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16. Abstract

Recent emphasis on sustainability in the eld of transportation has resulted in newly developed sustainability technical guidance, such as sustainability evaluation tools and technical documents. However, there is little guidance or industry-wide experience to instruct practitioners on how to integrate sustainability throughout the project lifecycle. This document provides an approach for practitioners to integrate sustainability into the planning, design, and construction of projects and is intended to be compatible with an owner's existing technical guidance for project development processes. The approach in this guidebook assumes that system-level planning eorts are complete and a specic project is identied. The approach is applicable to the project development phases of a project, including project planning, design, and construction. This document also includes guidance on leveraging sustainability technical guidance to aid in this approach. This document is not intended to set policy.

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ACRONYMS AND ABBREVIATIONS

ACEC – American Council of Engineering Companies

ACP – asphalt concrete pavement

CSS – context sensitive solutions

FHWA – Federal Highway Administration

FLH – Office of Federal Lands Highway

GreenLITES – Green Leadership In Transportation Environmental Sustainability

ISI – Institute for Sustainable Infrastructure

I-LAST – Illinois Livable and Sustainable Transportation

INVEST – Infrastructure Voluntary Evaluation Sustainability Tool

LEED®-ND – Leadership in Energy and Environmental Design Rating System for Neighborhood Development

LID – low-impact development

MUTCD – Manual of Uniform Traffic Control Devices

NEPA – National Environmental Policy Act

O&M – operations and maintenance

OM – Operations and Maintenance module

PD – Project Development module

PDDM – Project Development and Design Manual

PS&E – plans, specifications, and cost estimates

RAP – recycled asphalt pavement

SITES™ – Sustainable Sites Initiative

SP – System Planning module

STARS – Sustainable Transportation Access Rating System

TESC – temporary erosion and sediment control

DEFINITIONS

CONTEXT SENSITIVE SOLUTIONS	Context sensitive solutions (CSS) is a collaborative, interdisciplinary approach that involves all stakeholders in providing a transportation facility that fits its setting. It is an approach that leads to preserving and enhancing scenic, aesthetic, historic, community, and environmental resources, while improving or maintaining safety, mobility, and infrastructure conditions. (FHWA, 2007)
ECONOMIC PRINCIPLE	Efficiently and/or productively using public capital, avoiding deterioration of capital assets. This principle considers solutions based on factors such as financial durability, reliability, responsibility, lifecycle costs, benefit-cost-driven decisions, and the use of natural resources. (FHWA, 2012)
ENGINEERING	The profession in which knowledge of mathematical and natural science is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind. (Accreditation Board of Engineering and Technology, 1963)
ENVIRONMENTAL PRINCIPLE	Following three natural laws: • Do not extract substances from the Earth faster than they can be regenerated, • Do not produce waste faster or at a greater amount than it can decompose and reintegrate into an ecosystem, and Do not damage or disrupt natural processes or ecosystems with human activities. Often the easiest of the three principles to understand, the environmental principle considers solutions based on factors such as habitat, ecology, stormwater runoff and quality, air quality, recycling and reuse, energy efficiency, and noise management. (FHWA, 2012)
HIGHWAY	Any facility designed to accommodate motorized vehicular transportation. This includes all functional roadway classifications (arterial, collector, local) that accommodate motorized vehicles. (FHWA, 2012)
SOCIAL PRINCIPLE	Meeting basic human needs fairly and efficiently. This principle considers solutions based on factors such as human health, safety, access, mobility, mode choice, cultural resources, archeological resources, aesthetics, and recreation. (FHWA, 2012)
SUSTAINABILITY	Satisfying basic social and economic needs, both present and future, and the responsible use of natural resources, all while maintaining or improving the well-being of the environment on which life depends. (FHWA, 2011)
SUSTAINABLE DEVELOPMENT	With respect to development, the Brundtland Commission of the United Nations succinctly stated that sustainable development is "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs" (United Nations, 1987).
SUSTAINABLE HIGHWAY	FHWA views sustainable highways as an integral part of the broader context of sustainable development. A sustainable highway should satisfy the functional requirements of societal development and economic growth while reducing negative impacts on the environment and consumption of natural resources. The sustainability of a highway should be considered throughout the project lifecycle–from conception through construction (FHWA, 2011).
SUSTAINABILITY PRINCIPLES	The environmental, economic, and social principal.
SUSTAINABLE SOLUTION	A sustainable solution is a specific project activity, feature, or process that accomplishes the goal of promoting sustainability.

EXECUTIVE SUMMARY

This guidebook provides an approach for practitioners to integrate sustainability into the planning, design, and construction of roadway projects and is intended to be compatible with an owner's existing technical guidance for project development processes. The approach in this guidebook assumes that appropriate system-level planning efforts are complete and a specific project is identified for development. The approach is applicable to the project development phases of the project lifecycle, which include project planning, design, and construction.

This guidebook focuses on an approach for integrating sustainability rather than providing a set of sustainable solutions for practitioners to choose from that could quickly become outdated. Providing the approach, instead of the solutions, gives practitioners the tools they need to integrate sustainability and ensures that the guidebook remains current and relevant while sustainability technology and best practices continue to evolve. Additionally, by focusing on approach, this guidebook is flexible and applicable to different project types and sizes. The approach presented in this guidebook emphasizes establishing interdisciplinary coordination, maintaining accountability of sustainability throughout project development, and appropriately utilizing resources. This guidebook is intended for any practitioner involved in project development, including the owner's staff, public officials, planners, engineers, designers, and those involved in contractor oversight and management.

Recent emphasis on sustainability in the field of transportation has resulted in newly developed sustainability technical guidance, such as sustainability evaluation tools and technical documents. The purpose of sustainability evaluation tools, such as the Federal Highway Administration's (FHWA) Infrastructure Voluntary Evaluation Sustainability Tool (INVEST), is to assess the sustainability of roadway projects. The purpose of technical documents, such as *An Integrated Approach to Sustainable Roadside Design* (Office of Federal Lands Highway, 2013), is to provide technical information on making specific elements of a roadway section more sustainable. The value of these resources is considerable; they certainly should not be dismissed or underestimated. However, there is little guidance or industry-wide experience to instruct practitioners on how to integrate sustainability throughout the project lifecycle.

Sustainability is of critical importance because all the choices we as a society make today will affect, either negatively or positively, our future choices and options. Continuing unsustainable actions harms the human and natural environment by creating greenhouse gases that are causing climate change, depleting natural resources needed for future energy and infrastructure, and polluting the air, soil, and water on which we depend. In order to reduce these impacts, we must change the way we harvest materials, construct buildings and infrastructure, and conduct our daily activities.

1. Introduction

FHWA emphasizes environmental stewardship and adoption of sustainable techniques in design and construction of transportation facilities. Through efforts like the Sustainable Highways Initiative (www. sustainablehighways.dot.gov), FHWA supports efforts to facilitate balanced decision-making using the environmental, economic, and social principles of sustainability. FHWA places a high value on infrastructure sustainability and expects agencies to deliver on this expectation by including the most effective and appropriate sustainability features in their road projects. In response to this call for sustainability, the Office of Federal Lands Highway (FLH) Coordinated Technology Implementation Program developed this guidebook to assist in advancing the development of sustainable roadways.

1.1. Incorporating Sustainability in Roadway Projects

Integrating sustainability on a roadway project does not mean getting a high score in a sustainability evaluation or rating tool, meeting regulatory requirements, or incorporating equal parts of social, environmental, and economic solutions. Rather, it means developing an informed vision of sustainability, setting goals that support the vision and are contextually appropriate for the project, and then implementing sustainable solutions that achieve these goals. The result is a project that meets the sustainability vision.

Many current standard practices for project development are in place because of such regulations as the National Environmental Policy Act (NEPA), the Clean Water Act, and the Clean Air Act, and they often contribute to projects being more sustainable. However, the purpose of this guidebook is to integrate sustainable elements that go above and beyond what is required. Advancing sustainability in this manner can be an innovative and exciting process as projects continue to develop and apply new technologies and processes to maximize sustainability.

INTEGRATING SUSTAINABILITY

Integrating sustainability on a roadway project means developing an informed vision of sustainability, setting goals that support the vision and are contextually appropriate for the project, and then implementing sustainable solutions that achieve these goals.

Some practitioners may be hesitant to emphasize or encourage sustainability in project development and design due to perceived high cost and expensive maintenance requirements, reluctance to stray from standard design manuals and specifications, and perhaps a lack of understanding of the importance of sustainability. Additionally, while the availability of sustainability technical resources for design and construction continues to expand, little guidance is available to instruct practitioners on *how* to implement the solutions and ideas in these technical resources into design and construction. This guidebook aims to increase understanding and change negative perceptions of sustainability and provide a straightforward and manageable approach for integrating sustainability into roadway projects.

Figure 1-1 : Western Federal Lands—Going-to-the-Sun Road Rehabilitation Project. Sustainable solutions implemented on this project include reuse of historic retaining wall materials, planting of native vegetation, safety improvements, preservation of scenic views, and a comprehensive mitigation program to limit impacts on tourism

1.2. Approach

This guidebook provides a step-by-step approach for practitioners to integrate sustainability into the planning, design, and construction of roadway projects that is intended to be integrated with an owner's standard design practices, project development guidance, and technical guidance. The approach presented here should easily fit existing design practices and is not intended to be a separate process. In addition, this guidebook provides a brief background on sustainability and sustainable roadways; discusses best practices for integrating this approach with standard design and construction practices; summarizes existing sustainability technical resources, including evaluation tools and technical documents; and provides recommendations for using these resources in projects. Figure 1-1 gives examples of resources for both project development guidance and technical guidance in the development of plans, specifications, and estimates (PS&E) and shows where this guidebook and sustainability technical guidance fit with these typical resources.

GUIDEBOOK APPROACH

This guidebook provides an approach that integrates sustainability into the planning, design, and construction of roadway projects that is intended to be compatible with an owner's standard design practices, project development guidance, and technical guidance.

1.3. Scope

The approach in this guidebook assumes that appropriate system-level planning efforts (which include long-range transportation planning, statewide and regional transportation improvement program development, and initial project identification and selection) are complete and a specific project has been identified. The approach is applicable to the project development phases of the project lifecycle, which include project planning, design, and construction (Figures 1-2 and 1-3).

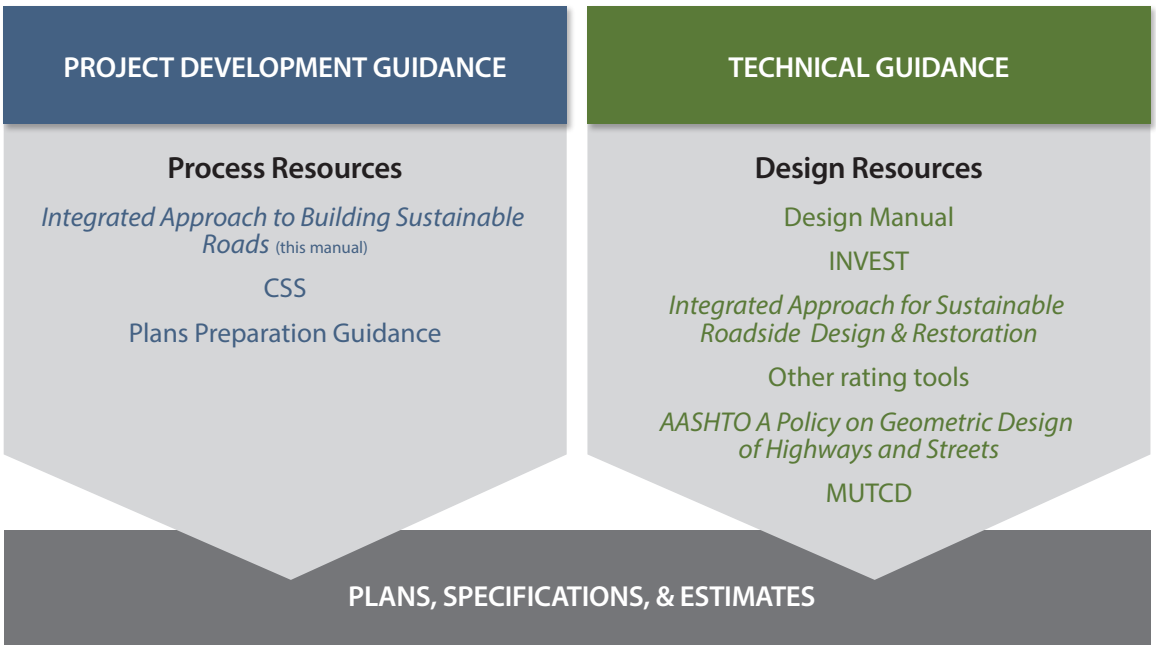


Figure 1-2: How this Guidebook Fits with Existing Technical and Project Development Guidance

Chapter 3, Best Practices, includes guidance for how to integrate sustainability in each phase of project development and how to transition between each of the project development phases and between project development and operations and maintenance (O&M) (Figure 1-3).

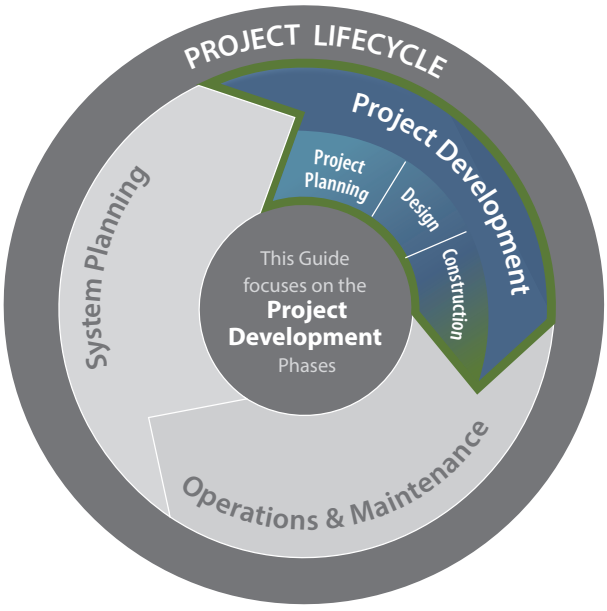


Figure 1-3: Scope of this Guidebook Relative to Project Lifecycle

1.4. References

This guidebook references the FLH *Project Development and Design Manual* (PDDM) (FLH, 2008) and *Federal Lands Highway Construction Manual* (FLH, 1996), which provide current policies, standards, criteria, and guidance for development, design, and construction oversight of FLH projects. However, the approach and best practices in this guidebook are easily adaptable to the design and construction manuals used by other agencies.

1.5. Who Should Use this Guidebook

This guidebook is intended for any practitioner involved in project development, including the owner's staff, public officials, planners, engineers, designers, and those involved in contractor oversight and management. It is recommended that the approach in this guidebook be used by a subset of the project team—an interdisciplinary team that can be led by a designated sustainability manager. The interdisciplinary team and sustainability manager roles are described below. For more information on these roles, see Section 4.1, Getting Organized.

INTERDISCIPLINARY TEAM

In every discipline and in every phase of project development, there are opportunities to integrate sustainability; therefore, successful integration of sustainability requires a partially static and partially dynamic interdisciplinary team of practitioners. Project teams evolve as projects evolve. While some practitioners stay with the project for each successive phase, such as the owner's staff and sometimes the project manager, other practitioners come and go based on the project phase and the needs of the project, meaning the particular task that needs to be accomplished at that time. The same is true when discussing the team of practitioners needed for integrating sustainability into project development. This team of practitioners will evolve over time and is based on the tasks that need to be accomplished. Figure 1-4 shows when the interdisciplinary team composition will likely change as the project progresses. See Section 4.1, Getting Organized, for a more detailed description of the suggested composition of this team.

