NATIONAL ASPHALT PAVEMENT ASSOCIATION

Product Category Rules (PCR)

For Asphalt Mixtures

Version 1.0

January 31, 2017

Validity Period: Through January 2022

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1. General Information

a. This product category rule (PCR) is intended to support Environmental Product Declarations (EPDs) of asphalt mixtures produced in the United States of America.

b. The PCR was prepared by members of the PCR Development Working Group (see Appendix A) in accordance with the following guidelines and underlying life cycle assessment (LCA):

   i. National Asphalt Pavement Association (NAPA) Environmental Product Declaration Program's General Program Instructions;

   ii. Guidance for Product Category Rule Development, v 1.0 (see Conformity Assessment Form in Appendix B); and

   iii. Life Cycle Assessment of Asphalt Mixtures in Support of an Environmental Product Declaration (Mukherjee, 2016).

c. The development of this PCR was funded by the State Asphalt Pavement Associations and the National Asphalt Pavement Association.

d. The PCR is in conformance with the requirements of the following standards:

   i. International Organization for Standardization (ISO) 14025:2006 Environmental Labels and Declarations — Type III Environmental Declarations — Principles and Procedures;

   ii. ISO 14040:2006 Environmental Management — Life Cycle Assessment — Principles and Framework; and

   iii. ISO 14044:2006 Environmental Management — Life Cycle Assessment — Requirements and Guidelines.

   iv. European Committee for Standardization (CEN) EN 15804:2012 Sustainability of Construction Works — Environmental Product Declarations — Core Rules for the Product Category of Construction Product.

e. The PCR references the following standard:

   i. ASTM D8-13b Standard Terminology Relating to Materials for Roads and Pavements.

f. This document is valid through January 2022.

   i. Review of PCR will begin four years from date of publication, or sooner if circumstances warrant an earlier review.

2. Identification of Program Operator

a. The Program Operator is the National Asphalt Pavement Association based in Lanham, Maryland, United States of America.

b. NAPA is a 501(c)(6) non-profit organization. It is the only trade association exclusively representing the interests of asphalt pavement material producers and paving

contractors on the national level with Congress, governmental agencies, and other national trade and business organizations. NAPA supports an active research program designed to answer questions about environmental issues and to improve the quality of asphalt pavements and paving techniques used in the construction of roads, streets, highways, parking lots, airports, and environmental and recreational facilities. The association provides technical, educational, and marketing materials and information to its members, and supplies technical information to users and specifiers of paving materials. The association, which counts more than 1,100 companies among its members, was founded in 1955.

c. The general program instructions and program contact information can be accessed at http://www.asphaltpavement.org/EPD.

3. PCR Review

a. To ensure conformance with the ISO standards this PCR underwent a public comment period and was reviewed by third-party review panel.

b. Third-Party ISO Reviewer Panel:

   i. Chair: Joep Meijer, theRightenvironment, LCA Expert
   ii. Member: Christoph Koffler, thinkstep, LCA Expert
   iii. Member: John T. Harvey, University of California, Davis, Domain Expert

c. Open Consultation Period:

   i. The first draft for stakeholder comments was published on June 1, 2016, and was open for public consultation for 30 days.
   ii. A list of stakeholders who provided comments or who were invited to provide comments is found in Appendix C.
   iii. More than 60 comments were received and integrated into this version.
   iv. A summary of the comments received and the PCR Development Working Group's response is found in Appendix D.

4. PCR Purpose

a. This PCR is being developed to accommodate the use and implementation of Type III EPDs that will provide the basis for determining cradle-to-gate environmental impacts for the production of asphalt mixtures in the United States of America, including the federal district and territories.

   i. This PCR is valid for business-to-business Type III EPDs for asphalt mixtures which consist of information modules from cradle to gate in line with ISO 14025.
   ii. Per the NAPA General Program Instructions, producers who develop an EPD in accordance with this PCR maintain sole ownership and have sole responsibility and liability for their EPDs.

iii. Life cycle assessment comparisons of pavement designs may use EPDs produced through this program as a data input. Comparison of life cycle environmental impacts of different pavement designs are only valid if similar system boundaries and secondary data sources for all pavement material inputs.

iv. EPDs in conformance with this program for asphalt mixtures are comparable if the mixtures are expected to meet similar performance criteria as specified by the customer.

b. This PCR is based upon the "Product Category Rules for Preparing an Environmental Declaration for Product Group Asphalt and Crushed Stone (NPCR 18)" published by The Norwegian EPD Foundation in November 2010. Primary differences between this document and NPCR 18 are as follows:

i. Geography: United States, including the federal district and territories;
ii. Environmental Impact Methods: Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) 2.1; and
iii. Data Sources: Prescribed upstream inventories.

c. Harmonization with other EPD programs: Currently no PCRs exist for asphalt mixture constituent materials. Efforts will be made in the future to maintain harmonization efforts undertaken by the Asphalt Institute, the international trade association of petroleum asphalt producers, manufacturers and affiliated businesses.

