



An Introduction to FHWA's LCA Pave: A Tool to Assess Environmental Impacts of Pavement Material and Design Decisions

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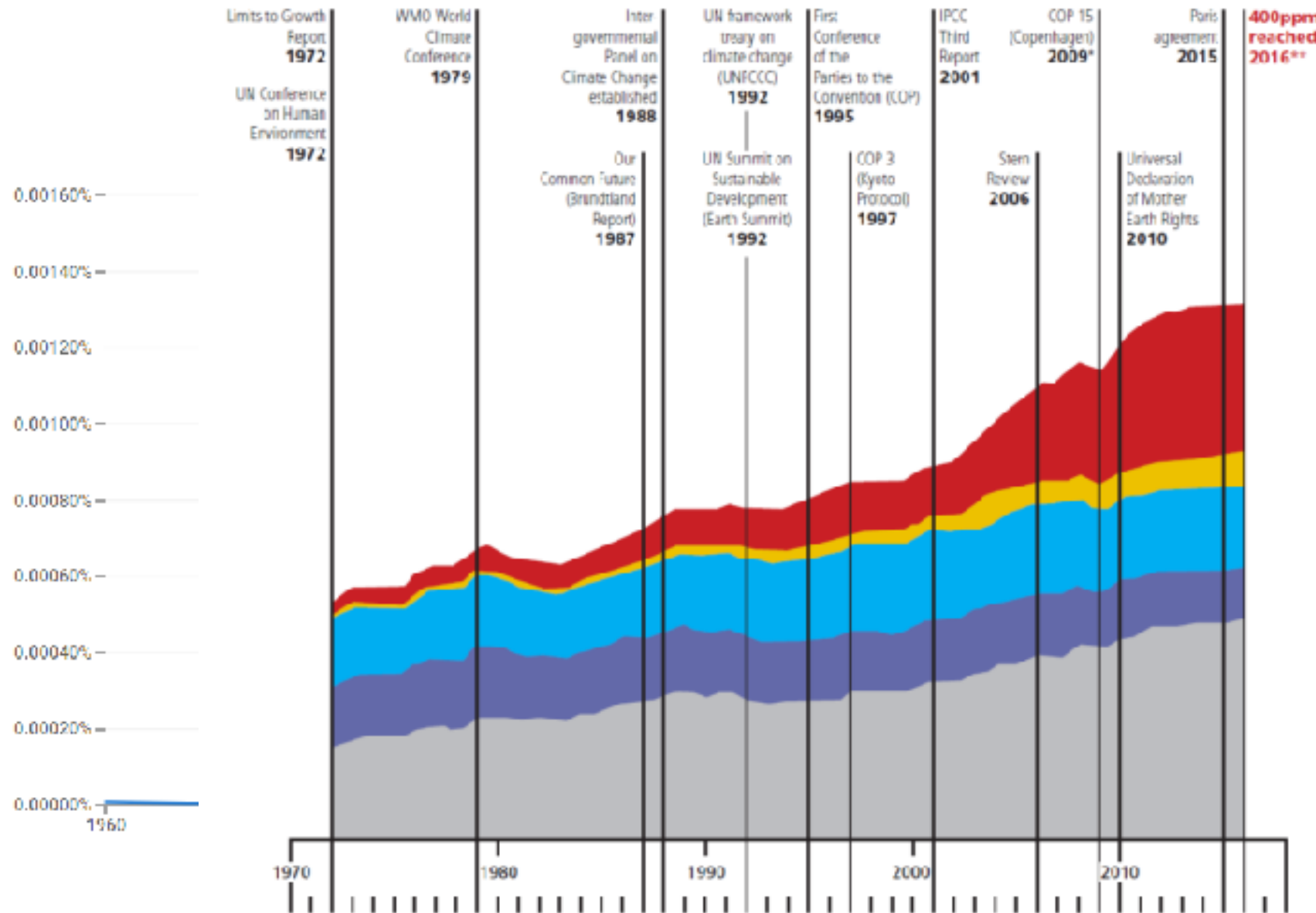
Applied Pavement Technology, Inc. (APTech)



Northwest Pavement Management Association Conference
Vancouver, WA | October 26, 2022



Timeline of events leading to Paris agreement in 2015



Continuing rise in greenhouse gas emissions

Stages of failure

Key

- China
- India
- United States
- European Union
- Rest of world

* Fails to come to any agreement on emissions cuts or finance for poor countries.

** Agreement reached puts world on path to +2°C increase in global warming

*** 400 parts per million concentration of CO₂ in the atmosphere – dangerous climate impacts and an uncertain future.

climate change



Photo by Lauren Adams | The Post

CULTURE

Groundhog Day faces challenges due to climate change

Climate Change is Real

- Arctic is melting, sea levels are rising
- Hurricanes and wildfires are more severe
- Optimistic models predict substantial climate change over the next century
 - Rate of change dependent on human activities
- We need tools to assess economic, environmental, and social impacts





Anthony Edwards @edwardsanthonyb · 6h

There are dozens of active, quick-spreading **wildfires** in Washington. The temperature is 86 degrees in Seattle. It has rained half an inch in the past 115 days.

The date is October 16.

This is climate change.



39 463 1,409



Tren Griffin @trongriffin · 13m

Breaking a Seattle temperature record by 16 degrees isn't normal.

