Establishing Native Grasses On Soil Faced Retaining Walls

Three years after installation, native grasses are well established on 20 feet high soil faced retaining walls.

by David Steinfeld, Scott Blower, George Fekaris, and Mike Miller

THE Agness-Illahe Road is the final three mile of a long, 32 mile trip up a windy road from the small coastal town of Gold Beach, Oregon. Notched in steeply tilted sedimentary rock and landslide material, this last section follows the contours of a steep mountainous slope, in and out of draws, and around outcrops. It ends at Foster Bar, famous for being the first take-out point for boaters who have rafted or kayaked through the magnificent Rogue River canyon, a three to four day excursion. If it wasn't for this fact, the road might have remained as it has been for years - a narrow, single lane road, with a deteriorated road surface, blind curves and sharp drop-offs to the river. But because of the high levels of recreational use, the road was identified by federal, state, and local agencies as a high priority for reconstruction to preserve access to Foster Bar and improve driving safety.

In 1998 the Western Federal Lands Highway Division (WFLHD), a department within the Federal Highway Administration (FHWA) that works primarily on improving roads on federal lands, developed a plan for public review that proposed improvements to the Agness-Illahe Road by realigning the curves to increase visibility of on-coming traffic and adding inter-visible turnouts. This was a challenge, considering that on one side of the existing road is the renown Rogue River, a federally designated "Wild and Scenic River" and on the other, the base of a steep, unstable slope. Cutting into the unstable slope was not an

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option on most sections of this road because of the potential landslides that would result during the winter months closing the road and sending sediments into the river. The only alternative was to widen sections of road by building retaining walls out toward the river.

Designing and building retaining walls along a 1.5 mile section of road is a difficult task in itself, but to design it in such a way that it blends into the landscape and doesn't become a "scar" seen by travelers using the road, or boaters and fisherman looking up from the river, added to the complexity of the project. The planning document that the WFLHD developed stated that reducing the visual impact would be accomplished by installing plants "in the wall or in front of the wall to screen the view of the wall from the river". This was a challenge that brought together engineers and plant scientists.

The WFLHD approached the Rogue River - Siskiyou National Forest to help in the overall road design to assure that it would conform to the objectives set forth in the management plan for the river. The WFLHD also contacted personnel at the J. Herbert Stone Nursery, a Forest Service facility that propagates native plant materials, to see if they would help develop a system to visually conceal the walls with native vegetation. J. Herbert Stone Nursery had become a leader in the movement to propagate seeds and seedlings of native plants for public lands in the Western United States over the past decade and they were interested in applying these plant materials to actual projects in the field. We now had a planning and implementation team that included plant material specialists along with local Forest Service biologists.

Our team approached the project with the objective of meeting short term and long term visual objectives. The short term goal spanned 5 to 10 years and would screen the walls by establishing a stand of grasses on the nearly vertical wall surfaces. The long term objective would be to establish shrubs and trees in front of the walls to blend the walls into the surrounding forested landscape. We agreed on a design that would place a foot of topsoil covering the front of the walls from which grasses would grow. Simple enough, but just how does one establish grasses on walls that rise 6 to 26 feet above the natural ground line? We began to answer that question by setting up a set of simple experiments.

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Several years before the bulldozers arrived on site, we built two small retaining walls (10 feet wide by 3 feet high) with a topsoil face, to mimic the final wall design. A series of native grass species, seed application methods, and erosion mats were tried to determine which combination of treatments or products would lead to the best establishment of grasses for this specific project area. Installing simple, inexpensive trials are invaluable because the findings can have far reaching effects for how a project is designed. For example, the first year findings from our small plots were a bust because the soil we used for topsoil was full of annual weed seeds. While the weeds hid the walls the first year, by the second year, the weeds had died out and there was just dead thatch remaining on the experimental walls. If we had not learned from these plots, we would have most likely been unsuccessful in revegetating the retaining walls within the project area. Based on this information

The first year experiment to establish grasses on soil-faced walls failed as a result of poor topsoil and annual weeds. The findings from our test plots proved invaluable for the final project.

Seeds were sown on erosion mats and glued to the surface. After the glue dried, the mats were rolled up and stored until construction of the walls.

we reinstalled a second study.

