420 RUTHERFORD AVENUE

WHOLE BUILDING LIFE CYCLE ASSESSMENT

RELATED BEAL

PROJECT NO.: B2100635.000
DATE: JUNE 2022
REVISED JULY 2022

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June 30, 2022
Revised July 13, 2022

Project number: B2100635.000

Ms. Elizabeth Farrell
Related Beal
177 Milk Street
Boston, MA 02109

Dear Ms. Farrell,

WSP has completed the whole building life cycle assessment (WBLCA) of the structure and enclosure of 420 Rutherford Avenue in Charlestown, MA. The report herein summarizes our findings based on our analysis of the WBLCA results generated using Tally®, which is an application that calculates the life cycle environmental impacts of building materials through Autodesk® Revit® models. This report updates modeling results issued in report dated June 30, 2022 to reflect the final design. See previous report for initial results.

Our findings indicate that this project is eligible to submit for one point under LEED version 4.1 Materials and Resources Credit, Building Life Cycle Impact Reduction, Option 2 Whole Building Life Cycle Assessment, Path 1: conduct a life cycle assessment (LCA) of the project's structure and enclosure. The results of the assessment are summarized below:

Table 1: Summary of WBLCA Results

	BASELINE BUILDING VALUE	PROPOSED BUILDING VALUE	UNITS	PERCENT REDUCTION
Global Warming Potential	5,473,453.05	5,294,749.49	$kgCO_2eq$	**3.26%**
Stratospheric Ozone Depletion Potential*	6.89E-01	6.89E-01	kgCFC-11eq	**-0.01%**
Acidification Potential of Land and Water	18,133.91	17,231.73	$kgSO_2eq$	**4.98%**
Eutrophication Potential	891.83	870.89	kgNeq	**2.35%**
Tropospheric Ozone Formation Potential	255,976.98	250,827.88	kgO_3eq	**2.01%**
Depletion of Non-Renewable Energy Resources	48,345,566.28	46,139,699.86	MJ	**4.56%**
LEED v4.1 Path 1: Conduct an LCA (1 point)			**Yes**	

* WSP does not consider the percent reduction a significant numeral change. Value is due to standard rounding practices within the modeling software.

The 50% Design Development Revit models, drawings, and specifications were used to define the baseline models. To define the proposed models, WSP used captured design decisions made up to the 50% Construction Document phase. The design changes that most contributed to embodied impact reductions are:

1. Using a higher strength steel (from 50 ksi to 65 ksi) for columns. This reduced the total tonnage of steel at the columns by 30 tons.

2 Decreasing the vibration requirements on the floor framing. This reduced the total tonnage of steel beams by 150 tons.

The following report includes information needed to document the credit in LEED online, as well as supplemental information for your reference. We are happy to discuss our findings if needed. Feel free to contact us with any questions.

SIGNATURES

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The original of the technology-based document sent herewith has been authenticated and will be retained by WSP for a minimum of ten years. Since the file transmitted is now out of WSP's control and its integrity can no longer be ensured, no guarantee may be given with regards to any modifications made to this document.

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APPENDICES

1 INTRODUCTION

1.1 PURPOSE

420 Rutherford Avenue is a complete demolition and rebuild of a new 113,191-SF core and shell life-sciences building in Charlestown, MA. The proposed three-story building will include open and wet labs, lab support space, and office space.

The purpose of this whole building life cycle assessment (WBLCA) is to determine the embodied impact reduction of the structure and enclosure materials of 420 Rutherford Avenue, from the 50% Design Development (herein referred to as the 'baseline') up to the 50% Construction Document (herein referred to as the 'proposed') design. The material "hot spots" from the initial baseline assessment were further studied through a material comparison analysis, where the goal was to identify material substitutions that would meet the noted carbon reduction targets below.

This assessment is used to document the LEED version 4.1 Materials and Resources Credit, Building Life Cycle Impact Reduction, Option 2 Whole Building Life Cycle Assessment (WBLCA). The credit includes four optional paths – this assessment pursues Path 1. The credit language can be found here: https://www.usgbc.org/credits/new-construction-core-and-shell-schools-new-construction-retail-new-construction-data-27?return=/credits/Core%20and%20Shell/v4.1/Material%20&%20resources

Path 1: Conduct a life cycle assessment (LCA) of the project's structure and enclosure (1 point).

Path 2: Conduct an LCA of the project's structure and enclosure that demonstrates a minimum of 5% reduction, compared with a baseline building, in at least three of the six impact categories listed below, one of which must be global warming potential (2 points).

Path 3: Conduct an LCA of the project's structure and enclosure that demonstrates a minimum of 10% reduction, compared with a baseline building, in at least three of the six impact categories listed below, one of which must be global warming potential (3 points). Path 3 is the original option in LEED version 4, which achieved three (3) points.

Path 4: Meet requirements of Path 3 and incorporate building reuse and/or salvage materials into the project's structure and enclosure for the proposed design. Demonstrate reductions compared with a baseline building of at least 20% reduction for global warming potential and demonstrate at least 10% reduction in two additional impact categories listed below (4 points).

For Paths 2, 3, and 4 above, no impact category assessed as part of the LCA may increase by more than 5% compared with the baseline building. The impact categories targeted for reduction are:

- Global Warming Potential (GWP), in $kgCO_2$ equivalent;
- Depletion of the Stratospheric Ozone Layer, in kgCFC-11 equivalent;
- Acidification of Land and Water Sources, in $kgSO_2$ equivalent;
- Eutrophication, in kgN equivalent;
- Formation of Tropospheric Ozone, in kgO_3 equivalent; and
- Depletion of Nonrenewable Energy Resources, in MJ.

1.2 METHODOLOGY

WBLCA TOOL

The WBLCA was conducted using Tally by Building Transparency. Tally is a plug-in for Autodesk Revit that quantifies the environmental impacts of building materials by assigning each construction material in the Revit model to a material in the Tally database. The Tally database of materials is custom designed to combine material attributes, assembly details, and architectural specifications with life cycle inventory data. The life cycle inventory data is a collaboration between Kieran Timberlake and thinkstep. thinkstep LCA modeling is done in GaBi using GaBi databases and modeling principles. The data within GaBi has been reviewed internally and externally, published in studies, and includes data from Environmental Product Declarations (EPDs) which are externally reviewed and publicly available. The Tally methodology is consistent with LCA standards ISO 14040, 14044, and EN 15978:2011. Tally data are intended to represent the US in the year 2013. Tally captures the cradle-to-gate impact of materials, which includes manufacturing and transportation.

SCOPE

The WBLCA system boundary included the building's structure and enclosure. Structural elements include frame and floors inclusive of fireproofing and concrete encasement. Enclosure includes all materials from the exterior cladding to the interior sheathing, inclusive of insulation. Roof assemblies include the entire assembly inclusive of membranes, insulation, and vapor barriers

The system boundary excludes: interior finishes on the walls (e.g. paints), floors, and ceilings; non-structural interior partitions; interior stairs; railings; Mechanical/Electrical/Plumbing (MEP) equipment; site elements (such as the exterior ramps); fire detection systems; elevators; parking lots; site improvements (such as pavements and curbs); and landscaping (such as landscaping and the green roof).

More specific information regarding the modeled systems specific to this project can be found in the Project Description section below.

SYSTEM BOUNDARY

- The service life of the model will be 60 years to fully account for material replacement.
- Building components that made up less than 5% of the total mass of the scope are not evaluated.
- The baseline and proposed designs are of a comparable size, function, orientation, and operating energy performance as defined in EA prerequisite Minimum Energy Performance.
- The life cycle inventory data sets comply with ISO 14044; and
- The assessment is cradle to grave including modules A1-A, A4, B2-B5, C2-C4, and Module D. The scope excludes module A5 (installation), B1 (use), and B6 (operational energy).

Life cycle stages are defined under the ISO standards 14040 and 14044 for conducting LCAs, and are summarized as the following:

Product (A1-A3): Sometimes referred to as "material manufacturing." Refers to the portion of a product life that includes removal of raw material from the earth, manufacture of intermediate materials, final product fabrication, and transportation during these stages.

Transportation (A4): Includes transportation of the material to the project location.

Maintenance and Replacement (B2-B5): Refers to the building operation phase, including energy consumption, water use, and water generation. It also considers the repair and replacement of building assemblies and systems, and transportation and equipment use for repair and replacement.

End of Life (C2-C4): Also referred to as Module C in ISO standards. Includes the energy used and waste produced from building demolition and disposal of materials to landfill, including transportation of waste. Recycling and reuse activities related to demolition can also be included in this phase.

Module D: Refers to the loads and benefits beyond the building life cycle. After building demolition, materials that do not go to landfill are recycled into new products. This module includes recycling of materials, reuse of products, and energy recovery. A load refers to impacts related to these processes, whereas a benefit quantifies the avoided impact for not producing new products.

WBLCA PROCESS

WSP received the 50% Design Development drawings, specifications, and Revit models of 420 Rutherford Avenue. To conduct this comparative assessment, the requirements and parameters of the LEED version 4.1 Materials and Resources Credit, Building Life Cycle Impact Reduction, Option 2 WBLCA were followed, including:

- Reviewing project documents received from the design team, including 50% Design Development architectural and structural drawings and specifications for the design.
- Reviewing 50% Design Development Revit models received from the design team for conformance to the contract documents, including one architectural model and one structural model of the design.
- Holding a conference call with the design team to clarify any questions on the architectural and structural designs.
- Reviewing area take-offs received from the design team for: the GFRC, wood, and roof canopies; GFRC rainscreen panels; curtain wall; stone panel cladding; metal rainscreen panels; and penthouse screens.
- Assigning each construction material within the two Revit models to materials in the Tally database, referencing the architectural and structural drawings, specifications, and submittals as needed.
- Generating output reports via Tally.
- Verifying the results of the reports with a WSP technical reviewer.

The Tally models were generated by changing the definitions of the modeled Revit construction materials within Tally to reflect the materials considered in the baseline design. In the absence of specific transportation data, we used Tally's default material transportation distances for all building materials.

After assigning all materials and running the Tally model, the software output Excel and PDF files that reported the WBLCA results per the TRACI 2.1 (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts) impact assessment method. TRACI is an impact assessment method developed by the U.S. Environmental Protection Agency. A WSP technical reviewer reviewed the Tally WBLCA reports prior to issuing this report.

The purpose of this internal technical review was to:

- Evaluate if the goals of the project team were achieved.
- Assess if the models met the LEED version 4.1 Materials and Resources Credit Building Life Cycle Impact Reduction, Option 2 Whole Building Life Cycle Assessment requirements.
- Ensure proper assignment of materials from the life cycle database.

1.3 PROJECT DESCRIPTION

1.3.1 BASELINE DESCRIPTION

The baseline structural system consists of concrete foundations, steel columns, and steel framing members. The foundation piles were excluded for this analysis, as they are understood to be preexisting on site (Figure 1). The ground floor is a conventional steel-reinforced concrete slab-on-grade over 6-inches of gravel fill, while the above-grade floors are 4 1/2-inch conventional steel-reinforced concrete over a 3-inch metal deck. The roof assemblies include a 60-mil adhered polyvinyl chloride (PVC) roofing membrane over cover board, R-30 polyisocyanurate (PIR) board insulation, and a self-adhering sheet vapor barrier. There is an area of green roof consisting of hot-applied rubberized asphalt membrane roofing system[1] and 8-inch extruded polystyrene (XPS) insulation. There is also an area of roof with 3/4-inch porcelain pavers[2] over the PVC membrane assembly. Areas of canopy consist of the above PVC roof membrane assembly, as well as metal plate panel and wood cladding rainscreen assemblies.

The exterior wall enclosure is primarily metal plate rainscreen panel on a subgirt system over 4-inch mineral wool insulation, a self-adhering sheet-applied air barrier, 5/8-inch exterior sheathing, 6-inch metal stud, and 5/8-inch interior sheathing. At the base of the building, there is stone cladding over a subgirt system, 4-inch XPS insulation board, and self-adhering sheet-applied air barrier over the foundation wall. A portion of the foundation wall assembly is architectural concrete instead of stone cladding. In addition, the envelope includes a 4-sided structural silicone glazed (SSG) low-E coated curtain wall system[3], with intermittent spandrel panels, and metal plate panels between each band of curtain wall.

At the penthouse, the above noted metal plate rainscreen panel assembly occurs at the exterior of weathertight building enclosure walls, and insulated metal wall panels occur over galvanized steel supports as a screen where there are no weathertight enclosure walls (Figure 2).

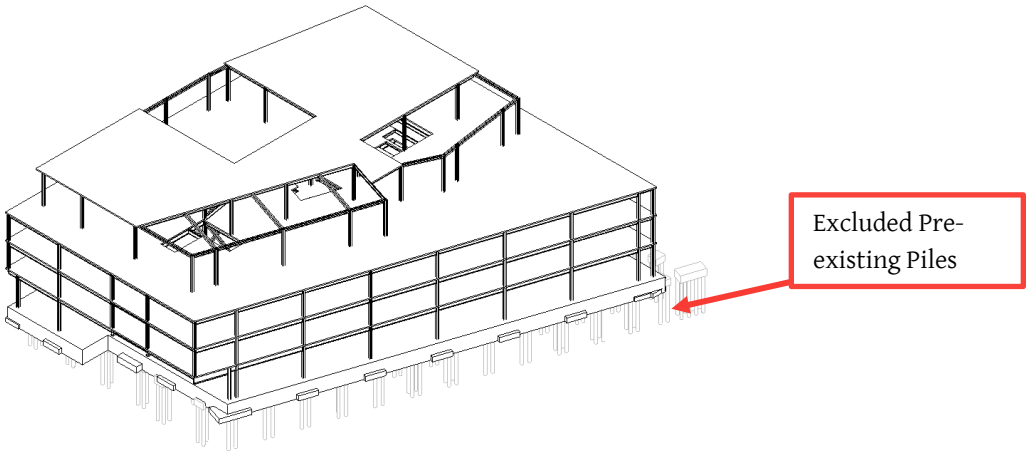

Figure 1: Excluded Elements – Pre-existing Foundation Piles

[1] As Tally does not have a hot-applied membrane roofing definition, the Tally definition for built-up asphalt roofing (cap and ply felt) was used, in addition to an "asphalt felt sheet" definition to mimic the layer of filter fabric typically part of a hot-applied roofing assembly.
[2] The pedestal portion of the porcelain pavers did not have an associated material definition in Tally, and thus have not been considered as part of this analysis.
[3] Due to the nature of the Revit model, the curtain wall mullions that occur around each panel of the curtain wall glass were included in the area of the glass calculations.

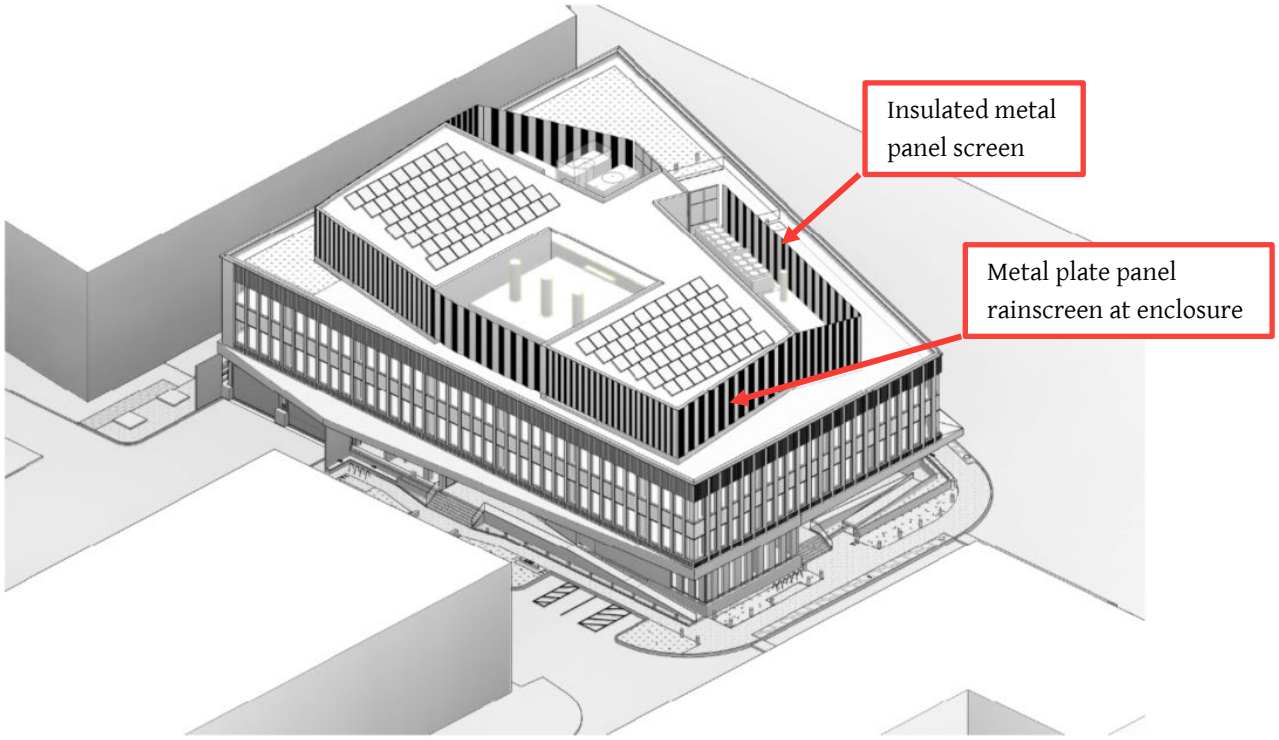

Figure 2: Penthouse Screen Assembly

In the Design Development phase, a project concrete mix design had not yet been developed. To generate a comparative assessment, WSP used the default concrete mixes provided by the National Ready Mixed Concrete Association (NRMCA) Member National and Regional LCA Benchmark (Industry Average Report) – V 3.0[4]. This report presents the six normal weight benchmark ready mixed products by compressive strengths typical to a region, as well as the U.S. National Benchmark mix design. The Eastern Region averages were used for the 4000PSI concrete mix design minus air entrainment, see Table 2 below. The NRMCA Eastern Average 4000 psi concrete was used in all of the concrete elements. In the absence of steel reinforcement design, the default Tally 'moderate' steel reinforcing was used for each of the below noted elements:

- Footings
- Columns
- Grade beams
- Foundation walls
- 4 1/2-inch concrete on 3-inch metal deck (moderate reinforcement in addition to 4x4 welded wire mesh)
- 6-inch concrete slab-on-grade (moderate reinforcement in addition to 4x4 welded wire mesh)
- 8-inch concrete foundation slab (#5 2-way reinforcement at 12-inch O.C. in lieu of moderate reinforcement)
- Concrete housekeeping pads and fill slabs

[4] https://www.nrmca.org/wp-content/uploads/2020/02/NRMCA_REGIONAL_BENCHMARK_Nov2019.pdf

Table 2: 4000PSI NRMCA Concrete Mix

	DENSITY	UNIT	
Cement	475	lb/cy	12%
Fly Ash	47	lb/cy	1%
Slag	82	lb/cy	2%
Sand	1,345	lb/cy	33%
Stone	1,634	lb/cy	40%
Water	289	lb	7%
Air	-	-	6%

To generate comparable sums of building materials, and thus comparable WBLCA results, WSP used the 50% Design Development Revit models to replicate design decisions made from the 50% Design Development up to the 50% Construction Document project phases. This reflects the "proposed" model methodology documented below. This methodology allowed us to utilize models that reflected the same gross building area and similar sums of mass totals of building materials.

1.3.2 PROPOSED DESCRIPTION

The proposed structural and architectural models contain the same materials and assemblies as the baseline model, with changes made to reflect modifications and refinements made throughout the design up to the 50% Construction Drawings phase. For the structural model, the steel framing systems were modified. For the architectural model, the overall design remained the same from the 50% Design Development up to the 50% Construction Document phases.

Following correspondence with the Architecture and Structural Engineering teams, changes made to the proposed design from the baseline design included:

1. Upgrading the strength of the steel columns to a higher strength steel (from 50 ksi to 65 ksi). This reduced the total tonnage of steel at the colums by 30 tons, as calculated by the project Structural Engineer. This changed the total weight of steel resulting from columns from 253.91 tons, to 223.91 tons. The baseline weight of steel columns was calculated by Tally, once material definitions were assigned to the steel columns.

2. Decreasing the vibration requirements on the floor framing. This reduced the total tonage of steel beams by 150 tons, as calculated by the project Structural Engineer. This changed the total weight of steel resulting from beams from 767.45 tons, to 617.45 tons. The baseline weight of steel beams was calculated by Tally, once material definitions were assigned to the steel beams.

2 RESULTS

2.1 SUMMARY OF RESULTS

Based on this analysis, this project is eligible to submit for one point under LEED version 4.1 Materials and Resources Credit, Building Life Cycle Impact Reduction, Option 2 Whole Building Life Cycle Assessment, Path 1 (Table 3). Per the credit requirements, a life cycle assessment of the project's structure and enclosure must be conducted.

Table 3: Summary of WBLCA Results

	BASELINE BUILDING VALUE	PROPOSED BUILDING VALUE	UNITS	PERCENT REDUCTION (%)
Global Warming Potential	5,473,453.05	5,294,749.49	$kgCO_2eq$	**3.26%**
Stratospheric Ozone Depletion Potential	6.89E-01	6.89E-01	kgCFC-11eq	**-0.01%**
Acidification Potential of Land and Water	18,133.91	17,231.73	$kgSO_2eq$	**4.98%**
Eutrophication Potential	891.83	870.89	kgNeq	**2.35%**
Tropospheric Ozone Formation Potential	255,976.98	250,827.88	kgO_3eq	**2.01%**
Depletion of Non-Renewable Energy Resources	48,345,566.28	46,139,699.86	MJ	**4.56%**

*WSP does not consider the percent reduction a significant numeral change. Value is due to standard rounding practices within the modeling software.

2.2 GLOBAL WARMING POTENTIAL

The figure below (Figure 3) summarizes the results of each material category in GWP. GWP is a reasonable indicator of overall embodied impact. Figure 3 shows that Concrete is the greatest contributor to GWP, and the improvement in GWP occurred in the Metals category. The improvement in the Metals category is due to a reduction in the quantity of steel. Upgrading the strength of the steel columns to a higher strength steel (from 50 ksi to 65 ksi) reduced the total tonnage of steel at the columns by 30 tons. In addition, decreasing the vibration requirements of the floor framing reduced the total tonnage of steel beams by 150 tons.

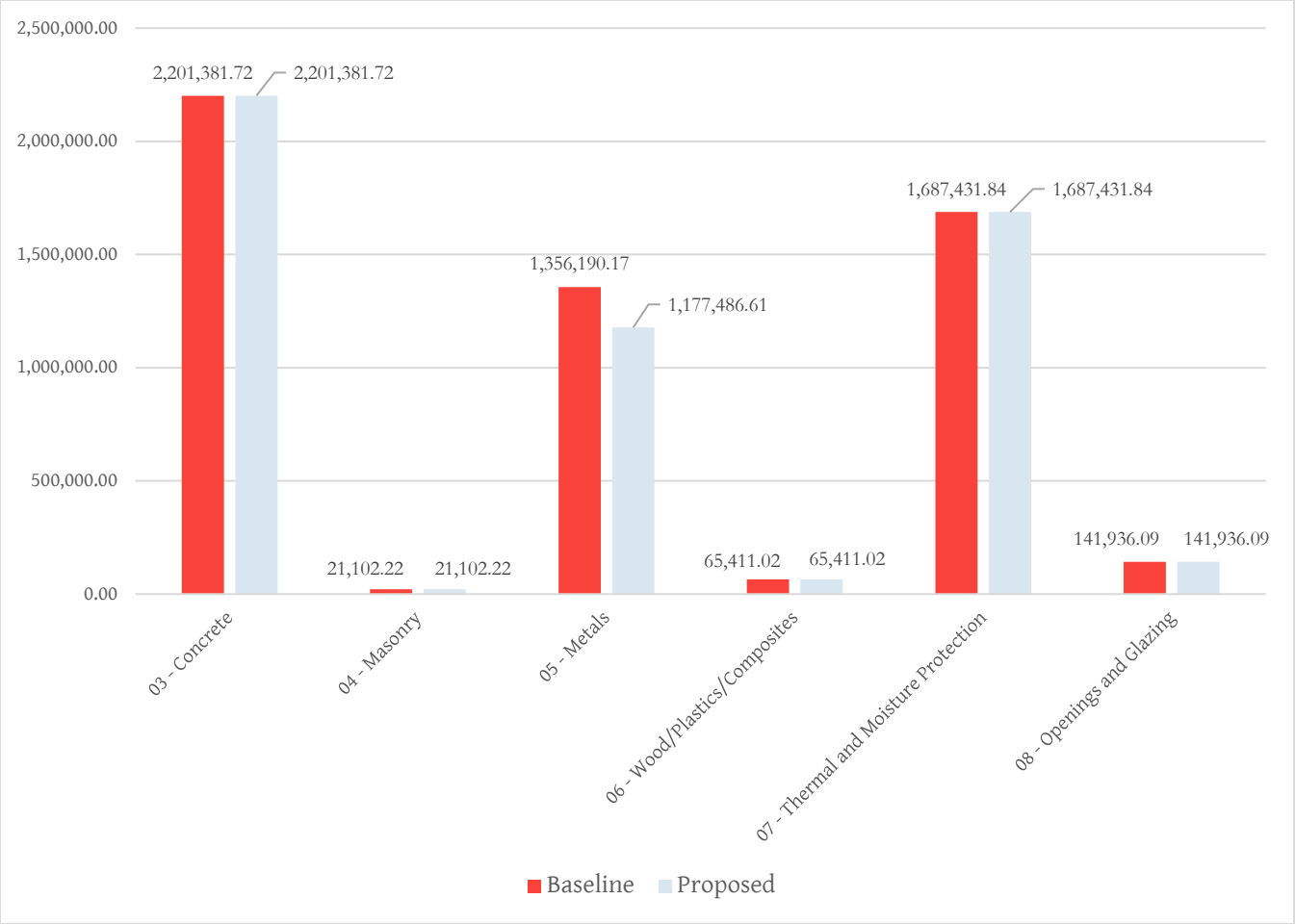

Figure 3: Global Warming Potential by Material Category ($kgCO_2e$)

A list of materials considered for each material category is further explained below. Materials are divided into their respective CSI MasterFormat specification sections, indicated by the numbers in front of each material category. The material categories consist of the following design elements:

03 - Concrete: Concrete footings, columns, grade beams, foundation walls, slabs (including slab-on-grade), and housekeeping pads and fill slabs. Includes steel reinforcing rods and welded wire mesh reinforcing. Also includes 6-inch gravel fill, modeled as course aggregate, and architectural precast panel at the base of the building.

04 - Masonry: Granite panels at the base of the building.

05 - Metals: Structural steel, cementitious fireproofing at columns and beams, and metal decking.

06 - Woods/Plastics/Composites: Fiberglass mat gypsum sheathing.

07 - Thermal and Moisture Protection: At wall and canopy cladding systems: metal plate wall panels; subgirt systems and cladding for metal plate, stone, architectural concrete, and hardwood rainscreen cladding; insulated metal panels; and self-adhering air barrier membrane. At the roof: HDPE vapor barrier; PVC; porcelain tile pavers; and asphalt BUR assembly (cap & felt ply) and asphalt felt sheet roofing underlayment used for the hot-applied roof assembly. Insulation, including PIR board, XPS, and mineral wool.

08 - Openings and Glazing: Aluminum mullions; glass, overhead, and hollow metal doors, including door frames; low-E vision glass glazing; and insulated spandrel glazing.

Figure 4 below summarizes each material category's percentage impact within each impact category of the baseline design, compared to Figure 5 which summarizes each material category's percentage impact within each impact category of the proposed design:

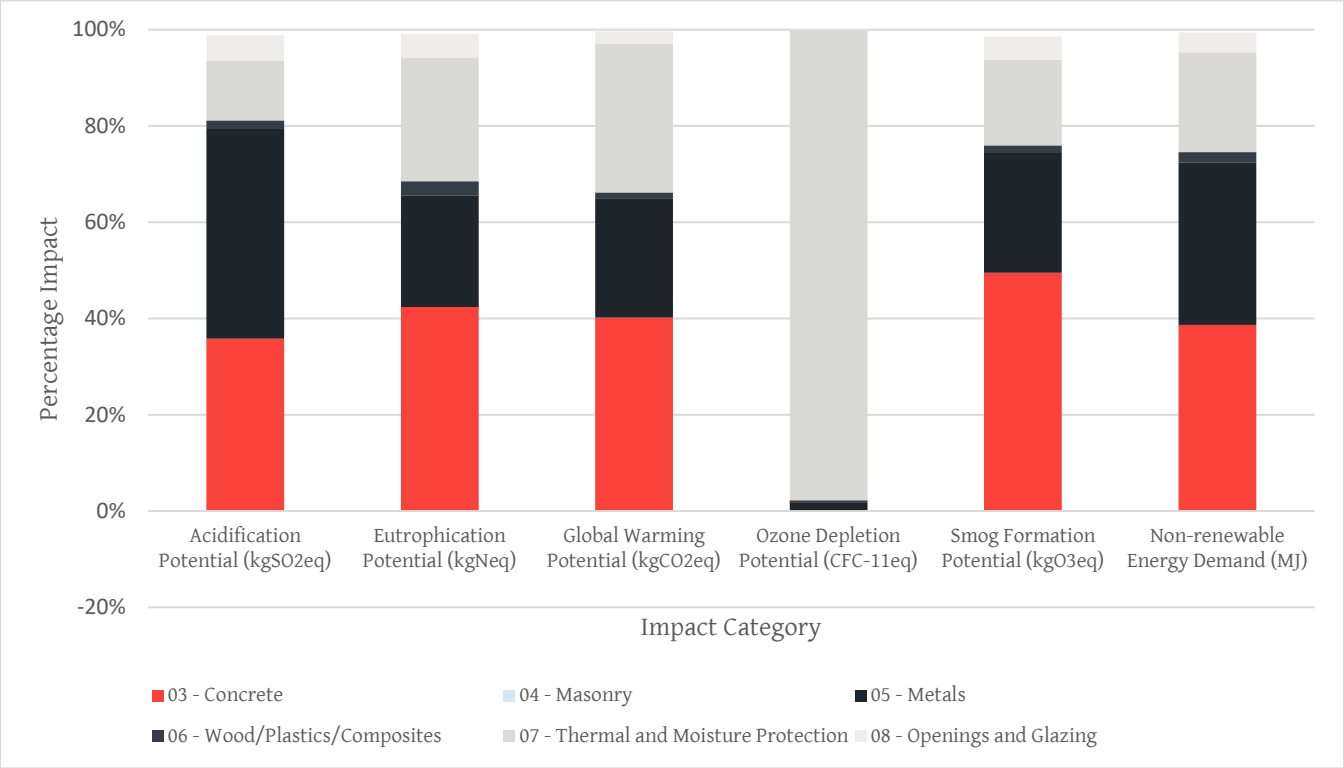

Figure 4: Design Impacts by Material Category - Baseline Design

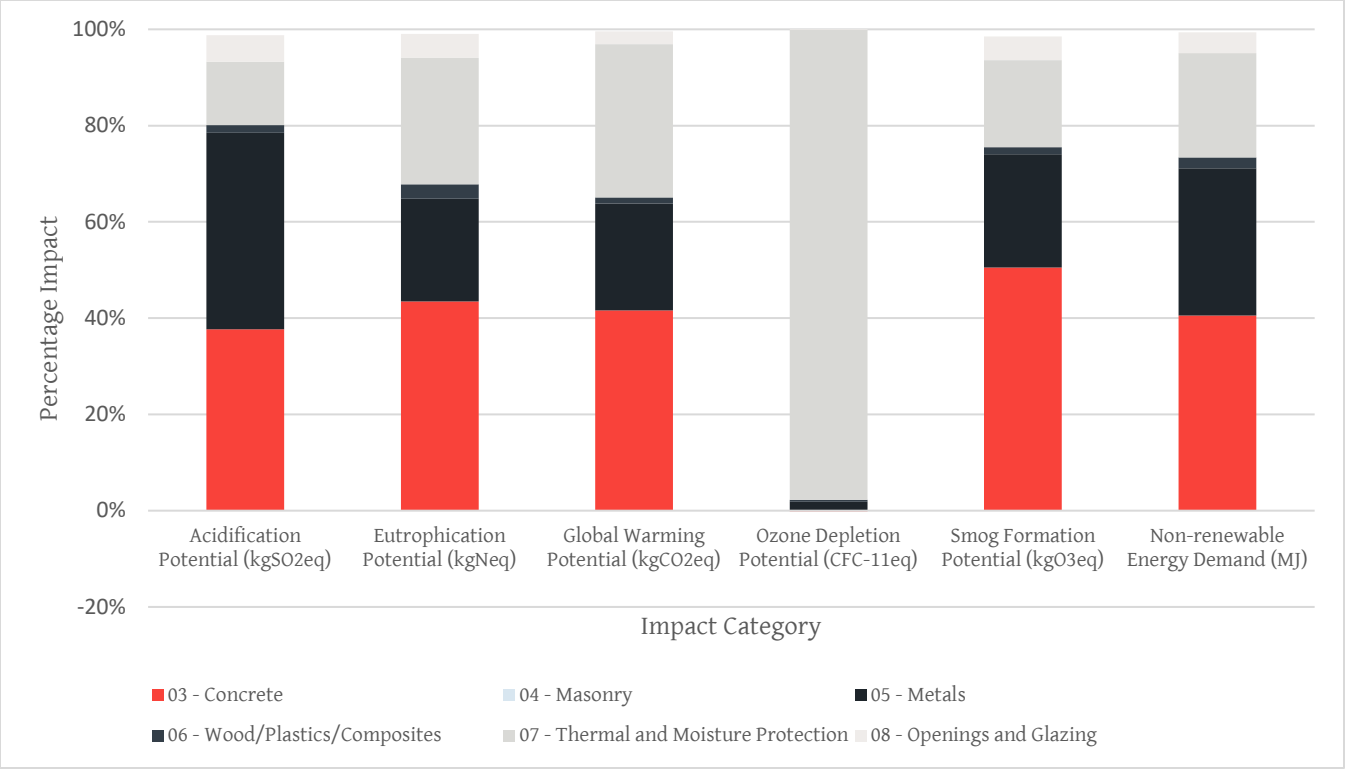

Figure 5: Design Impacts by Material Category – Proposed Design

3 DISCUSSION

WBLCA is most effective as a tool to support design decisions to evaluate and select environmentally preferable assemblies and materials including evaluating different structural systems, selecting building products and assemblies, and optimizing the structural system. For 420 Rutherford Avenue, the WBLCA quantified the embodied impact of several design changes at the same time. Many of the embodied impact reduction strategies used for this project can apply to other projects in the future.

