Lexington High School

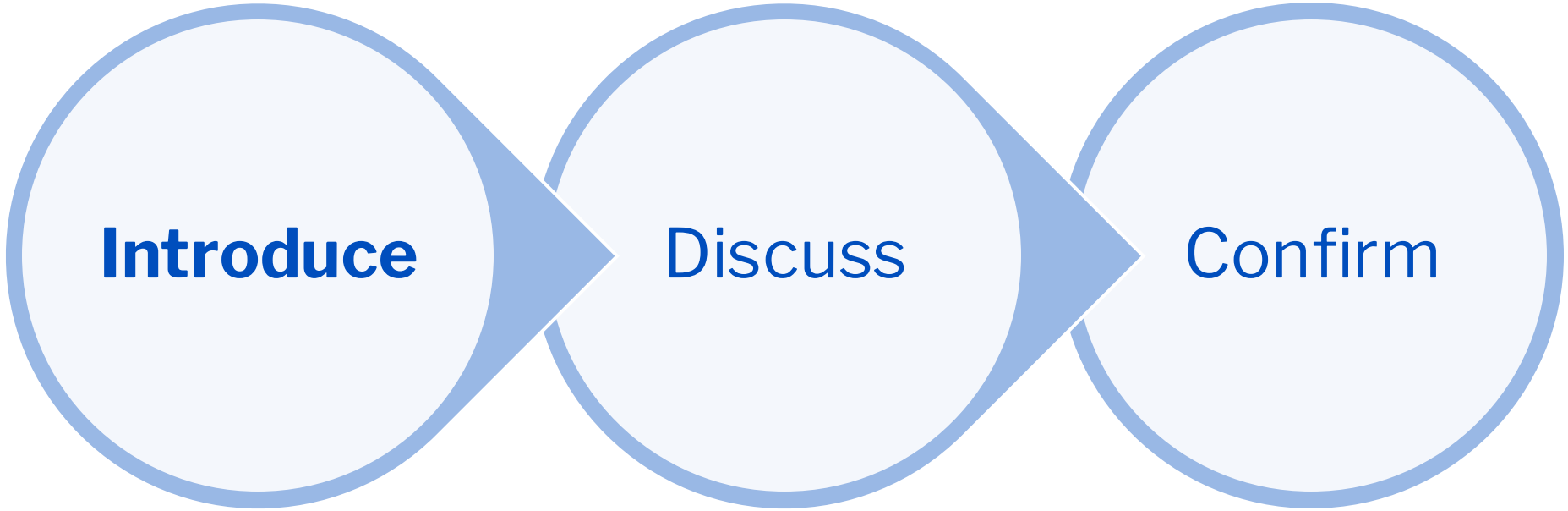
Permanent Building Committee Meeting

01/23/2025

Agenda

1. Add/Reno Field House Scope & Constructability
2. Mass Timber vs. Structural Steel
3. Define Assumed Floor to Floor Heights & Typical Ceiling Heights

Add/Reno Field House Scope & Constructability



Add/Reno Field House Scope & Constructability

PSR Site Plan

Add/Reno Field House Scope & Constructability

Program

- Total 48,000 Gross Floor Area in the Addition/Renovation
- 146m or 200m Track to be studied
- Existing space within Field House includes:
  - 3,300 sf Alternative PE
  - 679 sf Weight Room and Storage

Appropriate space allocations for future uses within the expanded Field House footprint will be determined in the current round of Schematic Design Programming meetings, which are ongoing.

Field House Programming and space priorities were discussed in a meeting with Physical Education, Athletics, and Recreation Departments on Tuesday, January 14 at LHS. A follow-up meeting is being scheduled.

A precise survey is being planned to support more detailed investigations of the options.

Add/Reno Field House Scope & Constructability

PSR Ground Floor Plan

Add/Reno Field House Scope & Constructability

Early Investigations – Domed Roof

- Maintain southeast half of foundation wall
- All new exterior shell, structure, and slab on grade
- Extend footprint northwest
- A domed roof with new steel trusses
- Height: same 48'-0" building height as existing Field House
- Does not allow for PV on roof

Add/Reno Field House Scope & Constructability

Current Investigations – Consolidated PE/Athletics/Community Programs

- School moves 10-15’ south to more fully engage with enlarged Field House volume
- All new exterior shell, structure, and slab on grade
- Physical features of Field House remain similar, but quantity of exterior enclosure may be reduced
- To be investigated: Could a flattened Field House roof allow for PV located on top?

Add/Reno Field House Scope & Constructability

Possible Consolidation of Ground Floor Plan (146m track)

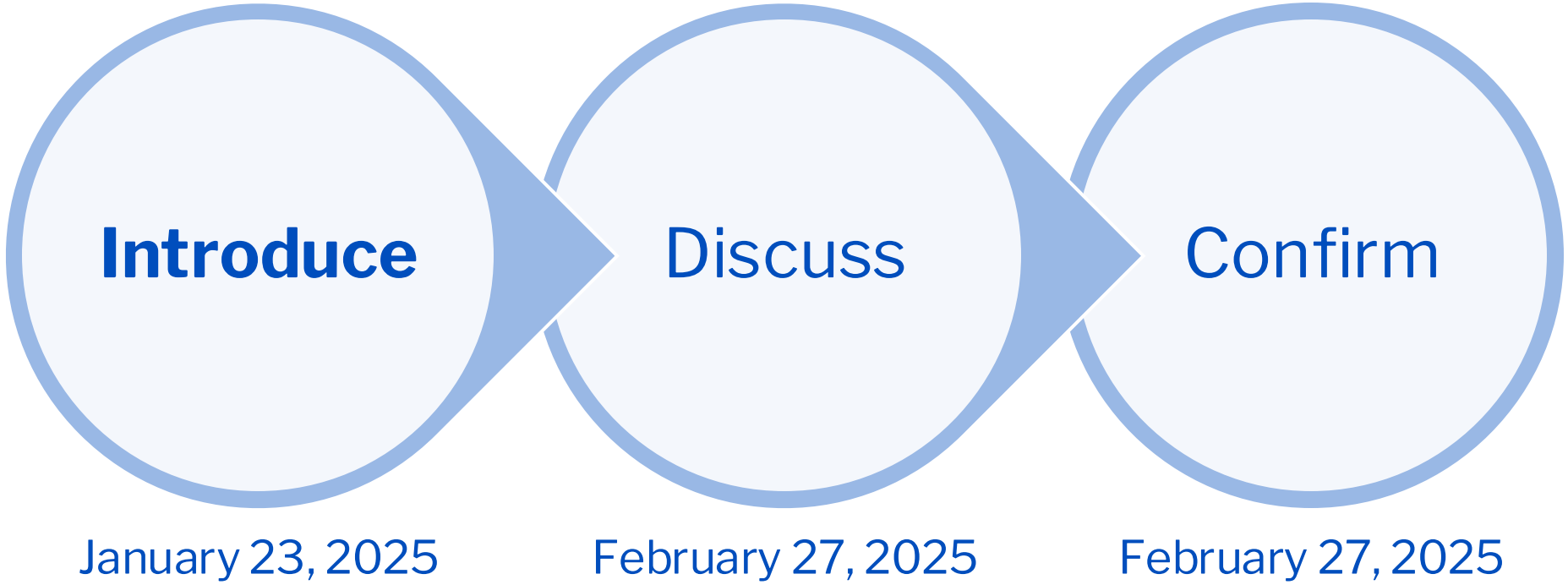
△ Better access from both public entrance and internal PE areas may be possible by means of a shared, access-controlled corridor

Add/Reno Field House Scope & Constructability

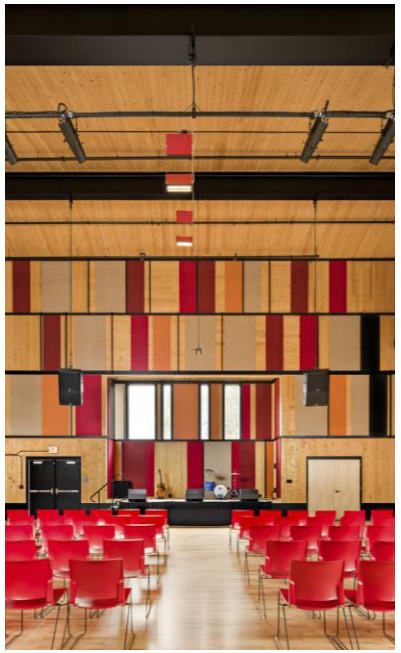
Possible Consolidation of Ground Floor Plan (200m track)

△ Better access from both public entrance and internal PE areas may be possible by means of a shared, access-controlled corridor

Mass Timber vs. Structural Steel



SUSTAINABILITY OF MASS TIMBER



Embodied Carbon

Construction Efficiency

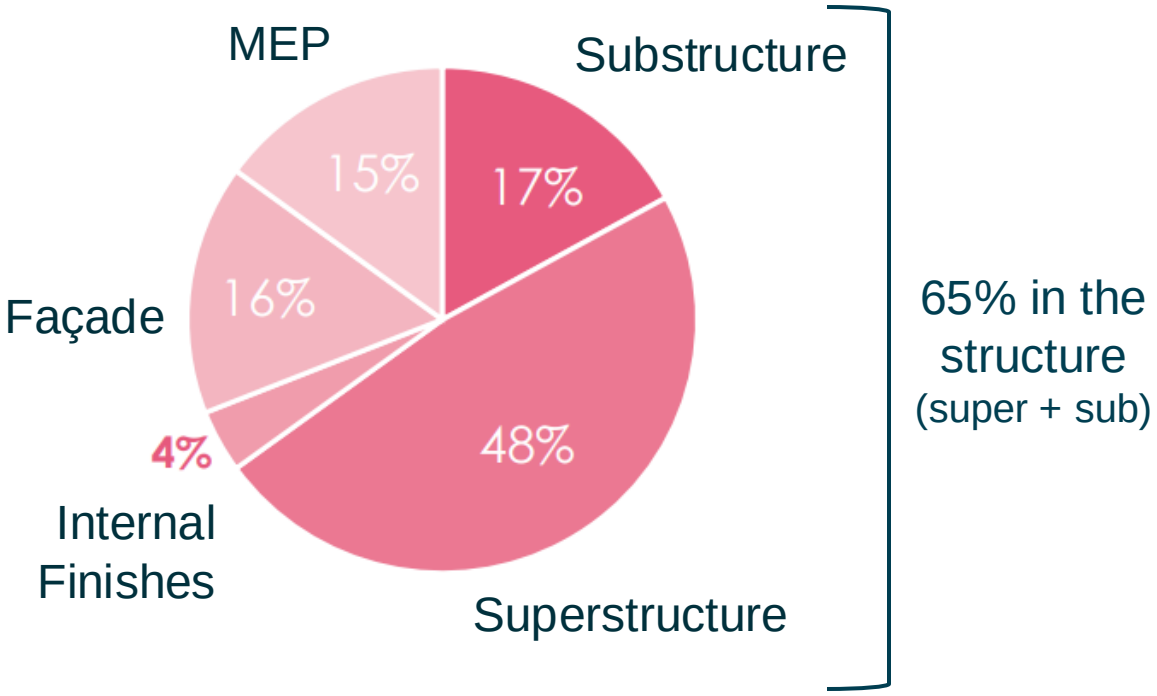
Deconstruct-ability & Material Circularity

