Life Cycle Assessment (LCA) Report for Zurn Vitreous Wall Hung Lavatories

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1 General Aspects

This report presents the findings of the Life Cycle Assessment (LCA) conducted by SCS Consulting Services (SCS) of two vitreous china lavatory product lines manufactured for Zurn Industries at the ceramics facility in Tangshan City, China.

The primary intended application of this LCA is to support the development of one Environmental Product Declaration (EPD), conformant to ISO 14025[1], ISO 14044[2], ISO 21930[3], and the Sustainable Minds (SM) LCA calculation rules and report requirements Part A[4] and Part B: Product group definition | Commercial Lavatories.[5] The LCA study scope, methodology, data sources, assumptions, and limitations used to calculate the final indicator results developed for the EPD are described in this report. The following life cycle stages are included: raw material extraction and processing; transport to the manufacturer; product manufacturing and packaging; product distribution; installation; use and maintenance, and product disposal.

This report is provided to aid in understanding the life cycle impacts for the Zurn vitreous china lavatories for the category indicators specified by the PCR. The intended audience for this technical LCA report includes Zurn, the EPD verifier, and other LCA practitioners or technical audiences with which Zurn chooses to share the report. The report is intended for business to business (B2B) communication. The results of the study are not intended for use in comparative assertions. This report has been critically reviewed by an external LCA practitioner independent of the project for conformance to ISO 14044 and the PCR.

The results presented herein are NOT to be used as the sole basis for a comparative assertion to be disclosed to the public.

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[1] ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and procedures
[2] ISO 14044:2006 Environmental Management – Life cycle assessment – Requirements and Guidelines
[3] ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services
[4] Sustainable Minds PCR Part A: Life Cycle Assessment Calculation Rules and Report Requirements. Version 4.0 | February 2026
[5] Sustainable Minds PCR Part B: Product group definition | Commercial lavatories | Part B #24-001, October 7, 2024.

2 Goal of the Study

The goals of the study include three primary objectives:

- To assess the potential environmental impacts, using the category indicators specified by the Part A PCR and Part B PCR, for two vitreous china lavatory product lines – the Z5340 and the Z5360 lavatory lines - over their entire life cycle, from raw material extraction and processing, product manufacture and packaging, product distribution, installation, product use and maintenance, and product disposal.
- To serve as the basis of preparing one Environmental Product Declaration (EPD), for the vitreous lavatories, conformant to the Part A PCR and Part B PCR, ISO 14025, ISO 14044, and ISO 21930:2017.

Life Cycle Impact Assessment (LCIA) results are reported using the indicators prescribed by the Part A PCR and Part B PCR for North America. It should be noted that the PCR does not require reporting of all environmentally relevant impacts, such as impacts to ecosystems, key species habitats, or water resources.

3 Scope of the study

3.1 Product description

The products assessed in this study are Zurn vitreous china commercial lavatory sinks and they belong to the CSI MasterFormat[6] code 22 42 16.13 / 22 42 33 and UNSPSC[7] code 30180000. The products are exchangeable devices that can be connected to a plumbing system to deliver and drain water quickly, are designed with a front overflow, and are installed in restrooms for commercial buildings, airports, stadiums, and the healthcare and hospitality sectors. The product systems under study do not include faucets.

Six specific SKUs across two product lines are included, three for each product line:

• Z5341, Z5344, and Z5348 — Wall hung lavatory (manufactured at Tangshan City, China) with a single faucet hole, 4” center faucet hole, and 8” center faucet hole, respectively.

• Z5361, Z5364, and Z5368 — High Back Wall hung lavatory (manufactured at Tangshan City, China) with a single faucet hole, 4” center faucet hole, and 8” center faucet, respectively.

The specifications and descriptions of each of the vitreous china products included in the study are shown below in Table 1. Note that the products included in this report not differ in their environmental impact indicators by more than ±10 %.

[6] Construction Specifications Institute (CSI)
[7] United Nations Standard Products and Services Code (UNSPSC)

Table 1. Specification of vitreous china lavatory product groups included in the study.

Specification	Z5341 / Z5344 / Z5348	Z5361 / Z5364 / Z5368
Material	Vitreous China	Vitreous China
Mounting Type	Wall Hung	Wall Hung
ADA Compliant	Yes	Yes
Compliance	ASME A112.19.2 / CSA B45.1	ASME A112.19.2 / CSA B45.1
Faucet holes	single, 4", or 8" centers, respectfully	single, 4", or 8" centers, respectfully
Width	457 mm (18 in)	457 mm (18 in)
Length	508 mm (20 in)	508 mm (20 in)

Figure 1. Z5341, Z5344, and Z5348 Wall hung lavatory

Figure 2. Z5361, Z5364, and Z5368 Wall hung lavatory

3.2 Function, functional unit and reference flows

According to ISO 14044, the functional unit is "the quantified performance of a product system, for use as a reference unit." Vitreous china lavatories are intended for connection to a plumbing system to deliver and drain water. These fixtures are primarily installed in the commercial environment including commercial buildings, airports, stadiums, healthcare, hospitality sectors, and others. This study defines the functional unit as one (1) commercial lavatory in an average commercial environment with a Reference Service Life (RSL) of 20 years in a building with an Estimated Service Life of 75 years.

The 75 year Estimated Service Life of the building is consistent with ASHRAE 189.1 (2014, Section 9.5.1) . The reference flows for the products included in this study are summarized in Table 2 below.

Table 2: Functional unit and reference flows for the product systems under study.

Name	Unit	Z5341 / Z5344 / Z5348	Z5361 / Z5364 / Z5368
Functional Unit	One (1) commercial lavatory used in an average commercial environment over the estimated service life of the building		
Mass	kg	18.4	20.4

3.3 System description

General description of the system

The Zurn vitreous china lavatories are manufactured in Tangshan City, China. The products vitreous china consisting of kaolin, feldspar, clay, quartz, calcite, minerals and an iron bracket component. The products are assessed based on the reference service life and functional unit noted in Section 3.2. Detailed product specifications and performance results can be found at the manufacturer's website: https://www.zurn.com/products/finish-plumbing/fixtures/lavatories.

The product systems studied in this LCA include the cradle-to-grave impacts of the Zurn vitreous china lavatories. The systems were modeled based on information provided by the manufacturer and completed Data Request Forms. Product packaging, including end-of-life disposal, is also included in the model.

Geographical coverage

This study is specific to the vitreous china lavatories manufactured in Tangshan City, China. The products are distributed throughout North America based on data provided by the manufacturer. Electricity use in the study was modeled using inventory datasets specific to the State Grid Corporation electricity grid in China. Disposal processes are modeled following assumptions based on regional statistics stated in the SM Part B PCR.

Time coverage

Manufacturer supplied data (primary data) are based on a 12-month period from January 1st 2025 through December 31st 2025.

3.4 System boundaries

Inclusion and exclusion rules for unit processes and flows

The product system under study includes the production of the lavatories, as well as the transportation to point of use, installation, use, maintenance, and end-of-life. The boundaries include all unit processes contributing measurably to category indicator results for the specified category indicators.

All inputs and outputs relevant to the production of the products were included in the LCA calculations. According to the PCR, processes contributing to greater than 1% of the total environmental impact indicator for each impact must be included in the inventory. In the present study, all known materials and processes were included in the life cycle inventory.

Capital equipment, construction, maintenance, and infrastructure were excluded from the system boundary, as the capital equipment is assumed to have a negligible impact to environmental effects due to the general long lifetime of the manufacturing buildings and capital equipment. Human activity such as personnel travel and resource were also excluded from the system boundary.

The life cycle stages included in this study are shown in Table 3. A flow diagram of the product system, including system boundaries, is provided in Figure 4.

Table 3. System boundary for the Vitreous Lavatories.

Product			Construction Process		Use							End-of-life				Benefits and loads beyond the system boundary
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material extraction and processing	Transport to manufacturer	Manufacturing	Transport	Construction - installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	Reuse, recovery and/or recycling potential
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	MND

X = Included in system boundary
MND = Module not declared

Figure 2. Flow diagram and system boundaries for the life cycle of the Zurn vitreous china lavatory products.

Allocation procedures

This study follows the allocation guidelines of ISO 14044 and sought to minimize the use of allocation wherever possible. In general, manufacturing facilities may produce multiple products, and in such cases it is necessary to divide the environmental impacts between the different products. For this study of Zurn vitreous china lavatories, a unit-based allocation based on the total facility production of finished products was used for the manufacturing facility, including the allocation of electricity and energy use at the facility. The secondary databases used for the product system apply allocation based primarily on physical relationships (e.g., volume, energy content, or mass-based relationships).

Impacts from the transportation, including product distribution to the installation site, were allocated based on the mass of material and distance transported.

No burdens are allocated across the system boundary with secondary material, secondary fuel or recovered energy flows arising from waste.

3.5 General assumptions

The assessment relied on a number of assumptions related to material composition, processing, installation, use, and end-of-life. The major assumptions used in the assessment are described below.

