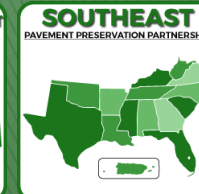
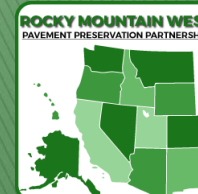


Environmental Product Declarations: HMA Treatments (a.k.a. Flexible Pavement Treatments)

Andrew Braham, Professor
University of Arkansas – Fayetteville
September 19, 2023



Outline

- ▶ **Context**
 - Environmental pillar
 - Motivation
- ▶ **Material background**
 - HMA/flexible pavement treatments
 - Asphalt emulsions
- ▶ **Asphalt emulsion progress**
 - Life Cycle Assessment (LCA)
 - Product Category Rule (PCR)
 - Environmental Product Declaration (EPD)
- ▶ **HMA treatment progress**
 - Not, just materials, construction too



(image from FHWA)

Importance of environmental pillar

- ▶ Three pillars of sustainability
 - Economic
 - Environmental
 - Social
- ▶ Economic pillar most established
 - Life Cycle Cost Analysis (LCCA)
- ▶ Social pillar highly underdeveloped
 - Human Development Index (HDI)
 - Social Impact Assessment (SIA)
- ▶ Environmental pillar
 - Relatively easy to quantify emissions and waste
 - Sustainability, resiliency, climate change...

Fog seal (roadresource.org)



**Agencies shifting
focus to EPDs**

Motivation

- ▶ Multiple agencies moving toward incorporating/requiring EPDs
- ▶ Lead by California → Buy Clean California Act
 - Jan 1, 2022: maximum acceptable GWP for eligible materials
 - Jul 1, 2022: GWP compliance measured through EPDs
 - Asphalt and aggregate a part of six pilot projects
- ▶ Other agencies/sources with existing/proposed legislation
 - Colorado, Oregon, Minnesota, New York, New Jersey, Washington
 - General Service Administration (GSA)
- ▶ EPDs are the end product of a sequence
 - Life Cycle Assessment (LCA)
 - Product Category Rule (PCR)
 - Environmental Product Declaration (EPD)



(escalontimes.com)

**What happened in
January 2023?**

General Services Administration : Jan 2023

▶ Section 60503: Inflation Reduction Act

- Construction materials and products
- Lower levels of embodied carbon

▶ Various material standards

- Portland cement concrete
- Asphalt concrete
- Steel
- Glass/glazing
- Cement

	GSA IRA Limits for Low Embodied Carbon Concrete - Jan. 2023 (Uncertainty-Adjusted GWPs, in kilograms of carbon dioxide equivalent per cubic meter - kgCO ₂ e/ m ³)		
Specified concrete strength class (compressive strength [f'c] in pounds per square inch [PSI])	Top 20% Limit	Top 40% Limit	Average or Better Limit
≤2499	240	291	334
3000	274	318	352
4000	305	351	385
5000	326	376	408
6000	315	375	414
≥7200	277	331	378

(GSA, 2023)

What does this have to do with flexible pavement treatments!?
Environmental considerations coming...

Flexible Pavement Treatments: asphalt emulsion based

- ▶ Surface treatments
 - Fog seal (rejuvenating fog seal)
 - Crack seal
 - Slurry surfacing (slurry and micro)
 - Chip seal (scrub seal)
 - Cape seal (chip + slurry)
- ▶ Structural treatments
 - Hot In-place Recycling (HIR)
 - Cold In-place Recycling (CIR)
 - Full Depth Reclamation (FDR)
- ▶ All can be asphalt emulsion based
 - Asphalt Emulsion Manufacturing Association (AMEA)



Cape seal (roadresource.org)

What are asphalt emulsions?

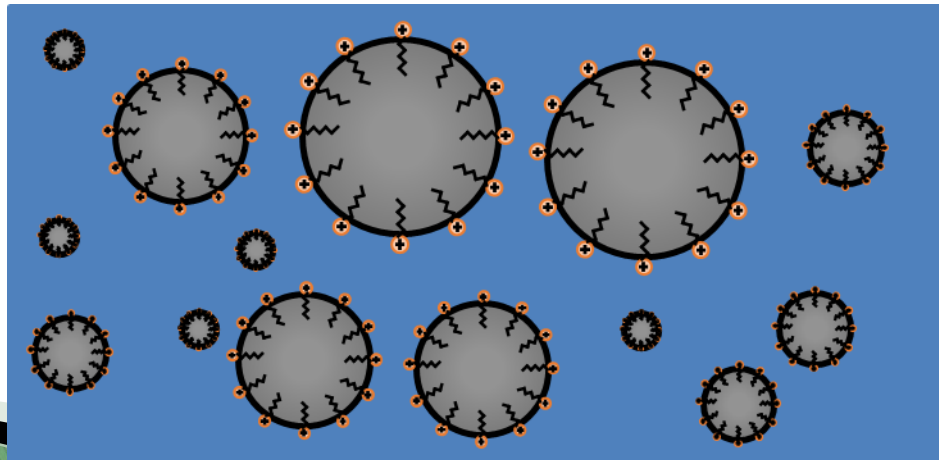
What is an asphalt emulsion?

small particles of asphalt binder (~65%) 

suspended in water (~33%) 

asphalt binder can't be dissolved or mixed into the water

asphalt binder is suspended in water
with the help of emulsifiers (~0.5–3.0%) 



Goal: low viscosity at ambient temperatures

Asphalt emulsion basics

▶ Setting speed

- Rapid (R)
- Quick (Q)
- Medium (M)
- Slow (S)

