watersheds, including a fan analysis in an arroyo characterization model may provide a fundamental tool for assessment. In addition, mapping alluvial fans could provide quality risk assessment data and suggest additional mitigation actions that assessing arroyo characteristics may not provide alone.

Stormwater Management, Impacts and Risks

When stormwater is absorbed into the ground, it is filtered and ultimately replenishes aquifers or flows into streams and rivers. In developed areas, however, impervious surfaces such as pavement and roofs prevent precipitation from naturally soaking into the ground in an evenly displaced manner. Instead, water collected from impervious surfaces gathers and flows more rapidly into storm drains, sewer systems, and drainage ditches and can cause:

- Downstream flooding
- Stream bank erosion
- Increased turbidity (muddiness created by stirred up sediment) from erosion
- Habitat destruction
- Changes in the stream flow hydrograph (a graph that displays the flow rate of a stream over a period of time)
- Combined sewer overflows
- Infrastructure damage
- Contaminated water

As runoff flows over the land or impervious surfaces, it accumulates debris, chemicals, sediment or other pollutants that could adversely affect water quality if the runoff is discharged untreated. In addition, most stormwater discharges are considered non-point sources (NPS) and require coverage under the U.S. Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES) permit. Stormwater discharges from construction activities (such as clearing, grading,

excavating, and stockpiling) that disturb one or more acres, or smaller sites that are part of a larger common plan of development or sale, are regulated under the NPDES stormwater program. The NPDES program requires the City to have a Small Municipal Separate Storm Sewer Systems (MS4s) permit for such construction activities. This includes a USEPA Construction General Permit requirement, where BMPs are mandatory during construction in order to control stormwater discharges; post-construction activities require runoff containment, revegetation or ponding are two ways to accomplish this.

Mitigating stormwater pollution by reducing impervious surface and preserving open space for drainage are examples of green infrastructure techniques. Although many green infrastructure strategies are not approved by the City at this time, developers and contractors understand the need for better stormwater management and have made changes to their practices independently where permitted. As we become more knowledgeable about these techniques and the benefits they bring, the City can incorporate these mitigation practices as acceptable means of drainage design. Studies should be conducted using green infrastructure techniques to gain more confidence in implementing these practices, which can achieve proper drainage performance, flood safety and cost effectiveness.

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Cisterns and rain barrels are a cost-effective way to collect and store water for garden and lawn irrigation and would keep the water out of storm drains.
Photos: www.epa.gov

Bioswales are vegetated, mulched or xeriscaped channels that provide treatment and retention as they move stormwater from one place to another. Swales slow, and filter stormwater flows. As linear features, vegetated swales are particularly suitable for draining water from streets and parking lots. Photo: Dave Leonard Tree Specialists, www.dlarborist.com

Permeable concrete and pavers allow rain to seep into the ground. Permeable paving can capture and soak in up to 80 to 100 percent of the rain that lands on it and can reduce construction costs for residential and commercial development by reducing the need for drainage features. Photos: www.epa.gov.

Sometimes, BMPs are not implemented properly or sufficient maintenance is not provided following construction. The City has begun to address this by dedicating additional staff and resources to inspection and enforcement of existing regulations. Policies calling for enforcement of BMPs may further improve these practices.[48] The use of structures to protect from flooding is sometimes necessary and even desirable, but structural floodplain management should not be the primary mitigation plan. Because areas exist that are already fully developed and near a flood hazard, it is necessary to thoughtfully explore some appropriate structural methods as part of an overall plan in order to protect existing property.

Upstream debris barriers stop or reduce the movement of debris down a channel system. Debris barriers may be permanent structures in the watershed or constructed as temporarily control measures. Either way, these structures allow flood waters and fine grained sediment to pass through but stop larger sediment, rocks and vegetative material from flowing downstream. Debris barriers are one example of an engineered watershed improvement designed to manage the effects of stormwater.

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Like many urban communities, Las Cruces relies on drainage channels, storm sewers, and other expensive infrastructure to deal with localized flooding from sudden storms. Both public and private landowner tax dollars pay to clean up nonpoint-source pollution caused when water transports contaminants from parking lots and other impermeable surfaces. But natural hydrologic systems recharge and cleanse the watershed from NPS pollutants. Undeveloped areas (i.e. natural land) provide a natural nonstructural floodplain management BMP because the land has not yet been altered with structures subject to the effects of flooding. In addition, NPS pollutants in discharge from urban runoff can affect EBID agricultural drains and may put the District's agricultural exemption from NPDES permitting at risk.

At the Rio Grande, the levees are intended to keep flows from leaving the river into the surrounding land during a flood event, that is, away from the river. This hinders runoff from arroyos and watersheds that flows toward the river in times of flooding. Elephant Butte Irrigation District's (EBID) drain and canal system flows mostly north to south, creating multiple impediments to arroyos and channels reaching the river. These drains and canals were not designed for storm flows, and were not designed for the increases in storm flow runoff associated with recent development.

Watershed conservation has proven to be a cost-effective alternative to expensive structural BMPs. Also, water sources can become polluted when sediment, pesticides, oil, animal waste and other contaminants wash into them from impervious surfaces. Conserving land and re-establishing vegetation along the sides of arroyos and other stream beds can help prevent this pollution. Vegetation also assists in bank stability and water quality mitigation within watersheds. Roots of riparian plants filter and remove suspended materials. Plants and algae use and remove such nutrients as nitrogen and phosphorus. Bacteria, fungi, and other microorganisms decompose organic material.[49] These are important functions of a healthy watershed.

The most significant hazard to public safety along incised channel reaches is often related to lateral erosion into infrastructure and adjacent property rather than flooding, because the capacity of the incised channel is typically quite large. All of the soils in Doña Ana County are considered highly

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[48] For the EPA's National Menu of BMPs, go to http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

[49] "*Eco Tipping Points: How a Vicious Cycle Can Become Virtuous.*" Amanda Suutari and Gerald Marten. Earth Island Journal 22, no. 2 (Summer 2007).

erodible.[50] Wind, rainfall, soil moisture, the type and size of soil particles, and the condition of the soil surface (e.g. vegetated, barren, or disturbed) all determine how much erosion occurs. The unstable and erosive nature of soils in the arroyos are what makes it so difficult to predict how an arroyo will change in any given flood event. As shown below, unchecked erosion could eventually reach a point at which retaining walls, accessory structures, or infrastructure would have no support and fall away.

Sediment that is eroded during the incision process is carried downstream where it can deposit in low energy zones, decreasing channel capacity and potentially increasing the flood hazard in the depositional zones. Stormwater generally develops a flowpath in the hillside areas and follows existing arroyos that are in its natural path. Just as on the East Mesa, development on our western hillsides creates impervious surfaces and modifies storm flows, which can lead to increased erosion. Excessive incision can also remove natural vegetation and destroy habitat adjacent to the channel.

Besides their unsightly appearance, canalized arroyos increase runoff volume and water velocity, thus contributing to flooding and erosion downstream. This is a section of the South Fork of the Las Cruces Arroyo, east of Roadrunner Parkway.

Natural areas reduce runoff volume while providing wildlife habitat. Most of the arroyos in our region have great potential for restoration and preservation. This is a different section of the South Fork of the Las Cruces Arroyo, further east.
(Photos by Peter Bennett.)

Another problem associated with erosion is damage to culverts under road crossings, usually caused by flood waters eroding culvert entrances or outlets and road embankments, and usually resulting in a full or partial washout, or misalignment of the culvert. Damage or failure of a culvert could be due to insufficient culvert capacity and/or inefficient end sections (mouth of the culvert), so appropriate hydrologic analyses of flood peaks and volumes, and applying appropriate culvert design criteria are both important. It is important to make a careful determination of the cause of the damage, as different

[50] Soil Survey of Dona Ana County New Mexico.

causes require different mitigation. Also, mitigation applied inappropriately could actually increase risk to the facility or other structures in the floodplain.[51]

In its simplest sense, an arroyo is only a drainage path. But with closer inspection it can be seen that the curves, width, and grade are all dynamic properties and continually seek a balance in response to its most recent flood event. For these reasons urbanization along banks inherently carries a higher risk for instability than does development further away. Some of the risks include 1) bank mass failure from bank instability through undercutting erosion or overloading of stormwater through development, 2) weaknesses from previous mass failure events, and 3) water flow regime risks by flooding of zones that have moved downward to place them below a 100-year flood elevation.

Further analysis of a given arroyo would identify many of the risks of urban development outside its flood zone boundary. This would help determine its inherent stability and likelihood of erosion and erosion speeds, and would identify historic failures within the embankment. This information could be used to help determine any necessary buffer distance for arroyos that have not yet been developed.

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The solution to this severe flooding problem near Rinconada was to broaden the channel and line it with concrete. The banks were seeded with native grasses and an erosion fence was added.

[51] Randolph Langenbach, Conservationtech.com: http://www.conservationtech.com

Flooding near the Sonoma Ranch Golf Course inspired a simple and inexpensive naturalistic erosion measure (below) which preserves natural vegetation and blends in with the surrounding terrain. Both photos: CLC Public Works Dept.

