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# Research Findings From Riparian Zone Management on Muddy Creek

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## Introduction

The Little Snake River Conservation District leads a riparian zone conservation effort on Muddy Creek near Baggs, Wyoming. Their current memorandum of understanding between private land owners, USDA agencies, BLM, and appropriate state agencies specifies they will coordinate the demonstration of values of riparian zones along Muddy Creek. In the past 5 years, they have documented multiple use land management alternatives for improving water quality. This Conservation District effort grew from the University of Wyoming Range Management Department's research effort establishing the Muddy Creek Experimental Watershed Study Area in 1983.
The Range Management Department is monitoring the Conservation District program by:

- i) measuring streamflow,
- ii) measuring tons of sediment deposited in and being transported through degraded, improving, and improved riparian zones,
- iii) measuring change in stream channel stability caused by instream wire dams and new growth of riparian vegetation,
- iv) measuring increased floodplain forage production and increased storage of ground water for prolonged instream release during drought seasons,
- v) number of individuals informed through extension activities.

## Muddy Creek

Muddy Creek is a major tributary of the Little Snake, Yampa, Green, and Colorado Rivers within the upper Colorado River Basin of southcentral Wyoming.
The headwaters of Muddy Creek rise on the west slope of the Continental Divide foothills at an elevation of 8,200 ft above mean sea level (msl) and flow to its confluence with the Little Snake River at 6,300 ft above msl on the north edge of the town of Baggs, Wyoming. Muddy Creek travels 110 channel miles of which 33 are located on private lands. The watershed encompasses 953.5 sq. miles (610,290 acres) and supports 136 perennial stream miles. The BLM administers 69 percent of the watershed land area, 25 percent is privately owned, and 6 percent is state land.

