



AAPS New Logan Elementary School

Sustainability Construction
Documentation (CD) Narrative

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Prepared for:

Ann Arbor Public Schools

Prepared by:

Stantec Consulting Ltd.



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AAPS NEW LOGAN ELEMENTARY SCHOOL

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EXECUTIVE SUMMARY

The New Logan Elementary School, located in Ann Arbor, Michigan, US is planned to be constructed at 2650 Nixon Road on the same campus as Clague Middle School. With an approximate area of 93,500 sq ft, the two-story building comprised of various learning spaces and amenities, is anticipated to serve 600 students.

Improvements to the site will include newly planted vegetation, a new parking lot, additional stormwater management capacity, and replacement of two existing tennis courts with a new soccer field.

The project has various sustainability goals that have been implemented based on inputs from the client and the project team explored during the integrated design charrette at Schematic Design phase. The project goals have further evolved based on coordination and findings during DD and CD phase, and have been captured as part of this 100% CD report.

The project sustainability targets, and guiding principles are as per below:

- Practical solutions and recommendations considering triple bottom line – the occupants, budget, health and environmental impacts, avoid rating system point chasing.
- Collaborative for High Performance Schools (CHPS) – Verified Leader level certification, considering impacts of integration, indoor environmental quality, energy, water, site, materials & waste, and operations impacts. The project is currently on track to achieve the certification target.
- Optimizing energy efficiency with a target EUI of 25 kBtu/ft²/year and present options to surpass the target. A minimum 20% improvement over a ASHRAE 90.1-2016 -Baseline is targeted and considerations to obtain as many potential points as possible for the superior Energy Efficient/ Zero Net Energy (Collaborative for high Performance School) CHPS credits.
- Reducing embodied carbon with a targeted reduction of 10%, contributing towards CHPS Low embodied carbon materials through structural and envelope efficiencies.
- Considering climate vulnerability assessment for potential hazard mitigation and resiliency measures in alignment with CHPS design for climate adaptation credit.

Implementation and adaptation of these strategies would continue to be evaluated as the project progresses into Construction phase with coordination with the Construction Manager.



1.0 SUSTAINABILITY & CHPS

1.0 SUSTAINABILITY & CHPS

1.1 INTRODUCTION

New Logan Elementary School is pursuing CHPS (Collaborative for High Performance Schools) Verified Leader Certification per US-CHPS v2.0 program which is a green building program integrating national standards and best practices for the design, construction, and operation of healthy, high-performance schools. The project has been registered under US-CHPS v2.0 and the applicable reference guide republished June 2022 is being utilized to guide the project requirements. The current CHPS scorecard identifies criteria supporting sustainability strategies for New Logan Elementary School and through prerequisites and credits required towards achievement of certification.

US-CHPS is divided into seven categories in order to streamline the implementation process:

- Integration (II),
- Indoor Environmental Quality (EQ),
- Energy (EE),
- Water (WE),
- Site (SS),
- Materials & Waste (MW), and
- Operations (OM).

Each category is comprised of prerequisites and credits. Prerequisites are required to be implemented in every project unless non-applicable due to project type or other allowed exemption.

1.2 GOAL

CHPS verification program offers two levels of certifications – CHPS Verified and CHPS Verified Leader. CHPS Verified Leader is the highest level of certification available. The target requires 160 points, a 10% target buffer is to be included with a minimum goal of 176 points. The intent is to avoid point chasing and implement best practices project providing value for project providing a balance with budget. Therefore, there is a focus on “why” during the implementation and documentation.

1.3 IMPLEMENTATION

As the project progressed into CD, sustainability and CHPS strategies were incorporated further as cornerstone guiding principles and a key part of the design. Each discipline within the project team was involved in various internal coordination and discussions to meet the requirements of CHPS prerequisites and credit requirements. The Sustainability team further coordinated with CHPS for clarifications regarding the rating system and interpretation requests for different prerequisites and credits with proposed strategies. These have been incorporated and coordinated with the project team, with a few pending items that will be addressed as the project progresses.



1.0 SUSTAINABILITY & CHPS

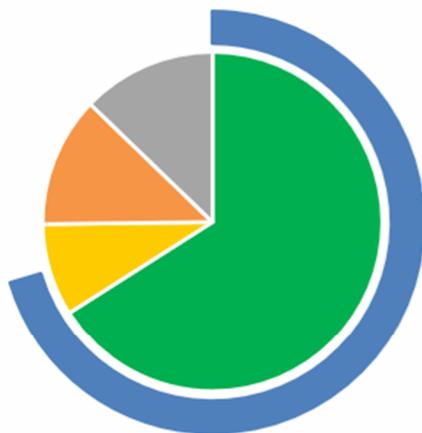
The project team is currently documenting CHPS design submission documentation which will go through QAQC process and then be submitted to CHPS for review. There are a number of items that our team is planning on pushing back on for some of the CHPS credit requirements:

1. Irrigation (6pts) – Due to non-applicability for no irrigation, for 100% reduction the project should not be penalized.
2. Daylight (5pts) – Requirements for daylight credit are too stringent for Michigan schools. Stantec to push back CHPS on this and request examples where projects meet this requirement in Michigan.
3. High performance lighting (2pts) – Requirements for European standards should not be in place for US project, local and US requirements shall be a priority without causing budget concerns with expensive european certification.
4. Submetering (3pts) – Requirements for submetering are too aggressive and not practical, provision of submeter at ever panelboard is not practical.

Additional items will be addressed as they are identified during the certification process, especially those requiring pushback or clarifications.

1.4 SCORECARD AND CONCLUSION

The CHPS scorecard has been refined further and would continue to be revised as the design progresses during CD, providing further clarity toward confirming certain credit requirements that could not be confirmed during DD given the level of detail which is typical at this stage.



| | |
|---------------------------|------------|
| Available Points: | 250 |
| Targeting: | 165 |
| Possible/Likely: | 22 |
| Possible/Unlikely: | 31 |
| Not Possible: | 32 |

Project Target: 176 points in targeted during submission

Currently the project stands at 165 points in Targeted, 22 in Maybe-likely, 31 in Maybe-unlikely, and 32 in Not Possible. The scorecard will be refined further upon CHPS design submission completion and as required upon coordination with the project construction manager with the intent of bringing the project to 176 points.

Figure 1 Current CHPS status

A copy of the current scorecard is included below.



2.0 ENERGY MODELLING

2.0 ENERGY MODELLING

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This section summarizes the results of energy simulations based on information available to Stantec at the time of preparation, including information from third parties about construction materials, equipment, proposed operation procedures, and projected usage. Simulations are not exact predictions of actual energy use or actual operating costs. Actual energy use and cost will differ from these simulations due to several reasons, including but not limited to variations in building construction, operation and maintenance, occupancy, operation schedules, equipment efficiencies, as well as differences between actual weather and the typical meteorological year represented in the climate data file. The results of these simulations cannot be used to size equipment.