Further Explanation — Life Cycle Inventory Data

To minimize variances resulting from differences in choice of secondary data sources, all life cycle inventory data is prescribed in this PCR. Therefore, EPDs in conformance with this PCR reflect only differences in primary data such as plant energy use, material use, and plant emissions. This provides an effective approach to compare the environmental impacts of the processes used in the production of asphalt mixtures with similar functions and performance.

5. Definitions

a. General LCA definitions are provided in the referenced ISO standards.

b. Definitions[1] specific to this PCR are as follows:

i. Aggregate — a collective term for mineral materials that vary in size and source, such as sand, gravel and crushed stone, used with a binding medium, such as asphalt binder, to form asphalt mixtures or other compound materials.
ii. Asphalt — also called "bitumen." A dark brown or black cement-like residuum obtained from the distillation of suitable crude oils or derived from naturally occurring deposits. Used to produce asphalt binder.

[1] Definitions are based on those provided in ASTM D8-13b Standard Terminology Relating to Materials for Roads and Pavements.

iii. Asphalt baghouse fines — dust particles captured from the exhaust gases of asphalt mixing plants.

iv. Asphalt binder — also called “liquid asphalt” or “asphalt cement.” A highly viscous liquid or semi-solid residue from petroleum refining used as the principal binding agent in asphalt mixtures. Asphalt binders may include materials added to modify its original properties.

v. Asphalt mixture — a plant-produced composite material of aggregates, asphalt binder, and other materials. The mixture may contain varying quantities of recycled materials as a substitute for virgin materials, including reclaimed asphalt pavement (RAP) and recycled asphalt shingles (RAS). See Table 4 in Annex I for a list of other material additives.

vi. Coarse aggregates — a collective term for the large aggregate components, generally those that are larger than the ⅜-inch sieve or No. 4 sieve.

vii. Equivalent single-axle loads (ESALs) — Wheel loads of various magnitudes and repetitions (“mixed traffic”) converted to an equivalent number of standard loads that a pavement is expected to encounter. As calculated as part of the specified mix-design method.

viii. Fibers — cellulose, mineral fibers, or synthetic fibers added to asphalt mixtures to improve cracking resistance and prevent drain-down.

ix. Fine aggregate — a collective term for the small aggregate components, generally those that pass through a ⅜-inch sieve or No. 4 sieve. Aggregates larger than ⅜ inch are referred to as “coarse aggregates”.

x. Fines – a general term referring the smallest of the aggregate components, generally those that pass through a #200 sieve.

xi. Foaming — a warm-mix asphalt technology that injects a small amount of water into an asphalt mixture to aid the coating of aggregate with asphalt binder while allowing reduction of the temperatures at which the material is mixed and placed on the road.

xii. Ground tire rubber (GTR) — scrap tires that are ground to small particles and added as a modifier to asphalt binder or to asphalt mixtures to supplement a portion of the fine aggregate.

xiii. Hydrated lime — a dry white powder consisting essentially of calcium hydroxide ($Ca(OH)_2$) that is added to improve the moisture susceptibility of asphalt mixes. Hydrated lime is processed by adding water to crushed lime (water accounts for approximately 1% of raw hydrate).

xiv. Lime — a mineral derived from heating (calcining) limestone, which is added to improve the moisture susceptibility of asphalt mixes.

xv. Liquid antistrip — additive added to asphalt binder to improve the moisture susceptibility of asphalt mixtures.

xvi. Load spectrum — distribution of wheel loads, characterized by number of axles, configuration, and weight, that a pavement is expected to encounter.

xvii. Polymer additives — Elastomers and plastomers used to modify asphalt binder to provide special properties. See Table 4 in Annex I for a list of specific polymer additives.

xviii. Primary data — site-specific data.

xix. Reclaimed asphalt pavement (RAP) — removed and/or reprocessed pavement materials containing asphalt binder and aggregates. RAP is typically generated by milling machines in rehabilitation projects or a special crushing plant that breaks down large pieces of discarded hot- or warm-mix asphalt pavement.

xx. Recycled fuel oil (RFO) — waste oil that is reprocessed to be used as a substitute energy source.

xxi. Recycled asphalt shingles (RAS) — asphalt shingle manufacturer waste or asphalt shingles removed during re-roofing or roof removal projects that are ground into fine particles to be added to asphalt mixtures as a replacement of a portion of virgin asphalt binder and fine aggregate.

xxii. Recycling agents — hydrocarbon materials designed to restore aged (oxidized) asphalt binder from RAP and/or RAS to the requirements of current asphalt cement specifications for asphalt mixes.

xxiii. Secondary data — data inventories from published sources that are not site-specific.

xxiv. Warm-mix additives — a variety of chemical additives that aid compaction and allow producers of asphalt mixtures to lower temperatures at which the material is mixed and placed on the road.

xxv. Warm-mix asphalt technologies — methods that allow asphalt mixtures to be compacted at lower temperatures than conventional asphalt mixtures, e.g., warm-mix additives or foaming.

