RECLAMATION

Managing Water in the West

Installing Erosion Control Structures Across a Landscape as a Restoration Treatment and Adaptive Watershed Management Alternative for Climate Change

Research and Development Office
Science and Technology Program
Final Report ST-2016-720

U.S. Department of the Interior
Bureau of Reclamation
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Mission Statements

The U.S. Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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14. ABSTRACT *(Maximum 200 words)* The study assessed the potential to develop partnerships, identify research locations, and develop a refined scope of work to conduct hydrologic research at Erosion Control Structure (ECS) installations. Anecdotal evidence indicates that ECS installations result in dramatic environmental improvements including: habitat establishment, maintenance, and inter-connectivity; reductions in stormflow bedload; reduced storm flow peaks; longer flow durations; increased availability of local water resources; and increased environmental awareness, education and economic opportunities. Climate change projections predict fewer yet more intense precipitation events. Adaptive watershed management alternatives may be used to manage and mitigate flood flows during intense storms. USGS research shows that ECS-treated drainages had fewer transmission losses, and showed a reduction in average rate of flow, primarily in the peak flow size and duration, by more than one half, but research indicates a lack of data to quantify ECS impacts. The study gained over 90 participants, developed cooperative collaborations with partners and stakeholders, identified research sites, developed a scope of work, and prepared a proposal to collect pre- and post-installation hydrologic data at ECS research sites.

15. SUBJECT TERMS Erosion Control Structures, Grade Control Structures, Restoration, Hydrology, Sediment Transport, Ephemeral Stream, Perennial Stream, Intermittent Stream, Peak Flood Flow, Surface Water, Bank Storage, Ecosystems, Habitat Interconnectivity

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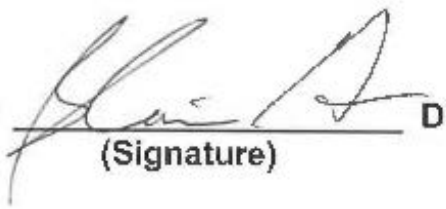
Reviewer  (Signature) Date reviewed 9-28-16

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Executive Summary

Problem

Installation of Erosion Control Structures (ECSs) across a landscape to manage stormflows is an ancient practice. Grassroots efforts are underway in Arizona by land owners and managers to install ECS's to reduce channel cutting and land degradation, promote river and habitat restoration, increase and extend surface water flows, recharge shallow groundwater systems, reduce sediment loads in flood flows, and slow storm flows as they discharge from the watershed.

Despite the increasing trend to install ECSs for land and ecosystem restoration, these installations typically do not include hydrologic and sediment transport monitoring to assess storm flow impacts. Anecdotal evidence and limited research show that ECS installations reduce storm peak flows, decrease sediment transport, and increase base flow. Water managers increasingly include ECSs as adaptation strategies for watershed resource planning. Surface water rights holders question whether storm flows, slowed by ECS installations, "capture flood flows" (ARS 45-141) and infringe on surface water appropriations. Anecdotal evidence indicates increases in the spatial and temporal extent of local water resources following installation of ECSs. However, hydrologic and sediment transport monitoring is lacking and required to assess the impact of ECS installations to inform policy.

Reclamation has capabilities to conduct research and the potential to collaborate with external partners who provide technical expertise with ECS installations, monitoring techniques and cross-jurisdictional data sharing. The U.S. Geological Survey (USGS) is developing methodologies to monitor ephemeral storm flows in remote locations and conducting post-installation research of mature ECS-treated drainages. ECS 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 (ECS) impacts" (Nichols, M.H., et al., 2012). Further, "A limited number of studies have been published quantifying the impacts of check dams on sediment retention" and "the authors are not aware of any studies specifically quantifying soil moisture impacts." (Nichols, M.H., et al., 2012).

Climate change predictions for the American Southwest include less frequent yet stronger precipitation events and fewer moderate events (U.S. Global Change Research Program, 2014). ECS installations may be an effective adaptive management tool to mitigate storm flow hazards and optimize water resources. However, pre- and post-ECS installation monitoring is required to assess impacts to water resources and sediment transport.

There may be significant legal and institutional barriers to the use of ECSs as an adaptive management strategy. Prior to considering implementation, legal and institutional issues must be considered.

Scoping Study

Work completed under the scoping study, which was geographically focused on central Arizona, assessed community interest and identified potential partners and stakeholders for future ECS research. Tasks completed included: develop partnerships, identify potential research locations, assess hydrologic and sediment transport data collection methodologies, develop a scope of work, prepare a conducting proposal (as described in Reclamation's FY16 Science and Technology Program Proposal Guidance), and disseminate information.

At inception of the ECS scoping study, the following were developed: an email notification list (Appendix A), a shared drive to allow public access to study materials, and a one-page summary (Appendix B) for outreach to potential partners and stakeholders. Five conference call and video conference meetings were held between December 14, 2015 and May 9, 2016. During the meetings, partners and stakeholders provided input on scoping study tasks including planning for an All Day Meeting (participant list provided in Appendix C); developing a literature search (Appendix D); identifying ECS research locations; and developing a scope of work for the proposed research. Agendas and meeting notes were distributed to the ECS notification list and posted on the shared drive.

A literature search was conducted and a list of references was compiled to assess current research activities, identify data gaps, avoid duplication and identify potential collaborations. In addition, an effort was begun to compile potential ECS installation locations within Arizona.

