



## Green Infrastructure Strategies: Tools and Practices to Measure the Sustainability of Transportation Projects

*Requested by*

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# Executive Summary

## **Background**

The recently revised Caltrans strategic management plan calls for the department to “make long-lasting, smart mobility decisions that improve the environment, support a vibrant economy, and build communities, not sprawl.” In support of that goal, Caltrans is seeking information that will aid in the development of a scoring tool to measure the use of green infrastructure techniques on transportation projects. Caltrans is particularly interested in how measurement practices have been planned, developed and implemented, and how these measurement tools can be applied at various stages of the project development process.

To assist with this effort, CTC & Associates reviewed published and in-progress research and other relevant documents to identify publications that address the tools and practices used in the United States and internationally to measure the results of various green infrastructure elements of transportation projects. This review also addressed alternative green infrastructure measurement practices and performance measures for various green infrastructure strategies.

Note that throughout this Preliminary Investigation, the terms “sustainable” and “sustainability” are used to connote green infrastructure elements, practices and strategies.

## **Summary of Findings**

This Preliminary Investigation of the tools and practices used to measure the sustainability of transportation projects throughout the project development cycle begins with a summary of the resources available from national agencies to aid in the assessment of green infrastructure strategies. Next, we profile eight sustainability tools currently in use by transportation agencies in the United States and internationally to provide perspective on the framework of these tools, including how and what they measure. Supplementing these profiles is a presentation of other sustainability tools and practices that show promise or are more targeted to address specific areas of sustainability (emissions, pavement materials and fiscal impacts). The Preliminary Investigation closes with a brief examination of sustainability performance measures and guidelines.

Research reports included in the *Comparing the Sustainability Tools* section of this Preliminary Investigation are particularly useful to compare and contrast the sustainability tools often cited in the literature and highlighted in this Preliminary Investigation. These reports, prepared for state DOTs wishing to identify the tool most appropriate to their needs, provide an excellent overview of many of the sustainability tools and describe in detail how these agencies approached their assessments. (Elements of the some of the tools have been updated since publication of these reports.)

## **National Guidance**

Resources available from national agencies include:

- An NCHRP project expected to conclude in May 2016 will identify sustainability practices that can be implemented during construction of highway projects.

- A 2014 NCHRP report provides an analytical framework and implementation approaches to evaluate current and future capacity to support sustainable practices.
- An interactive online tool (GIWiz) offers access to information about the U.S. Environmental Protection Agency’s green infrastructure tools and resources.
- A toolkit supported by the U.S. Forest Service is billed as a “one-stop shop for resources on green infrastructure and urban forestry planning, implementation, and management.”

## Examination of Selected Sustainability Tools

This Preliminary Investigation examines eight sustainability tools that address a variety of green infrastructure elements or sustainability practices.

Canadian Guide for Greener Roads. Released in April 2015 by the Transportation Association of Canada, this tool is applicable during the planning, design and construction phases of project development; operations and maintenance are also addressed. Twelve objectives related to sustainability provide the foundation for two tools—practice sheets that examine 31 sustainability practices, and an interactive self-evaluation tool that includes 38 sustainability questions that prompt a self-rating grade of A, B or C.

CEEQUAL. This tool released for use in the United Kingdom and Ireland in 2003 was made available in an international edition in 2011. Of the two tools available, the project-related tool is applicable beyond roadways to include other civil engineering and landscaping projects. CEEQUAL applies an evidence-based system that uses Yes/No questions with point values distributed among nine sections to assess sustainability. An online self-assessment tool requires a trained “assessor” and a fee-based verification of results.

Envision. Like CEEQUAL, Envision is applicable beyond roadway and bridge projects to include all types of civil infrastructure, and can be used multiple times throughout project development. Sixty sustainability criteria, or credits, are associated with five categories and 14 subcategories. Points are also awarded for innovation.” Tools include a self-assessment checklist in the form of a Yes/No questionnaire, and a free self-assessment rating system with an optional fee-based third-party evaluation.

GreenLITES. Released in September 2008, New York State Department of Transportation’s GreenLITES tool applies to all competitive bid projects and can be applied early in a project’s development (scoping); at design approval (midpoint check); and when developing the plans, specifications and estimate submittal. An Excel-based scorecard is organized into five categories with 18 subcategories. Point values are assigned to approximately 175 sustainable practices to determine a project’s qualification for one of four certification levels.

Greenroads. Launched in January 2010, Greenroads is a subscription-based scorecard that evaluates projects during design and construction but does not provide an evaluation of planning or operations. Twelve Project Requirements that must be completed to qualify for an award are coupled with 45 voluntary core credits across five categories. Extra credits are awarded for creativity and effort. A third-party rating is required, and projects must be registered and submitted for review. Four award levels are offered.

I-LAST. Developed by Illinois DOT and first used in 2011, I-LAST can be applied during project scoping, at the end of the design phase, and during construction. I-LAST is based on a checklist of sustainable practices with points allotted to each practice over nine categories and 25 subcategories. Intended to be simple to use and to require minimal time and effort, I-LAST does not provide a level of certification.

INVEST. Federal Highway Administration (FHWA) launched Version 1 of INVEST in October 2012; Version 1.2 became available in September 2015. Three modules with 64 criteria address system-level planning and programming; project development (project-specific planning, design and construction); and operations and maintenance activities. This free web-based tool uses standard and custom scorecards that prompt users to respond to questions to generate a score.

STARS. Development of STARS by transportation agencies in the Pacific Northwest began in 2009 and continued through 2015. One of three fee-based STARS tools, STARS-Project is applicable to transportation corridors and focuses on planning. Applicable to road, transit, bicycle and pedestrian projects, STARS-Project includes 12 credits organized into four credit categories.

Appendix A to this Preliminary Investigation presents a high-level summary of the scoring elements used in the tools described above (with the exception of CEEQUAL, for which detailed documentation was not publicly available). See the publications included in the *Tool/Documentation* sections of this Preliminary Investigation for full details of the tools' scoring protocols.

## **Other Sustainability Assessment Tools and Practices**

Additional perspective on assessing the sustainability of transportation projects is provided in publications addressing the following topic areas:

Analytic practices. A 2011 journal article describes three innovative system-based concepts for assessing the sustainability of transportation infrastructure projects: work, nature and flow.

Backcasting. An alternative to forecasting, backcasting takes an action-oriented approach to focus on what is desired for the future and identifies policies for achieving those goals.

Conservation. While not a tool or rating system, Eco-Logical, developed through SHRP2, is "a guide to making infrastructure more sensitive to wildlife and ecosystems through greater interagency cooperative conservation."

Emissions. A 2012 conference paper introduces the Project Emissions Estimator, a web-based tool that can be used to estimate and benchmark the CO<sub>2</sub> footprint of highway construction projects.

Fiscal practices. Developed by Parsons Brinckerhoff, the PRISM *tblv* tool is "designed to link investment factors with tradeoffs in clear quantitative terms." Two technical memoranda describe Minnesota DOT's use of PRISM.

National Park Service tool. The INSTEP (Innovative and Sustainable Transportation Evaluation Process) tool offers users a sustainability checklist to assist in tracking and complying with sustainability standards throughout the design and construction processes.

### Pavement design.

- BE<sup>2</sup>ST-in-Highways, an Excel-based tool, can be used during the screening phase and continues through design to assess the sustainability impact of different pavement materials.
- GreenPave, a simplified rating system based on Greenroads and customized for Ontario, provides guidance to designers in selecting sustainable pavement alternatives.

## **Comparing Sustainability Tools**

### State DOT Evaluations

In a 2014 report, researchers considered 10 sustainability tools and examined the needs of four Mountain-Plains Consortium members—Colorado, South Dakota, Utah and Wyoming DOTs—to identify the most appropriate tool to meet specific agency needs. In addition, a 2013 Georgia DOT project evaluated sustainability rating systems to prepare for development of a customized rating system that accommodates factors relevant to the agency. Researchers selected New York State DOT's GreenLITES as a model for a Georgia-specific system.

### General Assessments

A series of conference papers and a magazine article offer an opportunity to review a wide range of sustainability assessment tools and consider independent assessments of the tools.

## **Sustainability Performance Measures and Guidelines**

Many of the tools described in this Preliminary Investigation include best practices and measures that could be considered in a targeted review of sustainability performance measures. In addition, a 2011 NCHRP guidebook (NCHRP Report 708) provides data sources, examples of the use of sustainability performance measures, and a compendium of performance measures.

From a more local perspective, an EPA report shows how 12 sustainable performance measures have been used by metropolitan planning organizations in connection with programming and performance monitoring. A 2013 Alabama DOT research project examines sustainability performance measures from the regional perspective.

## **Gaps in Findings**

The scope of the Preliminary Investigation format did not permit an examination of all available green infrastructure strategies and sustainability tools, and there may be other tools or practices not addressed in this report that would be of interest to Caltrans. The scope of the Preliminary Investigation format also limited the extent to which each of the tools selected for review could be examined. Further research is needed to assess the strengths and limitations of these tools from Caltrans' perspective, compare and contrast the sustainability criteria and green infrastructure elements included in each tool, and identify the impact of how these criteria or practices are weighted and evaluated.

## **Next Steps**

Moving forward, Caltrans could consider:

- Comparing and contrasting the sustainability criteria and best practices included in each of the tools examined in this Preliminary Investigation to identify:
  - Commonalities among the tools.
  - Consistency with Caltrans' current green infrastructure practices.

- Gaps where Caltrans' green infrastructure efforts are not adequately addressed by the existing tools.
- Examining in detail the recent research reports that describe efforts by state DOTs to evaluate sustainability assessment tools and select an approach that meets specific agency needs.
- Further examining the tools described in this report to determine if any of these tools shows promise as a turnkey solution for Caltrans.
- Using one or more of the freely available sustainability tools on a pilot project to determine its efficacy in evaluating and prioritizing Caltrans transportation projects.
- Consulting with agencies that have piloted or are using a sustainability assessment tool to gather insights into implementation and ongoing use (see the *Agencies' Use of the Tool* sections of this Preliminary Investigation for possible contacts).

## Detailed Findings

Throughout this Preliminary Investigation we highlight a variety of sustainability tools—some in detailed profiles, others with resources that offer a more high-level description. The table below, while not all-inclusive, lists the most frequently referenced tools in the report sections that follow. The column labeled “For More Information” provides the page number where a description of each tool appears in this Preliminary Investigation.

<b>Index of Sustainability Tools</b>		
<b>Tool</b>	<b>Tool Developer</b>	<b>For More Information</b>
<b>BE<sup>2</sup>ST-in-Highways</b>	Recycled Materials Resource Center, University of Wisconsin–Madison	37
<b>Canadian Guide for Greener Roads</b>	Transportation Association of Canada	10
<b>CEEQUAL</b>	Institution of Civil Engineers, with funding from the government of the United Kingdom	12
<b>Eco-Logical</b>	Strategic Highway Research Program 2 (SHRP2)	34
<b>Envision</b>	Zofnass Program for Sustainable Infrastructure and Institute for Sustainable Infrastructure	14
<b>GreenLITES (Green Leadership In Transportation Environmental Sustainability)</b>	New York State DOT	17
<b>GreenPave</b>	Ontario Ministry of Transportation	38
<b>Greenroads</b>	University of Washington researchers and CH2M HILL	21
<b>I-LAST (Illinois Livable and Sustainable Transportation)</b>	Illinois DOT and Joint Sustainability Group	25
<b>INSTEP (Innovative and Sustainable Transportation Evaluation Process)</b>	National Park Service	37
<b>INVEST (Infrastructure Voluntary Evaluation Sustainability Tool)</b>	Federal Highway Administration	27
<b>PRISM</b>	Parsons Brinckerhoff	36
<b>Project Emissions Estimator</b>	Michigan DOT	35
<b>STARS (Sustainable Transportation Analysis &amp; Rating System)</b>	Portland Bureau of Transportation, North American Sustainable Transportation Council and Santa Cruz County Regional Transportation Commission	31

## National Guidance

**Guidebook for Selecting and Implementing Sustainable Highway Construction Practices**, NCHRP Project 10-91, in progress (expected completion May 2016).

<http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3402>

Excerpt from the abstract:

The objective of this research is to identify effective sustainability practices that can be implemented during the construction of highway projects and prepare a guidebook that can be used by DOTs, other transportation agencies, consulting engineers, and construction contractors, to aid them in identifying, evaluating, and selecting sustainable construction practices. The guidebook should also provide guidance on how to evaluate the relative costs and benefits of implementing various sustainability practices during construction.

**NCHRP Report 750: Strategic Issues Facing Transportation**; Volume 4: Sustainability as an Organizing Principle for Transportation Agencies, Booz Allen Hamilton, 2014.

[http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_rpt\\_750v4.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v4.pdf)

While more oriented to policy and strategy, this report does offer some information about sustainability tools. Some highlights:

- Chapter 8, Sustainability Tools and Methods: Key Directions for Development (page 125 of the report; page 138 of the PDF).
- Table 36, Assessment and rating tools—main focus on planning and programming (page 113 of the report; page 126 of the PDF).
- Table 37, Assessment and rating tools—main focus on project delivery (page 118 of the report; page 131 of the PDF).

**GIWiz (Green Infrastructure Wizard)**, U.S. Environmental Protection Agency.

<http://cfpub.epa.gov/giwiz/>

From the web site's disclaimer:

This is a beta version of the Environmental Protection Agency's Green Infrastructure Wizard (GIWiz). GIWiz is an interactive online tool designed to provide communities with fast and easy access to information about EPA's publicly available Green Infrastructure tools and resources. GIWiz is intended to serve the needs of a broad range of users including local communities, states, and the general public.

GIWiz is intended to provide tailored reports of EPA's Green Infrastructure tools and resources that users select according to their needs. GIWiz reports should not be used as the sole basis to make decisions regarding users' actions, or to determine regulatory compliance. Reports available through GIWiz are exclusively limited to those which are publicly available. The data and information provided through GIWiz are made available by EPA as a public service.

Also from the web site:

GIWiz offers you access to a repository of EPA-sourced Green Infrastructure tools and resources designed to support and promote sustainable water management and community planning decisions. The tools and resources available through GIWiz will help you analyze problems, understand management options, calculate design parameters, analyze costs and benefits, evaluate tradeoffs, engage stakeholders, and/or develop education and outreach campaigns.



**GIFT (Green Infrastructure & Forestry Toolkit)**, National Association of Regional Councils, Center for Leadership in Global Sustainability, and U.S. Forest Service.