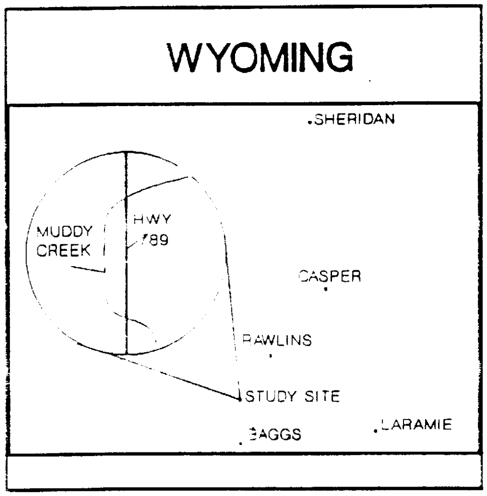


**Figure 1:** Location Map Muddy Creek

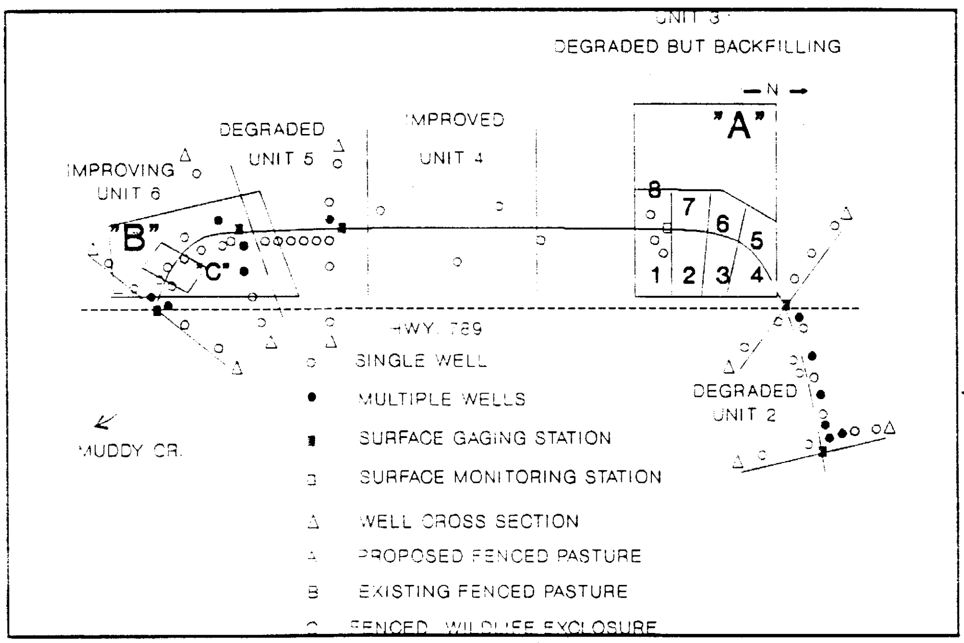


**Figure 2:** Muddy Creek Experimental Watershed Study Area

The Muddy Creek Experimental Watershed Study Area contains 6 stream reaches of over 3 miles of main stem channel in each (Figure). Each stream reach represents a different stream channel condition class. Unit 2 is degraded, unit 3 is degraded but fenced to relieve pressure from grazing and is being back filled with sediment because of the improved riparian zone downstream, unit 4. Unit 5 is degraded and unit 6 is an improving riparian zone caused by installed instream structures. Stream flow is measured at 6 locations above and below degraded, improved, and improving conditions using 6 stream gauging stations. For each station 2 bridges and 3 installed cable cars are used to measure suspended sediment and streamflow velocity. Also, 5 automatic sediment samplers are used to record suspended sediment on a continuous basis. Ground water storage is measured using 83 screened and grouted wells and 21 streamside piezometers are used to document channel seepage. The wells are placed as cross valley transects at each stream gauging station and along stream reaches between them. Cross valley well transects each have a nested design and one continuous well recorder to measure streamflow and groundwater interactions (Figure 3). Fencing is used to control livestock grazing. A wildlife/livestock exclosure,"C", has been constructed to demonstrate livestock/wildlife interactions. Numerous permanent transects are established within the riparian zones and across the stream channels of the degraded and improving reaches to evaluate differences in forage production, plant composition, and channel conditions due to sediment deposition. In 1989, the BLM designated this study site as the Great Divide Resource Area's Showcase Riparian Area.

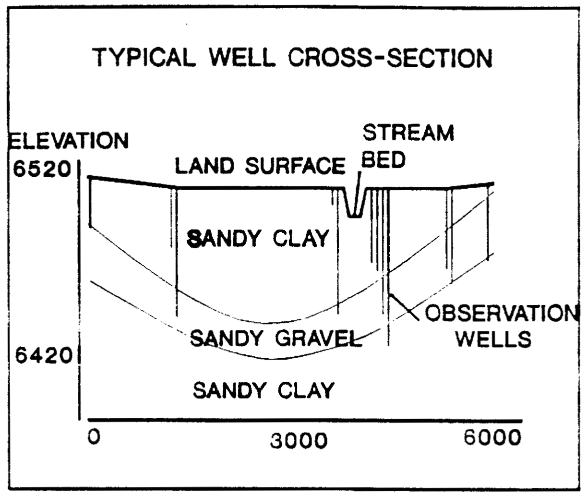


**Figure 3:** Typical Well Cross-Section and Sub-Surface

Vegetation of the six contributing watersheds to the riparian zone along the main stem of Muddy creek study area is dominated by greasewood (Sarcobatus vermiculatus) on saline soils or big sagebrush (Artemisia tridentata) on silty loam soils with a sparce understory dominated by western wheatgrass (Pascopyrum smithii). Low precipitation and soil conditions have resulted in low ground cover and a relatively high potential for erosion on areas bordering riparian zones.

## Methods Procedures, and Results

**Instream Structures:** Fifty six wire face dams 18 in. high have been installed on 16 straight reaches within Unit 6. Thirty two dams were placed in Muddy Creek during 1984, 16 during June and 16 during August. The August dams were placed at the downstream end of each straight reach to eventually backfill over the 1984 spring dams. All additional dams were installed 3 ft. upstream of dams filled with sediment. This procedure allows for the downstream apron of the new dam to overlap the filled dam and use all previous downstream aprons to hold sediment in place as the channel bottom rises behind the dam site. Dams have now been placed 4 lifts high on 8 sites and 3 high on 13 sites. Three sites did not hold the 1984 August dams. Failure of the 3 dams were caused by building them during late summer so bank roots did not have time to become established in the trenches holding the dam wings. Also the 1984 dams were plugged with sagebrush to pond water which causes excess pressure just after construction. It is best to let the dam fill with streamflow debris during the summer and fall and allow the roots to establish during the growing season within the bank trenches used for inserting the dam wings. The root growth and a slow increase in ponding behind the dam allows an increase in overall dam strength to withstand the next spring runoff.

