



# ANALYSES OF METHODS TO REDUCE GREEN HOUSE GAS (GHG) EMISSIONS IN DOD PAVEMENT PROJECTS

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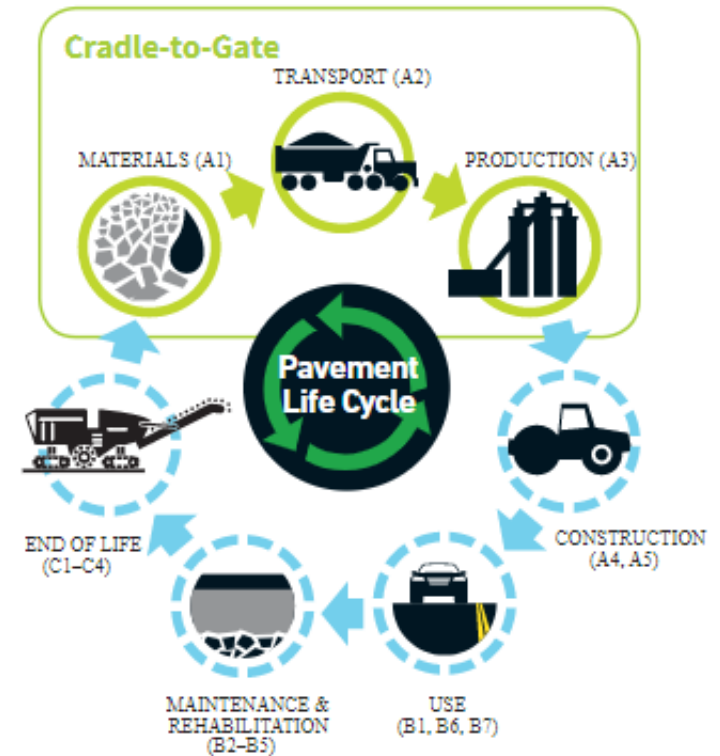


## OBJECTIVE:

Develop DOD Guidance for the Evaluation of Green House Gas (GHG) Emissions for Pavement Construction Materials and Processes to Encourage the Use of Sustainable Pavement Construction Practices

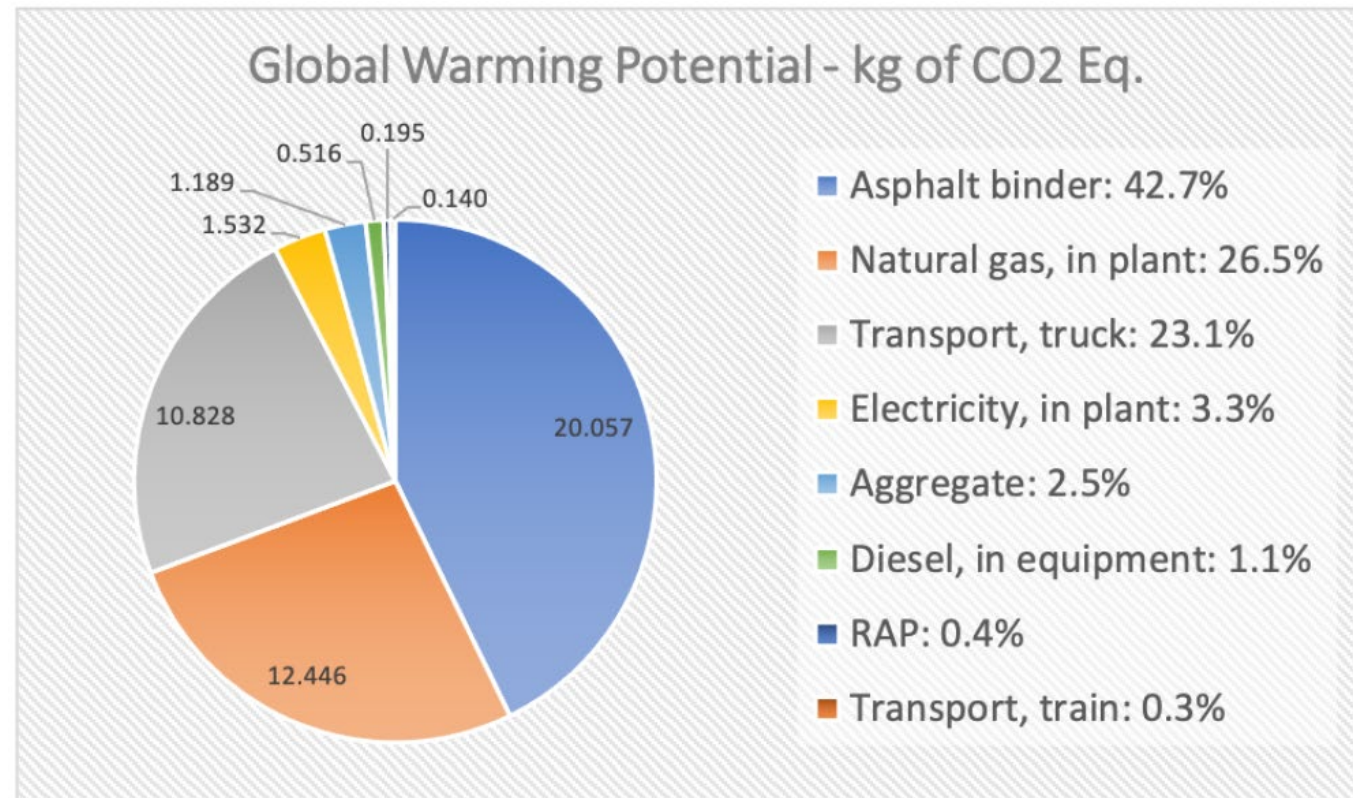
## APPROACH:

