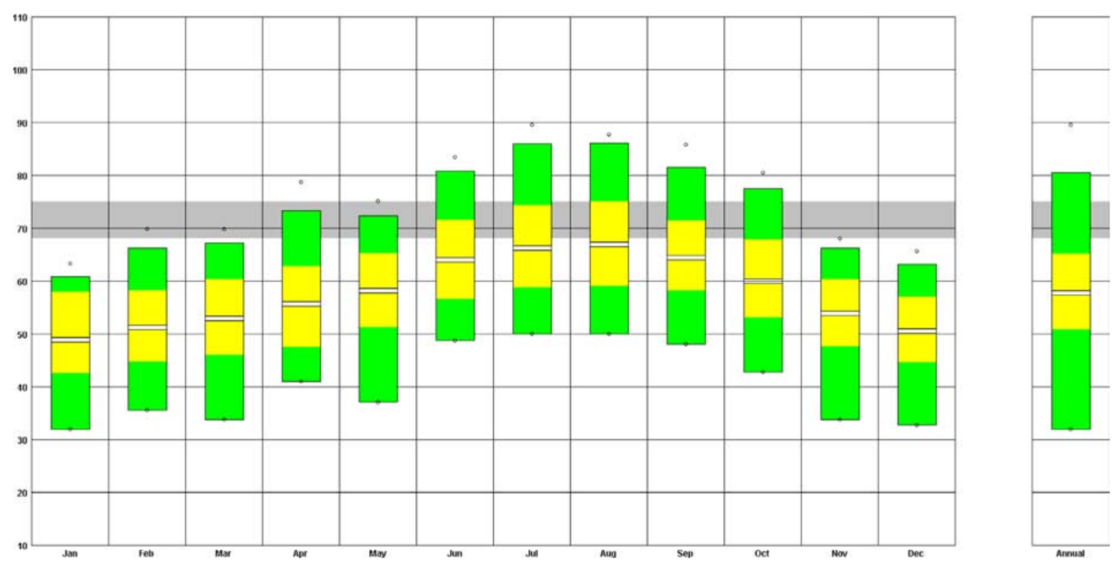
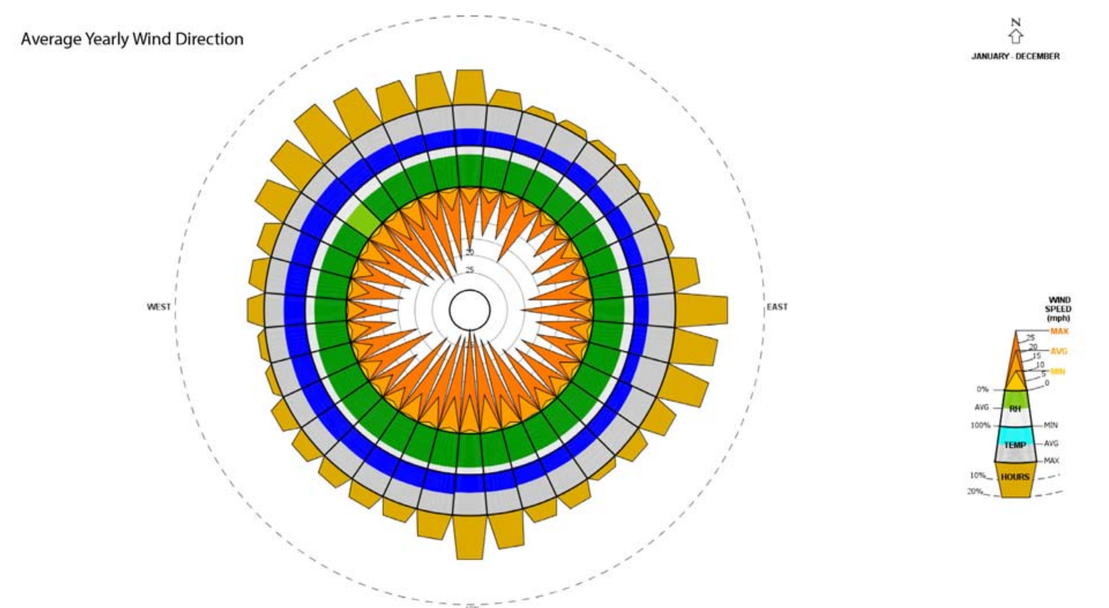
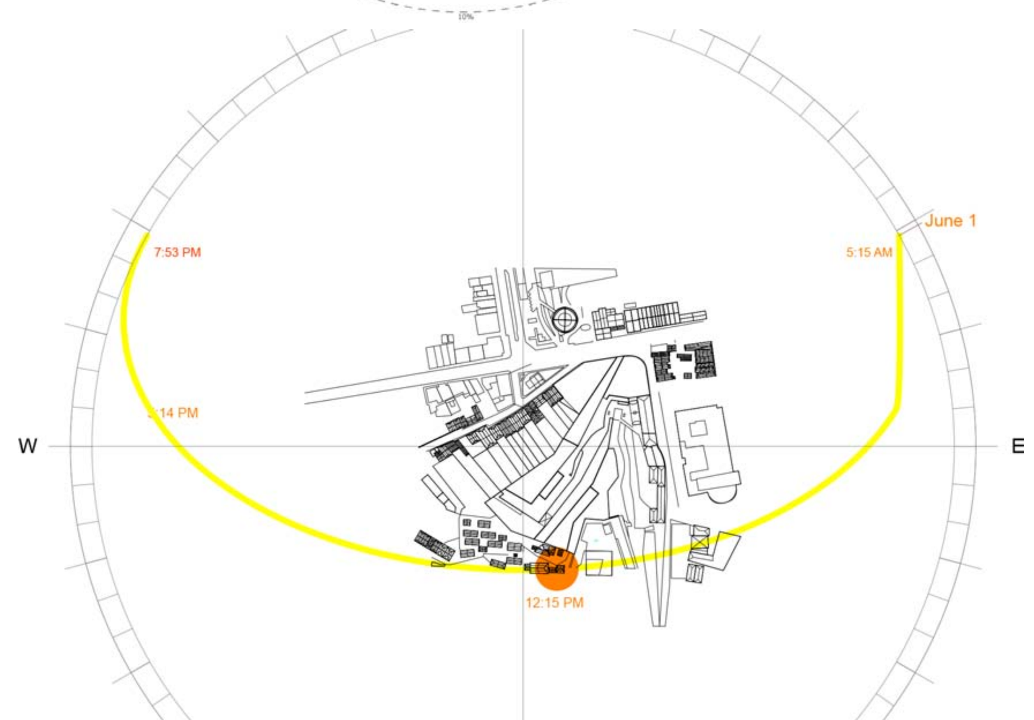
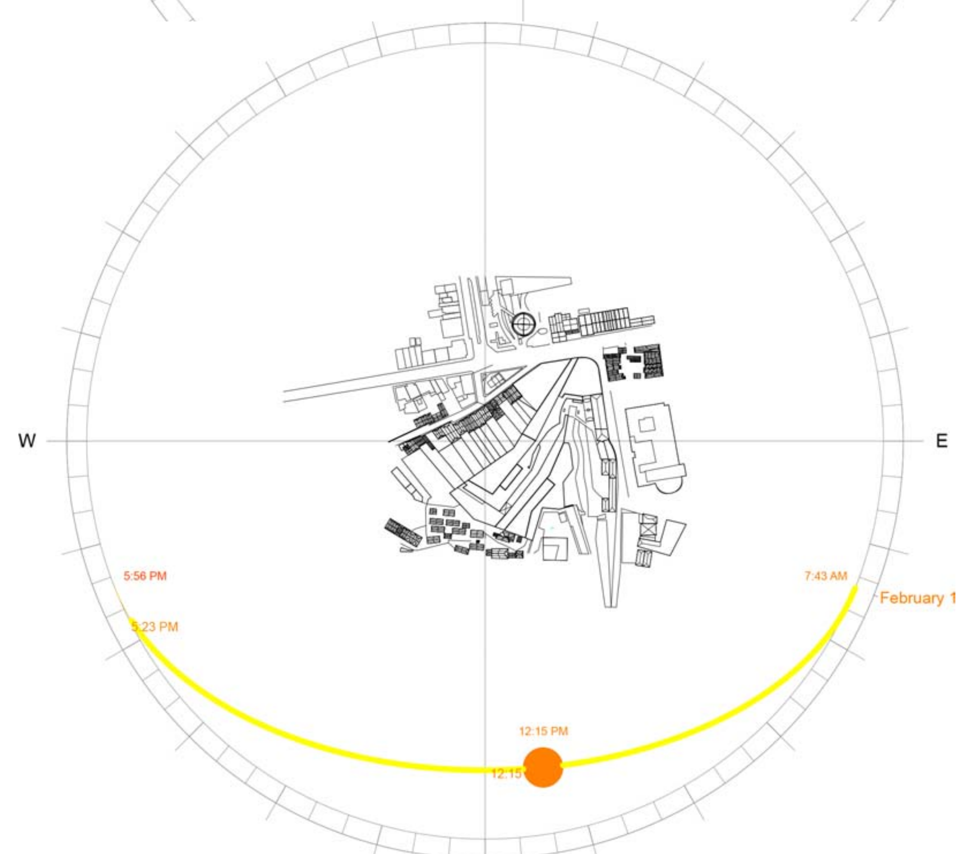
Museum of Architecture

