Bridge Views

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Sustainable Bridges and Infrastructure (Part I)

Julie Buffenbarger, FACI, LEED AP, Lafarge

Fig. 1. Nearly 80 years after it was first constructed, the Hope Memorial (Lorain-Carnegie) Bridge is "complete." In 2013, a protected bikeway opened, making the street safer, more family friendly and conveniently accessible for pedestrians and bicyclists who would prefer not to ride in the street to cross the Cuyahoga River valley. The $4.5 million investment is consistent with the Cleveland's Complete and Green Streets law, which requires sustainable transportation options be incorporated into new road projects.

(Part I of a two-part series)

The nation's economy and quality of life require highway and roadway systems that provide a safe, reliable, efficient, and comfortable driving experience. The fact that these structures are relied upon en masse is what renders communities vulnerable when these infrastructures fail from climatic or manmade events.[1-5] Across the U.S. and worldwide, the state of transportation infrastructure has reached a critical stage. Aging roads, bridges and other assets, many first built in the 1950s, are currently supporting the demands of increases in use, far beyond the originally engineered capacity and well beyond the intended service life expectations.[6-7] With this increased capacity and usage in conjunction with increased climate change instabilities (natural or man-made) comes accelerated deterioration of roadways and bridges[1-5]

Highway bridges comprise a critical link in infrastructure, numbering 607,751 for the entire US network. Maintenance to meet modern requirements of strength and serviceability is a necessity. In the 2013 National Bridge Inventory, 63,522 bridges (10.5%) were categorized as structurally deficient (requiring significant maintenance, rehabilitation or replacement) and 84,348 (13.9%) were categorized as functionally obsolete (below current design standards, e.g. narrow lanes or low load capacity) indicating an imminent need for repair or replacement.[8] Repairing existing bridges is extremely time consuming, often economically inefficient and logistically disruptive, since it results in long traffic and commerce interruption.

Today, transportation agencies are challenged to plan, build, and operate "sustainable" transportation systems that – in addition to achieving the important goals of mobility and safety – support a variety of asset management, environmental stewardship, climate mitigation/adaptation, and resilient infrastructure objectives. As stated by the American Association of State Highway and Transportation Officials (AASHTO), the sustainability of the transportation system is critical, as transportation is responsible for 10% of the global gross domestic product, 22% of global energy consumption, 25% of fossil fuel burning, and 30% of global air pollution and greenhouse gases.[9]

The Centre for Sustainable Transport in Canada identifies the following attributes of a sustainable transportation system:

- Allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations.
- Is affordable, operates efficiently, offers choices of transport mode, and supports a vibrant economy.
- Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of nonrenewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise.[10]

Alongside the transition to a more sustainable society, increasing infrastructure's functional resilience to climate change impacts is a high priority, to help protect the economy and its future growth. Functional resilience is defined as a structure's capacity to provide viable operations through extended service life, adaptive re-use and the challenges of natural and man-made disasters.[11]

The US Department of Transportation Center for Climate Change and Environmental Forecasting strategic plan states that climate change will likely have significant impacts on transportation infrastructure. Achievable reductions of climate change impacts on transportation infrastructure are attainable through:

- Fostering strategies to avoid, mitigate or adapt to the potential impacts of climate variability and change on the transportation system;
- Promotion of cost-effective strategies that reduce greenhouse gas emissions while supporting transportation safety, mobility, efficiency, and energy security; and
- Establishment of a leadership role on transportation and climate change issues by involving the transportation community and coordinating related USDOT programs and policies.[12]

The case for adapting infrastructure to climate change compelling. Bridge and highway infrastructure are an increasingly interconnected network of high-value assets with long operational lifetimes. The challenge and commitment to build climate resilient infrastructure with more secure, energy efficient and environmentally sustainable materials and practices is not a separate or mutually exclusive task, but interconnected to ensure best value from this investment.[13,14]

Designing for Sustainability and Resilience

Sustainable and resilient bridge design requires an integrated, long-term holistic view of all phases of the project: planning, designing, constructing, maintaining, operating, repair/rehabilitation, then final decommissioning and disposal at the end of its service life. The responsibility of a sustainable design team does not lie solely with aesthetical impact and functional performance, but also with key concerns such as integration of context-sensitive solutions, awareness of societal and biodiversity impacts, life cycle costing, climate mitigation/adaptation, and a minimizing the impact on the environment, society and the economy throughout the bridge's life (Table 1).

