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Final Report

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Oregon Department of Transportation Greenroads Pilot Project:

US 97: Lava Butte – S. Century Drive Section

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ABSTRACT

This project is a Greenroads Pilot Project on the Oregon Department of Transportation (ODOT) project "US 97: Lava Butte – S. Century Drive Section." Greenroads is a sustainability rating system for roadway design and construction (a complete description of Greenroads and its development can be found in TransNow report TNW 2009-13 and/or the Greenroads Manual available at www.greenroads.us). A Greenroads Pilot Project uses the Greenroads Rating System on an existing or planned project to determine (1) how the project scored as it is/was designed and constructed, (2) what the project could have scored had it pursued a Greenroads rating, (3) where best to revise the Greenroads Rating System to make it more usable for project personnel, and (4) determine how the Greenroads Rating System could best be used by the project and owner agency in pursuit of their sustainability goals. Key findings from this Pilot Project are:

- The project met 8 of 11 Project Requirements.
- The project achieved 46 Voluntary Credit and Custom Credit points.
- If the remaining 3 Project Requirements are completed, the project could be certified at the Silver level.
- Four potential custom credits were identified to be developed for ODOT.
- Six credits were identified as needing modification based on project observations.
- Medium to large ODOT projects (above $10 million) have the potential to score well in Greenroads.
- The publicity generated by this Greenroads Pilot Project was substantial.

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DISCLAIMER

EXECUTIVE SUMMARY

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INTRODUCTION

This report reflects the results of the Greenroads Pilot Project for the US 97: Lava Butte – S. Century Drive Section Project for the Oregon Depart of Transportation (ODOT). The results are presented using the Greenroads Progress Scorecard supplemented by a detailed credit-by-credit discussion. Recommendations are also included for applying the Greenroads sustainability performance metric to the project.

Preparation of the Pilot Project involved a review of project documents, interviews with project contacts, and a site visit. For a list of resources used to prepare the Pilot Project Report, refer to the Resources Consulted section.

The following section provides a brief project description. A detailed description of the Greenroads Rating System can be found in Appendix A, including a short list of Greenroads Project Requirements (PR) and Voluntary Credits (VC) for reference. A description of the Pilot Project methodology is provided in Appendix B, and supporting calculations for credits earned are provided in Appendix C.

PROJECT DESCRIPTION

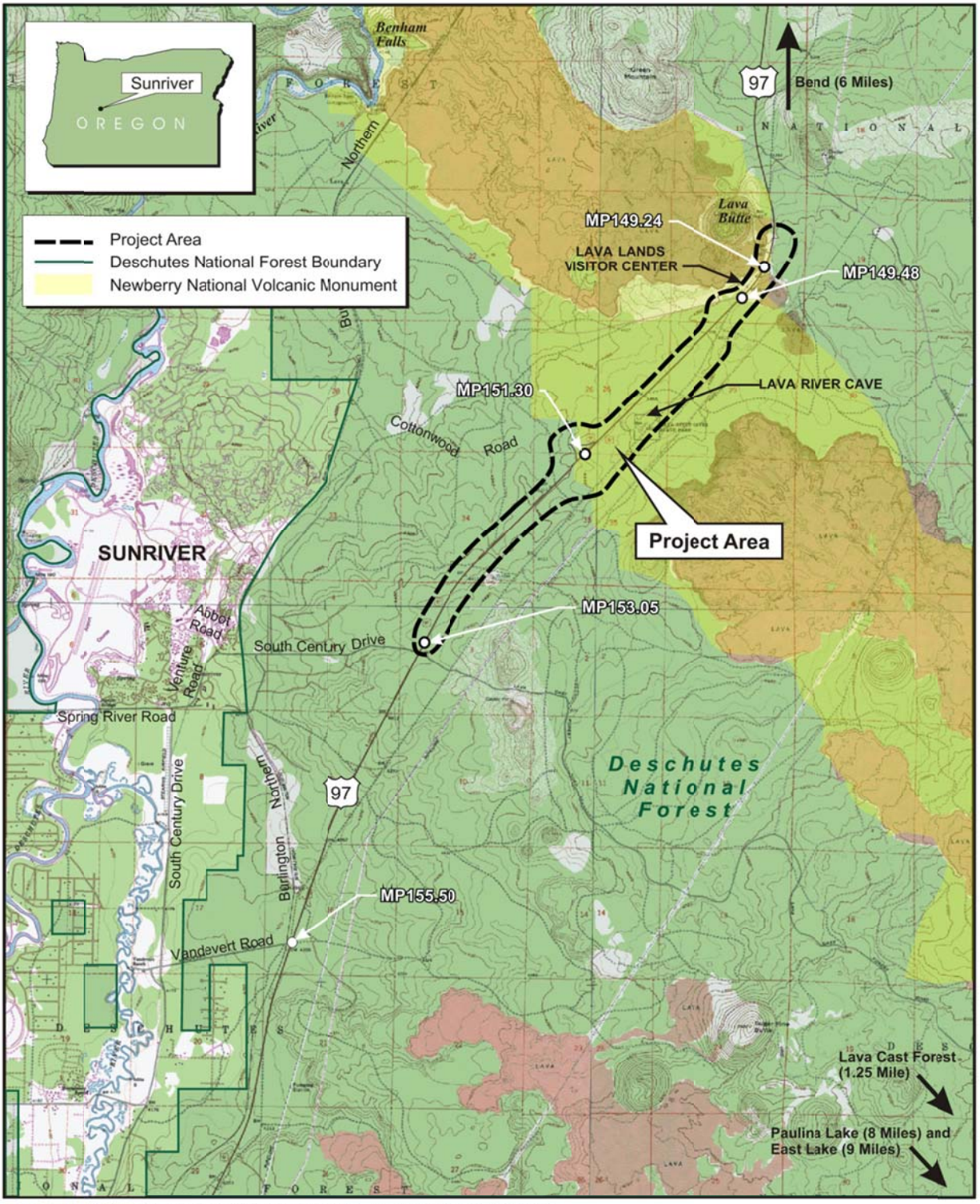
The project was located in central Oregon along US 97, the main north-south corridor on the east side of the Cascade Range. The project site was limited to the section of US 97 between Lava Butte (MP 149.24) and South Century Drive (approximate MP 153.05), and a "buffer area" adjacent to the roadway. The project area resided entirely within the Deschutes National Forest managed by the US Forest Service (USFS), and the north half of the project area was in the Newberry National Volcanic Monument.

The project was needed because the highway and roadway approaches to US 97 in the project area did not meet traffic operations and safety needs. The existing lane configuration of US 97 did not provide for adequate capacity for existing and forecast travel demand, nor were there safe ways to access and exit the highway at several key locations in the project area, including the Lava Lands Visitor Center, Lava River Cave and Cottonwood Road. The project average daily traffic (ADT) volume on US 97 north of Cottonwood Road was 19,200 in 2005, and was forecasted to increase to 32,680 by the year 2028. South of Cottonwood Road, the 2005 ADT was 15,600 in 2005 and was forecasted to increase to 28,640 by year 2028.

The US 97: Lava Butte – S. Century Drive Section Project addressed traffic operations and safety needs by:

- Increasing the capacity of the existing two- and three-lane highway to four lanes (two in each direction)
- Separating northbound and southbound traffic with a forested median of up to an approximate maximum of 108 feet in width
- Reconstructing the Cottonwood Road interchange into a full diamond interchange (on and off ramps in both directions)
- Constructing alternative access to Lava Lands Visitor's Center and Lava River Cave via Crawford Road and Cottonwood Road
- Constructing roadway shoulders that will accommodate bicyclists
- Building two structures and fencing to accommodate wildlife passage under US 97

The three year, $16 million contract was awarded to Knife River Corporation – Northwest. Construction began in June 2009 and is expected to be completed in November 2011.



USGS 7.5 Minute Quadrangle Series Lava Butte, Oregon 1963 (rev. 1981); Benham Falls, Oregon 1963 (rev. 1981); Lava Cast Forest, Oregon 1963 (rev. 1981); Anns Butte, Oregon 1963 (rev. 1981)

N Scale - 1 : 72 000

Figure 1: Location Map

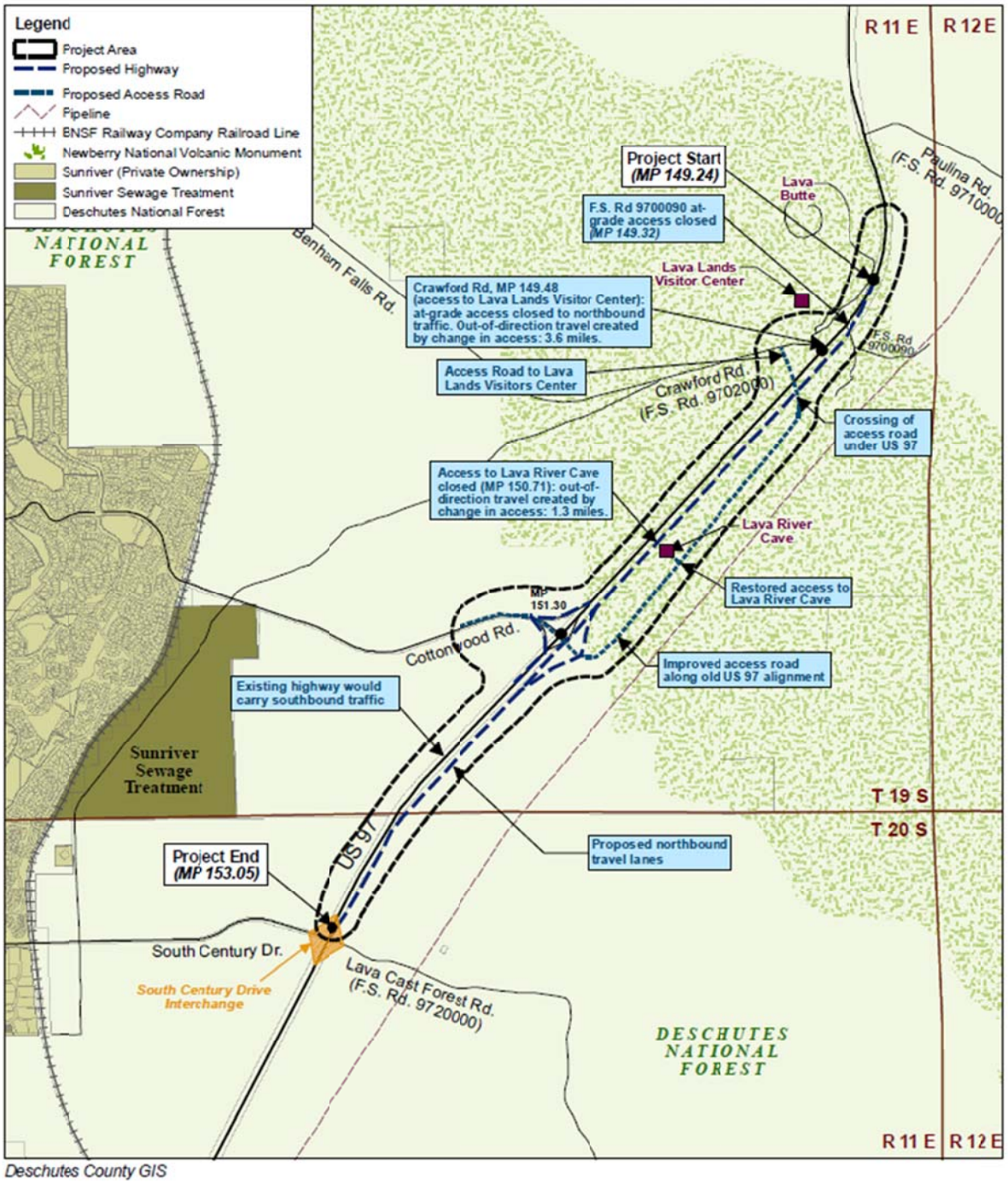


Figure 2: Project Site Map

RESOURCES CONSULTED

The following resources were used to prepare the Pilot Project.

- Berrin, Larry. Director of Conservation Education. Newberry National Volcanic Monument. Interview. July 2010.
- Biological Evaluation: US 97: Lava Butte – S. Century Dive Section. David Evans and Associates, Inc. March 2008.
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- Oregon Standard Specifications for Construction, Volume 1 and 2. Oregon Department of Transportation. 2008.
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- Serpico, Stephanie, P.E. Region 4 Interim Program Manager. Oregon Department of Transportation. Interview. April-July 2010.
- Site Visit. Conducted by Maleena Scarsella. July 15, 2010.
- US 97: Lava Butte – S. Century Dive Section Special Provisions. Oregon Department of Transportation. 2009.
- US 97: Lava Butte – S. Century Dive Section Contract and Bonds. Oregon Department of Transportation. Awarded June 2009.
- US 97: Lava Butte – S. Century Dive Section Plans for Proposed Project. Oregon Department of Transportation. May 2009.
- Water Quality Technical Memorandum: US 97: Lava Butte – S. Century Dive Section. David Evans and Associates, Inc. January 2008.

- Project Website: http://www.oregon.gov/ODOT/HWY/REGION4/US97_Lava_Butte_South_Century_Drive/US97LavaButte_SouthCenturyDrive.shtml

- Web location of photos: http://picasaweb.google.com/102477297602201918671/ODOTCaseStudy2010SR97LavaButte?authkey=Gv1sRgCPTZp6SXxLnXBA&feat=directlink

PILOT PROJECT SUMMARY

Project requirements. The US 97: Lava Butte – S. Century Drive Section Project met 8 of the 11 Greenroads Project Requirements (PR). In order to achieve a level of certification in Greenroads, all 11 Project Requirements must be completed and documented.

Achieved score. Thirty-nine (39) of the 108 possible voluntary credits were earned, and an additional seven (7) points were awarded for four new proposed custom credits, bringing the total number of credits achieved to 46 of 118 possible. This is would qualify the project for a Silver rating if all Project Requirements were met. Points that were achieved are shown in the *A* column in Figure 3.

Potential score. Some of the points not achieved can be (could have been) achieved with relatively low additional effort in the best judgment of the reviewer. *This does not mean that the project team should have achieved those points*. Rather it means that these points might be considered attainable on future projects or might still be attainable on the project reviewed here. These points can typically be earned with additional person-hours dedicated to completing paperwork, forms or calculations. They would likely incur additional costs associated with person-hours expended, but they would likely not raise the project's construction bid price. The potential score for this project is 55, and the corresponding certification level is Gold. Points that can be achieved with relatively low additional effort are shown in the *P* column in Figure 3.

Maximum possible score. The maximum possible score reflects the maximum number of points the project could have earned even if they incur greater initial cost and/or life-cycle cost. This includes all credits excepting those that are not reasonable to include given project scope and intent. Achieving the maximum possible score would likely incur added expense both in person-hours and bid price for initial cost, but many items may still result in a lower life-cycle cost. The maximum potential score for this project is 98, and the corresponding certification level is Evergreen.

Table 1 summarizes the results of this Greenroads Case Study.
Figure 3 is the Greenroads Scorecard for this project.

Table 1: Summary of Pilot Project Results

Project Name	US 97: Lava Butte – S. Century Drive Section
Project Requirements Met (of 11 Total)	8
Voluntary Credit Points Earned (of 108 Total)	39
Custom Credits Identified	7
Comments	PRs Incomplete
Achieved Score	46
Achieved Certification	Silver (if PR's were completed)
Potential Score	55
Potential Certification	Gold
Maximum Possible Score	98

Maximum Possible Certification	Evergreen

Point Totals
A = Achieved by this project
P = Potientially achievable with low additional effort
M = Maximum achievable regardless of cost

Certification Levels
C = Certified (All PR's Met + At Least 32 Points)
S = Silver (All PR's Met + At Least 43 Points)
G = Gold (All PR's Met + At Least 54 Points)
E = Evergreen (All PR's Met + At Least 64 Points)

Credit Scorecard

Project Requirements (PR)		Possible	A	P	M
PR-1	Environmental Review Process	*Req*	X	X	X
PR-2	Lifecycle Cost Analysis	*Req*	X	X	X
PR-3	Lifecycle Inventory	*Req*		X	X
PR-4	Quality Control Plan	*Req*	X	X	X
PR-5	Noise Mitigation Plan	*Req*		X	X
PR-6	Waste Management Plan	*Req*		X	X
PR-7	Pollution Prevention Plan	*Req*	X	X	X
PR-8	Low-Impact Development	*Req*	X	X	X
PR-9	Pavement Management System	*Req*	X	X	X
PR-10	Site Maintenance Plan	*Req*	X	X	X
PR-11	Educational Outreach	*Req*	X	X	X
	Total	**11**	**8**	**11**	**11**

Environment & Water (EW)		Possible	A	P	M
EW-1	Environmental Management System	*2*			2
EW-2	Runoff Flow Control	*1 - 3*			3
EW-3	Runoff Quality	*1 - 3*			3
EW-4	Stormwater Cost Analysis	*1*		1	1
EW-5	Site Vegetation	*1 - 3*	3	3	3
EW-6	Habitat Restoration	*3*			
EW-7	Ecological Connectivity	*1 - 3*	3	3	3
EW-8	Light Pollution	*3*			3
	Total	**21**	**6**	**7**	**18**

Access & Equity (AE)		Possible	A	P	M
AE-1	Safety Audit	*1 - 2*			2
AE-2	Intelligent Transportation Systems	*2 - 5*	3	3	5
AE-3	Context Sensitive Solutions	*5*	5	5	5
AE-4	Traffic Emissions Reduction	*5*	5	5	5
AE-5	Pedestrian Access	*1 - 2*	1	1	2
AE-6	Bicycle Access	*1 - 2*	1	1	2
AE-7	Transit & HOV Access	*1 - 5*			
AE-8	Scenic Views	*2*	2	2	2
AE-9	Cultural Outreach	*1 - 2*		1	2
	Total	**30**	**17**	**18**	**25**

Construction Activities (CA)		Possible	A	P	M
CA-1	Quality Management System	*2*			2
CA-2	Environmental Training	*1*		1	1
CA-3	Site Recycling Plan	*1*		1	1
CA-4	Fossil Fuel Reduction	*1 - 2*			2
CA-5	Equipment Emission Reduction	*1 - 2*			2
CA-6	Paving Emission Reduction	*1*	1	1	1
CA-7	Water Use Tracking	*2*		2	2
CA-8	Contractor Warranty	*3*			3
	Total	**14**	**1**	**5**	**14**

Materials & Resources (MR)		Possible	A	P	M
MR-1	Lifecycle Assessment	*2*			2
MR-2	Pavement Reuse	*4- 5*	4	4	5
MR-3	Earthwork Balance	*1*			
MR-4	Recycled Materials	*1 - 5*	2	5	5
MR-5	Regional Materials	*1 - 5*	4	5	5
MR-6	Energy Efficiency	*5*			
	Total	**23**	**10**	**14**	**17**

Pavement Technologies (PT)		Possible	A	P	M
PT-1	Long-Life Pavement	*5*	5	5	5
PT-2	Permeable Pavement	*3*			
PT-3	Warm Mix Asphalt	*3*		3	3
PT-4	Cool Pavement	*5*			5
PT-5	Quiet Pavement	*2 - 3*			
PT-6	Pavement Performance Tracking	*1*			1
	Total	**20**	**5**	**8**	**14**

Custom Credit (CC)		Possible	A	P	M
CC-1/2	*Custom Credit Title*	*1 - 5*	5	5	5
CC-3/4	*Custom Credit Title*	*1 - 5*	2	2	5
	Total	**10**	**7**	**7**	**10**

All 11 PR Met?		**No**	**Yes**	**Yes**
Greenroads Total	**108**	**46**	**59**	**98**
Certification Level			**G**	**E**

Figure 3 Greenroads Scorecard

CREDIT DISCUSSION BY CATEGORY

This section contains a detailed review of credits awarded and not awarded to the US 97: Lava Butte – S. Century Drive Section. Credit intent will not be discussed, and the reader is referred to Appendix A for these details.

PROJECT REQUIREMENTS (PR)

This project met 8 of 11 Project Requirements. These are outlined in Table 2.

Table 2: Project Requirements Category

Requirements Met		Requirements Not Met	
No.	*Title*	*No.*	*Title*
PR-1	Environmental Review Process*	PR-3	Lifecycle Inventory (LCI)
PR-2	Lifecycle Cost Analysis (LCCA)*	PR-5	Noise Mitigation Plan
PR-4	Quality Control Plan*	PR-6	Waste Management Plan
PR-7	Pollution Prevention Plan*		
PR-8	Low-Impact Development (LID)*		
PR-9	Pavement Maintenance Plan*		
PR-10	Site Maintenance Plan*		
PR-11	Educational Outreach		

*Denotes reference in Standard Specifications, or institutional best practice.

4.1.1

4.1.2 PR-1 Environmental Review Process

4.1.2.1.1.1.1 DETAILS

The Federal Highway Administration (FHWA) evaluated the Environmental Assessment and Revised Environmental Assessment and found them to adequately discuss the need, environmental issues, impacts of the project, and appropriate mitigation measures. The FHWA determined that an environmental impact statement was not required and issued a Findings of No Significant Impact (FONSI) in December 2008.