HF: High Float

“-1” → low viscosity “-2” → high viscosity

▶ Particle charge

- Negative (anionic “-”)
- Positive (cationic, “C”)
- Neutral (non-ionic)

“h” → hard

“s” → solvent

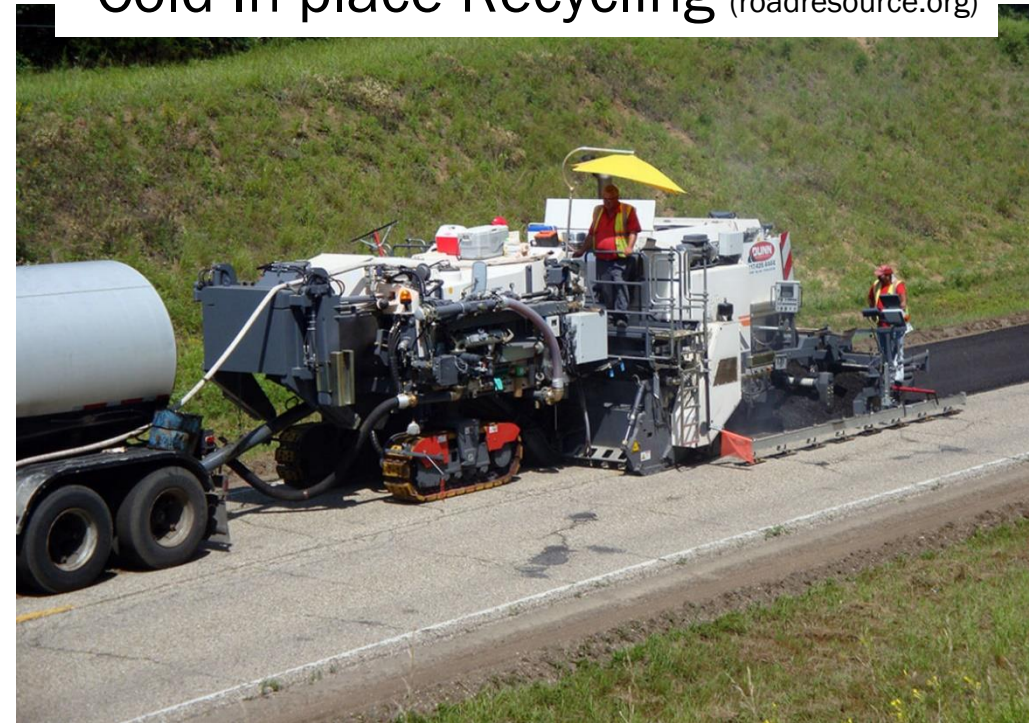
“P” → polymer

CRS-1P: cationic, rapid set, low viscosity, polymer modified
HFMS-2s: high float, anionic, medium set, high viscosity, solvent

Uses of asphalt emulsion

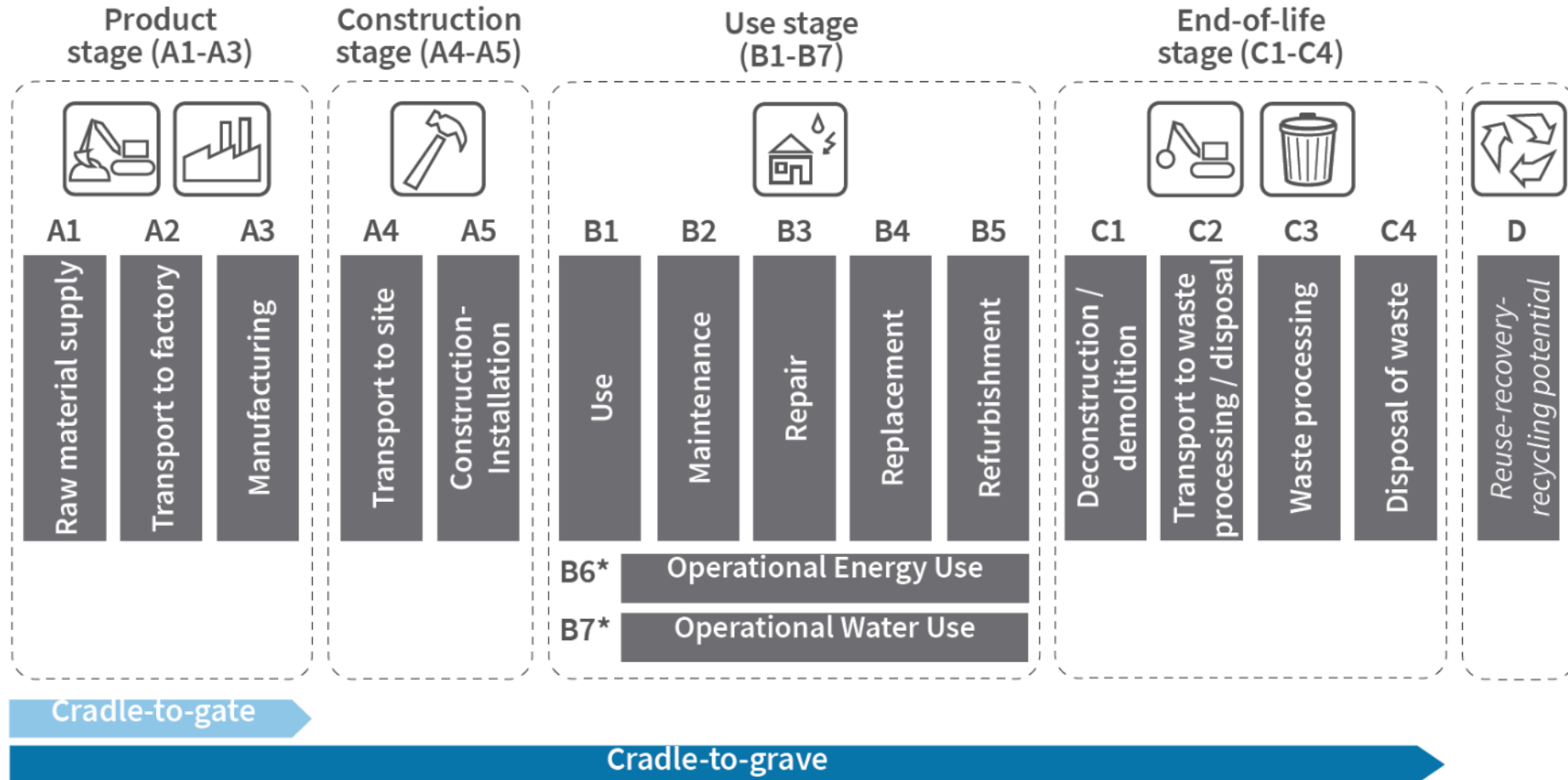
- ▶ Surface treatments (ISSA)
 - International Slurry Surfacing Association
 - Address surface issues
 - Generally rapid set or quick set emulsions
- ▶ Structural treatments (ARRA)
 - Asphalt Recycling & Reclaiming Association
 - Address structural issues
 - Generally slow set or medium set
- ▶ Various other applications
 - Cold Central Plant Recycling (CCPR) (ARRA)
 - Base and/or soil treatment
 - Prime coat, tack coat
- ▶ RoadResource.org

