CARBON LEADERSHIP FORUM

PRODUCT CATEGORY RULES (PCR) FOR
ISO 14025 TYPE III ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs) of
CONCRETE

ASTM C 94

UNSPSC code 30111500

EPDs created by this PCR are appropriate to be used to evaluate the
environmental impact of ready mixed concrete used in creation of products such
as:

03 03X XX Cast in Place Concrete
03 4X XX Precast Concrete
03 70 00 Mass Concrete
04 22 00 Masonry

Draft for Committee Review
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additional support from Arup and Degenkolb.
PCR Harmonization Notes

PCR DEVELOPMENT AND RESPONSES TO FIRST ROUND OF PUBLIC COMMENTS

This PCR began development in May of 2011 initiated by the Carbon Leadership Forum (CLF) at the University of Washington in response to a request by CLF sponsors. The first draft for stakeholder comments was published on Feb 14, 2012. Over 200 comments were received, and integrated into this revised version. A summary of comments and the CLF responses has been posted on the CLF website (www.carbonleadershipforum.org). The majority of the comments were related to the requirements for reporting variability based on this PCR and the default carbon footprint values. Variability requirements have been simplified for this draft of the PCR. The default valued provided within this PCR have been updated to better reflect current best data on industry average data for cement. Concrete suppliers without good quality upstream data can use the provided default data for use in developing product carbon footprints. The CLF will replace these numbers as better industry average and variability data is developed by industry and shared with the CLF research team.

CSI ‘GLOBAL’ PCR FOR CONCRETE

After the CLF PCR development was well underway, the Cement Sustainability Initiative (CSI) and the World Business Council for Sustainable Development (WBCSD) initiated the development of a ‘global’ PCR for Concrete. The CLF leadership has been in conversation with the CSI research team since late 2011 via email and conference calls. Through these conversations, regional process and government policy differences were confirmed and the need to develop regionally specific PCRs/EPDs was recognized. As the PCR is developed over future iterations, the CLF will continue to work toward the potential of a global PCR with options for regional variation.

Compared to the current draft CSI/WBCSD PCR dated 24 Feb, 2012 the following differences are noted:

1. The CLF product category is defined as ‘concrete’ rather than ‘unreinforced concrete’.
2. The CSI PCR provides guidance on reporting construction stage impacts - the CLF committee does not feel the methods are sufficiently developed at this time to include reporting in the EPD.
3. The CSI PCR provides guidance on additional declared units used in unreinforced concrete products. The CLF PCR only identifies cubic yards of concrete. (CSI uses 1 cubic meter).
4. The CSI PCR has more complex requirements for allocation of impacts from supplementary cementitious materials generally considered as waste in the US. The CLF PCR recognizes US EPA designations of waste products. See CLF PCR section 3.7. EU LCA legislation requires other allocation methods not appropriate in US context.
5. The CSI PCR has an explicit treatment of biogenic carbon (sequestered carbon) that differs from the CLF. CLF requires reporting of all emissions from bio-fuels products without considering carbon uptake through growth.
6. The CSI PCR has more prescriptive requirements for reporting water use. The CLF PCR recognizes limitations in current practice of reporting water footprints for upstream materials and has focused on reporting the ‘scope 1’ water use in mixing concrete and plant operations.
7. The CSI PCR outlines a comprehensive reporting of impacts and resource use. The CLF PCR provides a stepped approach aimed to encourage adoption of PCR by providing options for both ‘climate declarations’ and EPDs of increasing comprehensiveness.
8. The CSI PCR requires the reporting of different environmental impact categories and uses different characterization factors. The CLF PCR uses EPA Traci methodology.
The CLF PCR requires the following additional items not included in the CSI PCR:

1. The EPD shall report slump as a performance characteristic.
2. The EPD shall report environmental impacts using TRACI methodology (CML Optional).
3. The PCR provides additional clarification about how to model transportation impacts.
4. The PCR provides additional clarification on quantification of stage A3: plant operations.
5. The PCR provides additional clarification on assumptions regarding production waste and washing of vehicles.
6. The EPD reports water use in washing vehicles in stage A3. This water use is reported in stage A4 in the CSI EPD.

INTERNATIONAL EPD PCR FOR CEMENT

A PCR for cement exists (through International EPD System, PCR 2010:09 Version 1.0). Of note, the International EPD PCR includes the following statements:

‘All energy consumption is considered for all process phases, both thermal and electrical for all types of use (production and services). -And-All alternative fuels (recycled waste) must be counted.’ And:

‘Direct emissions of carbon dioxide resulting from decarbonation and combustion in pyroprocessing phase (clinker production) are recommended to be counted in compliance with “CO2 Emissions Monitoring and Reporting Protocol for Cement Industry”, prepared in March 2005 by Working Group Cement of World Business Council for Sustainable Development.’

EPDs produced to the International EPD PCR would be considered be compatible with this PCR with the following additional clarifications:

1. If a manufacturer produces an EPD for multiple facilities, a weighted average based on volume of production shall be used to represent actual conditions;
2. The variability of the data must be published to match the requirements outlined in the CLF PCR;
3. Transportation backhaul shall be considered;
4. Alternative fuels shall be allocated per this PCR.

PCA PCR FOR CEMENT

Additionally, the Portland Cement Association (PCA) initiated the development of a US PCR for cement in early 2012. The PCA should ensure that the developing US PCR builds upon the established International EPD PCR for cement and clearly identify why an additional PCR is required and what deviations exist (if any) between the LCA methodologies presented. Comparing the draft PCA PCR dated July 15, 2012 to the CLF PCR, the following differences are noted:

1. Reporting of industry averages and variability are not currently aligned.
2. The PCA PCR does not provide default values. The CLF PCR provides default values for both averages and ranges. If the PCA provides data to support industry averages and ranges, the CLF will update the defaults shown in Appendix B.
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Example EPD
1. Introduction

This product category rule (PCR) covers the product 'Concrete' and enables the quantification and reporting of the environmental impacts associated with the production of concrete.

This information can be used as a modular component to develop Life Cycle Assessments (LCAs) of products that use concrete including, but not limited to, cast in place concrete, precast concrete, concrete masonry units and concrete pavements, provided the life cycle impacts of all additional materials and processes are accounted for.

This PCR provides reporting criteria for developing an EPD in varying levels of detail:

- Product Carbon Footprint/Single Attribute EPD/Climate Declaration
- ISO Compliant Type III EPD

  *Additional guidelines provided in Appendix B*

- Report a comprehensive spectrum of environmental impacts in compliance with ISO 14025 (ISO, 2006a) and the CEN 15804 'Core Rules for the product category of construction products' (CEN 2011). This PCR outlines both required and optional impact categories that may be included.

A general summary of the materials and processes covered by this PCR is summarized in table 1.0. Additional detailed information regarding the system boundary and processes to include is found in sections 3 and 4 of this PCR.
1.1. Goal

The goal of this PCR (defined as ‘business goals’ by WRI/WBCSD) is to encourage concrete producers to quantify, report, better understand and reduce the environmental impacts of concrete production and to enable the creation of mix specific EPDs. The rules are designed to provide meaningful and applicable standards to enable concrete producers and specifiers to:

A. Quantify the environmental impacts of specific concrete mix designs;
B. Encourage the reporting of supply chain specific EPDs for upstream constituent materials;
C. Enable concrete producers to track and reduce the environmental impact of their operations and products;
D. Enable environmental impacts to be used as additional performance metrics for concrete; and

1.2. PCR Development
This PCR was developed over the period of May 2011 through January 2012 with a committee identified in Appendix A. This PCR was published for stakeholder review and comment in February 2012 for a 45 day period and subsequently revised in July of 2012. The updated PCR draft will be available for public comment in August of 2012.

See description of harmonization process and status on the first page of this PCR.

1.3. Period of Validity

This PCR is valid for 5 years from its initial adoption and may be updated earlier if new standards, data, processes, materials or analysis methods are developed.

