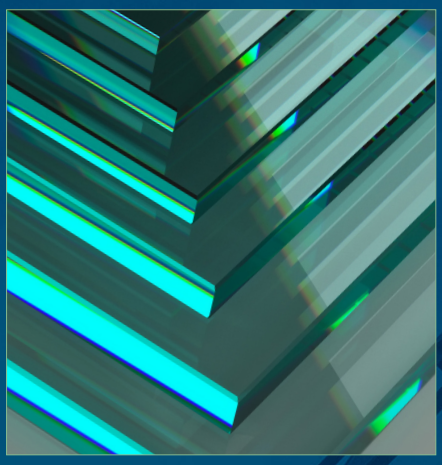

A Vision and Plan to Improve Secondary Life Cycle Assessment Data Used in Environmental Product Declarations

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Purpose

The purpose of this document is to outline a vision and a plan the Environmental Protection Agency will implement to improve secondary data in life cycle assessment models that underlie environmental product declarations. This plan will help ensure that environmental data the federal government uses to identify low embodied carbon construction materials are free-to-use, publicly accessible and well maintained.

The plan described here is part of EPA's efforts through the Low Embodied Carbon Construction Materials Program. This program includes the Reducing Embodied Greenhouse Gas Emissions for Construction Materials and Products Grant Program, Environmental Product Declaration Technical Assistance Program and the Label Program for Low Embodied Carbon Construction Materials, authorized under Sections 60112 and 60116 of the Inflation Reduction Act of 2022 ("Inflation Reduction Act of 2022," 2022).

This vision and plan are intended to support the Department of Transportation's Federal Highway Administration's and General Services Administration's related programs to purchase low embodied carbon construction materials under the Inflation Reduction Act. The vision and plan are also intended to align with the Department of Energy's *Blueprint for Decarbonizing U.S. buildings by 2050* and with DOE's role as defined in the 2023 Consolidated Appropriations Act to "increase participation in databases used in generating EPDs, the disclosure tool measuring the embodied carbon of a product or service, in coordination with the Environmental Protection Agency" (DOE 2024; "Energy and Water Development and Related Agencies Appropriations Act, 2023," 2022).

This vision and plan were shaped through close collaboration with the Interagency Team on Secondary Data[1] for EPDs[2].

Background

The EPD Data Challenge and EPA's Response

Embodied carbon is a term used to describe the greenhouse gas emissions over the life cycle of materials and products. EPDs provide standardized and verified product life cycle information, including embodied carbon data based on product category rules. Within the United States, EPDs generally report only the environmental impacts from raw material extraction through the manufacture or preparation of a product ("cradle to gate," Modules A1–A3). However, it is generally accepted and noted in relevant standards, such as section 5.2 of International Organization for Standardization

[1] Note that while "background data" and "secondary data" are often used interchangeably, EPA acknowledges the distinction between the two and is in the process of transitioning to the term "secondary data" where appropriate. "Background data" refers to data contained within the process(es) supporting the foreground system, whereas "secondary data" refers to data indirectly determined through measurement, estimation, or calculation and not based on specific original source measurements. See Appendix F for additional information.

[2] The Interagency Team on Secondary Data for EPDs is composed of staff from approximately 15 experienced LCA project leaders and practitioners from EPA, DOT-FHWA, the U.S. Department of Agriculture, DOE, the Department of Commerce's National Institute of Standards and Technology, and designated external experts. The group works to improve the Federal LCA Commons and its associated datasets. Opportunity for stakeholder engagement on these topics is forthcoming.

standard 21930:2017, that the full life cycle of a product also includes the use and end-of-life/disposal phases ("cradle to grave," Modules A1–C4). Major life cycle stages within information modules for construction EPDs are displayed in Appendix A.

The Inflation Reduction Act gives EPA the authority under Sections 60112 and 60116 to support the improvement and greater adoption of EPDs for construction materials and products. Implementation of Sections 60112 and 60116 will be conducted through grants, technical assistance and the Label Program for Low Embodied Carbon Construction Materials. The DOT-FHWA and GSA, under Sections 60506 and 60503 respectively, are to use EPA's determination of substantially lower embodied carbon construction products to procure and install construction materials/products through the $4.15 billion in funding designated under these sections.

At their best, EPDs can serve as tools to aid decision-making when procuring low embodied carbon materials and products. However, without confidence that EPDs are accurately representing the environmental impacts of materials and products, it is difficult to make meaningful claims about the lower environmental impact of a particular material or product over another. While standards such as ISO 14025:2006 provide basic guidance for EPDs to enable the comparison of products that meet the same functional purpose, they do not provide the level of rigor required to ensure that fair comparisons are made.

To address this challenge, EPA believes that additional standards, protocols, and investment are required, particularly in the realm of LCA modeling. EPDs rely on LCAs, and LCAs are modelled systematically through a process of understanding and mapping interdependencies between inputs, intermediary processes, outputs, and other pieces of information. Historically, no U.S. government standards have been widely adopted to ensure that data used in LCAs meet minimum data quality standards or to ensure that LCA practitioners use this input data to conduct the modeling process in a consistent manner. This has led to inconsistencies that result in differences in reported metrics in EPDs that can be inaccurate or do not reflect true differences in products (Lasvaux et al. 2015; Emami et al. 2019; Mukherjee et al. 2020; Butt and Harvey 2021; Kardish 2022).

While primary data is preferred, LCA modeling typically requires secondary data[3] due to the complexity of operations upstream and downstream of products. LCAs also need to represent the activities required to make or dispose of inputs and outputs throughout the life cycle of the product or material of interest; however, much of this activity is unknown and/or not measured. Given the large role that secondary datasets play in the development of EPDs, EPA recognizes that investment in these datasets is crucial to the success of the Low Embodied Carbon Construction Materials Program and larger efforts to decarbonize the construction materials manufacturing sector.

The challenges to improving secondary data in LCAs so that EPDs better inform procurement decisions can be summarized through the following three needs:

[3] Primary data refers to data determined by direct measurement, estimation, or calculation based on specific original source measurements for the system under investigation. In contrast, secondary data refers to data indirectly determined through measurement, estimation, or calculation and not based on specific original source measurements. Secondary data can include data that are originally developed using primary data sources, but are further aggregated to represent average processes or products. See Appendix F for additional information.

1. The need for *availability* of relevant and representative data that is interoperable with the rest of the LCA model, including the goal and scope as defined in the PCR, all life cycle inventory data, the life cycle impacts assessment, and other methods for metric reporting.[4]
2. The need for *specification* of that data in PCRs as required for developing associated EPDs.
3. The need for *usability* of the specified data so that LCA practitioners can use the data to generate EPDs that are representative of the products they assess and that are comparable to products that have the same functional purpose.

EPA is working to address these challenges by standardizing data quality, improving data quality and availability, improving and updating Federal LCA Commons data management processes, and engaging and training stakeholders.

Brief Summary of Federal Efforts to Date to Develop Common Data

The federal government uses LCAs extensively and develops data and models to support LCAs. For several years, various federal agencies have independently funded the development of models and data for individual LCA studies. In 2014, federal agencies came together to more formally coordinate LCA activities across the U.S. government, including publishing LCA data resources to increase data accessibility and transparency and provide a common background LCI to the marketplace. This effort, referred to as the Federal LCA Commons (Kahn, Antognoli, and Arbuckle 2022), includes leaders in LCA across the federal government who actively support and develop LCA data and perform or manage federal LCA studies and programs.

USDA and the National Agricultural Library initiated FLCAC efforts to maximize federal LCA data coordination by developing a FLCAC data management platform. This is a knowledge creation platform and data aggregator that supports the collaborative development of; curation of; and public access to numerous types of LCA data products. The portal includes a set of data repositories assembled by federal agencies and partners that contain LCA data largely developed for project-specific purposes. This data platform also includes the following:

- The U.S. Life Cycle Inventory, a database curated by the federal government with data provided primarily by industry associations.
- The Federal Electricity Baseline, a background LCI model for electricity that was developed by participating federal agencies in FLCAC.
- Various guidelines and LCA data resources created and curated for the FLCAC to inform the creation, use and management of data found on the data portal and elsewhere, such as the Federal LCA Commons Elementary Flow List, a comprehensive list of standardized emissions and resources that enable data sharing.[5]
- LCIA methods compatible with the FLCAC LCI repositories.

