BUREAU OF RECLAMATION

Hassayampa River Study
Assessing Low Impact Development (LID) for Stormwater Management

Stakeholder Meeting
August 25, 2021

Disclaimer

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Presentation Outline

- Study background
- Green Infrastructure/Green Stormwater Infrastructure
- Low Impact Development (LID) features in urban areas
- Grade Control Structures (GCS) on undeveloped land
- Surface water rights
- Existing research
- Study tasks

Hassayampa River Study
Assessing Low Impact Development for Stormwater Management

- Special Study
- November 2020 to November 2023

Study Goals

Attempts to answer the questions:

Can Low Impact Development (LID) and Grade Control Structures (GCS):

1. be used to meet regulatory requirements for managing stormwater generated by new residential developments and in undeveloped areas?
2. be integrated with regional stormwater management alternatives?

In addition, the study will:

- Assess requirements to maintain existing LID/GCS installations
- Develop an LID Design Standards Handbook for the City of Buckeye
- Develop a conceptual groundwater model to assess aquifer recharge

Agreement

- U.S. Bureau of Reclamation (BOR)
- City of Buckeye (Buckeye)

Stakeholders

BUCKEYE, AZ

Flood Control District of Maricopa County

USGS science for a changing world
Land Change Science Program

WHITE TANK MOUNTAINS CONSERVANCY
CONSERVE CONNECT COLLABORATE

MARICOPA COUNTY ARIZONA
Maricopa County
Parks and Recreation Department

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

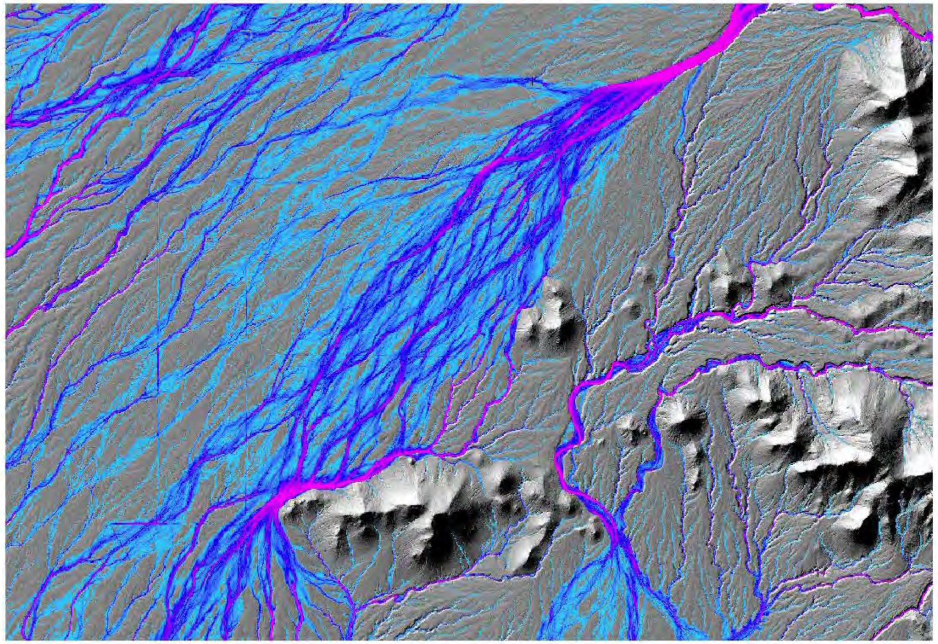
You?

FCDMC Sun Valley Area Drainage Master Plan

Flood Control District of Maricopa County (FCDMC)

Sun Valley Area Drainage Master Study/Plan Update
FCD 2018C025, Work Assignment #1
Area of Mitigation Interest Selection

August 17, 2020
DRAFT



Submitted by:

JE Fuller/ Hydrology and Geomorphology, Inc.
8400 S Kyrene Road, STE 201
Tempe, Arizona 85284
(480) 752-2124

on behalf of:

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009
(602) 506-1501

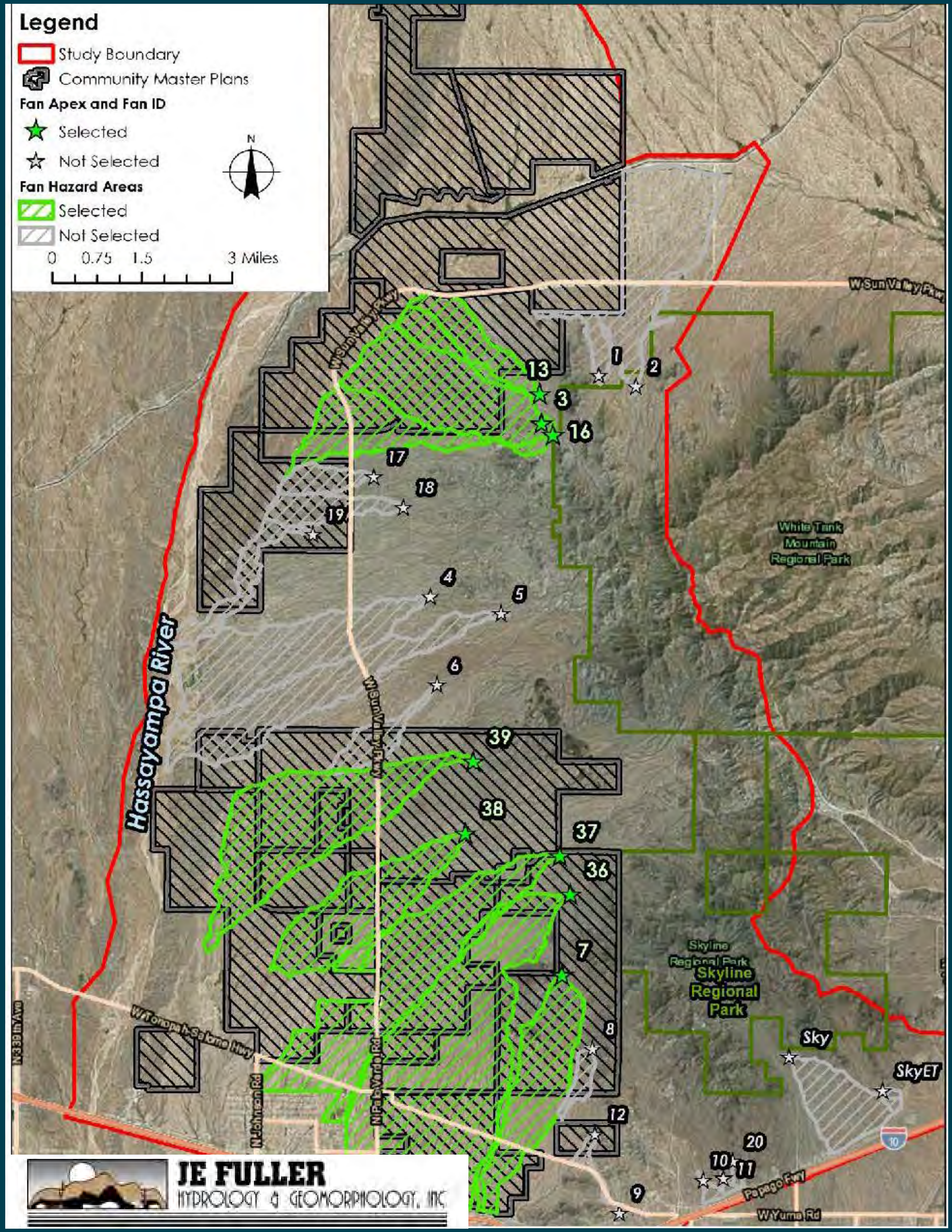
FCDMC Sun Valley ADMP Area

FCDMC Sun Valley Area Drainage Master Plan (ADMP) covers about 183 square miles in Buckeye and in unincorporated Maricopa County.

The watershed is bounded by Gates Road on the north, the White Tank Mountains on the east, Interstate 10 on the south, and the Hassayampa River on the west.

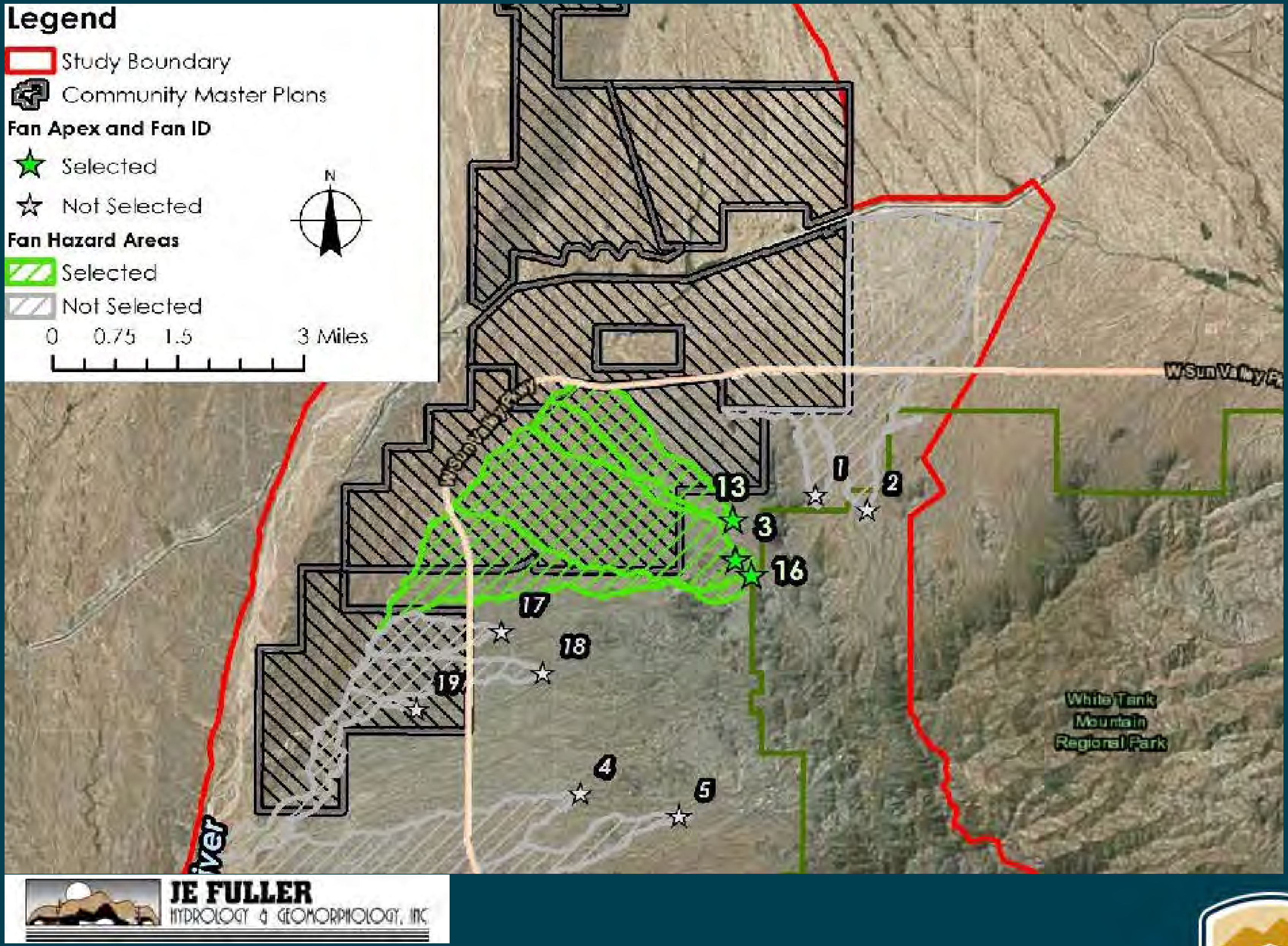
Purpose of the Sun Valley ADMP is to develop alternatives to mitigate previously identified flooding hazards and incorporates development plans and drainage policies to develop a preferred alternative.

[Details | Flood Control District | Maricopa County, AZ]

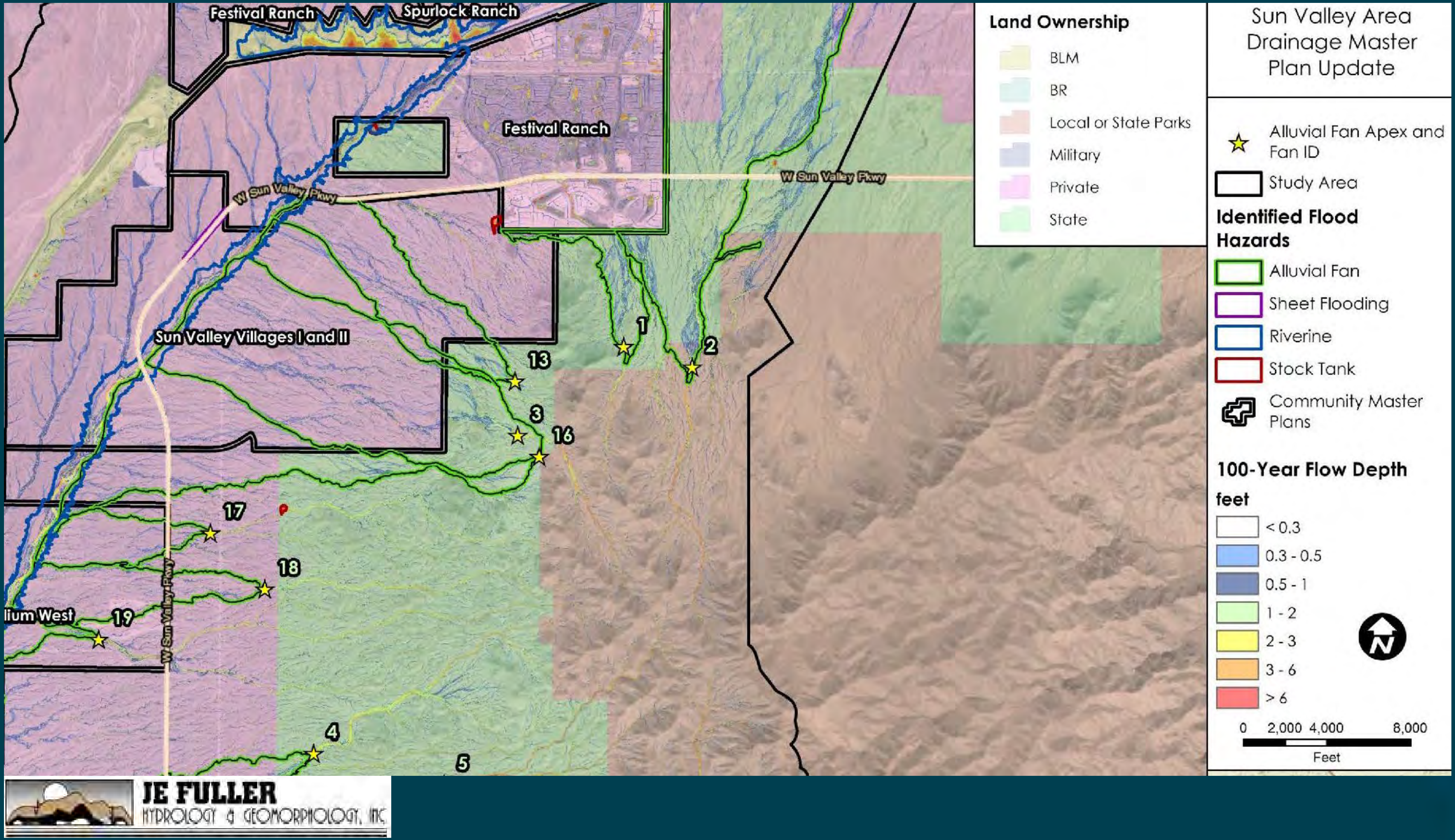


Study Area

Hassayampa River Study focuses on Alluvial Fans #3 and #13



Proposed Development in Fans #3 and #13



City of Buckeye
Imagine Buckeye 2040 Vision

"***Buckeye in 2040 is an innovative, visionary, healthy, and forward-thinking community*** *that is safe and secure with diverse employment, housing, education and business opportunities. Buckeye offers rural to urban lifestyles with a genuine sense of heritage* ***while being good stewards of our natural resources, open spaces and overall quality of life***."