1.4. Background LCI/PCR

The PCR development was based on the LCI of concrete prepared for the Portland Cement Association by CTLGroup (Marceau, 2007) along with other published LCI reports (CSI, 2006, Marceau, 2010, Flower & Sanjayan, 2007)

This PCR expands upon an out of date PCR for Concrete developed through the (Swedish based) International EPD program: PCR 2005:7. In addition to providing more detail than the existing PCR, this document modifies/clarifies the following conditions:

A. Terminology is consistent with North American practices, standards and specifications;

B. Allocation rules for waste materials and waste- and bio-based fuels are clarified;

C. Acceptable data sources and methodology are clarified; and

D. Impact assessment methodology is clarified and expanded.

E. Conform with the European Standard CEN 15804 Product Category Rules: Core rules for product category of construction product. (CEN, 2011a)

F. Clarification on how to report variability

1.5. Definitions & Abbreviations

allocation: Partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems. (ISO 14044)

ancillary input: Material input that is used by the unit process producing the product, but does not constitute part of the product. (ISO 14044)

average data: Data that represents an average (weighted by percent of production) of a product, material or process that is provided by more than one supplier or representing a range of products provided by one supplier.

carbon footprint: Shorthand for a measure of the climate change impact (global warming potential) reported as CO2eq or carbon dioxide equivalents calculated by using established global warming potential characterization factors.

characterization factor: Factor derived from a characterization model which is applied to convert an assigned life cycle inventory analysis result to the common unit of the category
indicator. NOTE: The common unit allows calculation of the category indicator result. (ISO 14044)

categorical assertion: Environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function. (ISO 14044)

cradle to gate: The partial life cycle assessment of a product from extraction of resources (“cradle”) to the gate (see below). Transportation to end user, nor use and end of life impacts are not considered.

declared unit: Quantity of a building product for use as a reference unit in an environmental product declaration (EPD) based on life cycle assessment (LCA), for the expression of environmental information needed in information modules. NOTE: The declared unit is used where the function and the reference scenario for the whole life cycle, on the building level, cannot be stated. (ISO 21930) A declared unit does not necessarily represent all performance criteria of a material or product nor does the EPD based on a declared unit represent impacts from all life cycle phase.

environmental product declaration (EPD): Claim which indicates the environmental aspects of a product or service. NOTE: An environmental label or declaration may take the form of a statement, symbol or graphic on a product or package label, in product literature, in technical bulletins, in advertising or in publicity, amongst other things. (ISO 14020)
gate: Point at which the building product or material leaves the factory before it becomes an input into another manufacturing process or before it goes to the distributor, a factory or building site. (ISO 21930)

impact category: Class representing environmental issues of concern to which life cycle inventory analysis results may be assigned. (ISO 14040)

information module: Compilation of data to be used as a basis for a type III environmental declaration, covering a unit process or combination of unit processes that are part of the life cycle of a product. (ISO 21930)

input: Product, material or energy flow that enters a unit process. (ISO 14040)

life-cycle assessment (LCA): Compilation and evaluation of the inputs, outputs and potential environmental impacts of a product systems throughout its life cycle. (ISO 14040)

life cycle impact assessment (LCIA): Phase of the life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product. (ISO 14040)

life cycle inventory analysis (LCI): Phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle. (ISO 14040)

product category: Group of products that can fulfill equivalent functions. (ISO 14025)

product category rules (PCRs): Set of specific rules, requirements and guidelines for developing Type III environmental declarations for one or more product categories. (ISO 14025)

program operator: Body or bodies that conduct a Type III environmental declaration program. (ISO 14025)

renewable energy: Energy generated from renewable non-fossil sources.
system boundary: Set of criteria specifying which unit processes are part of a product system. NOTE: The term "system boundary" is not used in this International Standard in relation to LCIA. (ISO 14040)

third party: Person or body that is recognized as being independent of the parties involved, as concerns the issues in question. NOTE: “Parties involved” are usually supplier (“first party”) and purchaser (“second party”) interests. (ISO 14025)

type III environmental declaration: Environmental declaration providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information. NOTE 1: The predetermined parameters are based on the ISO 14040 series of standards, which is made up of ISO 14040 and ISO 14044. NOTE 2: The additional environmental information may be quantitative or qualitative. (ISO 14025)

upstream processes:

waste: substances or objects which the holder intends or is required to dispose of. (ISO 21930)

Definitions
Definitions are per ISO 14040:2006, 14025: 2006,

Abbreviations
PCR Product Category Rule
LCA Life Cycle Assessment
LCI Life Cycle Inventory
LCIA Life Cycle Impact Assessment
EPD Environmental Product Declaration
SCM Supplementary Cementious Material
eq Equivalent

1.6. Relevant Standards

NEED TO INSERT LIST OF RELEVANT STANDARDS

1.1. Ownership/responsibility/liability of EPD

The concrete producer or a group of concrete producers who develop an EPD following this PCR maintain sole ownership and have responsibility and liability for their EPD.

1.2. Conversion Factors

CONCRETE PCR:
DRAFT 08/15/12
2. Definition of the Product

This PCR defines the rules for the product “concrete.” EPDs created with this PCR can be used to compare between mixes used in products such as, both cast in place, precast concrete and concrete masonry units provided the functional requirements of the mix are also equivalent and the additional requirements of section 2.3 are met.

2.1. Product Description & Declared Unit

See the following standards for definitions/characterizations of concrete:

- ASTM C 94
- UNSPSC code 30111500

The declared unit shall be defined as 1 yd³ of concrete. Although output shall be presented in SI units they all shall be per the declared unit of one cubic yard and can optionally present the additional information of impacts per cubic meter of concrete.

The EPD shall include the following descriptions of the product:

A. Specified compressive strength at specified age in days. (e.g. 3,000psi at 28 days (20MPA) or 4,000psi (60MPA) at 90 days);

B. Specified environmental exposure class (per ACI 318 or other specified or accepted standard); and

C. Specified slump or slump flow; and optionally

D. Any other specified characteristics that affect concrete performance (e.g. air entrainment or early strength requirements).

2.2. Life Cycle Stages: Modularity

This PCR is developed to capture the product stages A1-A3 (cradle to gate) and optionally A4 (gate to site) as defined in EN15804 (see Fig. 2.1 below) (CEN, 2011a) and thus provides information appropriate for use as a module in preparing a full cradle-to-grave life cycle assessment. EPDs based on this PCR are appropriate for use in business-to-business applications. Impacts from construction related activities such as formwork, curing or reinforcement are not captured within this PCR. Processes that sequester carbon in the curing process are also not captured within this PCR. These impacts are among the others that should be considered when creating comprehensive LCAs to compare concrete products or systems.
Data from stages A1, A2 & A3 may be declared as one aggregated module A1-3 or separated into three separate modules.

2.3. Use and Comparability

The application of this PCR can enable the comparison of the environmental impacts of different concrete mix designs. In order for the resulting data to be used to compare between manufacturers and/or to achieve product labeling or rating, the EPDs must be developed in accordance with this PCR.

As EPDs as covered by this PCR only cover the cradle to gate impacts of concrete, the results cannot be used to compare construction products (e.g. precast or site cast concrete) unless the following considerations are met:

1. The functional requirements are equivalent (e.g. code, clients requirements);
2. The performance characteristics are equivalent (e.g. mix specifications, strength, deflection, service life)
3. All materials and processes used in construction are included (e.g. reinforcement, formwork, curing agents);
4. The LCA system boundaries are equivalent; and
5. The impacts of the systems on operational impacts are accounted for.

3. Life Cycle Inventory

The scope included in EPDs developed in accordance with this PCR shall conform to the following system boundary assumptions and identify impacts and report data quality and variability as noted.

3.1. System Boundaries (core and upstream processes)

The PCR system boundaries follow the two principles below (as outlined in section 6.3.4.1 of CEN 15904:2011):

Fig. 2.1 Diagram of designations of modular information used for different stages of building assessment.
Figure 6 from CEN 15978:2011
A. The "modularity principle": Where processes influence the product’s environmental performance during its life cycle, they shall be assigned to the module of the life cycle where they occur; all environmental aspects and impacts are declared in the life cycle stage where they occur.

B. The "polluter pays principle": Process of waste processing shall be assigned to the product system that generates the waste until the end-of-waste state is reached.

### 3.1.1. System Boundaries General Requirements

A summary of the items to be included in EPDs developed from this PCR are as follows:

**A1 Raw Material Supply (upstream processes):** Extraction, handling and processing of the materials used in production of concrete.

**A2 Transportation:** Transportation of these materials from supplier to the ’gate’ of the concrete producer.

**A3 Manufacturing (core processes):** The core processes result from the energy used to store, batch, mix and distribute the concrete and operate the facility (ready mix concrete plant)

**A4 Construction Transportation (optional):** Transport of the concrete from the producer’s 'gate' to the construction site.

**Excluded from System Boundary:** A summary of items that can be excluded in the primary product stages include:

A. Production, manufacture and construction of buildings’ capital goods and infrastructure with an expected lifespan of over 5 years.

B. Production and manufacture of concrete production equipment, concrete delivery vehicles, earthmoving equipment, and laboratory equipment with expected lifespan of over 5 years.

C. Personnel-related activities (travel, furniture, office supplies).

D. Energy use related to company management and sales activities which may be located either within the factory site or at another location may be excluded.

### 3.1.2. Product Stage A1: Raw Material Supply (upstream processes)

The following items must be included in the system boundaries of the A1 life cycle phase:

1. Extraction and processing of raw materials (e.g. mining processes) and biomass production (e.g. agricultural and/or forestry operations);

2. Extraction and processing of primary fuels used as input for manufacturing the product;

3. Processing of any waste, recovered or recycled materials as required for use as secondary materials (e.g. re-processing, handling and sorting);

4. Generation of any electricity, steam or heat used in the product manufacturing processes;

5. Energy recovery from secondary and/or waste fuels that are used as input for manufacturing, not including the impacts related to the creation of the previous product and waste prior to the product being declared a waste. See section 3.7A.

