
BILTMORE
phius
PRO FORUM

WALSH
CONSTRUCTION CO.

MORE, BETTER HOUSING…LEVERAGING OPTIMIZATION IN THE DELIVERY OF COST-EFFICIENT, ENERGY-EFFICIENT AFFORDABLE HOUSING

phius PRO FORUM 2024

walshconstruction.com

Exploring A Path…

- Framing the issues…
  - HOUSING AFFORDABILITY → CONSTRUCTION COST
  - CLIMATE CRISIS
- Addressing the issues…
  - ENERGY EFFICIENCY
  - COST EFFICIENCY (via OPTIMIZATION)
- Demonstration projects

Orchards at Orenco

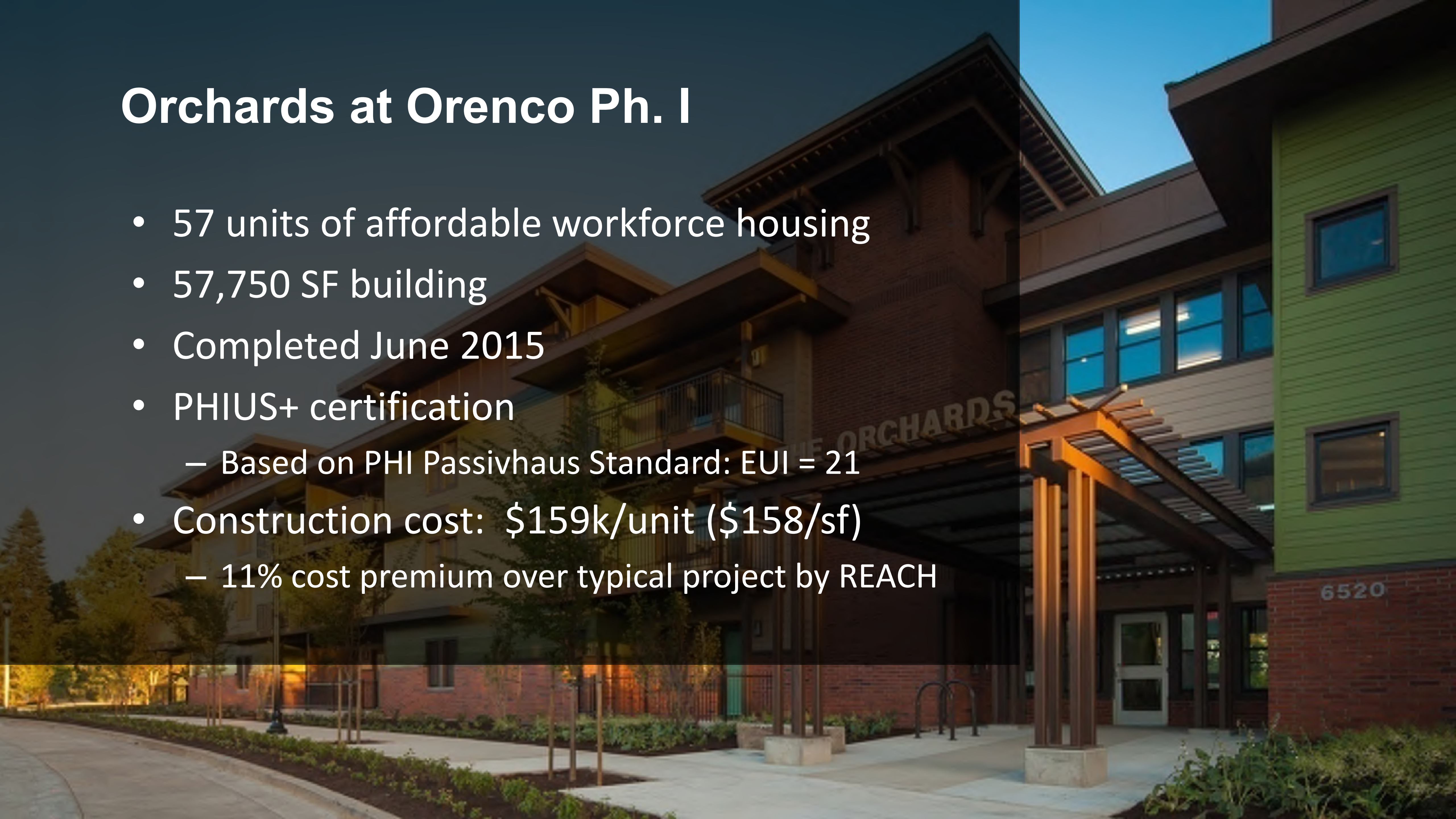
- 167 unit affordable housing development in Hillsboro, Oregon (suburb west of Portland)
- Three phases
- Passive House among the many owner goals
- 2012: design commenced
- 2018: completed third phase
- Developer/Owner:
  - REACH Community Development

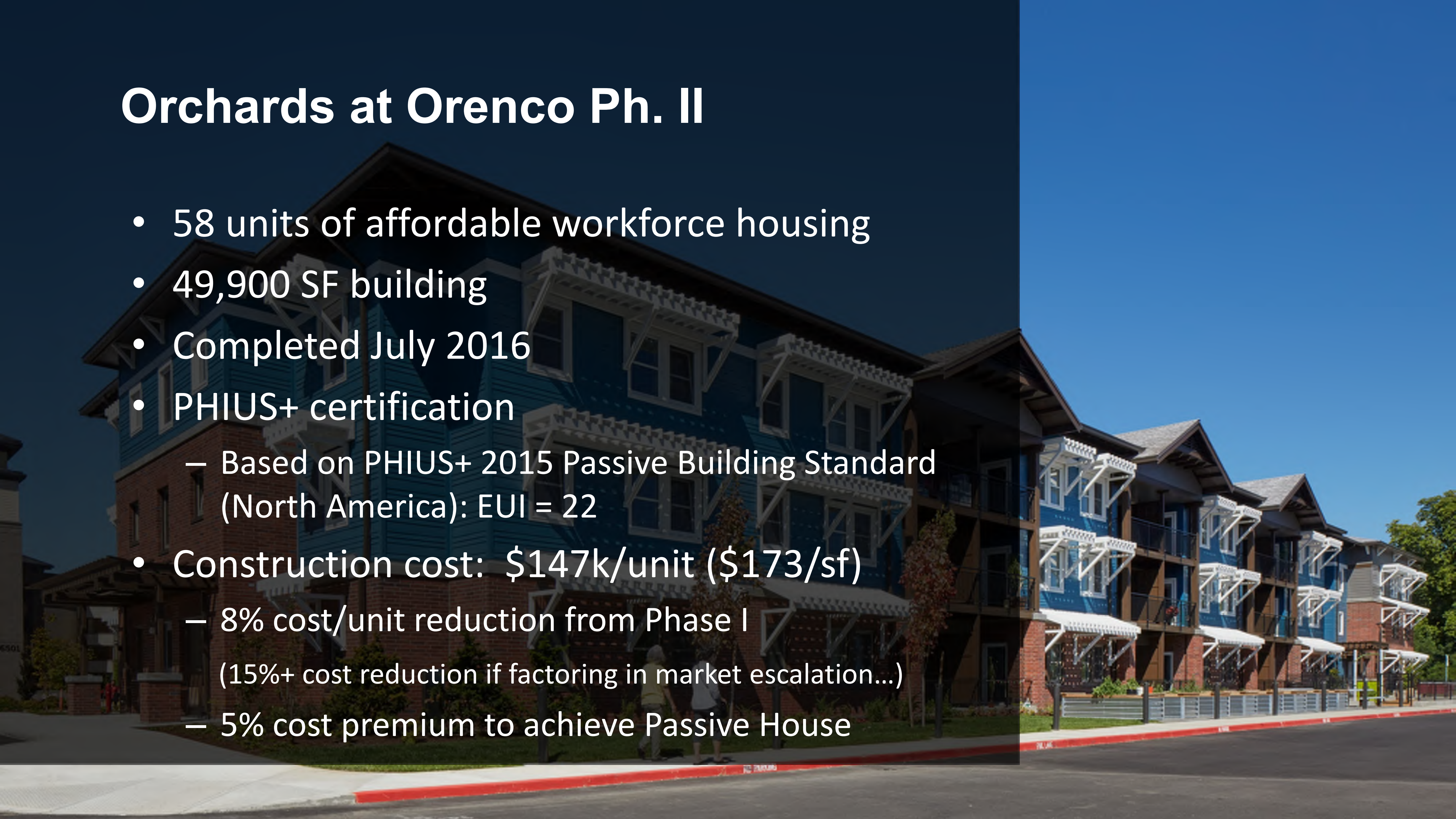
Image Credit: Ankrom Moisan Architects

Orchards at Orenco Hillsboro, Oregon

Orchards at Orenco Ph. I

- 57 units of affordable workforce housing
- 57,750 SF building
- Completed June 2015
- PHIUS+ certification
  - Based on PHI Passivhaus Standard: EUI = 21
- Construction cost: $159k/unit ($158/sf)
  - 11% cost premium over typical project by REACH





Orchards at Orenco Ph. II

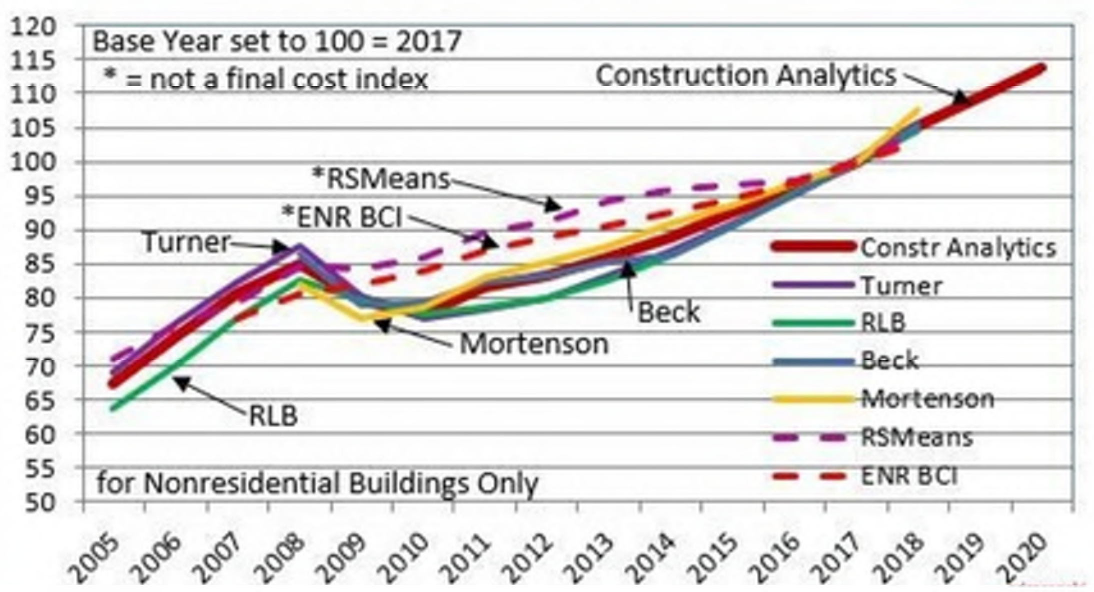
- 58 units of affordable workforce housing
- 49,900 SF building
- Completed July 2016
- PHIUS+ certification
  - Based on PHIUS+ 2015 Passive Building Standard (North America): EUI = 22
- Construction cost: $147k/unit ($173/sf)
  - 8% cost/unit reduction from Phase I

    (15%+ cost reduction if factoring in market escalation…)
  - 5% cost premium to achieve Passive House

Orchards at Orenco Ph. III

- 52 units of affordable family housing
- 62,750 SF building
- Completed September 2018
- Did not pursue Passive House certification
  - Somewhat better than code minimum…
- Construction cost: $198k/unit ($164/sf)
  - Two years of severe cost escalation in Portland market

Construction Building Cost Indices



Source: Ed Zarenski, Construction Analytics (edzarenski.com)

Construction Costs Rising…and Rising

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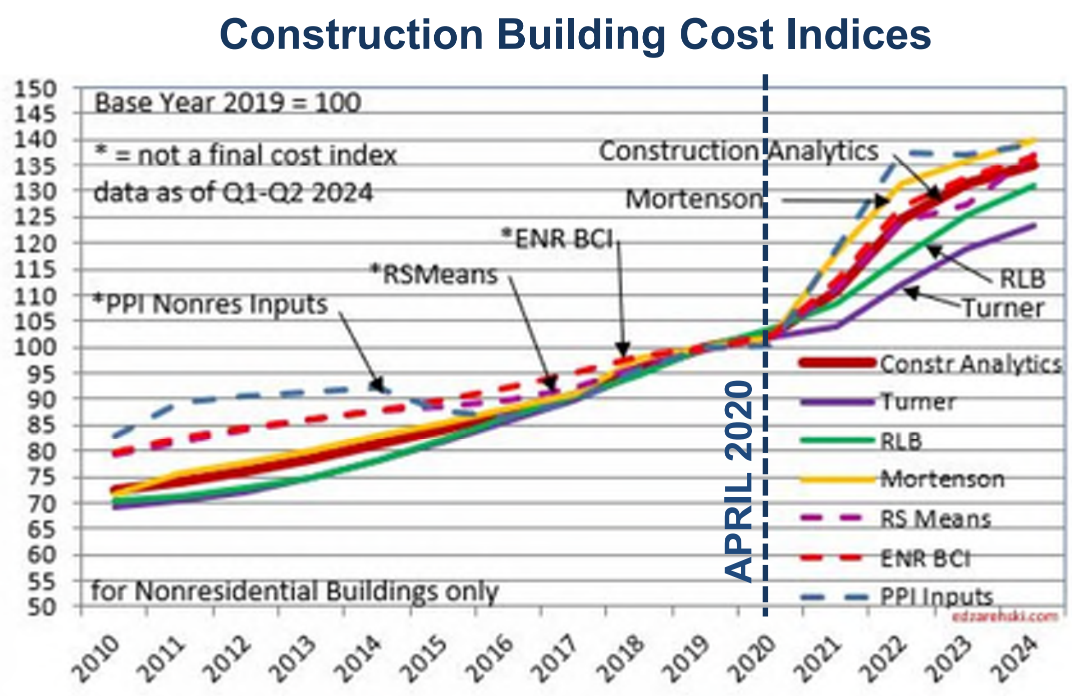
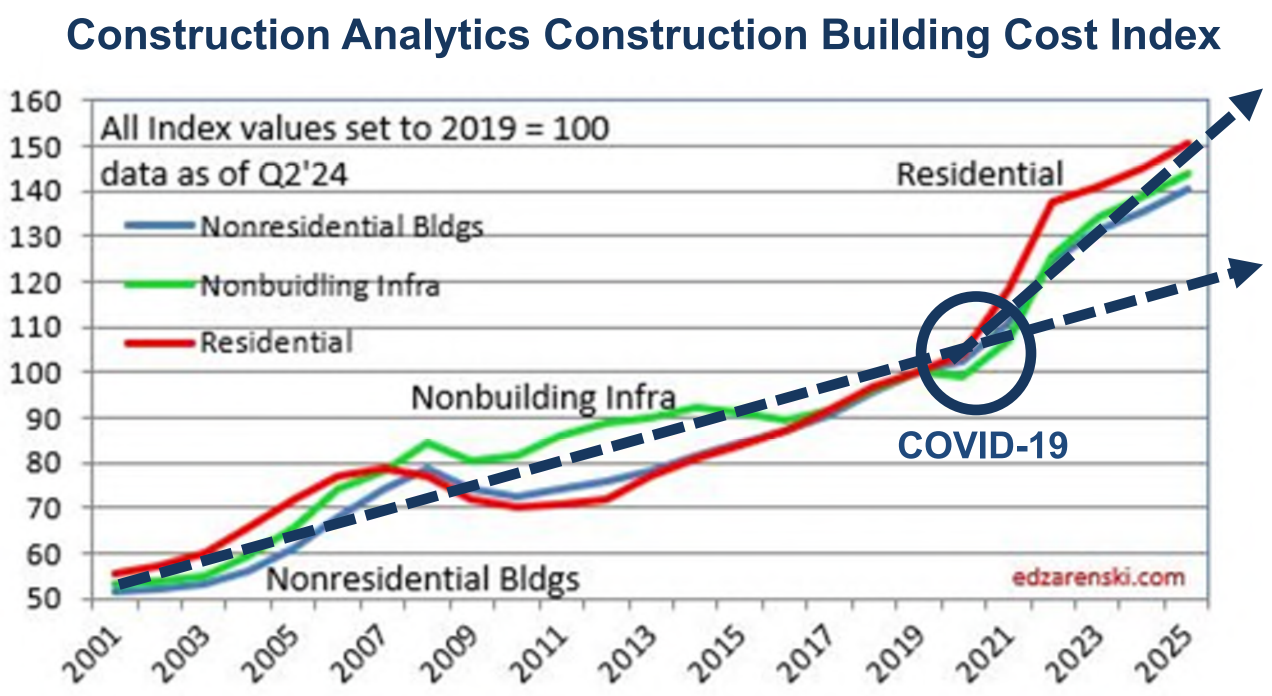
Photo Credit: New York Times





Source: Ed Zarenski, Construction Analytics (edzarenski.com)

Construction Costs Rising…and Rising

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Construction Costs: PNW Multifamily (2015-2024)

60-70%

(5.0 - 5.5% annual)

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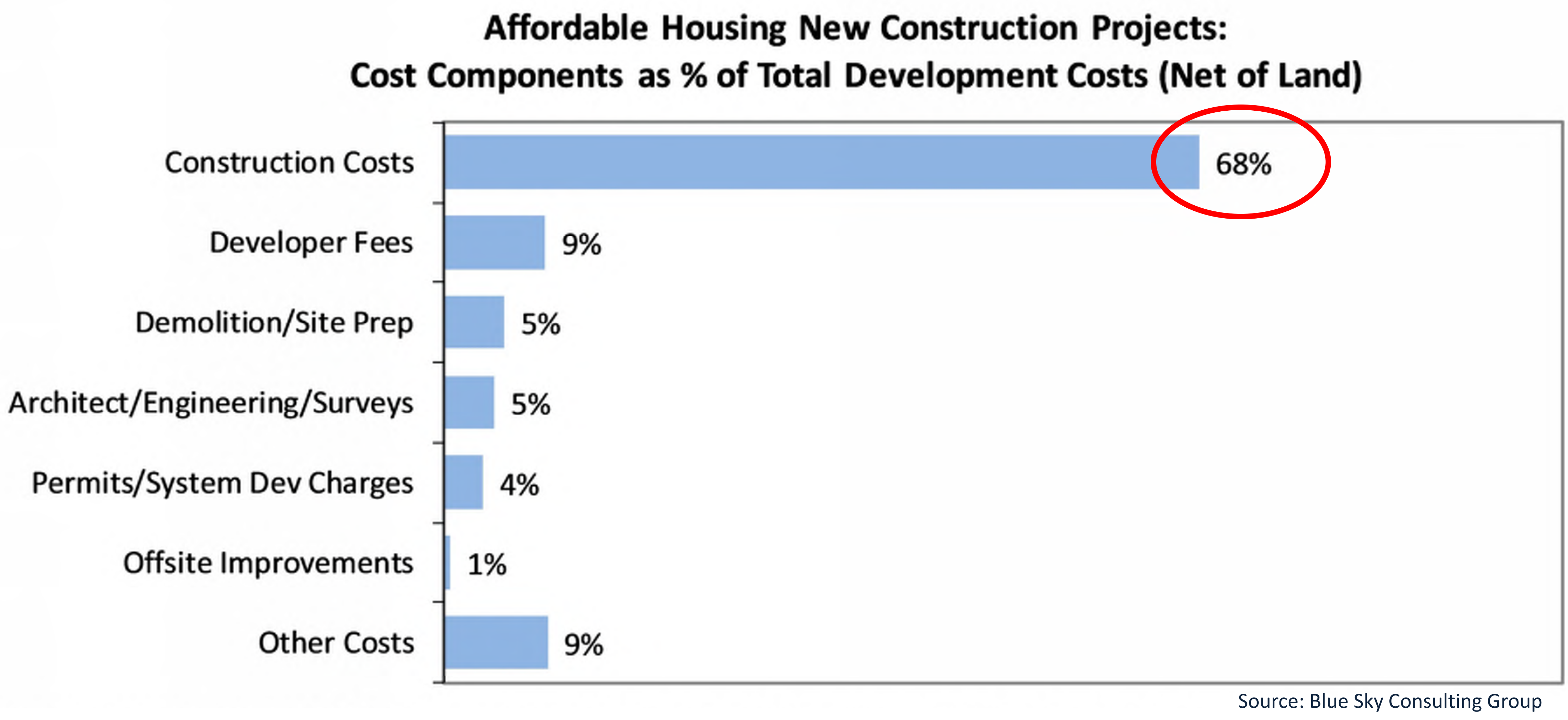
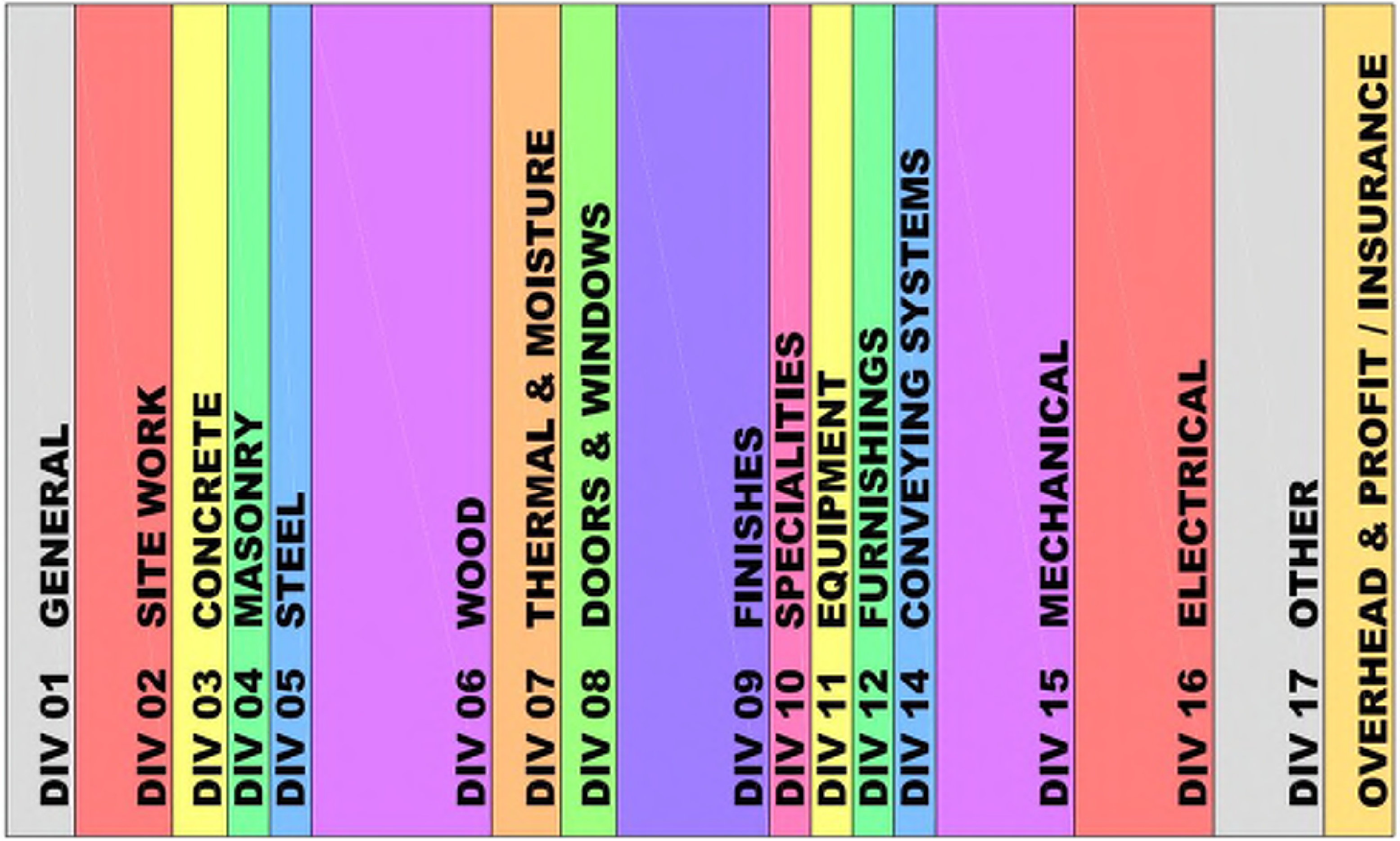
COST

- 5-5.5% cost escalation (annually), w/ radical spikes
- Multifamily market activity at all time highs (2014-2022)
  - Subcontractor books full
  - Increasing margins
- Severe labor shortage
  - Increasing wages
  - Lower productivity
  - Longer schedules
- Global pandemic
  - Disrupted supply chains
  - Increasing material prices
- Natural events



