

LECTURE 9

Sustainability in Highway Construction Practices and Transportation Operations and Maintenance

Transportation Planning and Delivery Process

Long-range transportation planning

Develop a vision for transportation investments

Short-range transportation planning

Use capital programming to match priority projects with funds

Project-level planning

Identify project needs, community concerns, and potential solutions

Project-level environmental review

Elaborate review to consider impact on environment, guided by regulations

Design, land acquisition, and permitting

Prepare engineering plans, purchase right of way, and obtain permits

Construction, maintenance, and operations

Build it and keep it working

Sustainable Construction Practices

Sustainable construction practices (SCPs) assist in:

1. Building highways
2. Preserving and restoring surrounding ecosystems
3. Meeting basic human needs such as equity, employment, health, safety, and happiness
4. Managing resources wisely (including money)

Source: S. Muench, G. Migliaccio, J. Kaminsky, M. Ashtiani, A. Mukherjee, C. Bhat, and J. Anderson.
NCHRP Research Report 916: Sustainable Highway Construction Guidebook. 2019.

Sustainable Construction Practices (Continued)

SCPs are those that:

Go above and beyond standard practice and/or required national regulatory minimums

Show innovation in meeting these standards and minimums in support of people and the environment

Source: S. Muench, G. Migliaccio, J. Kaminsky, M. Ashtiani, A. Mukherjee, C. Bhat, and J. Anderson.
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Impact of Highway Construction

Substantial highway construction impacts:

- **Energy consumption** (GHG emissions)
- **Habitat** (wildlife movement and distribution)
- **Water quality** (erosion, sediment, and site pollution)
- **Hydrologic cycle** (stormwater runoff and infiltration)
- **Air quality** (equipment emissions and fugitive dust)
- **Mobility and access** (traffic congestion and road closures)
- **Community** (inconvenience and business availability)
- **Non-renewable resources** (uses a lot)

However, the contribution of highway construction to national economic and greenhouse gas metrics is relatively small.

Source: S. Muench, G. Migliaccio, J. Kaminsky, M. Ashtiani, A. Mukherjee, C. Bhat, and J. Anderson. *NCHRP Research Report 916: Sustainable Highway Construction Guidebook*. 2019.

Sustainability Values in Construction

According to research:

- Most organizations value sustainability
- In highway construction, sustainability is not as important as cost or schedule
- There is some consensus that sustainability involves three components: human, environment, and economic
- Durability and long life of infrastructure are integral to sustainability
- Sustainability efforts are driven largely by cost
- There is no leading entity in highway sustainability

Source: S. Muench, G. Migliaccio, J. Kaminsky, M. Ashtiani, A. Mukherjee, C. Bhat, and J. Anderson. *NCHRP Research Report 916: Sustainable Highway Construction Guidebook*. 2019.

Use of SCPs

- There is little industry guidance on procuring sustainability in highway construction
- Materials recycling/reuse is the most identified SCP
- In a competitive bid environment, contractors are likely to implement SCPs that directly reduce their costs or help them make money; other practices must be compensated for by the owner
- The competitive advantage resulting from implementing a new SCP is short lived
- SCPs tend to work when used
- The performance of alternative materials/methods is addressed in relation to the current standard practice

Source: S. Muench, G. Migliaccio, J. Kaminsky, M. Ashtiani, A. Mukherjee, C. Bhat, and J. Anderson. *NCHRP Research Report 916: Sustainable Highway Construction Guidebook*. 2019.

Highway Construction Framework

Sustainable Highway Construction Guidebook divides highway construction into two basic levels:

1. Project delivery

- Practices used to fund, procure, and deliver projects
- Usually administrative or process oriented

2. Project

- Practices that administer, schedule, budget, and build projects
- May be administrative, process oriented, or activity oriented

Source: S. Muench, G. Migliaccio, J. Kaminsky, M. Ashtiani, A. Mukherjee, C. Bhat, and J. Anderson. *NCHRP Research Report 916: Sustainable Highway Construction Guidebook*. 2019.

