From Forest Nursery Notes, Summer 2008

16. The greening of public roadsides. Armstrong, A., Riley, S., Steinfeld, D., and Wilkinson, K. M. Public Roads 71(3):1-12. 2007.

U.S. Department of Transportation
Federal Highway Administration

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Public Roads
—featuring developments in Federal highway policies, programs, and research and technology—

November/December 2007 · Vol. 71 · No. 3

November/December 2007

The Greening of Public Roadsides

by Amit Armstrong, Scott Riley, David Steinfeld, and Kim M. Wilkinson

FHWA reinforces its commitment to environmental stewardship by developing an integrated approach to establishing native plants along roadsides.

Motorists demand that road modifications not only improve safety and mobility but also preserve, protect, and, where possible, promote healthy natural environments. In recent years the Federal Highway Administration (FHWA) has taken a leadership role in moving beyond regulation-driven mitigation approaches to proactive environmental stewardship that promotes healthy ecosystems.

Native plants are one of the foundations of ecological health and function. Revegetating roadsides with native plants is key to managing environmental impacts and improving conditions for healthy ecosystems.

According to George Fekaris, project manager for FHWA's Western Federal Lands Highway Division (WFLHD), "Our clients, the Federal land management agencies, need and want [roadside revegetation with native plants], and it's the right thing to do, both economically and environmentally."

Photo: Thomas D. Landis, Native Plant Nursery Consulting

(Above) Native plants support insects and other forms of life. Here, a butterfly is perched on the flower of a prairie blazing star (*Liatris pycnostachya Michx*).

Past approaches to post- construction roadside revegetation often failed, despite policy initiatives, customer desires, good intentions, and widespread recognition of the many economic, aesthetic, and ecological benefits of native plants. The lack of a consistent interdisciplinary, interagency team approach with early (3-years minimum) project participation, and inadequate communication and stated objectives among all involved parties at Federal, State, county, and private levels, often leads to revegetation failure. With dedicated interdisciplinary, interagency commitment, teamwork, and revegetation guidelines, roadside revegetation projects will succeed while fulfilling broad-ranging agency objectives.

Fekaris continues, "Our ability to successfully establish native plant communities on roadsides is the linchpin that will determine whether the 12 million-plus acres that make up the transportation corridors of this country will be a hospitable environment to plants, mammals, birds, and other forms of life — or a wasteland."

Benefits of Native Plants

Native plants along roadsides offer ecological, economic, safety, and aesthetic advantages. Ecologically, healthy native plant communities often are the best long-term defense against invasive and noxious weeds. Economically, maintenance costs for managing problematic vegetation are reduced, as are concerns that herbicides might cause pollution or that weeds from roadsides might invade neighboring lands.

In addition, well-planned, desirable vegetation supports transportation goals for safety and efficiency by stabilizing slopes, reinforcing infrastructure, and improving the road user's experience by creating natural beauty and diversity along the roadside.

The ineffectiveness of past roadside revegetation efforts resulted in problems such as erosion and sediment loading, thereby affecting soil and water quality. Visually, when road disturbance is not healed properly, the aesthetic experience of the road user is diminished.

Collaboration and Long-Term Goals Essential

According to Paul T. Anderson, the U.S. Department of Agriculture's (USDA) Forest Service (USFS) environmental streamlining liaison to FHWA, an integrated and collaborative approach is needed. "When protection or reestablishment of native vegetation was considered, it was too often an afterthought," he explains.

In some cases the goal was too shortsighted. Revegetation was considered important to improve the appearance of the roadside disturbance, but efforts emphasized seeding of exotic species because these were perceived as cheap, readily available, and quick to establish on disturbed sites. These exotics either spread to become problematic weeds or failed to persist because they were not locally appropriate.

"A collaborative process with an eye on long-term results, not just quick cover, is needed," says Anderson.

