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STUDY OF GROINS ON THE MIDDLE RIO GRANDE

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ABSTRACT

The Albuquerque Projects Office of the Bureau of Reclamation installed groins on the Middle Rio Grande to provide bank protection at a severe bend located near Santa Clara Indian Pueblo, approximately 75 miles (121 km) upstream of Albuquerque, New Mexico. During the first season of operation of the groins, a discharge near the 2 year design flood of 7,600 ft.^{3}/s (215 m^3/s) was experienced at the site. Many of the groins showed damage following the recession of the runoff, but performed well at the site. Replacement of riprap will be accomplished before the next runoff season.

Just after the peak runoff of 7,500 ft.^{3}/s (212 m^3/s), a bottom survey was made around the tip of each groin to estimate maximum local scour. Velocity measurements were also made at a discharge of 4,500 ft.^{3}/s (127 m^3/s). A comparison of predicted scour depths from empirical equations and estimated maximum scour will be discussed. Conclusions will be drawn on the overall performance of the groins.

INTRODUCTION

Santa Clara is located on the Rio Grande about 75 miles (121 km) upstream of Albuquerque, New Mexico, and one mile south of the Santa Clara Pueblo (figure 1). This reach has defined pools and riffles and averages about 300 ft. (91 m) in width with bi-modal sediment transport, and fine grained bank material. The south bank has a sharp bend and severe erosion has occurred requiring

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stabilization. An economic analysis showed that groins were the least expensive alternative when compared to a revetment. Design and construction of groins at the Santa Clara river maintenance site was completed in March 1991.

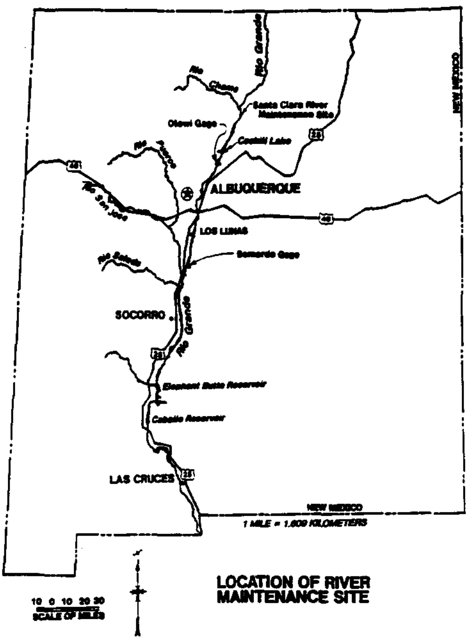

Figure 1 - Location map for the groin sites.

GROIN DESIGN AND CONSTRUCTION

Groins were designed and constructed for the bank erosion on the south bank (figure 2). The Albuquerque Projects office provided surveyed cross section data. The surveyed cross section data were used in the STARS model (Orvis and Randle, 1987) for discharges of 7,600 ft.^{3}/s (215 m^3/s); 13,000 ft.^{3}/s (368 m^3/s); and 16,000 ft.^{3}/s (453 m^3/s). Peak flows are generally caused by spring runoff snowmelt, although there are several ephemeral tributaries upstream of this site. The Manning's "n" friction factor selected was 0.032 for the channel and 0.045 for the overbanks. The river was divided into 10 tubes with the STARS model. Tube 2 river hydraulic data were used for the groin scour computations. Tube 2 data were used instead of tube 1 because of the additional side friction caused by the side walls. Sediment particle size data were obtained from samples collected at a similar site on the Rio Grande in August 1988. The particle size D_{50} is 15 mm and the D_{90} of the material is 40 mm. Scour estimates were made at each cross section based on scour equations described in Pemberton and Lara

(1984) and Copeland (1983) and Kehe (1984), as reported by Klumpp and Baird (1991). The average of the computed scour was 8.1 ft. (2.5 m) using 13,000 ft. ^{3}/s (368 m^3/s). For purposes of the design of riprap on groins, a scour depth of 9 ft. (2.7 m) was used at every section. In using scour prediction equations, previous experience with local scour near the site is the best method for ascertaining the reliability of the equations.

