

# IMPROVING ENVIRONMENTAL SUSTAINABILITY IN ROAD PROJECTS

Robert Montgomery, Howard Schirmer, Jr., and Art Hirsch





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# FOREWORD

## **Aurelio Menendez**

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Transportation and the environment are strongly interlinked and dependent. Sustainable transport projects, such as more efficient rural road rehabilitation and clean urban transport systems, not only provide economic development but important social benefits. However, transport projects can have significant effects on the environment and local communities if not addressed explicitly in the design and implementation of projects and programs. Moving beyond negative impact mitigation, toward more environmentally sustainable projects and programs, offers additional benefits, and project stakeholders are increasingly demanding and expecting environmental sustainability to be integrated into infrastructure projects. The World Bank Group views development in all sectors through the lens of social inclusion and environmental sustainability to ensure that progress benefits the poor and does not come at the expense of future generations.

The World Bank Transport & ICT Global Practice provides clients with infrastructure and policies to improve connectivity and competitiveness, and links people to markets and social services to stimulate economic growth, increase climate resilience, and reduce carbon footprint. These aims are achieved through, among others, financing infrastructure such as transport assets and corridors (rural and inter-urban roads and highways, railways, ports, waterways, aviation, logistics, and trade facilitation) and urban transport (inclusive and “clean” transport modes including public transport and walking/biking). By facilitating the movement of people, goods, and information, Transport and ICT enable economic and social development, food security, and access to jobs, health, and education services.

The World Bank Environment and Natural Resources Global Practice contributes to the Bank’s vision of a world without poverty through a strategic and operational focus on the linkages between a healthy environment, sustainable use of natural resources, and poverty alleviation. In partnership with developing countries, this Practice delivers solutions to improve people’s livelihoods and well-being, keeping development options open for both today and tomorrow. The role of this Practice is to advance sustainability in development projects through practical solutions that reduce harm, mitigate risks, and uncover net positive impacts. The Practice aims to ensure projects

and programs are structurally sound across sectors and ultimately deliver more lasting and robust development outcomes.

The World Bank is committed to providing technical knowledge and support to member countries, including contributing to the global knowledge exchange on innovation in addressing environmental and transport issues and the pursuit of greener and more inclusive growth. The World Bank often has the privilege to partner with countries and key stakeholders to pioneer innovative environmental policies and initiatives. This document seeks to bring to a broader public—decision makers, development practitioners, academics and other partners—ideas on improving the environmental sustainability in road projects in low and middle income countries. We hope that this will make a contribution to knowledge sharing among a wider audience within the Latin America and Caribbean region and globally.



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# LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials	HMA	Hot mix asphalt
CEEQUAL	Civil Engineering and Environmental Quality and Assessment Scheme	iRAP	International Road Assessment Programme
CSR	Corporate social responsibility	ISO	International Standards Organization
CST	Canadian Centre for Sustainable Transportation	NCHRP	National Cooperative Highway Research Program
DOTs	Departments of transportation	NIOSH	National Institute for Occupational Safety and Health
EMS	Environmental Management System	PCC	Portland cement concrete
EPA	Environmental Protection Agency	RAP	Recycled asphalt pavement
EU	European Union	RCA	Recycled concrete aggregate
FHWA	Federal Highway Administration	SRI	Solar reflectance index
GHG	Greenhouse gas	UL	Underwriters Laboratories Inc.
		VOC	Volatile organic compound



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# CHAPTER ONE

## INTRODUCTION



Sustainable economic growth in low- and middle-income countries is a key to poverty reduction and shared prosperity, which in part is dependent on reliable and safe transportation systems. Road and highway systems provide a critical function in creating and maintaining a desirable quality of life. Local businesses depend on reliable road systems for the efficient movement and distribution of manufactured goods and services, employee transportation to and from work, and movement and availability of energy and raw materials. Local communities are dependent on transportation for accessibility to health care, education, food and clothing, farm animal movement, and personal mobility. The planning, design, construction, and operation and maintenance of highway and road systems are vital to the functioning of communities, regions, and countries.

Many transportation planners, engineers, and environmental scientists worldwide recognize that roadway systems need to be more sustainable in light of finite natural resources, sensitive environmental conditions, and limited economic resources. Sustainability is not just about the environmental considerations associated with energy conservation and alternative energy generation; it is the inseparable integration of the environmental, community and society, and economic attributes that need to be managed at the project level to be effective and successful (box 1.1). For example, this can include transit accessibility, transit affordability, benefits by income group, average vehicle occupancy, transit productivity and safety. Thus, transportation systems need to be planned, designed, constructed, and maintained in a fashion that properly manages the potentially negative environmental and social impacts and risks while attempting to promote directly and indirectly related positive impacts or benefits.

Important benefits can be associated with a sustainable road project, including improved cost effectiveness, reduced material consumption, improved community quality of life, increased protection of finite environmental resources, improved consideration of a life-cycle approach, and enhanced innovation and increased knowledge transfer and capacity building (table 1.1). The financial and economic benefits can result from improved pollution prevention (for example, waste minimization and reuse, among others), reduced carbon emissions (for example, selling carbon credits),

## BOX 1.1. REPRESENTATIVE EXAMPLES OF SUSTAINABLE TRANSPORTATION DEFINITIONS

The Canadian Centre for Sustainable Transportation (CST) defines sustainable transport solutions as sustainable transportation that: 1) allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations; 2) is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy; 3) limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise (CST, 2005).

The European Union Council of Ministers for Transport and Telecommunications defined sustainable transportation as one that: 1) allows the basic access and development needs of individuals, companies, and society to be met safely and in a manner consistent with human and ecosystem health and promotes equity within and between successive generations; 2) is affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development; and 3) limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses nonrenewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise (European Union Council of Ministers for Transport and Telecommunications, 2001).

payment for environmental services, better labor management (for example, improved retention and productivity), and community relations (for example, a better situation for project expansion or accidents). These benefits, in turn, provide results to support an entity, such as a transport agency, in developing or demonstrating the implementation of its sustainability goals, policies, and programs.

The ability to demonstrate sustainability is especially important, as road project stakeholders are increasingly demanding and expecting environmental sustainability to be integrated into infrastructure projects. Although many benefits are quantifiable and thus often preferred by decision makers, some of the more subjective benefits

can be highly valuable. Improved environmental sustainability can also enhance the financing of road transport projects by helping agencies to meet the environmental requirements of financiers. For example, many commercial banks, international financial institutions, institutional investors, and pension funds include social and environmental factors in their financing decisions. And improved environmental sustainability can potentially increase access to “socially responsible” investors, which manage and invest billions of dollars in assets only in projects that are socially and environmentally sustainable.

Various types of sustainability-based programs and implementation tools have been developed and executed by road transportation agencies to help integrate sustainability-based philosophies, concepts, and actions at the program and project levels. These tools can take the form of a list of sustainable actions or the development of sustainability rating systems that rely on specific criteria for project team consideration and potential adoption. One specific approach to help promote environmentally sustainable transport projects has been an effort to develop comprehensive sustainability rating systems for transportation infrastructure systems (for example, Envision, CEEQUAL, INVEST, Green Roads, GreenLITES).

However, embedding sustainability principles and best practices into road projects in low- and middle-income countries has been a challenge for several reasons, including changing or varying degrees of commitment and limited financial resources. In addition, there is often a lack of understanding about sustainability concepts and how to address them, given country and project specific characteristics. Also, sustainability rating systems are relatively complex and their application is challenging given the range of road projects (type, size, location, and so on) and socioeconomic and environmental conditions in developing countries. There are rapidly evolving sustainable products and technologies for road construction and maintenance, but often limited availability in these countries.

The World Bank promotes a sustainability philosophy and the vision of a “Green, Clean, and Resilient World.” This strategy recognizes that all economies, particularly developing ones, still need to grow, but need to do so sustainably, so that income-producing opportunities are

**TABLE 1.1. REPRESENTATIVE BENEFITS OF A SUSTAINABLE ROAD TRANSPORTATION PROJECT**

<b>Benefit</b>	<b>Description and Rationale</b>
Improves cost effectiveness	Many sustainable actions can be cost effective, such as use of energy efficient lighting, alternative energy generation within right of ways, material recycling, and material and water reuse.
Promotes consistency with transport entity policy and goals	The implementation of sustainable action is consistent with the Green, Clean, and Resilient concepts to improve country development and help protect national and global resources by integrating environmental aspects into road transport policy and development planning.
Improves community quality of life	Sustainability goes beyond the economics of a project and helps balance and promote improved community values and environmental enhancement, for example, on quality of life elements such as aesthetics, public safety, and mobility.
Maintains and protects finite environmental resources	A sustainable road transportation project promotes recycling and reuse of materials, which reduce the use of materials and extraction impacts; promote protection and possible enhancement of sensitive flora and fauna species; and help protect air, water, and land resources by reducing material usage such as sand, gravel, and other road construction materials.
Recognizes infrastructure resiliency in light of climate change	Long-term transport infrastructure integrity is improved by consideration of potential climate change effects, such as weather extremes, in transportation design.
Reduces energy consumption and GHG emissions	Reuse of materials, such as concrete and asphalt, reduces the need for concrete and asphalt manufacturing, reduce GHG emissions, and reduces waste disposal costs and emissions.
Improves socioeconomic conditions	A sustainable road transportation project can provide an economic boost to local areas by hiring local labor and purchasing local raw materials and other goods and services.
Minimizes ecological project footprint	An environmentally sustainable project promotes the avoidance or minimization of project area impacts on natural resources, which can reduce project costs, and protects sensitive species and environments.
Promotes a life-cycle approach	A more accurate total project cost early in the project cycle ensures the project is economically, environmentally, and socially sustainable, especially during the long-term operation and maintenance periods.
Promotes innovation and new project approaches	An environmentally sustainable project provides incentives to project team members to do more with fewer financial resources and promotes project team research into new, cost-effective technologies.
Promotes positive public opinion	By promoting and demonstrating to the public and stakeholders the resolve of road project agencies and associated entities to utilize balanced, sustainability-based approaches and innovative transportation management, the project can be a positive public outreach tool to help show concern for and awareness of environmental, social, and economic factors.
Demonstrates leadership and innovation	An environmentally sustainable project helps show an entity’s leadership in addressing environmental issues by instituting sustainability elements in projects rather than developing high-level programmatic documents with limited implementation.

not pursued in ways that limit or close off opportunities for future generations. The strategy makes the following points:

- » Green refers to a world in which natural resources are conserved and sustainably managed to improve livelihoods over time and in which ecosystems are healthy and increase the economic returns from the activities they support.
- » Clean refers to a low-pollution, low-carbon world in which cleaner air, land, water, and oceans enable

people to lead healthy, productive lives. It is also a world in which cleaner production standards spur innovation, whether through reducing air pollution, addressing legacy pollution, or recycling.

- » Resilient refers to effective management of disaster risks, especially for the more frequent natural disasters and more volatile weather patterns. Resilience lessens exposure to natural disasters by anticipating shocks and adapting to climate change and climate variability.

The World Bank also recognizes the importance of climate change strategies, adaptation, and mitigation. The Bank promotes actions toward realizing the co-benefits of adaptation and helping to reduce the vulnerability of human or natural systems to the impacts of climate change and risks. Adaptation addresses climate variability by maintaining or increasing system adaptive capacity and resilience. An activity provides climate change mitigation co-benefits if it reduces greenhouse gas (GHG) emissions into the atmosphere or enhances GHG absorption from the atmosphere.

An objective of the World Bank's transport strategy, consistent with sustainable transport and aligned with the principle of country ownership, is to help partner countries establish the governance, strategies, policies and services that will deliver transport for development in a way that is economically, financially, environmentally, and socially sustainable. The World Bank sustainable transport priorities recognizes that transport can have significant effects on the environment that should be addressed explicitly in the design of projects and programs. Strategic action is required in the form of better directed planning of land use and stricter management of demand. The World Bank has supported various sustainable transport projects, such as more efficient rural road rehabilitation projects and clean urban transport systems (box 1.2).

The World Bank's Environmental and Natural Resources team in the Latin America and the Caribbean Region undertook an effort to assist World Bank clients and Bank project staff in better integrating environmentally sustainable elements into road transportation projects. The main goals are to help increase the inclusion of environmentally sustainable practices in lower and middle income country road transport projects and improve local technical capacity and knowledge. These efforts should assist in improving the decision-making process by program and project managers by helping them to recognize the necessary balance between environmental, social, and economic resource attributes, impacts, and benefits when initiating and executing infrastructure projects.

The focus of this document is to provide a wide range of ideas and options to improve the inclusion of environmental sustainability throughout the road transporta-

## BOX 1.2. REPRESENTATIVE EXAMPLES OF WORLD BANK PROJECTS IN LATIN AMERICA PROMOTING SUSTAINABLE TRANSPORT PROGRAMS AND INITIATIVES

- » Argentina Norte Grande Roads Project
- » Argentina Santa Fe Roads Project
- » Peru Rural Roads Project (three phases)
- » Brazil Mato Grosso do Sul Roads Project
- » Brazil Tocantins Transport Projects (two phases—second called Tocantins Regional Development)
- » Brazil Sao Paulo Sustainable Transport Project
- » Bolivia National Roads and Airport Infrastructure Project
- » Honduras Road Rehabilitation Project
- » Mexico Urban Transport Transformation Program
- » Brazil Upgrading and Greening the Rio de Janeiro Urban Transport System
- » Brazil Sao Paulo Metro Projects
- » Colombia Support to the National Urban Transport Program
- » Argentina Urban Transport for Metropolitan Areas

tion project cycle (system planning, project planning and design, construction, and operation and maintenance) based on environmental sustainability indicators and highlighting environmentally sustainable products and materials for road construction. The environmental focus is presented within the broader concept of project sustainability and can be integrated with other sustainability actions (financial, economic, social) in projects as well as other areas, such as governance and transparency. The emphasis is on sustainable actions that go beyond compliance with applicable in-country environmental regulatory requirements (mitigation of negative impacts, compliance with environmental permits, and so forth) and strive for best practices such as the reduction of consumption (energy, water, materials, and so on), no net resource impact, and social and environmental enhancement.

This document integrates various criteria for environmentally sustainable road transport projects. The criteria are from many technical and programmatic sources and have been compiled in a user-friendly summary table format for reference throughout the transportation project cycle.



This document aims to serve as a guide and improve technical capacity and knowledge for planners, design and construction engineers, and maintenance professionals, with ideas and options to consider for future and existing projects including those of the World Bank.

Chapter 2 describes environmentally sustainable road project criteria, which provide a range of ideas and options to improve environmental sustainability throughout the road transport project cycle. In chapter 3, information and sources for potentially relevant, environmentally

sustainable products and materials for road construction are presented. Chapter 4 explains how to use this document, with descriptions of ways to use the information in chapters 2 and 3 in low- to middle-income road projects, including generally and more specifically by road project phase, road transport project staff, and road project financiers such as the World Bank. The appendixes provide a summary of transport sustainability programs (appendix A), the road transportation sustainability criteria (appendix B), and summary of environmentally sustainable road technologies and approaches (appendix C).



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## CHAPTER TWO

# ENVIRONMENTALLY SUSTAINABLE ROAD CRITERIA

Environmental sustainability road criteria were identified by assessing sustainability guidelines and rating systems that are used for road transportation projects and conducting interviews with leading Latin American transportation professionals and professional societies. (See appendix A for a summary of transport sustainability systems.) A set of criteria representing a synthesis of sustainable best management practices were selected principally from five transportation and infrastructure sustainability rating systems:

- » Envision (Institute for Sustainable Infrastructure)
- » CEEQUAL (CEEQUAL Ltd., founded by the UK Institution of Civil Engineers)
- » INVEST (U.S. Federal Highway Administration)
- » Green Roads (Green Roads Foundation)
- » GreenLITES (New York State Department of Transportation)

The criteria were selected to promote environmentally sustainable road infrastructure and strive toward resource enhancement and restoration, and were supplemented from World Bank information. The criteria do not include measures associated with mitigation of negative impacts of road transportation construction and operations, which are included in the existing transport and infrastructure sustainability rating systems. Mitigation actions to address negative project impacts are identified during project environmental assessments (environmental impact assessments) and project environmental regulatory permitting. Thus, in this document, such criteria are considered as obligatory and would be part of a project's environmental regulatory compliance. Mitigation actions for negative impacts are normally meant to protect and maintain a resource and are usually not meant to enhance or restore the resource.

However, it is possible that a negative impact mitigation measure could be done in a more sustainable manner. For example, a regulation may require a storm water basin during and after construction to contain road storm water with high amounts of suspended and deposited sediment. The installation of the storm water basin is not considered a sustainability criteria or action. If a permanent wetland was constructed within or just downstream of the storm water

basin, it could be used to treat and filter the storm water. If the wetland also provided high-quality habitat for wildlife, the creation of the wetland would be considered an environmentally sustainable action in the context herein. Another example would be the use of more sustainable materials or approaches for erosion control and revegetation, or enhancing road habitat connectivity mitigation measures or developing expanded environmental baseline studies (e.g., box 2.1).

### BOX 2.1. PROVINCIAL ROAD 3, PROVINCE OF CHACO, ARGENTINA

The project involved road paving of a 60 km section of Provincial Road 3 in the Northern Province of Chaco, Argentina. The road passes through a very vulnerable area of natural dry forest lands, identified as an extremely valuable corridor in the Gran Chaco region's biodiversity. As part of project design, this challenge was transferred into a sustainability opportunity by adopting a landscape approach to ensure that the work and environmental management measures would incorporate the functionality of the ecological corridor, supporting the conservation of the natural resources and helping to enhance knowledge and local cultural heritage. Examples of environmentally sustainable measures included awareness signs and speed reduction measures in critical habitat areas and key landscape connectivity points were established (eight underground and three canopy wildlife crossings). The work resulted in a scientific

report on the ecological community in the area, based on an expanded survey of plants and animals related to the project that went well beyond that needed for environmental impact analysis.



Photos Credit: Pablo Francisco Herrera



The environmentally sustainable road criteria are separated into four main road transport project phases and presented in appendix B:

- » *Table B.1. Sustainable Road Transportation System Planning Criteria.* These 41 criteria are associated with road system planning, which includes short-term and long-term planning. Long-term planning focuses on existing and future system regional and corridor planning, capacity needs, future use, traffic congestion, traffic safety, freight movement, system access, and the efficient movement of goods and services. Short-term planning involves prioritization of projects and development of defined scopes, assessment of available financial resources, and potential phasing of projects based on projected budgets.
- » *Table B.2. Sustainable Road Transportation Project Planning and Design Criteria.* These 109 criteria are associated with road planning and design, including project coordination and design actions (conceptual through final design, including road rehabilitation) based on transportation plans, community needs, environmental impact assessments, and development of contractor subcontracts, specifications, and preconstruction documents. The criteria are also associated more broadly with road transport policy and strategic planning development and road program and network planning.
- » *Table B.3. Sustainable Road Transportation Construction Criteria.* These 94 criteria are associated with the construction of new roads or rehabilitation of existing roads. The criteria include the final design elements and specifications of construction and the contracting and training of subcontractors on performance expectations.

- » *Table B.4. Sustainable Road Operation and Maintenance Criteria.* These 88 criteria are associated with road operation and maintenance activities, including operation and maintenance actions to maintain safe, effective, and efficient operations for roads and associated facilities, such as rest areas and maintenance shops.

Some of the criteria are repeated (or slightly modified) in the different road project phases, as the criteria are applicable across more than one phase. For example, the Sustainable Road Transportation Project Planning and Design Criteria table (table B.2) and Sustainable Road Transportation Construction Criteria table (table B.3) contain the criterion “Have components or prefabricated units been easily separated or disassembled-deconstructed into material type suitable for recycling?” Depending on the project, it is possible that either the project designer (design phase) or the prime contractor (construction phase) would be responsible for the development of this action to fulfill this criterion.

The criteria are presented in a tabular format for each project cycle and phase and have been grouped into categories and subcategories (table 2.1). The five categories and 17 subcategories are somewhat subjective, but they are relatively consistent with many of the core transportation sustainability rating systems that were used. The purpose of developing categories and subcategories was to develop a user-friendly organization for the relatively large number of criteria. Some of the tables do not contain all the categories and subcategories in table 1 because of the nature of their particular function within the transportation project process. For example, the Transportation System Planning table (table B.1) does not have the subcategory material recycling and reuse.