Bridge engineers have been practicing many sustainable concepts through the decades – rapid construction with pre-fabricated components, integration of recycled or beneficial reuse materials, and extended service

Environmental	Social	Economic
Ecology & Biodiversity	Community Interaction	Life Cycle Costs
Landscape	Community Liveability	Project Management
Stormwater Impacts	Human Health Impacts	Financial Sustainability
Construction Waste Management	Historic & Cultural Preservation	Economic Analysis
Material Use	Scenic & Natural Qualities	Safety Programs
Energy & Carbon	Safety	Land Use
Reduce, Recyle & Reuse	Equity	Operation & Management Systems
Reduced Energy & Emissions	Stakeholder Involvement	Bridge Management Systems
Noise Pollution	Transportation Impacts	Energy Efficiency
Resiliency	Resiliency	Resiliency

Table 1. Sustainable Impacts for Bridges15-19

life through reliable and durable design.[20] However, additional improvements in sustainable project delivery are achievable through integration of material and design selection based upon life cycle analysis measurements; implementation of life cycle costing analysis versus lowest cost economics; use of innovative materials and technologies; and collaborative platforms during project design and construction.

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Envision Emerges: A new way to track bridge sustainability available for owners, project teams

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Sustainability

Envision,™ a rating system for sustainable infrastructure and developed by the Institute for Sustainable Infrastucture (ISI), was first released for public comment in July 2011. ISI is a non-profit organization founded jointly by the American Council of Engineering Companies (ACEC), the American Public Works Association (APWA), and the American Society of Civil Engineers (ASCE). Shortly after this first public-comment period, the Zofnass Program for Sustainable Infrastructure at Harvard University partnered with ISI to further develop the Envision rating system. Project certification under the Envision rating system began in September 2012.

The intent of the Envision rating system is to standardize evaluation of the sustainability of infrastructure projects. It is applicable to projects in sectors such as energy, water, waste, transportation, landscaping, and information. In the transportation sector, project types that can use Envision include airports, roads, highways, railways, public transit facilities, and bridges.

Fig. 1. The envision™ rating system is designed to evaluate, grade and give recognition to infrastructure projects that make progress and contributions to a more sustainable future. Photo: Caltrans.

Infrastructure is critical to a functioning society. It enables humans to have clean drinking water, travel between our homes and work, and ensures a reliable energy supply. However the earth’s resources are not infinite, and thus to maintain sustainable development, we must attempt to reduce negative environmental, economic, and social impacts in infrastructure design. The Intergovernmental Panel on Climate Change defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Similar to other green or sustainability rating systems, credits are grouped in categories related to environmental, social, and economic impacts. A total of 60 credits are distributed across five categories, each of which is explored further in the following sections. Within each credit, point levels are set based on meeting different levels of achievement, and points are weighted within Envision based on the importance of the credit related to overall infrastructure sustainability. An assessor assigned to the project will determine the level of achievement that the project team has reached for each individual credit using a predetermined set of evaluation criteria. The level of achievement for the entire project is determined by the number of points achieved in the different credit categories.

Envision levels of achievement include:

- Improved
- Enhanced
- Superior
- Conserving
- Restorative

In the following sections, all credits and their intents are listed. However due to space limitation, only some of the credits to which concrete bridges can contribute are discussed in more detail.

Quality of Life (QL)

Strategies in this category relate to a project's impact on the community. Broad credit categories include purpose, well being, and community. Table 1 lists the credits in this category and their intents. Two strategies in the Quality of Life category that relate to concrete bridges are explained in more detail in the following sections.

Credit Category	Credits	Intent
Purpose	QL1.1 Improve community quality of life	Improve the net quality of life of all communities affected by the project and mitigate negative impacts to communities
	QL1.2 Stimulate sustainable growth and development	Support and stimulate sustainable growth and development, including improvements in job growth, capacity building, productivity, business attractiveness, and livability
	QL1.3 Develop local skills and capabilities	Expand the knowledge, skills, and capacity of the community workforce to improve their ability to grow and develop
Well Being	QL2.1 Enhance public health and safety	Take into account the health and safety implications of using new materials, technologies or methodologies above and beyond meeting regulatory requirements
	QL2.2 Minimize noise and vibration	Minimize noise and vibration generated during construction and in the operation of the constructed works to maintain and improve community livability
	QL2.3 Minimize light pollution	Prevent excessive glare, light at night, and light directed skyward to conserve energy and reduce obtrusive lighting and excessive glare
	QL2.4 Improve community mobility and access	Locate, design and construct the project in a way that eases traffic congestion, improves mobility and access, does not promote urban sprawl, and otherwise improves community livability
	QL2.5 Encourage alternative modes of transportation	Improve accessibility to non-motorized transportation and public transit. Promote alternative transportation and reduce congestion
	QL2.6 Improve site accessibility, safety and wayfinding	Improve user accessibility, safety, and wayfinding of the site and surrounding areas
Community	QL3.1 Preserve historic and cultural resources	Preserve or restore significant historical and cultural sites and related resources to preserve and enhance community cultural resources
	QL3.2 Preserve views and local character	Design the project in a way that maintains the local character of the community and does not have negative impacts on community views
	QL3.3 Enhance public space	Improve existing public space including parks, plazas, recreational facilities, or wildlife refuges to enhance community livability

