Elkhorn / Las Delicias Demonstration Project: Planning, installing and monitoring watershed restoration practices in ephemeral arroyos and associated uplands in a flash flood dominated landscape, Altar Valley, Pima County, Arizona.

February 2014

A collaborative conservation project supported by
Freeport-McMoRan Copper and Gold Foundation
and Altar Valley Conservation Alliance
Partners and Stewards

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Executive Summary

The Elkhorn/Las Delicias Watershed Restoration Demonstration Project (Elk/LD Demo Project) showcases planning, installation, and monitoring of watershed restoration practices in ephemeral arroyos and associated uplands and tributaries in a flash flood dominated landscape of the Altar Valley located southwest of Tucson, Arizona in Pima County along the US-Mexico border. A generous grant from Freeport-McMoRan Copper and Gold funded the project, coupled with support from many Altar Valley Conservation Alliance (AVCA) partners. This report documents the planning, installation, monitoring and evaluation of this project and tells a story of collaborative conservation in action. You will find this report long on words and short on images. Please refer to www.altarvalleyconservation.org/ElkLDDemo for a more visual tour of the project, as well as access to numerous supporting documents.

The approximately 1300-acre project site, located on Arizona State School Trust Land, bridges two neighboring ranches. A poorly drained fence-line access road bisected 25 drainage channels, many of which had become deeply incised, with increasingly severe erosion creeping and branching upstream. A team of restoration experts evaluated the site and designed a treatment plan in April 2011 based on landowner objectives and the principles and practices described in the watershed restoration primer: ***Let the Water Do the Work: Induced Meandering, an Evolving Method for Restoring Incised Channels*** (Zeedyk and Clothier, 2009, The Quivira Coalition) and ADD ROAD BOOK. In January 2012, the planning team, armed with rock, machinery and volunteers, reconvened to install the project. All told, the project team staged and planted 920 tons of rock by hand and/or with machines, to install 359 structures in six of the 24 channels. A 7th channel was treated with mesquite harvested on site. The 3.25 mile stretch of road was treated with 54 rolling dips and 14 road crossing stabilization structures, with associated one rock and media luna structures.

The project team designed a monitoring program and collected base-line monitoring data during and immediately following construction, before any precipitation occurred in the project area. Monitoring of treated and untreated channels included extensive field evaluation, photo monitoring, vegetation and substrate transects in stream channels, survey of stream channels' longitudinal profile and cross sections, mapping, and rainfall. In January 2014, the project team reviewed monitoring data, conducted a thorough field evaluation, convened a one day public workshop attended by a diverse group of 25 people to evaluate the project, and worked together to compile this final project report.

Project Highlights

950 acres treated
1300 watershed acres affected
Approximately 400 structures installed
920 tons of rock planted by hand and machine
54 rolling dips to drain 3.25 miles of road
74 volunteer days invested – a vey conservative estimate
28 organizations involved
100+ different people involved
$50,000 real from Freeport-McMoRan
$200,000+ in-kind resources from many source

The project team is generally optimistic that the stage has been set for healing to continue over time via the natural processes of erosion and deposition that occur in river systems; and that the site is fulfilling its promise as a demonstration and learning site. Monitoring and evaluation findings to date, after only two years and three rainy seasons (2 monsoon and 1 winter) indicate:

- Increased soil deposition in channels and associated tributaries and uplands;
- Minimal vegetation change to date within, but is expected as soil deposition continues;
- Increased vegetation diversity and density evident in upland rock structures and road treatment sites;

- Impressive sediment and vegetation response to wood treatment in alluvial fan;
- Excellent structural integrity of all treatments, with very few repair needs;
- Monitoring techniques are repeatable, useful and statistically valid;
- Minimal to no evidence of construction impacts, with the exception of small amounts of left-over rock left on site for continued work;
- Project success can be enhanced by augmenting and/or adding rock or wood structures; and
- Significant learning and research opportunities are available due to excellent access, monitoring data, and broad support for the project.

Since project planning began in 2011, hundreds of people have visited the project site and/or followed its progress via Altar Valley Conservation Alliance communication and education activities. The Altar Valley Conservation Alliance produced several videos and added project materials to its website to document and share the demonstration project. AVCA is delighted that three organizations have emerged as key partners to conduct monitoring: *Southwestern Arid Grassland Ecology* (an emerging non-profit based in Tumacacori, AZ), *Tierra Seca* (the University of Arizona Society student chapter of the Society for Range Management), and the US Natural Resource Conservation. The Altar Valley Conservation Alliance and its partners hope that this report, and its companion pieces on the AVCA website, contribute to perpetuation of the Elk/LD Demo Project and inspire and inform similar projects in other arid landscapes, where conserving every drop of rain and inch of soil is vital!

ADD MAPS!

Origins of the Elkhorn / Las Delicias Demonstration Project

The Altar Valley Valley Conservation Alliance (AVCA) is a collaborative conservation organization founded in 1995, and incorporated as a 501(c)3 not-for-profit organization in 2000. Two neighboring ranchers, John King and Charley Miller, envisioned an organization that would work to keep the Altar Valley open, as an economically productive working landscape, where natural ecological regimes such as fire could be returned to the valley. For John King in particular, healing the excessive erosion of the Altar Wash that runs south to north through the heart of the valley, was and is a defining ambition. Restoring the Altar Wash into a system characterized by productive flood plain is at the core of the AVCA's plans for the watershed. This project is as big and complex as the wash itself, and progress has been slow. In the mean time, AVCA came to realize that working at smaller scales in tributary systems would set the stage for work on the "main stem" and contribute greatly to enhancing watershed health on and between individual ranches and sub-watershed areas.

AVCA Mission

The Alliance works through a strongly collaborative, science-based, community driven and integrated approach to:

- *CONSERVE health and productive working landscapes, including soil and water conservation, wildfire management, habitat conservation and protection of native species, and other environmental initiatives.*
- *PROMOTE a thriving agricultural economy by encouraging improved ranching and farming practices, diversification and innovation, and by supporting programs and politicies that support more effective, long-term economic development.*
- *SUSTAIN a resilient rural community by retaining and renewing the cultural and historical traditions of the Altar Valley.*

Around 2003 or 2004, AVCA board members Nathan Sayre and Peggy Rowley came home from a Quivira Coalition annual conference with news of promising watershed work championed by Bill Zeedyk, a retired Forest Service wildlife biologist turned watershed restoration practitioner. AVCA invited Bill to the Altar Valley, and beginning in 2005, Bill and various colleagues (including Van Clothier and Steve Carson) began teaching AVCA

about low-tech erosion control techniques that use strategically placed rock to slow down water, increase soil moisture, grow vegetation, and increase the length and width of stream channels such that flood plain characteristics can return. Previous erosion control project in the valley had often used larger structures (such as gabions made of rock filled wire baskets) that tended to "blow out" in large storm events, or the water carved new channels around them. Zeedyk's philosophy and techniques urged people to read the landscape and learn about how water and soil moves, and to do more subtle interventions. Bill encouraged people to *let the water do the work*. Another key lesson was the importance of removing or fixing the cause of watershed problems – more often than not, a poorly drained road or trail that interrupted water flow across the landscape and dumped excessive amounts of water and soil into channels that had evolved to handle smaller amounts of water.

Inspired by Bill's visit and aided by the energy and skills of its first Restoration Coordinator, David Seibert, AVCA set out to do a number of small watershed restoration and road rehabilitation projects plus several public training workshops. Seibert launched an innovative partnership with Freeport-McMoRan Copper and Gold, a mining company that seeks to leave long-term investments in communities where it operates; and he stretched a $17,000 grant into four separate small restoration projects. Many landowners and resource managers were successfully introduced to new restoration techniques and AVCA and its partners learned a lot about planning and doing restoration work. Freeport-McMoRan was impressed and urged AVCA to submit another proposal, which resulted in a $50,000 grant award in the fall of 2010.

The original concept was to set up a research project, in collaboration with the USDA Agricultural Research Station, where a suite of parallel channels would be treated with different types of erosion control structures to compare their effectiveness in the flash flood oriented arid Altar Valley landscape. In particular, AVCA and partners wanted to explore the effectiveness of an approach designed by Bill Zeedyk called *induced meandering*, where erosion control structures (baffles alternating with one rock dams) aim to restore flood plain characteristics of a channel by encouraging point bar formation and targeted erosion of the opposite bank, to widen and lengthen the stream channel. This tool has been controversial in southern Arizona. It appears that people are concerned about whether there is sufficient flowing water in this arid landscape to use this tool. People are also curious to see how the structures stand up to the flash floods typical of this area. Some question the validity of a technique that is meant, in part, to encourage erosion.

As the project team wrestled with an experimental design, Dr. Mary Nichols, from the USDA Agricultural Research Service, explained the fundamental importance of framing a research project around a clear hypothesis. It became that we could not clearly articulate a specific research goal and related hypothesis and tests. In a nutshell, there were too many questions and we couldn't hone them into a solid experimental design. Nichols recommended that we ask a team of experts to design their best possible watershed restoration treatment plan and a monitoring program to document results, with the idea that important research questions would emerge.

