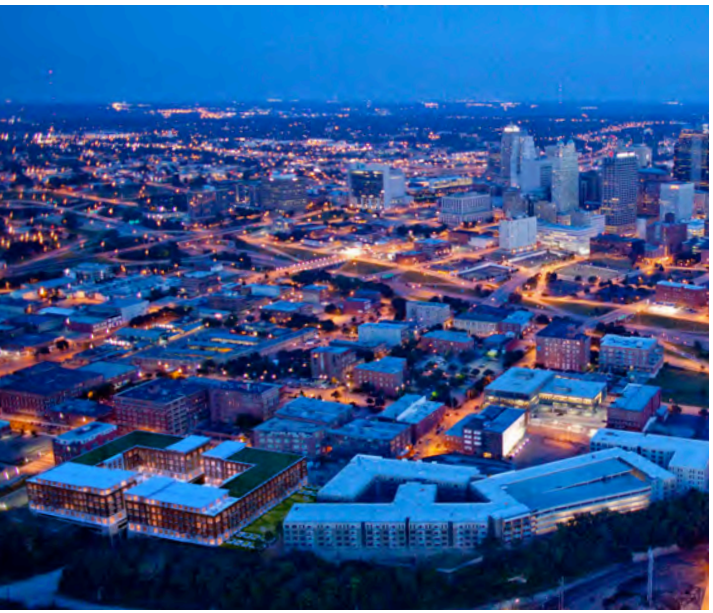
SECOND AND DELAWARE
SCALING PASSIVE HOUSE



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Creating Lasting Value through Sustainable Real Estate

ad ARNOLD DEVELOPMENT GROUP


1950-2010

2010-2040

Sustainable Development Opportunity

DISTRIBUTION OF HOUSEHOLDS WITH AND WITHOUT CHILDREN, AND SINGLE-PERSON HOUSEHOLDS, 1960, 2000, AND 2030

Household Type	1960	2000	2030
Households with Children	48%	33%	27%
Households without Children	52%	67%	73%
Single-Person Households	13%	26%	28%

In 2030, only 27% of U.S. Households will have Children

SUMMARY OF HOUSING PREFERENCE SURVEYS

Housing Type	Detailed Share	Total Type Share
Attached		38%
Apartment	14%	
Townhouse	15%	
Condominium/Cooperative	9%	
Detached		62%
Small Lot	37%	
Large Lot	25%	
Total "new urbanity" preference (attached + small lot detached)		75%

75% of U.S. Households prefer to live where they could walk to more destinations.

PROJECTED HOUSING DEMAND COMPARED TO CURRENT SUPPLY

Residential Type	Supply 2007 (in thousands)	Demand Share	Demand 2020 (in thousands)	Difference, 2007-2020 (in thousands)	Demand 2030 (in thousands)	Difference, 2020-2030 (in thousands)	Difference, 2007-2030 (in thousands)
Attached, all types	39,093	38%	55,242	16,149	60,521	5,279	21,428
Small lot	25,337	37%	53,789	28,542	58,929	5,140	33,592
Large lot	63,773	25%	36,344	(27,430)	39,817	3,473	(23,957)
Detached total	89,110	62%	90,132	1,022	98,745	8,613	9,635
Total	128,203		145,374	17,171	159,267	13,892	31,064

44.5 million new attached and small lot detached units will need to be built between now and 2020 to meet the demand.

Arthur C. Nelson, Director of Metropolitan Research
College of Architecture + Planning of the University of Utah

How should we build the next generation of housing?

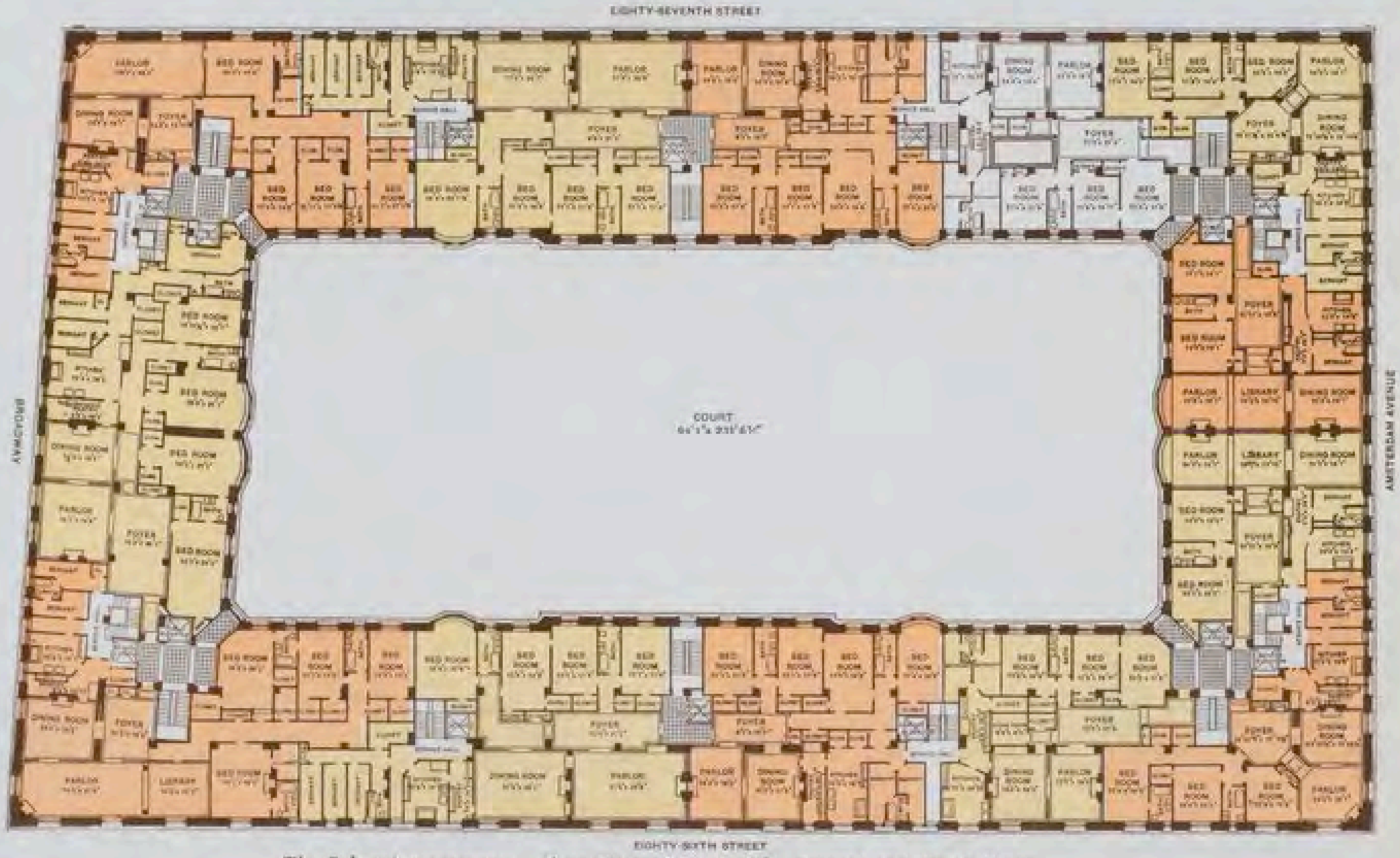
Last Generation Development Model

Wood Frame Construction:

- Not Adaptable - Cannot easily move walls.
- Poorly insulated and energy inefficient.
- OSB absorbs moisture and is prone to mold.
- Costly to maintain buildings over time.

While stick-built construction offers a low cost alternative to concrete construction, over time the structure becomes susceptible to mold.

Belnord Hotel - Concrete courtyard typology.



The Belnord Apartments—Floor Plan—Second, Fifth, Seventh and Tenth Floors

Long Term Investment Philosophy

- Build high performance real assets that outperform the current model financially, socially and environmentally.
- Combine best practices in building science, transportation, and urban food production to increase competitive

CORE COMPONENTS TO ADG DEVELOPMENTS

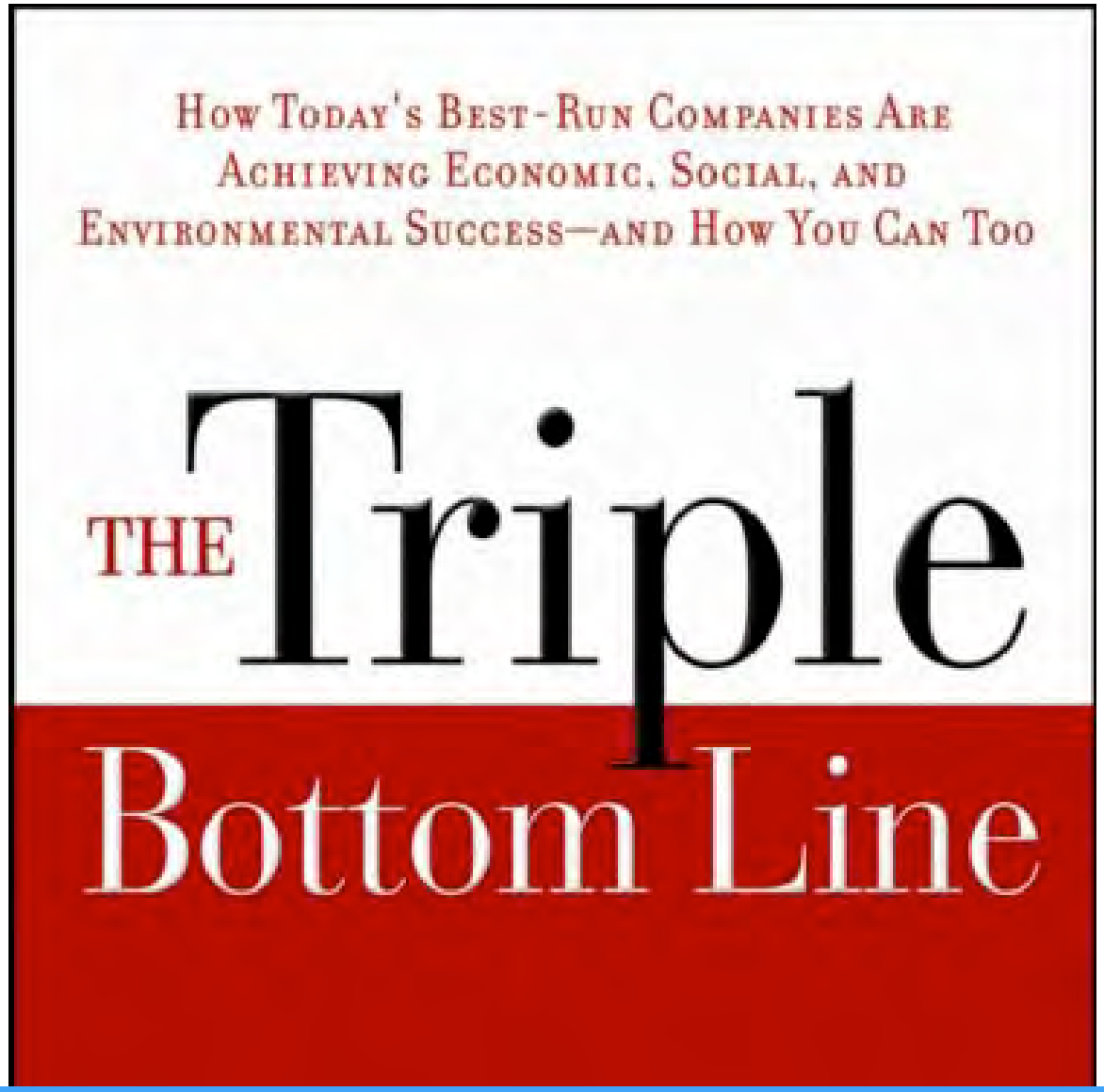
Concrete Structures
Making long lasting and adaptable buildings.

Super Insulated Envelopes
Passive House Certified buildings, reducing energy costs by 70-90%

Livable Density
Making density attractive, secure and desirable.

Urban Gardens
Producing food and strengthening communities.

Investment Philosophy



People
Profit
+ Planet

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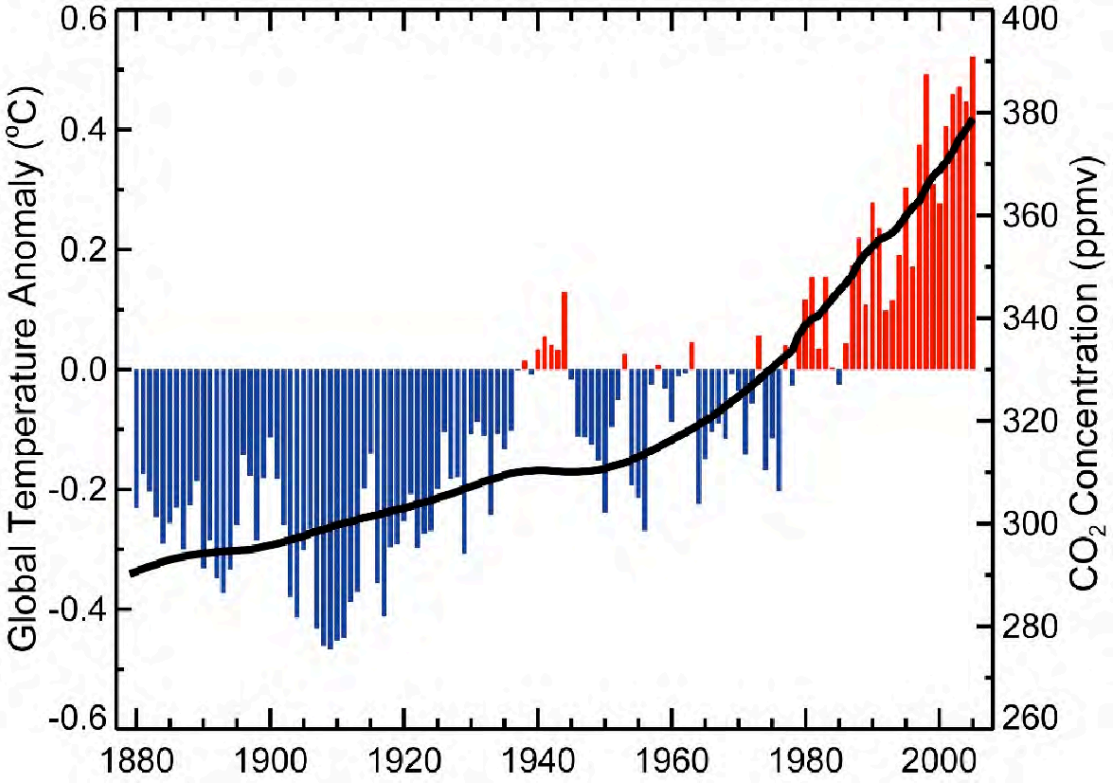
the change we seek™

Climate Change

"Climate change is the challenge of our time."

Henry Paulson
Former Treasury Secretary



How we respond to this challenge will largely determine the kind of world we leave our children and grandchildren.

Buildings account for 40-70% of carbon emissions. We need to change the way we build.

2 or 4 degree rise in temperature?

Income Inequality

Previous Work with the United Nations

The Future We Want

Jonathan Arnold and Bill Becker co-founded the project then partnered with the United Nations.

A **5-year initiative** to fill the "vision vacuum" in the sustainability space.

A **replicable model** for envisioning sustainable communities around the world.

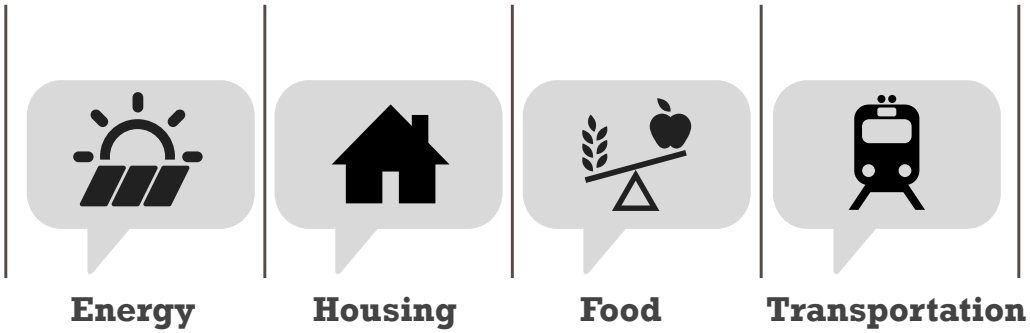
"We need everyone — Government Ministers and policymakers, business and civil society leaders, and young people — to work together to create a future worth choosing, a future we want."

- Secretary General Ban Ki-Moon

Conclusions after working with the United Nations

- We have all the technologies we need to create long lasting economically resilient environments.
- We need profitable models for smart growth developments that can be easily **replicated**.

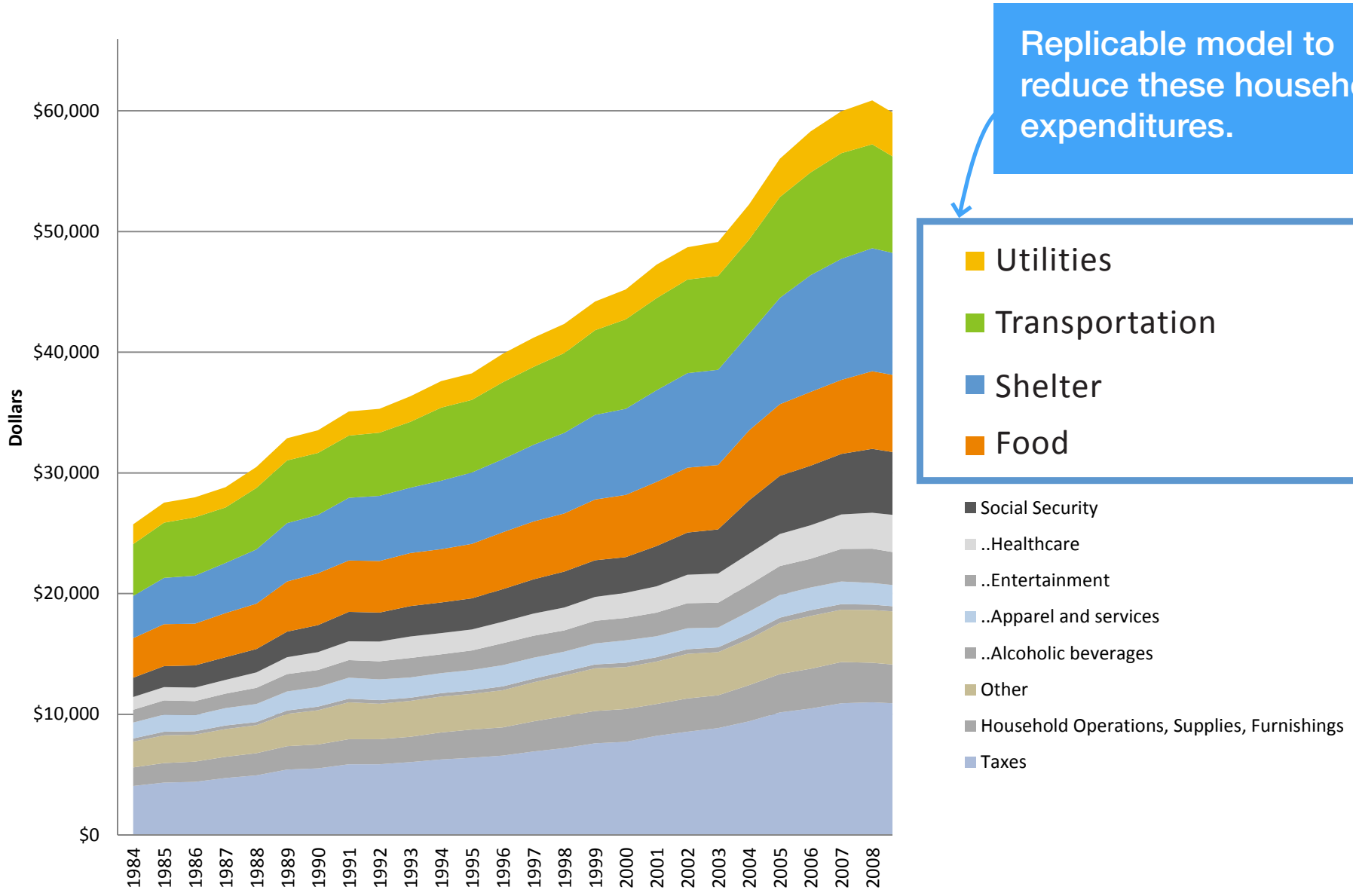
Siloed vs Systems Thinking



Siloed Thinking addresses issues as distinct "Problems" to be solved individually.

Systems Thinking considers the interdependence of objects and their attributes

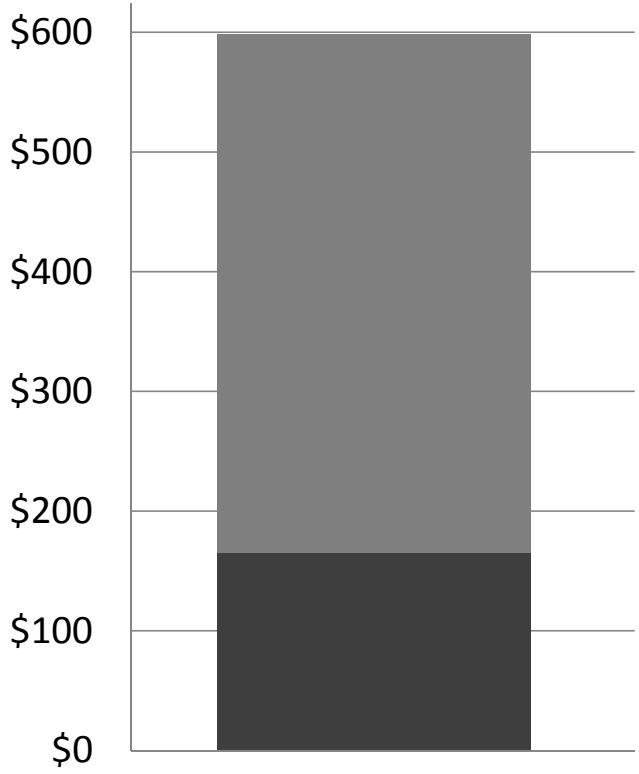
Goal: Reduce HH Expenditures through Sustainable Design



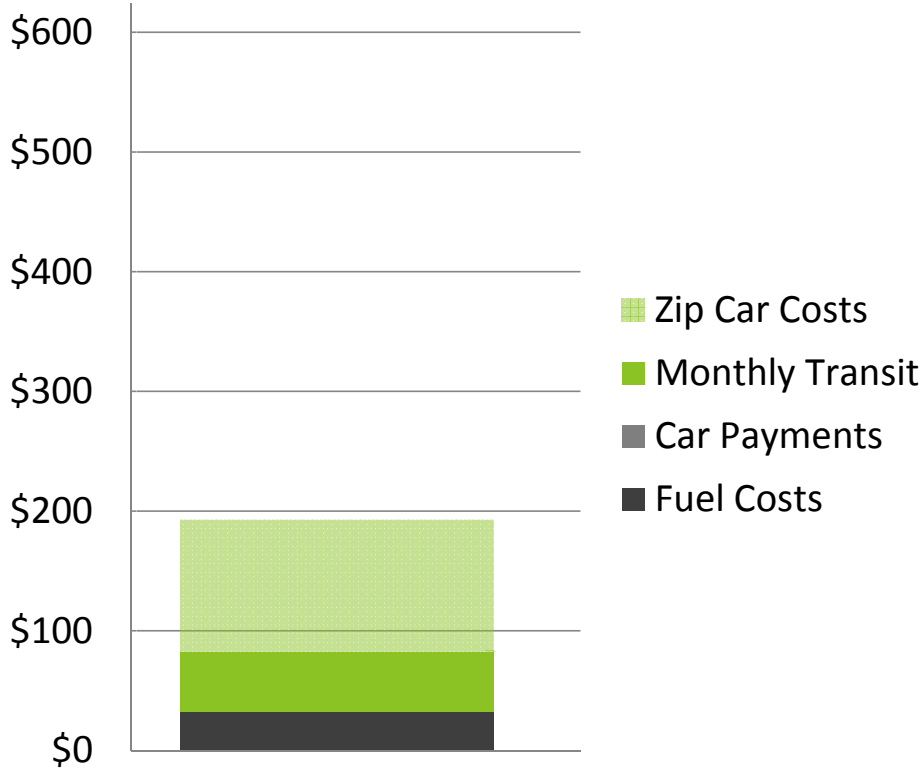
Source: U.S. Bureau of Labor Statistics, Consumer Expenditures in 2009, News Release, USDL-10-1390, October 2010.

Transit Oriented Development

Living in transit oriented neighborhoods can reduce transportation costs by 70%



Conventional Development



Transit Oriented Development

$598.25 per month → **$192.60** per month

Workforce Housing

20% of Units Reserved for 50% AMI

Reserving units for workforce housing increases social equity

Unit Mix	# of Units	Ave. Sq. Ft.	Total Sq. Ft.	Current Appraisal				Annual Income
Unit I - Studio	44	550	24,200	930	$ 1.69	$ 40,920	$	491,040
Unit IA - Studio 50%	14	550	7,700	531	$ 0.97	$ 7,434	$	89,208
Unit H1 - 1 Bed / 1 Bath	29	644	18,676	1035	$ 1.61	$ 30,015	$	360,180
Unit H1A - 1 Bed / 1 Bath 50%	7	644	4,508	557	$ 0.86	$ 3,899	$	46,788
Unit H2 - 1 Bed/ 1 Bath	10	700	7,000	1075	$ 1.54	$ 10,750	$	129,000
Unit H2A - 1 Bed/ 1 Bath 50%	3	700	2,100	557	$ 0.80	$ 1,671	$	20,052
Unit H3 - 1 Bed/ 1 Bath	57	850	48,450	1200	$ 1.41	$ 68,400	$	820,800
Unit H3A - 1 Bed/ 1 Bath 50%	11	850	9,350	557	$ 0.66	$ 6,127	$	73,524
Unit G - 2 Bed / 2 Bath	13	850	11,050	1300	$ 1.53	$ 16,900	$	202,800
Unit GA - 2 Bed / 2 Bath 50%	3	850	2,550	668	$ 0.79	$ 2,004	$	24,048
Unit E - 2 Bed/ 2 Bath	24	1,050	25,200	1400	$ 1.33	$ 33,600	$	403,200
Unit EA - 2 Bed/ 2 Bath 50%	6	1,050	6,300	668	$ 0.64	$ 4,008	$	48,096
Unit D - 2 Bed/ 2 Bath	29	1,150	33,350	1510	$ 1.31	$ 43,790	$	525,480
Unit DA - 2 Bed/ 2 Bath 50%	7	1,150	8,050	668	$ 0.58	$ 4,676	$	56,112
Unit B - 2 Bed/ 2 Bath	14	1,300	18,200	1650	$ 1.27	$ 23,100	$	277,200
Unit BA - 2 Bed/ 2 Bath 50%	4	1,300	5,200	668	$ 0.51	$ 2,672	$	32,064
Total / Average	**275**	**843**	**231,884**	**1,091**	**$ 1.28**	**$ 299,966**	**$**	**3,567,528**

$1,269 per month (Market Rate)

$654 per month (Workforce Housing)

Passive House Construction

Passive House Buildings have 70-90% lower utility bills.

5” Walls

$119.00 per month

16” Walls

$26.47 per month

Current Development Model uses poorly insulated walls and oversized mechanical systems to compensate for the thermal losses.

Passive House Model calls for super insulated building envelopes and require 70-90% less energy to heat and cool the building.

The New Development Model

- 276 Unit Multifamily Project
- Transit Oriented
- Passive House Certified
- 20% Workforce Housing

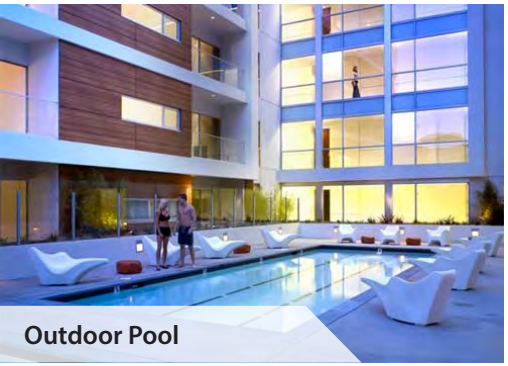
Aerial View

Landscaped Roof Gardens

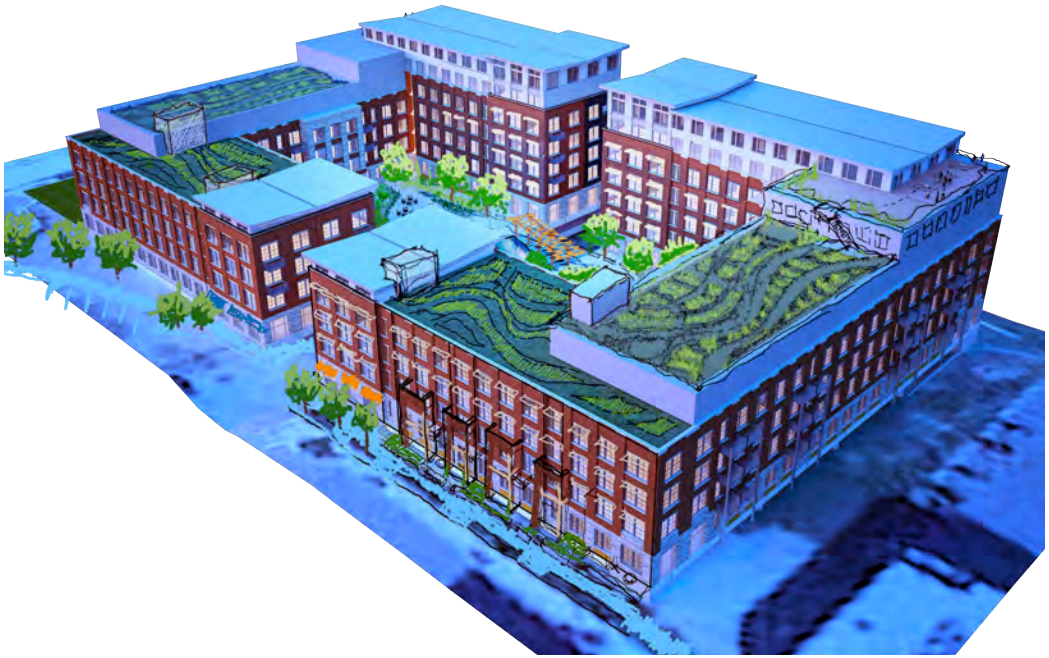
Roof Gardens

Toddler Play Room

Urban Agriculture



Outdoor Pool



Human Scale Design

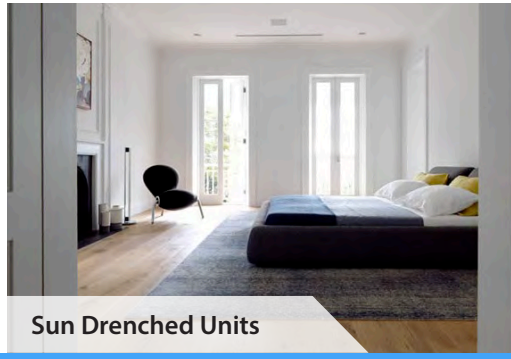
Raised Planting Beds

Shared Conference Room

Pocket Park

Living Walls

Workout Room



Sun Drenched Units

View from Delaware Street

View of Courtyard

View of the Pool

Environmental Benefits

Kansas City High Rise

Building Size 277,512 SF

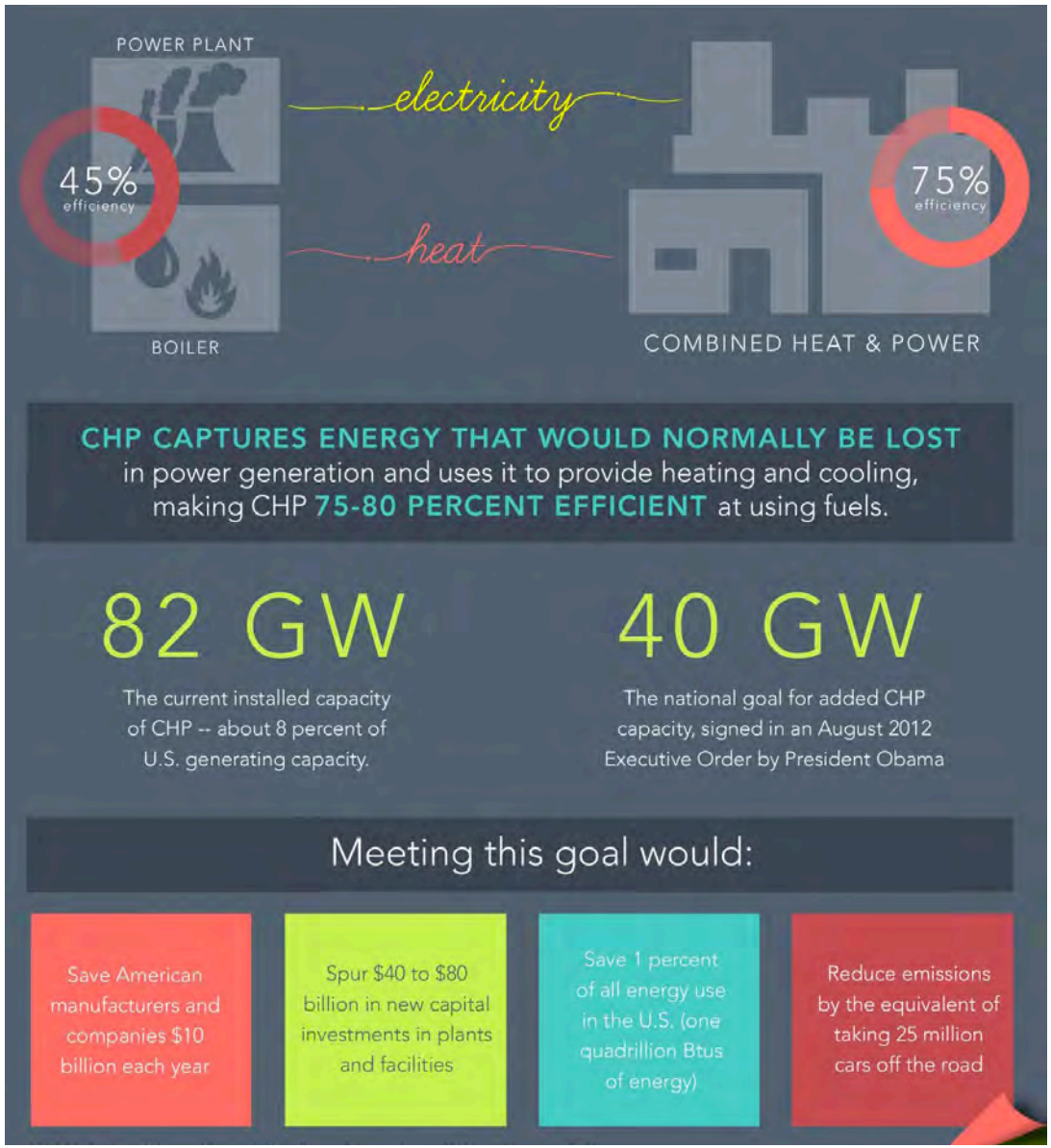
Site Energy **40,703,323** kBtu/yr

Second and Delaware (Passive House)

