NATURAL CHANNEL DESIGN ENGINEERING INC.

Playa Erosion Control Field Guide

Audience

- Landowners, land managers, and resource protection agencies

Application

- Practical, technical erosion control to reduce fine sediment accumulation in playas

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New Mexico Environment Department

Surface Water Quality Bureau, New Mexico Environment Department

Citation:
Natural Channel Design Engineering, Inc. (2024). *Playa Erosion Control Guide*. New Mexico Environment Department, Surface Water Quality Bureau Wetlands Program (NMED-SWQB).

Acknowledgements:
We at Natural Channel Design Engineering, Inc. would like to acknowledge the project funding from the New Mexico Environment Dept Wetlands Program & U.S. EPA Region 6. Thank you to Keystone Restoration Ecology, Inc. for their innovative restoration construction, and to the Playa Lakes Joint Venture (PLJV) for technical materials and graphics, and to the Grasslans Charitable Foundation for supporting playa restoration and monitoring on their land.

Funding:
Funding for the development of the Erosion Control Field Guide was provided by a Wetlands Program Development Grant CD #01F78801,
awarded to the New Mexico Environment Department Surface Water Quality Bureau Wetlands Program from the U.S. Environmental Protection Agency (EPA) Region 6. The contents of this document do not necessarily reflect the views and policies of the EPA, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

Cover page photo:
An impaired playa in Lea County, NM with a hydrological modification (pit dug out) and headcuts developing on the left side. (Photo by NCDE).

Photo and Illustration Acknowledgements:
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Contents

Summary

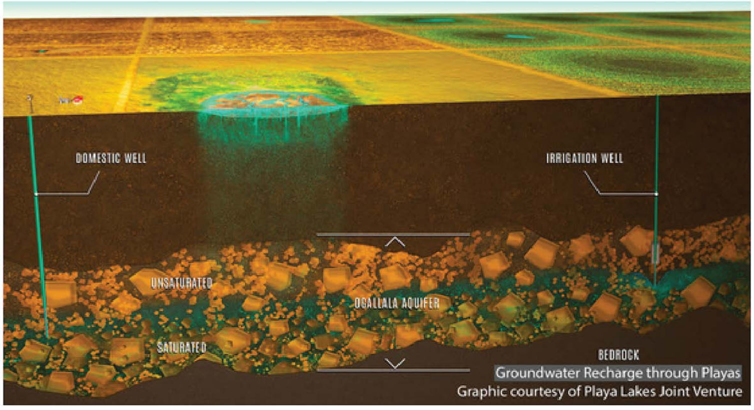
We created this erosion control handbook to help people conserve and restore playas to benefit humans, livestock, wildlife, and the environment to keep playas working and healthy. Playas are one of the few surface water sources across the Southern High Plains region and are essential to focus groundwater recharge towards aquifers. Groundwater recharge is a slow, long process and the work we do in playas today will help protect aquifers for future generations.

This guide focuses on practical, relatively low-cost solutions for erosion control around playas. Since erosion contributes to the degradation of healthy playas, erosion control can help maintain natural playa form and function.

Playas are complex systems, and this handbook is not meant to be an exhaustive management guide. Practices in this handbook may need to be adapted to your local needs and conditions. There are many factors besides erosion that contribute to healthy playas, but this guide focuses on erosion control.

What are Playas?

And how do they work?



Groundwater Recharge through Playas
Graphic courtesy of Playa Lakes Joint Venture

Playas are seasonal, depressional wetlands found across the Southern High Plains (map below), including eastern New Mexico. Healthy playas are important recharge points for the Ogallala aquifer by gathering surface flow. They also provide an incredibly important ecological function by creating surface water for plants & animals in a region that generally lacks abundant lakes, streams, and springs. As stormwater collects in playas, it becomes a main recharge point for the Ogallala aquifer (Osterkamp and Wood, 1987; Tsai et al., 2010). The Ogallala aquifer is incredibly important to agriculture, ranching, and as a fresh groundwater source for the region (Tsai et al. 2010). And water in playas benefits multiple resources including humans, migratory waterfowl (Anderson and Smith 1999), local wildlife, and livestock.

Playas are an important source of water to recharge groundwater by improving surface water interaction with the aquifer. This is especially important in areas such as croplands that rely heavily on ground water resources (Tsai et al. 2007). Aquifer recharge and surface water functions must work together to support the region. As you can see in the illustration above, aquifer recharge is a long, slow process where water collects in the playa, and then slowly seeps through the ground to the deeper layers of the regional aquifer. Aquifers are made up of many layers which filter the water and over time provide a fresh, clean groundwater source for multiple uses.

Sedimentation degrades playa function and can displace wetland vegetation and wetland or migratory wildlife that rely on these wetland systems. Healthy functioning playas have a bare clay basin which forms cracks and allows water to slowly seep through and contribute to aquifer recharge (PLJV). One of the most common and significant causes of playa degradation is upland erosion surrounding and contributing sediment to the playa (PLJV). When fine sediment from upland erosion accumulates in the playa basin, it reduces the amount of water in the playa and reduces the water standing in the playa (Skagen et al. 2008). The water residency time in playas is reduced when upland sediment fills the clay basins. And as the water surface raises because it is now sitting on top of accumulated fine sediment, it can also fill the playa faster and overflow onto the upland soils or infiltrate into the accumulated upland sediment in the playa (Luo et al. 1997; LaGrange et a. 2011). As sediment accumulates in the playa it can become a sponge and absorb water which would normally pond in the clay bottom (LaGrange et a. 2011). And as the water's surface area increases, more surface water is lost through evaporative processes (Tsai et al. 2007).

While completely avoiding impacts to playas is almost impossible in a mixed-use system, there are a variety of techniques to reduce the amount of fine sediment entering the playa. Regional use of surface and groundwater is in balance with the natural surface water, wetland habitat and aquifer recharge functions of playas' to continue supporting wildlife, cultivation, ranching, and ecosystem health.

Erosion control practices in this guide are based around soil stabilization to keep fine sediment out of playa bottoms. Our calibration of the NRCS grass-lined channels toolkit with regional field data confirmed that native bunchgrasses at regular density can effectively stabilize soils in channels with 3:1 bank slopes and bed slopes up to 15%. Reducing erosion in playa banks and the immediate surroundings keeps sediment out of playa bottoms, allowing water to seep into the ground and recharge aquifers. Playas are a relatively delicate balance of slow ground water recharge areas that support a wide area of ephemeral (seasonal) surface water, wetland ecology, support agriculture and wildlife. Maintaining the natural form of playas with bare clay soil basins, will maintain these playas as seasonal wetlands and support their contribution to aquifer recharge by allowing water to slowly seep through the cracks.

What are headcuts?

And how do they relate to

Channels and ***Erosion?***

Headcut erosion occurs when slopes change abruptly or a 'knick point' forms in soft, highly erodible soils. Once a headcut begins to form, it will continue marching uphill until running into a hard, erosion resistant surface. Concentrated flows causing gullies can lead to headcuts.

What is a headcut?

Headcuts are areas of downward cutting erosion, that form at abruptly steep slopes and/or changes from hard, stable soils to soft, fine and easily erodible soil. Once started, soil is quickly eroded into the headcut zone as the banks collapse inward. If left untreated, headcuts will continue cutting upstream. A variety of erosion control solutions to apply in playas are explained in this guide.

How can channels cause erosion?

Water typically flows over the surface in two ways, spreading out as a sheet flowing over the ground, or concentrated into a channel. Sheet flows over wide, shallow slopes are generally the slowest moving, and therefore least erosive flows. But when water is concentrated into a channel it moves faster and increases the shear stress, or ability for water to dislodge sediment. As water moves faster it increases the shear stress and the amount of sediment that water will dislodge and transport. When these channels lead towards playas, they can result in large amounts of sediment accumulating in the playa bottom.

Channel Evolution

Channels are constantly evolving as water moves through them. Streams, rivers, and even small drainage channels around playas, follow a channel evolution that describes the form, history, and evolution of a channel. By understanding the channel's current stage in the evolution, you can better understand the disturbance history and plan restoration.

There are various channel evolution models of varying complexity, but they can be thought of in four main stages:
1. Channelization
2. Incision or downcutting
3. Widening
4. Aggrading
(Schumm et al. 1984)

Once a channel forms, it is in a constant state of evolution to find a stable form. The evolution begins with incision or downcutting due to excessive erosion, widening as banks erode away, and then aggrading to regain access to the floodplain. There is a general 'equilibrium' or steady state at the beginning and end of the evolution, and this is what we aim to restore or maintain. When channels become unstable, they can rapidly erode valuable grasslands and impair playa wetlands. At the 'equilibrium' state, water can move freely without causing excessive changes to the channel depth and width. We think of this as a 'steady state'. (Schumm et al. 1984)

Channel Assessment

To restore a channel, you have to ask yourself two questions. "What do you have?" And "what do you want to achieve?" Stream channel assessment typically has three main steps: 1) characterization of existing conditions, 2) identification of the potential, or reference condition, and 3) comparing the existing condition against the potential of the system to identify channel needs and design criteria.