**TABLE 2.1. CATEGORIES AND SUBCATEGORIES OF ENVIRONMENTALLY SUSTAINABLE ROAD CRITERIA**

<b>Category</b>	<b>Subcategory</b>	<b>Subcategory Elements and Definition</b>
Quality of Life	Community Well-Being	Improve community quality of life, stimulate growth and development, develop local skills and labor, improve mobility and access, encourage alternative transportation modes, enhance accessibility and safety
	Community Context	Plan and coordinate with community, design with sense of community, preserve views, enhance community public space, enhance cultural resources
	Economics	Facilitate movement of goods, services, and freight; evaluate life-cycle costs
	Safety and Health	Enhance public and worker health and safety, conduct accident and prevention studies, improve security
Project Leadership	Collaboration	Develop sustainability program, define team structure, monitor sustainability elements
	Management and Planning	Identify byproduct synergies; implement training programs, long-term monitoring, and maintenance
Natural World	Siting-Alignment Selection	Preserve and enhance prime habitat, wetlands, and surface water systems; preserve prime farmland; avoid adverse geology; enhance floodplains; avoid undeveloped land
	Land-Water-Wildlife Habitat	Manage pesticide, herbicide, and fertilizer chemical usage; control surface and groundwater contamination; enhance wetland and surface water functions
	Biodiversity	Preserve and enhance species biodiversity, migration, and mobility; manage invasive species
Natural Resource Management	Materials	Use recycled and reused materials, use or develop a sustainable procurement program, select road materials that use local sources, use materials with cost-effective longevity
	Recycling-Reuse	Divert waste from landfills, reduce materials taken from project site, plan project deconstruction and recycling
	Waste Management	Control hazardous and solid waste, develop waste minimization strategies
	Energy	Reduce energy consumption via renewable energy and energy conservation
	Water	Protect freshwater systems for domestic uses, implement water conservation, develop storm water management enhancement strategies
	Atmosphere	Manage noise and vibration, light pollution, and air pollutant emissions
Climate Change	Resilience	Anticipate climate change induced threats, plan long-term adaptability, design for short-term hazards and heat island effects
	Greenhouse Gas (GHG) Emissions	Reduce GHG emissions

Each criteria table includes the following:

- » *Criteria.* A description of the sustainability criteria in a question-based format that can be used to develop project-specific sustainable actions.
- » *Measuring Success.* Identification of potential ways to measure or verify quantitatively whether criteria were selected and subsequently implemented on the project. (Note: not all of the identified criteria have quantitative performance measures.)
- » *Key Indicator.* General prioritization of criteria based on the level of enhancement and restoration

of resources, improvement of community quality, and economic cost effectiveness that should be considered for selection by the project team. (Note: Key indicators are subjective in nature and may depend on project-specific characteristics and contexts.)

- » *References.* Source(s) of criteria. (Note: In some cases, similar criteria from two or more references have been consolidated into one criterion.)



Photo Credit: Tony Mangan



## CHAPTER THREE

# ENVIRONMENTAL SUSTAINABILITY TECHNOLOGY INFORMATION

An important element in improving the environmental sustainability of road transportation projects is the use of new technologies, processes, and products that directly enhance the projects' environmental and economic sustainability through reduced consumption of energy and material. A good example is the use of recycled materials or more environmentally friendly cement, asphalt, or road base materials. Other examples include the use of energy conservation and generation, lighting, safety, and wintertime maintenance operations. In addition, the use of environmentally sustainable technology can also enhance road project related activities such as vegetation clearing and slope erosion control and stabilization. While ideally these technologies and process are defined as part of the project design, they can still be identified and implemented during construction and operation and maintenance (e.g., see box 4.1). However, the field of environmentally sustainable transportation technology and materials is rapidly changing and evolving; thus, utilizing updated information is important. Table 3.1 presents a representative list of some references to assist in identifying environmentally sustainable transportation practices and technologies in road projects. The table identifies technology and programmatic-based websites. Appendix C provides additional related information.

**TABLE 3.1. INFORMATIONAL REFERENCE SOURCES ON ROAD SUSTAINABILITY TECHNOLOGY**

Source	Internet Address	Overview
<b>Technology</b>		
AASHTO Sustainability Site, Center of Excellence	<a href="http://www.environment.transportation.org/">http://www.environment.transportation.org/</a>	The AASHTO Center for Environmental Excellence was developed in cooperation with the Federal Highway Administration (FHWA). The Center helps transportation agencies incorporate sustainability and stewardship into transportation planning, project development, construction, maintenance, and operations.
Compendium of Sustainable Development Indicator Initiatives	<a href="http://www.iisd.org/">http://www.iisd.org/</a>	The International Institute for Sustainable Development is a public policy research institute that has a long history of conducting cutting-edge research on sustainable development.
U.S. EPA Industrial Materials Recycling	<a href="http://www.epa.gov/epawaste/conservation/imr/index.htm">http://www.epa.gov/epawaste/conservation/imr/index.htm</a>	U.S. EPA provides an overview of industrial materials and their benefits and opportunities for reuse and recycling.
U.S. EPA Climate Change Adaptation Tools for Public Officials	<a href="http://www.epa.gov/climatechange/impacts-adaptation/adapt-tools.html">http://www.epa.gov/climatechange/impacts-adaptation/adapt-tools.html</a>	This site provides resources to help officials and transportation stakeholders with climate change adaptation planning and provides guidance, tools, and an information clearinghouse.
U.S. EPA Comprehensive Procurement Guidelines	<a href="http://www.epa.gov/epawaste/conservation/tools/cpg/index.htm">http://www.epa.gov/epawaste/conservation/tools/cpg/index.htm</a>	U.S. EPA provides information about construction and transportation products containing recycled content.
U.S. EPA	<a href="http://www.epa.gov/sustainability/">http://www.epa.gov/sustainability/</a>	U.S. EPA's area on sustainability practices and approaches includes labeling green products and promoting green chemistry and engineering, managing materials rather than creating waste, using green infrastructure to manage storm water runoff, and supporting the sustainable design of communities.

**TABLE 3.1.** INFORMATIONAL REFERENCE SOURCES ON ROAD SUSTAINABILITY TECHNOLOGY (*Continued*)

Source	Internet Address	Overview
U.S. FHWA Office of Pavement Technology's Recycling	<a href="http://www.fhwa.dot.gov/pavement/recycling">www.fhwa.dot.gov/pavement/recycling</a>	This site contains information about current projects and activities, research and references, publications, and policies associated with the use of recycled materials.
U.S. FHWA Sustainability Site	<a href="https://www.sustainablehighways.org/1/home.html">https://www.sustainablehighways.org/1/home.html</a>	U.S. FHWA's INVEST identifies characteristics of sustainable highways and provides information and techniques to help agencies and organizations integrate sustainability best practices into highway and other roadway projects.
GreenPave Rating System	<a href="http://www.mto.gov.on.ca/english/transtek/roadtalk/rt16-1/#a6">http://www.mto.gov.on.ca/english/transtek/roadtalk/rt16-1/#a6</a>	This material-focused system assists regions in rating selected pavement design alternatives. The objective is to create a rating system for pavement sustainability that applies to all designs of flexible and rigid pavement structures.
Green Highways Partnership	<a href="http://www.greenhighwayspartnership.org/">http://www.greenhighwayspartnership.org/</a>	This site contains sustainable actions for transportation infrastructure, including industrial materials and storm water practices.
International Road Federation Innovative Practices for Greener Highways	<a href="http://www.irfnet.ch/files-upload/pdf-files/IRF_BP_Environment_Web.pdf">http://www.irfnet.ch/files-upload/pdf-files/IRF_BP_Environment_Web.pdf</a>	The International Road Federation is a nongovernmental, not-for-profit organization with the mission to encourage and promote the development and maintenance of better, safer, and more sustainable roads and road networks. (See appendix C.)
I-15 Mobility Alliance Sustainable Transportation Solutions and Emerging Technologies	<a href="http://www.i15alliance.org/pdfs/tech_memos/sustainability_emerging_technologies/I-15CSMP_Sustainability_FINAL.pdf">http://www.i15alliance.org/pdfs/tech_memos/sustainability_emerging_technologies/I-15CSMP_Sustainability_FINAL.pdf</a>	The I-15 Mobility Alliance introduces sustainability and emerging technologies and discusses how they influence decision making by engineers. (See appendix D.)
Industrial Resources Council	<a href="http://www.industrialresourcescouncil.org/">http://www.industrialresourcescouncil.org/</a>	The Industrial Cooperative Highway Research Program provides information on industrial materials and their application for concrete and asphalt aggregate.

(Continued)

**TABLE 3.1. INFORMATIONAL REFERENCE SOURCES ON ROAD SUSTAINABILITY TECHNOLOGY** *(Continued)*

Source	Internet Address	Overview
National Cooperative Highway Research Program	<a href="http://www.trb.org/NCHRP/NCHRP.aspx">http://www.trb.org/NCHRP/NCHRP.aspx</a>	The National Cooperative Highway Research Program conducts research in areas that affect highway planning, design, construction, operation, and maintenance in the United States.
Recycled Materials Resource Center	<a href="http://rmrc.wisc.edu/">http://rmrc.wisc.edu/</a>	The Recycled Materials Resource Center provides systematic testing, evaluation, and development of appropriate guidelines that demonstrate environmentally acceptable increases in recycled material use in transportation system construction and maintenance.
Solar Roadways	<a href="http://www.solarroadways.com/main.html">http://www.solarroadways.com/main.html</a>	Solar Roadway is a series of structurally-engineered solar panels that are driven on. The idea is to replace all current petroleum-based asphalt roads, parking lots, and driveways with solar road panels that collect energy.
Transportation Research Board Sustainability Site	<a href="http://www.trb.org/Main/Home.aspx">http://www.trb.org/Main/Home.aspx</a>	The Transportation Research Board's mission is to provide leadership in transportation innovation and progress through research and information exchange.
Victoria Transport Policy Institute	<a href="http://www.vtpi.org/">http://www.vtpi.org/</a>	The Victoria Transport Policy Institute is an independent research organization dedicated to developing innovative and practical solutions to transportation problems.
<b>Programmatic</b>		
Center for Transportation and the Environment	<a href="http://www.itre.ncsu.edu/CTE/Projects/sustainability-blueprint.asp">http://www.itre.ncsu.edu/CTE/Projects/sustainability-blueprint.asp</a>	The Center is the Sustainability Blueprint for the North Carolina Department of Transportation institutionalizes sustainable principles and practices throughout all transportation phases and functions.
FHWA Every Day Counts	<a href="http://www.fhwa.dot.gov/everydaycounts/index.cfm">http://www.fhwa.dot.gov/everydaycounts/index.cfm</a>	Every Day Counts is designed to identify and deploy innovation aimed at shortening project delivery, enhancing the safety of roadways, and protecting the environment.

**TABLE 3.1. INFORMATIONAL REFERENCE SOURCES ON ROAD SUSTAINABILITY TECHNOLOGY (Continued)**

Source	Internet Address	Overview
EU ECOLABEL	<a href="http://ec.europa.eu/environment/ecolabel/">http://ec.europa.eu/environment/ecolabel/</a>	EU ECOLABEL is a voluntary system for environmental rating to identify and certificate products or services according to ISO 14024 provided by a third party or certifying agency.
Institute for Sustainable Infrastructure	<a href="http://www.sustainableinfrastructure.org/">http://www.sustainableinfrastructure.org/</a>	The Institute for Sustainable Infrastructure is structured to develop and maintain a sustainability rating system for civil infrastructure in the United States.
Sustainable Site Initiative	<a href="http://www.sustainablesites.org/">http://www.sustainablesites.org/</a>	The Sustainable Sites Initiative was created to promote sustainable land development and management practices that can apply to sites with and without building.
Route-Durable (France)	<a href="http://www.certivea.fr/certifications/certification-route-durable">http://www.certivea.fr/certifications/certification-route-durable</a>	Route-Durable is a tool for managing sustainable development approach in a road project to assist owners of road projects in establishing harmony of their projects with respect for social and economic life, the land, and the environment.
International Road Assessment Programme (iRAP)	<a href="http://www.irap.net/en/">http://www.irap.net/en/</a>	The program provides tools to assist in inspecting high-risk roads, developing Star Ratings and safer road investment plans, and tracking road safety performance.
EU Green Public Procurement Criteria for Road Construction	<a href="http://susproc.jrc.ec.europa.eu/road/">http://susproc.jrc.ec.europa.eu/road/</a>	This involves development of criteria to promote more environmentally sustainable road projects via public sector public procurement.
VIC Roads INVEST	<a href="http://www.vicroads.vic.gov.au/Home/">http://www.vicroads.vic.gov.au/Home/</a>	The purpose of VicRoads is to deliver social, economic, and environmental benefits to communities throughout Victoria, Australia, by managing the Victorian arterial road network and its use as an integral part of the overall transport system.

*Notes:* AASHTO = American Association of State Highway and Transportation Officials; U.S. EPA = U.S. Environmental Protection Agency; U.S. FHWA = U.S. Federal Highway Administration; EU = European Union.



Photo Credit: Shutterstock

## CHAPTER FOUR

# USE OF THIS DOCUMENT

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Road infrastructure projects need to better balance the demands and impacts associated with the environment, community, and local-regional economy. Implementing sustainable actions in projects can not only produce enhanced benefits and possibly reduce costs, but also demonstrate leadership in addressing the conservation, protection, and enhancement of the finite resources on which the planet depends. This document is intended as a tool to aid road transport decision makers and technical specialists in striving for more environmentally sustainable road transport projects. The goal is to assist in better integrating environmentally sustainable elements into road transportation projects and is relevant for a broad range of technical staff involved in such projects. Hopefully, this document will be used to improve local technical capacity and knowledge and assist in improving the decision-making process by program and project managers. The aim is for managers to recognize the necessary balance between environmental, social, and economic resource attributes, impacts, and benefits when developing and executing road infrastructure projects. This document was designed to be applicable at any road transport project phase or stage, but ideally should be referred to early and routinely throughout the project phases. To help facilitate the use of this document, this section offers ideas and suggestions to improve the usefulness of the environmentally sustainable road criteria presented in chapter 2, including generally and more specifically by road project phase, road transport project staff, and road project financiers such as the World Bank.

## GENERAL GUIDANCE

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It is recommended that this document be used early and then continuously during the road project planning, design, construction, and operation phases. It is never too late to implement environmentally sustainable actions, albeit the maximum benefits are likely obtained when actions are implemented at the early project planning and design stage. Continued use helps maximize the capacity-building effect. It is envisioned that the contents of this document, especially the environmental sustainability technology information presented in chapter 3, will be dynamic in nature. New sustainability-based approaches and technologies will continue to be developed and adopted. It is important to note that the actual potential for addressing environmental sustainability only as part of a project environmental assessment or environment permit regulatory process is normally severely limited due to lack of regulatory specificity and focus (that

## BOX 4.1. ROAD MS-436, MATO GROSSO DO SUL STATE, BRAZIL

As part of the Mato Grosso do Sul State Road Transport Project, in one section of Road MS-436, the original design planned a set of erosion control measures that cost approximately R\$1,080 million (approximately US\$460 million). However, during the construction phase a cost reduction of

10 percent was obtained by the project team by identifying and implementing more sustainable approaches, including the use of an enhanced natural vegetation recovery process with select revegetation techniques and construction interventions that were more superficial.



Photos Credit: Marcio Cerqueira Batitucci



is, environmental impact avoidance) and sustainability opportunities may have already been missed during the program planning and early part of project design phase.

The focus of the ideas and options to improve environmental sustainability throughout the road transportation project cycle is on sustainable actions that go beyond compliance with applicable in-country environmental regulatory requirements and strive toward best practices, such as the reduction of consumption (of energy, water, and materials), no net resource impact, and social and environmental enhancement. Thus, implementation of the measures is not an indicator or surrogate for a proper project environmental impact assessment or related analysis and associated project-specific measures to mitigate a project's negative environmental and social impacts and community and worker safety risks. However, the consideration of these measures will improve any project's environmental assessment and associated environmental management plan, while also providing potential project cost savings, reduced environmental impacts, and improved environmental and community benefits. The criteria focus on environmental aspects and should be considered within a broader context of other relevant project sustainability aspects, including financial, economic, and social.

Not all sustainability actions add to the overall cost of a project; instead, the actions may reduce material and energy consumption or other environmentally-related project costs. Many of the sustainability criteria are cost effective with relatively good return on investments (e.g., box 4.1). In addition, many of the criteria for the construction and operation and maintenance phases are actually part of the normal activities and thus are not additional, but affect how the activities are done (for example, material and energy usage).

Many environmental sustainability criteria are presented. The criteria represent a comprehensive list of ideas and options. If the list were used in its entirety, it could be used to perform an assessment (or rating) of a project's environmental sustainability. However, the intent of this document is not to provide an assessment tool, but to provide a list of potential ideas for consideration within a specific project. Thus, a key challenge is to identify which criteria to use in a specific project or program. Clearly the long-term goal is all road projects to implement all relevant measures to the extent technically and economically feasible thus maximizing the sustainability outcomes. However, from a practical standpoint, it is not expected that a project will adopt all the criteria; instead, the list should be used as a menu of potential sustainability ideas and options. Thus,



for example, an answer of no to one of the criteria does not imply an unacceptable project. Some criteria can be implemented in varying degrees, for example, the percentage of water use reduction during construction. For these criteria, just setting a goal and working to obtain it is good.

The selection and success of selected sustainability actions by the project team will depend on various factors:

- » Project scope and size (for example, new road versus rehabilitation, urban versus rural, multi-lane highway versus secondary two lane road; large scale versus small scale);
- » Project model (for example, public project, public-private project, road concession) and financial budget (for example, small, large);
- » Project phase (for example, design, construction);
- » Environmental context of the project, including environmental issues (for example, water or other material scarcity, impacted watersheds or airsheds) and established environmental priorities or strategies;
- » Governmental established sustainability-related priorities in transport sector and more broadly, such as water, air, solid waste, and land use;

- » Project stakeholder, in particular local community, preferences in terms of sustainability benefits (that is, interested in what type of benefits);
- » Project material usage and associated local costs; and
- » Sustainable action availability (for example, technology, equipment), implementability (including relevant institutional capacity) and result (that is, value of benefit given cost or level of effort to implement).

Ideally, the selection should be done in a collaborative manner with relevant players (decision makers, road design engineers, environmental and social specialists, construction contractors, and operation and maintenance specialists). When selecting and integrating sustainable action(s) into a project, there needs to be a reasonable balance among environmental, social, and economic elements.

In some cases, it may be appropriate for a project team to focus more on the engineering aspects of the project, such as material usage, waste reduction, and recycling and reuse. In other cases, greater focus will be on community benefits or environmental enhancement (e.g., box 4.2). The selected sustainable actions need to be cost effective or provide added

#### BOX 4.2. SAN LORENZO-OLANCHITO ROAD PROJECT, YORO PROVINCE, HONDURAS

The San Lorenzo-Olancho Road Project involved the paving of approximately 45 km of unpaved road located in the Aguan Valley which harbors the most representative remnant of very dry forest ecoregion in Honduras characterized by high endemism and habitat fragmentation. An enhanced habitat study was performed of all endemic species including the Honduran emerald hummingbird. Additionally, a Conservation Action Plan was developed, including strict protection of 419.9 ha of

dry thorn forest and purchase of additional private lands for strict conservation to build a network of core areas, conservation incentives for landholders, an ecological and compliance monitoring program, actions to promote ecotourism as a complementary economic activity, environmental education program, and expansion of the Pico Bonito National Park. Financial support was provided, in part, by a debt for nature swap between Honduras and Spain.



Photos Credit: Tuuli Johanna Bernardini



value to the project. Identifying and implementing sustainable actions can have a direct cost-saving effect to the project, such as using LED or lunar resonant street lighting, as opposed to normal metal halide and high-pressure sodium lighting. However, the cost benefit of not only avoiding a resource impact but actually enhancing a resource needs to be considered by the project team. Thus, while ideally addressing all the environmentally sustainable criteria may be a goal, for projects in low- and middle-income countries, even the implementation of any action that provides significant results can be deemed a success to some degree and a step in the right direction.

Environmental sustainability criteria can be included as part of a road project bid process and contractual requirement. For example, it could be required that the environmental sustainability criteria be specifically considered as part of the project design contract. Alternatively, specific criteria (actions) could be included in the road construction contract or operation and maintenance contract. The bid and contract could request the preparation of project sustainability management plan that established how a contractor will implement sustainability measures, including equipment and technologies, and measure and report on actual implementation. These contractual requirements can be specific to the type of sustainable actions expected throughout the project process or based on the achievement of a particular level or result. Sustainability actions can be expressed as “best efforts” clauses and thus there would be no penalty should the contractor fail to fulfill them. For example, include as part of the design analysis consideration of environmental sustainability measures or as a requirement to report on environmental sustainability during construction but with no required levels to be met. Alternatively, sustainability actions could be expressed as clauses with specified remedies should the contractor fail to fulfill them or with incentive clauses with specific economic or other rewards provided if the contractor fulfills the requirements. However, consideration of the necessary monitoring and verification is needed, depending on the selected clause. For example, for the action of providing an economic incentive, a required level of environmental sustainability, such as material utilization or waste generation, could be established. The bid selection method should allow for consideration of improving environmental sustainability, by addressing issues that can arise from selection based on lowest cost.

Measuring performance or success via field supervision, monitoring, and documentation is an important step to demonstrate actual results and thus needs to be planned and implemented. Some criteria can be assigned quantitative performance metrics. Such monitoring can be established as part of the construction or operation and maintenance environmental management plan. Monitoring helps to establish continuing quality improvement and measure the success of a specified action and its relevance for future projects. However, the value of monitoring data needs to be weighed against the cost of data collection and verification by the project owner or its contracted project supervisor.

