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# Illinois Tollway

## Life-Cycle Assessment

*Tool Development and Implementation*



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VP & Principal Engineer  
September 26, 2017

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# Today's Agenda

**Drive toward sustainable infrastructure**

**Developing the Tools**

**Results & Implementation**

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# Sustainability in Construction Started with Pavements and Materials

## Aggregates

- Re-use asphalt, concrete, & old aggregate base
- Rubblization

## Asphalt Materials

- Ground Tire Rubber, Warm Mix Asphalt, Fractionated RAP, Roof Shingles
- High ABR asphalt mixes

## Concrete Materials

- HPC bridge decks
- SHRP2 R21 – Composite Pavements, SHRP2 R05 – Precast Pavement
- Optimized mix design, ternary blends, performance mixes



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## Implementing Sustainability Research Saves Illinois Tollway More Than \$200 Million

STEVEN GILLEN

The author is Deputy Program Manager of Materials, Illinois State Toll Highway Authority, Downers Grove.

The Illinois Tollway has steadily increased the implementation of research findings over the past 12 years, producing new standards and policies for pavements, materials, and recycling. The tollway recently reviewed the documentation of con-

efficient methods to reprocess pavements into recycled aggregates, although other agencies had developed and successfully implemented on-site processing techniques and concrete pavement rubblization (1). The Illinois Tollway rubblized nearly 32 miles

of Illinois recently completed a field core samples of aged SMA overlay system. The findings con-

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cost savings of \$10 million. These levels of savings have continued after implementing higher quantities of FRAP.

### Recycled Asphalt Shingles

In 2009, with the help of a grant from the U.S. Environmental Protection Agency, the Illinois Tollway teamed with Iowa State University and the University of Illinois to study the combination of recycled asphalt shingles (RAS) with high FRAP in shoulder mixes (4). The up to 3 percent RAS allowable in asphalt mixes can reduce the need for virgin asphalt

of Illinois recently completed a field core samples of aged SMA overlay system. The findings con-

TABLE 1 Estimated Cost Savings, by Materials

Applications	Years	Total Cost Savings
Aggregate	2004-2015	\$113,000,000
Asphalt	2007-2015	\$74,000,000
Concrete	2013-2016	\$31,500,000
Total approximate savings		\$218,500,000

RESEARCH PAYS OFF



# Implementing Sustainability Research Saves Illinois Tollway More Than \$200 Million

used SMA mixes used by the Illinois Department of

of  
ial  
40 awaiting reuse on I-88.



saved more than \$200 million (see Table 1, above right) and hundreds of millions of dollars more. These include warm-mix asphalt for asphalt mixes, the development of precast concrete pavements and site-strength concrete patching mixes, the design for continuously reinforced concrete pavements, and the development of policies for accelerated bridge construction. These initiatives do not have large up-front

- Academy, Washington, D.C., 2013. <http://www.trb.org/Main/Blurbs/168833.aspx>.
- Brand, A. S., J. R. Roessle, L. L. Al-Qadi, and P. Sharggum. Fractured Reclaimed Asphalt Pavement (FRAP) as a Course Aggregate Replacement in a Ternary Blended Concrete Pavement, 2012.
  - Brand, A. S., A. N. Amirkhanian, and J. R. Roessle. Fatigue Capacity of Rigid Pavement Concrete Slabs with Recycled Aggregates, 2013.

Editor's Note: Appreciation is expressed to Nancy M. Whiting, Transportation Research Board, for her efforts in developing this article.

Suggestions for Research Pays Off topics are welcome. Contact Stephen Maher, Transportation Research Board, Keck 486, 300 Fifth Street, NW, Washington, DC 20001; 202-334-2955; smaher@nas.edu.

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# Design practices also contribute