FHWA's Fekaris adds, "You often see failures from lack of coordination. Specialists tend to work in isolation from each other. The engineers decide the slope grade, the soils person comes along and tries to stabilize or add soil, and then the revegetation person is invited to throw some seeds on top of that. In a year or two, it starts to fall down — you have an ugly, bare, or weedy disturbance, and folks wonder why."

WFLHD recognized that overcoming the obstacles to successful establishment of native plants would require more than just technical information. A systematic, comprehensive approach is needed. With environmental stewardship as one of FHWA's "vital few" goals for road projects, revegetation has to be considered at every phase of design and construction. Engineering and natural resource sciences need to be brought together in a collaborative way.

Safety First: Plants Support Safety Goals

The overriding goal of any road construction or modification project is safety, and rightly so. The establishment of locally adapted native plant communities supports transportation safety goals in a number of ways, but one of the most important is by improving the function of roadside engineering. Appropriate vegetation can enhance visibility and support design features to help drivers recover if their vehicles leave the pavement.

David E. Steinfeld, USFS

Native plants improve cut-slope stability, as shown here on a two-lane road.

When native plants are incorporated into road design, they can improve long-term slope stability while softening visual experiences. For example, hydroseeding with exotic grasses has been the conventional approach to stabilizing road cuts, but many grasses have shallow root systems and short life spans. Hydroseeding with a mix of forbs and native grasses over a matrix of planted shrubs and small trees will increase slope stability and prevent slumps and debris flows onto the road. Revegetation efforts poorly integrated with natural processes can threaten the function and structural integrity of the road itself, leading to premature deterioration of the road's infrastructure.

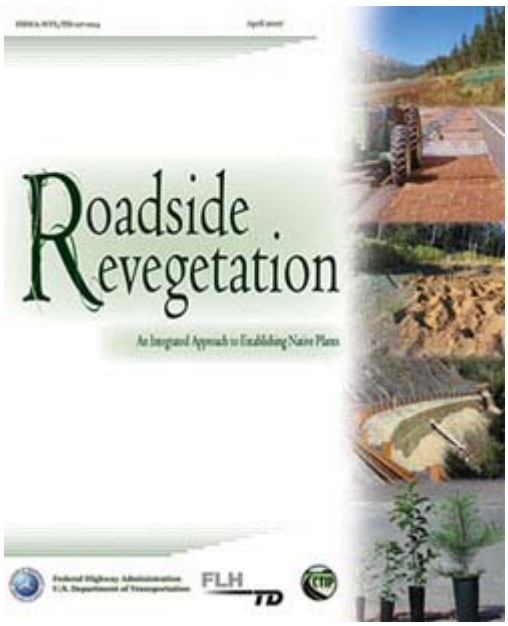
David E. Steinfeld, USFS

Native grasses, forbs, and shrubs can be established by hydroseeding. Here, workers are spraying a mix of water and native plant seeds onto a hillside adjacent to a road project.

A Productive Partnership

To meet this need, WFLHD embarked on a project to develop, in collaboration with USFS, an approach to roadside revegetation that is:

- *Goal-oriented:* Integrates revegetation with transportation objectives and customer needs, including safety, mobility, long-term ecological health, and cost effectiveness
- *Collaborative:* Incorporates the knowledge of biological scientists and engineers through collaborative processes and interagency cooperation
- *Context sensitive:* Recognizes that each project has unique ecological characteristics and that source-identified, locally adapted plant varieties ensure functional, self-sustaining plant communities, not just quick cover



Shown here is the front cover of *Roadside Revegetation*.

USFS and WFLHD synthesized the findings of their collaboration into a comprehensive report that can serve as a guide for practitioners and planners. The report, *Roadside Revegetation: An Integrated Approach to Establishing Native Plants*, brings theoretical and practical information to bear on the challenge of revegetating roadsides with native plants. Available on the Web (www.wfl.fha.dot.gov/td/revegetation.htm), the guide is designed to help fill current information and technology gaps, share strategies and techniques, facilitate collaborative processes through interagency and interdisciplinary coordination, and help practitioners through the process of successfully establishing native plant communities on roadsides. In addition, a summary report, *A Manager's Guide to Roadside Revegetation Using Native Plants* (www.wfl.fha.dot.gov/td/revegetation.htm), provides information for managers and planners on how to support successful processes.