During preparation of the scoping proposal, the Maricopa County Parks and Recreation Department (MCPRD) offered the Spur Cross Ranch Conservation Area (CA) in Cave Creek as a potential research site. During the scoping study, MCPRD included the Hassayampa River Preserve (HRP) in Wickenburg as another research site. A Geographic Information System (GIS) was used to compile information and prepare maps for the CA and HRP sites (Appendix E).

An All Day Meeting was held on May 24, 2016 at the Bureau of Land Management National Training Center in Phoenix. The agenda included a variety of presentations to provide an overview of current work within Arizona including: ECS installation methods, current monitoring, collaborations, potential regulatory concerns and future planning.

Following the All Day Meeting, additional collaborative efforts were identified and another potential ECS research site became available at the Heard Boy Scout

Camp (BS), located on the north side and base of South Mountain in Phoenix. The site is owned by the Boy Scouts of America.

Relevant watershed group meetings and conferences were identified, attended and three presentations were made to promote information sharing and for networking. One presentation was made to the Arizona Hydrological Society (AHS) Phoenix Chapter March 2016 dinner meeting to about 20 attendees. A second presentation was made to the Four-Corners Adaptation Forum sponsored by the Southern Rockies Landscape Conservation Cooperative (SRLCC) in May 2016, in Durango, CO. A third presentation was made to a larger audience at the AHS 2016 Annual Symposium held in September in Tucson. The Symposium typically attracts 150 to 400 attendees with multiple consecutive daily technical sessions scheduled.

Two meetings were attended to promote the ECS scoping study: 1) the 2015 Annual Conference of the Society for Ecological Restoration - Southwest Chapter in November 2015, in Tucson; and 2) a meeting between Babbitt Ranches and the SRLCC in April 2016, in Flagstaff.

Scoping Study Results

The scoping study provided a networking forum for interested individuals and groups from throughout Arizona who have installed or would like to install ECS systems. As a result, new collaborative cross-jurisdictional and interdisciplinary partnerships to research ECS systems as an adaptive management restoration alternative were established.

Presentations made to the AHS Phoenix Chapter, the Four-Corners Adaptation Forum and the AHS 2016 Symposium were well received, generated questions, and resulted in increased participation with the ECS scoping study.

Outreach efforts resulted in the ECS email notification list growing to ninety (90) participants, including partners and stakeholders from throughout Arizona and beyond. All available scoping study information was posted to the shared drive to help increase information sharing and communications.

As a result of the literature search and outreach efforts, future potential collaborative efforts were discussed with USDA-ARS research staff who have developed databases for ECS-associated references and ECS installation locations. Future work could involve data sharing to enhance the USDA-ARS regional databases. Further, the USDA-ARS is developing standard nomenclature associated with ECSs and has recommended the use of Grade Control Structures (GCS) versus ECSs for general reference to the methodology. ECS is used in this report to remain consistent with scoping study nomenclature.

A Geographic Information System (GIS) was used to conduct initial assessments of the CA and HRP sites. Information was displayed on maps (Appendix E) for dissemination and presentation to partners and stakeholders at the All Day Meeting, including:

- property boundaries
- land ownership
- nearest stream gage locations
- groundwater well locations
- flood zones,
- soil and topographic data.

During the GIS application process, available data were evaluated for future potential development of digital elevation models to identify ECS installation locations, and to characterize the pre-runoff channel profile and channel cross section geometry. Site evaluation criteria included: sites within partner ownership boundaries, sites with eroded and exposed soil surface, and drainages with concentrated flow paths.

An All Day Meeting was held on May 24, 2016 at the Bureau of Land Management National Training Center in Phoenix. Thirty-five attendees representing federal, tribal, state, local, non-profit, low-profit and private interests as well as representatives from Salt River Project (surface water rights holder) and Arizona Department of Water Resources (surface water rights manager) participated. Eleven (11) presentations were offered covering ECS installations in remote and urban settings; monitoring; hydrologic, environmental and sociological impacts; regulatory perspectives and requirements; and an overview of proposed research locations. Presentation topics were:

> ***An Overview of Selected Biological, Hydrological and Social Applications of Various Erosion Control Structure Installations*** by David Seibert, PhD and Executive Director of Borderlands Restoration L3C
>
> ***Water Sensitive Design – A Conservation Issue*** by Maggie Messerschmidt, Urban Conservation Program Associate, The Nature Conservancy
>
> ***Atturbury Wash Riparian Stewardship Project: Meeting the Challenges of an Urban Watershed*** by Andy Bennett, Ecological Restoration Specialist, Tucson Audubon Society
>
> ***Restoration of Cienegas and Headwater Tributaries of the Rio San Bernardino*** by David Hodges, Conservation History, Science, and Research, Cuenca Los Ojos

Increasing Watershed Resilience: Before and After Fire in the Chiricahua Mountains by Bryon Lichtenhan, Conservation Assistant, Sky Island and Jennifer Varin, Watershed Program Manager, Coronado National Forest, U.S. Forest Service

Erosion Control Structures, Spur Cross Ranch, Hassayampa River Preserve, Potential Study Sites by Ken Vonderscher, Planning and Development Manager, Maricopa County Parks and Recreation Department

Review of Potential Research Site Locations and Collaborations by Deborah Tosline, Hydrogeologist and Program Manager, Bureau of Reclamation

Monitoring and Modeling Arid Land Water Harvesting Structures: An Overview by Laura Norman, PhD, Research Physical Scientist, U.S. Geological Survey

Is it Erosion Control or Prior Appropriation? by Greg Kornrumph, Principal Analyst, Salt River Project

Coordinating with ADWR when Planning and Designing Erosion Control Projects by Karen Modesto, Tribal Issues and Statewide Strategic Planning, Arizona Department of Water Resources

Installing Erosion Control Structures across a Landscape as a Restoration and Adaptive Watershed Management Alternative for Climate Change by Deborah Tosline, Hydrogeologist and Program Manager, Bureau of Reclamation

A charrette (a means of conducting discussions in break-out groups that later rejoin) was scheduled to develop plans and consultation for future research, but instead, the session lent itself to an open discussion among the entire group. Participants networked, reviewed maps showing GIS data for the HRP and CA proposed research sites, and discussed and identified scope of work tasks for a three-year conducting proposal.