INCORPORATING SUPPLEMENTARY CEMENTITIOUS MATERIALS AND TYPE 1L CEMENT IN CONCRETE REDUCES THE GWP CONTRIBUTIONS OF CONCRETE, WHICH IS THE HIGHEST GWP CONTRIBUTER IN THE PROJECT.

Supplemental cementitious materials (SCMs) such as fly ash and slag (aka blast furnace slag) replace Portland Cement in concrete, thereby reducing the amount of emissions-intensive cement needed in a concrete mix design. Generally, replacement of up to 20% of cement does not impact cure time or color. If replacement exceeds 20%, the cure time needed to get to the desired strength can be longer and the color of the final material can be different. Due to the longer cure times, the amount of SCMs in post-tensioned slabs is limited.

In this project, a previous modeling iteration included the following:

- Using a concrete mix for foundations with 40% slag of the total cement mix, and no fly ash (the baseline NRMCA mix used for this project assumes 7.8% fly ash and 13.6% slag, for a total of 21.4% SCMs). This was applied to the 24-inch Foundation Slab, 36-inch Foundation Slab, Rectangular Beams, and Rectangular Footings.

- Using a concrete mix for the slabs with 25% slag of the total cement mix, and no fly ash. This was applied to the 6-inch and 8-inch concrete slabs.

The modeling iteration that included the above concrete mixes contributed to a 7% improvement in the GWP (measured in $kgCO_2eq$) of concrete. Per discussion with Related Beal, this strategy was removed due to constructability and timeline concerns.

Another optimization strategy is to incorporate Type 1L cement. Type 1L cement replaces Portland cement with ground limestone. The minimal processing required for limestone reduces the amount of emissions-intensive Portland cement needed in a concrete mix design. Type 1L cement is defined in ASTM C595 Standard Specification for Blended Hydraulic Cements. The ASTM standard replaces 15% of Portland cement with Type 1L cement, however, Type 1L cement can replace up to 30% of the cement portion of the concrete mix. Regardless of the percent replacement, Type 1L reduced the Portland cement quantity in the concrete mix design. The remaining cement can still include SCMs. Type 1L cement can be used in any application from footings, to slabs, to columns and beams. Refer to ASTM C1157 Performance Specification for the standard specification for Type 1L cement. We recommend incorporating Type 1L cement for all mix designs, as Type 1L cement can reduce GWP by 15%. This strategy was not incorporated into the final design for the 420 Rutherford project.

For greater GWP savings, future projects can consider partial replacement of Portland Cement with Type 1L cement, and incorporation of a higher percentage of SCMs in the remaining Portland Cement mix.

BUILDING AND MATERIAL RE-USE IS THE MOST EFFECTIVE STRATEGY TO REDUCE EMBODIED CARBON.

Both data and intuition tells us that the "greenest" building is the one that already exists. Reusing existing buildings or portions of buildings is a highly effective strategy to reduce embodied impact. The 420 Rutherford Avenue project included existing underground structural piles from a previous building that were either abandoned in place, or demolished to accommodate the new foundations. This modeling exercise did not include these existing piles in the results.

EARLY DESIGN MODELS OFTEN DON'T HAVE MATERIAL DETAILS, MAKING MODELING CHALLENGING.

WBLCA can be an effective design tool at any stage of a project – early, middle, or late. The stage of the project informs which LCA tool is the most appropriate. As a plug-in tool, Tally is dependent of the Revit model, which provides both benefits and limitations. Tally itemizes Revit components based on system type and component name. Tally also identifies the materials within each Revit assembly so that Tally materials can be assigned to the Revit materials. This means that if the Revit assembly is missing a material, or if a material is modeled as a generic component, Tally cannot read the material. If Tally cannot read the material, it must be added manually to ensure the model is complete. The time it takes to perform the modeling portion of the exercise depends on the completeness and accuracy of the Revit model. In the 420 Rutherford Avenue architectural model, various wall types were grouped together, and window types were modeled as grouped families, which would have required us to isolate the areas of each wall and window type to be able to complete the Tally model. As a work-around, NBBJ sent us these calculations from their Rhino model.

PROJECT SPECIFICATIONS CAN INCLUDE MATERIALS BETTER THAN MATERIALS IN TALLY DATABASE.

Another limitation is that Tally has a database limited by the number of manufacturers currently generating and contributing data to the inventory database. This results in material assignments that are often generic materials not specific to the project. For example, Tally is not able to account for above average recycled content in steel or glazing, so efforts to specify and use highly recycled materials are not accounted for. Despite these limitations, the process of assigning materials is intuitive, and the results generated through the PDF and excel files are well-organized. The limitations around manufacturer-specific materials could be reduced if more product manufacturers produced EPDs on their products, as these could be incorporated into Tally. In contrast Tally offers the ability to use custom concrete mixes in the analysis. For this project, the proposed case was able to use concrete with an increased recycled content compared to the regional average.

4 LEED CREDIT NARRATIVE

The following sections are organized per the LEED credit form and are meant to be entered directly into form fields. The Summary of Life Cycle Assessment Tool has been submitted under Appendix A of this report.

4.1 LIFE CYCLE ASSESSMENT IMPACT MEASURES

The following table (Table 4) can be copied into the LEED credit form:

Table 4: LEED Credit Table in MR form

	Baseline Building Value (Path 2-4 only)	Proposed Building Value	Units	Percent Reduction (%)
Global warming potential GHG	5,473,453.05	5,294,749.49	kg CO_2e	3.2649
Stratospheric ozone depletion	0.689	0.689	kg CFC-11e	0
Acidification of land and water	18,133.91	17,231.73	○ moles H+ ◉ kg SO_2e	4.9751
Eutrophication	891.83	870.89	◉ kg N ○ kg PO_4	2.348
Tropospheric ozone formation	255,976.98	250,827.88	○ kg NOx ◉ kg O_3 ○ kg C_2H_4	2.0115
Depletion of non-renewable energy resources	48,345,566.28	46,139,699.86	MJ	4.5627
Number of measures with at least a 5% reduction				0
Number of measures with at least a 10% reduction				0

4.2 DESCRIPTION OF BASELINE BUILDING

LEED Credit Prompt: Provide a summary description of the baseline building. Describe how the baseline building is of comparable size, function, orientation, and operating energy performance as defined in EA Prerequisite Minimum Energy Performance to the performance model. Include the life cycle assessment scope, boundary (or cut-offs), data source, tools used, life cycle inventory analysis description, and other relevant assumptions.

The baseline building reflects a design iteration generated once major decisions about the wall, roof, floor, and structural assemblies were made. It is the same size as the proposed building at 113,191 square feet. It has the same function and is in the same orientation as the proposed building. The baseline building model used for the whole building life cycle assessment (WBLCA) represents the same design as the baseline building used for the energy model.

The WBLCA covers a complete assessment of the building envelope and structural elements over life cycle stages outlined by the LEED credit requirements over a 60-year service life. For boundary conditions, building components that made up less than 5% of the total mass of the project scope were not evaluated. The impacts assessment method used was TRACI 2.1 (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts), a method developed by the U.S. Environmental Protection Agency. The tool used was Tally, an LCA plug-in for Autodesk Revit.

The baseline structural system consists of 4000PSI concrete members with moderate steel reinforcement including a slab-on-grade, composite metal decks, foundations, and columns. In addition, there are steel columns and steel framing members. In the absence of a project-specific concrete design mix during the baseline phase, the Eastern Region concrete mix from the National Ready Mixed Concrete Association (NRCMA) Member and Regional LCA Benchmark (Industry Average Report) – V 3.0 was used.

Architectural materials and assemblies included all materials required for each component's manufacturing such as sealants, adhesives, coatings, and finishes. The roof assemblies include a 60-mil adhered polyvinyl chloride (PVC) roofing membrane over cover board, R-30 polyisocyanurate (PIR) board insulation, and a self-adhering sheet vapor barrier. There is an area of green roof consisting of hot-applied rubberized asphalt membrane roofing system and 8-inch extruded polystyrene (XPS) insulation. There is also an area of roof with 3/4-inch porcelain pavers over the PVC membrane assembly. Areas of canopy consist of the above PVC roof membrane assembly, as well as metal plate panel and wood cladding rainscreen assemblies.

The exterior wall enclosure is primarily metal plate rainscreen panel on a subgirt system over 4-inch mineral wool insulation, sheet-applied air barrier, 5/8-inch exterior sheathing, 6-inch metal stud, and 5/8-inch interior sheathing. At the base of the building, there is stone cladding over a sub girt system, 4-inch extruded polystyrene (XPS) insulation board, and sheet-applied air barrier over the foundation wall. A portion of the foundation wall assembly is architectural concrete over XPS and sheet-applied air barrier. In addition, the envelope includes a 4-sided SSG low-E coated curtain wall system, with intermittent spandrel panels, and metal plate panels between each band of curtain wall.

At the penthouse, the above noted metal plate rainscreen assembly occurs at the exterior of weathertight building enclosure walls, and insulated metal wall panels occur over galvanized steel supports as a screen where there are no weathertight enclosure walls.

4.3 DESCRIPTION OF PROPOSED BUILDING

LEED Credit Prompt: Provide a summary description of the proposed building. Describe the size, function, orientation, and operating energy performance as defined in EA Prerequisite Minimum Energy Performance. Include the life cycle assessment scope, boundary (or cut-offs), data source, tools used, life cycle inventory analysis description, and other relevant assumptions.

The proposed building reflects a design iteration with a different selection of building products from the baseline building. It is the same size as the baseline building at 113,191 square feet. It has the same function and is in the same orientation as the baseline building. The proposed building model used for the whole building life cycle assessment (WBLCA) represents the same design as the proposed building used for the energy model. Changes implemented in the proposed model do not impact the energy model by maintaining the same R-values and fenestration ratios.

The WBLCA covers a complete assessment of the building envelope and structural elements of life cycle stages outlined by the credit requirements over a 60-year service life. For boundary conditions, building components that made up less than 5% of the total mass of the project scope were not evaluated. The impact assessment method used was TRACI 2.1 (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts), a method developed by the U.S. Environmental Protection Agency. The tool used was Tally, a life cycle assessment plug-in for Autodesk Revit.

The proposed structural model contains the same materials and assemblies as the baseline model, with changes made to the steel framing systems. The baseline architectural model was used for the proposed modeling case. Changes to the structural model included the following:

- Upgrading the strength of the steel columns to a higher strength steel (from 50 ksi to 65 ksi). This reduced the total tonnage of steel at the columns by 30 tons, as calculated by the project Structural Engineer. This changed the total weight of steel resulting from columns from 253.91 tons to 223.91 tons.

- Decreasing the vibration requirements on the floor framing. This reduced the total tonnage of steel beams by 150 tons, as calculated by the project Structural Engineer. This changed the total weight of steel resulting from beams from 767.45 tons to 617.45 tons.

5 LIMITATIONS

1 The scope of our work and related responsibilities related to our work are defined in our project authorization ("Conditions of Assignment").

2 Any user accepts that decisions made or actions taken based upon interpretation of our work are the responsibility of only the parties directly involved in the decisions or actions.

3 No party other than the Client shall rely on the Consultant's work without the express written consent of the Consultant, and then only to the extent of the specific terms in that consent. Any use which a third party makes of this work, or any reliance on or decisions made based on it, are the responsibility of such third parties. Any third party user of this report specifically denies any right to any claims, whether in contract, tort and/or any other cause of action in law, against the Consultant (including Sub-Consultants, their officers, agents and employees).The work reflects the Consultant's best judgement in light of the information reviewed by them at the time of preparation. It is not a certification of compliance with past or present regulations. Unless otherwise agreed in writing by WSP USA Buildings Inc., it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity; it is written to be read in its entirety.

4 Only the specific information identified has been reviewed. No physical or destructive testing and no design calculations have been performed unless specifically recorded. Conditions existing but not recorded were not apparent given the level of study undertaken. Only conditions actually seen during examination of representative samples can be said to have been appraised and comments on the balance of the conditions are assumptions based upon extrapolation. Therefore, this work does not eliminate uncertainty regarding the potential for existing or future costs, hazards or losses in connection with a property. We can perform further investigation on items of concern if so required.

5 The Consultant is not responsible for, or obligated to identify, mistakes or insufficiencies in the information obtained from the various sources, or to verify the accuracy of the information.

6 No statements by WSP USA Buildings Inc. are given as or shall be interpreted as opinions for legal, environmental or health findings. WSP USA Buildings Inc. is not investigating or providing advice about pollutants, contaminants or hazardous materials.

7 The Client and other users of this report expressly deny any right to any claim against WSP USA Buildings Inc., including claims arising from personal injury related to pollutants, contaminants or hazardous materials, including but not limited to asbestos, mold, mildew or other fungus.

APPENDIX

A SUMMARY OF LIFE CYCLE ASSESSMENT TOOL

Report Summary

Created with Tally
Commercial Version 2020.06.09.01

Author	WSP
Company	WSP
Date	6/2/2022
Project	420 RUTHERFORD AVENUE
Location	Charlestown, MA
Gross Area	113191 ft^2
Building Life	60 years
Boundaries	Cradle to grave, inclusive of biogenic carbon; see appendix for a full list of materials and processes

Goal and Scope of Assessment
Baseline whole building life cycle assessment for 420 Rutherford Avenue. Scope includes structure and building enclosure. Boundary of assessment is cradle to grave, inclusive of biogenic carbon. Modules included are A1-A3, A4, B2-B5, C2-C4, and Module D. Boundary exludes construction installation (A5), use (B1), and operational energy (B6).

Environmental Impact Totals	Product Stage [A1-A3]	Construction Stage [A4]	Use Stage [B2-B5]	End of Life Stage [C2-C4]	Module D [D]
Global Warming (kg CO_2eq)	4,883,151	94,921	164,189	631,795	-300,604
Acidification (kg SO_2eq)	16,452	981.6	793.7	1,034	-1,128
Eutrophication (kg Neq)	757.5	52.27	46.42	60.76	-25.1
Smog Formation (kg O_3eq)	199,619	24,729	20,611	20,137	-9,119
Ozone Depletion (kg CFC-11eq)	0.6871	3.131E-009	5.638E-004	1.351E-004	0.001296
Primary Energy (MJ)	4.604E+007	1,351,103	3,669,603	3,727,294	-3,510,552
Non-renewable Energy (MJ)	4.297E+007	1,322,785	3,423,911	3,485,698	-2,858,413
Renewable Energy (MJ)	3,066,113	28,138	246,242	245,726	-654,562
Environmental Impacts / Area					
Global Warming (kg CO_2eq/m^2)	464.4	9.027	15.61	60.08	-28.6
Acidification (kg SO_2eq/m^2)	1.565	0.09335	0.07547	0.09836	-0.1073
Eutrophication (kg Neq/m^2)	0.07203	0.004971	0.004415	0.005778	-0.002388
Smog Formation (kg O_3eq/m^2)	18.98	2.352	1.960	1.915	-0.8672
Ozone Depletion (kg CFC-11eq/m^2)	6.534E-005	2.978E-013	5.361E-008	1.285E-008	1.232E-007
Primary Energy (MJ/m^2)	4,378	128.5	349.0	354.4	-334
Non-renewable Energy (MJ/m^2)	4,086	125.8	325.6	331.5	-272
Renewable Energy (MJ/m^2)	291.6	2.676	23.42	23.37	-62.2

Report Summary

Created with Tally
Commercial Version 2020.06.09.01

Author	WSP
Company	WSP
Date	6/30/2022
Project	420 RUTHERFORD AVENUE
Location	Charlestown, MA
Gross Area	113191 ft^2
Building Life	60 years
Boundaries	Cradle to grave, inclusive of biogenic carbon; see appendix for a full list of materials and processes

Goal and Scope of Assessment
Proposed whole building life cycle assessment for 420 Rutherford Avenue. Scope includes structure and building enclosure. Boundary of assessment is cradle to grave, inclusive of biogenic carbon. Modules included are A1-A3, A4, B2-B5, C2-C4, and Module D. Boundary excludes construction installation (A5), use (B1), and operational energy (B6).

Environmental Impact Totals	Product Stage [A1-A3]	Construction Stage [A4]	Use Stage [B2-B5]	End of Life Stage [C2-C4]	Module D [D]
Global Warming (kg CO_2eq)	4,725,252	91,079	164,189	631,651	-317,422
Acidification (kg SO_2eq)	15,601	963.8	793.7	1,034	-1,161
Eutrophication (kg Neq)	739.4	50.82	46.42	60.73	-26.4
Smog Formation (kg O_3eq)	195,537	24,140	20,611	20,124	-9,584
Ozone Depletion (kg CFC-11eq)	0.6871	3.000E-009	5.638E-004	1.351E-004	0.001415
Primary Energy (MJ)	4.398E+007	1,295,224	3,669,603	3,724,827	-3,656,693
Non-renewable Energy (MJ)	4.098E+007	1,268,243	3,423,911	3,483,395	-3,015,332
Renewable Energy (MJ)	3,005,860	26,787	246,242	245,563	-643,769
Environmental Impacts / Area					
Global Warming (kg CO_2eq/m^2)	449.3	8.661	15.61	60.07	-30.2
Acidification (kg SO_2eq/m^2)	1.484	0.09165	0.07547	0.09829	-0.1104
Eutrophication (kg Neq/m^2)	0.07031	0.004833	0.004415	0.005775	-0.002515
Smog Formation (kg O_3eq/m^2)	18.59	2.296	1.960	1.914	-0.9114
Ozone Depletion (kg CFC-11eq/m^2)	6.534E-005	2.853E-013	5.361E-008	1.285E-008	1.345E-007
Primary Energy (MJ/m^2)	4,182	123.2	349.0	354.2	-348
Non-renewable Energy (MJ/m^2)	3,897	120.6	325.6	331.3	-287
Renewable Energy (MJ/m^2)	285.8	2.547	23.42	23.35	-61.2

APPENDIX

B TALLY WBLCA BASELINE MODEL RESULTS

420 RUTHERFORD AVENUE

Baseline WBLCA - NRMCA 4000PSI Concrete

6/2/2022

tally®

Table of Contents

Report Summary

Created with Tally
Commercial Version 2020.06.09.01

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Smog Formation (kg O_3eq)	199,619	24,729	20,611	20,137	-9,119
Ozone Depletion (kg CFC-11eq)	0.6871	3.131E-009	5.638E-004	1.351E-004	0.001296
Primary Energy (MJ)	4.604E+007	1,351,103	3,669,603	3,727,294	-3,510,552
Non-renewable Energy (MJ)	4.297E+007	1,322,785	3,423,911	3,485,698	-2,858,413
Renewable Energy (MJ)	3,066,113	28,138	246,242	245,726	-654,562
Environmental Impacts / Area					
Global Warming (kg CO_2eq/m^2)	464.4	9.027	15.61	60.08	-28.6
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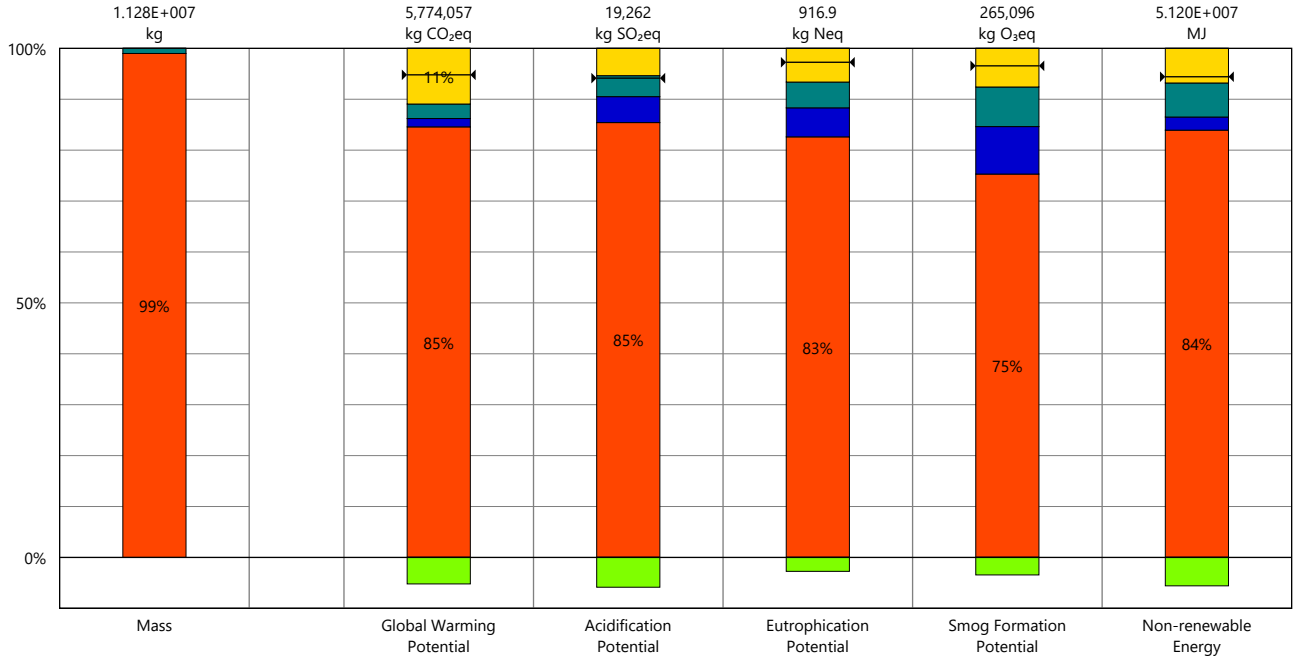
Renewable Energy (MJ/m^2)	291.6	2.676	23.42	23.37	-62.2

Results per Life Cycle Stage

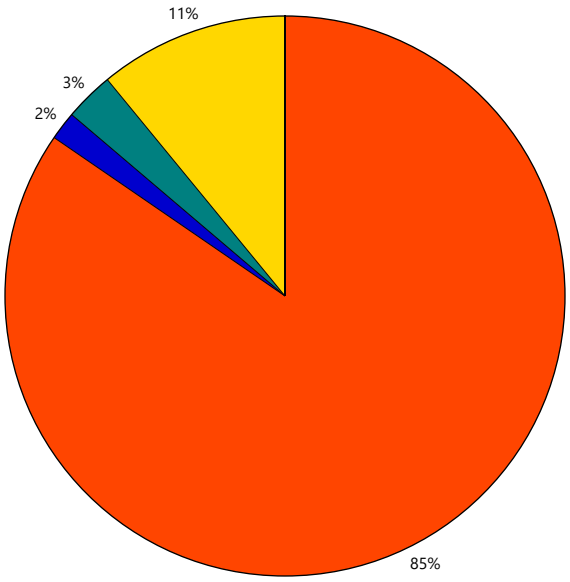


Legend

Net value (impacts + credits)

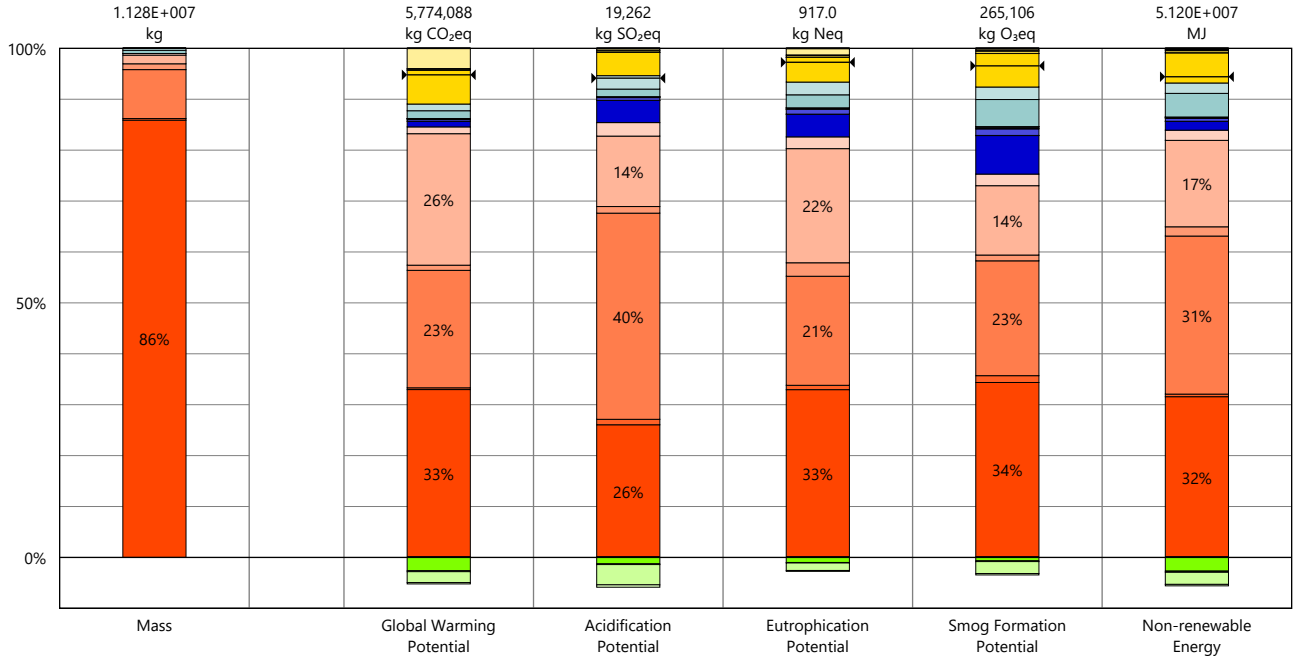
Life Cycle Stages

- Product [A1-A3]
- Transportation [A4]
- Maintenance and Replacement [B2-B5]
- End of Life [C2-C4]
- Module D [D]



Global Warming Potential

Results per Life Cycle Stage, itemized by Division



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Net value (impacts + credits)

Product [A1-A3]
- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing

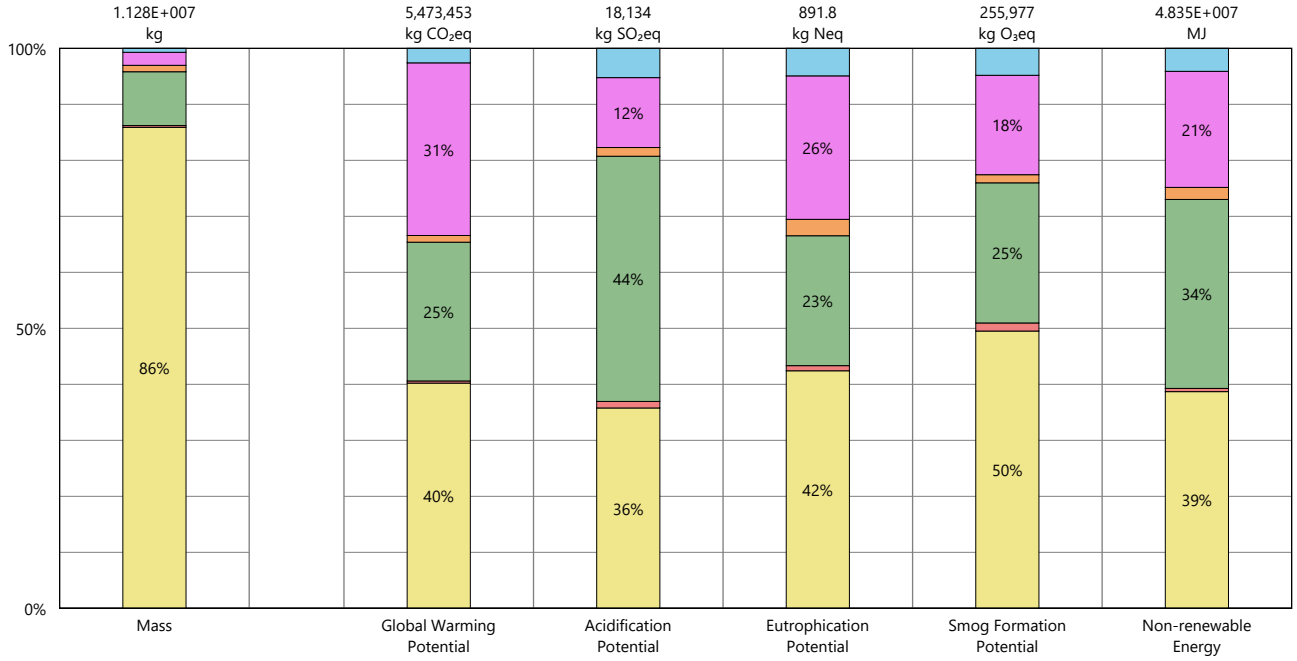
Transportation [A4]
- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing

Maintenance and Replacement [B2-B5]
- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing

End of Life [C2-C4]
- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing

Module D [D]
- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing

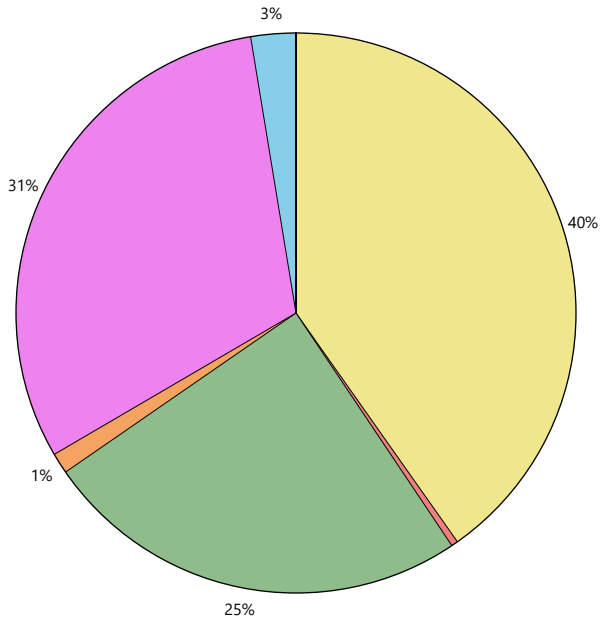
Results per Division



Legend

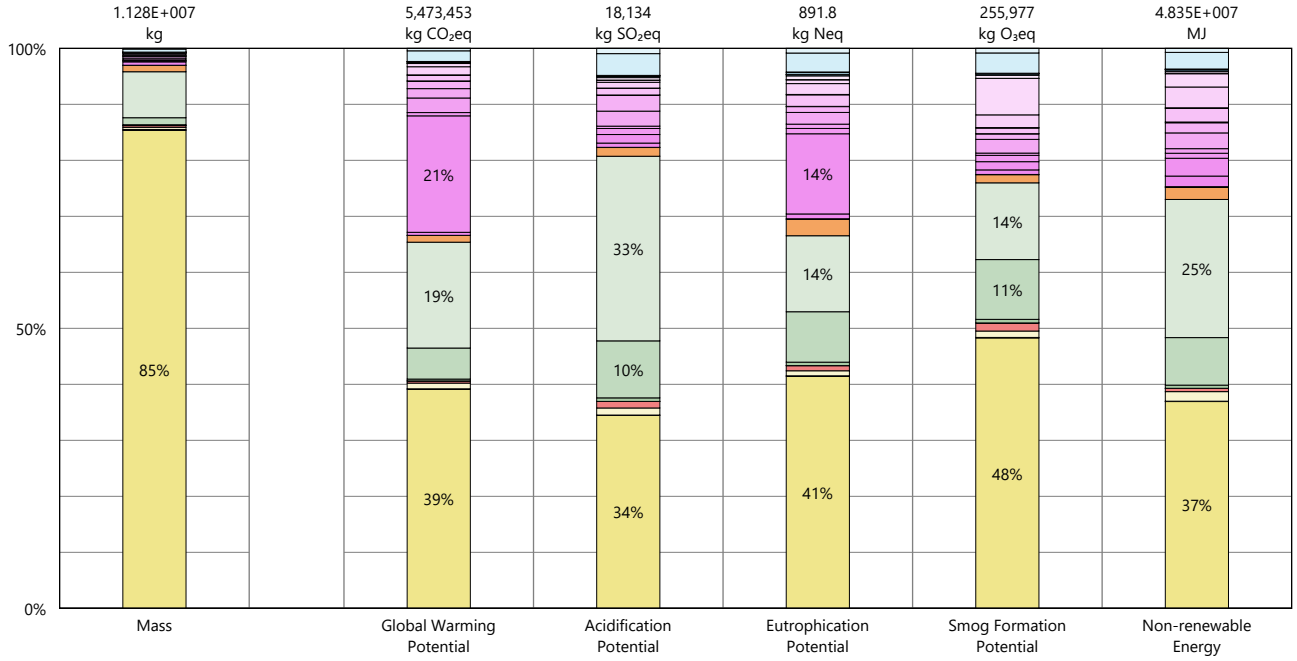
Divisions

- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing



Global Warming Potential

Results per Division, itemized by Tally Entry



Legend

03 - Concrete
- Cast-in-place concrete, custom mix
- Precast concrete nonstructural panel
- Steel, welded wire mesh

04 - Masonry
- Stone veneer wall, granite, grouted

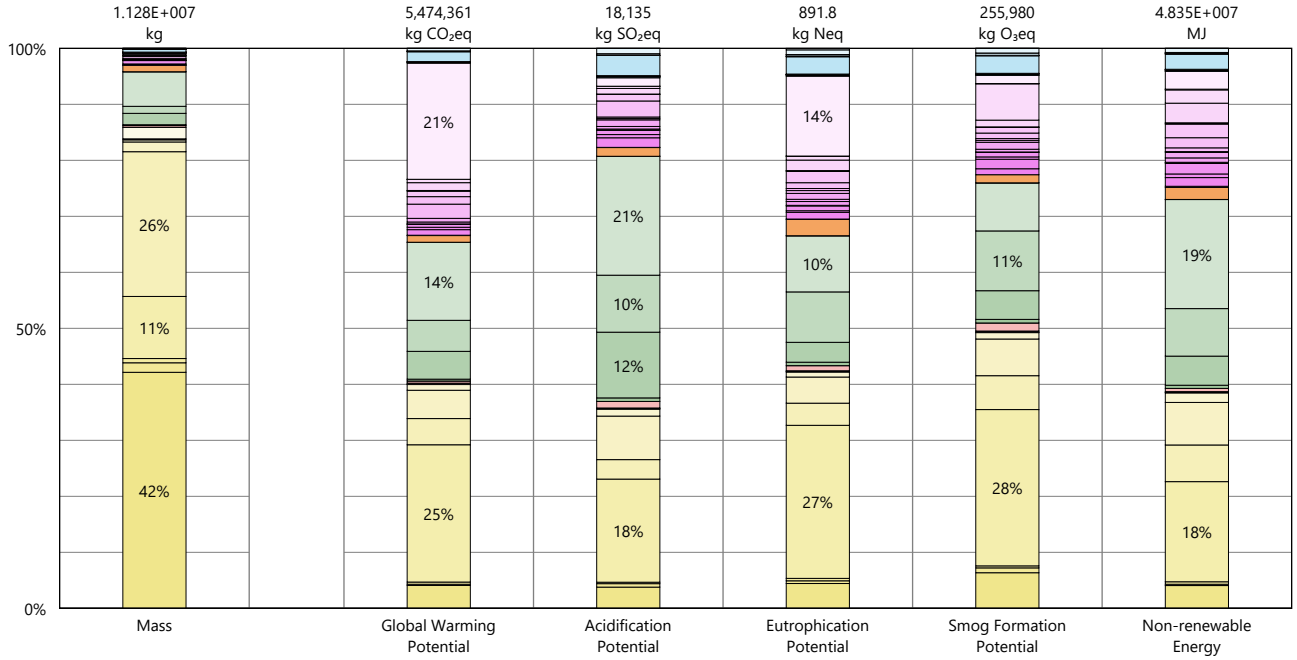
05 - Metals
- Aluminum, formed
- Steel, C-stud metal framing
- Steel, deck
- Steel, W section (wide flange shape)

06 - Wood/Plastics/Composites
- Fiberglass mat gypsum sheathing

07 - Thermal and Moisture Protection
- Asphalt felt sheet
- Built up asphalt roofing
- Extruded polystyrene (XPS), board
- Glass fiber reinforced concrete (GFRC) panel
- Insulated metal wall panel
- Metal wall panels, plate
- Mineral wool, board, generic
- Polyethelene sheet vapor barrier (HDPE)
- Polyisocyanurate (PIR), board
- Porcelain tile
- PVC roofing membrane, sheet
- Self adhering membrane
- Self-adhering, polymer-modified asphalt sheet underlayment
- Wood rainscreen, hardwood

08 - Openings and Glazing
- Aluminum mullion, custom finish
- Door frame, aluminum
- Door, exterior, aluminum
- Door, exterior, glass
- Door, exterior, steel
- Glazing, custom IGU
- Spandrel, glass, insulated

Results per Division, itemized by Material



Legend

03 - Concrete
- Coarse aggregate
- Expanded slag
- Fly ash
- Portland cement, PCA - EPD
- Sand
- Steel, reinforcing rod
- Steel, welded wire mesh
- Structural concrete, 3000 psi, 0% fly ash and slag
- Water

04 - Masonry
- Mortar type S
- Stone slab, granite

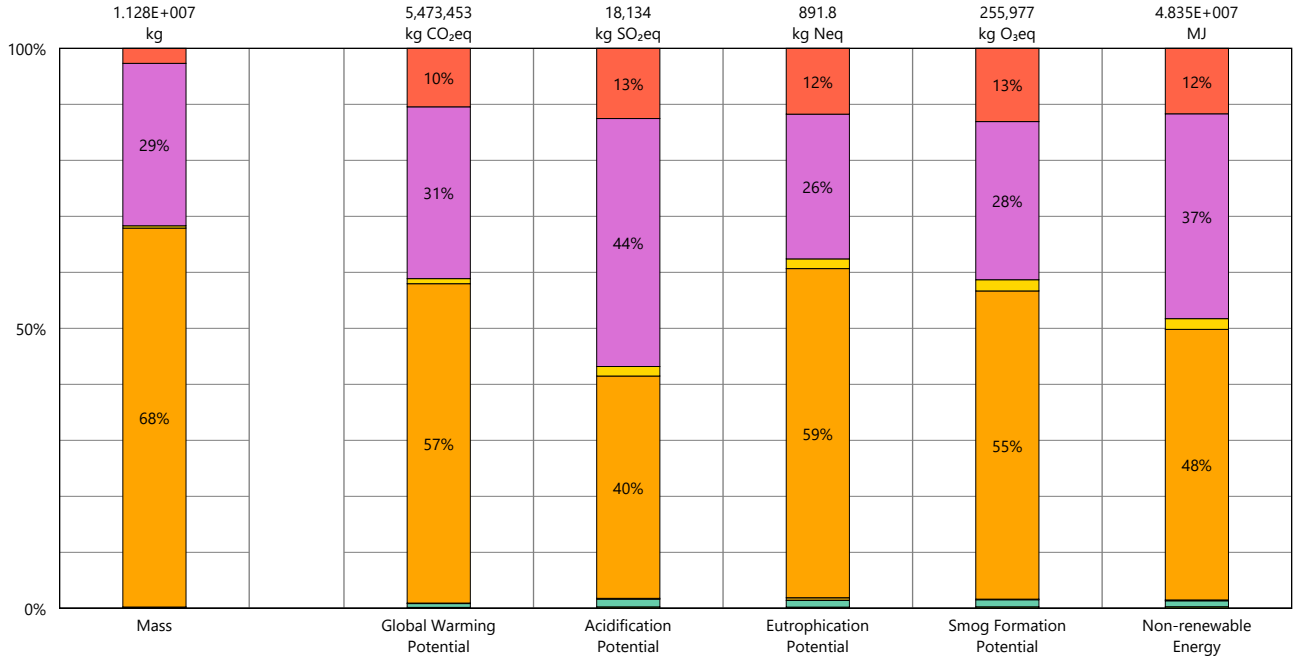
05 - Metals
- Aluminum, formed
- Cold formed structural steel
- Fireproofing, cementitious, by area
- Galvanized steel decking
- Hot rolled structural steel, AISC - EPD
- Powder coating, metal stock

06 - Wood/Plastics/Composites
- Fiberglass mat gypsum sheathing board

07 - Thermal and Moisture Protection
- Adhesive, polychloroprene (neoprene)
- Aluminum extrusion, AEC - EPD
- Aluminum, sheet
- Asphalt BUR, assembly (cap & ply felt), ARMA - EPD
- Asphalt felt sheet, roofing underlayment, ARMA - EPD
- Fasteners, stainless steel
- Fluoropolymer coating, metal stock
- Galvanized steel support
- GFRC
- Hard maple lumber, 1 inch
- Insulated metal panel (IMP), Metl-Span, CF42 - EPD
- Mineral wool, high density, NAIMA - EPD
- PIR rigid foam insulation, roof, R=15, PIMA - EPD
- Polyethelene sheet vapor barrier (HDPE)
- Porcelain ceramic tile, glazed
- PVC membrane, sheet
- Self adhering flashing membrane, 40 mil
- Self-adhering, polymer-modified asphalt sheet underlayment
- Wood stain, water based
- XPS insulation, Foamular average, Owens Corning - EPD

08 - Openings and Glazing
- Aluminum entrance door, YKK AP - EPD
- Aluminum extrusion, thermally-improved mill-finished, AEC - EPD
- Argon gas for IGU
- Door frame, aluminum, powder-coated, no door
- Fasteners, aluminum (anodized)
- Fasteners, stainless steel
- Fluoropolymer coating, metal stock
- Glazing, double, 3 mm, laminated safety glass
- Glazing, monolithic sheet, tempered
- Hardware, stainless steel
- Hollow door, exterior, steel, powder-coated
- IGU spacer
- Low-e coating (for glazing)
- Overhead door closer, aluminum
- Spandrel, glass, insulated (2" core)
- Steel door hinge

Results per Revit Category



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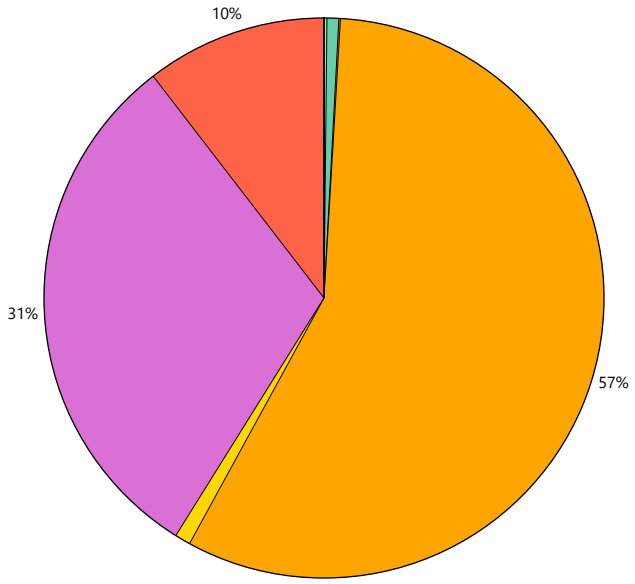
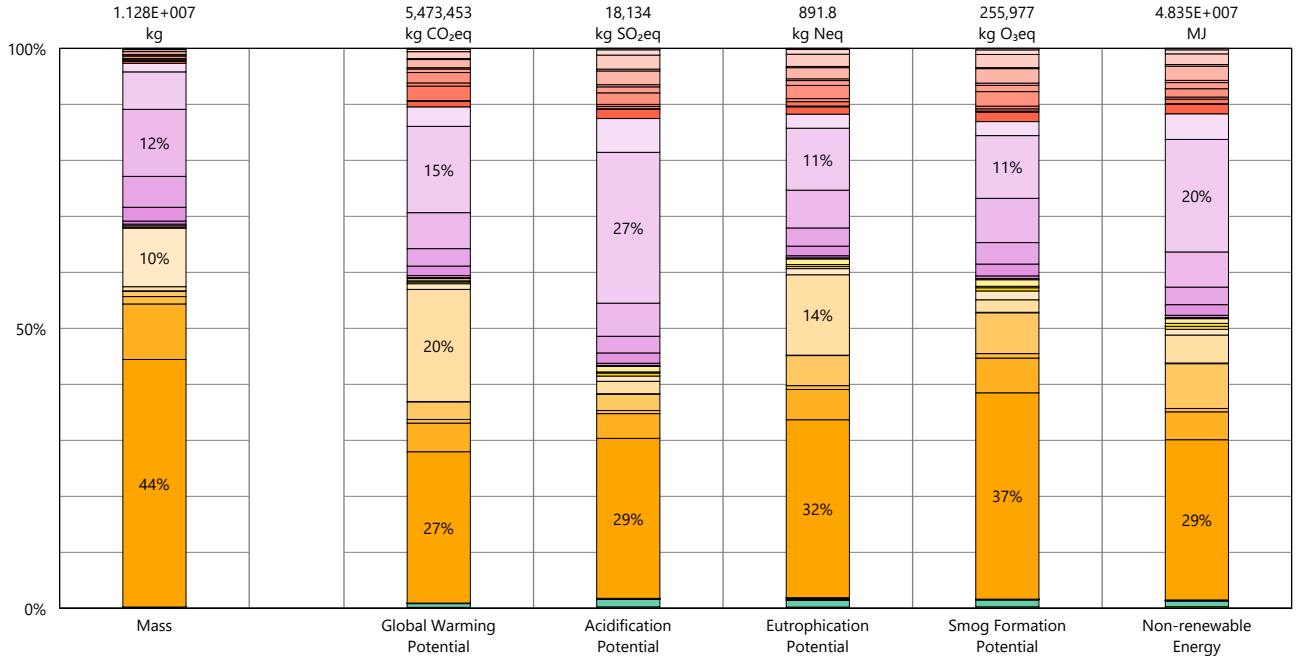
Revit Categories

- Curtainwall Mullions
- Curtainwall Panels
- Doors
- Floors
- Roofs
- Structure
- Walls



Global Warming Potential

Results per Revit Category, itemized by Family



Legend

Curtainwall Mullions
- Rectangular Mullion

Curtainwall Panels
- System Panel

Doors
- _Schematic-Swinging
- B2050-Exterior_Swinging
- Door Panel_Double Casement
- Door-Curtain-Wall-Single-Glass
- door-eco1602_faceofwallmount_300-series-cookson (2)
- Revolving Door 3

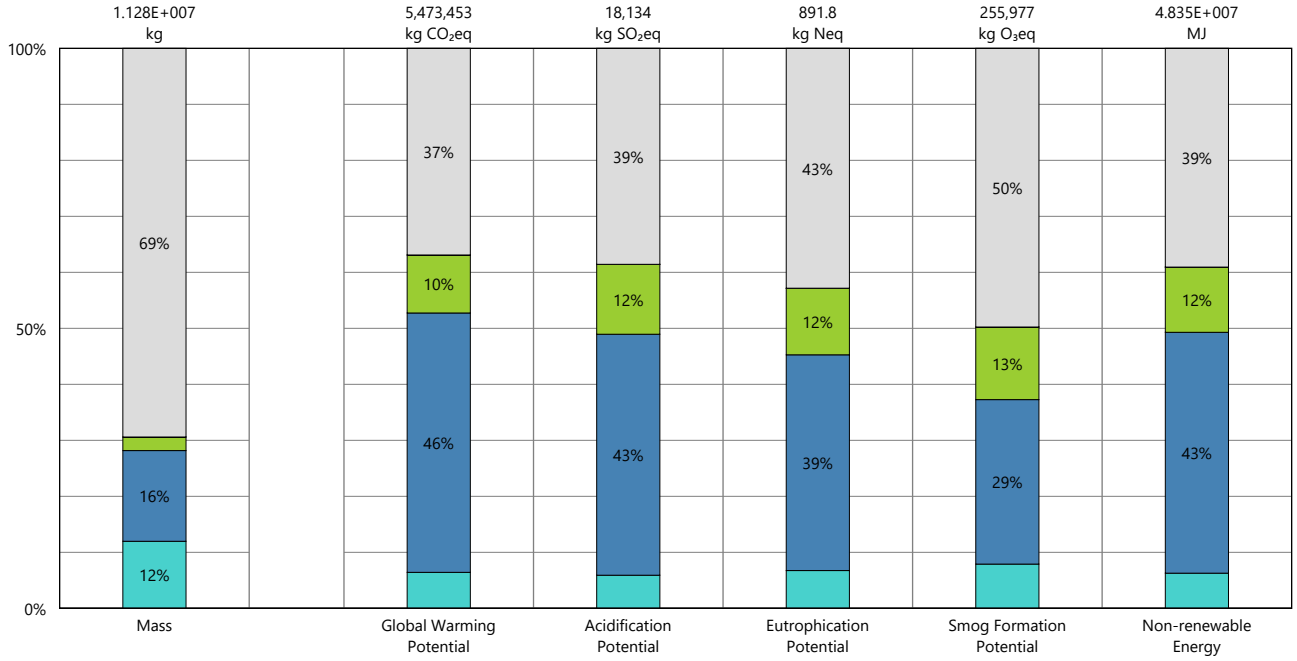
Floors
- 4.5" LW Concrete 3" Metal Deck
- 6" Concrete Slab
- 8" Concrete Slab
- Generic - 8"
- Site - Pavement - Wood - Roof Decking
- Site - Planting - 3
- WSP - 6" Gravel Fill

Roofs
- WSP - GFRC_NBBJ Calcs
- WSP - PVC Canopy_NBBJ Calcs 2
- WSP - Wood Canopy_NBBJ Calcs

Structure
- _TT-CL-Concrete Rectangular
- 24" Foundation Slab
- 36" Foundation Slab
- Concrete-Rectangular Beam
- Footing-Rectangular
- W-Wide Flange
- W-Wide Flange-Column

Walls
- _Schematic-Exterior_10"
- Concrete - 12"
- WSP - Exterior PH Screen_NBBJ Calcs 2
- WSP - Type 10 Architectural Concrete_NBBJ Calcs
- WSP - Type 10 Stone Cladding_NBBJ Calcs
- WSP - Type 13 Custom Metal_NBBJ Calcs
- WSP - Type 14 Precast Panel_NBBJ Calcs 2
- WSP - Type 6 GFRC_NBBJ Calcs
- WSP - Type 7 GFRC in CW_NBBJ Calcs 2
- WSP - Type 8 CW_NBBJ Calcs
- WSP - Type 9 CW Spandrel_NBBJ Calcs
- WSP_Schematic-Exterior_12"

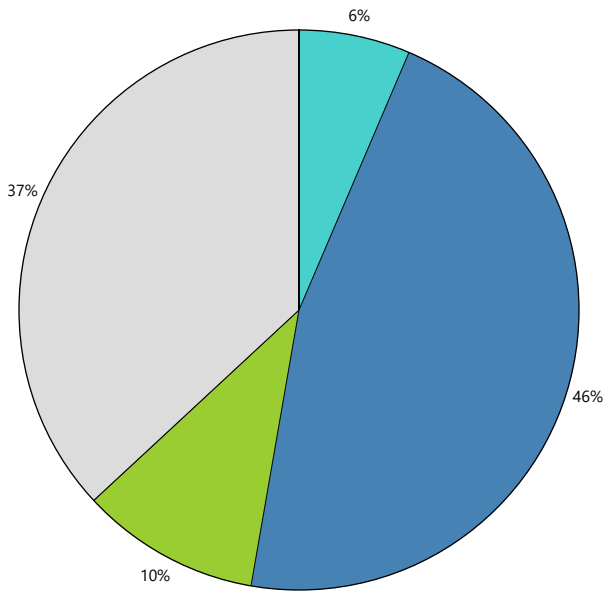
Results per Building Element



Legend

Building Elements

- Substructure
- Superstructure
- Enclosure
- Interiors
- Undefined



Global Warming Potential

Calculation Methodology

LIFE CYCLE ASSESSMENT METHODS

The following provides a description of terms and methods associated with the use of Tally to conduct life cycle assessment for construction works and construction products. Tally methodology is consistent with LCA standards ISO 14040-14044, ISO 21930:2017, ISO 21931:2010, EN 15804:2012, and EN 15978:2011. For more information about LCA, please refer to these standards or visit www.choosetally.com.

Studied objects

The life cycle assessment (LCA) results reported represent an analysis of a single building, multiple buildings, or a comparative analysis of two or more building design options. The assessment may represent the complete architectural, structural, and finish systems of the building(s) or a subset of those systems. This may be used to compare the relative environmental impacts associated with building components or for comparative study with one or more reference buildings. Design options may represent a full or partial building across various stages of the design process, or they may represent multiple schemes of a full or partial building that are being compared to one another across a range of evaluation criteria.

Functional unit and reference unit

A functional unit is the quantified performance of a product, building, or system that defines the object of the study. The functional unit of a single building should include the building type (e.g. office, factory), relevant technical and functional requirements (e.g. regulatory requirements, energy performance), pattern of use (e.g. occupancy, usable floor area), and the required service life. For a design option comparison of a partial building, the functional unit is the complete set of building systems or products that perform a given function. It is the responsibility of the modeler to assure that reference buildings or design options are functionally equivalent in terms of scope and relevant performance. The expected life of the building has a default value of 60 years and can be modified by the modeler.

The reference unit is the full collection of processes and materials required to produce a building or portion thereof and is quantified according to the given goal and scope of the assessment over the full life of the building. If construction impacts are included in the assessment, the reference unit also includes the energy, water, and fuel consumed on the building site during construction. If operational energy is included in the assessment, the reference unit includes the electrical and thermal energy consumed on site over the life of the building.

Data source

Tally utilizes a custom designed LCA database that combines material attributes, assembly details, and architectural specifications with environmental impact data resulting from the collaboration between KieranTimberlake and thinkstep. LCA modeling was conducted in GaBi 8.5 using GaBi 2018 databases and in accordance with GaBi databases and modeling principles.

The data used are intended to represent the US and the year 2017. Where representative data were unavailable, proxy data were used. The datasets used, their geographic region, and year of reference are listed for each entry. An effort was made to choose proxy datasets that are technologically consistent with the relevant entry.

Data quality and uncertainty

Uncertainty in results can stem from both the data used and their application. Data quality is judged by: its measured, calculated, or estimated precision; its completeness, such as unreported emissions; its consistency, or degree of uniformity of the methodology applied on a study serving as a data source; and geographical, temporal, and technological representativeness. The GaBi LCI databases have been used in LCA models worldwide in both industrial and scientific applications. These LCI databases have additionally been used both as internal and critically reviewed and published studies. Uncertainty introduced by the use of proxy data is reduced by using technologically, geographically, and/or temporally similar data. It is the responsibility of the modeler to appropriately apply the predefined material entries to the building under study.

System boundaries and delimitations

The analysis accounts for the full cradle to grave life cycle of the design options studied across all life cycle stages, including material manufacturing, maintenance and replacement, and eventual end of life. Optionally, the construction impacts and operational energy of the building can be included within the scope. Product stage impacts are excluded for materials and components indicated as existing or salvaged by the modeler. The modeler defines whether the boundary includes or excludes the flow of biogenic carbon, which is the carbon absorbed and generated by biological sources (e.g. trees, algae) rather than from fossil resources.

Architectural materials and assemblies include all materials required for the product's manufacturing and use including hardware, sealants, adhesives, coatings, and finishing. The materials are included up to a 1% cut-off factor by mass except for known materials that have high environmental impacts at low levels. In these cases, a 1% cut-off was implemented by impact.

Calculation Methodology

LIFE CYCLE STAGES

The following describes the scope and system boudaries used to define each stage of the life cycle of a building or building product, from raw material acquisition to final disposal. For products listed in Tally as Environmental Product Declarations (EPD), the full life cycle impacts are included, even if the published EPD only includes the Product stage [A1-A3].

Product [EN 15978 A1 - A3]

This encompasses the full manufacturing stage, including raw material extraction and processing, intermediate transportation, and final manufacturing and assembly. The product stage scope is listed for each entry, detailing any specific inclusions or exclusions that fall outside of the cradle to gate scope. Infrastructure (buildings and machinery) required for the manufacturing and assembly of building materials are not included and are considered outside the scope of assessment.

Transportation [EN 15978 A4]

This counts transportation from the manufacturer to the building site during the construction stage and can be modified by the modeler.

Construction Installation [EN 15978 A5] (Optional)

This includes the anticipated or measured energy and water consumed on-site during the construction installation process, as specified by the modeler.

Maintenance and Replacement [EN 15978 B2-B5]

This encompasses the replacement of materials in accordance with their expected service life. This includes the end of life treatment of the existing products as well as the cradle to gate manufacturing and transportation to site of the replacement products. The service life is specified separately for each product. Refurbishment of materials marked as existing or salvaged by the modeler is also included.

Operational Energy [EN 15978 B6] (Optional)

This is based on the anticipated or measured energy and natural gas consumed at the building site over the lifetime of the building, as indicated by the modeler.

End of Life [EN 15978 C2-C4]

This includes the relevant material collection rates for recycling, processing requirements for recycled materials, incineration rates, and landfilling rates. The impacts associated with landfilling are based on average material properties, such as plastic waste, biodegradable waste, or inert material. Stage C2 encompasses the transport from the construction site to end-of-life treatment based on national averages. Stages C3-C4 account for waste processing and disposal, i.e., impacts associated with landfilling or incineration.

Module D [EN 15978 D]

This accounts for reuse potentials that fall beyond the system boundary, such as energy recovery and recycling of materials. Along with processing requirements, the recycling of materials is modeled using an avoided burden approach, where the burden of primary material production is allocated to the subsequent life cycle based on the quantity of recovered secondary material. Incineration of materials includes credit for average US energy recovery rates.

PRODUCT	CONSTRUCTION	USE	END-OF-LIFE	MODULE D
A1. Extraction	**A4. Transport (to site)**	B1. Use	C1. Demolition	**D. Benefits and loads beyond the system boundary from:**
A2. Transport (to factory)	***A5. Construction Installation***	**B2. Maintenance**	**C2. Transport (to disposal)**	**1. Reuse**
A3. Manufacturing		**B3. Repair**	**C3. Waste processing**	**2. Recycling**
		B4. Replacement	**C4. Disposal**	**3. Energy recovery**
		B5. Refurbishment		
		B6. Operational energy		
		B7. Operational water		

Life-Cycle Stages as defined by EN 15978. Processes included in Tally modeling scope are shown in bold. Italics indicate optional processes.

Calculation Methodology

ENVIRONMENTAL IMPACT CATEGORIES

A characterization scheme translates all emissions and fuel use associated with the reference flow into quantities of categorized environmental impact. As the degree that the emissions will result in environmental harm depends on regional ecosystem conditions and the location in which they occur, the results are reported as impact potential. Potential impacts are reported in kilograms of equivalent relative contribution (eq) of an emission commonly associated with that form of environmental impact (e.g. kg CO_2eq).

The following list provides a description of environmental impact categories reported according to the TRACI 2.1 characterization scheme, the environmental impact model developed by the US EPA to quantify environmental impact risk associated with emissions to the environment in the United States. TRACI is the standard environmental impact reporting format for LCA in North America. Impacts associated with land use change and fresh water depletion are not included in TRACI 2.1. For more information on TRACI 2.1, reference Bare 2010, EPA 2012, and Guinée 2001. For further description of measurement of environmental impacts in LCA, see Simonen 2014.

Acidification Potential (AP) kg SO_2eq

A measure of emissions that cause acidifying effects to the environment. The acidification potential is a measure of a molecule's capacity to increase the hydrogen ion (H^+) concentration in the presence of water, thus decreasing the pH value. Potential effects include fish mortality, forest decline, and the deterioration of building materials.

Eutrophication Potential (EP) kg Neq

A measure of the impacts of excessively high levels of macronutrients, the most important of which are nitrogen (N) and phosphorus (P). Nutrient enrichment may cause an undesirable shift in species composition and elevated biomass production in both aquatic and terrestrial ecosystems. In aquatic ecosystems, increased biomass production may lead to depressed oxygen levels caused by the additional consumption of oxygen in biomass decomposition.

Global Warming Potential (GWP) kg CO_2eq

A measure of greenhouse gas emissions, such as carbon dioxide and methane. These emissions are causing an increase in the absorption of radiation emitted by the earth, increasing the natural greenhouse effect. This may, in turn, have adverse impacts on ecosystem health, human health, and material welfare.

Ozone Depletion Potential (ODP) kg CFC-11eq

A measure of air emissions that contribute to the depletion of the stratospheric ozone layer. Depletion of the ozone leads to higher levels of UVB ultraviolet rays reaching the earth's surface with detrimental effects on humans and plants. As these impacts tend to be very small, ODP impacts can be difficult to calculate and are prone to a larger margin of error than the other impact categories.

Smog Formation Potential (SFP) kg O_3eq

A measure of ground level ozone, caused by various chemical reactions between nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in sunlight. Human health effects can result in a variety of respiratory issues, including increasing symptoms of bronchitis, asthma, and emphysema. Permanent lung damage may result from prolonged exposure to ozone. Ecological impacts include damage to various ecosystems and crop damage.

Primary Energy Demand (PED) MJ (lower heating value)

A measure of the total amount of primary energy extracted from the earth. PED tracks energy resource use, not the environmental impacts associated with the resource use. PED is expressed in energy demand from non-renewable resources and from renewable resources. Efficiencies in energy conversion (e.g. power, heat, steam, etc.) are taken into account when calculating this result.

Non-Renewable Energy Demand MJ (lower heating value)

A measure of the energy extracted from non-renewable resources (e.g. petroleum, natural gas, etc.) contributing to the PED. Non-renewable resources are those that cannot be regenerated within a human time scale. Efficiencies in energy conversion (e.g. power, heat, steam, etc.) are taken into account when calculating this result.

Renewable Energy Demand MJ (lower heating value)

A measure of the energy extracted from renewable resources (e.g. hydropower, wind energy, solar power, etc.) contributing to the PED. Efficiencies in energy conversion (e.g. power, heat, steam, etc.) are taken into account when calculating this result.

LCI Data

END-OF-LIFE [C2-C4]

A Life Cycle Inventory(LCI) is a compilation and quantification of inputs and outputs for the reference unit.The following LCI provides a summary of all energy, construction, transportation, and material inputs present in the study. Materials are listed in alphabetical order along with a list of all Revit families and Tally entries in which they occur, along with any notes and system boundaries accompanying their database entries.Each entry lists the detailed scope for the LCI data sources used from the GaBi LCI database and identifies the LCI data source.

For LCI data sourced from an Environmental Product Declaration (EPD), the product manufacturer, EPD identification number, and Program Operator are listed. Where the LCI source does not provide data for all life cycle stages, default North American average values are used. This is of particular importance for European EPD sources, as EPD data are generally only provided for the product stage, and North American average values are used for the remaining life cycle stages.

Where specific quantities are associated with a data entry, such as user inputs, energy values, or material mass, the quantity is listed on the same line as the title of the entry.

TRANSPORTATION [A4]

Default transportation values are based on the three-digit material commodity code in the 2012 Commodity Flow Survey by the US Department of Transportation Bureau of Transportation Statistics and the US Department of Commerce where more specific industry-level transportation is not available.