- Specific data were not available on quartz in the product recipe. A secondary dataset for silica sand was used from the Ecoinvent database.
- Specific data were not available on calcite and wollastonite in the product recipe. Secondary datasets for calcium carbonate and limestone were used from the Ecoinvent database for these components, respectively.
- Transport of the manufacturing and installation waste was assumed to be 100 km.
- Product transport was assumed to be 800 km by truck, consistent with the Part B PCR.
- Installation of the products was assumed to be manual, requiring no additional materials or energy use.
- Transport of the product at end-of-life to waste processing and disposal was assumed to be 100 km by truck.
- The Reference Service Life (RSL) of the products was modeled as 20 years.
- The Estimated Service Life (ESL) of the building construction works was assumed to be 75 years.
- The maintenance of the products was assumed to include daily cleaning with a cleaning solution of 10 ml of 1% sodium lauryl sulfate solution for vitreous china Lavatories, performed 260 days per year.
- The products were assumed to require no replacement during the prescribed RSL, but requires replacement over the 75-year ESL (1.5 times).

- The use phase modules B1 (use), B3 (Repair), B5 (Refurbishment), B6 (Operational Energy Use) and B7 (Operational Water Use) were assumed to have no impacts, as there was no resource or energy use associated with these modules.
- The use phase modules B2 (Maintenance) and B4 (Replacement) were modeled for the building construction works ESL of 75 years.
- For the product end-of-life, disposal of product was assumed to 100% disposal in landfill, consistent with the Part B PCR.
- All transport included an empty return trip, which was built into the Ecoinvent dataset.

3.6 Equivalence of compared systems

The results presented in this report are not intended for use in comparative assertions.

3.7 Sensitivity analysis for refining the system boundaries

Sensitivity analyses were conducted to evaluate the impact of the various modeling assumptions on indicator results. The results of the analysis are presented and discussed in Section 8.

4 Data Requirements

4.1 Data Requirements

The life cycle inventory (LCI) of each unit process comprises those material and energy inputs, emissions, wastes, and product outputs associated with the operation. Environmental flows from the LCI modeling are used to calculate environmental impacts in the Life Cycle Impact Assessment (LCIA) phase, discussed in Section 5. According to the PCR, processes contributing greater than 1% of the total environmental impact indicator for each impact must be included in the inventory. In the present study, except as noted, all known materials and processes were included in the life cycle inventory.

The study included several key data requirements:

- Functional description of the products;
- Material composition of the products and packaging;
- Primary data for manufacturing facilities, including energy use and waste generation;
- Representative inventory data for many unit processes, using secondary data from the Ecoinvent[8] life cycle databases, with a prioritization for data with the highest degree of representativeness of the actual material or process;

[8] Ecoinvent v3.12 2025. Swiss Center for Life Cycle Inventories, 2025 http://www.ecoinvent.org

- Transportation data for materials and estimates of product distribution.

4.2 Data quality requirements

One of the primary goals of the study is to produce an LCA and EPD for the Zurn vitreous china lavatory products; as such the overarching data quality requirements are to enable a reliable assessment of the indicator results for all reported impact categories, with data quality sufficient as to identify the key unit processes, differentiated by overall contribution to final results. No data gaps were allowed which were expected to significantly affect the outcome of the indicator results.

A data quality assessment is provided in Section 4.3 of this report, according to the requirements of the PCR, and considers all of the following data quality requirements as noted in ISO 14044 Section 4.2.3.6.

- Time-related coverage of the data (age, minimum collection period);
- Geographical coverage;
- Technological coverage (specific technologies or technology mixes that should be used);
- Precision (measure of the variability of the data values for each data expressed);
- Completeness (percentage of flow that is measured or estimated);
- Representativeness (qualitative assessment of the degree to which the data set reflects the true population of interest);
- Consistency (qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis);
- Reproducibility (qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce results reported in the study);
- Sources of data; and
- Uncertainty of the information (e.g. data, models, and assumptions).

4.3 Data quality assessment

The data quality assessment addresses the following parameters: time-related coverage, geographical coverage, technological coverage, precision, completeness, representativeness, consistency, reproducibility, sources of data, and uncertainty.

Table 4. Data quality assessment.

Data Quality Parameter	Data Quality Discussion
Time-related Coverage: Age of data and the minimum length of time over which data is collected	The manufacturer provided primary data on product manufacturing for the Tangshan City facility on annual production for January 2025 - December 2025. The manufacturer provided primary data on product manufacturing for the vitreous china bowl, iron bracket hardware, and other resources. Representative datasets (secondary data) for upstream and background processes are generally less than 5 years old.
Geographical Coverage: Geographical area from which data for unit processes is collected to satisfy the goal of the study	The data used in the analysis provide the best possible representation available with current data. Electricity use for product manufacture is modeled using representative Ecoinvent grid-mixes dataset for the State Grid Corporation electricity grid in China. Surrogate data used in the assessment are representative of global or US operations and are considered sufficiently similar to actual processes.
Technology Coverage: Specific technology or technology mix	For the most part, data are representative of the actual technologies used for processing, transportation, and manufacturing operations. Representative component datasets, specific to the type of material, are used to represent the actual processes, as appropriate.
Precision: Measure of the variability of the data values for each data expressed	Precision of results are not quantified due to a lack of data. Data collected for operations were typically averaged for one or more years and over multiple operations, which is expected to reduce the variability of results.
Completeness: Percentage of flow that is measured or estimated	The LCA model included all known mass and energy flows for production of the products. In some instances, surrogate data used to represent upstream and downstream operations may be missing some data which is propagated in the model. No known processes or activities contributing to more than 1% of the total environmental impact for each indicator are excluded.
Representativeness: Qualitative assessment of the degree to which the data set reflects the true population of interest	Data used in the assessment represent typical or average processes as currently reported from multiple data sources and are therefore generally representative of the range of actual processes and technologies for production of these materials. Considerable deviation may exist among actual processes on a site-specific basis; however, such a determination would require detailed data collection throughout the supply chain back to resource extraction.
Consistency: Qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis	The consistency of the assessment is considered to be high. Data sources of similar quality and age are used; with a bias towards Ecoinvent v3.12 data where available. Different portions of the product life cycle are equally considered.
Reproducibility: Qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	Based on the description of the data and assumptions used, this assessment would be reproducible by other practitioners. All assumptions, models, and data sources are documented.
Sources of the Data: Description of all primary and secondary data sources	Data representing energy use at the Tangshan City facility manufacturing facility represent a 12-month average and are considered of high quality due to the length of time over which these data are collected, as compared to a snapshot that may not accurately reflect fluctuations in production. For secondary LCI data, Ecoinvent v3.12 data are used.
Uncertainty of the Information: Uncertainty related to data, models, and assumptions	Uncertainty related to materials in the products and packaging is low. Actual supplier data for upstream operations was not available for all suppliers and the study relied upon the use of existing representative datasets. These datasets contained relatively recent data (<5 years) but lacked geographical representativeness. Uncertainty related to the impact assessment methods used in the study are high. The impact assessment methodology includes impact potentials, which lack characterization of providing and receiving environments or tipping points.

4.4 Data types and sources

The life cycle inventory (LCI) of each unit process comprises material and energy inputs, emissions, and wastes. Primary data, as well as datasets from commercial LCI databases are used to model each unit process within the product system and include data quantifying the elementary and technology flows necessary to calculate environmental impacts in the LCIA phase. These include the following general types of data:

- Inputs from nature: biotic and abiotic resources;
- Inputs from the technosphere: ancillary materials, services such as waste management and transport, energy inputs, etc; and
- Outputs to nature: emission to air, water, and soil.

To the extent available, primary data are used for foreground processes (e.g., product manufacturing), while background processes are modeled using secondary data sourced from the Ecoinvent[9] 3.12 LCI databases with a bias towards the most recent and representative data.

Unit processes were developed with the OpenLCA v2.5 LCI model, drawing data from multiple sources. Primary data were provided by the manufacturing facility. In addition, the facility provided supplier locations and transport modes for the product component materials. The principal source of secondary LCI data is the Ecoinvent database. The datasets used in the LCA model to represent the manufacture of the Zurn Vitreous Lavatory products are shown in Table 5.

[9] Ecoinvent Centre (2025) Ecoinvent data from v3.12. Swiss Center for Life Cycle Inventories, Dubendorf, 2020. http://www.ecoinvent.org

Table 5. LCI datasets and associated databases used to model the Zurn Vitreous Lavatories.

