Towards Sustainable Pavement Systems: Webinar Series

Webinar #1:

Introduction, Concepts, Assessment

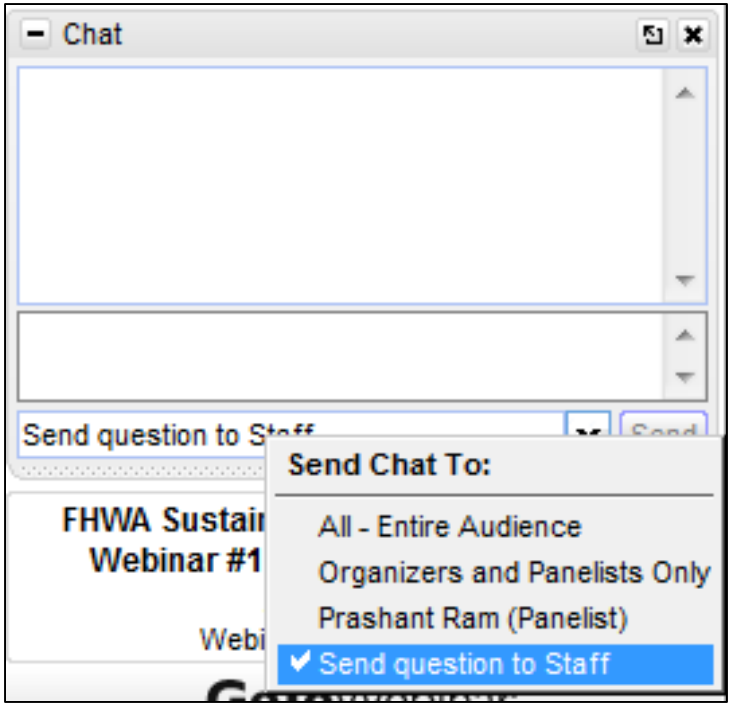
April 29, 2015

Webinar Series

- Sponsored by Federal Highway Administration
- Focuses on contents of recent publication "Towards Sustainable Pavement Systems: A Reference Document"
  - http://www.fhwa.dot.gov/pavement/sustainability/
- Total of 5 webinars from April to September
- Webinars recorded for posting on FHWA website

Housekeeping

- Formal Presentations:
  - 1 hour 40 min
- Questions:
  - 20 minutes
  - Use chat box to submit
  - Use dropdown menu to "send questions to staff"



- Professional Development Hours (PDHs) Certificates
  - 2 hours per webinar

Today's Webinar

- Topic: Introduction, Concepts, Assessment
- Speakers:
  - Gina Ahlstrom, FHWA
  - Steve Muench, University of Washington
  - Joep Meijer, The Right Environment, Inc.
  - Alissa Kendall, University of California-Davis
- Moderators:
  - Kurt Smith, Applied Pavement Technology, Inc.
  - Tom Van Dam, NCE

FHWA Sustainable Pavements Program

Background and Overview

Gina Ahlstrom

US DOT is Committed to Advancing Sustainability

- DOT will incorporate sustainability principles into our policies, operations, investments and research through innovative initiatives and actions such as:
  - Infrastructure investments and other grant programs,
  - Innovative financial tools and credit programs,
  - Rule- and policy- making,
  - Research, technology development and application,
  - Public information, and
  - Enforcement and monitoring.

U.S. Department of Transportation
Federal Highway Administration

Policy Statement

Signed Secretary Anthony R. Foxx, June 2014

FHWA
Sustainable Pavements Program

- Support the US DOT goals for sustainability
- Increase the body of knowledge regarding sustainability of asphalt and concrete materials throughout the pavement life cycle
- Increase the use of sustainable technologies and practices in pavement design, construction, preservation, and maintenance

“Towards Sustainable Pavements: A Reference Document”

- Guidelines for the design, construction, preservation and maintenance of sustainable pavements using asphalt and concrete materials
- Educate practitioners on how sustainability concepts can be incorporated into pavements
- Encourage adoption of sustainable practices

A Collaborative Effort

- Comprehensive review of current literature
- Extensive review by representative from key stakeholders groups:
  - State Departments of Transportation
  - Other Public Agencies
  - Asphalt and Concrete Industries
  - Academia

FHWA Sustainable Pavements Program

- What is Sustainability?
- Trade-off Considerations
- Life-Cycle Cost Analysis
- Rating Systems

Steve Muench

Sustainability Defined

In general

The “sustainability” of a human-devised system refers to its ability to:
(1) exist and function within a larger system without degrading it, and
(2) provide for and meet the human needs for which the system was developed.

For pavements

“Sustainable” in the context of pavements refers to system characteristics that encompasses a pavement’s ability to:

(1) achieve the engineering goals for which it was constructed

(2) preserve and restore surrounding ecosystems

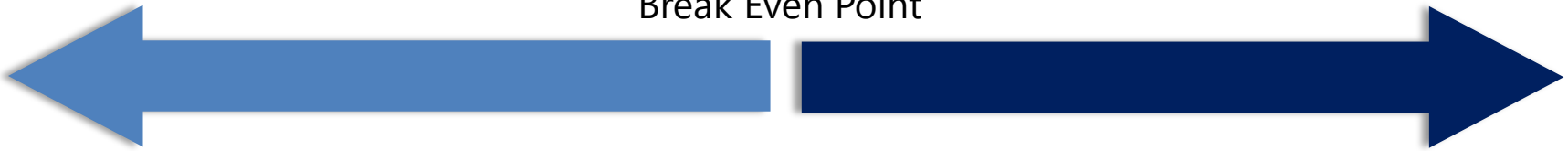
(3) use financial, human, and environmental resources economically

(4) meet basic human needs such as health, safety, equity, employment, comfort, and happiness

We are really talking about being “more sustainable” than we were. We are going for “do less bad”. The goal is “do good”.

Bad **Good**

Break Even Point



We use more than we replace
Nature cannot handle all that we produce
Excesses (waste) is harmful
We alter ecosystems

We replace all that we use
Nature can break down all that we produce
Excess (waste) is beneficial
We are fully integrated into nature

Example drawn from ideas in McDonough and Braungart’s *Cradle to Cradle* (2002)

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cherry trees

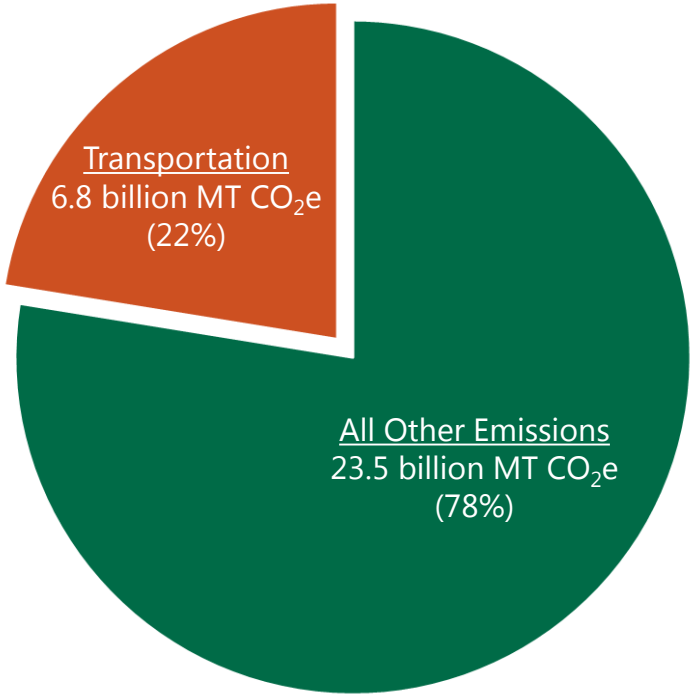
Example drawn from ideas in McDonough and Braungart’s *Cradle to Cradle* (2002)

How “sustainability” fits within an organization

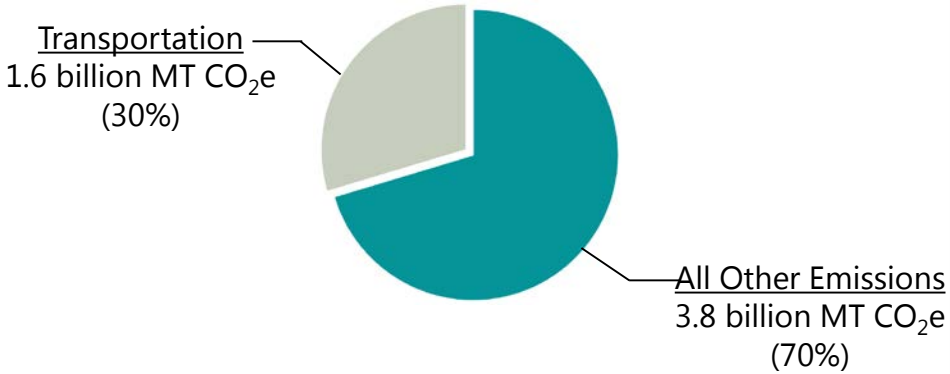
- “Sustainability” is the highest order consideration
  - It means consider <u>everything</u> when you undertake a project
  - It is <u>not</u> an add-on feature for a project
- Organizations set priorities within “sustainability”
  - Which sustainability components are particularly valued
  - The order of precedence for these values
  - The plan to operationalize those values and precedence
  - Often the results are:
    - Consider the bigger systems picture (things beyond direct control)
    - Raise emphasis on human needs and environment

Pavement sustainability in context: GHG emissions

Global CO_2 Emissions from Fuel Combustion
(30.3 billion MT CO_2e)



U.S. CO_2 Emissions from Fuel Combustion
(5.4 billion MT CO_2e)



U.S. Pavements (0.08 MT CO_2e)
(does NOT include use phase)

