Case Study 15 Streambank Stabilization in the Guadalupe River Basin, Santa Clara County, California

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Cover photo: Treated section of the Guadalupe River in Santa Clara County, California

Advisory Note

Techniques and approaches contained in this handbook are not all-inclusive, nor universally applicable. Designing stream restorations requires appropriate training and experience, especially to identify conditions where various approaches, tools, and techniques are most applicable, as well as their limitations for design. Note also that product names are included only to show type and availability and do not constitute endorsement for their specific use.

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Introduction

As part of a mitigation plan, geotextile blankets were applied to a bank of the Guadalupe River in an attempt to stabilize the channel slope in the fall of 2002. The blankets were installed within the channel, perpendicular to the flow. This project failed during a storm event in December 2002. Material was washed from beneath, and the blankets were dislodged and torn. In an attempt to repair the damage and provide education regarding biotechnical stabilization solutions, the Santa Clara Valley Water District employed the authors to recommend practices that would include a vegetative component to help stabilize the bank and improve habitat and aesthetic benefits.

Site description

Located in Santa Clara County in central California, the Guadalupe River drains 170 square miles of watershed into the southern tip of the San Francisco Bay. The river begins at the confluence of Alamitos and Guadalupe creeks, flows north through the center of San Jose, then discharges into the bay at Alviso. The river is surrounded by urbanization, yet still provides habitat for many plants and animals including Steelhead and Chinook salmon, both protected by the Endangered Species Act.

In the 1970s and 1980s, the Santa Clara Valley Water District was required to replenish the aquifer and control flooding. The Guadalupe River Basin has been greatly affected by human activity including the urbanization of the surrounding areas, installation of dams and reservoirs, the channelization of streams, and construction of levees for flood protection. Many miles of streambank were armored with sack concrete walls and riprap. Due to environmental concerns, the district was required to shift the focus of stream projects to incorporate only “green” solutions in the mid-1990s. This included replacing many hard structures constructed during past projects. Flooding concerns, threats to bridge integrity, loss of wildlife habitat, water quality issues, and lack of aesthetic value have led to significant restoration efforts within the watershed.

One site targeted for restoration is located between Willow Glen Way and Alma Avenue on both the east and west banks of the Guadalupe River. It is known as Reach 9 within the Stream Maintenance Program (SMP) administered by the Santa Clara Valley Water District. The river is channelized, narrow, incised, and characterized by high velocities and peak flows during storm events. The channel substrate is primarily made up of fine gravels with cobbles and small boulders. Prior to restoration efforts, the channel was confined by a sack concrete wall. Many areas up- and downstream of the site have solid reinforced concrete banks. The river cannot migrate laterally due to the presence of a bridge, and houses are located close to the channel.

Original project

The original restoration work involved removing the damaged concrete access ramp and the sack concrete wall (fig. CS15–1) and replacing the structures with more habitat-friendly treatments. Restoration of the streambank included complete removal of the access ramp. Biotechnical techniques were installed on

Figure CS15–1 Damaged access ramp and wall

the bank including vegetated log cribwall structures, geotextile erosion control blankets, and native vegetation. The primary goal was to protect the integrity of the downstream bridge while providing shade, wildlife habitat, and local bank stability.

Installation proceeded as planned in fall of 2002 (fig. CS15–2). Log structures were keyed into the toe of the slope to provide anchoring and stability. Blankets made from coir netting (900 g/m^2) were laid out vertically along the slope (or perpendicular to the flow, which was consistent with manufacturer recommendations for slope protection), with coir rolls installed on the top and toe edges of the blanket layer. The blanket was then stapled along the length of each section.

2002 storm event

During December 2002, the first winter following project completion, a significant storm event occurred with a 5-year return frequency. The coir netting was severely damaged, and the underlying fill on the toe and midslope of the streambank was undercut and washed away (fig. CS15–3). The logs at the toe of the slope remained in place, yet extensive scour occurred around the structures (fig. CS15–4).

Hydraulic analysis indicated that the river reached velocities of 6 feet per second, developed shear forces of approximately 1 pound per square foot, and was at least 17 feet deep during the storm. The question was whether the failure was due to shear forces too great for the geotextile material or due to improper installation.

