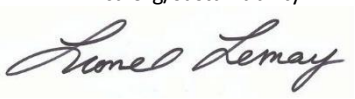
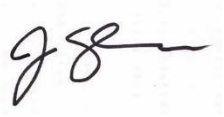
Environmental Product Declaration

Duke City Redi-Mix

EPD for concrete produced at two Duke City Facilities in New Mexico

NRMCA Certified Environmental Product Declaration

Declared Product:	Ready-mixed concrete produced by Duke City Redi-Mix	
Date of Issue:	December 13, 2019	
Period of Validity:	5 Years	
EPD Number	NRMCAEPD: 20030	
Declaration Owner:	**Duke City Redi-Mix** 7711 Broadway Blvd. SE, Albuquerque, NM 87105 www.dukecityredimix.com	
Program Operator:	**National Ready Mix Concrete Association** 66 Canal Center Plaza, Suite 250 Alexandria, VA 22314 703-706-4800 www.nrmca.org/sustainability  Lionel Lemay	
LCA and EPD Developer:	**Athena Sustainable Materials Institute** 280 Albert Street, Suite 404 Ottawa, ON K1P 5G8 613-729-9996 www.athenasmi.org  James Salazar	
Product Category Rule:	**ISO 21930:2017 Sustainability in Building Construction — Environmental Declaration of Building Products** serves as the core PCR. **NSF International Product Category Rule (PCR) for Concrete Version 1 (February 22, 2019)** serves as the sub-category PCR	
	Sub-category PCR review was conducted by: Thomas P. Gloria, Ph. D. Industrial Ecology Consultants	
Independent LCA Reviewer and EPD Verifier:	Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006 ☐ internal ☒external Third party verifier: Cara Vought, LCACP, LEED AP ID+C Sustainable Solutions Corporation	

Description of Company

Duke City Redi-Mix is a locally owned and operated ready mix concrete and aggregate supplier to the Albuquerque and surrounding areas. The company currently operates over thirty concrete mixer trucks from three plants in Albuquerque, Los Lunas and Rio Rancho.
As a local company, Duke City Redi-Mix has the benefit of quick decision making, but more importantly takes responsibility for the community and strive to make it a better place to live each day.
Duke City Redi-Mix is a member of the New Mexico Ready Mix Concrete and Aggregates Association and the National Ready Mix Concrete Association (NRMCA).

Location of Facilities

Albuquerque Ready Mix Plant
7711 Broadway SE
Albuquerque, NM 87105

Los Lunas Ready Mix Plant
4 Duarte Road
Los Lunas, NM 87031

Description of Product and Product System

Products covered by this EPD satisfy general purpose concrete as used in residential, commercial and public works applications in the United States. Product components include (in order of greatest mass per mix): Natural and crushed aggregates, portland cement, slag cement, admixtures, and batch water.

This EPD reports the impacts for 30 different ready-mixed concrete products produce at two different Duke City Redi-Mix facilities in accordance with the following:

- ACI 211: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
- ACI 318: Building Code Requirements for Structural Concrete
- ASTM C94: Standard Specification for Ready-Mixed Concrete
- CSI MasterFormat Division 03-30-00: Cast-in-Place Concrete
- UNSPSC Code 30111500: Ready Mix

This EPD is intended for use in Business to Business (B-to-B) communication. The scope of this EPD is cradle-to-gate and considers the following life cycle stages.

- **A1 - Raw Material Supply:** Includes all upstream processes related to extraction, handling, and processing of the raw materials and intermediate component products as well as fuels used in the production of concrete. Component products include cement, supplementary cementitious materials, aggregate (coarse and fine), water, admixtures and other materials or chemicals used in concrete mixtures.
- **A2 - Transportation:** Accounts for the transportation of all input materials and fuels from the supplier to the gate of the concrete plant.
- **A3 - Manufacturing (Core Processes):** Includes all core processes and the energy and water used to store, move, batch and mix the concrete and operate the concrete plant as well as the transportation and processing of wastes from these core processes.

Methodology of Underlying LCA

Declared Unit

The declared unit is 1 cubic yard of ready mixed concrete product. Key product variables include:

- Compressive strength – Compressive strengths are represented in the various mix designs and include the number of days after pouring as a part of the reference value: e.g. 3,000 psi (20.7 MPa) @ 28 days; 4,000 psi (27.6 MPa) @ 56 days; 6,000 psi (31.0 MPa) and 90 days; etc.
- Water to cementitious materials ratio (w/cm)– Varies, but generally lower for higher strength non-air entrained mix designs (above 5,000psi (34.5 MPa)) in accordance with ACI 211.1 recommendations;
- SCM use– various mix designs call for portland cement displacement by incorporating fly ash (FA) and/or slag cement (SL);
- Admixtures use – Admixture use was specified for the different mixes that were modeled. These admixtures included an air-entraining admixture, water reducing and accelerating admixtures, and high range water reducer admixtures.

Scope of LCA

A summary of life cycle stages included in the EPD is identified in Figure 1 as follows:

- A1: Raw Material Supply (upstream processes): Extraction, handling and processing of the raw materials used in the production of concrete: cement, supplementary cementitious materials, aggregate (coarse and fine), water, admixtures and other materials or chemicals used in concrete mixtures.
- A2: Transportation: Transportation of these materials from the supplier to the 'gate' of the concrete producer.
- A3: Manufacturing (core processes): The energy used to store, batch, mix and distribute the concrete and operate the facility (concrete plant)

A summary of activities excluded from the EPD is as follows:

- Production, manufacture, and construction of manufacturing capital goods and infrastructure;
- Production and manufacture of production equipment, delivery vehicles, and laboratory equipment;
- Personnel-related activities (travel, furniture, and office supplies); and
- Energy and water use related to company management and sales activities that may be located either within the factory site or at another location.