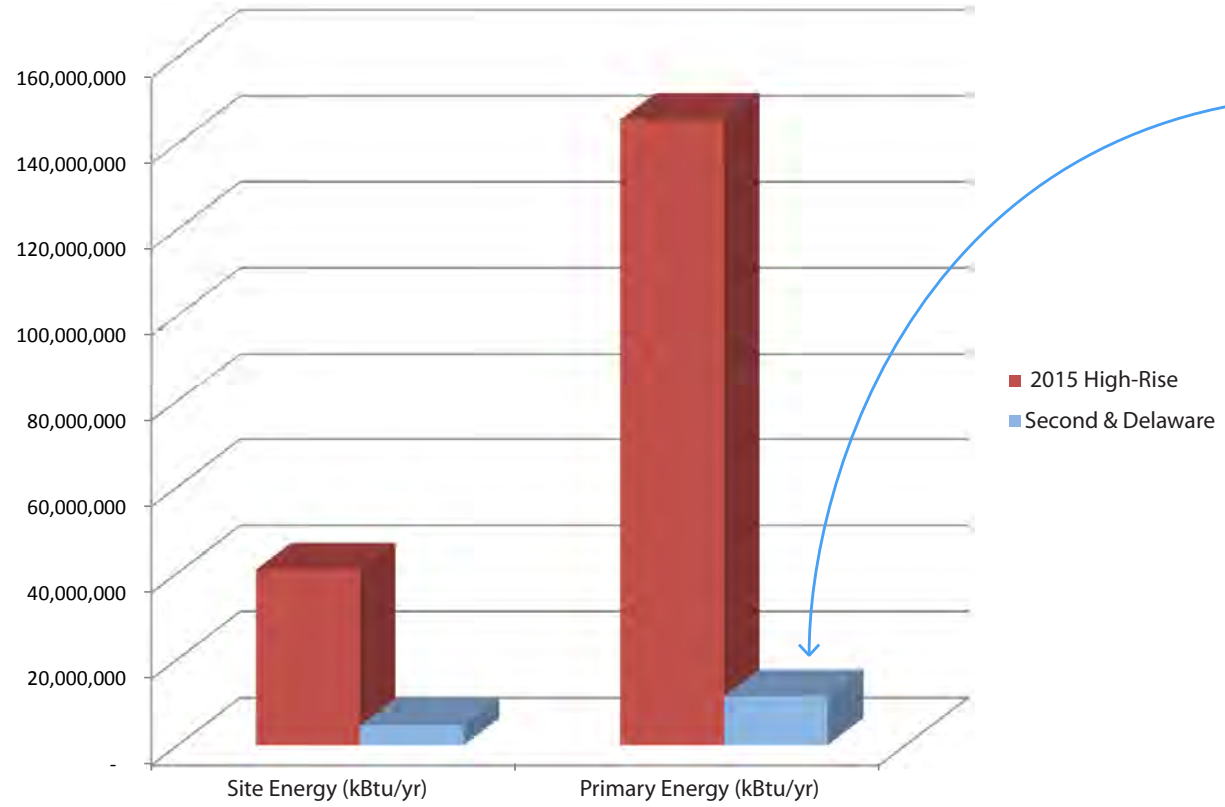
Building Size 321,096 SF

Site Energy **5,054,051** kBtu/yr

Natural Gas Combined Heat and Power



Primary Energy Comparison



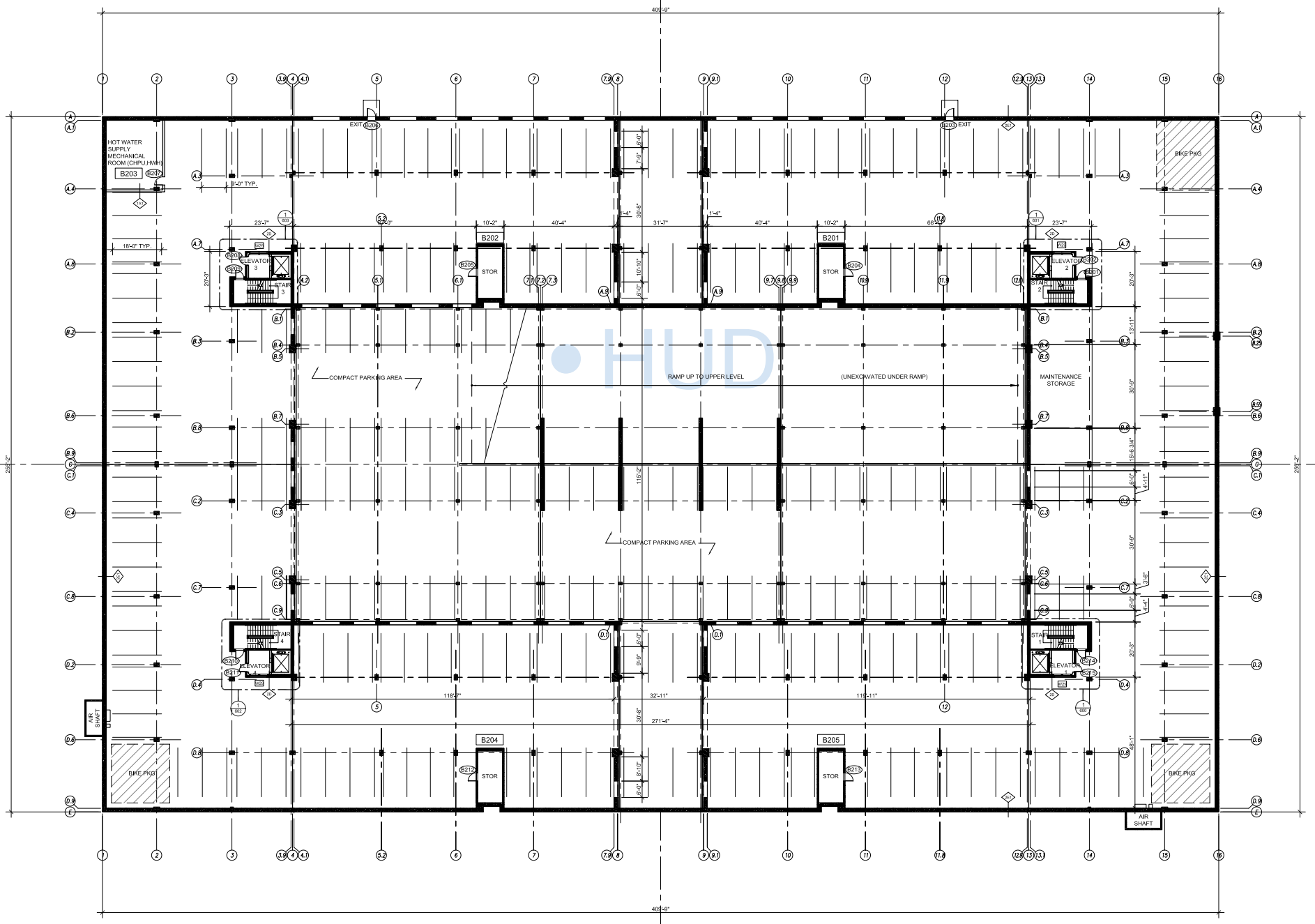
90% Reduction in Primary Energy

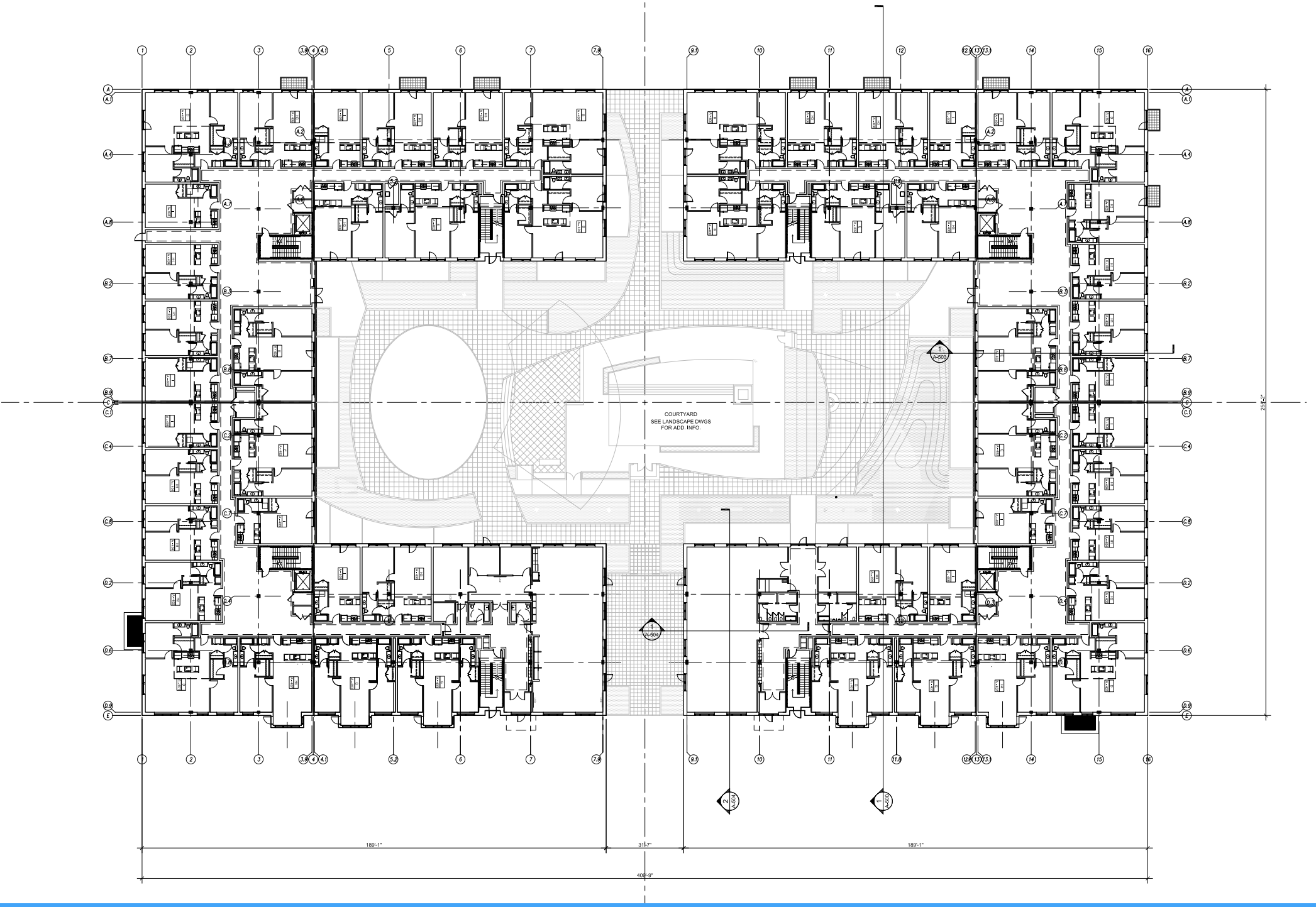
2015 High-Rise

122,177,964 kBtu/yr

Second and Delaware

12,591,648 kBtu/yr

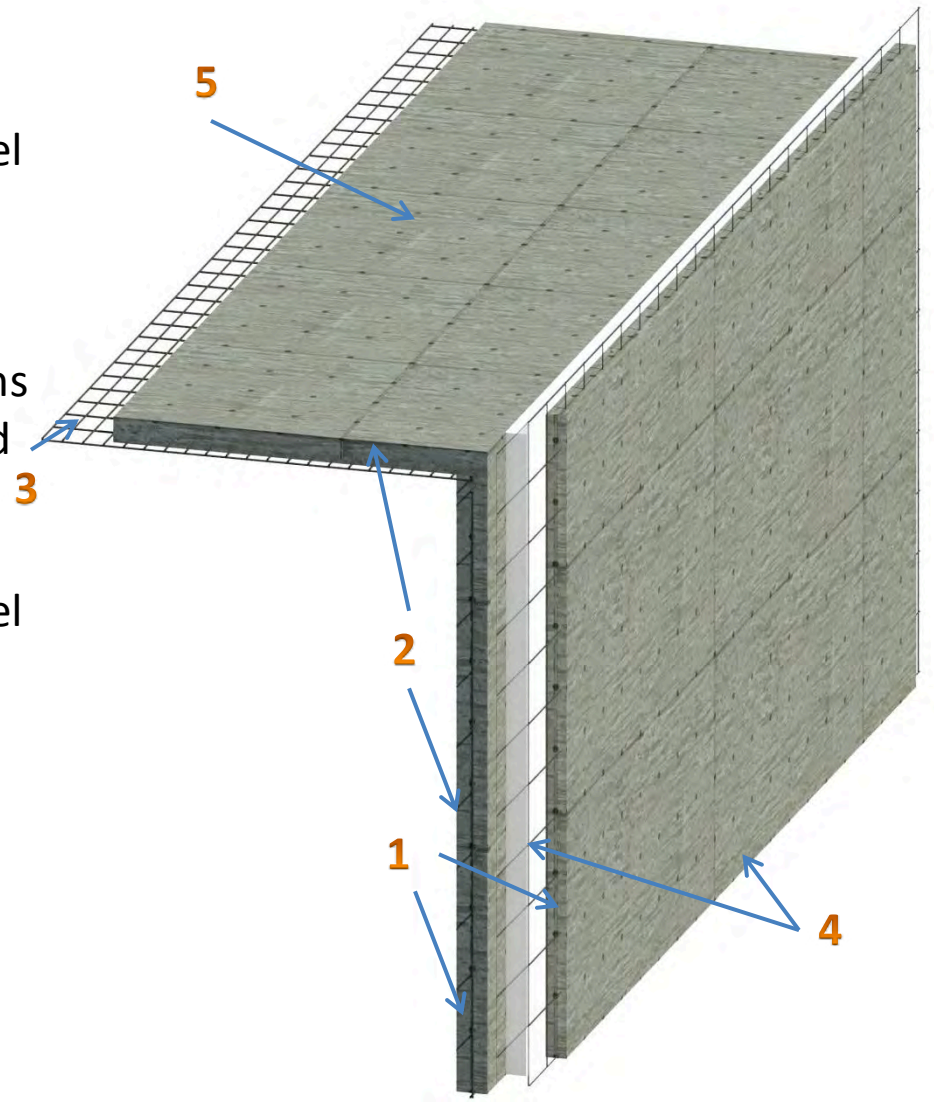

HOT WATER SUPPLY MECHANICAL ROOM (CHPU,HWH)
B203
EXIT
B206
B207
EXIT
BIKE PKG
B202
B201
STOR
STOR
ELEVATOR 3
STAIR 3
ELEVATOR 2
STAIR 2
COMPACT PARKING AREA
RAMP UP TO UPPER LEVEL
(UNEXCAVATED UNDER RAMP)
MAINTENANCE STORAGE
COMPACT PARKING AREA
STAIR 4
ELEVATOR 4
STAIR 1
ELEVATOR 1
AIR SHAFT
B204
B205
STOR
STOR
BIKE PKG
BIKE PKG
AIR SHAFT
409'-9"
255'-3"


COURTYARD
SEE LANDSCAPE DWGS
FOR ADD. INFO.
189'-1"
31'-7"
189'-1"
409'-9"
255'-2"

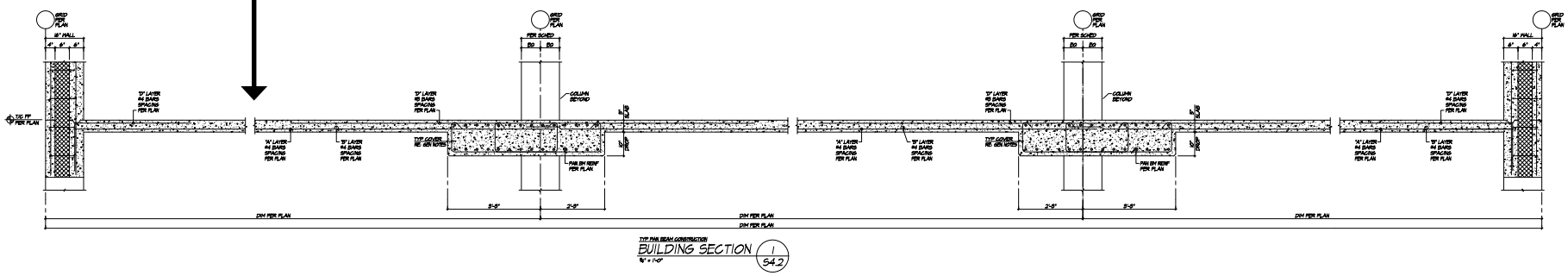
FORMWORK CYCLE – ACTIVITY DETAIL

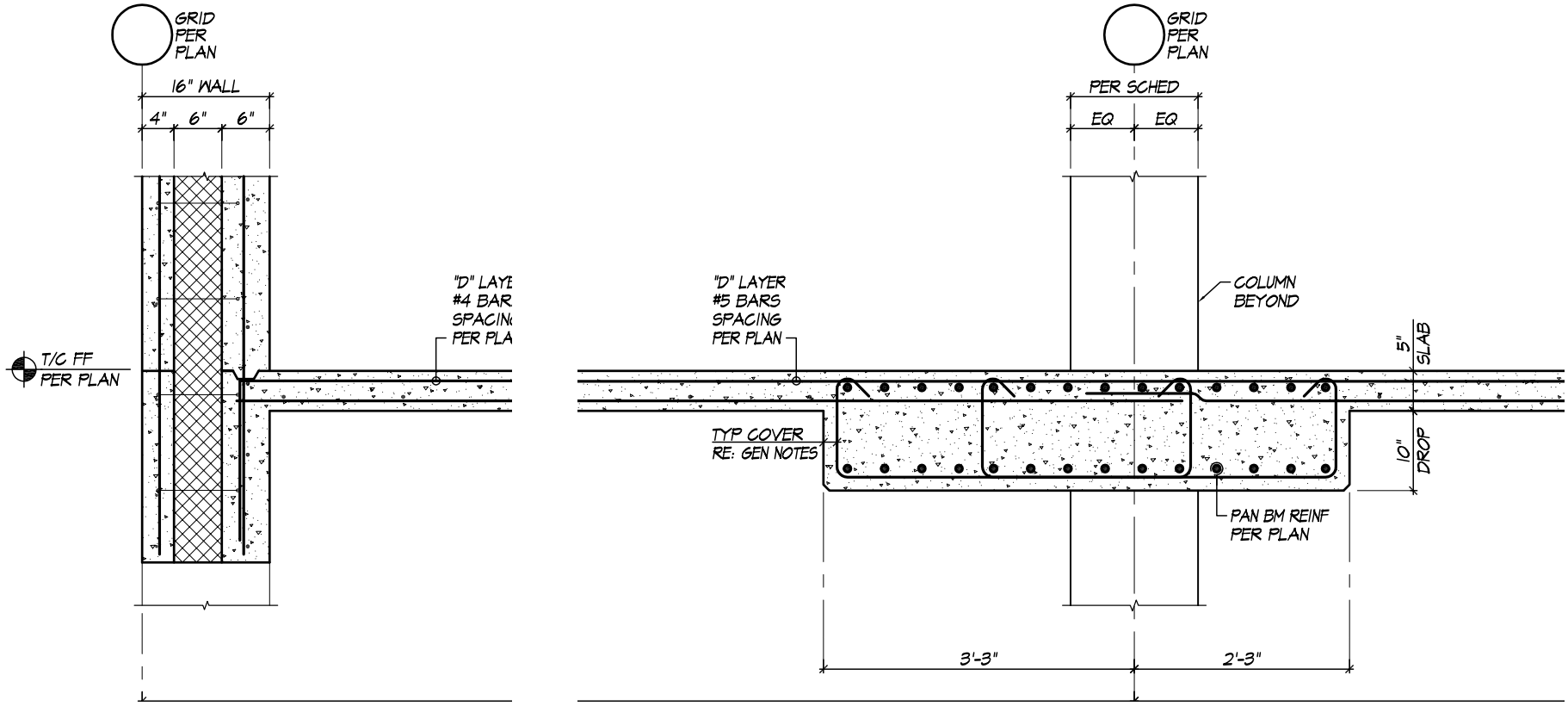
FORMWORK CYCLE

1. Steel & Utilities - Walls and Columns
   - Erect and Place Reinforcing Steel
   - Install Rough-In Electrical Conduits and Plumbing
2. Forming Part 1
   - Form Interior Walls and Columns
   - Form Interior Beams & Elevated Slabs
3. Steel & Utilities - Elevated Slab
   - Erect and Place Reinforcing Steel
   - Install Rough-In Electrical Conduits and Plumbing
4. Forming Part 2
   - Place Thermomass XPS in Wall Cavity
   - Form Exterior Wall – One Side
5. Pour & Finish Concrete



6” Non-Post Tensioned Concrete Slab





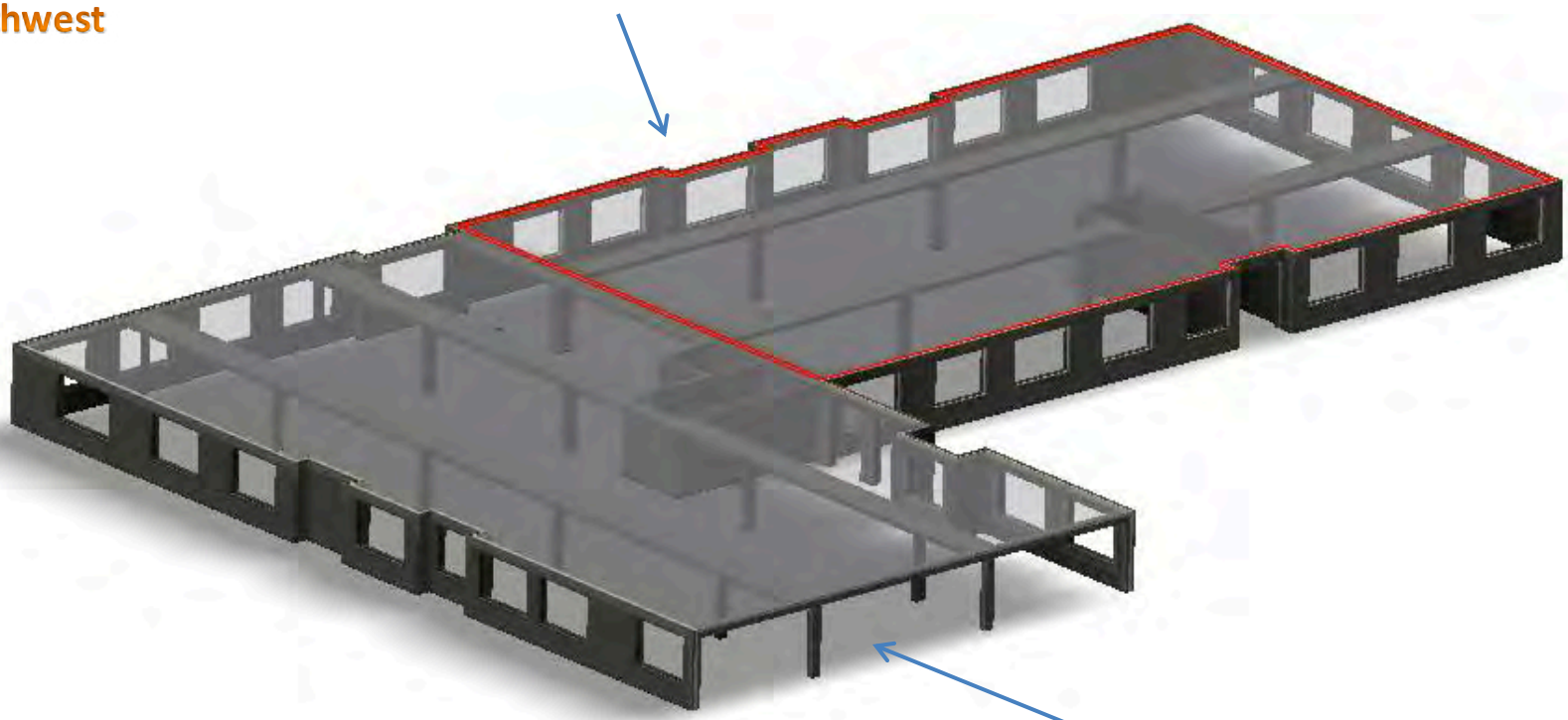
QUARTER COMPLEX – 1st FLOOR NW QUADRANT

ARNOLD DEVELOPMENT

QUADRANT 1
Northwest

POUR 1 – 240.21 Cubic Yards

6 STOREY TOWER
(FORM SET -1A)

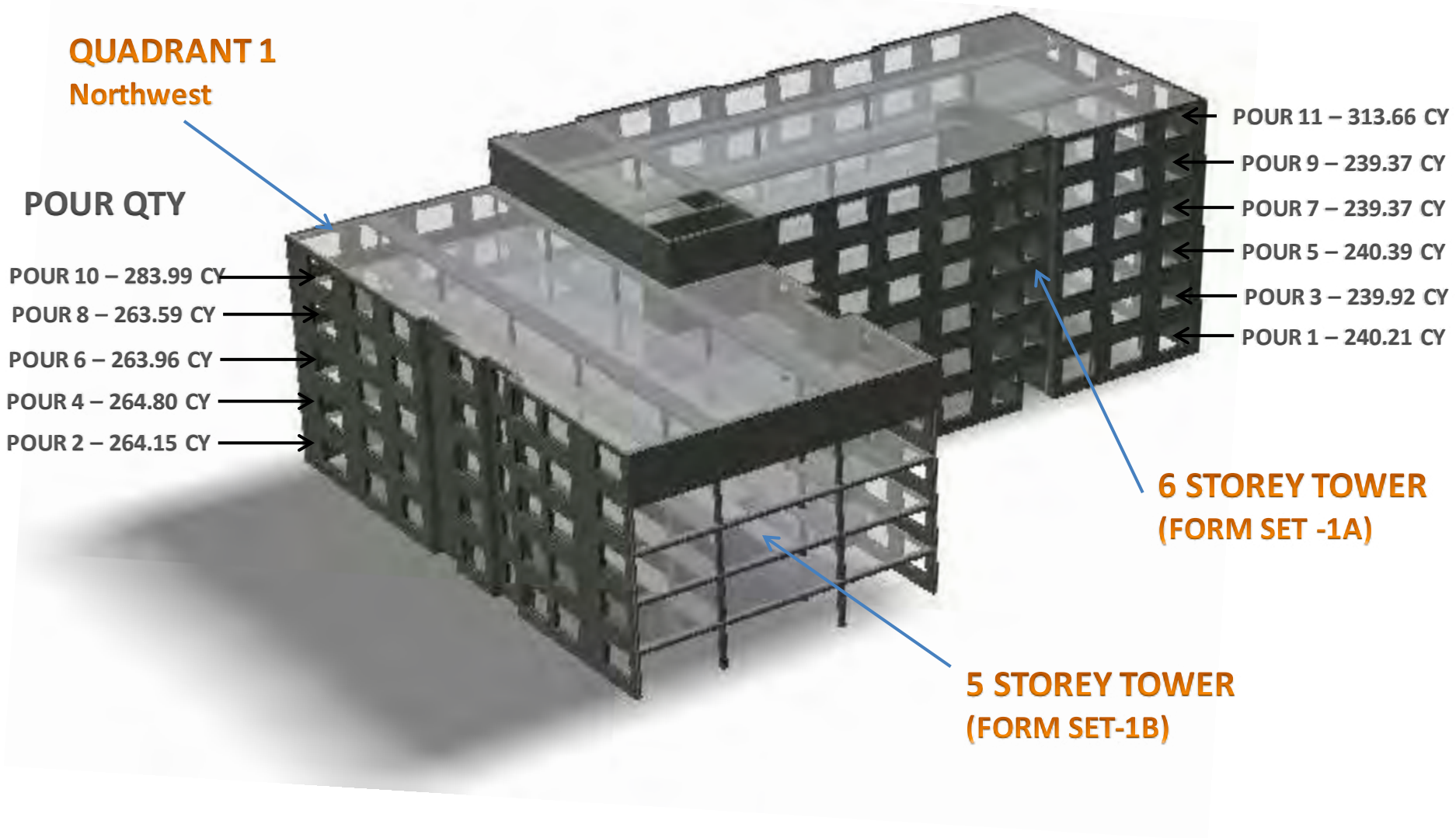


5 STOREY TOWER
(FORM SET-1B)

POUR 2 – 264.15 Cubic Yards

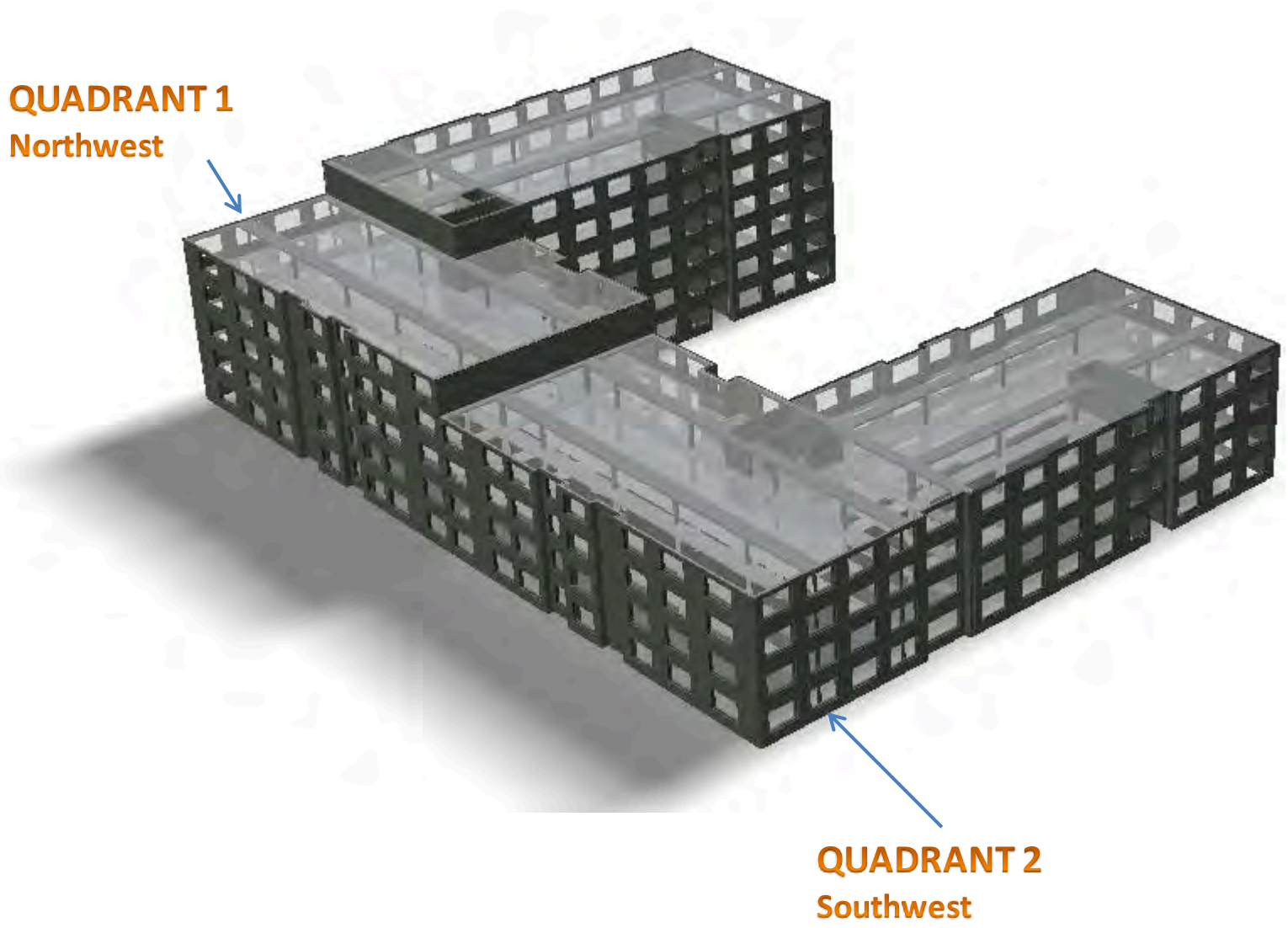
QUARTER COMPLETE – 1 QUADRANT

ARNOLD DEVELOPMENT



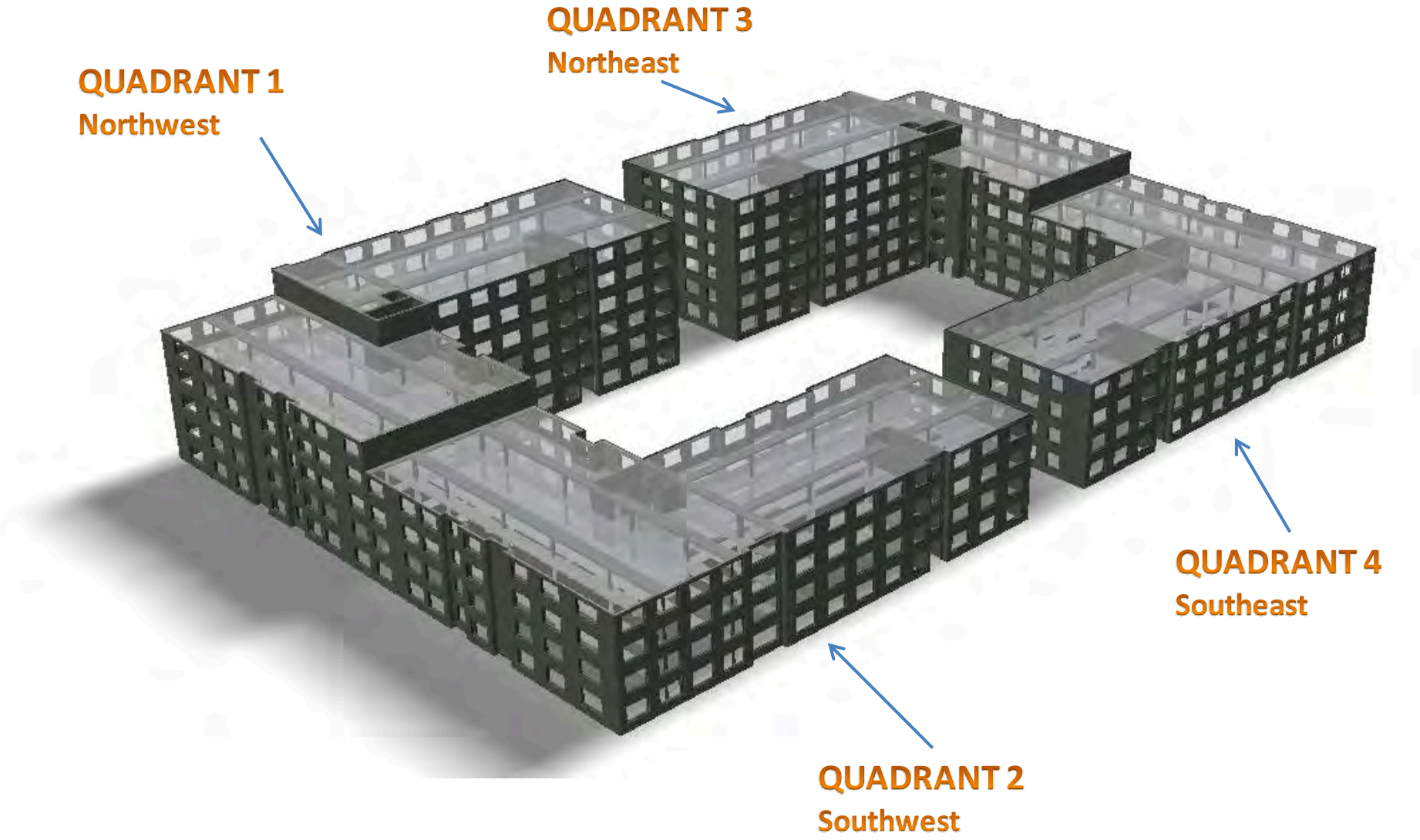
HALF COMPLEX – 2 QUADRANTS

ad ARNOLD DEVELOPMENT



ENTIRE COMPLEX – 4 QUADRANTS

ad ARNOLD DEVELOPMENT



Lean Construction & IPD

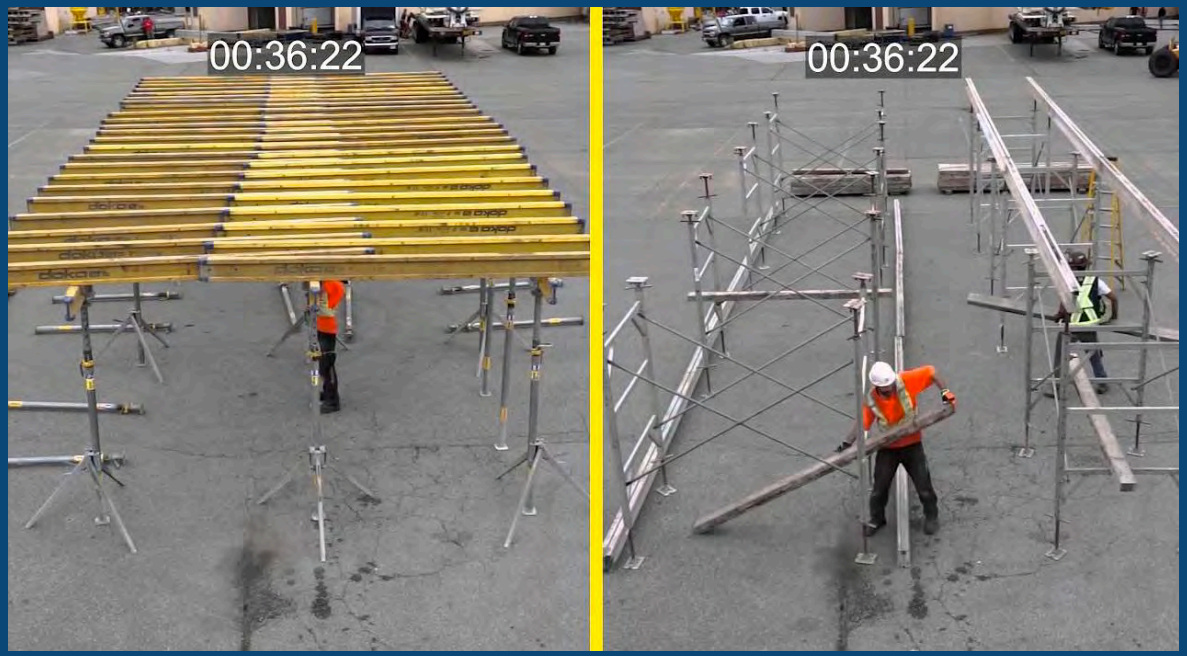
Between 50% and 75% of on-site labor does not produce value.

Lean Construction and Integrated Project Delivery (IPD) lowers waste by 10%-40%

Best Practices Key to Keeping Costs in Line:

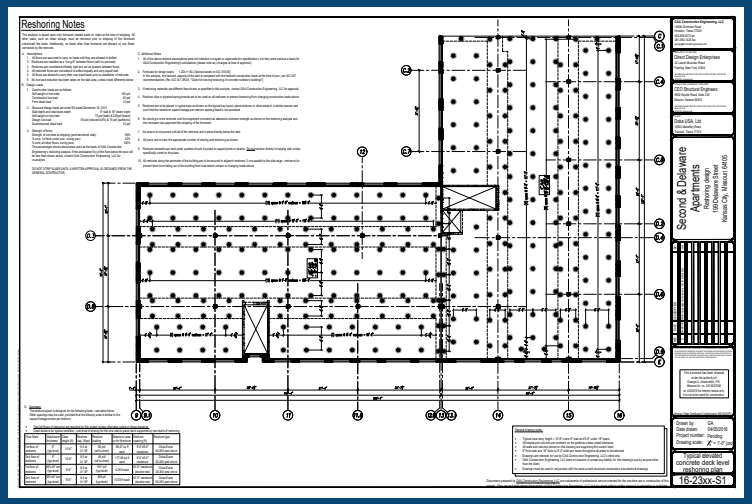
- Last Planner System
- Honored Commitments
- 6 Week Look Aheads
- Planning for Flow

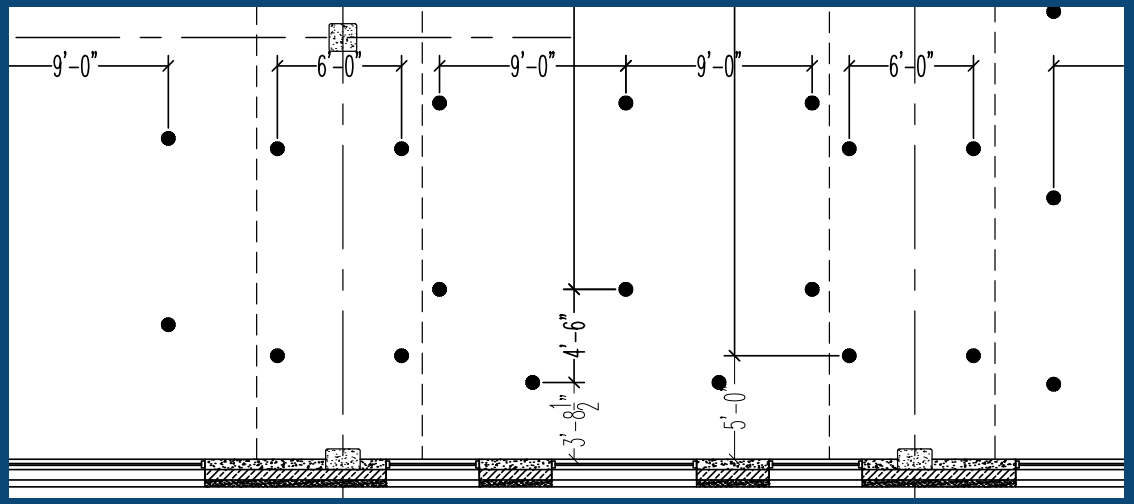
Efficient Systems (ie. Doka)

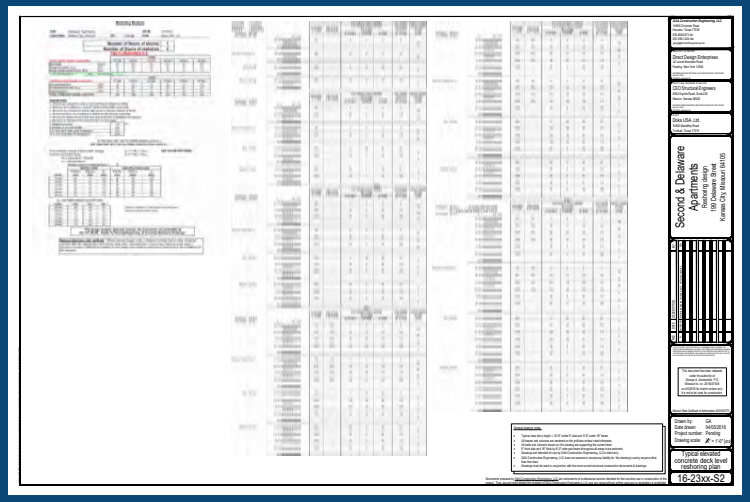


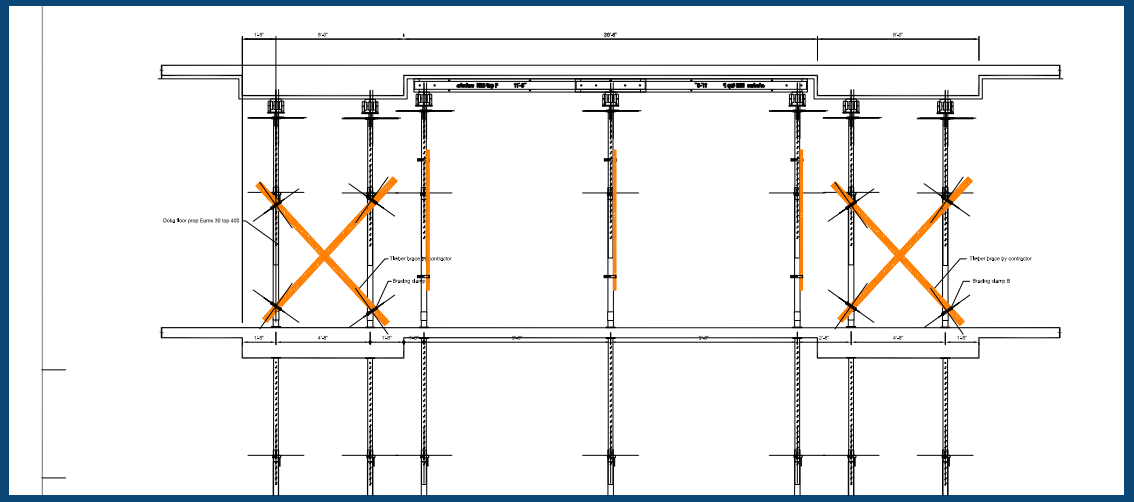
- Fewer shore posts
- No nails
- Less labor

Efficient Systems (ie. Doka)

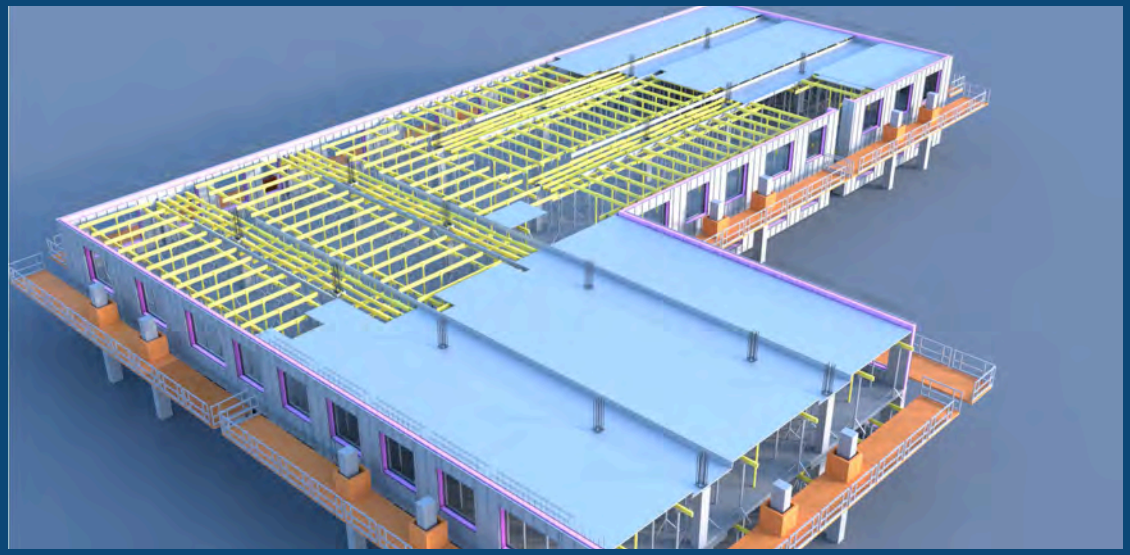








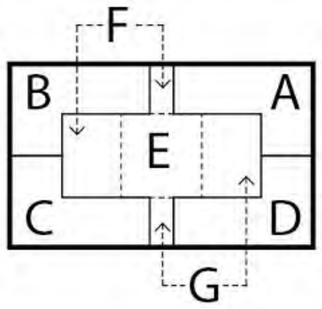
EZ Scaffold



Synchro Modeling

- Placed based scheduling
- Optimize crew size
- Identify constraints
- Communicate expectations
- Best practive in industry

