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Fielding International

AAPS New Thurston 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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EXECUTIVE SUMMARY

The New Thurston Elementary School, located in Ann Arbor, Michigan, US is planned to be constructed at 2300 Prairie Street at the site of the existing Thurston Elementary School. With an approximate area of 90,598 sqft, the two-storey building will be divided into four sections with various learning spaces and amenities assumed to be serving approximately 600 students, 80 staff and 10 visitors. Construction will be phased to allow the existing school building to remain in use until completion of the new building, after which the existing structure will be demolished. 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/ft^2/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

1.1 INTRODUCTION

New Thurston 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 Thurston 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.

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:

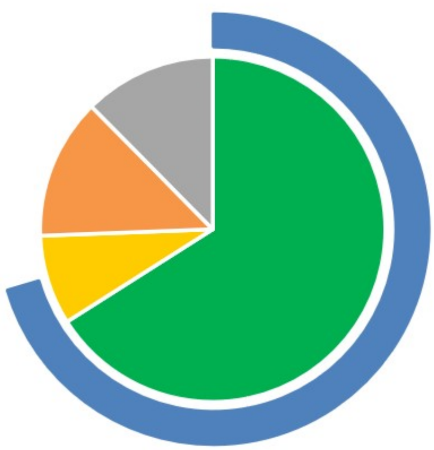
1. Irrigation (6pts) – Due to non-applicability for no irrigation, for 100% reduction the project should not be penalized.
2. Daylight (5pts) – Requirements for daylight credit are too stringent for Michigan schools. Stantec to push back CHPS on this and request examples where projects meet this requirement 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 project progresses through construction, providing further clarity toward confirming certain credit requirements that could not be confirmed during DD and CD given the level of detail which is typical at this stage.

Currently the project stands at 165 points in Targeted, 21 in Maybe-likely, 33 in Maybe-unlikely, and 31 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.



Available Points:	**250**
Targeting:	**165**
Possible/Likely:	**21**
Possible/Unlikely:	**33**
Not Possible:	31
Project Target:	**176 points in targeted during submission**

Figure 1 Current CHPS status

A copy of the current scorecard is included below.

US-CHPS 2.0 CHPS AAPS New School Construction - New Thurston Elementary

Discipline lead for each credit

Target: 176 The project requires 11 out of 21 pts from possible likely

Criteria	Title	Available Points	Targeted	Possible - Likely	Possible - Unlikely	Not Possible	Design Review	Construction Review		CHPS	Arch & ID	Mech	Elec	Struc	Civil	Land	Energy	Acou	Owner	CxA	CM
		250	165	21	33	31															
INTEGRATION																					
		35	24	1	6	4															
II P1.0	Integrated Design	1	1				D	C		X	X	X	X	X	X	X	X	X	X	X	X
II C1.1	Enhanced Integrated Design	2 for doing 1																			
II C1.1.1	Energy Modeling Variations		2				D	-			X	X	X				X		X		
II C1.1.2	Advanced Design Modeling	2					D	-		-	-	-	-	-	-	-	-	-	-	-	-
II C1.1.3	Cross-Category Workshops						D	-		-	-	-	-	-	-	-	-	-	-	-	-
II P2.0	Central Educational Display	1	1				D	C		X	X	X	X						X		
II C2.1	School as Learning Tool	5																			
II C2.1.1	Demonstration Areas	1	1				D	C		X	X	X	X					X	X		
II C2.1.2	Educational Integration/Environmental Curriculum	3			3		D	-		X	X	X	X						X		
II C2.1.3	School Gardens	1	1				-	C			X					X			X		
II C3.1	District Level Commitment (1-3 points)	3																			
II C3.1.1	CHPS Membership & Construction Resolution	1	1				D	-											X		
II C3.1.2	Benchmarking Resolution	2	2				D	-											X		
II C4.1	School Master Plan & Enhanced Plans (3-7 cumulative points)	7																			
II C4.1.1	School Master Plan or Commitment to Complete Sustainable Plan	3					-	C			X	X	X				X		X		
II C4.1.2	ZNE Master Plan	5	5				-	C			X	X	X				X		X		
II C4.1.3	Sustainable School Master Plan	6			1		-	C			X	X	X				X		X		
II C4.1.4	Sustainable School Climate Action Plan or Low/Zero Carbon School Master Plan	7			1		-	C			X	X	X				X		X		
II C5.1	Safer Schools by Design	1				1	D	-			X	X	X				X		X		
II C6.1	Low/Zero GHG Schools (1-6 points)	5																			
II C6.1.1	Energy Efficient, All Electric	1				0	D	C		-	-	-	-	-	-	-	-	-	-	-	-
II C6.1.2	100% Renewable Energy	1	1				D	C											X		
II C6.1.3	Low Embodied Carbon Materials	3	3				D	C		X	X			X							
II C6.1.4	Environmentally Preferable Refrigerants	1	1				D	-				X									
II C7.1	Design for Adaption & Resilience (1-5 points)	5																			
II C7.1.1	Climate Vulnerability Assessment	1	1				D	-		X											
II C7.1.2	Design for Climate Adaption	1		1			D	C		X	X	X	X	X	X	X	X		X		
II C7.1.3	Energy Resilience (1-2 points)	2				2	-	C		-	-	-	-	-	-	-	-	-	-	-	-
II C7.1.4	Passive Habitability/Survivability	1				1	D	C		-	-	-	-	-	-	-	-	-	-	-	-
II C8.1	Biophilic & Responsive Design	3																			
II C8.1.1	Biophilic Design	1	1				D	-			X					X					
II C8.1.2	Responsive Design	1	1				D	-			X		X			X		X	X		
II C8.1.3	Educational Curriculum Integration	1			1		D	-		X									X		
II C9.1	Innovation (1-2 points)	2	2				D	C		X	X	X	X	X	X	X	X	X	X	X	X

