United States Department of Agriculture

NRCS

Natural Resources Conservation Service
6200 Jefferson NE, Room 305
Albuquerque, NM 87109
Phone: (505) 761-4402 **Fax:** (505) 761-4463
Web site: www.nm.nrcs.usda.gov

April 21, 2010

ENGINEERING TECHNICAL NOTE NO. NM-3

SUBJECT: ENG – Hand Constructed Erosion Control Structures

Purpose: To distribute information to area and field offices.

Effective Date: Effective when received.

Filing Instructions: File in office, also maintained on New Mexico NRCS web page.

Bill Zeedyk of Zeedyk Ecological Consulting located in Sandia Park, NM has developed and tested several methods for erosion or gully control structures using rock materials. These techniques are variations of erosion control treatments which have been modified for use in the Southwest portion of the United States.

Attached is the technical description and installation instructions for four treatment techniques. The technology is offered as a lower cost, labor intensive option for erosion and gully control on upland sites.

In adapting these designs treatment areas, note the details of the area that are important to insuring function of these structures. Treated gullies are not to exceed eight feet in width and installation can be completed by a small group of individuals. If larger rock sizes are desired or needed, heavy equipment would be required for placement of the material.

Page 16A-2 of the EFM is included for use in determining average rock size. The chart provides an average rock size, so some rocks will be both larger and smaller. For the treated gully size, no filter material is required for these rock structures unless specified by the designer.

If you have any questions on this information, please contact Stephen Lacy, Geologist, at (505)761-4439.

Roger Ford

Roger Ford
State Conservation Engineer

Attachments

1/7/2010

Hand Built Rock Erosion Control Structure Graphics for Uplands Sites, Rills, Small Channels and Small Gullies.

(Small, Channel Size: Six to Eight Feet Wide or Less)

Please Note: Most of these structures can be installed in larger systems, however larger size materials must be used and this will generally require the use of heavy equipment to place the materials. Remember, it is a matter of scale. The larger the watershed, the large the discharge and the larger the materials will need to be.

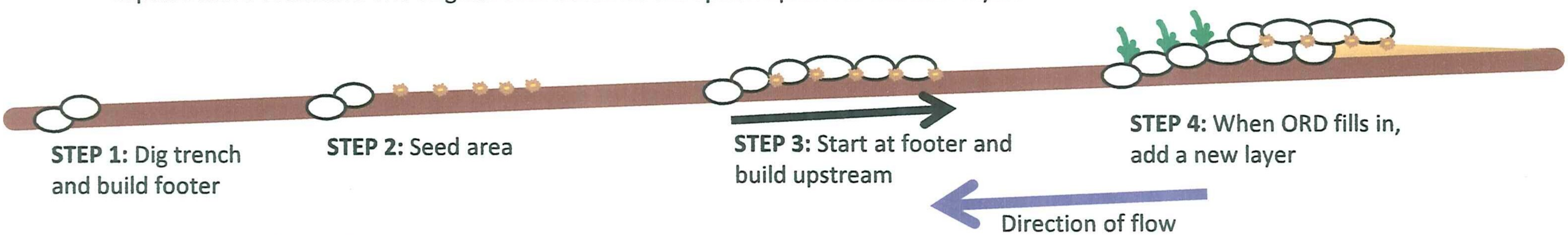
Use blank pages for notes.

ONE ROCK DAM "ORD"

*A low grade control structure built with a single layer of rock on the bed of the channel. ORDs stabilize the bed of the channel by slowing the flow of water, increasing roughness, recruiting vegetation, capturing sediment, and **gradually** raising the bed level over time. ORDs are also passive water harvesting structures. The single layer of rock is an effective rock mulch that increases soil moisture, infiltration, and plant growth.*

Design & Construction

1. Select area to build the ORD; dig a shallow footer trench and fill with one or two rows of rock, so that no rock protrudes more than two inches above the bed of the channel. This will serve as the ***splash apron*** for the ORD.
2. Scatter native grass and wildflower seeds in the area where the ORD is to be built.
3. Start building at the footer and continue upstream, laying down one layer of rock horizontally, as if you were building a rock wall.
4. Once the ORD is completely filled with sediment, another layer can be added to further raise the bed of the channel and capture more sediment. The original ORD becomes the splash apron for the new layer.



