Crabtree Hall Redesign Project

BHV Engineering, Inc.

April 15th, 2019

Meet our Team!

- **Kelsey Prem:** Project Manager, Construction Management Team
- **Todd Allen-Gifford:** Construction Management Team
- **Andrew Woodhouse:** Transportation Lead
- **Abby Fenn:** Geotechnical Lead
- **Samantha Chaudhari:** Structures Team
- **Sarah Chaudhari:** Structures Team
- **Julie Hoffman:** Structures Team
- **Nathaniel King:** Structures Team

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Presentation Overview

Introduction	• Scope, floor plans, architecture
Geotechnical	• Soil conditions, foundation design
Structural	• Building, auditorium, shear wall, pedestrian bridge
Transportation	• Traffic plans, intersection improvement, streetscape
Construction Management	• Logistics, schedule, estimate

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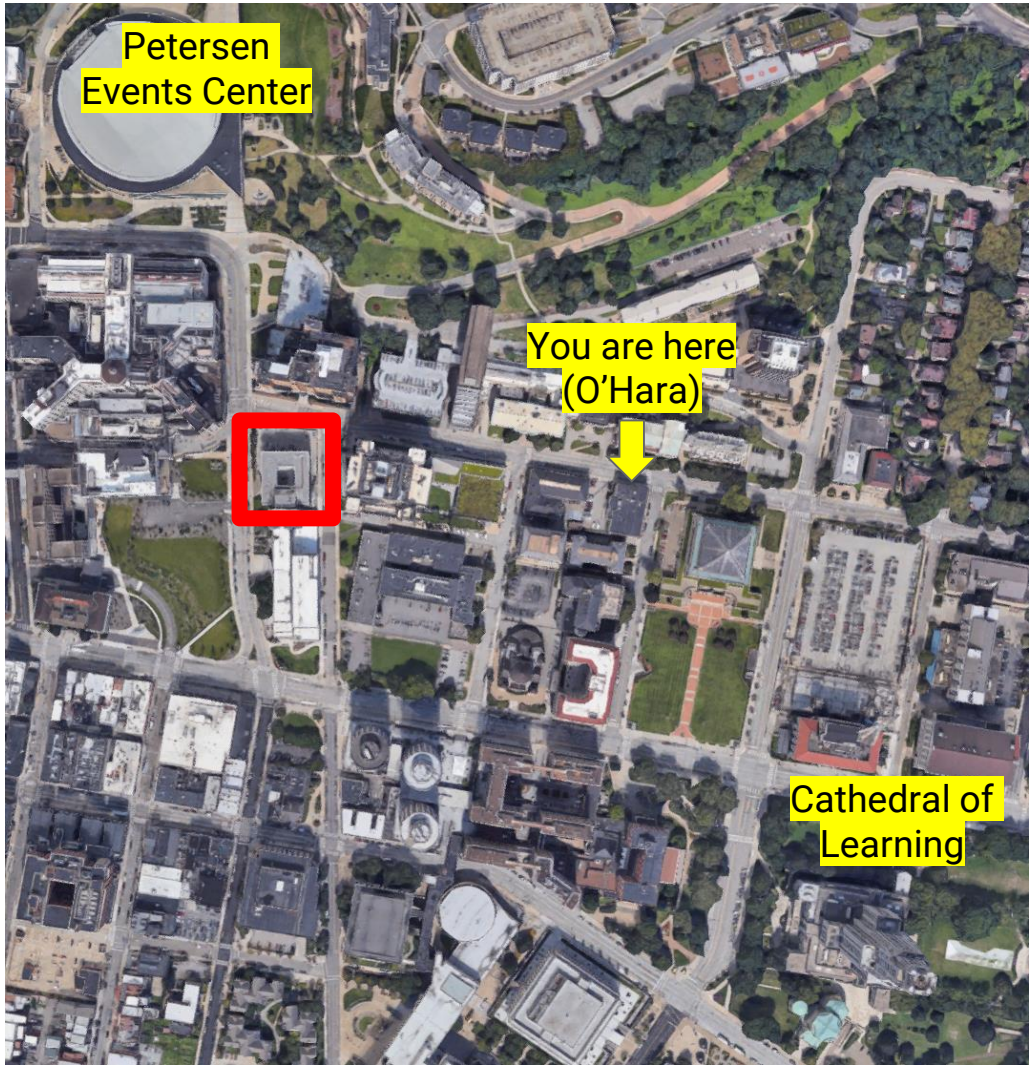
Introduction

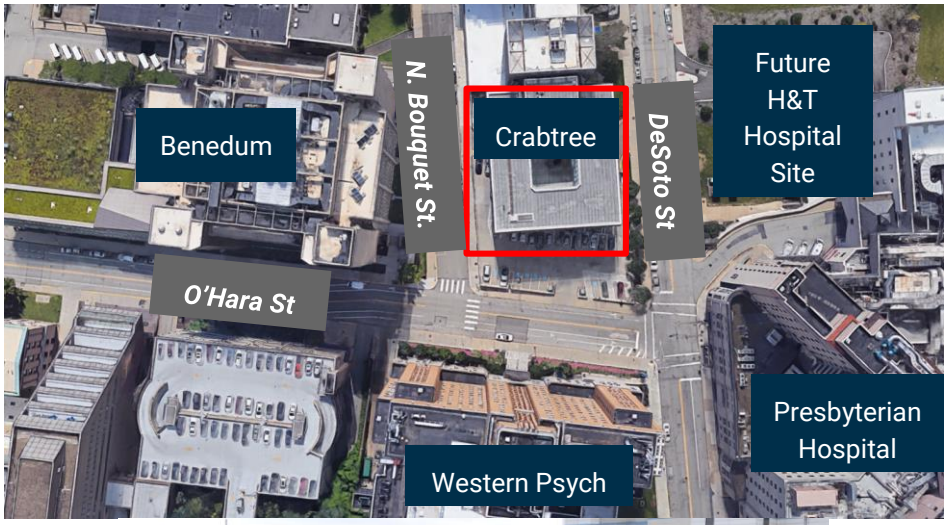
Current Site



Current Site

Crabtree Hall is...

- Mainly used by University of Pittsburgh School of Public Health
- Connected to adjacent building
- Seven floors
  - Academic
  - Parking
- In poor condition



Client Needs

- New academic building including classrooms, offices, and lab spaces
- Large auditorium
- On campus dining facilities
- Modern architecture
- Walkable streetscape
- Improve East-West connectivity of campus

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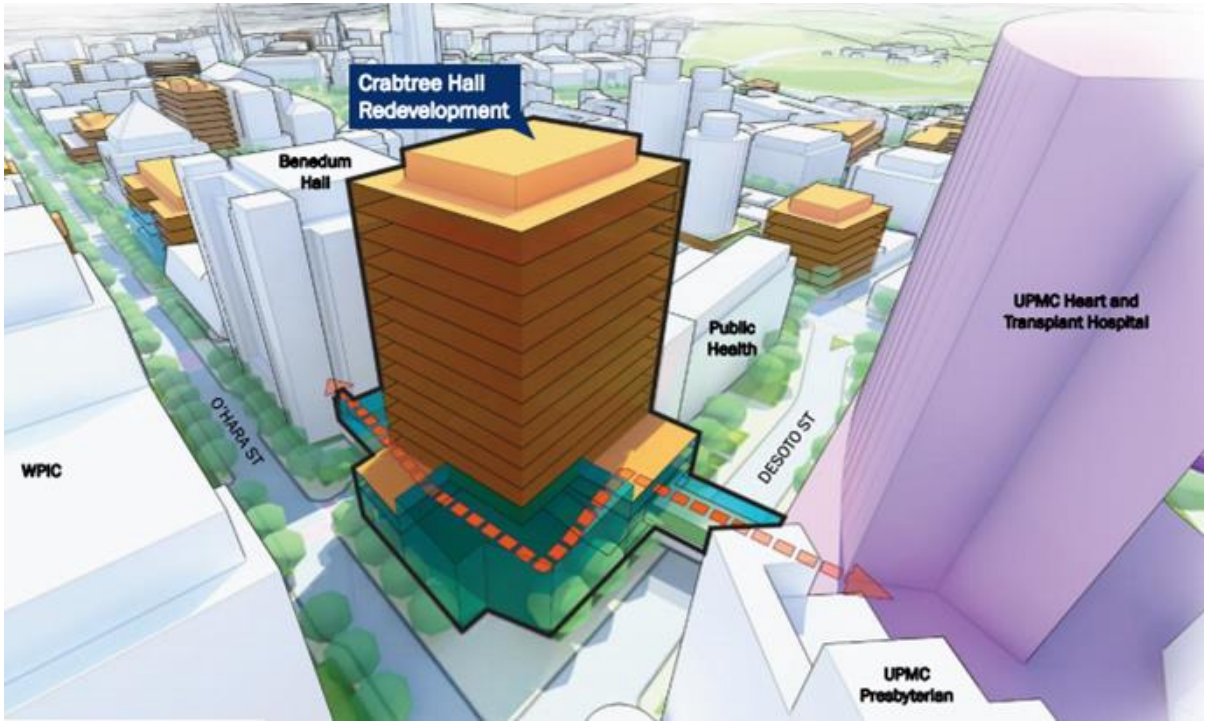
Project Scope

- Complete demolition of current Crabtree site
- Design new Crabtree Hall
- Pedestrian bridges to Benedum Hall and new UPMC development
- Improved streetscape and intersection signaling



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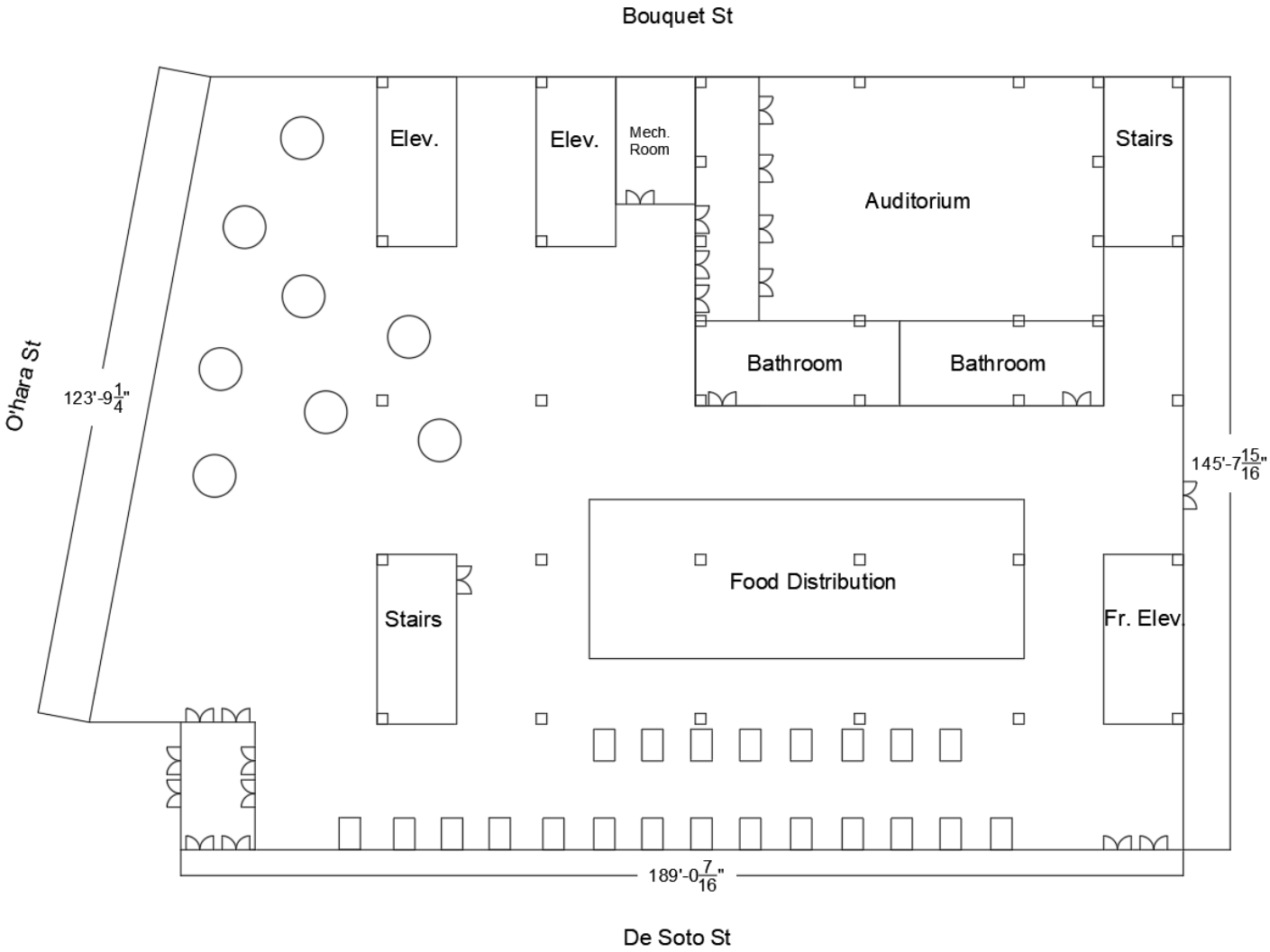
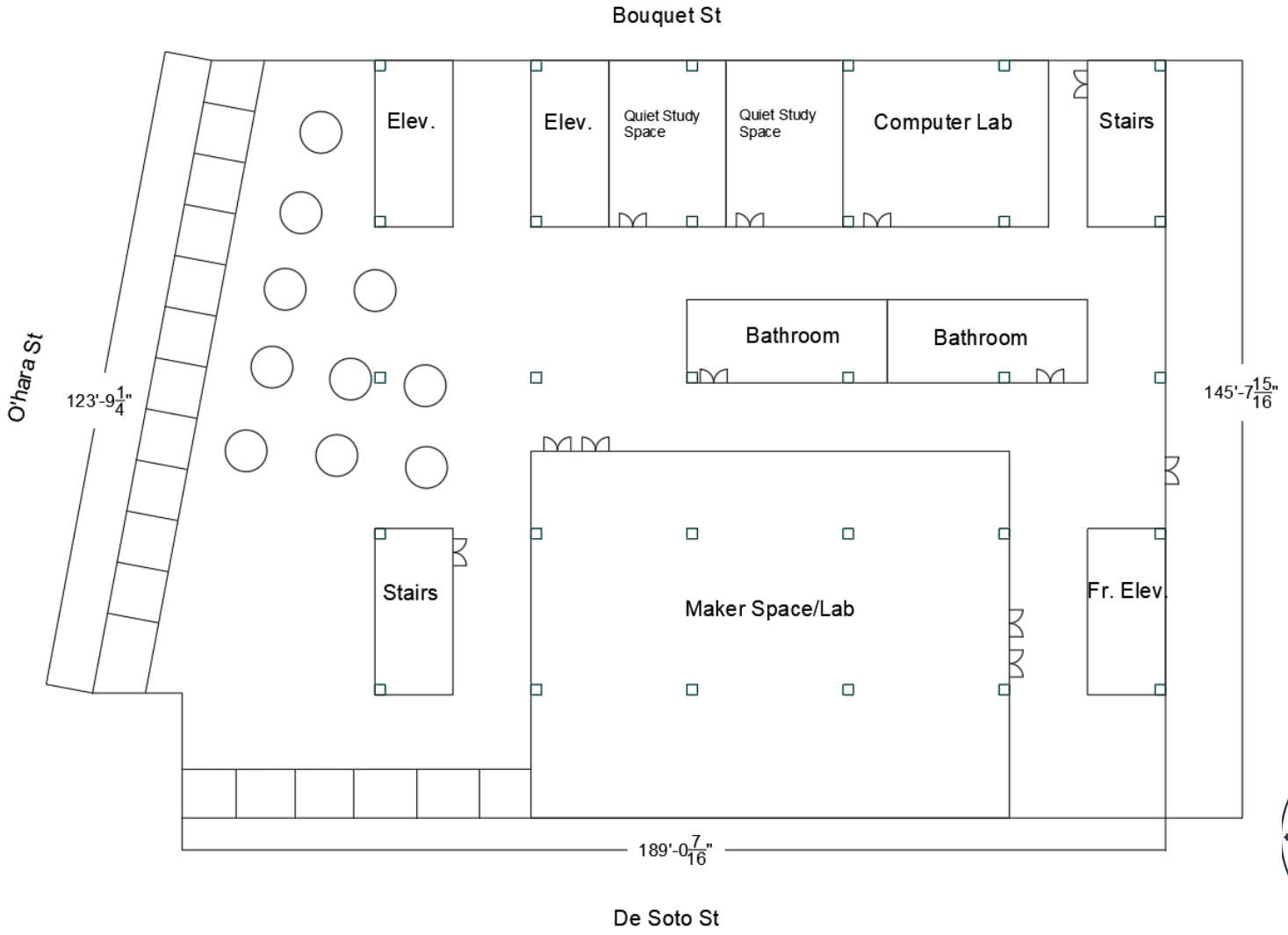
Floor Plan & Layout