[4] ISO 14044:2006 defines life cycle inventory as the phase of life cycle assessment involving the compilation and qualification of inputs and outputs for a product throughout its life cycle. ISO 21930:2017 defines life cycle impact assessment as the phase of LCA aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle. LCA data includes both LCI and LCIA data.

[5] Note that while these guidelines and LCA data resources were created for the FLCAC, they are not evenly applied across all FLCAC resources.

The core innovation behind the FLCAC platform is that it treats LCA data as code. It enables distributed collaboration on modeling, data creation and data reuse. The data are collected and publicly served through web services, which allow industry analysts and tool developers to automate access and use the data to create new data products. USDA designed the platform to enable open and FAIR[6] LCA data to allow industry to capitalize on federal investments in data. The role of EPA and federal partners is to develop consistent modeling conventions and data products for industry to use to meet policy requirements.

The FLCAC data platform can be distinguished from what is typically considered an LCA database or national database (UNEP, 2011) in a number of ways. Primarily, it was not designed to be a centrally managed, complete or consistent LCA database or single data product, although some contents within the FLCAC conform to traditional, internally consistent models and databases. While the datasets residing in multiple repositories within the FLCAC data portal that meet FLCAC guidelines can be made interoperable, they do not adhere to a common methodology and may have different intended applications (Arbuckle, Kahn, and Kriesberg 2017). It is incumbent upon EPA and federal partners to develop consistent data products that can be distributed through the platform.

To that end, federal agencies have been engaging with the specific problems related to secondary data gaps in EPDs by developing related guidance and participating in PCR committees, among other activities. For example, DOT-FHWA has played a significant role in facilitating discussions, performing research and compiling tools related to LCA for pavements. DOT-FHWA led an effort to compile publicly available, process-based secondary datasets that would initially be used for a pavement LCA tool called LCAPave (FHWA 2021).

The Public's View on Secondary LCA Data for EPDs

EPA has solicited feedback from the public on the subject of secondary data on multiple occasions. In January 2023, EPA released a formal public Request for Information associated with the Low Embodied Carbon Construction Materials Program established under the Inflation Reduction Act and received more than 100 responses that addressed secondary data. Overall, the RFI respondents recognized the FLCAC as the most prominent U.S. public entity for LCA data distribution. The majority of respondents were in favor of the federal government having a role in providing secondary data and recommended that the FLCAC portal be the official data hub.

In February 2024, EPA released the Draft Approach for Implementation of the EPA Label Program for Low Embodied Carbon Construction Materials ("Draft Label Program Approach") for public comment. Soon after in March 2024, EPA released the Draft Criteria for Product Category Rules ("Draft PCR Criteria") for public comment. As with the RFI, both the Draft Label Program Approach and the Draft PCR Criteria documents elicited numerous comments on the topic of secondary data, including 240 individual comments on the topic of specifying data for the Draft PCR Criteria alone. Public comments on the Draft PCR Criteria emphasized that "free and publicly available" secondary datasets may not have the highest data quality compared to proprietary secondary datasets, and that EPA needs to invest significant resources to rapidly improve data quality by the January 1, 2026 kick-in date for prescribing free-to-use and publicly accessible datasets as described in EPA's PCR Criteria (see Criterion 3.2.B).

[6] FAIR represents the guiding principles for scientific data management and stewardship: (F) findability, (A) accessibility, (I) interoperability, and (R) reusability. See: https://www.nature.com/articles/sdata201618.

The following sections describe the key takeaways from these public comment periods regarding what constitutes fit for purpose secondary data, challenges to developing fit for purpose secondary data and proposed solutions for developing fit for purpose secondary data.

What Constitutes Fit for Purpose Secondary Data

The Interagency Team on Secondary Data for EPDs conducted a formal keyword analysis of the RFI comments relating to secondary data and determined that the vast majority of respondents agreed on the need for ***common, publicly accessible,*** and ***up-to-date secondary datasets*** for EPDs (see Appendix B Table 1).

Separately, the Interagency Team on Secondary Data for EPDs conducted a survey among its members and ranked secondary data attributes by order of importance. Survey results indicated that the Interagency Team was aligned with public perception on the need for ***publicly accessible, consistent, relevant and well-maintained secondary datasets*** (see Appendix B).

Challenges to Developing Fit for Purpose Secondary Data

In addition to providing insight on the public opinion of what constitutes fit for purpose secondary data, the public comment period highlighted the current limitations of the FLCAC.

- Respondents identified electricity, transportation, fuels and equipment secondary data as some of the most important datasets missing in the FLCAC. Respondents also pointed to specific needs related to the electricity datasets, in particular to the need for residual mix-based[7] and region-specific electricity.
- Respondents noted the lack of institutional status and regular funding to assure that data continue to be made available.
- Respondents commented on the need for more stringent review of EPD secondary data.
- Respondents pointed to the limitations (e.g., based on dataset age, specificity, review, and available metadata documentation) associated with particular datasets on the FLCAC that have been recommended for use in PCRs or otherwise are commonly perceived as standard datasets.
- Respondents described usability challenges with the FLCAC data, the need for data to be interoperable and the need for a data management plan.

Proposed Solutions for Developing Fit for Purpose Secondary Data

Some RFI respondents also described novel solutions to secondary data issues.

- One respondent suggested that an open-template LCA model would be of great benefit for EPDs, implying a linkage of datasets in more complete product system models and referring to research done by the National Renewable Energy Laboratory (Feraldi and Carpenter 2023). This idea is further discussed in the "U.S. Government Plan to Improve LCA Secondary Data" section of this report.
- Another respondent suggested the formation of a committee of LCA and subject matter experts to serve as reviewers for federally developed datasets. DOT-FHWA's Sustainable Pavements

[7] Residual mix-based electricity refers to mixes that avoid double-counting generation that may be contractually obligated to a single party.

Technical Working Group conceived of a similar feedback and review function as a Data User Group.

U.S. Government Plan to Improve LCA Secondary Data

EPA, together with the Interagency Team on Secondary Data for EPDs, is committed to creating free-to-use, publicly accessible and well-maintained secondary data for use in EPD development. EPA's plan for improving secondary data is informed by the public comments received, the Interagency Team's collective experience working with and developing LCA data, and the Interagency Team's interactions with the wider LCA community.

EPA will collaborate with other federal agencies to implement this plan through mechanisms such as grants, contracts, federal human capital, and interagency agreements. As part of these efforts, EPA, DOE, USDA, DOT and NIST are entering a *Memorandum of Understanding (MOU)* to formalize and provide structure for the FLCAC as an interagency initiative.

In the near term, EPA will prioritize efforts that directly tie in with and will ensure the success of the Low Embodied Carbon Construction Materials Program. In the long term, EPA will support continued updates and improvements to the FLCAC for broader use. Rough timelines are noted in the following sections and outlined in the Interagency Secondary Data Plan Diagram (Appendix E).

Standardizing Data Quality

EPA is spearheading efforts to improve the quality of federal LCA data for use in EPDs. To this end, EPA is leading the following efforts:

- **Engaging in PCR committees** (ongoing): EPA sits on multiple PCR committees for the purpose of understanding material-specific PCR needs, including the timelines of PCR development, which PCRs are most aligned with EPA's PCR Criteria, and which PCRs are currently specifying secondary datasets.
- **Developing EPA's PCR Criteria**: As part of its efforts to implement Section 60116 of the Inflation Reduction Act, EPA has published *U.S. EPA Criteria for Product Category Rules (PCRs) to Support the Label Program for Low Embodied Carbon Construction Materials*. EPA's PCR Criteria aim to drive standardization across all PCRs, increase prescriptiveness, and yield consistent and comparable results in EPDs. EPA is including a provision in its PCR Criteria that requires PCRs to specify what secondary data or models must be used to develop LCAs for EPDs that fall under a particular product category. Additionally, EPA will provide support in assessing whether PCRs meet EPA's label program requirements.
- **Providing the Data Quality Assessment Method**: EPA's *Data Quality Assessment Method to Support the Label Program for Low Embodied Carbon Construction Materials* outlines a methodology for evaluating the fitness of secondary data used in LCAs supporting PCRs and provides guidance on how this methodology is to be referenced in PCRs. EPA will provide support to PCR committees in assessing whether LCAs meet the data quality standards outlined in this method. EPA has also published a DQA Method Template that LCA practitioners

and PCR committees can use to develop data quality indicator scores for the purposes of the label program.