Cold In-place Recycling (roadresource.org)



How do stages of interest enter the discussion?

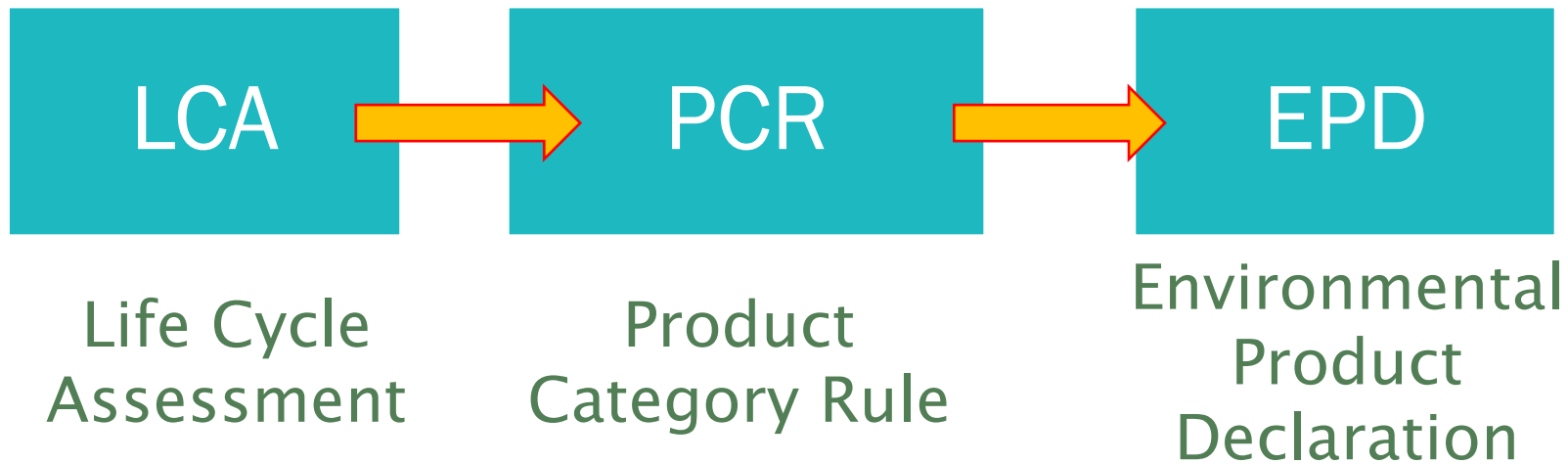
Stages of interest



(CLF, 2021)

How do we apply LCA → PCR → EPD?

The flow of terms



Let's go over each of these terms

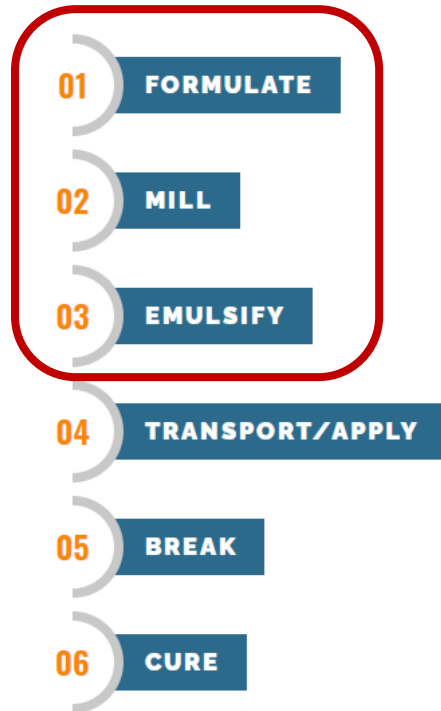
Life Cycle Assessment (LCA)

- ▶ Compile and quantify inputs/outputs of four stages
 - Product/materials, construction, use, end of life
 - Called “environmental flows”
- ▶ Inputs to LCA
 - Extraction, transportation, manufacturing, maintenance, etc.
- ▶ Outputs to LCA
 - Fuel/electricity use, waste (solid, liquid, hazardous), emissions, etc.
- ▶ Translate environmental flows to environment/human impacts
 - Impacts: depletion of resources, human health, ecosystem
 - Categories: energy use, resource use, emissions, toxicity, fresh water use, hazardous waste