4.1.2.1.1.1.2 RATIONALE

This project completed the National Environmental Policy Act (NEPA) process because it involved federal funding.

4.1.2.1.1.1.3 COST

The cost of preparing the Environmental Assessment was $625,000.

4.1.2.1.1.1.4 BENEFIT

The Environmental Assessment combined the analysis of the impacts and benefits of the project with input from the public and jurisdictional agencies. It allowed the best course of action to be developed based on its ability to best accomplish the objectives while also carefully focusing on avoidance, minimization of impacts, and mitigation.

4.1.3 PR-2 Lifecycle Cost Analysis (LCCA)

4.1.3.1.1.1.1 DETAILS

A Pavement Lifecycle Cost Analysis was prepared for this project.

4.1.3.1.1.1.2 RATIONALE

According to the ODOT Pavement Design Guide, LCCA for new pavement construction shall be conducted on projects where more than one mile of new roadbed will be constructed, and the results shall be used as a tool to select appropriate pavement design strategies. For rehabilitation of existing pavements, LCCA must be conducted where major rehabilitation is necessary, where options of different life expectancies are being considered, and when considering pavement design strategies with structural life less than the minimum standard of 15 years.

4.1.4 PR-3 Lifecycle Inventory (LCI)

4.1.4.1.1.1.1 DETAILS

This PR was not completed by the project team. As part of this Pilot Project, the reviewer prepared an LCI using the PaLATE tool. Results indicated that over the life of the project, initial construction and maintenance activities (assumed to be a 2-inch mill-and-fill every 15 years) will use approximately 57,300 GJ of energy and produce 4.74 million kg of carbon dioxide equivalents.

4.1.4.1.1.1.2 RATIONALE

An LCI was not prepared by the project team because this is not a standard practice for ODOT projects. However, future ODOT projects could achieve this PR with low additional effort because the PaLATE tool can be used by a member of the project team to prepare an LCI in less than one hour.

4.1.5 PR-4 Quality Control Plan

4.1.5.1.1.1.1 DETAILS

Quality Control (QC) Plans were prepared for design and construction. The project documents specified various forms of quality control for work performed. The construction contractor prepared a QC Plan for materials testing, as required by the contract with ODOT.

4.1.5.1.1.1.2 RATIONALE

As part of ODOT standard practice, the agency required the contractor to prepare a QC Plan that followed established policies, such as those in the ODOT Manual of Field Testing Procedures.

4.1.5.1.1.1.3 COST

The cost for designers to prepare QC Plans was approximately $1,000 to $2,000. The cost for the contractor to prepare the QC Plan for materials was $1,000.

4.1.5.1.1.1.4 BENEFIT

The QC Plans ensured that design and regulatory requirements were met.

4.1.6 PR-5 Noise Mitigation Plan

4.1.6.1.1.1.1 DETAILS

This PR was not completed because a formal Noise Mitigation Plan (NMP) was not prepared according to the requirements in the Greenroads Manual.

4.1.6.1.1.1.2 RATIONALE

ODOT outlined project-specific noise mitigation procedures in the Final Noise Technical Report and incorporated these procedures in the project specifications. For example, wildlife concerns led to restrictions on when drilling and blasting activities could be performed. It is standard practice for ODOT to prepare Noise Technical Reports when deemed necessary and to incorporate all noise mitigation procedures into the project specifications.

The construction contractor (including subcontractors) followed the noise mitigation procedures included in the project documents, but did not prepare a formal NMP. Formal NMP's are not part of the contractor's standard practice, so future ODOT projects can achieve this PR by including an NMP requirement as part of the project contract.

This PR could have been accomplished with minimal additional effort, as writing the requirement into the project contract and writing the NMP require very little time and effort.

4.1.7 PR-6 Waste Management Plan

4.1.7.1.1.1.1 DETAILS

This PR was not completed because a formal Construction and Demolition Waste Management Plan (CWMP) was not prepared according to the requirements in the Greenroads Manual.

4.1.7.1.1.1.2 RATIONALE

Waste management measures were included in the contract documents, as ODOT has numerous policies and procedures for handling waste materials. However this project requirement was not met because the contractor was not required to prepare a formal CWMP. Formal CWMP's are not part of the contractor's standard practice, so future ODOT projects can achieve this PR by including a CWMP requirement as part of the project contract.

This PR could have been accomplished with minimal additional effort, as writing the requirement into the project contract and writing the CWMP would have required very little time and effort.

4.1.8 PR-7 Pollution Prevention Plan

4.1.8.1.1.1.1 DETAILS

This PR was completed. The Temporary Erosion and Sedimentation Control procedures were included in the project documents.

4.1.8.1.1.1.2 RATIONALE

Temporary Erosion and Sedimentation Control procedures are required for all ODOT projects that are not deemed exempt.

4.1.8.1.1.1.3 COST

The cost of producing the Temporary Erosion and Sedimentation Control was $515.

4.1.8.1.1.1.4 BENEFIT

The Temporary Erosion and Sedimentation Control procedures were used to minimize the effects of pollution associated with the construction of this project.

4.1.9 PR-8 Low-Impact Development (LID)

4.1.9.1.1.1.1 DETAILS

This PR was completed. Although a LID hydrologic evaluation was not provided by the project team, it is reasonable to assume that an evaluation was performed because ODOT policies encourage the use of low-impact development (LID).

4.1.9.1.1.1.2 RATIONALE

This PR was achieved because ODOT voluntarily emphasizes the value of LID for its projects. More information about ODOT's LID practices, including case studies and cost information, can be found at http://www.oeconline.org/our-work/rivers/stormwater/low-impact-development/lid-practices.

4.1.9.1.1.1.3 COST

The cost of achieving this PR could not be extracted.

4.1.9.1.1.1.4 BENEFIT

According to the Fact Sheet about LID for Oregon, LID provides the following benefits:

For the environment

- Protects water quality
- Maintains natural stream flows in rivers, creeks and wetlands
- Provides and protects fish and wildlife habitat
- Improves air quality
- Maintains soil quality

For developers

- More attractive, sustainable neighborhoods that sell faster and for a premium
- Reduces stormwater utility fees
- Reduces the cost of clearing, excavation, compaction, erosion control, and infrastructure construction
- Can provide more buildable lots by distributing stormwater management around the site in small facilities instead of building a single large detention pond

For communities

- Helps prevent flooding and reduces the cost of associated damage
- Helps maintain clean drinking water supplies
- Can lower cost of streets, curbs, gutters and other infrastructure
- Increases the aesthetics of neighborhoods
- Reduces long-term maintenance costs

For agencies

- Helps meet regulatory requirements, including the Federal Clean Water Act (MS4 permits and TMDL plans), Endangered Species Act, Safe Drinking Water Act, and state land use planning goals 5 and 6

4.1.10 PR-9 Pavement Management Program

4.1.10.1.1.1.1 DETAILS

The ODOT Construction Section operates a Pavement Management System (PMS) through its Pavement Services Unit. Pavement Management Reports are prepared every two years and made available on the ODOT website (http://www.oregon.gov/ODOT/HWY/CONSTRUCTION/pavement_management_sys.shtml). The website also provides public access to Pavement Condition and Remaining Service Life Spreadsheets, which record when preservation efforts occur.

4.1.10.1.1.1.2 RATIONALE

ODOT has chosen to use the Pavement Management System for all mainline state highways under its jurisdiction.

4.1.10.1.1.1.3 COST

Based on the budget for PMS and the number of lane miles in the system, the system costs approximately $25 per lane mile per year to operate. Therefore after construction, PMS for this project area will cost approximately $400 per year.

4.1.10.1.1.1.4 BENEFIT

The Pavement Management System provides decision makers with information necessary to find cost effective strategies for providing, evaluating, and maintaining pavements in a serviceable condition.

4.1.11 PR-10 Site Maintenance Plan

4.1.11.1.1.1.1 DETAILS

Maintenance responsibility for this site is shared among the Forest Service, Deschutes County, Oregon Department of Fish and Wildlife, and ODOT according to the Intergovernmental Agreement Maintenance Agreement. The Agreement specifies the areas of the project that each agency is responsible for and designates a primary contact for maintenance.

4.1.11.1.1.1.2 RATIONALE

Preparing Intergovernmental Agreement Maintenance Agreements and planning the maintenance of road construction projects is standard practice for ODOT.

4.1.11.1.1.1.3 COST

Cost information for this PR could not be extracted because, for the most part, maintenance will be performed as needed. The cost will be quite variable from year to year and will depend heavily on the weather conditions each season.

4.1.11.1.1.1.4 BENEFIT

This project will benefit from the shared responsibility among the Forest Service, Deshutes County, Oregon Department of Fish and Wildlife, and ODOT because maintenance will be performed by the agency that has the most experience with each type of work. Each agency will also benefit from the agreement because it will share the cost of maintenance with the other agencies.

4.1.12 PR-11 Educational Outreach

4.1.12.1.1.1.1 DETAILS

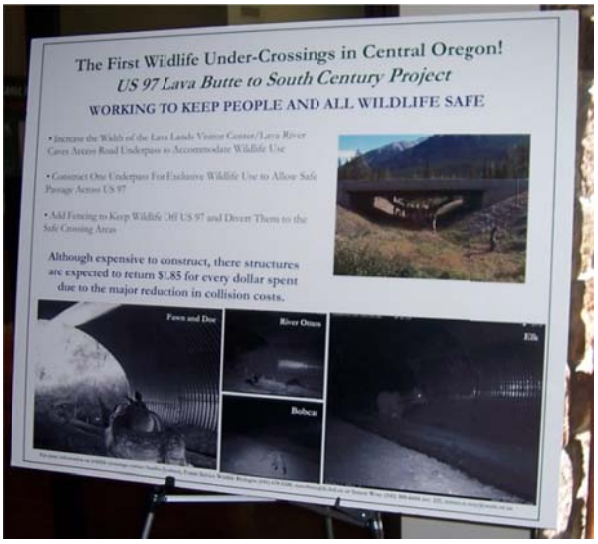
The project involved at least the following three educational elements:

1. A point-of-interest kiosk at the Lava Lands Visitor Center displays information about the project.

2. The informational project website allows the public to submit feedback and comments. The website can be accessed at http://www.oregon.gov/ODOT/HWY/REGION4/US97_Lava_Butte_South_Century_Drive/US97LavaButte_SouthCenturyDrive.shtml.

3. The project is documented with this Greenroads Pilot Project.

4.1.12.1.1.1.2 RATIONALE



ODOT offered the point-of-interest kiosk and the website voluntarily because the project team believed that it was important for the public to be aware of this project. The project offered a unique educational opportunity because it was located in the Newberry National Volcanic Monument and included the Lava Lands Visitor Center, where thousands of people come each year to learn more about the surrounding area. ODOT wanted to take advantage of this opportunity to teach people about the impact roadways have on the environment and how the impact can be reduced with features such as the wildlife under crossings. After the project is completed, the Forest Service plans to install a permanent exhibit at the visitor center that will include photographs, video footage, and educational material about the wildlife under crossings.

ODOT also voluntarily pursued education outreach by using this project for a Greenroads Pilot Project. This decision reflected ODOT's desire to further its sustainability goals and learn about how it can evaluate the sustainable features of its roadway projects.

in the

4.1.12.1.1.1.3 COST

The cost of providing a point-of-interest kiosk and an informational website was approximately $20,000.

The cost of having this Pilot Project Report prepared was approximately $25,000. This cost was not associated with the project budget, however, as the funds came from the ODOT research budget. This cost must also include a caveat because it is an approximate estimate of the cost for the University of Washington research team to review project documents, perform a site visit, and prepare this report. If this project had applied for certification, the project team would have collected the documentation and performed the necessary calculations. This would have shifted the cost burden from the University of Washington to the project team, but the additional cost would be expected to be much less than $25,000.

4.1.12.1.1.1.4 BENEFIT

The public benefitted from opportunities to learn more about the project through the point-of-interest kiosk and an informational website. People learned about the environmental impacts of the project and stayed informed about the progress of construction activities.

ODOT also benefitted from the educational outreach features because it used the kiosk and website to form a relationship with the public, to receive public input, and to generate positive publicity for the project.

ENVIRONMENT & WATER (EW)

This project earned 6 of the 21 points available in this category. The points were awarded for using non-invasive, native plants that do not require irrigation after the plant establishment period, and for implementing two wildlife crossings. The credits earned in this category are outlined in Table 3.

Table 3: Environment & Water Voluntary Credit Category

Credits Earned		Credits Not Earned	
No.	*Title*	*No.*	*Title*
EW-5	Site Vegetation	EW-1	Environmental Management System
EW-7	Ecological Connectivity	EW-2	Runoff Quantity
		EW-3	Runoff Quality
		EW-4	Stormwater Cost Analysis
		EW-6	Habitat Restoration
		EW-8	Light Pollution

4.1.13 EW-1 Environmental Management System

4.1.13.1.1.1.1 DETAILS

This credit was not earned.

4.1.13.1.1.1.2 RATIONALE

The general contractor, Knife River Corporation, does not have a formal environmental management process. The project superintendent remarked that while environmental concerns were a focus of this project, Knife River does not have a company-wide environmental policy.

This project could have achieved this credit, but it would have depended on a significant effort from the general contractor to implement a company-wide environmental management system.

4.1.14 EW-2 Runoff Flow Control

4.1.14.1.1.1.1 DETAILS

This credit was not earned. Prior to construction, the mean storm flow was 0.68 ft^3/sec and the mean storm volume was 59,198 ft^3. After construction, the mean storm flow was 1.40 ft^3/sec and the mean storm volume was 121,898 ft^3. Predevelopment values were therefore 49% of post-construction values. This percentage must be at least 80% to earn points for EW-2 Runoff Flow Control according to the Greenroads Manual.

4.1.14.1.1.1.2 RATIONALE

The hydraulic analysis for this project determined that runoff flow control facilities were not necessary according to ODOT stormwater control policies. The soil in the project area is a very porous volcanic material, which drains readily.

The project could have achieved this credit, but it would have required a significant increase in project cost to design and construct runoff flow control facilities.

4.1.15 EW-3 Runoff Quality

4.1.15.1.1.1.1 DETAILS

This credit was not earned.

4.1.15.1.1.1.2 RATIONALE

As stated above, the hydraulic analysis determined that runoff flow control facilities were not necessary for this project. Therefore, this project did not include runoff flow control facilities to treat stormwater.

The project could have achieved this credit, but it would have required a significant increase in project cost to design and construct runoff flow control facilities.

4.1.16 EW-4 Stormwater Cost Analysis

4.1.16.1.1.1.1 DETAILS

This credit was not earned.

4.1.16.1.1.1.2 RATIONALE

There was no need to prepare a Stormwater Cost Analysis for this project because, as stated above, the hydraulic analysis determined that no runoff flow control facilities were necessary. ODOT's standard practice is to prepare a Stormwater Cost Analysis only when the location of the project gives rise to multiple stormwater utility options.

The project could have achieved this credit with low additional effort because this VC does not require the use of runoff flow control facilities, but rather a comparison of potential costs.

4.1.17 EW-5 Site Vegetation

4.1.17.1.1.1.1 DETAILS

The project was awarded three points for using non-invasive plant species only, not using irrigation after the plant establishment period, and using native plant species only.

4.1.17.1.1.1.2 RATIONALE

Plant species were chosen to meet USDA Forest Service guidelines on the avoidance of noxious weed species and the use of native species.

4.1.17.1.1.1.3 COST

The Forest Service developed a revegetation plan, collected and purchased plants, provided labor and installation to implement the revegation plan, and agreed to perform monitoring for one, three and five years. For these services, ODOT paid the Forest Service approximately $500,000.

4.1.17.1.1.1.4 BENEFIT

In addition to meeting Forest Service guidelines and avoiding causing future noxious weed issues, the vegetation on this project promoted aesthetic and wildlife connectivity goals. The use of native plant species was in line with aesthetic goals because they helped preserve the natural look of the national monument. Vegetation was planted under the underpasses to provide a more natural feeling for large animals and hiding cover for smaller animals using the structure. According to Sandra Jacobson, a wildlife biologist for the Forest Service, the vegetation plan also represents a step towards learning how to create "ecosystem process" passages that function to connect processes as well as wildlife movement.

4.1.18 EW-6 Habitat Restoration

4.1.18.1.1.1.1 DETAILS

This credit was not earned.

4.1.18.1.1.1.2

4.1.18.1.1.1.3 RATIONALE

This credit requires the Index of Biological Integrity (IBI), which characterizes the biological functionality of a water body. The IBI could not be determined for this project because the area does not include a water body.

The offsite habitat improvement goal for this VC was addressed because ODOT and the Forest Service worked together to treat 28.33 miles of unwanted roads in adjacent areas of the Deschutes National Forest. Of this, 14.95

miles were closed, decompacted, and revegetated and 13.38 miles were closed and allowed to revegetate naturally. These roads were identified prior to this project by the Deschutes National Forest as being in excess of travel needs, and the this project provided a good opportunity to close them. This represents an area of roughly 55 acres restored, compared to roughly 25 acres of newly disturbed surface for this project. This restoration activity does not, however, meet all of the requirements of the Habitat Restoration Credit.

Future versions of the Greenroads Manual should consider addressing this problem by allowing all projects to achieve this credit regardless of whether the area includes a water body.

4.1.18.1.1.1.4 COST

The estimated cost of closing the unwanted roads is $78,700.

4.1.18.1.1.1.5 BENEFIT

By closing the unwanted roads in the Deschutes National Forest, the agencies hope to mitigate the amount of habitat loss caused by this project. The increased wildlife habitat area is also expected to increase the effectiveness of the wildlife underpasses.

4.1.19 EW-7 Ecological Connectivity

4.1.19.1.1.1.1 DETAILS

Three points were awarded for this credit. This project involved installation of two sets of new wildlife crossing structures and protective fencing. The wildlife crossing structures were primarily designed for deer, but they will also likely provide connectivity for species such as coyote, bobcat, cougar, elk, and smaller animals such as badger, fox, wolverine, marten, and others.

Figure 5 Ecological Connectivity
This under crossing (shown under construction) was designed for the exclusive use of wildlife.

4.1.19.1.1.1.2 RATIONALE

In accordance with the USDA Forest Service's mandate to maintain viability of wildlife species, the wildlife crossing structure and fencing were chosen to provide a mitigation measure to help restore migratory mule deer herd

access to winter range and also reduce vehicle collisions. Additionally, because the forest service is mandated to manage all species, the structures were designed to be effective for all wildlife in the area.

4.1.19.1.1.1.3 COST

Each wildlife crossing consisted of fencing and two structures, one under each side of the highway. The southern crossing was designed exclusively for use by wildlife. Construction costs for this pair of structures totaled approximately $1.1 million.

The northern underpass was originally designed to provide safe pedestrian, bicycle, and vehicle access to the Lava Lands Visitor Center during the summer. ODOT and the Forest Service later decided to modify the design to provide another purpose, to allow wildlife to cross the highway safely and undisturbed when there are no people present (which is all day during winter months when the Visitor Center is close). The bridge structures were designed larger to allow more space for animals to walk through the unpaved area, and more wildlife fences were added to guide animals to the under crossing. Therefore, the total construction costs for the structures cannot be attributed to ecological connectivity alone. The total cost of the fencing and structures is approximately $2.5 million. The project designers estimated that 20% of this cost, or $500,000, can be considered the additional cost of adding the wildlife crossing function to the feature.

In addition, ODOT is responsible for the cost of operating and maintaining of the wildlife fence, up to $2,000 in any state fiscal year.

4.1.19.1.1.1.4 BENEFIT

The land management agencies are hopeful that the crossing structures and fencing will enable the remaining migratory mule deer to restore their traditional access to winter range, although the numbers have been dramatically reduced from wildlife/vehicle collisions and other factors. The structures will also enable movement of all other animals in the area to cross the highway safely. Additionally, any animals using the structures will not be on the highway, therefore the risk of animal/vehicle collisions will be reduced.

ODOT conducted a cost-benefit analysis of the structures and found that $1.85 of benefit to taxpayers would be achieved for every $1.00 spent on the mitigation. This considered property damage alone and did not consider the risk of human injury or fatality, nor did it consider the value of wildlife. Thus, the benefit is actually a very conservative estimate.

4.1.20 EW-8 Light Pollution

4.1.20.1.1.1.1 DETAILS

This credit was not earned.

4.1.20.1.1.1.2 RATIONALE

No points were awarded for this credit because no Dark-Sky compliant lamps were used. The project site did not involve existing lighting, not were new lighting fixtures installed. No lighting was used during construction. The decision to avoid using illumination was based on protection of the natural habitat. If the project would have included a lighting system, Dark-Sky compliant lamps would have been used as part of ODOT standard practice for a forest setting.

This indicates that use of no lighting may address the intent of the Light Pollution Credit in the context of a rural road project. Future revisions of the Greenroads Manual should consider this modification.