STEP 1: Dig trench and build footer

STEP 2: Seed area

STEP 3: Start at footer and build upstream

STEP 4: When ORD fills in, add a new layer

Direction of flow

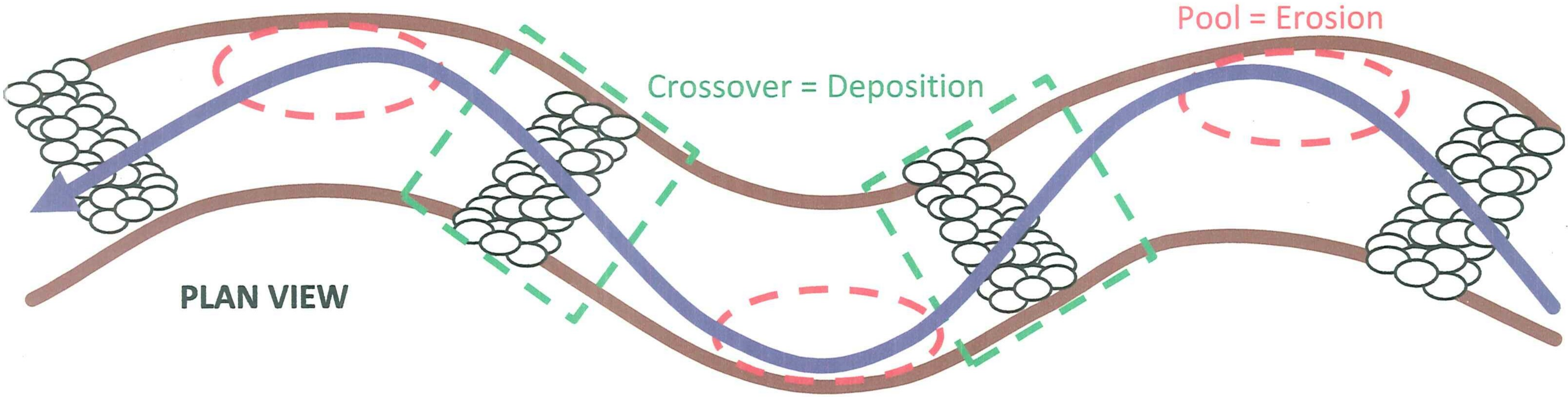
Orientation of Rocks: Placing rocks vertically is called book-stacking, this makes a very strong structure, especially when using small rocks. It is also a good way to make a slightly higher structure.