Table 1. Quality of Life Credits and Intents

QL2.3 Minimize light pollution

The metric for this credit is that "lighting meets minimum standards for safety but does not spill over into areas beyond site boundaries, nor does it create obstrusive [sic] and disruptive glare." Concrete bridges can contribute to this credit because light-colored concrete requires fewer lights for the same amount of visibility. This reflectability also reduces energy costs associated with outdoor lighting because more reflective surfaces reduce the amount of fixtures and lighting required. Concrete bridges can reduce outdoor lighting requirements and can contribute to lessening the associated light pollution.

QL2.4 Improve community mobility and access

For this credit, the metric is "extent to which the project improves access and walkability, reductions in commute times, traverse times to existing facilities and transportation. Improved user safety considering all modes, e.g., personal vehicle, commercial vehicle, transit and bike/ pedestrian." There are synergies between reducing environmental impacts and reducing construction-related user delays. During initial construction, various concrete bridge types can minimize on-site construction activities, thereby lessening the amount of time that drivers are inconvenienced. Likewise, by choosing a concrete bridge that has greater durability and fewer maintenance requirements, user delays during the service life of the bridge can also be reduced. This in turn reduces energy consumption of user vehicles and the resultant emissions to air.

Leadership (LD)

Strategies in this category relate to incentivizing more-credible management and leadership related to a project's sustainability. Broad credit categories include collaboration, management, and planning. Table 2 lists the credits in this category and their intents. Most of the strategies in the Leadership category relate to the project team, thus aren't as related to the structural system chosen for a bridge. There are bridges where stakeholder input (LD1.4) has guided the selection of the structural system. However, no strategies in the Leadership category are explained in more detail in this article.

Credit Category	Credits	Intent
Collaboration	LD1.1 Provide effective leadership and commitment	Provide effective leadership and commitment to achieve project sustainability goals
	LD1.2 Establish a sustainability management system	Create a project management system that can manage the scope, scale, and complexity of a project seeking to improve sustainable performance
	LD1.3 Foster collaboration and teamwork	Eliminate conflicting design elements, and optimize system by using integrated design and delivery methodologies, and collaborative processes
	LD1.4 Provide for stakeholder involvement	Establish sound and meaningful programs for stakeholder identification, engagement, and involvement in project decision making
Management	LD2.1 Pursue by-product synergy opportunities	Reduce waste, improve project performance, and reduce project costs by identifying and pursuing opportunities to use unwanted by-products or discarded materials and resources from nearby operations
	LD2.2 Improve infrastructure integration	Design the project to take into account the operational relationships among other elements of community infrastructure that results in an overall improvement in infrastructure efficiency and effectiveness
Planning	LD3.1 Plan for long-term monitoring and maintenance	Put in place plans and sufficient resources to ensure as far as practical that ecological protection, mitigation, and enhancement measures are incorporated in the project and can be carried out
	LD3.2 Address conflicting regulations and policies	Work with officials to identify and address laws, standards, regulations, or policies that may unintentionally create barriers to implementing sustainable infrastructure
	LD3.3 Extend useful life	Extend a project's useful life by designing the project in a way that results in a completed works that is more durable, flexible, and resilient

Table 2. Leadership Credits and Intents

Resource Allocation (RA)

Strategies in this category relate to reducing a project's embodied energy and use of virgin, non-renewable resources. Broad credit categories include materials, energy, and water. Table 3 lists the credits in this category and their intents. Four strategies in the Resource Allocation category that relate to concrete bridges are explained in more detail in the following sections.