This photo illustrates what can happen when development restricts a natural channel. Continued erosion could eventually reach the point at which the retaining wall would have no support and would fall away. The photo below illustrates a quick and inexpensive (although unsightly) fix for the erosion problem. All photos: CLC Public Works Dept.

Utilities and Infrastructure

City utilities oftentimes place sewer interceptors in or near arroyos. These interceptors receive flow from a number of other sewer lines for transport to one of the three wastewater treatment plants operated by the City. Challenges with the location of these interceptors in or near arroyos can occur despite the installation of erosion control structures, such as rip-raps or check dams. For instance, since the soil is disturbed to bury the lines, the soil becomes more susceptible to erosion during a flood event and infrastructure may become exposed. Exposure may also occur when stormwater creates higher and faster runoff. In addition, water and gas mains and services are to have 5-foot minimum cover and sewer mains a 6-foot cover, as measured from the bottom, or floor, of the arroyo. But as arroyo floors erode with rain events, there is a risk of exposure, regardless of how deep the pipes were initially buried.

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A cost-benefit analysis may warrant the efficiencies gained by locating interceptors or other utilities in or near arroyos. If warranted, updated design and installation procedures could help to ensure the least amount of disturbance to the arroyo environment. For example, when road crossings are constructed, arroyos become semi-closed channels that have limited or restricted access from a bridge or street. Most (if not all) of these bridges do not have large enough culvert openings to drive through, and bridge design typically doesn't include an access ramp for maintenance vehicles or a vactor truck. Without proper design to allow access, arroyo disturbance potentially increases when City staff needs to reach manholes or exposed pipes that cross or lie on the arroyo floor. According to the City's Utilities Standards, manholes must be accessible by 2-wheel-drive vehicles 24 hours a day and must be approachable by a dedicated 15-ft. (minimum) right-of-way or City utility easement.[52] However, this is very often not the case due to space constraints.

On the West Mesa, infrastructure such as utility lines and roads are more expensive to install and maintain due to a more hilly terrain. Access becomes more difficult to provide because hillside roads are generally narrower, do not always provide secondary connection due to physical constraints, and can be easily blocked or narrowed due to on-street parking.

[52] City Utility Standards Sections 504, Sewer Lines Outside of Street/Road Right-of-Way, and 510, Manhole Design Criteria, www.las-cruces.org/Departments/Utilities

Exposure around the manhole indicates incision in this reach of up to 2 to 3 feet in this area. Note that some of the exposure could also be due to lateral movement of the low flow channel. This is the Alameda Arroyo looking downstream (west) from Roadrunner Parkway. Both photos: USACE Sediment Transport Analysis Report

Exposed pipeline in an incised reach of the South Fork Arroyo downstream (west) from Roadrunner Parkway.

Flood Control Dam Functionality

Several of the flood control/detention dams listed on page 29 are within the East Mesa watershed. Some dams were built at the request of residents and were designed to protect those residents, but most were built with a lower hazard in mind and present a potential risk to those who have developed below them since their installation. Maintenance of these structures has been neglected over the past 30-40 years during which time the pool areas have experienced extensive sediment deposition and build-up. This has impeded the primary outfall of most of the dams and diminished their storage capacities. These dams were originally intended to protect agricultural land, not urban or rural development. The City's Storm Drain Master Plan of 2006 found that:

> "Under current conditions, the effectiveness of the Civilian Conservation Corps (CCC) dams as flood control structures is questionable; their main role at this time appears to [be] control and retention of sediment." [53]

According to the Natural Resources Conservation Service (NRCS), many of the dams are approaching the end of their planned service life and will require rehabilitation to continue to function safely. To ignore these dams will eventually place life and property at risk.[54]

The key areas where additional technical information is needed to support dam rehabilitation activities are summarized as:

- Technology for predicting performance of dams during extreme hydrologic events.
- Improved means of characterizing reservoir sediment quantity, quality, and distribution.
- Improved tools and guidance documentation for efficient application of current technology at the field level.
- Improved technology and tools for predicting the environmental impacts of dam failure.
- Improved procedures for predicting the response of channel and reservoir systems to change.
- Improved procedures for evaluating the short and long-term impacts of dam removal.

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The Agricultural Research Service (ARS) and the NRCS have cooperated in the development and application of design criteria for flood control structures and channel stabilization measures. Over the past 60 years, achievements such as the development of tools to predict upland erosion, sediment delivery, and stream channel stability have contributed to improved reservoir design. ARS has also worked closely with NRCS in the development of design criteria for flood control project components such as spillways and stilling basins that allow the dams to operate effectively. Joint efforts in the area of software development for technology application are continuing to result in improved tools for design and analysis of dams and systems.

There are different options for dams to provide flood control functionality for Las Cruces. These could range from larger dams and reservoirs just outside developed areas, to a series of smaller dams strategically located through the extent of the arroyo system. These dams also represent the potential for wetlands and habitat where wetlands never existed before, but such repurposing could have impacts on the flood control function of the dams. Assessments on effective and desirable flood control structures would need to be addressed when considering upgrades or rehabilitation of the dams, and would involve the State Engineer's Office of Dam Safety, the NRCS, the Dona Ana County Flood Commission, the USBOR, the, private property owners and many other entities. In addition, the recent designation of the Organ Mountain Desert Peaks National Monument may impact owners' ability to maintain their dams, depending on the management plan created by the U.S. Bureau of Land Management.

Since the City has limited control over the fate of these dams (with the exception of the Villa Mora, Sandhill Arroyo and Las Cruces Dams), policies addressing upgrades and rehabilitation are not included in the AMP. However, the City fully supports a regional stormwater management strategy that fulfills

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[53] City of Las Cruces Storm Drain Master Plan, 2006, Bohannan Huston Inc.

[54] Rehabilitation of Aging Watershed Flood Control Dams. U.S. Department of Agriculture Technology Fact Sheet, May 2001. www.nrcs.usda.gov

the programs of all entities and would participate as a regional partner in efforts to mitigate problems associated with improving dam functionality.

Factors that need to be considered include the costs for rehabilitation (including technology that would aid in decision-making), the values of downstream development which would be at risk due to dam ineffectiveness, and whether or not these flood control dams would be the best way to handle stormwater runoff. Other methods, including larger dams, designed channels to redirect flows where development has taken place downstream or ponds may be more effective. But the Las Cruces, Alameda, North Fork, and South Fork Dams are important to the overall drainage of the East Mesa watershed because they play a major role in the watershed's hydrology.

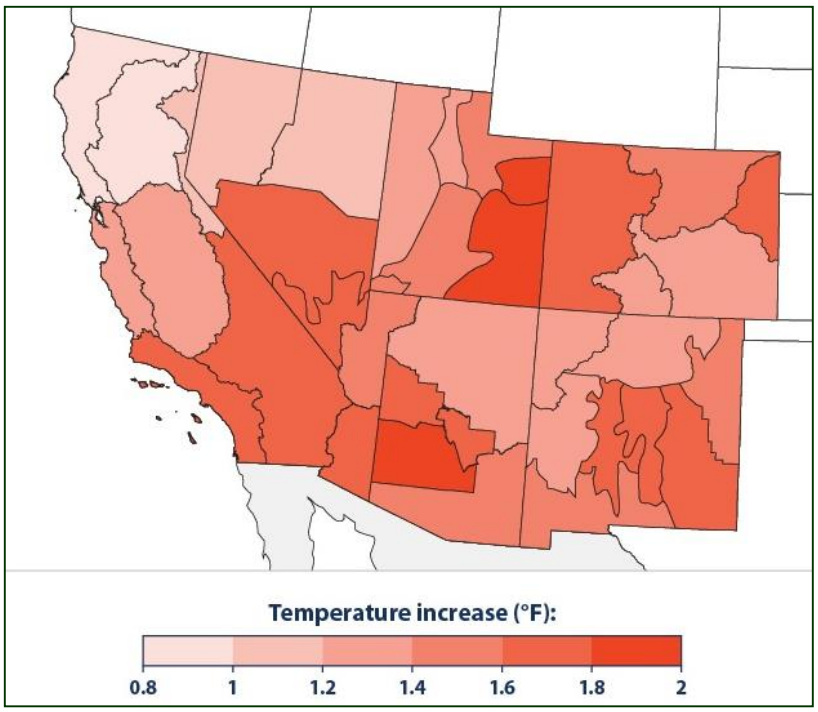
Weather and Climate Variability

One does not have to accept theories about climate change to understand that the unpredictability of El Niño, La Niña and the North American Monsoon makes it difficult to plan for storm events and flooding, and makes it all the more important. Monsoonal rainfall events in southern New Mexico tend to be short and spotty, with intense, local storms drenching some neighborhoods but not others. Rising temperatures and increased storm activity have occurred simultaneously, although the timing, intensities and frequencies of storms change from region to region and from year to year and may not be related to climate change at all.[55] It is worth noting, however, that the increased droughts, fires, flooding and severity of storms recorded in the last ten years have all occurred with a warming of only 1.3°F [56] and scientists project that Earth's average temperatures will rise between 2 and 12 degrees Fahrenheit by 2100.[57] In the Southwest, temperatures since 2000 have risen about 1.5°F from recorded averages.