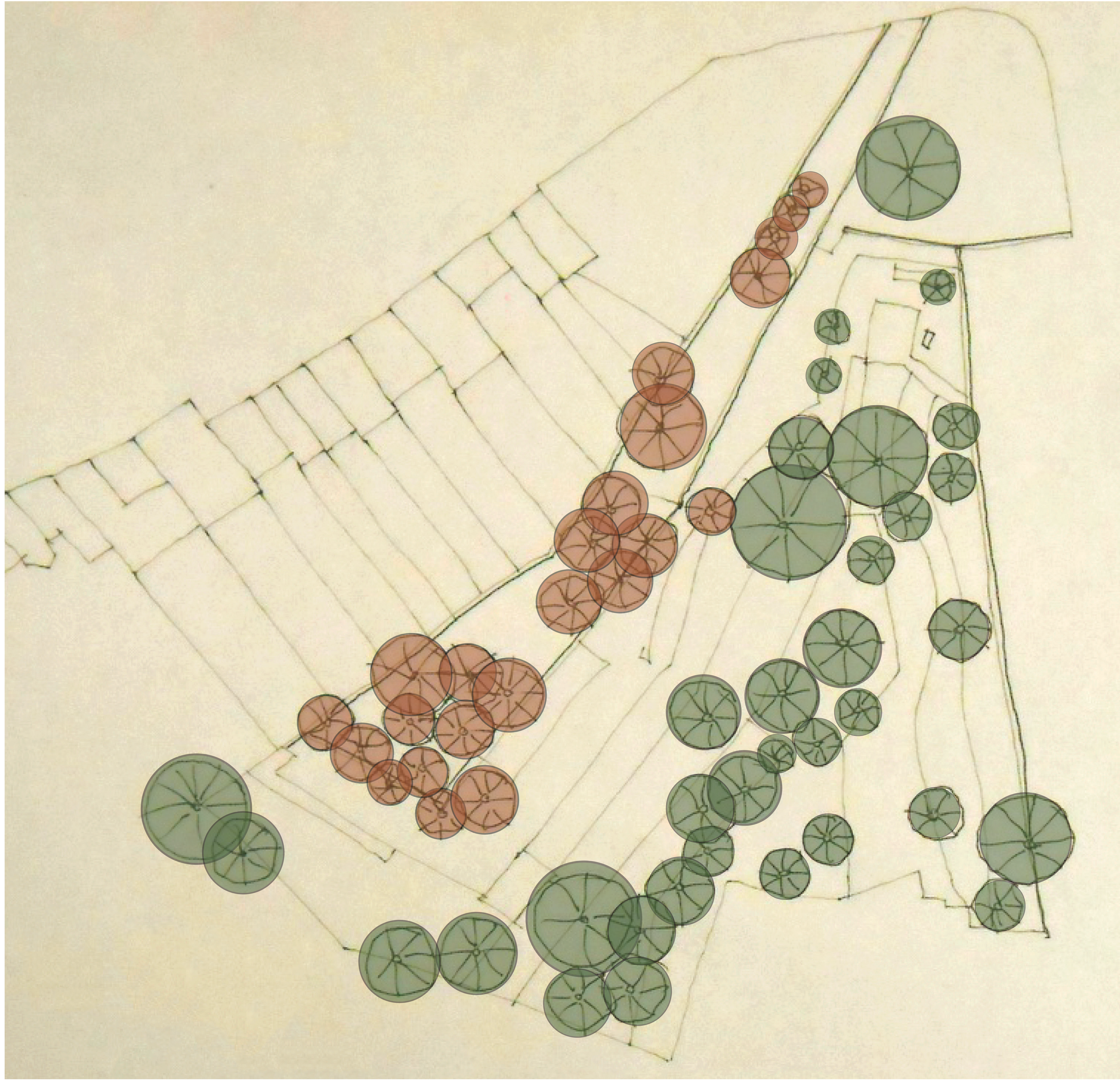
Porto Studio 2016 -Environmental science 3
Dennis Selke Spring 2016
John Dobyns Instructor, AR833











Trees to be pre-served

Replaceable-Trees

Site conditions 1/32”=1’

Final Project - Porto Portugal, Dennis Selke Spring 2016 AR833 John Dobyns, Instructor