Component	Dataset	Geographic Coverage	Data Source	Publication Date
Product				
Kaolin	kaolin production | kaolin | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Clay	market for clay | clay | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Feldspar	feldspar production | feldspar | Cutoff, S - RoW	RoW	Ecoinvent v3.12	2025
Quartz	silica sand production | silica sand | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Calcite	market for calcium carbonate, precipitated | calcium carbonate, precipitated | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Zirconium silicate	zirconium oxide production | zirconium oxide | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Wollastonite	limestone production, crushed, washed | limestone, crushed, washed | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Iron	iron pellet production | iron pellet | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
	metal working, average for metal product manufacturing | metal working, average for metal product manufacturing | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Packaging				
Corrugated	market for corrugated board box | corrugated board box | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Transport				
Truck	market for transport, freight, lorry 16-32 metric ton, EURO4 | transport, freight, lorry 16-32 metric ton, EURO4 | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Ship	market for transport, freight, sea, container ship | transport, freight, sea, container ship | Cutoff, U - GLO	Global	Ecoinvent v3.12	2025
Manufacturing				
Plaster	stucco production | stucco | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Electricity	market for electricity, medium voltage | electricity, medium voltage | Cutoff, U - CN-NCGC	China NCGC	Ecoinvent v3.12	2025
Natural Gas	market for heat, district or industrial, natural gas | heat, district or industrial, natural gas | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Water	market for tap water | tap water | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Use				
Fatty alcohol sulfate	market for fatty alcohol sulfate | fatty alcohol sulfate | Cutoff, U – GLO	Global	Ecoinvent v3.12	2025
water	market for tap water | tap water | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Waste				
Non-Hazardous Waste	market for inert waste | inert waste | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Hazardous Waste	process-specific burdens, residual material landfill | process-specific burdens, residual material landfill | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025
Wastewater	treatment of wastewater from ceramic production, wastewater treatment | wastewater from ceramic production | Cutoff, U - RoW	RoW	Ecoinvent v3.12	2025

4.5 Life cycle inventory data quality

Environmental flows from the LCI modeling are used to calculate environmental impacts in the Life Cycle Impact Assessment (LCIA) phase, discussed in Section 6.

The resource use and emissions from each step of the product life cycle are summed to obtain the life cycle inventory results. The LCIA and inventory flow results were calculated using the OpenLCA model v2.5.0 and summarized for the functional unit of one (1) installed commercial unit from cradle-to-grave.

Life cycle inventory results were reviewed for completeness, consistency and representativeness. Overall, with respect to those impact categories assessed, the inventory was considered consistent and generally representative of the system processes as the same types of data sources are used throughout, primarily from the manufacturer, as well as the Ecoinvent life cycle inventory database. As noted previously, all known processes and materials of the product system are included in the inventory.

4.6 Limitations of the study

As a result of the choice of study scope and LCIA methodologies used, there were several important study limitations which should be understood to ensure an appropriate interpretation of results. None of these limitations were judged to have significant relevance to final indicator results and were deemed acceptable limitations.

Limitations in the Study Scope

- Lacking detailed supplier information, much of the upstream raw materials extraction and processing could not be modeled with actual process information. Representative data from the Ecoinvent LCI databases were utilized as appropriate.
- No specific data was available to estimate the downstream transportation distance from the distribution center in the US to the installation sites. Assumptions were used to estimate the average shipment distance.

Limitations in the Life Cycle Impact Assessment Phase

There are several important limitations in the LCIA methodologies and impact categories used. There may be additional impacts relevant to the production of the products at the manufacturing facility. Some of these omitted impact categories are listed in Table 6. This list is not exhaustive; there may be other impact categories which are not included.

Table 6. Impact categories not included.

Impact Categories
Terrestrial ecotoxicity
Marine aquatic ecotoxicity
Loss of key species
Freshwater aquatic ecotoxicity
Human toxicity

It should also be noted that LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins, or risks.

4.7 Type of critical review

This LCA report has been critically reviewed by an external and independent LCA expert not involved with the execution of this study, in conformance with ISO 14044, following ISO 14071.

5 Life Cycle Inventory

5.1 Primary and Secondary Data

The life cycle inventory (LCI) of each unit process comprises the material and energy inputs, emissions, wastes, and product outputs associated with the operation. Data sources for these inventories include primary data for the material composition of the product and manufacturing energy use and waste generation provided by the manufacturer via completed Data Request Forms (DRFs). Secondary data is sourced from the Ecoinvent LCI databases with a bias towards the most recent and representative data. The primary and secondary data used to model the product systems considered in the assessment are described in the following sections. The life cycle inventory was created in the OpenLCA v2.5.0 software, using a mix of primary and secondary data sources. These inventory data sources were used to create results for each inventory flow relative to the functional unit.

5.2 Product Composition (Module A1)

The product system studied in this LCA includes the cradle-to-grave impacts of the Zurn vitreous china lavatories products described above. The reference flow for the product system is defined as one (1) installed commercial lavatory with a reference service life (RSL) of 20 years.

The raw material recipe for the vitreous china lavatories is the same mixture of kaolin, clay, quartz, feldspar, calcite, zirconium silicate and wollastonite across all products. The differences between the six products are the mass, shape, and size. Each packaged lavatory also includes an iron bracket. Table 7 summarizes the components of the vitreous china lavatories by weight and material type for each product line, including hardware and product packaging (note that packaging is included in module A3).

Table 7. Material component summary for the Vitreous Lavatories.

Product	Z5341 / Z5344 / Z5348		Z5361 / Z5364 / Z5368	
Component Group	**Mass (kg)**	**% Mass**	**Mass (kg)**	**% Mass**
Kaolin	3.60	19.6%	4.00	19.7%
Feldspar powder	4.50	24.5%	5.00	24.6%
Washed Clay	1.98	10.8%	2.20	10.8%
White Clay	1.80	9.8%	2.00	9.8%
Quartz	3.96	21.6%	4.40	21.6%
Calcite	0.540	2.9%	0.600	2.9%
Zirconium silicate	0.720	3.9%	0.800	3.9%
Wollastonite	0.900	4.9%	1.00	4.9%
Iron bracket	0.350	1.9%	0.350	1.7%
Product Total	**18.4**	**100%**	**20.4**	**100%**
Packaging	**Mass (kg)**	**% Mass**	**Mass (kg)**	**% Mass**
Cardboard	1.10	100%	1.20	100%
Packaging Total	**1.10**	**100%**	**1.20**	**100%**

**May not sum due to rounding*

In conformance with the PCR, product materials were reviewed for the presence of any toxic or hazardous chemicals. Based on a review of the product components provided by the manufacturer, no regulated chemicals were identified in the product or product components.

5.3 Raw Material Transportation (Module A2)

Transportation for the LCA model is estimated based on the supplier location and transport data provided by the manufacturer for transport from the component manufacturer (1st tier supplier) to the production facility. Transportation data for 2nd tier suppliers (material supplier to component manufacturer) are based on data embedded in the representative LCI datasets. Road transport is assumed to be by diesel truck and ocean transport is assumed to by container ship. Table 8 lists the average range of transportation used to model each raw material and packaging material.

Table 8. Raw material transportation summary for the Vitreous Lavatories.

Material	Truck Transport (kg*km)	Train Transport (kg*km)	Ship Transport (kg*km)
Z5341 / Z5344 / Z5348	14,584	-	14,386
Z5361 / Z5364 / Z5368	16,006	-	15,984
Packaging	**Truck Transport (kg*km)**	**Train Transport (kg*km)**	**Ship Transport (kg*km)**
Z5341 / Z5344 / Z5348	27.5	-	-
Z5361 / Z5364 / Z5368	30	-	-

5.4 Manufacturing (Module A3)

The Zurn vitreous china lavatories are manufactured in Tangshan City, China. Raw materials, including feldspar, kaolin, clay, quartz, and other minerals are mixed with water and ground thoroughly. The blend is then cast in plaster molds and then dried before a glazing process. After glazing, the fixture is sent for drying and firing. The final products are then inspected and sorted and packaged for distribution. The manufacturer provided primary data for twelve months of data including production, resource use and electricity consumption, and waste generation at the facility. Note that modules A1 and A2 account for the wastage within this module. Table 9 summarizes the manufacture inputs and outputs for the Zurn vitreous china lavatories.

Table 9. Manufacture input and output summary for the Vitreous china lavatories.

Input	Units	Z5341 / Z5344 / Z5348	Z5361 / Z5364 / Z5368
Electricity	kWh	5.08	5.08
Natural gas	kWh	37.0	37.0
Water	kg	70.1	70.1
Ancillary	**Units**	**Z5341 / Z5344 / Z5348**	**Z5361 / Z5364 / Z5368**
Plaster	kg	4.03	4.03
Output	**Units**	**Z5341 / Z5344 / Z5348**	**Z5361 / Z5364 / Z5368**
Emissions to Air: CO_2	kg	60.9	60.9
Emissions to Air: Sulfur Oxides	kg	1.03×10^{-3}	1.03×10^{-3}
Emissions to Air: Nitrogen Dioxide	kg	3.39×10^{-3}	3.39×10^{-3}
Emissions to Water: Ammonia	kg	5.12×10^{-5}	5.12×10^{-5}
Emissions to Water: Ammonium	kg	1.43×10^{-5}	1.43×10^{-5}
Wastewater	kg	34.1	34.1
Hazardous Waste	kg	4.42×10^{-3}	4.42×10^{-3}
Non-Hazardous Waste	kg	5.49	5.77

5.5 Transportation and Distribution (Module A4)

Transportation distance and mode from the manufacturing facility to the Zurn distribution center in Simpsonville, SC was provided by the manufacturer. Transportation from the Simpsonville distribution center to sales and installation locations were not available. This leg of transportation assumes 800 km by truck, as outlined in the Part B PCR. Modeling parameters for product distribution, by transport mode and distance, are summarized in Table 10.