This time a source of topsoil was used that was free of weed seeds and amended with compost. We also compared two local grass species and two types of erosion mats to hold the soil in the baskets. The grass species, blue wild rye (*Elymus glaucus*) and California fescue (*Festuca californica*) were perennial bunchgrasses, native to the area. The two erosion mats were a composite turf reinforcement mat (composed of 70% straw and 30% coconut fiber) and a netted straw blanket. The results from the second year test gave us the information we needed to proceed. The composite turf reinforcement mat had better germination and grass establishment than the netted straw blanket because of the greater thickness of the mat. We also observed that the California fescue created a consistent cover of vegetation that remained green through the hot, dry summer while the blue wild rye established well but did not persist as long.

At this point we needed to take the information obtained from a 30 square foot section of wall and apply it to 25,000 square feet of retaining wall that was due to be constructed within a year. The challenge was figuring out how to place seeds between the soil and the erosion mat. Originally we had placed the seeds as best we could while filling the baskets with soil. But this was a clumsy method where more seeds were used than

Above: 2003. Grass seeds began to germinate in late fall, three months after wall installation. Below: 2006. Three years later, retaining walls are screened by strands of native grasses.

necessary. We eventually settled on gluing the seeds to the mats with a non-toxic co-polymer resin used at J. Herbert Stone Nursery to hold down our seed bed mulch from blowing away in the afternoon winds. A few trials of gluing seed on erosion mats using several dilution rates proved successful and we were ready to operationally produce seeded mats.

A seed bank had been developed for this project during the three years leading up to construction. Taking seeds collected near or within the project area by Forest Service personnel, we established grass and forb seed production beds at J. Herbert Stone Nursery. After several years of growing, enough seeds were harvested for this project and other adjacent wildlife projects on the Rogue Siskiyou National Forest that required native, locally adapted grass and forb seeds for restoration. California fescue was the main species glued to the mats, but we also used two native forb species common to the area, Oregon sunshine (*Eriophyllum lanatum*) and naked buckwheat (*Eriogonum nudum*) to add color and interest.

Gluing seeds to erosion mats takes lots of space and warm, dry weather. We waited until the summer months when day time temperatures reached into the 80's and 90's ˚F in the afternoon. Starting in the early mornings at the nursery, we closed our paved road to local traffic, and laid out the erosion mats. We typically laid out about a quarter miles worth of mats, placing two, side by side, with just enough space for a tractor to drive between. Using high seeding rates (500 to 750 pure live seeds to per square foot),

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seeds were hand sowed evenly on the mats. Included with the seeds was a commercial mycorrhizal inoculum to assure that the grass seedlings would have ready access to the spores of these beneficial soil organisms as they became established. Then with one of our farm tractors, glue was applied to the mats from application booms in two passes. By lunch the glue was dry and the erosion

mats were rolled up and placed in storage. The mats were stored in a cool, dry warehouse until the walls were ready for grass mat installation. We typically produced around 40 rolls of seeded mats in a morning, averaging between 1 to 1.5 rolls per person hour.

The last detail that remained before the seeded mats could be installed was to approve the topsoil source that the road construction contractor was to obtain for the project. We were uncertain where the contractor would purchase the 60,000 cu ft of topsoil since local topsoil was not available and it would have to be trucked in from miles away. We were sticklers for getting a good source of topsoil based on our encounter with weeds in the first wall and from the realization that there would be no way to amend the soil once it was placed in the near vertical walls. This was very different than most revegetation projects we had been involved with, where if there is a deficiency in the soil, we adjust by applying fertilizer or soil amendments. For this project, there was only one shot at these walls and the soils had to be of high quality to develop a self-sustaining vegetative cover.

Two forb species were added to the seed mix-nude buckwheat (the white flower) and Oregon sunshine.

The answer to the topsoil question came one day as the contractor was excavating out an area for staging equipment and discovered a deep deposit of alluvial material, free of rock and seed load, with a loam texture that would please any gardener. We sent samples of the material to

a soil laboratory for analysis and from this information developed a recipe that basically called for organic matter, lime materials, and fertilizer.

The organic matter came from the compost produced by J. Herbert Stone Nursery. This material was trucked to the site and mixed in with the alluvial loams at a rate of one part compost to three parts loam borrow (25% compost by volume). A slow-release, organic fertilizer was added during this operation because of the importance of having fertilizer available for several years while the vegetation became established. Using a fast-release, inorganic fertilizer, would allow some nutrients, such as nitrogen, to leach out of the soil before the plants could adequately utilize them. This would definitely be a drawback on this site, which receives over 60 inches of rainfall in the winter. Lime material was also applied to raise the pH to above 6.0. Using a front end loader, these materials were thoroughly mixed, then stockpiled on site until the material was needed for wall construction.