Museum of Architecture

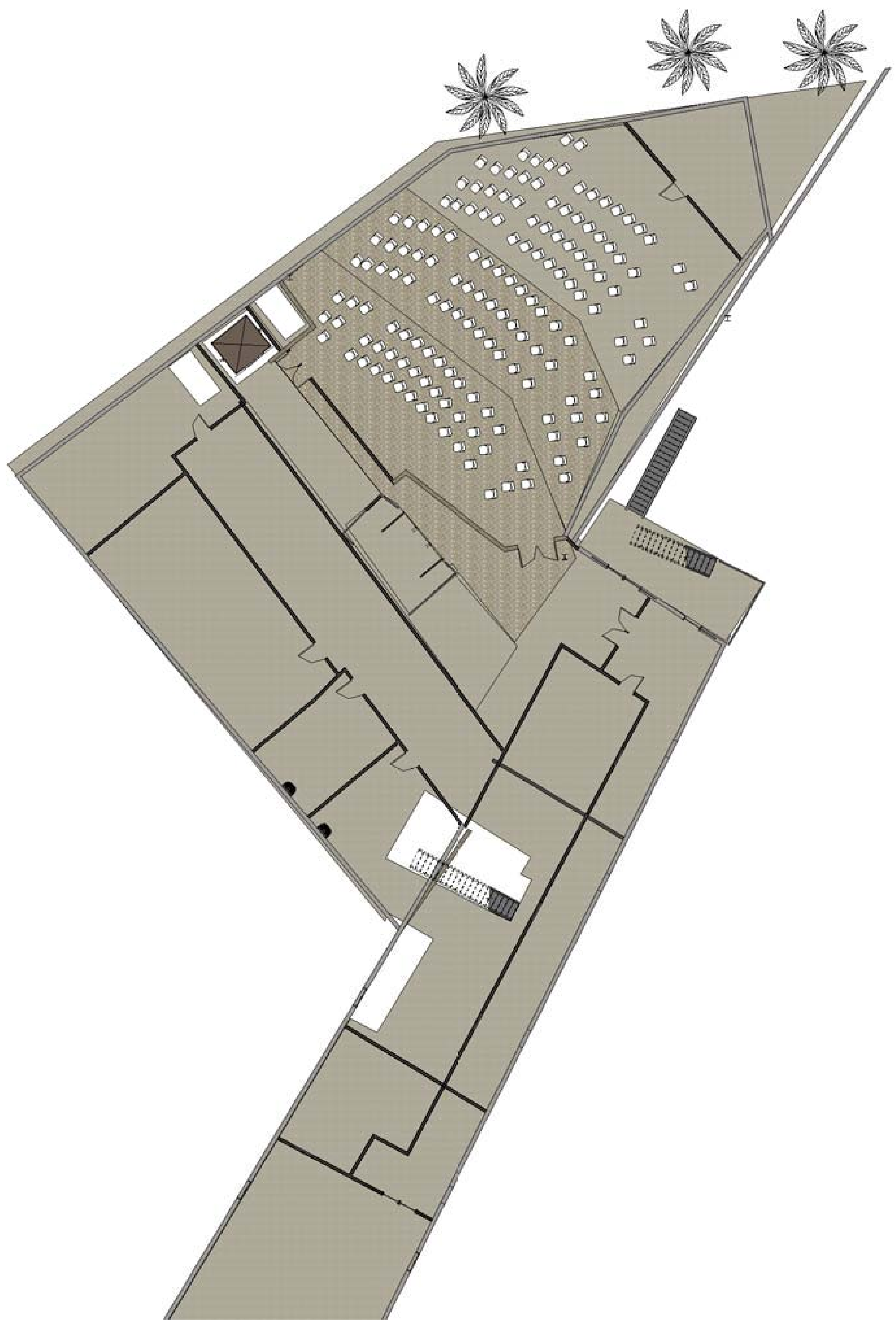
Room legend

Porto Portugal casa de arquitectura

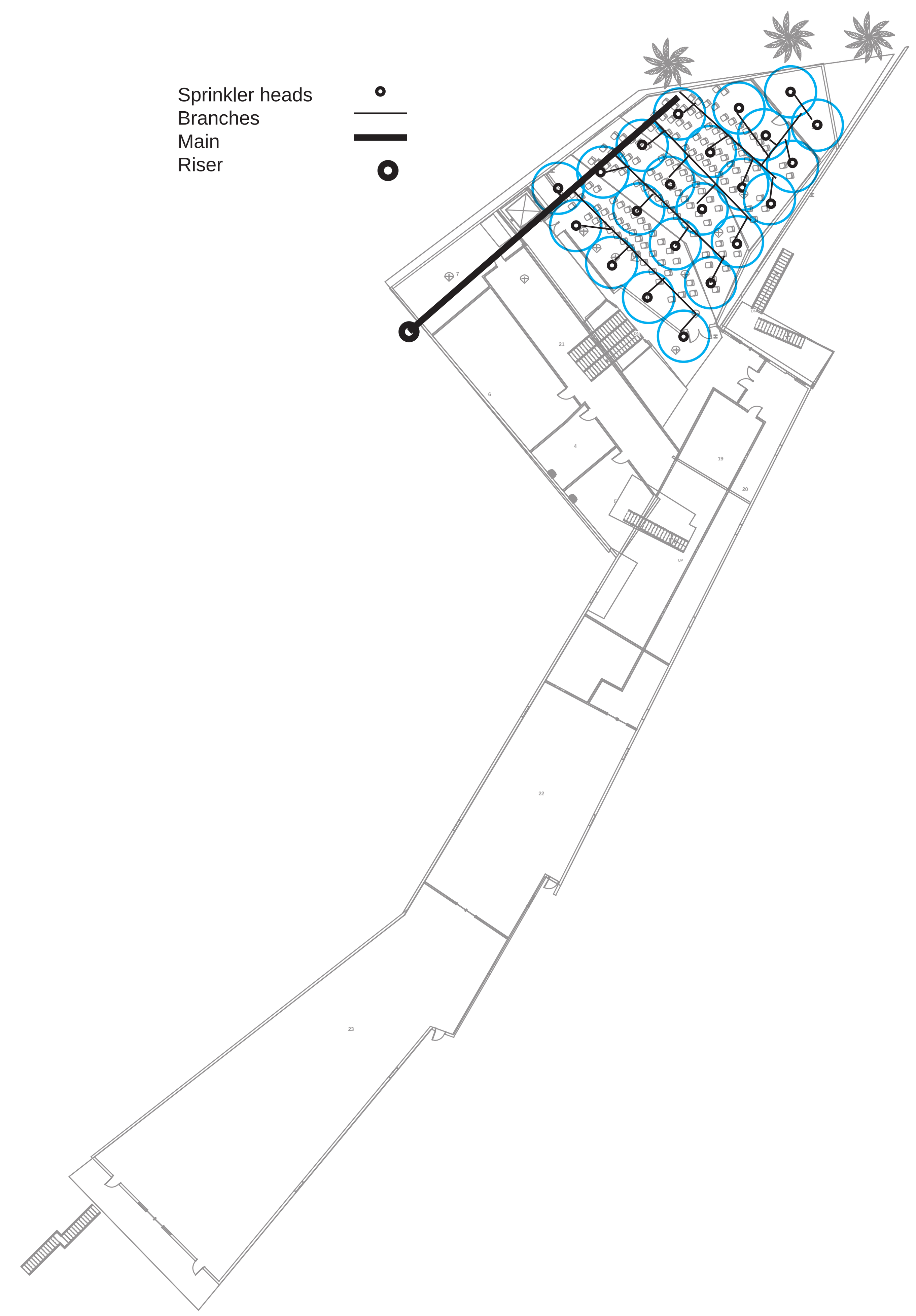
			Square feet
exterior			
20,21,27		Main access	
	1	service and delivery area	
outdoor		landscaped spaces	
outdoor		gardens	
outdoor		terraces	
outdoor		patios	
public areas			
	38	entrance foyer	3766
	16	bookstore/gift shop	2152
	35	cafeteria	1614
	18	auditorium (200 occ)	3012.8
	36	exhibit hall 1	6456
	37	exhibit hall 2	3228
	24	classroom (divisible in 2)	2152
	30	support room	430.4
8,9,22,23		library/reading	6994
	2	mens room	645.6
	3	ladies room	968.4
admin			
	10	offices	4304
	31	mens room	430.4
	3	ladies room	645.6
technical / archive			
	33	lab	1614
	15	collection/delivery area	1614
	32	restoration workshop	1398.8
	25	archive deposit	8608
	26	documentation room (1)	2690
	29	documentation room (2)	2690
	19	technical	538
	5	mens room	430.4
	4	ladies room	645.6
service areas			
	39	delivery dock	1614
	40	loading area	1291.2
	28	offices	968.4
	32	model workshop	269
	6	security room	753.2
	41	mens room	269
	42	womens room	484.2
	7	staff rest area	484.2
	32	mounting space	1076
	19	technical areas	3228
	11	pump room	762
	12	boiler room	769
	13	fan room	385
	14	data room	362
	17	projection	
	27	mechanical	

Mechanical spaces

Lowest Basement level -1   1/32 ”=1’