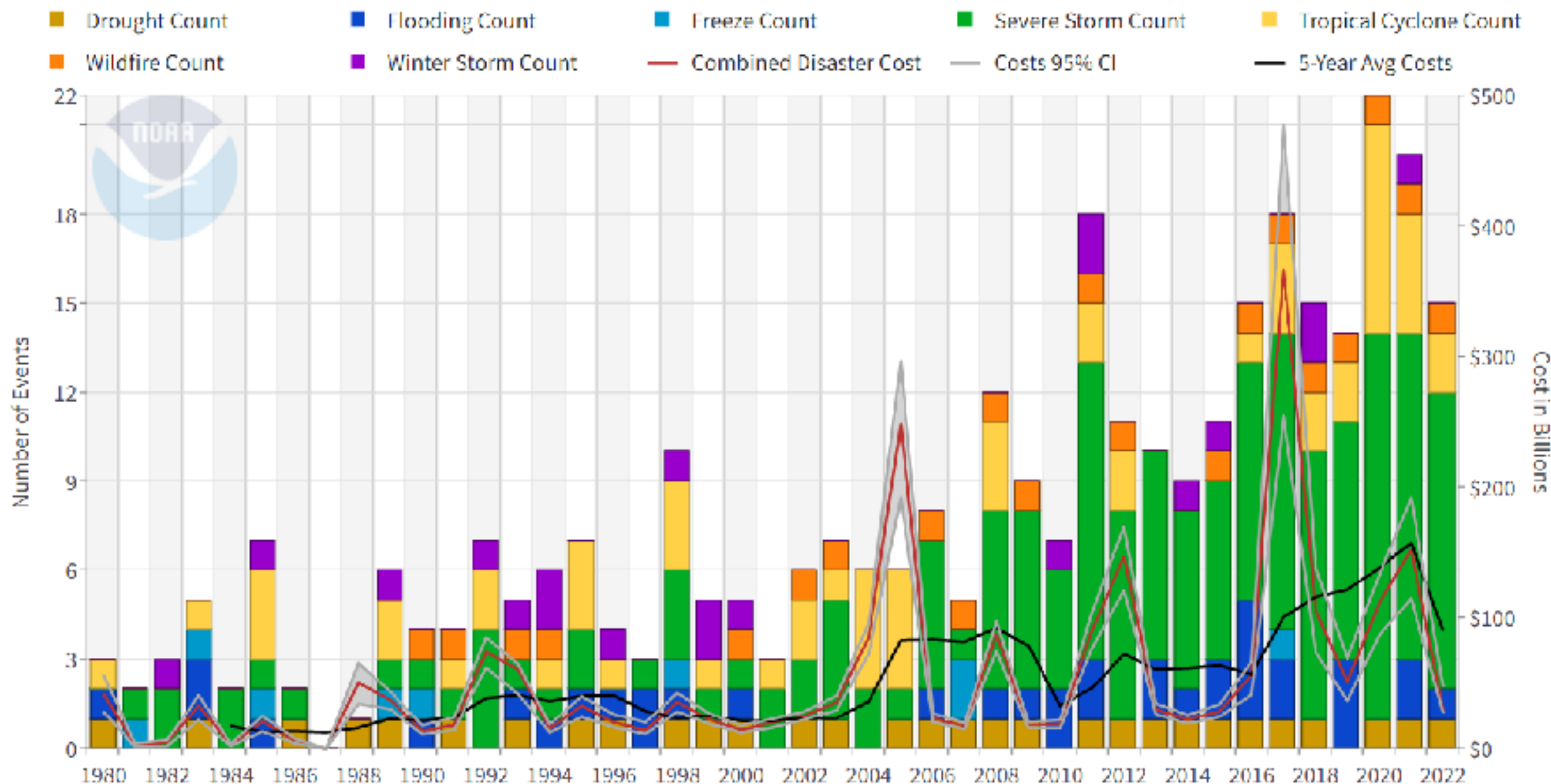
Loch Katrine fire is in the foreground, Bolt Creek fire in the middle, with the Suiattle River fire in the background.

Sea-Tac Airport 88° today (old record 72°, 2018)

[Show this thread](#)



United States Billion-Dollar Disaster Events 1980-2022 (CPI-Adjusted)



Updated: October 11, 2022

Powered by ZingChart



ALJAZEERA

The world must cut emissions by 43% by 2030 to meet Paris goals. Instead, they're set to rise by 10.6%.

What's Been Happening Lately in the U.S.?

- Federal Buy Clean Initiative
 - Promote use of low-carbon materials made in the U.S.
 - \$4.5 Billion for GSA, DOT, and EPA
- FHWA Climate Challenge
 - 35 Projects from 27 agencies (2 local agencies)
 - \$7.1 Million to implement LCAs and EPDs
 - Washington and Oregon State DOTs are participants
 - Local Agencies: City of Seattle and Port Authority of NY & NJ



What Can I Learn From This Presentation?

- A primer on Life Cycle Assessment (LCA)
- Environmental Product Declarations (EPDs) and Product Category Rules (PCRs)
- An introduction to the LCA Pave tool:
 - Scope of the tool and use cases
 - Applications and limitations
 - Tool's structure and user interface
- Pavements and rock stars – what's the connection?

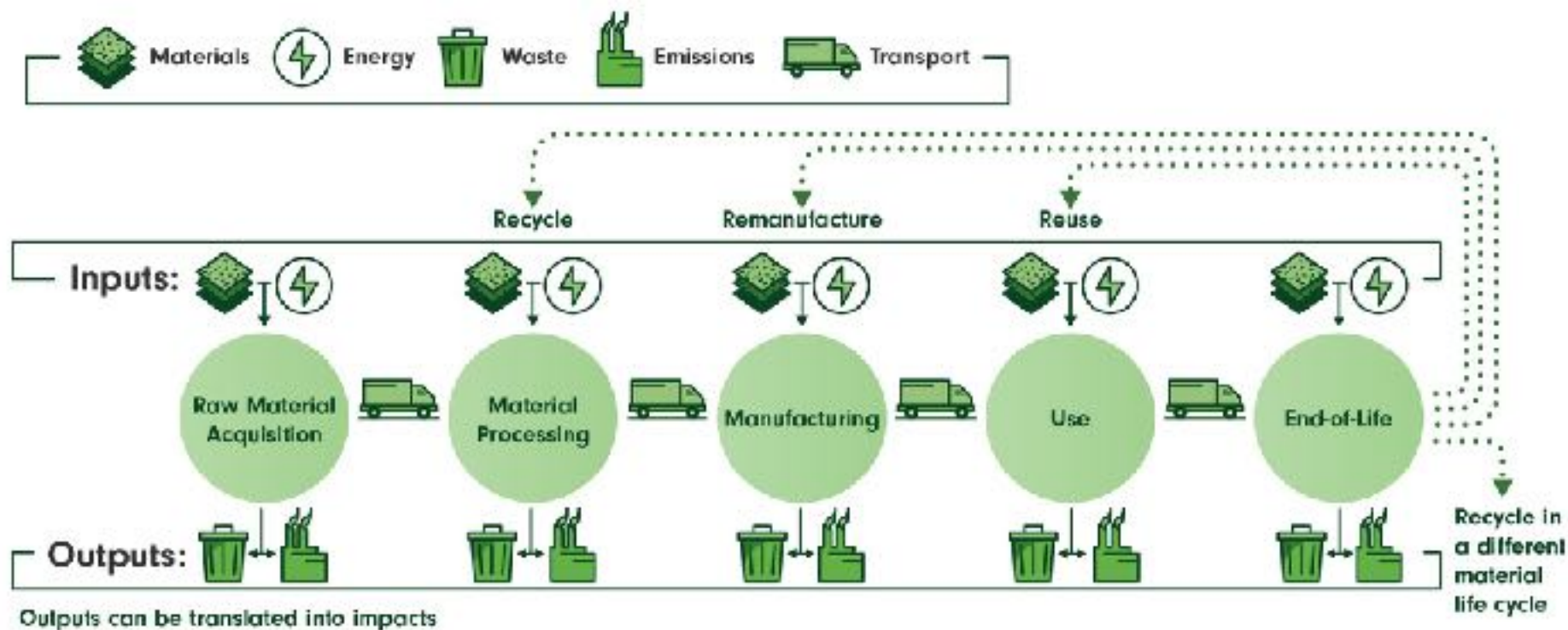




A PRIMER ON LIFE-CYCLE ASSESSMENT (LCA)

What is LCA?