<http://gifttoolkit.org/>

From the web site:

The Green Infrastructure & Forestry Toolkit is your one-stop shop for resources on green infrastructure and urban forestry planning, implementation, and management. GIFT was developed to capture and organize the tools, guides, and stories available online to support people looking to integrate green infrastructure and urban forestry into the fabric of their regions, cities, and communities. Resources are organized in two different ways – according to steps in the ideal planning process, and according to the different action items.

A Resources link allows the user to filter a search using these categories:

- Calculators and modeling.
- Case studies and developed plans.
- Current research.
- Data sets.
- Education and outreach materials.
- General.
- Model land use policies.
- Technical guides.
- Tutorials and templates.

## **Examination of Selected Sustainability Tools**

Many domestic and international sustainability tools and practices evaluate the application of green infrastructure elements or sustainable practices in the planning, design and construction of transportation projects. Highlighted below are eight of these tools that address a broad range of sustainability practices and have been considered for use or are in use by a range of transportation agencies (state departments of transportation (DOTs), regional planning organizations and local agencies). The tools examined in this section include:

- Canadian Guide for Greener Roads.
- CEEQUAL.
- Envision.
- GreenLITES (Green Leadership In Transportation Environmental Sustainability).
- Greenroads.
- I-LAST (Illinois Livable and Sustainable Transportation).
- INVEST (Infrastructure Voluntary Evaluation Sustainability Tool).
- STARS (Sustainable Transportation Analysis & Rating System).

All of these tools use some type of scoring protocol to evaluate the sustainability of a transportation project. [Appendix A](#) presents a high-level summary of the scoring elements applied by the tools described below (with the exception of CEEQUAL, for which detailed documentation was not publicly available).

Information about other sustainability tools and practices—including BE<sup>2</sup>ST-in-Highways, Eco-Logical, GreenPave, INSTEP and PRISM—appears in the **Other Sustainability Assessment Tools and Practices** section of this Preliminary Investigation (see page 33).

## Canadian Guide for Greener Roads

Canadian Guide for Greener Roads	
Developed by Transportation Association of Canada	
<b>Launch date:</b>	April 2015
<b>Development influences:</b>	<p>U.S. influences include:</p> <ul style="list-style-type: none"> <li>• Envision.</li> <li>• GreenLITES.</li> <li>• Greenroads.</li> <li>• I-LAST.</li> <li>• INVEST.</li> </ul> <p>Non-U.S. influences include CEEQUAL and GreenPave.</p>
<b>Project applicability:</b>	<ul style="list-style-type: none"> <li>• Planning.</li> <li>• Design.</li> <li>• Construction.</li> <li>• Operations and maintenance.</li> <li>• Decommissioning.</li> </ul>
<b>Scoring elements:</b>	Twelve objectives that reflect 31 sustainability practices (practice sheets); self-evaluation tool includes 38 sustainability questions that are self-rated with an A, B or C.
<b>Tool(s):</b>	Practice sheets and an Access-based interactive self-evaluation tool.
<b>Users:</b>	The tool is so new that examples of users are not publicly available.

**Tool description.** Practice sheets and an interactive tool are based on 12 objectives that are “clear, meaningful relevant and achievable,” including:

- Reduce virgin material use.
- Optimize waste stream.
- Reduce energy use.
- Reduce emissions to air.
- Maintain or improve hydrologic regime characteristics.
- Maintain biodiversity.
- Engage community values and sense of place.
- Improve safety.
- Improve access and mobility.
- Improve local economy.
- Increase life-cycle efficiency.
- Promote innovation.

**Practice sheets.** Developers prepared 31 practice sheets that are organized and described to meet the 12 objectives. The tool's 31 practice sheets address:

- A description of the practice.
- Why the practice is done.
- How a practice is incorporated in a transportation project.
- Barriers and issues associated with the practice.
- Who can be consulted to provide information about use of a practice.
- Examples of the practice.
- Targets and metrics.
- Relationship to other sustainability practices.
- Resources and references.

**Project scoring.** Thirty-eight sustainability questions assist in the self-evaluation of a road project. The interactive software tool helps users review each question and identify the sustainability practices applicable to each project. Users self-rate each question using a letter grade (A, B or C). Tool developers note that agencies may wish to track their evaluations and use the results to develop benchmarks for each question.

#### *Tool Documentation*

**Canadian Guide for Greener Roads**, Transportation Association of Canada, April 2015. Publication description at <http://tac-atc.ca/en/canadian-guide-greener-roads-released>  
Excerpts from the abstract:

The CGGR helps users self-evaluate and strengthen the benefits of integrating sustainability principles into Canadian roadway projects. It is intended for technical laypersons such as environmental planners and transportation engineers with some technical understanding who may not be subject-matter experts.

....

The *Canadian Guide for Greener Roads – User Manual* includes:

- **CHAPTER 1:** goals and scope, and links to other environmental processes
- **CHAPTER 2:** how to use the guide to self-evaluate road projects, strengthen their sustainability benefits, and support agency plans and programs
- **CHAPTER 3:** the guide's development process
- **APPENDIX A:** sustainability objectives that describe the sustainability benefits related to a road project
- **APPENDIX B:** sustainability practices (such as 'Bicycle Access' or 'Habitat Retention') that can be addressed in a project in order to achieve the sustainability objectives
- **APPENDIX C:** sustainability questions related to the practices that can be used to self-evaluate a road project

The user manual is accompanied by an interactive tool, which can be opened with Microsoft Access (version 2010 or later) or Microsoft Runtime. The tool filters and links

the sustainability practices to sustainability questions and objectives. It helps users access relevant information easily and in a variety of ways, and allows them to choose between finding practices and undertaking the self-evaluation. A PDF-version of the user manual is included in the interactive tool, as are instructional videos via the 'Help' button.

**“Transportation Association of Canada’s The Canadian Guide for Greener Roads,”**

Clark Gunter, *Annual Western Canada Pavement Workshop*, February 2013.

[http://www.c-tep.com/pdf/C-TEP%20Pavement%20Workshop%202013%20Presentations/\(2\)%20Gunter-The%20Canadian%20Guide%20for%20Greener%20Roads-TAC%20.pdf](http://www.c-tep.com/pdf/C-TEP%20Pavement%20Workshop%202013%20Presentations/(2)%20Gunter-The%20Canadian%20Guide%20for%20Greener%20Roads-TAC%20.pdf)

This presentation describes the development of the tool’s framework, including the project’s objectives and the use of project sheets to evaluate a project.

**CEEQUAL**

<b>CEEQUAL</b>	
Developed by the Institution of Civil Engineers with financial support from the government of the United Kingdom	
<b>Launch date:</b>	Initial launch September 2003; 2011 launch of CEEQUAL for international projects.
<b>Development influences:</b>	Desire to encourage sustainability in civil engineering projects.
<b>Project applicability:</b>	International Edition of CEEQUAL for Projects is applicable to civil engineering, infrastructure, landscaping and public realm projects anywhere in the world; the international edition contains the same question set as the United Kingdom (UK) version.
<b>Scoring elements:</b>	An evidence-based system that uses Yes/No questions with point values (0 for a “No” response or the assigned value for a “Yes” response) distributed among nine sections to assess sustainability.
<b>Tool(s):</b>	Online self-assessment tool requires a trained “assessor” and a fee-based verification of results.
<b>Users:</b>	After initially launching in the UK, CEEQUAL is now available worldwide.

**Tool description.** Three tools are available:

- CEEQUAL for Projects (UK and Ireland edition).
- CEEQUAL for Projects (international edition).
- CEEQUAL for Term Contracts.

The same question set is used for both CEEQUAL for Projects editions.

This online self-assessment tool requires a trained CEEQUAL assessor to evaluate projects on a range of environmental and social issues organized in nine sections:

- Project strategy.
- Project management.
- People and communities.
- Land use and landscape.
- Historic environment.
- Ecology and biodiversity.
- Water environment.
- Physical resources: Use and management.
- Transport.

For each question, which is assigned a possible score for a “Yes” response (0 points are assigned to a “No” response), the user is provided with guidance both to determine if the question is relevant to the project being evaluated and how to answer the question. In the final section of the score sheet, examples of evidence are provided that can be used to ensure that the user has scored that question appropriately.

In 2012, a Project Strategy Section was added to CEEQUAL for Projects, which provides an “assessment of ‘worthwhileness’ alongside indirect economic issues through consideration of energy, materials and waste that can significantly influence the financial outcome of a project or contract. It also covers the wider economic, social and environmental impacts and benefits of the project or contract. CEEQUAL as a rating system does not assess the wisdom of clients or the planning system in promoting and allowing works to proceed. However, it does assess whether a project or contract is helping the community(ies) it serves to live more-sustainably.”

**Project scoring.** A first-time “assessor” using the CEEQUAL system must complete a CEEQUAL training session before beginning an assessment. Assessors use the CEEQUAL manual to identify questions relevant to a specific project and then score the agency’s performance against questions relevant to their project. Total project scores are associated with a particular level of achievement—pass, good, very good or excellent.

As the web site indicates, “a key feature of CEEQUAL is the weighting of the question scores. With CEEQUAL International, blanket use of the established UK & Ireland weightings and scores is felt to be inappropriate because of differences in physical environmental conditions and/or cultural influences. A project team using CEEQUAL International therefore needs to work with CEEQUAL and others in the area to create a set of weightings for their specific country or region.”

A fee is charged to have a CEEQUAL assessment verified. Fees are based on the value of the project and its location.

#### *Tool Documentation*

**CEEQUAL**, CEEQUAL Ltd.

<http://www.ceequal.com/>

The CEEQUAL web site provides a brief history of the tool and resources for new and existing users.

**CEEQUAL International**, Leaflet, CEEQUAL Ltd.

<http://www.ceequal.com/pdf/CEEQUAL%20International%20Leaflet%202015.pdf>

This two-page leaflet describes use of the CEEQUAL Assessment Methodology by international users.

## Envision

<b>Envision</b>	
Developed as a collaboration of the Zofnass Program for Sustainable Infrastructure at the Harvard University Graduate School of Design and the Institute for Sustainable Infrastructure	
<b>Launch date:</b>	2012
<b>Development influences:</b>	LEED (Leadership in Energy and Environmental Design), a building certification program developed by the U.S. Green Building Council.
<b>Project applicability:</b>	Applicable beyond roadway and bridge projects to include all types of civil infrastructure; can be used multiple times throughout project development.
<b>Scoring elements:</b>	Sixty sustainability criteria, or credits, with five categories and 14 subcategories.
<b>Tool(s):</b>	Checklist (a Yes/No questionnaire used as a self-assessment), and a rating system (free self-assessment or fee-based third party evaluation).
<b>Selected users:</b>	City of Los Angeles, California State Department of Water Resources, Port Metro Vancouver (see <a href="https://www.sustainableinfrastructure.org/awards/index.cfm">https://www.sustainableinfrastructure.org/awards/index.cfm</a> for a list of project awards).

**Tool description.** Envision is a free, web-based self-assessment tool that uses an online score sheet to evaluate projects. Third-party evaluation is available for a fee.

As the Envision web site indicates, “Envision provides a holistic framework for evaluating and rating the community, environmental, and economic benefits of all types and sizes of infrastructure projects. It evaluates, grades, and gives recognition to infrastructure projects that use transformational, collaborative approaches to assess the sustainability indicators over the course of the project’s life cycle.”

Two tools are available to Envision users:

- A checklist based on the Envision rating system that uses Yes/No questions can be used as a stand-alone assessment to permit a quick comparison of project alternatives.
- A rating system can be used as a self-assessment tool or to permit third-party assessment. Developers recommend that a self-assessment be overseen by someone trained in the use of Envision. Projects may be eligible for an Envision award if at least one person has received Envision-related credentials, and the self-assessment must be submitted to ISI to verify the points achieved.

Fees for a third-party evaluation range from \$2,400 to \$28,000 for ISI members (\$3,000 to \$33,000 for nonmembers) for projects up to \$250 million. There is a \$1,000 registration fee.

**Project scoring.** The tool's 60 credits are divided into five categories and 14 subcategories. The online tool provides a two-page assessment of each credit that addresses the "intent, metric, levels of achievement, description, an explanation of how to advance to a higher achievement level, evaluation criteria and documentation, sources, and related credits."

The amount of points earned in each credit depends on the "Level of Achievement," which may be improved; enhanced; superior, conserving; or restorative. Award levels include:

- Bronze (20 percent of total applicable points).
- Silver (30 percent of total applicable points).
- Gold (40 percent of total applicable points).
- Platinum (50 percent of total applicable points).

### *Tool Documentation*

**Envision Sustainable Infrastructure Rating System**, Institute for Sustainable Infrastructure, 2015.

<https://www.sustainableinfrastructure.org/rating/index.cfm>

Users can log in to an Envision account and learn more about the rating system using this web site that also provides links to resources and background information related to Envision.

**Envision: Rating System for Sustainable Infrastructure**, Institute for Sustainable Infrastructure, 2015.

[http://research.gsd.harvard.edu/zofnass/files/2015/06/Envision-Manual\\_2015\\_red.pdf](http://research.gsd.harvard.edu/zofnass/files/2015/06/Envision-Manual_2015_red.pdf)

This is the most recent manual for users of Envision. See page 15 of the document for the Envision Points Table, an excellent summary of the tool's sustainability practices and the allocation of points associated with each level of achievement.

**Envision Credit List**, Institute for Sustainable Infrastructure, undated.

[http://www.sustainableinfrastructure.org/downloads/Envision\\_Credit\\_List.pdf](http://www.sustainableinfrastructure.org/downloads/Envision_Credit_List.pdf)

This is a list of the credits associated with the Envision tool.

**Envision Facts**, Institute for Sustainable Infrastructure, undated.

[http://www.sustainableinfrastructure.org/downloads/Envision\\_factsheet.pdf](http://www.sustainableinfrastructure.org/downloads/Envision_factsheet.pdf)

This two-page fact sheet describes the features and benefits of Envision.

### *Agencies' Use of the Tool*

**"Evaluating Sustainability and Resilience in Infrastructure: Envision, SANDAG, and the LOSSAN Rail Corridor,"** Richard Dial, Bruce Smith and Gheorghe Rosca, Jr., *ICS/ 2014: Creating Infrastructure for a Sustainable World*, pages 164-174, November 2014.