## Longer life pavement design

- Joint spacing in concrete
- Mix selection in asphalt

## Designs to accommodate potential for future truck weights

## Pavement optimization using AASHTO Pavement ME

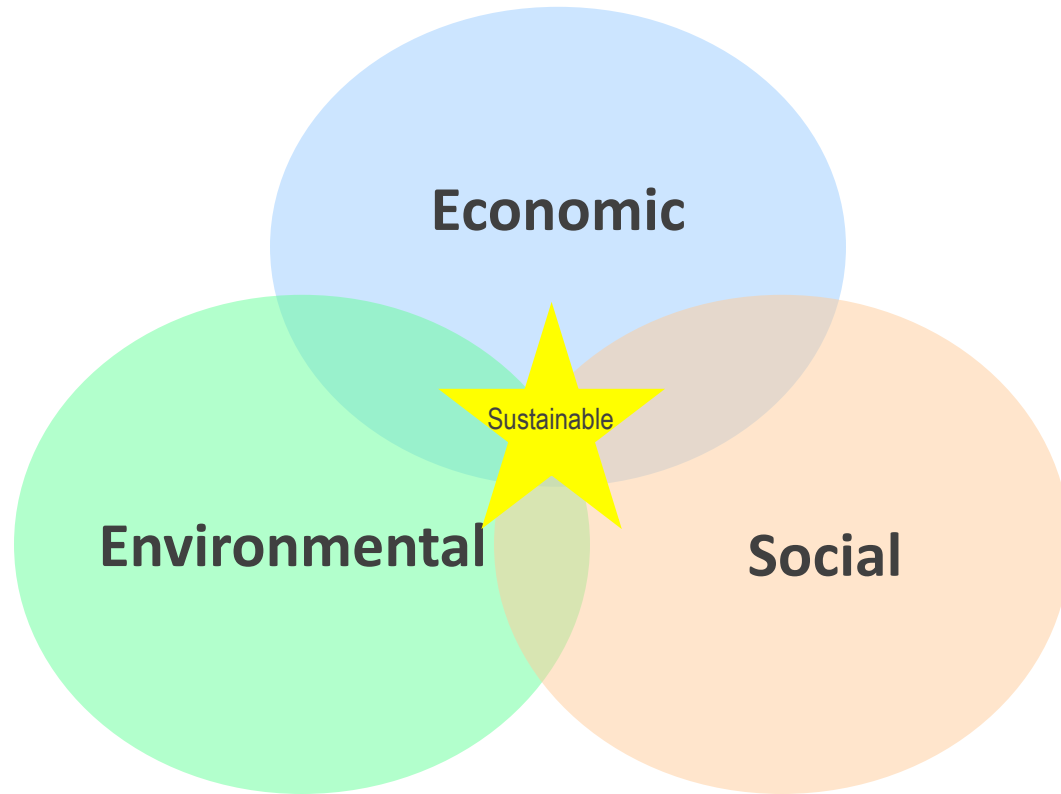


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# Sustainability is the goal



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# Sustainability is a Primary Goal for the Capital Program

*“As good environmental stewards, the tollway's capital program promises to be the **"cleanest and greenest"** program in tollway history.”*

*Tollway Executive Director, 2011*

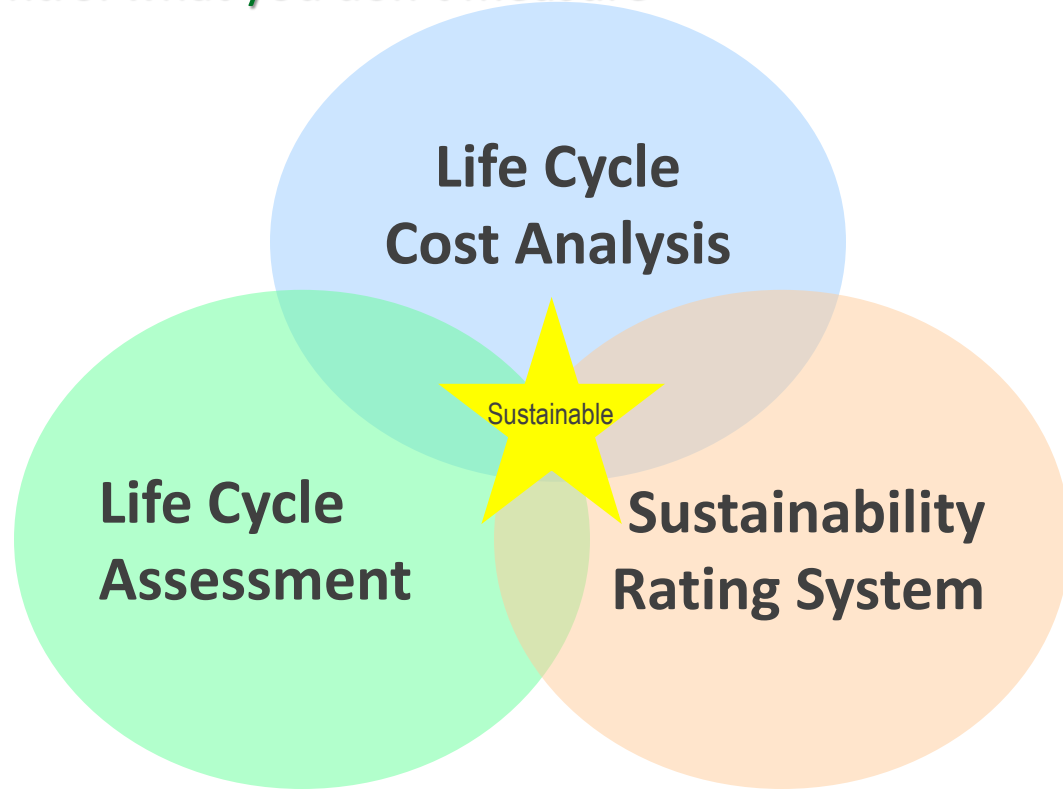


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# All three sustainability legs should be measured

