Pre-vegetated Coir Achieves Rapid Results in Reconstructed Stormwater Channel

by Paul B. Hook, PhD.

Introduction

A legacy of mining and urbanization in Butte, Montana, left the Metro Storm Drain badly degraded, a weedy, polluted ditch that had not been upgraded since its completion in the 1930s. Recently, the need to install a new pipeline and isolate contaminated groundwater spurred reconstruction of 7000 feet of the channel. Innovative revegetation practices using pre-planted coir accelerated channel stabilization and helped efforts to create an attractive greenway.

Butte lies at the upstream end of the largest contiguous EPA Superfund site in the United States and bears the marks of over 130 years of metal mining, milling, and smelting in addition to more typical impacts of urban development. The Butte Metro Storm Drain is a case in point. It occupies a 1.5 mile section of what was once upper Silver Bow Creek, a tributary to the Clark Fork of the Columbia River. This part of Butte was a center for industrial and urban activity for over a century, and mine wastes and other fill were deposited in the stream corridor in the early years. In the 1920s and 1930s the channel was dredged out and armored to improve storm water flows. It became the Metro Storm Drain, a ditch fed by groundwater and urban runoff contaminated with copper, zinc, cadmium, manganese, and arsenic.

The Metro Storm Drain Reconstruction Project started with plans to run a pipe for water from a new treatment plant down the channel corridor. This pipeline will allow treated water from the Berkeley Pit to be discharged at either the upper or lower end of the Metro Storm Drain when water in the Pit reaches its final level a decade or more from now. Anticipating major equipment and crew mobilization for the pipeline, the Atlantic Richfield Company (ARCO) proposed a plan to install a subsurface drainage system to collect contaminated groundwater at the same time. Local officials of the consolidated Butte-Silver Bow city-county government, which owns the channel corridor, also saw an opportunity

The Butte Metro Storm Drain before reconstruction and revegetation.

Final stages of channel reconstruction. One foot of gravel covers the entire channel bottom (lower left). The pilot channel and "floodplain" were created by placing one foot of soil over the gravel except in the meandering pilot channel (center). Soil was covered with erosion control fabric after seeding (right).

to make the area more attractive and provide a walking and cycling path. The entire channel corridor was already going to be excavated and reconstructed. Why not add the public benefits of a recreational greenway?

Like most environmental rehabilitation projects in the Butte-Silver Bow area, the Metro Storm Drain Reconstruction involved many partners and goals. Plans were negotiated among the Atlantic Richfield Company, who funded most of the work, the Butte-Silver Bow government, the U.S. Environmental Protection Agency, and the State of Montana. The objectives that had to be juggled included remediation of historic and ongoing environmental impacts, water use and treatment for active mine operations, plus the normal water, stormwater, and recreational needs of any small American city. Pioneer Technical Services of Butte were responsible for design and engineering. Jordan Contracting of Anaconda performed excavation and construction, and Butte-Silver Bow staff oversaw some aspects of revegetation.

Channel reconstruction

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The larger main channel was built with a trapezoidal cross-section averaging 20 ft across at the bottom and with 2:1 sideslopes. The channel was sized to carry runoff from a 24-hour, 25-year design storm, which was estimated to yield approximately 450 CFS by the lower end of the project. During rough excavation, the channel was over-excavated to remove mine wastes where encountered. The reconstructed channel was close to its previous location and gradient.

A subdrain was installed over about three-quarters of the project length. It was made by cutting a trench four ft deep in the bottom of the channel, penetrating into groundwater. A perforated 10-inch PVC pipe was laid in the bottom and buried with coarse aggregate. The drain was topped with a geosynthetic filter fabric, and the channel was then lined with a geosynthetic clay liner to separate surface water from groundwater. In the channel bottom and lower slopes, the GCL was protected by a high survivability fabric.

With the subdrain and liner in place, channel construction became more routine. A one ft base of coarse gravel was

laid across the entire channel bed. Soil was laid over the entire channel, one ft deep across the bottom and two ft deep on the side slopes. While soil was placed, a four-ft wide, one-ft deep pilot channel with 1:1 sideslopes was built into the bottom in a meandering pattern, leaving the gravel exposed as a simulated streambed. Soil was protected with a coconut fiber erosion control fabric, which was wrapped beneath the soil at the pilot channel bank.