Common Erosion Drivers

Sparse grass and fine soils

Grass spaced at regular densities helps to hold soil together and resist erosion. In grazed systems, it's important to maintain the dense roots of bunchgrasses for soil stability. Due to the fine sediments and dry conditions in E. NM, dense native bunchgrasses are essential to stabilize soils from surface flows. When water is concentrated into channels, you may need to modify the channel width, slope, or banks to encourage grass establishment in the swale.

Fine soils are highly susceptible to wind and water erosion, especially when bare of vegetation. Dense grass helps to stabilize the soil to reduce erosion and soil loss. Gently sloping topography and uniform grass cover create runoff patterns that create widely dispersed, shallow flows and help to create a self-sustaining condition. Concentrated runoffs from culverts, livestock trails, rills and gullies accelerate erosion and are a primary source of sediment accumulation in playas.

Hydrological modifications

Excavating pits or dugouts in playa basins may temporarily increase the standing water in wet summer months in the pit itself. But in the long run, these pits actually reduce the amount of water that playas can hold, because the water infiltrates laterally into the exposed fine sediment, rather than sitting over a larger area of bare clay and slowly seeping through the cracks. When berms are built next to the pits, it reduces the amount of water that can be held in the playa before spilling over the sides (Russell et al. 2020). The effects of dugouts in playas are typically more pronounced in small playas than large playas, because the volume of water in the dugout is a larger percentage of the overall playa volume (BLM 2013).

If you think of playas as a bowl of water with cracks in the bottom, water in a full bowl will seep through the cracks in the entire bottom of the bowl. But if you have a bowl with a pit in the bottom that is covered in fine sediment rather than clay, the water will fall into the pit lined with fine sediment rather than clay, causing the water stay on the surface and be lost to evaporative processes, rather than to seep through cracked clay and move towards the aquifer. Water collected in the pit may stay deeper for longer, but the water's overall surface area on the landscape is reduced. Playas can most effectively balance their functions of surface water and aquifer recharge, in their natural or restored unmodified states.

Concentrated surface flows can form rills and gullies

Gullies cause rapid erosion and transport of fine sediments

Livestock trails

Livestock like to follow straight and easy paths to access water in playas. Over time, these trails become bare of vegetation and compacted, which concentrates flowing water and increases erosion. These trails can become gullies and transport large amounts of sediment into the playa bottoms, which degrades playa function and the water source over time. Runoff concentrates in these depressions and channels, increasing erosion.

Concentrated drainage

Surface flow in playa areas is generally wide and shallow with very low shear stress developing during runoff events. Even in fine soil, maintaining dense, native bunchgrasses helps to stabilize soil. Road culverts concentrate flows, which create higher shear stress than soils and vegetation can withstand.

Water flowing over roads can carry high sediment loads, which can accumulate in playa bottoms. Culverts funnel the water and can create headcuts where water is concentrated directly downstream. Once a headcut forms, it continues working uphill, rapidly eroding sediment until it runs into a hard enough surface. Hard, impermeable surfaces like roads concentrate surface water flows that would have been spread and absorbed over a natural landscape. Redispersing surface flow over a wider area helps to wet grass over a larger area, as well as reducing erosion from concentrated surface flow.

Sparse grass and fine soils

Sparse grass and fine soils in an arid environment are easily eroded by wind and water. As water runs over the surface or in channels, it dislodges fine sediment which can accumulate in the bottom of the playas. As wind blows over the land, it can take fine sediment with it and remove precious topsoil. Fine soils are highly susceptible to erosion, but dense root systems can help stabilize the soil and resist erosion.

Digging pits in the bottom of playas or creating berms is intended to hold a deeper water depth. However, it disrupts the aquifer recharge function of the playas and it reduces the surface area of water available on the landscape. In this photo, you can see the excavation and berm created in the bottom of a playa, changing the natural hydrology.

Hydrological modifications

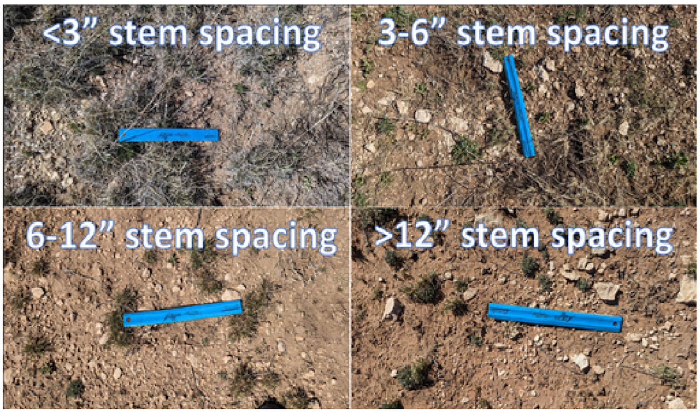
Livestock trails

Livestock tend to follow straight paths to water in the bottom of playas. As these paths become compacted, they become bare of vegetation and highly erodible. Concentrated water flowing through these trails incises the channel and they become a source of sediment and also transport additional sediment to the bottom of the playa.

Concentrated drainage, such as culverts carrying road runoff, increase the depth and velocity of water which increases the shear stress and erosion. When water is forced through a single concentrated drainage rather than broadly over the landscape, it erodes the soil more rapidly. A better alternative for drainage is to spread the water over a larger area or to create many small drainage points rather than a single large drainage.

Concentrated drainage

Generalized Solutions



Dense grass cover

Maintaining a high density of native bunchgrass is essential to resist erosion. Grass root density is essential for erosion control. In grazed systems, grass can be grazed down and still stabilize soil, as long as the collar and root bunch remain intact. Native grasses may need to be seeded along with resting and rotating grazing practices in areas near playas.

Leading livestock to water along contour

Grazing livestock tend to follow the same paths to water in the playa bottoms, which form gullies and lead to heavy erosion, this can occur even in well-grassed systems. When water flows through deep, narrow gullies it moves faster and collects more sediment along the way. Redirecting livestock along contour rather than down slopes, through fencing or other diversions allows livestock water access while reducing erosion. A preferred alternative is to move livestock water access to areas away from the playa, to reduce sediment accumulation in the playa bottoms and restore healthy playa function.

Soil conservation

Stable soils are essential to keep sediment out of playa bottoms, and healthy fertile soil in the fields. Healthy playas have bare, clay basins in which water can slowly seep into the cracks and recharge the aquifers over time.

Headcut armoring

Erosion will continue rapidly after a headcut forms. The erosion control practices in this handbook focus on stabilizing grades and armoring headcuts, or rerouting concentrated flows away from headcuts. Rock is one of the best, long-term ways to armor headcuts and banks. But in areas with scarce rocks, you may be able to substitute dense brush mats or erosion control fabric as shown in the construction guides.

In-channel and out-of-channel restoration

In-channel structures and practices are meant to actively restore and help rebuild stable channels. Out-of-channel structures and practices are typically meant to reduce erosion and keep sediment from entering waterways. We've recommended practices that can be paired together and adapted to your site goals.

Grade control and stabilization

When slope changes abruptly, water will create a "waterfall", which causes more erosion than steady flows and which can lead to headcuts. Grade control structures or gradual earth sloping help to absorb and redisperse concentrated surface flows to slow erosion and aid vegetation re-establishment. Grade stabilization can be accomplished by using combinations of the practices in this guide, to stabilize slope and armor knick points that can develop into headcuts. Structures and practices are described in this handbook that can be adapted to your location, available materials, and site goals.

Sediment capture structures

Brush and rock structures, grade stabilization, and surface flow dispersal can reduce the accumulation of fine upland sediment in playas. There are specially made erosion control products available, including erosion control fabric and straw wattles to assist in sediment capture. Or you can use structures in this guide, made of rocks, brush, mulch and straw bales to utilize on-site materials for a similar effect to manufactured products.

Sheetflow concentrated into gullies increases erosion and sediment accumulation in playas

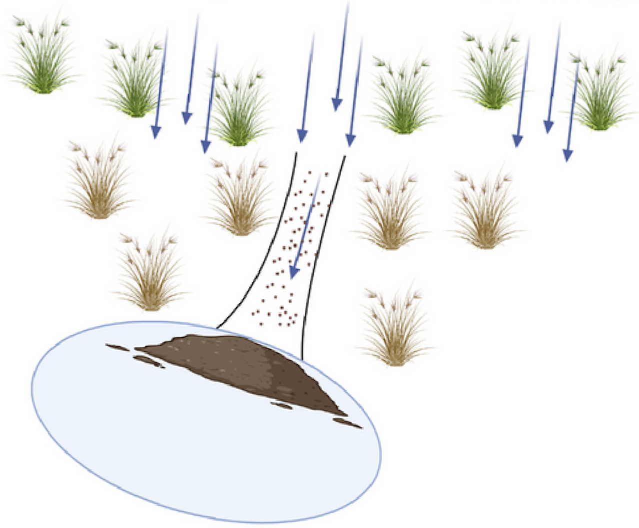
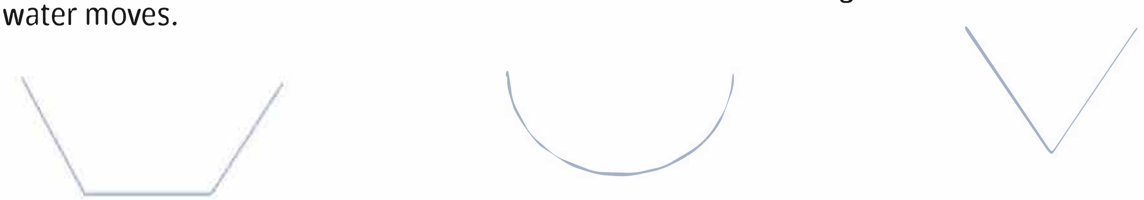


Illustration adapted from Zeedyk and Vrooman (2017).