Highway Construction Framework (Continued)



Level	Category
Project Delivery	Project Delivery Method
	Financing
	Procurement
	Contracting
Project	Scheduling
	Estimating
	Project Controls/Administration
	Earthwork
	Drainage/Sewer/Water
	Aesthetics
	Walls
	Bridges
	Pavement
	Work Zone Traffic Control
	Materials
	Safety
	Employment
	Training
	Community Outreach
	Noise
	Lighting
	Constructability/Deconstruction
Quality	
Equipment	
Utilities	
Landscaping	

Source: S. Muench, G. Migliaccio, J. Kaminsky, M. Ashtiani, A. Mukherjee, C. Bhat, and J. Anderson. *NCHRP Research Report 916: Sustainable Highway Construction Guidebook*. 2019.

Sustainability Framework

- *Sustainable Highway Construction Guidebook* divides sustainability into three common dimensions:
 1. Human well-being
 2. Environmental well-being
 3. Economic well-being
- Within these dimensions, sustainability is divided into 10 categories that show how the dimensions relate to highway construction

Source: S. Muench, G. Migliaccio, J. Kaminsky, M. Ashtiani, A. Mukherjee, C. Bhat, and J. Anderson. *NCHRP Research Report 916: Sustainable Highway Construction Guidebook*. 2019.

Sustainability Framework (continued)



Dimension	Category	Explanation
Human Well-being	Workers	All those who work in the highway construction process.
	Neighbors and Stakeholders	Those nearby and with a vested interest in the project.
	Users	Users of the highway both during and after construction.
Environmental Well-being	Pollution	Water/air pollution and waste associated with highway construction.
	Local Ecosystem and Habitat	Nearby or related ecosystems and habitat affected by highway construction.
	Consumption	Consumption of resources and materials associated with highway construction.
	Climate	Impacts on the climate attributable to highway construction.
Economic Well-being	Project Budget	Costs and benefits, both short and long term, directly associated with highway construction.
	Maintenance and Operations	Follow-on processes affected by highway construction.
	Economic Development/Employment	Economic or employment impacts associated with highway construction.

Source: S. Muench, G. Migliaccio, J. Kaminsky, M. Ashtiani, A. Mukherjee, C. Bhat, and J. Anderson. *NCHRP Research Report 916: Sustainable Highway Construction Guidebook*. 2019.

Mapping Construction and Sustainability

Highway Construction Framework		Sustainability Framework									
		Human Well-being			Environmental Well-being				Economic Well-being		
		Workers	Neighbors and Stakeholders	Users	Pollution	Local Ecosystem and Habitat	Consumption	Climate	Project Budget	Maintenance and Operations	Economic Development/ Employment
Level	Category										
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- Mapping shows how the two frameworks relate to one another
- In this example, green indicates that a highway construction category addresses a sustainability category
- This relationship helps identify SCPs that address specific sustainability categories

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Construction and Maintenance Objectives for Sustainability



- Reduce crash risk in work zones
- Reduce delay to commuters due to construction or maintenance activities
- Reduce delay due to construction or maintenance activities equitably
- Minimize the impact of construction activities on system efficiency
- Ensure construction, maintenance, and operation costs are within budget
- Apply context-sensitive corridor habitat restoration and landscaping during project implementation; reduce herbicide use during project maintenance
- Increase the percentage of waste diverted from landfill during construction and maintenance
- Use biofuel for non-road construction and maintenance equipment
- Reduce equipment emissions (equipment conforming to latest EPA emissions standards)
- Reduce adverse impact on traffic operations (lane reductions, traffic interruptions, detours, and night operations)

Operations Sustainability Objectives



- Reduce the crash risk of the traveling public using transit
- Improve travel time reliability to jobs and other essential destinations through operational improvements
- Ensure that transportation costs do not disproportionately affect low-income users
- Implement operational improvements that enhance or maintain the reliability of transportation options
- Implement operational improvements that enhance the security of freight transportation assets
- Support growth in jobs by improving travel efficiency/reducing congestion
- Ensure construction, maintenance, and operation costs are within budget
- Reduce vehicle–animal collisions during operations
- Reduce litter
- Purchase green energy
- Maintain efficient traffic operations

Life-Cycle- Based Analyses

- Life-cycle cost analysis (LCCA) takes into account economic costs of a transportation investment over the lifetime
- Life-cycle analysis (LCA) takes into account environmental impacts from material production to end of life
- Both are important considerations for sustainability, especially in selection of materials and construction methods



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