Example: asphalt emulsion

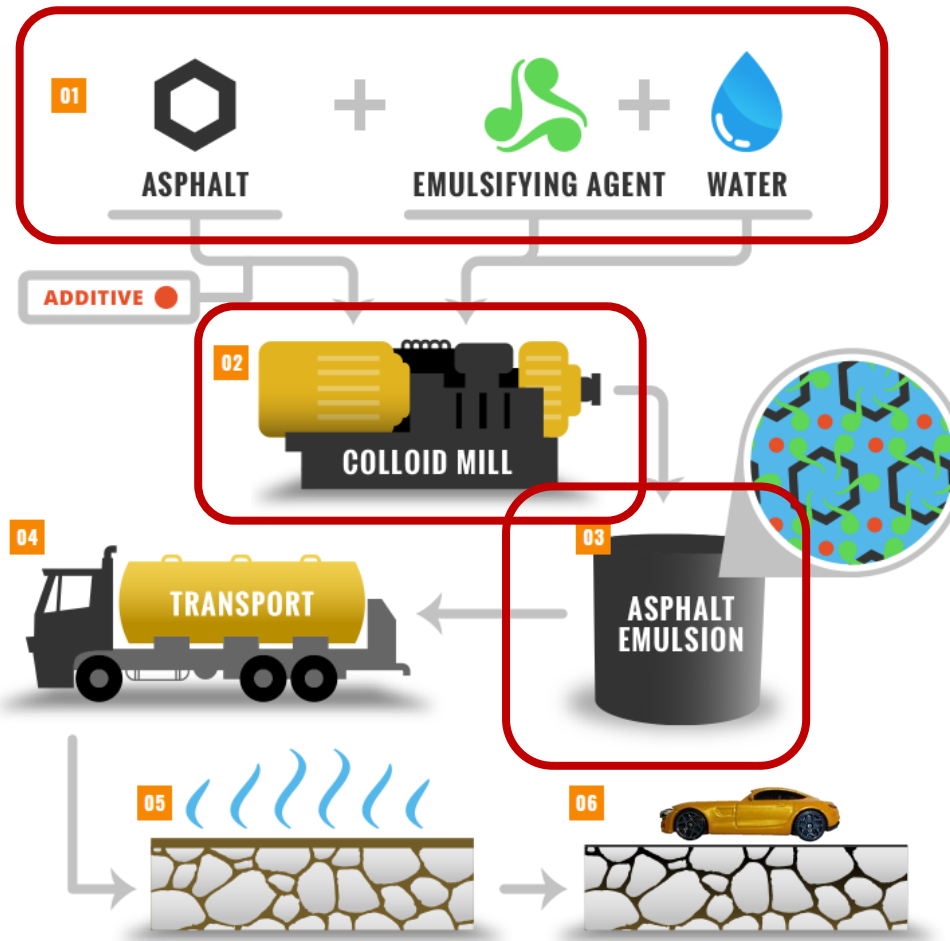
Asphalt emulsion life cycle: from RoadResource.org

01 - 03:
cradle to gate



How is an Emulsion Made?

Designed for Precision & Performance



An LCA for
asphalt
emulsion is in
final draft form

LCA content for asphalt emulsion: overview

- ▶ Scope of study
 - Representativeness, allocation procedures, data quality, system boundary, etc.
- ▶ Life cycle inventory analysis
 - Survey, data collection, product composition, manufacturing
- ▶ Life cycle impact assessment
 - OpenLCA/publicly available data, detailed results
- ▶ Interpretation
 - Key findings, sensitivity analysis, quality assessment, assumptions, limitations, conclusion

Eight emulsions defined

Neat vs. polymer modified binder
With or with rejuvenator

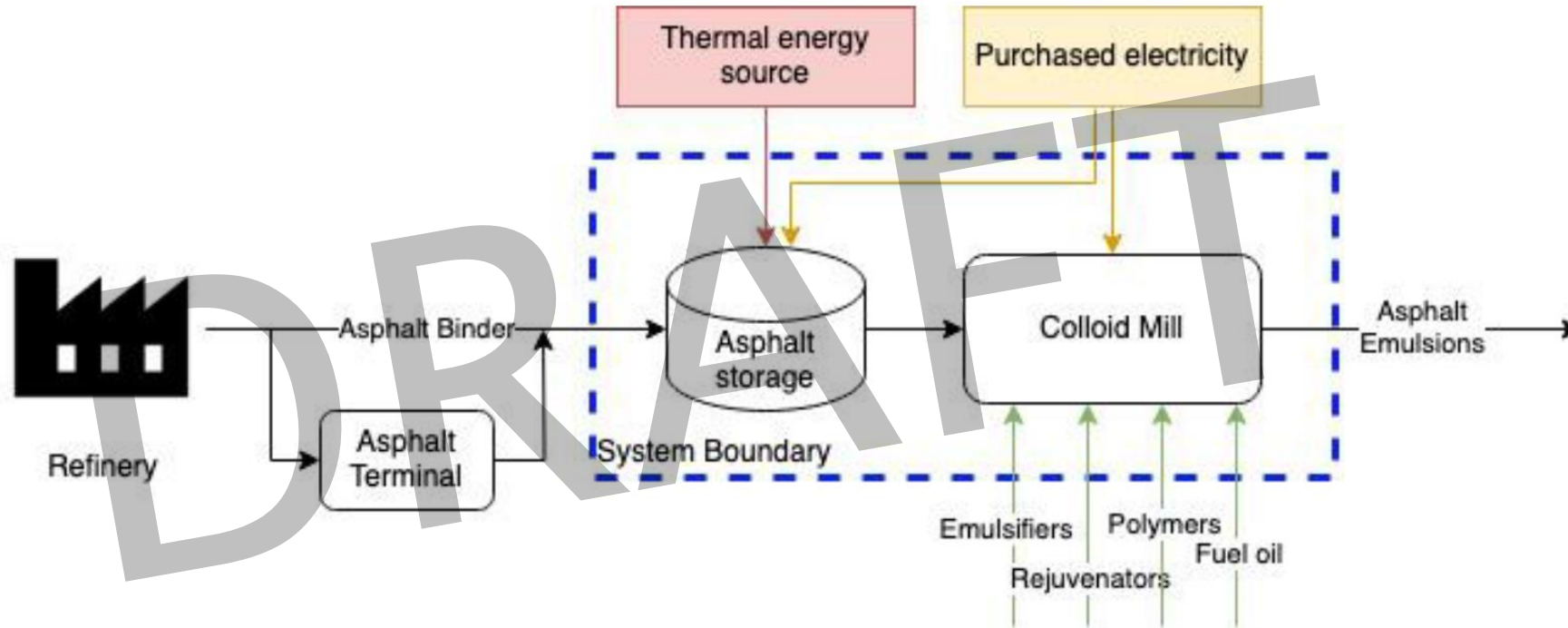
With or without fuel oil
Diluted or undiluted