Previous reconnaissance adventures, combined with landowner interest, had revealed an ideal site along the Elkhorn Ranch Road, a well-traveled Pima County Road. The site offered an ensemble of 25 roughly parallel channels, some healthy and stable and some highly incised, bisected by an excessively eroded and badly drained fence-line access road. It offered opportunities to demonstrate the suite of restoration techniques as well as the chance to informally experiment with different combinations of treatments, at a readily accessible and high profile site. The team set out to build the site into a demonstration project, where people could see healthy channels, treated channels, learn about how to do restoration work, and monitor and evaluate progress. Guided by a detailed work plan that included project goals, and a site ripe for improvement, the team began the design process.

ELK/LD Demo Project Site Overview

Figure 1. Aerial view showing intersection of Elkhorn Ranch and fence-line access roads.

The site is located on Arizona State School Trust Land in Altar Valley, Pima County, AZ about 50 miles southwest of Tucson off of State Highway 286 (the Sasabe Highway). It is bisected by a fence and access road dividing two ranches. Elkhorn Ranch, upstream and to the east, has been operated by the same family since 1945, with conservative rest-rotation grazing practices in place since the early 1980s. Downstream and to the west, the Las Delicias (owned by Santa Margarita Ranch since 1997), has experienced numerous ownership changes. Various projects dating back to the 1950s and 60s, including chaining construction of large dikes for water diversion, altered the landscape considerably. Even with an increasingly conservative grazing system in place, Santa Margarita Ranch has struggled to improve rangeland conditions on the Las Delicias.

Over time, the fence-line access road became incised due to water becoming trapped in the road. In addition, as road conditions deteriorated, vehicles made new routes, thus increasing road width. The increasingly wide and deep fence-line road interrupted and captured water sheet flow. Water caught in the road was then released into the natural drainage channels at higher volumes than the natural capacity of the channel. Increased water volume encouraged channel incision. There is also evidence of bulldozer work to "smooth out" eroded crossings by pushing rough soil and rock out of the channel so that vehicles could pass, thus further deepening the stream channel. As these channels became deeper and deeper at the road crossings, the channel incision began to march upstream in the form of "head cuts". The combined effects of past land use and the road caused serious channel incision problems in numerous channels, as well as related tributaries, and these effects were heading upstream.

Figure 2. Incised fence-line road that triggered extreme watershed degradation at the Elk/LD Demo site.

Incised channel definition

Zeedyk (2009) explains that an incised channel is a stream that has lost access to its floodplain. Channels that deepen faster than they widen become isolated from their floodplain. As a result, water tables can drop and local soil moisture decreases, resulting in loss of vegetation. Vegetation loss further decreases channel stability. A negative cycle of watershed degradation can perpetuate and spread.

Project Goals and Indicators of Success -- Developed by AVCA and ranch owners to guide project planning

- ***Improve watershed productivity and health.***
  - In stream channels, evidence of success would include:
    - Head cut advancement upstream is halted.
    - Channel aggradation and evidence of sediment deposition.
    - Increased width of stream channel.
    - Increased length of stream channel.
    - Evidence of flood plain.
    - Increased vegetation density and diversity.
  - In upland area adjacent to stream channels, evidence of success would include:
    - Increased vegetation density and diversity.
    - Increased evidence and/or presence of animal species.
    - Presence of rills, demonstrating movement and deposition of litter.
  - In road ways and areas downstream of roads, evidence of success would include:
    - Stable road surface, including areas where crossing drainage channel.
    - Increased vegetation density and diversity along edge of road, in road drainage areas, and in stream channel below road crossing.

- ***Enhance practical knowledge of erosion control / arroyo restoration techniques and monitoring in the Altar Valley flash flood dominated landscape .***
  - Document project goals, measurable objectives, and treatment plan.
  - Gain necessary permits and permissions prior to project installation.
  - Develop monitoring plan and collect baseline and post-treatment data.
  - Install treatments according to project time frame and budget.
  - Produce project documents that provide model for future projects – such as planning checklist, data collections forms, budget assumptions, work plans, and final report.

- ***Engage local citizens, partners, and researchers in restoration learning process.***
  - Showcase project results at 2011, 12 & 2013 AVCA community meetings.
  - Engage volunteers and partners in project construction.
  - Create 3 multi-media presentations with video, photography, and interviews focusing on 1) installation and 2) monitoring for the AVCA community meetings and AVCA social media and website.
  - Hold a field workshop Fall 2013 to evaluate and discuss project techniques and success, as well as research questions.
  - Produce project report by December 2013.
  - Generate and distribute research questions to research community via AVCA Science Advisory Board

Planning – Design, Permitting, Logistics

An ounce of prevention is worth a pound of cure. Good planning is essential! Here are the basic planning steps and time frames that the Elk/LD Demo project team experienced, along with some 20/20 hindsight.

Project planning takes 2+ years

- 2 + years prior to start date -- Identify project site and problem to be solved.
- 1 – 2 years prior – Sketch out resource needs and available resources. **Consider permitting and map needs early - they will impact planning time and cost!**
- 12-18 months prior – Assemble team and draft necessary agreements and work plan.
    - Assemble project maps & any background information.
    - Initiate permitting and survey work such as: National Environmental Policy Act, Endangered Species, Clean Water, National Historic Preservation, State Land, etc.
    - **Ask for help and guidance from permitting agencies early in process!** Arrange a field visit to introduce them to the project!
    - Consider monitoring early. Try to budget for at least a couple of years, so that you can watch your project closely through a few rainy seasons. At minimum, do some photo point monitoring.
- 12 + months prior – Put your team on the ground to do field reconnaissance, with your work plan and maps in hand. The work product for this phase should be a written treatment plan. This step will take more time than you expect, and you'll be tempted to under-budget it – don't make that mistake!
    - The fanciness of your plan will depend on the complexity of your project and your audience, but it needs to have some essential elements – define the problem, define treatment methods (there may be some alternatives at this stage), permits & their timing, and resources you'll need (people, time, equipment, rock, safety, food, lodging, porta potties, seed, etc).
    - It is very likely that you'll need to do some tough thinking about your budget and project expectations – this is the time to do it, and refine your original work plan accordingly.
    - Remember to include monitoring activities in your planning.
    - Make sure permitting is underway. This could delay your project, so pay attention!
- 12 to 9 months prior – Schedule and contract all resources, and amend previous agreements as needed.
- 6 to 3 months prior – Order supplies & equipment, keep in touch with all key players!
- 3 months out – Critical time to check off everything on your list, to be sure everything is in order!
- 3 months to start date – Mobilize resources at the site & assure that everyone has logistics in hand!
    - Be sure that any baseline monitoring data is collected prior to the start of construction!
- Start date – Safety meeting first thing and review the plan for the day, repeat daily until done.
- Close out with an evaluation. Appoint someone to check the project after the first major rain events!

Written work plans and contracts or agreements are important

*This part of the work isn't fun, but it is **really important**. A work plan simply documents all the W's – who, what, when, where, and why. It keeps everyone on track. It may be 1 page or 20 pp. The formality of it can vary according to your needs and audience – but take the time to do it!*

Contracts or agreements are also critical. Again, the formality may vary. Be clear about roles, timing, money, final expectations, etc. The workplan can be an attachment to the contract / agreement.

Check that appropriate workers compensation insurance agreements are in place, or liability releases for volunteers.

Make sure that safety, camp safety and hygiene (ie porta potties, water source), and other aspects of logistical aspects of gathering people together are considered!

Highlights of the Elk/LD Demo planning process and lead up to construction

- October 2010 – Carson and Seibert walked all channels to do preliminary recon of the site.
- Winter 2011 – AVCA prepared a detailed project work plan and contracts for team members.
- March 2011 – Range management consultant Dan Robinett and NRCS Range Conservationist Katie Meyers prepared a brief two page description of the site and its problems that was provided to team.
- April 2011 -- Project personnel spent approximately one week of intense field-work to do thorough reconnaissance of the project site and develop a treatment plan. Basic elements of the plan included:
    - The project area included 24 roughly parallel drainages, of which 7 were chosen for treatment. Various combinations of treatments were chosen, to both demonstrate and informally experiment. The written treatment plan consisted of a treatment summary table accompanied by spread sheets that summarized structure size and materials needs.
    - Here are some basic features of the plan.
        - Address the primary source of the problem by treating the road, by installing rolling dips to drain the road, stabilization structures where the channels crossed the road, and some media lunas.
        - Utilize imported rock for 6 channels and mesquite harvested on site for 1 channel.
        - Some channels were treated with structures called one rock dams; others were treated with a combination of one rock dams and baffle structures, referred to as an induced meandering treatment.
        - For some channels, treat areas adjacent to channel including the tributaries. These areas were referred to generically as uplands, as opposed to the treatments done within channels. Uplands and were treated with one rock dams and media lunas made from imported rock.
        - Rock staging and hauling was considering during planning – a key element of the plan!