Major Components of Affordable Housing Development Cost



Major Components of Construction Cost

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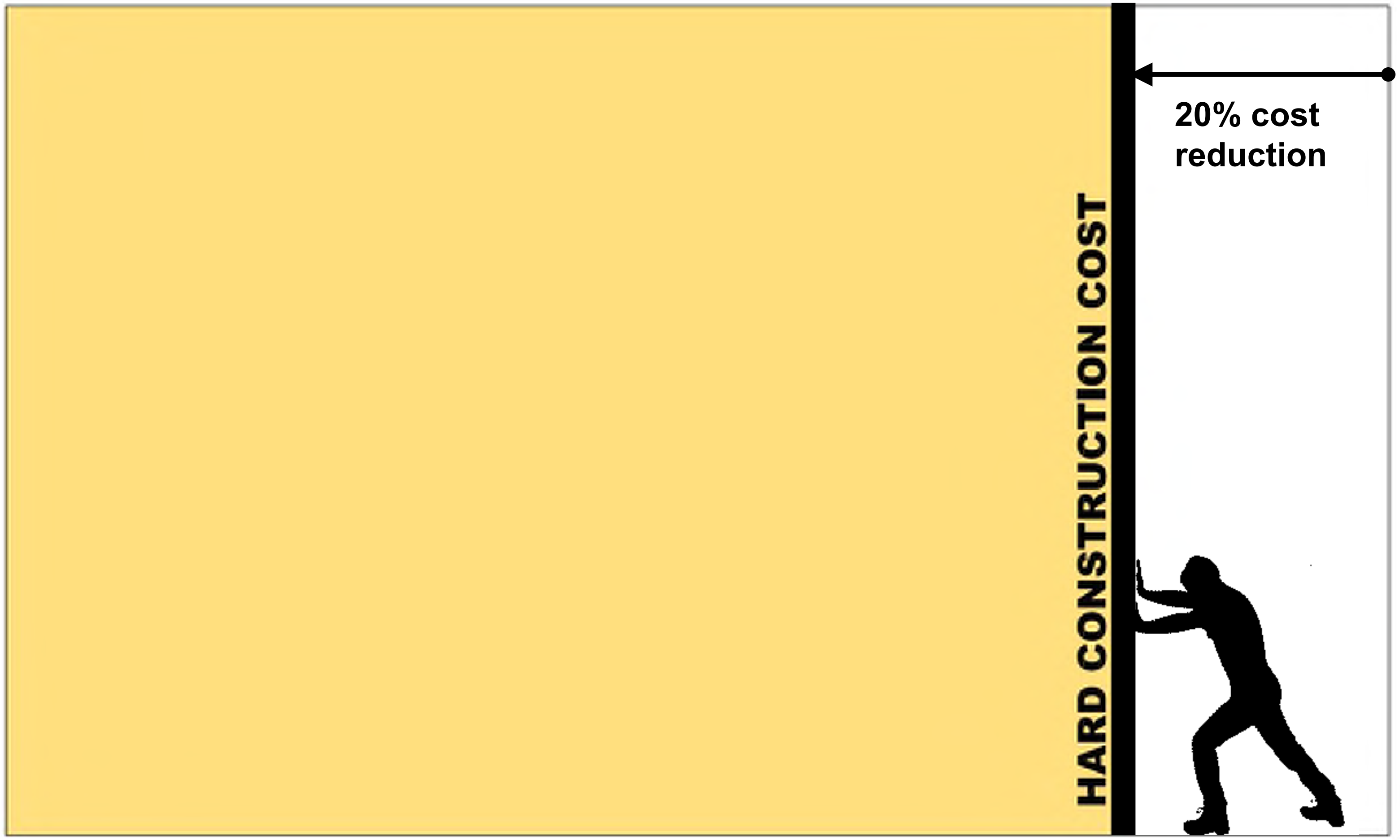
Major Components Added Up = Hard Cost



Pushing Cost Back to Achieve Better Buildings

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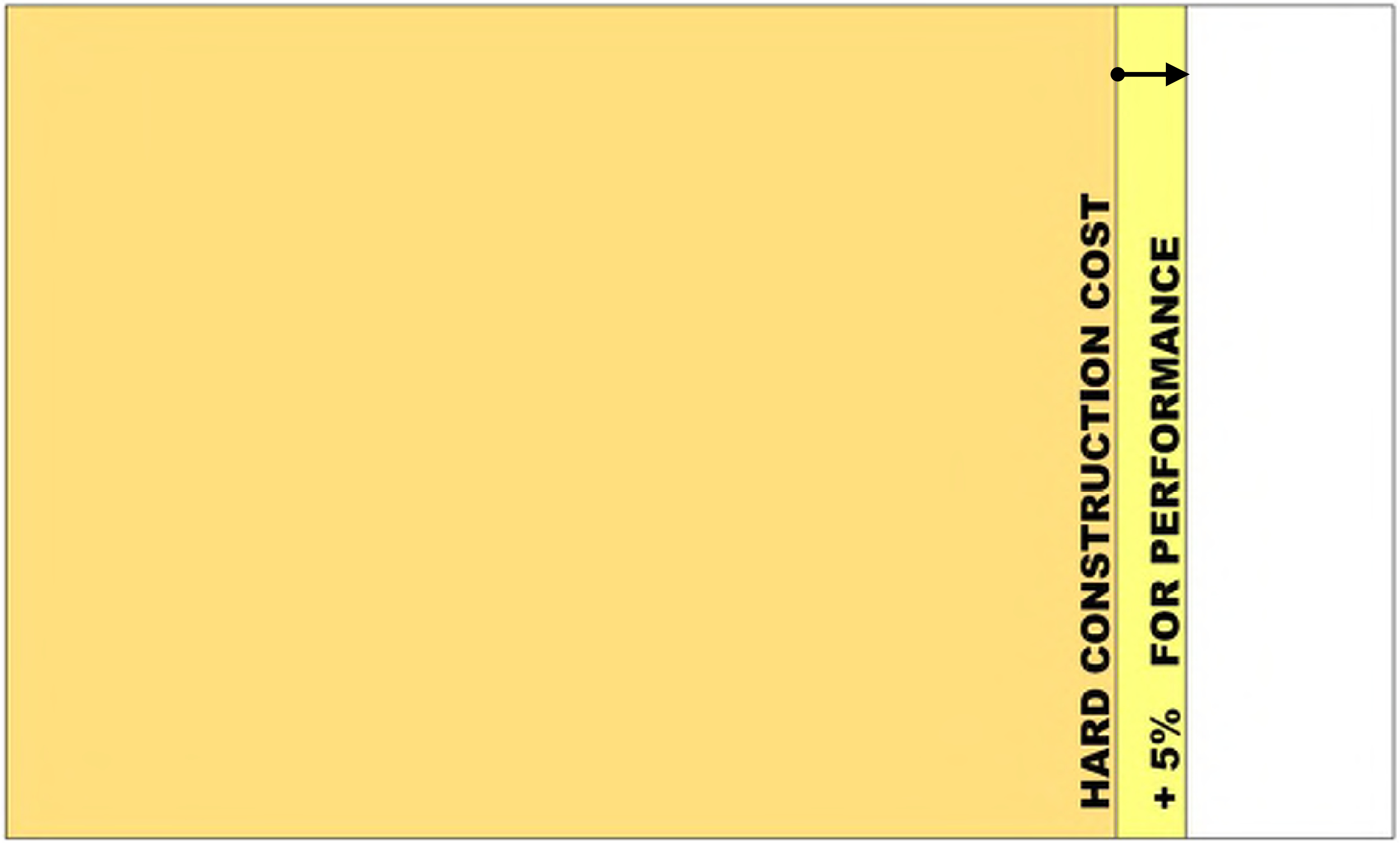

Pushing Cost Back to Achieve Better Buildings

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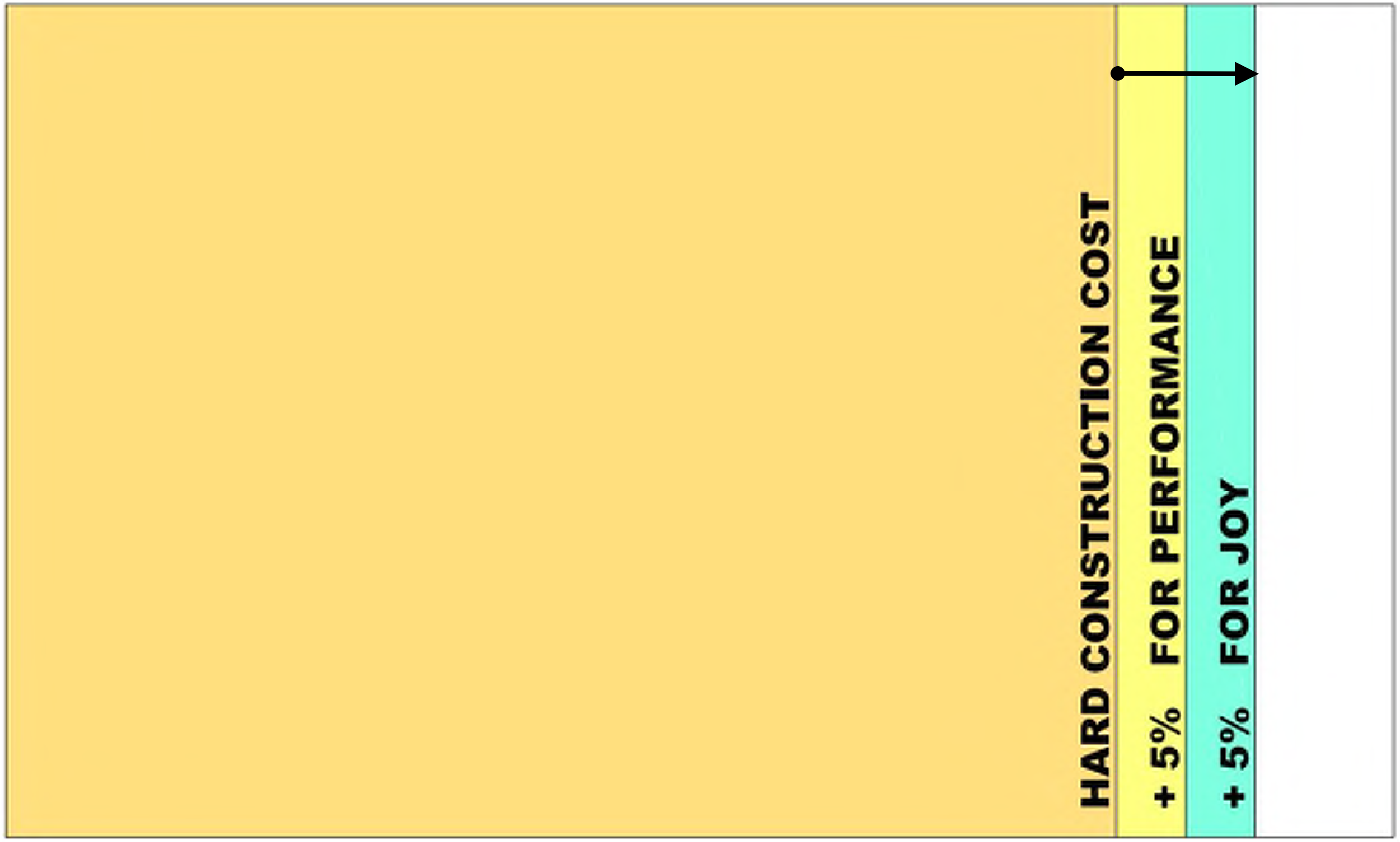
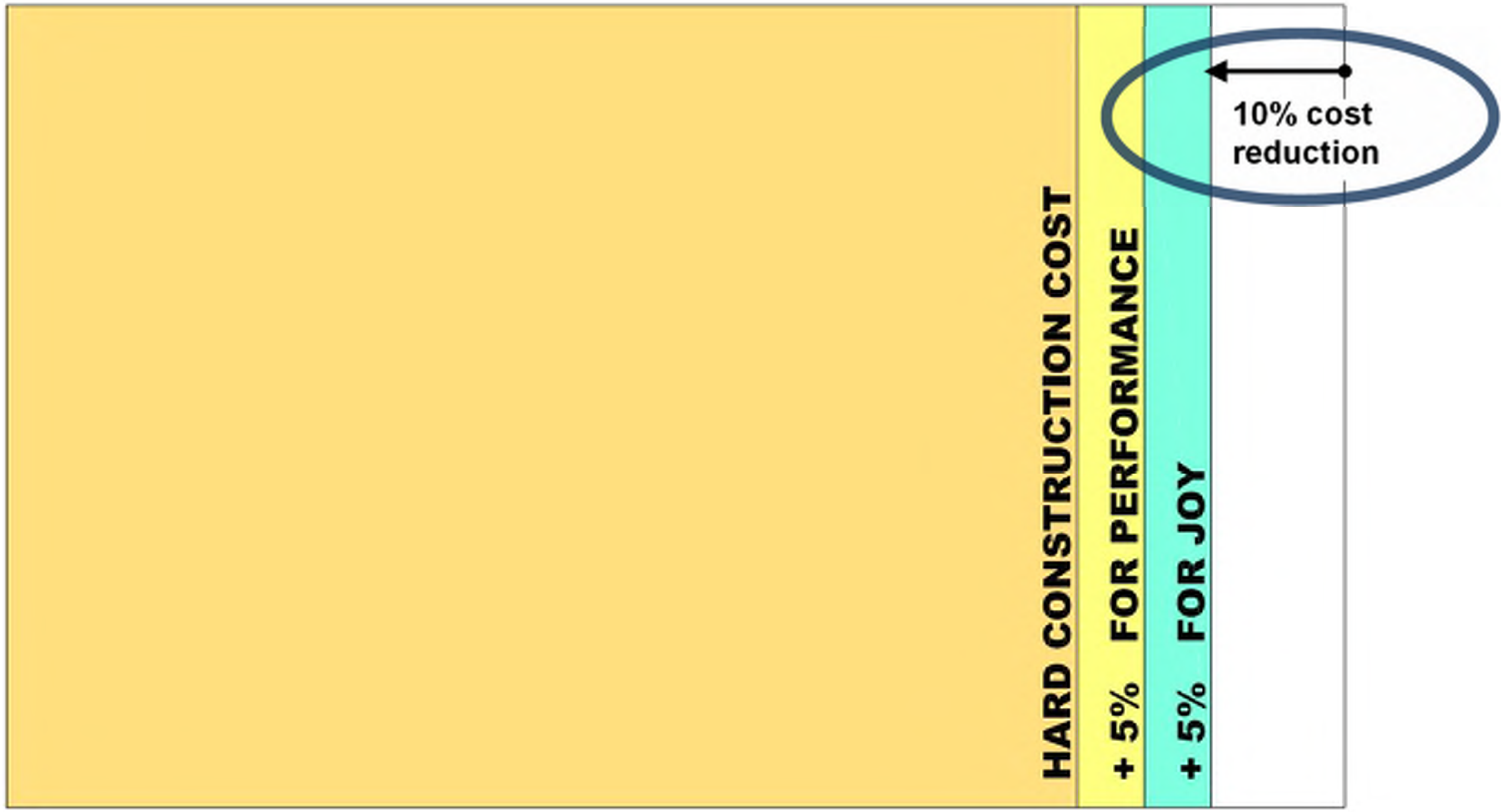


Pushing Cost Back to Achieve Better Buildings

WALSH CONSTRUCTION CO.



Pushing Cost Back to Achieve Better Buildings

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Exploring Innovations to Reduce Cost & Make Better Buildings

- Cost Efficient Design and Construction (CEDC)
  - Applying cost efficiency principles to overall design of buildings…and to building's sub-systems
  - Utilizing standardization, repetition, prefabrication
  - Utilizing economies of scale whenever possible
- Lean Methods
  - Optimizing the widget (i.e. unit plans) as basic building blocks for efficient building layouts
  - Deeper integration & collaboration (incl. subs)
  - Target Value Design (TVD)
  - Eliminating waste…

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Cost-Efficient Design and Construction of Affordable Housing

Walsh Construction Co.

For more than 50 years Walsh Construction Co. has partnered with public housing agencies, non-profit community development organizations and various for-profit entities across the Pacific Northwest to deliver more than 15,000 units of affordable housing to our communities. Each of those units is still standing today and is serving as affordable housing. We have learned a few things along the way about how to design and construct affordable housing in the most cost-efficient manner. We do not believe design quality and cost-efficiency are mutually exclusive. We believe it is a matter of including cost-efficiency as a valid constraint in the design of affordable housing and doing the best to give simpler, "leaner" designs a sense of place, character and distinction. To start the conversation with project teams, WALSH has developed the following list of important considerations for cost efficient design and construction.

Project Approach / Concept / Scale

- Strive at all times for simplicity. Applying a discipline to "keep it simple" will go a long way towards helping to reduce costs so that important architectural and performance features can be included in the project, even when working with limited budgets.
- Consider developing a larger project. All things being equal, larger projects are more cost-efficient. There are roughly the same number of components to design, specify and construct in a 20-unit building as in a 200-unit building. On larger projects, the cost of design services and construction management can be spread over a greater number of units and thus the cost per unit can be brought down significantly.

CEDC - Key Working Principles

- Strive to "keep it simple"
- Larger projects = economy of scale
- Seek out "unencumbered" sites
- Efficient building plans
  (net to gross area > 80%)
- Efficient unit plans (narrow "aspect ratio")
- Simple and compact forms
- Building/unit layout on 2 foot module
- Optimized structure / framing
- Floor to floor heights set for drywall
  (increments of 48", 54", 96")
- Stack the units (duh!)
- Compact plumbing layouts
  ("back to back" is most ideal)
- Avoid cantilevers
- Avoid steel (<u>yes</u> it is possible…)
- "Disciplined" approach to windows
- Standardize and repeat typical elements
- Prefabricate as much as makes sense for the specific project

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Standardize/Optimize

80%

- Typical unit plans
- Corridors
- Exit stairways
- Foundation system
- Structural system
- Enclosure system
- Windows and doors
- MEP systems
- Typical interior finishes
- Cabinets
- Appliances
- Lighting
- Elevator(s)
- Laundry facilities

Customize

20%

- Response to the site
- Interface with the street
- The space between buildings
- Building plan / layout
- Building form / massing
- Façade design / expression
- Building entry / lobby
- Community room(s)
- Public stairway
- Select common area finishes
- A few select unit plans
- A few select windows
- Balconies (if any)
- Roof deck amenity (if any)

Optimization Potential

- Building form and massing

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- For individuals, who are not trainees, certified professionals or Alliance members that would like to submit a project for certification, a Project Submitter Profile must be created.
- Use this form to create a Submitter profile. A Phius ID will be assigned to you and sent to you via email, and you will be granted access to the Phius Portal to submit a project.

Any questions regarding Phius Portal access should be directed here.

I-1.3 Editing Project Public Listing

Project editing can be done through the Phius Portal under the 'My Projects & Products' tab.

- Phius is responsible for filling in all data shown on the 'Phius Project Data' tab of the portal.
- The project team is responsible for entering the data for all of the remaining tabs that appear in the project listing.

Please review this blog post for additional information.

I-2 Tips for Passive Building Design

I-2.1 Tips to Design a Low-Cost Passive Building

- Keep the thermal envelope simple (add "architectural interest" outside of it).
- Keep window area down (10-15% of wall area for single-family houses).
- For small buildings, design a compact shape.
- For large buildings, bump-ins for daylighting may be more important.
- Limit "open to below" areas on the floor.
- Not too "tiny" and detached – design attached housing with small units instead.
- Use details that do not require excessive labor to air-seal (avoid "conceptual retrofitting").

I-2.2 Tips on Assemblies

Air Barrier

Mid-wall is the best place for the air barrier. Exterior/interior placement is more vulnerable.

Perfect Wall

Keep in mind the "perfect wall" concept - structure to the inside, insulation to the outside. Diffusion open or exterior rigid foam, both versions can work moisture-wise and super-insulated.[65],[66]

Slab Construction

Moisture barrier and air barrier are typically placed between the foam layer and slab.

Polyisocyanurate (PolyIso) insulation is typically not to be used below grade.[67] Thoroughly follow the application guidance of the manufacturer's warranty and any ICC Evaluation Service report that pertains.

Keep it simple!
Keep it compact!

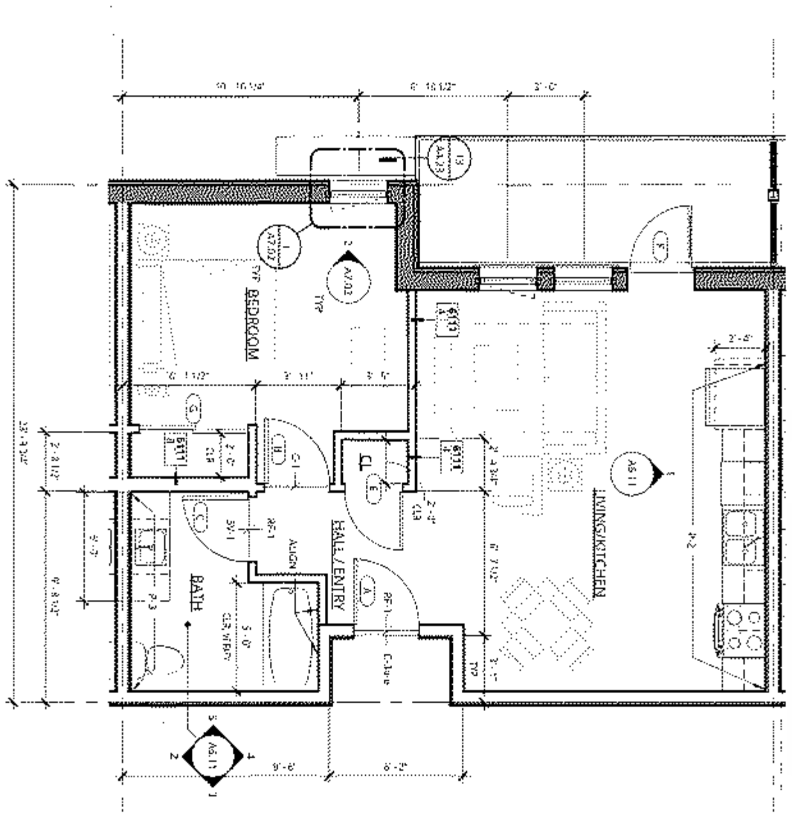
[65] Lstiburek, Joseph. BSI-001: The Perfect Wall. Building Science Corporation, 15 July 2010. Web. 16 May 2016.
[66] BSI-091: Flow-Through Assemblies. Building Science Corporation, 13 Jan. 2016. Web. 16 May 2016.
[67] Home » Green Basics: Encyclopedia » Envelope and Structure » Insulation Choices » Rigid Foam Insulation. Green Building Advisor. The Taunton Press, 9 Aug. 2012. Web. 16 May 2016.

Looking At Unit Plans

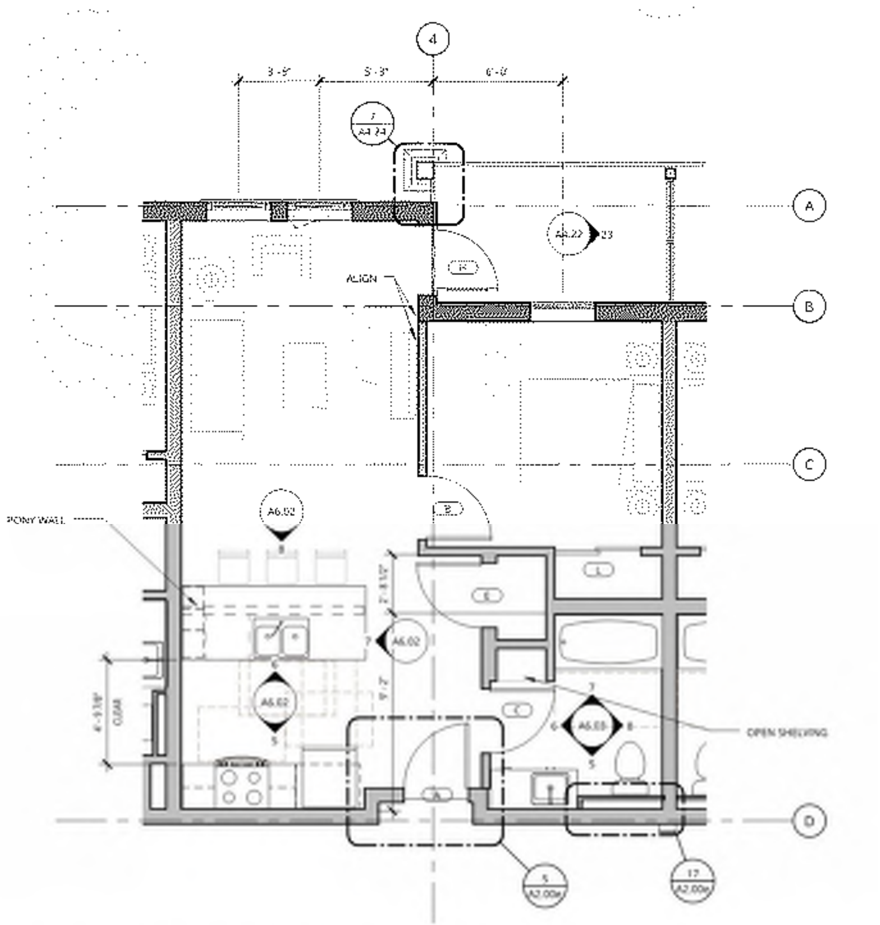
Orchards at Orenco

Image Credit: Ankrom Moisan Architects

Optimizing the Widget



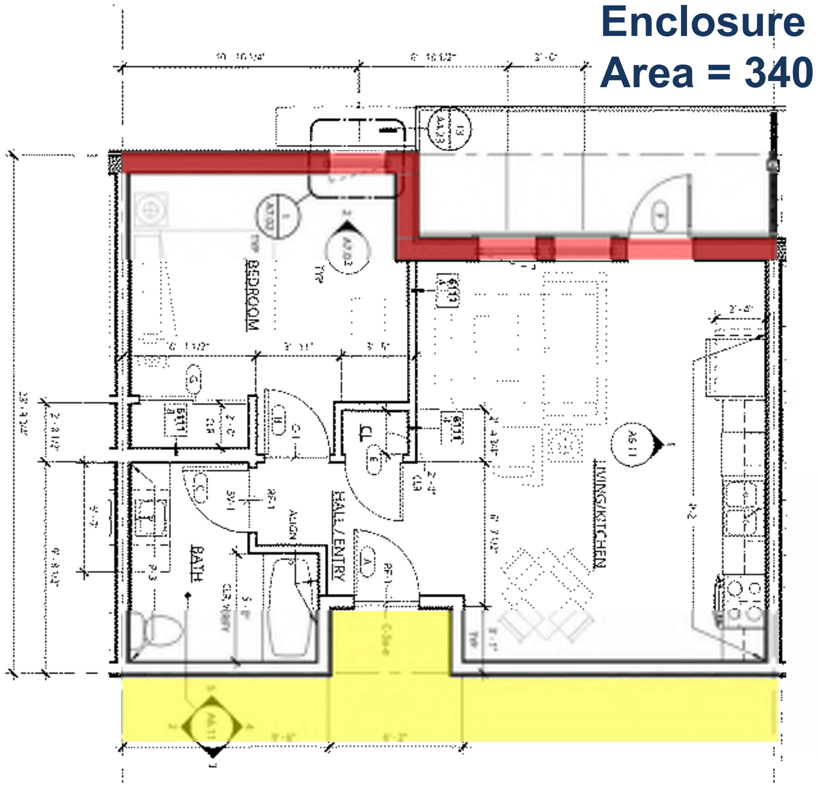
Orchards Ph. I: 656 square feet
30 feet wide