Green Infrastructure/Green Stormwater Infrastructure for Stormwater Management

Green Infrastructure (GI)

Refers to **engineered-as-natural** ecosystems including green roofs, porous pavement, and swales that use soil and vegetation to infiltrate, evapotranspirate, and/or **harvest stormwater runoff and reduce flows** to drainage collection systems. GI is considered an umbrella term for other terms, like LID and GCS.

Green Stormwater Infrastructure (GSI)

Emphasizes approaches that rely on natural or engineered-as-natural ecosystems to specifically **control and manage stormwater runoff**.

www.epa.gov/greeninfrastructure
Terminology of Low Impact Development: Distinguishing LID from other Techniques that Address Community Growth Issues (epa.gov)

Green Stormwater Infrastructure
LID and GCS for Stormwater Management

Low Impact Development

LID is a management approach and set of practices that can reduce runoff and pollutant loadings by managing runoff as close to its source(s) as possible.

LID includes site design approaches (holistic or integrated) and individual small-scale stormwater management practices (isolated LID practices) that promote the use of natural systems for infiltration, evapotranspiration and the harvesting and use of rainwater.

www.epa.gov/nps/lid

Terminology of Low Impact Development: Distinguishing LID from other Techniques that Address Community Growth Issues (epa.gov)

Green Stormwater Infrastructure
LID and GCS for Stormwater Management

Grade Control Structures

GCS consist of earthen, wooden, concrete or other structure built to:

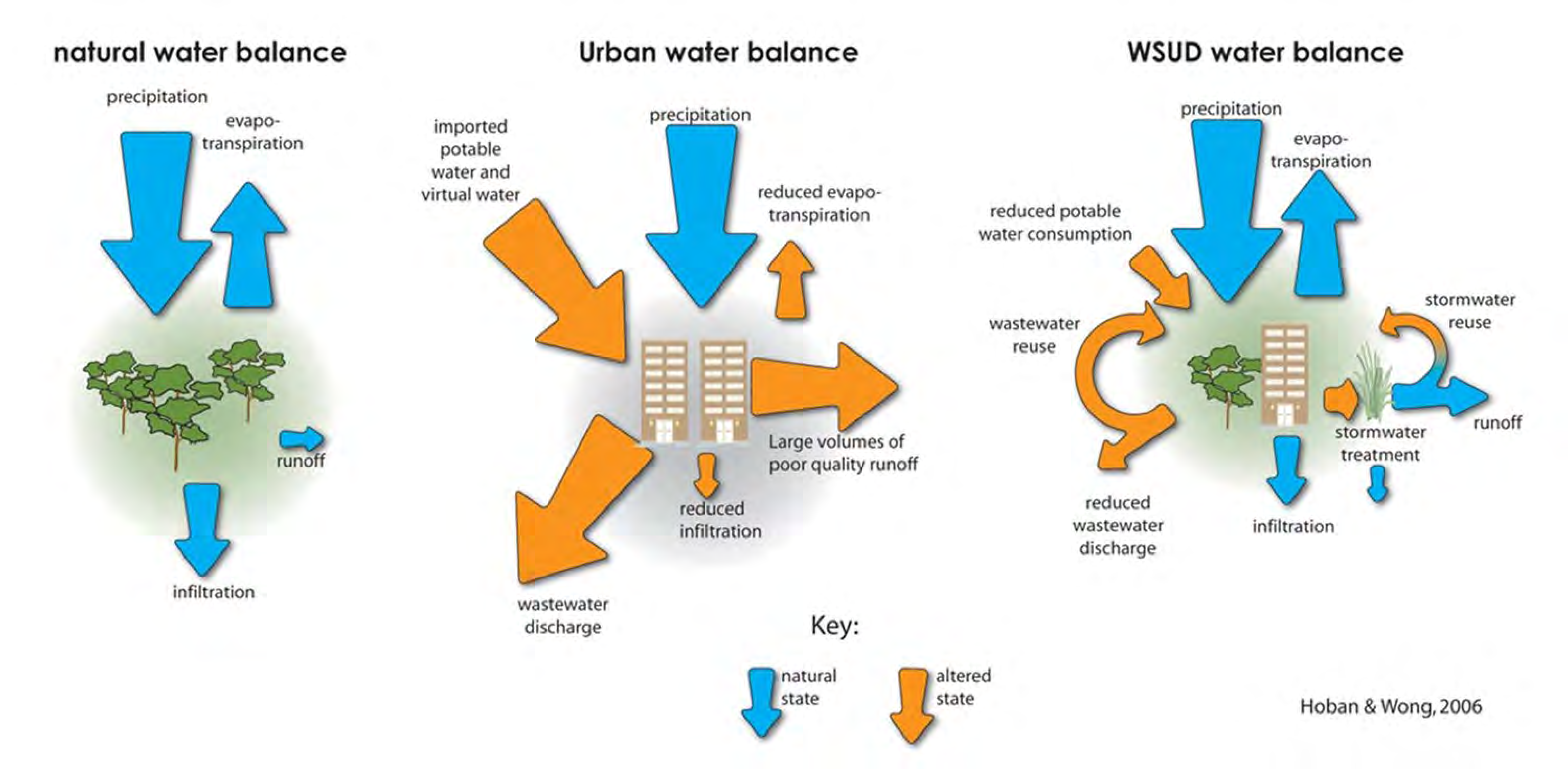
- Stabilize the grade and control erosion in natural or artificial channels
- Prevent gully head cut formation and channel bed erosion by lowering water in a controlled manner
- Enhance environmental quality and reduce pollution hazards

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/?cid=nrcs142p2_044354

Green Stormwater Infrastructure
LID and GCS for Stormwater Management

- LID (urban lands); GCS (undeveloped lands)
- LID and GCS features are used to manage and treat stormwater alone or in conjunction with conventional stormwater management practices.
- LID and GCS mimic natural processes to reduce stormwater runoff and sediment transport and to infiltrate stormwater into the soil as close to its source as possible.
- LID/GCS provide many co-benefits

LID Features in Urban Areas



[Nature-Based Solutions for Cities in Viet Nam: Water Sensitive Urban Design (adb.org)]

LID Benefits in Urban Areas

- Decrease stormwater runoff flows
- Reduce land degradation and sediment transport
- Reduce urban heat island
- Reduce local flooding
- Increase infiltration
- Support trees and vegetation
- Improve air quality
- Improve stormwater quality
- Enhance biking/walking environment

Photo credit: City of Phoenix – Taylor Mall

LID Features in Urban Areas

Curb cuts

Pervious concrete at Phoenix Manzanita Park Parking Lot

Photo credit: City of Phoenix – Taylor Mall

Curb Core

City of Phoenix

LID Features in Urban Areas

Bioswale

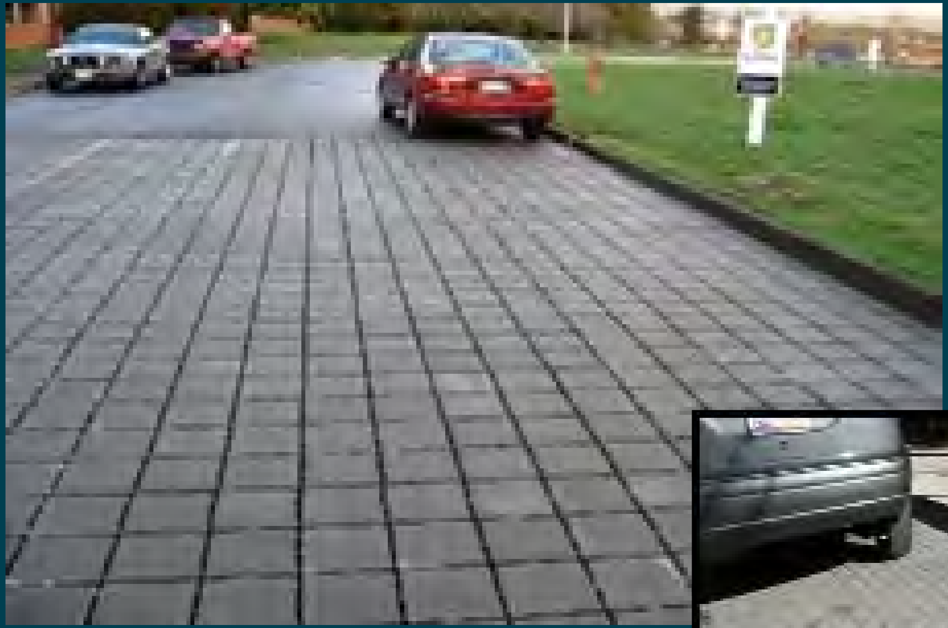
FCDMC – Durango Campus

FCDMC – Durango Campus

City of Phoenix - Primera Iglesia

LID Features in Urban Areas

Permeable Pavers and Roundabouts



PCSWMM
https://www.pcswmm.com/

City of Phoenix - Taylor Mall ASU
Walter Cronkite School of Journalism and Mass Communication

City of Phoenix
36th St. & Rosemont

LID Features in Urban Areas

Cisterns/rain barrels and Infiltration Trenches

Rooftop Capture or Disconnection (cisterns/rain barrels)

Photo Credit: EPA SWMM Manual 2016

Infiltration Trenches

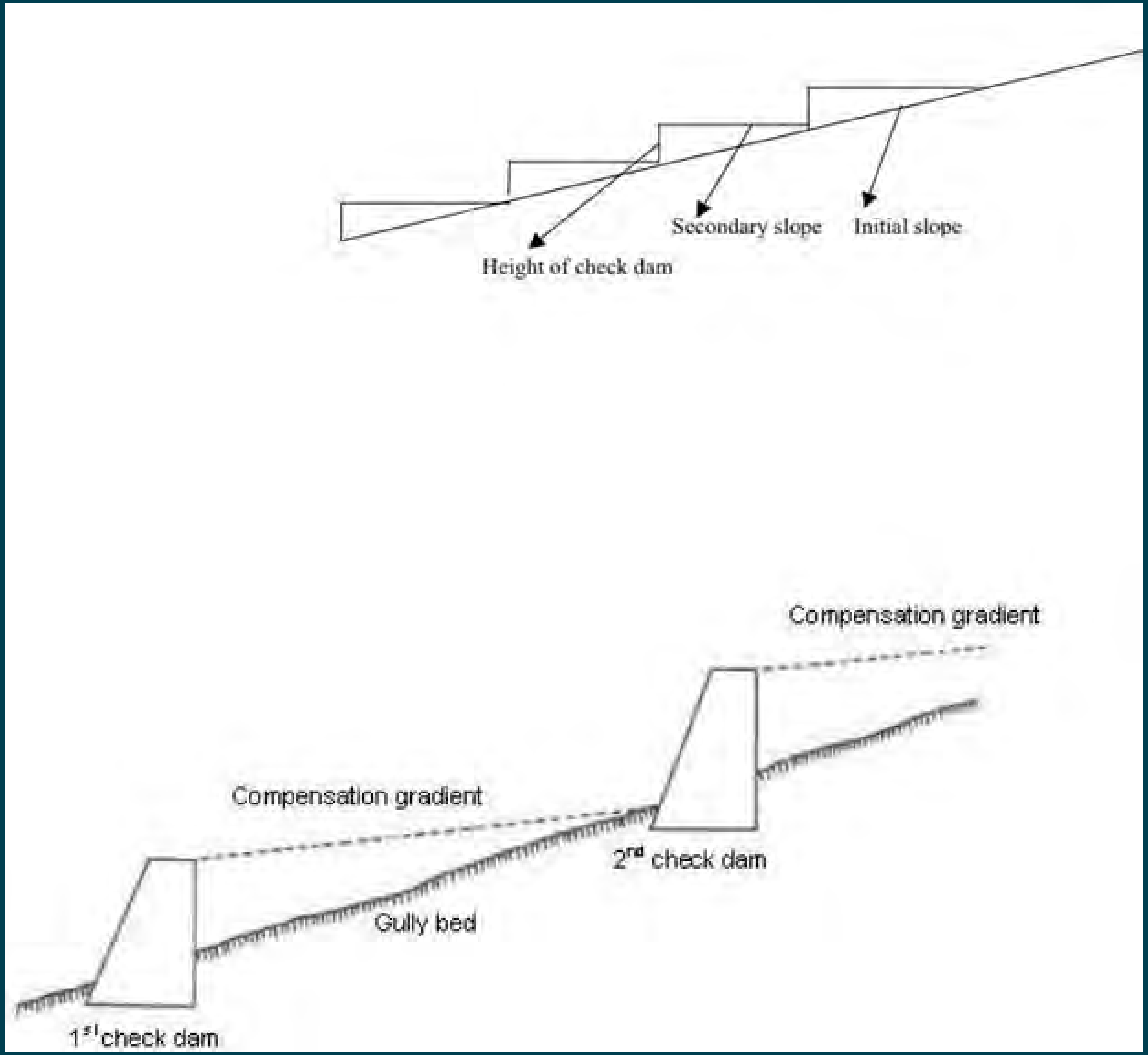
Photo Credit: EPA SWMM Manual 2016

GCS Benefits on Undeveloped Lands

- Decrease storm volume and peak flows
- Reduce land degradation and sediment transport
- Increase surface water flow distance and duration
- Slow, low flows enhancing water availability
- Increase infiltration
- Increase moisture for ecosystems and habitat interconnectivity
- Improve watershed function