Marking treatments -- a curious challenge

When you're in the field doing your recon planning, you need to think about how to mark your treatment sites, keeping in mind that you may not be back for a year plus. Also consider whether agency people involved in permitting will need to visit your site – what do you need to do to help them find their way?

Critters will eat flagging; weather will impact paint. The truth is, there's no perfect answer. There's a good chance that whatever you do during recon will likely need to be remarked to some degree when you return to do the work. Here are a few tips: *STEVE/BILL other ideas?*

- *Flagging is VERY temporary … days or weeks.*
- *Wood stakes with paint may last a year or so.*
- *Paint on the ground may last a year or so, with blue having the most longevity in comparison to oranges, red, yellow. Talk with landowner about use of paint so that no surprises when they see paint on the ground.*
- *Rebar is solid, but expensive – probably worth it for monitoring sites.*
- *Steele T-post good for marking photo monitoring sites, plus you can rest camera on it to assure accurate camera location year to year.*

GPS may be a useful tool, depending on how tech savvy your team may be. Factor in technical time in the office if GPS will be used. Consider the role of GPS early in the project when you talk about how you will approach project mapping!

- The project involved a LOT of rock and several size categories. A spreadsheet was developed to house individual structure dimensions that were measured in the field. Calculations were added to compute the rock needed. These spreadsheets became the detailed treatment plan.
    - The initial rock calculation was way over budget, particularly for the road crossing stabilization structures, so Carson reengineered his treatment to reduce costs.
- The team determined rock staging sites, as well as volunteer camp locations, so that they too could be cleared with the State Land Department as part of permitting.
- The team recommended and contacted volunteer groups with skills already in hand – Volunteers for Outdoor Arizona and Sky Island Alliance.

- June 2011 – Since the project site was located on State of Arizona School Trust lands, the two ranches submitted Land Treatment Applications to Arizona State Land Department. Applications were submitted in June 2011 to allow time for review and processing. ASLD range conservationist John Patton conducted biological and cultural resource clearance work -- a significant contribution to the project!
- May 2011 – A video showcasing project planning was shared at the spring AVCA Community Meeting.
- Summer 2011 – Volunteer crews from Volunteers for Outdoor Arizona and Sky Island Alliance were scheduled well in advance.
- Fall 2011 – Construction manager Steve Carson and project manager Mary Miller were in frequent contact to watchdog permitting, rock purchase, equipment rental, and overall logistical planning.
    - Steve took great care in checking the rock source to assure that the quality and shape of the rock, as well as size consistency would appear on the ground as planned and needed!
    - Mary coordinated with the Tucson Natural Resource Conservation Service and the two ranches to plan and source an effective seed mixture.
- Fall 2011 – Pre-construction monitoring was supposed to take place at this time, but did not due to personnel changes as well as difficulty honing in on a cost effective and logistically feasible plan. The team also struggled with exactly when to install monitoring – the importance of seeing the site untreated; in comparison to the challenge of logistical challenge of installing monitoring before treatments are actually in place. A conundrum.
- January 2012 – The project team gathered, using Elkhorn Ranch as a base station, for a 2 1/2 week construction window. Steve Carson arrived several days early to receive the rented equipment and check the final details. Then we were off and running!

Seed mix designed to include warm and cool season plants

10 PLS	Rothrock grama
5 PLS	Sand drop seed
10 PLS	Cane beardgrass
5 PLS	Purple three-awn
5 PLS	Desert globemallow
2 PLS	Desert zinnia
2 PLS	Desert marigold

PLS = Pounds Live Seed
Source: Armenta Seed

The rock purchase – an important big ticket item

Source .. amount … white rock … shape … stagingRock we used was marble salvaged from a mine clean up project. It was light colored and quite reflective. We theorized that the light color might reduce temperature slightly, creating a favorable micro-habitat for plant growth. The high visibility of the rock from the air was another unexpected benefit. Be aware of rock type – high iron pyrite (from mine overburden) content could leach from rock and be toxic to plants!

Treatment Plan Summary

Channel	Goal	UPLAND-Media Luna	UPLAND-One Rock Dams	CHAANNEL – One Rock Dams	CHANNEL – Induced Meandering	ROAD – Rolling Dips	330 structures, detailed by quantify & type	Materials	Notes
Fence-line Rd N & S of Elkhorn Rd	ROAD DRAINS TO REESTABLISH SHEET FLOW, WATER HARVESTING, AND GRADE CONTROL	X	X			X	52 Rolling dip 19 Grade control 27 One rock dam 13 Media luna 1 Baffel	Earth Rock	Good opportunity to monitor combine effects of rolling dips, grade control, one-rock and media luna.
24	UPLAND TREATMENT USING ROCK STRUCTURES	X	X				14 One rock dam 4 Media luna	Rock	One-rock & media lunas only. Compare with 5 & 11. 5 piles of stored rock left on site.
23	UPLANDS TREATMENT AND INDUCED MEANDERING IN CHANNEL, USING MACHINE AND HAND BUILT ROCK STRUCTURES	X	X	X	X		19 One rock dam 5 Baffel 4 Media luna	Rock	Only channel to receive one-rock, baffles, and media lunas. 10 piles of stored rock left on site.
21	INDUCED MEANDERING USING ROCK STRUCTURES			X	X		50 One rock dam 16 Baffle 2 Media luna	Rock	No sheet flow media luna treatments. 10 piles of stored rock.
19	UPLAND TREATMENTS ONLY WITH ROCK STRUCTURES	X	X				90 One rock dam 1 Baffel 44Media luna	Rock	One-rock & media lunas only. Compare with 5 & 11. 55 piles of stored rock.
13	INDUCED MEANDERING ONLY USING ROCK STRUCTURES			X	X		20 One rock dam 11 Baffle	Rock	No sheet flow media luna treatments. 4 piles of stored rock.
11	SPREAD WATER WITH BRUSH STRUCTURES	X	X				7 Brush dams and media luna	Mesquite	Unique re. use of mesquite as stabilization tool
9	UPLANDS TREATMENT ONLY USING ROCK STRUCTURES.	X	X				28 One rock dam 10 Media luna	Rock	One-rock & media lunas only. Compare with 5 & 11. 26 piles of stored rock.
5	SPREAD WATER WITH BRUSH STRUCTURES.	X	X				Initially planned mesquite treatment, but decided that not necessary during final installation planning.		

Channel numbering

All channels were numbered at the point where they intersected the fence-line road, and documented accordingly during Seibert and Carson's initial field recon in the fall of 2010. Channel 24 is closest to Elkhorn Ranch Road. Channels decrease in number moving south to north. Channel 13 is near the east/west fence and gate that splits the Las Delicias portion of the project area into two separate pastures. Channel 5 located just south of Sabino Wash. Untreated channels adjacent to treated channels may serve as reference channels.

Treatment designs

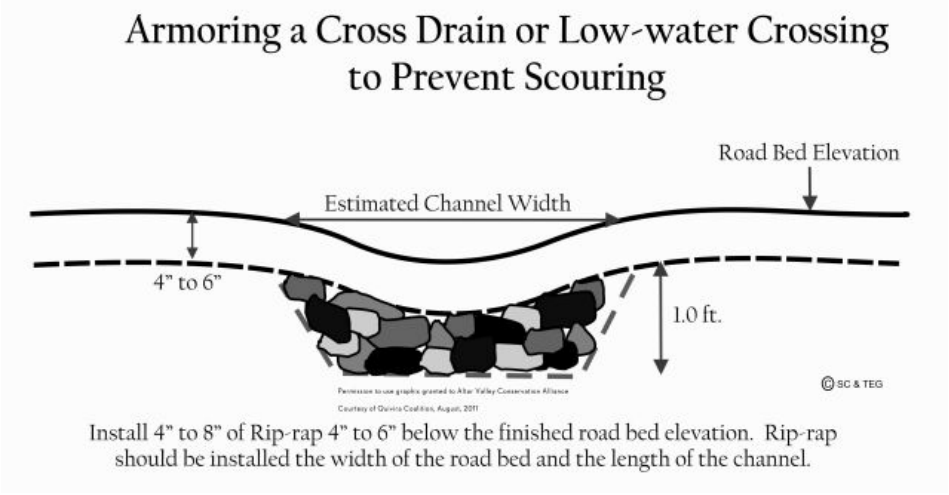
Conceptual diagrams provided in this report are used with permission from Bill Zeedyk (personal communication with Mary Miller, February 9, 2014). Treatment designs are documented in two primary sources:

- Zeedyk, William D., and Clothier, Van (2009). Let the Water do the Work: Induced Meandering, an Evolving Method for Restoring Incised Stream Channels. Santa Fe, NM: The Quivira Coalition. International Standard Book Number: 978-0-9708264-3-5.