Second & Delaware
IPD Phase Planning A3
by **Calayde Davey** cdavey@arnoldidevelopmentgroup.com

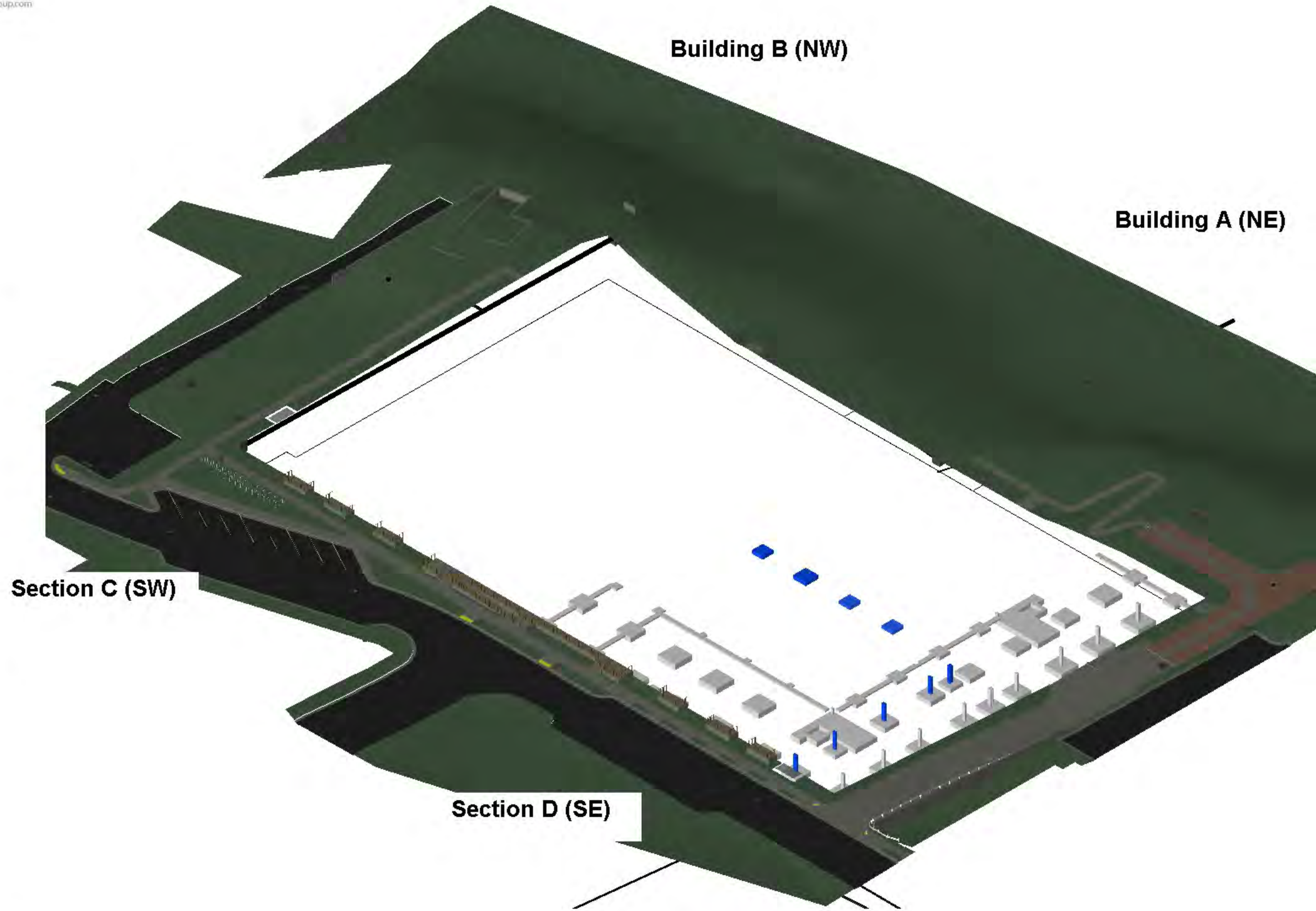


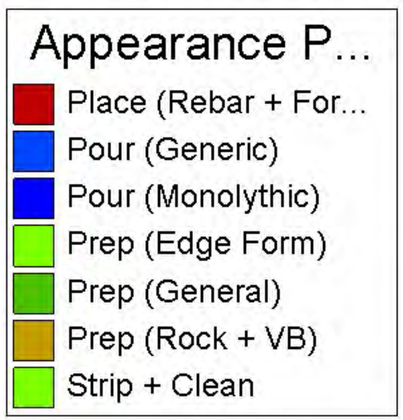
7/1/2016

Week: 4

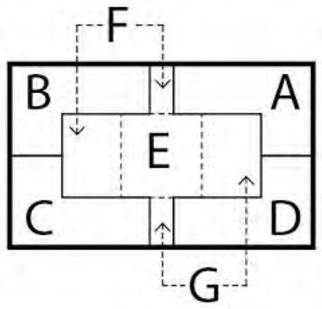
Daily Activities

Place + Pour Columns D (West)
Elevator Pitt Sleeves D
Install (B)ranch Lines (A)
Column Pads G (South Ramp)





Second & Delaware
IPD Phase Planning A3
by **Calayde Davey** cdavey@arnoldidevelopmentgroup.com

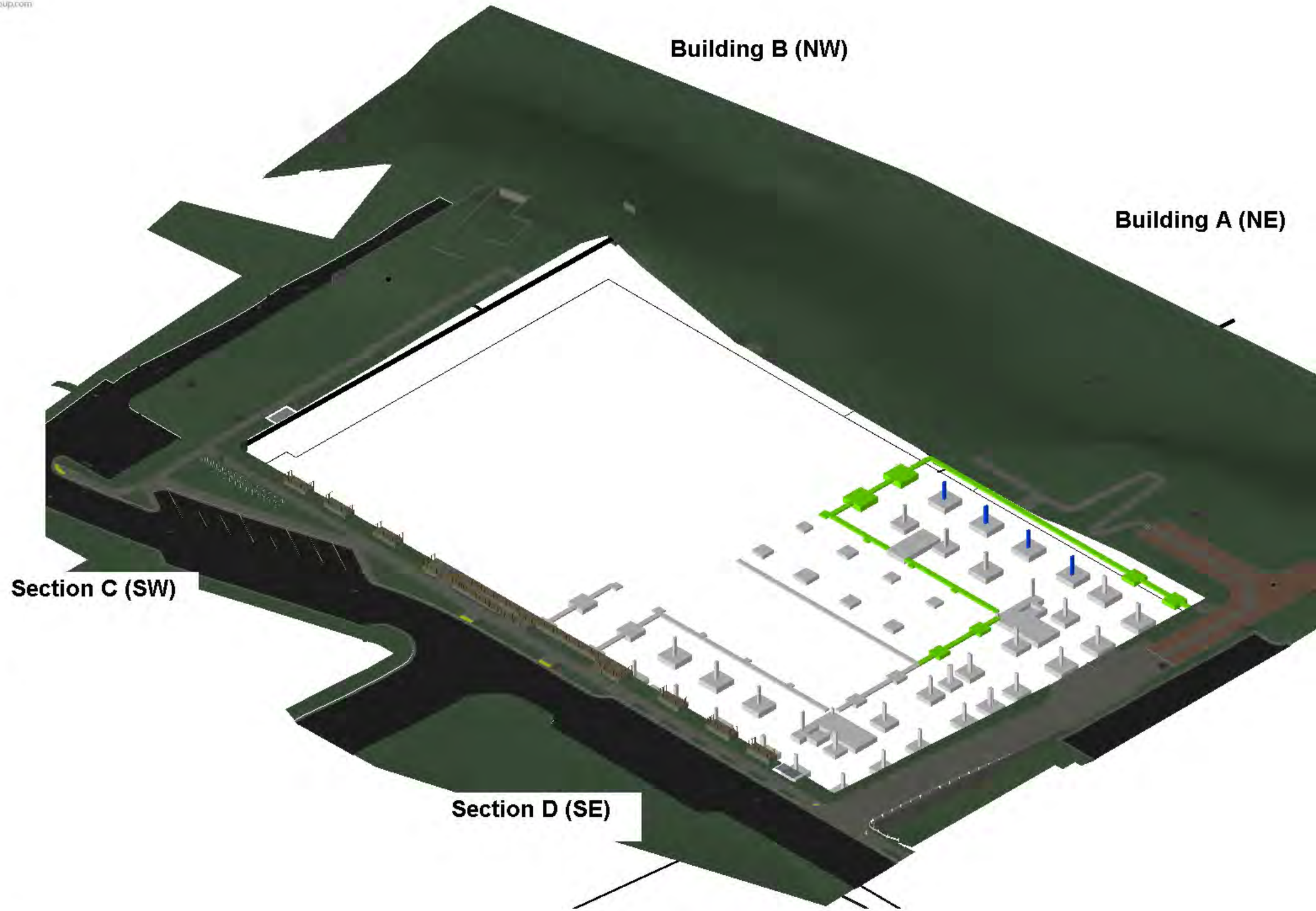


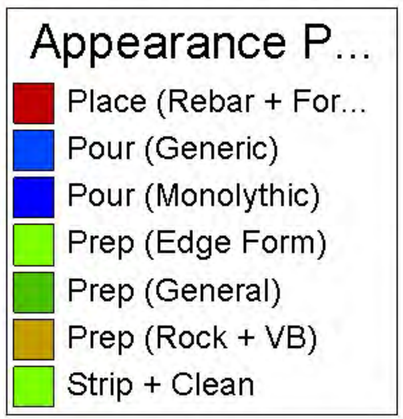
7/8/2016

Week: 5

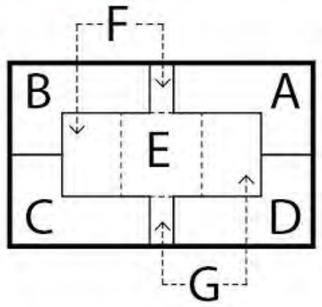
Daily Activities

Install Lateral (B)ranch Lines / Vent D
Place + Pour Columns A (North) Edge Form (A)
Under Slab Water G)round Conduit (A)
Under Slab (B)ranch Circuit (A)
Strip Footing C (West)





Second & Delaware
IPD Phase Planning A3
by **Calayde Davey** cdavey@arnoldidevelopmentgroup.com

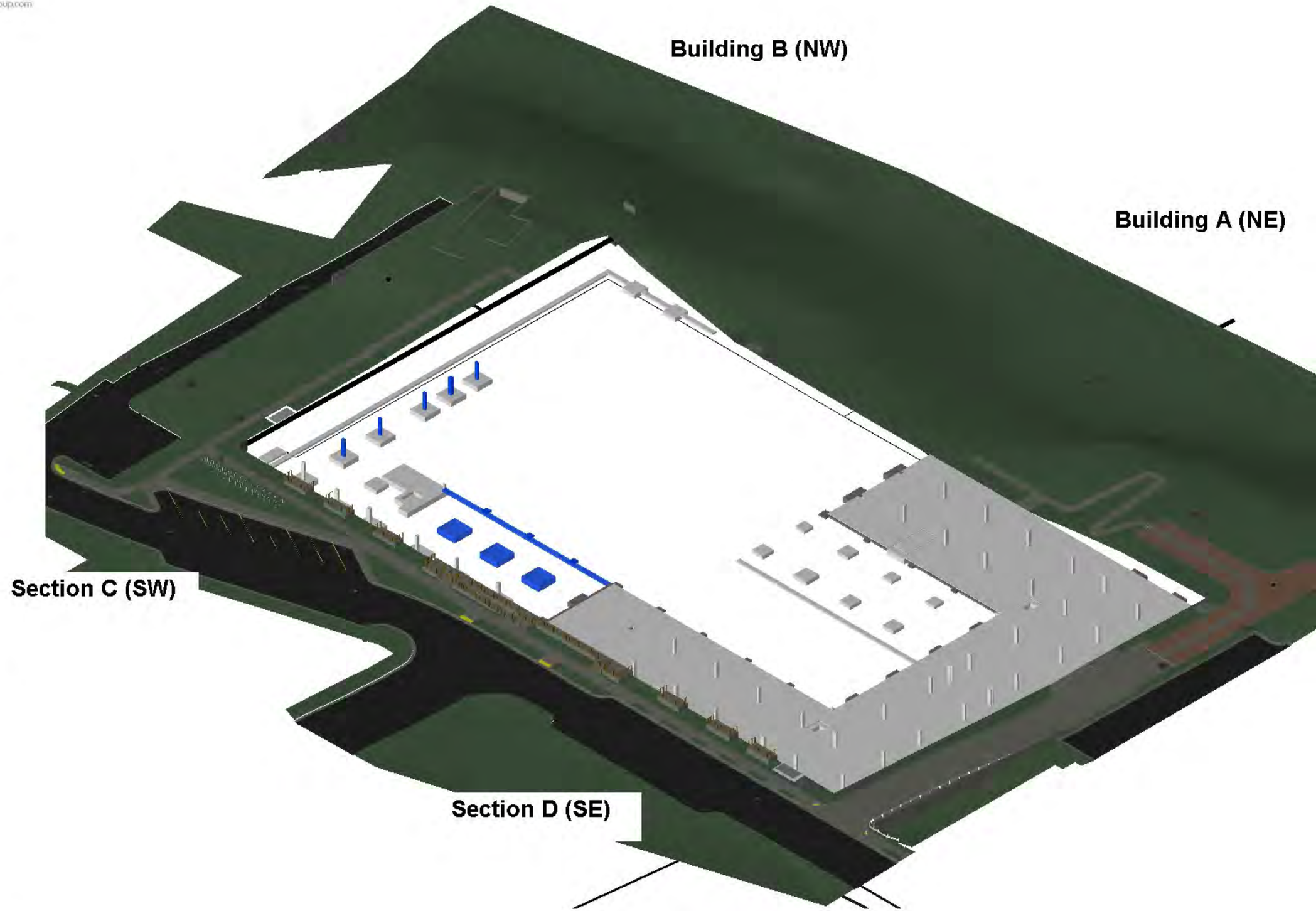


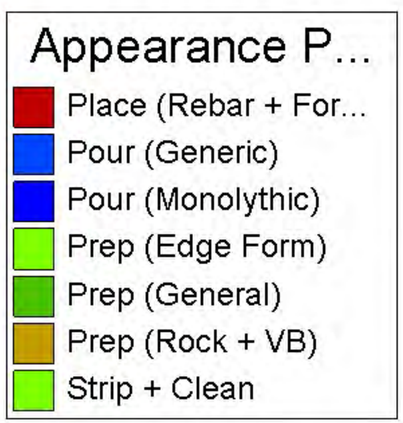
7/15/2016

Week: 6

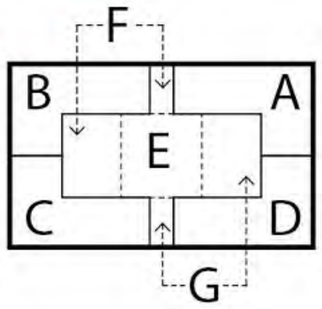
Daily Activities

Place + Pour Columns
Column Pads C (North)
Strip Footing C (North)





Second & Delaware
IPD Phase Planning A3
by **Calayde Davey** cdavey@arnoldidevelopmentgroup.com

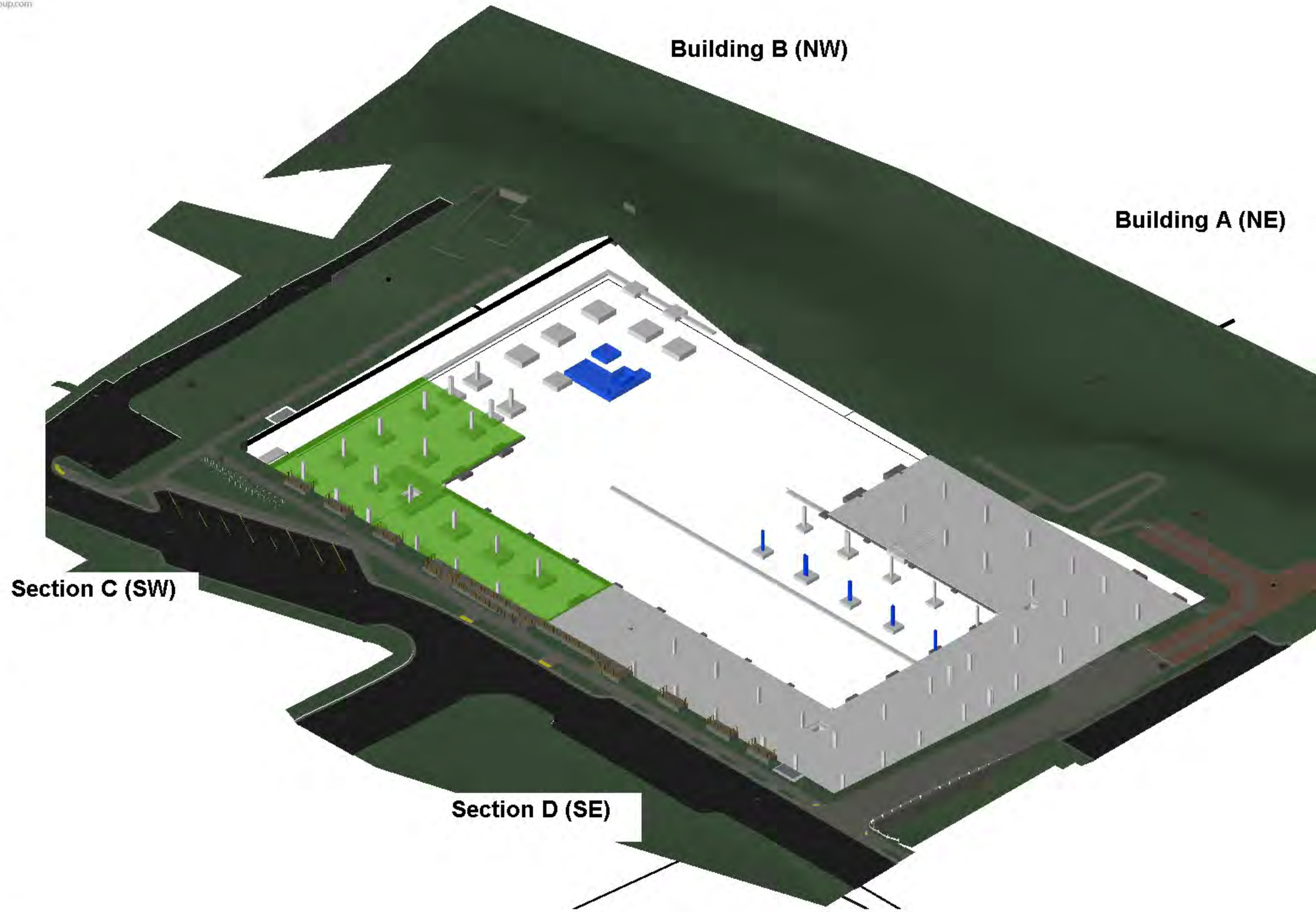


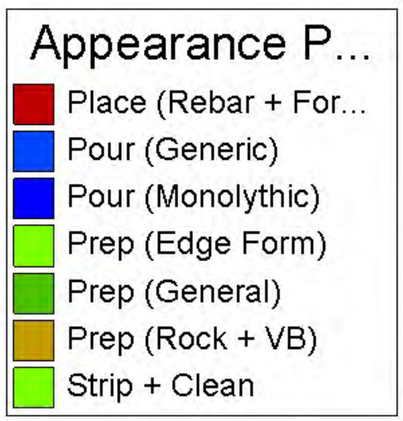
7/22/2016

Week: 7

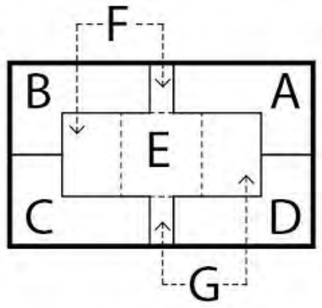
Daily Activities

Form Prep C
Elevator Pad B + Pad
Ramp Columns G (South)





Second & Delaware
IPD Phase Planning A3
by **Calayde Davey** cdavey@arnoldidevelopmentgroup.com

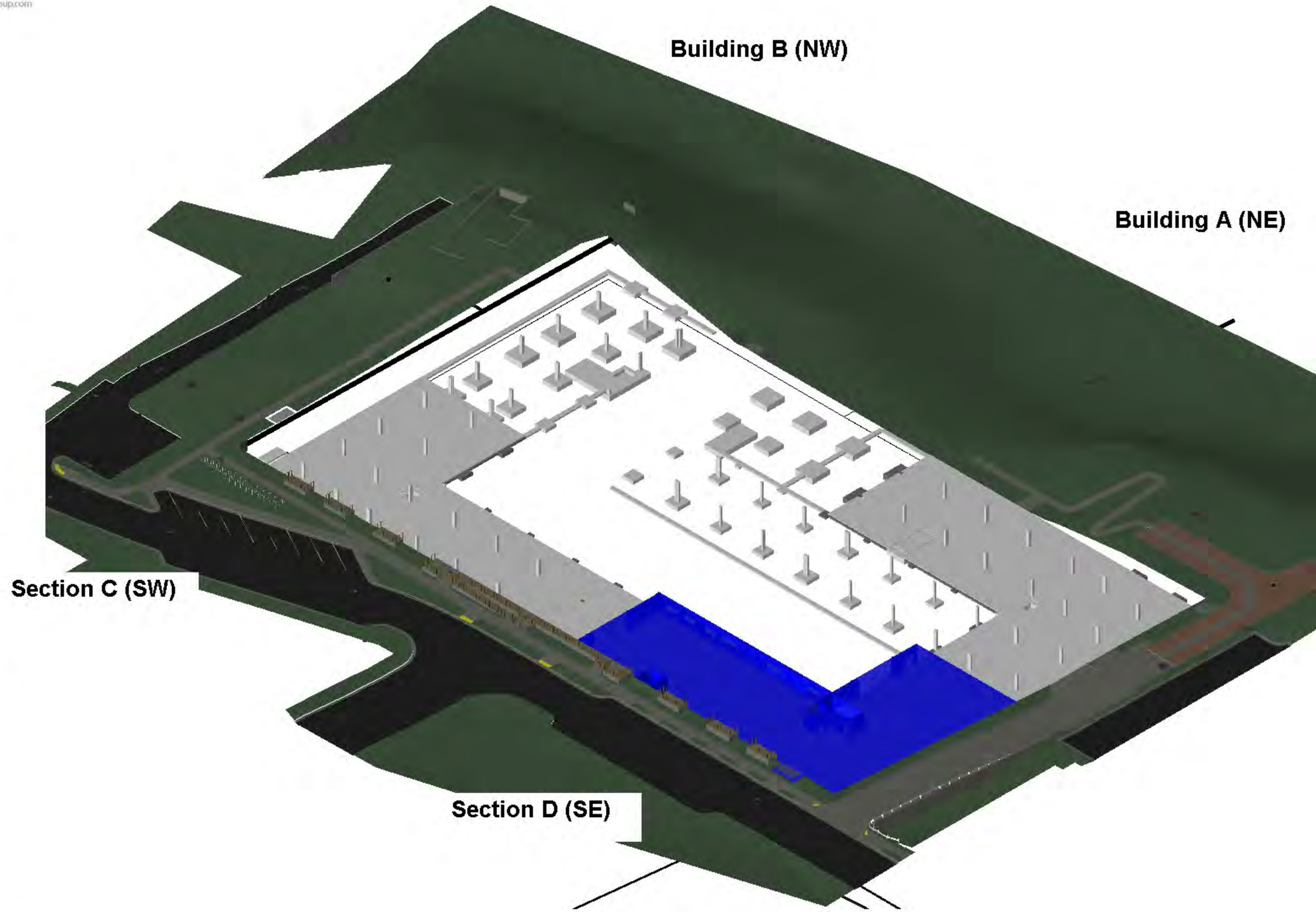


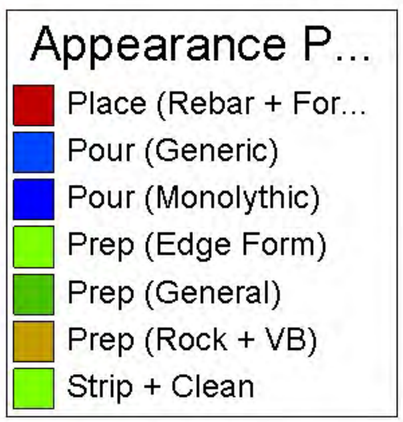
7/29/2016

Week: 8

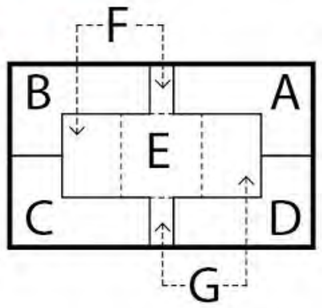
Daily Activities

Pour Walls + Slab D





Second & Delaware
IPD Phase Planning A3
by **Calayde Davey** cdavey@arnoldidevelopmentgroup.com

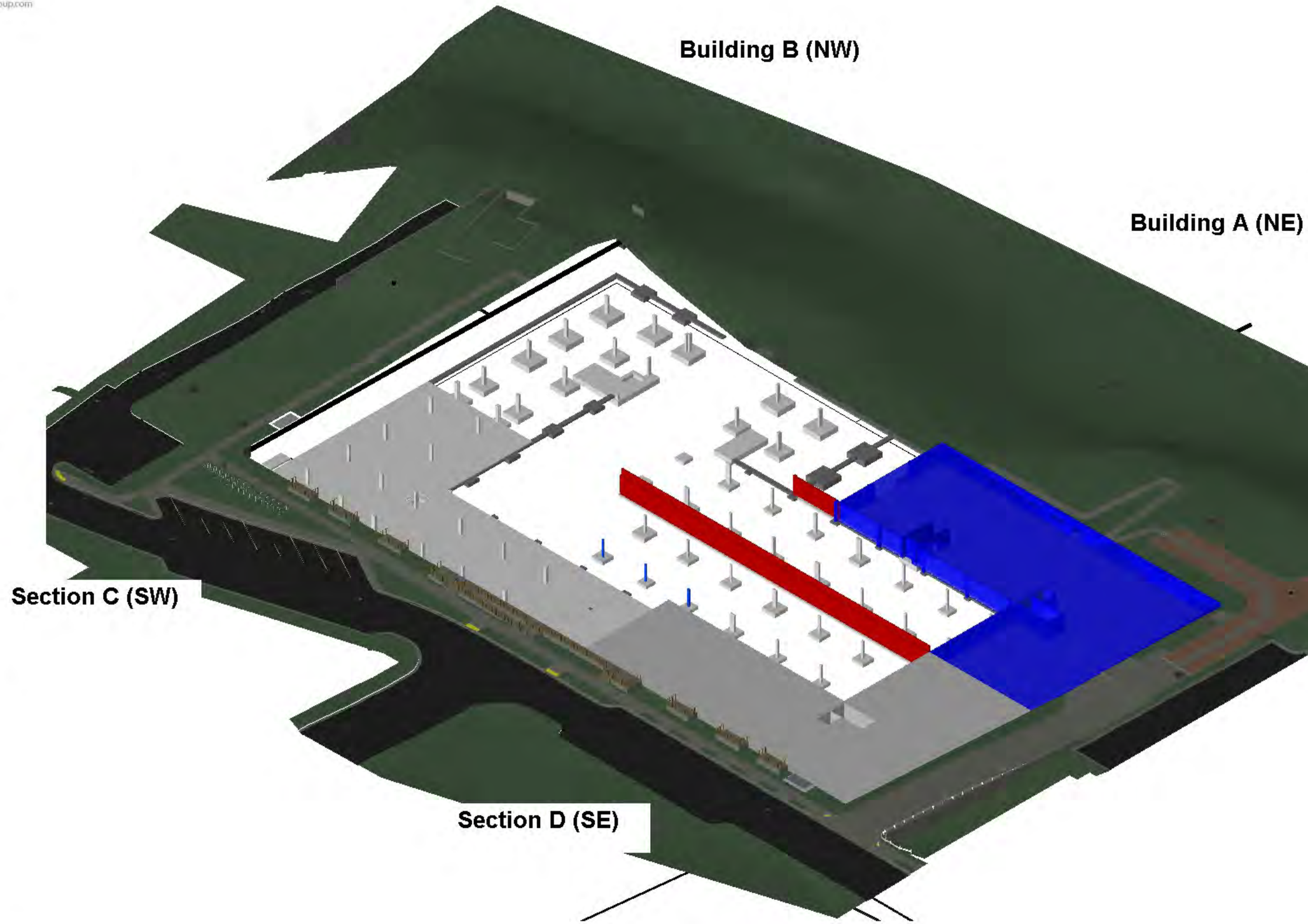


8/5/2016

Week: 9

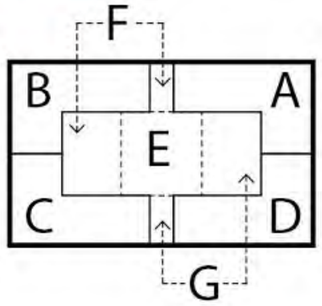
Daily Activities

Backfill South East
Set Wall Forms for Ramp
Place + Pour Columns E (South)
Pour Walls + Slab (A)



Appearance P...
- Place (Rebar + For...
- Pour (Generic)
- Pour (Monolythic)
- Prep (Edge Form)
- Prep (General)
- Prep (Rock + VB)
- Strip + Clean

Second & Delaware
IPD Phase Planning A3
by **Calayde Davey** cdavey@arnoldevelopmentgroup.com

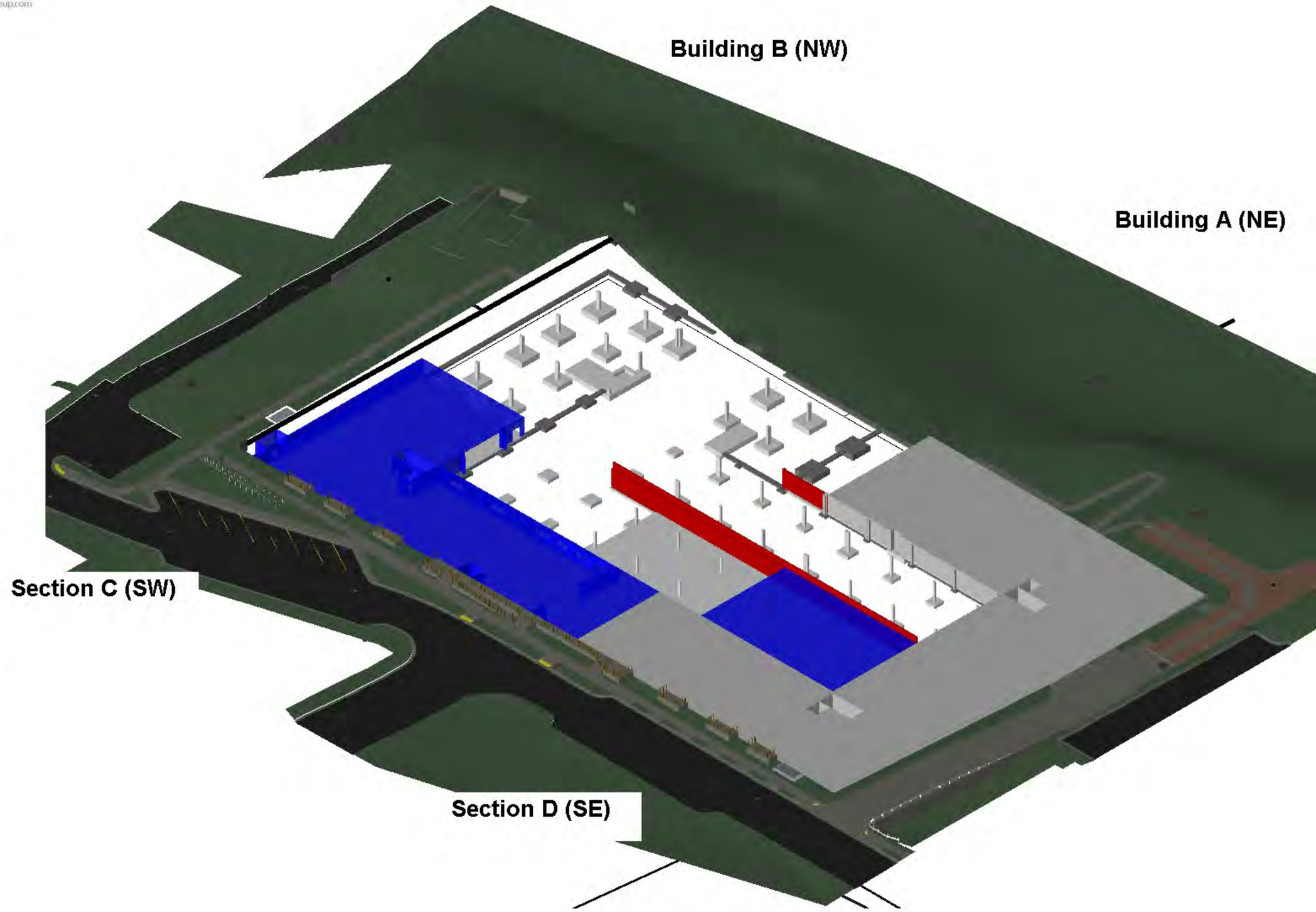


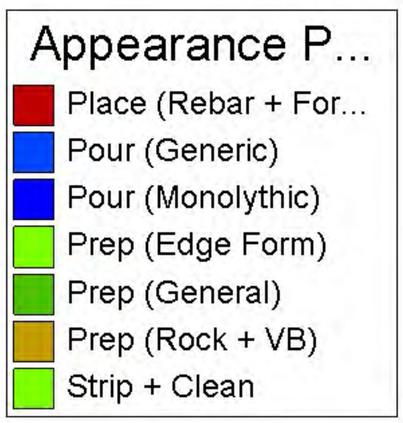
8/12/2016

Week: 10

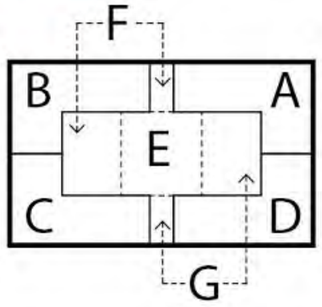
Daily Activities

Backfill North East
Pour Walls + Slab C
Pour Slab G (South)
Pour Slab G





Second & Delaware
IPD Phase Planning A3
by **Calayde Davey** cdavey@arnoldidevelopmentgroup.com

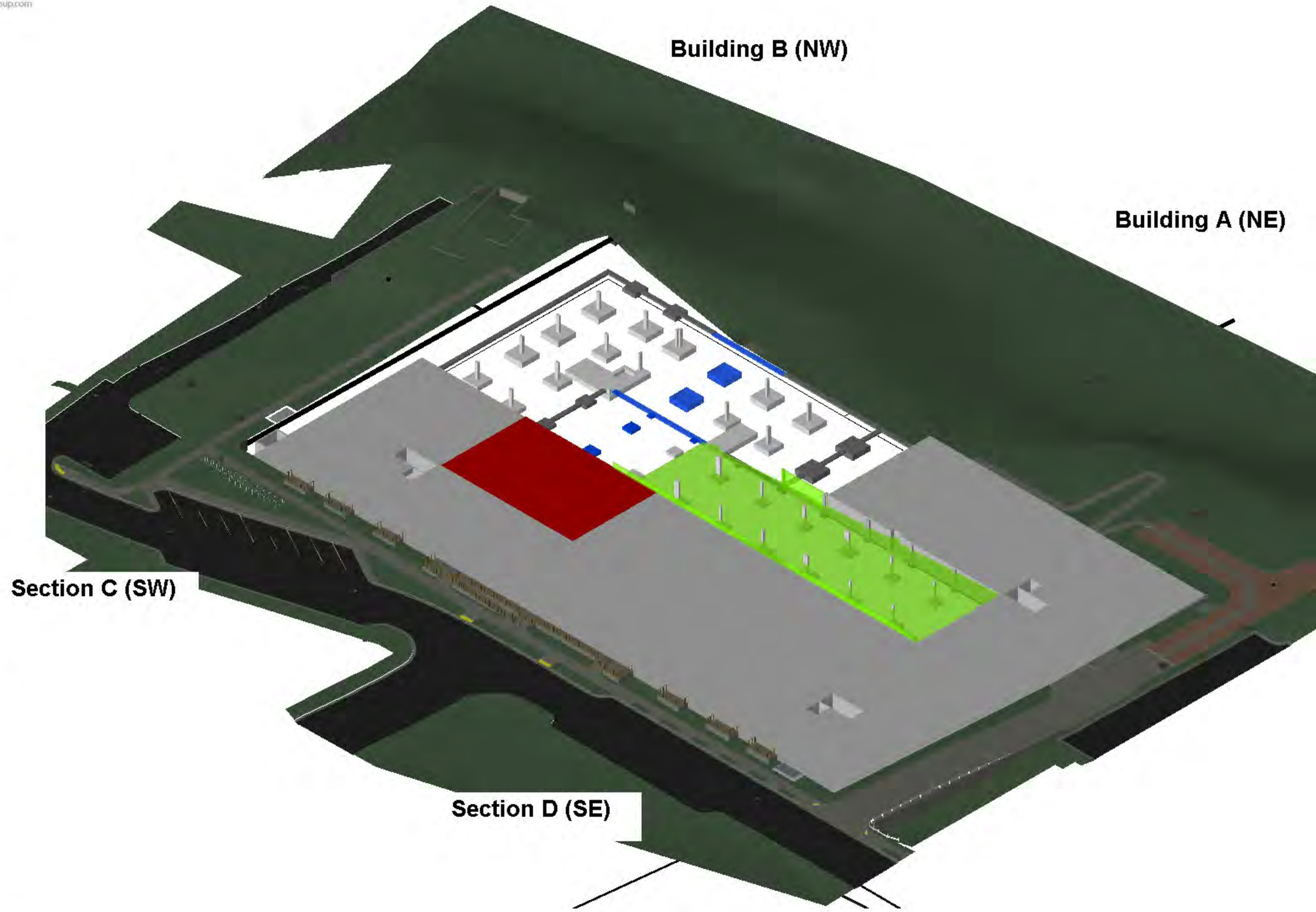


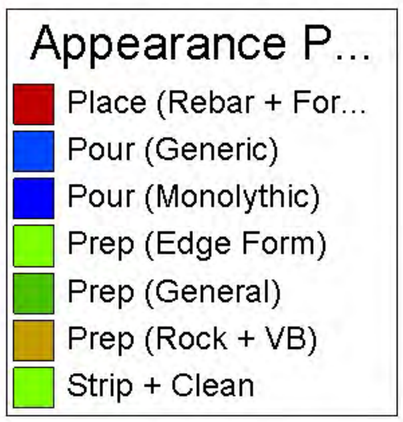
8/19/2016

Week: 11

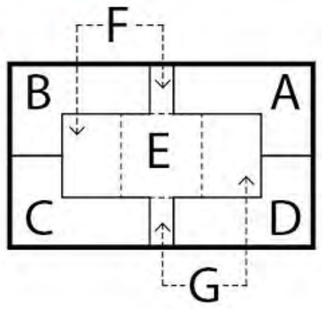
Daily Activities

Backfill South West
Strip Footing B (North)
Column Pads B (North)
Strip Footing B (South)
Strip Ramp
Column Pads F (North)
Place Rebar + Form Slab F (South)





Second & Delaware
IPD Phase Planning A3
by **Calayde Davey** cdavey@arnoldidevelopmentgroup.com