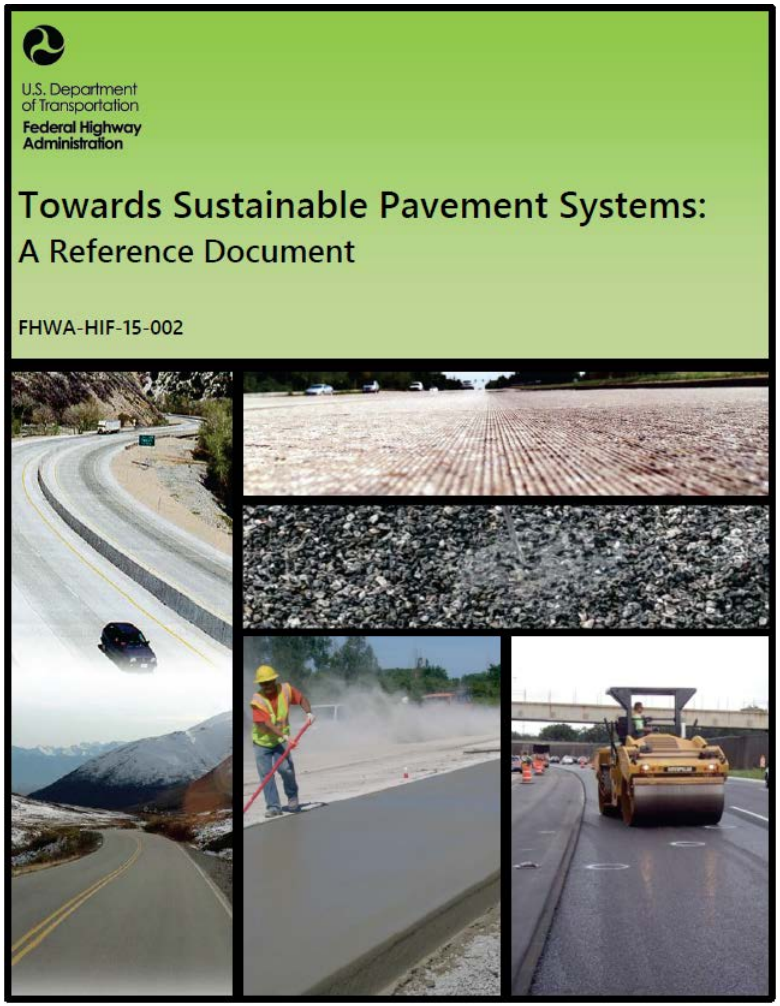
Pavement sustainability in context: beyond GHG emissions

- Energy consumption
- Habitat loss, fragmentation, and change
- Water quality
- Hydrologic cycle changes
- Air quality
- Mobility
- Access
- Freight
- Community
- Depletion of non-renewable resources
- Economic development

This document structures its discussion of pavement sustainability by life-cycle phase.

Chapters

1. Introduction
2. Concepts of pavement sustainability
3. Materials
4. Pavement design
5. Construction
6. Use
7. Maintenance & preservation
8. End-of-life
9. Pavement within larger systems
10. Assessing pavement sustainability
11. Concluding remarks



You cannot have everything. Sustainability involves trade-offs.

- Sustainability is a broad systems characteristic
  - Most things are “sustainable” in some manner
  - Cannot choose everything
- In evaluating trade-offs:
  - Weigh benefits/costs of features
  - Go beyond economics/costs
  - Consider opportunity cost
- When weighing the benefits/costs, consider:
  - Priorities and values of organization or project
  - Risk

Measuring sustainability is possible and can prove useful.

- Reasons to measure sustainability
  - Accounting
    - Provide numbers for reporting requirements
      Example: what GHG emissions are attributable to DOT infrastructure projects this year?
  - Decision support
    - Provide information that can influence a decision
      Example: which alternative uses the least energy?
  - Process improvement
    - Provide feedback to improve a process
      Example: how can we reduce the GHG footprint of portland cement?

There are several ways to measure pavement sustainability.

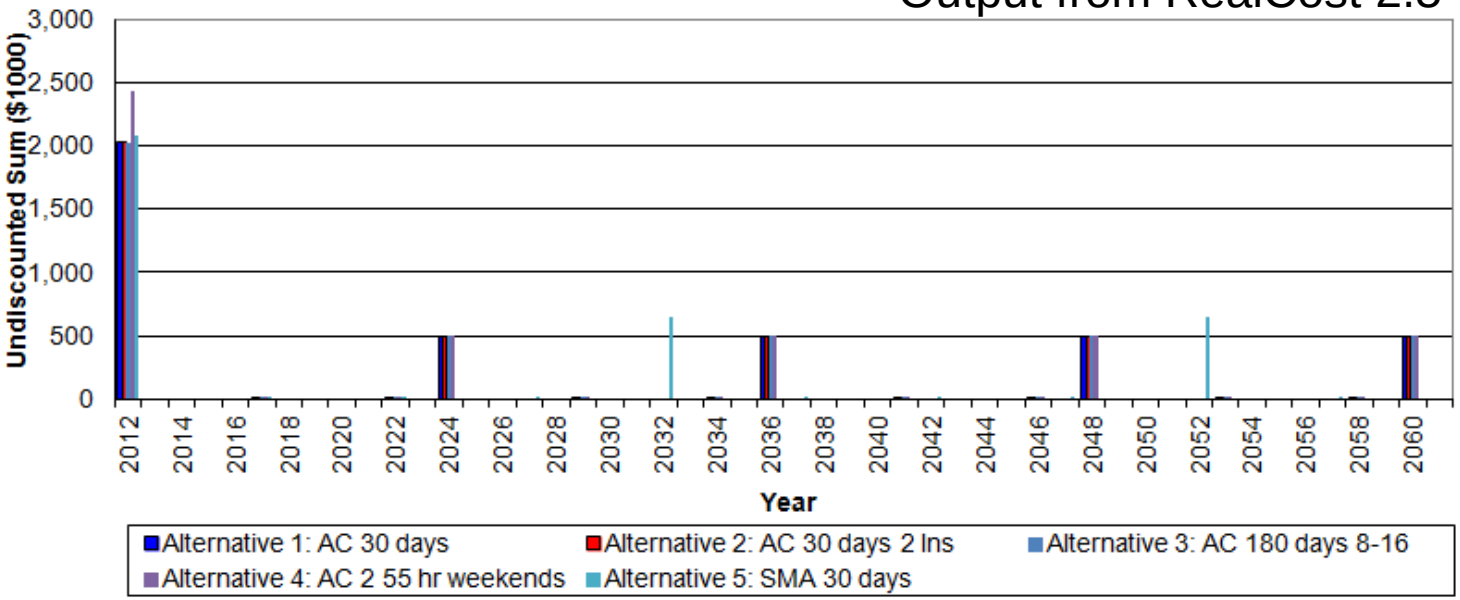
- Performance Assessment
  - Evaluate performance vs. intended function
  - Metrics: distress, thickness, material attributes
  - Usually new systems compared to traditional ones
- Life-Cycle Cost Analysis (LCCA)
- Sustainability Rating Systems
- Life Cycle Assessment (LCA)

Life-Cycle Cost Analysis (LCCA)

<u>Definition</u>

A generally accepted accounting practice that uses economic analysis to evaluate the total <u>cost</u> of an investment option over an analysis period.

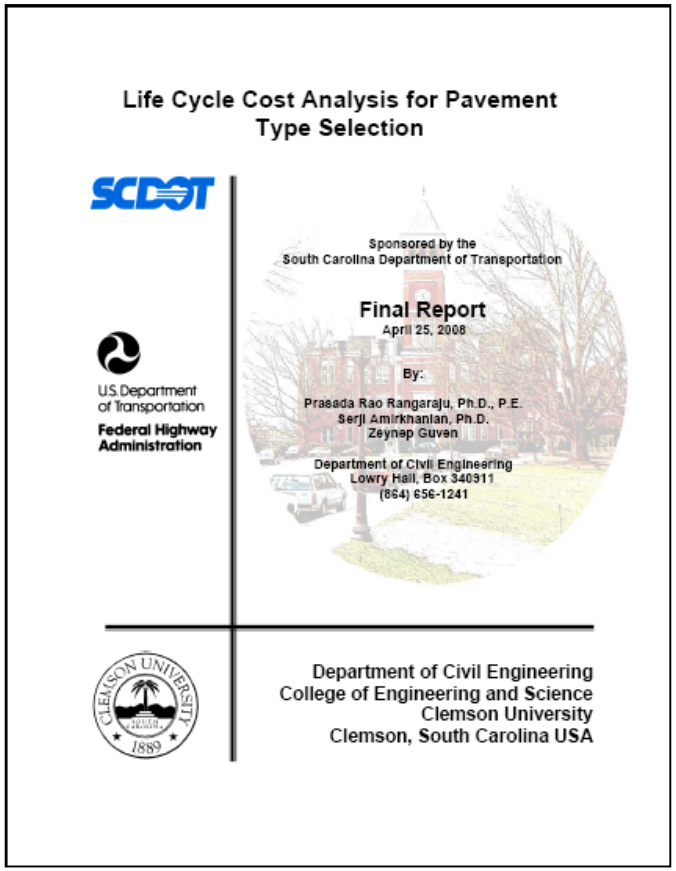
Output from RealCost 2.5



General LCCA Trends in the U.S.

<u>From South Carolina Study (2008)</u>

- Survey of DOTs (21 responded)
- 92% using LCCA in some form
- Not done for all pavements
- 59% do not consider user costs
- Discount rate around 4% but some use OMB value
- Moving to longer analysis periods (40-50 years)
- Rehab timing comes from PMS
- 56% include salvage value



Life Cycle Cost Analysis for Pavement Type Selection

SCDOT

Sponsored by the South Carolina Department of Transportation

Final Report
April 25, 2008

By:

Prasada Rao Rangaraju, Ph.D., P.E.
Serji Amirkhanian, Ph.D.
Zeynep Guven

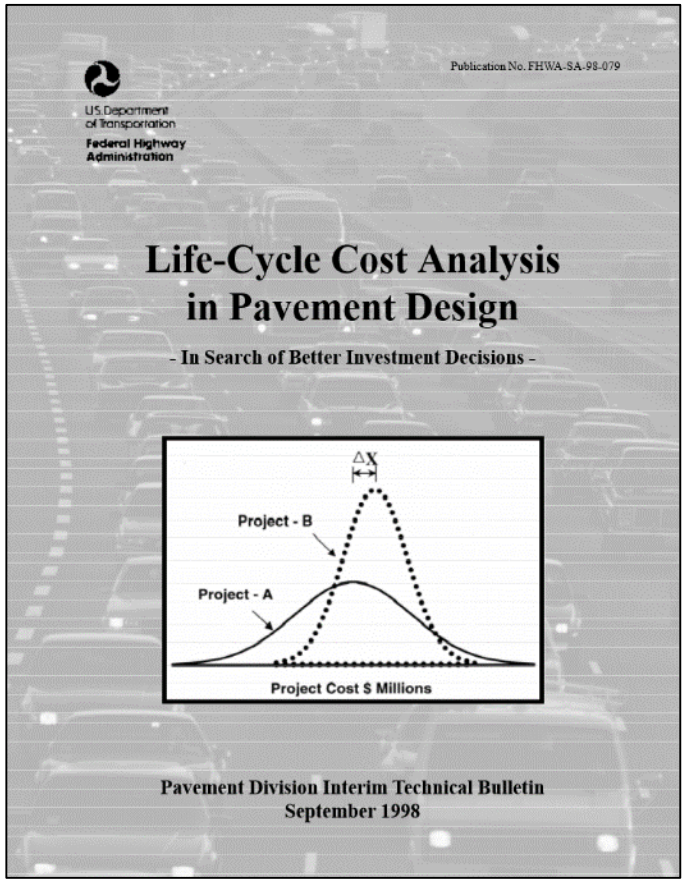
Department of Civil Engineering
Lowry Hall, Box 340911
(864) 656-1241

U.S. Department of Transportation
Federal Highway Administration

Department of Civil Engineering
College of Engineering and Science
Clemson University
Clemson, South Carolina USA

From:
Rangaraju, R.; Amirkhanian, S. and Guven, Z. (2008). *Life Cycle Cost Analysis for Pavement Type Selection*. FHWA-SC-08-01, South Carolina DOT, Columbia, SC.