Citation at <http://dx.doi.org/10.1061/9780784478745.015>

Excerpt from the abstract:

This paper documents the use of the Envision sustainability rating system, developed by the Institute for Sustainable Infrastructure in 2012 to evaluate the relative sustainability of two rail improvement projects in San Diego County, California, undertaken by the San Diego Association of Governments (SANDAG). One project was at 100% design and the other at the 30% design level. SANDAG's intent in using this



tool was to "test drive" this new rating system and to provide a representative baseline on its overall sustainability efforts in designing and constructing projects on the San Diego County portion of the Los Angeles-San Diego-San Luis Obispo (LOSSAN) rail corridor. In addition, Envision could be used by future project development teams to take a more sustainable approach to project delivery. The methodology helped the project team to quantify measures that can be undertaken to further improve sustainable resilience, like increasing a project's lifespan, reduce overall life-cycle costs, and to provide additional resilience against potential flooding from sea level rise and/or severe storm activity.

### *Related Publications*

**"Envisioning Sustainable Infrastructure: An Interview with Tim Psomas,"** *Fast Fast Forward*, XL Catlin, November 2014.

<http://xlcatlin.com/fast-fast-forward/articles/envisioning-sustainable-infrastructure-an-interview-with-tim-psomas>

This interview with the founding chair of the Institute for Sustainable Infrastructure's board of directors includes a discussion of the principles behind development of Envision, the role of verifiers in the evaluation process, and what's next for the tool.

**"Envision: A Measure of Infrastructure Sustainability,"** Shilpa Shivakumar, Tom Pedersen, Suzanne Wilkins and Stefan Schuster, *Pipelines 2014: From Underground to the Forefront of Innovation and Sustainability*.

Citation at <http://dx.doi.org/10.1061/9780784413692.205>

From the abstract:

In the recent past, rating systems for infrastructure in the United States were sector specific, and a single rating tool applicable to all the different infrastructure categories didn't exist until 2012, when Envision was released. Envision is an infrastructure rating system applicable to all infrastructure categories such as energy, water, waste, transportation, and information. Envision is a tool for evaluating and rating the social, economic, and environmental benefits of all types and size of civil infrastructure projects. Envision provides an objective framework to assess project sustainability, build sustainability awareness, and meet client requirements for project sustainability. Sustainability of civil infrastructure is critical to project owners, funding agencies, regulators, professionals, and the public. Envision guides practitioners, owners, and stakeholders in framing infrastructure solutions and performance goals. This paper discusses how the rating system assesses performances, recognizes achievements, and serves as a measure of infrastructure sustainability. Envision is more than a mere rating tool, a true path forward in advancing sustainability knowledge and education for future generations.



## GreenLITES (Green Leadership In Transportation Environmental Sustainability)

GreenLITES (Green Leadership In Transportation Environmental Sustainability)	
Developed by New York State DOT	
<b>Launch date:</b>	September 2008
<b>Development influences:</b>	Building industry's LEED program and Greenroads.
<b>Project applicability:</b>	Applies to all competitive bid projects in these phases: <ul style="list-style-type: none"> <li>• Early in a project's development (scoping).</li> <li>• At design approval (midpoint check).</li> <li>• At plans, specifications and estimate (PS&amp;E) submittal.</li> </ul>
<b>Scoring elements:</b>	Five categories with 18 subcategories are assigned a point value; approximately 175 sustainable practices. Tool offers four certification levels.
<b>Tool(s):</b>	Excel-based scorecard; related tools available for operations certification, regional agency project solicitation and regional pilot sustainability assessment.
<b>Selected users:</b>	New York State and Colorado DOTs

**Tool description.** An Excel-based scoring tool is used to conduct a project-level evaluation at three points in the project development process: during scoping, when design is complete, and when the PS&E package is submitted.

**Project scoring.** Each of the tool's five categories includes subcategories that are examined to determine a point value using a guidance document. An Excel-based scorecard is used to determine progress toward achieving GreenLITES certification. For New York State DOT, the final project scorecard will become part of the PS&E package. A modified rating system may be used for element-specific and maintenance projects. Scoring levels include:

- **Certified.** This certification highlights a project design that has incorporated a number of sustainable choices (15 to 29 points).
- **Silver.** A project design that has incorporated a number of sustainable choices with several of these choices having a high level of impact, or having advanced the state of practice (30 to 44 points).
- **Gold.** A project design that has incorporated a number of sustainable choices with many of these choices having a high level of impact, or having advanced the state of practice (45 to 59 points).
- **Evergreen.** A project design that has incorporated the highest number of sustainable choices with many of these choices having an extremely high level of impact. Additionally, these projects may advance the state of practice or are innovative in the way environmental sustainability is approached on the project (60 points and up).

Local municipalities may use GreenLITES to certify their federally funded transportation projects. This use is voluntary.

**Related tools.** In the GreenLITES Operations Certification Program, 40 “green” items have been incorporated into the agency’s annual maintenance and operations plan using eight categories (bridges, pavement, drainage, signals and lighting, snow and ice, facilities and rest areas, roadside environment and signs, and innovative/unlisted activities).

A draft GreenLITES Project Solicitation Tool, developed in collaboration with several New York metropolitan planning organizations (MPOs) can be used by MPOs to rate projects considered for inclusion in a Transportation Improvement Program. The tool includes seven questions related to local plans, environment, economic vitality, modal options and financing.

In March 2010, the agency launched a pilot Regional Pilot Sustainability Assessment Table that includes components for design, operations and region, and ratings for the elements of the triple bottom line: economy, environment and social equity (including livability and safety).

#### *Tool Documentation*

**GreenLITES: Recognizing Leadership in Transportation Environmental Sustainability,** New York State DOT.

<https://www.dot.ny.gov/programs/greenlites>

From the web site:

GreenLITES is a self-certification program that distinguishes transportation projects and operations based on the extent to which they incorporate sustainable choices. This is primarily an internal management program for NYSDOT to measure our performance, recognize good practices, and identify where we need to improve. It also provides the Department with a way to demonstrate to the public how we are advancing sustainable practices. NYSDOT project designs and operations are evaluated for sustainable practices and based on the total credits received, an appropriate certification level is assigned. The rating system recognizes varying certification levels, with the highest level going to designs and operational groups that clearly advance the state of sustainable transportation solutions.

**GreenLITES Project Design Certification Program,** Version 2.1.0, GreenLITES: Recognizing Leadership in Transportation Environmental Sustainability, New York State DOT, revised April 2010.

[https://www.dot.ny.gov/programs/greenlites/repository/Green%20LITES%20Certification%20Program%20Document%20-%20April%202010\\_092111.doc](https://www.dot.ny.gov/programs/greenlites/repository/Green%20LITES%20Certification%20Program%20Document%20-%20April%202010_092111.doc)

This guidance document provides information about the five GreenLITES certification categories (sustainable sites, water quality, materials and resources, energy and atmosphere, and innovation/unlisted). Each category includes subcategories that are assigned a point value in the GreenLITES scorecard.

**GreenLITES Project Environmental Sustainability Rating System Scorecard,** Version 2.1.0, GreenLITES: Recognizing Leadership in Transportation Environmental Sustainability, New York State DOT, revised April 2010.

[https://www.dot.ny.gov/programs/greenlites/repository/GREENLITES\\_Scorecard\\_2%201%2000.xls](https://www.dot.ny.gov/programs/greenlites/repository/GREENLITES_Scorecard_2%201%2000.xls)

This Excel-based scorecard lists the five GreenLITES certification categories and the possible points for each of the sustainable practices identified within each category.

**GreenLITES for Sustainable Planning**, GreenLITES: Recognizing Leadership in Transportation Environmental Sustainability, New York State DOT.

<https://www.dot.ny.gov/programs/greenlites/GreenLITESplanning>

This web site provides a link to a draft project solicitation tool that can be used by MPOs to evaluate projects that have been submitted for consideration for inclusion in the agency's Transportation Improvement Program.

**Operations Certification Program**, GreenLITES: Recognizing Leadership in Transportation Environmental Sustainability, New York State DOT.

<https://www.dot.ny.gov/programs/greenlites/operations-cert>

From the web site:

To incorporate sustainability into its work, the Operations Division has added and / or highlighted some 100 separate tasks into its planning process so that sustainability tradeoffs can be quantified and performance can explicitly be tracked on a spreadsheet to insure continuing progress in this evolving and vital area.

*Related Resources:*

**GreenLITES Draft Operations Certification Program**, GreenLITES: Recognizing Leadership in Transportation Environmental Sustainability, New York State DOT, February 2012.

[https://www.dot.ny.gov/programs/greenlites/repository/GreenLITES%20Operations%20Draft%20Guidance%20February%202012%20\(2\).doc](https://www.dot.ny.gov/programs/greenlites/repository/GreenLITES%20Operations%20Draft%20Guidance%20February%202012%20(2).doc)

From the document:

The scorecard lists operations areas, such as bridge maintenance or roadside work. Within each area are activities:

- Most are specific, such as bridge cleaning, training or installing snow fence, and have a measure of accomplishment.
- For activities that are innovative, or not listed as specific activities, and that an organization feels contribute to sustainability, there is a place to list as many activities as are needed.

Each activity has a "GreenLITES factor," which is a good faith effort to quantify the relative importance of the work to sustainability.

Scoring will be based on a statistical analysis, review team input and follow-up consultations with regional and Main Office groups as needed.

**GreenLITES Measures: State Fiscal Year 2011-2012 DRAFT**, GreenLITES: Recognizing Leadership in Transportation Environmental Sustainability, New York State DOT.

[https://www.dot.ny.gov/programs/greenlites/repository/Copy%20of%20GreenLITES%20Measures%20Draft%20for%202011-12%20\(2\).xls](https://www.dot.ny.gov/programs/greenlites/repository/Copy%20of%20GreenLITES%20Measures%20Draft%20for%202011-12%20(2).xls)

This Excel spreadsheet includes eight categories and 40 activities that are self-rated to assess the performance of the Operations Division as it relates to sustainable practices.

## Agencies' Use of the Tool

**“Incorporating GreenLITES Program Concepts in Colorado DOT’s Transportation Design,”** Art Hirsch, *2010 Transportation Research Board Environment and Energy Research Conference*, June 2010.

[http://terralogicss.designtechstudio.com/literature\\_39816/2010\\_TRB\\_Presentation\\_\(Raleigh\\_North\\_Carolina\)\\_GreenLITES\\_Implementation\\_in\\_Colorado](http://terralogicss.designtechstudio.com/literature_39816/2010_TRB_Presentation_(Raleigh_North_Carolina)_GreenLITES_Implementation_in_Colorado)

This conference presentation describes Colorado DOT’s evaluation of the GreenLITES scoring tool using two test cases. Among the lessons learned:

- 3 to 3.5 hours needed for scoring.
- Need support from engineering management and design team.
- Project Manager needs to be the driving force behind the GreenLITES scoring and design integration.
- Concern about the cost of sustainability implementation (which ones are the most cost effective?).
- Definition of terms and criteria needed for consistent evaluation and understanding.
- Scoring criteria could include other sustainability elements such as electrical energy conservation, petroleum conservation and water reduction requirements.

**“Incorporating Sustainability into New York State DOT's Decisions,”** Debra A. Nelson, Paul Krekeler and Michael Rossi, *Proceedings of the 2011 International Conference on Ecology and Transportation*, pages 861-869, 2012.

Citation at <http://trid.trb.org/view/2012/C/1348834>

Excerpt from the abstract:

This paper will touch on NYSDOT’s sustainability ethic established through its GreenLITES (Green Leadership in Transportation and Environmental Sustainability) program and highlight NYSDOT’s recent efforts to incorporate sustainability principles into its asset management, comprehensive program update and capital investments decisions. NYSDOT is working to refine innovative tools to ensure strategic, tactical and operational transportation decisions that further social, economic and environmental sustainability. The authors' goal is to integrate ecological, structural, safety, and economic needs into the transportation decision-making process.

**“Moving Towards Sustainability: New York State Department of Transportation’s GreenLITES Story,”** Gary R. McVoy, Debra A. Nelson, Paul Krekeler, Elisabeth Kolb and Jeffery S. Gritsavage, *Conference Proceedings: 2010 Green Streets & Highways Conference*, pages 461-479, 2010.

<https://www.dot.ny.gov/programs/greenlites/repository/ASCE%20GreenLITES%20Final%20Paper%207-12-10.pdf>

This conference paper describes a regional application of the GreenLITES tool. From page 15 of the paper:

To expand GreenLITES to include more multimodal aspects (transit, pedestrian, bicycle, rail), NYSDOT conducted an initial consciousness-raising exercise in March 2010 in each of eleven regions. The Pilot GreenLITES Regional Assessment Tool (Figure 5) was developed and applied to assess “existing” and “desired” states for a full range of sustainability factors, mostly gleaned from the Bipartisan Policy Project (National Transportation Policy Project 2009). The GreenLITES Regional Assessment rubric

includes a Design Component (normalized average regional GreenLITES project scores), an Operations (Residency) Component (normalized average regional Operations score), and a Regional Component (determined by completing the Draft Regional Assessment Table) that includes ratings for the elements of the triple bottom line: economy, environment, and social equity - including livability and safety.

## **Greenroads**

<b>Greenroads</b>	
<b>Developed jointly by University of Washington researchers and CH2M HILL</b>	
<b>Launch date:</b>	Version 1.0 launched in January 2010.
<b>Development influences:</b>	LEED
<b>Project applicability:</b>	<ul style="list-style-type: none"> <li>• Design.</li> <li>• Construction.</li> <li>• Does not evaluate planning and operations.</li> </ul>
<b>Scoring elements:</b>	Twelve Project Requirements with 45 voluntary core credits across five categories; extra credits for creativity and effort (4 credits/15 points).
<b>Tool(s):</b>	Subscription-based scorecard that is subjected to a third-party rating; projects must be registered and submitted for review.
<b>Selected users:</b>	Alaska, California and Oregon state DOTs; cities of San Francisco and San Jose, CA; Las Vegas, NV; and Seattle, Bellingham and Tacoma, WA (see <a href="https://www.greenroads.org/portfolio">https://www.greenroads.org/portfolio</a> for a catalog of completed projects).

**Tool description.** A manual describing the current version of Greenroads—Version 2—is not publicly available. The most recent publicly available handbook is for Version 1.5 (see **Tool Documentation** below), which is no longer being updated. The following summarizes information available on the Greenroads web site about the most current version of the tool.

**Subscription fees.** New pricing for registering Greenroads projects went into effect July 2015. While submitting a project screening application is free, registration fees apply after a project has been approved by Greenroads staff. The fees:

- Registration for domestic projects <=\$15 million = \$1,995.
- Registration for domestic projects >\$15 million = \$4,995.