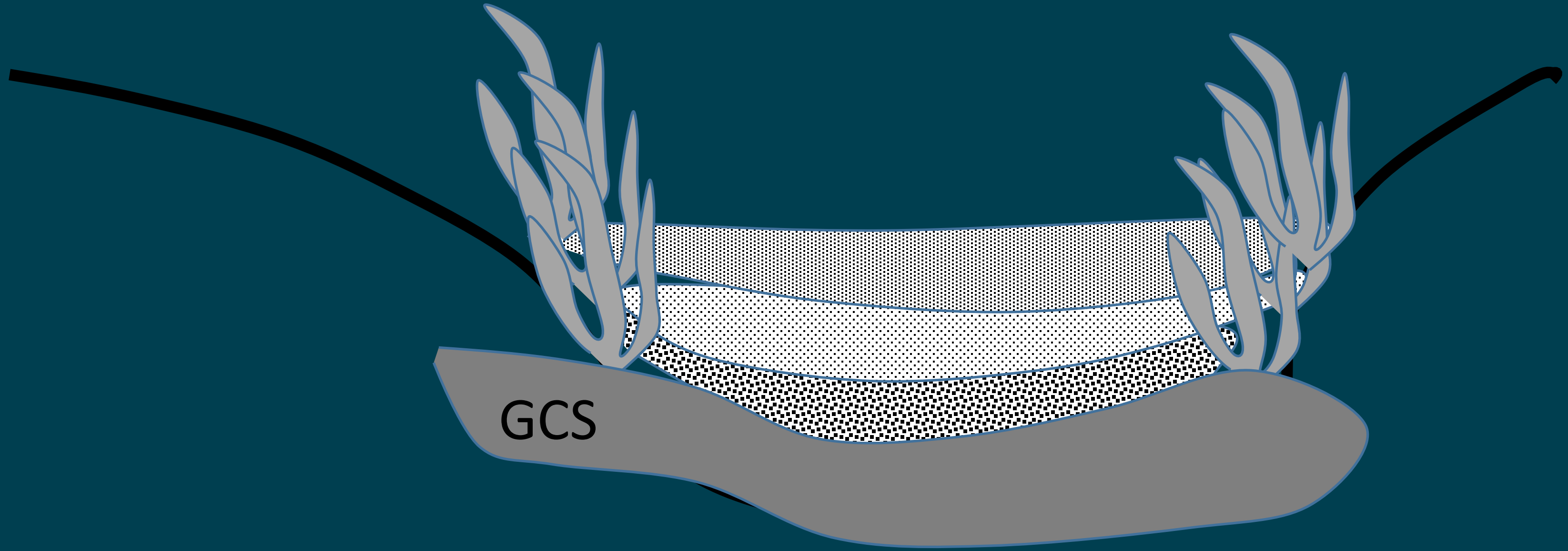
Photo Credit: Deborah Tosline

GCS Features on Undeveloped Land



[5:13 AM] Norman, Laura MGeyik, M. P. (1986). Gully Control. In *Watershed Management Field Manual* (Vol. 2). Rome: Food and Agricultural Organization of the United Nations. Retrieved from http://www.fao.org/docrep/006/ad082e/ad082e00.htm

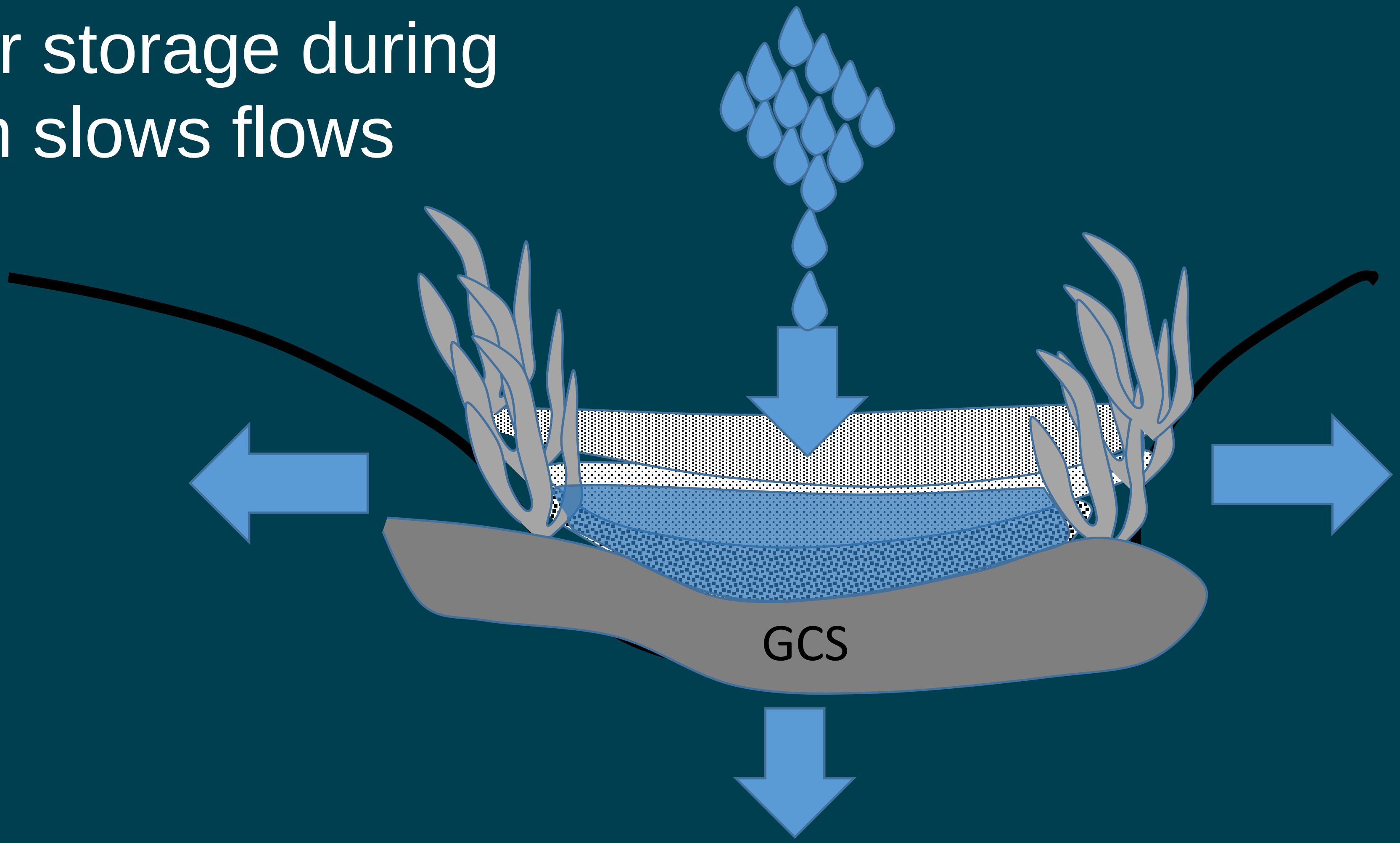
GCS Function



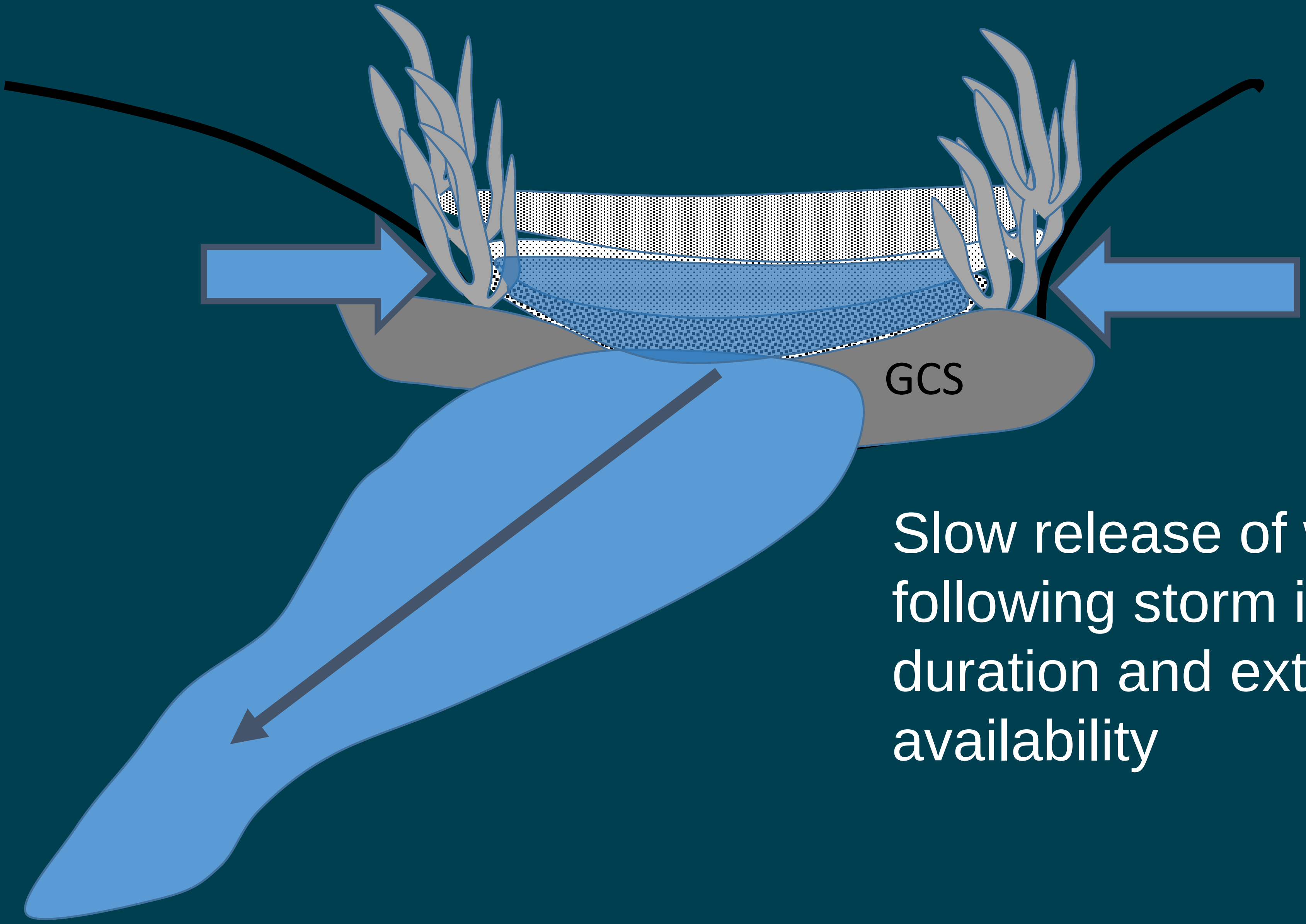
Sedimentation after storm and plant establishment

GCS Function

Water storage during storm slows flows

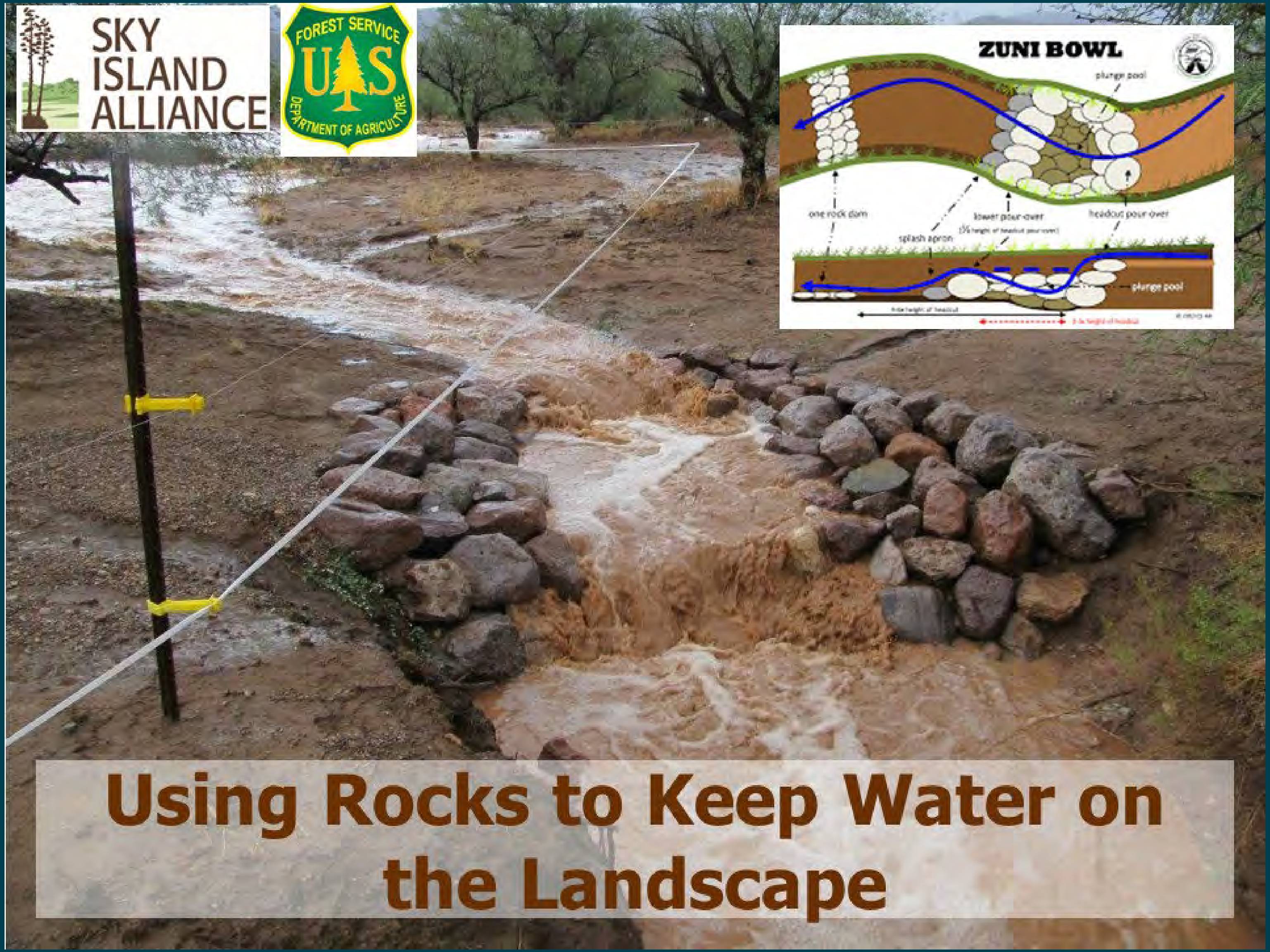


GCS Function



Slow release of water following storm increases duration and extent of water availability

GCS Features on Undeveloped Land



GCS Features on Undeveloped Land

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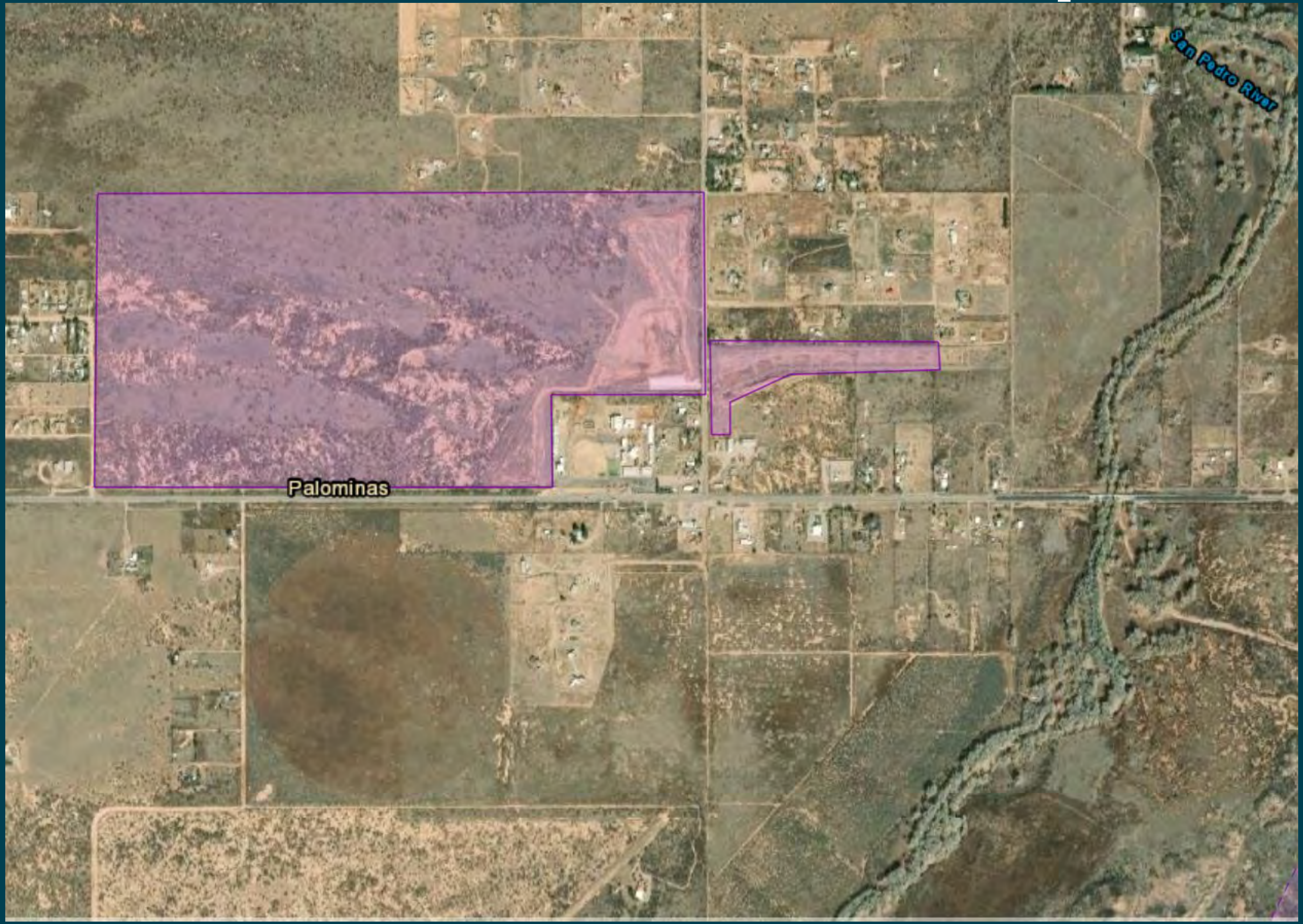
GCS Features on Undeveloped Land