1. Neat Binder Emulsion
2. Neat Binder Emulsion with Rejuvenator, Diluted
3. Neat Binder Emulsion with Rejuvenator, Undiluted
4. Neat Binder Emulsion with Fuel Oil
5. Polymer Modified Binder Emulsion
6. Polymer Modified Binder Emulsion with Rejuvenator, Diluted
7. Polymer Modified Binder Emulsion with Rejuvenator, Undiluted
8. Polymer Modified Binder Emulsion with Fuel Oil

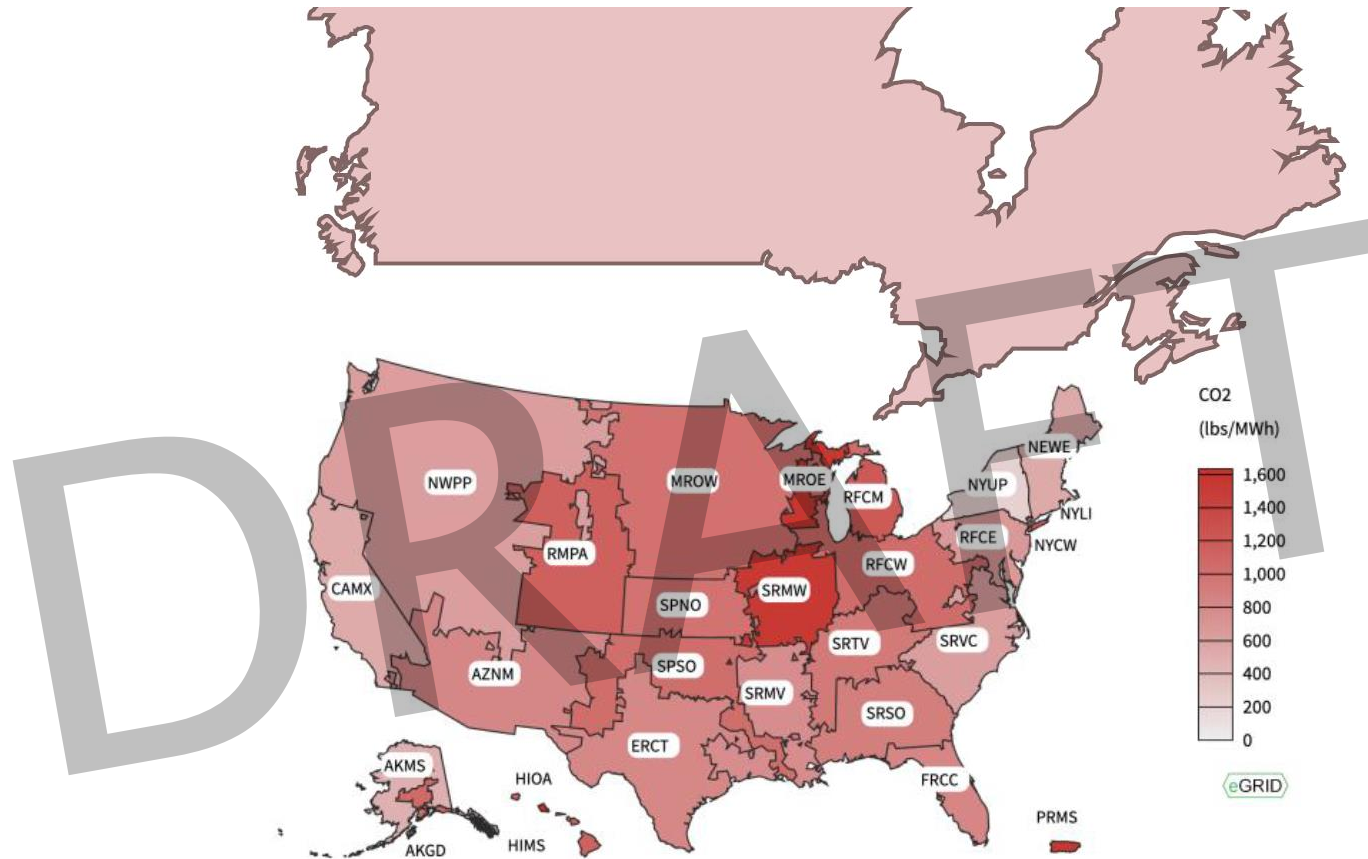
Mapped eight asphalt emulsions to treatments, standards, and typical emulsions