Criteria	Title	Available Points	Targeted	Possible - Likely	Possible - Unlikely	Not Possible	Design Review	Construction Review	CHPS	Arch & ID	Mech	Elec	Struc	Civil	Land	Energy	Acou	Owner	CxA	CM
		250	165	21	33	31														
INDOOR ENVIRONMENTAL QUALITY																				
		81	55	7	12	7														
EQ P1.0	Ventilation & IAQ	5	5				D	C			X									
EQ C1.1	Enhanced Ventilation, Filtration & Dedicated Outdoor Air System (1-11	11																		
EQ C1.1.1	Enhanced Filtration Media	1			1		D	C			X									
EQ C1.1.2	Enhanced Ventilation	5	5				D	-			X					X				
EQ C1.1.3	Dedicated Outdoor Air System	5	5				D	-			X					X				
EQ P2.0	Off-Gassing	2	2				D				X									
EQ C2.1	Pollutant & Chemical Source Control (6 points for 3 categories).	6																		
EQ C2.1.1	Walk Off Mats	3 of 6	2				D	C		X								X		X
EQ C2.1.2	Surface Dust Control		2				D	-		X			X	X						
EQ C2.1.3	Electric Ignitions for Gas-Fired Equipment						D	-			X	X								
EQ C2.1.4	No Mobile Fossil Fuel Powered Equipment Indoors		2				D	-			X	X						X		
EQ C2.1.5	Carbon Monoxide (CO) Sensors						D	-			X	X								
EQ C2.1.6	Electronic Product Environmental Assessment (EPEAT)						D	-										X		
EQ C3.1	Outdoor Moisture Management	2	2				D	C		X	X			X						X
EQ C4.1	Construction IAQ Management	5					-	C												X
EQ C4.1.1	SMACNA Guidelines for Occupied Renovations	1				1	D	C	X											X
EQ C4.1.2	SMACNA Guidelines for Duct Cleanliness - New Ducts Only	1	1				D	C	X											X
EQ C4.1.3	Building Flush Out	2		2			-	C												X
EQ C4.1.4	Mold Prevention/Moisture Management	1	1				D	C												X
EQ C5.1	Post-Construction Indoor Air Quality	1	1				D	C										X		
EQ P6.0	Low Emitting Materials	2	2				D	C	X	X										X
EQ C6.1	Additional Low Emitting Materials	6																		
EQ C6.1.1	*Adhesives & Sealants*	1	1				D	C	X	X										X
EQ C6.1.2	*Flooring Systems*	1	1				D	C	X	X										X
EQ C6.1.3	*Composite Wood & Agrifiber*	1	1				D	C	X	X										X
EQ C6.1.4	*Furniture & Furnishings*	1	1				D	C	X	X								X		X
EQ C6.1.5	*Paints & Coatings*	1	1				D	C	X	X										X
EQ C6.1.6	*Ceiling & Wall Systems*	1	1				D	C	X	X										X
EQ C7.1	Material Health Disclosures (1-2 points)	2	2				D	C	X	X										X
EQ C8.1	Drinking Water: Toxin-Free Plumbing (1-3 points)	3																		
EQ C8.1.1	Plumbing System Components	2				2	D	C			X			X						
EQ C8.1.2	District Resolution to Test Drinking Water	1	1				-	C										X		
EQ C9.1	Low Radon	1	1				D	C		X	X		X					X		
EQ C10.1	Thermal Comfort – ASHRAE 55	2				2	D	-			X									
EQ C11.1	Controllability of Indoor Environment	2		2			D	C		X	X									
EQ P12.0	Daylight: Glare Protection	4	4				D	-		X		X								
EQ C12.1	Daylight Availability (1-5 points)	5																		
EQ C12.1.1	All Classroom Spaces (1-3 points)	3			3		D	-		X		X								
EQ C12.1.2	All Support Spaces (1-2 points)	2			2		D	-		X		X								
EQ C13.1	Views (1-3 points)	3	2			1	D	-		X										
EQ C14.1	Electric Lighting Performance & Circadian Lighting (2-7 points)	7																		
EQc14.1.1	High Performance Lighting	2			2		D	C				X								
EQc14.1.2	Illuminatrion Levels & Multimodal Systems	2		2			D	C				X								
EQc14.1.3	Lighting Controls	1		1			D	C				X								
EQc14.1.4	Superior Performance Lighting Systems	1	1				D	C				X								
EQc14.1.5	Circadian Lighting	1				1	-	C				X								
EQ P15.0	Acoustical Performance	7	7				D	C		X	X						X			
EQ C15.1	Enhanced Acoustical Performance	5					D	C		X	X						X			
EQc15.1.1	Reverberation Time	1	1							X							X			
EQc15.1.2	Background Noise	2			2					X	X						X			
EQc15.1.3	Noise Isolation	2			2												X			

Criteria	Title	Available Points	Targeted	Possible - Likely	Possible - Unlikely	Not Possible	Design Review	Construction Review	CHPS	Arch & ID	Mech	Elec	Struc	Civil	Land	Energy	Acou	Owner	CxA	CM
		250	165	21	33	31														
ENERGY																				
		57	**45**	**0**	**6**	**6**														
EE P1.0	Energy Efficient Design	5	5				D	-								X				
EE C1.1	Superior Energy Efficient Design & Zero Net Energy (1-34 points)	34	30			4	D	-		X	X	X				X				
EE P2.0	Commissioning	4	4				D	C										X	X	
EE C2.1	Enhanced Commissioning (1-3 points)	3																		
EE C2.1.1	Certified Commissioning Professional	1	1				D	-											X	
EE C2.1.2	Building Envelope Commissioning	2	2				D	C											X	
EE C3.1	Energy Management Systems & Submetering	9																		
EE C3.1.1	Systems Control	3	3				D	-			X	X								
EE C3.1.2	Automated Demand Management	3			3		D	-			X	X								
EE C3.1.3	Submetering/Data Acquisition & Storage	3			3		D	-			X	X								
EE C4.1	Advanced Ventilation Strategies	2																		
EE C4.1.1	Natural Ventilation	1				1	D	C	-	-	-	-	-	-	-	-	-	-	-	-
EE C4.1.2	Energy Conservation Interlocks	1				1	D	-	-	-	-	-	-	-	-	-	-	-	-	-
WATER																				
	Workbook Total: 20	**20**	**9**	**2**	**3**	**6**														
WE P1.0	Indoor Potable Water Use Reduction	4	4				D	C			X									
WE C1.1	Enhanced Indoor Water Use Reduction (2-7 points)	7																		
WE C1.1.1	Calculated Water Savings (2-5 points)	5		2	3		D	C			X									
WE C1.1.2	Efficient Appliances	2	2				D	-			X	X								
WE P2.0	Outdoor Water Use Reduction	3	3				D	-							X					
WE C2.1	Enhanced Outdoor Water Use Reduction (1-5 points)	5																		
WE C2.1.1	Non-Recreational Irrigation (1-3 points)	3				3	D	C	X						X					
WE C2.1.2	Recreational Irrigation (1-2 points)	2				2	D	C	X						X					
WE C3.1	Irrigation Systems Commissioning	1				1	D	C	X						X				X	
SITES																				
		23	**10**	**7**	**1**	**5**														
SS P1.0	Environmental Site Assessment	3	3				D	-										X		
SS C2.1	Sustainable Site Use & Sensitive Lands Conservation (1-3 points)	3																		
SS C2.1.1	Sustainable Site Use	1	1				D	-	X	X				X	X					
SS C2.1.2	Sensitive Lands Conservation	1			1		D	-	X					X	X					
SS C2.1.3	Additional Sensitive Lands Conservation	1				1	D	-	X					X	X					
SS C3.1	Stormwater & Sedimentation Management	6																		
SS C3.1.1	Erosion & Pollutant Control During Construction	2	2				D	C												X
SS C3.1.2	Stormwater & Pollutant Control Post-Construction	4		4			D	C						X						
SS C4.1	Central Location & Near Public Transportation	3																		
SS C4.1.1	Proximity to Students & Community Services	2				2	D	-	X											
SS C4.1.2	Availability of Public Transit System	1	1				D	-	X											
SS C5.1	Joint Use of Facilities	1																		
SS 5.1.1	Interior Joint Use	1			0		D	-	X	X								X		
SS 5.1.2	Joint Use of school grounds			1			D	-	X	X								X		
SS C6.1	Human-Powered Transportation (1-2 points)	2																		
SS C6.1.1	Bike Accomodation	1	1				D	C						X				X		
SS C6.1.2	Community Bike Lanes	1			0		-	C						X				X		
SS C6.1.3	Walking School Bus/Safe Routes to School			1			-	C										X		
SS C7.1	Reduce Heat Islands (1-3 points)	3																		
SS C7.1.1	Non-Roof & Impervious Surfaces	2				2	D	-	-	-	-	-	-	-	-	-	-	-	-	-
SS C7.1.2	Roofs & Walls/Trellises	1	1				D	C		X										
SS C8.1	Light Pollution Prevention	2																		
SS C8.1.1	Auto Controlled Outdoor Lighting	1		1			D	-				X								
SS C8.1.2	Outdoor Lighting Specifications	1	1				D	C				X								