Building Life Cycle Information Modules (x: Included in LCA; mnd: Module Not Declared)														
Product stage			Construction Process stage		Use stage							End-of-life stage			
Raw Material supply	Transport	Manufacturing	Transport	Construction/Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	De-Construction/ Demolition	Transport	Waste processing	Disposal
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
x	x	x	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd

Figure 1. Life cycle stage schematic – alpha-numeric designations as per NSF PCR

Cut-off Rules

The cut-off criteria for all activity stage flows considered within the system boundary conform with ISO 21930: 2017 Section 7.1.8. Specifically, the cut-off criteria were applied as follows:

- All inputs and outputs for which data are available are included in the calculated effects and no collected core process data are excluded.
- A one percent cut-off is considered for renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process. The sum of the total neglected flows does not exceed 5% of all energy consumption and mass of inputs.
- All flows known to contribute a significant impact or to uncertainty (e.g., portland cement and admixtures) are included.
- The cut-off rules are not applied to hazardous and toxic material flows – all of which are included in the life cycle inventory.
- Proxy data was used for admixtures used by Duke City Redi-Mix that did not align with any of the admixture categories published in the EFCA EPDs. In those cases, the Water Reducing Admixture data was selected as a conservative assumption as per the NSF PCR Appendix A.

Allocation

The allocation of co-products or secondary flows cross the system boundary conforms with ISO 21930: 2017 Section 7.2.4. Specifically, the allocation criteria were applied as follows:

- Allocation was not applied any of the gate-to-gate production facilities. For facilities that manufacture additional products (i.e. aggregate), the LCI flows at the facility specific to the concrete production were reported.
- For secondary data sources, the NSF PCR default allocation selection (i.e. “Cut-off” or “Alloc Rec”) was applied.
- The product category rules for this EPD recognize fly ash, silica fume and slag as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a concrete material input
- A portion (30%) of the reported fleet energy use for truck mixing plants was allocated to the mixing facility.

Data Sources

This EPD is based on foreground LCI data collected from the participating company’s production facilities for the calendar year 2018. All upstream material, resource and energy carrier inputs have been sourced from various industry-average datasets and literature. Many of these data sets are defaulted to those specified for use in the NSF PCR 2019. Tables 1 to 3 describe each LCI data source and the data quality for each data source.

EPD Calculation Tool

This EPD was produced with a software tool developed by the Athena Sustainable Materials Institute. Initial verification of the software system confirmed the tool calculates environmental impacts correctly utilizing Input-Output testing of calculations in conformance with the ISO/IEC/IEEE 29119 Software Testing Standard. A verification letter attesting to the software’s conformance is appended to this EPD.

An automated EPD generation system does not require verification of every EPD: only outliers are audited.

Table 1. A1 - Raw Material Supply				
Materials	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**
USA Cement ***ASTM C150, C595, C1157***	Portland Cement Association EPD USA Portland Cement[1] (Modeled with complete LCI to support ISO 21930:2017)	USA	2016	• **Technology:** very good • **Time:** very good • **Geography:** very good • **Completeness:** very good • **Reliability:** very good
Fly Ash ***ASTM C618***	None, no incoming burden, only inbound transport is considered	N/A	N/A	• **N/A** • **Recovered material**
Crushed Aggregates *coarse and fine* ***ASTM C33***	ecoinvent 3.4: "Gravel, crushed {RoW}| production | Cut-off, U" Modified with region-specific electricity grid.	Global/ Regional	2001	• **Technology:** very good • **Time:** poor • **Geography:** good • **Completeness:** very good • **Reliability:** very good
Natural Aggregates *coarse and fine* ***ASTM C330***	ecoinvent 3.4: "Gravel, round {RoW}| gravel and sand quarry operation | Cut-off, U" Modified with region-specific electricity grid.	Global/ Regional	2001	• **Technology:** very good • **Time:** poor • **Geography:** good • **Completeness:** very good • **Reliability:** very good
Manufactured Lightweight Aggregates	ecoinvent 3.4: Expanded clay {RoW}| production | Cut-off, U Modified with United States average electricity grid	Global/ USA	2000	• **Technology:** good Representative per: http://www.epa.gov/ttnchie1/ap42/ch11/final/c11s20.pdf • **Time:** poor • **Geography:** good • **Completeness:** very good • **Reliability:** very good
Admixtures ***ASTM C494***	EFCA EPDs for Air Entrainers, Plasticisers and superplasticisers, Hardening Accelerators, Set Accelerators, Water Resisting Admixtures, and Retarders Non-supported LCIA indicators estimated using TRACI equivalents	EU	2015	• **Technology:** very good • **Time:** good • **Geography:** fair • **Completeness:** good • **Reliability:** very good

1: This EPD was calculated using industry average cement data. Cement LCA impacts can vary depending upon manufacturing process, efficiency and fuel source by as much as 50% for some environmental impact categories. Cement accounts for as much as 97% of the impacts of the concrete mixes included in this EPD and thus manufacturer specific cement impacts could result in variation of as much as 49%.

Table 1. A1 - Raw Material Supply				
Materials	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**
Batch and Wash Water ***ASTM C1602***	ecoinvent 3.4: Tap water {RoW}| market for | Cut-off, U Modified with US average electricity grid	Global/ USA	2011	• **Technology:** very good • **Time:** good • **Geography:** good • **Completeness:** very good • **Reliability:** very good

Table 2. A2 - Transportation				
Process	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**
Rail	USLCI 2014: Transport, train, diesel powered /US U	USA	2007	• **Technology:** very good • **Time:** fair • **Geography:** very good • **Completeness:** very good • **Reliability:** very good
Road	USLCI 2014: Transport, combination truck, short-haul, diesel powered/tkm/RNA Adjusted for Backhauls per NSF PCR 7.1.7.2	USA	2010	• **Technology:** very good • **Time:** good • **Geography:** very good • **Completeness:** very good • **Reliability:** very good

