Environmental Product Declaration

This document is a product-specific Type III Environmental Product Declaration (EPD) for thee Ground Glass Pozzolans produced from E-glass at Vitro Minerals’ Jackson Plant, 95 Pinnacle Drive, Jackson, TN, 38301.

VitroMinerals
Glass Pozzolans & Additives

General Information

This cradle to gate Environmental Product Declaration cover three ground-glass pozzolans produced by Vitro Minerals meeting the ASTM C1886 specification for Type GE Ground-Glass Pozzolan for Use in Concrete (ASTM, 2020). This study was conducted in accordance with ISO 14040 (ISO 14040, 2006), and 14044 (ISO 14044, 2006) and the requirements of the ISO 21930 (ISO 21930, 2017). ISO 21930 (ISO 21930, 2017) provides the core rules for the Type III Environmental Product Declaration (EPD) produced from this study. No PCR has been developed for ground-glass pozzolans meeting ASTM C1866 specification.

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Date of Issue:

February XX, 2021 (valid for 5 years until February xx, 2026)

ASTM Declaration Number: EPD-XXX

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Product Description

Three ground-glass pozzolans were evaluated in this study: VCAS™ 140 and VCAS™ 160, and VCAS™ Ultra 200. Vitro Mineral's has branded their products VCAS™ Pozzolans (for Vitreous Calcium-Alumino-Silicate). These pozzolans have low alkali content, consistent chemistry, and color. They are especially suited for white concrete applications where they impart desirable benefits such as increased long-term strength and improved long-term durability of concrete products. Each of these powders is produced from waste E-glass and meet the ASTM C1866 specification for a Type GE Ground-Glass Pozzolan for Use in Concrete.

Table 1: Product specifications

Product	Particle Size (D50)[1]	Brightness[2]
VCAS™ 140	12 microns	87-89
VCAS™ 160	10 microns	87-89
VCAS™ Ultra 200	7 microns	87-89

VCAS 160™ and VCAS™ 140 are commonly used in systems with low water/cement ratio and steam cured or warm weather curing conditions where the lower reactivity associated with a 4000 Blaine product[3] is sufficient for the application. VCAS™ 200 has a much finer particle size and has the reactivities normally associated with silica fume and metakaolin with the advantage of being white in color. All VCAS™ grades exhibit approximately 10% lower water demand than silica fume or metakaolin and can be used at cement replacement levels of up to 40%.

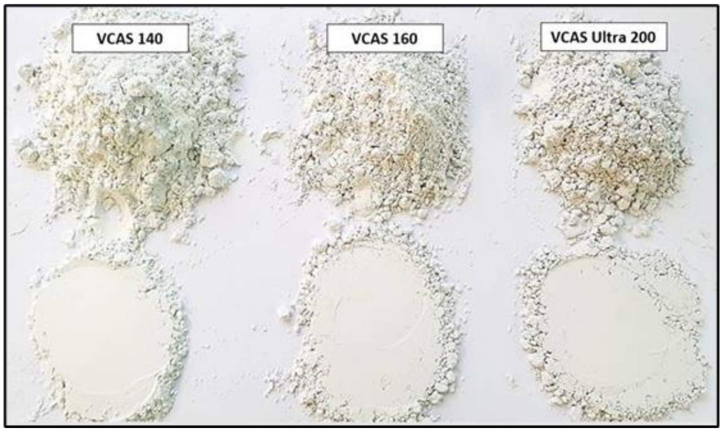

Figure 1: Type GE ground-glass pozzolan product types covered in study[4]

Production of VCAS 160™, VCAS™ 140 and VCAS™ 200 starts with the primary sizing of the waste E-glass. This feed stock is then finely ground and processed through high efficiency classifiers to produce a fine white powder with quality assured physical properties. The consistent chemical composition and tightly controlled particle size distribution offers excellent repeatability of properties in concrete applications.

