Project Name: Upper Rio Penasco Stream Restoration Phase I

Lincoln National Forest, Sacramento Ranger District, Otero County

Proposed Action

The proposed restoration site is along the Rio Penasco directly downstream of where the Rio Penasco Rd crosses the stream near Sunspot Hwy. The stream flows through a narrow meadow in this area. The stream reach proposed for restoration is less than 0.5 mile long and includes the main channel and side channels in that reach, not every location within the treatment reach would be treated, just areas experiencing excessive erosion. The Stream and wetland restoration activities proposed in the Upper Rio Penasco include the construction of Zuni bowls, worm ditches, media lunas, sod dams, plug and pond techniques, one-rock dams, and flow-splitters (described below). Zuni bowls, media lunas, and one-rock dams are constructed using rock and heavy equipment or may be constructed by hand. Worm ditches, sod dams, plug and pond techniques, and flow-splitters are constructed by excavating shallow ditches and depressions with the back-hoe. In the project area, these features would help mitigate the effects of high velocity flows from several culverts that contribute to channel incision. Other benefits would be to stabilize headcuts and spread the flow of water out over the wetland, increasing saturation, raising the level of the water table, and restoring wetland soil and vegetation characteristics to the area. This would result in improved quality forage for livestock and wildlife, better water quality and quantity, and improved flood mitigation. Equipment used for this project would include a small rubber-tire track hoe and a small loader. Specific site locations and the accompanying techniques for each location are shown below following the treatment descriptions. They can also be found in "Rio Penasco Assessment Report Including Wills Canyon (Van Clothier and Theo Keller, Stream Dynamics, Inc. August 31, 2016). "UpperRioPenascoStreamRestorationPhaseI".

Treatment Techniques:

Treatment Technique descriptions, schematics and photos below were taken directly from the sources below:

- **"Characterization and Restoration of Slope Wetlands in New Mexico" by the Quivara Coalition, 2014 and Bill Zeedyk**
- **"Let the Water do the Work" by Bill Zeedyk and Van Clothier, 2009)**

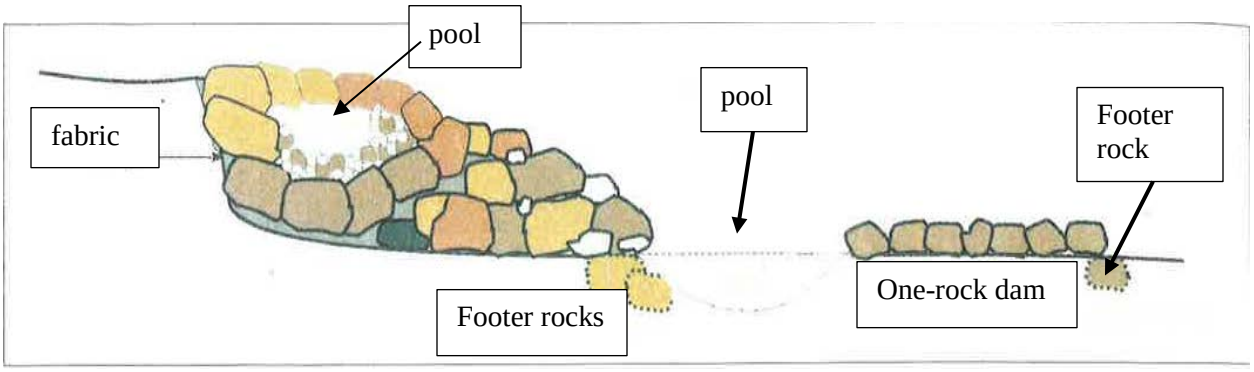
Zuni Bowl (https://www.milkwood.net/2011/11/04/making-a-zuni-bowl-let-the-water-do-the-work/)

The Zuni Bowl is a commonly used headcut control structure built by machine or hand, using properly sized rock, for headcuts ranging from 1 ½ to 6 feet in height. The Zuni Bowl is built on the step-falls or step-pool principle and is designed to create two or more drops replacing the single drop of the original headcut.

The bowl is lined with rock to harden the bed against the erosive, scour effect of falling water. Water pooled within the bowl blunts the shear stress of the falling water, further reducing erosion of the bed and walls of the headcut.

The design and construction of the Zuni Bowl is as follows:

1. *Shape and lay back the face of the headcut to create a uniform surface on which to build.*
2. *Determine the height of the headcut. Most of the headcuts within the proposed project area are 2-4 feet high. Next measure and mark the location downstream that is two to three times the height of the headcut. At this location a shallow trench will be dug and filled with one to two rows of rock, so that no rock protrudes more than 2 inches above the bed of the channel. This will serve as the splash apron for the Zuni Bowl.*
3. *Gather the largest rocks available, and place them in a row just upstream from, and in contact with the splash apron. These rocks should sit at an elevation approximately ½ the total height of the headcut. This will serve as the lower pour-over of the Zuni Bowl.*
4. *Armor the bottom of the plunge pool with a single layer of rock. Place these rocks at a uniform height to create a stable foundation for the rest of the Zuni Bowl. The maximum recommended height of each step is one and a half feet. Because this headcut is about 5 ½ feet in height, it will be necessary to construct four or five steps.*
5. *Starting just upstream from the lower pour-over, lay courses of rock around the face of the headcut. This will form the walls of the bowl. Maintain contact with the shaped surface. The structure will have more integrity if built with layers of off-set rocks that form a sloping wall around the headcut, as opposed to merely lining the face with rocks. Therefore, it will be necessary to lay back some of the sidewalls as well as the lip of the headcut itself to create a more gentle angle for securing rock in these sections of the headcut. Improve the durability of the structure by avoiding gaps in the rock work. Biodegradable geotextile fabric may be used to line the face of the headcut prior to laying rocks. However, this will be difficult if water is flowing in the steam.*
6. *Continue to lay courses of rock around the face of the headcut until a height of the headcut pour-over is reached. No rocks should protrude above this level to allow water to flow freely over the structure.*



Zuni Bowls in the project area will be constructed either my hand or by means of heavy equipment. Access to the sites to construct the Zuni Bowls will be across the wetland/former wetland area. No equipment will be allowed to travel across areas that are saturated. This may require that implementation activities be accomplished during the dry times of the year. Transporting rocks to the sites may be done by means of a loader, an ATV pulling a small trailer, or with a wheel barrel.