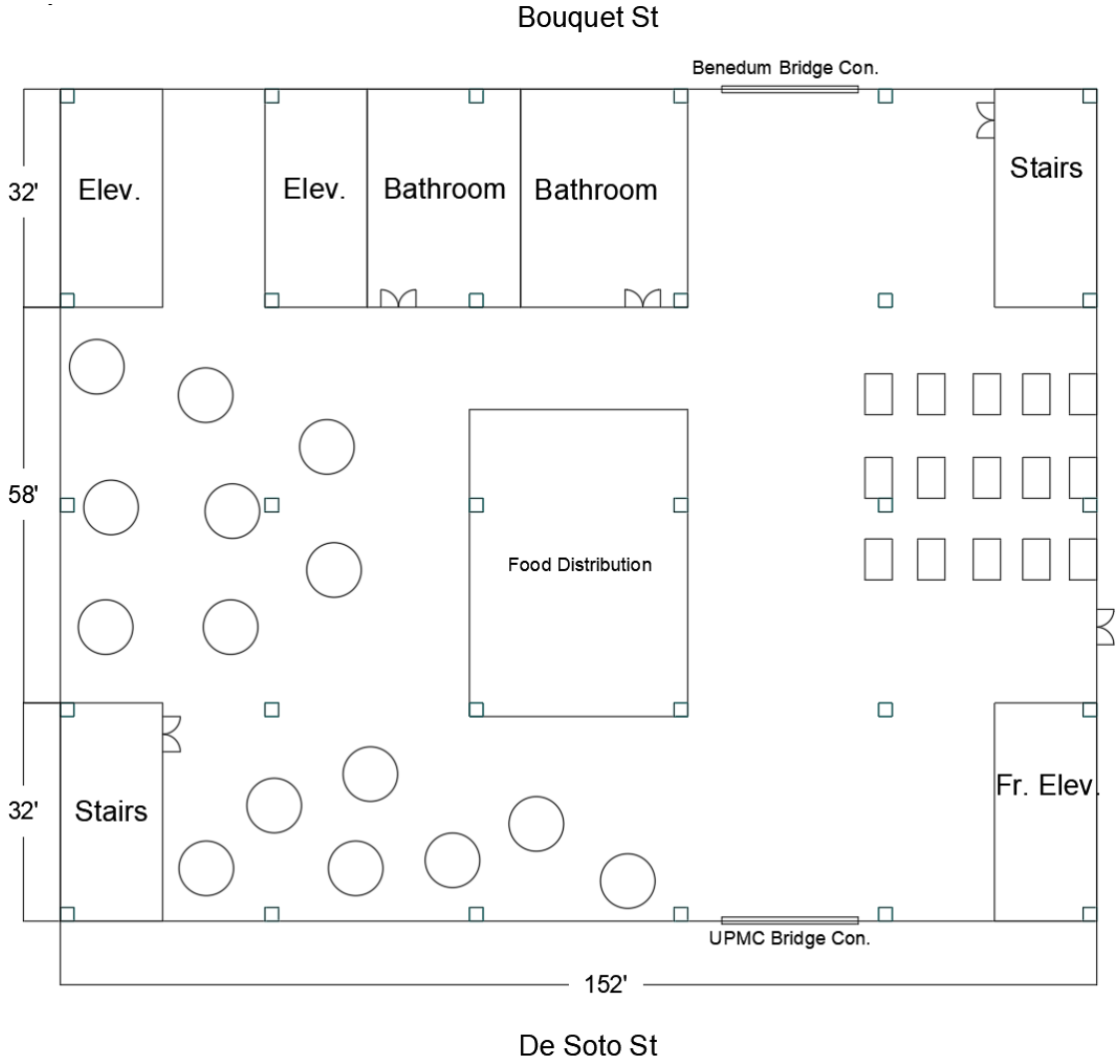
Floor Plans: First Floor



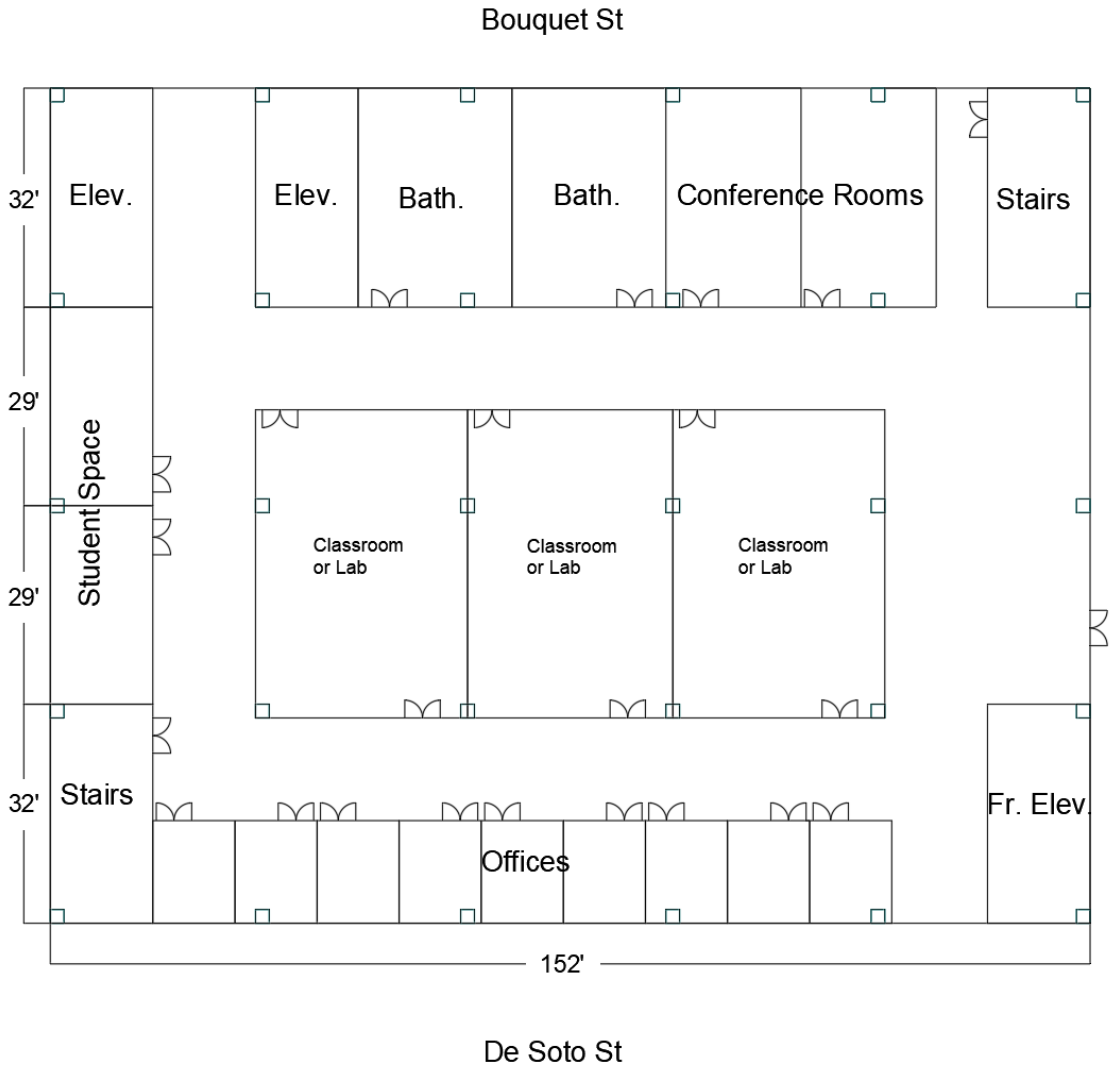
Floor Plans: Second Floor



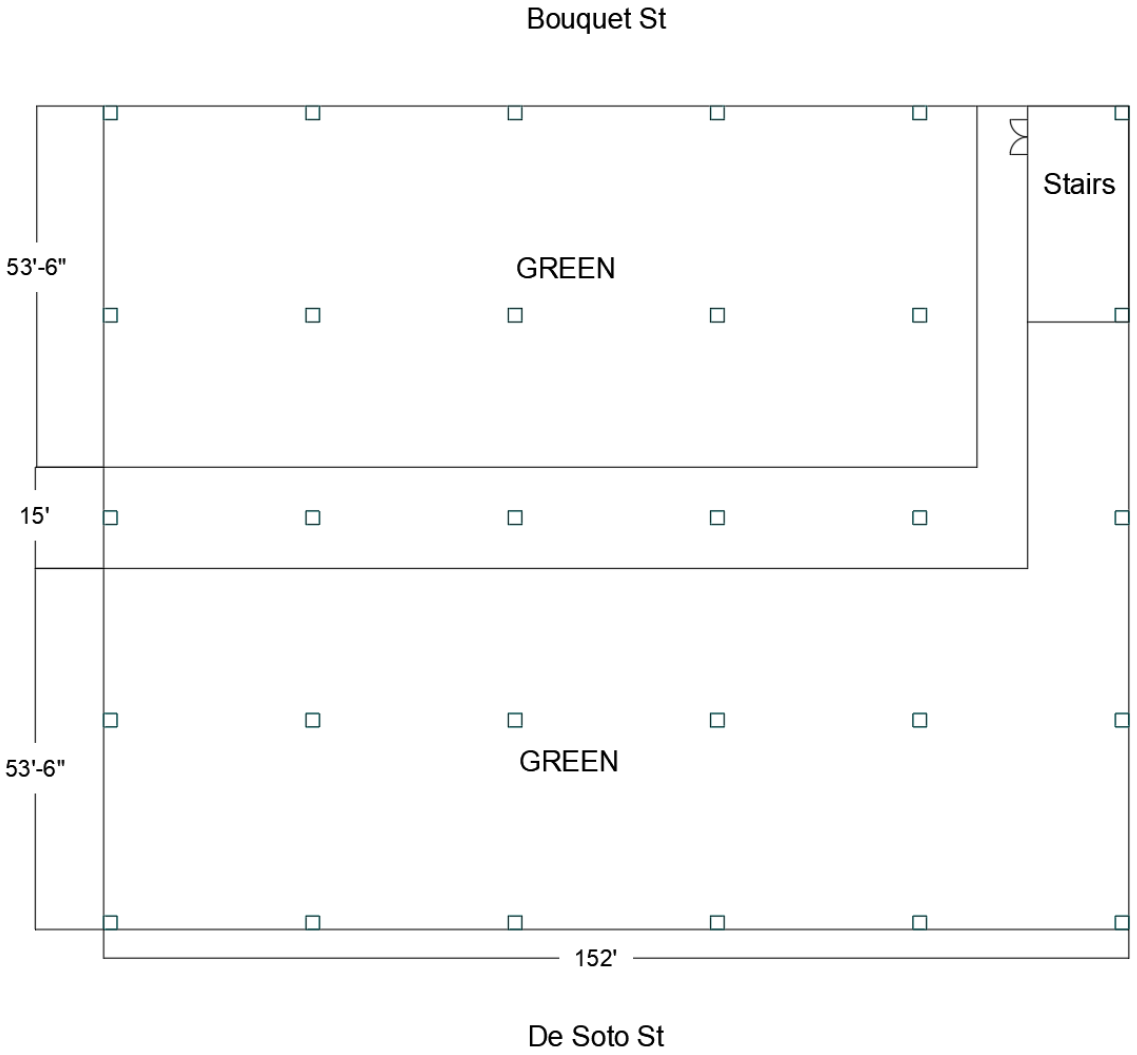
Floor Plans: Third Floor



Floor Plans: Upper Floors

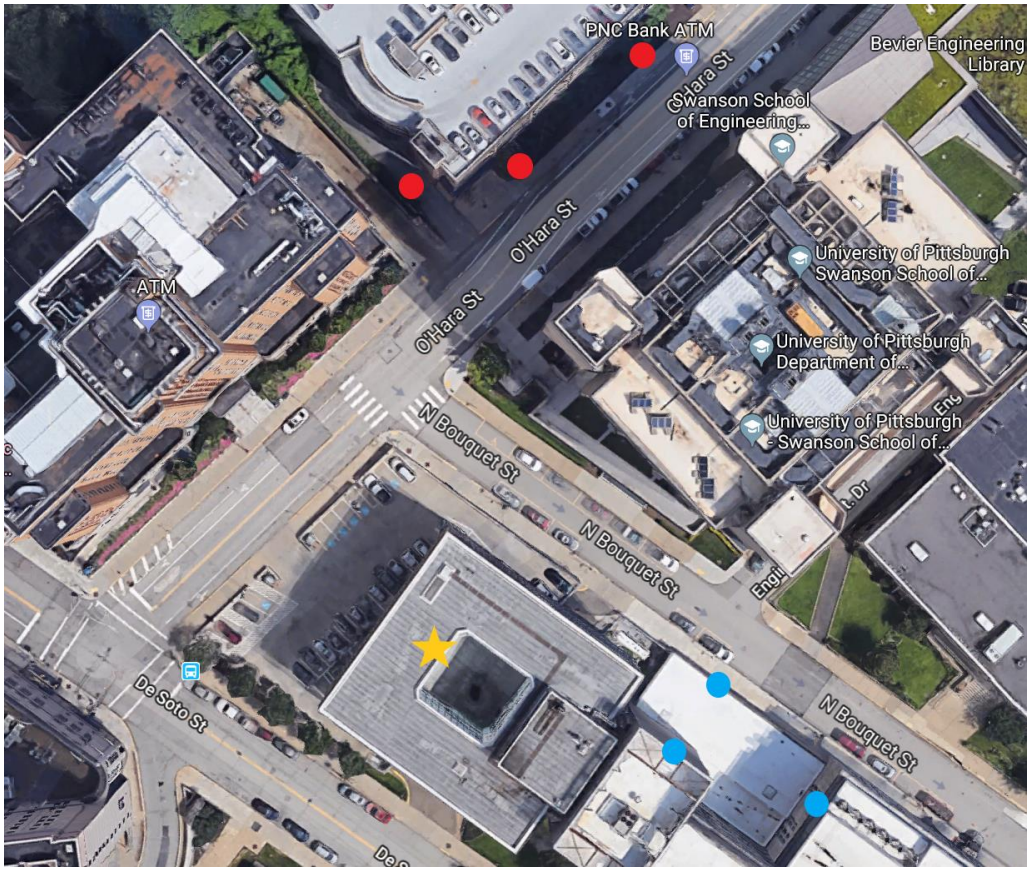


Floor Plans: Roof



Foundation Design

Soil and Rock Properties



- Civil and Environmental Consultants, Inc. bore holes
- GeoMechanics, Inc bore holes
- Crabtree Hall

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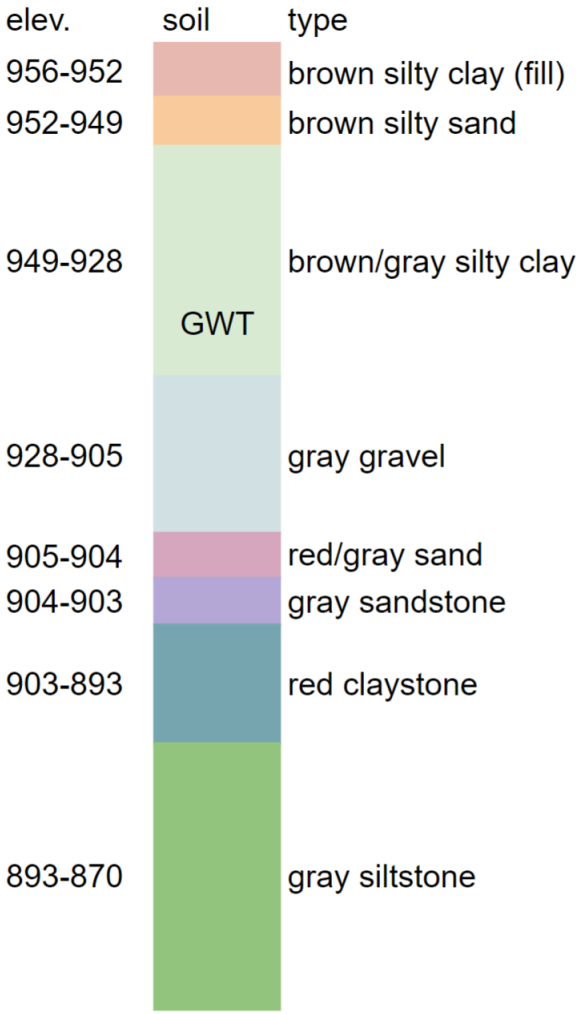
Soil Properties – Bore Test Data



Layer	Classification	Unit Weight (pcf)	Consistency
Silty Clay	Fill	125	Stiff
Silty Sand	Alluvial	115	Loose
Gray Gravel	Alluvial	130	Loose
Sandstone/Claystone	Rock	160	Very Broken
Siltstone	Bedrock	165	Blocky

Groundwater table located approximately 28-ft below the surface, assumed to vary 10-ft throughout seasonal changes

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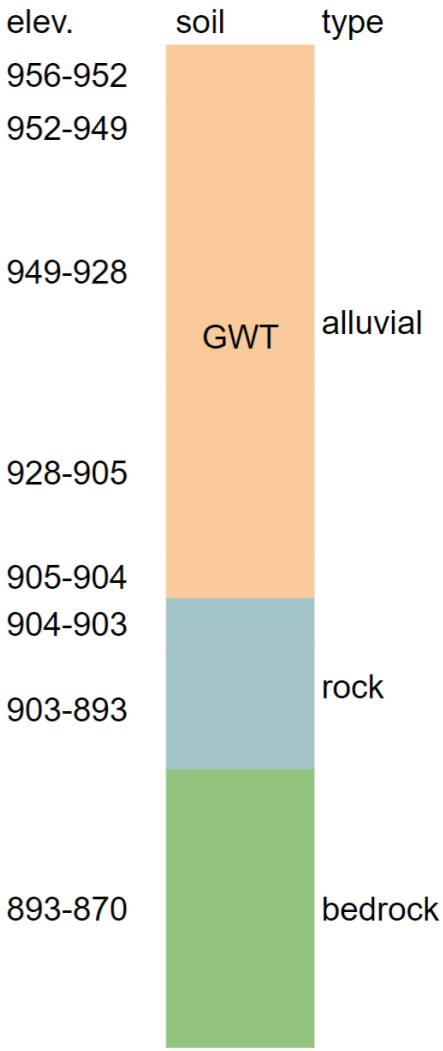
Foundation Design



- Fill and alluvial soils treated as one layer
- Sandstone/claystone treated as second layer
- Circular shape caissons
  - CFAs were considered but ruled out
- Drilling down and socketing into the bedrock
- AASHTO LRFD Design Specifications

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Split Level Foundation

Floor	Elevation	Pile Length
Basement	940 ft	45 ft
Floor 1	960 ft	65 ft

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Nominal Axial Compression Resistance

- Tip and side resistance in rock
  - Accounts for bearing on the bedrock and skin friction on the wall
  - Controlled by strength of bedrock

Tip Resistance (ksf)	55.5
Side Resistance (ksf)	24.7

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Bedrock Properties For Design

Rock Mass Rating (RMR)

Table 10.4.6.4-4—Approximate Relationship between Rock-Mass Quality and Material Constants Used in Defining Nonlinear Strength (Hoek and Brown, 1988)

Rock Quality	Constants	Rock Type: A = Carbonate rocks with well developed crystal cleavage—*dolomite, limestone and marble*; B = Lithified argillaceous rocks—*mudstone, siltstone, shale and slate (normal to cleavage)*; C = Arenaceous rocks with strong crystals and poorly developed crystal cleavage—*sandstone and quartzite*; D = Fine grained polymineralic igneous crystalline rocks—*andesite, dolerite, diabase and rhyolite*; E = Coarse grained polymineralic igneous & metamorphic crystalline rocks—*amphibolite, gabbro gneiss, granite, norite, quartz-diorite*				
		A	B	C	D	E
INTACT ROCK SAMPLES Laboratory size specimens free from discontinuities. CSIR rating: *RMR* = 100	*m* *s*	7.00 1.00	10.00 1.00	15.00 1.00	17.00 1.00	25.00 1.00
VERY GOOD QUALITY ROCK MASS Tightly interlocking undisturbed rock with unweathered joints at 3–10 ft CSIR rating: *RMR* = 85	*m* *s*	2.40 0.082	3.43 0.082	5.14 0.082	5.82 0.082	8.567 0.082
GOOD QUALITY ROCK MASS Fresh to slightly weathered rock, slightly disturbed with joints at 3–10 ft CSIR rating: *RMR* = 65	*m* *s*	0.575 0.00293	0.821 0.00293	1.231 0.00293	1.395 0.00293	2.052 0.00293
FAIR QUALITY ROCK MASS Several sets of moderately weathered joints spaced at 1–3 ft CSIR rating: *RMR* = 44	*m* *s*	0.128 0.00009	0.183 0.00009	0.275 0.00009	0.311 0.00009	0.458 0.00009
POOR QUALITY ROCK MASS Numerous weathered joints at 2 to 12 in.; some gouge. Clean compacted waste rock. CSIR rating: *RMR* = 23	*m* *s*	0.029 3×10^{-6}	0.041 3×10^{-6}	0.061 3×10^{-6}	0.069 3×10^{-6}	0.102 3×10^{-6}
VERY POOR QUALITY ROCK MASS Numerous heavily weathered joints spaced <2 in. with gouge. Waste rock with fines. CSIR rating: *RMR* = 3	*m* *s*	0.007 1×10^{-7}	0.010 1×10^{-7}	0.015 1×10^{-7}	0.017 1×10^{-7}	0.025 1×10^{-7}

RMR Rating	100–81	80–61	60–41	40–21	<20
Class No.	I	II	III	IV	V
Description	Very good rock	Good rock	Fair rock	Poor rock	Very poor rock

Fractured Rock Parameters using Rock Quality Designation (RQD)

	Parameter		Ranges of Values						
1	Strength of intact rock material	Point load strength index	>175 ksf	85–175 ksf	45–85 ksf	20–45 ksf	For this low range, uniaxial compressive test is preferred		
		Uniaxial compressive strength	>4320 ksf	2160–4320 ksf	1080–2160 ksf	520–1080 ksf	215–520 ksf	70–215 ksf	20–70 ksf
	Relative Rating		15	12	7	4	2	1	0
2	Drill core quality RQD		90% to 100%	75% to 90%		50% to 75%	25% to 50%		<25%
	Relative Rating		20	17		13	8		3
3	Spacing of joints		>10 ft	3–10 ft		1–3 ft	2 in.–1 ft		<2 in.
	Relative Rating		30	25		20	10		5
4	Condition of joints		• Very rough surfaces • Not continuous • No separation • Hard joint wall rock	• Slightly rough surfaces • Separation <0.05 in. • Hard joint wall rock		• Slightly rough surfaces • Separation <0.05 in. • Soft joint wall rock	• Slicken-sided surfaces or • Gouge <0.2 in. thick or • Joints open 0.05–0.2 in. • Continuous joints		• Soft gouge >0.2 in. thick or • Joints open >0.2 in. • Continuous joints
	Relative Rating		25	20		12	6		0
5	Groundwater conditions (use one of the three evaluation criteria as appropriate to the method of exploration)	Inflow per 30 ft tunnel length	None	<400 gal./hr.		400–2000 gal./hr.	>2000 gal./hr.		
		Ratio = joint water pressure/major principal stress	0	0.0–0.2		0.2–0.5	>0.5		
		General Conditions	Completely Dry	Moist only (interstitial water)		Water under moderate pressure	Severe water problems		
	Relative Rating		10	7		4	0		

RQD (percent)	E_m/E_i	
	Closed Joints	Open Joints
100	1.00	0.60
70	0.70	0.10
50	0.15	0.10
20	0.05	0.05

Bedrock Properties For Design

Compressive Strength	1063 ksf
RMR	46
Rock Mass Class	III - Fair Rock
RQD	66%
Joint/Crack Spacing	1-6 inches (closed)
Fractured Rock Parameters for tip resistance (m, s)	0.183, 0.00009
Reduction Factors for side resistance (α_E)	0.8

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Caisson Design

Rebar Requirement

- Area of steel > 0.8% area of concrete
  - $A_s >> 0.008A_g$ ✓
- Spacing > 5 times the max aggregate size
  - 5 * ¾ = 3.75 in ✓

	Type 1	Type 2
Diameter (in)	12	36
Longitudinal Rebar	7#10 bars	12#9 bars
Spacing (in)	4	8.5
Spiral Ties	#4 ties	#4 ties
Spacing (in)	6	18

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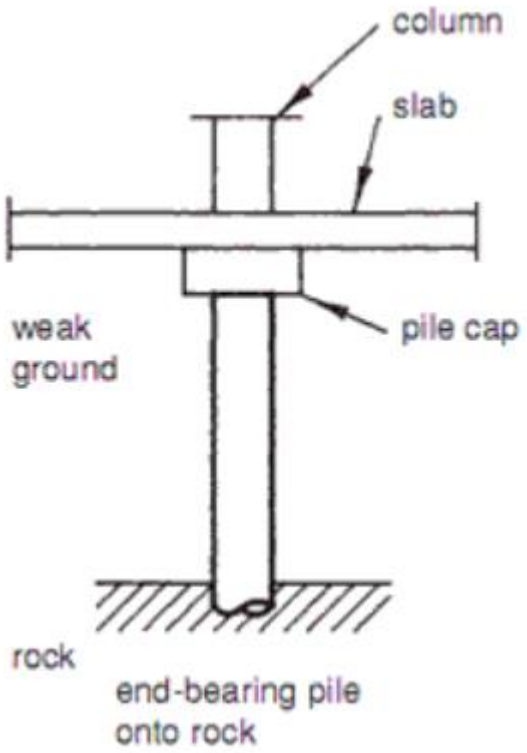
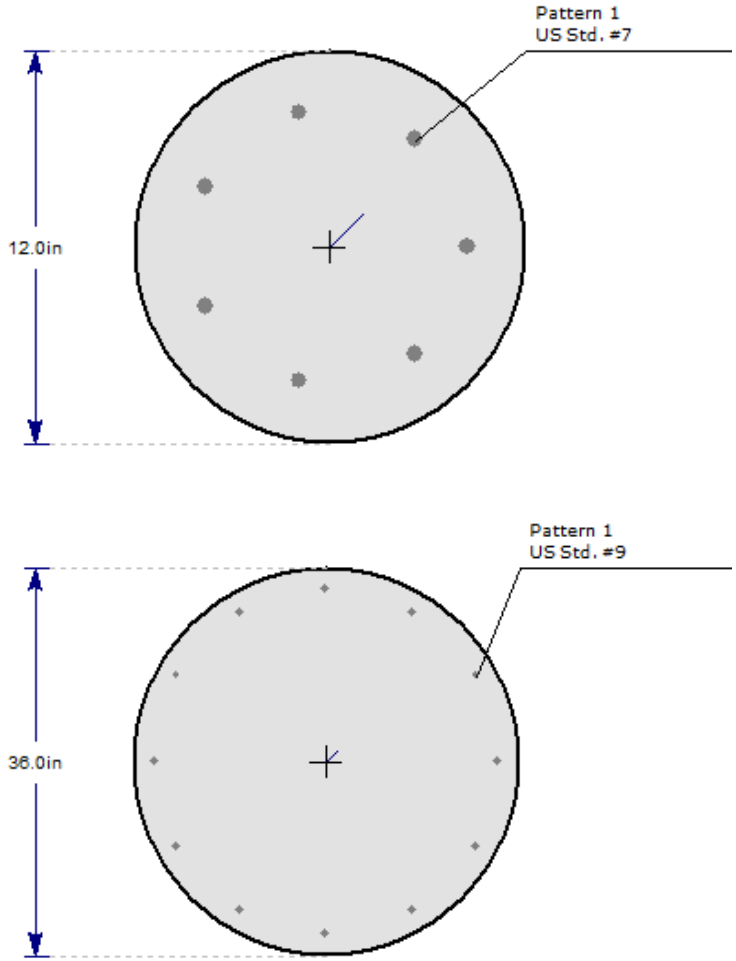
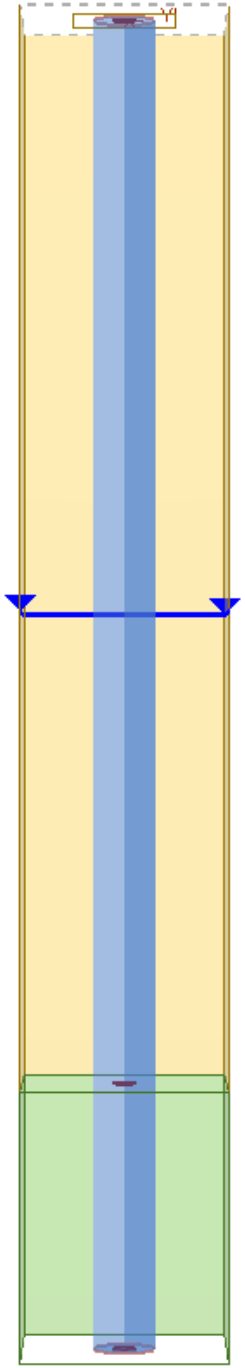
Final Design

- Two designs
- Pile caps
  - Rebar embedded 6 inches
  - 6 inch cover on all sides

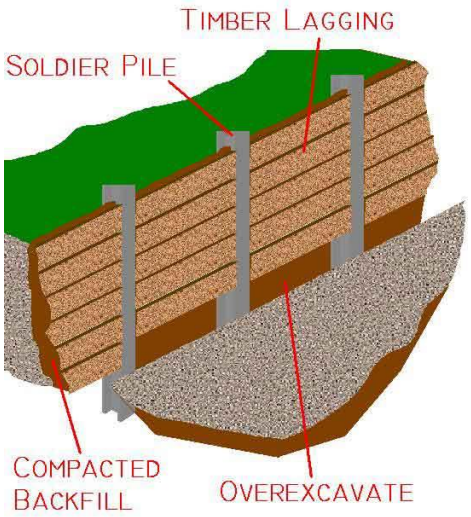






Shoring Walls

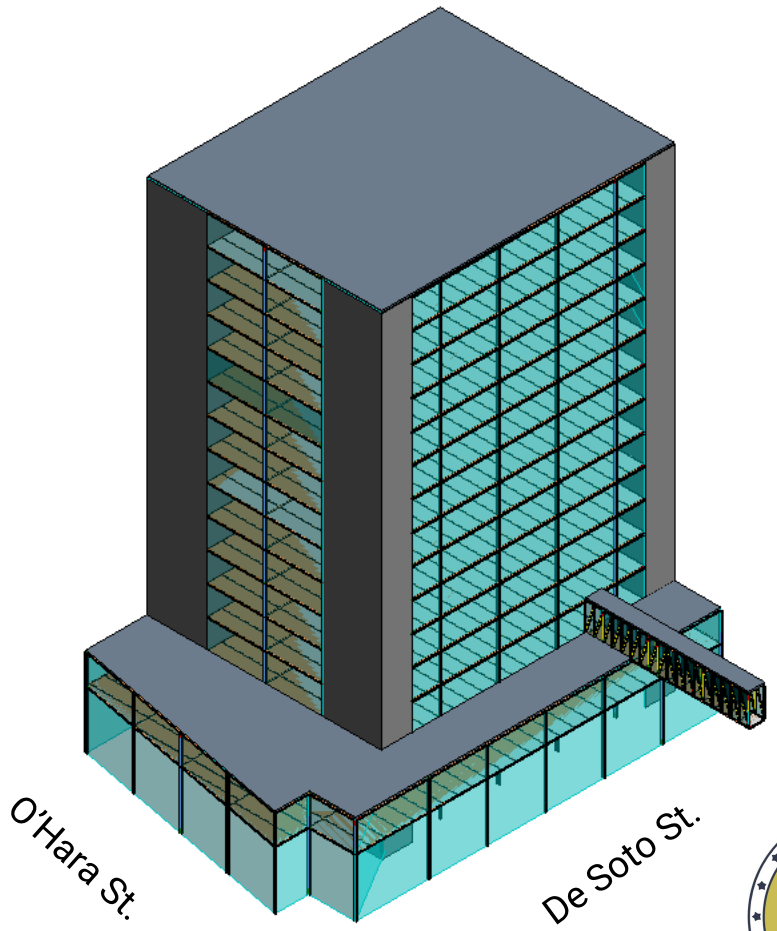
- For excavation phase
- Shoring walls for a depth of 20 ft
- Soldier pile shoring wall
  - Retains soil and transfers lateral loads
  - Typical intervals of 12 ft



Structural Design

Structural Overview

- Gravity System
  - Steel Frame
  - Composite steel and concrete floor slabs
  - Steel auditorium truss
- Lateral Load System
  - Reinforced concrete shear wall
- Pedestrian bridges



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Structural Considerations

- Difficult to connect to Graduate School of Public Health
- Auditorium on the ground floor creates issues with column spacing
- Using shear wall in the corners instead of the center
- Pedestrian bridges

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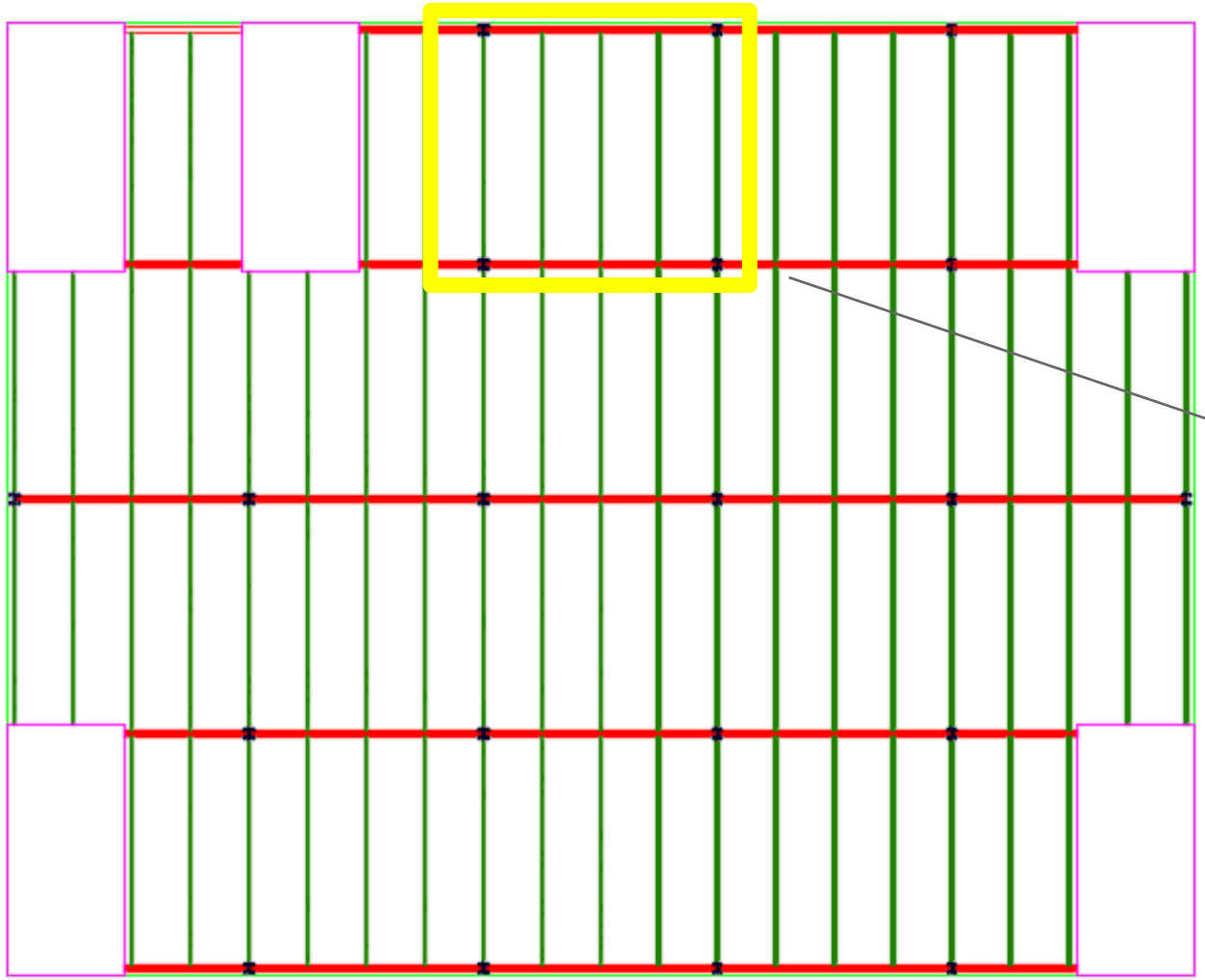
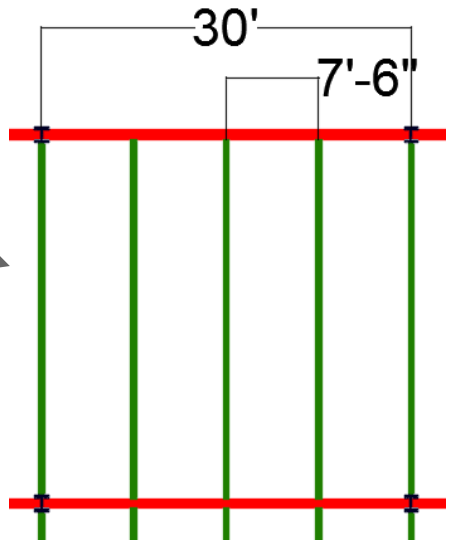
Steel Building Design