6. Acronyms

a. General LCA acronyms are provided in the referenced ISO standards.

b. Acronyms used in this PCR are as follows:

AASHTO American Association of State Highway and Transportation Officials
Btu British thermal unit
CO_2eq Carbon dioxide equivalents
EPD Environmental product declaration
ESALs Equivalent single-axle loads
GTR Ground tire rubber
GREET Greenhouse gases, Regulated Emissions, and Energy use in Transportation
HMA Hot-mix asphalt
kWH Kilowatt hour
LCA Life cycle assessment
LCI Life cycle inventory
Mcf One thousand cubic feet
MMBtu One million British thermal units
NAPA National Asphalt Pavement Association
NERC North American Electric Reliability Corporation
NREL National Renewable Energy Laboratory
PCA Portland Cement Association
PCR Product category rules
RAP Reclaimed asphalt pavement
RAS Recycled asphalt shingles
RFO Recycled fuel oil

7. Life Cycle Assessment: Product Scope

a. This PCR addresses UNSPSC — United Nations Standard Products and Services — Code 30111509: Asphalt Based Concrete. An asphalt mixture is defined as a plant-produced composite material of aggregates, asphalt binder, and other materials.

   i. The mixture may contain varying quantities of materials suitable for recycling as a substitute for virgin materials, as well as chemical additives and modifiers which will be included as and when appropriate inventory data becomes available.

   ii. Table 4 in Annex I lists various asphalt-mix additives and modifiers with the current status of data availability.

   iii. Asphalt mixtures may be further classified by mix type, such as dense-graded, open-graded friction course, gap-graded, porous, or stone-matrix asphalt mixtures.

b. The asphalt mix shall be described in accordance to the product specifications under which it is purchased, as well as production information.

   i. Product specifications include, but are not limited to, the AASHTO M323-04 Standard Specification for Superpave Volumetric Design and the traffic volume in ESALs or the load spectrum of the pavement for which the mixture is intended to be used.

   ii. Production information declared shall include the company name, asphalt mixture plant, identification of asphalt mixture, the production temperature range, and the type of warm-mix technology (chemical or foaming) used, if any.

Further Explanation — Asphalt Production Temperature

Reducing production temperatures can reduce energy requirements and thus lower the environmental impact of asphalt production. Different plants achieve temperature reductions in different ways; however, the use of RAP and/or polymer-modified asphalts can limit how much temperatures can be reduced. This creates significant variability in the actual temperatures at which asphalt mixtures are produced. Furthermore, energy consumption at plants is not recorded separately per mix design. Therefore, the reduced energy consumption of asphalt mixtures using warm-mix technologies currently cannot be isolated from the energy consumption of mixes produced at traditional temperatures. To recognize production efforts to reduce energy consumption, the plant production temperature for each asphalt mixture will be declared in the EPD.

8. Life Cycle Assessment: Declared Unit

a. 1 short ton of asphalt mixture.

9. Life Cycle Assessment: System Boundary

a. The system boundary for the study are established in Figures 1 and 2.

b. This PCR accounts for processes that are within the bounds of Modules A1: Raw Material Supply, A2: Transport, and A3: Manufacturing (Figure 1).

c. The scope of the underlying life cycle assessment of the asphalt mixture (Mukherjee, 2016) is strictly cradle-to-gate, with the gate being defined as the point at which the asphalt mixture is transferred from the silo at an asphalt mixture plant to the truck for transport to consumer.

d. All inputs and outputs to the unit processes identified must be included in the calculation (Figure 2).

e. The items are referenced using the modules and associated number on the list. Hence, A1:2 refers to item 2 in Module A1.