Project Partners:
Cochise County, TNC

Size:
285 acres

Type:
Stormwater (sheet flow) recharge project

Status:
Completed in 2014

Funding Sources:
WFF, Wingate Foundation, Fort Huachuca ACUB, TNC, Cochise County

Water Benefits:
Recharged: 93 AF since 2015; 4.9 AF in 2020
Precluded Pumping: 141 AF since 2015; 24 AF in 2020

Palominas Stormwater Recharge and Flood Control Project

Cochise County owns and manages Palominas in the Cochise Conservation and Recharge Network

https://storymaps.arcgis.com/stories/5110541947c54842958ad560ecdb334f#ref-n-102D5n

GCS Features on Undeveloped Land

Palominas Stormwater Recharge and Flood Control Project

Cochise County owns and manages Palominas in the Cochise Conservation and Recharge Network

https://storymaps.arcgis.com/stories/5110541947c54842958ad560ecdb334f#ref-n-102D5n

Surface Water Rights / Prior Appropriation

Water Rights Holders – Do GCS installations impact prior surface water appropriations?

45-141. Public nature of waters of the state; beneficial use; reversion to state; actions not constituting abandonment or forfeiture.

A. The waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, flood, waste or surplus water, and of lakes, ponds and springs on the surface, belong to the public and are subject to appropriation and beneficial use as provided in this chapter.

GCS practitioners must assure GCS pose no material impact to prior appropriators from "capturing flood flows."

Arizona Department of Water Resources
Surface Water Rights / Prior Appropriation

ADWR Surface Water Rights Program

Considerations for
Erosion Control Structures
without a surface water right:

- Detention –

  Structures must allow the surface water to completely pass through.

- No Retention –

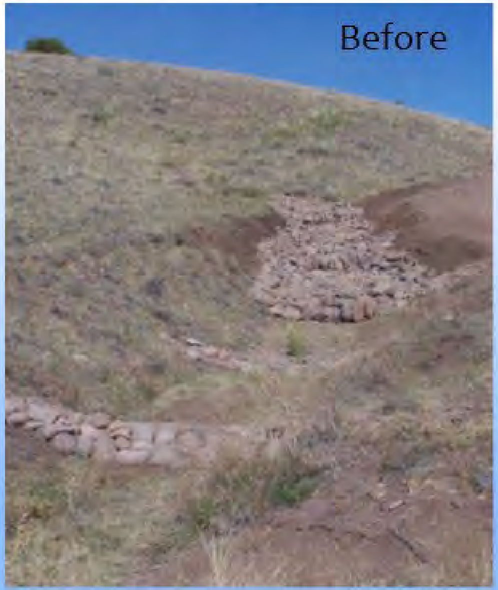
  Any structure constructed in a natural channel that captures surface water and prevents it from flowing downstream may be in violation of State surface water law.
  (impounding water → permit or certificate required)

Surface Water Rights / Prior Appropriation

Arizona Water Protection Fund – Example of funded projects that have included erosion control structures

Double Circle Ranch
Erosion Control Projects, Phase II

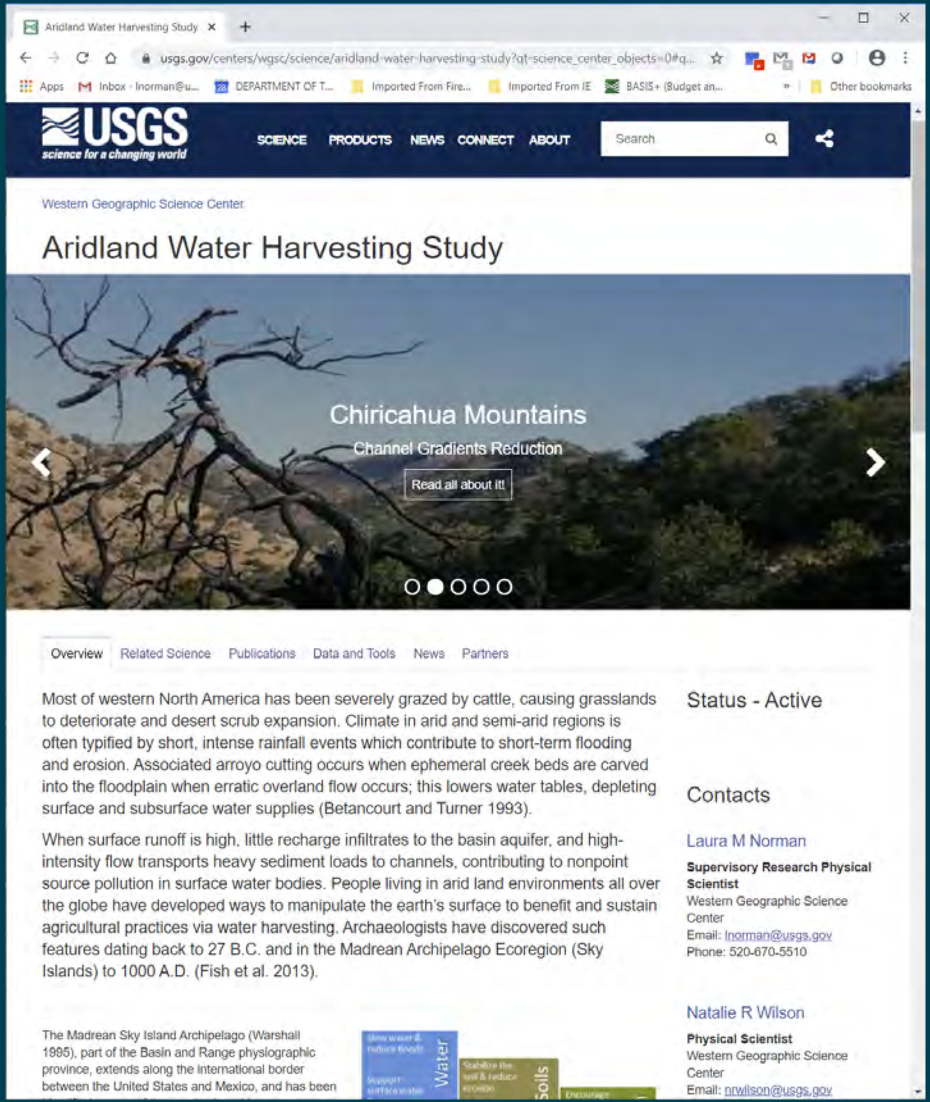
Reduction in sediment flow
towards Eagle Creek: benefitting aquatic habitat,
increasing water infiltration/water table, and an increase of productive soil
improving forage for wildlife and livestock.



USGS Research on LID/GCS

USGS science for a changing world
Land Change Science Program

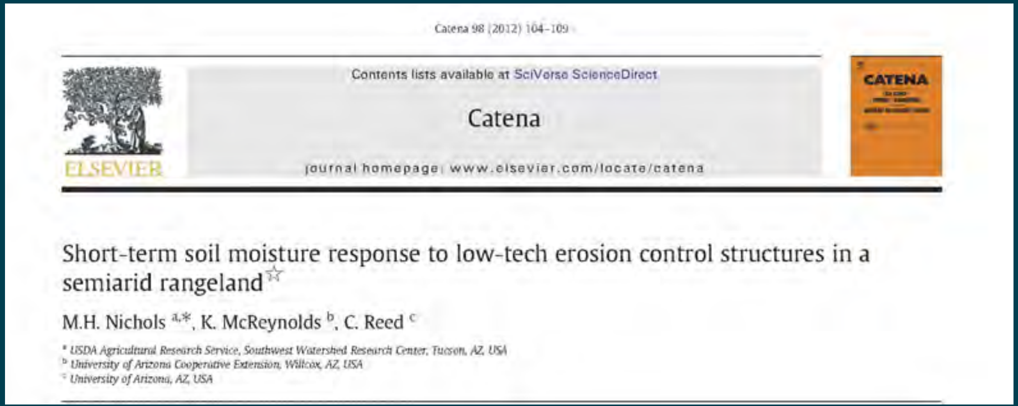
- Decrease peak flows for small-medium flood events
- Decrease stress in plants and increase vegetation health
- Increase surface-water availability at sites 5km downstream and 1km upstream
- Extend seasonal flows and increase volumes (by ~28%)
- Increase OM in soils (i.e. carbon sequestration); increase soil-moisture at structures (by ~10%)
- Decrease sedimentation downstream
- Benefit from modelling before installation occurs



http://usgs.gov/WGSC/Aridlands/
https://www.usgs.gov/staff-profiles/laura-m-norman

USDA Research Santa Rita Research Station

LID research conducted by the U.S. Department of Agriculture–Agricultural Research Service (USDA-ARS) includes pre- and post-installation monitoring which provides a great foundation to build on; however, there is “lack of (and need for) data to quantify their (LID) impacts” (Nichols, M.H., et al., 2012).


Catena 98 (2012) 104–109

Contents lists available at SciVerse ScienceDirect

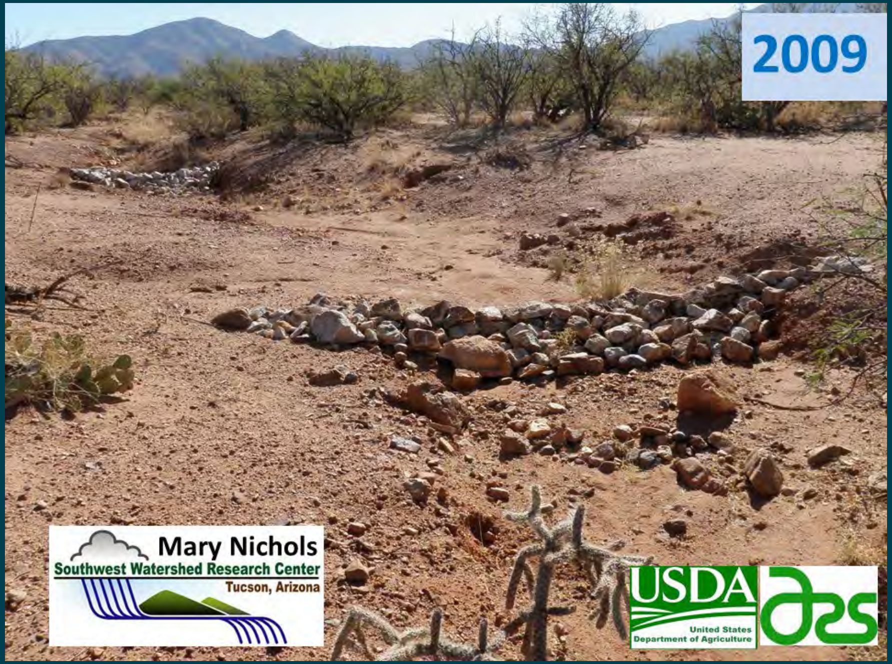
Catena

journal homepage: www.elsevier.com/locate/catena

Short-term soil moisture response to low-tech erosion control structures in a semiarid rangeland

M.H. Nichols [a,*], K. McReynolds [b], C. Reed [c]

[a] USDA Agricultural Research Service, Southwest Watershed Research Center, Tucson, AZ, USA
[b] University of Arizona Cooperative Extension, Willcox, AZ, USA
[c] University of Arizona, AZ, USA



Reclamation's Science & Technology Program

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Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy

Science and Technology Program
Research and Development Office
Final Report No. ST-2017-1751-01

Photo: Grade Control Structure #10 looking downstream, March 11, 2020 (Photo credit: Boy Scouts of America, Heard Scout Pueblo, Cameron Thomas)

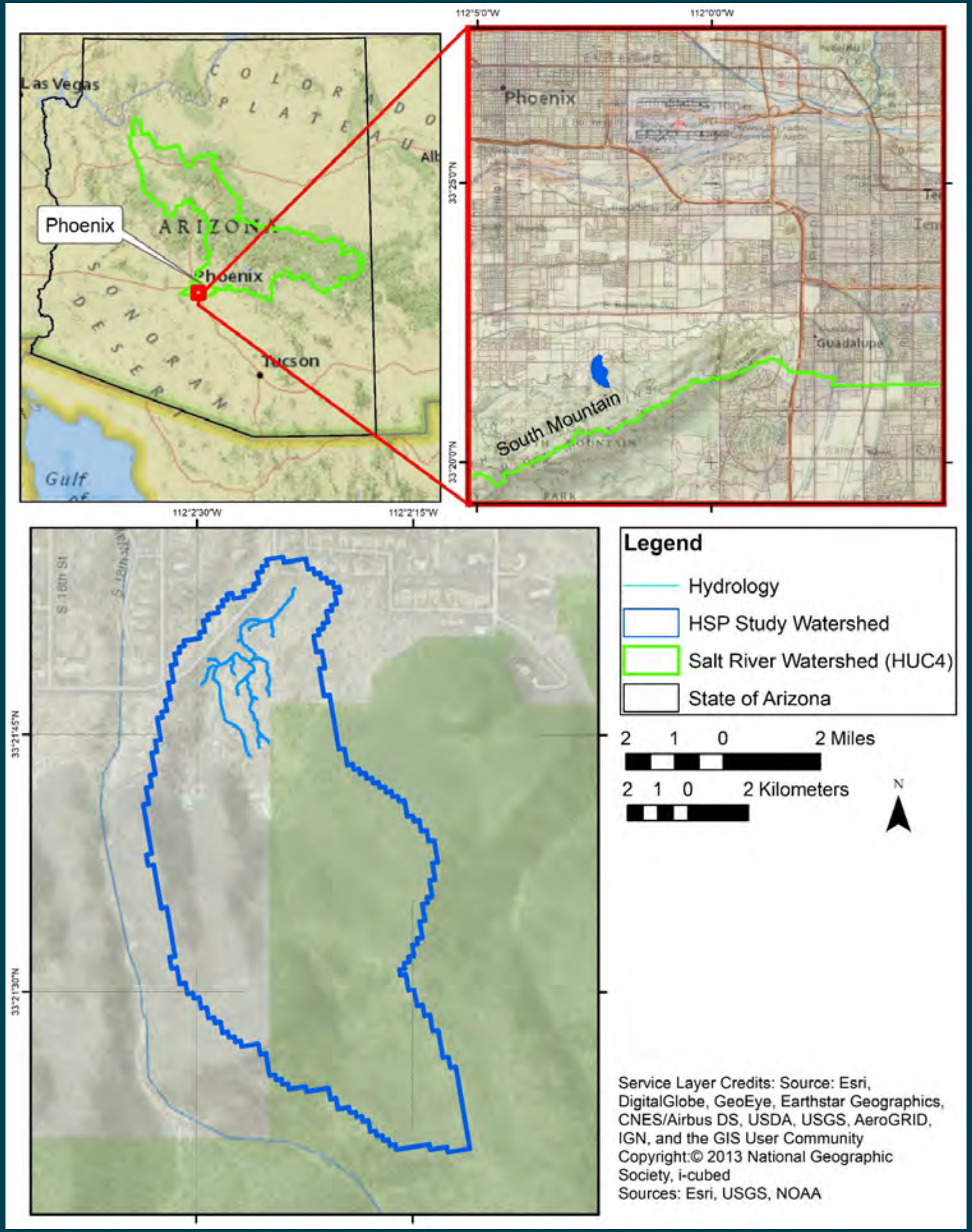
Photo: Grade Control Structure #2 looking upstream, March 13, 2020 (Photo credit: Bureau of Reclamation, Phoenix Area Office, Deborah Tosline)