- Review Pavement Material Production Processes
- Review Pavement Construction Processes
- Review Pavement Maintenance Processes
- Review End-of-Life Pavement Disposal Processes
- Review Life-Cycle Cost Analysis Approaches
- Review Available Emissions Databases and Calculation Tools
- Review Available LCA Software Products
- Review Product Category Rules (PCRs) & Environmental Product Declaration (EPD) Formats
- Reviewed Pavement Performance Models (Distress Prediction from Critical Responses)
- Select An Appropriate LCA Approach
- Select An Appropriate Emissions Database and Calculation Tool
- Adapt an Existing or Develop a New LCA Software Tool for DOD
- Develop Supporting Guidance Including Rules for Developing EPDs
- Develop Detailed Guidance for Analyzing and Rating Alternative Paving Materials and Construction Processes



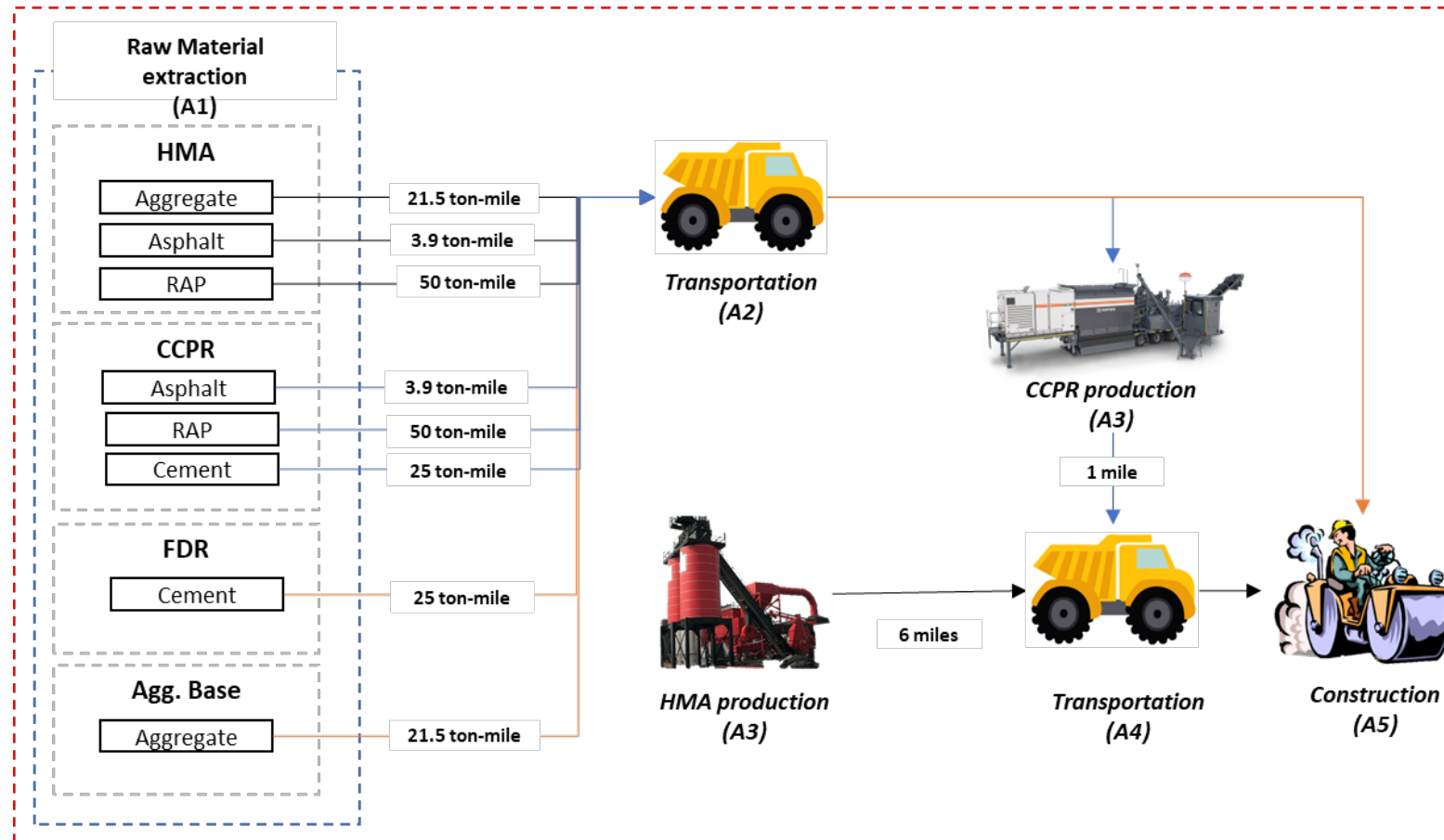
## CRADLE-TO-GATE (MATERIAL PRODUCTION) EXAMPLE:

- Quantification of the Sustainability of Different Paving Material Options
- Computed in Terms of Global Warming Potential Based upon the Amount of CO<sub>2</sub>
- Example for the Production of Hot Mix Asphalt



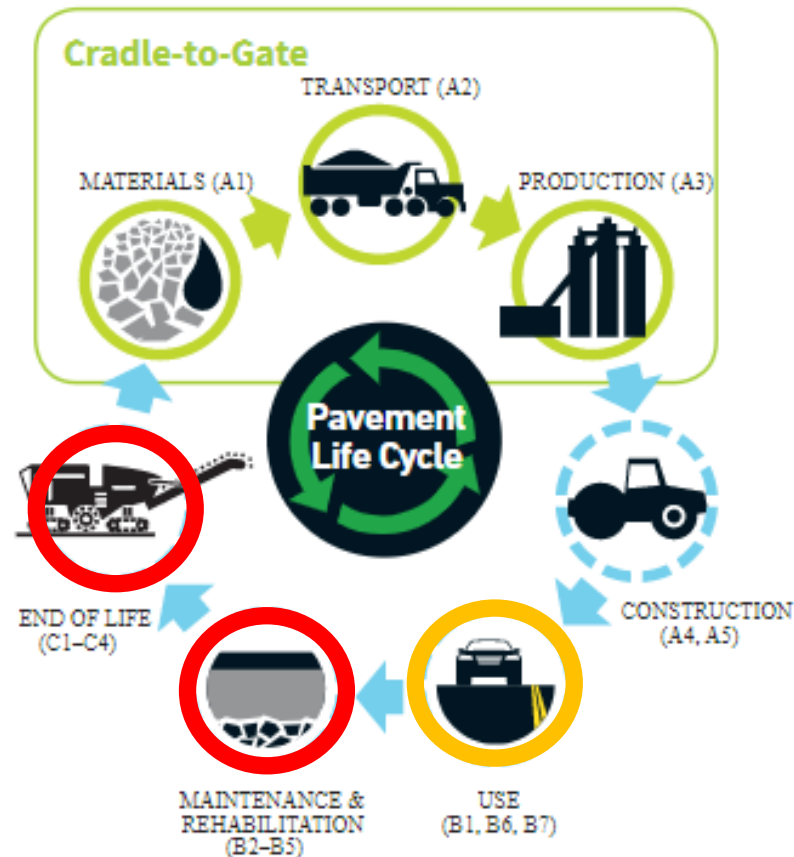
# CRADLE-TO-CONSTRUCTED (Include Construction Processes):

