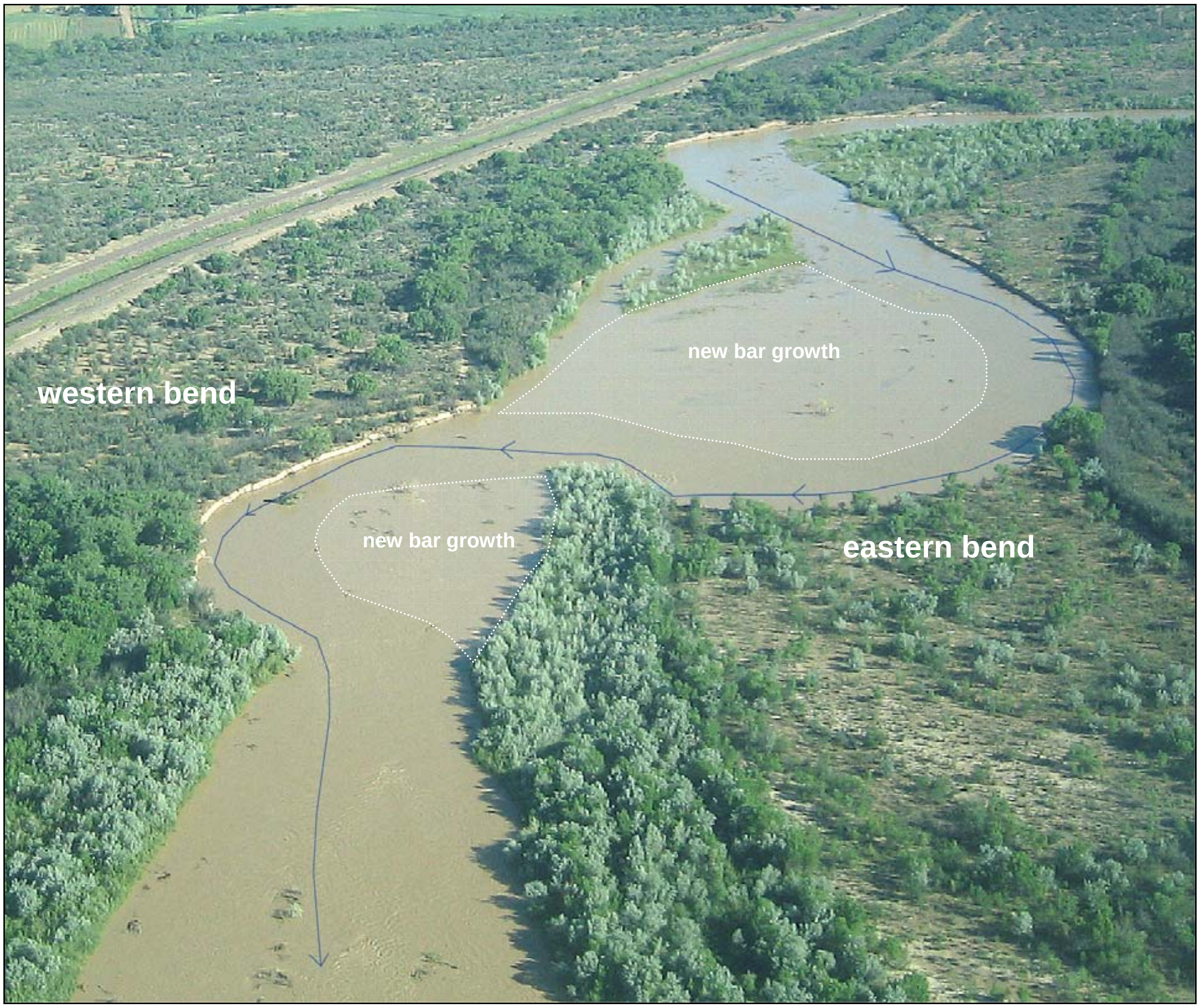
RECLAMATION
Managing Water in the West

Evolution of the Bends at RM 110



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INTRODUCTION

As of October 2005, two bends are actively eroding the Rio Grande bankline at River Mile 110 (RM 110). The concern is that the bend on the west side formed rapidly during the 2005 runoff and that it appears to be migrating towards the levee and low flow conveyance channel (cover picture). The purpose of this report is to discuss the probable future migration pattern of the two bends at RM 110.