Revegetation approach

Butte's cool, semiarid climate presents difficult conditions for revegetation. The site is at about 5450 ft elevation, and the growing season is relatively short. Annual precipitation averages just 13 inches. Methods for revegetating uplands successfully in this area have been tested over several decades, and a conventional approach was used for most of the project. The entire area was seeded before the erosion control fabric was installed. Roughly 1,000 trees and shrubs were planted away from the channel bottom and watered with a drip-irrigation system.

Prevegetated coir immediately after installation. Cover of native sedges and rushes is already quite dense, though not complete, and plants are primed for vigorous root growth.

This project also faced the common difficulties of working in an active channel without practical options for rerouting storm flows. Though the Metro Storm Drain trickles most of time, it carries large, flashy flows during snowmelt and rainfall events. Butte Hill, the major source of storm runoff from the north and

west, is largely urbanized and relatively steep (>4%). The high proportion of impervious area results in heavy runoff from moderate rains, and streets and storm sewers convey runoff to MSD rapidly. Storm events in May and June, 2004, washed out some completed areas of graded soil and erosion control fabric and deposited sediment in the pilot channel.

Climate and hydrology posed special challenges for establishing vegetation on the pilot channel's banks. Many desirable riparian species, particularly sedges, have proved very difficult to establish from seed, and even the use of vegetative plugs requires a prolonged grow-in period. For this project, the streambank vegetation needed to handle high storm flows as soon as possible but also had to be sustained by very low baseflows. Furthermore, use of woody plants was excluded along the pilot channel due to the risk that deep roots might penetrate the clay liner and allow surface and groundwater to mix.

Butte-Silver Bow reclamation staff advocated using prevegetated coir to improve odds of revegetation success on the pilot channel banks. Prevegetated coir products combine well developed plants and a fiber blanket in one unit and can accelerate channel stabilization while yielding immediate aesthetic results. They are used increasingly in stream and wetland habitat enhancement, especially in low energy settings, but installation in a high-energy storm runoff situation remains fairly novel.

Butte-Silver Bow County crews stake prevegetated coir in place in August, 2004.

The prevegetated coir product used, Native Sod Solutions' Wetland Sod, consists of a heavy coir blanket measuring roughly 3.3 by 16.4 ft and planted with one to three wetland species. The sedges, rushes, bulrushes, and grasses are planted directly into the coir blanket and grown hydroponically in a nursery until ready to install. When delivered, root systems are well developed and shoot cover is relatively dense.

Approximately 6600 linear ft of prevegetated coir was installed, covering roughly half the streambank area of the project. For diversity, the 410 piece order included six different species mixtures, each with two or three of the following species: Nebraska sedge (*Carex nebrascensis*), beaked sedge (*Carex utriculata*), woolly sedge (*Carex lanuginosa*), water sedge (*Carex aquatilis*), creeping spikerush (*Eleocharis palustris*), and

Baltic rush (*Juncus balticus*). Other streambank treatments such as rock revetments were used in the remaining areas.

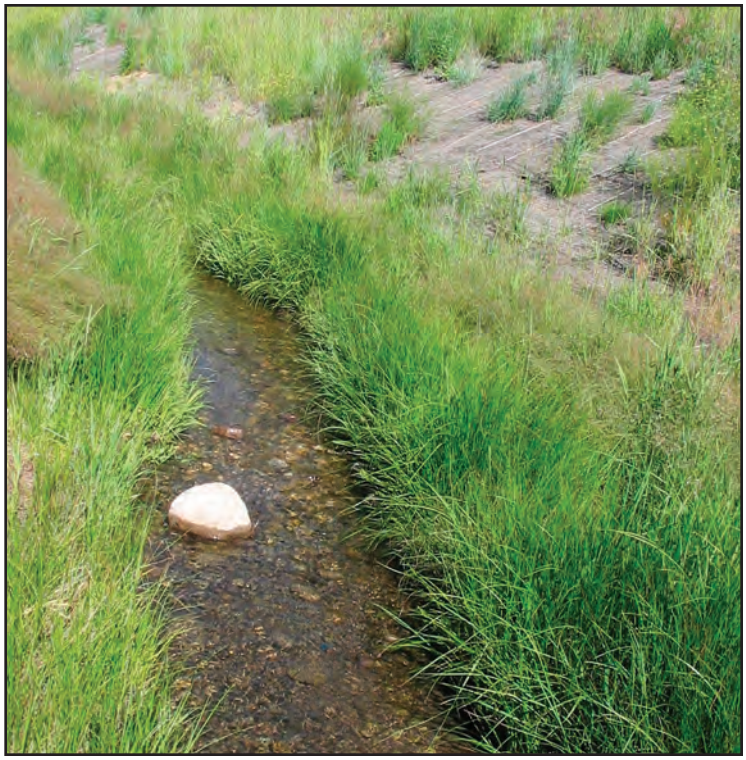
Installation and establishment of prevegetated coir

Planting was originally scheduled for late May to early June, 2004, but storm events set back site preparation. After repairing storm damage, the majority of prevegetated coir was planted during the first week of August. Installation was completed August 12.