**Project requirements and categories.** Greenroads Version 2 includes 12 Project Requirements (PRs). Every project must meet these 12 requirements to qualify for an award. The PRs are “intended to capture some of the most critical ideas of sustainability for any roadway project from planning, design, construction and operations and maintenance.” The PRs are:

- PR-1 Ecological impact analysis.
- PR-2 Carbon and energy footprint.
- PR-3 Low-impact development.
- PR-4 Social impact analysis.
- PR-5 Community engagement.
- PR-6 Life cycle cost analysis.
- PR-7 Quality control.
- PR-8 Pollution prevention.
- PR-9 Waste management.
- PR-10 Noise and glare control.
- PR-11 Utility conflict analysis.
- PR-12 Asset management.

**Project scoring.** After meeting the 12 PRs, a project is assessed using five standard categories and four voluntary extra credits. A project can earn a maximum of 130 points across all categories. Projects must complete and document all 12 PRs and document a minimum of 40 points to be eligible for a minimum rating. The award levels include:

- Bronze: 40 points + 12 PRs (about 30 percent of total points available).
- Silver: 50 points + 12 PRs (about 38 percent of total points available).
- Gold: 60 points + 12 PRs (about 46 percent of total points available).
- Evergreen: 80 points + 12 PRs (about 62 percent of total points available).

**Greenroads and transportation planning.** Greenroads Manual Version 1.5 includes this about how the tool relates to planning:

Decisions regarding the location, type, timing, feasibility or other planning level ideas for roadway projects are excluded. For example, Greenroads does not answer the question “should we build a road or not?” While planning is fundamental to roadway and community sustainability, these decisions are often too complex or political to be adequately defined by a point-based system. Project level planning however, in terms of project development and/or project delivery, is included and many of the Project Requirements and Voluntary Credits can be used during design and development to help shape decisions on the project.

### *Tool Documentation*

**The Greenroads Rating System**, Greenroads Foundation, September 2015.  
<https://www.greenroads.org/1184/rating-system.html>

The web site notes the following comparisons of Version 2 of Greenroads with the initial version of the tool launched more than four years ago:

- The same core concepts and approach.
- An eye toward environmental justice.
- A bigger role for contractors and suppliers.
- More performance-based standards.
- More options, simplified language.

**Version 2 Credit Comparison**, Greenroads, Greenroads Foundation, undated.  
<https://www.greenroads.org/files/5895.pdf>

This document compares the PRs and credits appearing in Version 1.5 with the new parameters in Version 2, providing the rationale for each change.



**Greenroads Version Comparison**, Greenroads, Greenroads Foundation, undated.  
<https://www.greenroads.org/files/5892.pdf>

This document compares the credit and point allotments under Versions 1.5 and 2 and the differences in the certification award levels under the new version of the rating system.

**Greenroads Project Handbook: Greenroads Certification and Assessment**, Version 1.5, Greenroads Foundation, August 2012.

<https://www.greenroads.org/files/244.pdf>

While somewhat outdated, this handbook still provides a good overview of the steps involved to participate in the Greenroads independent third-party evaluation process.

**Greenroads Manual**, Version 1.5, University of Washington, 2011.

<http://www.greenroads.org/files/236.pdf>

While the PRs, categories and credits in the current version of the tool reflect changes that are not indicated in this version of the Greenroads manual, Version 1.5 can provide a useful overview of what is reflected in the rating system and how it operates.

**Greenroads Abridged Manual**, Version 1.5, University of Washington, February 2011.

<https://www.greenroads.org/files/235.pdf>

This is an abridged version of the full Greenroads Manual cited above.

#### *Agencies' Use of the Tool*

**“Innovative Methods to Inventory Sustainability Practices on State Route 76, San Diego,”** Lindsey R. Sousa and Cecily Way, *Green Streets, Highways, and Development 2013: Advancing the Practice*, pages 410-420, November 2013.

Citation at <http://dx.doi.org/10.1061/9780784413197.032>

Excerpt from the abstract:

Parsons Brinckerhoff led an analysis for Caltrans District 11 to inventory sustainable practices implemented as part of the widening and realignment of State Route (SR) 76 in San Diego County. The team assessed the project against two leading national green infrastructure rating systems (Federal Highway Administration (FHWA) and Greenroads) to help inventory the project's performance, developed a preliminary project "score," and gathered associated supporting documentation. The overall intent of this project was to help Caltrans raise the bar on its sustainability practices by identifying tangible steps that could be taken during both design and construction. This analysis found that the SR 76 would achieve most of the credits under the Environment and Water and Access and Equity categories, but not under Pavement Technologies. Assuming the Greenroads project requirements were met, the project would likely receive a Silver rating. Under the extended scorecard from the Infrastructure Voluntary Evaluation Sustainability Tool (INVEST) beta version rating system, the project would likely score a Gold rating. Enhancing pavement technology applications would help boost the rating under both systems. The analysis also confirmed that selection of a sustainability rating system would depend greatly on the needs and goals of an agency or project considering utilizing such a system.

**“Evaluating Project-Based Roadway Sustainability Rating System for Public Agency Use,”** Stephen T. Muench, Maleena Scarsella, Margi Bradway, Liz Hormann and Lyn Cornell, *Transportation Research Record* 2285, pages 8-18, 2012.

Citation at <http://trid.trb.org/view/2012/C/1129008>

From the abstract:

Several road-owning organizations are considering the use of project-based sustainability rating systems either now or in the near future. However, there is little information on how these systems might be evaluated or best used. Experience from the Oregon Department of Transportation (DOT) represents a reasonable approach to contextualizing and evaluating such rating systems. Early support by upper management and specific direction helped the Oregon DOT develop an organizational approach to sustainability within which a rating system could be evaluated for use. The Oregon DOT’s interest in project-based rating systems led to its evaluation of the Greenroads rating system and use of it on three Oregon DOT in-progress projects. The Greenroads evaluation identified 11 sustainability best practices achieved by the Oregon DOT and identified 10 more that could be achieved for low additional effort, indicating potential for improvement. Ultimately, it appears that a sustainability rating system, when used in the proper context, can provide a flexible approach for an owner agency to measure, manage, improve, and communicate sustainability at the project level.

#### *Related Publications*

**“Sustainability Trends Measured by the Greenroads Rating System,”** Jeralee L. Anderson and Stephen T. Muench, *Transportation Research Record* 2357, pages 24–32, 2013.

Citation at <http://dx.doi.org/10.3141/2357-03>

Excerpt from the abstract:

Forty projects identified as sustainable were compared with 65 typical projects representing conventional practice. The objectives of this study were to (a) identify trends in Greenroads project ratings, (b) benchmark the current state of the practice and identify potential areas for improved sustainability performance, (c) determine whether Greenroads can differentiate among projects on the basis of their sustainability efforts, and (d) identify the implications of these findings to practice. The results show that (a) some credits and categories are easily achieved, although achievement of others is more challenging and offers opportunities for improved environmental performance; (b) typical roadway projects tend to meet environmental regulatory standards but rarely do much more even when possible; therefore, they score fewer points for credits that focus on environmental benefits beyond the regulatory minimum; (c) contractors and materials suppliers appear to have unrealized opportunities to contribute; and (d) an early emphasis on the environment during project development appears to differentiate between typical and sustainable projects and manifest as higher Greenroads scores.



## **I-LAST (Illinois Livable and Sustainable Transportation)**

<b>I LAST (Illinois Livable and Sustainable Transportation)</b>	
<b>Developed by Illinois DOT in collaboration with the Joint Sustainability Group</b>	
<b>Launch date:</b>	Development began in 2008; actual use began in 2011.
<b>Development influences:</b>	GreenLITES
<b>Project applicability:</b>	The tool can be used at various stages of project development, including: <ul style="list-style-type: none"> <li>• Project scoping.</li> <li>• End of design phase.</li> <li>• During construction.</li> </ul>
<b>Scoring elements:</b>	Nine categories with 25 subcategories.
<b>Tool(s):</b>	Self-assessment scorecard/checklist uses a point system, with scoring intended to be relatively simple and require minimal time and effort. No level of certification award.
<b>Selected users:</b>	Illinois DOT, Illinois Tollway

**Tool description.** Use of this self-assessment tool to evaluate the sustainability of highway projects is voluntary within Illinois DOT. I-LAST is based on a checklist of sustainable practices with points allotted to each practice. Following each item on the checklist is a description of the intent of each section and the rationale and measures of effectiveness for each item. Lists of source materials and additional background resources assist in understanding and applying the practices.

The developers indicate in the tool’s guide that I-LAST is not considered a method to aid in project selection. This is due to the variability of transportation projects, with the developers noting that there will “often be a large number of points that are not applicable on an individual project. Therefore comparing the absolute score of different projects would not be indicative of the level of sustainability for those projects. Projects can be evaluated based on the inclusion of the practices that were applicable to the project.”

**Project scoring.** Nine categories and 25 subcategories are used to assess the application of best practices and sustainability measures. Most subcategories have a specific number of points that can be earned if the project meets the criteria identified in the checklist. In some cases, a range of points is offered, with the user determining how many points a project may earn based on the scale identified.

Projects can be evaluated at three points in project development:

- At the beginning of the project.
- At the end of the design phase.

- During construction, I-LAST can capture practices used by the contractor for the project, or the contractor may identify additional sustainable opportunities within the limits of the specifications.

Unlike other tools, I-LAST does not offer a level of certification awarded based on a point count.

#### *Tool Documentation*

**I-LAST: Illinois – Livable and Sustainable Transportation Rating System and Guide**, Version 2.02 Illinois DOT and Illinois Joint Sustainability Group, September 2012.

<http://www.idot.illinois.gov/assets/uploads/files/transportation-system/reports/desenv/enviromental/i-last%20v%20%202%2002.pdf>

As the guide indicates, “[t]he guide is not intended to provide ‘cookbook’ solutions to complex problems, but to foster and identify where creative thought may lead to innovative solutions and more sustainable projects.”

**Case Study in Sustainability: Creating the Illinois Livability and Sustainable Transportation (I-LAST) Tool**, FHWA Sustainable Highways Program, January 2012.

[https://www.sustainablehighways.dot.gov/documents/ILAST\\_Case\\_Study.pdf](https://www.sustainablehighways.dot.gov/documents/ILAST_Case_Study.pdf)

This case study describes development of I-LAST and lessons learned from the development process.

#### *Agencies’ Use of the Tool*

**INVEST Project Development Manual**, Illinois Tollway, Illinois State Toll Highway Authority, March 2015.

[http://www.illinoistollway.com/documents/10157/30214/01\\_INVEST\\_Manual\\_032015\\_FINAL](http://www.illinoistollway.com/documents/10157/30214/01_INVEST_Manual_032015_FINAL)

This manual includes a discussion of how elements of I-LAST were incorporated with elements of another rating tool—INVEST—to develop a custom rating tool used by the Illinois Tollway. See the discussion that begins on page 19 of the manual (page 27 of the PDF) to identify how sustainable practices included in the I-LAST scoring tool are included in the customized tool described in the manual.

## **INVEST (Infrastructure Voluntary Evaluation Sustainability Tool)**

<b>INVEST (Infrastructure Voluntary Evaluation Sustainability Tool)</b> Developed by Federal Highway Administration	
<b>Launch date:</b>	October 2012 (Version 1.0); September 2015 (Version 1.2).
<b>Development influences:</b>	Many other scoring tools.
<b>Project applicability:</b>	<ul style="list-style-type: none"> <li>• System-level planning and programming (state or region).</li> <li>• Project development (project-specific planning, design and construction)</li> <li>• Operations and maintenance activities.</li> </ul>
<b>Scoring elements:</b>	Three modules with 64 criteria; seven scorecard types.
<b>Tool(s):</b>	Standard and custom scorecards; web-based tool prompts users to respond to questions to generate a score.
<b>Selected users:</b>	State DOTs including Arizona, California, Delaware, Kentucky, Massachusetts, Montana, New Hampshire, Ohio, Pennsylvania, Utah, Texas and Washington.

**Tool description.** This free, web-based self-evaluation tool was developed by Federal Highway Administration (FHWA) in collaboration with DOTs, metropolitan planning organizations and local governments electing to use early versions of the tool and test it. The tool includes a “collection of sustainability best practices, called criteria, intended to help transportation practitioners evaluate programs and projects in the area of sustainability. The goals of INVEST include identifying these criteria, assisting agencies in researching and applying the criteria, and establishing an evaluation method to measure the progress toward more sustainable highway projects.” The latest version, Version 1.2, released in September 2015, includes “significant changes to criteria, scorecards, modules, and scoring.”

INVEST offers three modules that include 64 criteria:

- **System Planning for States (SPS)**, which includes 16 criteria plus one bonus criteria that agencies are eligible for based on their scores on the first three criteria.
- **Project Development**, which includes 33 criteria that are organized into categories from planning to design to construction. This is the module likely to be of greatest interest to Caltrans in evaluating project-level sustainability tools. The criteria “span the entire project development process from early planning, alternatives analysis, environmental documentation, preliminary and final design, and construction.”
- **Operations & Maintenance** includes 14 criteria, including four aimed at internal operations and 10 focused on maintenance and operations.

A fourth module—System Planning for Regions, or SPR—is also available.

**Project scoring.** Users can score a project using both the Browse and Score modes. Highlights from the INVEST web site describe how the tool scores projects:

- Each INVEST criterion describes a particular sustainability best practice and assigns it a point value (or "weight") according to its relative impact on transportation sustainability.
- The points associated with the criteria that are achieved for a given program or project are added together to give a total score. That score can then be used internally for purposes such as tracking progress toward more sustainable infrastructure, tracking integration of sustainable best practices into projects, and stakeholder and community outreach.
- The fundamental basis for weighting the criteria is based on both the triple bottom line principles and related benefits of sustainability.
- Version 1.2 of INVEST applies weighting for the Project Development criteria only. Criteria in the System Planning modules and the Operations and Maintenance module are all equally weighted at 15 points (except the bonus criterion in each SPS and SPR which is valued at 10 points).

When scoring within a module, the user is presented with information about each criterion, including its goal, how the criterion affects triple bottom line principles (social, environmental and economic), scoring requirements, and supporting documentation that can be used to validate the score. Users select the criteria that fit a specific project or goals and score only those items. The tool generates questions that must be answered by the user. Responses are used to score each criterion and identify a final score. The final score is used to determine the award for a project—bronze, silver, gold or platinum—which is based on the fraction of total points possible.

**Scorecards.** Seven types of scorecards are available: paving, basic rural, basic urban, extended rural, extended urban, recreational and scenic, and custom. Custom scorecards are used when an agency wishes to develop a unique set of criteria to assess a particular project. The custom scorecard includes 19 core criteria that are used as the basis to begin building a custom assessment tool. Custom scorecards will not receive an award designation.