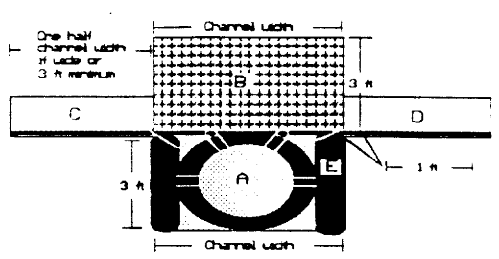


**Figure 4:** Top View Looking Upstream of Wire Dams

"A" (Fig. 4) illustrates erosion cloth attached to the center metal posts supporting the dam face. The cloth is attached by slitting the cloth and placing it over the center posts and by end tie wires attached to the upstream ends of the cloth and to the 2 metal posts inserted 1 ft. inside and against the downstream side of the 1 ft wide trenches used to insert the dam bank wings. The center tire is attached by wire to bank protection tires "E" placed on end against the bank and along the spillway of the dam. The number of center tires will vary as the width of the channel increases and so will the number of channel dam support posts which should not be over 3 ft. apart. All tires are wired to the bottom of the dam support posts and the dam wing posts 1 ft. from the channel edges. The erosion cloth, the width of the stream channel, and tires used to hold this cloth down constitutes the downstream apron. This apron holds the channel bottom in place around the dam support posts and moves the plunge pool downstream where under cutting of the face of the dam can not occur.

"B" (Fig. 4) represents the upstream apron which is a section of 4 in. woven wire 3 ft. wide and as long as the channel bottom. It is centered and attached by tie wire to the single piece dam face and bank wings with a 4 in. overlap up the dam face. This wire apron is covered on top with erosion cloth and attached with wire ties. The wire and then erosion cloth sits on the channel bottom and is held down by placing channel bottom material on it and against the 4 in. apron and erosion cloth overlap along the dam face.

"C" and "D" (Fig. 4) are the dam wings and are supported by 2 metal posts each. The end posts in the trench are used to clamp a stretched dam support cable woven through the top of the channel dam face and wings 18 in. up from the channel bottom. The trench posts 1 ft. from the channel edge are used to attach the downstream erosion cloth and tire apron and hold the dam straight across the channel. The dam wings are lined on the upstream side with erosion cloth that is attached to the 3 ft. high woven wire with wire ties. The purpose of the dam wing is to keep channel bank and trench soil fill material in place when saturated with water and to reduce streamflow erosion around the ends of the channel dam. Each dam wing should be a minimum of 3 ft. long. If the channel is over 6 ft. wide the dam wing length should be one half the width of the channel and reach the back of the bank trench. The 1 ft. wide trenches are dug to the bottom of the channel as to be on grade with the stream channel bottom surface material. As the trenches are filled with soil material behind the dam wings, brush is interspersed in layers to keep the trench soil in place when saturated.

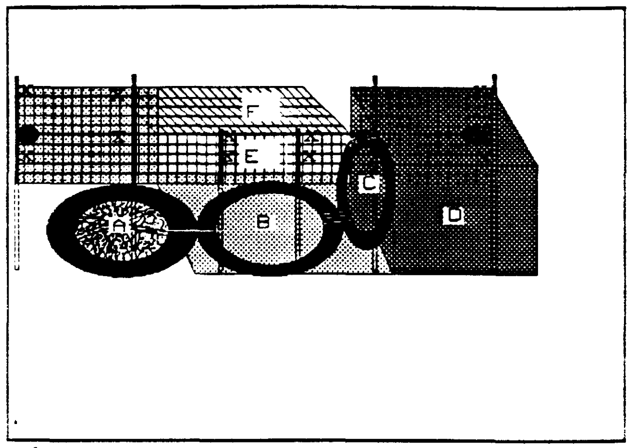


**Figure 5:** Front View Looking Up Stream of Wire Dam

"A" (Fig. 5) illustrates brush used to fill the downstream apron tires. The brush breaks the hydraulic force of water spilling over the dam face and also traps sediment. The brush and sediment weigh the channel center tires down which then holds the erosion cloth against the channel bottom "B". The brush filled tires placed on end against the bank and dam spillway "E" retards erosion of the downstream bank "D". The Dam spillway "E" is completed after: a) the trenches are dug, b) metal support posts are driven, c) the downstream apron is attached to the dam support posts, e) the dam, dam wings, and upstream apron are placed upstream and against all support posts, and the 18 in. dam support cable is stretched and clamped to the end posts of each trench "solid circles". The dam spillway is created when "F" is cut out at each edge of the channel bank down 18 in. to the dam support cable and then folded upstream and down against the dam face and over the 4 in. upstream apron overlap. The wire dam is then attached to the support posts by wire ties "X" and the trenches back filled.