EAST BEND DESCRIPTION

In approximately 1999, a bend formed on the east bank of the Rio Grande at River Mile 110 (Figure 1). This bend (the eastern bend) is a primary bend, as it formed first and is influencing the bankline on both sides of the channel. After 1999, the bankline temporarily stabilized until the 2005 spring runoff when it began migrating again. Even in its initial formation, the eastern bend was large, over 3 acres of eroded bank material with a length of 400 meters (Table 1). The bend immediately formed a point bar on the inside of the bend, naturally directing the thalweg to the outside of the bend (Figure 1).

Field observations between 1999 and 2005 found that during this low flow period, the thalweg had shifted towards the center of the bend and sediment was being deposited on the outside of the bend (Figure 1). This sediment, however, did not become vegetated, and so it is assumed that sporadic high flows (thunderstorm event) periodically re-activated these sediments. Field observations in October 2005 found that the thalweg ‘hugs’ the eastern bank line with the emergence of a very large bar along the western bankline (cover photo and Figure 2). At present, no vegetation is growing on the point bar.

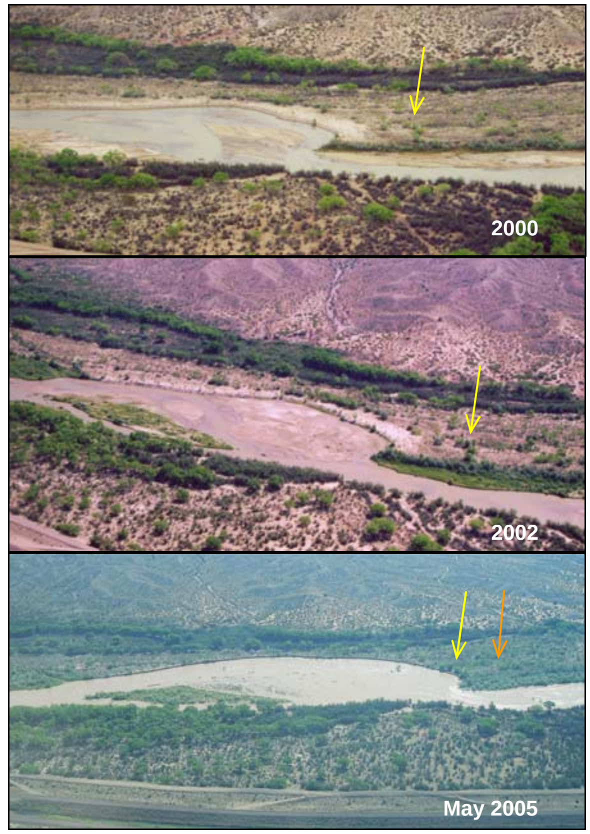

Figure 1: Aerial photos looking east towards the bend at RM 110 East (2000, 2002 and May 2005). The yellow arrow points to the same set of trees in each photo. The orange arrow shows the approximate location of the bankline in October 2005.

Table 1: Summary of the eastern bend characteristics (D/S=downstream).

Date	Total Area Eroded	Length of bankline	D/S Apex erosion
2001	14,700 m^2 (3.6 acres)	400 m (1,310 ft)	--
2005	59,100 m^2 (14.6 acres)	650 m (2,130 ft)	155 m (510 ft)

The eastern bend is eroding through two different surfaces: an active floodplain; and an abandoned (terraced) river channel (Figure 2). The floodplain surface was active channel in the 1992 photos and is currently heavily vegetated with willows and Russian olive trees. In 2005, part of the river flowed across this surface; flow was from the east towards the west bank.