4.1.20.1.1.1.3

4.1.20.1.1.1.4

4.1.20.1.1.1.5 COST

Based on the preliminary lighting design that was ultimately omitted, the decision not to use lighting reduced the project budget by $200,000.

4.1.20.1.1.1.6 BENEFIT

The choice to not use lighting reduced the project budget and helped protect the natural habit for wildlife.

ACCESS & EQUITY (AE)

This project earned 17 of the 30 points available in this category. Many of these points resulted from using a Context Sensitive Solutions approach to project planning. This approach allowed the project team to address the needs of various stakeholders, including pedestrians and bicyclists. The credits are outlined in Table 4.

Table 4: Access & Equity Voluntary Credit Category

Credits Earned		Credits Not Earned	
No.	*Title*	*No.*	*Title*
AE-2	Intelligent Transportation Systems	AE-1	Safety Audit
AE-3	Context Sensitive Solutions	AE-7	Transit and HOV Access
AE-4	Traffic Emissions Reduction	AE-9	Cultural Outreach
AE-5	Pedestrian Access		
AE-6	Bicycle Access		
AE-8	Scenic Views		

4.1.21 AE-1 Safety Audit

4.1.21.1.1.1.1 DETAILS

This credit was not earned.

4.1.21.1.1.1.2 RATIONALE

ODOT recently began conducting safety audits on a voluntary basis for select projects. Therefore this project could potentially earn this credit, but only with a significant amount of additional effort from ODOT personnel.

4.1.22 AE-2 Intelligent Transportation Systems

4.1.22.1.1.1.1 DETAILS

This project earned three points for including intelligent transportation system (ITS) applications from three separate categories:

1. Road Weather Management: ODOT's Road Weather Information Systems (RWIS) use sensors at weather stations to monitor weather conditions. The information is used for making winter road maintenance decisions and is shared with the public through TripCheck, Oregon's website for road conditions.

2. Information Dissemination: Changeable message signs were used during construction. Highway Advisory Radio (HAR) disseminates information about roadway conditions via AM radio frequencies to motorists en-route on Oregon's highways.

3. Traveler Information: TripCheck (http://www.tripcheck.com), TripCheck Mobile, and 511 make information available to travelers before their trip and en-route.

4.1.22.1.1.1.2 RATIONALE

ODOT voluntarily provides RWIS, TripCheck, HAR, and 511 as statewide ITS programs.

4.1.22.1.1.1.3 COST

The cost of providing changeable message signs during construction was $8,000. Cost information for the rest of this credit could not be extracted because these programs are statewide and the cost to maintain and run the program varies with the type of roadway and weather conditions.

4.1.22.1.1.1.4 BENEFIT

ODOT makes use of ITS to address transportation problems and enhance the movement of people and goods.

4.1.23 AE-3 Context Sensitive Solutions

4.1.23.1.1.1.1 DETAILS

Context Sensitive Design was effectively achieved as part of the Environmental Assessment. Five points were awarded.

4.1.23.1.1.1.2 RATIONALE

The Environmental Assessment was prepared as part of the National Environmental Policy Act (NEPA) process because the project involved federal funding. From the Forest Service's perspective, Context Sensitive Solution principles are similar to the USDA Forest Service's interdisciplinary process and public involvement process, so it was standard operating procedure.

4.1.23.1.1.1.3 COST

The cost of creating a Context Sensitive Design could not be extracted because the focus on interdisciplinary work and public involvement was part of the overall planning process.

4.1.23.1.1.1.4 BENEFIT

The Context Sensitive Solutions approach led to a project design that addressed the needs of multiple parties, including ODOT, the Forest Service, Deschutes County, the Department of Fish and Wildlife, and the public. The design also incorporated the need for multiple modes of transportation, as described in AE-4 and AE-5 below.

4.1.24 AE-4 Traffic Emissions Reduction

4.1.24.1.1.1.1 DETAILS

Five points were awarded for this credit. Oregon House Bill 3543 establishes the state's policies for reducing greenhouse (GHG) gas emissions to specified goals, which include achieving GHG emission reduction of 10% below 1990 levels by 2020. The policies apply to the transportation sector and require the Oregon Global Warming Commission to include a member with significant experience in transportation. Oregon's State Standard Exceedance Levels mandate Clean Air Act criteria pollutants to be equal to or less than the current Environmental Protection Agency's (EPA) design values.

4.1.24.1.1.1.2 RATIONALE

Oregon House Bill 3543 reflects Oregon Governor Kulongoski's (and presumably his constituents') concern with reducing greenhouse gas emissions.

4.1.24.1.1.1.3 COST

The cost of achieving this credit could not be extracted because it depended on establishing a state policy, which was not directly linked to project costs.

4.1.25 AE-5 Pedestrian Access

4.1.25.1.1.1.1 DETAILS

One point was awarded for providing pedestrian access via the under crossing for the Lava Lands Visitor Center. This improvement did not qualify for two points because the under crossing did not include a sidewalk that is separated from the roadway.

4.1.25.1.1.1.2

4.1.25.1.1.1.3 RATIONALE

The under crossing addressed the need for a safer means for pedestrians to cross the highway to access the Lava Lands Visitor Center. It accommodates vehicles, non-motorists, and wildlife when people are not present.

In addition, the new shoulders constructed in the project area were designed wide enough to accommodate pedestrians, particularly along Cottonwood Road and along the new access road. Although this does not fit the requirements of AE-5 Pedestrian Access, this indicates that extra wide shoulders may address the intent of the credit in the context of a rural road project. Future revisions of the Greenroads manual should consider this modification.

4.1.25.1.1.1.4 COST

The construction cost for the undercrossing (which includes three overcrossing bridge structures but not the wildlife fencing) was approximately $2.09 million. It is important to note that this cost cannot be attributed to pedestrian access only, as the undercrossing also provides bicycle and wildlife access.

4.1.25.1.1.1.5 BENEFIT

This under crossing provided many benefits. It addressed one of the identified goals of the project, which was to provide safer pedestrian access to the Lava Lands Visitor Center. In addition, it provided bicycle access and wildlife connectivity. More information about these benefits can be found in the AE-6 Bicycle Access and EW-7 Ecological Connectivity sections.

4.1.26 AE-6 Bicycle Access

4.1.26.1.1.1.1 DETAILS

One point was awarded for providing bicycle access via the under crossing for the Lava Lands Visitor Center. This improvement did not qualify for two points because the under crossing did not include a bicycle only facility.

4.1.26.1.1.1.2 RATIONALE

This credit is similar to the Pedestrian Access Credit described above. The under crossing addressed the need for a safer means for bicyclists to cross the highway to access the Lava Lands Visitor Center. It accommodates vehicles, non-motorists, and wildlife when people are not present.

In addition, the new shoulders constructed in the project area were designed wide enough to accommodate bicycles because improved safety for bicyclists was identified as one of the needs for this project. Although this does not fit the requirements of AE-6 Bicycle Access, this indicates that extra wide shoulders may address the intent of the Bicycle Access Credit in the context of a rural road project. Future revisions of the Greenroads manual should consider this modification.

4.1.26.1.1.1.3 COST

The construction cost for the undercrossing (which includes three overcrossing bridge structures) was approximately $2.09 million. It is important to note that this cost cannot be attributed to bicycle access only, as the undercrossing also provides pedestrian and wildlife access.

4.1.26.1.1.1.4 BENEFIT

As described above, the under crossing provided many benefits. It addressed one of the identified goals of the project, which was to provide safer bicyclist access to the Lava Lands Visitor Center. In addition, it provided pedestrian access and wildlife connectivity.

4.1.27 AE-7 Transit and HOV Access

4.1.27.1.1.1.1 DETAILS

This credit was not earned.

4.1.27.1.1.1.2

4.1.27.1.1.1.3 RATIONALE

This VC was not achieved because transit and HOV access were not practical design goals for a highway in a rural area.

4.1.28 AE-8 Scenic Views

4.1.28.1.1.1.1 DETAILS

Two points were awarded for this credit. The segment of US 97 involved in this project is not a designated National Byway. However it is known as a Scenic Corridor, meaning that it is managed for foreground scenic view retention under the Standards and Guidelines of the Deschutes National Forest Land and Resource Management Plan.

Figure 6 Scenic Views
Protecting the scenic view was a primary design goal for this project, which is shown in the background of this photograph.

4.1.28.1.1.1.2

4.1.28.1.1.1.3 RATIONALE

This segment of US 97 is a Scenic Corridor because of its location in the Deschutes National Forest.

4.1.28.1.1.1.4 COST

There are no costs associated with this credit because the highway was a scenic corridor before the project began.

4.1.28.1.1.1.5 BENEFIT

As a Scenic Corridor, the project site is protected by the Foreground Scenic Retention Standard in the Deschutes National Forest Land and Resource Management Plan. This standard prohibits activities that are visually apparent to the casual forest visitor in order to preserve the value of the visual resource.

4.1.29 AE-9 Cultural Outreach

4.1.29.1.1.1.1 DETAILS

This credit was not earned.

4.1.29.1.1.1.2 RATIONALE

There are multiple Historic Places within 10 miles of the project boundary, including Old Town Historic District. However, the project site did not include any informational infrastructure to direct roadway users to the Historic Places. This credit could have been achieved with minimal additional cost by installing a sign in the project area that directs visitors to the Historic Places.

This project was located in the Newberry National Historic Monument, a designation that helps protect the area from further development and allows visitors to experience the Lava Lands of Central Oregon. However, this did

not qualify the project for this credit because the Newberry National Historic Monument is not listed on the United States Register of Historic Places. Future versions of the Greenroads Manual should consider including national historic monuments in the Cultural Outreach Credit.

CONSTRUCTION ACTIVITIES (CA)

For this category, one (1) of the 14 possible points was earned. The credits are shown in Table 5.

Table 5: Construction Activities Voluntary Credit Category

Credits Earned		Credits Not Earned	
No.	*Title*	*No.*	*Title*
CA-6	Paving Emission Reduction	CA-1	Quality Management System
		CA-2	Environmental Training
		CA-3	Site Recycling Plan
		CA-4	Fossil Fuel Reduction
		CA-5	Equipment Emission Reduction
		CA-7	Water Use Tracking
		CA-8	Contractor Warranty

4.1.30 CA-1 Quality Management System

4.1.30.1.1.1.1 DETAILS

This credit was not earned.

4.1.30.1.1.1.2 RATIONALE

The general contractor, Knife River Corporation, does not have a documented quality management system. This project could have achieved this credit, but only with substantial additional effort from the contractor.

4.1.31 CA-2 Environmental Training

4.1.31.1.1.1.1 DETAILS

This credit was not earned.

4.1.31.1.1.1.2 RATIONALE

ODOT has policies in place for requiring environmental training and reporting, but there is no requirement for contractors to prepare a formal environmental training plan. Environmental training did occur for both ODOT's and the contractor's personnel for this project. For ODOT, construction inspection personnel were required to keep certifications or attend training on various construction activities, some of which require the inspectors to monitor specific environmental components (i.e. pollution and sediment control, noise, and protection of biological and cultural resources). At the preconstruction conference, ODOT briefed the contractor on key environmental conditions including wildlife migration, cultural resource protection, waste disposal, and natural resource protection.

This credit could have been achieved with low additional effort because it would have required very little time to summarize the training plan in a formal document.

4.1.32 CA-3 Site Recycling Plan

4.1.32.1.1.1.1 DETAILS

This credit was not earned.

4.1.32.1.1.1.2 RATIONALE

Several sections of the project specifications addressed material recycling, but a formal Site Recycling Plan was not prepared for this credit. Specifically, asphalt, duff material, concrete barrier and guardrail was recycled and/or reused. ODOT's standard practice is to recycle materials like these when possible.

This credit could have been achieved with low additional effort because it would have required little additional effort to address recycled materials in a Construction Waste Management Plan.

4.1.33 CA-4 Fossil Fuel Reduction

4.1.33.1.1.1.1 DETAILS

This credit was not earned.

4.1.33.1.1.1.2 RATIONALE

The general contractor did not own any non-road equipment that used biofuel or biofuel blends. The project superintendent was not aware of any plans that the company might have to use biofuel for its fleet.

The Oregon Department of Environmental Quality (ODEQ) created an incentive for using cleaner burning fuels with its Fleet Forward Program. More information about this program can be found here: http://www.deq.state.or.us/aq/fleet/home.htm

This project could have achieved this credit but only with substantial additional effort from the general contractor.

4.1.34 CA-5 Equipment Emission Reduction

4.1.34.1.1.1.1 DETAILS

This credit was not earned.

4.1.34.1.1.1.2 RATIONALE

The project personnel who were interviewed were not aware of any non-road construction equipment that achieved the EPA Tier 4 emission standard.

This project could have achieved this credit but only with substantial additional effort from the general contractor.

4.1.35 CA-6 Paving Emission Reduction

4.1.35.1.1.1.1 DETAILS

One point was awarded.

4.1.35.1.1.1.2 RATIONALE

Knife River uses NIOSH engineered controls on pavers as standard practice.

4.1.35.1.1.1.3 COST

The cost associated with this credit could not be extracted because the exhaust controls were already in place on the pavers and are used on all Knife River paving projects.

4.1.35.1.1.1.4

4.1.35.1.1.1.5 BENEFIT

The use of NIOSH engineered controls on pavers reduced worker exposure to asphalt fumes.

4.1.36 CA-7 Water Use Tracking

4.1.36.1.1.1.1 DETAILS

This credit was not earned.

4.1.36.1.1.1.2 RATIONALE

Water use was a particularly important aspect of this project because the porous rock material drains so quickly that insufficient watering led to compaction problems on previous projects in the area. ODOT project personnel monitored the water use closely to ensure that enough water was used to achieve proper compaction.

Another important aspect of the water use for this project was that the contractor obtained non-potable effluent from the local waste water treatment plant and used it for all water-related activities except curing the concrete. This is standard practice for Knife River, as it reduces the contractor's expense for obtaining water. Points were awarded under Custom Credits for using non-potable water for construction activities.

The contractor submitted daily tally sheets to ODOT to report the amount of and purpose for all water used. This is standard practice for ODOT projects and is required for the contractor to receive payment for the water used. However, neither the contractor nor ODOT tracked water use in a spreadsheet that addressed all of the necessary elements outlined in the Greenroads Manual.

This credit could have been achieved with very little additional effort. The information required for proper documentation was likely available from the contractor. Assembling the information into a single document would have required additional effort from the project team, but no additional construction costs.

4.1.37 CA-8 Contractor Warranty

4.1.37.1.1.1.1 DETAILS

This credit was not earned.

4.1.37.1.1.1.2 RATIONALE

In general, ODOT does not include contractor warranties with project contracts. Project personnel remarked that ODOT has expressed some interest in finding a way to incorporate contractor warranties but that this change is not likely to come in the very near future.

Therefore, while this credit could have been achieved for this project, it would have required substantial effort from ODOT personnel.

MATERIALS & RESOURCES (MR)

For this category, ten (10) of the 23 possible voluntary credits were earned. These credits acknowledged the reuse of at least 80% of the existing pavement, using at least 20% recycled asphalt pavement, and obtaining at least 90% of materials from within a 50 mile radius of the project. These credits are outlined in Table 6.

Table 6: Materials & Resources Voluntary Credit Category

Credits Earned		Credits Not Earned	
No.	*Title*	*No.*	*Title*
MR-2	Pavement Reuse	MR-1	Lifecycle Assessment (LCA)
MR-4	Recycled Materials	MR -3	Earthwork Balance
MR-5	Regional Materials	MR-6	Energy Efficiency

4.1.38 MR-1 Lifecycle Assessment (LCA)

4.1.38.1.1.1.1 DETAILS

This credit was not earned.

4.1.38.1.1.1.2 RATIONALE

ODOT does not prepare lifecycle assessments for any roadway projects. Therefore, while this credit could have been achieved for this project, it would have required substantial effort from ODOT personnel.

4.1.39 MR-2 Pavement Reuse

4.1.39.1.1.1.1 DETAILS

Four points were awarded for this credit. Based on the project manager's rough calculations, at least 80% of the existing pavement was reused for this project.

4.1.39.1.1.1.2 RATIONALE

The primary design decision that allowed the project to achieve this credit was to convert the existing two-lane alignment (one northbound lane and one southbound lane) into the southbound lanes and construct two new northbound lanes to provide additional capacity. This decision was based on cost savings and overall feasibility.

Although pavement is the only material addressed by this credit, it should be noted that several other materials were reused on this project, including tree stumps for mulch, duff material, concrete barrier and guardrail. After trees in the project area were logged, the construction contractor ground the stumps to produce nearly 12,800 cubic yards of mulch for use on the site. Future versions of the Greenroads manual should consider modifying this credit to award points for reusing materials other than pavement. For this report, points were awarded under Custom Credits for reusing vegetation material onsite.

4.1.39.1.1.1.3 COST

The cost of achieving this goal could not be extracted because there were savings associated with avoiding the construction of four new lanes and expenses associated with maintaining the older structure. While these quantities are difficult to estimate, the project designers believe that a substantial amount of money was saved by reusing the existing pavement.

4.1.39.1.1.1.4 BENEFIT

The benefits of reusing a large portion of the existing pavement include construction cost savings and reduced construction time.

4.1.40 MR-3 Earthwork Balance

4.1.40.1.1.1.1 DETAILS

This credit was not earned.

The cut and fill quantities were not closely balanced, and some material had to be imported. This caused the cut and fill quantities to be within about (A) 22%, the import to be about (B) 9% of the fill material, and the export to be (C) 0%. Therefore, A% + B% + C% was about 31%, which is greater than the allowable limit for the credit. Refer to the Greenroads Manual for further explanation of this equation. Refer to Appendix D of this report to see how these values were calculated.

4.1.40.1.1.1.2 RATIONALE

ODOT project designers typically try to balance the cut and fill quantities to minimize the cost of importing and exporting material. This goal could not be achieved for this project because the new northbound lanes had to be built at a higher elevation than the existing highway in order to protect the underground lava tube that runs from one side of the project to the other. The elevation restrictions made it impractical to design the project for an ideal cut and fill balance. Therefore, this credit was not practical for this project due to its location near sensitive volcanic features.

4.1.41 MR-4 Recycled Materials

4.1.41.1.1.1.1 DETAILS

Two points were awarded for this credit for using reclaimed asphalt pavement (RAP).

RAP accounted for 30% of the bases course and 20% of the wearing course (measured by weight of the material). The average RAP content was therefore between 20% and 30%, which qualified the project for two points.

4.1.41.1.1.1.2 RATIONALE

ODOT's policy is to allow RAP to account for up to 30% of pavement materials by weight. Paving contractors may choose how much RAP to use, but they typically include as much as possible to realize significant cost savings between the price of new asphalt binder and RAP.

4.1.41.1.1.1.3 COST

ODOT personnel estimate that using RAP on this project saved $10 to $15 per ton of pavement. This value is based on the current price of oil, as the asphalt binder is the most valuable material in RAP.

4.1.41.1.1.1.4 BENEFIT

The primary benefit of using RAP on this project was the cost savings experienced by the contractor and passed onto ODOT as part of the construction price.

4.1.42 MR-5 Regional Materials

4.1.42.1.1.1.1 DETAILS

Four points were awarded for obtaining at least 90% (based on cost) of materials from suppliers located within a 50 mile radius of the project site.

4.1.42.1.1.1.2 RATIONALE

The greatest contributions toward earning this credit came from obtaining embankment material and crushed rock aggregate from Gas Station Quarry (located about 4 miles from the project) and using local concrete and asphalt suppliers.

ODOT leased Gas Station Quarry from the National Forest Service and offered it to the contractor for use on this project. (The long term lease will also allow ODOT to offer the source to contractors for future projects in the area.) The contractor chose to use the Quarry because the only cost it involved was the price to load the material and haul it less than 4 miles. This greatly reduced the contractor's cost compared to obtaining the material from a private quarry and hauling it farther.

The contractor also chose the concrete and asphalt suppliers based on expected cost. The concrete was obtained from a supplier in Tumalo, Oregon, and the asphalt came from a plant in Redmond, Oregon.

4.1.42.1.1.1.3 COST

The cost savings associated with this credit could not be extracted, but they are expected to be quite significant. As described above, using Gas Station Quarry saved the contractor a great deal of money compared to obtaining the material from a private source, and these savings were passed onto ODOT. Using local suppliers to obtain concrete, asphalt, and other materials also reduced the costs for transportation.

4.1.42.1.1.1.4 BENEFIT

The primary benefit of using local regional materials for this project was the cost savings experienced by the contractor and passed onto ODOT.

4.1.43 MR-6 Energy Efficiency

4.1.43.1.1.1.1 DETAILS

This credit was not earned.

4.1.43.1.1.1.2 RATIONALE

The project site does not involve existing lighting, nor will new lighting fixtures be installed. Refer to EW-8 Light Pollution for a discussion of why lighting was not used on this project.

This credit is not practical for this project because it requires the use of lighting fixtures which are not necessary in this context.