One-rock Dam

The one-rock dam (ORD) is used to raise the level of an incised channel or gully. To construct a ORD, rocks are placed only one tier deep in several parallel rows across the channel and packed tightly together. The row of rocks will be of approximately equal height and appear relatively flat from bank to bank. This can be accomplished by placing larger rocks in the deepest part of the channel, smaller ones to either side. Rock will not be stacked on top of one another the get the needed height, as stacked rocks will be swept away by high flows. Oversized rocks placed in the structure will generate turbulence that could undermine the structure. Rocks will be sized proportionately to no more than 1/3 bankful depth. Flood flows will pack smaller-sized bedload particles between the rocks, gradually strengthening the structure over time as the new riffle develops at the site.

The elevation of the upstream row may be slightly higher than the downstream row so that the dam slopes gently from the top edge to the bottom edge. Dams consisting of 3 to 5 parallel rows of rocks have considerable mass but minimal surface exposure to the force of moving water. Therefore, advancing floodwaters slide across the surface of the dam rather than pushing against it. Because the dam is low in height, the water drops only a few inches and has little power to erode or create a scour pool that may undercut the structure. ORDs may be constructed using either a rubber-tired track hoe or by hand, or both.

One rock dam

In the project area, one-rock dams will be constructed by hand and will require the use of picks and shovels. In the process of construction, there will be some minor local disturbance of the stream channel and the sides of the banks as the rocks are placed. There will be some excess sediment that will be temporarily conveyed downstream for a minimal distance. Rocks will be transported to the site where

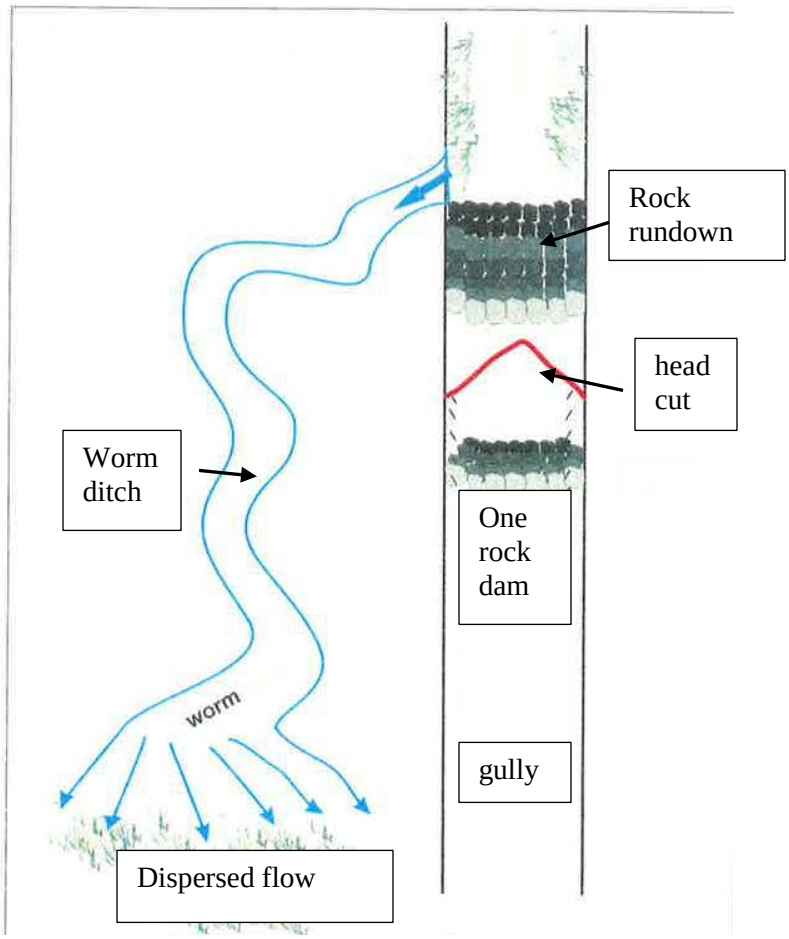
the one rock dams will be constructed by means of wheel barrel, front end loader, or ATV hauling the rocks in a small trailer.

Worm Ditch

One way to stop a headcut is to starve it for water. This is accomplished by redirecting erosive flows to a well-protected entry point, or re-entry point downstream. A worm ditch is a bypass channel dug around a headcut. A successful worm ditch requires: (1) a broad valley with sufficient space to between the gully and the hillslope for the worm ditch; (2) a well-armored re-entry point downstream of the headcut: and (3) wetland soils capable of supporting a dense growth of wetland plants such as sedges. A worm ditch is an effective treatment for a headcut in a wet meadow. It is not intended to be used on a stream but on surfaces characterized by dispersed (sheet) flow.