Figure CS15–3 Damaged streambank following a 5-year frequency event in December 2002

Figure CS15–2 Finished original project in fall of 2002

Figure CS15–4 Evidence of scour and exposure of the log structures

Biotechnical project installation

In May 2003, a field trip was conducted along the Guadalupe River with staff from various Federal, state, and local agencies to come up with alternatives and designs to repair the damaged bank. The authors were asked to visit the site and recommend potential techniques that could stabilize the slope while providing wildlife habitat and aesthetic value. Recommendations, designs, and specific installation criteria were supplied for live siltation, cobble placement, and a redesigned coir blanket layout. Installation commenced in July 2003, and work began with the removal of the torn and dislodged blankets and regrading of the damaged bank. Maintenance crews of the Santa Clara Valley Water District performed the construction and application with guidance and training by the authors.

Live siltation

Live siltation is a technique in which willow cuttings are arranged in bunches to provide roughness and encourage sediment deposition. Willow cuttings were staked into the soil and rock above and within the log structures at the toe of the bank (fig. CS15–5). Deep, voided areas from the previous erosion allowed the stakes to be planted without digging. Willows are capable of withstanding periodic inundation and high velocity flows, and the roots help anchor the toe, while surface vegetation provides shading and habitat.

Cobble placement

The use of stone was prohibited due to new policies that allowed only “green” solutions within the watershed. The recommendation that cobble be installed was met with resistance; however, regulatory personnel were reassured that cobble would provide natural habitat and aesthetic value while improving channel integrity. Following the installation of the willows, cobble was placed on the toe of the slope to armor the bank and provide initial support for the willows during establishment (fig. CS15–6). Rounded cobble was used and fit in with the appearance of the river while providing the stability needed at the toe of the bank.

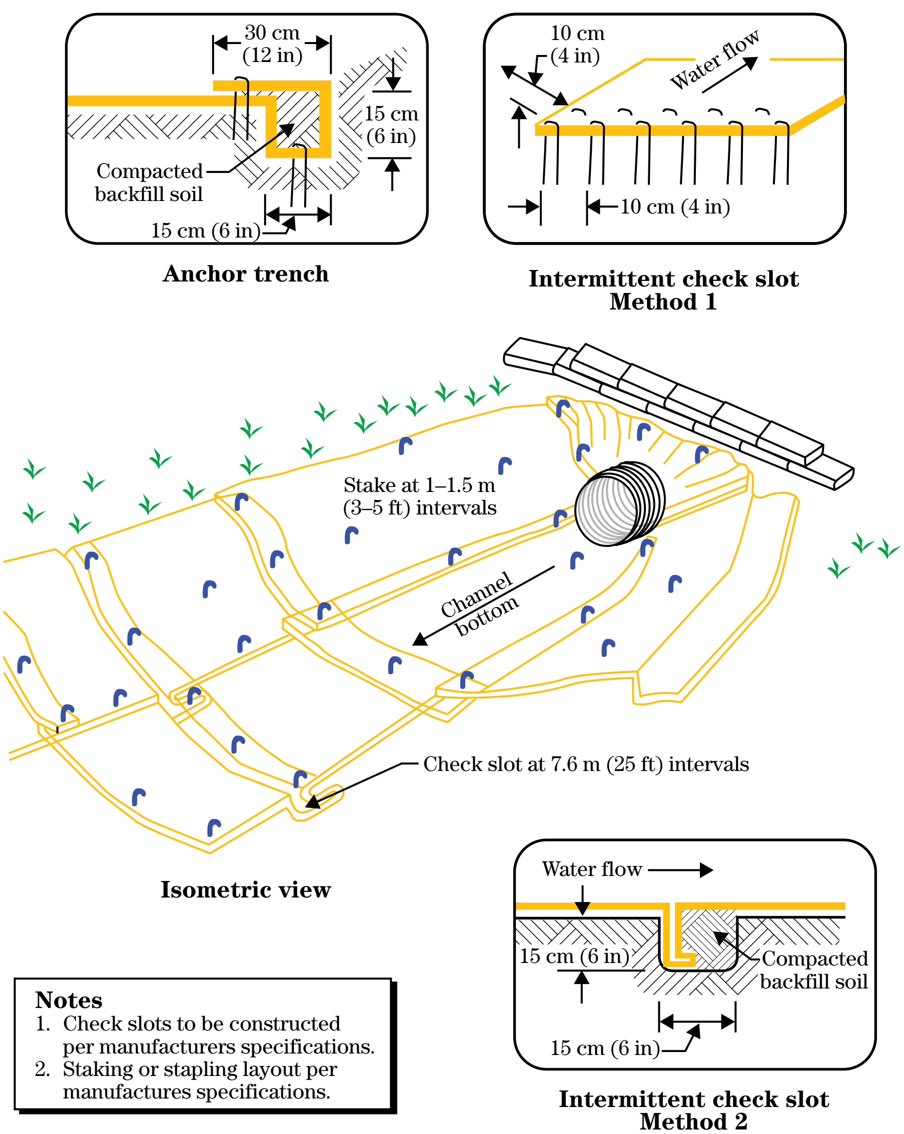
Figure CS15–5 Live siltation installation