Tower Framing Plan





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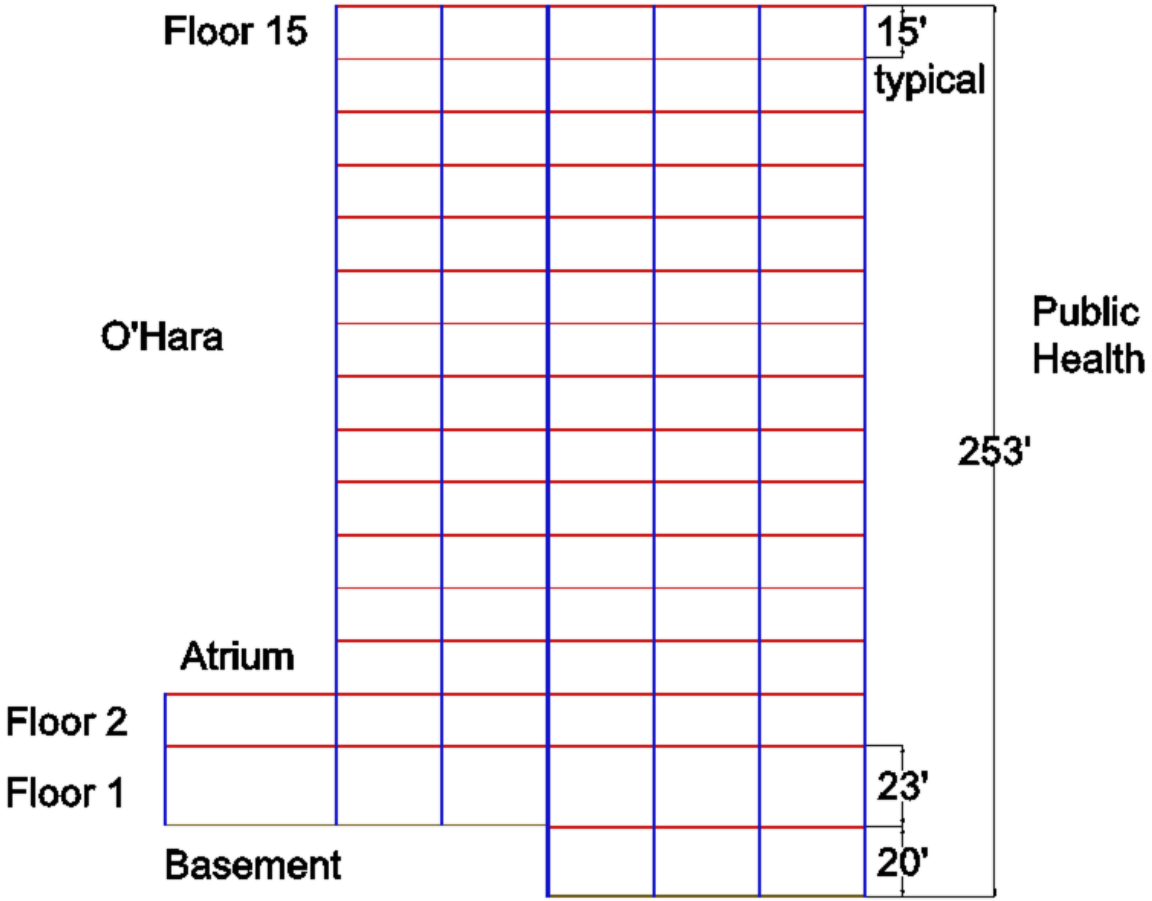
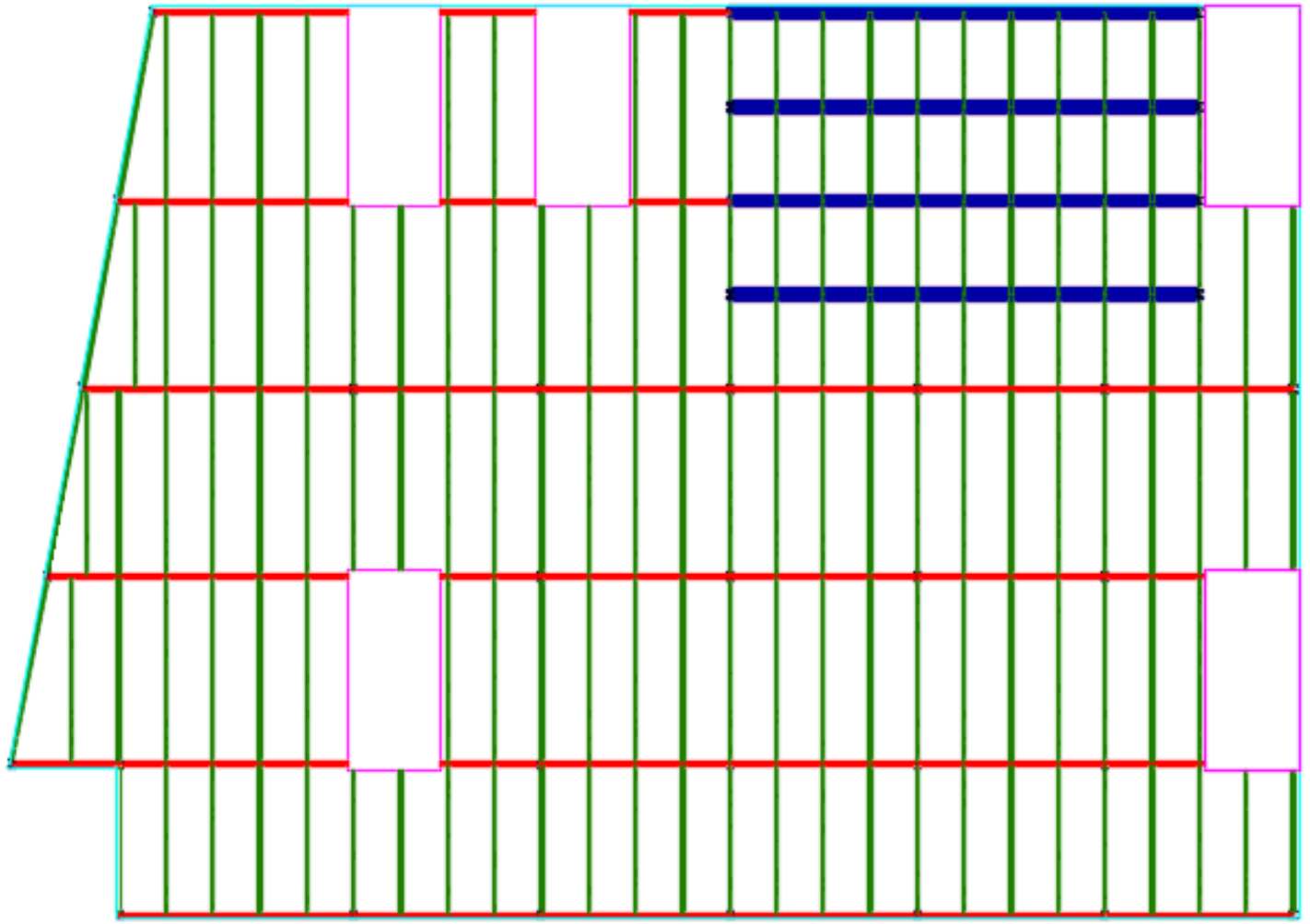
Typical Columns



Floor	Exterior Columns	Interior Columns
14-15	W14x43	W14x43
12-13	W14x48	W14x61
10-11	W14x61	W14x90
8-9	W14x74	W14x109
6-7	W14x90	W14x145
4-5	W14x99	W14x176
2-3	W14x120	W14x193

Atrium & Auditorium Framing Plan



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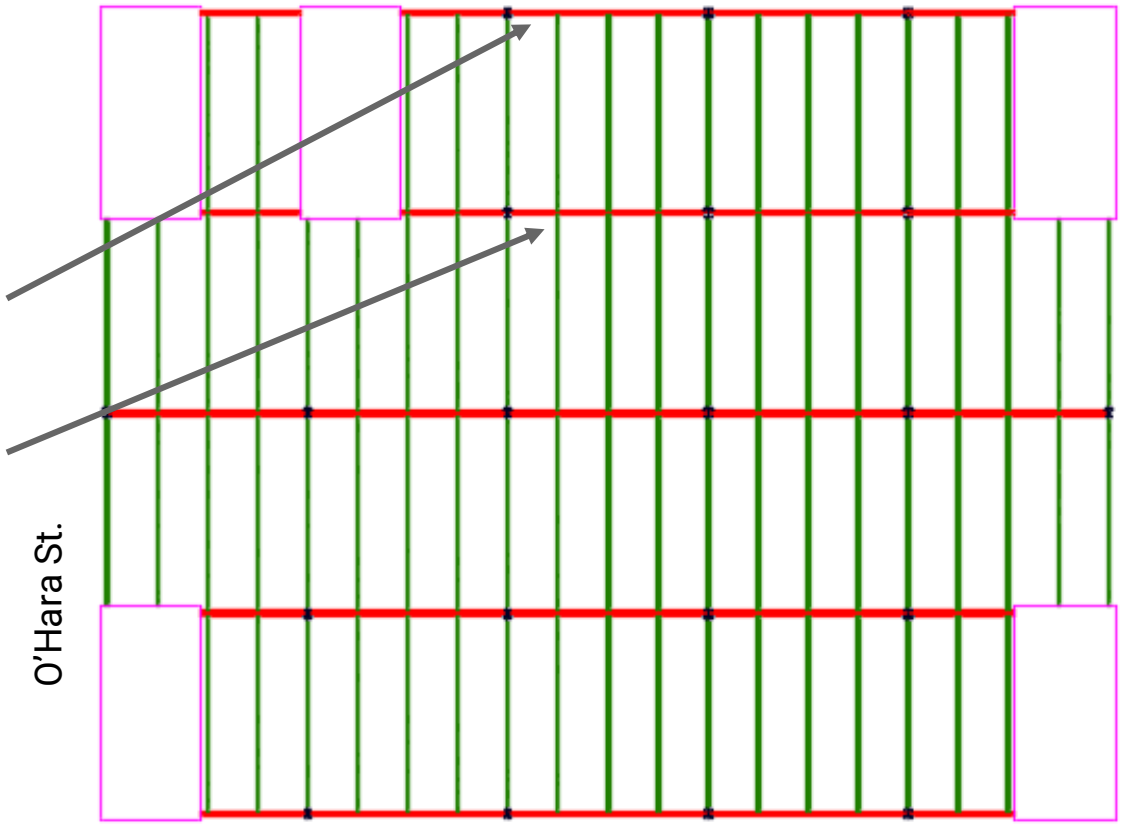
Girders

Beam Selection	Typical Floor	Roof
Exterior Girder	W24x55	W21x44
Interior Girder	W24x76	W24x62
Bridge Connection Girder	W24x94	-
Atrium Girder	W24x162	-



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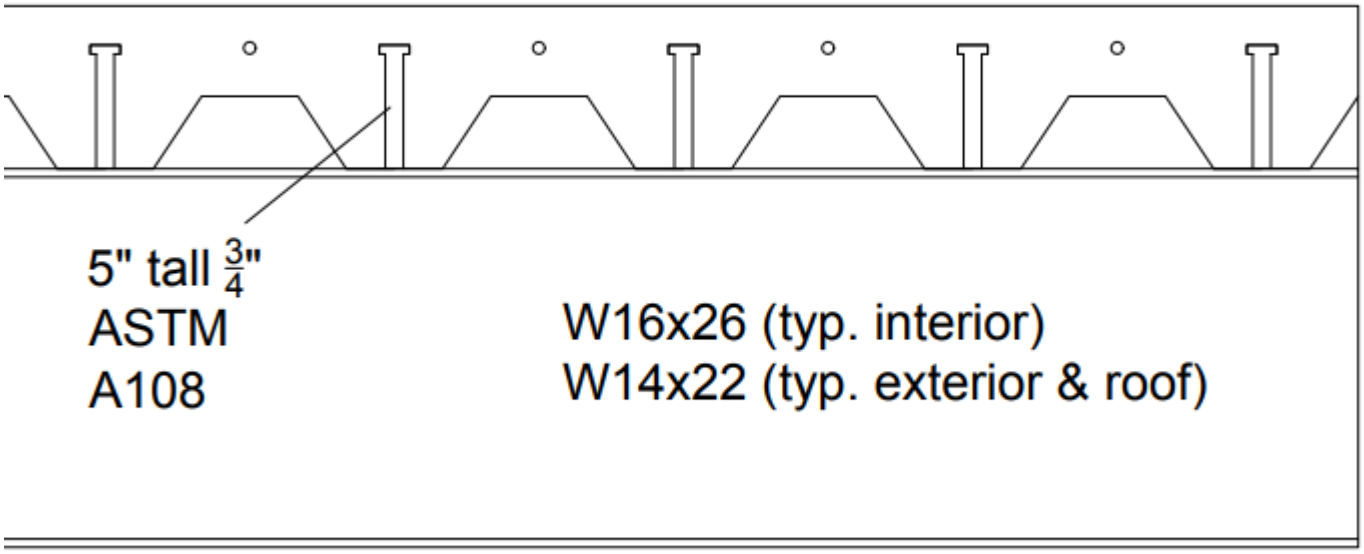
Composite Beams

- 7.5 ft spacing, 30 ft long
- Shear studs every foot



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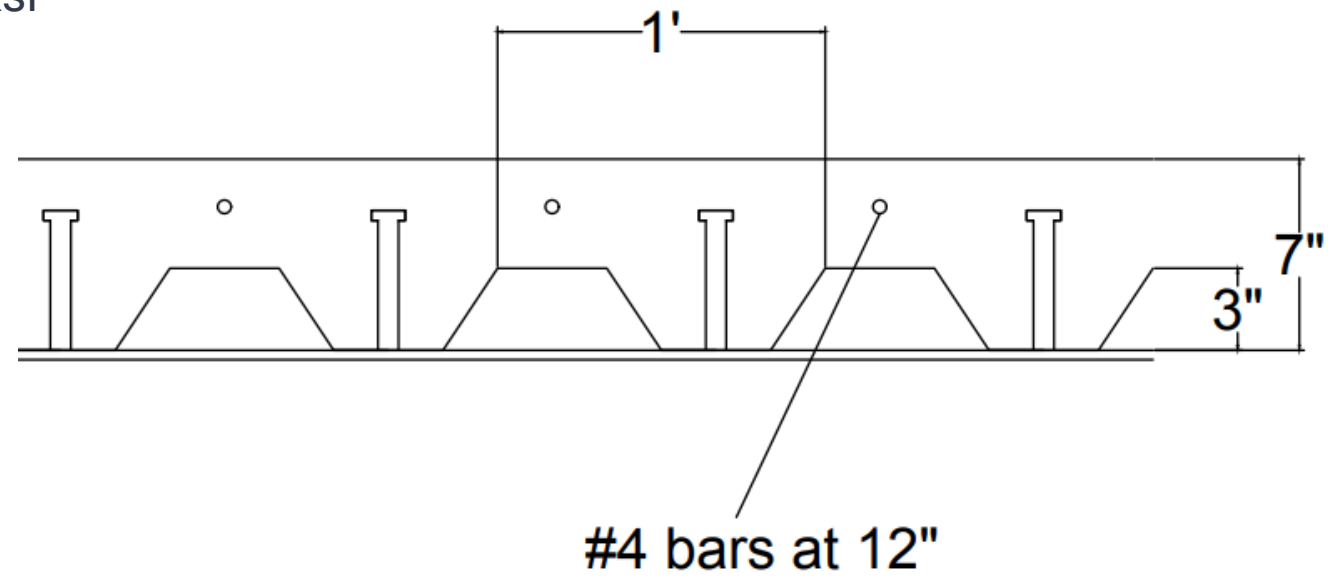
Slab Design

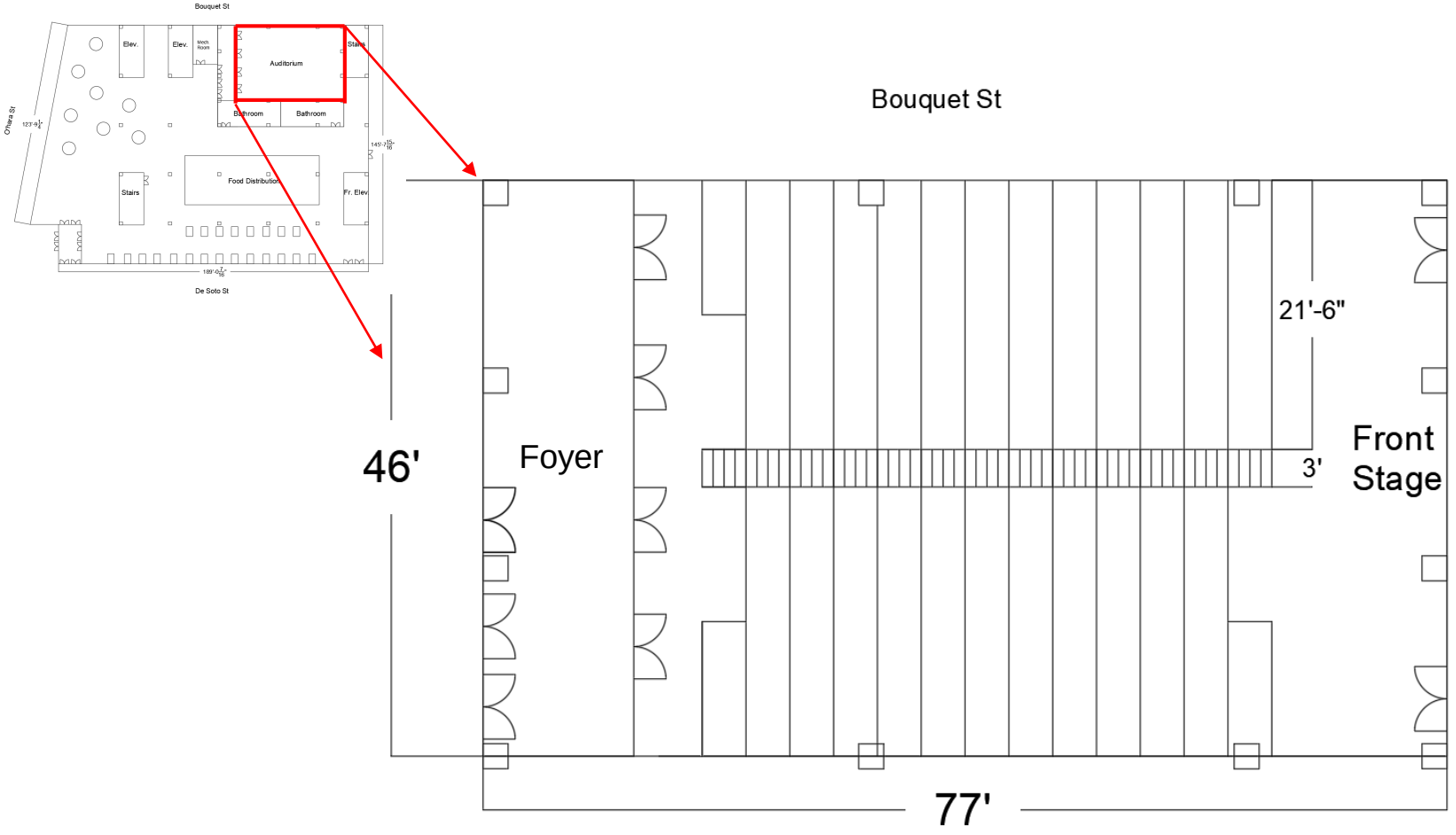
Slab Characteristics

- Depth = 7”
- Factored load = 200 psf/ft
- f'_c= 4,000 psi
- f_y= 60 ksi



Auditorium Design

Auditorium Layout



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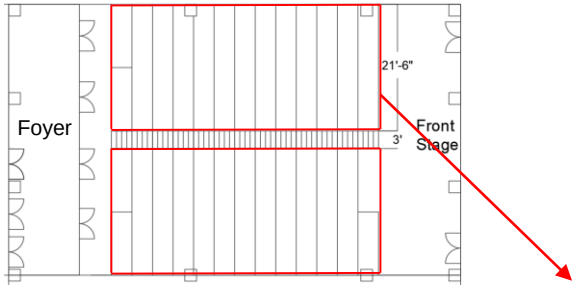
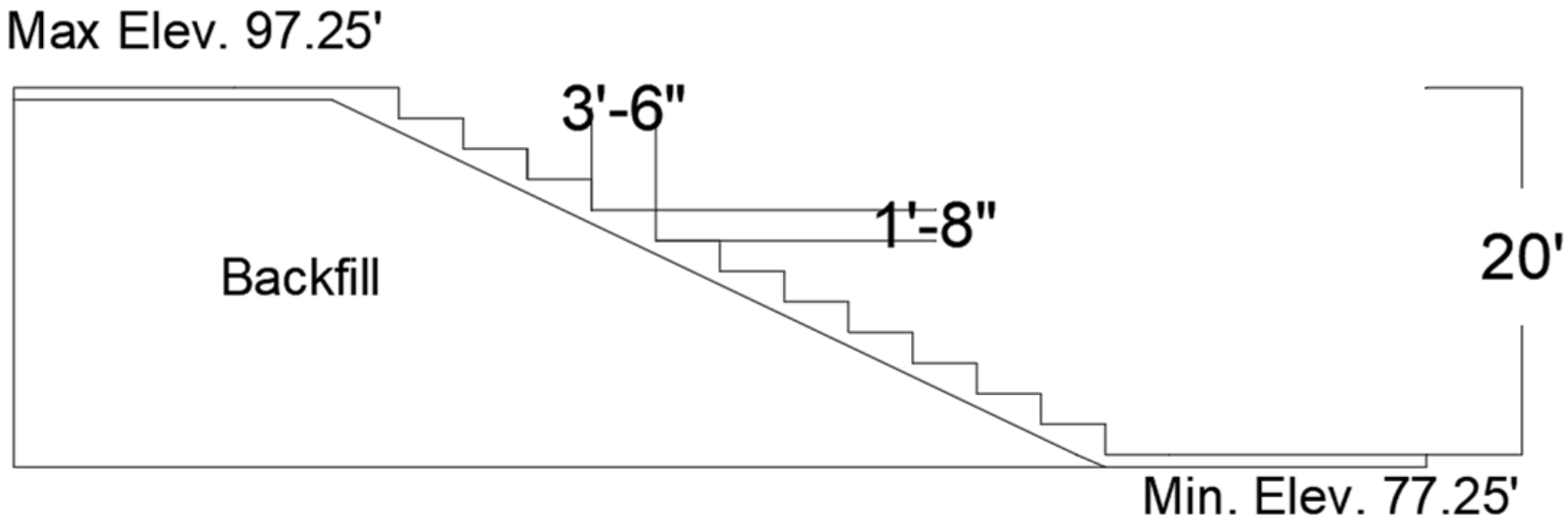
Step Design: Landings