- **Identifying a common set of characterization factors**: EPA has published a set of reference LCIA characterization factors (available on EPA's website) to facilitate data harmonization and consistency. These include characterization factors for the five LCIA indicators specified by Table 5 in ISO 21930:2017, as well as factors for additional indicators, sometimes referred to as non-LCIA indicators. The non-LCIA factors are for other indicators commonly specified in PCRs related to resource use, water consumption, waste and other categories. More details on the characterization factors are given in Appendix D.
- **Updating TRACI 3.0** (by 2025): EPA is working to update TRACI to reflect recent characterization factors, including incorporating Intergovernmental Panel on Climate Change Sixth Assessment Report (AR6) global warming potential values, incorporating additional LCIA metrics and developing regional characterization factors (e.g., eutrophication, smog formation) where applicable. EPA is also working to make this update of TRACI compatible with the Federal LCA Commons Elementary Flow List.
- **Creating methodology for secondary data development** (by 2025): EPA is working to create and document an LCA database methodology that will ensure consistency in the data underlying EPDs, such as background LCI data and associated dependencies (e.g., parameters, aggregation approach, allocation, uncertainty analysis), LCIA data, elementary flows and data quality reporting.
- **Updating the Federal LCA Commons Elementary Flow List:** The Interagency Team on Secondary Data for EPDs will ensure that the FEDEFL is continually maintained and that new releases support ongoing updates to other resources including new LCI and LCIA datasets and new non-LCIA metrics. The list will be maintained on its GitHub site *fedelemflowlist* and new releases will be posted to LCACommons.gov. EPA will also develop new elementary flow mapping files, including those that support connections to other LCA software.
- **Developing data and creating a management plan for secondary data:** The Interagency Team will coordinate with federal agencies and industry organizations on the initiatives shown in the Secondary Data Diagram (Appendix E) and new data collection efforts outlined in the section "EPA's Strategies for Addressing Data Gaps". EPA will develop a management plan to describe how the secondary data provided by the federal government will be managed and updated to support EPDs. Additional data development activities are anticipated to occur through EPA's Reducing Embodied Greenhouse Gas Emissions for Construction Materials and Products grant program.
- **Developing open-template LCA models** (by 2026): The Interagency Team commits to developing open-template LCA models—complete product system models that represent product category averages and ranges. Open-template LCA models will serve as public LCA data sources that promote robustness and consistency and have the potential to reduce costs through a more simplified LCA and EPD development process. The open-template LCA models will be dictated by a combination of PCRs and more general conventions that will align the models across product categories. The models and their supporting secondary data will be served through the FLCAC application programming interface to enable more automated

maintenance. EPD developers will be able to input the models into private environments and add in primary data to produce EPDs.[8]

Improving Data Quality and Availability

EPA's PCR Criteria require that PCRs include the use of free-to-use and publicly accessible datasets or a commitment to use free and publicly accessible datasets by January 1, 2026 (see Criterion 3.2.B). EPA is committed to ensuring that this is feasible and will invest in the resources needed to make public data accessible for materials and products across the federal construction supply chain, with priority placed on the four materials outlined in the Interim Determination (concrete, steel, asphalt, and glass). To this end, EPA is leading the efforts described in the following subsections.

EPA's Measures to Identify Data Gaps

Data Gap and Data Quality Assessment

EPA has developed an initial *Life Cycle Inventory Data Gap Assessment* of secondary data along the construction supply chain. EPA developed the data gap assessment by reviewing secondary LCI datasets currently recommended in PCRs and engaging with industry contacts in PCR committees. The agency then cross-walked the data gap assessment with existing free-to-use and publicly accessible data from federally developed sources.

The data gap assessment will inform how EPA will prioritize datasets in need of development when coordinating the development of secondary LCI datasets for the construction supply chain with the Interagency Team on Secondary Data for EPDs. The data gap assessment will be periodically updated based on active PCR committee needs and feedback from other federal and industry stakeholders.

As described in the section "Standardizing Data Quality", EPA has also developed a DQA Method and will provide support to PCR committees in assessing whether LCAs along the construction material supply chain meet the data quality standards outlined in this method. EPA will reference the outcomes of the DQAs to determine what improvements are needed to existing datasets.

EPA's Strategies for Addressing Data Gaps

Developing high-quality secondary LCI datasets for the range of processes applicable to construction supply chains is a large endeavor that will require coordination across many organizations, both within the federal government and across industry. Below is a description of data development options EPA is considering, in order of preference. These options require further consideration, and do not represent a finalized plan.

- Coordination with federal partners and other EPA programs
- Engage with industry leaders to develop data
- Assessment of publishing proprietary data
- Use of Information Collection Requests

Coordination with Federal Partners and Other EPA Programs

Overview: EPA will coordinate internally and across federal agencies through the Interagency Team on Secondary Data for EPDs to determine which secondary LCI data gaps can be filled by past or existing federal data development efforts. EPA will request that federal agencies provide these datasets in a

[8] As an example, refer to Feraldi and Carpenter 2023.

format aligned with FLCAC data guidelines and other best practices to be provided by EPA's label program.

Based on a preliminary review, federal LCI datasets that are currently in development or planned for development include the following (See Appendix E):

- Electricity and fuel supply chains
- Transport and equipment processes
- Concrete and asphalt and associated supply chains[9]
- Downstream construction material use and disposal
- Environmentally-extended input-output model enhancements (EPA's USEEIO model)

Benefits: Data developed by federal agencies are typically intended to be free-to-use and publicly accessible. Such data benefit the general public, fulfill data review requirements, fulfill transparency requirements to provide underlying model calculations and source data, and leverage public sources such as emissions databases (e.g., EPA's National Emissions Inventory and Greenhouse Gas Reporting Program) that are based on detailed facility information and updated regularly. Many federal agencies are also now ensuring that their data meet FLCAC metadata and formatting guidelines, which improves cross-agency life cycle data interoperability.

Challenges: Federal agencies develop secondary LCI data based on their individual missions, and federal secondary LCI data may not exist for all identified data gaps in the construction material supply chain. The update and maintenance of federal secondary LCI data is also dependent on congressional appropriation.

One option to fill gaps for data not available in process-based federal LCI datasets is to use EPA's USEEIO model, which inherently covers all sectors in the economy. To do this, conversion factors will need to be developed to translate economic expenditures into physical units.[10]

Engage with industry leaders to develop data

Overview: The Interagency Team on Secondary Data for EPDs will engage industry associations and other industry partners to understand what LCI data development activities may be suitable to support free-to-use and publicly accessible secondary LCI data needs. EPA is particularly interested in supporting the publication of data developed by industry in a format suitable for use in EPA's label program.

The Interagency Team will support the publication of LCI data developed by industry through various activities, including the following:

- Engaging with industry associations to identify in-progress data development that could support the label program.

[9] Concrete and asphalt have been identified as materials that have existing efforts, primarily from DOT-FHWA and DOT's Federal Aviation Administration. If other materials and associated supply chains have provided secondary LCI data to federal agencies, these may be added as resources allow.

[10] Hybrid LCA approaches that use process-based LCI for key commodity materials, energy inputs and transport and environmentally-extended input-output data to fill gaps have been used in existing FLCAC repositories such as EPA's Construction and Demolition Debris Management repository.

- Encouraging industry with secondary LCI data to submit data to the USLCI database, a repository on the FLCAC that houses industry data, to allow industry data to be more interoperable with other federally produced datasets.
- Developing best practices to aggregate industry data.
- Providing technical assistance, such as stakeholder trainings, to publish and align industry-developed data with FLCAC requirements.
- Conducting DQAs for industry-developed secondary data and encouraging industry adoption of the EPA DQA Method.
- Indirectly supporting industry LCI data development through EPA's low embodied carbon grant program.

Benefits: Because industry stakeholders bring unique subject matter knowledge through operation of the facilities producing the actual supply chain materials and products, industry-developed data may fill gaps that are not being filled by other federal data development activities.