General Guidance



Title: **Life-Cycle Cost Analysis in Pavement Design – Interim Technical Bulletin**

Authors: Walls and Smith (for FHWA)

Published: 1998

Description: Recommends procedures for conducting LCCA of pavements. Set's standard for inclusion of user costs (WZ only) and probabilistic analysis.

Where: USDOT and various other websites

- http://isddc.dot.gov/OLPFiles/FHWA/013017.pdf

LCCA: Key Issues

- Discount rate
- Salvage value / remaining service life
- User costs
- Deterministic vs. probabilistic

LCCA: Key Issues

- Discount rate selection: OMB Guidance

Real Discount Rates. A forecast of real interest rates from which the inflation premium has been removed and based on the economic assumptions from the 2016 Budget is presented below. These real rates are to be used for discounting constant-dollar flows, as is often required in cost-effectiveness analysis.

Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in percent)

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
0.1	0.4	0.7	0.9	1.2	1.4

(inflation assumed for budget is 2.0%) -revised December, 2014

http://www.whitehouse.gov/omb/circulars_a094_a94_appx-c

LCCA: Key Issues

- Salvage value / remaining service life

  Assigning a value to pavement at the end of the analysis period to capture the value of the remaining pavement.

  Issue 1: salvage value vs. remaining service life
  - **Remaining service life**: some service life is still left
  - **Salvage value**: value of existing pavement materials that have no remaining service life (e.g., as a support layer for an overlay)

  Issue 2: allocation of salvage value
  - Who owns “salvaged” materials (contractor or owner)?
  - Where is benefit accounted for (old project, new project)?

LCCA: Key Issues

- User costs
  - Typically considered: VOC + delay + crash

LCCA: Key Issues

- User costs used vary
  - Passenger cars: $8 to $40
  - Trucks: $20 to $40
  - Numbers from Walls and Smith (1998):

Vehicle Class	$ Value Per Vehicle-Hour	
	Value	Range
Passenger Vehicles	$17.43	$15 to 19
Single-Unit Trucks	$27.90	$25 to 30
Combination Trucks	$33.58	$31 to 35

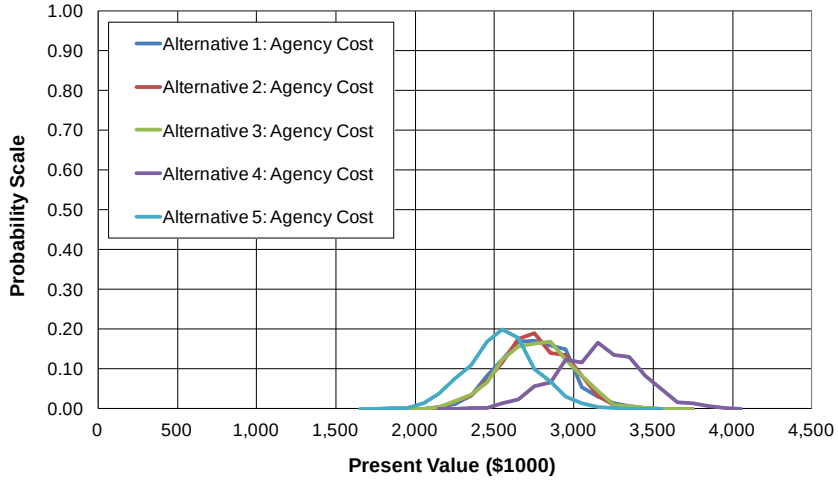
Table from Life-Cycle Cost Analysis in Pavement Design, updated to 2015 Dollars

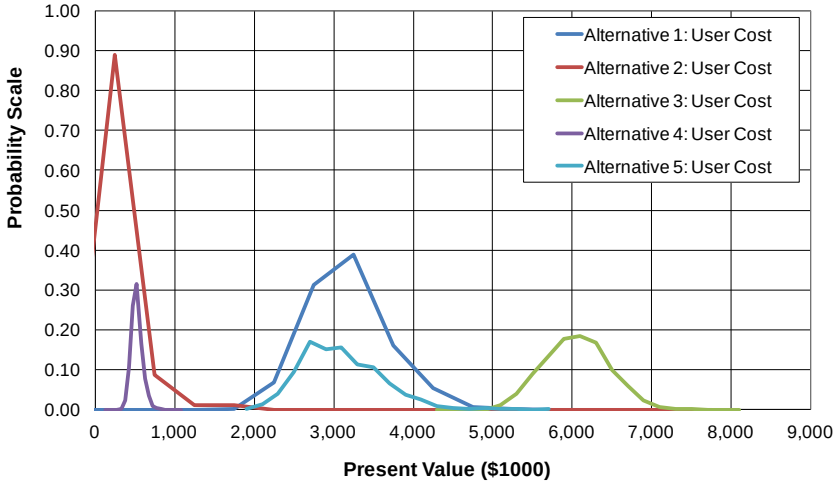
LCCA: Key Issues

- Deterministic vs. Probabilistic

  Deterministic: use of fixed values for inputs
  Probabilistic: use of probabilistic distributions for inputs

The idea that ONE specific predicted value can be arrived at given varying inputs and a long (40-50 year) analysis period is unrealistic.



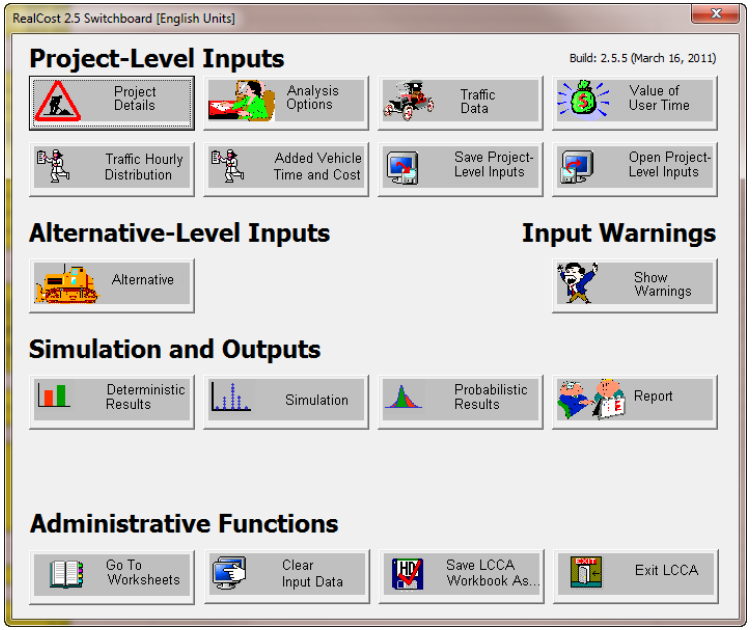


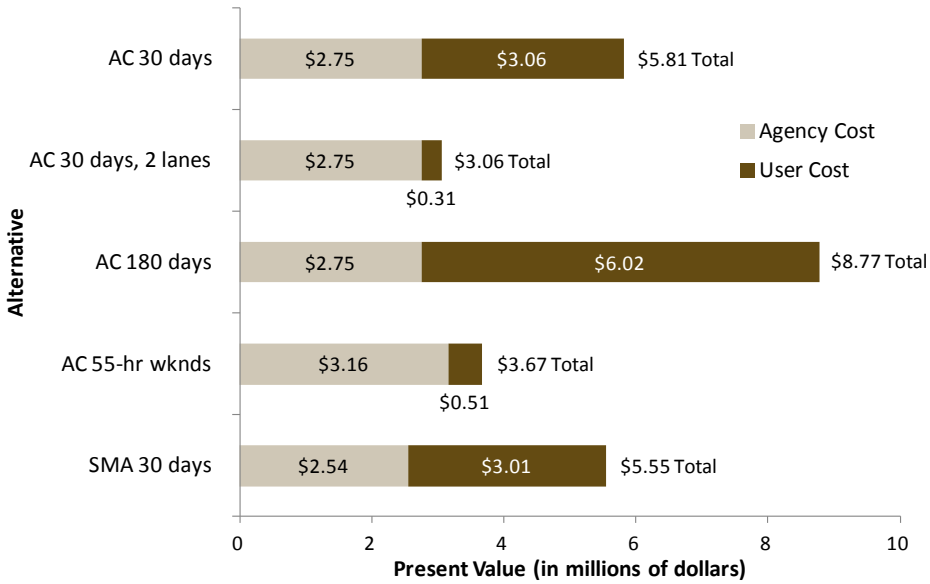
LCCA: Use in Project Delivery

- Design-bid-build (hard bid)
  - Agency does pavement type selection
  - A+B bidding: accounts for initial construction user costs
- Alternate design/bid projects
  - Contractor chooses among design alternatives
  - Must calculate LCCA of alternatives
- Design-build variations (DB, DBM, DBOM)
  - Bids reflect initial construction + maintenance

LCCA: Available Tools

- RealCost (v2.5)
  - FHWA Excel-based LCCA software
  - Based on Walls and Smith methods
- Others based on Walls and Smith





Sustainability Rating Systems

<u>Definition</u>

A list of sustainability best practices with an associated common metric (usually points).