Many regions are experiencing more frequent and severe heat waves while experiencing more intense rainfall, as well. Scientists theorize that changing the average global temperature by even a degree or two can lead to serious consequences and predict that for about every 2°F of warming, we can expect to see:

- 3—10% increases in the amount of rain falling during the heaviest precipitation events, which can increase flooding risks.
- 5—10% decreases in stream flow in some river basins, including the Rio Grande.
- 200%—400% increases in the area burned by wildfire in parts of the western United States which increases the likelihood of soil erosion and flooding in burned areas. [58]

[55] "Understanding the Southwestern Monsoon," Jack Guido. Southwest Climate Network, 2010. www.southwestclimatechange.org
[56] "Understanding Climate Change: A Primer," Woods Hole Research Center, 2014. www.whrc.org
[57] *America's Climate Choices: Final Report*. National Research Council, 2011. The National Academies Press, Washington, DC, USA. http://nas-sites.org/americasclimatechoices/
[58] *Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia*. National Research Council, 2011. The National Academies Press, Washington, DC, USA. http://nas-sites.org/americasclimatechoices/

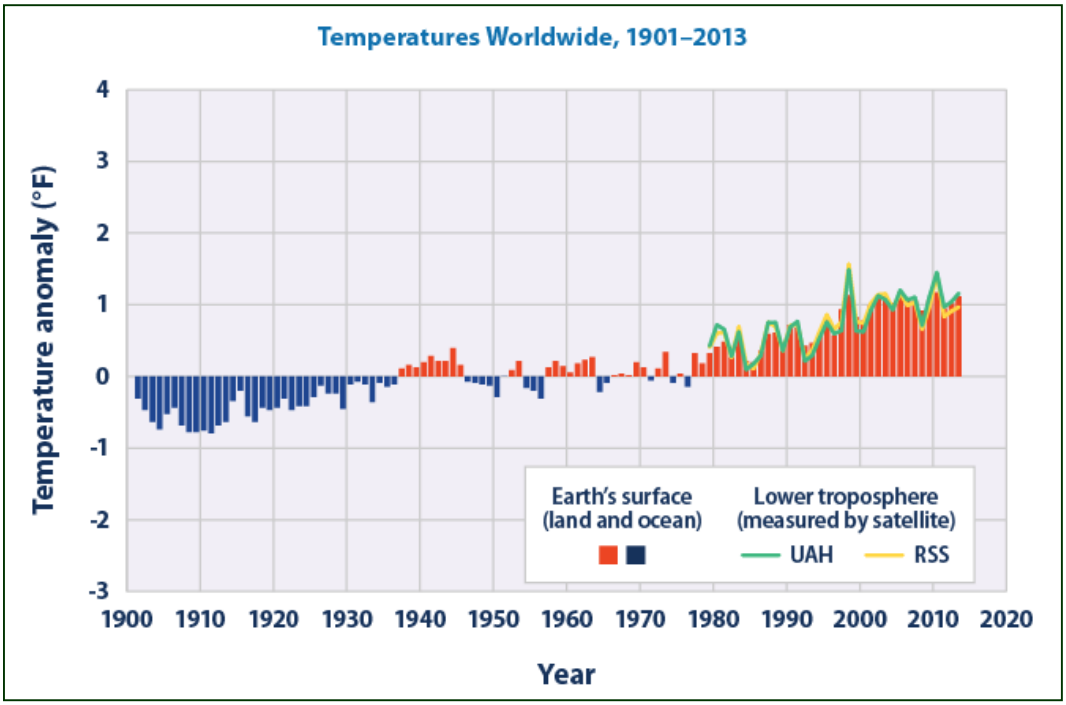


This map shows the average increase in air temperature in the Southwest compared to long-term averages (1901-2013). Southern New Mexico has experienced an average increase of 1.5° F in the last decade. National Climatic Data Center, National Oceanic and Atmospheric Administration (NOAA), 2014. www.ncdc.noaa.gov/oa/ncdc.html

The high costs associated with extreme and variable weather is something to keep in mind during discussions about development and arroyo management. Most climate models indicate that the Southwest will become drier in the twenty-first century, and that there will be increased frequencies of extreme weather events, including drought, flooding, and heat waves.[59] Increasing temperatures are expected to alter precipitation patterns (i.e. volume, frequency, and intensity) and correspondingly alter regional stream flow patterns.[60]

[59] IPCC 2007

[60] Climate Choices for a Sustainable Southwest," from The Assessment of Climate Change in the Southwest United States. Available at http://swcarr.arizona.edu/content/about-report. P 286



This figure shows how annual average temperatures worldwide have changed since 1901, when reliable temperature data began being collected. In the early part of the 20th century, temperatures were slightly below normal. The first significant heat wave occurred in the mid-1930s, but steady and sharp increases in temperature began to occur in the late 1970's. National Climate Data Center, National Oceanic and Atmospheric Administration (NOAA), 2014. www.ncdc.noaa.gov/oa/ncdc.html and www.epa.gov/climatechange/indicators

Typically, arroyo capacity is analyzed with respect to the 100-year storm event, to assure no development occurs within the inundated areas. With predicted increases in intensity and frequency of storms, arroyos will have to carry a greater amount of water than they currently do and will flow beyond the 100-year flood boundary.

Short- and long-term perspectives on disaster risk management and adaptation to weather extremes can be difficult to reconcile. But community vision changes over time and development decisions are framed by tradeoffs between competing prioritized values and objectives. In other words, what we want today may not be what we want tomorrow. A proactive approach would not necessarily commit our community to a different vision, but would simply prepare us for whatever it may be. Planners, developers and elected officials will face choices to react to extreme storms and flood events or to take steps that could help head off some of the more damaging and expensive results of them. In the long run, better planning and erring on the side of caution save money and could simultaneously make our region better able to cope with the coming changes.[61]

A regional stormwater management plan, based on thorough hydrologic modeling, may help identify the most fragile land forms where development should not occur. If we consider potential extreme weather events and climate change in determining locations of critical facilities and systems and more fully incorporate natural systems to help control erosion and manage stormwater, we may be reducing

[61] Melanie Lenart, Southwest Climate Change Network, March 2013. http://www.southwestclimatechange.org/node/16780

disaster risk because we have a better understanding and acceptance of the natural hazards we may face in the future.[62]

Vegetation and habitat

Mitigation measures to restore vegetation disturbed during development can be challenging because vegetation generally takes a long time to establish in the desert environment. Also, since soil is disturbed during construction, it is more likely to erode, making vegetation more vulnerable to destruction.

Vegetation loss and desertification are issues with development as well. More impervious surfaces and narrow channels diverting stormwater to arroyos cause increased velocities and flows. Devices such as rip-rap, check dams and energy dissipaters are not always incorporated at drainage outlets that enter arroyos, causing destruction of downstream vegetation. Those that are incorporated sometimes fail due to poor design or insufficient maintenance.

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Construction permitees in New Mexico are required to follow Section 9.4. of the NPDES General Permit for Discharges from Construction Activities, which states that operators in New Mexico have three years to establish a uniform perennial vegetative cover with a density of 70 percent of the native background vegetative cover for all unpaved areas and areas not covered by permanent structures. Other areas of the U.S. are required to revegetate areas in one year, but the EPA recognizes the difficulty in arid desert regions and therefore has allowed a longer time period for this requirement in New Mexico.

According to the Army Corps of Engineers' *East Mesa Watershed Study* (2007), the relative scarcity of perennial grasses that would be expected to occur in this area is a cause for some concern and perhaps presents an opportunity for restoration. Typically native species like sideoats grama, black grama, fluff grass, vine mesquite, tobosa, burro grass, alkali mallow and cane bluestem are very rare or absent altogether across the East Mesa, but could be replanted as part of mitigation efforts following construction.

Wildlife

As part of a healthy desert ecosystem, arroyos provide vital wildlife habitat and are natural east-west wildlife corridors. It is important to have intact, unfragmented corridors so that wildlife can access different parts of their home territory without crossing highways or arterial roadways. The East Mesa Watershed has undergone significant changes over time, especially within the past two decades.[63] Before development, the watershed was largely comprised of Chihuahuan Desert vegetation, with Chihuahuan Desert arroyo riparian communities, interspersed in the valley areas and along the arroyos. However, these community types are experiencing increased pressure from development, grazing, and other human uses. With development, wildlife habitats are encroached upon which can force interaction with humans or the elimination of their ranges and areas altogether.