Table 10. Distribution transportation summary for the Vitreous Lavatories.

Name	Unit	Value
Fuel type	-	Diesel
Liters of fuel	l/100 km	18.7
Vehicle Type	-	Freight Truck
Total Transport Distance	km	1,270
Manufacturing Site to Port		*80*
Port to Distribution Center		*390*
Distribution to Installation site		*800*
Capacity utilization	%	37
Vehicle Type	-	Ocean Freight
Transport Distance	km	19,975
Capacity utilization	%	70
Gross Mass: Lavatory_Z5340	kg	19.5
Gross Mass: Lavatory_Z5360	kg	21.6

5.6 Product Installation (Module A5)

Installation of the product is included in the life cycle of the vitreous china lavatories. The installation of the lavatories is completed using manual labor and does not require additional ancillary materials. Waste is generated from the disposal of the packaging material and is modeled as required in the Part A and Part B PCR. Table 11 summarizes the modeling parameters for the installation phase.

Table 11. Installation summary for the *vitreous china lavatories*.

Name	Unit	Z5341 / Z5344 / Z5348	Z5361 / Z5364 / Z5368
Ancillary materials	kg	0	0
Net freshwater consumption specified by water source and fate	m^3	0	0
Other resources	kg	0	0
Electricity consumption	kwh	0	0
Other energy carriers	MJ	0	0
Product loss per functional unit	kg	0	0
Waste materials at the construction site before waste processing, generated by product installation	kg	0	0
Output materials resulting from on-site waste processing	kg	0	0
Mass of packaging waste specified by type	kg	1.10	1.20
Recycle	kg	0.750	0.818
Landfill	kg	0.282	0.307
Incineration	kg	0.068	0.074
Biogenic carbon contained in packaging	kg CO_2	2.02	2.20
Direct emissions to ambient air, soil, and water	kg	0	0
VOC emissions	µg/m^3	0	0

5.7 Product Use (Modules B1-B7)

This study of vitreous china lavatories includes impacts associated with use phase scenarios. Module B1 is assumed to have no impacts, as the water use for the vitreous china Lavatories does not control the water flow which would be captured in the faucet's life cycle assessment. Modules B3 (Repair), B5 (Refurbishment), B6 (Operational Energy Use) and B7 (Operational Water Use) are also assumed to have no impacts as the there are no resource use or waste outputs required in these modules.

Module B2 includes the impacts of maintenance. Typical maintenance for lavatory fixtures include daily cleaning with 10 mL of a 1% sodium lauryl sulfate solution for 260 days per year, consistent with the Part B PCR. Table 12 provides the relevant information for the maintenance (Module B2) over the RSL.

Table 12. Use phase maintenance (Module B2) summary for the Zurn vitreous china lavatories.

Maintenance	Unit	Value
Description of process	-	Daily cleaning with 10 ml 1% sodium lauryl sulfate solution
Maintenance cycle	Cycles/RSL	5,200
Maintenance cycle	Cycles/ESL	19,500
Net freshwater consumption		
City water disposed to sewer	m^3/RSL	5.20×10^{-2}
Ancillary materials		
Sodium lauryl sulfate solution	kg/RSL	0.520
Other resources	kg	0
Energy input	kWh	0
Other energy carriers	kWh	0
Power output of equipment	kW	0
Waste materials from maintenance	kg	0
Direst emissions to ambient air, soil, and water	kg	0
Further assumptions for scenario development	-	-

Table 13. Use phase replacement (Module B4*)* summary for the Zurn vitreous china lavatories

Replacement	Unit	Value
Reference Service Life	Years	20
Replacement cycle (ESL/RSL)-1	-	2.75
Energy input	kWh	0
Net freshwater consumption	m^3	0
Ancillary materials	kg	0
Replacement of worn parts	kg	0
Direct emissions to ambient air, soil, and water	kg	0
Further assumptions for scenario development	-	-

As per the PCR, refurbishment is not expected to occur in the normal operation of the product, and hence zero impacts are assumed.

The operational use phase are also assumed to have no impacts as the there are no resource use or waste outputs required in these modules. Impacts from water use are allocated to the water metering device (e.g., faucet).

5.8 Product End-of-Life (Modules C1-C4)

Impacts for deconstruction and dismantling process (Module C1) were not applicable to this study as it is a manual process performed with hand tools and does not require energy for the removal of the product. Transport of the waste material at end-of-life is assumed to be 100 km as indicated by the Part B PCR. Module C3 (Waste Processing) is also not applicable to this study as the selected scenario is 100% landfilled at the end of life. Table 14 summarizes the relevant information for the end-of-life assumptions for the Vitreous Lavatories.

Table 14. End-of-Life summary for vitreous china lavatories.

End-of-life		Unit	Z5341 / Z5344 / Z5348	Z5361 / Z5364 / Z5368
Assumptions for scenario development				
Collection process	Collected separately	kg	0	0
	Collected with mixed construction waste	kg	18.4	20.4
Recovery	Reuse	kg	0	0
	Recycling	kg	0	0
	Landfill	kg	18.4	20.4
	Incineration	kg	0	0
	Incineration with energy recovery	kg	0	0
	Energy conversion	-	-	-
Disposal	Product of material for final deposition	kg	18.4	20.4
Removals of biogenic carbon (excluding packaging)		kg CO_2	0	0

6 Life Cycle Impact Assessment (LCIA)

6.1 General approach

LCIA Methodology

From the LCI data, impact assessment results are calculated. The choice of methods and indicators used in the assessment are based on the requirements of the Part A and Part B PCR. It should be noted that the LCIA results presented below are relative expressions and do not predict impacts on category endpoints, exceedance of thresholds, safety margins, or risks associated with the product system. Furthermore, the environmental relevance of LCIA results is not affected by LCI functional unit calculation, system wide averaging, aggregation, and allocation.

Indicator calculations

Impact category indicators are estimated using the TRACI 2.2[10] and the IPCC AR6[11] characterization method as required by the PCR. It should be noted that the indicators prescribed by the PCR do not represent all categories of potential environmental and human health impact associated with the life cycle of the lavatories and this represents a general limitation of the LCA study. Additionally, these indicators have no "environmental relevance," as defined in the ISO-14044 §4.4.2.2.2, 4.4.2.2.4, and 4.4.5, with the exception of the "Potential for Global Warming" indicator, which has low environmental relevance. That is, these "potential" results may or may not have any relationship to actual impacts occurring.

Contribution analysis

Life cycle modeling of the vitreous china lavatories was divided into distinct life cycle phases, including raw material extraction and processing, product manufacturing, delivery and installation, product use,

[10] Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI). U.S. EPA. https://www.epa.gov/chemical-research/tool-reduction-and-assessment-chemicals-and-other-environmental-impacts-traci
[11] IPCC Sixth Assessment Report (AR6) Working Group I — Climate Change 2021

and disposal. A detailed examination of the potential environmental impacts provides some insight into the relative contributions from each of the product's life cycle phases.

6.2 Life cycle impact assessment indicators

Mandatory elements

The LCA conforms to ISO 14044/44 and the Part A and Part B PCRs. Indicator results are estimated using the impact categories required in the PCR. For this study, the characterization factors from the TRACI 2.2, EF 3.1 and IPCC AR6 (2021) were used. Based on the component materials of the product and production processes, there are no impacts associated with land-use changes, nor are environmental impacts associated with carbonation relevant for the product system. The impact indicators used for this assessment are presented in Table 15.

Table 15. Impact categories used for this assessment.

Category Indicator	LCIA Method	Unit	Impact Category and Environmental Mechanism
Global warming potential (GWP) total Global warming potential (GWP) fossil Global warming potential (GWP) biogenic Global warming potential (GWP) luluc	IPCC 2021	kg CO_2 eq	Anthropogenic emissions of greenhouse gases and short-lived climate forces have led to increased radiative forcing which has in turn increased the global mean temperature. As global mean temperatures continue to climb, global climate change will result. Some of the possible impacts include reductions in food and food supplies, water supplies, and sea level rise. GWP Fossil refers to the global warming potential from fossil fuels. GWP Biogenic the global warming potential from biogenic sources. And GWP Luluc is the calculated global warming potential from land use and land use change, while Green House Gas is the calculated global warming potential following the CO2 equivalent of an emission of a greenhouse gas over its accumulated lifetime.
Ozone depletion potential (ODP)	TRACI 2.2	kg CFC-11 eq	Emissions of ozone depleting substances such as chlorofluorocarbons contribute to a thinning of the stratospheric ozone layer. Damage to the ozone layer reduces its ability to prevent ultraviolet (UV) light entering the earth's atmosphere, increasing the amount of carcinogenic UVB light reaching the earth's surface. CFCs, halons, and HCFCs are the major causes of ozone depletion.
Eutrophication Freshwater: (EP Freshwater)	TRACI 2.2	kg P eq	Eutrophication is the build-up of a concentration of chemical nutrients in an ecosystem which leads to abnormal productivity. In some regions, emissions of excess nutrients (including phosphorus and nitrogen) into water can lead to increased algal blooms. If algal blooms are intense enough the decaying algae consumes dissolved oxygen in the water and starving other organisms of needed oxygen. Emissions of ammonia, nitrates, nitrogen oxides, and phosphorous to air or water all have an impact on eutrophication.
Eutrophication Marine: (EP Marine)	TRACI 2.2	kg N eq	
Acidification potential (AP)	TRACI 2.2	kg SO_2 eq	Acidification is the increasing concentration of hydrogen ion (H^+) within the local environment and occurs as a result of adding acids such as nitric acid and sulfuric acids into the environment. These acids may deposit in soils are sensitive to the increased acid burden. In acid-sensitive soils, the deposition can decrease the soil and freshwater body pH (acidification), causing endpoints such as tree die-offs and dead lakes. Emissions of sulfur dioxide and nitrogen oxides from the combustion of fossil fuels have been the greatest contributor to acid rain.