Purpose:

- Encourage sustainability practices
- Communicate sustainability

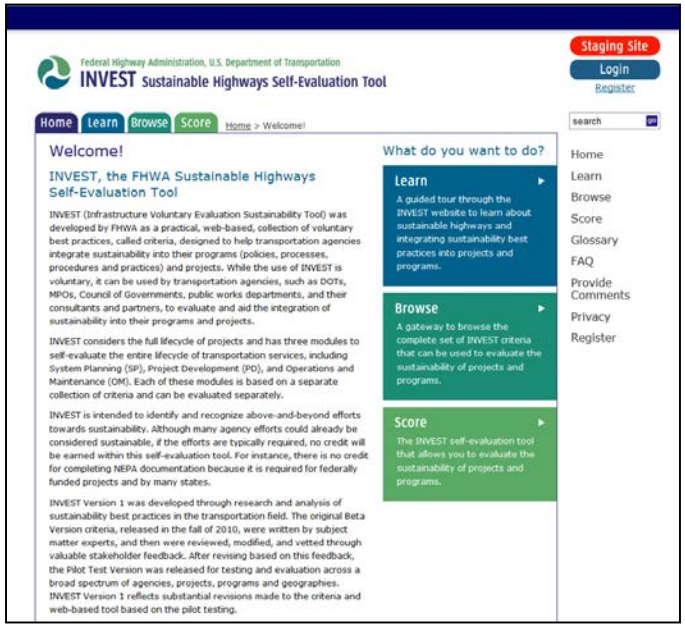
Appeal:

- Measure sustainability
- Simple communication tool
- Provide a context for innovation

Rating Systems: Currently Available

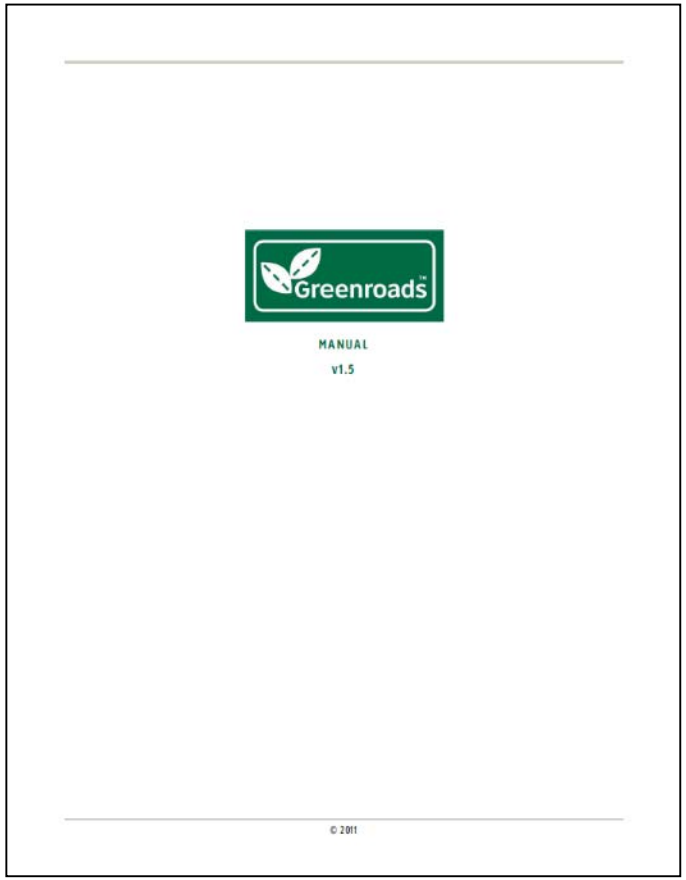
Status	Road Systems	Infrastructure Systems
Mature Released v1 ≥ 3 yrs old Rated 10 projects	Greenroads GreenLITES	LEED ND CEEQUAL Sustainable Sites CEEQUAL International
Operational Released v1 < 3 yrs old Rated 1 project	INVEST Infrastructure Sustainability STARS	Envision
Development Internal systems Not yet v1 Early stages Internal pilots Research	BE^{2}ST-in-Highways Green Guide for Roads GreenPAVE I-LAST STEED INVEST VicRoads SUNRA (EU)	

Rating Systems: Examples



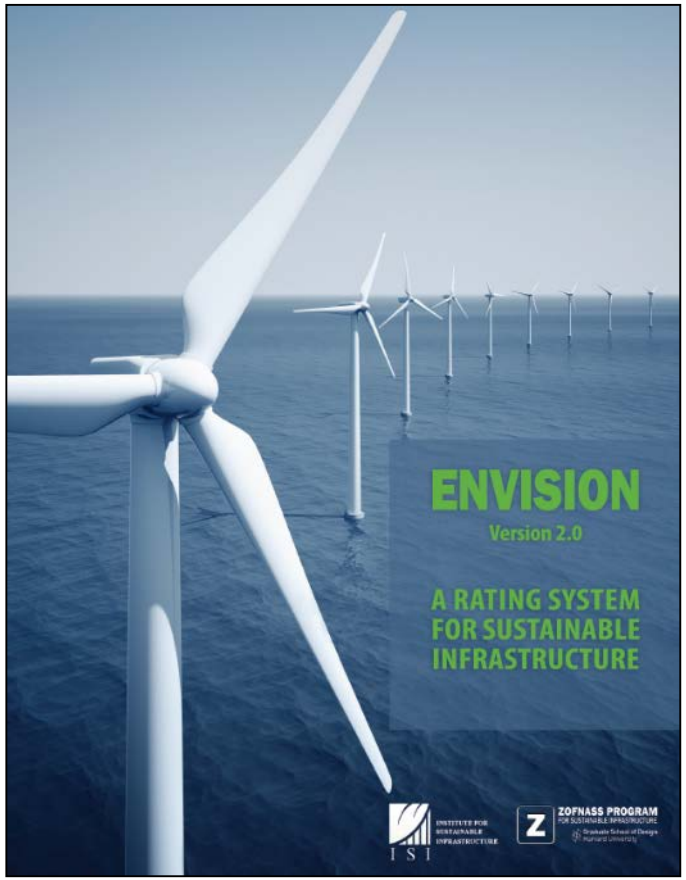
Title:	**INVEST, version 1.1 (Infrastructure Voluntary Evaluation Sustainability Tool)**
Authors:	FHWA
Published:	2012 (version 1.1 released 1/7/2015)
Description:	Voluntary sustainability self-evaluation tool for highways. Includes all aspects: system planning, project development (design and construction), and operations/maintenance. Similar to Greenroads but also includes planning and operations specific criteria.
Where:	www.sustainablehighways.org
Pavements:	48% of points (14 criteria) (Project Development section only)

Rating Systems: Examples



Title:	**Greenroads, v1.5**
Authors:	Muench, Anderson, Hatfield, Koester, Soderlund, et al.
Published:	2011
Description:	Sustainability rating system for roadway design and construction. Owned and operated by the Greenroads Foundation. Developed largely at the UW. It is run as an independent 3rd party rating system. Can be used to rate a project or as a set of best practices from which to choose.
Where:	www.greenroads.org
Pavements:	49% of points (26 credits)

Rating Systems: Examples



Title: **ENVISION, version 2.0**

Authors: Institute for Sustainable Infrastructure (ISI) and the Zoffnass Program for Sustainable Infrastructure (Harvard University)

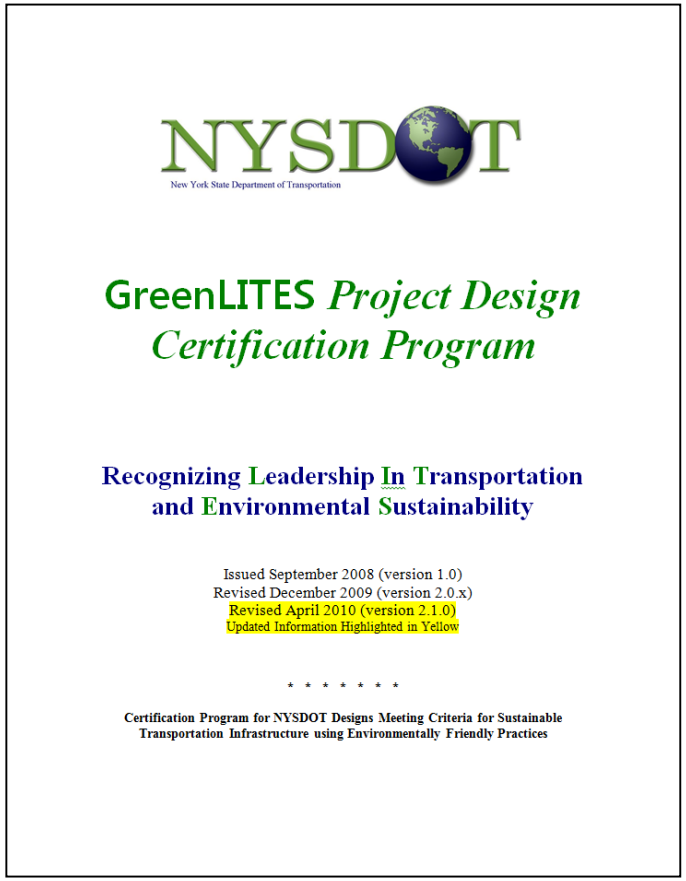
Published: 2012

Description: Self-evaluation or 3rd party rating tool for any infrastructure project (roads included). Just starting out. Kind of hard to follow the logic, but it may be expected since this system is supposed to address ALL infrastructure. http://www.sustainableinfrastructure.org

Where: 31% of points (17 credits)

Pavements:

Rating Systems: Examples


NYSDOT
New York State Department of Transportation

GreenLITES *Project Design Certification Program*

Recognizing Leadership In Transportation and Environmental Sustainability

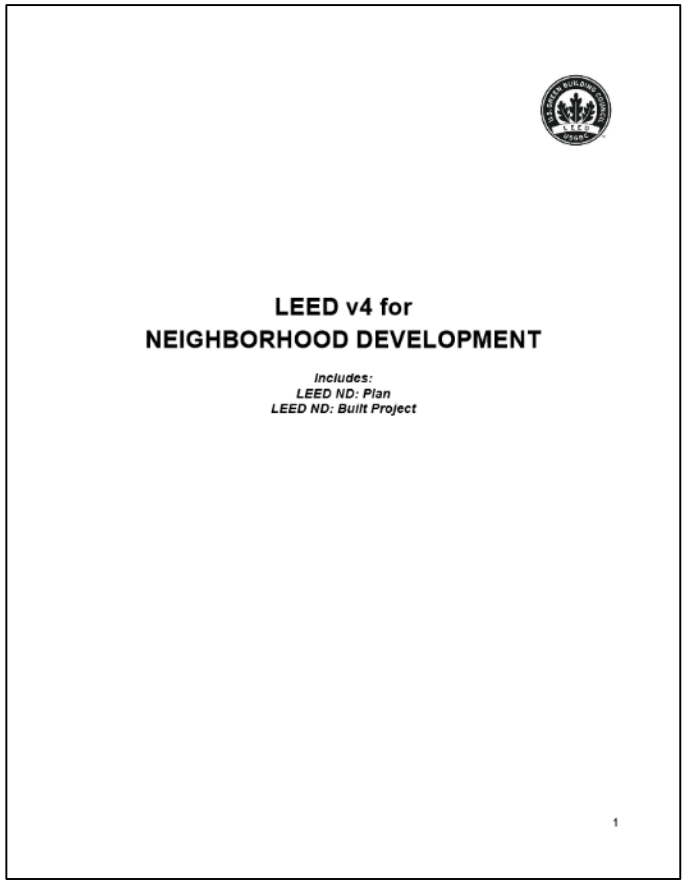
Issued September 2008 (version 1.0)
Revised December 2009 (version 2.0.x)
Revised April 2010 (version 2.1.0)
Updated Information Highlighted in Yellow

* * * * * * *

Certification Program for NYSDOT Designs Meeting Criteria for Sustainable Transportation Infrastructure using Environmentally Friendly Practices

Title:	**GreenLITES Project Design Certification Program**
Authors:	NYSDOT
Published:	2010
Description:	Self-certification program for transportation design projects. Used as an internal management tool at the NYSDOT to measure performance and recognize good practice. There is also a program covering OPERATIONS available from the same location.
Where:	https://www.dot.ny.gov/programs/greenlites
Pavements:	10% of points (16 credits)

Rating Systems: Examples


LEED v4 for
NEIGHBORHOOD DEVELOPMENT

Includes:
LEED ND: Plan
LEED ND: Built Project

1

Title:	**LEED v4 for Neighborhood Development (LEED ND)**
Authors:	US Green Building Council (USGBC)
Published:	2013
Description:	LEED rating system used for neighborhood design. Independent 3rd party rating for sustainable development. Minimal treatment of roads beyond recycled materials and access to different transportation modes (i.e., transit, bicycle, pedestrian).
Where:	http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148
Pavements:	6% of points (4 total)

Rating Systems: Common Pavement-Related Items

Item	Number of Systems
Materials Production	
Materials production emissions	4
Reduce energy consumption	11
Pavement Design	
Durable structures (long life)	3
Minimize materials (reduce)	10
Construction	
Construction equipment emissions	7
Materials transport emissions	5
Waste management/minimization	11
Noise reduction (construction noise)	8
Fuel use	7
Worker/jobsite safety	3
Job training	4
Local employment	4
Quality control	3

Item	Number of Systems
Use	
Stormwater runoff quality	8
Stormwater runoff volume/flow	8
LCCA and/or cost-benefit	4
Noise reduction	9
Maintenance & Rehabilitation	
(included in other phases)	
End-of-Life	
Material recycling	10
Material reuse (existing pavement)	10

11 road-related rating systems reviewed

CEEQUAL, Envision, GreenLITES, Greenroads, INVEST
VicRoads, INVEST, IS, LEED-ND, I-LAST, STARS, STEED

Analysis from:
Veeravigrom, Muench, and Kosonen (2014). *A Global Framework for Sustainable Roadway Rating Systems*. 2015 TRB Annual Meeting.

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State of Practice

- **LCCA**
  - Generally accepted (most DOTs use at some level)
  - FHWA Interim Bulletin is the industry standard
  - GAO recommends updating FHWA guidelines
- **Rating systems**
  - Use is infrequent but growing
  - Focus on road (and not just pavement)
  - Treatment of pavement varies greatly

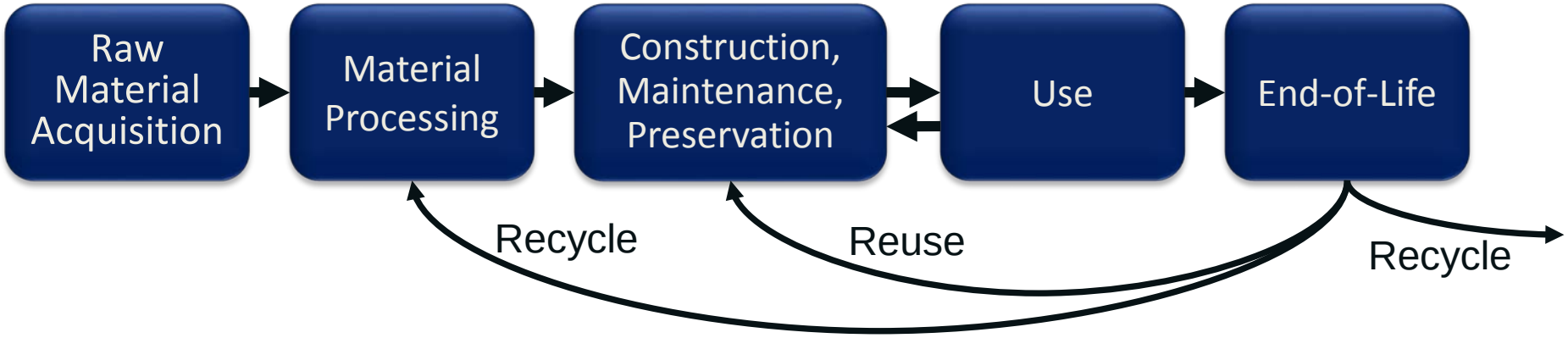
FHWA Sustainable Pavements Program

- Pavement Life Cycle
- Life Cycle Assessment

Alissa Kendall

The Pavement Life Cycle

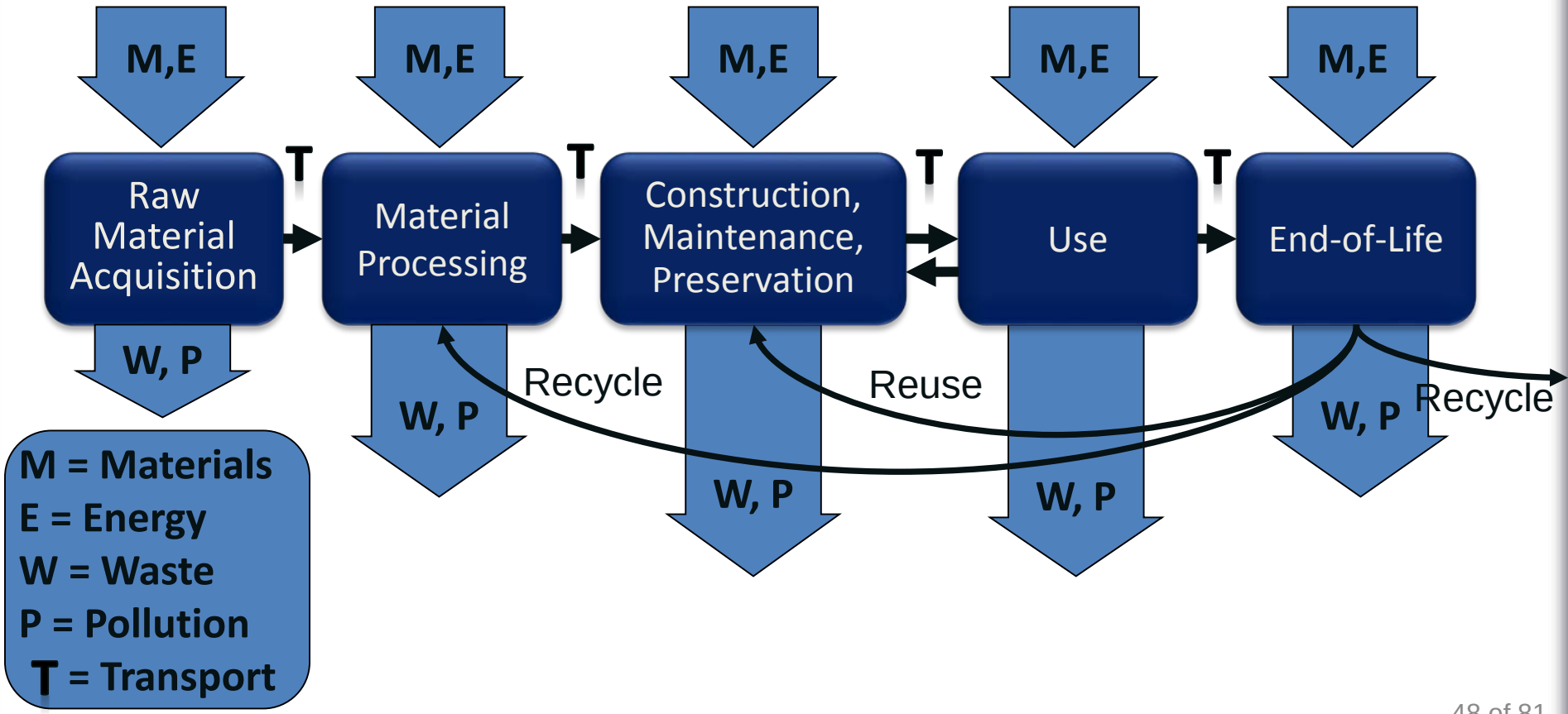
- The pavement life cycle considers each phase; from material production, construction, use and retirement.