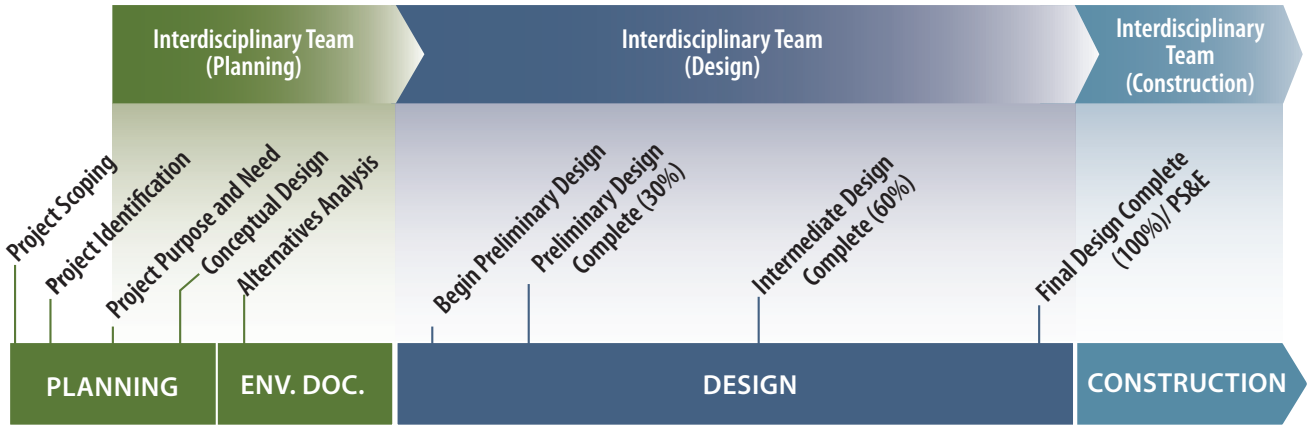


Figure 1-4: Evolution of Interdisciplinary Team

SUSTAINABILITY MANAGER

It is recommended that the interdisciplinary team be led by a sustainability manager. Assigning this role to a member of the team is the best way to consistently and successfully follow the approach in this guidebook. While ideally the sustainability manager will remain the same through each successive phase, a large part of the rest of the sustainability team will evolve with both the phase and the needs (the current tasks) of the project as discussed above. Section 4.1.1, Sustainability Manager, discusses who should serve as the sustainability manager and what responsibilities the role fulfills.

1.6. How to Use this Guidebook

This guidebook is intended to be a reference throughout project development.

Upon beginning a project with the intention of integrating sustainability, the practitioner should review Chapter 2, Sustainability, to refresh understanding of sustainability and its importance, sustainability in transportation, Context Sensitive Solutions, and keys to integrating sustainability.

Next, Chapter 3, Approach, will provide the practitioner a step-by-step approach with a single project example carried through each step. The project example strives to illustrate how to accomplish the steps in the approach. Each step in the approach builds on the work completed in prior steps.

For additional guidance on how to accomplish the approach, the practitioner can review Chapter 4, Best Practices. This chapter will give the user ideas on how to move forward and manage the integration of sustainability on a project.

Ideally, these steps are begun early in project development; however, the approach presented can be applied to projects that are already underway. For those projects, review Section 4.2.2, Modifying the Approach for Projects that Are Underway.

1.7. Limitations

It is important for the practitioner to understand that sustainability is an evolving field and, as a result, the pool of available and feasible solutions is constantly changing. For example, over the course of a project, solutions may change from being infeasible to becoming a standard best practice. Additionally, every project context is unique and, therefore, the sustainable solutions that will accomplish the developed sustainability goals and support the defined sustainability vision will be different for each project. For these reasons, this guidebook does not feature a list of sustainable solutions that may be considered for projects.

This guidebook encourages practitioners to brainstorm and develop solutions by using interdisciplinary collaboration to identify solutions that meet the sustainability goals for a project. This guidebook also refers to sources where the reader can find sustainable solutions to choose from; however, the user should be prepared to do more investigation of solutions as new documents, technologies, and research develop (Figure 1-5).

Progress of Sustainable Technologies

As time passes, technologies that were **emerging** evolve from **available** to **adopted**. The pool of emerging technologies is continually replenished as technology advances.

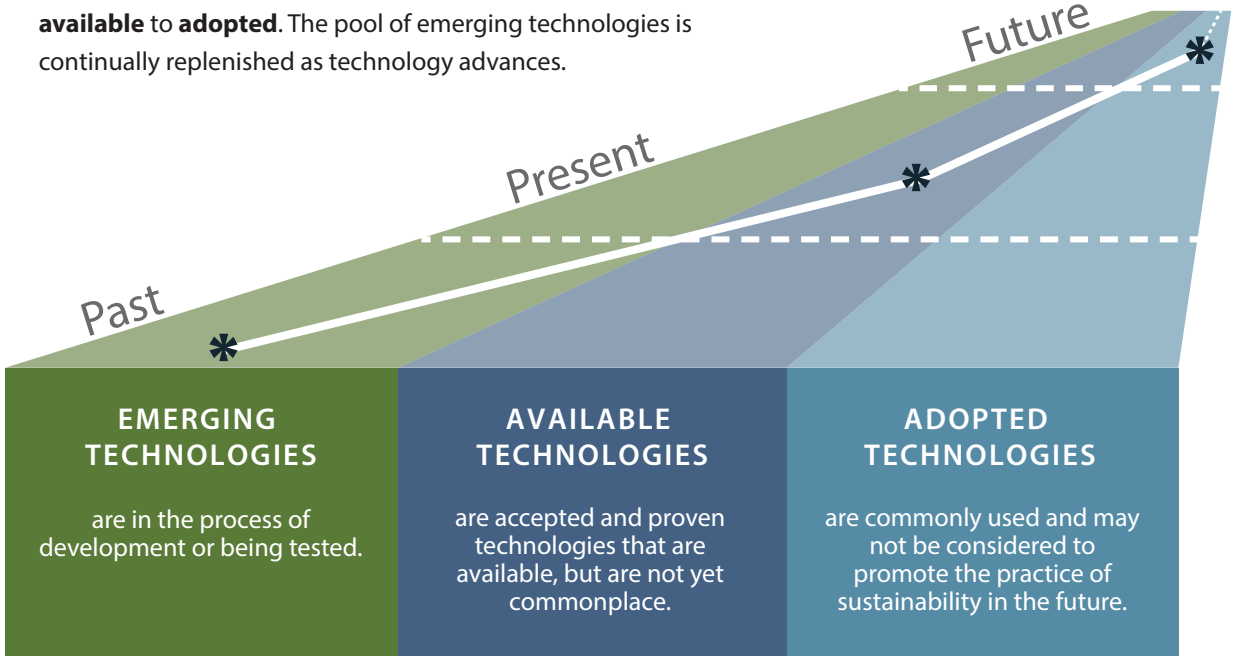


Figure 1-5: Evolution of Sustainability Technologies

2. Sustainability

This chapter contains basic information needed to understand sustainability in the field of transportation and its importance. It provides a quick review of context sensitive solutions (CSS) and sustainable solutions, which are both vital to integrating sustainability in a project. This chapter also discusses some potential challenges when evaluating these solutions and the importance of understanding trade-offs when selecting appropriate solutions for a project.

2.1 Sustainability and Transportation

Sustainable transportation systems involve a multitude of challenges, including the significant requirements for land and natural resources to build roadways and to power the vehicles that use them, as well as negative impacts on the human and natural environment from the emissions, congestion, and accidents created by the vehicles operating on those systems. There are many ways to encourage a more sustainable transportation system, such as emphasizing more sustainable modes of transportation and optimizing the current transportation system; however, these strategies are outside the scope of this guidebook, which assumes that appropriate system-wide planning efforts are complete and a specific project has been identified. This guidebook also assumes that the purpose and need for a roadway project have been appropriately justified. Given these assumptions and the critical role that roadways play in our transportation infrastructure, the goal of this guidebook is to help practitioners plan, design, and construct *more sustainable* roads.

2.2. Defining Sustainability

The following basic definitions of sustainability, sustainable development, and sustainable highways have been adopted by FHWA for use in INVEST:

- **Sustainability:** "Satisfying basic social and economic needs, both present and future, and the responsible use of natural resources, all while maintaining or improving the well-being of the environment on which life depends" (FHWA, 2011).
- **Sustainable Development:** With respect to development, the Brundtland Commission of the United Nations succinctly stated that sustainable development is "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs" (United Nations, 1987).
- **Sustainable Highway:** "Sustainable highways are an integral part of the broader context of sustainable development. A sustainable highway should satisfy the functional requirements of societal development and economic growth while reducing negative impacts on the environment and consumption of natural resources. The sustainability of a highway should be considered throughout the project lifecycle—from conception through construction" (FHWA, 2011).

SUSTAINABLE SOLUTIONS AND THE PRINCIPLES OF SUSTAINABILITY

Most solutions are not exclusively beneficial to just one of the principles. For example, recycling materials in-place is beneficial because it:

- Reduces emissions related to hauling virgin materials (social and environmental benefits),
- Generally costs less (economic benefit), and
- Reduces fossil fuel consumption (natural resources) related to hauling materials (environmental benefit).

2.2.1. The Principles of Sustainability

Most widely accepted definitions of sustainability are based on achieving a balance of three primary principles: social, environmental, and economic (Figure 2-1). While it is unlikely to perfectly balance these three principles for a given solution or on a single project, applying the principles of sustainability to a project means at least considering all three of these principles. As we strive to balance them on each project, we come closer to balancing the three principles on a broader set of projects, and sustainability will be advanced at a programmatic level.

Figure 2-1: The Three Principles of Sustainability

The three principles can be further defined as follows:

- The **Social** principle: Meeting basic human needs fairly and efficiently. This principle considers solutions based on factors such as human health, safety, access, mobility, mode choice, cultural resources, archeological resources, aesthetics, and recreation.

- The **Environmental** principle follows three natural laws:
  - Do not extract substances from the Earth faster than they can be regenerated
  - Do not produce waste faster or at a greater amount than it can decompose and reintegrate into an ecosystem
  - Do not damage or disrupt natural processes or ecosystems with human activities.

  Often the easiest of the three principles to understand, the environmental principle considers solutions based on factors such as habitat, ecology, stormwater runoff and quality, air quality, recycling and reuse, energy efficiency, and noise management.
- The **Economic** principle: Efficiently and productively using public capital, avoiding deterioration of capital assets. This principle considers solutions based on factors such as financial durability, reliability, responsibility, lifecycle costs, benefit-cost-driven decisions, and the use of natural resources.

2.3. The Importance of Sustainability

As noted above, FHWA has put a renewed emphasis on environmental stewardship and adoption of sustainable techniques in design and construction. It places a high value on infrastructure sustainability and appeals to agencies to deliver by including the most effective and appropriate sustainability features in their road projects.

Sustainability is of critical importance because all of the choices society makes today will affect, either negatively or positively, future choices and options. Continuing unsustainable actions harms the human and natural environment by creating greenhouse gases that are causing climate change, depleting natural resources needed for future energy and infrastructure, and polluting the air, soil, and water on which we depend. In order to reduce these impacts, we must change the way we harvest materials, construct buildings and infrastructure, and conduct our daily activities.

2.4. Sustainable Solutions

This guidebook continually refers to sustainable solutions since they are the key building blocks to integrating sustainability into projects. A sustainable solution is a specific project activity, feature, or process that accomplishes the goal of promoting sustainability. Some examples are shown in the box at right.

SUSTAINABLE SOLUTIONS

A sustainable solution is a specific project activity, feature, or process that accomplishes the goal of promoting sustainability.

Some examples are:

- **Activity:** Recycling existing pavement materials in place or mitigating construction noise.
- **Feature:** Installing bicycle lanes or sidewalks.
- **Process:** Analyzing lifecycle costs or tracking environmental commitments.

When integrating sustainable solutions into project development, solutions should be:

- Appropriate for the context of the project
- Defensible in their application, as with any design decision or element
- Feasible and well defined
- Measurable
- Tracked to capture lessons learned and to record the solutions for future uses

2.5. Context Sensitive Solutions

Striving for sustainability in project development (especially finding solutions that are consistent with the context of the project) is consistent and harmonious with a context sensitive solutions (CSS) process and should be integrated with a CSS process whenever possible.

CSS is defined by FHWA as "a collaborative, interdisciplinary, holistic approach to the development of transportation projects. It is both process and product, characterized by a number of attributes. It involves all stakeholders, including community members, elected officials, interest groups, and affected local, state, and federal agencies. It puts project needs and both owner and community values on a level playing field and considers all trade-offs in decision making. Often associated with design in transportation projects, Context Sensitive Solutions should be a part of all phases of program delivery, including long-range planning, programming, environmental studies, design, construction, operations, and maintenance." More information on CSS can be found at www.contextsensitivesolutions.org. This website provides a wealth of useful information and resources.

2.6. Evaluating Sustainable Solutions and Trade-offs

Perhaps the most daunting task for practitioners incorporating sustainability into roadway projects is managing trade-offs in individual solutions to determine which solutions to select. The following are some examples of trade-offs that a project team may encounter:

- Solutions that are both appropriate and feasible for a project but cannot coexist. For example, a project team might need to decide whether to use warm-mix asphalt pavement or a long-life Portland Cement Concrete pavement.
- Situations where the initial investment for a solution may be higher than a traditional design option but less expensive over the life of the project. For example, long-life pavements are typically cheaper over their lifespan but require more money to construct initially.
- Solutions that emphasize different principles of sustainability, such as balancing safety and environmental goals. For example, using high-albedo pavements (with high reflectivity and therefore cooler) to reduce the heat island effect that could increase the glare on the roadway and may adversely affect safety.

Practitioners involved in transportation projects are familiar with making similar decisions and weighing alternatives, such as deciding between a less expensive material and a material that will last longer but

have a higher initial cost. Selecting appropriate sustainable solutions requires another layer of analysis in order to manage trade-offs.

Project teams working to integrate sustainability into project development will encounter multiple opportunities to evaluate trade-offs for solutions or between multiple solutions. Understanding the sustainability goals and measures, the project context, and the project lifecycle will be essential to help evaluate and select the appropriate solutions.

2.7. Keys to Integrating Sustainability

While the word "sustainability" seems to be the latest buzz word, it is not just a passing fad. "Sustainability" is actually a low bar; it is the minimum that needs to be achieved to maintain livelihoods and the planet. If unsustainable actions continue, the quality of life of future generations will be compromised. Engineering has been defined as "the profession in which knowledge of mathematical and natural science is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind." Sustainability should not be seen as an add-on to the development of a project, another demand or burden on the project, or an additional task. Integrating sustainability in project development is simply better engineering.

ENGINEERING

The profession in which knowledge of mathematical and natural science is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind. (Accreditation Board of Engineering and Technology, 1963)

Key concepts to successfully integrating sustainability into project development include sustainable actions through all project phases, close interdisciplinary coordination, and appropriate use of sustainability resources.

2.7.1. Sustainable Actions through all Project Phases

A project's lifecycle consists of three stages: system planning, project development, and operations and maintenance (O&M). In the project development stage, there are three phases: project planning, design, and construction. This guidebook focuses on these three phases. It is important to understand these phases in order to recognize where the project is in project development and how it determines which decisions can be influenced at that time. The opportunities to incorporate sustainability vary and eventually diminish as a project moves through development.

- **Project planning**- This phase involves project scoping and the beginning of the environmental review process. The desired sustainability

KNOW WHERE YOU ARE

It is important to know where a project is in development in order to understand which decisions have already been made about a project and which decisions can still be influenced.

For example, it is unrealistic for a roadway project that has a 50 percent complete design to go back and implement sustainable best practices in project planning and alternatives analysis, but it is very practical to incorporate recycled materials and a construction waste management plan since decisions regarding those items have yet to be made.

outcome of this phase is to introduce sustainability early by **developing a sustainability vision, understanding the project context, and defining sustainability goals for the project.**

- **Design**- In the design phase, the project evolves from a conceptual design to a designed project. Most opportunities to incorporate sustainability on a project level occur here and vary from alignment analysis to materials selection to ensuring that environmental commitments are tracked and fulfilled. The desired sustainability outcome of this phase is to **identify, assess, and select sustainable solutions and incorporate these solutions into construction contract documents.**
- **Construction**- Construction is the execution phase of the design phase. During construction, designed sustainable solutions are constructed and processes are executed (such as managing construction waste). The desired sustainability outcome of this phase is to **communicate goals and intents from the earlier phases with the project engineer (or whoever is managing the contract) and monitor incorporation of sustainable practices and features that were required in the contract.**

2.7.2. Interdisciplinary Coordination

Coordination within the interdisciplinary team and among those on the project team is critical to the successful integration of sustainability into a project. This coordination must occur throughout project development and during each step of the approach. Interdisciplinary coordination is important because the selection of solutions by one discipline will likely have impacts on other disciplines or require the cooperation of another discipline. Each discipline may have ideas and methods that help accomplish the sustainability goals of the project.