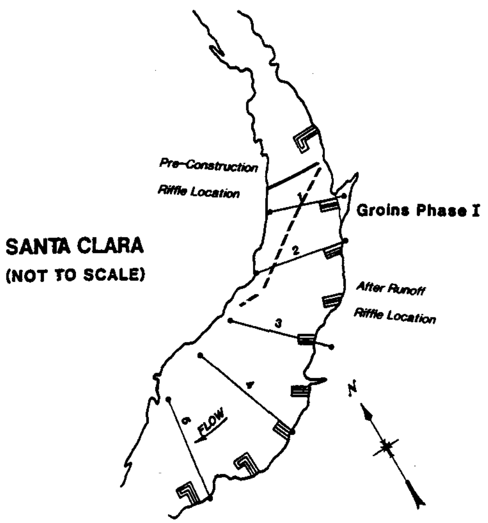

Figure 2 - Location of groins at Santa Clara.

The downstream and upstream slopes of the groins at Santa Clara are 1.5 to 1 with a cross section top width of 14 ft. (4.3 m). The groin spacing used in the design is 1.5 times the length for groins. The riprap quantity estimating procedure was described by Klumpp and Baird (1991).

The core fill material was constructed from sandy gravelly river bar material. Only the tips of the groins were protected with riprap over the estimated zone of scour influence. This provided for more economical construction. The riprap was fairly rounded without any fractured faces, and had a D_{50} size of 24 in. (.6 m). Part of the point bar on the upstream side was removed to widen the river. Construction was completed prior to the spring runoff of 1991. The riprap quantity used was 2,250 yd^3 (1,720 m^3), and the fill material was 3,010 yd^3 (2,300 m^3) for seven groins.

GROIN PERFORMANCE

During the spring runoff of 1991, on May 22, 1991, a flow of 7,500 ft.^{3}/s (212 m^3) was experienced during the first season of operation of the groins. On May 30-31, 1991, at a flow of 4,500 ft.^{3}/s (127 m^3/s) a bottom survey was made to develop a topographic map to estimate the maximum local scour (figure 3).

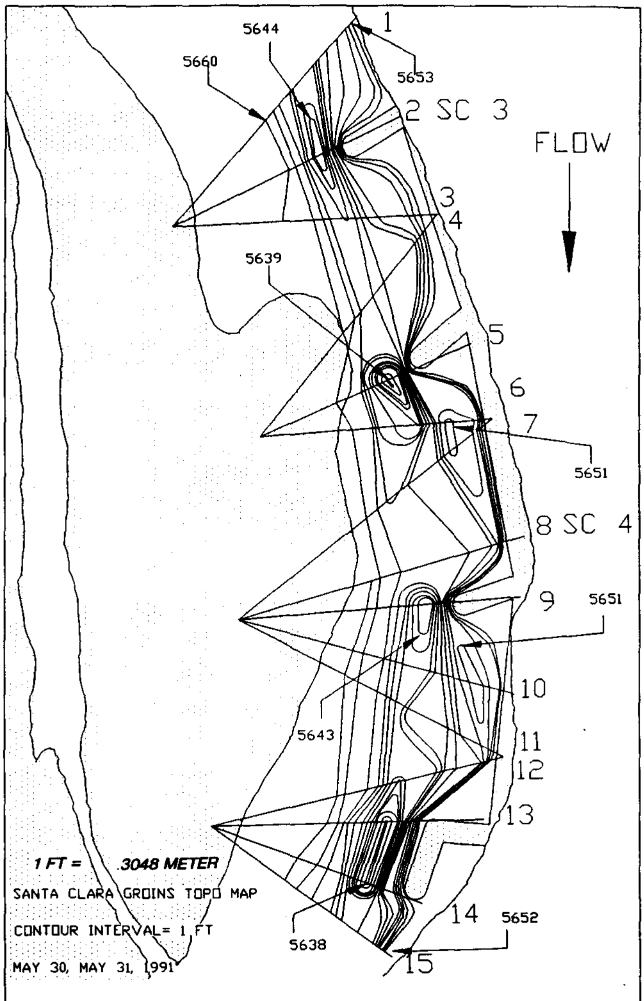

Figure 3 - Santa Clara groin topographic map.