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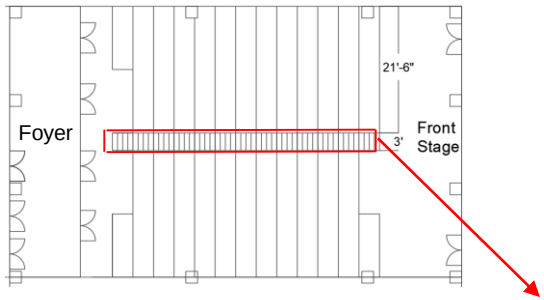
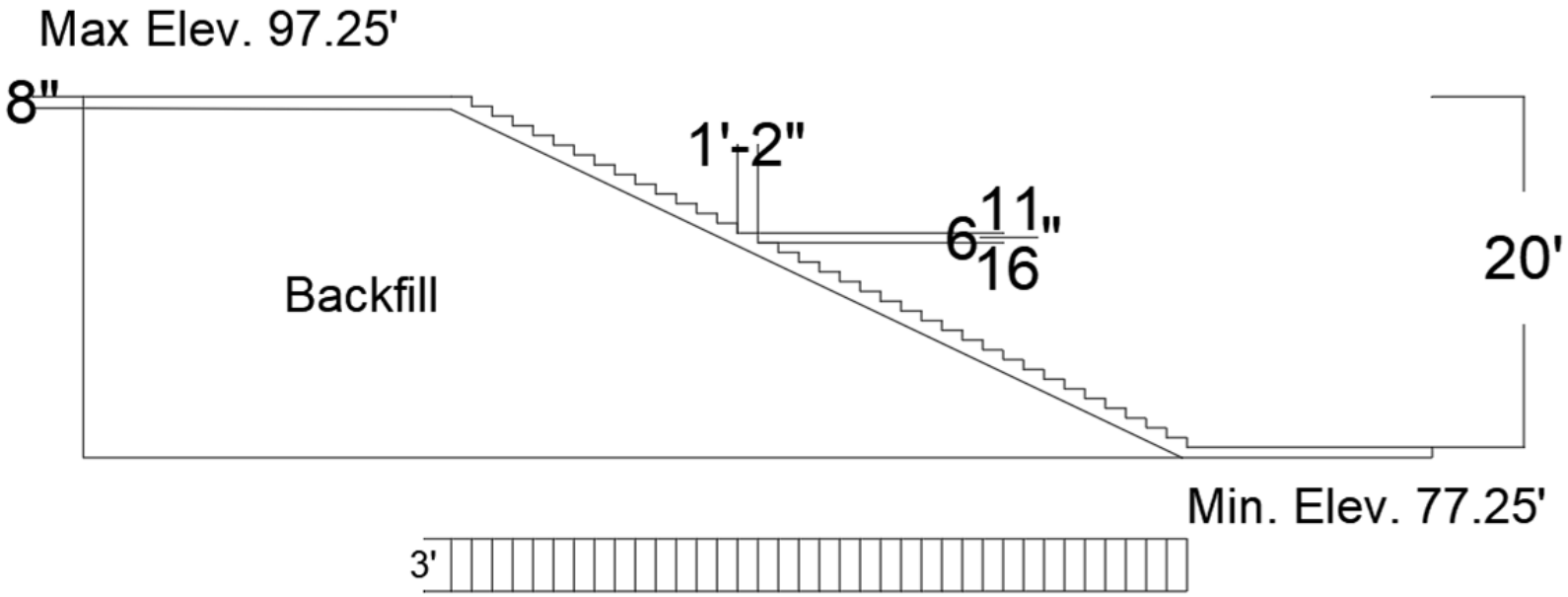
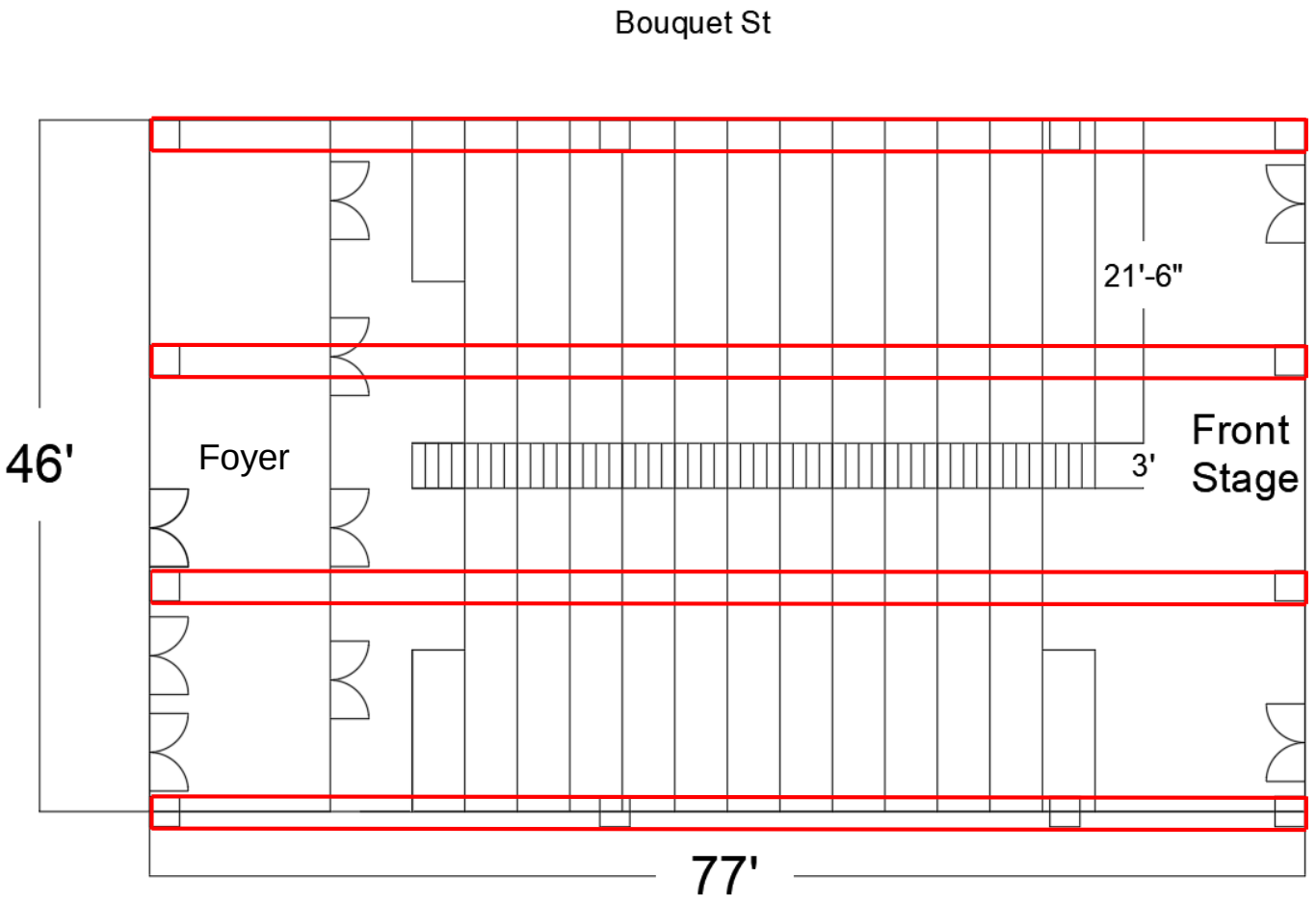
Step Design: Stairs

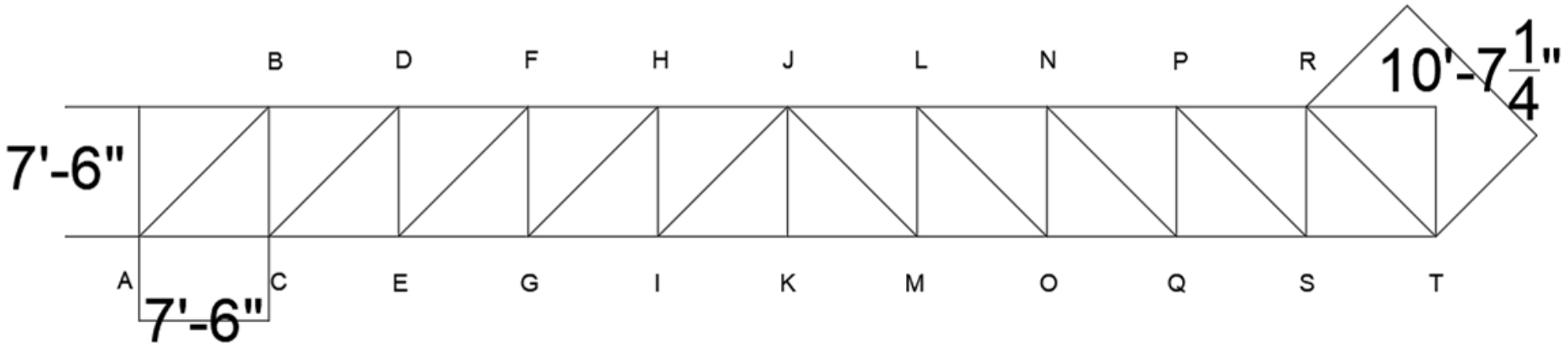




Auditorium Trusses



Auditorium Trusses



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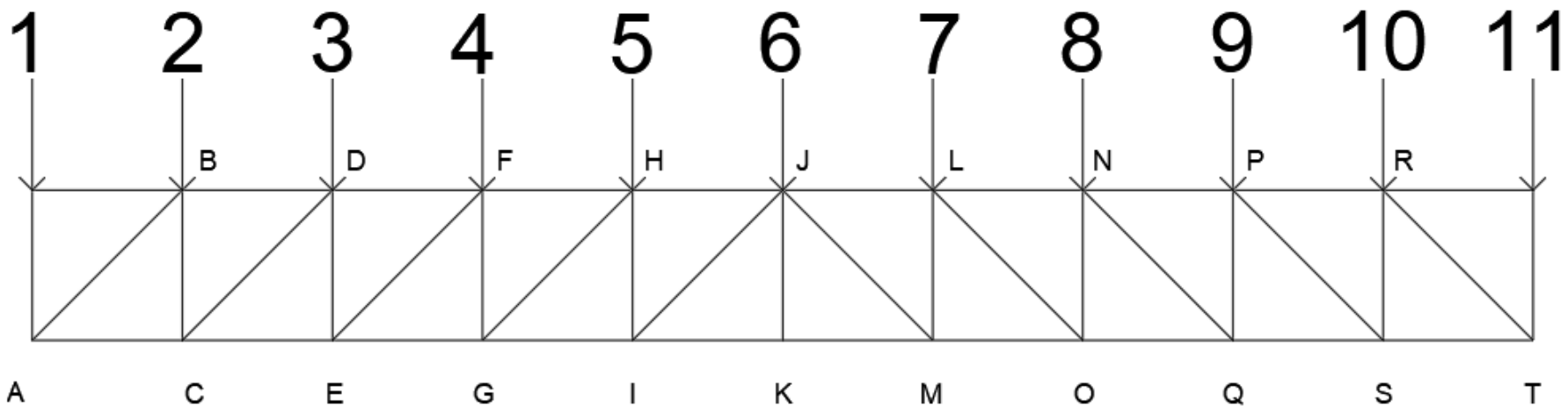
Auditorium Truss Point Loading



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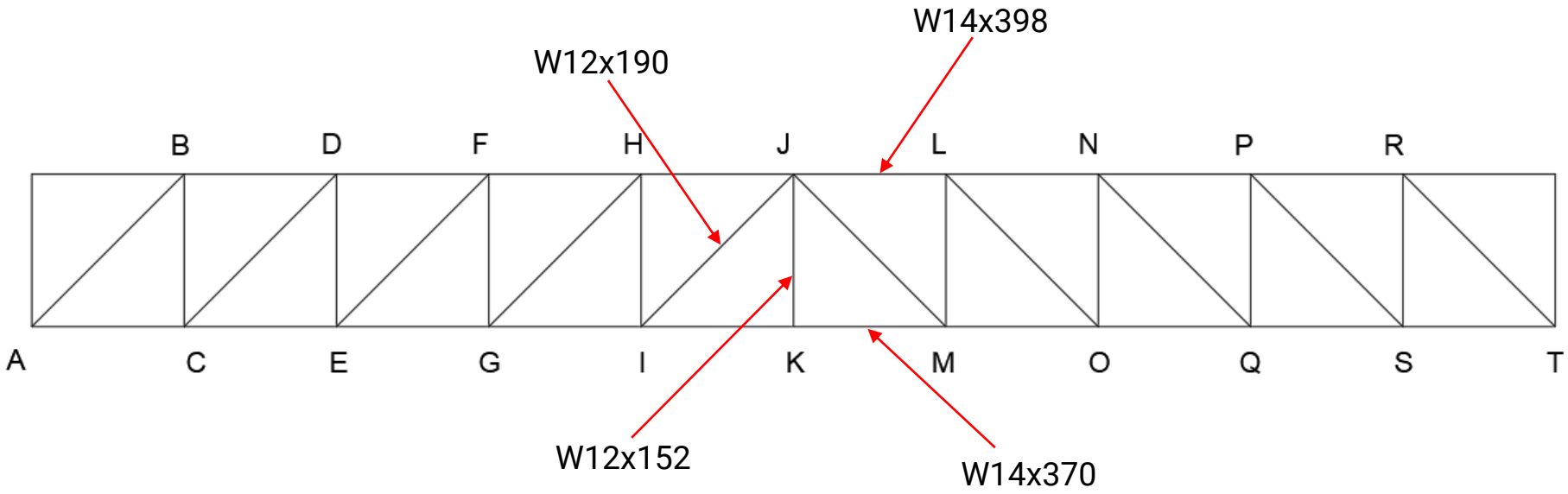
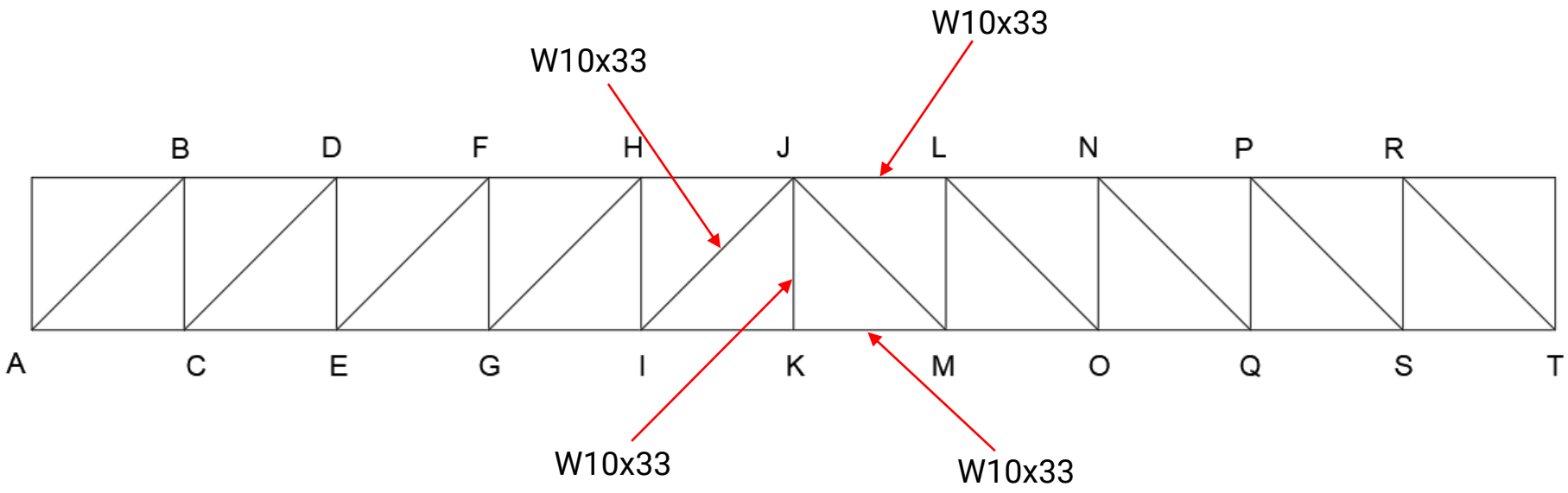
Auditorium Truss 1 Loads



Maximum Loads:

- Vertical Member = 1600 kips (T)
- Diagonal Member = 2300 kips (C)
- Bottom Member = 4600 kips (T)
- Top Member = 4700 kips (C)

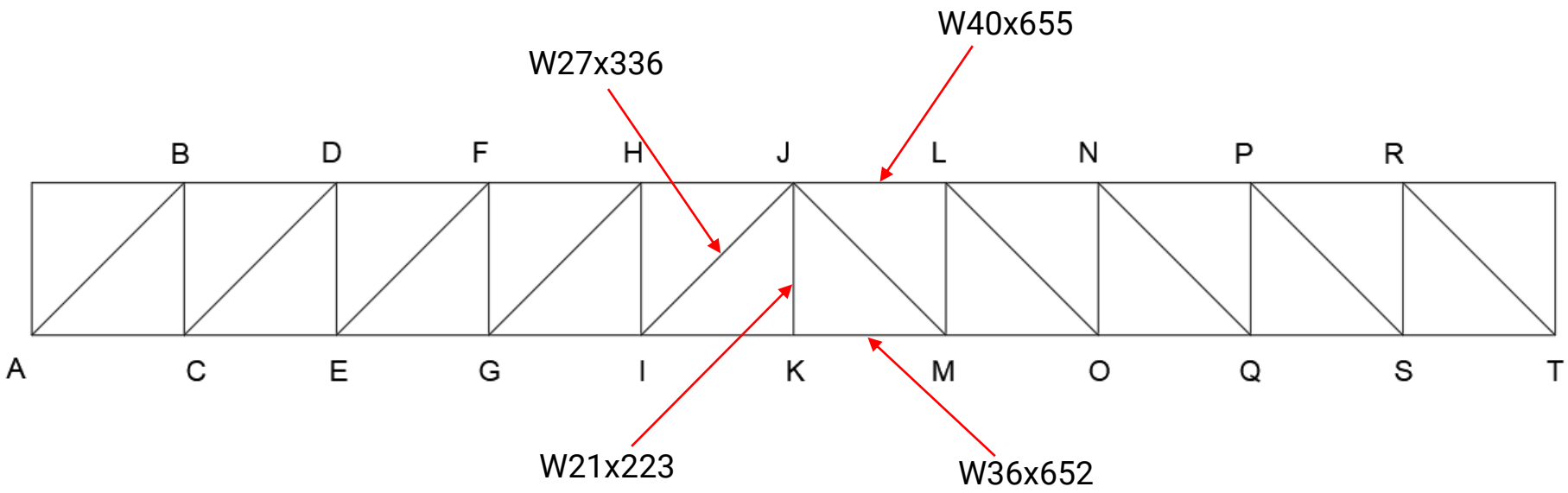
Auditorium Trusses 2 & 4 Loads



Maximum Loads:

- Vertical Member = 23 kips (T)
- Diagonal Member = 38 kips (C)
- Bottom Member = 88 kips (T)
- Top Member = 80 kips (C)

Auditorium Truss 3 Loads



Maximum Loads:

- Vertical Member = 2800 kips (T)
- Diagonal Member = 4000 kips (C)
- Bottom Member = 8000 kips (T)
- Top Member = 8000 kips (C)

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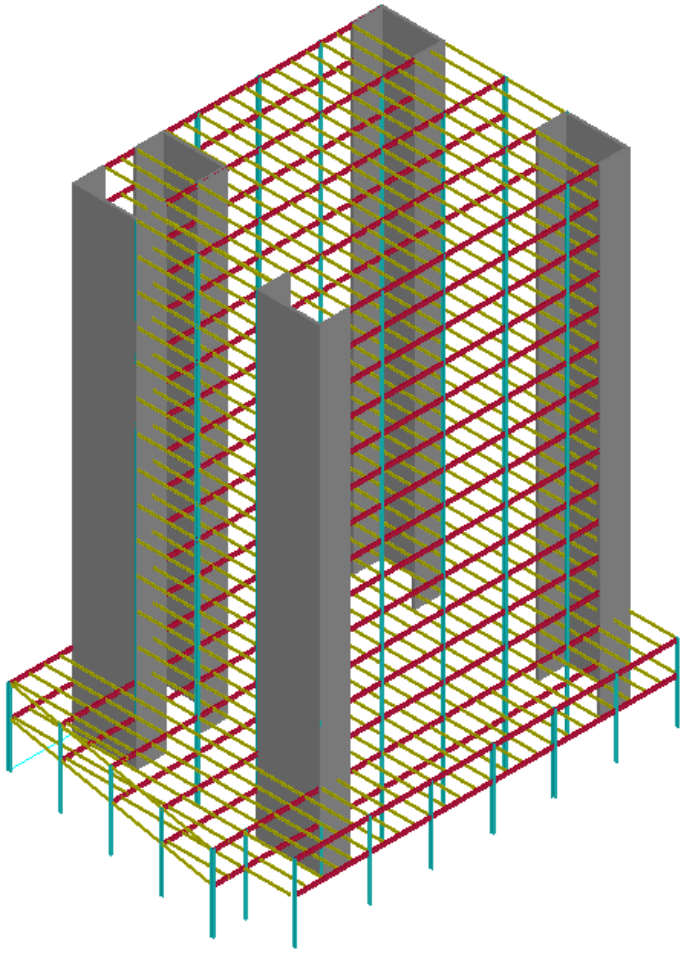
Shear Wall Design

Shear Wall

- Purpose
  - Resist lateral loading of building (wind)
  - Provide some support of gravity loads
- 5 total shear walls



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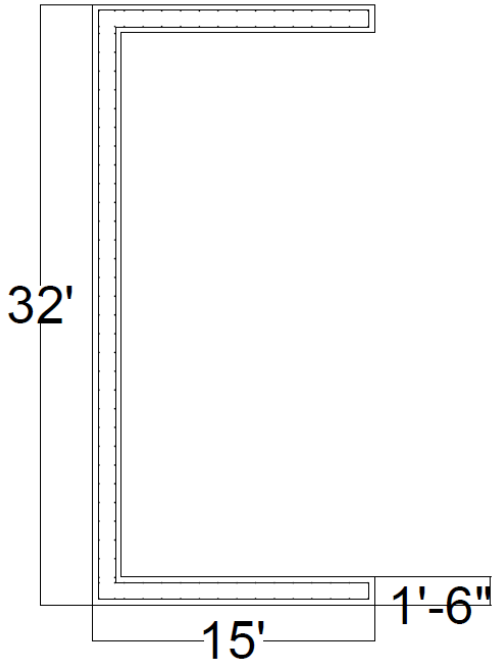
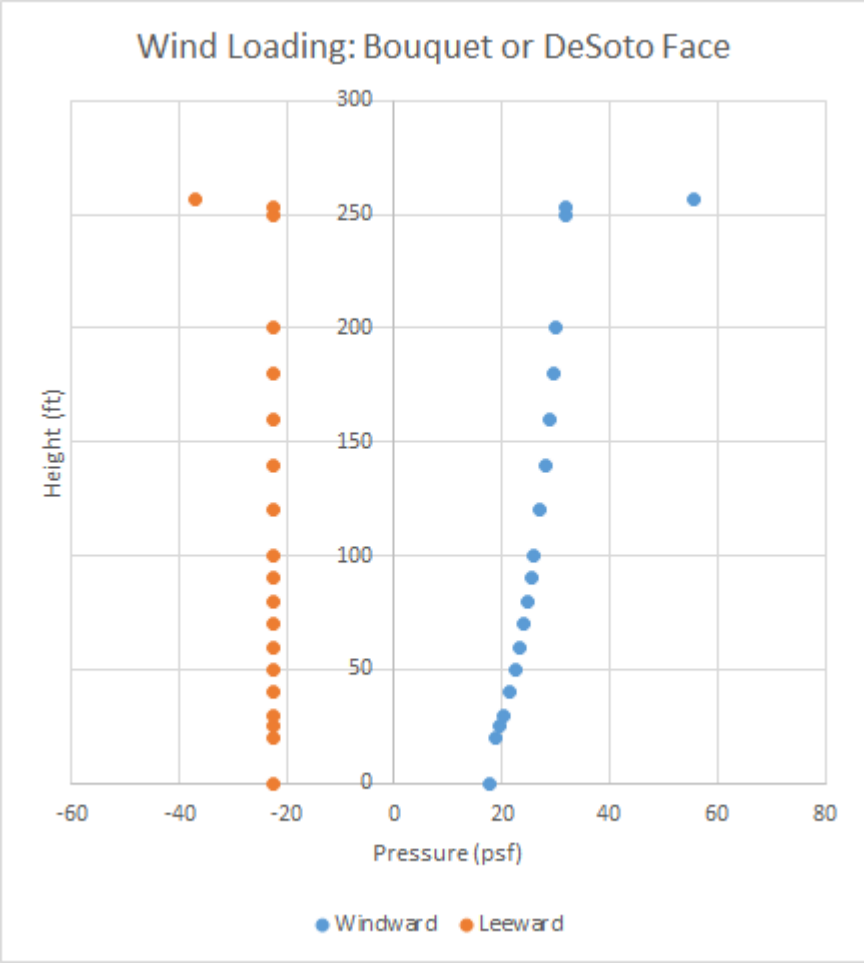
Shear Wall Design

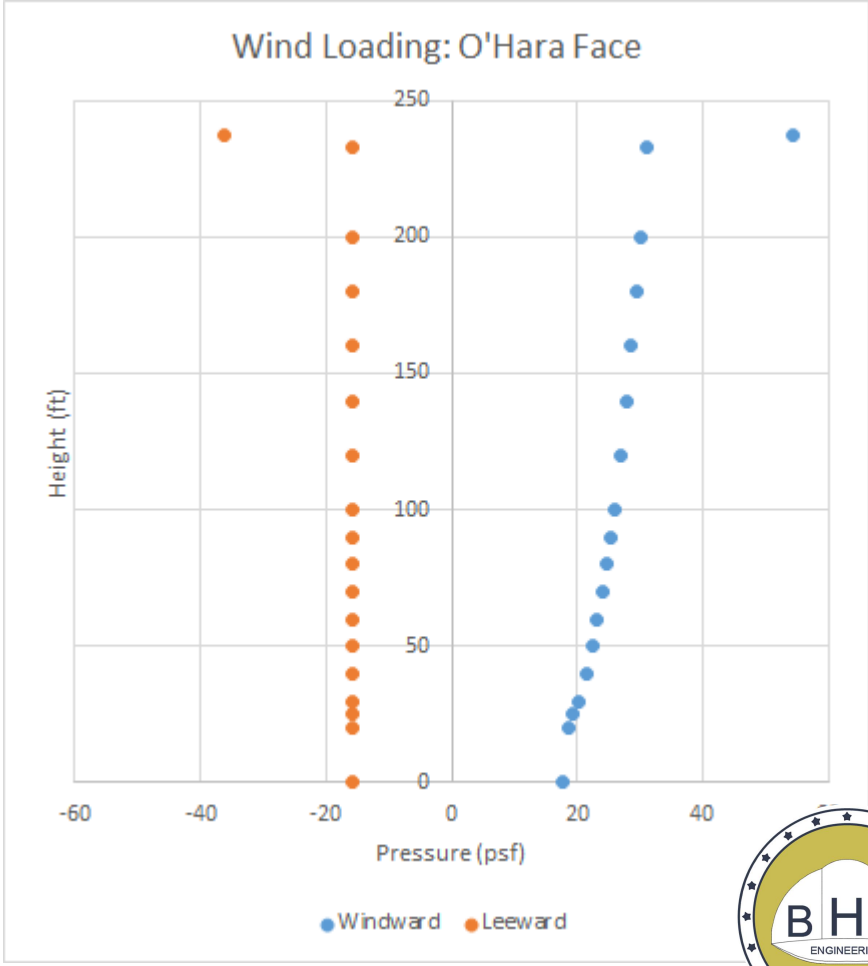
ACI 318-14 11.6.2		ρ required	ρ actual
ρ_l	#5 bars at 12 in	0.0025	0.0029
ρ_t	#5 bars at 12 in	0.0025	0.0029