- It starts at the mine, quarry, or oil well, and ends when pavements (or a portion of the pavement) reaches its end-of-life

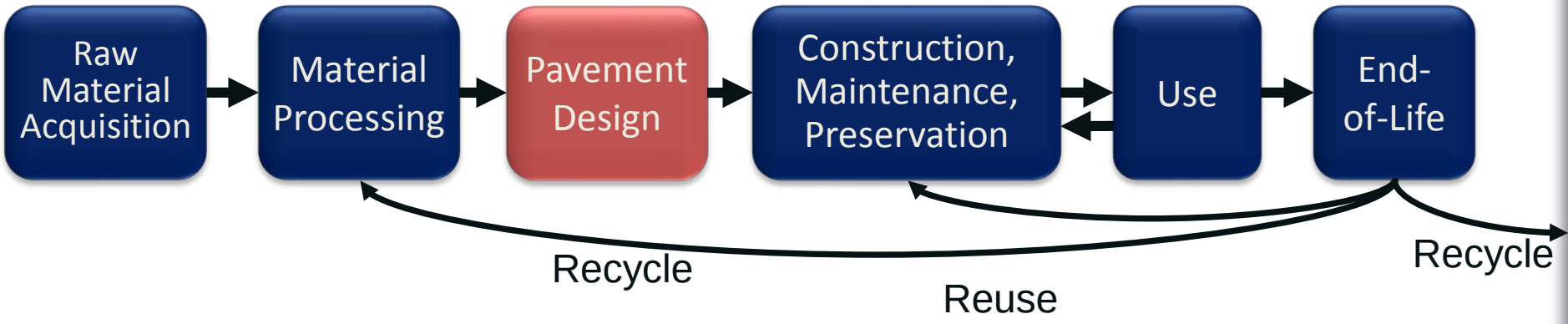
Pavement Life Cycle Assessment

- Life cycle assessment examines the environmental flows occurring at each stage

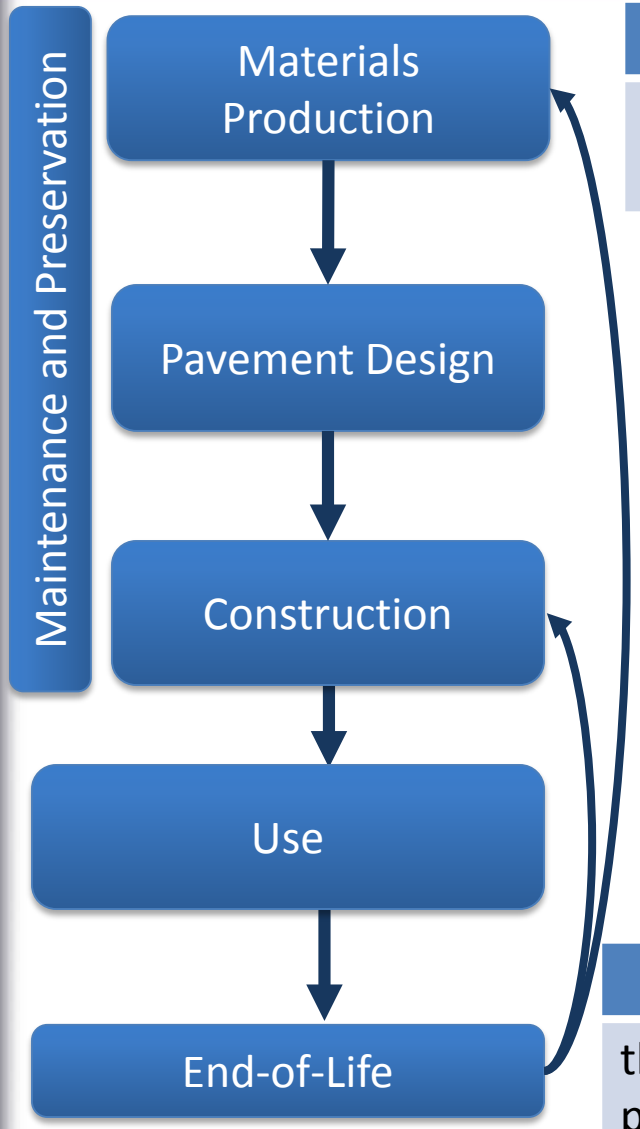


The Pavement Life Cycle

- One influential element in determining this life cycle is the pavement design stage, which influences everything from material selection, service life, and maintenance



A Practical View of the Pavement Life Cycle



Materials & Plant Processes

Refers to all processes involved in pavement materials acquisition (e.g., mining) and processing (e.g., refining, mixing)

Materials/Systems Considered & Pavement Design

Identify the structural/functional requirements of a pavement, determine the pavement structural composition and accompanying materials

Field Processes

processes and equipment associated with the construction, as well as subsequent maintenance and rehabilitation

Use

Pavement interactions with vehicle operations and the environment.

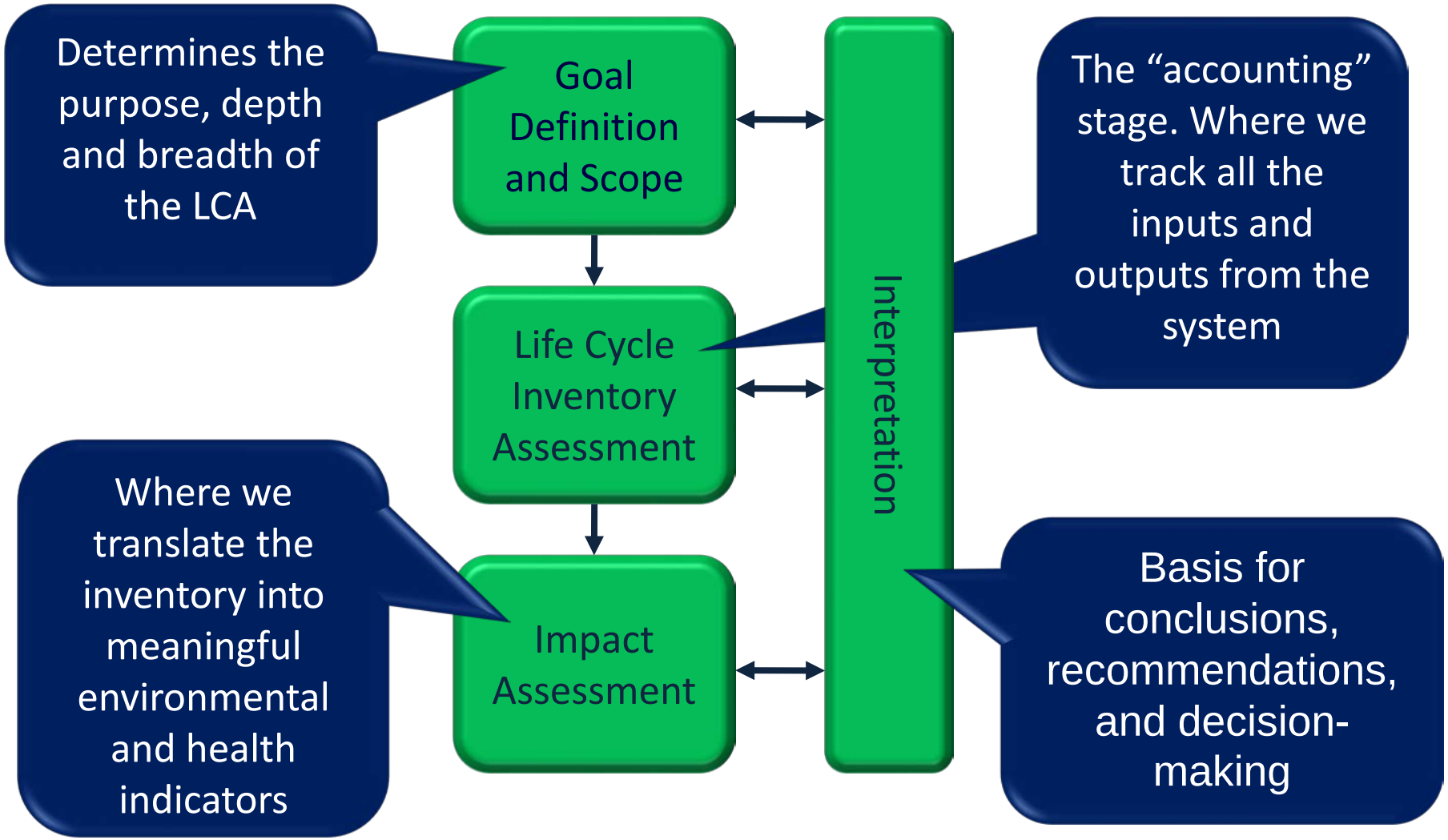
Landfill or Recycling

the final disposition and subsequent reuse/recycling of any portion of a pavement system at the end of its useful life.

The Purpose of an LCA

- LCA is a structured evaluation methodology that quantifies the environmental impacts over the full life cycle of a product or system, including impacts that occur throughout the supply chain.
- LCA can be used for a variety of purposes
  - Identifying opportunities to improve environmental performance
  - Inform and guide decision-making for policy, planning, or design
  - Support environmental claims or EPD

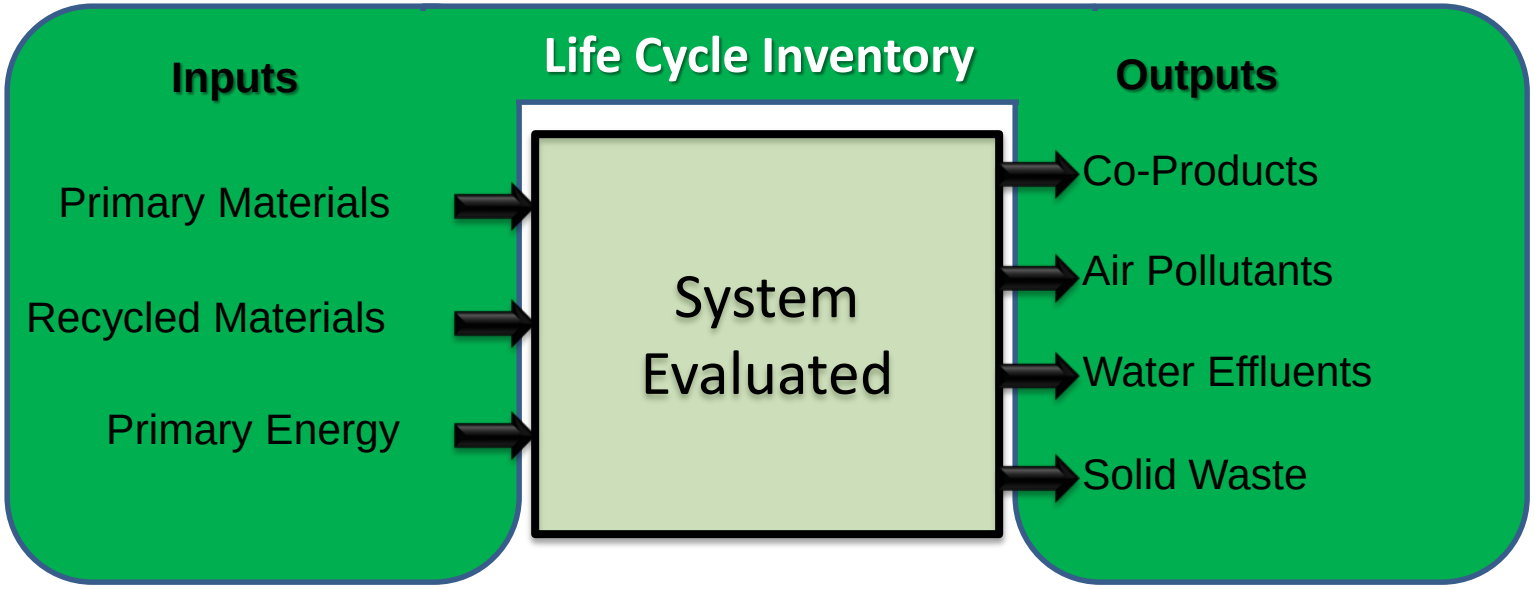
LCA Study Process



Adapted from ISO 14044 (2006)