Credit Category	Credits	Intent
Materials	RA1.1 Reduce net embodied energy	Conserve energy by reducing the net embodied energy of project materials over the project life
	RA1.2 Support sustainable procurement practices	Obtain materials and equipment from manufacturers and suppliers who implement sustainable practices
	RA1.3 Use recycled materials	Reduce the use of virgin materials and avoid sending useful materials to landfills by specifying reused materials, including structures and material with recycled content
	RA1.4 Use regional materials	Minimize transportation costs and impacts and retain regional benefits through specifying local sources
	RA1.5 Divert waste from landfills	Reduce waste, and divert waste streams away from disposal to recycling and reuse
	RA1.6 Reduce excavated materials taken off site	Minimize the movement of soils and other excavated materials off site to reduce transportation and environmental impacts
	RA1.7 Provide for deconstruction and recycling	Encourage future recycling, up-cycling, and reuse by designing for ease and efficiency in project disassembly or deconstruction at the end of its useful life
Energy	RA2.1 Reduce energy consumption	Conserve energy by reducing overall operation and maintenance energy consumption throughout the project life cycle
	RA2.2 Use renewable energy	Meet energy needs through renewable energy sources
	RA2.3 Commission and monitor energy systems	Ensure efficient functioning and extend useful life by specifying the commissioning and monitoring of the performance of energy systems
Water	RA3.1 Protect fresh water availability	Reduce the negative net impact on fresh water availability, quantity, and quality
	RA3.2 Reduce potable water consumption	Reduce overall potable water consumption and encourage the use of gray water, recycled water, and storm water to meet water needs
	RA3.3 Monitor water systems	Implement programs to monitor water systems performance during operations and their impacts on receiving waters

Table 3. Resource Allocation Credits and Intents

RA1.3 Use recycled materials

To contribute to this credit, a "percentage of project materials that are reused or recycled." Concrete bridges can contribute to this credit by using industrial wastes such as fly ash, slag cement, and silica fume as part of the cementitious materials—with certain aesthetic (color) and early compressive strength considerations. This strategy reduces the environmental impact of the concrete and also uses by-product materials that may otherwise be disposed of in a landfill.

RA1.4 Use regional materials

The metric for this credit is that "percentage of project materials by type and weight or volume sourced within the required distance." For concrete, the distance requirement is 100 miles. Using local materials reduces the environmental impact (energy and emissions) related to transporting heavy building materials. Most concrete plants (ready-mixed and precast) are close to project sites, and likewise the cement, aggregates, and reinforcing steel used to make the concrete, and the raw materials to manufacture cement, are usually obtained or extracted from local sources.

RA1.5 Divert waste from landfills

For this credit, the metric is "percentage of total waste diverted from disposal." Precast concrete girders can be reused when bridges are expanded, and concrete can be recycled as road base, fill, or aggregate in new concrete at the end of its useful life. Concrete pieces from demolished structures can be reused to protect shorelines. Most concrete from demolition in urban areas is recycled and not placed in landfills. Also important is that concrete generates a small amount of waste with a low toxicity.

RA1.7 Provide for deconstruction and recycling

To contribute to this credit, the project must use a "percentage of components that can be easily separated for disassembly or deconstruction." Precast concrete bridge girders can be reused for pedestrian crossings or other applications. To reuse components effectively, engineers need to be able to determine the residual service life of the components. Precast concrete construction provides the opportunity to disassemble the bridge should its use or function change, and the components can be reused in a different application. These characteristics of precast concrete make it sustainable in two ways: by diverting solid waste from landfills and by reducing the depletion of natural resources and production of air and water pollution caused by new construction.

Other ways that the concept of reuse is facilitated with concrete components are:

- Concrete pieces from demolished structures can be reused to protect shorelines and create fisheries.
- Wood forms can generally be used 25 to 30 times without major maintenance while fiberglass and steel forms have significantly longer service lives.

Natural World (NW)

Strategies in this category relate to a project's impact on biodiversity. Broad credit categories include purpose, well being, and community. Table 4 lists the credits in this category and their intents. Most of the strategies in the Natural World category relate to the where the project is located, thus aren't as related to the structural system chosen for