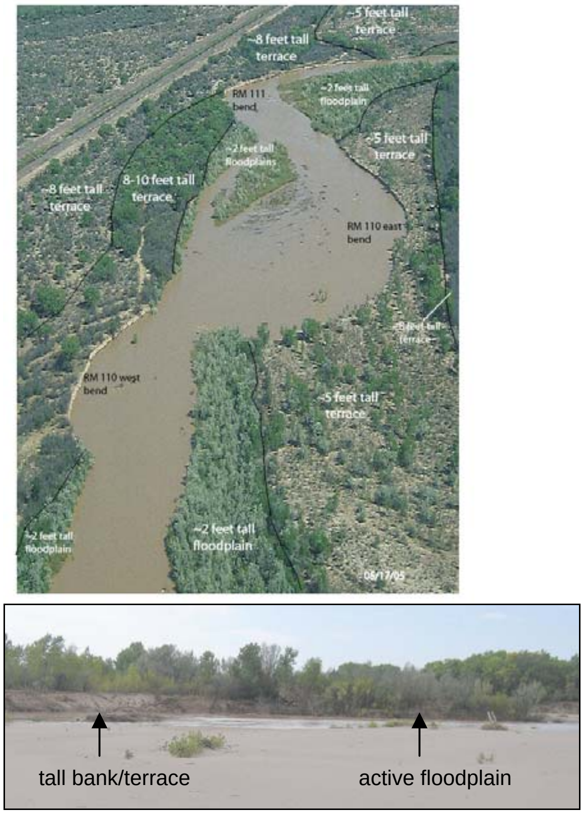

Figure 2: Photographs from 2005 illustrating the location of the floodplain surface with the terrace at RM 110.

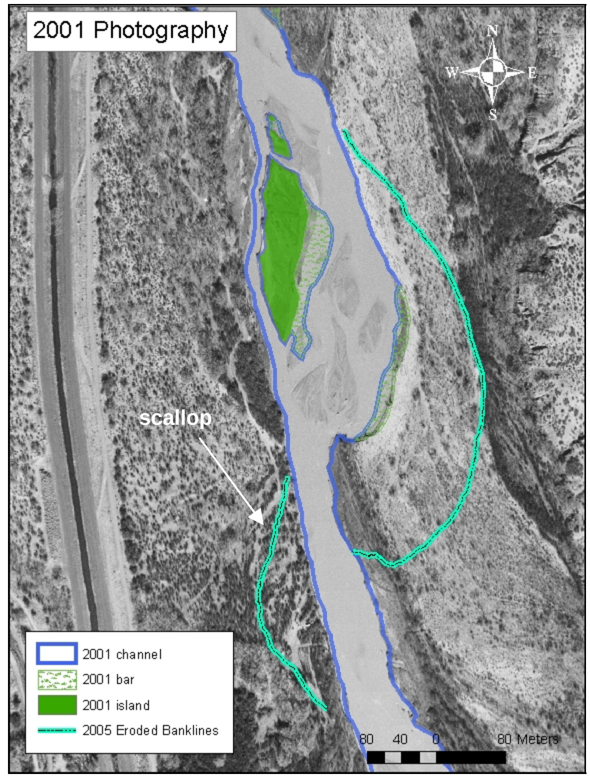

Figure 3: Extent of bankline erosion at RM 110 during the 2005 runoff.

The tall terrace along the eastern bankline is sparsely vegetated and composed of loosely consolidated sand/silt material (a.k.a., sugar sand). Based on the 1949 and 1962 aerial photographs, this surface was active channel in 1949 but abandoned by 1962. As a result of the loose sediment structure in the tall eastern bank, the river easily erodes it. However, the active floodplain appears to resist erosion as a hook has formed at the end of the bend (Figure 3). This resistance also retards the downstream migration of this large eastern bend. In order for the bend to migrate, it must first 'rip-out' the floodplain vegetation/surface. Field observations in 2005 reveal that the river eroded this floodplain surface from the east, thereby flanking it. Based on these data, high flows are most likely to cause bend migration at this site, as it takes high flows to erode the vegetated floodplain surface.