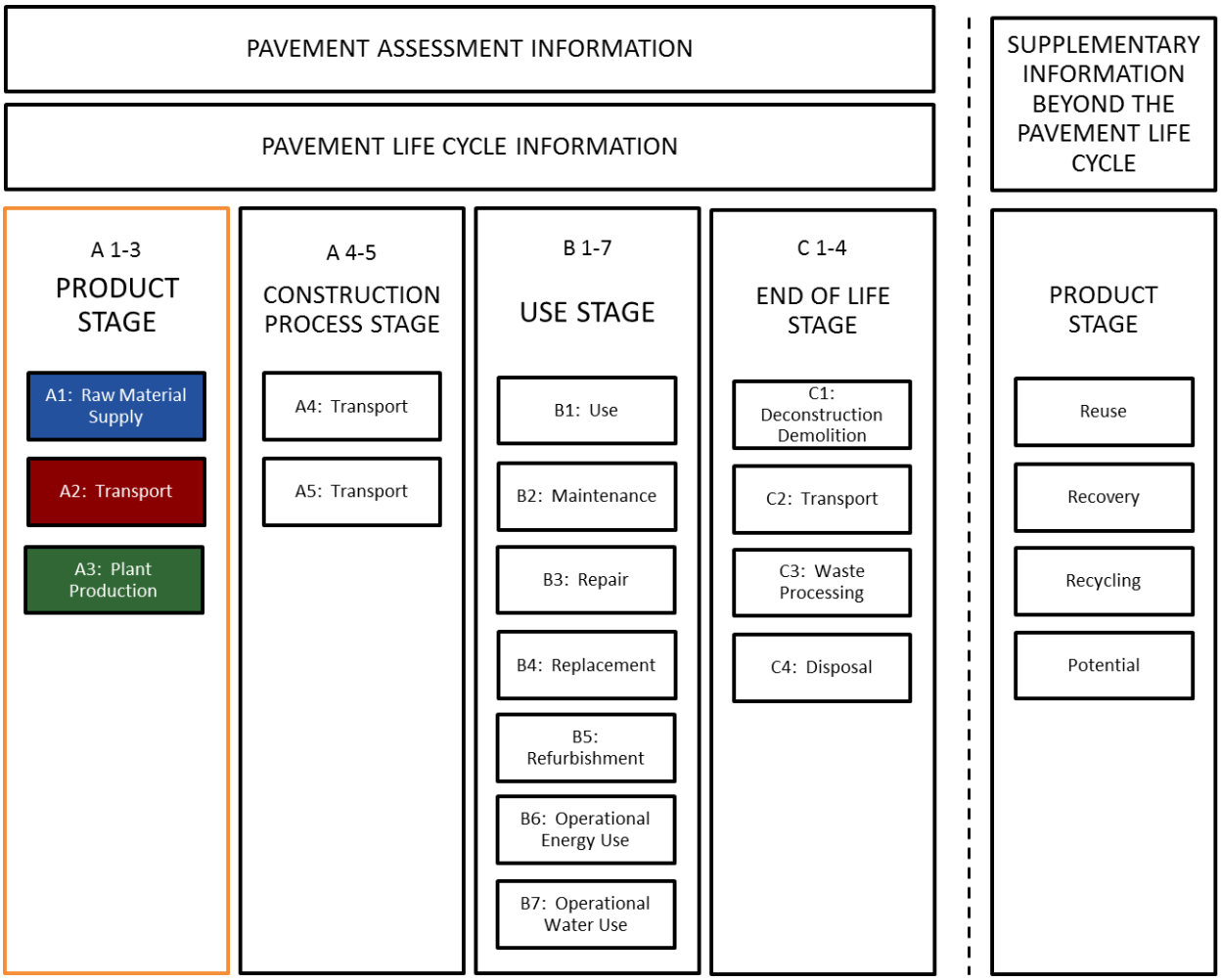

Figure 1. Diagram of designations of modular information used for life cycle assessments for pavements (adapted from CEN EN 15978:2011). This PCR's boundary is in the box outlined in orange, covering Modules A1–A3.

Processes in Module A1: Material Supply, Mining, and Production

Data for all these processes will be based on secondary data sources, as prioritized in Section 13.b. The following impacts are included:

1. Impacts of all co-products of crude oil refining, including extraction, refining, and storage.
2. Impacts associated with the extraction and production of natural gas used as burner fuel.
3. Impacts associated with the mining, extraction, and production of aggregate.
4. Impacts associated with the production of electricity (renewable and non-renewable) and its transmission to the asphalt mixture plant.
5. Impacts associated with bio-fuels, if used, at the plant.
6. Impacts associated with the recycled/reclaimed materials such as RAP/RAS. See Section 14: Allocation.

Processes in Module A2: Transport to Plant

Transportation modes and two-way distances of raw materials to the asphalt mixture plant and empty trips back are considered primary data collected in accordance with Section 13.a. However, transportation that is part of upstream processes, involving transport of a raw material through the supply chain before it is transported to the plant, is considered part of the secondary data and data sources are prioritized in Section 13.b.

1. Two-way transportation of crude oil from well to refinery and transportation of all co-products of refining (except for asphalt binder) from the refinery to the asphalt mixture plant with emp. This will be based on secondary data.
2. Two-way transportation of natural gas from well to refinery and transportation of all co-products of refining (except for asphalt binder) from the refinery to the asphalt mixture plant. This will be based on secondary data.
3. Two-way transportation of asphalt binder from the refinery or terminal to the asphalt mixture plant. This will be based on primary data collected for each plant.
4. Two-way transportation of virgin aggregate from source to the asphalt mixture plant. This will be based on primary data collected for each plant.
5. Two-way transportation of recycled materials, such as RFO, RAP, and RAS, to the asphalt mixture plant. This will be based on primary data collected for each plant.
6. Two-way transportation of additives to the asphalt mixture plant contingent upon data availability for the manufacture and processing of such additives. This will be based on primary data collected for each plant.