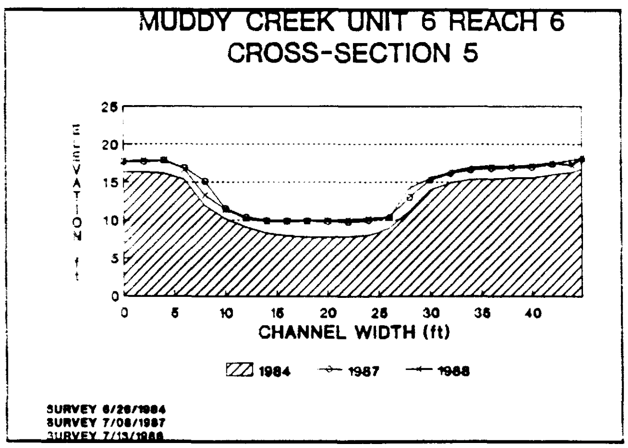


**Figure 6:** Cross-Section of One of Sixteen Dam Sites in Unit 6

Figure 6 illustrates that the wire dams can fill the downcut channel and also build banks. Because of the last 3 years drought Muddy Creek has not flooded over its banks and all dams are not yet filled. In addition to Muddy Creek, 12 dams were placed in Slate Creek in 1986 in southwestern Wyoming and 14 dams in Kirby Creek in northcentral, Wyoming during 1987. These streams are like Muddy Creek and one dam each has failed in each of the two additional sites. One was plugged by a dead horse just after being built and the other by a flash flood and cottonwood tree. Over 95% of all wire dams constructed since 1984 are holding showing the dam, as described, can be placed in cold desert steppe streams and hold.

**Surface and Groundwater:** The Muddy Creek Study Site sub-surface hydrology below the creek along the entire length of Unit 2 through Unit 6 has been modeled, using the USGS finite-difference groundwater model, as a steady-state system in two dimensions. The objectives of this effort were to : i) evaluate the hydrologic interactions along Muddy Creek, ii) Define the aquifer storage relationships present in the stream's riparian zones, and iii) stage collecting an appropriate streamflow/groundwater well data set to conduct a 3 dimensional modeling effort to evaluate hydrologic interactions within the study area valley. The model was calibrated using 2 two time periods corresponding to the periods of high and low streamflow. Predictions for three other time periods were then made and checked against actual field data. The conclusions of this study are:

* Muddy Creek in the study area is a losing stream
* The aquifer is in hydraulic connection with the stream
* Groundwater is not lost to deeper aquifers
* Improved riparian zones store twice as much water as degraded riparian zones
* Instream wire dams add 0.40 acre feet of water to the surrounding aquifer for 1000 ft of channel downstream in Unit 6

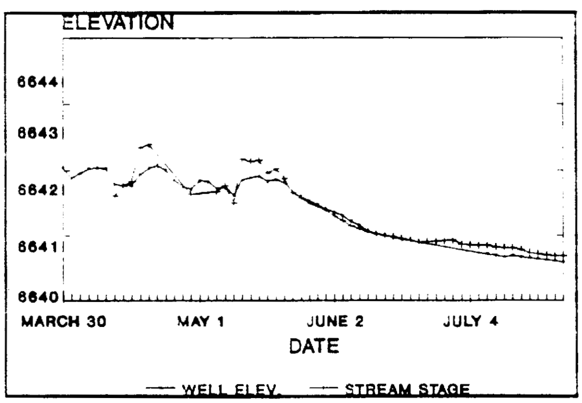


**Figure 7:** Relationship Between Stream Stage and Groundwater in Unit 2

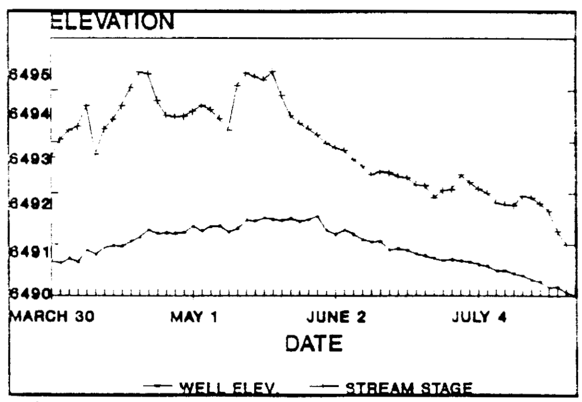


**Figure 8:** Relationship Between Stream Stage and Groundwater in Unit 6

Examples of the relationship between stream stage and groundwater are illustrated in Figures 7 and 8. The connection between the stream channel and the unconfined aquifer is greater in the upstream degraded Unit 2 than the downstream improving Unit 6.