Category Indicator	LCIA Method	Unit	Impact Category and Environmental Mechanism
Smog Formation Potential (Smog)	TRACI 2.2	kg O_3 eq	Photochemical ozone, also called “ground level ozone”, is formed by the reaction of volatile organic compounds and nitrogen oxides in the presence of heat and sunlight. If ozone concentrations reach above certain critical thresholds, health effects in humans can result, including bronchitis, asthma, and emphysema. The impact category depends largely on the amounts of carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxide (NO), ammonium and NMVOC (non-methane volatile organic compounds).
Abiotic Depletion Potential for Fossil Resources (ADP_f)	EF 3.1	MJ, LHV	Fossil resources are non-renewable energy resources that are extracted from geological reserves. To quantify the depletion of non-living, non-renewable natural resources, such as the finite geological stock of oil, coal, and natural gas, fossil fuel mass is converted to its potential energy equivalents in megajoules (MJ).

The PCR requires that several other parameters be reported in the EPD, including resource use, waste categories and output flows, and other environmental information. Many of these additional parameters seek to classify resources and materials with respect to their use as raw materials for the product. While the LCA model tracks the input of these elementary flows, the model does not explicitly track whether those energy flows are used to generate energy (e.g., natural gas-based electricity) or used in a product (e.g., fossil-based plastics). Elementary flows related to land occupation were not included. The additional required parameters are presented in Tables 16 and 17.

Table 16. Additional transparency parameters – Resource Use.

Indicator	Unit	Description
Renewable primary resources used as an energy carrier (RPR_E)	MJ	Use of renewable primary energy excluding renewable primary energy resources used as raw materials. Since there are no renewable energy resources used as raw materials, this parameter equals the total consumption of renewable primary energy resources.
Renewable primary resources with energy content used as materials (RPR_M)	MJ	Use of renewable primary energy resources used as raw materials. No classification scheme is available in OpenLCA for this parameter, as such these values were manually calculated for the cardboard within the product system using the LHV of 4.6 kWh/kg.
Non-renewable primary resources used as an energy carrier ($NRPR_E$)	MJ	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials. No classification scheme is available in OpenLCA for energy resources used as raw materials. This parameter is estimated as the difference between the total non-renewable primary energy resources and the non-renewable primary energy resources used as raw materials.
Non-renewable primary resources with energy content used as material ($NRPR_M$)	MJ	Use of non-renewable primary energy resources used as raw materials. No classification scheme is available in OpenLCA for energy resources used as raw materials. No non-renewable energy resources are used as raw materials in the product system based on a review of the material content of the products.
Secondary materials (SM)	kg	The products assessed include recycled or secondary material components which are quantified and reported for this parameter.
Renewable secondary fuels (RSF)	MJ	The main consumption of any secondary fuel in the product systems is the combustion of municipal solid waste, used to generate electricity in some regions. In the U.S., municipal solid waste incineration accounts for less than 2% of total electricity generation. This parameter is reported as zero, per ACLCA guidance.
Non-renewable secondary fuels (NRSF)	MJ	The main consumption of any secondary fuel in the product systems is the combustion of municipal solid waste, used to generate electricity in some

Indicator	Unit	Description
		regions. In the U.S., municipal solid waste incineration accounts for less than 2% of total electricity generation. This parameter is reported as zero, per ACLCA guidance.
Recovered energy (RE)	MJ	Energy recovered from disposal of waste in previous systems, such as energy recovery from combustion of landfill gas or energy recovered from other systems using energy sources. This parameter is assumed negligible for the current assessment.
Consumption of freshwater (FW)	m^3	Net use of fresh water (consumption) is included in the Ecoinvent datasets used for modeling and are reported for all modules. Water consumption includes evaporation, transpiration, product integration and discharge into a different drainage basin or the sea. Use of fresh water is calculated from life cycle inventory flows using the freshwater parameter within 'Selected Indicators, Additional' provided by OpenLCA 2.5.

Table 17. Additional transparency parameters – Waste and Output Flows.

Indicator	Unit	Description
Hazardous waste disposed (HWD)	kg	All flows of hazardous waste included in the full LCI and other data sources were aggregated into a single result for total hazardous waste disposal. This parameter is calculated using primary data provided on the hazardous waste generated within the manufacturing facility, per the ACLCA guidance.
Non-hazardous waste disposed (NHWD)	kg	This includes all waste produced across all life cycle stages included in the study scope. This parameter is calculated using primary data on nonhazardous waste generated within the facility, per the ACLCA guidance
High level radioactive waste (RWD)	kg	This parameter includes flows of radioactive wastes in the primary data reported as intermediate-level and high-level radioactive wastes, per the ACLCA guidance.
Intermediate and low level radioactive waste (RWD)	kg	
Components for re-use (CRU)	kg	There are no components of the product which can be re-used at the end of life.
Materials for recycling (MR)	kg	This parameter represents secondary material for use in the next product system.
Materials for energy recovery (MER)	kg	The production of materials for energy recovery crossing the system boundaries is negligible and reported as zero.
Recovered energy exported from the product system (EE)	MJ, LHV	The recovered energy crossing the system boundaries is negligible and reported as zero.

Value Choices and Optional Elements

The study avoids the use of value choices in the assessment, as described in ISO 14044, such as normalization, weighting or grouping of indicator results. The study also includes a data quality assessment, considered optional under ISO 14044.

Table 18. Additional transparency parameters – Waste and Output Flows.

Indicator	Unit	Description
BCRP	kg CO_2	Biogenic carbon removals from product
BCEP	kg CO_2	Biogenic carbon emissions from product
BCRK	kg CO_2	Biogenic carbon removals from packaging
BCEK	kg CO_2	Biogenic carbon emissions from packaging
CCE	kg CO_2	Carbon emissions from calcination
CCR	kg CO_2	Carbon removals from carbonation
CBCEW	kg CO_2	Carbon emissions from combustion of waste (renewable)
CWNR	kg CO_2	Carbon emissions from combustion of waste (non-renewable)

6.3 Calculation methods

The LCIA and inventory results were calculated based on the TRACI 2.2 and IPCC AR6 characterization methodologies using OpenLCA model v2.5.0 with primary and secondary data as described in Section 4.

7 LCIA Results

Category indicator results for the Vitreous Lavatories are summarized for the functional unit of one (1) installed commercial lavatory with a reference service life (RSL) of 20 years for the Estimated Service Life (ESL) of 75-years as required by the PCR. All values are rounded to three significant digits.

7.1 Zurn Vitreous Lavatory Line Z5340 Results

Table 17. TRACI 2.2 and IPCC 2021 environmental impact results for the Zurn Vitreous China Lavatory Line Z5340.

Module	GWP total	GWP biogenic	GWP fossil	GWP luluc	AP	EP fresh	EP marine	ODP	Smog	ADP_f
	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg SO_2 eq	kg P eq	kg N eq	kg CFC-11 eq	kg O_3 eq	MJ, LHV
A1	5.60	4.35×10^{-2}	5.55	7.26×10^{-3}	3.40×10^{-2}	2.73×10^{-3}	1.80×10^{-2}	1.92×10^{-7}	0.427	69.0
A2	3.07	6.90×10^{-4}	3.07	1.40×10^{-3}	1.49×10^{-2}	3.10×10^{-4}	1.41×10^{-2}	4.41×10^{-8}	0.345	42.5
A3	72.9	0.107	72.8	7.46×10^{-3}	4.38×10^{-2}	1.70×10^{-3}	4.25×10^{-2}	1.96×10^{-7}	0.760	144
A1-A3 Total:	81.6	0.151	81.4	1.61×10^{-2}	9.27×10^{-2}	4.74×10^{-3}	7.46×10^{-2}	4.32×10^{-7}	1.53	255
A4	4.96	1.13×10^{-3}	4.96	2.25×10^{-3}	1.90×10^{-2}	5.10×10^{-4}	1.92×10^{-2}	7.11×10^{-8}	0.469	69.1
A5	2.81×10^{-2}	6.87×10^{-6}	2.81×10^{-2}	1.11×10^{-5}	1.20×10^{-4}	2.56×10^{-6}	1.30×10^{-4}	5.44×10^{-10}	3.18×10^{-3}	0.467
B1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B2	1.48	5.86×10^{-3}	1.17	0.313	8.62×10^{-3}	3.40×10^{-4}	5.54×10^{-3}	3.00×10^{-8}	8.16×10^{-2}	22.1
B3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B4	239	0.418	239	5.11×10^{-2}	0.313	1.46×10^{-2}	0.265	1.41×10^{-6}	5.66	915
B5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2	0.369	8.43×10^{-5}	0.368	1.70×10^{-4}	1.41×10^{-3}	3.79×10^{-5}	1.43×10^{-3}	5.29×10^{-9}	3.49×10^{-2}	5.13
C3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4	0.102	3.06×10^{-5}	0.102	1.89×10^{-5}	6.20×10^{-4}	4.98×10^{-6}	7.50×10^{-4}	3.81×10^{-9}	1.83×10^{-2}	2.68

Table 18. Resource use indicator results for the Zurn Vitreous China Lavatory Line Z5340.