Linking and, more important, properly communicating the benefits from implementing an environmentally sustainable action (criteria) require focused attention and efforts. Benefits expressed in monetary units (economic or financial) create strong evidence and incentives for sustainability. However, there may be a lack of adequate data to monetize the benefits, the presence of shadow costs and cost disparities, or technically difficult to monetize a specific benefit. Benefits from more sustainable projects must be considered and measured given the local socio-economic, political and environmental context in the particular country. Additionally, it important to understand that different stakeholders (for example, governmental road agency, municipal authorities, local citizens using the road and living near the road) will likely have differing perceptions on the importance or value of the benefits. The effects of some sustainability criteria may have longer returns on investments or the return on investment or cost effectiveness may not be easily calculated or estimated. Thus, although the quantification of benefits provides much stronger results and evidence for additional actions, even reporting subjective benefits is valuable.

It is important that the project manager and project team have strong support and commitment from the relevant senior management to explore new sustainability avenues and actions, as identified in this guide.

## UTILIZATION IN THE ROAD TRANSPORT PROJECT PHASE

This document can serve as a reference tool for identifying potentially relevant, environmentally sustainable practices in the main road transport project phases.

Common to all project phases is that the consideration of sustainability-based actions should be done in a collaborative manner with a team composed of the project manager, design or planning team members, environmental and social specialists, construction engineers, and maintenance representatives. It is also encouraged that major stakeholders be identified to participate in the sustainability action selection process. Selected sustainability actions that are incorporated into a project design should continually be referenced throughout the project process. The sustainability concept should be initiated early in all stages of the project cycle and ideally should be an integral part of the road infrastructure project management.

## TRANSPORTATION SYSTEM PLANNING

Long-term transportation planning takes into account local and regional transportation needs for the future. For example, transportation planning may look forward 20 to 30 years to estimate vehicle miles traveled, projected congestion areas, potential safety-problem areas, and business access to facilitate economic growth. Transportation planning representatives coordinate with local and regional

representatives to identify future transportation needs and identify financial resources for design and construction. Representative examples of how the guidance criteria (table B.1) could be used include as:

- » An educational tool by environmental professionals in interfacing (and training) with transportation planning officials to improve the environmental sustainability plan;
- » A mechanism to help initiate improved environmental and community considerations early in the decision making process;
- » A verification tool to assess the extent to which sustainable transportation planning elements are considered;
- » A mechanism to promote improved consideration of environmental sustainability in country road transport policy and strategic planning development (e.g., box 4.3)
- » Input to improve capacity of public sector procurement regarding environmental sustainability; and
- » A tool to improve public education related to environmentally sustainable road system planning.

### BOX 4.3. TOCANTINS STATE ROAD PROJECT, BRAZIL

The Tocantins Integrated Sustainable Regional Development Project included various rural road improvement sub-projects. The project promoted improved sustainability at a programmatic level by incorporating, as part of the project planning and design stage, capacity building in areas of biodiversity protection, sustainable land use management, strengthening of environmental monitoring, and sustainable hydrologic resources management. The project also sup-

ported the establishment of an improved state environment policy and regulatory framework. The results included development of practices such as ecological corridors; integrated management strategies for water, particularly in semi-desert areas; preparation of watershed master plans and orientations for basin committees; studies on land cover and fauna and flora; and studies on 16 new protected areas.



Photos Credit: Marcio Cerqueira Batitucci



## TRANSPORTATION PROJECT PLANNING AND DESIGN

The Transportation Project Planning and Design Phase includes various aspects, such as alternative analysis, concept design, feasibility analysis, environmental assessments, and public and stakeholder participation. The design stage is a critical step in the road transportation cycle to integrate sustainability-based actions into the project, including as design specifications and contract requirements for the construction of the project.

Representative examples of how the planning and design criteria (table B.2) could be used include as a:

- » List of sustainability criteria that the project team should consider at the initial scoping stage and to assist in establishing design criteria and potential mitigation strategies;
- » Reference tool to support the development of project-specific environmentally sustainable road elements;
- » Periodic reference guide for the entire project team throughout the design process (checked at a minimum at the 30, 60, and 100 percent design phases) to track selected sustainability actions;
- » List of possible sustainability actions to be considered as part of the project's alternative design analysis process;
- » Public outreach and education document for the project for public participation and outreach to help demonstrate the environmental sustainability of a proposed project;
- » Project evaluation tool (checklist) that can be used to assess the environmental enhancement actions that are incorporated into the project's design and specifications;
- » Validation tool to assist in a project life-cycle cost assessment to ensure that relevant cost and cost savings associated with environmental aspects are properly considered; and
- » Tool to assess the incorporation and consistency of sustainability with the road transport agency or road project financier's sustainability policies.

## TRANSPORTATION CONSTRUCTION

Construction contractors can be directed by the project owner to incorporate sustainability actions into road con-

struction. Design specifications, bid requests, and contract language are important elements and provide opportunities to define such actions. In many cases, construction contractors are selected based on low bids and may have little idea about environmentally sustainable actions and specifically the cost-saving opportunities that the actions may present. Table B.3 provides the project owner, design team, and contractor with a list of criteria that can be reviewed and agreed on by all parties before construction is started. However, even if the criteria are not specified in the construction contract, it may be viable for the construction contractor to implement environmentally sustainable actions, while meeting the bid and contract specifications, and thus provide potential cost savings and improved environmental benefits. During construction, ongoing dialogue with relevant actors, including local stakeholders, can help identify these opportunities. Additional representative examples of how the criteria (for example, table B.3) could be used include:

- » As a menu of potential actions that can eliminate or reduce construction impacts, reduce costs, or improve environmental benefits;
- » For identification of new sustainability construction options for project design and construction contractors that can be cost effective, such as material selection, reuse, and recycling;
- » As a checklist to assess how environmentally sustainable elements were implemented during construction, including potential opportunities for consideration during construction; and
- » For potential consideration in purchasing materials and hiring employees locally.

## SUSTAINABLE ROAD TRANSPORTATION OPERATION AND MAINTENANCE

Road operation and maintenance are essential, ongoing, long-term actions. Highway operations and maintenance is often underfunded. And cost-effective operations and actions are important to maintain safety, mobility, and movement of goods and services. Representative examples of how the guidance criteria (table B.4) could be used include as a:

- » Reference guide to identify potential environmentally sustainable actions for road maintenance and operations;
- » List of options to reduce finite resource consumption, thus saving financial resources;

- » Guide for long-term maintenance planning that promotes improved environmental sustainability and quality of life for the community; and
- » Reference for the development or improvement of road maintenance standard operating procedures that integrate environmental sustainability.

## UTILIZATION BY ROAD TRANSPORT PROJECT STAFF

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This document can be used by many types of road transportation professionals. For example, it can be used as a tool by regional or corridor-scale transportation system planners or as a reference for design engineers since it provides a list of environmentally sustainable options that can be employed during project scoping, analysis of alternatives, and throughout the design process. The document can provide a road construction contractor with a wide range of cost-effective sustainability actions for resource consumption, such as material selection, recycling or reuse, and waste minimization. For maintenance professionals, the document describes environmentally sustainable ways to conduct long-term maintenance operations. Table 4.1 summarizes the potentially relevant environmentally sustainable road criteria for road transport personnel.

## UTILIZATION BY ROAD PROJECT FINANCIERS

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This document can be an important tool to assist road project financiers, such as the World Bank, not only in promoting and improving environmental sustainability in individual projects, but also capacity building in clients (for example, road governmental agencies) and other project stakeholders (for example, construction contrac-

tors, road planning and design engineers, consultants, and others). The document can also be used to help address the mandates, goals, and strategic objectives of financial institutions, related to their financial and technical support activities. For the principal stages of interaction between a financial institution and its clients, table 4.2 presents some representative examples of how the guide can be utilized in investment project financing. As discussed earlier in this chapter, the degree of criteria use in a given project should depend on the project's characteristics and does not imply a significant additional burden, but an opportunity for significant additional benefits. The document can also help lead to more “bankable” projects, for example by helping to improve and demonstrate project environmental sustainability and client commitment to environmental sustainability. This demonstration can indirectly support the adequate management of project-related negative environmental and social impacts and risks, thus helping the project to meet the environmental and social safeguard policies of project financiers.

For project financing based upon outputs or results, such as the World Bank Program for Results financing, the document could be used to identify specific criteria or indicators to measure road project environmental sustainability and thus provide partial financial support to improving the sustainability in a country's road program. For financing linked to policy, such as the World Bank Development Policy Financing, the document could be an input to establish links to disbursements related to modification of existing laws or regulations to specifically promote increased environmental sustainability in road projects, establishment of a sustainability program and measures within a country's road program, or development of a sustainability rating system to be used in road projects.

**TABLE 4.1. REPRESENTATIVE ENVIRONMENTALLY SUSTAINABLE CRITERIA RELEVANT FOR ROAD PROJECT PERSONNEL**

<b>User</b>	<b>Transportation Project Cycle Phase</b>	<b>Appendix Table Reference</b>	<b>Criteria Elements</b>
Regional transportation planning organizations (engineers and planners)	Regional and corridor planning	B.1	Community quality of life, economic benefits, sensitive environmental areas, life-cycle costs
Transportation and roadway highway designers	Project planning and design	B.2	Alignments, community coordination, local employment, material selection, environmental enhancement, contractor specifications, system resilience
Environmental impact and assessment staff	Project planning and design, construction, and operation and maintenance	Appendix C and tables B.2, B.3, and B.4	Innovative impact mitigation and environmental protection, enhancement and restoration included in regulatory document to promote implementation, life-cycle GHG emissions
Prime contractors	Construction, including as part of corporate social responsibility (CSR) actions	B.3	Local employment, material selection, waste management, material recycling and reuse, reduction of temporary impacts (staging areas, haul roads)
Highway and roadway operation and maintenance management	Operation and maintenance	B.4	Material reuse and recycling, safety, asset management, right-of-way management, energy, and emissions
Public outreach and education specialists	All phases	Appendix B	Sustainable criteria tables filled out during scoping and throughout the project and provided to and discussed with the public
Bank environmental and engineering staff	All phases	Appendix B	Auditing checklist, borrower performance metrics, public outreach tool, life-cycle GHG emissions, rating system scoring
Bank borrowers, consultants, contractors, and public-private partnership investors	Design, construction, and operation and maintenance, including as part of private company CSR actions	Appendixes B.2, B.3, and B.4	Best practices for all phases of transportation with emphasis on system planning early in the process, used as a guidance document for public-private partnership projects
Bank sustainability program management	All phases	Appendix B	Mechanism to gauge project sustainability implementation, accountability, and project comparison; foundation for rating system; indicator of sustainability program benchmarks, progress and areas for adjustment

**TABLE 4.2. REPRESENTATIVE EXAMPLES OF POTENTIAL UTILIZATION BY THE WORLD BANK**

<b>Stage or Type of World Bank Activity</b>	<b>Examples of Utilization of the Document</b>
Country programming	<ul style="list-style-type: none"> <li>• Input to Policy Note and Country Programming Strategy to help improve environmental sustainability in road transport projects, which in turn can provide reduced costs and improved benefits</li> <li>• Input to governments in developing more environmentally sustainable transportation policies, programs, and projects, which benefit the country and its population and create a better project for financing</li> <li>• Potential study (technical assistance) for a country on environmentally sustainable road programs and projects, including recommended good practices and opportunities</li> <li>• Promotion of improved consideration of environmental sustainability in country road transport policy and strategic planning development, road program and network planning, and sustainable transport agency</li> </ul>
Project identification and preparation	<ul style="list-style-type: none"> <li>• Identification of opportunities to improve environmental sustainability in assessment and design of road policies, network and road development, and specific road projects</li> <li>• Input to Terms of Reference for road project feasibility or design regarding how to increase environmental sustainability</li> <li>• Input to project Environmental Analysis, Environmental Impact Assessment, and Environmental Management Plans on how to help reduce potential environmental impacts and increase environmental sustainability and benefits</li> <li>• Input to the definition and selection of Project Development Outcomes and results indicators and the identification of potential project-related benefits</li> <li>• Identification of potential activities to include in project-related technical assistance to help improve environmental sustainability</li> <li>• Identification of potential environmental sustainability indicators to be used in project impact evaluation</li> </ul>
Project execution	<ul style="list-style-type: none"> <li>• Potential criteria and clauses to include in project bid packages and contracts</li> <li>• Input to construction contractors and operation and maintenance entities to improve environmental sustainability, which in turn can reduce costs and increase benefits</li> <li>• Input to project supervisors of construction contractors and operation and maintenance entities to establish environmental sustainability performance measures</li> <li>• Use by the Bank to assess project environmental performance and identify opportunities to improve environmental sustainability, thus providing value-added advice to clients to help reduce costs and increase benefits</li> <li>• Potential indicators of project environmental performance for Implementation Status Reports</li> <li>• Input to develop and implement specific capacity-building plans and activities (for example, training and learning events) that focus on demonstrating the value for decision makers and the range of potential environmentally sustainable actions in road projects for technical specialists</li> <li>• For entities with a goal of demonstrating the development of more sustainable roads, use to promote the environmental sustainability rating of projects to help track progress in sustainability</li> </ul>
Project closing	<ul style="list-style-type: none"> <li>• Input for assessment on project environmental performance and benefits for Implementation Completion Reports and value-added of Bank participation</li> <li>• Basis for identifying more technical-based results and lessons learned on improving environmental sustainability</li> <li>• Input on lessons learned to <ul style="list-style-type: none"> <li>◦ Improve the identification and quantification, to the extent possible, of benefits from implementing environmentally sustainable actions in developing country road projects</li> <li>◦ Develop more specific and detailed approaches for incorporation in project contracts (design, construction, operation, and maintenance and construction supervision), including proactive actions by relevant players and rewarding positive results</li> <li>◦ Improve the identification of “high return” environmentally sustainable actions in the context of developing countries and their intrinsic characteristics, thus assisting in prioritization of actions to implement first</li> <li>◦ Develop better cost-benefit approaches for monitoring and supervision of implementation of environmentally sustainable criteria, in light of cost and resource limitations in most developing country road projects</li> </ul> </li> </ul>



Photo Credit: Ernesto Monter Flores



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# APPENDIX A

## SUMMARY OF TRANSPORT SUSTAINABILITY PROGRAMS

Over the past 14 years, there has been an effort by some organizations to develop large, comprehensive sustainability rating systems for transportation infrastructure systems that are similar to the LEED sustainability rating system for buildings. Instead of adopting the large rating system programs, some state departments of transportation (DOTs) and municipal transportation departments have embraced the sustainability rating system concept by developing programs with their own unique criteria, indicators, and performance measures that encompass transportation planning, design, construction, and operation and maintenance activities. DOT-specific rating systems have an advantage over larger template-type programs in that the sustainable criteria reflect the actual state's environmental conditions and community context. Specific rating systems can be developed based on the DOT management style, executive orders, philosophy, financial resources, and sustainability program needs.

According to the Compendium of Sustainable Development Indicator Initiatives, there are more than 140 sustainability-based transportation initiatives that encompass performance indicator programs, methodologies, guidance documentation, and sustainability development programs. The number of worldwide sustainability-based initiatives continues to grow for all infrastructure-type projects, and there are reportedly more than 900 initiatives.

One of the first transportation-specific sustainability rating systems was developed and implemented by the New York State Department of Transportation, which developed the GreenLITES (Recognized Leadership in Transportation and Environmental Sustainability) program. The nationally recognized GreenLITES program initially developed an extensive list of criteria specifically for transportation design activities. Since the creation of GreenLITES, other sustainability rating systems have been developed that address all or portions of the transportation process (planning, design, construction, and operation and maintenance). The following is a list of some of the more notable infrastructure-transportation rating systems, the date of their development, and the corresponding transportation phase:

- » LEED (1998), design
- » CEEQUAL (2003), design and construction
- » GreenLITES (2008), design, planning (draft), and operation and maintenance
- » Sustainable SITES (2009), design and construction
- » STARS (2010), planning
- » Green Roads (2010), design and construction
- » ILAST (2010), design
- » BE2ST(2010), design and construction

- » INVEST (2011–2012), planning, design, construction, and operation and maintenance
- » ENVISION (2012), design
- » Greenway (2012), construction
- » VicRoads-INVEST (2012), design and construction

These sustainability rating systems have some similarities in that they use criteria that are weighted, meaning that criteria are given a priority ranking based on their importance by numeric points. The more important the criteria are to the organization, the more points are designated to the criteria. The rating systems calculate the totals in a spreadsheet format and the total scores are compared with certification threshold values. Certification levels are given based on achieving scores beyond predetermined thresholds (silver, gold, platinum, and so on). Most rating systems use a yes/no format when addressing a criterion in a question format.

The criteria categories—such as site selection, community, energy, atmosphere, water, natural environment, and materials—are similar across the rating systems. The sustainability criteria in these rating systems are a mixture of activities related to system enhancement, restoration, protection, mitigation, and regulatory compliance. The simplistic rating system formats are popular because of their ease of use and understanding.

The transportation rating systems differ according to internal application and management involvement. Project managers are directed and required by the New York State DOT Chief Engineer to go through the GreenLITES processes before a project can be allowed to go to bid. The other rating systems are voluntary and are intended to be reference tools for engineers, contractors, and maintenance professionals. The ENVISION checklist is unique, since it is based on levels of achievement of a sustainability-based objective (question)—the higher the level of achievement toward restoration and enhancement levels, the higher the numeric scores. As a program prerequisite, Greenroads requires the development of a life-cycle cost and inventory analysis in addition to nine resource-specific management plans (waste management, noise management, emission controls, and so on) to be submitted and approved before starting the certification process. CEEQUAL makes extensive use of quantitative performance indicators to acquire numeric points.

Sustainability rating systems have been found to be an added value tool to transportation agencies at the program and project levels. These rating systems are a mechanism for implementing a sustainability vision and philosophy directly into projects. Transportation agencies and departments have found that the development and implementation of sustainability-based criteria form the

basis of important decision-making tools for engineers and project managers toward integrating their sustainability program within and outside their organizations.

Some DOTs and organizations recognize that rating systems provide a mechanism to develop new program and management

approaches that are cost effective based on the worldwide dynamic changes and challenges facing infrastructure projects and systems. Rating systems can also be used as an effective public relations tool during public meetings and as a management tool that contains metrics to measure project or program success.