- Technique to quantify environmental impacts of products, processes, or systems
- Covers a range of environmental impacts

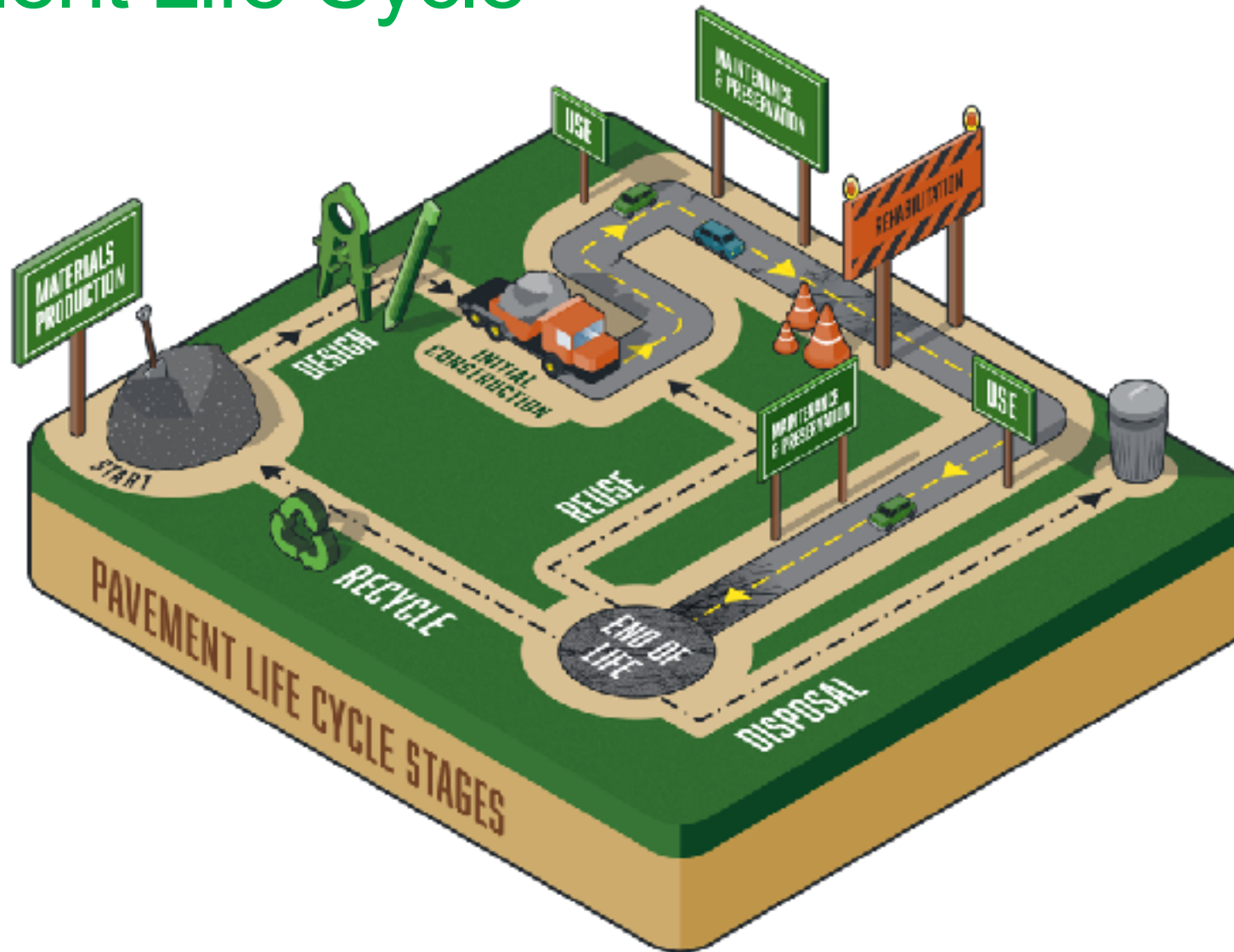


LCA ≠ LCCA

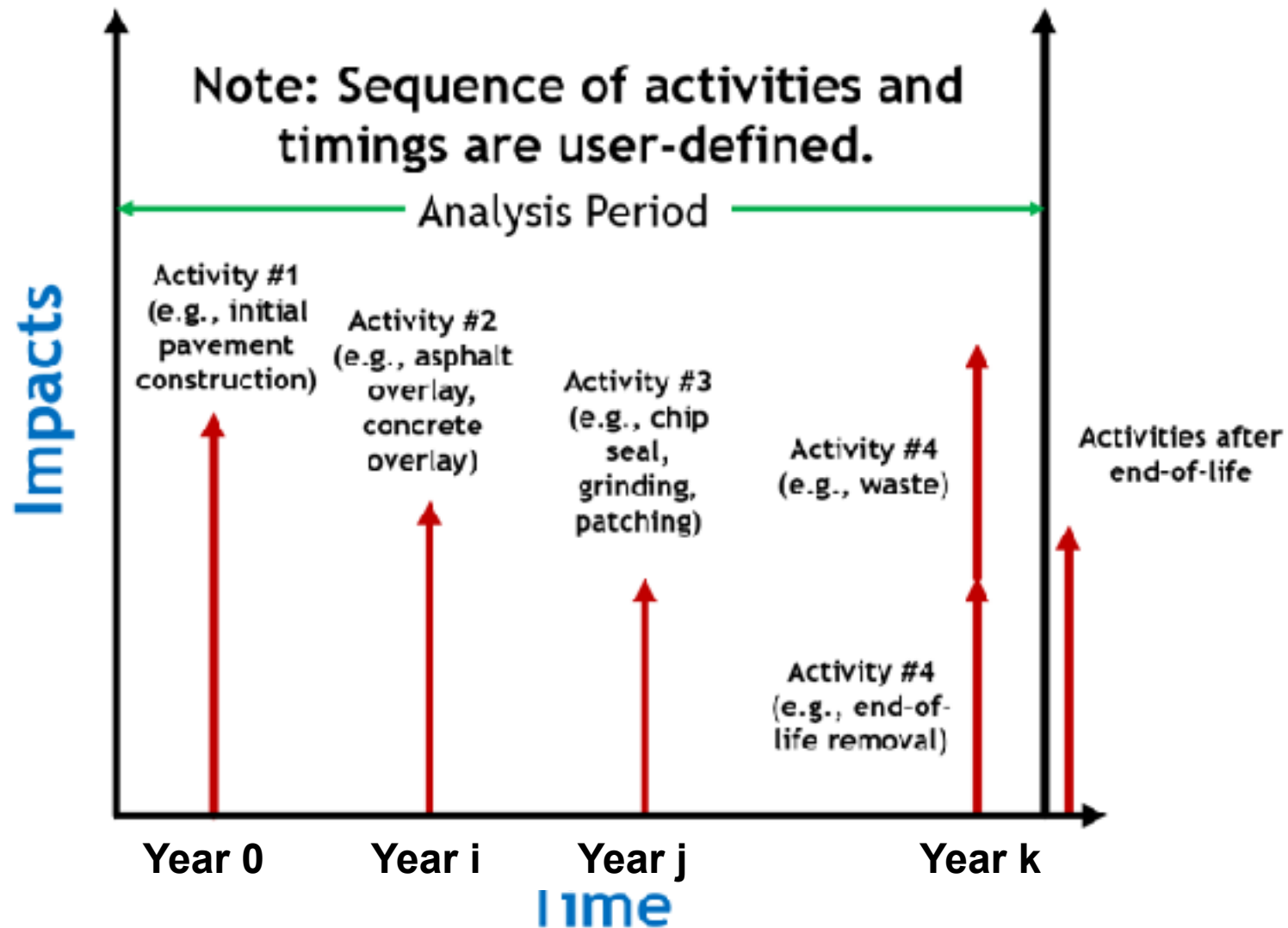
- Life-cycle cost analysis (LCCA) evaluates life-cycle economic impacts
- Life-cycle assessment (LCA) quantifies life-cycle environmental impacts