Orchards Ph. II: 608 square feet
23 feet wide

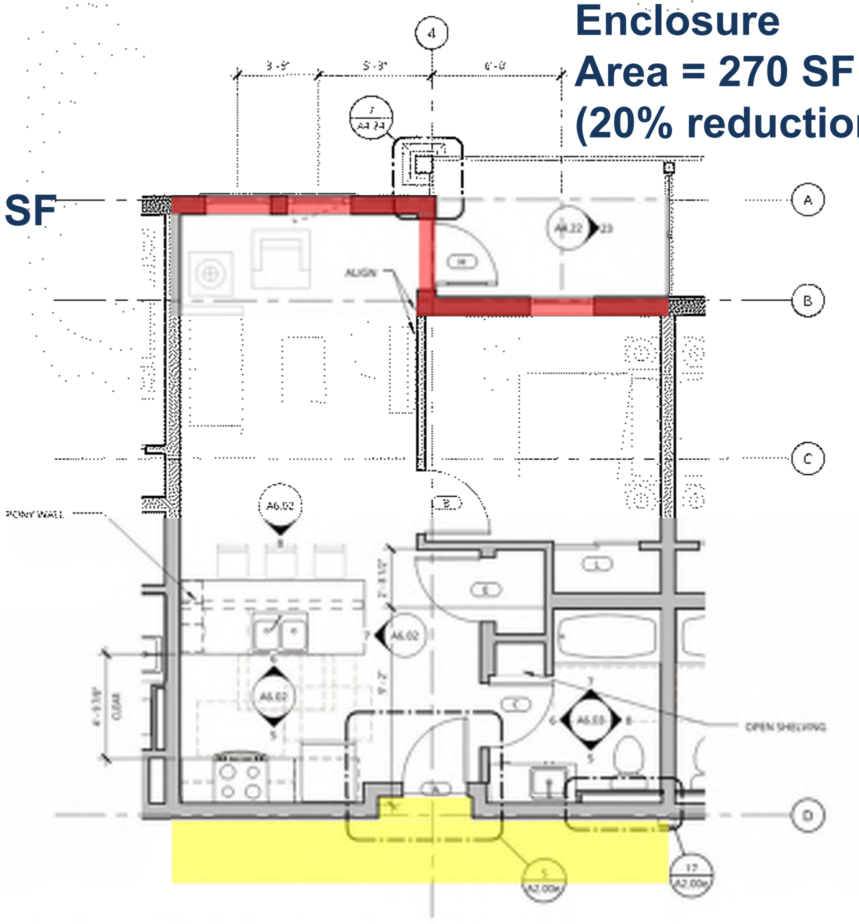
Image Credit: Ankrom Moisan Architects

Optimizing the Widget



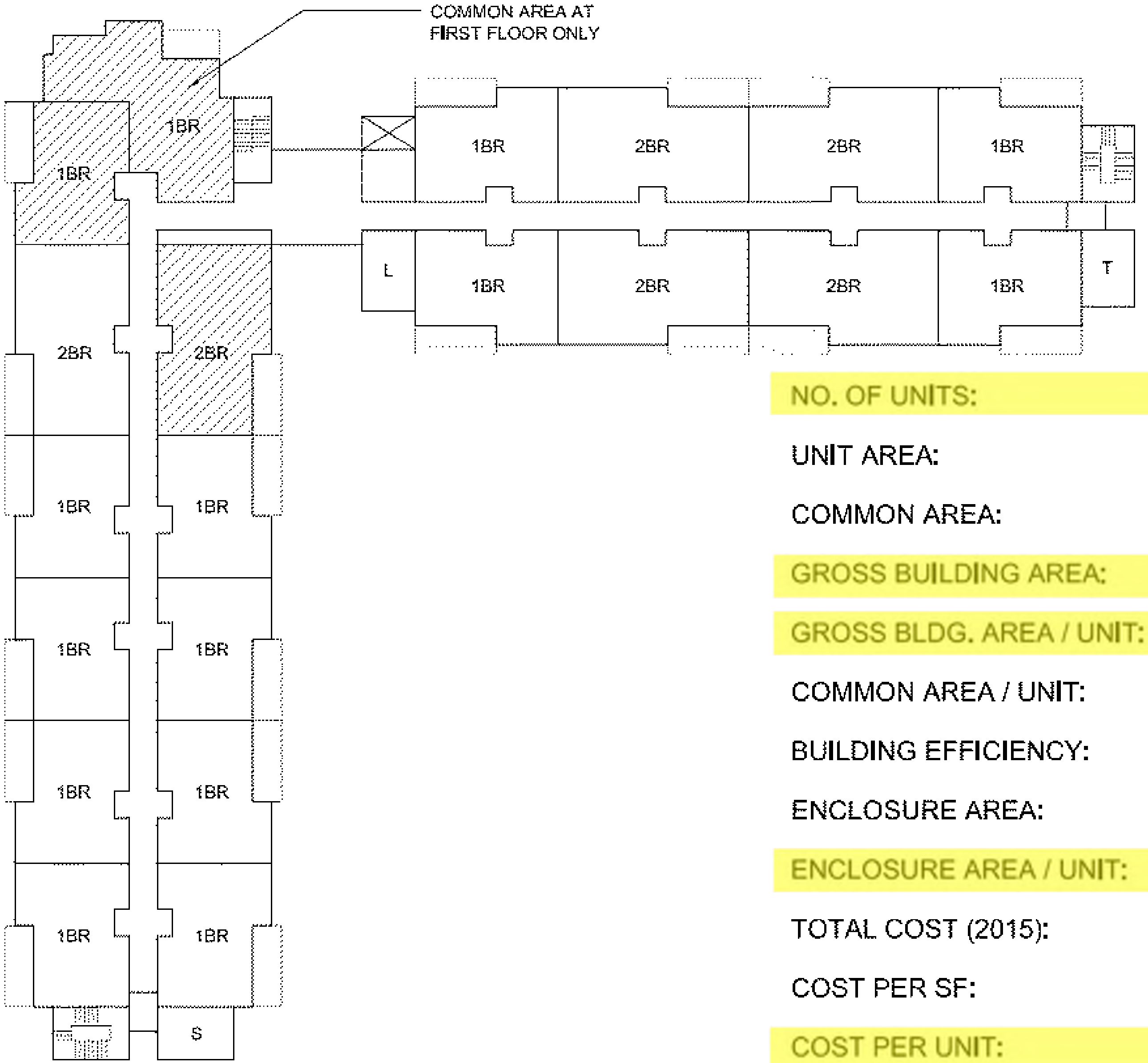
Vertical Enclosure Area = 340 SF

Common Area (Corridor) = 108 SF

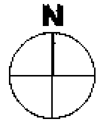


Vertical Enclosure Area = 270 SF (20% reduction)

Common Area (Corridor) = 74 SF (32% reduction)

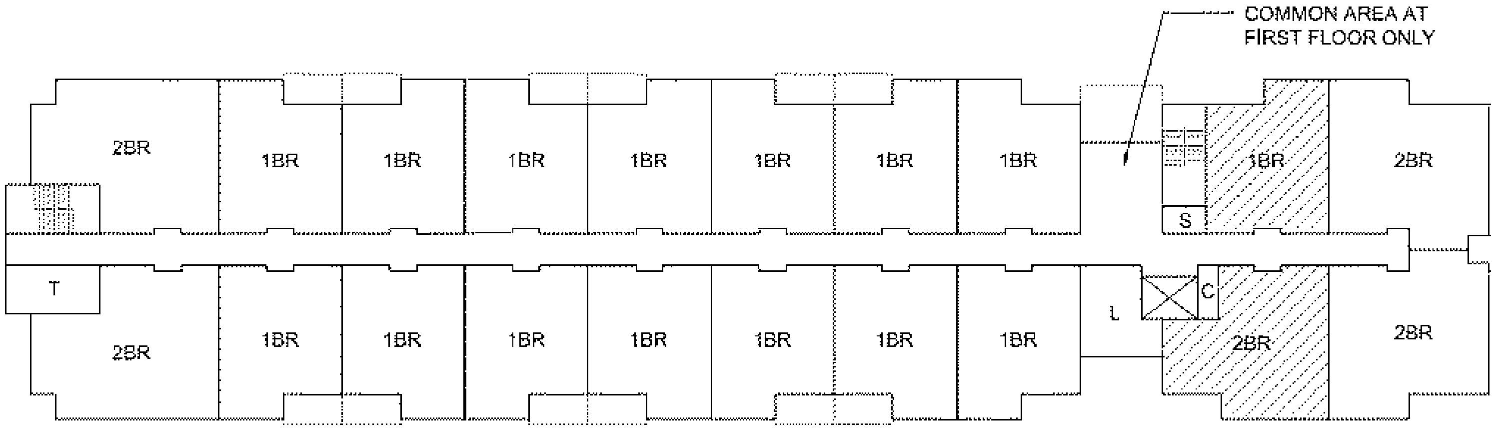


NO. OF UNITS:	57
UNIT AREA:	42,638 SF
COMMON AREA:	15,112 SF
GROSS BUILDING AREA:	57,750 SF
GROSS BLDG. AREA / UNIT:	1,013 SF
COMMON AREA / UNIT:	265 SF
BUILDING EFFICIENCY:	74%
ENCLOSURE AREA:	50,050 SF
ENCLOSURE AREA / UNIT:	878 SF
TOTAL COST (2015):	$9,053,040
COST PER SF:	$158
COST PER UNIT:	$159,527



Orchards Phase I

CEDC Project



NO. OF UNITS:	58
UNIT AREA:	40,124 SF
COMMON AREA:	9,776 SF
GROSS BUILDING AREA:	49,900 SF
GROSS BLDG. AREA / UNIT:	860 SF (15% reduction)
BUILDING EFFICIENCY:	80%
COMMON AREA / UNIT:	168 SF
ENCLOSURE AREA:	39,712 SF
ENCLOSURE AREA / UNIT:	684 SF (22% reduction)
TOTAL COST (2016):	$8,531,624
COST PER SF:	$173
COST PER UNIT:	$147,097 (8% reduction)

Orchards Phase II

CEDC Project

Unit Plan Optimization

- Keep it simple, reduce materials, minimize waste…
  - Less can be more
- Optimize width-to-depth (i.e. "aspect ratio")
- Reduce circulation area
- Provide open space with flexible layout
- Use modular layout
- "Cut corners"
- Reduce walls and doors
- Make every inch count
- Repeat basic unit plans

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Seeking Better Building Blocks for Affordable Housing: Notes on the Design of Unit Plans

Walsh Construction Co.

Unit plans are the basic building blocks of multi-unit residential building design. Efficient unit plans are the starting point for creating efficient building plans. A well laid out unit plan properly accommodates all the basic functional areas for living, cooking, dining, sleeping and bathing, and does so using a minimum of square footage and building volume. Ideally, spaces should have a loose fit to accommodate multiple activities and a variety of furniture layouts. There should be ample space within the unit for storage and the area dedicated to circulation should be minimized.

Minimum area requirements for dwelling units advocated or required by some project stakeholders exceed what is necessary to provide commodious living space for occupants if the unit layouts are well planned and optimized. The market rate housing delivery system clearly understands this and commonly offers smaller unit sizes, especially in more urban settings where occupants spend much of their daily life outside of the unit. Affordable housing providers should consider challenging the minimum area requirements to create more efficient building plans, reduce overall costs per unit, and thus stretch the resources that are to be invested in the provision of affordable housing. More efficiency = more affordable homes delivered to the community, for less subsidy per unit.

In the process of developing the most optimized unit plans in an effort towards standardization, WALSH recently undertook a series of studies of different unit configurations and sizes for studio, one-bedroom and two-bedroom units, working together with project partners at REACH CDC and Ankrom Moisan Architects. We built a full-size mockup of the units, to allow our team to test assumptions and fine tune the configuration and sizing. The intent of the study was to develop efficient, standardized unit plan layouts that optimize the overall size of the units while not reducing their core functionality and livability. Plan layouts are based on the following principles:

Use modular layout. The units are laid out on 2-foot modules. This supports the most efficient use of framing and finish materials. Exterior walls are laid out on 2-foot module to support optimum advanced framing methods and windows are laid out on framing module to further simplify the wall framing and reduce material use, while increasing thermal/energy performance by reducing thermal bridges.

"Cut corners." No, this doesn't mean to cheat, or cheapen the design! The idea here is to reduce the number of corners at the walls within the unit, which will improve framing and drywall productivity. At the exterior, it is about avoiding steps in the wall plane as much as possible. These steps create framing and drywall complexity and add cost, and also introduce thermal bridges in the wall that reduce thermal/energy performance and comfort.

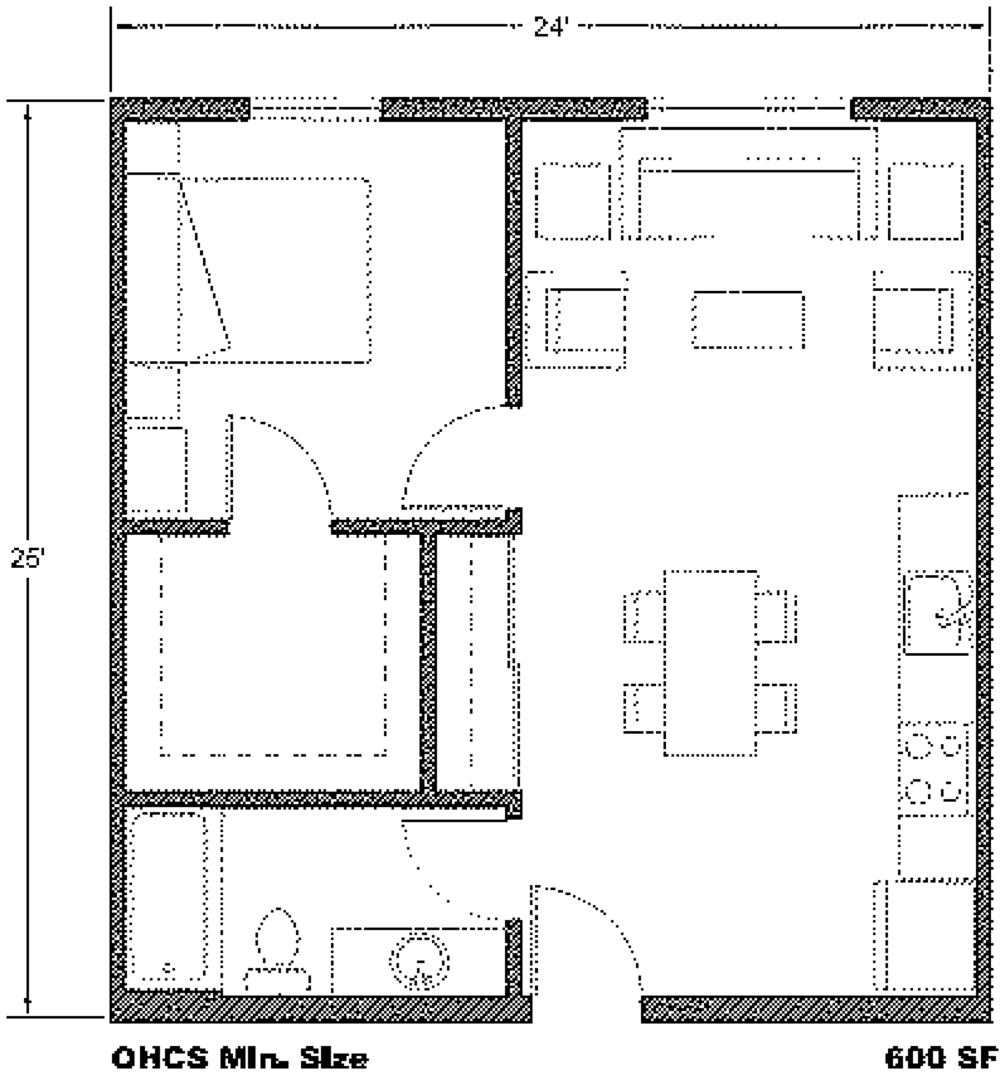
Reduce walls and doors. The quantity of walls within the unit can be minimized to reduce costs and increase flexibility in use. Taken to its extreme, the only walls needed at a typical unit are those that enclose the bathroom. The kitchen area is often "walled off" from the living area but does not need to be. Doors can also be reduced to the minimum needed to maintain privacy or screen closet areas from view.

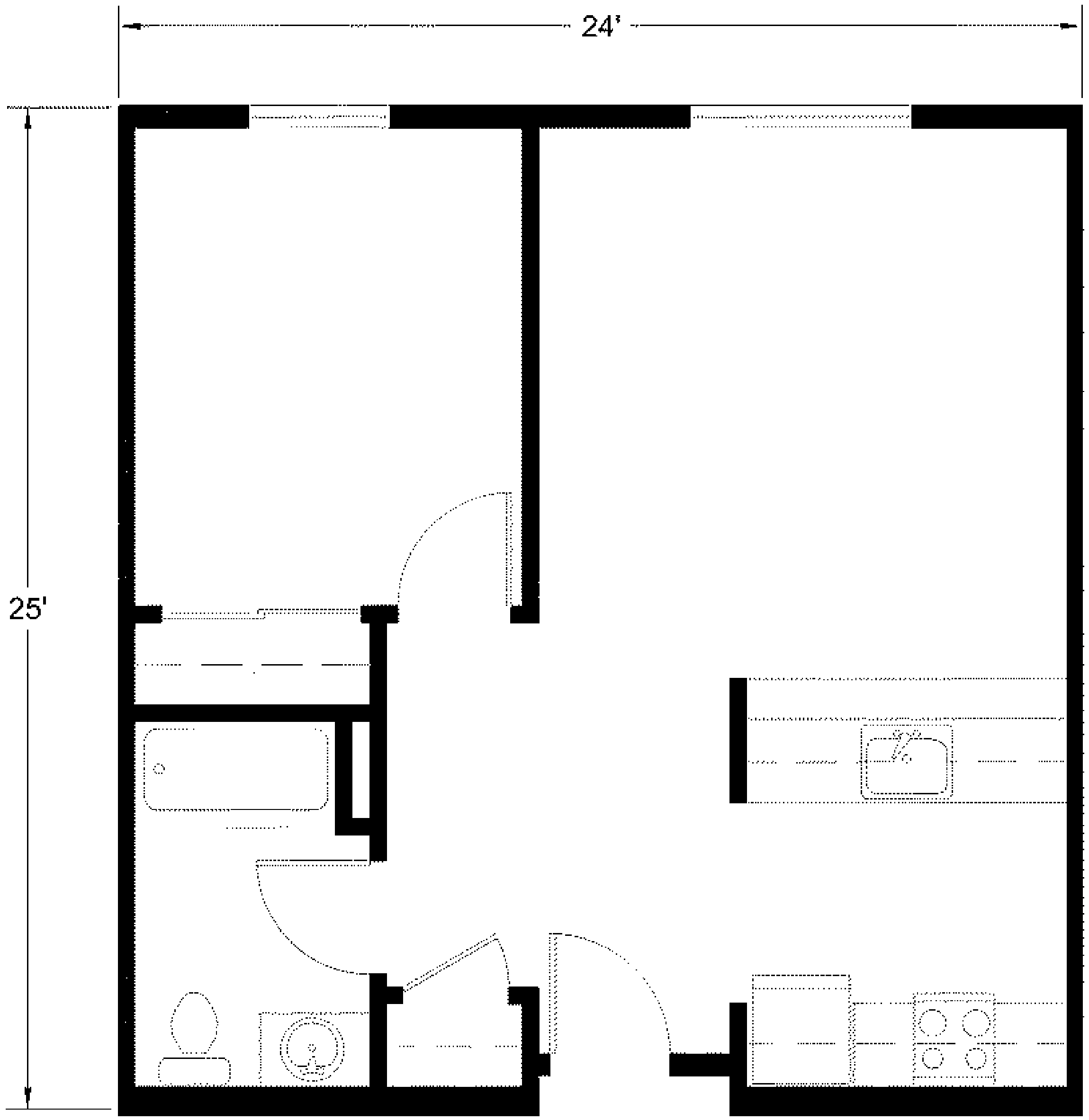
Make every inch count. Every inch matters when it comes to maintaining room sizes and clearances in the primary spaces, to allow the greatest number of furnishing options and overall flexibility. Keep the bathroom and kitchen dimensions as minimal as possible while meeting accessibility requirements. A bathroom "pod" – 5'-4" wide x 9'-6" long – has been developed, based on the smallest, simplest layout that meets those requirements for Type B units. Likewise, a kitchen "pod" – 12'-6" long – has been developed, with a straightforward, compact layout that increases the overall usability of a limited amount of cabinetry and countertop while meeting accessibility requirements.

Repeat basic unit plans as much as possible. The same basic optimized layout is used for all units, however where articulation at the exterior is needed or desired for architectural reasons, the living zone can be enlarged several feet to create articulation in the façade, while adding some extra space to the living/dining/kitchen areas. This move will also accommodate a slightly larger kitchen pod – 13'-6" long – that may be needed to meet Type A accessibility requirements. Where a larger bathroom is required to meet Type A requirements, additional space can be borrowed from the closet area to allow a variety of

OHCS Min. Unit Requirements

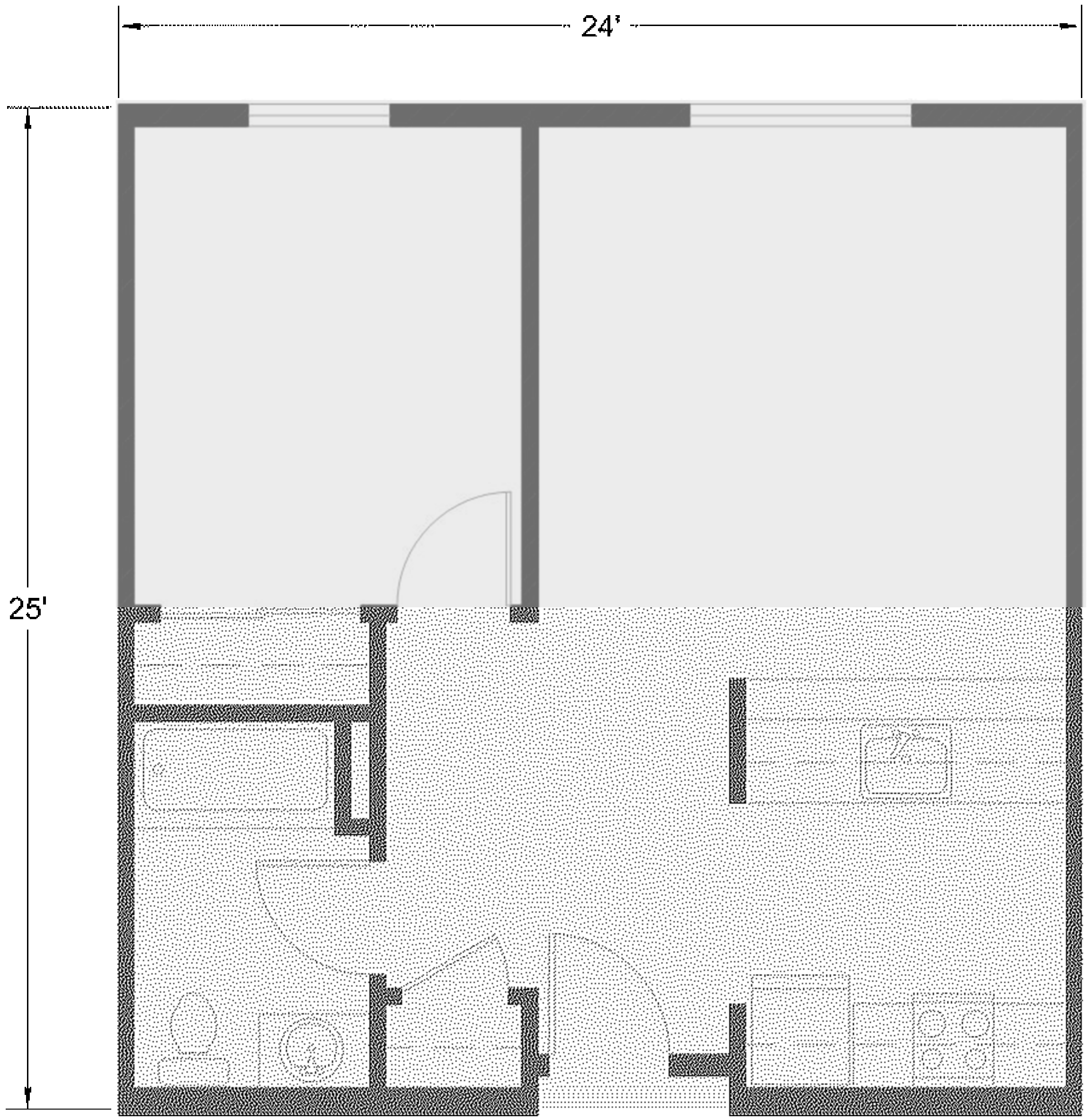
- 600 SF min. area
- Efficient, flexible layout
- Avoid hallways
- Bedrooms furnishable with two twin beds
- Ample storage