# APPENDIX B

## SUSTAINABLE TRANSPORTATION CRITERIA MATRICES

**TABLE B.1.** SUSTAINABLE ROAD TRANSPORTATION SYSTEM PLANNING CRITERIA

#	Category	Sub-Category	Criteria	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>						
P-1		Community Well-being	Does transportation planning support and consider sustainable growth stimulation including improved labor skills, business attractiveness, and community livability?	Ensure estimation or measurement of community-based improvement in skill education and business attractiveness	x	ENVISION
P-2			Does the transportation planning increase access to job opportunities and to other essential destinations?	Evaluate transportation plan or reports identifying key employment opportunity areas to promote employment and measure increases in job growth	x	NCHRP 708
P-3			Does transportation planning promote and preserve the use and safety of pedestrian and bicycle transportation as an integral part of efficient, sustainable transport systems?	Assess current bicycle usage and locations and projected area improvements; assess accident data; plan placed in design scope of work	x	Bogota Declaration 2011
P-4			Does the transportation planning promote the expansion and improvement of public transport services, based on attending the user's needs, in such a way that these are affordable, safe, reliable, and of high quality?	Review the transportation plan to ensure the transport services meet users' needs in estimated costs and services		Bogota Declaration 2011
P-5			Does the transportation planning support behavioral changes towards sustainable mobility alternatives through information and education of the population?	Conduct transportation user surveys and/or establish monitoring program on mobility options to assess increased ridership and use	x	Bogota Declaration 2011
P-6			Does the transportation planning promote special consideration and assess vulnerable users in planning, implementation, and operation of infrastructure and sustainable transport systems, actions aimed at improving the quality, safety, and accessibility for all, including women, the elderly, disabled persons, children, and low income people?	Ensure that the transportation plan incorporates the planning of the transportation project(s) that address accessibility equity for women, elderly, and disadvantaged people; studies have been conducted to assess their travel needs and affordability; items placed in design scope of work	x	Bogota Declaration 2011/GreenLITES

(Continued)

**TABLE B.1. SUSTAINABLE ROAD TRANSPORTATION SYSTEM PLANNING CRITERIA** (*Continued*)

#	Category	Sub-Category	Criteria	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>						
P-7			Does transportation planning ensure accessibility to jobs and essential destinations for all communities that accommodate the level of access for disadvantaged populations to jobs, schools, health services, grocery stores, civic and public spaces, and recreation?	Evaluate plan regarding local community needs studies and existing planning documents; access to critical services; education and health care is identified and addressed; alignments placed in design scope of work	x	NCHRP/ INVEST
P-8			Does the transportation planning address improved transportation infrastructure and accessibility equitably for all communities within the corridor?	Ensure community equity in the transportation plan that will not allow one community to economically dominate		NCHRP
P-9			Has the transportation planning considered the expected degree to which projects will contribute to local employment, training, and education, with emphasis on the most needy and disadvantaged groups?	Ensure that future projects will identify, consider, and prioritize locations in areas for employment and skill training		ENVISION
P-10			Does the transportation planning approach address traffic congestion and improve mobility and access while not promoting urban sprawl?	Ensure consistency with local land use plans—the community vision on growth land use and congestion		ENVISION
P-11		Community Context	Does the transportation planning consider the unique and cultural characteristics of the communities by investing in healthy, culturally sound, safe, and walkable neighborhoods?	Determine coordination with public officials and stakeholders; cultural information is reviewed and summarized to identify unique community and cultural features; financial resources were estimated or obtained for enhancement	x	GreenLITES
P-12			Does the transportation planning avoid impacts to cultural, physical, social, and environmental resources such as indigenous territories, natural protected areas (for example, parklands), critical historical and archeological sites, farmlands, and view sheds?	Determine if there is documentation that is referenced in transportation plan addressing type and location of unique cultural attributes for enhancement or avoidance; avoidance alignment in design scope of work		GreenLITES/ World Bank
P-13			Does the transportation planning take into account accident frequencies and user and pedestrian injuries and deaths with consideration of increasing share of motorcycle ridership?	Determine if transportation plan has performed or references accident frequency analysis for transportation corridors; evaluate if design's purpose and need is based upon safety improvements.	x	NCRHP 708/Bogota Declaration 2011



Category	Sub-Category	Criteria	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>					
P-14	Economics	Does the transportation planning promote the adoption of innovative financing mechanisms (taxing or public-private partnerships) for building sustainable transport infrastructure and providing complementary services?	Transportation plan identifies creative funding mechanisms for building and maintaining new infrastructure leading to a reliable system for the movement of goods and services and public mobility; funding estimates provided; public-private partnerships obtained	x	Bogota Declaration 2011
P-15		Does the regional transportation planning address the life-cycle cost estimations to ensure long term reliability and operation and maintenance of the regional and local transportation system?	Review life-cycle cost estimates, funding acquired for the design, construction and long term operations and maintenance	x	TRB/ World Bank Transport Business Strategy 2008–12
P-16		Does the transportation plan consider targeting investments to improve rural and fringe-urban transport that are critical to access markets and service and increasing the productivity of small farmers beyond subsistence levels?	Evaluate transportation plan for needed financial estimated investments; funding opportunities and improvements identified for fringe systems; ensure mobility to critical markets is identified	x	World Bank Transport Business Strategy 2008–12
P-17		Does the transportation planning ensure that a competitive option for freight movement exists or all communities in the region?	Evaluate the transportation plan for focus on major freight movement roads and corridors; equity in corridor improvements is considered for economic competitiveness		NCHRP 708
<b>Project Leadership</b>					
P-18	Collaboration	Has the transportation planning process used engaging public meeting participation techniques beyond normal planning outreach activities such as charettes, newsletters, project-specific web pages with communications issued in multiple languages?	Review file documentation and talk with local community officials to determine if innovative outreach actions were used and if public feedback was considered and added into the resulting transportation project design scope of work	x	GreenLITES
P-19		Does the planning recognize the early engagement of natural resource and environmental regulatory agencies regularly in creating transportation plans and programs?	Review file meeting documentation and the transportation plan, and talk with agency officials about planned alignment avoidance for sensitive area environmental protection and enhancement; alignments in design scope of work reflect avoidance	x	INVEST

(Continued)

**TABLE B.1. SUSTAINABLE ROAD TRANSPORTATION SYSTEM PLANNING CRITERIA** (*Continued*)

#	Category	Sub-Category	Criteria	Measuring Success	Key Indicator	Reference
<b>Project Leadership</b>						
P-20			Does transportation planning institutional mechanisms engage the local community and key stakeholders routinely in creating plans and programs (education, engineering, enforcement and emergency services) that are consistent with the local community goals and vision?	Review file documentation and transportation plan, and talk with local community officials, and review community land use or vision plans to determine if final transportation plans and resulting project addressed existing community goals and vision	x	INVEST
P-21			Does the planning call for the engagement of freight service providers and stakeholders in creating local and regional plans and programs to improve freight mobility?	Review file documentation, the transportation plan, and talk with local and regional business-freight owners and leaders to determine if plans address their freight mobility concerns; determine if resulting design project addressed freight mobility and access improvements		INVEST
P-22			Do the local and regional transportation planners consult with environmental impact specialists, regulators, and natural resource agencies to coordinate data and information to support the initiation and performance of environmental statements and strategic environmental assessments?	Review planning documentation; interview regulatory agencies and natural resource officials about data acquisition and coordination; evaluate if environmental avoidance was considered during alignment placement; review meeting summaries with agencies to see if concerns were addressed in future plans and projects		INVEST
P-23		Management and Planning	Does the planning process foster the integration of transport, environment, urban development, and health policies?	Obtain and review file documentation and the transportation plan; talk with local stakeholders about the integration success and if the transportation planning was successful	x	Bogota Declaration 2011
P-24			Does the transportation planning address or consider combating corruption (informal payments to inspectors, traffic police), which can facilitate dangerous driving, unsafe vehicles, noxious exhaust, vehicle overloading and transport from illegal activities (illegal logging, endangered fauna and flora species)?	Evaluate transportation plan and documentation to determine if corruption was considered in the transportation planning process with concerns about safe operations, long term maintenance, and the necessary funding to support those activities		World Bank Transport Business Strategy 2008–12/ World Bank
P-25			Does the transportation plan consider road traffic accidents and the role of transport in disease and pest transmission?	Evaluate transportation plan and documentation to determine if disease and pest transmission was considered in the road alignment; evaluate conversations and meetings with health officials to see if improved safety considerations are included in design scope of work	x	World Bank Transport Business Strategy 2008–12

Category	Sub-Category	Criteria	Measuring Success	Key Indicator	Reference
<b>Project Leadership</b>					
P-26		Have the environmental opportunities for environmental enhancements and associated social issues been identified and clearly recorded for planning and prioritization according to significance?	Obtain and review transportation plan and documentation and determine if environmental and social enhancement were part of the criteria for prioritization; review enhancement elements elected for future project scope	x	CEEQUAL
P-27		Is there clear evidence that the transportation planning team has adopted a whole life-cycle approach to environmental aspects of the project?	Review planning documentation to assess if environmental protection and enhancements were identified throughout the life the project		CEEQUAL
P-28		Were land and home acquisition avoidance or minimization approaches considered in the transportation planning process?	Review the transportation plan and documentation; determine if the type and number of relocations influenced alignment planning and were included in the prioritization criteria; design scope reflects minimizing land and residential takes	x	CEEQUAL
<b>Natural World</b>					
P-29	Siting-Alignment Selection	Does the transportation planning consider alignments upon waste sites, which can lead to public benefits and protection through the removal or remediation of hazardous wastes?	Review transportation plan documentation and file to assess if hazardous waste sites were researched and considered for remediation; assess if action contained in design scope		GreenLITES
P-30		Does the transportation planning attempt to avoid previously undeveloped lands for transportation alignments such as open spaces or wildlife refuges?	Review transportation plan documentation to determine if undeveloped land was avoided for alignment locations	x	GreenLITES
P-31	Land-Water Wildlife Habitat	Did the transportation planning team assemble data on natural resources and apply system or landscape scale evaluation to assess ecological conditions and avoid and/or minimize potential impacts of planned transportation projects to the natural environment?	Review transportation plan documentation and file to assess if sensitive environmental areas were mapped and avoided for alignment selection; determine if resource agencies were involved with the alignment locations	x	INVEST
P-32		Did the transportation planning team assemble data on socioeconomic, population, immigration, and change in land value dynamics and apply modeling scenarios to assess pressures on renewable resources and avoid potential impacts to the natural environment?	Assess if socioeconomic dynamic assessments and modeling were performed during transportation planning to evaluate natural resource impacts; determine if results directly impacted planned alignments and design scope		World Bank

(Continued)

**TABLE B.1. SUSTAINABLE ROAD TRANSPORTATION SYSTEM PLANNING CRITERIA** (*Continued*)

#	Category	Sub-Category	Criteria	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>						
P-33		Energy	Does the planning identify transportation strategies that could reduce fossil fuel consumption?	Review and evaluate transportation planning documentation and file to assess if fuel consumption and conservation estimates were calculated; determine if findings influenced alignments and design scope	x	INVEST
P-34			Does the transportation planning seek for a reduction of individual travel by integrating the concepts of land use and accessibility using strategic planning tools for regional development?	Determine if user outreach education and incentives were offered by planning officials; determine coordination and communication between land use planning and transportation agencies in the placement of alignments	x	Bogota Declaration 2011
P-35			Does the transportation planning address more sustainable modes of passenger transport, such as buses and trains, including the implementation of high quality services that, according to the demand conditions, offer alternatives to private cars and air transport?	Review transportation plan documentation to determine if a full range of multimodal options and alternatives were considered in the transportation planning decision making; assess if sustainable modes included in design scope		Bogota Declaration 2011
P-36			Does the transportation planning encourage the efficient use of energy resources and renewable energy alternatives?	Determine if energy conservation techniques were considered and incentives developed for vehicle energy efficiency; ascertain if the selected alignments consider alternative energy sources within the right of way (wind, solar)	x	GreenLITES
P-37	Atmosphere		Does the transportation planning promote the increased use of cleaner vehicles and fuels, phasing out highly polluting vehicles, and implement greater energy efficiency and emission control measures in all transport modes?	Determine if education and incentive programs were developed to promote cleaner vehicles; assess if electric charging or alternative fuel stations were considered; assess if emission control monitoring has been established to measure emission control success	x	Bogota Declaration 2011/World Bank Transport Business Strategy 2008–12
P-38			Does transportation planning establish or improve technical vehicle inspection regimes, and progressively implement safety standards and standards to reduce atmospheric emissions?	Determine if vehicle emission and/or safety inspection requirements have been instituted or considered; determine if plans address reduced vehicle miles traveled to reduce emissions		Bogota Declaration 2011

Category	Sub-Category	Criteria	Measuring Success	Key Indicator	Reference
<b>Climate Change</b>					
P-39	Resilience	Does the transportation planning consider adaptation of existing transport infrastructure, existing services, and new projects to reduce their vulnerability to the adverse effects associated with climate change such as relative sea level rise, storm activity/intensity, temperature and heat waves, precipitation events, lake levels, and stream flow, etc.?	Determine if increasing engineering safety factors have been considered to allow for changes over the life of the project; evaluate if planning addressed the need for new infrastructure materials and the revision of structure drainage safety factors for flow and velocity, transportation flexibility, and redundancy to address hazards in design scope	x	Bogota Declaration 2011/ INVEST
P-40	Greenhouse Gas Emissions	Does the transportation planning promote mitigation of greenhouse gas (GHG) emissions that contribute to climate change by considering sustainable transport actions?	Determine if transportation planning decision makers assessed greenhouse gas/carbon loading projections from projected operations vehicle miles traveled; see if programs have been developed for economic incentives for transit and carpooling, carbon sequestration projects, and reduction in worker commuting during peak travel hours.		INVEST/ World Bank Transport Business Strategy 2008–12
P-41		Are transportation plans consistent and do they complement adopted climate change action plans and international protocols?	Review transportation plan documentation to evaluate consideration of regional or state climate control plans; assess if Intergovernmental Panel on Climate Change recommendations protocols and international agreements and protocols (Kyoto, Rio De Janeiro) were considered; evaluate whether energy and emission controls are in design scope	x	NCHRP

**TABLE B.2. SUSTAINABLE ROAD TRANSPORTATION PROJECT PLANNING AND DESIGN CRITERIA**

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>							
D-1		Community Well-being	Does the design identify at least one access point from the project to a designated area for vehicles to exit the traffic stream to stop and experience scenic, natural, recreational, or other features along the roadway?		Review project designs to identify tourist and user services structures and pull-outs such as scenic viewpoints or overlooks, welcome centers, tourist activities or information centers, or recreation areas; verify that services were built according to designs and are being used by public	x	INVEST
D-2			Will the project create a significant number of local jobs during its design, construction, operation, and maintenance?		Review job creation estimations from design-based studies; assess baseline conditions and measure short- and long-term job creation as a result of the transportation project	x	ENVISION
D-3			Will the road rehabilitation project strive to create job opportunities for members of the local communities, particularly in regard to the most needy, disadvantaged, and unskilled laborers, and gender equality?		Review job creation estimations from design-based studies; assess baseline conditions and measure short and long-term job creation as a result from transportation project; additional surveys may be needed to assess employment success with unskilled labor and gender equality issues	x	African Development Fund/ ENVISION
D-4			Is there evidence that appropriate measures have been taken in the design of the project and implemented to prevent light spillage to neighboring areas during operation?		Review designs and specifications to determine if light scattering is controlled by lighting fixtures that directly focused lighting onto the roadway or rest area; review if lighting timers or sensors are within the design; assess public acceptance	x	CEEQUAL
D-5			Has the land and residential takes (voluntary and involuntary relocations) of different scheme designs, process designs, and layouts of the planned works been calculated, and have these calculations influenced the design process and the land use efficiency of the final design?		Evaluate design alternatives and analyze to see if the number of land and residential takes were taken into account and avoided whenever possible by the final alignment	x	CEEQUAL
D-6			Has the Design Team identified sensitive community facilities and receptors and avoided the placement of alignments and traffic volumes near them?		Review the design project file to determine if sensitive facilities (hospital, schools, nursing homes, etc.) were identified and if various alignment alternatives were adopted for avoidance or, if appropriate, buffer zones provided beyond regulatory requirements	x	NCHRP 708

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>							
D-7		Community Context	Is the unique character or sense of place (both natural and built) of the project area taken into account for the project beyond regulatory requirements in terms of structure designs, materials, landscaping, and townscape pattern?		Obtain project meeting summaries and reports to determine if community character was defined; review project structures, landscape plans, and alignment to assess consistency with community quality; determine community acceptance	x	GreenLITES/CEEQUAL
D-8			Have the designs for noise and vibration mitigation, enhancement, and monitoring for the construction stage been developed for implementation for sensitive receptors such as schools or hospitals?		Review project documentation for the identification of sensitive receptors and review noise/monitoring plan for implementation; review monitoring data to assess if thresholds were exceeded and mitigation performed	x	INVEST
D-9			Does the road rehabilitation design address the impacts to small businesses that are established in the right of way by identifying alternative relocation sites that can improve the vending environment by constructing purposeful stalls and sheds?		Review the project documentation file to identify communication and coordination with small, poor businesses; determine if business removal was necessary and if relocation occurred with appropriate cost reimbursement or support	x	African Development
D-10	Economics		Has the Project Team conducted life-cycle cost analyses of key project items such as pavement structure alternatives and long-term maintenance including road rehabilitation?		Review the project file documentation to assess life-cycle costs for pavement material and other structures and if financial resources necessary for sustainable operation were estimated; determine if annual funding is consistent with life-cycle cost estimates	x	INVEST
D-11			Does the road rehabilitation project encourage proactive and innovative private sector involvement in the maintenance of infrastructure, strengthen monitoring/control of road maintenance activities, and provide basic institutional support for sustainable road maintenance planning?		Review project documentation to assess the cost of the rehabilitation project and the public-private mechanism used to finance the project and long term maintenance		World Bank
D-12			Has the design project considered future road rehabilitation and maintenance by local population committees?		Review project documentation regarding local community involvement and employment; interview local community members to determine if maintenance employment occurred for the project		World Bank
D-13			Has the Design Team determined if the expected value of the economic and social benefits created by the project exceeds the project costs?		Obtain project socio-economic and environmental information gathered during the environmental assessment and compare to past and estimated future project cycle costs; attempt to place actual costs to environmental mitigation and enhancement		NCHRP 708

(Continued)

**TABLE B.2.** SUSTAINABLE ROAD TRANSPORTATION PROJECT PLANNING AND DESIGN CRITERIA (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>							
D-14		Safety and Health	Has the Design Team incorporated intelligent transportation system technology for sustainable system efficiency and safety?		Assess whether the project design and final project addresses some of the following ITS items: signal control, advanced signal systems, vehicle restrictions reversible flow lanes, pricing lane control, variable speed limits, emergency evacuation dynamic message signs, speed enforcement, traffic signal enforcement, ramp meter enforcement, ramp metering, highway-rail crossing warning systems, intersection collision warning, animal warning, hazardous systems pavement conditions, atmospheric conditions, internet/wireless toll collection call boxes, and service patrols emergency		INVEST
D-15			Have truck transport spill prevention and response plans and/or structures been incorporated into the design beyond regulatory requirements?		Determine if sensitive and environmental locations were identified relative to truck tanker transport; determine if risk evaluation was performed by Design Team toward development of spill prevention and response plans; evaluate if plans and structures were implemented along right of way at high risk areas		ENVISION
D-16			Has the Design Team incorporated safety improvements specifically for truck freight such as additional safety signage, speed warning systems for hills, and other intelligent transportation system solutions beyond those required by regulations or standards?		Determine from project documentation that a safety analysis was performed within the project area and high accident areas were identified; assess if pro-active safety design and signage was implemented beyond basic regulations		INVEST
D-17			Have recommendations or opportunities for installing special structures or facilities for encouraging or accommodating appropriate wildlife and the safety of traveling vehicles (road kill protection) been identified and incorporated in the project design?		Determine if the project Design Team reviewed road kill and wildlife related data in migration areas; determine if special structures such as escape ramps, higher fencing, or underpasses were designed and constructed	x	CEEQUAL



#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>							
D-18			Does the project design consider addressing corruption (informal payments to inspectors, traffic police), which can facilitate dangerous driving, unsafe vehicles, noxious exhausts, and vehicle overloading related to, but not limited to, transport of illegal freight such as timber from unauthorized areas and wild flora and fauna species?		Determine if Design Team considered special precautions in the project such as creating inspection check point areas or cell phone call in numbers to identify dangerous conditions on roadway system		World Bank
<b>Project Leadership</b>							
D-19		Collaboration	Has the Design Team incorporated a comprehensive and innovative public educational outreach program beyond regulatory environmental assessment requirements that promotes and educates the public about sustainability in the planning, design, construction, and operational phases of the roadway project?		Review project documentation and files to assess that the project outreach plan goes beyond regulatory requirements in outreach and interaction; determine if Design Team used a qualified coordinator who used newsletters, a project-specific web page, development of grievance mechanisms, and communications issued in multiple languages; determine if meaningful public participation occurred during the design phase	x	INVEST/ GreenLITES/ World Bank/ CEEQUAL
D-20			Has the project Planning Team taken a proactive approach beyond normal regulations or requirements in working with regulators and resource agencies to avoid the negative environmental effects or enhance environmental conditions?		Review project documentation for meeting summaries and outreach plans for proactive coordination and communication early and often throughout the project; assess if regulatory and resource agency recommendations for avoidance and enhancement were integrated into the design and construction documents	x	GreenLITES
D-21			Does the road rehabilitation use a community-driven development approach that allows communities to choose their own priorities?		Review project documentation and/or contact local community officials to determine if community feedback was used to identify and prioritize road rehabilitation locations and improvements		World Bank
D-22			Did the community relations program go beyond normal requirements and allow for a mechanism for local interest groups to communicate directly and interact with the project Design Team?		Review public outreach plans and meeting summaries to determine if face to face interactive forums were used to explain the project and solicit design feedback; evaluate if public recommendations were included in the designs		CEEQUAL

(Continued)

**TABLE B.2.** SUSTAINABLE ROAD TRANSPORTATION PROJECT PLANNING AND DESIGN CRITERIA (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Project Leadership</b>							
D-23		Management and Planning	Has the Prime Contractor (designer) developed incentives, especially financial, to increase subcontractor commitment and actual environmental performance in contract bids?		Review Prime Contractor and subcontractor contract language to identify if environmental performance expectations, requirements, and incentives were addressed early in the project; determine if incentives were awarded	x	World Bank
D-24			Has the Prime Contractor (designer) developed subcontractor contract language to promote worker safety, ergonomics, and environmental enforcement?		Review Prime Contractor and subcontract contract language to identify health, safety, environmental compliance, and enforcement requirements; determine if reduced injuries and compliance problems occurred	x	World Bank
D-25			Has the Prime Contractor (designer) selected subcontractors based upon their past achievement of specified environmental and social performance, corporate social responsibility concerning labor benefits, community investment programs, philanthropy donations, and employee voluntarism?		Review Design Team subcontractor requirements and determine if selection criteria is based upon environmental and social responsibilities; evaluate if subcontractor selection was actually based upon these elements	x	World Bank/ CEEQUAL
D-26			Has the project Design Team defined a sound and viable sustainable procurement plan for materials and equipment from vendors with sustainable actions or policies?	15% of materials from sustainable sources;  15% of purchased materials and supplies certified by reputable, third-party accreditation and standard-setting organizations	Obtain and review the Design Team, client, or subcontractor procurement policy and plan; evaluate plan based upon sound sustainable practices; assess if indicator measurements were achieved	x	ENVISION/  CEEQUAL

