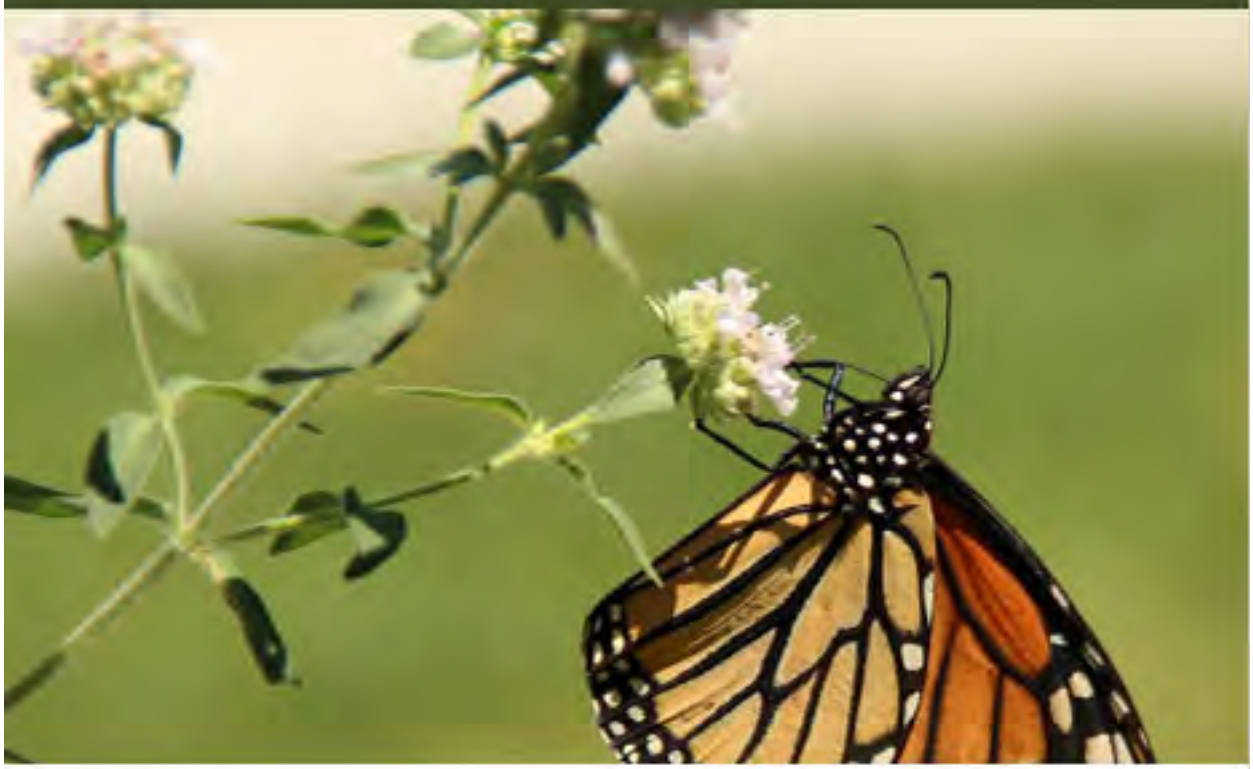
Primer
Roadside Revegetation
An Integrated Approach to Establishing Native Plants and Pollinator Habitat

September 2017

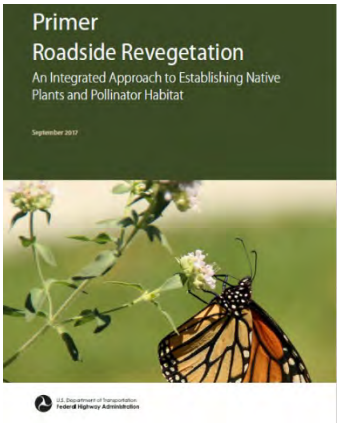


U.S. Department of Transportation
Federal Highway Administration

PRIMER
ROADSIDE REVEGETATION
An Integrated Approach to Establishing Native Plants and Pollinator Habitat

For those who are involved with a revegetation task:
CLIENTS – MANAGERS – DESIGNERS – INSTALLERS – MAINTENANCE STAFF

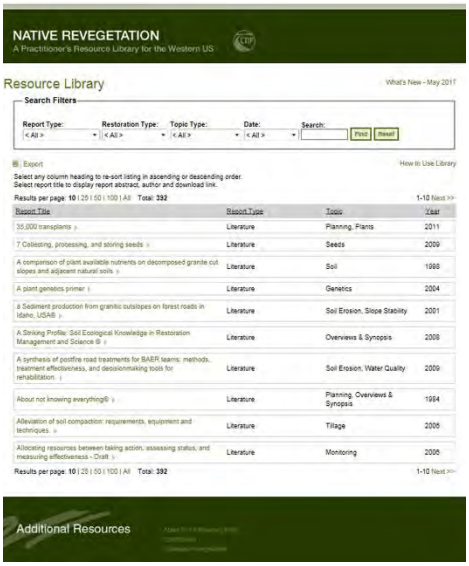
This Primer serves as Quick Start Reference for using three Native Revegetation information resources.