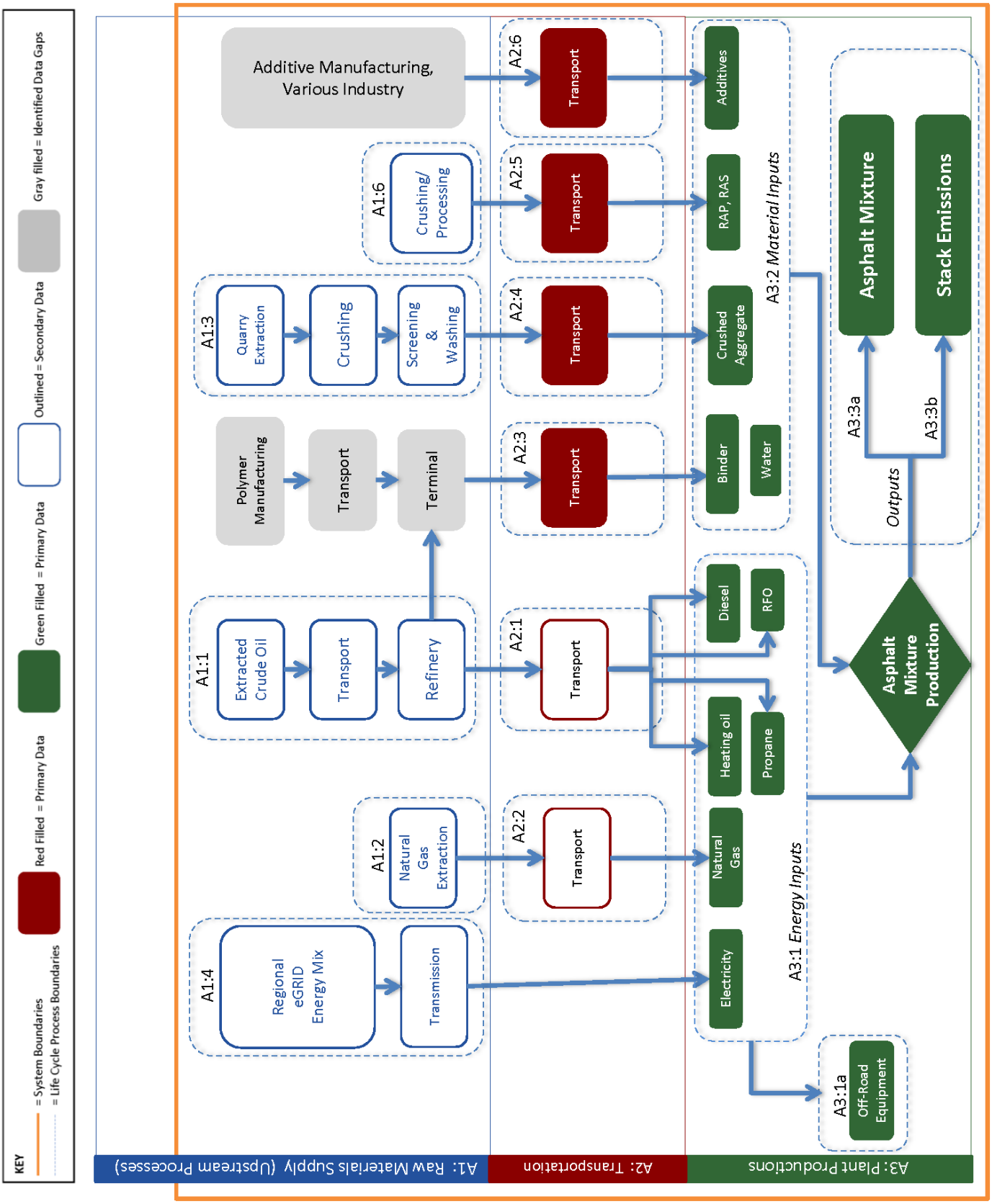

Figure 2. Diagram of the system boundary and data types.

Processes in Module A3: Plant Operations

All data collected for this part of the system will be directly based on plant operations and will be considered primary data collected in accordance with Section 13.a.

1. Energy (fuel and electricity) used at the plant for the asphalt mix production process, including:
    a. Off-road equipment used in moving aggregate and other related mobile equipment used on site in the production of asphalt mixtures.
    b. Burner used for the drying of aggregates.
    c. Burner used for secondary purposes (heating exhaust gases).
    d. Heating of asphalt binder in storage tanks.
    e. Movement of aggregate and asphalt binder through the plant and mixing process.
    f. Asphalt mixture storage in silos and asphalt binder in tanks.
    g. Processing of RAP and RAS completed at the plant site.
    h. Additive addition completed at the plant, e.g., chemical antistrip or hydrated lime, warm mix, recycling agents, etc.
2. Materials used at the plant for the asphalt mix production process, including:
    a. Total amount of water used at the asphalt mixture plant for dust control, washing aggregates, and/or foaming. No differentiation is made between water used for dust control and water used for foaming.
    b. Total amount of materials added at the plant used in 1 short ton of asphalt mixture, such as fine aggregates, coarse aggregates, RAP, RAS, asphalt binder, and any additives.
3. Outputs from plant:
    a. Total amount of asphalt mixture produced at the plant. Production is defined by total tonnage of asphalt mixture sold.
    b. Total plant emissions from stack.
    c. Total quantity of asphalt baghouse fines not reclaimed for use in asphalt mixes.

10. Life Cycle Assessment: Cutoff Criteria

a. All inputs and outputs to a unit process for which data are available must be included in the calculation. Data gaps may be filled by conservative assumptions with generic data from secondary data sources, as prescribed in Section 13.b. Any assumptions for such choices shall be documented in the LCA report.

b. In the case of insufficient input data or data gaps for a unit process, the cutoff criteria shall be 1% of the total energy used in the foreground unit processes (i.e., fuels and electricity based on lower heating value) or 1% of the total mass inputs for the

foreground unit processes (excluding fuels) whichever is lesser. The total sum of data that meets the cutoff criteria shall not exceed 5% of total energy use and 5% of total mass inputs for the model. Conservative assumptions in combination with plausible considerations and expert judgment can be used to demonstrate conformance with these criteria and must be documented in the LCA report.