Channel Dimensions & Grass-Lined Channels

Channel shapes

Channels are typically described as trapezoidal, 'U', or 'V' shapes. Water moves differently through different channel shapes and based on the bank slope and bottom width. Erosion is caused by shear stress, which is a product of water depth and channel slope. Therefore by widening the channel bottom and/or gently sloping the sides from a 'V' to a 'U' or trapezoid. By reducing water depth and/or channel slope, you can reduce erosion. Bank slopes are measured as vertical rise over horizontal run. Typically, a 3' rise and 1' run or 3:1 slope is recommended as the steepest stable slope that will readily regrow vegetation. In addition to the channel bank slopes, the channel width determines the amount of water that can flow through the channel and how fast that water moves.



Trapezoidal Channel (*least erosive*) "U" Channel "V" channel (*most erosive*)

Grass-lined channels

Channels and swales in the playa region are not naturally protected from erosion by cobble or boulder. Vegetation root density is vital to holding fine grained soils together. Sufficient grass spacing and density helps to stabilize soils from erosion and works particularly well with infrequent flows and inundation (NRCS 2007). Grass-lined channel designs and desired grass densities are based on the slope as well as grass type, height, and spacing (NRCS 2007). Success depends on conservation and maintenance of slope and grass density.

We developed a set of guidelines for stable slopes and channel shapes, based on the equations from NRCS grass-lined channels toolkit. Overall, this tool shows that channels without grass cover will continue to erode even at shallow slopes. Due to the semi-arid environment and multiple land uses of playas and surrounding grasslands, we realize that these grasslands are essential to grazing. It's important in grazed systems that the root bunches remain intact and have regular dense spacing, as shown in the photo at the top of page 8. Native bunchgrasses will be most effective for soil stabilization, and we found blue grama (*Bouteloua gracilis*) was the most common bunchgrass in the field. Large areas with bare soil or sparse grass have the highest erosion potential. The table below demonstrates how widening channels and maintaining grass cover reduces shear stress, even on steeper slopes.

Stable channel dimensions

Maximum stable slopes with 3:1 banks and bunchgrass density of 10 stems/sq. ft. at 2 CFS flow

Channel Type	Bottom Width (ft.)	Max Stable Channel Slope
Trapezoid	2	7.5%
Trapezoid	5	15%
Trapezoid	10	15%

Use this table as a rule of thumb when working with channelized flows within these slope ranges.

Erosion Control Structures

If managing channel shape and vegetation cover is not possible, then the construction of erosion control structures may be required. The following pages will break down these structures. Structures can be combined to maximize effectiveness. Examples of combinations on (pg. 24).

One-Rock Dam (ORD)

Summary

One-rock dams (ORDs) are simple structures built with 8-12” diameter rocks for maintaining grade or raising grades, to prevent headcuts. ORDs, like all rock structures, need to be “tied in” to the native slope meaning that the rocks are dug into the slope and connect to a hard surface like a rock or a stable bank.

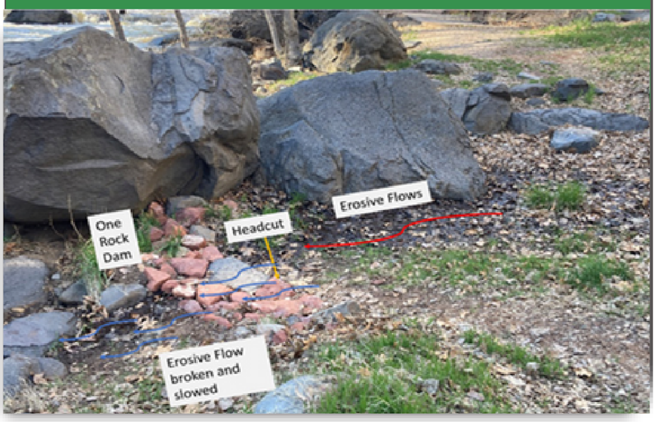
ORDs are used for grade control, and to stabilize headcuts. In deep headcuts or gullies, you can continue building ORDs moving uphill, as the first layer is filled with sediment.

Using ORDs for aggradation will reconnect the channel with the floodplain and allow water to spill onto the sides of the playa in a less erosive sheet flow. This practice will in turn help maintain grass on the sides of the playa for soil stability and playa function.

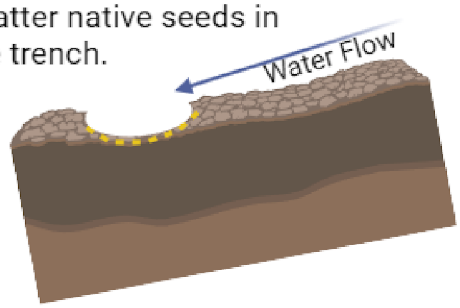
At-A-Glance

• Where to build?
Active headcuts and erosive channels

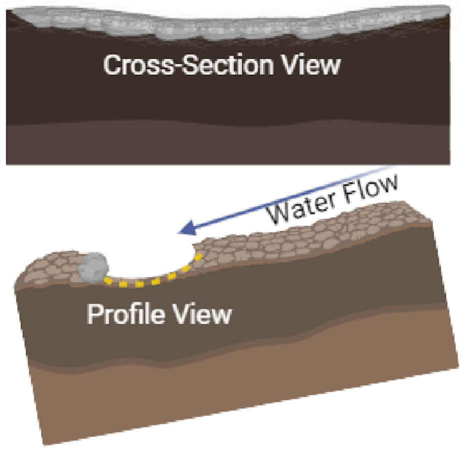
• Sediment reduction potential
High



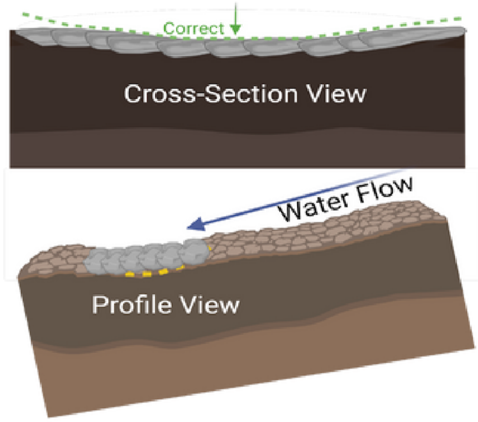
1. Dig a shallow trench where grade changes. Scatter native seeds in the trench.



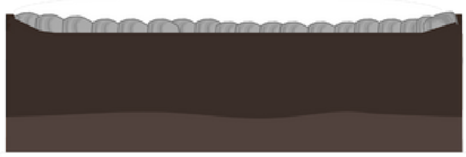
2. Lay the first row of rocks level across the trench. Tops of rocks should be no more than 2" above native soil. Rocks need to be tied into the slope or erosion will work around the sides.



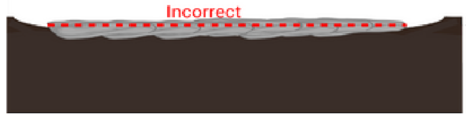
3. Continue adding rows of rocks upstream in the same fashion. Make sure there is a low point in the middle for water to flow.



Rocks can also be placed vertically like books on a shelf. This works well with small rocks or in deeper headcuts.



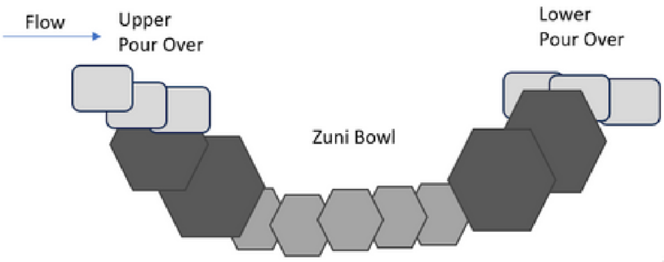
If rocks are not tied into the slope, or are laid without a low point, water will flow to the sides and continue bank erosion.