The HRP is located within a thriving riparian habitat with a historic building that houses a Visitor Center. HRP amenities would support research staff and provide public access for education opportunities. The Hassayampa River flows perennially within the preserve. The HRP is bound on the south by an active railroad and on the north by US Highway 60. These bounding conditions would make it challenging to install ECSs in tributaries to the Hassayampa River.

The CA drainages consist of tributaries to Cave Creek that appear undisturbed with healthy ecosystems. Data collected at this site would provide information about the impact of ECS installations on hydrology and sediment in an undisturbed ephemeral drainage. This would provide an opportunity to observe how a healthy drainage system responds to ECS installations. Public education opportunities could be created for adults and older children as the site is a one-mile hike from the parking lot.

Initial assessment of the HRP and CA sites resulted in selection of the CA as a proposed ECS research site. HRP land restrictions limit accessibility to nearby tributaries to the Hassayampa River. The CA has little to no development and provides unrestricted, if not remote, access to ephemeral tributaries to Cave Creek. Reclamation staff conducted a site visit in May 2016 and identified a tributary suitable for pre- and post-ECS installation monitoring. The site is located about one and one-half hours from downtown Phoenix.

Following the All Day Meeting, additional collaborative efforts were identified and a research site became available at the Heard Boy Scout Camp (BS), located on the north side and base of South Mountain Park/Preserve in Phoenix. The site is owned by the Boy Scouts of America and is located about 15 minutes from downtown Phoenix. There are several drainages at the BS site that originate within the mountain preserve and drain onto adjacent urban development. The wilderness area adjacent to the site is degraded and there have been issues with storm flows and sedimentation on and off site. Degradation is primarily due to foot traffic in the desert adjacent to residences and the BS. Erosion and flooding concerns in the vicinity of the site were identified by the Flood Control District of Maricopa County which has identified the site as a potential location for a flood hazard mitigation structure to alleviate downstream flood risk to people and property. Data collected at this site would provide information about the impact of ECS installations on hydrology and sediment transport in a disturbed ephemeral drainage adjacent to urban development.

The BS location would provide enhanced opportunities for public involvement and is well suited to host several ECS techniques. The Boy Scout organization and Eagle Scout candidates are available and interested in training and volunteer work to build and monitor ECS installations. The BS site would also provide Science, Technology, Engineering, and Mathematics (STEM) education opportunities for the Scouts and others.

A site visit was conducted with representatives from The Nature Conservancy, Flood Control District of Maricopa County, and the Boy Scouts of America in August 2016.

As a result of collaborative partnerships developed during the scoping study, a three-year conducting proposal was submitted to the S&T program in FY2016 titled:

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

The primary focus of the conducting proposal is to monitor hydrologic and sediment transport data collected pre- and post-ECS installations in ephemeral channels to assess hydrologic conditions, soil moisture, and sediment transport.

Partners on the conducting proposal for hydrologic research at ECS installations are: The Arizona Department of Water Resources, Arizona Geological Survey, Arizona State University, Boy Scouts of America, Flood Control District of Maricopa County, Maricopa County Parks and Recreation Department, Pima Association of Governments, The Hopi Tribe, The Nature Conservancy, Bureau of Reclamation, U.S. Department of Agriculture – Agricultural Research Station, U.S. Fish and Wildlife Service, U.S. Forest Service, and U.S. Geological Survey.

The CA and BS sites were selected as potential research locations as they each provide unique environmental conditions that will be useful in assessing ECS installations. Prior to starting work, site assessments would be conducted to review each location and determine the optimum way to proceed. Either the best site or both sites would be used based on scientific merit and suitability.

Following final selection of the site(s), planning and identification of ECS installation and monitoring locations would proceed. The proposed research would assess ECS installation impacts on storm flows, local hydrology, soil moisture, and sediment transport at these locations and build on existing work and relationships. Measuring stream flow and sediment transport in remote ephemeral channels presents challenges. Work completed under the conducting proposal includes progressive methods developed by the USGS including the Continuous Slope-Area (CSA) method (SIR 2010-5241) and the Sediment-Monitoring Gaging Network (OFR-2014-1137) which can be used to monitor the impacts of ECS installations. The USGS is working with the Flood Control District of Maricopa County and the Arizona Department of Transportation to install innovative instrumentation for a flood control monitoring network in Maricopa County. It may be possible to cost-share project costs with these agencies by adding ECS research sites to the local flood control monitoring network. At a minimum, networking and data sharing optimizes all efforts and encourages cross-jurisdictional partnerships.

The USGS would install CSA gages, one Scour Chain, one Large Scale Photo Image Velocimetry (LSPIV) gage and one sediment gage at each research site and begin collecting surface water volume/flow, precipitation, soil moisture, photo surveys, and sediment transport data. The USGS would provide data analysis, information sharing and reporting.