Credit Category	Credits	Intent
Siting	NW1.1 Preserve prime habitat	Avoid placing the project and the site compound/temporary works on land that has been identified as of high ecological value or as having species of high value
	NW1.2 Protect wetlands and surface water	Protect, buffer, enhance, and restore areas designated as wetlands, shorelines, and water bodies by providing natural buffer zones, vegetation, and soil protection zones
	NW1.3 Preserve prime farmland	Identify and protect soils designated as prime farmland, unique farmland, or farmland of statewide importance
	NW1.4 Avoid adverse geology	Avoid development in adverse geologic formations and safeguard aquifers to reduce natural hazards risk and preserve high-quality groundwater resources
	NW1.5 Preserve floodplain functions	Preserve floodplain functions by limiting development and development impacts to maintain water management capacities and capabilities
	NW1.6 Avoid unsuitable development on steep slopes	Protect steep slopes and hillsides from inappropriate and unsuitable development in order to avoid exposures and risks from erosion and landslides, and other natural hazards
	NW1.7 Preserve greenfields	Conserve undeveloped land by locating projects on previously developed greyfield sites and/or sites classified as brownfields
Land & Water	NW2.1 Manage stormwater	Minimize the impact of infrastructure on stormwater runoff quantity and quality
	NW2.2 Reduce pesticide and fertilizer impacts	Reduce non-point source pollution by reducing the quantity, toxicity, bioavailability, and persistence of pesticides and fertilizers, or by eliminating the need for the use of these materials
	NW2.3 Prevent surface and groundwater contamination	Preserve fresh water resources by incorporating measures to prevent pollutants from contaminating surface and groundwater, and monitor impacts over operations
Biodiversity	NW3.1 Preserve species biodiversity	Protect biodiversity by preserving and restoring species and habitats
	NW3.2 Control invasive species	Use appropriate non-invasive species and control or eliminate existing invasive species
	NW3.3 Restore disturbed soils	Restore soils disturbed during construction and previous development to bring back ecological and hydrological functions
	NW3.4 Maintain wetland and surface water functions	Maintain and restore the ecosystem functions of streams, wetlands, water bodies, and their riparian areas

Table 4. Natural World Credits and Intents

a bridge. The use of longer spans, segmental construction, or top down construction can be used to minimize the impact at ground level, however, no strategies in the Natural World category are explained in more detail in this article.

Credit Category	Credits	Intent
Emission	CR1.1 Reduce greenhouse gas emissions	Conduct a comprehensive life-cycle carbon analysis and use this assessment to reduce the anticipated amount of net greenhouse gas emissions during the life cycle of the project, reducing project contribution to climate change
	CR1.2 Reduce air pollutant emissions	Reduce the emission of six criteria pollutants: particulate matter (including dust), ground level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, lead, and noxious odors
Resilience	CR2.1 Assess climate threat	Develop a comprehensive Climate Impact Assessment and Adaptation Plan
	CR2.2 Avoid traps and vulnerabilities	Avoid traps and vulnerabilities that could create high, long-term costs and risks for the affected communities
	CR2.3 Prepare for long-term adaptability	Prepare infrastructure systems to be resilient to the consequences of long-term climate change, perform adequately under-altered climate conditions, or adapt to other long-term change scenarios
	CR2.4 Prepare for short-term hazards	Increase resilience and long-term recovery prospects of the project and site from natural and man-made short-term hazards
	CR2.5 Manage heat islands effects	Minimize surfaces with a high solar reflectance index (SRI) to reduce localized heat accumulation and manage microclimates

Table 5. Climate and Risk Credits and Intents

Climate and Risk (CR)

Strategies in this category relate to minimizing emissions and ensuring a project is resilient. Broad credit categories include emissions and resilience. Table 5 lists the credits in this category and their intents. Four strategies in the Climate and Risk category that relate to concrete bridges are explained in more detail in the following sections.

Resilience

Credits CR2.1, CR2.3, and CR2.4 relate to the ability of a structure to withstand, and continue to function to some degree, after a natural or man-made disaster. The metric for each of these credits is:

- CR2.1 Assess climate threat: prepare a plan that is a "summary of steps taken to prepare for climate variation and natural hazards."
- CR2.3 Prepar e for long-term adaptability: "the degree to which the project has been designed for long-term resilience and adaptation."
- CR2.4 Prepare for short-term hazards: "steps taken to improve protection measures beyond existing regulations."

Concrete bridges can contribute to these three credits because concrete structures are resistant to tornados, hurricanes, wind, floods, and earthquakes. Concrete can be economically designed to resist tornadoes, hurricanes, and wind.

In general, concrete is not damaged by water; concrete that does not dry out continues to gain strength in the presence of moisture. Concrete submerged in water only absorbs very small amounts of water even over long periods of time, and typically this water does not damage the concrete.

Concrete structures can be designed to be resistant to earthquakes. Appropriately designed concrete systems have a proven capacity to withstand major earthquakes.

