



GREEN INFRASTRUCTURE AND ITS BENEFITS

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September 18, 2014

- What is Green Infrastructure (GI)
- What are the benefits of implementing GI practices?
- What does GI look like?
- How is EPA involved with GI?
- Future plans and opportunities

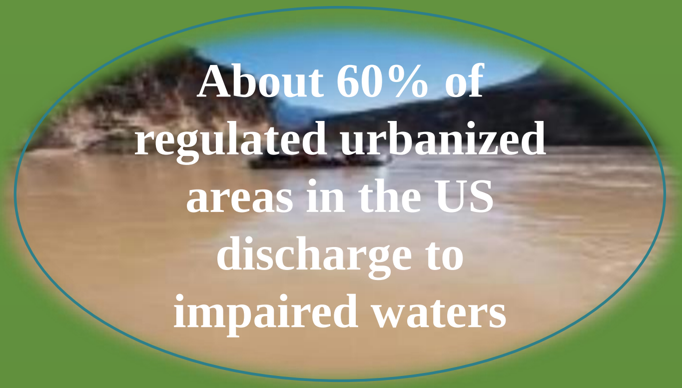
The Problem: Urban Runoff

- Stormwater runoff is a major cause of water pollution in urban areas.
- In most urban areas, stormwater is drained through engineered collection systems and discharged into nearby water bodies.
- The stormwater carries trash, bacteria, heavy metals, and other pollutants from the urban landscape, degrading the quality of the receiving waters.

Communities are facing many challenges

- Urban stormwater is a leading source of impairment
- Fast growing water quality concern
- Development often increases the amount of impervious cover in the landscape
- Small increases in impervious cover lead to significant impacts in receiving waters

Increases in impervious cover lead to increases in stormwater volumes and peaks



COMMUNITY CHALLENGES

Excess volume and velocity of stormwater lead to:

- Erosion
  - Steeper banks
  - Wider channels
  - Channel straightening
  - Shallow streams
- Flooding
- Soil deposits

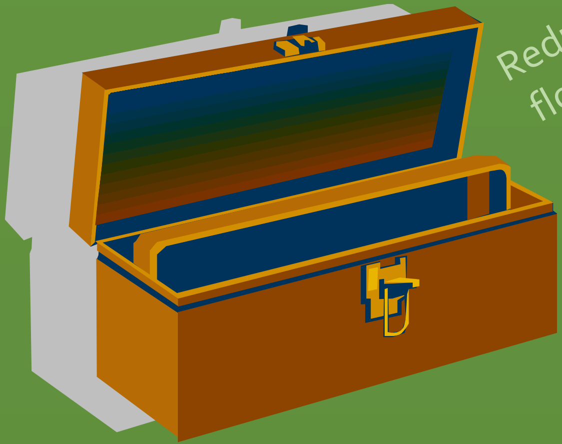
EPA Defines Green Infrastructure as:

- 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.

- Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water.

Green Infrastructure Solutions

An increasing number of communities are integrating green infrastructure practices in the design of the project that retain the stormwater volume through infiltration, evapotranspiration and rainwater harvesting.



Reducing flooding

Improving livability

Reducing small stream erosion

Enhancing water supplies

Reducing human health impacts

Reducing urban heat island effect

Enhancing resiliency

Reducing energy demands

Reducing combined sewer overflows

Improving air quality

What is Green Infrastructure?

System of natural and engineered components that nfiltrate, evaporate, transpirate capture, and reuse rainfall

- Rainwater harvest system
- Detention pond-Dry.
- Retention pond-wet (artificial wetlands)
- Bioretention basin-rain garden
- Media filters
- Porous/pervious pavement
- Vegetated swales, buffers, strips
- Green roof
- Infiltration basin
- Check dams
- Rock flumes

What are the Benefits of Implementing GI Practices?

- Water Quality
- Water Quantity
- Water Supply
- Potential Cost Savings
- Air Quality
- Energy and Climate Change
- Habitat and Wildlife
- Community

Green Infrastructure at Work

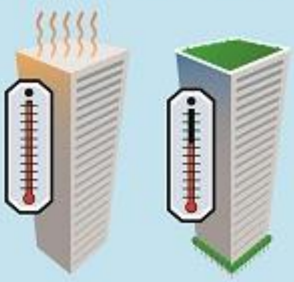
MANAGE FLOOD RISK

A study in Burnsville, MN showed a **93%** **reduction** in runoff volume after the installation of 17 rain gardens in a 5.3 acre neighborhood.[8]

KEEP WATER LOCAL

By capturing rain where it falls, urbanized Southern California and the San Francisco Bay area could boost water supplies by up to **200 billion gallons per year** – as much water as the city of Los Angeles uses annually.[6]

LOWER URBAN HEAT ISLAND EFFECTS



Studies show that green roofs can **reduce the energy** needed for cooling on the floor below the roof by more than **50%**[5]

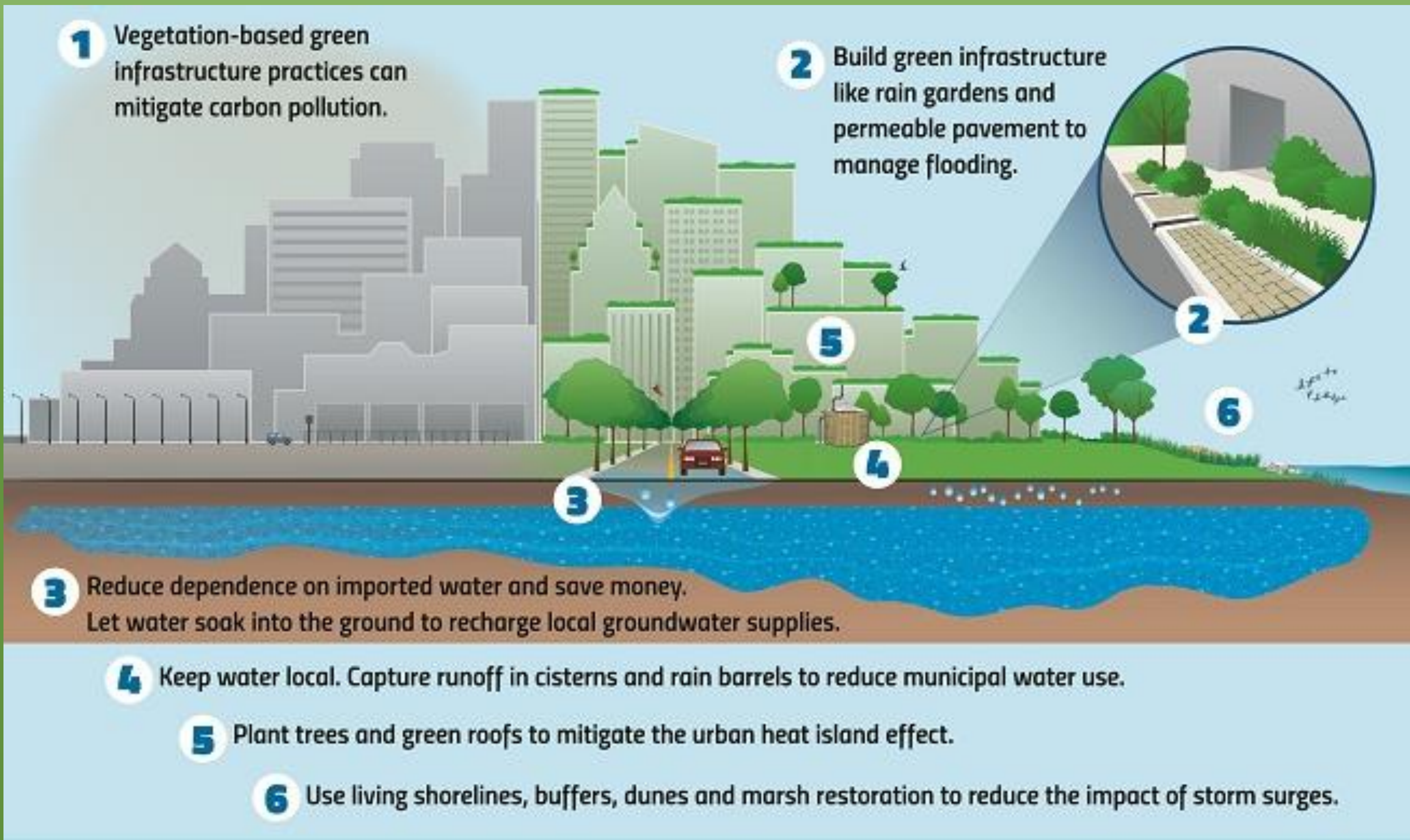
BUILD COASTAL RESILIENCY

Research suggests that **wave height can be reduced by 50%** within the first 16 feet of marsh and 95% after crossing 100 feet of marsh.[7]

USE LESS ENERGY

Give your air conditioner a rest! One young, healthy tree can produce cooling effects **equivalent to ten room-size air conditioners** operating 20 hours a day.[9]

Green Infrastructure Builds Resiliency



What does GI look like?

Rainwater Harvest System

- **Rainwater harvest (RWH) system collects and stores rainfall for later use.**
- **The RWH system is designed to slow and reduce runoff, as well as provide irrigation water, reduce water bills and conserve municipal water supplies, which may be particularly attractive in arid/semi-arid regions, where they can reduce demands on increasingly limited water supplies.**
- **The system includes either active storage of collected water in a receptacle or changing surface topography to slow/capture runoff to increase water storage for sediments**

Courtest of Y.Yang, Ph.D, EPA ORD

Detention Pond-Dry

- **Dry detention ponds (also known as dry ponds, extended detention basins) are ponds whose outlets have been designed to detain stormwater runoff for a minimum time of 24 hours to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool of water..**
- **They are reasonably effective in removing sediment and other pollutants associated with particulate matter.**
- **Dry detention ponds can play a key role in downstream channel protection if appropriated designed.**

Courtest of Y.Yang, Ph.D, EPA ORD

Retention Pond

- Retention ponds (RP), also known as wet retention ponds, wet extended detention ponds, wet basin, are constructed basins that have a permanent pool of water throughout the year (or at least throughout the wet season).
- RP are often for water quality treatment purpose, and they also could be used for temporary runoff storage.
- Ponds treat incoming stormwater runoff by allowing sediment particles to settle and algae to take up nutrients.
- In arid regions, it is difficult to justify the supplemental water needed to maintain a permanent pool because of the scarcity of water.

Bioretention (Rain Garden)

- **Bioretention (BR), or rain gardens, are landscaping features adapted to provide on-site treatment of stormwater runoff.**
- **They are commonly located in parking lot islands or within small pockets of residential land uses.**
- **Surface runoff is directed into shallow, landscaped depressions and these depressions are designed to incorporate many of the pollutant removal mechanisms that operate in forested ecosystems.**

Courtest of Y.Yang, Ph.D, EPA ORD

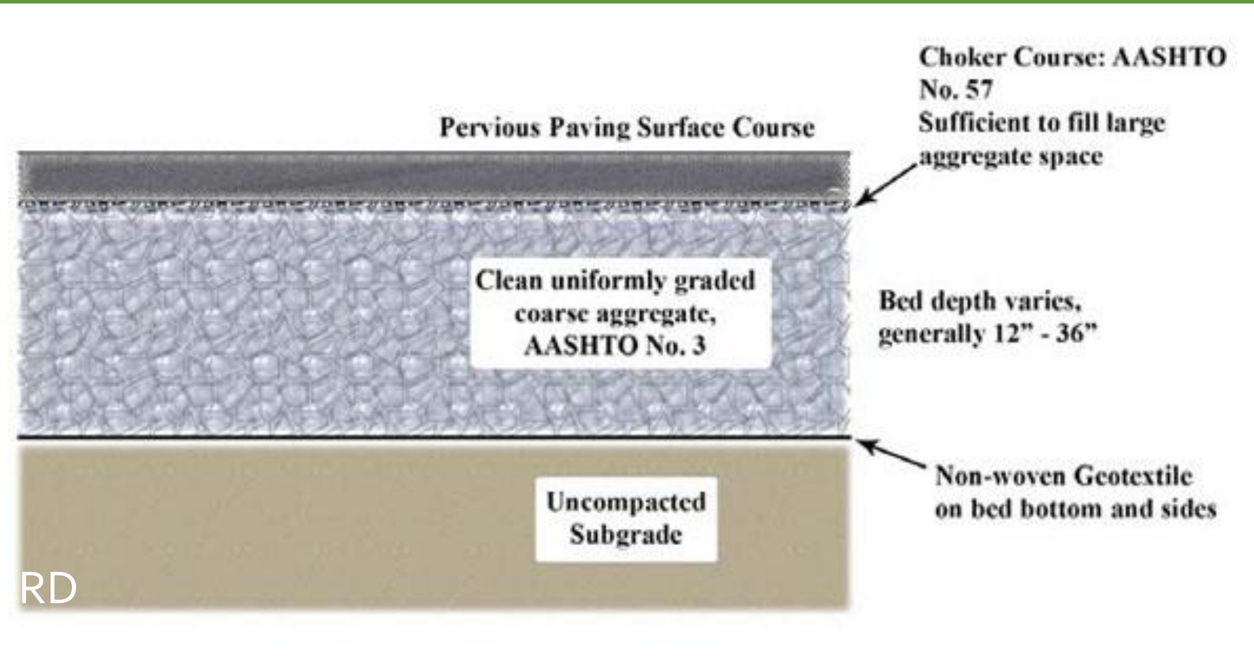
Media Filter

- Stormwater media filter (MF) system capture and temporarily store the stormwater and pass it through a filter bed of sand, organic matter, soil or other media.
- Filtered runoff may be collected and returned to the conveyance system, or allowed to partially exfiltrate into the soil.
- Filtering practices are generally adapted only to provide pollutant removal, although in exfilter designs, some ground water recharge can be provided.
- Sand filters are widely used and can be applied in most regions of the country and on most types of sites (USEPA, 2000a).

Courtest of Y.Yang, Ph.D, EPA ORD

Porous Pavement

- Porous pavement (PP) encompasses a variety of mediums, from porous concrete and asphalt to plastic grid systems and permeable interlocking concrete pavement (PICP).
- Stormwater media filter (MF) system capture and temporarily store the stormwater and pass it through a filter bed of sand, organic matter, soil or other media.
- Filtered runoff may be collected and returned to the conveyance system, or allowed to partially exfiltrate into the soil, or provide ground water recharge.
- They reduce runoff volumes at a considerably smaller cost than traditional storm drain systems (USEPA, 2000a).