CSA gage installation includes CSA sensors and a barometer. The gage produces records of three stage hydrographs, and one discharge hydrograph. The data would be collected at 5 minute intervals, and published on the National Water Information System (NWIS) web interface. One scour chain would be installed at each CSA cross section (three scour chains per site) and data would be collected four times per year. A LSPIV gage (also known as Particle Tracking) would also be installed. The LSPIV gage produces a one-minute video every 5 minutes when there is significant flow at the location. The video provides visual documentation of the stream condition and is additionally used to generate velocity maps of the water surface. The velocity data will provide direct evidence of flow regimes and changes to the energy profile with ECSs. Additionally, the velocity data can be used in conjunction with surveyed cross sections to provide discharge data. Because flows are recorded over the event hydrograph, multiple discharge values can be calculated during an event. The technology is limited to use during daylight hours. Depending on site conditions, a sediment station may be installed with an automated sampler. The gage produces record of discharge (loading) based on suspended sediment concentration from the samples collected by the automated sampler.

Three years is a relatively short monitoring period and precipitation may be limited. However if any significant precipitation does occur, this project will provide new, rarely collected data to better understand hydrologic impacts associated with ECSs. The project will form new collaborations for conducting unique research in central Arizona that will build on work being done in southern Arizona, and will provide data to inform policy as local and federal entities seek to reduce stormflow hazards and secure and increase water supplies.

The instrumentation and expertise required to install, maintain, download, process and analyze hydrologic data is expensive and the primary reason why hydrologic data is lacking from the thousands of ECSs in Arizona, although associated changes to local water systems are consistently theorized. The equipment and methodologies proposed for the research were developed for remote areas and are based on implementation and methods used in similar investigations by the USGS and USDA-ARS.

The conducting proposal lends itself to cross jurisdictional partnerships and inter-disciplinary research. ECS installations may be used as mitigation strategies to reduce sediment deposition in reservoirs, enhance local water resources, reduce stream velocities, support ecosystems and optimize watershed function under climate change. ECS installation, monitoring, and ecosystem impacts are conducive to public engagement via volunteer work; field trips; STEM education opportunities and to engage the public and promote vested interest in water resources, environment, ecosystems and science.

Research Benefits

The interest and movement to utilize ECSs in watershed management continues to grow. To understand how ECSs impact local water resources and sediment transport, hydrologic research is required to inform policy. The cost of hydrologic research at ECS installations has been prohibitive but with Reclamation support, this research could be accomplished.

Results of this research may be used to meet the requirements in Reclamation's SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water 2016 Report to Congress. The report includes stormwater capture as an adaptation strategy and identifies the need to take action to build ecosystem resiliency. Work completed under a conducting proposal would provide data to assess the use of ECS installations as adaptive watershed management strategies under climate change and to inform policy for use of ECSs in Arizona. Due to an overall scarcity of hydrologic data associated with ECS installations, the information would also be useful to assess the potential of such systems to enhance groundwater recharge and wetland, meadow, and stream corridor restoration in the Truckee River Basin; improve resource stewardship for forest health in the Sacramento and San Joaquin Basins; and increase groundwater storage capacity and improve soils and watershed resiliency in the Rio Grande Basin.

There may be significant legal and institutional barriers to the use of ECSs as an adaptive management strategy. Prior to considering implementation, legal and institutional issues must be considered.

References

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Appendices

Appendix A – Study Notifications
Appendix B – Study Summary
Appendix C – All Day Meeting Participants (Pre-Registration)
Appendix D – Literature Search
Appendix E – Maps

Appendix A
Study Notifications (via e-mail)

Craig Ahrens	Global Environmental Legacy
Francisco Anaya	U.S. Forest Service
James Bays	CH2MHILL
Joshua Bednarek	City of Phoenix
Andy Bennett	Tucson Audubon Society
Stacie Beute	Desert Botanical Garden
Donald Bills	U.S. Geological Survey
Ben Bloodworth	Tamarisk Coalition
Rich Burtell	Plateau Resources LLC
James Callegary	U.S Geological Survey
Carianne Campbell	Sky Island Alliance
R. Cardin	Maricopa County
Codey Carter	Bureau of Land Management
Claire Catlett	Stream Dynamics Inc.
Anna Clark	Cuenca Los Ojos Foundation
Van Clothier	Stream Dynamics Inc.
Kaylee Colter	Maricopa County
Harry Cooper	Maricopa County
Bill Cordasco	Babbitt Ranches
Laurence de Bure	Waterock, L3C
Chuck Denton	U.S. Forest Service
Joe Diaz	City of Phoenix
James Duffield	Hopi Tribe
Michele Girard	Sky Island Restoration Cooperative
Leslie Graser	City of Prescott
Floyd Gray	U.S. Geological Survey

Blair Greimann	Bureau of Reclamation
Andrew Griffin	Little Colorado River Watershed Chapters Association
Tim Grosch	U.S. Fish and Wildlife Service
Jeanmarie Haney	The Nature Conservancy
Einav Henenson	Arizona Department of Water Resources
Mary Hoadley	Cosanti Foundation
David Hodges	Cuenca Los Ojos
Jonathan Horst	Tucson Audubon Society
Genevieve Johnson	Desert Landscape Conservation Cooperative
Justin Johnson	Gila Watershed Partnership
Jennifer Kaplan	U.S. Fish and Wildlife Service
Greg Kornrumph	Salt River Project
Kendall Kroesen	Tucson Audubon Society
Laurel Lacher	Lacher Hydrological Consulting
Kelly Mott-Lacroix	U.S. Geological Survey
Bryon Lichtenhan	Sky Island Alliance
Doug McCarty	Arizona Department of Environmental Quality
Carlee McClellan	Navajo Department of Water Resources
Marie McCormick	Oak Creek Watershed
Doug McMillan	Retired Civil Engineer
Maggie Messerschmidt	The Nature Conservancy
Mead Mier	Pima Association of Governments
Louise Misztal	Sky Island Alliance
Karen Modesto	Arizona Department of Water Resources
Rachel More-Hla	University of Arizona
John Munderloh	Prescott Valley
Dave Murray	Bureau of Land Management
Hasan Mushtaq	City of Phoenix
Mary Nichols	U.S. Department of Agriculture