The Technical Report
A comprehensive resource (in hyperlinked PDF and online formats) to support engineers, landscape architects, botanists, revegetation specialists, contractors and landscape subcontractors through current best practices for revegetation of roadsides using native plants with specific methods to modify roadside revegetation and maintenance practices to create habitat for pollinators.

The Ecoregional Revegetation Assistant (ERA) Tool
A user-friendly online tool to identify and generate a digital spreadsheet of the BEST NATIVE PLANTS for revegetation and pollinator habitats in a project ecoregion. The ERA is a pollinator-friendly search-and-print nationwide revegetation mapping and plant database created for designers as a starting point for developing appropriate plant palettes and seed mixes specific to a project site.

Online Native Revegetation Resource Library
The searchable online database includes a comprehensive compilation of current revegetation and pollinator reference materials supporting the project cycle. The library includes scientific literature, reports, specifications, plus national and state-specific information related to revegetation and pollinator habitat creation.



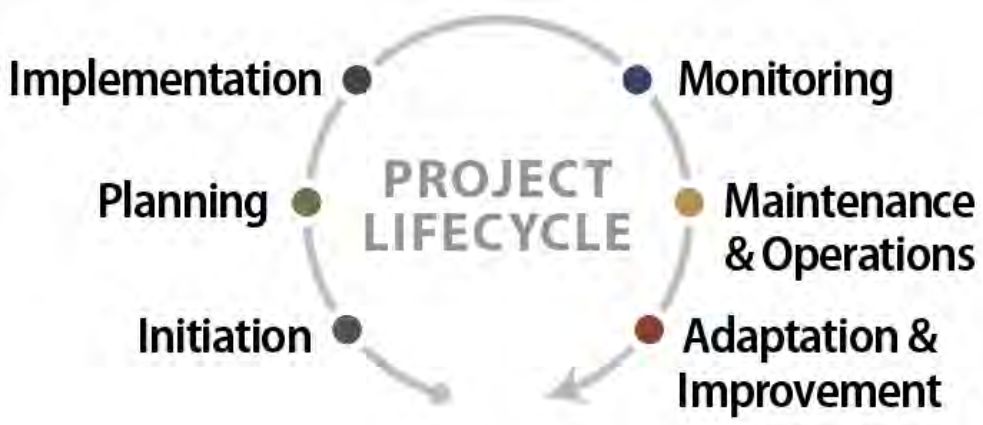
THE TECHNICAL REPORT

An Integrated Approach to Establishing Native Plants and Pollinator Habitat report was written to provide current best practices for planning, designing, and implementing a revegetation project that will also create habitat for pollinators. The report identifies steps and considerations in developing a revegetation project from a variety of perspectives, and presents them in a typical design project order, from planning through implementation and maintenance.

A diverse writing team of experienced botanists, geneticists, pollinator conservation specialists, soil scientists, restoration specialists, civil engineers, transportation engineers, landscape architects, and environmental protection specialists applied their specific experience and knowledge to this report. Technical aspects of the writing were reviewed by Department of Transportation (DOT) civil engineers and landscape architects and revegetation specialists from several state and federal agencies, who also applied their regional perspective on the planning, design, installation, and maintenance processes.

Illustration: David Thorp

The processes used to reestablish the plant communities that were disturbed by the road project are collectively known as “roadside revegetation”.



A Stepwise Approach to Revegetation using the Report

The revegetation process can be simplified into 15-steps distributed across the four phases of a typical revegetation project cycle (Initiation, Planning, Implementation, and Monitoring and Maintenance). Each step is described in detail within the report chapters, which are referenced below.

	Revegetation Process Steps		Further defined here
Initiation Phase	1	Due diligence, plan development	Chapter 2
Planning Phase	2	Objectives and desired future condition	Section 3.2, Section 3.7
	3	Pre-field information	Section 3.3
	4	Revegetation units and reference sites	Section 3.4, Section 3.5
	5	Field information	Section 3.6
	6	Limiting factors to plant establishment and pollinator habitat	Section 3.8, Section 3.9
	7	Site resources	Section 3.10
	8	Maintenance strategy	Section 3.11
	9	Site improvement treatments	Section 3.12
	10	Plant species	Section 3.13
	11	Plant establishment methods	Section 3.14
	12	Revegetation plan	Section 3.15, Chapter 4
Implementation Phase	13	Implementation	Chapter 5
Monitoring and Maintenance Phase	14	Monitoring	Chapter 6
	15	Operations and maintenance	Chapter 7

CHAPTER 1 INTRODUCTION - HIGHLIGHTS

Chapter 1 introduces the reader to the importance of revegetating roadsides with native plants to create pollinator habitat.