Criteria	Title	Available Points	Targeted	Possible - Likely	Possible - Unlikely	Not Possible	Design Review	Construction Review		Responsibility											
		250	165	21	33	31				CHPS	Arch & ID	Mech	Elec	Struc	Civil	Land	Energy	Acou	Owner	CxA	CM
MATERIALS & WASTE																					
	Workbook total: 16	**16**	**11**	**0**	**2**	**3**															
MW P1.0	Storage and Collection of Recyclables & Organic Waste	2	2				D	C		X	X								X		
MW C1.1	Food Waste Reduction & Prevention	3																			
MW C1.1.1	Share Table	1	1				D	C			X								X		
MW C1.1.2	Storage & Donation	1	1				D	C			X	X							X		
MW C1.1.3	Composting	1	1				D	C			X								X		
MW C2.1	Construction Site Waste Management (1-4 points)	4																			
MW C2.1.1	Recycle, Reuse, Salvage (1-3 points)	3	2		1		D	C		X									X		X
MW C2.1.2	Waste Recovery Plan	1				1	D	C		-	-	-	-	-	-	-	-	-	-	-	-
MW C3.1	Certified Wood & Recycled Content Materials	3																			
MW C3.1.1	Certified Wood	1	1				-	C		X	X										X
MW C3.1.2	Recycled Content (1-2 points)	2	1		1		-	C		X	X			X							X
MW C4.1	Building Reuse (1-2 points)	2				2	D	C			X								X		X
MW C5.1	Environmental Product Declarations	2	2				-	C		X	X										X
OPERATIONS & METRICS																					
	Workbook total: 18	**18**	**11**	**4**	**3**	**0**															
OM P1.0	Facility Staff & Occupant Training	2	2				-	C											X	X	
OM C2.1	Post-Occupancy Transition	2	2				-	C		X									X		
OM P3.0	Energy & GHG Performance Benchmarking	4	4				D	-									X		X		
OM C4.1	High Performance Operations & Systems Management Plan (1-4 points)	4																			
OM C4.1.1	Monitoring & Benchmarking	1		1			-	C				X	X						X		
OM C4.1.2	Designated Resource Manager	1	1				-	C											X		
OM C4.1.3	Designated Advocate	1			1		-	C											X		
OM C4.1.4	Systems Maintenance Plan	1	1				-	C											X	X	
OM C5.1	Indoor Environmental Management (1-4 points)	4																			
OM C5.1.1	Indoor Environmental Management Plan	1			1		-	C											X		
OM C5.1.2	Green Cleaning	2		2			-	C											X		
OM C5.1.3	Integrated Pest Management	1		1			D	C											X		
OM C6.1	Anti-Idling Measure	1			1		D	C											X		
OM C7.1	Green Power	1	1				D	-											X		

Note: It is the responsibility of the individuals and disciplines identified in the responsibility column of a given credit/prerequisite to incorporate the requirements of that credit/prerequisite into the design and construction of the building. The role of the CHPS consultant is to provide support and coordination to the project team for the achievement of these credits/prerequisites. If there are questions or concerns about the requirements of a credit/prerequisite, it is up to the party responsible for that credit/prerequisite to approach the CHPS consultant for clarification. If there are concerns about the assignment of responsibility for the CHPS credit/prerequisite, it is up to the concerned party to discuss the assignment with the CHPS consultant.

This checklist is intended as an overview only. Please refer to the US-CHPS v2.0 Reference guide here:
https://static1.squarespace.com/static/642de662bb454d02a92440d4/t/644ab8a80931317c3ff1d15c/1682618539169/US-CHPS+Criteria+v2.0+2020_0.pdf

2.0 ENERGY MODELLING

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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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2.1 INTRODUCTION

This report represents the energy model at the 100% Construction Documentation (CD) 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, 89,165 ft2 (8,283 m2).

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

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

The energy model has been updated according to the 100% CD design drawings. The table below presents the results of the updated analysis.

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 Baseline	140.0	N/A	N/A	N/A
Proposed Design	14.3	90%	82%	30

2.2 PROJECT OVERVIEW AND ENERGY EFFICIENCY GOALS

The project consists of a two-story school with a total floor area of approximately 89,165 ft2 (8,283 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:

1. Reach an EUI of 25 kBtu/ft2/year
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.

This report 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 Appendix G baseline scenario. The energy savings associated with the design determines how many points are achieved towards certification. Error! Reference source not found. outlines the points rewarded for achieving a certain percentage improvement compared to the ASHRAE 90.1-2016 Appendix G baseline. There are 30 available points for improving the energy efficiency of the facility compared to the ASHRAE 90.1-2016 Appendix G baseline.

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

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 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.