Laura Norman	U.S. Geological Survey
Keith Pahovama	The Hopi Tribe
Keith Pajkos	Arizona State Forestry
Marilyn Polivema	The Hopi Tribe
Kris Randall	U.S. Fish and Wildlife Service
Mary Reece	Bureau of Reclamation
Ryan Revells	Bureau of Reclamation
John Rice	Bureau of Reclamation
Ben Ruddell	Arizona State University
Jan Schipper	Arizona State University
Bonnie Secakuku	The Hopi Tribe
David Seibert	Borderlands Restoration, L3C
Roger Selina	The Hopi Tribe
Salek Shafiqullah	U.S. Forest Service
Keiran Sikdar	Watershed Management Group
David Smith	U.S. Fish and Wildlife Service
Willie Sommers	Arizona Department of Forestry and Fire Management
Connie Svoboda	Bureau of Reclamation
Dan Taylor	Bat Conservation International
Max Taylor	The Hopi Tribe
Alvita Tenakhongva	The Hopi Tribe
Ron Tiller	Arizona Department of Environmental Quality
Jennifer Varin	U.S. Forest Service
Ken Vonderscher	Maricopa County
Dana Warnecke	Arizona Game and Fish Department
Kevin Warner	U.S. Forest Service
Thomas Whitham	Northern Arizona University
Ron Whitler	City of Buckeye
Jeffrey Whitney	Arizona Department of Forestry and Fire Management

Guy Whol	Prescott Creeks
Rodney Wittler	Bureau of Reclamation
Ann Youberg	Arizona Geological Society

Appendix B
Study Summary

DATE: February 23, 2016

SUBJECT: Science & Technology (S&T) #720 Installing Erosion Control Structures across a Landscape as a Restoration Treatment and Adaptive Watershed Management Alternative for Climate Change

CURRENT STATUS: In Fiscal Year (FY) 2016, Reclamation's S&T program provided $20,000 for a scoping study to assess use of Erosion Control Structures (ECS) in land and habitat restoration to mitigate flood flows and increase water availability. The study includes: a literature search, an all-day meeting in Phoenix on May 24, 2016, identification of potential research sites, development of a scope of work, and preparation of a proposal to install and monitor ECSs for research. Partners coordinate via planning meetings.


Photo by Van D. Clothier

BACKGROUND: ECSs of varying sizes and materials, commonly rocks, are installed within drainages to slow storm flows for land restoration. Degradation of habitats in arid western states prompted private land owners in southeastern Arizona to install ECSs in drainages resulting in improvements in restoration including: habitat establishment, maintenance, and inter-connectivity; reduction in stormflow bedload; reduced stormflow peaks, longer flow durations, and increased availability of local water resources; and increased environmental awareness, education and economic opportunities. Climate change projections predict fewer yet more intense precipitation events in the Southwest. Anecdotal reports and limited research support the use of ECSs as an adaptive management alternative to manage and mitigate flood flows during intense storms. USGS conducted investigations during the 2014 monsoon season comparing stormflow measurements from a mature, treated drainage to measurements from an untreated drainage (control) and found that stormflows in the treated drainage were less flashy, had fewer transmission losses, extended summer baseflow, and showed a reduction in average rate of flow by more than one half, primarily in the size and duration of the peak flow (Norman et al, 2015).


Photo by Deborah Tosline

Results from sediment modeling (no field measurements) estimate that 800 tons per year are eroded in the treated drainage and that 200 tons per year would be captured in the ECS system (Norman and Niraula, 2016). ECS 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 (ECS) impacts" (Nichols, M.H., et al., 2012). Further studies are necessary to collect data to assess safety, potential impact on downstream water rights holders, impacts to the environment and society. Reclamation research of ECS installations would build on the work of the others and collect data to inform policy.

PARTNERS: Includes representatives from Reclamation's Denver Technical Services Center and Southern Rockies and Desert Landscape Conservation Cooperative, Maricopa County Parks and Recreation Department, Flood Control District of Maricopa County, Boy Scouts of America Grand Canyon Council, US Geological Survey, US Department of Agriculture – Agricultural Research Station, Hopi Tribe, Navajo Nation, The Nature Conservancy, US Forest Service, Arizona State University, Arizona Geological Society, Sky Island Restoration Cooperative, Sky Island Alliance, Tucson Audubon, Cuenca Los Ojos, Borderlands Restoration L3C, WateRock L3C, Stream Dynamics, Inc., Bat Conservation International, and private citizens.

EFFORTS: During FY2016 Reclamation and partners identified potential research locations and strategies and S&T proposal #1751 was submitted requesting funding for ECS research for FY2017 through FY2020.