You can't control what you don't measure



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# Rating system is different from life cycle assessment (LCA)

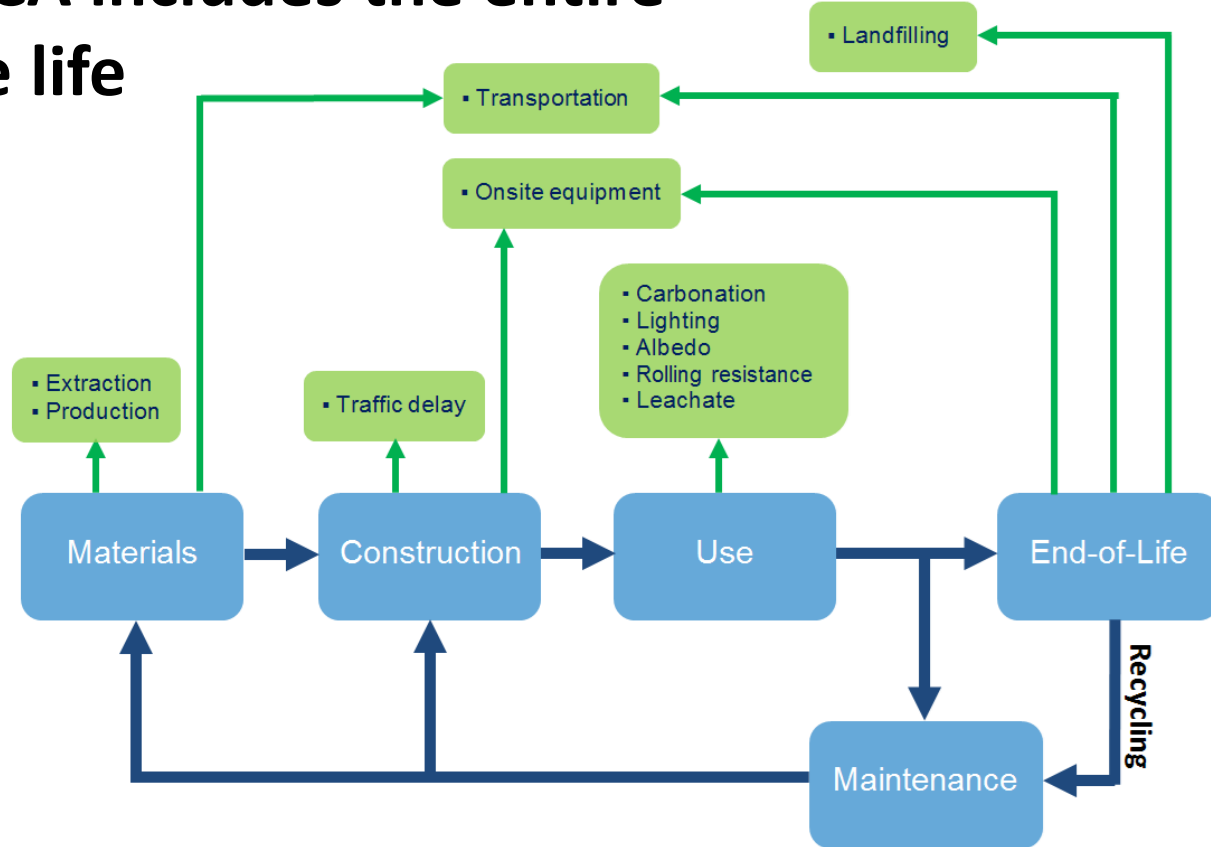
Sustainability Rating System	Life Cycle Assessment
Qualitative	Quantitative
Social, Economic, and Environmental	Environmental
Rates a system	Typically for a product (eg. pavement, bridge, etc.)
Result is points	Result is detailed inputs & outputs