PAVEMENT TECHNOLOGIES (PT)

For this category, five (5) of the 20 possible voluntary credits were earned for designing the new section of highway for long life. The credits are shown in Table 7.

Table 7: Pavement Technologies Voluntary Credit Category

Credits Earned		Credits Not Earned	
No.	*Title*	*No.*	*Title*
PT-1	Long-Life Pavement	PT-2	Permeable Pavement
		PT-3	Warm Mix Asphalt
		PT-4	Cool Pavement
		PT-5	Quiet Pavement
		PT-6	Pavement Performance Tracking

4.1.44 PT-1 Long Life Pavement

4.1.44.1.1.1.1 DETAILS

Five points were awarded for this credit. For the newly constructed section of highway, the base thickness was 11 inches, which exceeds the minimum base thickness for this credit. The equivalent single axle loads (ESAL's) were 15.3 million for the 20 year design life. According to Figure PT-1.1 in the Greenroads Manual, 15.3 million ESAL's corresponds to a minimum surfacing thickness of approximately 11 inches. The newly constructed section of the highway was designed with 11 inch thick pavement; therefore PT-1 Long Life Pavement was achieved.

4.1.44.1.1.1.2 RATIONALE

The ODOT Pavement Design Guide requires a minimum 20 year design life for new highway sections. In this case, the pavement design for the 20 year life met the requirements of the Long Life Pavement Credit.

4.1.44.1.1.1.3 COST

The cost associated with designing the pavement for long life could not be extracted because the design team did not consider using a shorter design life at any point.

4.1.44.1.1.1.4 BENEFIT

The use of long life pavement is expected to decrease lifecycle costs, as less rehabilitation and maintenance should be needed over time.

4.1.45 PT-2 Permeable Pavement

4.1.45.1.1.1.1 DETAILS

This credit was not earned.

4.1.45.1.1.1.2 RATIONALE

ODOT has used permeable pavement on an experimental basis for select test projects, but this project was not selected to be a test project. If it had been selected, it would have only been practical to use permeable pavement on the shoulders because permeable pavement is not suitable for high volume traffic loads. This relatively small area would not likely have been able to treat the runoff volume required by the Greenroads Manual in order to achieve this credit.

Therefore, this credit is not practical for this project.

4.1.46 PT-3 Warm Mix Asphalt

4.1.46.1.1.1.1 DETAILS

This credit was not earned.

4.1.46.1.1.1.2 RATIONALE

ODOT has used warm mix asphalt (WMA) on several test projects, two of which were in Central Oregon. Some of the pavement sections experienced transverse cracking this winter, and there was concern that the cracking was related to the WMA. Therefore, although the contractor proposed using WMA on this project, ODOT chose not to make this a test project.

Because the contractor could have used WMA if ODOT allowed it, this credit could have been achieved with minimal additional effort.

4.1.47 PT-4 Cool Pavement

4.1.47.1.1.1.1 DETAILS

This credit was not earned.

4.1.47.1.1.1.2 RATIONALE

The project team was not aware of the use of cool pavement on any ODOT projects. ODOT would only use this technology on an experimental basis.

This credit could have been achieved, but it likely would have required a significant amount of addition effort from ODOT to make it a test project for cool pavement.

4.1.48 PT-5 Quiet Pavement

4.1.48.1.1.1.1 DETAILS

This credit was not earned.

4.1.48.1.1.1.2 RATIONALE

The project team was not aware of the use of quiet pavement on any ODOT projects. ODOT would only use this technology on an experimental basis. However, if ODOT had a test project effort underway, this project would not likely have been selected as a test project because it is not located in a densely populated area. In a report from the Norwegian Public Roads Administration, researchers found that quiet pavement was only an economical noise reduction solution in areas that have at least 100 households per kilometer[1]. There are no households in the immediate vicinity of this project, so quiet pavement would not have been a practical design feature.

Therefore, this credit is not practical for this project.

4.1.49 PT-6 Pavement Performance Tracking

4.1.49.1.1.1.1 DETAILS

This credit was not earned.

4.1.49.1.1.1.2 RATIONALE

ODOT does not have a pavement performance tracking system, nor does it have plans to implement such a system in the future.

This credit could have been achieved for this project, but only with significant additional effort from ODOT to implement a pavement performance tracking system.

POTENTIAL CUSTOM CREDITS

Four (4) best practices implemented on this project were identified as possibly meriting a designation as a Greenroads Custom Credit. A total of seven (7) additional points are tentatively awarded. CC-1 and CC-3 would likely fit into the Environment and Water category, CC-2 would likely be categorized with Materials and Resources,

[1] Norwegian Public Roads Administration. (2009). *Environmentally Friendly Pavements.* Sandvika: ViaNova Plan og Trafikk AS.

and CC-4 would likely be categorized with Access and Equality. Note that research has not been completed at this time and that the Greenroads Development Team will review each credit application and vet the credit before incorporating it into later versions of the metric. Table 8 provides the credit title and intent.

Table 8: Potential Custom Credits

No.	Title	Pts.	Description
CC-1	Non-Potable Water Use	3	Eliminate the use of potable water for construction activities
CC-2	Vegetation Reuse	2	Reuse all vegetation cleared from the project site (See Figure 6)
CC-3	Habitat Creation	1	Construct new wildlife habitat features (e.g. bat roosting crevices beneath bridges) (See Figure 7)
CC-4	Aesthetics	1	Design structures to provide aesthetic appeal and blend in with the natural environment (See Figure 8)

Figure 7 Vegetation Reuse
Vegetation that was cleared from the project site was used onsite as duff material.

Figure 8 Habitat Creation
Bridge structures were designed to provide crevices where bats can roost.

Figure 9 Aesthetic Features
Texture and pigment were applied to bridge abutments (shown here before pigment was applied) to make them blend with the natural geology.

RECOMMENDATIONS

Several changes to the Greenroads manual were recommended in the sections above. The recommendations are summarized here:

- EW-6: The Habitat Restoration Credit should be modified to allow all projects to achieve this credit regardless of whether the area includes a water body. This project addressed part of the intent of this credit with an associated ODOT and Forest Service collaboration which treated 28.33 miles of unwanted roads in adjacent areas of the Deschutes National Forest. However, the project cannot earn any points for this credit the way it is currently written because it does not include a water body and the IBI cannot be calculated.

- EW-8: The Light Pollution Credit should be modified to allow projects located in rural areas to achieve this credit by opting not to implement a lighting system if it can be shown that the decision was based on protection of the environment. For this project, the design team chose to use no lighting over using Dark-Sky compliant fixtures because it reduced the impact on wildlife. However, this credit is written so that it could have only been achieved if Dark-Sky compliant fixtures were implemented.

- AE-5: The Pedestrian Access Credit should be modified to allow projects located in rural areas to achieve this credit by constructing extra-wide shoulders to accommodate non-motorists. The design team did not consider sidewalks as a practical feature for a highway in a forest, but rather decided to address the need for pedestrian access by designing extra-wide shoulders.

- AE-6: Like the Pedestrian Access Credit, the Bicycle Access Credit should be modified to allow projects located in rural areas to achieve this credit by constructing extra-wide shoulders to accommodate non-motorists. The design team did not consider bike-only facilities as a practical feature for a highway in a forest, but rather decided to address the need for bicycle access by designing extra-wide shoulders.

- AE-9: The Cultural Outreach Credit should be modified to allow projects located in or very near to National Historic Monuments to achieve this credit. This project is located in the Newberry National Volcanic Monument (and includes informational infrastructure to direct visitors to the Monument), but it cannot earn points for this credit because the Newberry National Volcanic Monument is not listed in the United State National Register of Historic Places.

- MR-2: The Pavement Reuse Credit should be modified to allow projects to earn points for reusing materials other than pavement. This project reused tree stumps for mulch, duff material, concrete barrier and guardrail, but could only earn points for using RAP.

The potential custom credits described in the previous section should also be considered for inclusion in future versions of the Greenroads Manual.

LIMITATIONS

Pilot Project results are based on discussions with project personnel only, and any project documents provided to the University of Washington Review Team. In general, more case studies of varying project types are needed to better reflect current ODOT sustainability practices. This Pilot Project Report provides only a small glimpse of current efforts on a specific project, and therefore study results may not accurately reflect the level of effort made toward sustainability best practices that are put forward by similar project types within ODOT.

Regulatory requirements tend to dictate many of the actions of most roadway project teams and transportation agencies. However, the intent of Greenroads is to encourage best practices that go above and beyond existing United States regulations and requirements. A list of current regulatory requirements is provided in the Introduction to the Greenroads Manual (Muench & Anderson, 2010).

Greenroads is continually under development. Case studies completed under the version 1.0.1 rating system that has been used to rate this project may not score equivalently under future versions of Greenroads.

APPENDIX A

About Greenroads

ABOUT GREENROADS

This section details the Greenroads Sustainability Performance Metric, including a brief background on development of the system, the operating definition of sustainability used, and a brief description of how it works and can be implemented. More detailed information, including the Version 1.0.1 manual of requirements and credits can be found on the official Greenroads website: http://www.greenroads.us.

The list of credits including a brief description is attached at the end of this short appendix.

BACKGROUND

Greenroads is a research project (Söderlund, 2007) that is jointly developed by the University of Washington (UW) and CH2M HILL. Greenroads is a collection of sustainability best practices that apply to roadway design and construction, much like the Leadership in Energy and Environmental Design (LEED) Rating System for Buildings that is administered by the United States Green Building Council (USGBC). In general, these sustainability best practices are divided into two types: required and voluntary. There is currently one required category with 11 required best practices called "Project Requirements" or PRs. At minimum, all of these best practices must be completed in order for a roadway to be considered a Greenroad.

What is a Greenroad?

A Greenroad is defined as roadway project that has been designed and constructed to a level of sustainability that is substantially higher than current common practice.

What is Sustainability?

Sustainability is the characteristic of a system that represents its capacity to support natural laws and human values. (Anderson, 2008; Muench et. al, 2010)

Projects that register using the Greenroads website are eligible to earn a certification award and will be able to display the Greenroads logo on their project to recognize their achievement.

STRUCTURE OF THE METRIC

In general, the Greenroads sustainability best practices are divided into two types: required and voluntary. There is currently one required category with 11 required best practices called "Project Requirements" or PRs. At minimum, all of these best practices must be completed in order for a roadway to be considered a Greenroad. Thirty-seven (37) other voluntary best practices are characterized in five additional categories, called "voluntary credits" or VCs. After the PR requirements have been met, a number of different VCs may be achieved and points may be earned toward one of four ratings: *Certified, Silver, Gold* and *Evergreen*. Additionally, a sixth VC category is available to projects that demonstrate and implement innovative ideas or more sustainable practices and would like to write or submit their own customized or new ideas for points.

Following is a brief description of the seven categories in Greenroads. The relative weights of the five main VC categories are shown in Figure A.1.

Project Requirements

This category contains all 11 Project Requirements (PR) that a Greenroads project must meet in order to be considered for a certification level award. The general intent of this category is to encourage environmentally responsible decision-making processes and to have management plans in place for construction, and to establish a minimum baseline for every project that applies for certification.

Environment & Water (EW)

This category contains eight (8) voluntary credits worth up to 21 points. The intent of this category is to promote best practices related to stormwater management and ecological resources within the project boundary.

Access & Equity (AE)

This category contains nine (9) voluntary credits worth up to 30 points. The intent of this category is to promote safety, access, and mobility to users of the roadway.

Construction Activities (CA)

This category contains eight (8) voluntary credits worth up to 14 points. The intent of this category is to promote responsible construction management, reduce use of fossil fuels and improve health and safety of construction workers.

Materials & Resources (MR)

This category contains six (6) voluntary credits worth up to 23 points. The intent of this category is to promote responsible materials and energy management by combinations of recycling, reusing and reducing both virgin and waste materials.

Pavement Technologies (PT)

This category contains six (6) voluntary credits worth up to 20 points. The intent of this category is to highlight specific pavement engineering innovations and ideas or broad types of technologies or techniques which are well-established in practice and have direct sustainability benefits.

Custom Credits (CC)

This category contains up to 10 credits which may be earned by a project that implements sustainable or innovative ideas. The project team may submit applications with a detailed description and explanation of the practice to earn credits in this category ranging in value from 1 to 5 points. Points awarded for the custom credit are determined through review and collaboration with Greenroads representatives. There is currently no limit established for how many custom credits a project may submit for review.

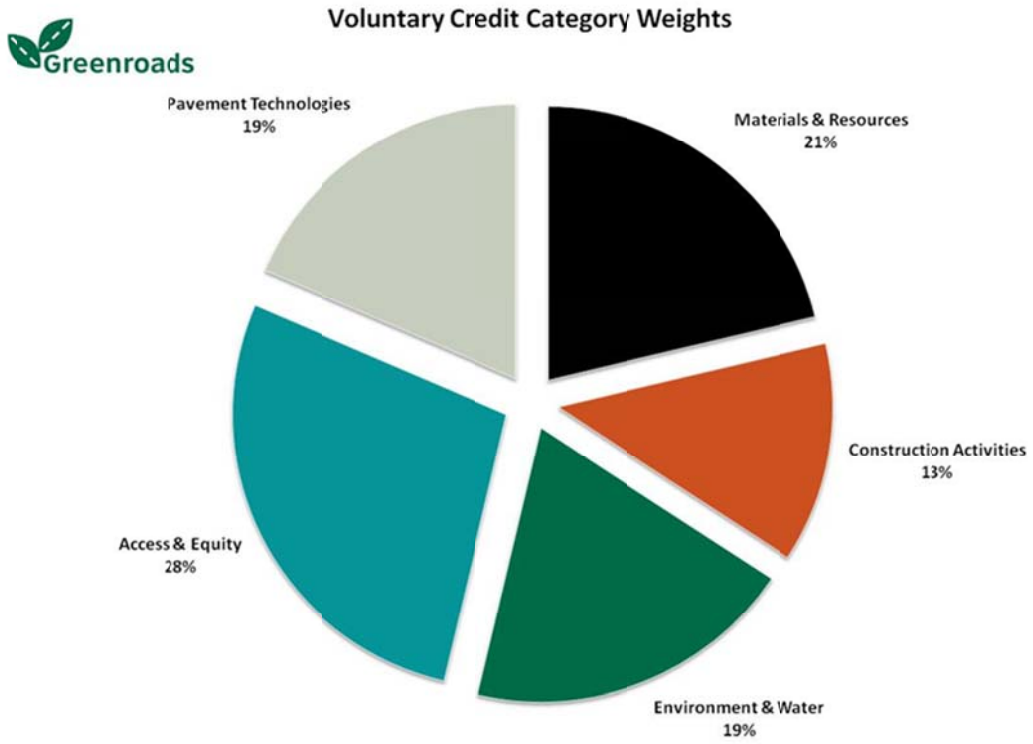


Figure A.10. Relative Weights of Greenroads VC Categories (Muench et al. 2010)

APPENDIX B

Case Study / Pilot Project Method

REVIEW METHODS

There are four types of Greenroads evaluations that vary in formality, objectives, time required, and level of effort for communication and documentation. This project review constitutes what is called a **Case Study.** All four methods are listed with a short description below for context of the method used.

What is a Workshop Assessment?

A workshop assessment is the least formal evaluation and requires no documentation. The format is interactive and discussion-based. Select PRs and VCs are reviewed to determine feasibility for a specific project while completing the Greenroads checklist. Participation is voluntary, but at least one Project Manager or design team lead should be present. The end result is a completed checklist that may be used as an internal benchmarking tool if desired.

What is a Case Study?

Generally a retroactive application of the Greenroads metric done on projects that are already completed, case studies are part of the calibration and testing process for validating the metric in its current state. Case studies include review of some documentation but in most cases, documentation may not be available. Case studies also require communication with a Project Manager, but in-person interaction is not necessary.

What is a Pilot Project?

A pilot project begins after initial completion of a case study. It involves ongoing communication between the Project Team and the Greenroads development team. Ultimately, the purpose of this process is to document and collect information regarding feasibility and practical barriers or successes for implementing some or all of the practices in Greenroads. This process lasts from completion of the case study through completion of the roadway project, and is characterized by regular progress reports. Certification is not guaranteed or part of this process. While pilot projects may begin at any time during design and construction, they are most important to begin early in the design phase or project development. Designated pilot projects may use the Greenroads logo and advertise that they are a Greenroads Pilot Project, but may not reference certification levels or state any award has been achieved.

What is a Certification Review?

Certification is the highest level of formality and requires final documentation for verification of earned PRs and VCs at time of evaluation. Projects must complete and document both a Design Review and a Construction Review in order to achieve a Greenroads rating; these two reviews may be done separately or in combination. The certification process includes registration on the Greenroads website, paying associated fees and submitting all documents for reviewed through an electronic process. At this time, there is no third-party certification available but this is anticipated near the end of 2011.

CASE STUDY/PILOT PROJECT METHOD

The case study/pilot project methodology used on this project contains three main steps.

1. **Greenroads holds a live discussion with the Project Manager.** This discussion helps to identify general information about the project, including the needs and goals, and planning decisions that were made at the outset. Additionally, it helps to identify what information and documentation needs (or whether documentation even exists) in order to proceed with the case study/pilot project review. The discussion also helps to determine the Project Manager's current perception of sustainability and how the project could fit with the Greenroads metric. Typically, this step includes a brief overview and discussion of each credit. Ultimately, the conversation should allow the review team to understand what "perceived level of effort" may be required in order to establish or document whether or not a particular sustainability best practice has been implemented on a project. Perceived level of effort is further explained below.
2. Based on this discussion, review of documents provided, follow-up communication, Greenroads completes the Greenroads Project Checklist for the project. The Checklist shows the number of project requirements (PR) that have been met by the project, any voluntary credits achieved and points awarded, and also the

certification award level achieved, if any. Additionally, the checklist shows the potential levels achievable if various levels of effort were to be pursued during the planning, design or construction process. As requested, the checklist also shows which credits directly or indirectly provide a greenhouse gas (GHG) benefit. The checklist is submitted for review by the Project Manager.

3. Finally, Greenroads generates a brief report of the results of the case study/pilot project and provides recommendations based on these results and the scope of work for the study. The format for a case study/pilot project report is likely to be a short informational memorandum rather than a detailed technical report, though more detailed case study/pilot project reports may be warranted in special situations or requested.

Generally, this methodology was used for this project. Any deviations from this method are identified within the report.

WHAT IS "PERCEIVED LEVEL OF EFFORT"?

During the discussion with the Project Manager (PM), Greenroads establishes the potential for each credit to be achieved according to PM and the Greenroads reviewer. This is largely a gage of subjective perceptions unless documentation is provided to support achievement of a particular VC (or otherwise indicates it was not achieved).

DEFINING "EFFORT"

"Effort" is defined by any of the following, or combinations of the following:

- Amount of documentation required by Greenroads
- Amount of time to provide and generate documentation that is in addition to standard project documentation (not typically included in tender packages)
- Amount of resources that may or may not be physically available or accessible to complete a task, implement a technology or practice, or to document them
- Amount of money involved in acquiring and documenting a Greenroads credit
- Conflicts with existing regulatory standards, if any
- Conflicts with implementing Greenroads credits in the design process, if any
- Conflicts with implementing Greenroads credits in the construction process, if any

Effort is rated on a scale of Yes, Maybe (?), or No, and credits which were not appropriate or applicable to a particular project are also designated. The Level of Effort column on the Checklist reflects the amount of effort required if the credit were to be pursued. If the credit is pursued, it may earn the points corresponding to the level of effort pursued if the progress of the action items is complete (at 100%).

For example, if a 3-point credit was considered to be low effort (abbreviated "L"), 3 points for that credit were placed in the column for that credit called "Low."A key is provided on each worksheet with the abbreviations used.

Note that types of credits have ranges of points, such as the Recycled Materials (MR-4) credit. Point values for incremental types of credits may vary in effort level required, and depending on what effort level is attempted, not all of the points for a particular credit may be earned. These points for incremental credits are distributed across the range of effort levels based on the discussions with the Project Managers. The same theory is true for buffet-style credits where a number of alternatives may be available to meet a certain objective, but have varying degrees of effort associated with each alternative.

Low Effort

A low level of effort represents a low difficulty in providing information to the Greenroads team (for example, documentation exists as part of the standard tender package) or involves very little additional administrative resources and time to produce evidence that the credit requirements were achieved. Low effort also could mean a low- or no- cost addition or minor design change to the project, or that the intent of the credit does not

obviously conflict with existing regulations or standards. This designation may also represent a perceived high availability of physical materials or equipment.

Note that a designation of low effort may represents any credit that was achieved by regulatory means or similar policy and standards because it is assumed that the task must be completed in order to meet requirements other than those outlined in Greenroads Project Requirements or Voluntary Credits. An example of a low effort is submitting a standardized design document, such as a pavement evaluation, to meet the criteria for the Life Cycle Cost Analysis (PR-2) requirement.