Challenges: To be published publicly, industry association data typically require aggregation to protect sensitive company information. This aggregation, while necessary, reduces the transparency of the underlying model and calculations. Different LCA practitioners may use different aggregation and modeling approaches as well as different secondary datasets. Such variability in approaches can limit the standardization and comparability of industry data produced for different projects. Industry data development schedules and review requirements also vary by project.

EPA's technical assistance will support movement toward increased standardization of approaches to aggregate and publish industry LCI data (see the methodology for the secondary data development document in the "Standardizing Data Quality" section).

Assessment of Publishing Proprietary Data

If coordination with federal agencies and industry engagement are not sufficient to address all data gaps, EPA will explore options relating to purchasing existing commercial proprietary LCI datasets and explore opportunities to develop end user license agreements to ensure that this proprietary data can be free-to-use and publicly accessible to support EPA's label program. EPA may provide additional support in ensuring that the proprietary data align with modeling approaches and secondary datasets used in the federally developed secondary LCI datasets.

Benefits: Commercial proprietary LCI datasets for purchase have been developed over a number of years and are commonly used in industry LCA models. Given their widespread use and inclusion of industry data, they represent a potentially important source of data to fill gaps.

Challenges: Use of commercial proprietary LCI datasets will be dependent on the development of end user license agreements that allow the data to be free-to-use and publicly accessible. Similar to the path of developing LCI through industry engagement, there will be variability in the transparency and modeling approaches for each commercial proprietary LCI dataset. EPA will continue to explore ways to ensure the purchased data meets the data quality needs of the label program.

Use of Information Collection Requests

EPA may collect and aggregate data directly from industry to develop secondary LCI and generate industry average datasets for use as secondary LCI to support EPA's label program. EPA would collect this data using the federal ICR process per the Paperwork Reduction Act. This approach will only be

considered if there are no alternative options to fill the identified data gap. In the event that this approach is necessary, EPA will provide data collection templates to industry to facilitate the provision of the needed data. EPA will also provide technical assistance in reviewing the data provided, such as conducting mass balances and following up with data providers to ensure the data is being interpreted correctly according to industry experts with knowledge of the specific technology and facility assessed. To produce industry averages, EPA will develop and follow procedures for aggregating data (see the methodology for the secondary data development document in the "Standardizing Data Quality" section).

Benefits: This approach will offer an option for EPA to develop new, high-quality industry data based on a standard approach that ensures interoperability with other federal life cycle data while protecting sensitive information.

Challenges: This approach would be resource-intensive and potentially require EPA and industry to spend a substantial amount of time on data development. As such, this option will be reserved for addressing priority secondary LCI data gaps in the construction material supply chain.

EPA's Measures to Ensure Usability of Data

Support for Federal LCA Tools and Guidance Material

The Interagency Team on Secondary Data for EPDs will support the development of data platforms, guidance materials, and other tools to improve the interoperability of secondary LCI data through the following activities:

- **EPA website:** EPA will develop a dedicated section of the EPA website for LCA tools and guidance materials.
- **Improving FLCAC data**: EPA will invest in improving the quality and availability of data in the FLCAC. While EPA's investment in the FLCAC will be primarily driven by EPA's Data Gap Assessment, DQA Method, and interactions with stakeholders, EPA will also closely coordinate with other agencies that have similar objectives and activities related to improving LCA data availability. Specifically, EPA's efforts to improving the quality of available data in the FLCAC will include coordination with the following:
    - DOT-FHWA, which continues to work closely with the pavement materials industries and associated EPD communities through its Sustainable Pavements Program.
    - NIST, which has active research programs in LCA for concrete materials and is assessing existing EPDs for secondary LCI data utilization.
    - The DOE's National Energy Technology Laboratory, which is enhancing electricity and other energy-related datasets.
    - The DOE's Advanced Materials and Manufacturing Technologies Office, which is directing funding to support data development to support EPDs
    - The National Renewable Energy Laboratory, funded by DOE AMMTO, which will provide centralized data curation for the FLCAC. NREL will also:
        - Further develop transportation and equipment datasets.
        - Provide enhanced data curation support for the USLCI database.
        - Provide trainings to federal partners on how to submit data to the FLCAC.
        - Support maintenance and enhancement of the Federal LCA Commons Elementary Flow List.

        - Support mapping files to allow data exchange of FLCAC data with other existing LCA and EPD tools and data repositories.
    - Other DOE-affiliated labs, which have relevant LCI development projects. For example, Argonne National Laboratory is working to convert material, energy, fuel and transport datasets from its GREET model to FLCAC.
    - The Forest Service, which is building forestry and forest products datasets for FLCAC.

- **Provide public access to FLCAC data:** USDA's National Agricultural Library operates the FLCAC data portal. EPA will collaborate with USDA, federal users, and the data curation/program support team to improve operational effectiveness by implementing best practices for software development and deployment to assure reliable access and data integrity.

Improving and Updating FLCAC Data Management Processes

The Interagency Team on Secondary Data for EPDs seeks to improve the accessibility, interoperability and usability of FLCAC data with existing software and tools used for EPD generation, and to encourage use of the FLCAC to maximize the standardization of public LCA data. With funding from DOE AMMTO, NREL has begun efforts to update the FLCAC and curate data for improved usability, automation and interoperability, and to ensure that FLCAC data remain relevant and accessible.

The Interagency Team is developing and/or conducting the following activities:

- **Data curation and interoperability tracking:** The FLCAC will now have support from a centralized data curator. An ongoing task of the data curator is to maintain interoperability of elements within the FLCAC ecosystem. Interoperability refers to the ability of datasets in repositories to be compatible with datasets from other repositories, impact assessment methods, metadata and other elements within the FLCAC workflow. The data curator will track and resolve interoperability issues on an ongoing basis. The data curator will also assess existing resources on the FLCAC and address known interoperability issues.

- **LCIA Formatter maintenance and updates:** The LCIA Formatter (lciafmt) is a Python package that standardizes LCIA methods, primarily for use with the FEDEFL. Currently, the LCIA Formatter has methods available for EPA's TRACI 2.1, ReCiPe 2016, ImpactWorld+, Intergovernmental Panel on Climate Change Global Warming Potential characterization factors, and a suite of inventory methods from the FEDEFL. The LCIA Formatter will be actively maintained and enhanced to handle new LCIA and non-LCIA methods. The resources on the FLCAC will be updated as new methods become available through the LCIA Formatter.

- **Guidelines and procedures for data submission, repository interoperability (libraries), quality assurance/quality control and versioning**:

    - There are currently two primary sets of data submission guidance documents of the FLCAC: the FLCAC Draft Data Handbook (and the draft update) and the USLCI Submission Handbook. The FLCAC data curator will review, consolidate and further extend these documents to provide up-to-date guidance for data submission.
    - The libraries feature will be implemented to allow databases to be used together without requiring that databases be imported on top of one another. A library serves as a read-only database that can be easily combined with other databases.

  - To harmonize QA/QC practices, the FLCAC data curator will develop approaches that apply a consistent assessment framework to all repositories in the FLCAC.
  - The FLCAC will (1) standardize version control via guidance for version numbering; (2) develop a collaboration server "releases" feature and a release comparison sub-feature; and (3) revise repository metadata, release hosting, and presentation on LCACommons.gov.

- **Data submission tool:** In order to establish a scalable workflow for FLCAC data submission, the data curator will develop enhanced technical assistance and tools to guide data providers through the submission process. A streamlined data submission tool will help to reduce the volume of back-and-forth and individualized support that the existing submission process requires.
- **FLCAC webpage, documentation and updates:** The technical assistance material on the FLCAC will be continually improved to provide support to data providers and users. Web content will also be coordinated with EPA web resources pages to ensure they complement one another.
- **FLCAC platform development and deployment:** EPA will develop and deploy new features for the FLCAC Collaboration Server, the data platform underlying the FLCAC, to support user requirements. USDA will maintain a product roadmap which prioritizes feature development based on user input. Routine deployment cycles will be established to assure operational, security and data integrity. The API will be refined and documentation will be developed for accessing the API to pull and utilize data from the FLCAC in other applications.