During the Army Corps of Engineers *East Mesa Watershed Study* (2007), many species of wildlife expected to be present in the area were either absent or not observed. It has been speculated that

[62] United Nations Office for Disaster Risk Reduction, www.unisdr.org/we/coordinate/hfa
[63] East Mesa Watershed Study, U.S. Army Corps of Engineers, 2007.

development and competition by other species or predation have caused this decline.[64] Development within the watershed has transformed the wide, uninhibited alluvial fan to a patchwork of subdivisions that have restricted arroyo flows and segmented wildlife corridors and habitat. New roadways and neighborhoods have interrupted connectivity and have made it nearly impossible for wildlife to travel outside a very limited range. Although they have been reduced in size and diversity, some unfragmented wildlife corridors could perhaps be identified and preserved. A requirement for arroyo buffers could also benefit wildlife in appropriate areas.

Wildlife have adapted to changes caused by human presence and are drawn to garbage, gardens, pet food, and backyard bird feeders. Left, Coyote: Albuquerque Journal. Middle, Collared Peccary aka Javalina: Encyclopedia of Life, http://eol.org. Right, Desert Cottontail: New Mexico Tech, http://www.nmt.edu.

[64] Ibid

Parks and Open Space

Arroyos are an important recreational asset. Runners, cyclists, equestrians and walkers use the arroyos the open spaces adjacent to them on a regular basis. Encroaching development has threatened open space recreational opportunities by limiting access to these areas through subdivision design. As an example, subdivisions may reduce or limit pedestrian and bicycle access, may make no provisions for trails and may reduce opportunities for amenities along arroyos due to development that is too close to the 100-year flood zone boundary. This limits the value of arroyo systems as a multi-faceted community asset. In addition to providing more trail possibilities, planning development further back from the 100-year flood zone would also provide more privacy for property owners and would provide greater flooding protection in higher risk areas.

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Unfortunately, motorcycles and all-terrain vehicles (ATV) have disturbed vegetation and wildlife and over time, leave a scarred landscape that isn't easily returned to a natural state. Signage and perhaps fencing in specific areas may help with this as will education and raising awareness of the value of the natural environment. Providing dedicated ATV areas may also reduce the overall damage to natural areas.

Equestrians often travel along arroyo bottoms but crossing under thoroughfares is difficult because bridges are generally too low to ride under. Increased demand for natural areas, trails and trail connections, and equestrian amenities means there is a need for design standards for trail construction and trail and road crossings that consider the needs of all users. These do not currently exist.

Suitable trails for equestrians have become increasingly hard to find, particularly close to urban areas. Many trails prohibit equestrian use, fearing conflicts with other users and damage to the trail surface. However, with proper design, a multi-use trail can accommodate equestrians while minimizing user conflicts. Hard surfaces (asphalt and concrete) and coarse gravel can injure horse hooves, so loose or compacted dirt trails may be called for in selected locations.

There may be opportunities for east-west linear parks along certain arroyos, but this has not yet been studied in any great detail. Further analysis of arroyos based on geology and soil stability, vegetation, slopes, drainage patterns, etc. will identify suitable areas for such parks. More important, there is a need for an identified funding source so that open space and arroyo buffers may be acquired by the City and to ensure adequate maintenance and repairs are performed.

Buffers along arroyo systems can provide non-motorized transportation for commuting cyclists and pedestrians. Left: This mostly flat paved trail in Tucson follows the banks of the normally dry Santa Cruz River for 9.5 miles.
Photo: www.flickr.com/photos/lasertrimguy

According to the publication *Better! Cities & Towns*, total U.S. driving has dipped then leveled off in recent years, and per capita vehicle miles traveled (VMT) has steadily dropped since 2005. Per capita driving is down 8.75 percent, and is now at 1996 levels.[65] In other words, non-motorized transportation networks are becoming increasingly important. There are very few connections in Las Cruces between schools, neighborhoods, commuter bike routes and major commercial areas. Trails adjacent to arroyos are part of the Mesilla Valley Metropolitan Planning Organization's proposed trail plan and could easily be factored into new development proposals in an effort to provide additional connectivity for non-motorized transportation.

Passive recreation opportunities that incorporate arroyo systems can bring a boost to an area's economy through tourism, sporting events, and quality of life factors. Photos, clockwise from upper left: National Recreational Trails; BLM; Albuquerque Journal; Arizona Foothills Magazine.

The Economy and Quality of Life

Today the U.S. economy is dominated by high technology and service businesses selling knowledge and intellectual expertise. This economic sector is not tied to specific business locations or by the need for certain kinds of transportation facilities or raw materials. With more freedom to choose a site, businesses often select one with a high quality of life – including parks, aesthetics open space, and easy access to the outdoors – in order to compete for highly trained, in-demand workers.[66]

Companies frequently relocate where their top talent wants to live, and that is most often in places of natural beauty. When land is protected, the adjacent properties often increases in value, with homes selling for 10–20 percent more than comparable homes without access to such areas. A survey by the

[65] *Better! Cities & Towns,* Ithaca, NY 14851, June 2013. www.bettercities.net
[66] "Conservation: An Investment That Pays." Trust for Public Land, 2007, http://www.tpl.org

National Association of Realtors concludes that new homebuyers value trails and natural areas above any other amenity.[67]

As quality of life becomes an increasingly important factor for business location, there will be a greater demand for natural areas and passive recreation activities. Frederick Law Olmsted, designer of New York's Central Park, was one of the first people to suggest that parks could be paid for with increasing tax revenues that resulted from rising land values adjacent to the park. In fact, studies conducted by the Trust for Public Land have shown that investments in land conservation and open space return from $4 to $10 for every dollar invested.[68]

Conserved land and open space can provide opportunities for eco-tourism as well. The Bosque del Apache National Wildlife Refuge (NWR), which is located about 130 miles north of Las Cruces, is a protected area with unique wildlife viewing opportunities. Recreational visits generate over $4.5 million in tax revenue for the region. For every $1 of the NWR budget, there is a local economic effect of nearly $8.

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One method for estimating the economic value of open space and recreation areas that do not have a market value is through hedonic[69] pricing methods. This statistical approach is used to link a good traded in the marketplace (i.e. a house) with an environmental good (i.e. a nice view) that is not traded in the market. According to a survey done by the Robert Wood Johnson Foundation, various research studies conclude that the average household living half a mile from open space would be willing to pay $4,104 more for a home to live a quarter mile closer to the open space.[70] In addition, traditional neighborhood development concentrates neighborhood density, allowing room for large open space areas. Neighborhoods that feature open spaces, parks and greenbelts have been found to have higher home sale prices, enhanced marketability and often faster sales or leases than conventional development.[71]

Key research results found by the Robert Wood Johnson survey include:

- Open spaces such as parks and recreation areas can have a positive effect on nearby residential property values, and can lead to proportionately higher property tax revenues for local governments.
- In general, urban parks, natural areas and preserved open spaces showed positive effects on property values.
- Environmental protection, greenhouse gas reductions, and mental health benefits, as well as recreational benefits, should be considered as indirect effects.

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[67] The Economic and Tax-Base Benefits of Land Conservation, Land Trust Alliance Factsheet. www.landtrustalliance.org. 2003

[68] Ibid

[69] Hedonic pricing is a model identifying price factors according to the premise that price is determined both by internal characteristics of the good being sold and external factors affecting it. The most common example of the hedonic pricing method is in the housing market: the price of a property is determined by the characteristics of the house (size, appearance, features, condition) as well as the characteristics of the surrounding neighborhood (accessibility to schools and shopping, level of water and air pollution, value of other homes, etc.).

[70] The Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design, Active Living Research, Robert Wood Johnson Foundation, May 2010. www.activelivingresearch.org

[71] Ibid

- Natural area parks, on average, have the largest statistically significant effect on a home's sale price, holding all other factors constant. Value increase to homes located within 1,500 feet of the following types of parks:
    - Natural areas: $10,648
    - Golf courses: $8,849
    - Specialty parks: $5,657
    - Urban parks: $1,214[72]

It is often more cost-effective for a community to maintain open space, which can control flooding, filter water runoff, or help to mitigate air pollution, than to invest tax dollars in expensive infrastructure projects to achieve the same function.[73] For developers, these economic benefits can translate into reduced financial liability, faster sales and ultimately higher profits. The design elements of compact developments may also present cost savings. Watershed areas that are used as a form of natural drainage protection and open space also reduce construction and maintenance costs from stormwater drainage systems.

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Conservation easements have been a powerful tool to protect land from development by providing federal tax breaks for donating land development rights. With a conservation easement, a property owner gives some or all of the development rights on the property to a government agency or not-for-profit (there are more than 1,700 local land trusts), and receives a federal income tax deduction for the gift amounting to the difference in the value of the land before and after the easement is in place. The land owner still owns the land and can continue to use it.

The Enhanced Easement Incentive is a temporary measure that was originally enacted by Congress in 2006, and repeatedly extended. The most recent extension, which was in effect until the end of 2013, allowed a non-farmer donor to use a conservation donation deduction for up to 50% of his gross income in any year, up from the normal 30% that is a permanent part of the law. The temporary break also allowed a donor to carry forward any unused write-off for a full 15 years, instead of the normal five. Currently, there is a new measure before Congress which would make the incentive permanent and would allow modest-income landowners to receive significant tax deductions for donating conservation easements that permanently protect important natural or historic resources on their lands.