To build a worm ditch channel, select a starting point above the headcut that will conduct most of the concentrated runoff. A point 50-100 feet upstream should suffice. Select the re-entry point downstream. Measure the straight line distance (valley length) between those two points. The constructed worm ditch should have a channel length about two times the valley length and a constant slope equal to half the valley slope.

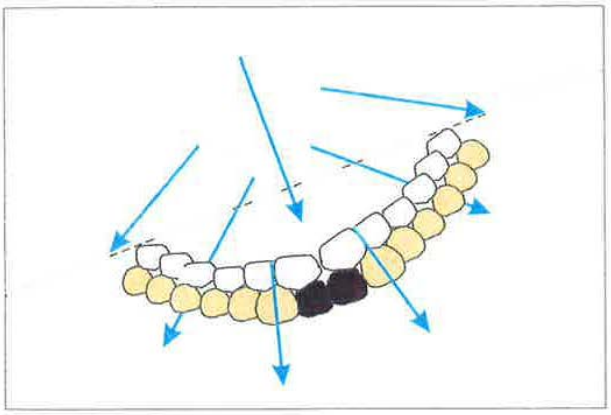
Tip: Use a length of rope twice the valley length. On a trial and error basis, lay out the rope in a series of evenly spaced meander loops connecting starting and ending points. This will be the course of the new channel. Using a sharp spade or shovel, dig a meandering channel next to the rope. Make it 12-18 inches wide and 6-12 inches deep. Scatter the soil. Do not build a levee along the downstream end of the ditch except to plug any low spots. Flood flows will follow the channel and some water will spill over to irrigate the wetland plants and gently heal the cut.

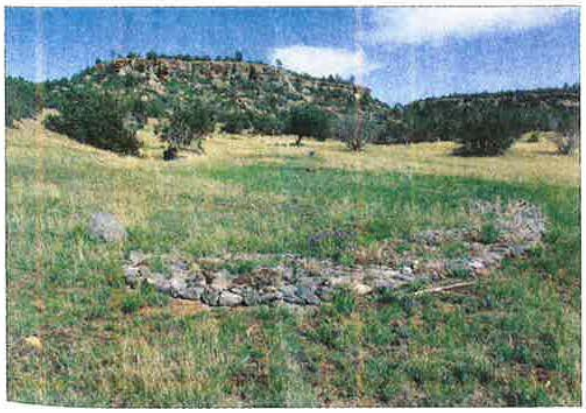


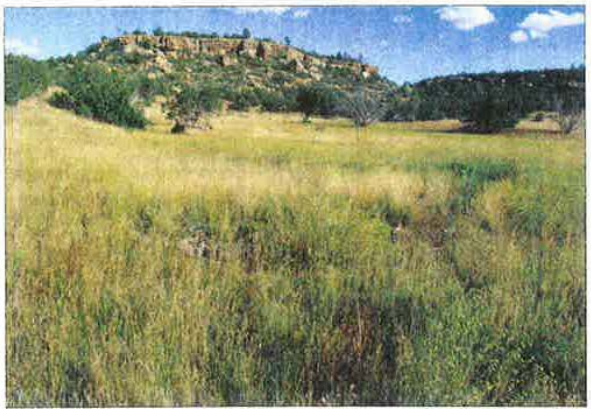
Worm ditch on Commanche Creek. Schematic shows how to use a worm ditch in conjunction with other treatment structures to divert water out of an incised channel or gully.

Media Luna

A Media Luna is a curving loose rock structure, shaped like a half-moon and designed to spread or disperse water onto the wetland surface. Loose rock, usually 4-8 inches in diameter, is spread on the wetland surface as a rock mulch in a band 4-6 feet wide and as long as needed (often 40-80 feet). The ends point up valley and are installed at equal elevations on the contour. As well as spreading water, this application may also be applied to restore dispersed flow to wetlands and alluvial fans.







The schematic shows the proper placement of the Media Luna structure and the subsequent photographs show a newly constructed Media Luna as recovery progressed at a restoration site near Wagon Mound, New Mexico (note the increase in forage as water is dispersed across the site).

Sod Dams

Sod dams, or sod plugs, can be used to stabilize incised channels up to two feet deep cutting through wetlands. The purpose is to restore sheetflow across the soil surface. Sod plugs are most appropriate in wetlands dominated by sedges and wetland grasses. Sod "bricks" used to build the plugs are cut with a sharp shovel from the adjacent wetland. Soil bricks should be cube shaped and be approximately 10" X 10" X 10" in size. Use as many layers as needed to plug the incised channel and reconnect the wetland surface. Place sod bricks in tightly packed layers the width of the channel and 3 to 5 feet long in the direction of flow. This work may be done by hand or by means of a small rubber tire backhoe. If done using a backhoe, care will be taken to not degrade sensitive wetland soils.