Pavement Life Cycle



Quantify Environmental Impacts from Each Activity



Important To Know

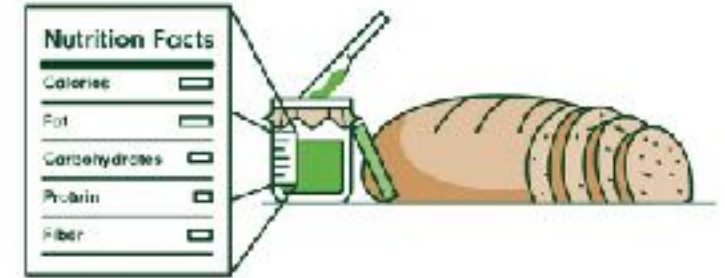
- LCAs are context sensitive
 - Results from different LCA studies should not be compared
- LCA is just one indicator in the decision-making process
 - Other key factors (life-cycle agency costs, work zone safety, user costs, etc.) should also be considered



What Are EPDs?



- Communicate environmental impacts of material or product
- Express the results of an LCA
- Developed with stakeholder input
- Follow industry standards described in the PCR



Similar to nutrition labels for food products, EPDs communicate critical environmental information on pavement materials to the customer.

Using guidance from ISO and European Standards,



Product Category Rules (PCR)




- PCRs are sets of industry-consensus standards and guidelines used to develop EPDs
- PCRs ensure EPD:
 - Consistency
 - Transparency



Example EPD



 An Environmental Product Declaration for Asphalt Mixtures				
TRACI Impact Indicator	Unit	Materials	Transport	Production
Global Warming Potential	kg CO ₂ -Equiv.	83.4	11.8	168
Ozone Depletion	kg CFC 11-Equiv.	1.81e-08	5e-10	8.55e-11
Acidification	kg SO ₂ -Equiv.	0.485	0.0577	1.08
Eutrophication	kg N-Equiv.	0.0253	0.00373	0.0207
Smog Air	MJ surplus energy	8.23	1.81	13.3

Note: Impacts for Test Mix 1, a dense-graded Superpave asphalt mixture, categorized as a hot-mix asphalt mixture, produced within a temperature range of 100 to 250°F.

Courtesy of National Asphalt Pavement Association



How Are EPDs Used?



- Provide Verifiable and Transparent Information
- Performance Metric Supporting Innovation
 - Procurement
- Communicate Good Stewardship
- Data Source for
 - Benchmarking Progress
 - LCAs for Informing Policy, Pavement Design, or Pavement Management Practices





A Tool to Assess Environmental Impacts of
Pavement Material and Design Decisions

What is LCA Pave?

- LCA tool developed by FHWA with stakeholder input
- Microsoft® Excel®-based
- For use by State and local highway agencies and individuals knowledgeable of LCA principles



Tool Uses

- Evaluate environmental impacts of pavement materials, pavement structures, pavement treatments, and mix designs
- Compare material sources and hauling alternatives
- Evaluate life-cycle strategies for maintenance, preservation, and rehabilitation
- Compare pavement end-of-strategies (recycling vs. reuse vs. landfill)



Tool Scope and Features

- Focus on project-level analysis
- Uses publicly available national average data
- Allows users to add, store, update, and use data stored in the tool's library
- Handles metadata and data quality indicators
- Includes all pavement life-cycle stages except use stage
- Allow users to add environmental product declarations (EPDs) for pavement materials and mix designs



Environmental Impact Indicators

- Tool includes life-cycle inventory (LCI) flows and Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts (TRACI) 2.1 life-cycle impact assessment (LCIA) indicators

LCI Flows

- Use of renewable primary energy, excluding renewable primary resources used as raw materials
- Use of renewable primary energy resources used as raw materials
- Total use of renewable primary energy resources
- Use of nonrenewable primary energy, excluding nonrenewable primary energy resources used as materials
- Use of nonrenewable primary energy used as raw materials
- Recycled material usage
- Disposed non-hazardous waste
- Disposed hazardous waste
- Disposed radio-active waste
- Net use of fresh water
- Supplementary Cementitious Material (SCM) usage

TRACI 2.1 LCIA Indicators

- Acidification
- Ecotoxicity
- Eutrophication
- Fossil Fuel Depletion
- Global Warming Potential
- Human Health – Cancer
- Human Health – Noncancer
- Human Health Effects – Particulates
- Ozone Depletion
- Smog Formation

Note: TRACI is a tool from the US Environmental Protection Agency (EPA)
[TRACI Webpage](#)



Tool Structure and User Interface Overview

Tool Components

- **Data Libraries:**

- Contains default and user-developed items used to model different design alternatives

- **Analysis Session:**

- Model design alternatives
- Run an analysis
- Display results



Data Libraries

- Materials
- Equipment
- Waste
- Transport
- Mix Designs
- Activities

List of items available in the library selected

Properties associated with the selected library item

Library

Use the controls below to define library items that will be available for use when cond.

Library Selection

Materials Equipment Waste Transport Mix Designs Activities

Library Collections: 'Materials'

- [-] Admixture/Additive
- [-] Aggregate
- [-] Asphalt Binder
- [-] Cementitious
- [-] Electricity
- [-] Element
- [-] Fuel
- [-] Other
- [-] Recycled, By-Product, or Waste Material
- [-] Steel
 - Steel, Reinforcing
 - Steel, Reinforcing, Epoxy-coated
 - Steel, Rod, Galvanized
 - Steel, Stankers
 - Dowel Bar
 - Dowel bar, 1.5" x 18"
 - Dowel bar, 1.75" x 18"
 - Tie bar, threaded

Selection Details: 'Material Item'

View: 1: Properties Impact Indicators Metadata

General Properties

Material type: Steel

Item Name: Steel, Reinforcing

Measure Type: Mass

Quantity: 1 short ton

Mass Conversion: Factor Not Needed

Agency ID:

From HPII?: No

Description: WorldSteel LCI

Editable?: No (Default Database Item)

Copy Add New Edit

Paste Delete

Impact Indicators

Library

Library

Use the controls below to define library items that will be available for use when conducting a life cycle assessment.