Sections

- An Integrated Approach
- The Ecological Context of Roads
- Objectives of this Report
- Scope
- Approach
- How to Navigate through this Report

Why Create a Pollinator-Friendly Habitat on Roadsides?

Our Nation's food supply is at risk.

- Over 75 percent of the world's principle cultivated crops benefit from pollinators, and pollinator-dependent food crops make up a critical component of the human diet.
- Roughly 35 percent of global crop production is dependent on pollinators.

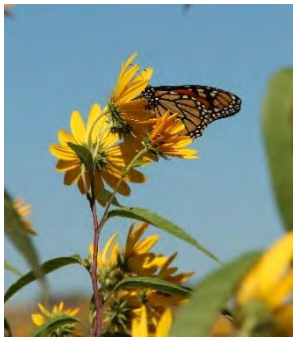
Wild pollinators are in decline.

- Wild pollinators are experiencing rapid decline due to a loss of habitat, the spread of disease, overuse of pesticides, and various other factors.
- Pollinator decline threatens the viability of agricultural productivity and the health of natural ecosystems.

Roadsides can serve as a much-needed habitat for pollinators.

- The 17+ million acres of roadsides in the United States can serve as much needed habitat for pollinators, offering food, breeding, shelter and/or nesting opportunities.
- Roadsides can support a diversity of generalist pollinators, including bumble bees, honey bees, butterflies, and hummingbirds as well as rare or federally-listed species.
- The linear shape and connectivity of roadsides facilitates pollinator movement through landscapes (especially highly-altered landscapes) in search of food or in pursuit of new habitat.

Caterpillars, butterflies, and moth larvae devour plant material
Photo: MJ Hatfield



Mowing can affect food sources
Photo: Jennifer Hopwood

Wasps build their nests from mud
Photo: Betsy Betros

Ground nesting bee nests
Photo: Matthew Shepherd

(CHAPTER 1 CONTINUED)

Best Practices for Revegetation Success

Revegetation that includes pollinator habitat creation is accomplished with greatest success when the following best practices are implemented.

- The roadside revegetation value and contribution to project safety and environmental goals are collaboratively integrated into revegetation planning at the project outset.
- The revegetation plan is developed to address the ecological context of the project site, including the climate, soils, and vegetation.
- The revegetation objectives, design, and expectations are clearly conveyed to the project engineers, contractor, and sub-contractors.
- The revegetation plan is revised with informed input from all stakeholders throughout the design process.
- Monitoring and maintenance activities begin immediately after installation and continue through construction, and beyond to achieve revegetation objectives.

Planning, design and implementation of pollinator habitat during roadside revegetation brings significant short- and long-term value.

Safety - for the motorist and for large wildlife
Slope Stabilization and Erosion Control – for environmental and ecological management
Sustainable Practices – use of native plants, planted in the right place, lowers maintenance
Pollinator Habitat – to preserve, enhance, and create stronger ecosystems
Sustainable Design – for all stakeholders and the environment

Roadsides offer an opportunity for improving ecosystems by establishing and maintaining native plant communities important for pollinators. Photo: Kirk Henderson

CHAPTER 2 INITIATION - HIGHLIGHTS

Chapter 2 instructs the non-engineer how to read road plans, and explains how the understaning of the project can be used to integrate revegetation into road design.