Engaging and Training Stakeholders

The Interagency Team on Secondary Data for EPDs will continue to involve the LCA community, including industry associations, in providing the aggregate data needed to drive the described systems, as well as providing expertise on the value chain structure of the open-template models. The Interagency Team will perform the following activities to engage and train stakeholders:

- **Participating in PCR committees** (ongoing): See the description in the "Improving Data Quality and Availability" section.
- **Improving the EPA website** (by summer 2025): EPA will develop a webpage for publicly posting all its efforts relating to secondary data and the FLCAC.
- **Engaging LCA data users** (by fall 2024): The Interagency Team will begin to engage with stakeholders as part of EPA's larger Low Embodied Carbon Construction Materials Program. EPA will provided additional details by the fall of 2024 so that the LCA expert community can provide feedback on improvements needed to the FLCAC and larger secondary data efforts.
- **Providing data submission trainings and technical assistance** (ongoing): NREL will continue to host openLCA and FLCAC data submission trainings.
- **Providing technical assistance resources** (ongoing): USDA and NREL will post technical assistance resources covering data submission and other topics on the LCACommons.gov website and related GitHub locations.

Impact of Secondary Data Work

The Interagency Team on Secondary Data for EPDs is committed to improving the quality and quantity of free-to-use and publicly accessible secondary data for LCAs within the United States. The Interagency Team will support LCA efforts from the federal government, LCA practitioners, academia, the private sector and other relevant stakeholders. Because of EPA's funding under the Inflation Reduction Act, the Interagency Team is steadfast in its belief that key efforts to improve the quality and quantity of data on the FLCAC will be completed by 2026, with critical efforts having already been started. Such efforts will support secondary data requirements prescribed in EPA's PCR Criteria. The Interagency Team jointly look forward to the success of these efforts and further engagement with stakeholders. Such efforts will ultimately result in secondary datasets that are suitable for use to produce comparable EPDs for procurement decisions. Higher quality EPDs for decision-making will yield meaningful and measurable embodied carbon reduction within the United States.

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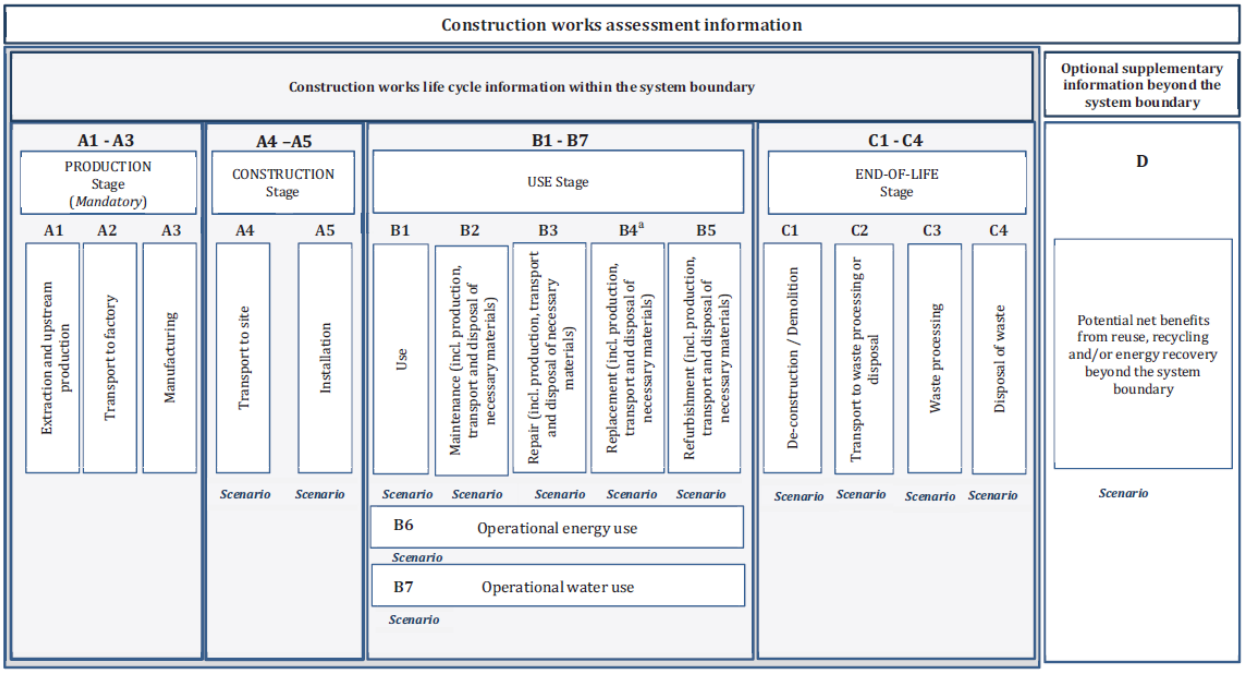
List of Abbreviations

DOE AMMTO	Department of Energy Advanced Materials and Manufacturing Technologies Office
DOT-FHWA	Department of Transportation—Federal Highway Administration
EPA	Environmental Protection Agency
EPD	environmental product declaration
FLCAC	Federal LCA Commons
GHG	greenhouse gas
GSA	General Services Administration
LCA	life cycle assessment
LCI	life cycle inventory
NIST	National Institute of Standards and Technology
NETL	National Energy Technology Laboratory
NREL	National Renewable Energy Laboratory
PCR	product category rule
PNNL	Pacific Northwest National Laboratory
RFI	Request for Information
UNEP	United Nations Environment Programme
USDA	U.S. Department of Agriculture

Appendix A: Life Cycle Stages and Information Modules

ISO 21930:2017 delineates and defines broad and universal life cycle stages for construction EPDs (see Figure A-1). Each major life cycle stage can comprise multiple processes.



[a] Replacement information module (B4) not applicable at the product level.

Figure A-1: Life Cycle Stages and Modules for Construction Works Assessment Information from ISO 21930:2017, Section 5.2.1.

Appendix B: Key Attributes of Secondary Data

In January 2023, EPA released a formal public Request for Information associated with the Low Embodied Carbon Construction Materials Program established under the Inflation Reduction Act. The agency received more than 100 responses to questions that addressed secondary data. The Interagency Team on Secondary Data for EPDs qualitatively reviewed and summarized the responses and used basic text analysis methods to assess associations and frequencies of keywords in the responses and their contexts. Key findings are as follows.

- Respondents identified electricity and transportation secondary data (mentioned in 21 responses), fuel data (mentioned in 14 responses) and equipment data (mentioned in 4 responses) as the most needed datasets.
- Respondents identified "public," "available," "updated," "current," "consistent," "accessible," "open" and "free" to be the key attributes of fit for purpose secondary data. This is captured in Table 1 below.

Table 1. Keywords Associated with the Term "Data" in Relevant RFI Responses

keyword	frequency
public	36
available	36
updated	20
current	19
consistent	16
accessible	12
open	12
free	8

The keywords from the RFI were then summarized into the following list, which captures the range of desired attributes for secondary datasets with minimal duplication in definitions: ***common, publicly accessible*** and ***up to date***.

Separately, eight members of the Interagency Team on Secondary Data for EPDs independently provided a list of the top three to five attributes of fit for purpose secondary data. The responses were freeform with no options provided to choose from. The attributes in the responses were harmonized into common terms or phrases to describe those attributes. Nine unique attributes were identified and defined as follows:

- **Reviewed:** Data have been independently quality assured and reviewed by subject matter and LCA experts to ensure accuracy and conformance to guidelines.

- **Relevant:** Data are temporally, geographically, technologically and market relevant and collected using adequate procedures.
- **Publicly available:** Data are accessible and free to access and use.
- **Transparent and reproducible:** The source of the original data inputs used to develop the secondary data profile are clearly documented to enable a third party to independently recreate the secondary data result based on the data documentation (metadata) with reported or linked data sources.
- **Based on representative public data and consistent data sources:** Data use federal or other public statistical data to the fullest extent possible but allow verified industry data to fill knowledge gaps. To the maximum extent possible, datasets should be based on the same underlying source data.
- **Meet anticipated user requirements (i.e., usability):** Data meet requirements for one or more known use cases.
- **Interoperable:** Data use a data structure and/or nomenclature that enables utilization with external LCA datasets/software.
- **Maintained:** Plans and resources for future updates are present and communicated.
- **Used (i.e., common):** Data are already used in applications, indicating their value and relevance to end users.

The number of responses with any of these attributes were counted, and the Interagency Team ranked the attributes based on the highest combined frequency of occurrence across all responses. Table 2 presents the attributes by rank order.