Courtest of Y.Yang, Ph.D, EPA ORD

Vegetated Swale, Buffer, and Strip

- **Vegetated Swale (also known as grassed channel, biofilter, or bioswale) refers to a vegetated, open-channel management practices designed specifically to treat and attenuate stormwater runoff for a specified water quality volume (USEPA, 2000a).**
- **As stormwater runoff flows, it is treated through vegetation slowing the water to allow sedimentation, filtering through a subsoil matrix, or infiltration into the underlying soils. Swales are well suited for treating highway or residential road runoff because they are linear practices (USEPA, 2000a).**

Courtest of Y.Yang, Ph.D, EPA ORD

Green Roof

- A green roof is a building rooftop partially or completely covered with vegetation over high quality waterproof membranes to compensate for the vegetation that was removed when the building was constructed (USEPA 2000b).
- It can be effectively used to reduce stormwater runoff from commercial, industrial, and residential buildings; meanwhile, it was proved to help mitigate the urban "heat island" effect.

Don't try this at home!

Courtest of Y.Yang, Ph.D, EPA ORD

Infiltration Basin/Trench

- An infiltration basin/trench (also known as infiltration galley) is a rock-filled trench that receives stormwater runoff and has no outlet. This system is designed to infiltrate stormwater into the soil.
- Storm water runoff passes through some combination of pretreatment measures, such as a swale and detention basin, and into the trench. There, runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. (USEPA, 2000a).

Courtest of Y.Yang, Ph.D, EPA ORD

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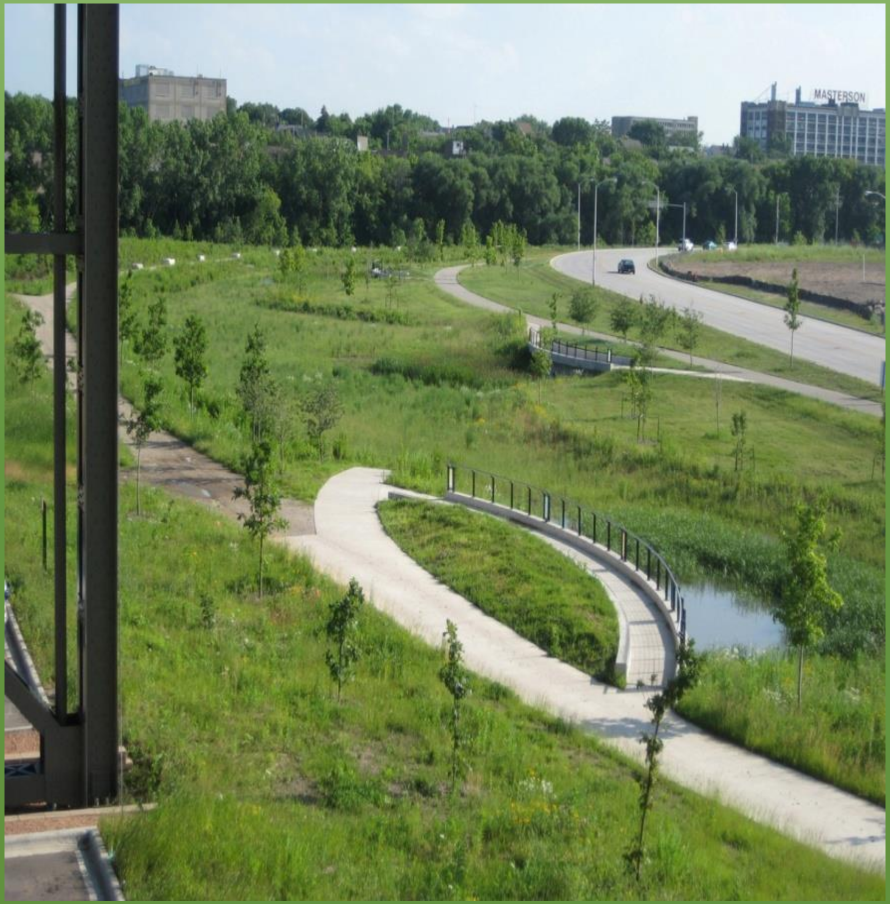
Examples- Large Scale

Milwaukee, WI

- Revitalized brownfield site now mitigates impacts of localized flooding up to the 100 year storm event
- 70 acre stormwater park provides a high-value community recreation asset



Menomonee River Stormwater Park

Examples- Large Scale

Examples

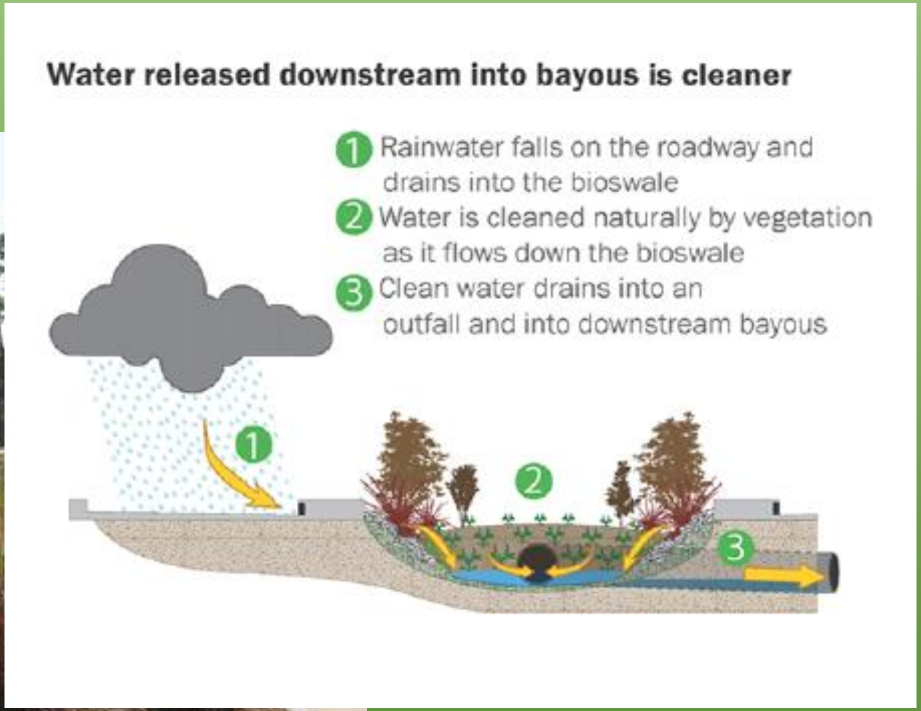
City of Austin

Newly planted right-of-way rain garden project on 10th and Rio Grande Avenue.

San Antonio River Authority Permeable Pavers

Downspout disconnection and permeable paving in the parking lot for the offices of the San Antonio River Authority.

Examples



<u>Bioswales</u>

<u>Birnamwood Drive Roadway Project</u>

Harris County, Texas

- First Low Impact Development (LID) roadway project in Texas
- 32-foot depressed median in the middle of a four-lane concrete boulevard
- Combines natural and engineered components to eliminate the need for off-site stormwater detention
- <u>Results</u>: cleaner downstream water quality & improved aesthetics

EXAMPLES

Green Roof

Botanical Research Institute of Texas (Ft. Worth, TX)

- 70,000 square-foot building includes a living roof with 6,000 plants
- The roof reduces rainwater runoff by absorbing rain that would usually end up in a storm drain
- Insulation from the plants also reduces cooling & heating needs, helping conserve energy (approx. $37,000 per year in savings

Examples

Rainwater Harvesting

Sante Fe Railyard Park and Plaza (Santa Fe, NM)

- 12.5 acre facility
- Catchment system collects rainwater from nearby building roofs
- Water is stored in underground tanks as well as a 35,000 gallon elevated water tower
- Water is used for irrigation throughout the park

EXAMPLES

University of Texas at Arlington

The Green at UTA College Park manages stormwater with the use of permeable pavements, bioswales, rain gardens and larger bioretention systems.

Examples

Rain Garden

Turkey Mountain Urban Wilderness Area (Tulsa, OK)

- Captures entire runoff from a 70-space parking lot
- Water flows through a rock flume, to slow flow and capture floatable debris, then into a native garden
- The garden catches sediment and filters pollutants
- Attached detention area to capture remaining runoff

EXAMPLES

<u>Pervious Concrete Demonstration</u>

West Yard Facility (Tulsa, OK)

- <u>Purpose</u>: produce a case study of pervious concrete in OK to address climate-specific performance issues
- Certified 20 people as pervious concrete technicians, dramatically increasing the number of technicians in OK
- The demonstration has lasted two years, and is monitored quarterly by Oklahoma State University graduate students

EXAMPLES

Retention pond/wet pond

City Park Wetlands

New Orleans, Louisiana

- Educational & interpretive wetland
- Provides temporary stormwater detention (6-12 in. of water at all times)
- Deep pools allow pollutants to settle
- Incorporates native wetland plants that tolerate inundation during large rain events

Green Infrastructure in the Border Region

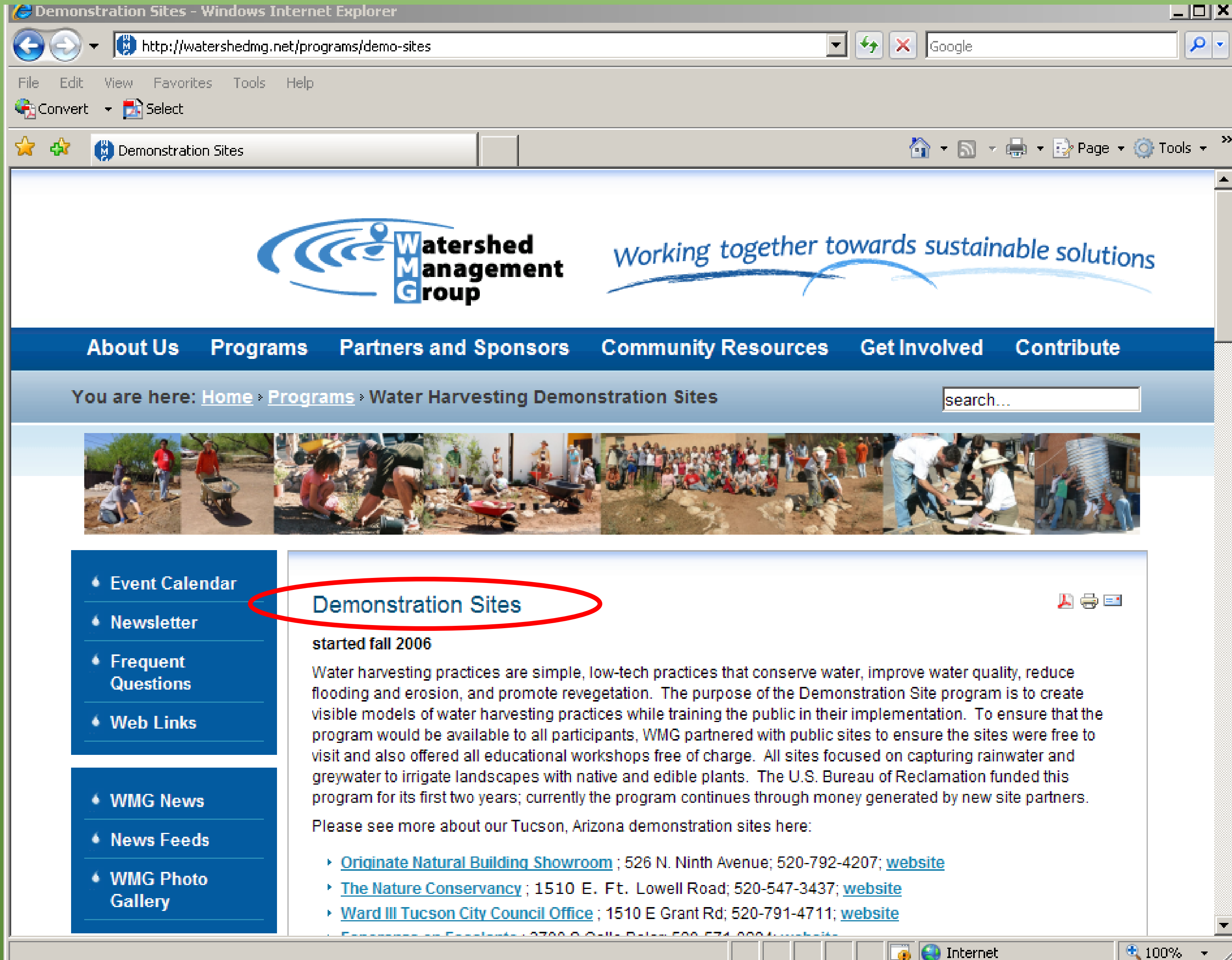
Enhancing Resiliency to Drought, Flooding, and Erosion

Tucson, AZ

- City of Tuscon partners with NGOs to install green infrastructure on roads and has adopted an internal policy that all public streets must integrate green streets concepts into initial designs.