Prevegetated coir pieces are delivered in rolls about the size of a 55-gallon barrel and weighing either side of 150 pounds depending on degree of saturation. Pieces are unrolled like lawn sod during installation. For this project, each piece was laid down lengthwise on the pilot channel bank, with one edge near the toe of the bank and the other on the flat bench of the larger channel bottom. The coir mats were pinned in place with ten wooden stakes each to secure them until fully rooted. The coir blanket contributes to temporary erosion control but is mainly a growth medium and physical "carrier" for the plants. Erosion protection relies on full rooting and robust shoot growth; it's the plants, not the coir, that provide the real, permanent erosion control.

As with any newly installed plantings, care and maintenance during the establishment phase is critical to success. On a channel with naturally unreliable flows such as the Metro Storm Drain, low flows risk excessive drying and poor growth or even death of plants. In cases like this, supplemental irrigation is essential. Even before the isolation of the surface channel from groundwater discharge, baseflows were quite low; installation of the subdrain and clay liner removed even that source of baseflow.

For this project, the solution was to provide artificial baseflow and use temporary check dams to spread the water. Butte-Silver Bow owns some of the clean water piped from the Pintlar Mountains via the Silver Lake Pipeline. Officials allocated about 0.2 million gallons per day (0.3 CFS) as baseflow for the Metro Storm Drain. At this flow, the shallow water in the pilot channel would not wet soil far enough up banks to ensure successful rooting of the entire width of prevegetated coir. County staff used irrigation tarp dams to raise water levels and maintain moist to saturated conditions in soils. The dams backed water up the channel from 30 ft to more than 100 yards depending on local slope. They were moved periodically to keep all streamside areas well irrigated and were usually left in one place for about a week. Staff watched for signs of drying and moved dams to rewet these areas, assuring good initial growth after installation. Because the tarp dams were inexpensive, easy to move, and worked well, it was a very cost-effective solution.



Revegetated channel in July, 2005, less than one year after installation.

Use of the tarp dams also provided a significant water conservation benefit. The original plan was to provide artificial baseflows of up to 3 million gallons per day (4.6 CFS), but with dams, 0.2 MGPD was found adequate to maintain vegetation and aesthetics. With clean water in short supply in Butte, officials felt water should be conserved for other uses. The artificial baseflow is provided from before the start of the growing season until after hard freezes.

Initial performance

There have been several significant storm runoff events since the project was completed, including several soon after revegetation. According to Tom Malloy, Reclamation Manager for the Butte-Silver Bow Planning Department, water in the Metro Storm Drain was several feet deep during one event. The areas planted with prevegetated coir were inspected after runoff events and were found to have stood up well to the flows. In 2005, areas planted with prevegetated coir were firmly rooted and had a dense, lush cover.

Another notable success has been exclusion of weeds. Before the project, the channel was infested with noxious weeds including spotted knapweed, toadflax, thistle, and bitter nightshade. The prevegetated coir has effectively excluded these weeds where it was installed. In experiments comparing revegetation using prevegetated coir, seeding, or nursery plugs, we previously found that prevegetated coir was superior in its ability to exclude undesirable weeds and other unplanted volunteer species.

Conclusion

The Metro Storm Drain Reconstruction has contributed to several priorities for environmental remediation and urban renewal including groundwater remediation, storm water infrastructure, and development of greenways with paths. The overall reaction of officials and the public to the project has been positive. Malloy notes that the new channel looks much better than the old one, and this is the main thing people notice. The revegetated channel corridor is seen

as a nice addition to the community. The county has installed a paved walking and bicycling trail that is already used heavily and picnic areas. The trail eventually will be connected to an extensive trail system that is being developed throughout the city and along restored sections of Silver Bow Creek downstream from the Metro Storm Drain. **L&W**

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