Some assumptions have been made for parameters of the operation or performance of equipment and materials where data was not available. The use of these values and parameters shall in no way imply endorsement of a specific product or manufacturer.



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2.0 ENERGY MODELLING

2.1 INTRODUCTION

This section represents the energy model at the 100% construction design stage of the project. The project is a new school facility located in Ann Arbor, Michigan. The project is a two-story building that consists of a gymnasium, classrooms, study areas, a library, kitchen, offices, conference rooms, a reception area, storage space and mechanical/electrical rooms with a total building floor area of approximately, 91,397 ft² (8,494 m²). Note that this floor area typically varies from 100% CD given ASHRAE 90.1-2016 and energy modelling methodology guidelines.

As part of the owner's project requirements, the project has the following energy performance goals:

5. Reach an EUI of 25 kBtu/ft²/year and present options to surpass that target.
6. A minimum 20% improvement over a ASHRAE 90.1-2016 App.G Reference model.
7. Obtain as many potential points as possible for the superior Energy Efficient/ Zero Net Energy (Collaborative for high Performance School) CHPS credit.

The design team identified potential energy efficiency strategies that have been applied to the design to achieve the listed energy performance goals. Energy modelling was performed to analyze the potential energy efficiency strategies and determine which improvements can be applied to meet the project targets.

Table 1: SUMMARY OF PROJECT PERFORMANCE TARGETS

| Design Scenario | EUI (kBtu/ft ² /year) | Site Energy Saving compared to ASHRAE (%) | Energy Saving over ASHRAE Source Energy (%) | CHPS Points |
|----------------------------|----------------------------------|---|---|-------------|
| ASHRAE 90.1-2016 Reference | 145.86 | N/A | N/A | N/A |
| Proposed Design | 17.77 | 88% | 68% | 30 |



2.0 ENERGY MODELLING

2.2 PROJECT OVERVIEW AND ENERGY EFFICIENCY GOALS

The project consists of a two-story school with a total floor area of approximately 91,397 ft² (8,494 m²) which consists of a gymnasium, classrooms, study areas, a library, kitchen, offices, conference rooms, a reception area, storage space and mechanical/electrical rooms.

As part of the owner's project requirements, the project has set the following sustainability goals:

8. Reach an EUI of 25 kBtu/ft²/year
9. A minimum 20% improvement over a ASHRAE 90.1-2016 Reference.
10. Obtain as many potential points as possible for the superior Energy Efficient/ Zero Net Energy CHPS credit.

This section summarizes the design of the project at 100% CD stage.

2.3 ENERGY PERFORMANCE

2.3.1 Analysis Methodology

2.3.1.1 Energy Modelling Approach

The project is pursuing certification with the US-Collaborative High-Performance Schools (CHPS) program. This is a guide for the construction of high-performance schools and considers design features such as sustainable sites, material selections, water reduction, energy efficiency and indoor environmental quality. The energy model is used to inform design for the CHPS credit – EE c1.1 Superior Energy Efficient Design & Zero Net Energy which has 34 potential points available. The project is looking to maximize the amount of points from this credit towards certifying the building under CHPS. This credit compares the energy savings of the design to an ASHRAE 90.1-2016 baseline scenario. The energy savings associated with the design determines how many points are achieved towards certification. **Table 2** outlines the points rewarded for achieving a certain percentage improvement compared to the ASHRAE 90.1-2016 baseline. There are 30 available points for improving the energy efficiency of the facility compared to the ASHRAE 90.1-2016 baseline.

$$\text{Percentage Improvement} = \frac{\sum \text{Baseline Building Source Energy} - \sum \text{Proposed Building Source Energy}}{\sum \text{Baseline Building Source Energy}}$$



2.0 ENERGY MODELLING

Table 2: CHPS Credits Based Percentage energy Improvement

| Points | Percentage Improvement |
|--------|------------------------|
| 1 | 2% |
| 2 | 4% |
| 3 | 6% |
| 10 | 20% |
| 15 | 30% |
| 20 | 40% |
| 25 | 50% |
| 30 | >=60% |

This credit also has 4 available points for Zero Net Energy. This includes 1 point for designing the schools to be Zero Net Energy Capable with the intent of being 100% powered by on-site renewable energy in the future. The project can also achieve 4 points for designing to be Zero Net Energy with the intent of generating 100% of the energy requirements for the facility with on-site renewable energy.

2.3.1.2 Study Limitations

The results from this study are used to determine energy performance for compliance purposes. The calculations are not predictions of actual energy use of the building after construction. Actual energy use and will differ from these calculations due to a number of variables including variations in occupancy and building operation schedules; energy use for equipment not included in the simulation or not covered by the applicable energy code; differences in actual weather and the typical meteorology year represented in the climate data file.



2.0 ENERGY MODELLING

2.3.2 Model Inputs and Assumptions

2.3.2.1 ASHRAE 90.1-2016 Baseline and Proposed Design

The energy model is based on the 100% Construction Drawings received from different design teams. The architectural details and building layout of the energy model is based on 100% CD architectural drawings. The mechanical design information is based on the latest mechanical drawing set provided.

Table 3 shows a summary of the ASHRAE 90.1-2016 Baseline and proposed design model inputs.

Table 3: Energy Model inputs

| CHPS for Schools Baseline (ASHRAE 90.1-2016) | | |
|---|---|--|
| General | | |
| Location | Ann Arbor, MI | |
| Building Type | School | |
| Climate Zone | Climate Zone 5a | |
| Weather File | USA_MI_Ann.Arbor.Muni.AP.725374_TMYx.2007-2021.epw | |
| Energy Modeling Software | IESVE 2023.5.1.0 | |
| Reference Standard(s) | ASHRAE 90.1- 2016 Appendix G. | |
| Modelled Floor Area | 91,397 ft ² (8,494 m ²) | |
| Architectural | | |
| | Proposed Design | ASHRAE 90.1-2016 |
| Overall Above Grade Wall R-value | R25.3 / USI-0.224 (R value as per 5.1.71 of Thermal bridging guide v 1.6), Assembly details as per 100% Architectural drawing set (5" of mineral wool insulation) | ASHRAE 90.1-2016 Zone 5A Wall: R-11.9 / USI – 0.47 |
| Overall, Roof R-value | Flat roof R34 / USI-0.17 | ASHRAE 90.1-2016 Zone 5A Roof: R-15.9 / USI – 0.36 |
| Slab-on-grade F-Value | R-7.5@1.2m Perimeter insulation only, 1.5" of XPS F-0.65 | ASHRAE 90.1-2016 Zone 5A Slab-on-grade: F-0.73 |
| Doors R-Value | Proposed glazed swinging door: U=0.44 Proposed opaque swinging door U=0.32 | ASHRAE 90.1-2016 Zone 5A Door: USI – 3.96 |
| Skylight | 1.2% | ASHRAE 90.1-2016 Zone 5A Skylight: USI 0.69 |
| Window to wall ratio | ~22% | ASHRAE 90.1-2016 Building School type: 22% |
| | Proposed glazing specifications. U-0.27, R 3.7/ USI 1.53 | ASHRAE 90.1-2016 + Zone Window: R 1.75/ USI – 3.23 |