Table 2. Ranked Attributes of Fit For Purpose Secondary Data as Identified by the Interagency Team on Secondary Data for EPDs

Rank	Secondary Data Attribute
1	Reviewed
2	Relevant
2	Publicly available
4	Transparent and reproducible
4	Based on representative public data and consistent data sources
6	Meet anticipated user requirements
7	Interoperable
8	Maintained
8	Used

Survey results were then summarized into the following list, which captures the range of desired attributes for secondary data with minimal duplication: ***consistent, publicly accessible, relevant and well maintained***.

A comparison of the two studies confirmed the Interagency Team's alignment with the public's view on key attributes of fit for purpose secondary data.

These attributes were used to inform development of the indicators used in EPA's Data Quality Assessment Method to Support the Label Program for Low Embodied Carbon Construction Materials.

Appendix C: Secondary Data Improvement Documents

Many key secondary data improvement efforts have already started, with many referenced within this document. This appendix contains a linked list of all available deliverables as of the publishing of this document:

- *EPA's PCR Criteria*
- *Memorandum of Understanding among the U.S. Department of Energy, U.S. Environmental Protection Agency, U.S. Department of Agriculture, U.S. Department of Transportation, and the National Institute of Standards and Technology on the Federal Life Cycle Assessment Commons*
- *Life Cycle Inventory Data Gap Assessment*
- *Data Quality Assessment Method for Secondary Data to Support the Label Program for Low Embodied Carbon Construction Materials*
- *Life Cycle Impact Assessment (LCIA) Characterization Factors (available on EPA's website)*

Appendix D: LCIA and Non-LCIA Factors

LCIA Factors

To support EPD development, EPA released a set of LCIA factors (labeled as ISO21930-LCIA-US), which align with the five LCIA categories specified by Table 5 in ISO 21930:2017 (available on EPA's website):

1. Greenhouse gases,
2. Ozone depletion potential,
3. Eutrophication potential,
4. Acidification potential, and
5. Photochemical ozone formation potential.

The characterization factors, except for GHGs, are identical to those currently in TRACI 2.1 for the corresponding impact categories. The four TRACI 2.1 impact categories have the same names as those in ISO 21930:2017 except for POCP, which is labeled "smog formation" in TRACI 2.1. The characterization factors for GHGs are the 100-year GWPs from the International Panel for Climate Change's Fifth Assessment Report.

Non-LCIA Factors

EPA has developed a set of recommendations for non-LCIA factors to make available for EPD generators. These non-LCIA factors go beyond those specified in Table 5 of ISO 21930:2017 to include additional indicators related to resource use, water consumption, and waste, as well as additional metrics to track GHG emissions. The recommendations are based on a review of indicators mandated or recommended in a variety of PCRs (Table 3), guidance materials and EPA resources. Additionally, the recommendations are based on an evaluation of their implementation viability in the label program with respect to their compatibility with the FEDEFL. A summary of the indicators and a crosswalk to relevant PCRs is provided in Table 4 at the end of this appendix.

Table 3. List of PCRs Evaluated for Non-LCIA Factors

PCR Title	Program Operator
PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements	UL
PCR for Asphalt Mixtures v2	NAPA
NGA PCR for Flat Glass: UN CPC 3711	NSF International
NSF 1112-19 with 2023 Deviation PCR for Concrete v2.3	NSF International
PCR for Portland, Blended, Masonry, Mortar, and Plastic (Stucco) Cements v3.2	NSF International
NSF 1102-23 PCR for Fenestration Assemblies	NSF International
PCR for EPDs Architectural Coatings	NSF International
PCR for Gypsum Panel Products	NSF International
PCR for Clay Brick, Clay Brick Pavers, and Structural Clay Tile	NSF International
NSF/ASTM 1104-23 PCR for North American Pressure-Treated Wood Products (UN CPC 313)	NSF International
PCR for Construction Aggregates: Natural Aggregate, Crushed Concrete, and Iron/Steel Furnace Slag	NSF International

The recommendations for indicators below are presented in the following categories: carbon and GHGs, waste management, resource: energy, resource: water, resource: other, and other emissions. For each category, the recommended indicators are presented, and justifications for inclusion and exclusion of the metrics are described. In some cases, incorporating certain indicators may not require a new unique indicator, but may necessitate that the practitioner use certain modeling approaches. These recommendations are included for each category where appropriate.

Carbon and GHGs

Recommended Indicators:

- Gross GHG emissions (covered within ISO21930-LCIA-US)
- Net GHG emissions (excluding biogenic carbon)
- GHG emissions from biogenic carbon

To date, there has not been consensus among FLCAC members on the best approach for identifying and tracking carbon that is biogenic in nature. Currently, there is no distinct elementary flow in the FEDEFL to track or report biogenic carbon (or biogenic carbon dioxide), as the "biogenic" characterization is considered metadata and not a core chemical distinction with a carbon dioxide flow. Without a specific biogenic carbon flow, carbon could be tracked as a resource (input) at the point of biomass harvest. Net emissions are the difference between gross emissions and carbon uptake (as resource flow), i.e., the mass of gross emissions minus the mass of resource use (uptake).

Alternatively, biogenic emissions can be tracked at the point of release based on assumptions made regarding the biogenic content of an emitting source. To distinguish these emissions from gross carbon emissions would require a distinct elementary flow in the FEDEFL (i.e., biogenic carbon dioxide). This is a prerequisite to enable a net GHG emissions indicator that excludes biogenic carbon. A distinct biogenic carbon dioxide flow would also require clear guidance on the use of the existing carbon dioxide flow, whether it represents gross emissions or fossil emissions. The biogenic carbon dioxide flow would then need to be characterized in a calculation of gross GHG emissions, but not net GHG emissions.

Currently, LCIA methods in the LCIA Formatter (International Panel on Climate Change, TRACI 2.1, ReCiPe2016), track only gross emissions for GHG indicators. That is, they do not assess carbon dioxide resource flows.

Waste Management

Recommended Indicators:

- Hazardous waste disposed
- High-level radioactive waste disposed
- Intermediate- and low-level radioactive waste disposed
- Non-hazardous waste disposed
- Materials for recycling

A standardized waste flow list does not currently exist across FLCAC data. Within the openLCA schema, generation or disposal of waste is typically performed using a "waste flow." Waste flows can be characterized in LCIAs in the same way as elementary flows. Creating a waste flow indicator in LCIA Formatter would require identifying a standard list of waste flows (including materials for recycling), ideally from standard sources (such as EPA's RCRAInfo), similar to the standardized list of elementary flows in the FEDEFL. These flows could be tagged based on which category of waste they are in. Broad

or more generalized categories might provide interim options for EPD providers prior to the generation of a comprehensive standardized list of waste flows by EPA.

Resource: Energy

Recommended Indicators:

- Non-renewable primary resources with energy content used as energy or material
- Renewable primary resources with energy content used as energy or material

The FEDEFL contains energy resource flows for both non-renewable (e.g., natural gas, coal, nuclear) and renewable (e.g., solar energy, biomass, hardwood) sources. These flows are in the class "energy," "biological," or "geological." Those flows that are not in energy units by default have energy unit conversions. The LCIA Formatter can generate inventory methods for these categories in the form of "nonrenewable_energy" or "renewable_energy."

However, FEDEFL does not track the ultimate use of the energy resource and so cannot distinguish fuel from material applications. In modeling applications utilizing the FEDEFL, it is expected that resource flows are documented in an LCI at the point of extraction (for geologic resource flows), the point of generation (for energy resource flows) or the point of harvest (for biological resource flows). How these resource flows get utilized in downstream modeling cannot be tracked under standard modeling approaches.

Resource: Water

Recommended Indicators:

- Gross freshwater consumption
- Net freshwater consumption

The existing FEDEFL inventory methods track gross water consumption via "water" elementary flows consumed as resources using the "freshwater_resources" indicator. Re-emissions of water are not included. To better account for potential discrepancies in modeling approaches, EPA also recommend including a new indicator in the LCIA Formatter to track net freshwater consumption, which would include characterization factors of -1 for emissions of fresh water to bodies of water. Practitioners and EPD generators would benefit from guidance to ensure that the accounting of water use is consistent across LCI data (i.e., whether net or gross water consumption is being reported in an inventory).