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Project Leadership</b>							
D-27			Has the project team made efforts to identify any unresolved worker health, safety, or environmental violations of manufacturers or suppliers?		Determine if the project team performed due diligence actions by investigating the environmental performance/worker violations of selected vendors; review project documentation and vendor information		ENVISION
D-28			Is the project developing or better enabling use of public transit areas such as bus shelters, bicycle parking, and security?		Determine if project designs addressed transit area enhancements to promote more use of public transportation systems; evaluate increase in ridership from actions		GreenLITES
D-29			Are the project roles, responsibilities, and authorities for addressing the sustainability-based issues and management follow up beyond regulatory requirements for the project Design Team clearly assigned and sufficiently delegated commensurate with the scope, scale, and complexity of the project?		Review the project design documentation such as project management plans or sustainability plans; review organizational charts for sustainability responsibilities; evaluate if sustainability reporting to management is within the project plan and has been performed	x	ENVISION Stage 1 Second Draft/ NCHRP
D-30			Has the project Design Team considered the ability for future transportation expansion or reconfiguration?		Ensure that the project scope and design is consistent and complements the long term sustainable transportation planning; expand environmental investigations beyond normal boundaries	x	ENVISION
D-31			Has the Project Team assembled the necessary information needed to train future construction and operations workers in a way that facilitates proper training to guide workers' interaction and behavior with indigenous groups and local communities?		Determine if the project Design Team developed a training program for all project members including all subcontractors; review meeting summaries, presentations, documentation of conducting meetings, and member attendance signatures		ENVISION/ World Bank/ CEEQUAL
D-32			Has project identified and allocated time and budget for the responsibility to collect data and report on sustainability performance to the owner and project management?		Review the project design management plan to determine if a sustainability coordinator is identified to work in an integrated fashion with the transportation design engineers; review project monitoring plans before construction for sustainability and environmental enhancement commitments	x	NCHRP
D-33			Do the project designs recognize the need for equipped check points to control weight of trucks and buses and prevent damage to pavement in case road alignments are close to forest lands and protected areas?		Review project designs to determine if extended shoulder areas or structures are addressed in the project; assess if there are truck weight control plans and monitoring systems to prevent unnecessary road impacts and reduced roadway longevity	x	World Bank

(Continued)

**TABLE B.2.** SUSTAINABLE ROAD TRANSPORTATION PROJECT PLANNING AND DESIGN CRITERIA (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Project Leadership</b>							
D-34			Has proactive road rehabilitation provisions and techniques beyond local requirements been included in the design or future maintenance of existing bridges, roads, drainage structures, accommodating storm water flow, road safety devices, and truck lay-bys?		Determine if rehabilitation designs or activities are addressing enhancements in drainage systems and road safety via design review and onsite inspections	x	African Development Fund/Planning Rural Roads in Developing Countries
D-35			Is there evidence that there has been a suitable level of consultation on, or consideration in the design given to, the future development to pedestrians and cyclists, links with existing and proposed routes to local services, links between communities, the quality of new open space, and its position within the hierarchy of local amenity space provision?		Evaluate design consistency to existing bicycling plans and programs, existing and future transit planning and land use planning documentation		CEEQUAL
D-36			Does the Design Team have a documented Environmental Management System (EMS) for the entire project and in place for the duration of project construction consistent with International Standards Organization (ISO) 14001:2004?		Assess if project EMS system or plan was in place for the design and construction phases; assess if can-do-plan-act system was actually used in the design of the project		Greenroads
D-37			Has the Design Team implemented new (or improved existing) operations or technologies for bicycle facilities such as (but is not limited to) added signage, installing bicycle detectors in driving lanes, granting signal priority, and adding bicycle storage facilities (lockers, racks, etc.)?		Review design documentation to assess if enhanced bicycle accommodations are incorporated into the design and verify that they were implemented during construction; evaluate if increased bike usage occurred in project area	x	Greenroads
<b>Natural World</b>							
D-38		Siting-Alignment Selection	Does the project road design alignment avoid impacts to social and environmental resources of parklands, wetlands, historic sites, farmlands, residential and commercial buildings, indigenous lands, etc.?		Review design documentation to determine if the final alignment was aggressive in impact avoidance and enhancement and that the final alignment was not totally based upon lowest financial cost	x	GreenLITES/World Bank

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural World</b>							
D-39			Does the project design address new separated bike path or shoulder widening to provide for on-road bike lanes or provide shoulder restoration for bicycling, farm-related equipment, farm animals, 2- and 3-wheelers, and non-motorized vehicles?		Review design documentation to assess bicycle or pedestrian enhancements for essential movement of goods and services and the movement of agricultural farm animals for poor communities; determine if enhancements were constructed	x	GreenLITES (modified)
D-40			Does the design provide flexibility to align roadway and other highway features/ structures (water lines, sewer lines, communication lines, gas lines, etc.) within right of way to enable future development of separated multi-use paths or other bike and pedestrian facilities?		Review design documentation for utility planning, mapping and coordination; assess consistency and flexibility to future multi-modal transportation planning	x	GreenLITES
D-41			Does the design conserve undeveloped land by locating alignments and right of ways on previously developed sites and/or previously contaminated sites?	Percent of alignment area previously used: 25% 50% 75% 100%	Review design documentation to assess if alignment alternatives considered the placement in already developed or previously contaminated land; verify percentage of previously used area calculations	x	ENVISION
D-42		Land-Water Wildlife Habitat	Has the project team designed the landscaping to incorporate plant species that require no pesticides, herbicides, and fertilizers, or use integrated pest management approaches?		Determine if the project team developed an integrated pest management plan for implementation during and after construction; verify success by onsite assessment	x	ENVISION
D-43			Has the Design Team provided enhancements to existing wildlife habitat or created new ones (for example, bird and bat houses, nesting boxes, fish spawning, threatened and endangered habitat improvements) and identified wildlife mortality reduction measures such as right-of-way fence, wildlife crossing signs, etc.?		Review design documentation for wildlife habitat design enhancements; verify implementation and habitat improvements in the field	x	GreenLITES/ World Bank/ CEEQUAL
D-44			Did the Design Team develop scheduling and logistic requirements to avoid disrupting wildlife nesting or breeding activities?		Review project-based wildlife management plans and the preliminary project construction schedule that accommodates wildlife nesting and breeding periods beyond regulatory requirements	x	GreenLITES
D-45			Did the Design Team permanently protect the new or expanded habitat through environmental or conservation easements?		Review easement and conservation easement agreements with local agencies or conservation groups in project documentation; review meeting summaries and easement documentation		GreenLITES

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**TABLE B.2. SUSTAINABLE ROAD TRANSPORTATION PROJECT PLANNING AND DESIGN CRITERIA** *(Continued)*

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural World</b>							
D-46			Does the project alignment progressively minimize the overall construction “footprint” to avoid environmental impacts?		Review design alternative analysis to determine if footprint reduction beyond regulatory requirements was conducted by the Design Team; assess if additional area impact minimization could have been performed	x	GreenLITES
D-47			Has the project specified the use of native species for seed mixes and other native plantings for vegetation restoration and soil stabilization?		Review the specified seed mix specification provided by the Client or by the Design Team Landscape Architect; assess if native species are in landscaping and revegetation plan; assess implementation via field assessment	x	GreenLITES
D-48			Does the project maintain or enhance riparian and aquatic habitat connectivity and the maintenance or enhancement of the riparian and in-channel physical and vegetative habitat to support and enhance threatened and endangered or otherwise desirable species?		Determine if habitat restoration assessments and plans were developed for project designs; review environmental assessment to determine if additional habitat improvements were designed; assess actual implementation via onsite visit	x	ENVISION/ CEEQUAL
D-49			Do project designs protect, buffer, enhance, and restore areas designated as wetlands, shorelines, and water bodies by providing natural buffer zones, vegetation, and soil protection zones?	Buffer zone distance from sensitive area (meters): >15 >30 >60 >90	Review design documentation and measure buffer width distances from sensitive areas; verify buffer zones in the field	x	ENVISION
D-50			Is there evidence that the project team have actively considered, beyond regulatory requirements, the retention and enhancement of trees and other vegetation as part of design as recommended by a qualified landscape architect?		Review project design landscaping plan and compare to environmental assessment to determine if tree/vegetation enhancement was considered in the design; determine if sensitive vegetation was identified and protected by the design team		CEEQUAL
D-51			Has the Design Team developed a monitoring program after construction to assess the success of habitat enhancement and conservation measures?		Review project documentation for the wildlife management plan and monitoring plan; assess performance measures for successful enhancement and conservation; verify implementation by field visit	x	CEEQUAL

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural World</b>							
D-52		Biodiversity	Will the project remove undesirable invasive plant species (removal or burial of invasive species) to preserve desirable overall natural species diversity?		Determine if Design Team specified to Contactor the control of invasive species during construction and ensure compliance with pest management plan during construction and operations		GreenLITES/ ENVISION
D-53			Does the project design enhance aquatic and terrestrial habitat connectivity to promote system mobility and biodiversity?		Review design plans to determine if habitat restoration assessments and plans were developed specifically to address mobility and habitat fragmentation; assess if structures constructed and successful via field visit	x	ENVISION
<b>Natural Resource Management</b>							
D-54		Materials	Has the Design Team specified that the highest possible proportion of timber and timber products used in permanent works is either from legal and sustainably managed sources with recognized timber labeling or from reuse?	<10% >10% to <25% >25% to <40% >40% to <55% >55% to <70% >70% to <85% >85%	Review design specifications and documentation showing that certified sustainable lumber (Forest Stewardship Council or equivalent) was required for project; review and certify calculations; verify certification labeling from vendor	x	CEEQUAL
D-55			Has the Design Team required new or reconstructed pavement surface area for pavement to meet long-life pavement design criteria (minimum 40-year design life)?	75% of new pavement	Review design specifications and documentation showing that long life pavement was selected	x	Greenroads
D-56			Has the Design Team or Contractor considered materials beyond only the pavement binder materials or considered only the hot mix asphalt (HMA) or Portland Cement Concrete (PCC) pavement materials?		Determine if a full range of material alternatives was considered by the Design Team		INVEST/ GreenLITES
D-57			Has the Design Team considered all pavement materials that include the HMA or PCC layers as well as granular base layers (either unbound or bound) as well as any other added materials or considered recycling/ reuse of all structure materials (bridge piers, structures) in existing structures within the project?		Determine if a full range of material alternatives was considered by the Design Team	x	INVEST/ GreenLITES

(Continued)





#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
D-62			Has the Design Team specified the use of porous pavement systems in light duty situations (for example, sidewalks, truck turnarounds, rest stops, parking lots, police turnarounds) to control and treat at least 50% of the 90th percentile average annual rainfall event post-construction runoff volume to 25 mg/L concentration of total suspended solids or less for storm water control?		Review design material specifications and material documentation that specify porous pavement		GreenLITES/ Greenroads
D-63		Recycling-Reuse	Has the Design Team estimated the amount of excavated material (soil and topsoil) that is suitable for use and has been beneficially reused on site such as revegetation, embankments, and fill?	Percent re-use: <15% >15% to <30% >30% to <50% >50% to <90% >90% to 100%	Review project design documentation calculations and contractor specifications for reuse; evaluate if reuse indicators were met by contractor's field records	x	CEEQUAL/ GreenLITES
D-64			Has the Design Team specified what percentage (by volume) of components for prefabricated units used can be easily separated on disassembly or deconstruction into material types suitable for recycling?	Percent by volume: <15% >15% to <30% >30% to <45% >45% to <60% >60% to <75% >75% to <90% >90%	Review project design documentation to determine if disassembly or deconstruction was considered in the design placed in contractor specifications; assess volume calculations		CEEQUAL
D-65			Does the design identify that the reuse of previous pavement and other materials (excluding topsoil and subsoil) have been incorporated into the project as replacement road subbase, embankment fill, or usable aggregate material (as opposed to being disposed of via landfilling)?	Percent by volume: <30% >30 to <60% >60 %	Review project design documentation to determine whether waste material other than soil was considered in the design; assess volume calculations and if indicator value(s) placed in contractor specifications		CEEQUAL/ ENVISION/ GreenLITES
D-66			Has the Design Team identified existing structures (such as roads, tanks, and pipework) that have been retained and reused within the project?	Percent by volume: <25% >25% to <50% >50% to <75% >75%	Review project design documentation to determine if road-based waste material and other materials were reused on the project; assess volume calculations and if placed via contractor specifications	x	CEEQUAL/ GreenLITES

(Continued)

**TABLE B.2. SUSTAINABLE ROAD TRANSPORTATION PROJECT PLANNING AND DESIGN CRITERIA (Continued)**

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
D-67			Did the Design Team specify the lumber salvaging of removed trees for lumber or similar uses other than standard wood-chipping?		Review project design documentation to determine if lumber salvaging was used on the project; find documentation of wood material transport to lumber vendor and if placed via contractor specifications		GreenLITES
D-68			Did the Design Team specify the use of tire shreds, removed concrete, or other materials for embankments?		Review project design documentation to determine if waste concrete material and tire shreds were addressed in the design; find documentation of receipt of tire shreds or other types of suitable reused rubber material		GreenLITES
D-69			Has the Design Team specified the use of recycled glass in pavements and embankment as drainage material or filter media, where adequate local sources can be obtained?		Review project design documentation to determine if recycled glass in pavements and embankments were addressed in the design		GreenLITES
D-70			Has the Design Team specified the use of crumb rubber or recycled plastic for noise barrier material?		Review project design documentation to determine if crumb rubber or recycled plastic for noise barrier material was addressed in the design; obtain receipts of recycled materials to verify		GreenLITES
D-71			To avoid landfilling, are the project specifications specifying the recycling or reuse of chipped untreated wood waste for use as mulch and/or ground cover (pressure-preservative-treated or painted/coated wood excluded)?		Review project design specifications or contractor logs to determine if recycling of wood chips and waste used onsite for landscaping and erosion control; verify use via onsite inspection	x	GreenLITES
D-72			Do the project specifications require the salvage of materials for reuse/recycling or moving of houses or other structures rather than demolition for disposal in landfills?		Review project design documentation and contractor specifications to determine if usable material from demolished homes was salvaged; verify by material receipts from vendors	x	GreenLITES
D-73			Will the project establish and strive to achieve a recycling goal of existing pavement materials and structural elements (that include but are not limited to asphalt, Portland Cement Concrete, unbound granular base material, stabilized base material, reinforced concrete, structural steel, and timber)?	Percent by volume or weight: 50% Percent of significant waste streams diverted from disposal: <25% 50% 75% 100%	Determine if the project Design Team developed a recycling goal within the waste management plan; assess documentation calculations for achieving recycling actions	x	Greenroads/ ENVISION



**TABLE B.2.** SUSTAINABLE ROAD TRANSPORTATION PROJECT PLANNING AND DESIGN CRITERIA (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
D-79		Energy	Has the design incorporated operational energy through autonomous renewable energy sources?	Percent of lifetime energy provided: 20% 40% 60% 80% 100% 110%	Compare design documentation and vendor information to determine the amount of autonomous renewable energy that will be used; verify energy use calculations by Design Team or vendor; evaluate installation by onsite evaluation	x	INVEST/ ENVISION
D-80			Does the design address energy efficient lighting that meets illumination requirements for solar powered streets, signal lighting, warning signs, and retrofitting existing street/sign lighting?	Percent of reduced energy: 10% 20% 30% 40% >50%	Assess design documentation and vendor information to determine if efficient lighting was specified; research and verify energy use calculations by Design Team or vendor and product specifications	x	CEEQUAL/ GreenLITES
D-81			Does the project reduce energy consumption by a minimum of 10% over industry norms?	10% reduced energy consumption over industry norms	Assess design documentation and contractor specifications to reduce project energy consumption during the life of the project	x	ENVISION
D-82			To reduce fuel and water consumption, is the project reestablishing natural ground cover and/or seeding with low maintenance seed species?		Review project landscaping plan to assess native species used and reduced mowing areas; review design material specifications; verify installation via onsite inspections	x	GreenLITES
D-83			Has a life-cycle energy assessment been undertaken for the key materials and components to be used in the project?		Assess design documentation for life cycle analysis for materials; assess if energy and carbon life cycles performed according to accepted protocols		CEEQUAL
D-84		Water	Does the project Design Team reduce potable water consumption for the duration of the project?	Percent of industry norms: <25% 50% 75% 100%	Review contractor specification and/or requirements about water conservation; review contractor information on water consumption; perform calculations and review data associated with industry norms	x	ENVISION

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
D-85			Does the road alignment establish a minimum buffer zone between the edge of pavement and a natural watercourse or significantly sized natural wetland to serve the purpose of storm water filtration?	Minimum 30 meter buffer zone	Review design documentation and measure buffer width distances from sensitive areas; verify buffer zones in the field		GreenLITES
D-86			Does the project strive to enhance existing water quality and/or nearby habitat conditions through the use of construction based storm water controls, stream restoration, additional wetland utilization, and inclusion of permanent-sustainable storm water management practices?		Review the storm water management plan and/or water quality management plan to assess storm water controls and determine that enhanced storm water controls are improving water quality and aquatic habitat	x	GreenLITES
D-87			Does the long term post construction storm water best management practices design reflect effectively removing surface pollutants from runoff through low impact development techniques such as infiltration trenches or basins, grass buffers, or storm water wetlands (going beyond regulatory requirements)?		Review the storm water management plan and/or water quality management to determine design and installation of controls that promote infiltration and sustainable low impact techniques		GreenLITES/ Greenroads
D-88			Does the project avoid potential alignments within the design frequency floodplain for waterways of all sizes (unless water dependent infrastructure must cross a waterway)?		Acquire and assess the project floodplain areas and alignments to determine floodplain avoidance beyond normal requirements	x	ENVISION
D-89			Do the project designs recognize the need for water conservation and the reduction and elimination of irrigation after native plant species establishment, post construction?		Review landscaping plan to assess native species used and the eventual elimination of irrigation; review design material specifications for native plants	x	INVEST
D-90			Is there evidence that the project Design Team has made provisions for capturing storm water runoff for beneficial use on the project or for environmental enhancement for the completed project?		Review the storm water management plan and/or water quality management plan and storm water control designs to determine if water capturing for environmental enhancement was implemented		CEEQUAL
D-91			Have proactive opportunities been identified by the Design Team beyond regulatory requirements for vegetative planting prior to construction, thus enabling plants to become established during the construction phase to reduce erosion and protect water quality?		Assess the project revegetation and landscaping plan for erosion control for innovative approaches	x	CEEQUAL

(Continued)

**TABLE B.2. SUSTAINABLE ROAD TRANSPORTATION PROJECT PLANNING AND DESIGN CRITERIA** *(Continued)*

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
D-92			Have the most environmentally beneficial ways beyond regulatory requirements been adopted for addressing the percent exposed soil, vegetative grubbing, and clearance to reduce erosion and protect water quality?		Assess the project revegetation and landscaping plan for erosion control for innovative approaches that reduce the amount of exposed soil without stabilization during construction		CEEQUAL
D-93		Atmosphere	Has the Design Team developed strategies that will reduce air emissions (compared to base year of plan) for at least one pollutant?	Percent reductions compared to base year: 1% 3% 5%	Review project emissions control plan or other project documentation; identify pollutant reduction strategy and verify calculations	x	INVEST
D-94			Do design specifications identify non-usable cutback asphalt (Volatile Organic Compound [VOC] emitter) and all paints and coatings so as to comply with GS-11 Green Seal Environmental Standard for Paints and Coatings?	Percent of reduced energy: 10% 20% 30% 40% 50% or greater	Review project emissions control plan, material specifications, or other project documentation; identify VOC reduction strategies and reduction calculations		INVEST
D-95			Do the project specifications reduce energy and emissions in pavement materials such that low-energy materials are used for the project pavement?	50% of total project pavement	Review project emissions control plan or other project design documentation; identify if low energy pavement material is used at the indicator level	x	Greenroads
D-96			Do specifications identify that ENERGY STAR® certified cement production plant for cement materials must be used on the project by the contractor?	Energy Rating System	Review design specifications and contractor requirements to determine if the vendor's concrete production plan is qualified or has ENERGY STAR® certification (score in the top 25% based on the EPA National Energy Performance)		Greenroads
D-97			Does the project team prioritize vendors who burn recycled oil, waste materials, or other fuel saving technologies in hot mix asphalt plants or cement production plants to reduce conventional fuel usage?	Reduce conventional fuel usage by a minimum of 25%.	Review design specifications and contractor requirements to determine if the vendor uses this fuel conservation technique; verify percent reduction achieved		INVEST
D-98			Has the Project Team designed the project to eliminate the occurrence of adverse dust during construction and operations through innovative construction phasing, landscaping, and erosion control techniques?		Review the project dust control and air pollution management plan that eliminates or significantly reduces air particulates; review landscape or erosion control plan for innovative approaches	x	ENVISION