U.S. Department of the Interior

September 30, 2020

https://www.usbr.gov/research/projects/detail.cfm?id=1751

Heard Scout Pueblo Research Site



The research was conducted in the foothills of South Mountain Park /Preserve

BOY SCOUTS OF AMERICA
GRAND CANYON COUNCIL

Heard Scout Pueblo Research Site Drainage

Monitoring and GCS installations were within the highlighted portions of the channel

Assessing LID for Stormwater Management, Stakeholder Meeting August 25, 2021

BOY SCOUTS OF AMERICA
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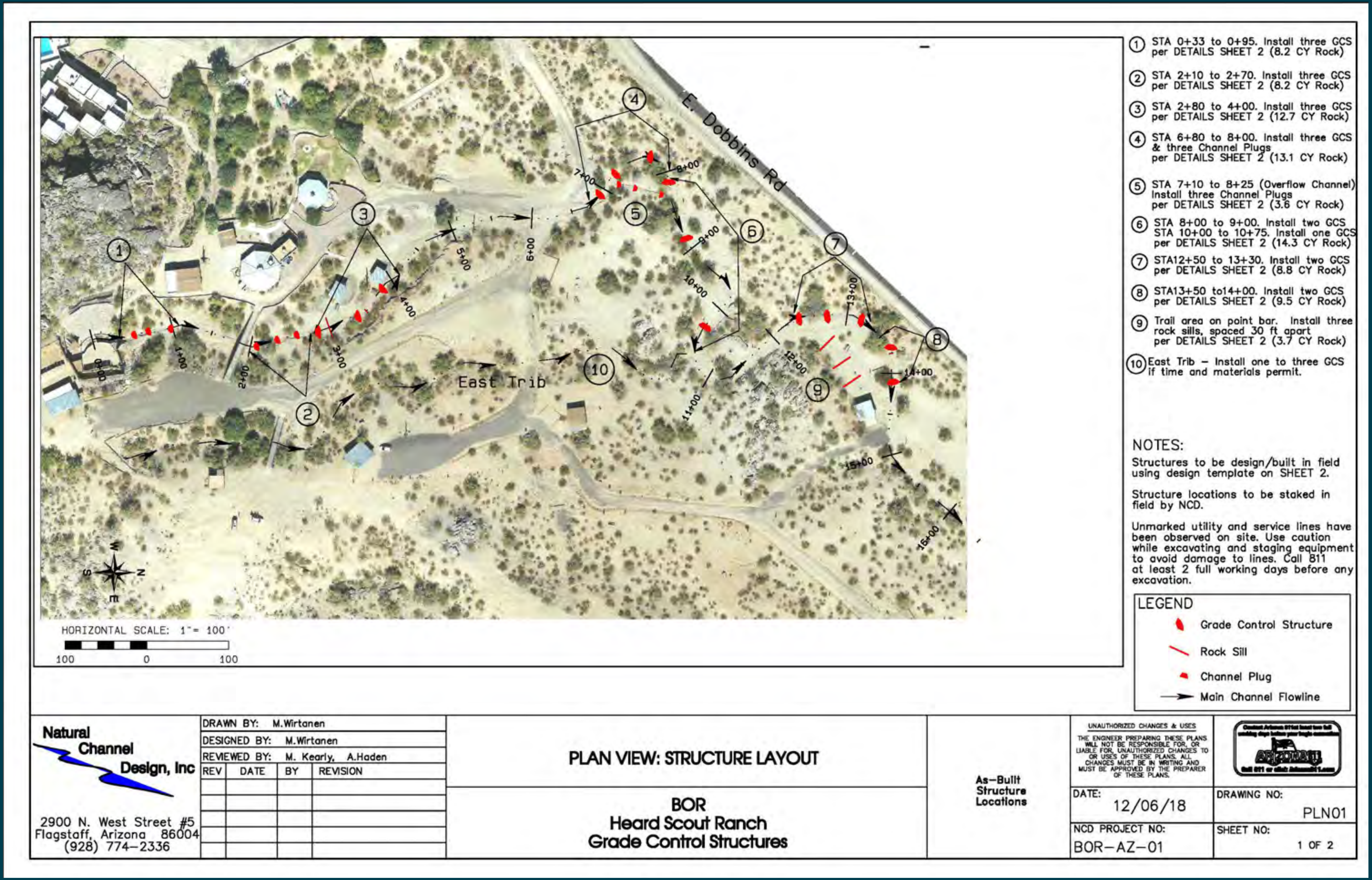
Natural Channel Design (NCD) – GCS Locations



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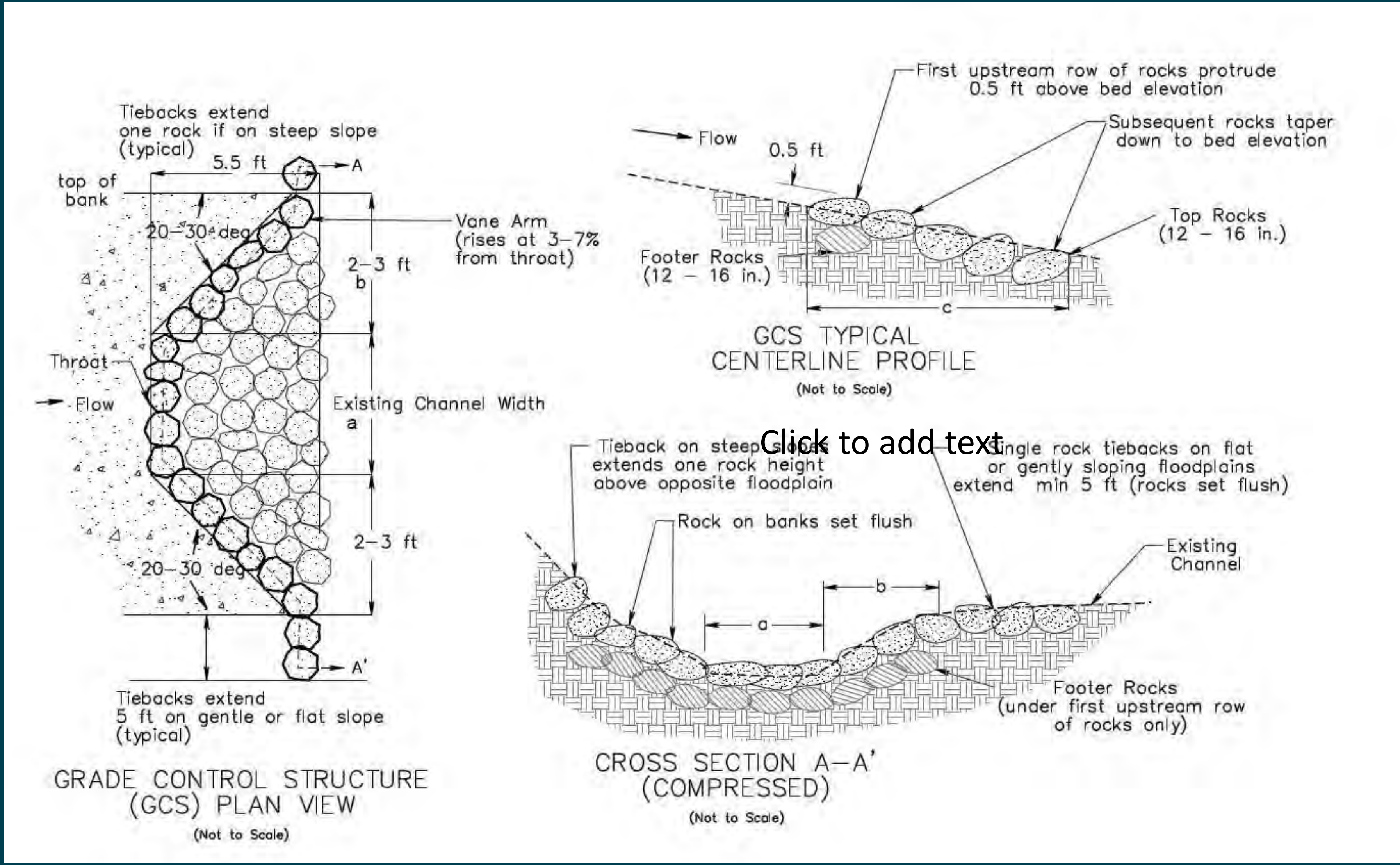
GRAND CANYON COUNCIL

Example GCS Designs



Created by Natural Channel Design for Heard Scout Pueblo Research

BOY SCOUTS OF AMERICA
GRAND CANYON COUNCIL

American Conservation Experience (ACE)