Treatment	Material standard	Standard emulsions per material standard*	LCA category emulsion
Chip seal	AASHTO M 340	All CRS/CHFRS/HFRS/RS, Medium set equivalents as needed	NBE, NBE+R(UD), PMBE, PMBE +R(UD), NBE+FO, PMBE+FO
Micro surfacing	AASHTO M 341	CQS-1P, CQS-1hP	PMBE
Cold mix asphalt (Cold Central Plant Recycling, Cold In- place Recycling)	AASHTO MP 31	CSS-1, CSS-1h, HFMS-2, HFMS-2h, HFMS-2s	NBE, NBE+FO

System boundary

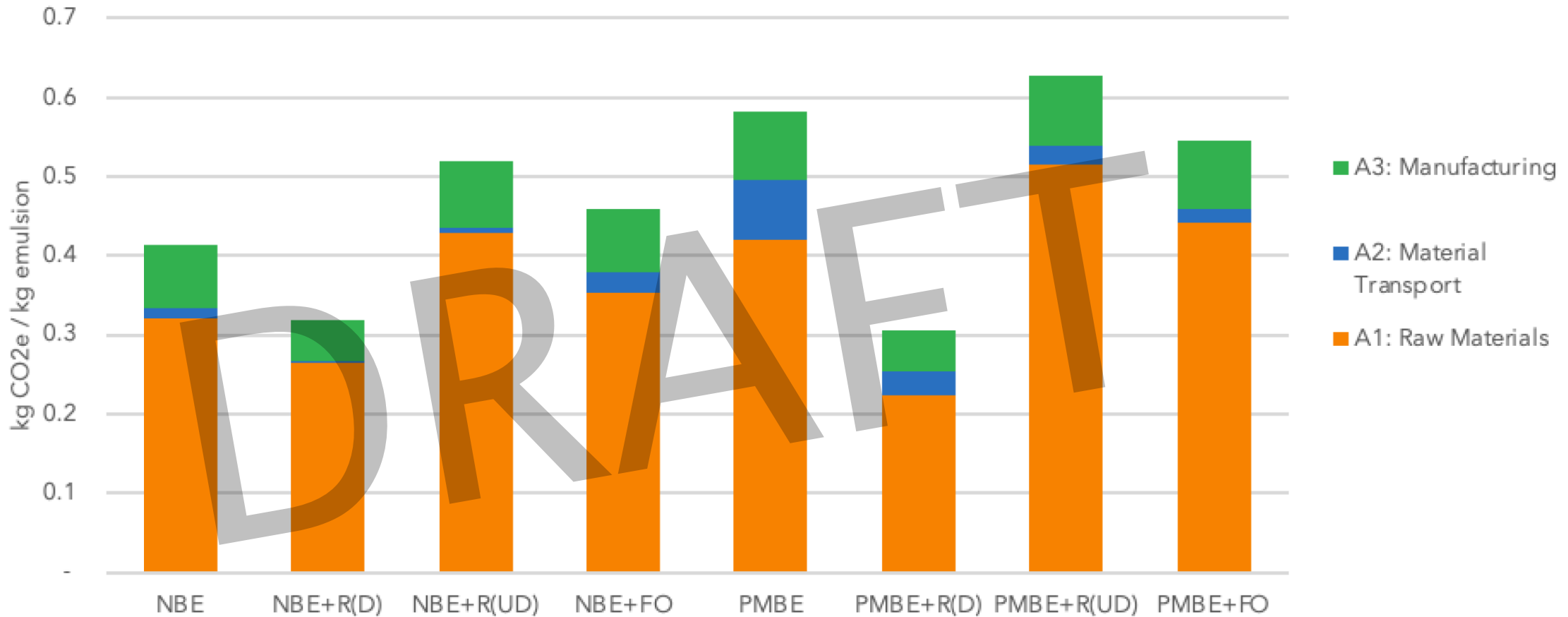


Geographic representativeness

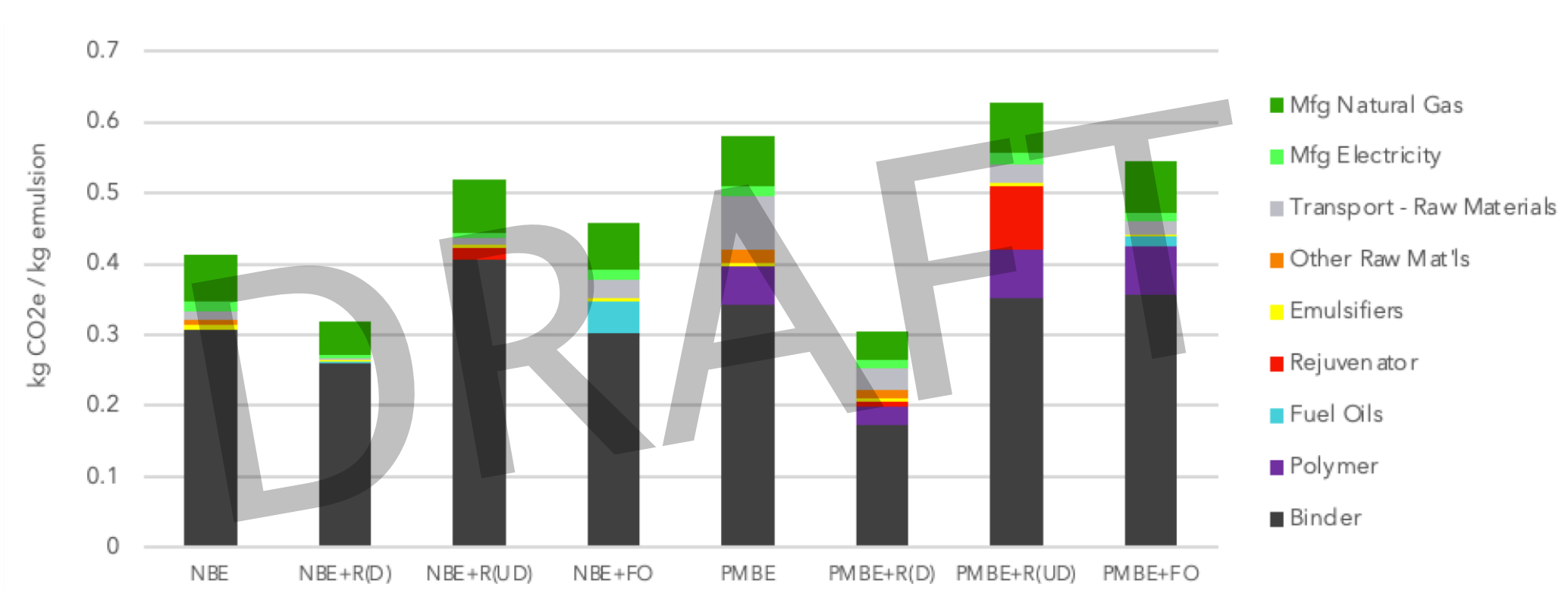


Based on eGRID subregion

Overview of Product Impacts [OpenLCA & Public data]



Global Warming Potential (public data)



Also acidification, eutrophication, and smog formation potential



Product Category Rule (PCR)

- ▶ Set of rules, requirements, guidelines for developing EPDs
- ▶ Main components
 - Definition and description
 - Goal and scope, stages
 - Environmental flows
 - Environment/human impacts
 - Materials and substances to be declared
 - Instructions for producing data, content, and format
 - Period of validity (five years)
- ▶ Third party review panel is required
- ▶ In progress