Library Selection

Materials Equipment Waste Transport Mfg Designs Activities

Library Collection: Materials

- Retarding Admixture
- Water Proofing Agent
- Aggregate
- Asphalt Binder
- Cementitious
- Flexibility
- Flament
- Fuel
- Other
- Recycled, Co Product, or Waste Material
- Steel
 - Steel, Reinforcing
 - Steel, Reinforcing, Epoxy-coated
 - Steel, Rail, Galvanized
 - Steel, Stainless
 - Dowel Bar
 - Dowel bar, 1.5" x 18"
 - Dowel bar, 1.25" x 16"
 - Tie bar, threaded

Copy Add New Edit

Print Delete

Selection Details: 'Material' Item

View: 1: Properties 2: Impact Indicators 3: Metadata

Life-Cycle Inventory Life-Cycle Impact Assessment

Library Item: Steel, Reinforcing

Quantity: 1 short-ton

Included?	Impact Indicator	Quantity	Units
Yes	Acidification	5.2	kg SO ₂ eq
Yes	Eutrophication	3,677	kg Nitrogen/kg
Yes	Eutrophication	0.6797	kg N eq
Yes	Fossil Fuel Depletion	1,123	MJ surplus
Yes	Global Warming	1,462	kg CO ₂ eq
Yes	Human Health - Cancer	0.0003	CTU/kg
Yes	Human Health - NonCancer	0.0009	CTU/kg
Yes	Human Health - Particulates	1.42	kg PM _{2.5} eq
Yes	Ozone Depletion	0.37E-05	kg CFC-11 eq
Yes	Smog Formation	27.1	kg O ₃ eq

LCI flows and TRACI 2.1 LCIA indicators



Metadata and Data Quality Indicators

The screenshot displays a software interface for managing a library of materials. The main window is titled "Library" and contains several sections:

- Library Selection:** Includes tabs for Materials, Equipment, Waste, Transport, Mfg Designs, and Activities.
- Library Collection: 'Materials':** A tree view showing various material categories such as Accelerating Admixture, Air Entrainer, and Aggregate.
- Selection Details: 'Material' Item:**
 - General:** Contains tabs for General and Data Quality Assessment.
 - Metadata:** Displays key information including:
 - Person recording data: IICPRC
 - Source of data/model calculations: http://www.atra.info/atra_publications/environmental/#
 - Data produced/published year: 2015
 - Data accessed/recorded date: 1/23/2020
 - How type/description/name: Provided by NRMCA (conversion from LI CA LINDs)
 - Location where data is produced: EU
 - Other properties: GMI methodology (per kg of materials) not TRAC; Depletion potential of the stratospheric ozone layer (kg CFC11-Eq.) 0.000000
- Data Quality Assessment:** Shows a table of ratings for various indicators. A "Rating Details" button is present next to the table.

A red box highlights the "Data Quality Assessment" tab in the Selection Details section, with an arrow pointing to a larger view of the ratings table. A callout box above the ratings table states: "Provides details on rating scale".

Data Quality Assessment Ratings Table:

Indicator	Rating
Reliability: Data Checks	4 (1 to 5 scale)
Reliability: Data Ownership	1 (1 to 5 scale)
Reliability: Data Updates and Statistics	1 (1 to 5 scale)
Collections: Representativeness	5 (1 to 5 scale)
Collections: HAZI Compatibility	4 (1 to 4 scale)
Time Period: Data Age	2 (1 to 5 scale)
Time Period: Seasonal Variations	2 (1 to 4 scale)
Geography	1 (1 to 5 scale)
Technology: Materials	1 (1 to 5 scale)
Technology: Manufacturing	1 (1 to 5 scale)
Process Review	3 (1 to 5 scale)
Process Completeness	5 (1 to 5 scale)

Using EPD Data in LCA Pave

Users can indicate if data is obtained from an EPD

Field used to document EPD details

Environmental impact data from EPDs

Edit 'Material' Library Item

Use the controls below to edit the current 'Material' library item.

General Properties

Material Type: Aggregate

Item Name: Crushed Stone (Quarry) Aggregate for Cur

Measure Type: Mass

Quantity: 1 Units: short-tons

Mass Conversion: Factor: Not Needed

Agency ID:

From EPD? Yes No

Description:

Vulcan Materials (ASTM), Average for: Rock Dust D1023-11; 1/2" Crushed D693; 3/4" Crushed D693; 3/8" Crushed D693; Manufactured (MFC) Sand D1073-1; 1 Class II Base D2940; Crushed Class II Perm D2940; Class II Perm D2940; 1" x #4 ASTM C33; 3/4" x #4 ASTM C33; 3/8" Pm Gravel ASTM C33; Top Sand ASTM C33. Energy values are Btu.

Item Details

View: Impact Indicators Metadata

Impact Indicators

Life-Cycle Inventory | Life-Cycle Impact Assessment

Impact Indicator	Quantity	Units
<input checked="" type="checkbox"/> Renew. Energy (Non-Raw Mat)	11.46	MJ
<input checked="" type="checkbox"/> Renew. Energy (Raw Mat)	0	MJ
<input checked="" type="checkbox"/> Total Renew. Energy Use	11.46	MJ
<input checked="" type="checkbox"/> Nonrenew. Energy (Non-Raw Mat)	719.09	MJ
<input checked="" type="checkbox"/> Nonrenew. Energy (Raw Mat)	0	MJ
<input checked="" type="checkbox"/> Total Nonrenew. Energy	719.09	MJ
<input checked="" type="checkbox"/> Recycled Mat. Use	0	Short tons
<input checked="" type="checkbox"/> Disposed Non-Hazardous Waste	0.000099	Short-tons
<input checked="" type="checkbox"/> Disposed Hazardous Waste	0.000002	Short-tons
<input type="checkbox"/> Disposed Radio-Active Waste	No Data	Short-tons
<input checked="" type="checkbox"/> Net Use of Fresh Water	0.192	Cubic meters
<input checked="" type="checkbox"/> STM Usage	0	Short-tons

Select All Deselect All



Analysis Session Structure

1. Analysis Session

2. Analysis Alternatives (1, 2, 3, etc.)

3. Pavement (Mainline, Shoulder, Ramps etc.)

4. Life-Cycle Stage (Initial Construction, Maint. & Preservation etc.)

Example:

Life-Cycle Stage: Maintenance @ Yr. 20

Project: Slab Replacement (SR) & Diamond Grinding (DG)

5a. Activity #1: 5% SR

6a. Processes

Materials
Equipment
Waste
Etc.

5b. Activity #2: 100% DG

6b. Processes

Equipment
Waste
Etc.



Design Alternative Definition Interface

Design Alternative Definition (Step 2 of 3)

Design Alternative Definition

Use the controls below to define up to five different Design Alternatives to compare in the analysis.

Selected Alternative: Alternative 1 Alternative 2

Alternative Definition

- Alternative 1
 - New Pavement (Mainline)
 - Initial Construction
 - 5 inch Aggregate Base (Selected)
 - 4-inch HMA Layer-HMA-1
 - Maintenance and Preservation
 - 1 Inch Mill and Fill HMA-1
 - Maintenance and Preservation
 - 1-inch Mill and Fill-HMA-1
 - Removal
 - Demolish 4 Inch HMA Landfill

Aggregate Base

Activity Definition

6 inch Aggregate Base (1,504 short tons)

- Materials
 - Crushed Stone (Coarse Aggregate) (940 short tons)
 - Transport: To Construction Site (12,355 short ton miles)
 - Fine Aggregate (604 short tons)
 - Transport: To Construction Site (8,237 short-ton-miles)
- Equipment
 - Paver (5 hours)
 - Transport: To Construction Site (400 short ton miles)

Level 1: Alternative

Level 2: Pavement facility

Level 3: Pavement life-cycle stage

Level 4: Activities

Level 5: Processes associated with the activity selected

Move Up Copy

Move Down Delete

Selection: Activity (6-inch Aggregate Base)
Quantity: 1,504 short tons



Results Interface

- Users can choose functional unit and select impact indicators to be included in the results

Results (Step 3 of 3)

Results

Use the controls on this page to select impact indicators of interest and view related outputs.