"It's been exciting to watch this collaboration unfold," says Thomas D. Landis, retired USFS national nursery specialist. "Field-level practitioners with a long history of successful roadside native revegetation projects were tapped to develop the approach, integrating expertise from soil science, botany, restoration ecology, engineering, and other disciplines. The result is practical, user-friendly information that will be valuable to anyone concerned with establishing native plants on roadsides."

Breaking New Ground: Innovative Plant Materials and Installation Techniques

The partnership between FHWA and USFS led to the use of new stock types of native plants and methods for installing them along roadsides. To ensure that plants become established in highly disturbed sites, restoration specialists developed innovative "tall pot" stock types. These plants are grown in modified polyvinyl chloride (PVC) pipe containers and have vigorous root systems from 0.6 to 0.9 meter (2 to 3 feet) in length.

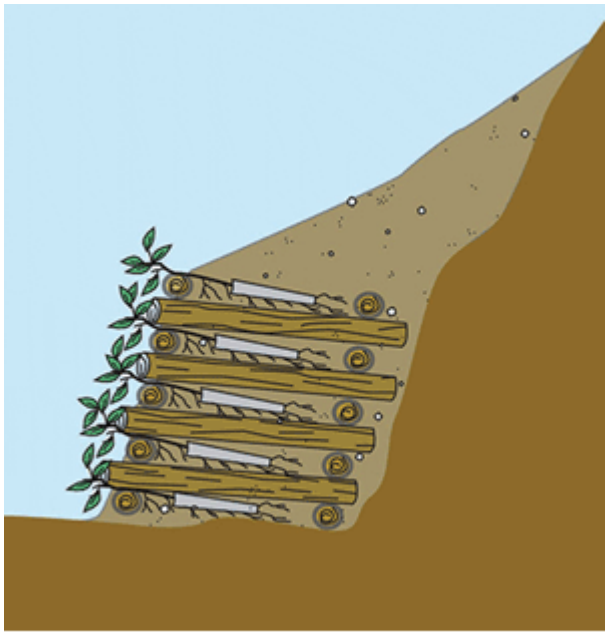
David E. Steinfeld, USFS

"Tall pot" stock types, shown here at a nursery, can help revegetate difficult sites. They are grown in modified PVC pipe containers and develop vigorous root systems.

David E. Steinfeld, USFS

A worker is using a tractor with a sprayer attachment to apply native grass and forb seeds to erosion blankets.

Tall pots can be installed manually during the building of biotechnically engineered structures such as live crib walls. The expandable stinger planter (a mechanized planter probe attached to an excavator boom) can be used to plant tall pots or long cuttings in rocky soils or even through riprap (a layer of rocks used to prevent erosion on a slope). Because the roots are installed so that they penetrate beyond the surface layer, the plants are able to tap into deep moisture sources. They survive better and grow faster, even on harsh sites.



Logan Steinfeld

(Above) As illustrated in this diagram, tall pots incorporated in "live" crib walls, where the root systems can grow deep into the slope, can improve slope stability at roadcuts.

The restoration specialists also developed an operational way to mass produce seeded blankets. Long lengths of erosion fabric are seeded and glued with a tackifier (a resin adhesive). After drying, the blankets are rolled and transported to the project site where they are installed on the outer surface of gabions (baskets or cages filled with earth or rocks), which are backfilled with topsoil. The result is biologically functional and attractive roadsides.

Dan Culley, Dayton Tractor & Crane Company

An expandable stinger attached to an excavator boom, as shown above, can plant nursery stock on steep slopes or in riprap.

David E. Steinfeld, USFS

A researcher stands beside a gabion wall that was revegetated using a seeded erosion blanket.