### *Tool Documentation*

**INVEST (Infrastructure Voluntary Evaluation Sustainability Tool), FHWA.**

<http://www.sustainablehighways.org/>

This web site provides a wealth of information about the scoring tool, including an in-depth description of the tool's infrastructure and links to a range of supporting materials for the new user. The INVEST library (see <https://www.sustainablehighways.org/1524/invest-library.html>) contains links to guidance documents and other materials essential to understanding the tool.

**INVEST Version 1.2: INVEST, Sustainable Highways Self-Evaluation Tool, FHWA,** September 2015.

<https://www.sustainablehighways.org/files/1295.pdf>

This document, referred to as a compendium, includes detailed information about the criteria included in the four INVEST modules. The introduction indicates that this document "is not intended to be an instructional manual or guidebook," and the user is directed to the web site for instruction on how to use INVEST.

**"Evaluating Sustainable Development: A Quality-of-Life Focus for Transportation Decision Making,"** Adjo A. Amekudzi, *TR News*, No. 288, pages 4-9, September 2013.

<http://onlinepubs.trb.org/onlinepubs/trnews/trnews288.pdf>

(This link is for entire issue of the magazine. The article begins on page 4.)

From the abstract:

In October 2012, the Federal Highway Administration (FHWA) launched a voluntary online tool to help agencies identify opportunities for incorporating sustainability into transportation projects and programs. INVEST 1.0 consists of a collection of sustainability best practices, called criteria, in three modules—system planning, project development, and operations and maintenance—that address the full life cycle of a highway. With the web-based tool, an agency can evaluate each module independently and receive a score based on the points achieved for each criterion. Beyond the score, however, INVEST 1.0 meets an identified need for a collaborative virtual workspace that promotes communications and encourages participation by a range of sustainability-minded practitioners. This article explains the development of INVEST 1.0 and highlights the tool's flexibility and functionality.

### *Agencies' Use of the Tool*

**The Collaborative Benefits of Using FHWA's INVEST—Arizona Department of Transportation Sustainability Implementation**, Arizona DOT and FHWA, April 2015.

<https://www.sustainablehighways.org/files/3210.pdf>

This report describes the results of a project funded in part through a grant from FHWA. Among Arizona DOT's INVEST implementation goals:

- Score projects in ADOT's five-year construction program using the Project Development (PD) module, with a specific focus on statewide roundabout projects.
- Develop an internal ADOT INVEST and ADOT/local government INVEST training framework to develop new sustainability operational and partnering opportunities.

From the report's conclusion (page 59 of the report; page 60 of the PDF):

ADOT has attempted to develop and implement the INVEST tool not simply to score and measure the projects that are developed on an annual basis, but to use the INVEST tool to build the foundation for an Intermodal Transportation Division sustainability program. It quickly became clear, as the project developed, there was no reason to stop at simply developing a foundation. It was determined that this effort could create new, novel ways to gather the collective knowledge of all ADOT participants in the project development process. The grant allowed ADOT to far exceed the original expectations. It allowed ADOT to explore ways to further analyze opportunities, develop a host of sustainable program initiatives and meet a Triple Bottom Line goal of advancing economic, environmental and social aspects of how ADOT operates.

**Green Infrastructure**, Sarah M. McCormack, Roy Sturgill, Brian Howell, Chris Van Dyke and Doug Kreis, Kentucky Transportation Cabinet, June 2014.

[http://www.ktc.uky.edu/files/2014/11/KTC\\_14\\_10\\_SPR\\_447\\_12\\_1F\\_.pdf](http://www.ktc.uky.edu/files/2014/11/KTC_14_10_SPR_447_12_1F_.pdf)

Excerpt from the abstract:

As part of an effort to understand the extent to which sustainable design and construction principles are being used, this report selects and analyzes three case studies involving previously completed Kentucky Transportation Cabinet (KYTC) projects and assesses their commitment to sustainable concepts. Specifically, this report examines the extent to which KYTC utilized sustainable concepts for each case study as described in the Federal Highway Administration's (FHWA's) INVEST rating system. This research effort comprised three components. First, Kentucky Transportation Center

(KTC) researchers analyzed KYTC's policies and manuals for project planning, design, and construction and determined the extent to which INVEST criteria and related principles were incorporated into their standard processes. Second, KTC analyzed the individual case studies themselves, to include project plans and other relevant documentation. Finally, KTC conducted interviews with each of the KYTC district offices responsible for managing those previously completed projects and obtained feedback on the INVEST criteria used for each particular project.

**“Innovative Methods to Inventory Sustainability Practices on State Route 76, San Diego,”** Lindsey R. Sousa and Cecily Way, *Green Streets, Highways, and Development 2013: Advancing the Practice*, pages 410-420, November 2013.

Citation at <http://dx.doi.org/10.1061/9780784413197.032>

Excerpt from the abstract:

Parsons Brinckerhoff led an analysis for Caltrans District 11 to inventory sustainable practices implemented as part of the widening and realignment of State Route (SR) 76 in San Diego County. The team assessed the project against two leading national green infrastructure rating systems (Federal Highway Administration (FHWA) and Greenroads) to help inventory the project's performance, developed a preliminary project "score," and gathered associated supporting documentation. The overall intent of this project was to help Caltrans raise the bar on its sustainability practices by identifying tangible steps that could be taken during both design and construction. This analysis found that the SR 76 would achieve most of the credits under the Environment and Water and Access and Equity categories, but not under Pavement Technologies. Assuming the Greenroads project requirements were met, the project would likely receive a Silver rating. Under the extended scorecard from the Infrastructure Voluntary Evaluation Sustainability Tool (INVEST) beta version rating system, the project would likely score a Gold rating. Enhancing pavement technology applications would help boost the rating under both systems. The analysis also confirmed that selection of a sustainability rating system would depend greatly on the needs and goals of an agency or project considering utilizing such a system.

## **STARS (Sustainable Transportation Analysis & Rating System)**

<b>STARS (Sustainable Transportation Analysis &amp; Rating System)</b>	
<b>Developed by Portland Bureau of Transportation, North American Sustainable Transportation Council, and Santa Cruz County Regional Transportation Commission</b>	
<b>Launch date:</b>	Development began in 2009; development and piloting of the tool continued through 2015.
<b>Development influences:</b>	LEED
<b>Project applicability:</b>	STARS-Project focuses on planning; applicable to road, transit, bicycle and pedestrian projects.
<b>Scoring elements:</b>	Twelve credits in four credit categories.
<b>Tool(s):</b>	Fee-based series of tools: <ul style="list-style-type: none"> <li>• STARS-Project (transportation corridors).</li> <li>• STARS Safety, Health and Equity Credit Tool (stand-alone tool and integrated into STARS-Project).</li> <li>• STARS-Plan (transportation system plans).</li> </ul>
<b>Users:</b>	Cities and counties in Oregon, transit agencies in Washington (see <a href="http://www.transportationcouncil.org/about-stars/whos-using-stars">http://www.transportationcouncil.org/about-stars/whos-using-stars</a> for other STARS users).

**Tool description.** STARS is a fee-based series of evaluation tools that requires oversight by the tool developer, Sustainable Transportation Council (STC). The project-specific STARS tool—STARS-Project—compares project alternatives based on performance rather than modes. STARS-Project uses a four-step approach that includes backcasting, described by project developers as an “iterative approach that helps users establish future performance targets, then test and refine strategies to achieve them.”

Developers believe STARS is most effective when used to plan a project or series of corridor projects, contrasted with other rating tools that are most effective when used during the project design and construction phases. Other unique elements of STARS include an emphasis on reducing energy use and climate pollution, and evaluating the cost effectiveness of different strategies. As the project manual indicates, other rating tools “focus on road projects or infrastructure, rather than the whole systems approach STARS uses.” To illustrate the difference, the project manual offers this distinction: STARS may be used for planning the type of transportation project that should be built and how it is operated, while Greenroads may provide value during design and construction.

**Project scoring.** Limited information about project scoring is available publicly. For the STARS-Project tool, 12 credits are organized into four credit categories: integrated process, access, climate and energy, and cost effectiveness analysis. The first credit in each of the categories is a required credit. Within each category, the tool applies four types of credits:

- Establish goals and objectives (typically required).
- Evaluate strategies to achieve the objectives.



- Implement the strategies.
- Measure performance.

A 2013 pilot project application manual indicates that most projects submitted to STC for a STARS analysis involve a contract cost of \$5,000 to \$20,000.

**Related tools.** The STARS Safety, Health and Equity Credits tool can be used as a stand-alone tool or incorporated into the STARS-Project tool, though it does not appear that documents are publicly available that describe this integration. Under each credit category (safety, health and equity) are goals, with objectives associated with each goal. Objectives may be quantifiable, with users setting their own targets, or qualitative.

### *Tool Documentation*

#### **North American Sustainable Transportation Council**

<http://www.transportationcouncil.org/>

This web site provides links to STARS-related documents, and describes the development of STARS and the parties involved.

#### **Sustainable Transportation Analysis and Rating System (STARS) Pilot Project Application Manual**, Version 1.2, North American Sustainable Transportation Council and Portland Bureau of Transportation, May 2013.

<http://www.transportationcouncil.org/wp-content/uploads/2013/05/STARS-Project-1.2-Introduction.pdf>

This is the introduction to the STARS-Project manual. The full manual is available upon request.

#### **STARS Safety, Health, and Equity Credits**, North American Sustainable Transportation Council, Upstream Public Health, Portland Bureau of Transportation and Multnomah County Health Department, March 2012.

[http://www.transportationcouncil.org/wp-content/uploads/2011/12/STARS\\_SHE\\_Introduction.pdf](http://www.transportationcouncil.org/wp-content/uploads/2011/12/STARS_SHE_Introduction.pdf)

As with other STARS manuals, only the introduction to the STARS Safety, Health and Equity Credits tool is available publicly. Page 7 of the document (page 11 of the PDF) includes a table summarizing the tool's credits, goals and objectives. A full manual is available upon request.

### *Agencies' Use of the Tool*

#### **“Developing a Comprehensive Sustainable Transportation Analysis Framework,”**

George A. Dondero, Kelly Rodgers and Peter T. Hurley, *TRB 92nd Annual Meeting Compendium of Papers*, Paper #13-0348, 2013.

Citation at <http://trid.trb.org/view.aspx?id=1240459>

Excerpt from the abstract:

Since 2009 the Sustainable Transportation Analysis and Rating System (STARS) has been under development and is being tested on both transportation projects and regional plans. This paper identifies characteristics of STARS that advance the state of the practice while highlighting challenges and gaps. STARS provides a suite of credits incorporating tools and guidance based upon triple bottom line principles. Backcasting is used to establish desired future outcomes, rather than the more traditional forecasting



process. STARS uses performance measures to analyze all transport modes and strategies. A pilot project in Santa Cruz County, California is highlighted. Performance monitoring will determine whether the system changes practices and outcomes.

## **Other Sustainability Assessment Tools and Practices**

Below we highlight a range of tools and practices that offer additional perspective on assessing the sustainability of transportation projects. The citations in this section are organized into seven categories:

- Analytic Practices.
- Backcasting.
- Conservation.
- Emissions.
- Fiscal Practices.
- National Park Service Tool.
- Pavement Design.

### **Analytic Practices**

**Assessing Sustainability Effect of Infrastructure Transportation Projects Using Systems-Based Analytic Framework**, Islam El-adaway and Dennis D. Truax, National Center for Intermodal Transportation for Economic Competitiveness, July 2015.

<http://www.ncitec.msstate.edu/wp-content/uploads/2013-11FR.pdf>

Excerpt from the abstract:

The narrow focus of the currently available assessment methods does not collectively address the technical, environmental, economic, social/cultural, and individual sustainability indicators as well various aspects of sustainability. To this end, this research develops three innovative system-based concepts to assess sustainability of the transportation infrastructure projects: (1) work, (2) nature, and (3) flow. The “work benchmark” defines the socio-behavioral relationships amongst the products and the actors of the built environment. It also attempts to delineate how the end-product is affected by how well the producers are connected to the product. The “nature benchmark” focuses on the effects of the infrastructure system on the environment through studying the interaction between the transportation projects actors, their associated processes, and the end-products within their host systems. The “flow benchmark” identifies the overall system changes within the host systems and the effects of these changes on the natural environment and the socio-economic setting. For testing and evaluation of “nature” and “work” on five different transportation and civil infrastructure projects, which are in a relation to a transportation project, the authors utilized a three-step methodology comprising: (1) structured survey; (2) data collection; and (3) analysis. This process provided an improved understanding of the environmental, social, and economic effects of these projects from a systems perspective.

## **Backcasting**

**“Backcasting for Sustainable Transportation Planning,”** Elise Barrella and Adjo A. Amekudzi, *Transportation Research Record* 2242, pages 29-36, 2011.

Citation at <http://dx.doi.org/10.3141/2242-04>

From the abstract:

Transportation problems are often sustainability problems and as such are complex, long-reaching, and difficult to address through incremental policies. Planning for these problems requires analyzing future conditions of the transportation system and the systems with which it interacts. Traditional futures studies using the forecasting method do not deal adequately with the uncertainty inherent in long-term studies of transportation problems. This paper reviews recent innovations in futures studies and their applications to planning studies for transportation system sustainability. The new methods, including scenario planning, backcasting (determining policy to meet future end point), and strategic sustainability assessment, involve both qualitative assessment and scientific models to create and analyze future states. In particular, the paper focuses on backcasting as an alternative to forecasting for scenario building and provides examples of how the method has been applied in the transportation sector. The review suggests that backcasting is a better option for analyzing transportation sustainability problems because it is an action-oriented approach focused on creating desirable future images and developing effective policies for achieving them.

## **Conservation**

### **Eco-Logical**

**Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects,** Janice W. Brown, Office of Project Development and Environmental Review, FHWA, April 2006.

<https://www.environment.fhwa.dot.gov/ecological/ecological.pdf>

While not a scoring tool or rating system, the Eco-Logical system may be of interest to Caltrans given its inclusion of performance measures related to conservation and sustainable use. An excerpt from the report's abstract:

*Eco-Logical* is guide to making infrastructure more sensitive to wildlife and ecosystems through greater interagency cooperative conservation. It describes ways for streamlining the processes that advance approvals for infrastructure projects – in compliance with applicable laws – while maintaining safety, environmental health, and effective public involvement. As a way to accomplish this, the guide outlines an approach for the comprehensive management of land, water, and biotic and abiotic resources that equitably promotes conservation and sustainable use. Key components of the approach include integrated planning, the exploration of a variety of mitigation options, and performance measurement.