Setup: [Results Setup](#) | Summary Results: [Overall Summary](#) | [Area Comparison](#) | [By Category](#) | [Back](#) | [View Detailed Output](#)

Output Setup

Use the controls below to choose a functional unit and select the impact indicators you want to include in your results. Note some functional unit choices are dependent on the user defined analysis period, computed lane miles, and computed total area for each alternative.

Functional Unit: **Total (Entire Project)**

Life Cycle Inventory

- Use of renewable resources (Per Lane Mile)
- Use of renewable resources (Per Lane Mile Per Year)
- Total use of renewable primary resources (Per Square Foot)
- Use of nonrenewable primary energy, excluding nonrenewable
- Use of nonrenewable primary energy used as raw materials
- Total use of nonrenewable primary energy resources
- Recycled Material Usage
- Disposed Non-Hazardous Waste
- Disposed Hazardous Waste
- Disposed Radio-Active Waste
- Net Use of Fresh Water
- Supplementary Cementitious Material Usage

Life Cycle Impact Assessment (LCIA) Results

- Acidification
- Ecotoxicity
- Eutrophication
- Fossil Fuel Depletion
- Global Warming
- Human Health - Cancer
- Human Health - NonCancer
- Human Health Effects
- Ozone Depletion
- Smog Formation

[Select All](#) | [Deselect All](#)

Results View #1 – Overall Summary

- Shows calculated values for each impact indicator selected for each alternative modeled

Results (Step 4 of 5)

Results

Use the controls on this page to select impact indicators of interest.

Setup: Results Setup Summary Results: Overall Summary

Output Results: Overall Summary

Functional Units: Total (Entire Project)

Generates editable Excel spreadsheet with results

[View Excel Table](#)

Impact Indicator	Alternative 1	Alternative 2	Units
Renew. Energy (Non-Raw Mat)	2,179,291	2,537,909	MJ
Renew. Energy (Raw Mat)	3.12	2.0	MJ
Total Renew. Energy Use	2,179,294	2,537,911	MJ
Nonrenew. Energy (Non-Raw Mat)	3,722,516	3,095,508	MJ
Nonrenew. Energy (Raw Mat)	4,271,426	4,504,664	MJ
Total Nonrenew. Energy	7,994,943	6,500,262	MJ
Recycled Mat. Use	0	0	Short-ton
Disposed Non-Hazardous Waste	1,754	239	Short-ton
Disposed Hazardous Waste	15.94	17.11	Short-ton
Disposed Radio-Active Waste	0	0	Short-ton
Net Use of Fresh Water	46,748	50,174	Cubic meters
SCM Usage	0	0	Short-Tons
Acidification	496	521	kg SO2 eq
Ecotoxicity	19,945	20,217	CTUeco/kg
Eutrophication	141	140	kg N eq
Fossil Fuel Depletion	557,293	615,462	MJ surplus
Global Warming	139,395	150,706	kg CO2 eq
Human Health - Cancer	0.0002	0.0003	CTU/kg
Human Health - NonCancer	0.0114	0.0123	CTU/kg
Human Health - Particulates	53.79	65.06	kg PM2.5 eq
Ozone Depletion	0.0024	0.0022	kg CFC-11 eq
Smog Formation	12,043	12,111	kg O3 eq
Analysis Period:	N/A	N/A	
Total Lane Miles:	1.00 In mi	1.00 In mi	
Total Area:	63,360 sf	63,360 sf	

Results View #2 – Tree Comparison

- Shows comparisons between two alternatives for the impact indicator selected

Results (Step 3 of 3)

Results

Use the controls on this page to select impact indicators of interest and view related outputs.

Setup: Results Setup Summary Results Overall Summary **Tree Comparison** By Category

Output Results: Tree Comparison

Use the controls below to view side-by-side environmental impact summaries for two different design alternatives.

Functional Unit: Total (Entire Project) Impact Indicator: Renew. Energy (Non-Renew. Mat) (MJ) Hide Units

Results Tree #1

Selection 1: 1: IMA Design 1

- [-] IMA Design 1 (2,179,281 MJ)
 - [-] New Pavement (2,179,281 MJ)
 - [-] Initial Construction (1,457,900 MJ)
 - 6 inch Aggregate Base (EXAMPLE) (15,417 MJ)
 - 4 inch IMA 1 (EXAMPLE) (1,442,512 MJ)
 - [-] Maintenance and Preservation (360,648 MJ)
 - 1 inch Mill and Fill 1 (EXAMPLE) (360,648 MJ)
 - [-] Maintenance and Preservation (360,648 MJ)
 - 1-inch Mill and Fill-1 (EXAMPLE) (360,648 MJ)
 - [-] Removal (55.16 MJ)
 - Demolish 4-inch HMA-1 and fill (55.16 MJ)

Analysis Period: N/A Total Area: 63,360 sf
Total Lane Miles: 1.00 In-Mi

Results Tree #2

Selection 2: 2: IMA Design 2

- [-] IMA Design 2 (2,537,909 MJ)
 - [-] New Pavement (2,537,909 MJ)
 - [-] Initial Construction (1,456,907 MJ)
 - 6 inch Aggregate Base (EXAMPLE) (15,417 MJ)
 - 4 inch IMA 2 (EXAMPLE) (1,441,390 MJ)
 - [-] Maintenance and Preservation (360,367 MJ)
 - 1 inch Mill and Fill 2 (EXAMPLE) (360,367 MJ)
 - [-] Maintenance and Preservation (360,367 MJ)
 - 1-Inch Mill and Fill-2 (EXAMPLE) (360,367 MJ)
 - [-] Removal (360,367 MJ)
 - 1-Inch Mill and Fill-2 (EXAMPLE) (360,367 MJ)

Analysis Period: N/A Total Area: 63,360 sf
Total Lane Miles: 1.00 In-Mi

Results View #3 – By Category

- Shows results by categories established in the tool for the selected impact indicator

Results (Step 3 of 3) ✕

Results

Use the controls on this page to select impact indicators of interest and view related outputs.