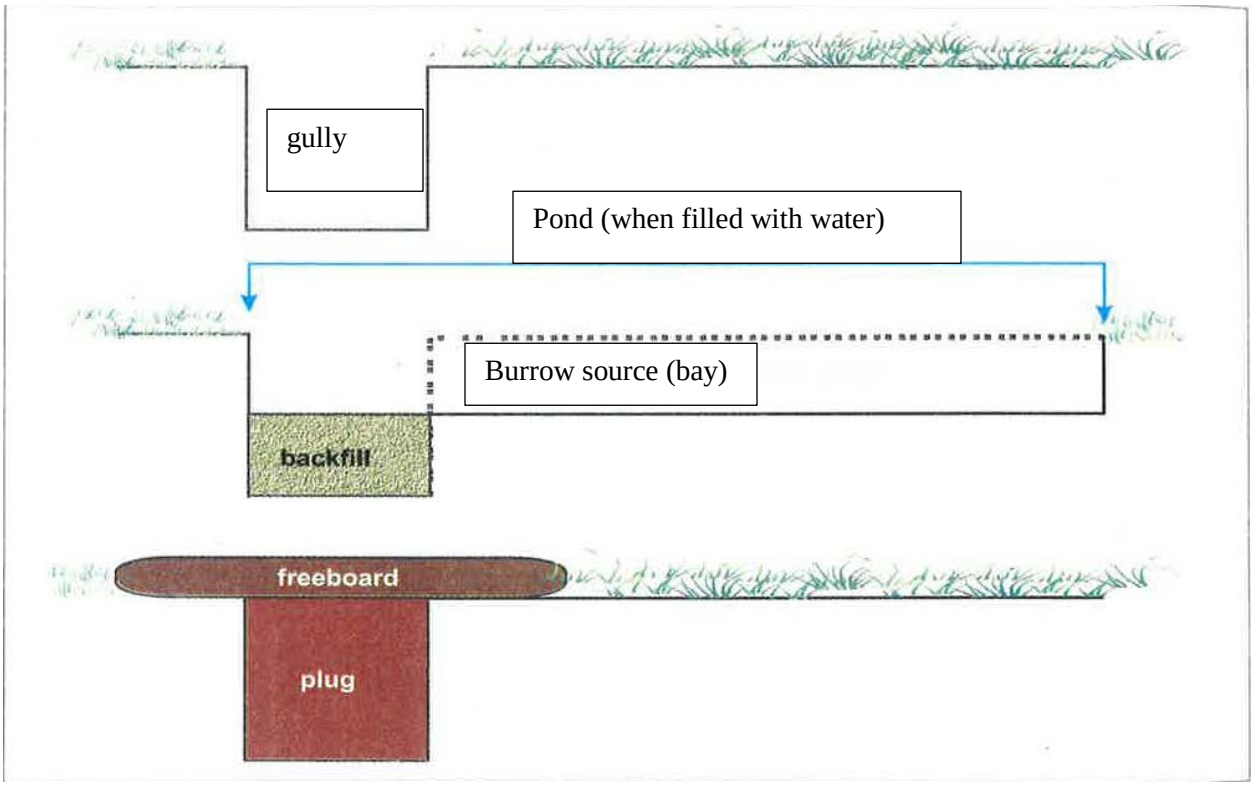
Two modes of collection may be used. The first is to cut the bricks from isolated divots scattered across the wetland surface. The other is to cut the bricks from shallow pits on the wetland surface. This results in the formation of small isolated pools that will fill with water. Where the incised channel is subject to flooding, the sod plug can be augmented with a one rock dam for added stability and to control erosion of the downstream end of the plug. This portion of the plug may end up acting as a headcut if it is not anchored to a one rock dam.

This sod plug is slowing water flow in an incised channel cutting through the wetland. Water is spilling back over the wetland surface as shown in the photograph.

Plug and Pond

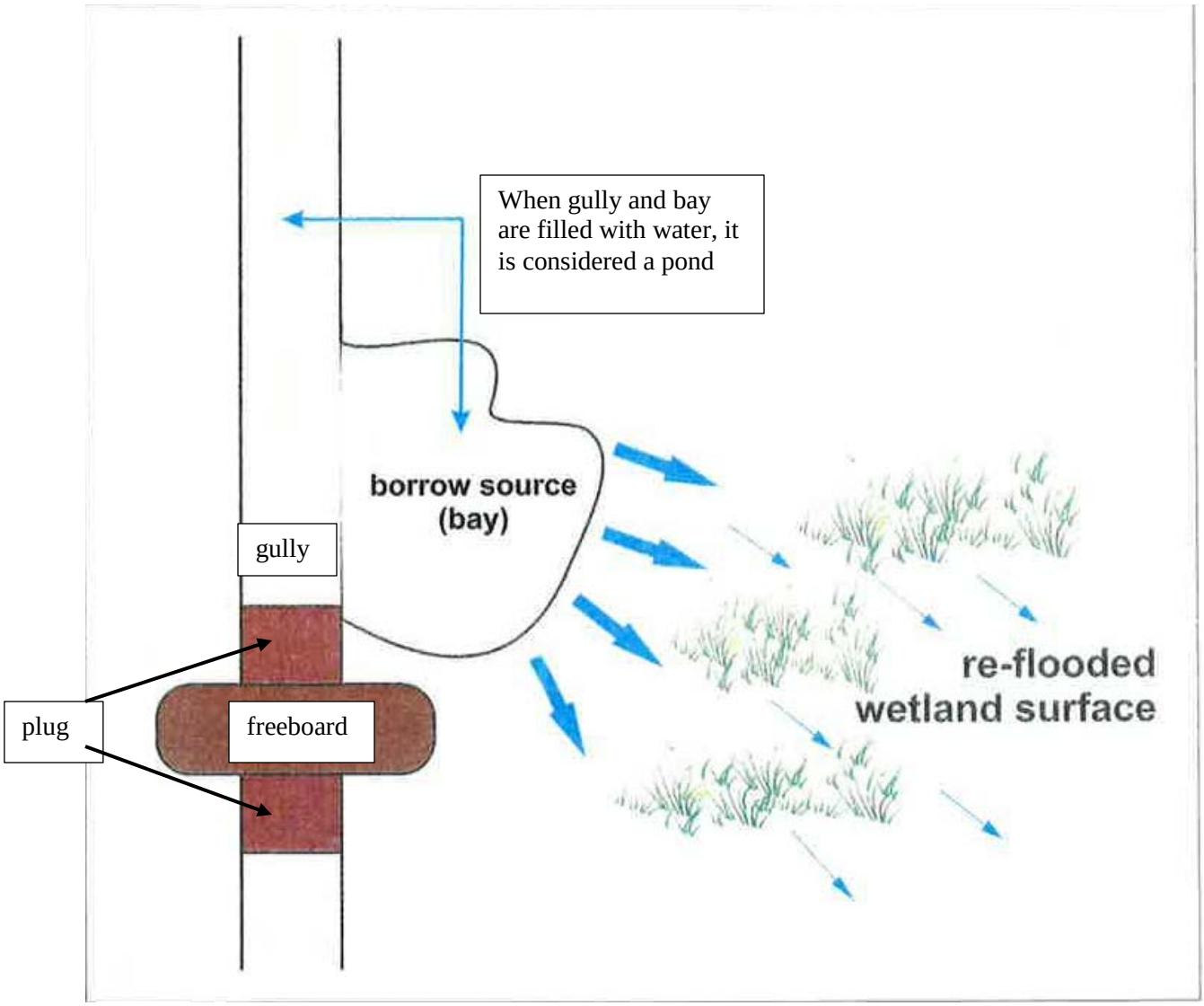
The purpose of this technique is similar to that of the sod dam and is to return flows captured by an incised channel (gully) to the historic impaired wetland surface. The water captured behind the plug will spill across the former wetland surface as sheetflow. A more appropriate term for this technique may be "plug and spread". The plug is situated in the incised (downcut) channel at a place and in a manner that will achieve maximum rewetting of the wetland surface for the effort expended. Plug and pond treatments are most appropriate where groundwater flow is persistent, although it may still be appropriate in former wetlands that have totally dried out.