[72] , Active Living Research, Robert Wood Johnson Foundation, May 2010. http://activelivingresearch.org.
[73] "Conservation: An Investment That Pays," Kline, J., et al, 2009. Trust for Public Land, www.tpl.org

CHAPTER 5. GOALS AND POLICIES

We are fortunate to be able to enjoy the arroyos for passive recreation activities, wildlife viewing and other fresh air experiences. But it's important to remember that first and foremost, arroyos exist as natural stormwater conveyance systems and are an integral part of the desert ecosystem. In developing policy guidance for arroyo management, our goals must further systematic flood control and drainage functions, allow continuance of historic flows in arroyos, and protect arroyos in their natural state. If those things are done well, we can continue to enjoy open space experiences for years to come.

This chapter is divided into four sections. *Land Use* addresses overarching issues related to development and growth management. *Environment* focuses ways in which the land, vegetation and wildlife can be protected. *Community Facilities* suggests policies to increase the use of arroyo systems as community assets. *Utilities and Stormwater* looks at design standards for more effective and efficient stormwater management, including erosion control, sedimentation, and utilities installation and maintenance.

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Goals and Policies describe *what* should be accomplished; Actions explain *how* they will be carried out. The guiding actions to implement the goals and policies are listed in tables in Chapter 6, Administration and Implementation. Many of the policies in this plan are limited to arroyos that are not already privately owned or to arroyo areas that have not yet been developed. This will have to be determined on a case-by-case basis as individual arroyo characterization modeling is carried out. Those that may affect developed areas are limited to maintenance or mitigation issues, since flood control systems are already in place. Some of the policies below will require changes to existing codes, including LCMC Chapter 32 Design Standards and Chapter 37 Subdivisions. However, AMP policies provide guidance for decision making but are not regulatory. As is the case currently, public and private development projects follow codes that are in place at the time of development.

SECTION 1 -- LAND USE

Wise land use practices must balance the rights of landowners with the protection of our region's unique landscapes, arid vegetation and natural wildlife habitat. It is also critical that we increase our ability to manage arroyos holistically by understanding the potential impacts of our actions on a regional and watershed level. Development in the East Mesa area (and eventually on the West Mesa) should logically occur from downstream to upstream so that downstream infrastructure can be in place before upstream development occurs. It is also important that upstream flood control measures be engineered sufficiently so that downstream properties are not adversely affected.

The major arroyos that are most important to the City in the context of stormwater management and open space protection are the Alameda, Sandhill and Las Cruces Arroyos. As development moves further away from the city center, managing other arroyos properly will also become a priority. The Fillmore, Doña Ana, Moreno and Torgugas Arroyos extend into the ETZ and will be impacted as our community grows.

GOAL 1. Take a proactive approach to watershed management that takes into account existing drainage conditions as well as conditions affected by future development.

Policies:

1.1. Complete a detailed characterization of the main stems of each major arroyo so that it may be managed for optimum protection, stabilization and resiliency.

1.2. Work with governmental agencies (BLM, SLO, etc.) to retain or dedicate their arroyos and identified buffer areas to the City or County before public lands are sold for development.

1.3. Identify critical and sensitive environmental areas and contiguous open spaces and protect them from development using conservation easements, incentives, the Open Space (OS) zoning designation, etc.

1.4. Develop public/private partnerships to develop funding strategies for acquisition and maintenance of arroyo systems.

1.5. Clearly outline drainage or flood control modifications to arroyos in PUD concept plans and master plans, and include necessary details in subsequent development processes for review and approval purposes.

1.6. In areas that are in close proximity to arroyos, design and lay out lots and street locations in a way such that the natural characteristics of arroyos, such as vegetation and contours, are utilized. Site specific plans that address these issues rather than a standard design often results in a safer, more cost effective result.

1.7. In new development proposals include intended pedestrian, bicycle and equestrian connections between arroyos, thoroughfares and existing developments.

1.8. Allow green infrastructure techniques in development proposals as a way to manage storm water before it reaches the arroyos.

1.9. Increase the availability of reclaimed (purple pipe) water that could be used for establishing and supplementing native vegetation adjacent to arroyos.

1.10. Identify areas adjacent to arroyos or sections of arroyos that may be suitable for linear parks, trails or scenic corridors and provide incentives to create them.

GOAL 2. Improve the safety of the flood control dams and restore native vegetation in the storage pool areas.

Policies:

2.1. Evaluate conditions of Sandhill, Villa Mora and Las Cruces flood control dams and prioritize them for necessary mitigation, such as seepage and slope stability, pool area and spillway capacity of each dam, etc., and identify responsible City departments for these actions.

2.2. Complete appropriate re-vegetation with Chihuahuan Desert native grasses following any dam rehabilitation or maintenance activities that disturb existing vegetation.

2.3. In development proposals downstream of flood control dams, include an analysis of dam effectiveness and potential flooding impacts to that development.

2.4. Support a regional stormwater management strategy that fulfills the programs of all entities and participate as a regional partner in efforts to mitigate problems associated with improving dam functionality.

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2.5. Ensure that development, zoning, and land use changes do not impede flood control dam maintenance or operations.

GOAL 3. Improve road crossing infrastructure to maximize drainage function

Policies:

3.1. Design and/or retrofit existing arroyo crossings to limit or prevent a hydraulic constriction/bottleneck under present conditions and for potential flows under future hydrologic conditions. Failure to do so could lead to incision problems and hazards to adjacent infrastructure and property improvements.

3.2. Make maximum use of existing infrastructure and previously developed road crossings to minimize encroachment into natural areas.

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SECTION 2 -- ENVIRONMENT

Many opportunities exist for environmental restoration of riparian ecosystems on the East and West Mesas. While it may be unrealistic to set goals to restore developed areas to historic riparian and grassland ecosystems, it is possible to make significant strides in that direction. Desert riparian communities that will survive with surface water flows along arroyos can be restored within the watershed by various erosion control and arroyo stabilization techniques. Also, there are opportunities for environmental restoration at the dam sites in the watershed.[74] Through sound development standards, new development can adapt to existing natural environments, topography, soils, vegetation, geology, and hydrology so that fragile land forms, natural wildlife habitat and wildlife connectivity are protected.

GOAL 4: Protect and maintain natural vegetation within arroyo systems and mitigate damage that may result from development.

Policies:

4.1. Without compromising engineering design standards, promote flexibility in planning and landscaping development and utility installations that propose to retain the natural characteristics of the terrain or preserve undisturbed tributaries that feed major arroyo corridors.

4.2. When constructing and installing utility components, survey existing vegetation in arroyos and design utility installations to disturb as little vegetation as possible.

4.3. Replace vegetation lost during construction by reseeding with Chihuahuan Desert native vegetation following the requirements in NPDES 9.4.[75]

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[74] ACOE East Mesa Watershed Study 2007

[75] Construction permitees in New Mexico are required to follow section 9.4. of the NPDES General Permit for Discharges from Construction Activities, which states that operators have additional time – up to three years – to establish a uniform perennial vegetative cover with a density of 70 percent of the native background vegetative cover for all unpaved areas and areas not covered by permanent structures. See EPA Construction General Permit, http://cfpub.epa.gov/npdes/stormwater/cgp.cfm

GOAL 5: Manage arroyos to retain wildlife corridors.

Policies:

5.1. Increase valuable desert wildlife habitat by evaluating areas within the watersheds where native plant restoration is feasible.

5.2. Identify and map wildlife corridors so they may be protected from construction activities.

5.3. No fencing or walls may obstruct free flow of waters or debris.

SECTION 3 -- COMMUNITY FACILITIES

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Strengthening arroyo systems as a community asset can improve quality of life and bolster our economy. Las Cruces' natural areas attract tourists and new residents to the community. In addition, arroyos already provide occasions for outdoor recreation and non-motorized transportation for current residents. But it is important that in doing so, the privacy and rights of residents living adjacent to the arroyos are respected. Proper design of parks, trails, trail amenities, connectivity, equestrian facilities, street crossings, parking, signage, etc. will result in opportunities that meet the needs of all users. The Mesilla Valley Metropolitan Planning Organization (MPO) includes a Trail Plan map in their long-range transportation plan, Transport 2040. Policies in the Arroyo Management should complement and support the MPO's goals.

GOAL 6: Minimize impacts created by development and human activities to realize the full potential of arroyo systems as a community and economic asset.

Policies:

6.1. Create regional development and conservation guidelines for arroyos that cross jurisdictional boundaries.

6.2. Identify and map those arroyos and open spaces that might serve as natural connections to other public properties.

6.3. Promote neighborhood and subdivision designs that incorporate arroyos as neighborhood amenities. These may include such things as street alignments that are placed between developed areas and arroyos; open space corridors, linear parks, trails, etc.

6.4. Put forth a Quality of Life initiative to help fund community amenities such as open space acquisition.

6.5. Use adopted park impact fees or development waivers as incentives to developers to designate open space, trails and connectivity, or a linear park on a case-by-case basis.