CR2.5 Manage heat islands effects

The metric for this credit is "[maximize] surfaces with a high solar reflectance index (SRI) to reduce localized heat accumulation and manage microclimates." Concrete without added pigment can meet the high SRI value (29) required in this credit. Concrete bridges provide reflective surfaces that minimize the urban heat island effect and contribute to this credit. Urban heat islands are primarily attributed to horizontal surfaces, such as roads, decks, and walkways, which absorb solar radiation. Two methods of mitigating heat islands are providing shade and increasing albedo. Using materials with higher albedos (solar reflectance values), such as concrete, will reduce the heat island effect, save energy, and improve air quality.

Application

Project teams use the assessment tools provided by the Envision system to evaluate the community, environmental, and economic benefits of projects. Currently two tools are available, with two new tools projected for release after 2012. The available tools include:

Stage 1—Self-assessment checklist: this tool can be used for educational purposes or to track project progress related to sustainability.

Stage 2—Third-party, objective rating verification: in this scenario, the project team's assessment is validated by an independent, third-party verifier. This allows for public recognition of the project. Using this tool, projects can earn points in 60 potential credits within the five credit categories.

Evaluating Sustainability with INVEST

Alexandra Oster, FHWA

For the Federal Highway Administration (FHWA), a sustainable approach to highways means helping decision makers make balanced choices among environmental, economic, and social values—the triple bottom line of sustainability—that will benefit current and future road users. Launched by FHWA in 2012, INVEST is a practical, web-based collection of best practices to help transportation agencies integrate sustainability into their programs and projects. Agencies, such as State Departments of Transportation, Metropolitan Planning Organizations, Councils of Government, public works departments, and their consultants and partners, can voluntarily use INVEST to evaluate the sustainability of their programs and projects. The tool is intended to identify and recognize efforts that go above and beyond standard practice toward the goal of sustainability. This article focuses on how the scoring system works and how INVEST is being used to achieve sustainable outcomes that go above and beyond statutory requirements.

Fig. 1. INVEST can help transportation professionals better integrate sustainability into bridge planning, development, and management (Photo courtesy of FHWA).

How is INVEST structured?

INVEST allows users to evaluate the transportation life cycle using the system's three modules: System Planning, Project Development, and Operations and Maintenance. Each module is based on a specific set of criteria and can be used separately. System Planning evaluates the sustainability of system-level planning and programming policies, processes, procedures and practices. Project Development incorporates sustainability into project planning, from design to construction. And **Operations and Maintenance** focuses on integrating sustainability into system-level operations and maintenance activities. Within each of the modules, the decision of when to evaluate a program or project is up to the user. Typically, the earlier in the development of a program or project a self-evaluation is performed, the more ability the user has to positively influence sustainability.

How does scoring work?

After users select a module they begin scoring a project or program based on the criteria in that module. Each INVEST criterion describes a particular sustainability best practice and assigns it a point value according to its relative impact on transportation sustainability. The points associated with each criterion are then added together to give a total score.

How does INVEST address bridge projects and long-term bridge management and preservation?

INVEST provides several criteria that can help transportation professionals integrate sustainability into bridge planning, development, and management. For example, as part of the Project Development Module, numerous criteria could apply to the development and construction of a bridge project. Certain criteria focus on reducing the life-cycle costs of both roadway and bridge projects through reducing, reusing, and recycling materials and designing long-lasting pavement structures. Other relevant criteria address the impacts of construction activities to the surrounding neighborhoods and environments, such as Construction Environmental Training and

Construction Noise Mitigation.

Transportation agency staff may also be interested in using the Bridge Management System criterion included in the Operations and Maintenance Module to assess and achieve sustainability for their bridge networks. A sustainable bridge management system will extend the life and function of bridges while balancing impacts to the human and natural environment. This criterion focuses on developing a Bridge Management System, collecting and leveraging relevant data, tracking bridge network performance, setting bridge system performance goals, and monitoring progress toward those goals.

Users may find other criteria useful for bridge planning, development, and management and should explore the tool to learn more.

INVEST across America

There are more than 50 projects in 25 States using INVEST. These projects are spread across 29 agencies at the Federal, State, and local levels. If your agency is using INVEST and would like to be included in this tally please contact sustainablehighways@dot.gov.

FHWA's Sustainable Highways Initiative in the Office of Planning, Environment, and Realty encourages everyone interested in sustainable transportation—from the public to transportation professionals—to take advantage of the INVEST tool.

*Because INVEST is not based on third-party validation of scores or certifications, scores are not considered recognition by FHWA that a program has met the achievement level of sustainability. Rather, it is recognition that the user has self-evaluated their program and met the indicated achievement level.