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
D-99			Has the team adopted a design in which at least 75% of the total new or reconstructed pavement surface area produces tire-pavement noise levels below 88dBA?		Review the project noise control plan or the project materials plan to identify pavement types and traffic speeds for reduced noise generation beyond normal pavement types		Greenroads
D-100			Does the design attempt to minimize surfaces with a high solar reflectance index (SRI) to reduce localized heat accumulation, reduce heated storm water runoff and manage microclimates?	Percent reduction in surfaces with low SRI: >10% to <30% >30% to <60% >60% to <90% >90% to <100%	Review the design materials plan to identify if SRI criteria was considered for heat island effect; review project material specifications; verify implementation in the field	x	ENVISION
<b>Climate Change</b>							
D-101		Resilience	Has the Design Team conducted a system-level assessment of potential hazards to the project such as seismic events, relative sea level rise, storm activity/intensity, temperature and heat waves, precipitation events, elevated lake levels, and stream flows, etc. and identified potentially vulnerable locations at risk?	Prepared for: 1 in 50 year event 1 in 100 year event	Review the project climate adaptation plan or other design documentation; evaluate existing risk studies in and outside of project area; ensure designs provide safety factors or features that address the indicator levels	x	INVEST/ ENVISION
D-102			Has the project Design Team considered ways to extend the durability and resilience of the project early in the design stage to reduce future transportation system maintenance and rehabilitation?		Review the project climate adaptation plan or other design documentation; evaluate extended safety factors and enhanced design elements	x	ENVISION
D-103			Does the road rehabilitation design address adaptation to the impacts of climate change to ensure that drainage structures are able to accommodate high rainfall and flash floods?		Review the project climate adaptation plan or other design documentation; evaluate achievement in reaching extended safety factors and enhanced design elements for critical high flow events	x	African Development Fund
D-104			Has the Design Team developed a comprehensive Climate Impact Assessment and Adaption Plan?		Verify that the project climate change plan was developed and adaptation design elements were integrated into design	x	ENVISION

(Continued)

**TABLE B.2.** SUSTAINABLE ROAD TRANSPORTATION PROJECT PLANNING AND DESIGN CRITERIA (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Climate Change</b>							
D-105			Have designs reduced human and natural system vulnerability by increasing adaptive capacity in the project and system?		Evaluate programs or plans that detail evaluations and improvements in resilience to climate change impacts		World Bank
D-106		Greenhouse Gas Emissions	Has an embodied life-cycle carbon and greenhouse gas emission assessment been undertaken for the key materials and components to be used in the project?		Review life cycle analysis performed according to accepted greenhouse gas emission protocols		CEEQUAL
D-107			What percent of the carbon emission reduction identified in the life-cycle assessment has subsequently been incorporated in the design and the completed works?	Percent carbon reduction: <10% >10% to <20% >20% to <40% >40% to <60% >60% to <80% >80%	Review emissions control plan developed for the project; identify key emissions; ascertain that project calculations meet indicator levels	x	CEEQUAL
D-108			Has the Design Team conducted a comprehensive life-cycle carbon analysis and used this assessment to reduce the anticipated amount of net greenhouse gas emissions during the life cycle of the project, thus reducing project contribution to climate change?	Percent reductions in carbon emissions as compared to regulatory requirements: <10% >10% to <40% >40% to <80% >80% to <100% >100%	Review emissions control plan developed for the project and carbon/greenhouse gas emissions life cycle analysis; verify that calculations meet indicator levels		ENVISION
D-109			Do design actions provide mitigation as a co-benefit by reducing greenhouse gas emissions or enhancing absorption from the atmosphere?		Obtain design plans and landscaping records to evaluate greenhouse gas reductions and landscaping planning for carbon sequestration or other absorption methods		World Bank



**TABLE B.3. SUSTAINABLE ROAD TRANSPORTATION CONSTRUCTION CRITERIA**

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>							
C-1		Community Well-being	Does the project create a significant number of jobs during construction?		Assess number of local jobs created versus the total number on the workforce	x	ENVISION Stage 1 Second Draft
C-2			Has the Contractor for the road rehabilitation project created local public awareness about available job opportunities to ensure both men and women are availed equal opportunities to apply for various jobs?		Review documentation in project file showing advertisements, media announcements, and outreach plan that addressed gender equity	x	African Development Fund
C-3			Has the Contractor provided local people with on-the-job training for road rehabilitation construction positions?		Review documentation regarding meeting minutes, lesson plans, and records of training courses held; review local employment records toward achieving increased employment		African Development Fund
C-4			Will the project contribute to creating training and education programs, with emphasis on the most needy and/or disadvantaged groups, through construction?		Analysis of community outreach and education programs initiated by the project; identification of community groups; evaluate increase in employment of disadvantaged groups	x	ENVISION Stage 1 Second Draft
C-5			Has the project been able to contribute to maintaining key conservation skills and creating sustainable heritage employment?		Review specifications, training records, and meeting minutes		CEEQUAL
C-6			Was there a documented commitment to consider and assess the community social aspects during construction?		Review evidence in written plans to address community social issues and meeting minutes	x	World Bank
C-7			Has the Contractor encouraged sustainable growth in small businesses in close proximity to the construction site?		Review project files for purchasing agreements, advertisements, and minutes of meetings with workforce; evaluate if growth in business occurred as a result of project	x	World Bank
C-8			Has the Contractor actively promoted the development of good laws, regulations, and contract documents with government agencies and in local and regional trade organizations?		Assess evidence in interviews with government officials, competitors, subcontractors, and trade organization officials; evaluate if new laws and regulations were developed by project	X	World Bank

*(Continued)*

**TABLE B.3. SUSTAINABLE ROAD TRANSPORTATION CONSTRUCTION CRITERIA** (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>							
C-9			Has the Contractor considered selection of subcontractors based on corporate social responsibility concerning labor benefits, community investment programs, philanthropy donations, and employee voluntarism?		Review evidence in announcements of upcoming contracts, stated selection criteria, and minutes of meetings		World Bank
C-10			Is there evidence that there has been a suitable level of consultation on, or consideration given to, the compatibility and permeability of the development during construction to pedestrians and cyclists, links with existing and proposed routes to local services, links between communities, the quality of new open space, and its position within the hierarchy of local amenity space provision?		Review minutes from meetings with local groups, drawings or documents that show consideration of public space/access	x	CEEQUAL
C-11			Is there evidence that measures have been taken to minimize the adverse visual impact of the site during the construction stage?		Review documentation of measures taken; verify implementation by site records and photographs; evaluate improved aesthetic conditions from project		CEEQUAL
C-12		Community Context Design	If historical restoration or enhancement works have been completed, is there evidence that the current best practices have been applied and historically appropriate materials used?		Review design report and file information assessing different materials, receipts of material purchases, photographs, and consultation with relevant expert organizations; determine if actual improvements occurred by visual evaluation	x	CEEQUAL
C-13			Has there been any public opportunity provided to learn about, observe, or take part in any activity to understand or promote the historic environment local to the project?		Review the level of public access such as visitor books, press advertisements of access or tour times, photographs of public facilities, information boards, leaflets, web postings, and notices of invitations to public to participate in assessment or mitigation of the project		CEEQUAL
C-14		Safety and Health	Has the Contractor developed Subcontractor contract language and trained its supervisors to actively promote worker safety, ergonomics, and environmental enforcement when needed?		Review subcontracts, minutes of meetings, and construction memorandums to supervisors; evaluate if improved worker safety and compliance was experienced on project via accident reports and compliance documentation	x	World Bank

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>							
C-15			Has the Contractor instructed its workers and personnel about procedures to follow in case one of them is bitten by poisonous fauna species and provided telephone numbers of health centers nearby?		Access health and safety manuals, employee files, list of emergency telephone numbers given to workforce, and posters in workplace; review map showing closest medical facility to work place	x	World Bank
C-16			Has the Contractor proactively fenced the project to avoid accidents to children and livestock?		Review photographs taken during construction, contractor specifications diaries, and accident reports	x	African Development Fund/ World Bank
C-17			Has the Contractor removed temporary fencing when construction is complete?		Review before and after photographs, contractor diaries, and documentation acknowledging removal	x	African Development Fund
C-18		Collaboration	Is there evidence that the Construction Team proposed changes to the specifications to improve the whole-life environmental performance of the project during the construction stage easing its reuse or ultimate disassembly?		Obtain and review value engineering reports, agreement of alternative methods within management plans, design change notes, and letters to the Design Team; study list of waste materials recycled and reused	x	CEEQUAL
C-19			Has Contractor developed incentives, especially financial, to increase Subcontractor commitment and environmental performance in contract bids?		Review evidence in contract agreements with Subcontractors; retrieve contract agreements with Subcontractors to improve environmental performance and sustainability awareness	x	World Bank
C-20			Is there evidence that the Owner/Client and Contractor have taken steps to actively encourage local firms to compete for work?		Review project documentation in advertisements and number of tenders from local companies; assess increased local employment	x	CEEQUAL
C-21			Have any partnership links been established with local groups (for example, donation of skills or surplus materials)?		Determine relationships formed that will facilitate resource purchasing and allow for better coordination of local resources; review meeting minutes describing donations to local community groups		CEEQUAL
C-22			Has the Construction Team assessed the responses from the community relations program and have they taken appropriate action within the construction process?		Review evidence that comments from the community assessed and were taken into account in the decision-making process		CEEQUAL

(Continued)

**TABLE B.3. SUSTAINABLE ROAD TRANSPORTATION CONSTRUCTION CRITERIA** *(Continued)*

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>							
C-23			Has a local participatory environmental monitoring committee been established by the community?		Review evidence that a committee was formed to hold interviews with community leaders, meeting minutes, and newspaper articles		World Bank
C-24		Management and Planning	Was there a documented commitment to consider and assess the environmental aspects during construction?		Assess documentation in a written commitment from Project Director with policy statement, objectives, and targets	x	CEEQUAL
C-25			Is there clear evidence that a member of the Contractor's Team was identified as responsible for managing the environmental and sustainability aspects of the project and was the project role, responsibilities and authorities for addressing the issues of sustainability during construction clearly defined?		Review project file for a formal note of appointment, records of meetings where the role, responsibilities, and authorities were clearly set out, and reports from the appointed environmental person during operations resulting in achieving sustainability goals and objectives	x	CEEQUAL/ ENVISION Stage 1 Second Draft
C-26			Have the environmental opportunities for environmental enhancements and associated social issues been identified and clearly recorded during construction and prioritized according to significance?		Review evidence in a report on the environmental opportunities, minutes of project team meetings, and management directive about enhancement integration	x	CEEQUAL
C-27			Did the selection procedure for the Contractor and the key Sub-contractor(s) consider their past environmental performance?		Assess evidence in supplier appraisals and quality submissions information on environmental issues during the tender stage	x	CEEQUAL
C-28			Has a Fire Control Plan been prepared to specify actions to prevent and mitigate fires during road construction in forest areas and has it been implemented?		Obtain and review the Fire Control Plan, photographs, and meeting minutes; verify that no fires were created by project	x	World Bank
C-29			Has a Hunting Control Plan been prepared to specify actions to prevent and mitigate hunting during road construction in nearby forest areas?		Review the Hunting Control Plan and meeting minutes		World Bank
C-30			Has the Contractor developed and implemented an Environmental Training Plan that is customized to the project?		Review the Environmental Training Plan and a signed letter from the Client's representative stating that the Contractor followed the plan as submitted and updated; assess presentation outlines and compliance record	x	Greenroads/ INVEST

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>							
C-31			Does the Contractor, Design-builder, or Construction Management firm have a documented Quality Management System for the entire company or at least the portion(s) of the company participating in the project?		Review evidence in ISO 9001:2008 or ISO 9001:2000 certification or in a Quality Management System that meets ISO 9001:2008 or ISO 9001:2000 requirements but is not formally certified	x	Greenroads
C-32			Does the Contractor have a formal construction Quality Control Plan in place and used for the project?		Obtain and review the Quality Control Plan for the project	x	Greenroads/ INVEST
C-33			Did the Contractor search for and identify unwanted by-products, discarded or salvaged materials located in nearby facilities for use in the project?		Evaluate project information that the Contractor and Subcontractors actively searched for unwanted by-products, discarded or salvaged materials for use on the project, and transportation tickets	x	ENVISION Stage 1 Second Draft
C-34			Does the Contractor have a policy or code of practice regarding considerate behavior with respect to neighbors?		Assess documentation in Code of Practice or Policy statement coupled with an assessment of results	x	CEEQUAL
<b>Natural World</b>							
C-35		Siting-Alignment	Is there evidence that the Construction Team has made effective use of land resources made available to them and minimized the long-term adverse impacts to natural land temporarily used during the construction period (staging areas and haul roads)?		Review records of evaluation of the options, calculations from alternative site layouts, plans, site guidelines, and photographs showing avoidance of sensitive areas to prevent disturbance	x	CEEQUAL
C-36		Land-Water-Wildlife Habitat	Has the Contractor designated a qualified Environmental Construction Monitor to provide construction oversight in sensitive environmental areas?		Review evidence in the letter of appointment, qualifications, and the definition of role and responsibilities	x	GreenLITES
C-37			Have opportunities been taken for advance works, such as planting prior to construction, thus enabling plants to become established during the construction phase?		Review site programs; compare photographs showing the extent of advance work		CEEQUAL
C-38			Has the Contractor restored or reused 100% of the soils disturbed during construction?		Review evidence in photographs and inclusion in landscaping plans; inspect site after completion	x	ENVISION Stage 1 Second Draft

(Continued)

**TABLE B.3. SUSTAINABLE ROAD TRANSPORTATION CONSTRUCTION CRITERIA** (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural World</b>							
C-39			Has the Contractor restored or reused 100% of the soils disturbed by previous development?		Review evidence in before/after photographs; inspect site after completion	x	ENVISION Stage 1 Second Draft
C-40			On completion of the construction stage, is there any evidence of a net increase in wildlife habitat area compared to site baseline data prepared before construction commences?	Percent by square kilometers: <5% >5% to <25% >25% to <50% >50% to <75% >75%	Assess information in written report by an ecologist or equivalent	x	CEEQUAL/ World Bank
C-41			Has the Contractor scheduled work and provided logistics to avoid disrupting wildlife nesting or breeding activities?		Review documentation in meeting notes with biologists, fish, wildlife, and environmental agencies and actual construction schedules	x	GreenLITES
<b>Natural Resource Management</b>							
C-42		Materials	Have existing structures, such as roads, tanks, pipe work, etc. been retained and used within the project?	Percent by volume: <25% >25% to <50% >50% to <75% >75%	Review site photographs, construction drawings, and bill of quantities coupled with substantiation of the percent being claimed	x	CEEQUAL
C-43			Has the Contractor defined a sound and viable sustainable procurement plan?		Evaluate documentation in minutes of meetings, bill of quantities, and notes detailing locations for products needed to construct the project	x	ENVISION Stage 1 Second Draft
C-44			Has the Contractor made efforts to identify any unresolved worker health and safety or environmental violations of Manufacturers, Suppliers, and Subcontractors identified for the project?		Obtain evidence in a check with enforcement agencies for any unresolved or pending health and safety issues tied to Suppliers and Subcontractors		ENVISION Stage 1 Second Draft
C-45			Has the Contractor purchased the materials and supplies that are certified from sustainable sources by reputable, third party accreditation, and standard-setting organizations?	Percent by dollar amount: >15%	Review material bills from confirmed reputable suppliers detailing quantities purchased	x	ENVISION Stage 1 Second Draft
C-46			Has the Contractor verified local sources of supply by making an itemized list of all materials, parts, components, and products intended for permanent installation on the project including weights, total costs, shipping costs, location of purchase, and/or source of these materials?		Review reports for material sourcing, notes; hold discussions with vendors and material lists	x	Greenroads

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
C-47			Has the Contractor researched and used locally sourced equipment, materials, plants, aggregates, and soils including those that have been recycled?	<80 kilometers of site	Review project file reports for material sourcing, address of source, records of discussions with vendors, and invoices for materials and equipment	x	CEEQUAL/ ENVISION Stage 1 Second Draft/ Greenroads
C-48			Is there evidence that the selection and use of prefabricated units has been considered and implemented by the Contractor on the merit of their environmental benefits?		Review the comparison of design and construction records, meeting notes, and photographs	x	CEEQUAL
C-49			Is there evidence that the highest possible proportion of timber and timber products used in permanent and/or temporary works has been specified to be either from legal and sustainable managed sources with recognized timber labeling (Forest Stewardship Council or equivalent), or from reuse?	Percent by board feet: <10% >10% to <25% >25% to <40% >40% to <55% >55% to <70% >70% to <85% >85%	Review calculations showing the comparison of specification requirements to overall timber quantities; review subcontracts with timber suppliers with positive declarations with proof of quantities	x	CEEQUAL
C-50			Have bulk fill and subbase material used in the project come from previously used material, whether reclaimed from the site or elsewhere?	Percent by volume: <20% >20% to <30% >30% to <60% >60%	Review calculations showing the comparison of specification requirements to substantiated actual amounts	x	CEEQUAL
C-51			Has the Contractor used hot-in-place or cold-in-place recycling of hot mix asphalt pavements?		Review contractor specifications and evidence in contractor diaries, equipment utilization, and photographs	x	GreenLITES
C-52			Has the Contractor placed hot mix asphalt using a paver that is certified to have met the National Institute for Occupational Safety and Health (NIOSH) emission guidelines as set forth in engineering Control Guidelines for Hot Mix Asphalt Pavers, Part 1 New Highway-Class Pavers?	Percent by volume: >90% of hot mix	Review copy of the manufacturing certification provided with the paver when purchased and signed statement by a Paving Contractor indicating that the certified paver was used on the project for 90% of the work		Greenroads
C-53			Have all coatings and treatments for permanent work materials been factory-applied (except for cut ends)?		Review and assess evidence in specifications, subcontract requirements, and inspection reports	x	CEEQUAL

(Continued)

**TABLE B.3. SUSTAINABLE ROAD TRANSPORTATION CONSTRUCTION CRITERIA** (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
C-54			Has the Contractor reduced or eliminated potentially polluting substances from the construction of the completed works?		Compare the design documents/specifications with the as built drawings/specifications, as well as hold discussions with the Client's inspection staff	x	ENVISION Stage 1 Second Draft
C-55		Reuse-Recycle	Has the Contractor salvaged removed trees for lumber or similar uses other than standard wood chipping?		Review photographs, construction diaries, and on site material logs	x	GreenLITES
C-56			Can components or prefabricated units be easily separated on disassembly-deconstruction into material types suitable for recycling?	Percent by volume: <15% >15% to <30% >30% to <45% >45% to <75% >75% to <90% >90%	Substantiate by any means that assesses how materials are utilized and combined within the works	x	CEEQUAL
C-57			Has a materials register been provided to the Client, Agency, or Operator identifying main material types to facilitate recycling during disassembly or deconstruction?		Review evidence in log of material types that will enable recycling upon demolition		CEEQUAL
C-58			Have unused materials been beneficially reused (or stored for reuse)?	Percent by volume: <10% >10% to <30% >30% to <50% >50% to <70% >70% to <90% >90%	Verify evidence in records showing that surplus materials have been taken to another site for use compared with waste disposal records with declaration by Contactor as to use and volume	x	CEEQUAL
C-59		Waste Management	Has the Contractor used an on-site location for chipped wood waste disposal from clearing and grubbing operations?		Review evidence in meeting minutes, diaries, Waste Management Plan, design plans and specifications, and before and after photographs	x	GreenLITES
C-60			Has the Contractor used tire shreds in embankments?		Assess evidence in photographs, material transfer information, and waste transfer slips		GreenLITES
C-61			Has the disposal or transfer site been checked to ensure the waste was taken there?		Review documentation such as chain of custodies or bills of lading; verify documentation by telephone checks, following trucks carrying waste, and daily consignment notes		CEEQUAL



#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
C-62			Have the most environmentally beneficial ways of dealing with clearance and disposal of existing vegetation been explored and implemented for the majority of vegetation cleared?	Percent by volume: <50% >50%	Review onsite records such as photographs, waste transfer notes, and evidence of exempt activity	x	CEEQUAL
C-63			Has an identification of waste streams arising on site from construction been undertaken?		Obtain and review evidence in analyses of design documents identifying where waste is likely to be generated, its composition, and quantity		CEEQUAL
C-64			Does the Contractor have a formal Construction and Demolition Waste Management Plan for waste minimization and for identifying and dealing with all wastes arising from the project?		Review documentation to verify inclusion with the waste management plan and quality or environmental management system records	x	CEEQUAL/ INVEST/ Greenroads
C-65			Has waste from demolition or deconstruction been taken to the landfill?	Percent by volume: >70% >50% to <70% >30% to < 50% >10% to <30% <10%  >25%	Obtain and review evidence in quantity surveyors' documentation or project accounts substantiating percentage	x	CEEQUAL  ENVISION Stage 1 Second Draft
C-66			Has non-hazardous waste material been segregated (on or off site) and diverted from landfill?	Percent by volume: <10% >10% to <25% >25% to <40% >40% to <55% >55% to <70% >70% to, 85% >85%	Review waste transfer notes or photographs showing different segregated groups	x	CEEQUAL
C-67			Is there evidence of measures (and their effectiveness) to keep access roads that are open to the public and clean, and any site roads properly managed?		Review copies of instructions, inspection logs, complaint records, and photographs during construction showing screening, tidy storage of material, absence of litter, and lack of site hoardings		CEEQUAL

(Continued)