6.6. Work with other City departments and other agencies to develop strategies to prevent illegal dumping in the arroyos, such as sign postings, Neighborhood Watch, Adopt-A-Spot, increased patrols by Codes Enforcement officers, etc.

6.7. Incorporate linear parks adjacent to arroyos into the City's Parks and Open Space Master Plan in areas where an arroyo is suitable for such a park.

6.8. Create a promotional outreach campaign about recreation opportunities, nature and open space experiences, etc. in the Las Cruces area.

GOAL 7: Achieve the goals of the MPO Trail Plan to create a continuous system of regional trails that integrates and connects arroyo systems.

Policies:

7.1. Working from the proposed trails mapped in the MPO Trail Plan, identify areas where arroyo trails may be located.

7.2. Provide adequate distance from residential development to protect privacy of property owners and from roadways to provide safe pedestrian and bicycle passage.

7.3. Construct trails outside the designated 100-year flood zone boundary on an arroyo.

7.4. Update MPO Trail Plan to improve connectivity of trails between arroyos, parks and other public open spaces, such as SLO and BLM land.

7.5. Identify potential trail locations that would be appropriate for accessibility and compliance with ADA standards.

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GOAL 8: Work with the Mesilla Valley MPO to create design guidelines that ensure trails suit the characteristics of the arroyo, provide maximum usefulness and address pedestrian, cyclist and equestrian safety.

Policies:

8.1. Develop standards in the LCMC Chapter 32 Design Standards for arroyo trails according to the characteristics of the arroyo and its available buffer area.

8.2. Design arroyo crossings to include appropriate measures such as signage, push button signals or other features that will maximize safety, access and mobility.

8.3. Where applicable during the development design process, meet with adjacent neighborhoods to discuss appropriate trail amenities for pedestrians, bicycles and equestrians.

8.4. Where possible, locate parking, trail heads and amenities in such a way as to support a dual use such as postal cluster boxes, playgrounds, parks, etc.

8.5. In partnership with the MPO, develop standards for park, trail and facilities signage, route and wayfinding signage and an informational brochure identifying existing and planned trail facilities.

SECTION 4 – UTILITIES AND STORMWATER MANAGEMENT

Safe and effective engineering standards for flood control, utilities installation, storm water conveyance and water storage are important. But these designs should maintain the natural character of the arroyo and minimize impacts of development so the arroyos function optimally and natural terrain is not destroyed. This is also important to ensure historical drainage patterns are not altered.

The City promotes flexible design standards when channelizing and storing stormwater for development adjacent to designated arroyos that will enhance the natural arroyo system. It should be noted that the LCMC Chapter 34 (Drainage and Flood Control) may require more than minimum storm water standards if arroyos on a site to be developed or immediately downstream of the site show evidence of increased

flooding, accelerated erosion, channel erosion of sedimentation, as a direct result of conditions on the site. These additional requirements may include buffer zones, re-vegetation of highly eroded areas, and arroyo restoration or other erosion control measures within highly eroded channels.

GOAL 9: Create safe and effective engineering standards for flood control and conveyance while maintaining the natural character of the arroyo and achieving visual harmony.

Policies:

9.1. Keep arroyos in a natural or naturalistic condition to counteract erosion. Naturalistic treatments could include such things as native vegetation and channel stabilization using rock riprap, weirs, weirs, gabions, contouring, etc.

9.2. Do not alter a natural arroyo unless such a modification is shown to be without reasonable hazard and liability, and there are no adverse impacts to public and private infrastructure, habitats and open space. Altering a drainage path may create new and unpredictable flood responses.

9.3. Replace vegetation in areas that are disturbed during construction, in accordance to NPDES 9.4. This includes a well-established mixture of native grasses, forbs, and other ground cover to help reduce sediment movement.

9.4. In laying out adjacent street systems, keep drainage outfall structures to the minimum needed to maintain a naturalistic arroyo treatment.

9.5. Pursue innovative methods of funding storm water management practices. Special funding could include user fees, special taxation, tax incentives, grants, conservation easements, and Public or Private Improvement Districts.

GOAL 10: Minimize soil and slope instability, erosion, sedimentation and water run-off to protect water quality and the natural characteristics of the land.

Policies:

10.1. Use public education to raise awareness level of the general public and the construction/development community in regard to urban runoff, non-point source pollution and other watershed-related issues.

10.2. Strengthen the permitting and inspection process to improve compliance with the EPA NPDES MS4 permit and Construction General Permit

10.3. Do not discharge stormwater runoff directly into arroyos. Direct discharge into a settling pond, impoundment or other solution designed to stop or slow water before it reaches the arroyo. This will assist in bank stabilization by minimizing erosion and promoting growth of native vegetation.

10.4. Extend drainage structures completely into the arroyo bottom, extending to the arroyo flow line, and matching the natural terrain.

10.5. Confirm that a Notice of Intent (NOI) to the Environmental Protection Agency (EPA) has been submitted before issuing grading permits.

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10.6. Place fills in such a way that they do not cause encroachment upon arroyos or other natural drainage ways.

10.7. Use Best Management Practices (BMPs) related to NPDES compliance to reduce pollutants from storm water.

10.8. Apply credits to the FEMA/Community Rating System (CRS) program for those projects adopting the management practices in the CRS program plan. This will provide additional flood protection and cost savings.

GOAL 11: Improve the safety and efficiency of utilities installation to better protect the natural environment.

Policies:

11.1. Bury utilities to a depth as determined through a soil stability analysis and to meet requirements outlined in the City Utilities Standards. In some cases this may be deeper than the minimum standard.

11.2. Design utility crossings to minimize damage to flora and fauna and to minimize changes in surrounding natural grades.

11.3. Replace desert vegetation lost during utilities installation as per NPDES 9.4.

11.4. Provide erosion control measures for infrastructure built in arroyos.

11.5. Provide appropriate access provisions to infrastructure and other facilities in arroyos and along their buffers to provide for necessary operation and maintenance.

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CHAPTER 6. ADMINISTRATION AND IMPLEMENTATION

The City's comprehensive planning framework begins with broad goals defined in *Comprehensive Plan 2040*, and is referred to as "Level 1" within the framework. More detailed plans, Level 2, include community planning blueprints and neighborhood, corridor and technical plans. The Arroyo Management Plan (AMP) is considered a Level 2 technical plan. In order to accomplish goals and policies in these Level 2 plans, Actions are identified, some of which lead to regulations in our codes, such as the Zoning Code, Development Standards, Subdivision Code and other related chapters in the City's Municipal Code. Goals, Policies and Actions are defined as:

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> **Goals** represent an ideal future condition or long-term end state that the City strives to achieve, but which are not necessarily measurable.
> **Policies** are statements that guide action and imply clear commitment toward achieving or advancing a goal.
> **Actions** identify procedures, programs, or techniques City departments and/or other entities accomplish on a day-to-day basis that will make the policies and goals a reality.

The last step is in this process is implementation, during which most of the actions are carried out. Actions in the AMP involve changes to codes, strengthening enforcement of these codes, educating the public, and regulating the City's own practices in such a way that we meet or exceed the minimum requirements. In some cases, regulations and practices that are not already reflected as policies in the AMP will have to be added later as a plan amendment. In this way, policy and practice are consistent and support the same purpose. Listed below are actions that address goals in the Land Use, Environment, Community Facilities, and Utilities & Stormwater Management sections of Chapter 5. In most cases, cooperation among City departments, other governmental agencies and/or the private sector will be critical.

The actions noted below are intended to guide arroyo management and may need to be modified somewhat to reflect the realities of implementation. For example, some measures as written may simply be too expensive to implement or may conflict with existing regulations. In these cases, steps should be taken to remove barriers to implementation, i.e. secure funding, amend existing codes, etc.

As noted earlier, the City supports a regional stormwater management strategy and would participate as a regional partner in efforts to manage arroyo systems. It is important that we look broadly at arroyo systems at the watershed level, and then continue to characterize individual arroyos for specific management needs. This will require the participation and collaboration of many different public and private entities with land and natural resource management responsibilities. Development would then occur systematically and would be based on thorough physical and regulatory analyses of the arroyos and surrounding terrain.

LAND USE

GOAL 1. Take a proactive approach to watershed management that takes into account existing drainage conditions as well as conditions affected by future development.

Actions for Policies 1.1 – 1.10

It is important to understand the potential impacts of human actions on a regional and watershed perspective. By managing arroyo systems holistically – looking broadly at the watershed level – we can help to ensure that the full potential of arroyos as a community asset is realized and in doing so, maintain the desert's ecological health over time. Protecting arroyo systems and improving overall stormwater management begins by amending existing ordinances that would set parameters for these activities. Once amended, a checklist of reports, data or other appropriate information that should be submitted with development proposals ensures that these issues are addressed to the satisfaction of the City.