Along with retarding bend migration, the strong hook shape of the eastern bend forces the thalweg to change directions quickly (cover picture). As the thalweg changes directions, it narrows, deepens, and becomes more defined. During the 2005 runoff, the concentrated thalweg was directed almost perpendicularly across the river channel towards the western bankline. As a consequence, western bank erosion began in early May, just as the spring runoff flows began to increase. This bank erosion quickly formed a scallop in the western bankline (Figure 3) that grew throughout the 2005 runoff event.

WEST BEND DESCRIPTION

The west side bend at RM 110 currently is a relatively smooth-arc shaped bend, without a ‘hook’ at the downstream end (Figure 4). The erosion at this site began in early May as a modestly sized scallop formed in the bankline. By mid-May, the bankline was eroding rapidly in both the western direction as well as downstream. The bankline erosion ceased as the spring runoff ended in late June. The total 2005 erosion at this site increased the bankline length by almost 20% (Table 2) but more impressively, in less than 1.5 months, over 12,000 m^2 (~3 acres) of land was eroded and transported downstream.

Table 2: Summary of the western bend characteristics.

Date	Total Area Eroded	Length of bankline
2001	0 m^2	280 m (930 ft)
2005	12,000 m^2 (~3 acres)	345 m (1,130 ft)

The channel between the west bend and the east bend is relatively deep and flows rapidly; unlike other bend systems on the Rio Grande, the channel does not become shallow between the bends. The lack of a ‘riffle’ between the bends is not typical of a laterally migrating river. In fact, both upstream of the eastern bend and downstream of the western bend, the channel shallows appreciably and defining a thalweg is more difficult a common attribute of riffles.

The western bank sediments are older than those found on the eastern bank, but still appear to be composed predominantly of sand (Figure 5); the 1935 photography shows most of this area as being active channel. At present, the bank height is 8-10 feet above the current channel (Figure 2). Near the downstream end of the bend, the older bankline/terrace (pre-1918) has a stand of mature cottonwoods (Figure 4), however, the surface height does not change appreciably. In general, the western bank surface is more vegetated than that found on the tall terrace on the eastern bank.

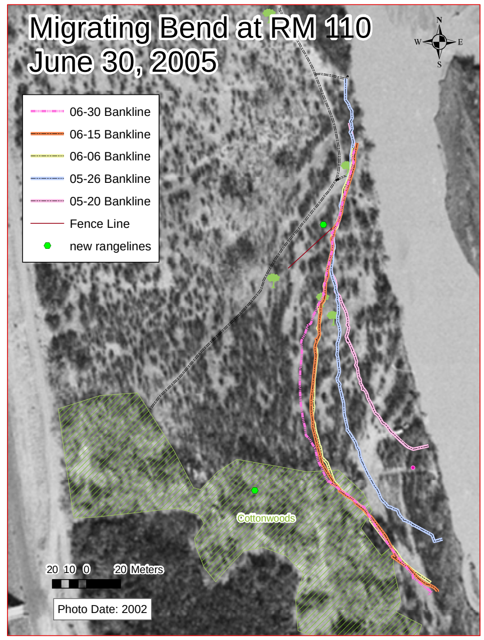

Figure 4: Westward migrating bend at RM 110 with measured bankline location during the 2005 spring runoff event (May and June 2005).

Figure 5: Westward migrating bend at RM 110, looking upstream from within the stand of cottonwoods on the pre-1918 surface.

The bank sediments appear to be slightly more cohesive on the older pre-1918 surface than on the 1935 channel deposits, however, this apparent cohesion may be due to more extensive roots of the mature cottonwoods present in the older sediments. Regardless of age or composition, neither deposit appears to be retarding bank erosion (Figure 5). As these banks are relatively tall (8-10 feet above high water), the river channel is able to readily undermine the roots of any vegetation growing on the bank surface and cause bank retreat.