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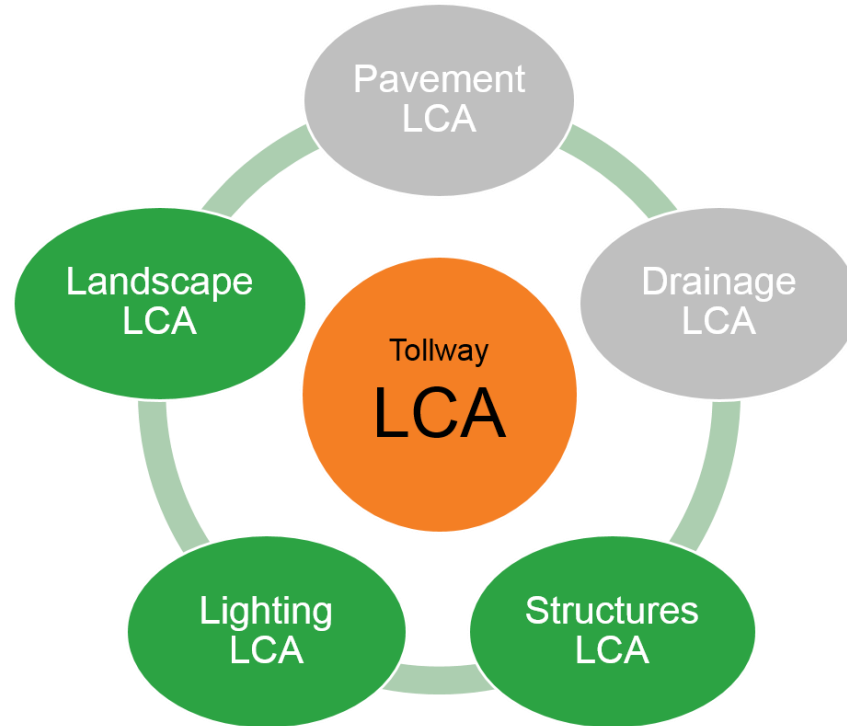
# A complete LCA includes the entire infrastructure life

*Cradle to grave interactions of environment and production system*



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# Sustainability measurement is for the entire roadway system



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# Tollway LCA Is Full Roadway Evaluation

## Each infrastructure type has up to 4 phases:

- Materials & Construction
- Maintenance & Rehabilitation
- Use (only for DR, LI, and PA)
- End-of-Life

## Environmental impact categories:

- Greenhouse gas emissions
- Energy consumption
- Single Point Score (several impacts combined into a single value)



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# Pay Items are the “language” of road design/construction

## Able to measure impacts at different stages

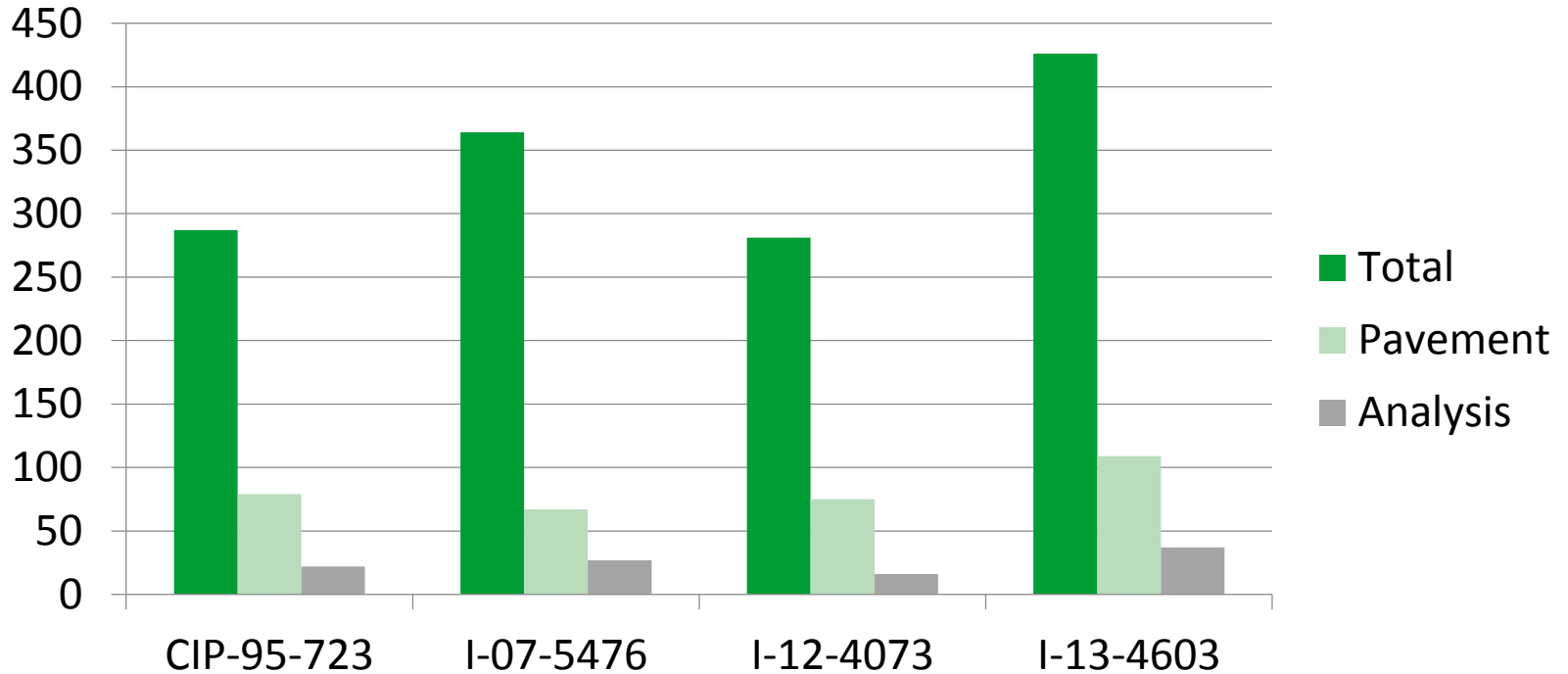
- Initial design estimate
- Contractor bids
- Final Invoice (as-built)