2.0 ENERGY MODELLING

| CHPS for Schools Baseline (ASHRAE 90.1-2016) | | |
|---|---|-------------------------|
| Overall, Glass U-value including frame and SHGC | SHGC = 27% | SHGC = 39% |
| Infiltration | 0.15 CFM/ ft ² façade) Sources: ASHRAE 90.1 2016 App. G, Calculated as per Page 276 App.G. ASHRAE 90.1 2016. | |
| External Wall Area (ft ²) | 50,697 ft ² | 50,697 ft ² |
| Roof Area (ft ²) | 59,976 ft ² | |
| Electrical | | |
| Lighting Power Density (LPD) | Space Type | W/ft² |
| | Classroom | 0.21 |
| | Office | 0.11 |
| | Conference/ Multipurpose/ Music | 0.86 |
| | Corridor | 0.40 |
| | Vest | 0.40 |
| | Washroom | 0.24 |
| | Storage (<50ft2) | 0.43 |
| | Stairs | 0.12 |
| | Mech/ Elec | 0.24 |
| | Copy/Print room | 0.40 |
| | Fitness | 0.17 |
| | Lobby | 0.60 |
| | Lounge | 0.50 |
| | Café and Servery | 0.33 |
| | Kitchen | 0.59 |
| | Proposed lighting power densities as per 100% CD electrical drawings. Occupancy sensors and daylight sensors included. Source: Baseline/Reference Lighting power densities as per ASHRAE 90.1-2016 App. G. | |
| Lighting Controls | Occupancy sensors and daylight sensors included. | None |



2.0 ENERGY MODELLING

| CHPS for Schools Baseline (ASHRAE 90.1-2016) | |
|---|---|
| Equipment Load | 1.73 W/ ft ² (For educational workshop, offices) (0.5 W/ft ² -all other spaces ^{as} per Table G-4 ASHRAE 90.1 User manual) |
| Operation | |
| Indoor Design Temperature | <p>Heating Setpoint: 22.2 °C (72 °F), Cooling Setpoint:23.9 °C (75 °F)</p> <ul style="list-style-type: none"> • Cafeteria • Classroom • Classroom/ Preschool to 12th grade • Conference / Meeting room • Copy / Print Room • Corridor/ Transition • Food preparation • Gymnasium/ Fitness center • Library • Lobby • Lounge/ Breakroom • Office • Restroom • Stairs • Storage <p>Rooms that require heating supply only 20 °C (68 °F):</p> <ul style="list-style-type: none"> • Vestibules • Mechanical Room |
| Occupancy | 75 (ft ² /Person) |
| Mechanical | |
| Heating/ Cooling Plant | <p>Heating / Cooling</p> <p>Four-pipe fan coil served by the hot water and chilled water loops. The cooling loop is a water-to-water heat pump system that rejects heat to the geothermal field. The heating system is same water-to-water heat pump loop and pulls heat from the geothermal field with a condensing Elec boiler backup.</p> <p>Electric rooms served by fan coil units, Technology spaces served by split systems.</p> <p>Separate DOAS single zone recirculation units for the fitness area and the library spaces.</p> <p>System 5: Packaged VAV with Reheat</p> <p>Heating: Boiler: 80% efficient</p> <p>Cooling: DX Cooling (COP 3.28)</p> |



2.0 ENERGY MODELLING

| CHPS for Schools Baseline (ASHRAE 90.1-2016) | | |
|---|---|--|
| Loop Temperature Supply Setpoint | Min Source Temperature for heating -4 °F Min Source Temperature for cooling 122 °F | Hot water: 180 °F with reset per outdoor temperature |
| Dehumidification | Yes | |
| Domestic Hot Water Load (L/h) | 11.2 gallons/hour (Based on fixture specifications as per CHPS requirements and number of people) | |
| Service Hot Water Plant | Electric water heater 100% efficient | 81% Natural Gas Hot Water Tank (as per ASHRAE) |
| Pump Power | As per Mechanical cutsheets. | Hot water: 19 W/gpm |
| Pump Control | Variable | Variable |
| Interior Fan Power | As per mechanical cutsheets | 0.30 W/cfm |
| Fan Control | Variable | Variable |
| Outdoor Air Ventilation | Values received from Mechanical team calculations (as per 100% CD Mechanical drawing set), 30% additional CHPS ventilation requirement. | |
| Heat Recovery (Enthalpy wheel) | RTU 1,2,3 – 76% RTU 4 – 74% RTU 5 – 80% RTU 6 – 75% RTU 7 – 60% RTU 8 – 77% As per 100% CD Mechanical drawings. | 50% Heat recovery added on level 1 spaces only. (ASHRAE 90.1-2016: Section G3.1.2.10) - 50% Heat Recovery if both a design supply air capacity of 5000 cfm or greater and have a minimum design outdoor air supply of 70% or greater. |



2.0 ENERGY MODELLING

2.3.3 Analysis & Results

Energy modelling and simulation is used to determine the design concept solutions that meet the project's building performance targets:

1. Reach an EUI of 25 kBtu/ft² and present options to surpass that target.
2. A minimum 20% improvement over a ASHRAE 90.1-2016 Baseline.
3. Obtain as many potential points as possible for the superior Energy Efficient/Zero Net Energy CHPS credit.

The following sections show the results of the energy analysis.