Transportation by Barge

Scope:
The data set represents the transportation of 1 kg of material from the manufacturer location to the building site by barge.

LCI Source:
GLO: Average ship, 1500t payload capacity/ canal ts (2017)
US: Diesel mix at filling station ts (2014)

Transportation by Container Ship

Scope:
The data set represents the transportation of 1 kg of material from the manufacturer location to the building site by container ship.

LCI Source:
GLO: Container ship, 27500 dwt payload capacity, ocean going ts (2017)
US: Heavy fuel oil at refinery (0.3wt.% S) ts (2014)

Transportation by Rail

Scope:
The data set represents the transportation of 1 kg of material from the manufacturer location to the building site by cargo rail.

LCI Source:
GLO: Rail transport cargo - Diesel, average train, gross tonne weight 1000t / 726t payload capacity ts (2017)
US: Diesel mix at filling station ts (2014)

Transportation by Truck

Scope:
The data set represents the transportation of 1 kg of material from the manufacturer location to the building site by diesel truck.

LCI Source:
US: Truck - Trailer, basic enclosed / 45,000 lb payload - 8b ts (2017)
US: Diesel mix at filling station ts (2014)

LCI Data (continued)

END-OF-LIFE [C2-C4]

Specific end-of-life scenarios are detailed for each entry based on the US construction and demolition waste treatment methods and rates in the 2016 WARM Model by the US Environmental Protection Agency except where otherwise specified. Heterogeneous assemblies are modeled using the appropriate methodologies for the component materials.

End-of-Life Landfill

Scope:

Materials for which no recycling or incineration rates are known, no recycling occurs within the US at a commercial scale, or which are unable to be recycled are landfilled. This includes glass, drywall, insulation, and plastics. The solids contents of coatings, sealants, and paints are assumed to go to landfill, while the solvents or water evaporate during installation. Where the landfill contains biodegradable material, the energy recovered from landfill gas utilization is reflected as a credit in Module D.

LCI Source:

US: Glass/inert on landfill ts (2017)
US: Biodegradable waste on landfill, post-consumer ts (2017)
US: Plastic waste on landfill, post-consumer ts (2017)

Concrete End-of-Life

Scope:

Concrete (or other masonry products) are recycled into aggregate or general fill material or they are landfilled. It is assumed that 55% of the concrete is recycled. Module D accounts for both the credit associated with off-setting the production aggregate and the burden of the grinding energy required for processing.

LCI Source:

US: Diesel mix at refinery ts (2014)
GLO: Fork lifter (diesel consumption) ts (2016)
EU - 28 Gravel 2/32 ts (2017)
US: Glass/inert on landfill ts (2017)

Metals End-of-Life

Scope:

Metal products are modeled using the avoided burden approach. The recycling rate at end of life is used to determine how much secondary metal can be recovered after having subtracted any scrap input into manufacturing (net scrap). Net scrap results in an environmental credit in Module D for the corresponding share of the primary burden that can be allocated to the subsequent product system using secondary material as an input. If the value in Module D reflects an environmental burden, then the original product (A1-A3) contains more secondary material than is recovered.

LCI Source:

Aluminum - RNA: Primary Aluminum Ingot AA/ts (2010)
Aluminum - RNA: Secondary Aluminum Ingot AA/ts (2010)
Brass - GLO: Zinc mix ts (2012)
Brass - GLO: Copper (99.99% cathode) ICA (2013)
Brass - EU-28: Brass (CuZn20) ts (2017)
Copper - DE: Recycling potential copper sheet ts (2016)
Steel - GLO: Value of scrap worldsteel (2014)
Zinc - GLO: Special high grade zinc IZA (2012)

Wood End-of-Life

Scope:

End of Life waste treatment methods and rates for wood are based on the 2014 Municipal Solid Waste and Construction Demolition Wood Waste Generation and Recovery in the United States report by Dovetail Partners, Inc. It is assumed that 65.5% of wood is sent to landfill, 17.5% to incineration, and 17.5% to recovery.

LCI Source:

US: Untreated wood in waste incineration plant ts (2017)
US: Wood product (OSB, particle board) waste in waste incineration plant ts (2017)
US: Wood products (OSB, particle board) on landfill, post-consumer ts (2017)
US: Untreated wood on landfill, post-consumer ts (2017)
RNA: Softwood lumber CORRIM (2011)

LCI Data

MODEL ELEMENTS

Revit Categories
- Ceilings
- Curtainwall Mullions
- Curtainwall Panels
- Doors
- Floors
- Roofs
- Stairs and Railings
- Structure
- Walls
- Windows

420_Rutherford_Architecture_R20.rvt_working.03.rvt

Worksets
- 00_EXISTING GRID
- 00_PROPERTY LINE
- 00_REFERENCES
- 00_SCOPE BOXES
- 00_SHARDED LEVELS AND GRIDS
- 01_ARCH - AREA
- 01_ARCH - CORE
- 01_ARCH - DEVICES_CEILING
- 01_ARCH - DEVICES_FLOOR
- 01_ARCH - DEVICES_WALL
- 01_ARCH - EQUIPMENT
- 01_ARCH - LIGHTING
- 01_ARCH - LIGHTING - SITE
- 01_ARCH - SHELL
- 01_ARCH - STRUCTURE
- 01_ARCH - TOPO
- 02_ARCH - FURNITURE
- 02_ARCH - INTERIOR TESTFITS
- 03_SITE - 440 Overall
- 03_SITE - AREA
- 03_SITE - FOUNDATION IMPROVEMENT SOIL
- 03_SITE - FURNITURE + LIGHTING
- 04_LINK - CAD FILES
- 04_LINK - ELECTRICAL
- 04_LINK - FIRE PROTECTION
- 04_LINK - LANDSCAPING
- 04_LINK - LIGHTING
- 04_LINK - MECHANICAL
- 04_LINK - PLUMBING
- 04_LINK - RHINO_FACADE
- 04_LINK - STRUCTURE
- 04_LINK - SURVEY
- Workset1

Phases
- Existing
- New Construction

420_Rutherford_Structure_R20.rvt_NRMCA.rvt (Read-only)

Worksets
- EXISTING GRIDS
- Shared Views, Levels, Grids
- Workset1

Phases
- Existing
- New Construction

420_Rutherford_Architecture_R20.rvt_working_Proposed.rvt (Read-only)

Worksets
- N/A

Phases
- N/A

PRODUCT [A1-A3]

Materials and components are listed in alphabetical order along with a list of all Revit families and Tally entries in which they occur. The masses given here refer to the quantity of each material used over the building's life-cycle, which includes both Product [A1-A3] and Use [B2-B5] stages.

Additional provided data describing scope boundaries for each life cycle stage may be useful for interpretation of the impacts associated with the specific material or component. Each material or component is listed with its service life, or period of time after installation it is expected to meet the service requirements prior to replacement or repair. This value is indicated in parentheses next to the mass of the material associated with the listed Revit family. Values for transportation distance or service life shown with an asterisk (*) indicate user-defined changes to default values. Values for service life shown with a dagger (†) indicate materials identified by the modeler as existing or salvaged.

Adhesive, polychloroprene (neoprene) **1,283.5 kg**

Used in the following Revit families:
- Generic - 8" 1,208.8 kg (20 yrs)
- WSP - PVC Canopy_NBBJ Calcs 2 74.6 kg (20 yrs)

Used in the following Tally entries:
- PVC roofing membrane, sheet

Description:
Generic polychlorprene contact adhesive.

Life Cycle Inventory:
- Polychloroprene
- Alkylphenolic resin
- Magnesium oxide, tin oxide
- Solvents (petroleum ether/cycloaliphatic/ketone/ester blends)

Product Scope:
Cradle to gate, plus emissions during application, excludes energy for application

Transportation Distance:
By truck: 840 km

End-of-Life Scope:
27% solids to landfill (plastic waste)

LCI Source:
EU-28: Solvent-based polychloroprene adhesive of good heat resistance (estimation) (2017)

Aluminum entrance door, YKK AP - EPD **48.7 kg**

Used in the following Revit families:
- B2050-Exterior_Swinging 48.7 kg (30 yrs)

Used in the following Tally entries:
- Door, exterior, aluminum

Description:
Average aluminum entrance door by YKK AP America, including VersaJamb, Smart Series, MegaTherm, and Protek products. Entry includes includes door frame, door, finish, and necessary weather stripping, sealant, etc. Reference door is 1.23 m x 2.18m. Glazing (if any) is excluded and should be added as an accessory material by the user. EPD representative of conditions in the US.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate, excluding glazing

Transportation Distance:
By truck: 663 km

End-of-Life Scope:
Aluminum scrap is assumed to have a 95% recycling rate, and the other 5% and other materials are landfilled in the EoL

LCI Data (continued)

Module D Scope:
Credit given for the avoided burden associated with recovered material, includes burden for processing

LCI Source:
EPD (US), YKK AP America (2015)

EPD Source:
4786832322.102.1

EPD Designation Holder:
YKK AP America

EPD Program Operator:
UL Environment

EPD Expiration:
11/13/2020

Aluminum extrusion, AEC - EPD **19,194.8 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	4,543.9 kg (60 yrs)
Site - Pavement - Wood - Roof Decking	233.5 kg (60 yrs)
WSP - GFRC_NBBJ Calcs	1,818.6 kg (60 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	3,003.9 kg (60 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	1,082.5 kg (60 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	6,944.7 kg (60 yrs)
WSP - Wood Canopy_NBBJ Calcs	838.0 kg (60 yrs)
WSP_Schematic-Exterior_12"	729.6 kg (60 yrs)

Used in the following Tally entries:
Metal wall panels, plate
Porcelain tile
Wood rainscreen, hardwood

Description:
Extruded aluminum part. Industry-wide EPD from the Aluminum Extruders Council.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 663 km

End-of-Life Scope:
95% Recovered
5% Landfilled (inert material)

Module D Scope:
Product has 36.4% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Aluminum extrusion, mill finish - AEC (A1-A3) ts-EPD (2015)
RNA: Primary Aluminum Ingot AA/ts (2010)
RNA: Secondary Aluminum Ingot AA/ts (2010)

EPD Source:
11240237.101.1

EPD Designation Holder:
Aluminum Extruders Council (AEC)

EPD Program Operator:
UL Environment

EPD Expiration:
10/4/2021

Aluminum extrusion, thermally-improved mill-finished, AEC - EPD **2,213.1 kg**

Used in the following Revit families:

Rectangular Mullion	2,213.1 kg (60 yrs)

Used in the following Tally entries:
Aluminum mullion, custom finish

Description:
Mill-finished (uncoated), thermally-improved, or thermal barrier, aluminum extrusions. Industry-wide EPD from the Aluminum Extruders Council. EPD representative of conditions in North America.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle-to-gate

Transportation Distance:
By truck: 663 km

End-of-Life Scope:
95% Recovered
5% Landfilled (inert material)

Module D Scope:
Credit given for the avoided burden associated with recovered material

LCI Source:
EPD (US), American Extruders Council (2016)

EPD Source:
11240237.102.1

EPD Designation Holder:
Aluminum Extruders Council (AEC)

EPD Program Operator:
UL Environment

EPD Expiration:
10/4/2021

Aluminum, formed **0.0 kg**

Used in the following Revit families:

door-eco1602_faceofwallmount_300-series-cookson (2)	0.0 kg (60 yrs)

Used in the following Tally entries:
Aluminum, formed

Description:
Formed aluminum member. Data based on industry-wide EPD for cold-rolled aluminum from the Aluminum Association (EPD ID 4786092064.101.1).

Life Cycle Inventory:
100% Aluminum

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 663 km

End-of-Life Scope:
95% Recovered
5% Landfilled (inert material)

Module D Scope:
Product has 65% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Cold Rolled Aluminium ts/AA (2010) [EPD]
GLO: Steel sheet stamping and bending (5% loss) ts (2017)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
RNA: Primary Aluminum Ingot AA/ts (2010)
RNA: Secondary Aluminum Ingot AA/ts (2010)

Aluminum, sheet **7,547.7 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	1,733.5 kg (60 yrs)
WSP - GFRC_NBBJ Calcs	693.8 kg (60 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	1,146.0 kg (60 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	413.0 kg (60 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	2,649.4 kg (60 yrs)
WSP - Type 7 GFRC in CW_NBBJ Calcs 2	633.6 kg (60 yrs)
WSP_Schematic-Exterior_12"	278.3 kg (60 yrs)

Used in the following Tally entries:
Metal wall panels, plate

Description:
Aluminum sheet, formed and cut. Data based on industry-wide EPD for cold-rolled aluminum from the Aluminum Association (EPD ID 4786092064.101.1).

Life Cycle Inventory:
100% Aluminum

LCI Data (continued)

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 663 km

End-of-Life Scope:
95% Recovered
5% Landfilled (inert material)

Module D Scope:
Product has 65% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Cold Rolled Aluminium ts/AA (2010) [EPD]
GLO: Steel sheet stamping and bending (5% loss) ts (2017)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
RNA: Primary Aluminum Ingot AA/ts (2010)
RNA: Secondary Aluminum Ingot AA/ts (2010)

Argon gas for IGU **91.7 kg**

Used in the following Revit families:

System Panel	21.6 kg (40 yrs)
WSP - Type 8 CW_NBBJ Calcs	70.1 kg (40 yrs)

Used in the following Tally entries:
Glazing, custom IGU

Description:
Argon gas in insulating glass unit

Life Cycle Inventory:
Argon gas

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 940 km

End-of-Life Scope:
100% to landfill (inert waste)

LCI Source:
US: Argon (gaseous) ts (2017)

Asphalt BUR, assembly (cap & ply felt), ARMA - EPD **67,613.1 kg**

Used in the following Revit families:

Site - Planting - 3	67,613.1 kg (30 yrs)

Used in the following Tally entries:
Built up asphalt roofing

Description:
Asphalt Built-up roofing (BUR) consisting of a cap sheet and 3 plys of glass-fiber felt. Industry-wide EPD from the Asphalt Roofing Manufacturers Association.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate, accounts for product overlap when installing

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
100% Landfilled (plastic waste)

LCI Source:
RNA: Built-up asphalt roofing ply felt - ARMA (A1-A3) (2012)
RNA: Built-up asphalt roofing cap sheet - ARMA (A1-A3) (2012)

EPD Source:
4787168709.103.1

EPD Designation Holder:
Asphalt Roofing Manufacturers Association (ARMA)

EPD Program Operator:
UL Environment

EPD Expiration:
10/28/2021

Asphalt felt sheet, roofing underlayment, ARMA - EPD **1,943.7 kg**

Used in the following Revit families:

Site - Planting - 3	1,943.7 kg (60 yrs)

Used in the following Tally entries:
Asphalt felt sheet

Description:
Asphalt felt sheet, exclusive of spray adhesive for roofing and wall application. Type II felt, also called No. 30 asphalt felt, is the minimum accepted by the IBC and IRC for underlayment and interlayment. Data based on industry-wide EPD from the Asphalt Roofing Manufacturers Association.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
5% Recycled into bitumen
95% Landiflled (inert waste)

Module D Scope:
Avoided burden credit for recycling into bitumen, includes grinding energy

LCI Source:
RNA: Underlayment, asphalt shingle roofing system component - ARMA (A1-A3) ts (2012)

EPD Source:
4787168709.101.1

EPD Designation Holder:
Asphalt Roofing Manufacturers Association (ARMA)

EPD Program Operator:
UL Environment

EPD Expiration:
10/28/2021

Coarse aggregate **4,755,840.4 kg**

Used in the following Revit families:

_TT-CL-Concrete Rectangular	13,741.6 kg (60 yrs)
24" Foundation Slab	24,161.4 kg (60 yrs)
36" Foundation Slab	108,512.3 kg (60 yrs)
4.5" LW Concrete 3" Metal Deck	2,057,146.2 kg (60 yrs)
6" Concrete Slab	472,404.8 kg (60 yrs)
8" Concrete Slab	63,573.8 kg (60 yrs)
Concrete - 12"	12,707.1 kg (60 yrs)
Concrete-Rectangular Beam	257,540.4 kg (60 yrs)
Footing-Rectangular	565,040.7 kg (60 yrs)
WSP - 6" Gravel Fill	1,181,012.1 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Concrete mix ingredient: Gravel

Life Cycle Inventory:
Gravel

Product Scope:
Cradle to gate, excludes mixing and pouring impacts

Transportation Distance:
By barge: 5 km
By container ship: 12 km
By rail: 29 km
By truck: 37 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
EU-28: Gravel 2/32 ts (2017)

LCI Data (continued)

Cold formed structural steel **16,600.1 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	4,764.9 kg (60 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	3,046.4 kg (60 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	1,116.1 kg (60 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	6,918.6 kg (60 yrs)
WSP_Schematic-Exterior_12"	754.1 kg (60 yrs)

Used in the following Tally entries:
Steel, C-stud metal framing

Description:
Cold-rolled or formed structural steel, such as used in steel studs.

Life Cycle Inventory:
100% Cold rolled steel

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 431 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 16% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Steel finished cold rolled coil worldsteel (2007)
GLO: Steel sheet stamping and bending (5% loss) ts (2017)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
GLO: Value of scrap worldsteel (2014)

Door frame, aluminum, powder-coated, no door **191.2 kg**

Used in the following Revit families:

Door Panel_Double Casement	41.6 kg (50 yrs)
Door-Curtain-Wall-Single-Glass	68.0 kg (50 yrs)
door-eco1602_faceofwallmount_300-series-cookson (2)	65.3 kg (50 yrs)
Revolving Door 3	16.3 kg (50 yrs)

Used in the following Tally entries:
Door frame, aluminum

Description:
Aluminum door frame

Life Cycle Inventory:
94% Aluminum
6% Powder coat (by weight)

Product Scope:
Cradle to gate
excludes hardware, casing, sealant

Transportation Distance:
By truck: 568 km

End-of-Life Scope:
95% aluminum recovered
5% aluminum landfilled (inert material)

Module D Scope:
Product has 36.4% scrap input while remainder is processed and credited as avoided burden

LCI Source:
DE: Aluminium frame profile, powder coated (EN15804 A1-A3) ts (2017)
modified with: RNA: Aluminum extrusion, mill finish - AEC ts (2015)
DE: Top coat powder (aluminium) (EN15804 A1-A3) ts (2017)
RNA: Secondary Aluminum Ingot AA/ts (2010)
RNA: Primary Aluminum Ingot AA/ts (2010)

Expanded slag **191,981.5 kg**

Used in the following Revit families:

_TT-CL-Concrete Rectangular	738.0 kg (60 yrs)
24" Foundation Slab	1,297.6 kg (60 yrs)
36" Foundation Slab	5,827.5 kg (60 yrs)
4.5" LW Concrete 3" Metal Deck	110,476.4 kg (60 yrs)
6" Concrete Slab	25,369.9 kg (60 yrs)
8" Concrete Slab	3,414.1 kg (60 yrs)
Concrete - 12"	682.4 kg (60 yrs)
Concrete-Rectangular Beam	13,830.9 kg (60 yrs)
Footing-Rectangular	30,344.8 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Concrete mix ingredient: Expanded slag

Life Cycle Inventory:
Slag

Product Scope:
Cradle to gate, excludes mixing and pouring impacts

Transportation Distance:
By barge: 41 km
By container ship: 625 km
By rail: 10 km
By truck: 54 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
DE: Slag-tap granulate (EN15804 A1-A3) ts (2017)

Fasteners, aluminum (anodized) **2.2 kg**

Used in the following Revit families:

Door-Curtain-Wall-Single-Glass	1.0 kg (50 yrs)
door-eco1602_faceofwallmount_300-series-cookson (2)	1.0 kg (50 yrs)
Revolving Door 3	0.2 kg (50 yrs)

Used in the following Tally entries:
Door frame, aluminum

Description:
Extruded and anodized aluminum part, appropriate for use as fasteners and specialized hardware (bolts, rails, clips, etc.). Data based on industry-wide EPD for anodized aluminum from the Aluminum Extruders Council (EPD ID 11240237.101.1).

Life Cycle Inventory:
100% Aluminum

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1001 km

End-of-Life Scope:
95% Recovered
5% Landfilled (inert material)

Module D Scope:
Product has 34.5% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Aluminum extrusion, anodized - AEC (A1-A3) ts-EPD (2015) [EPD]
RNA: Primary Aluminum Ingot AA/ts (2010) [EPD]
RNA: Secondary Aluminum Ingot AA/ts (2010) [EPD]

Fasteners, stainless steel **794.6 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	90.9 kg (50 yrs)
Door Panel_Double Casement	0.9 kg (50 yrs)
WSP - Exterior PH Screen_NBBJ Calcs 2	398.0 kg (60 yrs)
WSP - GFRC_NBBJ Calcs	36.4 kg (50 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	60.1 kg (50 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	21.6 kg (50 yrs)

LCI Data (continued)

WSP - Type 6 GFRC_NBBJ Calcs	138.9 kg (50 yrs)
WSP - Type 7 GFRC in CW_NBBJ Calcs 2	33.2 kg (50 yrs)
WSP_Schematic-Exterior_12"	14.6 kg (50 yrs)

Used in the following Tally entries:
Door frame, aluminum
Insulated metal wall panel
Metal wall panels, plate

Description:
Stainless steel part, appropriate for use as fasteners and specialized hardware (bolts, rails, clips, etc.). Data based on industry-wide EPDs for primary and secondary metal from the World Steel Association.

Life Cycle Inventory:
100% Stainless steel

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1001 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 58% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RER: Stainless steel Quarto plate (304) Eurofer (2010)
GLO: Steel turning ts (2017)
US: Electricity grid mix ts (2014)
RER: Stainless steel flat product (304) - value of scrap Eurofer (2010)

Fiberglass mat gypsum sheathing board **129,170.9 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	16,379.6 kg (60 yrs)
Generic - 8"	54,469.4 kg (60 yrs)
WSP - GFRC_NBBJ Calcs	3,277.8 kg (60 yrs)
WSP - PVC Canopy_NBBJ Calcs 2	3,362.6 kg (60 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	10,828.4 kg (60 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	3,902.1 kg (60 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	25,034.1 kg (60 yrs)
WSP - Type 7 GFRC in CW_NBBJ Calcs 2	2,993.4 kg (60 yrs)
WSP - Wood Canopy_NBBJ Calcs	6,293.5 kg (60 yrs)
WSP_Schematic-Exterior_12"	2,630.0 kg (60 yrs)

Used in the following Tally entries:
Fiberglass mat gypsum sheathing

Description:
Fiberglass treated gypsum sheathing product appropriate for use in high-moisture environments.

Life Cycle Inventory:
92% Gypsum
8% Fiberglass mat

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
DE: Gypsum plaster board (Moisture resistant) (EN15804 A1-A3) ts (2017)
US: Fiberglass Duct Board NAIMA (2007)

Fireproofing, cementitious, by area **229,661.2 kg**

Used in the following Revit families:

W-Wide Flange	190,187.1 kg (60 yrs)
W-Wide Flange-Column	39,474.1 kg (60 yrs)

Used in the following Tally entries:
Steel, W section (wide flange shape)

Description:
Cementitious fireproofing spray for structural steel and concrete. Default application rate is 1" thickness.

Life Cycle Inventory:
65% Cement
15% Vermiculite
10% MICA
10% Calcium carbonate

Product Scope:
Cradle to gate, includes electricity estimate for application but neglects any direct emissions at installation

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
US: Portland cement PCA/ts (2014)
GLO: Vermiculite ts (2017)
US: Silica sand (Excavation and processing) ts (2017)
US: Limestone flour (5mm) ts (2017)
US: Electricity grid mix ts (2014)

Fluoropolymer coating, metal stock **1,104.1 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	200.1 kg (60 yrs)
Rectangular Mullion	87.0 kg (60 yrs)
WSP - Exterior PH Screen_NBBJ Calcs 2	145.8 kg (60 yrs)
WSP - GFRC_NBBJ Calcs	80.1 kg (60 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	132.3 kg (60 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	47.7 kg (60 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	305.8 kg (60 yrs)
WSP - Type 7 GFRC in CW_NBBJ Calcs 2	73.1 kg (60 yrs)
WSP_Schematic-Exterior_12"	32.1 kg (60 yrs)

Used in the following Tally entries:
Aluminum mullion, custom finish
Insulated metal wall panel
Metal wall panels, plate

Description:
Standard fluoropolymer coating for metals. This entry is used as a part of the larger MCA EPD for Roll Formed Steel Panels (EPD ID 13CA27321.101.1).

Life Cycle Inventory:
100% Fluoropolymer coating

Product Scope:
Cradle to gate, including application

Transportation Distance:
N/A

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
US: Coil coating MCA (2010)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)

Fly ash **85,398.7 kg**

Used in the following Revit families:

_TT-CL-Concrete Rectangular	328.3 kg (60 yrs)
24" Foundation Slab	577.2 kg (60 yrs)
36" Foundation Slab	2,592.2 kg (60 yrs)
4.5" LW Concrete 3" Metal Deck	49,142.9 kg (60 yrs)
6" Concrete Slab	11,285.2 kg (60 yrs)
8" Concrete Slab	1,518.7 kg (60 yrs)
Concrete - 12"	303.6 kg (60 yrs)
Concrete-Rectangular Beam	6,152.4 kg (60 yrs)
Footing-Rectangular	13,498.2 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Concrete mix ingredient: Fly ash
50 pcf

LCI Data (continued)

Life Cycle Inventory:
Fly ash

Product Scope:
Cradle to gate, excludes mixing and pouring impacts

Transportation Distance:
By container ship: 47 km
By rail: 49 km
By truck: 99 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
DE: Fly ash (EN15804 A1-A3) ts (2017)

Galvanized steel decking **141,572.9 kg**

Used in the following Revit families:
4.5" LW Concrete 3" Metal Deck 141,572.9 kg (60 yrs)

Used in the following Tally entries:
Steel, deck

Description:
Hot dip galvanized steel roof decking, corrugated profile. Default roof decking is galvanized to G90 standards, coated on both sides of 20 gauge steel deck, roll formed and precut.

Life Cycle Inventory:
100% Steel, hot dip galvanized

Product Scope:
Cradle to gate for deck only.

Transportation Distance:
By truck: 431 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 44% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Steel hot dip galvanized worldsteel (2007)
GLO: Steel sheet stamping and bending (5% loss) ts (2014)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
US: Metal roll forming M CA (2010)
GLO: Value of scrap worldsteel (2014)

Galvanized steel support **16,600.5 kg**

Used in the following Revit families:
WSP - Type 10 Architectural Concrete_NBBJ Calcs 3,742.8 kg (60 yrs)
WSP - Type 10 Stone Cladding_NBBJ Calcs 11,228.3 kg (60 yrs)
WSP - Wood Canopy_NBBJ Calcs 1,629.5 kg (50 yrs)

Used in the following Tally entries:
Glass fiber reinforced concrete (GFRC) panel
Wood rainscreen, hardwood

Description:
Hot dipped galvanized steel profile, for use with cladding systems.

Life Cycle Inventory:
100% Steel, hot dip galvanized

Product Scope:
Cradle to gate for deck only.

Transportation Distance:
By truck: 431 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 44% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Steel hot dip galvanized worldsteel (2007)
GLO: Steel sheet stamping and bending (5% loss) ts (2014)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
US: Metal roll forming M CA (2010)
GLO: Value of scrap worldsteel (2014)

GFRC **0.0 kg**

Used in the following Revit families:
WSP - Type 10 Architectural Concrete_NBBJ Calcs 0.0 kg (60 yrs)
WSP - Type 10 Stone Cladding_NBBJ Calcs 0.0 kg (60 yrs)

Used in the following Tally entries:
Glass fiber reinforced concrete (GFRC) panel

Description:
Glass fiber reinforced concrete (GFRC), applied manually. Appropriate for exterior facade panels and precast elements.

Life Cycle Inventory:
12% Cement
5% Glass fibers
39% Gravel
38% Sand
7% Water

Product Scope:
Cradle to gate, excludes mortar
Anchors, ties, and metal accessories outside of scope (<1% mass)

Transportation Distance:
By truck: 24 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
US: Portland cement PCA/ts (2014)
DE: Gravel (Grain size 2/32) (EN15804 A1-A3) ts (2017)
US: Tap water from groundwater ts (2017)
US: Silica sand (Excavation and processing) ts (2017)
US: Glass fibres ts (2017)

Glazing, double, 3 mm, laminated safety glass **1,065.3 kg**

Used in the following Revit families:
Door Panel_Double Casement 438.1 kg (35 yrs)
Door-Curtain-Wall-Single-Glass 412.1 kg (35 yrs)
Revolving Door 3 215.0 kg (35 yrs)

Used in the following Tally entries:
Door, exterior, glass

Description:
Laminated glass, 2 lites 3 mm thick, inclusive of polyvinyl butyral. Note: this entry is appropriate for clear or tinted glass.

Life Cycle Inventory:
3% PVB film (30% adipic acid
70% PVB)
97% Glass

Product Scope:
Cradle to gate, excluding sealant

Transportation Distance:
By truck: 940 km

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
DE: Window glass simple (EN15804 A1-A3) ts (2017)
DE: Adipic acid from cyclohexane ts (2017)
DE: Polyvinyl Butyral Granulate (PVB) ts (2017)

LCI Data (continued)

GLO: Plastic film (PE, PP, PVC) ts (2017)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)
US: Lubricants at refinery ts (2014)

Glazing, monolithic sheet, tempered **60,040.9 kg**

Used in the following Revit families:

System Panel	21,810.0 kg (40 yrs†)
WSP - Type 8 CW_NBBJ Calcs	38,230.8 kg (40 yrs)

Used in the following Tally entries:
Glazing, custom IGU

Description:
Tempered float glass. Note: this entry is appropriate for clear or tinted glass. Default thickness is 3 mm.

Life Cycle Inventory:
Tempered glazing

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 940 km

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
DE: Window glass simple (EN15804 A1-A3) ts (2017)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)

Hard maple lumber, 1 inch **12,806.5 kg**

Used in the following Revit families:

WSP - Wood Canopy_NBBJ Calcs	12,806.5 kg (50 yrs)

Used in the following Tally entries:
Wood rainscreen, hardwood

Description:
Kiln-dried Hard Maple (sugar, rock, or black maple) hardwood lumber of 1" nominal thickness as produced in the United States, focusing on the main production technologies. Maple is frequently used for moulding, flooring, furniture, and millwork. Link for interactive LCA data tool is provided at the link listed as "EPD Information" full LCA report is available at http://naturespackaging.org/wp-content/uploads/2016/02/LifeCycleAssessment-Lumber.pdf.

Life Cycle Inventory:
100% Hard Maple

Product Scope:
Cradle to gate, uncoated

Transportation Distance:
By truck: 383 km

End-of-Life Scope:
14.5% Recovered
22% Incinerated with energy recovery
63.5% Landfilled (wood product waste)

Module D Scope:
Recovered wood products credited as avoided burden.

LCI Source:
US: Hard Maple lumber, 1 inch (705 kg/m^3), kiln-dried ts/AHEC (2017)

EPD Source:
Information

EPD Designation Holder:
American Hardwood Export Council (AHEC)

Hardware, stainless steel **93.8 kg**

Used in the following Revit families:

_Schematic-Swinging	6.0 kg (60 yrs)
B2050-Exterior_Swinging	10.6 kg (60 yrs)
Door Panel_Double Casement	31.8 kg (60 yrs)
Door-Curtain-Wall-Single-Glass	29.9 kg (60 yrs)
Revolving Door 3	15.6 kg (60 yrs)

Used in the following Tally entries:
Door, exterior, aluminum
Door, exterior, glass
Door, exterior, steel

Description:
Finished, cast stainless steel, applicable for door, window or other accessory hardware

Life Cycle Inventory:
100% Stainless steel

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1001 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 58% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RER: Stainless steel Quarto plate (304) Eurofer (2010)
DE: Steel cast part machining ts (2017)
US: Electricity grid mix ts (2014)
RER: Stainless steel flat product (304) - value of scrap Eurofer (2010)

Hollow door, exterior, steel, powder-coated **221.1 kg**

Used in the following Revit families:

_Schematic-Swinging	110.6 kg (30 yrs)
B2050-Exterior_Swinging	110.6 kg (30 yrs)

Used in the following Tally entries:
Door, exterior, steel

Description:
Hollow door, exterior, steel, 18 ga. inclusive of EPS insulation, no frame

Life Cycle Inventory:
5% Extruded polystyrene
95% Powder-coated steel

Product Scope:
Cradle to gate, excludes assembly, frame, hardware, and adhesives

Transportation Distance:
By truck: 568 km

End-of-Life Scope:
70% Steel recovered
30% Steel landfilled (inert material)
100% Insulation landfilled (plastic material)
100% Core landfilled (biodegradable material)

Module D Scope:
Product has 15% scrap input while remainder is processed and credited as avoided burden.