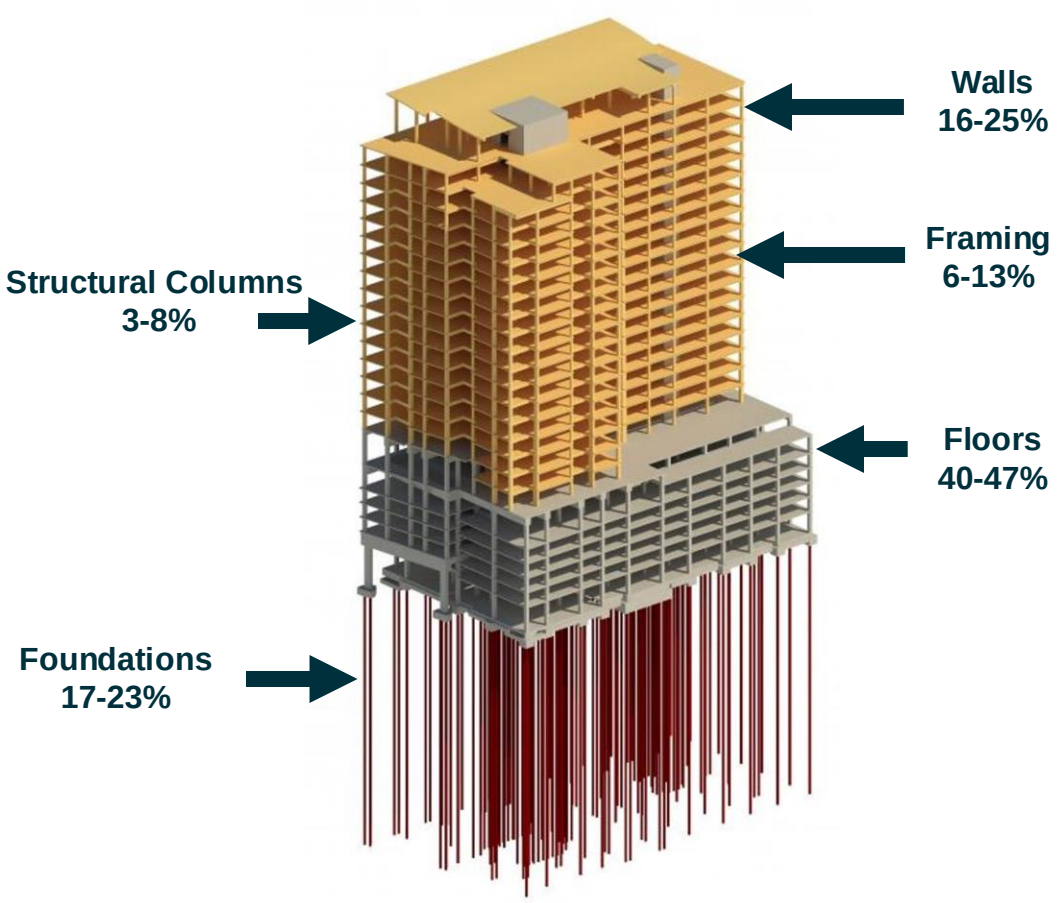
Biophilic Design

Wellbeing & Productivity

Certification Opportunities

CARBON OF STRUCTURES

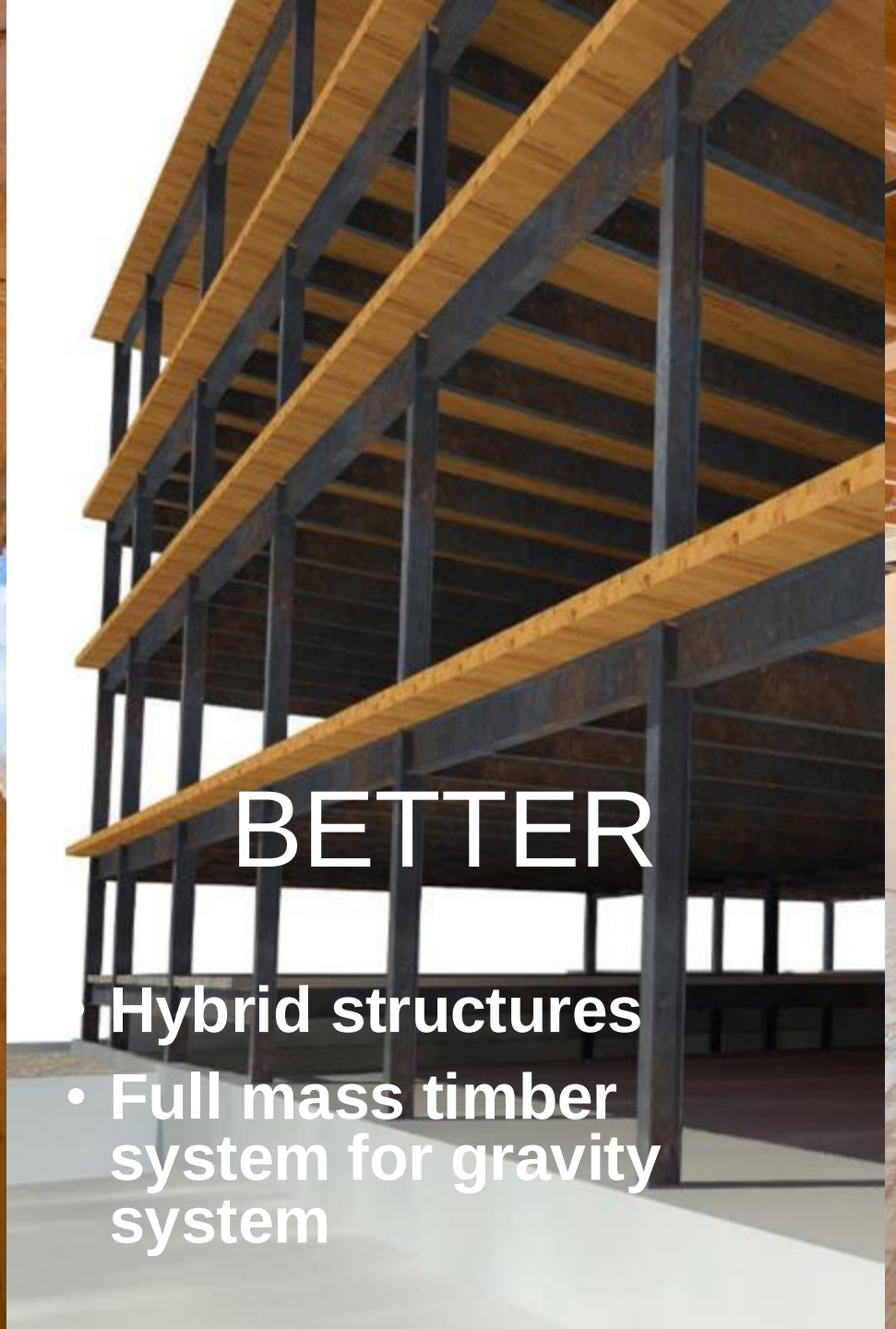




Source: LETI Embodied Carbon Primer

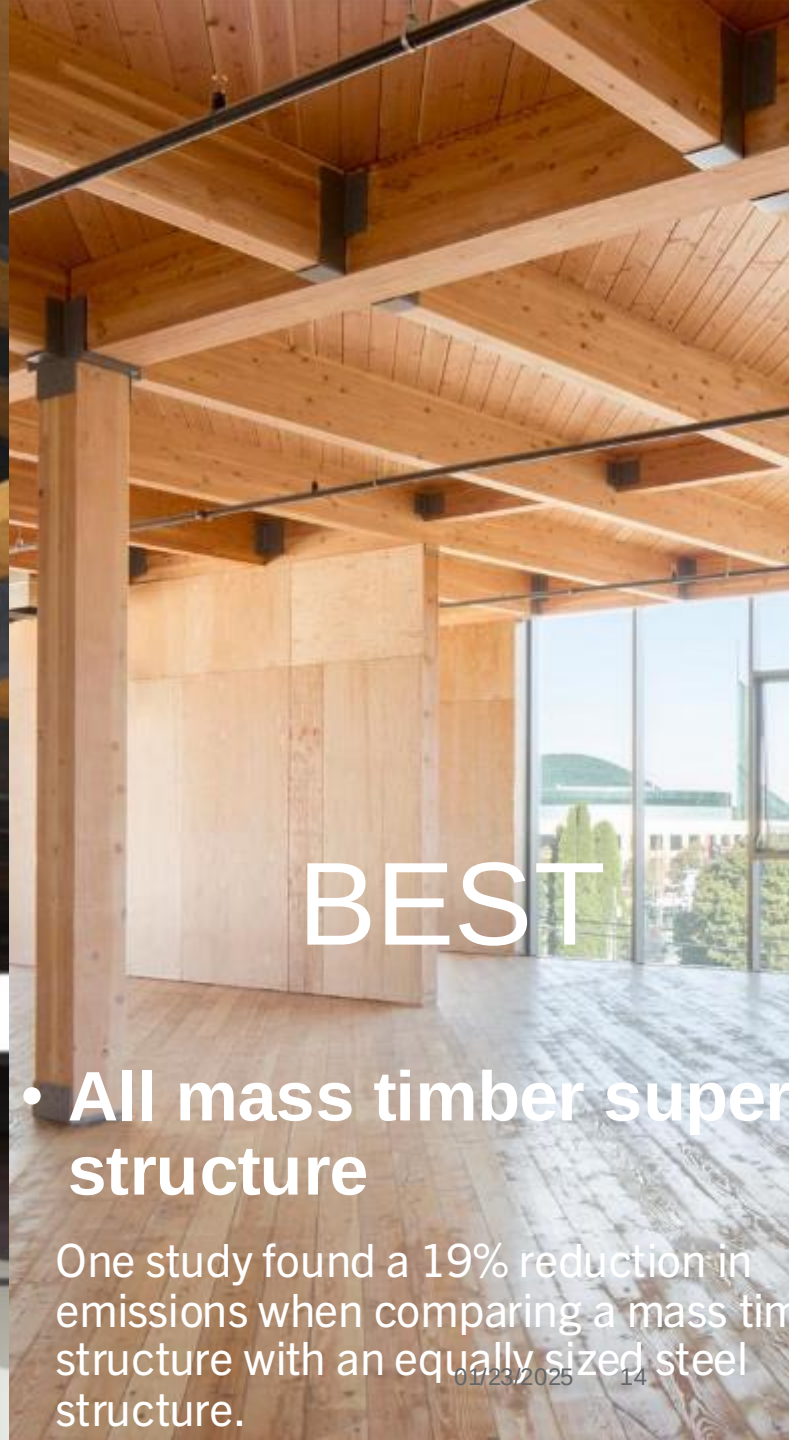
GOOD

- **CLT shaft walls (stairs, elevators)**



BETTER

- **Hybrid structures**
- **Full mass timber system for gravity system**

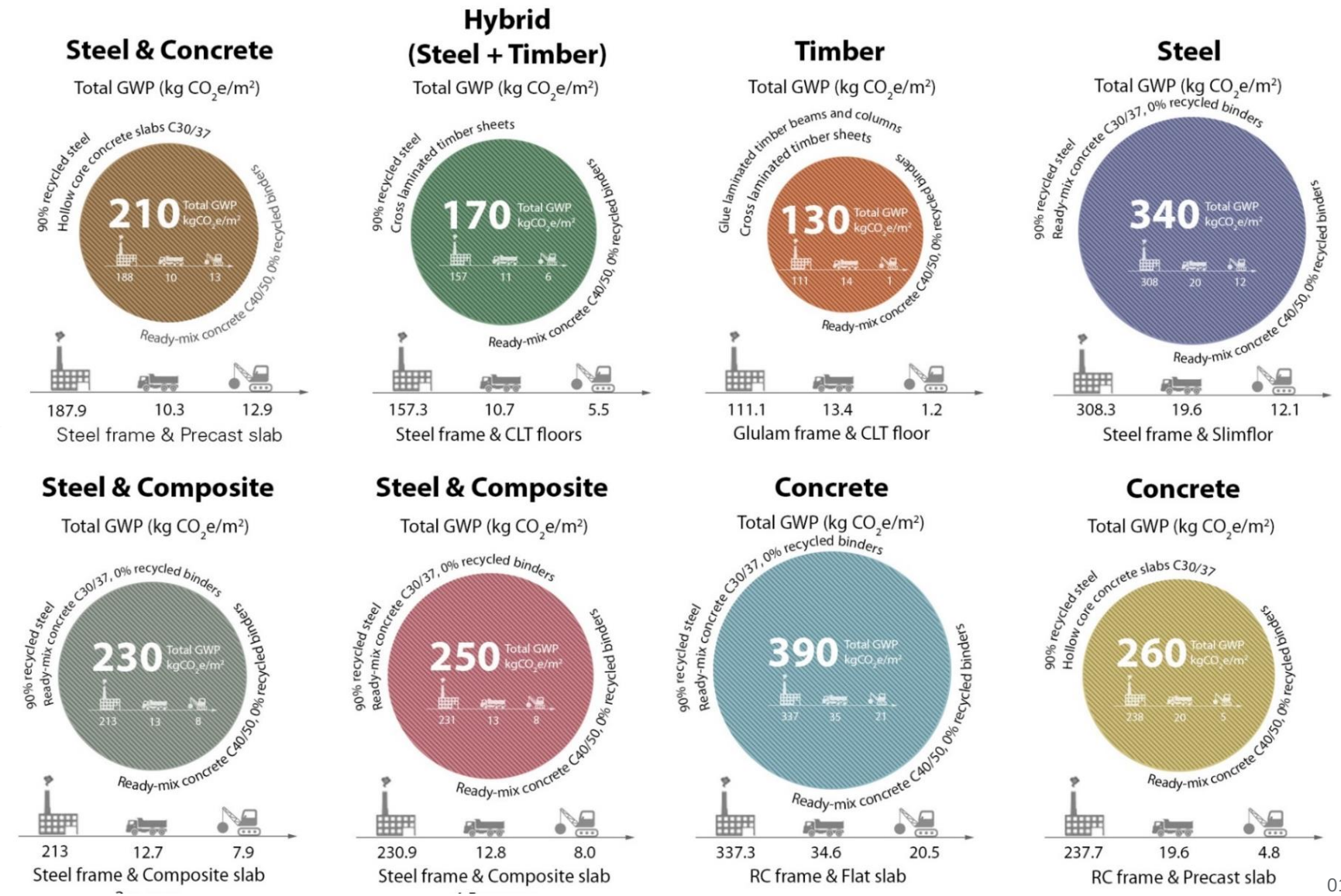


BEST

- **All mass timber super structure**

One study found a 19% reduction in emissions when comparing a mass tim structure with an equally sized steel structure.