Wall Thickness	
Maximum Unbraced Floor Height, L	23 ft
L/15	18.4 in
L/20	13.8 in
Width chosen	18 in
Clear cover	3 in



Wind Loads





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Shear Wall: P-M Curve

- 3 different P-M analyses based on the direction of wind/location of the neutral axis

Figure A: Wind on face of Bouquet or DeSoto

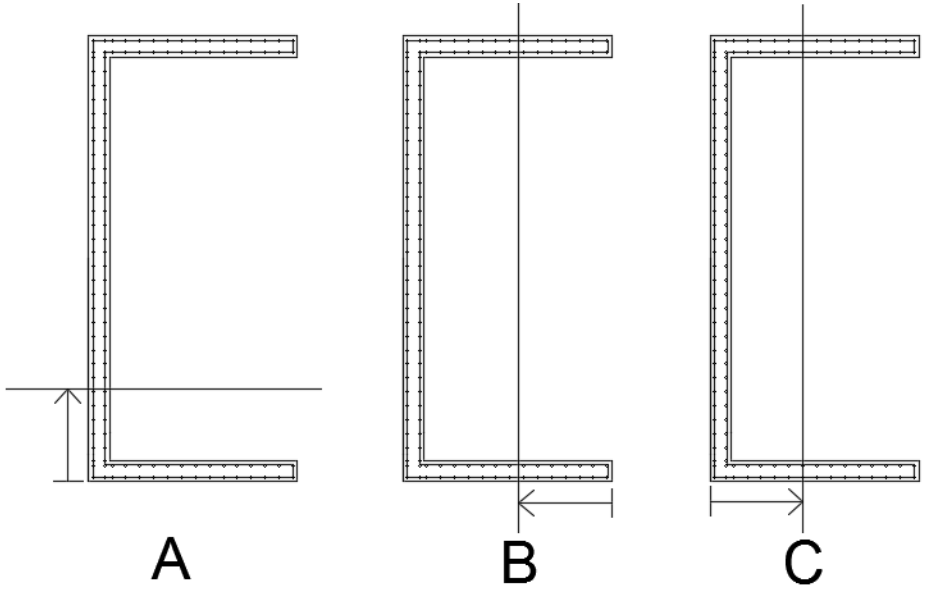
- i.e. from the bottom or top of the screen

Figure B: Wind on face of O'Hara

- i.e from the left of the screen

Figure C: Wind on face of O'Hara

- i.e. from the right of the screen



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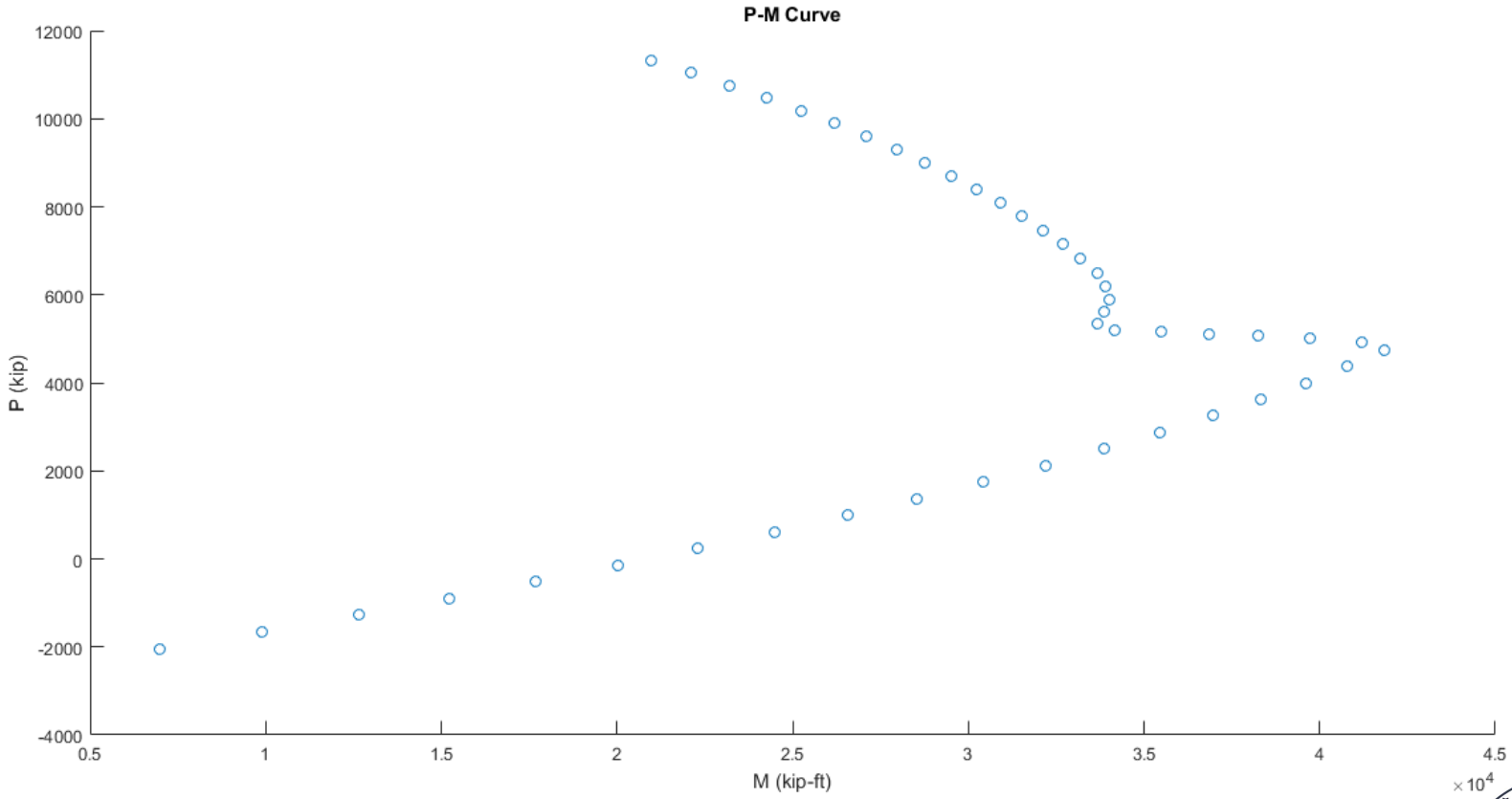
Shear Wall: P-M Curve



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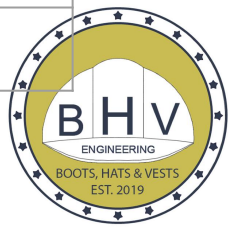
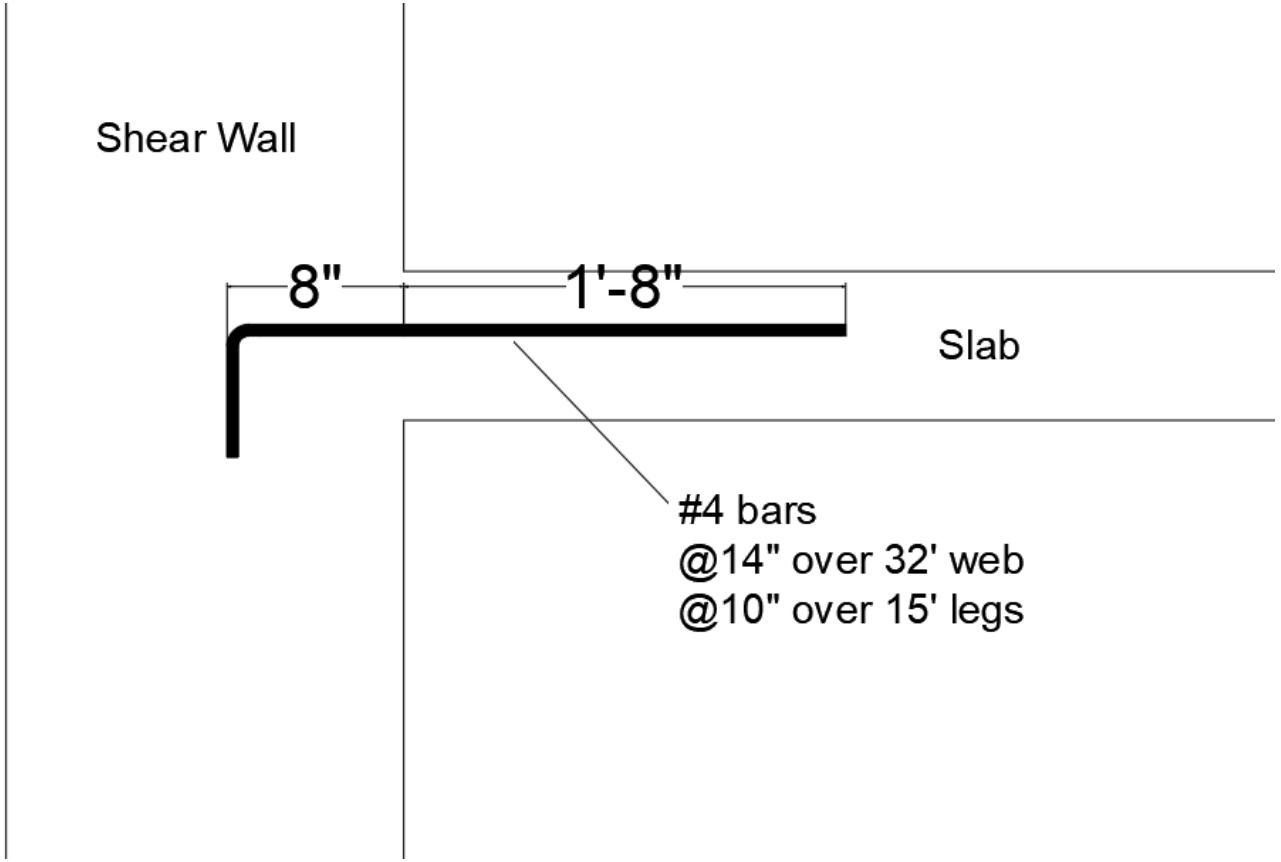
Shear Wall Design Values

Loads for Wind on Bouquet or DeSoto Face		
	Design Value Per Wall	Capacity per Wall
Moment	79,000 kip-ft	150,000 kip-ft ✓
Shear	385 kip	394 kip ✓
Axial	7,700 kip	8,000 kip ✓

Design Loads for Wind on O'Hara Face		
	Design Value Per Wall	Capacity per Wall
Moment	44,800 kip-ft	120,000 kip-ft ✓
Shear	243 kip	287 kip ✓
Axial	7,700 kip	8,000 kip ✓



Shear Wall Tie to Slab



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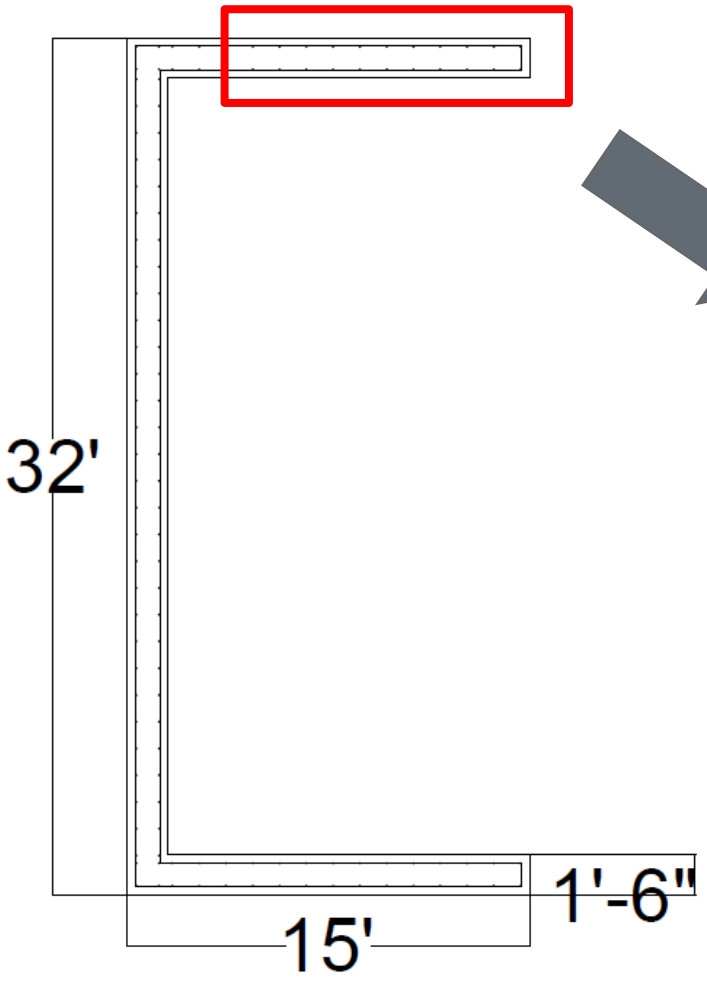
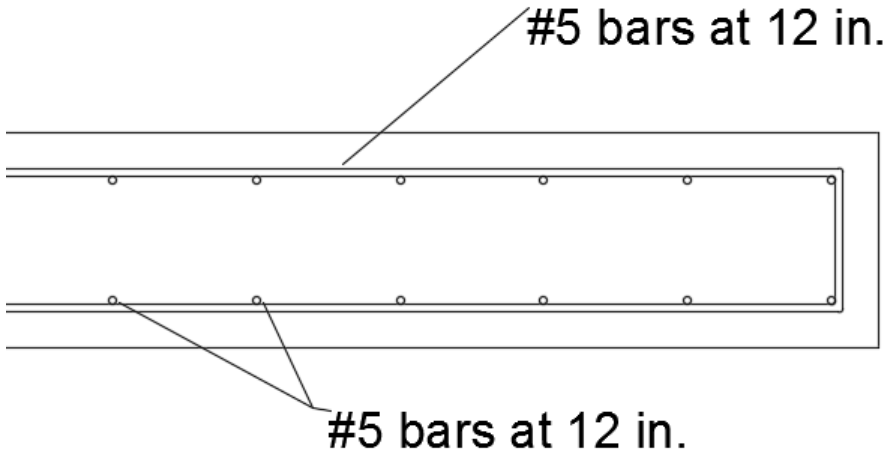
Shear Wall Design





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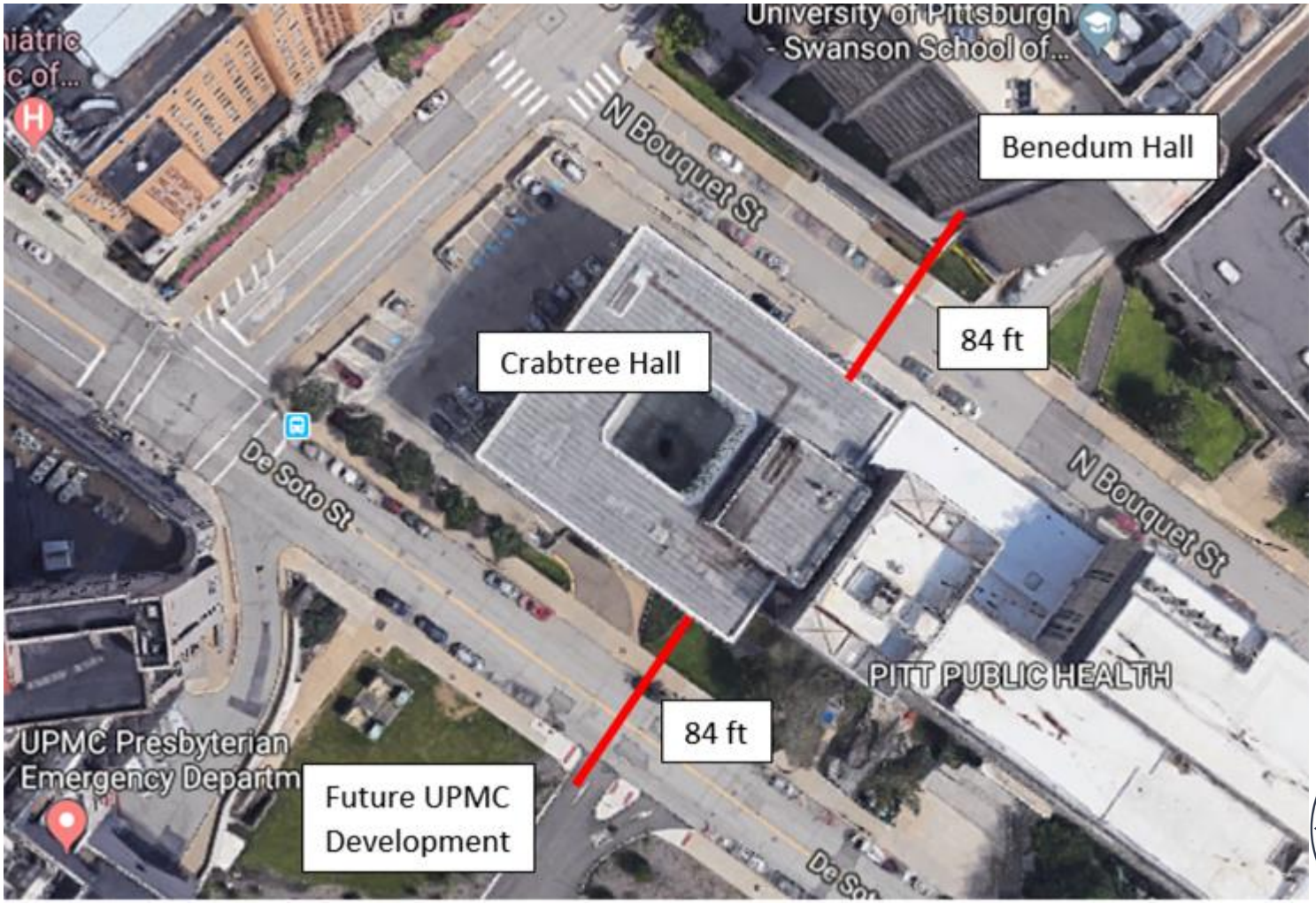
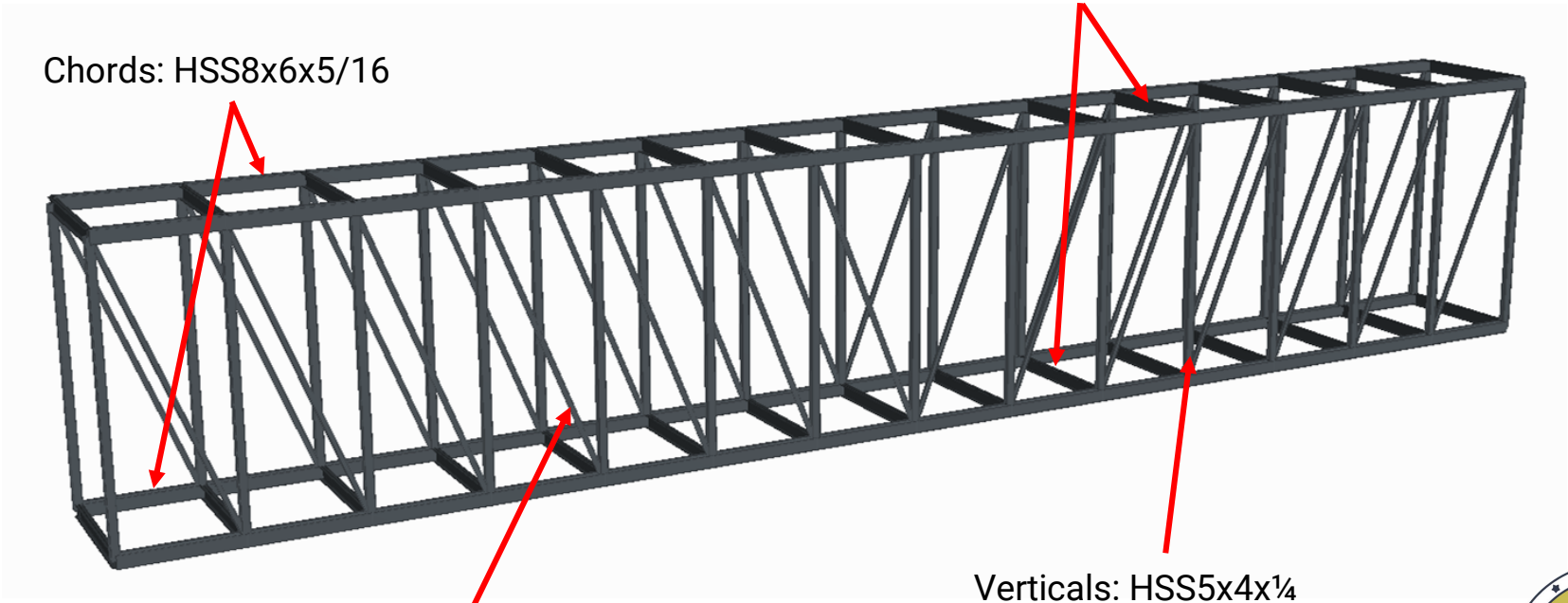
Pedestrian Bridge Design

Pedestrian Bridge Overview



Pedestrian Bridge Design

- Utilizing a through Pratt truss
- 8 ft wide, 15 ft high, 84 ft long, 6 ft bays



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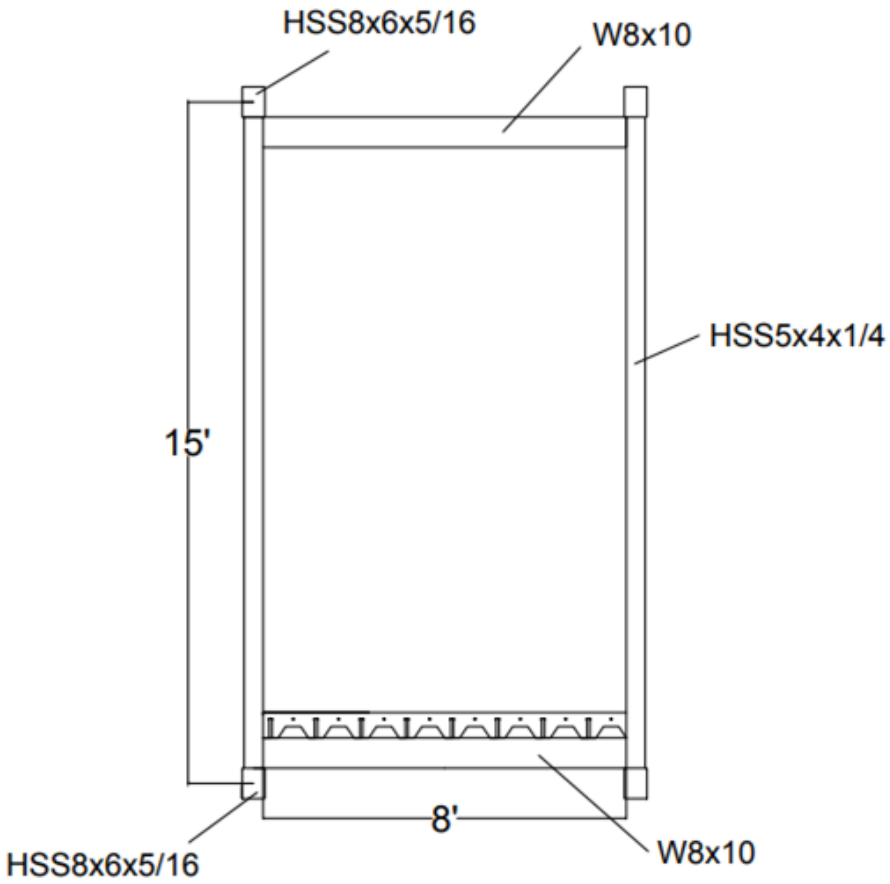
Pedestrian Bridge Design



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Pedestrian Bridge Design

Loads

Dead (DC)	1587	plf
Live Load (PL)	720	plf
Horizontal Wind (WS_H)	850	plf
Vertical Wind (WS_V)	120	plf

AASHTO LRFD Table 3.4.1-1

	DC	PL	WS
Strength I	1.25	1.75	0
Strength III	1.25	0	1.4
Service I	1	1	0.3

Load Combinations

Strength I	1622	plf
Strength III	1160	plf
Service I	1190	plf

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Pedestrian Bridge Design

Other Checks

- Allowable deflection is 2.8 “ for 84 ft span
  - Maximum deflection is 1.07” ✓
- Top chord checks
  - Slenderness $KL/r_x=79 < 120$ ✓
  - Slenderness $KL/r_y = 99 < 120$ ✓
  - φP_n (compressive resistance) = 137 kips > 47.4 kips ✓
- Vibrations
  - Vertical frequency is 3.4 Hz > 3 Hz ✓
- Buckling ✓