- Incorporate Sustainability of Pavement Construction Processes
- Computed in Terms of Global Warming Potential Based upon the Amount of CO<sub>2</sub>
- Example for the Production of Hot Mix Asphalt



## CRADLE-TO-GRAVE (Include Use Stage/Maintenance/Disposal):

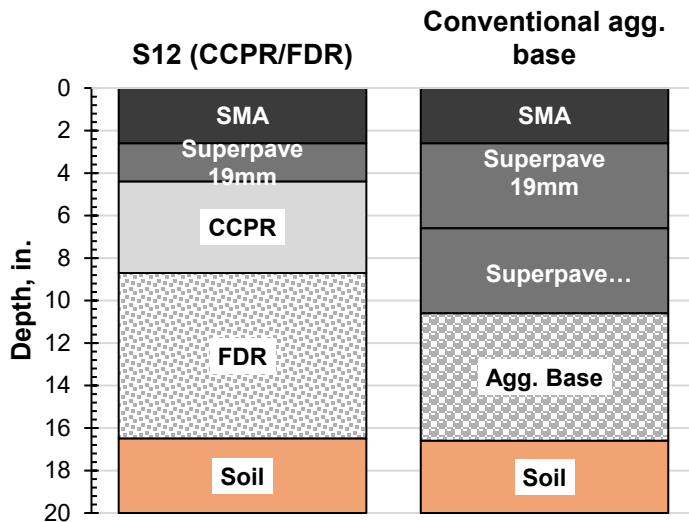
- Incorporate Sustainability of Use Stage Related to Pavement Type/Condition
- Incorporate Sustainability of Pavement Maintenance Functions Based Upon Frequency
- Incorporate Sustainability of Pavement Disposal Processes at End-of-Life



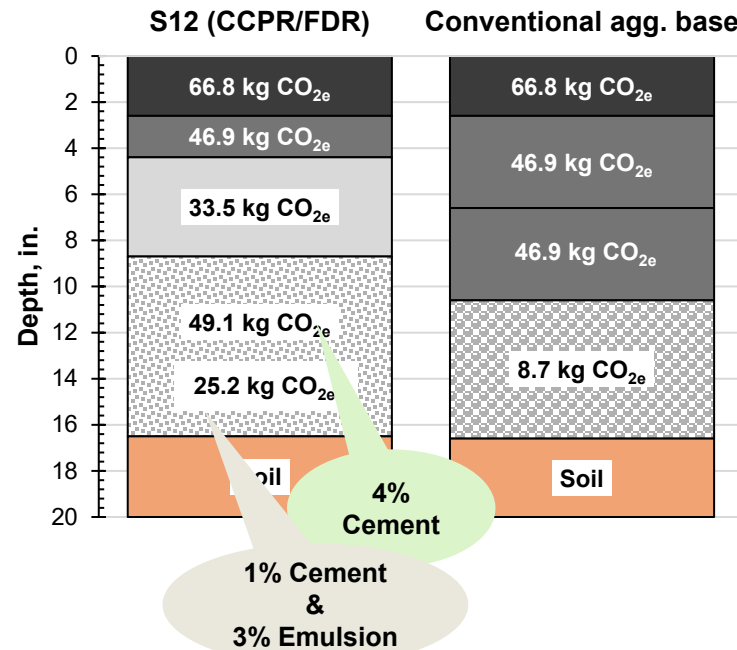
# STANDARDIZE PROCESS/TOOLS FOR SUSTAINABILITY COMPARISONS:

- Identify Potential CO2 Reduction Strategies
- Utilize Databases and Software Tools to Compute Sustainability Costs and Compare

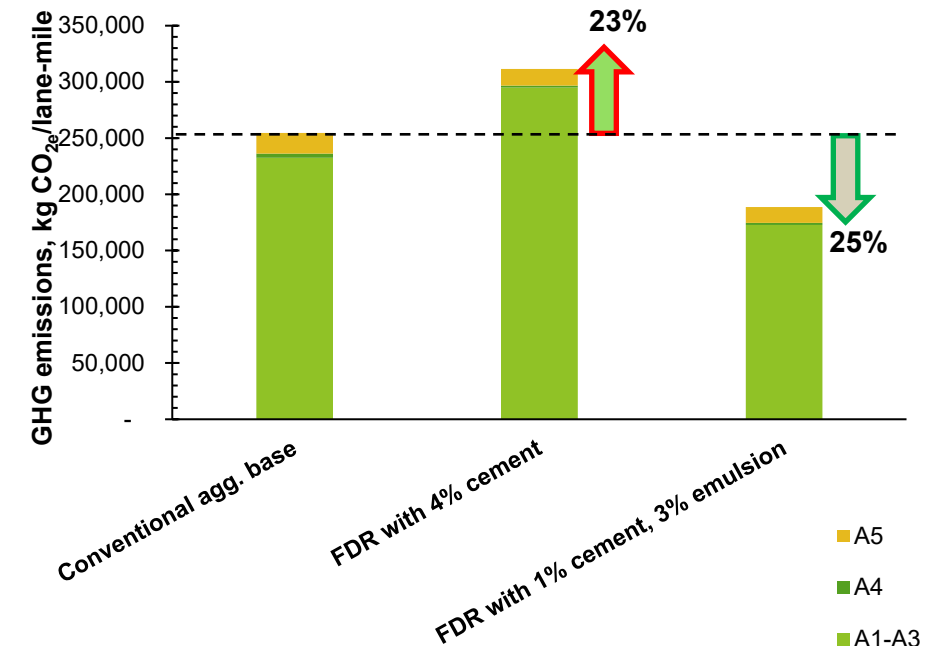
**Alternative Design Strategies**



**Cradle-to-Gate Emissions per Short ton of Material**



**Calculated Emissions per Lane-mile of pavement section**



## Deliverables and Schedule:

- Review of Existing Sustainability Guidance and Tools – October 2022 to December 2023
- Comparison of Alternative Emission Databases – March 2023 to September 2023
- Comparison of Alternative LCA Software Tools – June 2023 to November 2023
- Development of Cradle-to-Gate Guidance – December 2023 to May 2024
- Development of Cradle-to-Constructed Guidance – June 2024 to December 2024
- Development of Cradle to Grave Guidance – January 2025 to July 2025
- Preparation of Complete LCA Guidance and Case Study Experimentation – July 2025 to December 2025
- TSPWG Guidance Documents:
  - Overall Process Guide for Sustainability Analysis
  - Standardization of Emissions Database
  - Standardization of LCA Software
  - Guidance for Preparation of EPDs
  - Guidance for Comparison of Alternative Materials/Processes