**TABLE B.3. SUSTAINABLE ROAD TRANSPORTATION CONSTRUCTION CRITERIA** (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
C-68		Energy	Is there evidence that the Contractor has considered energy consumption and appropriate measures to reduce energy consumption and/or carbon emissions during construction and have these been incorporated through an energy management plan?		Review transportation records for materials, waste, and analyses of size of components to enable efficient lifting and placing	x	CEEQUAL
C-69			Has the Contractor assessed and implemented use of other, more sustainable transport routes (other than road), such as rail and water, for the movement of construction materials and/or waste?		Assess evidence in records showing consideration of alternative transport methods	x	CEEQUAL
C-70			Is there evidence that construction areas and ancillary equipment have been maintained to maximize fuel efficiency and minimize carbon emissions?		Obtain and review contractor records of regular maintenance and emission testing	x	CEEQUAL
C-71			Has the Contractor reduced the fossil fuel requirements of non-road construction equipment by using biofuel or biofuel blends as a replacement for fossil fuel or use engines that meet US Environmental Protection Agency Tier 4 emission standards or have diesel retrofit devices for after-treatment pollution control?	Percent by number of hours: >50% of fleet >75% of fleet Percent by gallons: 15% reduction of fossil fuel using biofuel or biofuel blends 25% reduction of fossil fuel using biofuel or biofuel blends	Review analysis of number of operating hours accomplished using equipment that meet one or more of the emissions control criteria  Documentation in a signed letter from the Contractor that describes fossil fuel use reduction measures used and the percentage reduction achieved; review spreadsheet summarizing all receipts for all fuel used in non-road equipment for the project	x	INVEST  Greenroads
C-72			Has the procurement, maintenance, and use of construction areas been influenced by consideration of their energy efficiency, energy type, or carbon emissions?		Review the comparison of actual plant and equipment with contract specifications		CEEQUAL

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
C-73			Has warm mix asphalt been used to reduce fossil fuel use at the asphalt plant?	Percent by weight: >50% of total project pavement	Review evidence in records of the warm mix asphalt design, name of technology, additive used if any, total tons of percent by weight of binder or by weight of mix, tons of warm mix asphalt compared total tons of pavement, exit temperature at drum exit, total fuel used in burner per ton of warm mix asphalt, and total fuel used in burner; review photographs if hot mix used	x	Greenroads
C-74		Water	Has the Contractor created a spreadsheet that records total water use during construction?		Review contractor water consumption spreadsheet used to record water use that includes: <ul style="list-style-type: none"> <li>• dates of use</li> <li>• amounts of use</li> <li>• locations and sources of water used</li> <li>• portability of water source(s)</li> <li>• each construction activity requiring water use</li> <li>• total water quantity used in each construction activity</li> <li>• method of measurement to determine total quantity used</li> <li>• disposal practice for unused water</li> <li>• type of water use permit, if any</li> </ul>		Greenroads
C-75			During construction, has consultation been undertaken with regulatory authorities on water conservation issues related to the project, including the need for any consent and has the outcome been communicated to the Project Team members?		Review available meeting notes or letters, obtaining consents or licenses, applications, granting of licenses, licensing application outcomes, notes of team briefings, and circulation of consent conditions	x	CEEQUAL
C-76			Has a practical system been put in place to minimize consumption of water during the construction process?		Review information that positive measures have been implemented to reduce water usage such as a comparison of before/after volumes used from meter records and third party written assessments	x	CEEQUAL
C-77			Will the water quality monitoring of surface waters for domestic drinking supplies for community users be monitored during the construction period?	Within 0.8 kilometers of the site	Review monitoring reports, data tables and analyses, meeting minutes, and reports to government authorities		African Development Fund

(Continued)

**TABLE B.3. SUSTAINABLE ROAD TRANSPORTATION CONSTRUCTION CRITERIA** (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
C-78			Have opportunities to improve the local drinking water been implemented?		Review before/after photographs and before/after water quality sample comparisons to determine improvement levels	x	CEEQUAL
C-79			Has the Contractor during construction reduced runoff and controlled associated pollutants into adjacent water resources by allowing infiltration of surface water, filtration of pollutants or other methods to treat storm water runoff?		Assess evidence showing features that make use of highly permeable soils through infiltration trenches or basins, bio-retention cells or rain gardens, grass buffers, storm water wetlands, wet or dry swales, sand filters, filter bags, storm water treatment systems, underground detention systems, and catch basin inserts	x	GreenLITES
C-80		Atmosphere	Did the construction site set-up include measures to minimize travel impacts of the workforce?		Evaluate evidence showing what facilities the Site Team provided to minimize workforce travel such as access to public transport links, provision of a minibus, provision of temporary accommodation, encouraging carpooling, and prescribing specific routes for travel	x	CEEQUAL
C-81			Have these travel impact measures been successful in reducing workforce travel impacts during construction?		Review reports on numbers of workforce traveling to work by car as opposed to public transport and car counts compared to total number of workforce living on site		CEEQUAL
C-82			Has the local authority been consulted regarding the noise implications of construction?		Review correspondence with local authority and minutes of meetings		CEEQUAL
C-83			If there are noisy aspects of construction that can impact sensitive receptors, have they been monitored at appropriate intervals throughout the construction stage?		Review documentation such as a project Noise Plan, collected noise data, and noise analysis	x	CEEQUAL
C-84			Did the monitoring of noise levels at sensitive locations demonstrate that acceptable noise levels were achieved throughout the construction stage?		Review evidence in noise monitoring data, records, and method statements	x	CEEQUAL
C-85			Have vibration levels been monitored at appropriate intervals for sensitive locations throughout the construction stage and has corrective action been taken where necessary?		Review documentation in Vibration Plan, monitoring records, and method statements	x	CEEQUAL

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
C-86			Is there evidence that appropriate measures have been taken at the construction stage to eliminate or significantly minimize adverse impacts on local air quality?		Review evidence in design drawings, specifications, and records of complaints	x	CEEQUAL
C-87			Is there evidence that appropriate measures have been taken to prevent nuisance light spillage to sensitive receptors into neighboring areas during construction?		Review evidence in design drawings, specifications, photographs, and records of complaints	x	CEEQUAL
C-88		Resilience	Has the Contractor planned the temporary works to accommodate high rainfall and flash floods, which could arise from climate change weather patterns?		Review and assess construction drainage design drawings, hydrologic data, and prediction model in files, meeting minutes, and photographs	x	African Development Fund
C-89			Has construction actions reduced human and natural system vulnerability by increasing adaptive capacity in assets?		Evaluate programs or plans that detail asset evaluations and improvements in resilience to climate change impacts		World Bank
C-90		Greenhouse Gas Emissions	Has energy from renewable and/or low- or zero-carbon resources been used during construction?		Evaluate project information showing source of energy such as agreements with energy suppliers showing fully renewable sources, photographs of alternative energy sources, and use of renewable energy	x	CEEQUAL
C-91			Is there evidence that energy use has been monitored and controlled on site as and where possible?		Review and assess documentation that energy use and/or carbon emissions were assessed and monitored, targets set, and equipment used to proactively manage consumption and emissions	x	CEEQUAL
C-92			Has the Contractor maintained plant and equipment to limit carbon emissions?		Review contractor information regarding maintenance logs and equipment disposal records		African Development Fund
C-93			Has the Contractor planted trees along the road periphery to help absorb carbon emissions from road traffic?	10 trees per kilometer	Assess contractor landscaping plans; review before and after photographs and invoices for trees; perform field reconnaissance		African Development Fund
C-94			Will construction actions provide mitigation as a co-benefit by reducing greenhouse gas emissions or enhancing absorption from the atmosphere?		Obtain construction records to evaluate greenhouse gas reductions and landscaping for carbon sequestration or other absorption methods		World Bank

**TABLE B.4. SUSTAINABLE ROAD OPERATION AND MAINTENANCE CRITERIA**

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>							
M-1		Community Well-being	Are products bought from local vendors to support the local economy?		Evaluate the comparison of payments of invoices having local vendor names with those vendors located at distance; determine if there was an increase in local business revenue	x	GreenLITES Operations
M-2			Is there a comprehensive public educational outreach program in the operational phase of the project?		Review outreach plan, minutes of management meetings, and minutes of documented meetings with community organizations; determine number of meeting attendees and their continued participation	x	Greenroads
M-3			Has the Agency or Operator coordinated with Owners and Operators of adjacent facilities, amenities and/or transportation hubs to address issues of mobility and access during operation of the constructed works?		Evaluate assessment studies and reports, memorandums, minutes of meetings, and letters to Managers and Operators of adjacent facilities; contact adjacent operators of facilities to gage coordination		ENVISION Stage 1 Second Draft
M-4			Does the Agency or Operator encourage active management of vehicles within the existing roadway infrastructure to alleviate the major causes of congestion, including insufficient capacity (bottlenecks), incidents (crashes, disabled vehicles), weather (snow, ice, fog), work zones, poor signal timing, and nonrecurring events (special events)?		Review documentation to demonstrate effective and safe traffic management in one of the following: <ul style="list-style-type: none"> <li>• Improvement Plan detailing implementable strategies and technologies, or</li> <li>• mature program in place for signal timing and coordination, work zone coordination, incident management, or</li> <li>• performance metric and report of where the greatest improvements made, or</li> <li>• list of goals achieved and proof of progress toward goals</li> </ul>	x	INVEST
M-5			Has the Agency or Operator encouraged sustainable growth in small businesses in close proximity to the construction site?		Determine increase in small businesses generating jobs via evidence in purchasing agreements, advertisements, and minutes of meetings with workforce	x	World Bank
M-6			Has the Agency or Operator actively promoted the development of good laws, regulations, and contract documents with government agencies, and in local and regional trade organizations?		Review evidence through interviews and meeting notes with government officials, competitors, subcontractors, and trade organization officials; study new regulations developed to support community improvement	x	World Bank

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>							
M-7			Has the Agency or Operator considered selection of subcontractors based on corporate social responsibility concerning labor benefits, community investment programs, philanthropy donations, and employee voluntarism?		Determine promotion and awareness of sustainability expectations via announcements of upcoming contracts, stated selection criteria, and minutes of meetings	x	World Bank
M-8			Has the Agency or Operator enhanced scenic overlooks by trimming trees and shrubs to allow for views, planting and maintaining wildflower beds, placing picnic tables, and garbage cans?		Study before and after photographs, diaries, minutes of meetings; make on site visit for verification of enhanced aesthetics and quality of life elements	x	GreenLITES/ World Bank
M-9		Community Context	Do maintenance buildings and other facilities fit into the environment where they are located and are unsightly scrap metal piles, pipes, etc. screened from the public view?		Review evidence in photographs, minutes of meetings with community and government organizations; make onsite visit for verification for improved visual aesthetics	x	GreenLITES Operations
M-10			Has the Agency or Operator improved bridge aesthetics by using form liners to match existing aesthetic features and earthen tone stone matching historic-aesthetically pleasing features?		Obtain from project file documentation in photographs, minutes of meetings with historical societies and community; make on site visit for verification for sense of place aesthetics		GreenLITES
M-11		Safety and Health	Has the Agency or Operator developed Subcontractor contract language and trained its supervisors to actively promote worker safety, ergonomics, and environmental enforcement?		Obtain and review Subcontractor contracts, agreements, minutes of meetings, and construction memorandums to supervisors; review training outline or presentation; verify that no environmental fines and injuries occurred on the project	x	World Bank
M-12			Has the Agency or Operator instructed its workers and personnel about procedures to follow in case one of them is bitten by poisonous fauna species, and provided telephone numbers of health centers nearby?		Access health and safety manuals, employee files, list of emergency telephone numbers given to workforce, and posters in workplace; review map showing the closest medical facility in work place	x	World Bank
M-13			Have bridge crews replace grates that have their openings parallel to the roadway which are dangerous to bicycle riders (as bicycle wheels may become lodged in the grate with reticulin grates)?		Review documentation in diaries, photos, and invoices for new grates; assess improved safety conditions via the elimination of bicycle accidents		GreenLITES Operations

(Continued)

**TABLE B.4. SUSTAINABLE ROAD OPERATION AND MAINTENANCE CRITERIA (Continued)**

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Quality of Life</b>							
M-14			Have shoulders been restored for pedestrian and bicycling safety?		Evaluate evidence in before and after photographs and on site evaluations of safety features; determine reduction in accidents and improved local mobility		GreenLITES Operations
M-15			Where appropriate, have pedestrian countdown timers been installed to aid pedestrians in safer street crossings and to increase the use of sidewalks?		Acquire project documentation such as invoices for new timers and inspection logs for all the traffic lights serving pedestrian traffic; study improved pedestrian safety via reduced accident data		GreenLITES Operations
M-16			Has the Agency or Operator gathered data and completed Road Safety Audits/ Assessments during road use?		Assess documentation of parties doing the safety audits proving qualifications, audit scope, data on frequency, crash type, and severity with a summary of recommendations executed; determine improved public safety achievement	x	INVEST/ Greenroads
M-17			Does the Agency or Operator maximize the safety of the existing roadway network through a systematic and comprehensive review of safety data and the allocation of resources in planning and programming to support safety in operations and maintenance?		Review evidence in safety plans, implementation of the recommendations in the Road Safety Audit; determine improved worker and pedestrian safety	x	INVEST
M-18			Does the Agency or Operator use paints and coatings that comply with GS-11 Green Seal Environmental Standard for Paints and coatings and not use cutback asphalt to reduce exposure to hazardous airborne compounds?		Review contract requiring Operator to use paint and coatings that meet GS-11 Green Seal Environmental Standard for Paints and Coatings and that no cutback asphalt used; review invoices for products purchased that results in less VOC emissions	x	INVEST
<b>Project Leadership</b>							
M-19		Collaboration	Is there evidence that the Agency or Operator proposed changes to improve the whole-life environmental performance of the project thus easing its reuse or ultimate disassembly?		Obtain and review value engineering reports, agreement of alternative methods within management plans and design change notes and letters to the Design Team; study list of recycled or reused waste materials	x	CEEQUAL
M-20			Has the Agency or Operator developed incentives, especially financial, to increase Subcontractor commitment and environmental performance in contract bids?		Retrieve and review contract agreements with Subcontractors to verify improvements in environmental performance and sustainability awareness	x	World Bank



#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Project Leadership</b>							
M-21			Have any partnership links been established with local groups (for example, donation of skills or surplus materials)?		Determine relationships formed that will reduce resource purchasing and allow for better coordination of local resources		CEEQUAL
M-22		Management and Planning	Is there clear evidence that a member of the Agency or Operator was identified as responsible for managing the environmental and sustainability aspects of the project, and was the project role, responsibilities, and authorities for addressing the issues of sustainability during operation clearly defined?		Review project file for a formal note of appointment and records of meetings where the role, responsibilities, and authorities were clearly set out; study reports from the appointed environmental person during operations to confirm achievement of sustainability goals and objectives	x	CEEQUAL/ ENVISION Stage 1 Second Draft
M-23			Has the Agency or Operator developed and implemented an Environmental Training Plan that is customized to the project?		Evaluate Environmental Training Plan and updates and a signed letter from the Agency's representative stating that the Agency or Operator followed the plan as submitted and updated; evaluate whether the training resulted in a high level of compliance and accomplished sustainable actions	x	Greenroads/ INVEST
M-24			Have the environmental opportunities for environmental enhancements and associated social issues been identified and clearly recorded during highway operation and prioritized according to significance?		Review evidence in a report on the environmental opportunities, minutes of project team meetings, and management directive about enhancement integration	x	CEEQUAL
M-25			Have sufficient resources been allocated for the monitoring and maintenance of the constructed works?		Review existing Monitoring Plan, site access for designated persons, budget for long term monitoring according to the plan, and commitment that assures the budgeted resources will be available long term		ENVISION Stage 1 Second Draft
M-26			Is there an Asset Management System in effect that includes the paved and unpaved roads?		Review evidence in a signed letter or document from the Agency or Operator stating: <ul style="list-style-type: none"> <li>• a Pavement Management System is in place or will be put in place</li> <li>• Agency or Operator will manage the pavements and unpaved roads</li> <li>• means for accomplishing measuring road conditions, processing documented decision criteria for timing preservation actions, storage of database, and information display</li> </ul>	x	Greenroads

(Continued)

**TABLE B.4.** SUSTAINABLE ROAD OPERATION AND MAINTENANCE CRITERIA (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Project Leadership</b>							
M-27			Is there an Asset Management System in effect that includes critical structural features on the project, such as bridges and drainage structures?		Review evidence in a signed letter from the Agency or Operator stating: <ul style="list-style-type: none"> <li>• a Bridge Management System is in place or will be put in place</li> <li>• Agency or Operator will manage bridges and drainage structures</li> <li>• means for accomplishing measuring bridge and drainage structure conditions, processing documented decision criteria for timing preservation actions, storage of database, and information display</li> </ul>	x	Greenroads
M-28			Has the Agency or Operator done performance tracking by integrating quality and pavement performance data using a process that allows quality measurements and long-term pavement performance measurements to be spatially located and correlated to one another?		Ensure existence of a signed letter from the Agency or Operator stating that there is a performance tracking system in place that is operational and populated with the required data; obtain evidence in the field or in project file		Greenroads
M-29			Has a comprehensive environmental compliance tracking system been designed and implemented to ensure that commitments made during project development are tracked, fulfilled, and verified throughout operations and maintenance activities?		Review documentation in one of the following in the project file to ensure all formal commitments have been addressed: <ul style="list-style-type: none"> <li>• copies of databases, forms, lists, and hold points used for environmental commitment tracking</li> <li>• documentation of the ISO 14001:2004 certification</li> <li>• summary of system performance in a chart, table, or spreadsheet</li> <li>• progress towards the goal in a chart, table, or spreadsheet</li> </ul>		INVEST
M-30			Does the Agency or Operator use a Maintenance Management System to inventory, assess, analyze, plan, program, implement, and monitor maintenance activities to effectively and efficiently extend the life of the system and improve the service, such as to roadside and facilities?		Review documentation in one of the following: <ul style="list-style-type: none"> <li>• existence of a Maintenance Management System</li> <li>• documentation of features and elements of a Maintenance Management System</li> </ul>	x	INVEST

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Project Leadership</b>							
M-31			Does the Agency or Operator have an implemented plan to reduce the environmental impact of snow and ice control, such as reducing salt use, using an anti-icing program, conducting a training course on proper use of salt and chemicals, calibration of equipment, reducing cost, and improving fuel efficiency by optimizing routes?		Review evidence in the Snow and Ice Control Plan, meeting minutes with interagency stakeholders, photographs, and annual reports on plan progress; assess monitoring of water quality data or reports of nearby surface waters; evaluate reductions in material (traction sand) collected from highway ditches	x	INVEST/ GreenLITES Operations
M-32			Does the Agency or Operator have a program, committee, or task force that reviews and establishes policies (including training) regarding work zone traffic control?		Obtain and review evidence in a written program and meeting minutes; assess success of traffic controls by reduced accidents and road closures	x	INVEST
M-33			Does the Agency or Operator have a policy or code of practice regarding considerate behavior with respect to neighbors?		Review documentation in Code of Practice or policy statement coupled with an assessment of results; assess neighborhood complaints and ensure code is in contractor training materials	x	CEEQUAL
<b>Natural World</b>							
M-34		Land-Water- Wildlife Habitat	Has the Agency or Operator implemented wildlife-vehicle reduction measures or maintained activities/projects that enhance habitat and reduce wildlife mortality?		Review project file for work plans and accident logs of the number of wildlife killed before and after reduction measures implemented; assess if a reduction in traffic accidents and road-kill occurred	x	GreenLITES
M-35			Is there a program in place (for the years after project completion) for monitoring the success of any management, habitat creation or translocation and species conservation measures undertaken on site?		Review specific Monitoring Plan or part of a more generic Maintenance Plan that demonstrates monitoring is in place to ensure successful habitat improvements and mobility	x	CEEQUAL
M-36			Has the Agency or Operator reduced or eliminated potentially polluting substances from the operation of the completed works?		Review operational files to assess if hazardous material purchases have been reduced and replaced; review documents showing replacements and/or reductions	x	ENVISION Stage 1 Second Draft
M-37			Have bridges and roadways been cleaned consistent with good environmental practices avoiding fish spawning season, if applicable, and considering bird nesting activities?		Review standard operating procedures and documentation in meeting notes with biologists in fish, wildlife, and environmental agencies confirming that cleaning schedules for bridges do not coincide with spawning and nesting seasons		GreenLITES/ GreenLITES Operations

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**TABLE B.4.** SUSTAINABLE ROAD OPERATION AND MAINTENANCE CRITERIA (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural World</b>							
M-38			Have opportunities to construct storm water management facilities such as infiltration basins, dry swales, and permanent stone check dams been assessed to improve water quality?		Review standard operating procedures and storm water best management plans to assess use of infiltration based practices; review inspection and assessment reports, photographs, and storm water maintenance reports	x	GreenLITES Operations
M-39			Have both large and small culverts and catch basins undergone preventative maintenance and cleaning?		Review standard operating procedures and maintenance documentation; assess if practices prevented culvert plugging and overflow conditions; perform onsite inspection	x	GreenLITES Operation
M-40			Does the crew use natural alternatives to herbicides for invasive species control?		Review documentation in diaries, landscaping records, and chemical composition reports showing the use of vegetation barriers, planting weed suppressive vegetation or grasses, and use of a herbicide composed of naturally based ingredients or a hot foam system	x	GreenLITES Operations
M-41			Has the Agency or Operator installed mowing markers to protect natural areas and wetlands?		Obtain evidence in before and after photographs, diaries, and invoices for mowing markers or site specific standard operating procedures; perform onsite inspections to evaluate mowing distance from road and vegetative height		GreenLITES
M-42		Biodiversity	Do crews establish/maintain wildflowers/native species on the right of way including hand pulling weed management?		Review evidence in before and after photographs, diaries, invoices for wildflower purchases, and standard operating procedures to verify actions performed	x	GreenLITES Operations
<b>Natural Resource Management</b>							
M-43		Materials	Has the Agency or Operator defined a sound and viable sustainable procurement plan?		Review Operator or Agency policies and criteria for supplier identification via a formal written procurement plan; assess that sustainable products are being purchased and used	x	ENVISION Stage 1 Second Draft