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# Number is reduced by module and cost



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# Pay items are defined by their impacts

Each significant pay items is “defined”

## Definitions include:

- Mix designs (where appropriate)
- Materials
- Equipment
- Operations

Objective is to account for all impacts associated with providing a unit of a pay item, in-place, accepted by the Tollway



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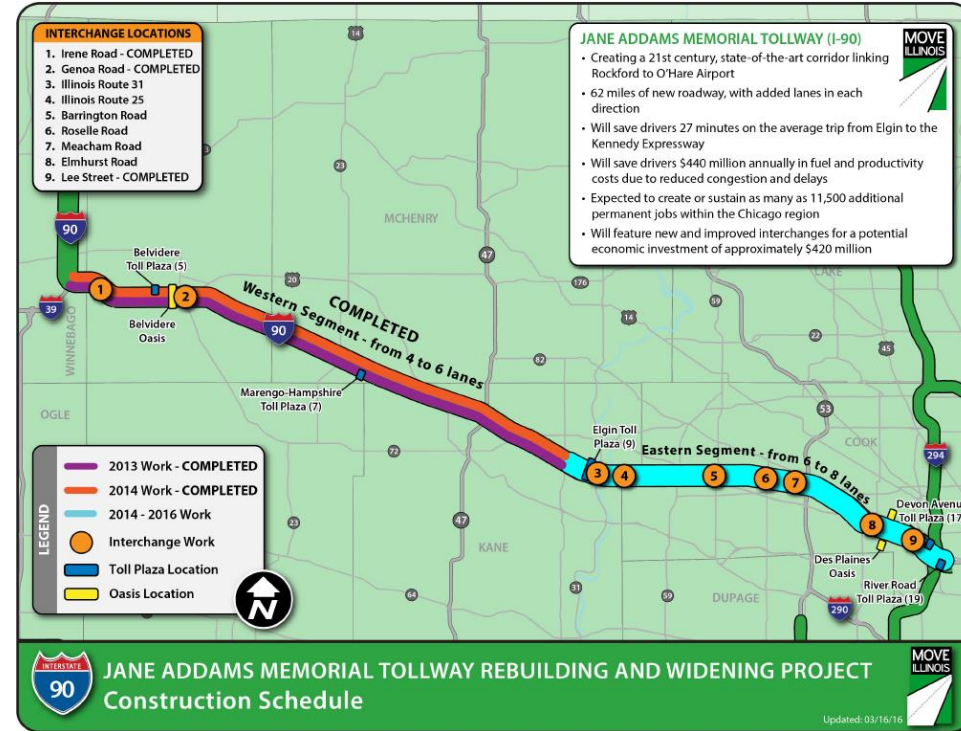
# We can use I-90 to evaluate our progress and how the LCA system works