# Goals of Environmental Product Declarations (EPDs)

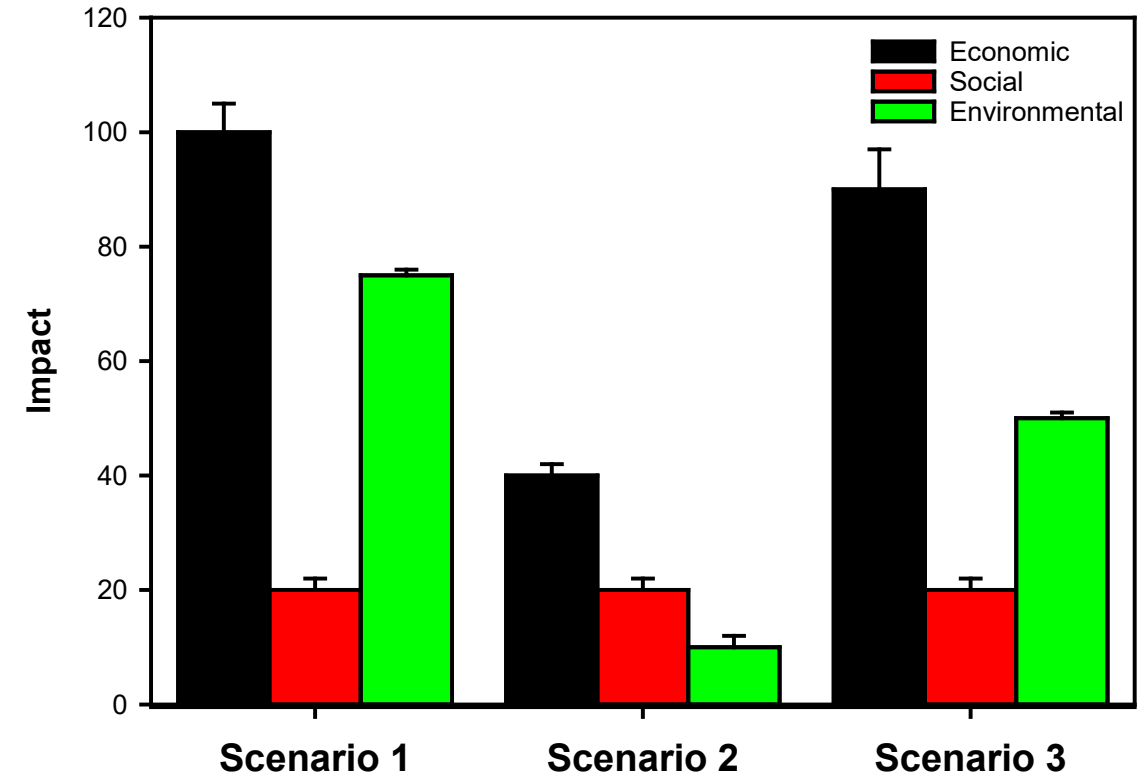
**Scenario 1** might be the current practice

**Scenario 2** might be an alternative that minimizes environmental impacts, but might not be economically viable.

**Scenario 3** would be the desired outcome. A slight reduction in economic profit for a significant reduction in environmental impact.

Manufacturers should develop EPDs towards Scenario 3 to demonstrate product stewardship.

Social and economic aspects of sustainability are “excluded” from ISO 21930, which often serves as the core-rules for EPDs. However, economic viability and economic value are used in developing scenarios and establishing system boundaries.