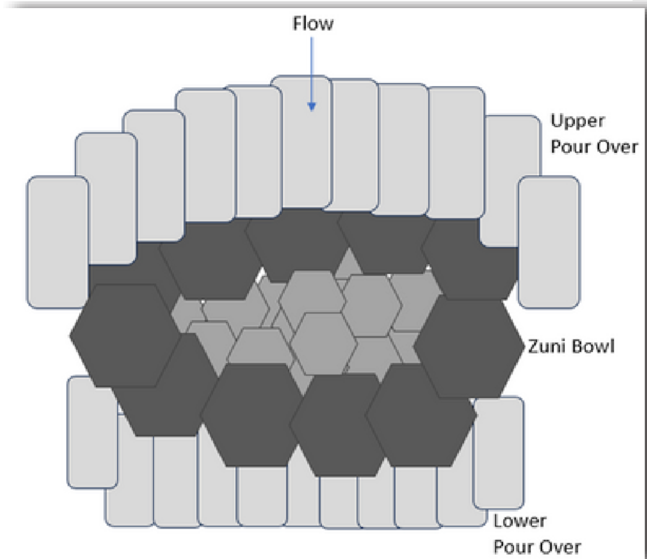


Zuni Bowl

Summary

Zuni bowls stabilize headcuts by spreading water's energy as it drops into the bowl. Build zuni bowls directly in existing headcuts to arrest the headcut and allow soil to fill in over time. Seeding under where the rocks will go can speed up vegetation establishment. Zuni bowls are most effective when paired with additional grade control like One Rock Dams.





Construction

1. (Lower Pour Over) Start at the widest point of the headcut and build a row of large rocks end to end across the gully. Ensure there are no gaps between these rocks.

2. (Zuni Bowl) start building the bowl in the center with small rocks and increase rock size as you move out and up the sides, like the picture on the left.

3. Add rows of progressively larger rock around the bowl up to the height of the original grade.

4. (Upper Pour Over) Add a row of rocks across the top to concentrate flow to the bowl.

At-A-Glance

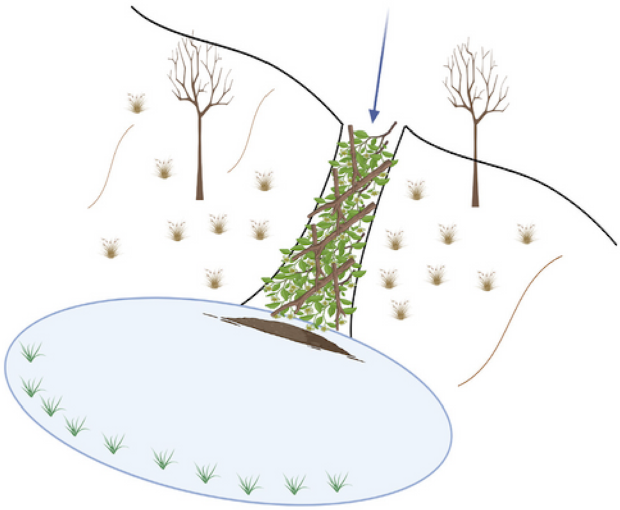
• Where to build?
Headcuts and gullies

• Sediment reduction potential
High

Brush Matting

Summary

Brush mats help to slow flows, to reduce erosion and capture fine sediment to rebuild gullies and channel bottoms. As fine sediment and plant material are captured in the brush, they will rebuild the incised channels. This structure also captures wind-blown sediment to fill gullies. The brush mat captures fine sediment by reducing the speed of flowing water. Over time, the channel bed is raised, and banks are rebuilt to a stable grade. Brush mats can also provide a micro-climate, to establish vegetation.



Construction

1. Remove woody shrubs like mesquite that have encroached into the playa and use this woody material to build a dense compacted brush mat in the channel.

2. Start packing leafy brush into the channel with the leaf end downstream and the stems upstream. This allows water to flow through and sediment or brush to get caught in the branches after the leaves fall off.

3. Build up and compact the brush mat until the compacted height is equal to the height of the gully. Large branches on top will help compact over time. Brush mats may also discourage livestock trailing within the channel.

At-A-Glance

• Where to build?
Headcuts and gullies

• Sediment reduction potential
High

Brush Dam

Summary

Brush dams can be built in eroding channels to catch sediment in the leafy brush, while allowing water to filter through to the playa. Over time, soil and vegetative material will be trapped in the brush dam to fill the channel and reduce sediment that can enter the playa.

Construction

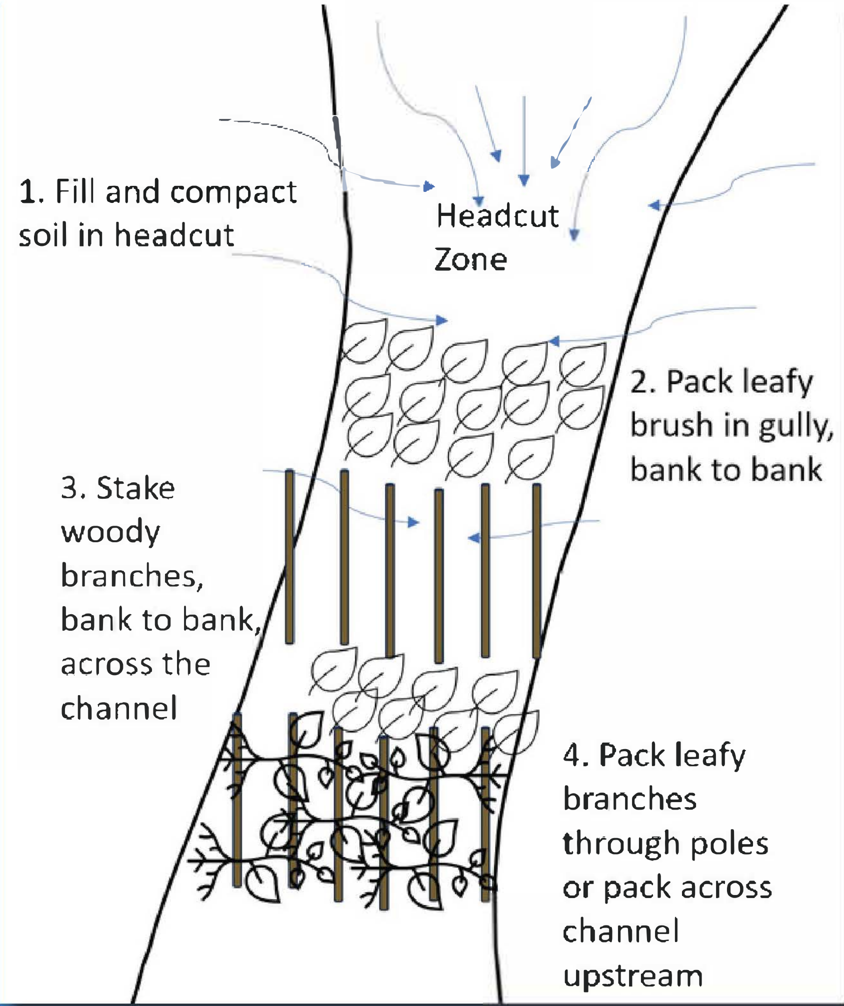
1. Construct brush dams in existing headcuts and gullies from woody vegetation

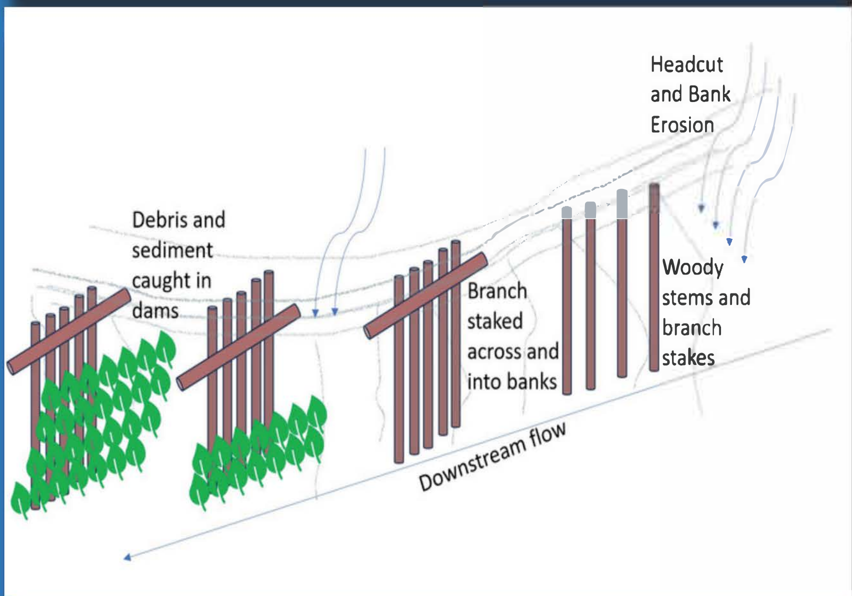
2. Hammer straight, sturdy branches or t-posts across the gully as fence stays. Stems in the gully, can also be used as posts.