2.5 billion of capital program

62 miles of roadway

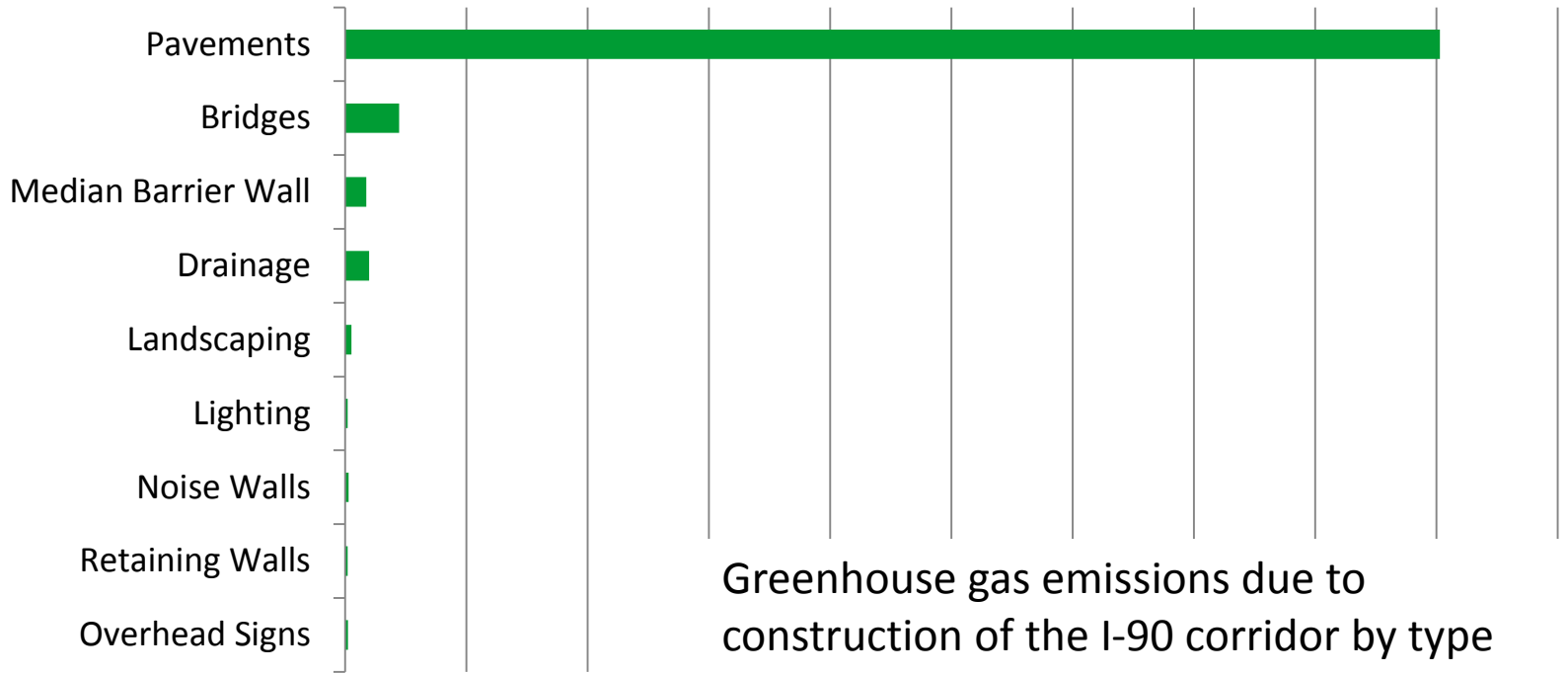
Western section completed in 2014

Eastern Section completed in 2016





# Pavements drive the construction impact on the I-90 Corridor

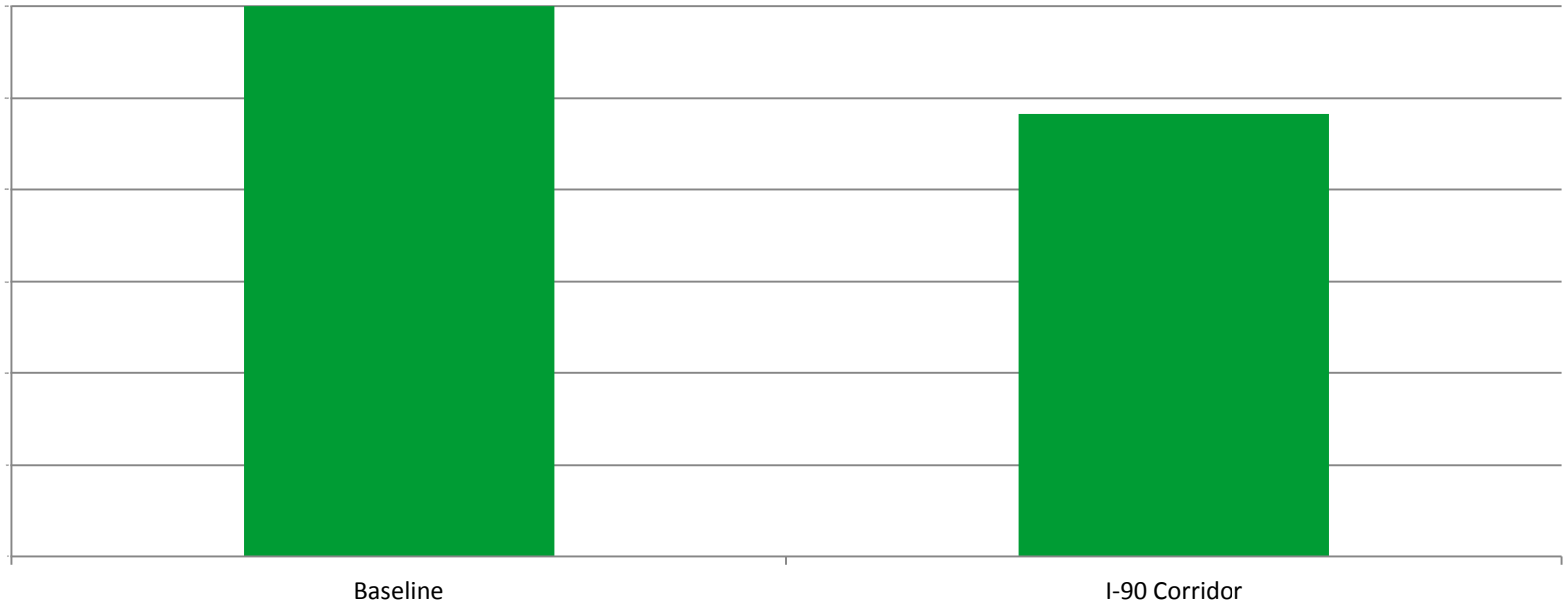