Typical One Bedroom Unit

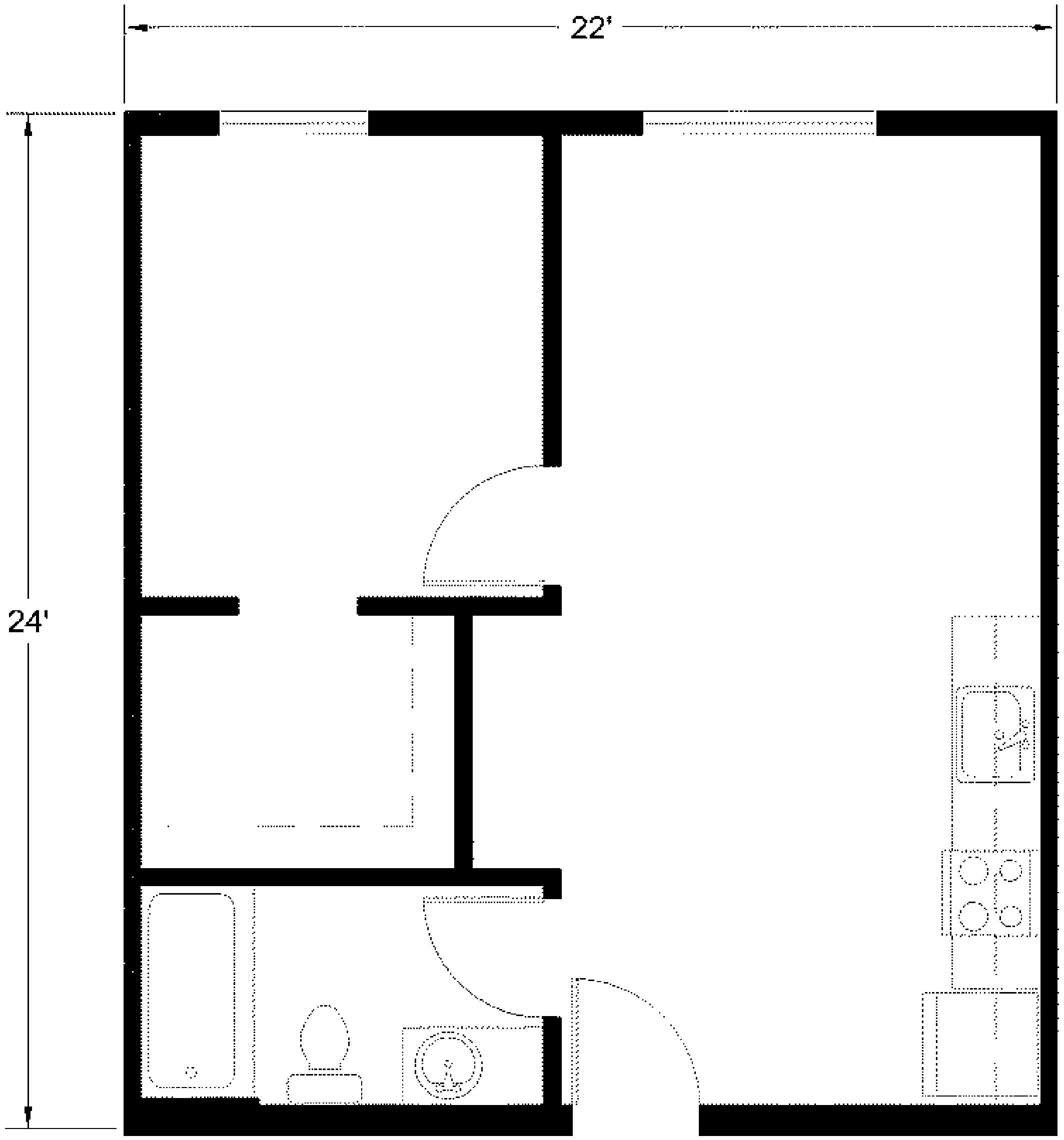
CEDC Project



600 square feet

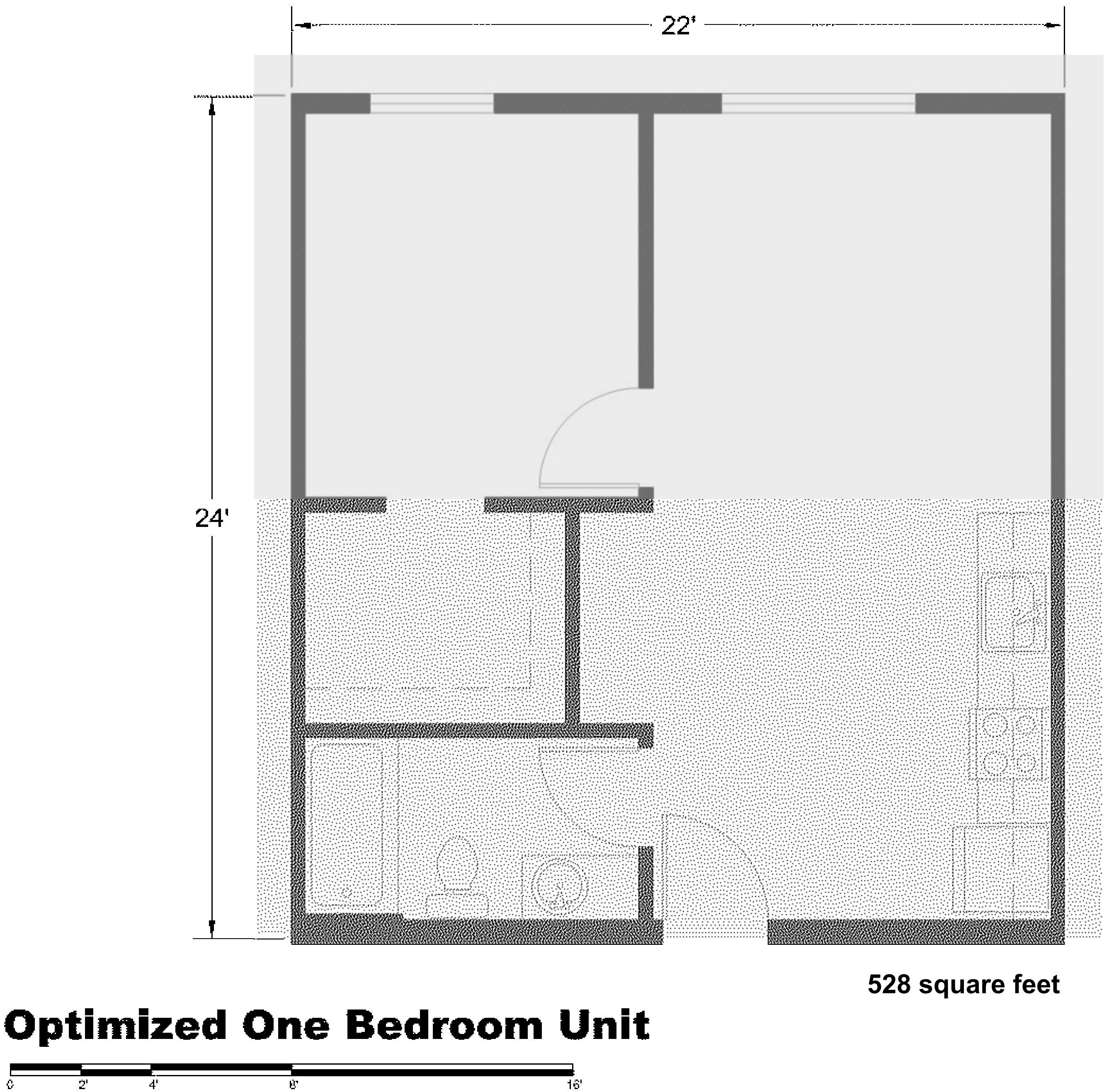
Typical One Bedroom Unit

CEDC Project



Optimized One Bedroom Unit

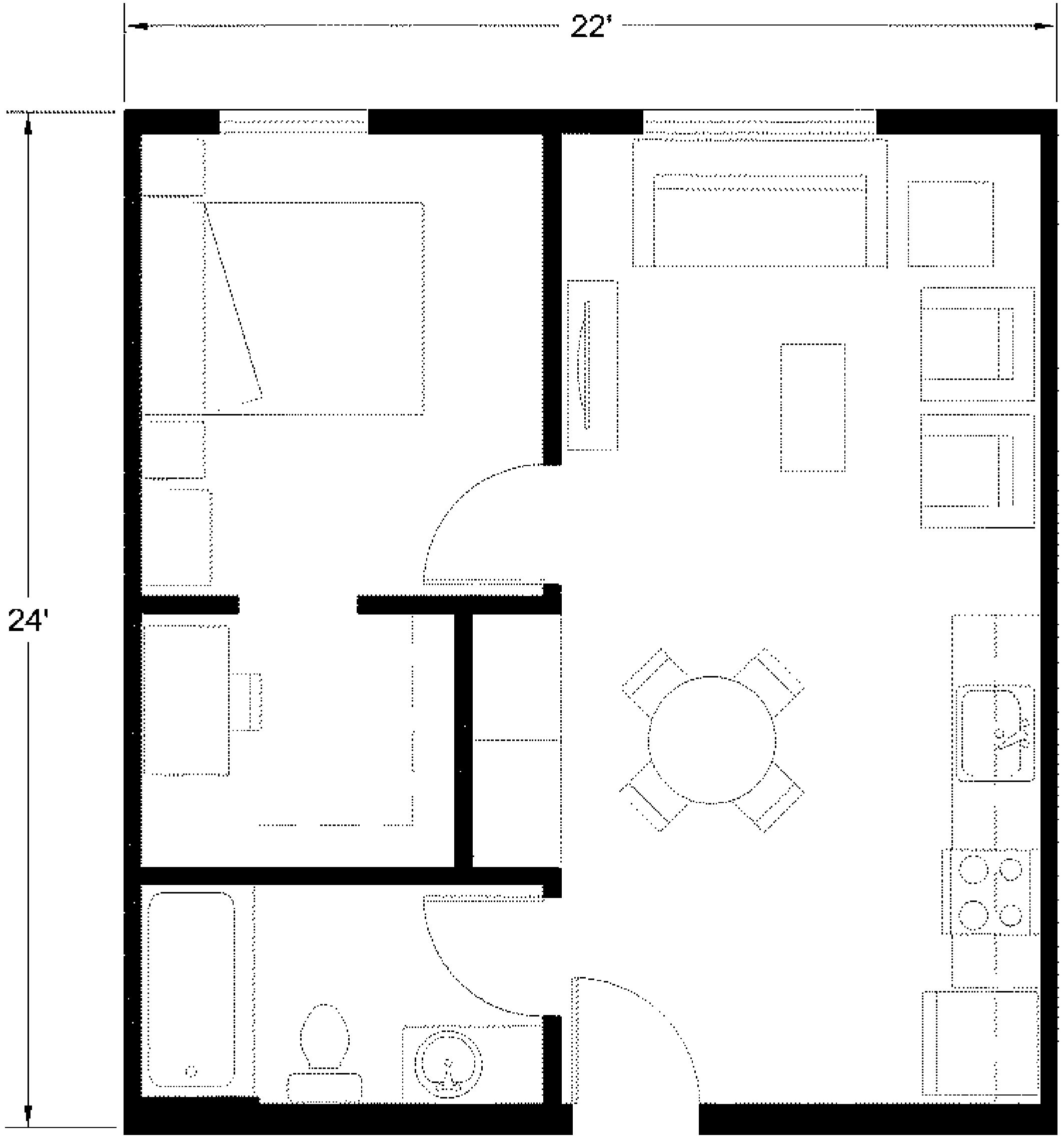
CEDC
Project



528 square feet

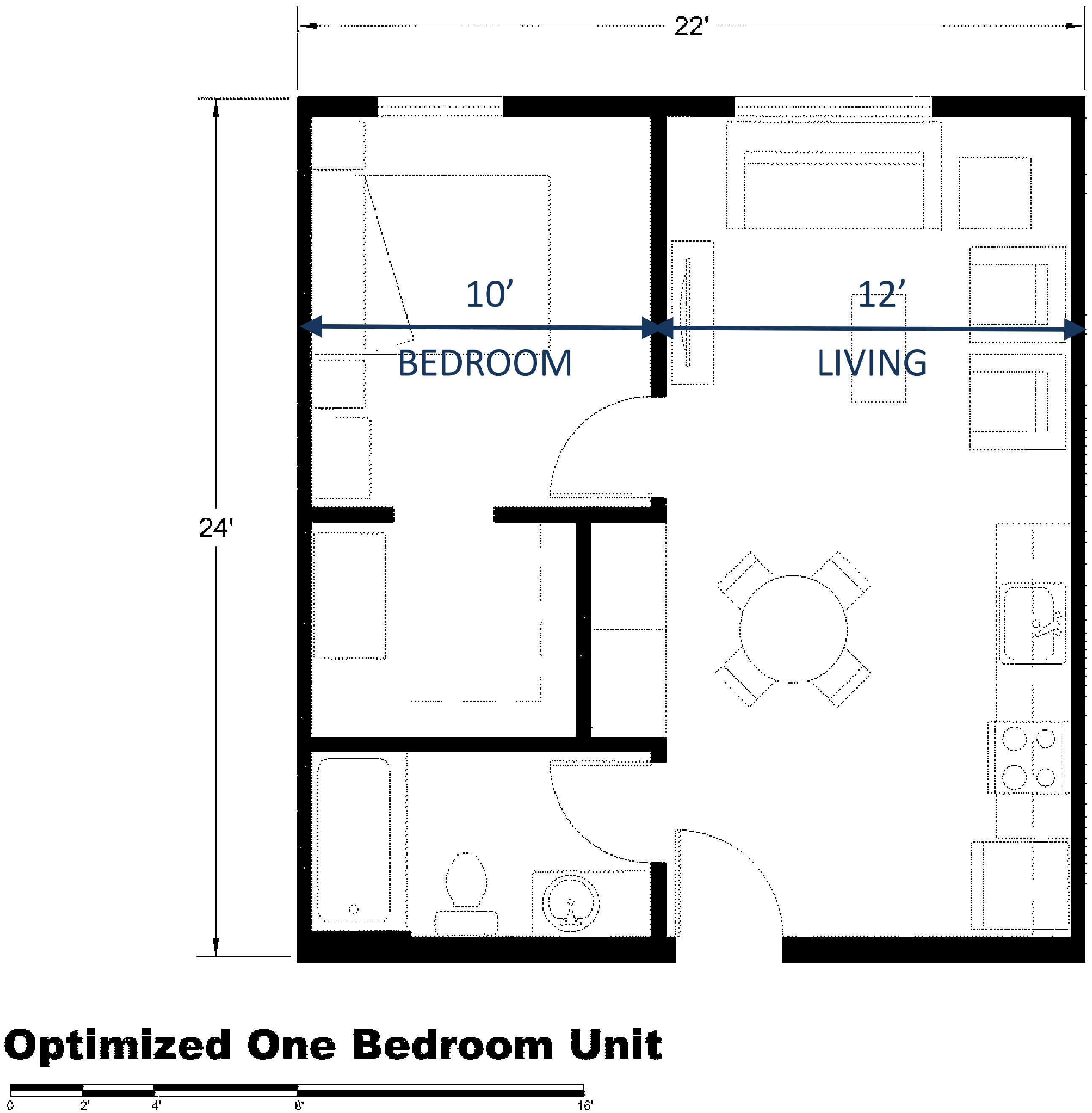
Optimized One Bedroom Unit

CEDC
Project



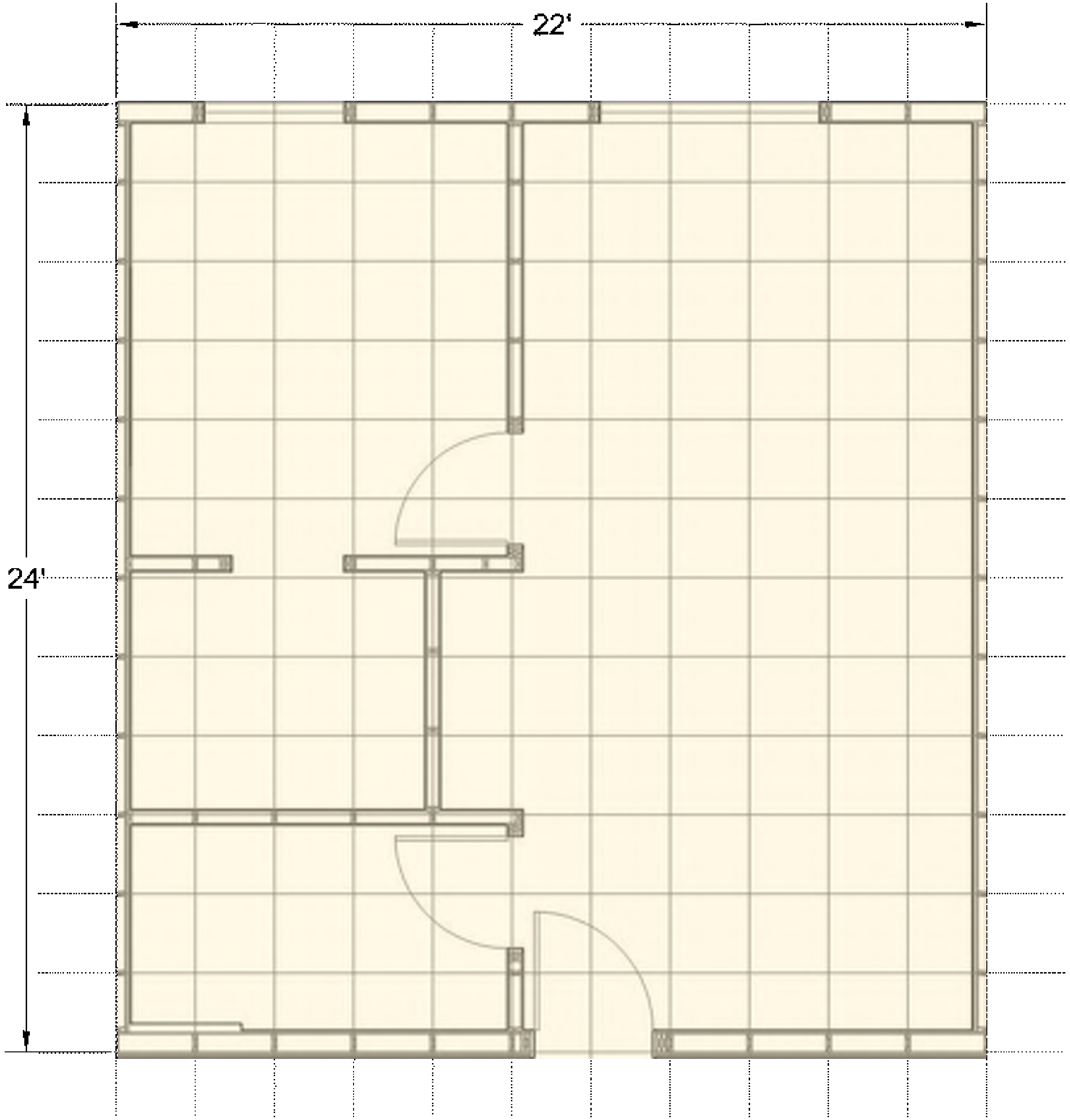
Optimized One Bedroom Unit

CEDC
Project



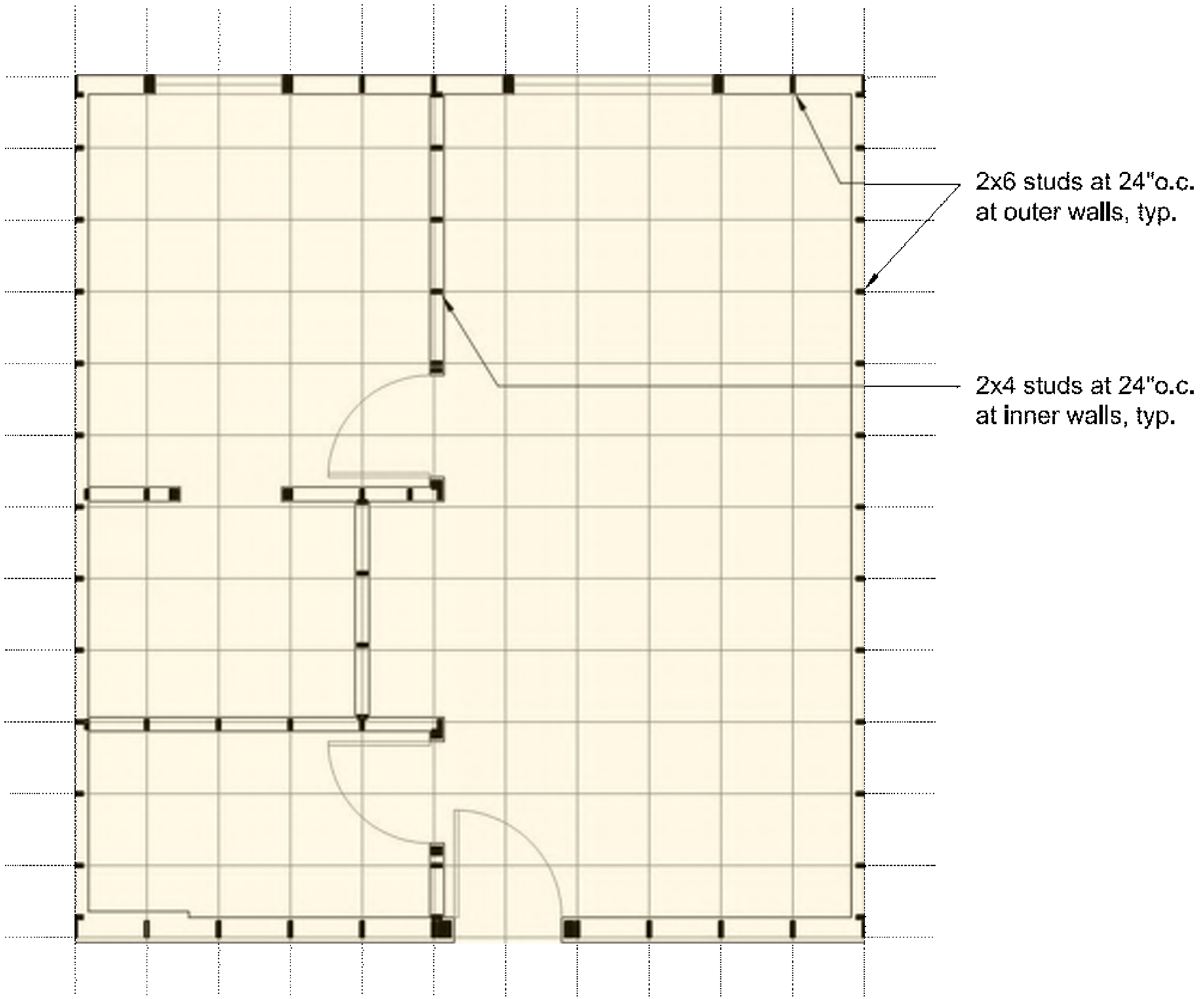
Optimized One Bedroom Unit

CEDC Project

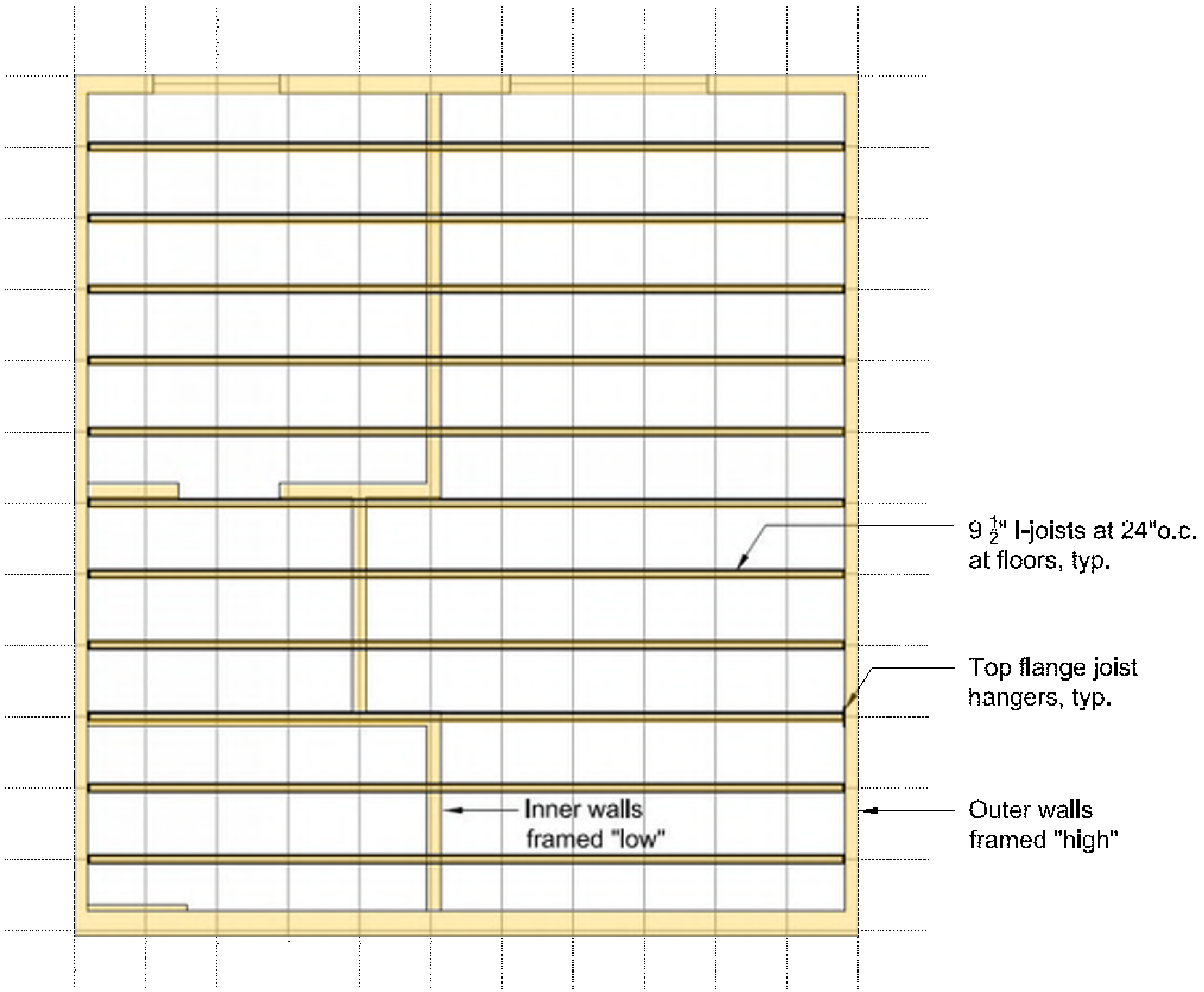


2 Foot Grid Layout

CEDC Project



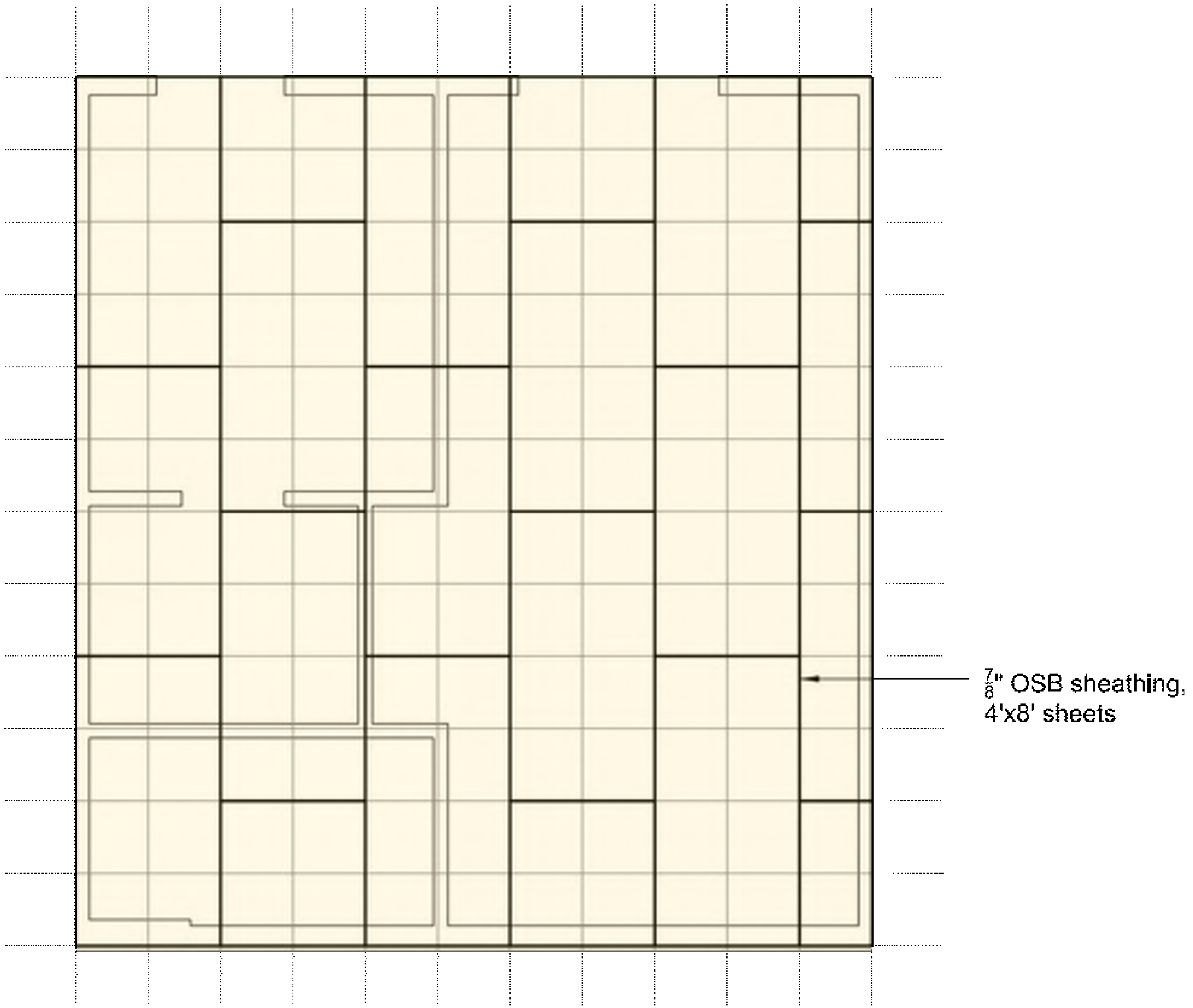
Wall Framing



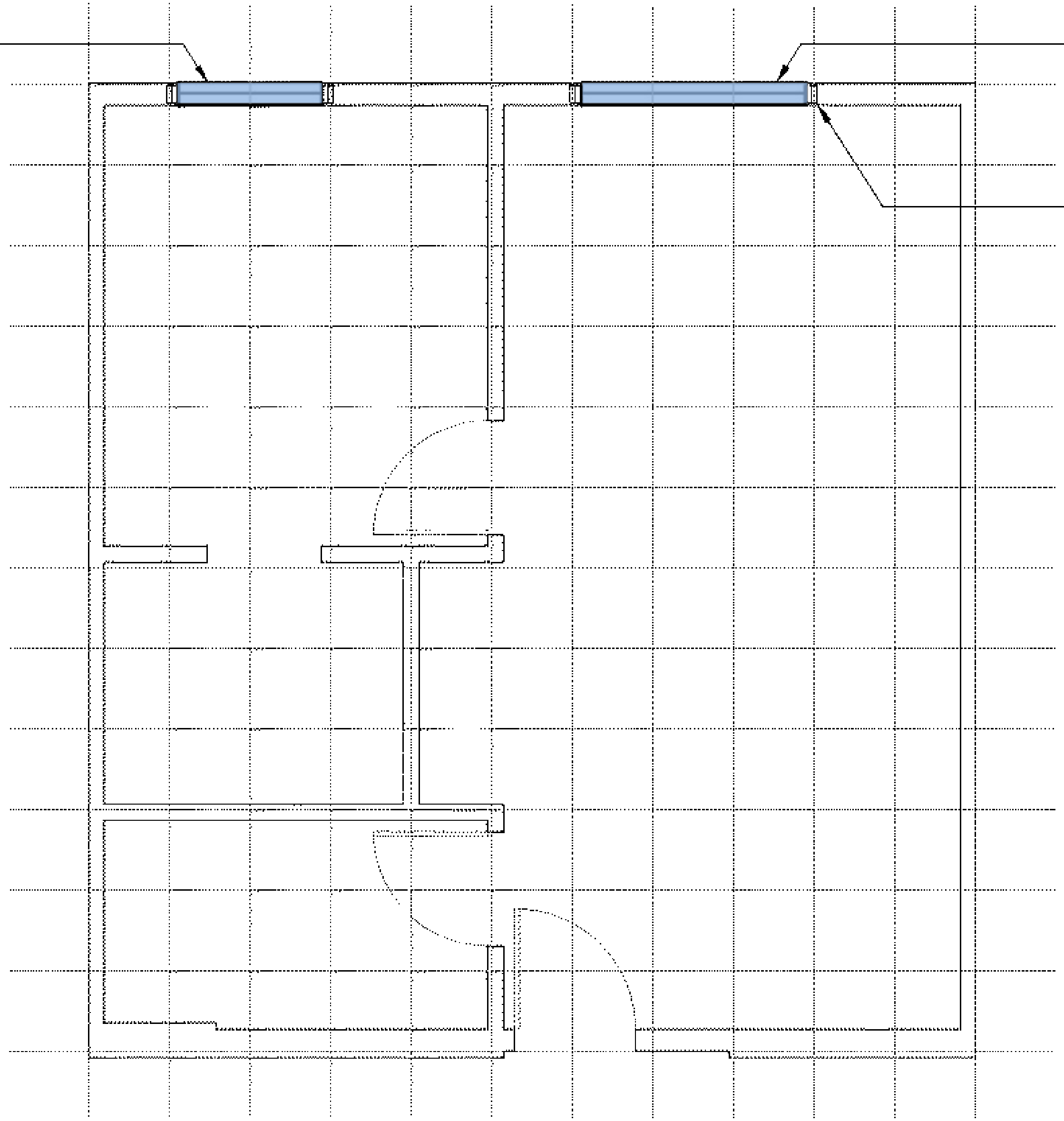
Floor Framing

CEDC Project

Floor Sheathing



CEDC Project



Window Layout

CEDC Project

Cost Efficient Design and Construction (CEDC)

UNIT PLAN BOOK