6. Waste disposal directly related to the manufacturing process; and

7. Any transportation required from the upstream supply chain.
In addition to items outlined the above, the following criteria apply to the typical upstream processes of material production of concrete:

<table>
<thead>
<tr>
<th>Material</th>
<th>Declared Unit</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
</table>
| Aggregate    | Pounds        | Density, size, ASTM specification (C33 normal weight or C330 light weight), site location, type (natural or crushed) | • See water appendix-better data is needed.  
• Site annual emissions to be allocated by mass to product class.  
• Include impacts from consumable equipment used in production.  
• Recycled aggregate must include impacts related to transportation and processing after primary demolition of source aggregate is completed. |
| Cement       | Pounds        |                                                                             | • Identify and use data for actual plant production type (wet, dry etc.)  
• Include emissions from chemical reactions per WBCSD guidelines (REF)                                                             |
| Fly Ash      | Pounds        | ASTM C618                                                                   | • See section 3.7  
• Any process energy/impacts required to make appropriate for use as SCM.  
• Include transport from waste site  
• Include drying energy.                                                                               |
| GGBFS        | Pounds        | ASTM 989                                                                    | • See section 3.7  
• Include transport from waste site.  
• Include grinding and drying energy.  
• Any other process energy/impacts required to transform to SCM.                                                                 |
| Silica Fume  | Pounds        |                                                                             | • See section 3.7  
• Include transport from waste site.  
• Include drying energy.  
• Any other process energy/impacts required to transform to SCM.                                                                 |
| Other SCM    | Pounds        |                                                                             | • Justify status of source material per section 3.7.  
• If non waste source include all upstream energy and material flows.  
• Any process energy/impacts required to make appropriate for use as SCM.                                                                 |


### 3.1.3. Product Stage A2: Transportation

The following items must be included in the system boundaries of the A2 life cycle phase:

1. The actual distance and mode traveled and emission factors for transportation.
2. The transportation of all materials from origin of extraction or upstream production to site.
3. The transportation to interim distribution centers. If multiple suppliers are used, a weighted average based on volume or mass can be used.
4. The backhaul of trucks assuming empty return unless documented otherwise.

### 3.1.4. Product Stage A3: Manufacturing (core processes)

The following items must be included in the system boundaries of the A3 life cycle phase:

1. Plant operating energy consumption:
   - Report impacts per average cubic yard produced on an annual basis. This includes heating and lighting for manufacturing facility and management office support.
2. Fuel Consumption:
   - Report impacts from fuel purchased per average cubic yard on annual basis.
3. Factor to account for material losses and overproduction.
   - Assume 5% losses unless supplier tracks and reports losses on an average annual basis (Loss = Volume returned or disposed of divided by total volume produced at plant).
4. Impacts from disposal of wastes and final residues including packaging not leaving the factory gate.
   - Report impacts per average cubic yard on an annual basis.
5. Washing of vehicles and equipment

### 3.1.5. Product Stage A4: Transportation to Site

1. The transportation shall account for the fuel and truck type.
2. The in-use average miles per gallon (liters per kilometer) of gasoline/diesel or miles per ft³ (kilometers per m³) for natural gas for trucks shall be used.
3. The total annual distance traveled for each type of truck shall be used.
4. The average impact per cubic yard (cubic meter) shall be estimated by dividing the total impact of transportation fuel used by the total cubic yards (cubic meters) of concrete produced per year.
5. Alternatively, the EPD can declare typical emission factors for each ton-mile (tkm) to enable the user to develop project specific data.

### 3.2. Impact categories
For each of EPD level the following impact categories, derived from life cycle stages identified in the EPD, shall be separated and reported. Use the characterization factor(s) noted. Note that for the impact categories, EPDs using this PCR can optionally report the impacts calculated using CML factors in addition to the TRACI factors noted.
**1 LIFE CYCLE ASSESSMENT DATA TO BE INCLUDED IN EPD**

**2 Product Carbon Footprint/Single Attribute EPD/Climate Declaration (Type A)**

**Impact Category Indicators**

<table>
<thead>
<tr>
<th>Impact Category Indicators</th>
<th>kg CO₂ eq</th>
<th>TRACI (CML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Change/Carbon Footprint'</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**3 See Appendix B for detailed information on calculating and reporting GWP to be in conformance with WRI/WBCSD Product Carbon Footprint Standards.**

**4 Note: any inventory items or impact categories from the Type B or Optional additional information listed below may be included in a Type A EPD at the manufacturers discretion.**

**5 ISO Compliant Type III EPD (Type B)**

**Life Cycle Inventory Data**

<table>
<thead>
<tr>
<th>Total primary energy consumption</th>
<th>BTU (MJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-mass/bio-fuel consumption (if any)</td>
<td>BTU (MJ)</td>
</tr>
<tr>
<td>Water Use (batch)</td>
<td>lb (kg)</td>
</tr>
<tr>
<td>Water Use (wash)</td>
<td>lb (kg)</td>
</tr>
<tr>
<td>Total waste disposed</td>
<td>lb (kg)</td>
</tr>
</tbody>
</table>

**Impact Category Indicators**

<table>
<thead>
<tr>
<th>Impact Category Indicators</th>
<th>kg CO₂ eq</th>
<th>TRACI (CML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Change/Carbon Footprint'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ozone Depletion</td>
<td>kg CFC 11 eq</td>
<td>TRACI (CML)</td>
</tr>
<tr>
<td>Acidification Air</td>
<td>kg SO₂ eq</td>
<td>TRACI</td>
</tr>
<tr>
<td>Eutrophication Air</td>
<td>kg N eq (kgPO4)</td>
<td>TRACI (CML)</td>
</tr>
<tr>
<td>Eutrophication Water</td>
<td>Kg N eq</td>
<td>TRACI</td>
</tr>
<tr>
<td>Photochemical ozone creation/smog</td>
<td>Kg O₃ eq</td>
<td>TRACI</td>
</tr>
</tbody>
</table>

**8 OPTIONAL ADDITIONAL INFORMATION**

**Inventory Items**

<table>
<thead>
<tr>
<th>Energy from waste recovery</th>
<th>BTU (MJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-renewable energy consumption</td>
<td>BTU (MJ)</td>
</tr>
<tr>
<td>Renewable energy consumption</td>
<td>BTU (MJ)</td>
</tr>
<tr>
<td>Bio-mass energy consumption</td>
<td>BTU (MJ)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content Declaration/Chemicals of Concern</th>
<th>list</th>
<th>Appendix D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous waste disposed</td>
<td>lb (kg)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sequestered Carbon</th>
<th>Kg CO₂ eq</th>
<th>Document methodology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate matter emissions</td>
<td>KgPM10eq</td>
<td></td>
</tr>
</tbody>
</table>

**Impact Category Indicators**

<table>
<thead>
<tr>
<th>Break out impacts from waste recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Health CF Non-Cancer</td>
</tr>
<tr>
<td>Human Health CF Cancer</td>
</tr>
</tbody>
</table>
### 3.3. Criteria for the exclusion of inputs and outputs

The cut-off criteria for flows to be considered within each system boundary shall conform with CEN 15804:2011section 6.3.5 summarized as follows:

A. All inputs and outputs, for which data are available shall be included in the calculation;

B. The cut-off criteria shall be 1% for energy and mass and the total of neglected input flows shall be a maximum of 5% of energy or mass.

C. Particular care should be taken with flows known to cause significant impact or data uncertainty including: cement production and chemical admixtures. Provide documentation in LCA report to justify all neglected input flows.

### 3.4. Selection of Data

Data should be selected per CEN 15904:2011 summarized and expanded as follows:

4. An EPD describing an average product shall be calculated using representative average data of all the products declared in the EPD.

5. Data shall use the highest quality and most representative data available. Data sources shall be identified within the LCA and reviewed by the EPD verifier. The concrete producer shall request primary data in the form of a product EPD from all of its suppliers. Only after confirmation that no EPD exists or is forthcoming may the default values given in Appendix B or generic data be utilized.

6. Choice of data shall be prioritized as follows and data selections justified in the LCA report.

   a. Plant specific EPD results.
   b. Company weighted average EPD results.
   c. Regional weighted average EPD results.
   d. ISO compliant and reviewed LCI for used supplier.
   e. CO2e: Use defaults noted in Appendix B
   f. Life Cycle Inventory of Portland Cement Concrete, Marceau et al., 2007. This is only applicable to U.S. manufactured concrete and should not be used for imported materials.
   g. The following default sources:

<table>
<thead>
<tr>
<th>Category</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td>US Life Cycle Inventory Database (NREL) and US Environmental Protection Agency (EPA 2003)</td>
</tr>
<tr>
<td>Electricity</td>
<td>US EPA Emissions &amp; Generation Resource Integrated Database (eGRID) North American Electric Reliability Council (NERC) regions as the source for energy data.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Emissions</td>
<td>US LCI Database with ‘dummies’ substituted with appropriate proxies from other LCI databases. Justify</td>
</tr>
<tr>
<td>Site Generated Energy</td>
<td>assumptions in LCA report.</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>US LCI Database with ‘dummies’ substituted with appropriate proxies from other LCI databases. Justify assumptions in LCA report.</td>
<td></td>
</tr>
<tr>
<td>h. US LCI Database (NREL)</td>
<td></td>
</tr>
<tr>
<td>i. Other LCI sources—must match technology and energy source mix</td>
<td></td>
</tr>
</tbody>
</table>

### 3.5. Data Quality

Data collection for upstream constituent materials as well as specific data shall follow the guidance provided in ISO 14044:2006, 4.3.2 and CEN 15804:2011. Data shall be as current as possible. Data used in calculations shall have been updated within the last 10 years for industry average data and within the last 5 years for site-specific data;

A. Data sets shall be based on 1 year averaged data; deviations shall be justified;
B. The technology shall reflect the physical reality of the material and/or product;
C. Industry average data shall be checked for plausibility by the verifier; and
D. Data sets shall be complete according to the criteria of inclusion of inputs and outputs of this PCR.