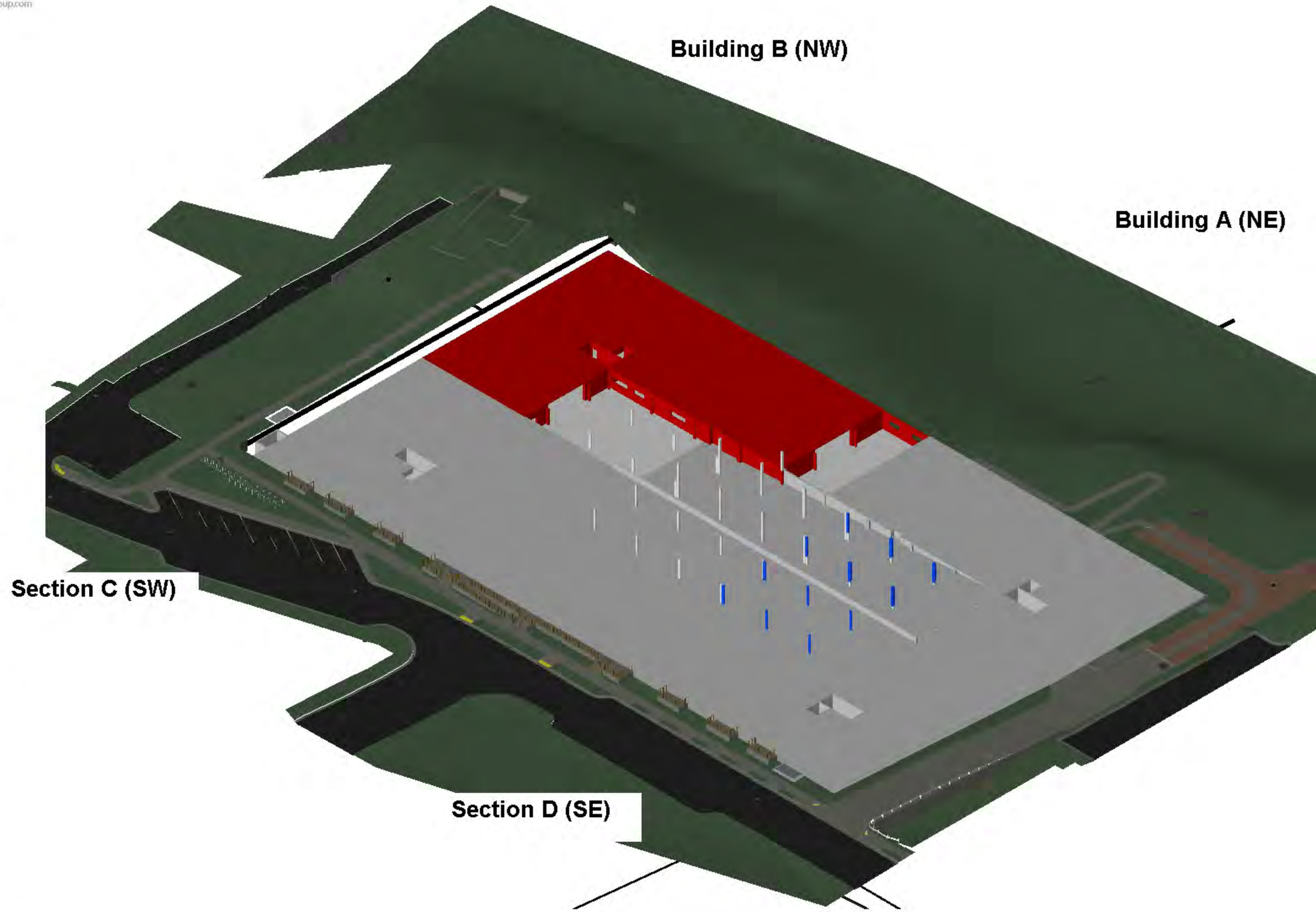


8/26/2016

Week: 12

Daily Activities

Place Rebar + Forms Wall B
Pour Columns G

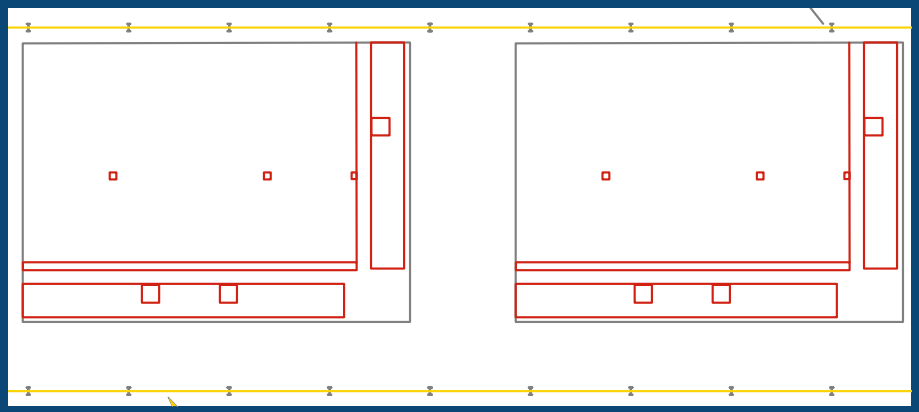


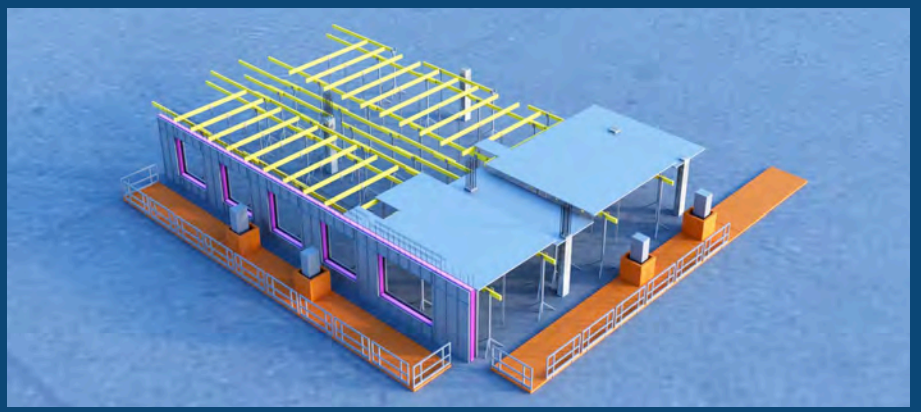
Appearance P...
- Place (Rebar + For...
- Pour (Generic)
- Pour (Monolythic)
- Prep (Edge Form)
- Prep (General)
- Prep (Rock + VB)
- Strip + Clean

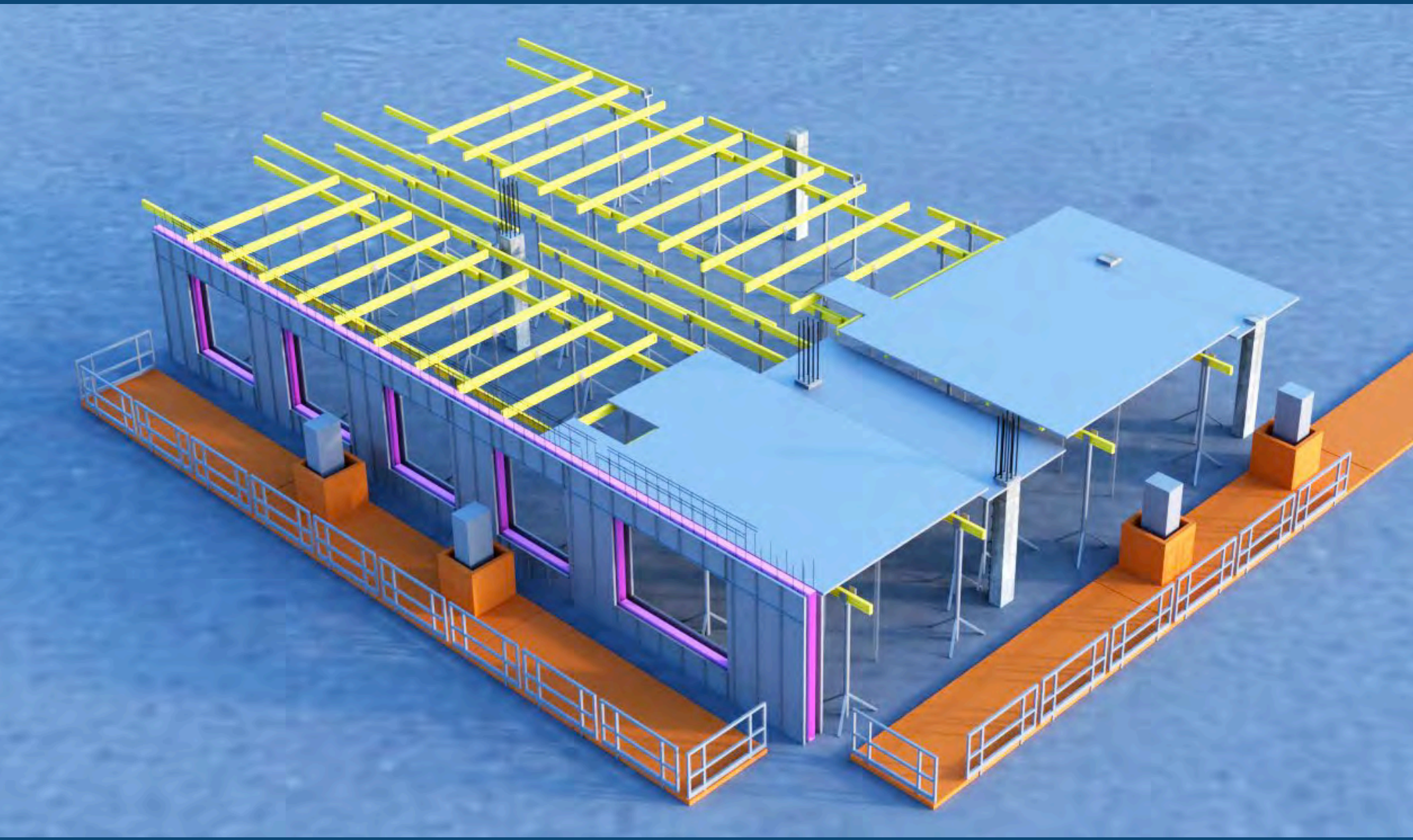
Continuous Improvement

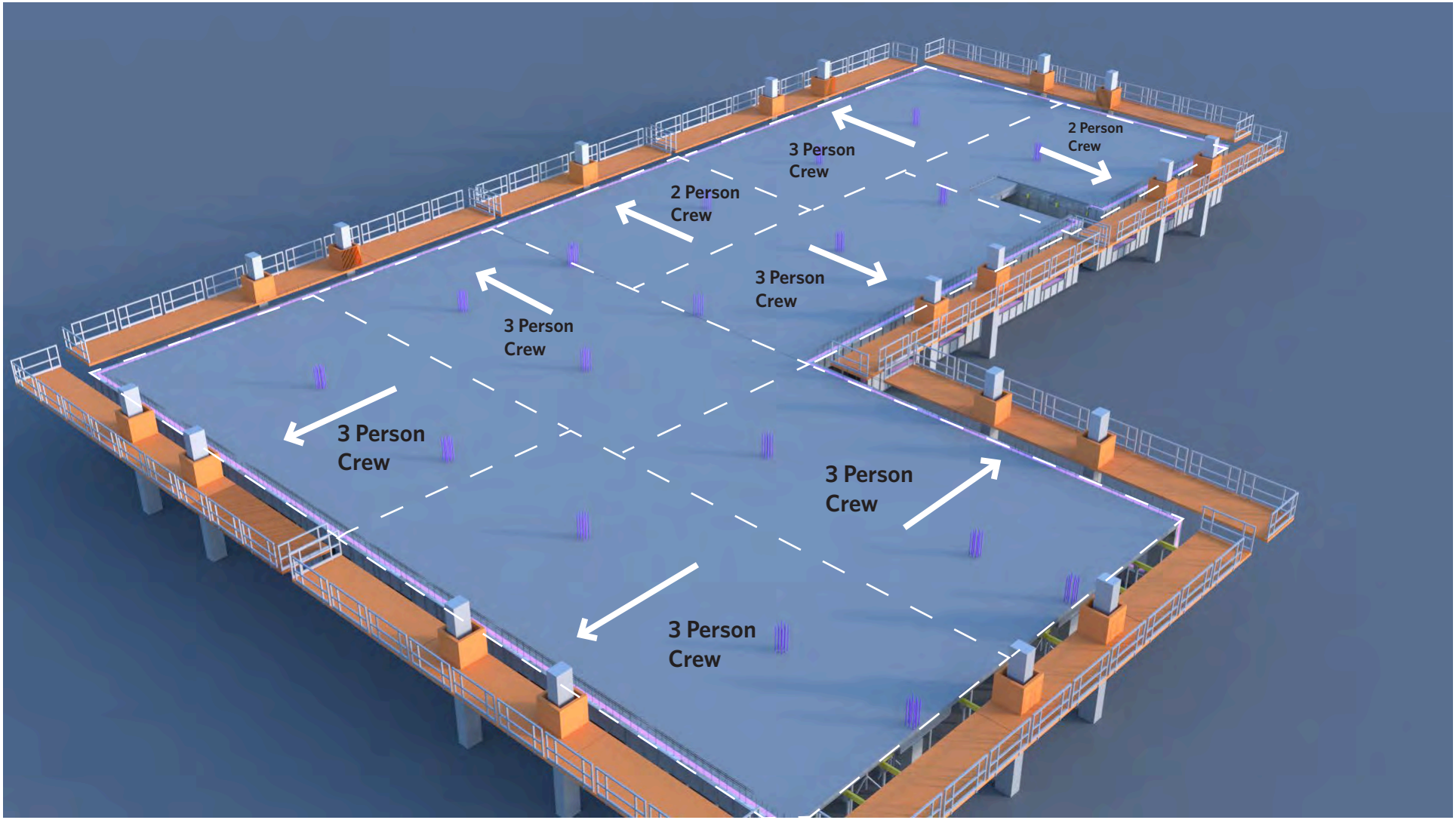
B) Training workers on the benefits of standardized work practices, the continuous improvement of work practices and the negative impact upon the Project of failing to achieve commitments;

C) Using mockups, first run studies, early completion of standard work units, and similar efforts to demonstrate and document agreed-upon levels of quality;







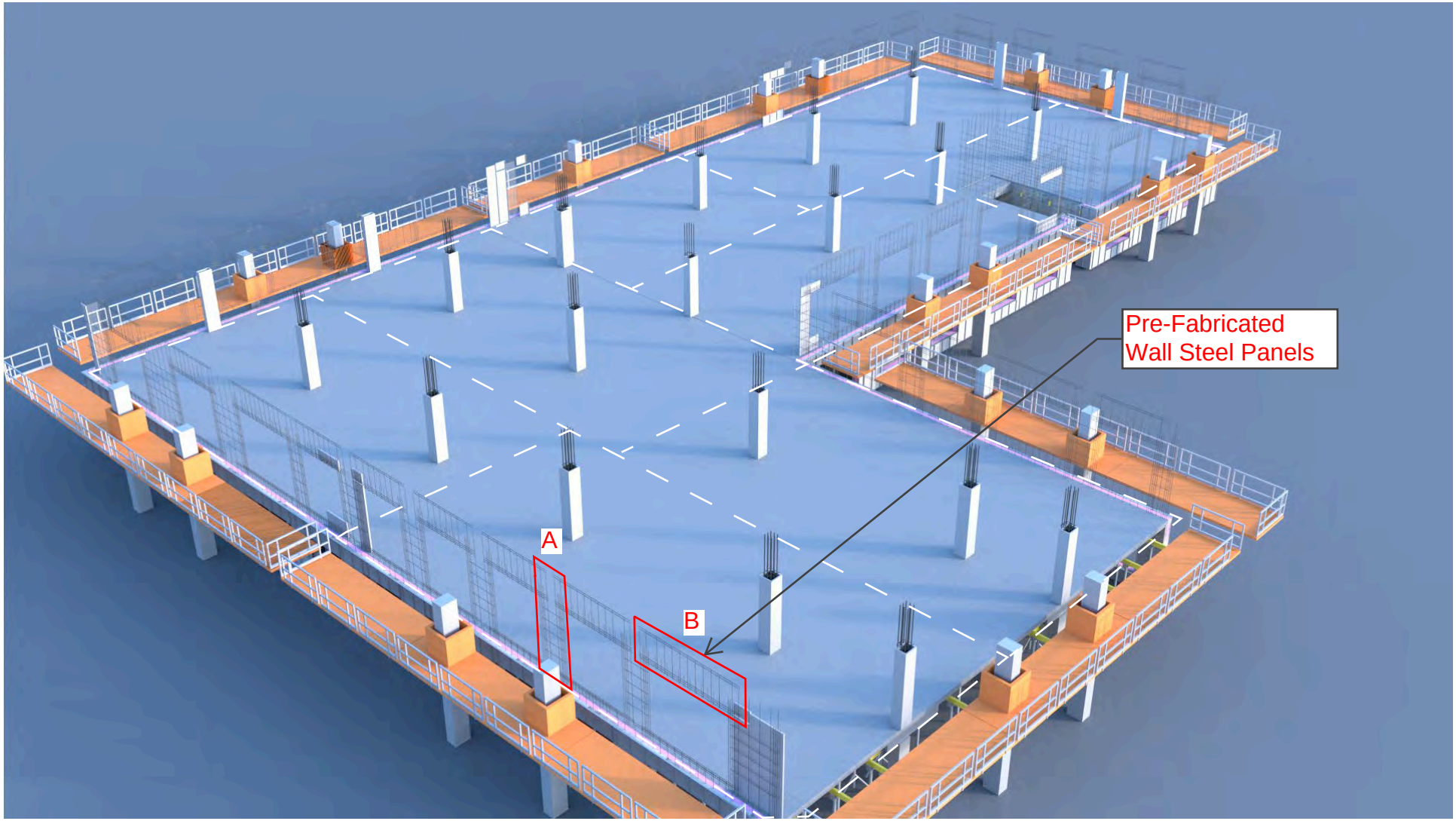


TUESDAY

7:00 AM - 10:00 AM STRIP & CLEAN WALL & COLUMN FORMS ON FLOOR BELOW (22)

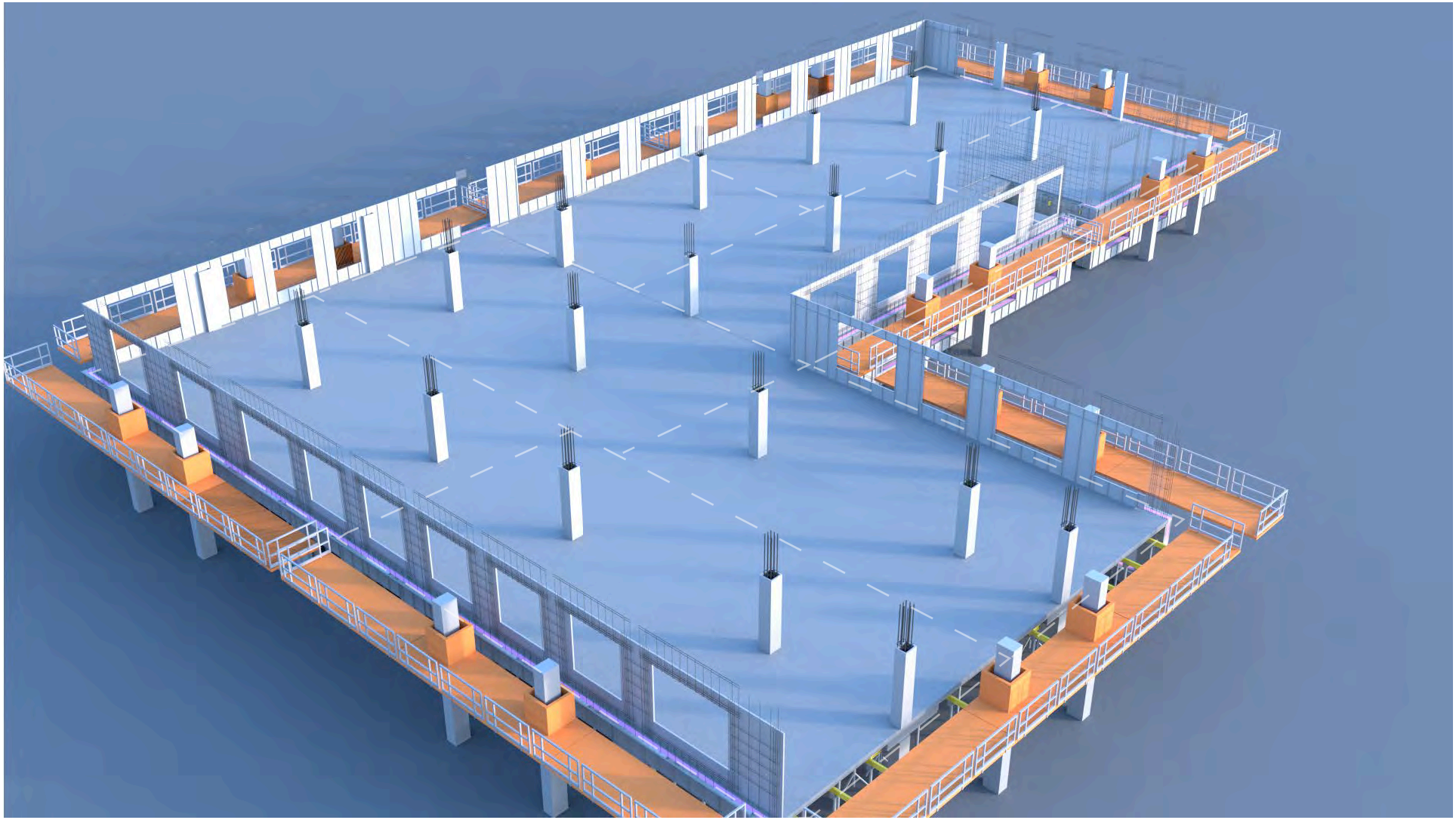
10:00 PM - 2:00 PM SET COLUMN STEEL & COLUMN FORMS (22)

2:00 - 4:00 PM PREP WALL STEEL, FOAM and WALL FORMS ON EZ SCAFFOLD FOR NEXT DAY (22)



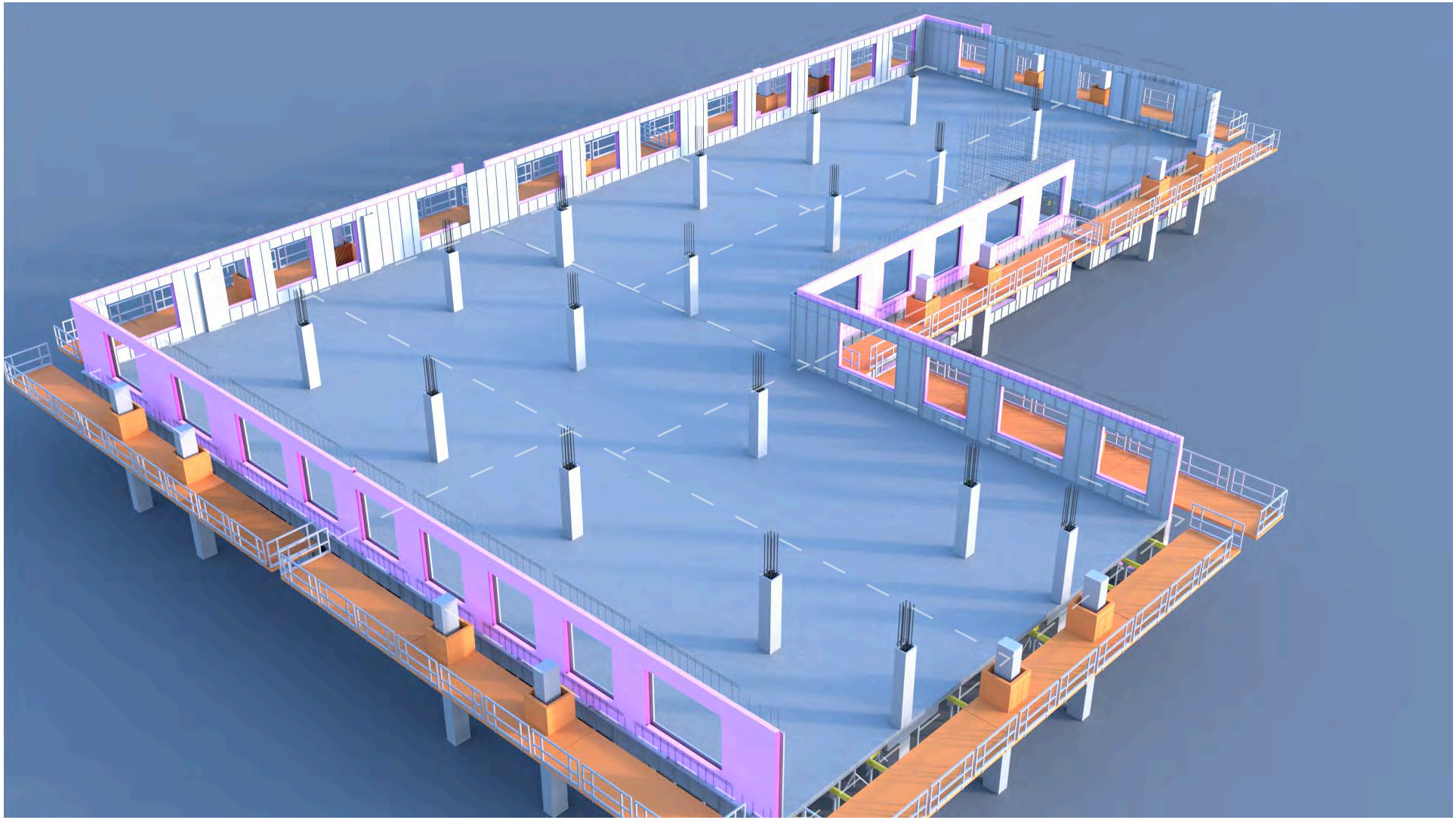
WEDNESDAY

8:00 AM INSTALL PRE-TIED INSIDE WALL STEEL, INSPECT AND BEGIN WALL FORMS (22)



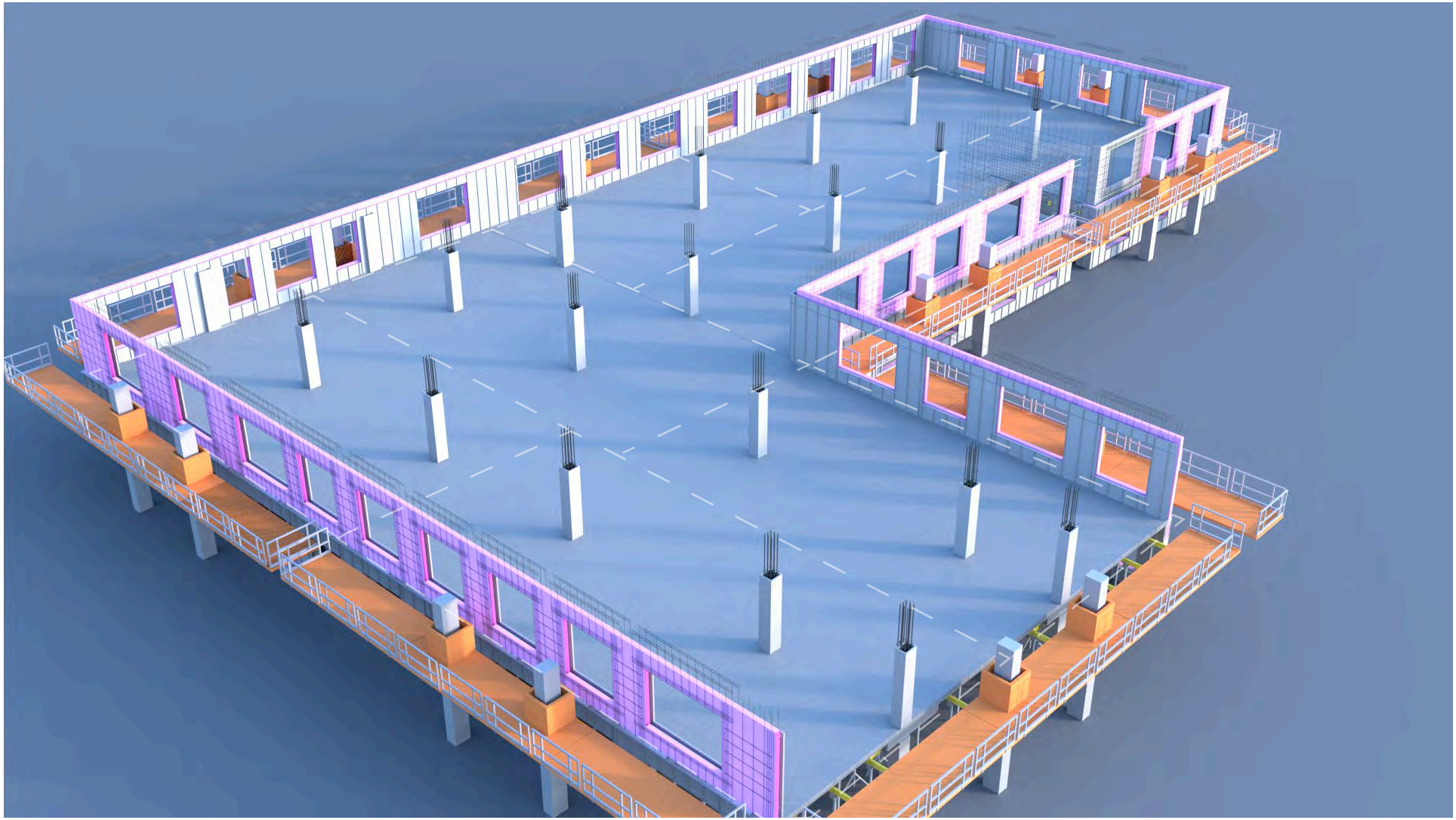
WEDNESDAY

9:00 AM INSIDE WALL FORMS (22)



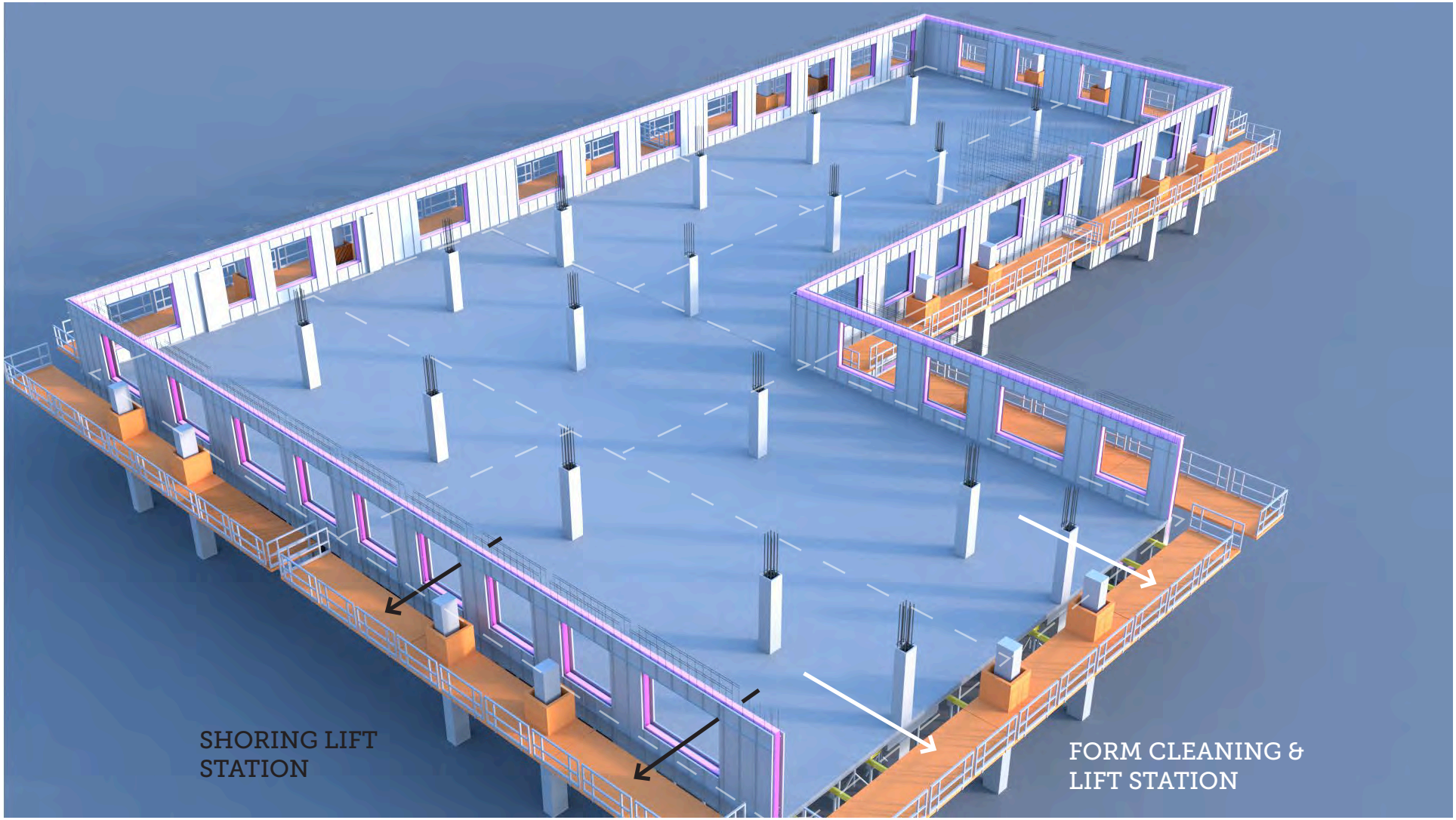
WEDNESDAY

10:00 AM INSERT WALL FOAM and THERMOMASS TIES (22)



WEDNESDAY

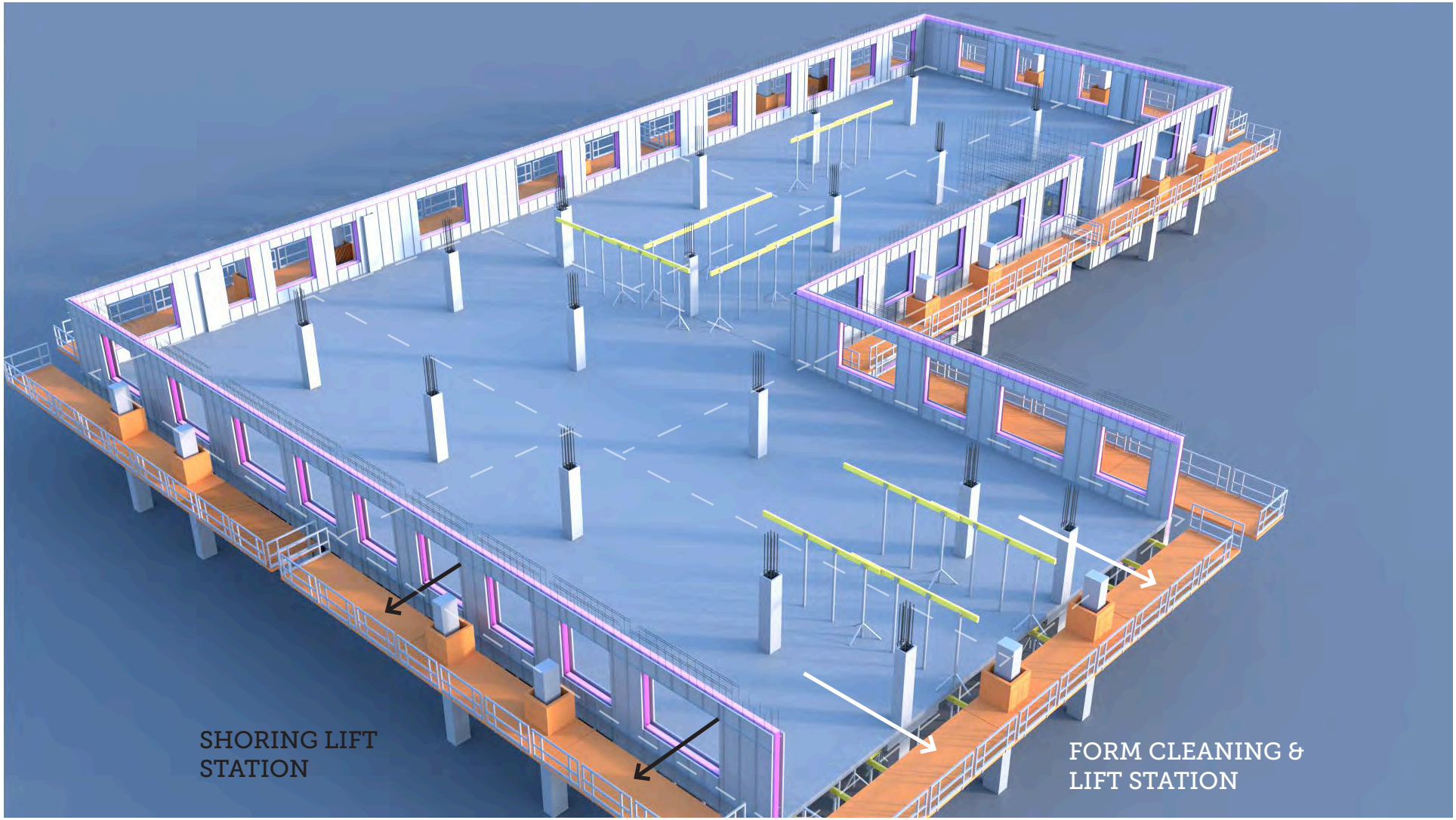
11:00 PM - 12:00 PM INSERT PRE-TIED OUTSIDE WALL STEEL & INSPECT OUTSIDE STEEL (22)



WEDNESDAY

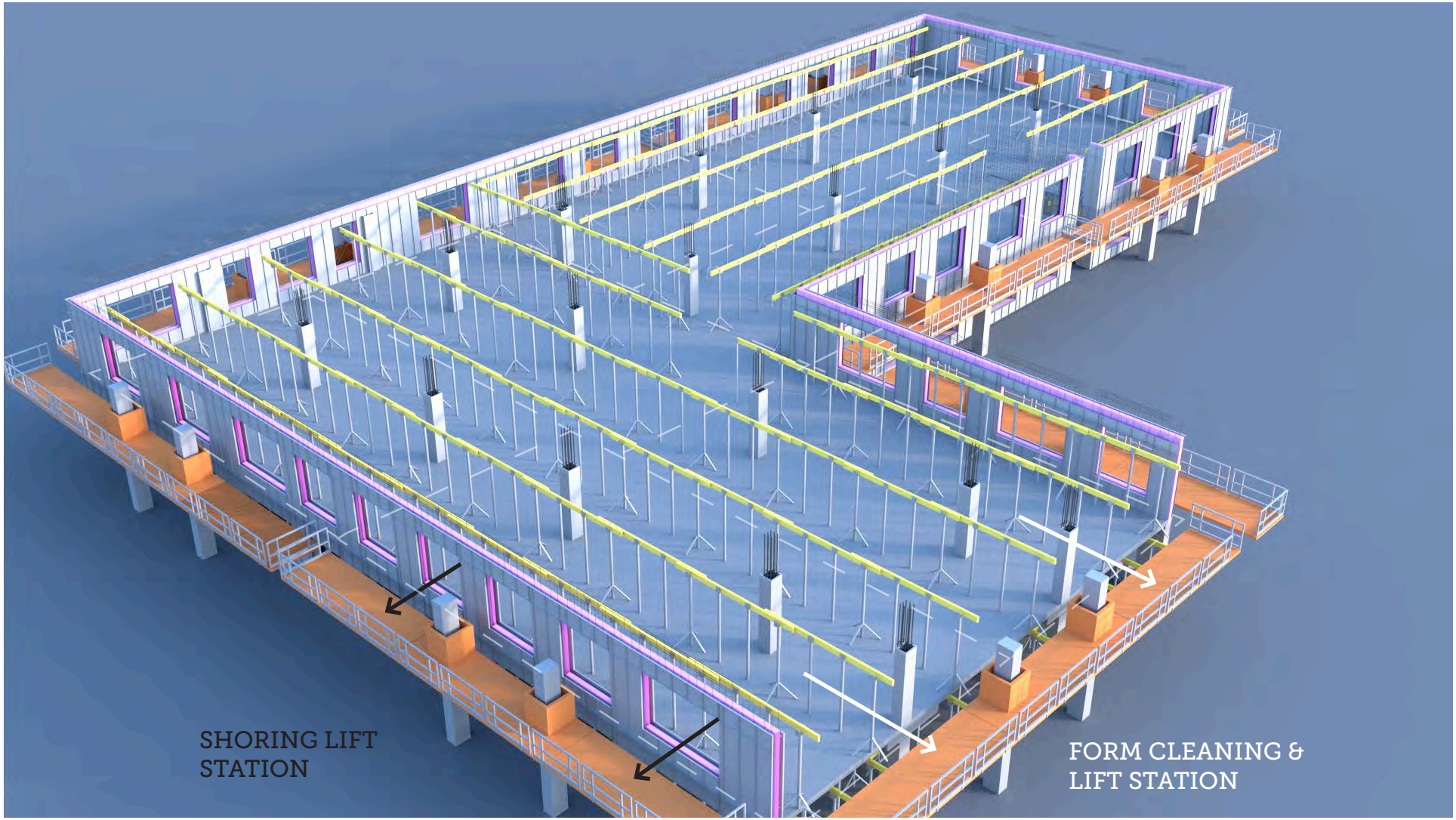
12:30 PM - 2:00 PM SET OUTSIDE WALL and WINDOW FORMS.