2.7.3. Utilizing Technical Resources

There are two types of resources that will be most useful to the team integrating sustainability into roadway projects; these include technical documents and sustainability evaluation tools. It is important to understand what tools are available, their purposes, and how to use them appropriately.

Generally, **technical documents** are focused on implementing specific sustainable solutions. For example, *An Integrated Approach to Sustainable Roadside Design and Restoration* (Office of Federal Lands Highway Division, 2013) is a document that is focused primarily on integrating sustainability into elements of the road section beyond the edge of pavement to the right-of-way.

There are several available **sustainability evaluation tools** for transportation projects. But, unlike this guidebook, none are primarily dedicated to the *process* of integrating sustainability throughout project development. Most of these tools are retrospective evaluations of projects that have been completed.

A notable exception is FHWA's INVEST; while not quite achieving the status of a guidebook or formal approach, INVEST has in-depth guidance and suggestions for using the tool for projects and programs both retrospectively and prospectively.

Throughout this guidebook, reference is made to INVEST, which is a collection of best practices, organized into criteria, designed to assess the sustainability of roadway projects and agencies' system planning and O&M programs. The goals of INVEST are to encourage implementation of sustainable practices, help agencies assess their level of sustainability implementation and identify areas for internal improvement,

provide a framework for communicating with stakeholders and decision makers about sustainability, and establish a method for identifying sustainable best practices in highway systems, projects, and programs.[1] This guidebook aims to provide a process to integrate sustainability independently of INVEST; however, INVEST is valuable to teams interested in more sustainable project development. For more information on INVEST, see Section 4.5.3.

Section 4.5, Technical Resources, discusses available technical documents and sustainability evaluation tools in more detail and best practices for using these tools in conjunction with the approach presented in this guidebook.

INVEST

FHWA "INVEST" Website:

http://www.sustainablehighways.org/

FHWA Sustainable Highway Initiative:

http://www.sustainablehighways.dot.gov/

[1] See http://www.sustainablehighways.org/

3. Approach

This chapter provides a step-by-step approach for practitioners to integrate sustainability into the planning, design, and construction of roadway projects that should be integrated with an owner's standard design practices, project development guidance, and technical guidance.

This chapter (and the guidebook in general) focuses on project-level planning, project development, and construction. It assumes that system-level planning and programming are complete and that the project is entering the early stages of planning for project development. Sustainability can be integrated at any time during project development; however, the earlier sustainability is considered, the more opportunities for integration there will be. The step-by-step approach presented here can be applied at any time; however, for more specific guidance on how to apply the approach after a project is underway, see Section 4.2.2.

Throughout this chapter, a hypothetical example project is carried through the six steps. At the end of each section, a graphic shows a sample of the work that was performed for that step. This example does not represent an actual project and is intended to be illustrative of the proposed approach rather than comprehensive.

3.1. Introduction

The intent of this approach is multifaceted:

- The approach encourages project teams to develop an informed vision of sustainability that is contextually appropriate for the project.
- The approach shows project teams how to select and implement solutions that support this vision and go beyond just meeting regulatory requirements. Analytical thought, problem-solving, "pushing the envelope," and ingenuity are encouraged.
- The approach supports meeting the purpose and need of a project, while conserving and protecting the environment and being mindful and respectful of resource limitations. This is what is meant by "balancing the social, environmental, and economic solutions." It does not necessarily mean incorporating equal parts of social, environmental, and economic solutions.

While the end result of this approach may lead to a project that likely scores high on a sustainability evaluation tool, such as FHWA's INVEST, the intent of this guidebook is to make "better" sustainability approachable and attainable on every project, no matter the size, type, or location. It is an opportunity to think beyond the design manual and collaborate with other disciplines to achieve a better product. This approach does not have to be an overwhelming task or resource-intensive. It is an approach to do a bit more, without adding too much additional effort.

3.1.1. The Six Steps of the Approach

The six steps of the approach are:

- Step 1—Develop a Sustainability Vision
- Step 2—Identify Project Context
- Step 3—Define Sustainability Goals
- Step 4—Identify Sustainable Solutions
- Step 5—Assess and Select Sustainable Solutions
- Step 6—Incorporate Solutions

3.1.2. How to Adapt the Approach to Phases of Project Development

Steps 1, 2, and 3 are intended to be completed during project planning. Steps 4 and 5 are intended to be completed during project design and Step 6 is intended to be conducted throughout design and completed during construction. Figure 3-1 shows both the optimal timing for each step in project development and the window of acceptable timing. The earliest feasible time to accomplish each step is the best time because the opportunities for incorporating sustainable solutions diminish as a project progresses.

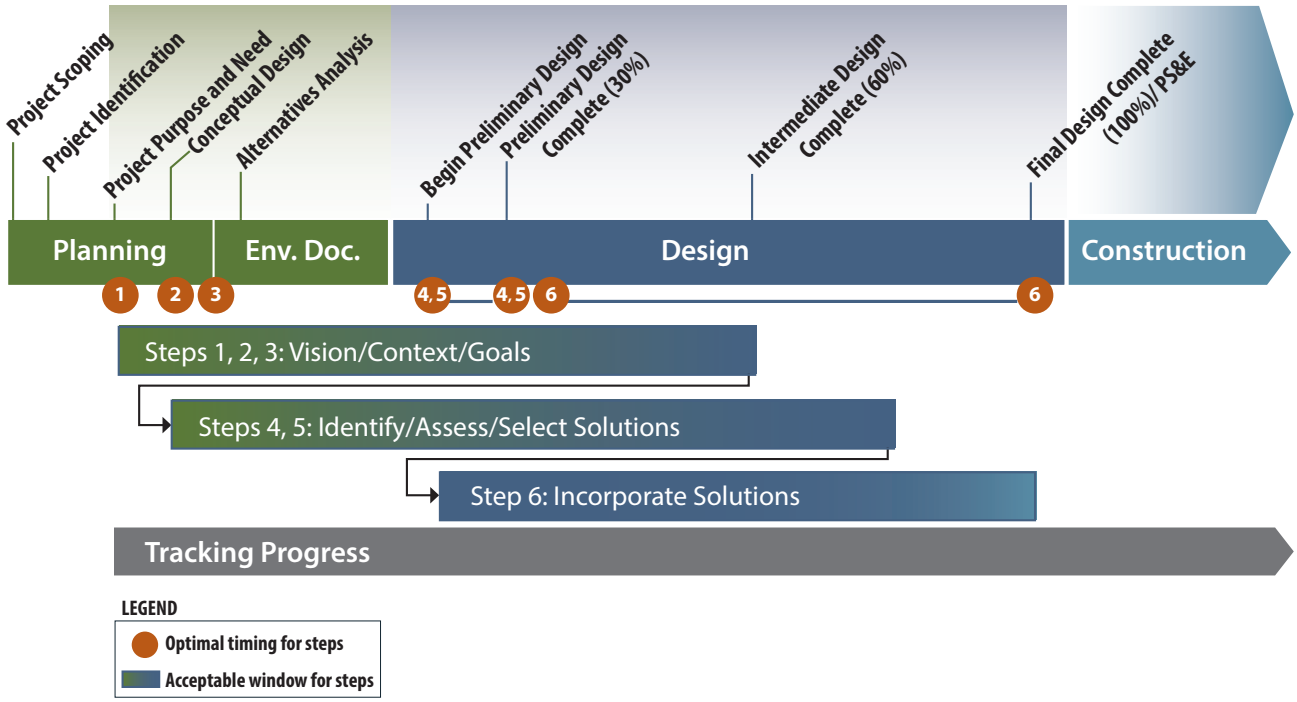


Figure 3-1: Timeline of Approach

3.2. Step 1- Develop a Sustainability Vision

WHAT IS A SUSTAINABILITY VISION?

The sustainability vision is a brief, well-crafted statement with the purpose of aligning the project team with a desired sustainability outcome and providing them with broadly stated guidance that can be used to develop goals and evaluate performance. This vision is focused on sustainability, specifically on how the project can contribute to the social, environmental, and economic principles and, therefore, it has a different purpose than the project vision that was established in project planning and programming.

IDENTIFYING A SUSTAINABILITY VISION

Related INVEST Criteria

PD-3: Context Sensitive Project Development

PD-5: Educational Outreach

WHO SHOULD CREATE THE VISION?

The responsibility for developing the sustainability vision for a project depends on where the project is in project development. If the project is still in the planning phase, the sustainability vision should be developed by the owner, community, and stakeholders. If the project is already in design, it may be more appropriate for the owner and project team to develop the sustainability vision.

WHY IS DEVELOPING A SUSTAINABILITY VISION IMPORTANT?

Developing a sustainability vision is important to ensure the project team understands the desired outcome of a project. Developing the sustainability vision gives the project team[1]-1 and stakeholders an opportunity to start the conversation about what sustainability means to those involved and how sustainability could be achieved by the project team. Ultimately, the agreed-upon sustainability vision will help shape the sustainability goals (see Section 3.4).

WHEN IS A SUSTAINABILITY VISION DEVELOPED?

Creating the sustainability vision early, preferably before or during alternatives development, makes sustainability an integral part of the project from day one.

HOW IS A SUSTAINABILITY VISION DEVELOPED?

There are several points to keep in mind in creating a successful sustainability vision:

- The development of the vision should be collaborative with input from the owner, interdisciplinary team, and stakeholders.
- The sustainability vision should be high-level but not vague. If a vision is too vague, there is a risk of casting the net too wide for the initial set of sustainability goals and solutions.
- The vision should reflect the values and goals of the owner, the partner agencies, affected communities, and the project.
- The vision should be consistent with the project's purpose and need.
- The vision of the project should remain consistent among the project alternatives.
- If a sustainability vision statement already exists for an owner or for a set of projects (for example, if it was included in system-level programming), this step will be an opportunity to review and accept the vision or to adjust the vision based on any project-specific issues.

EXAMPLE PROJECT

In the example project solution shown on Figure 3-2, the integrated project team developed a sustainability vision specific to the project.

3.3. Step 2- Identify Project Context

WHAT IS THE PROJECT CONTEXT?

Project context is the physical, social, economic, and regulatory setting of a project.

WHO NEEDS TO UNDERSTAND THE PROJECT CONTEXT?

The project context should be identified in the project planning phase with input from the owner, community, and stakeholders. As the project progresses, the project context will continually evolve as

[2] See PDDM Section 3.2.1.4.

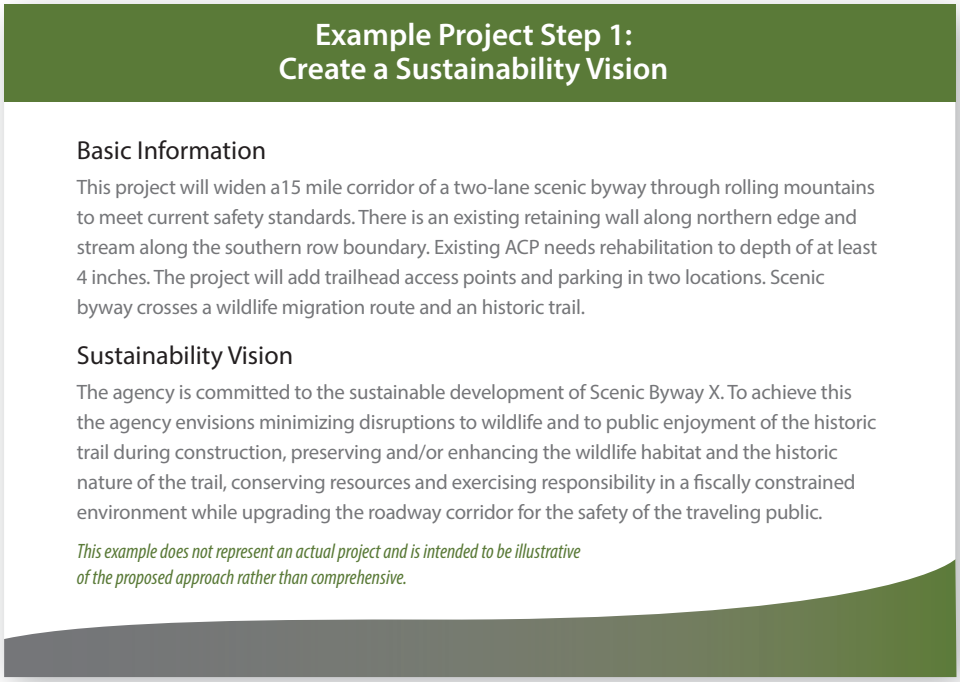


Figure 3-2: Example Project Step 1

more is known about the project and its surroundings. As the project enters the design phase, it may be appropriate for the owner and project team to revisit the context to establish any changes.

WHY IS UNDERSTANDING THE PROJECT CONTEXT IMPORTANT?

Understanding the context of the project has several benefits, including understanding the boundaries and constraints of the project as well as the opportunities that the unique project setting can offer.

The more information the project team gathers on the current conditions of the area, the more informed the team will be when developing its sustainability goals. Later in the approach, the team will select sustainable solutions; the project context will be important in evaluating which solutions are feasible and relevant and which are not. By having a clear understanding of the project context early in the project development, the team will be able to integrate sustainable solutions into the project early and easily.

VALIDATING CONTEXT

FHWA "What is CSS" Website:
http://www.fhwa.dot.gov/context/what.cfm

National Cooperative Highway Research Program (NCHRP) 708 Report
http://www.contextsensitivesolutions.org/

Related INVEST Criteria
PD-3: Context Sensitive Project Development

WHEN IS PROJECT CONTEXT DETERMINED?

The team should strive to understand the context during the project planning phase, as conceptual design begins. However, context is not steady-state; it will evolve as the project progresses and as time passes. Physical context is likely to be more understood once surveys and other field explorations are conducted. Additionally, the social and economic contexts are likely to change if there is a large time gap between

conceptual and preliminary design. As the project progresses, the team should review the context when new information comes available and review these context changes for how they may affect sustainable solutions selected for the project.

HOW IS PROJECT CONTEXT DETERMINED?

Context is unique for every project. The project's context can be broken into four components: physical, social, economic, and regulatory. It is important to identify the details for each. Answering the following questions will help project teams understand the project context:

PHYSICAL

- What is the topography of the area?
- What are the prominent geographic features?
- What is the geological/soil composition?
- What vegetation is currently in the area?
- Are there any structures/buildings in the area?
- What features need to be protected, enhanced, or amended?
- What key environmental issues need to be addressed (water, air quality, habitat, etc.)?

SOCIAL

- Does anyone live in the area? If so, what are the demographics?
- Who are the users of the road?
- What is the current transportation behavior?
- What is the historical context?
- Who are the project stakeholders?

ECONOMIC

- What are the current land uses?
- What is the current O&M cost?
- What is the expected project budget?
- What economic factors are important (longevity, low maintenance, inexpensive materials)?

REGULATORY

- What agencies/permits are needed?
- What design manuals apply?
- What design criteria apply?
- What are the requirements of the project?

EXAMPLE PROJECT

In the example project solution shown on Figure 3-3, the integrated project team identified the noteworthy context elements in the physical, social, economic, and regulatory categories.