Module	RPR_E	RPR_M	RPR_T	$NRPR_E$	$NRPR_M$	$NRPR_T$	SM	RSF	NRSF	RE	FW
	MJ	MJ	MJ	MJ	MJ	MJ	kg	MJ	MJ	MJ	m^3
A1	1.51	0.00	1.51	62.7	0.00	62.7	0.00	0.00	0.00	0.00	3.34
A2	0.149	0.00	0.149	41.7	0.00	41.7	0.00	0.00	0.00	0.00	0.221
A3	20.5	18.2	38.7	136	0.00	136	0.00	0.00	0.00	0.00	1.41
A1-A3 Total:	22.1	18.2	40.3	240	0.00	240	0.00	0.00	0.00	0.00	4.98
A4	0.248	0.00	0.248	67.7	0.00	67.7	0.00	0.00	0.00	0.00	0.367
A5	2.37×10^{-3}	0.00	2.37×10^{-3}	0.457	0.00	0.457	0.00	0.00	0.00	0.00	9.07×10^{-3}
B1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B2	16.7	0.00	16.7	20.8	0.00	20.8	0.00	0.00	0.00	0.00	3.05
B3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B4	61.6	0.00	61.6	869	0.00	869	0.00	0.00	0.00	0.00	15.1
B5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2	1.84×10^{-2}	0.00	1.84×10^{-2}	5.03	0.00	5.03	0.00	0.00	0.00	0.00	2.73×10^{-2}
C3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4	2.12×10^{-2}	0.00	2.12×10^{-2}	2.62	0.00	2.62	0.00	0.00	0.00	0.00	0.124

Table 19. Waste and Output indicators for the Zurn Vitreous China Lavatory Line Z5340.

Module	HWD	NHWD	HLRW	ILLRW	CRU	MR	MER	EE
	kg	kg	kg	kg	kg	kg	kg	MJ, LHV
A1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A3	4.42×10^{-3}	5.49	0.00	0.00	0.00	0.00	0.00	0.00
A1-A3 Total:	4.42×10^{-3}	5.49	0.00	0.00	0.00	0.00	0.00	0.00
A4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A5	0.00	0.350	0.00	0.00	0.00	0.750	0.00	0.00
B1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B4	1.22×10^{-2}	66.7	0.00	0.00	0.00	2.06	0.00	0.00
B5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4	0.00	18.4	0.00	0.00	0.00	0.00	0.00	0.00

Table 20. Carbon Emissions and Removals for the Zurn Vitreous China Lavatory Line Z5340.

Carbon LCI Indicator	Acronym	Unit	Value
Biogenic carbon removals from product	BCRP	kg CO_2	0.00
Biogenic carbon emissions from product	BCEP	kg CO_2	0.00
Biogenic carbon removals from packaging	BCRK	kg CO_2	-2.02
Biogenic carbon emissions from packaging	BCEK	kg CO_2	2.02
Carbon emissions from calcination	CCE	kg CO_2	0.659
Carbon removals from carbonation	CCR	kg CO_2	0.00
Carbon emissions from combustion of waste (renewable)	CBCEW	kg CO_2	0.00
Carbon emissions from combustion of waste (non-renewable)	CWNR	kg CO_2	0.00

7.2 Zurn Vitreous Lavatory Line Z5360 Results

Table 21. TRACI 2.2 environmental impact results for the Zurn Vitreous China Lavatory Line Z5360.

Module	GWP total	GWP biogenic	GWP fossil	GWP luluc	AP	EP fresh	EP marine	ODP	Smog	ADP_f
	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg SO_2 eq	kg P eq	kg N eq	kg CFC-11 eq	kg O_3 eq	MJ, LHV
A1	6.12	4.41×10^{-2}	6.07	7.95×10^{-3}	3.70×10^{-2}	2.95×10^{-3}	1.97×10^{-2}	2.12×10^{-7}	0.468	75.6
A2	3.37	7.60×10^{-4}	3.37	1.54×10^{-3}	1.64×10^{-2}	3.30×10^{-4}	1.56×10^{-2}	4.84×10^{-8}	0.379	46.6
A3	73.0	0.116	72.9	7.97×10^{-3}	4.44×10^{-2}	1.75×10^{-3}	4.29×10^{-2}	2.01×10^{-7}	0.770	146
A1-A3 Total:	82.5	0.161	82.3	1.75×10^{-2}	9.78×10^{-2}	5.03×10^{-3}	7.82×10^{-2}	4.61×10^{-7}	1.62	268
A4	5.5	1.26×10^{-3}	5.49	2.49×10^{-3}	2.11×10^{-2}	5.60×10^{-4}	2.13×10^{-2}	7.88×10^{-8}	0.520	76.5
A5	3.07×10^{-2}	7.49×10^{-6}	3.06×10^{-2}	1.21×10^{-5}	1.30×10^{-4}	2.79×10^{-6}	1.40×10^{-4}	5.93×10^{-10}	3.47×10^{-3}	0.509
B1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B2	1.48	5.86×10^{-3}	1.17	0.313	8.62×10^{-3}	3.40×10^{-4}	5.54×10^{-3}	3.00×10^{-8}	8.16×10^{-2}	22.1
B3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B4	244	0.447	243	5.55×10^{-2}	0.333	1.55×10^{-2}	0.281	1.52×10^{-6}	6.05	973
B5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2	0.409	9.35×10^{-5}	0.408	1.90×10^{-4}	1.57×10^{-3}	4.20×10^{-5}	1.59×10^{-3}	5.86×10^{-9}	3.87×10^{-2}	5.69
C3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4	0.113	3.39×10^{-5}	0.113	2.10×10^{-5}	6.90×10^{-4}	5.53×10^{-6}	8.30×10^{-4}	4.22×10^{-9}	2.03×10^{-2}	2.97

Table 22. Resource use indicator results for the Zurn Vitreous China Lavatory Line Z5360.

Module	RPR_E	RPR_M	RPR_T	$NRPR_E$	$NRPR_M$	$NRPR_T$	SM	RSF	NRSF	RE	FW
	MJ	MJ	MJ	MJ	MJ	MJ	kg	MJ	MJ	MJ	m^3
A1	1.66	0.00	1.66	68.7	0.00	68.7	0.00	0.00	0.00	0.00	3.68
A2	0.164	0.00	0.164	45.8	0.00	45.8	0.00	0.00	0.00	0.00	0.243
A3	22.2	19.9	42.1	137	0.00	137	0.00	0.00	0.00	0.00	1.45
A1-A3 Total:	24.1	19.9	44.0	252	0.00	252	0.00	0.00	0.00	0.00	5.38
A4	0.274	0.00	0.274	75	0.00	75	0.00	0.00	0.00	0.00	0.407
A5	2.58×10^{-3}	0.00	2.58×10^{-3}	0.499	0.00	0.499	0.00	0.00	0.00	0.00	9.90×10^{-3}
B1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B2	16.7	0.00	16.7	20.8	0.00	20.8	0.00	0.00	0.00	0.00	3.05
B3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B4	67.1	0.00	67.1	923	0.00	923	0.00	0.00	0.00	0.00	16.4
B5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2	2.04×10^{-2}	0.00	2.04×10^{-2}	5.58	0.00	5.58	0.00	0.00	0.00	0.00	3.02×10^{-2}
C3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4	2.35×10^{-2}	0.00	2.35×10^{-2}	2.9	0.00	2.9	0.00	0.00	0.00	0.00	0.138

Table 23. Waste and Output indicators for the Zurn Vitreous China Lavatory Line Z5360.

Module	HWD	NHWD	HLRW	ILLRW	CRU	MR	MER	EE
	kg	kg	kg	kg	kg	kg	kg	MJ, LHV
A1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A3	4.42×10^{-3}	5.77	0.00	0.00	0.00	0.00	0.00	0.00
A1-A3 Total:	4.42×10^{-3}	5.77	0.00	0.00	0.00	0.00	0.00	0.00
A4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A5	0.00	0.381	0.00	0.00	0.00	0.818	0.00	0.00
B1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B4	1.22×10^{-2}	73	0.00	0.00	0.00	2.25	0.00	0.00
B5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4	0.00	20.4	0.00	0.00	0.00	0.00	0.00	0.00

Table 24. Carbon Emissions and Removals for the Zurn Vitreous China Lavatory Line Z5360.