### 3.6. Data Variability

LCAs can contain two main types of data variability: 1. variability within the underlying LCI data (e.g., variability in actual emissions from coal fired power plants); and 2. variability known due to process and material differences (e.g. different manufacturing plants, crushed vs natural aggregate, different transportation distances). Although both types of variability are important, at this time the methods and data to permit reporting of the first type of variability are not adequately developed to be reasonably included. However, the second type of variability can be computed and should be reported. Additional requirements of this PCR include:

A. An EPD describing an average mix design or industry average shall report a weighted average based on volume of production that represents the technology, transportation modes and distances process, and energy sources used.
B. The range (10th and 90th percentile) of the ‘carbon footprint’ shall be published as a line item in the EPD report.
C. If industry average data is used for upstream constituent materials, variability of the underlying data should be included. If no published data is available, use default assumptions in data variability for material carbon footprints outlined in Appendix B.
D. Primary data shall be used for all processes over which the producer has direct influence (plant energy use, water use, fuel use etc.).

### 3.7. Allocation Assumptions

The procedures outlined in CEN 15804 for co-product allocation apply with the following clarifications:

A. Emissions from waste incineration (e.g. tires) shall be included in the EPD. Emissions from upstream production may be omitted (allocated to primary use) however transportation of waste from end-of-life state to production facility must be included.
B. Emissions from bio-fuels can be considered as net-zero ‘carbon’/climate change impact provided that the bio-fuels are waste-product biomass as certified by the Green-e Climate Protocol for Renewable Energy (CRC, 2010) under section 3 additionality tests for solid or liquid biomass page 3 item 5) which outlines a list of eligible fuels as: Woody waste, agricultural crops or waste; and animal and other organic waste.

C. Impacts from transportation and transformation of the wastes to useable fuel shall be included.

D. Emissions from the generation of coal power and production of steel or ferro-silica metal production need not be allocated to the waste products used as source materials when producing supplementary cementitious materials (SCMs). All processing and transportation required to transform these waste products to SCMs must be included.

4. NO LONGER USED

5. Reporting: Content of the EPD

The following general items shall be declared in the EPD (per CEN 15804:2011):

1. The name and address of the manufacturer(s);
2. The description of the construction product’s use and the declared unit of the construction product to which the data relates;
3. Construction product identification by name (including UNSPSC product code and CSI Specification Section) and ideally a simple visual representation to which the data relates;
4. Name of the EPD program used and the program operators name and address and, if relevant, logo and website;
5. The following table shall be completed and reproduced in the EPD:

<table>
<thead>
<tr>
<th>The Carbon Leadership Forum PCR dated X/X/XXXX serves as the PCR for this EPD</th>
<th><a href="http://www.carbonleadershipforum.org">www.carbonleadershipforum.org</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent verification of the declaration, according to ISO 14025:2006</td>
<td>☐ internal ☐ external</td>
</tr>
<tr>
<td>Independent Verifier</td>
<td>&lt;Name and Organization of the Independent verifier&gt;</td>
</tr>
</tbody>
</table>

6. The date the declaration was issued and the 5 year period of validity;
7. Information on which life cycle stages are not considered in the EPD;
8. In the case where an EPD is declared as an average environmental performance for a number of products, a statement to that effect shall be included in the declaration together with a description of the range (10th and 9th percentile) and variability (standard deviation and/or coefficient of variation).
9. A statement regarding data quality and variability: Options include one of the following:.
   a. This EPD was created using industry average data for upstream materials. Variation can result from differences in supplier locations, manufacturing processes, manufacturing efficiency and fuel type used. Climate change impacts could range between XXCO2e and YYCO2e per cubic yard. (insert actual range predicted per appendix B) Other environmental impact values will have a different range.
b. This EPD was created using plant specific data for upstream materials. Potential variations due to supplier locations, manufacturing processes and efficiencies and fuel use are thus accounted for in this EPD.

10. A statement that: ‘EPDs of concrete mixes may not be comparable if they do not comply with this standard and data from this EPD shall not be used to compare between construction products unless integrated into a comprehensive whole building LCA’;

11. In the case where an EPD is declared as an average environmental performance for a number of products, a statement to that effect shall be included in the declaration together with a description of the range/variability of the LCA results;

12. The site(s), manufacturer or group of manufacturers or those representing them for whom the EPD is representative;

13. Other information relating to environmental performance such as third party certifications or labels awarded to the manufacturer or product.

NOTE: See appendix F for an example EPD format/content.

6. Project Report

6.1. General

The project report is the systematic and comprehensive summary of the project documentation supporting the verification of an EPD. The project report shall record that the LCA-based information and the additional information as declared in the EPD meet CEN 15804. It shall be made available to the verifier with the requirements on confidentiality stated in ISO 14025.

The project report is not part of the public communication.

The project report should contain any data and information of importance for the data published in the EPD and as required in CEN 15804. Special care is necessary to demonstrate in a transparent way how the data and information declared in the EPD results from the LCA study.

NOTE In this context ‘project’ means the LCA study on the declared product.

6.2. LCA-related elements of the project report

The results, data, methods, assumptions, limitations and conclusions of the LCA shall be completely and accurately reported without bias. They shall be transparent and presented in sufficient detail to allow independent verification and to permit an understanding of the complexities and trade-offs inherent in the LCA. The report should also allow the results and interpretation to be used in support of the data and additional information made available in the respective EPD.

The project report shall give the following, (taken directly from CEN 15804):

A. General aspects:

1. commissioner of the LCA study, internal or external practitioner of the LCA study;
2. date of report;
3. statement that the study has been conducted according to the requirements of this PCR;

E. Goal of the study:
1. reasons for carrying out the study and its intended application and audience, i.e. providing information and data for an EPD for business-to-business and/or business-to-consumer communication;

F. Scope of the study:

1. declared/functional unit, including:
   ii. definition, including relevant technical specification(s);
   iii. calculation rule for averaging data e.g. when the declared/functional unit is defined for:
       1. a group of similar products produced by different suppliers or
       2. the same product produced at different production sites;
   iii. omissions of life cycle stages, processes or data needs;
   iv. quantification of energy and material inputs and outputs, taking into account how plant-level data is allocated to the declared products; and
   v. assumptions about electricity production and other relevant background data;

3. system boundary according to the modular approach as outlined in Figure 2.1, including:
   iii. omissions of life cycle stages, processes or data needs;
   iv. quantification of energy and material inputs and outputs, taking into account how plant-level data is allocated to the declared products; and
   v. assumptions about electricity production and other relevant background data;

4. cut-off criteria for initial inclusion of inputs and outputs, including:
   iv. description of the application of cut-off criteria and assumptions;
   v. list of excluded processes;

G. Life cycle inventory analysis:

3. qualitative/quantitative description of unit processes necessary to model the life cycle stages of the declared unit, taking into account the provisions of EN ISO 14025 regarding data confidentiality;

4. sources of generic data or literature used to conduct the LCA;

5. validation of data, including:
   iv. data quality assessment; and
   v. treatment of missing data;

6. allocation principles and procedures, including:
   iii. documentation and justification of allocation procedures; and
   iv. uniform application of allocation procedures;

H. Life cycle impact assessment:

3. the LCIA procedures, calculations and results of the study;

4. the relationship of the LCIA results to the LCI results;

5. reference to all characterization models, characterization factors and methods used.

6. a statement that the LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks;

I. Life cycle interpretation:

5. the results;

6. assumptions and limitations associated with the interpretation of results as declared in the EPD, both methodology and data related;

7. the variance from the means of LCIA results should be described if generic data are declared from several sources or for a range of similar products;

8. data quality assessment;
9. full transparency in terms of value-choices, rationales and expert judgments.

6.3. Documentation on additional information

The project report shall include any documentation on additional environmental information declared in the EPD as required in this standard. Such documentation on additional environmental information may include, e.g. as copies or references:

- laboratory results/measurement for the content declaration;
- laboratory results/measurement of functional/technical performance;
- documentation on declared technical information on life cycle stages that have not been considered in the LCA (e.g. transport distances, energy consumption during use, cleaning cycles, etc.);
- laboratory results/measurement for the declaration of emissions to indoor air, soil and water during the product’s use stage.