c. Materials that are less than 1% of the total mass inputs for the foreground unit processes (excluding fuel), but which are considered environmentally relevant include chemical additives and polymers, such as those listed below. As there are data gaps in their publicly available life cycle inventories, these materials will be included in the analysis as soon as reliable and transparent sources become available. These data gaps must be clearly noted on the EPD, as prescribed in Section 16.a.vii. Environmentally relevant materials may include, but are not limited to, the following:

   i. Liquid antistrips, recycling agents, and warm-mix chemical additives;
   ii. Ground tire rubber and energy used for recycling rubber; and
   iii. Polymers in binder, broken down into two classes of chemicals: elastomers or rubbers, such as styrene-butadiene-styrene (SBS), and plastomers.

11. Life Cycle Assessment: Excluded from System Boundary

a. Upstream impacts of extraction, production, and manufacturing of any material that is not consumed in the production of the asphalt mixture is considered part of the asphalt mixture plant infrastructure and is therefore explicitly excluded from the system boundary. These include:

   i. The asphalt mixture production equipment and machinery and its upkeep and maintenance, including lubricants and any other substance used to facilitate the smooth functioning of the plant;
   ii. Machinery for the recycling of RAP and RAS;
   iii. Any equipment used for on-site generation of electricity or heat;
   iv. Any materials consumed by the general management, office, and headquarters operations; and
   v. Any office materials consumed at the asphalt mix plant or energy consumed by personnel commuting to and from the plant.

12. Data Quality

a. The following data quality aspects shall be addressed and documented in the LCA report that underlies the EPD:

   a. Temporal Representativeness (Age)
   b. Technological Representativeness
   c. Geographical Representativeness (Geography)

d. Precision
e. Uncertainty
f. Completeness

b. Units — For input data, English customary and SI unit options are acceptable to accommodate different reporting practices at U.S. asphalt mixture plants. LCA outputs are provided in units recommended by the identified TRACI impact indicators.

13. Life Cycle Inventory

a. Primary data shall be in accordance with the following requirements:
   i. Temporal Representativeness (Age): All data must be reflective of plant production over a period of 12 consecutive months from no later than 2012 annual production data.
   ii. Documents on File: Primary data should be based on utility and energy bills, production records, and other similar documents, all of which should be on file and easily accessible.
   iii. Uncertainty Check: Benchmarking of the total process energy and electricity consumption per ton of asphalt mixture shall be used to assess the accuracy of the primary data collected. Primary data should follow the statistical trends identified in the underlying LCA by Mukherjee (2016). These trends will be used to create checks and balances to assure data quality and to identify possible errors or anomalies in reporting. Data reported by plants that do not fall within the error margins based on these trends should be checked for reporting errors or explained.
   iv. Generic vs. Specific Data: All data reported for a plant must be specific to that plant.
   v. Data Gaps: Efforts should be made to ensure gaps in primary data collection are limited to only those items for which a predetermined scenario has been provided (RAP/RAS energy requirements and transportation distances — items n and o in the below listing of data to be reported).
   vi. The following data must be collected:
      a) Total asphalt mixtures produced at the plant, reported in short tons
      b) Total electricity in kWh
         1) Line power in kWh and zip code to identify energy production mix for the eGRID subregion data in which the plant is located as preference. Data pertaining to NERC regions can be used as an alternative.
         2) Solar power produced and consumed on-site in kWh
         3) Wind power produced and consumed on-site in kWh
         4) Other renewable energy produced and consumed on-site in kWh (please specify other renewable energy type)

5) Solar power produced on-site and uploaded to the grid in kWh
6) Wind power produced on-site and uploaded to the grid in kWh
7) Other renewable energy produced on-site and uploaded to the grid in kWh (please specify other renewable energy type)

c) Generator energy
   1) Diesel fuel in gallons
   2) Liquid biofuels in gallons
   3) Natural gas use in MMBtu or Mcf if MMBtu is not available
   4) Propane used in gallons
   5) RFO in MMBtu or gallons if MMBTu is not avaialble

d) Plant burner energy
   1) Natural gas use in MMBtu or Mcf if MMBtu is not available
   2) Propane used in gallons
   3) Diesel fuel in gallons
   4) RFO in MMBtu or gallons if MMBTu is not avaialble
   5) Biofuels in gallons

e) Hot oil heater energy
   1) Natural gas use in MMBtu or Mcf if MMBtu is not available
   2) Propane used in gallons
   3) Diesel fuel in gallons
   4) RFO in MMBtu or gallons if MMBTu is not avaialble
   5) Biofuels in gallons

f) Mobile equipment energy
   1) Diesel fuel use in gallons
   2) Natural gas use in MMBtu or Mcf if MMBtu is not available
   3) Gasoline fuel use in gallons

g) Percent of aggregates (coarse and fine) by weight of total asphalt mixture

h) Percent of asphalt binder by weight of total asphalt mixture

i) Percent of recycled materials (RAP and RAS) by weight of total asphalt mixture

j) Binder additives by weight of total asphalt binder

k) Asphalt mixture additives by weight of the total asphalt mixture

l) Two-way distances travelled to plant per transportation mode for asphalt binder, aggregate (both virgin and recycled) and any additives, expressed in miles. If producer can prove logistics for a one-way trip, one-way distances are acceptable.