LCI Source:
DE: Expanded Polystyrene (PS 25) (EN15804 A1-A3) ts (2017)
GLO: Steel sheet stamping and bending (5% loss) ts (2017)
GLO: Value of scrap worldsteel (2014)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
RNA: Steel finished cold rolled coil worldsteel (2007)
DE: Top coat powder (aluminium) (EN15804 A1-A3) ts (2017)

Hot rolled structural steel, AISC - EPD **696,901.7 kg**

Used in the following Revit families:

W-Wide Flange	565,053.3 kg (60 yrs)
W-Wide Flange-Column	131,848.5 kg (60 yrs)

Used in the following Tally entries:
Steel, W section (wide flange shape)

Description:
Hot rolled structural steel. Industry-wide EPD from the American Institute of Steel Construction.

LCI Data (continued)

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 431 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 100% scrap input, burden reflects difference between recovered material and scrap input

LCI Source:
RNA: Hot rolled structural steel sections AISC (2010)

EPD Source:
4786979051.102.1

EPD Designation Holder:
American Institute of Steel Construction

EPD Program Operator:
UL Environment

EPD Expiration:
3/31/2021

IGU spacer **444.4 kg**

Used in the following Revit families:

System Panel	104.6 kg (40 yrs)
WSP - Type 8 CW_NBBJ Calcs	339.7 kg (40 yrs)

Used in the following Tally entries:
Glazing, custom IGU

Description:
Insulating glass unit (IGU) spacer and gasket used to separate two or more plies of glass. Density value assumes a 1/2" (13/2 mm) spacer.

Life Cycle Inventory:
70% Polybutadiene rubber spacer
30% Nitrile rubber spacer

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 940 km

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
DE: Polybutadiene rubber ts (2017)
DE: Nitrile butadiene rubber, incl. MMA (NBR-speciality) ts (2017)

Insulated metal panel (IMP), Metl-Span, CF42 - EPD **6,105.3 kg**

Used in the following Revit families:

WSP - Exterior PH Screen_NBBJ Calcs 2	6,105.3 kg (60 yrs)

Used in the following Tally entries:
Insulated metal wall panel

Description:
Metl-Span CF42 insulated metal panel (IMP) made of two steel sheets glued to a polyurethane core, cut to shape and size as required. Appropriate for exterior wall applications. EPD representative of steel-faced product with a 3 inch thickness. EPD representative of manufacturing conditions in the US.

Life Cycle Inventory:
For information and quantities, see EPD.

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 657 km

End-of-Life Scope:
88% of steel scrap is assumed to be recovered
remainder of materials to landfill
does not include disposal of installation components

Module D Scope:
All recovered metal is processed and credited as avoided burden

LCI Source:
US: Insulated metal panel (IMP), CF wall panel - Metl-Span PE-EPD (2011)
US: Disposal of insulated metal panels (IMP), CF wall panel - Metl-Span PE-EPD (2011)

EPD Source:
4788189841.102.1

EPD Designation Holder:
Metl-Span

EPD Program Operator:
UL Environment

EPD Expiration:
7/1/2024

Low-e coating (for glazing) **500.1 kg**

Used in the following Revit families:

System Panel	117.8 kg (40 yrs)
WSP - Type 8 CW_NBBJ Calcs	382.3 kg (40 yrs)

Used in the following Tally entries:
Glazing, custom IGU

Description:
Low-e coating for application to glazing lite

Life Cycle Inventory:
Ferro chrome mix
Nickel mix
Tin
Silver mix

Product Scope:
Cradle to gate

Transportation Distance:
N/A

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
Low-e coating from DE: Double glazing unit (EN15804 A1-A3) ts (2017)

Mineral wool, high density, NAIMA - EPD **41,331.5 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	8,068.7 kg (60 yrs)
WSP - GFRC_NBBJ Calcs	3,229.3 kg (60 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	5,334.1 kg (60 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	1,922.2 kg (60 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	12,331.9 kg (60 yrs)
WSP - Type 7 GFRC in CW_NBBJ Calcs 2	2,949.2 kg (60 yrs)
WSP - Wood Canopy_NBBJ Calcs	6,200.4 kg (60 yrs)
WSP_Schematic-Exterior_12"	1,295.6 kg (60 yrs)

Used in the following Tally entries:
Mineral wool, board, generic

Description:
Rock board, heavy density. Industry-wide EPD from the North America Insulation Manufacturers Association. EPD representative of conditions in North America.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
US: Rock board insulation (heavy density) NAIMA (2007)

EPD Source:
4786060412.102.1

EPD Designation Holder:
North American Insulation Manufacturer's Association (NAIMA)

LCI Data (continued)

EPD Program Operator:
UL Environment

EPD Expiration:
11/8/2018

Mortar type S **0.0 kg**

Used in the following Revit families:
WSP - Type 10 Stone Cladding_NBBJ Calcs 0.0 kg (60 yrs)

Used in the following Tally entries:
Stone veneer wall, granite, grouted

Description:
Mortar Type S (medium strength mortar) for use with masonry walls and flooring.

Life Cycle Inventory:
Dried mix: 78% sand
17% cement
4% calcium hydroxide
1% limestone (12% water evaporates on drying)

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
DE: Siliceous sand (grain size 0/2) ts (2017)
DE: Cement (CEM I 32.5) (EN15804 A1-A3) ts (2017)
DE: Gravel (Grain size 2/32) (EN15804 A1-A3) ts (2017)
US: Tap water from groundwater ts (2017)

Overhead door closer, aluminum **80.9 kg**

Used in the following Revit families:
_Schematic-Swinging 6.2 kg (30 yrs)
B2050-Exterior_Swinging 10.9 kg (30 yrs)
Door Panel_Double Casement 32.8 kg (30 yrs)
Door-Curtain-Wall-Single-Glass 30.9 kg (30 yrs)

Used in the following Tally entries:
Door, exterior, aluminum
Door, exterior, glass
Door, exterior, steel

Description:
Aluminum overhead door closer. Data based on product-specific EPD from FV S+B.

Life Cycle Inventory:
See EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1001 km

End-of-Life Scope:
95% Recovered
5% Landfilled (inert material)

Module D Scope:
Product has 0% scrap input, burden reflects difference between recovered material and scrap input

LCI Source:
DE: Overhead door closer aluminum - FV S+B PE-EPD (2009)
RNA: Secondary Aluminum Ingot AA/ts (2010)
RNA: Primary Aluminium Ingot AA/ts (2010)

EPD Source:
EPD-ARG-20160183-IBG1-EN

EPD Designation Holder:
European Federation of Associations of Lock and Builders Hardware Manufacturers (ARGE)

EPD Program Operator:
Institut Bauen and Umwelt (IBU)

EPD Expiration:
9/13/2021

PIR rigid foam insulation, roof, R=15, PIMA - EPD **21,295.1 kg**

Used in the following Revit families:
Generic - 8" 20,056.9 kg (60 yrs)
WSP - PVC Canopy_NBBJ Calcs 2 1,238.2 kg (60 yrs)

Used in the following Tally entries:
Polyisocyanurate (PIR), board

Description:
Polyisocyanurate rigid foam roof insulation with glass-fiber reinforced facers, R-value of 15, 2.6" thickness (66 mm). Industry-wide EPD from the Polyisocyanurate Insulation Manufacturers Association.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 250 km

End-of-Life Scope:
100% Landfilled (plastic waste)

LCI Source:
RNA: Polyisocyanurate rigid foam board roof insulation, R=15 (A1-A3) ts-EPD (2013)

EPD Source:
EPD10043

EPD Designation Holder:
Polyisocyanurate Insulation Manufacturers Association

EPD Program Operator:
NSF International

EPD Expiration:
2/6/2020

Polyethelene sheet vapor barrier (HDPE) **810.2 kg**

Used in the following Revit families:
6" Concrete Slab 810.2 kg (60 yrs)

Used in the following Tally entries:
Polyethelene sheet vapor barrier (HDPE)

Description:
Polyethelene sheet vapor barrier (HDPE) membrane
entry exclusive of adhesive or other co-products

Life Cycle Inventory:
100% Polyethylene film

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1299 km

End-of-Life Scope:
10.5% Recycled into HDPE
89.5% Landiflled (plastic waste)

Module D Scope:
Avoided burden credit includes processing

LCI Source:
US: Polyethylene High Density Granulate (PE-HD) ts (2017)
GLO: Plastic Film (PE, PP, PVC) ts (2017)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)
US: Lubricants at refinery ts (2014)

LCI Data (continued)

Porcelain ceramic tile, glazed **8,406.9 kg**

Used in the following Revit families:
- Site - Pavement - Wood - Roof Decking: 8,406.9 kg (50 yrs)

Used in the following Tally entries:
Porcelain tile

Description:
Porcelain ceramic tile, glazed

Life Cycle Inventory:
100% Ceramic tile, glazed

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1250 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
DE: Stoneware tiles, glazed (EN15804 A1-A3) ts (2017)

Portland cement, PCA - EPD **1,251,189.9 kg**

Used in the following Revit families:
- _TT-CL-Concrete Rectangular: 4,809.6 kg (60 yrs)
- 24" Foundation Slab: 8,456.5 kg (60 yrs)
- 36" Foundation Slab: 37,979.3 kg (60 yrs)
- 4.5" LW Concrete 3" Metal Deck: 720,001.2 kg (60 yrs)
- 6" Concrete Slab: 165,341.7 kg (60 yrs)
- 8" Concrete Slab: 22,250.8 kg (60 yrs)
- Concrete - 12": 4,447.5 kg (60 yrs)
- Concrete-Rectangular Beam: 90,139.1 kg (60 yrs)
- Footing-Rectangular: 197,764.2 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Concrete mix ingredient: portland cement. Data is based on Industry-wide EPD from the Portland Cement Association.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate

Transportation Distance:
By barge: 67 km
By container ship: 399 km
By rail: 72 km
By truck: 120 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
US: Portland cement PCA/ts (2014)

EPD Source:
EPD 035

EPD Designation Holder:
Portland Cement Association

EPD Program Operator:
ASTM International

EPD Expiration:
5/31/2021

Powder coating, metal stock **48.9 kg**

Used in the following Revit families:
- door-eco1602_faceofwallmount_300-series-cookson (2): 48.9 kg (50 yrs)

Used in the following Tally entries:
Aluminum, formed

Description:
Powder coating, for metal stock

Life Cycle Inventory:
100% Powder coating

Product Scope:
Cradle to gate, including application

Transportation Distance:
N/A

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
DE: Application top coat powder (aluminium) ts (2017)
DE: Coating powder (industry, outside, red) ts (2017)

PVC membrane, sheet **23,645.4 kg**

Used in the following Revit families:
- Generic - 8": 22,270.6 kg (20 yrs)
- WSP - PVC Canopy_NBBJ Calcs 2: 1,374.8 kg (20 yrs)

Used in the following Tally entries:
PVC roofing membrane, sheet

Description:
PVC roofing membrane

Life Cycle Inventory:
100% PVC membrane

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1299 km

End-of-Life Scope:
100% Landfilled (plastic waste)

LCI Source:
US: Polyvinylchloride granulate (Suspension, S-PVC) ts (2017)
GLO: Plastic Film (PE, PP, PVC) ts (2017)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)
US: Lubricants at refinery ts (2014)

Sand **2,916,464.2 kg**

Used in the following Revit families:
- _TT-CL-Concrete Rectangular: 11,210.9 kg (60 yrs)
- 24" Foundation Slab: 19,711.7 kg (60 yrs)
- 36" Foundation Slab: 88,528.0 kg (60 yrs)
- 4.5" LW Concrete 3" Metal Deck: 1,678,288.4 kg (60 yrs)
- 6" Concrete Slab: 385,403.6 kg (60 yrs)
- 8" Concrete Slab: 51,865.6 kg (60 yrs)
- Concrete - 12": 10,366.9 kg (60 yrs)
- Concrete-Rectangular Beam: 210,110.0 kg (60 yrs)
- Footing-Rectangular: 460,979.0 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Concrete mix ingredient: Sand

Life Cycle Inventory:
Sand

Product Scope:
Cradle to gate, excludes mixing and pouring impacts

Transportation Distance:
By barge: 4 km
By container ship: 24 km
By rail: 14 km
By truck: 37 km

LCI Data (continued)

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
US: Silica sand (Excavation and processing) ts (2017)

Self adhering flashing membrane, 40 mil **15,174.8 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	1,265.7 kg (40 yrs)
Generic - 8"	8,418.0 kg (40 yrs)
WSP - GFRC_NBBJ Calcs	506.6 kg (40 yrs)
WSP - Type 10 Architectural Concrete_NBBJ Calcs	184.0 kg (40 yrs)
WSP - Type 10 Stone Cladding_NBBJ Calcs	551.9 kg (40 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	836.7 kg (40 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	301.5 kg (40 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	1,934.5 kg (40 yrs)
WSP - Wood Canopy_NBBJ Calcs	972.6 kg (40 yrs)
WSP_Schematic-Exterior_12"	203.2 kg (40 yrs)

Used in the following Tally entries:
Self adhering membrane

Description:
40 mil (1 mm) Asphalt rubber sheet inclusive of polyethelyne backing

Life Cycle Inventory:
82% Rubberized asphalt (25% SBS)
18% Polyethylene HD

Product Scope:
Cradle to gate for materials only, neglects manufacturing requirements

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
100% Landfilled (plastic waste)

LCI Source:
US: Styrene-butadiene rubber (SBR) ts (2017)
DE: Bitumen cold adhesive (EN15804 A1-A3) ts (2017)
US: Polyethylene High Density Granulate (PE-HD) ts (2017)
GLO: Plastic Film (PE, PP, PVC) ts (2017)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)
US: Lubricants at refinery ts (2014)

Self-adhering, polymer-modified asphalt sheet underlayment **1,487.7 kg**

Used in the following Revit families:

WSP - PVC Canopy_NBBJ Calcs 2	1,487.7 kg (40 yrs)

Used in the following Tally entries:
Self-adhering, polymer-modified asphalt sheet underlayment

Description:
Self-adhering, polymer-modified asphalt sheet underlayment.

Life Cycle Inventory:
52% Bitumen
14% Slag
12% Glass fleece
12% Limestone
4% Sand
3% SBR
3% Titanium dioxide
1% PE film

Product Scope:
Cradle to gate, excludes self-adhering materials and polymers

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
100% Landfilled (inert material)

LCI Source:
US: Bitumen at refinery ts (2013)
DE: Glass fibre fleece (21% UF resin) (estimation) ts (2012)
US: Silica sand (flour) ts (2017)
US: Limestone flour (5mm) ts (2017)
US: Styrene-butadiene rubber (SBR) ts (2017)
US: Polyethylene film (LDPE/PE-LD) ts (2017)
US: Titanium dioxide pigment (sulphate process) ts (2017)

Spandrel, glass, insulated (2" core) **14,688.2 kg**

Used in the following Revit families:

WSP - Type 9 CW Spandrel_NBBJ Calcs	14,688.2 kg (30 yrs)

Used in the following Tally entries:
Spandrel, glass, insulated

Description:
Insulated glass spandrel panel of 1/8" thick plate glass, 2" air gap, and 2" high density fiberglass insulation with 24 guage steel backing

Life Cycle Inventory:
19% Fiberglass
63% Glass
18% Steel

Product Scope:
Cradle to gate
Excludes sealant, assembly, and any substrates

Transportation Distance:
By truck: 940 km

End-of-Life Scope:
70% Steel recovered (product has 7.14% scrap input while remainder is processed and credited as avoided burden)
30% Steel landfilled (inert material)
100% Insulation and core landfilled (inert material)

Module D Scope:
Product has 3.1% steel scrap input while remainder is processed and credited as avoided burden

LCI Source:
GLO: Steel sheet stamping and bending (5% loss) ts (2017)
RNA: Steel finished cold rolled coil worldsteel (2011)
GLO: Value of scrap worldsteel (2014)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
DE: Window glass simple (EN15804 A1-A3) ts (2017)
US: Fiberglass Duct Board NAIMA (2007)

Steel door hinge **62.9 kg**

Used in the following Revit families:

_Schematic-Swinging	4.9 kg (30 yrs)
B2050-Exterior_Swinging	8.5 kg (30 yrs)
Door Panel_Double Casement	25.5 kg (30 yrs)
Door-Curtain-Wall-Single-Glass	24.0 kg (30 yrs)

Used in the following Tally entries:
Door, exterior, aluminum
Door, exterior, glass
Door, exterior, steel

Description:
Steel and stainless steel door hinge. Data based on product-specific EPD from FV S+B.

Life Cycle Inventory:
See EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1001 km

End-of-Life Scope:
70% Recovered
30% Landfilled (inert material)

Module D Scope:
Product has 0% scrap input, burden reflects difference between recovered material and scrap input

LCI Source:
DE: Door hinge - Object hinge - FV S+B PE-EPD (2009)
GLO: Value of scrap worldsteel (2014)

LCI Data (continued)

EPD Source:
EPD-ARG-20160193-IBG2-EN

EPD Designation Holder:
European Federation of Associations of Lock and Builders Hardware Manufacturers (ARGE)

EPD Program Operator:
Institut Bauen and Umwelt (IBU)

EPD Expiration:
9/13/2021

Steel, reinforcing rod **196,337.5 kg**

Used in the following Revit families:

_TT-CL-Concrete Rectangular	1,800.9 kg (60 yrs)
24" Foundation Slab	5,972.6 kg (60 yrs)
36" Foundation Slab	26,823.6 kg (60 yrs)
4.5" LW Concrete 3" Metal Deck	67,339.7 kg (60 yrs)
6" Concrete Slab	16,114.3 kg (60 yrs)
8" Concrete Slab	2,387.5 kg (60 yrs)
Concrete - 12"	1,047.0 kg (60 yrs)
Concrete-Rectangular Beam	28,293.7 kg (60 yrs)
Footing-Rectangular	46,558.3 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Common unfinished tempered steel rod suitable for structural reinforcement (rebar)

Life Cycle Inventory:
100% Steel rebar

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 431 km

End-of-Life Scope:
70% Recovered
30% Landfilled (inert material)

Module D Scope:
Product has a 16.4% scrap input while remainder is processed and credited as avoided burden.

LCI Source:
GLO: Steel rebar worldsteel (2014)

Steel, welded wire mesh **42,207.4 kg**

Used in the following Revit families:

4.5" LW Concrete 3" Metal Deck	30,296.3 kg (60 yrs)
6" Concrete Slab	11,911.2 kg (60 yrs)

Used in the following Tally entries:
Steel, welded wire mesh

Description:
Steel rods further processed into wires appropriate for welded wire mesh reinforcement

Life Cycle Inventory:
100% Carbon steel wire

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 431 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 16% scrap input while remainder is processed and credited as avoided burden

LCI Source:
GLO: Steel wire rod worldsteel (2014)
DE: Copper wire (0.6 mm) ts (2017)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)

Stone slab, granite **35,735.2 kg**

Used in the following Revit families:

WSP - Type 10 Stone Cladding_NBBJ Calcs	35,735.2 kg (60 yrs)

Used in the following Tally entries:
Stone veneer wall, granite, grouted

Description:
Cut granite stone slab, such as for use in a veneer wall.

Life Cycle Inventory:
100% Granite

Product Scope:
Cradle to gate
excludes mortar
anchors, ties, and metal accessories outside of scope (<1% mass)

Transportation Distance:
By truck: 217 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
DE: Natural stone slab, rigid, facade (EN15804 A1-A3) ts (2017)

Structural concrete, 3000 psi, 0% fly ash and slag **20,576.7 kg**

Used in the following Revit families:

WSP - Type 10 Architectural Concrete_NBBJ Calcs	20,576.7 kg (60 yrs)

Used in the following Tally entries:
Precast concrete nonstructural panel

Description:
Structural concrete, 3000 psi, 0% fly ash and slag. Mix design matches National Ready-Mix Concrete Association (NRMCA) Industry-wide EPD.

Life Cycle Inventory:
Coarse aggregate: 44%, Sand: 36%, Portland cement PCA - EPD: 13%, Water: 7%, Admixture: <1%

Product Scope:
Cradle to gate
Anchors, ties, and metal accessories outside of scope (<1% mass)

Transportation Distance:
By truck: 24 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
US: Portland cement PCA/ts (2014)
DE: Pumice gravel (grain size 4/16) (EN15804 A1-A3) ts (2017)
DE: Gravel (Grain size 2/32) (EN15804 A1-A3) s (2017)
DE: Fly ash (EN15804 A1-A3) ts (2017)
DE: Slag-tap granulate (EN15804 A1-A3) ts (2017)
DE: Expanded clay (EN15804 A1-A3) ts (2017)
DE: alcium nitrate ts (2017)
DE: Sodium ligninsulfonate ts (2017)
DE: Sodium naphtalene sulfonate [estimated] ts (2017)
US: Sodium hydroxide (caustic soda) ix (100%) ts (2017)
US: Colophony (rosin, refined) from CN pine gum rosin ts (2017)
US: Tap water from groundwater ts (2017)
US: Electricity grid mix s (2014)
US: Natural gas mix ts (2014)
US: Diesel mix at filling station (100% fossil) ts (2014)
US: Liquefied Petroleum Gas (LPG) (70% propane
30% utane) ts (2014)
US: Light fuel oil at refinery ts (2014)

LCI Data (continued)

Water **231,701.8 kg**

Used in the following Revit families:

_TT-CL-Concrete Rectangular	890.7 kg (60 yrs)
24" Foundation Slab	1,566.0 kg (60 yrs)
36" Foundation Slab	7,033.2 kg (60 yrs)
4.5" LW Concrete 3" Metal Deck	133,333.5 kg (60 yrs)
6" Concrete Slab	30,618.8 kg (60 yrs)
8" Concrete Slab	4,120.5 kg (60 yrs)
Concrete - 12"	823.6 kg (60 yrs)
Concrete-Rectangular Beam	16,692.4 kg (60 yrs)
Footing-Rectangular	36,623.0 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Concrete mix ingredient: Tap water

Life Cycle Inventory:
Tap water

Product Scope:
Cradle to gate, excludes mixing and pouring impacts

Transportation Distance:
N/A

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
US: Tap water from groundwater ts (2017)

Wood stain, water based **315.8 kg**

Used in the following Revit families:

WSP - Wood Canopy_NBBJ Calcs	315.8 kg (10 yrs)

Used in the following Tally entries:
Wood rainscreen, hardwood

Description:
Semi-transparent stain for interior and exterior wood surfaces

Life Cycle Inventory:
60% Water
28% Acrylate resin
7% Acrylate emulsion
5% Dipropylene glycol
1.3% NMVOC emissions

Product Scope:
Cradle to gate, including emissions during application

Transportation Distance:
By truck: 642 km

End-of-Life Scope:
38.7% solids to landfill (plastic waste)

LCI Source:
US: Tap water from groundwater ts (2017)
US: Acrylate resin (solvent-systems) ts (2017)
DE: Acrylate (emulsion) ts (2017)
US: Dipropylene glycol by product propylene glycol via PO hydrogenation ts (2017)

XPS insulation, Foamular average, Owens Corning - EPD **15,259.9 kg**

Used in the following Revit families:

Site - Planting - 3	14,271.0 kg (60 yrs)
WSP - Type 10 Architectural Concrete_NBBJ Calcs	247.2 kg (60 yrs)
WSP - Type 10 Stone Cladding_NBBJ Calcs	741.6 kg (60 yrs)

Used in the following Tally entries:
Extruded polystyrene (XPS), board

Description:
FOAMULAR XPS (polystyrene) insulation board, HFC foaming agent. EPD representative of US manufacturing condition. FOAMULAR insulation board is available with a variety of R-values and compressive strengths. The default value is based on a thermal resistance of RSI 1 and a compressive strength of 30 psi. If the intended R-value and compressive strength of the assembly is known, use the drop-down menu to designate a specific product.

Note: This temporary entry is sourced directly from third-party verified EPD data and replaces a Tally entry that is undergoing a quality assurance review. This entry developed using data from ecoinvent and modeled in SimaPro but adheres to

Life Cycle Inventory:
For information and quantities, see EPD.

Product Scope:
Cradle to gate.
Note: Product stage expanded to include blowing agent emissions during distribution and installation, and diffusion from product over service life (B1). As these impacts make a significant contribution to GWP they have been included in the product stage.

Transportation Distance:
By truck: 1190 km

End-of-Life Scope:
100% Landfilled (plastic waste), includes blowing agent emissions released during disposal

LCI Source:
US: Extruded polystyrene (XPS) insulation board, FOAMULAR - Owens Corning EPD (2018), modeled with Simapro 8, source for secondary data is ecoinvent 3.4

EPD Source:
4788721182.101.1

EPD Designation Holder:
Owens Corning

EPD Program Operator:
UL Environment

EPD Expiration:
1/1/2024

APPENDIX

C TALLY WBLCA PROPOSED MODEL RESULTS

420 RUTHERFORD AVENUE

Proposed WBLCA

6/30/2022

tally®

Table of Contents

Report Summary

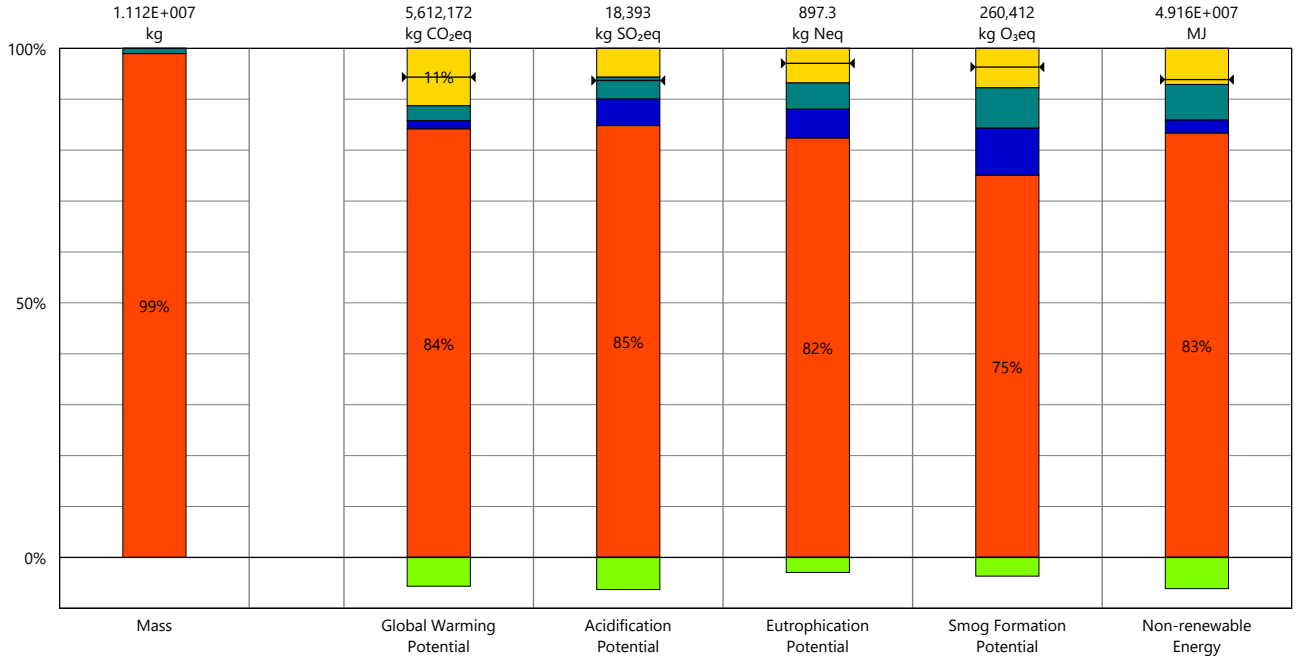
Created with Tally
Commercial Version 2020.06.09.01

Author	WSP
Company	WSP
Date	6/30/2022
Project	420 RUTHERFORD AVENUE
Location	Charlestown, MA
Gross Area	113191 ft^2
Building Life	60 years
Boundaries	Cradle to grave, inclusive of biogenic carbon; see appendix for a full list of materials and processes

Goal and Scope of Assessment
Proposed whole building life cycle assessment for 420 Rutherford Avenue. Scope includes structure and building enclosure. Boundary of assessment is cradle to grave, inclusive of biogenic carbon. Modules included are A1-A3, A4, B2-B5, C2-C4, and Module D. Boundary excludes construction installation (A5), use (B1), and operational energy (B6).