Book-stacked rocks are vertically placed

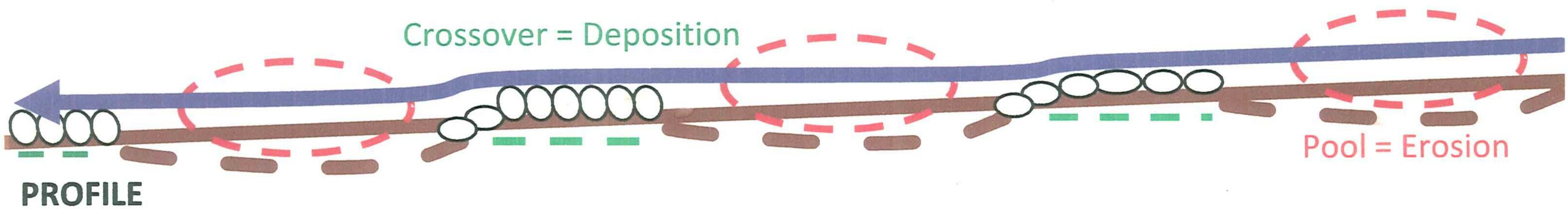
Rocks placed flat

ONE ROCK DAM

1. Always position grade control structures at meander crossovers.



2. Placement at crossovers maintains natural erosion and deposition patterns.



3. Always maintain channel cross section to protect banks.

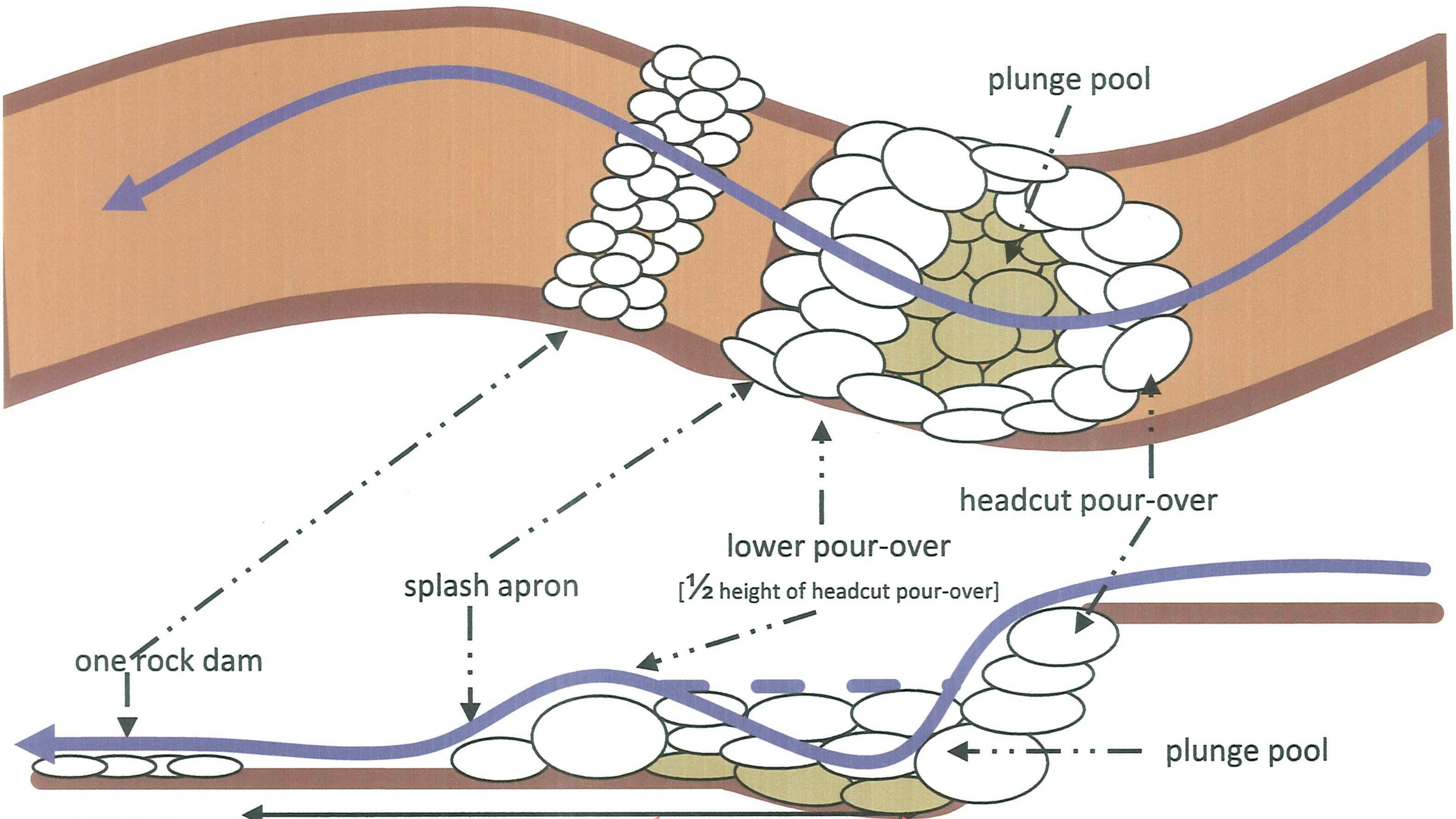
ZUNI BOWL

A headcut control structure composed of rock lined step falls and plunge pools that prevents headcuts from continuing to migrate upstream. Zuni Bowls stabilize actively eroding headcuts by dissipating the energy of falling water at the headcut pour-over and the bed of the channel. The structure converts the single cascade of an eroding headcut into a series of smaller step falls. Zuni Bowls also serve to maintain soil moisture on the face of the headcut, encouraging the establishment of protective vegetation.

Design & Construction

1. Select a headcut for treatment; shape and layback the face of the headcut to create a uniform surface on which to build.
2. Determine the height of the headcut. Next measure and mark the location downstream from the face of the headcut that is three times the height of the headcut. At this location dig a shallow trench and fill with one or two rows of rock, so that no rock protrudes more than two inches above the bed of the channel. This will serve as the ***splash apron*** for the Zuni Bowl.
3. Scatter native grass and wildflower seeds in the area where the Zuni Bowl is to be built.
4. 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.
5. Armor the bottom of the ***plunge pool*** with a single layer of rocks. Place these rocks at a uniform height to create a stable foundation for the rest of the Zuni Bowl.
6. 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. Improve the durability of the structure by avoiding gaps in the rock work. As an extra precaution, you can use biodegradable geotextile fabric to line the face of the headcut prior to laying rocks.
7. Continue to lay courses of rock around the face of the headcut until you reach the height of the ***headcut pour-over***. No rocks should protrude above this level.
8. Construct a ***ORD*** downstream from the Zuni Bowl. Place the upstream edge of the ORD approximately four to six times the height of the headcut away from the headcut pour-over.

ZUNI BOWL


plunge pool
headcut pour-over
lower pour-over
[½ height of headcut pour-over]
splash apron
one rock dam
plunge pool
4-6x height of headcut
2-3x height of headcut