Declared Unit: 1 metric ton of ground-glass pozzolan

Product Components: 100% E-glass

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[1] D50: The portions of particles with diameters smaller and larger are 50%.
[2] VCAS pozzolans are whiter than white cement and will not discolor decorative concrete.
[3] Blane number refers to particle size distribution.
[4] For further description see https://vitrominerals.com/products/recycled-glass-powders/vcas-white-pozzolans/

System boundary

This study is cradle-to-gate covering A1-A3 stages of the life cycle as illustrated in Figure 3.

- **A1 – Raw Material Supply** (upstream processes): Extraction, handling, and processing of the materials (including fuels) used in the production of glass powder.
- **A2 – Transportation:** Transportation of these materials from the supplier to the 'gate' of the Jackson, TN Plant.
- **A3 – Manufacturing** (core processes): Manufacturing of the product including, grinding, packaging and waste handling and treatment.

PRODUCTION Stage (*Mandatory*)			CONSTRUCTION Stage		USE Stage					END-OF-LIFE Stage			
Extraction and upstream production	Transport to factory	Manufacturing	Transport to site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	De-construction/ Demolition	Transport to waste processing or disposal	Waste processing	Disposal of waste
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Figure 2: Life-cycle stages and modules

Note: MND = module not declared; X = module included.

Except as noted above, all other life cycle stages as described in Figure 1 are excluded from the LCA study. The following processes are also excluded from the study:

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

The main processes included in the system boundary are illustrated in Figure 3.

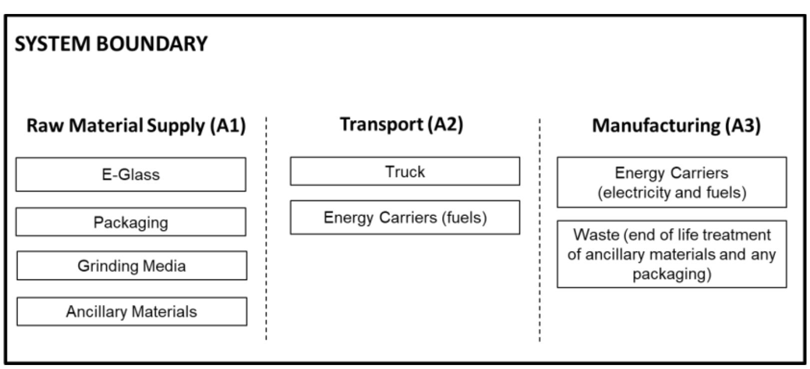

Figure 3: System Boundary for study

Electricity impacts are calculated based on electricity provided at the grid of the state of Tennessee provided by US EI database (Long Trail Sustainability, 2020). The resource mix for the state of Tennessee is: 44.4% nuclear, 25.7% coal, 16.4% natural gas, 11.9% hydro, 1.2 wood chips, 0.2% solar, and <0.1% oil, and wind.

Allocation procedure

This study follows the rules of ISO 14044, 2006 section 4.3.4, avoiding allocation wherever possible, and when allocation cannot be avoided, partitioning impacts based on physical causality. Recycling procedures follow the rules of the ISO 21930:2017 Section 7.2.6 (ISO 21930, 2017). E-glass is treated as recovered material and thus the environmental impacts allocated are limited to the treatment and transportation required to use as a ground-glass pozzolan material input.

Cutoff criteria

All inputs and outputs to a unit process have been included in the calculation, for which data are available. Data gaps have been filled by conservative assumptions with average or generic data. Any assumptions for such choices have been documented. When data was not reasonably available, the following cutoff criteria were used:

- Mass | If a flow is less than 1% of the cumulative mass of the model flows, it may be excluded, provided its environmental relevance is minor.
- Energy | If a flow is less than 1% of the cumulative energy of the system model, it may be excluded, provided its environmental relevance is minor.
- Environmental relevance | Material and energy flows known or expected to have the potential to cause environmentally relevant emissions into air, water, or soil related to the environmental indicators of the PCR shall be included unless justification for exclusion is documented.

The total of neglected input flows is less than 1% of energy usage and mass.

References

ACLCA (2019): *ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017.*

ASTM (2020): *ASTM C1866 / C1866M-20, Standard Specification for Ground-Glass Pozzolan for Use in Concrete.* West Conshohocken, PA: ASTM International.