Table 3. A3 - Manufacturing				
Process	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**
Electricity	ecoinvent 3.4: Electricity, low voltage {WECC}| market for | Cut-off, U Electricity grids based on 2014 NERC regions.	USA	2015	• **Technology:** very good • **Time:** very good • **Geography:** very good • **Completeness:** very good **Reliability:** very good
Diesel	USLCI 2014: Diesel, combusted in industrial boiler /US U	USA	2007	• **Technology:** very good • **Time:** fair • **Geography:** very good • **Completeness:** very good **Reliability:** very good
Gasoline	USLCI 2014: Gasoline, combusted in equipment /US U	USA	2007	• **Technology:** very good • **Time:** fair • **Geography:** very good • **Completeness:** very good • **Reliability:** very good
Liquefied Propane Gas	USLCI 2014: Liquefied petroleum gas, combusted in industrial boiler /US U	USA	2007	• **Technology:** very good • **Time:** fair • **Geography:** very good • **Completeness:** very good • **Reliability:** very good
Hazardous Solid Waste,	ecoinvent 3.4: Hazardous waste, for incineration {RoW}| treatment of hazardous waste, hazardous waste incineration | Alloc Rec, U Modified with United States average electricity grid	Global	2011	• **Technology:** very good • **Time:** good • **Geography:** good • **Completeness:** very good • **Reliability:** very good
Non-Hazardous Solid Waste,	ecoinvent 3.4: Inert waste {RoW}| treatment of, sanitary landfill | Alloc Rec, U Modified with United States average electricity grid	Global	2011	• **Technology:** very good • **Time:** good • **Geography:** good • **Completeness:** very good • **Reliability:** very good

Life Cycle Assessment Results

This EPD supports 25 life cycle impact assessment indicators and inventory metrics as listed in Table 4. The US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), version 2.1, 2012 impact categories were used to calculate mandatory category indicators.

Emerging LCA impact categories and inventory items are still under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting data in these categories. Additionally, EPDs are comparable only if they comply with this document, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works. No regulated substances of very high concern were identified in the LCA.

Table 4. Life Cycle Category Indicators and Inventory Metrics

Core Mandatory Impact Indicator		
Global warming potential	GWP	kg CO2e
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e
Acidification potential of soil and water sources	AP	kg SO2e
Eutrophication potential	EP	kg Ne
Photochemical smog creation potential	POCP	kg O3e
Abiotic depletion potential (ADPfossil) for fossil resources;	ADPf	MJ, NCV
Fossil fuel depletion	FFD	MJ Surplus
Use of Primary Resources		
Renewable primary energy carrier used as energy	RPRE	MJ, NCV
Renewable primary energy carrier used as material	RPRM	MJ, NCV
Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV
Non-renewable primary energy carrier used as material	NRPRM	MJ, NCV
Secondary Material, Secondary Fuel and Recovered Energy		
Secondary material	SM	kg
Renewable secondary fuel	RSF	MJ, NCV
Non-renewable secondary fuel	NRSF	MJ, NCV
Recovered energy	RE	MJ, NCV
Mandatory Inventory Parameters		
Consumption of freshwater resources;	FW	m3
Calcination and carbonation emissions	CCE	kg CO2e
Indicators Describing Waste		
Hazardous waste disposed	HWD	kg
Non-hazardous waste disposed	NHWD	kg
High-level radioactive waste, conditioned, to final repository	HLRW	m3
Intermediate- and low-level radioactive waste, conditioned,	ILLRW	m3
Components for re-use	CRU	kg
Materials for recycling	MR	kg
Materials for energy recovery	MER	kg
Recovered energy exported from the product system	EE	MJ, NCV

Tables 5 and 6 present the LCA results for the mixes produced at the two facilities. The results are presented first on the basis of a declared unit of 1 cubic yard (Tables 5a and 6a) and on the basis of 1 cubic meter (Tables 5b and 6b).

Table 5a: LCA Results (A1-A3) for Ready Mix Concrete per yd^3
Duke City Redi-Mix – Albuquerque

Mix ID		30348925	41C00	40348920 AEA	40348920 AEA DC	75 A	70	71	72	73	75
Strength	PSI @ 28 d.	3000	3000	4000	4000	250	3000	4000	4000	3000	250
Core Mandatory Impact Indicators											
GWP	kg CO^2e	230.92	247.78	274.70	278.55	56.46	228.49	271.63	231.93	255.30	55.18
ODP	kg CFC11e	8.55E-06	8.63E-06	9.46E-06	9.45E-06	3.37E-06	8.37E-06	9.37E-06	8.50E-06	9.02E-06	3.57E-06
AP	kg SO^2e	0.82	0.81	0.93	0.94	0.34	0.81	0.93	0.81	0.89	0.30
EP	kg Ne	0.30	0.32	0.35	0.36	0.08	0.30	0.35	0.30	0.33	0.08
SFP	kg O^3e	17.14	16.91	19.41	19.48	7.79	16.92	19.52	17.04	18.77	6.71
ADPf	MJ, NCV	1558.32	1607.56	1782.74	1842.16	591.86	1525.47	1771.03	1552.86	1694.33	550.21
ADPe	kg Sbe	1.37E-04	1.48E-04	1.67E-04	1.69E-04	3.44E-05	1.36E-04	1.66E-04	1.38E-04	1.55E-04	2.78E-05
FFD	MJ Surplus	130.16	128.69	142.54	151.44	71.96	125.93	142.69	128.73	139.48	64.42
Use of Primary Resources											
RPRE	MJ, NCV	72.37	77.28	84.40	87.31	17.37	70.70	82.77	72.24	78.29	18.41
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	1634.99	1677.80	1861.10	1925.15	636.58	1598.28	1848.84	1627.23	1772.12	592.41
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters											
FW	m^3	1.81	1.95	2.21	2.22	0.44	1.81	2.21	1.83	2.06	0.36
CCE	kg CO^2e	96.55	107.99	119.42	119.42	11.43	96.55	117.64	97.82	108.75	12.70
Indicators Describing Waste											
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	42.89	42.89	42.89	42.89	42.89	42.89	42.89	42.89	42.89	42.89
HLRW	m^3	2.70E-09	1.81E-09	2.62E-09	2.62E-09	4.62E-09	2.74E-09	2.95E-09	2.62E-09	3.09E-09	3.23E-09
LLRW	m^3	1.31E-03	2.31E-03	1.77E-03	3.51E-03	1.26E-07	9.11E-04	1.55E-03	1.33E-03	1.51E-03	8.38E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5a Continued: LCA Results (A1-A3) for Ready Mix Concrete per yd^3
Duke City Redi-Mix – Albuquerque