(roadresource.org)



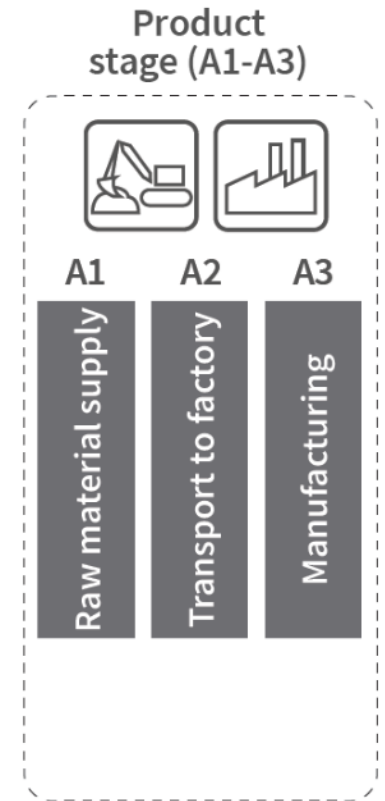
Environmental Product Declaration (EPD)

► Objectives of an EPD

- Encourage improvement of environmental performance
- Provide information for assessing environmental impacts of products over life cycle
- Assist purchasers, users → make informed comparisons between products

► Asphalt emulsion EPD preliminary steps

- Eight national average EPDs will be developed
- Anticipated that companies will be able to generate their own, site specific EPDs through website
- Note: ONLY product stage



Example: asphalt concrete emission table

One example from National Asphalt Pavement Association

PARAMETER	UNIT	A1	A2	A3
Global Warming Air, incl. Biogenic Carbon	[kg CO2-Equiv.]	22.9	2.34	2.86
Ozone Depletion Air	[kg CFC 11-Equiv.]	4.84e-09	9.89e-11	2.1e-11
Acidification	[kg SO2-Equiv.]	0.133	0.0114	0.00693
Eutrophication	[kg N-Equiv.]	0.00794	0.000737	0.000433
Smog Air	[kg O3-Equiv.]	2.36	0.358	0.275
Abiotic Depletion for Fossil Resources	[MJ surplus energy]	MND*	MND*	MND*

A1: materials A2: transport A3: production

1 short ton asphalt mixture (dense graded, 3/4" NMAS, 0% RAP, hot mix)