- Zeedyk, W.D. (2006). A Good Road Lies Easy on the Land: Water Harvesting from Low Standard Rural Roads. Santa, NM: The Quivira Coalition.

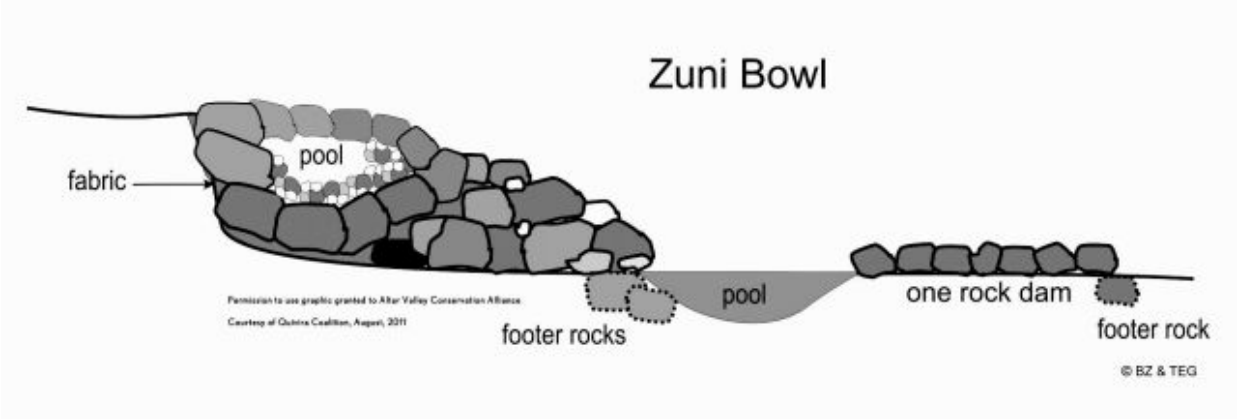
Grade control structure

Used to stabilize places where the road crossed the channel and encourage upstream sediment deposition.



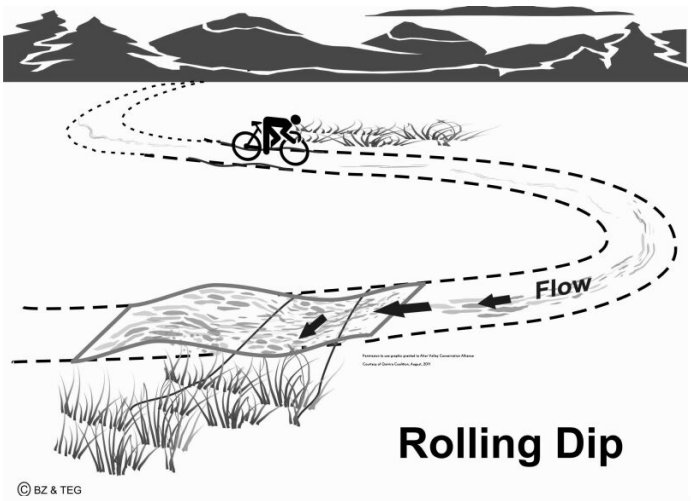
Zuni bowl

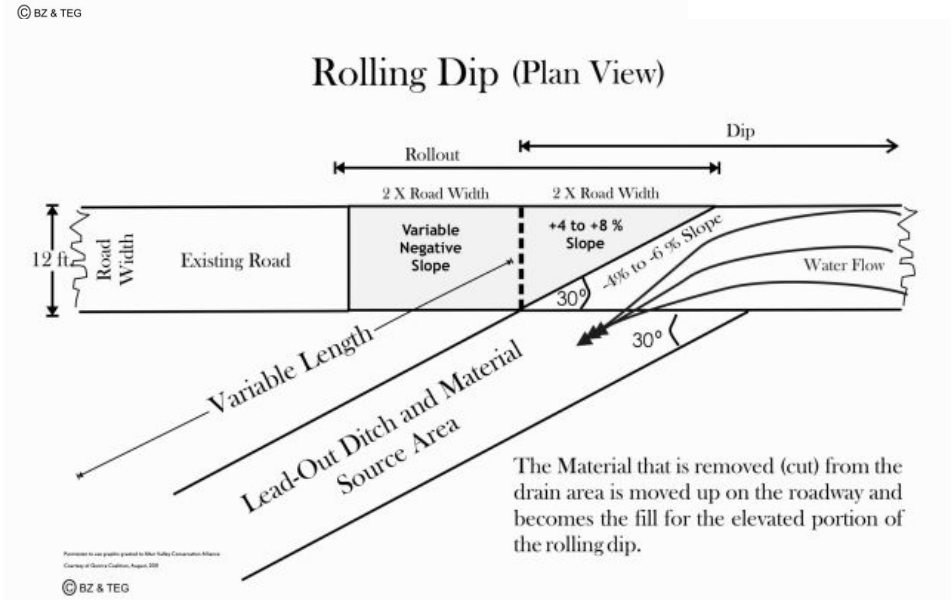
Used to stabilize head cuts. A rock run down structure is a blend of a zuni bowl and one rock dam, that lacks the pool element of a zuni bowl.

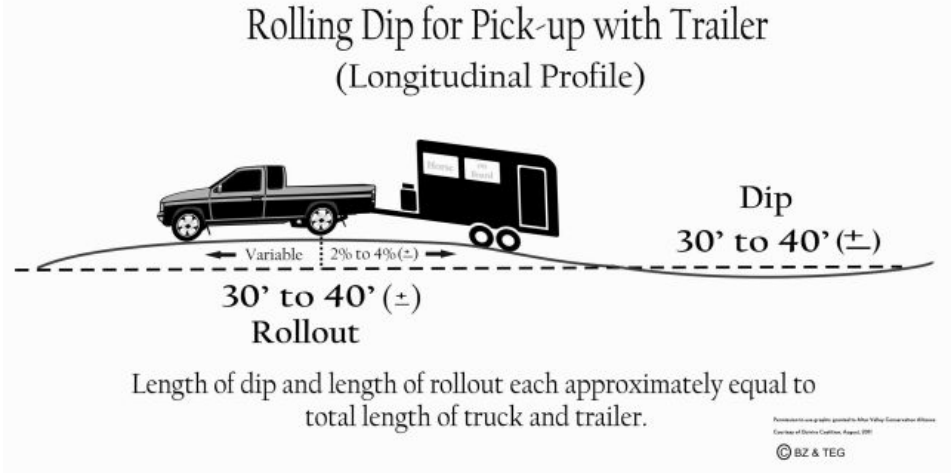


Rolling Dip

Used to drain the road and reestablish sheet flow patterns.