Mix ID		303426	303426 AEA	403420 AEA	303420	303420 AEA	403420	453420 AEA	353420	52	55
Strength	PSI @ 28 days	3000	3000	4000	3000	3000	4000	4500	3500	4000	3000
Core Mandatory Impact Indicators											
GWP	kg CO^2e	230.34	231.35	274.18	242.25	246.54	266.99	299.51	260.55	321.13	273.96
ODP	kg CFC11e	8.49E-06	8.39E-06	9.44E-06	8.90E-06	8.86E-06	9.41E-06	1.00E-05	9.26E-06	1.05E-05	9.45E-06
AP	kg SO^2e	0.81	0.81	0.93	0.85	0.85	0.91	1.00	0.89	1.06	0.93
EP	kg Ne	0.30	0.30	0.35	0.32	0.32	0.35	0.38	0.34	0.41	0.35
SFP	kg O^3e	17.05	16.97	19.37	17.68	17.81	19.10	20.91	18.71	22.27	19.51
ADPf	MJ, NCV	1552.58	1545.70	1776.41	1632.14	1627.97	1762.41	1913.65	1716.48	2015.13	1766.05
ADPe	kg Sbe	1.37E-04	1.38E-04	1.67E-04	1.43E-04	1.48E-04	1.61E-04	1.84E-04	1.57E-04	2.00E-04	1.67E-04
FFD	MJ Surplus	129.78	127.94	141.84	136.35	132.90	144.02	150.24	139.97	154.44	139.82
Use of Primary Resources											
RPRE	MJ, NCV	71.88	71.84	83.94	76.22	76.18	82.82	90.81	80.33	95.89	83.30
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	1627.85	1618.95	1853.77	1711.36	1702.92	1842.95	1993.40	1794.29	2094.76	1842.76
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters											
FW	m^3	1.81	1.83	2.21	1.89	1.96	2.13	2.45	2.08	2.67	2.22
CCE	kg CO^2e	96.55	97.82	119.42	101.64	105.45	114.34	132.13	111.80	143.81	119.68
Indicators Describing Waste											
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	42.89	42.89	42.89	42.89	42.89	42.89	42.89	42.89	42.89	42.89
HLRW	m^3	2.70E-09	2.70E-09	2.62E-09	2.51E-09	2.55E-09	2.62E-09	2.72E-09	2.58E-09	2.93E-09	2.74E-09
LLRW	m^3	1.42E-03	1.35E-03	1.70E-03	1.95E-03	1.42E-03	2.13E-03	1.77E-03	1.77E-03	1.29E-03	1.07E-03
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5a Continued: LCA Results (A1-A3) for Ready Mix Concrete per yd^3
Duke City Redi-Mix – Albuquerque

Mix ID		54	56	57	Mix #28 P	303823	403825	603420	353400	403415	503422 AEA
Strength	PSI @ 28 days	4000	3000	4000	3000	3000	4000	6000	3500	4000	5000
Core Mandatory Impact Indicators											
GWP	kg CO^2e	366.75	274.40	309.15	267.14	261.93	316.98	331.13	288.37	265.39	279.76
ODP	kg CFC11e	1.14E-05	9.51E-06	1.02E-05	9.14E-06	9.20E-06	9.90E-06	1.07E-05	1.01E-05	9.42E-06	1.06E-05
AP	kg SO^2e	1.19	0.93	1.03	0.91	0.90	1.03	1.09	0.95	0.90	0.99
EP	kg Ne	0.46	0.35	0.39	0.34	0.34	0.39	0.42	0.37	0.34	0.37
SFP	kg O^3e	24.89	19.58	21.56	18.98	18.84	21.74	22.91	19.80	18.84	20.55
ADPf	MJ, NCV	2251.89	1771.79	1951.43	1777.62	1726.27	1982.19	2107.77	1841.88	1738.62	1884.64
ADPe	kg Sbe	2.33E-04	1.67E-04	1.92E-04	1.64E-04	1.58E-04	2.03E-04	2.07E-04	1.72E-04	1.59E-04	1.62E-04
FFD	MJ Surplus	167.94	140.52	150.65	148.36	140.78	153.86	165.35	143.83	140.47	156.29
Use of Primary Resources											
RPRE	MJ, NCV	107.87	83.52	92.68	82.23	80.89	92.08	99.93	88.75	82.24	88.79
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	2333.38	1849.21	2030.23	1855.07	1804.80	2051.12	2192.54	1921.06	1817.53	1979.68
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters											
FW	m^3	3.10	2.22	2.56	2.15	2.10	2.70	2.74	2.28	2.10	2.15
CCE	kg CO^2e	167.44	119.68	137.72	114.34	112.31	143.56	146.86	127.04	114.34	116.88
Indicators Describing Waste											
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	42.89	42.89	42.89	42.89	42.89	42.89	42.89	42.89	42.89	42.89
HLRW	m^3	3.12E-09	2.74E-09	2.88E-09	2.86E-09	2.74E-09	3.25E-09	3.02E-09	1.81E-09	2.37E-09	2.37E-09
LLRW	m^3	1.50E-03	1.07E-03	1.23E-03	3.48E-03	1.84E-03	2.48E-03	2.66E-03	1.60E-03	1.77E-03	1.77E-03
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5b: LCA Results (A1-A3) for Ready Mix Concrete per m^3
Duke City Redi-Mix – Albuquerque