*Related Resources:*

**Better Environmental and Highway Outcomes Through Integrated Planning; Implementing Eco-Logical (C06),** SHRP2 Solutions, FHWA.

[http://www.fhwa.dot.gov/goshrp2/Solutions/all/C06/Implementing\\_citeEcoLogicalcite/](http://www.fhwa.dot.gov/goshrp2/Solutions/all/C06/Implementing_citeEcoLogicalcite/)

This web site provides links to fact sheets, case studies and webinars that provide information about the Eco-Logical program.

**“Eco-Logical in Practice: Implementing an Ecosystem-Based Approach, Streamlining Environmental Processes for Transportation Projects,”** Julianne Schwarzer and Haley Peckett, *TR News*, Vol. 288, pages 22-27, October 2013.

<https://www.volpe.dot.gov/sites/volpe.dot.gov/files/docs/eco-logical%20in%20practice.pdf>

This article describes the origins and evolution of Eco-Logical.

**“MARC's Eco-Logical Project: A Regional Approach to Linking Environmental and Transportation Planning,”** Tom Gerend, Tom Jacobs and Lisa Pool, *Proceedings of the 2009 International Conference on Ecology and Transportation*, pages 779-785, 2010.

[http://www.icoet.net/ICOET\\_2009/downloads/proceedings/ICOET09-Proceedings-Session422.pdf](http://www.icoet.net/ICOET_2009/downloads/proceedings/ICOET09-Proceedings-Session422.pdf)

(Note: Go to page 17 of the PDF to locate the cited conference paper. Other conference papers in this document that address use of Eco-Logical may also be of interest to Caltrans.)

Excerpt from the abstract:

To foster greater interagency collaboration and partnerships, improve data sharing, and create more integrated polices, plans, strategies, and actions, the Mid-America Regional Council (MARC), the Kansas City region's metropolitan planning organization, is carrying out an Eco-Logical project via a grant from the Federal Highway Administration (FHWA). The Eco-Logical framework supports making infrastructure more sensitive to wildlife and ecosystems through greater interagency cooperation and conservation. MARC's project focuses on three interrelated goals: education, collaboration and ecosystem-based transportation planning. Ultimate project outcomes include the following: i) multi-faceted educational programs structured to foster stronger interagency relationships and understanding of Eco-Logical approaches, ii) the development of a highly collaborative and integrative environmental-transportation planning and consultation process, and iii) a framework to support the creation of a regional, ecosystem-based green infrastructure conservation, restoration and mitigation plan.

## **Emissions**

**“A Project Based Framework for Assessing and Monitoring Highway Construction Greenhouse Gas Emissions,”** Amlan Mukherjee and Darrell Cass, *Construction Research Congress 2012: Construction Challenges in a Flat World*, pages 1941-1950, May 2012.

Citation at <http://dx.doi.org/10.1061/9780784412329.195>

From the abstract:

Motivated by the need to address challenges of global climate change, this study develops and implements a project-based life cycle assessment framework that can be used to estimate the carbon footprint for typical construction work-items found in highway reconstruction and rehabilitation projects. The proposed framework considers the life cycle emissions of products and processes involved in the raw material acquisition and manufacturing phase, and the pavement construction phase. It also accounts for emissions due to vehicular use and maintenance operations during the service life of the pavements. The framework introduces methods based in life cycle assessment to (i) develop project emission inventories for highway construction, rehabilitation and maintenance projects, (ii) analyze the inventories to calculate project level construction emission estimation metrics. Fourteen highway construction and rehabilitation projects in the State of Michigan were used to implement the method and validate the analysis approach. In addition, the paper

introduces the Project Emissions Estimator (PE-2) - a web based tool that can be used to estimate and benchmark the CO2 footprint of highway construction projects. The contribution of this research is that it furthers our understanding of pavement life cycle assessment methods while providing an emission estimation tool that can be used by decision-makers to monitor and assess project emissions.

## **Fiscal Practices**

### **PRISM tblv**

“**PRISM tblv: Triple Bottom Line Valuation Tool**,” Gary McVoy and Kumudu Gunasekera, *Economic Forecasting Review*, Vol. 5, No. 1, pages 58-62, June 2011.

<https://prism.pbworld.net/html/themes/prism/docs/EFR%20Vol.%205%20Iss.%201%20PRISM%20TBLV.pdf>

As this article describes it, Parsons Brinckerhoff’s “emerging sustainability assessment tool, PRISM tblv, is designed to link investment factors with tradeoffs in clear quantitative terms. It provides a much needed vehicle for informed, transparent tradeoff analyses that can help support the decision making needed for infrastructure investment.”

#### *Related Resources:*

**Technical Memorandum #1: Approaches to Evaluating Investment Options**, Supporting Development of Minnesota’s Transportation Investment Options, Minnesota DOT, August 2013.

[http://www.smartgrowthamerica.org/documents/mndot-working-paper-1\\_8-2013.pdf](http://www.smartgrowthamerica.org/documents/mndot-working-paper-1_8-2013.pdf)

This technical memorandum identifies 21 MnDOT performance measures (see page 4 of the report) and discusses MnDOT’s use of PRISM, a proprietary tool developed by Parsons Brinckerhoff, in its new Corridor Investment Management Strategy (CIMS) to capture social, economic and environmental factors as a benefit-cost ratio. The PRISM tool accounts for 60 percent of project scores in CIMS.

**Technical Memorandum #3: Return on Investment Methodology & Scenario Evaluation**, Supporting Development of Minnesota’s Transportation Investment Options, Minnesota DOT, October 2013.

[http://www.smartgrowthamerica.org/documents/mndot-working-paper-3\\_10-2013.pdf](http://www.smartgrowthamerica.org/documents/mndot-working-paper-3_10-2013.pdf)

From page 12 of the report:

Through calculations supported by the PRISM benefit-cost model, MnDOT has drafted a return on investment measure incorporating safety benefits, travel time savings, environmental externalities, and operating and life-cycle costs, reflecting the multi-dimensional impacts from these major projects. In all cases, a Capacity Development (CD) scenario is compared against a No Build (NB) baseline. At this early evaluation stage, when candidate projects lack detailed studies for benefit components and construction scope and expense, the ROI estimates that enable a preliminary ranking must rely on key assumptions – which may be refined in the future with expert office review.

## **National Park Service Tool**

### **INSTEP**

**NPS Innovative and Sustainable Transportation Evaluation Process (INSTEP)**, INSTEP—Sustainability, National Park Service.

<http://www.nps.gov/articles/transinstep.htm?>

The Denver Service Center (DSC) Transportation Division of the National Park Service (NPS) “provides project management services to transportation projects within the national park system.” This NPS web site describes a tool that facilitates sustainable development of transportation projects:

As green infrastructure rating systems have developed and grown in use, so has the NPS interest in capturing existing sustainability practices and encouraging innovations in sustainable transportation. All DSC-managed transportation projects meet federal sustainability requirements, and are designed and constructed in compliance with the [NPS Innovative and Sustainable Transportation Evaluation Process \(INSTEP\) Guidance](#) (Beta Version)

DSC maintains the NPS INSTEP Checklist, ... which assists project teams in tracking, understanding, and complying with sustainability standards throughout the design and construction process. The sustainability checklist is organized around the INSTEP categories and criteria, and identifies federal requirements. It is used for both DSC delivered and Federal Lands Highways (FLH) delivered NPS transportation projects. It is designed to track progress throughout the project's life cycle.

## **Pavement Design**

### **BE<sup>2</sup>ST-in-Highways**

**BE<sup>2</sup>ST-in-Highways** (Building Environmentally and Economically Sustainable Transportation-Infrastructure-Highways), Recycled Materials Resource Center, University of Wisconsin–Madison.

<http://rmrc.wisc.edu/be2st-in-highways/>

This web site offers access to a user manual, the tool’s Excel-based workbook and other information about the tool.

**“Evaluation of Variables Affecting Sustainable Highway Design With BE<sup>2</sup>ST-in-Highways System,”** Jin Cheol Lee, Tuncer B. Edil, Craig H. Benson and James M. Tinjum, *Transportation Research Record* 2233, pages 176-186, 2011.

Citation at <http://trid.trb.org/view/2011/C/1092340>

Excerpt from the abstract:

To illustrate how BE<sup>2</sup>ST-in-Highways is employed, 10 alternative designs were evaluated and compared with two reference pavement designs for a pilot project (Baraboo Bypass, Wisconsin). The results of this pilot project evaluation indicate that the use of recycled materials instead of conventional materials in highway construction can improve sustainability considerably: about 27% reduction in global warming potential and energy and water use. Reductions in carbon dioxide emissions and energy and water consumption are

largely due to the reduction of the material production phase (e.g., mining and processing) by substituting existing recycled materials and reducing the thickness of the base layer and the number of rehabilitation events due to longer service life because of superior properties. Use of recycled material resulted in reductions in the life-cycle cost by as much as 30%. Using recycled materials in the surface layer is not the use with the highest value. Using recycled materials in the base course is thus more advantageous and has higher value because larger material quantities are involved in the base course with greater potential for cost savings, as shown in this case study.

*Related Resource:*

**“Use of BE<sup>2</sup>ST-in-Highways for Green Highway Construction Rating in Wisconsin,”** Jincheol Lee, Tuncer B. Edil, Craig H. Benson and James M. Tinjum, *2010 Green Streets and Highways Conference*.

Citation at <http://trid.trb.org/view/2010/C/1094826>

Excerpt from the abstract:

BE<sup>2</sup>ST-in-Highways employs life cycle analysis techniques to provide a quantitative assessment of the impacts associated with a highway construction project. Energy and water consumption, greenhouse gas emissions, service life, and life cycle cost are evaluated in a quantitative framework that can be used to compare alternative construction strategies from a holistic perspective. The methodology is grounded in quantitative metrics rather than an arbitrary point system so that a transparent linkage exists between the project rating and the sustainable practices employed in design and construction. This transparency reduces the potential for ‘gaming’ of the rating system. Application of the BE<sup>2</sup>ST-in-Highways system to a project in Wisconsin is described. Results of the application indicate that using recycled materials in a pavement can result in reductions in global warming potential (32%), energy consumption (28%), water consumption (29%), and hazardous waste generation (25%) as compared to the reference design using conventional materials, while also extending the service life of the pavement. In addition, using recycled materials in a pavement can result in a life cycle cost savings of 23%.

## **GreenPave**

**“GreenPave, Ontario’s Pavement Sustainability Rating System” (Poster)**, S. Chan, B. Bennett, B. Lane and T. Kazmierowski, *2012 Conference and Exhibition of the Transportation Association of Canada; Transportation: Innovations and Opportunities*.

<http://conf.tac-atc.ca/english/annualconference/tac2012/docs/session29/chan.pdf>

This poster describes the GreenPave simplified rating system, which is based on LEED and Greenroads and customized for Ontario. The focus of the tool is on pavement components. The tool’s two components address design (provides guidance to designers to select “green” pavement alternatives) and construction (encourages contractors to incorporate “green” practices).

*Related Resources:*

**Reference Guide: GreenPave, Green Pavement Design Rating System**, Version 2.0, Materials Engineering and Research Office, Ontario Ministry of Transportation, March 2014. <http://www.library.mto.gov.on.ca/getattachment.asp?passport=b4f88492-3ebd-4846-b869-9eec20352080&TemplateGUID=c36ec88e-067b-45b1-bbc9-cd42fe489177&RecordGUID=12b0ac2e-309c-4955-baa4-fe1a7d805a0e&FieldGUID=eea74945-da4f-422e-800e-a53392110279&AttachmentIndex=0>

This second edition of the GreenPave Reference Guide provides the procedures used by the Ontario Ministry of Transportation. As the foreword to the guide indicates, “[u]se of these design practices will assist in providing cost-effective and environmentally friendly pavement design.”

**“Sustainability Metrics of Two Pavement Rating Systems Developed in Canada,”**

Tom Kazmierowski and Michael Navarra, *Transportation 2014: Past, Present, Future; 2014 Conference and Exhibition of the Transportation Association of Canada*.

<http://conf.tac-atc.ca/english/annualconference/tac2014/s-22/kazmierowski.pdf>

Excerpt from the abstract:

In an effort to bring awareness of and promote “green” initiatives to designers, both the Ontario Ministry of Transportation (MTO) and Golder Associates created user-friendly SRS [sustainability rating systems] to promote sustainable pavement technologies for the design, construction, rehabilitation, reconstruction, and preservation of roads. The MTO system is known as GreenPave and the Golder system as GoldSET.

This paper describes the development and implementation of these two SRS and compares their analysis through two case studies, one dealing with a rigid pavement rehabilitation project and the other addresses a flexible pavement project.



# Comparing Sustainability Tools

## State DOT Evaluations

**A Framework for Assessing Transportation Sustainability Rating Systems for Implementation in U.S. State Departments of Transportation**, Sherona P. Simpson, Mehmet E. Ozbek, Caroline M. Clevenger and Rebecca A. Atadero, Mountain-Plains Consortium, May 2014.

<http://www.mountain-plains.org/pubs/pdf/MPC14-268.pdf>

Excerpt from the Introduction:

The purpose of this study is to develop a specific framework to assess existing TSRSs [transportation sustainability rating systems] for implementation in individual state DOTs across the United States. The framework supports identification of the most important capabilities in a TSRS as preferred by a state DOT and then facilitates weighting of those capabilities via a well-established methodology, the Analytical Hierarchy Process (AHP). Finally, results derived from the AHP evaluation can be used to determine which existing TSRS is best suited for adoption by the state DOT by determining the extent to which preferred capabilities are satisfied by each system. The contribution of this research is to provide a framework that can be implemented by any state DOT to assist in the selection of “best fit” TSRS.

The 10 tools examined in this research project include:

- BE<sup>2</sup>ST-in-Highways.
- CEEQUAL.
- Envision.
- Green Guide for Roads.
- GreenLITES.
- GreenPave.
- Greenroads.
- I-LAST.
- INVEST.
- STARS.

Page 29 of the report (page 38 of the PDF) presents a discussion of the unique features of each of these tools.

Researchers examined the needs of four Mountain-Plains Consortium members—Colorado, South Dakota, Utah and Wyoming DOTs—to identify the most appropriate tool to meet specific agency needs. Results indicate that INVEST is the most suitable tool for Colorado and Wyoming DOTs, GreenLITES is the most suitable alternative for South Dakota DOT, and the results for Utah DOT were inconclusive. Researchers noted that the research project considered only existing sustainability tools and did not amend them to meet specific DOT needs.