Carbon LCI Indicator	Acronym	Unit	Value
Biogenic carbon removals from product	BCRP	kg CO_2	0.00
Biogenic carbon emissions from product	BCEP	kg CO_2	0.00
Biogenic carbon removals from packaging	BCRK	kg CO_2	-2.20
Biogenic carbon emissions from packaging	BCEK	kg CO_2	2.20
Carbon emissions from calcination	CCE	kg CO_2	0.733
Carbon removals from carbonation	CCR	kg CO_2	0.00
Carbon emissions from combustion of waste (renewable)	CBCEW	kg CO_2	0.00
Carbon emissions from combustion of waste (non-renewable)	CWNR	kg CO_2	0.00

7.3 LCIA Analysis

Across both product families, the manufacturing stage (A3) is the dominant contributor to most environmental impact categories, including GWP total, acidification, eutrophication (marine), and smog formation. This is primarily driven by the energy-intensive ceramic firing process, which requires significant quantities of natural gas and produces direct CO_2 emissions from the calcination of mineral raw materials.

The raw material extraction stage (A1) is the second largest contributor, reflecting the environmental burden of mining and processing ceramic raw materials such as kaolin, feldspar, quartz, and other mineral inputs.

The maintenance stage (B2) contributes notably to water-related indicators (freshwater eutrophication and water use) due to the long 75-year Estimated Service Life and daily cleaning requirements. Figures 5-7 present the relative contribution of each life cycle stage to the overall environmental impact for each lavatory product family. Results are shown for TRACI 2.2 impact indicator results without the replacement (B4) modules.

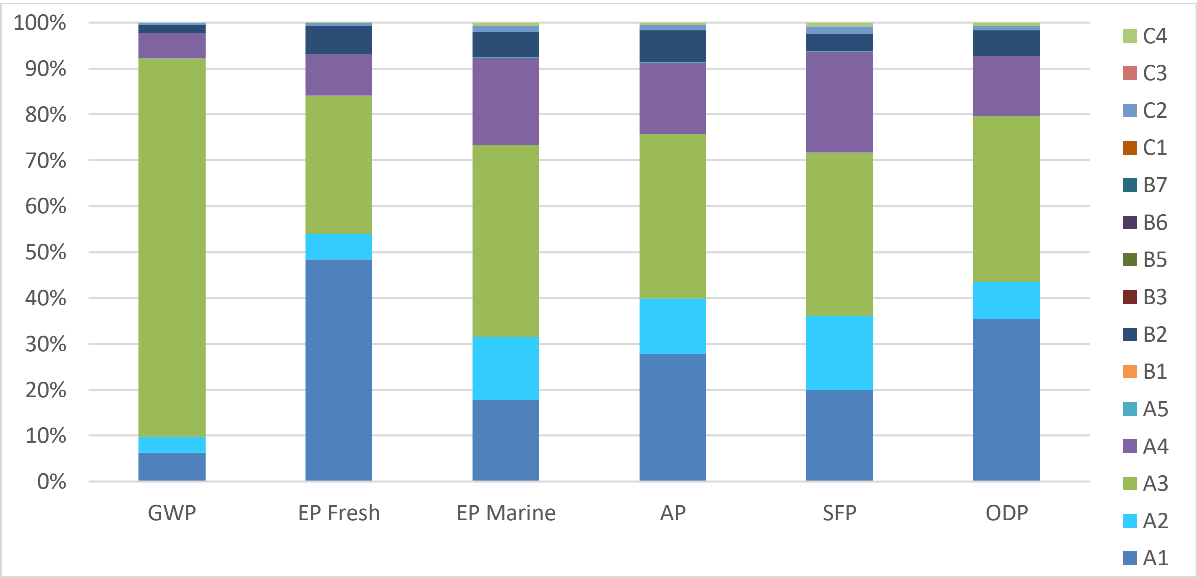

Figure 5. Contribution analysis for the Zurn Vitreous China Lavatory Line Z5340.

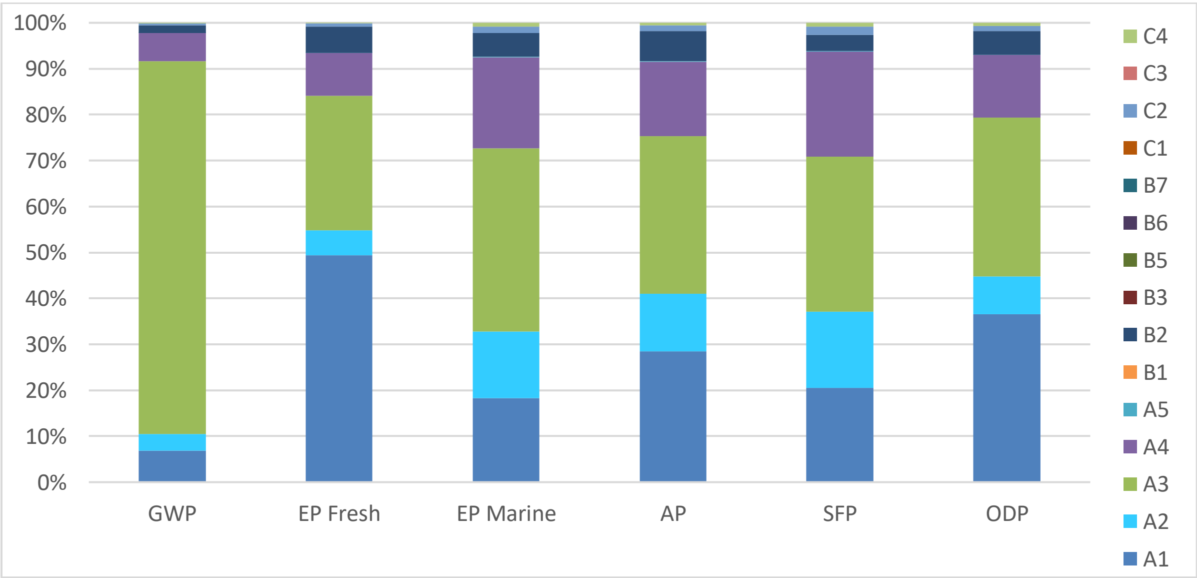

Figure 6. Contribution analysis for the Zurn Vitreous China Lavatory Line Z5360.

8 Sensitivity Analysis

Sensitivity analyses were conducted to evaluate the effect of various modeling assumptions on indicator results, and are described below. All sensitivity results are presented for the functional unit of 1 packaged, installed unit using the TRACI impact assessment method.

8.1 Renewable energy sensitivity analysis

Renewable energy sources such as hydroelectric power, geothermal and solar represent major potential breakthroughs for reducing the environmental impacts of manufactured goods when manufacturing sites elect the option to move all power to renewables. China has been investing heavily in its infrastructure for PV solar power, and within the last year or two the country has been reaping the boons of this green development. Hebei Province, where the manufacturing facility is located, has been at the forefront of this transition, with over 100 GW of wind and solar capacity in operation. A sensitivity analysis was conducted to explore the environmental benefits of switching the electricity supply at both facilities to 100% solar PV, while maintaining the existing proportion of electricity to natural gas to light fuel oil at each facility — only the source of the electricity component is modified from the regional grid mix to solar. This analysis provides insight into the degree to which GWP and other impact categories in Module A3 could be reduced under a realistic renewable electricity procurement scenario. All values are rounded to three significant digits.

Table 25. Sensitivity analysis results for renewable energy usage during manufacturing production of Zurn Vitreous Lavatories.

Lavatory Line	Module	GWP total	GWP biogenic	GWP fossil	GWP luluc	Acidification	EP: fresh	EP: marine	Ozone depletion	Smog
		(kg CO_2 eq)	(kg CO_2 eq)	(kg CO_2 eq)	(kg CO_2 eq)	(kg SO_2 eq)	(kg P eq)	(kg N eq)	(kg CFC-11 eq)	(kg O_3 eq)
Z5340	Original A3	72.9	0.107	72.8	7.46×10^{-3}	4.38×10^{-2}	1.70×10^{-3}	4.25×10^{-2}	1.96×10^{-7}	0.76
	Solar A3	66.8	0.109	66.7	6.16×10^{-3}	1.42×10^{-2}	7.00×10^{-4}	2.29×10^{-2}	1.90×10^{-7}	0.281
	%Change	-8.40%	2.00%	-8.40%	-17.4%	-67.6%	-58.8%	-46.1%	-3.30%	-63.0%
Z5360	Original A3	73	0.116	72.9	7.97×10^{-3}	4.44×10^{-2}	1.75×10^{-3}	4.29×10^{-2}	2.01×10^{-7}	0.77
	Solar A3	66.9	0.118	66.8	6.67×10^{-3}	1.48×10^{-2}	7.50×10^{-4}	2.33×10^{-2}	1.95×10^{-7}	0.291
	%Change	-8.40%	1.90%	-8.40%	-16.3%	-66.7%	-57.1%	-45.7%	-3.20%	-62.2%

The most dramatic reductions from switching the manufacturing electricity grid to 100% solar energy are seen in acidification, with decreases of ~67% for the Z5340 and Z5360 products. Smog formation potential follows closely, with reductions of 63.0% and 62.2% for the Z5340 and Z5360, respectively. Removing coal-heavy grid electricity from the manufacturing mix eliminates the upstream SO_2 and NO_x emissions that drive acidification and smog formation potential. Freshwater eutrophication also sees substantial decreases of 58.8% (Z5340) and 57.1% (Z5360), while marine eutrophication is reduced by 46.1% and 45.7%. Fossil fuel resources such as coal and natural gas and their associated refining activities release nutrient-driving emissions that lead to over-enrichment of water bodies, often resulting in algae blooms harmful to the environment. Mining, fuel processing, and power plant operations all generate phosphorus and nitrogen-bearing wastewater, while combustion-related NO_x emissions contribute substantially to marine and freshwater eutrophication. Decreasing the reliance on these fossil fuels and increasing the share of solar in the electricity mix will lead directly to the eutrophication potential reductions, as observed in these results.