Mix ID		30348925	41C00	40348920 AEA	40348920 AEA DC	75 A	70	71	72	73	75
Strength	PSI @ 28 days	3000	3000	4000	4000	250	3000	4000	4000	3000	250
Core Mandatory Impact Indicators											
GWP	kg CO^2e	301.64	323.66	358.83	363.86	73.75	298.46	354.81	302.95	333.49	72.08
ODP	kg CFC11e	1.12E-05	1.13E-05	1.24E-05	1.24E-05	4.40E-06	1.09E-05	1.22E-05	1.11E-05	1.18E-05	4.66E-06
AP	kg SO^2e	1.07	1.06	1.21	1.22	0.45	1.05	1.21	1.06	1.16	0.39
EP	kg Ne	0.40	0.42	0.46	0.47	0.10	0.39	0.46	0.40	0.43	0.10
SFP	kg O^3e	22.39	22.09	25.35	25.44	10.18	22.10	25.50	22.25	24.51	8.76
ADPf	MJ, NCV	2035.56	2099.88	2328.71	2406.33	773.12	1992.65	2313.41	2028.43	2213.22	718.72
ADPe	kg Sbe	1.79E-04	1.93E-04	2.18E-04	2.21E-04	4.49E-05	1.78E-04	2.17E-04	1.80E-04	2.03E-04	3.63E-05
FFD	MJ Surplus	170.02	168.11	186.19	197.82	94.00	164.50	186.38	168.16	182.19	84.15
Use of Primary Resources											
RPRE	MJ, NCV	94.53	100.94	110.25	114.05	22.69	92.35	108.12	94.36	102.26	24.05
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	2135.71	2191.63	2431.06	2514.73	831.53	2087.76	2415.05	2125.57	2314.84	773.84
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters											
FW	m^3	2.37	2.55	2.89	2.91	0.58	2.37	2.88	2.39	2.69	0.46
CCE	kg CO^2e	126.12	141.06	156.00	156.00	14.94	126.12	153.67	127.78	142.06	16.60
Indicators Describing Waste											
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	56.03	56.03	56.03	56.03	56.03	56.03	56.03	56.03	56.03	56.03
HLRW	m^3	3.53E-09	2.36E-09	3.42E-09	3.42E-09	6.03E-09	3.58E-09	3.86E-09	3.42E-09	4.04E-09	4.22E-09
LLRW	m^3	1.71E-03	3.01E-03	2.32E-03	4.59E-03	1.64E-07	1.19E-03	2.03E-03	1.74E-03	1.98E-03	1.09E-07
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5b Continued: LCA Results (A1-A3) for Ready Mix Concrete per m^3
Duke City Redi-Mix – Albuquerque

Mix ID		303426	303426 AEA	403420 AEA	303420	303420 AEA	403420	453420 AEA	353420	52	55
Strength	PSI @ 28 days	3000	3000	4000	3000	3000	4000	4500	3500	4000	3000
Core Mandatory Impact Indicators											
GWP	kg CO^2e	300.88	302.20	358.15	316.44	322.04	348.75	391.23	340.34	419.48	357.85
ODP	kg CFC11e	1.11E-05	1.10E-05	1.23E-05	1.16E-05	1.16E-05	1.23E-05	1.31E-05	1.21E-05	1.37E-05	1.23E-05
AP	kg SO^2e	1.06	1.06	1.21	1.11	1.11	1.19	1.30	1.17	1.39	1.22
EP	kg Ne	0.39	0.39	0.46	0.42	0.42	0.45	0.50	0.44	0.53	0.46
SFP	kg O^3e	22.27	22.17	25.30	23.10	23.27	24.95	27.31	24.45	29.09	25.49
ADPf	MJ, NCV	2028.06	2019.07	2320.44	2131.99	2126.55	2302.16	2499.71	2242.15	2632.27	2306.90
ADPe	kg Sbe	1.79E-04	1.81E-04	2.18E-04	1.87E-04	1.93E-04	2.10E-04	2.41E-04	2.05E-04	2.62E-04	2.18E-04
FFD	MJ Surplus	169.53	167.12	185.28	178.11	173.60	188.12	196.25	182.84	201.74	182.64
Use of Primary Resources											
RPRE	MJ, NCV	93.90	93.84	109.65	99.56	99.51	108.19	118.62	104.94	125.26	108.81
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	2126.38	2114.76	2421.49	2235.47	2224.45	2407.36	2603.88	2343.79	2736.29	2407.11
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters											
FW	m^3	2.37	2.40	2.89	2.47	2.56	2.78	3.20	2.71	3.48	2.90
CCE	kg CO^2e	126.12	127.78	156.00	132.76	137.74	149.36	172.59	146.04	187.86	156.33
Indicators Describing Waste											
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	56.03	56.03	56.03	56.03	56.03	56.03	56.03	56.03	56.03	56.03
HLRW	m^3	3.53E-09	3.53E-09	3.42E-09	3.28E-09	3.33E-09	3.42E-09	3.56E-09	3.37E-09	3.83E-09	3.58E-09
LLRW	m^3	1.85E-03	1.76E-03	2.22E-03	2.55E-03	1.85E-03	2.78E-03	2.32E-03	2.32E-03	1.68E-03	1.40E-03
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5b Continued: LCA Results (A1-A3) for Ready Mix Concrete per m^3
Duke City Redi-Mix – Albuquerque

Mix ID		54	56	57	Mix #28 P	303823	403825	603420	353400	403415	503422 AEA
Strength	PSI @ 28 days	4000	3000	4000	3000	3000	4000	6000	3500	4000	5000
Core Mandatory Impact Indicators											
GWP	kg CO^2e	479.06	358.43	403.83	348.96	342.14	414.05	432.54	376.68	346.66	365.43
ODP	kg CFC11e	1.49E-05	1.24E-05	1.33E-05	1.19E-05	1.20E-05	1.29E-05	1.40E-05	1.32E-05	1.23E-05	1.38E-05
AP	kg SO^2e	1.55	1.22	1.34	1.18	1.17	1.34	1.43	1.24	1.18	1.29
EP	kg Ne	0.60	0.46	0.51	0.44	0.44	0.51	0.55	0.49	0.45	0.49
SFP	kg O^3e	32.51	25.58	28.17	24.79	24.60	28.40	29.92	25.87	24.61	26.84
ADPf	MJ, NCV	2941.54	2314.41	2549.06	2322.02	2254.94	2589.24	2753.28	2405.97	2271.08	2461.81
ADPe	kg Sbe	3.04E-04	2.18E-04	2.51E-04	2.14E-04	2.07E-04	2.66E-04	2.70E-04	2.25E-04	2.07E-04	2.12E-04
FFD	MJ Surplus	219.37	183.56	196.79	193.79	183.90	200.97	215.99	187.87	183.48	204.16
Use of Primary Resources											
RPRE	MJ, NCV	140.91	109.10	121.07	107.41	105.66	120.28	130.53	115.93	107.43	115.99
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	3047.98	2415.54	2652.00	2423.19	2357.53	2679.28	2864.01	2509.39	2374.16	2585.95
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters											
FW	m^3	4.05	2.90	3.34	2.81	2.74	3.52	3.58	2.98	2.75	2.81
CCE	kg CO^2e	218.73	156.33	179.89	149.36	146.70	187.53	191.84	165.95	149.36	152.68
Indicators Describing Waste											
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	56.03	56.03	56.03	56.03	56.03	56.03	56.03	56.03	56.03	56.03
HLRW	m^3	4.07E-09	3.58E-09	3.77E-09	3.74E-09	3.57E-09	4.24E-09	3.95E-09	2.36E-09	3.10E-09	3.10E-09
LLRW	m^3	1.96E-03	1.40E-03	1.61E-03	4.54E-03	2.41E-03	3.24E-03	3.47E-03	2.08E-03	2.32E-03	2.32E-03
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6a: LCA Results (A1-A3) for Ready Mix Concrete per yd^3
Duke City Redi-Mix – Los Lunas