2.3.2 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 Documentation 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 100% 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 – Appendix G)		
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 2024.0.0.0		
Reference Standard(s)	ASHRAE 90.1- 2016 Appendix G.		
Modelled Floor Areas	89,165 ft^2 (8,283 m^2)		
Architectural			
	Proposed Design		**ASHRAE 90.1-2016 Appendix G**
Overall Above Grade Wall R-value	R21 / USI-0.271 (R-value as per 5.1.71 and 5.1.84 of Thermal bridging guide v 1.6)), Assembly details as per 100% Architectural drawing set		ASHRAE 90.1-2016 Zone 5A Wall: R-11.9 / USI – 0.47
	3 5/8" BRICK VENEER 1 1/4" AIR SPACE 5" MINERAL WOOL INSULATION W/ ADJUSTABLE BRICK TIES @ 16" O.C. FLUID APPLIED SELF HEALING AIR BARRIER / VAPOR BARRIER 5/8" TYPE-X GLASS-MAT EXTERIOR SHEATHING	1X6 NOM, HORIZONTAL COMPOSITE WOOD VENEER 6 1/2" AIR SPACE 5" MINERAL WOOL INSULATION W/ 6" FIBERGLASS GIRT W/ ADJUSTABLE, CONT GALV METAL RAIL FLUID-APPLIED SELF-HEALING AIR BARRIER / VAPOR BARRIER	

2.0 ENERGY MODELLING

	CHPS for Schools Baseline (ASHRAE 90.1-2016 – Appendix G)		
	6" CFMF BACK-UP, RE: STRUCT FOR ADDITIONAL INFO 5/8" TYPE-X GYPSUM BOARD	5/8" TYPE-X GLASS-MAT EXTERIOR SHEATHING 6" CFMF BACK-UP, RE: STRUCT FOR ADDITIONAL INFO 5/8" TYPE-X GYPSUM BOARD	
Overall, Roof R-value	Flat roof R34 / USI-0.17		ASHRAE 90.1-2016 Zone 5A Roof: R-15.9 / USI – 0.36
	TPO ROOF MEMBRANE 1/2" ROOF COVER BOARD 6" MIN RIGID INSULATION (2 LAYERS, STAGGER JOINTS) FLUID-APPLIED AIR BARRIER / VAPOR RETARDER 5/8" TYPE-X ROOF SUBSTRATE BOARD CLT ROOF DECK, RE: STRUCT	TPO ROOF MEMBRANE 1/2" ROOF COVER BOARD 6" MIN RIGID INSULATION (2 LAYERS, STAGGER JOINTS) FLUID-APPLIED AIR BARRIER / VAPOR RETARDER 5/8" TYPE-X ROOF SUBSTRATE BOARD METAL ROOF DECK, RE: STRUC	
Slab-on-grade F-Value	R-7.5@1.2mPerimeter 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
Window-to-wall ratio	~21%		ASHRAE 90.1-2016 Building School type: 22%
Overall, Glass U-value including frame and SHGC	Proposed glazing specifications. U-0.33, R 3.03 / USI 1.87 2" X 4 1/2" THERMALLY BROKEN STOREFRONT SYSTEM, FRONT GLAZED 1" GLAZING UNIT (RE: ELEVATIONS)		ASHRAE 90.1-2016 + Zone Window: R 1.75/ USI – 3.23
	SHGC = 27%		SHGC = 39%
Infiltration	0.15 CFM/ ft^2 façade) Sources: ASHRAE 90.1 2016 App. G		
External Wall Area (ft^2)	51,665 ft^2		51,665 ft^2
Roof Area (ft^2)	57,743 ft^2		

2.0 ENERGY MODELLING

<table>
<tr><th></th><th colspan="3">CHPS for Schools Baseline
(ASHRAE 90.1-2016 – Appendix G)</th></tr>
<tr><td colspan="4">Electrical</td></tr>
<tr><td></td><td colspan="2">Proposed Design</td><td>ASHRAE 90.1-2016</td></tr>
<tr><td rowspan="16">Lighting Power Density (LPD)</td><td>Space Type</td><td>W/ft²</td><td>W/ft²</td></tr>
<tr><td>Classroom</td><td>1.04</td><td>1.40</td></tr>
<tr><td>Office</td><td>0.28</td><td>1.10</td></tr>
<tr><td>Workshop</td><td>0.57</td><td>1.40</td></tr>
<tr><td>Corridor</td><td>0.10</td><td>0.50</td></tr>
<tr><td>Vest</td><td>0.01</td><td>0.50</td></tr>
<tr><td>Washroom</td><td>0.12</td><td>0.90</td></tr>
<tr><td>Storage</td><td>0.08</td><td>0.80</td></tr>
<tr><td>Stairs</td><td>0.01</td><td>0.60</td></tr>
<tr><td>Mech/ Elec</td><td>0.33</td><td>1.50</td></tr>
<tr><td>Gym</td><td>0.16</td><td>1.40</td></tr>
<tr><td>Lobby</td><td>0.33</td><td>1.30</td></tr>
<tr><td>Café</td><td>0.12</td><td>0.90</td></tr>
<tr><td>Kitchen</td><td>0.12</td><td>1.20</td></tr>
<tr><td>Library</td><td>0.19</td><td>1.20</td></tr>
<tr><td colspan="2">Proposed lighting power densities as per 100% CD electrical drawings.</td><td></td></tr>
<tr><td>Lighting Controls</td><td colspan="2">Occupancy sensors and daylight sensors are included. (OS reduction was taken based on ASHRAE 90.1 2016 Table G3.7)</td><td>None</td></tr>
<tr><td>Equipment Load</td><td colspan="3">1.73 W/ ft² (For educational workshop, offices)
(0.5 W/ft² –all other spaces as per Table G-4 ASHRAE 90.1 User manual)</td></tr>
<tr><td colspan="4">Operation</td></tr>
<tr><td>Indoor Design Temperature</td><td colspan="3">Heating Setpoint: 22.2 ºC (72 ºF), Cooling Setpoint:23.9 ºC (75 ºF)
• Cafeteria
• Classroom
• Classroom/ Preschool to 12th grade
• Conference / Meeting room
• Copy / Print Room
• Corridor/ Transition
• Food preparation
• Gymnasium/ Fitness center
• Library
• Lobby
• Lounge/ Breakroom</td></tr>
</table>

2.0 ENERGY MODELLING

	CHPS for Schools Baseline **(ASHRAE 90.1-2016 – Appendix G)**	
	• Office • Restroom • Stairs • Storage Rooms that require a heating supply of only 20 ºC (68 ºF): • Vestibules • Mechanical Room	
Occupancy	75 (ft^2/Person)	
Mechanical		
Heating/ Cooling Plant	**Heating / Cooling** DOAS - Four-pipe fan coil served by the hot water and chilled water loops. The cooling loop is supplied by a water-to-water heat pump system that rejects heat to the geothermal field with a fluid cooler backup if the geo-field is completely saturated. The heating system is the same water-to-water heat pump loop and pulls heat from the geothermal field with an Elec boiler backup. (All spaces except electrical and mechanical rooms and vestibules, storages, fitness area and library) Separate DOAS units for the fitness area and the library spaces. Mechanical rooms, Storages, Vestibules: Cabinet Unit Heaters Electrical rooms: AC units Heating COP: 3.7 Cooling COP: 4.3 As per the central plant heat pump cut sheet	**System 5:** Packaged VAV with Reheat as per ASHRAE 90.1 section G3.1.1 **Heating:** Boiler: 80% efficient **Cooling:** DX Cooling (COP 3.28)
Loop Temperature Supply Setpoint	Min Source Temperature for heating -4 ºF Min Source Temperature for cooling 122 ºF	Hot water: 180 ºF with reset per outdoor temperature as per ASHRAE 90.1 section G3.1.3.4
Dehumidificatio n	Yes, Dehumidification setpoint: 55%	
Pump Power	GEHP: 22.2 W/gpm CHWP: Primary 2.30 W/gpm, Secondary 7.17 W/gpm HWHP: Primary 3.03 W/gpm, Secondary 4.57 W/gpm	Hot water: 19 W/gpm
Pump Control	Variable	Variable
Fan Power	Central fan: varies from 0.7 kW to 8.5 kW for each RTU (as per mechanical cut sheets)	As per ASHRAE 90.1 section G3.1.2.9