Climate Earth (2021): Vitro Minerals LCA Project Report.

EPA (2014): *Tool for the Reduction of Assessment of Chemical and Other Environmental Impacts (TRACI).*

ISO 14020 (2000): *Environmental labels and declarations – General principles*

ISO 14025 (2006): *Environmental labels and declarations, Type III environmental declarations, Principles and procedures.*

ISO 14040 (2006): *ISO 14040; Environmental Management - Life Cycle Assessment - Principles and Framework.*

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

ISO 21930 (2017): *ISO 21930; Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of custruction products and services.*

PRé Sustainability (2020): *SimaPro Vers. 9.1.0.8.* www.pre-sustainability.com/simapro.

Life Cycle Impact Assessment Results

Table 2:Cradle to Gate (A1-A3) impact results per metric tonne for each ground-glass pozzolan

Impact Assessment	Unit	VCAS-140	VCAS-160	VCAS-Ultra200
Global warming potential (GWP)[5]	kg CO_2 e	**95.8**	**119**	**150**
Depletion potential of the stratospheric ozone layer (ODP)[6]	kg CFC-11 e	**8.12E-06**	**1.02E-05**	**1.30E-05**
Eutrophication potential (EP)[4]	kg N e	**0.25**	**0.31**	**0.40**
Acidification potential of soil and water sources (AP) [4]	kg SO2 e	**0.46**	**0.57**	**0.71**
Formation potential of tropospheric ozone (POCP) [4]	kg O_3 e	**4.74**	**5.67**	**6.90**
Resource Use				
Abiotic depletion potential for fossil resources (ADPfossil)	MJ, NCV	**1,072**	**1,327**	**1,664**
Renewable primary energy resources as energy (fuel), (RPRE)*[7]	MJ, NCV	**145**	**177**	**219**
Renewable primary resources as material, (RPRM)*[5]	MJ, NCV	**0**	**0**	**0**
Non-renewable primary resources as energy (fuel), (NRPRE)* [5]	MJ, NCV	**2,507**	**3,140**	**3,974**
Non-renewable primary resources as material (NRPRM)* [5]	MJ, NCV	**0**	**0**	**0**
Consumption of fresh water[5]	m3	**3.22**	**3.90**	**4.80**
Secondary Material, Fuel and Recovered Energy				
Secondary Materials, (SM)* [5]	kg	**1,000**	**1,000**	**1,000**
Renewable secondary fuels, (RSF)* [5]	MJ, NCV	**0**	**0**	**0**
Non-renewable secondary fuels (NRSF)* [5]	MJ, NCV	**0**	**0**	**0**
Recovered energy, (RE)* [5]	MJ, NCV	**0**	**0**	**0**
Waste & Output Flows				
Hazardous waste disposed*[5]	kg	**0**	**0**	**0**
Non-hazardous waste disposed*[5]	kg	**0**	**0**	**0**
High-level radioactive waste*[5]	m3	**7.77E-07**	**9.82E-07**	**1.25E-06**
Intermediate and low-level radioactive waste*[5]	m3	**3.75E-06**	**4.73E-06**	**6.03E-06**
Components for reuse*[5]	kg	**0**	**0**	**0**
Materials for recycling*[5]	kg	**0.25**	**0.25**	**0.25**
Materials for energy recovery*[5]	kg	**2.02E-02**	**2.02E-02**	**2.02E-02**
Recovered energy exported from the product system*[5]	MJ	**0**	**0**	**0**

Life cycle impact assessment (LCIA) results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins, or risks.

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

LCA Interpretation

Most glass powder impacts come from the A3 life cycle stage. Electricity from the grinding operation is the primary source of global warming potential (GWP) impacts for this stage.

* 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.

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[5] Calculated as per U.S. EPD TRACI v2.1, with IPCC 2013 (AR 5)
[6] Calculated as per U.S. EPA TRACI v2.1 (EPA, 2014)
[7] Calculated as per ACLCA ISO 21930 Guidance (ACLCA, 2019)