Environmental Impact Totals	Product Stage [A1-A3]	Construction Stage [A4]	Use Stage [B2-B5]	End of Life Stage [C2-C4]	Module D [D]
Global Warming (kg CO_2eq)	4,725,252	91,079	164,189	631,651	-317,422
Acidification (kg SO_2eq)	15,601	963.8	793.7	1,034	-1,161
Eutrophication (kg Neq)	739.4	50.82	46.42	60.73	-26.4
Smog Formation (kg O_3eq)	195,537	24,140	20,611	20,124	-9,584
Ozone Depletion (kg CFC-11eq)	0.6871	3.000E-009	5.638E-004	1.351E-004	0.001415
Primary Energy (MJ)	4.398E+007	1,295,224	3,669,603	3,724,827	-3,656,693
Non-renewable Energy (MJ)	4.098E+007	1,268,243	3,423,911	3,483,395	-3,015,332
Renewable Energy (MJ)	3,005,860	26,787	246,242	245,563	-643,769
Environmental Impacts / Area					
Global Warming (kg CO_2eq/m^2)	449.3	8.661	15.61	60.07	-30.2
Acidification (kg SO_2eq/m^2)	1.484	0.09165	0.07547	0.09829	-0.1104
Eutrophication (kg Neq/m^2)	0.07031	0.004833	0.004415	0.005775	-0.002515
Smog Formation (kg O_3eq/m^2)	18.59	2.296	1.960	1.914	-0.9114
Ozone Depletion (kg CFC-11eq/m^2)	6.534E-005	2.853E-013	5.361E-008	1.285E-008	1.345E-007
Primary Energy (MJ/m^2)	4,182	123.2	349.0	354.2	-348
Non-renewable Energy (MJ/m^2)	3,897	120.6	325.6	331.3	-287
Renewable Energy (MJ/m^2)	285.8	2.547	23.42	23.35	-61.2

Results per Life Cycle Stage

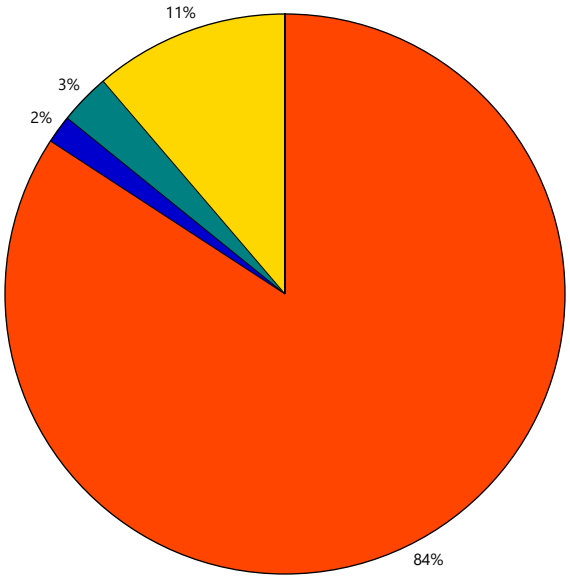


Legend

Net value (impacts + credits)

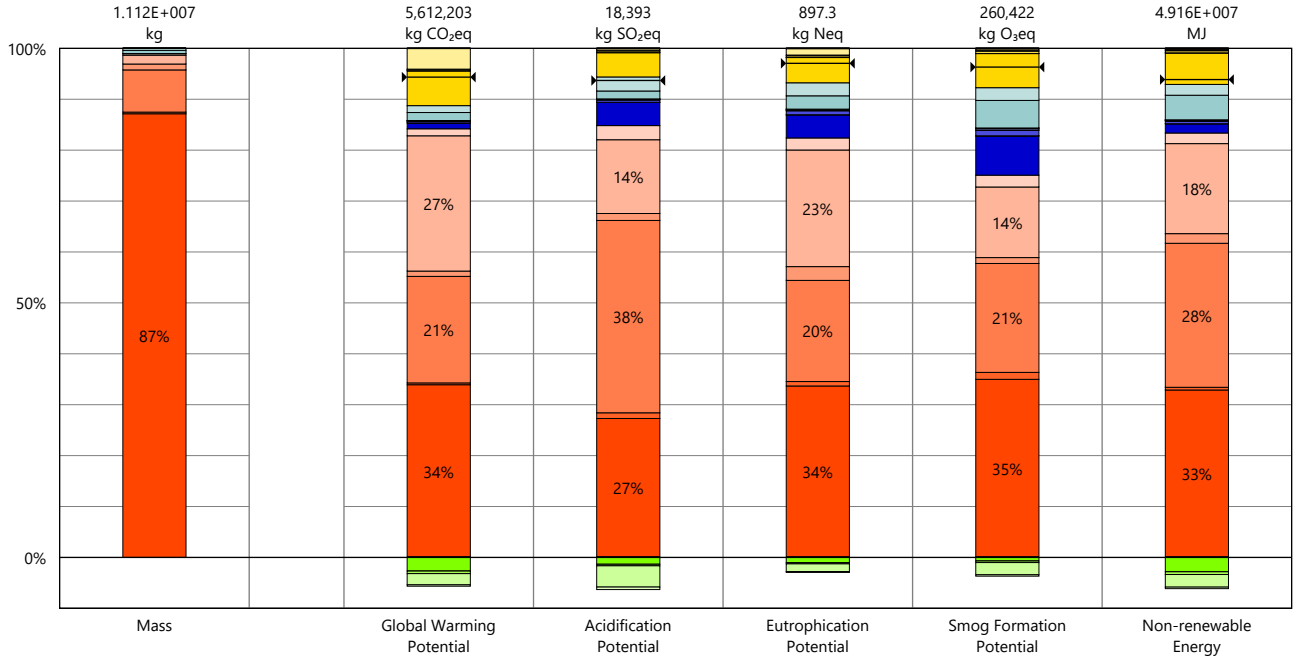
Life Cycle Stages

- Product [A1-A3]
- Transportation [A4]
- Maintenance and Replacement [B2-B5]
- End of Life [C2-C4]
- Module D [D]



Global Warming Potential

Results per Life Cycle Stage, itemized by Division



Legend

Net value (impacts + credits)

Product [A1-A3]
- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing

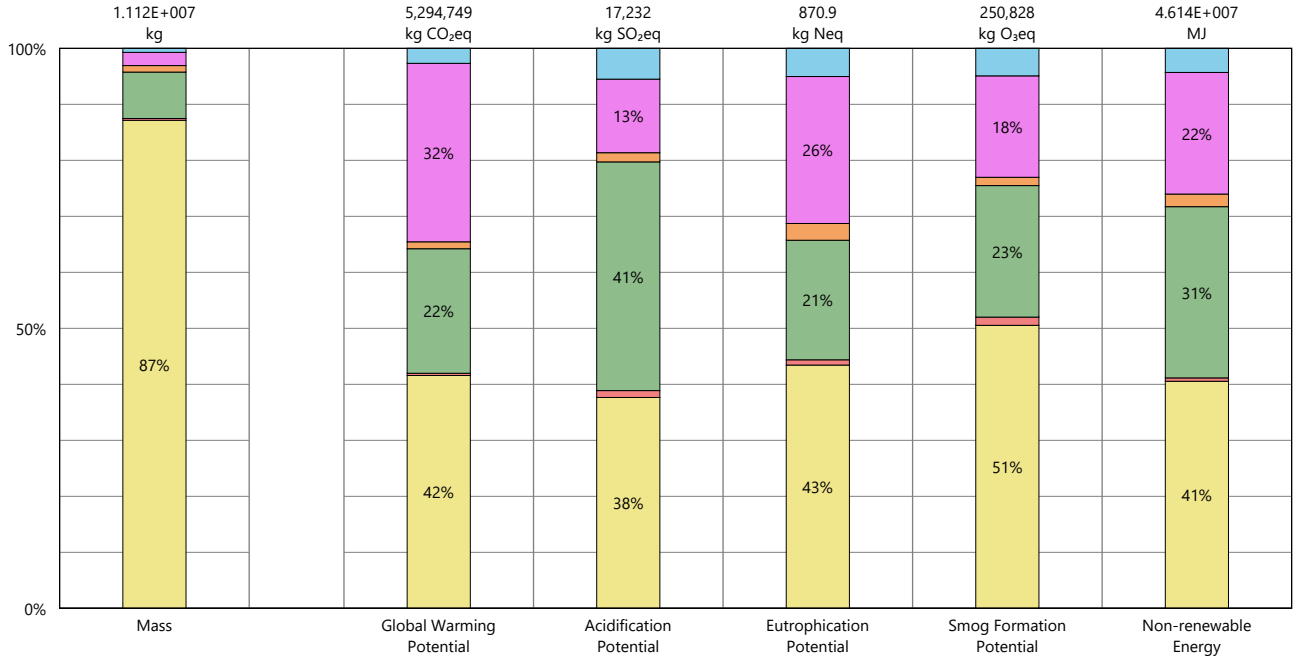
Transportation [A4]
- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing

Maintenance and Replacement [B2-B5]
- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing

End of Life [C2-C4]
- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing

Module D [D]
- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing

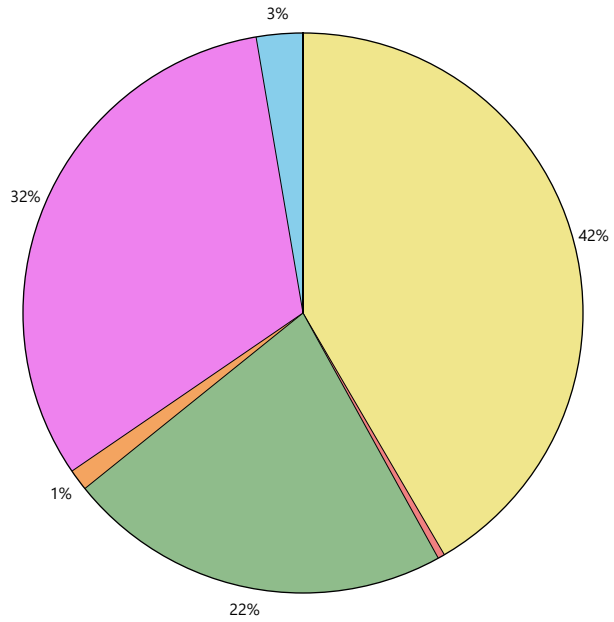
Results per Division



Legend

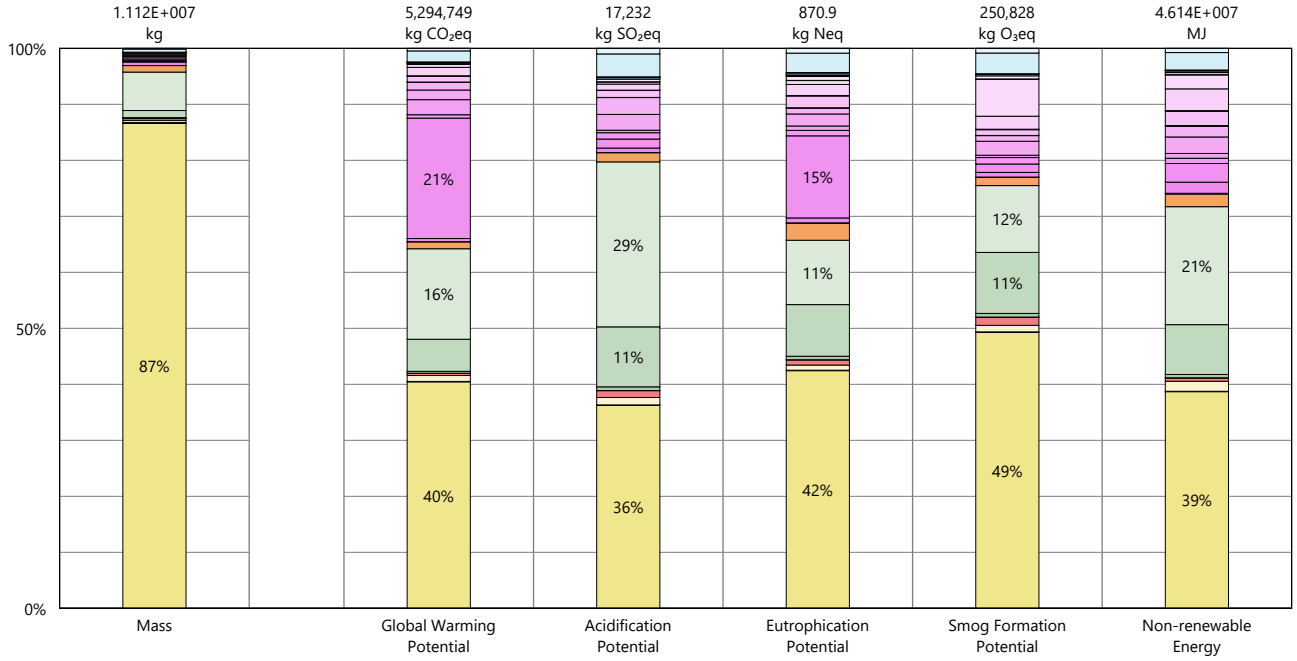
Divisions

- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing



Global Warming Potential

Results per Division, itemized by Tally Entry



Legend

03 - Concrete
- Cast-in-place concrete, custom mix
- Precast concrete nonstructural panel
- Steel, welded wire mesh

04 - Masonry
- Stone veneer wall, granite, grouted

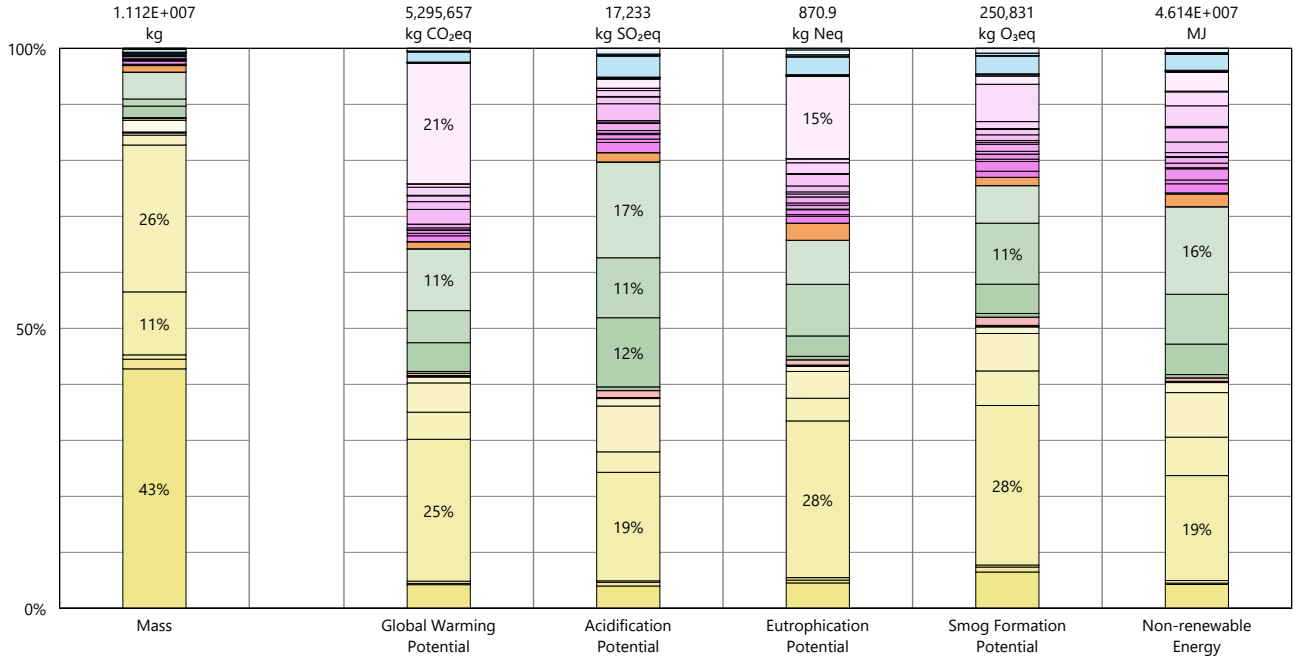
05 - Metals
- Aluminum, formed
- Steel, C-stud metal framing
- Steel, deck
- Steel, W section (wide flange shape)

06 - Wood/Plastics/Composites
- Fiberglass mat gypsum sheathing

07 - Thermal and Moisture Protection
- Asphalt felt sheet
- Built up asphalt roofing
- Extruded polystyrene (XPS), board
- Glass fiber reinforced concrete (GFRC) panel
- Insulated metal wall panel
- Metal wall panels, plate
- Mineral wool, board, generic
- Polyethelene sheet vapor barrier (HDPE)
- Polyisocyanurate (PIR), board
- Porcelain tile
- PVC roofing membrane, sheet
- Self adhering membrane
- Self-adhering, polymer-modified asphalt sheet underlayment
- Wood rainscreen, hardwood

08 - Openings and Glazing
- Aluminum mullion, custom finish
- Door frame, aluminum
- Door, exterior, aluminum
- Door, exterior, glass
- Door, exterior, steel
- Glazing, custom IGU
- Spandrel, glass, insulated

Results per Division, itemized by Material



Legend

03 - Concrete
- Coarse aggregate
- Expanded slag
- Fly ash
- Portland cement, PCA - EPD
- Sand
- Steel, reinforcing rod
- Steel, welded wire mesh
- Structural concrete, 3000 psi, 0% fly ash and slag
- Water

04 - Masonry
- Mortar type S
- Stone slab, granite

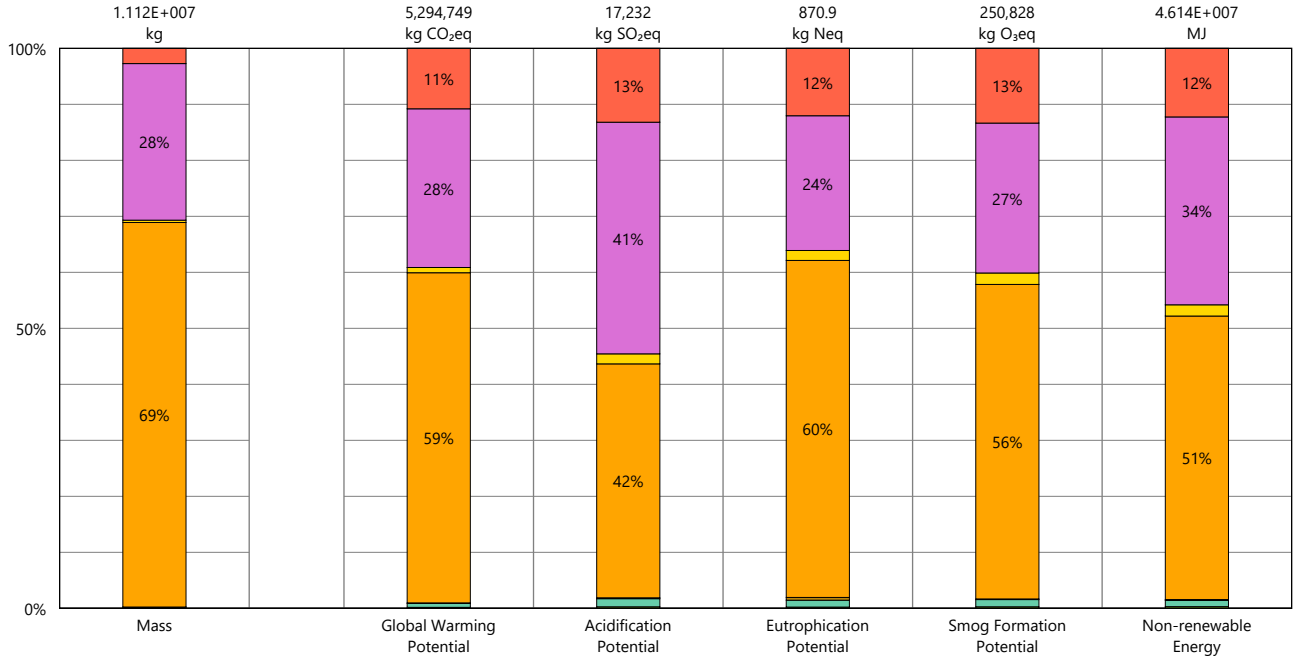
05 - Metals
- Aluminum, formed
- Cold formed structural steel
- Fireproofing, cementitious, by area
- Galvanized steel decking
- Hot rolled structural steel, AISC - EPD
- Powder coating, metal stock

06 - Wood/Plastics/Composites
- Fiberglass mat gypsum sheathing board

07 - Thermal and Moisture Protection
- Adhesive, polychloroprene (neoprene)
- Aluminum extrusion, AEC - EPD
- Aluminum, sheet
- Asphalt BUR, assembly (cap & ply felt), ARMA - EPD
- Asphalt felt sheet, roofing underlayment, ARMA - EPD
- Fasteners, stainless steel
- Fluoropolymer coating, metal stock
- Galvanized steel support
- GFRC
- Hard maple lumber, 1 inch
- Insulated metal panel (IMP), Metl-Span, CF42 - EPD
- Mineral wool, high density, NAIMA - EPD
- PIR rigid foam insulation, roof, R=15, PIMA - EPD
- Polyethelene sheet vapor barrier (HDPE)
- Porcelain ceramic tile, glazed
- PVC membrane, sheet
- Self adhering flashing membrane, 40 mil
- Self-adhering, polymer-modified asphalt sheet underlayment
- Wood stain, water based
- XPS insulation, Foamular average, Owens Corning - EPD

08 - Openings and Glazing
- Aluminum entrance door, YKK AP - EPD
- Aluminum extrusion, thermally-improved mill-finished, AEC - EPD
- Argon gas for IGU
- Door frame, aluminum, powder-coated, no door
- Fasteners, aluminum (anodized)
- Fasteners, stainless steel
- Fluoropolymer coating, metal stock
- Glazing, double, 3 mm, laminated safety glass
- Glazing, monolithic sheet, tempered
- Hardware, stainless steel
- Hollow door, exterior, steel, powder-coated
- IGU spacer
- Low-e coating (for glazing)
- Overhead door closer, aluminum
- Spandrel, glass, insulated (2" core)
- Steel door hinge

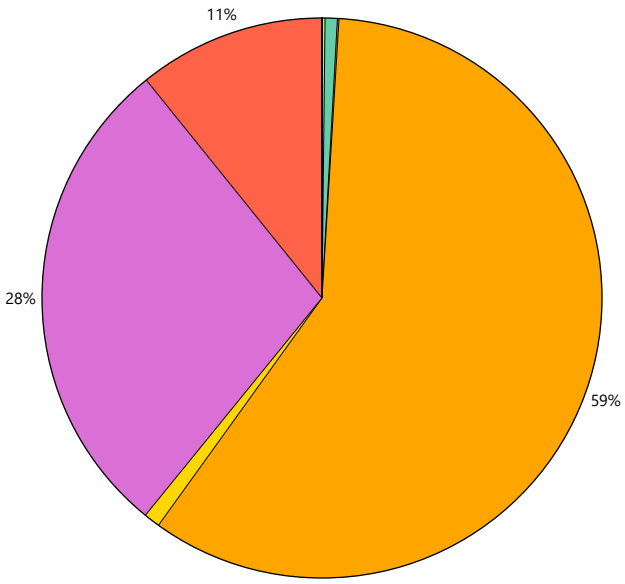
Results per Revit Category



Legend

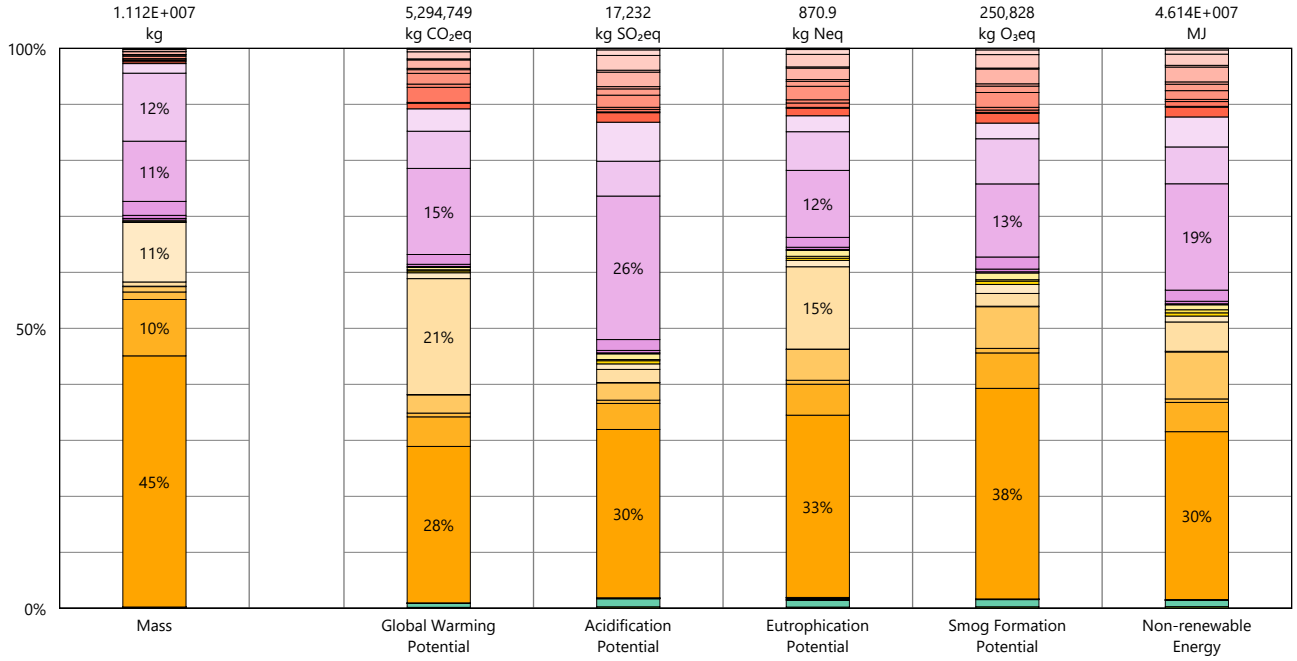
Revit Categories

- Curtainwall Mullions
- Curtainwall Panels
- Doors
- Floors
- Roofs
- Structure
- Walls



Global Warming Potential

Results per Revit Category, itemized by Family



Legend

Curtainwall Mullions
- Rectangular Mullion

Curtainwall Panels
- System Panel

Doors
- _Schematic-Swinging
- B2050-Exterior_Swinging
- Door Panel_Double Casement
- Door-Curtain-Wall-Single-Glass
- door-eco1602_faceofwallmount_300-series-cookson (2)
- Revolving Door 3

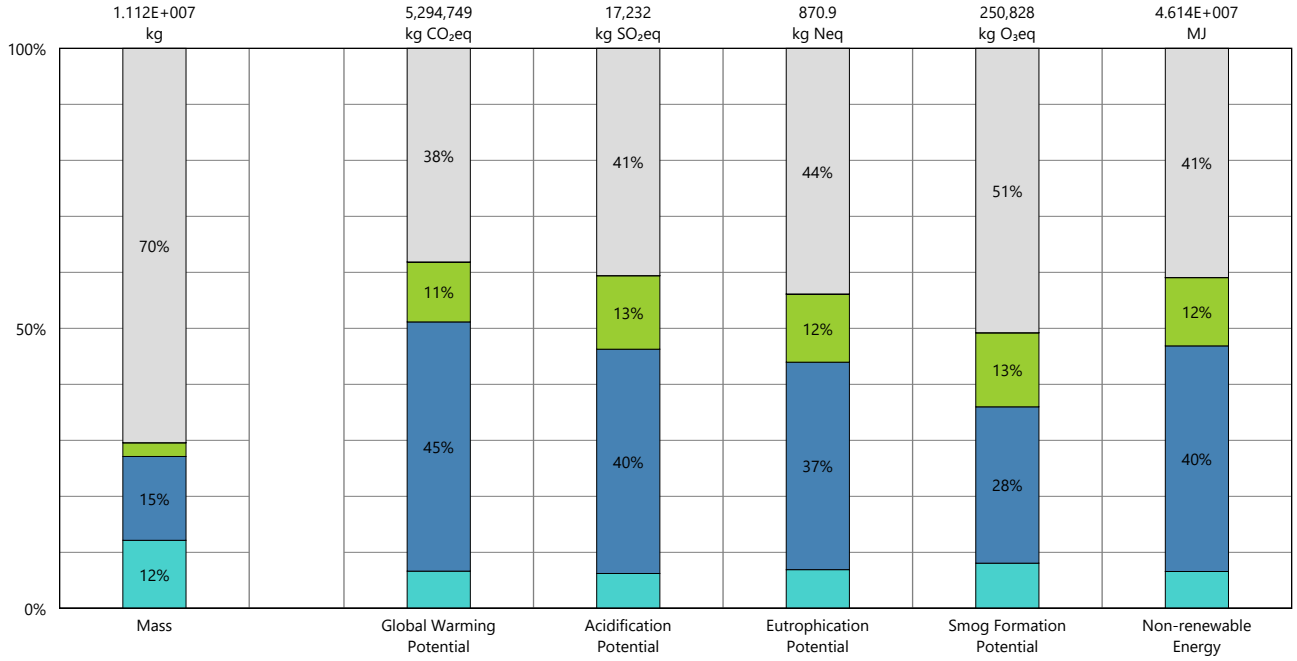
Floors
- 4.5" LW Concrete 3" Metal Deck
- 6" Concrete Slab
- 8" Concrete Slab
- Generic - 8"
- Site - Pavement - Wood - Roof Decking
- Site - Planting - 3
- WSP - 6" Gravel Fill

Roofs
- WSP - GFRC_NBBJ Calcs
- WSP - PVC Canopy_NBBJ Calcs 2
- WSP - Wood Canopy_NBBJ Calcs

Structure
- _TT-CL-Concrete Rectangular
- 24" Foundation Slab
- 36" Foundation Slab
- Concrete-Rectangular Beam
- Footing-Rectangular
- WSP_W-Wide Flange-Columns

Walls
- _Schematic-Exterior_10"
- Concrete - 12"
- WSP - Exterior PH Screen_NBBJ Calcs 2
- WSP - Type 10 Architectural Concrete_NBBJ Calcs
- WSP - Type 10 Stone Cladding_NBBJ Calcs
- WSP - Type 13 Custom Metal_NBBJ Calcs
- WSP - Type 14 Precast Panel_NBBJ Calcs 2
- WSP - Type 6 GFRC_NBBJ Calcs
- WSP - Type 7 GFRC in CW_NBBJ Calcs 2
- WSP - Type 8 CW_NBBJ Calcs
- WSP - Type 9 CW Spandrel_NBBJ Calcs
- WSP_Schematic-Exterior_12"

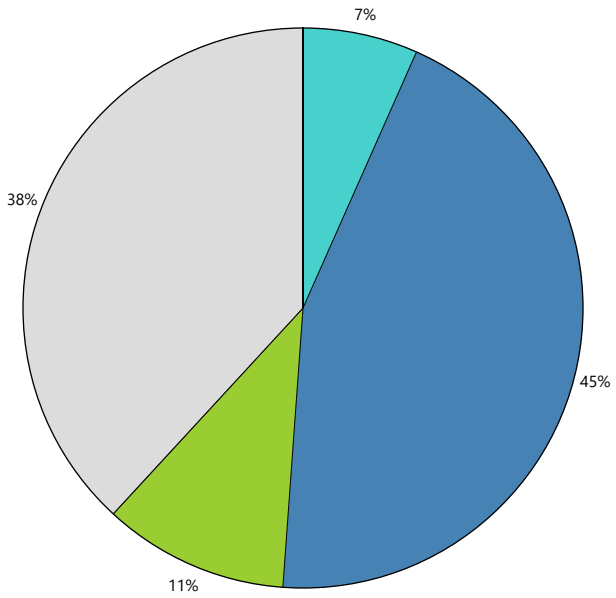
Results per Building Element



Legend

Building Elements

- Substructure
- Superstructure
- Enclosure
- Interiors
- Undefined



Global Warming Potential

Calculation Methodology

LIFE CYCLE ASSESSMENT METHODS

The following provides a description of terms and methods associated with the use of Tally to conduct life cycle assessment for construction works and construction products. Tally methodology is consistent with LCA standards ISO 14040-14044, ISO 21930:2017, ISO 21931:2010, EN 15804:2012, and EN 15978:2011. For more information about LCA, please refer to these standards or visit www.choosetally.com.

Studied objects

The life cycle assessment (LCA) results reported represent an analysis of a single building, multiple buildings, or a comparative analysis of two or more building design options. The assessment may represent the complete architectural, structural, and finish systems of the building(s) or a subset of those systems. This may be used to compare the relative environmental impacts associated with building components or for comparative study with one or more reference buildings. Design options may represent a full or partial building across various stages of the design process, or they may represent multiple schemes of a full or partial building that are being compared to one another across a range of evaluation criteria.

Functional unit and reference unit

A functional unit is the quantified performance of a product, building, or system that defines the object of the study. The functional unit of a single building should include the building type (e.g. office, factory), relevant technical and functional requirements (e.g. regulatory requirements, energy performance), pattern of use (e.g. occupancy, usable floor area), and the required service life. For a design option comparison of a partial building, the functional unit is the complete set of building systems or products that perform a given function. It is the responsibility of the modeler to assure that reference buildings or design options are functionally equivalent in terms of scope and relevant performance. The expected life of the building has a default value of 60 years and can be modified by the modeler.

The reference unit is the full collection of processes and materials required to produce a building or portion thereof and is quantified according to the given goal and scope of the assessment over the full life of the building. If construction impacts are included in the assessment, the reference unit also includes the energy, water, and fuel consumed on the building site during construction. If operational energy is included in the assessment, the reference unit includes the electrical and thermal energy consumed on site over the life of the building.

Data source

Tally utilizes a custom designed LCA database that combines material attributes, assembly details, and architectural specifications with environmental impact data resulting from the collaboration between KieranTimberlake and thinkstep. LCA modeling was conducted in GaBi 8.5 using GaBi 2018 databases and in accordance with GaBi databases and modeling principles.

The data used are intended to represent the US and the year 2017. Where representative data were unavailable, proxy data were used. The datasets used, their geographic region, and year of reference are listed for each entry. An effort was made to choose proxy datasets that are technologically consistent with the relevant entry.

Data quality and uncertainty

Uncertainty in results can stem from both the data used and their application. Data quality is judged by: its measured, calculated, or estimated precision; its completeness, such as unreported emissions; its consistency, or degree of uniformity of the methodology applied on a study serving as a data source; and geographical, temporal, and technological representativeness. The GaBi LCI databases have been used in LCA models worldwide in both industrial and scientific applications. These LCI databases have additionally been used both as internal and critically reviewed and published studies. Uncertainty introduced by the use of proxy data is reduced by using technologically, geographically, and/or temporally similar data. It is the responsibility of the modeler to appropriately apply the predefined material entries to the building under study.

System boundaries and delimitations

The analysis accounts for the full cradle to grave life cycle of the design options studied across all life cycle stages, including material manufacturing, maintenance and replacement, and eventual end of life. Optionally, the construction impacts and operational energy of the building can be included within the scope. Product stage impacts are excluded for materials and components indicated as existing or salvaged by the modeler. The modeler defines whether the boundary includes or excludes the flow of biogenic carbon, which is the carbon absorbed and generated by biological sources (e.g. trees, algae) rather than from fossil resources.

Architectural materials and assemblies include all materials required for the product's manufacturing and use including hardware, sealants, adhesives, coatings, and finishing. The materials are included up to a 1% cut-off factor by mass except for known materials that have high environmental impacts at low levels. In these cases, a 1% cut-off was implemented by impact.

Calculation Methodology

LIFE CYCLE STAGES

The following describes the scope and system boudaries used to define each stage of the life cycle of a building or building product, from raw material acquisition to final disposal. For products listed in Tally as Environmental Product Declarations (EPD), the full life cycle impacts are included, even if the published EPD only includes the Product stage [A1-A3].

Product [EN 15978 A1 - A3]

This encompasses the full manufacturing stage, including raw material extraction and processing, intermediate transportation, and final manufacturing and assembly. The product stage scope is listed for each entry, detailing any specific inclusions or exclusions that fall outside of the cradle to gate scope. Infrastructure (buildings and machinery) required for the manufacturing and assembly of building materials are not included and are considered outside the scope of assessment.

Transportation [EN 15978 A4]

This counts transportation from the manufacturer to the building site during the construction stage and can be modified by the modeler.

Construction Installation [EN 15978 A5] (Optional)

This includes the anticipated or measured energy and water consumed on-site during the construction installation process, as specified by the modeler.

Maintenance and Replacement [EN 15978 B2-B5]

This encompasses the replacement of materials in accordance with their expected service life. This includes the end of life treatment of the existing products as well as the cradle to gate manufacturing and transportation to site of the replacement products. The service life is specified separately for each product. Refurbishment of materials marked as existing or salvaged by the modeler is also included.