Setup: [Results Setup](#) Summary Results: [Overall Summary](#) [Tree Comparison](#) [By Category](#) [Back](#) [View Detailed Output](#)

Output Results: By Category Summary [View Excel Table](#)

Functional Units: Total (Entire Project)

Impact Indicator: Renew. Energy (Non Raw Mat) (MJ)

Category: Life Cycle Stage

Life Cycle Stage	Facility Type	Alternative 1	Alternative 2	Units
Initial Construction	Life Cycle Stage	1,457,930	1,456,007	MJ
Maintenance and Rehabilitation	Activity Type	721,295	720,734	MJ
Reconstruction	Process Type	0	0	MJ
Removal		55.15	360,367	MJ

Analysis Period: N/A N/A

Total Lane-Miles: 1.00 In-mi 1.00 In-mi

Total Area: 63,360 sq ft 63,360 sq ft

Results View #4 – Detailed Outputs

- Generates customizable output report template with detailed outputs

Detailed LCA Output		Return to Session
<p>Overall and alternative-specific output associated with your current analysis session is provided in the visible worksheet tabs below. To aid in the navigation of specific output of interest, a list of hyperlinks to the different worksheet tabs is also provided below. Note, you can also use CTRL-FgDn and CTRL-FgUp to navigate between output tabs.</p> <p>Click the 'Return to Session' button to return to your current analysis session.</p>		Export Output to New Workbook
Summary of Output Worksheets		
Tab Name	Tab Description	
Session Summary	Summary of general analysis session attributes.	
Alternative Comparison Summary	Comparison of included impact indicators for all included Design Alternatives.	
Alternative 1 Definition	General description of the Alternative 1 object and all of its components.	
Alternative 1 Definition SO8	SO8-compliant version of the table shown on tab 'Alternative 1 Definition'.	
Alternative 1 Details	Summary of the environmental impacts for each component in Alternative 1, for each included Impact Indicator.	
Alternative 1 Details SO8	SO8-compliant version of the table shown on tab 'Alternative 1 Details'.	
Alternative 1 By Category Data	Summary of the by category environmental impacts for each component in Alternative 1, for each included impact indicator.	
Alternative 1 Pct of Catg Data	Summary of the by category environmental impact percentages for each component in Alternative 1, for each included impact indicator.	
Alternative 1 Summary Charts	Series of by category environmental impact charts for Alternative 1.	
Alternative 2 Definition	General description of the Alternative 2 object and all of its components.	
Alternative 2 Definition SO8	SO8-compliant version of the table shown on tab 'Alternative 2 Definition'.	
Alternative 2 Details	Summary of the environmental impacts for each component in Alternative 2, for each included Impact Indicator.	
Alternative 2 Details SO8	SO8-compliant version of the table shown on tab 'Alternative 2 Details'.	
Alternative 2 By Category Data	Summary of the by category environmental impacts for each component in Alternative 2, for each included impact indicator.	
Alternative 2 Pct of Catg Data	Summary of the by category environmental impact percentages for each component in Alternative 2, for each included impact indicator.	





Analysis Example

Modeling Asphalt Pavement Life Cycle

Alternative #1

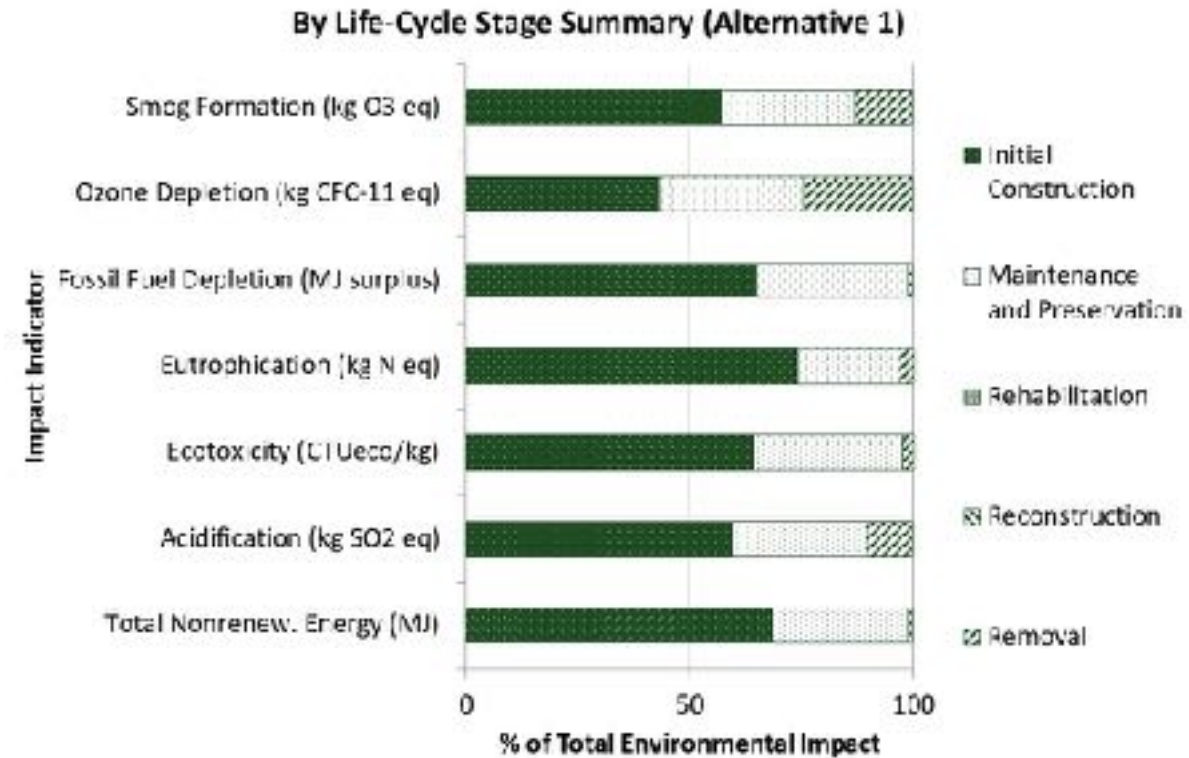
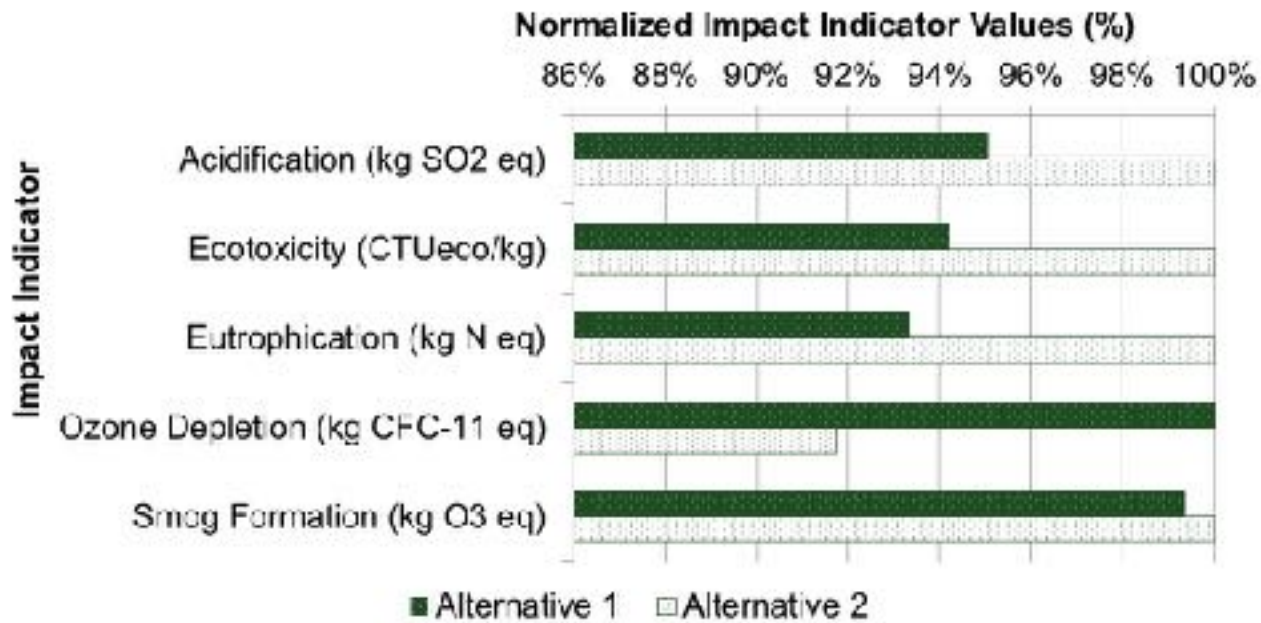
- Asphalt Mix Design: HMA-1
- Analysis Period: 25 years
- Pavement Life-Cycle Activities:
 - Year 0: 4-inch HMA over 6-inch aggregate base
 - Year 10: 1-inch mill and fill
 - Year 18: 1-inch mill and fill
 - Year 25: Demolish and Landfill