COMPARATIVE STUDIES



CONSTRUCTION EFFICIENCY

Speed of Onsite Construction

- Prefabricated timber elements reduces time to erect the frame

Smaller Crews

- Lower emissions for construction teams

Efficiencies in Interior Work

- Exposed mass timber elements reduces the cost, carbon emissions, and time of installation of finish materials

Image: Ascent Tower timber elements, Milwaukee, WI (photo: Swinerton Mass Timber)

ADDITIONAL EC CONSIDERATIONS

Biogenic Carbon Storage

- Biogenic carbon refers to carbon that is stored in living organisms, such as trees
- When wood is harvested from sustainably managed forests and used in construction, the biogenic carbon stored in the wood remains stored in the building, providing **a carbon sink for the life of the building**

Reduction of Interior Finishes

- Leaving mass timber elements are left exposed to serve as the interior finish material **reduces the need for additional finish materials**

Image: Ascent Tower in construction

DECONSTRUCT-ABILITY & MATERIAL CIRCULARITY

Deconstruct-ability of Mass Timber

- Made viable via modular elements, standardized dimensions, and reversible connections (e.g. metal connections)

Material Passports

- A digital record of each unique material element in a building used facilitate circular material strategies at the end of the building's life that informs inform material recovery, reuse, and recycling

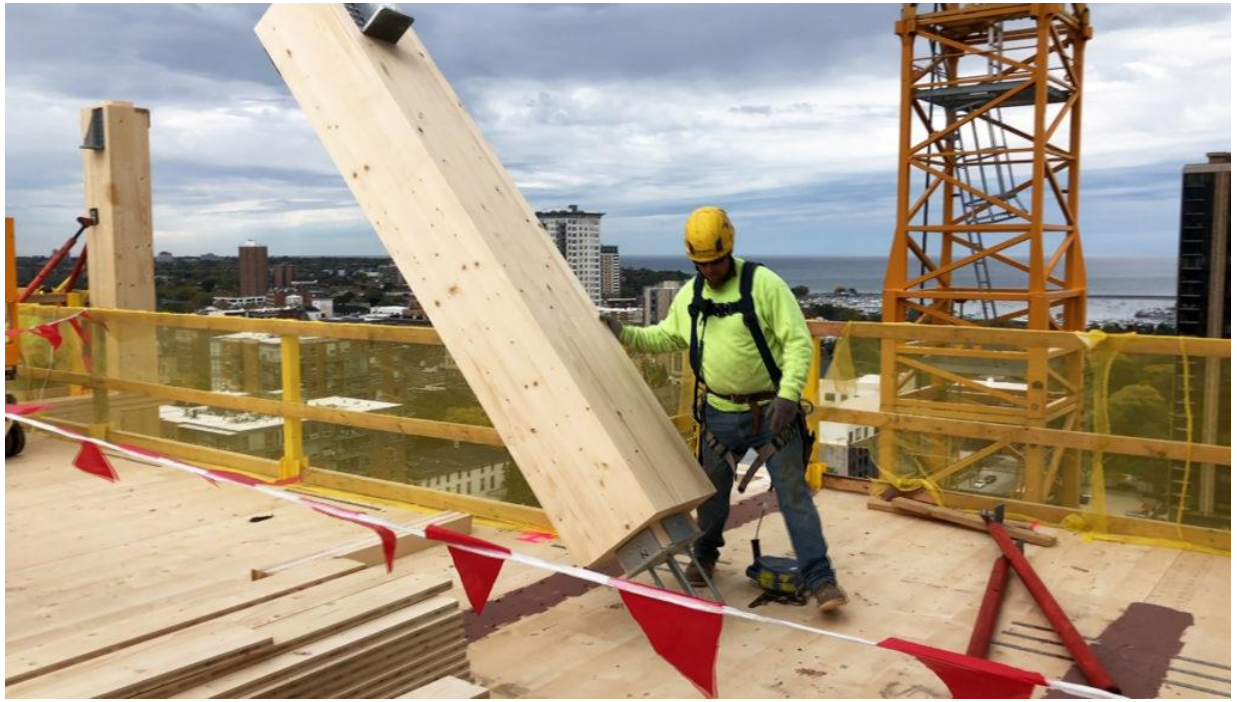


Image: Ascent Tower from PBS News Hour: "Is mass timber the building material of the future?"

BIOPHILIA HEALTH BENEFITS

A landmark study discovered that exposure to wooden environments can result in a significant **10% reduction in blood pressure, a 6% decrease in heart rate, and a 15% decrease in stress hormone levels among participants.**

Biophilic elements (such as wood) have a significant impact on cognitive function, improving on average 8% and elevating emotional well-being and positive emotions 12%.

Wood based interiors demonstrate:

- **9-12% reduction in stress**
- **15% improvement in emotional states**
- **12% increase in positive emotions**

Presence of plants improve feeling of **occupant wellness 40%.**

The visual presence of wooden elements can lower stress more effectively than plants. Rooms with 45% wooden surfaces boost perceptions of comfort and lower blood pressure.

*** Data references available upon request.**

Thornton Tomasetti

BENEFITS: ALREADY INTEGRATED

Environmental Benefits

- **Renewable Resource:** Trees grown in sustainably managed forests and replanted after harvest, make Mass Timber renewable
- **Minimized Waste:** Sawmill residues used in Mass Timber manufacturing reduce waste
- **Reduced Resource Extraction:** Mass Timber does not require mined minerals or fossil fuels
- **Circularity:** Mass Timber can be repurposed
- **Water Efficiency:** Mass Timber production uses far less water than concrete and timber
- **Carbon Storage:** Mass Timber can store carbon and other pollutants for the life of the building

Economic Benefits

- **Faster Construction Time:** Mass Timber construction can be faster than traditional methods
- **Project Efficiency:** Prefabricated Mass Timber requires less on-site assembly, streamlining construction
- **Increased Safety:** Mass Timber prefabrication requires less on-site construction in high or precarious places
- **Reduced Labor Needs:** Mass Timber requires half the number of workers for erection
- **Cost Competitive:** Mass Timber is often cost-competitive with conventional materials
- **Job Creation in Diverse Communities:** Growing, harvesting, processing, and manufacturing of Mass Timber products creates substantial job opportunities

Human Benefits

- **Thermal Comfort:** Wood outperforms steel and concrete in terms of thermal conductivity (310 times better that steel according to the American Wood Council). Materials with low thermal conductivity resist heat flow, improving a building's energy efficiency
- **Noise Reduction and Tranquility:** Mass Timber provides excellent sound insulation and absorption properties, promoting a peaceful indoor environment
- **Excellent Fire Resistance:** Mass Timber's natural fire resistance makes is a safer building material--when ignited, the outer layers form a char layer, which protects and insulates the inner layers of the material-maintain structural integrity
- **Health and Wellness:** The presence of wood in the indoor environment can result in a significant reduction in blood pressure, a decrease in heart rate, and a decrease in stress hormone levels among participants.

*** Data references available upon request.**

RED LIST

Red List Substances to Avoid:

- Cadmium
- PVC
- Formaldehyde

Wood Preservatives:

- Creosote
- Arsenic
- Pentachlorophenol

Declare.

Mass Timber
SmartLam North America

Final Assembly: Columbia Falls, Montana, USA; Dothan, Alabama, USA
Life Expectancy: 100 Year(s)
Embodied Carbon: 178kg CO2 eq
Declared Unit: per Cubic Meter of Product
End of Life Options: Salvageable/Reusable in its Entirety, Biodegradable/Compostable (98%), Landfill (2%)

Ingredients:

softwood lumber, planed, dry: wood; **Adhesive:** Isocyanic acid, polymethylenepolyphenylene ester, polymer with 2-methyloxirane and oxirane; Polymethylene polyphenyl isocyanate; 4,4'-Methylenediphenyl diisocyanate; Benzene, 1-isocyanato-2-[(4-isocyanatophenyl)methyl]-; Boron zinc oxide (B6Zn2O11); Siloxanes and Silicones, di-Me, reaction products with silica; Benzene, 1,1'-methylenebis[2-isocyanato-

Living Building Challenge Criteria: Compliant

I-13 Red List:
■ LBC Red List Free
□ LBC Red List Approved
□ Declared
% Disclosed: 100% at 100ppm
VOC Content: Not Applicable

I-10 Interior Performance: Not Applicable
I-14 Responsible Sourcing: Product Available with FSC Chain of Custody; Low Risk Wood

SML-0001
EXP. 01 JUN 2025
Original Issue Date: 2023

MANUFACTURER RESPONSIBLE FOR LABEL ACCURACY
INTERNATIONAL LIVING FUTURE INSTITUTE™ living-future.org/declare

SmartLam (Manufactured in US)

Declare.

Glued-laminated Timber
Mercer Mass Timber

Final Assembly: Okanagan, British Columbia, Canada
Life Expectancy: 60 Year(s)
End of Life Options: Biodegradable/Compostable (99%), Recyclable (100%)

Ingredients:

Douglas Fir-Larch, Alaska Yellow Cedar; Formic Acid; Resorcinol; 1,4-Butanediol; Caprolactam; Formaldehyde (gas)[1]

[1]LBC Temp Exception RL-009 - Formaldehyde

Living Building Challenge Criteria: Compliant

I-13 Red List:
□ LBC Red List Free
■ LBC Red List Approved
□ Declared
% Disclosed: 100% at 100ppm
VOC Content: Not Applicable

I-10 Interior Performance: Not Applicable
I-14 Responsible Sourcing: Product Available with FSC Chain of Custody

MMT-0002
EXP. 01 DEC 2025
Original Issue Date: 2024

MANUFACTURER RESPONSIBLE FOR LABEL ACCURACY
INTERNATIONAL LIVING FUTURE INSTITUTE™ living-future.org/declare

Mercer (Manufactured in Canada)

Mass Timber vs. Structural Steel

What is Mass Timber?

Engineered wood assembly of solid wood panels that are nailed or glued together

Glulam Beam

Glulam Column

Cross-Laminated Timber (CLT)

Mass Timber vs. Structural Steel

Davis Center – Williams College

28,000 GSF

- Glulam Columns
- Glulam Beams
- TJI/LVL Joists and plywood with concrete topping
- Supplemental Steel members

C Gerald Lucey Building – DUA Brockton

33,000 GSF

- Glulam Columns
- Glulam Beams
- CLT Slabs with concrete topping
- Steel-framed portions where needed

Mass Timber vs. Structural Steel

Advantages

- Low carbon footprint
  - Sequestered carbon during tree growth
  - Lower embodied carbon to manufacture members
- Potentially slightly lighter construction = smaller foundations
- Installation can be quicker than steel construction
- Attractive finished product

Disadvantages

- Cost (15%-50% more than steel and concrete framing)
- Weaker and more flexible material than steel
- Larger members (floor to floor dimensions will grow)
- Smaller column spacing (20 feet vs 30+ feet for steel)
- Not suitable for long spans and floors of assembly spaces
- Difficult to alter in the field for ducts/pipes (MEP Preconstruction Coordination required)

Other considerations

- Mass timber needs to be "oversized" to achieve a fire rating
- Floors will need a 2"-3" concrete topping to mitigate vibration and sound transmission
- Hybrid approach is commonly used, combining steel framing with mass timber

Mass Timber vs. Structural Steel / Embodied Carbon

Embodied Carbon Study Options	Embodied Carbon Reduction from Baseline Model (% tons CO_2eq)	LEED Impact
New Construction with Steel/Concrete Structure	-6.0*	2 points (10% reduction goal)
New Construction with Mass Timber Structure	-19.6	3 points (20% reduction goal)

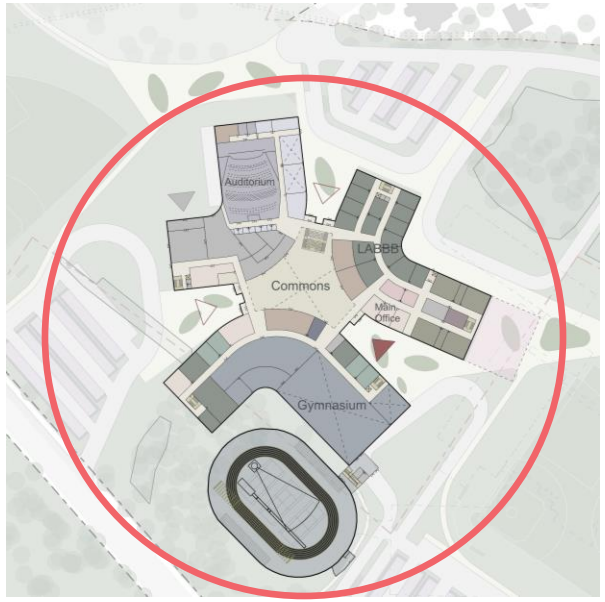
Notes:

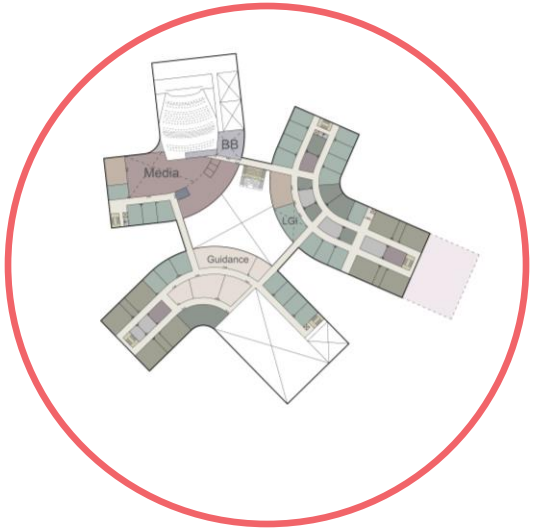
1. *Preliminary PSR Results of Structural Design Options. Analysis to be updated in SD.*
2. *Preliminary PSR analysis conducted using EPIC early carbon assessment tool (60-year LCA). Modeling tool Baseline model assumes building structure only recycled content, not including Low-Carbon concrete measures and enclosure components towards 10% goal.*
3. *Both Options in achieving 2 points will provide additional Regional Priority point.*

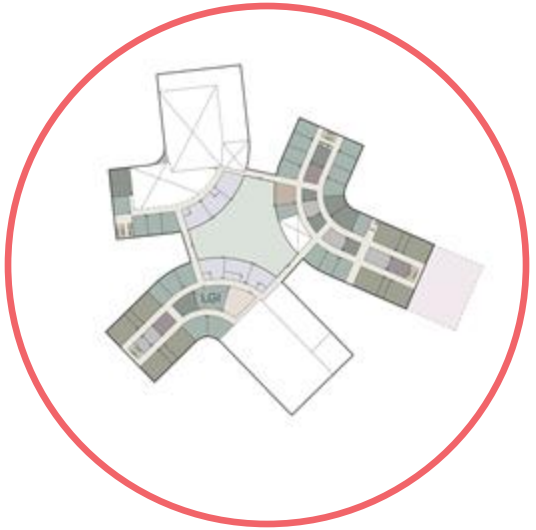
Mass Timber vs. Structural Steel

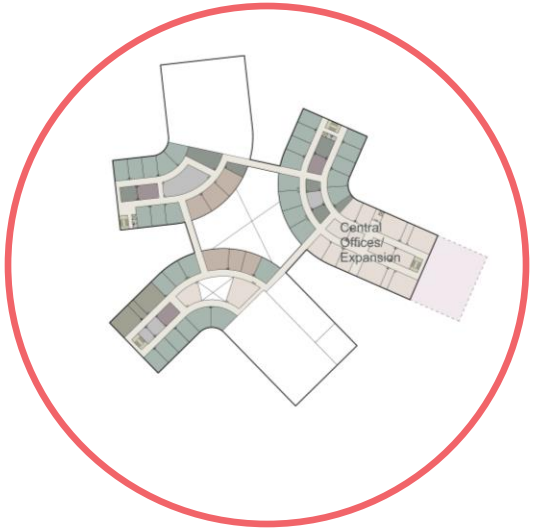
PSR Cost Estimate Considerations

- **Option A** (Mass timber used for the entire structure)
  - Est. Total Project Cost = $24,000,000





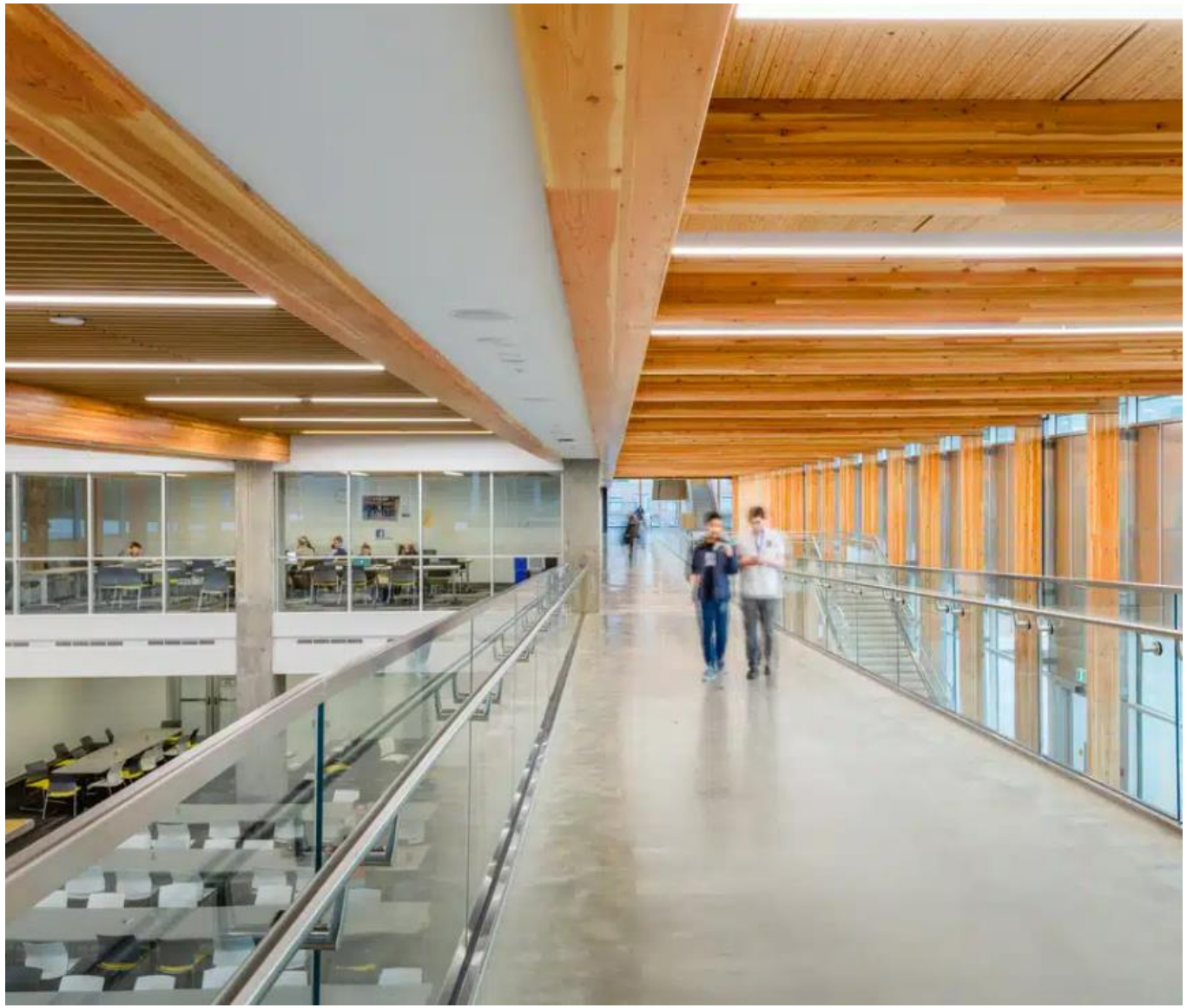




Mass Timber vs. Structural Steel

PSR Cost Estimate Considerations

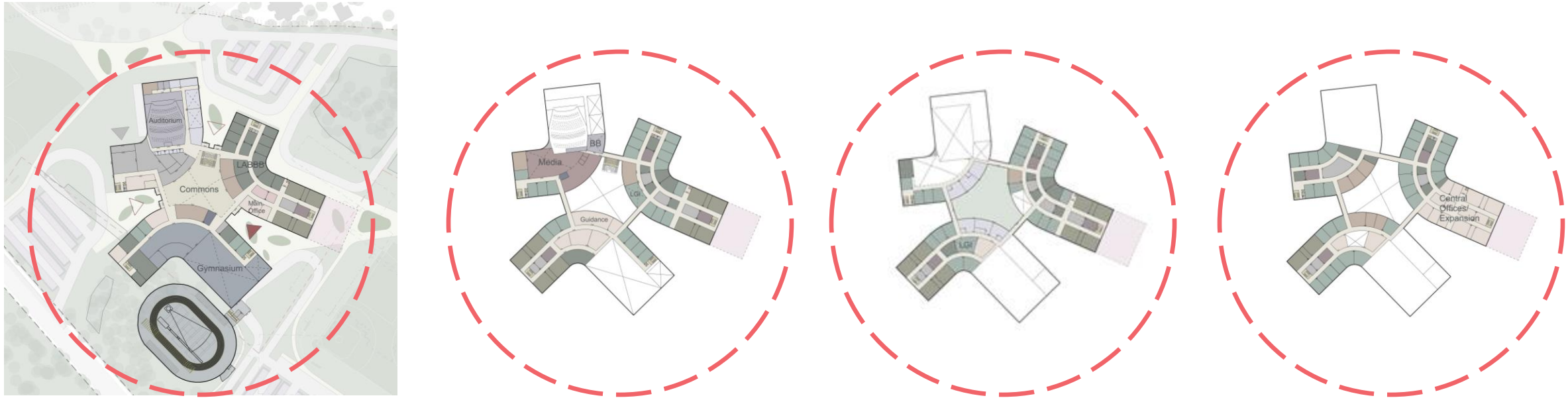
- **Option A** (Mass timber used for the entire structure)



Mass Timber vs. Structural Steel

PSR Cost Estimate Considerations

- **Option B** (Hybrid system – all mass timber except steel used for columns)
  - Est. Total Project Cost = $19,000,000



Mass Timber vs. Structural Steel

PSR Cost Estimate Considerations

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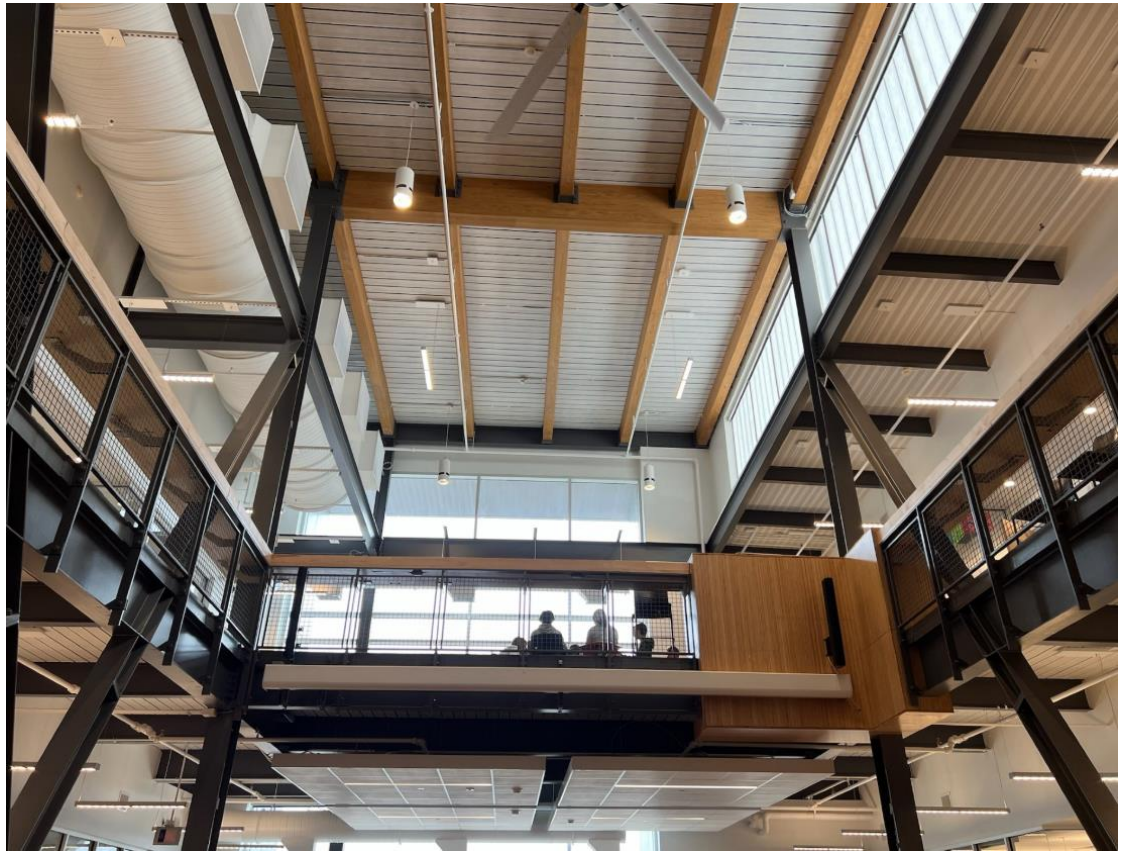
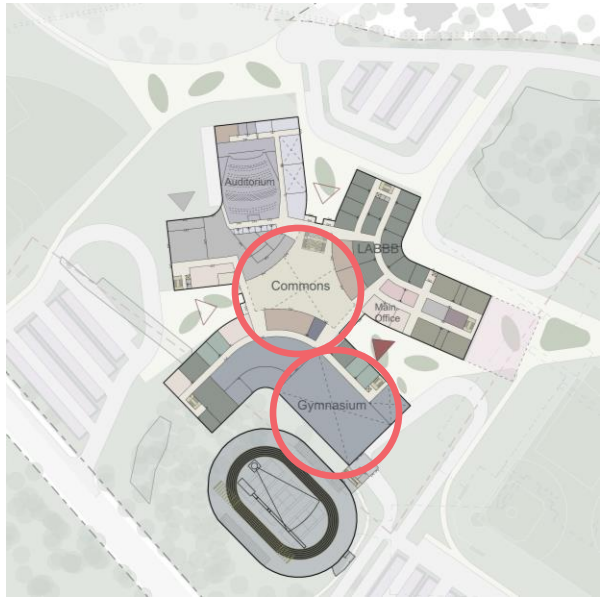
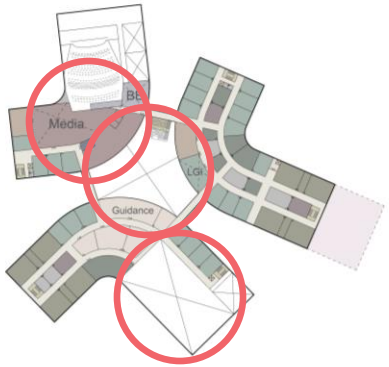