6.4. Data availability for verification

To facilitate verification, it is considered good practice to make the following information available to the EPD verifier, taking into account data confidentiality according to ISO 21930:2007, 7.4 and 9.1:

- analysis of material and energy flows to justify their inclusion or exclusion;
- quantitative description of unit processes that are defined to model processes and life cycle stages of the declared unit;
- attribution of process and life cycle data to datasets of an LCA-software (if used); LCIA results per modules of unit processes, e.g. structured according to life cycle stages; LCIA results per production plant/product if generic data is declared from several plants or for a range of similar products;
- documentation that substantiates the percentages or figures used for the calculations in the end-of-life scenario;
- documentation that substantiates the percentages and figures (number of cycles, prices, etc.) used for the calculations in the allocation procedure, if it differs from the PCR.

7. Verification and Validity of an EPD

After verification, an EPD is valid for a 5 year period from the date of issue, after which it shall be updated. The supplier must affirm that technology or other circumstances have not changed that could alter the content and accuracy of the declaration. An EPD does not have to be recalculated after 5 years if the underlying data has not changed significantly.

EPDs for unique concrete mixes can be generated by a software system that has been verified by an EPD operator provided a systematic method of review of the unique EPDs is in place and the mix uses only materials previously verified by the EPD operator.

The process for verification and establishing the validity of an EPD shall be in accordance with EN ISO 14025 and ISO 21930.
NOTE A reasonable change in the environmental performance of a product to be reported to the verifier is +/- 10% on any one of the declared impacts of the EPD. Such a change may require an update of the EPD.

REFERENCES


**APPENDIX A: Committee Composition**

The development of this PCR was sponsored by the Carbon Leadership Forum and the College of Built Environments at the University of Washington. The committee was led by Kathrina Simonen who was the primary author of this document.

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alicia Daniels Uhlig</td>
<td>GGLO Architecture</td>
</tr>
<tr>
<td>Jeff Davis</td>
<td>Central Concrete</td>
</tr>
<tr>
<td>Francesca DesMarais</td>
<td>Architecture 2030 (observer)</td>
</tr>
<tr>
<td>Chris Erickson</td>
<td>Climate Earth</td>
</tr>
<tr>
<td>Dean Frank</td>
<td>Precast/Pre-stressed Concrete Institute</td>
</tr>
<tr>
<td>Heather Gadonniex</td>
<td>UL Environment</td>
</tr>
<tr>
<td>Won Lee</td>
<td>Independent Engineer</td>
</tr>
<tr>
<td>Lionel Lemay</td>
<td>National Ready Mix Concrete Association</td>
</tr>
<tr>
<td>Greg McKinnon</td>
<td>Stoneway Concrete</td>
</tr>
<tr>
<td>Helena Meryman</td>
<td>Consultant</td>
</tr>
<tr>
<td>John Ochsendorf</td>
<td>Massachusetts Institute of Technology</td>
</tr>
<tr>
<td>Kathrina Simonen</td>
<td>University of Washington</td>
</tr>
<tr>
<td>Carlo Strazza</td>
<td>University of Genoa</td>
</tr>
<tr>
<td>Mark Webster</td>
<td>Simpson Gumpertz &amp; Heger</td>
</tr>
</tbody>
</table>
APPENDIX B: Guidelines for Product Carbon Footprint

This appendix has been developed explicitly to permit the development of a ‘single attribute’ EPD/WRI Product Carbon Footprint and to provide guidance for developing the Global Warming Potential (GWP) impact category for all EPDs in support of the Architecture 2030 Challenge for Products.

When developing the GWP for concrete, the preferred condition is to use site specific GWP data for the upstream products and processes. Prior to using industry average data to construct the concrete EPD, the concrete producer must contact all the suppliers and request product specific GWP data.

Provide documentation to demonstrate that all suppliers have been asked to provide an EPD that includes GWP. This shall be included as part of the project report to be reviewed by the EPD verifier.

NOTE: See the Architecture 2030 website (http://www.architecture2030.org/files/2030products_RFI.pdf) for suggestions on how to request this information.

Where no site-specific GWP data from upstream/constituent products and processes exists, the baseline numbers and variations noted on the next page shall be used for upstream components until site specific EPDs for the upstream/constituent products and processes are produced.

In the case where an EPD is the source of average environmental performance for a number of products, a statement to that effect shall be included in the declaration together with a description of the range/variability of the LCIA results.
### Table B1: DEFAULT GWP VALUES (RANGE MIN-MAX kgCO2e/kg material)

<table>
<thead>
<tr>
<th>AGGREGATES</th>
<th>CEMENTITIOUS MATERIALS</th>
<th>WATER</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td>Type III EPD -OR-</td>
<td>Type III EPD -OR-</td>
<td>Type III EPD -OR-</td>
</tr>
<tr>
<td>Crushed</td>
<td>Type III EPD -OR-</td>
<td>Type III EPD -OR-</td>
<td>Type III EPD -OR-</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>See Note 3</td>
<td>See Note 3</td>
<td>EPO -OR-</td>
</tr>
<tr>
<td>Silica F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GGBFS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upper Bound</td>
<td>Default</td>
<td>Lower Bound</td>
</tr>
<tr>
<td></td>
<td>0.014</td>
<td>0.01</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>0.1</td>
<td>0.05</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>0.93</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>3E-06</td>
</tr>
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<td></td>
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<td>3E-06</td>
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<td>TBD</td>
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<td></td>
<td></td>
<td></td>
<td>TBD</td>
</tr>
</tbody>
</table>

**SUM OF GWP/yd³ FROM MATERIAL COMPONENTS:**
Translate to mix specific GWP per mix design proportions.

**PLANT ENERGY USE/yd³:** Electricity, Natural Gas, Diesel, Fuel Oil, LPG
Translate to average GWP per cubic yard

**MIX SPECIFIC PRODUCT CARBON FOOTPRINT (CRADLE TO GATE)**
kgCO2e/yd³

### Baseline GWP Chart Notes:

1. Present mix GWP as a range that reflects the variability of the known data.
2. Attaining technology-specific EPDs for concrete material inputs should be prioritized.
3. Other materials or admixtures used but not outlined here (including materials produced outside the U.S.) shall have impacts estimated using best available LCA impact data.
4. This appendix will be updated by CLF as better LCI data provided by industry.
B1: BASELINE GWP EMISSIONS REFERENCES

The baseline GWP numbers in this PCR are reported in units of kg CO2e per kg of material. The PCR research team has identified the following sources for U.S. produced:

**Natural Aggregates (both fine and coarse): High=0.014 and Low =0.005 Default 0.01**


**DISCUSSION:** This value is for sand processing using a sand dryer. While other processing methods exist, the data describing their greenhouse gas emissions is not well-documented. The emissions values for aggregates from the sources we collected showed orders of magnitude of differences. The value given in this report is significantly higher than those found in some sources (low of 0.005 per Bath ICE & private consultant), but lower than in others (high of 0.07 - private consultant). It is also very similar to the value collected from primary data on open-pit sand extraction (0.0139 – Flower and Sanjayan 2007).

**Crushed Aggregates (both fine and coarse): High=0.10 and Low =0.01 Default =0.05**


**DISCUSSION:** A value of 0.05 is given for granite and hornfels extraction, collected as primary data by Flower and Sanjayan (2007) in Australia. While electricity is a significant source of energy in the quarrying process, and Australia’s electricity mix is coal-heavy (91.3% brown coal – Flower & Sanjayan), this should be a conservative number. Therefore, it is an appropriate default choice given that the defaults are meant to encourage primary data collection.

Data available on aggregate production is poor. Thus uncertainty of the variability is high. Better data is needed. Until better data is developed, assume large variability.

**Portland Cement: High 1.5 and Low 0.75 Average 0.93**


BEEs online software, Building for Environmental and Economic Sustainability, National Institute of Standards and Technology, 2011.

**DISCUSSION:** The PCA report (Marceau, 2010) provides average numbers for the primary cement processes but does not provide information on the variability of these results. Of the four cement kiln types, wet kilns typically will have the highest emissions because they are the least energy efficient. However, because the types of fuels used in cement kilns (especially wet kilns, in order to remain economically competitive) can vary widely, this value will likely still have significant variability. (via personal communication, van Oss, 2011). Without access to
the Portland Cement Association’s primary data, we used data from the Cement Sustainability Initiative (CSI) Report (WBCSD, 2006) to estimate the likely range of emissions from cement plants.

Total impacts from Mining = Transport + Heat+ Chemical Reaction + Organic material in limestone + Grinding and Plant Operations

Given data available, the following is a summary of the GWP related to cement production extrapolated from the CSI Report (WBCSD, 2006). Note that these calculations do not include mining, transport and handling impacts.