Moderate Effort

This perception level falls somewhere between Low and High depending on interpretation of the Project Manager. Moderate effort may also reflect an educational endeavor or public awareness program where there is a learning curve involved for the design team, agency or construction team on the project.

In some rare cases, a moderate level of effort may be a reflection of the average perceptions of the consulting team and the Project Manager. Where possible, this distinction is made in the Reviewer Comments section of the Checklists for each individual project. For example, Ecological Connectivity (EW-7) was a high priority for the Kickinghorse Canyon (Highway 1) project, but much of effort, specifically cost and time required for detailed environmental review, was required by the Canadian Environmental Assessment Act (CEAA) due to the project's location in an ecologically sensitive area. While the Project Manager perceived that the project had gone above and beyond conventional design, planning, and cost expenditures for environmental considerations (corresponding to a very high level of effort), the consulting team recognizes that they were clearly required to do so by federal policy. However, the consulting team also recognizes that not every project is located in a highly ecologically sensitive area and therefore this effort, though regulated, does have merit due to the resulting positive ecological impact.

High Effort

This level of perception indicates a significant design process change or regulatory change would need to happen in order to achieve a credit and meet the credit requirements as specified in the Greenroads Manual. High effort also reflects significant added cost (above 3% of total project cost, for example, was considered "significant" as noted by Project Manager Jon Jensen). For example, Performance-Based Warranty (CA-8) is considered a high level of effort, because it would require a significantly larger risk to be taken by the contractor (three years instead of the some agency standard one year warranties), which would likely be reflected in the project budget as an added cost.

Not Applicable (N/A)

It is not possible for any single project to earn all of the credits in Greenroads. Where a particular credit was not appropriate for a project, this credit was designated "not applicable" with the notation "N/A." For example, the Energy Efficiency credit (MR-6) is not applicable on a project without any electric lighting installed.

APPENDIX C

Project Calculations

Data Provided by the Project Team:

US97 LAVA BUTTE- S. CENTURY DRIVE
STAGE 1 EARTHWORK QUANTITIES
all quantities shown are in cubic yards

Quantities based off Cross Sections provided at Pre Bid.

Alignment	Excavation (in situ)	Embankment (in place)
NB	71,223	197,779
C	36,983	3,442
SB		
CA		
CB	15,560	5,374
CC	10,624	2,095
CD		
CE		
WL		
DCB	1,846	77
Totals	134,390	208,690

Additional Materials needed for Stage I	74,300	CY (in place)

Available Borrow Materials Based Section 00235 and GM-8
Quantities are in situ stockpiled materials described in Narrative provided at bidding. Contractor responsible for determining the suitability of materials for embankment construction.

Site B-1	41,210	in situ
Site B-2	37,880	in situ
Site B-3	19,820	in situ
Total	98,910	in situ

Imported: 20,000 cy from Gas Station Quarry

Calculations:

See the Greenroads Manual for an explanation of the equations used.

A = 74,300/(134,390+208,690) = 21.7%

B = 20,000/208690 = 9.58%

C = 0/134,390 = 0%

A +B + C= 31.28 > 10%

Award 0 Points.

PILOT PROJECT REPORT

VERSION 1.0.1

US 97: LAVA BUTTE – S. CENTURY DRIVE SECTION

OREGON DEPARTMENT OF TRANSPORTATION

Prepared by

Maleena Scarsella

October 2010

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INTRODUCTION

This report reflects the results of the Greenroads Pilot Project for the US 97: Lava Butte – S. Century Drive Section Project for the Oregon Depart of Transportation (ODOT). The results are presented using the Greenroads Progress Scorecard supplemented by a detailed credit-by-credit discussion. Recommendations are also included for applying the Greenroads sustainability performance metric to the project.

Preparation of the Pilot Project involved a review of project documents, interviews with project contacts, and a site visit. For a list of resources used to prepare the Pilot Project Report, refer to the Resources Consulted section.

The following section provides a brief project description. A detailed description of the Greenroads Rating System can be found in Appendix A, including a short list of Greenroads Project Requirements (PR) and Voluntary Credits (VC) for reference. A description of the Pilot Project methodology is provided in Appendix B, and supporting calculations for credits earned are provided in Appendix C.

PROJECT DESCRIPTION

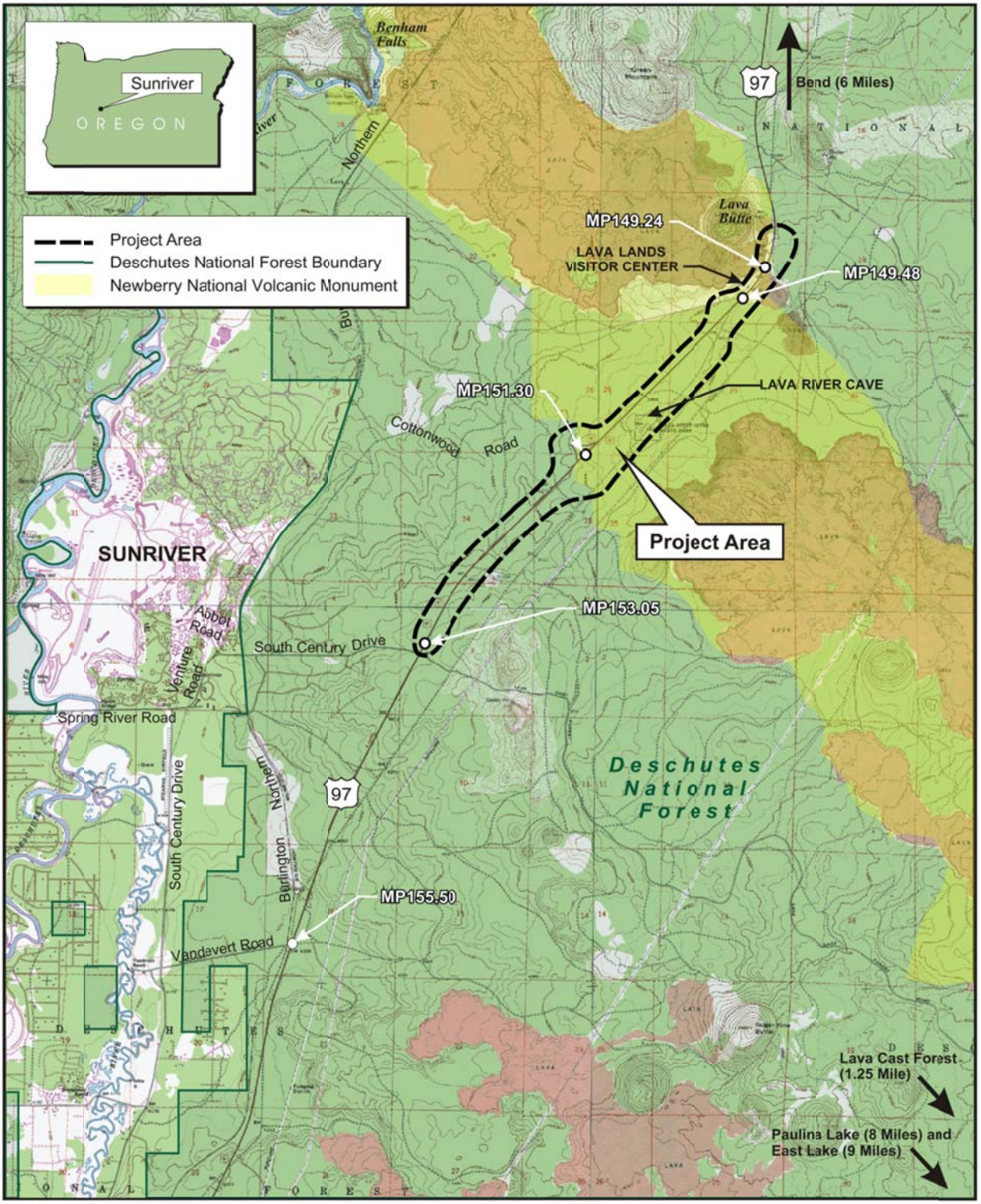
The project was located in central Oregon along US 97, the main north-south corridor on the east side of the Cascade Range. The project site was limited to the section of US 97 between Lava Butte (MP 149.24) and South Century Drive (approximate MP 153.05), and a "buffer area" adjacent to the roadway. The project area resided entirely within the Deschutes National Forest managed by the US Forest Service (USFS), and the north half of the project area was in the Newberry National Volcanic Monument.

The project was needed because the highway and roadway approaches to US 97 in the project area did not meet traffic operations and safety needs. The existing lane configuration of US 97 did not provide for adequate capacity for existing and forecast travel demand, nor were there safe ways to access and exit the highway at several key locations in the project area, including the Lava Lands Visitor Center, Lava River Cave and Cottonwood Road. The project average daily traffic (ADT) volume on US 97 north of Cottonwood Road was 19,200 in 2005, and was forecasted to increase to 32,680 by the year 2028. South of Cottonwood Road, the 2005 ADT was 15,600 in 2005 and was forecasted to increase to 28,640 by year 2028.

The US 97: Lava Butte – S. Century Drive Section Project addressed traffic operations and safety needs by:

- Increasing the capacity of the existing two- and three-lane highway to four lanes (two in each direction)
- Separating northbound and southbound traffic with a forested median of up to an approximate maximum of 108 feet in width
- Reconstructing the Cottonwood Road interchange into a full diamond interchange (on and off ramps in both directions)
- Constructing alternative access to Lava Lands Visitor's Center and Lava River Cave via Crawford Road and Cottonwood Road
- Constructing roadway shoulders that will accommodate bicyclists
- Building two structures and fencing to accommodate wildlife passage under US 97

The three year, $16 million contract was awarded to Knife River Corporation – Northwest. Construction began in June 2009 and is expected to be completed in November 2011.



USGS 7.5 Minute Quadrangle Series Lava Butte, Oregon 1963 (rev. 1981); Benham Falls, Oregon 1963 (rev. 1981); Lava Cast Forest, Oregon 1963 (rev. 1981); Anns Butte, Oregon 1963 (rev. 1981)

N Scale - 1 : 72 000

Figure 11: Location Map

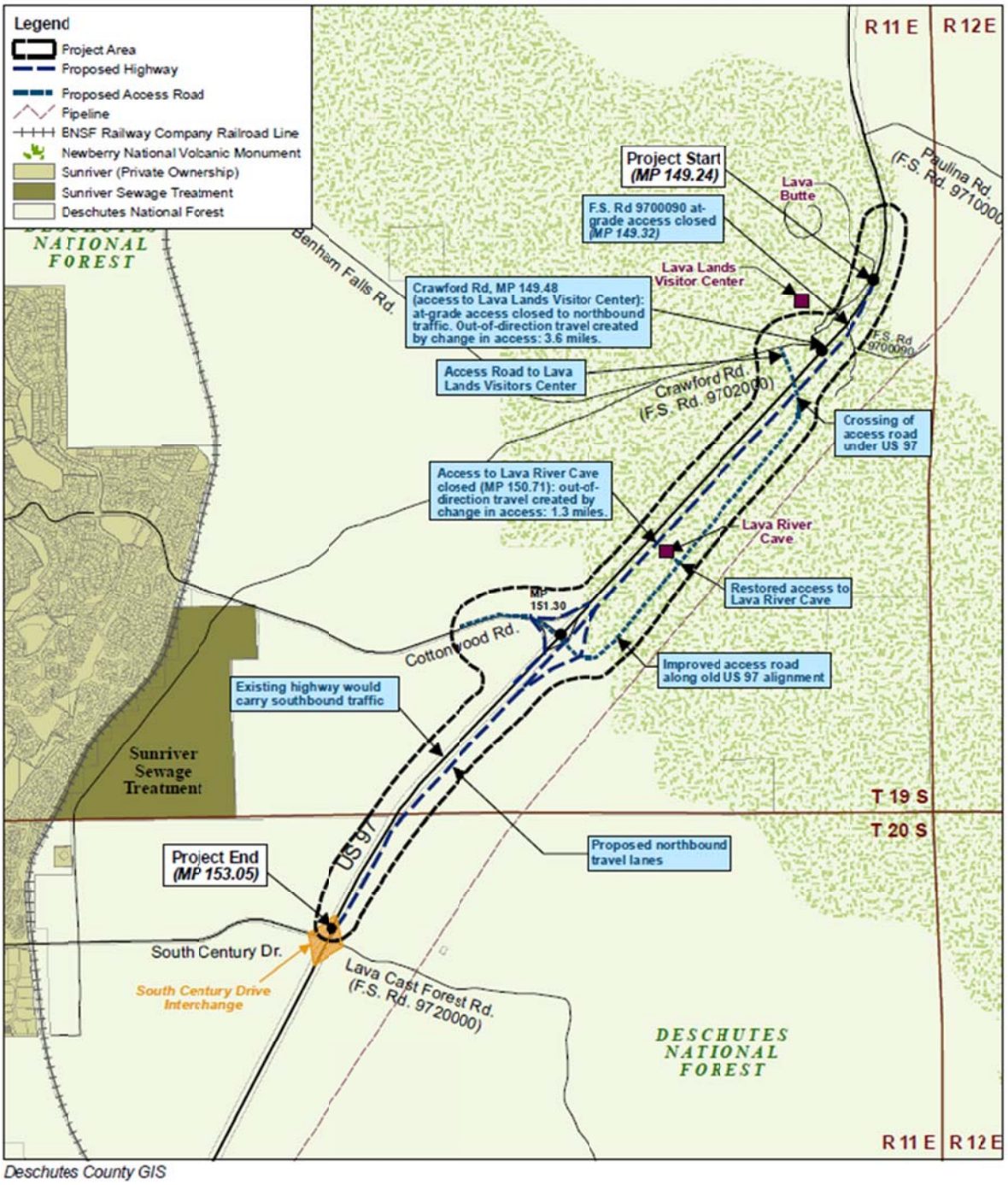


Figure 12: Project Site Map

RESOURCES CONSULTED

The following resources were used to prepare the Pilot Project.

- Berrin, Larry. Director of Conservation Education. Newberry National Volcanic Monument. Interview. July 2010.
- Biological Evaluation: US 97: Lava Butte – S. Century Dive Section. David Evans and Associates, Inc. March 2008.
- Coplantz, John. Pavement Management Engineer. Oregon Department of Transportation. Email correspondence. April 2010.
- Cornell, Lyn. Research Coordinator. Oregon Department of Transportation. Interview. April-July 2010.
- Davenport, Jay, P.E. Assistant Construction Manager. Oregon Department of Transportation. Interview. July 2010.
- Davis, Ron. Construction Foreman. Knife River Corporation. Interview. July 2010.
- Final Noise Technical Report: US 97: Lava Butte – S. Century Dive Section. HDR Engineering, Inc. March 2008.
- Jacobson, Sandra. Wildlife Biologist. USDA Forest Service. Pacific Southwest Research Station. Email correspondence. April 2010.
- Kittrell, Ken. Deschutes National Forest Transportation Engineer. USDA Forest Service. Email correspondence. April 2010.
- Oregon Standard Specifications for Construction, Volume 1 and 2. Oregon Department of Transportation. 2008.
- Revised Environmental Assessment: US 97: Lava Butte – S. Century Dive Section. Oregon Department of Transportation. U.S. Department of Transportation Federal Highway Administration. December 2008.
- Serpico, Stephanie, P.E. Region 4 Interim Program Manager. Oregon Department of Transportation. Interview. April-July 2010.
- Site Visit. Conducted by Maleena Scarsella. July 15, 2010.
- US 97: Lava Butte – S. Century Dive Section Special Provisions. Oregon Department of Transportation. 2009.
- US 97: Lava Butte – S. Century Dive Section Contract and Bonds. Oregon Department of Transportation. Awarded June 2009.
- US 97: Lava Butte – S. Century Dive Section Plans for Proposed Project. Oregon Department of Transportation. May 2009.
- Water Quality Technical Memorandum: US 97: Lava Butte – S. Century Dive Section. David Evans and Associates, Inc. January 2008.

- Project Website: http://www.oregon.gov/ODOT/HWY/REGION4/US97_Lava_Butte_South_Century_Drive/US97LavaButte_SouthCenturyDrive.shtml

- Web location of photos: http://picasaweb.google.com/102477297602201918671/ODOTCaseStudy2010SR97LavaButte?authkey=Gv1sRgCPTZp6SXxLnXBA&feat=directlink

PILOT PROJECT SUMMARY

Project requirements. The US 97: Lava Butte – S. Century Drive Section Project met 8 of the 11 Greenroads Project Requirements (PR). In order to achieve a level of certification in Greenroads, all 11 Project Requirements must be completed and documented.

Achieved score. Thirty-nine (39) of the 108 possible voluntary credits were earned, and an additional seven (7) points were awarded for four new proposed custom credits, bringing the total number of credits achieved to 46 of 118 possible. This is would qualify the project for a Silver rating if all Project Requirements were met. Points that were achieved are shown in the *A* column in Figure 3.

Potential score. Some of the points not achieved can be (could have been) achieved with relatively low additional effort in the best judgment of the reviewer. *This does not mean that the project team should have achieved those points*. Rather it means that these points might be considered attainable on future projects or might still be attainable on the project reviewed here. These points can typically be earned with additional person-hours dedicated to completing paperwork, forms or calculations. They would likely incur additional costs associated with person-hours expended, but they would likely not raise the project's construction bid price. The potential score for this project is 55, and the corresponding certification level is Gold. Points that can be achieved with relatively low additional effort are shown in the *P* column in Figure 3.

Maximum possible score. The maximum possible score reflects the maximum number of points the project could have earned even if they incur greater initial cost and/or life-cycle cost. This includes all credits excepting those that are not reasonable to include given project scope and intent. Achieving the maximum possible score would likely incur added expense both in person-hours and bid price for initial cost, but many items may still result in a lower life-cycle cost. The maximum potential score for this project is 98, and the corresponding certification level is Evergreen.

Table 1 summarizes the results of this Greenroads Case Study.
Figure 3 is the Greenroads Scorecard for this project.

Table 9: Summary of Pilot Project Results

Project Name	US 97: Lava Butte – S. Century Drive Section
Project Requirements Met (of 11 Total)	8
Voluntary Credit Points Earned (of 108 Total)	39
Custom Credits Identified	7
Comments	PRs Incomplete
Achieved Score	46
Achieved Certification	Silver (if PR's were completed)
Potential Score	55
Potential Certification	Gold
Maximum Possible Score	98
Maximum Possible Certification	Evergreen

Point Totals
A = Achieved by this project
P = Potientially achievable with low additional effort
M = Maximum achievable regardless of cost

Certification Levels
C = Certified (All PR's Met + At Least 32 Points)
S = Silver (All PR's Met + At Least 43 Points)
G = Gold (All PR's Met + At Least 54 Points)
E = Evergreen (All PR's Met + At Least 64 Points)

Credit Scorecard

Project Requirements (PR)		Possible	A	P	M
PR-1	Environmental Review Process	Req	X	X	X
PR-2	Lifecycle Cost Analysis	Req	X	X	X
PR-3	Lifecycle Inventory	Req		X	X
PR-4	Quality Control Plan	Req	X	X	X
PR-5	Noise Mitigation Plan	Req		X	X
PR-6	Waste Management Plan	Req		X	X
PR-7	Pollution Prevention Plan	Req	X	X	X
PR-8	Low-Impact Development	Req	X	X	X
PR-9	Pavement Management System	Req	X	X	X
PR-10	Site Maintenance Plan	Req	X	X	X
PR-11	Educational Outreach	Req	X	X	X
	Total	**11**	**8**	**11**	**11**

Environment & Water (EW)		Possible	A	P	M
EW-1	Environmental Management System	2			2
EW-2	Runoff Flow Control	1 - 3			3
EW-3	Runoff Quality	1 - 3			3
EW-4	Stormwater Cost Analysis	1		1	1
EW-5	Site Vegetation	1 - 3	3	3	3
EW-6	Habitat Restoration	3			
EW-7	Ecological Connectivity	1 - 3	3	3	3
EW-8	Light Pollution	3			3
	Total	**21**	**6**	**7**	**18**

Access & Equity (AE)		Possible	A	P	M
AE-1	Safety Audit	1 - 2			2
AE-2	Intelligent Transportation Systems	2 - 5	3	3	5
AE-3	Context Sensitive Solutions	5	5	5	5
AE-4	Traffic Emissions Reduction	5	5	5	5
AE-5	Pedestrian Access	1 - 2	1	1	2
AE-6	Bicycle Access	1 - 2	1	1	2
AE-7	Transit & HOV Access	1 - 5			
AE-8	Scenic Views	2	2	2	2
AE-9	Cultural Outreach	1 - 2		1	2
	Total	**30**	**17**	**18**	**25**

Construction Activities (CA)		Possible	A	P	M
CA-1	Quality Management System	2			2
CA-2	Environmental Training	1		1	1
CA-3	Site Recycling Plan	1		1	1
CA-4	Fossil Fuel Reduction	1 - 2			2
CA-5	Equipment Emission Reduction	1 - 2			2
CA-6	Paving Emission Reduction	1	1	1	1
CA-7	Water Use Tracking	2		2	2
CA-8	Contractor Warranty	3			3
	Total	**14**	**1**	**5**	**14**

Materials & Resources (MR)		Possible	A	P	M
MR-1	Lifecycle Assessment	2			2
MR-2	Pavement Reuse	4- 5	4	4	5
MR-3	Earthwork Balance	1			
MR-4	Recycled Materials	1 - 5	2	5	5
MR-5	Regional Materials	1 - 5	4	5	5
MR-6	Energy Efficiency	5			
	Total	**23**	**10**	**14**	**17**

Pavement Technologies (PT)		Possible	A	P	M
PT-1	Long-Life Pavement	5	5	5	5
PT-2	Permeable Pavement	3			
PT-3	Warm Mix Asphalt	3		3	3
PT-4	Cool Pavement	5			5
PT-5	Quiet Pavement	2 - 3			
PT-6	Pavement Performance Tracking	1			1
	Total	**20**	**5**	**8**	**14**

Custom Credit (CC)		Possible	A	P	M
CC-1/2	Custom Credit Title	1 - 5	5	5	5
CC-3/4	Custom Credit Title	1 - 5	2	2	5
	Total	**10**	**7**	**7**	**10**

All 11 PR Met?		**No**	**Yes**	**Yes**
Greenroads Total	**108**	**46**	**59**	**98**
Certification Level			**G**	**E**

Figure 13 Greenroads Scorecard

CREDIT DISCUSSION BY CATEGORY

This section contains a detailed review of credits awarded and not awarded to the US 97: Lava Butte – S. Century Drive Section. Credit intent will not be discussed, and the reader is referred to Appendix A for these details.