m) Water used, water discharged, and water evaporated in gallons

Pre-determined default values: For parameters that may be difficult to estimate or collect primary data, the following estimates shall be used (Mukherjee, 2016):

n) Default energy requirements for processing of RAP/RAS is 0.1 gallon of diesel fuel oil per short ton

o) Distance travelled by RAP/RAS to plant is 50 miles by truck

b. Secondary data shall be in accordance with the following requirements:
   i. Temporal Representativeness (Age): The reference year of any background data should not be older than 10 years compared to the reference year of the EPD.
   ii. Technological and Geographical Representativeness: Representative of the technology used for the proper geographical region.
      i. Local data when available, and then regional or national data.
      ii. Data with energy mixes reflecting the eGRID subregion data may be used or NERC regions can be used as an alternative.
   iii. Prioritized as follows:
      i. Product-specific EPDs for the U.S.
      ii. Industry-average EPDs for the U.S.
      iii. Freely available public datasets prescribed on the NAPA EPD Program website (also noted in Annex I).

14. Allocation

a. Allocation must follow ISO 14044, which states:
   i. Allocation should be avoided; wherever possible, subdivision or system expansion should be used.
   ii. If allocation cannot be avoided, inputs and outputs of the system should be partitioned based on physical relationships before other alternative relationships, such as economic, are used except where stated in this document.

b. Recycled/reclaimed materials, such as RAP, RAS, GTR, and RFO, are treated as a waste material without economic value.

Further Explanation — Choice of Data Sources

Data sources prescribed are publicly available and freely accessible to ensure transparency. Use of the prescribed data source will ensure comparability among EPDs developed using this PCR by limiting any variability due to differences in the upstream data within the system boundary.

i. The upstream impacts associated with recycled/reclaimed materials' previous life cycles, including production/manufacturing, transport and use, are excluded from the system boundary.

ii. Impacts associated with the processes involved in recycling materials for use in the asphalt mixture are considered part of the system boundary. Hence, the included processes are:

a) Impacts of crushing RAP or grinding RAS and transportation to plant;

b) Impacts of recycling motor oil and other non-traditional fuels such as cooking oil and biofuels and transportation to plant; and

c) Impacts for producing crumb rubber from waste tires and transportation to plant.

c. Until a public secondary data source for asphalt binder is published and prescribed on the NAPA EPD Program website, the *NREL U.S. LCI Crude oil, at refinery* data using a combination of mass yield and economic allocation at the refinery, which is in accordance to the procedure defined by Yang (2014) and outlined in Annex I.

15. Life Cycle Impact Assessment

a. The potential environmental impacts per declared unit are to be reported based on the U.S. EPA's TRACI tool, Version 2.1 (Bare, 2012).

i. Environmental impact indicators to be reported per declared unit are:

a) Global warming potential (GWP_{100}), fossil, in kilograms of CO_2eq

b) Depletion potential of the stratospheric ozone layer (ODP), in kilograms of CFC-11 equivalents

c) Acidification potential of land and water resources (AP), in kilograms of SO_2 equivalents

d) Eutrophication potential (EP), in kilograms of N equivalents

e) Smog formation potential (SFP), in kilograms of O_3 equivalents.

b. The energy reporting in the EPD shall distinguish between energy sources, such as coal, petroleum products, biomass, etc., based upon how they are used. Energy sources shall be reported separately when used as a material component of a product versus used as energy in the product's creation, as follows:

i. Use of renewable primary energy sources as a material, in MJ

ii. Use of renewable primary energy sources as energy, in MJ

iii. Use of nonrenewable primary energy sources as a material, in MJ

iv. Use of nonrenewable primary energy sources for energy, in MJ

Lower heating values (Table 1) shall be used to convert to physical units to MJ.

Table 1: Lower Heating Values

LHV	MJ/kg
Asphalt Binder	40.20
Crude oil	43.05
Gasoline	44.15
Diesel	42.91
Fuel oil	40.87
LPG	46.28
Kerosene	43.69
Hydrogen	119.95
Coal	25.75
Natural gas	45.86

c. The water reporting in the EPD shall be by total in gallons.

16. EPD Format

a. The following items must be included in the EPD (see Appendix E for template):

i. Information about asphalt mix producer (including company name, plant name/identification, location, and contact person and phone number).

ii. Product Description, including description of application and mix type, UNSPSC, product specification, production temperature range, warm-mix technology used if applicable, and an optional graphic of the product.

iii. Reference to this PCR and the name of the Program Operator under which the declaration will be registered.

iv. EPD Validity Period through January 2022.

v. Third-party verification with contact information for the verifier, confirming that the EPD conforms to this PCR and the relevant ISO standards ISO 14044 and ISO 14025.

vi. Life Cycle Assessment Information:

a) Declared unit and product definition as defined by this PCR.

b) Diagram of life cycle modules included and excluded in reference to modules in Figure 1.