Typically, this consists of four constructed features: the plug, the borrow areas, the backfill, and a berm that creates freeboard above the plug. An earthen plug is used to fill an incised channel or gully. Soil for the plug is excavated from one or both sides of the channel to form a shallow bay. The channel is not deepened and may be partially backfilled. The outlet or spillway from the bay is built on the contour and as wide as possible in order to spread the water runoff across the wetland surface.



A channel in a wetland constitutes a degraded condition. The plug and pond treatment both stabilizes the system and returns water to disperse flow across the wetland surface.

The earthen dam or plug (fill) should be built in layers of soil 3 to 6 inches thick and compacted after each layer is added. The plug should be the width of the incised channel and at least four feet in length per foot of channel depth. The purpose of the longer plug is to protect it from weakening by burrowing animals. The plug is constructed to the height of the channel bank. Freeboard is the added height of the plug above the wetland surface or channel bank, which should be higher than the maximum expected flood depth across the wetland surface. Freeboard should extend out onto the wetland surface far enough to extend flood flows completely around the plug on both sides.



This schematic shows a plug and pond design with one bay flooded.

Flow Splitters

Flow splitters are used to split the flow of water away from an incised channel and return the flow to the wetland surface. They may also be used to more evenly distribute sheet flow across the wetland surfaces. They can be made of many different material, depending on availability and site conditions.

Splitting the flow can be used both to maintain the health and vigor of wetland vegetation along an existing incised channel and to return water to drying wetlands. The key consideration is 1) how to apportion water flow between target areas and 2) how the flow should be apportioned during low flow periods vs. times of high flows. Flow splitters can be both stabilizing and restorative in application.

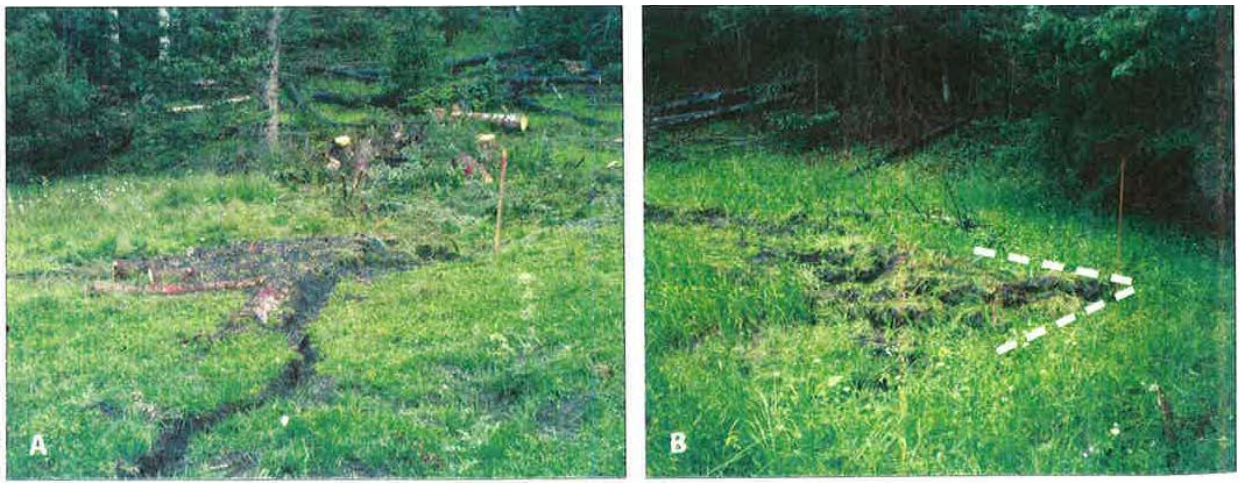


Figure A shows a log flow splitter leading to a worm ditch. Figure B shows a flow splitter constructed from sod, which may be used to spread water flow when the channel is not deeply incised.