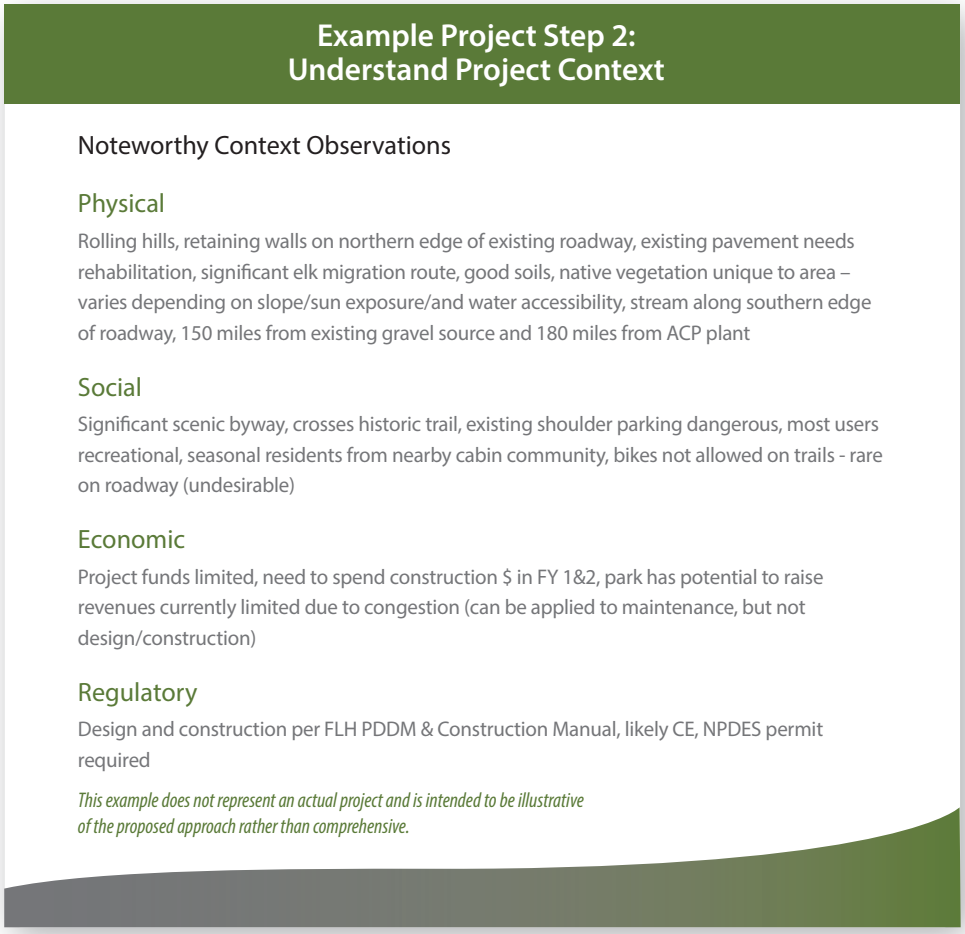


Figure 3-3: Example Project Step 2

3.4. Step 3 - Define Sustainability Goals

WHAT ARE SUSTAINABILITY GOALS?

A sustainability goal sets an expected standard to be achieved for the project. Accomplishment of the goal will support the sustainability vision and the accomplishment of all of the goals for the project should ensure the sustainability vision is realized. Goals provide the framework for the design phase and for selecting and deciding among sustainable solutions.

There is no specific number of goals a project should have; it will depend on the size and type of project. However, it is a best practice not to exceed five to seven goals. Succinct but well-defined goals will create a strong framework for project development. A small number of concise goals is recommended because it is manageable.

WHO SHOULD DEFINE THE SUSTAINABILITY GOALS?

This step should be completed by the interdisciplinary team (see Section 1.5) with feedback from project stakeholders.

WHY ARE SUSTAINABILITY GOALS IMPORTANT?

Defining sustainability goals achieves several things:

- Organization and prioritization of desired outcomes
- A means for analyzing and ranking sustainable solutions
- A connection between sustainability and the NEPA process
- Interdisciplinary discussions and consensus-building
- A way to measure progress toward sustainability

WHEN ARE SUSTAINABILITY GOALS DEFINED?

Once the team begins to understand the context in the project planning phase, the interdisciplinary team should have enough background information to begin defining project-level sustainability goals. The team should work to define sustainability goals after the project's purpose and need is documented and as conceptual design and the environmental documentation process begins. It is important to define project-level sustainability goals at this time because the environmental documentation process occurs concurrently with preliminary and conceptual design; therefore, identifying sustainability goals after the environmental document is completed is too late for them to drive alternatives and decision-making.

The environmental document outlines potential impacts and, in many ways, identifies where opportunities exist for implementing sustainable solutions. Additionally, many aspects of the environmental document, such as mitigation measures, can be directly tied into sustainable solutions. Defining sustainability goals at this time will integrate the sustainability goals with the project's overall goals.

HOW ARE SUSTAINABILITY GOALS DEFINED?

Sustainability goals should be more specific than the sustainability vision and should be consistent with it. The project's sustainability vision should be used in forming and evaluating goals to ensure the vision is supported. For example, if the sustainability vision is to build a road while minimizing the environmental impact, the sustainability goals may include improving local water quality, protecting or enhancing habitat, and limiting use of energy resources. Eventually the project team will use these goals in identifying sustainable solutions. As goals are identified and discussed with stakeholders, it may also be useful to rank goals in order of importance. This will help later in project development when analyzing the trade-offs for sustainable solutions.

The goals should be consistent with context. The project team should understand the answers to the following questions before defining the project's sustainability goals:

- What is the purpose and need of the project?
- What are the requirements of the project (regulations)?
- Who will be affected by the project (stakeholders)?

- What economic factors are important (longevity, low maintenance, inexpensive materials)?
- What key environmental issues need to be addressed (water, air quality, habitat, etc.)?

Once these are understood, developing sustainability goals for the project will be easier.

There are several types of sustainability goals to consider and they vary in level of detail (Table 1). The project may have any combination of the types of goals.

Goal Type	Description	Example	Benefits	Weaknesses
PRESCRIBED TOOLS	Identifies a specific sustainability evaluation tool to use on the project. The owner may apply this goal to all projects or selected projects.	Use FHWA's INVEST to monitor and evaluate overall sustainability of project at 30%, 50%, and 100% design submittals.	Rating tools provide lists of sustainable solutions and consistent methods for evaluation (and sometimes implementation). They create an easy framework to work within.	Could potentially limit the types of sustainable solutions applied to a project. Could focus the project team more on the tool and score than the actual sustainability of the project.
PERFORMANCE GOALS	Sets a target rating or score for a project using a specific sustainability evaluation tool.	Obtain a Gold rating using the Rural Extended scorecard in FHWA's INVEST.	Rating tools provide lists of sustainable solutions and consistent methods for evaluation (and sometimes implementation). Targets can set stretch goals for project teams to accomplish.	Targeting a specific score as a goal may focus the project team more on the score than the actual sustainability of the project and could mislead the team into selecting solutions that are not necessarily appropriate for the project.
CATEGORICAL GOALS	Broad sustainability goals that the project team should consider when selecting sustainable solutions for the project, such as improving water quality or reducing greenhouse gases.	Reduce materials and energy use. Reduce water use. Reduce emissions. Optimize habitat and land use.	Categorical goals allow the project to be flexible in selecting solutions because they are generally less specific but still state a clear goal to measure against.	Categorical goals may be too vague to guide a team to sustainable solutions.
SPECIFIC GOALS	Sometimes an owner has a policy in place that is very specific and can be listed as a goal. Or it may have been decided in the planning phase that a certain feature is very important to a project.	Recycle and reuse 100% of existing retaining wall and pavement materials within project limits.	Specific goals are generally clear and easier to implement.	Setting specific goals this early in the project process could be problematic if impacts to the budget and site conditions are unknown.

Table 1: Types of Sustainability Goals

EXAMPLE PROJECT

In the example project solution shown on Figure 3-4, the sustainability vision is repeated. The integrated project team defined sustainability goals that were consistent with the sustainability vision.

Figure 3-4: Example Project Step 3

3.5. Step 4 - Identify Sustainable Solutions

WHAT ARE SUSTAINABLE SOLUTIONS?

Sustainable solutions are specific project activities, features, or processes that contribute to accomplishing one or more project sustainability goals and support the sustainability vision for the project.

Step 5 assesses and selects the sustainable solutions for project inclusion. At Step 4, sustainable solutions need only be specific and measurable, relevant to the project context, and consistent with the project sustainability goals.

WHO IDENTIFIES SUSTAINABLE SOLUTIONS?

The interdisciplinary team (see Section 1.5), with representation from all disciplines, identifies potential solutions.

SUSTAINABLE SOLUTIONS

A sustainable solution is a specific project activity, feature, or process that accomplishes the goal of promoting sustainability.

Some examples are:

- **Activity**: Recycling existing pavement materials in place or mitigating construction noise.
- **Feature**: Installing bicycle lanes or sidewalks.
- **Process**: Analyzing lifecycle costs or tracking environmental commitments.

WHY IS IDENTIFYING SUSTAINABLE SOLUTIONS IMPORTANT?

It is important to identify sustainable solutions to determine specifically what opportunities exist to accomplish the sustainability vision and goals from Steps 1 and 3 on the project. This is where the specific sustainable activities, features, or processes that will be incorporated into the project are brainstormed.

WHEN ARE SUSTAINABLE SOLUTIONS IDENTIFIED?

The team can begin identifying solutions any time after an alternative is selected, preferably as preliminary design begins. It is best to identify, assess, and select solutions as early in the design phase as possible because this maximizes the number of solutions available to the project. As the project progresses in design, decisions may be made that limit or change the applicability of some solutions. Identifying solutions early in the design process allows the team to actively decide on these trade-offs instead of being forced to accept the remaining solutions.

INTERDISCIPLINARY COORDINATION

No solution belongs to just one discipline; coordination between disciplines is crucial for successful integration of sustainability into a project.

Note that on some projects certain disciplines might progress quicker than others. For example, the drainage design is often further developed in the environmental phase than other elements. In this case, sustainable solutions may need to be identified earlier to incorporate them into alternatives or permit requests.

HOW ARE SUSTAINABLE SOLUTIONS IDENTIFIED?

The purpose of identifying sustainable solutions is to "brainstorm" potential sustainable solutions that would achieve the sustainability goals of the project.

Each discipline should review the sustainability goals and then brainstorm solutions, within its discipline, that could be applied to the project to achieve each of the goals. This will provide the team with a manageable and organized set of solutions that will help focus the team and provide ideas that will encourage interdisciplinary collaboration (in the next step).

This should be viewed as a "big picture" or "brainstorming" activity in which sustainable solutions are identified. The team should strive not to get fixated on subtleties and details of each solution in an effort to determine if it should be accepted or receive further consideration. Additionally, the team should not dismiss solutions because they are not allowed by current standards or specifications. In this brainstorming activity, team members should be encouraged to "push the envelope" and apply analytic thought and problem-solving skills to design tasks within their discipline to develop solutions that fit the context of the project and are in support of the project sustainability goals. It is more important at this step to get the idea on paper. The ingenuity exercised here is valuable for identifying a depth and breadth of solutions for discussion and assessment in the next step.

The result of this research is a set of solutions that the interdisciplinary team will assess in Step 5. It is helpful to document these solutions in a tracking system to ensure they are assessed and, if applicable, selected and incorporated into the project. More information on a suggested tracking system is given in Section 4.3.

EXAMPLE PROJECT

In the example project solution shown in Figure 3-5, the integrated project team brainstormed solutions for two of the sustainability goals and grouped them by discipline.

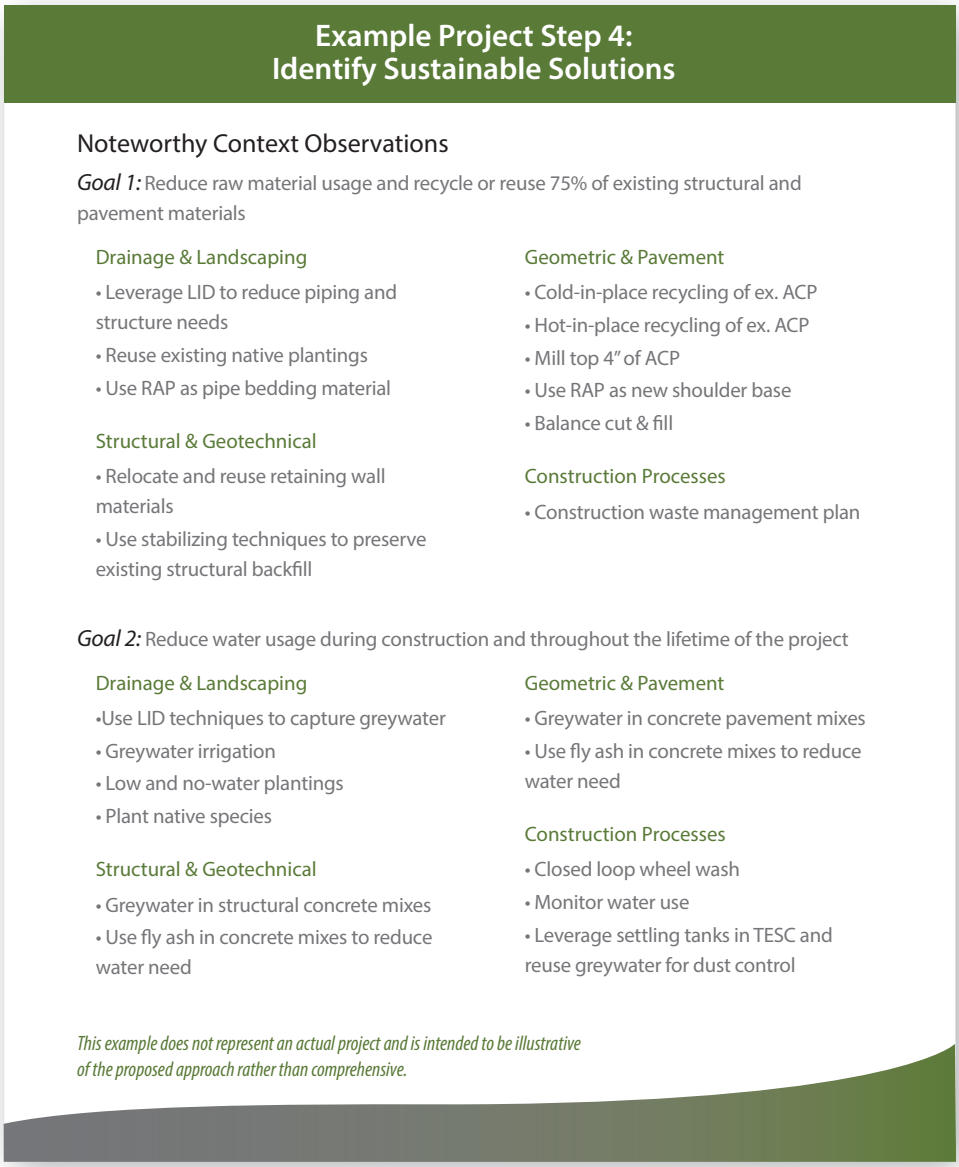


Figure 3-5: Example Project Step 4

3.6. Step 5—Assess and Select Sustainable Solutions

WHO ASSESSES AND SELECTS SUSTAINABLE SOLUTIONS?

The interdisciplinary team (see Section 1.5) should assess and select the sustainable solutions generated by each discipline for each goal. It is recommended that the interdisciplinary team meet together for this step so solutions can be discussed by all disciplines affected and collaboration can be achieved.

WHY IS ASSESSING AND SELECTING SUSTAINABLE SOLUTIONS IMPORTANT?

The purpose of assessing the sustainable solutions is to select an achievable set of solutions for the project. It is not reasonable to expect that one project can achieve every solution identified in the previous step as some solutions will be mutually exclusive, some may not be feasible, and others may not be cost-effective. Reaching agreement within the interdisciplinary team and getting buy-in from the owner on which solutions are to be incorporated into the project are critical for achieving success.

WHEN ARE SUSTAINABLE SOLUTIONS ASSESSED AND SELECTED?

The team should begin assessing and selecting solutions soon after the solutions are identified in Step 4, preferably within the timeframe of preliminary design. If additional information is needed or a long list of solutions has been generated, an iterative process may be necessary to assess all of the solutions identified.