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Appendix C
May 24, 2016 All Day Meeting Participants (Pre-Registration)

Craig Andrews	The Hopi Tribe
Lyle Bennett	Bureau of Indian Affairs - Navajo Region
Andy Bennett	Tucson Audubon Society
James Callegary	U.S. Geological Survey
Codey Carter	Bureau of Land Management
Brett Chimerica	The Hopi Tribe
Harry Cooper	Maricopa County
Laurence de Bure	Waterock, L3C
Sy de Bure	Waterock, L3C
Chuck Denton	U.S. Forest Service
James Duffield	The Hopi Tribe
Howard Eugene	The Hopi Tribe
Blair Greimann	Bureau of Reclamation
Andrew Griffin	Little Colorado River Watershed Chapter Association
Tim Grosch	U.S. Fish and Wildlife Service
Jean Marie Haney	The Nature Conservancy
Mary Hoadley	Cosanti Foundation
David Hodges	Cuenca Los Ojos
Justin Johnson	Gila Watershed Partnership
Genevieve Johnson	Desert Landscape Conservation Cooperative
Jennifer Kaplan	U.S. Fish and Wildlife Service
Greg Kornrumph	Salt River Project
Bryon Lichtenhan	Sky Island Alliance
Carl McClellan	Navajo Nation

Doug McMillan	Retired Civil Engineer
Maggie Messerschmidt	The Nature Conservancy
Karen Modesto	Arizona Department of Water Resource
Rachel More-Hla	University of Arizona
David Murray	Bureau of Land Management
Shannon Naha	The Hopi Tribe
Laura Norman	U.S. Geological Survey
Kris Randall	U.S. Fish and Wildlife Service
Ryan Revells	Bureau of Reclamation
Richard Secakuyva, Sr.	The Hopi Tribe
David Seibert	Borderlands Restoration, L3C
David Smith	U.S. Fish and Wildlife Service
Willie Sommers	Arizona Department of Forestry and Fire Management
Albert Susunkewa	The Hopi Tribe
Deborah Tosline	Bureau of Reclamation
Jennifer Varin	U.S. Forest Service
Ken Vonderscher	Maricopa County
Tate Yoiwyma, Sr.	The Hopi Tribe

Appendix D
Erosion Control Structures Literature Search

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http://www.usbr.gov/pn/fcrps/documents/lwm.pdf