PROJECT REQUIREMENTS (PR)

This project met 8 of 11 Project Requirements. These are outlined in Table 2.

Table 10: Project Requirements Category

Requirements Met		Requirements Not Met	
No.	*Title*	*No.*	*Title*
PR-1	Environmental Review Process*	PR-3	Lifecycle Inventory (LCI)
PR-2	Lifecycle Cost Analysis (LCCA)*	PR-5	Noise Mitigation Plan
PR-4	Quality Control Plan*	PR-6	Waste Management Plan
PR-7	Pollution Prevention Plan*		
PR-8	Low-Impact Development (LID)*		
PR-9	Pavement Maintenance Plan*		
PR-10	Site Maintenance Plan*		
PR-11	Educational Outreach		

*Denotes reference in Standard Specifications, or institutional best practice.

PR-1 Environmental Review Process

DETAILS

The Federal Highway Administration (FHWA) evaluated the Environmental Assessment and Revised Environmental Assessment and found them to adequately discuss the need, environmental issues, impacts of the project, and appropriate mitigation measures. The FHWA determined that an environmental impact statement was not required and issued a Findings of No Significant Impact (FONSI) in December 2008.

RATIONALE

This project completed the National Environmental Policy Act (NEPA) process because it involved federal funding.

COST

The cost of preparing the Environmental Assessment was $625,000.

BENEFIT

The Environmental Assessment combined the analysis of the impacts and benefits of the project with input from the public and jurisdictional agencies. It allowed the best course of action to be developed based on its ability to best accomplish the objectives while also carefully focusing on avoidance, minimization of impacts, and mitigation.

PR-2 Lifecycle Cost Analysis (LCCA)

DETAILS

A Pavement Lifecycle Cost Analysis was prepared for this project.

RATIONALE

According to the ODOT Pavement Design Guide, LCCA for new pavement construction shall be conducted on projects where more than one mile of new roadbed will be constructed, and the results shall be used as a tool to select appropriate pavement design strategies. For rehabilitation of existing pavements, LCCA must be conducted where major rehabilitation is necessary, where options of different life expectancies are being considered, and when considering pavement design strategies with structural life less than the minimum standard of 15 years.

PR-3 Lifecycle Inventory (LCI)

DETAILS

This PR was not completed by the project team. As part of this Pilot Project, the reviewer prepared an LCI using the PaLATE tool. Results indicated that over the life of the project, initial construction and maintenance activities (assumed to be a 2-inch mill-and-fill every 15 years) will use approximately 57,300 GJ of energy and produce 4.74 million kg of carbon dioxide equivalents.

RATIONALE

An LCI was not prepared by the project team because this is not a standard practice for ODOT projects. However, future ODOT projects could achieve this PR with low additional effort because the PaLATE tool can be used by a member of the project team to prepare an LCI in less than one hour.

PR-4 Quality Control Plan

DETAILS

Quality Control (QC) Plans were prepared for design and construction. The project documents specified various forms of quality control for work performed. The construction contractor prepared a QC Plan for materials testing, as required by the contract with ODOT.

RATIONALE

As part of ODOT standard practice, the agency required the contractor to prepare a QC Plan that followed established policies, such as those in the ODOT Manual of Field Testing Procedures.

COST

The cost for designers to prepare QC Plans was approximately $1,000 to $2,000. The cost for the contractor to prepare the QC Plan for materials was $1,000.

BENEFIT

The QC Plans ensured that design and regulatory requirements were met.

PR-5 Noise Mitigation Plan

DETAILS

This PR was not completed because a formal Noise Mitigation Plan (NMP) was not prepared according to the requirements in the Greenroads Manual.

RATIONALE

ODOT outlined project-specific noise mitigation procedures in the Final Noise Technical Report and incorporated these procedures in the project specifications. For example, wildlife concerns led to restrictions on when drilling and blasting activities could be performed. It is standard practice for ODOT to prepare Noise Technical Reports when deemed necessary and to incorporate all noise mitigation procedures into the project specifications.

The construction contractor (including subcontractors) followed the noise mitigation procedures included in the project documents, but did not prepare a formal NMP. Formal NMP's are not part of the contractor's standard practice, so future ODOT projects can achieve this PR by including an NMP requirement as part of the project contract.

This PR could have been accomplished with minimal additional effort, as writing the requirement into the project contract and writing the NMP require very little time and effort.

PR-6 Waste Management Plan

DETAILS

This PR was not completed because a formal Construction and Demolition Waste Management Plan (CWMP) was not prepared according to the requirements in the Greenroads Manual.

RATIONALE

Waste management measures were included in the contract documents, as ODOT has numerous policies and procedures for handling waste materials. However this project requirement was not met because the contractor was not required to prepare a formal CWMP. Formal CWMP's are not part of the contractor's standard practice, so future ODOT projects can achieve this PR by including a CWMP requirement as part of the project contract.

This PR could have been accomplished with minimal additional effort, as writing the requirement into the project contract and writing the CWMP would have required very little time and effort.

PR-7 Pollution Prevention Plan

DETAILS

This PR was completed. The Temporary Erosion and Sedimentation Control procedures were included in the project documents.

RATIONALE

Temporary Erosion and Sedimentation Control procedures are required for all ODOT projects that are not deemed exempt.

COST

The cost of producing the Temporary Erosion and Sedimentation Control was $515.

BENEFIT

The Temporary Erosion and Sedimentation Control procedures were used to minimize the effects of pollution associated with the construction of this project.

PR-8 Low-Impact Development (LID)

DETAILS

This PR was completed. Although a LID hydrologic evaluation was not provided by the project team, it is reasonable to assume that an evaluation was performed because ODOT policies encourage the use of low-impact development (LID).

RATIONALE

This PR was achieved because ODOT voluntarily emphasizes the value of LID for its projects. More information about ODOT's LID practices, including case studies and cost information, can be found at http://www.oeconline.org/our-work/rivers/stormwater/low-impact-development/lid-practices.

COST

The cost of achieving this PR could not be extracted.

BENEFIT

According to the Fact Sheet about LID for Oregon, LID provides the following benefits:

For the environment

- Protects water quality
- Maintains natural stream flows in rivers, creeks and wetlands
- Provides and protects fish and wildlife habitat
- Improves air quality

- Maintains soil quality

For developers

- More attractive, sustainable neighborhoods that sell faster and for a premium
- Reduces stormwater utility fees
- Reduces the cost of clearing, excavation, compaction, erosion control, and infrastructure construction
- Can provide more buildable lots by distributing stormwater management around the site in small facilities instead of building a single large detention pond

For communities

- Helps prevent flooding and reduces the cost of associated damage
- Helps maintain clean drinking water supplies
- Can lower cost of streets, curbs, gutters and other infrastructure
- Increases the aesthetics of neighborhoods
- Reduces long-term maintenance costs

For agencies

- Helps meet regulatory requirements, including the Federal Clean Water Act (MS4 permits and TMDL plans), Endangered Species Act, Safe Drinking Water Act, and state land use planning goals 5 and 6

PR-9 Pavement Management Program

DETAILS

The ODOT Construction Section operates a Pavement Management System (PMS) through its Pavement Services Unit. Pavement Management Reports are prepared every two years and made available on the ODOT website (http://www.oregon.gov/ODOT/HWY/CONSTRUCTION/pavement_management_sys.shtml). The website also provides public access to Pavement Condition and Remaining Service Life Spreadsheets, which record when preservation efforts occur.

RATIONALE

ODOT has chosen to use the Pavement Management System for all mainline state highways under its jurisdiction.

COST

Based on the budget for PMS and the number of lane miles in the system, the system costs approximately $25 per lane mile per year to operate. Therefore after construction, PMS for this project area will cost approximately $400 per year.

BENEFIT

The Pavement Management System provides decision makers with information necessary to find cost effective strategies for providing, evaluating, and maintaining pavements in a serviceable condition.

PR-10 Site Maintenance Plan

DETAILS

Maintenance responsibility for this site is shared among the Forest Service, Deschutes County, Oregon Department of Fish and Wildlife, and ODOT according to the Intergovernmental Agreement Maintenance Agreement. The Agreement specifies the areas of the project that each agency is responsible for and designates a primary contact for maintenance.

RATIONALE

Preparing Intergovernmental Agreement Maintenance Agreements and planning the maintenance of road construction projects is standard practice for ODOT.

COST

Cost information for this PR could not be extracted because, for the most part, maintenance will be performed as needed. The cost will be quite variable from year to year and will depend heavily on the weather conditions each season.

BENEFIT

This project will benefit from the shared responsibility among the Forest Service, Deshutes County, Oregon Department of Fish and Wildlife, and ODOT because maintenance will be performed by the agency that has the most experience with each type of work. Each agency will also benefit from the agreement because it will share the cost of maintenance with the other agencies.

PR-11 Educational Outreach

DETAILS

The project involved at least the following three educational elements:

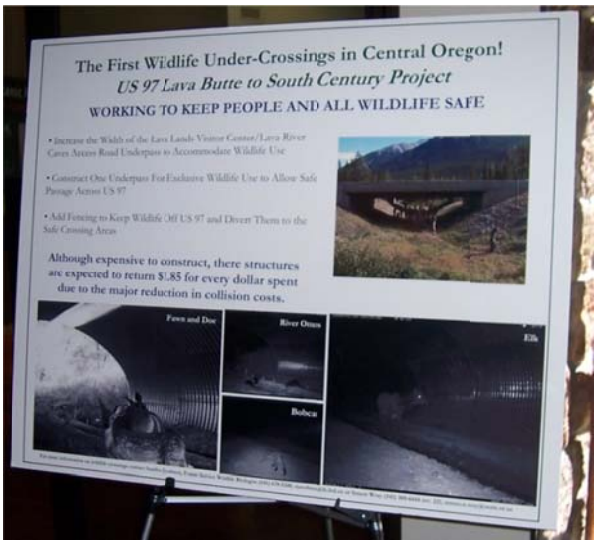
4. A point-of-interest kiosk at the Lava Lands Visitor Center displays information about the project.

5. The informational project website allows the public to submit feedback and comments. The website can be accessed at http://www.oregon.gov/ODOT/HWY/REGION4/US97_Lava_Butte_South_Century_Drive/US97LavaButte_SouthCenturyDrive.shtml.

6. The project is documented with this Greenroads Pilot Project.

RATIONALE

ODOT offered the point-of-interest kiosk and the website voluntarily because the project team believed that it was important for the public to be aware of this project. The project offered a unique educational opportunity because it was located in the Newberry National Volcanic Monument and included the Lava Lands Visitor Center, where thousands of people come each year to learn more about the surrounding area. ODOT wanted to take advantage of this opportunity to teach people about the impact roadways have on the environment and how the impact can be reduced with features such as the wildlife under crossings. After the project is completed, the Forest Service plans to install a permanent exhibit at the visitor center that will include photographs, video footage, and educational material about the wildlife under crossings.



ODOT also voluntarily pursued education outreach by using this project for a Greenroads Pilot Project. This decision reflected ODOT's desire to further its sustainability goals and learn about how it can evaluate the sustainable features of its roadway projects.

in the

COST

The cost of providing a point-of-interest kiosk and an informational website was approximately $20,000.

The cost of having this Pilot Project Report prepared was approximately $25,000. This cost was not associated with the project budget, however, as the funds came from the ODOT research budget. This cost must also include a caveat because it is an approximate estimate of the cost for the University of Washington research team to review project documents, perform a site visit, and prepare this report. If this project had applied for certification, the project team would have collected the documentation and performed the necessary calculations. This would have shifted the cost burden from the University of Washington to the project team, but the additional cost would be expected to be much less than $25,000.

BENEFIT

The public benefitted from opportunities to learn more about the project through the point-of-interest kiosk and an informational website. People learned about the environmental impacts of the project and stayed informed about the progress of construction activities.

ODOT also benefitted from the educational outreach features because it used the kiosk and website to form a relationship with the public, to receive public input, and to generate positive publicity for the project.

ENVIRONMENT & WATER (EW)

This project earned 6 of the 21 points available in this category. The points were awarded for using non-invasive, native plants that do not require irrigation after the plant establishment period, and for implementing two wildlife crossings. The credits earned in this category are outlined in Table 3.

Table 11: Environment & Water Voluntary Credit Category

Credits Earned		Credits Not Earned	
No.	*Title*	*No.*	*Title*
EW-5	Site Vegetation	EW-1	Environmental Management System
EW-7	Ecological Connectivity	EW-2	Runoff Quantity
		EW-3	Runoff Quality
		EW-4	Stormwater Cost Analysis
		EW-6	Habitat Restoration
		EW-8	Light Pollution

EW-1 Environmental Management System

DETAILS

This credit was not earned.

RATIONALE

The general contractor, Knife River Corporation, does not have a formal environmental management process. The project superintendent remarked that while environmental concerns were a focus of this project, Knife River does not have a company-wide environmental policy.

This project could have achieved this credit, but it would have depended on a significant effort from the general contractor to implement a company-wide environmental management system.

EW-2 Runoff Flow Control

DETAILS

This credit was not earned. Prior to construction, the mean storm flow was 0.68 ft^3/sec and the mean storm volume was 59,198 ft^3. After construction, the mean storm flow was 1.40 ft^3/sec and the mean storm volume was 121,898 ft^3. Predevelopment values were therefore 49% of post-construction values. This percentage must be at least 80% to earn points for EW-2 Runoff Flow Control according to the Greenroads Manual.

RATIONALE

The hydraulic analysis for this project determined that runoff flow control facilities were not necessary according to ODOT stormwater control policies. The soil in the project area is a very porous volcanic material, which drains readily.

The project could have achieved this credit, but it would have required a significant increase in project cost to design and construct runoff flow control facilities.

EW-3 Runoff Quality

DETAILS

This credit was not earned.

RATIONALE

As stated above, the hydraulic analysis determined that runoff flow control facilities were not necessary for this project. Therefore, this project did not include runoff flow control facilities to treat stormwater.

The project could have achieved this credit, but it would have required a significant increase in project cost to design and construct runoff flow control facilities.

EW-4 Stormwater Cost Analysis

DETAILS

This credit was not earned.

RATIONALE

There was no need to prepare a Stormwater Cost Analysis for this project because, as stated above, the hydraulic analysis determined that no runoff flow control facilities were necessary. ODOT's standard practice is to prepare a Stormwater Cost Analysis only when the location of the project gives rise to multiple stormwater utility options.

The project could have achieved this credit with low additional effort because this VC does not require the use of runoff flow control facilities, but rather a comparison of potential costs.

EW-5 Site Vegetation

DETAILS

The project was awarded three points for using non-invasive plant species only, not using irrigation after the plant establishment period, and using native plant species only.

RATIONALE

Plant species were chosen to meet USDA Forest Service guidelines on the avoidance of noxious weed species and the use of native species.

COST

The Forest Service developed a revegetation plan, collected and purchased plants, provided labor and installation to implement the revegation plan, and agreed to perform monitoring for one, three and five years. For these services, ODOT paid the Forest Service approximately $500,000.

BENEFIT

In addition to meeting Forest Service guidelines and avoiding causing future noxious weed issues, the vegetation on this project promoted aesthetic and wildlife connectivity goals. The use of native plant species was in line with aesthetic goals because they helped preserve the natural look of the national monument. Vegetation was planted under the underpasses to provide a more natural feeling for large animals and hiding cover for smaller animals using the structure. According to Sandra Jacobson, a wildlife biologist for the Forest Service, the vegetation plan also represents a step towards learning how to create "ecosystem process" passages that function to connect processes as well as wildlife movement.

EW-6 Habitat Restoration

DETAILS

This credit was not earned.

RATIONALE

This credit requires the Index of Biological Integrity (IBI), which characterizes the biological functionality of a water body. The IBI could not be determined for this project because the area does not include a water body.

The offsite habitat improvement goal for this VC was addressed because ODOT and the Forest Service worked together to treat 28.33 miles of unwanted roads in adjacent areas of the Deschutes National Forest. Of this, 14.95 miles were closed, decompacted, and revegetated and 13.38 miles were closed and allowed to revegetate naturally. These roads were identified prior to this project by the Deschutes National Forest as being in excess of travel needs, and the this project provided a good opportunity to close them. This represents an area of roughly 55 acres restored, compared to roughly 25 acres of newly disturbed surface for this project. This restoration activity does not, however, meet all of the requirements of the Habitat Restoration Credit.

Future versions of the Greenroads Manual should consider addressing this problem by allowing all projects to achieve this credit regardless of whether the area includes a water body.

COST

The estimated cost of closing the unwanted roads is $78,700.

BENEFIT

By closing the unwanted roads in the Deschutes National Forest, the agencies hope to mitigate the amount of habitat loss caused by this project. The increased wildlife habitat area is also expected to increase the effectiveness of the wildlife underpasses.

EW-7 Ecological Connectivity

DETAILS

Three points were awarded for this credit. This project involved installation of two sets of new wildlife crossing structures and protective fencing. The wildlife crossing structures were primarily designed for deer, but they will also likely provide connectivity for species such as coyote, bobcat, cougar, elk, and smaller animals such as badger, fox, wolverine, marten, and others.

Figure 15 Ecological Connectivity
This under crossing (shown under construction) was designed for the exclusive use of wildlife.

RATIONALE

In accordance with the USDA Forest Service's mandate to maintain viability of wildlife species, the wildlife crossing structure and fencing were chosen to provide a mitigation measure to help restore migratory mule deer herd access to winter range and also reduce vehicle collisions. Additionally, because the forest service is mandated to manage all species, the structures were designed to be effective for all wildlife in the area.

COST

Each wildlife crossing consisted of fencing and two structures, one under each side of the highway. The southern crossing was designed exclusively for use by wildlife. Construction costs for this pair of structures totaled approximately $1.1 million.

The northern underpass was originally designed to provide safe pedestrian, bicycle, and vehicle access to the Lava Lands Visitor Center during the summer. ODOT and the Forest Service later decided to modify the design to provide another purpose, to allow wildlife to cross the highway safely and undisturbed when there are no people present (which is all day during winter months when the Visitor Center is close). The bridge structures were designed larger to allow more space for animals to walk through the unpaved area, and more wildlife fences were added to guide animals to the under crossing. Therefore, the total construction costs for the structures cannot be attributed to ecological connectivity alone. The total cost of the fencing and structures is approximately $2.5 million. The project designers estimated that 20% of this cost, or $500,000, can be considered the additional cost of adding the wildlife crossing function to the feature.

In addition, ODOT is responsible for the cost of operating and maintaining of the wildlife fence, up to $2,000 in any state fiscal year.

BENEFIT

The land management agencies are hopeful that the crossing structures and fencing will enable the remaining migratory mule deer to restore their traditional access to winter range, although the numbers have been dramatically reduced from wildlife/vehicle collisions and other factors. The structures will also enable movement of all other animals in the area to cross the highway safely. Additionally, any animals using the structures will not be on the highway, therefore the risk of animal/vehicle collisions will be reduced.

ODOT conducted a cost-benefit analysis of the structures and found that $1.85 of benefit to taxpayers would be achieved for every $1.00 spent on the mitigation. This considered property damage alone and did not consider the risk of human injury or fatality, nor did it consider the value of wildlife. Thus, the benefit is actually a very conservative estimate.

EW-8 Light Pollution

DETAILS

This credit was not earned.