3. Tightly pack leafy branches across the gully, against the poles.

4. Place the sharp branch ends between the leafy branches and poles.

5. If you have extra brush and branches, you can continue packing further up the gullies to form a brush mat.





At-A-Glance

• Where to build?
In eroding channels

• Sediment reduction potential
Medium

Media Luna

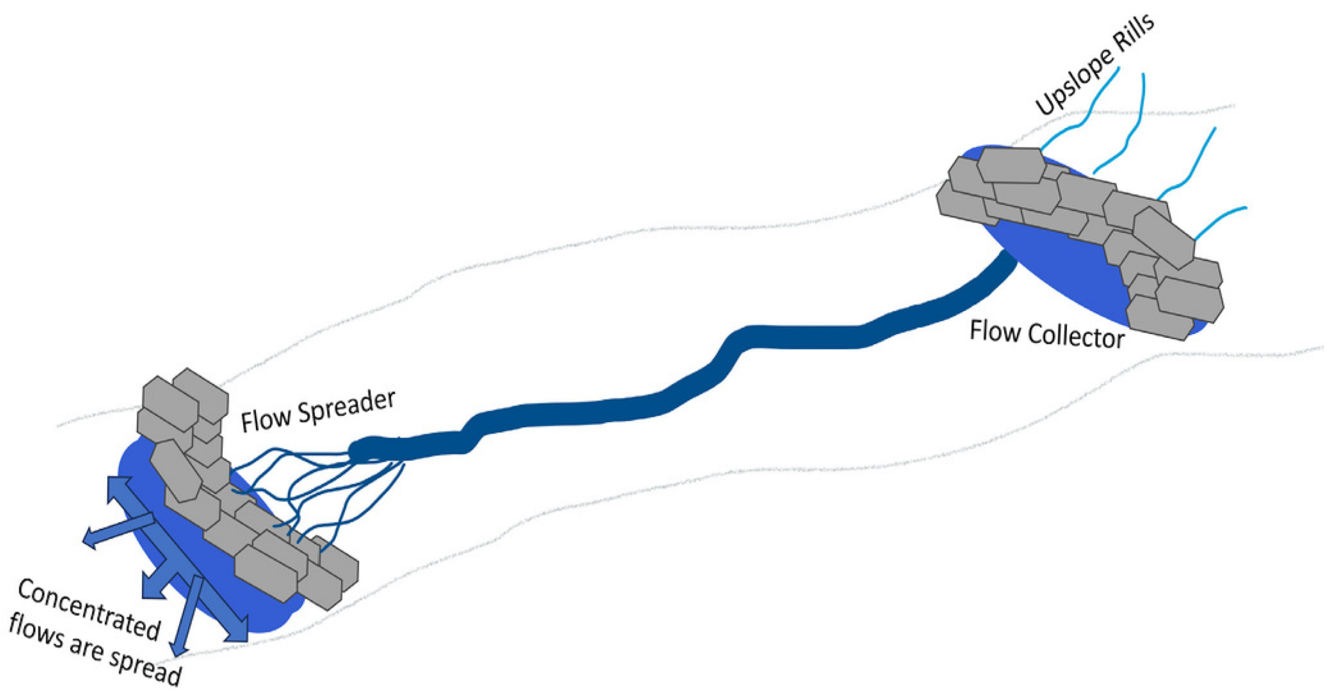


Illustration adapted from Sponholtz and Anderson (2010).

Summary

Media lunas can be built as collectors or spreaders of sheet flow. Collectors (upslope) gather flows from rills and gullies to prevent small headcuts. And spreaders (downslope) disperse channelized flows and concentrated erosion over a larger flatter area, to reduce the shear stress. Together these can be combined to concentrate rills into a stable channel moving downhill then spread the water back out. This allows you to mitigate small headcuts from turning into large headcuts and spread it around the playa sides.

Construction

1. (Collector) Place a rock on each side of the bank, directly downstream of rills.

2. Lay a level convex arc of rocks that captures all upstream rills you want to collect, working up from the first row. Place rocks all the way from one bank to the other. Close any gaps, or else new channels will form between the gaps.

3. (Spreader) Place a rock on each bank, wide enough apart to capture the entire channels flow.

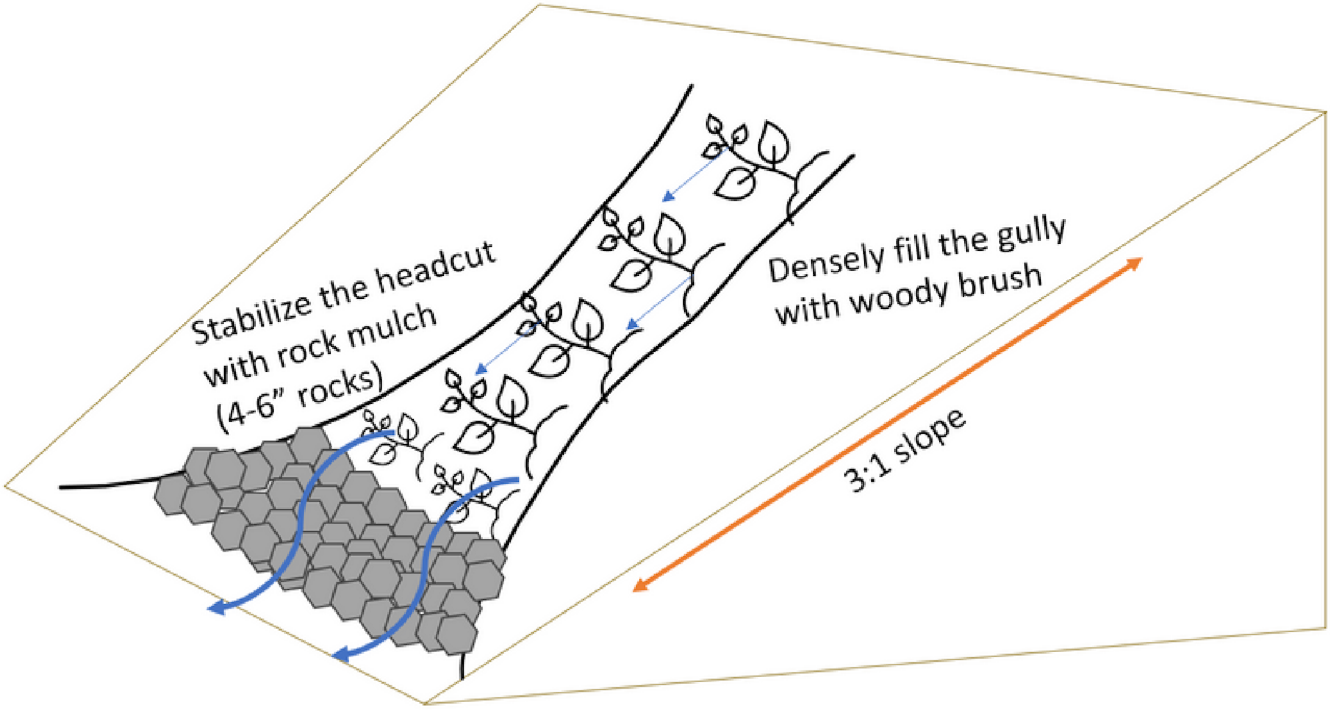
4. Add level layers in a concave arc working from bottom-up.

At-A-Glance

• Where to build?
Slopes with rill and gully formation

• Sediment reduction potential
Medium

Rock Mulch-Brush Rundown



Summary

Build rundowns in shallow-angle headcuts to reduce erosion and stabilize soil to help reestablish vegetation. This structure should only be used in low-energy headcuts, or the water will move the rocks/brush downstream and further carve out the channel center. Erosion control fabric or densely packed brush mats can be combined to reduce the amount of rocks needed.

Construction

1. Reshape the headcut and surrounding slope to a 3' rise : 1' run.

2. Build a u-shaped channel in the existing headcut to spread the water's energy in the headcut.

3. Spread native seeds in the channel, these will be covered with erosion control fabric and/or densely packed woody brush.

4. Armor the headcut by spreading small rocks ("rock mulch"). Build a low point in the center of the rocks, to create a flow path. Then fill the channel upstream with densely packed brush.

At-A-Glance

• Where to build?
Shallow headcuts and gullies

• Sediment reduction potential
Moderate

Plug and Spread

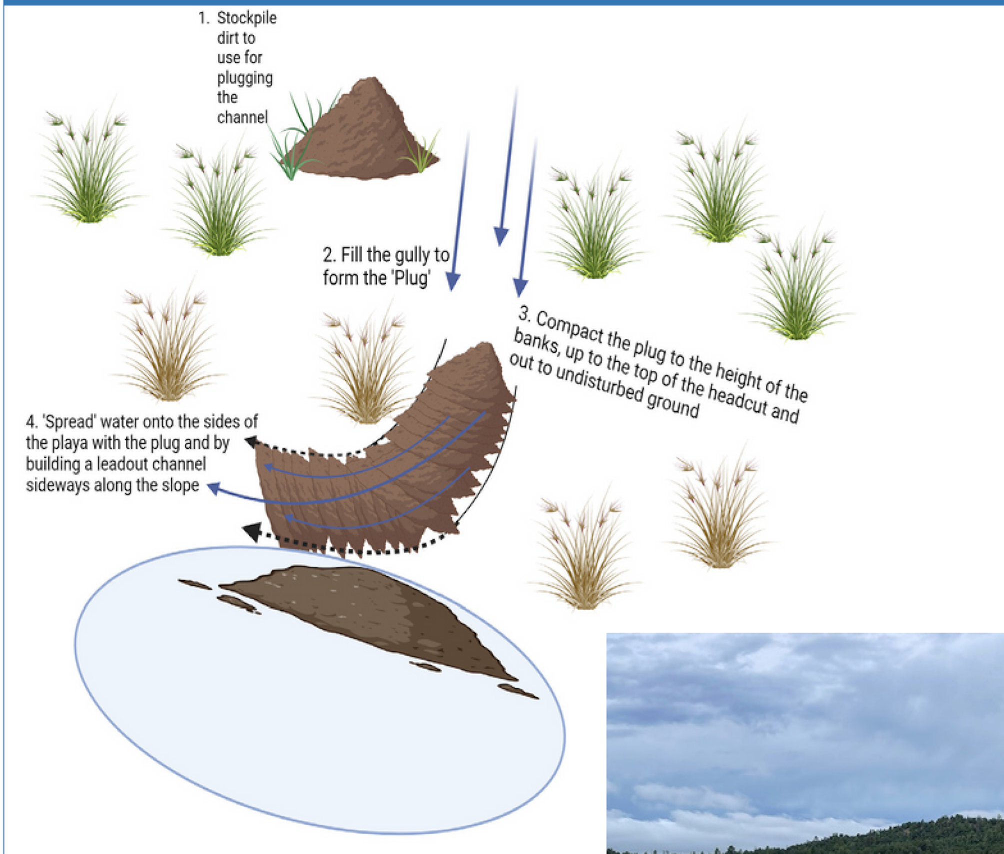


Illustration adapted from Zeedyk and Vrooman (2017).