**Sustainable Streets and Highways: An Analysis of Green Roads Rating Systems**, Ana Eisenman and Michael Meyer, Georgia DOT, November 2013.

<http://www.dot.ga.gov/BuildSmart/research/Documents/10-13.pdf>



Excerpt from the abstract:

The two objectives of this project are: (1) to evaluate emerging transportation sustainability rating systems to determine best practices and methods that might be applied in the Georgia Department of Transportation (GDOT); and (2) to propose a straightforward Georgia-specific rating system that would enable uniform consideration of sustainability characteristics for state DOT projects. This report proposes a rating system that is specific to the GDOT, but which bears some semblance to operational systems that have been used in other states.

Researchers selected GreenLITES as a model for a Georgia-specific system. Researchers noted that “GreenLITES was also deemed credible for GDOT because the New York DOT has been able to use the program widely and successfully across a broad range of projects and over a longer period of time. The other programs have been less tested thus far, but have the potential to provide useful insight and guidance in the future.” A new scorecard based on the GreenLITES scorecard reflects regional differences identified in Georgia and reduces the number of line items in the original GreenLITES tool.

Researchers also recommended changing the scoring and point allocation to reflect a normalized score. To accomplish this, a column was added to the scoring system to allow the user to indicate whether a specific item is applicable to a particular project. Totals will be accumulated over those points specifically applicable to that project, not all points available in the system.

## **General Assessments**

**“Sustainability Assessment of Transport Infrastructure Projects: A Review of Existing Tools and Methods,”** Paola Carolina Bueno, Jose Manuel Vassallo and Kevin Cheung, *TRB 94th Annual Meeting Compendium of Papers*, Paper #15-4101, 2015.

Citation at <http://trid.trb.org/view/2015/C/1338424>

From the abstract:

Attempts to integrate sustainability in the decision-making process continue to gain momentum. For transport infrastructure projects, a number of tools and methodological frameworks—such as ratings systems, traditional decision-making techniques, checklists and different evaluation frameworks and models—are available. This paper presents a review on the current assessment tools of sustainability applied to transport infrastructure projects. It begins by providing an explanatory and comparative analysis of the tools and methods in terms of their effectiveness to appraise sustainability. The main finding of this analysis is that despite the availability of numerous tools, none appears to be useful for providing a thorough appraisal of sustainability. While there are positive characteristics associated with each tool, some practical issues remain unsolved. There is also the need for more standardized tools in order to appraise the sustainability of transport projects. This research makes a critical evaluation of the current state of the art to identify limitations of the existing approaches, point out new areas of research, and propose a sustainability appraisal agenda for the future.

**“Sustainability Rating Systems: Broad Based or Narrowly Focused?”** Sean Vargas and Kevin Thornton, *CE News*, Vol. 25, No. 8, pages 44-46, September 2013.

<http://cenews.com/article/9438/sustainability-rating-systems-broad-based-or-narrowly-focused>

From the abstract:

There are a variety of rating systems to assess how sustainable infrastructure projects are. Systems include Envision, a broad-based infrastructure rating system; Greenroads Rating System, a transportation-specific rating system; and INVEST, the Infrastructure Voluntary Evaluation Sustainability Tool from the Federal Highway Administration, which is also transportation specific. For project owners to decide which rating system to use, they must decide which is most applicable to the project. Because Envision is broad, it can be used for any infrastructure projects, not limited only to transportation. It is particularly useful for evaluating combinations of infrastructure improvements. Greenroads is focused on roadway projects, though it can also be useful for paths and trails. INVEST covers road and bridge projects, with separate scorecards depending on the type of area where the project is to take place.

**“Review of Sustainability Rating Systems Used for Infrastructure Projects,”** Caroline M. Clevenger, Mehmet E. Ozbek and Sherona Simpson, *49th Associated Schools of Construction Annual International Conference Proceedings*, 2013.

<http://ascpro0.ascweb.org/archives/cd/2013/paper/CPRT88002013.pdf>

From the abstract:

The construction industry in general and infrastructure projects in particular have significant environmental impacts. Across the building industry, sustainability rating systems have been developed and implemented over the last decade to address and reduce the environmental impacts of vertical projects. During the same period, civil infrastructure projects have not received the same attention with respect to sustainability. Over the last several years, however, several entities have started developing sustainability rating systems applicable to infrastructure projects. In this paper, the authors review and provide a comparison of the six most prominent emerging sustainability rating systems: BE<sup>2</sup>ST-in-Highways, Envision, GreenLITES, Greenroads, I-LAST and INVEST. The review reveals that many similarities exist between these systems. Specifically each rating system evaluates items related to consumption and management of water, energy, and materials. Differences lie primarily in differences in process and implementation requirements, as well as how weights are assigned among rating criteria. The comparison presented highlights the strengths and weaknesses of various approaches, and motivates future research on sustainable rating systems for infrastructure projects.

**“Approach for Integrating Sustainability into Roadway Project Development,”** Lisa M. Reid, Anneke J. Davis and Timothy Bevan, *TRB 92nd Annual Meeting Compendium of Papers*, Paper #13-1772, 2013.

Citation at <http://trid.trb.org/view.aspx?id=1241167>

From the abstract:

Efforts to increase the sustainability of roadways continue to gain momentum. In recent years, numerous organizations and agencies have developed sustainability evaluation tools, including third-party rating systems, self-assessments, and checklists, with the goal of evaluating the sustainability characteristics and performance of roadway projects. While these sustainability tools are highly valuable and the result of much research and knowledge, there is little guidance on how to apply and leverage them to best integrate sustainability throughout project development. The focus of this paper, in addition to providing considerations for using sustainability evaluation tools and summarizing the available tools and, is to provide an approach for integrating sustainability into project development by leveraging sustainability evaluation tools.

**“Using a Thematic Framework to Compare Sustainability Rating Systems Applicable to Transportation Projects,”** Ross Curz, Jin-Lee Kim and Hee Sung Cha, *Construction Research Congress 2012*, pages 1991-2000.

Citation at <http://ascelibrary.org/doi/abs/10.1061/9780784412329.200>

From the abstract:

In line with current trends of measuring the sustainability in built environments, there has been an increasing interest in the environmental assessments of green transportation projects. As a result, a number of environmental assessment tools are used, or are being developed to evaluate the sustainability level of a transportation project. Thus, the use of quantitative environmental assessment tools for transportation projects is expected to increase, making it relevant to ascertain their status of development process. This study aims to apply a unified thematic framework to compare the sustainability rating systems for transportation projects. In an effort to do so, this paper describes and compares various different tools used for the quantitative environmental assessment of transportation projects. Selected here are four quantitative assessment tools, which measure the sustainability of a transportation project or program in the United States over life cycle. The purpose of this paper is to provide all thresholds, such as planners, contractors, state officials, and environmentalists, with a better picture of the situation and indicate the benefits and shortcomings of the tools, but not to prioritize the four different tools to determine which the best system is.

**“Greening the Road: Using Green Rating Systems to Evaluate Your Transportation Project,”** David Hein, *Michigan Transportation Planning Association Annual Conference*, August 2012.

[http://www.mtpa-mi.org/downloads/david\\_hein\\_greening\\_the\\_road\\_080212\\_mtpa.pdf](http://www.mtpa-mi.org/downloads/david_hein_greening_the_road_080212_mtpa.pdf)

This conference presentation identifies sustainability objectives and challenges in the planning and management of transportation projects, and includes a discussion of selected sustainable solutions. Also included is a brief discussion of several sustainability rating tools, including INVEST, Greenroads and GreenPave.

# **Sustainability Performance Measures and Guidelines**

**NCHRP Report 708: A Guidebook for Sustainability Performance Measurement for Transportation Agencies**, Josias Zietsman, Tara Ramani, Joanne Potter, Virginia Reeder and Joshua DeFlorio, June 2011.

[http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_rpt\\_708.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_708.pdf)

Included in this guidebook are data sources and examples of the use of sustainability performance measures, and a compendium of performance measures. An appendix includes case studies that describe how performance measures have been tracked and applied to decision-making, as well as lessons learned from the development and adoption of these measures. A CD-ROM included with the print version of the report provides an Excel-based version of the performance measure compendium. The spreadsheet can be used to modify existing measures, and the spreadsheet's macros allow the user to generate and export a custom list of measures.

*Related Resource:*

**Sustainability Performance Measures for State DOTs and Other Transportation Agencies**, Josias Zietsman and Tara Ramani, NCHRP Project No. 08-74, July 2011.

[http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP08-74\\_FR.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP08-74_FR.pdf)

This is the contractor's final report for NCHRP Report 708 describing how the research was conducted. Researchers describe the identification of best practices and case studies, the development of a sustainability framework, and application of performance measures.

**Guide to Sustainable Transportation Performance Measures**, U.S. Environmental Protection Agency, August 2011.

[http://www.epa.gov/sites/production/files/2014-01/documents/sustainable\\_transpo\\_performance.pdf](http://www.epa.gov/sites/production/files/2014-01/documents/sustainable_transpo_performance.pdf)

While the focus of the 12 performance measures described in this guidebook is on decision-making at the regional or metropolitan level, many of the measures can be applied at the state level. Examples are provided that show how metropolitan planning organizations have used sustainable performance measures in connection with programming and performance monitoring.

The 12 measures are:

- Transit accessibility.
- Bicycle and pedestrian mode share.
- Vehicle miles traveled per capita.
- Carbon intensity.
- Mixed land uses.
- Transportation affordability.
- Distribution of benefits by income group.
- Land consumption.
- Bicycle and pedestrian activity and safety.
- Bicycle and pedestrian level of service.
- Average vehicle occupancy.
- Transit productivity.

**“Leveraging Big Data for the Development of Transport Sustainability Indicators,”** Caitlin D. Cottrill and Sybil Derrible, *Journal of Urban Technology*, Vol. 22, No. 1, pages 45-64, January 2015.

Citation at <http://trid.trb.org/view/2015/C/1351040>

From the abstract:

While increasing transportation sustainability is an ongoing effort, measuring the results of these efforts is not a trivial task. Not only is indicator selection challenging, but efforts made to design useful indicators are often hampered by the presence of erroneous or incomplete data. Nevertheless, in this era of Big Data, the significant penetration of new technologies such as smartphones and smart infrastructure could hold the key to developing more relevant and comprehensive indicators. Here, the authors recall commonly used indicators and discuss the limitations of the data upon which they are built. They then describe several new technologies that hold promise for collection of more pertinent and accurate data sets for indicator development. Finally, they illustrate potential benefits and concerns of these approaches via discussion of possible indicator development from a one-day GPS trace. While the first and obvious application of new technologies will be to improve much needed accuracy, successfully combining different sources together could hold much potential from model calibration to real-time operations.

**“Guidelines on Developing Performance Metrics for Evaluating Transportation Sustainability,”** Jason Zheng, Norman W. Garrick, Carol Atkinson-Palombo, Chris McCahill and Wesley Marshall, *Research in Transportation Business & Management*, Vol. 7, pages 4-13, July 2013.

Citation at <http://dx.doi.org/10.1016/j.rtbm.2013.02.001>

From the abstract:

Transportation systems have a significant impact on environmental, social, and economic sustainability. Traditional transportation performance metrics, which tend to focus on vehicle mobility and congestion, fail to assess the degree to which transportation planning leads to sustainable outcomes. Lacking appropriate metrics, transportation managers and policy-makers often do not have sufficient information to make decisions that consider sustainability as an outcome. Accordingly, this paper focuses on the process for developing such metrics in the form of a composite index. The intent of this paper is not to provide a singular, definitive index; rather, the goal is to provide guidance into the issues of selecting an appropriate index or developing their own. The authors begin by reviewing the existing literature on indicator selection criteria, examining the construction of composite indices, and exploring existing rating systems. Building on this knowledge, they describe the process for creating a systematic tool for assessing sustainable transportation called the Transportation Index for Sustainable Places (TISP). They also provide an example of one element of the TISP to illustrate the necessary steps involved in the ranking process.

**Developing Sustainable Transportation Performance Measures for ALDOT,** Houssam A. Toutanji, Michael Anderson and Kathleen M. Leonard, University Transportation Center for Alabama, June 2013.

<http://ntl.bts.gov/lib/48000/48000/48078/12302-Final-Report.pdf>

Excerpt from the abstract:

The research project was designed to establish a baseline understanding of the potential for using sustainability performance measures in the Alabama Department of Transportation. Quite a number of sustainability initiatives have discussed various definitions and performance measures of sustainable transportation systems, but very few regional agencies have developed planning tools that successfully incorporate sustainability in the

transportation sector. This study develops a working definition of sustainability from various proposed definitions, and demonstrates a feasible methodology for evaluating and quantifying sustainability performance measures, thus incorporating sustainability considerations into the regional transportation decision-making process.

**“Developing Context-Sensitive Livability Indicators for Transportation Planning: A Measurement Framework,”** Harvey J. Miller, Frank Witlox and Calvin P. Tribby, *Journal of Transport Geography*, Vol. 26, pages 51-64, January 2013.

Citation at <http://trid.trb.org/view/2013/C/1245853>

From the abstract:

New emphases on livability and sustainability are creating demands for measuring and applying these concepts in transportation policy and planning. However, livability and sustainability are complex, multidimensional concepts that require careful measurement if they are to be applied meaningfully in plan evaluation and benchmarking. This paper provides a framework for constructing and applying quantitative livability and sustainability indicators. In addition to critically reviewing principles of constructing indicators describing a multidimensional concept such as livability or sustainability, the authors also discuss methods for capturing local context, a critical feature for transportation planning. Specifically, they review methods for incorporating diverse stakeholder perspectives into indicator construction and spatial analytic tools for geographic entities and relationships. They also discuss spatial decision support systems and the Geodesign concept for organizing these tools and technologies as well as integrating livability indicators into the overall planning process.

**Green Infrastructure Planning Guidelines for Coastal Georgia**, Coastal Regional Commission of Georgia, undated.

<http://www.crc.ga.gov/departments/planning/Docs/GreenInfrastructurePlanningGuidelinesV1.pdf>

This document is an example of how sustainability guidelines are incorporated in a regional planning organization’s planning program.

## **Appendix A: Sustainability Tool Scoring Elements**

The tables below provide a high-level summary of the scoring elements used in seven of the sustainability tools addressed in this Preliminary Investigation:

- Canadian Guide for Greener Roads.
- Envision.
- GreenLITES.
- Greenroads.
- I-LAST.
- INVEST.
- STARS.