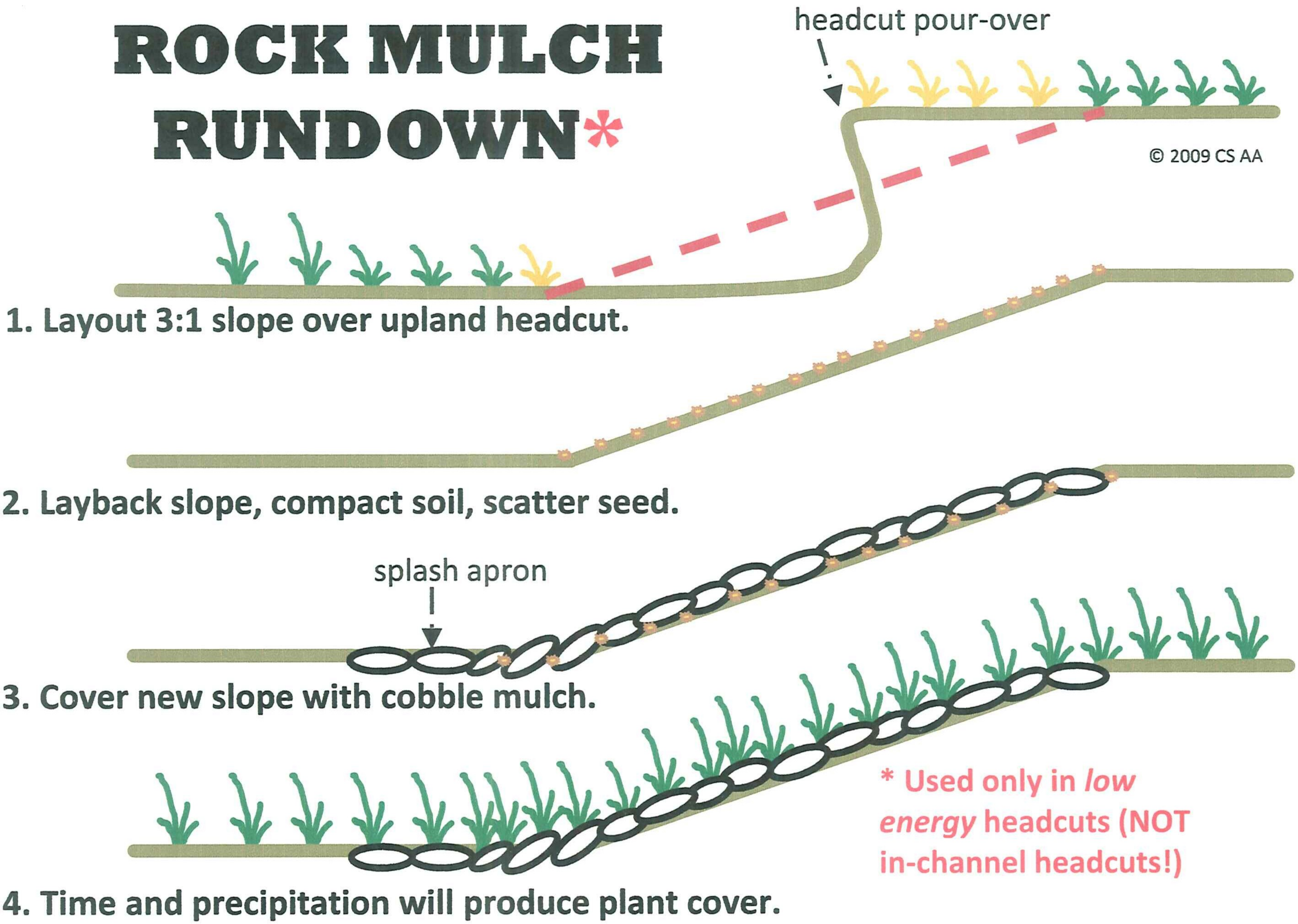
ROCK MULCH RUNDOWN

A headcut control structure where the face of the headcut has been laid back to a stable angle of repose (minimum of a 3:1 slope), and then covered with a single layer of rock mulch. The mulch serves to slow runoff, increase soil moisture, recruit vegetation, and ultimately prevent the headcut from migrating further up slope. Rock Mulch Rundowns are to be used ONLY on low energy headcuts, like those found in uplands rills and gullies with small catchment areas, and where sheetflow collects and enters a channel.

Design & Construction

1. Select a low energy headcut for treatment.
2. Determine the extent of the 3:1 slope. Take care to balance the space required to achieve a 3:1 slope vs. the potential disturbance to existing vegetation.
3. Layback the headcut by cutting away soil from the top of the face, and then use the cut material to fill the base of the headcut. Where possible, the Rundown should be the entire width of the channel below the headcut, or when no channel exists, the width of the headcut itself. Narrow headcuts may need to be widened to accommodate to the rock work. Adjacent headcuts, separated by uneroded fingers of earth, but leading to the same channel, can be combined into single Rundown structures. Knock down the uneroded earth between the headcuts, and use it as fill.
4. Compact the fill.
5. Scatter native grass and wildflower seed and rake the surface of the Rundown.
6. Dig a shallow trench on the down slope side of the Rundown and fill with one or two rows of rock, so that no rock protrudes more than two inches above the bed of the channel. This will serve as the ***splash apron*** for the Rundown.
7. Cover the entire surface of the Rundown with a single layer of rock mulch. The center of the Rundown should be the lowest point in the structure so that water will not run around the edges.
8. Continue to lay rock on the surface of the Rundown until you reach the height of the ***headcut pour-over***. No rocks should protrude above this level. It is very important to avoid gaps in the rock work because gaps cause weak points in the structure. To improve durability, you can use a biodegradable geotextile mesh to line the surface of the Rundown prior to laying rocks.