Looking downstream from plugged headcut to leadout channel. (Photo courtesy of Keystone Restoration Ecology)

Summary

The Plug N' Spread structures are built in existing headcuts to reduce water velocity and the erosive force by plugging the headcut and spreading the flows to the sides. A small 'pond' can be excavated above the headcut to reduce the amount and speed of water entering the headcut. Plug N' Spread can be used in conjunction with brush mats to capture additional sediment in the channel. As water is spread it will re-wet the surrounding area and aid vegetation reestablishment.

Looking upstream at end of leadout channel. (Photo courtesy of Keystone Restoration Ecology)

At-A-Glance

• Where to build?
Active headcuts and gullies

• Sediment reduction potential
High

Erosion Control Fabric

Summary

Erosion control fabric is typically a natural-fiber fabric weaved in a grid pattern, designed to hold soil in place while capturing fine sediments and seeds. The fabric also creates an ideal microclimate for vegetation re-establishment by providing shade and trapping moisture. Natural fiber fabrics like natural coir (coconut fiber) will break down after a few years, so it is important to seed below to help vegetation reestablish after the soil is stabilized. Fabrics typically last for a few years before degrading.
Do NOT use a fabric with plastic mesh – it is a wildlife hazard

Construction

1. Slope banks to a stable grade, no steeper than 3:1.

2. Dig a shallow trench and bury the end of the first roll.

3. Roll out fabric over slopes and stake at least every 2 ft. with stakes or staples.

4. Trench and bury the end of each roll.

5. When overlapping two rolls, lay the upstream piece over the downstream piece to “shingle” the rolls and ensure water flows over rather than under the fabric.

At-A-Glance

• Where to build?
Steep slopes and bare soil

• Sediment reduction potential
Low

Straw Wattles

Summary

Bio-logs or straw wattles are available off the shelf and can be secured with wooden stakes or fencing staples along eroding slopes, banks, or sides of playas. These are designed for low volume surface flows, and if your site has higher flows, you may opt for straw bale barriers instead. The net and straw will create a barrier to catch fine sediment as it erodes downslope. Straw wattles will break back down into the soil over multiple years and may need to be replaced occasionally. This is a short-term stabilization solution that should be combined with other erosion control practices.

Construction

1. Stabilize soil by sloping banks to 3:1 slope.

2. Dig a shallow trench (2-4" deep) to place the wattle

3. Stake wattles every four feet across to extend upstream and downstream of the problem area, so erosion doesn't work around the sides.

4. Ensure the rolls are placed along contours and "keyed in" to the slope, meaning the ends are buried into the ground, rather than being placed directly on top. This helps ensure water will not work around or underneath the barriers.

5. When banks cannot be reshaped to a stable grade, you can install the wattles in bundles, with the larger diameters downslope

At-A-Glance

• Where to build?
Steep slopes and bare soil

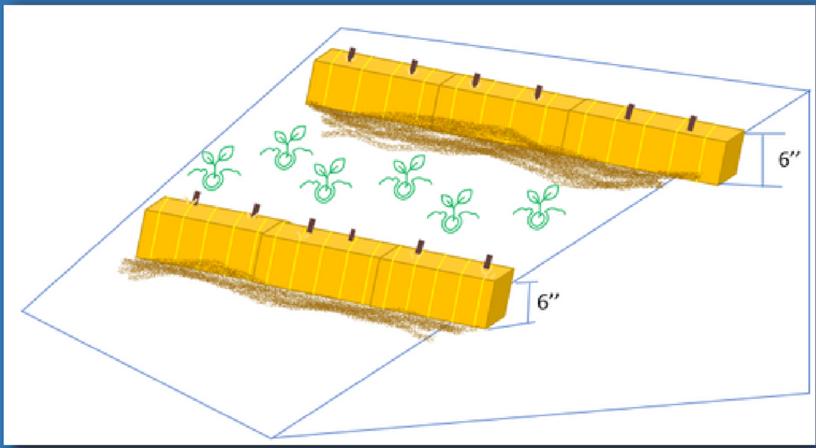
• Sediment reduction potential
Low

Slope	Wattle Spacing
1:1	10'
2:1	20'
3:1	30'
4:1	40'

Straw Bale Sediment Barrier

Summary

Straw bales can be used as sediment barriers, as an alternative to manufactured straw wattles. These are temporary structures and will require replacement as they weather. As the straw bales disintegrate, the straw can be used as mulch on the playa sides or areas with bare soil. This practice should be used on newly sloped banks with disturbed soil, or on the sides of playas with sparse grass cover and exposed soil and should not be used where there is grazing pressure from cattle. If straw bales are used to control erosion in grazed systems, they may need to be supplemented with on-contour fencing.



Construction

1. Place straw bales in rows perpendicular to the slope and bury them 6" on the up and downhill sides.

2. Hammer wooden stakes through the hay 12" into the soil to secure the bales.

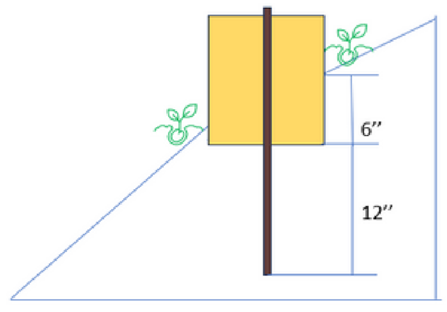
3. Plant grass seed between and above the bales. Over time, as grass recovers on the sides of the playas, grass will stabilize the soil and the straw bales can be removed.

4. Bales should be placed tightly end to end, without large gaps between bales for water to flow through and develop new rills.