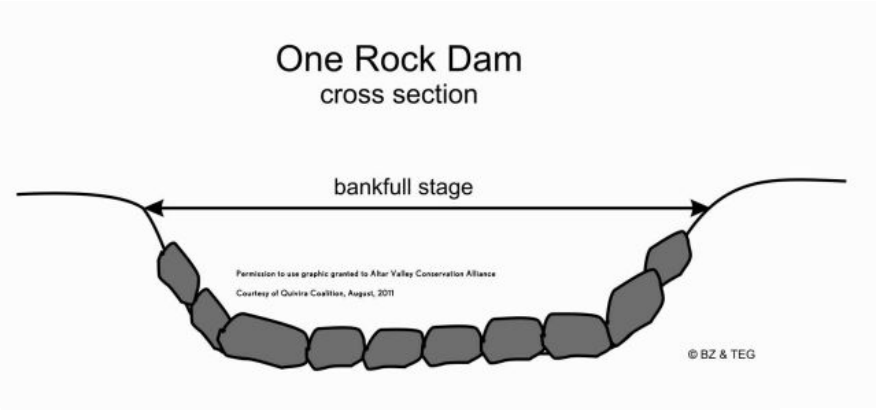


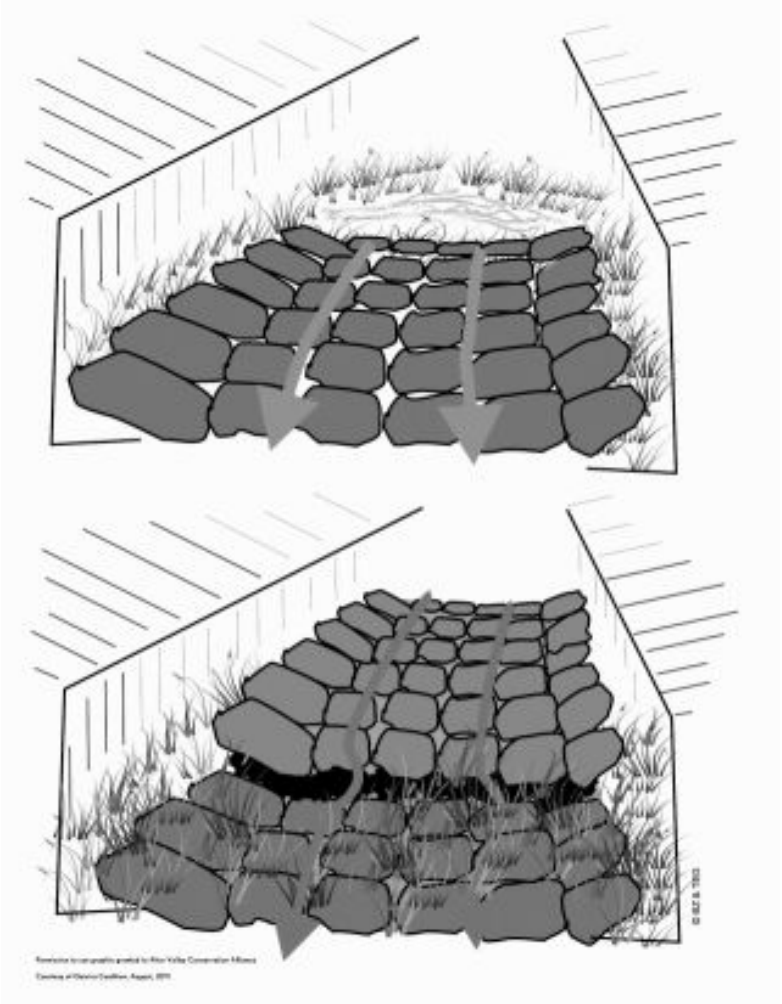




One rock dams

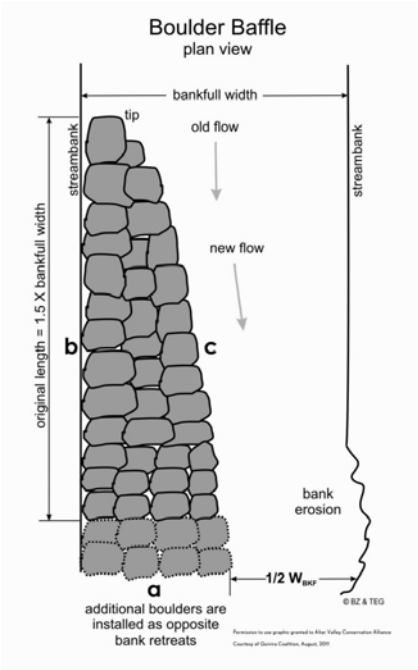
Used in many locations to reduce water velocity and encourage soil deposition. Bill Zeedyk first used the term one rock dam in 1995. It is very different than a check dam. It assumes the role of a "run" in the longitudinal profile of a channel thalweg. Several such structures in succession have the effect of raising the bed elevation of the treated reach. They do not dam up the creek.





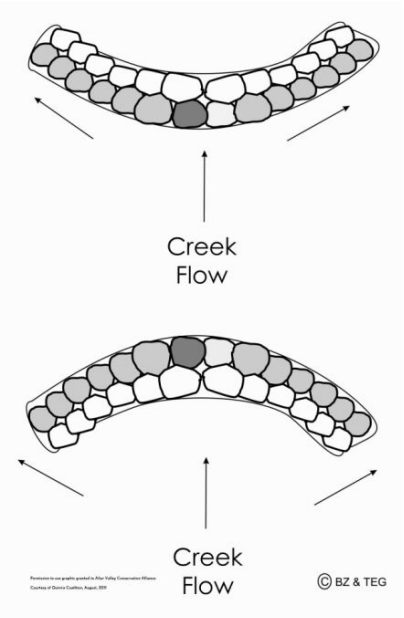
Baffels

Used to encourage point bar formation. Baffels are used in combination withone rock dams to achieve an induced meandering treatment.



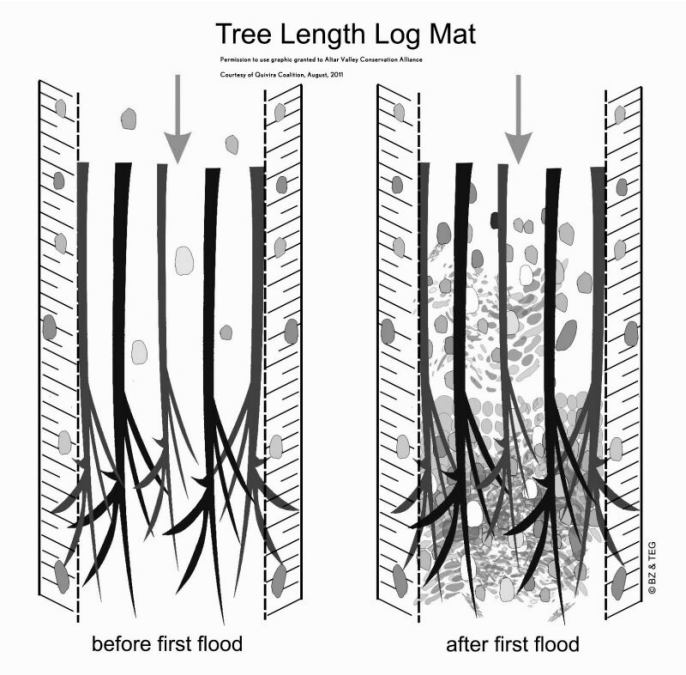
Media lunas

Used to decrease water velocity, spread water and encourage soil deposition – they also provide a protected nursery for vegetation growth. Media lunas are generally used in situations where channel incision is less advanced, often to prevent it from starting.



Tree length log mat

Used to reduce water velocity and encourage soil deposition in an alluvial fan situation, using mesquite harvested on site.



Key concept -- water detention versus retention.

It is important to note that all *road and erosion control treatments are designed to* ***detain or slow*** *water velocity and spread water*, *resulting in* ***detention*** *of water on the landscape*; in other words they will slow down and spread water – any water ponding is short term and temporary. In contrast, a dam results in *retention of water or long term or permanent storage of water*.

As AVCA talked with partners about the ideas shared by Bill Zeedyk and his partners, the term *one rock dam* became raised proverbial red flags with regard to Clean Water Act permitting and/or water rights. The concerns related to the possibility of water being stored. In one project (not the Elk/LD Demo), the permitting crisis was addressed by placing open pipes in structures to allow water to flow through the pipes. The pipes promptly filled with sediment and the one rock dams and baffles allowed water to flow through and sediment to deposit, as per their purpose.

Throughout the course of this project, Zeedyk's terminology has been intermixed with terms people have mined from their own experience, like water bar or check dam. AVCA tried *one rock erosion control structure* (way too bulky, plus the point isn't to control erosion, rather to direct it usefully) and even mis-used terms like check dam a few times. During the project evaluation, the project team discussed terminology, AVCA affirmed that it would continue to use Zeedyk's terminology, despite the issue with the term dam. Over time, more and more people have adopted use of the technique and the term, know what it is, and more importantly what is isn't. These structures are not check dams in any way, shape or form – they are truly structures that are one rock high, and perhaps in the end the term one rock dam is indeed perfect in that it communicates the idea of interrupting water flow, but to a limited one rock high extent. In fact, during evaluation a few structures were found to be more than one rock high and their function was impaired.

Installation

Installation of the Elk/LD Demo project occurred over the course of two weeks. Most project participants stayed at nearby Elkhorn Ranch or camped at the project site. Steve Carson (Rangeland Hands) was the overall construction boss; and Bill Zeedyk provided technical oversight and quality control. Many people played a key role construction: Rangeland Hands employee Jason Cathcart, volunteer Forrest Sherman, Elkhorn Ranch employee/volunteer Jerome Miller, former AVCA Restoration coordinator David Seibert, Sky Island Alliance and Volunteers for Outdoor Arizona, and many others (listed at the end of the project).

The construction process

- Treated the road first, which enabled access to the project.
- Conducted longitudinal and latitudinal profile monitoring in some channels prior to treatment – to measure channel length and width.
- Simultaneously re-marked treatments with spray paint, flagged rock access and staging locations, and rock in small piles close to the actual treatment sites.
- Simultaneously placed rock with machines and by hand, with volunteer crews.
- Seeded all structures, except for fence-line road structures south of the Elkhorn Ranch road.
- Rehabilitation of volunteer camp and rock staging area involved ripping and seeding on contour, at about 25-50 foot intervals. Rehab of rock haul roads involved installation of some size appropriate rolling dips, roughening the surface with the dozer tracks, and seeding.
- Installed photo and vegetation/soil monitoring transects following construction, prior to any rain.

Camp site key elements

Porta potty (s)
Water and food plans
Signs to help people get there
Portable fire pit – great for camaraderie!
Fire wood
Rehab plan for camp site

Evaluation of construction process

The last day of the project construction phase included rehab of the camp site and rock haul access roads, fence repair, litter clean up, and an evaluation meeting.