Mix ID		30348925	41C00	40348920 AEA	40348920 AEA DC	75 A	70	71	72	73	75
Strength	PSI @ 28 days	3000	3000	4000	4000	250	3000	4000	4000	3000	250
Core Mandatory Impact Indicators											
GWP	kg CO^2e	231.23	249.39	275.34	279.21	60.45	229.23	272.49	232.66	256.08	59.14
ODP	kg CFC11e	8.56E-06	8.64E-06	9.46E-06	9.46E-06	3.37E-06	8.38E-06	9.37E-06	8.51E-06	9.03E-06	3.58E-06
AP	kg SO^2e	0.78	0.79	0.89	0.90	0.35	0.77	0.90	0.78	0.86	0.31
EP	kg Ne	0.30	0.32	0.35	0.36	0.08	0.30	0.35	0.30	0.33	0.08
SFP	kg O^3e	16.03	16.18	18.39	18.47	7.77	15.94	18.58	16.05	17.79	6.67
ADPf	MJ, NCV	1559.47	1627.37	1788.75	1848.34	645.94	1532.88	1780.16	1560.11	1702.22	603.76
ADPe	kg Sbe	1.37E-04	1.48E-04	1.67E-04	1.69E-04	3.45E-05	1.37E-04	1.67E-04	1.38E-04	1.56E-04	2.80E-05
FFD	MJ Surplus	130.26	131.55	143.35	152.29	79.89	126.96	143.96	129.73	140.57	72.26
Use of Primary Resources											
RPRE	MJ, NCV	72.89	77.80	84.92	87.83	17.89	71.22	83.29	72.76	78.81	18.93
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	1636.68	1699.26	1867.94	1932.16	694.36	1606.60	1858.98	1635.37	1780.95	649.63
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters											
FW	m^3	1.81	1.95	2.21	2.23	0.44	1.81	2.21	1.83	2.06	0.36
CCE	kg CO^2e	96.55	107.99	119.42	119.42	11.43	96.55	117.64	97.82	108.75	12.70
Indicators Describing Waste											
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	41.29	41.29	41.29	41.29	41.29	41.29	41.29	41.29	41.29	41.29
HLRW	m^3	2.90E-09	2.01E-09	2.81E-09	2.81E-09	4.82E-09	2.94E-09	3.15E-09	2.81E-09	3.29E-09	3.43E-09
LLRW	m^3	1.31E-03	2.31E-03	1.77E-03	3.51E-03	1.27E-07	9.11E-04	1.55E-03	1.33E-03	1.51E-03	8.47E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6a Continued: LCA Results (A1-A3) for Ready Mix Concrete per yd^3
Duke City Redi-Mix – Los Lunas

Mix ID		303426	303426 AEA	403420 AEA	303420	303420 AEA	403420	453420 AEA	353420	52	55
Strength	PSI @ 28 days	3000	3000	4000	3000	3000	4000	4500	3500	4000	3000
Core Mandatory Impact Indicators											
GWP	kg CO^2e	231.03	232.21	275.04	242.67	247.44	267.57	300.35	261.48	322.00	274.62
ODP	kg CFC11e	8.50E-06	8.40E-06	9.44E-06	8.91E-06	8.86E-06	9.42E-06	1.00E-05	9.27E-06	1.05E-05	9.46E-06
AP	kg SO^2e	0.78	0.78	0.89	0.81	0.82	0.88	0.97	0.86	1.03	0.90
EP	kg Ne	0.30	0.30	0.35	0.32	0.32	0.35	0.38	0.34	0.41	0.35
SFP	kg O^3e	16.05	16.03	18.42	16.61	16.88	18.07	19.96	17.79	21.33	18.51
ADPf	MJ, NCV	1559.27	1554.86	1785.51	1635.01	1637.69	1767.54	1922.52	1726.59	2024.40	1772.28
ADPe	kg Sbe	1.37E-04	1.39E-04	1.67E-04	1.43E-04	1.48E-04	1.61E-04	1.85E-04	1.57E-04	2.01E-04	1.67E-04
FFD	MJ Surplus	130.70	129.23	143.11	136.71	134.26	144.70	151.48	141.40	155.74	140.67
Use of Primary Resources											
RPRE	MJ, NCV	72.41	72.36	84.46	76.74	76.70	83.34	91.33	80.86	96.41	83.82
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	1635.41	1629.13	1863.88	1714.87	1713.69	1848.85	2003.27	1805.48	2105.05	1849.83
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters											
FW	m^3	1.81	1.83	2.21	1.89	1.96	2.13	2.45	2.08	2.67	2.22
CCE	kg CO^2e	96.55	97.82	119.42	101.64	105.45	114.34	132.13	111.80	143.81	119.68
Indicators Describing Waste											
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	41.29	41.29	41.29	41.29	41.29	41.29	41.29	41.29	41.29	41.29
HLRW	m^3	2.90E-09	2.90E-09	2.81E-09	2.71E-09	2.74E-09	2.81E-09	2.92E-09	2.78E-09	3.13E-09	2.94E-09
LLRW	m^3	1.42E-03	1.35E-03	1.70E-03	1.95E-03	1.42E-03	2.13E-03	1.77E-03	1.77E-03	1.29E-03	1.07E-03
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6a Continued: LCA Results (A1-A3) for Ready Mix Concrete per yd^3
Duke City Redi-Mix – Los Lunas