Photo credits: Deborah Tosline, BOR

BOY SCOUTS OF AMERICA
GRAND CANYON COUNCIL

Heard Scout Pueblo (HSP) GCS Installations
Excavation and Hand Building

Photo credits: Deborah Tosline, BOR

BOY SCOUTS OF AMERICA
GRAND CANYON COUNCIL

HSP GCS Sill Construction

Photo credits: Deborah Tosline, BOR

NAU Citizen Science at HSP

Stage

Take a photo and send it

Photo credits: Deborah Tosline, BOR

BOY SCOUTS OF AMERICA
GRAND CANYON COUNCIL

HSP GCS Installations in March 2020

GCS #10

Photo credit: Boy Scouts of America, Heard Scout Pueblo, Cameron Thomas

Photo credit: Deborah Tosline, BOR

GCS #1

BOY SCOUTS OF AMERICA
GRAND CANYON COUNCIL

HSP GCS Structure #1

Photo: 2018 after installation

Looking Upstream

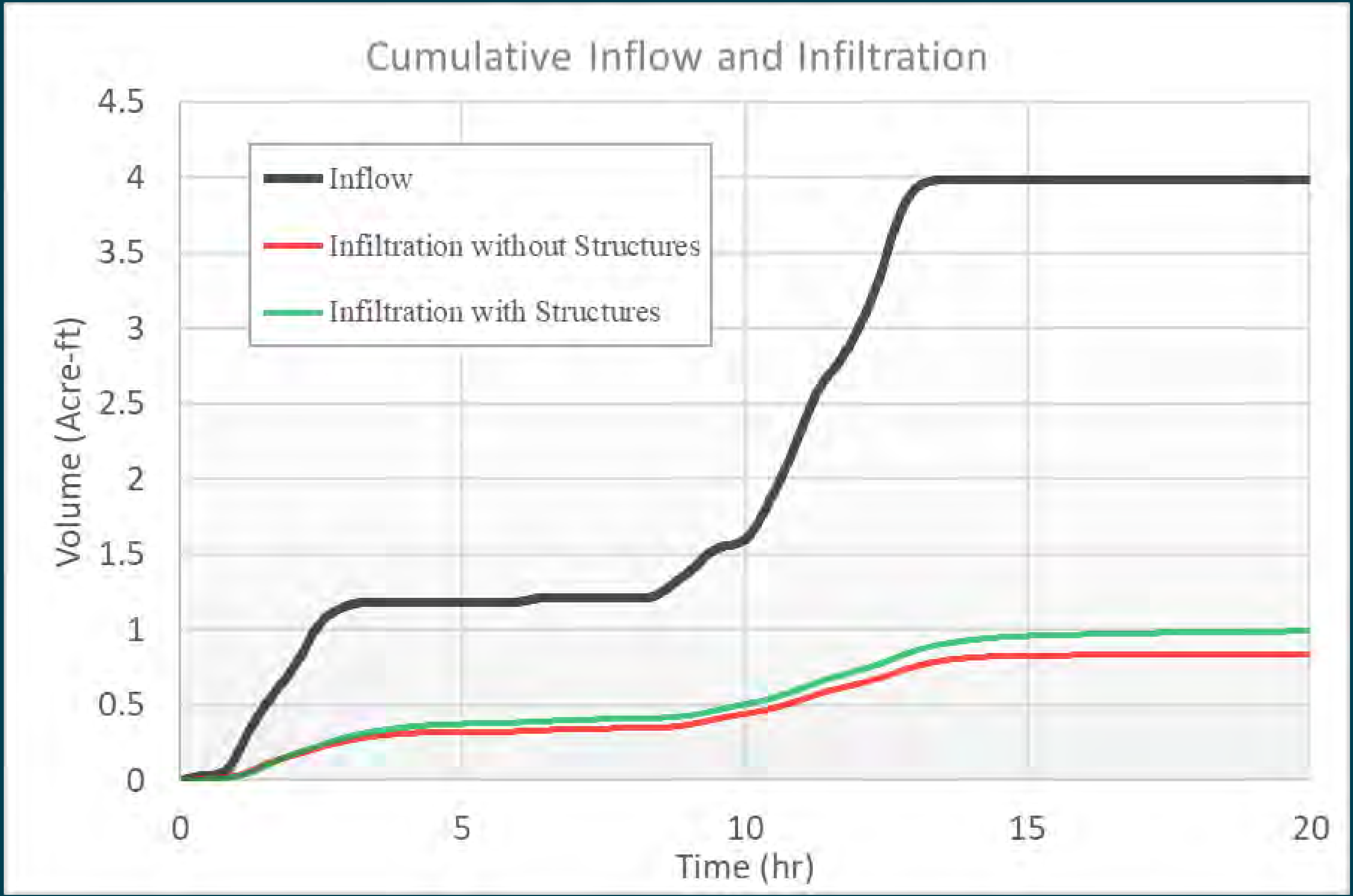
Photo: March 13, 2020

Sedimentation above and below GCS

Photo credits: Deborah Tosline, BOR

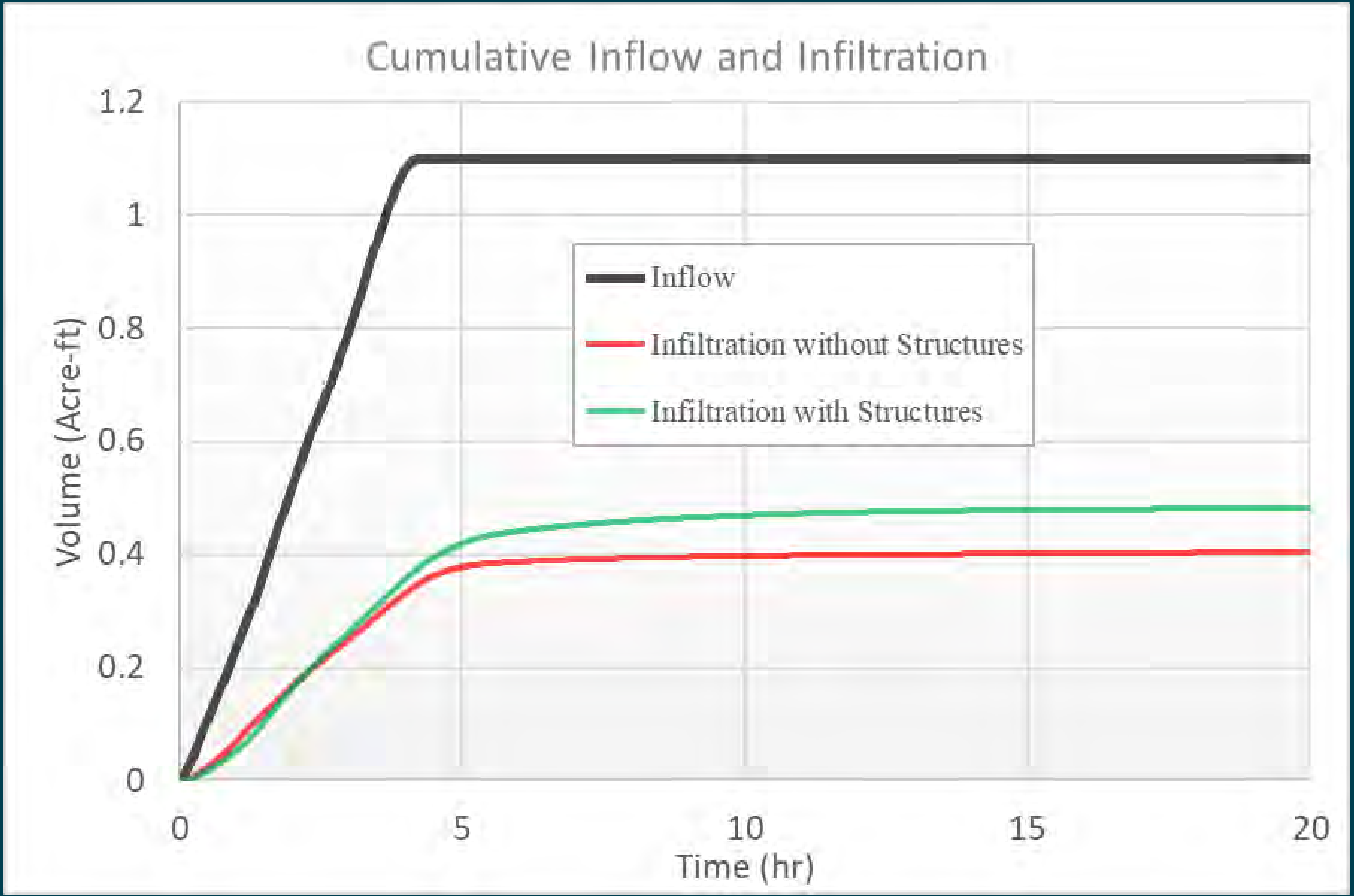
BOY SCOUTS OF AMERICA
GRAND CANYON COUNCIL

Simulated Cumulative Infiltration: October 13, 2018



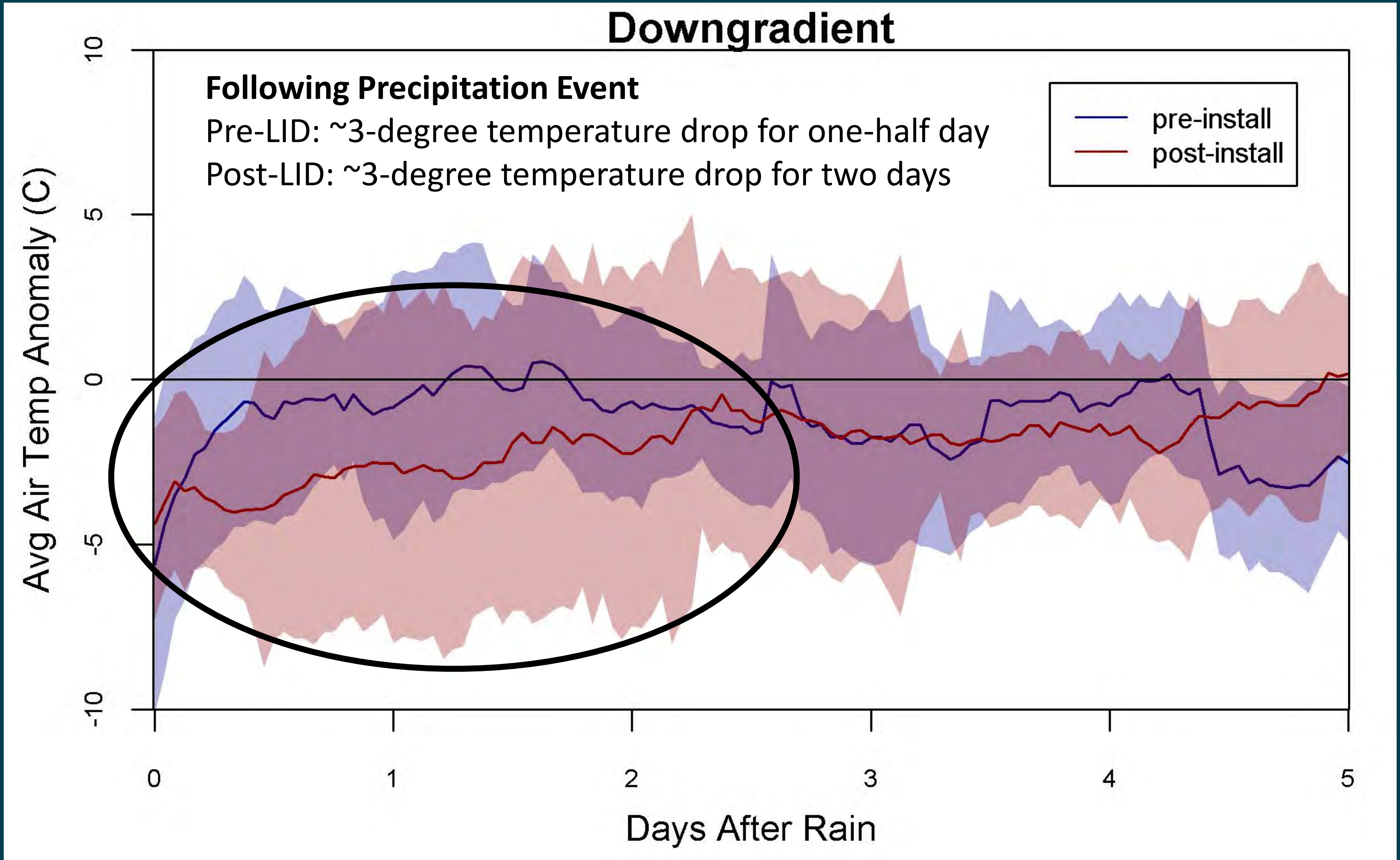
- Assumed hydraulic conductivity (1.4 in/hr)
- Simulated with and without GCS
- Increased infiltration by approximately 15%

Simulated Cumulative Infiltration November 29, 2019



- Assumed hydraulic conductivity (1.4 in/hr)
- Simulated with and without LID

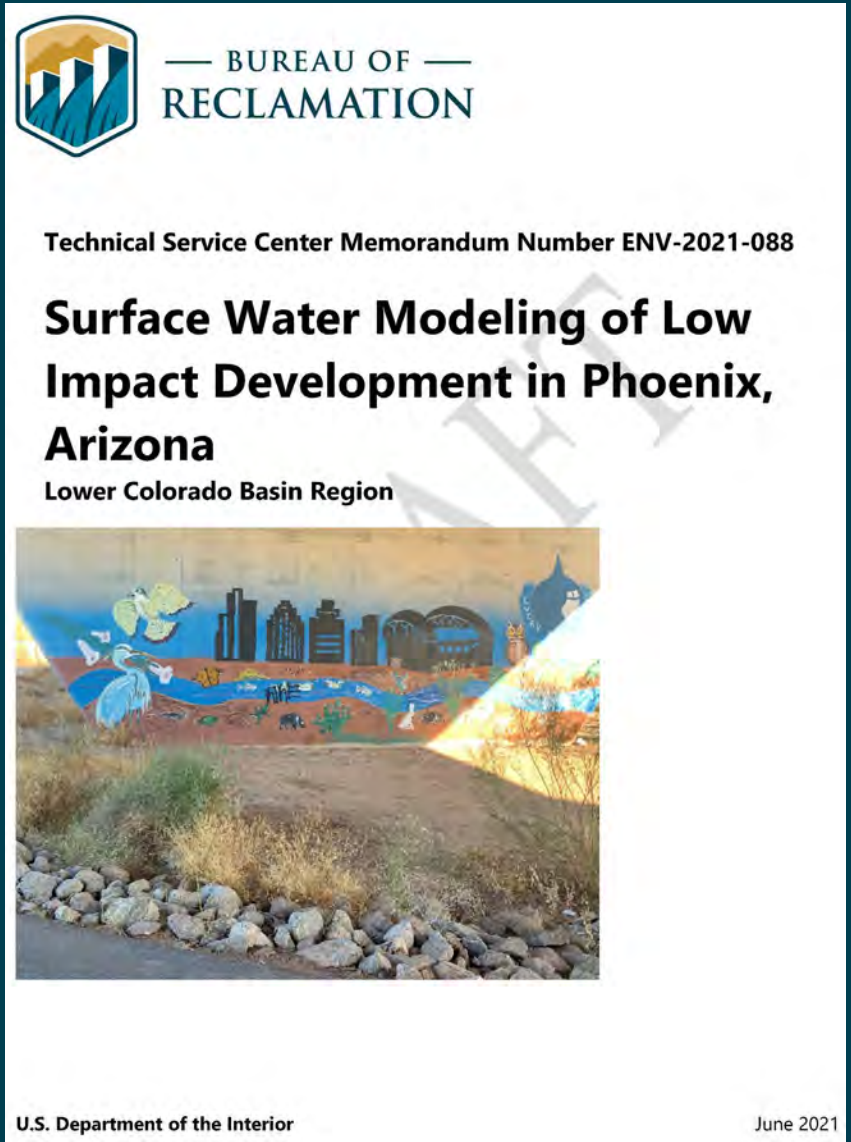
HSP GCS Microclimate – Temperature



- Anomaly; mean departure from ROD mean this month
- Lag in days after rainfall ended
- Weighted in proportion to the depth of rainfall
- Pre = blue, Post = red; envelope is range observed

Study - Identifying Key Areas in the City of Phoenix for Infiltration and Retention Using Low Impact Development (LID Floodplain Study)

Surface Water Model Draft Report



— BUREAU OF —
RECLAMATION

Technical Service Center Memorandum Number ENV-2021-088

Surface Water Modeling of Low Impact Development in Phoenix, Arizona

Lower Colorado Basin Region

U.S. Department of the Interior

June 2021

Example Theoretical LID Residential Scenarios from Reclamation's LID Floodplain Study

KEY

- Rain garden / Chicanes
- Rain Barrels
- Disconnected Downspout

Example Theoretical LID Public Scenarios from Reclamation's LID Floodplain Study

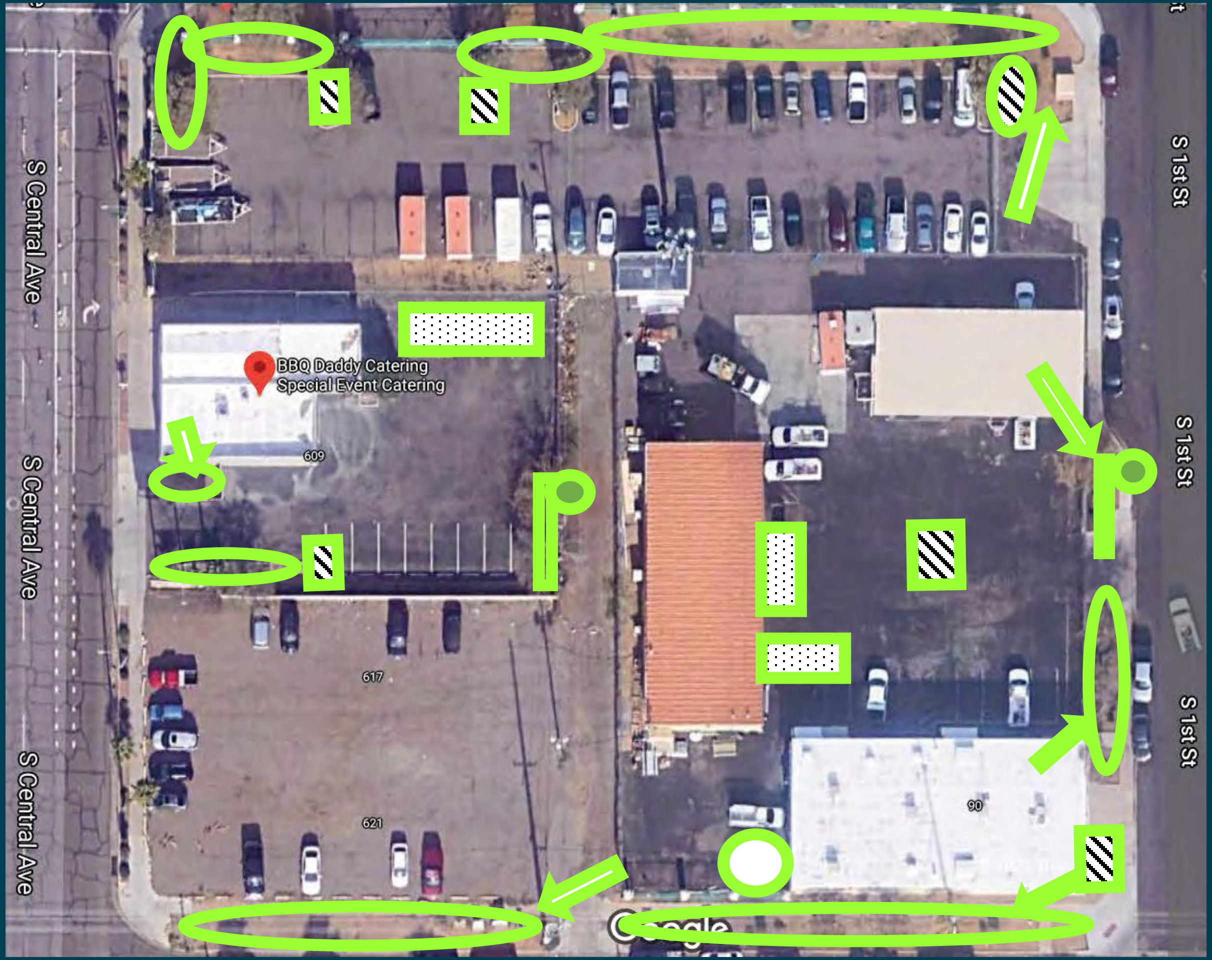
KEY

- Bio-Retention
- Rain garden / Chicanes
- Permeable pavement
- Rain Barrels/ Cisterns
- Disconnected Downspout