Parking lot designed to infiltrate runoff in Tuscon, AZ
Photo Credit: Watershed Management Group

http://watershedmg.net/programs/demo-sites

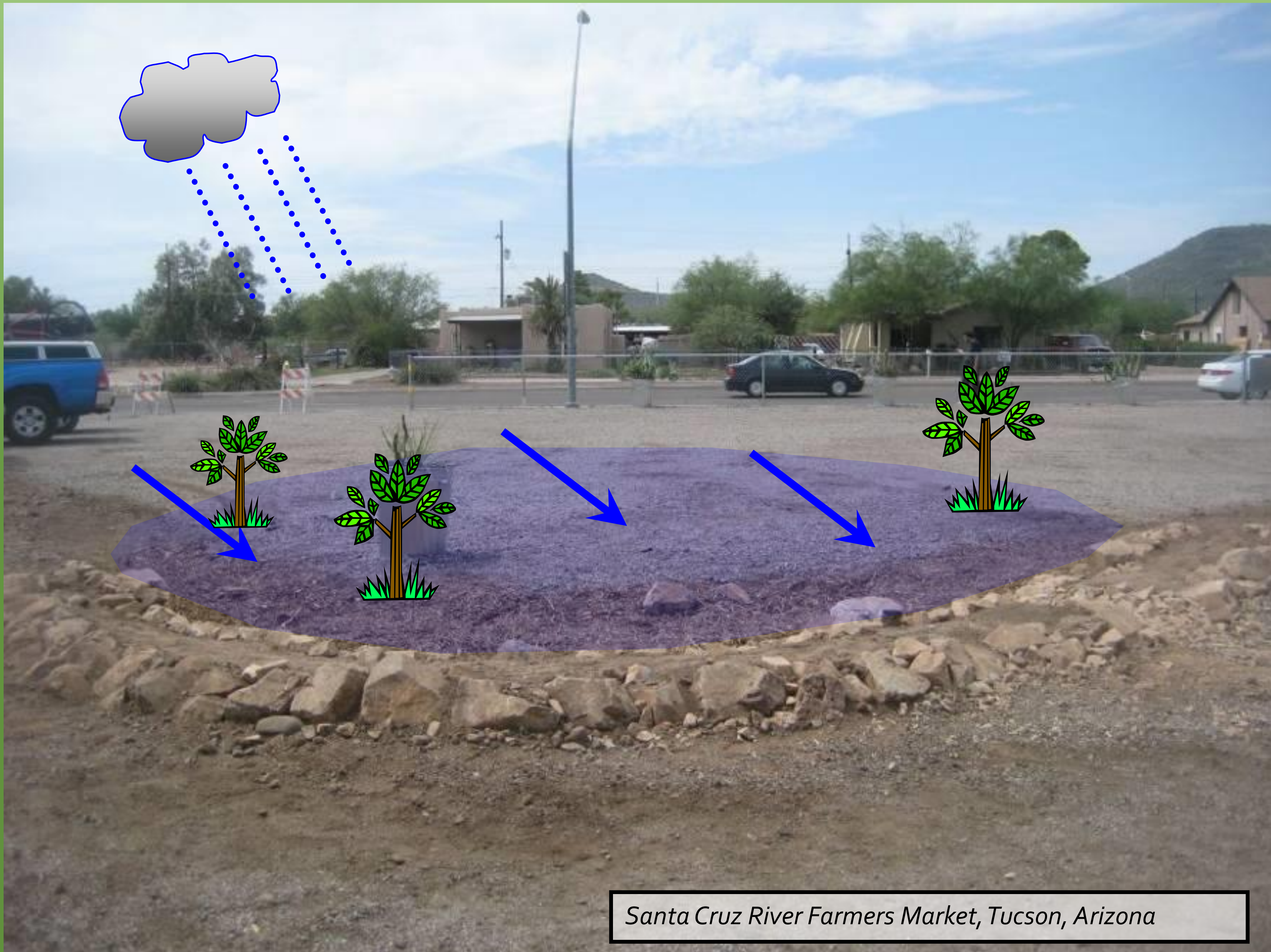


Trabajos Moviendo Tierra
Earthworks

Santa Cruz River Farmers Market, Tucson, Arizona

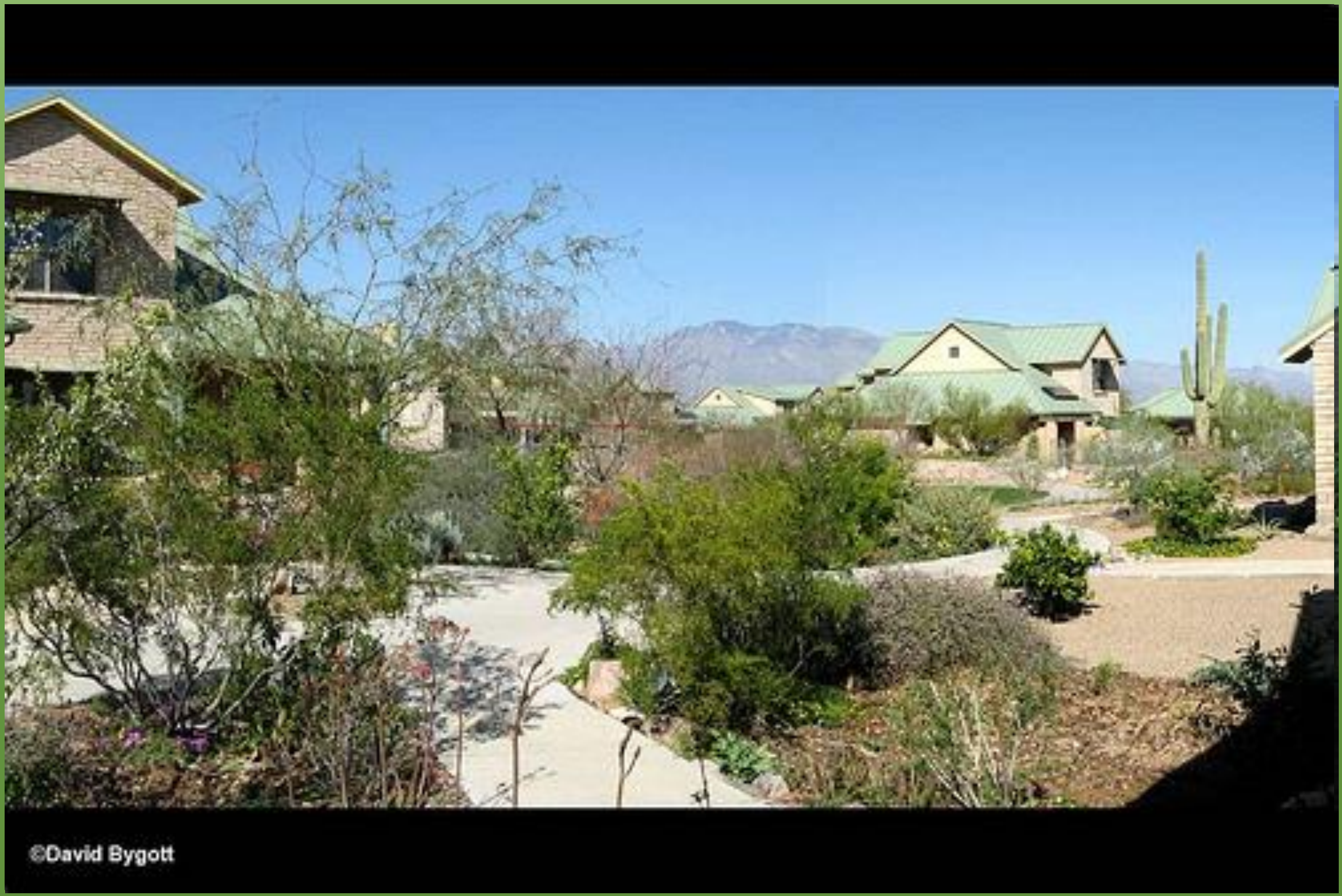



Santa Cruz River Farmers Market, Tucson, Arizona



Santa Cruz River Farmers Market, Tucson, Arizona

Milagro Co-Housing Community, Tucson, Arizona



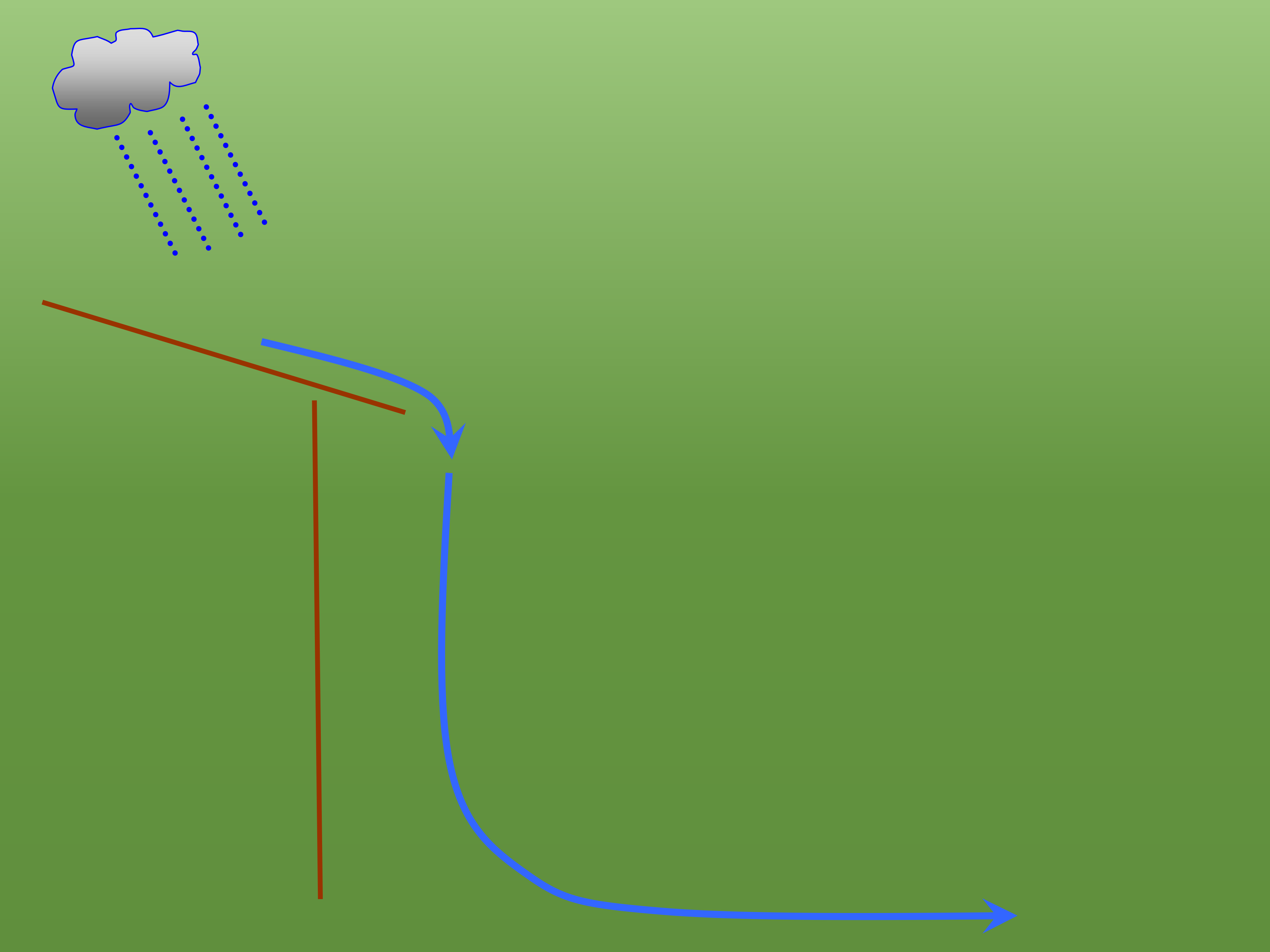
August, 2003 | April, 2004 | January, 2005 | August, 2006 | March, 2008

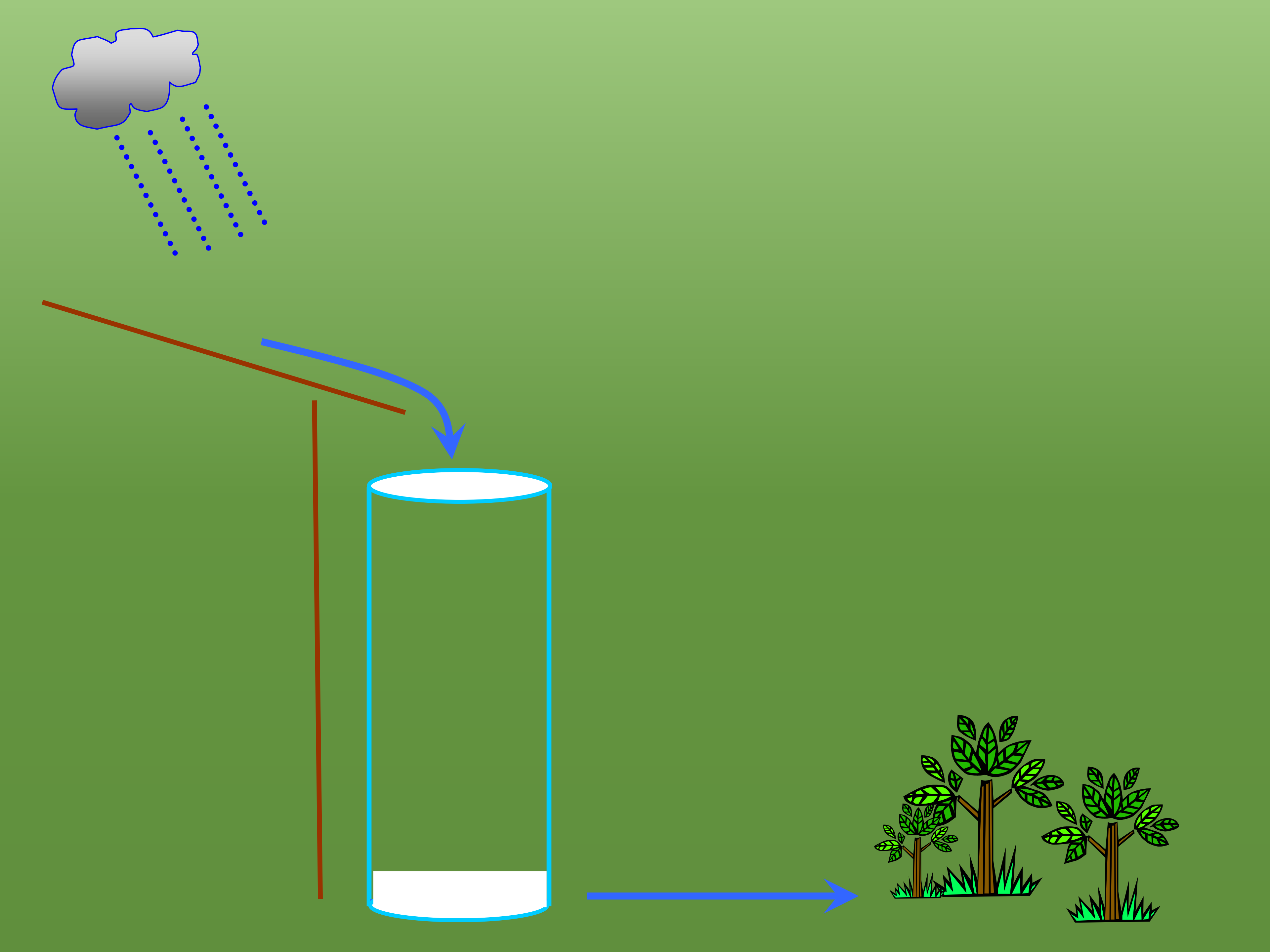
Photos courtesy of David Bygot

GI projects in AZ/SON border

(slides provided by Hans Huth, Hydrologist, Arizona Department of Environmental Quality, and water harvesting enthusiast)