Resource: Other

Recommended Indicators:

- Mineral resource use

The FEDEFL has an initial list of mineral resources based on data characterized by the U.S. Geological Survey's Minerals Yearbook Survey ("USGS_mineral_resources" in LCIA Formatter). Some LCIA methods attempt to account for mineral scarcity by developing a midpoint resource depletion indicator (e.g., ReCiPe 2016). The USGS inventory method in FEDEFL, however, is a summation of mass flows across all covered resources. One challenge common to mineral resource metrics is that the practitioner or data developer needs to distinguish between the mineral content of an ore and the mass of an ore when building an inventory. The FEDEFL does not include resource flows of ores with mixed mineral contents, though this is common in other LCI datasets.

Other Emissions

Recommended Indicators:

- Human health toxicity, cancer and non-cancer via USEtox
- Ecotoxicity (various sources)

The human health and ecological health impacts of emissions to air, water and soil are commonly characterized in LCIA methods. LCIA Formatter includes several indicators that account for human and ecological health from various sources, including TRACI 2.1 (via USEtox), ImpactWorld+ and ReCiPe 2016.

Table 4. Crosswalk of Non-LCIA Indicators to Relevant PCRs

Category	Indicator	Unit	FEDEFL Compliant?	Relevant PCRs
Carbon and GHGs	Biogenic carbon, package	kg CO_2	Biogenic carbon is not explicitly captured as an elementary flow; would require distinguishing CO_2 emissions from specific unit processes.	PCR for Asphalt Mixtures
Carbon and GHGs	Biogenic carbon, products	kg CO_2	Biogenic carbon is not explicitly captured as an elementary flow; would require distinguishing CO_2 emissions from specific unit processes.	PCR for Asphalt Mixtures
Carbon and GHGs	Biogenic carbon, renewable waste combustion	kg CO_2	Biogenic carbon is not explicitly captured as an elementary flow; would require distinguishing CO_2 emissions from specific unit processes.	• PCR for Asphalt Mixtures • PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements
Carbon and GHGs	Carbon from calcination and carbonation	kg CO_2	No. Would require distinguishing CO_2 emissions from specific unit processes	PCR for Asphalt Mixtures
Carbon and GHGs	Carbon from non-renewable waste combustion	kg CO_2	No. Would require distinguishing CO_2 emissions from specific unit processes.	PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements
Carbon and GHGs	Carbon from land use change	kg CO_2	No. Land use change and transformation are not tracked in the FEDEFL.	PCR for Asphalt Mixtures
Waste Management	Hazardous waste disposed	kg	Feasible. Would require comprehensive list of waste flows	• NGA PCR for Flat Glass: UN CPC 3711 • PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Asphalt Mixtures
Waste Management	High-level radioactive waste disposed	kg or m^3	Feasible. Would require comprehensive list of waste flows.	PCR for Asphalt Mixtures
Waste Management	Intermediate- and low-level radioactive waste disposed	kg or m^3	Feasible. Would require comprehensive list of waste flows.	PCR for Asphalt Mixtures
Waste Management	Materials for recycling	kg	Feasible. Would require comprehensive list of materials for recycling.	• NGA PCR for Flat Glass: UN CPC 3711 • PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Asphalt Mixtures

Category	Indicator	Unit	FEDEFL Compliant?	Relevant PCRs
Waste Management	Non-hazardous waste generated	kg	Feasible. Would require comprehensive list of waste flows.	• NGA PCR for Flat Glass: UN CPC 3711 • PCR for Asphalt Mixtures • PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Clay Brick, Clay Brick Pavers, and Structural Clay Tile • PCR for Natural Aggregate, Crushed Concrete, and Iron/Steel Furnace Slag UNCPC 1538
Resource: Energy	Non-renewable primary resources used as an energy carrier (fuel)	MJ	Partly (nonrenewable_energy); FEDEFL does not track the ultimate use of the energy resource so cannot distinguish fuel from material.	• PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Asphalt Mixtures • PCR for Gypsum Panel Products
Resource: Energy	Non-renewable primary resources with energy content used as material	MJ	Partly (nonrenewable_energy); FEDEFL does not track the ultimate use of the energy resource so cannot distinguish fuel from material.	• PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Asphalt Mixtures • PCR for Gypsum Panel Products
Resource: Energy	Renewable primary resources used as energy carrier (fuel)	MJ	Partly (renewable_energy); FEDEFL does not track the ultimate use of the energy resource so cannot distinguish fuel from material.	• PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Asphalt Mixtures • PCR for Gypsum Panel Products
Resource: Energy	Renewable primary resources with energy content used as material	MJ	Partly (renewable_energy); FEDEFL does not track the ultimate use of the energy resource so cannot distinguish fuel from material.	• PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Asphalt Mixtures • PCR for Gypsum Panel Products
Resource: Water	Net fresh water	kg	Feasible. Existing indicator (freshwater_resources); captures gross water consumption. New indicator for net water consumption is feasible.	• PCR for Clay Brick, Clay Brick Pavers, and Structural Clay Tile • PCR for Natural Aggregate, Crushed Concrete, and Iron/Steel Furnace Slag UNCPC 1538 • PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • NGA PCR for Flat Glass: UN CPC 3711 • Fenestration Assemblies

Category	Indicator	Unit	FEDEFL Compliant?	Relevant PCRs
Resource: Other	Mineral resource depletion potential	Mass of Fe equivalents in kg	Yes, aligns with existing indicators from ReCiPe and other sources.	NGA PCR for Flat Glass: UN CPC 3711
Other Emissions	Human health; ecotoxicity	various	Yes, aligns with existing indicators from TRACI, ReCiPe and other sources.	NGA PCR for Flat Glass: UN CPC 3711
Other Emissions	Ecotoxicity	kg	Yes, aligns with existing indicators from TRACI, ReCiPe, and other sources.	NGA PCR for Flat Glass: UN CPC 3711
Secondary Materials and Fuels	Renewable secondary fuels	MJ	No. Indicator methods cannot feasibly be applied to technosphere flows.	• PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Asphalt Mixtures • PCR for Gypsum Panel Products
Secondary Materials and Fuels	Non-renewable secondary fuels	MJ	No. Indicator methods cannot feasibly be applied to technosphere flows.	• PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Asphalt Mixtures • PCR for Gypsum Panel Products
Secondary Materials and Fuels	Secondary materials	kg	No. Indicator methods cannot feasibly be applied to technosphere flows.	• PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Asphalt Mixtures • PCR for Gypsum Panel Products
Secondary Materials and Fuels	Components for re-use	kg	No. Indicator methods cannot feasibly be applied to technosphere flows.	• PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Asphalt Mixtures
Secondary Materials and Fuels	Recovered energy	MJ	No. Indicator methods cannot feasibly be applied to technosphere flows.	• PCR for Asphalt Mixtures • PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Gypsum Panel Products
Secondary Materials and Fuels	Recovered energy exported from the product system	MJ	No. Indicator methods cannot feasibly be applied to technosphere flows.	• PCR for Building-Related Products and Services: Steel Construction Product EPD Requirements • PCR for Asphalt Mixtures

Appendix E: Secondary Data Diagram

Interagency Secondary Data Coordination

KEY: EPA Label Program Milestones | Interagency Secondary Data Work | Continual Support Efforts

Note: Quarters represent the calendar year; timeline is a rough approximation. For many tasks, there will be intermediate products not shown here. NREL activity is funded by DOE AMMTO.