Topsoil was manufactured on site using loam from an alluvial deposit and mixing it three bucket loads of loam to one bucket of compost. Lime, slow release fertilizer, and mycorrhizae were added and then thoroughly mixed in.

Road construction began in 2003. The construction firm, Ladd and Associates Inc., of Redding CA, was awarded the road building contract through a full open competition bidding process. The contractor suggested several changes to the contract that would lower project costs and still meet or exceed the design criteria. Called a "value engineering proposal", the cost savings are split between the contractor and the government. One of the proposals was to manufacture topsoil using onsite materials instead of hauling it from long distance sources. Another was to change the design of the retaining walls from a gabion wall to a mechanically stabilized earth (MSE) design. Both proposals were accepted and implemented.

The retaining walls in the MSE system were built by laying out a horizontal wire mat over the road base. The wire mat was bent at the end in an "L" shape which formed a two foot high wire frame which became the surface of the wall and held the topsoil after it was placed. As the walls were built, the wire mats were covered with two feet of compacted fill, leaving a foot of space near the surface of the wall where the topsoil would be placed. The wire face of the MSE walls were then lined with the seeded erosion mat and filled behind with topsoil. The side of the mat with the glued seeds were placed facing toward the soil, so that there was good seeds to soil contact for optimum germination and seedling establishment. Once placed, the soil was hand tamped, but not overly compacted, assuring that roots would easily penetrate the soil. When this was completed, another layer of road fill was placed until the road was built up to grade. As the walls were being built, topsoil was also placed at the base of the retaining walls to a depth of 3 feet to create planting sites for shrub and tree seedlings and exposed soils were stabilized with hydromulch, tackifier, and a seed mix of native species.

It took three and a half months to complete the walls. There were up to five wall crews working at a time, ranging from 5 to 8 workers per crew. While the retaining walls were being constructed, the road was at times partially and fully closed. During these periods you could wait, or you could elect to take the 16 mile detour around.

Summers in the Siskiyou Mountains are long and hot, with at most only a few rainstorms passing through for a couple of days. For this reason, it was not until fall, when storm fronts from off the coast brought sustained rains, that seeds began to germinate. Young grass plants took hold over the mild fall and by winter a green sheen could be seen on all the walls. The topsoil remained inplace during the periodic rainstorms because the road was designed to divert water away from the face of the retaining walls by using asphalt curbing. The erosion mat used on the face of the retaining walls also kept the soil secure. During the winter months, native shrub and tree seedlings were planted at the base of the MSE walls where topsoil had been added, setting in motion the longer term goal of screening the walls with larger vegetation.

The grasses continued to grow in the spring and by summer 2004 it had become harder to make out any details of the wire or erosion mat that held in the topsoil. Grasses stayed green throughout most of the summer which was unexpected considering the hot, dry weather and the lack of an irrigation system. By the

following year, the grasses had matured into a well established cover. Monitoring plant cover in the third year showed that over 90 percent of the walls were covered by grasses and less than 10 percent of the walls showed the wire or erosion mat. Many of the seedlings planted at the base of the walls also survived and had grown significantly.

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Now, four years after the walls have been installed, grasses are still healthy and the larger vegetation is growing up to screen the walls. We knew from our small plots that we could establish a vertical grass face that would survive for a year yet were uncertain of whether it could sustain itself for much longer. The fact that this project has exceeded our expectations can be attributed to several factors. The attention to the quality of manufactured topsoil was central to the success of the project, especially the compost that was added. Compost is the long-term energy and nutrient bank of the soil and over time, it helps create the structure that allow roots to fully penetrate the soil. Selecting the appropriate species and seed source was also important. California fescue is a long lived perennial grass that can be seen hanging on to steep slopes in this country so it was the ideal species to thrive on the walls that we built. Paying attention to how the seed was collected, propagated, and handled from gluing on erosion mats to installing in walls also assured that optimum germination would occur.

The success of any project is in the details and this project had many. The partnerships forged between the FHWA, Forest Service, and the road building contractor was critical in creating an atmosphere where no detail was compromised. **L&W**

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