Diverse Native Plant Communities: The Best Defense Against Weeds

David E. Steinfeld, USFS

Vehicles carry weed seeds along roadways, and the disturbance of road construction creates the ideal habitat for invasive species such as Himalayan blackberry (*Rubus discolor*) and Scotch broom (*Cytisus scoparius*). To make matters worse, the frequent disturbance of mowing creates the ideal habitat for weeds.

In addition, mowing roadsides is expensive, ranging from $5.75 to $230 per cut per acre, according to the January 2006 issue of *Better Roads* magazine. Herbicides are another option for controlling roadside weeds, but contractors charge from $2.37 to $455.16 per acre per application. Besides, many members of the public are not tolerant of large-scale spraying of pesticides in their immediate environment.

David E. Steinfeld, USFS

Native grasses and forbs on a revegetated slope.

Preventing weed establishment is the key to reducing herbicide use. The establishment of healthy native plant communities is one of the best and most cost-effective long-term defenses against invasive and noxious weeds. Prompt sowing and planting of native plants after roadside disturbance creates a physical barrier against weed establishment, while providing a beautiful landscape for travelers to enjoy.

Sally Long, USFS

Himalayan blackberry (Rubus discolor, at left) and Scotch broom (*Cytisus scoparius*, yellow flowered plant at right) are growing along this revegetated roadside.

Building on a Legacy

FHWA is a pioneer in addressing concerns about incorporating native plants in road projects. In 2000, FHWA published a landmark book edited by B. L. Harper-Lore and M. Wilson, *Roadside Use of Native Plants,* that brought the importance of roadside native plants to national attention. Since then, FHWA has been a leader in supporting information resources and research to establish and manage native plants. FHWA helped support development of Integrated Roadside Vegetation Management (IRVM) programs to better manage roadside plants beyond repeated applications of herbicides. In 2005, FHWA helped support the National Academy of Sciences in producing a report titled *Assessing and Managing the Ecological Impacts of Paved Roads*.

Internally, FHWA also has invested in several initiatives to improve integration of ecological concerns with road planning. These programs include the Eco-Logical approach, Context Sensitive Solutions, Exemplary Ecosystem Initiatives, the newly formed Green Highways Partnership, and other cutting-edge initiatives and policies.

Roadside Revegetation builds on these visions by applying the concepts of integrated planning, ecological thinking, context sensitivity, and environmental stewardship to the challenge of establishing native plants on roadsides.

While advances were being made within FHWA and the transportation community, progress also was underway in the science and practice of restoration ecology and native plant propagation. For example, the Society for Ecological Restoration International published guidelines and principles applicable to restoring ecological function to degraded sites.

Plant geneticists at a number of Federal agencies came to a consensus about what truly defines a "native" plant and developed seed collection, transfer, and propagation guidelines to ensure that locally adapted materials are used with optimum results. And in both the public and private sectors, seed and plant producers and installers developed innovative methods to meet unique site conditions.

"Tremendous strides have been made in native plant technologies over the past decade," says USFS National Nursery Specialist Kas Dumroese, editor of the *Native Plants Journal*. "Seed collection, storage, and nursery production capabilities are stronger than ever, and plant quality has never been higher. Innovative stock types and installation methods are literally breaking new ground in terms of where and how native plants can be established. This report [*Road-side Revegetation*] is the first I've seen to apply the knowledge of cutting-edge native plant technologies to the goal of revegetating roadsides."

To achieve the goals expressed in *Roadside Revegetation*, WFLHD Division Engineer Clara Conner says, "We need to have some proven tools to ensure that native plant species are used and established whenever possible as a result of highway and road improvements. We have a responsibility to provide our partners with tools and strategies to provide long-term ecological, economic, and aesthetic gains from establishing native plants on roadsides. This report does this and more. With the process outlined in *Roadside Revegetation*, native vegetation concerns are fully integrated into the larger processes of road design and construction."