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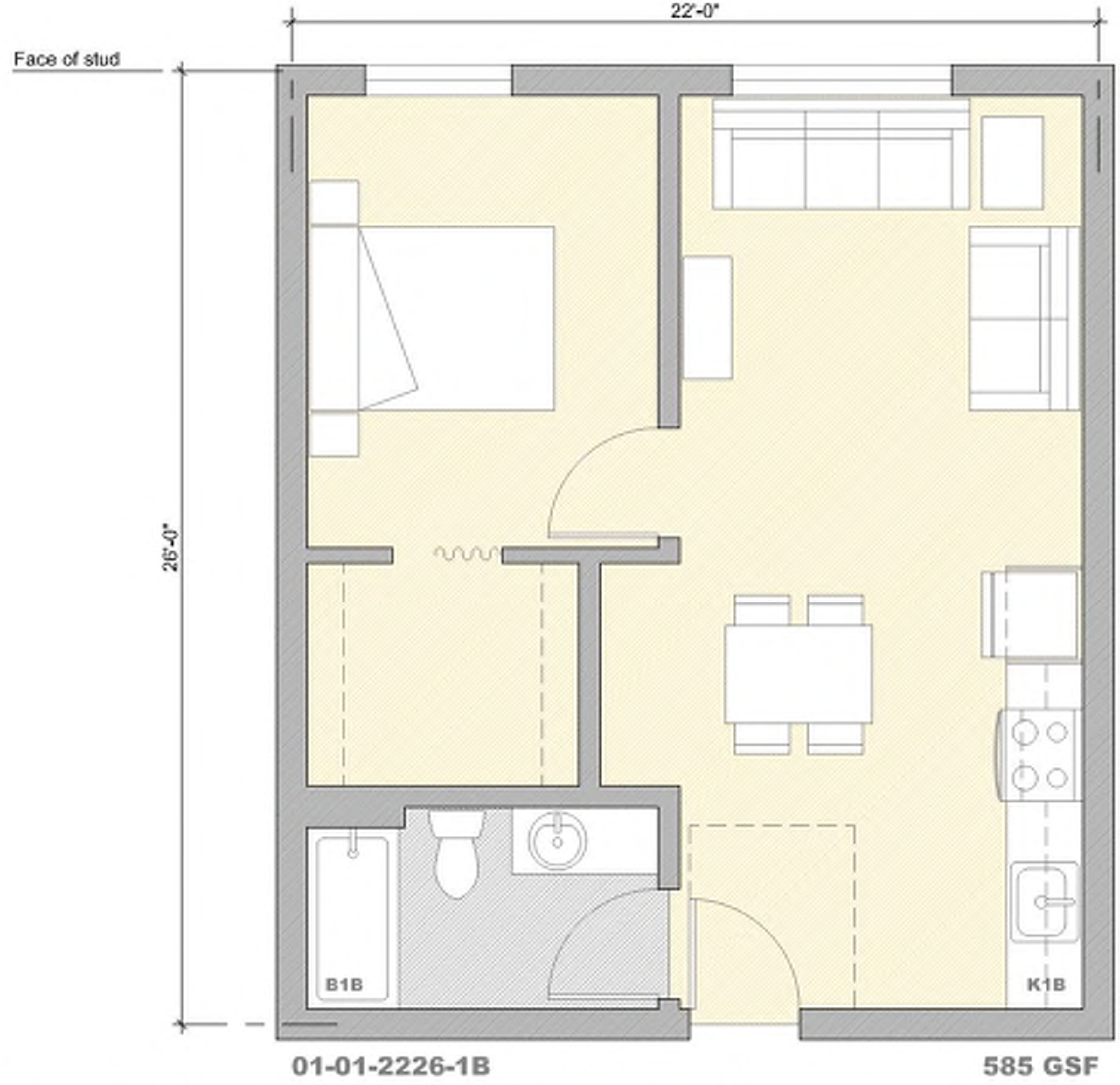
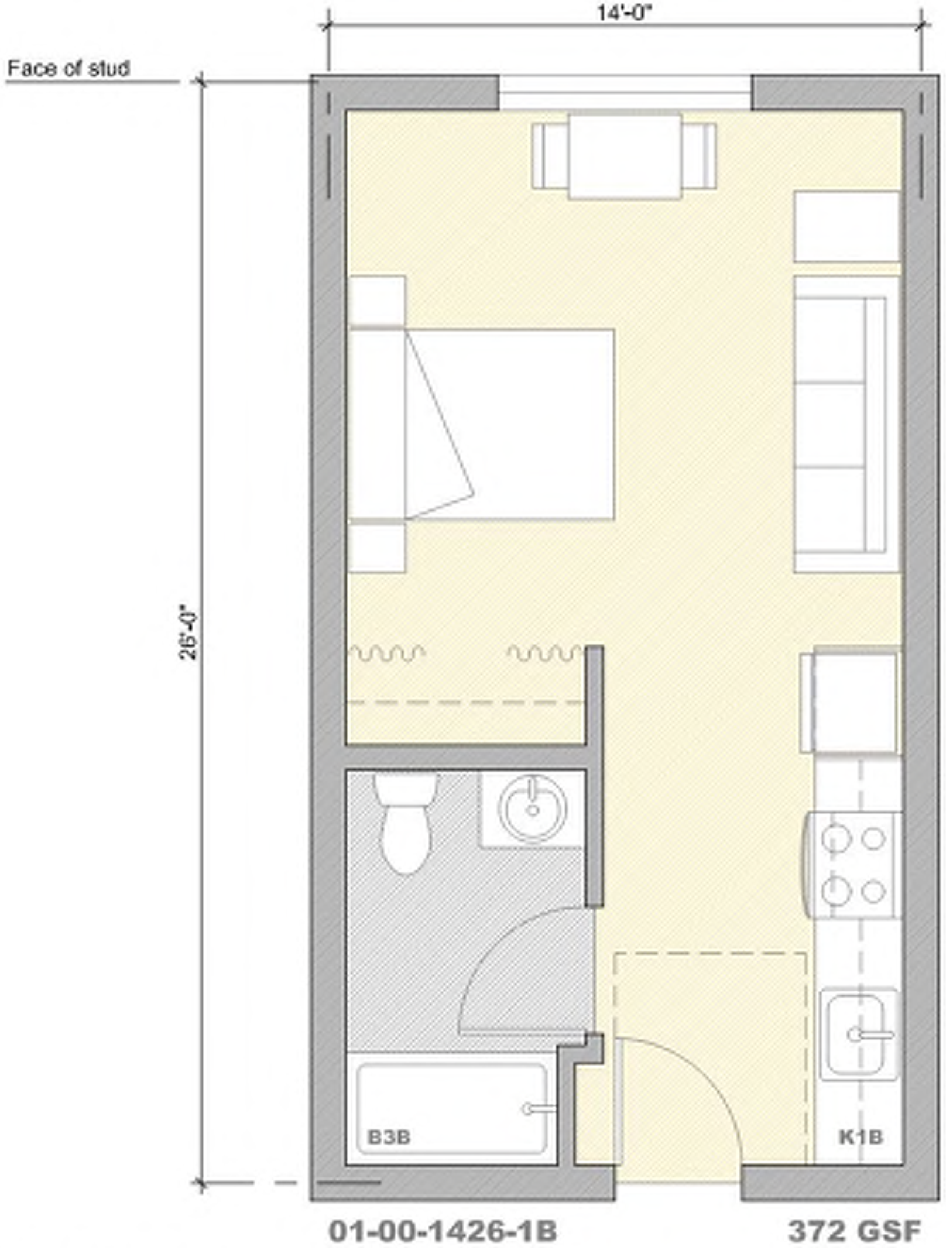
CEDC
Project



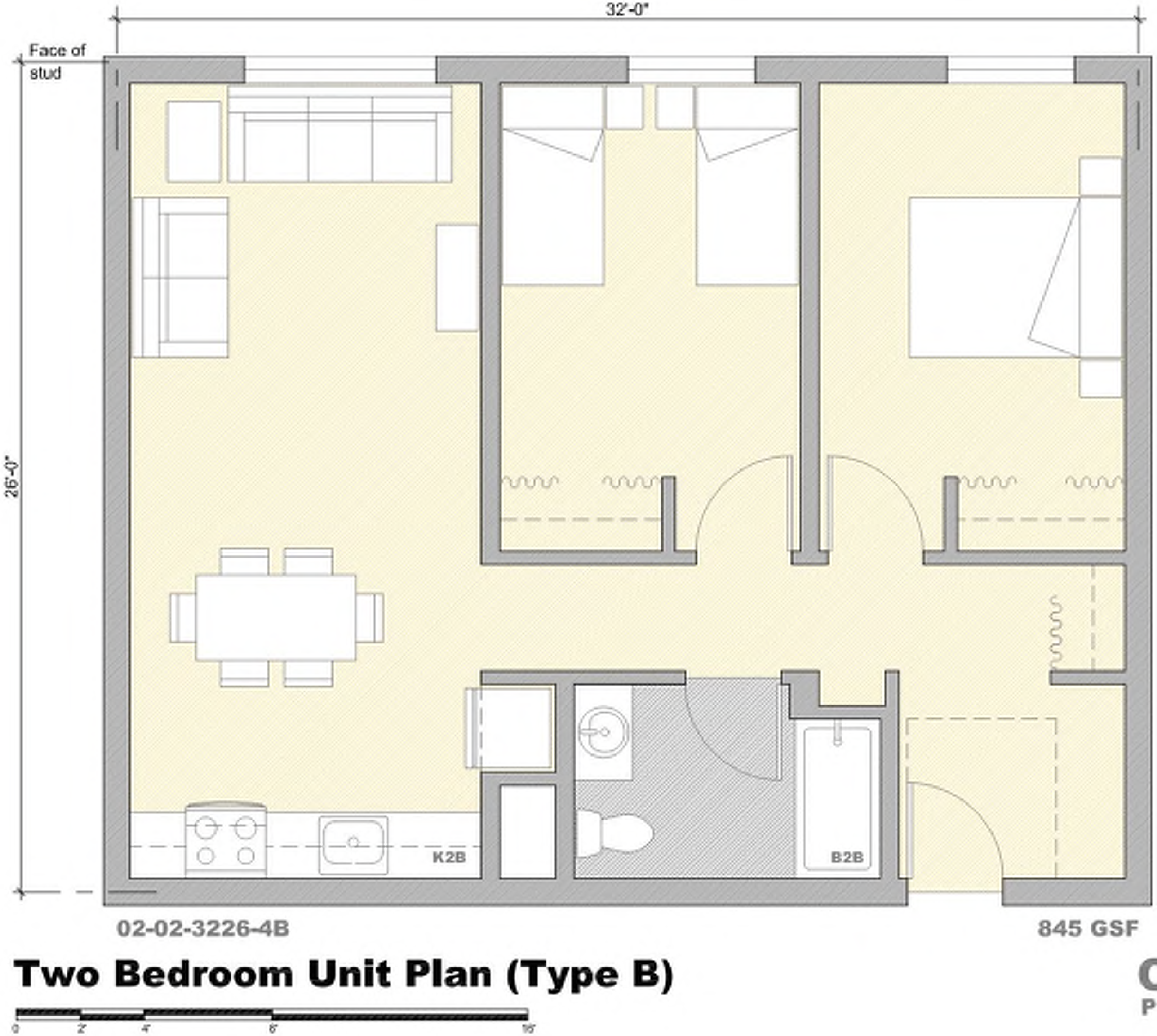
One Bedroom Unit Plan (Type B)

CEDC Project



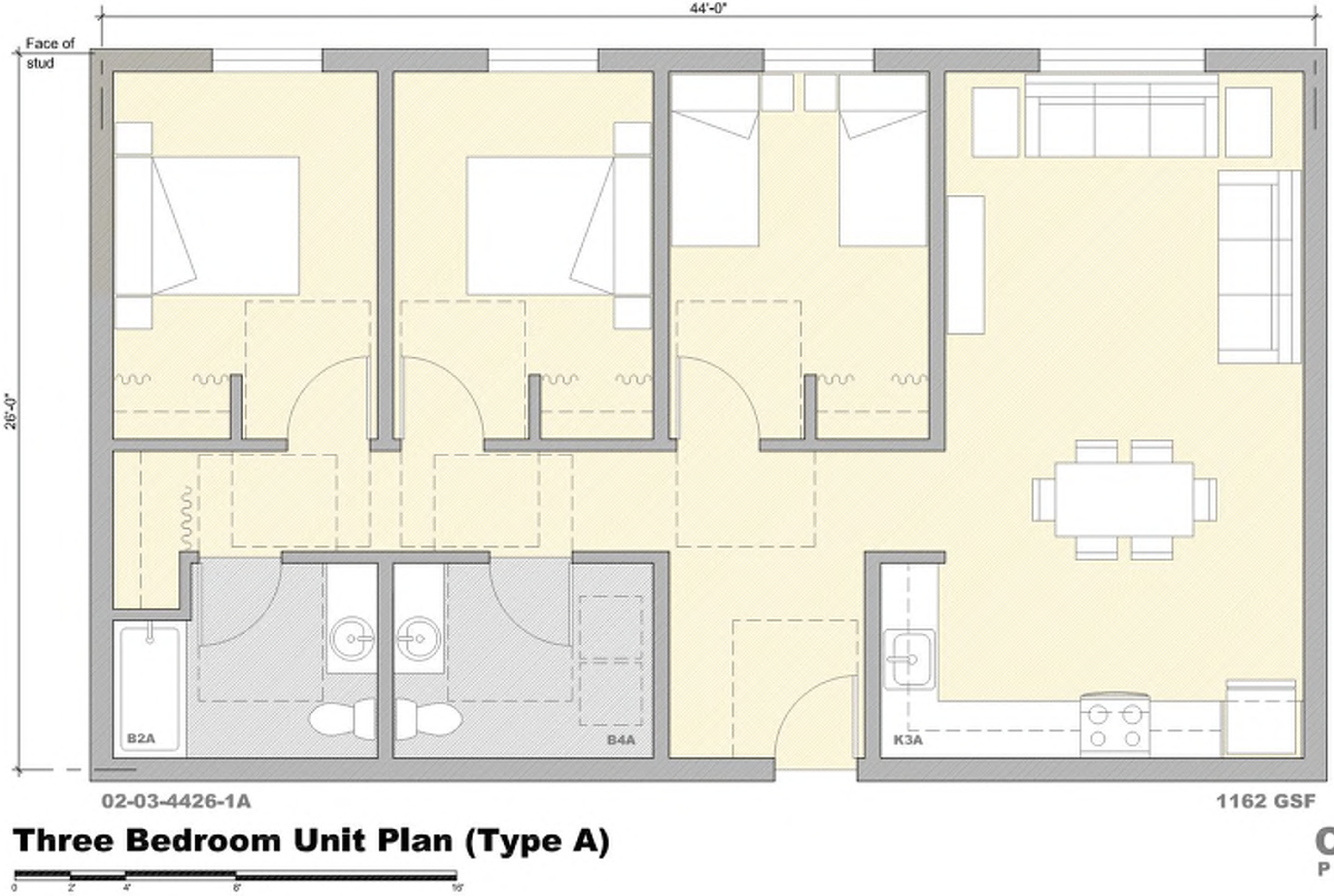
Studio Unit Plan (Type B)

CEDC
Project



Two Bedroom Unit Plan (Type B)

CEDC
Project



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1162 GSF

Three Bedroom Unit Plan (Type A)

CEDC
Project

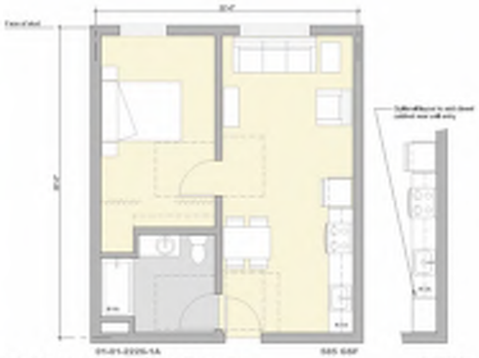
Studio Unit Plan (Type B)

Studio Unit Plan (Type A)

Studio Unit Plan (Type A)

One Bedroom Unit Plan (Type B)

One Bedroom Unit Plan (Type A)



One Bedroom Unit Plan (Type A)

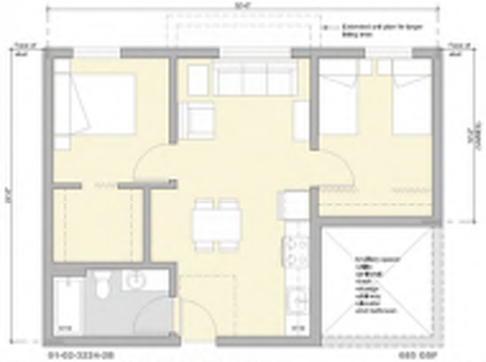
CEDC Project

One Bedroom Unit Plan (Type B) @ Inside Corner

CEDC Project

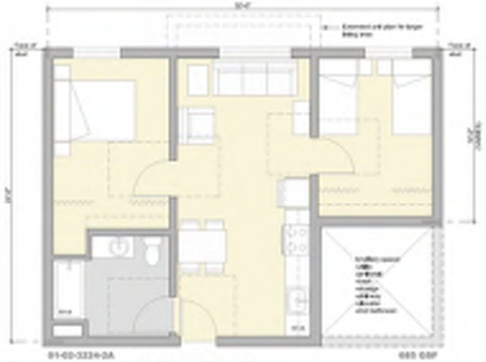
Bedroom Unit Plan (Type B) @ Outside Corner