2.3.3.1 ASHRAE 90.1-2016 App. G Reference Model

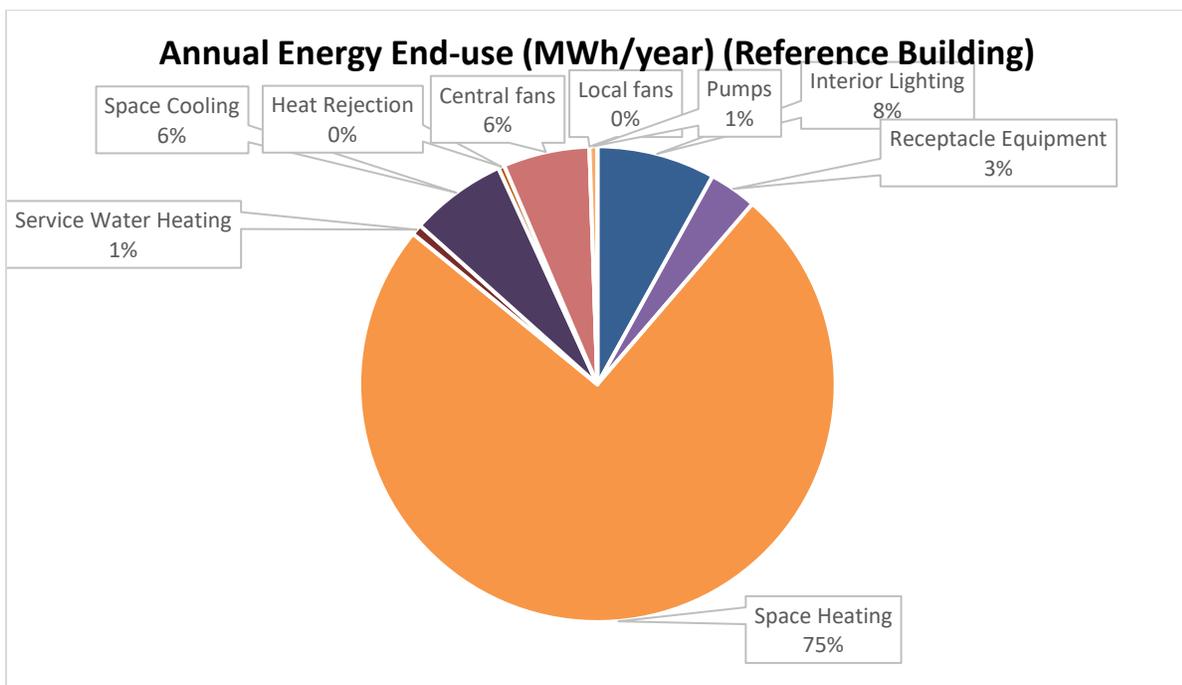


Figure 2 and **Figure 3** show the energy breakdown and energy fuel type for the ASHRAE 90.1-2016 baseline model. Space heating, and interior lighting are the highest energy consumers, which is expected for a facility located in a northern climate.



2.0 ENERGY MODELLING

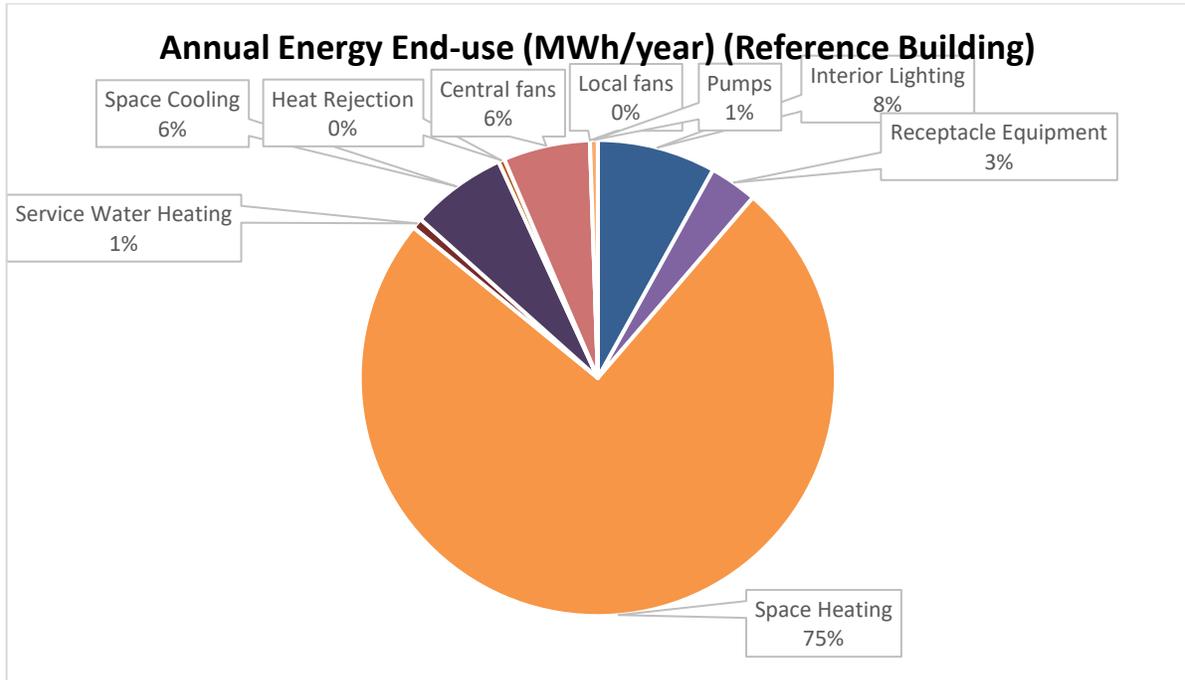


Figure 2: ASHRAE 90.1-2016 Reference Energy end-use consumption breakdown

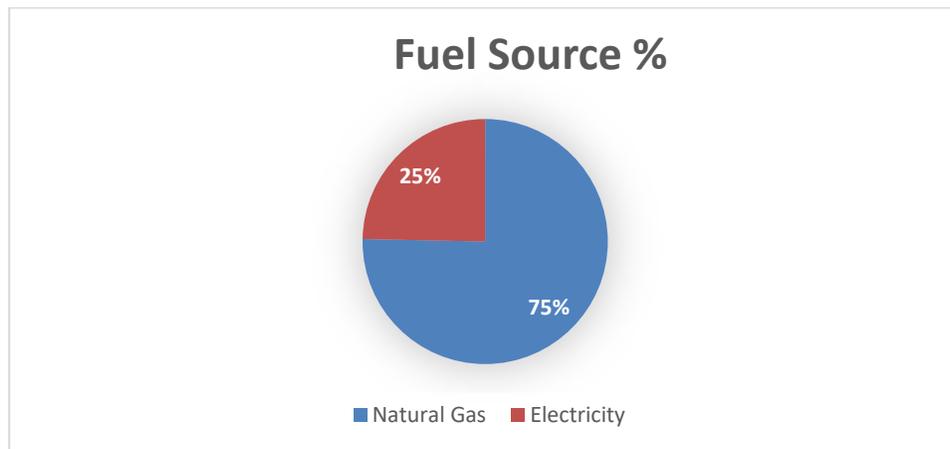


Figure 3: ASHRAE 90.1-2016 Reference Energy consumption by fuel type



2.0 ENERGY MODELLING

2.3.3.2 Proposed Model

Figure 4 and Figure 5 show the energy breakdown, and energy fuel type for the proposed model. Space heating, and fans energy are the highest energy consumers, which is expected for a facility located in a northern climate. However, it is worth noting that the suggested design for the proposed model is entirely electric, with no natural gas use. Additionally, **Table 4** shows the energy end use breakdown comparison between proposed model and ASHRAE 90.1-2016 model.