Sections

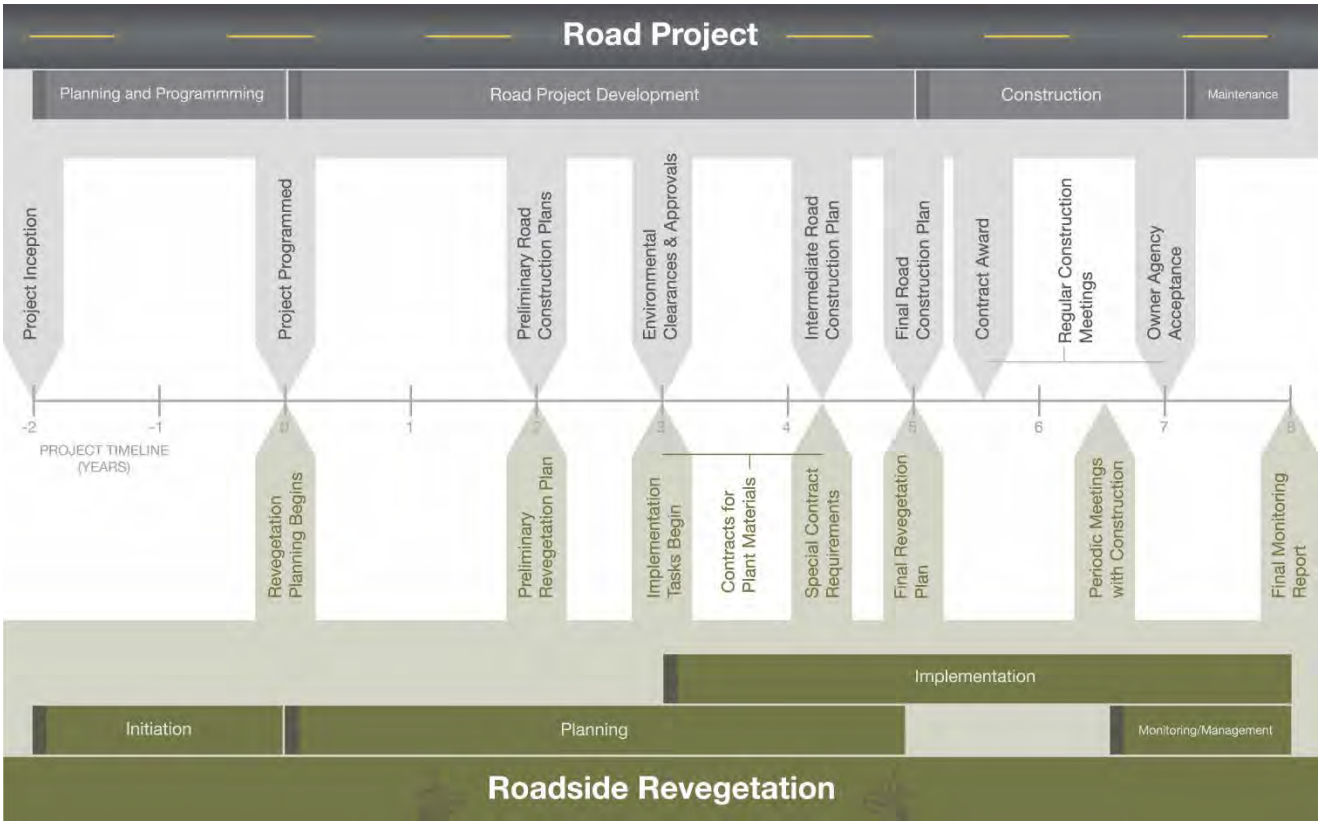
- Preliminary Tasks of Initiation
- The Process of Road Development
- Road Construction Plans
- Interpreting Engineering Views for Revegetation Planning
- Understanding Technical Concepts and Terminology

Diligence early in the project planning process is key

Who are the decision-makers?
Who is the land-owning agency?
Who are the stakeholders?
Who maintains the road and roadsides?
Who will be carrying out the road construction project?
Who is funding the project?
What are the objectives of the project?
What is the timeline?

Integrating the revegetation effort into the road project process is essential.

Coordinating the revegetation effort with the larger processes of road construction is essential. While the timelines and agencies involved will vary, this cross-section figure illustrates some of the key opportunities for communication, integration, and collaboration.



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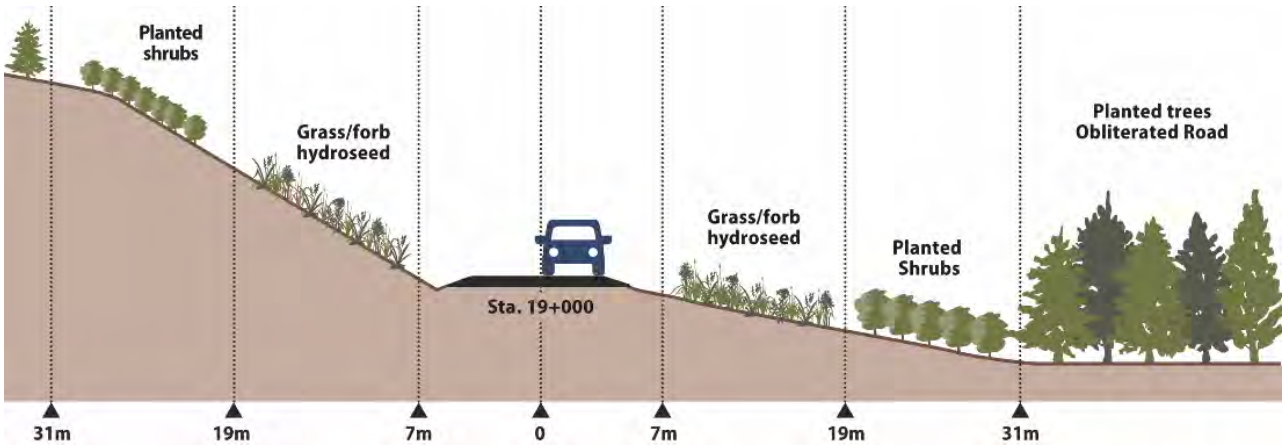
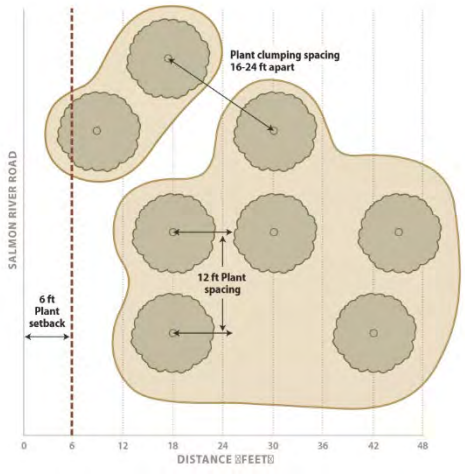
Integrating revegetation into the road project requires knowledge of road design.