Mass Timber vs. Structural Steel

PSR Cost Estimate Considerations

- **Option C** (Mass timber used at the Gymnasium, Dining Commons and Media Center only)
  - Est. Total Project Cost = $2,000,000

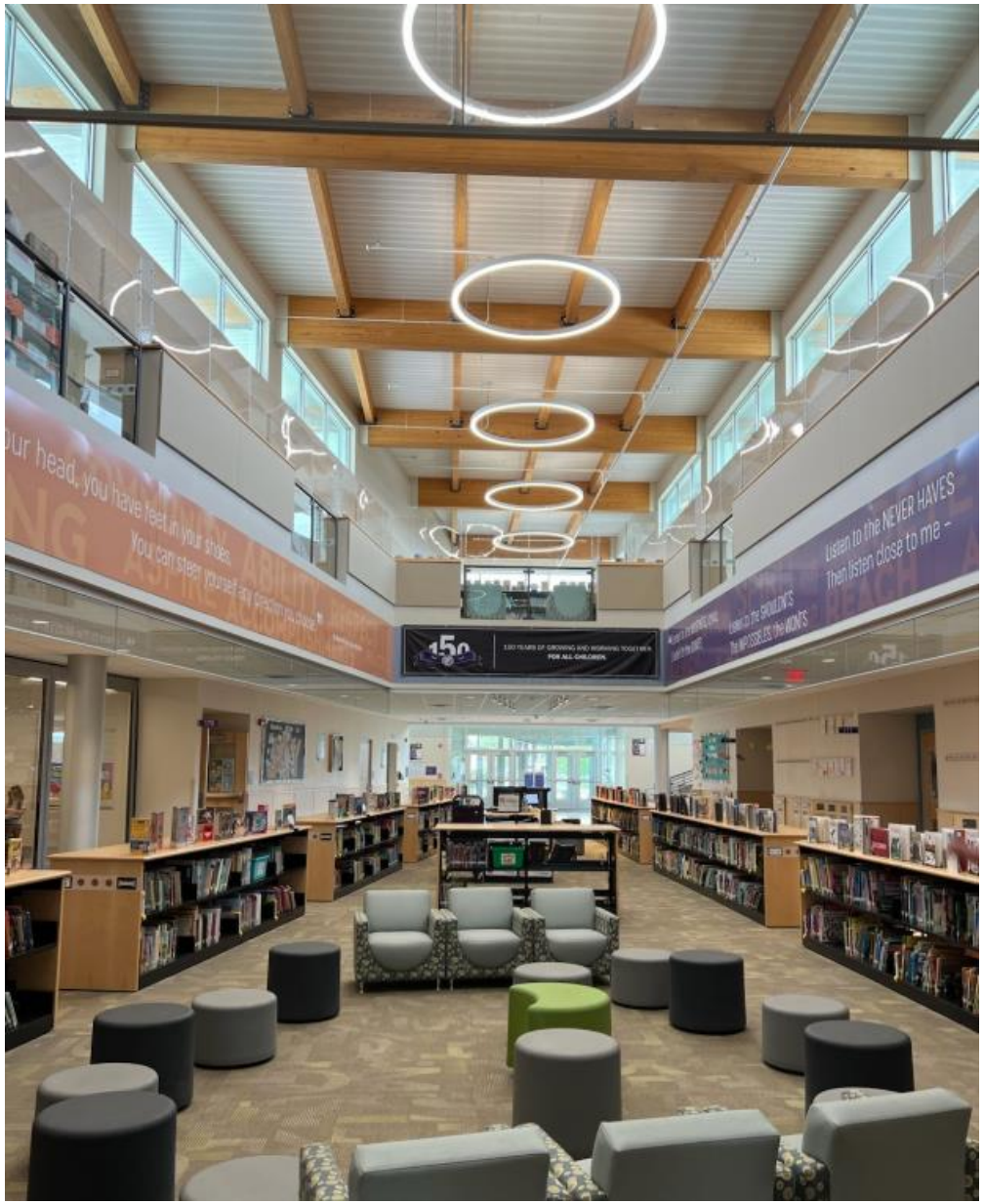




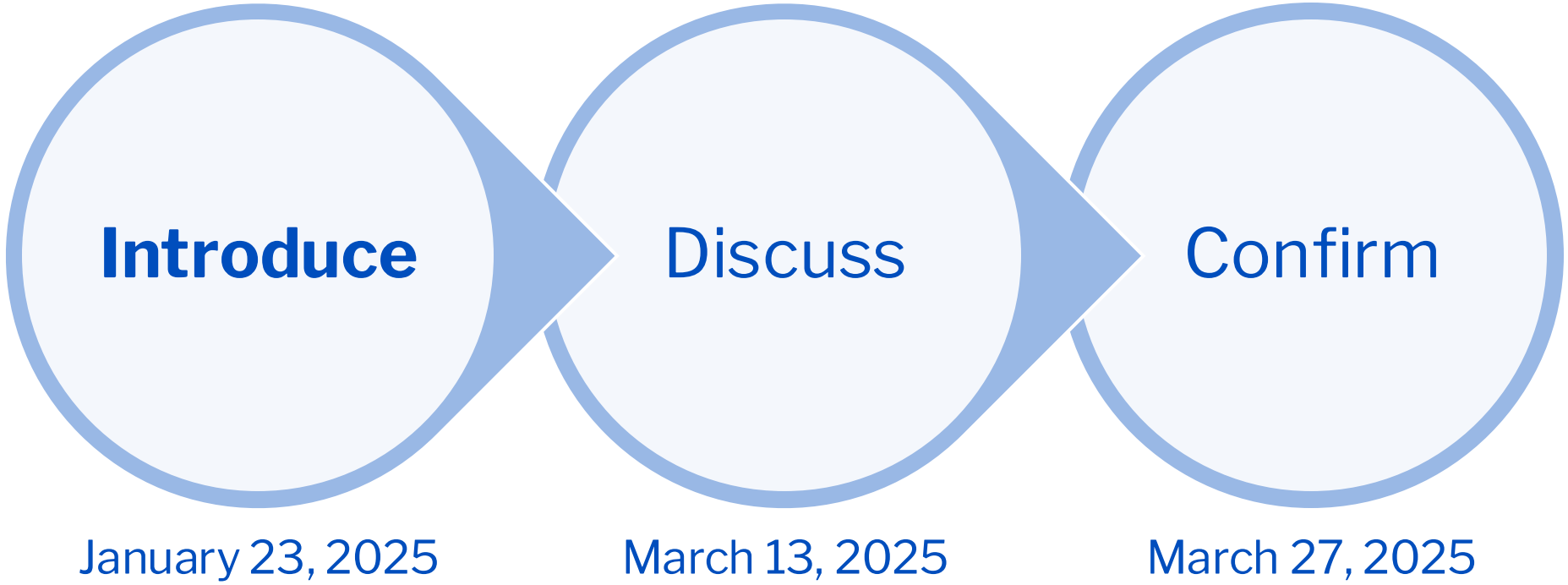
Mass Timber vs. Structural Steel

PSR Cost Estimate Considerations

- **Option C** (Mass timber used at the Gymnasium, Dining Commons and Media Center only)



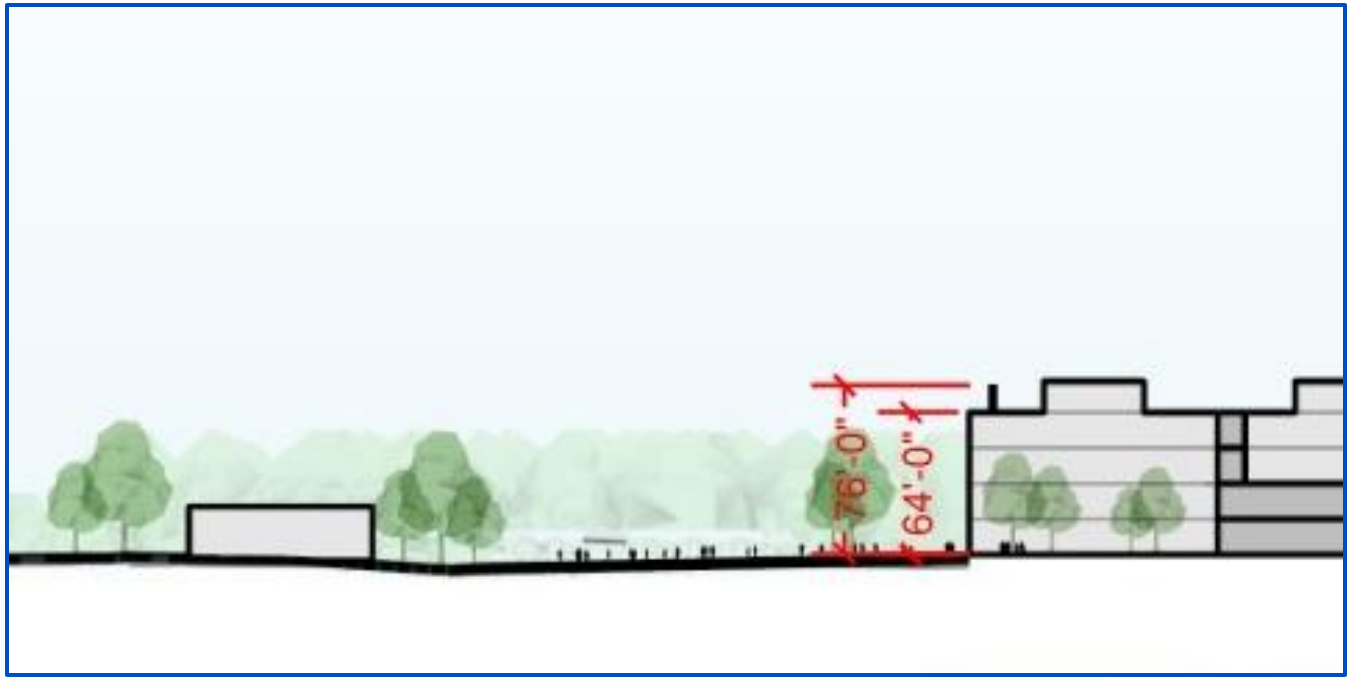
Define Assumed Floor to Floor Heights & Typical Ceiling Heights

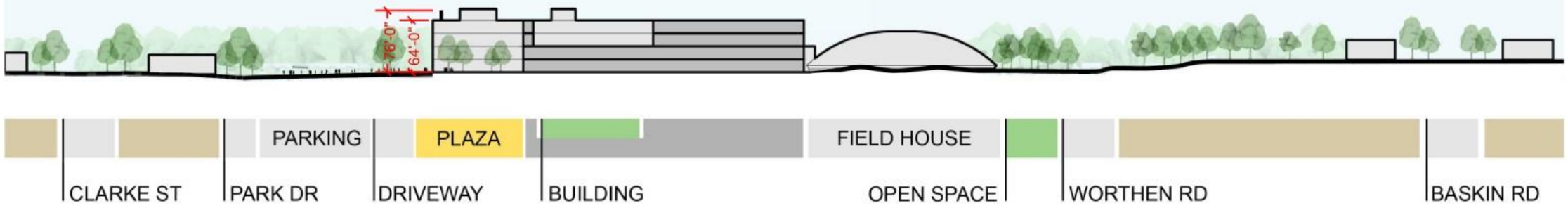


Floor to Floor Heights

Impact on Total Building Height

16’-0” floor to floor height
= 64’-0” building height to top of roof*
+ 12’-0” mechanical roof screen
= 76’-0” height to top of screen