2:00 PM - 4:00 PM BREAK DOWN BEAM SHORING & FORMS AND CLEAN BEAM FORMS (22)



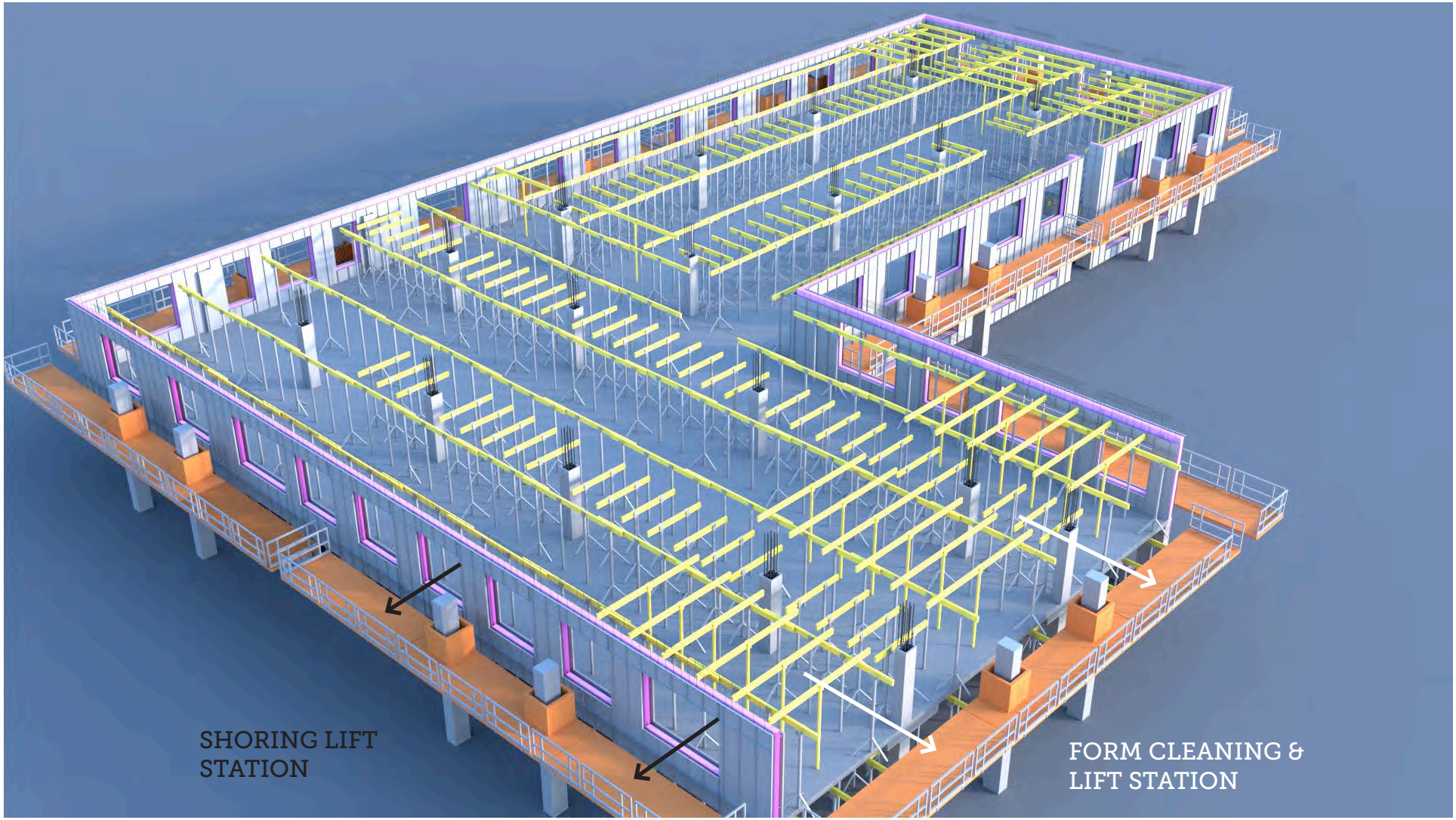
THURSDAY

7:00 AM - 8:00 AM SET UP SHORING & CONTINUE TO TAKE DOWN DECK FORMS ON DECK BELOW (27)



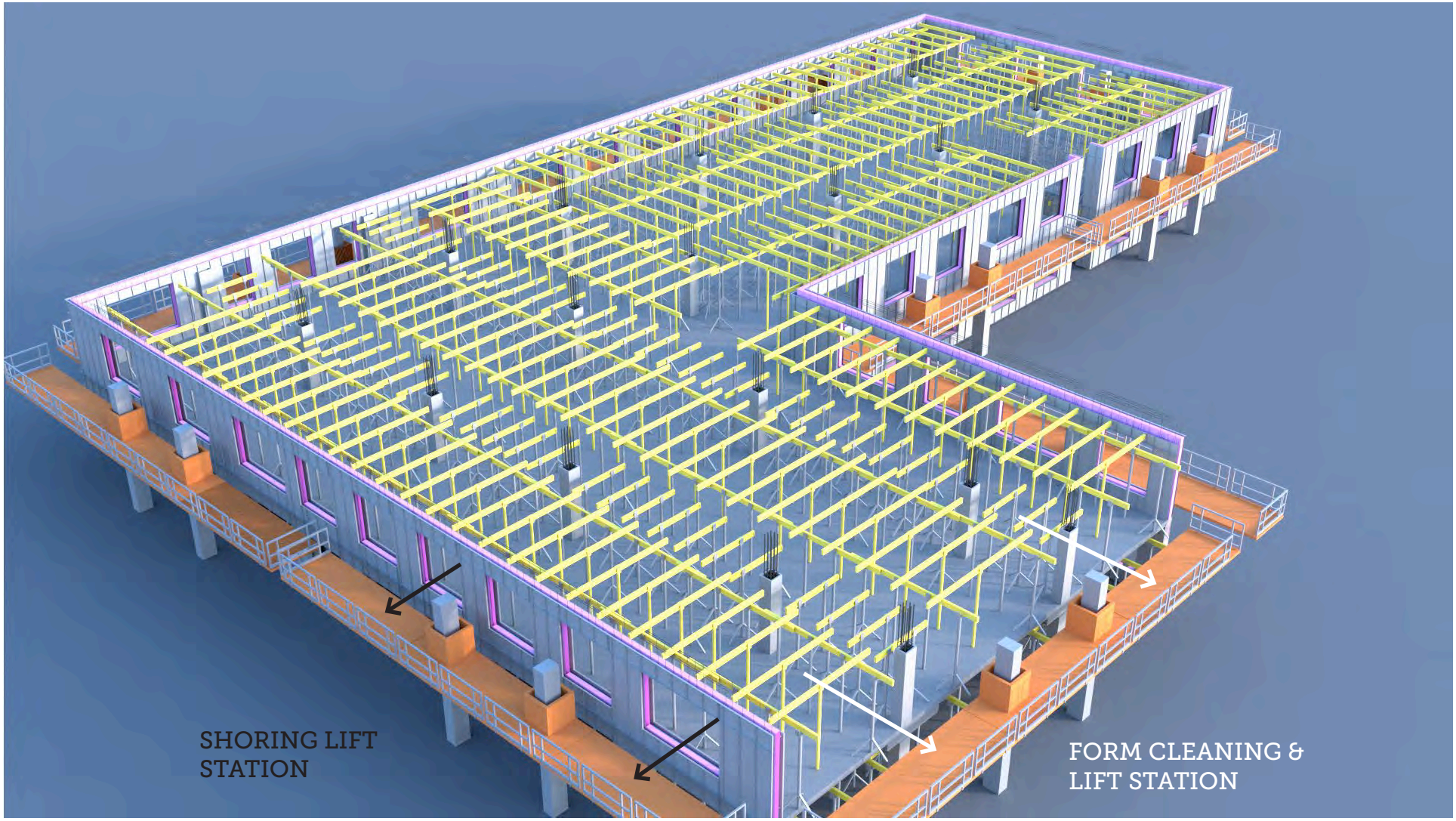
THURSDAY

9:00 AM SET UP SHORING (10) & TAKE DOWN, CLEAN & OIL DECK FORMS ON DECK BELOW (17)



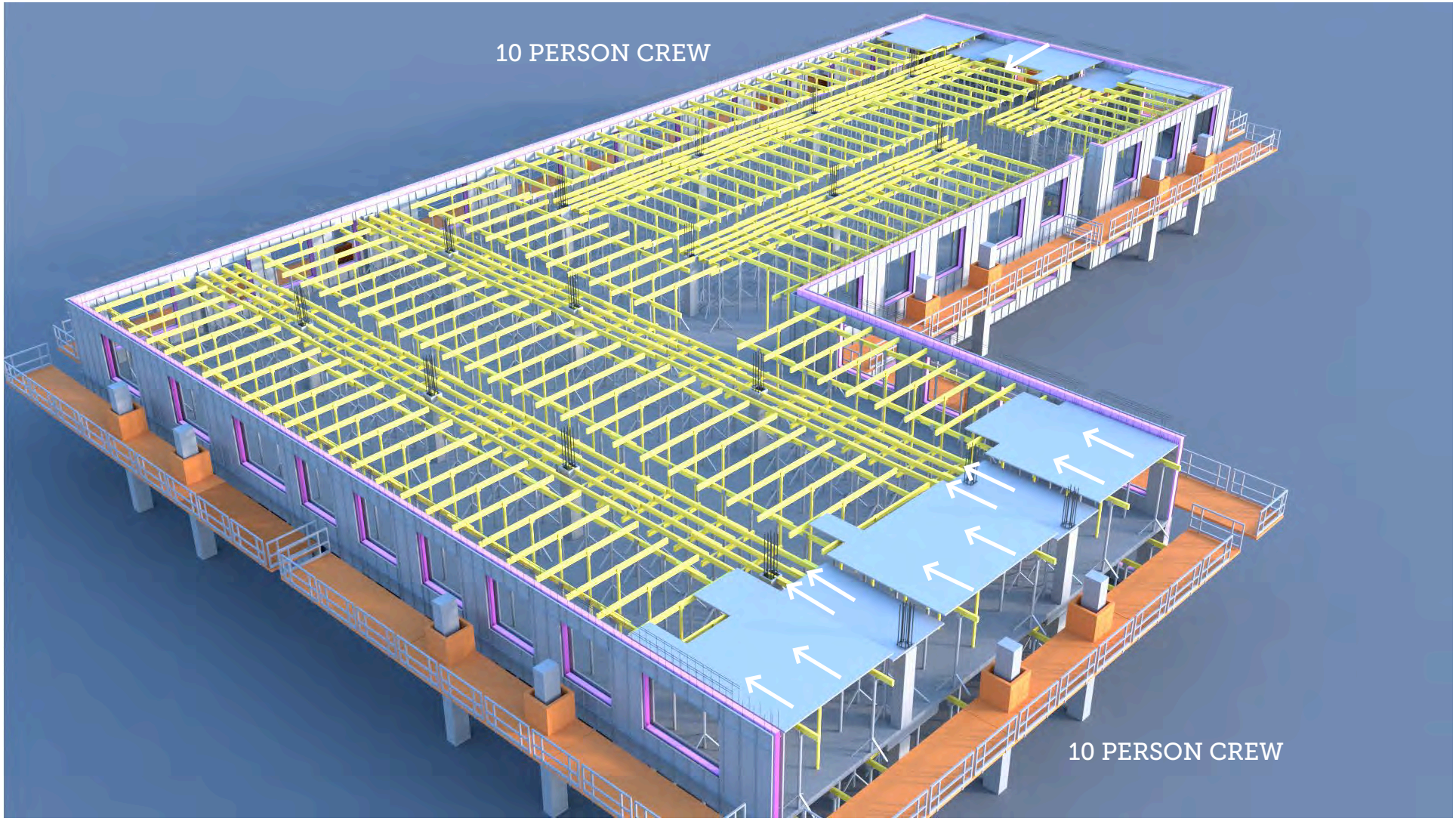
THURSDAY

10:00 AM SET UP SHORING (10) & TAKE DOWN DECK FORMS ON DECK BELOW (17)



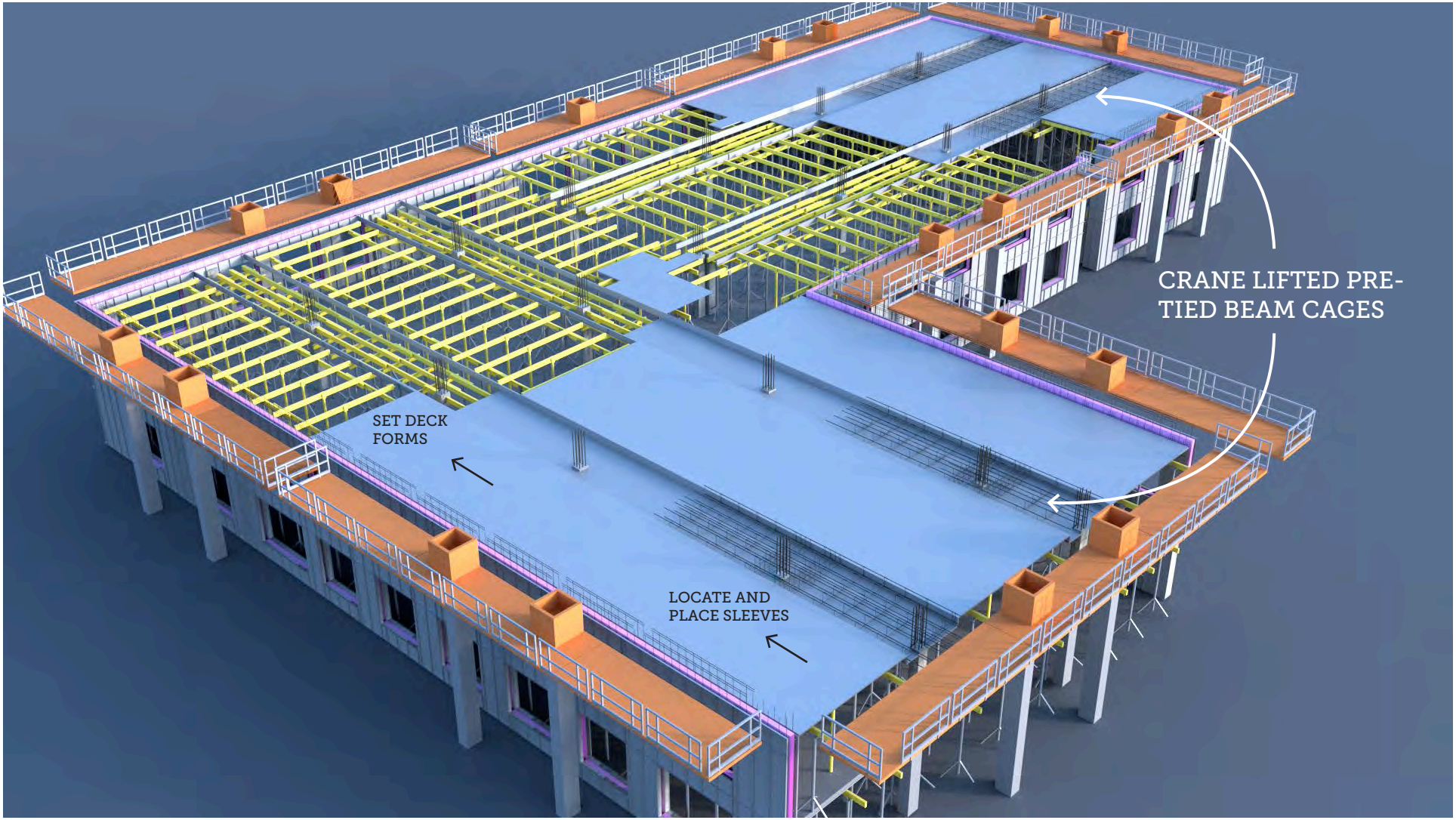
THURSDAY

11:00 AM COMPLETE SHORING (10) & CLEAN AND MOVE DECK FORMS FROM BELOW and START PLACING DECK FORMS (17)



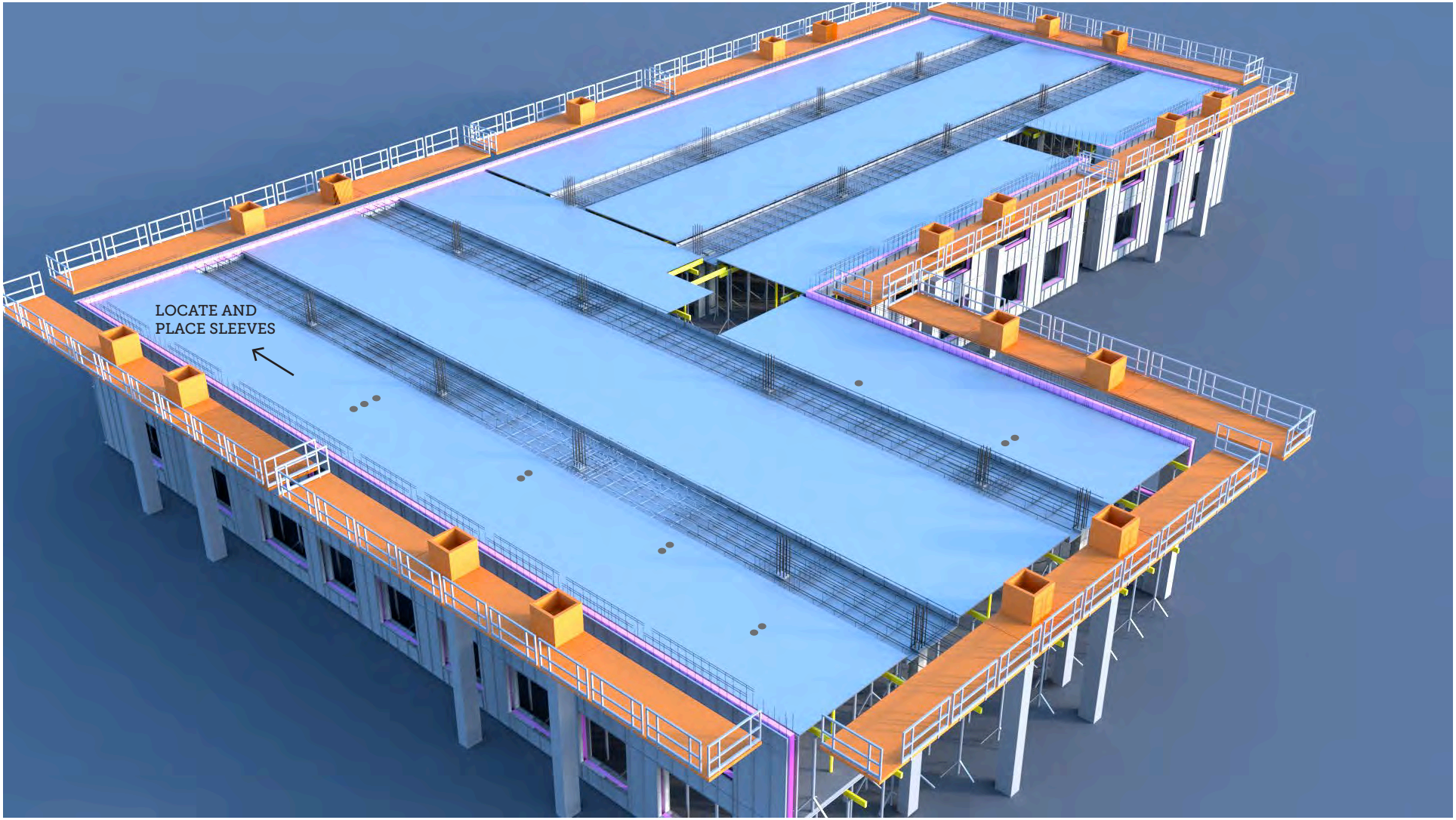
THURSDAY

10:00 AM BEGIN TO SET DECK FORMS (20)



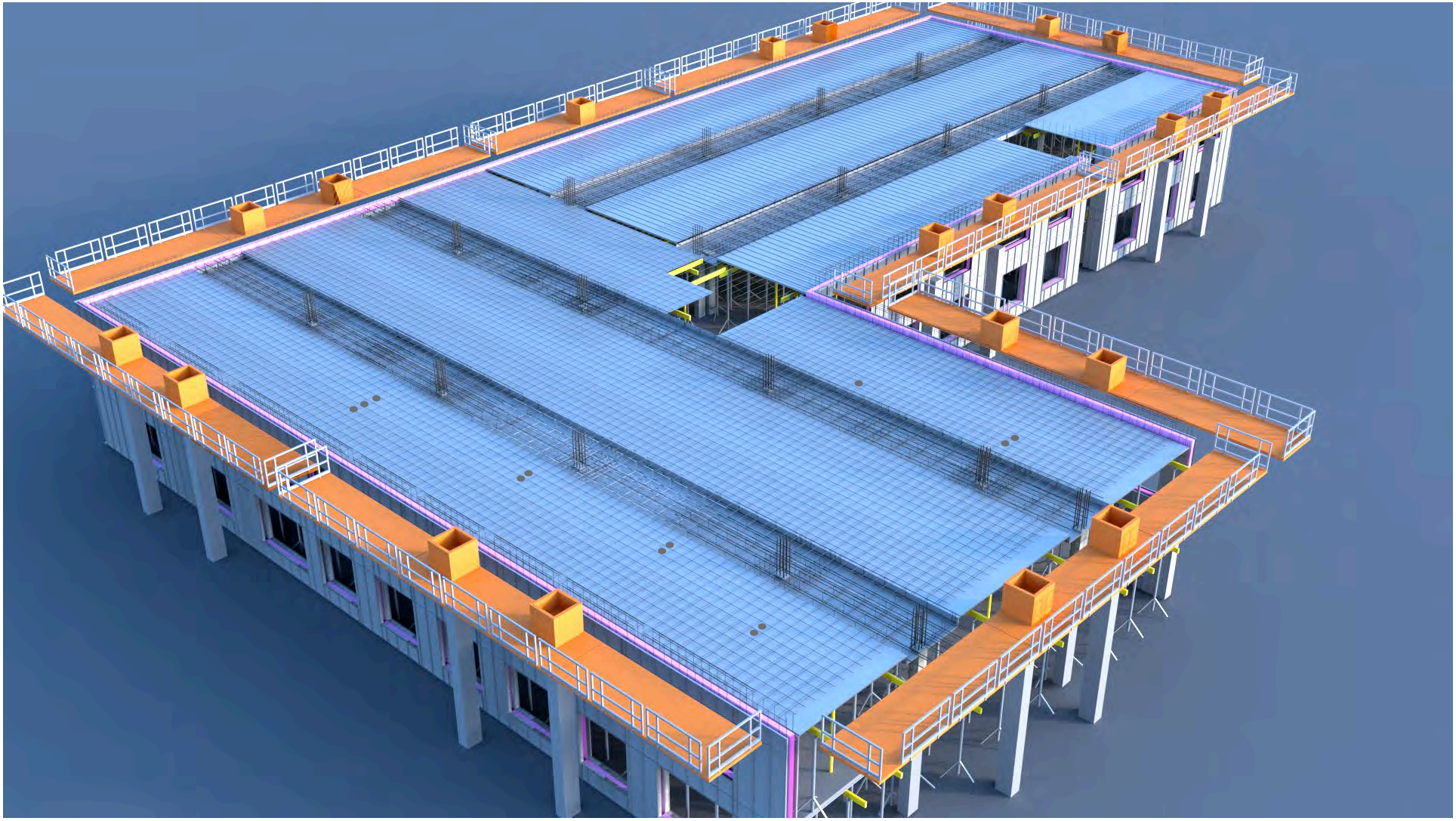
THURSDAY

10:00 AM - 5:00 PM SET DECK FORMS (20) & LOCATE AND PLACE SLEEVES & FLY IN BEAMS (7)



THURSDAY

7:00 PM COMPLETE SLEEVES & FLYING IN BEAMS (10)



FRIDAY

7:00 AM - 3:00 PM COMPLETE TIE DECK STEEL (20) & INSPECTION

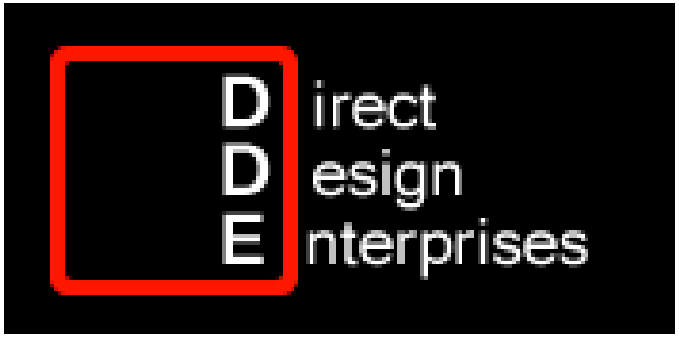

PASSIVSCIENCE
Knowledge saves power


PHIUS
Passive House Institute US


Klearwall

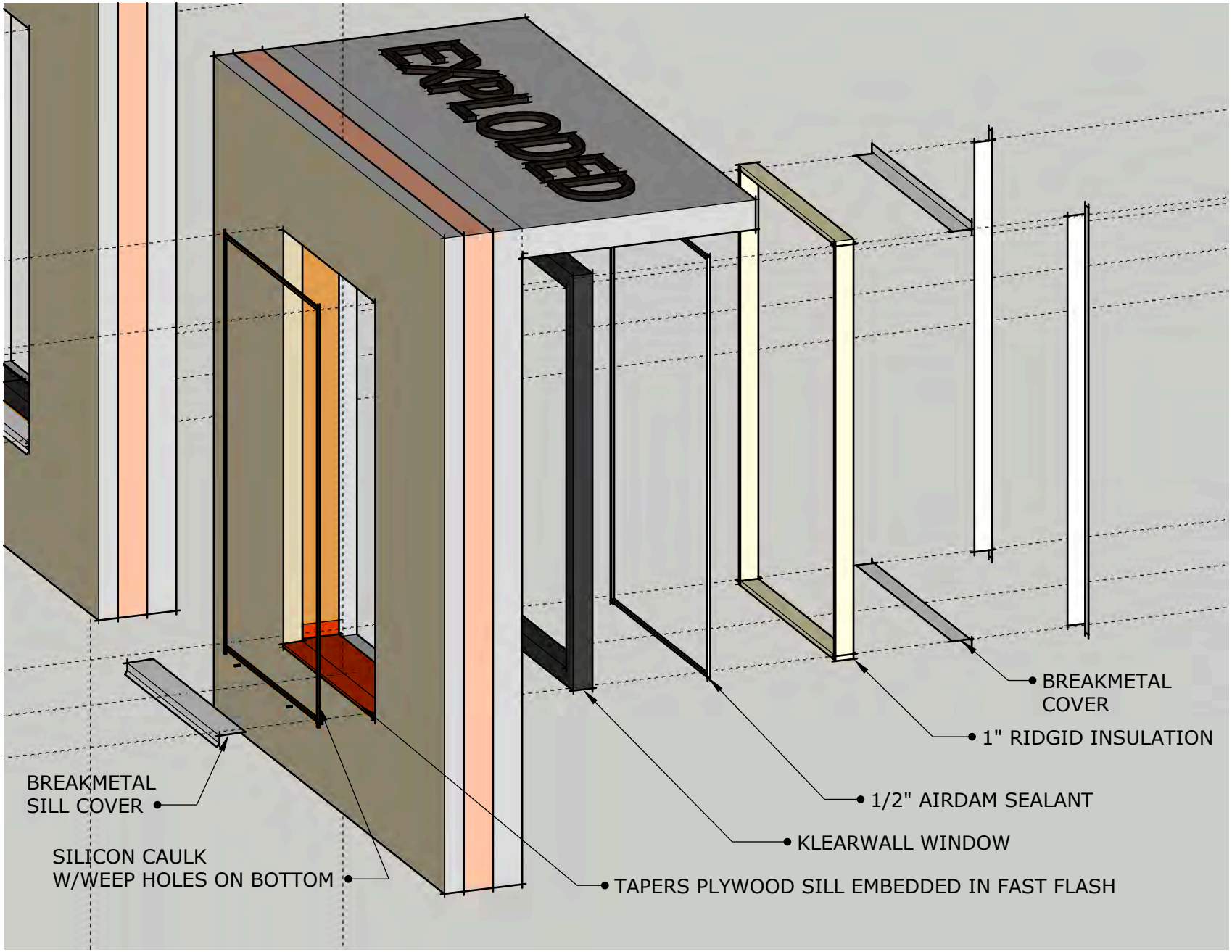

STAENGL
ENGINEERING

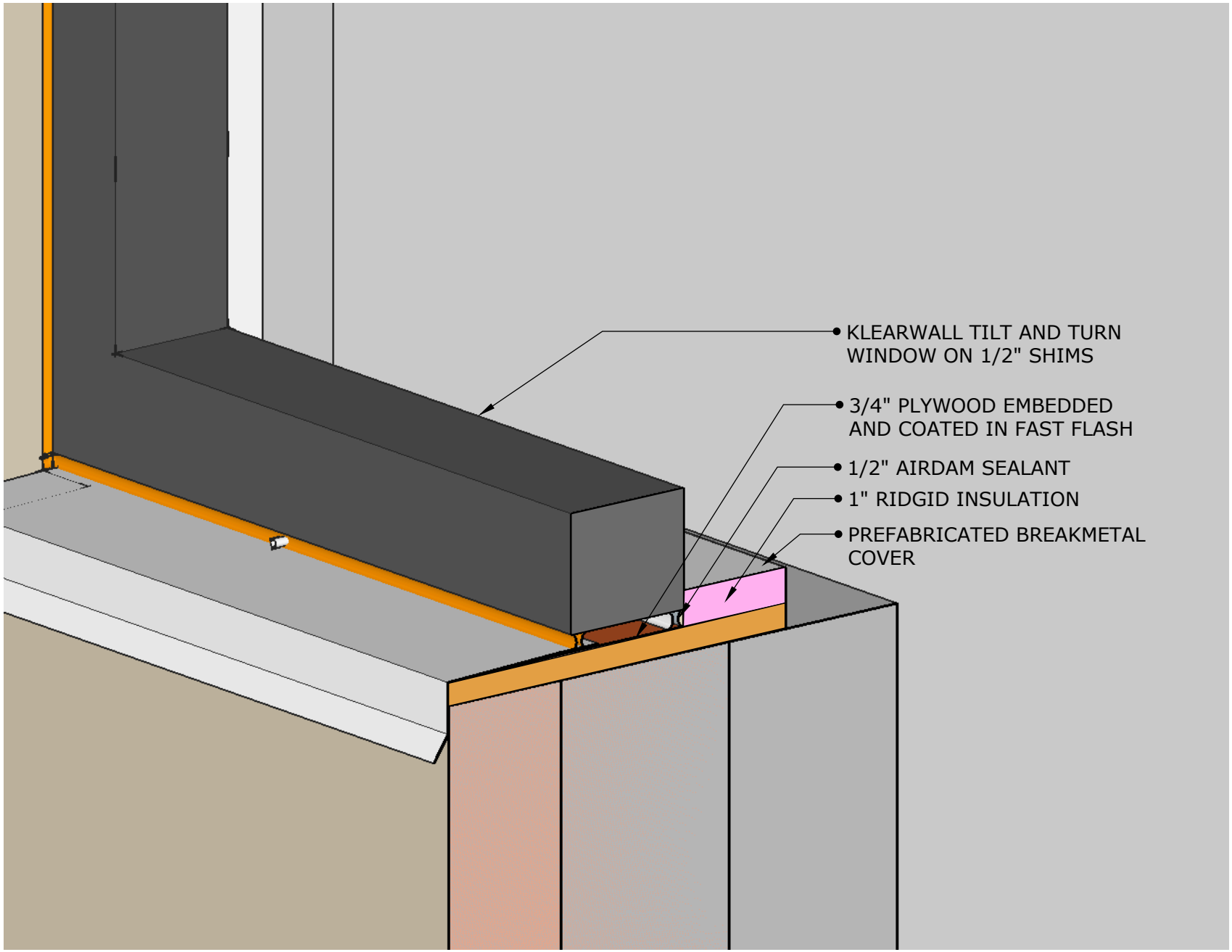

Western
Forms


D irect
D esign
E nterprises


clockwork
ARCHITECTURE + DESIGN

PROSOCO


BREAKMETAL
COVER
1" RIDGID INSULATION
1/2" AIRDAM SEALANT
KLEARWALL WINDOW
TAPERS PLYWOOD SILL EMBEDDED IN FAST FLASH
BREAKMETAL
SILL COVER
SILICON CAULK
W/WEEP HOLES ON BOTTOM


KLEARWALL TILT AND TURN WINDOW ON 1/2" SHIMS
3/4" PLYWOOD EMBEDDED AND COATED IN FAST FLASH
1/2" AIRDAM SEALANT
1" RIDGID INSULATION
PREFABRICATED BREAKMETAL COVER

Structure Cost Per Square Foot:

			ADG Model	Stick
0	**Land**	**$4,256,000**	**$ 7.74**	**$ 10.06**
3	Concrete	$14,289,502	$ 25.98	$ 6.50
4	Masonry	$899,800	$ 1.64	$ 1.64
5	Metals	$1,423,506	$ 2.59	$ 2.18
6	Rough Carpentry	$377,280	$ 0.69	$ 8.00
6	Finish Carpentry	$686,830	$ 1.25	$ 1.25
7	Waterproofing	$380,002	$ 0.69	$ 0.69
7	Insulation	$0		$ 0.50
7	Roofing	$1,352,451	$ 2.46	$ 2.46
7	Sheetmetal	$54,277	$ 0.10	$ 0.10
8	Doors	$587,361	$ 1.07	$ 1.07
8	Windows	$1,743,247	$ 3.17	$ 3.17
8	Glass	$0	-	$ -
9	Lath and Plaster	$0	-	$ -
9	Drywall	$3,290,604	$ 5.98	$ 11.97
9	Tile Work	$0		$ 0.82
9	Wood Flooring	$0		$ 3.80
9	Painting and Decorating	$813,231	$ 1.48	$ 1.48
10	Specialties	$108,388	$ 0.20	$ 0.20
11	Special Equipment	$15,000	$ 0.03	$ 0.03
11	Cabinets	$893,875	$ 1.63	$ 1.63
11	Appliances	$963,841	$ 1.75	$ 1.75
12	Blinds and Shades, Artwork	$136,836	$ 0.25	$ 0.25
12	Carpets	$229,790	$ 0.42	$ 0.42
13	Special Construction	$1,721,503	$ 3.13	$ 3.13
14	Elevators	$536,560	$ 0.98	$ 0.98
15	Plumbing and Hot Water	$2,732,365	$ 4.97	$ 4.97
15	Heat and Ventilation	$2,602,679	$ 4.73	$ 8.01
16	Electrical	$4,209,080	$ 7.65	$ 7.65
	Subtotal (Structures)	**$40,048,008**		
			$80.55	$84.68

Total Life-cycle Cost

	ADG Model	Stick
Land and Stuctures Cost	**$ 80.55**	**84.68**
First Cost Savings	**4.12**	**-**
Operating Expenses Savings		
Painting at Turnover (50%)	0.04	
General Maintenance (50%)	0.04	
Utilities (76% Less)	0.34	
Insurance (15% Less)	0.02	
Vacancy (1% less)	0.09	
Total	0.53	
Value at 5% Cap Rate	**10.59**	**-**
20% of NPV of Years 50-100	**1.170**	**-**
Total Life-cycle Cost	**$68.79**	**$84.68**

New Model is 19% Lower in Life-cycle

ADG Model Summary

- Efficient flexible structures
- Efficient Land Use
- 90% Energy Savings
- 5% Lower First Cost
- 19% Lower life-cycle costs

Financing Team

Ameritas - Bond Underwriting

Ameritas is a highly experienced public finance team of bankers and administrators with knowledge and expertise in preparing for public bond issuance. They structure bond financing for public infrastructure and tax credit components of our projects.

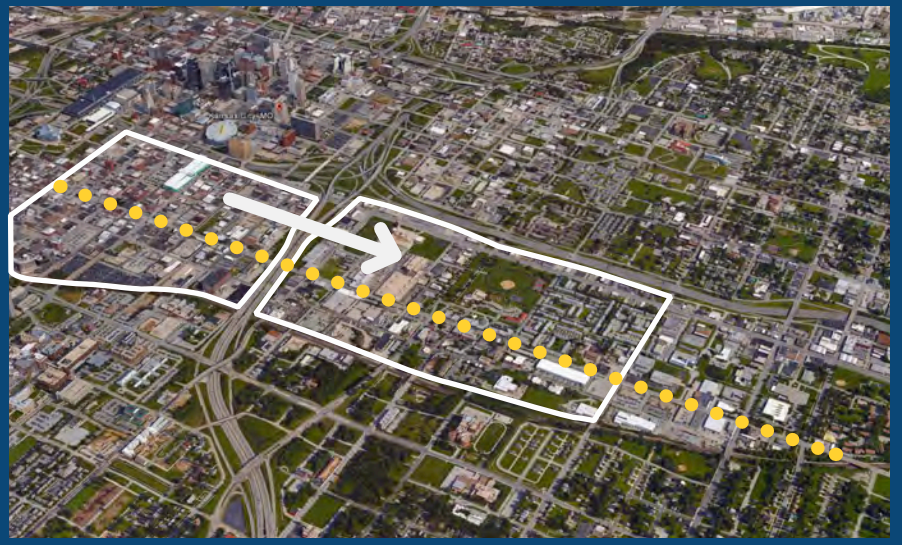
Oppenheimer Multifamily Housing & Healthcare Finance, Inc.

Oppenheimer Multifamily Housing & Healthcare Finance, Inc. is a wholly-owned subsidiary of the same Oppenheimer and Co. that provides investors with the necessary expertise and insight to meet their financial challenges. Oppenheimer Multifamily Housing & Healthcare Finance will be the lender for the construction and permanent financing for the project.

Berkshire Hathaway AHP

Berkshire Hathaway's Affordable Housing Partners is direct investor in historic and affordable housing developments. Affordable Housing is a subsidiary of Warren Buffett's holding company, Berkshire Hathaway Inc., which had total revenue of $143.7 billion in 2011.

From Buildings to Urban Villages



Second and Delaware

275 unit Passive-house Certified development in Kansas City, MO.

Funded with HUD 221(d)4 loan guarantee, Low Income Housing Tax Credits and Equity.

Cost: $60 million

Affordable Units: 58

Start Construction: September - 2015

Urban Villages

4,000 residential units, 500,000 sf commercial space, parks, and schools in transit oriented urban core locations.

Cost: $1.1 billion

Equity Required: $50 million

Return on Equity: 11-14%

Bridging East and West with Sustainable Development

ARNOLD DEVELOPMENT GROUP

ADG | Smart Growth Fund LP

OFFERING CAPITAL APPRECIATION THROUGH RISK-MITIGATED INVESTMENTS IN SUSTAINABLE AND SOCIALLY RESPONSIBLE REAL ESTATE

THIRD QUARTER 2016

Thank you.