Operational Energy [EN 15978 B6] (Optional)

This is based on the anticipated or measured energy and natural gas consumed at the building site over the lifetime of the building, as indicated by the modeler.

End of Life [EN 15978 C2-C4]

This includes the relevant material collection rates for recycling, processing requirements for recycled materials, incineration rates, and landfilling rates. The impacts associated with landfilling are based on average material properties, such as plastic waste, biodegradable waste, or inert material. Stage C2 encompasses the transport from the construction site to end-of-life treatment based on national averages. Stages C3-C4 account for waste processing and disposal, i.e., impacts associated with landfilling or incineration.

Module D [EN 15978 D]

This accounts for reuse potentials that fall beyond the system boundary, such as energy recovery and recycling of materials. Along with processing requirements, the recycling of materials is modeled using an avoided burden approach, where the burden of primary material production is allocated to the subsequent life cycle based on the quantity of recovered secondary material. Incineration of materials includes credit for average US energy recovery rates.

PRODUCT	CONSTRUCTION	USE	END-OF-LIFE	MODULE D
A1. Extraction	**A4. Transport (to site)**	B1. Use	C1. Demolition	**D. Benefits and loads beyond the system boundary from:**
A2. Transport (to factory)	***A5. Construction Installation***	**B2. Maintenance**	**C2. Transport (to disposal)**	**1. Reuse**
A3. Manufacturing		**B3. Repair**	**C3. Waste processing**	**2. Recycling**
		B4. Replacement	**C4. Disposal**	**3. Energy recovery**
		B5. Refurbishment		
		B6. Operational energy		
		B7. Operational water		

Life-Cycle Stages as defined by EN 15978. Processes included in Tally modeling scope are shown in bold. Italics indicate optional processes.

Calculation Methodology

ENVIRONMENTAL IMPACT CATEGORIES

A characterization scheme translates all emissions and fuel use associated with the reference flow into quantities of categorized environmental impact. As the degree that the emissions will result in environmental harm depends on regional ecosystem conditions and the location in which they occur, the results are reported as impact potential. Potential impacts are reported in kilograms of equivalent relative contribution (eq) of an emission commonly associated with that form of environmental impact (e.g. kg CO_2eq).

The following list provides a description of environmental impact categories reported according to the TRACI 2.1 characterization scheme, the environmental impact model developed by the US EPA to quantify environmental impact risk associated with emissions to the environment in the United States. TRACI is the standard environmental impact reporting format for LCA in North America. Impacts associated with land use change and fresh water depletion are not included in TRACI 2.1. For more information on TRACI 2.1, reference Bare 2010, EPA 2012, and Guinée 2001. For further description of measurement of environmental impacts in LCA, see Simonen 2014.

Acidification Potential (AP) kg SO_2eq

A measure of emissions that cause acidifying effects to the environment. The acidification potential is a measure of a molecule's capacity to increase the hydrogen ion (H^+) concentration in the presence of water, thus decreasing the pH value. Potential effects include fish mortality, forest decline, and the deterioration of building materials.

Eutrophication Potential (EP) kg Neq

A measure of the impacts of excessively high levels of macronutrients, the most important of which are nitrogen (N) and phosphorus (P). Nutrient enrichment may cause an undesirable shift in species composition and elevated biomass production in both aquatic and terrestrial ecosystems. In aquatic ecosystems, increased biomass production may lead to depressed oxygen levels caused by the additional consumption of oxygen in biomass decomposition.

Global Warming Potential (GWP) kg CO_2eq

A measure of greenhouse gas emissions, such as carbon dioxide and methane. These emissions are causing an increase in the absorption of radiation emitted by the earth, increasing the natural greenhouse effect. This may, in turn, have adverse impacts on ecosystem health, human health, and material welfare.

Ozone Depletion Potential (ODP) kg CFC-11eq

A measure of air emissions that contribute to the depletion of the stratospheric ozone layer. Depletion of the ozone leads to higher levels of UVB ultraviolet rays reaching the earth's surface with detrimental effects on humans and plants. As these impacts tend to be very small, ODP impacts can be difficult to calculate and are prone to a larger margin of error than the other impact categories.

Smog Formation Potential (SFP) kg O_3eq

A measure of ground level ozone, caused by various chemical reactions between nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in sunlight. Human health effects can result in a variety of respiratory issues, including increasing symptoms of bronchitis, asthma, and emphysema. Permanent lung damage may result from prolonged exposure to ozone. Ecological impacts include damage to various ecosystems and crop damage.

Primary Energy Demand (PED) MJ (lower heating value)

A measure of the total amount of primary energy extracted from the earth. PED tracks energy resource use, not the environmental impacts associated with the resource use. PED is expressed in energy demand from non-renewable resources and from renewable resources. Efficiencies in energy conversion (e.g. power, heat, steam, etc.) are taken into account when calculating this result.

Non-Renewable Energy Demand MJ (lower heating value)

A measure of the energy extracted from non-renewable resources (e.g. petroleum, natural gas, etc.) contributing to the PED. Non-renewable resources are those that cannot be regenerated within a human time scale. Efficiencies in energy conversion (e.g. power, heat, steam, etc.) are taken into account when calculating this result.

Renewable Energy Demand MJ (lower heating value)

A measure of the energy extracted from renewable resources (e.g. hydropower, wind energy, solar power, etc.) contributing to the PED. Efficiencies in energy conversion (e.g. power, heat, steam, etc.) are taken into account when calculating this result.

LCI Data

END-OF-LIFE [C2-C4]

A Life Cycle Inventory(LCI) is a compilation and quantification of inputs and outputs for the reference unit.The following LCI provides a summary of all energy, construction, transportation, and material inputs present in the study. Materials are listed in alphabetical order along with a list of all Revit families and Tally entries in which they occur, along with any notes and system boundaries accompanying their database entries.Each entry lists the detailed scope for the LCI data sources used from the GaBi LCI database and identifies the LCI data source.

For LCI data sourced from an Environmental Product Declaration (EPD), the product manufacturer, EPD identification number, and Program Operator are listed. Where the LCI source does not provide data for all life cycle stages, default North American average values are used. This is of particular importance for European EPD sources, as EPD data are generally only provided for the product stage, and North American average values are used for the remaining life cycle stages.

Where specific quantities are associated with a data entry, such as user inputs, energy values, or material mass, the quantity is listed on the same line as the title of the entry.

TRANSPORTATION [A4]

Default transportation values are based on the three-digit material commodity code in the 2012 Commodity Flow Survey by the US Department of Transportation Bureau of Transportation Statistics and the US Department of Commerce where more specific industry-level transportation is not available.

Transportation by Barge

Scope:
The data set represents the transportation of 1 kg of material from the manufacturer location to the building site by barge.

LCI Source:
GLO: Average ship, 1500t payload capacity/ canal ts (2017)
US: Diesel mix at filling station ts (2014)

Transportation by Container Ship

Scope:
The data set represents the transportation of 1 kg of material from the manufacturer location to the building site by container ship.

LCI Source:
GLO: Container ship, 27500 dwt payload capacity, ocean going ts (2017)
US: Heavy fuel oil at refinery (0.3wt.% S) ts (2014)

Transportation by Rail

Scope:
The data set represents the transportation of 1 kg of material from the manufacturer location to the building site by cargo rail.

LCI Source:
GLO: Rail transport cargo - Diesel, average train, gross tonne weight 1000t / 726t payload capacity ts (2017)
US: Diesel mix at filling station ts (2014)

Transportation by Truck

Scope:
The data set represents the transportation of 1 kg of material from the manufacturer location to the building site by diesel truck.

LCI Source:
US: Truck - Trailer, basic enclosed / 45,000 lb payload - 8b ts (2017)
US: Diesel mix at filling station ts (2014)

LCI Data (continued)

END-OF-LIFE [C2-C4]

Specific end-of-life scenarios are detailed for each entry based on the US construction and demolition waste treatment methods and rates in the 2016 WARM Model by the US Environmental Protection Agency except where otherwise specified. Heterogeneous assemblies are modeled using the appropriate methodologies for the component materials.

End-of-Life Landfill

Scope:

Materials for which no recycling or incineration rates are known, no recycling occurs within the US at a commercial scale, or which are unable to be recycled are landfilled. This includes glass, drywall, insulation, and plastics. The solids contents of coatings, sealants, and paints are assumed to go to landfill, while the solvents or water evaporate during installation. Where the landfill contains biodegradable material, the energy recovered from landfill gas utilization is reflected as a credit in Module D.

LCI Source:

US: Glass/inert on landfill ts (2017)
US: Biodegradable waste on landfill, post-consumer ts (2017)
US: Plastic waste on landfill, post-consumer ts (2017)

Concrete End-of-Life

Scope:

Concrete (or other masonry products) are recycled into aggregate or general fill material or they are landfilled. It is assumed that 55% of the concrete is recycled. Module D accounts for both the credit associated with off-setting the production aggregate and the burden of the grinding energy required for processing.

LCI Source:

US: Diesel mix at refinery ts (2014)
GLO: Fork lifter (diesel consumption) ts (2016)
EU - 28 Gravel 2/32 ts (2017)
US: Glass/inert on landfill ts (2017)

Metals End-of-Life

Scope:

Metal products are modeled using the avoided burden approach. The recycling rate at end of life is used to determine how much secondary metal can be recovered after having subtracted any scrap input into manufacturing (net scrap). Net scrap results in an environmental credit in Module D for the corresponding share of the primary burden that can be allocated to the subsequent product system using secondary material as an input. If the value in Module D reflects an environmental burden, then the original product (A1-A3) contains more secondary material than is recovered.

LCI Source:

Aluminum - RNA: Primary Aluminum Ingot AA/ts (2010)
Aluminum - RNA: Secondary Aluminum Ingot AA/ts (2010)
Brass - GLO: Zinc mix ts (2012)
Brass - GLO: Copper (99.99% cathode) ICA (2013)
Brass - EU-28: Brass (CuZn20) ts (2017)
Copper - DE: Recycling potential copper sheet ts (2016)
Steel - GLO: Value of scrap worldsteel (2014)
Zinc - GLO: Special high grade zinc IZA (2012)

Wood End-of-Life

Scope:

End of Life waste treatment methods and rates for wood are based on the 2014 Municipal Solid Waste and Construction Demolition Wood Waste Generation and Recovery in the United States report by Dovetail Partners, Inc. It is assumed that 65.5% of wood is sent to landfill, 17.5% to incineration, and 17.5% to recovery.

LCI Source:

US: Untreated wood in waste incineration plant ts (2017)
US: Wood product (OSB, particle board) waste in waste incineration plant ts (2017)
US: Wood products (OSB, particle board) on landfill, post-consumer ts (2017)
US: Untreated wood on landfill, post-consumer ts (2017)
RNA: Softwood lumber CORRIM (2011)

LCI Data

MODEL ELEMENTS

Revit Categories
- Ceilings
- Curtainwall Mullions
- Curtainwall Panels
- Doors
- Floors
- Roofs
- Stairs and Railings
- Structure
- Walls
- Windows

420_Rutherford_Architecture_R20.rvt_working.03.rvt

Worksets
- 00_EXISTING GRID
- 00_PROPERTY LINE
- 00_REFERENCES
- 00_SCOPE BOXES
- 00_SHARDED LEVELS AND GRIDS
- 01_ARCH - AREA
- 01_ARCH - CORE
- 01_ARCH - DEVICES_CEILING
- 01_ARCH - DEVICES_FLOOR
- 01_ARCH - DEVICES_WALL
- 01_ARCH - EQUIPMENT
- 01_ARCH - LIGHTING
- 01_ARCH - LIGHTING - SITE
- 01_ARCH - SHELL
- 01_ARCH - STRUCTURE
- 01_ARCH - TOPO
- 02_ARCH - FURNITURE
- 02_ARCH - INTERIOR TESTFITS
- 03_SITE - 440 Overall
- 03_SITE - AREA
- 03_SITE - FOUNDATION IMPROVEMENT SOIL
- 03_SITE - FURNITURE + LIGHTING
- 04_LINK - CAD FILES
- 04_LINK - ELECTRICAL
- 04_LINK - FIRE PROTECTION
- 04_LINK - LANDSCAPING
- 04_LINK - LIGHTING
- 04_LINK - MECHANICAL
- 04_LINK - PLUMBING
- 04_LINK - RHINO_FACADE
- 04_LINK - STRUCTURE
- 04_LINK - SURVEY
- Workset1

Phases
- Existing
- New Construction

420_Rutherford_Structure_R20.rvt_working_Proposed_Steel Only.rvt (Read-only)

Worksets
- EXISTING GRIDS
- Shared Views, Levels, Grids
- Workset1

Phases
- Existing
- New Construction

420_Rutherford_Structure_R20.rvt_NRMCA.rvt (Read-only)

Worksets
- N/A

Phases
- N/A

PRODUCT [A1-A3]

Materials and components are listed in alphabetical order along with a list of all Revit families and Tally entries in which they occur. The masses given here refer to the quantity of each material used over the building's life-cycle, which includes both Product [A1-A3] and Use [B2-B5] stages.

Additional provided data describing scope boundaries for each life cycle stage may be useful for interpretation of the impacts associated with the specific material or component. Each material or component is listed with its service life, or period of time after installation it is expected to meet the service requirements prior to replacement or repair. This value is indicated in parentheses next to the mass of the material associated with the listed Revit family. Values for transportation distance or service life shown with an asterisk (*) indicate user-defined changes to default values. Values for service life shown with a dagger (†) indicate materials identified by the modeler as existing or salvaged.

Adhesive, polychloroprene (neoprene) **1,283.5 kg**

Used in the following Revit families:
- Generic - 8" 1,208.8 kg (20 yrs)
- WSP - PVC Canopy_NBBJ Calcs 2 74.6 kg (20 yrs)

Used in the following Tally entries:
- PVC roofing membrane, sheet

Description:
Generic polychlorprene contact adhesive.

Life Cycle Inventory:
- Polychloroprene
- Alkylphenolic resin
- Magnesium oxide, tin oxide
- Solvents (petroleum ether/cycloaliphatic/ketone/ester blends)

Product Scope:
Cradle to gate, plus emissions during application, excludes energy for application

Transportation Distance:
By truck: 840 km

End-of-Life Scope:
27% solids to landfill (plastic waste)

LCI Source:
EU-28: Solvent-based polychloroprene adhesive of good heat resistance (estimation) (2017)

Aluminum entrance door, YKK AP - EPD **48.7 kg**

Used in the following Revit families:
- B2050-Exterior_Swinging 48.7 kg (30 yrs)

Used in the following Tally entries:
- Door, exterior, aluminum

Description:
Average aluminum entrance door by YKK AP America, including VersaJamb, Smart Series, MegaTherm, and Protek products. Entry includes includes door frame, door, finish, and necessary weather stripping, sealant, etc. Reference door is 1.23 m x 2.18m. Glazing (if any) is excluded and should be added as an accessory material by the user. EPD representative of conditions in the US.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate, excluding glazing

Transportation Distance:
By truck: 663 km

End-of-Life Scope:
Aluminum scrap is assumed to have a 95% recycling rate, and the other 5% and other materials are landfilled in the EoL

LCI Data (continued)

Module D Scope:
Credit given for the avoided burden associated with recovered material, includes burden for processing

LCI Source:
EPD (US), YKK AP America (2015)

EPD Source:
4786832322.102.1

EPD Designation Holder:
YKK AP America

EPD Program Operator:
UL Environment

EPD Expiration:
11/13/2020

Aluminum extrusion, AEC - EPD **19,194.8 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	4,543.9 kg (60 yrs)
Site - Pavement - Wood - Roof Decking	233.5 kg (60 yrs)
WSP - GFRC_NBBJ Calcs	1,818.6 kg (60 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	3,003.9 kg (60 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	1,082.5 kg (60 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	6,944.7 kg (60 yrs)
WSP - Wood Canopy_NBBJ Calcs	838.0 kg (60 yrs)
WSP_Schematic-Exterior_12"	729.6 kg (60 yrs)

Used in the following Tally entries:
Metal wall panels, plate
Porcelain tile
Wood rainscreen, hardwood

Description:
Extruded aluminum part. Industry-wide EPD from the Aluminum Extruders Council.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 663 km

End-of-Life Scope:
95% Recovered
5% Landfilled (inert material)

Module D Scope:
Product has 36.4% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Aluminum extrusion, mill finish - AEC (A1-A3) ts-EPD (2015)
RNA: Primary Aluminum Ingot AA/ts (2010)
RNA: Secondary Aluminum Ingot AA/ts (2010)

EPD Source:
11240237.101.1

EPD Designation Holder:
Aluminum Extruders Council (AEC)

EPD Program Operator:
UL Environment

EPD Expiration:
10/4/2021

Aluminum extrusion, thermally-improved mill-finished, AEC - EPD **2,213.1 kg**

Used in the following Revit families:

Rectangular Mullion	2,213.1 kg (60 yrs)

Used in the following Tally entries:
Aluminum mullion, custom finish

Description:
Mill-finished (uncoated), thermally-improved, or thermal barrier, aluminum extrusions. Industry-wide EPD from the Aluminum Extruders Council. EPD representative of conditions in North America.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle-to-gate

Transportation Distance:
By truck: 663 km

End-of-Life Scope:
95% Recovered
5% Landfilled (inert material)

Module D Scope:
Credit given for the avoided burden associated with recovered material

LCI Source:
EPD (US), American Extruders Council (2016)

EPD Source:
11240237.102.1

EPD Designation Holder:
Aluminum Extruders Council (AEC)

EPD Program Operator:
UL Environment

EPD Expiration:
10/4/2021

Aluminum, formed **0.0 kg**

Used in the following Revit families:

door-eco1602_faceofwallmount_300-series-cookson (2)	0.0 kg (60 yrs)

Used in the following Tally entries:
Aluminum, formed

Description:
Formed aluminum member. Data based on industry-wide EPD for cold-rolled aluminum from the Aluminum Association (EPD ID 4786092064.101.1).

Life Cycle Inventory:
100% Aluminum

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 663 km

End-of-Life Scope:
95% Recovered
5% Landfilled (inert material)

Module D Scope:
Product has 65% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Cold Rolled Aluminium ts/AA (2010) [EPD]
GLO: Steel sheet stamping and bending (5% loss) ts (2017)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
RNA: Primary Aluminum Ingot AA/ts (2010)
RNA: Secondary Aluminum Ingot AA/ts (2010)

Aluminum, sheet **7,547.7 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	1,733.5 kg (60 yrs)
WSP - GFRC_NBBJ Calcs	693.8 kg (60 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	1,146.0 kg (60 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	413.0 kg (60 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	2,649.4 kg (60 yrs)
WSP - Type 7 GFRC in CW_NBBJ Calcs 2	633.6 kg (60 yrs)
WSP_Schematic-Exterior_12"	278.3 kg (60 yrs)

Used in the following Tally entries:
Metal wall panels, plate

Description:
Aluminum sheet, formed and cut. Data based on industry-wide EPD for cold-rolled aluminum from the Aluminum Association (EPD ID 4786092064.101.1).

Life Cycle Inventory:
100% Aluminum

LCI Data (continued)

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 663 km

End-of-Life Scope:
95% Recovered
5% Landfilled (inert material)

Module D Scope:
Product has 65% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Cold Rolled Aluminium ts/AA (2010) [EPD]
GLO: Steel sheet stamping and bending (5% loss) ts (2017)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
RNA: Primary Aluminum Ingot AA/ts (2010)
RNA: Secondary Aluminum Ingot AA/ts (2010)

Argon gas for IGU **91.7 kg**

Used in the following Revit families:

System Panel	21.6 kg (40 yrs)
WSP - Type 8 CW_NBBJ Calcs	70.1 kg (40 yrs)

Used in the following Tally entries:
Glazing, custom IGU

Description:
Argon gas in insulating glass unit

Life Cycle Inventory:
Argon gas

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 940 km

End-of-Life Scope:
100% to landfill (inert waste)

LCI Source:
US: Argon (gaseous) ts (2017)

Asphalt BUR, assembly (cap & ply felt), ARMA - EPD **67,613.1 kg**

Used in the following Revit families:

Site - Planting - 3	67,613.1 kg (30 yrs)

Used in the following Tally entries:
Built up asphalt roofing

Description:
Asphalt Built-up roofing (BUR) consisting of a cap sheet and 3 plys of glass-fiber felt. Industry-wide EPD from the Asphalt Roofing Manufacturers Association.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate, accounts for product overlap when installing

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
100% Landfilled (plastic waste)

LCI Source:
RNA: Built-up asphalt roofing ply felt - ARMA (A1-A3) (2012)
RNA: Built-up asphalt roofing cap sheet - ARMA (A1-A3) (2012)

EPD Source:
4787168709.103.1

EPD Designation Holder:
Asphalt Roofing Manufacturers Association (ARMA)

EPD Program Operator:
UL Environment

EPD Expiration:
10/28/2021

Asphalt felt sheet, roofing underlayment, ARMA - EPD **1,943.7 kg**

Used in the following Revit families:

Site - Planting - 3	1,943.7 kg (60 yrs)

Used in the following Tally entries:
Asphalt felt sheet

Description:
Asphalt felt sheet, exclusive of spray adhesive for roofing and wall application. Type II felt, also called No. 30 asphalt felt, is the minimum accepted by the IBC and IRC for underlayment and interlayment. Data based on industry-wide EPD from the Asphalt Roofing Manufacturers Association.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
5% Recycled into bitumen
95% Landiflled (inert waste)

Module D Scope:
Avoided burden credit for recycling into bitumen, includes grinding energy

LCI Source:
RNA: Underlayment, asphalt shingle roofing system component - ARMA (A1-A3) ts (2012)

EPD Source:
4787168709.101.1

EPD Designation Holder:
Asphalt Roofing Manufacturers Association (ARMA)

EPD Program Operator:
UL Environment

EPD Expiration:
10/28/2021

Coarse aggregate **4,755,840.4 kg**

Used in the following Revit families:

_TT-CL-Concrete Rectangular	13,741.6 kg (60 yrs)
24" Foundation Slab	24,161.4 kg (60 yrs)
36" Foundation Slab	108,512.3 kg (60 yrs)
4.5" LW Concrete 3" Metal Deck	2,057,146.2 kg (60 yrs)
6" Concrete Slab	472,404.8 kg (60 yrs)
8" Concrete Slab	63,573.8 kg (60 yrs)
Concrete - 12"	12,707.1 kg (60 yrs)
Concrete-Rectangular Beam	257,540.4 kg (60 yrs)
Footing-Rectangular	565,040.7 kg (60 yrs)
WSP - 6" Gravel Fill	1,181,012.1 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Concrete mix ingredient: Gravel

Life Cycle Inventory:
Gravel

Product Scope:
Cradle to gate, excludes mixing and pouring impacts

Transportation Distance:
By barge: 5 km
By container ship: 12 km
By rail: 29 km
By truck: 37 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
EU-28: Gravel 2/32 ts (2017)

LCI Data (continued)

Cold formed structural steel **16,600.1 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	4,764.9 kg (60 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	3,046.4 kg (60 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	1,116.1 kg (60 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	6,918.6 kg (60 yrs)
WSP_Schematic-Exterior_12"	754.1 kg (60 yrs)

Used in the following Tally entries:
Steel, C-stud metal framing

Description:
Cold-rolled or formed structural steel, such as used in steel studs.

Life Cycle Inventory:
100% Cold rolled steel

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 431 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 16% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Steel finished cold rolled coil worldsteel (2007)
GLO: Steel sheet stamping and bending (5% loss) ts (2017)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
GLO: Value of scrap worldsteel (2014)

Door frame, aluminum, powder-coated, no door **191.2 kg**

Used in the following Revit families:

Door Panel_Double Casement	41.6 kg (50 yrs)
Door-Curtain-Wall-Single-Glass	68.0 kg (50 yrs)
door-eco1602_faceofwallmount_300-series-cookson (2)	65.3 kg (50 yrs)
Revolving Door 3	16.3 kg (50 yrs)

Used in the following Tally entries:
Door frame, aluminum

Description:
Aluminum door frame

Life Cycle Inventory:
94% Aluminum
6% Powder coat (by weight)

Product Scope:
Cradle to gate
excludes hardware, casing, sealant

Transportation Distance:
By truck: 568 km

End-of-Life Scope:
95% aluminum recovered
5% aluminum landfilled (inert material)

Module D Scope:
Product has 36.4% scrap input while remainder is processed and credited as avoided burden

LCI Source:
DE: Aluminium frame profile, powder coated (EN15804 A1-A3) ts (2017)
modified with: RNA: Aluminum extrusion, mill finish - AEC ts (2015)
DE: Top coat powder (aluminium) (EN15804 A1-A3) ts (2017)
RNA: Secondary Aluminum Ingot AA/ts (2010)
RNA: Primary Aluminum Ingot AA/ts (2010)

Expanded slag **191,981.5 kg**

Used in the following Revit families:

_TT-CL-Concrete Rectangular	738.0 kg (60 yrs)
24" Foundation Slab	1,297.6 kg (60 yrs)
36" Foundation Slab	5,827.5 kg (60 yrs)
4.5" LW Concrete 3" Metal Deck	110,476.4 kg (60 yrs)
6" Concrete Slab	25,369.9 kg (60 yrs)
8" Concrete Slab	3,414.1 kg (60 yrs)
Concrete - 12"	682.4 kg (60 yrs)
Concrete-Rectangular Beam	13,830.9 kg (60 yrs)
Footing-Rectangular	30,344.8 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Concrete mix ingredient: Expanded slag

Life Cycle Inventory:
Slag

Product Scope:
Cradle to gate, excludes mixing and pouring impacts

Transportation Distance:
By barge: 41 km
By container ship: 625 km
By rail: 10 km
By truck: 54 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
DE: Slag-tap granulate (EN15804 A1-A3) ts (2017)

Fasteners, aluminum (anodized) **2.2 kg**

Used in the following Revit families:

Door-Curtain-Wall-Single-Glass	1.0 kg (50 yrs)
door-eco1602_faceofwallmount_300-series-cookson (2)	1.0 kg (50 yrs)
Revolving Door 3	0.2 kg (50 yrs)

Used in the following Tally entries:
Door frame, aluminum

Description:
Extruded and anodized aluminum part, appropriate for use as fasteners and specialized hardware (bolts, rails, clips, etc.). Data based on industry-wide EPD for anodized aluminum from the Aluminum Extruders Council (EPD ID 11240237.101.1).

Life Cycle Inventory:
100% Aluminum

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1001 km

End-of-Life Scope:
95% Recovered
5% Landfilled (inert material)

Module D Scope:
Product has 34.5% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Aluminum extrusion, anodized - AEC (A1-A3) ts-EPD (2015) [EPD]
RNA: Primary Aluminum Ingot AA/ts (2010) [EPD]
RNA: Secondary Aluminum Ingot AA/ts (2010) [EPD]

Fasteners, stainless steel **794.6 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	90.9 kg (50 yrs)
Door Panel_Double Casement	0.9 kg (50 yrs)
WSP - Exterior PH Screen_NBBJ Calcs 2	398.0 kg (60 yrs)
WSP - GFRC_NBBJ Calcs	36.4 kg (50 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	60.1 kg (50 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	21.6 kg (50 yrs)

LCI Data (continued)

WSP - Type 6 GFRC_NBBJ Calcs	138.9 kg (50 yrs)
WSP - Type 7 GFRC in CW_NBBJ Calcs 2	33.2 kg (50 yrs)
WSP_Schematic-Exterior_12"	14.6 kg (50 yrs)

Used in the following Tally entries:
Door frame, aluminum
Insulated metal wall panel
Metal wall panels, plate

Description:
Stainless steel part, appropriate for use as fasteners and specialized hardware (bolts, rails, clips, etc.). Data based on industry-wide EPDs for primary and secondary metal from the World Steel Association.

Life Cycle Inventory:
100% Stainless steel

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1001 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 58% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RER: Stainless steel Quarto plate (304) Eurofer (2010)
GLO: Steel turning ts (2017)
US: Electricity grid mix ts (2014)
RER: Stainless steel flat product (304) - value of scrap Eurofer (2010)

Fiberglass mat gypsum sheathing board **129,170.9 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	16,379.6 kg (60 yrs)
Generic - 8"	54,469.4 kg (60 yrs)
WSP - GFRC_NBBJ Calcs	3,277.8 kg (60 yrs)
WSP - PVC Canopy_NBBJ Calcs 2	3,362.6 kg (60 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	10,828.4 kg (60 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	3,902.1 kg (60 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	25,034.1 kg (60 yrs)
WSP - Type 7 GFRC in CW_NBBJ Calcs 2	2,993.4 kg (60 yrs)
WSP - Wood Canopy_NBBJ Calcs	6,293.5 kg (60 yrs)
WSP_Schematic-Exterior_12"	2,630.0 kg (60 yrs)

Used in the following Tally entries:
Fiberglass mat gypsum sheathing

Description:
Fiberglass treated gypsum sheathing product appropriate for use in high-moisture environments.

Life Cycle Inventory:
92% Gypsum
8% Fiberglass mat

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
DE: Gypsum plaster board (Moisture resistant) (EN15804 A1-A3) ts (2017)
US: Fiberglass Duct Board NAIMA (2007)

Fireproofing, cementitious, by area **229,660.5 kg**

Used in the following Revit families:

Concrete-Rectangular Beam	190,186.6 kg (60 yrs)
WSP_W-Wide Flange-Columns	39,473.8 kg (60 yrs)

Used in the following Tally entries:
Steel, W section (wide flange shape)

Description:
Cementitious fireproofing spray for structural steel and concrete. Default application rate is 1" thickness.

Life Cycle Inventory:
65% Cement
15% Vermiculite
10% MICA
10% Calcium carbonate

Product Scope:
Cradle to gate, includes electricity estimate for application but neglects any direct emissions at installation

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
US: Portland cement PCA/ts (2014)
GLO: Vermiculite ts (2017)
US: Silica sand (Excavation and processing) ts (2017)
US: Limestone flour (5mm) ts (2017)
US: Electricity grid mix ts (2014)

Fluoropolymer coating, metal stock **1,104.1 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	200.1 kg (60 yrs)
Rectangular Mullion	87.0 kg (60 yrs)
WSP - Exterior PH Screen_NBBJ Calcs 2	145.8 kg (60 yrs)
WSP - GFRC_NBBJ Calcs	80.1 kg (60 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	132.3 kg (60 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	47.7 kg (60 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	305.8 kg (60 yrs)
WSP - Type 7 GFRC in CW_NBBJ Calcs 2	73.1 kg (60 yrs)
WSP_Schematic-Exterior_12"	32.1 kg (60 yrs)

Used in the following Tally entries:
Aluminum mullion, custom finish
Insulated metal wall panel
Metal wall panels, plate

Description:
Standard fluoropolymer coating for metals. This entry is used as a part of the larger MCA EPD for Roll Formed Steel Panels (EPD ID 13CA27321.101.1).

Life Cycle Inventory:
100% Fluoropolymer coating

Product Scope:
Cradle to gate, including application

Transportation Distance:
N/A

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
US: Coil coating MCA (2010)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)

Fly ash **85,398.7 kg**

Used in the following Revit families:

_TT-CL-Concrete Rectangular	328.3 kg (60 yrs)
24" Foundation Slab	577.2 kg (60 yrs)
36" Foundation Slab	2,592.2 kg (60 yrs)
4.5" LW Concrete 3" Metal Deck	49,142.9 kg (60 yrs)
6" Concrete Slab	11,285.2 kg (60 yrs)
8" Concrete Slab	1,518.7 kg (60 yrs)
Concrete - 12"	303.6 kg (60 yrs)
Concrete-Rectangular Beam	6,152.4 kg (60 yrs)
Footing-Rectangular	13,498.2 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Concrete mix ingredient: Fly ash
50 pcf

LCI Data (continued)

Life Cycle Inventory:
Fly ash

Product Scope:
Cradle to gate, excludes mixing and pouring impacts

Transportation Distance:
By container ship: 47 km
By rail: 49 km
By truck: 99 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
DE: Fly ash (EN15804 A1-A3) ts (2017)

Galvanized steel decking **141,572.9 kg**

Used in the following Revit families:

4.5" LW Concrete 3" Metal Deck	141,572.9 kg (60 yrs)

Used in the following Tally entries:
Steel, deck

Description:
Hot dip galvanized steel roof decking, corrugated profile. Default roof decking is galvanized to G90 standards, coated on both sides of 20 gauge steel deck, roll formed and precut.

Life Cycle Inventory:
100% Steel, hot dip galvanized

Product Scope:
Cradle to gate for deck only.