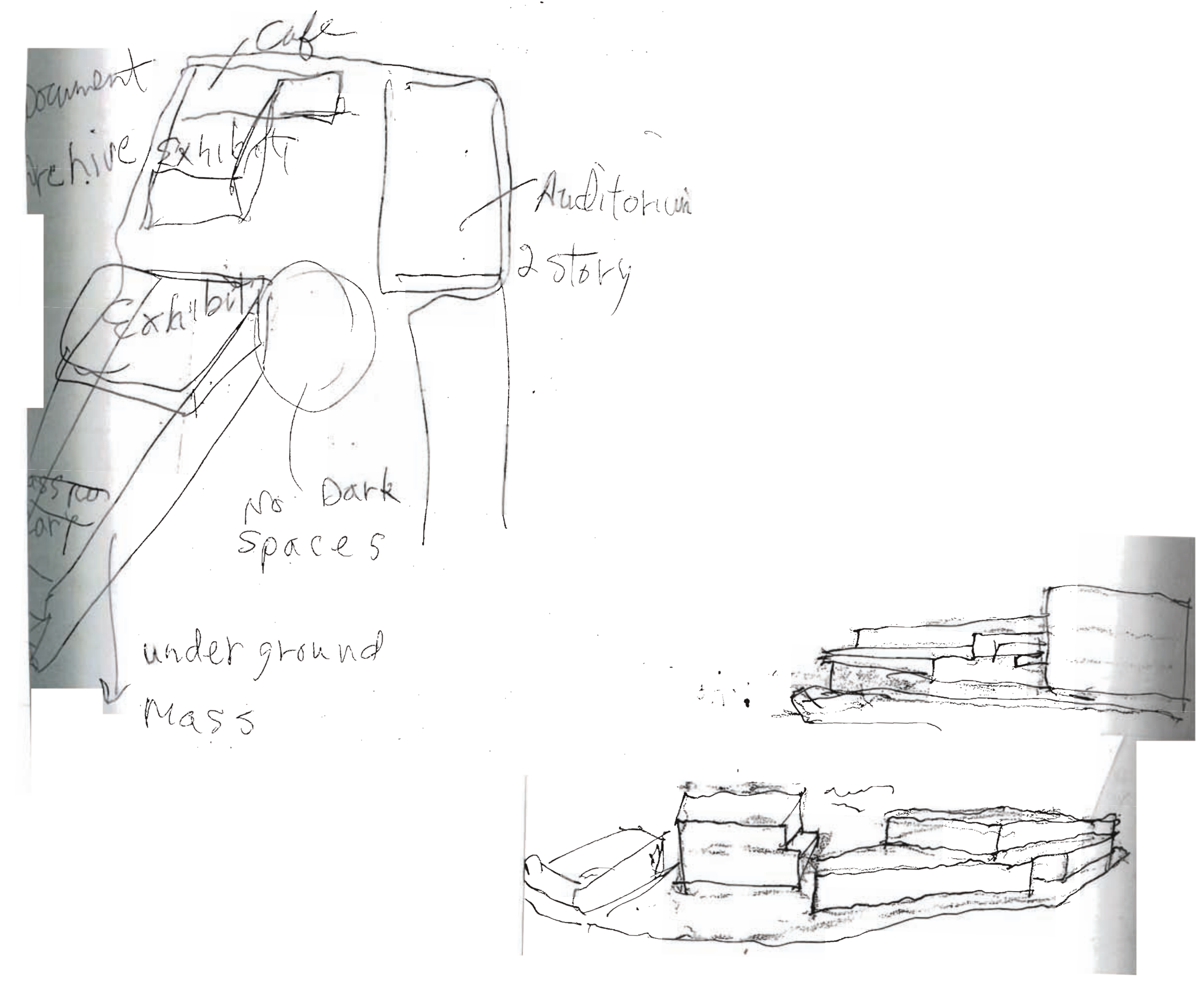


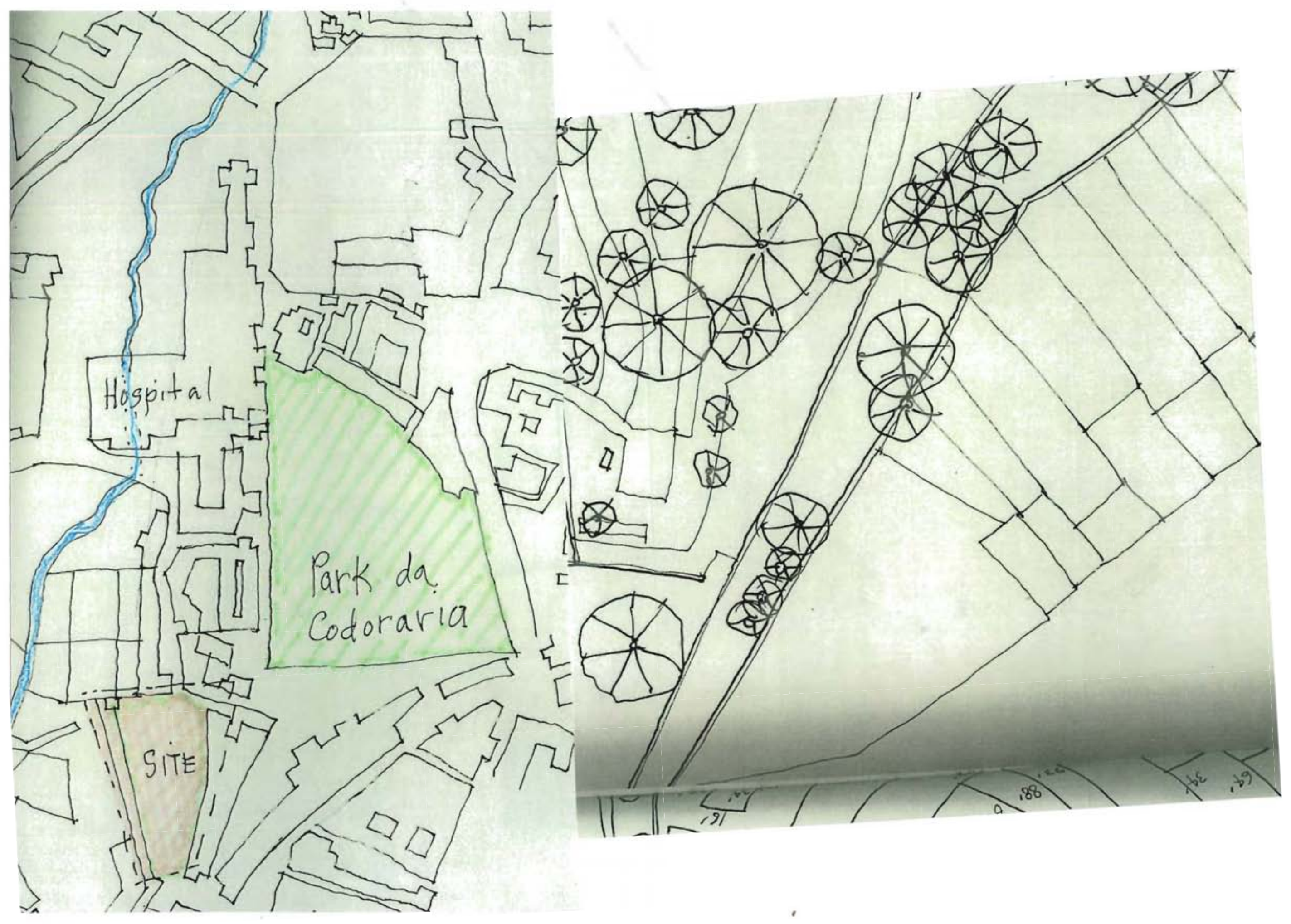
Auditorium

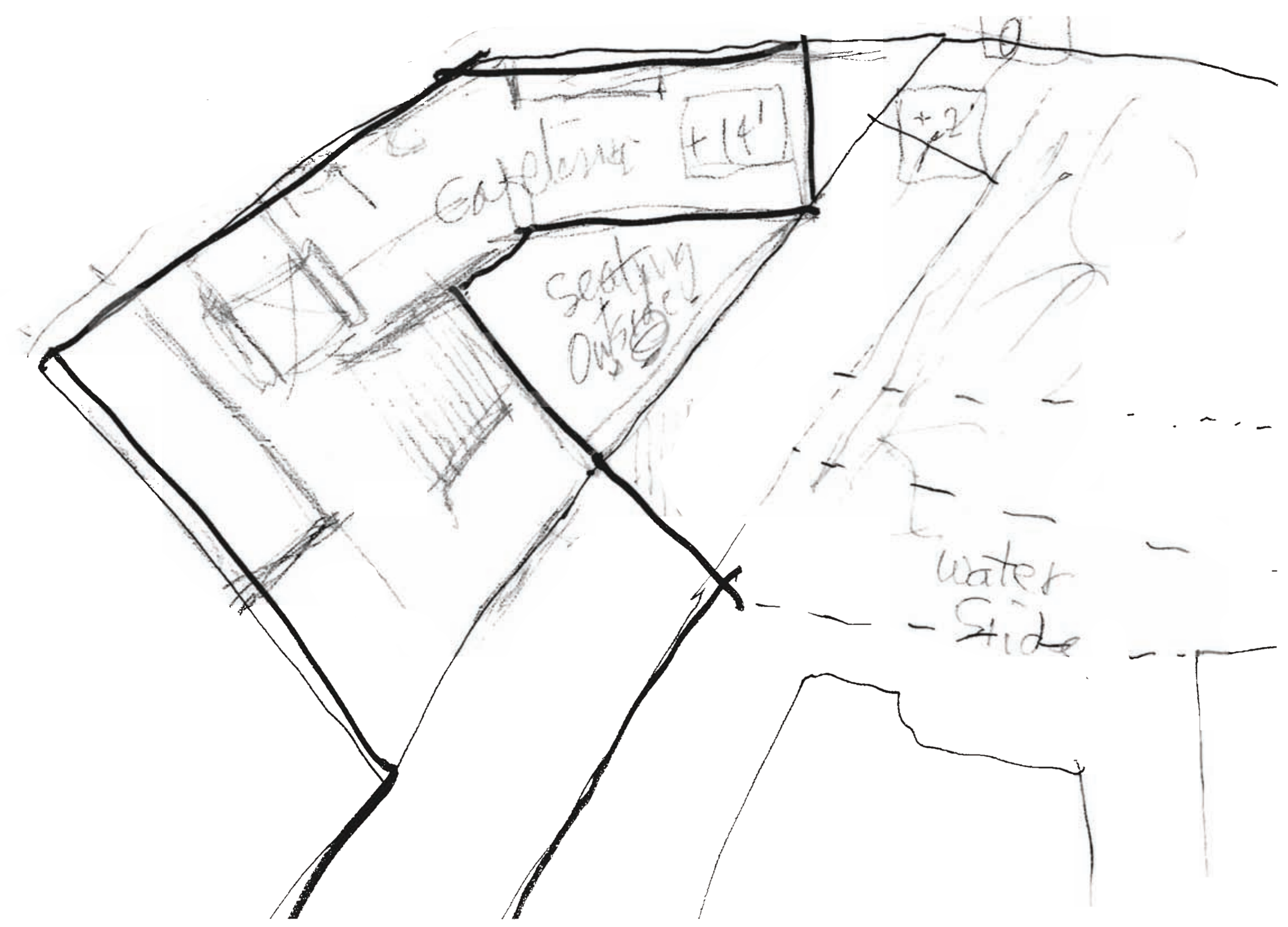


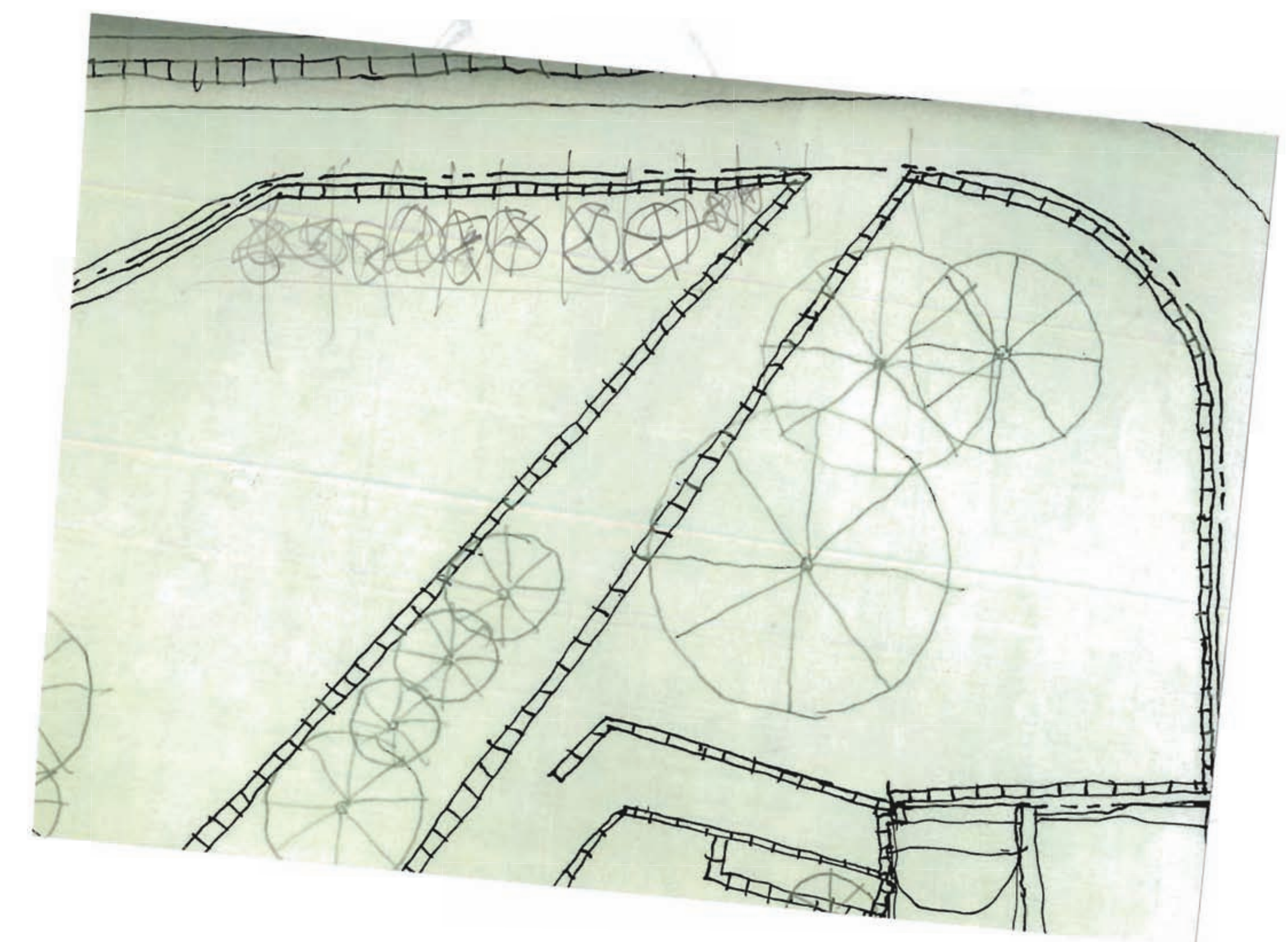
Auditorium sprinkler plan

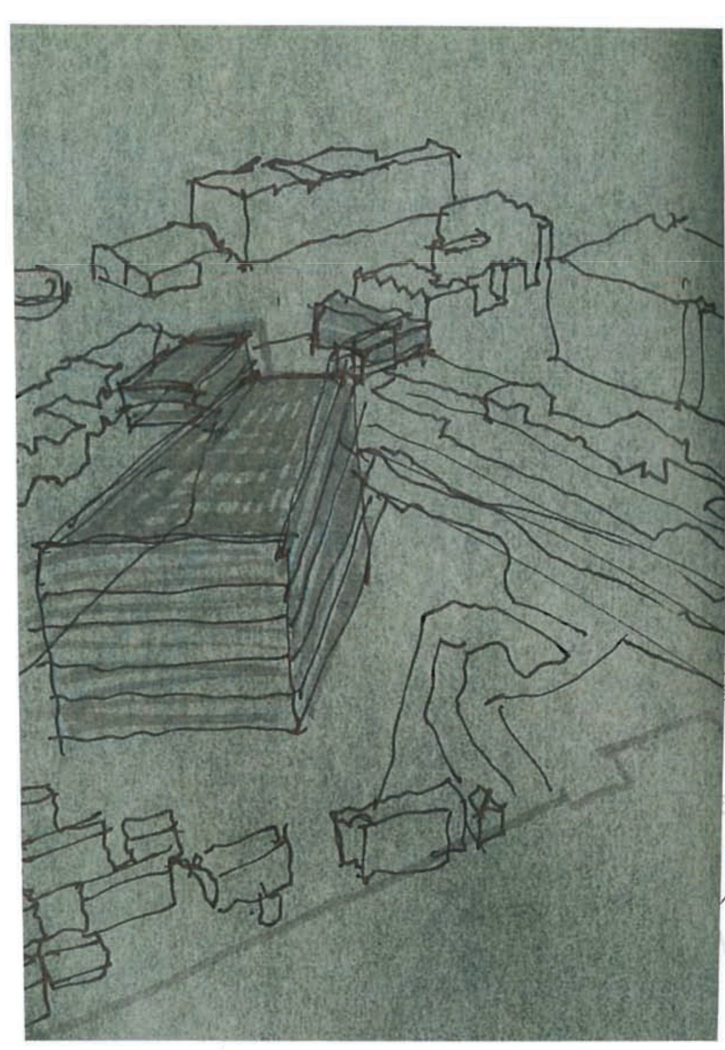
Museum of Architecture

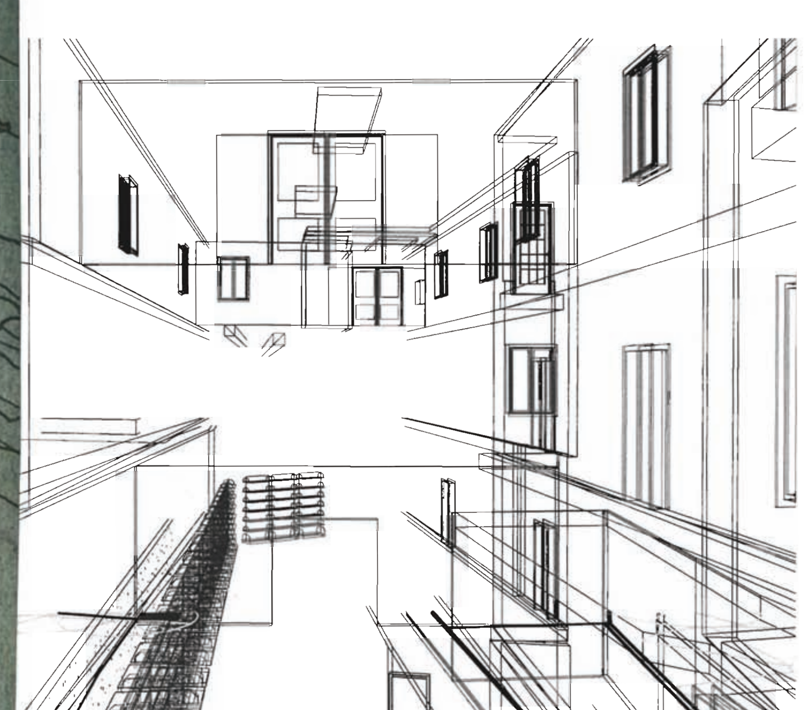


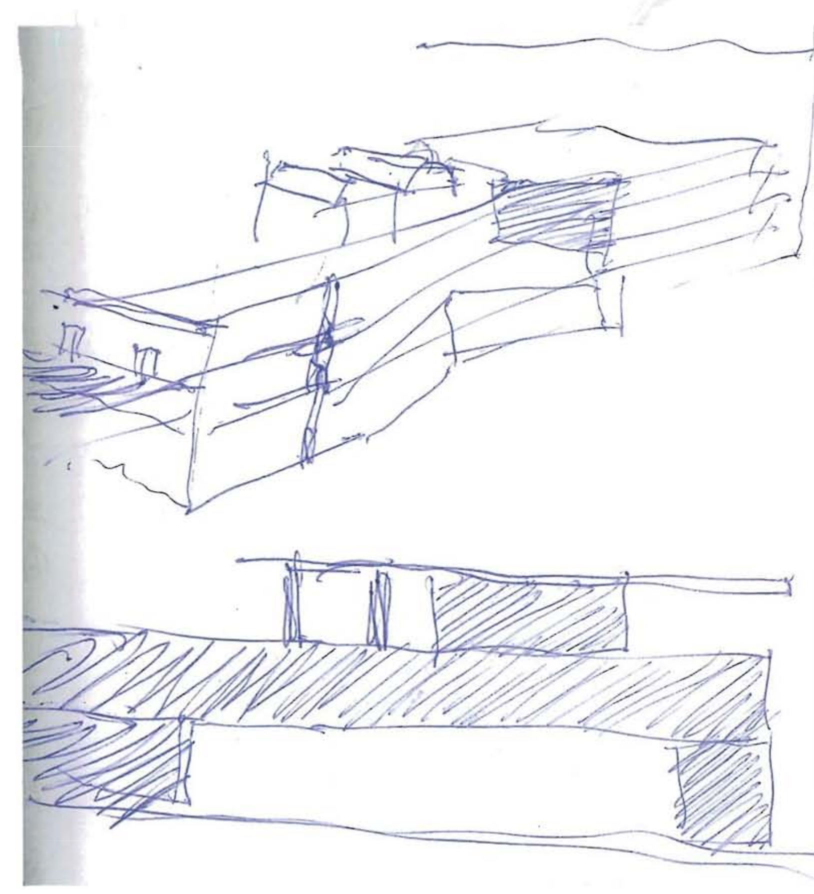


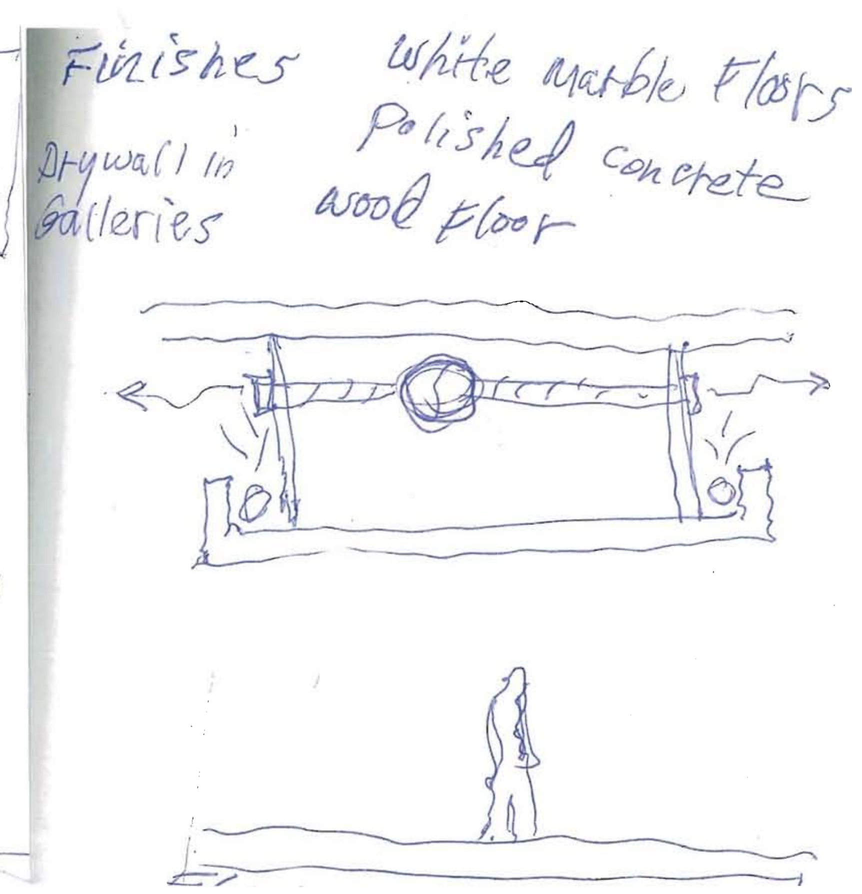


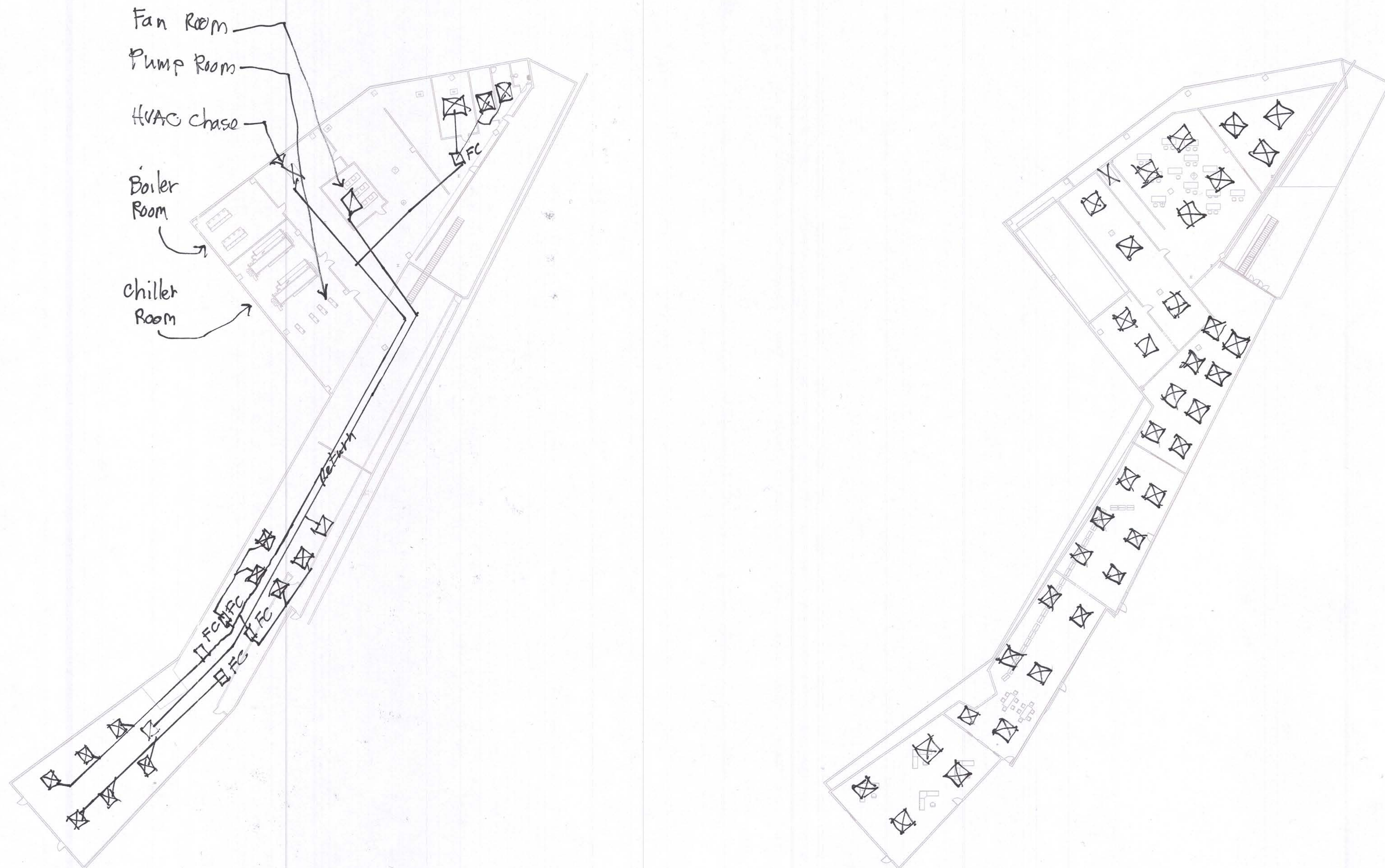




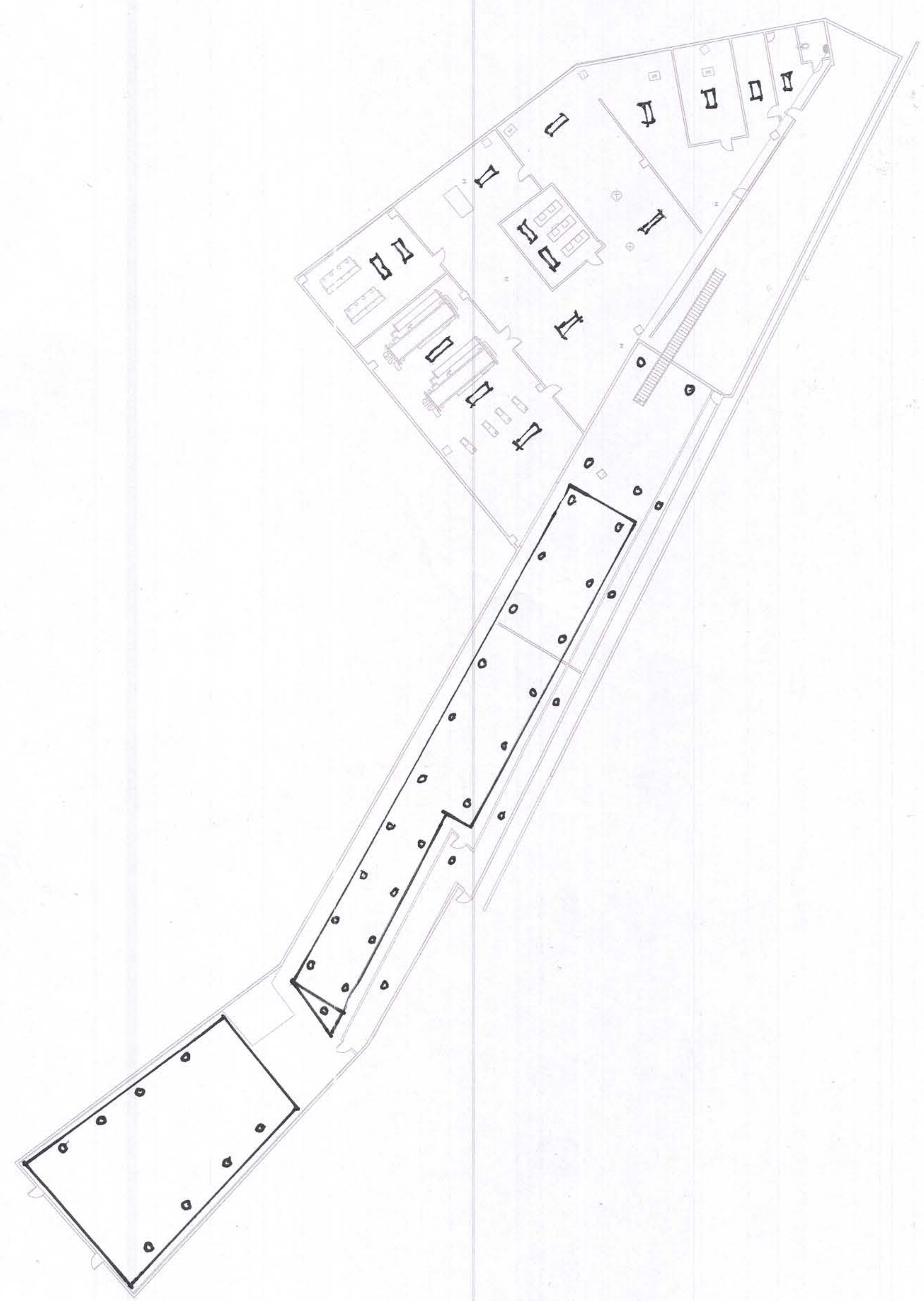


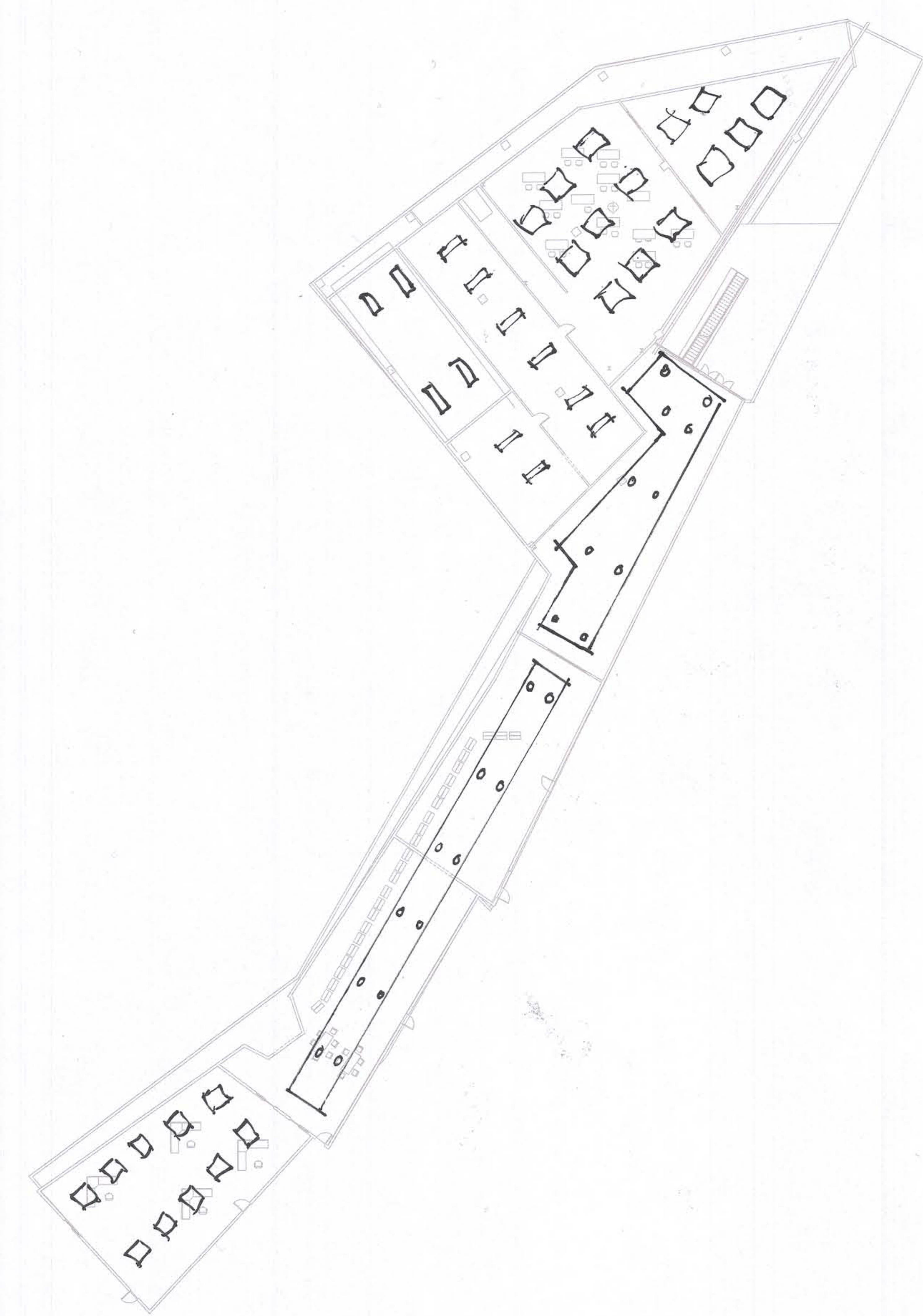






Reflected Ceiling Plans - HVAC