2.0 ENERGY MODELLING

	CHPS for Schools Baseline (ASHRAE 90.1-2016 – Appendix G)	
	Interior fan: ~0.30 W/cfm (as per mechanical cut sheets)	
Fan Control	Variable	Variable
Outdoor Air Ventilation	As per Mechanical calculation.	
Preheat coil & Energy Recovery	RTU 1,2,3 – 72% RTU 4 – 67% RTU 5 – 78% RTU 6 – 81% RTU 7 – 73% RTU 8 – 75% RTU 9 – 68% As per 100% CD Mechanical drawings. Preheat coil target temperature RTU 1,2,3,4,6,7,9: 5 ºF RTU 5,8: None	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.
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)

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/ft^2 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.

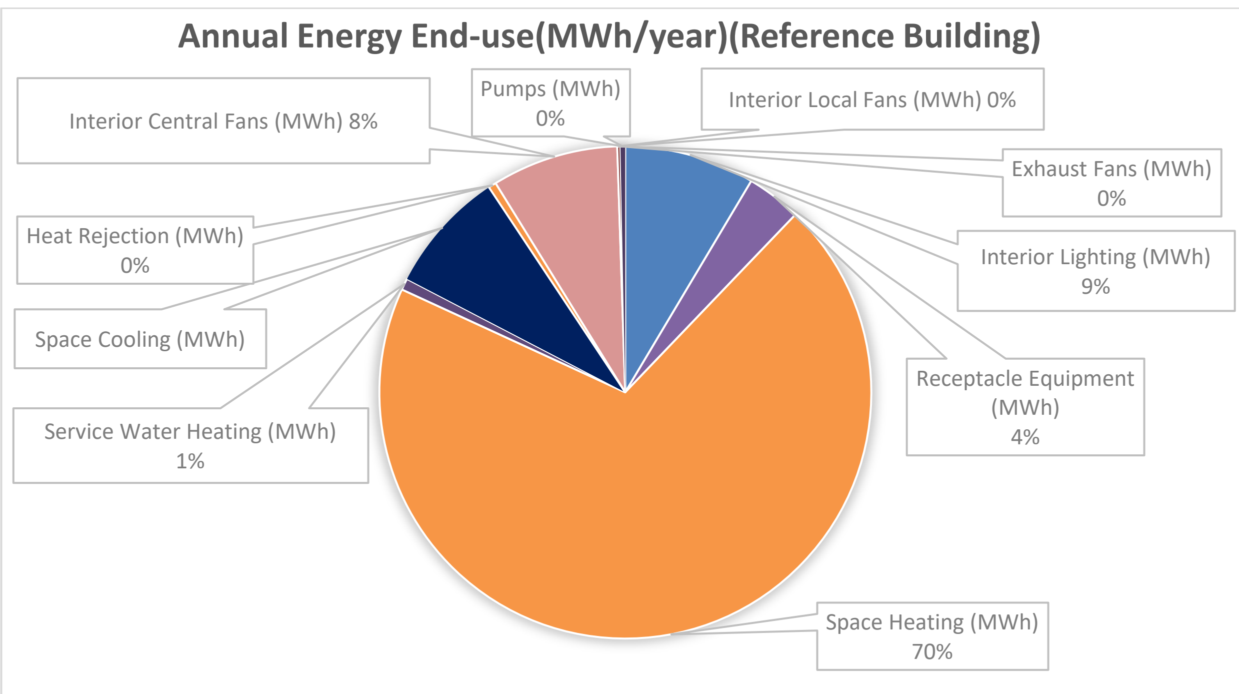

Figure 2: ASHRAE 90.1-2016 Reference Energy end-use consumption breakdown

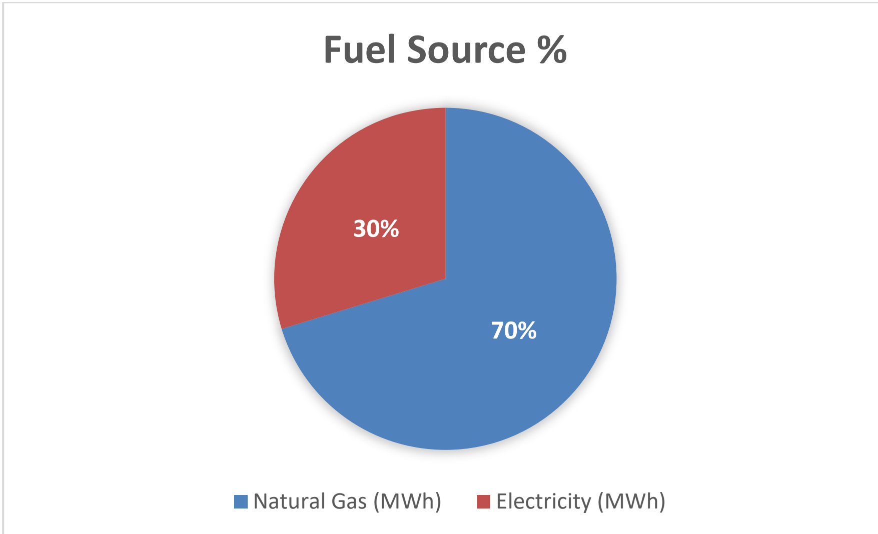

Figure 3: ASHRAE 90.1-2016 Reference Energy consumption by fuel type

2.3.3.2 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 267kW 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.