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
M-44			Has the Agency or Operator purchased materials and supplies that are certified from sustainable sources by reputable, third party accreditation and standard-setting organizations?	Percent by dollar volume: >25% to <50% >50% to <75% >75%	Obtain and assess policies and criteria for supplier identification, third party accreditation, bill of quantities to be purchased, documentation of the weight, and volume purchased	x	ENVISION Stage 1 Second Draft
M-45			Has the Agency or Operator made efforts to identify any unresolved worker health and safety or environmental violations of manufacturers or suppliers identified for the project?		Assess compliance to contract requirements made with suppliers and enforcement agencies regarding their health and safety violations		ENVISION Stage 1 Second Draft
M-46			Are recycled products bought first, (whenever possible) such as office paper, aggregate, glass, rubber, wood related products, and so forth?		Review current procurement policy to determine priority purchasing; inspect evidence in invoices from local suppliers	x	GreenLITES Operations
M-47			Are recycled materials used in erosion/ sediment control for maintenance projects?		Review approved materials listing for erosion control; review evidence in photographs, inspection logs, and Maintenance Plan; review project Erosion Control Plans	x	GreenLITES Operations
M-48			Has rubberizing crack and sealing of Portland cement concrete pavement been done?		Obtain evidence in construction documents and specifications, photographs and inspection reports	x	GreenLITES
M-49			For asphalt pavements, is crack sealing done using material with 50% recycled asphalt content?		Review maintenance logs documents and specifications, photographs, and inspection reports	x	GreenLITES Operations
M-50			Are single course overlays used?		Evaluate evidence in construction documents and specifications, photographs, and inspection reports	x	GreenLITES Operations
M-51			Are liquid asphalt treatments used to extend the life cycle of the pavement surface?		Assess evidence in construction documents, specifications, photographs, and inspection reports	x	GreenLITES
M-52			Is recycled asphalt used in pavements for repairs?		Review evidence in the construction documents and inspection reports	x	GreenLITES Operations
M-53			Is paving done using recycled asphalt?		Review evidence in construction documents and material specifications, photographs, and inspection reports	x	GreenLITES

(Continued)

**TABLE B.4. SUSTAINABLE ROAD OPERATION AND MAINTENANCE CRITERIA (Continued)**

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
M-54			Has mechanical snow fencing been installed to reduce the need for frequent snow plowing and road salt applied in areas where the wind carries snow onto the highway?		Review documentation in maintenance plans, photographs, diaries, and invoices for snow fencing; evaluate if there was a reduction in road plowing maintenance costs and accidents	x	GreenLITES Operations
M-55			Has living snow fencing, such as new plantings or agreements with local farmers asking them to leave corn rows or similar tall vegetation standing through the winter months been used to reduce the need for frequent snow plowing?		Review evidence in the amount of new landscape or tree planting, Maintenance Plan, inspection logs, letter exchanges with farmers; evaluate if there was a reduction in road plowing maintenance costs and accidents	x	GreenLITES Operations
M-56			Is all salt stored on top of an impervious surface and covered to protect it from precipitation and wind?		Obtain documentation in photographs and site plans; review groundwater data if available on presence of salt concentrations greater than background conditions		GreenLITES Operations
M-57			Has a Chemical Storage Inventory (item description, quantity, container size, and expiration date as well as receiving date) been prepared for maintenance yard facilities?		Verify documentation in the inventory and past operational audit findings		GreenLITES Operations
M-58		Reuse-Recycling	Has previous subbase been reused in full-depth asphalt reconstruction projects?		Review project files and assess if designs called for full depth reconstruction reusing road base; evaluate construction documents, specifications, photographs, and inspection reports; review disposal document to verify sub base was not disposed of in landfill	x	GreenLITES
M-59			Has granite curbing been reused?		Review evidence in construction documents, specifications, photographs, inspection reports, or via onsite observations		GreenLITES
M-60			Is in place recycling of pavements used?		Assess documentation in the maintenance documents, photographs, and maintenance standard operating procedures	x	GreenLITES Operations
M-61			Are spent asphalt and concrete products such as millings recycled for other purposes?	Percent by volume or weight: 10% 20% 30% 40% 50%	Review calculations by adding up only pavement binder and hot mix asphalt and Portland cement concrete pavement materials; determine if in maintenance standard operating procedures	x	INVEST/ GreenLITES Operations

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
M-62			Are spent asphalt and concrete products such as millings and structures reused within the project limits?	Percent by volume or weight: 50% 60% 70% 80% 90%	Review calculation by adding up all reused materials; determine if in maintenance standard operating procedures	x	INVEST
M-63			Are all materials (pavement binder, hot mix asphalt, Portland cement concrete, rock base layers concrete structures, signs and traffic control devices) recycled for other purposes on project or made available for reuse on other projects or by others, for example, local Highway Departments?	Percent by volume or weight: 20% 30% 40% 50% 60%	Review calculations by adding up pavement binder, hot mix asphalt, Portland cement concrete, rock base layers concrete structure, signs, and traffic control devices	x	INVEST/ GreenLITES Operations
M-64		Waste Management	Is a “Zero Waste Strategy” used to allow only those items to enter the waste stream (trash) that cannot be recycled or reused?		Review documentation in Maintenance Waste Minimization Management Plan; review disposal records of material being disposed	x	GreenLITES Operations
M-65			Have bridges been cleaned consistent with good environmental practices with sweepings, and have the debris been properly disposed of?		Review documentation in maintenance plans, notes, photographs, and waste transportation transfer slips; determine if in routine maintenance standard operating procedures	x	GreenLITES Operations
M-66			Has a high production vacuum paint removal system been used to control paint particles while allowing the operation to proceed in a time efficient manner reducing road closures and detours?		Assess maintenance documentation in maintenance manuals, invoices, operational logs, and standard operating procedures for vacuum paint removal tool		GreenLITES
M-67			Are office and maintenance facility wastes collected and recycled?		Review Waste Management Plan, meeting minutes, and inspection records for offices; review disposal records; evaluate recycle containers via onsite evaluation	x	GreenLITES Operations
M-68			Are fluorescent light bulbs collected and recycled?		Assess evidence in Waste Management Plan, meeting minutes, and inspection records for offices showing recycle receptacle locations; review disposal records; evaluate recycle containers via onsite evaluation	x	GreenLITES Operations

(Continued)

**TABLE B.4.** SUSTAINABLE ROAD OPERATION AND MAINTENANCE CRITERIA (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
M-69			Does the Agency or Operator operate animal composting facility to dispose of road kill?		Documentation in Waste Management Plan, maintenance logs, and disposal records detailing dead animal pick up; determine if included in standard operating procedures		GreenLITES
M-70	Energy		Has the Agency engaged an independent entity to commission and oversee monitoring of the whole system or to periodically check the monitoring of the transportation project?		Obtain and review evidence in commissioning requirements in contract documents; study the engagement contract with third party to commission and oversee monitoring the project	x	ENVISION Stage 1 Second Draft
M-71			Have building and maintenance facilities been audited routinely for energy usage?		Verify via audit inspection documentation	x	GreenLITES Operations
M-72			Has the Agency or Operator reduced the fossil fuel requirements of maintenance and operation equipment by using biofuel or biofuel blends as a replacement for fossil fuel?		Obtain and assess operational information in a signed letter from the Agency or Operator that describes fuel use reduction measures used, the percent reduction achieved, and a spreadsheet summarizing all receipts for all fuel used highlighting the associated biofuel blend	x	Greenroads
M-73			Does the agency use hybrid/alternative fuel vehicles?		Review evidence in capital asset inventory of vehicle fleet and calculations of fuel and cost savings quantified; perform onsite verification; review vehicle phase out plan		GreenLITES
M-74			Has the Agency or Operator reduced lifetime energy consumption of signal and lighting systems for roadways by replacing existing incandescent lights with LED lighting, induction lighting, or other new technology that is Underwriters Laboratories Inc. (UL) listed for the intended use?	Percent reduction in KWh: <10% >10% to <20% >20% to <30% >40% to <50% >50%	Assess documentation that demonstrates an energy reduction level such as in contract documents and cut sheets compared to traditional lighting design	x	INVEST/ GreenLITES/ World Bank
M-75			Has the Agency or Operator replaced overhead sign lighting with higher type reflective sign panels?		Obtain evidence in before and after photographs, invoices for sign panels, maintenance logs, diaries, and energy savings		GreenLITES



#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
M-76			Does the Agency or Operator have a documented plan that outlines how renewable energy will be procured for operations and maintenance of facilities, including roadway lighting, traffic control, rest areas, maintenance and operations facilities, and other Agency or Operator operated administration facilities?		Review evidence in Renewable Energy Plan with current usage and projected usage for the next two years, copy of the monitoring system, and statement of renewable energy goal	x	INVEST
M-77			Is there a documented Fleet Management Plan that, as a minimum, describes the Agency's or Operator's planned actions to reduce fossil fuel usage, transition to alternative fuels or energy sources, increase overall fuel efficiency, and reduce vehicle miles traveled in operations and maintenance activities?		Review documentation in the Fleet Management Plan that describes the Agency's or Operator's planned actions to reduce fossil fuel usage, transition to alternative fuels, efficiency improvements, and miles traveled reduction plus tracking program and goal definition	x	INVEST
M-78			Has the truck fleet been retrofitted with LED lighting and battery upgrades to eliminate the need for idling during work zone and other activities?		Review evidence in truck fleet maintenance records		GreenLITES
M-79		Water	Will the project integrate operational impact monitoring to mitigate negative impacts and improve efficiency?		Review documentation of commissioning and monitoring authority requirements in the contract documents, signed agreement with third party to monitor, installation of labeled submeters to check flows and leak detection systems, and written rationale as to how monitoring will improve efficiency and mitigate impacts	x	ENVISION Stage 1 Second Draft
M-80			Have washout threats been addressed such as those located along stream banks, steep slopes, ditches, and alongside bridges and culverts using preventative maintenance, plants, and bio-engineered materials?		Obtain evidence in inspection reports, diaries and before and after photographs that indicates successful erosion control practices		GreenLITES/ GreenLITES Operations

(Continued)

**TABLE B.4.** SUSTAINABLE ROAD OPERATION AND MAINTENANCE CRITERIA (*Continued*)

#	Category	Sub-Category	Criteria	Indicator Measurement	Measuring Success	Key Indicator	Reference
<b>Natural Resource Management</b>							
M-81		Atmosphere	Do bridge crews use dust-free concrete preparation tools to reduce impacts to the environment by preventing dust?		Evaluate maintenance documentation in maintenance manuals, dust-free tool invoices, and diaries	x	GreenLITES Operations
M-82			Are paving equipment and tools cleaned with green cleaning products instead of diesel and kerosene?		Review evidence in construction documents, specifications, photographs, and inspection reports; evaluate if green cleaning products are being used via onsite evaluation		GreenLITES Operations
M-83			Have maintenance trucks and equipment received air emissions retrofits to help improve air quality?		Review evidence in truck fleet maintenance records		GreenLITES Operations
M-84			Has the truck fleet been converted to liquid natural gas so as to run on a clean fuel?		Obtain evidence in truck fleet maintenance records and any clean fuel conversion plans	x	GreenLITES
M-85			Has noise from maintenance operations been reduced such as through rescheduling activities to lessen impacts on receptors?		Review documentation in community complaint letters and meeting minutes; evaluate compliance to local noise regulations		GreenLITES/ INVEST
M-86			Will maintenance actions provide mitigation as a co-benefit by reducing greenhouse gas emissions or enhancing absorption from the atmosphere?		Obtain maintenance records to evaluate greenhouse gas reductions and landscaping planning for carbon sequestration or other absorption methods		World Bank
M-87		Resilience	Has maintenance actions reduced human and natural system vulnerability by increasing adaptive capacity in assets?		Evaluate programs or plans that detail asset evaluations and improvements in resilience to climate change impacts		World Bank
M-88			Has the Agency or Operator developed an Emergency Response Plan that enables efficient recovery after extreme weather and geologic events such as snow and rainstorms, typhoons, earthquakes, tsunamis, and landslides?		Obtain and evaluate documentation of a system level assessment of potential hazards such as seismic events, relative rise in sea level, storm activity/intensity, temperature and heat waves, precipitation events, stream flow for current and future hazards, and the Emergency Response Plan	x	INVEST

# APPENDIX C

## ENVIRONMENTALLY SUSTAINABLE ROAD TRANSPORTATION TECHNOLOGIES AND APPROACHES

Many new road transportation technologies and approaches are being developed in the area of transportation sustainability. This is a new and exciting area and offers great potential to improve transportation projects and systems, reduce costs, and create green-sustainable projects. The development and implementation of environmentally sustainable transportation technologies and actions is dynamic, with a large focus on the effective management of energy and environmental resources. This appendix presents some representative examples of new transportation technologies that are being researched and implemented. See Table 3.1 and the bibliography in the main report for websites on new, environmentally sustainable technologies.

Mobility Alliance, Sustainable Transportation Solutions and Emerging Technologies I-15:

- » Automated Snow Plow Routing
- » Biofuels-Based Pavements
- » Carbon Nano Fiber Reinforced Cement Composite
- » Carbon-Neutral Roadways
- » Car Plug-in Stations
- » Design for Deconstruction
- » Electric Vehicles
- » Emerging Highway Technologies
- » Glass Highways
- » Glass Materials in Highways
- » Green Cement
- » Heated Bridge Decks
- » Hydrogen Highways
- » Improvements to Reduce Rolling Resistance for Pavements
- » Inherently Low Emission Vehicles
- » ITS Technologies for Traffic Management
- » ITS Technology for Vehicular Spacing and Speed (IntelliDrive)
- » Maglev
- » Natural Gas and/or Biofuel Fueling Stations
- » Online Electric Vehicle
- » Pavement Heat Exchangers
- » Photocatalytic Concrete
- » Plug-in Hybrids
- » Resin-Based Pavement
- » Solar Highway Energy Generation
- » Solar Power Pavement Markings and Signs
- » Solar and Wind Power Generators
- » Sustainable Rest Areas

A Sustainable Future for Transport, Towards an Integrated Technology Led and User Friendly System, European Commission Directorate General for Energy and Transport, June 2009:

- » Transporters Benefit from Integrated ITS Systems, such as Navigation and Digital Tachographs
- » Fleet and Freight Management and Electronic Toll Payment
- » Toll Payments Automated, Eliminating the Need to Stop at the Toll Gate
- » Vehicle Involvement in an Accident Sends its Precise Location, Obtained by Satellite Positioning via a Communications Network, to an Emergency Center
- » Real-time Traffic Information for Drivers Helps Fight Congestion and Reduce Bottlenecks

International Road Federation, International Road Federation Innovative Practices for Greener Roads:

- » 3M Diamond Grade DG<sup>3</sup> Reflective Sheeting
- » Mimar: Map for the Interpretation of the Environment Throughout the Road Network
- » Greener Roads Through New Mixing and Compaction Technologies
- » Delivering Sustainable Outcomes
- » Achieving Innovation for Sustainable Roads
- » Marketing Environmentally Sound Road Marking Products that Enhance Safety
- » The Caterpillar D7E Tractor
- » Developing Silent, Natural, Low Temperature, Recycled Road Products and Techniques
- » Promoting the Widespread Use of VALORCOL
- » Reduction of Road Noise with Crumb Rubber Modified Asphalt
- » Maximizing Sustainability in Concrete Road Construction
- » Creating New Methods and Materials for 21st Century Roads
- » The IRF Greenhouse Gas Calculator
- » Intelligent Electronic Road User Charging Systems
- » Michelin Fleet Solutions
- » Assessing Storm Water Runoff into Sensitive Receiving Areas
- » Road Energy Systems Thermal Energy Asphalt Pavements
- » Highway Sustainability Checklist
- » Building Green Infrastructures
- » Delivering The Right Highways Using the Right Materials

- » Eco-Design of LED Traffic Lights and Variable Message Signs
- » Keeping Runoff Pollutants out of Long Island Sound
- » Amphibian Rescue Fences
- » Combining Human Factors with Intelligent Transport Systems

#### L Street Light Research Project

Remaking Cities Institute, Pittsburgh, Pennsylvania, September 2011:

- » LED Street Lighting
- » Street Lighting Standards
- » Street Lighting Conditions
- » Business District Typologies
- » Dimensions of Nighttime Vision
- » Lighting the Public Right-of-Way: Considerations
- » Sustainable Street Lighting Concepts
- » Business District Focus Group Analysis
- » Measuring and Evaluating LED Street Light Installations
- » Case Study Measurements

#### Transportation Research Board Technical Journals:

- » Travel Behavior
- » Social, Environmental, and Economic Sustainability
- » Concrete Materials
- » Developing Countries
- » Hazardous Waste
- » Energy and Global Climate Change
- » Current Practices in Greenhouse Gas Emissions Savings from Transit
- » Bituminous Materials and Mixtures
- » Geomaterials
- » Maintenance Services and Surface Weather

#### AASHTO Above and Beyond:

- » Planning and Designing Transportation to Fit the Community
- » Transportation and Land Use to Promote Sustainable Communities
- » Enhancing Quality of Life by Promoting Walking and Biking
- » On the Road to Cleaner Air and Water Quality and Wetlands
- » Preserving Wildlife and Ecosystems for Future Generations
- » Building Bridges to America's Past
- » Recycling—Transportation Agencies “Go Green” Beautifying America's Roadsides
- » Sound Solutions Keep Down the Noise

#### University of North Carolina Highway Safety Research Center:

- » Accessible Pedestrian Signals
- » Red-Light Cameras
- » Road Diets
- » Roundabouts
- » Speed Management
- » Traffic Data
- » Traffic Calming

#### The Victoria Transport Policy Institute:

- » Strategies to Achieve Specific Objectives
- » Best Strategies for Various Organizations and Stakeholder Groups
- » TDM Strategies
- » Improved Transport Options
- » Parking and Land Use Management
- » Policy and Institutional Reforms
- » TDM Programs and Program Support

#### NCHRP Report 577 Guidelines for the Selection of Snow and Ice Control Materials to Mitigate Environmental Impact:

- » Snow and Ice Control Operational and Performance Considerations
- » Products Used and Properties
- » Chloride Salts
- » Organic Products
- » Sand or Abrasives
- » Storage
- » Solid Snow and Ice Control Materials
- » Liquid Snow and Ice Control Materials
- » Sand or Abrasives
- » Handling and Application Methods
- » Agency Survey—Current and Future Status of Use in the United States and Canada
- » Product Use and Methods of Application
- » Natural Environment Concerns
- » Corrosion Concerns
- » Purchasing Issues
- » Application Strategies
- » Anti-Icing
- » Deicing
- » Prewetting
- » Dry Abrasive and Chemical Mixes
- » Abrasive Use
- » Stockpile Treatment
- » Application Strategy Studies
- » Materials Loading
- » Product Selection
- » Application Amounts
- » Strategy Selection
- » Framework for Protection of Environmental Systems

#### Federal Highway Administration, Flexibility in Highway Design, FHWA-PD-97-062:

- » Overview of the Highway Planning and Development Process
- » Highway Design Standards
- » Functional Classification
- » Design Controls
- » Horizontal and Vertical Alignment
- » Cross-Section Elements
- » Bridges and Other Major Structures
- » Intersections

#### Pavement:

- » Tire Rubber Asphalt
- » Recycled Materials in Stabilized Base

- » Recycled Materials in Embankment or Fill
- » Recycled Materials in Granular Base
- » Recycled Materials in Portland Cement Concrete Pavement
- » Recycled Materials in Asphalt Concrete Pavement
- » Recycled Concrete Pavement
- » Crushed Concrete Aggregate
- » Hot-In Place Asphalt
- » Foundry Sand in Subbase Layers
- » Recycled Materials in Flowable Fill
- » Porous Asphalt Pavements
- » DS-328 Polymer: Cement Adhesive
- » Soil-Cement
- » Ecological Bricks

#### Greenhouse Gas

- » Construction CO<sub>2</sub>e Measurement Protocol (European Network of Construction Companies for Research and Development) <http://www.ghgprotocol.org/ENCORD-guidance-for-construction-companies>
- » Carbon calculator for construction activities (United Kingdom Environment Agency) <http://www.environment-tools.co.uk/directory/tool/uri/%2Fgroups%2F1cf/name/carbon-calculator-for-construction-activities/id/482>
- » PE-2 Transportation infrastructure greenhouse gas estimator (Michigan Technological University) [http://www.construction.mtu.edu/cass\\_reports/webpage/](http://www.construction.mtu.edu/cass_reports/webpage/)
- » Road construction emissions model (Sacramento Metropolitan Air Quality District) <http://www.airquality.org/ceqa/>



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