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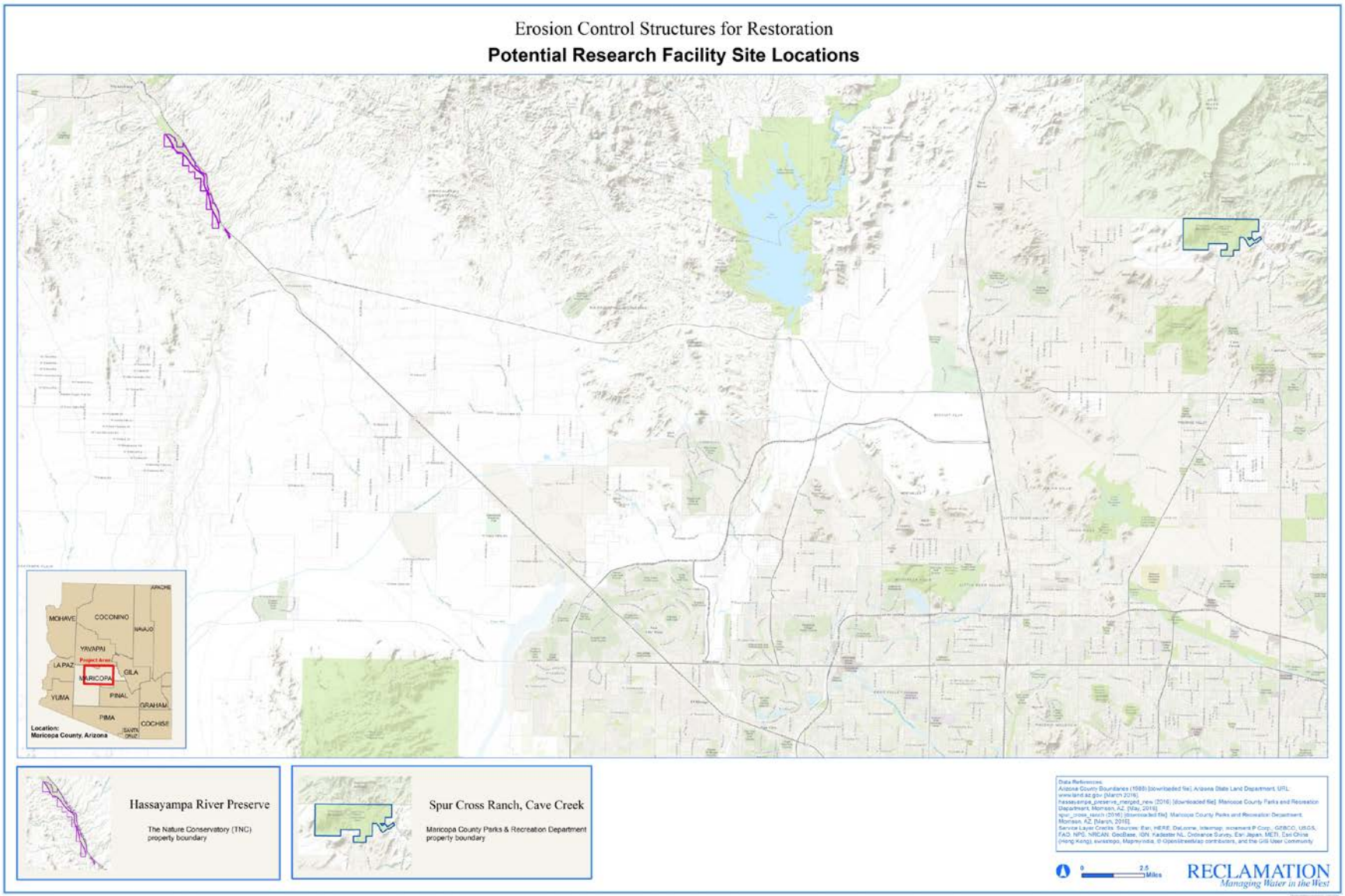
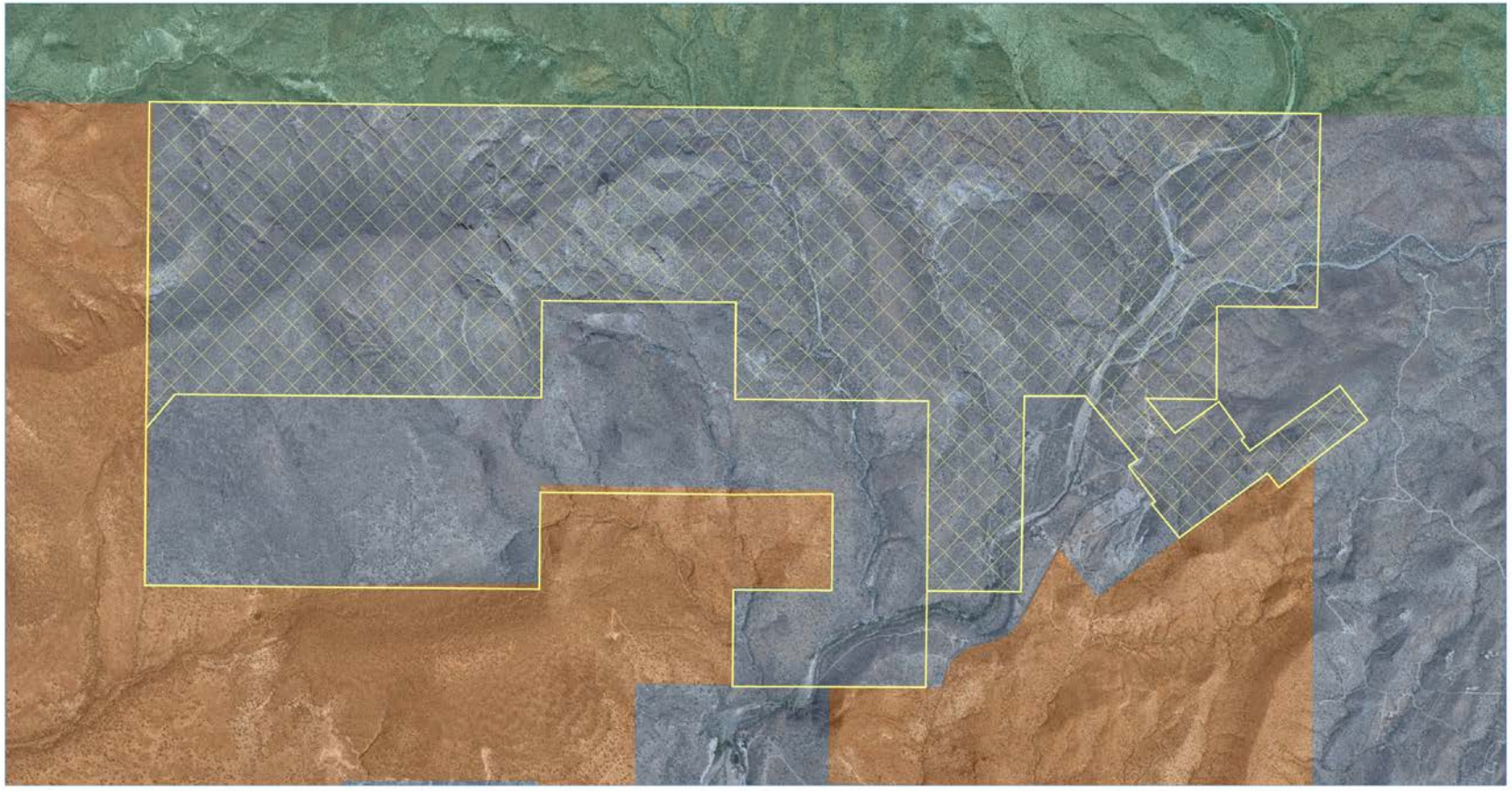
Appendix E

Maps


Erosion Control Structures for Restoration
Potential Research Facility Site Locations
APACHE
MOHAVE
COCONINO
NAVAJO
YAVAPAI
LA PAZ
Project Area
MARICOPA
GILA
YUMA
PINAL
GRAHAM
PIMA
COCHISE
SANTA CRUZ
Location:
Maricopa County, Arizona
Hassayampa River Preserve
The Nature Conservatory (TNC) property boundary
Spur Cross Ranch, Cave Creek
Maricopa County Parks & Recreation Department property boundary
Miles
RECLAMATION
Managing Water in the West