SECTION B

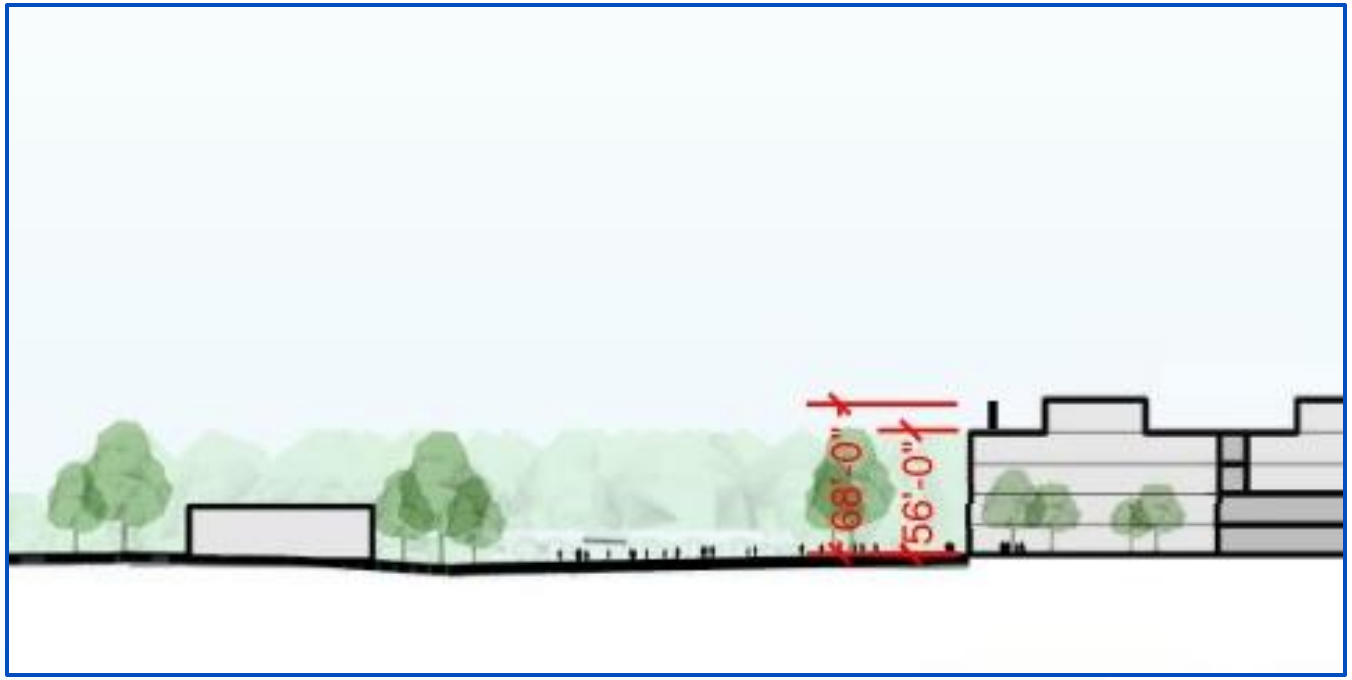
0 100' 200' 500' 1000'

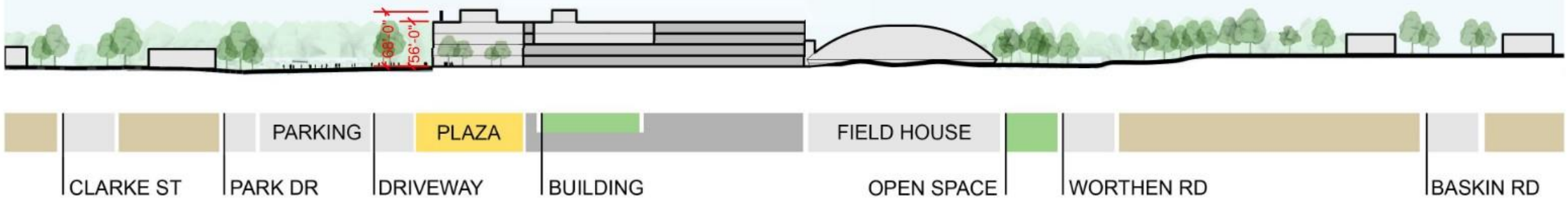
* Zoning building height is defined by the vertical distance between the lower elevation (defined as the natural grade of land at the point of measurement prior to disturbance for construction) and the upper elevation (defined as the highest point of any ridge, gable, other roof surface, or parapet). The lower elevation has yet to determined.

Floor to Floor Heights

Impact on Total Building Height

14’-0” floor to floor height
= 56’-0” building height to top of roof*
+ 12’-0” mechanical roof screen
= 68’-0” height to top of screen





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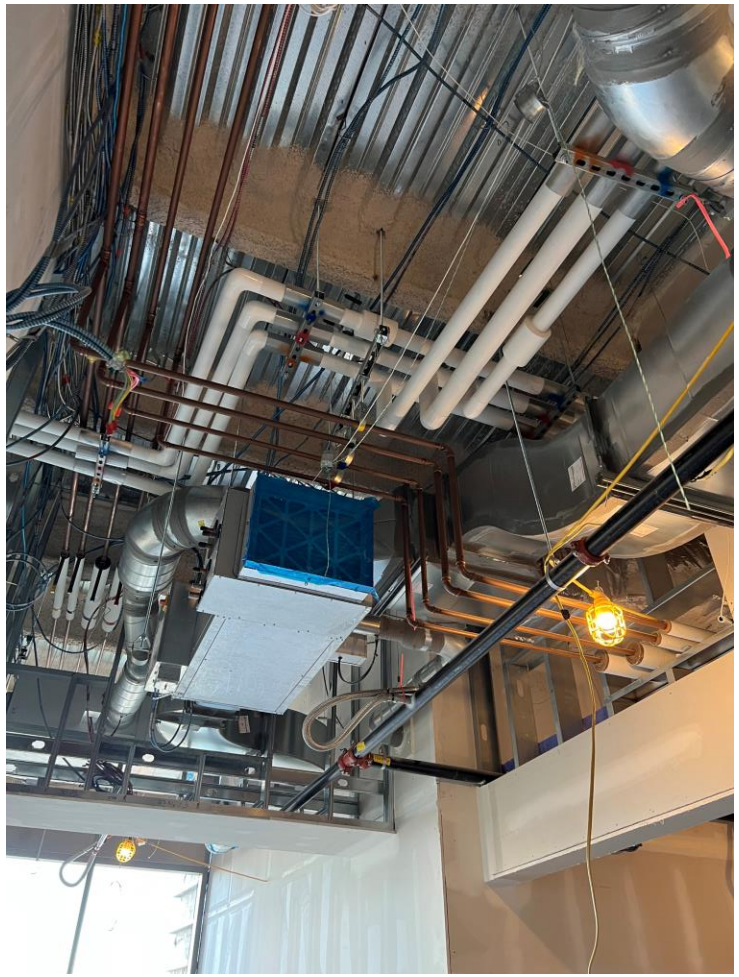
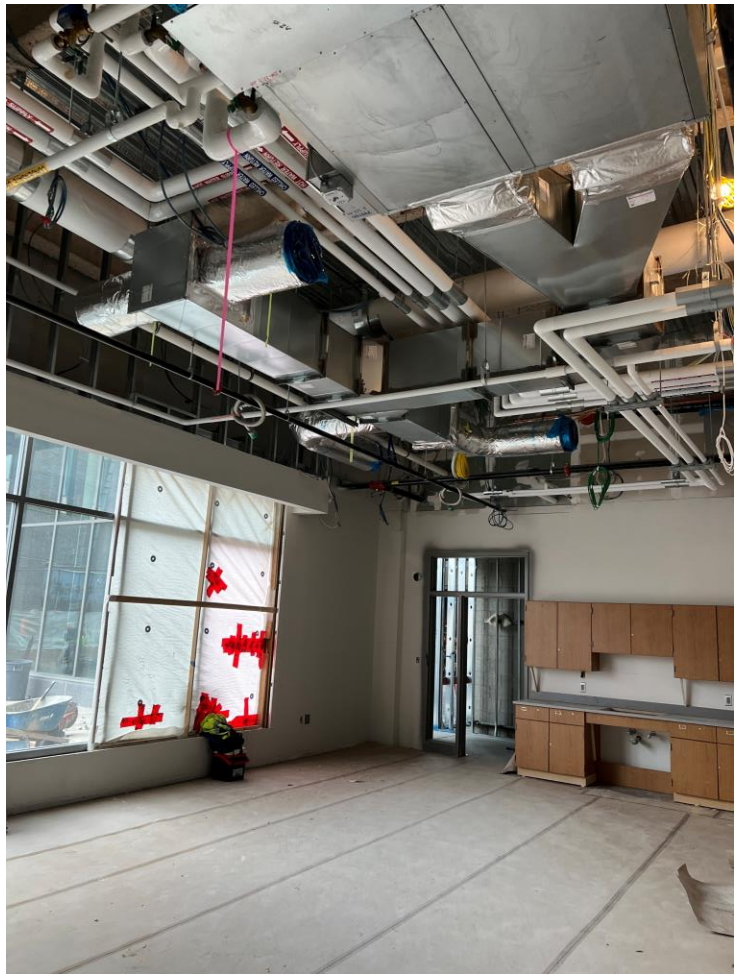
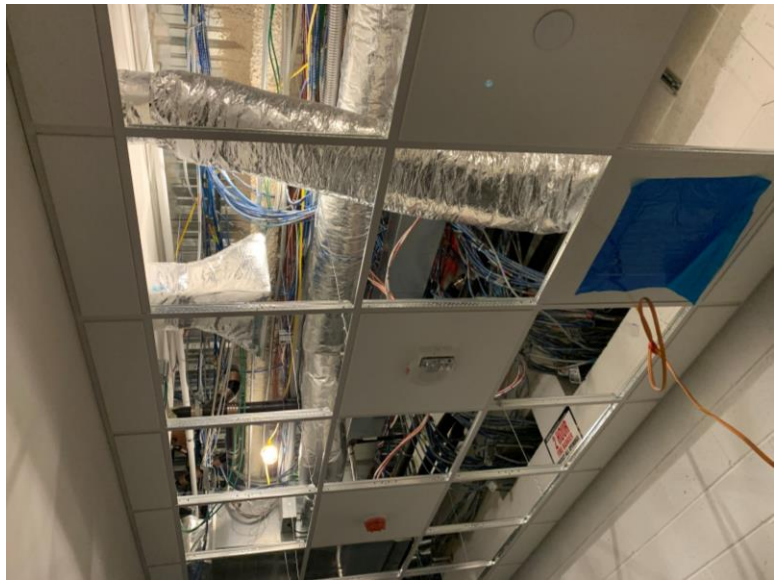
Floor to Floor Heights

Photos of Plenum Spaces on Recent Projects





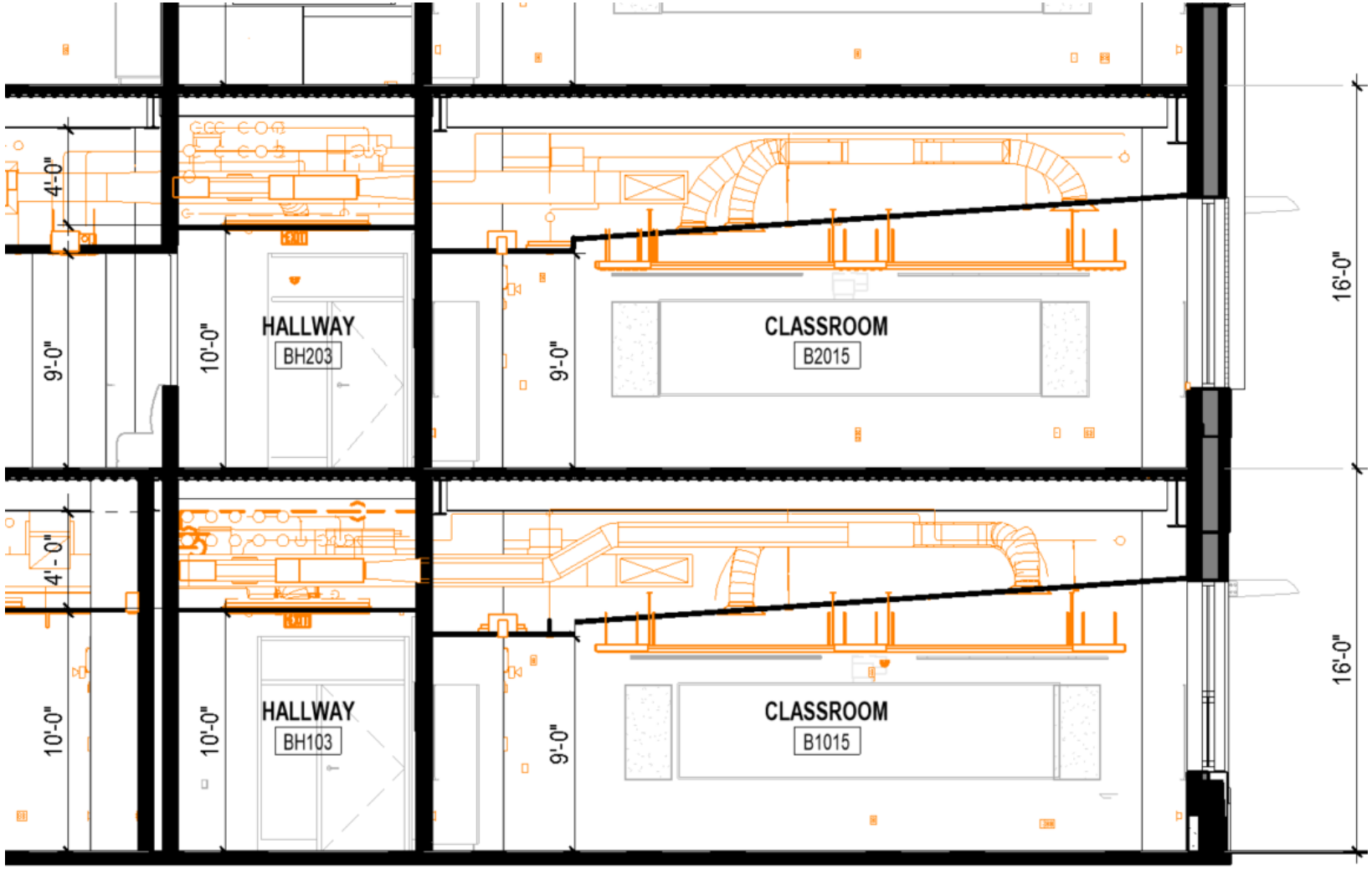


Floor to Floor Heights

Typical Plenum Section at 16’-0” Floor to Floor Height

Example: Wakefield Memorial High School

- Ceiling height = 10’-0” AFF
- Effective usable space above finish ceiling = +/- 4’-0”
- All-electric building
- Each classroom is served by one fan coil unit located in the hallway. Access for filter and fan replacement necessitated large clearances on 3 sides and underside of fan coil unit.