Cuencas de Bioretencion
Bioretention Basins





Tucson Metropolitan Ministry and Family Services, Tucson, Arizona

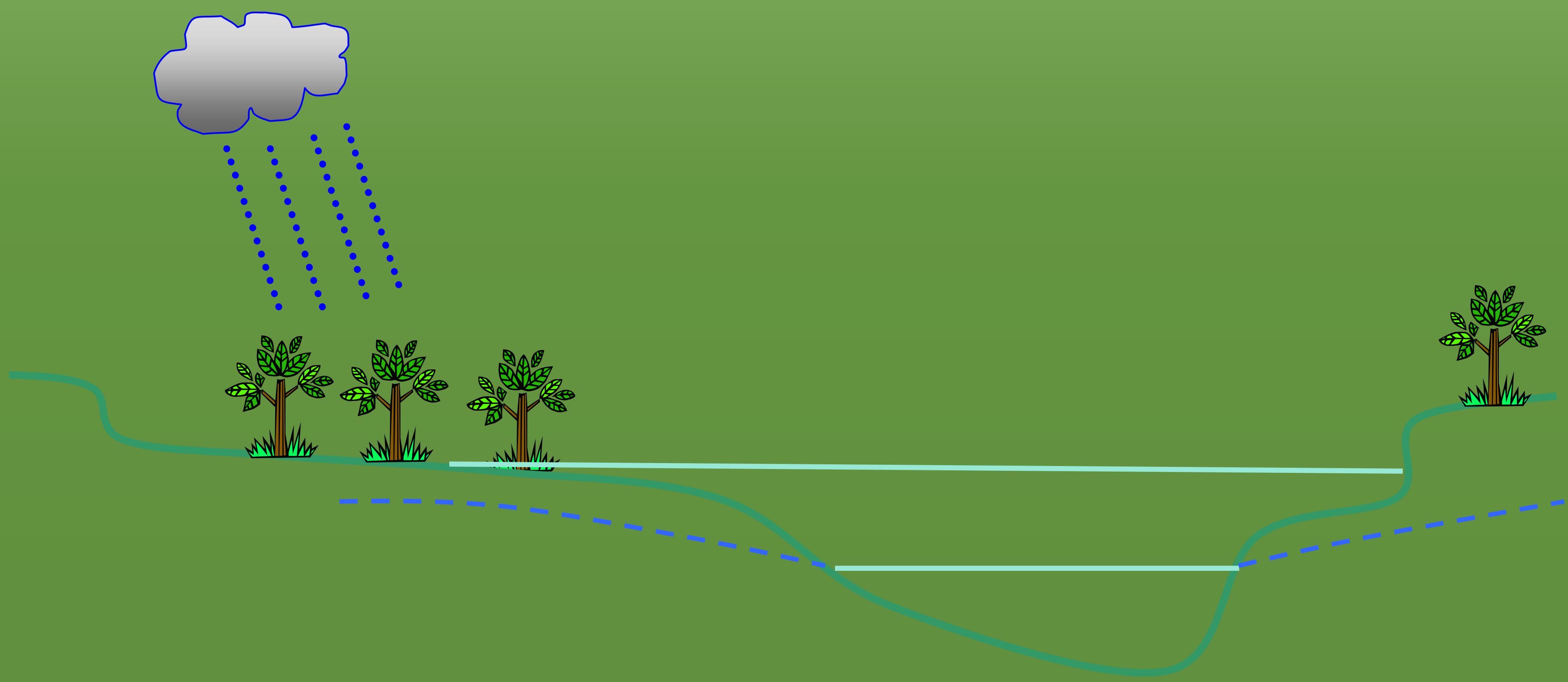
Private residence, Tucson, Arizona

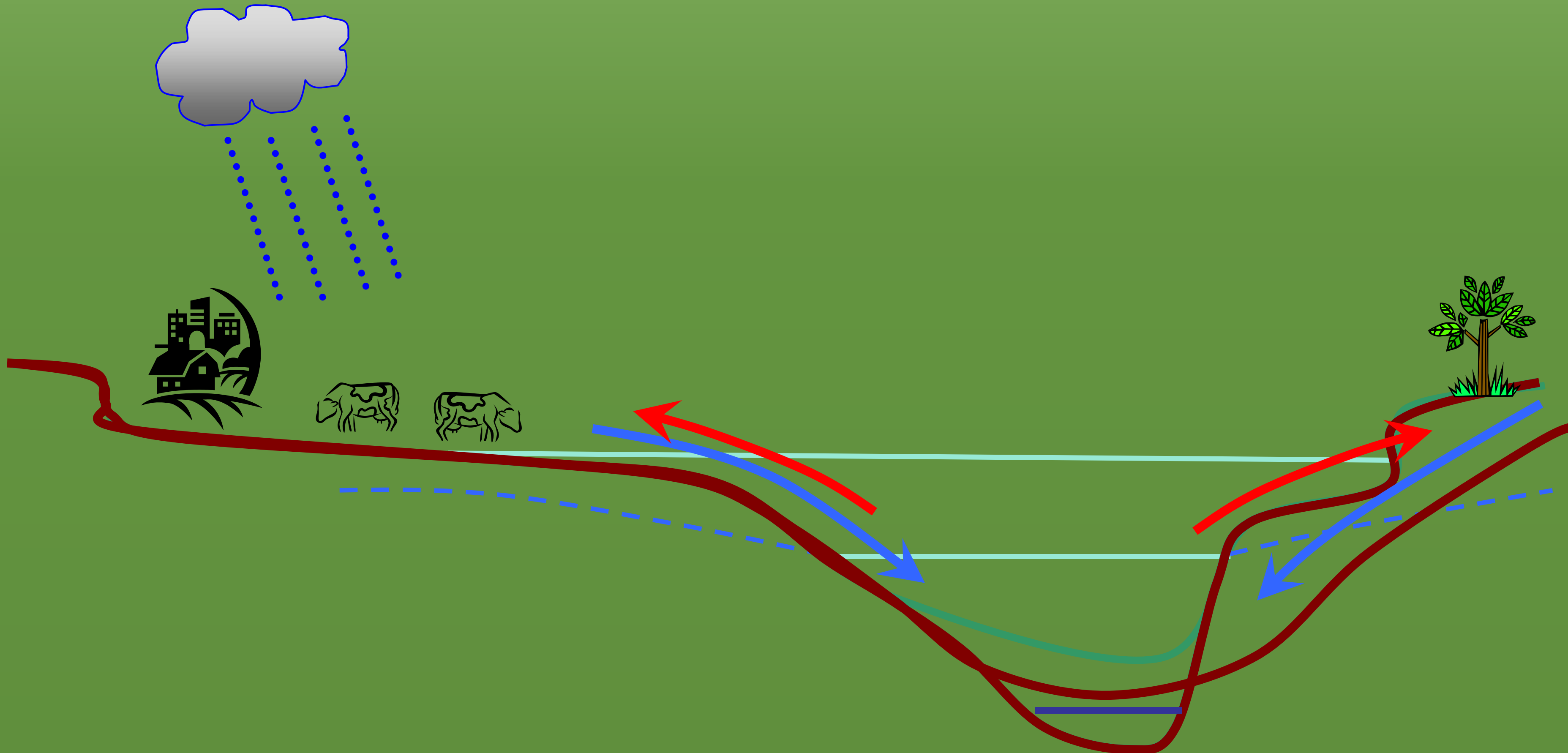
Private residence, Tucson, Arizona

Scott Street, Tucson, Arizona

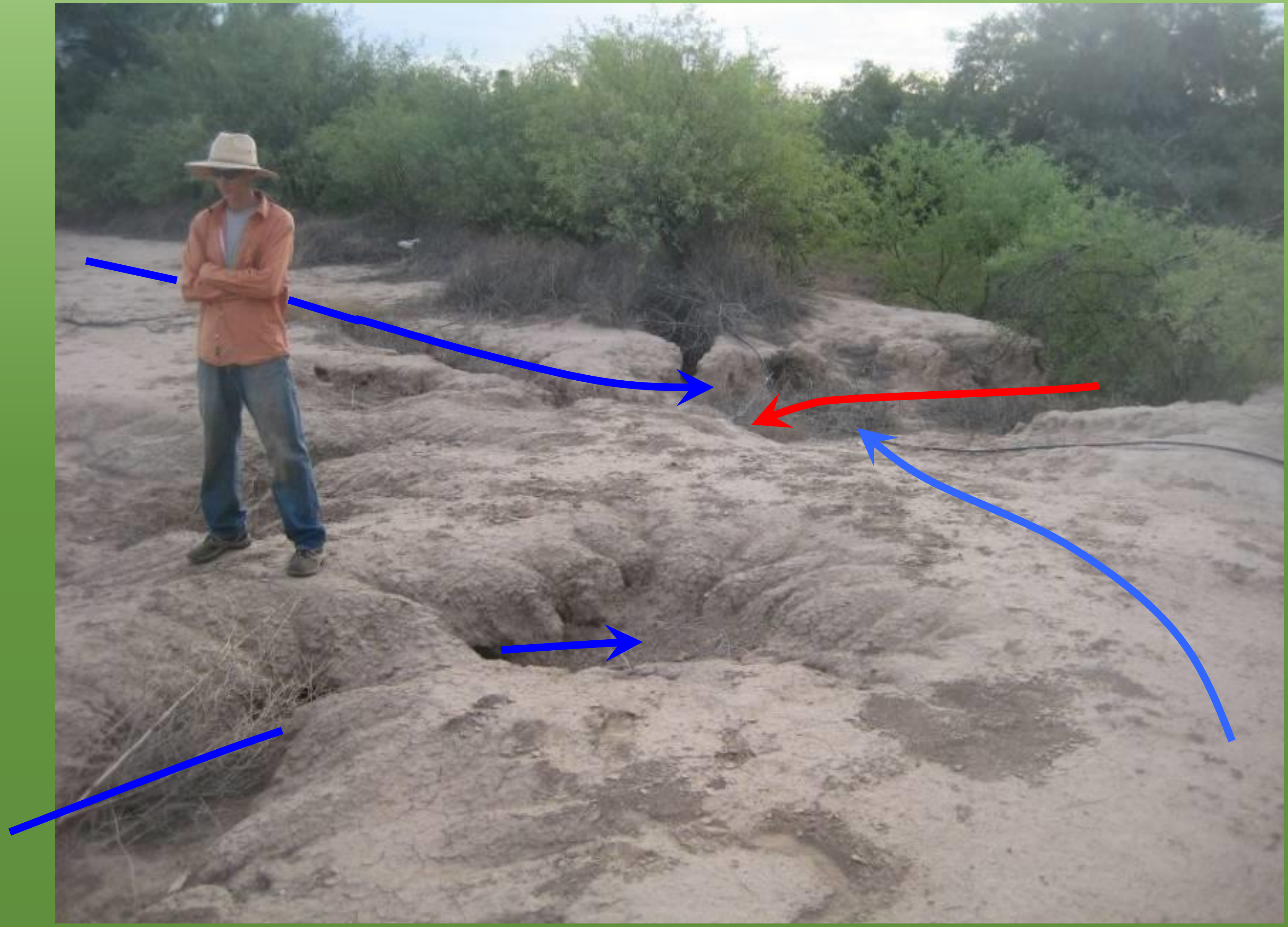

SUPER TARGET

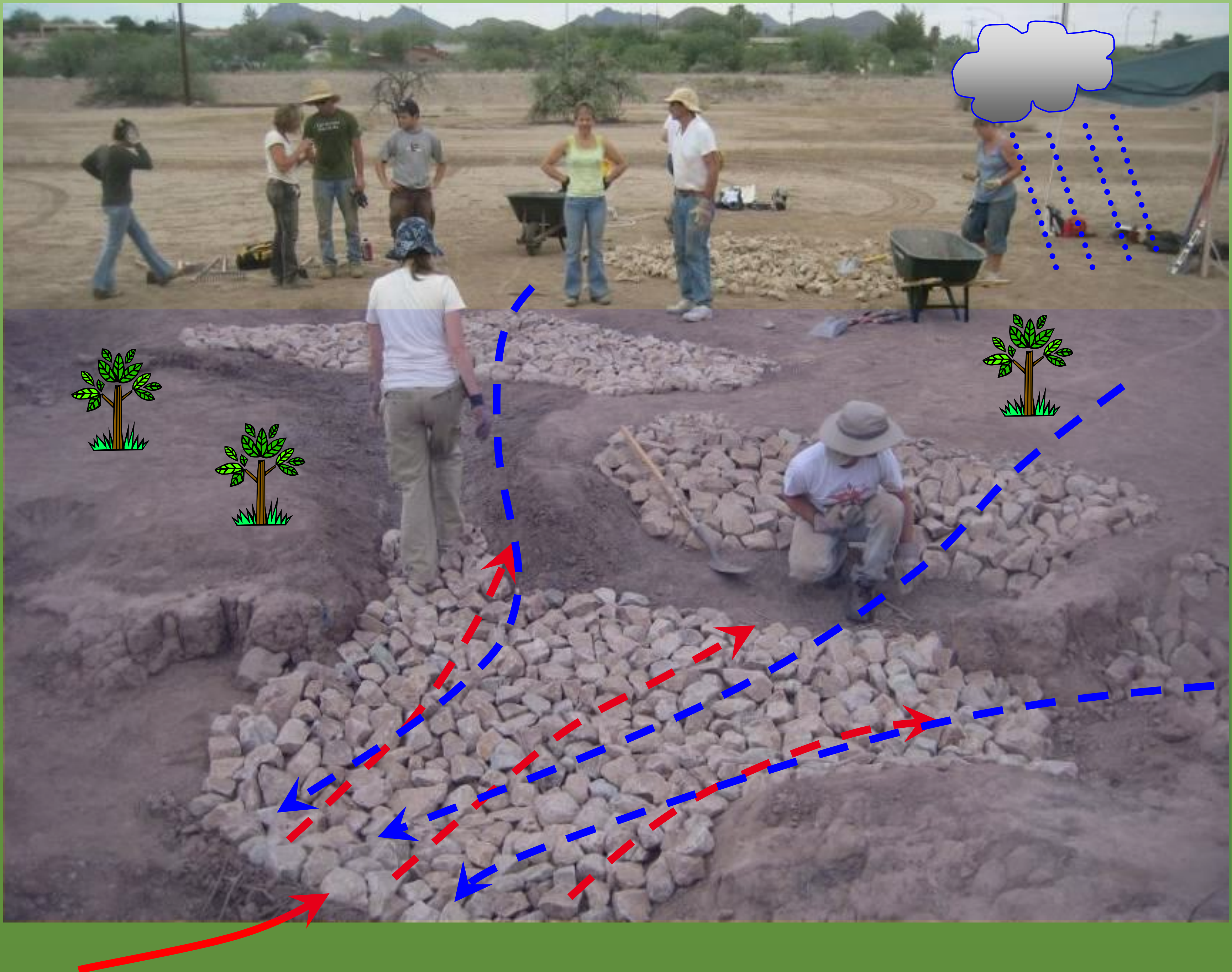
“Presas de una roca”
One Rock Dams



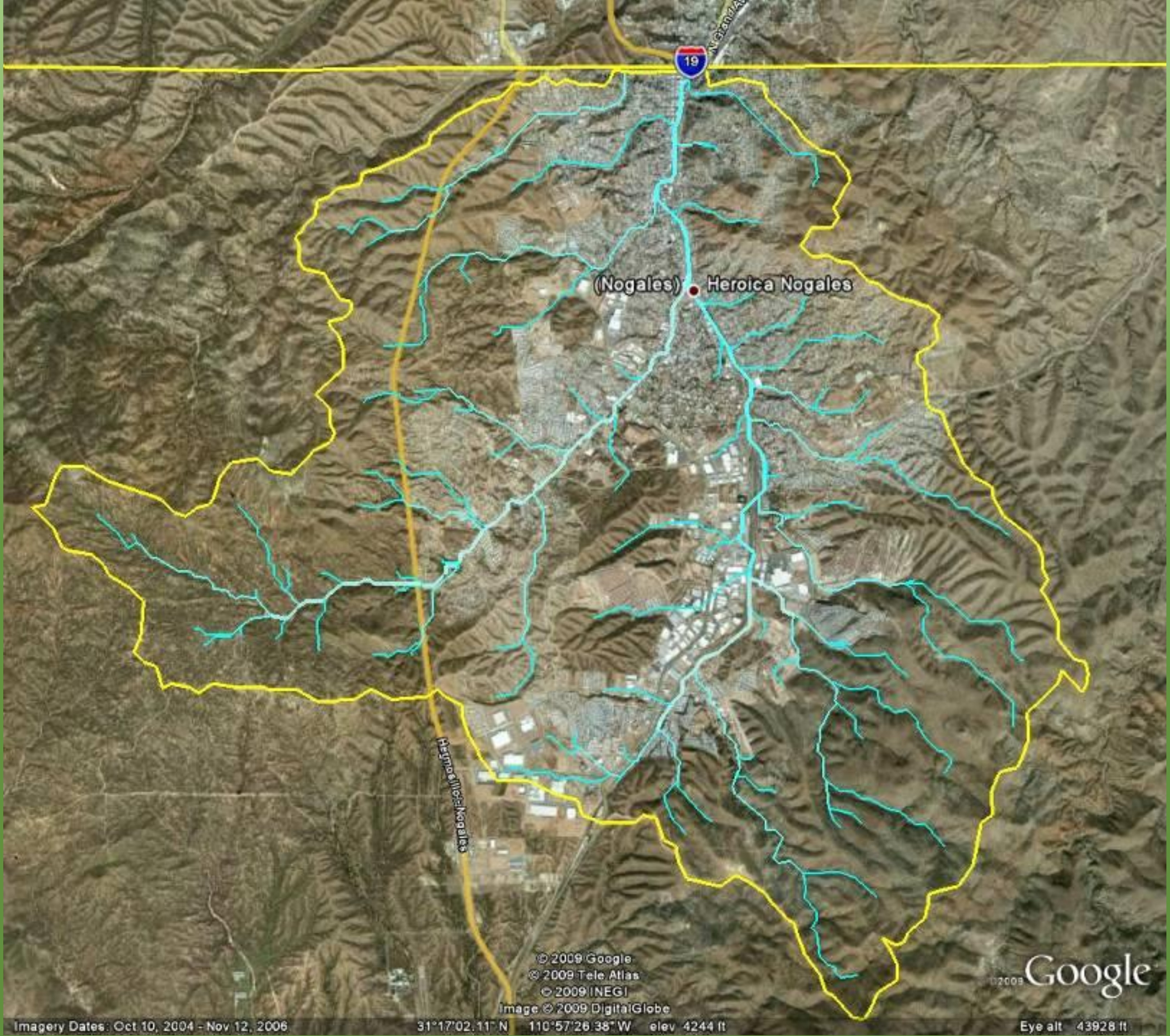



Entrenched tributary of the Santa Cruz River
Tucson, Arizona
S Mission Rd
Headcut, piping and sapping





Green Infrastructure possibilities for Nogales, Sonora



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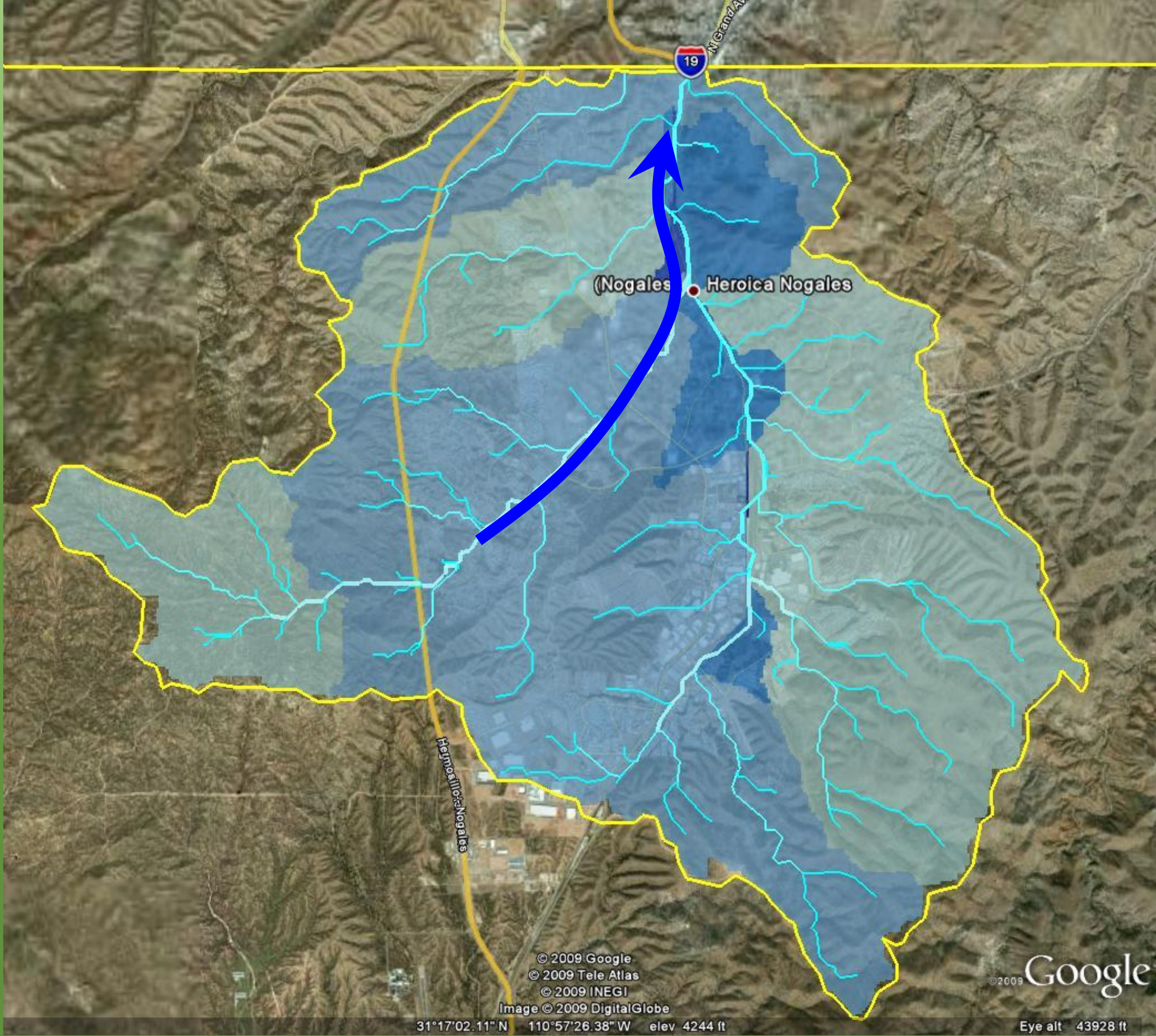
N Grand Av
(Nogales)
Heroica Nogales
Hermosillo-Nogales
© 2009 Google
© 2009 Tele Atlas