The contract specifications integrate the revegetation objectives into road project design.



CHAPTER 3 PLANNING - HIGHLIGHTS

Chapter 3 outlines the key steps important to consider when developing a revegetation plan.

Sections

- Defining Revegetation Objectives
- Gathering Pre-field Information
- Defining Revegetation Units
- Identifying Reference Sites
- Gathering Field Information
- Defining the Desired Future Condition
- Identifying Limiting Factors to Plant Establishment
- Identify Factors That Affect Pollinators
- Inventory of Site Resources
- Developing a Vegetation Management Strategy during Project Design
- Select Site Improvement Treatments
- Selecting Plant Species for Propagation
- Select Plant Establishment Methods
- Develop a Revegetation Plan

What's your objective?
Revegetation
Restoration
Reclamation
Rehabilitation

1. Understanding the site

Determine site ecology - soils, climate, plants, and pollinators – using Internet resources, and ground-check through field visits, where more site-specific soils, pollinator, and plant species may be collected.

2. Developing revegetation objectives

Establish clear objectives and desired future conditions will be used to determine the success of the revegetation effort.

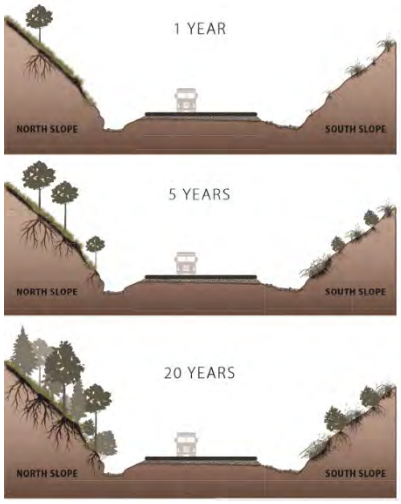
3. Identifying limitations

Identify unique climate and soils that will affect the establishment of vegetation and assess what is limiting creation of optimum pollinator habitat.

4. Creating a vegetation management strategy

Consider what will happen 5, 10, 20 years and beyond after road construction and revegetation is completed.

- How will the road be maintained and will this affect vegetation and pollinators?
- What type of disturbances can be expected and how will these disturbances be handled to maintain native vegetation and pollinator habitats?
- How will unwanted vegetation be controlled?



A vegetation management strategy accounts for how roadsides will evolve over time.

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5. Putting it all together in a plan

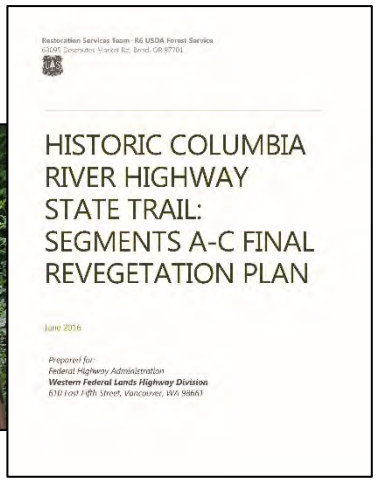
A revegetation plan provides a clear strategy and focus. There is no size or set format for a revegetation plan, but there are elements common to most plans.

- Revegetation unit map and unit description
- limiting factors and site resources
- Site improvement treatments
- Contract specifications
- Species and plant materials table
- Seed sources
- Planting and seeding plans
- Monitoring
- Schedule
- Budget
- Roles and responsibilities
- Maintenance strategy

A well-designed and implemented revegetation plan results in high native plant diversity and floral cover, which are important for pollinator habitat.
Photo: Arizona Department of Transportation

Example of a Revegetation Plan

Chapter 4 includes a complete revegetation plan.



FHWA's Historic Columbia River Highway State Trail project has a representative revegetation plan for the planning stage.
Photo: Matt Horning

CHAPTER 5 IMPLEMENTATION - HIGHLIGHTS

Chapter 5 described detailed practices that are common to most revegetation projects.

Sections
- Soil and Site Treatments
- Obtaining Plant Materials
- Installing Plant Materials
- Post-Installation Care of Plant Materials

Making the Revegetation Plan work on the ground
Clear communication about revegetation plan *intent* is critical when moving from the Planning phase to the Implementation phase. Individuals involved in project planning need to clearly communicate both details of the revegetation plan *and* the contract specifications to the construction and revegetation personnel who will implement the Plan. Continued consultation from planners throughout the implementation phase is beneficial.

- **Implementing soil treatments**
  Most post-construction sites are in poor condition for plant growth and require a set of mitigation measures for optimal revegetation.