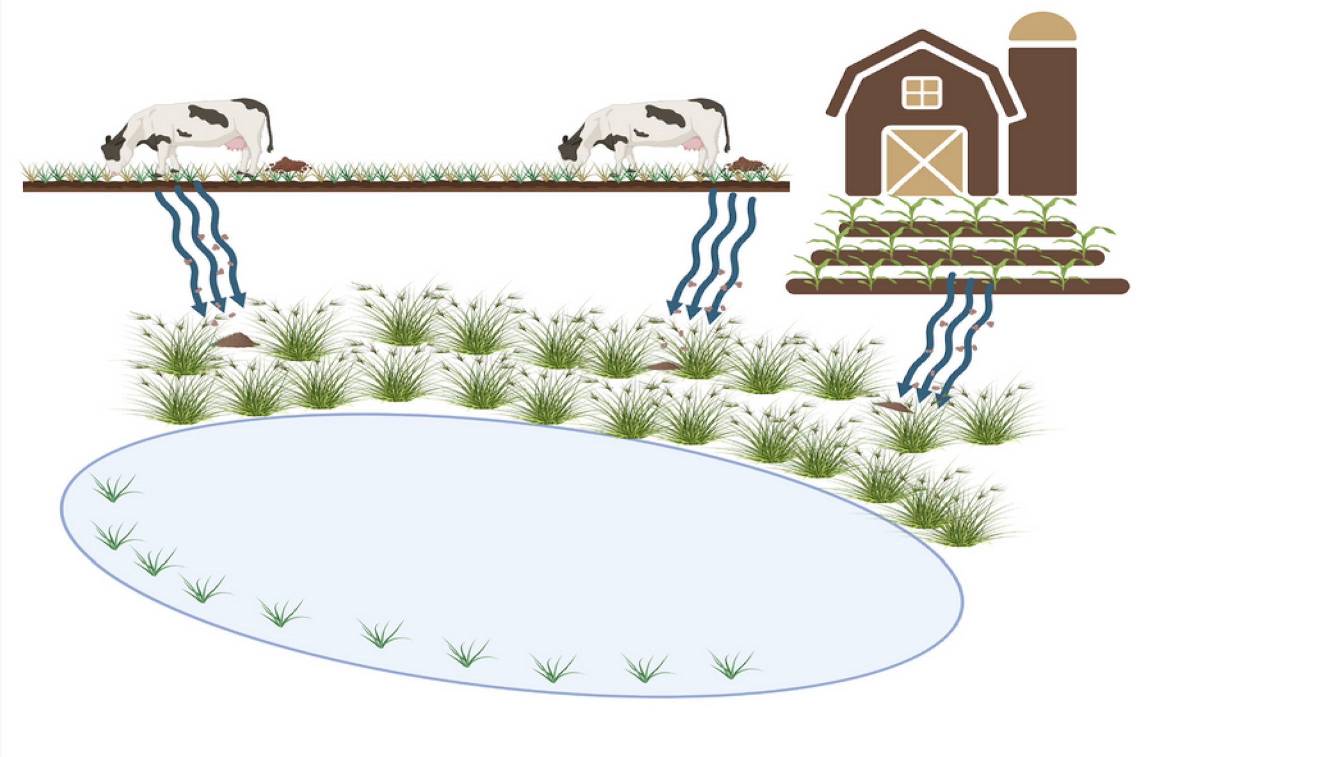
At-A-Glance

• Where to build?
Slopes with rill and gully formation

• Sediment reduction potential
Medium



Vegetation Filter Strip



Summary

Maintaining a vegetation filter strip between cultivated fields, roads, or grazing lands can filter sediment and chemical runoffs from entering playas. Filtering runoff reduces fine sediment accumulation in playa bottoms and can act as a natural filter to catch pollutants. Filter strips can also include a single or double net erosion control fabric to aid vegetation reestablishment.

Construction

1. Strategically maintain filter strips to intercept sediment and contaminants between playas and surrounding land uses

2. In addition to capturing sediment, filter strips can also be effective below cultivated fields to catch agricultural runoff e.g. fertilizers, organic material, and dissolved salts which can impair water quality.

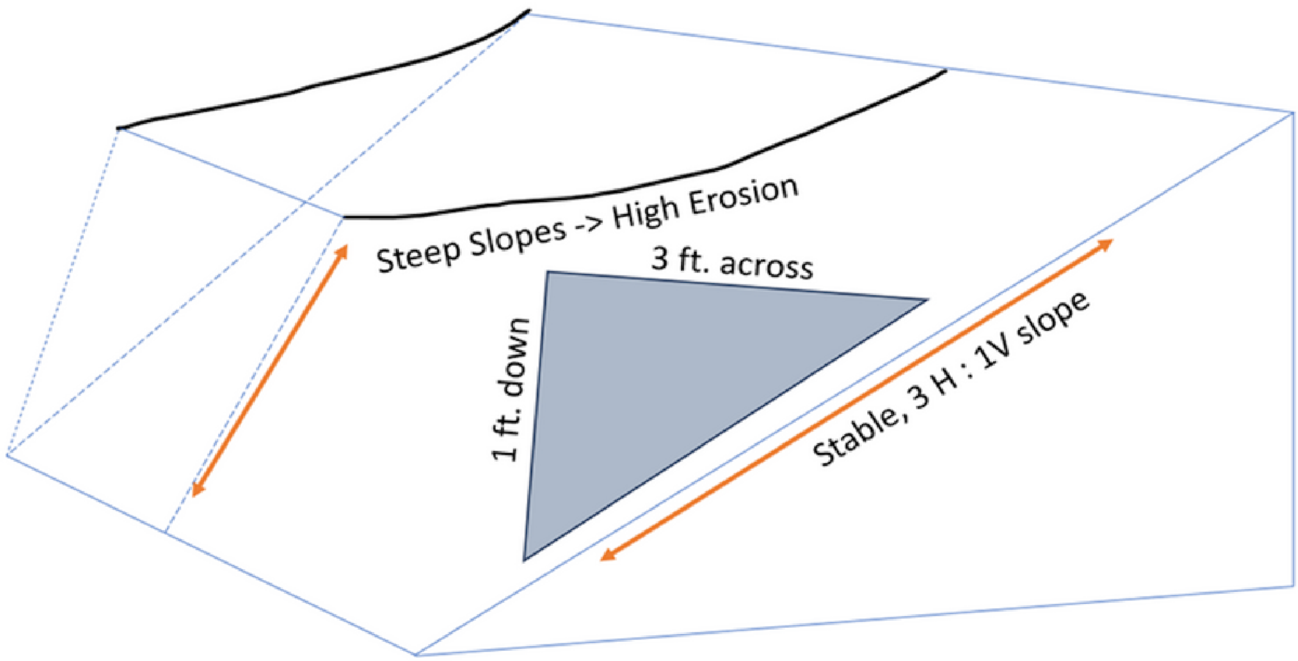
3. Filter strips to catch runoff should be strategically located below potential contaminant entry points.

At-A-Glance

• Where to build?
Downstream of agricultural, road, or bare slope runoff

• Sediment reduction potential
Low

Bank Sloping



Construction

1. Bank sloping is a simple erosion reduction technique to reshape steep, highly erodible slopes to a stable grade.

2. Steep or vertical channel banks are highly erodible and should be sloped to a stable grade suitable for vegetation, (3:1 or greater slopes). Remaining stable banks should be left undisturbed.

3. Sloping should begin at the bottom of the bank and move material from the bottom up.

4. Care should be taken not to disturb the toe of the bank, as much as possible.

5. Excavated material can be hauled off-site or distributed in a thin layer on the flat terrace above the bank. Do not leave loose material on the newly sloped banks or it will continue to erode back into the playa bottom.

6. Bank-sloping should be paired with revegetation or erosion control fabric, or banks will continue to erode. This technique can be used on channel banks, beds, and the surrounding drainage.

At-A-Glance

• Where to build?
Eroding, overly steep slopes and banks

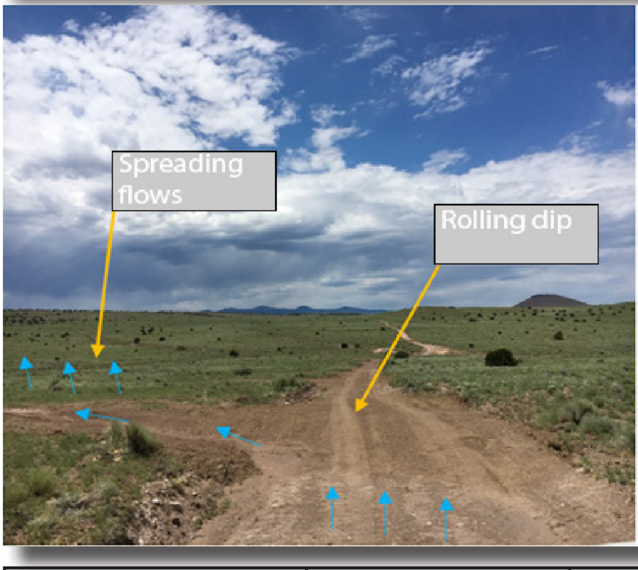
• Sediment reduction potential
Varies by site

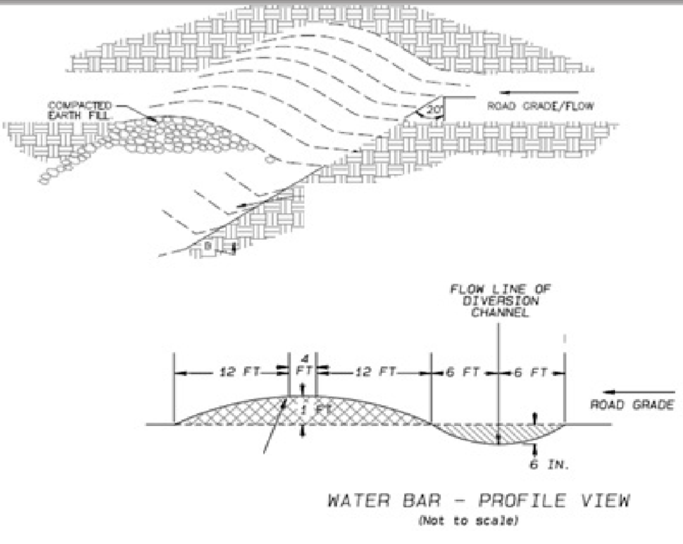
Water Bars (Rolling Dips)

Summary

Water bars will improve road drainage by creating rolling dips, where water is collected and directed off the road. Bars are constructed at a spacing that is based upon road slope, soil type and area needed to dissipate flows collected at the water bar.

A water bar built in the low point of the road can stabilize drainage and keep fine sediment out of the playa bottoms





Road grade (% slope)	Water bar spacing (aggregate surface)	Water bar spacing (native soil surface)
1-6 4-6	600	100
7-9 10-	300	80
12 13+	200	70
	150	60
	80	50

Construction

1. Dips are created from compacted fill as shown in the profile drawing.

2. The lead outs should be placed on contour to allow for water to leave roadway and irrigate adjacent hill slope.

At-A-Glance

• Where to build?
Across sloped roads where flows gather, especially down cut roads

• Sediment reduction potential
Immediate

Best Management Practices

Fine sediment accumulation

Fine sediment accumulation in playa bottoms can quickly cover the clay basin and reduce a playa's ability to slowly filter water into underground aquifers. The erosion control structures and practices in this guide are meant to reduce erosion and keep fine sediment out of playas. Stable grade sloping and structures to armor weak points and help fill headcuts will help the 'water do the work' (Zeedyk and Clothier, 2009) in stabilizing soil around playas and keeping sediment on the slopes.