<table>
<thead>
<tr>
<th>Process Assumed Fuel</th>
<th>Clinker production M/Metric tonne</th>
<th>Kiln Heat</th>
<th>Chemical Reaction</th>
<th>Organic</th>
<th>Plant Operations</th>
<th>TOTAL</th>
<th>Marceau 2010</th>
<th>% difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best PH-PC Waste</td>
<td>3382</td>
<td>0</td>
<td>540</td>
<td>60</td>
<td>600</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Better PH-PC NG</td>
<td>3699</td>
<td>184</td>
<td>540</td>
<td>60</td>
<td>784</td>
<td>870</td>
<td>(10%)</td>
<td></td>
</tr>
<tr>
<td>Worst Wet Coal</td>
<td>4489</td>
<td>444</td>
<td>540</td>
<td>10</td>
<td>100</td>
<td>1274</td>
<td>1100</td>
<td>16%</td>
</tr>
<tr>
<td>Ave US per CSI Coal</td>
<td>6343</td>
<td>294</td>
<td>540</td>
<td>5</td>
<td>80</td>
<td>1038</td>
<td>930</td>
<td>12%</td>
</tr>
</tbody>
</table>

Table B2: Summary of Cement GWP calculations in gCO2e/kg material

DISCUSSION: The average number above is comparable to those given by the PCA report (Marceau, 2010). The PCR committee did not have access to the Portland Cement Association’s primary data that would reveal the data spread resulting from this use of varied fuel types. However, the CSI report uses data that represents 78% of US manufacturers. The results attained match what would be expected: that the average values for total production and wet process numbers would be less than a ‘worst case’ assumption and that the average numbers for the higher performing plant types would be less than a ‘best case’ assumption.

This PCR recommends assuming that cement GWP be reported with a range of 750-1500 kg CO2e/kg cement unless the EPD is prepared with data from a cement EPD that justifies different numbers and different variability. The average number to use in generating default carbon footprints should be the best available number as currently reported in the Marceau 2010 study.

GGBFS (Slag Cement): High=0.3 and Low=0.1 Default 0

Flower and Sanjayan (2007)


DISCUSSION: Flower and Sanjayan (2007) published a value of 0.14. Kim and Worrell published value of 0.25. Better data is needed to quantify the impacts of process of blast furnace slag to create ground, granulated blast furnace slag (GGBFS). Given the two published data sources the high and low were rounded to one significant digit.

**Admixtures**

DISCUSSION: Most admixtures are used in dosages such that their mass is considerably less than 1% of the mass of concrete and can be ignored in the LCA. However data has been obtained from the EU admixture association and will be used to generate baseline data to use for GWP of chemical admixtures.

**Industrial Water:**


DISCUSSION: Number needs to be adjusted to reflect US use. Need better data on GWP impacts of water. Number given is small and will have minimal impact on final results however should be updated as better data is available.
B2: Content of the WRI/WBCSD PS Compliant Product Carbon Footprint

The following general items shall be declared in addition to the requirements noted in the PCR. These are:

A. GHG emissions used for each primary material component and ready mix plant with an identification if data is from product EPD/primary data or default PR data and a characterization of data quality.

B. Coefficient of variation for data required per section 3.6. Provide for all data if available.

C. Time value for data provided and date of reporting.

D. Quantify the percentage of primary data in the final inventory: divide CO2e determined via EPD or core processes by total product CO2e.

E. Data Assurance type (Third party or self-assurance). If internal assurance providers are used, the following information shall be disclosed in the product GHG inventory report or assurance statement:
   A. their relative competencies;
   B. the reason for selecting them as the assurance providers; and
   C. how any potential conflict of interest was avoided.

D. The following statement shall be added to all declarations:
   'The reported 'carbon footprint' represents a cradle-to-site inventory of the greenhouse gas emissions attributed to the production of this unique concrete mix design. The calculations were prepared in conformance with the Carbon Leadership Forum’s Concrete Product Rules dated DATE which provide clarification for adopting the WRI/WBCSD Greenhouse Gas Protocol Initiative Product Accounting & Reporting Standards dated DATE.

E. The following statement shall be added to all declarations with only first-party verification:
   'The reported data has not been assured by a third party and thus is only appropriate for use in comparing between mixes within a single company and is not appropriate for use in purchasing decisions, GHG labeling programs or comparative assertions.'

F. The following statement shall be added to all declarations with third-party assurance:
   'The reported data has been assured by a third party and thus is appropriate for use in comparing between mix designs, use in purchasing decisions and GHG labeling programs. This data should not be used for comparative assertions unless a LCA in conformance with ISO 14044, assessing all environmental impacts is performed.'
APPENDIX C: Water Footprint from Concrete Production

Methods to characterize and report water use throughout the supply chain are still in development. For the purposes of this PCR, water footprint need only report the fresh water consumed at a ready mixed concrete plant (life cycle stage A3). Water use in life cycle stage A3 shall be computed per the NRMCA Sustainable Plant Guidelines as summarized here (NRMCA, 2011):

Water Footprint from Concrete Production

At a ready mixed concrete facility, three categories of water must be addressed: fresh water, process water and stormwater. For the purposes of this PCR, the following definitions are provided for the three categories of water. Fresh water is water from a municipal source (tap), surface water or on-site wells that can be consumed as drinking water. Process water is water used directly or indirectly in the production of concrete such as batching concrete, washing activities and dust control. Stormwater is any precipitation from rain and snowmelt events that flow over land or impervious surfaces.¹²

A successful water management program at a ready mix plant should:

• Minimize the use of fresh water
• Limit the generation of process water
• Collect, treat, and reuse as much process water as possible
• Manage stormwater to prevent commingling with process water
• Harvest and use stormwater for batching and other plant operations.

The amount of fresh water used at the plant can be significantly reduced through effective collection and recycling of process water and stormwater. Because the discharge of process water requires a permit and possibly treatment prior to discharge, recycling process water can be both environmentally and economically advantageous. Reducing stormwater runoff through infiltration and through stormwater harvesting can also provide significant environmental and economic benefit.

In an effective water management strategy, fresh water, process water, and stormwater are each managed efficiently in daily operations and water disposal is minimal.

Batching Water

Fresh water use in batching concrete can be reduced by replacing fresh water with recycled water, and chemical admixtures may lower the amount of water necessary in a mix. This value is relatively easy to measure since it is equal to the total fresh water in the mix as reported on the concrete batch ticket minus an estimate of the average recycled water used in the mix.

¹ http://epub.epa.gov/npdes/home.cfm?program_id=6
² Generally “Stormwater Associated with Industrial Activity” is regulated. It is defined as the discharge from any point source which is used for collecting and conveying stormwater and which is directly related to manufacturing, processing, or raw material storage areas at an industrial site. Facilities considered to be engaged in “industrial activities” include those activities defined in 40 CFR 122.26(b)(14). The term does not include discharges from facilities or activities excluded from the NPDES program. Because these Guidelines are meant to provide avenues for performance beyond regulations, Stormwater Associated with Industrial Activity is not discussed in the following credits.
Partially or fully replacing fresh water used as mixing water will have a significant impact in minimizing the amount of fresh water used in concrete batching. The American Society for Testing and Materials (ASTM) has permitted recycled water for use in ready mixed concrete batching since 1978, and currently ASTM C 1602 *Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete* addresses the requirements for water sources used as mixing water. Chemical admixtures can also reduce the need for fresh water in concrete batching. Consider the use of water reducing and plasticizing chemical admixes rather than adding more mixing water and cement to obtain the required consistency of fresh concrete.

To reduce the amounts of fresh water in concrete batching consider the following strategies:

1. Specifications should allow for the use of recycled water in batching in accordance with ASTM C 1602, thus maximizing use of recycled water.
2. Concrete producers should use water reducing chemical admixtures (water reducers, high and mid-range superplasticizers, etc.) which allow for reductions in water use and consequently the amount of cementitious materials used in a mix.
3. Concrete producers should optimize mix proportions to minimize the amount of cement, SCM, and water in the mix.

**Process Water**

Water consumption, beyond use in batching, is influenced by the type of plant, plant location, and plant size. Central mix plants tend to use less truck rinse water than transit mixer operations, which load dry material. Rural plants with longer average hauls are more likely to have transit mixers than urban plants with shorter hauls, and thus use more water. Also, larger plants (particularly in urban areas) are more likely to have water recycling systems.

Recycled process water and captured stormwater should be used wherever possible to avoid the use of fresh water – these types of water are less of an environmental burden by reducing municipal water treatment loads, and take a plant closer to self-sufficiency by reducing dependence on municipal sources of water. One best management practice includes using recycled process water for truck exterior washing and mixer drum washout. Another best management practice is to use captured stormwater for truck washing, mixer drum washout, and dust suppression. Use of color-coded pipes at different stations (e.g. green for recycled water, blue for municipal water) will distinguish fresh and recycled process and stormwater sources. Train all employees on water conservation and the proper use of all water reclamation equipment.