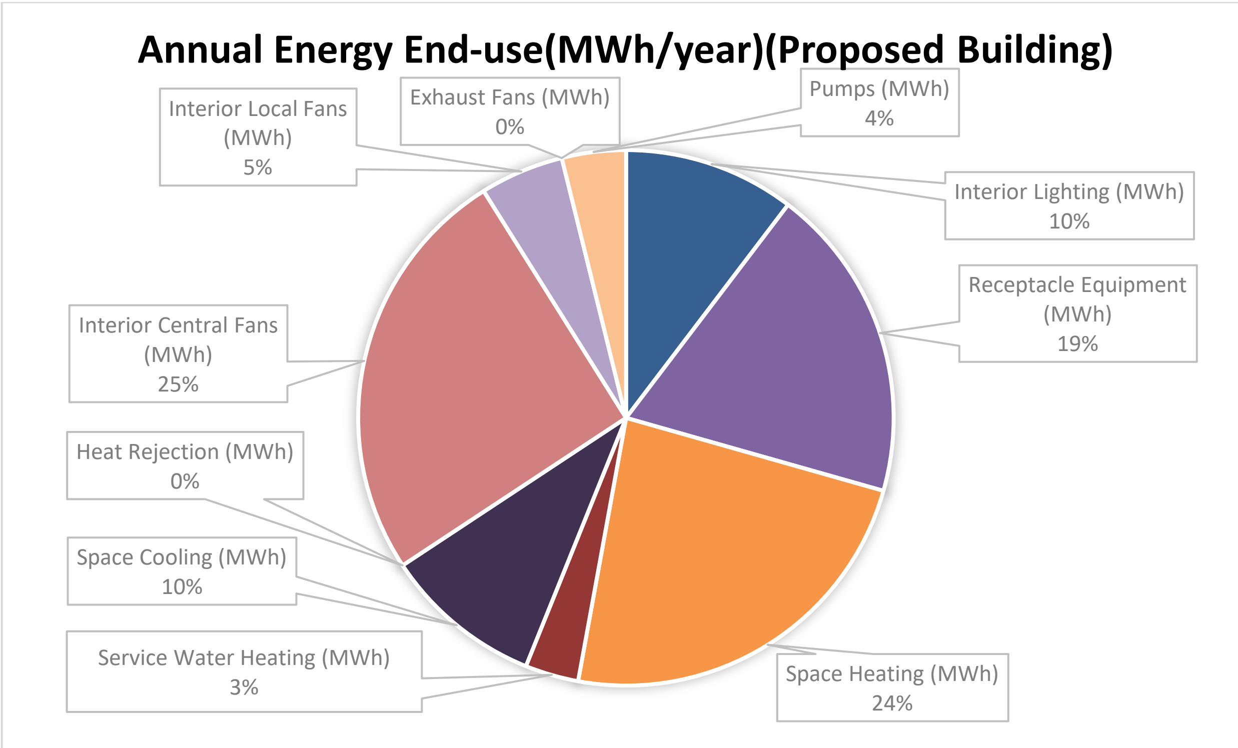

Figure 4: Proposed Energy end-use consumption breakdown

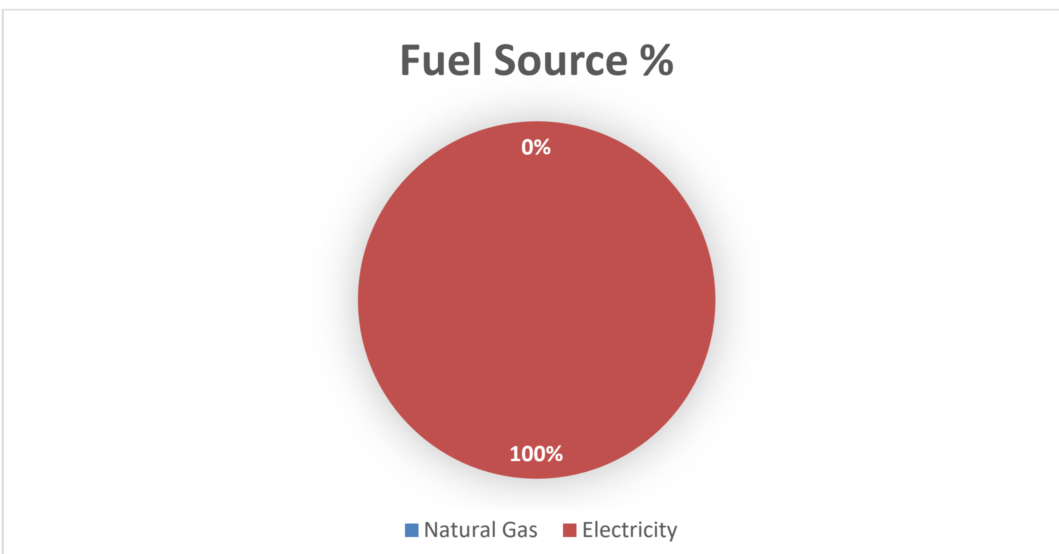

Figure 5 :Proposed Model Energy consumption by Fuel Type

Table 4 - Energy End-Use Consumption breakdown

Energy End Use	Proposed Model (MWH)	ASHRAE 90.1-2016 baseline (MWH)	Saving (%)
Interior Lighting	72.7	316.3	77%
Receptacle Equipment	133.5	133.5	0%
Space Heating	164.5	2578.3	94%
Service Water Heating	22.7	28.4	20%
Space Cooling	67.4	297.2	77%
Heat Rejection	0.1	19.0	100%
Central fans	178.0	307.5	42%
Local fans	35.4	7.4	-379%
Pumps	27.1 [1]	11.8	-130%
Total	**701.3**	**3699.3**	**81%**

1. The pump energy was reduced by 75% to show the Variable Flow. The Modeling software cannot account for Variable Flow for GEHP.

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) without PV production	701.3	3699.3	81%
PV panel production (MWh/year)	327.8	-	-
Final Energy consumption (MWh/year) including PV production	**373.5**	**3699.3**	**90%**

Table 6 – Energy use intensity with PV panel production

EUI (kBTU/ft2/year)	Proposed Building
EUI without PV	26.9
EUI with PV (100% CD)	**14.3**

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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3.1 INTRODUCTION

A preliminary Life Cycle Assessment (LCA) of the Thurston Elementary project was performed using the Bid Package design reports 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 proposed design can achieve approximately a 14.16% 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 in three product categories.

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.