ROCK MULCH RUNDOWN*



MEDIA LUNA

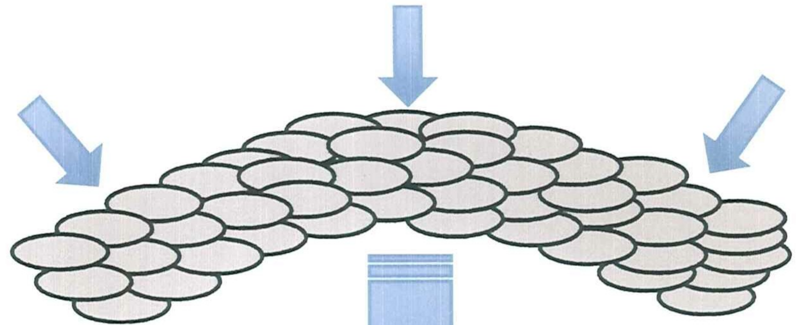
There are two types of Media Luna structures – both used to manage sheet flow and prevent erosion. "Sheet flow collectors" (tips DOWN) prevent erosion (i.e. headcuts) at the head of rills and gullies by creating a stable transition from sheet flow to channel flow at the collection point. "Sheet flow spreaders" (tips UP) are used on relatively flat ground to disperse erosive channelized flow and reestablish sheet flow where it once occurred.

Design & Construction

1) Identify which type of Media Luna (i.e. "tips UP" or "tips DOWN") is appropriate for the treatment site.
2) If the treatment site is at the collection point of a network of rills or small gullies, then use a ***sheet flow collector*** (tips DOWN). Select two points 6" above the bed on each bank of the main channel immediately downslope of where the rills collect. Layout an arc from bank to bank so that the tips point down slope.
3) If the treatment site is located where runoff from a shallow channel (<1 ft deep) can easily be spread across relatively flat ground, then use a ***sheet flow spreader*** (tips UP). Layout an arc across the flat area with the tips at the same elevation (i.e. use a leveling tool) and the center slightly lower.
4) Layout the up slope edge of the structure by tracing an arc parallel to the lower edge to create a band that is at least four feet wide. Media Lunas composed of wider bands of cobble mulch offer more protection from erosion, improved infiltration and increased plant recruitment.
5) Start by digging a shallow trench from tip to tip along the down slope side. Fill the trench with one or two rows of rock, so that no rock protrudes more than two inches above ground level. This will serve as the ***splash apron*** for the Media Luna.
6) Scatter native grass and wildflower seeds in the area where the Media Luna is to be built.
7) For both types of Media Lunas continue to cover the ground with a single layer of cobble mulch to form a band at least four feet wide.