Features of the Report

Roadside Revegetation synthesizes an integrated approach that can be used for effective revegetation of roadsides and other disturbed areas associated with road construction, modification, or obliteration. The report will be of interest to public and private sector practitioners, and to transportation and planning professionals, land managers, policymakers, and owners and operators of roads.

After introducing the challenges of roadside revegetation, the report provides a systematic, interdisciplinary guide through the four stages of the revegetation process. The first stage, initiation of a project, involves creating bridges between nonengineers and engineers on terminology and technical concepts to improve communication. It also creates key relationships to navigate the decision process. Essential steps to coordinate revegetation efforts with road planning and construction are detailed in the report, including budgetary and scheduling issues.

The second stage, planning, guides readers through the process of defining project objectives, assessing the site, overcoming limitations, strategizing revegetation procedures, and integrating the revegetation activities with the road project.

The third stage, implementation, offers information on how to make the project unfold in the

field, coordinate contracts, create budgets, and build timelines for caring for the plants as they mature. Implementation guides included in the report provide practical how-to information for cost-effective site treatments and revegetation tactics.

Finally, the monitoring stage describes how to assess the effectiveness of the revegetation project, correct any short-comings, and add to future knowledge. Some sample monitoring protocols are included to help readers select monitoring methods appropriate to their project's goals. Once vegetation has been established, long-term management dovetails with the practices outlined in IRVM programs.

The report can be consulted during any phase of a revegetation project. It is also intended to serve as a foundation for training in revegetation processes.

Goal-Oriented

"Integrating ecological considerations into all phases of road development — from planning to construction, vehicle use, and ongoing maintenance — is a continuing challenge," Lance Gunderson, chairman of the Committee on Ecological Impacts of Road Density, said at the National Research Council of the National Academies. "Practitioners are moving in that direction and are encouraged to continue in that direction. We suggest that integrative assessments done earlier in the planning process are a key solution to this chronic issue."

Taking up this challenge, the report illustrates how to integrate revegetation into decision processes. It includes an outline of typical timelines and indicates the most opportune windows for collaboration as projects develop.

"Whenever disturbance to soils and vegetation are planned, revegetation specialists should be part of the discussion," FHWA's Fekaris says. "Their involvement will not only help minimize the construction footprint but also will help us plan to facilitate faster recovery of natural vegetation in the road corridor after disturbance."

Coordinating timelines so the appropriate people are involved at optimal times is the key to working together to preclude problems and optimize results. "The report walks the reader through a generic process and shows people on both the engineering and revegetation ends when and how they should be collaborating," Fekaris says.

The approach employed in *Roadside Revegetation* recognizes that financial and personnel resources are limited. The approach is feasible technically and economically, and is designed to produce long-term gains for native plants, ecological functions, and soil and water protection.

Scott Riley, USFS

Placing no-spray signs like this one is a method of identifying areas to protect from herbicide application.

Context Sensitive

Given the unique ecological factors at play in each project, the report is not prescriptive but rather provides principles and a step-by-step process for practitioners to take into the field to generate and implement their own locally appropriate, context sensitive revegetation plan. Because the goal is plant communities that are functional in the long term, the approach is intended to facilitate the process of developing locally appropriate steps on a project-by-project basis. Top-down and ground-up information are integrated to meet the specific challenges at hand.

"If anyone is under the impression that there are some simple instructions or a 'one-size-fits-all' plant mix that you can apply under any circumstances and be successful 100 percent of the time — forget it," says USFS's Landis. "There are too many variables."

He continues, "People working to establish native plants on roadsides have to be adaptable. This report is a conceptual exercise, guiding the reader through every phase of a revegetation project. Guidelines are provided with many examples so that even inexperienced personnel can identify unique site characteristics and how to best manage them. The process and tools needed to arrive at appropriate solutions are logical and simple to apply. By following the steps outlined in this report, practitioners will be able to generate the information they need to revegetate any roadside project."