Filling Pits in Playas

When pits are dug into the bottoms of playas to hold more water, it can temporarily increase the amount of water available. But it reduces the overall time playa that clay bottoms stay wet and recharge groundwater. Filling excavated pits in playa bottoms can be a low-cost, low-risk and high-reward to keep playas wet longer and allow water to slowly, pond and then seep through the cracked clay to recharge underground aquifers. The pit must be filled with the same clay material as the playa bottom. This material is likely to be found as side cast or as a berm around the pit.

Erosion control fabric

Erosion control fabric helps to stabilize soil physically and by creating a microclimate for vegetation to reestablish underneath. While the fabric reduces the erosional force of water, it also traps moisture and creates shade underneath which can aid vegetation reestablishment. There are woven and non-woven varieties, some which are bio- or UV-degradable and will break down over time. This practice should be used wherever possible on bare or eroding slopes. Erosion control fabric can be combined with most of the other practices in this handbook to increase their effectiveness. Potential suppliers include Rolanka™ or Western Excelsior™ .

Mulch

Mulching is a low-cost method to control erosion by stabilizing soil and creating favorable conditions for vegetation. Woody vegetation removed from the site can be mulched and used as a lower-cost alternative to erosion control fabric. Care should be taken with green mulch as it can remove nitrogen from the soil as it decomposes and prevent growth of new vegetation.

Grazing and livestock water access

Playas are an important water source for wildlife and grazing livestock but can quickly become impaired due to erosion and sediment inundation. Livestock trails in straight lines to water concentrate water into narrow channels which tend to incise and form gullies. The fast-moving water will transport larger sediments and a higher volume of sediment into the playa basins. When possible, livestock water access can be relocated away from the playa with a drinker or tank. Alternatively, livestock trails can be redirected along contour slopes rather than across contour slopes with fencing or natural materials, e.g. mesquite fences.

Wildlife friendly fencing

Fencing can be made wildlife friendly by adding reflectors and smooth wire. Reflectors can be added on the wires to aid wildlife like the Lesser Prairie chicken to avoid getting caught in wires. And stringing the bottom of fences with smooth wire allow ungulates to slide under the fences. (Paige 2012)

Native seeding

Vegetation can effectively stabilize channels and slopes to hold sediment in place. Native plants that are adapted to the local environment and climate will be more likely to tolerate drought and maintain their cover. Spreading native seeds over bare areas or in combination with the practices in this guide may improve structure efficiency by stabilizing soil and keeping fine sediment out of playa bottoms. Spreading and maintaining native vegetation may have the additional benefit of reducing weeds and unpalatable grass for livestock. Potential suppliers include Granite Seed™ or Pawnee Buttes Seed, Inc ™.

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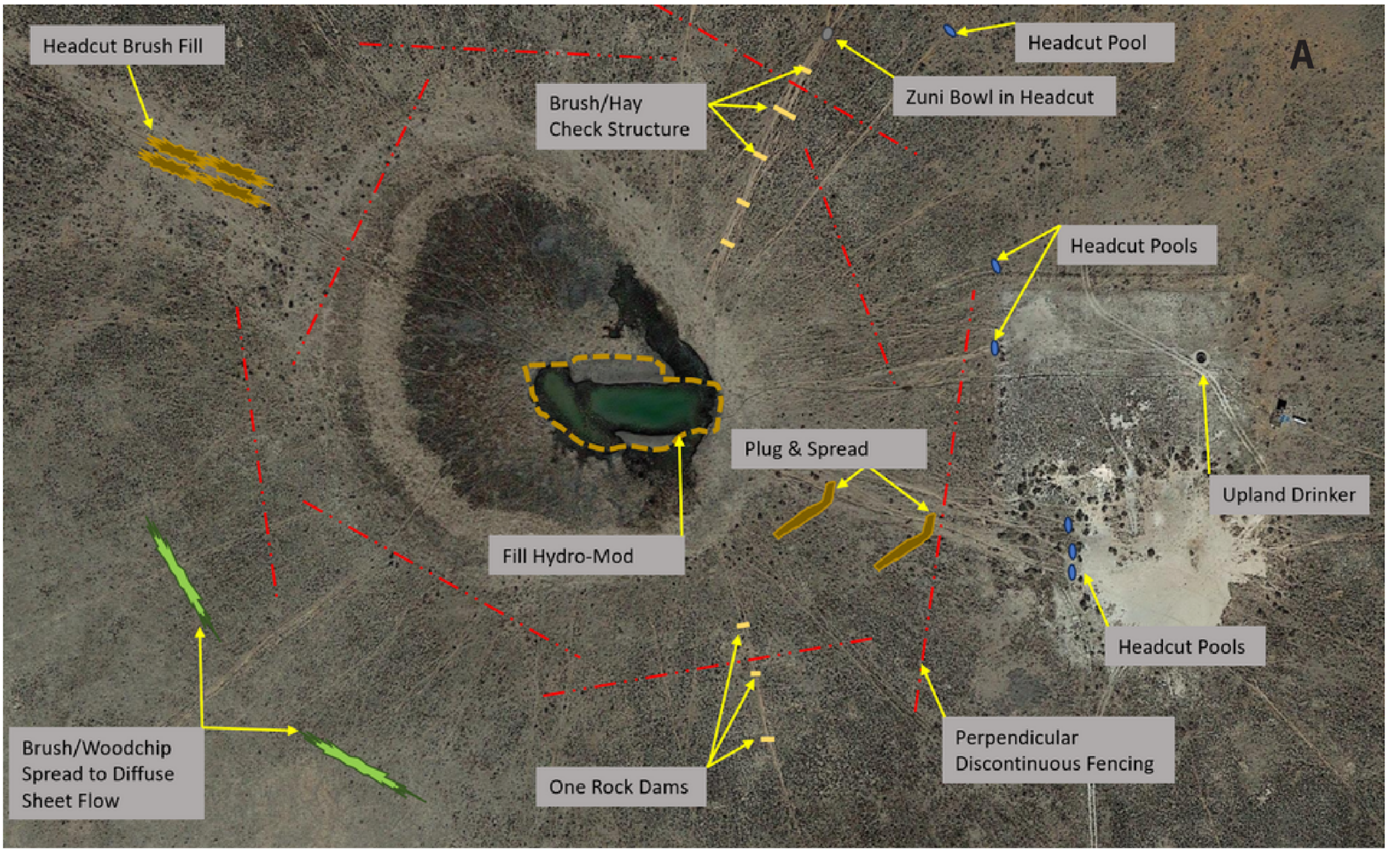
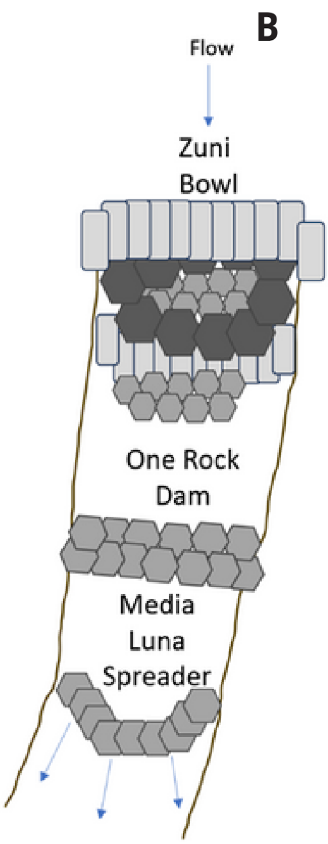
Combining Practices

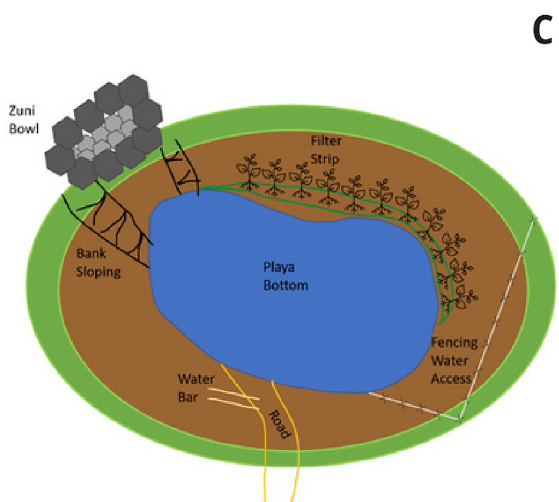


The erosion control practices in this handbook can be combined to maximize success and to fit your site specific needs and budget. The figure above (A), shows how in-channel and out-of-channel practices can be combined on a larger site, or any of these practices can be used alone.



The figure on the left (B) demonstrates combining multiple in-channel rock structures in a series to arrest an existing headcut (Zuni Bowl), create stable grade control (One Rock Dam), and then spread the flow (Media Luna Spreader).

The figure below (C) shows how to combine a zuni bowl in a headcut, sloping of steep eroding banks, maintaining a vegetation filter strip, diverting water access along contour, and installing a water bar in a road leading to the playa.



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