RATIONALE

No points were awarded for this credit because no Dark-Sky compliant lamps were used. The project site did not involve existing lighting, not were new lighting fixtures installed. No lighting was used during construction. The decision to avoid using illumination was based on protection of the natural habitat. If the project would have included a lighting system, Dark-Sky compliant lamps would have been used as part of ODOT standard practice for a forest setting.

This indicates that use of no lighting may address the intent of the Light Pollution Credit in the context of a rural road project. Future revisions of the Greenroads Manual should consider this modification.

COST
Based on the preliminary lighting design that was ultimately omitted, the decision not to use lighting reduced the project budget by $200,000.

BENEFIT
The choice to not use lighting reduced the project budget and helped protect the natural habit for wildlife.

ACCESS & EQUITY (AE)

This project earned 17 of the 30 points available in this category. Many of these points resulted from using a Context Sensitive Solutions approach to project planning. This approach allowed the project team to address the needs of various stakeholders, including pedestrians and bicyclists. The credits are outlined in Table 4.

Table 12: Access & Equity Voluntary Credit Category

Credits Earned		Credits Not Earned	
No.	*Title*	*No.*	*Title*
AE-2	Intelligent Transportation Systems	AE-1	Safety Audit
AE-3	Context Sensitive Solutions	AE-7	Transit and HOV Access
AE-4	Traffic Emissions Reduction	AE-9	Cultural Outreach
AE-5	Pedestrian Access		
AE-6	Bicycle Access		
AE-8	Scenic Views		

AE-1 Safety Audit

DETAILS
This credit was not earned.

RATIONALE
ODOT recently began conducting safety audits on a voluntary basis for select projects. Therefore this project could potentially earn this credit, but only with a significant amount of additional effort from ODOT personnel.

AE-2 Intelligent Transportation Systems

DETAILS
This project earned three points for including intelligent transportation system (ITS) applications from three separate categories:

4. Road Weather Management: ODOT's Road Weather Information Systems (RWIS) use sensors at weather stations to monitor weather conditions. The information is used for making winter road maintenance decisions and is shared with the public through TripCheck, Oregon's website for road conditions.

5. Information Dissemination: Changeable message signs were used during construction. Highway Advisory Radio (HAR) disseminates information about roadway conditions via AM radio frequencies to motorists en-route on Oregon's highways.

6. Traveler Information: TripCheck (http://www.tripcheck.com), TripCheck Mobile, and 511 make information available to travelers before their trip and en-route.

RATIONALE
ODOT voluntarily provides RWIS, TripCheck, HAR, and 511 as statewide ITS programs.

COST
The cost of providing changeable message signs during construction was $8,000. Cost information for the rest of this credit could not be extracted because these programs are statewide and the cost to maintain and run the program varies with the type of roadway and weather conditions.

BENEFIT
ODOT makes use of ITS to address transportation problems and enhance the movement of people and goods.

AE-3 Context Sensitive Solutions

DETAILS
Context Sensitive Design was effectively achieved as part of the Environmental Assessment. Five points were awarded.

RATIONALE
The Environmental Assessment was prepared as part of the National Environmental Policy Act (NEPA) process because the project involved federal funding. From the Forest Service's perspective, Context Sensitive Solution principles are similar to the USDA Forest Service's interdisciplinary process and public involvement process, so it was standard operating procedure.

COST
The cost of creating a Context Sensitive Design could not be extracted because the focus on interdisciplinary work and public involvement was part of the overall planning process.

BENEFIT
The Context Sensitive Solutions approach led to a project design that addressed the needs of multiple parties, including ODOT, the Forest Service, Deschutes County, the Department of Fish and Wildlife, and the public. The design also incorporated the need for multiple modes of transportation, as described in AE-4 and AE-5 below.

AE-4 Traffic Emissions Reduction

DETAILS
Five points were awarded for this credit. Oregon House Bill 3543 establishes the state's policies for reducing greenhouse (GHG) gas emissions to specified goals, which include achieving GHG emission reduction of 10% below 1990 levels by 2020. The policies apply to the transportation sector and require the Oregon Global Warming Commission to include a member with significant experience in transportation. Oregon's State Standard Exceedance Levels mandate Clean Air Act criteria pollutants to be equal to or less than the current Environmental Protection Agency's (EPA) design values.

RATIONALE
Oregon House Bill 3543 reflects Oregon Governor Kulongoski's (and presumably his constituents') concern with reducing greenhouse gas emissions.

COST
The cost of achieving this credit could not be extracted because it depended on establishing a state policy, which was not directly linked to project costs.

AE-5 Pedestrian Access

DETAILS
One point was awarded for providing pedestrian access via the under crossing for the Lava Lands Visitor Center. This improvement did not qualify for two points because the under crossing did not include a sidewalk that is separated from the roadway.

RATIONALE

The under crossing addressed the need for a safer means for pedestrians to cross the highway to access the Lava Lands Visitor Center. It accommodates vehicles, non-motorists, and wildlife when people are not present.

In addition, the new shoulders constructed in the project area were designed wide enough to accommodate pedestrians, particularly along Cottonwood Road and along the new access road. Although this does not fit the requirements of AE-5 Pedestrian Access, this indicates that extra wide shoulders may address the intent of the credit in the context of a rural road project. Future revisions of the Greenroads manual should consider this modification.

COST

The construction cost for the undercrossing (which includes three overcrossing bridge structures but not the wildlife fencing) was approximately $2.09 million. It is important to note that this cost cannot be attributed to pedestrian access only, as the undercrossing also provides bicycle and wildlife access.

BENEFIT

This under crossing provided many benefits. It addressed one of the identified goals of the project, which was to provide safer pedestrian access to the Lava Lands Visitor Center. In addition, it provided bicycle access and wildlife connectivity. More information about these benefits can be found in the AE-6 Bicycle Access and EW-7 Ecological Connectivity sections.

AE-6 Bicycle Access

DETAILS

One point was awarded for providing bicycle access via the under crossing for the Lava Lands Visitor Center. This improvement did not qualify for two points because the under crossing did not include a bicycle only facility.

RATIONALE

This credit is similar to the Pedestrian Access Credit described above. The under crossing addressed the need for a safer means for bicyclists to cross the highway to access the Lava Lands Visitor Center. It accommodates vehicles, non-motorists, and wildlife when people are not present.

In addition, the new shoulders constructed in the project area were designed wide enough to accommodate bicycles because improved safety for bicyclists was identified as one of the needs for this project. Although this does not fit the requirements of AE-6 Bicycle Access, this indicates that extra wide shoulders may address the intent of the Bicycle Access Credit in the context of a rural road project. Future revisions of the Greenroads manual should consider this modification.

COST

The construction cost for the undercrossing (which includes three overcrossing bridge structures) was approximately $2.09 million. It is important to note that this cost cannot be attributed to bicycle access only, as the undercrossing also provides pedestrian and wildlife access.

BENEFIT

As described above, the under crossing provided many benefits. It addressed one of the identified goals of the project, which was to provide safer bicyclist access to the Lava Lands Visitor Center. In addition, it provided pedestrian access and wildlife connectivity.

AE-7 Transit and HOV Access

DETAILS

This credit was not earned.

RATIONALE

This VC was not achieved because transit and HOV access were not practical design goals for a highway in a rural area.

AE-8 Scenic Views

DETAILS

Two points were awarded for this credit. The segment of US 97 involved in this project is not a designated National Byway. However it is known as a Scenic Corridor, meaning that it is managed for foreground scenic view retention under the Standards and Guidelines of the Deschutes National Forest Land and Resource Management Plan.

Figure 16 Scenic Views
Protecting the scenic view was a primary design goal for this project, which is shown in the background of this photograph.

RATIONALE

This segment of US 97 is a Scenic Corridor because of its location in the Deschutes National Forest.

COST

There are no costs associated with this credit because the highway was a scenic corridor before the project began.

BENEFIT

As a Scenic Corridor, the project site is protected by the Foreground Scenic Retention Standard in the Deschutes National Forest Land and Resource Management Plan. This standard prohibits activities that are visually apparent to the casual forest visitor in order to preserve the value of the visual resource.

AE-9 Cultural Outreach

DETAILS

This credit was not earned.

RATIONALE

There are multiple Historic Places within 10 miles of the project boundary, including Old Town Historic District. However, the project site did not include any informational infrastructure to direct roadway users to the Historic Places. This credit could have been achieved with minimal additional cost by installing a sign in the project area that directs visitors to the Historic Places.

This project was located in the Newberry National Historic Monument, a designation that helps protect the area from further development and allows visitors to experience the Lava Lands of Central Oregon. However, this did not qualify the project for this credit because the Newberry National Historic Monument is not listed on the United States Register of Historic Places. Future versions of the Greenroads Manual should consider including national historic monuments in the Cultural Outreach Credit.

CONSTRUCTION ACTIVITIES (CA)

For this category, one (1) of the 14 possible points was earned. The credits are shown in Table 5.

Table 13: Construction Activities Voluntary Credit Category

Credits Earned		Credits Not Earned	
No.	*Title*	*No.*	*Title*
CA-6	Paving Emission Reduction	CA-1	Quality Management System
		CA-2	Environmental Training
		CA-3	Site Recycling Plan
		CA-4	Fossil Fuel Reduction
		CA-5	Equipment Emission Reduction
		CA-7	Water Use Tracking
		CA-8	Contractor Warranty

CA-1 Quality Management System

DETAILS

This credit was not earned.

RATIONALE

The general contractor, Knife River Corporation, does not have a documented quality management system. This project could have achieved this credit, but only with substantial additional effort from the contractor.

CA-2 Environmental Training

DETAILS

This credit was not earned.

RATIONALE

ODOT has policies in place for requiring environmental training and reporting, but there is no requirement for contractors to prepare a formal environmental training plan. Environmental training did occur for both ODOT's and the contractor's personnel for this project. For ODOT, construction inspection personnel were required to keep certifications or attend training on various construction activities, some of which require the inspectors to monitor specific environmental components (i.e. pollution and sediment control, noise, and protection of biological and cultural resources). At the preconstruction conference, ODOT briefed the contractor on key environmental conditions including wildlife migration, cultural resource protection, waste disposal, and natural resource protection.

This credit could have been achieved with low additional effort because it would have required very little time to summarize the training plan in a formal document.

CA-3 Site Recycling Plan

DETAILS

This credit was not earned.

RATIONALE

Several sections of the project specifications addressed material recycling, but a formal Site Recycling Plan was not prepared for this credit. Specifically, asphalt, duff material, concrete barrier and guardrail was recycled and/or reused. ODOT's standard practice is to recycle materials like these when possible.

This credit could have been achieved with low additional effort because it would have required little additional effort to address recycled materials in a Construction Waste Management Plan.

CA-4 Fossil Fuel Reduction

DETAILS

This credit was not earned.

RATIONALE

The general contractor did not own any non-road equipment that used biofuel or biofuel blends. The project superintendent was not aware of any plans that the company might have to use biofuel for its fleet.

The Oregon Department of Environmental Quality (ODEQ) created an incentive for using cleaner burning fuels with its Fleet Forward Program. More information about this program can be found here: http://www.deq.state.or.us/aq/fleet/home.htm

This project could have achieved this credit but only with substantial additional effort from the general contractor.

CA-5 Equipment Emission Reduction

DETAILS

This credit was not earned.

RATIONALE

The project personnel who were interviewed were not aware of any non-road construction equipment that achieved the EPA Tier 4 emission standard.

This project could have achieved this credit but only with substantial additional effort from the general contractor.

CA-6 Paving Emission Reduction

DETAILS

One point was awarded.

RATIONALE

Knife River uses NIOSH engineered controls on pavers as standard practice.

COST

The cost associated with this credit could not be extracted because the exhaust controls were already in place on the pavers and are used on all Knife River paving projects.

BENEFIT
The use of NIOSH engineered controls on pavers reduced worker exposure to asphalt fumes.

CA-7 Water Use Tracking

DETAILS
This credit was not earned.

RATIONALE
Water use was a particularly important aspect of this project because the porous rock material drains so quickly that insufficient watering led to compaction problems on previous projects in the area. ODOT project personnel monitored the water use closely to ensure that enough water was used to achieve proper compaction.

Another important aspect of the water use for this project was that the contractor obtained non-potable effluent from the local waste water treatment plant and used it for all water-related activities except curing the concrete. This is standard practice for Knife River, as it reduces the contractor's expense for obtaining water. Points were awarded under Custom Credits for using non-potable water for construction activities.

The contractor submitted daily tally sheets to ODOT to report the amount of and purpose for all water used. This is standard practice for ODOT projects and is required for the contractor to receive payment for the water used. However, neither the contractor nor ODOT tracked water use in a spreadsheet that addressed all of the necessary elements outlined in the Greenroads Manual.

This credit could have been achieved with very little additional effort. The information required for proper documentation was likely available from the contractor. Assembling the information into a single document would have required additional effort from the project team, but no additional construction costs.

CA-8 Contractor Warranty

DETAILS
This credit was not earned.

RATIONALE
In general, ODOT does not include contractor warranties with project contracts. Project personnel remarked that ODOT has expressed some interest in finding a way to incorporate contractor warranties but that this change is not likely to come in the very near future.

Therefore, while this credit could have been achieved for this project, it would have required substantial effort from ODOT personnel.

MATERIALS & RESOURCES (MR)

For this category, ten (10) of the 23 possible voluntary credits were earned. These credits acknowledged the reuse of at least 80% of the existing pavement, using at least 20% recycled asphalt pavement, and obtaining at least 90% of materials from within a 50 mile radius of the project. These credits are outlined in Table 6.

Table 14: Materials & Resources Voluntary Credit Category

Credits Earned		Credits Not Earned	
No.	*Title*	*No.*	*Title*
MR-2	Pavement Reuse	MR-1	Lifecycle Assessment (LCA)
MR-4	Recycled Materials	MR -3	Earthwork Balance
MR-5	Regional Materials	MR-6	Energy Efficiency

MR-1 Lifecycle Assessment (LCA)

DETAILS

This credit was not earned.

RATIONALE

ODOT does not prepare lifecycle assessments for any roadway projects. Therefore, while this credit could have been achieved for this project, it would have required substantial effort from ODOT personnel.

MR-2 Pavement Reuse

DETAILS

Four points were awarded for this credit. Based on the project manager's rough calculations, at least 80% of the existing pavement was reused for this project.

RATIONALE

The primary design decision that allowed the project to achieve this credit was to convert the existing two-lane alignment (one northbound lane and one southbound lane) into the southbound lanes and construct two new northbound lanes to provide additional capacity. This decision was based on cost savings and overall feasibility.

Although pavement is the only material addressed by this credit, it should be noted that several other materials were reused on this project, including tree stumps for mulch, duff material, concrete barrier and guardrail. After trees in the project area were logged, the construction contractor ground the stumps to produce nearly 12,800 cubic yards of mulch for use on the site. Future versions of the Greenroads manual should consider modifying this credit to award points for reusing materials other than pavement. For this report, points were awarded under Custom Credits for reusing vegetation material onsite.

COST

The cost of achieving this goal could not be extracted because there were savings associated with avoiding the construction of four new lanes and expenses associated with maintaining the older structure. While these quantities are difficult to estimate, the project designers believe that a substantial amount of money was saved by reusing the existing pavement.

BENEFIT

The benefits of reusing a large portion of the existing pavement include construction cost savings and reduced construction time.

MR-3 Earthwork Balance

DETAILS

This credit was not earned.

The cut and fill quantities were not closely balanced, and some material had to be imported. This caused the cut and fill quantities to be within about (A) 22%, the import to be about (B) 9% of the fill material, and the export to be (C) 0%. Therefore, A% + B% + C% was about 31%, which is greater than the allowable limit for the credit. Refer to the Greenroads Manual for further explanation of this equation. Refer to Appendix D of this report to see how these values were calculated.

RATIONALE

ODOT project designers typically try to balance the cut and fill quantities to minimize the cost of importing and exporting material. This goal could not be achieved for this project because the new northbound lanes had to be built at a higher elevation than the existing highway in order to protect the underground lava tube that runs from one side of the project to the other. The elevation restrictions made it impractical to design the project for an ideal cut and fill balance. Therefore, this credit was not practical for this project due to its location near sensitive volcanic features.

MR-4 Recycled Materials

DETAILS

Two points were awarded for this credit for using reclaimed asphalt pavement (RAP).

RAP accounted for 30% of the bases course and 20% of the wearing course (measured by weight of the material). The average RAP content was therefore between 20% and 30%, which qualified the project for two points.

RATIONALE

ODOT's policy is to allow RAP to account for up to 30% of pavement materials by weight. Paving contractors may choose how much RAP to use, but they typically include as much as possible to realize significant cost savings between the price of new asphalt binder and RAP.

COST

ODOT personnel estimate that using RAP on this project saved $10 to $15 per ton of pavement. This value is based on the current price of oil, as the asphalt binder is the most valuable material in RAP.

BENEFIT

The primary benefit of using RAP on this project was the cost savings experienced by the contractor and passed onto ODOT as part of the construction price.

MR-5 Regional Materials

DETAILS

Four points were awarded for obtaining at least 90% (based on cost) of materials from suppliers located within a 50 mile radius of the project site.

RATIONALE

The greatest contributions toward earning this credit came from obtaining embankment material and crushed rock aggregate from Gas Station Quarry (located about 4 miles from the project) and using local concrete and asphalt suppliers.

ODOT leased Gas Station Quarry from the National Forest Service and offered it to the contractor for use on this project. (The long term lease will also allow ODOT to offer the source to contractors for future projects in the area.) The contractor chose to use the Quarry because the only cost it involved was the price to load the material and haul it less than 4 miles. This greatly reduced the contractor's cost compared to obtaining the material from a private quarry and hauling it farther.

The contractor also chose the concrete and asphalt suppliers based on expected cost. The concrete was obtained from a supplier in Tumalo, Oregon, and the asphalt came from a plant in Redmond, Oregon.

COST

The cost savings associated with this credit could not be extracted, but they are expected to be quite significant. As described above, using Gas Station Quarry saved the contractor a great deal of money compared to obtaining the material from a private source, and these savings were passed onto ODOT. Using local suppliers to obtain concrete, asphalt, and other materials also reduced the costs for transportation.

BENEFIT

The primary benefit of using local regional materials for this project was the cost savings experienced by the contractor and passed onto ODOT.

MR-6 Energy Efficiency

DETAILS

This credit was not earned.

RATIONALE

The project site does not involve existing lighting, nor will new lighting fixtures be installed. Refer to EW-8 Light Pollution for a discussion of why lighting was not used on this project.

This credit is not practical for this project because it requires the use of lighting fixtures which are not necessary in this context.

PAVEMENT TECHNOLOGIES (PT)

For this category, five (5) of the 20 possible voluntary credits were earned for designing the new section of highway for long life. The credits are shown in Table 7.

Table 15: Pavement Technologies Voluntary Credit Category

Credits Earned		Credits Not Earned	
No.	*Title*	*No.*	*Title*
PT-1	Long-Life Pavement	PT-2	Permeable Pavement
		PT-3	Warm Mix Asphalt
		PT-4	Cool Pavement
		PT-5	Quiet Pavement
		PT-6	Pavement Performance Tracking

PT-1 Long Life Pavement

DETAILS

Five points were awarded for this credit. For the newly constructed section of highway, the base thickness was 11 inches, which exceeds the minimum base thickness for this credit. The equivalent single axle loads (ESAL's) were 15.3 million for the 20 year design life. According to Figure PT-1.1 in the Greenroads Manual, 15.3 million ESAL's corresponds to a minimum surfacing thickness of approximately 11 inches. The newly constructed section of the highway was designed with 11 inch thick pavement; therefore PT-1 Long Life Pavement was achieved.

RATIONALE

The ODOT Pavement Design Guide requires a minimum 20 year design life for new highway sections. In this case, the pavement design for the 20 year life met the requirements of the Long Life Pavement Credit.

COST

The cost associated with designing the pavement for long life could not be extracted because the design team did not consider using a shorter design life at any point.

BENEFIT

The use of long life pavement is expected to decrease lifecycle costs, as less rehabilitation and maintenance should be needed over time.

PT-2 Permeable Pavement

DETAILS

This credit was not earned.

RATIONALE

ODOT has used permeable pavement on an experimental basis for select test projects, but this project was not selected to be a test project. If it had been selected, it would have only been practical to use permeable pavement on the shoulders because permeable pavement is not suitable for high volume traffic loads. This relatively small

area would not likely have been able to treat the runoff volume required by the Greenroads Manual in order to achieve this credit.

Therefore, this credit is not practical for this project.

PT-3 Warm Mix Asphalt

DETAILS

This credit was not earned.

RATIONALE

ODOT has used warm mix asphalt (WMA) on several test projects, two of which were in Central Oregon. Some of the pavement sections experienced transverse cracking this winter, and there was concern that the cracking was related to the WMA. Therefore, although the contractor proposed using WMA on this project, ODOT chose not to make this a test project.

Because the contractor could have used WMA if ODOT allowed it, this credit could have been achieved with minimal additional effort.