c) Table of impact indicator results with the following note: ***"The life cycle impact assessment results are relative expressions and do not predict actual impacts on category endpoints, the exceeding of thresholds, safety margins, or risks."***

d) Energy as defined in the energy reporting Section 15.b.

e) Total water

vii. Additional Environmental Information: Asphalt mixture plants may declare if they are a Diamond Achievement Sustainability Commendation Recipient with the following note: **"Visit http:goaspha.lt/2fdZ4qT to see current status."**

viii. Summary of Limitations:

a) List data gaps due to additives — fibers, crumb rubbers (if it is added at a plant), liquid antistrips, recycling agents, stabilizers, etc.

b) An EPD for an asphalt mixture that uses a modified asphalt binder must include the following statement: ***"This mix uses a [polymer/GTR/polymer + GTR] modified asphalt binder. The upstream impacts associated with the process of extraction, manufacturing/production, and transportation of the materials used in the modification process have not been accounted for in this EPD."***

c) An EPD for an asphalt mixture that uses RAS, must include the following statement: ***"The impact of recycling asphalt shingles was estimated using data for processing reclaimed asphalt pavement. The source of the shingles (tear off or factory rejects) is not being accounted."***

References

Argonne National Laboratory (2015). GREET Model. https://greet.es.anl.gov/

ASTM International (2013). ASTM D8-13b, Standard Terminology Relating to Materials for Roads and Pavements. doi:10.1520/D0008

Bare, J.C. (2012). Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), Version 2.1 — User's Guide. Report No. EPA/600/R-12/554 2012. U.S. Environmental Protection Agency, Cincinnati, Ohio.

European Committee for Standardization (CEN) (2013). EN 15804+A1 Sustainability of Construction Works — Environmental Product Declarations — Core Rules for the Product Category of Construction Products.

International Organization for Standardization (2006). ISO 14025:2006 Environmental Labels and Declarations — Type III Environmental Declarations — Principles and Procedures.

International Organization for Standardization (2006). ISO 14040:2006 Environmental Management — Life Cycle Assessment — Principles and Framework.

International Organization for Standardization (2006). ISO 14044:2006 Environmental Management — Life Cycle Assessment — Requirements and Guidelines.

Mukherjee, A. (2016). Life Cycle Assessment of Asphalt Mixtures in Support of an Environmental Product Declaration.

National Renewable Energy Laboratory (2012). U.S. Life Cycle Inventory Database. http://www.nrel.gov/lci/

Marceau, M.L., M.A. Nisbet, & M.G. VanGeem (2007). Life Cycle Inventory of Portland Cement Concrete. Report No. SN3011. Portland Cement Association, Skokie, Illinois.

Yang, R.Y. (2014). Development of a Pavement Life Cycle Assessment Tool Utilizing Regional Data and Introducing an Asphalt Binder Model, MS Thesis. University of Illinois, Urbana–Champaign, Urbana, Illinois. Accessed at: http://hdl.handle.net/2142/50651

Appendix A: PCR Development Working Group

Name	Title	Company
Daniel T. Crago, P.E.	Environmental & Quality Control Manager	Valley Asphalt Corp.
Ronald A. Sines, P.E.	Vice President, Asphalt Performance	Oldcastle Materials
Jon E. Callahan	Operations Manager	Palmer Paving Corp.
Christopher Piche, P.E.	Asphalt Technical Representative	Phillips 66
Joe P. Mahoney, Ph.D.	William M. And Marilyn M. Conner Professor	University of Washington
Meagan Sylvia, LEED AP, REM	Director of Environmental Services	The Lane Construction Corp.
Mark S. Buncher, Ph.D., P.E.	Director of Engineering	Asphalt Institute
Darrell Cass, P.E.	Federal Aid Project Manager	MnDOT
Gina Ahlstrom	Team Leader-Pavement Design and Analysis	Federal Highway Administration
Randy Bowman, P.E.	Assistant Director of Public Service	City of Columbus, Ohio

Appendix B: Conformity Assessment Form

Available At www.asphaltpavement.org/EPD.

Appendix C: Stakeholders

Stakeholders Notified by Direct Email
Applied Pavement Technology, Inc.
The Associated General Contractors of America (AGC)
Athena Sustainable Materials Institute
Australian Asphalt Pavement Association
Baker Rock Resources
Eurobitume
European Asphalt Pavement Association
FHWA Sustainable Pavement Technical Working Group and Friends
Institute for Environmental Research & Education
Lamar University
Louisiana State University
Michigan Technological University
NAPA Sustainability Committee and Friends
National Stone, Sand, and Gravel Association
Oregon Department of Environmental Quality
Polytechnic University of Milan
Randall Publishing
Rock Road Companies Inc.
TRB Sustainable Pavements Subcommittee
University of Washington
Utility Cabinet

Other Methods of Notification

- *Asphalt Pavement* magazine
- NAPA *ActionNews* email newsletter
- NAPA Website
- Presentations at Industry Meetings (NAPA, SAPA, FHWA SPTWG, LCA Conference, Greenbuild, etc.)
- Social Media: LinkedIn, Twitter, Facebook

Appendix D: Response to Public Comments

Available At www.asphaltpavement.org/EPD.

Appendix E: EPD Template

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Will be added to Final Copy.