For more information visit:

ArnoldDevelopmentGroup.com

or send an email to:

jarnold@ArnoldDevelopmentGroup.com

2nd and Delaware

Galen Staengl, PE CPHC

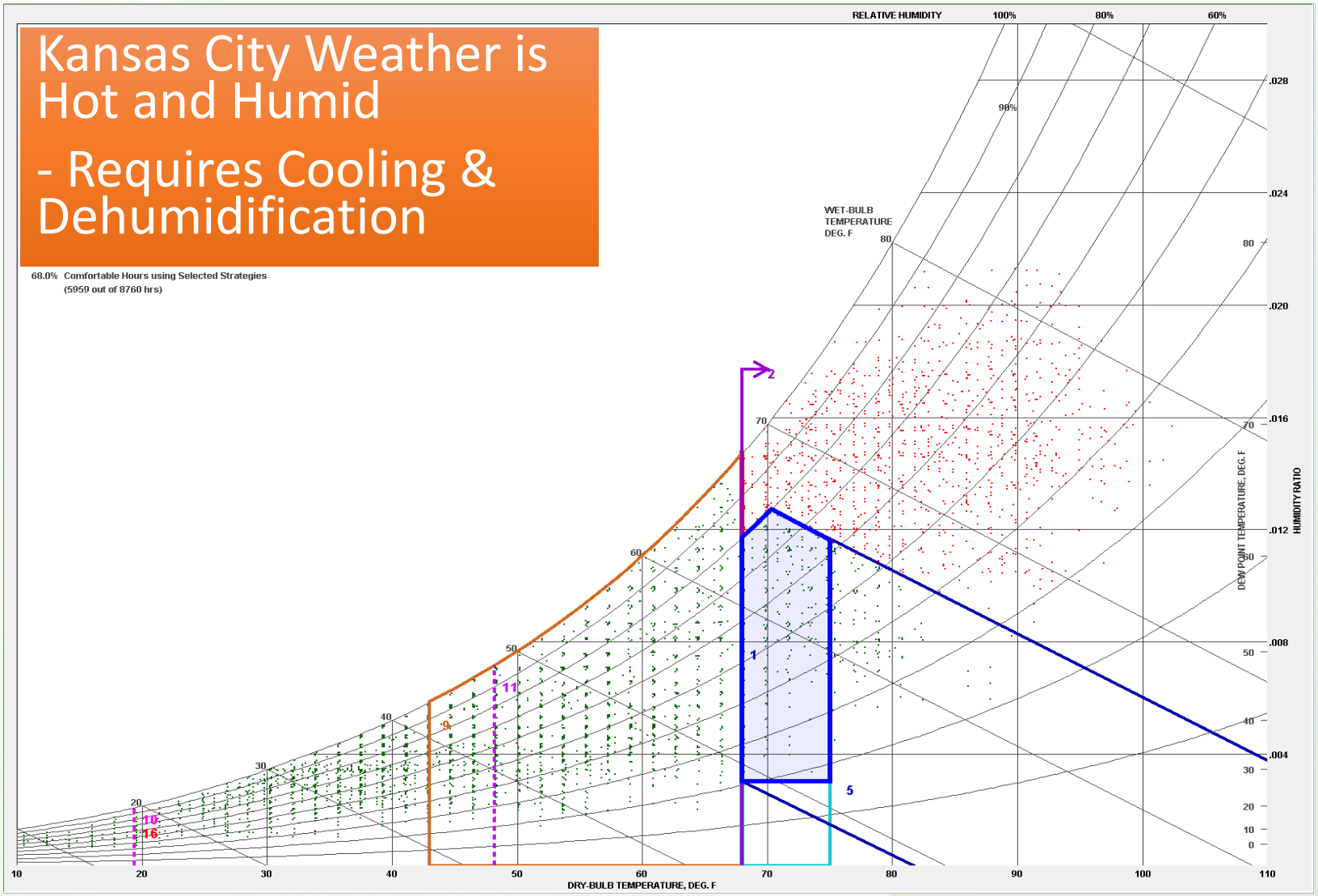
Arnold Imaging

STAENGL ENGINEERING

2nd and Delaware

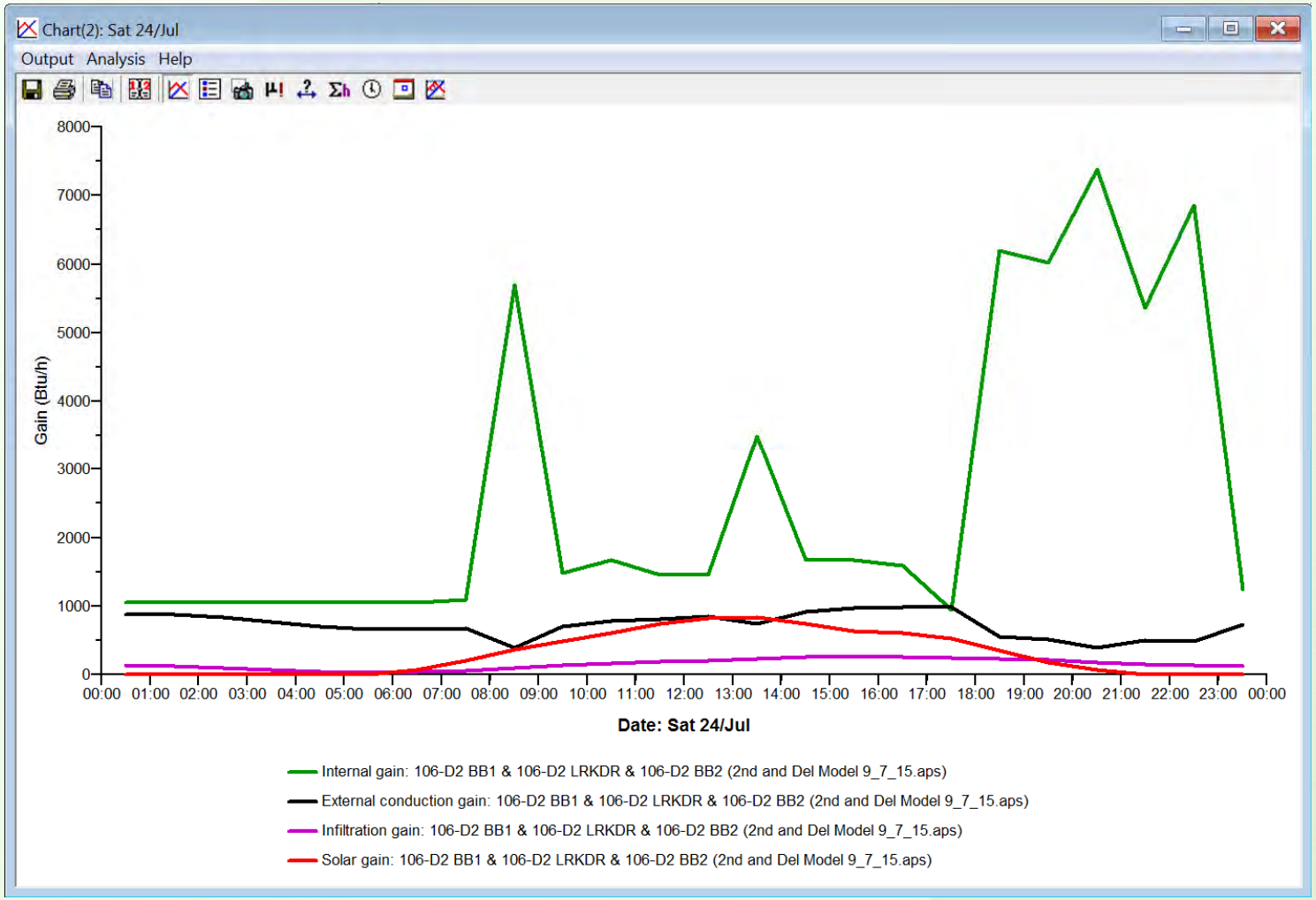
- 276 Unit apartment building in Kansas City, Mo.
- Project is using Integrated Project Delivery and Lean Construction to deliver a concrete constructed, Passive House building for market rate costs: ~$140 / sqft.
- Project is currently in the end stages of design, and construction will begin this year.
- Developer: Arnold Development Group.

2nd and Delaware



2nd and Delaware

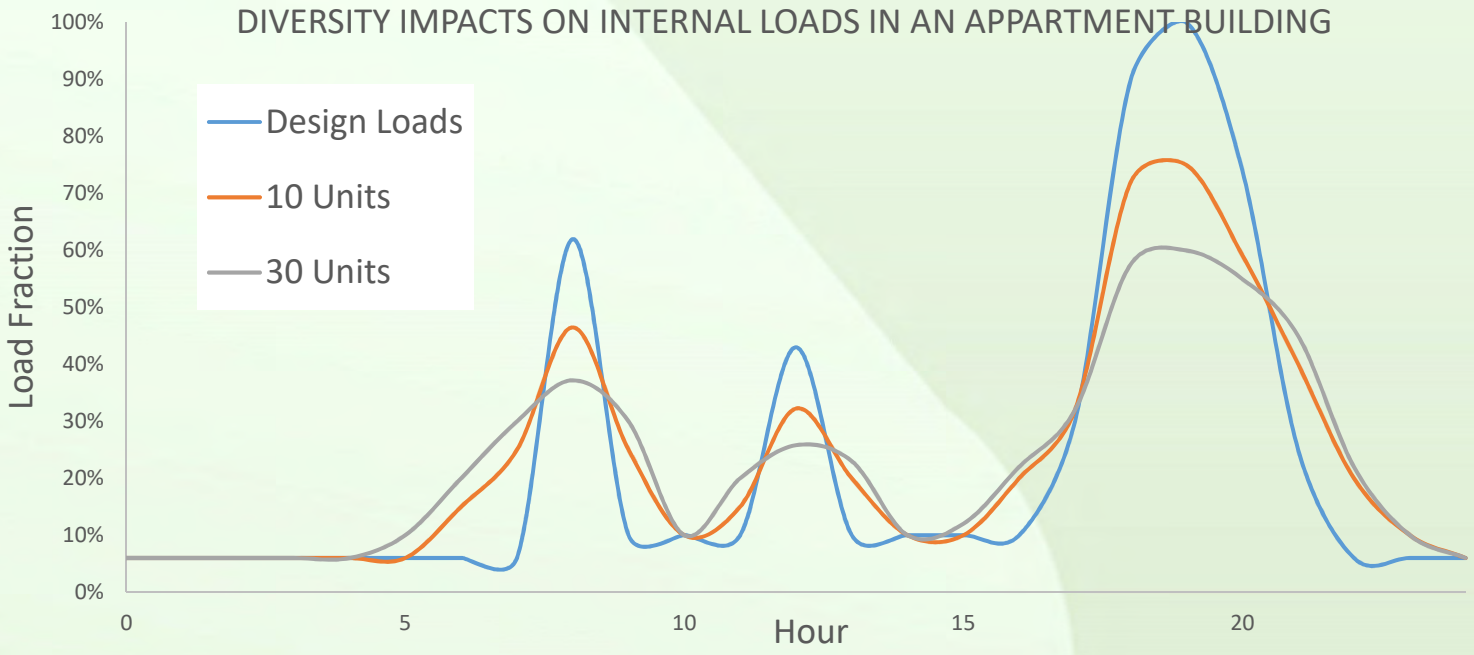
Peak Load Driven by Cooking (Dinner Hour)



2nd and Delaware

Peak load diversity allows 150% of indoor unit capacity connected per outdoor unit capacity.

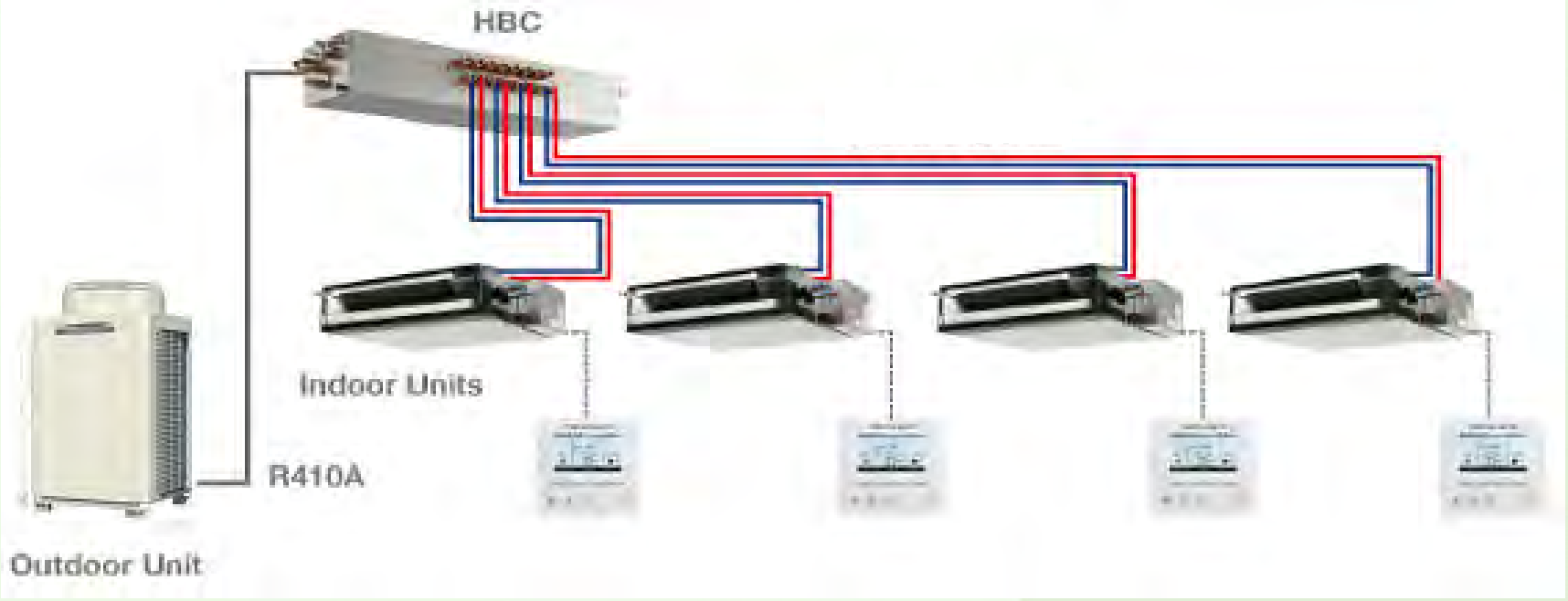
Units are connected to 16 ton outdoor units to maximize unit cost efficiency, and to keep system refrigeration charge within safe limits.



2nd and Delaware

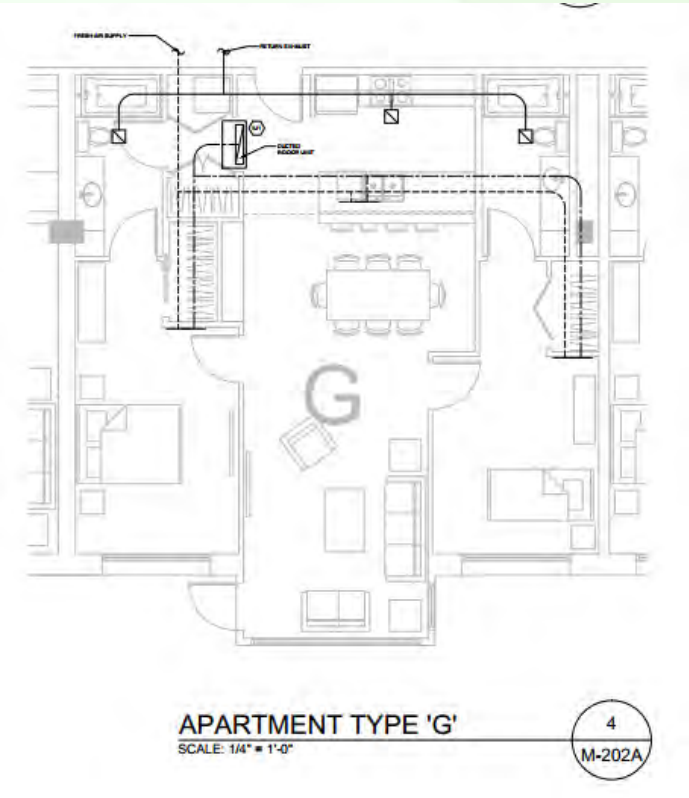
Peak load diversity allows 150% of indoor unit capacity connected per outdoor unit capacity.

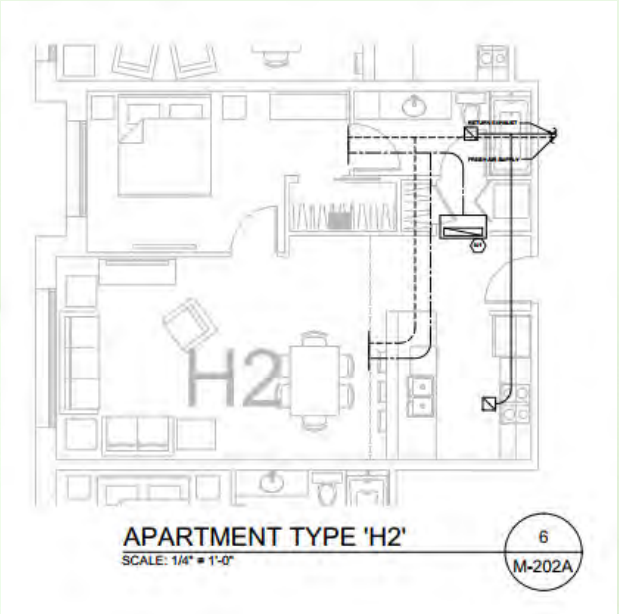
~30 indoor units are connected to each 16 ton outdoor units to maximize unit cost efficiency, and to keep system refrigeration charge within safe limits.



2nd and Delaware

1 and 2 Bedroom Units

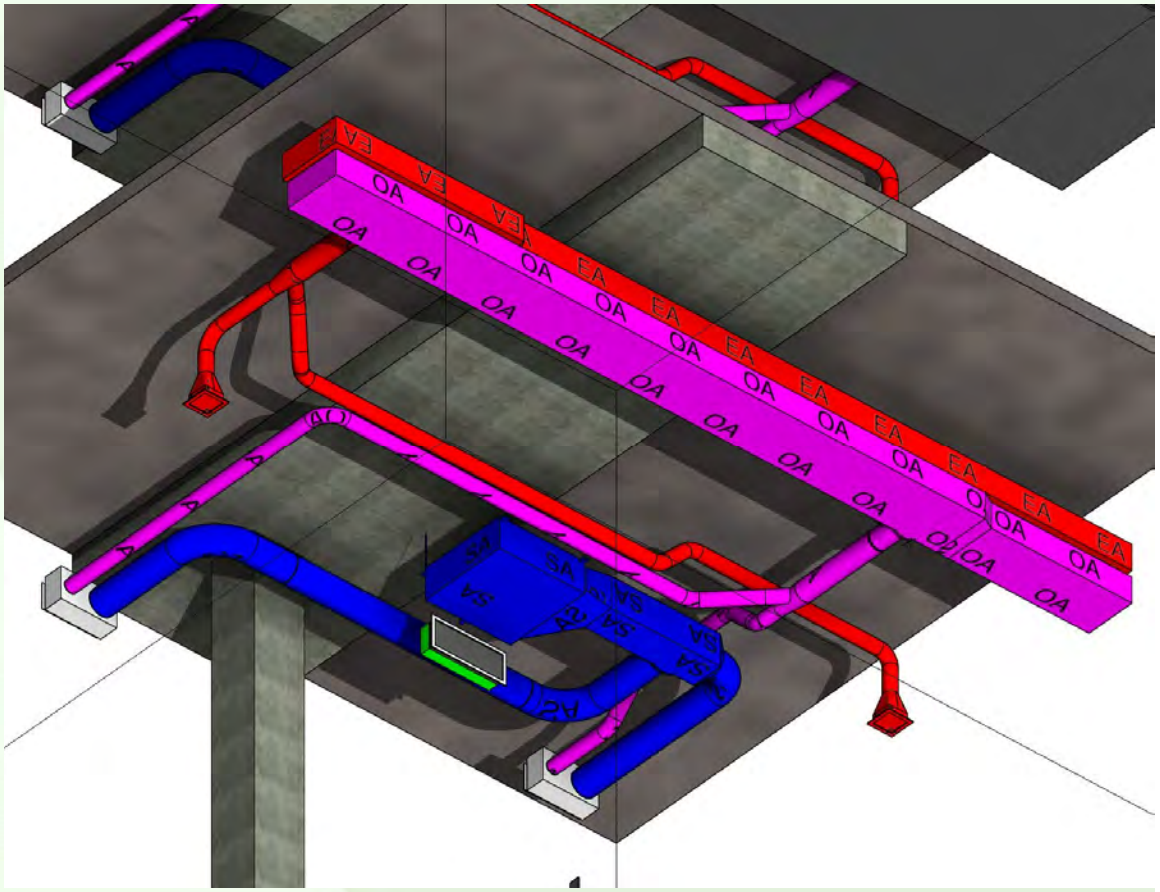




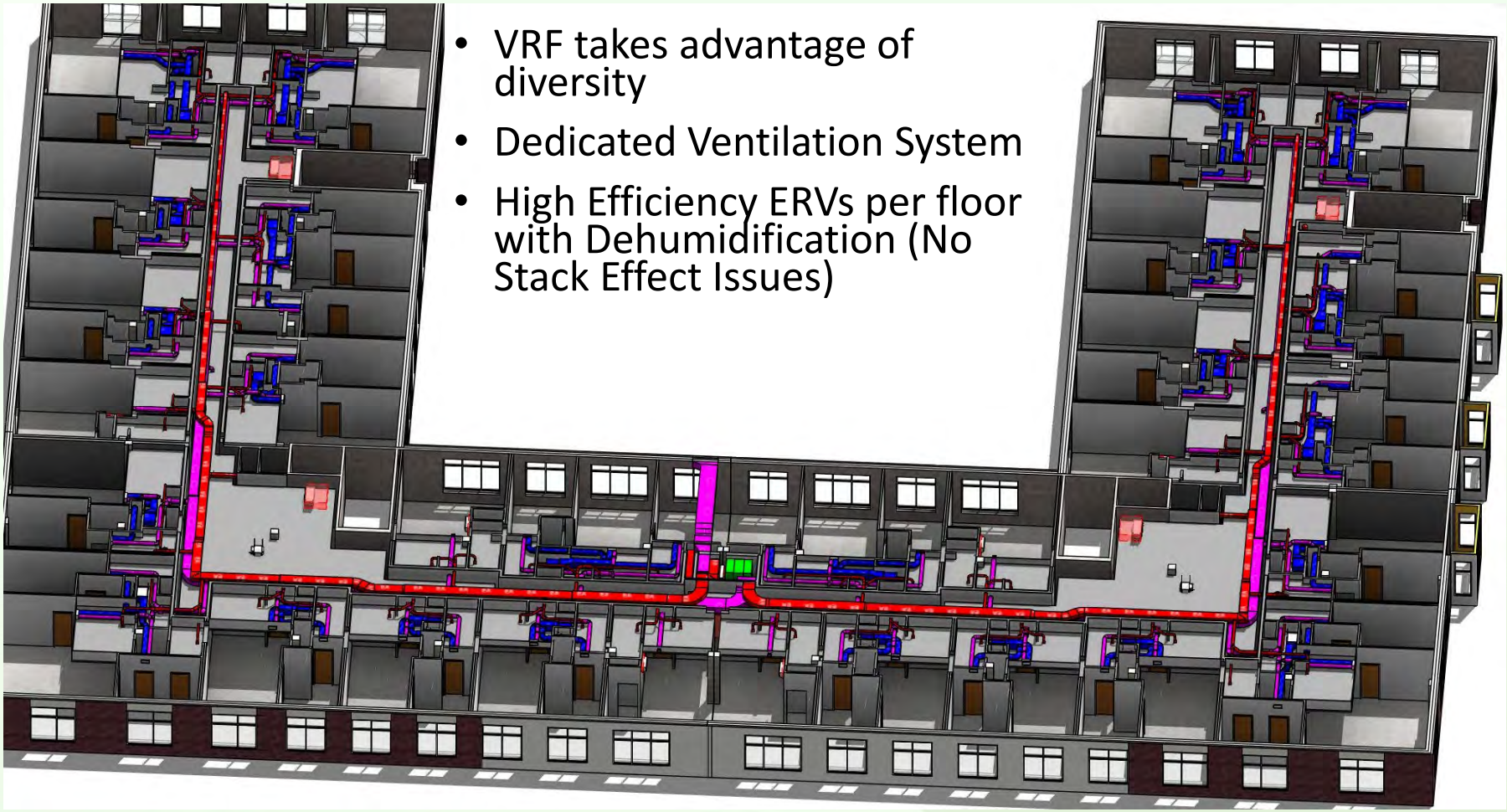
2nd and Delaware

Centralized (per floor) ERV allows dehumidification of ventilation air:

- Conditioned air delivered to rooms handles cooling load for low load situations (~20% of cooling hours).
- VRF terminals provide “re-heat” if required.
- Combo Supply/Outdoor air terminals in units
  - save installation costs and complexity
  - allow constant outside air delivery



2nd and Delaware

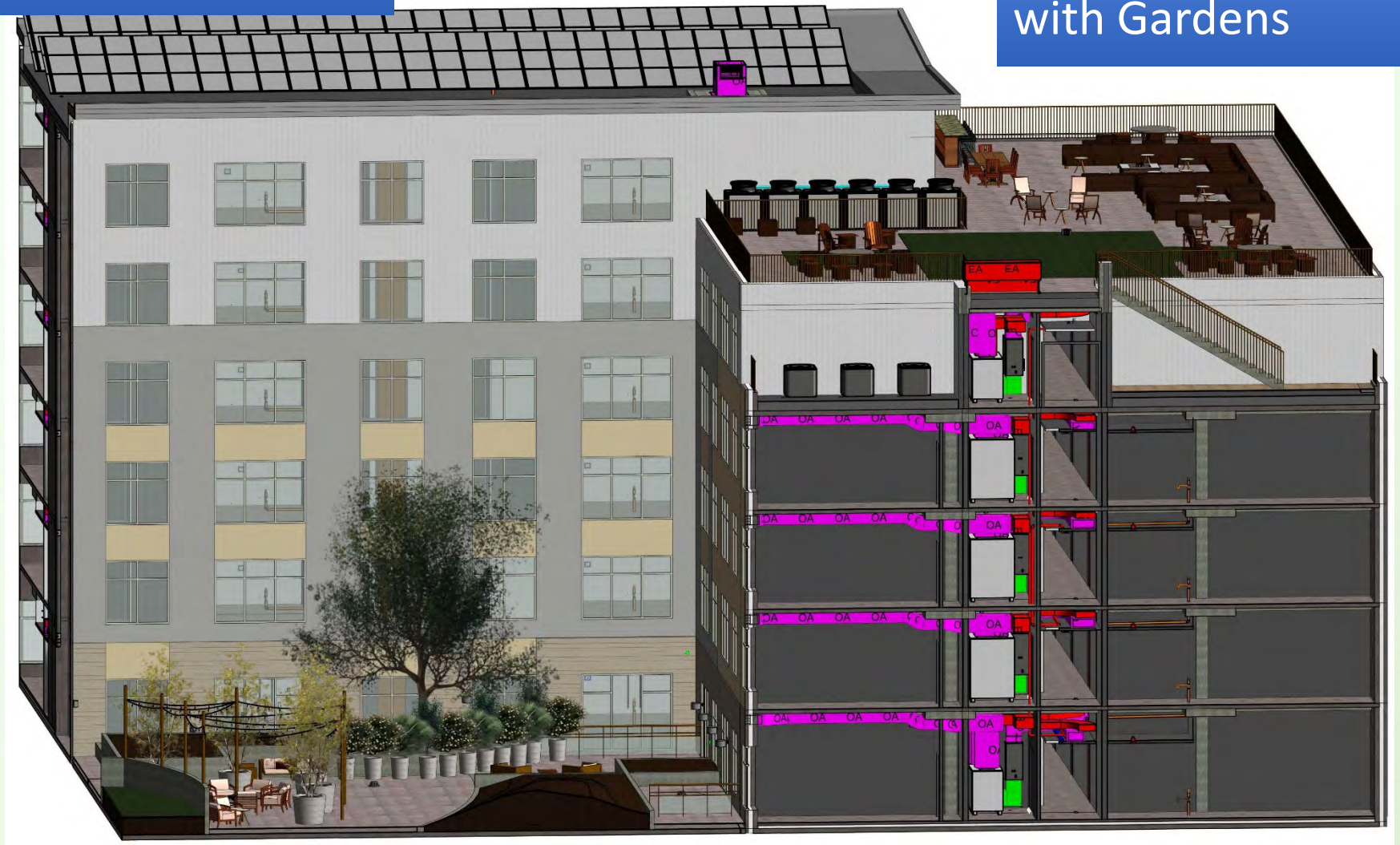


- VRF takes advantage of diversity
- Dedicated Ventilation System
- High Efficiency ERVs per floor with Dehumidification (No Stack Effect Issues)

2nd and Delaware

150 kW Rooftop PV Array

Shared Roof Space with Gardens

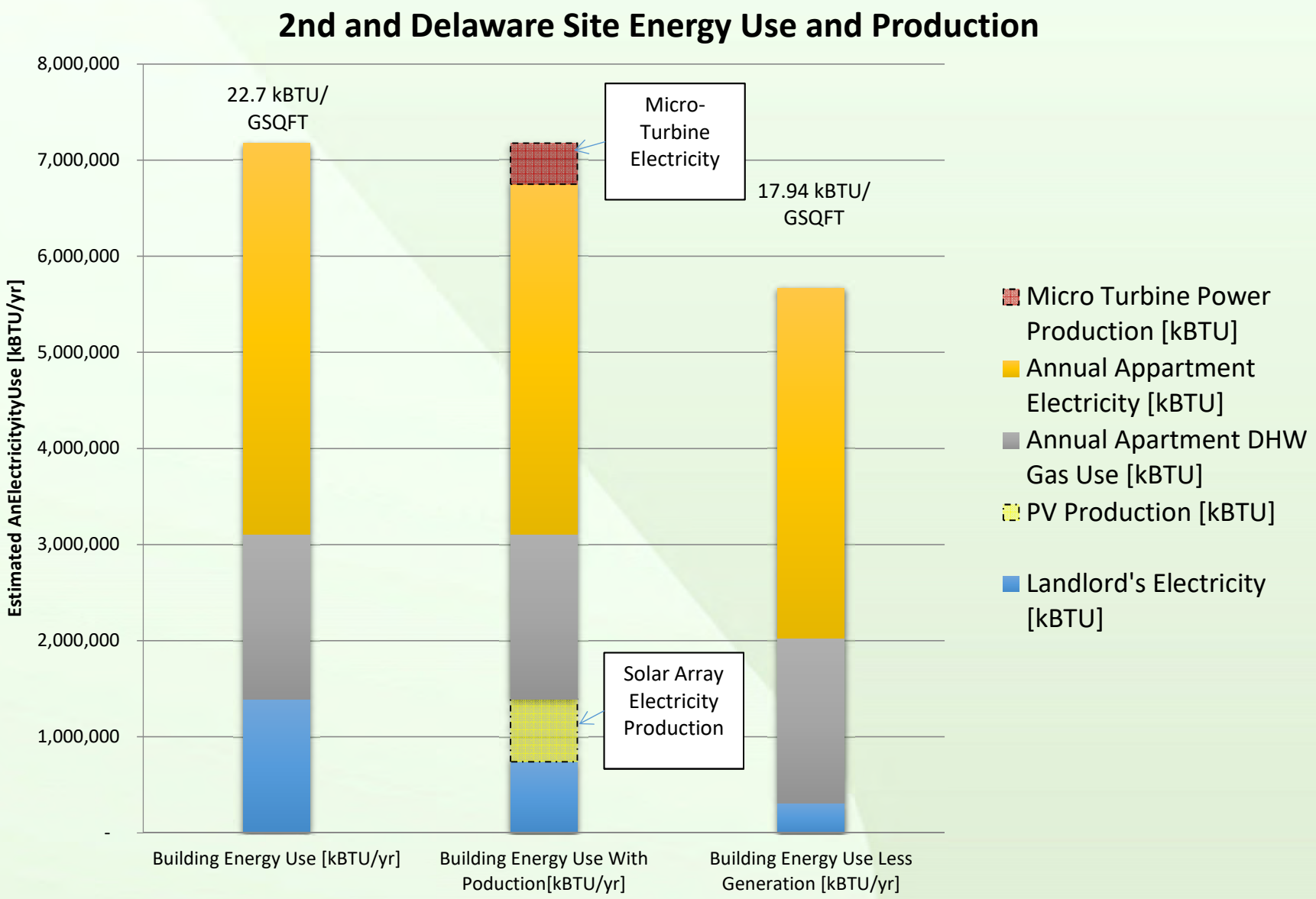


2nd and Delaware

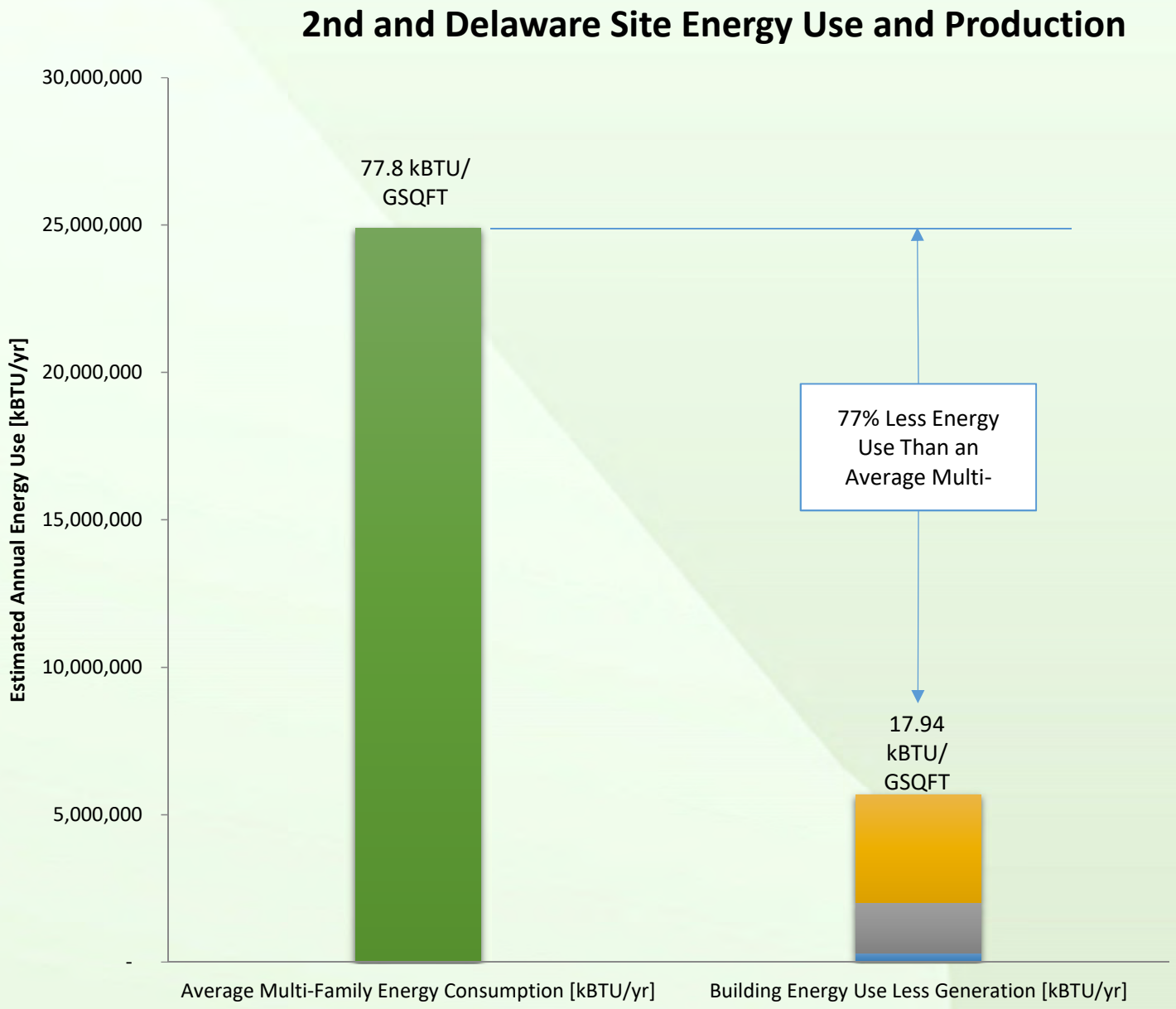
Centralized HW system allows use of combined heat and power micro-turbine to generate power and domestic hot water.

- Design is optimized to keep turbine running maximum hours.
- Will offset ~8% of building electricity use while making hot water.

2nd and Delaware



2nd and Delaware



Questions?

Galen Staengl, PE, LEED BD+C, CPHC - gstaengl@staenglengineering.com

PASSIVSCIENCE
Knowledge saves power

STAENGL
ENGINEERING

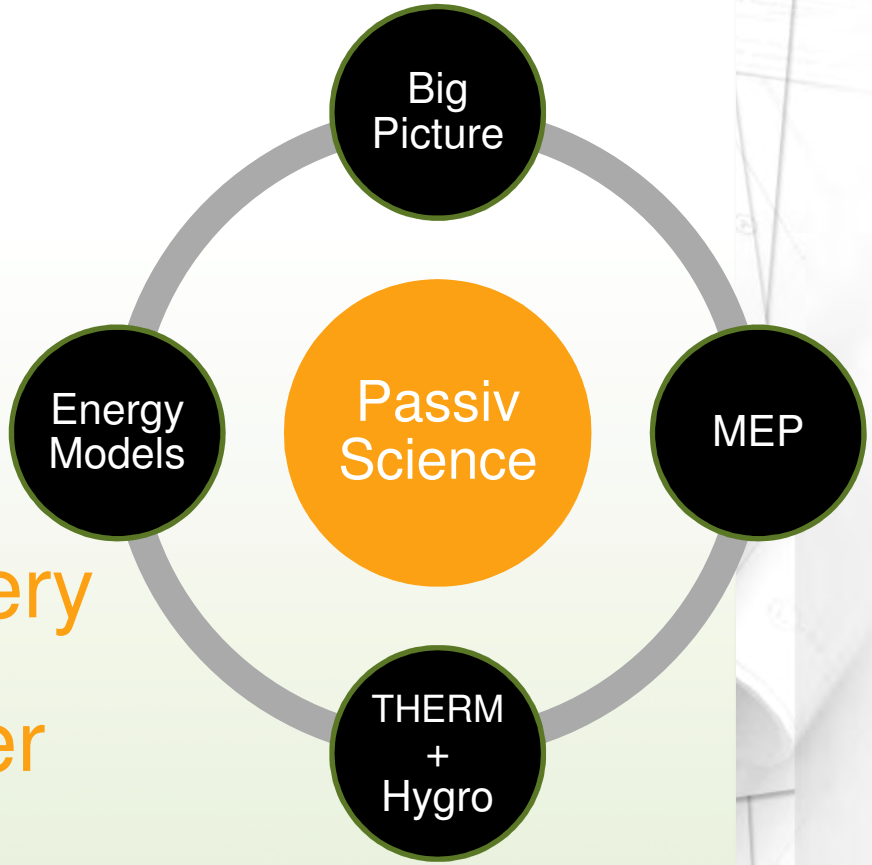
2nd + Delaware

» ***276 Unit PHIUS+ Multifamily***

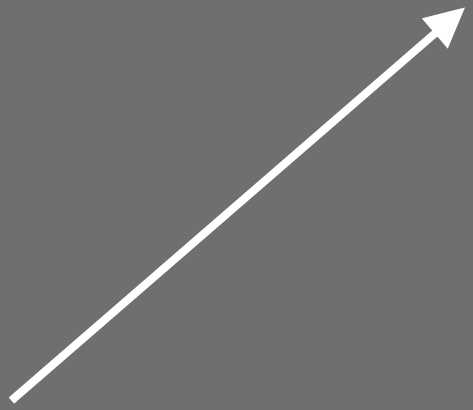
Prudence Ferreira, CPHC

Passiv Science Team: Do what you love

- 4 CPHC Partners
  - Prudence Ferreira
  - Adam Cohen
  - Galen Staengl
  - Russell Richman
- Lean Project Delivery
- Visionary Developer



Success



What people think it looks like

Success

What it really looks like

Lean Project Delivery: Work Smarter

Eliminate Waste

- Don't produce anything before you have to
- Make the profit collaborative through IPD contract

Maximize Efficiency

- Make decisions as you need to and have all information
- Systematize repetitive tasks
- Streamline hand-offs

Optimize Results

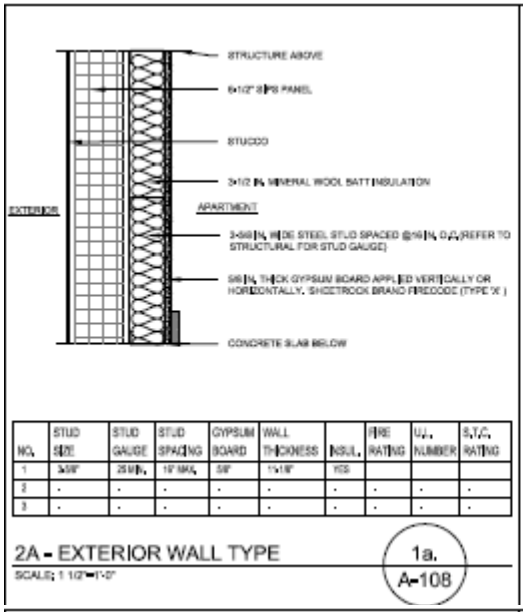
- Rely on your experts, trust your team
- Communicate with ALL Tm's even those who aren't directly involved may have valuable insight

Challenge: Complexity

Image: C.J. Burton

6 Exterior Walls Avg R-25

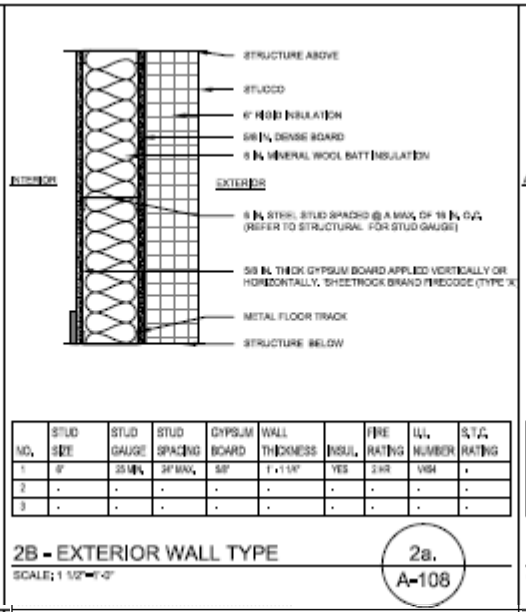
R-52 Roof (12-16in foam w/taper) | R17 Floor (4in foam)



NO.	STUD SIZE	STUD GAUGE	STUD SPACING	GYPSUM BOARD	WALL THICKNESS	INSUL.	FIRE RATING	U.L. NUMBER	S.T.C. RATING
1	3x5/8"	25 MIN.	16" MAX.	5/8"	5"x1/8"	YES			
2	.	.	.	.	.	.	.	.	.
3	.	.	.	.	.	.	.	.	.