A number of strategies can be implemented on-site to reduce the amount of fresh water used for process applications. Drum washouts use significant amounts of water and by using multiple lower volume rinses to complete washout, the amount of washout water needed can be nearly cut in half. While an efficient washout may be accomplished with one rinse using 250 gallons (946 l), a double rinse using 100 gallons (379 l) twice, 200 gallons (757 l) total, or a triple rinse using 50 gallons (189 l)

---

three times, 150 gallons (568 l) total, are equivalent.\(^5\) The “rock out” method may also be appropriate. This method consists of adding dry aggregate to the drum after any returned concrete is discharged, then running it at mixing speed to collect wet concrete. The dry aggregate with collected wet concrete is then discharged and allowed to dry for later use as recycled material.

Water can also be conserved when heating and cooling aggregate by heating a small amount of water to create steam to heat aggregates rather than heating all the mix water. If aggregate is sprayed for cooling or dust suppression, collect the runoff for reuse.

At fresh water use locations, separate pumps and meters will pinpoint where water use reduction strategies should be targeted. Water use can be reduced by installing flow-control nozzles or use small diameter hoses. Shut-off valves can be installed to eliminate truck overflows during tank filling.

### Calculating Water Footprint

\[
\text{Water Footprint per Declared Unit} = \frac{(\text{Batching Fresh Water} + \text{Process Fresh Water})}{\text{yd}^3}
\]

\[
\text{Batching Fresh Water} = \frac{(\text{Total Batching Water} - \text{Recycled Batching Water} - \text{Harvested Rain Water})}{\text{yd}^3}
\]

\[
\text{Process Fresh Water} = \frac{(\text{Total Process Water} - \text{Recycled Process Water} - \text{Harvested Rain Water})}{\text{yd}^3}
\]

Generally, concrete producers can measure and report Batching Fresh Water. Process water is more difficult to track but can be done. Normally, a producer would not know the specifics of how much process water was used for a specific yard of concrete but could establish an average per cubic yard over a period of time that could be used to calculate the water footprint. When water footprint is being calculated for an average or range of mix designs, average water footprint over a range of mixes can be reported.

APPENDIX D: Example EPD

[NOTE: This SAMPLE Environmental Product Declaration (EPD) provides the basic information that should be included in an EPD. The values presented here are for demonstration purposes only and do not represent actual environmental impacts associated with concrete. No LCA was conducted to obtain these values.]

SAMPLE Environmental Product Declaration
For ready mixed concrete produced by Rock Hard Concrete Company, Plant 99 West, 99 West Street, Middleton, KS, USA with the following product names:

1. STR040
2. STR050
3. STR080
4. EXT050

Company
Rock Hard Concrete Company is a privately held ready mixed concrete producer based in Kansas City, KS, and operates 11 concrete production facilities in Kansas and Missouri. This environmental product declaration was created for concrete produced at Plant 99 West located in Middleton, KS.

Headquarters:
Rock Hard Concrete Company
101 Main Street
Kansas City, KS 55555
555-555-5555

Plant:
Rock Hard Concrete Company, Plant 99 West
99 West Street
Middleton, KS, 99999
999-999-9999

The Carbon Leadership Forum PCR dated X/X/XXXX serves as the PCR for this EPD www.carbonleadershipforum.org
Independent verification of the declaration, according to ISO 14025:2006
☐ internal  ☐ external

Independent Verifier
<Name and Organization of the Independent verifier>
**Products Description and Declared Unit**

This EPD reports the impacts for the product "concrete" used in both cast in place and precast concrete applications. See the following standards for definitions/characterizations of concrete:

- ASTM C 94
- UNSPSC code 30111500
- CONSTRUCTION SPECIFICATIONS INSTITUTE/CSI SPECIFICATION SECTIONS:
  - 03 03X XX Cast in Place Concrete
  - 03 4X XX Precast Concrete
  - 03 70 00 Mass Concrete
  - 04 22 00 Masonry

The declared unit is 1 cubic yard (1 cubic meter) of concrete for each of the following concrete products:

<table>
<thead>
<tr>
<th>Product name</th>
<th>Specified Compressive Strength</th>
<th>Specified Environmental Exposure Class (in accordance with ACI 318)</th>
<th>Specified Slump</th>
<th>Typical Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>STR040</td>
<td>4000 psi (28 MPa) at 28 days</td>
<td>F0, S1, P0, C0</td>
<td>6 in. +/- 1.5 in. (152 mm +/- 38 mm)</td>
<td>Foundations, footings, basement walls and slabs on grade with moderate sulfate exposure</td>
</tr>
<tr>
<td>STR050</td>
<td>5000 psi (35 MPa) at 28 days</td>
<td>F0, S0, P0, C0</td>
<td>6 in. +/- 1.5 in. (152 mm +/- 38 mm)</td>
<td>Structural beams, girders and slabs with no exposure</td>
</tr>
<tr>
<td>STR080</td>
<td>8000 psi (55 MPa) at 56 days</td>
<td>F0, S0, P0, C0</td>
<td>24 in. +/- 3 in. (610 mm +/- 76 mm)</td>
<td>Structural columns with no exposure</td>
</tr>
<tr>
<td>EXT050</td>
<td>5000 psi (35 MPa) at 28 days</td>
<td>F3, S0, P0, C2</td>
<td>6 in. +/- 1.5 in. (152 mm +/- 38 mm)</td>
<td></td>
</tr>
</tbody>
</table>
Typical Applications | Parking deck slabs, beams and columns

### Product Components

#### Product STR040

<table>
<thead>
<tr>
<th>Component</th>
<th>Meeting the Following Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Cement</td>
<td>ASTM C 150 Type II</td>
</tr>
<tr>
<td>Slag cement</td>
<td>ASTM C 989</td>
</tr>
<tr>
<td>Fly ash</td>
<td>ASTM C 618</td>
</tr>
<tr>
<td>Fine and Coarse Aggregate</td>
<td>ASTM C 33</td>
</tr>
<tr>
<td>Admixtures</td>
<td>ASTM C 494</td>
</tr>
<tr>
<td>Water</td>
<td>ASTM C 1602</td>
</tr>
</tbody>
</table>

#### Product STR050

<table>
<thead>
<tr>
<th>Component</th>
<th>Meeting the Following Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Cement</td>
<td>ASTM C 150 Type I</td>
</tr>
<tr>
<td>Fly ash</td>
<td>ASTM C 618</td>
</tr>
<tr>
<td>Fine and Coarse Aggregate</td>
<td>ASTM C 33</td>
</tr>
<tr>
<td>Admixtures</td>
<td>ASTM C 494</td>
</tr>
<tr>
<td>Water</td>
<td>ASTM C 1602</td>
</tr>
</tbody>
</table>

#### Product STR080

<table>
<thead>
<tr>
<th>Component</th>
<th>Meeting the Following Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Cement</td>
<td>ASTM C 150 Type I</td>
</tr>
<tr>
<td>Slag cement</td>
<td>ASTM C 989</td>
</tr>
<tr>
<td>Fly ash</td>
<td>ASTM C 618</td>
</tr>
<tr>
<td>Fine and Coarse Aggregate</td>
<td>ASTM C 33</td>
</tr>
<tr>
<td>Admixtures</td>
<td>ASTM C 494</td>
</tr>
<tr>
<td>Water</td>
<td>ASTM C 1602</td>
</tr>
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</table>

#### Product EXT050

<table>
<thead>
<tr>
<th>Component</th>
<th>Meeting the Following Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Cement</td>
<td>ASTM C 150 Type I</td>
</tr>
<tr>
<td>Fly ash</td>
<td>ASTM C 618</td>
</tr>
<tr>
<td>Silica Fume</td>
<td>ASTM C 1240</td>
</tr>
<tr>
<td>Fine and Coarse Aggregate</td>
<td>ASTM C 33</td>
</tr>
<tr>
<td>Admixtures</td>
<td>ASTM C 494</td>
</tr>
<tr>
<td>Water</td>
<td>ASTM C 1602</td>
</tr>
</tbody>
</table>

### EPD Program

This environmental product declaration was developed following the Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) of Concrete developed and registered at the Carbon Leadership Forum www.carbonleadershipforum.org.
The reported 'carbon footprint' represents a cradle-to-site inventory of the greenhouse gas emissions attributed to the production of this unique concrete mix design. The calculations were prepared in conformance with the Carbon Leadership Forum’s Concrete Product Rules dated 2/14/88 which provide clarification for adopting the WRI/WBCSD Greenhouse Gas Protocol Initiative Product Accounting & Reporting Standards dated 2/14/99.

The EPD Program Operator verifying/registering this EPD is Green Environmental Sustainability, Inc.:

1000 Heavenly Way
Seattle, WA 88888
www.GESwebsite.net

The Life Cycle Assessment was independently verified by Go Get Em Environmental:

2000 Cradle Lane
Cradle, CA 77777
www.GOgetEMEnvironmental.com

Date of Issue
January 1, 2099

Period of Validity
5 years

Use of this EPD
The applicability of this EPD allows for the comparison of the environmental impacts of different concrete mix designs (products). In order for the comparisons to be valid, the products should have identical product description and declared unit. It should not be used to compare different products or products that have different functions or performance characteristics.