CEDC Project



Two Bedroom Unit Plan (Type B)

CEDC Project



Two Bedroom Unit Plan (Type A)

CEDC Project

Two Bedroom Unit Plan (Type B)

CEDC Project

Two Bedroom Unit Plan (Type A)

CEDC Project

Three Bedroom Unit Plan (Type B)

CEDC Project

Three Bedroom Unit Plan (Type B)

CEDC Project

Three Bedroom Unit Plan (Type A)

CEDC Project

Additional Optimization Potential

- Building form and massing
- Structural system
- Enclosure system
- Mechanical and electrical systems
- Finishes (incl. drywall)
- Bathrooms
- Kitchens
- Cabinets
- Appliances
- Windows and doors

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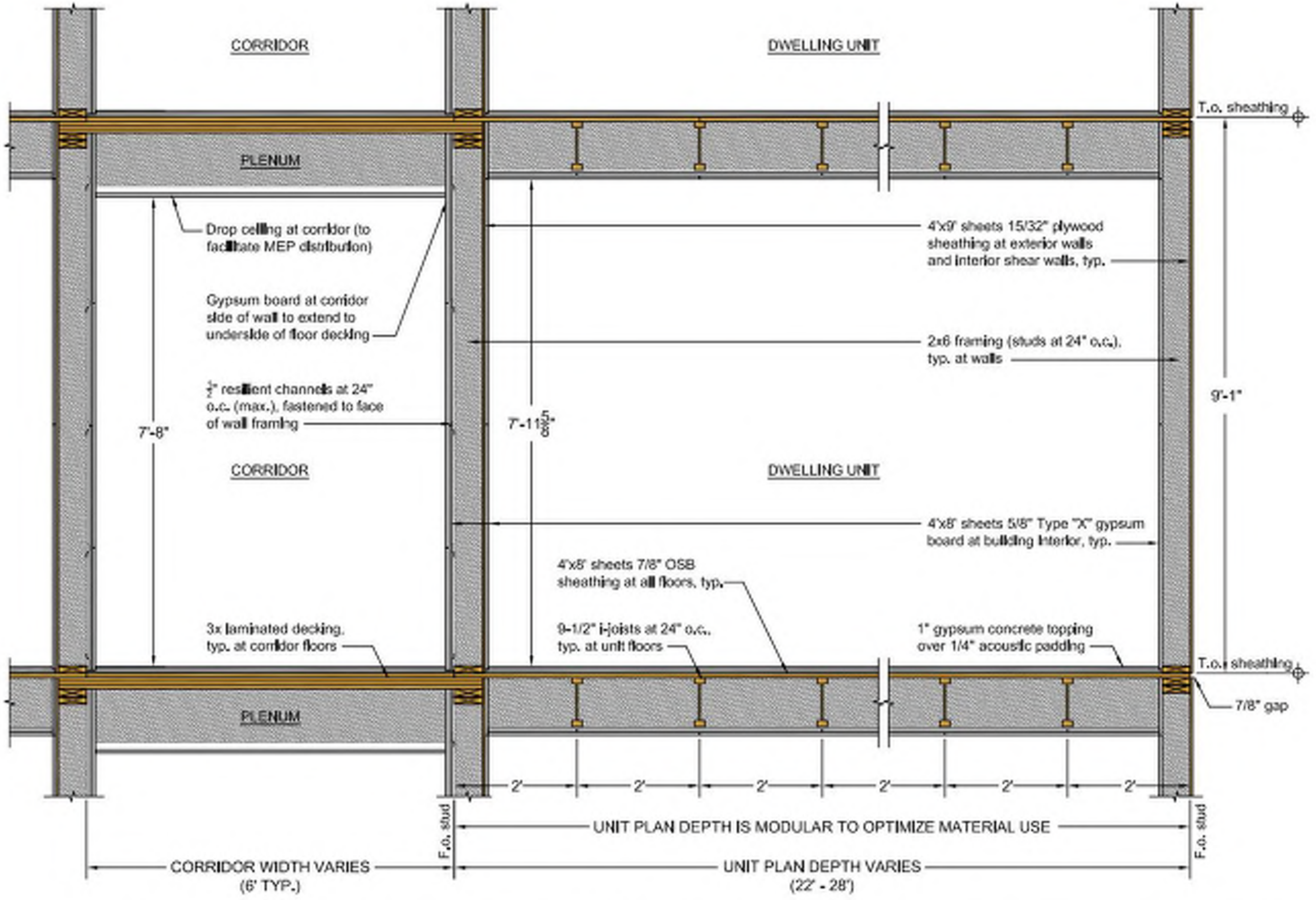
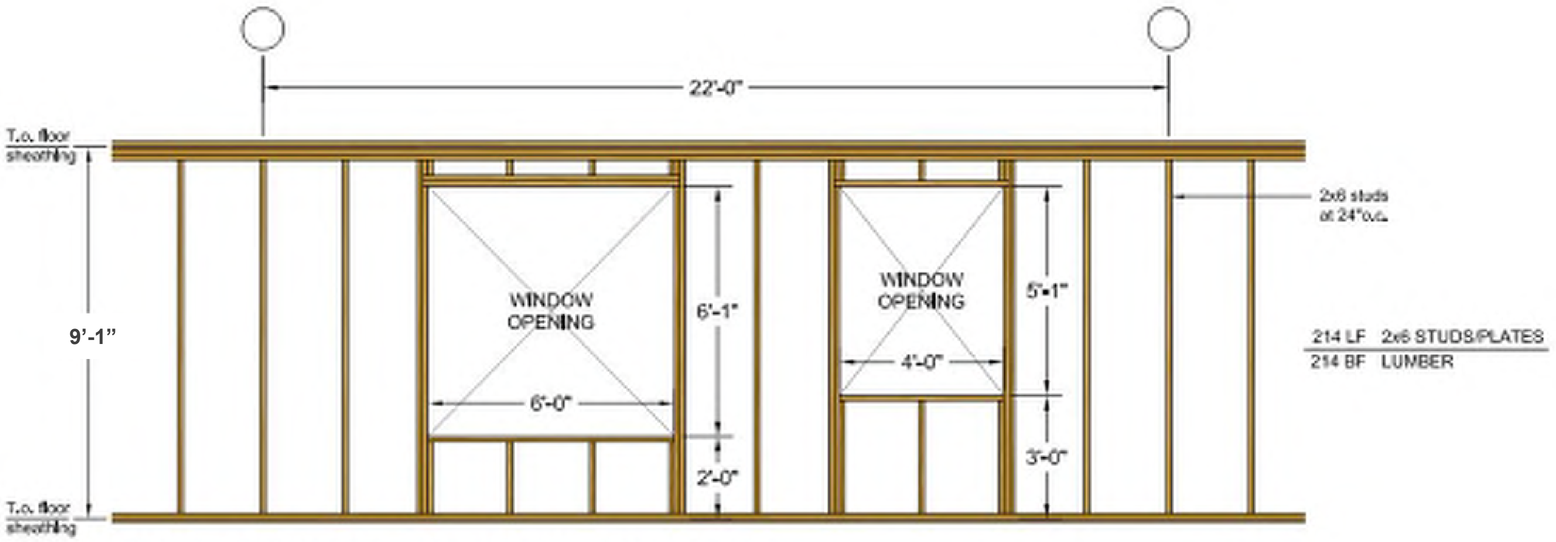
Optimization Examples

- Framing
- Drywall



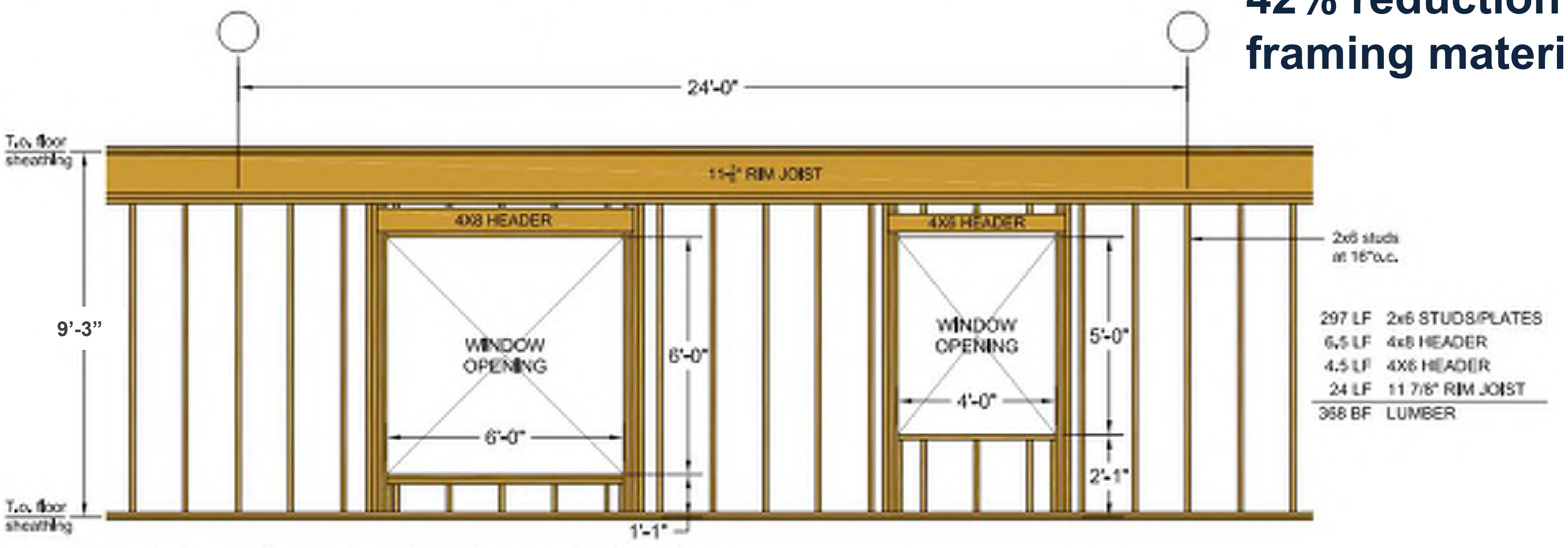
Section through Optimized Unit and Corridor

CEDC Project



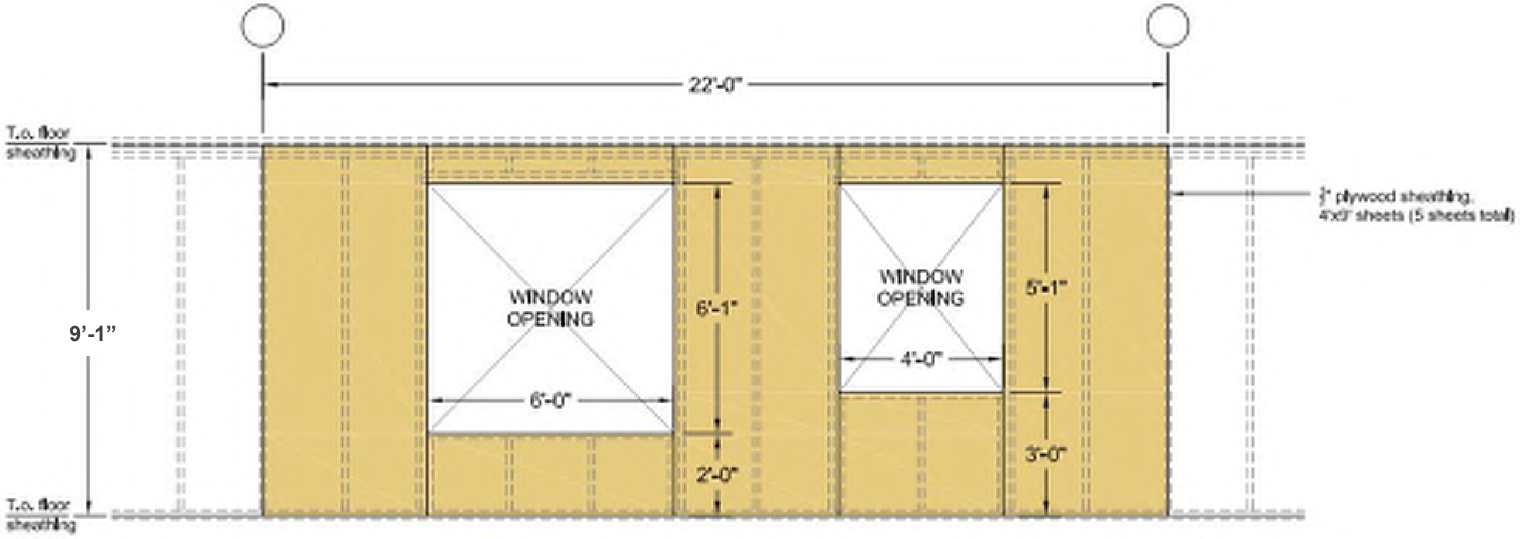
Exterior Wall Framing Elevation (Optimized Design)

42% reduction in framing material



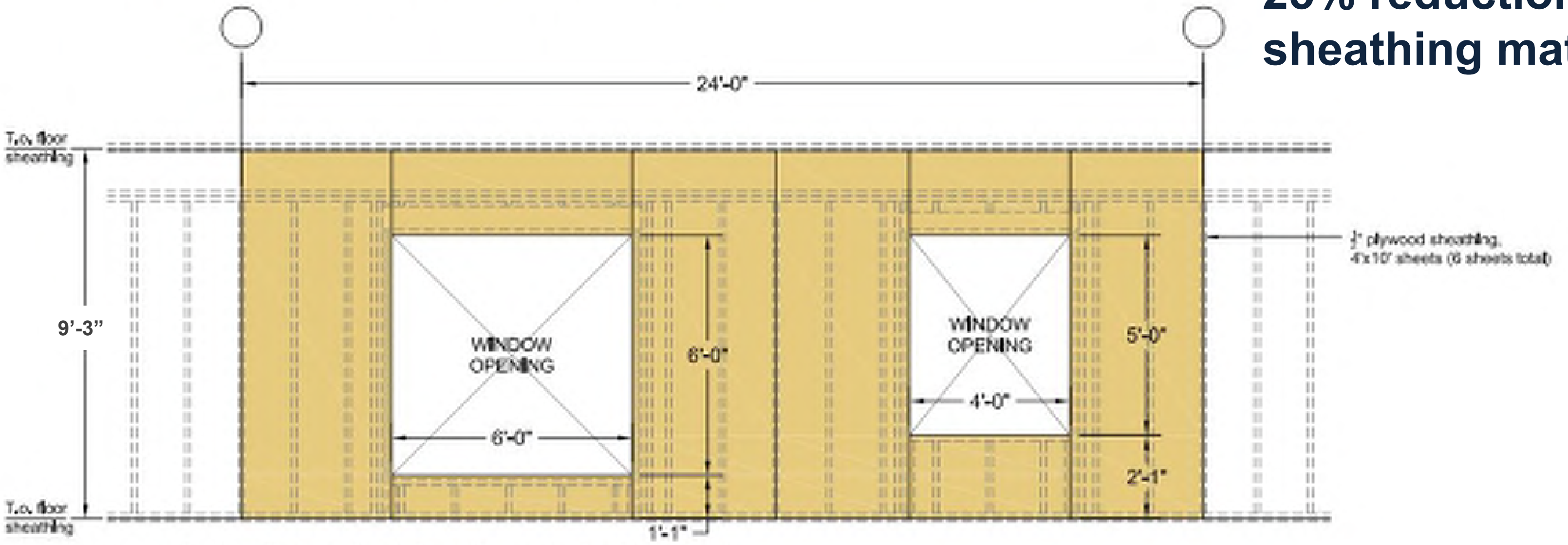
Exterior Wall Framing Elevation (Typical Design)

Exterior Wall Framing



Exterior Wall Framing Elevation (Optimized Design)

25% reduction in sheathing material



Exterior Wall Framing Elevation (Typical Design)

Exterior Wall Sheathing

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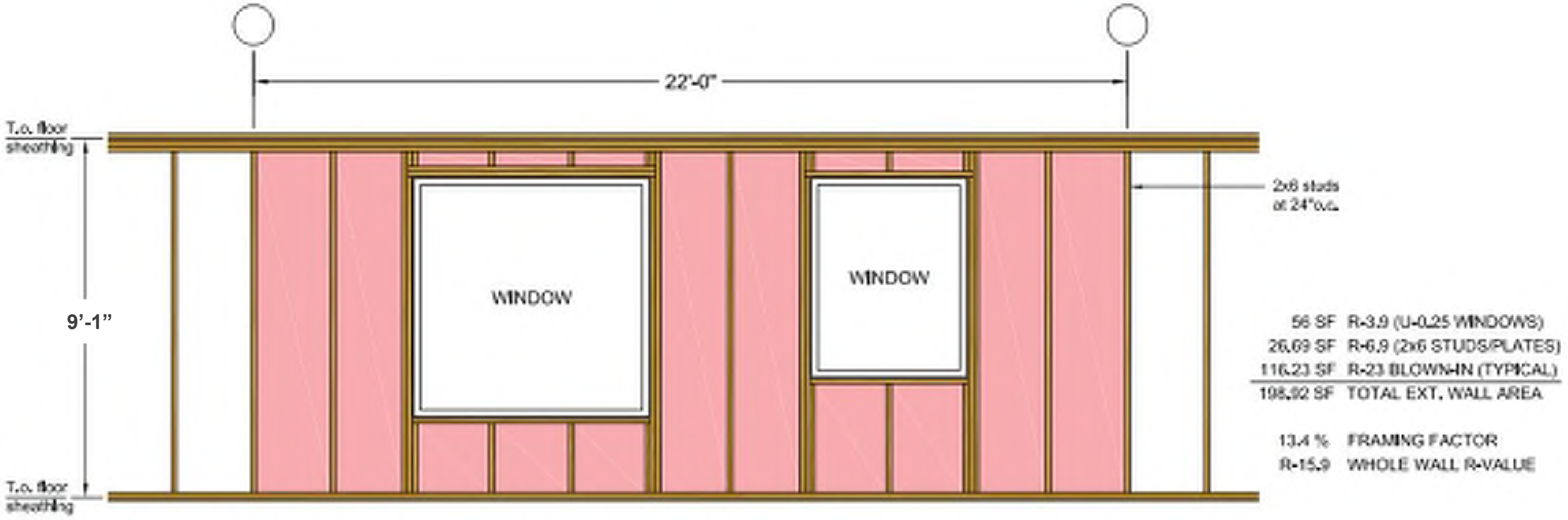
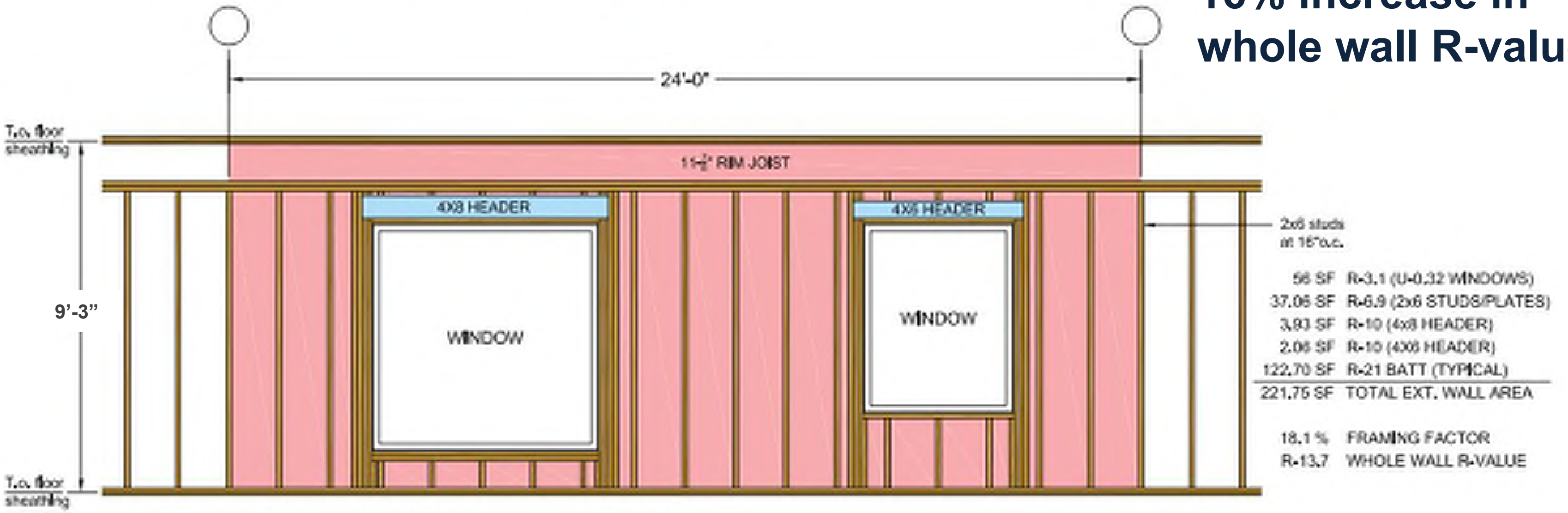


Exterior Wall Insulation Elevation (Optimized Design)

16% increase in whole wall R-value



Exterior Wall Insulation Elevation (Typical Design)

Exterior Wall Insulation

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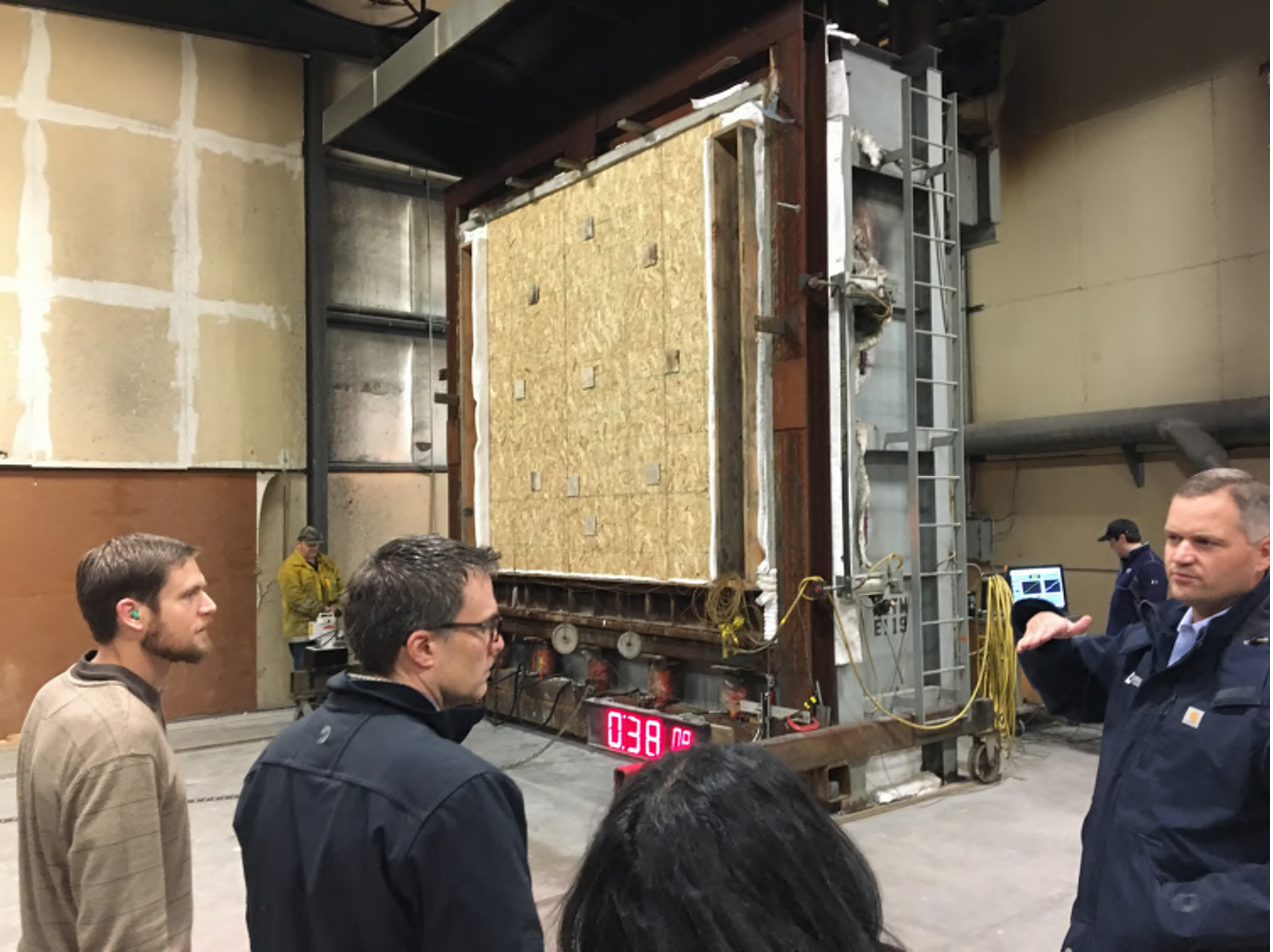