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# Significant improvements in concrete pavements

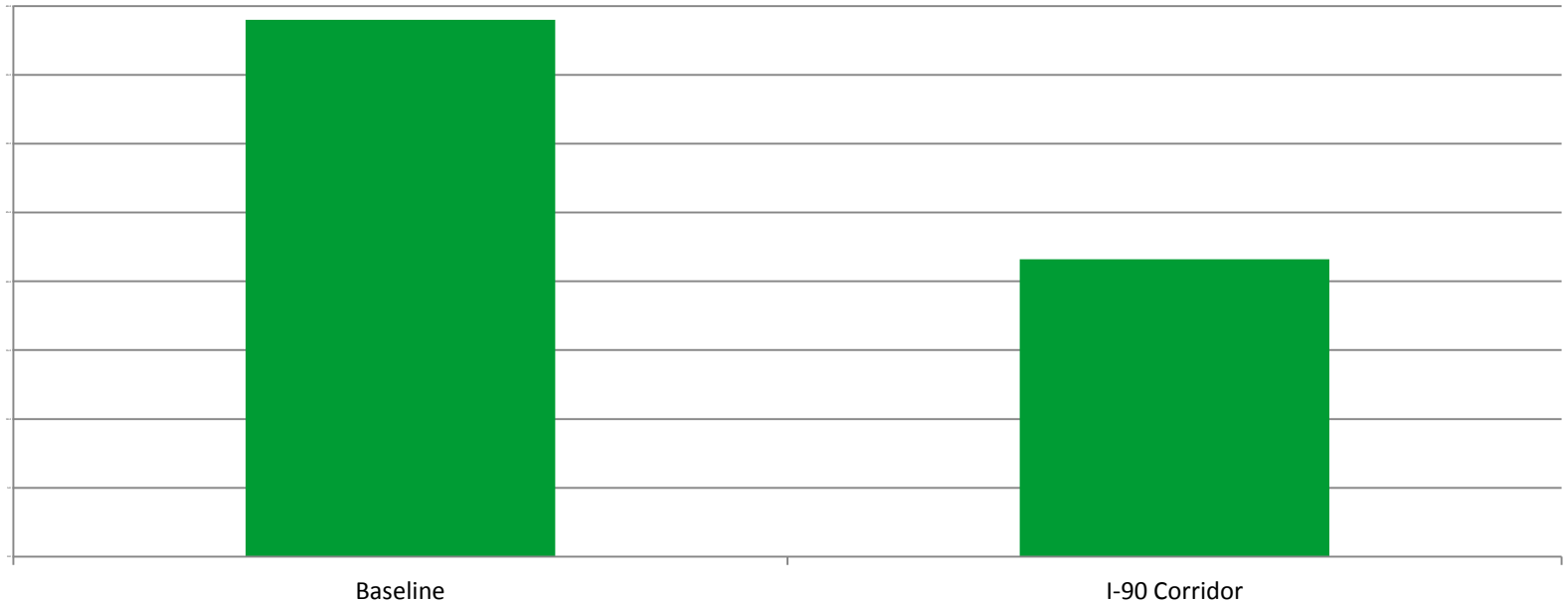
GHG per cu yd of PCC (kg CO<sub>2</sub>-equiv). *19.7% reduction*