PV panels which a generation potential of 150kW is included in this proposed design which offsets the total energy consumption for the building, which helps in getting more CHPS points for the project.

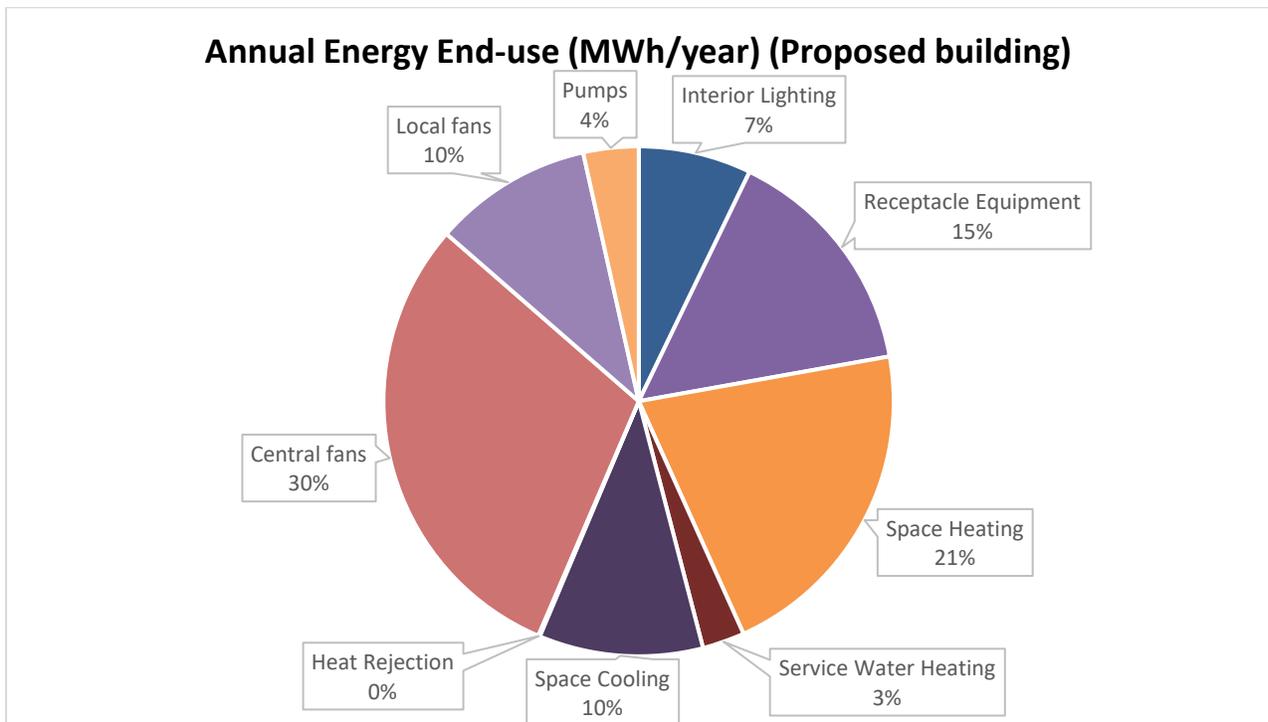


Figure 4: Proposed Energy end-use consumption breakdown



2.0 ENERGY MODELLING

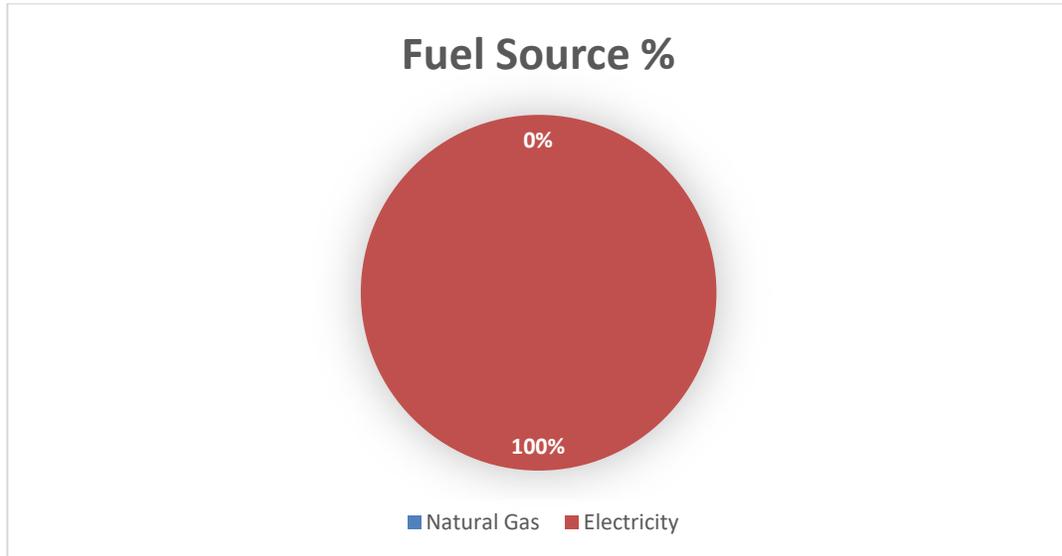


Figure 5 :Proposed Model Energy consumption by Fuel Type

Table 4 - Energy End-Use Consumption breakdown

| Energy (MWh/year) | | | |
|-------------------|-------------------|--------------------|------------|
| End-use category | Proposed building | Reference building | % Savings |
| Central fans | 252.29 | 229.39 | -10% |
| Space heating | 177.34 | 2,909.07 | 94% |
| Receptacles | 126.31 | 134.69 | 6% |
| Space Cooling | 87.45 | 254.51 | 66% |
| Local Fans | 84.91 | - | - |
| Interior lighting | 60.35 | 313.79 | 81% |
| Pumps | 29.43 | 20.84 | -41% |
| Service hot water | 22.70 | 28.39 | 20% |
| Heat Rejection | 0.90 | 16.25 | 94% |
| Total | 842 | 3,907 | 78% |



2.0 ENERGY MODELLING

Table 4 breaks down the energy end-use consumption in the Proposed building and the Reference building (ASHRAE App.G. 2016). Most savings are achieved through the space conditioning due to use of highly efficient geo-thermal heat pumps as compared to the gas boilers in the Reference building.

Table 5 – Energy consumption with PV panel production

| | Proposed Building | Reference building | % Savings |
|--|--------------------------|---------------------------|------------------|
| Energy consumption (MWh/year) | 842 | 3,907 | 78% |
| PV panel production (MWh/year) | 366 | - | - |
| Total Energy consumption (MWh/year) | 476 | 3,907 | 88% |

Table 6 – Energy use intensity with PV panel production

| EUI (kBTU/ft²/year) | Proposed Building |
|---------------------------------------|--------------------------|
| EUI without PV | 31.42 |
| EUI with PV (100% CD) | 17.77 |

The **Table 6** describes the energy use intensity without the PV and with the PV panels (final design).