Example Theoretical LID Commercial Scenarios from Reclamation's LID Floodplain Study

KEY

- Bio-Retention
- Rain garden
- Permeable pavement
- Rain Barrels/ Cisterns
- Disconnected Downspout
- Infiltration trenches



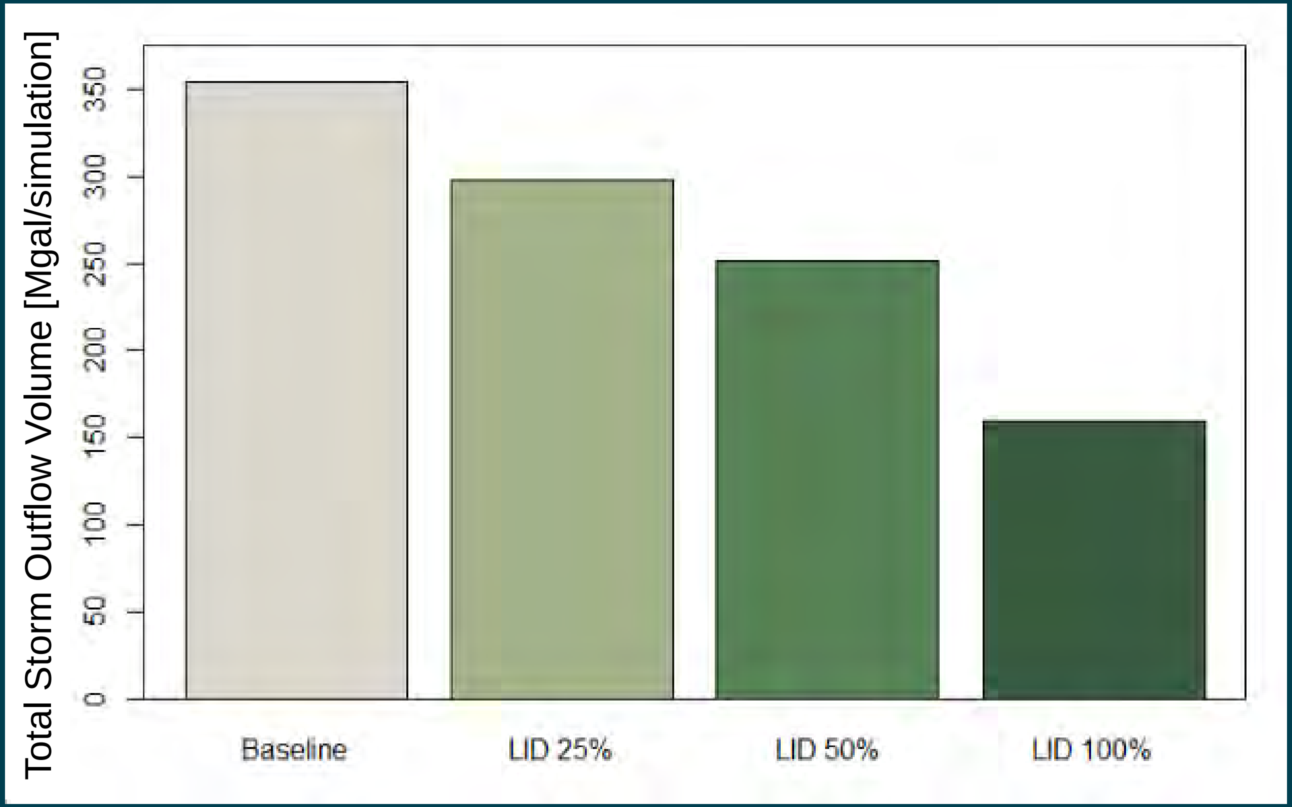
Example Theoretical LID Industrial Scenarios from Reclamation’s LID Floodplain Study

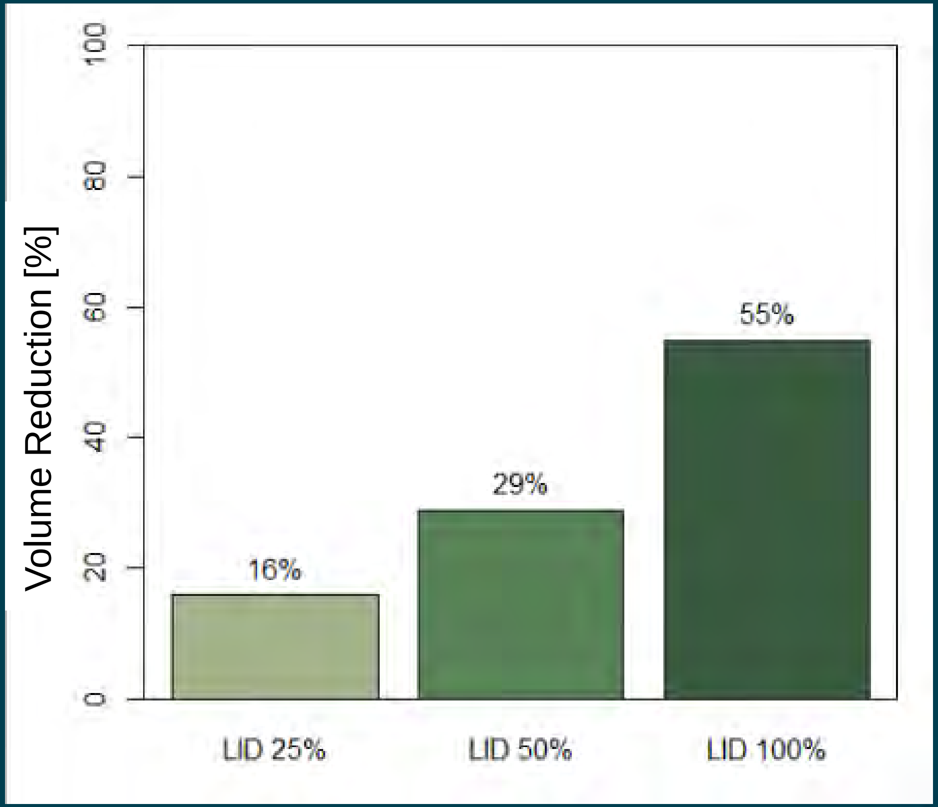
KEY

- Bio-Retention
- Rain garden
- Permeable pavement
- Rain Barrels/ Cisterns
- Disconnected Downspout
- Infiltration trenches

LID Floodplain Study Surface Water Model

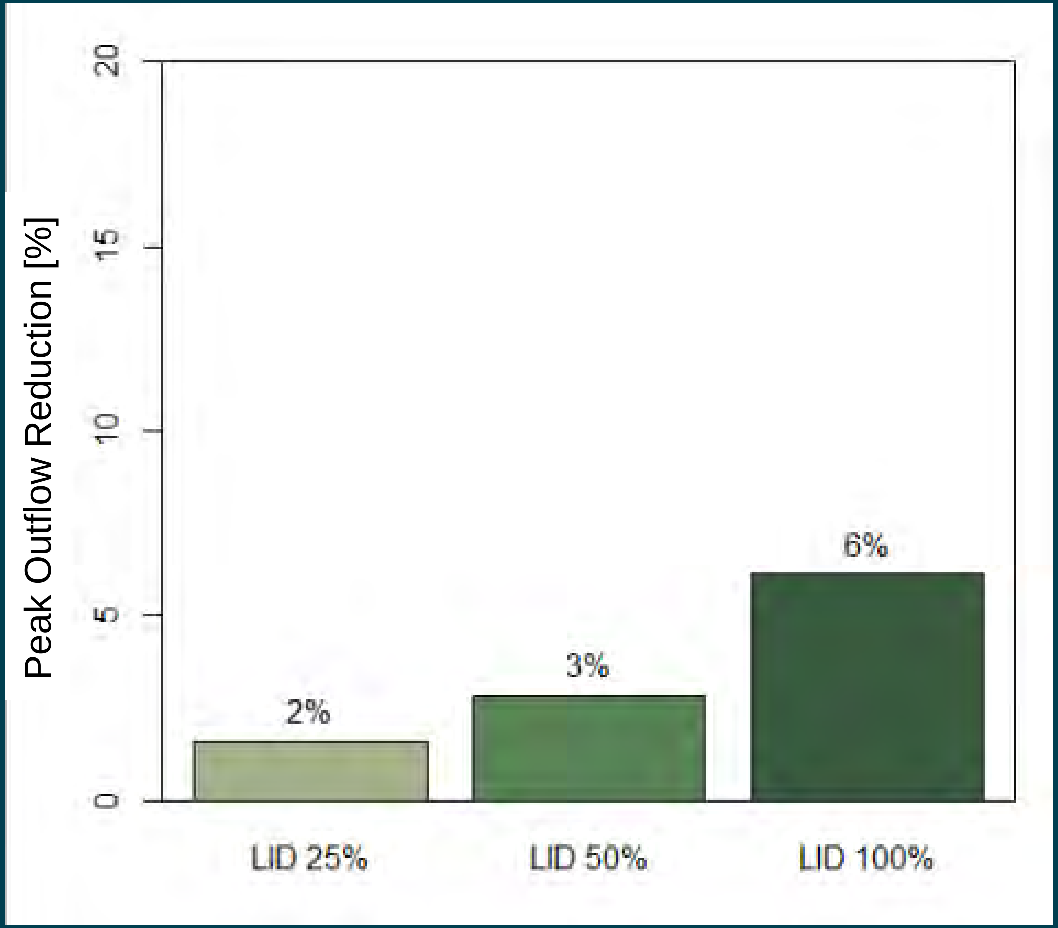
Results - Change in Total Outflow Volume





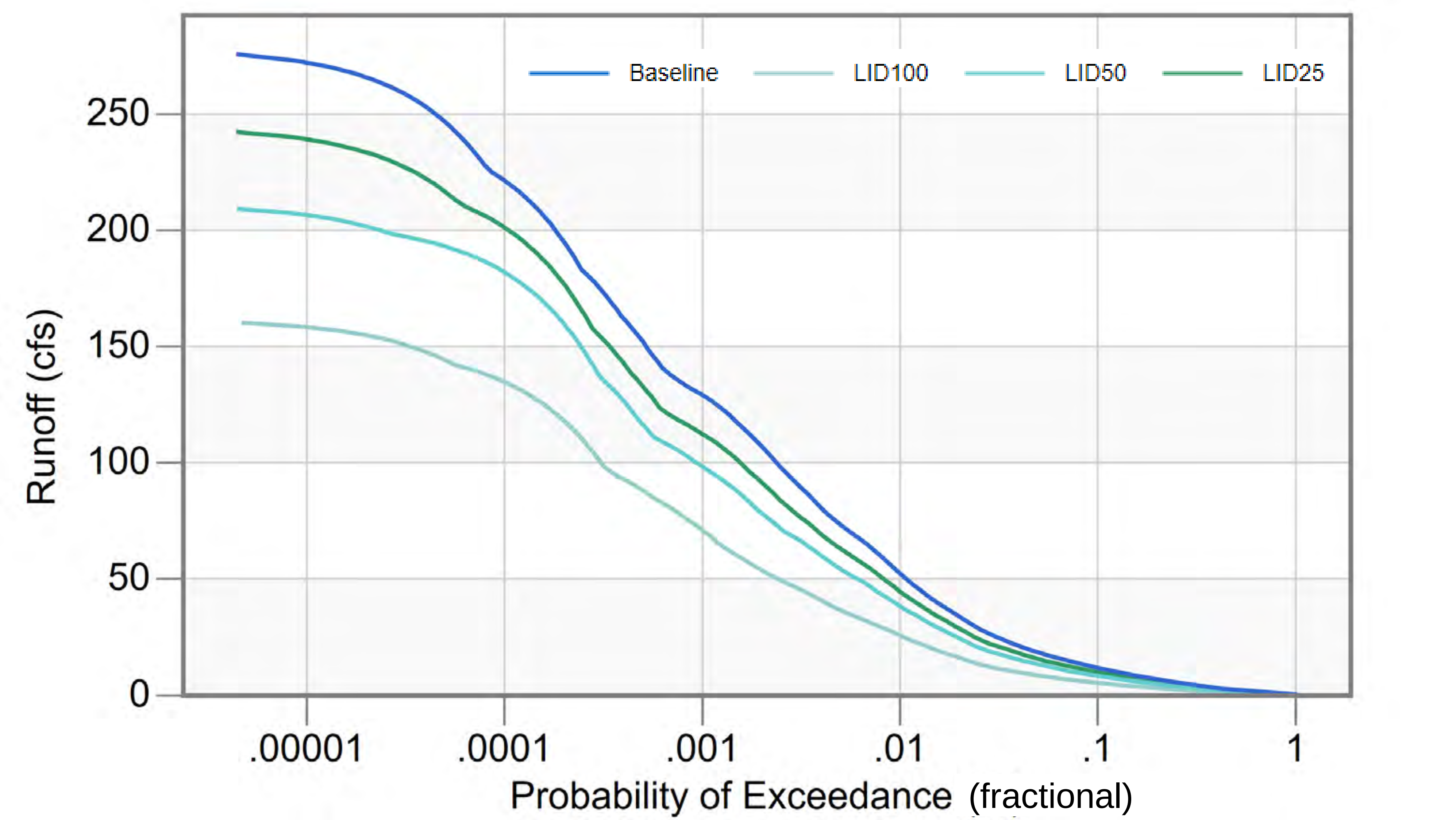
LID Floodplain Study Surface Water Model