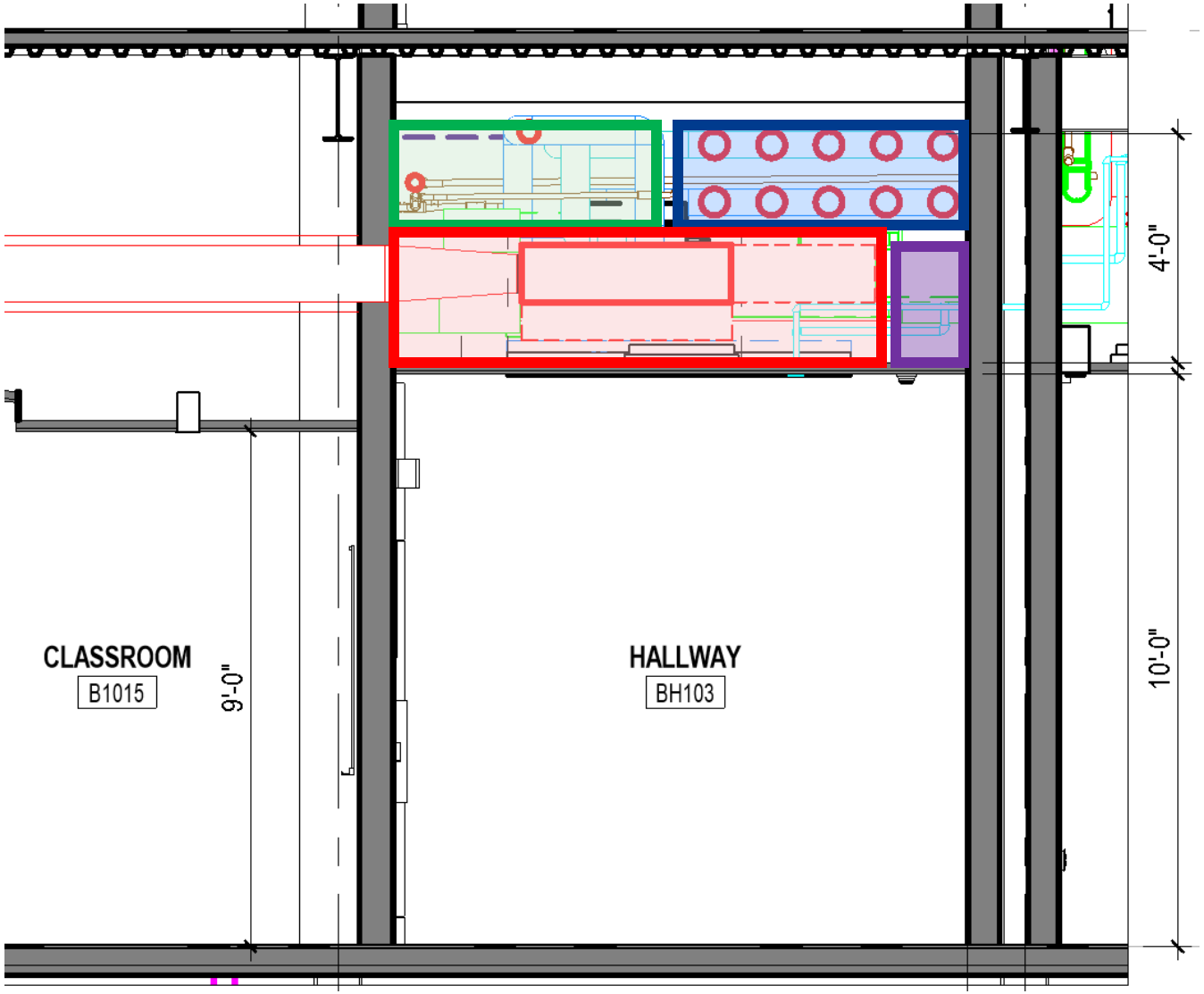


Floor to Floor Heights

Typical Plenum Section at 16’-0” Floor to Floor Height

Example: Wakefield Memorial High School

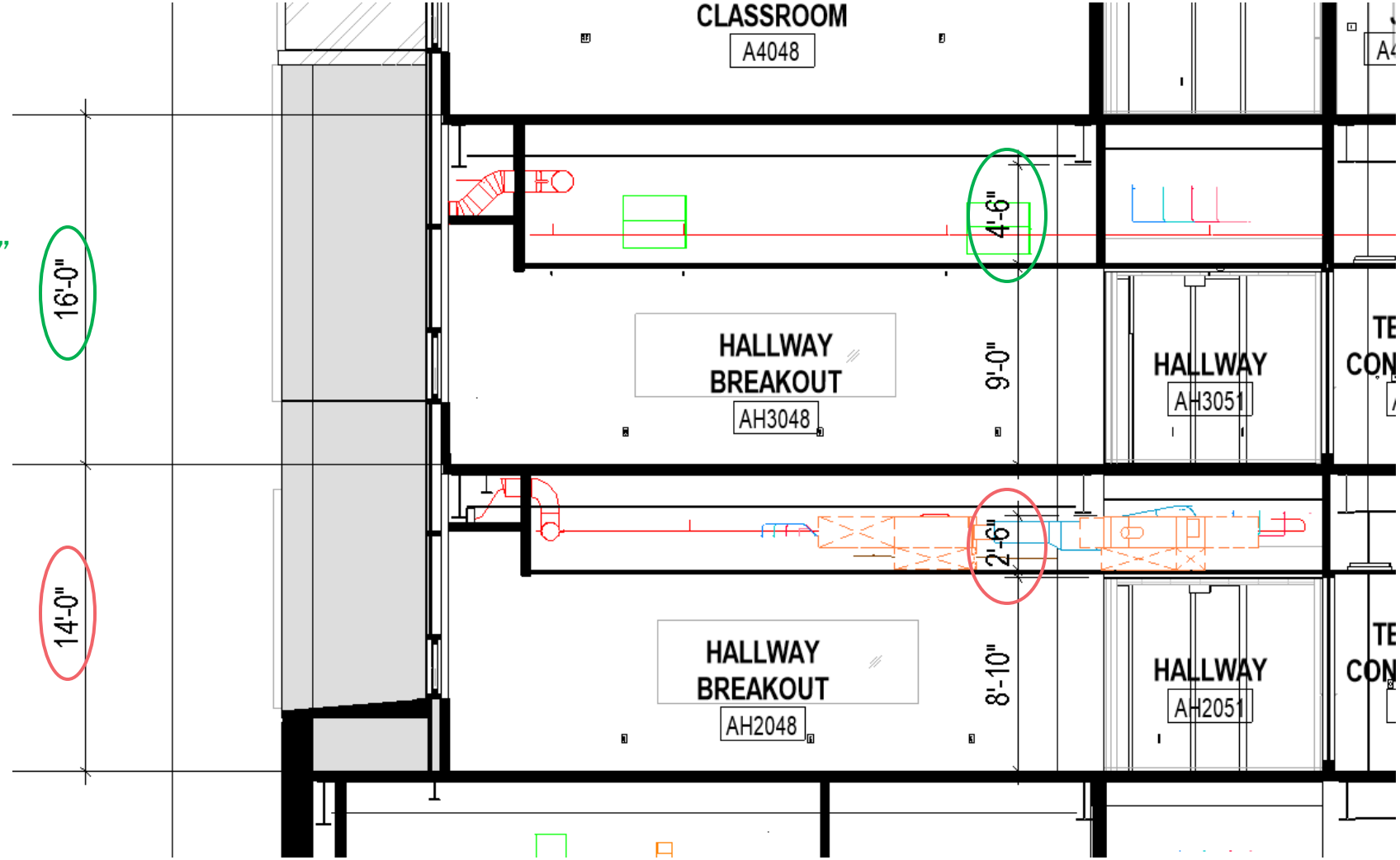
- General plenum discipline zones
  - **Red** = Mechanical + Mechanical Clearances
  - **Green** = Plumbing and Fire Protection
  - **Blue** = Mechanical Piping
  - **Purple** = Electrical/Tech



Floor to Floor Heights

Typical Plenum Sections at 14’-0” and 16’-0” Floor to Floor Height

- Example: Waltham High School
- Ceiling height = +/-9’-0” AFF
- Effective usable space above finish ceiling = +/- 2’-6” to +/- 4’-6”
- Building designed under the previous iteration of energy and mechanical codes



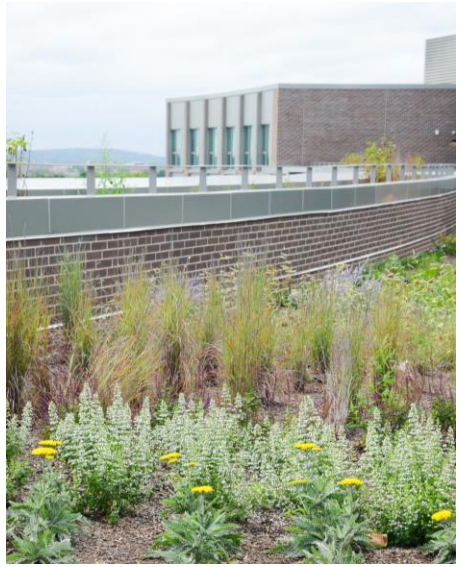
Floor to Floor Heights

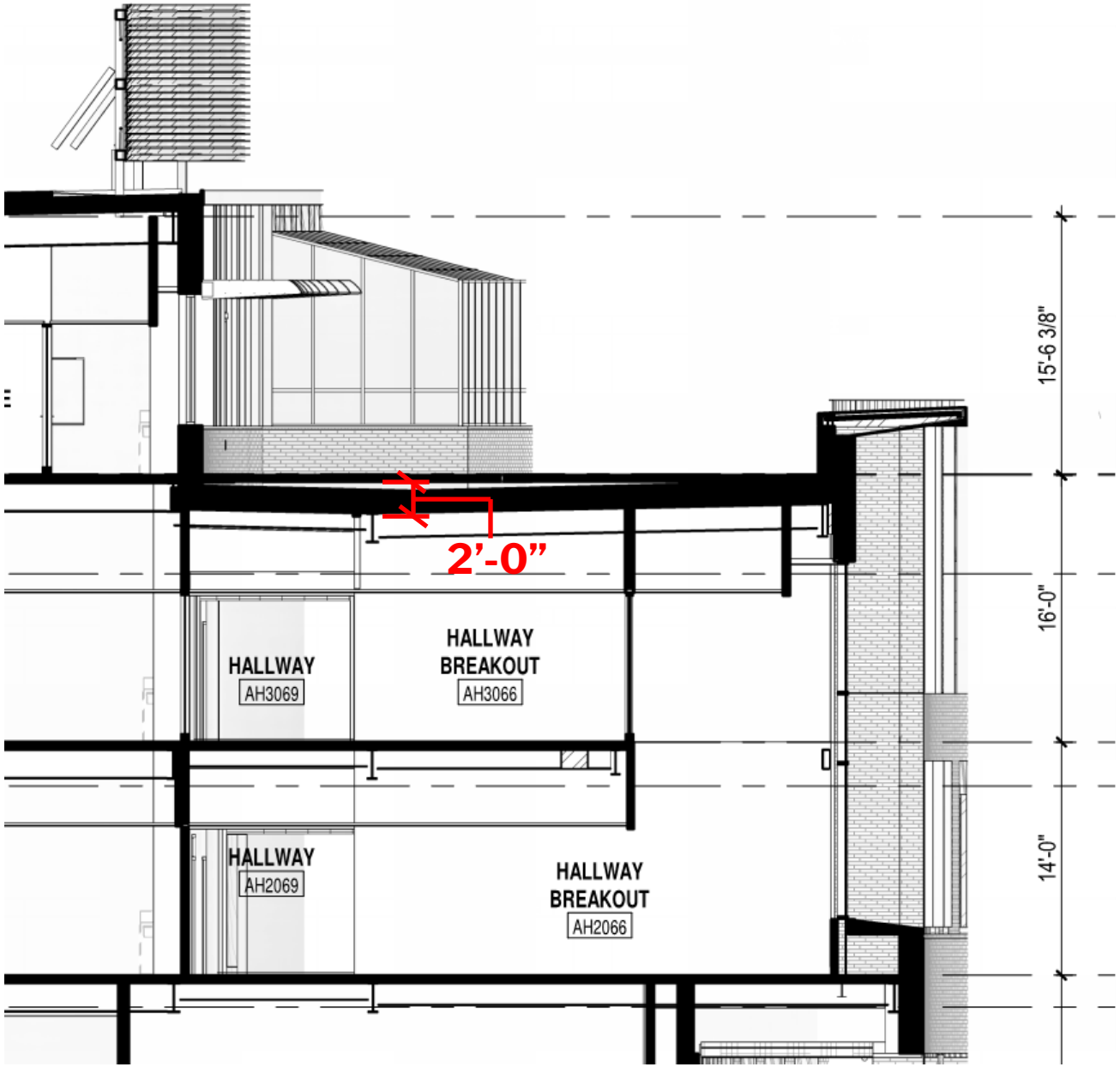
Level 3 Courtyard Impact

Precedent example: Waltham High School

A green roof and paver system section is deeper than a typical metal deck roof, and a structural offset is needed to accommodate both the added depth and the sloped drainage. The section at the right is through the Level 4 terrace and shows that a 2’-0” drop in structure was required due to the location above a classroom hallway.