**Vegetation**: Above ground vegetation production for dominate plant species within Unit 6 is being measured using weight estimate and clipping procedures at each wire dam site on straight stream reaches. Within Unit 6, production outside the exclosure are shown by reaches 1,2 (furthest upstream) and 7,8 (directly upstream from the wildlife exclosure. Reaches 13 and 14 are inside the wildlife exclosure are: Stream reach 18 is one of three downstream controls. Unit 2 measurements begin in 1988 on straight stream reaches using clipping procedures. Examples of preliminary results by year are:

The dam sites at reaches 1 and 2, the furthest upstream in Unit 6, started off with less total vegetation production than downstream dam sites and the control. Production at reaches 7,8,13,and 14 and the control, reach 18, is essentially the same before dams were in place in 1984. Total vegetation generally increased to 1987 at all dam sites and then crashed in 1988. Three factors contributed to this crash, drought, beaver, and wildlife grazing.

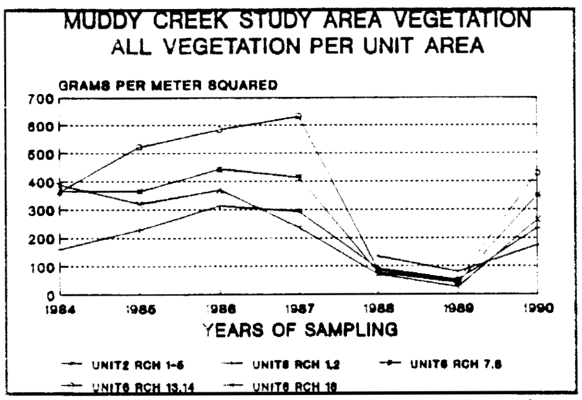


**Figure 9:** All Vegetation Production per Unit Area

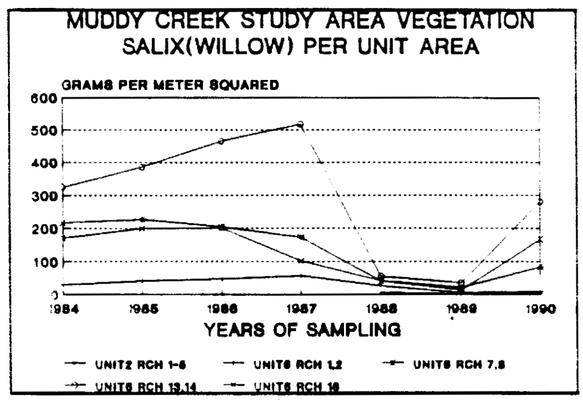


**Figure 10:** Willow Production per Unit Area

Figure 8 documents willow production. During the server winter of 1983-84, large number of deer and antelope were forced to the channel area of the Muddy Creek Study Area. Willow and all other herbaceous material was grazed to the ground surface. The production recorded for 1984 therefore represents total production for a single growing season for dominate riparian zone plants. Production for 1985 through 1989 may include previous year growth. Livestock graze reaches 1,2, 7, and 8, during late fall and winter and wildlife reach 18. All large wildlife and livestock are excluded from reaches 13 and 14.

Willow constitutes the dominate plant making up production within the wildlife exclosure and about half for reaches 6,7, and 18. Little willow exists on reaches 1 and 2. Willow production increased within the wildlife exclosure through 1987, remained approximately the same above the exclosure while being subjected to livestock and large wildlife grazing and declined on the control in 1987. Beaver moved into the wildlife exclosure during 1987 and harvested the willow for winter food. 1988 through 1990 were drought years and Muddy Creek dried up during July and August each year. Also, no spring runoff overflowed the channel banks. Recovery of willow in 1990 represents approximately the annual growth observed for 1984 when near complete harvest of willow occurred. However, instead of forced feeding by large wildlife during a critical winter, beaver removed willow and drought decreased annual production. Total production for the degraded Unit 2 is approximately the same for the improved Unit 6 during 1988 and 1989 but lower in 1990.