MEDIA LUNA

***Sheet Flow Collector** (tips DOWN)*
Prevents developing rills and gullies from eroding upslope.



***Sheet Flow Spreader** (tips UP)*
Spreads runoff from channels and initiates sheet flow.

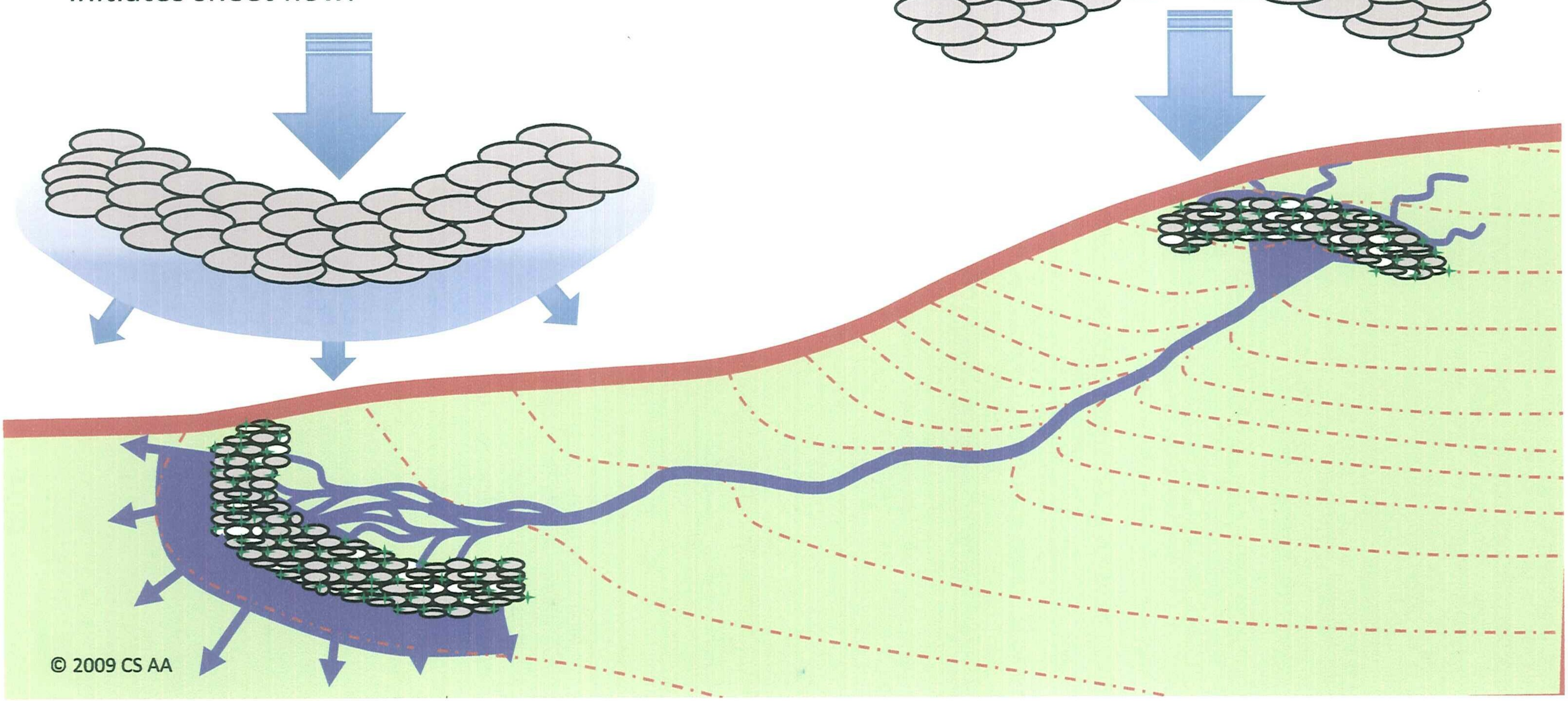


Figure 16A–2 Rock size based on Far West States (FWS)-Lane method

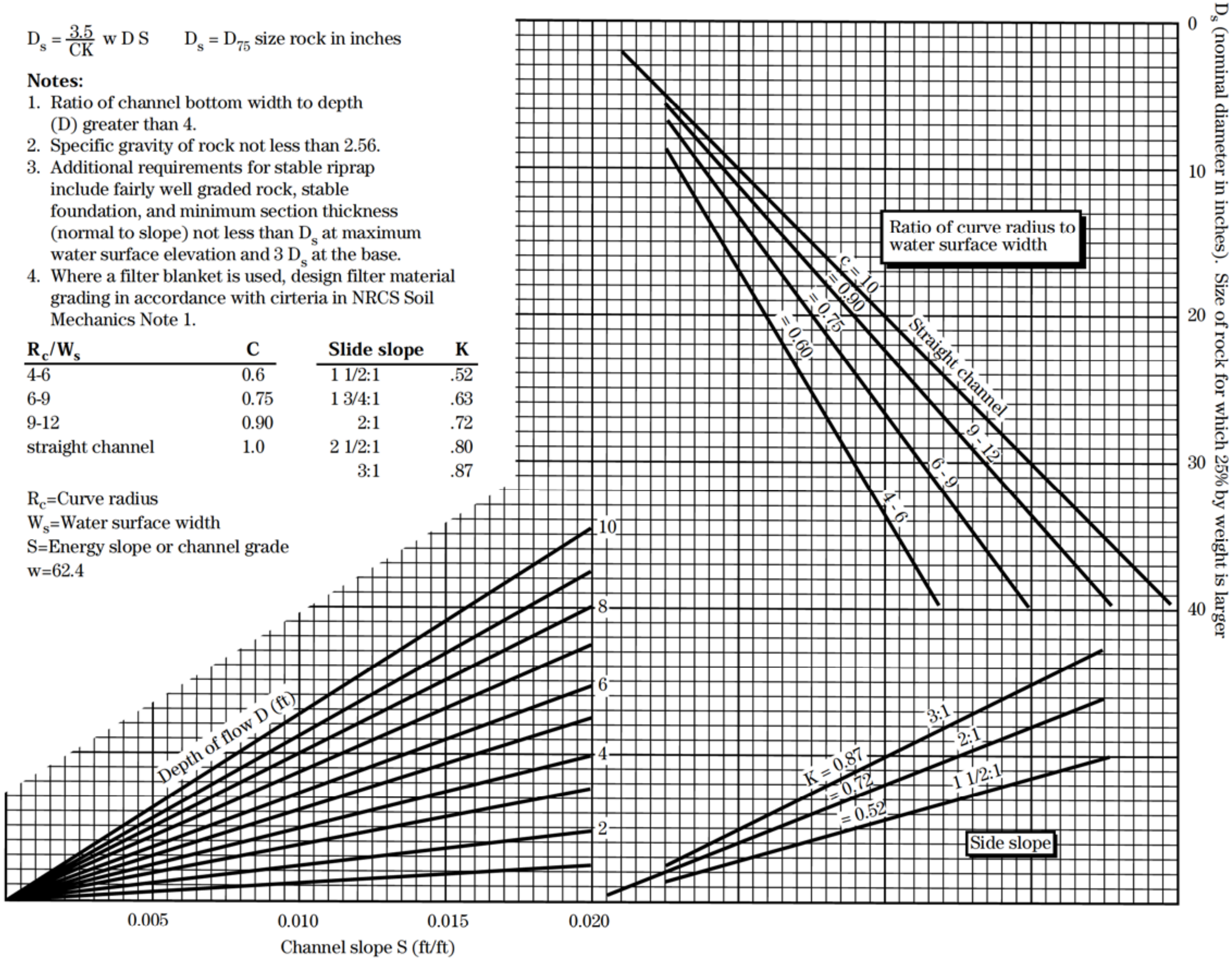
$D_s = \frac{3.5}{CK} \, w \, D \, S$ $\quad D_s = D_{75}$ size rock in inches

Notes:
1. Ratio of channel bottom width to depth (D) greater than 4.
2. Specific gravity of rock not less than 2.56.
3. Additional requirements for stable riprap include fairly well graded rock, stable foundation, and minimum section thickness (normal to slope) not less than D_s at maximum water surface elevation and 3 D_s at the base.
4. Where a filter blanket is used, design filter material grading in accordance with cirteria in NRCS Soil Mechanics Note 1.

R_c/W_s	C
4-6	0.6
6-9	0.75
9-12	0.90
straight channel	1.0

Slide slope	K
1 1/2:1	.52
1 3/4:1	.63
2:1	.72
2 1/2:1	.80
3:1	.87

R_c=Curve radius
W_s=Water surface width
S=Energy slope or channel grade
w=62.4



Procedure
1. Determine the average channel grade or energy slope.
2. Enter fig. 16A-2 with energy slope, flow depth, and site physical characteristics to determine basic rock size.
3. Basic rock size is the D_{75} size.