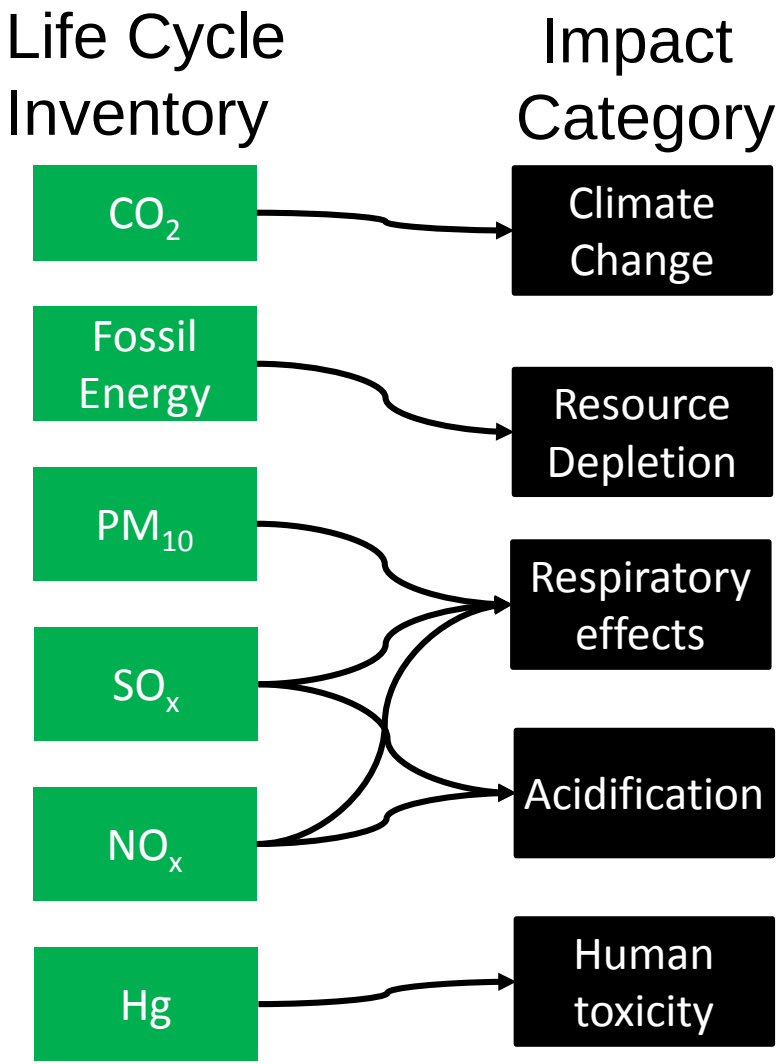
Life Cycle Inventory (LCI)

- The quantification of relevant inputs and outputs for a given product system throughout its life cycle



Life Cycle Impact Assessment

- Translate resources consumed or pollutants emitted into effects on humans or the environment.



Key Issues

- Lack of a general pavement LCA framework
  - LCA practitioners have to make many assumptions and make methodological choices that can lead to confusing and contradictory results among studies.
- Lack of a centralized database of non-proprietary LCIs for materials, equipment, vehicles, and other elements that can serve as a reference database for practitioners

Key Issues

- A pavement life cycle can extend over a period of 60 to 75 years, requiring predictive modeling
  - Predictive modeling increases uncertainty (Santero, Masanet and Horvath, 2010)
  - Transparently reporting the uncertainty in these assumptions is one step to improving LCAs.

Key Issues

- When the use phase is included, traffic often dominates other life-cycle stages.
  - Some of these parameters are not yet sufficiently researched, such as vehicle and pavement interactions

Available Tools

- No dedicated pavement LCA tools exist
- LCA software exists (e.g., Athena, Gabi, SimaPro) include relevant LCI datasets
- Tools for life cycle greenhouse gas (GHG) or CO_2 emissions have been developed
  - A life cycle-base study focusing only on CO_2 or GHGs is not strictly an LCA (which requires inclusion of many impact categories), but rather is often referred to as a carbon footprint.

Life Cycle GHG Tools

- Project Emissions Estimator (PE-2)
  - GHG emissions model for construction, maintenance, and use
    - (Mukherjee, Stawowy, and Cass 2013)
- GreenDOT from AASHTO
  - CO_2 from the operations, construction, and maintenance activities of state highway agencies, from a single project to an entire state, and ranging from 1 day to several years
    - (Gallivan, Ang-Olson, and Papson 2010)

Findings from Example Studies

- When traffic is excluded, materials used in construction dominate life cycle impacts
  - Transportation of materials, particularly aggregates can be relevant especially for recycling
- Because traffic dominates, traffic flow management such as nighttime work can be important in minimizing impacts
  - Santero, Masanet, and Horvath (2010)

Findings from Example Studies

- Pavement longevity can lead to reduced impacts.
  - Ram et al. (2011)
- Vehicle pavement interactions mean that treatments reducing roughness on high volume roads leads to a reduction in fuel use and GHG emissions
  - Wang et al. (2012)

FHWA Sustainable Pavements Program

- Product Category Rules and Environmental Product Declarations
- Allocation
- Pavement LCA Framework
- Using Assessment Methods

Joep Meijer

Product Category Rules and Environmental Product Declarations (EPD)

- EPD, defined in the ISO 14025 standard
- Declaration which can be certified
- If all products had an EPD, a pavement LCA would benefit in quality and cost.
- EPDs can be issued on a specific product from a specific producer, but may also be issued for a generic product from a group of manufacturers (such as an association).

Product Category Rules and Environmental Product Declarations

- The basis for an EPD is a Product Category Rule (PCR) document generated through a stakeholder procedure and including rules for specific product categories,
- PCR is owned by a program operator
- LCA is conducted according to the PCR
- LCA is third party verified
- EPD can be certified by a Program Operator

Allocation

- Assigning environmental flows to a system when system boundaries are crossed

- Examples:
  - Multi-output: co-products (e.g. refineries)
  - Use of recycled material (e.g. SCMs)
  - Multi-input: landfill

Allocation

Multi-output: co-products (e.g. refineries)

- The preferred way to deal with assigning impacts to multi-outputs is to reflect the physical properties of the outgoing flows, such as mass, economic value or energy content.
- If a relationship can be established that is more suitable than mass, it should be used.

Allocation

Use of recycled material (e.g. SCMs)

- Most EPD approaches use a conservative approach:
  - Demolition processes and handling are assigned to the life cycle of the pavement that is demolished or reconstructed
  - All processes and transportation needed to reuse or recycle the material are assigned to the pavement utilizing the recycled content.

Allocation

Allocation rules should be set up to:

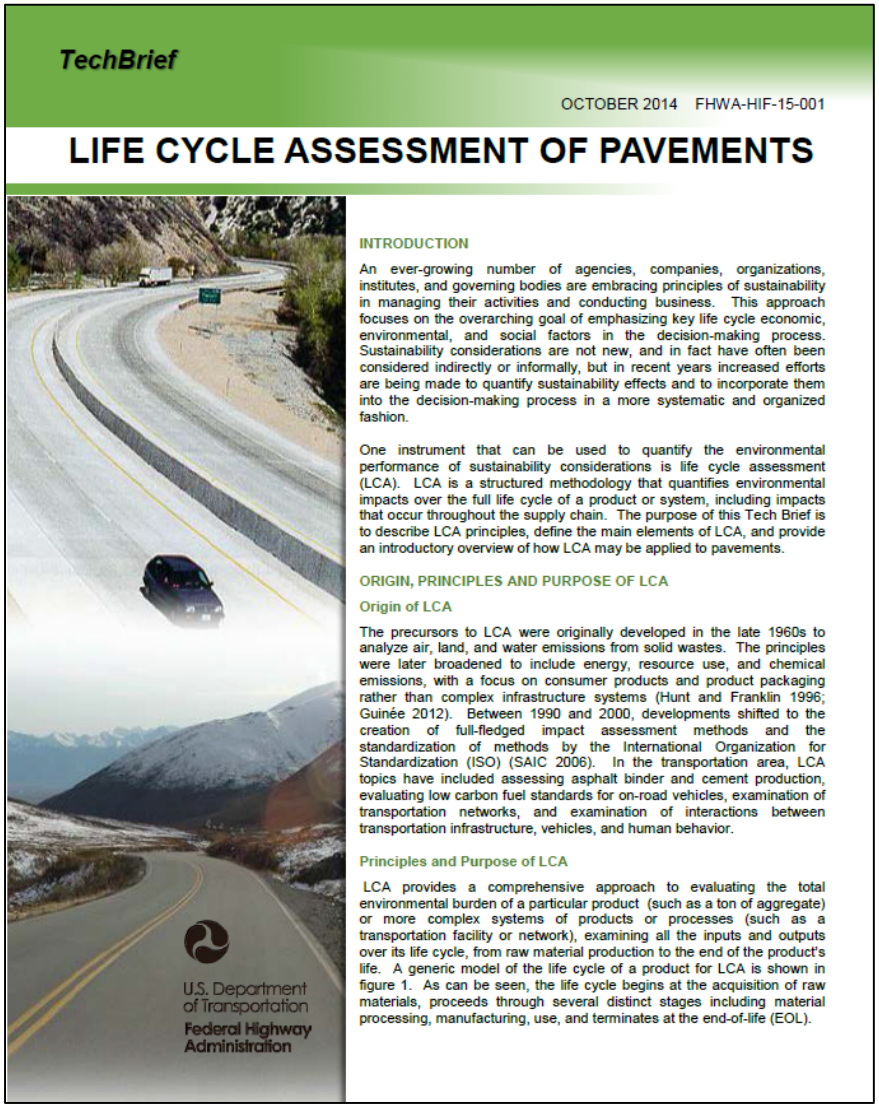
- Incentivize reduced environmental impact.
- Prevent double counting or omissions.
- Provide fairness between industries by reflecting as closely as possible what is actually happening.
- Be transparent so that all parties can understand how allocation is applied and how it influences the results.