Mix ID		54	56	57	Mix #28 P	303823	403825	603420	353400	403415	503422 AEA
Strength	PSI @ 28 days	4000	3000	4000	3000	3000	4000	6000	3500	4000	5000
Core Mandatory Impact Indicators											
GWP	kg CO^2e	367.98	274.98	309.98	269.35	262.61	321.03	332.11	289.03	265.97	278.23
ODP	kg CFC11e	1.14E-05	9.51E-06	1.02E-05	9.14E-06	9.21E-06	9.91E-06	1.07E-05	1.01E-05	9.42E-06	1.06E-05
AP	kg SO^2e	1.16	0.90	0.99	0.89	0.86	1.03	1.06	0.92	0.87	0.93
EP	kg Ne	0.46	0.35	0.39	0.34	0.34	0.39	0.42	0.37	0.34	0.37
SFP	kg O^3e	24.05	18.55	20.61	18.43	17.83	21.74	22.00	18.80	17.81	18.89
ADPf	MJ, NCV	2266.39	1776.90	1960.05	1805.98	1732.77	2037.11	2118.55	1848.13	1743.69	1859.48
ADPe	kg Sbe	2.33E-04	1.67E-04	1.92E-04	1.64E-04	1.59E-04	2.04E-04	2.07E-04	1.72E-04	1.59E-04	1.62E-04
FFD	MJ Surplus	170.02	141.21	151.85	152.48	141.67	161.90	166.87	144.68	141.14	152.51
Use of Primary Resources											
RPRE	MJ, NCV	108.39	84.04	93.21	82.75	81.41	92.61	100.45	89.28	82.76	89.32
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	2349.22	1855.09	2039.84	1885.61	1812.16	2109.81	2204.43	1928.15	1823.37	1953.48
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters											
FW	m^3	3.10	2.22	2.56	2.15	2.10	2.70	2.74	2.28	2.10	2.15
CCE	kg CO^2e	167.44	119.68	137.72	114.34	112.31	143.56	146.86	127.04	114.34	116.88
Indicators Describing Waste											
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	41.29	41.29	41.29	41.29	41.29	41.29	41.29	41.29	41.29	41.29
HLRW	m^3	3.31E-09	2.94E-09	3.08E-09	3.06E-09	2.93E-09	3.45E-09	3.22E-09	2.01E-09	2.57E-09	2.57E-09
LLRW	m^3	1.50E-03	1.07E-03	1.23E-03	3.48E-03	1.84E-03	2.48E-03	2.66E-03	1.60E-03	1.77E-03	1.77E-03
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6b: LCA Results (A1-A3) for Ready Mix Concrete per m^3
Duke City Redi-Mix – Los Lunas

Mix ID		30348925	41C00	40348920 AEA	40348920 AEA DC	75 A	70	71	72	73	75
Strength	PSI @ 28 days	3000	3000	4000	4000	250	3000	4000	4000	3000	250
Core Mandatory Impact Indicators											
GWP	kg CO^2e	302.04	325.76	359.67	364.72	78.96	299.43	355.94	303.91	334.50	77.25
ODP	kg CFC11e	1.12E-05	1.13E-05	1.24E-05	1.24E-05	4.41E-06	1.09E-05	1.22E-05	1.11E-05	1.18E-05	4.67E-06
AP	kg SO^2e	1.02	1.03	1.17	1.18	0.45	1.01	1.17	1.02	1.12	0.40
EP	kg Ne	0.40	0.42	0.46	0.47	0.10	0.39	0.46	0.40	0.43	0.11
SFP	kg O^3e	20.93	21.14	24.03	24.13	10.15	20.82	24.26	20.96	23.24	8.72
ADPf	MJ, NCV	2037.06	2125.75	2336.56	2414.39	843.76	2002.33	2325.34	2037.89	2223.52	788.66
ADPe	kg Sbe	1.79E-04	1.93E-04	2.18E-04	2.21E-04	4.51E-05	1.79E-04	2.18E-04	1.80E-04	2.03E-04	3.65E-05
FFD	MJ Surplus	170.15	171.84	187.26	198.92	104.35	165.84	188.05	169.46	183.63	94.39
Use of Primary Resources											
RPRE	MJ, NCV	95.21	101.62	110.93	114.73	23.37	93.03	108.80	95.04	102.95	24.73
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	2137.91	2219.66	2440.00	2523.89	907.01	2098.62	2428.30	2136.21	2326.37	848.58
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters											
FW	m^3	2.37	2.55	2.89	2.91	0.58	2.37	2.88	2.39	2.69	0.46
CCE	kg CO^2e	126.12	141.06	156.00	156.00	14.94	126.12	153.67	127.78	142.06	16.60
Indicators Describing Waste											
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	53.93	53.93	53.93	53.93	53.93	53.93	53.93	53.93	53.93	53.93
HLRW	m^3	3.79E-09	2.62E-09	3.68E-09	3.68E-09	6.29E-09	3.84E-09	4.12E-09	3.68E-09	4.30E-09	4.48E-09
LLRW	m^3	1.71E-03	3.01E-03	2.32E-03	4.59E-03	1.65E-07	1.19E-03	2.03E-03	1.74E-03	1.98E-03	1.11E-07
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6b Continued: LCA Results (A1-A3) for Ready Mix Concrete per m^3
Duke City Redi-Mix – Los Lunas