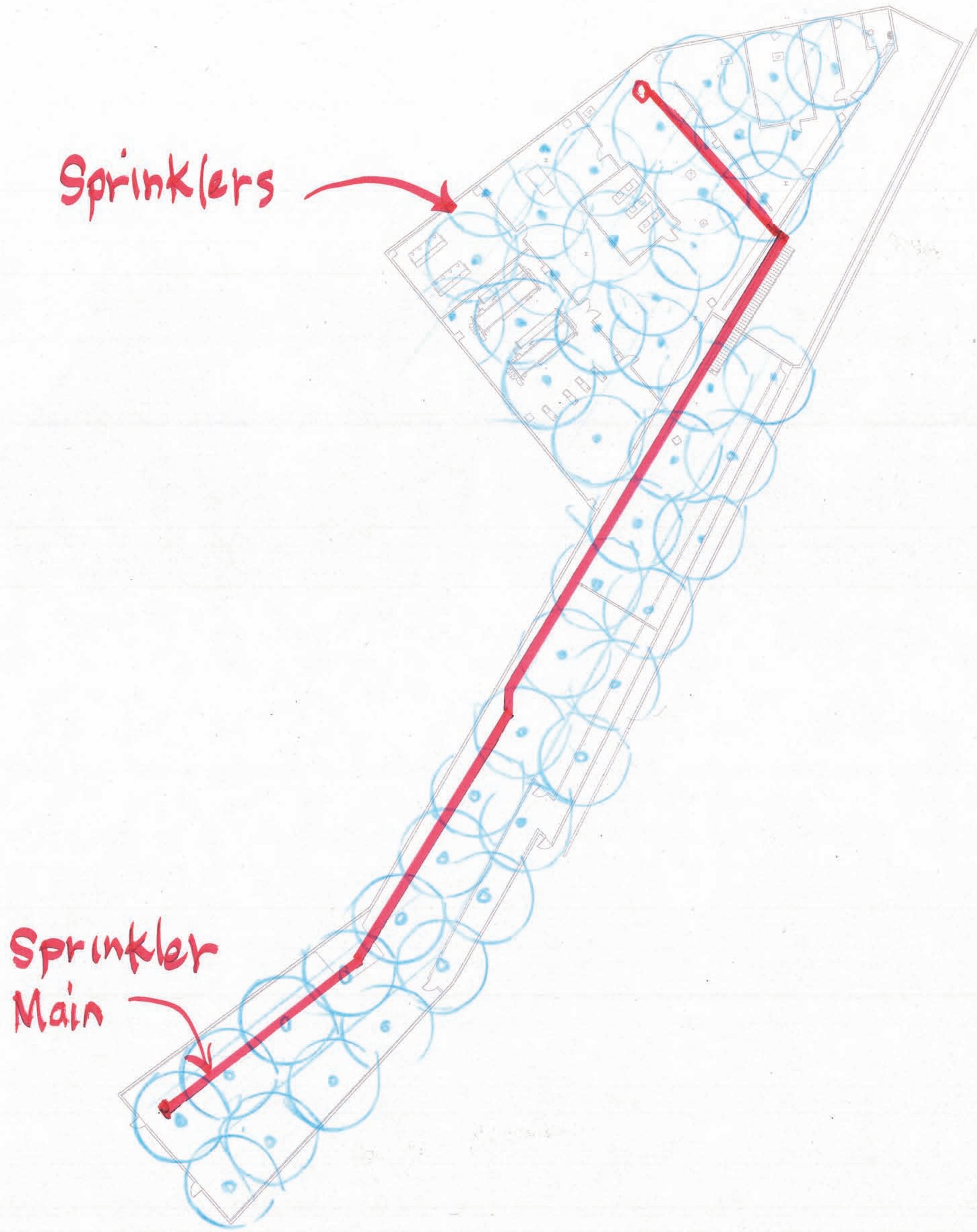


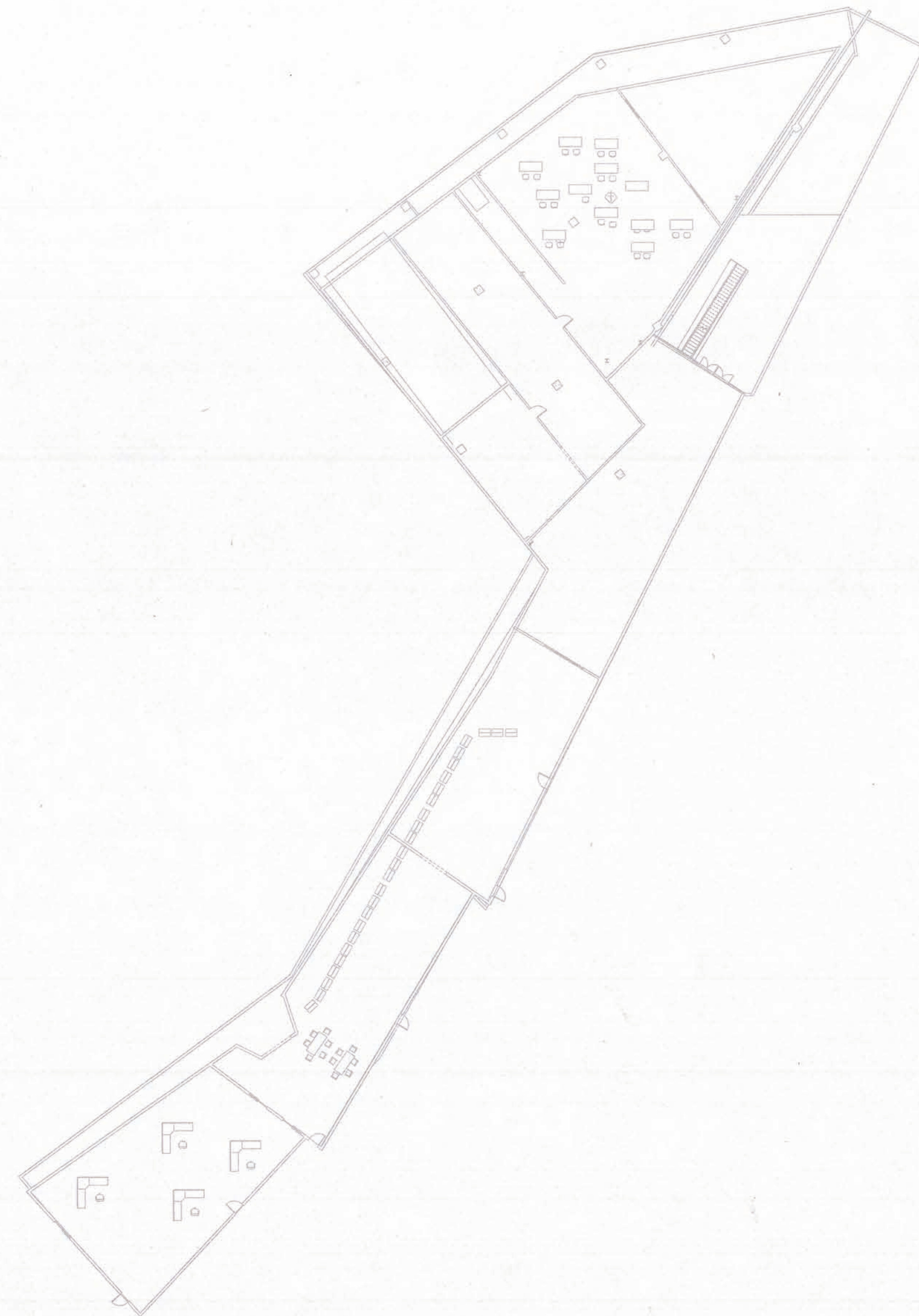


Lighting

Lowest Basement level -1   1/32 ”=1’

Basement level 0   1/32” =1’



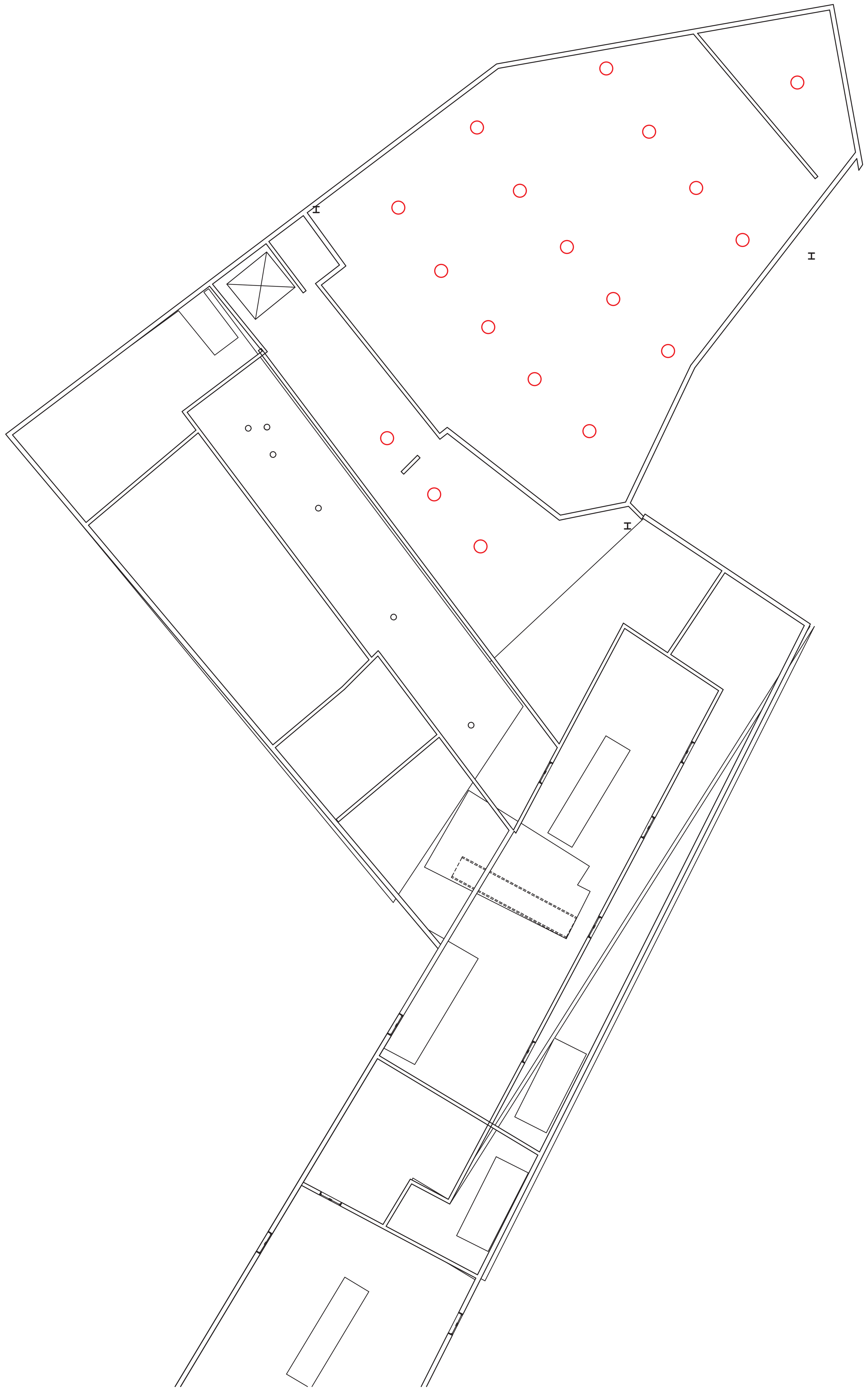


Sprinklers

Lowest Basement level -1   1/32 ”=1’

Basement level 0   1/32” =1’

Light fixtures, LED flat round ceiling light
2800k color temp
60w 120v



Reflected Ceiling Plan - Lighting

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — The adjustable LED Gimbal downlighting module is 80% more efficient than incandescent luminaries, performing for 