Proposed Locations and Treatments

The following information and photos were taken directly from:

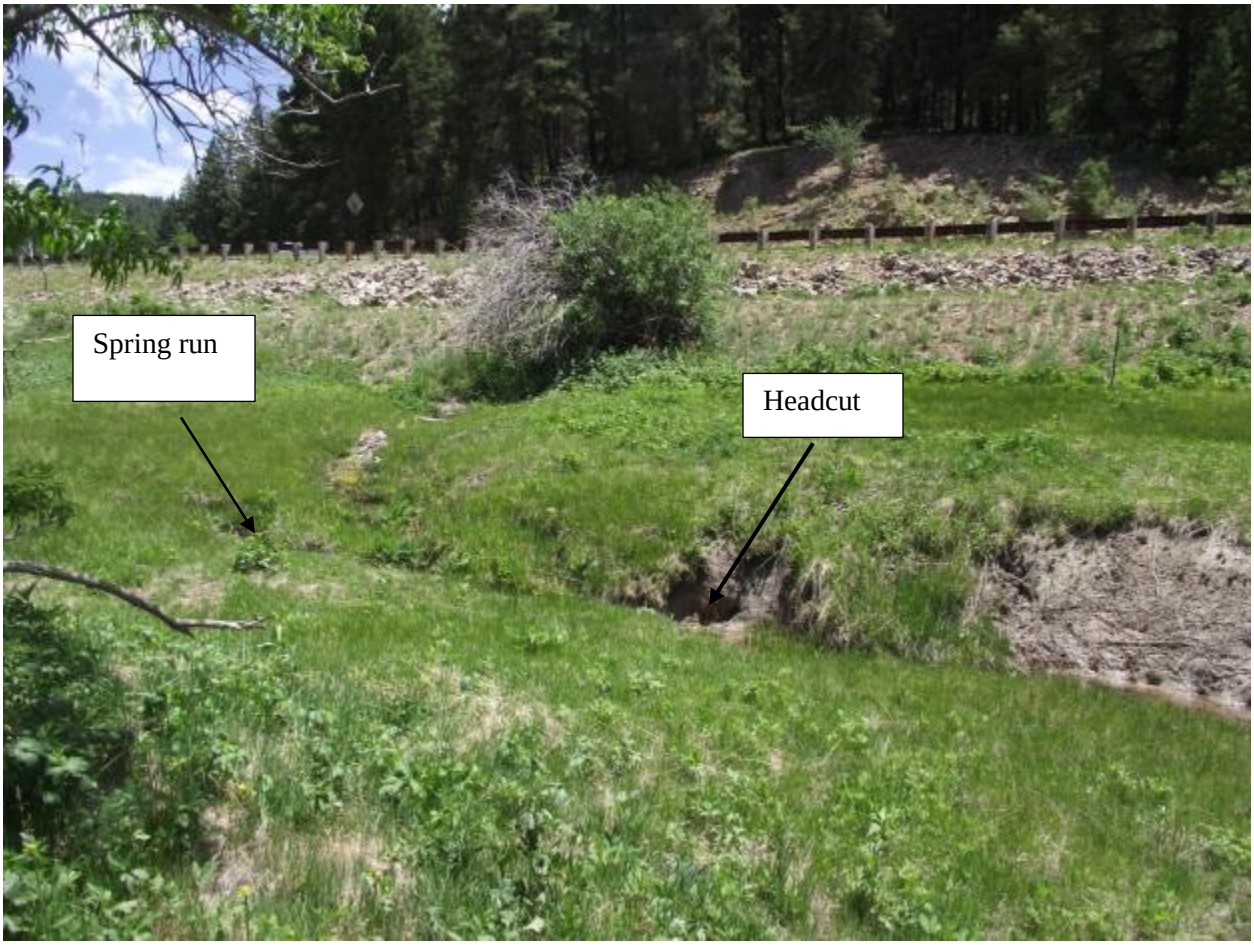
- **"Rio Penasco Assessment Report Including Wills Canyon (Van Clothier and Theo Keller, Stream Dynamics, Inc. August 31, 2016)**

Specific locations where treatments are proposed are shown on KMZ photos and accompanying photographs taken on the ground. "River left" refers to the left side of the stream looking downstream and "river right" refers to the right side of the stream looking downstream. Brief statements explaining the positive benefits of each treatment accompany each ground-based photograph.

Google Earth View of Restoration Points P1 through P10

P1--Looking upstream at the beginning of the surveyed reach of the Rio Peñasco. Culverts are creating a high velocity situation during peak flows. This could be mitigated with the installation of **Zuni Bowls** for both of the big culverts and the little culvert (to the middle left of the photo next to a bush).

P1--Looking upstream from a bit farther downstream from the above photo. More Zuni Bowls are needed and a worm ditch to stop this small headcut from drying up the adjacent wetland.



P 1.5-- Looking east. Using sod plugs, plug this spring run in several places on left side of stream and build a rock Zuni Bowl to treat this headcut.

P2-- A small **worm ditch** or an **overflow channel** to river left on the left side of the stream (looking downstream) would improve the saturation of this wet meadow.

P3-- Looking West from left of stream. **Media Lunas** would spread the flow from this spring run back onto its natural delta near its confluence with the Rio Peñasco.

P4-- Matthew “Theo” Keller of Stream Dynamics, Inc. is pointing to where a **sod dam** with an overflow to the left of the photo would create a pond with the water from this spring run. This would transform this site into an emergent wetland.

P5-- A rock **Media Luna** would spread out and dissipate flows from this tributary coming through this culvert to the right of the Rio Penasco (looking downstream).