Transportation Distance:
By truck: 431 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 44% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Steel hot dip galvanized worldsteel (2007)
GLO: Steel sheet stamping and bending (5% loss) ts (2014)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
US: Metal roll forming M CA (2010)
GLO: Value of scrap worldsteel (2014)

Galvanized steel support **16,600.5 kg**

Used in the following Revit families:

WSP - Type 10 Architectural Concrete_NBBJ Calcs	3,742.8 kg (60 yrs)
WSP - Type 10 Stone Cladding_NBBJ Calcs	11,228.3 kg (60 yrs)
WSP - Wood Canopy_NBBJ Calcs	1,629.5 kg (50 yrs)

Used in the following Tally entries:
Glass fiber reinforced concrete (GFRC) panel
Wood rainscreen, hardwood

Description:
Hot dipped galvanized steel profile, for use with cladding systems.

Life Cycle Inventory:
100% Steel, hot dip galvanized

Product Scope:
Cradle to gate for deck only.

Transportation Distance:
By truck: 431 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 44% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RNA: Steel hot dip galvanized worldsteel (2007)
GLO: Steel sheet stamping and bending (5% loss) ts (2014)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
US: Metal roll forming M CA (2010)
GLO: Value of scrap worldsteel (2014)

GFRC **0.0 kg**

Used in the following Revit families:

WSP - Type 10 Architectural Concrete_NBBJ Calcs	0.0 kg (60 yrs)
WSP - Type 10 Stone Cladding_NBBJ Calcs	0.0 kg (60 yrs)

Used in the following Tally entries:
Glass fiber reinforced concrete (GFRC) panel

Description:
Glass fiber reinforced concrete (GFRC), applied manually. Appropriate for exterior facade panels and precast elements.

Life Cycle Inventory:
12% Cement
5% Glass fibers
39% Gravel
38% Sand
7% Water

Product Scope:
Cradle to gate, excludes mortar
Anchors, ties, and metal accessories outside of scope (<1% mass)

Transportation Distance:
By truck: 24 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
US: Portland cement PCA/ts (2014)
DE: Gravel (Grain size 2/32) (EN15804 A1-A3) ts (2017)
US: Tap water from groundwater ts (2017)
US: Silica sand (Excavation and processing) ts (2017)
US: Glass fibres ts (2017)

Glazing, double, 3 mm, laminated safety glass **1,065.3 kg**

Used in the following Revit families:

Door Panel_Double Casement	438.1 kg (35 yrs)
Door-Curtain-Wall-Single-Glass	412.1 kg (35 yrs)
Revolving Door 3	215.0 kg (35 yrs)

Used in the following Tally entries:
Door, exterior, glass

Description:
Laminated glass, 2 lites 3 mm thick, inclusive of polyvinyl butyral. Note: this entry is appropriate for clear or tinted glass.

Life Cycle Inventory:
3% PVB film (30% adipic acid
70% PVB)
97% Glass

Product Scope:
Cradle to gate, excluding sealant

Transportation Distance:
By truck: 940 km

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
DE: Window glass simple (EN15804 A1-A3) ts (2017)
DE: Adipic acid from cyclohexane ts (2017)
DE: Polyvinyl Butyral Granulate (PVB) ts (2017)

LCI Data (continued)

GLO: Plastic film (PE, PP, PVC) ts (2017)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)
US: Lubricants at refinery ts (2014)

Glazing, monolithic sheet, tempered **60,040.9 kg**

Used in the following Revit families:

System Panel	21,810.0 kg (40 yrs†)
WSP - Type 8 CW_NBBJ Calcs	38,230.8 kg (40 yrs)

Used in the following Tally entries:
Glazing, custom IGU

Description:
Tempered float glass. Note: this entry is appropriate for clear or tinted glass. Default thickness is 3 mm.

Life Cycle Inventory:
Tempered glazing

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 940 km

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
DE: Window glass simple (EN15804 A1-A3) ts (2017)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)

Hard maple lumber, 1 inch **12,806.5 kg**

Used in the following Revit families:

WSP - Wood Canopy_NBBJ Calcs	12,806.5 kg (50 yrs)

Used in the following Tally entries:
Wood rainscreen, hardwood

Description:
Kiln-dried Hard Maple (sugar, rock, or black maple) hardwood lumber of 1" nominal thickness as produced in the United States, focusing on the main production technologies. Maple is frequently used for moulding, flooring, furniture, and millwork. Link for interactive LCA data tool is provided at the link listed as "EPD Information" full LCA report is available at http://naturespackaging.org/wp-content/uploads/2016/02/LifeCycleAssessment-Lumber.pdf.

Life Cycle Inventory:
100% Hard Maple

Product Scope:
Cradle to gate, uncoated

Transportation Distance:
By truck: 383 km

End-of-Life Scope:
14.5% Recovered
22% Incinerated with energy recovery
63.5% Landfilled (wood product waste)

Module D Scope:
Recovered wood products credited as avoided burden.

LCI Source:
US: Hard Maple lumber, 1 inch (705 kg/m^3), kiln-dried ts/AHEC (2017)

EPD Source:
Information

EPD Designation Holder:
American Hardwood Export Council (AHEC)

Hardware, stainless steel **93.8 kg**

Used in the following Revit families:

_Schematic-Swinging	6.0 kg (60 yrs)
B2050-Exterior_Swinging	10.6 kg (60 yrs)
Door Panel_Double Casement	31.8 kg (60 yrs)
Door-Curtain-Wall-Single-Glass	29.9 kg (60 yrs)
Revolving Door 3	15.6 kg (60 yrs)

Used in the following Tally entries:
Door, exterior, aluminum
Door, exterior, glass
Door, exterior, steel

Description:
Finished, cast stainless steel, applicable for door, window or other accessory hardware

Life Cycle Inventory:
100% Stainless steel

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1001 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 58% scrap input while remainder is processed and credited as avoided burden

LCI Source:
RER: Stainless steel Quarto plate (304) Eurofer (2010)
DE: Steel cast part machining ts (2017)
US: Electricity grid mix ts (2014)
RER: Stainless steel flat product (304) - value of scrap Eurofer (2010)

Hollow door, exterior, steel, powder-coated **221.1 kg**

Used in the following Revit families:

_Schematic-Swinging	110.6 kg (30 yrs)
B2050-Exterior_Swinging	110.6 kg (30 yrs)

Used in the following Tally entries:
Door, exterior, steel

Description:
Hollow door, exterior, steel, 18 ga. inclusive of EPS insulation, no frame

Life Cycle Inventory:
5% Extruded polystyrene
95% Powder-coated steel

Product Scope:
Cradle to gate, excludes assembly, frame, hardware, and adhesives

Transportation Distance:
By truck: 568 km

End-of-Life Scope:
70% Steel recovered
30% Steel landfilled (inert material)
100% Insulation landfilled (plastic material)
100% Core landfilled (biodegradable material)

Module D Scope:
Product has 15% scrap input while remainder is processed and credited as avoided burden.

LCI Source:
DE: Expanded Polystyrene (PS 25) (EN15804 A1-A3) ts (2017)
GLO: Steel sheet stamping and bending (5% loss) ts (2017)
GLO: Value of scrap worldsteel (2014)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
RNA: Steel finished cold rolled coil worldsteel (2007)
DE: Top coat powder (aluminium) (EN15804 A1-A3) ts (2017)

Hot rolled structural steel, AISC - EPD **533,615.2 kg**

Used in the following Revit families:

Concrete-Rectangular Beam	382,581.2 kg (60 yrs)
WSP_W-Wide Flange-Columns	151,034.0 kg (60 yrs)

Used in the following Tally entries:
Steel, W section (wide flange shape)

Description:
Hot rolled structural steel. Industry-wide EPD from the American Institute of Steel Construction.

LCI Data (continued)

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 431 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 100% scrap input, burden reflects difference between recovered material and scrap input

LCI Source:
RNA: Hot rolled structural steel sections AISC (2010)

EPD Source:
4786979051.102.1

EPD Designation Holder:
American Institute of Steel Construction

EPD Program Operator:
UL Environment

EPD Expiration:
3/31/2021

IGU spacer **444.4 kg**

Used in the following Revit families:

System Panel	104.6 kg (40 yrs)
WSP - Type 8 CW_NBBJ Calcs	339.7 kg (40 yrs)

Used in the following Tally entries:
Glazing, custom IGU

Description:
Insulating glass unit (IGU) spacer and gasket used to separate two or more plies of glass. Density value assumes a 1/2" (13/2 mm) spacer.

Life Cycle Inventory:
70% Polybutadiene rubber spacer
30% Nitrile rubber spacer

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 940 km

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
DE: Polybutadiene rubber ts (2017)
DE: Nitrile butadiene rubber, incl. MMA (NBR-speciality) ts (2017)

Insulated metal panel (IMP), Metl-Span, CF42 - EPD **6,105.3 kg**

Used in the following Revit families:

WSP - Exterior PH Screen_NBBJ Calcs 2	6,105.3 kg (60 yrs)

Used in the following Tally entries:
Insulated metal wall panel

Description:
Metl-Span CF42 insulated metal panel (IMP) made of two steel sheets glued to a polyurethane core, cut to shape and size as required. Appropriate for exterior wall applications. EPD representative of steel-faced product with a 3 inch thickness. EPD representative of manufacturing conditions in the US.

Life Cycle Inventory:
For information and quantities, see EPD.

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 657 km

End-of-Life Scope:
88% of steel scrap is assumed to be recovered
remainder of materials to landfill
does not include disposal of installation components

Module D Scope:
All recovered metal is processed and credited as avoided burden

LCI Source:
US: Insulated metal panel (IMP), CF wall panel - Metl-Span PE-EPD (2011)
US: Disposal of insulated metal panels (IMP), CF wall panel - Metl-Span PE-EPD (2011)

EPD Source:
4788189841.102.1

EPD Designation Holder:
Metl-Span

EPD Program Operator:
UL Environment

EPD Expiration:
7/1/2024

Low-e coating (for glazing) **500.1 kg**

Used in the following Revit families:

System Panel	117.8 kg (40 yrs)
WSP - Type 8 CW_NBBJ Calcs	382.3 kg (40 yrs)

Used in the following Tally entries:
Glazing, custom IGU

Description:
Low-e coating for application to glazing lite

Life Cycle Inventory:
Ferro chrome mix
Nickel mix
Tin
Silver mix

Product Scope:
Cradle to gate

Transportation Distance:
N/A

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
Low-e coating from DE: Double glazing unit (EN15804 A1-A3) ts (2017)

Mineral wool, high density, NAIMA - EPD **41,331.5 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	8,068.7 kg (60 yrs)
WSP - GFRC_NBBJ Calcs	3,229.3 kg (60 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	5,334.1 kg (60 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	1,922.2 kg (60 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	12,331.9 kg (60 yrs)
WSP - Type 7 GFRC in CW_NBBJ Calcs 2	2,949.2 kg (60 yrs)
WSP - Wood Canopy_NBBJ Calcs	6,200.4 kg (60 yrs)
WSP_Schematic-Exterior_12"	1,295.6 kg (60 yrs)

Used in the following Tally entries:
Mineral wool, board, generic

Description:
Rock board, heavy density. Industry-wide EPD from the North America Insulation Manufacturers Association. EPD representative of conditions in North America.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
US: Rock board insulation (heavy density) NAIMA (2007)

EPD Source:
4786060412.102.1

EPD Designation Holder:
North American Insulation Manufacturer's Association (NAIMA)

LCI Data (continued)

EPD Program Operator:
UL Environment

EPD Expiration:
11/8/2018

Mortar type S **0.0 kg**

Used in the following Revit families:
WSP - Type 10 Stone Cladding_NBBJ Calcs 0.0 kg (60 yrs)

Used in the following Tally entries:
Stone veneer wall, granite, grouted

Description:
Mortar Type S (medium strength mortar) for use with masonry walls and flooring.

Life Cycle Inventory:
Dried mix: 78% sand
17% cement
4% calcium hydroxide
1% limestone (12% water evaporates on drying)

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
DE: Siliceous sand (grain size 0/2) ts (2017)
DE: Cement (CEM I 32.5) (EN15804 A1-A3) ts (2017)
DE: Gravel (Grain size 2/32) (EN15804 A1-A3) ts (2017)
US: Tap water from groundwater ts (2017)

Overhead door closer, aluminum **80.9 kg**

Used in the following Revit families:
_Schematic-Swinging 6.2 kg (30 yrs)
B2050-Exterior_Swinging 10.9 kg (30 yrs)
Door Panel_Double Casement 32.8 kg (30 yrs)
Door-Curtain-Wall-Single-Glass 30.9 kg (30 yrs)

Used in the following Tally entries:
Door, exterior, aluminum
Door, exterior, glass
Door, exterior, steel

Description:
Aluminum overhead door closer. Data based on product-specific EPD from FV S+B.

Life Cycle Inventory:
See EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1001 km

End-of-Life Scope:
95% Recovered
5% Landfilled (inert material)

Module D Scope:
Product has 0% scrap input, burden reflects difference between recovered material and scrap input

LCI Source:
DE: Overhead door closer aluminum - FV S+B PE-EPD (2009)
RNA: Secondary Aluminum Ingot AA/ts (2010)
RNA: Primary Aluminium Ingot AA/ts (2010)

EPD Source:
EPD-ARG-20160183-IBG1-EN

EPD Designation Holder:
European Federation of Associations of Lock and Builders Hardware Manufacturers (ARGE)

EPD Program Operator:
Institut Bauen and Umwelt (IBU)

EPD Expiration:
9/13/2021

PIR rigid foam insulation, roof, R=15, PIMA - EPD **21,295.1 kg**

Used in the following Revit families:
Generic - 8" 20,056.9 kg (60 yrs)
WSP - PVC Canopy_NBBJ Calcs 2 1,238.2 kg (60 yrs)

Used in the following Tally entries:
Polyisocyanurate (PIR), board

Description:
Polyisocyanurate rigid foam roof insulation with glass-fiber reinforced facers, R-value of 15, 2.6" thickness (66 mm). Industry-wide EPD from the Polyisocyanurate Insulation Manufacturers Association.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 250 km

End-of-Life Scope:
100% Landfilled (plastic waste)

LCI Source:
RNA: Polyisocyanurate rigid foam board roof insulation, R=15 (A1-A3) ts-EPD (2013)

EPD Source:
EPD10043

EPD Designation Holder:
Polyisocyanurate Insulation Manufacturers Association

EPD Program Operator:
NSF International

EPD Expiration:
2/6/2020

Polyethelene sheet vapor barrier (HDPE) **810.2 kg**

Used in the following Revit families:
6" Concrete Slab 810.2 kg (60 yrs)

Used in the following Tally entries:
Polyethelene sheet vapor barrier (HDPE)

Description:
Polyethelene sheet vapor barrier (HDPE) membrane
entry exclusive of adhesive or other co-products

Life Cycle Inventory:
100% Polyethylene film

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1299 km

End-of-Life Scope:
10.5% Recycled into HDPE
89.5% Landiflled (plastic waste)

Module D Scope:
Avoided burden credit includes processing

LCI Source:
US: Polyethylene High Density Granulate (PE-HD) ts (2017)
GLO: Plastic Film (PE, PP, PVC) ts (2017)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)
US: Lubricants at refinery ts (2014)

LCI Data (continued)

Porcelain ceramic tile, glazed **8,406.9 kg**

Used in the following Revit families:

Site - Pavement - Wood - Roof Decking	8,406.9 kg (50 yrs)

Used in the following Tally entries:
Porcelain tile

Description:
Porcelain ceramic tile, glazed

Life Cycle Inventory:
100% Ceramic tile, glazed

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1250 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
DE: Stoneware tiles, glazed (EN15804 A1-A3) ts (2017)

Portland cement, PCA - EPD **1,251,189.9 kg**

Used in the following Revit families:

_TT-CL-Concrete Rectangular	4,809.6 kg (60 yrs)
24" Foundation Slab	8,456.5 kg (60 yrs)
36" Foundation Slab	37,979.3 kg (60 yrs)
4.5" LW Concrete 3" Metal Deck	720,001.2 kg (60 yrs)
6" Concrete Slab	165,341.7 kg (60 yrs)
8" Concrete Slab	22,250.8 kg (60 yrs)
Concrete - 12"	4,447.5 kg (60 yrs)
Concrete-Rectangular Beam	90,139.1 kg (60 yrs)
Footing-Rectangular	197,764.2 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Concrete mix ingredient: portland cement. Data is based on Industry-wide EPD from the Portland Cement Association.

Life Cycle Inventory:
For information and quantities, see EPD

Product Scope:
Cradle to gate

Transportation Distance:
By barge: 67 km
By container ship: 399 km
By rail: 72 km
By truck: 120 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
US: Portland cement PCA/ts (2014)

EPD Source:
EPD 035

EPD Designation Holder:
Portland Cement Association

EPD Program Operator:
ASTM International

EPD Expiration:
5/31/2021

Powder coating, metal stock **48.9 kg**

Used in the following Revit families:

door-eco1602_faceofwallmount_300-series-cookson (2)	48.9 kg (50 yrs)

Used in the following Tally entries:
Aluminum, formed

Description:
Powder coating, for metal stock

Life Cycle Inventory:
100% Powder coating

Product Scope:
Cradle to gate, including application

Transportation Distance:
N/A

End-of-Life Scope:
100% Landfilled (inert waste)

LCI Source:
DE: Application top coat powder (aluminium) ts (2017)
DE: Coating powder (industry, outside, red) ts (2017)

PVC membrane, sheet **23,645.4 kg**

Used in the following Revit families:

Generic - 8"	22,270.6 kg (20 yrs)
WSP - PVC Canopy_NBBJ Calcs 2	1,374.8 kg (20 yrs)

Used in the following Tally entries:
PVC roofing membrane, sheet

Description:
PVC roofing membrane

Life Cycle Inventory:
100% PVC membrane

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1299 km

End-of-Life Scope:
100% Landfilled (plastic waste)

LCI Source:
US: Polyvinylchloride granulate (Suspension, S-PVC) ts (2017)
GLO: Plastic Film (PE, PP, PVC) ts (2017)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)
US: Lubricants at refinery ts (2014)

Sand **2,916,464.2 kg**

Used in the following Revit families:

_TT-CL-Concrete Rectangular	11,210.9 kg (60 yrs)
24" Foundation Slab	19,711.7 kg (60 yrs)
36" Foundation Slab	88,528.0 kg (60 yrs)
4.5" LW Concrete 3" Metal Deck	1,678,288.4 kg (60 yrs)
6" Concrete Slab	385,403.6 kg (60 yrs)
8" Concrete Slab	51,865.6 kg (60 yrs)
Concrete - 12"	10,366.9 kg (60 yrs)
Concrete-Rectangular Beam	210,110.0 kg (60 yrs)
Footing-Rectangular	460,979.0 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Concrete mix ingredient: Sand

Life Cycle Inventory:
Sand

Product Scope:
Cradle to gate, excludes mixing and pouring impacts

Transportation Distance:
By barge: 4 km
By container ship: 24 km
By rail: 14 km
By truck: 37 km

LCI Data (continued)

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
US: Silica sand (Excavation and processing) ts (2017)

Self adhering flashing membrane, 40 mil **15,174.8 kg**

Used in the following Revit families:

_Schematic-Exterior_10"	1,265.7 kg (40 yrs)
Generic - 8"	8,418.0 kg (40 yrs)
WSP - GFRC_NBBJ Calcs	506.6 kg (40 yrs)
WSP - Type 10 Architectural Concrete_NBBJ Calcs	184.0 kg (40 yrs)
WSP - Type 10 Stone Cladding_NBBJ Calcs	551.9 kg (40 yrs)
WSP - Type 13 Custom Metal_NBBJ Calcs	836.7 kg (40 yrs)
WSP - Type 14 Precast Panel_NBBJ Calcs 2	301.5 kg (40 yrs)
WSP - Type 6 GFRC_NBBJ Calcs	1,934.5 kg (40 yrs)
WSP - Wood Canopy_NBBJ Calcs	972.6 kg (40 yrs)
WSP_Schematic-Exterior_12"	203.2 kg (40 yrs)

Used in the following Tally entries:
Self adhering membrane

Description:
40 mil (1 mm) Asphalt rubber sheet inclusive of polyethelyne backing

Life Cycle Inventory:
82% Rubberized asphalt (25% SBS)
18% Polyethylene HD

Product Scope:
Cradle to gate for materials only, neglects manufacturing requirements

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
100% Landfilled (plastic waste)

LCI Source:
US: Styrene-butadiene rubber (SBR) ts (2017)
DE: Bitumen cold adhesive (EN15804 A1-A3) ts (2017)
US: Polyethylene High Density Granulate (PE-HD) ts (2017)
GLO: Plastic Film (PE, PP, PVC) ts (2017)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)
US: Lubricants at refinery ts (2014)

Self-adhering, polymer-modified asphalt sheet underlayment **1,487.7 kg**

Used in the following Revit families:

WSP - PVC Canopy_NBBJ Calcs 2	1,487.7 kg (40 yrs)

Used in the following Tally entries:
Self-adhering, polymer-modified asphalt sheet underlayment

Description:
Self-adhering, polymer-modified asphalt sheet underlayment.

Life Cycle Inventory:
52% Bitumen
14% Slag
12% Glass fleece
12% Limestone
4% Sand
3% SBR
3% Titanium dioxide
1% PE film

Product Scope:
Cradle to gate, excludes self-adhering materials and polymers

Transportation Distance:
By truck: 172 km

End-of-Life Scope:
100% Landfilled (inert material)

LCI Source:
US: Bitumen at refinery ts (2013)
DE: Glass fibre fleece (21% UF resin) (estimation) ts (2012)
US: Silica sand (flour) ts (2017)
US: Limestone flour (5mm) ts (2017)
US: Styrene-butadiene rubber (SBR) ts (2017)
US: Polyethylene film (LDPE/PE-LD) ts (2017)
US: Titanium dioxide pigment (sulphate process) ts (2017)

Spandrel, glass, insulated (2" core) **14,688.2 kg**

Used in the following Revit families:

WSP - Type 9 CW Spandrel_NBBJ Calcs	14,688.2 kg (30 yrs)

Used in the following Tally entries:
Spandrel, glass, insulated

Description:
Insulated glass spandrel panel of 1/8" thick plate glass, 2" air gap, and 2" high density fiberglass insulation with 24 guage steel backing

Life Cycle Inventory:
19% Fiberglass
63% Glass
18% Steel

Product Scope:
Cradle to gate
Excludes sealant, assembly, and any substrates

Transportation Distance:
By truck: 940 km

End-of-Life Scope:
70% Steel recovered (product has 7.14% scrap input while remainder is processed and credited as avoided burden)
30% Steel landfilled (inert material)
100% Insulation and core landfilled (inert material)

Module D Scope:
Product has 3.1% steel scrap input while remainder is processed and credited as avoided burden

LCI Source:
GLO: Steel sheet stamping and bending (5% loss) ts (2017)
RNA: Steel finished cold rolled coil worldsteel (2011)
GLO: Value of scrap worldsteel (2014)
US: Electricity grid mix ts (2014)
US: Lubricants at refinery ts (2014)
GLO: Compressed air 7 bar (medium power consumption) ts (2014)
DE: Window glass simple (EN15804 A1-A3) ts (2017)
US: Fiberglass Duct Board NAIMA (2007)

Steel door hinge **62.9 kg**

Used in the following Revit families:

_Schematic-Swinging	4.9 kg (30 yrs)
B2050-Exterior_Swinging	8.5 kg (30 yrs)
Door Panel_Double Casement	25.5 kg (30 yrs)
Door-Curtain-Wall-Single-Glass	24.0 kg (30 yrs)

Used in the following Tally entries:
Door, exterior, aluminum
Door, exterior, glass
Door, exterior, steel

Description:
Steel and stainless steel door hinge. Data based on product-specific EPD from FV S+B.

Life Cycle Inventory:
See EPD

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 1001 km

End-of-Life Scope:
70% Recovered
30% Landfilled (inert material)

Module D Scope:
Product has 0% scrap input, burden reflects difference between recovered material and scrap input

LCI Source:
DE: Door hinge - Object hinge - FV S+B PE-EPD (2009)
GLO: Value of scrap worldsteel (2014)

LCI Data (continued)

EPD Source:
EPD-ARG-20160193-IBG2-EN

EPD Designation Holder:
European Federation of Associations of Lock and Builders Hardware Manufacturers (ARGE)

EPD Program Operator:
Institut Bauen and Umwelt (IBU)

EPD Expiration:
9/13/2021

Steel, reinforcing rod **196,337.5 kg**

Used in the following Revit families:

_TT-CL-Concrete Rectangular	1,800.9 kg (60 yrs)
24" Foundation Slab	5,972.6 kg (60 yrs)
36" Foundation Slab	26,823.6 kg (60 yrs)
4.5" LW Concrete 3" Metal Deck	67,339.7 kg (60 yrs)
6" Concrete Slab	16,114.3 kg (60 yrs)
8" Concrete Slab	2,387.5 kg (60 yrs)
Concrete - 12"	1,047.0 kg (60 yrs)
Concrete-Rectangular Beam	28,293.7 kg (60 yrs)
Footing-Rectangular	46,558.3 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Common unfinished tempered steel rod suitable for structural reinforcement (rebar)

Life Cycle Inventory:
100% Steel rebar

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 431 km

End-of-Life Scope:
70% Recovered
30% Landfilled (inert material)

Module D Scope:
Product has a 16.4% scrap input while remainder is processed and credited as avoided burden.

LCI Source:
GLO: Steel rebar worldsteel (2014)

Steel, welded wire mesh **42,207.4 kg**

Used in the following Revit families:

4.5" LW Concrete 3" Metal Deck	30,296.3 kg (60 yrs)
6" Concrete Slab	11,911.2 kg (60 yrs)

Used in the following Tally entries:
Steel, welded wire mesh

Description:
Steel rods further processed into wires appropriate for welded wire mesh reinforcement

Life Cycle Inventory:
100% Carbon steel wire

Product Scope:
Cradle to gate

Transportation Distance:
By truck: 431 km

End-of-Life Scope:
98% Recovered
2% Landfilled (inert material)

Module D Scope:
Product has 16% scrap input while remainder is processed and credited as avoided burden

LCI Source:
GLO: Steel wire rod worldsteel (2014)
DE: Copper wire (0.6 mm) ts (2017)
US: Electricity grid mix ts (2014)
US: Thermal energy from natural gas ts (2014)

Stone slab, granite **35,735.2 kg**

Used in the following Revit families:

WSP - Type 10 Stone Cladding_NBBJ Calcs	35,735.2 kg (60 yrs)

Used in the following Tally entries:
Stone veneer wall, granite, grouted

Description:
Cut granite stone slab, such as for use in a veneer wall.

Life Cycle Inventory:
100% Granite

Product Scope:
Cradle to gate
excludes mortar
anchors, ties, and metal accessories outside of scope (<1% mass)

Transportation Distance:
By truck: 217 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
DE: Natural stone slab, rigid, facade (EN15804 A1-A3) ts (2017)

Structural concrete, 3000 psi, 0% fly ash and slag **20,576.7 kg**

Used in the following Revit families:

WSP - Type 10 Architectural Concrete_NBBJ Calcs	20,576.7 kg (60 yrs)

Used in the following Tally entries:
Precast concrete nonstructural panel

Description:
Structural concrete, 3000 psi, 0% fly ash and slag. Mix design matches National Ready-Mix Concrete Association (NRMCA) Industry-wide EPD.

Life Cycle Inventory:
Coarse aggregate: 44%, Sand: 36%, Portland cement PCA - EPD: 13%, Water: 7%, Admixture: <1%

Product Scope:
Cradle to gate
Anchors, ties, and metal accessories outside of scope (<1% mass)

Transportation Distance:
By truck: 24 km

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
US: Portland cement PCA/ts (2014)
DE: Pumice gravel (grain size 4/16) (EN15804 A1-A3) ts (2017)
DE: Gravel (Grain size 2/32) (EN15804 A1-A3) s (2017)
DE: Fly ash (EN15804 A1-A3) ts (2017)
DE: Slag-tap granulate (EN15804 A1-A3) ts (2017)
DE: Expanded clay (EN15804 A1-A3) ts (2017)
DE: alcium nitrate ts (2017)
DE: Sodium ligninsulfonate ts (2017)
DE: Sodium naphtalene sulfonate [estimated] ts (2017)
US: Sodium hydroxide (caustic soda) ix (100%) ts (2017)
US: Colophony (rosin, refined) from CN pine gum rosin ts (2017)
US: Tap water from groundwater ts (2017)
US: Electricity grid mix s (2014)
US: Natural gas mix ts (2014)
US: Diesel mix at filling station (100% fossil) ts (2014)
US: Liquefied Petroleum Gas (LPG) (70% propane
30% utane) ts (2014)
US: Light fuel oil at refinery ts (2014)

LCI Data (continued)

Water **231,701.8 kg**

Used in the following Revit families:

_TT-CL-Concrete Rectangular	890.7 kg (60 yrs)
24" Foundation Slab	1,566.0 kg (60 yrs)
36" Foundation Slab	7,033.2 kg (60 yrs)
4.5" LW Concrete 3" Metal Deck	133,333.5 kg (60 yrs)
6" Concrete Slab	30,618.8 kg (60 yrs)
8" Concrete Slab	4,120.5 kg (60 yrs)
Concrete - 12"	823.6 kg (60 yrs)
Concrete-Rectangular Beam	16,692.4 kg (60 yrs)
Footing-Rectangular	36,623.0 kg (60 yrs)

Used in the following Tally entries:
Cast-in-place concrete, custom mix

Description:
Concrete mix ingredient: Tap water

Life Cycle Inventory:
Tap water

Product Scope:
Cradle to gate, excludes mixing and pouring impacts

Transportation Distance:
N/A

End-of-Life Scope:
55% Recycled into coarse aggregate
45% Landfilled (inert material)

Module D Scope:
Avoided burden credit for coarse aggregate, includes grinding energy

LCI Source:
US: Tap water from groundwater ts (2017)

Wood stain, water based **315.8 kg**

Used in the following Revit families:

WSP - Wood Canopy_NBBJ Calcs	315.8 kg (10 yrs)

Used in the following Tally entries:
Wood rainscreen, hardwood

Description:
Semi-transparent stain for interior and exterior wood surfaces

Life Cycle Inventory:
60% Water
28% Acrylate resin
7% Acrylate emulsion
5% Dipropylene glycol
1.3% NMVOC emissions

Product Scope:
Cradle to gate, including emissions during application

Transportation Distance:
By truck: 642 km

End-of-Life Scope:
38.7% solids to landfill (plastic waste)

LCI Source:
US: Tap water from groundwater ts (2017)
US: Acrylate resin (solvent-systems) ts (2017)
DE: Acrylate (emulsion) ts (2017)
US: Dipropylene glycol by product propylene glycol via PO hydrogenation ts (2017)

XPS insulation, Foamular average, Owens Corning - EPD **15,259.9 kg**

Used in the following Revit families:

Site - Planting - 3	14,271.0 kg (60 yrs)
WSP - Type 10 Architectural Concrete_NBBJ Calcs	247.2 kg (60 yrs)
WSP - Type 10 Stone Cladding_NBBJ Calcs	741.6 kg (60 yrs)

Used in the following Tally entries:
Extruded polystyrene (XPS), board

Description:
FOAMULAR XPS (polystyrene) insulation board, HFC foaming agent. EPD representative of US manufacturing condition. FOAMULAR insulation board is available with a variety of R-values and compressive strengths. The default value is based on a thermal resistance of RSI 1 and a compressive strength of 30 psi. If the intended R-value and compressive strength of the assembly is known, use the drop-down menu to designate a specific product.

Note: This temporary entry is sourced directly from third-party verified EPD data and replaces a Tally entry that is undergoing a quality assurance review. This entry developed using data from ecoinvent and modeled in SimaPro but adheres to

Life Cycle Inventory:
For information and quantities, see EPD.

Product Scope:
Cradle to gate.
Note: Product stage expanded to include blowing agent emissions during distribution and installation, and diffusion from product over service life (B1). As these impacts make a significant contribution to GWP they have been included in the product stage.

Transportation Distance:
By truck: 1190 km

End-of-Life Scope:
100% Landfilled (plastic waste), includes blowing agent emissions released during disposal

LCI Source:
US: Extruded polystyrene (XPS) insulation board, FOAMULAR - Owens Corning EPD (2018), modeled with Simapro 8, source for secondary data is ecoinvent 3.4

EPD Source:
4788721182.101.1

EPD Designation Holder:
Owens Corning

EPD Program Operator:
UL Environment

EPD Expiration:
1/1/2024