Figure CS15–6 Cobble placement following the live siltation installation

Coir blanket installation

The authors determined that the blankets had been installed incorrectly because the application had been applied based on the principles of slope stabilization, not channel stabilization. Channel installation requires that blankets be oriented parallel to the flow and include anchor slots (fig. CS15–7). Prior to coir blanket application, the slope was regraded, top soil was placed on terraces and compacted to 85 percent of optimum density, and mulch and seed were applied hydraulically to the slope. Longitudinal slots (horizontal) and check slots (vertical) were dug into the fill material on the middle and upper portions of the bank to serve as footings for anchoring the blankets and coir logs.

Figure CS15–7 Erosion control blankets channel installation



Materials included 55 coir logs at 6 inches in diameter and 10 feet in length, 7 rolls of GEOCOIR®/DeKoWe® 900 geotextile blanket, and one 100 #3 rebar J-hook staples (with 18-in legs and 6-in hooks). The coir blankets were rated to withstand velocities of 10 feet per second by the manufacturer. The blankets were installed loosely to allow all fibers to make contact with the soil surface and were laid horizontally along the slope (parallel to the river) to reduce the potential for undermining and dislodging by high flows. The coir logs were installed over the blankets in the previously dug trenches and anchored with the hooked staples on both sides of the coir log. The edges of the blankets were incorporated into small trenches and backfilled to secure the material to the slope (fig. CS15–8). Additional cobble was brought in and incorporated on the toe of the slope following blanket installation, and the project was completed (fig. CS15–9). Container plants were installed later with DriWater™ packets to provide necessary moisture during the establishment period.

Biotechnical project performance

During the winters of 2003 and 2004, the slope remained stable, and the blankets, cobble, and willows stayed in place. Photographs taken during storm events demonstrated the inundation experienced by the slope during high flows (fig. CS15–10). Following a storm in January 2004, the flow line reached high elevations on the slope and indicated that the restoration work had been successful (fig. CS15–11).

Conclusion

The restoration work performed in 2003 was extremely successful in stabilizing the slope. In April 2004, the bank was becoming vegetated (fig. CS15–12), and the willows were successfully established at the toe (fig. CS15–13). For future projects, plantings should be performed with minimal disturbance to the geotextile blanket (holes cut for the vegetation were quite large and could provide a potential point of undermining). The project emphasized the importance of installing geotextile blankets parallel to the flow of water within channels where inundation will occur. Combining techniques such as cobble revetment, live staking, pole planting, live siltation, hydroseeding, and coir blankets provided the stability, habitat, and aesthetic value needed for the site.

Figure CS15–8 Slope preparation and blanket installation

Figure CS15–9 Finished project

Figure CS15–10 Inundation of the restored slope

Figure CS15–11 Flow line after a storm in January 2004

Figure CS15–12 Revegetated slope 1 year later

Figure CS15–13 Willow establishment at the toe