  Fertilizers
  Tillage
  Mulches
  Topsoil
  Organic Matter
  Lime Amendments
  Beneficial microorganisms
  Topographic enhancements

A combination of soil treatments, such as tillage and organic matter incorporation, can be performed with an excavator.
Photo: David Steinfeld

- **Obtaining appropriate plant materials**
  Acquiring the plant species from the appropriate seed source and stocktype requires advanced planning and lead time, as grass and forbs seeds are not always available from commercial sources and may need to be grown.


Obtaining seeds for some pollinator plant species may require that they be grown in seed-production fields.
Photo: David Steinfeld

(CHAPTER 5 CONTINUED)

- **Installing plant materials**
  Optimal seeding operations should

  a. incorporate how seeds are uniformly distributed over an area:
     i. where seeds are placed vertically (in, on, or under the soil surface)
     ii. species composition in the seed mix; and
     iii. when seeding takes place

  b. be adapted for the unique climate, soils, and species requirements.

It is important to use the appropriate stocktype and planting method for the roads design as shown in this vegetated MSE wall.
Photo: David Steinfeld

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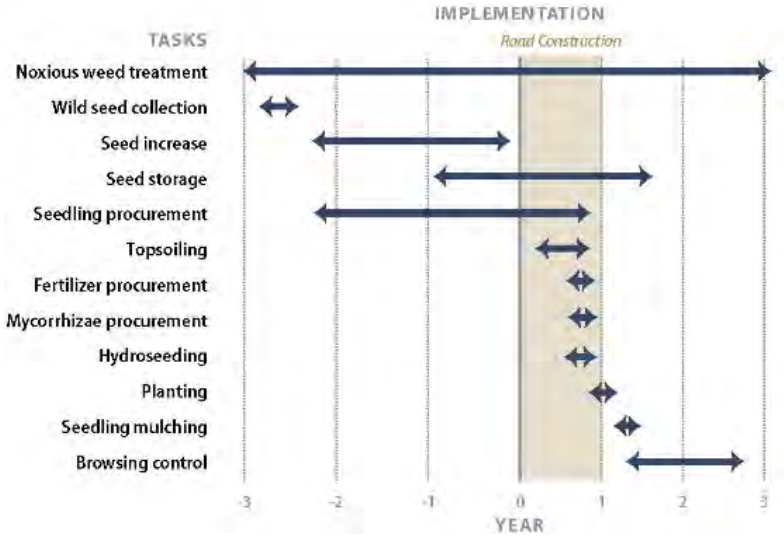
- **Caring for established vegetation**
  Following plant installation, plants may require:
  Protection from animal damage
  Irrigation
  Shade
  Wind protection

Seeding may require a mulch applied over the seed
Photo: David Steinfeld

Check list to successfully implement a revegetation plan

- ✓ Develop contracts
- ✓ Develop an implementation schedule
- ✓ Maintain a materials inventory
- ✓ Review plans and coordinate with project engineer
- ✓ Assist with contract implementation
- ✓ Communicate!



Implementing a revegetation plan often involves a series of tasks conducted over several years

CHAPTER 6 MONITORING - HIGHLIGHTS

Chapter 6 describes a monitoring approach for determining the success of a revegetation project.

Sections:

- Developing a Monitoring Plan
- Plant and Soil Monitoring Procedures
- Pollinator Monitoring Procedures
- Photo Point Monitoring Procedures
- Developing a Monitoring Report

Monitoring answers questions.

Were goals, expectations and targets of the revegetation plan met?
If not, should corrective action be considered?
Are there differences in plant responses between different revegetation treatments?
Should standard revegetation methods be revised based upon monitoring data?
How are pollinators responding to revegetation treatments?
Did revegetation result in a plant community capable of supporting a diverse pollinator population?

Developing a simple Monitoring Plan can minimize costs and increase understanding.

Monitoring projects often fail or are unnecessarily expensive when the purpose, goals, and monitoring methods are not clearly defined. Addressing the following components of a revegetation plan prior to going to the field will make monitoring achievable.

Purpose	Outlining the reason for monitoring, goals, and criteria for success
Intensity	Determining if monitoring will be low, moderate, or high intensity
Who	Identifying needed expertise
What	Determining parameters to monitor (e.g. soil cover, plant species, pollinator species)
When	Determining frequency
Where	Delineating where sampling will occur
How	Selecting the monitoring procedures for data collection and analysis
Logistics	Defining timeline, budget, data management, and equipment

The intensity of data collection is based on the need to know

There are many forms of monitoring, from conducting a site walkthrough and noting how plants are growing (low intensity), and photo-monitoring (moderate intensity), to collecting statistically-based data (high intensity). Monitoring intensity is typically based on the importance of answering a specific monitoring question. While it is not always necessary to collect statistically-designed monitoring data, when it is required, user protocols that will produce the best data for the least amount of effort.