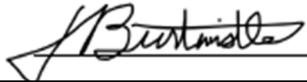
3.0 WHOLE BULDING LIFE CYCLE ASSESSMENT (WBLCA)

The conclusions in the Section titled “3.0 Whole Building Life Cycle Assessment (wbLCA)” are Stantec’s professional opinion, as of the time of the Section, and concerning the scope described in the Section. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Section relates solely to the specific project for which Stantec was retained and the stated purpose for which the Section was prepared. The Section is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient’s own risk.

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3.0 WHOLE BUILDING LIFE CYCLE ASSESSMENT (WBLCA)

3.1 INTRODUCTION

A preliminary Life Cycle Assessment (LCA) of the AAPS New Logan Elementary School was performed using the Construction Document Review Set as a reference to develop the bill of materials and OneClick LCA as the software tool. The purpose of this study is to help the client and design team understand the total carbon embodied in the construction materials of the building for the current proposed building and how they can reduce the embodied carbon emissions through an analysis of various options for structural and envelope materials.

The current analysis shows that the current proposed design can achieve approximately an 13.14% reduction in embodied carbon from the baseline building by incorporating several commonly available lower carbon materials, explained in further detail in the full section. However, some of the methods proposed to realize these results will need to be reviewed with the full design team and further refined through subsequent design iterations.

3.2 WBLCA

The Life-Cycle Assessment (LCA) provides a method for quantifying the various environmental impacts of a particular product or process. Whole Building LCA (WBLCA) aggregates data for individual building products or systems to develop an overall total of the various environmental impacts.

3.3 GOAL

The goal of this initial WBLCA is to calculate initial values for total embodied carbon in support of the project's sustainability goals. Additionally, the study aims to support the project's CHPS certification, which allows projects to achieve points for achieving a reduction in embodied carbon.

3.4 SCOPE

The scope of a WBLCA refers to the components of the building that are included in the analysis. As this analysis was done to also help the project comply with CHPS Low Embodied Carbon Materials requirements (3 points), the project followed the methodology from CHPS. The scope therefore includes the structure and enclosure of the building, including elements such as foundations, above grade structure, external walls, and other elements. The interior partitions and finishes were not included in this assessment. The assessment period was 60 years. This LCA covers the cradle to grave scope with the following modules: A1-A4 (materials supply and transportation), B3-B5 (repair, maintenance, and replacement of materials) and C1-C4 (end of life of materials). Modules B1 and B2 are not relevant (MNR). Modules A5 and D are excluded for CHPS purposes, but biogenic carbon is quantified in the results section.



Sources of embodied carbon across the construction lifecycle

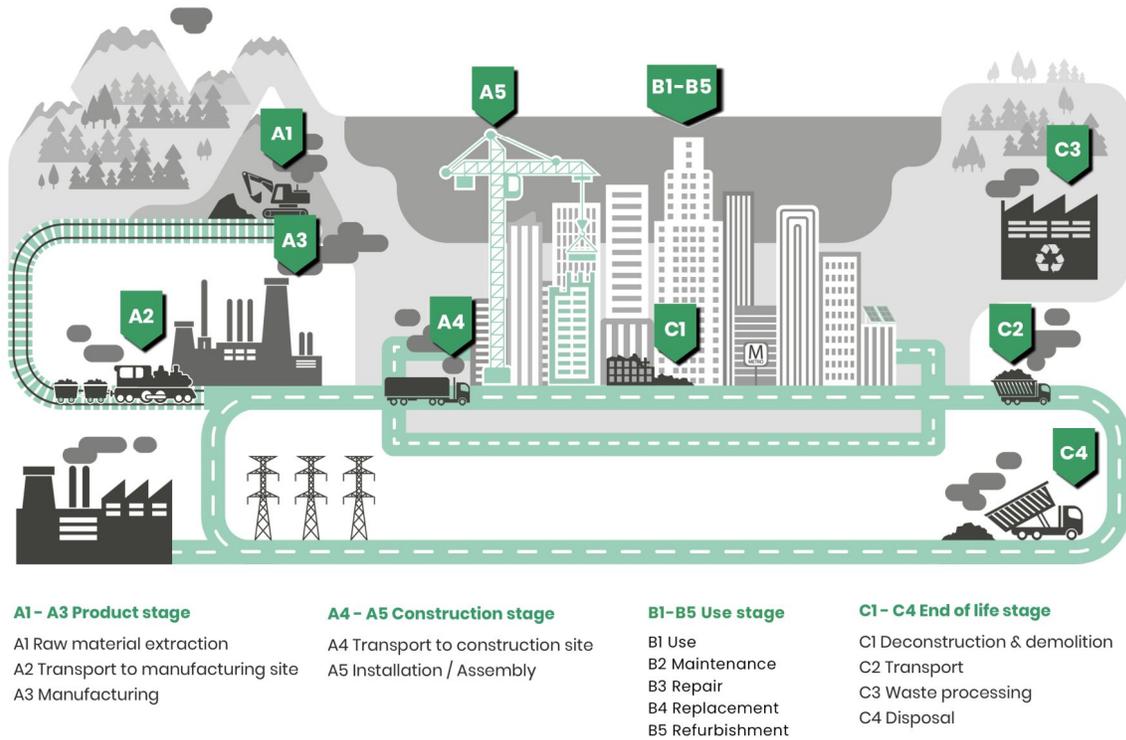


Figure 6. Life Cycle Stages according to EN standards¹

Since the goal of the assessment was primarily embodied carbon, the Global Warming Potential (GWP), represented in kilograms of CO₂ equivalent (kg CO₂e), was the impact metric examined and presented most thoroughly in this section. GWP represents the ‘embodied carbon’ in materials, and these terms are often used interchangeably. The software used also computes impact assessment categories required by CHPS, and results for all impact categories are shared in the results section.

¹

<https://oneclicklca.zendesk.com/hc/en-us/articles/360015064999-Life-Cycle-Stages>



3.0 WHOLE BUILDING LIFE CYCLE ASSESSMENT (WBLCA)

3.4.1 Tools and Methodology

3.4.2 Tools

The primary tool used for conducting this LCA was OneClick LCA, which is a European cloud-based software tool specifically for LCAs. Despite being a European entity, the data used in this assessment draws from North American Environmental Product Declarations (EPDs) and benchmarks.

3.4.3 Methodology

Takeoffs were drawn from the Construction Document Review Set model for the envelope area, and structural quantities were provided by the structural engineer. These combined to provide the Bill of Materials for the current proposed design. The baseline was then created by substituting standard construction assemblies where the proposed design was innovative or using more sustainable alternatives than standard practice.