HOW ARE SUSTAINABLE SOLUTIONS ASSESSED AND SELECTED?

If Steps 1 through 4 are successfully completed and the transition between steps is well managed, most of the solutions brainstormed in Step 4 should support the sustainability vision, fit the project context, and help achieve the sustainability goals. However, the first step in assessing solutions is to determine the answers to the following two questions for each of the solutions:

- Does the solution fit the project context?
- Does the solution fulfill one or more project sustainability goals?

Solutions that are found by the team not to fit the project context or the sustainability goals should be removed from the set of solutions. As a best practice, it is recommended that the team document why it decided not to pursue the solution.

Beyond vision, context, and goals, the team should agree upon additional criteria or questions that the team should use to assess and select the solutions. Some examples of criteria or questions that may be used in this assessment are discussed below. These criteria or questions are not exhaustive and should be developed based on what is important and critical to the project's success.

Are there trade-offs? Does the solution conflict with another solution or a sustainability goal?

Examples of trade-offs include:

- Two solutions that are both appropriate and feasible for a project but may be mutually exclusive
- A solution that has competing principles, such as benefits to the environment but at a high economic cost
- A solution has delayed benefits, such as when the initial capital costs are relatively high but the lifecycle costs are overall lower than a typical design

There are no right answers for these trade-offs. One of the benefits of an interdisciplinary team working together on these solutions is that the "right" answer for the sustainability solution trade-offs usually becomes apparent quickly during discussion.

Feasibility or availability?

Is the solution achievable given the resources and skills available to incorporate this solution and the current state of technology? It may be desirable to identify emerging technologies and solutions on projects, but the implementation of these solutions may not become feasible in time for construction or the owner may decide not to risk the implementation of untested solutions.

Is the solution cost-effective and does it fit within the project budget?

Here, the team can look at cost in several ways. One way is to look at the total cost of each solution; however, that is cumbersome and may be difficult to estimate early in design. An alternative way of looking at cost is to estimate the relative cost. For example, does the solution cost about the same as, slightly more than, or considerably more than the traditional method? A relative cost range such as this may be easier to estimate this early in the design phase. Another consideration of cost effectiveness is to examine the initial cost versus the life cycle cost of solutions; some solutions may have a higher initial cost than a traditional solution but have lower replacement or maintenance costs.

What is the sustainable value?

Sustainability is difficult to measure, but the interdisciplinary team may want to measure sustainability on a scale of how significant the sustainable benefit is and how long the benefit lasts or another method that the team views as appropriate. For example, one might score a solution related to dust control lower than a solution related to habitat restoration because dust control benefits would only last through the construction phase while habitat restoration benefits would last throughout the project's lifetime.

Is the solution relevant to where the project is in project development?

It is important to know where a project is in project development in order to understand which decisions have already been made about a project and which decisions can still be influenced. For example, it is unrealistic for a roadway project that has a 50-percent complete design to go back and implement sustainable best practices in project planning and alternatives analysis, but it is very practical to incorporate recycled materials and a construction waste management plan since decisions regarding those items have yet to be made.

The team should use the questions above to facilitate a discussion about each of the solutions identified in Step 4. As solutions are discussed using the criteria and questions above, the team will identify solutions that are not suitable for the project. These solutions should be removed from the set of solutions. It is recommended that the team document why it decided not to pursue a solution in its range of solutions.

EXAMPLE PROJECT

In the example project solution shown below in Figures 3-6 and 3-7, the integrated project team discussed the potential sustainable solutions identified in Step 4 using the questions noted above. Several solutions were eliminated because they are inconsistent with project material selection or because one approach needed to be selected when multiple methods were mutually exclusive.

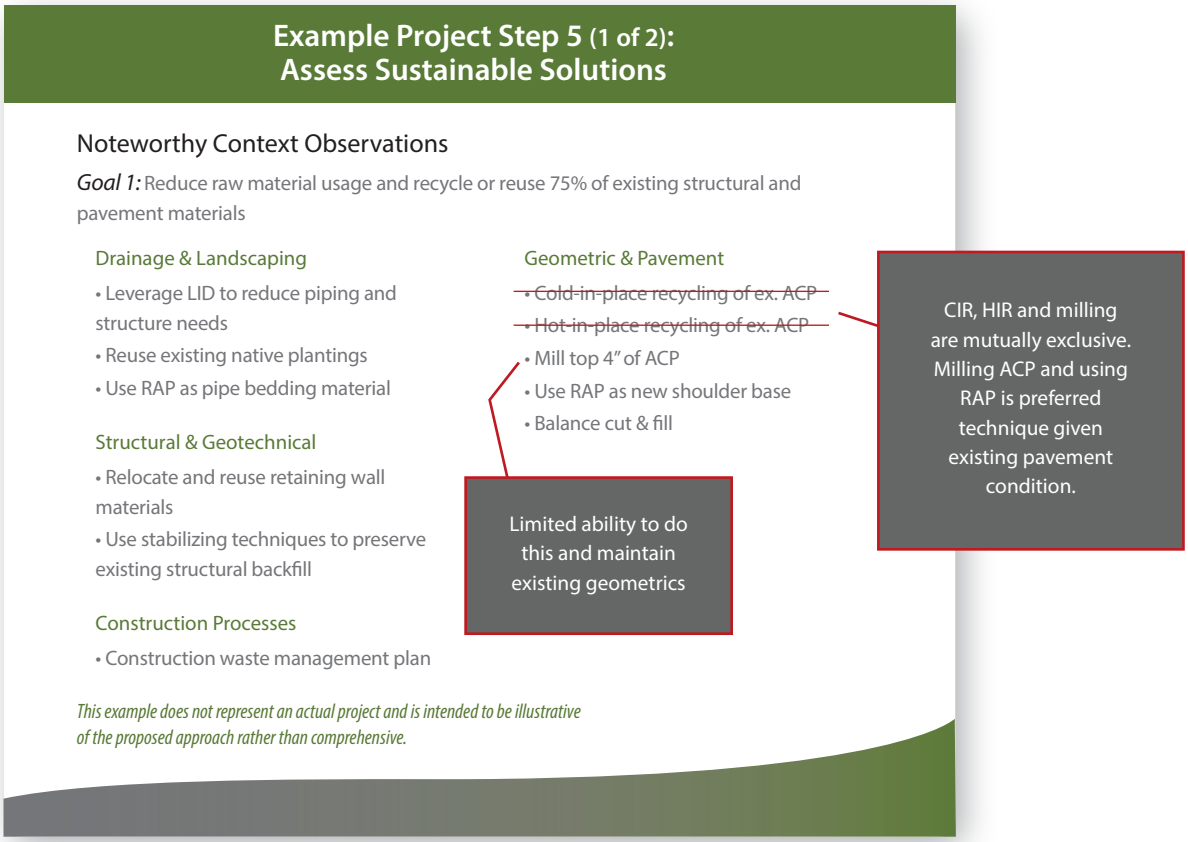


Figure 3-6: Example Project Step 4

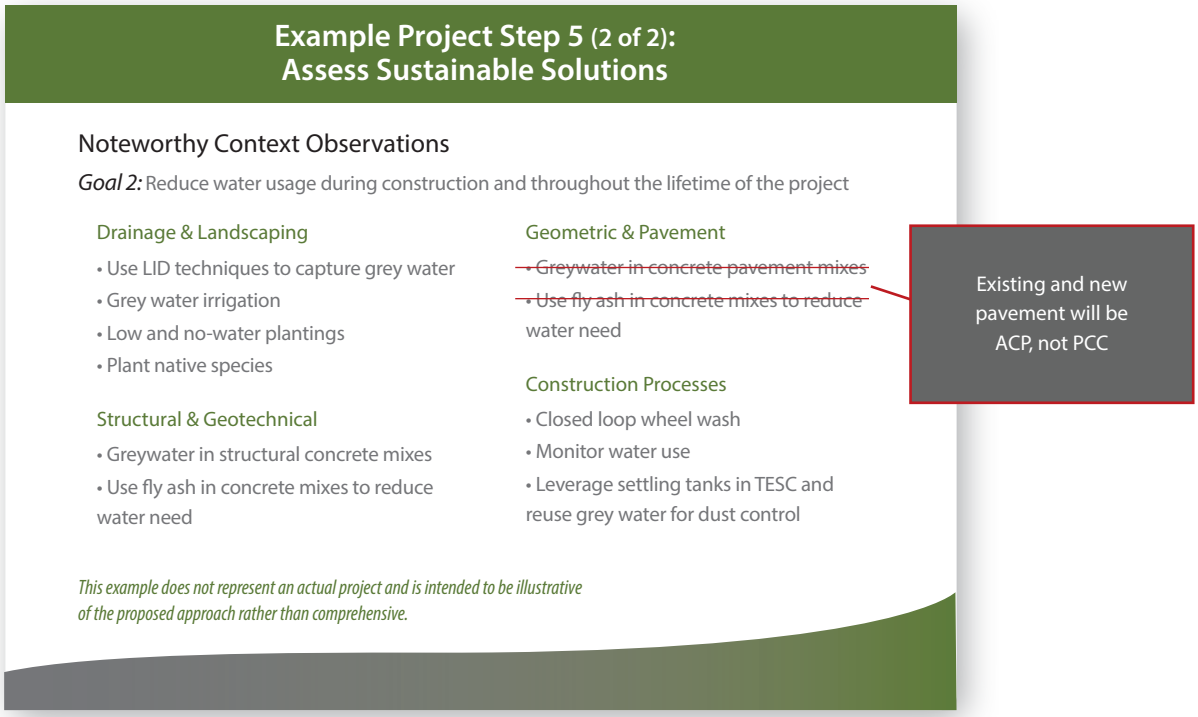


Figure 3-7: Example Project Step 4

3.7. Step 6—Incorporate Solutions

WHO INCORPORATES SUSTAINABLE SOLUTIONS?

The interdisciplinary team (see Section 1.5) is responsible for ensuring that the selected solutions are incorporated into the design.

WHEN ARE SUSTAINABLE SOLUTIONS INCORPORATED?

The team should begin incorporating solutions as soon as each solution is assessed and selected. Incorporation must be complete by final design, and all solutions selected must be incorporated in the PS&E.

The timing for the activity of incorporating each solution will vary by solution. Some solutions can be included in the plan set as early as the preliminary design submittal or as late as intermediate or final design, while many others will only need to appear in the specifications. For the purposes of tracking progress, it may be helpful to document in the design schedule where (in which design documents) and when each solution should be incorporated.

HOW ARE SUSTAINABLE SOLUTIONS INCORPORATED?

Each solution should be assigned to a member of the interdisciplinary team or delegated to a discipline lead for design and integration into the PS&E. The assigned discipline lead should be responsible for coordinating with other discipline leads as necessary and ensuring the solution is developed and integrated into the design according to the design schedule. Problems, issues, and coordination needs for sustainable solutions should become part of the regularly scheduled design meetings.

Most often in standard practice, specifications are drafted late in the design process. While this standard practice is not likely to change, it is a best practice for an engineer to draft specifications for non-standard elements concurrently with design as early as possible. Drafting these specifications concurrently with design can help identify any issues that may need to be addressed in the design or require coordination with other disciplines, and such elements may require a thorough review and take time to gain acceptance from the owner.

EXAMPLE PROJECT

In the example project solution shown on Figure 3-8, the integrated project team is tracking the sustainable solutions that were selected to ensure that they are incorporated as design progresses.

Example Project Step 6: Incorporate Solutions

Responsible Person	Sustainable Solution	When Incorporated	Status
	Leverage LID to reduce piping and structure needs	Intermediate Design	Complete
	Reuse existing native plantings	Final Design	In Process
	Use RAP as pipe bedding material Mill top 4" of ACP Use RAP as new shoulder base Balance cut and fill Relocate and reuse retaining wall materials Use stabilizing techniques to preserve existing structural backfill	Intermediate Design	Complete
	Construction Waste Management Plan	Specifications	In Process
	Use LID techniques to capture grey water Gray water irriation Low and no-water plantings Plant native species	Intermediate Design	In Process
	Closed loop wheel wash Monitor water use Leverage settling tanks in TESC and reuse gray water for dust control	Specifications	In Process

This example does not represent an actual project and is intended to be illustrative of the proposed approach rather than comprehensive.

Figure 3-8: Example Step 6

4. Best Practices

The goal of this chapter is to provide recommended methods and helpful hints for accomplishing the approach in Chapter 3. These methods, or best practices, show the practitioner how to organize the team, how and when to get started even when a project is already underway, and methods and tools for tracking progress. This chapter also covers suggested best practices broken down by phase (planning, design, and construction) and how to transition between phases. And finally, this chapter concludes with a discussion of available sustainability evaluation tools, including FHWA's INVEST, and ideas and suggestions on when and how to use these tools and how these tools can be used while following the approach in Chapter 3.

4.1. Getting Organized

This section discusses the recommended composition of the interdisciplinary team and its leadership.

4.1.1. Sustainability Manager

The approach described in Chapter 3 can best be accomplished by an interdisciplinary team led by a sustainability manager. The sustainability manager for a project can be the project manager or, depending on the size of the project and its emphasis on sustainability, could be a role delegated to another project team member. It is recommended that a sustainability manager be responsible for managing and guiding the project team through the approach presented in this guidebook to ensure that the team is successfully integrating sustainability.

The key responsibilities of the sustainability manager are the following:

- Guide the project team through the approach presented in this guidebook.
- Assign responsibility and create accountability within the project team or the interdisciplinary team (see Section 4.1.2).
- Encourage and facilitate interdisciplinary coordination (see Section 4.1.3).
- Track progress (see Section 4.3).
- Act as a quality control reviewer to ensure that selected solutions are incorporated.
- Ensure continuity as the project team evolves during project development.

SUSTAINABILITY MANAGER

The sustainability manager:

- Could be the same person throughout project development or could transition between phases
- Should have experience with CSS, evaluating alternatives, managing projects, and performing quality control
- Could assign as additional role to team member or select new team member

Depending on the size and duration of the project, the sustainability manager could be the same person throughout project development, or the sustainability manager role may be fulfilled by two or more people. While the project is still in the planning phase, it may be desirable to have a planner serve as the sustainability manager. As the project transitions from project planning into design, the sustainability manager role might be best served by a team member with engineering expertise.

The person selected to be the sustainability manager should be the project manager or a project team member, such as a planner, engineer, or technical expert with experience in sustainability, implementing CSS, evaluating alternatives, managing projects, and performing quality control. While the sustainability manager should be well versed in the process of integrating sustainability into design, the manager does not need to be an expert in all disciplines and all areas of sustainability—that would not be feasible and is not necessary if this approach is followed.

There are multiple approaches to selecting a sustainability manager, and again, this decision may be dependent on the size and duration of the project. As stated, the sustainability manager role could be an additional role assigned to a person already on the project. Or, the sustainability manager could be an

outside, non-project resource, a person with qualifications in sustainability who serves several projects at once and steps in intermittently to ensure the project team is successfully integrating sustainability.

4.1.2. Interdisciplinary Team Composition

The purpose of the interdisciplinary team is to brainstorm and provide input to develop the vision, help identify factors that allow the team to understand the project context, and contribute to defining the project's sustainability goals. Further, the interdisciplinary composition of the team facilitates cross-discipline understanding, collaboration, and design coordination in the brainstorming, assessment, selection, and integration of sustainable solutions throughout project development.

The interdisciplinary team may be most effective and efficient if it is a smaller subset of the project team. This streamlined team should consist of only the project team members necessary to make decisions in consideration of the approach. For example, while the entire project team at some point in project development may help identify or incorporate solutions, only a handful of discipline leads need to be directly involved in interdisciplinary team meetings to define sustainability goals and make decisions in the assessment of solutions.

As a project evolves from project planning to design and finally to construction, the interdisciplinary team may change in composition to meet the needs of the project. Figure 4-1 shows the composition of the interdisciplinary team and how it evolves relative to project development and the approach steps.