Evaluation highpoints included:

- Excellent safety;
- Effective logistics, especially rock transport and staging;
- Successful project permitting;
- Overall quality of installation;
- Outstanding volunteer contributions;
- Completed all planned treatments, except one channel, which Elkhorn personnel completed a few weeks later.

Helpful planning assumptions

Construction planning involves breaking down work into chunks, for example …

- 9 tons rock moved by one dump truck
- 45 minutes haul time to stage rock
- 45 minutes to build a rolling dip with dozer
- 1 hour +/- to machine build a rock road grade control structure
- 2 tons of rock planted by a volunteer in 1 day, if rock staged by work site

Concerns included:

- Inadequate budget for planning and coordination;
- Struggles with production of map resources to aid planning;
- Loss of project resources mid-way through installation;
- Lack of monitoring plan prior to installation;
- State Land Department concern over marking treatments with spray paint;
- A few instances where vegetation was unnecessarily impacted during rock transport.

Elk/LD Demo construction, monitoring, and evaluation timeline

- **Monday – Friday, January 9 – 13, 2012 – Focus road work, rock staging, and monitoring.**
  - Construction boss SCarson launched project with safety briefing and assigned jobs.
  - Carson used D4 dozer to build rolling dips on road, beginning on south end – this opened access.
  - BZeedyk, assisted by JMiller, worked from south → north to mark treatment sites, rock staging location, and flag access pathway to rock dump locations.
  - Three Pima County Natural Resources Parks and Recreation staff used 1 loader and 2 dump trucks to ferry about 75% of the rock to channel and road rock dump sites.
  - JCathcart used backhoe with thumb to build rock road stabilization structures.
  - DSeibert, FSherman & BKidd did longitudinal and cross-section profiles on 8 channels.
  - CORRECT ALL NAME ABBREVIATIONS TO BE THE SAME!
- **Weekend, January 13 – 15, 2012 – Focus hand installation of rock by volunteers.**
  - Volunteers for Outdoor Arizona crew worked on hand installation of structures for 2 days, supervised primarily by Bill Zeedyk, Steve Carson and David Seibert.
  - Williams College students worked for 1 day, and had orientation with Zeedyk and Mary Miller.
  - Jason Cathcart continued road channel crossing work with backhoe.
- **January 16 – 20, 2012 – Focus complete road work, rock staging, and wood treatments.**
  - Carson completed and seeded all rolling dips on the road.
  - Cathcart finished all channel/road stabilization structures, including adding wildlife water plunge pool at some locations.
  - Sherman hauled/staged remaining 25% of rock.
  - Zeedyk & Miller supervised one day of Buenos Aires NWR volunteer crew hand rock work.
  - Zeedyk & Miller spent 2 days placing mesquite at channels using mesquite for stabilization.
  - Miller and Elkhorn crew Craig Errazuriz spent one day on hand rock placement.
  - Carson and Cathcart constructed machine built media lunas.
  - Seibert worked on monitoring plan.
- **Weekend, January 21-22, 2012 – Focus hand installation of rock by volunteers.**
  - Sky Island Alliance volunteer group placed rock, and brought project very close to completion.
  - Began site clean up, rehab of rock staging area, volunteer camp, and rock hauling paths.
- **Monday – January 23, 2012 – Focus clean up and evaluate.**
  - Equipment picked up by rental companies, fence repair, garbage pick up, site inspection.
  - Several hour long evaluation discussion by project team, including decisions on monitoring.
- **February 2012 – Focus complete hand rock installation.**
  - Elkhorn staff J Miller, C Errazuriz, and J Burton completed rock installation.
- **March 2012 – Focus complete installation of baseline monitoring.**
  - Sherman & Robinett installed 4 monitoring vegetation/channel substrate monitoring transects
  - F Sherman installed rain gauges and photo monitoring "trapline".
- **December 2012 Monitoring** – Repeat photos & 4 transects, with UA Tierra Seca, NRCS, and volunteers.
- **Winter 2013 Data Work** – Forrest Sherman processed data and produced monitoring report book.
- **December 2013 Data Work** -- Repeat photos & 4 transects, with UA Tierra Seca, NRCS, and volunteers.
- **January 2013 Data & Reporting Work** – Sherman provided monitoring data, Miller completed draft project report, and **evaluation event held January 30-31, 2014**.
- **February 2014 – Evaluation Wrap up**. Projected completion or project report, evaluation session video.
- **Spring 2014 – Share project & seek support for continued monitoring and necessary repair and/or structure augmentation.** Make Elk/LD Demo portion of www.altarvalleyconservation.org live, share video at spring AVCA Community meeting.

Monitoring

Figuring out how to approach monitoring is one of the most difficult aspects of resource management and restoration work. Almost every grant wants it but doesn't fund it, and we all know we should do it! But monitoring is expensive, time consuming, and very particular – especially when the aim is to produce statistically relevant data. It is hard work and very important work, without which we cannot learn and adapt.

Unlike many projects, the Elk/LD Demo Project included some monitoring (two years worth) in the original project design. However, an unexpected loss of funding during the project resulted in loss of virtually all of the project funding allocated to monitoring and follow-up evaluation. In addition, the project team's intent to have a monitoring plan and pre-installation baseline monitoring in place prior to construction did not occur as planned due to unexpected changes in project personnel. As part of post-installation evaluation, the project team got down to brass tacks to assemble a cost-effective plan. AVCA adjusted its priorities to provide financial support and most importantly, a volunteer, Forrest Sherman of SAGE (Southwestern Arid Lands Ecology, based in Tumacacori, AZ) stepped up to take responsibility for the program. Dan Robinett worked with Forrest to design and conduct the vegetation and substrate channel protocol. AVCA assembled a "monitoring field day" crew of NRCS personnel, UA Tierra Seca students, and other volunteers in the fall to accomplish the time-consuming channel vegetation and substrate monitoring in one full day – an outstanding display of collaborative conservation in action, and a great learning opportunity for all!

Elk/LD Monitoring Plan 2012-2013

- Photo monitoring at 35 stations, baseline March 2012 & annually in December.
- Seasonal rainfall monitoring at 2 sites within project area at end of June and end of September annually.
- Vegetation, channel substrate & photo monitoring of 4 channels March 2012 and Dec. 2012 & 2013.
- Structural integrity observation – ongoing.
- Longitudinal profile measurement at 8 channels and cross-section measurements at 14 channels.
- Raw data is stored in three places: AVCA (MMiller), SAGE (FSherman) and NRCS – Tucson Field Office.

Photo Monitoring

Forrest Sherman established 35 photo monitoring station throughout the project site in March following construction, prior to any precipitation, and repeated the photographs annually in early December 2012 and 2013. The photo point route takes one person one day. Stations are marked with a steel pin and survey whiskers – the pins are stable, the whiskers have disappeared in many places. Even with GPS, some stations are difficult to find. At each station, an upstream and downstream photo were taken; and four photos were taken at media luna structures. Proper archiving of photos required 1-2 days follow up in the office.

Seasonal rainfall measurement

Seasonal rainfall gauges made of PVC pipe were attached to the fenceline at 2 sites within the project area. The project area rainfall data can be supplemented with seasonal data from Elkhorn Ranch monitoring locations south and west of the project site, as well as daily rainfall measurement data from Elkhorn Ranch headquarters.

Vegetation and channel substrate monitoring

The vegetation and channel substrate monitoring was particularly tricky to design and tough choices had to be made about where to work, given resource constraints. After much consideration, two channels (21 and 13) that received the same ***induced meandering only using rock*** treatment were chosen, and paired with nearby channels (19 and 12) that did not receive channel treatments. (Note that Channel 19 uplands were treated.) The two channel pairs were located in two distinct geomorphic surfaces. The southern portion of the project area, represented by channels 21 & 19, are very old Whitehouse soils that have a high clay content in the subsurface and are more eroded. The northern portion of the project area, represented by channels 13 & 12, are younger Altar, Sasabe soils. In general, the older soils on the southern part of the project area produce more water run-off than the younger soils to the north. So, the channel choices offered the opportunity to *observe the different rates of change for of vegetation and channel substrate* between treated and untreated channels, as well as two distinctly different soil types with different hydrology and runoff tendencies. (It is not appropriate to directly compare vegetation nor substrate data between channels, as their baselines were different.)

A modified Daubenmire[1] technique was used to measure vegetation and substrate cover within the channels. Sample points locations were randomly chosen in untreated channels; and points just downstream of randomly chosen treatments were chosen in treated channels. Percent cover categories for plant species and substrate (rock, gravel, sand, biotic crust) were measured in 6 frames layed perpendicular to the channel. Upstream and downstream photos were also taken from each sample point.

Initial establishment in March 2012 of the four transects required several days of field work by DRobinett and FSherman. Subsequent field work in early December of 2012 and 2013 was accomplished in one full day, by a team of 12-15 people split into 4 teams. Each team was led by an expert with monitoring and plant knowledge, and supported by volunteers, mostly from UA Tierra Seca Club. The field days were great learning days for all. Each field day required several days of office work to enter data into spreadsheets for statistical analysis and archive photos. For statistical purposes, grouped perennial plant species were analyzed as was soil type (rock, gravel, soil). Analysis focused on the degree of change over time at each channel.