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ACTION	COLLABORATING PARTIES
To characterize individual arroyos, combine existing and new modeling work to include data about hydrology, land use, vegetation, wildlife, soil type, topography, drainage patterns, etc. This complete watershed model would be used to determine buffers, areas appropriate for linear parks, scenic corridors, and areas that are more susceptible to erosion that may require treatments beyond the minimum regulations. Measured laterally from the 100-year flood zone boundary, buffers would be determined based on the characteristics of the arroyo or its banks. For example, a buffer may include bands of indicator species of vegetation and small channels that are apparent outside the 100-year floodplain if the modeling data support those inclusions.	City of Las Cruces all appropriate departments
Carry out appropriate joint agreements to dedicate arroyo systems (arroyo + buffer) to the City of Las Cruces.	City of Las Cruces, NM State Land Office, Bureau of Land Management
Identify long-term funding sources and other strategies for land acquisition, maintenance and other activities. These may include such things as: • Land and Water Conservation Fund **(**LWCF**)** funding to acquire new lands and secure conservation easements on private lands. • General obligation bonds could be used for "Quality of Life" amenities including open space acquisition. Generally backed by the City and paid back through property taxes. • Special Assessment District (SAD) distributes the cost of a project to property owners who realize a direct benefit once the improvements are constructed. This could be used for storm drains, sanitary sewers, water service, roadways, sidewalks and other related public infrastructure.	CLC all appropriate departments

• Public Improvement Districts are similar to a SAD in that they provide a means to generate funds for construction and maintenance of public infrastructure. Cost of project is distributed to only those properties that gain a direct benefit. Different from SAD in that funds are placed in a fund that is managed by a board of directors. Increasing mil levy for Dona Ana County Flood Commission projects or reconsider the creation of the Las Cruces Metropolitan Flood Control Authority (LCMAFCA).Other federal funding sources for environmental protection.	
Map arroyos and proactively zone major arroyo systems as OS-NC to preserve them as open space.	CLC Community Development
Consider a City development pilot project that adheres to the goals and policies of the AMP to demonstrate the plan's implementation.	CLC all appropriate departments
Amend appropriate chapters of the LCMC to revise requirements for PUD and subdivision proposals to fulfill policies herein.	CLC all appropriate departments
Expand education program about project designs that minimize impact to water quality.	CLC all appropriate departments
Identify areas requiring erosion protection in development proposals and require designs for protective measures, as provided in UTILITIES & STORMWATER MANAGEMENT GOALS in Chapter 5	CLC all appropriate departments
Strengthen enforcement of NPDES Stormwater BMPs for Construction and Post-Construction.	CLC all appropriate departments
Create incentives for developments that zone arroyo buffers or larger contiguous areas of opens space as OS-NC.	CLC Community Development
Increase access to reclaimed water.	CLC Utilities

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GOAL 2. Improve the safety of the flood control dams and restore native vegetation in the storage pool areas.

Actions for Policies 2.1 – 2.5:

The initial purpose of East Mesa flood control dams, particularly the Alameda, North Fork, and South Fork Dams, was to provide localized flood and sediment control. These dams are at varying stages of effectiveness and currently serve, mainly, as sediment catch basins. According to the 2006 Storm Drain Master Plan, these three dams are serving to reduce peak discharge rates under both the 100- and 500-year storms. The dams do not have a major impact on the total volume of water that is delivered to each analysis point as they are designed as detention and not retention facilities; even so, the dams are still valuable for peak reduction and lagging.[76] Additionally, the conditions of the dams have probably changed somewhat since 2006. For example, the Bureau of Land Management has performed rehabilitation work on the Alameda Dam. Updating the dam condition and effectiveness reports may be called for.

[76] City of Las Cruces Storm Drain Master Plan, Section 4, Analysis of the Dams in the East Mesa Watershed, Bohannan Huston, Inc., 2006

There is an opportunity for improving dam safety and bringing them up to current safety standards. Additionally, there is an opportunity for environmental restoration features in the storage pool areas. Las Cruces can participate in a regional effort to address problems related to the flood control dams. But direct responsibilities and actions are limited to the Villa Mora, Las Cruces and Sandhill dams.

ACTION	COLLABORATING PARTIES
Consider City membership in the South-Central New Mexico Storm Water Management Coalition support watershed-level planning for arroyo management. For dams outside the jurisdiction of the City of Las Cruces, the City encourages participating entities to re-evaluate dam effectiveness and make appropriate decisions about mitigation measures, such as breaching, installing hydraulic structures, rehabilitating, etc. This may include vegetative restoration if disturbed during dam maintenance or rehabilitation. For the City's dams and for dams outside the jurisdiction of the City of Las Cruces, the following measures are suggested: • Install hydraulic structures upstream and increase capacities of those dams identified by the Army Corps of Engineers for such measures. • Utilize the full catalog of storm water management, erosion control, and revegetation options for dam rehabilitation before making the decision to breach those dams which have been identified for such actions. • Implement appropriate restoration measures in the upper reaches of the watersheds to slow flow and decrease sediment loads that reach the dams.	All entities participating in regional stormwater management.

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GOAL 3. Improve road crossing infrastructure to maximize drainage function

Actions for Policies 3.1 – 3.2:

ACTION	COLLABORATING PARTIES
Amend Design Standards to require strategies to prevent erosion, sedimentation and constriction problems under roadway crossings, such as installing sediment catch basins upstream of the culvert, debris barriers, energy dissipaters, etc.	City of Las Cruces all appropriate departments
Identify and secure increased funding for regular maintenance of such infrastructure.	

ENVIRONMENT

GOAL 4: Protect and maintain natural habitat & wildlife connectivity within arroyo systems to the greatest extent possible and mitigate damage that may result from development.

Goal 5: Manage arroyos to retain wildlife corridors.

Actions for Policies 4.1 – 5.3:

ACTION	COLLABORATING PARTIES
Amend Landscape Design Standards to include revegetation requirements as per NPDES General Construction Permit Section 9.4., including a list of acceptable/desirable species for revegetation in and/or adjacent to arroyos and dam ponding areas.	CLC all appropriate departments
Work with the local Soil and Water Conservation District to offer programs to encourage planting native vegetation and trees. Outreach to developers and homeowners would demonstrate the importance of establishing vegetation and other measures to control soil erosion.	CLC all appropriate departments
Work with NMSU, U.S. Fish & Wildlife and/or other appropriate organizations to begin a wildlife corridor database project.	CLC, NMSU, USFW, etc.

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COMMUNITY FACILITIES

GOAL 6: Minimize impacts created by development and human activities to realize the full potential of arroyo systems as a community and economic asset.

Actions for Policies 6.1 – 6.8:

Since these areas are managed by private and public sector parties, actions that will maximize the public value of arroyo systems and open space must satisfy the policies and needs of all parties. Providing incentives, securing additional funding sources and creating partnership agreements are just some of the ways this can be achieved.

ACTION	COLLABORATING PARTIES
Work with appropriate agencies to establish regional conservation guidelines within city limits and the ETZ area.	CLC all appropriate departments, Doña Ana County (including Flood Commission), SLO, BLM, NMSU, etc.
Identify and map existing and potential open space linkages and zone as OS-NC.	CLC all appropriate departments

Amend appropriate codes to allow transfer of development rights.	CLC all appropriate departments
Intensify Neighborhood Watch, Adopt-A-Spot, and other anti-dumping programs in areas where illegal activity is frequent.	CLC Police (Codes Enforcement)
Advertise local transfer stations and county collection centers to promote proper disposal of waste and reduce trash dumping in arroyos and other open spaces.	CLC all appropriate departments, Doña Ana County
Using the arroyo characterization model, develop criteria to define a linear park and identify arroyo systems suitable for such parks.	CLC all appropriate departments

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GOAL 7: Working from the MPO Trail Plan, create a plan for a continuous system of regional trails that integrates and connects arroyo systems.

GOAL 8: Create design guidelines for trails and trail crossings to ensure that the trails suit the characteristics of the arroyo, provide maximum usefulness and address pedestrian, cyclist and equestrian safety.

Actions for Policies 7.1 – 8.5:

Connecting isolated pockets of open space to each other and to existing parks, trails and schools will expand the potential of arroyos systems as a public asset. While some arroyo systems may be perfectly suited for a multi-use trail, others may not due to lack of soil stability or sufficient buffer distances. Trails and trail crossings must be designed according to the type of trail desired and the characteristics of individual arroyos.

ACTION	COLLABORATING PARTIES
Amend Design Standards to reflect policies 7.1 through 8.7. regarding landscaping, trails, trail crossings and trail heads that will meet the needs of bicyclists and equestrians as well as pedestrians.	CLC Community Development, Public Works (Facilities), and Parks
Identify appropriate locations for multi-use trails (accessible) and include them in next updates of the Parks & Recreation Master Plan and MPO Transport 2040.	MVMPO, CLC Community Development, Parks, Public Works (Facilities), GIS

UTILITIES AND STORMWATER MANAGEMENT

GOAL 9: Create safe and effective engineering standards for flood control and conveyance while maintaining the natural character of the arroyo and achieving visual harmony.

Actions for Policies 9.1 – 9.5:

These actions are intended to minimize the visual impacts of stormwater management structures adjacent to and in the arroyos and protect the natural landscape as much as possible. While it may first appear difficult or expensive to carry out these methods, most of them are techniques that are already used extensively and will only require small changes.