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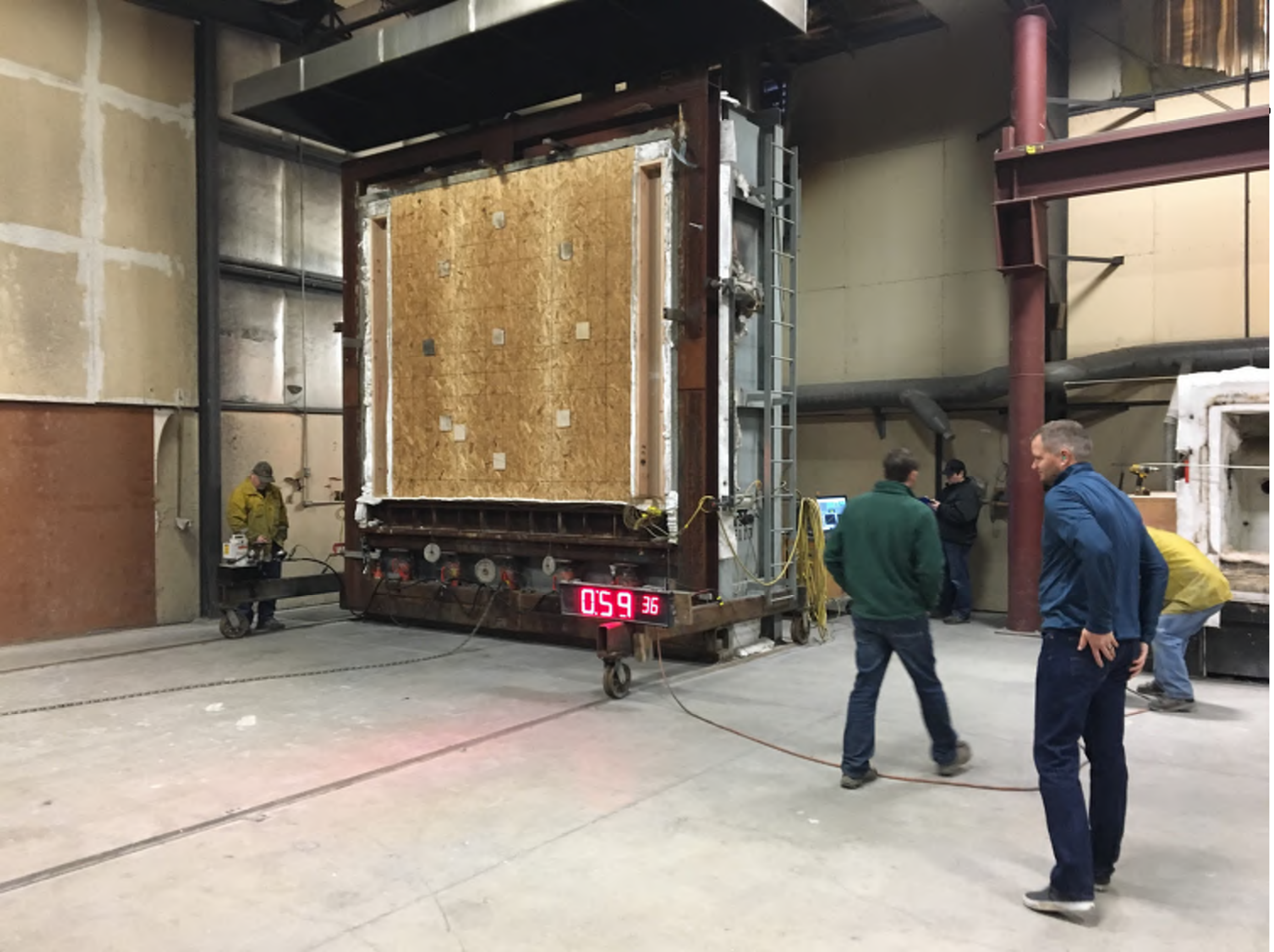
wall



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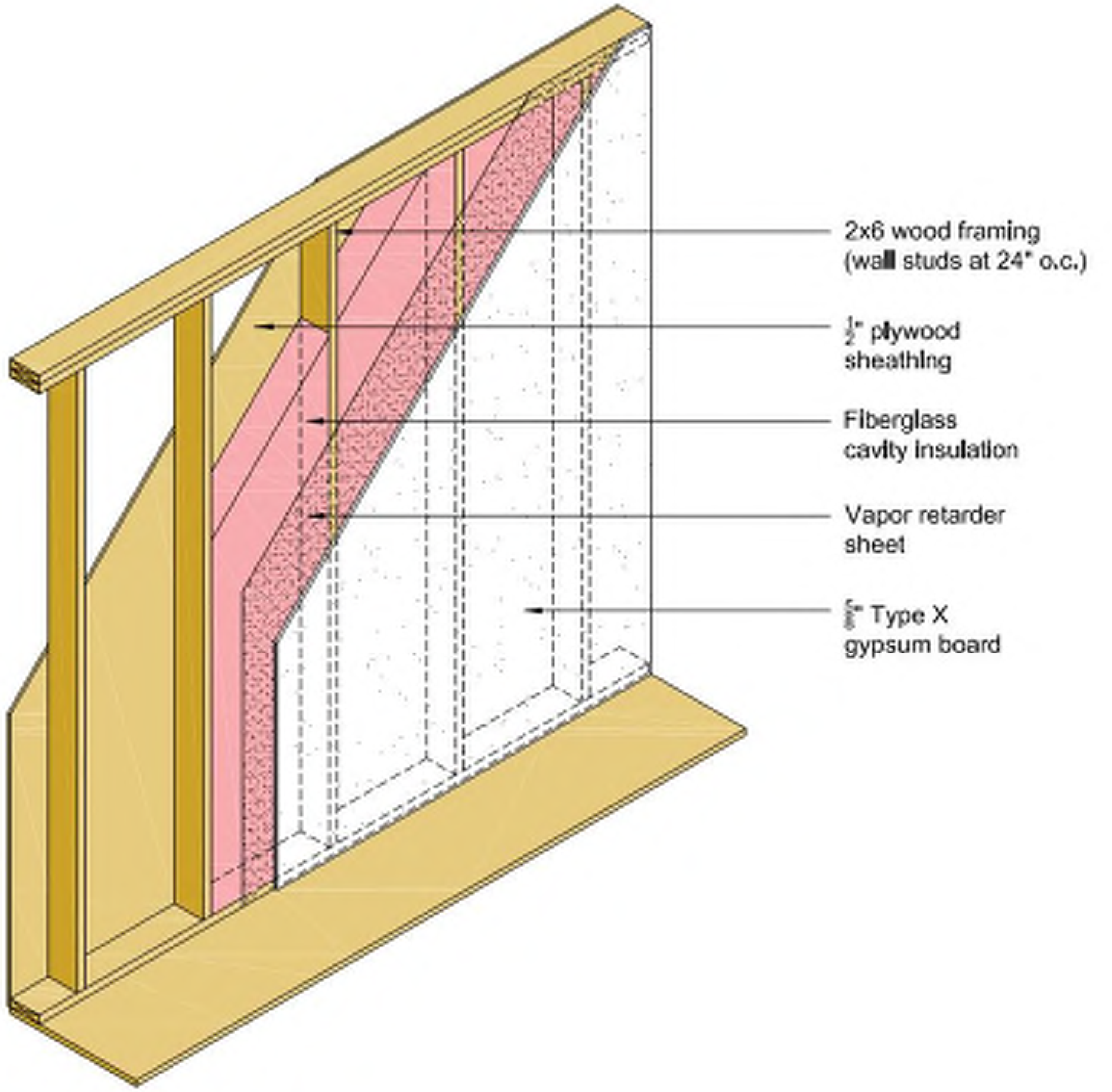

One Hour Rated Advanced Framed Exterior Wall

CEDC Project

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Design for Code Acceptance

3

Fire-Resistance-Rated Wood-Frame Wall and Floor/Ceiling Assemblies

Building Code Requirements

For occupancies such as stores, apartments, offices, and other commercial and industrial uses, building codes commonly require floor/ceiling and wall assemblies to be fire-resistance rated in accordance with standard fire tests. This document is intended to aid in the design of various wood-frame walls and wood-frame floor/ceiling assemblies, where such assemblies are required by code to be fire-resistance-rated.

Depending on the application, wall assemblies may need to be fire-resistance-rated for exposure from either one side or both sides. Exterior walls are required to be rated for both interior and exterior fire exposure where the wall has a fire separation distance of 10 feet or less. For exterior walls with a fire separation distance of greater than 10 feet, the required fire-resistance-rating applies only to exposure from the interior. The designer should note that some state and local building code amendments may require fire resistance rating for exposure from both sides of exterior walls, regardless of fire separation distance; however, the solutions and example details provided in this document are based on compliance with national model building codes.

Code recognition of one and two-hour wood-frame wall systems is also predicated on successful fire and hose stream testing in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction Materials*.

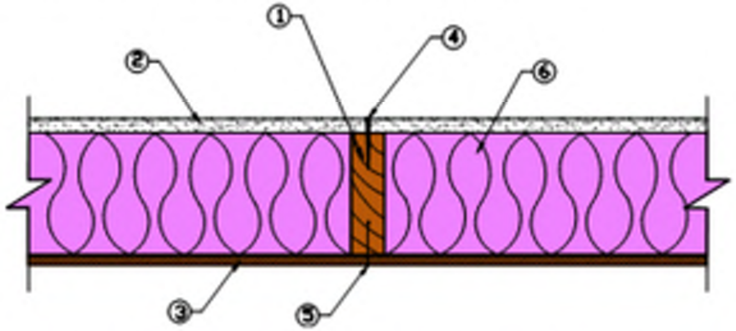
Fire Tested Assemblies

Fire-resistance-rated wood-frame assemblies can be found in a number of sources including the *International Building Code (IBC)*, Underwriters Laboratories (UL) *Fire Resistance Directory*, Intertek Testing Services' *Directory of Listed Products*, and the Gypsum Association's *Fire Resistance Design Manual* (GA 600). The American Wood Council (AWC) and its members have tested a number of wood-frame fire-resistance-rated assemblies (see photos). Descriptions of successfully tested lumber wall assemblies are provided in Table 1 for one-hour fire-resistance-rated wall assemblies and Table 2 for two-hour fire-resistance-rated wall assemblies. Lumber shall be identified by the grade mark of a lumber grading or inspection agency that has been approved by an accreditation body that complies with the *American Softwood Lumber Standard (PS 20)*. The fire-resistance-rated assemblies described in this document, as well as those listed in other sources are not species- or grade-specific unless specifically noted as such.

Descriptions of successfully tested I-joist floor assemblies are provided in Table 3 for one-hour fire-resistance-rated floor/ceiling assemblies and Table 4 for two-hour fire-resistance-rated floor/ceiling assemblies. I-joists are required to comply with ASTM D5055, *Standard Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists*.

WS6-1.6 One-Hour Fire-Resistance-Rated Wood-Frame Wall Assembly (Rated from gypsum wallboard side)

2x6 Wood Stud Wall – 100% Design Load – ASTM E 119/NFPA 251



1. Framing - Nominal 2x6 wood studs, spaced 24 in. o.c., double top plates, single bottom plate
2. Interior Sheathing - 5/8 in. Type X gypsum wallboard, 4 ft. wide, applied vertically. All panel edges backed by framing or blocking.
3. Exterior Sheathing - Minimum 15/32 in. wood structural panels, applied vertically, horizontal joints blocked
4. Gypsum Fasteners - 2-1/4 in. #6 Type S drywall screws, spaced 7 in. o.c.
5. Panel Fasteners - 6d common nails (bright) - 12 in. o.c. in the field, 6 in. o.c. panel edges
6. Insulation - minimum R-19 fiberglass insulation
7. Joints and Fastener Heads - Wallboard joints covered with paper tape and joint compound, fastener heads covered with joint compound

Tests conducted at Western Fire Center
Test No: WFCi Report #18090r1 (Fire Endurance & Hose Stream) February 22, 2019

Third Party Witness: Western Fire Center, Inc.

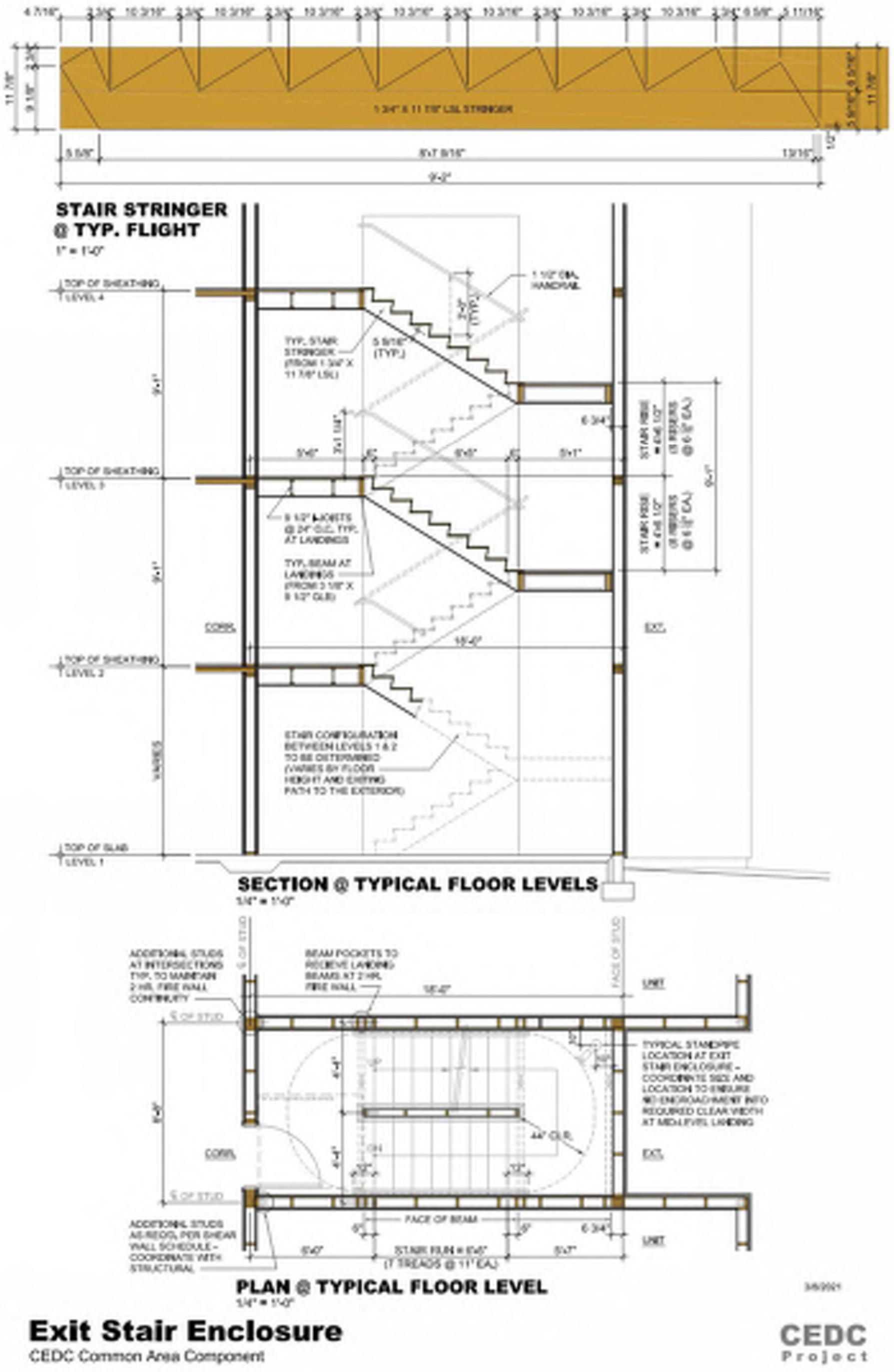
> This assembly was tested at 100% design load, calculated in accordance with the 2018 *National Design Specification® for Wood Construction*. The authority having jurisdiction should be consulted to assure acceptance of this report.

Image Credit: American Wood Council

Optimization Examples

- Framing
- Drywall

- Exit stair enclosure



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COST…not just a “first cost” thing

- CEDC approach → Reducing first costs <u>and</u> reducing life cycle costs…

- Greater efficiency leading to reduced quantity on per unit / per person basis yields:
  - Operational cost reduction:
    - Less area/volume to light, heat, cool, ventilate…
  - Maintenance cost reduction:
    - Less area to clean, maintain, repair…
  - Replacement cost reduction:
    - Less wall area / ceiling area to re-paint
    - Less floor area to re-carpet / re-tile
    - Less cladding area to re-paint / re-seal
    - Less roof area to re-roof

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Demonstration Projects

- Wy'East Plaza (fka 124th & Ash)
  - 175 units workforce housing

- Buri Building (fka Glisan Gateway)
  - 159 units workforce housing

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Wy'East Plaza

- Affordable workforce housing project in Portland, Oregon
- Developer/ Owner: REACH Community Development
- Architect: Ankrom Moisan Architects
- Contractor: Walsh Construction Co.

- Awarded Meyer Memorial Trust grant to support innovation in production of cost efficient affordable housing
- Programmed as 150-190 unit project → final unit count = 175
- Construction start: Summer 2019; completion Oct. 2020

Wy'East Plaza - Lean Construction Process

- Owner sets clearly defined goals / targets
  - **Goal → 30% reduction in total development cost compared to OHCS baseline**
- High degree of team collaboration
  - WALSH / AMA / REACH
- *Target Value Design*
  - *Estimate the concept…then design to the estimate*
- Optimizing the widget(s)
  - The unit plan is our basic building block…
- Trade partners involved early

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Wy’East Plaza - Site (East Portland)

Image Credit: Shapiro / Didway

Wy'East Plaza - Site Plan

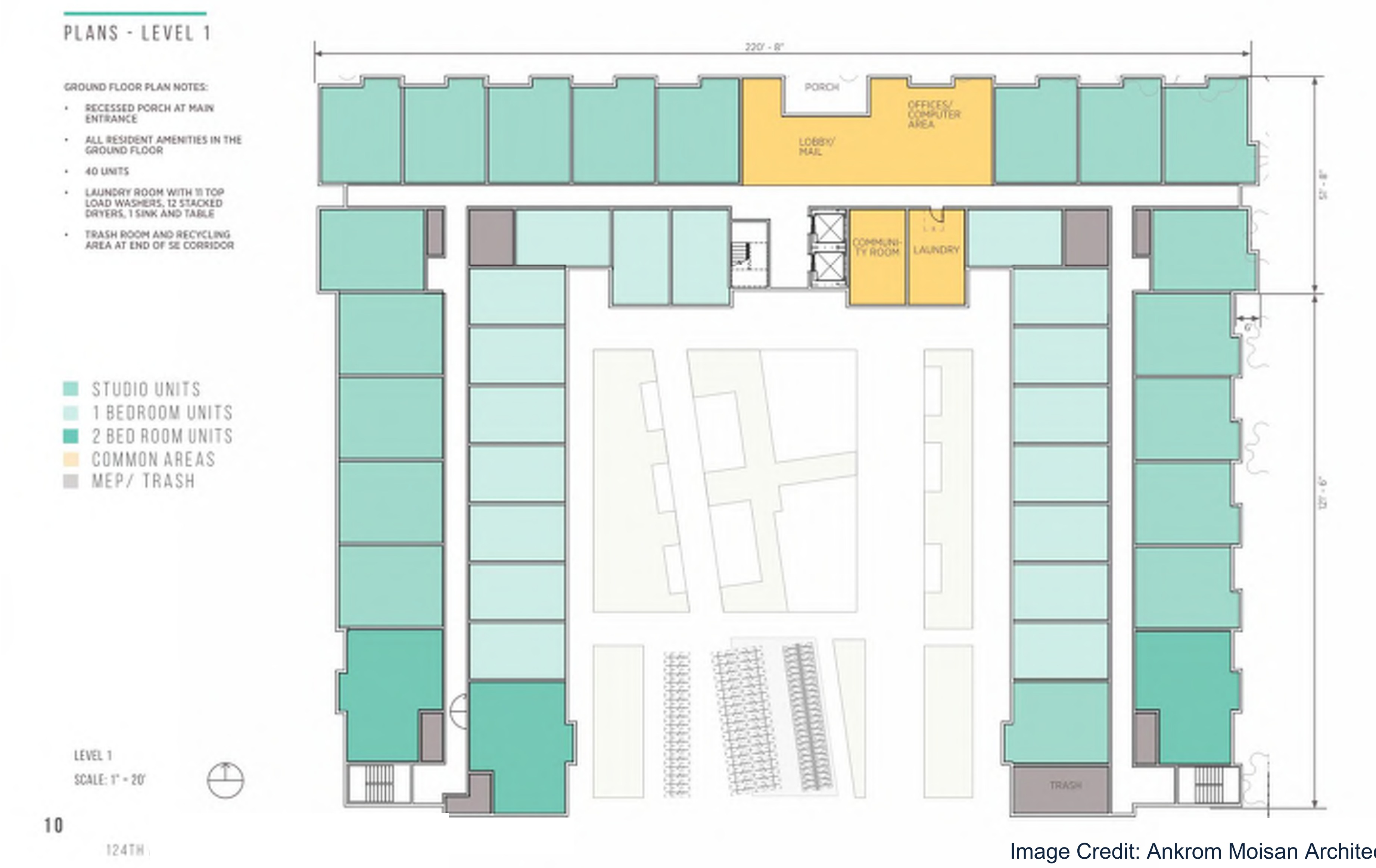

Image Credit: Ankrom Moisan Architects

Wy’East Plaza - First Floor Plan

Image Credit: Ankrom Moisan Architects

Wy'East Plaza - Typical Floor Plan


Wy’East Plaza
Image Credit: Ankrom Moisan Architects

39%

below target cost
(total development cost)

Wy’East Plaza

Portland, OR (2020)

Construction Cost:	**$111k per unit**
Construction Duration:	**14 months**

Menu of Architectural / Programmatic Upgrades

- Increased articulation
- Premium cladding or roofing materials
- Enhanced entry / lobby / common areas
- Balconies / patios
- Roof deck / courtyard
- Sunspaces / social nooks
- “Irresistible” stairway
- Enhanced landscape

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Performance Upgrades → PH / ZE Ready

TARGET EUI =
15-23 kBtu/sf/yr

- Balanced ventilation system
- Heat recovery at ventilation
- Shading elements at windows
- Increased airtightness (roof, windows, exterior walls)
- Increased R-value (roof, windows, exterior walls, slab)
- Lighting: (LED fixtures, lighting controls)
- Plumbing: (water heater, low flow fixtures, pipe insulation)
- MEL: appliances (CEE Tier II/III), elevators (MRL traction)

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Wy’East Plaza - PH Feasibility Studies

WUFI®Passive

BUILDING INFORMATION

Category:	Residential
Status:	In planning
Building type:	New construction
Year of construction:	2019
Units:	175
Number of occupants:	267 (Design)

Boundary conditions

Climate:	OR - PORTLAND INTERNATIONAL AP (Monthly)	
Internal heat gains:	1.2	Btu/hr ft²
Interior temperature:	68	°F
Overheat temperature:	77	°F

Building geometry

Enclosed volume:	932,758.5	ft³
Net-volume:	715,207	ft³
Total area envelope:	94,730.6	ft²
A/V ratio:	0.1	1/ft
Floor area:	98,708	ft²

PASSIVEHOUSE REQUIREMENTS

Certificate criteria: PHIUS+ 2015 Standard

Heating demand

specific:	3.99	kBtu/ft²yr
target:	4.8	kBtu/ft²yr
total:	393,761.98	kBtu/yr

Cooling demand

sensible:	1.05	kBtu/ft²yr
latent:	0.01	kBtu/ft²yr
specific:	1.05	kBtu/ft²yr
target:	1.1	kBtu/ft²yr
total:	103,945.48	kBtu/yr

Heating load

specific:	2.42	Btu/hr ft²
target:	3.6	Btu/hr ft²
total:	238,924.12	Btu/hr

Cooling load

specific:	0.86	Btu/hr ft²
target:	3.9	Btu/hr ft²
total:	84,443.11	Btu/hr

WUFI®Passive

Source energy

PHIUS+ Source Zero: NO

total:	1,618,383.85	kWh/yr
specific:	6,061	kWh/Person yr
target:	6,200	kWh/Person yr
total:	5,521,609.85	kBtu/yr
specific:	55.94	kBtu/ft²yr

Site energy

total:	2,245,501.64	kBtu/yr
specific:	22.75	kBtu/ft²yr
total:	658,156.53	kWh/yr
specific:	6.67	kWh/ft²

Air tightness

ACH50:	0.4	1/hr
CFM50 per envelope area:	0.05	cfm/ft²
target:	0.4	1/hr
target CFM50:	0.05	cfm/ft²

PASSIVEHOUSE RECOMMENDATIONS

HRV efficiency:	75	%
Frequency of overheating: Cooling system is required	24	%

Frequency of overheating only applies if there is not a (properly sized) cooling system installed.

esco energy systems consulting

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Enhanced Envelope / HRV / 18% FF / CI

PASSIVEHOUSE REQUIREMENTS

Certificate criteria: PHIUS+ 2015 Standard

Heating demand

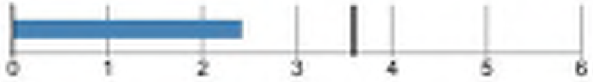
specific:	**3.99**	kBtu/ft²yr
target:	**4.8**	kBtu/ft²yr
total:	393,761.98	kBtu/yr

Cooling demand

sensible:	**1.05**	kBtu/ft²yr
latent:	**0.01**	kBtu/ft²yr
specific:	**1.05**	kBtu/ft²yr
target:	**1.1**	kBtu/ft²yr
total:	103,945.48	kBtu/yr

Heating load

specific:	**2.42**	Btu/hr ft²
target:	**3.6**	Btu/hr ft²
total:	238,924.12	Btu/hr



Cooling load

specific:	**0.86**	Btu/hr ft²
target:	**3.9**	Btu/hr ft²
total:	84,443.11	Btu/hr

Enhanced Envelope / HRV / 18% FF / CI

Source energy **PHIUS+ Source Zero: NO**

total:	**1,618,383.85**	kWh/yr
specific:	**6,061**	kWh/Person yr
target:	**6,200**	kWh/Person yr
total:	**5,521,609.85**	kBtu/yr
specific:	55.94	kBtu/ft²yr

Site energy

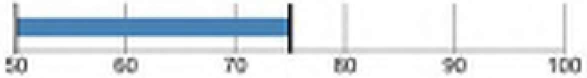
total:	2,245,501.64	kBtu/yr
specific:	22.75	kBtu/ft²yr
total:	658,156.53	kWh/yr
specific:	6.67	kWh/ft²

Air tightness

ACH50:	**0.4**	1/hr
CFM50 per envelope area:	**0.05**	cfm/ft²
target:	**0.4**	1/hr
target CFM50:	**0.05**	cfm/ft²

PASSIVEHOUSE RECOMMENDATIONS

HRV efficiency: **75** %



Frequency of overheating: **24** %
Cooling system is required

Frequency of overheating only applies if there is not a [properly sized] cooling system installed.