The tables below are provided for summary purposes only. See the publications included in the *Tool Documentation* sections of this Preliminary Investigation for full details of the tools' scoring protocols. CEEQUAL is not included in this Appendix because detailed documentation on that tool was not publicly available.

### **Canadian Guide for Greener Roads**

(See page 10 of this Preliminary Investigation for a description of Canadian Guide for Greener Roads.)

The tool includes practice sheets for these 31 sustainability practices:

- Award-winning case study: Transport Quebec environmental monitoring.
- Bicycle access.
- Context sensitive solutions.
- Earthwork balance.
- Energy-efficient illumination.
- Environmental protection during road construction.
- Environmental protection during road maintenance.
- Erosion and sediment control plan.
- Green procurement.
- Habitat retention.
- High-occupancy vehicle lanes.
- Holistic right of way landscape.
- Intelligent transportation systems (ITS).
- Life-cycle assessment.
- Life-cycle cost analysis.
- Light pollution control.
- Long-life pavements.
- Low-impact development.
- Nonpavement concrete reuse and recycling.
- Pavement preservation and reuse.
- Pedestrian access.
- Permeable pavements.
- Recovered materials in pavement.
- Reduced energy consumption pavement.
- Reuse of nonpavement road elements.
- Road safety—urban bicycles facilities.
- Road salt management.
- Runoff flow control.
- Runoff quality.
- Safe intersections and driveways.
- Waste management plan.



The 38 sustainability questions included in the interactive tool and self-rated using an A, B or C are not publicly available.

## **Envision**

(See page 14 of this Preliminary Investigation for a description of Envision.)

<b>Envision Scoring Elements</b>		
<b>Category</b>	<b>Subcategory</b>	<b>Sustainability Criteria/Credit</b>
<b>Quality of life</b>	<b>Purpose</b>	<ul style="list-style-type: none"> <li>• Improve community quality of life.</li> <li>• Stimulate sustainable growth and development.</li> <li>• Develop local skills and capabilities.</li> </ul>
	<b>Well-being</b>	<ul style="list-style-type: none"> <li>• Enhance public health and safety.</li> <li>• Minimize noise and vibration.</li> <li>• Minimize light pollution.</li> <li>• Improve community mobility and access.</li> <li>• Encourage alternative modes of transportation.</li> <li>• Improve site accessibility, safety and wayfinding.</li> </ul>
	<b>Community</b>	<ul style="list-style-type: none"> <li>• Preserve historic and cultural resources.</li> <li>• Preserve views and local character.</li> <li>• Enhance public space.</li> </ul>
	<b>Innovation</b>	<ul style="list-style-type: none"> <li>• Innovate or exceed credit requirements.</li> </ul>
<b>Leadership</b>	<b>Collaboration</b>	<ul style="list-style-type: none"> <li>• Provide effective leadership and commitment.</li> <li>• Establish a sustainability management system.</li> <li>• Foster collaboration and teamwork.</li> <li>• Provide for stakeholder involvement.</li> </ul>
	<b>Management</b>	<ul style="list-style-type: none"> <li>• Pursue by-product synergy opportunities.</li> <li>• Improve infrastructure integration.</li> </ul>
	<b>Planning</b>	<ul style="list-style-type: none"> <li>• Plan for long-term monitoring and maintenance.</li> <li>• Address conflicting regulations and policies.</li> <li>• Extend useful life.</li> </ul>
	<b>Innovation</b>	<ul style="list-style-type: none"> <li>• Innovate or exceed credit requirements.</li> </ul>

Envision Scoring Elements		
Category	Subcategory	Sustainability Criteria/Credit
Resource allocation	Materials	<ul style="list-style-type: none"> <li>• Reduce net embodied energy.</li> <li>• Support sustainable procurement practices.</li> <li>• Use recycled materials.</li> <li>• Use regional materials.</li> <li>• Divert waste from landfills.</li> <li>• Reduce excavated materials taken off site.</li> <li>• Provide for deconstruction and recycling.</li> </ul>
	Energy	<ul style="list-style-type: none"> <li>• Reduce energy consumption.</li> <li>• Use renewable energy.</li> <li>• Commission and monitor energy systems.</li> </ul>
	Water	<ul style="list-style-type: none"> <li>• Protect fresh water availability.</li> <li>• Reduce potable water consumption.</li> <li>• Monitor water systems.</li> </ul>
	Innovation	<ul style="list-style-type: none"> <li>• Innovate or exceed credit requirements.</li> </ul>
Natural world	Siting	<ul style="list-style-type: none"> <li>• Preserve prime habitat.</li> <li>• Protect wetlands and surface water.</li> <li>• Preserve prime farmland.</li> <li>• Avoid adverse geology.</li> <li>• Preserve floodplain functions.</li> <li>• Avoid unsuitable development on steep slopes.</li> <li>• Preserve greenfields.</li> </ul>
	Land and water	<ul style="list-style-type: none"> <li>• Manage stormwater.</li> <li>• Reduce pesticide and fertilizer impacts.</li> <li>• Prevent surface and groundwater contamination.</li> </ul>
	Biodiversity	<ul style="list-style-type: none"> <li>• Preserve species biodiversity.</li> <li>• Control invasive species.</li> <li>• Restore disturbed soils.</li> <li>• Maintain wetland and surface water functions.</li> </ul>
	Innovation	<ul style="list-style-type: none"> <li>• Innovate or exceed credit requirements.</li> </ul>

<b>Envision Scoring Elements</b>		
<b>Category</b>	<b>Subcategory</b>	<b>Sustainability Criteria/Credit</b>
<b>Climate and risk</b>	<b>Emissions</b>	<ul style="list-style-type: none"> <li>• Reduce greenhouse gas emissions.</li> <li>• Reduce air pollutant emissions.</li> </ul>
	<b>Resilience</b>	<ul style="list-style-type: none"> <li>• Assess climate threat.</li> <li>• Avoid traps and vulnerabilities.</li> <li>• Prepare for long-term adaptability.</li> <li>• Prepare for short-term hazards.</li> <li>• Manage heat island effects.</li> </ul>
	<b>Innovation</b>	<ul style="list-style-type: none"> <li>• Innovate or exceed credit requirements</li> </ul>

**GreenLITES (Green Leadership In Transportation Environmental Sustainability)**

(See page 17 of this Preliminary Investigation for a description of GreenLITES.)

<b>GreenLITES Scoring Elements</b>	
<b>Category</b>	<b>Subcategory</b>
<b>Sustainable sites</b>	Alignment selection.
	Context sensitive solutions.
	Land use/community planning.
	Protect, enhance or restore wildlife habitat.
	Protect, plant or mitigate for removal of trees and plant communities.
<b>Water quality</b>	Stormwater management (volume and quality).
	Reduce runoff and associated pollutants by treating stormwater runoff through best management practices.
<b>Materials and resources</b>	Reuse of materials.
	Recycled content.
	Locally provided material.
	Bioengineering techniques.
	Hazardous material minimization.

<b>GreenLITES Scoring Elements</b>	
<b>Category</b>	<b>Subcategory</b>
<b>Energy and atmosphere</b>	Improved traffic flow.
	Reduce electrical consumption.
	Reduce petroleum consumption.
	Improve bicycle and pedestrian facilities.
	Noise abatement.
	Stray light reduction.
<b>Innovation / unlisted</b>	Innovation.
	Unlisted.
	NYCDOT Street Design Manual.

**Greenroads** (See page 21 of this Preliminary Investigation for a description of Greenroads.)

<b>Greenroads Scoring Elements</b>	
<b>Category</b>	<b>Credit</b>
<b>Environment and water</b>	<ul style="list-style-type: none"> <li>• Preferred alignment.</li> <li>• Ecological connectivity.</li> <li>• Habitat conservation.</li> <li>• Land use enhancements.</li> <li>• Vegetation quality.</li> <li>• Soil management.</li> <li>• Water conservation.</li> <li>• Runoff flow control.</li> <li>• Enhanced treatment: metals.</li> <li>• Oil and contaminant treatment.</li> </ul>
<b>Construction activities</b>	<ul style="list-style-type: none"> <li>• Environmental excellence.</li> <li>• Work zone health and safety.</li> <li>• Quality process.</li> <li>• Equipment fuel efficiency.</li> <li>• Work zone air emissions.</li> <li>• Work zone water use.</li> <li>• Accelerated construction.</li> </ul>

<b>Greenroads Scoring Elements</b>	
<b>Category</b>	<b>Credit</b>
<b>Construction activities (continued)</b>	<ul style="list-style-type: none"> <li>• Procurement integrity.</li> <li>• Communications and outreach.</li> <li>• Fair and skilled labor.</li> <li>• Local economic development.</li> </ul>
<b>Materials and design</b>	<ul style="list-style-type: none"> <li>• Preservation and reuse.</li> <li>• Recycling and recovery.</li> <li>• Environmental product declarations.</li> <li>• Health product declarations.</li> <li>• Local materials.</li> <li>• Long life design.</li> </ul>
<b>Utilities and controls</b>	<ul style="list-style-type: none"> <li>• Utility upgrades.</li> <li>• Maintenance and emergency access.</li> <li>• Electric vehicle infrastructure.</li> <li>• Energy efficiency.</li> <li>• Alternative energy.</li> <li>• Lighting and controls.</li> <li>• Traffic emissions reduction.</li> <li>• Travel time reduction.</li> </ul>
<b>Access and livability</b>	<ul style="list-style-type: none"> <li>• Safety audit.</li> <li>• Safety enhancements.</li> <li>• Multimodal connectivity.</li> <li>• Equity and accessibility.</li> <li>• Active transportation.</li> <li>• Health impact analysis.</li> <li>• Noise and glare reduction.</li> <li>• Culture and recreation.</li> <li>• Archaeology and history.</li> <li>• Scenery and aesthetics.</li> </ul>
<b>Creativity and effort</b>	<ul style="list-style-type: none"> <li>• Education team.</li> <li>• Innovative ideas.</li> <li>• Enhanced performance.</li> <li>• Local values.</li> </ul>

## **I-LAST (Illinois Livable and Sustainable Transportation)**

(See page 25 of this Preliminary Investigation for a description of I-LAST.)

<b>I-LAST Scoring Elements</b>	
<b>Category</b>	<b>Subcategory</b>
<b>Planning</b>	Context sensitive solutions.
	Land use/community planning.
<b>Design</b>	Alignment section.
	Context sensitive design.
<b>Environmental</b>	Protect, enhance or restore wildlife and its habitat.
	Trees and plant communities.
	Noise abatement.
<b>Water quality</b>	Reduce impervious areas.
	Stormwater treatment.
	Design practices to protect water quality.
<b>Transportation</b>	Traffic operations.
	Transit.
	Improve bicycle and pedestrian facilities.
<b>Lighting</b>	Reduced electrical consumption.
	Stray light reduction.
<b>Materials</b>	No subcategories, only measures.
<b>Innovation</b>	Use of experimental feature.
<b>Construction</b>	Protect, enhance or restore wildlife and its habitat.
	Trees and plant communities.
	Maximize trucking efficiencies.
	Certified suppliers.
	Reduce impervious area.
	Stormwater treatment.
	Construction practices to protect water quality.
	Construction practices.

## **INVEST (Infrastructure Voluntary Evaluation Sustainability Tool)**

(See page 27 of this Preliminary Investigation for a description of INVEST.)

<b>INVEST Scoring Elements</b>	
<b>Module</b>	<b>Criteria</b>
<b>System planning for states</b>	Integrated planning: Land use and economic development.
	Integrated planning: Natural environment.
	Integrated planning: Social.
	Integrated planning: Bonus.
	Access and affordability.
	Safety planning.
	Multimodal transportation and public health.
	Freight and goods access and mobility.
	Travel demand management.
	Air quality and emissions.
	Energy and fuels.
	Financial sustainability.
	Analysis methods.
	Transportation systems management and operations.
	Linking asset management and planning.
	Infrastructure resiliency.
Linking planning and NEPA.	
<b>Project development</b>	Economic analyses.
	Life-cycle cost analyses.
	Context sensitive project delivery.
	Highway and traffic safety.
	Educational outreach.
	Tracking environmental commitments.
	Habitat restoration.
	Stormwater quality and flow control.
	Ecological connectivity.
	Pedestrian facilities.



INVEST Scoring Elements	
Module	Criteria
<b>Project development (continued)</b>	Bicycle facilities.
	Transit and high-occupancy-vehicle facilities.
	Freight mobility.
	ITS for system operations.
	Historic, archaeological and cultural preservation.
	Scenic, natural or recreational qualities.
	Energy efficiency.
	Site vegetation, maintenance and irrigation.
	Reduce, reuse and repurpose materials.
	Recycle materials.
	Earthwork balance.
	Long-life pavement design.
	Reduced energy and emissions in pavement materials.
	Permeable pavement.
	Construction environmental training.
	Construction equipment emission reduction.
	Construction noise mitigation.
	Construction quality control plan.
	Construction waste management.
	Low-impact development.
Infrastructure resiliency planning and design.	
Light pollution.	
Noise abatement.	
<b>Operations and Maintenance</b>	<b>Internal Operations (Administrative):</b>
	Internal sustainability plan.
	Electrical energy efficiency and use.
	Vehicle fuel efficiency and use.
	Reduce, reuse and recycle.
	<b>Infrastructure Operations and Maintenance:</b>
	Safety management.

<b>INVEST Scoring Elements</b>	
<b>Module</b>	<b>Criteria</b>
<b>Operations and Maintenance (continued)</b>	Environmental commitments tracking system.
	Pavement management system.
	Bridge management system.
	Maintenance management system.
	Highway infrastructure preservation and maintenance.
	Traffic control infrastructure maintenance.
	Road weather management program.
	Transportation management and operations.
	Work zone traffic control.

**STARS (Sustainable Transportation Analysis and Rating System)**

(See page 31 of this Preliminary Investigation for a description of STARS.)

<b>STARS Scoring Elements</b>	
<b>Category</b>	<b>Credit</b>
<b>Integrated process</b>	Establish project framework and goals.
<b>Access</b>	Establish access goals and objectives.
	Evaluate expanded transportation demand management strategies.
	Evaluate expanded transportation system management strategies.
	Evaluate expanded transportation supply and service.
<b>Climate and energy</b>	Establish climate and energy goals and objectives.
	Evaluate vehicle mile reduction strategies.
	Evaluate improving vehicle flow.
	Evaluate construction materials and methods.
	Evaluate renewable energy and energy efficiency.
<b>Cost effectiveness analysis</b>	Cost estimation and cost-effective calculations.
	Selecting cost-effective projects and programs.