Photo point monitoring is a method of recording landscape changes in vegetation over time and showing the success or failure of a revegetation project. This type of monitoring is relatively simple and very effective in telling the revegetation story.
Photo: David Steinfeld

(CHAPTER 6 CONTINUED)

- **Plant and Soil Monitoring Procedures**
  Following statistically-based monitoring procedures - specific to the revegetation project – will help answer monitoring question. Procedures include:

  Soil Cover
  Species Cover
  Species Presence
  Plant Density
  Plant Attributes (growth characteristics)

- **Pollinator Monitoring Procedures**
  Monitoring procedures for bees, butterflies, and monarch butterflies can be used to assess the quality of revegetated roadsides as pollinator habitat. Procedures include:

  Bee abundance
  Bee and butterfly diversity
  Monarch butterfly reproduction
  Habitat

The Bee Abundance procedure documents the number of honey bees and wild bees in a project area
Photo: Mace Vaughan

The Monarch Butterfly Reproduction and Habitat procedure records the abundance of milkweeds, nectar plants in bloom, and the number of monarch eggs and larvae.
Photo: Sara Morris

Summarizing what has been learned into Monitoring Report

Well-designed monitoring often produces a wealth of information that will determine (i) how well the revegetation plan was implemented; (ii) whether corrective action is needed; and (iii) if there were any new lessons learned. Documenting results in a monitoring report facilitates knowledge sharing with others and serves as a case history of the site for future specialists.

CHAPTER 7 OPERATIONS & MAINTENANCE - HIGHLIGHTS

Chapter 7 outlines a strategy for maintaining long-term native roadside vegetation that supports pollinators. Roadside maintenance is the final step in the revegetation timeline, and occurs when the revegetation responsibilities are transferred to the road maintenance staff for long-term management.

Sections:

- Decision Process for Treating Unwanted Vegetation
- Vegetation Treatment Options
- Prevention
- Protection

Establish a decision-making process for treating unwanted vegetation

An approach to managing unwanted vegetation includes:

- Inventorying roadsides for unwanted vegetation
- Defining the objectives for controlling unwanted vegetation
- Considering all the options for vegetation control
- Establishing a plan for treatments to use and their effects on pollinators and pollinator habitats
- Establishing a threshold point when treatment will occur
- If a treatment is made, monitoring how well it worked to control unwanted vegetation or harmful effects on pollinators
- If it was ineffective or harmful, adjust and improve the treatments

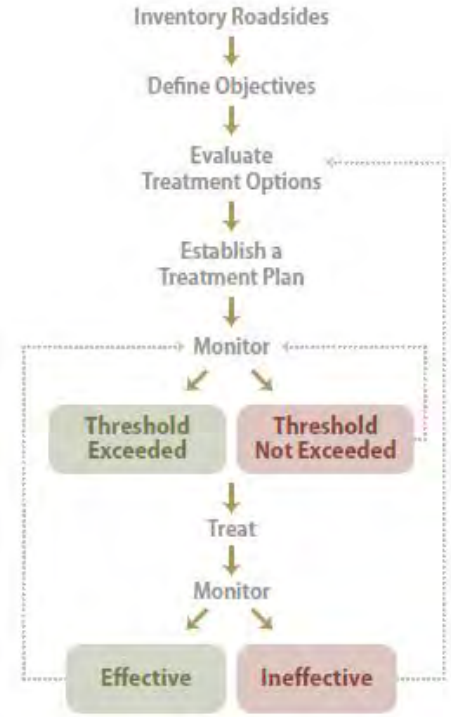


Figure 7-1 | **Components of a decision-making process for treating unwanted vegetation**

Implement treatments for vegetation control that benefit pollinators

There are numerous options for adjusting vegetation control treatments (e.g., mowing, herbicides, manual and mechanical removal, grazing, haying, fire, biological control) to be less harmful to pollinators and improve pollinator habitats.

⇨ **Preventing weed invasion in the first place is a good maintenance strategy**
Maintaining a healthy native plant community following a roadside revegetation projects greatly reduces the possibility for future weed invasion.

Although mowing a clear zone directly adjacent to the pavement poses little harm to pollinators, frequent roadside mowing of the entire roadside can decrease the densities of pollinators.
Photo: Idaho Transportation Department

THE ECOREGIONAL REVEGETATION APPLICATION (ERA)

The Ecoregional Revegetation Application (ERA) is an online tool for identifying native plant species for individual EPA Level III ecoregions, with an emphasis on workhorse species for creating robust pollinator habitat. This comprehensive data set of native-accepted plant species was compiled from a broad range of sources from scientific literature, museum specimens, and experts. Nomenclature and distribution are from the USDA PLANTS database.