Velocity measurements were also made near the groin tips. The maximum point velocity measured was 7.2 $ft.^3/s$ (2.2 m^3/s) and the maximum average velocity was 6.2 ft./s (1.9 m/s). Figure 4 shows cross section 3 prior to construction and after the runoff event. The scour elevation that developed was 5,543.5 ft. (1,689.66 m), the original bed elevation was 5,546.8 ft. (1,690.66 m), and the predicted scour elevation was 5,537.8 ft. (1,687.92 m). About 3.3 ft. (1 m) of scour was measured, however, scour during the peak flow was probably greater than was measured. About 860 yd^3 (1,657 m^3) of the riprap dislodged from the groin tips and some of the core fill material eroded. Several groins were overtopped and experienced erosion of the core fill material. The core fill material on other groins was eroded by eddy circulation between groins. The upstream riffle moved diagonally into the groins as shown in figure 2. This contributed to further erosion of the unprotected portion of several groins by directing flows at a steep angle towards several groins. The riprap erosion can be attributed to the following factors: 1) the riprap volume required to fill the scour hole was larger than the available toe protection riprap, 2) the rounded riprap rolled downstream into the scour hole, 3) the high velocities on the groin tips, 4) the core fill material piping through the

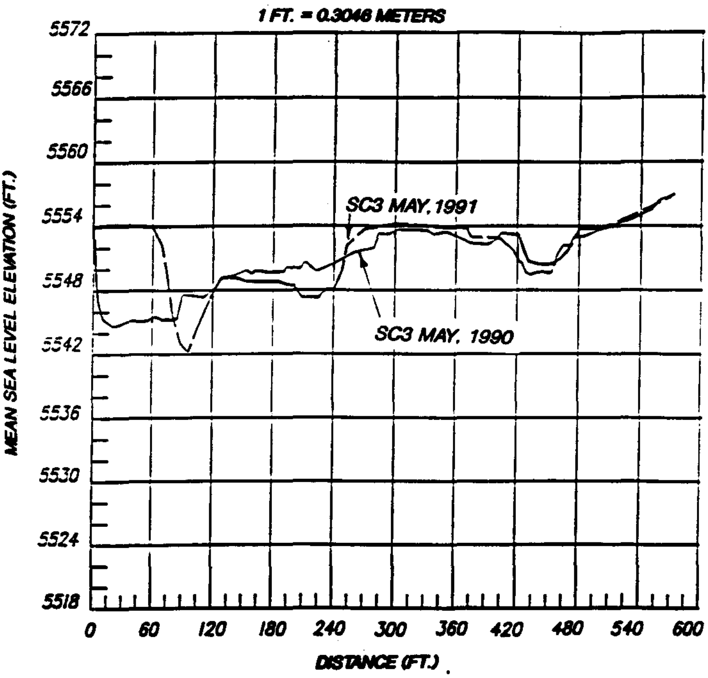

Figure 4 - Santa Clara cross section 3.

riprap, and 5) severity of the bend curvature. In spite of the dislodged riprap and overtopped groins, the severely eroded bend was protected and did not experience further erosion. On the downstream side of each groin a gravel bar was deposited. These bars may in the future reduce the eddy circulation and velocity between each groin increasing their effectiveness. The river bank downstream of the groins was eroded, requiring the construction of one additional groin. Repairs to the groins are planned for completion prior to the spring runoff of 1992. Repairs include replacing the dislodged riprap, raising and covering the groins with 6 in. (152 mm) nominal size riprap, adding about 30% more riprap to each groin, and making two groins into "T" groins. The "T" groins will provide extra protection and flow control for the two groins most severely damaged. The additional riprap will be added to the changed areas of each groin to provide extra protection. The objective of repairs is to make the groins stable under the design discharge of 13,000 cfs (368m^3/s).

SUMMARY AND CONCLUSIONS

Groins can provide an economical bank stabilization alternative provided the toe can be adequately protected from scour and riprap erosion. Five potential causes of riprap erosion have been identified. Continued monitoring of these groins is required to access the cause and prevent future riprap erosion.

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