© 2009 INEGI
Image © 2009 DigitalGlobe
©2009 Google
Imagery Dates: Oct 10, 2004 - Nov 12, 2006
31°17'02.11" N 110°57'26.38" W elev 4244 ft
Eye alt 43928 ft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Heroica Nogales
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Image © 2009 DigitalGlobe
31°17'02.11" N
110°57'26.38" W
elev 4244 ft
Eye alt 43928 ft
Google

Reto / Challenge

Reto / Challenge

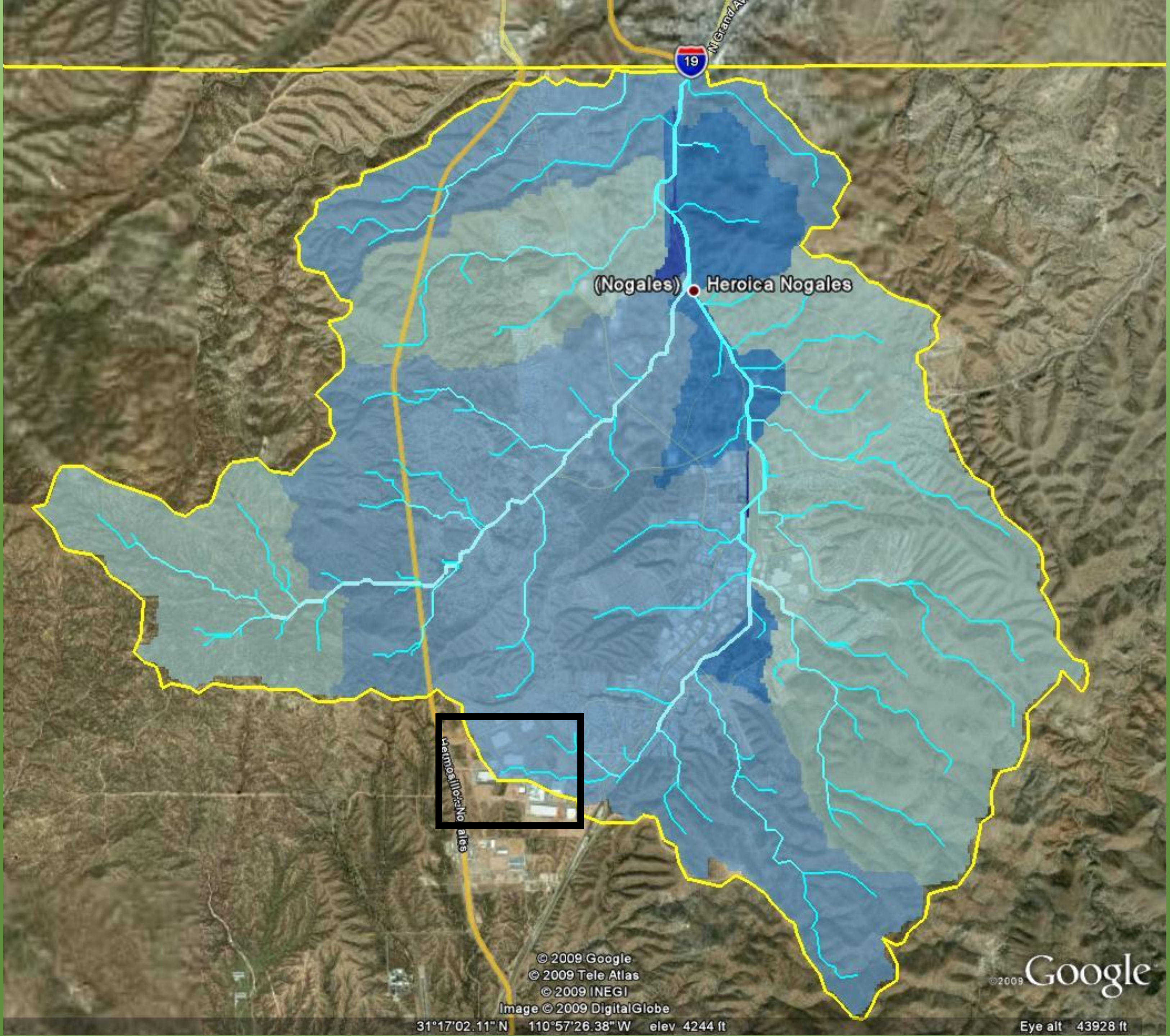
La incorporación de suelos en flujos concentrados impactan la infraestructura que corre debajo de los arroyos de Nogales y sus afluentes.

Peak flows introduce sediment into wastewater infrastructure located within Nogales Wash and its tributaries.

Reto / Challenge

La infiltración y entrada de aguas pluviales en el sistema de alcantarillado contribuye a las fugas de aguas residuales.