2A - EXTERIOR WALL TYPE — 1a. A-108

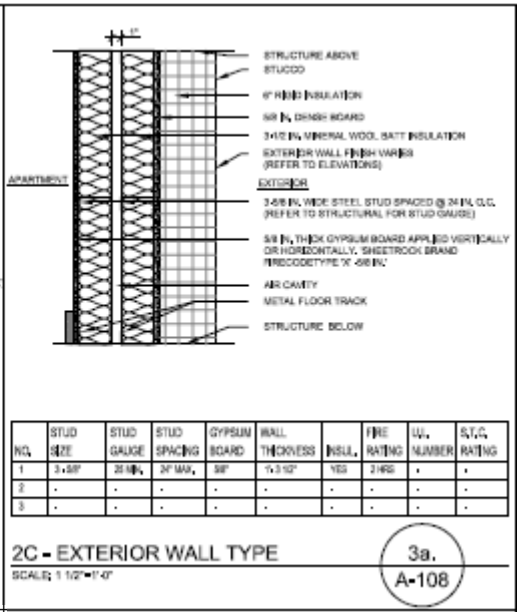
SCALE: 1 1/2"=1'-0"



NO.	STUD SIZE	STUD GAUGE	STUD SPACING	GYPSUM BOARD	WALL THICKNESS	INSUL.	FIRE RATING	U.L. NUMBER	S.T.C. RATING
1	6"	25 MIN.	24" MAX.	5/8"	1'-1 1/2"	YES	2 HR	V464	.
2	.	.	.	.	.	.	.	.	.
3	.	.	.	.	.	.	.	.	.

2B - EXTERIOR WALL TYPE — 2a. A-108

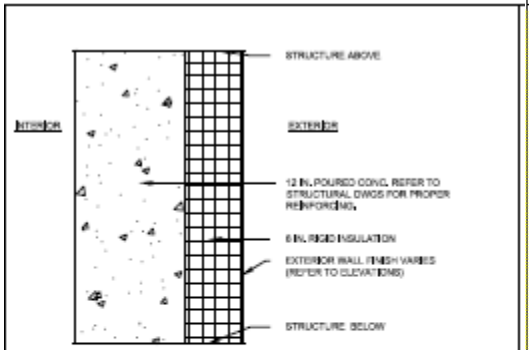
SCALE: 1 1/2"=1'-0"



NO.	STUD SIZE	STUD GAUGE	STUD SPACING	GYPSUM BOARD	WALL THICKNESS	INSUL.	FIRE RATING	U.L. NUMBER	S.T.C. RATING
1	3 x 5/8"	25 MIN.	24" MAX.	5/8"	5"x 1/2"	YES	2 HRS	.	.
2	.	.	.	.	.	.	.	.	.
3	.	.	.	.	.	.	.	.	.

2C - EXTERIOR WALL TYPE — 3a. A-108

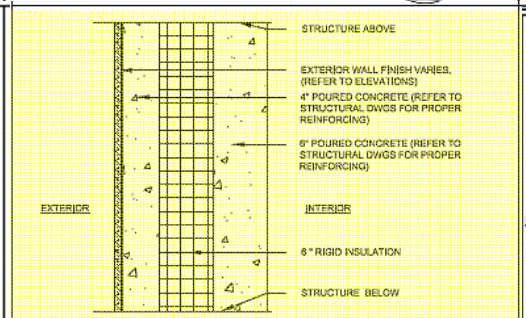
SCALE: 1 1/2"=1'-0"



NO.	CONC. THICK.	INSUL. THICK.	WALL THICKNESS	INSUL.	FIRE*** RATING	U.L. NUMBER	S.T.C. RATING
1	12"	6" RIGID	1'-0"	YES	4+ HRS*	.	.
2	.	.	.	.	.	.	.
3	.	.	.	.	.	.	.

2D - EXTERIOR WALL TYPE — 4a. A-108

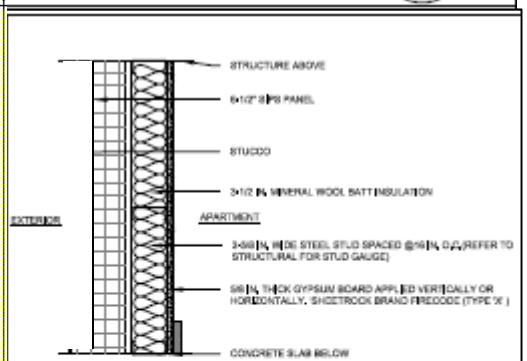
SCALE: 1 1/2"=1'-0"



NO.	STUD SIZE	STUD GAUGE	STUD SPACING	GYPSUM BOARD	WALL THICKNESS	INSUL.	FIRE*** RATING	U.L. NUMBER	S.T.C. RATING
1	.	.	.	.	1'-4"	6"	4+ HRS*	.	.
2	.	.	.	.	.	.	.	.	.
3	.	.	.	.	.	.	.	.	.

2F - EXTERIOR WALL TYPE — 6a. A-108

SCALE: 1 1/2"=1'-0"



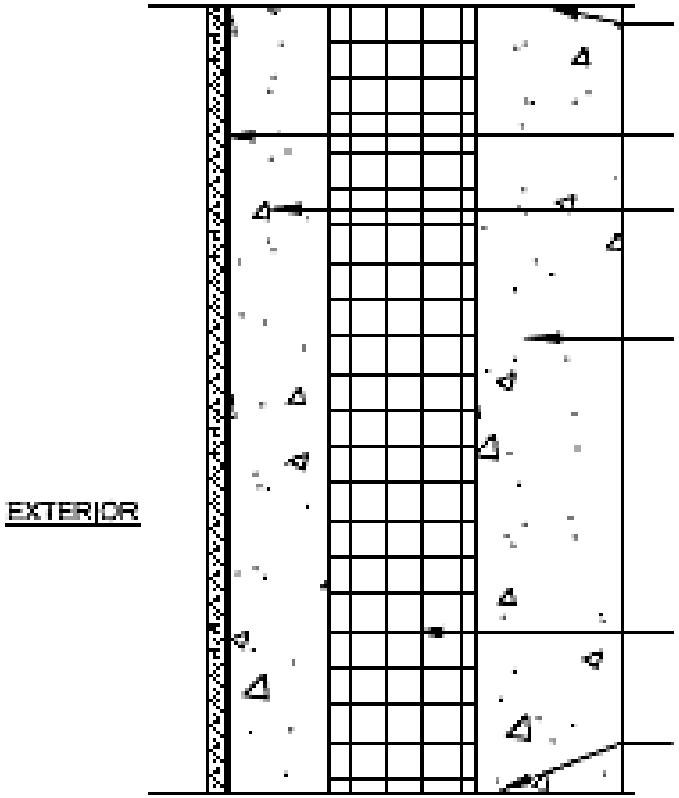
NO.	STUD SIZE	STUD GAUGE	STUD SPACING	GYPSUM BOARD	WALL THICKNESS	INSUL.	FIRE RATING	U.L. NUMBER	S.T.C. RATING
1	3x5/8"	25 MIN.	16" MAX.	5/8"	5"x1/8"	YES			
2	.	.	.	.	.	.	.	.	.
3	.	.	.	.	.	.	.	.	.

2A - EXTERIOR WALL TYPE GARAGE — 1a. A-108

SCALE: 1 1/2"=1'-0"

Direct Design Enterprises

4 in exterior
6 in foam
6 in interior



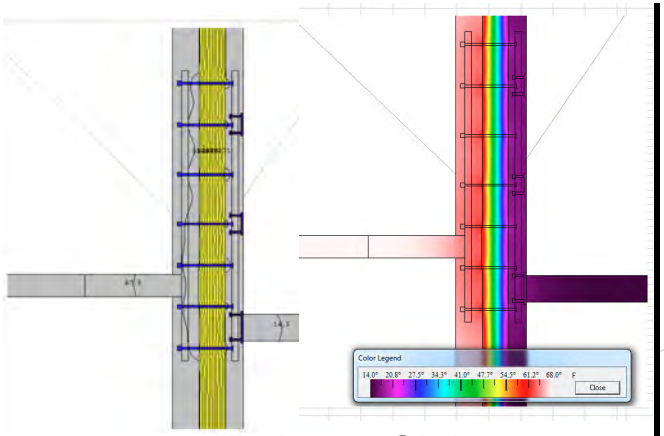
NO.	STUD SIZE	STUD GAUGE	STUD SPACING	GYPSUM BOARD	WALL THICKNESS	INSUL.	FIRE*** RATING	U.L. NUMBER	S.T.C. RATING
1	•	•	•	•	1'-4"	6"	4+ HRS*	•	•
2	•	•	•	•	•	•	•	•	•
3	•	•	•	•	•	•	•	•	•

2F - EXTERIOR WALL TYPE

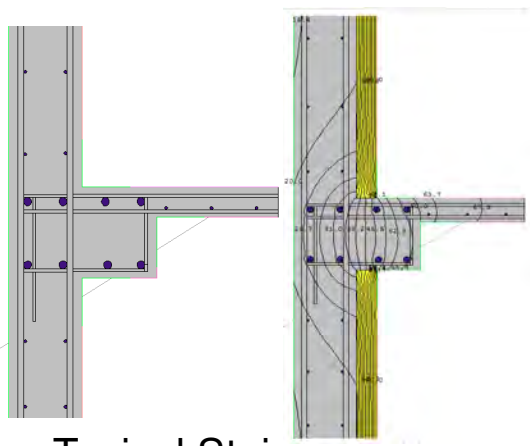
SCALE: 1 1/2"=1'-0"

6a.
A-108

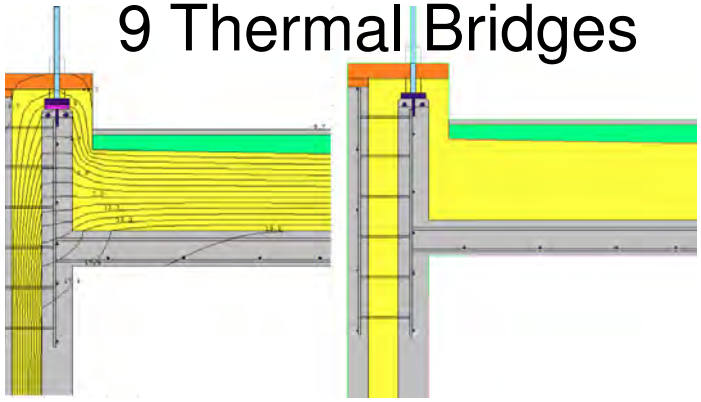
9 Thermal Bridges



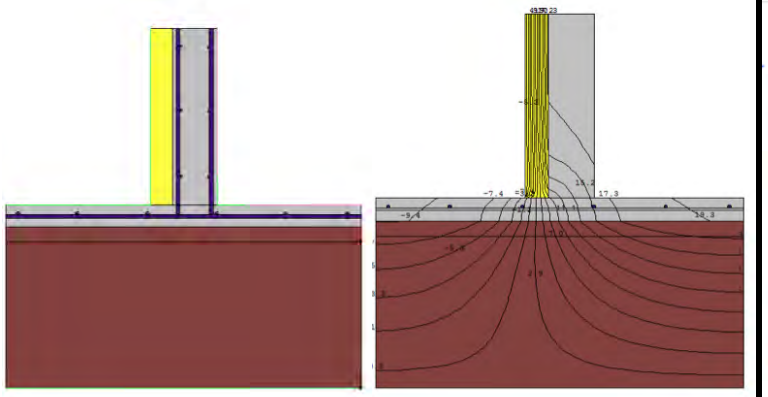
Balcony Slab



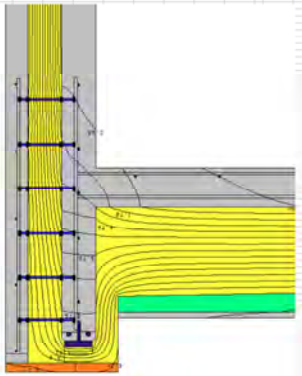
Typical Stair



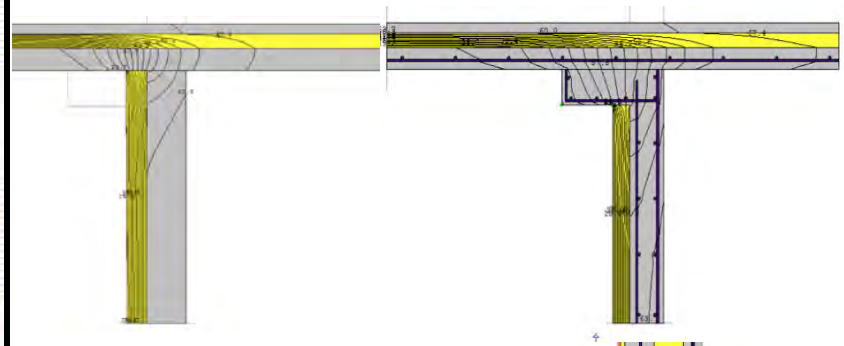
Guardrail @ Roof Parapet



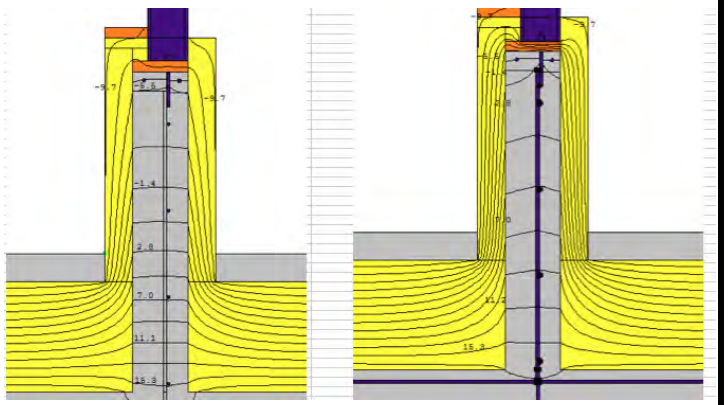
Stair Below Grade



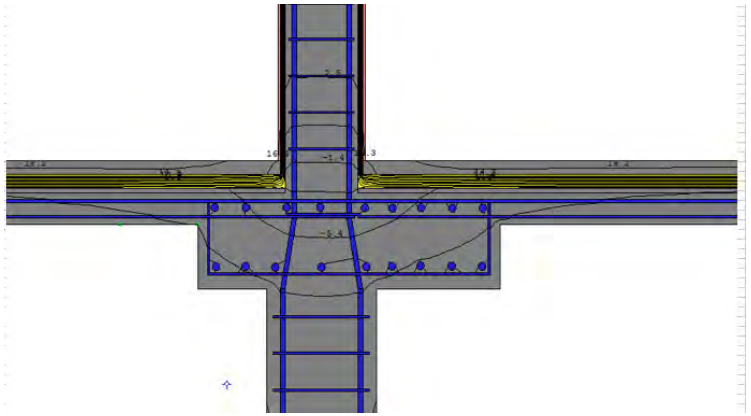
Roof Curb



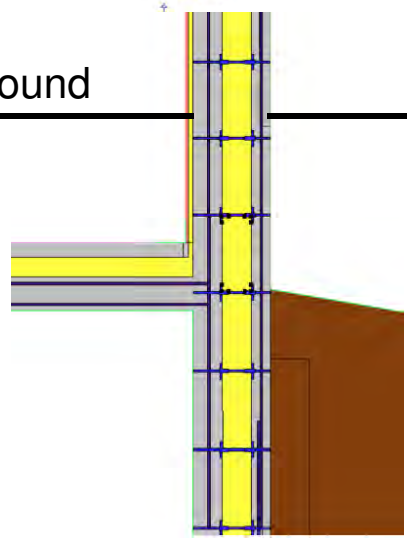
Stair @ Ground



Curb@ Greenhouse



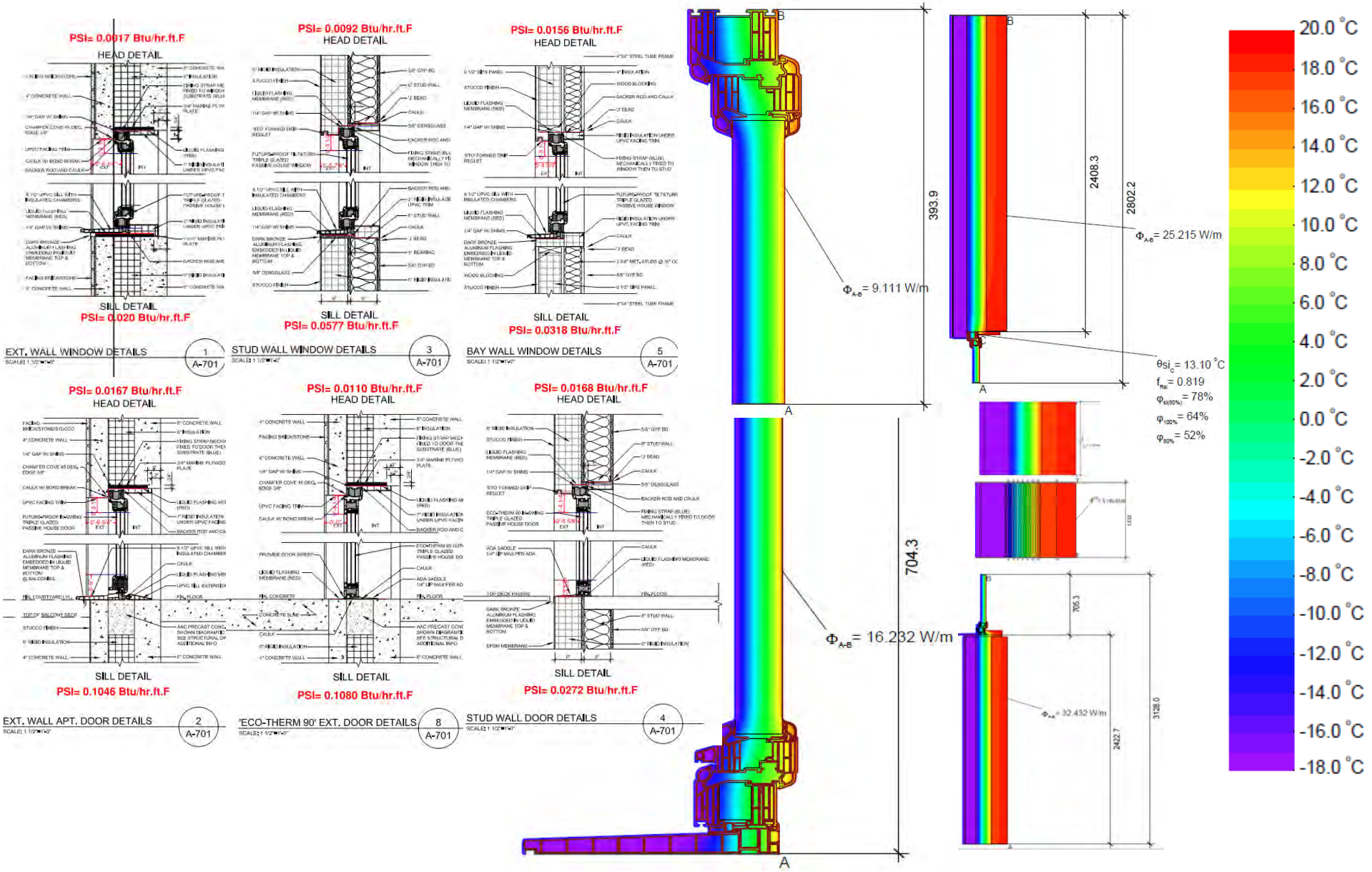
1st Floor Column@ Garage

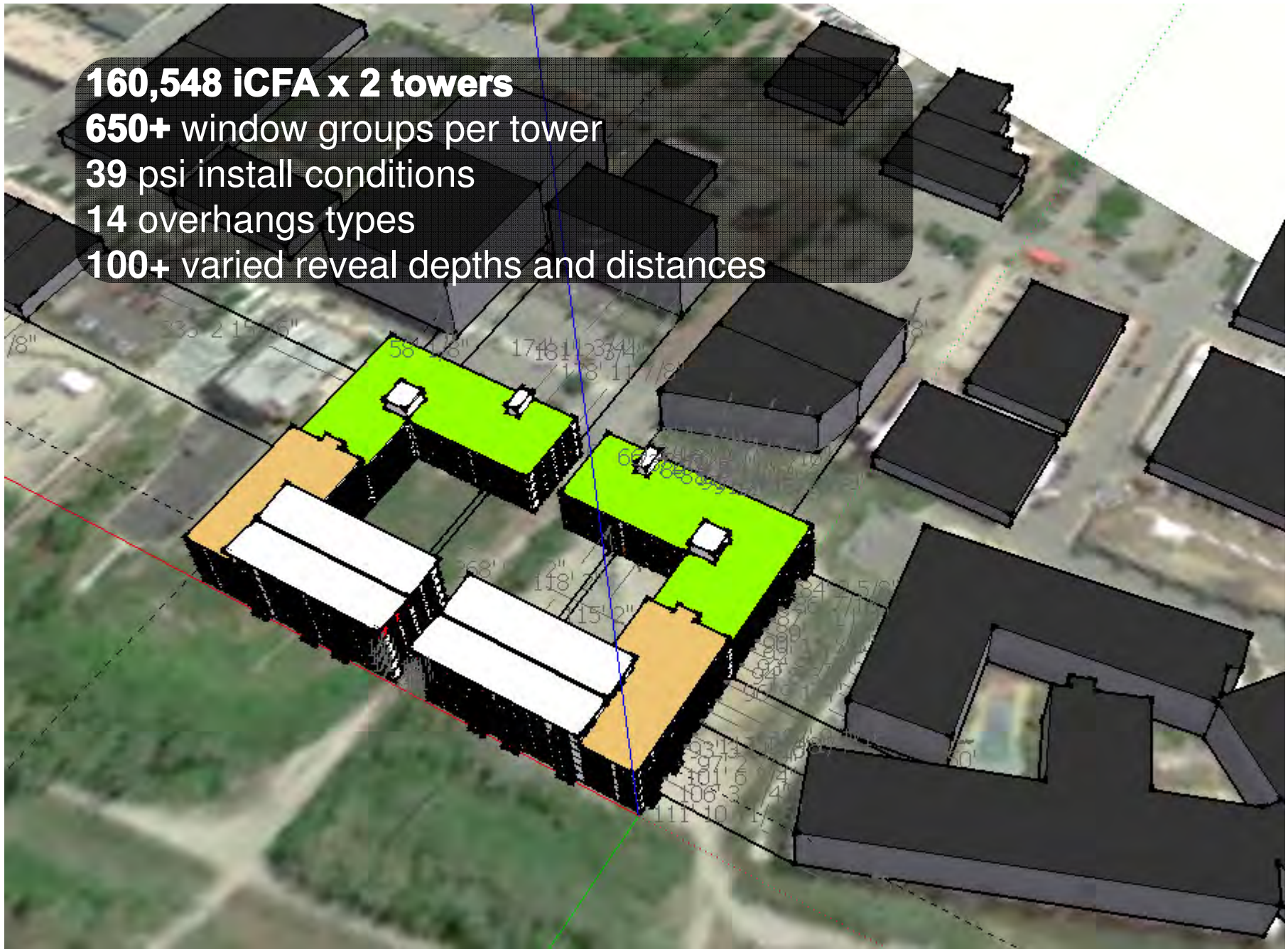


Ext Wall @ 1st Floor Garage

6 window installation details: 12 psi install factors,

fluid applied window air sealing




160,548 iCFA x 2 towers
650+ window groups per tower
39 psi install conditions
14 overhangs types
100+ varied reveal depths and distances

Challenge: Complexity

Workflow Solutions:

- Weekly meeting with entire team
- Slack + Share File + ProCore
- Creation and continual improvement of ‘standard work’ templates for Passiv Science/SE team to eliminate waste + optimize hand-off’s
  - Thermal Bridge Analysis + Reporting
  - WUFI Passive Mechanical Inputs
  - Utility Estimates
  - Natural Gas Cogen Calculator
  - Frequent standardized peer review and alignment between mechanical and passive energy models

Challenge 1: Complexity

Alignment/comparison of mechanical and passive models: (IES VE + WUFI Passive)

- Share sketchup file for geolocation and shading
- Enclosure and shading
- Appliances
- Occupancy (+schedules)
- Plug loads (+ schedules)
- DHW load (+ schedules)
- WUFI Passive – Compliance
- IES VE – Loads and Utilities

Challenge: Complexity

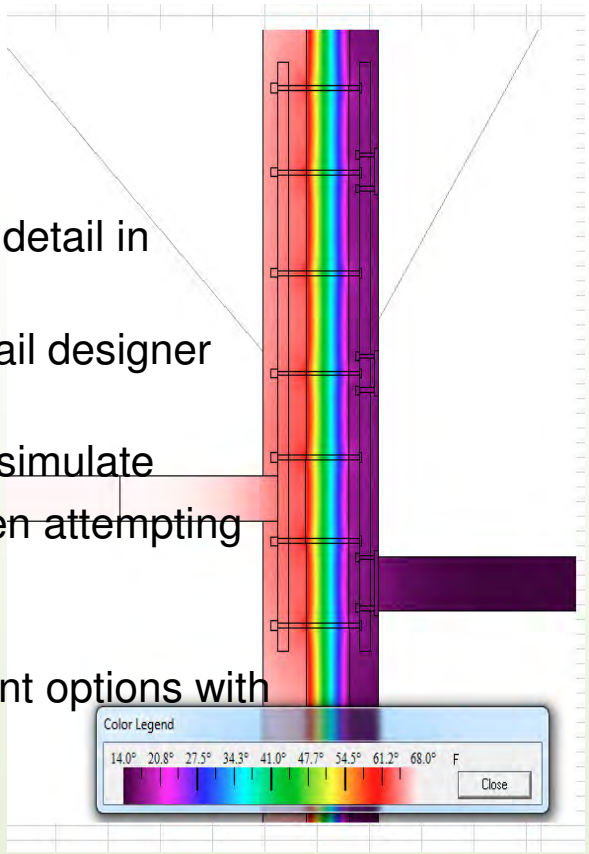
Lessons Learned:

- Design team shouldn't get ahead of construction pricing team
  - Because of HUD deadlines more drawings were done earlier then should have been
  - Pricing couldn't keep up with the mad dash on drawings, so there has to be a lot of rework to get pricing in line
  - Without artificial deadline, real time costing could have been employed. This is the approach we advocate - real time continuous cost model

Challenge: Complexity

Lessons Learned:

- Thermal Bridging Calcs
  - Dated and organized iterations of each detail in question is key
  - Single point of contact between the detail designer and the thermal bridge simulator
  - Finalize material properties before you simulate
  - Agree on a set of design strategies when attempting to improve details (stick to that set of strategies…rather than guessing)
  - It is always good to discuss improvement options with all team members

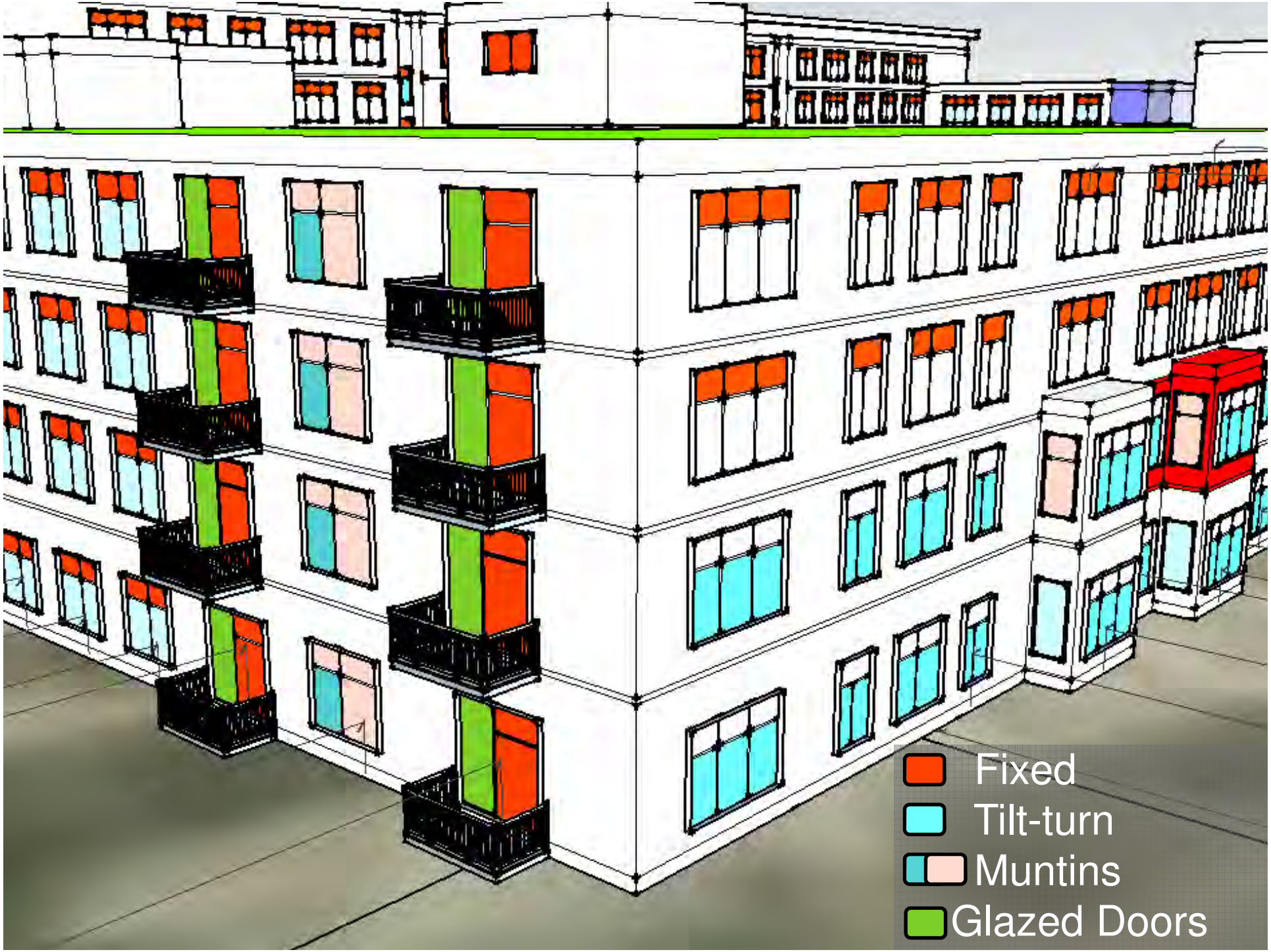


Update!! WUFI Updates will simplify

Challenge: Complexity

Lessons Learned:

- Complex Shading
  - Geometrical sketchup or other 3D model with color-coded windows is extremely helpful to refer to during modeling
  - Detailed window modeling to allow yourself and certifiers to check entries against label works best
    - **W1-5a FX@Conc Wall A-701/1 Zone 1 - 1001 - 32.15@26.59**
    - W1 - Façade
    - 5a – Floor + position for overhang/head reveal
    - FX - fixed window type
    - @Conc Wall A-701/1 installation detail for base reveal depth
    - Zone 1 – if multi-zone model
    - 1001 – install code
    - 32.15@26.59 – distance/height of horizontal obstruction

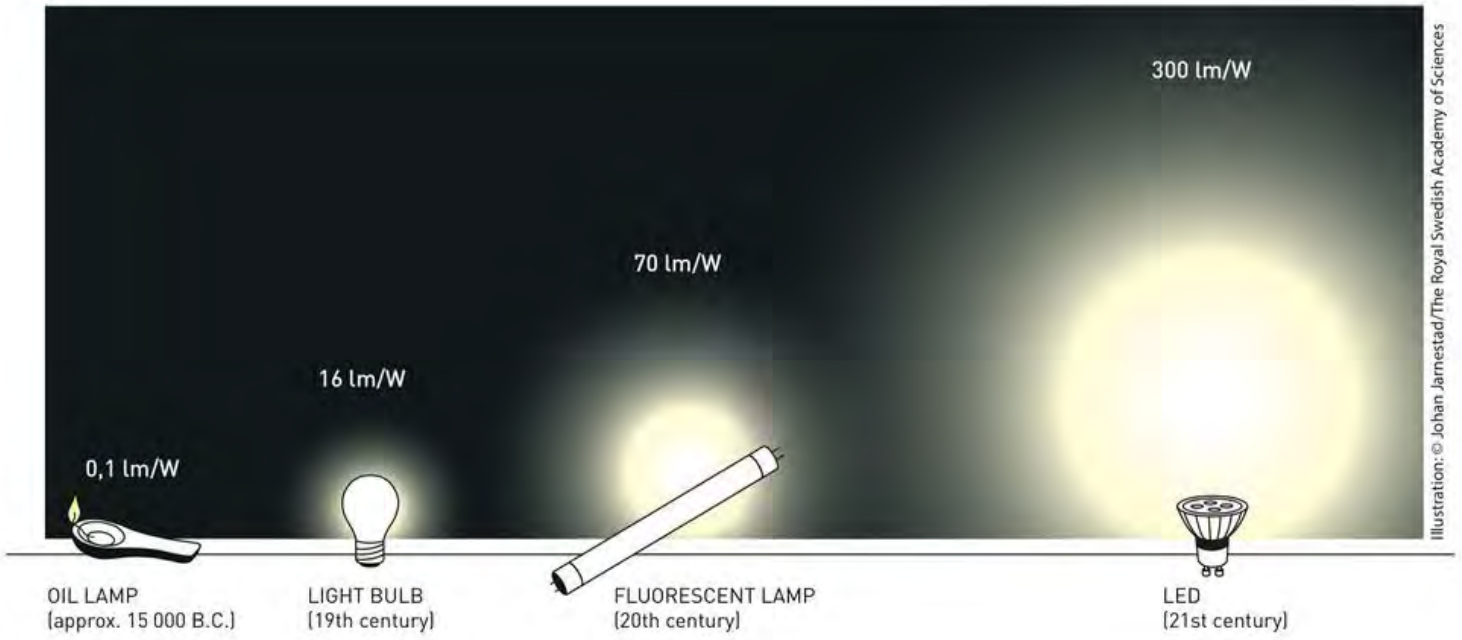

Fixed
Tilt-turn
Muntins
Glazed Doors

Challenge: Appliance Efficiency

AS GOOD AS IT GETS…FOR NOW

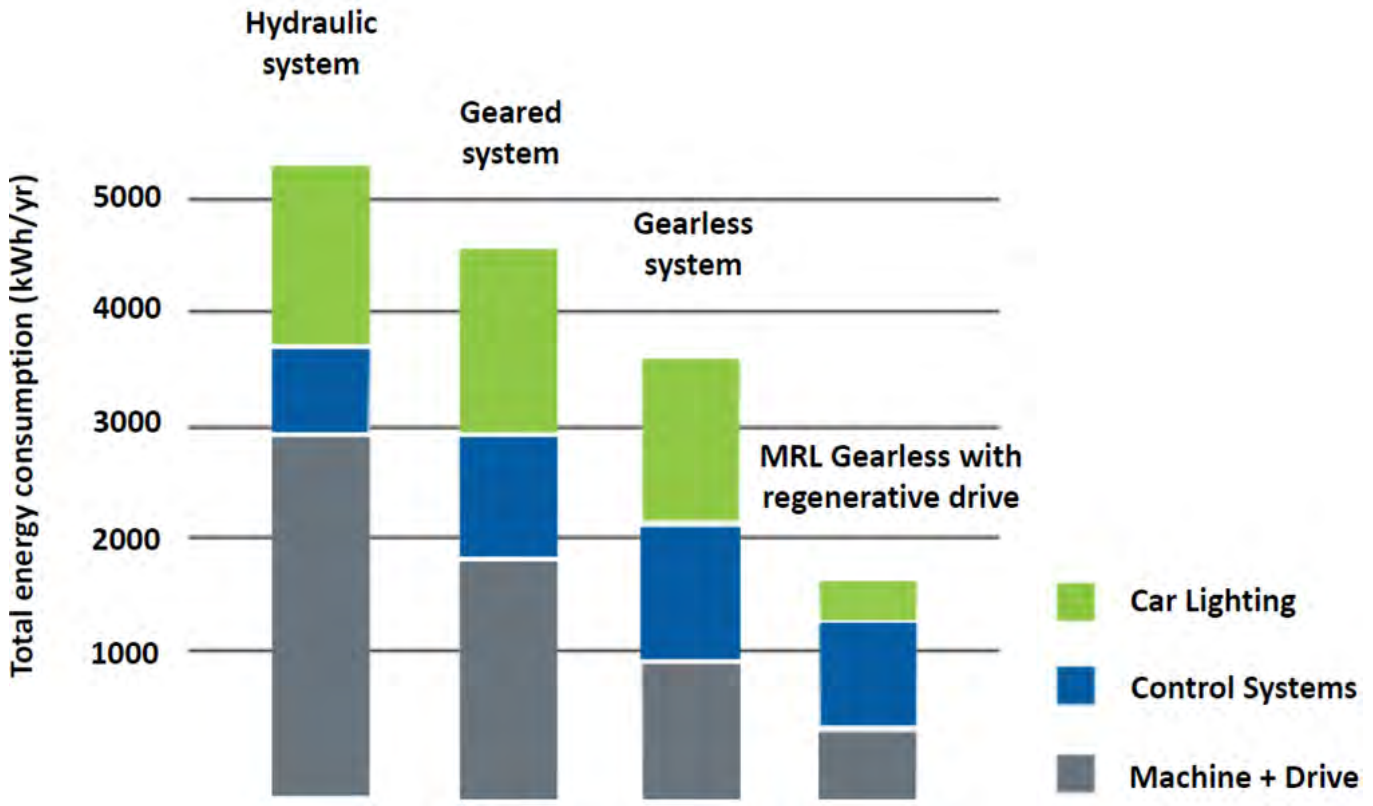
Dishwasher:	Bosch - SHE9ER5*UC	0.93 kWh/use
Washer:	Speed Queen - LFNE5BJP113+	0.17 kWh/use
Dryer:	Whirlpool WED99HED HP Dryer	2.03 kWh/use
Fridge/freezer:	Frigidaire FFHT1814Q*	1.1 kWh/day

Challenge: Lighting Efficiency



Where do you go beyond 100% LED lighting?

Challenge: Elevator Efficiency



(Source: http://www.otisworldwide.com)

Challenge sum(a:c): Monster Internal Gains

Challenge 3: Internal Gains - Project History

✓Project started using Passivhaus Criteria, then transitioned to PHIUS+ 2015

March 2014 First Energy Model: Passivhaus Criteria	Design Development ensues for the next 11+ months	PHIUS+ 2015 Criteria introduced	Feb 2015 Model updated to PHIUS+ Protocols	Comparison of PHIUS+ model to earlier Passivhaus model

Count on IHG of at least 1 Btu/hr.ft^2

Challenge 3: Efficiency of Internal Loads

Solutions & Lessons Learned: Model These on 1st Pass!

- CPHC-driven appliance performance spec to meet PE
  - Do your homework, know energy star baseline and most efficient for each appliance type
  - **Don't use defaults! Model with ES baseline first, then adjust to optimize**
- ALWAYS calculate actual lighting energy
  - PHPP 100% high efficacy @2900hr/P severely underestimates (11%) PHIUS+ can be 30% greater than LPD 0.75 W/ft2 for common areas
  - At start of project use PHIUS+ calc or a conservative LPD as a placeholder
- Don't forget the elevator(s)
  - Min 1900 kWh/yr as placeholder. Look for low standby energy
  - Calculate trips per year to determine kWh use

PHIUS+ LIGHTcomm @100% high efficacy ≈ 30% higher than actual with LED.
PHIUS+ LIGHTdwell @100% high efficacy ≈ actual lighting.