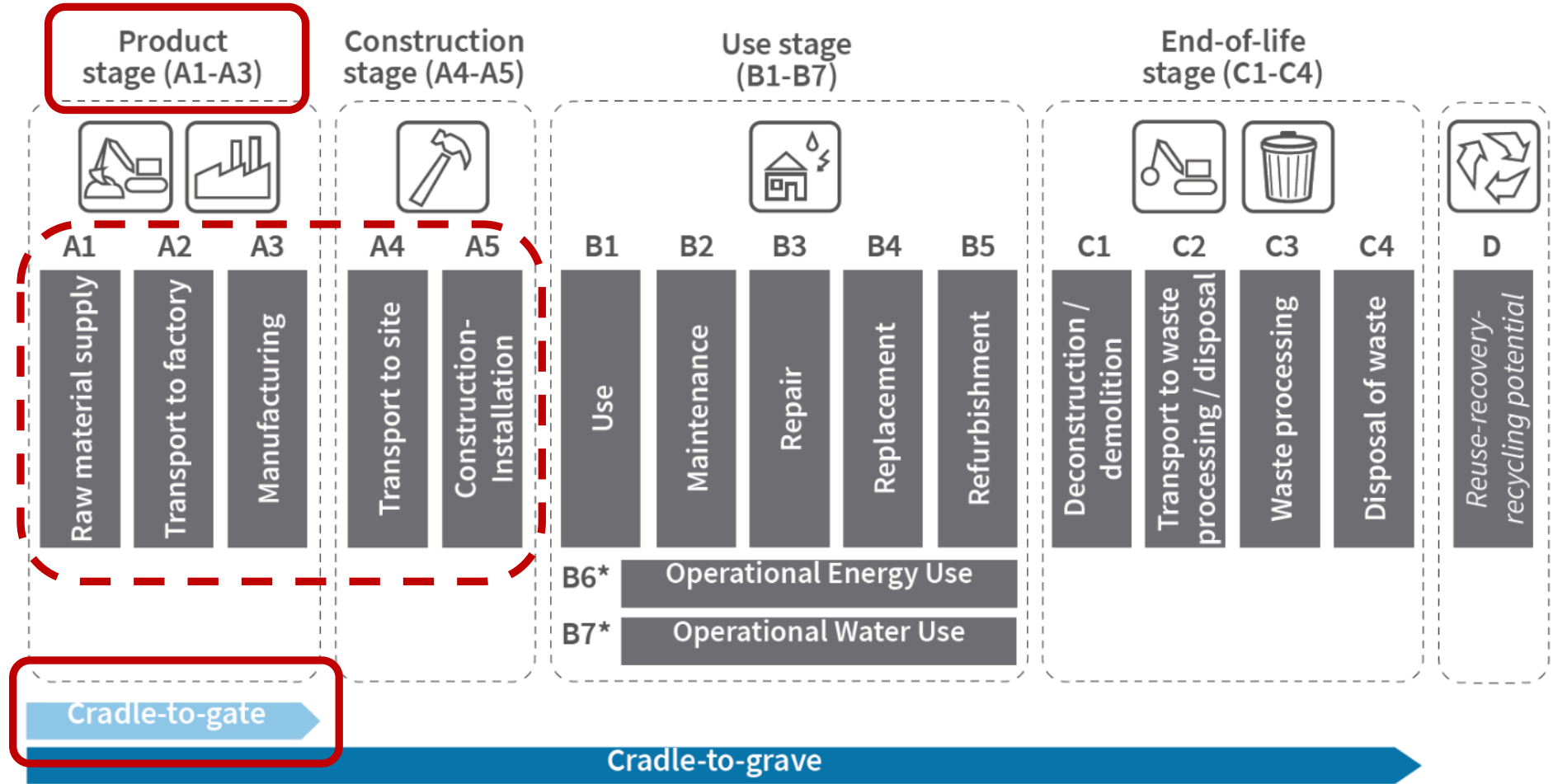
What about flexible pavement treatments?!

Let's go back to stages of interest

(CLF, 2021)

Asphalt emulsion

Flexible pavement treatments



Emulsions: A1 – A3 → Treatments: A1 – A5

Flexible pavement treatments

- ▶ ISSA
 - Surface treatments
 - Slurry surfacing, chip seal, crack seal
- ▶ ARRA
 - Structural treatments
 - HIR, CIR, FDR, CCPR
- ▶ Leverage existing LCAs
 - Aggregate, asphalt emulsion, additives
 - A1–A3
- ▶ Develop own LCA, PCR, EPDs
 - A1–A5
 - Cradle to “release to traffic”
 - Not as common as cradle to gate



Micro surfacing (roadresource.org)

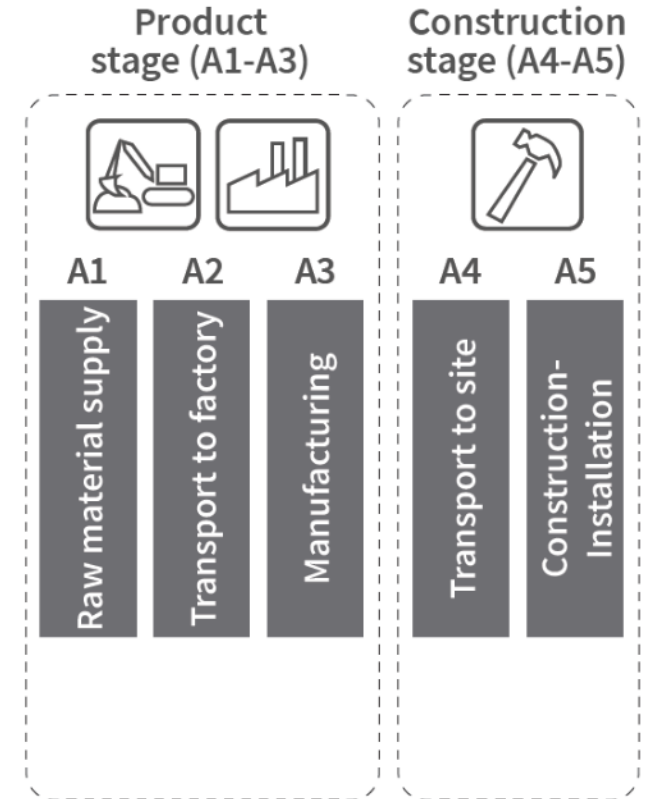


Full Depth Reclamation (roadresource.org)

In preliminary planning

Conclusions

- ▶ Environmental pillar, motivation
- ▶ Material background
 - Flexible pavement treatments, asphalt emulsions
- ▶ Asphalt emulsion progress
 - Lead by AEMA
 - LCA, PCR, EPDs
- ▶ Flexible pavement treatment progress
 - Use asphalt emulsion, other materials, A1–A3
 - ISSA and ARRA will go through A5



(CLF, 2021)

Thank you! Questions?
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