Most flows along this bend will erode the bank sediments, as the thalweg is directed at the bank. Even during low flow periods (i.e., October), the thalweg 'hugs' the bankline throughout the bend. Unlike other bends where the thalweg location may shift with changes in discharge, it will not change here unless the eastern bend migrates downstream, then it will also migrate downstream. Without erosion on the eastern bend, all moderate to high flows will likely cause bank erosion in a predominantly western direction.

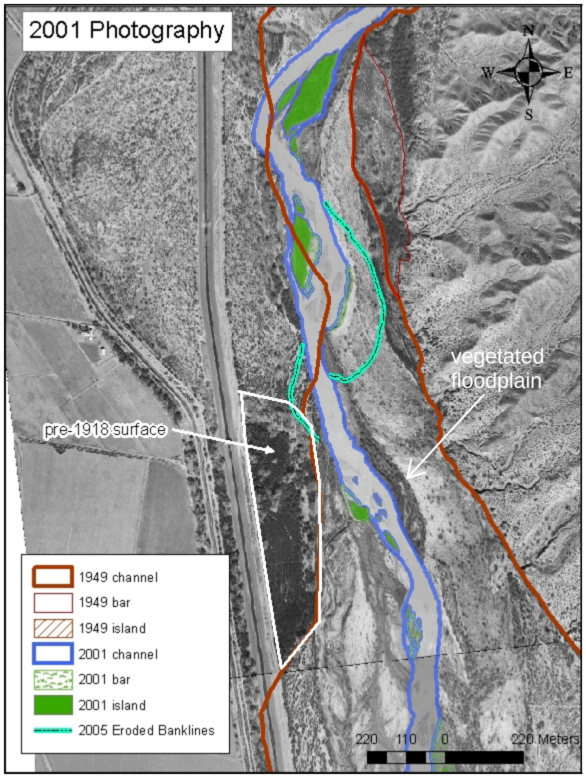

Figure 5: Historical channels and the 2005 banklines at the RM 110 bends.

BEND EVOLUTION

Since the westward migrating bend appears to be a secondary bend of the eastern bend, evolution of the western bend is correlated to that of the eastern bend. A secondary bend, as defined for this study, is forced by the upstream bend; its rate and dominant direction of migration is controlled by that of the primary bend.

The main river feature that determines primary versus secondary bend formation at RM 110 is control of the thalweg. The hook in the eastern bend concentrates and then directs the thalweg into the western bankline. As the eastern bend migrates downstream, the location of the thalweg hitting the western bankline will migrate downstream too. Hence, both bends will likely migrate downstream at a similar rate and the rate will be controlled by erosion of the eastern bankline.

This primary/secondary bend relationship will likely cease about ½ kilometer downstream, where the eastern vegetated floodplain surface ends (Figure 5). Without the floodplain surface, the 'hook' in the eastern bend will likely disappear; at this time, the radius of curvature of both bends may increase, hence decreasing the channel's sinuosity and ending the dependency of the western bed on the eastern bend.

Lateral migration of the eastern bankline is limited as the bend already is close to the eastern valley wall/bluff. Lateral migration of the western bend will occur predominantly during moderate flows when the thalweg location remains stable.

MONITORING RECOMMENDATIONS

These two bends should be monitored regularly, probably on a yearly basis. Based on the current data, the eastern bend will migrate downstream during high flows but will likely remain stable during non-high flow runoffs. As this eastern bend migrates downstream it will pull the western bend downstream as well.

Unlike the eastern bend, moderate flows will erode the bankline along the western bend and it may laterally migrate in a western direction. Although the western bend is over 400 feet away from the levee toe, western erosion rates are unknown and they could be significant during long-lasting moderate flows. Due to the relatively large distance to the levee, however, it is unlikely that this bend will directly threaten the levee in the near future (next couple of years).

Bankline monitoring could be accomplished by either mapping the bankline location with a GPS unit or through aerial photography mapping. Either method would yield the appropriate data to assess bend migration rates, direction of migration, and distance to the levee toe.

Historical Channels at RM 110