Mix ID		303426	303426 AEA	403420 AEA	303420	303420 AEA	403420	453420 AEA	353420	52	55
Strength	PSI @ 28 days	3000	3000	4000	3000	3000	4000	4500	3500	4000	3000
Core Mandatory Impact Indicators											
GWP	kg CO^2e	301.79	303.33	359.28	316.99	323.22	349.51	392.34	341.56	420.62	358.72
ODP	kg CFC11e	1.11E-05	1.10E-05	1.23E-05	1.16E-05	1.16E-05	1.23E-05	1.31E-05	1.21E-05	1.37E-05	1.24E-05
AP	kg SO^2e	1.02	1.01	1.17	1.06	1.07	1.15	1.26	1.13	1.34	1.17
EP	kg Ne	0.39	0.39	0.46	0.41	0.42	0.45	0.50	0.44	0.53	0.46
SFP	kg O^3e	20.97	20.94	24.06	21.69	22.05	23.61	26.07	23.23	27.86	24.18
ADPf	MJ, NCV	2036.80	2031.05	2332.32	2135.74	2139.24	2308.85	2511.30	2255.37	2644.38	2315.04
ADPe	kg Sbe	1.79E-04	1.81E-04	2.18E-04	1.87E-04	1.93E-04	2.10E-04	2.41E-04	2.05E-04	2.62E-04	2.19E-04
FFD	MJ Surplus	170.73	168.80	186.94	178.58	175.38	189.02	197.87	184.70	203.44	183.75
Use of Primary Resources											
RPRE	MJ, NCV	94.58	94.52	110.33	100.24	100.19	108.87	119.30	105.62	125.94	109.49
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	2136.26	2128.06	2434.69	2240.05	2238.51	2415.06	2616.78	2358.41	2749.73	2416.35
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters											
FW	m^3	2.37	2.40	2.89	2.47	2.56	2.78	3.20	2.71	3.49	2.90
CCE	kg CO^2e	126.12	127.78	156.00	132.76	137.74	149.36	172.59	146.04	187.86	156.33
Indicators Describing Waste											
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	53.93	53.93	53.93	53.93	53.93	53.93	53.93	53.93	53.93	53.93
HLRW	m^3	3.79E-09	3.79E-09	3.68E-09	3.54E-09	3.58E-09	3.68E-09	3.81E-09	3.63E-09	4.09E-09	3.84E-09
LLRW	m^3	1.85E-03	1.76E-03	2.22E-03	2.55E-03	1.85E-03	2.78E-03	2.32E-03	2.32E-03	1.68E-03	1.40E-03
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6b Continued: LCA Results (A1-A3) for Ready Mix Concrete per m^3
Duke City Redi-Mix – Los Lunas

Mix ID		54	56	57	Mix #28 P	303823	403825	603420	353400	403415	503422 AEA
Strength	PSI @ 28 days	4000	3000	4000	3000	3000	4000	6000	3500	4000	5000
Core Mandatory Impact Indicators											
GWP	kg CO^2e	480.68	359.19	404.91	351.83	343.03	419.35	433.82	377.55	347.42	363.44
ODP	kg CFC11e	1.49E-05	1.24E-05	1.33E-05	1.19E-05	1.20E-05	1.29E-05	1.40E-05	1.32E-05	1.23E-05	1.38E-05
AP	kg SO^2e	1.51	1.17	1.30	1.16	1.13	1.35	1.39	1.20	1.13	1.21
EP	kg Ne	0.60	0.46	0.51	0.44	0.44	0.51	0.55	0.49	0.45	0.48
SFP	kg O^3e	31.41	24.24	26.92	24.07	23.30	28.39	28.73	24.55	23.27	24.68
ADPf	MJ, NCV	2960.48	2321.08	2560.32	2359.07	2263.43	2660.99	2767.36	2414.12	2277.69	2428.96
ADPe	kg Sbe	3.05E-04	2.19E-04	2.51E-04	2.14E-04	2.07E-04	2.66E-04	2.70E-04	2.25E-04	2.08E-04	2.12E-04
FFD	MJ Surplus	222.08	184.46	198.36	199.18	185.06	211.49	217.98	188.99	184.37	199.21
Use of Primary Resources											
RPRE	MJ, NCV	141.59	109.78	121.75	108.09	106.34	120.97	131.21	116.62	108.11	116.67
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	3068.68	2423.22	2664.55	2463.08	2367.14	2755.95	2879.55	2518.65	2381.78	2551.74
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters											
FW	m^3	4.05	2.90	3.34	2.81	2.74	3.52	3.58	2.98	2.75	2.81
CCE	kg CO^2e	218.73	156.33	179.89	149.36	146.70	187.53	191.84	165.95	149.36	152.68
Indicators Describing Waste											
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	53.93	53.93	53.93	53.93	53.93	53.93	53.93	53.93	53.93	53.93
HLRW	m^3	4.33E-09	3.84E-09	4.03E-09	4.00E-09	3.83E-09	4.50E-09	4.21E-09	2.62E-09	3.36E-09	3.36E-09
LLRW	m^3	1.96E-03	1.40E-03	1.61E-03	4.54E-03	2.41E-03	3.24E-03	3.47E-03	2.08E-03	2.32E-03	2.32E-03
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

References

American Concrete Institute (ACI) 211: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

American Concrete Institute (ACI) 318: Building Code Requirements for Structural Concrete ASTM International

(ASTM) C94: Standard Specification for Ready-Mixed Concrete

Athena Sustainable Materials Institute (2019) A Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete Manufactured by Duke City Redi-Mix.

Construction Specifications Institute (CSI) MasterFormat Division 03-30-00 Cast-in-Place Concrete

EN 15804:2012 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.

European Federation of Concrete Admixture Associations (2015). EFCA Environmental Declarations for Admixtures. http://www.efca.info/efca-publications/environmental/

ISO 21930:2017 Sustainability in Building Construction — Environmental Declaration of Building Products.

ISO 14025: 2006 Environmental labeling and declarations - Type III environmental declarations - Principles and procedures.

ISO 14044: 2006 Environmental management - Life cycle assessment - Requirements and guidelines.

ISO 14040: 2006 Environmental management - Life cycle assessment - Principles and framework.

National Ready Mixed Concrete Association (2013) Program Operator Instructions for Environmental Product Declarations v1.2.

National Renewable Energy Laboratory (2014) U.S. Life Cycle Inventory Database. https://www.lcacommons.gov/nrel/search.

NSF (2019) International Product Category Rule (PCR) for Concrete Version 1 (February 22, 2019)