Life Cycle Assessment

System Boundaries
A summary of life cycle stages included in the EPD are as follows:

1. Raw Material Supply (upstream processes): Extraction, handling and processing of the raw materials used in production of concrete: cement, supplementary cementitious materials, aggregate (coarse and fine), water and admixtures.
2. Transportation: Transportation of these materials from supplier to the 'gate' of the concrete producer.
3. Manufacturing (core processes): The core processes result from the energy used to store, batch, mix and distribute the concrete and operate the facility (ready mix concrete plant)

A summary of life cycle stages excluded from the EPD:

1. Construction Transportation: Transport of the concrete from the producer's 'gate' to the construction site.
2. Production, manufacture and construction of buildings capital goods and infrastructure with an expected lifespan of over 5 years.
3. Production and manufacture of concrete production equipment, concrete delivery vehicles, earthmoving equipment, laboratory equipment with expected lifespan of over 5 years.
4. Personnel-related activities (travel, furniture, office supplies)

Data Quality and Variability
The life cycle inventory data used to conduct the LCA for the products in this EPD was obtained from industry average data and is classified as “good” quality. The data was obtained from Life Cycle Inventory of Portland Cement Concrete, by Marceau, et al.

This EPD was created using industry average data for upstream materials. Variation can result from differences in supplier locations, manufacturing processes, manufacturing efficiency and fuel type used. Climate change impacts could range between 230 CO2e and 300 CO2e per cubic yard. Other environmental impact values will have a different range.

Environmental Impacts per Cubic Yard (Cubic Meter) of Concrete [Level A EPD]:

The reported data has been assured by a third party and thus is appropriate for use in comparing between mix designs, use in purchasing decisions and GHG labeling programs. This data should not be used for comparative assertions unless a LCA in conformance with ISO 14044, assessing all environmental impacts is performed.

Product STR040

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Impacts (US Units)</th>
<th>Impacts (SI Units)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Potential</td>
<td>254 kg CO2eq/yd3</td>
<td>334 kg CO2eq/m3</td>
<td>TRACI</td>
</tr>
</tbody>
</table>

Product STR050

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Impacts (US Units)</th>
<th>Impacts (SI Units)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Potential</td>
<td>274 kg CO2eq/yd3</td>
<td>361 kg CO2eq/m3</td>
<td>TRACI</td>
</tr>
</tbody>
</table>
## Product STR080

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Impacts (US Units)</th>
<th>Impacts (SI Units)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Potential</td>
<td>294 kg CO2eq/yd³</td>
<td>387 kg CO2eq/m³</td>
<td>TRACI</td>
</tr>
</tbody>
</table>

## Product EXT050

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Impacts (US Units)</th>
<th>Impacts (SI Units)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Potential</td>
<td>274 kg CO2eq/yd³</td>
<td>361 kg CO2eq/m³</td>
<td>TRACI</td>
</tr>
</tbody>
</table>

## Environmental Impacts per Cubic Yard (Cubic Meter) of Concrete [Level B EPD]:

### Product STR040

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Impacts (US Units)</th>
<th>Impacts (SI Units)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Primary Energy</td>
<td>2.13 MBTU/yd³</td>
<td>2957 MJ/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Batch Water</td>
<td>210 lbs/yd³</td>
<td>127 kg/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Wash Water</td>
<td>30 lbs/yd³</td>
<td>18 kg/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Total Waste Disposed</td>
<td>40 lbs/yd³</td>
<td>24 kg/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Global Warming Potential</td>
<td>254 kg CO2 eq/yd³</td>
<td>334 kg CO2eq/m³</td>
<td>TRACI</td>
</tr>
<tr>
<td>Ozone Depletion</td>
<td>0.00 kg CFC11 eq/yd³</td>
<td>0.00 kg CFC11 eq/m³</td>
<td>TRACI</td>
</tr>
<tr>
<td>Acidification Potential</td>
<td>0.59 kg SO2 eq/yd³</td>
<td>0.78 kg SO2 eq/m³</td>
<td>TRACI</td>
</tr>
<tr>
<td>Eutrophication Potential Air</td>
<td>0.00 kg N eq/yd³</td>
<td>0.00 kg N eq/yd³</td>
<td>TRACI</td>
</tr>
<tr>
<td>Eutrophication Potential Water</td>
<td>0.07 kg N eq/yd³</td>
<td>0.09 kg N eq/m³</td>
<td>TRACI</td>
</tr>
<tr>
<td>Photochemical Ozone Creation/Smog</td>
<td>0.05 kg C2H6 eq/yd³</td>
<td>0.06 kg C2H6 eq/m³</td>
<td>TRACI</td>
</tr>
</tbody>
</table>

### Product STR050

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Impacts (US Units)</th>
<th>Impacts (SI Units)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Primary Energy</td>
<td>2.33 MBTU/yd³</td>
<td>3235 MJ/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Batch Water</td>
<td>220 lbs/yd³</td>
<td>133 kg/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Wash Water</td>
<td>30 lbs/yd³</td>
<td>18 kg/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Total Waste Disposed</td>
<td>42 lbs/yd³</td>
<td>25 kg/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Impact Category</td>
<td>Impacts (US Units)</td>
<td>Impacts (SI Units)</td>
<td>Reference</td>
</tr>
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<td>---------------------------------------</td>
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</tr>
<tr>
<td>Total Primary Energy</td>
<td>2.53 MBTU/yd³</td>
<td>3512 MJ/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Batch Water</td>
<td>240 lbs/yd³</td>
<td>145 kg/m³</td>
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<tr>
<td>Wash Water</td>
<td>30 lbs/yd³</td>
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<td>N/A</td>
</tr>
<tr>
<td>Total Waste Disposed</td>
<td>44 lbs/yd³</td>
<td>26 kg/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Global Warming Potential</td>
<td>294 kg CO2 eq/yd³</td>
<td>387 kg CO2 eq/m³</td>
<td>TRACI</td>
</tr>
<tr>
<td>Ozone Depletion</td>
<td>0.00 kg CFC11 eq/yd³</td>
<td>0.00 kg CFC11 eq/m³</td>
<td>TRACI</td>
</tr>
<tr>
<td>Acidification Potential</td>
<td>0.59 kg SO2 eq/yd³</td>
<td>0.78 kg SO2 eq/m³</td>
<td>TRACI</td>
</tr>
<tr>
<td>Eutrophication Potential Air</td>
<td>0.00 kg N eq/yd³</td>
<td>0.00 kg N eq/yd³</td>
<td>TRACI</td>
</tr>
<tr>
<td>Eutrophication Potential Water</td>
<td>0.07 kg N eq/yd³</td>
<td>0.09 kg N eq/m³</td>
<td>TRACI</td>
</tr>
<tr>
<td>Photochemical Ozone Creation/Smog</td>
<td>0.05 kg C2H6 eq/yd³</td>
<td>0.06 kg C2H6 eq/m³</td>
<td>TRACI</td>
</tr>
</tbody>
</table>

Product STR080

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Impacts (US Units)</th>
<th>Impacts (SI Units)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Primary Energy</td>
<td>2.13 MBTU/yd³</td>
<td>2957 MJ/m³</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Product EXT050
<table>
<thead>
<tr>
<th></th>
<th>lbs/yd³</th>
<th>kg/m³</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch Water</td>
<td>210</td>
<td>127</td>
<td>N/A</td>
</tr>
<tr>
<td>Wash Water</td>
<td>30</td>
<td>18</td>
<td>N/A</td>
</tr>
<tr>
<td>Total Waste Disposed</td>
<td>40</td>
<td>24</td>
<td>N/A</td>
</tr>
<tr>
<td>Global Warming Potential</td>
<td>254</td>
<td>334</td>
<td>TRACI</td>
</tr>
<tr>
<td>Ozone Depletion</td>
<td>0.00</td>
<td>0.00</td>
<td>TRACI</td>
</tr>
<tr>
<td>Acidification Potential</td>
<td>0.59</td>
<td>0.78</td>
<td>TRACI</td>
</tr>
<tr>
<td>Eutrophication Potential Air</td>
<td>0.00</td>
<td>0.00</td>
<td>TRACI</td>
</tr>
<tr>
<td>Eutrophication Potential Water</td>
<td>0.07</td>
<td>0.09</td>
<td>TRACI</td>
</tr>
<tr>
<td>Photochemical Ozone Creation/Smog</td>
<td>0.05</td>
<td>0.06</td>
<td>TRACI</td>
</tr>
</tbody>
</table>
Additional Environmental Information:

Rock Hard Concrete Company is dedicated to continuous environmental improvements through product and process innovation. It demonstrates its dedication to sustainable development through the following certifications:

1. NRMCA Certified Concrete Production Facility
2. NRMCA Green-Star Certification
3. NRMCA Sustainable Concrete Plant Certification – Silver Level

References:

1. Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) of Concrete, Carbon Leadership Forum, Seattle, WA, 2012.
3. Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), US Environmental Protection Agency, Washington, DC.