Inflow and infiltration of stormwater introduced into the sewers contributes to sanitary sewer overflows.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31°17'02.11" N 110°57'26.38" W elev 4244 ft
Eye alt 43928 ft
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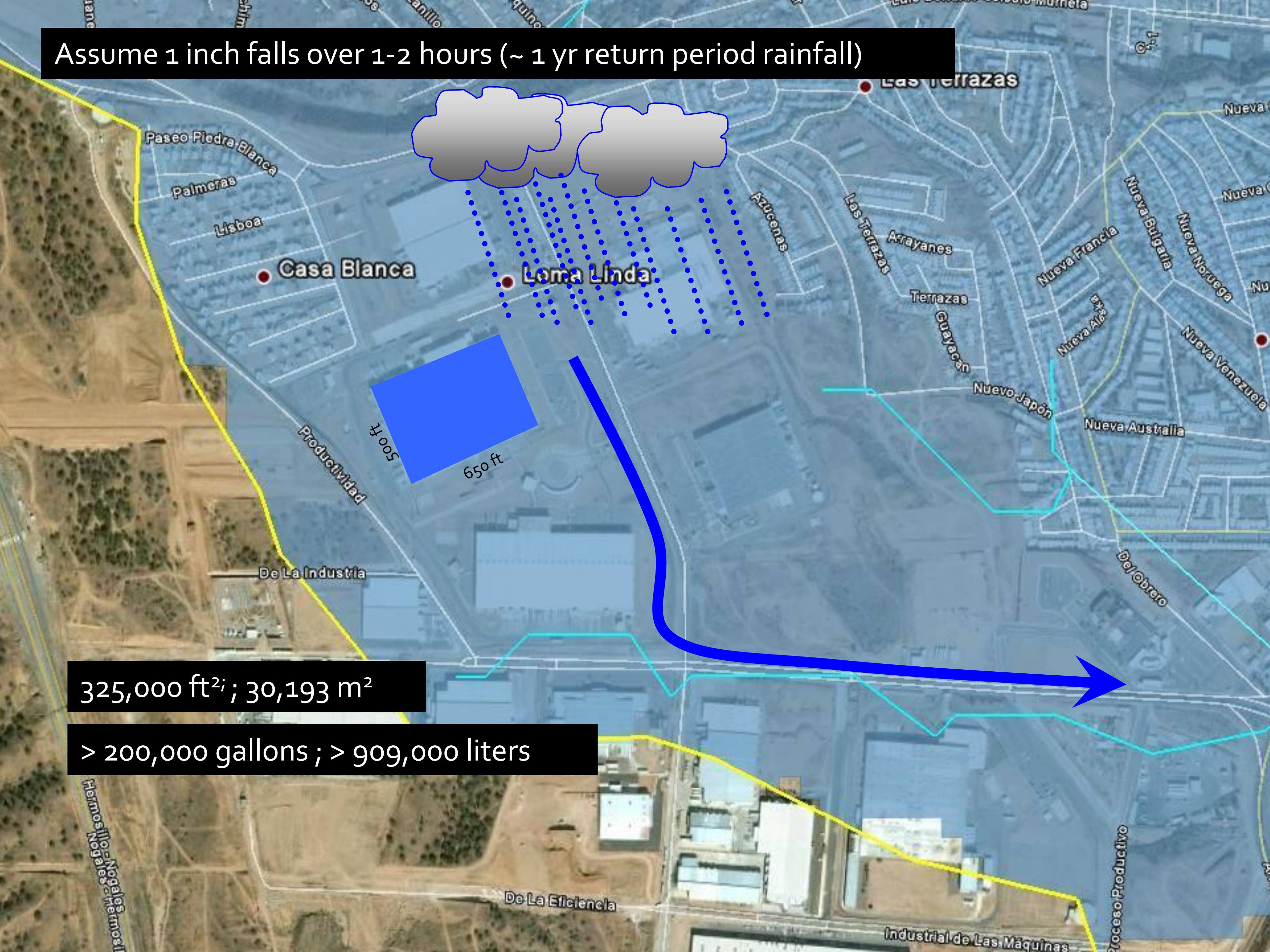
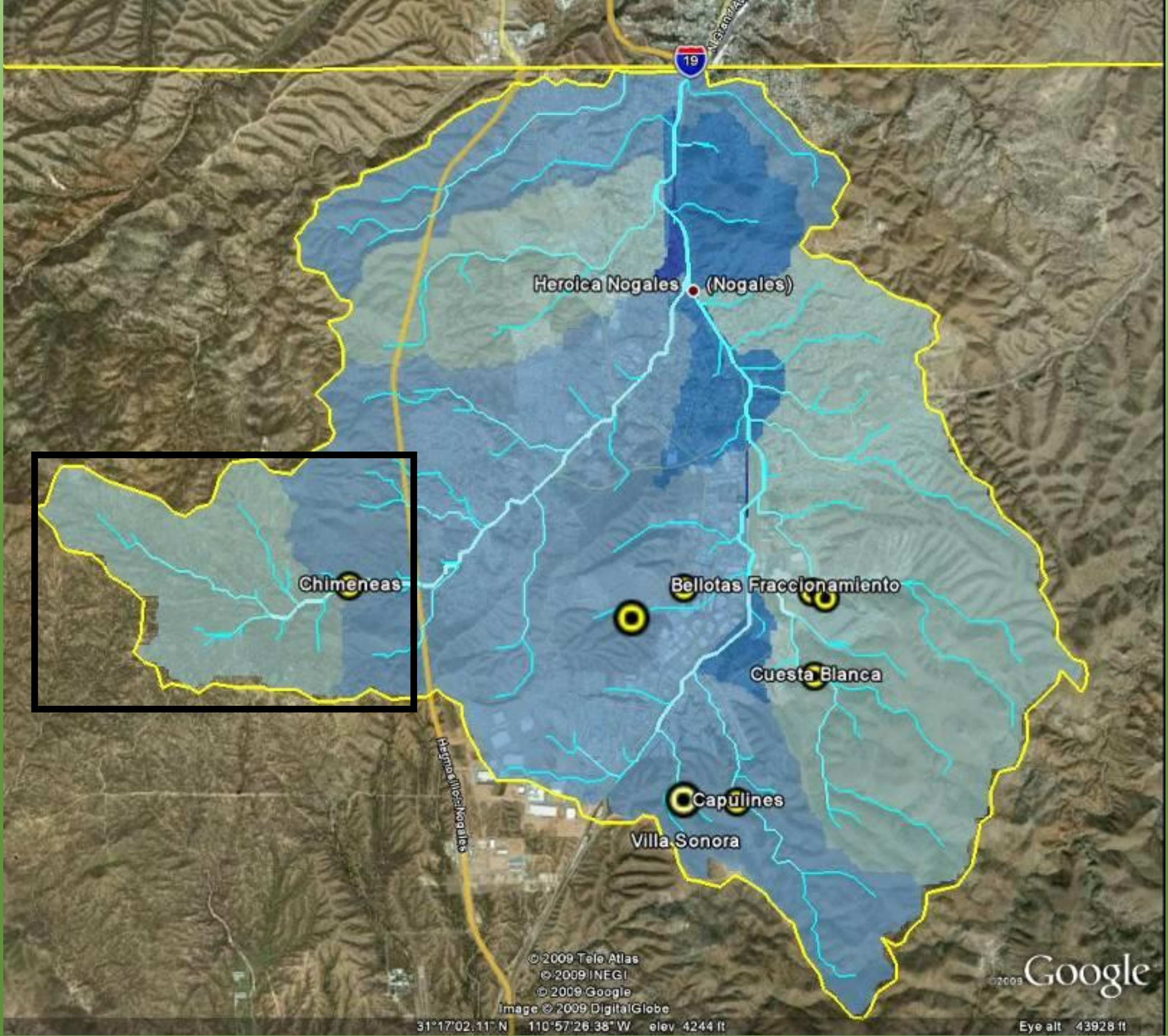

Assume 1 inch falls over 1-2 hours (~ 1 yr return period rainfall)
325,000 ft²; 30,193 m²
> 200,000 gallons ; > 909,000 liters
500 ft
650 ft
Las Terrazas
Paseo Piedra Blanca
Palmeras
Lisboa
Casa Blanca
Loma Linda
Azucenas
Arrayanes
Terrazas
Nueva Francia
Nueva Bulgaria
Nueva Noruega
Nueva Venezuela
Nuevo Japón
Nueva Australia
Productividad
De La Industria
Del Obrero
De La Eficiencia
Industrial de Las Máquinas
Proceso Productivo

1450 gallon cistern

X 137

El represo cuenta con una altura de 5.30 m, longitud de 16.00 m y un largo de corona de 14.00 m. El arroyo presenta un gasto de 39.06 m³/s, que es retenida por la estructura, con capacidad de 6,000 m³ y que tiene un tiempo de retardo de 6 horas.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Heroica Nogales
(Nogales)
Chimeneas
Bellotas
Fraccionamiento
Cuesta Blanca
Capulines
Villa Sonora
Hermosillo-Nogales
© 2009 Tele Atlas
© 2009 INEGI
© 2009 Google
Image © 2009 DigitalGlobe
31°17'02.11" N 110°57'26.38" W elev 4244 ft
Eye alt 43928 ft
Google

STORMWATER IN TIJUANA WATERSHED

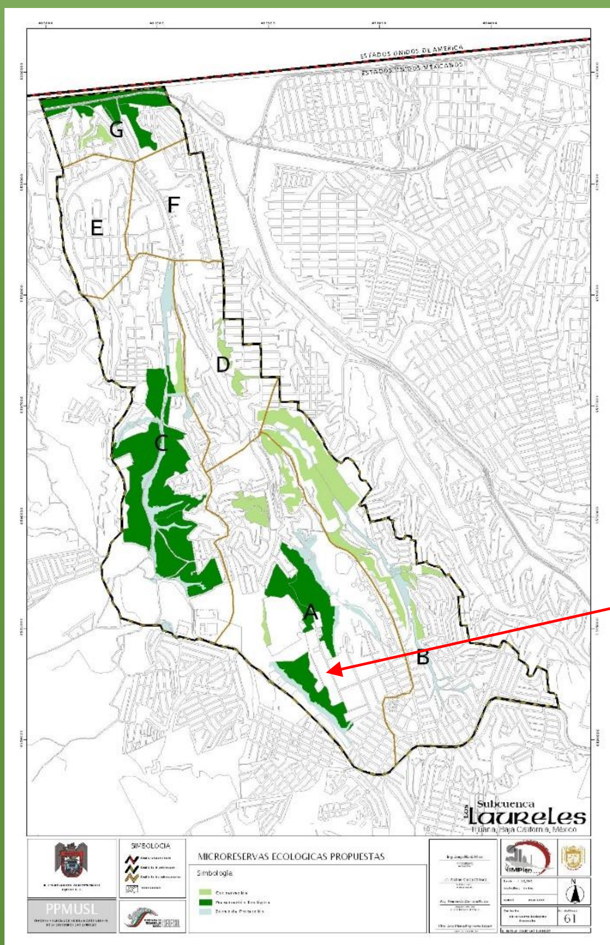
Watershed drains into Tijuana River National Estuarine Research Reserve

Flows carry sediment, tires, and trash

What a tidal marsh is supposed to look like:

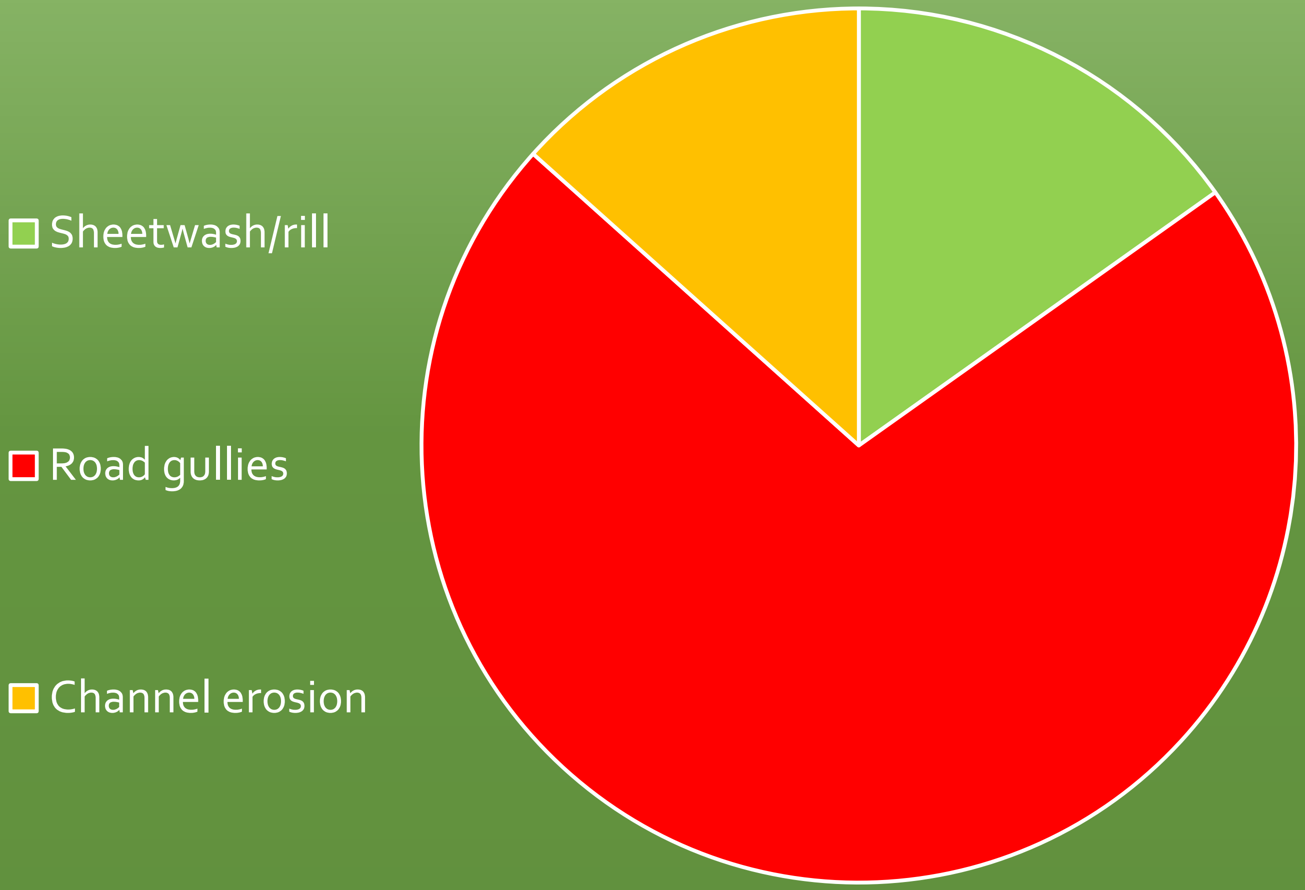
After a storm event buries vegetation:

Land designated by City for conservation is being developed



80% of roads unpaved
Gullies filled after each storm

Conclusion from surveys: Road gullies a dominant source of sediment in Goat Canyon



Courtesy of SDSU

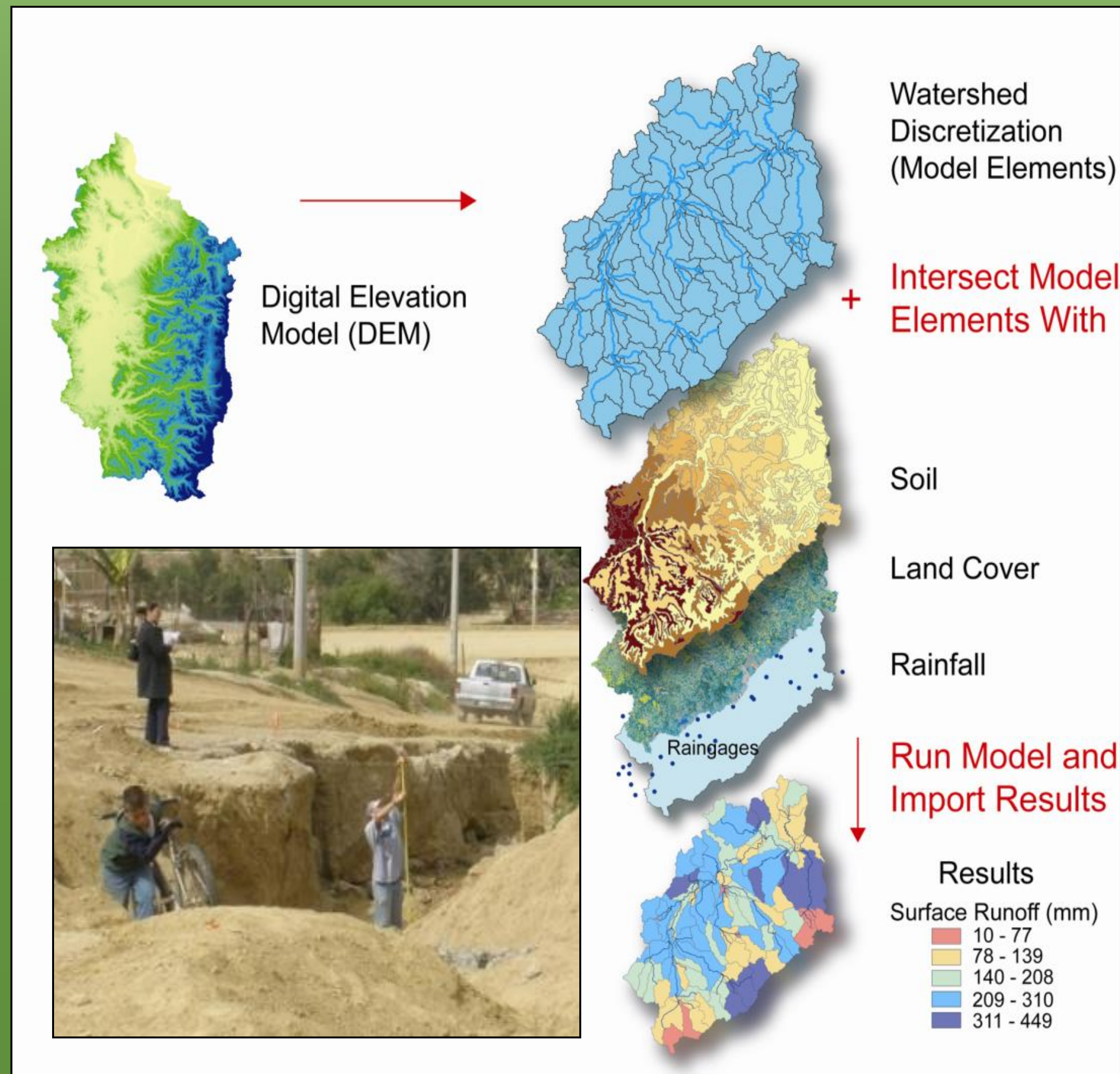
1. Where are the hotspot areas that are producing the most sediment in Los Laureles watershed?

2. What would be the impact of different land use changes and green infrastructure on sediment and stormflow?

- Continued urbanization
- Road paving (already happening—should it be encouraged?)
- Sediment retention basins

Strategy:
Measure stream discharge and sediment yield during storms
Model stormflow and sediment yield under different land uses and GI practices
Map gullies with cameras (and balloons, minicopters) after storms

SEDIMENT MODEL DEVELOPMENT FOR LOS LAURELES FUNDED BY EPA IN 2013:



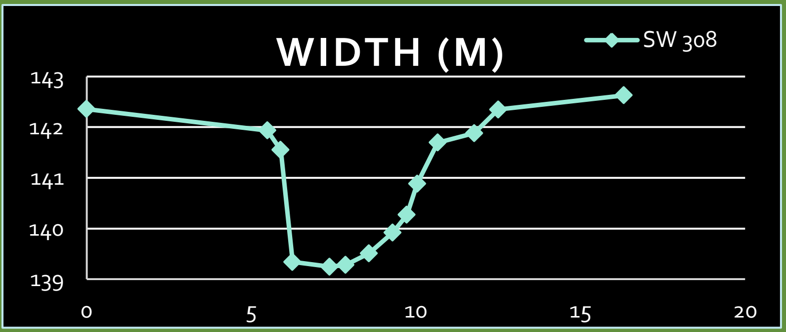
Field Surveys in 2014

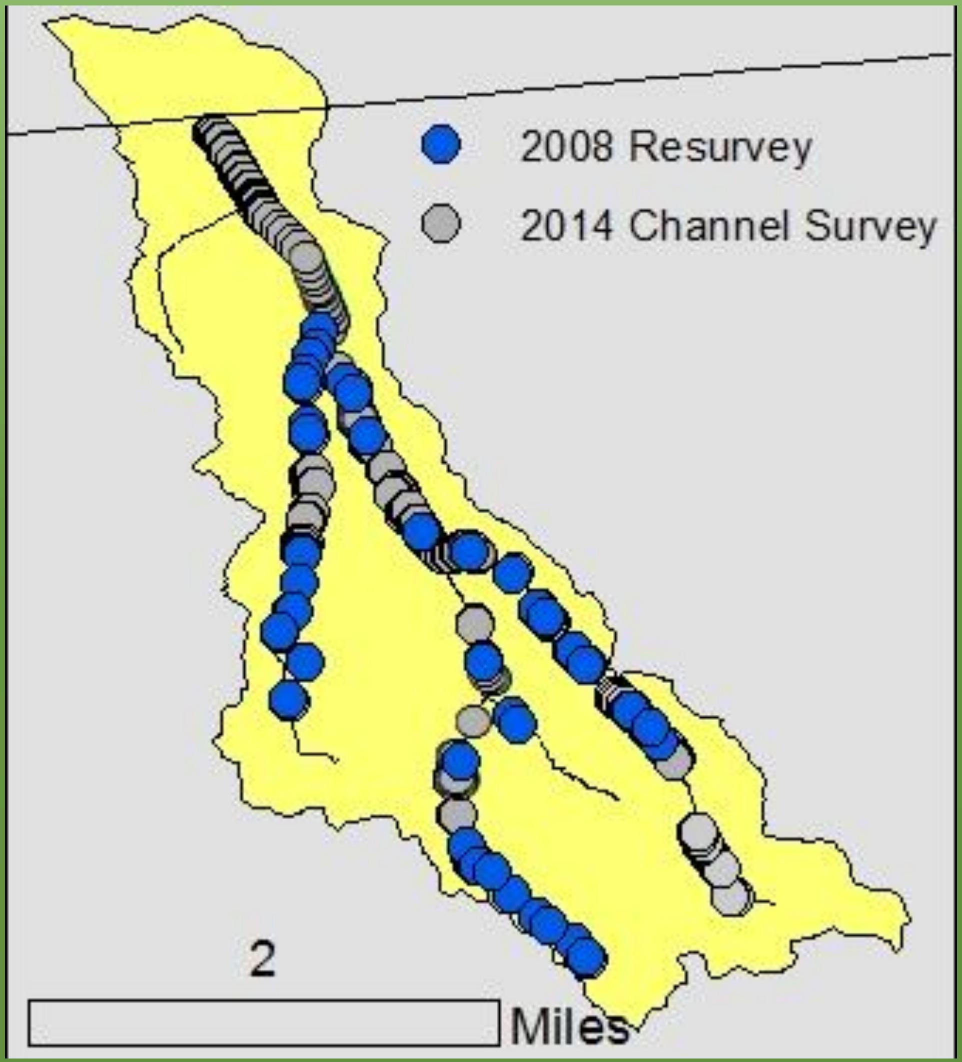
Channel Profiles:

38 locations from 2008 re-surveyed

71 additional locations surveyed

27% (and growing) of channels are concrete





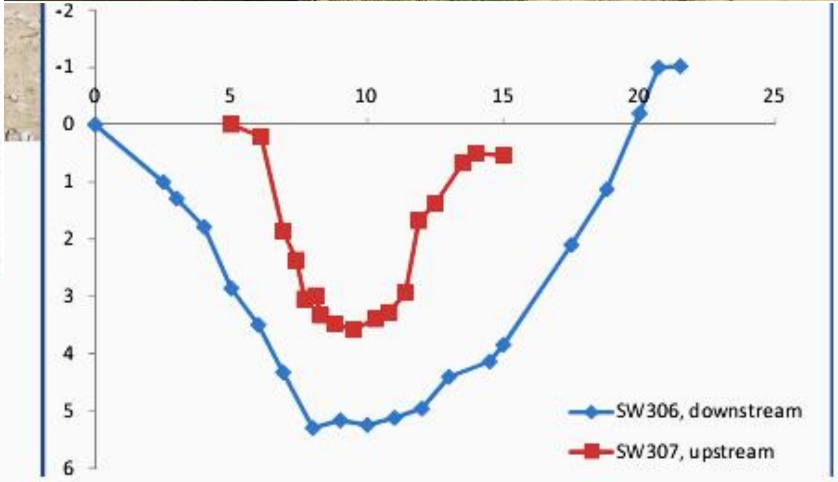
Courtesy of SDSU

Cross Sectional Surveys

IMPACTS OF HARDPOINTS

Courtesy of SDSU

Width: 8 m → 20m
Depth: 3.5 m → 5 m



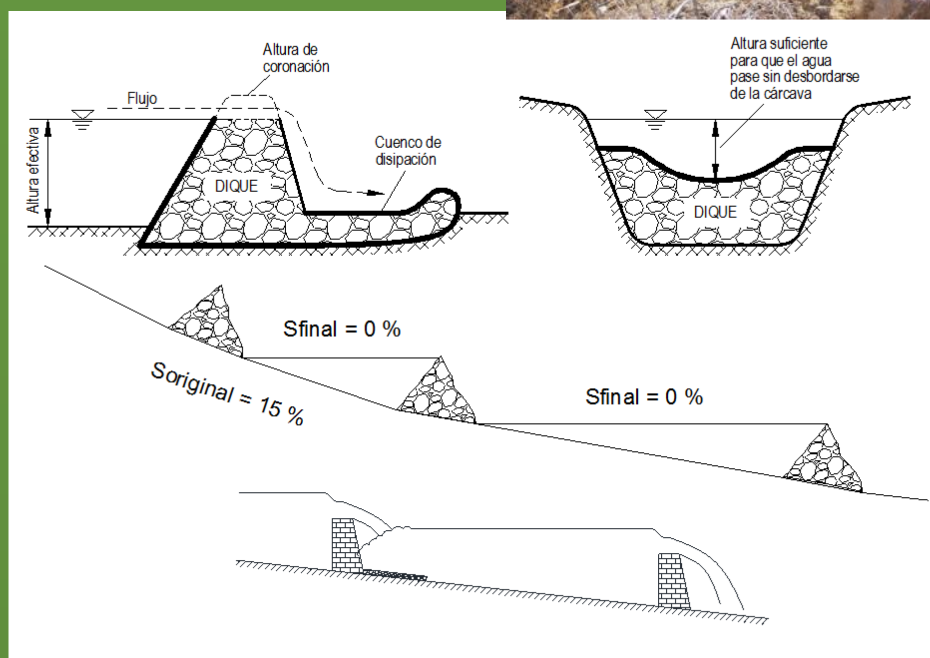
Sediment capture devices in Tijuana

Local efforts in Tijuana to control erosion

Low Impact Development, sediment control BMPs, and Green Infrastructure alternatives

check dams/ "gabiones" (properly designed)

IAS-CSIC



Courtesy of C. Castillo, University of Cordoba

How is EPA Involved with GI?

- Research
- Outreach and Communications
- Tools
- Clean Water Act regulatory support
- Economic Viability and Funding
- Demonstrations and Recognitions
- Partnerships

RESOURCES DEVELOPED

- Protocols to quantify environmental benefits
- GI Resource Center
- Technical Tools – Guidebooks -Training
- **Protocols fo**r cost evaluations
- Information on financing mechanisms
- Recognition and Incentive programs

Better Coordination with Other Federal Agencies

Identify, track, and incorporate green infrastructure activities

Integrate green infrastructure into federal flood/extreme event mitigation efforts

Coordinate to reduce impacts of roadway stormwater

Partnerships :Green Infrastructure Collaborative

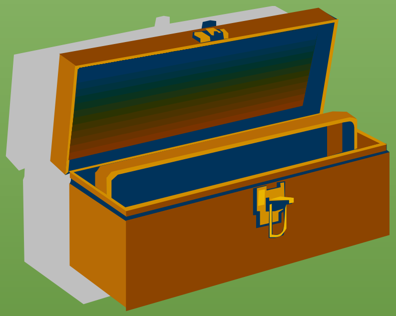
- EPA has joined with federal agencies, NGOs, and other private sector entities to form a broad-based network of organizations interested in promoting and implementing green infrastructure. the network will help communities more easily implement green infrastructure. Commitments include:

- Technical assistance
- Recognize innovative green infrastructure projects
- Work with States to integrate ecosystems and transportation planning
- Incorporate green infrastructure practices into agency facilities or lands
- Emphasizing GI in existing grant programs.
- Disseminate the best ideas and lessons learned from existing grant programs.