Results – Change in Peak Outflows



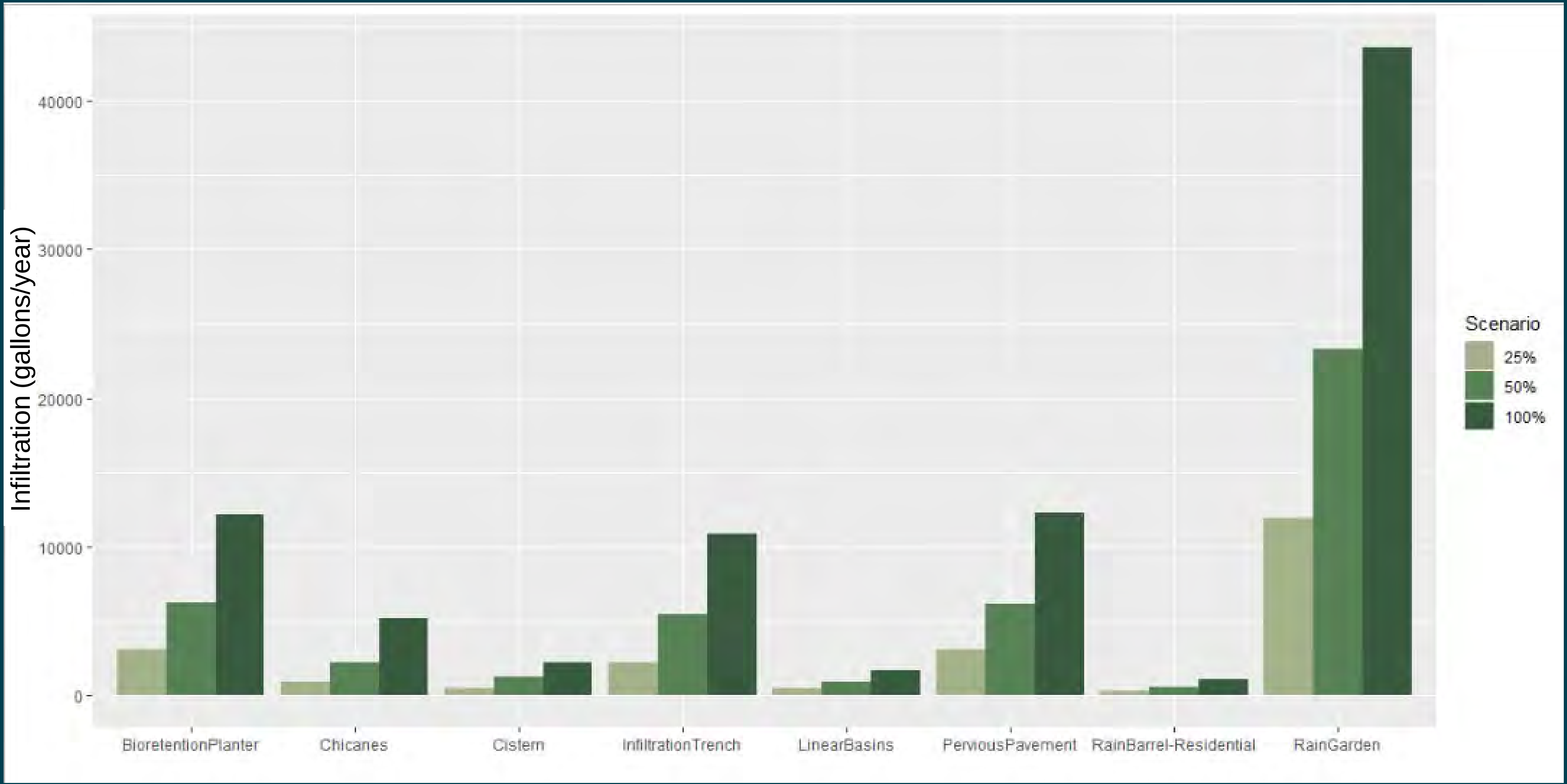
LID Floodplain Study Surface Water Model

Results – Runoff exceedance



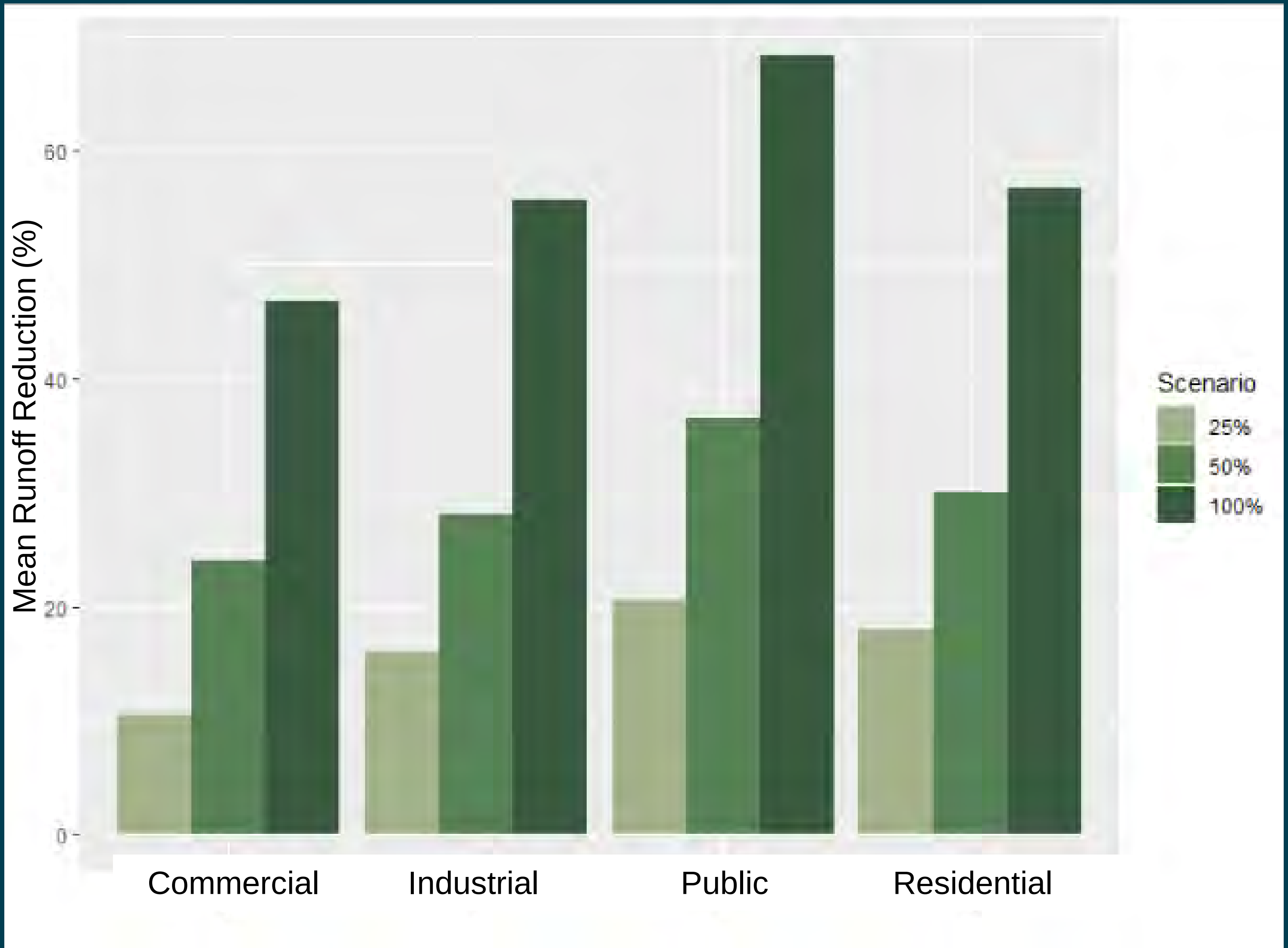
LID Floodplain Study Surface Water Model

Results – Infiltration by feature type

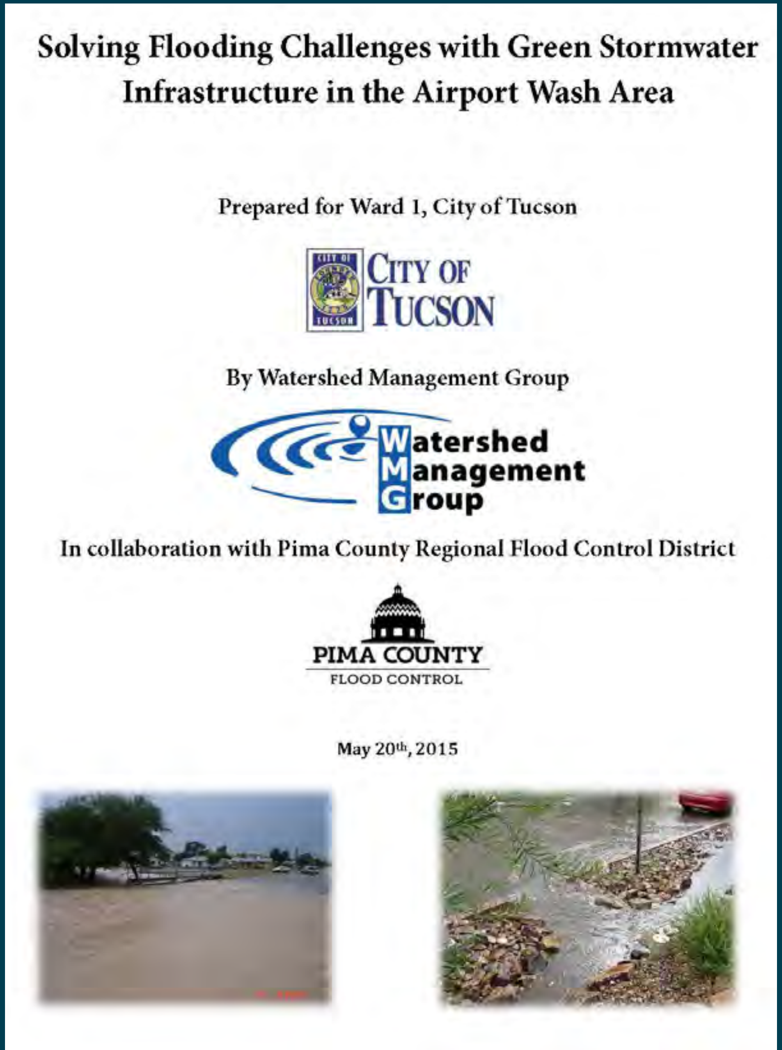


LID Floodplain Study Surface Water Model

Results – Change in runoff by land use



Limited LID Modeling in Arizona Urban Settings



Solving Flooding Challenges with Green Stormwater Infrastructure in the Airport Wash Area

Prepared for Ward 1, City of Tucson

CITY OF TUCSON

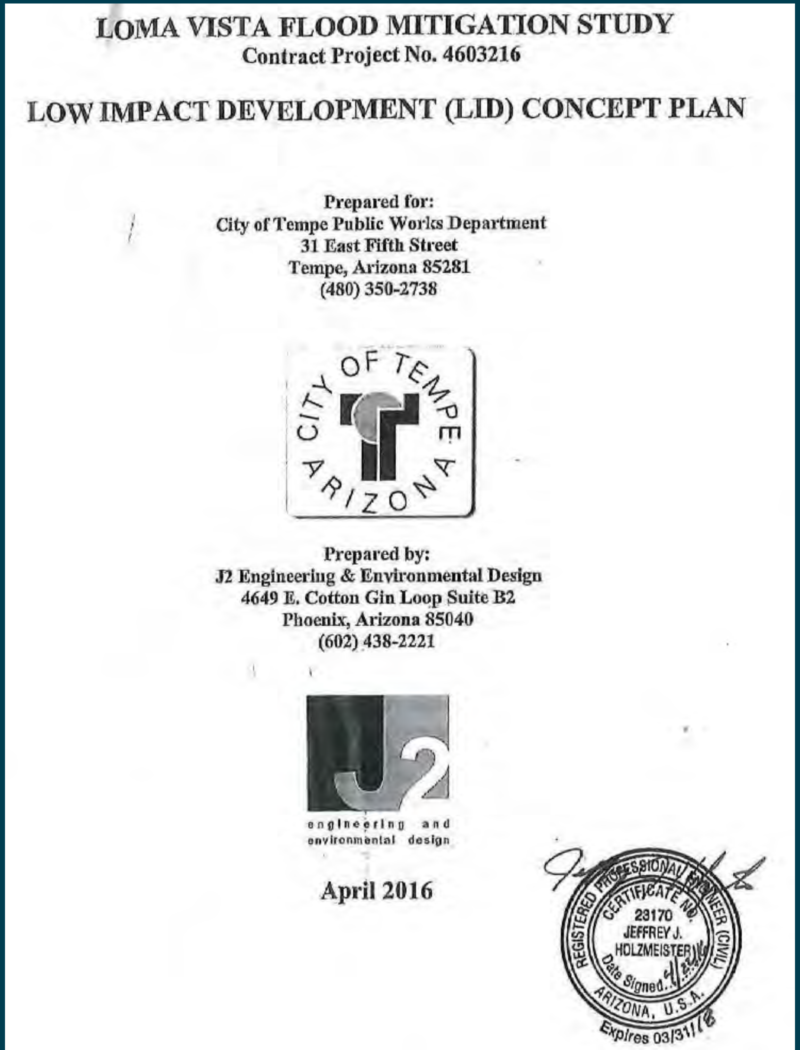
By Watershed Management Group

Watershed Management Group

In collaboration with Pima County Regional Flood Control District

PIMA COUNTY
FLOOD CONTROL

May 20th, 2015



LOMA VISTA FLOOD MITIGATION STUDY
Contract Project No. 4603216

LOW IMPACT DEVELOPMENT (LID) CONCEPT PLAN

Prepared for:
City of Tempe Public Works Department
31 East Fifth Street
Tempe, Arizona 85281
(480) 350-2738

CITY OF TEMPE ARIZONA

Prepared by:
J2 Engineering & Environmental Design
4649 E. Cotton Gin Loop Suite B2
Phoenix, Arizona 85040
(602) 438-2221

J2 engineering and environmental design

April 2016

REGISTERED PROFESSIONAL ENGINEER (CIVIL)
CERTIFICATE NO. 23170
JEFFREY J. HOLZMEISTER
Date Signed
ARIZONA, U.S.A.
Expires 03/31/18

Hassayampa River Study - Assessing LID for Stormwater Management

Tasks

- Collaborate with Flood Control District of Maricopa County (FCDMC)
  - Data and information sharing from Sun Valley (SV) Area Drainage Master Plan (ADMP)
  - Coordinate to augment results of Hassayampa River and FCDMC SV ADMP studies
- Develop surface water model to assess effectiveness of using LID/GCS to manage stormwater
- Assess operations and maintenance (O&M) requirements for existing LID/GCS
- Develop City of Buckeye LID Design Standards Handbook
- Develop conceptual groundwater model to assess the effect of LID/GCS on aquifer recharge
- Interim and Final Reports

Surface Water Model

- Develop and model theoretical LID/GCS installations
  - Urban and undeveloped
  - Withing and upstream from developments
  - On alluvial fans on west side of White Tank Mountains
- Assess LID/GCS potential to:
  - reduce volume and velocity of stormflows
  - reduce erosion
  - maintain pre-development infiltration and groundwater recharge conditions
  - reduce sediment transport
- Determine LID/GCS installation rate required to meet regulatory requirements
- Assess whether GCS stabilize channel conditions in alluvial fans
- Simulate how far upstream GCS features need to be installed
- Develop and model LID/GCS treatment scenarios
- Compare effectiveness of LID/GCS versus conventional stormwater treatments

Assessment of O&M Actual Costs for Existing LID Installations

- Reference search
  - Arid and Semi-Arid Lands
  - Existing LID features with routine O&M
  - Urban and Wilderness LID
  - Function
  - Sedimentation
  - Trash removal
  - Existing LID installations with routine O&M
- Interviews with entities who maintain existing LID installations
- Compile and assess estimated versus actual LID O&M costs
- Technical Memorandum

City of Buckeye LID Design Standards Handbook

- Compile and review existing LID/Green Infrastructure (GI) handbooks and engineering standards pertaining to Arizona for arid and semi-arid environments

- Identify LID/GCS features of interest or concern

- Identify new LID/GCS features for Buckeye conditions/needs:
  - GCS in alluvial fans
  - LID/GCS transitions between undeveloped and developed areas

- Prepare Buckeye LID Design Standards Handbook

[Greater Phoenix Metro Green Infrastructure Handbook: Low-Impact Development Details for Alternative Stormwater Management - Sustainable Cities Network (asu.edu)]

Conceptual Groundwater Model

- Develop conceptual integrated groundwater-surface water model (hydrogeologic model)
- Simulate aquifer recharge characteristics of LID/GCS runoff-control features and compare with conventional stormwater management
- Modify existing West Salt River Valley groundwater model (WSRV Basin Study model) as a base model and add stormwater component
- Provide framework for understanding the system of surface to subsurface movement of water and project future outcomes related to LID/GCS and non-LID/GCS stormwater management

QUESTIONS or COMMENTS?

Deborah Tosline, RG, PMP
Hydrogeologist/Program Manager
U.S. Bureau of Reclamation
Phoenix Area Office
623-773-6277 dtosline@usbr.gov

BUREAU OF RECLAMATION