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Transportation

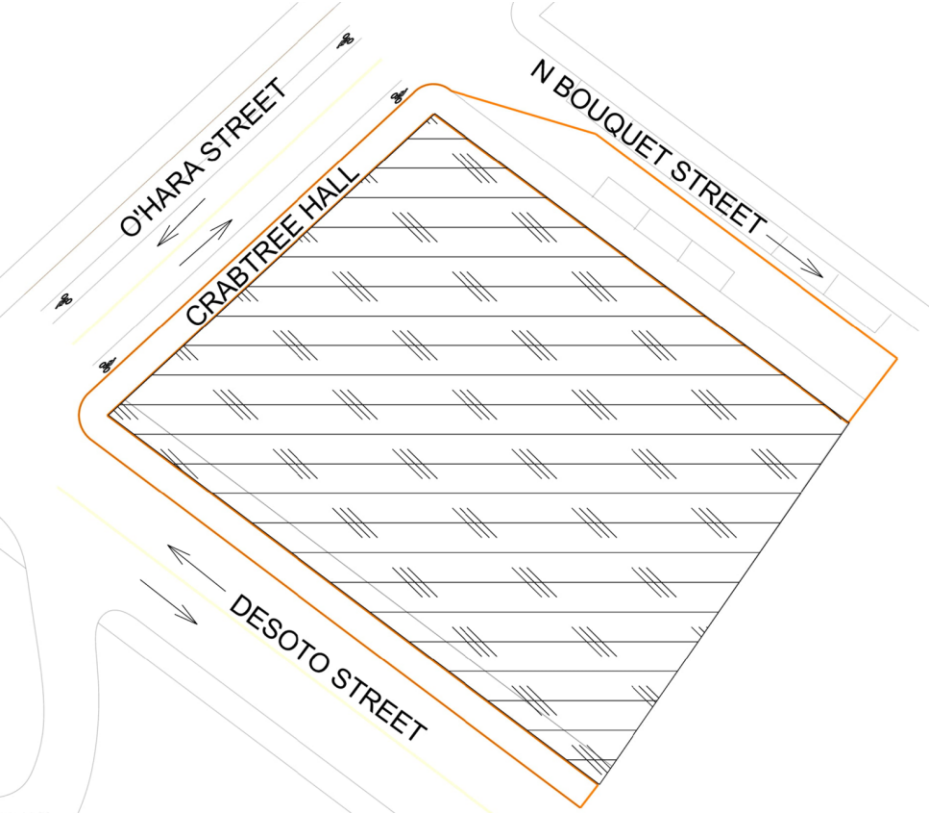
Transportation Overview

- Work zone traffic plans
- Intersection improvements
- Streetscape design

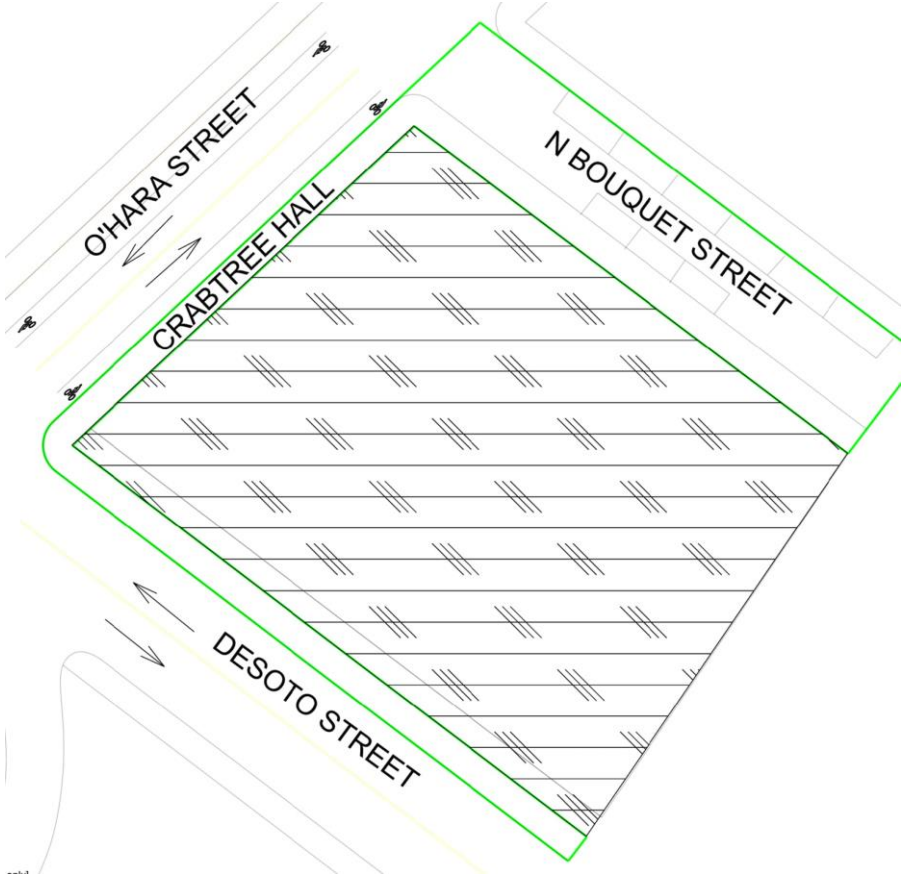
Work Zone Traffic Control

Transportation - Work Zone Traffic Plans

Option 1: 1 Lane of traffic on Bouquet. Closure limited to sidewalk on O'Hara and DeSoto

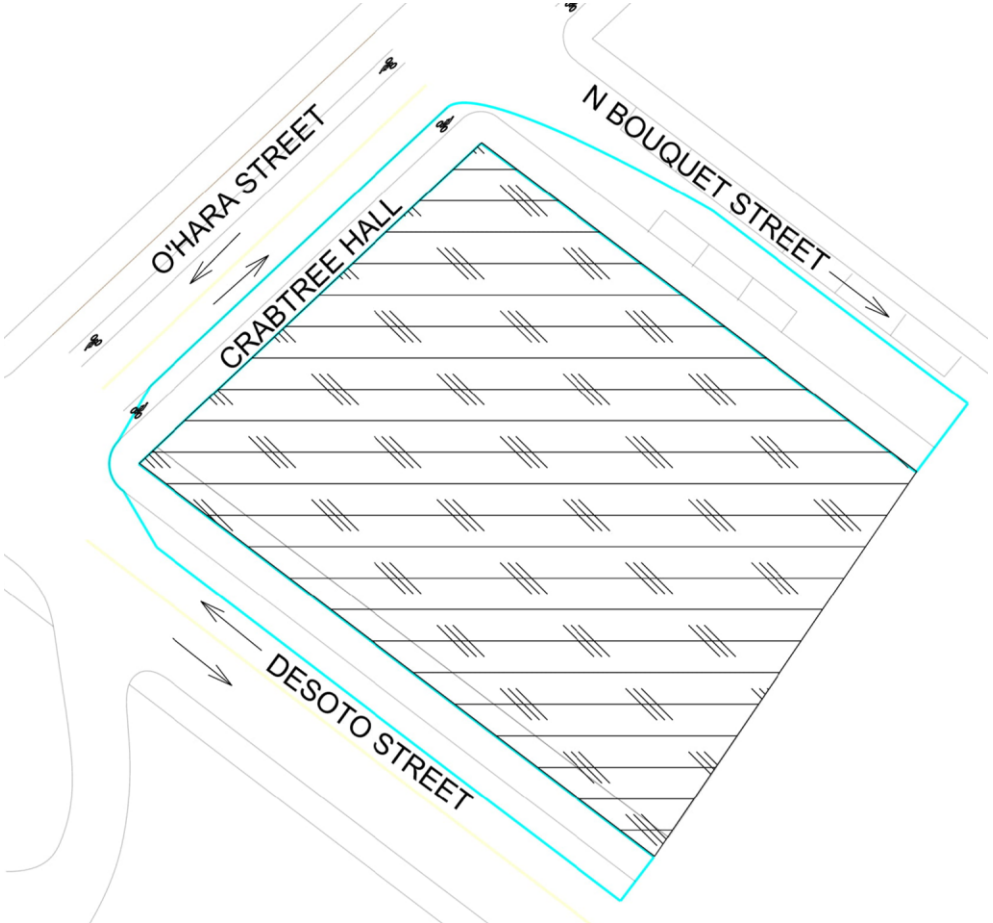


Option 2: Full Closure of bouquet



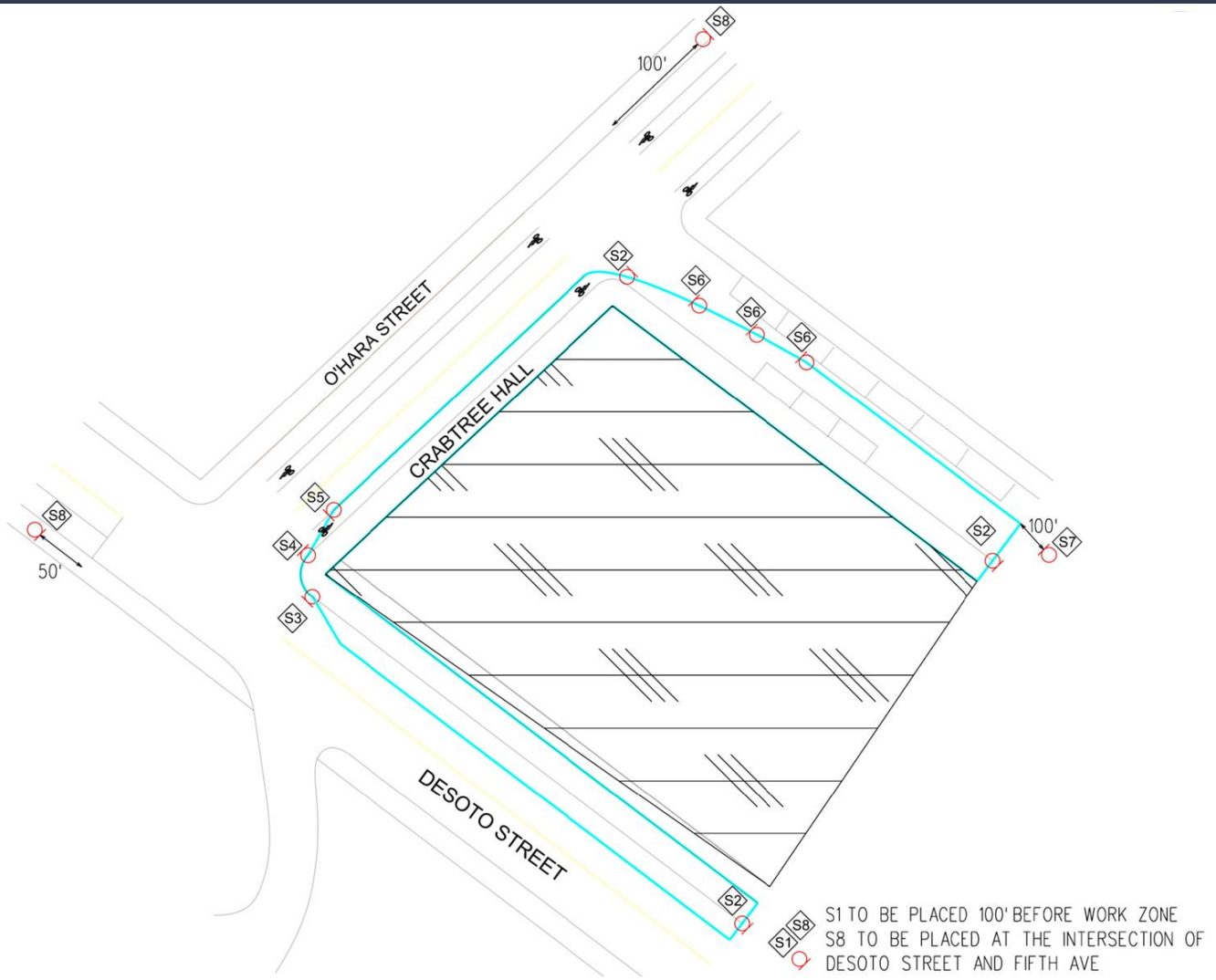
Transportation – Work Zone Traffic Plans

Option 3: Closure of Parking on Desoto, bike lane on O'Hara, 1 lane open on Bouquet



Option 3 is the preferred Alternative

Transportation-Work Zone Closure Plan



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Transportation-Work Zone Closure Plan

S1		W 21-5 A 36" X 36"
		R 9-11 24" X 18"
S2		W 21-5 A 36" X 36"
		R9-9 24" X 12"
S3		R9-9 24" X 12"
		R9-3Bp 12"x18"
S4		R9-9 24" X 12"
		R9-3Bp 12"x18"

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Transportation-Work Zone Closure Plan

S5

R 4-11 30" X 30"

S6

W 1-8 18" X 24"

S7

G 20-2 36" X 18"

SIGN TO BE PLACED 100' AFTER

THE END OF THE WORK ZONE

S8

W 21-5 36" X 36"

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Intersection Improvements

Transportation-Intersection Improvements

Signal Upgrades at intersection of O'Hara St & DeSoto St

- Due to nearby development, signal rebuild required
- Add flashing yellow arrow signal head to accommodate new phasing and operations

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Crash History at Intersection:
O'Hara and DeSoto Street

3 Accidents from 2014-2017

- 1 Rear end Accident
- 2 pedestrian injury accidents
  - 2015 and 2016
  - One mild injury crash and one apparent injury crash

This intersection has a higher pedestrian accident frequency compared to nearby intersections of similar size and volume.

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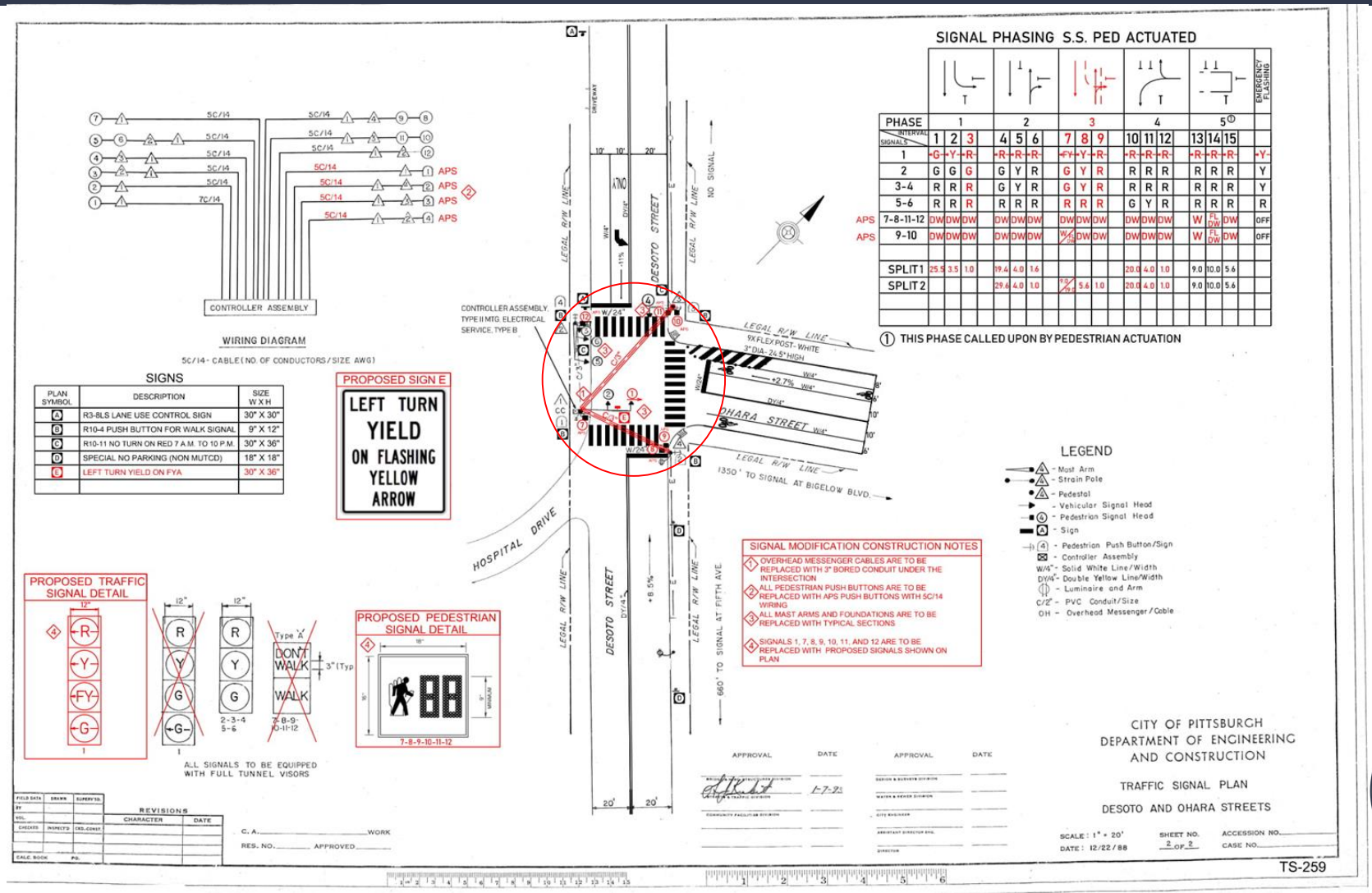
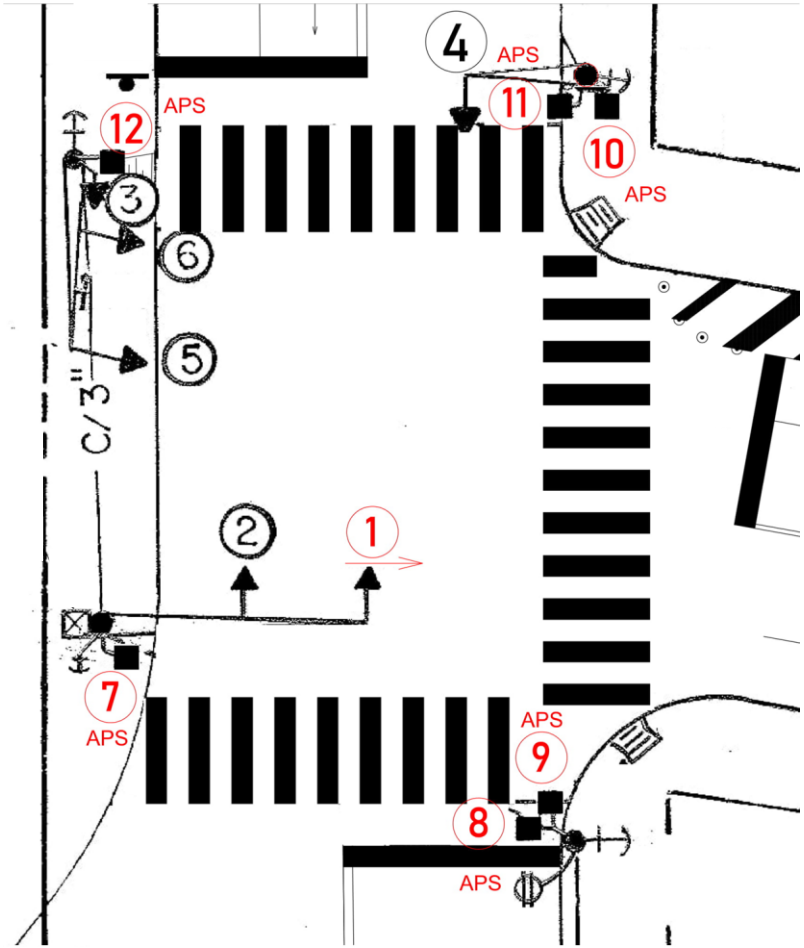
Transportation- Intersection Improvements



Transportation- Intersection Improvements



Accessible Pedestrian Signals

Flashing Yellow Arrow Signals

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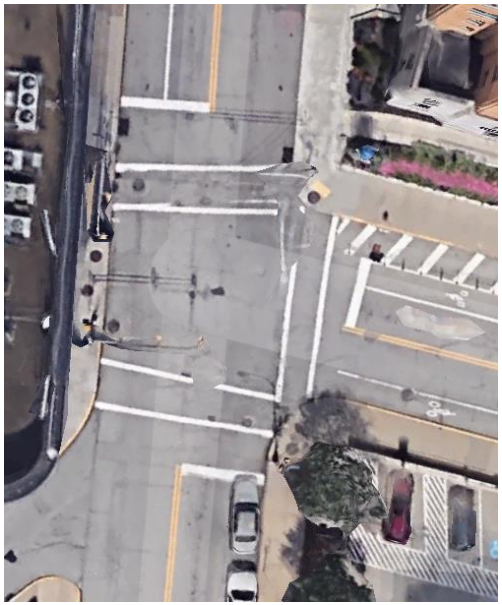
Transportation- Intersection Improvements

Existing Conditions

- Intersection LOS- B
- Critical LOS- D (O'Hara Street WB)
- Critical Delay of 38.3 Seconds



Improvements

Peak Hour Phasing

- Intersection LOS-C
- Critical LOS-C (O'Hara St. WB & Desoto St. Left Turn)
- Critical Delay of 33.9 Seconds

Off Peak Phasing

- Intersection LOS-B
- Critical LOS-C (Desoto Street Left Turn)
- Increased Pedestrian Mobility on N/S corridor
- Critical Delay of 24.0 seconds

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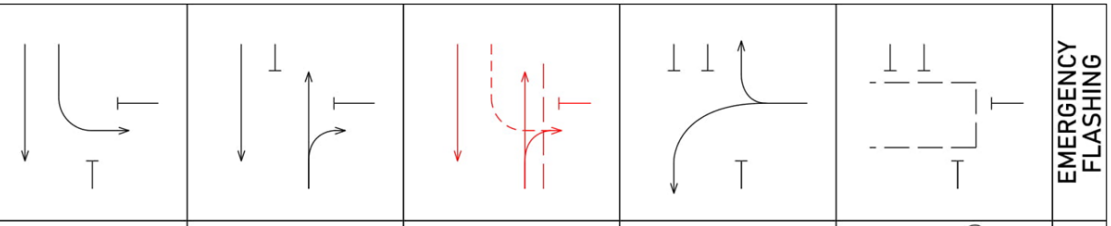
Transportation- Intersection Improvements

SIGNAL PHASING S.S. PED ACTUATED

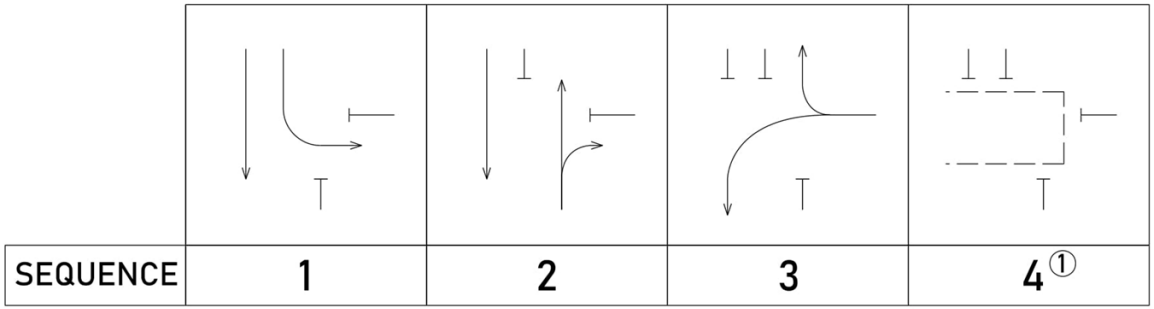


	PHASE	1				2				3				4				5 ①				EMERGENCY FLASHING
	INTERVAL / SIGNALS	1	2	3		4	5	6		7	8	9		10	11	12		13	14	15		
	1	G	Y	R		R	R	R		FY	Y	R		R	R	R		R	R	R		Y
	2	G	G	G		G	Y	R		G	Y	R		R	R	R		R	R	R		Y
	3-4	R	R	R		G	Y	R		G	Y	R		R	R	R		R	R	R		Y
	5-6	R	R	R		R	R	R		R	R	R		G	Y	R		R	R	R		R
APS	7-8-11-12	DW	DW	DW		DW	DW	DW		DW	DW	DW		DW	DW	DW		W	FL DW	DW		OFF
APS	9-10	DW	DW	DW		DW	DW	DW		W / FL DW	DW	DW		DW	DW	DW		W	FL DW	DW		OFF
	SPLIT 1	25.5	3.5	1.0		19.4	4.0	1.6						20.0	4.0	1.0		9.0	10.0	5.6		
	SPLIT 2					29.6	4.0	1.0		9.0 / 19.0	5.6	1.0		20.0	4.0	1.0		9.0	10.0	5.6		

① THIS PHASE CALLED UPON BY PEDESTRIAN ACTUATION

Transportation- Intersection Improvements

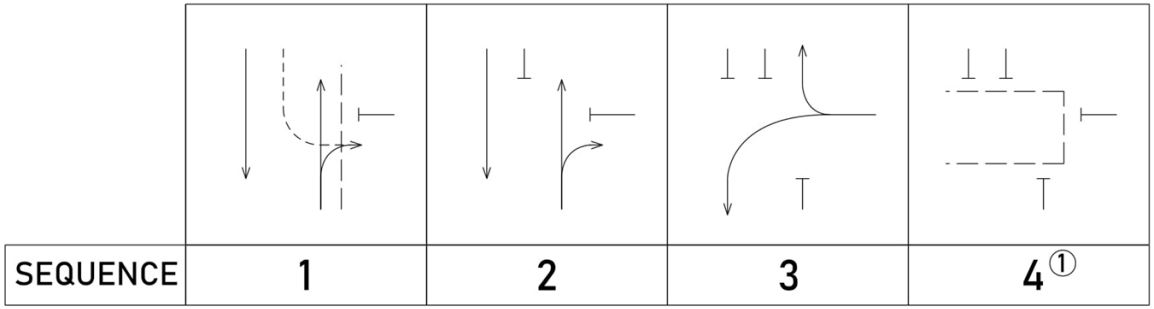
AM/PM PEAK HOUR PHASING



SEQUENCE	1	2	3	4 ①

① THIS PHASE CALLED UPON BY PEDESTRIAN ACTUATION

OFF PEAK PHASING



SEQUENCE	1	2	3	4 ①

① THIS PHASE CALLED UPON BY PEDESTRIAN ACTUATION

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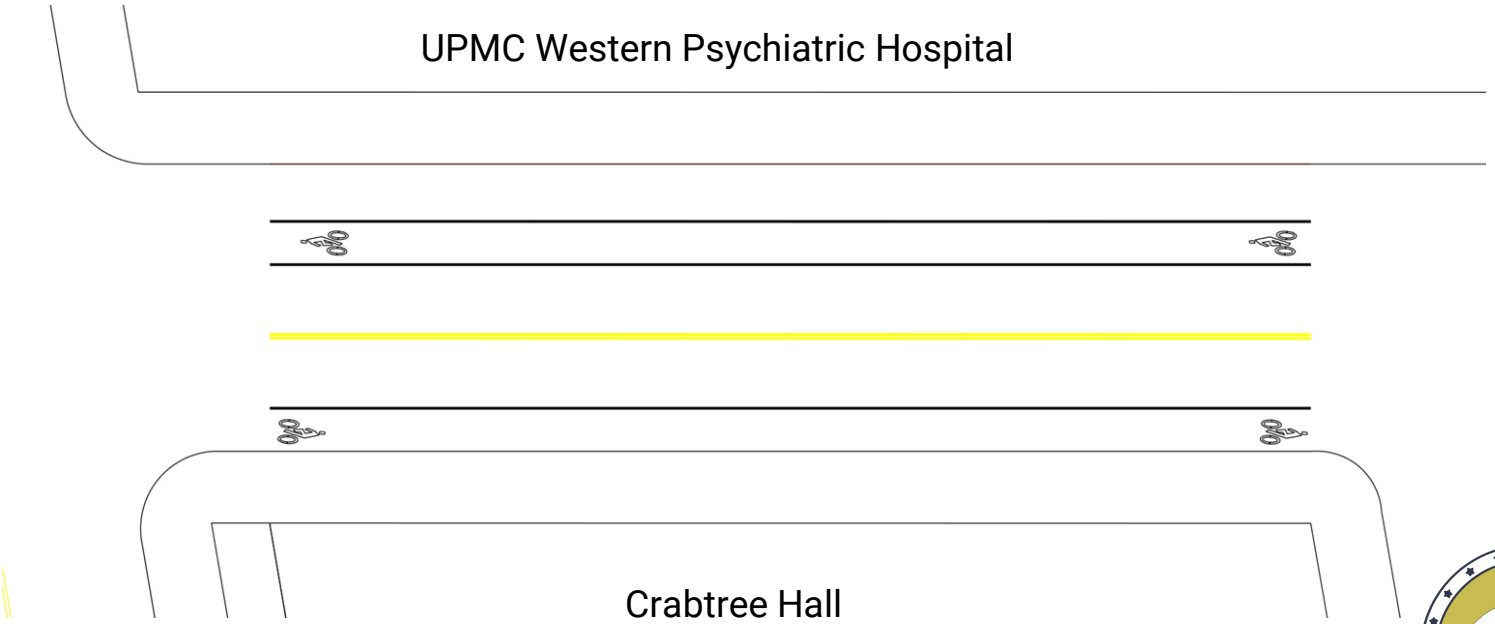
Streetscape Design