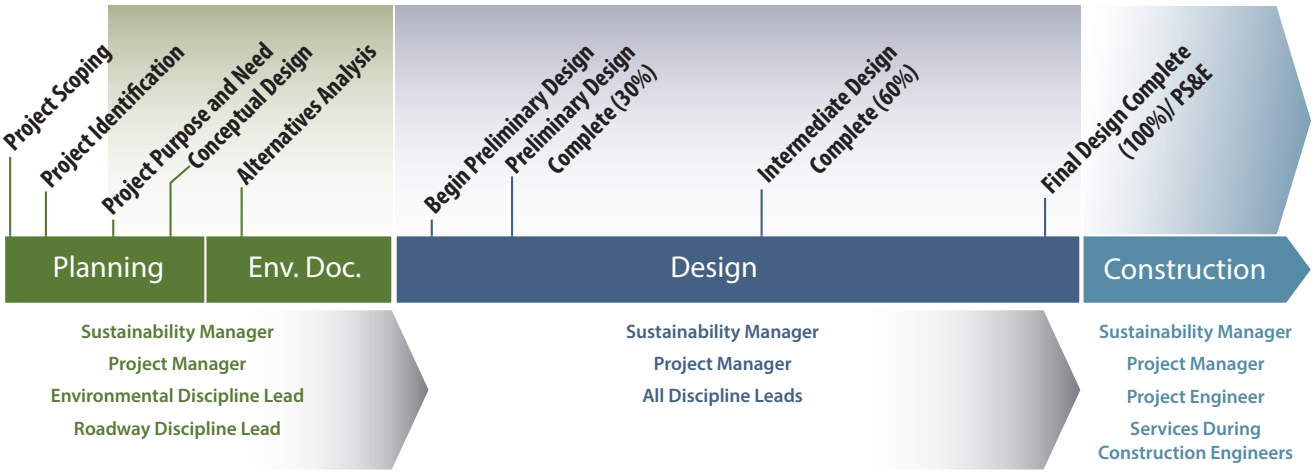


Figure 4-1: Interdisciplinary Team Composition

INTERDISCIPLINARY TEAM (PLANNING)

During the project planning phase and during conceptual design, the interdisciplinary team should include, in addition to the sustainability manager, the project manager, and, at a minimum, the environmental and roadway discipline leads. Consider including a project engineer (for construction expertise) as needed. If the early steps of this approach occur during the project planning phase, the owner may consider including the owner's partners and stakeholders in the interdisciplinary team.

INTERDISCIPLINARY TEAM (DESIGN)

As the project enters preliminary design, the team should expand as appropriate and consist of the sustainability manager, the project manager, and the following discipline leads: roadway, traffic, structures, environmental, drainage, utilities, illumination, landscaping, and survey. Consider including a project engineer for advice regarding the constructability of solutions and an O&M expert for advice regarding the ongoing maintenance requirements of solutions.

INTERDISCIPLINARY TEAM (CONSTRUCTION)

As the project enters construction, the interdisciplinary team should downsize. Only those individuals involved in the management of construction are needed. These include the project manager, the project engineer, and the discipline leads who are providing services during construction.

CONTINUITY

It is important to maintain accountability as the team transitions in step with the phases of project development, as well as to document decisions that affect sustainability and to track progress throughout the project. Each successive team must understand the decision-making process and methodologies followed to-date to ensure continuity between teams. A sustainability tracking system (see Section 4.3) will support this continuity. The sustainability manager(s) should strive to understand how each decision will affect the future phases of the project, and team members should make a concerted effort to provide accurate and useful information for subsequent teams. Refer to Section 4.4 for best practices by phase, which includes a discussion on transitions between phases.

4.1.3. Interdisciplinary Coordination

Coordination within the interdisciplinary team and with the larger project team is critical to the successful integration of sustainability into a project. For example, Step 4 of the approach could be accomplished through brainstorming by discipline and then coming together to assess and select these solutions in a workshop. This has the benefit of providing a depth and breadth of solutions to meet each goal. Discussing the solutions as a group will help identify solutions that likely need assistance from other disciplines to accomplish.

The sustainability manager can facilitate interdisciplinary coordination through interdisciplinary team meetings and workshops, design meetings, cross-discipline review of design documents, and quality control reviews. All of these methods will encourage regular interdisciplinary discussions.

4.2. Getting Started

There is no single appropriate time to begin this approach; there is both an "optimal" time to pursue each step and a window of time in which the step can still be pursued and accomplished. It is important to understand that the opportunities to incorporate sustainability vary and eventually diminish as a project progresses through project development. While it is generally preferable to consider sustainability as early as possible, there is still some opportunity for practitioners to incorporate sustainability after design commences. Knowing where a project is in its development and what decisions have already been made will help practitioners understand which decisions can still be influenced. Section 4.2.1 discusses

the optimal time to achieve each step of the approach, while Section 4.2.2 discusses the window of opportunity for each step. These "optimal" and "window" time frames are shown in Figure 4-2.

4.2.1. Where to Begin

It is recommended that Step 1 of this approach, Develop a Sustainability Vision, begin soon after the project's purpose and need have been identified. Step 2, Understand Project Context, and Step 3, Define Sustainability Goals, may be best to first attempt during conceptual design, as the project enters environmental documentation. Once preliminary design begins, it is appropriate to start Step 4, Identify Sustainable Solutions, and Step 5, Assess and Select Sustainable Solutions. Identifying, assessing, and selecting solutions can be done sequentially or they can be accomplished through an iterative process. Ideally, the sustainable solutions for the project team to pursue should be selected before the completion of the preliminary design. The team should work on Step 6, Incorporate Solutions, and continue the interdisciplinary coordination as the project advances from preliminary design to final design.

4.2.2. Modifying the Approach for Projects that Are Underway

If sustainability was not addressed in project planning, the 6-step approach can be modified for projects that are already underway. The interdisciplinary team should simply start at Step 1 and follow the approach with the understanding that some solutions identified in Step 4 may not be feasible due to decisions already made by the project or constraints already added to the project. Projects that are well into design may find that there is not enough time to achieve the first three steps and that the opportunity to incorporate solutions has diminished greatly because it is too late in design to make significant changes to the project. Figure 4-2 shows the window of opportunity to accomplish each step, from the earliest feasible time to the last reasonable time.

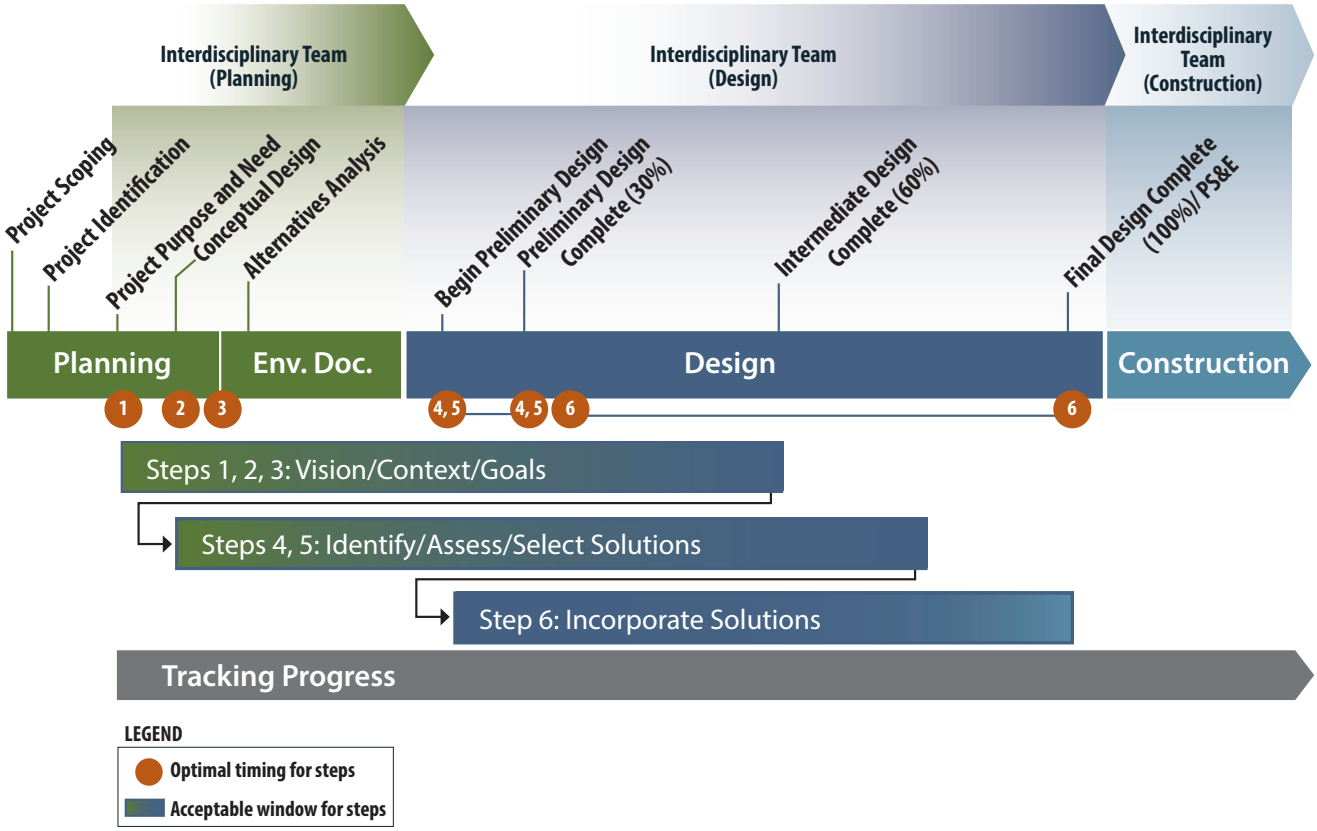


Figure 4-2: Timeline of Approach

4.3. Tracking System

As progress is made with each of the steps, it is important to maintain a tracking system. A tracking system keeps project information intact and documents the pertinent decision-making related to the incorporation of sustainability into the project. Without a tracking system, there is little or no accountability for meeting the sustainability vision and sustainability goals. By documenting decisions, a tracking system provides continuity between each phase by ensuring that decisions made during each phase are understood by the team in the next phase. It helps teams consider the phases of project development, reminding them that the decisions made in the planning phase will affect those working on the project in future phases.

During the first three steps, the tracking system can be a written record of the team's actions, including meeting minutes and decisions made, the sustainability vision, a brief summary of the project context to date, and the sustainability goals. How and when the vision and goals were developed and defined and who was involved are all important to include in the written record. Often, project development is delayed after alternative selection. Documenting sustainability decisions during these early steps will provide continuity between project planning and design. Figures 3-2, 3-3, and 3-5 in Sections 3.2, 3.3, and 3.4, respectively, show how project information from Steps 1, 2, and 3 might be documented with the project files.

As the team begins Step 4, Identify Sustainable Solutions, a tracking system facilitates accountability and maintains a database of potential solutions. Utilizing a database as a tracking system might be an effective means of managing this information. See Table 2 for an example of this database. Initially, the database

could contain each solution identified, note which discipline lead would be responsible for it and which goal it addresses, and provide other information, such as relative cost and conflicts with other solutions. As Steps 4 and 5 are completed, the database should be updated as solutions are assessed, selected or dismissed, and incorporated into the project. Some solutions may be designated by the team as needing further assessment to determine feasibility or appropriateness for the project; the actions needed for these solutions should be recorded and assigned. Decisions about dismissal of solutions should also be recorded.

Once sustainable solutions are selected for incorporation into a project, tracking progress will help project teams plan, design, and incorporate the solutions. Because solutions are incorporated into the design at varying times and some appear in the plan set while others appear exclusively in the specifications, an organized method, such as a database, is an effective way to monitor and manage the solution set.

It is not necessary to follow the examples cited in this section for tracking sustainability, nor is it necessary to track sustainability separate from other project decisions and critical path items that must be tracked. However, it is necessary to utilize a method to track progress. Maintaining a tracking system facilitates accountability by providing a method for ensuring sustainable solutions agreed upon are incorporated into design and construction. Incorporating these solutions will, in turn, ensure the project achieves its sustainability vision and goals.

Tracking this progress can be achieved in a number of ways, but it is recommended that one person, such as the sustainability manager, be appointed to track progress. This person should maintain a comprehensive tracking database that lists all the selected solutions along with other pertinent data, such as:

- A description of each solution
- The goal(s) each solution supports
- The stage(s) in design when each solution must be implemented
- Current status of each solution
- The discipline leads responsible for ensuring a solution is integrated into design
- Pertinent notes or comments for future reference

During the quality control reviews, the sustainability manager should check that solutions were incorporated at review milestones in the project. If the tracking system is kept up to date, this should be a simple check against the PS&E.

	MEETS SUSTAINABILITY GOALS			DESIGN STATUS			
Solution Number	Solution	(# - Goal that solution supports)	Assumptions and Comments	Discipline	Task Lead	Stage to Implement	Design Status
1	Leverage LID to reduce piping and structure needs	1 - Reduce raw material usage and recycle or reuse 75% of existing structural and pavement materials		Drainage		Intermediate Design	Complete
2	Reuse existing native plantings	1 - Reduce raw material usage and recycle or reuse 75% of existing structural and pavement materials		Landscaping		Final Design	In Process
3	Use RAP as pipe bedding material	1 - Reduce raw material usage and recycle or reuse 75% of existing structural and pavement materials	Coordinate with Roadway to determine RAP quantities	Drainage		Intermediate Design	Complete
4	Mill top 4" of ACP	1 - Reduce raw material usage and recycle or reuse 75% of existing structural and pavement materials		Roadway		Intermediate Design	Complete
5	Use RAP as new shoulder base	1 - Reduce raw material usage and recycle or reuse 75% of existing structural and pavement materials	Coordinate with Drainage to determine RAP needs	Roadway		Intermediate Design	Complete
6	Balance cut and fill	1 - Reduce raw material usage and recycle or reuse 75% of existing structural and pavement materials		Roadway		Intermediate Design	Complete
7	Relocate and reuse retaining wall materials	1 - Reduce raw material usage and recycle or reuse 75% of existing structural and pavement materials		Structural		Intermediate Design	Complete
8	Use stabilizing techniques to preserve existing structural backfill	1 - Reduce raw material usage and recycle or reuse 75% of existing structural and pavement materials		Geotechnical		Intermediate Design	Complete
9	Construction Waste Management Plan	1 - Reduce raw material usage and recycle or reuse 75% of existing structural and pavement materials		Construction		Specifications	In Process
10	Use LID techniques to capture grey water	2 - Reduce water usage during construction and throughout the lifetime of the project.		Drainage		Intermediate Design	In Process
11	Gray water irrigation	2 - Reduce water usage during construction and throughout the lifetime of the project.	Coordinate with Drainage for grey water	Landscaping		Intermediate Design	In Process
12	Low and no-water plantings	2 - Reduce water usage during construction and throughout the lifetime of the project.		Landscaping		Intermediate Design	In Process
13	Plant native species	2 - Reduce water usage during construction and throughout the lifetime of the project.		Landscaping		Intermediate Design	In Process

Table 2: Example of Sustainability Tracking System (Database)

4.4. Best Practices by Phase

Best practices are strategies for integrating sustainability into each phase of project development. Figure 4-3 illustrates the overall approach for integrating sustainability into roadway project development throughout the three phases.

Figure 4-3: Integrating Sustainability throughout Project Development Phases

4.4.1. Project Planning

BACKGROUND

Planning can be categorized in two ways: at the system level and the project level. System-level planning may happen at a regional level by a metropolitan planning organization, through a local long-range transportation plan, or through a statewide transportation improvement program. These transportation planning documents usually identify projects that are expected to occur within a certain time frame. The level of detail in which the individual projects are described varies. Generally, the system-wide programs identify the location and the estimated budget of projects (since oftentimes this is how transportation dollars are allocated) as well as the prioritization of projects. Project details are usually identified later during project scoping. This guidebook assumes that system-level planning for a particular project is complete. For additional guidance on integrating sustainability into system-level planning and programming, see FHWA's INVEST System Planning module.