Fossil GWP and total GWP see moderate reductions of 8.40% for both the Z5340 and Z5360 product lines. Both product lines are manufactured at the facility in Tangshan City, where natural gas dominates the energy mix for the ceramic firing process — limiting the degree to which a switch to solar electricity alone can reduce overall GWP.

Note that biogenic GWP shows a slight increase of +2% for Z5340 and +1.9% for Z5360 under the solar scenario, attributable to upstream biomass-related impacts associated with solar panel manufacturing infrastructure, as well as increased natural gas use at solar facilities to support power output during periods of low solar irradiance. Together, these factors become more pronounced at high levels of solar usage, resulting in a small net increase in biogenic GWP relative to the baseline scenario.

Overall, the solar grid sensitivity scenario demonstrates that electricity-intensive impact categories — particularly those tied to combustion emissions driving acidification, smog, and eutrophication — are most responsive to a renewable energy transition, while impact categories governed by material extraction and non-energy processes such as GWP remain largely unchanged.

9 Interpretation

9.1 Preliminary interpretation

Results were summarized by life cycle phase for a cradle-to-grave assessment of the Zurn vitreous china lavatory lines Z5340 (SKUs Z5341, Z5344, and Z5348), Z5360 (SKUs Z5361, Z5364, and Z5368). Examining results outside of the use and replacement phases, the total impact indicator results are dominated by the product manufacturing and the raw material processing. The maintenance stage also contributes significantly to certain impact indicators, mainly water related indicators like Eutrophication of Marine waterways driven by the accumulation of water usage from nearly daily cleanings over the product's lifecycle. Sensitivity analysis on the use of renewable electricity to power Zurn's manufacturing operations could decrease the overall environmental burden of the product, in particular the product's Eutrophication Potential.

9.2 Evaluation

Completeness check

Life cycle inventory results were reviewed for completeness, consistency and representativeness. Overall, with respect to those impact categories assessed, the inventory was considered consistent and generally representative of the product system as the same types of data sources are used throughout, primarily from the manufacturer, as well as the Ecoinvent life cycle inventory database.

Sensitivity check

Sensitivity analyses were conducted to investigate the effects on estimated indicator results of the use of renewables within the product system. Estimated impacts are within acceptable ranges as noted above.

9.3 Conclusions, limitations, and recommendations

General conclusions

This Life Cycle Impact Assessment of the Zurn vitreous china lavatories was conducted to support the development of an Environmental Product Declaration (EPD) conformant to ISO 14044, ISO 14025, ISO 21930 and the Part A and Part B PCRs using the indicators prescribed by the PCR based on the TRACI 2.2 characterization methodology and IPCC AR6 report. Impact category indictor results for the product system considered are presented in Section 7.

Impact category indicator results are summarized by life cycle phase including raw material extraction and processing; transport to manufacturer; product manufacturing and packaging; product distribution; installation; use, and product disposal. Results were evaluated using sensitivity and process contribution analyses.

Limitations

The assessment relied on a number of assumptions and limitations, the most relevant of which are discussed in this report. Most of the upstream raw materials extraction and processing could not be modeled with actual process information. Representative data from Ecoinvent life cycle inventory databases were utilized as appropriate. These datasets were modified to represent the product system, where necessary.

It is noted that the LCIA results presented in this report are relative expressions and do not predict impacts on category endpoints, exceedance of thresholds, safety margins, or risks associated with the product system. Impact indicators rely on the use of generic models and potential impacts and therefore are not able to measure actual environmental impacts. Additionally, the indicators prescribed by the PCR do not represent all categories of potential environmental and human health impacts associated with the life cycle of the assessed products, and this represents a general limitation of the LCA study.

Recommendations

Emissions stemming from Zurn's vitreous lavatory manufacturing contribute significantly to the products' overall environmental impact. The sensitivity analysis presented in this report suggests switching to solar power at the manufacturing facility, a renewable resource that is likely available in the province which manufacturing occurs, can help reduce the overall impact of Zurn's manufacturing operations and the cradle to grave impact of the products examined in this study.

APPENDIX 1: ISO 14044 Critical Review Report

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August 19th, 2026

Verification Statement for EPDs of Zurn as per the SCS Global Services EPD program

Introduction

The Athena Sustainable Materials Institute (www.athenasmi.org) was engaged to perform third-party verification of the Zurn LCA report and EPD conducted by SCS Global Services (https://www.scsglobalservices.com/).
Lindita Bushi, Ph.D., an approved third-party verifier by the SCS Global Services EPD program, completed the verification.

The verifier reviewed the first draft and verified the final version of the Zurn LCA report and EPD dated 18.08. 2026, in accordance with the following:

1. *Sustainable Minds Transparency Report [EPD]™ Program, Part B: Product group definition | Commercial lavatories | Part B #24-001. October 7, 2024*,
2. *SM Transparency Report™ / EPD Framework Part A, LCA calculation rules and report requirements, Version 4.0 | Feb 2026*,
3. SCS Type III Environmental Declaration Program: Program Operator Manual. V12.0 November 2023. SCS Global Services,
4. *ISO standards* listed below –
   ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations - Principles and procedures,
   ISO 14044:2006/Amd1:2017/Amd2:2020 Environmental Management - Life Cycle Assessment - Requirements and Guidelines.
   ISO 14040:2006/Amd1:2020 Environmental Management – Life cycle assessment – Principles and Framework
   ISO 21930: 2017 Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services.

Verification Statement

After a detailed examination, the verifier confirms that *no relevant deviations* within the EPDs and its supporting project report have been established concerning:

- The underlying data collected as used for the LCA calculations,
- The way the LCA-based calculations have been carried out to comply with the calculation rules described in the reference PCR,
- The presentation of environmental performance included in the EPD, and
- Other additional environmental information included in the declaration.

Further, no material deviations were found concerning the procedural and methodological requirements in ISO 14025:2006, ISO 14044:2006, ISO 21930:2017, and SCS Global Services POR 2023.

EPD registration number(s):	*Provided by the SCS Global Services EPD program*
Product(s):	Zurn| Vitreous China Wall Hung Lavatories
Organization:	Zurn 511 W Freshwater Way Milwaukee, WI 53204 United States www.zurn.com
PCR:	SM Part B: Product group definition | Commercial lavatories | Part B #24-001. October 7, 2024.
Validity of EPD:	Five years

The verifier confirms that the LCA-based data has been examined for plausibility and consistency; the declaration owner is responsible for its factual integrity and that the product does not violate relevant legislation.

The verifier confirms that she has sufficient knowledge and experience of declared products, relevant standards, and the geographical area of the EPDs to carry out this verification.

The verifier confirms that she has been independent in her role as a verifier in accordance with the ISO 14025 requirements, e.g., she has not been involved in the execution of the LCA or the development of the declarations and has no conflicts of interest regarding this verification.

Based on the verification objectives, the LCA/LCI data were determined to be ***in conformance*** with the relevant program operator rules, product category rules and applicable ISO standards. The plausibility of the LCA-based data, the quality and accuracy of the LCA-based data, and additional environmental information and supporting information are also confirmed.

A copy of the Zurn verification statement (in PDF) and verification report (in Excel) *from 19.08.2026,* is provided to the SCS Global Services EPD program operator. As per ISO 14025, Clause 8.1.4, the verification report shall be made available to any interested party upon request.

The verifier appreciates the professional responsiveness of the SCS Global Services LCA team to all technical queries and comments and that of all parties involved in the verification process.

Name and organization of independent verifier: Lindita Bushi, Ph.D., LEED Green Associate Athena Sustainable Materials Institute D: 416 269 8571 E: lindita.bushi@athenasmi.org	**Address:** 280 Albert St., Suite 404, Ottawa ON, K1P 5G8 http://www.athenasmi.org

Signature:

Lindita Bushi

Enclosed:
Verification report- ISO 21930 SCS Zurn LCA report, EPD, 19082026, Final.