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# Significant improvements in asphalt pavements

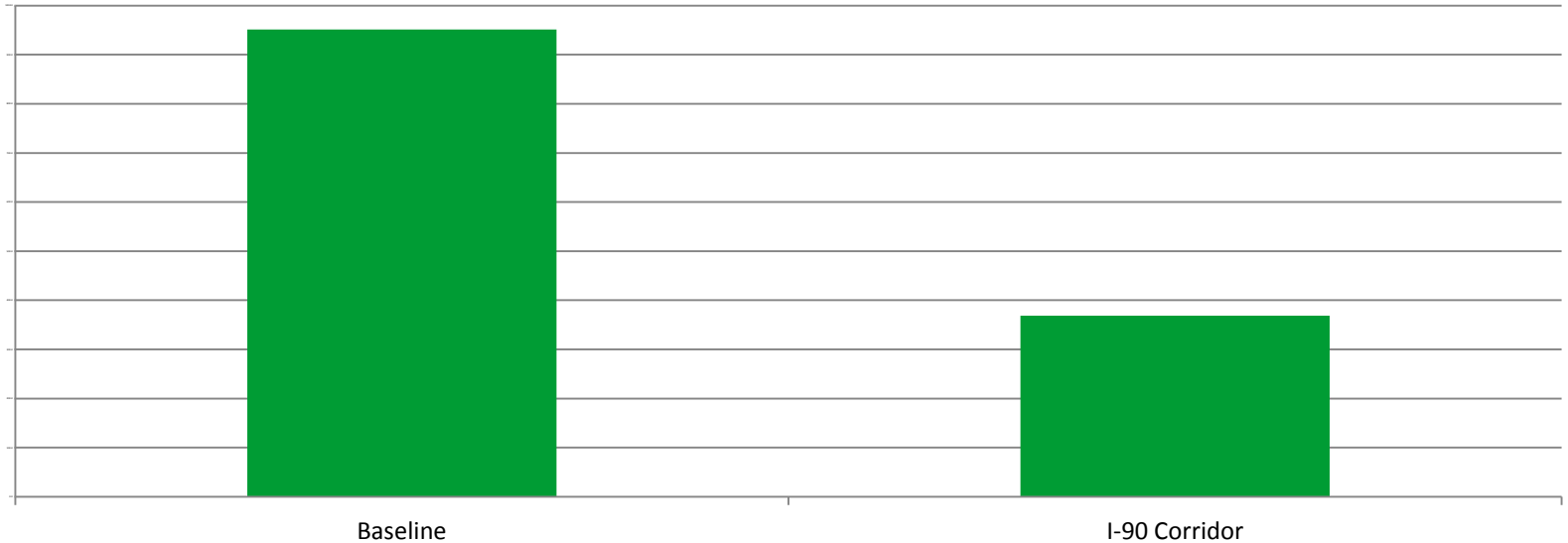
GHG per cu yd of HMA (kg CO<sub>2</sub>-equiv.) *44.6% reduction*



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# Significant improvements in lighting

GHG per light-year (kg CO<sub>2</sub>-equiv.)  
*61.3% reduction*



# Implementation will begin in 2018

## LCA used in planning

- Design alternatives (pavement type selection)

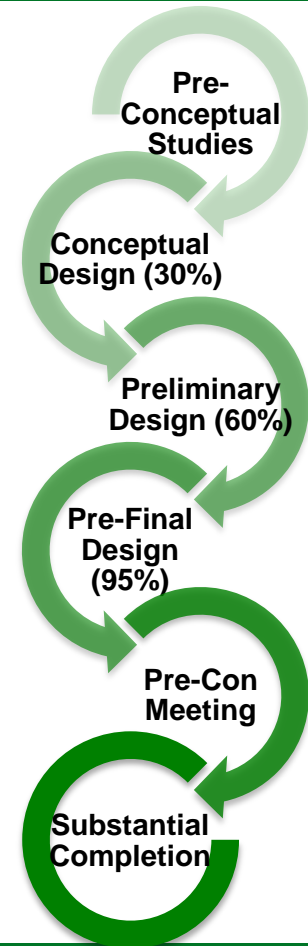
## LCA informs design decisions

- Material specifications & special provisions
- Design features

## LCA used to evaluate construction

- Actual construction mixes, distances, etc.
- Construction data used to update standard inputs

## LCA performance reported annually



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# In summary

- Research leads to innovation...
- Innovation facilitates doing more with less
- Measurement allows good management
- Managing facilitates sustainable success



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Thank  
You!

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