The floor to floor between Level 3 and 4 was raised from 14’-0” to 16’-0” to offset the impact on the spaces below the terrace.





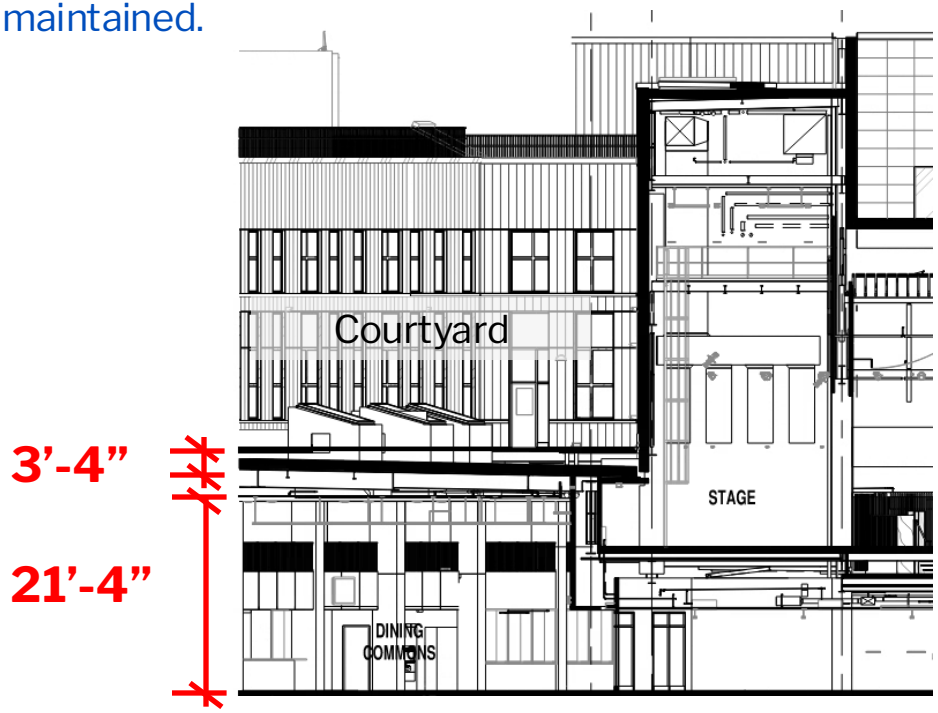
Floor to Floor Heights

Level 3 Courtyard Impact

Precedent example: Somerville High School

The interior courtyard required a drop in structure of up to 3’-4” to maintain the accessible finish floor transition while allowing for roof assembly construction and slope to drains below pedestal pavers.

Because the courtyard space is above the double-height Dining Commons, the overall level height of 14’-0” could be maintained.



Floor to Floor Heights

Recent Project Comparisons

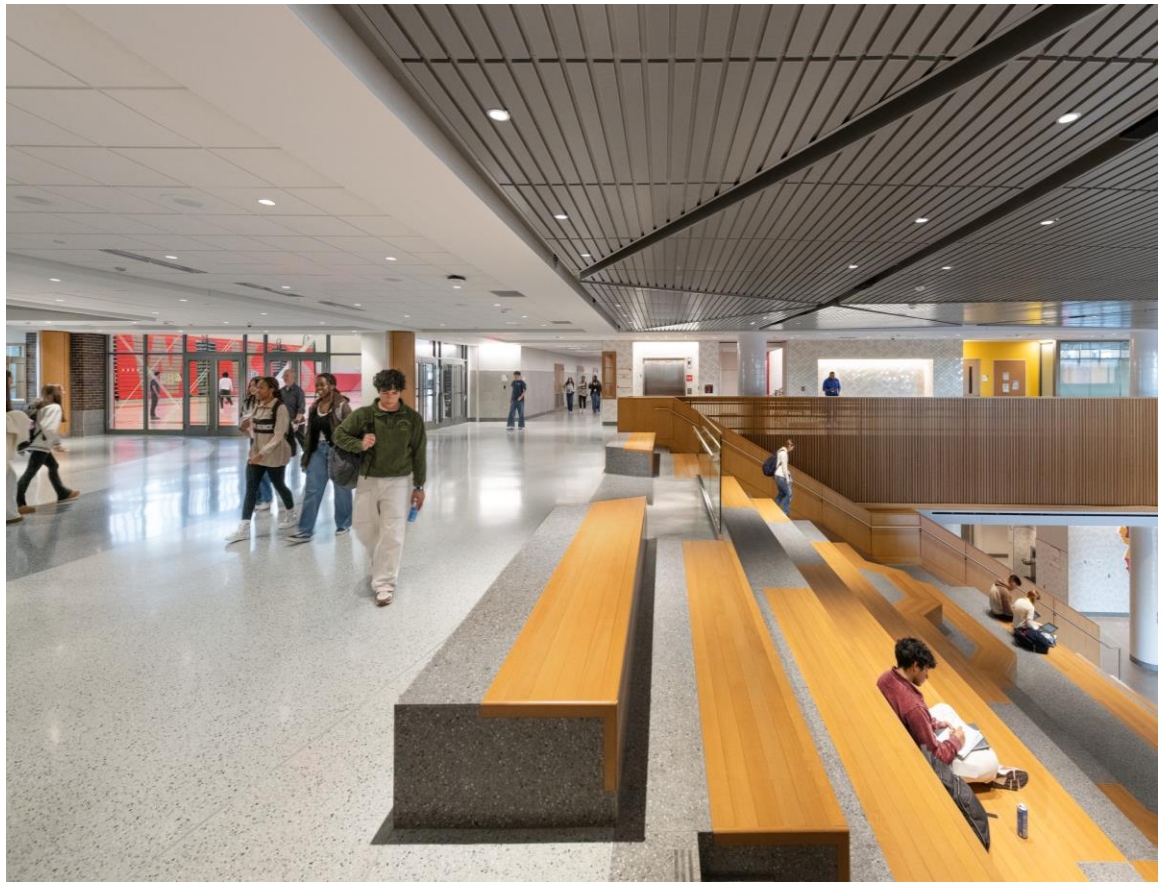
Somerville High School

Hallway ceiling height = 9’-0” typical with conditions as low as 8’-0” AFF (varies)

Floor to floor height = 14’-0” typical at above-grade levels, except 15’-7 at L5 to roof

Floor to Floor Heights

Recent Project Comparisons



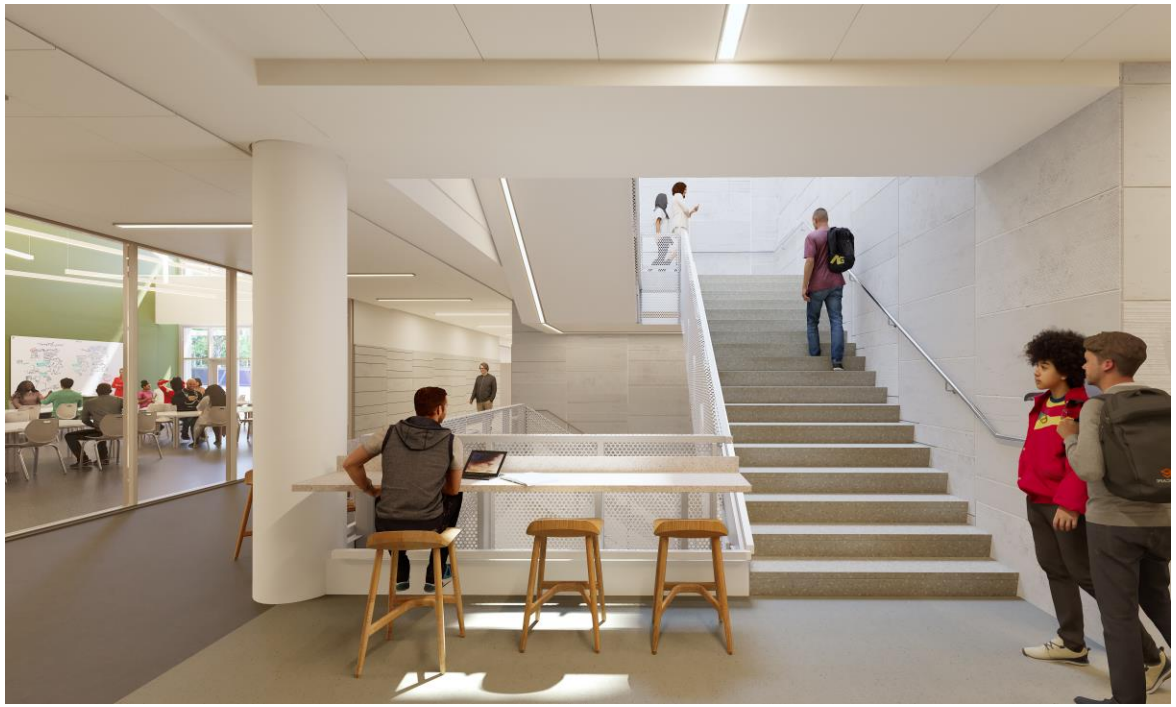
Waltham High School

Hallway ceiling height = 9’-0” AFF typical

Floor to floor height = Level 1 to 2 = 18’-0” / Level 2 to 3 = 14’-0” / Level 3 to 4 = 16’-0” / Level 4 to Roof = 15’-6”

Floor to Floor Heights

Recent Project Comparisons



Wakefield Memorial High School

Hallway ceiling height = 10’-0” AFF typical

Floor to floor height = 16’-0” / Level 3 to Roof = 17’-0”**

** Due to the need for a large area of roof surface to be allocated for solar panels, rooftop mechanical units were constrained to a very compact footprint, allowing for less horizontal flexibility in locating transitions into vertical duct shafts, thus the top level was increased by one foot vs lower floors.

Floor to Floor Heights

Mechanical Notes

- Ductwork size is not impacted by use of either ground source or air source heat pumps
- Fan coil units dictate the general MEP system layout at hallways
    - Units have large maintenance access clearances on 4 sides
    - Every classroom requires a fan coil
- VRF cassette systems are effective in small plenums
    - They are noisier and not ideal for classrooms
    - They tend to be used more often in offices and similar small spaces

Ceiling cassette example

Floor to Floor Heights

Lower Floor to Floor Height Trade Offs

Pros

- Less steel at columns
- Less exterior finish materials
- Shorter overall building height
- Reduced building volume and surface area reduces energy usage

Cons

- Lower finish ceiling heights
- Shorter window heights = less daylight into spaces
- MEP coordination within ceiling plenum is more difficult
- Placement of rooftop mechanical units may limit flexibility of duct routing
- Less forgiving if duct size & pipe sizes are increased during design
- Less flexibility if structural beam sizes are increased

Floor to Floor Heights

Schematic Design Considerations

- Mechanical system has yet to be selected
- The structural beam sizes have yet to be designed
- The use and scope of mass timber has yet to be determined
    - Mass timber beams will be deeper than steel beams
- The Level 1 survey elevation has yet to be determined
- The optimal finish ceiling heights have yet to be determined

- 16’-0” floor to floor was carried as a slightly conservative assumption in the PSR cost estimate
- Potential height reductions can be worked towards as major elements listed above are decided upon

Thank you