GI Funding Opportunities

- EPA Clean Water Act grants and loans
- Department of Energy
- Department of Interior
- Department of Transportation
- HUD
- NOAA
- USDA
- Others

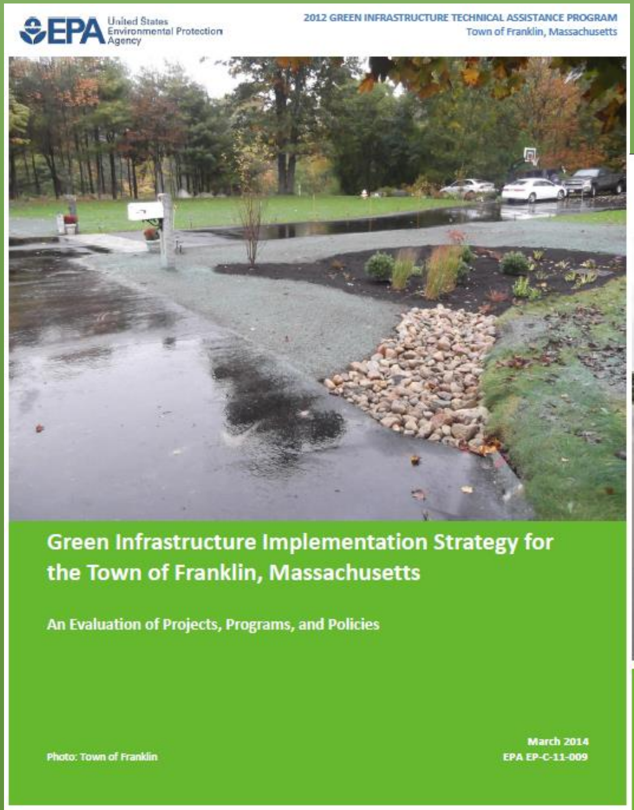
Sharing Green Infrastructure Information with Communities

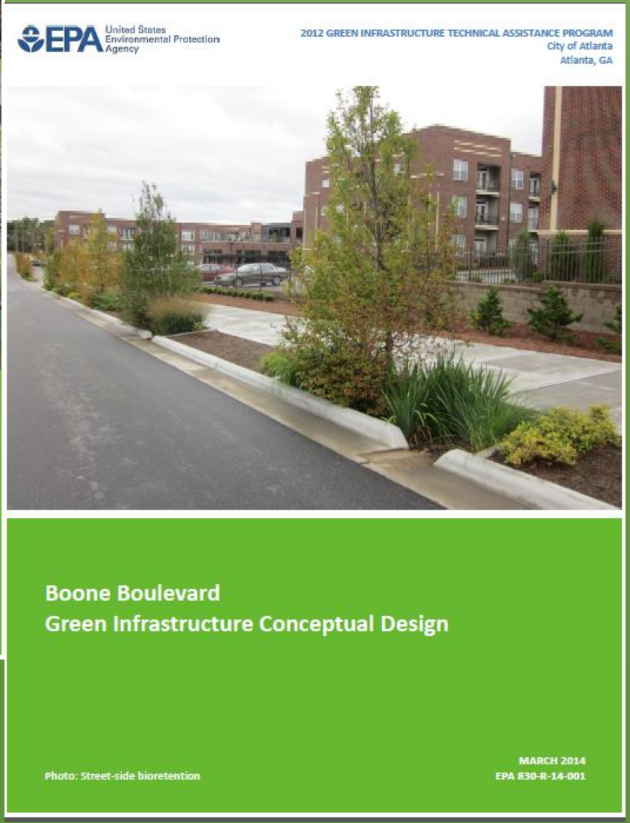


Sharing information about the benefits of green infrastructure

Disseminating information with growing communities that taking steps now will prevent the need for costly retrofits later

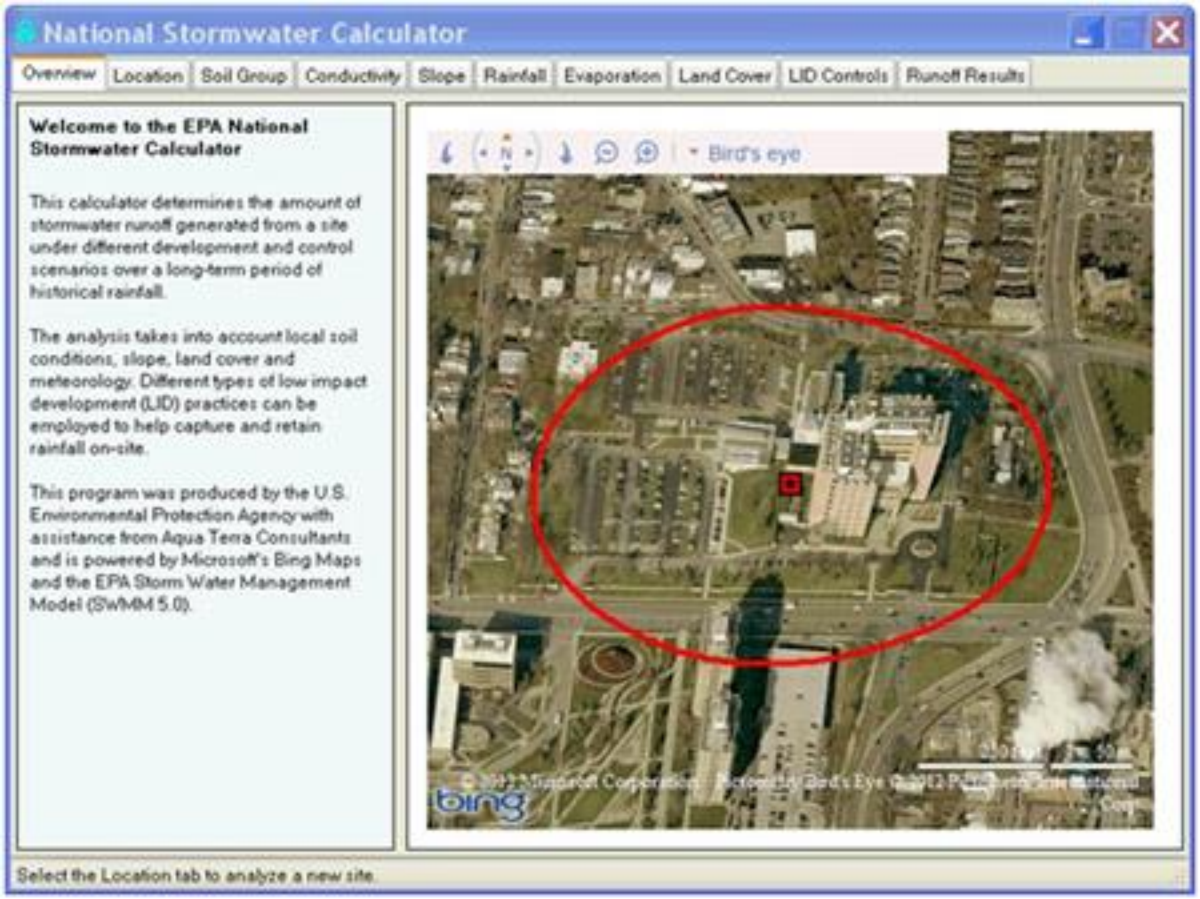
PROVIDE COMMUNITIES WITH TECHNICAL ASSISTANCE





www.epa.gov/greeninfrastructure

EXISTING RESOURCES: THE NATIONAL STORMWATER CALCULATOR

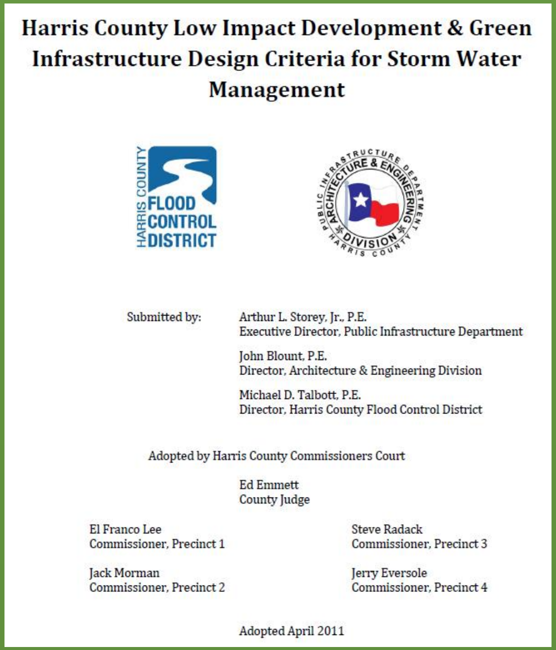


Available at: http://www.epa.gov/research/gems/stormwater.htm

Low Impact Development Design competitions

HOUSTON LID DESIGN COMPETITION- 2010

- Design workshops for manual development
- Successful stakeholder input and reviews
- LID/GI Design Criteria Manual



Harris County Low Impact Development & Green Infrastructure Design Criteria for Storm Water Management

HARRIS COUNTY FLOOD CONTROL DISTRICT

PUBLIC INFRASTRUCTURE DEPARTMENT ARCHITECTURE & ENGINEERING DIVISION HARRIS COUNTY

Submitted by:

Arthur L. Storey, Jr., P.E.
Executive Director, Public Infrastructure Department

John Blount, P.E.
Director, Architecture & Engineering Division

Michael D. Talbott, P.E.
Director, Harris County Flood Control District

Adopted by Harris County Commissioners Court

Ed Emmett
County Judge

El Franco Lee
Commissioner, Precinct 1

Steve Radack
Commissioner, Precinct 3

Jack Morman
Commissioner, Precinct 2

Jerry Eversole
Commissioner, Precinct 4

Adopted April 2011

CAMPUS RAINWORKS CHALLENGE

College students GI competition : Provides a hands-on, interdisciplinary learning experience through which students and faculty can gain practical experience that may be applied in their future practice.

2013 Master Plan Winner: University of Florida

2013 Site Design Winner: Kansas State University

Future Plans and Opportunities

Leverage Our Existing Regulations to Require Communities to Better Protect Waters

Tools & Resources

Assistance

Training

Recognize Communities & Sites that Use Green Infrastructure to Manage Stormwater

- Continue working with partners with established recognition programs

- Explore recognition of MS4s

- Explore recognition program for builders/developers

Clean Water Act Regulatory Support

- Incorporate green infrastructure into MS4 permits and water enforcement actions
  - GI provisions incorporated into growing number of state requirements and MS4 permits
  - GI now routinely considered as part of CSO consent decrees

Retention Standards

- An increasing number of states and communities are relying on retention standards to reduce impacts of stormwater from impervious cover

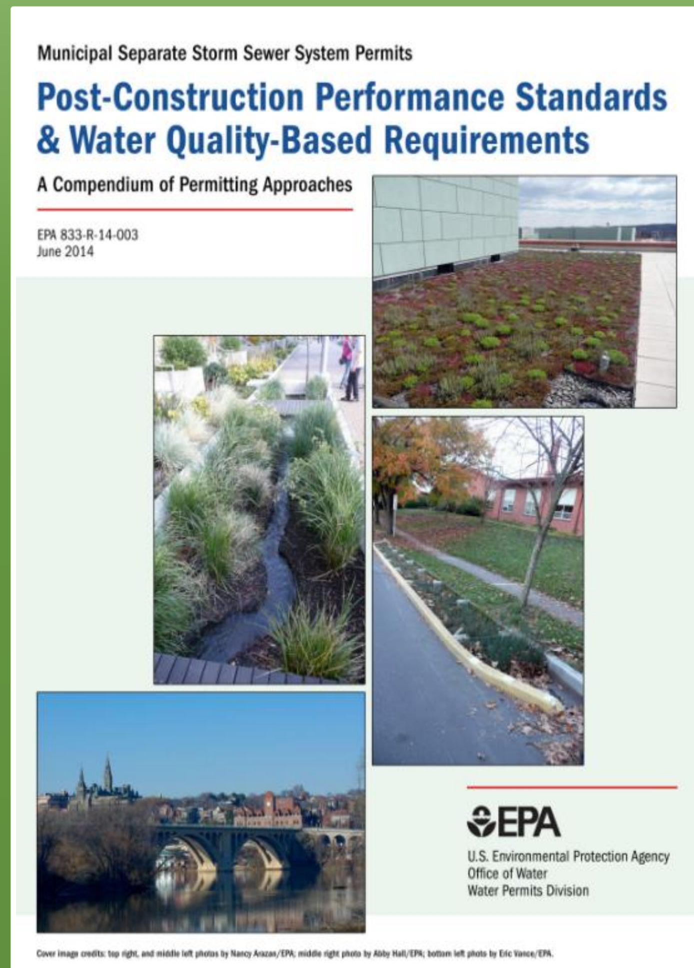
- Retaining stormwater near where it falls reduces:
  - Pollutants
  - Volume and velocity
  - Flooding

- Retention standards are cost-effective
  - It is more cost-effective to incorporate sustainable controls as development occurs and prevent the need for costly retrofits or restoration
  - For new development, these standards can save money because smaller detention ponds and less gray infrastructure would be used

18 states and DC have standards based on retention of a certain volume of stormwater.

(as of 2011)

Existing Resources: post-Construction Performance Standards & Water Quality-Based Requirements



Available at: www.epa.gov/npdes/pubs/sw_ms4_compendium.pdf

Cycle of Insanity-The Real Story of Water- 20 min animated video by Surfrider Foundation

Thank You!

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Websites:

- Green Infrastructure
  www.epa.gov/greeninfrastructure
- Stormwater
  www.epa.gov/npdes/stormwater
- EPA Region 6 GI
  http://www.epa.gov/region6/water/npdes/greeninfrastructure/index.html

Listserv:

- Greenstreams: To join greenstream, an EPA listserv featuring updates on green infrastructure publications, training, and funding opportunities, send an email to join-greenstream@lists.epa.gov