ACTION	COLLABORATING PARTIES
Participate in the creation of a regional stormwater utility – an organization complete with its own revenue source that collects, treats and disposes of stormwater. (Legislation to enable the establishment of the Las Cruces Metropolitan Flood Control Authority (LCMAFCA) was passed in XXXX but the Authority was never formed.)	City of Las Cruces and all entities involved in stormwater management and flood control in the plan area.
Consistently follow and enforce Storm Water Management Ordinance requirements.	CLC all appropriate departments
Amend Chapter 32 Design Standards and other relevant codes to reflect policies above.	CLC all appropriate departments
Improve review and inspection of all construction projects, including CLC-initiated projects, for compliance with the MS4 Permit, specifically PART 5 Storm Water Management Program (SWMP).	CLC all appropriate departments

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GOAL 10: Minimize soil and slope instability, erosion, sedimentation and water run-off to protect water quality and the natural characteristics of the land.

Actions for Policies 10.1 – 10.8:

ACTION	COLLABORATING PARTIES
Amend development standards in Chapter 32 to create maximums for the amounts and types of cut and fill activity allowed adjacent to and surrounding identified arroyos systems and drainage facilities.	City of Las Cruces all appropriate departments
Amend Design Standards to adhere more closely to National Menu of Best Management Practices (BMPs) to further reduce pollution from stormwater. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm	City of Las Cruces all appropriate departments

GOAL 11: Improve the safety and efficiency of utilities installation to better protect the natural environment.

Actions for Policies 11.1 – 11.5:

ACTION	COLLABORATING PARTIES
Create improved methods for constructing utilities, taking into account proper scour analysis, loss of service risk, and minimizing aesthetic impacts to the arroyos.	City of Las Cruces all appropriate departments
Require revegetation of areas where native vegetation is disturbed, as per NPDES General Construction Permit Section 9.4.	City of Las Cruces all appropriate departments
Develop handbook of appropriate modifications to arroyos for situations in which minimally containing the arroyo would be the most appropriate option. For example, illustrations of acceptable structures, materials, etc.	City of Las Cruces all appropriate departments
Engage the Soil and Water Conservation District to offer programs to encourage planting native vegetation and trees. Outreach to developers and homeowners would demonstrate the potential for soil erosion in the region and the importance of establishing vegetation and other measures to control soil erosion.	CLC Community Development, Public Works (Facilities), Utilities and Parks
Develop an erosion and sedimentation design guide for use by the City, developers and property owners.	CLC Public Works
Require minimum LID techniques in all development proposals and provide incentives for those proposals that exceed minimums.	CLC Public Works, Parks, Community Development

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CHAPTER 7. CONCLUSIONS

Since 1956, City of Las Cruces planning documents have called for an approach to development and stormwater management that preserves arroyos in their natural state. In recent years, Comprehensive Plan 2040, the Storm Water Management Plan, Transport 2040, the Parks and Recreation Master Plan, and other related plans adopted by the City have included policies to guide both public and private efforts. The Comprehensive Plan 2040 Future Concept Map specifically calls for "conservation areas" consisting of areas of historical, cultural, environmental value or open areas that could become community assets and are worth conserving, such as arroyos.

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As development has increased, arroyos have been rerouted, channelized, or dammed to prevent or mitigate flood damage. In some cases, these actions were the only alternatives to protect downstream property. But in general, this has interrupted natural drainage function, wildlife connectivity and the propagation of vegetation, and have, in several instances, modified historic drainage in negative ways.

Specifically in arroyo environments, development designs can be implemented to maintain the natural character of the arroyo. It is also important to maintain arroyos to ensure historical drainage patterns adhere to water quality regulations administered by the U.S. Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES) permit program. In addition, arroyos can provide a variety of recreational opportunities.

Geographically, the AMP includes major arroyos on the East and West Mesas, undeveloped floodways, unnamed 100-year flood zones, including areas in the Extraterritorial Zone (ETZ), and largely native areas on the West Mesa escarpment, as called for in the 1992 Storm Water Management Policy Plan. Within this planning area, arroyos and the lands adjacent to them are owned by many parties, mainly the New Mexico State Land Office, U.S. Bureau of Reclamation, City of Las Cruces and numerous private owners. While some of the policies in the plan may guide maintenance efforts in already-developed areas, the plan is primarily intended as guiding policy for public and privately-owned lands that are undeveloped.

The AMP suggests utilizing "buffers" in certain instances where additional flood protection may be called for. The plan defines a buffer as an area adjacent to an arroyo where development may not occur or may be reduced in intensity. It would be measured laterally from the boundary of the 100-year flood zone. Over the arroyo's length, the buffer may vary, depending on the hydrology, natural vegetation, wildlife corridors, the slope of the sides of the arroyo, soil type, etc. Buffer distances could be determined using similar computer modeling software that is used to determine flood zone boundaries. Additional data could be integrated into the modeling, such as the presence of wildlife, pockets of vegetation outside the 100-year flood zone and other geographical or built features that may inform appropriate buffer locations and distances.

Identified buffer acreage could be dedicated to the City or withdrawn by the New Mexico State Land Office or U.S. Bureau of Land Management prior to selling acreage for development. If privately held, a buffer could take the form of a linear park, trail, or conservation easement, all of which could be offset by various incentives such as higher density farther away from the arroyo, federal tax break, or park credits

Although one may not think immediately of economic development when considering arroyo management, key research results found by a Robert Wood Johnson Foundation survey conclude that open space has a positive effect on residential property values and that environmental protection and the mental health benefits afforded by open space protection should be considered indirect positive effects. In addition, it is often more cost-effective for a community to maintain open space, which can control flooding, filter water runoff, or help to mitigate air pollution, than to invest tax dollars in expensive infrastructure projects to achieve the same function. For developers, these economic benefits can translate into reduced financial liability, faster sales and ultimately higher profits.

Planning for the possibility of more intense rain storms in the future, protecting vegetation and wildlife habitat, maintaining the flood control dams, and carrying out improved installation and maintenance of utility infrastructure are just some of the considerations that must be kept in mind when planning for future growth in our community. Requiring buffers in specific areas for added erosion protection, proactively zoning land as Open Space-Recreation (OS-R) and Open Space-Natural/Conservation (OS-NC), tightening compliance with stormwater management regulations, opting to go beyond the minimum requirements, and committing to Best Management Practices are a few changes that will further protect the health, safety and welfare of the general public. This integrated approach to development and open space preservation will prevent further damage to our open lands and improve the overall health of our environment.

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RESOURCES

EPA Stormwater Home Page -- This website contains technical and regulatory information about the NPDES stormwater program. It is organized according to the three types of regulated stormwater discharges – municipal separate storm sewer systems (MS4s), construction activities, and industrial activities. It also provides links to general stormwater topics and tools available, including Best Management Practices (BMP).
http://water.epa.gov/polwaste/npdes/stormwater/index.cfm

Using Smart Growth Techniques as Stormwater Best Management Practices
http://www.epa.gov/smartgrowth/pdf/sg_stormwater_BMP.pdf

Protecting Water Resources with Higher-Density Development – This report is intended for water quality professionals, communities, local governments, and state and regional planners who are grappling with protecting or enhancing their water resources while accommodating growing populations.
http://www.epa.gov/smartgrowth/pdf/protect_water_higher_density.pdf

Center for Watershed Protection -- The Center for Watershed Protection, Inc. is a 501(c)(3) non-profit organization dedicated to fostering responsible land and water management through applied research, direct assistance to communities, award-winning training, and access to a network of experienced professionals.
http://www.cwp.org/

The **Stormwater Manager's Resource Center** is designed specifically for stormwater practitioners, local government officials and others that need technical assistance on stormwater management issues. Created and maintained by the Center for Watershed Protection, the SMRC has everything you need to know about stormwater in a single site:
http://www.stormwatercenter.net/

Low Impact Development -- LID is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible.
http://water.epa.gov/polwaste/green/

Low Impact Development (LID) Urban Design Tools Website -- This site provides watershed managers with a new set of tools and techniques that can be used to meet regulatory and receiving water protection program goals for urban retrofits, re-development projects, and new development sites.
http://www.lid-stormwater.net/index.html

Green Infrastructure – GI generally refer to systems and practices that use or mimic natural processes to infiltrate, evapotranspirate (the return of water to the atmosphere either through evaporation or by plants), or reuse stormwater or runoff on the site where it is generated.
http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm

Municipal Separate Storm Sewer System (MS4) Main Page -- Stormwater runoff is commonly transported through a Municipal Separate Storm Sewer System (MS4), from which it is often discharged untreated into local water bodies such as the Rio Grande. To prevent harmful pollutants from being washed or dumped into an MS4, operators (in our case, the City of Las Cruces) must obtain a NPDES permit and develop a stormwater management program.
http://water.epa.gov/polwaste/npdes/stormwater/Municipal-Separate-Storm-Sewer-System-MS4-Main-Page.cfm

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