Once the baseline was developed, the proposed model was developed including strategies to reduce the overall embodied carbon of the project through replacing specific materials and assemblies with alternate materials being included by the design team.

Where material parameters were not explicitly specified in the schematic design, assumptions were drawn based on best practice or past project experience. As the design has been further refined in current stages of the project, assumptions more accurately reflect the proposed building.

3.4.4 Assumptions

The data drawn from the Construction Document Review Set reflects the proposed design of the project, so several assumptions for the baseline had to be made based on regional benchmarks and construction best practices. Below is a brief summary of major assumptions that were made in the current models:

- Foundations
 - Structural provided a breakdown of foundation assemblies according to concrete strength. All footings, subgrade walls, and blocks were assumed to be 5000 psi, while the slab on grade (SOG) was assumed to be 4000 psi per structural drawings.
 - No fly ash was assumed in the baseline, and the proposed design assumed 20% flyash throughout. Structural notes indicate that the slab on grade is not to exceed 15% flyash, but other components can often go higher and there was no 15% flyash EPD available.
 - Rebar mass per cubic meter of concrete was assumed to be 85kg/m³.
 - Rebar was assumed to have 80% average recycled content.



3.0 WHOLE BUILDING LIFE CYCLE ASSESSMENT (WBLCA)

- External Walls
 - Baseline assumed SPF spray foam insulation per direction from the design team for common wall construction in the Ann Arbor region.
 - All assemblies as per CD, with wall areas per the Revit model.
 - Assumed double pane aluminium framed windows throughout.
 - The Pure+Freeform Aluminum product was not in the OneClick database, so an extruded aluminum cladding product from Longboard was used.
 - Trespa had an HPL product in the database, but it wasn't the exact product (Meteon) identified in the design. It was still used as the cladding as the EPD indicated it was appropriate for exterior applications.
 - Alucobond did not have product specific EPDs available, only a Metal Composite Material Panel from the Metal Construction Association, which Alucobond is a member and participated in the development of the EPD.

3.5 RESULTS

The overall baseline for the project is currently indicating that there are 4,156 metric tonnes of CO₂e in the structural and envelope materials for new construction.

When compared with the baseline design, the current proposed design is achieving a 13.14% reduction in embodied carbon, primarily due to the use of CLT roof construction and mineral wool insulation.

At this stage the sensitivity analysis of individual materials was not conducted, rather the LCA compared the baseline with the proposed design per the CD. Cladding materials were kept consistent between the two models, with substitutions made for concrete (20% fly ash), roof (CLT instead of steel structure), some beams (glulam instead of HSS steel) and insulation (mineral wool instead of spray foam).

Biogenic Carbon

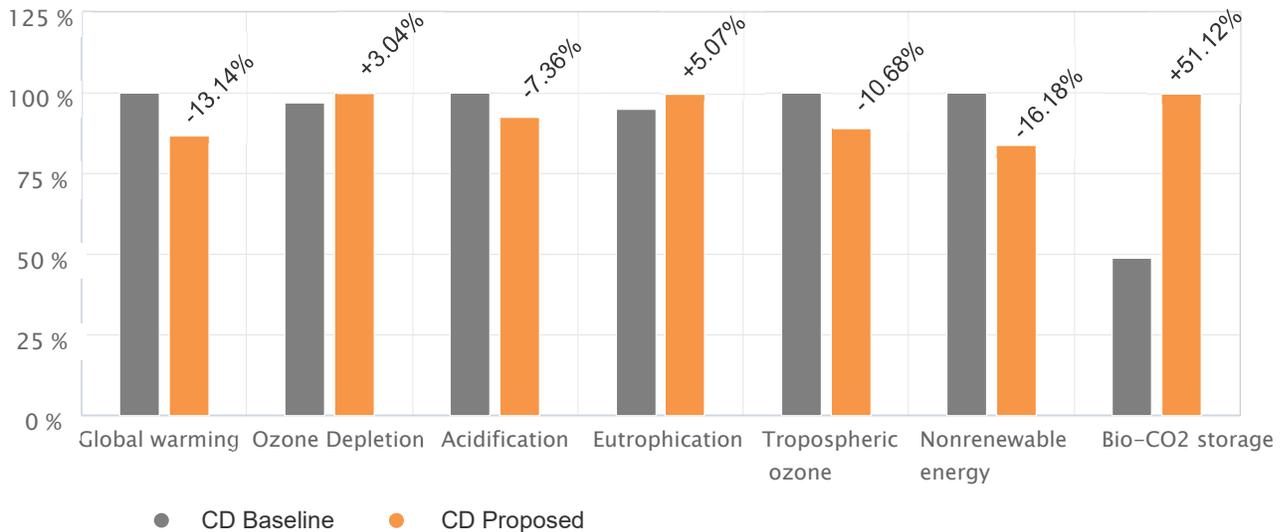
Not included in this reduction is the biogenic carbon from the cross laminated timber (CLT) and other wood products, which was calculated to be 1,009.5 tonnes in the proposed design. This would represent approximately 29.3% additional savings from the baseline. However, biogenic carbon is still not accounted for in most LCA methodologies due to ongoing research into the full lifecycle impacts of deforestation and sequestering carbon in bio-based materials.



3.0 WHOLE BUILDING LIFE CYCLE ASSESSMENT (WBLCA)

3.5.1 Impact Categories

Based on the changes in the proposed model all TRACI impact categories were assessed and the results shown below. Reductions greater than 10% were achieved in 3 of 6 impact categories, with biogenic carbon discussed previously as being outside of scope.



3.6 CONCLUSION & RECOMMENDATIONS

The project is on track to achieve the CHPS II C6.1.3 Low Embodied Carbon Materials credit based on the proposed design. Based on these initial results, the following recommendations are presented for the design team and client to consider during costing and construction.

- Specify low carbon concrete options including GUL cement and high fly ash or other SCM content, varying according to application (i.e., slightly lower in floors to avoid long curing times).
- Specifications currently call for a minimum 80% recycled content in steel products. The project team could consider increasing this to 90% or even 97% for products where increased recycled content is readily available.
- Ensure CLT and glulam structural components are maintained through tender. Consider requesting alternative pricing for FSC lumber products to understand the cost of sustainable sourcing of mass timber.