Structural Integrity Monitoring

If you do nothing else, revisiting the treated areas periodically to check on whether the structures built are still intact and performing well is important. It is particularly important to check the site after the first big precipitation events. FSherman took responsibility for these visits, and the Millers checked the site periodically too. SCarson also visited the site several times.

Channel measurements

Longitudinal profile measurements document the length and depth of the channel. Cross-section measurements document the shape of the channel. A 3-person team used survey equipment to take the first set of base-line measurements prior to construction over the course of about a week. In fall of 2013, FSherman returned to begin repeating measurements using a very refined geographic positioning system (RTK GPS) tool, which greatly speeded up the work. The GPS measurements were finely tuned enough to actually see the structures and stream morphology associated with the structures. Data processing to compare the data sets is ongoing. The RTK GPS tool offers a rich opportunity to document channel morphology change over time.

[1] Smith, L. et.al. 2012, Guide to Rangeland Monitoring and Assessment, Basic Concepts for Collecting, Interpreting and Use of Rangeland Data for Management Planning and Decisions, A publication of the Arizona Grazing Lands Conservation Association. January 2012.

Evaluation

In January 2014, the project team gathered to formally evaluate the project. Zeedyk, Carson, Robinett and Sherman revisited the project site on their individually and as a group, and monitoring data was reviewed and discussed in doors. MMiller recorded notes, and AVCA gathered video footage. On January 31, 2014, a public workshop attended by 25 people was held in the field to view and discuss the project and video commentary.

Evaluation Findings Relative to Project Goals

GOALS	EVALUATION FINDINGS
IMPROVE WATERSHED PRODUCTIVITY AND HEALTH.	
In stream channels, evidence of success would include:	
Head cut advancement upstream is halted.	**YES**
Channel aggradation and evidence of sediment deposition.	**YES**
Increased width of stream channel.	**SLIGHT CHANGE AT PRESENT, WITH POSTIVE TREND**
Increased length of stream channel.	**SLIGHT CHANGE AT PRESENT, WITH POSTIVE TREND**
Evidence of flood plain.	**YES**
Increased vegetation density and diversity.	**SLIGHT CHANGE AT PRESENT, WITH POSTIVE TREND**
In upland area adjacent to stream channels, evidence of success would include:	
Increased vegetation density and diversity.	**YES, within media luna and road drains**
Increased evidence and/or presence of animal species.	**NOT MEASURED, nor specifically discussed**
Presence of rills, demonstrating movement and deposition of litter.	**YES**
In road ways and areas downstream of roads, evidence of success would include:	
Stable road surface, including areas where crossing drainage channel.	**YES**
Increased vegetation density and diversity along edge of road, in road drainage areas, and in stream channel below road crossing.	**YES**
ENHANCE PRACTICAL KNOWLEDGE OF EROSION CONTROL / ARROYO RESTORATION TECHNIQUES AND MONITORING IN THE ALTAR VALLEY FLASH FLOOD DOMINATED LANDSCAPE.	
Document project goals, measurable objectives, and treatment plan.	**YES**
Gain necessary permits and permissions prior to project installation.	**YES,** 2 ASLD Land Treatment permits & follow up completed.
Develop monitoring plan and collect baseline and post-treatment data.	**Poor beginning, but good recovery**. Generous FSherman volunteer contributions essential to success. Concerns about resources to assure continued monitoring.
Install treatments according to project time frame and budget.	**Good**, with caveat that budget change mid-way made volunteer contributions critical. **Excellent rock estimate** within +/-10%, leaving good amount on site for repair/augmentation. **Excellent installation logistics**, particularly with regard to staging rock and overall work flow.
Produce project documents that provide model for future projects – such as planning checklist, data collections forms, budget assumptions, work plans, and final report.	**YES**
ENGAGE LOCAL CITIZENS, PARTNERS, AND RESEARCHERS IN RESTORATION LEARNING PROCESS.	
Showcase project results at 2011, 12 & 2013 AVCA community meetings.	**YES**
Engage volunteers and partners in project construction.	**Excellent, and essential to project success.**
Create 3 multi-media presentations with video, photography, and interviews focusing on 1) installation and 2) monitoring for the AVCA community meetings and AVCA social media and website.	**Excellent -- 3rd video is under production and due for presentation in May/June 2014.**
Hold a field workshop Fall 2013 to evaluate and discuss project techniques and success, as well as research questions.	**YES.**
Produce project report by December 2013.	**YES,** but 2 months late.
Generate & distribute research questions to research community via AVCA Science Advisory Board	**YES,** with presentation / discussion planned for spring 2014.

Discussion of evaluation findings

In summary, the project team in combination with the evaluation day participants found the scope and success of the Elk/LD Demo Project to be impressive. It appears that the treatments have served their intended purpose of stabilizing channel bottoms and initiating positive changes leading towards increased soil deposition. Road drainage work has performed extremely well, with surprisingly positive success from seeding efforts, and road/channel crossing stabilization structures have worked very well. Use of the area for demonstration purposes has been outstanding. More specific observations follow.

- In general, there appears to be significant positive change in soil cover on the project site – that is less rock, and more soil and/or other finer materials. Vegetation change thus far is not significant. This finding is based on visual observation and photo point data, supported by channel vegetation and substrate data.

- When comparing the channel data, it is necessary to look at the change in veg and/or soil cover of the paired treated and untreated channels relative to each other, due to the location of the pairs in different geomorphic surfaces and fact that baseline vegetation for each area was different. Rather look at the rate of change in each channel, and compare the rate between the channel pairs.

- The channel veg/substrate methodology appears to be repeatable and easy to use. Photos of the actual transect sites in the four channels receiving veg/substrate monitoring are very important tools for interpreting change on the project site, as well as to assure that monitoring locations are replicated accurately.

- Alluvial fan areas appear to be "sweet spots" for watershed restoration, and may be increasingly important target areas for restoration given their ability to serve as sponges that can hold water, particularly given the prospect of temperature and seasonal rain-fall pattern changes.

- Throughout the project, the team discussed and observed the dynamic between mesquite density, watershed stability and vegetation growth. It appears that mesquite is playing a role, particularly in the alluvial fan areas on north end of project, in providing a "sweet spot" for grass and forb growth beneath its canopy. Dan Robinett led an interesting discussion where a number of ideas were considered:
    - Do seasonal differences between mesquite and grass / forb moisture make a complimentary situation?
    - Does the mesquite canopy protect plants from herbivory?
    - Does mesquite canopy protect plants from excessive heat?
    - Are the mesquite trees encouraging water to braid?

  Robinett also referenced research from the Santa Rita Experimental Range related to mesquite density and run-off that suggest that some level of mesquite density and grass can co-exist. During recent decades, mesquite density has appeared to be a major problem in the Altar Valley watershed. It appears that the mesquite density quandary is ever more complex.

- The response to seeding, based on visual observation of species present and plant volume was outstanding, especially at road drains, area where camp & rock staging were rehabbed, and some media lunas. In general, there was little to no evidence of construction activities on the project site.

- Rock calculations done during planning were extremely accurate, and resulted in around 10% excess rock or about 50 tons+/- left on site – a good amount to have available for structure repair and

augmentation. As soil deposition occurs, it is important to return to add additional layers of rocks. Recommendations for areas requiring this work are summarized in the follow-up section of this report.

- Some media luna structures were not built properly.
    - If the tips of the media luna are not even on contour, you will see tracks of water flowing around the edges – repair this error by moving rock to make the tips even on contour.
    - Some machine built media lunas were too big, and held too much loose rock debris between rocks, resulting in more of a low dam than a media luna – repair this error by returning to the treatment by hand, to reshuffle and remove excess. Excess may be used to build more structures near by!

- Project maintenance was discussed with Arizona State Land Department personnel during the evaluation. Adding structural materials to the treatment areas would be considered project maintenance, and would not require further permitting.

- Thus far, the project has been through only three rainy seasons – summer 2011, winter 2012, and summer 2013. Climate data hasn't been summarized yet.

- A few isolated patches of buffel grass were observed in the project area. Dan Robinett pointed out that this was not surprising, in that former Las Delicias owner Domingo Pesquida seeded about 1000 acres with Lehmans love grass and buffel grass. The group discussed the regional challenge of buffel grass eradication as well as the site specific method, which involves 3-5 consistent treatments to kill a plant. It was suggested that AVCA consider publicizing the buffel grass hotline information to citizens that call with concerns.