The project-level planning (or "project planning") phase includes project scoping (which includes initial public and stakeholder involvement, preliminary studies and surveys, tentative project costs, schedule, and the beginning of identifying project alternatives) and the beginning of the environmental review process (Figure 4-4). The approach in this guidebook, specifically Steps 1, 2, and 3, should begin during the project planning phase. While a project team may begin following this approach during the design phase, the sooner a project team starts considering sustainability, the better.

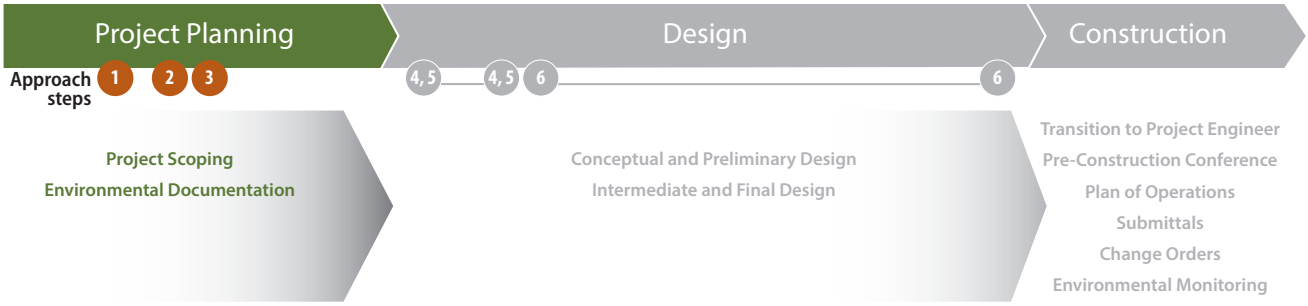


Figure 4-4: Integrating Sustainability throughout Project Development Phases

BEST PRACTICES FOR PROJECT PLANNING

In the project-planning phase, the sustainability vision is developed, the context is identified and begun to be understood, and sustainability goals for the project are defined. This section discusses best practices for achieving Steps 1, 2, and 3 during the planning phase. Ideally, these steps are completed by the time a project enters design. However, it is still possible to complete these steps once a project has already entered design (see Table 2 and Section 4.2.2).

Sustainability vision

The sustainability vision goes beyond the project's purpose and need by asking, "How can this project protect and enhance economic, social, and environmental resources?"

Ideally, developing a sustainability vision should be done with a collaborative approach, through meetings and public outreach, to reach a vision that is broadly supported. Often the vision of a project results directly from the problem the project was proposed to solve, whether it is rebuilding an unsafe road, expanding a congested highway, or restoring an historic resource. A collaborative approach that involves stakeholders may provide the project team with a different perspective of the project, which may help identify the sustainability elements that are the most important to the project.

Project context

As noted in Section 2.5, sustainability is closely tied to CSS. According to FHWA (2007), the desired outcome of implementing CSS is developing projects that:

- "Are in harmony with the community and preserve the environmental, scenic, aesthetic, historic, and natural resource values of the area.
- Are safe for all users.
- Solve problems that are agreed upon by a full range of stakeholders.
- Meet or exceed the expectations of both designers and stakeholders, thereby adding lasting value to the community, the environment, and the transportation system.
- Demonstrate effective and efficient use of resources (people, time, budget) among all parties."

UNDERSTANDING PROJECT CONTEXT

Related INVEST Criteria:

PD-3: Context Sensitive Project Development

However, it is important to understand how to evaluate and use this information for eventually implementing sustainable solutions. Using the project context questions in Step 2 (see Section 3.3), the project team can create a list of context features that the project should protect, enhance, or amend. For example, the current drainage problems within a project area would be a potential opportunity for implementing a sustainable solution that addresses stormwater later in the process.

Sustainability goals

While the exercise of defining sustainability goals may be developed for each project, it is just as likely that an owner agency may set sustainability goals common to its entire program. In this case, the interdisciplinary team need only review the goals and ensure that each goal is relevant to the project and consistent with the project's sustainability vision.

4.4.2. Transition from Planning to Design

Once the project team has a sustainability vision, understands the project's context, and has developed sustainability goals, it needs to ensure that this vision is advanced to the next phase of project development. This helps to ensure that future decisions are aligned with the project's sustainability vision and goals. The vision, goals, and the project context will be relied on in evaluating which sustainable solutions should be selected for implementation. The transition from planning to design will likely be done in conjunction with the creation of sustainability goals, but it needs to be done before the project has moved too far into the design phase.

4.4.3. Transition to Lead Design Engineer

Once the sustainability tracking documentation for the planning phase is complete, the sustainability manager should meet with the project manager (if different) for the design phase of the project development to review the vision, context, and project-level goals identified to date. This guidebook should also be discussed to ensure that both parties are aware of the resources available to them. This step is essential for the successful integration of sustainable design in the design phase of the project.

4.4.4. Design

The design phase is key to the successful integration of sustainability into a project because this phase is when the sustainability vision and sustainability goals for the project either come to fruition or fail. This section discusses best practices for achieving Steps 4, 5, and 6 during the design phase (Figure 4-5). Ideally

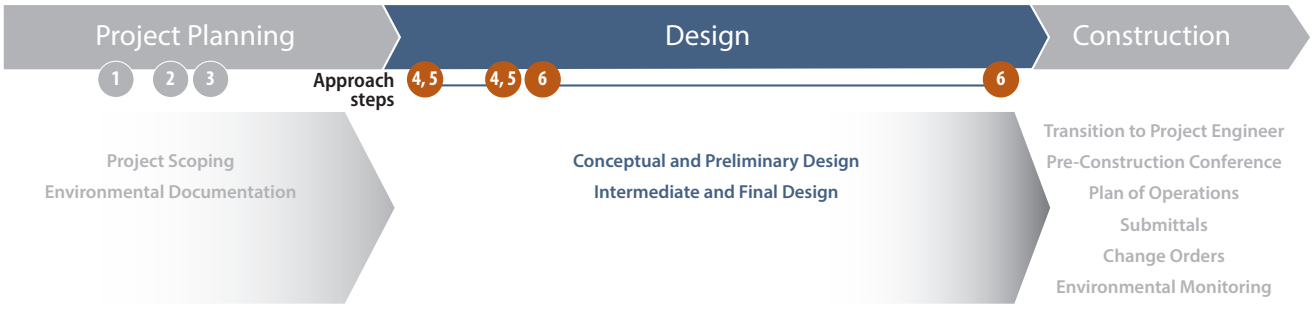


Figure 4-5: Integrating Sustainability in Design

Steps 1, 2, and 3 are completed by the time a project enters design. However, it is still possible to complete these steps once a project has already entered design (see Table 2 and Section 4.2.2).

If a long time lapse has occurred between project planning and the beginning of design, and Steps 1, 2, and 3 were completed at that time, the sustainability manager should review the tracking documentation, not only for understanding, but to validate the project context and sustainability goals identified previously. This should be done before beginning Step 4.

An interdisciplinary team may find that the most effective method of identifying, assessing, and selecting sustainable solutions is to work together in a series of well-planned meetings or workshops. The purpose of having a series of workshops is to encourage an iterative process and participation by all disciplines. In these interdisciplinary gatherings, discipline leads can discuss and debate each solution regarding its potential trade-offs or conflicts, feasibility or availability, cost, sustainability value, and relevance. For some solutions, the team may decide that it is not readily apparent whether the solution should be incorporated and, therefore, additional research will help the team understand the solution and decide whether it is appropriate for the project. Having a series of workshops gives time for discipline leads to research these solutions and report back to the team at the next workshop. These workshops do not necessarily need to be additional meetings for the interdisciplinary team—they could likely be accomplished by expanding the agenda of existing project coordination meetings.

In the first workshop, the sustainability manager should consider leading the interdisciplinary team in a review of the purpose of the workshops and ensure that the team understands the project's sustainability vision, goals, and context. Before the team begins assessing solutions, it is important for the team to discuss what factors it should use to assess solutions. In addition to the factors suggested in Section 3.6, the team may have additional factors to filter solutions by.

As the project continues through design, occasional workshops should be held as necessary in order to complete the assessment of all identified solutions. Once solutions are selected, the progress of incorporating solutions (Step 6) should be monitored via a tracking system by the project manager or sustainability manager. Most of this management can occur during regularly scheduled design meetings and quality control reviews.

During Steps 5 and 6, implementation of a tracking system is critically important to the successful integration of sustainability into project development. In the design phase, incorporation of sustainable solutions may vary by timing of implementation and location for recording in the project documentation. Some solutions selected for incorporation may be designed and represented in the plan set while others may only be described in the project special provisions, which are generally written toward the end of the design phase. Additionally, sustainable solutions are not yet standard practice and may be unfamiliar to many practitioners. A tracking system, as described in Section 4.3, and quality control reviews are essential for maintaining accountability.

DESIGN PHASE

1. Review the vision, context, and goals
2. Work together in an iterative process through a series of interdisciplinary workshops
3. Include all solutions in PS&E
4. Track progress and conduct quality control review

The importance of including the selected solutions in the plans and specifications cannot be over-emphasized. While the project engineer can help the contractor understand the sustainability vision and goals of a project, the solutions that support these goals must be designed and specified in the contract documents, just like all other elements of design.

4.4.5. Transition from Design to Construction

Once the tracking system is up to date per the work in Section 4.3, the project manager or sustainability manager should meet with the project engineer for construction to specifically review the vision, context, and project-level goals and the solutions incorporated in the plans and specifications.

4.4.6. Construction

BACKGROUND

In the construction phase (Figure 4-6), successful integration of sustainable solutions into the design of a project can result in a constructed project that meets the original sustainability vision for the project and meets or exceeds each sustainability goal. This section discusses best practices during the construction phase to ensure that the solutions selected for incorporation in Step 6 are successfully constructed and that the intent of the design is not lost or made unachievable through field change orders, construction operations, or other decisions made during construction.

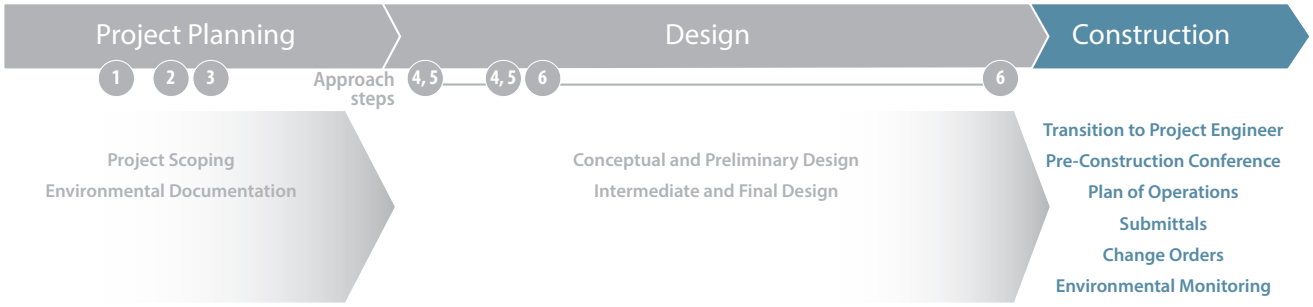


Figure 4-6: Integrating Sustainability in Construction

The project engineer plays a key role in ensuring the project complies with sustainability commitments because it is the project engineer who exercises direct authority at the construction site. Therefore, it is important to ensure that the project engineer clearly understands the sustainability commitments and design decisions and works to prevent field changes that could prevent the integration of a sustainable element. The project engineer must monitor, support, and consult with the contractor as necessary on the construction or implementation of sustainable solutions.

FACILITATE UNDERSTANDING IN BOTH PROJECT ENGINEER AND CONTRACTOR

Although all steps of the approach are completed by the time a project enters construction and all sustainable solutions are incorporated into the plans and specifications, the project engineer and others conducting construction management need to understand what the sustainability elements of the design are and why they were designed as such. The sustainable solutions might utilize a method or

technology that is unfamiliar to both the project engineer and contractor. Providing the project engineer with a written record of the decisions regarding sustainability, such as the tracking system described in Section 4.3, can help. The project engineer is more likely to make a decision that supports the sustainability vision if he or she understands the background of the project and the decision and trade-offs made in the pursuit of integrating sustainability into the project. Adequate background information will help the project engineer understand the interconnectivity of decisions. This understanding will ensure the project engineer does not approve field changes that could prevent a solution from being constructed or implemented.

Contractors may be accustomed to following a set of standard procedures and inclined to request changes to elements of the project when an element is unfamiliar. Conducting a partnering exercise with the contractor can help the contractor identify and understand the sustainable solutions incorporated in the design and the sustainability goals of the project. This can also be accomplished through the preconstruction conference.

PLAN OF OPERATIONS

The project engineer should review the contractor's plan of operations, which includes a schedule, safety plan, temporary erosion and sediment control (TESC) plan, and traffic control plan and is required to be submitted prior to beginning work, typically at the preconstruction conference.[1] The plan of operations must be consistent with the contract.

SUBMITTALS AND CHANGE ORDERS

The project engineer should ensure that submittals (including but not limited to shop and falsework drawings, requests for information, and material submittals) and change orders are consistent with the sustainability vision, goals, or sustainable solutions incorporated in the plans. Where changes have to be made, the project engineer should consult with the design engineer(s) and attempt to find a substitute solution that meets the same sustainability goals and vision as the original solution, if possible.

Upon completion of the sustainable project elements, the project engineer should record observations and provide feedback for the engineer of record.[2] The following is an example of feedback that might be recorded and transmitted to the engineer of record:

> A special provision was required for porous pavement used on a bike path adjacent to the roadway; however, the contractor had to make minor adjustments to the mix design to match available materials from the local distributors. This approach was acceptable to the designers and met the intent of the sustainable solution.

ALTERNATIVE CONTRACTING METHODS

Innovative contracting is a way of rewarding a contractor for sustainable actions that are not normally included in the contract or to build in sustainable benefit for just a marginal cost to the contract. Every contractor has the opportunity to incorporate additional sustainable means and methods into its work that may not be included in the contract documents. The project engineer can be a resource of potential processes, including those from the INVEST criteria PD-25 through PD-29, and should encourage the contractor to work toward accomplishing incentives built into such a contract.

ENVIRONMENTAL MONITORING

Environmental monitoring and reporting may already be a part of the project from the commitments that came out of the environmental review process. If so, monitoring sustainable solutions can be handled at the same time and in a similar manner. However, it is important to distinguish between those commitments that are bound by environmental documents or permits and those that are implemented voluntarily.

4.4.7. Transition from Construction to O&M

Once sustainable solutions are constructed on a project, the project engineer should update the sustainability tracking system to reflect the construction and any feedback as well as any information relevant to the O&M of sustainable facilities.

4.5. Technical Resources

The approach in this guidebook relies on the team to develop solutions that address sustainability goals, but does not address where solutions might be "found." As mentioned in Section 2.7.3, there are two types of resources that will be valuable to the team integrating sustainability into roadway projects: technical documents and sustainability evaluation tools.

Each of these resources lends significant and valuable technical information. It is important to understand what resources are available, what their purpose is, and how to use them appropriately. This section discusses available technical documents and sustainability evaluation tools, highlights FHWA's INVEST, and provides best practices for leveraging these tools in conjunction with the approach presented in this guidebook.

4.5.1. Technical Documents

Applicable sustainable solutions for roadway projects can be found in technical documents, such as WFL's *Roadside Revegetation: An Integrated Approach to Establishing Native Plants* (WFL, 2007) and WFL's *An Integrated Approach to Sustainable Roadside Design and Restoration*. (WFL, 2013)

- *Roadside Revegetation* is a sustainability process guide that presents a comprehensive process for establishing native plants.
- WFL's *An Integrated Approach to Sustainable Roadside Design and Restoration* is a document that is focused primarily on integrating sustainability into elements of the road section beyond the edge of pavement to the right-of-way. Specific solutions can be found, including the use of bio-retention and bio-slopes in locations where run-off from rural roadways may impact ecologically sensitive areas.