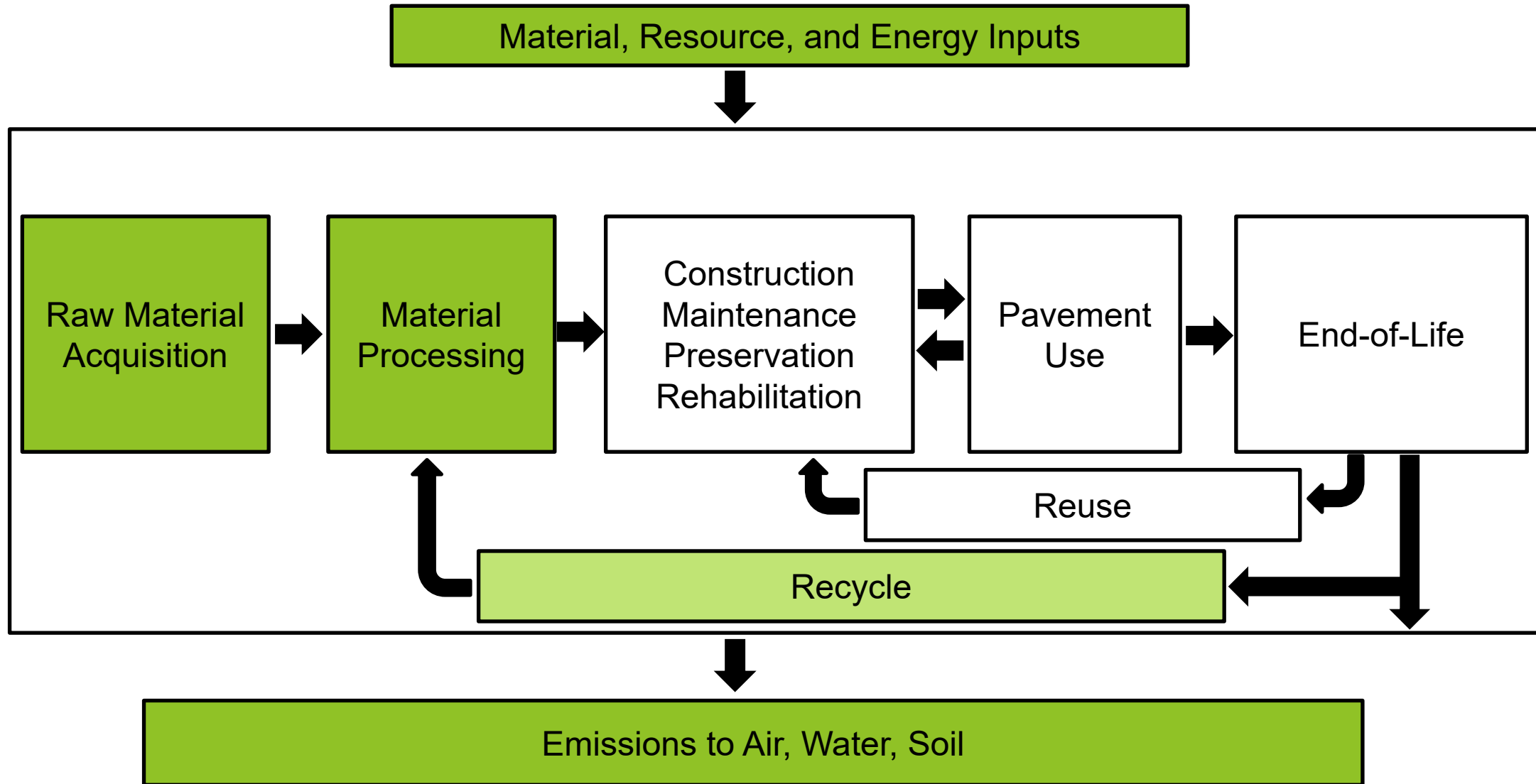
# Environmental “Impact Categories” or “Midpoint Indicators”

- 1.) Carbon footprint or global warming potential (GWP, measured in kg CO<sub>2</sub> eq.)
- 2.) Depletion potential of the stratospheric ozone layer (ODP, in kg CFC11 eq.)
- 3.) Acidification potential of soil and water sources (AP, in kg SO<sub>2</sub> eq.)
- 4.) Eutrophication potential (EP, in kg N eq.),
- 5.) Photochemical smog creation potential (POCP, in kg O<sub>3</sub> eq.)
- 6.) Human health criteria (cancer, non-cancer, and criteria pollutants/particulates)
- 7.) Resource depletion (fossil fuel use, land use, and water use/water footprint)
- 8.) Other?

These indicators should only be used to make comparisons after it is determined that products are in the same category (equivalent function). The compared products need to have the same system boundaries (next slide).

These indicators are as good as the quality of the data that goes into them. How is data quality confirmed?

These indicators are produced through the consolidation of data – what is lost when these data are combined?



**Source:** Cradle-to-Grave Pavement Life Cycle, Adapted from Butt et al. 2019 "Life-Cycle Assessment of Airfield Pavements and Other Airside Features: Framework, Guidelines, and Case Studies"

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