Alternative #2

- Asphalt Mix Design: HMA-2
- Analysis Period: 25 years
- Pavement Life-Cycle Activities:
 - Year 0: 4-inch HMA over 6-inch aggregate base
 - Year 10: 1-inch mill and fill
 - Year 18: 1-inch mill and fill
 - Year 25: Recycle On-Site



Example Outputs





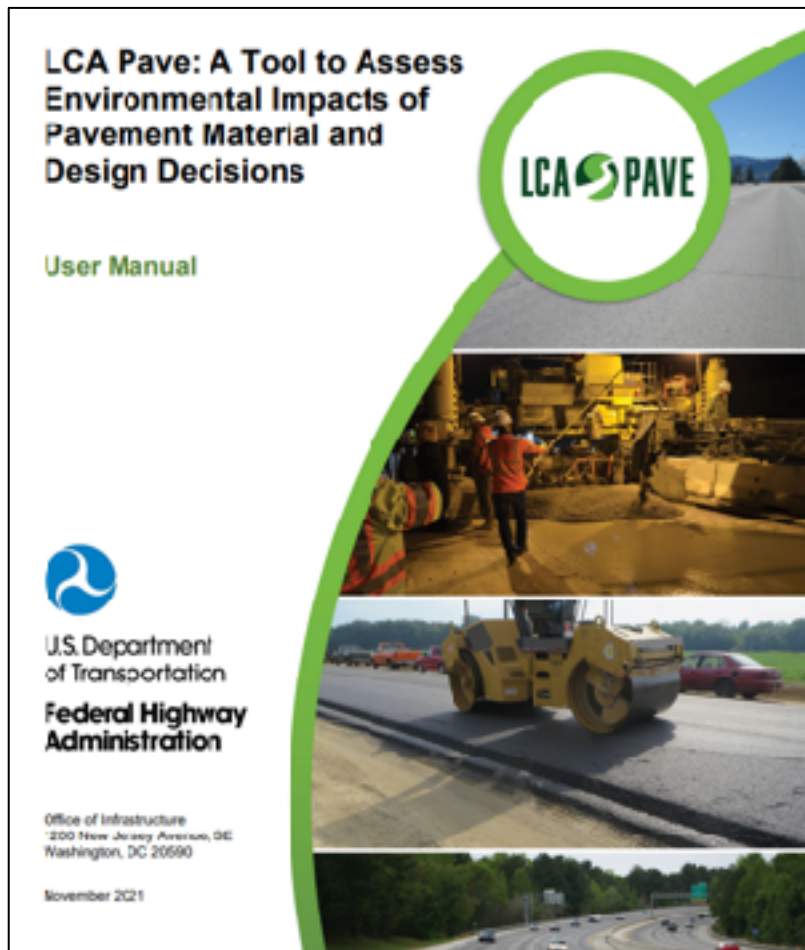
Summary

Summary

- Created with stakeholder input
- Uses public data sets
- Incorporates metadata and data quality indicators
- Handles EPD data
- Tool Uses
 - Training
 - Pilot Studies



LCA Pave Resources



<https://www.fhwa.dot.gov/pavement/lcatool/>



Other Resources and Tools

- [FHWA Pavement LCA Framework](#)
- [FHWA Tech Brief on Pavement LCA](#)
- [FHWA Tech Brief on Life-Cycle Thinking](#)
- [FHWA Tech Brief on EPDs](#)
- [FHWA Tech Brief on Data Needs for Pavement LCA: What Agencies Need to Know](#)
- [Federal LCA Commons](#)
- [TRACI](#)

www.fhwa.dot.gov/pavement/sustainability



Pavements and Rocks



Pavements and Rock Stars



"...the road becomes my bride..."



Pavement



Pavement in 1993

Background information

Origin	Stockton, California
Genres	Indie rock, lo-fi

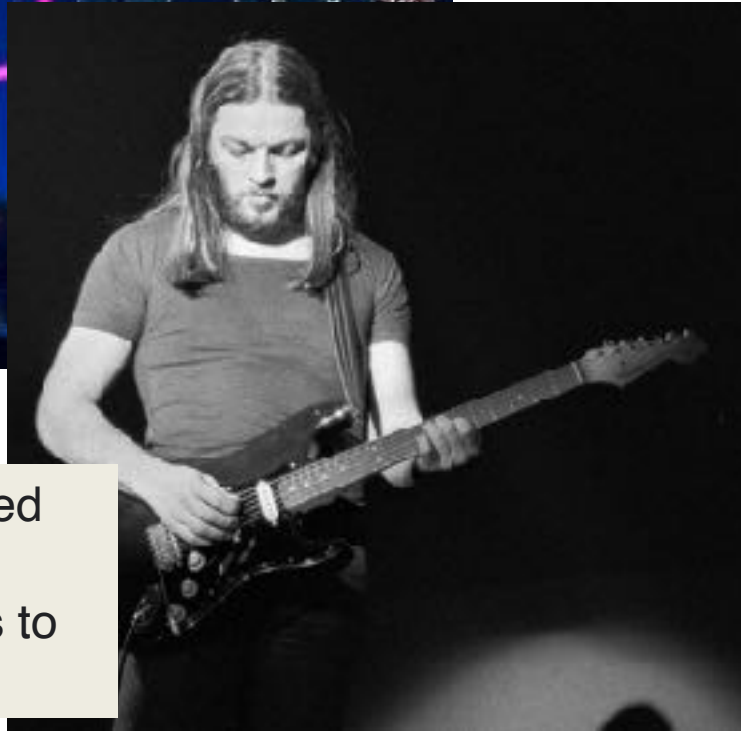


Rockstars and Climate Change

Coldplay announced when promoting their last album, Everyday Life, that they would no longer be touring “if it's not carbon neutral”.



David Gilmour donated the money raised from the sale of his collection of classic guitars to ClientEarth, to support efforts to fight the climate crisis.



Joni Mitchell's "Big Yellow Taxi" discusses humanity's role in climate change, particularly with regards to deforestation.



Thank You!

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