Collaborative

Collaborative approaches are the key to success. A Context Sensitive Solutions approach incorporates principles that embody early and continuous stakeholder involvement, including the use of interdisciplinary teams to facilitate the best solution for each individual project. According to Anderson, "Nature doesn't divide the world into disciplinary categories. Neither can we, if we want to be successful. Subsoil, soil, and living plants are linked together to create slope stability. Therefore, engineers, soil specialists, and plant specialists have to work together to get the results we are looking for."

He continues, "This often requires interagency cooperation, too. If everyone works in isolation, it doesn't cut it. On the other hand, when engineers and revegetation specialists collaborate from day one, the result can be even greater than the sum of the parts."

The report provides timelines and processes for effective collaboration throughout the phases of the project. For example, the early stages of project development include key opportunities for collaboration. When design engineers are discussing disturbances to soils and vegetation, the revegetation specialist can help determine what types of disturbances are feasible to revegetate using native plants or propose alternatives that facilitate revegetation. The revegetation specialist's work in developing the regrowth plan, advising on how to reduce the construction footprint, and protecting native vegetation on the project site will become an integral part of the road construction plan. Then, after the vegetation is reestablished, coordination with the road-owning agency is essential to ensure that maintenance methods are appropriate for native vegetation. For instance, if blanket herbicide application is standard practice along roadsides, the road owner may need to revise its maintenance methods to avoid undoing portions of the revegetation.

A Way Forward

Although limited resources such as funding and time are important factors, establishing desirable vegetation is widely recognized as an essential and cost-effective step to improve the safety, efficiency, and effectiveness of roads and associated management, according to R. L. Berger in a 2005 Transportation Research Board report, *Integrated Roadside Vegetation Management*.

The *Roadside Revegetation* report generated through the collaboration of FHWA's WFLHD and USFS is available on the Web with highly interactive features. The report can be used as a guide during any phase of a project or as a foundation for training.

According to Robert Lale, director of project delivery for WFLHD, "We're solving this problem in a collaborative way, bringing people together from different organizations. Engineering and the natural sciences work together to meet these challenges in a holistic manner, starting even before any disturbance to soil or vegetation takes place."

Lale continues, "This report will help [FHWA's Federal Lands Highway (FLH) Program] to achieve its goals by improving our ultimate end product, the finished road, and [will help FLH] to do a better job meeting our partners' needs. Not only will our partners and the driving public be happier, but the other communities affected by road projects — the plants,

animals, and other forms of life — will be better served, too. We're committed to that."

Amit Armstrong, Ph.D., P.E., is a technology deployment engineer at WFLHD in Vancouver, WA. He has been with FHWA for 5 years, coordinating deployment of new, innovative, emerging, and underutilized technologies in design and construction of roads on Federal lands projects. He has more than 15 years of experience in numerical simulation and visualization of natural systems and is a licensed professional engineer. Armstrong received his doctorate in civil engineering from Texas Tech University.

Scott Riley has been with USFS for 10 years. He has worked in Idaho, Oregon, and Washington as a botanist and currently is a roadside restoration coordinator with the Forest Highways Program in Idaho, Montana, Oregon, and Washington. He holds a bachelor's degree in botany from Boise State University.

David Steinfeld has been with USFS for more than 30 years. He has worked as a field soil scientist and geomorphologist in Oregon and Utah, as an assistant nursery manager and nursery culturist at the J. Herbert Stone Nursery in Oregon, and as a revegetation specialist for Region 6 in Oregon. For the past 8 years, Steinfeld has worked with FHWA on revegetating road construction disturbances with native plants. He holds a bachelor's degree in agriculture (soil science) from Oregon State University.

Kim M. Wilkinson is a writer/editor and consultant specializing in environmental management. She has a bachelor's degree in human/natural ecology and anthropology from Emory University, a master's degree in environmental management from Yale School of Forestry & Environmental Studies, and 10 years of experience with revegetation projects.

For more information, contact Amit Armstrong at 360-619-7668 or amit.armstrong@dot.gov. The reports can be downloaded from www.wfl.fha.dot.gov/td/revegetation.htm.

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