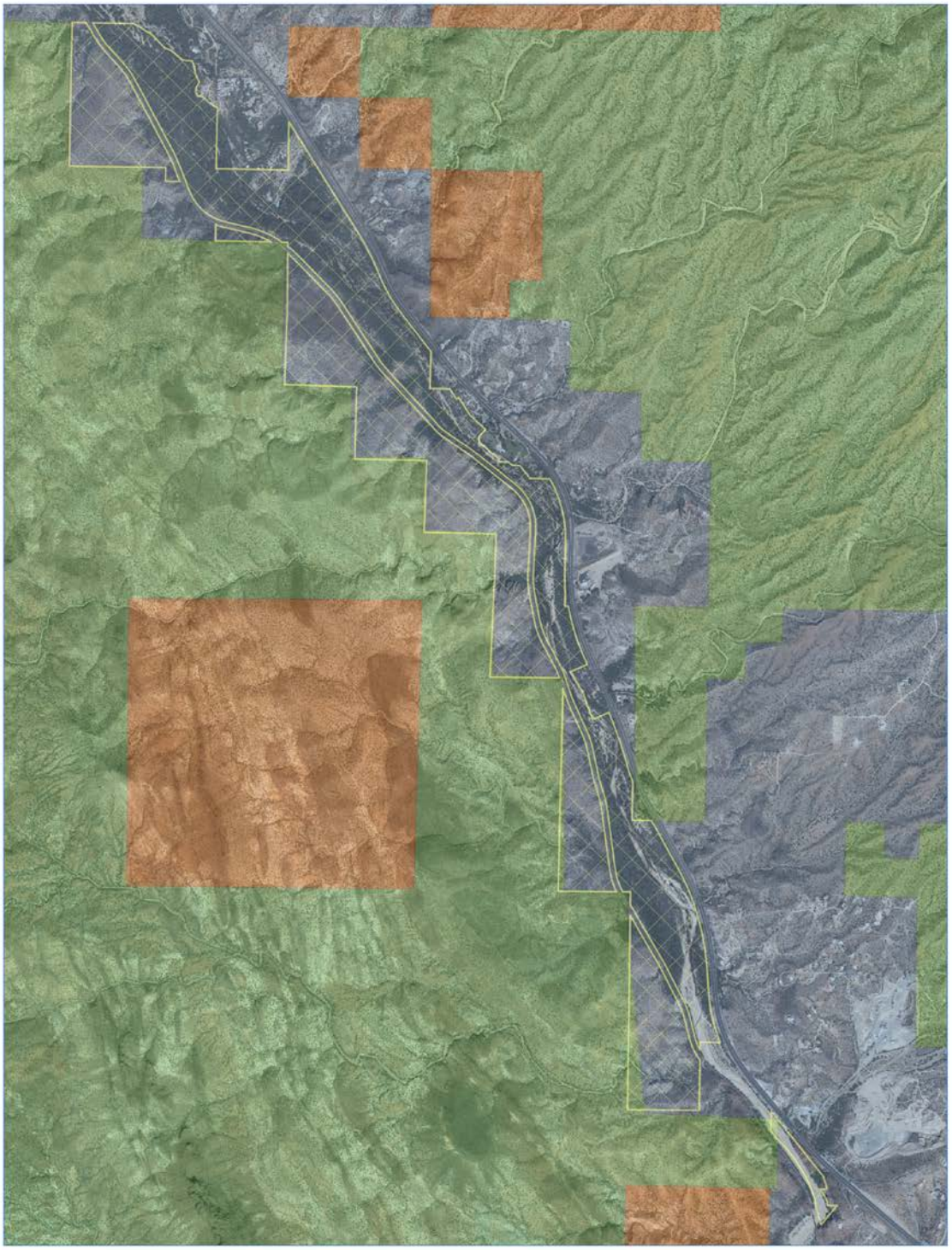
Erosion Control Structures for Restoration

Spur Cross Ranch Land Ownership



Erosion Control Structures for Restoration

Hassayampa Preserve Land Ownership



The Nature Convservancy Property Boundary

Surface Manager

- Private Land
- Bureau of Land Management
- State Trust Land

Land ownership is derived from the Arizona Land Resource Information System, produced by the Arizona State Land Department. Federal land updates are made primarily by the Bureau of Land Management.

Private Land is made up of parcels owned by private individuals, businesses, and local agencies.

Data References:
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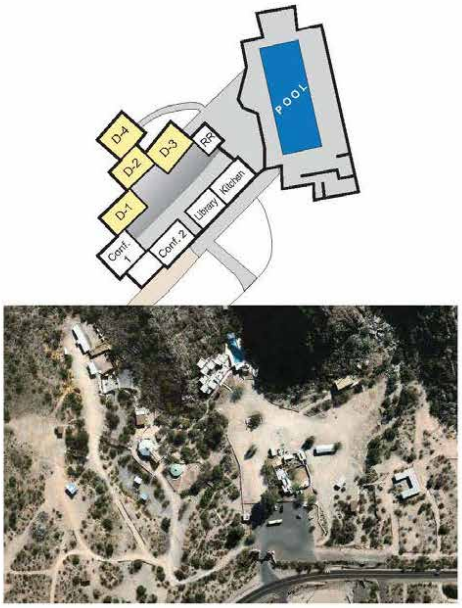
0 1,000 Feet

RECLAMATION
Managing Water in the West

Potential Research Site, Boy Scouts of America, Heard Scout Pueblo, Phoenix Arizona



HEARD SCOUT PUEBLO
GRAND CANYON COUNCIL INC., BSA

Heard Scout Pueblo*
1901 E Dobbins Rd
Phoenix, AZ 85042
GPS: Latitude: N 33.3° 21'46.36"
Longitude: W 112° 2'32.51"

Ranger: **Bob Ochoa**
Ranger Phone: **602-819-4649**
Camp Headquarters: NONE
Fax: 602-276-8656
Email: **bsarcranch@gmail.com**

* To schedule Year Round Camping or Summer Camp Sessions
Contact Grand Canyon Council Office: **602-955-7747**
The Camp Ranger does **NOT** schedule reservations