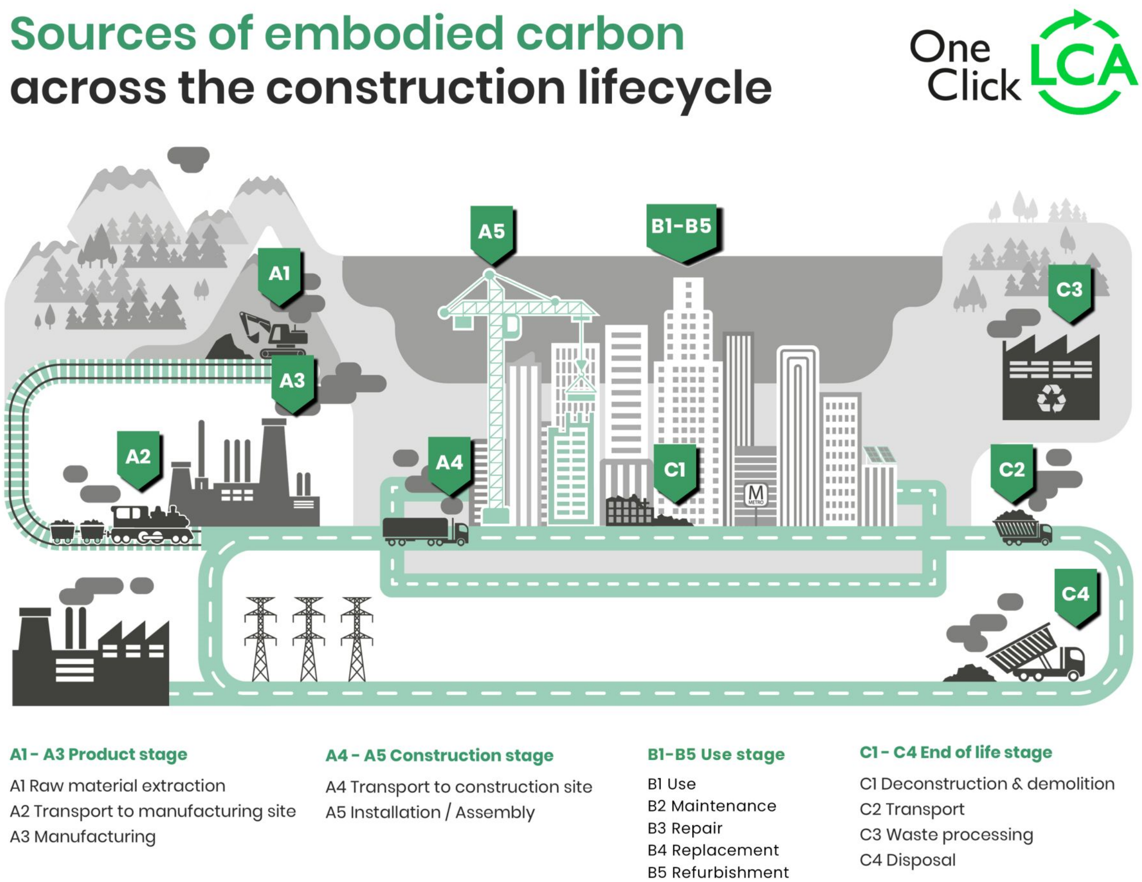


Figure 6. Life Cycle Stages according to EN standards[1]

Since the goal of the assessment was primarily embodied carbon, the Global Warming Potential (GWP), represented in kilograms of CO_2 equivalent (kg CO_2e), 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

3.4.1 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 100% Construction Documentation 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, primarily in the CLT roof and concrete mixes.

Once the baseline was developed, scenarios were analyzed to reduce the overall embodied carbon of the project through replacing specific envelope materials with alternate materials being considered by the design team to determine which option has a lower embodied carbon per functional unit (cubic meter, kg, etc).

Where material parameters were not explicitly specified in the design, assumptions were drawn based on best practice or past project experience.

3.4.4 Assumptions

The data drawn from the 100% Construction Documentation 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
  - For concrete mixes, no supplementary cementitious material (SCM, fly-ash, slag, etc) was assumed in the baseline. The proposed used the industry average mixes for Eastern US, which averages concrete across suppliers and mix designs for respective strength concretes, so some fly ash would be included. The specifications indicate a maximum 25% SCM, so actual results would likely be better but will depend on concrete supplier data.
  - Rebar mass per cubic meter of concrete was assumed to be 85kg/m^3.
  - Rebar was assumed to have 80% average recycled content.
- External Walls
  - All assemblies as per CD drawings, with spray foam assumed in place of the mineral wool in the baseline.
  - Assumed double pane aluminium framed windows throughout.
  - The Trespa product EPD was not in the OneClick database, so an extruded aluminum cladding product from Longboard was used instead, which has a similar embodied carbon per functional unit to Trespa.
  - A generic clay brick EPD, which includes the preferred supplier Belden, was used as the baseline and proposed.
  - A cast stone product was not available in OneClick LCA, so a natural stone was used in both the baseline and proposed.
  - A metal frame wall system construction from OneClick LCA was used for the backup wall of all external walls, but the thickness of insulation included in this construction was reduced to 0.00001 to eliminate the impacts.
- Super Structure
  - 3 Ply and 5 Ply CLT with 2.25" of concrete topping was used in the proposed as per the drawings. These were substituted with a standard composite metal deck construction (metal deck, concrete and rebar) in the baseline with the same areas as the CLT floors.

- The CLT stair construction was provided as a volume of CLT, whereas the available EPD in OneClick for a corresponding concrete stair was provided in meters of height. The volume was converted assuming a standard 10ft floor to floor

- The specifications call for structural steel to have a recycled content of no less than 25%. OneClick LCA does not have an EPD with 25% recycled content so one with 20% was used in both baseline and proposed.

3.5 RESULTS

The overall baseline for the project is currently indicating that there are 5,081.03 metric tonnes of CO_2e in the structural and envelope materials for new construction. The proposed design contains 4,361.64 metric tonnes of CO_2e.

When compared with the current proposed CD design, the project is achieving a 14.16% reduction in embodied carbon primarily due to the use of CLT roof construction and more sustainable concrete mixes.

Earlier stages of the LCA focused on various envelope alternatives, and several of the recommendations were incorporated in the CD design, including an increase in the overall proportion of brick cladding, which has a lower GWP than the alternatives considered for this project.