PT-4 Cool Pavement

DETAILS

This credit was not earned.

RATIONALE

The project team was not aware of the use of cool pavement on any ODOT projects. ODOT would only use this technology on an experimental basis.

This credit could have been achieved, but it likely would have required a significant amount of addition effort from ODOT to make it a test project for cool pavement.

PT-5 Quiet Pavement

DETAILS

This credit was not earned.

RATIONALE

The project team was not aware of the use of quiet pavement on any ODOT projects. ODOT would only use this technology on an experimental basis. However, if ODOT had a test project effort underway, this project would not likely have been selected as a test project because it is not located in a densely populated area. In a report from the Norwegian Public Roads Administration, researchers found that quiet pavement was only an economical noise reduction solution in areas that have at least 100 households per kilometer[2]. There are no households in the immediate vicinity of this project, so quiet pavement would not have been a practical design feature.

Therefore, this credit is not practical for this project.

PT-6 Pavement Performance Tracking

DETAILS

This credit was not earned.

[2] Norwegian Public Roads Administration. (2009). *Environmentally Friendly Pavements.* Sandvika: ViaNova Plan og Trafikk AS.

RATIONALE

ODOT does not have a pavement performance tracking system, nor does it have plans to implement such a system in the future.

This credit could have been achieved for this project, but only with significant additional effort from ODOT to implement a pavement performance tracking system.

POTENTIAL CUSTOM CREDITS

Four (4) best practices implemented on this project were identified as possibly meriting a designation as a Greenroads Custom Credit. A total of seven (7) additional points are tentatively awarded. CC-1 and CC-3 would likely fit into the Environment and Water category, CC-2 would likely be categorized with Materials and Resources, and CC-4 would likely be categorized with Access and Equality. Note that research has not been completed at this time and that the Greenroads Development Team will review each credit application and vet the credit before incorporating it into later versions of the metric. Table 8 provides the credit title and intent.

Table 16: Potential Custom Credits

No.	Title	Pts.	Description
CC-1	Non-Potable Water Use	3	Eliminate the use of potable water for construction activities
CC-2	Vegetation Reuse	2	Reuse all vegetation cleared from the project site (See Figure 6)
CC-3	Habitat Creation	1	Construct new wildlife habitat features (e.g. bat roosting crevices beneath bridges) (See Figure 7)
CC-4	Aesthetics	1	Design structures to provide aesthetic appeal and blend in with the natural environment (See Figure 8)

Figure 17 Vegetation Reuse
Vegetation that was cleared from the project site was used onsite as duff material.

Figure 18 Habitat Creation
Bridge structures were designed to provide crevices where bats can roost.

Figure 19 Aesthetic Features
Texture and pigment were applied to bridge abutments (shown here before pigment was applied) to make them blend with the natural geology.

RECOMMENDATIONS

Several changes to the Greenroads manual were recommended in the sections above. The recommendations are summarized here:

- EW-6: The Habitat Restoration Credit should be modified to allow all projects to achieve this credit regardless of whether the area includes a water body. This project addressed part of the intent of this credit with an associated ODOT and Forest Service collaboration which treated 28.33 miles of unwanted roads in adjacent areas of the Deschutes National Forest. However, the project cannot earn any points for this credit the way it is currently written because it does not include a water body and the IBI cannot be calculated.

- EW-8: The Light Pollution Credit should be modified to allow projects located in rural areas to achieve this credit by opting not to implement a lighting system if it can be shown that the decision was based on protection of the environment. For this project, the design team chose to use no lighting over using Dark-Sky compliant fixtures because it reduced the impact on wildlife. However, this credit is written so that it could have only been achieved if Dark-Sky compliant fixtures were implemented.

- AE-5: The Pedestrian Access Credit should be modified to allow projects located in rural areas to achieve this credit by constructing extra-wide shoulders to accommodate non-motorists. The design team did not consider sidewalks as a practical feature for a highway in a forest, but rather decided to address the need for pedestrian access by designing extra-wide shoulders.

- AE-6: Like the Pedestrian Access Credit, the Bicycle Access Credit should be modified to allow projects located in rural areas to achieve this credit by constructing extra-wide shoulders to accommodate non-motorists. The design team did not consider bike-only facilities as a practical feature for a highway in a forest, but rather decided to address the need for bicycle access by designing extra-wide shoulders.

- AE-9: The Cultural Outreach Credit should be modified to allow projects located in or very near to National Historic Monuments to achieve this credit. This project is located in the Newberry National Volcanic Monument (and includes informational infrastructure to direct visitors to the Monument), but it cannot earn points for this credit because the Newberry National Volcanic Monument is not listed in the United State National Register of Historic Places.

- MR-2: The Pavement Reuse Credit should be modified to allow projects to earn points for reusing materials other than pavement. This project reused tree stumps for mulch, duff material, concrete barrier and guardrail, but could only earn points for using RAP.

The potential custom credits described in the previous section should also be considered for inclusion in future versions of the Greenroads Manual.

LIMITATIONS

Pilot Project results are based on discussions with project personnel only, and any project documents provided to the University of Washington Review Team. In general, more case studies of varying project types are needed to better reflect current ODOT sustainability practices. This Pilot Project Report provides only a small glimpse of current efforts on a specific project, and therefore study results may not accurately reflect the level of effort made toward sustainability best practices that are put forward by similar project types within ODOT.

Regulatory requirements tend to dictate many of the actions of most roadway project teams and transportation agencies. However, the intent of Greenroads is to encourage best practices that go above and beyond existing United States regulations and requirements. A list of current regulatory requirements is provided in the Introduction to the Greenroads Manual (Muench & Anderson, 2010).

Greenroads is continually under development. Case studies completed under the version 1.0.1 rating system that has been used to rate this project may not score equivalently under future versions of Greenroads.

APPENDIX A

About Greenroads

ABOUT GREENROADS

This section details the Greenroads Sustainability Performance Metric, including a brief background on development of the system, the operating definition of sustainability used, and a brief description of how it works and can be implemented. More detailed information, including the Version 1.0.1 manual of requirements and credits can be found on the official Greenroads website: http://www.greenroads.us.

The list of credits including a brief description is attached at the end of this short appendix.

BACKGROUND

Greenroads is a research project (Söderlund, 2007) that is jointly developed by the University of Washington (UW) and CH2M HILL. Greenroads is a collection of sustainability best practices that apply to roadway design and construction, much like the Leadership in Energy and Environmental Design (LEED) Rating System for Buildings that is administered by the United States Green Building Council (USGBC). In general, these sustainability best practices are divided into two types: required and voluntary. There is currently one required category with 11 required best practices called "Project Requirements" or PRs. At minimum, all of these best practices must be completed in order for a roadway to be considered a Greenroad.

What is a Greenroad?

A Greenroad is defined as roadway project that has been designed and constructed to a level of sustainability that is substantially higher than current common practice.

What is Sustainability?

Sustainability is the characteristic of a system that represents its capacity to support natural laws and human values. (Anderson, 2008; Muench et. al, 2010)

Projects that register using the Greenroads website are eligible to earn a certification award and will be able to display the Greenroads logo on their project to recognize their achievement.

STRUCTURE OF THE METRIC

In general, the Greenroads sustainability best practices are divided into two types: required and voluntary. There is currently one required category with 11 required best practices called "Project Requirements" or PRs. At minimum, all of these best practices must be completed in order for a roadway to be considered a Greenroad. Thirty-seven (37) other voluntary best practices are characterized in five additional categories, called "voluntary credits" or VCs. After the PR requirements have been met, a number of different VCs may be achieved and points may be earned toward one of four ratings: *Certified, Silver, Gold* and *Evergreen*. Additionally, a sixth VC category is available to projects that demonstrate and implement innovative ideas or more sustainable practices and would like to write or submit their own customized or new ideas for points.

Following is a brief description of the seven categories in Greenroads. The relative weights of the five main VC categories are shown in Figure A.1.

Project Requirements

This category contains all 11 Project Requirements (PR) that a Greenroads project must meet in order to be considered for a certification level award. The general intent of this category is to encourage environmentally responsible decision-making processes and to have management plans in place for construction, and to establish a minimum baseline for every project that applies for certification.

Environment & Water (EW)

This category contains eight (8) voluntary credits worth up to 21 points. The intent of this category is to promote best practices related to stormwater management and ecological resources within the project boundary.

Access & Equity (AE)
This category contains nine (9) voluntary credits worth up to 30 points. The intent of this category is to promote safety, access, and mobility to users of the roadway.

Construction Activities (CA)
This category contains eight (8) voluntary credits worth up to 14 points. The intent of this category is to promote responsible construction management, reduce use of fossil fuels and improve health and safety of construction workers.

Materials & Resources (MR)
This category contains six (6) voluntary credits worth up to 23 points. The intent of this category is to promote responsible materials and energy management by combinations of recycling, reusing and reducing both virgin and waste materials.

Pavement Technologies (PT)
This category contains six (6) voluntary credits worth up to 20 points. The intent of this category is to highlight specific pavement engineering innovations and ideas or broad types of technologies or techniques which are well-established in practice and have direct sustainability benefits.

Custom Credits (CC)
This category contains up to 10 credits which may be earned by a project that implements sustainable or innovative ideas. The project team may submit applications with a detailed description and explanation of the practice to earn credits in this category ranging in value from 1 to 5 points. Points awarded for the custom credit are determined through review and collaboration with Greenroads representatives. There is currently no limit established for how many custom credits a project may submit for review.

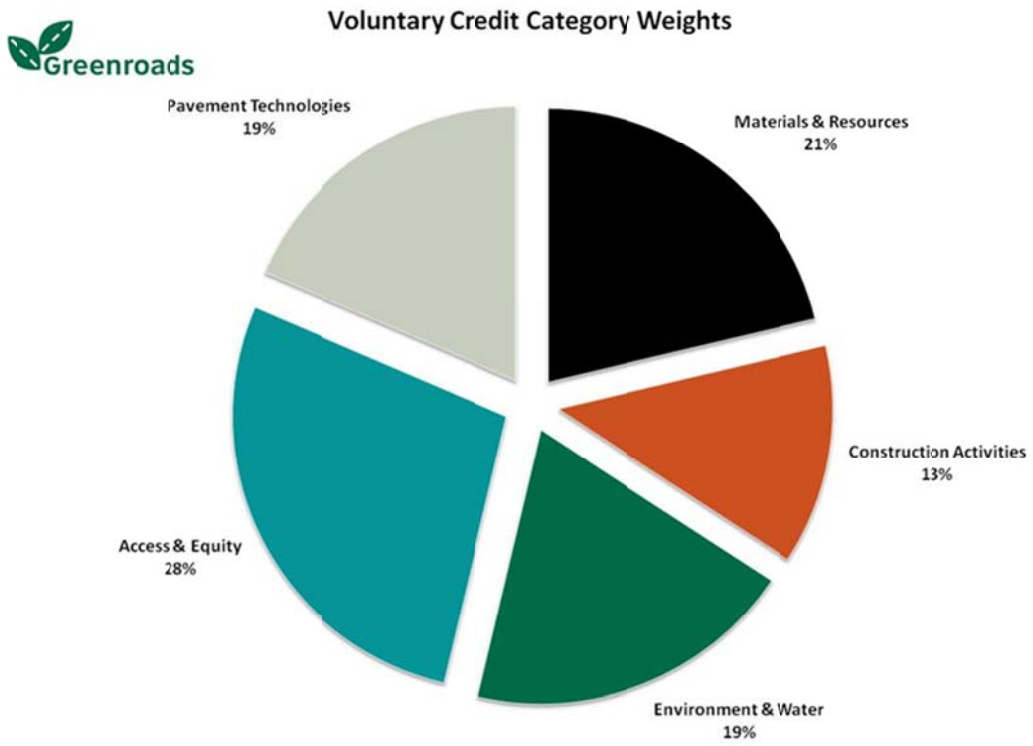


Figure A.20. Relative Weights of Greenroads VC Categories (Muench et al. 2010)

APPENDIX B

Case Study / Pilot Project Method

REVIEW METHODS

There are four types of Greenroads evaluations that vary in formality, objectives, time required, and level of effort for communication and documentation. This project review constitutes what is called a **Case Study.** All four methods are listed with a short description below for context of the method used.

What is a Workshop Assessment?

A workshop assessment is the least formal evaluation and requires no documentation. The format is interactive and discussion-based. Select PRs and VCs are reviewed to determine feasibility for a specific project while completing the Greenroads checklist. Participation is voluntary, but at least one Project Manager or design team lead should be present. The end result is a completed checklist that may be used as an internal benchmarking tool if desired.

What is a Case Study?

Generally a retroactive application of the Greenroads metric done on projects that are already completed, case studies are part of the calibration and testing process for validating the metric in its current state. Case studies include review of some documentation but in most cases, documentation may not be available. Case studies also require communication with a Project Manager, but in-person interaction is not necessary.

What is a Pilot Project?

A pilot project begins after initial completion of a case study. It involves ongoing communication between the Project Team and the Greenroads development team. Ultimately, the purpose of this process is to document and collect information regarding feasibility and practical barriers or successes for implementing some or all of the practices in Greenroads. This process lasts from completion of the case study through completion of the roadway project, and is characterized by regular progress reports. Certification is not guaranteed or part of this process. While pilot projects may begin at any time during design and construction, they are most important to begin early in the design phase or project development. Designated pilot projects may use the Greenroads logo and advertise that they are a Greenroads Pilot Project, but may not reference certification levels or state any award has been achieved.

What is a Certification Review?

Certification is the highest level of formality and requires final documentation for verification of earned PRs and VCs at time of evaluation. Projects must complete and document both a Design Review and a Construction Review in order to achieve a Greenroads rating; these two reviews may be done separately or in combination. The certification process includes registration on the Greenroads website, paying associated fees and submitting all documents for reviewed through an electronic process. At this time, there is no third-party certification available but this is anticipated near the end of 2011.

CASE STUDY/PILOT PROJECT METHOD

The case study/pilot project methodology used on this project contains three main steps.

4. **Greenroads holds a live discussion with the Project Manager.** This discussion helps to identify general information about the project, including the needs and goals, and planning decisions that were made at the outset. Additionally, it helps to identify what information and documentation needs (or whether documentation even exists) in order to proceed with the case study/pilot project review. The discussion also helps to determine the Project Manager's current perception of sustainability and how the project could fit with the Greenroads metric. Typically, this step includes a brief overview and discussion of each credit. Ultimately, the conversation should allow the review team to understand what "perceived level of effort" may be required in order to establish or document whether or not a particular sustainability best practice has been implemented on a project. Perceived level of effort is further explained below.
5. Based on this discussion, review of documents provided, follow-up communication, Greenroads completes the Greenroads Project Checklist for the project. The Checklist shows the number of project requirements (PR) that have been met by the project, any voluntary credits achieved and points awarded, and also the

certification award level achieved, if any. Additionally, the checklist shows the potential levels achievable if various levels of effort were to be pursued during the planning, design or construction process. As requested, the checklist also shows which credits directly or indirectly provide a greenhouse gas (GHG) benefit. The checklist is submitted for review by the Project Manager.

6. Finally, Greenroads generates a brief report of the results of the case study/pilot project and provides recommendations based on these results and the scope of work for the study. The format for a case study/pilot project report is likely to be a short informational memorandum rather than a detailed technical report, though more detailed case study/pilot project reports may be warranted in special situations or requested.

Generally, this methodology was used for this project. Any deviations from this method are identified within the report.

WHAT IS "PERCEIVED LEVEL OF EFFORT"?

During the discussion with the Project Manager (PM), Greenroads establishes the potential for each credit to be achieved according to PM and the Greenroads reviewer. This is largely a gage of subjective perceptions unless documentation is provided to support achievement of a particular VC (or otherwise indicates it was not achieved).

DEFINING "EFFORT"

"Effort" is defined by any of the following, or combinations of the following:

- Amount of documentation required by Greenroads
- Amount of time to provide and generate documentation that is in addition to standard project documentation (not typically included in tender packages)
- Amount of resources that may or may not be physically available or accessible to complete a task, implement a technology or practice, or to document them
- Amount of money involved in acquiring and documenting a Greenroads credit
- Conflicts with existing regulatory standards, if any
- Conflicts with implementing Greenroads credits in the design process, if any
- Conflicts with implementing Greenroads credits in the construction process, if any

Effort is rated on a scale of Yes, Maybe (?), or No, and credits which were not appropriate or applicable to a particular project are also designated. The Level of Effort column on the Checklist reflects the amount of effort required if the credit were to be pursued. If the credit is pursued, it may earn the points corresponding to the level of effort pursued if the progress of the action items is complete (at 100%).

For example, if a 3-point credit was considered to be low effort (abbreviated "L"), 3 points for that credit were placed in the column for that credit called "Low."A key is provided on each worksheet with the abbreviations used.

Note that types of credits have ranges of points, such as the Recycled Materials (MR-4) credit. Point values for incremental types of credits may vary in effort level required, and depending on what effort level is attempted, not all of the points for a particular credit may be earned. These points for incremental credits are distributed across the range of effort levels based on the discussions with the Project Managers. The same theory is true for buffet-style credits where a number of alternatives may be available to meet a certain objective, but have varying degrees of effort associated with each alternative.

Low Effort

A low level of effort represents a low difficulty in providing information to the Greenroads team (for example, documentation exists as part of the standard tender package) or involves very little additional administrative resources and time to produce evidence that the credit requirements were achieved. Low effort also could mean a low- or no- cost addition or minor design change to the project, or that the intent of the credit does not

obviously conflict with existing regulations or standards. This designation may also represent a perceived high availability of physical materials or equipment.

Note that a designation of low effort may represents any credit that was achieved by regulatory means or similar policy and standards because it is assumed that the task must be completed in order to meet requirements other than those outlined in Greenroads Project Requirements or Voluntary Credits. An example of a low effort is submitting a standardized design document, such as a pavement evaluation, to meet the criteria for the Life Cycle Cost Analysis (PR-2) requirement.

Moderate Effort

This perception level falls somewhere between Low and High depending on interpretation of the Project Manager. Moderate effort may also reflect an educational endeavor or public awareness program where there is a learning curve involved for the design team, agency or construction team on the project.

In some rare cases, a moderate level of effort may be a reflection of the average perceptions of the consulting team and the Project Manager. Where possible, this distinction is made in the Reviewer Comments section of the Checklists for each individual project. For example, Ecological Connectivity (EW-7) was a high priority for the Kickinghorse Canyon (Highway 1) project, but much of effort, specifically cost and time required for detailed environmental review, was required by the Canadian Environmental Assessment Act (CEAA) due to the project's location in an ecologically sensitive area. While the Project Manager perceived that the project had gone above and beyond conventional design, planning, and cost expenditures for environmental considerations (corresponding to a very high level of effort), the consulting team recognizes that they were clearly required to do so by federal policy. However, the consulting team also recognizes that not every project is located in a highly ecologically sensitive area and therefore this effort, though regulated, does have merit due to the resulting positive ecological impact.

High Effort

This level of perception indicates a significant design process change or regulatory change would need to happen in order to achieve a credit and meet the credit requirements as specified in the Greenroads Manual. High effort also reflects significant added cost (above 3% of total project cost, for example, was considered "significant" as noted by Project Manager Jon Jensen). For example, Performance-Based Warranty (CA-8) is considered a high level of effort, because it would require a significantly larger risk to be taken by the contractor (three years instead of the some agency standard one year warranties), which would likely be reflected in the project budget as an added cost.

Not Applicable (N/A)

It is not possible for any single project to earn all of the credits in Greenroads. Where a particular credit was not appropriate for a project, this credit was designated "not applicable" with the notation "N/A." For example, the Energy Efficiency credit (MR-6) is not applicable on a project without any electric lighting installed.

APPENDIX C

Project Calculations

MR-3 EARTHWORK BALANCE CALCULATIONS

Data Provided by the Project Team:

US97 LAVA BUTTE- S. CENTURY DRIVE
STAGE 1 EARTHWORK QUANTITIES
all quantities shown are in cubic yards

Quantities based off Cross Sections provided at Pre Bid.

Alignment	Excavation (in situ)	Embankment (in place)
NB	71,223	197,779
C	36,983	3,442
SB		
CA		
CB	15,560	5,374
CC	10,624	2,095
CD		
CE		
WL		
DCB	1,846	77
Totals	134,390	208,690

Additional Materials needed for Stage I	74,300	CY (in place)

Available Borrow Materials Based Section 00235 and GM-8
Quantities are in situ stockpiled materials described in Narrative provided at bidding. Contractor responsible for determining the suitability of materials for embankment construction.

Site B-1	41,210	in situ
Site B-2	37,880	in situ
Site B-3	19,820	in situ
Total	98,910	in situ

Imported: 20,000 cy from Gas Station Quarry

Calculations:

See the Greenroads Manual for an explanation of the equations used.

A = 74,300/(134,390+208,690) = 21.7%

B = 20,000/208690 = 9.58%

C = 0/134,390 = 0%

A +B + C= 31.28 > 10%

<u>Award 0 Points.</u>