Q2 2024	Q3 2024	Q4 2024	Q1 2025	Q2 2025	Q3 2025	Q4 2025	Q1 2026
	Release of Label Program Package: - Label Program Approach - Secondary Data Improvement Plan - Federal LCA Commons MOU - EPA's PCR Criteria - Data Gap Assessment - Data Quality Assessment (DQA) Method - LCIA Methods			Estimated Date for First Threshold			Effective Date for Free-to-Use and Publicly Accessible Data as Specified by EPA's PCR Criteria

Standardizing Data Quality

- Data Quality Assessment (DQA) Method; Agency: EPA
- DQA Method Application to be used in Secondary Data Development for FLCAC; Agency: EPA
- EPA Data Quality Assessment Approach for Petroleum; Agency: EPA
- Journal Article on Data Quality Assessment Method Applied to Petroleum Datasets; Agency: EPA
- LCIA and non-LCIA Indicator (not in Table 5: ISO 21930) Recommendations; Agency: EPA
- Method Development for non-LCIA Indicators Agency: EPA
- Public non-LCIA Document for EPD Generators Agency: EPA
- FLCAC Process-Level Data Quality Assessment Approach; Agency: NREL
- FLCAC Process-Level Data Quality Approach Applied to Existing FLCAC Data; Agency: NREL
- International Working Group Developing a Data Quality Assessment Approach for Primary Data in Natural Gas Space; Agency: DOE
- Methodology for Secondary Data Development to support LCA data development for EPDs; Agency: EPA
- Open Template LCA Models; Agency: EPA
- TRACI 3.0 LCIA Method; Agency: EPA

Improving Data Quality and Availability: Identifying Gaps

- Crosswalk of Data Requirements in PCRs with Available Publicly Accessible Data to Inform Data Gap Assessment; Agency: EPA
- Identification of Priority Industry Data Providers and Data Users (FLCAC/USLCI) to Engage based on Data Gap and Quality Assessment; Agency: NREL
- Pavement LCI Data Gap Assessment; Agency: FAA
- FLCAC Data Gap Assessment based on EEIO and Process LCI; Agency: NREL
- Final FLCAC Data Gap Report; Agency: NREL
- EPD/PCR LCI Data Gap Assessment and LCIA Results Comparison; Agency: NIST
- EPD/PCR LCI Data Gap Assessment for Non/Low Priority Construction Materials or Materials Outside of EPA Scope; Agency: NIST

Interagency Secondary Data Coordination

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	Release of Label Program Package: - Label Program Approach - Secondary Data Improvement Plan - Federal LCA Commons MOU - EPA's PCR Criteria - Data Gap Assessment - Data Quality Assessment (DQA) Method - LCIA Methods		Estimated Date for First Threshold				Effective Date for Free-to-Use and Publicly Accessible Data as Specified by EPA's PCR Criteria

Improving Data Quality and Availability: Addressing Gaps

- FLCAC Transport/Equipment Dataset Plan; Agency: NREL
- Design for Improved USLCI Data Submission Portal Tool; Agency: NREL
- FLCAC and USLCI Data Curator Data Development: Onroad (EPA MOVES) and Nonroad Transport and Equipment and other Datasets based on Gap Analysis; Agency: NREL
- ISO 21930 LCIA Method; Agency: EPA
- Final FLCAC Data Gap Report; Agency: NREL
- Alpha Version of USLCI Data Submission Portal Tool; Agency: NREL
- Beta Version of USLCI Data Submission Portal Tool; Agency: NREL
- Live Version of USLCI Data Submission Portal Tool; Agency: NREL
- Average Downstream (Use and Disposal) Datasets for Construction Materials; Agency: EPA
- GREET Transport, Fuel/Energy Processes, and Material Datasets for FLCAC; Agency: Argonne National Laboratory
- Electricity Baseline and Fossil-Fuel Supply Chains (Natural Gas, Petroleum); Agency: NETL
- FLCAC Pavement, Transport, and Equipment Datasets; Agency: FHWA, FAA and California
- Forestry and Forest Products Datasets; Agency: USDA Forest Service
- Continued Enhancements to USEEIO Model (Including Imports); Agency: EPA
- Embodied Carbon Sector Dashboard (w/ USEEIO); Agency: EPA
- RTU (Rooftop Unit) LCI Template; Agency: PNNL

LCIA Formatter LCIA Method and Federal Elementary Flow List Maintenance and Improvements (NREL); Data Curation Support for FLCAC Data Providers (NREL)

Improving and Updating FLCAC Data Management Processes

- FLCAC Interoperability/Issues Audit Agency: NREL
- Improved Interoperability for Current FLCAC Data and FLCAC GitHub Development; Agency: NREL
- FLCAC Data Curation Plan; Agency: NREL
- Improved FLCAC Flow Mapping Resources for Data Users of Commercial LCA Software Flow Lists; Agency: NREL
- FLCAC Collaboration Server Roadmap and Interoperability Feature Improvements (e.g., Releases, Libraries, Tags); Agency: USDA

FLCAC Collaboration Server and Website Maintenance and Improvements (USDA); Technical Assistance Resources for FLCAC Website and FLCAC Github Support (NREL)

Interagency Secondary Data Coordination

KEY: EPA Label Program Milestones | Interagency Secondary Data Work | Continual Support Efforts

Note: Quarters represent the calendar year; timeline is a rough approximation. For many tasks, there will be intermediate products not shown here. NREL activity is funded by DOE AMMTO.

Q2 2024	Q3 2024	Q4 2024	Q1 2025	Q2 2025	Q3 2025	Q4 2025	Q1 2026
	Release of Label Program Package: - Label Program Approach - Secondary Data Improvement Plan - Federal LCA Commons MOU - EPA's PCR Criteria - Data Gap Assessment - Data Quality Assessment (DQA) Method - LCIA Methods		Estimated Date for First Threshold				Effective Date for Free-to-Use and Publicly Accessible Data as Specified by EPA's PCR Criteria

Engaging and Training Stakeholders

- FLCAC Stakeholder Engagement Plan; Agency: NREL
- Establish Mix of Industry and Federal Stakeholder to Beta Test LCI Data Submission Tool and Complete Testing; Agency: NREL
- Enhanced USLCI Data Submission Support for Industries Identified by Gap Assessment; Agency: NREL
- Public Webinar on USLCI and FLCAC Data Curation Update; Agency: NREL
- Public Webinar on USLCI Data Submission Tool; Agency: NREL
- EPA Webpage of Secondary Data Resources; Agency: EPA
- Engage PCR Committees to Identify Secondary LCI Data Gaps; Agency: EPA
- Secondary Data Review and Data Quality Assessment Support for PCR Committees; Agency: EPA
- ACLCA Conference Special Sessions and Workshop on Public Data; Agency: NREL/EPA/USDA/NIST
- ACLCA Conference Workshop on Public Secondary Data Updates Agency: NREL
- openLCA and FLCAC Data Submission Trainings for Industry/Public (NREL)
- Federal Engagement on PCR Committees; Review of PCRs against EPA's PCR Criteria (EPA)

Appendix F: Terminology

Definitions of General Terms

Environmental product declaration (EPD): An environmental claim providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information. An EPD also includes additional product and company information.

Life cycle assessment (LCA): The compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.

Life cycle impact assessment (LCIA): The phase of LCA aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle.

Life cycle inventory (LCI): The phase of life cycle assessment involving the compilation and qualification of inputs and outputs for a product throughout its life cycle.

Product category rule committee (PCR committee): Group of interested parties tasked by the program operator with drafting and finalizing the product category rules.

Definitions and Descriptions of Secondary Data and Related Terms

Background data: Data contained within the process(es) supporting the foreground system. Background data constitute the "background system" in a product system.

Foreground data: Data contained within the process(es) a manufacturer is modeling for its product system. This term should be used, for example, when describing processes associated with the production of the material the manufacturer is producing. This term is defined in EPA's Life Cycle Assessment Principles and Practices Glossary as "data from the foreground system that is the system of primary concern to the analyst." Foreground data constitute the "foreground system" in a product system.

Product system: The collection of all activities in an LCA model. The product system is composed of the "foreground system" and "background system." What is understood to be the foreground system and background system is dependent on the focus of the LCA study. This definition is adopted from ISO 14040:2006, which defines a product system as a "collection of unit processes with elementary and product flows, performing one or more defined functions, and which models the life cycle of a product." In the context of EPDs of construction products, product systems may consist of every part of the product system, including production, finishing, packaging, wholesaling/retailing/warehousing, delivery, installation, use and final disposal of the construction material of interest.

Primary data: Data determined by direct measurement, estimation or calculation based on specific original source measurements for the system under investigation. This definition is derived from ISO 21930:2017. This term should be used when referencing specific emissions (or other flow) facility data for the foreground system.

Secondary data: Data indirectly determined through measurement, estimation or calculation and not based on specific original source measurements. This can include data that is originally developed using primary data sources but is further aggregated to represent average processes or products. This definition is derived from ISO 21930:2017. Secondary data is useful because it can be used across many LCAs. For instance, secondary data used to represent electricity in the manufacturing of one

product might also be used to represent electricity in the manufacturing of a different product, after being customized and scaled to fit the appropriate characteristics and quantity of electricity used for that other product.