P6-- **Plug and pond** this spring run in 5 places to irrigate this meadow.

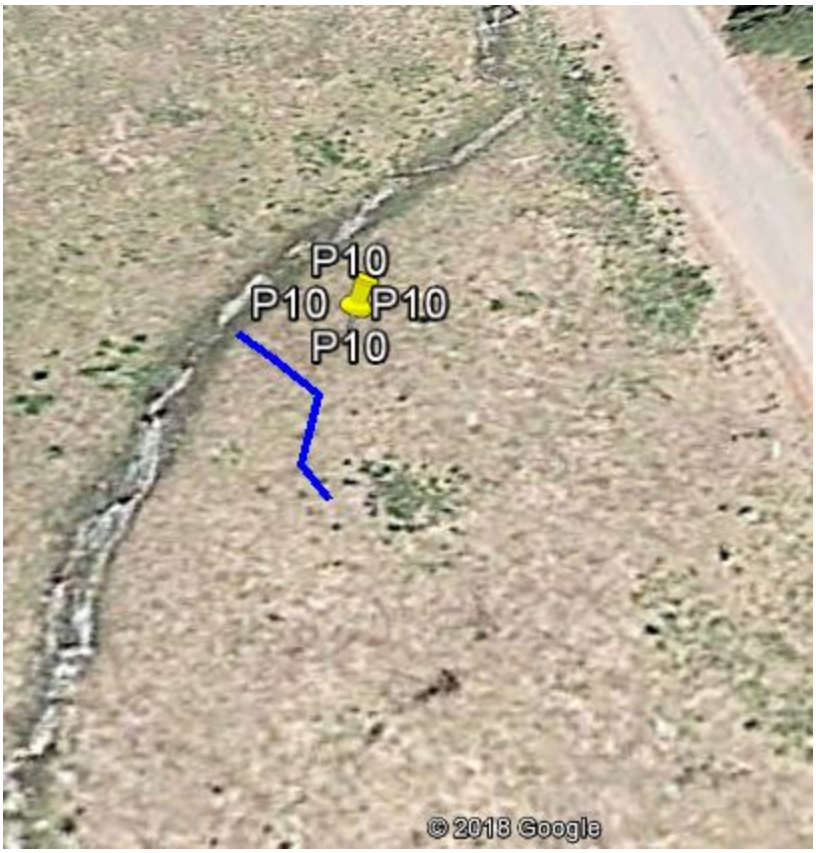
P7-- **Plug and pond** here will irrigate a very large area.

P8-- Another ideal **Plug 'N Pond** site. These are very low risk and high gain projects because of the constant low flow spring run and the lack of high scouring flows.

Looking upstream at the meadow areas that can be improved as demonstrated in the previous photos. The culvert from GPS point 5 is visible at the bottom of the road embankment.

P9-- Entering a slightly incised reach. Possible treatment with one rock dams could raise the grade of the Rio and sub-irrigate the alluvium.