Performance Upgrades → PH / ZE Ready

$19,487,763 x .05 = $974,388 budget

TARGET EUI = 15-23 kBtu/sf/yr

$6k/unit

- Balanced ventilation system
  $0 (already in)
- Heat recovery at ventilation
  $440,000 ($290k HRVS, $150k "ancillary")
- Shading elements at windows
  $108,000 ($1200/window x 90 windows)
- Increased airtightness (roof, windows, exterior walls)
  $131,000 ($48k spray foam, 83k taped sheathing)
- Increased R-value (roof, windows, exterior walls, slab)
  $193,000 ($37k framing, 0k windows, 28k walls, 78k ci, 17k roof, 33k slab)
- Lighting: (LED fixtures, lighting controls)
  $0 (already in)
- Plumbing: (water heater, low flow fixtures, pipe insulation)
  $14,000 ($0k 95% eff. boiler, 0k faucets/showerheads, 14k pipe insulation)
- MEL: appliances (CEE Tier II/III), elevators (MRL traction)
  $49,000 ($280/refr x 175 refrigerators)
  $32,000 (elevators - $4k/stop)

$967,000 (4.9% premium)

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Performance Upgrades → PH / ZE Ready

$19,487,763 x .05 = $974,388 budget

TARGET EUI =
15-23 kBtu/sf/yr
$15k/unit

- Balanced ventilation system
  $0 (already in)
- Heat recovery at ventilation
  $440,000 ($290k HRVS, $150k "ancillary")
- Shading elements at windows
  $108,000 ($1200/window x 90 windows)
- Increased airtightness (roof, windows, exterior walls)
  $131,000 ($48k spray foam, 83k taped sheathing)
- Increased R-value (roof, windows, exterior walls, slab)
  $193,000 ($37k framing, 0k windows, 28k walls, 78k ci, 17k roof, 33k slab)
- Lighting: (LED fixtures, lighting controls)
  $0 (already in)
- Plumbing: (water heater, low flow fixtures, pipe insulation)
  $14,000 ($0k 95% eff. boiler, 0k faucets/showerheads, 14k pipe insulation)
- MEL: appliances (CEE Tier II/III), elevators (MRL traction)
  $49,000 ($280/refr x 175 refrigerators)
  $32,000 (elevators - $4k/stop)

$967,000 + 328,000 + 1,380,000 = $2,675,000 (13.7% premium)

VRF heating/cooling + HPWH → 328,000

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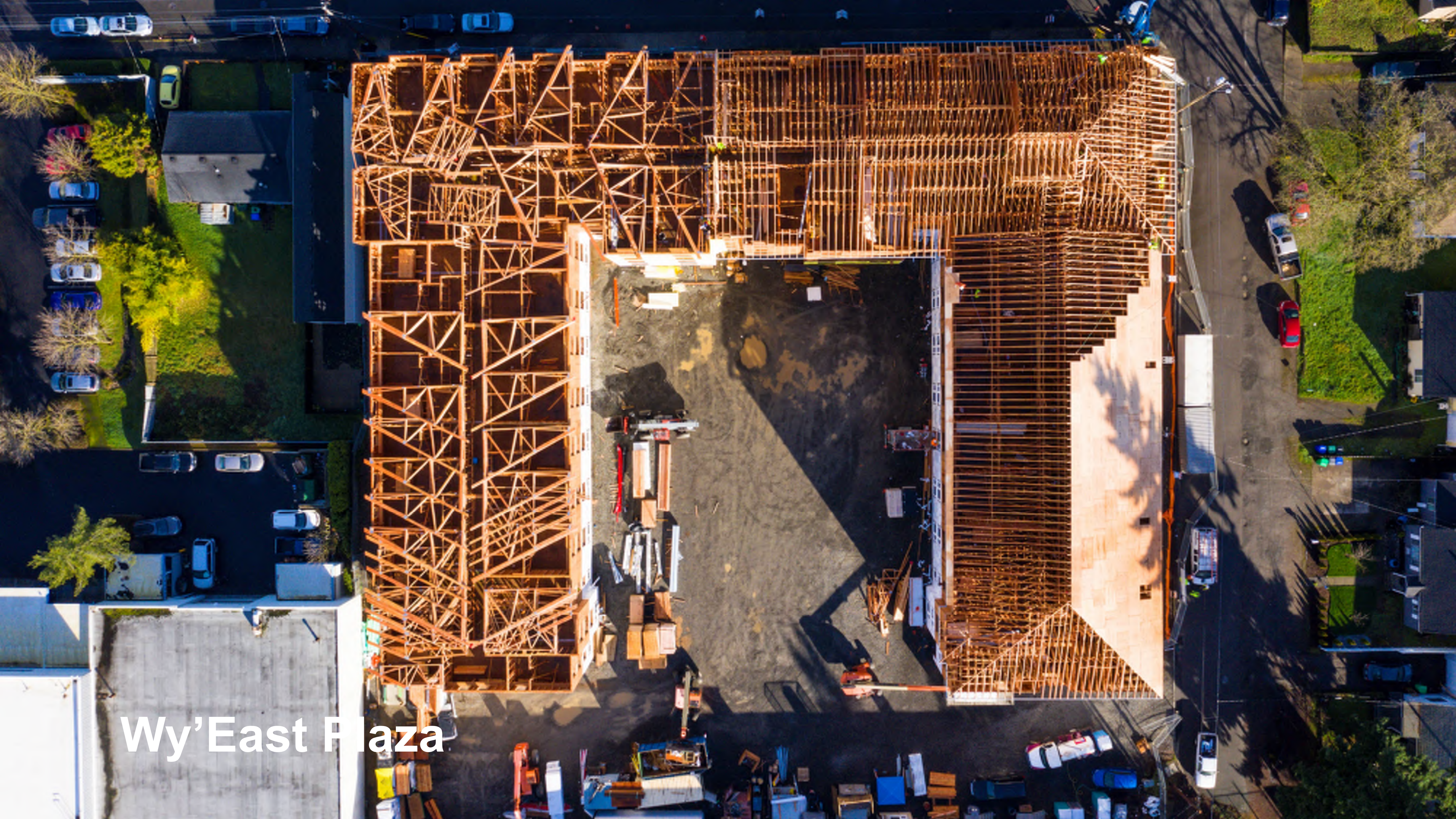
Wy’East Plaza


Wy'East Plaza


Wy’East Plaza


Wy’East Plaza

Buri Building

- Affordable workforce housing project in Portland, Oregon
- Developer/ Owner: Northwest Housing Alternatives
- Architect: MWA Architects
- Contractor: Walsh Construction Co.

- Programmed for 120-160 units → final unit count = 159
- Construction start: Spring 2019; completion: July 2020

Image Credit: MWA Architects

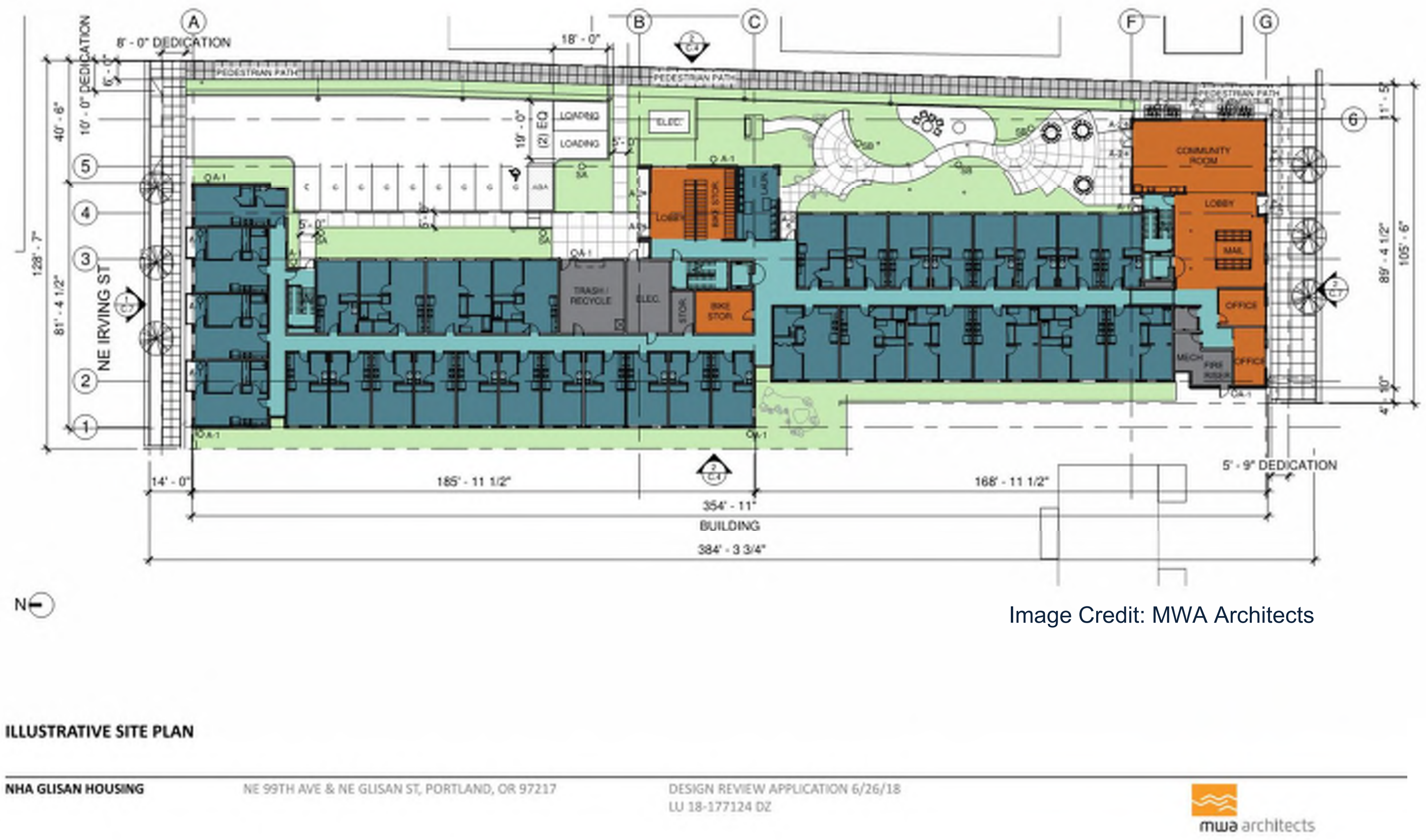


Image Credit: MWA Architects

Buri Building - First Floor Plan

Buri Building

Portland, OR (2020)

Construction Cost: $123k per unit

Construction Duration: 14 months

Buri Building

Buri Building

Cost Tracking Log

Portland Area Affordable Housing Pipeline 2016-2024

Project Name	Sponsor	Architect	Contractor	Gross Building Area (SF)	No. of Units	No. of BR	Total Development Cost (TDC)	TDC/Unit	TDC/Bdrm	Hard Construction Cost (HCC)	HCC/SF**	HCC/Unit	HCC/Bdrm	Construction Type	Start Date	Prevailing Wage
Low Income Single Adult Hsg.	TPI	HOLST	Walsh	23,940	72	72	11,597,968	161,083	161,083	8,152,379	341	113,227	113,227	3 story wood	Jun. '19	BOLI
124th & Ash	REACH	AMA	Walsh	100,392	175	190	28,337,287	161,927	149,144	19,487,763	194	111,359	102,567	4 story wood	Jul. '19	No
Gateway Housing	NHA	MWA	Walsh	91,554	159	165	28,050,265	176,417	170,002	19,530,490	213	122,833	118,367	4 story wood	Feb. '19	D-B
Stark Street Apartments*	CCC	AMA	Team	92,067	153	214	29,197,817	190,835	136,438	20,484,012	222	133,882	95,720	4 story wood	Nov. '17	D-B
Interstate Apartments*	CCC	Circosta	Silco	30,823	51	68	9,756,805	191,310	143,482	5,991,815	194	117,487	88,115	4 story wood	Nov. '17	No
Eastside Campus Apartments*	CCC	AMA	Walsh	63,045	124	124	24,626,280	198,599	198,599	18,238,194	289	147,082	147,082	4 story wood / 2 story conc	Nov. '17	BOLI
St. Francis Park Apartments*	Catholic Charities	MWA	OWCB	74,005	106	107	23,250,483	219,344	217,294	14,291,211	193	134,823	133,563	3 story wood / 1 story conc	Feb. '16	D-B
Alphabet District Housing	NHA	CHA	Bremik	73,177	149	149	33,307,000	223,537	223,537	?	?	?	?	?	?	?
106 Halsey*	Human Solutions	HOLST	LMC	?	75	85	17,425,037	232,334	205,000	?	?	?	?	5 story wood / 1 story conc	Apr. '19	BOLI
The Fields Apartments	GSL	?	?	243,400	264	396	62,986,117	238,584	159,056	42,639,612	175	161,514	107,676	4 story wood	Aug. '18	?
72nd & Foster*	REACH	HOLST	LMC	79,549	101	131	24,356,329	241,152	185,926	17,506,000	220	173,327	133,634	3 story wood / 1 story conc	Sep. '17	BOLI
Willow Creek Crossing Apts.	GSL	TVA	Walsh	98,294	120	131	29,744,546	247,871	227,058	21,640,053	220	180,334	165,191	5 story wood / 1 story conc	Aug. '18	BOLI
New Meadows*	Bridge Meadows	CHA	Walsh	10,700	15	15	3,850,183	256,679	256,679	2,415,500	226	161,033	161,033	2 story wood	Sep. '17	No
Red Rock Creek Commons	CPAH	CHA	?	?	48	48	12,954,501	269,885	269,885	?	?	?	?	?	?	?
Argyle Apartments*	REACH	MWA	Walsh	153,998	189	272	51,758,869	273,856	190,290	34,526,428	224	182,680	126,935	4 story wood / 1 story conc	Jan. '19	No
Hill Park Apartments*	CCC	CHA	Colas	25,384	39	39	10,840,188	277,954	277,954	6,538,253	242	167,647	167,648	3 story wood	Apr. '16	No
Isabella Court - Phase II	REACH	MWA	Team	47,679	49	64	13,909,492	283,867	217,336	9,152,253	192	186,781	143,004	4 story wood	Sep. '18	?
Orchards at Orenco - Ph. III	REACH	AMA	Walsh	62,771	52	123	14,820,447	285,009	120,491	10,318,405	164	198,431	83,889	3 story wood	Oct. '17	No
Pleasant Ave. Veterans Hsg.	NHA	KASA	Walsh	18,040	24	32	7,077,430	294,893	221,170	4,430,308	246	184,596	138,447	2 story wood	Oct. '18	D-B
Magnolia Apartments - Ph. II	IHI	CHA	Bremik	44,584	50	93	15,126,249	302,525	162,648	?	?	?	?	3 story wood / 1 story conc	Nov. '18	?
91st & Foster*	Prosper Portland	Hacker	Bremik	?	54	78	16,565,025	306,760	212,372	?	?	?	?	3 story wood / 1 story conc	Feb. '17	?
Grand Avenue Apts. (Block 45)	Home Forward	LRS / Lever	OWCB	186,000	240	283	73,770,121	307,376	260,672	52,477,106	282	218,655	185,431	12 story concrete	Jan. '18	BOLI
Beatrice Morrow*	PCRI	CHA	Colas	?	80	132	25,131,244	314,141	190,388	18,526,938	294	231,587	140,356	4 story wood / 1 story conc	May '17	?
Oliver Station*	Palindrome	AMA	Urban Edge	?	126	204	40,011,635	317,553	196,135	?	?	?	?	4 story wood / 1 story conc	Nov. '16	?
Cedar Grove	CPAH	CHA	LMC	?	44	58	14,321,892	325,498	246,929	?	?	?	?	4 story wood	?	?
The Jade*	ROSE	SERA	OWCB	47,798	48	66	15,660,784	326,266	237,285	11,983,572	251	249,658	181,569	3 story wood / 1 story conc	Jan. '18	BOLI
Meriwether Place	VHA	EW	Walsh	24,708	30	30	9,900,000	330,000	330,000	5,947,648	241	198,255	198,255	4 story wood	Jul. '17	BOLI
Woody Guthrie Apartments*	ROSE	CHA	Walsh	60,878	64	90	21,551,152	336,737	239,457	14,932,222	245	233,316	165,914	4 story wood	Mar. '18	D-B
King + Parks Apartments*	PCRI	Merryman	Colas	?	70	132	26,000,000	371,429	196,970	?	?	?	?	3 story wood / 1 story conc	?	?
NHA Campus Housing	NHA	MWA	OWCB	30,201	28	57	10,620,846	379,316	186,331	8,778,600	291	313,521	154,011	3 story wood	May '18	D-B
14th & Raleigh*	IHI	LRS	Bremik	78,307	93	188	35,842,665	385,405	190,652	24,689,479	315	265,478	131,327	12 story concrete	Nov. '17	BOLI

Cost Tracking Log

Portland Area Affordable Housing Pipeline 2016-2024

TOTAL DEVELOPMENT COST RANGE: $161,000 - $730,000 per unit

Project Name	Sponsor	Architect	Contractor	Gross Building Area (SF)	No. of Units	No. of BR	Total Development Cost (TDC)	TDC/Unit	TDC/Bdrm	Hard Construction Cost (HCC)	HCC/SF**	HCC/Unit
Low Income Single Adult Hsg.	TPI	HOLST	Walsh	23,940	72	72	11,597,968	161,083	161,083	8,152,379	341	113,227
124th & Ash WY'EAST	REACH	AMA	Walsh	100,392	175	190	28,337,287	161,927	149,144	19,487,763	194	111,359
Gateway Housing BURI	NHA	MWA	Walsh	91,554	159	165	28,050,265	176,417	170,002	19,530,490	213	122,833
Stark Street Apartments*	CCC	AMA	Team	92,067	153	214	29,197,817	190,835	136,438	20,484,012	222	133,882
Interstate Apartments	CCC	Circosta	Silco	30,823	51	68	9,756,805	191,310	143,482	5,991,815	194	117,487
Eastside Campus Apartments*	CCC	AMA	Walsh	63,045	124	124	24,626,280	198,599	198,599	18,238,194	289	147,082
St. Francis Park Apartments*	Catholic Charities	MWA	OWCB					219,344				
Alphabet District Housing	NHA	CHA	Bremik					223,537				
106 Halsey*	Human Solutions	HOLST	LMC					232,334				
The Fields Apartments	GSL	?	?					238,584				
72nd & Foster*	REACH	HOLST	LMC					241,152				
Willow Creek Crossing Apts.	GSL	TVA	Walsh					247,871				
New Meadows*	Bridge Meadows	CHA	Walsh					256,679				
Red Rock Creek Commons	CPAH	CHA	?					269,885				
Argyle Apartments*	REACH	MWA	Walsh					273,856				
Hill Park Apartments*	CCC	CHA	Colas					277,954				
Isabella Court - Phase II	REACH	MWA	Team					283,867				
Orchards at Orenco - Ph. III	REACH	AMA	Walsh					285,009				
Pleasant Ave. Veterans Hsg.	NHA	KASA	Walsh	18,040	24	32	7,077,430	294,893	221,170	4,430,308	246	184,596
Magnolia Apartments - Ph. II	IHI	CHA	Bremik	44,584	50	93	15,126,249	302,525	162,648	?	?	?
91st & Foster*	Prosper Portland	Hacker	Bremik	?								?
Grand Avenue Apts. (Block 45)	Home Forward	LRS / Lever	OWCB	186,000								218,655
Beatrice Morrow*	PCRI	CHA	Colas	?								231,587
Oliver Station*	Palindrome	AMA	Urban Edge	?	126	204	40,011,635	317,553	196,135	?	?	?

TDC/Unit	HCC/Unit
161,083	113,227
161,927	111,359
176,417	122,833
190,835	133,882

ACTUAL RESULTS

CEDC Projects Across the Pacific Northwest

- Completed:
  - Clayton Mohr Commons, Oregon City
  - **Wy'East Plaza, Portland**
  - **Buri Building, Portland**
  - **George Fleming Place, Seattle**
  - Columbia Heights, Vancouver
  - **Trillium House, Warrenton**
  - Martha's Place, Mt. Vernon
  - The Aries Apartments, Seattle
  - Good Shepherd Housing, Seattle
  - **Mercy Greenbrae, Lake Oswego**

- In Construction:
  - Hilltop Housing, Tacoma
  - Killingsworth Apartments, Portland

- Numerous other projects in design phase or pre-planning / conceptual stages

- **Demonstrating broad replicability and scalability…**

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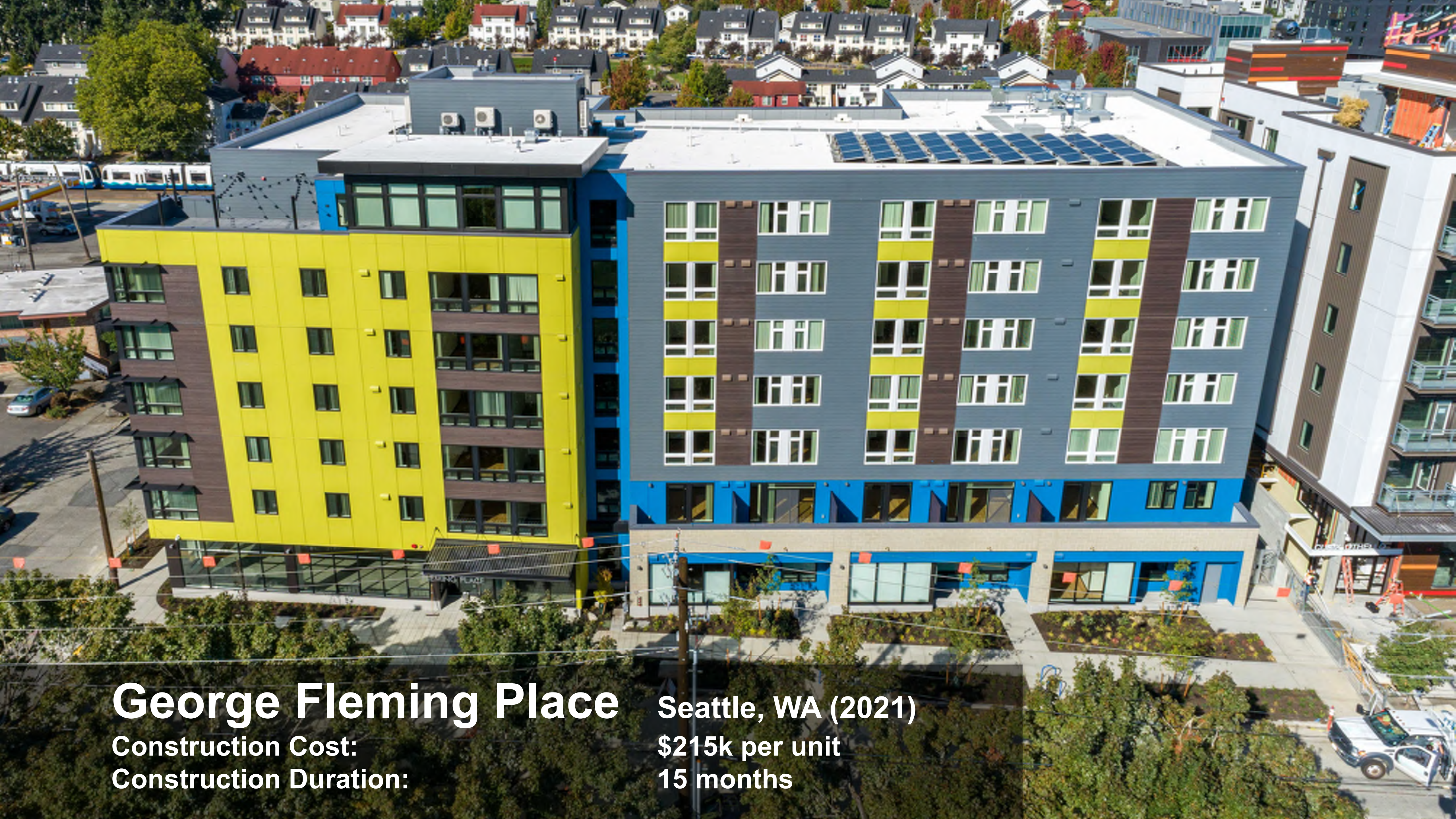

George Fleming Place

Seattle, WA (2021)

Construction Cost: $215k per unit

Construction Duration: 15 months

Trillium House

Warrenton, OR (2023)

Construction Cost: $268k per unit

Construction Duration: 12 months

Mercy Greenbrae

Lake Oswego, OR (2024)

Construction Cost: $300k per unit

Construction Duration: 18 months

Bayside Anchor
Portland, ME

Image Credit: Kaplan Thompson Architects

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Conclusion

- We need MORE homes → 3,900 homes x 1.1 = 4,300 homes!
- We need BETTER homes
  - Low energy / low emission (PH, NZE) should be the standard not the exception…
- We have the methods, and the technology, to create BETTER homes…
- Do we have the **discipline** to create MORE homes?

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Thank You

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