3.0 WHOLE BUILDING LIFE CYCLE ASSESSMENT (WBLCA)

3.7 BASELINE BILL OF MATERIALS

| Resource name | Product Category Rules (PCR) | Technical specification | Upstream database | Amount | Units |
|--|---|---|-------------------|---------|-------|
| Aggregate (crushed gravel), generic, dry bulk density | EN15804+A1 | 1600 kg/m3 | ecoinvent | 705.54 | m3 |
| Aluminium frame window double-glazed, operable (tilt and turn), 50% recycled aluminium | EN15804+A1, EN15804+A2 | 1.48 m x 2.18 m, 25.3 kg/m2 | OneClick LCA | 1248.86 | m2 |
| Clay Brick | PCR for Clay Brick, Clay Brick Pavers and Structural Clay Tile | 2120 kg/m3 | ecoinvent | 272.286 | m3 |
| Composite metal decking | LCIA: TRACI 2.1, GWP IPCC 2013 | 30 mil | GaBi | 5505.6 | m2 |
| CMU | Part B: Concrete Masonry and Segmental Concrete Paving Product EPD Requirements, March 2022. V1.1 | 2000 psi, 2002.31 kg/m3 | | 362.37 | m3 |
| Concrete, ready mix | NSF PCR for Concrete Version 1 (February 22, 2019) | 4001-5000 psi (C30/35) | ecoinvent | 705.53 | m3 |
| Concrete, ready mix | NSF PCR for Concrete Version 1 (February 22, 2019) | 3001-4000 psi (C20/25) | ecoinvent | 1164.29 | m3 |
| Cross laminated timber (CLT) | EN15804+A1, EN15804+A2 | 481 kg/m3, 12% (+/- 3%) moisture content | One Click LCA | 485.925 | m3 |
| EPDM membrane roofing | LCIA: TRACI 2.1, GWP IPCC 2013 | 0.1in | GaBi | 5505.6 | m2 |
| Extruded aluminium | PCR Part B for Aluminum Construction Products | 2700 kg/m3 | GaBi | 5.952 | m3 |
| Gypsum plaster board, regular, generic | EN15804+A1 | 6.5-25 mm (0.25-0.98 in), 10.725 kg/m2 (2.20 lbs/ft2) (for 12.5 mm/0.49 in), 858 kg/m3 (53.6 lbs/ft3) | OneClick LCA | 4664.97 | m2 |



3.0 WHOLE BUILDING LIFE CYCLE ASSESSMENT (WBLCA)

| Resource name | Product Category Rules (PCR) | Technical specification | Upstream database | Amount | Units |
|---|--|--|--|-------------------|-------|
| Hollow structural sections (HSS) - fabricated, Carbon Leadership Forum benchmark | PCR Part A: Calculation rules for the LCA and requirements project report (IBU/UL Environment, V3.2, 12.12.2018) and Part B: Designated Steel Construction Product EPD Requirements (UL Environment, V2.0, 08.26.2020) | 7800 kg/m3 | GaBi | 111.08 | tons |
| Metal frame wall system, 2x4, 16 inches spacing, cavity insulation (R13) and external insulation (R5); climate zone 2 (except 2R) | Various. | R13 (Rsi=2.29 m2K/W) (cavity)+R5(external insul.); cavity insulation options: fiberglass batt, cellulose, or cell spray foam / external insulation options: 1-inch (25.4 mm) XPS, incl. One Click LCA generic data, for USA and Canada | Various. OneClick LCA Construction Assembly. Insulation types modified to match assumptions. | 4620.2 | m2 |
| Oriented strand board (OSB), generic | EN15804+A1 | 9.5-28.5 mm (0.37-1.12 in), 610 kg/m3 (38.1 lbs/ft3), min. G4-2 | One Click LCA | 4664.97 | m2 |
| Plastic composite with wood fibers, for decking, fencing and cladding | PCR 2019:14 Construction Products, Version 1.0 | 23.24 kg/m2 (average) | ecoinvent | 695.54 | m2 |
| Polyisocyanurate (PIR) insulation boards, high-density | PCR Guidance for Building-Related Products and Services Part B: Building Thermal Insulation EPD Requirements (UL10010-1, Version 2.0). | 2.69kg/m2 (5.93lb/m2), 28.8mm (1.13in), 1m2K/W (5.678ft2°Fh/Btu), 92.76 kg/m3 | ecoinvent | 5505.6 (6" thick) | m2 |
| Ready-mix concrete | - | 5000 psi, 34.5 Mpa | ecoinvent | 10,619.975 | m3 |
| Reinforcement steel (rebar), generic | EN15804+A1 | 80% recycled content, A615 | One Click LCA | 159847.87 | kg |



3.0 WHOLE BUILDING LIFE CYCLE ASSESSMENT (WBLCA)

| Resource name | Product Category Rules (PCR) | Technical specification | Upstream database | Amount | Units |
|---|--|---|-------------------|--------------------|----------------|
| Reinforcement steel (rebar), generic | EN15804+A1 | 90% recycled content, A615 | One Click LCA | 48669.5 | kg |
| Softwood plywood | UL Environment: Product Category Rules for Building-Related Products and Services Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report, v3.2 Part B: Structural and Architectural Wood Products EPD Requirements, v1.0 | 9.5 mm, 484 kg/m ³ , 7% moisture content | ecoinvent | 695.54 | m ² |
| Spray polyurethane foam insulation for closed cell, with HFO blowing agent (incl. A5 installation and B1 use phase impacts) | UL PCR Part B: Building Envelope Thermal Insulation EPD Requirements, 2018 | 0.022 W/mK, 32 kg/m ³ average density | GaBi | 4664.97 (5" thick) | m ² |
| Steel stud framing for drywall/gypsum plasterboard per sq. meter of wall area (incl. air gaps per m ³) | - | C-profile: 4 x 2 inch, gauge 25, 10 ft. height x 16 inch (40 cm) spacing | USLCI | 29638.87 | kg |
| Structural steel profiles, generic | EN15804+A1 | 90% recycled content (typical), I, H, U, L, and T sections, S235, S275 and S355 | One Click LCA | 72.41 | tons |
| Thermoplastic polyolefin (TPO) membrane roofing | LCIA: TRACI 2.1, GWP IPCC 2013 | 0.06in | GaBi | 5505.6 | m ² |
| XPS insulation board | LCIA: TRACI 2.1, GWP IPCC 2013 | 1.02in | GaBi | 513.05 (4" thick) | m ² |



4.0 CONCLUSION

4.0 CONCLUSION

As the project progresses into Construction phase, the sustainability team will work closely with the project team to implement various strategies including but not limited to:

- CHPS Verified Leader Certification – Submit CHPS design submission and update CHPS scorecard as required upon coordination with the project construction manager with the intent of bringing the project to 176 points.
- The project has met the target EUI of 25 kBtu/ft²/year per 100% CD and anticipates 30 points for EE1.1.1 Superior Energy Efficient Design CHPS credit.
- The project has met the target of 10% reduction in embodied carbon through strategies implemented for structure and envelope. This also contributed towards II C6.1.3 Low Embodied Carbon Materials CHPS credit.
- Climate Vulnerability Assessment recommendations were followed for potential hazard mitigation and resiliency measures and provided alignment with II C7.1.1 Climate Vulnerability assessment CHPS credit for climate adaptation.

Implementation and adaptation of these strategies will continue to be evaluated as the project progresses into Construction phase.