P10-- A **one rock dam** here would raise the water surface high enough to have a small diversion ditch to river left to irrigate the meadow. To see where this worm ditch is, see below the blue line feature associated with point 10 on the Google Earth KMZ file.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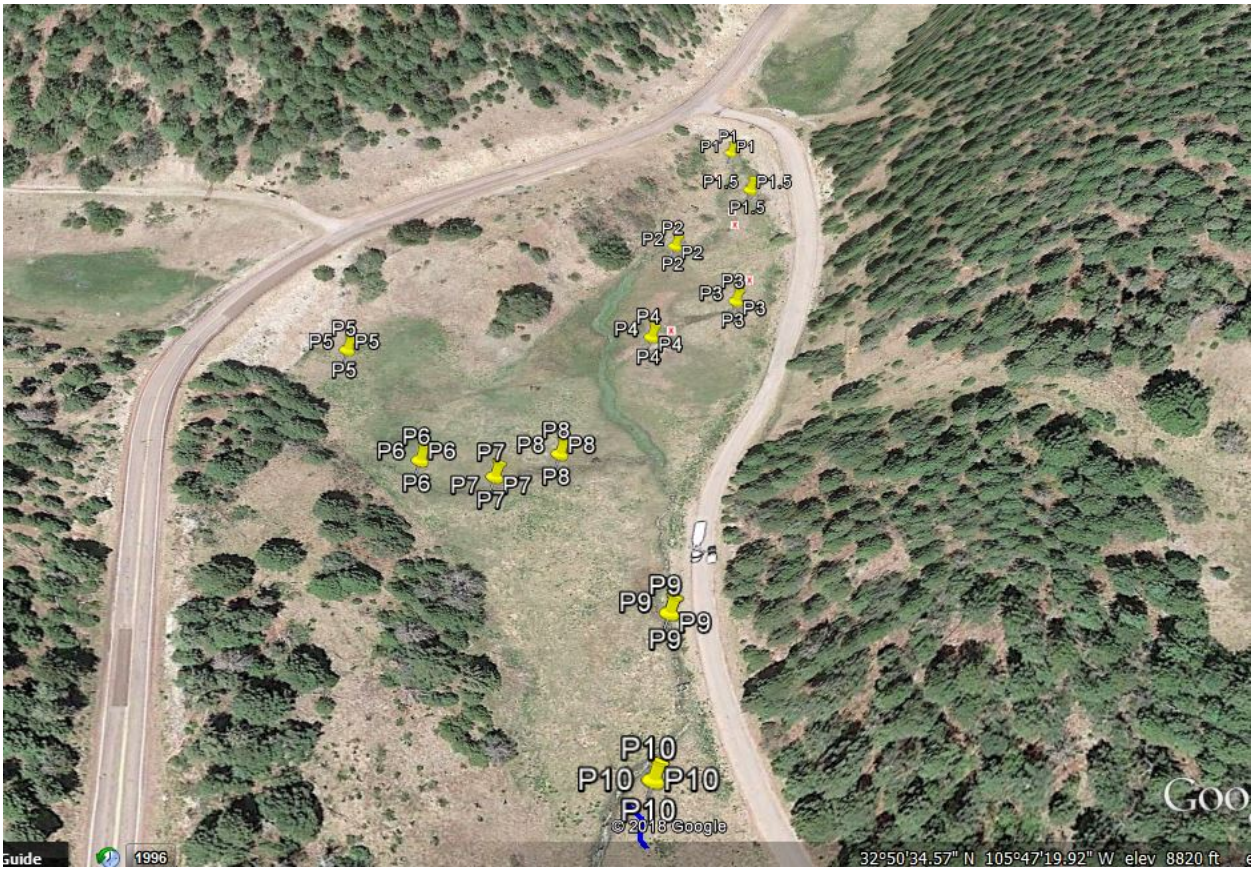
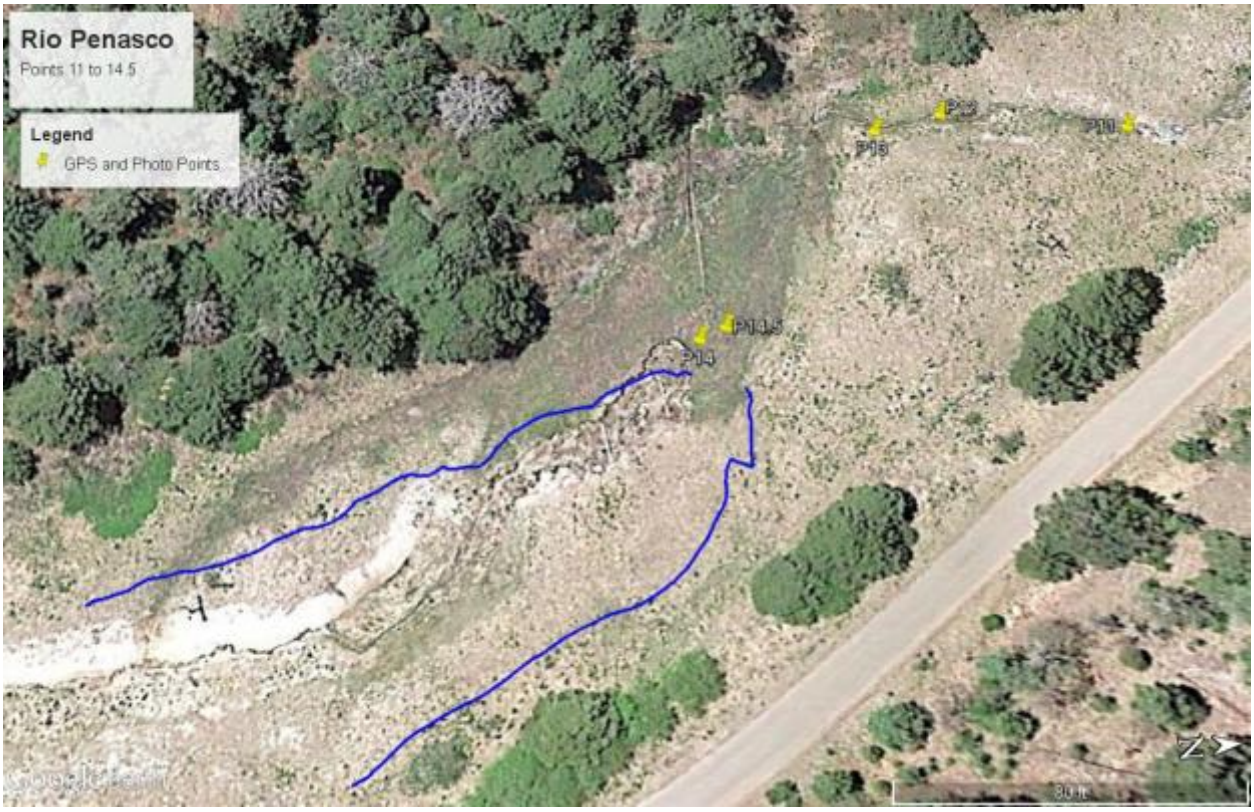


Another Google Earth view of P1-P10.



Overview of points 11-14.5 shows a very tall valley eating headcut with proposed **worm ditches** irrigating both high terraces. The measurements and exact locations of these worm ditches can be found in the Google Earth KMZ file. The one on river left is 228 feet long, and the one on river right is 253 feet long. The depth should be approximately 6” and the ditches should have grade controls built within them.

P11-- Looking upstream at “Babe Pool” We recommend building a **flow splitter** below the pool to create sheet flow on river left (to the right in this photo)

P12—View downstream of headcut.

P13-- looking downstream. Theo is pointing to where a **flow splitter** going to river left would help to spread the flow and improve wetland conditions.

P14-- Looking downstream with the creek to the left of the photo. We propose to cut through the tree and make a **worm ditch** to river right, taking flows away from the headcut and irrigating the vicinity of the valley eating headcut to improve its vegetative stability.

P14.5-- Upper headcut of a very severe series of headcuts that are lowering the water table and draining the wet meadow. **Worm ditches** will significantly slow the progress of the headcuts and cause the valley sides to slowly slump. This will have a very gradual effect over time of slightly raising the grade of the creek below the headcuts in places.