Transportation- Streetscape

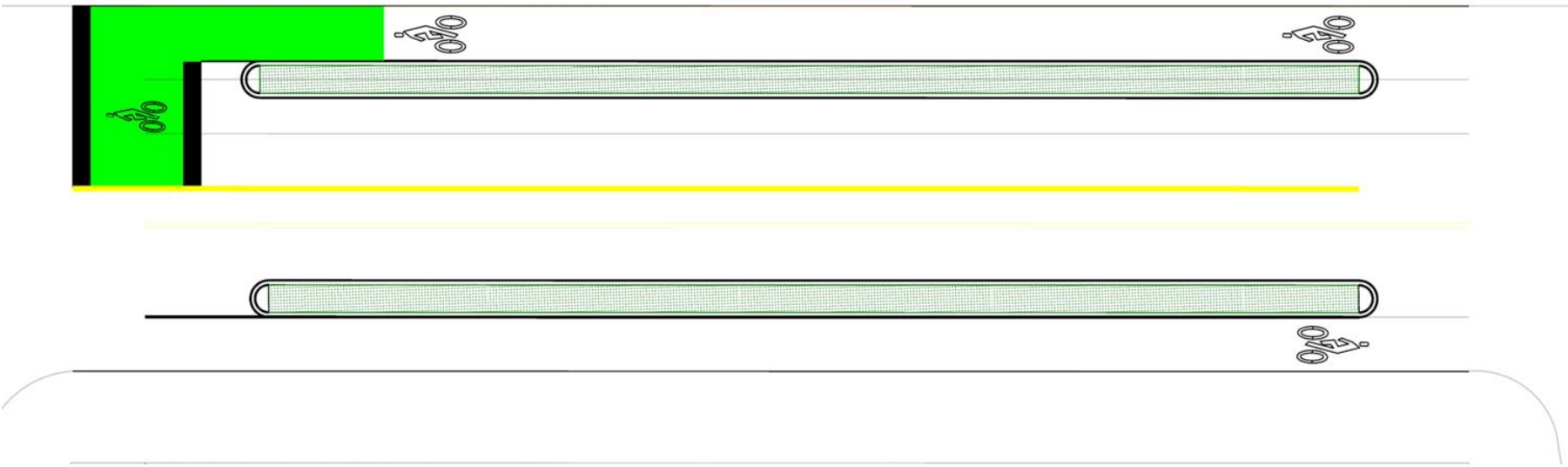
Existing Conditions



Transportation- Streetscape

Alternative 1

UPMC Western Psychiatric Hospital



Crabtree Hall

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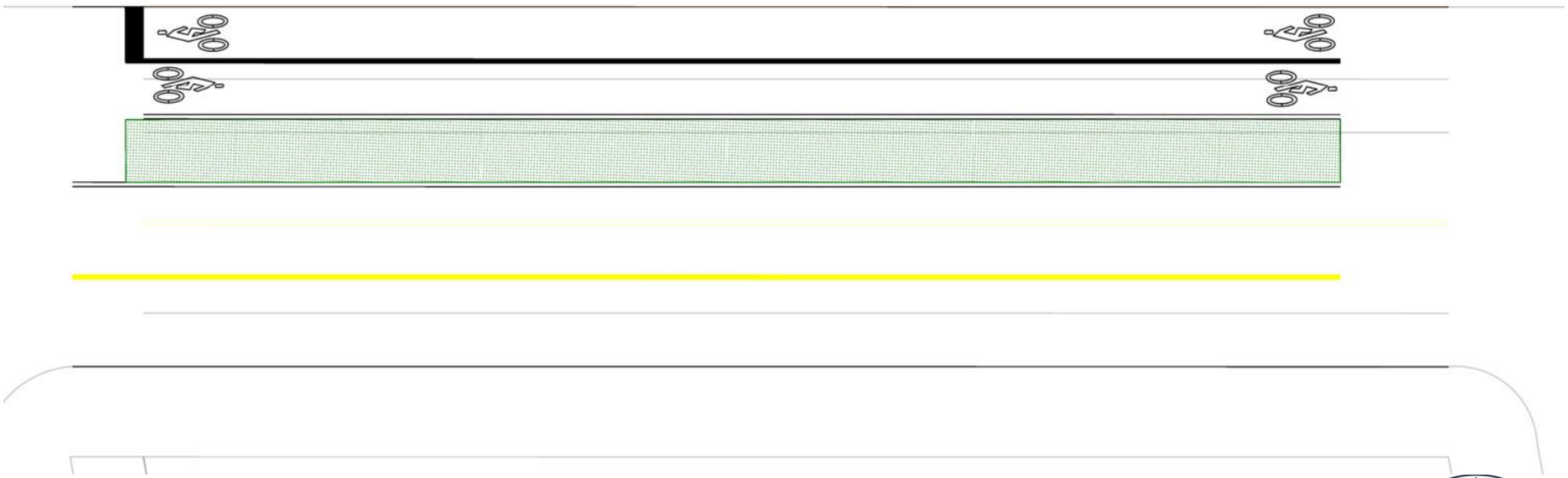
Transportation- Streetscape

Alternative 2

UPMC Western Psychiatric Hospital

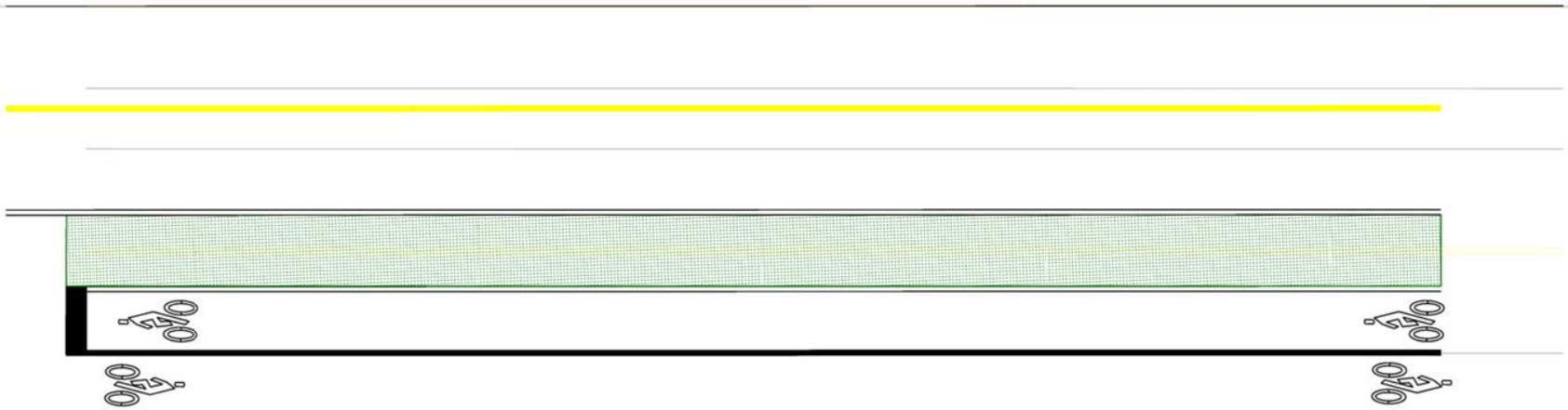


Crabtree Hall

Transportation- Streetscape

Alternative 3

UPMC Western Psychiatric Hospital



Crabtree Hall

Evaluation of Streetscape Alternatives

	Evaluation Criteria				
Option	Cost	Visual Aesthetic	Mobility	Safety	Parking
Existing Conditions	++	--	+	-	+
Alternative 1	-/0	++	++	++	-
Alternative 2	-/0	+	-	0	-
Alternative 3	-/0	+	-	0	-

Legend	
++	Excellent
+	Good
0	Neutral
-	Bad
--	Unacceptable

Alternative 1 is the preferred option

Streetscape Signage Plans

Selected Option:

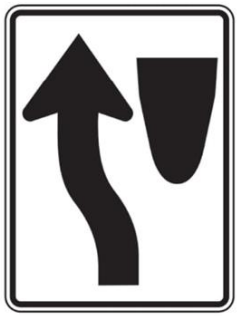
Alternative 1

UPMC Western Psychiatric Hospital

Crabtree Hall

Streetscape Signage Plans

1



R4-8 24" X 30"

OM-3c 12" X 36"

2

R5-1b 12" X 18"

R9-3cP 12" X 12"

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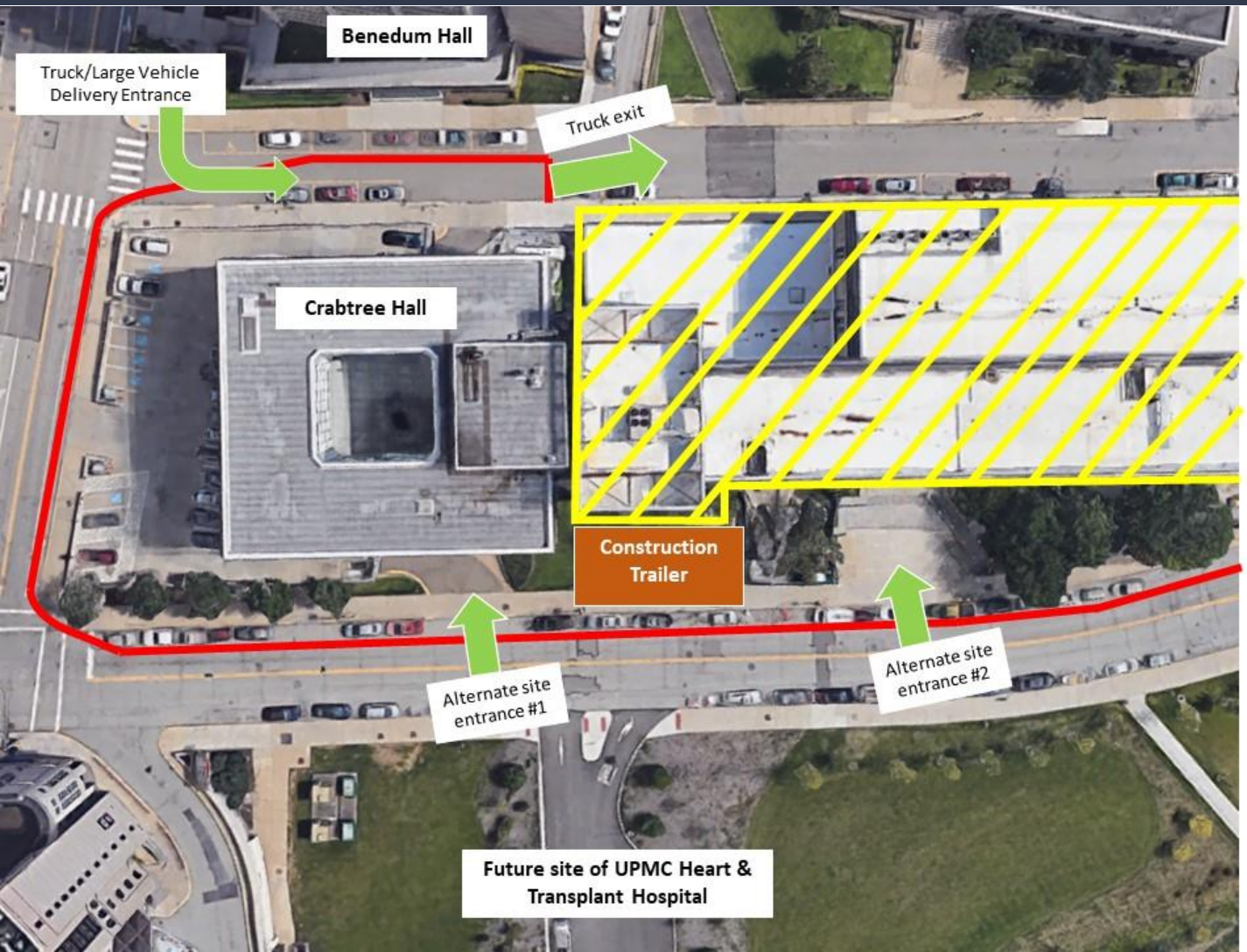
Construction Management

Construction Logistics



Legend

- Physical barriers comprising construction fencing plan
- Not part of this project
- Access points to construction site
- Temporary office trailer

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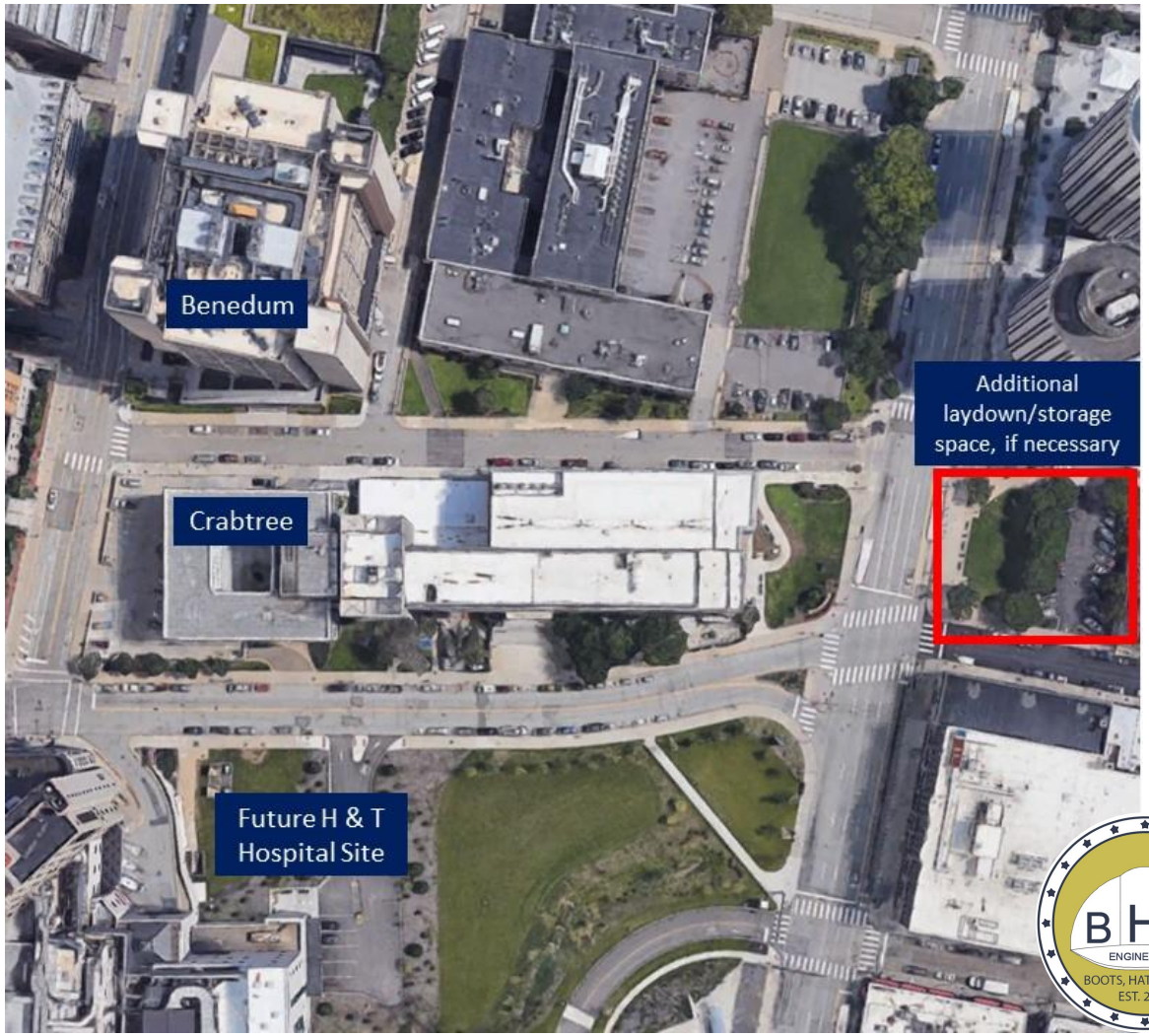
Construction Logistics

- Primary lay down and storage area will be the perimeter of our project site
- Additional storage area indicated, to be used if necessary



Project Schedule

MILESTONES

- **Project Start:** October 30, 2023
- **Premises Vacated By:** December 18, 2023
- **Hazardous Material Removal Begins:** December 20, 2023
- **Demolition Begins:** March 13, 2024
- **Foundation Installation Begins:** August 26, 2024
- **Steel Erection Begins:** September 25, 2024
- **Pedestrian Bridges Installation Begins:** October 22, 2025
- **Installation of New Intersection Controls Begins:** November 4, 2025
- **Furniture and Equipment Move-In Begins:** January 14, 2026
- **Completion of work:** July 27, 2026

TOTAL SCHEDULE

October 30, 2023 – July 27, 2026

(2 Years, 9 months)

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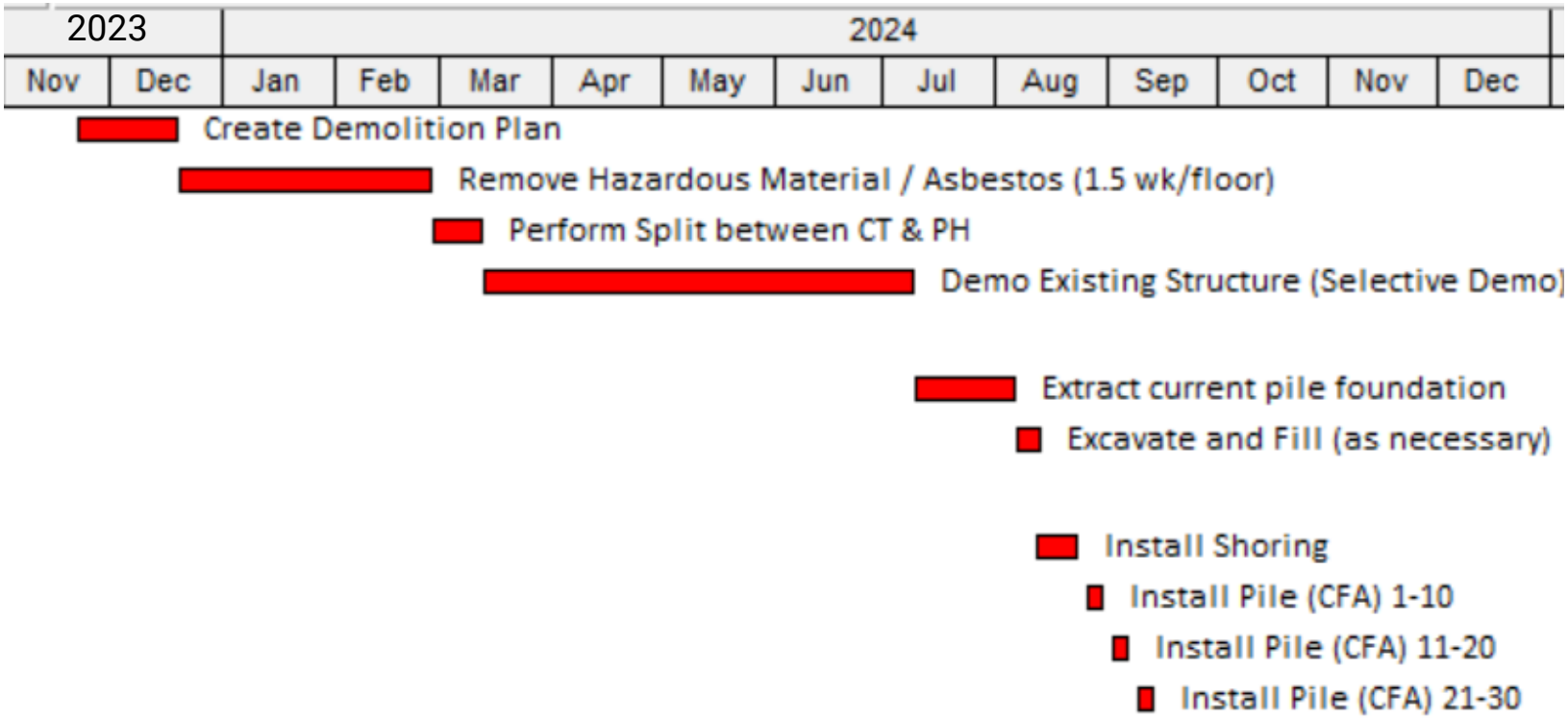
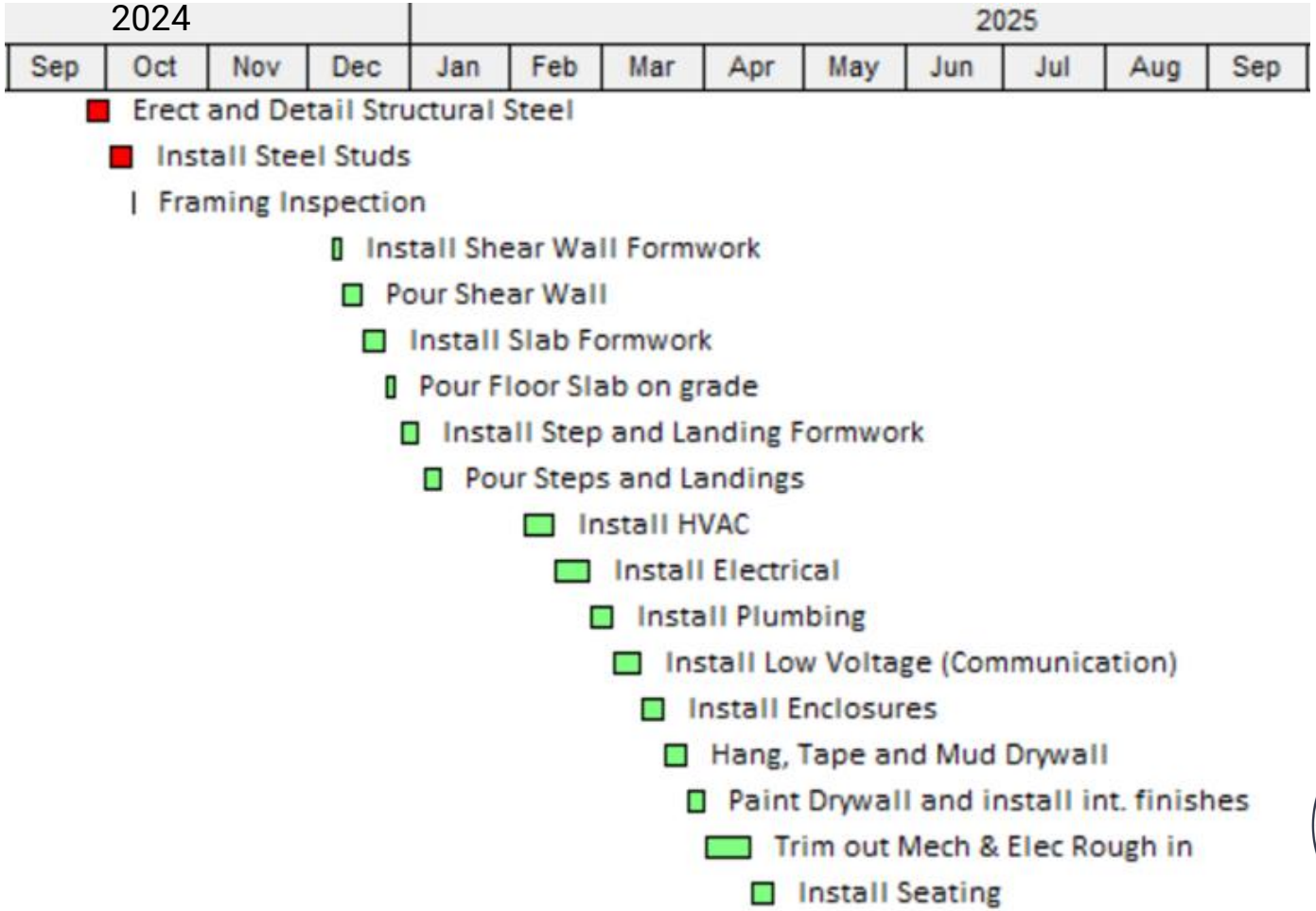
Project Schedule