These two documents, and others like them, provide strategies and tools for integrating sustainability into roadside design and can be easily adapted into sustainable solutions for a given project. While technical documents provide in-depth knowledge on their subject, the converse limitation of technical documents is their lack of comprehensive information. For example, *Roadside Revegetation* covers one specific subject area, vegetation within rights-of-way, and *An Integrated Approach to Sustainable Roadside Design and Restoration* focuses on sustainability elements outside of the paved roadway section.

4.5.2. Sustainability Evaluation Tools

Sustainability evaluation tools are excellent resources of sustainable solutions. These tools are generally designed as retrospective tools used to evaluate completed projects. While sustainability evaluation tools, such as INVEST or Greenroads™, are comprehensive(as opposed to the in-depth focus of technical documents), they tend not to provide well-developed guidance on the *process* of integrating sustainability throughout project development, the focus of this guidebook.

It is important to remember that some evaluation tools may provide a specific "goal" but not necessarily the specific project activity, feature, or process needed to accomplish that goal. It is those specific project activities, features, or processes, in other words "actions," that comprise a sustainable solution. When using these tools to identify sustainable solutions, it is important to focus on the potential solutions and not the point values assigned to the credits or criteria. It is more critical to find solutions that fit the context and goals of the project than to determine how a project might theoretically score on an evaluation tool. If a team must decide between mutually exclusive solutions, the point values may appropriately be a determining factor if the team desires.

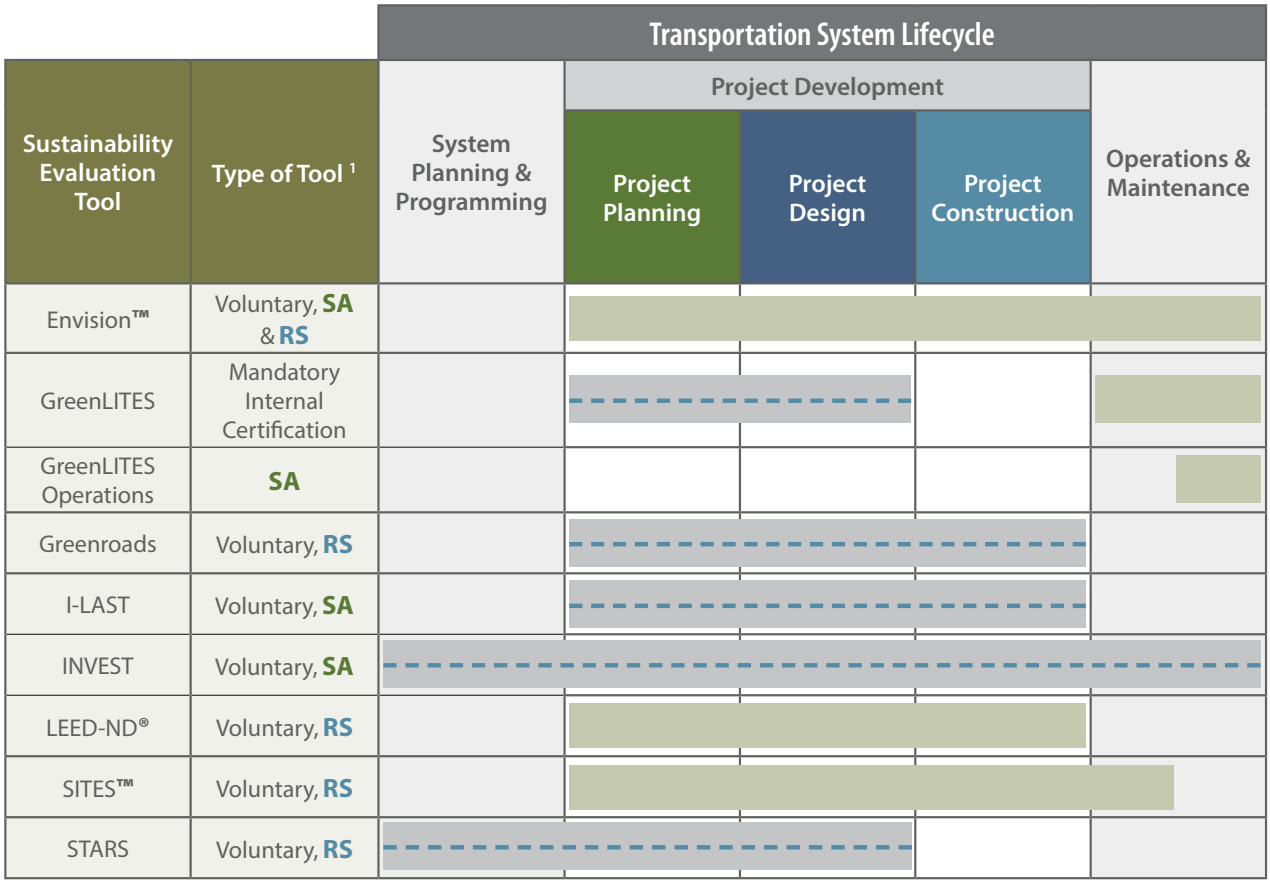
Figure 4-7, which is adopted from *Best Practices for Integrating Sustainability into Roadway Project Development* (Reid, Davis, Bevan, 2011), shows a comparison of currently available sustainability evaluation tools, including a key to the stages when a particular evaluation tool might be a good source of solutions. The evaluation tools reviewed in Figure 21 are transportation-specific or have some applicability to roadway projects and are applicable to different phases of the transportation system lifecycle. It is important to understand the focus and intent of each of these tools in deciding to leverage them. These tools are relevant to roadways and are currently ready or under development in the U.S. They vary greatly in their degree of completion and include both self-evaluation tools and third-party rating systems.

The sustainability evaluation tools in Figure 4-7 are described briefly below.

- **Envision™**- Developed by the Zofnass Program for Sustainable Infrastructure and the Institute for Sustainable Infrastructure (ISI), a non-profit organization founded by the American Council of Engineering Companies (ACEC), the American Public Works Association, and the American Society of Civil Engineers. ISI's Envision™ rating systems, released in January 2012, are specifically designed to address the needs of civil engineering infrastructure in the U.S. and Canada. www.sustainableinfrastructure.org

- **GreenLITES Project Design and GreenLITES Operations (Green Leadership In Transportation Environmental Sustainability)**- developed by the New York State Department of Transportation for use on New York State roadway projects. A self-certification program developed primarily as an internal management program for New York State Department of Transportation, it is formatted as a comprehensive checklist. GreenLITES Project Design (Version 2.1.0, published April 2010) focuses on roadway planning and design. GreenLITES Operations (Version 1, published April 2009) focuses on the post-construction roadway and sustainable practices in this area. www.nysdot.gov/programs/greenlites

- **Greenroads™**- developed by the University of Washington and CH2MHILL for use in multiple U.S. jurisdictions, now managed by The Greenroads Foundation, a non-profit, third-party corporation. This voluntary rating system focuses on urban and rural roadway planning, design, and construction.



1 Type of Tool indicates planned ultimate tool type. Some emerging systems are at a lesser point of development.
Source: Best Practices for Integrating Sustainability into Roadway Project Development. Reid, Davis, and Bevan, 2011

Figure 4-7: Comparison of Current Sustainability Evaluation Tools

Version 1.5 of the Greenroads manual was completed in February 2011 and includes comprehensive and specific examples, strategies, research, and citations. www.greenroads.us

- **I-LAST (Illinois Livable and Sustainable Transportation)**- developed by the Joint Sustainability Group of the Illinois Department of Transportation, ACEC-Illinois, and the Illinois Road and Transportation Builders Association. An advisory document intended to ascertain and document sustainable practices on state highway projects in planning, design, and construction, it was initially released in January 2010. Construction was added with Version 2.0 in January 2012. A list of credits is included, but descriptions are short and sometimes general. www.acec-il.org/handouts/I-LASTGuidebook.pdf

- **INVEST (Infrastructure Voluntary Evaluation Sustainability Tool)**- developed by FHWA. This sustainability self-evaluation tool covers all aspects of major highway investment and maintenance. INVEST considers the lifecycle of projects with criteria for system planning, project development, and O&M. Version 1 was released in October 2012. www.sustainablehighways.org

- **LEED®-ND (Leadership in Energy and Environmental Design Rating System for Neighborhood Development)**- developed by the U.S. Green Building Council in partnership with the Congress for the New Urbanism and the Natural Resources Defense Council. Given that the LEED®-ND system is for neighborhood development, it should be noted that only a few credits apply to roadways. The system is presented in a well-developed manual but lacks substantial research or empirical evidence in its present form. LEED®-ND recently completed the pilot phase and is available for general use. New project registration and certification is through the Green Building Certification Institute. www.usgbc.org

- **SITES™ (Sustainable Sites Initiative)**- developed as an interdisciplinary effort by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at The University of Texas at Austin, and the United States Botanic Garden to create voluntary national guidelines and performance benchmarks for sustainable land design, construction, and maintenance practices. The guidelines are focused on site development; some credits apply to roads but only in their relationship to site development. The 2-year pilot program closed in June 2012; SITES is slated to be released in summer 2013. www.sustainablesites.org

- **STARS (Sustainable Transportation Access Rating System)**- developed by the North American Sustainable Transportation Council, a registered nonprofit organization. STARS is an integrated planning framework for transportation plans and projects and is designed to assess the lifecycle sustainability of transportation plan or project alternatives during the planning and design phases. Version 1.0, the pilot project application manual, was released in November 2010. The development of the certification and rating system component of STARS-Project and STARS-Plan began in the fall of 2012. http://www.transportationcouncil.org/about-stars

4.5.3. INVEST

INVEST was developed by FHWA (www.sustainablehighways.org) as a practical, web-based collection of voluntary best practices, called criteria, designed to help transportation agencies integrate sustainability into their programs (policies, processes, procedures, and practices) and projects. While the use of INVEST is voluntary, it can be used by transportation agencies, such as departments of transportation, master planning organizations, councils of governments, public works departments, federal land management agencies, and their consultants and partners, to evaluate and aid the integration of sustainability into their programs and projects.

There are several reasons why INVEST was selected to be highlighted in this guidebook:

- It is focused on highways and transportation, while some of the other tools cover broader topics, such as general civil infrastructure or site development.

- It is based upon ideas from the other tools and input from the highway industry. It can serve as a national tool and resource with coordination and input from the whole industry.

- It is adaptable to many types and sizes of projects (paving, reconstruction, new construction, highway, arterial, etc.) and project settings (urban and rural).

- It is a voluntary self-evaluation tool that is free to use. Many other sustainability evaluation tools involve third party certification reviews and require payment of fees for reviews and certifications.

- It is consistent with rules regarding projects with federal funding.

OVERVIEW OF INVEST

FHWA's INVEST identifies characteristics of sustainable highways and provides information and techniques to help integrate sustainability best practices into highway and other roadway projects. The tool is intended to provide a method for practitioners to evaluate their transportation projects and to encourage progress in the sustainability arena.

The INVEST website provides users an opportunity to **Learn** about sustainable highways and INVEST, **Browse** the criteria, and **Score** projects and programs against the criteria. The Learn section is a guided tour through INVEST to learn about sustainability and sustainable highways, why and how sustainability is measured, and how context influences sustainability. In addition to the background information, this section explains what INVEST is, how it measures sustainability, and how it is organized. Finally, there is information about using INVEST to evaluate system planning, project development, and O&M phases of programs and projects. The Browse section presents the complete set of INVEST criteria, and the Score section allows users to create a project scorecard to self-evaluate projects. The website provides a scoring tutorial; once registered on the INVEST website, users can add projects and score them using INVEST criteria.

INVEST CRITERIA

INVEST criteria are a set of best practices used to rate a project for sustainability. While these are sometimes the same as sustainable solutions discussed in this guidebook, they are usually more general.

For example, a sustainable solution might be to reuse stones from a retaining wall in a relocated wall. This would fit under INVEST criterion PD-20: Recycle Materials. Depending on the project, it may receive full points, partial points, or no points for this criterion based on this one solution. Some criteria would require several sustainable solutions to be selected and implemented to receive the points.

INVEST is intended to provide agencies an opportunity to self-evaluate their projects or programs, to learn more about sustainability, and to incorporate more sustainable practices into their projects and programs.

WHEN TO USE INVEST

INVEST can be used at any point in the project lifecycle, including system planning, project development (planning, design, and construction), and O&M. The tool is designed to provide information for the user on sustainability, the INVEST tool, the criteria, and scoring at any time; although registering a project is required, it does not have to be a real project. In fact, scoring a sample or test project is a great way to learn more about sustainability, INVEST, and the criteria.

INVEST considers the full lifecycle of projects and has three modules to self-evaluate the entire lifecycle of transportation services: System Planning (SP), Project Development (PD), and Operations and Maintenance (OM). Each of these modules is based on a separate set of criteria and can be evaluated by itself. There are 60 criteria in total, including 17 for the SP module, 29 for the PD module, and 14 for the OM module.

INVEST is intended to identify and recognize above-and-beyond efforts toward sustainability. Although many owner's efforts could already be considered sustainable, if the efforts are typically required, no credit will be earned in this self-evaluation tool. For instance, there is no credit for completing NEPA documentation because it is required for federally funded projects and by many states.

HOW TO USE INVEST

The Learn section of INVEST provides information on how to evaluate (score) a project using the tool. In My Workspace, additional information is provided in the Scoring Tutorial that shows how to use the score function with step-by-step instructions and graphics illustrating how to use the tool.

Using INVEST to Find Solutions

INVEST is comprised of criteria which consist of a goal and several actions that work toward reaching the goal of each criterion. The actions within each criterion are intended to help score and evaluate the criterion. However, a team using the tool prospectively may choose to select actions from the INVEST criterion as a solution for their project.

4.5.4. Using Technical Resources in Conjunction with the Approach

Both technical documents and sustainability evaluation tools can be used as in-depth technical resources in the process of identifying, assessing, and incorporating solutions. Step 4 advises the team that each discipline should review the sustainability goals and then brainstorm solutions that could be applied to the project to achieve each of the goals. To enhance this brainstorming activity and find more possible solutions during Step 4, the team could utilize technical documents and sustainability evaluation tools to identify possible solutions that fit its project's context and sustainability goals.

Sustainability evaluation tools were reviewed and summarized in Figure 4-3. These are all organized by criteria or credits. To find solutions, the practitioner must research the criteria and credits to understand the requirements and then develop a solution that meets those requirements. The "organized by" column in Figure 4-8 indicates if the evaluation tool is further organized by solution, phase, or discipline.

In contrast, sustainability technical documents are generally discipline-specific and are often organized by solution. The practitioner simply needs to find solutions within the document that meet the project's context and goals.

The use of one or more evaluation tools, in addition to sustainability technical documents, will provide a large selection of potential sustainable solutions for assessment during Step 5 to help ensure the sustainability goals of the project are met.

Sustainability Evaluation Tool	Type of Tool [1]	Transportation System Lifecycle					Organized by		
		System Planning & Programming	Project Development			Operations & Maintenance	Solutions	Phase	Discipline
			Project Planning	Project Design	Project Construction				
Envision™	Voluntary, **SA** & **RS**		▒	▒	▒	▒			x
GreenLITES	Mandatory Internal Certification		▒	▒		▒	x		x
GreenLITES Operations	**SA**					▒	x		x
Greenroads	Voluntary, **RS**		▒	▒	▒			x	x
I-LAST	Voluntary, **SA**		▒	▒	▒			x	x
INVEST	Voluntary, **SA**	▒	▒	▒	▒	▒		x	x
LEED-ND®	Voluntary, **RS**		▒	▒	▒				
SITES™	Voluntary, **RS**		▒	▒	▒	▒	x		x
STARS	Voluntary, **RS**	▒	▒	▒					

LEGEND

RS = 3rd Party Rating System

SA = Self Assessment

▒ Tool Specifically Targeted at Roadway Projects

▒ Tool Targeted at General Infrastructure

[1] Type of Tool indicates planned ultimate tool type. Some emerging systems are at a lesser point of development.

Figure 4-8: Comparison of Sustainability Evaluation Tools

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