Features
Highlight/select US ecoregions
Jump to US states (map auto-zoom)
View sample Workhorse Plants by Ecoregion (pop-up box)
View all plant species by Ecoregion (tabular data search, filter and sort)
Download custom plant species lists (MS Excel format)
Zoom in/out

Data Layers
EPA Level III Ecoregions
Seed Zones

Display Views
Google base map
Workhorse Plant snapshot
Tabular data

www.NativeRevegetation.org/ERA/

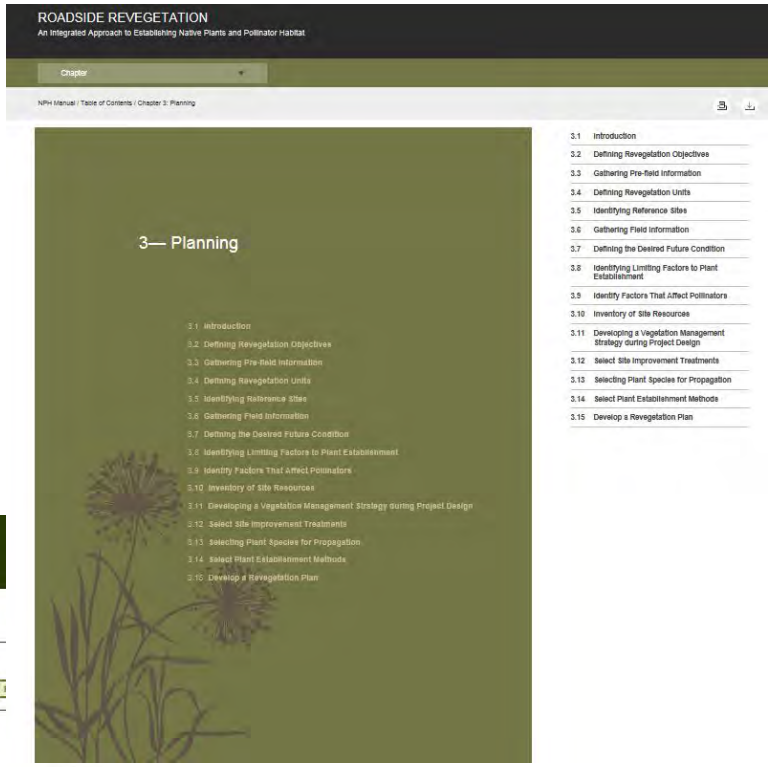
THE RESOURCE LIBRARY AND ROADSIDE REVEGETATION WEBSITES

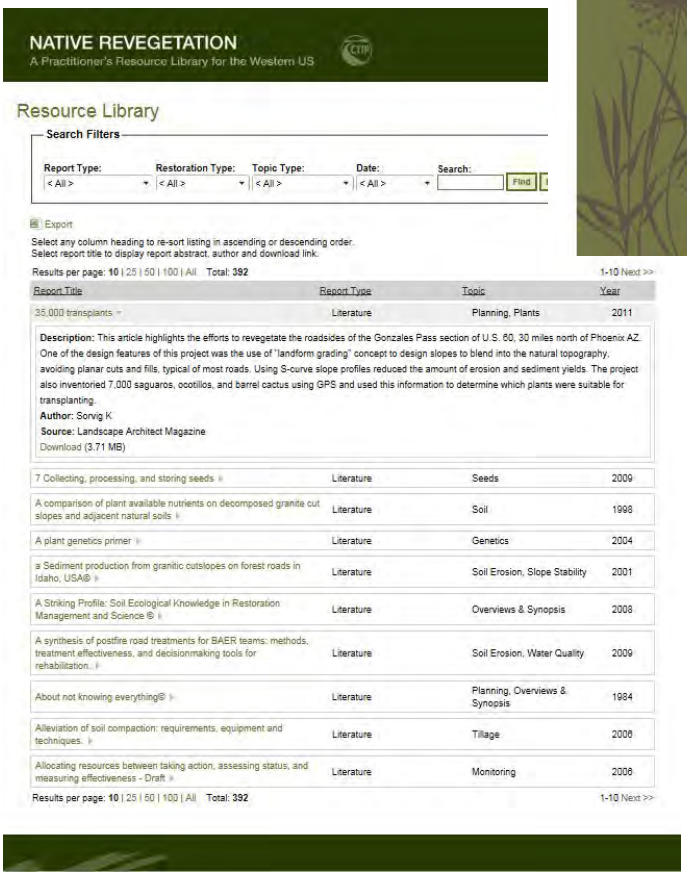
The website *Roadside Revegetation: An Integrated Approach to Establishing Native Plants and Pollinator Habitat* provides the technical report in an online format to facilitate access, data searches and download.

Features

- Interactive Table of Contents
- Cross-linked chapter/section references
- Chapter download (PDF)
- Print-friendly pages
- Multi-device display

- Resource Library Database
  (search, sort, filter over 350 references)





When planned well, successful roadside revegetation programs support transportation goals for safety and efficiency, stabilize slopes, reinforce infrastructure, and create natural beauty and diversity along the roadside that supports pollinators while also improving the road user's experience.