Recommended research questions and/or strategies

- Will there be a vegetation response in the channels? How does treatment type affect vegetation response? Will there be a difference in the rate of change between the two major soil types?
- Evaluate the relative importance of the road work and channel crossing stabilization relative to the work done within channels? Note that work being conducted downstream from the Elk/LD Demo project area focuses primarily on road work, and would present an opportunity for comparison.
- Can we see differences between the channels where induced meandering structures were installed in comparison to channels where only one-rock dams were installed?
- Do we see change within Ch 19 channel that relates to upland treatment?
- Was seeding worth it? Any observations on plant species used for seeding?
- What type of storm event produces bankful water flows 2 out of 3 years, that is how big a rain does it take to make washes run? Could this be modeled using available data? What methods could be used to augment data?
- Build on channel measuring and mapping program by mapping basic parameters of channels in good condition (such as CH 22 and CH 17) and continue similar work on treated channels. Elements include: sinuousity, cross-section and channel elevation. Systematic use of the RTK-GPS tool to measure channels.
- Measure soil moisture change at various treatment sites.
- Capture more detailed climate data within different soil type areas on project.
- Consider methods to evaluate wildlife related change, such as an annual bird count or insect survey.
- In general, systematic data collection over long term to serve research and modeling purposes.

Follow-up notes

- Data and photo archiving: Recheck that all 2011-2013 data sheets and photos are archived at all three locations. Complete transfer all photo monitoring data to power-point / pdf suitable for use in the field, and organized such that future years may be added to the data set with ease. Also recheck that detailed monitoring procedure notes are stored in all locations.
    - Discuss and make note of now channel monitoring station locations would be handled in treated channels if structures are augmented with additional rock.
    - Refine channel data tables for attachment to AVCA website and project records.

- Rural road maintenance: Follow up with Pima County regarding revision of regulatory guidance for rural roads, and seek opportunities to do road training aimed at both managers and machine operators.

- Summarize rainfall data from the project site and nearby ranch rainfall monitoring locations.

- Various portions of the project have rock available on site to augment and repair treatments. One rock dams are augmented by placing another series of about 5 rows of rock over the downstream half of the original one rock dam, plus extending it downstream – the old and new rock thus overlaps on the downstream end. Baffles are augmented by placing new rows of rock along the downstream base of the triangle, thus extending the point of the baffle towards the outer curve of the channel. Target areas for further work include:
    - CH 9 – significant amount of rock for more upland work;
    - CH 13 – some baffles are too flat, rework angles when return to augment and/or check;
    - CH 11 – add wood to structures, and add additional structures to "split" water flow whenever possible;
    - CH 19 – use left-over rock, plus re-work and spread rock from overbuilt machine made media lunas;
    - CH 21 – left over rock plus loose rock to augment structures.

- Explore possibility of extending CH 11 wood structure and seeding work downstream on the Las Del side of the fence with Santa Margarita Ranch and ASLD.

- Follow up with ASLD regarding project maintenance via email.

- Publicize buffel grass reporting information.

- Share project video and photography with Bill Zeedyk for his efforts to build video documentation of his methods.

- Refine content for project signs and have signs made.

- Seek avenues to publish Elk/LD Demo story in a reputable journal such as Journal of Range Management or Society for Ecological Restoration.

- Discuss research questions with AVCA Board and Science Advisory Board, and formally incorporate into the AVCA research agenda document.

- Seek resources for continued monitoring.

Project Statistics

We extend our apologies for anyone, any group, or any statistic that isn't quite perfect or that we missed – it was a big project with many moving parts!

NUMERICAL PERSPECTIVES

- 18+ months planning horizon
- 1 month installation time horizon
- 2 years monitoring … so far!
- 100+ people who "touched" the project
- 30 organizations who "touched" the project
- 87 days volunteer time to install project[2]
- $50,000 Freeport-McMoRan grant
- Approximately $250,000 total project cost
- 920 tons of rock delivered in 4 size classes
- $35 per ton average rock cost
- $31,878 total rock cost
- 45 machine days
- 2 dump trucks
- 2 backhoes
- 1 dozer
- 9 tons moved by one dump truck
- 45 minutes haul time to stage rock
- 45 minutes to build a rolling dip with dozer
- 2 tons of rock planted by a volunteer in 1 day
- 7 channels and 3.25 miles of road treated
- 52 rolling dips
- 19 grade control structures at road channel crossings
- 77 media lunas
- 248 one rock dams
- 34 baffles
- 9 zuni bowls
- 110 small rock piles for future work
- Approximately 400 structures built
- 40 pounds of seeds planted
- 1300 acre project area
- 950 acres directly affected by treatments
- 38 photo monitoring sites
- 4 channels with vegetation and soil surface monitoring (15 transects per channel, 6 ten square foot frames per transect)
- Longitudinal & cross section profiles surveyed on 8 channels
- 2 rain gauges

PEOPLE PERSPECTIVES

Contributing Organizations

1. Altar Valley Conservation Alliance
2. Arizona Game and Fish Department
3. Arizona State Land Department
4. Armenta Seed
5. AVCA Science Advisory Board
6. Buenos Aires National Wildlife Refuge
7. Elkhorn Ranch
8. Freeport-McMoRan Copper and Gold
9. Friends of the Buenos Aires National Wildlife Refuge
10. Pima County Natural Resources, Parks, and Recreation
11. Pima County Office of Sustainability and Conservation
12. Pima County Regional Flood Control District
13. Porta potty provider
14. Rangeland Hands
15. Lamb Rock
16. Santa Margarita Ranch
17. Seibert Ecological Consulting
18. Sky Island Alliance
19. Southwestern Arid Grassland Ecology
20. University of Arizona, Green Keepers
21. University of Arizona, Tierra Seca
22. US Border Patrol
23. US Buenos Aires National Wildlife Refuge
24. US Bureau of Land Management
25. US Department of Agriculture – Agricultural Research Station, Southwest Watershed Research Center
26. US Natural Resources Conservation Service
27. Volunteers for Outdoor Arizona
28. Williams College
29. Zeedyk Ecological Consulting

- [2] (BANWR x 8, VoAz x 27, Williams x 8, SIA x 17, Lancaster et al x 4, Pollock x 4, Sherman x 15, ER x 4)

Individuals

1. Armenta, Ray
2. Babcock, Neal
3. Bahre, Conrad
4. Baker, Michael
5. Baldwin, Kerry
6. Barlow, Jane
7. Becker, Jennifer
8. Blais, Maggie
9. Blanchard, Ed
10. Blanchard, Melissa
11. Brock, Timothy
12. Buckner, Michael
13. Burt, Diane
14. Burton, James
15. Canova, Jane Canova
16. Carson, Nansy
17. Carson, Steve
18. Carter, Jade
19. Cathcart, Jason
20. Chenevert-Steffler, Ann
21. Chilcote, Trevor
22. Cline, Katie
23. Collins, Anna
24. Corella, Emilio
25. Davis, Julia
26. Ducote, Richard
27. Egen, Kristen
28. Elkhorn Ranch kitchen crew
29. Ellis, Arienne
30. Errazuriz, Craig
31. Fankiso, Klishatha
32. Foscue, Katie
33. Fox, Heather
34. Gall, Sally
35. Geil, Kerrie
36. Goodbody , Nicholas
37. Goodwin, Sage
38. Graham, Dave
39. Gyam, Ebenezer K.
40. Hare, Trevor
41. Harper, Anastasia
42. Harper, Inge
43. Harper, Robert
44. Hawkes, Kelsey
45. Hernandez, Brenda Hernandez
46. Heunisch, Sandy
47. Huesler, Alex
48. Hutchison, Chuck
49. Kaplan, Jennifer
50. Keller, Jackie
51. Kellner, Joe & colleagues
52. Kennedy, Linda
53. Kennedy, Linda
54. Kidd, Bill
55. King, Joe
56. King, John
57. King, Pat
58. King, Sarah
59. LeBlond, Dennis
60. Lee, Daniel
61. Marra, Ralph
62. Maxwell, Harold
63. Millard, Janet
64. Miller, Charley
65. Miller, Jerome
66. Miller, Mary
67. Mothner, Michael
68. Nichols, Mary
69. Ostroot, John
70. Patton, John
71. Pecilunas, Emily
72. Phipps, Alisha
73. Pollock, Mat
74. Powell, Brian
75. Reeves, Richard
76. Rice, Marisa
77. Riggs, Alanna
78. Robinett, Dan
79. Rose, Robert
80. Seibert, David
81. Sheridan, Tom
82. Sherman, Forrest
83. Simms, Jeff
84. Snodgrass, Mike
85. Steele, Sarah
86. Steele, Sherie
87. Su, Amanda
88. Tam, Man Yee
89. Tanner, Susan
90. Terpening, Kristin
91. Thiebes, Sue
92. Tucker, Rana
93. Valenzuela, Hipolita Acuna
94. Wagner, Eric

95. White, Floyd
96. Wilke , Cindy
97. Wilke , Mike
98. Williams, Stephen
99. Wood, Alison
100. Zeedyk, Bill
101. Zeedyk, Mary