Lighting Reality Check: PHIUS+ vs Actual

Space Type	Fixture Label	Quantity	LED Wattage per Fixture	Total Watts per Fixture per Space	Total Watts per Space	Area (ft^2)	Watts per tower	Hours/yr	kWh/yr	W/ft^2
First Floor Corridor	R1	66	15	990	2,640	8,647	1,320	8,760	11,563	0.31
	R2	18	45	810						
	R3	46	10	460						
	R5	2	10	20						
	P2	8	45	360						
Typical Floor Corridor	R1	68	15	1,020	2,340	7,789	3,510	8,760	30,748	0.30
	R2	16	45	720						
	R3	60	10	600						
Fifth Floor Corridor	R1	36	15	540	1,200	3,960	600	8,760	5,256	0.30
	R2	8	45	360						
	R3	30	10	300						
Fifth Floor Rooftop	SA	7	16	112	205	6,478	103	4,380	449	0.03
	SB	31	3	93						
Sixth Floor Corridor	R1	16	15	240	1,390	2,228	695	8,760	6,088	0.62
	R2	22	45	990						
	R3	16	10	160						
Sixth Floor Rooftop	SA	6	16	96	576	3,418	288	4,380	1,261	0.17
	SB	16	3	48						
	SD	4	108	432						
Rooftop Elevator Lobby	P6	2	36	72	72	31	36	8,760	315	2.32
Staircase	W2	2	29	58	58	180	29	8,760	254	0.32
Elevator	W3	2	15	30	30	63	15	8,760	131	0.47
Utility Rooms	W2	1	29	29	29	50	15	365	5	0.58

PHPP @100% high efficacy = Only 11% of actual lighting energy - <u>BEWARE!</u>

PHIUS+ MELcomm ≈ estimated actual
PHIUS+ MELdwell ≈ +/- 5% estimated actual

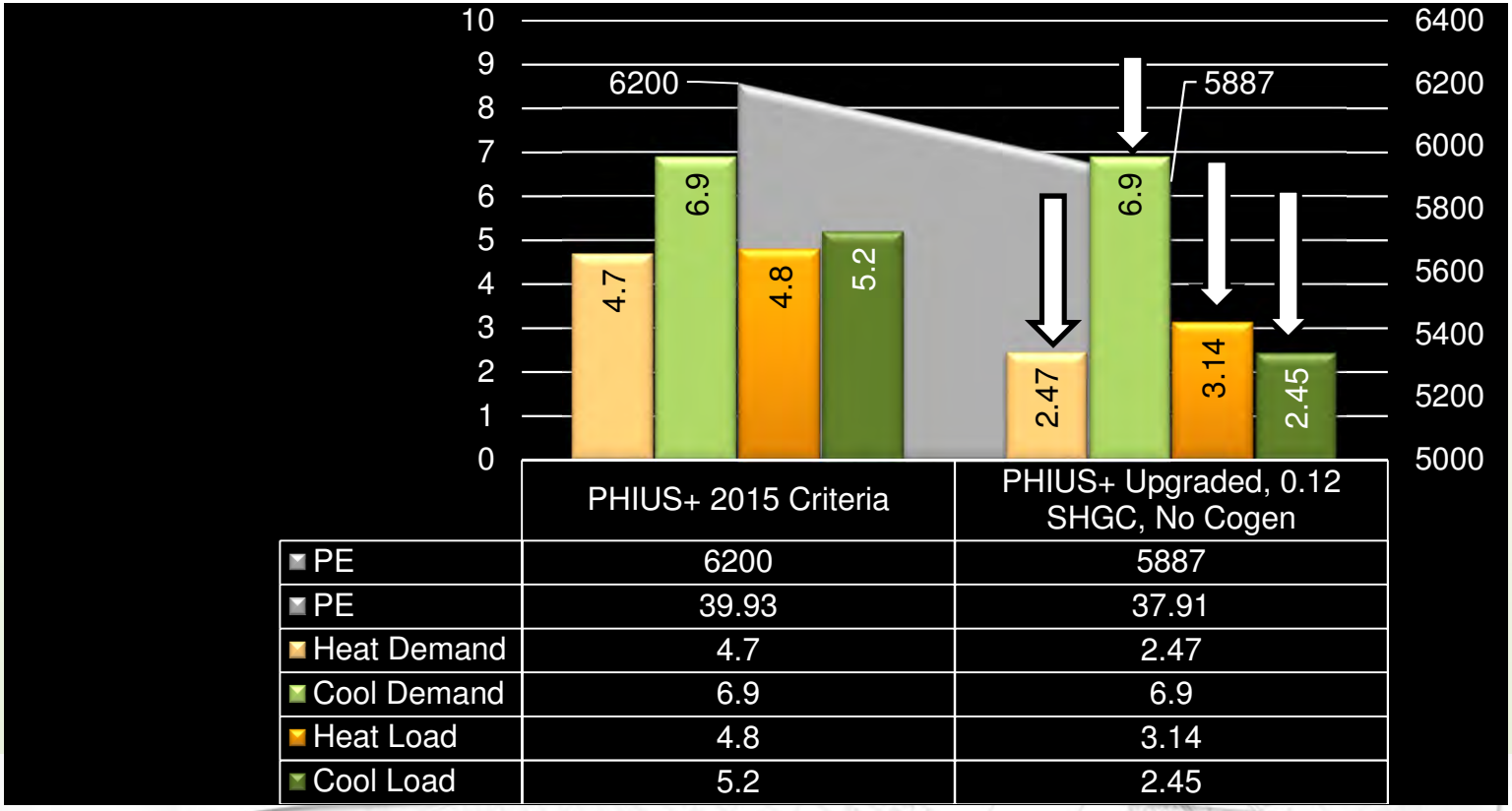
Plug Load Reality Check: PHIUS+ vs Actual

Room	Area (ft^2)	Loads	Load Consumption		UOM	ASHRAE Heat Gain (btuh)				
						Rated	Standby	1	2	3
Kitchen / LR	700	Refrigerator	295	watts/hr			1008	0.25	0.25	0.25
		Dishwasher	32	watts/hr		1302		0	0	0
		Electric Oven	55	watts/hr		8189		0	0	0
		Range - Induction	112	watts/hr		9167		0	0	0
		Microwave	67	watts/hr		10900		0	0	0
		Toaster	33	watts/hr		18080		0	0	0
		Coffee Maker	4	watts/hr		3413	0	0	0	0
		Range Hood Fan	4	watts/hr		341	0	0	0	0
		Computer	15	watts/hr		222	15	0	0	0
		Printer	4	watts/hr		61	14	0	0	0
		Monitor	5	watts/hr		92	3	0	0	0
		Modem\Router\DVR	40	watts/hr		0	136	1	1	1
		TV	8	watts/hr		92	10	0	0	0
		Max Load	**2.90**	**w/sqft**				**12**	**12**	**12**
		Max Load	**2.03**		**kW**	**Schedule %**		**0.6%**	**0.6%**	**0.6%**

PHPP 'Plug Load + Small App' Defaults = Only 57% of estimated actual -BEWARE!!

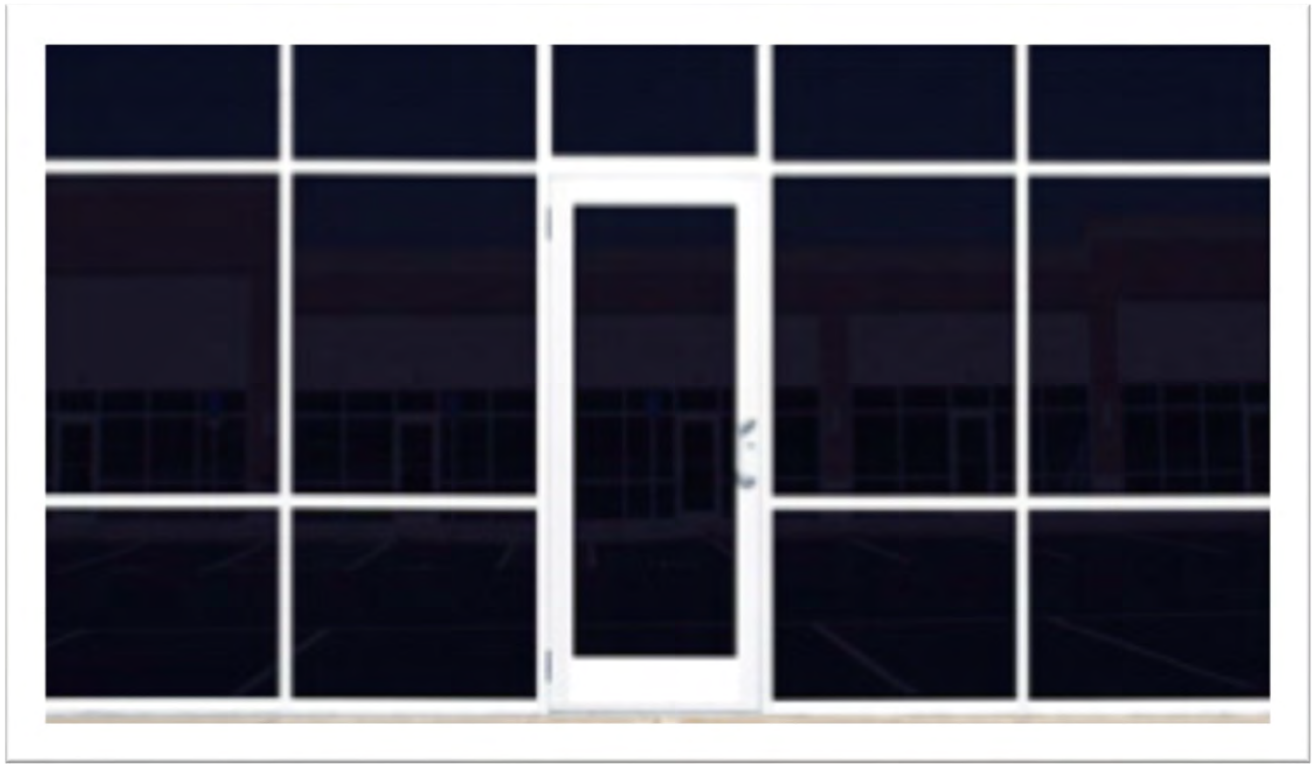
PHIUS+ Optimization Waypoint

- NOW All internal gains are in the model. I made it comply…..but I did not like the required measures



	PHIUS+ 2015 Criteria	PHIUS+ Upgraded, 0.12 SHGC, No Cogen
PE	6200	5887
PE	39.93	37.91
Heat Demand	4.7	2.47
Cool Demand	6.9	6.9
Heat Load	4.8	3.14
Cool Load	5.2	2.45

Challenge: The right glazing /shading



Challenge: The right glazing /shading

Progression and Lessons Learned:

- 1- PHPP defaults for internal loads placeholder (BAD IDEA)
  - 0.37 SHGC was best fit with summer screens, but caused severe overheating once accurate lighting and plug loads were modeled
- 2- Transition to PHIUS+ was a wake-up call
  - Holy internal gains! 0.17 SHGC with 83% solar reflective bug screen was only way to meet PHIUS+ ACD criteria.(=0.12 SHGC)TOO DARK!
  - **0.17 SHGC AVAILABLE, BUT NOT IDEAL!**

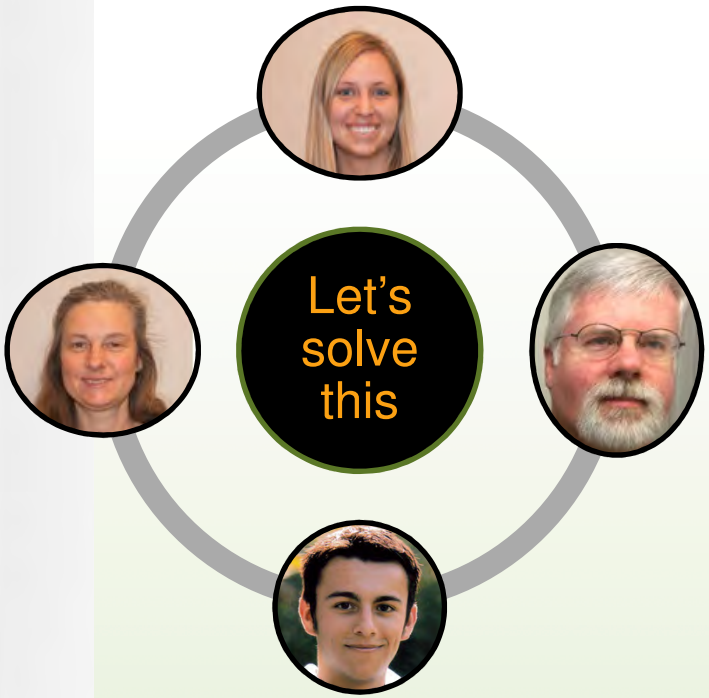
PHIUS+ Multifamily

2nd + DE

PHIUS

Passive House Institute US

Subject: HELP!!



- Lighting can't get more efficient. All LED!
- Appliances can literally not get more efficient. Best Energy Star has for 2016…
- We've got 193 kWh of PV production and no budget for more…
- ERV efficiency and humidity recovery is as high as we can find…
- The internal gains are the issue, not the solar gains, but if I go to 0.12 SHGC, we can comply, but…
- 0.12 is too LOW! No daylight. We really need to look at this issue.
- Dynamic effects of thermal mass aren't reflected in static model, actual peaks will be lower, thus demand lower

Final Glazing Spec: U-0.09, 0.33 SHGC, Tvis 50%+ (no screens, no film, no fins)

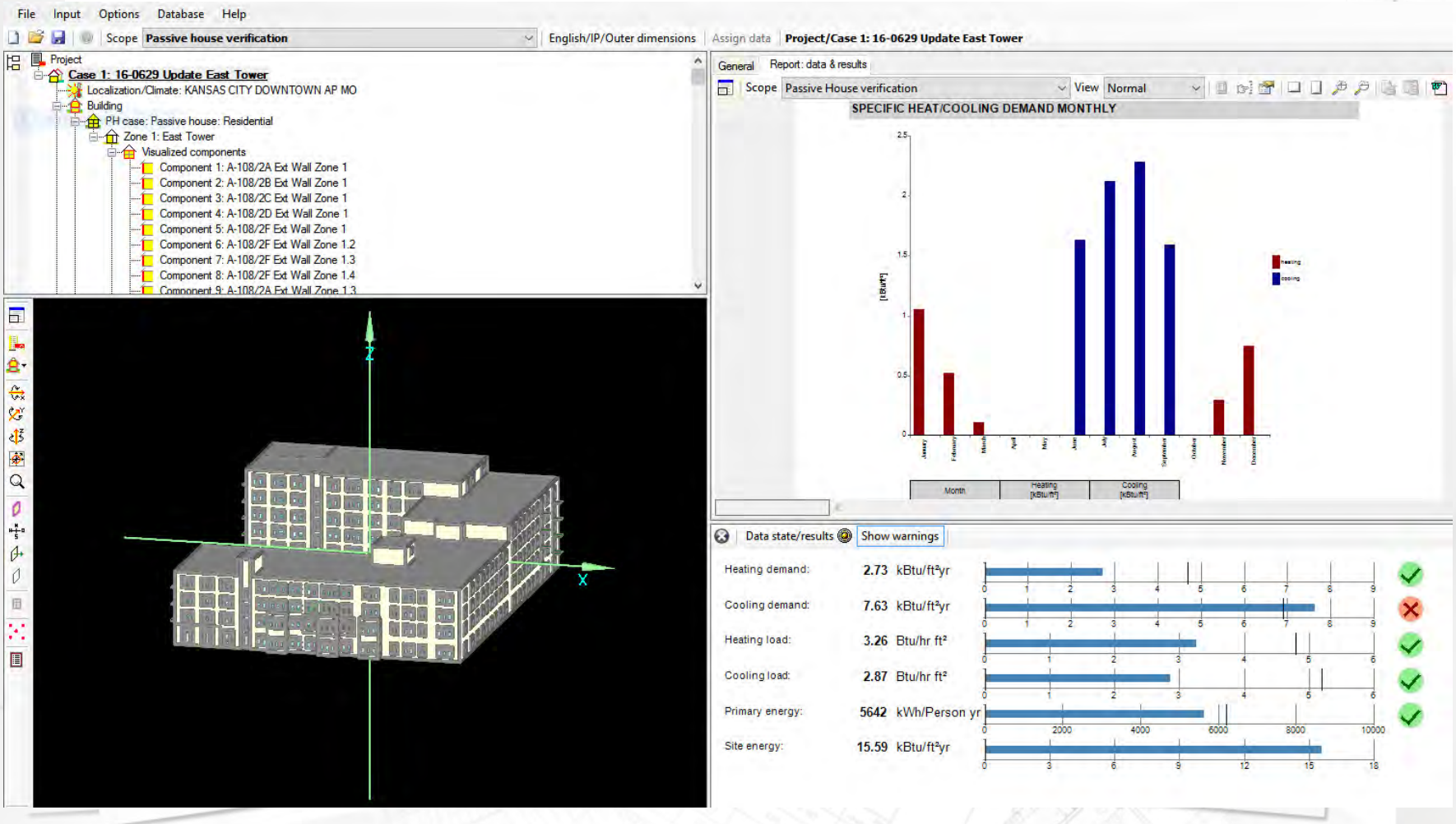
BEWARE! Modeled result to meet criteria does not necessarily equate to good design

PERFORMANCE + COMPARISONS

PHIUS+ Multifamily

2nd + DE

30+ cases

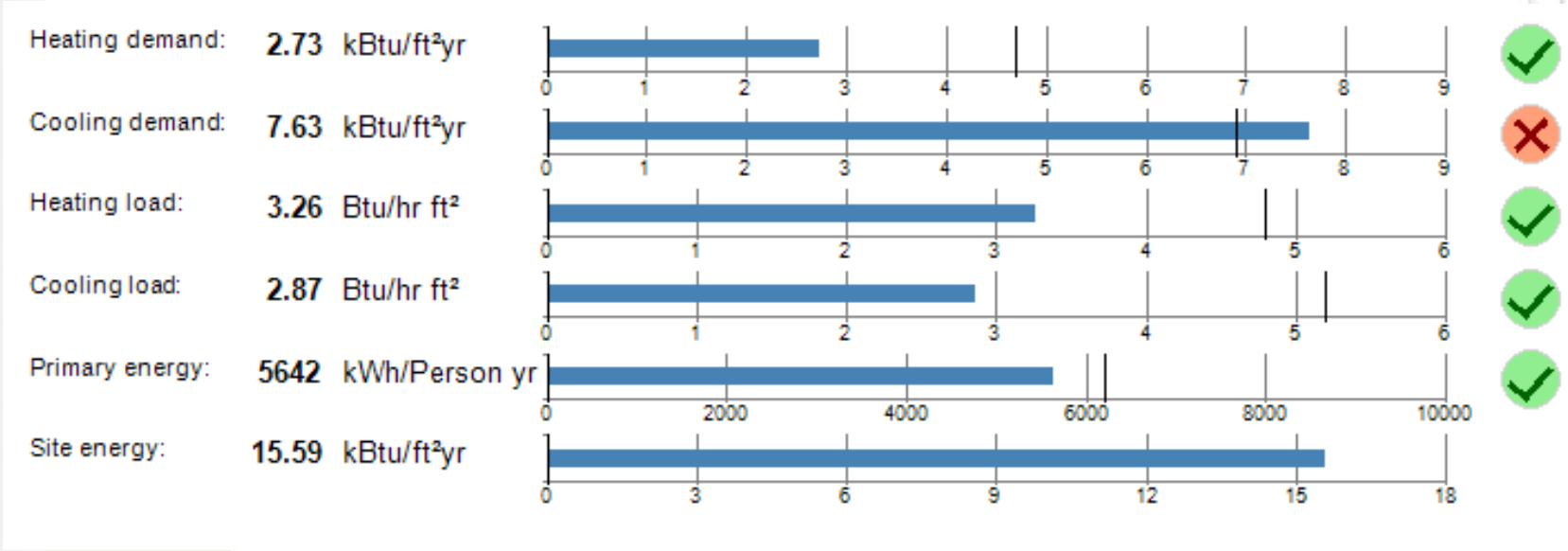


PHIUS+ Multifamily

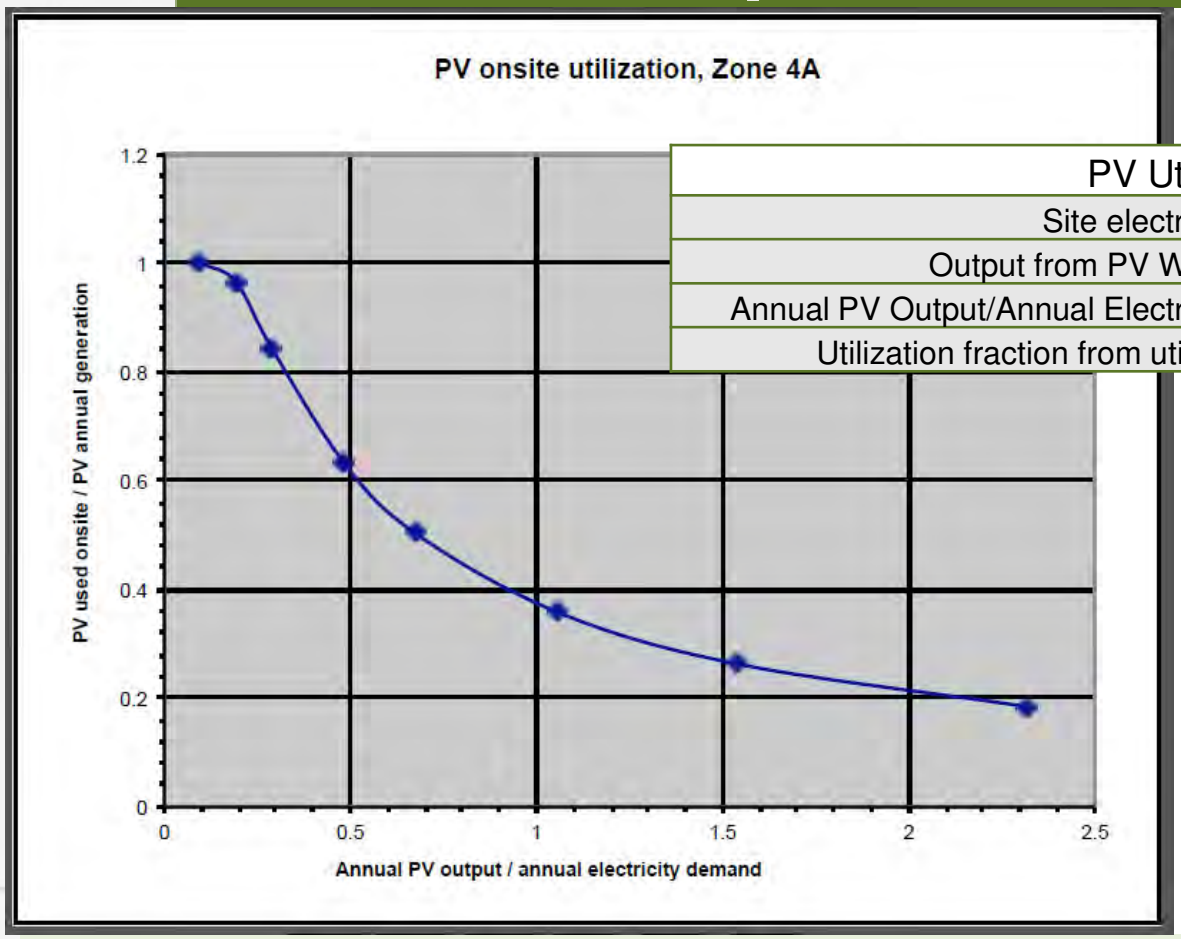
2nd + DE

Final Modeled Results

- PE below without cogen
- With cogen PE = lower



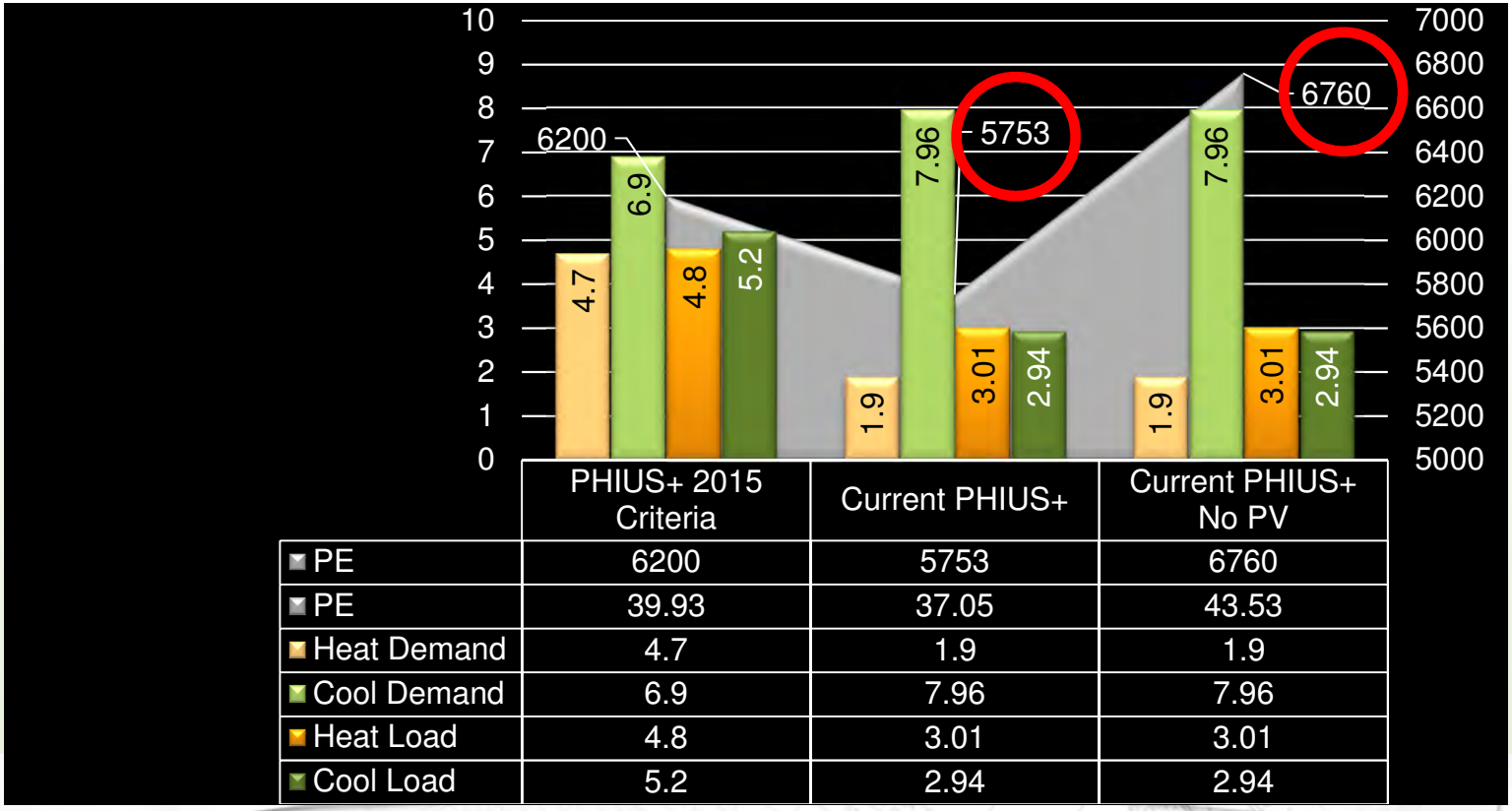
PV Utilization [i.e.credit claimed in model]



PV Utilization	
Site electricity (kWh/yr)	2634592.68
Output from PV Watts (kWh/yr)	96487
Annual PV Output/Annual Electricity Demand	0.04
Utilization fraction from utilization curve	1

Impacts of PV

- If we didn't have solar, PE would be blown and no room to move SHGC upwards for better Tvis



	PHIUS+ 2015 Criteria	Current PHIUS+	Current PHIUS+ No PV
PE	6200	5753	6760
PE	39.93	37.05	43.53
Heat Demand	4.7	1.9	1.9
Cool Demand	6.9	7.96	7.96
Heat Load	4.8	3.01	3.01
Cool Load	5.2	2.94	2.94

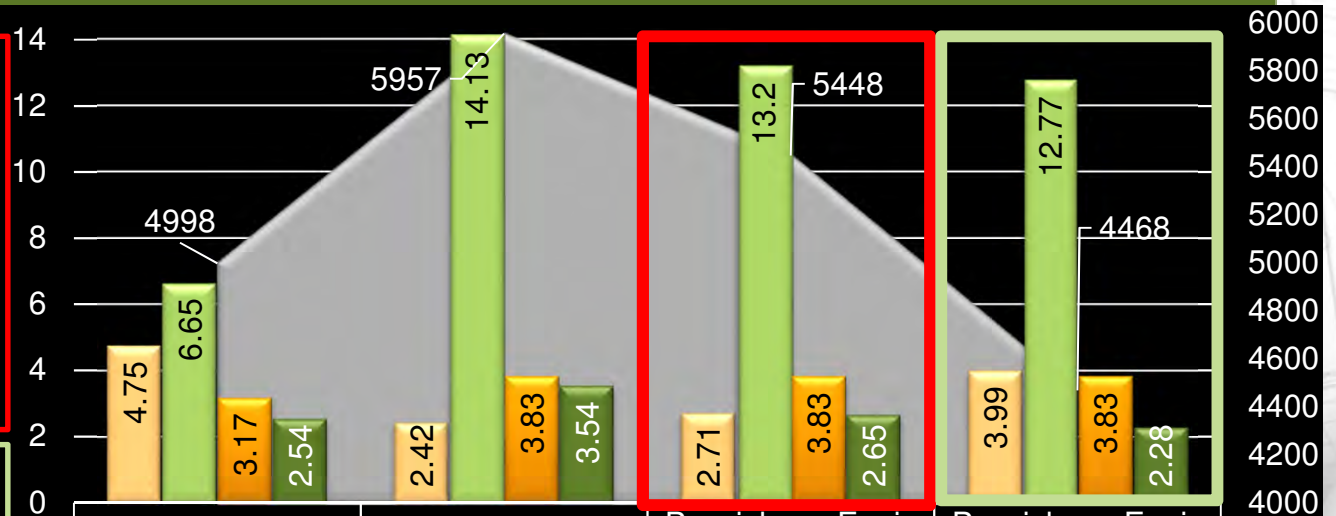
PHIUS+ Multifamily

2nd + DE

How to meet Passivhaus PE Criteria (38 kBtu/ft2/yr)?

Optimization 1
1. Lower DHW to 6.6
2. Summer shutters
3. Eliminate:
   - Washers
   - Dryers
   - Dishwashers
   - Elevators
   - Ext lighting
   - Garage lighting

Optimization 2
1. Undo above
2. Reduce lighting kWh by 90% by using PHPP lighting@11 W setting



	Passivhaus Criteria	Passivhaus Equiv of Current	Passivhaus Equiv of PHIUS+ "Optimized" to comply 1	Passivhaus Equiv of PHIUS+ "Optimized" to comply 2
PE	4998	5957	5448	4468
PE	38	45.29	41.42	33.97
Heat Demand	4.75	2.42	2.71	3.99
Cool Demand	6.65	14.13	13.2	12.77
Heat Load	3.17	3.83	3.83	3.83
Cool Load	2.54	3.54	2.65	2.28

PHPP 7 cooling algorithm

COOLER CLIMATES
PHFA PROJECTS

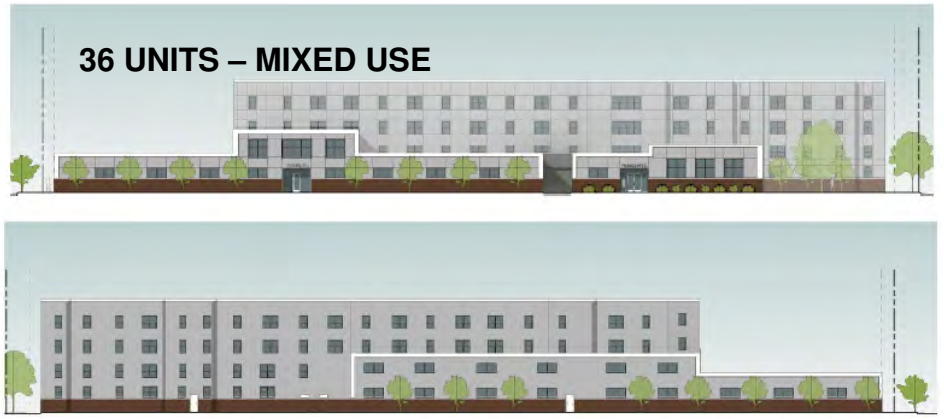
52 UNITS

43 UNITS

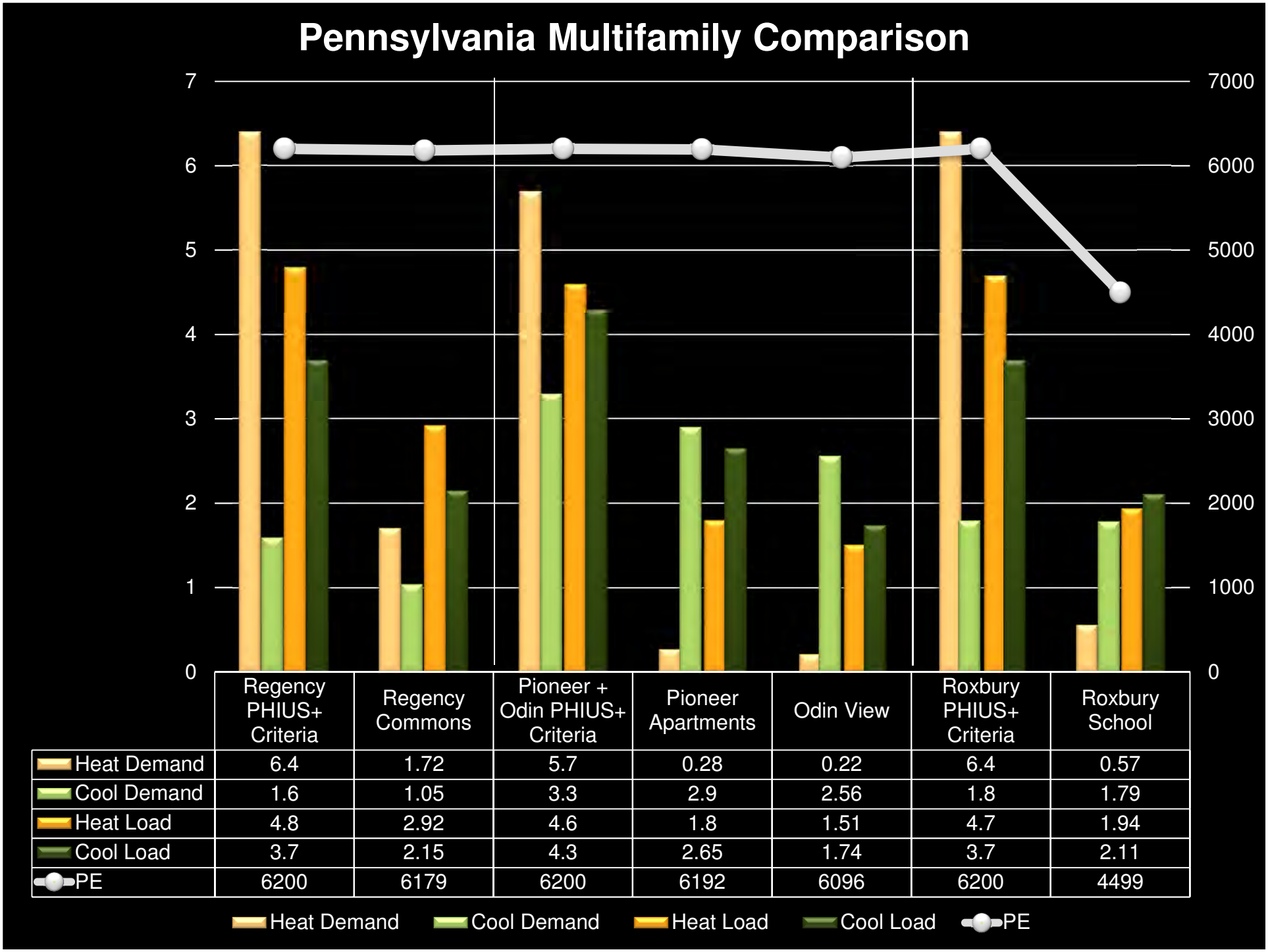
47 UNITS

48 UNITS

36 UNITS – MIXED USE



Pennsylvania Multifamily Comparison



	Regency PHIUS+ Criteria	Regency Commons	Pioneer + Odin PHIUS+ Criteria	Pioneer Apartments	Odin View	Roxbury PHIUS+ Criteria	Roxbury School
Heat Demand	6.4	1.72	5.7	0.28	0.22	6.4	0.57
Cool Demand	1.6	1.05	3.3	2.9	2.56	1.8	1.79
Heat Load	4.8	2.92	4.6	1.8	1.51	4.7	1.94
Cool Load	3.7	2.15	4.3	2.65	1.74	3.7	2.11
PE	6200	6179	6200	6192	6096	6200	4499

CONCLUSIONS

In Summary…

LEAN and IPD can help minimize waste associated with complexity… not just for construction folk

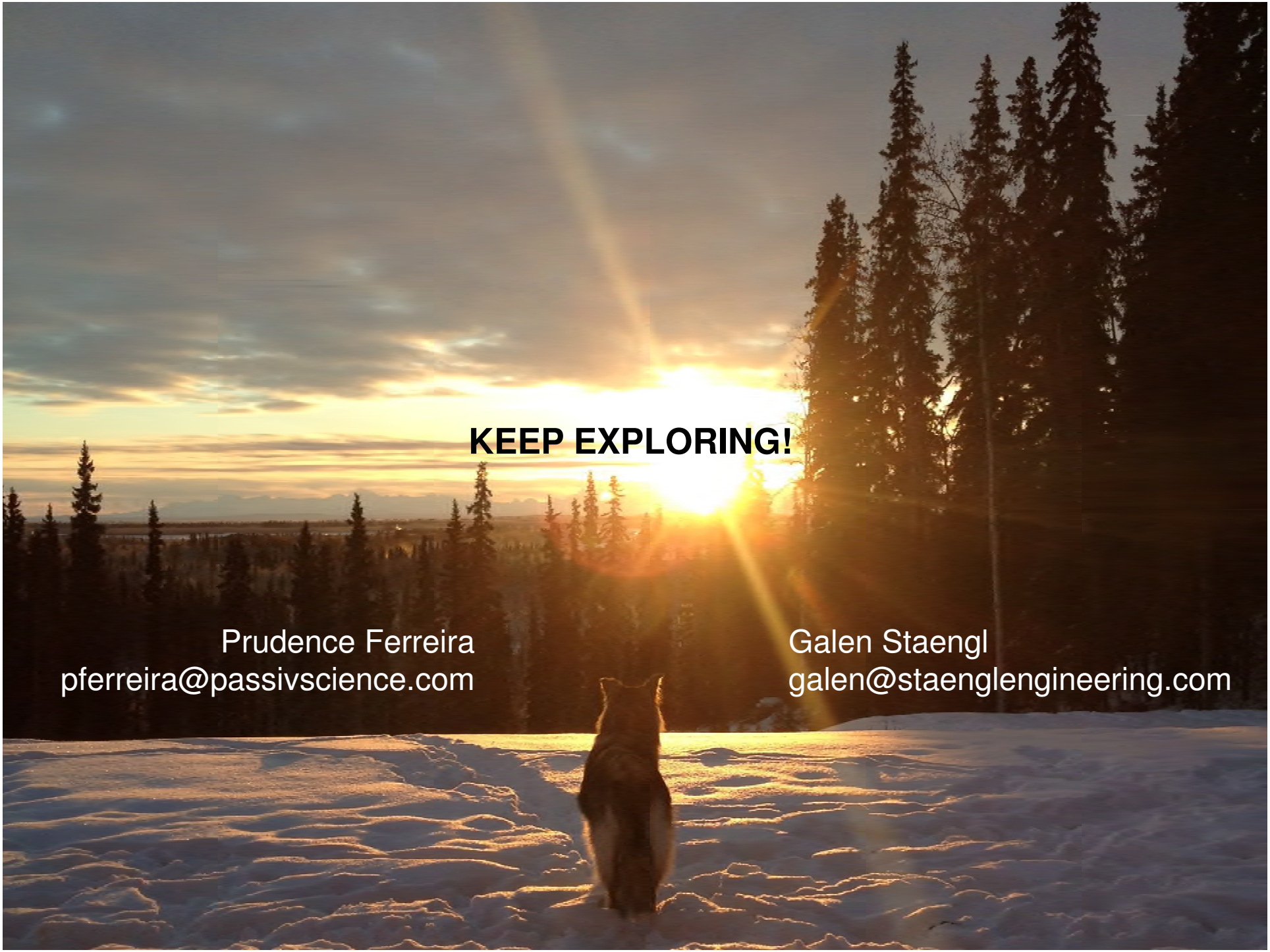
Harmonization of passive compliance and dynamic HVAC models is imperative.

Accurate accounting of internal gains in multifamily is critical for comfort and utility estimates

MF is more difficult in mixed humid and humid climates

More Info on 2+D and Multifamily

http://multifamily.phius.org/case-study/second-and-delaware



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