Allocation

- In addition, ISO standards, such as ISO 14044 for LCA, require sensitivity analysis to evaluate the impact of allocation rules to determine how they might change the final results of the assessment

Tech Brief: LCA

- Origin, principles and purpose
- Standards
- Life cycle phases
- Moving forward
- LCA thinking
- References



TechBrief

OCTOBER 2014 FHWA-HIF-15-001

LIFE CYCLE ASSESSMENT OF PAVEMENTS

U.S. Department of Transportation
Federal Highway Administration

INTRODUCTION

An ever-growing number of agencies, companies, organizations, institutes, and governing bodies are embracing principles of sustainability in managing their activities and conducting business. This approach focuses on the overarching goal of emphasizing key life cycle economic, environmental, and social factors in the decision-making process. Sustainability considerations are not new, and in fact have often been considered indirectly or informally, but in recent years increased efforts are being made to quantify sustainability effects and to incorporate them into the decision-making process in a more systematic and organized fashion.

One instrument that can be used to quantify the environmental performance of sustainability considerations is life cycle assessment (LCA). LCA is a structured methodology that quantifies environmental impacts over the full life cycle of a product or system, including impacts that occur throughout the supply chain. The purpose of this Tech Brief is to describe LCA principles, define the main elements of LCA, and provide an introductory overview of how LCA may be applied to pavements.

ORIGIN, PRINCIPLES AND PURPOSE OF LCA

Origin of LCA

The precursors to LCA were originally developed in the late 1960s to analyze air, land, and water emissions from solid wastes. The principles were later broadened to include energy, resource use, and chemical emissions, with a focus on consumer products and product packaging rather than complex infrastructure systems (Hunt and Franklin 1996; Guinée 2012). Between 1990 and 2000, developments shifted to the creation of full-fledged impact assessment methods and the standardization of methods by the International Organization for Standardization (ISO) (SAIC 2006). In the transportation area, LCA topics have included assessing asphalt binder and cement production, evaluating low carbon fuel standards for on-road vehicles, examination of transportation networks, and examination of interactions between transportation infrastructure, vehicles, and human behavior.

Principles and Purpose of LCA

LCA provides a comprehensive approach to evaluating the total environmental burden of a particular product (such as a ton of aggregate) or more complex systems of products or processes (such as a transportation facility or network), examining all the inputs and outputs over its life cycle, from raw material production to the end of the product's life. A generic model of the life cycle of a product for LCA is shown in figure 1. As can be seen, the life cycle begins at the acquisition of raw materials, proceeds through several distinct stages including material processing, manufacturing, use, and terminates at the end-of-life (EOL).

http://www.fhwa.dot.gov/pavement/pub_details.cfm?id=935

FHWA Pavement LCA Framework

The overall goal is to establish a framework for performing an LCA specific to pavements, with guidance provided on the overall approach and methodology as well as on the system boundaries.

An information document on the best practice for conducting a pavement LCA, and not a FHWA policy or mandate.

Normative References

- Build on ISO 14040 series and EN15804
- Based on learnings and current status for Pavement LCA from literature review
- Existing guidance, as in the UCPRC guidelines

Table of Contents

Section 1. Goal and Scope
Section 2. Inventory
Section 3. Impact assessment
Section 4. Interpretation
Section 5. Reporting
Section 6. Critical Review

Timeline

- Task 1—Literature Search (complete)
- Task 2—Development of First Draft of Pavement LCA Framework (complete)
- Task 3—Gather Feedback (in progress)
- Task 4—Development of 2nd Draft (summer)
- Task 5—Delivery of Framework (Sept. 2015)

Use of Assessment Methods

- Assessment methods are amongst others: LCA, LCCA, rating systems
- Agencies that use one or more of the assessment methods do so by choice because they recognize a benefit.

Owner/Agency, Project Priorities

- LCCA, LCA, and rating systems can be used alone or in concert to measure sustainability.
- Using them in concert provides a more holistic assessment of sustainability
- Ultimately, the priorities of the owner/agency and the characteristics of the project determines what assessment methods are used and what priority is given to each

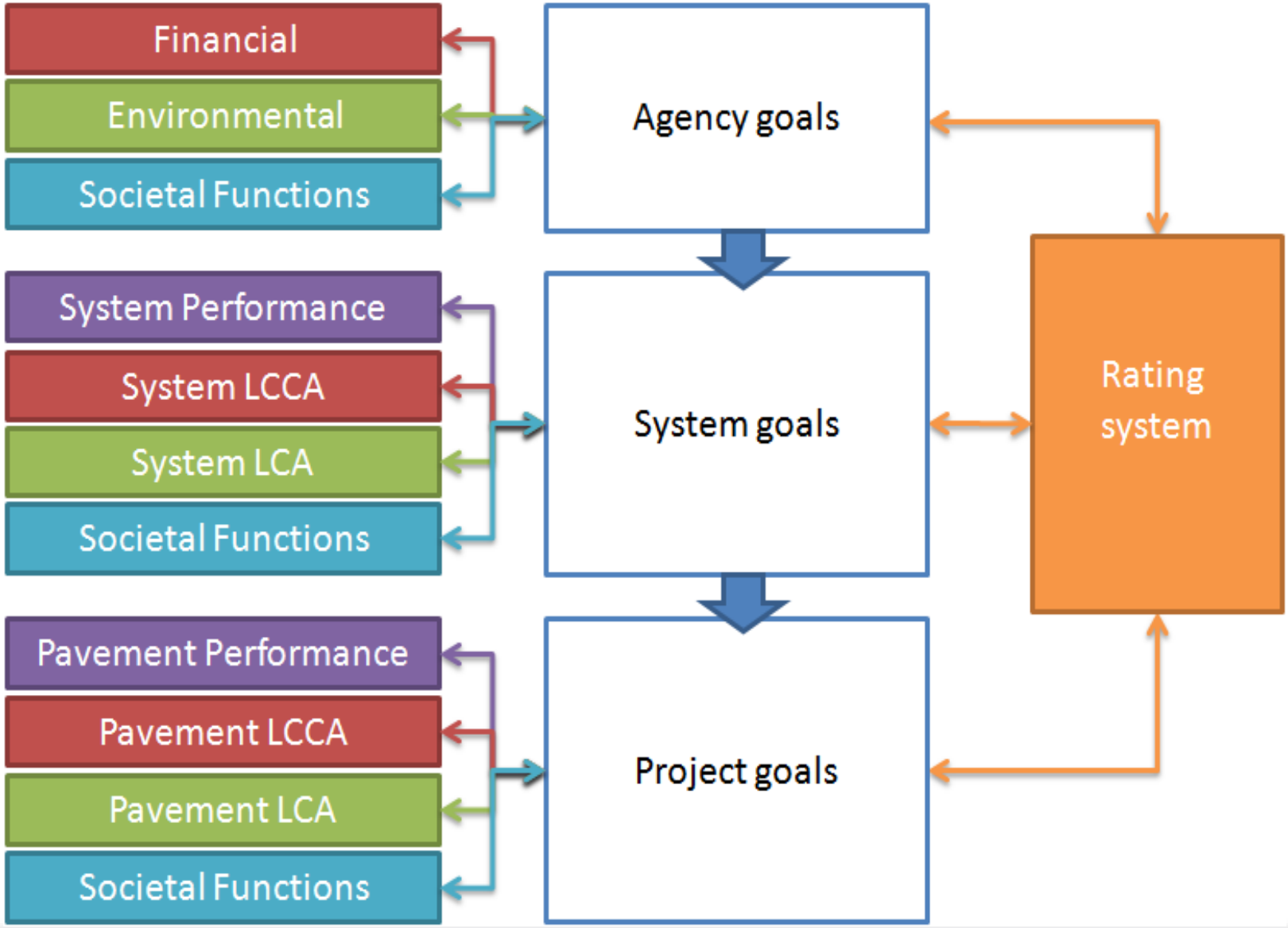
Owner/Agency, Project Priorities

- For instance, lowest life-cycle solutions has driven the use of LCCA in their pavement type selection process.
- LCCA and LCA can be used in conjunction.
- A strategic DOT goal to improve or communicate sustainability may make it sensible to use a rating system that takes a broad view of sustainability.

Application at Various Levels

- Goals for addressing sustainability can be defined on
  - Agency level
  - Pavement system level
  - Pavement project level
- The assessment methods can be used and tailored to address these different goals.

8. Use of Assessment Methods



Level of Standardization

- Currently, LCCA is the most mature and widely used by DOTs
- The FHWA Pavement LCA Framework document aims at providing guidance specific to the pavement industry.
- Rating systems are relatively new and are not subject to a standard. The more mature ones generally focus on transportation infrastructure as a whole rather than just specifically on pavements.

Thank You!

- Gina Ahlstrom: Gina.Ahlstrom@dot.gov
- Kurt Smith: ksmith@appliedpavement.com
- Tom Van Dam: tvandam@ncenet.com
- Steve Muench: stmuench@myuw.net
- Alissa Kendall: amkendall@ucdavis.edu
- Joep Meijer: joepmeijer@therightenvironment.net

- **Please join us at these upcoming webinars!**

Schedule	Webinar Event
May 19 **1-3 pm EDT**	#2: Sustainable Strategies for Asphalt Pavements: Materials, Design, Construction
Jun 25 **1-3 pm EDT**	#3: Sustainable Strategies for Concrete Pavements: Materials, Design, Construction
Aug 20 **1-3 pm EDT**	#4: Maintenance, Rehabilitation, and End-of-Life
Sep 9 **1-3 pm EDT**	#5: Use Phase, Livable Communities, and Path Forward