Biogenic Carbon

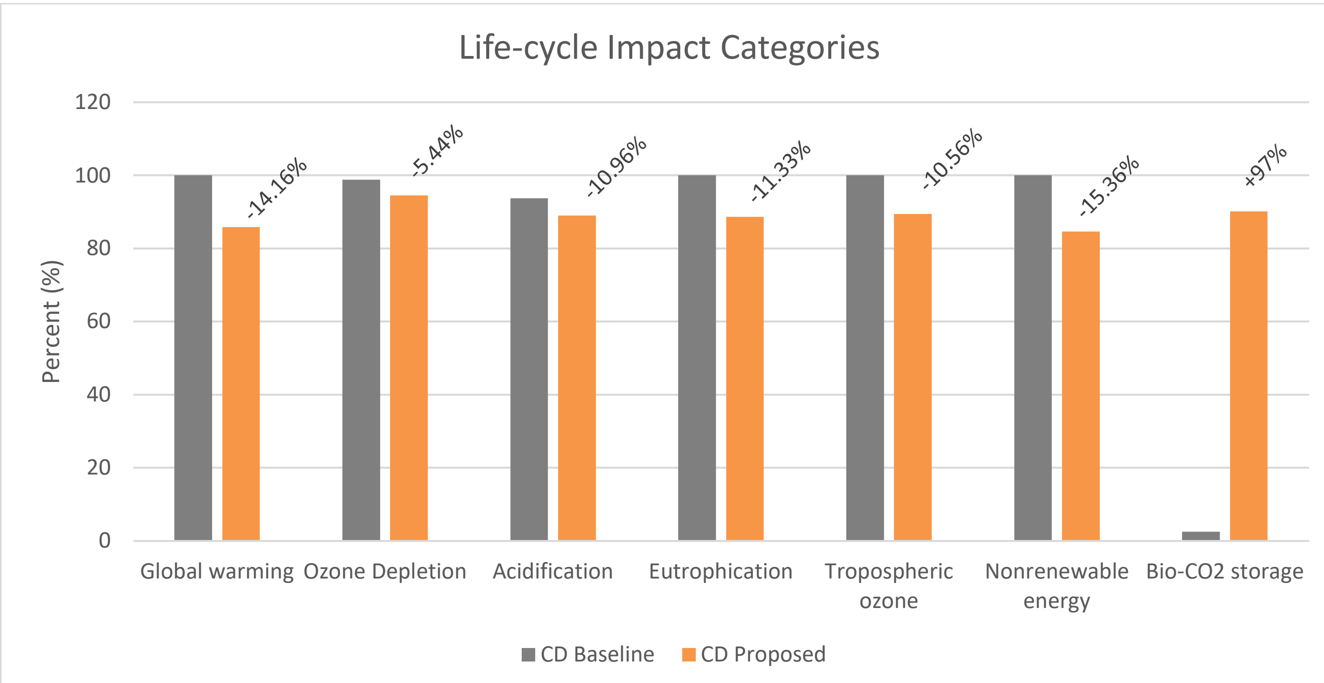
Not included in this reduction is the biogenic carbon from the cross laminated timber (CLT) and other wood products, which was calculated to be 1,111.2 tonnes. This would represent approximately 26.8% additional savings from the baseline. However, biogenic carbon is still not accounted for in most LCA methodologies due to ongoing research into the full lifecycle impacts of deforestation and sequestering carbon in bio-based materials.

Sensitivity Analysis

As this was the analysis for the 100% Construction Documentation set, no sensitivity analysis was performed on the model at this stage, simply a comparison of the baseline and proposed models. Please refer to the DD report for sensitivity analysis done on envelope cladding options.

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 5 of 6 impact categories, with biogenic carbon discussed previously as being outside of scope.



3.6 CONCLUSION & RECOMMENDATIONS

Based on the above results, the project is achieving the target of 10% reduction in embodied carbon and CHPS II C6.1.3 Low Embodied Carbon Materials credit reducing embodied carbon emissions in concrete, steel and insulation.

The following recommendations are presented for the design team and contractor to consider as construction begins.

- Follow specifications for concrete and explore maximum fly-ash content where possible.
- Explore CarbonCure™ or other similar technologies to reduce carbon emissions in concrete even further.
- Recommend increasing the percentage of recycled content in structural steel from 25% to at least 60%, and try to source steel products from suppliers with strong documentation practices.

3.7 BASELINE BILL OF MATERIALS

Resource name	Product Category Rules (PCR)	Technical specification	Upstream database	Quantity	Units
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	One Click LCA	331.092	m2
Aluminium framed stick curtain wall system with clear float glass insulating unit, double glazed	EN15804+A1, EN15804+A2	4-16-4, 36.4 kg/m2, 50% recycled aluminium	One Click LCA, LCA Commons, Plastics Europe	331.092	m2
Clay brick	PCR for Clay Brick, Clay Brick Pavers and Structural Clay Tile	2120 kg/m3	ecoinvent	289.257	m3
Composite roof system, corrugated metal deck, reinforced concrete 4400/5400 psi, external insulation (R25), climate zones 2 & 3		with US industry average EPDs	Other	8115.816828	m2

3.0 WHOLE BULDING LIFE CYCLE ASSESSMENT (WBLCA)

Resource name	Product Category Rules (PCR)	Technical specification	Upstream database	Quantity	Units
Concrete assembly for stairs and elevator shafts per 3.2 ft (1 m) height		with US industry average concrete EPD	Other	46	m
Concrete, ready mix	NSF PCR for Concrete Version 1 (February 22, 2019)	3001 - 4000 psi, (C20/25)	ecoinvent	686.744	m3
Concrete, ready mix	NSF PCR for Concrete Version 1 (February 22, 2019)	4001 - 5000 psi (C30/35)	ecoinvent	1232.63	m3
EPDM membrane roofing	LCIA: TRACI 2.1, GWP IPCC 2013	0.1in	GaBi	5757.75	m2
Extruded aluminium	PCR Part B for Aluminum Construction Products	2700 kg/m3	GaBi	7.622	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)	One Click LCA	4052.477	m2

3.0 WHOLE BULDING LIFE CYCLE ASSESSMENT (WBLCA)

Resource name	**Product Category Rules (PCR)**	**Technical specification**	**Upstream database**	**Quantity**	**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	107.12	ton
Metal frame wall system, 2x4, 16 inches spacing, cavity insulation (R13) and external insulation (R5); climate zone 2 (except 2R)		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	Other	4052.477	m2

Resource name	Product Category Rules (PCR)	Technical specification	Upstream database	Quantity	Units
Natural stone cladding	ULE PCR Part B: Cladding Product Systems EPD requirements v2.0, 2021	56.77mm, 86.85 kg/m2, mortar and connectors included	ecoinvent	97.79	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	52.92	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	5757.75	m2
Reinforcement steel (rebar), generic	EN15804+A1	80% recycled content, A615	One Click LCA	163146.733	kg
Single wythe (layer) masonry CMU wall, without insulation, per sq.ft		including: grouting mortar, normal weight CMUs, waterproofing membrane and vertical reinforcement	Other	1561.945	m2

Resource name	Product Category Rules (PCR)	Technical specification	Upstream database	Quantity	Units
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/m3 average density	GaBi	4441.015	m2
Steel door frame	PCR Guidance for Building-Related Products and Services: Commercial Steel Doors and Steel Frames EPD Requirements, UL 10010-27. Version: September 1, 2020	1.51 mm, depth 5.75 inch, 21.3 kg/unit	ecoinvent	24	unit

Resource name	Product Category Rules (PCR)	Technical specification	Upstream database	Quantity	Units
Steel flush door with polystyrene core	PCR Guidance for Building-Related Products and Services: Commercial Steel Doors and Steel Frames EPD Requirements, UL 10010-27. Version: September 1, 2020	1.21 mm, 3 ft x 7 ft, 42.1 kg/unit	ecoinvent	24	unit
Structural steel profiles, generic	EN15804+A1	20% recycled content, I, H, U, L, and T sections, S235, S275 and S355	One Click LCA	544.34	ton
Thermoplastic polyolefin (TPO) membrane roofing	LCIA: TRACI 2.1, GWP IPCC 2013	0.06in	GaBi	5784.21	M2

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/ft^2/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.