Demolition and Foundation Schedule



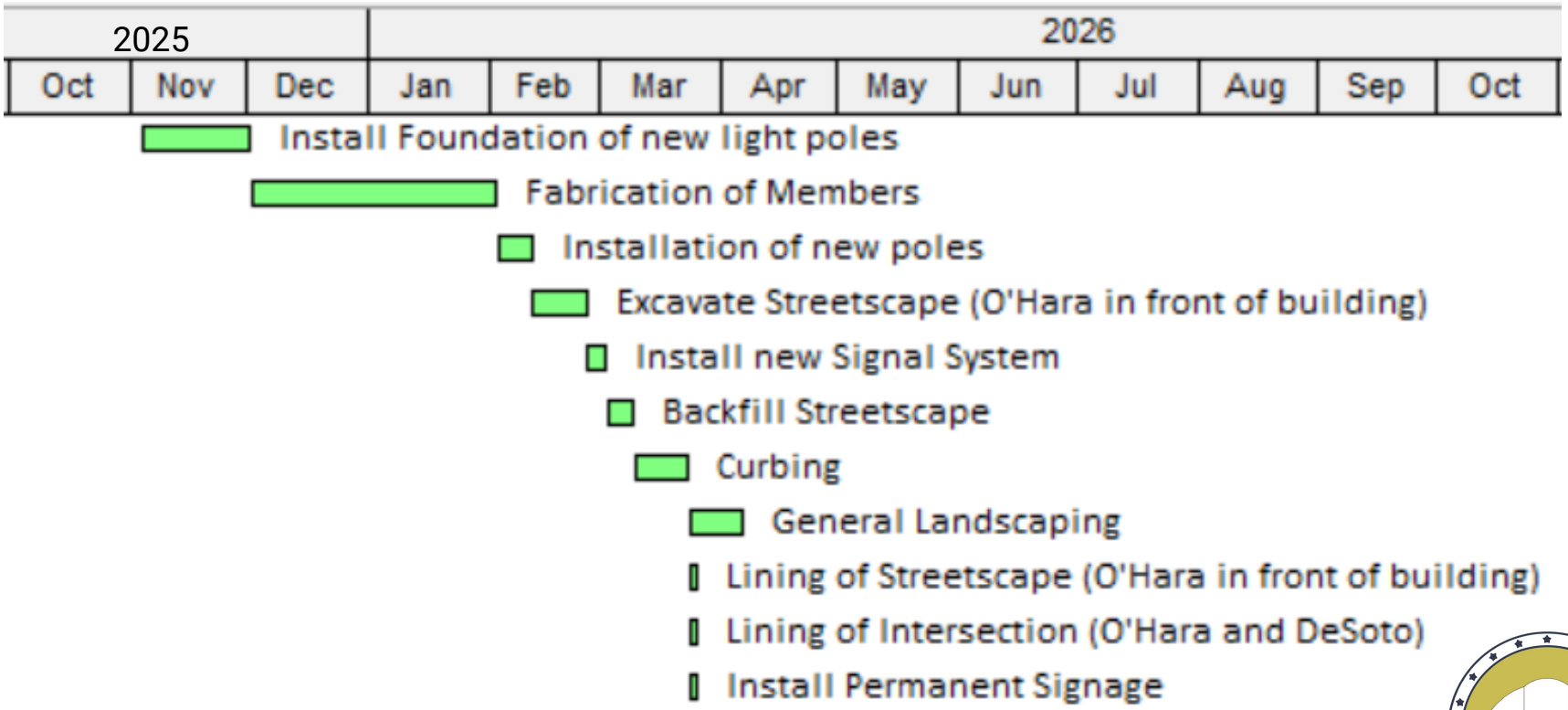
Project Schedule

First Floor Schedule



Project Schedule

Transportation/Streetscape Schedule



Detailed Base Estimate

RSMeans Building
Construction Costs, ed. 2018

Section	Description	Total
010000	General Conditions	$4,912,000
020000	Demolition & Hazardous Material Removal	$3,356,000
030000	Concrete	$6,447,000
050000	Structural Steel	$5,029,000
053100	Steel Decking	$955,000
073300	Natural Roof	$359,000
081000	Doors, Frames, Hardware	$714,000
084000	Entrances and Curtain Wall	$5,179,000
092000	Gypsum System	$745,000
096000	Flooring	$303,000
099000	Wall Finishes/Painting	$320,000
110000	Equipment	$20,508,000
120000	Furnishings	$10,505,000
210000	Fire Suppression	$1,800,000
220000	Plumbing	$5,500,000
230000	HVAC	$5,500,000
260000	Electrical	$5,500,000
323400	Fabricated Bridges	$183,000
329000	Sitework (Planting & Accessories)	$157,000
340000	Transportation	$100,000

Base Bid Total:

$78,072,000

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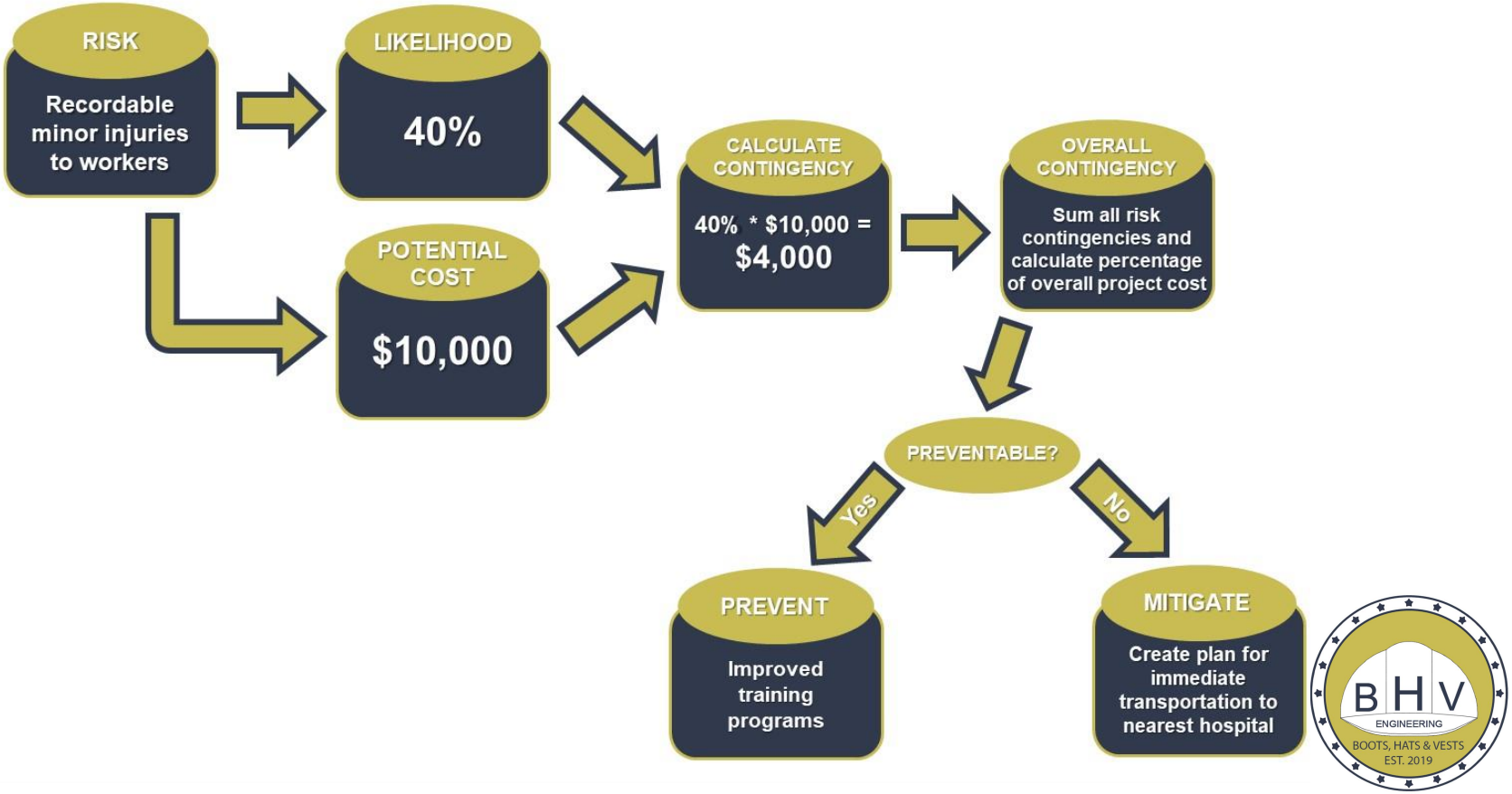
Risk Management Plan

- Risk Contingency calculated by assessing combination of likelihood and cost of major project risks



Estimate Summary

BASE BID:	$78,072,000
Design Contingency (1%):	$780,720
Risk Contingency (2.6%):	$2,030,000
Overhead (5%):	$3,904,000
Inflation (2.5%/yr)	$9,759,000
Profit (5%)	$3,904,000
FINAL ESTIMATE:	**$98,400,000**

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Thank you!

Any Questions?

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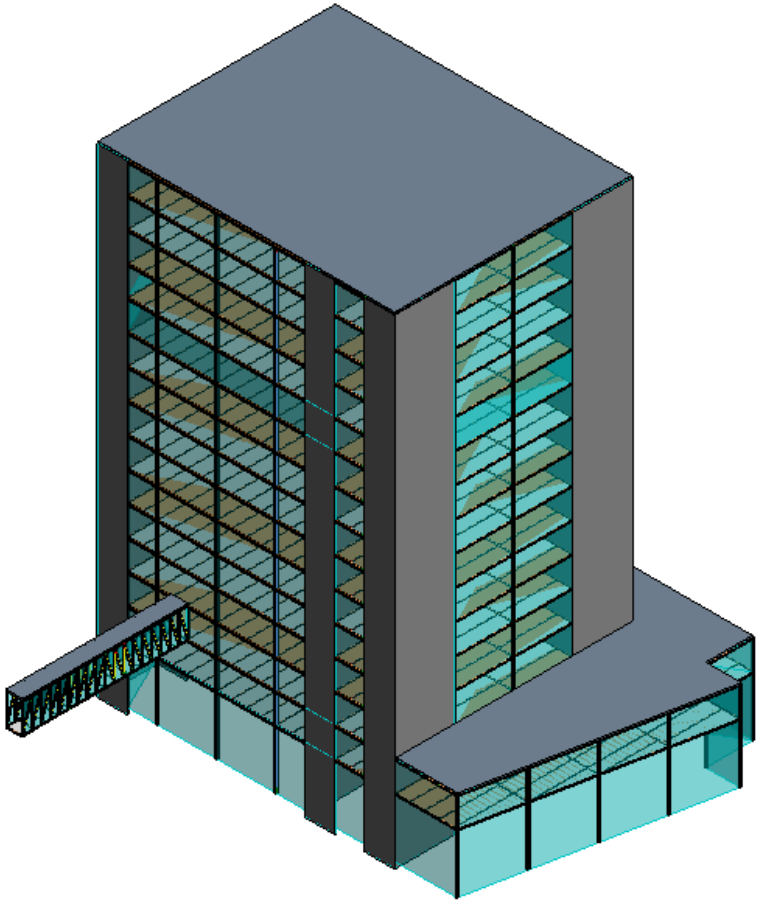

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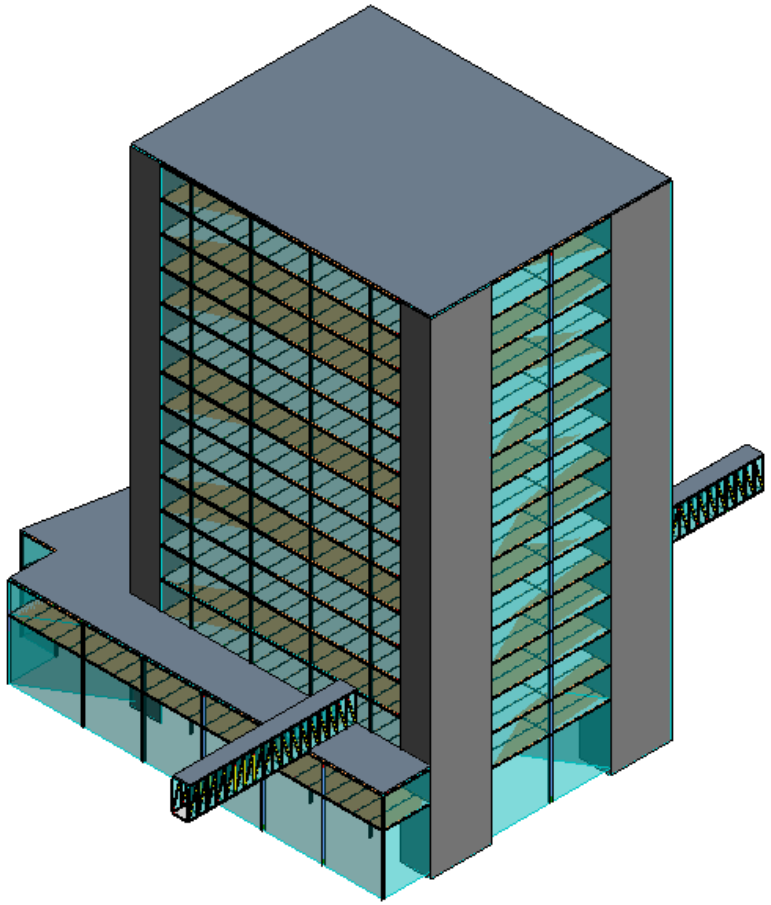

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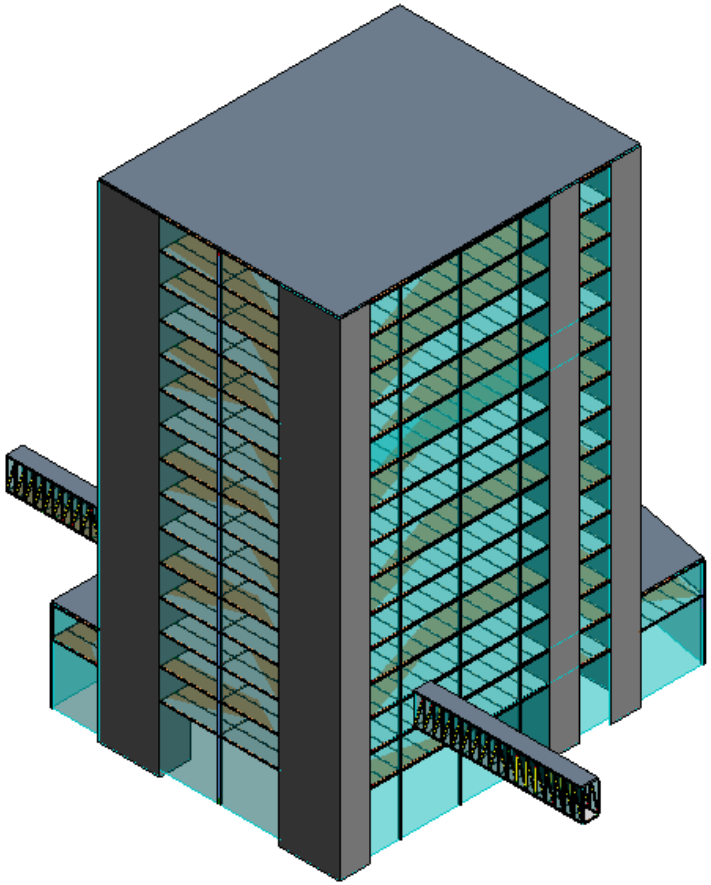

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Exterior Columns

Exterior Columns	Basement	Floor 1-2	Floor 2-3	Floor 4-5	Floor 6-7	Floor 8-9	Floor 10-11	Floor 12-13	Floor 14-15
Pu (kips)	1594	1485	1385	1181	978	776	573	372	174
Length (ft)	18	23	15	15	15	15	15	15	15
Effective Length (ft)	11.70	14.95	9.75	9.75	9.75	9.75	9.75	9.75	9.75
Column Selection	**W14x145**	**W14x145**	**W14x120**	**W14x99**	**W14x90**	**W14x74**	**W14x61**	**W14x48**	**W14x43**
ϕPn_min (kips)	1754	1656	1479	1218	1106	834	682	482	428

Interior Columns

Interior Columns	Basement	Floor 1-2	Floor 2-3	Floor 4-5	Floor 6-7	Floor 8-9	Floor 10-11	Floor 12-13	Floor 14-15
Pu (kips)	2731	2542	2366	2019	1673	1328	985	642	300
Length (ft)	18	23	15	15	15	15	15	15	15
Effective Length (ft)	11.70	14.95	9.75	9.75	9.75	9.75	9.75	9.75	9.75
Column Selection	**W14x233**	**W14x233**	**W14x193**	**W14x176**	**W14x145**	**W14x109**	**W14x90**	**W14x61**	**W14x43**
ϕPn_min (kips)	2829	2680	2405	2191	1804	1340	1106	682	428

Atypical Columns

Atypical Columns	Atrium Exterior- O'Hara		Atrium Corner		Foyer	
	Floor 1	Floor 2	Floor 1	Floor 2	Floor 1	Floor 2
Pu	307	162	90	46	614	324
Length	23	15	23	15	23	15
Effective Length	14.95	9.75	14.95	9.75	14.95	9.75
Selected Column	W14x48	W14x43	W14x43	W14x43	W14x74	W14x43
ϕPn (kips)	333	428	293	428	669	428

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Atypical Columns Continued

Atypical Columns Continued	Atrium Interior O'Hara		Atrium Exterior - DeSoto			Atrium Interior - DeSoto		
	Floor 1	Floor 2	Basement	Floor 1	Floor 2	Basement	Floor 1	Floor 2
Pu	1733	1427	274	179	91	2223	1753	1445
Length	23	15	20	23	15	20	23	15
Effective Length	14.95	9.75	13	14.95	9.75	13	14.95	9.75
Selected Column	W14x159	W14x145	W14x43	W14x43	W14x43	W14x193	W14x159	W14x145
ϕPn (kips)	1849	1804	345	293	428	2293	1849	1804

Truss Columns

Truss Columns	Truss - O'Hara Columns			Truss - PH Floor 1			Truss - PH Floor B		
	Truss 1	Truss 2 & 4	Truss 3	Truss 1	Truss 2 & 4	Truss 3	Truss 1	Truss 2 & 4	Truss 3
Pu	4051	149	6891	3108	149	4397	3206	283	4444
Length	23	23	23	23	23	23	20	20	20
Effective Length	15.0	15.0	15.0	15.0	15.0	15.0	13.0	13.0	13.0
Selected Column	W14x370	W14x43	W14x605	W14x283	W14x43	W14x398	W14x283	W14x43	W14x398
ϕPn (kips)	4311	293	7149	3274	293	4639	3384	345	4784

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Atypical Columns

Atypical Columns	Atrium Exterior- O'Hara		Atrium Corner		Foyer	
	Floor 1	Floor 2	Floor 1	Floor 2	Floor 1	Floor 2
Pu	307	162	90	46	614	324
Length	23	15	23	15	23	15
Effective Length	14.95	9.75	14.95	9.75	14.95	9.75
Selected Column	W14x48	W14x43	W14x43	W14x43	W14x74	W14x43
ϕPn (kips)	333	428	293	428	669	428

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Truss Columns

Truss Columns	Truss - O'Hara Columns			Truss - PH Floor 1			Truss - PH Floor B		
	Truss 1	Truss 2 & 4	Truss 3	Truss 1	Truss 2 & 4	Truss 3	Truss 1	Truss 2 & 4	Truss 3
Pu	4051	149	6891	3108	149	4397	3206	283	4444
Length	23	23	23	23	23	23	20	20	20
Effective Length	15.0	15.0	15.0	15.0	15.0	15.0	13.0	13.0	13.0
Selected Column	W14x370	W14x43	W14x605	W14x283	W14x43	W14x398	W14x283	W14x43	W14x398
ϕPn (kips)	4311	293	7149	3274	293	4639	3384	345	4784

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Exterior & Interior Girders

Exterior Girders	Floor 1	Floor 2-15	Roof
	W24x55	**W24x55**	**W21x44**
Mu (kip*ft)	479	439	327
ϕMn (kip*ft)	490	490	340
Vu (kips)	64	58	44
ΦVn (kips)	252	252	217
Δ max (in)	1.4	1.3	1.4

Interior Girders	Floor 1	Floor 2-15	Roof
	W24x76	**W24x76**	**W24x62**
Mu (kip*ft)	733	668	547
ϕMn (kip*ft)	750	750	567
Vu (kips)	98	89	73
ΦVn (kips)	315	315	306
Δ max (in)	1.4	1.3	1.5

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Additional Girders

Glass Exterior Girder	Floor 1 & 2
	W24x55
Mu (kip*ft)	459
ϕMn (kip*ft)	490
Vu (kips)	61
ΦVn (kips)	252
Δ max (in)	1.4

Atrium Short Span	Floor 1 & 2
	W24x76
Mu (kip*ft)	698
ϕMn (kip*ft)	750
Vu (kips)	93
ΦVn (kips)	315
Δ max (in)	1.4

Atrium Long Span	Floor 1 & 2
	W24x76
Mu (kip*ft)	718
ϕMn (kip*ft)	750
Vu (kips)	96
ΦVn (kips)	315
Δ max (in)	1.4

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Pedestrian Bridge Design

Member Analysis

	Length (ft)	Member Selected	Maximum Force	Capacity
Top Chord	6	HSS 8x6x5/16	-65.6 kip	-320 kip
Bottom Chord	6	HSS 8x6x5/16	66.7 kip	265 kip
Diagonals	16.2	HSS 3x1.5x1/4	48.7 kip	60.9 kip
Verticals	15	HSS 5x4x1/4	-45.2 kip	-66 kip
Floor beams	8	W 8x10	15.3 kip ft	23.9 kip ft

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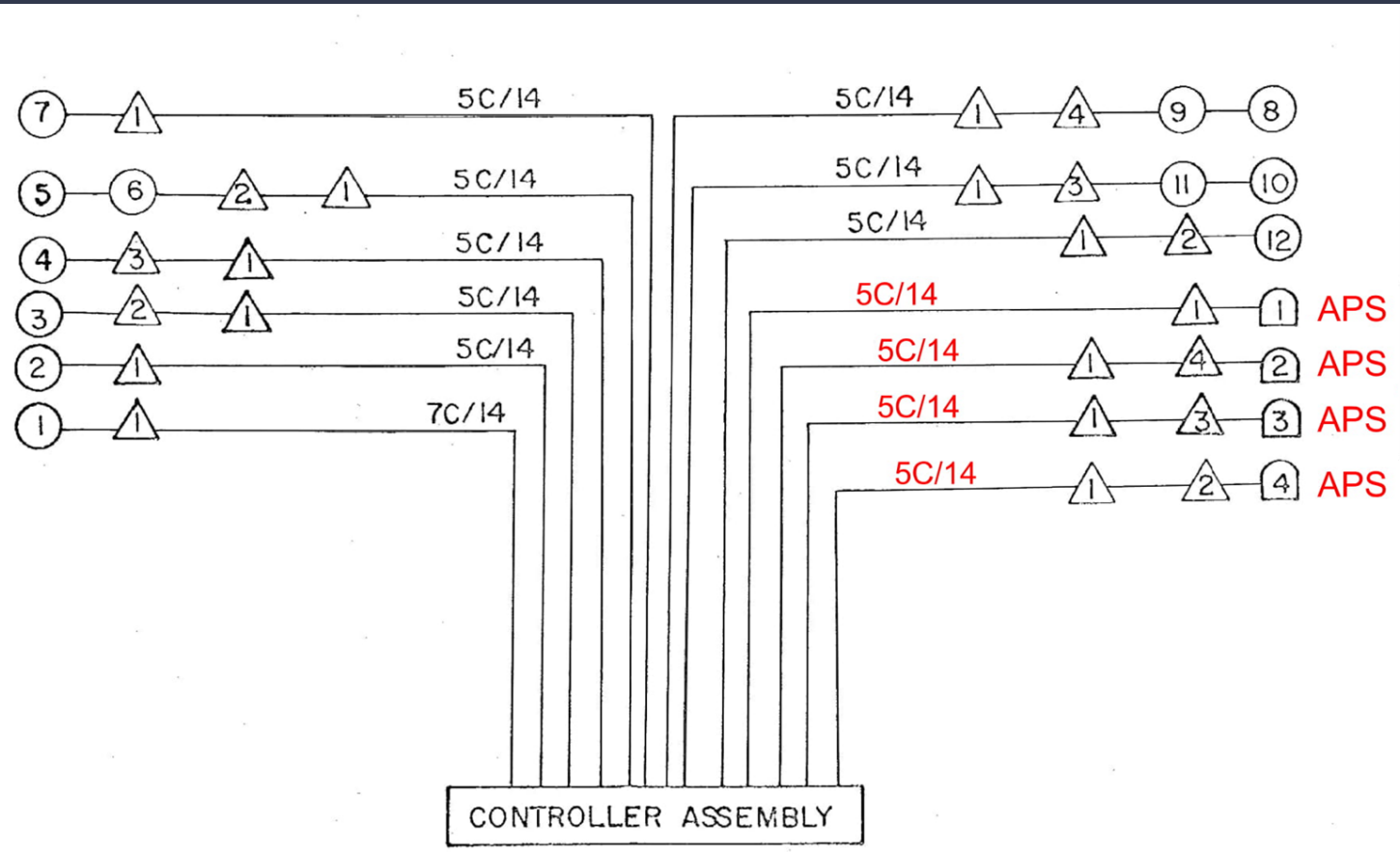
Signal Wiring Diagram



LEGEND

- 4 - Most Arm
- 4 - Strain Pole
- 4 - Pedestal
- - Vehicular Signal Head
- 4 - Pedestrian Signal Head
- A - Sign
- 4 - Pedestrian Push Button/Sign
- - Controller Assembly
- W/4" - Solid White Line/Width
- DY/4" - Double Yellow Line/Width
- - Luminaire and Arm
- C/2" - PVC Conduit/Size
- OH - Overhead Messenger/Cable

WIRING DIAGRAM

5C/14 - CABLE (NO. OF CONDUCTORS/SIZE AWG)

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