35,000 hours or more with exceptional energy efficiency and near zero maintenance. Multiple trim finish options are available to pick the style that matches the décor for any office or home. The LED Gimbal is intended for sloped ceiling applications, grazing textured surfaces, wall washing, and highlighting artwork or other architectural features. Retrofits into most existing recessed downlighting installations or new construction and remodel applications.

CONSTRUCTION — Spun steel gimbal reflectors with 180° of rotation and at least 35° of adjustable tilt in both directions. Driver affixed to a static yoke to allow maximization of LED light engine rotation and pivot movements.

OPTICS — Diffused lens at end of mixing chamber to provide even light distribution for general illumination, equivalent to 50W incandescent flood lamp.

Wide flood beam angle at >90°. CRI >90. Equivalent to 50W incandescent. The LED module maintains at least 70% light output for 35,000 hours.

ELECTRICAL — Primary power disconnect provided for simple connection to a dedicated LED connector in the housing. Dimming down to 15%. For compatible dimmers, refer to Compatible Dimmers Chart.

INSTALLATION — Suitable for installation in standard height rough-in sections. E26 socket adapter and splice kit ships standard. This enables easy installation or permanent conversion to an LED source for Title 24 compliance. Includes three friction clips to ensure easy installation.

LISTINGS — CSA certified to US and Canadian safety standards. ENERGY STAR® certified; California T24 compliant. Damp location listed.

WARRANTY — 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

4G1

IC/Non-IC
Retrofit Gimbal

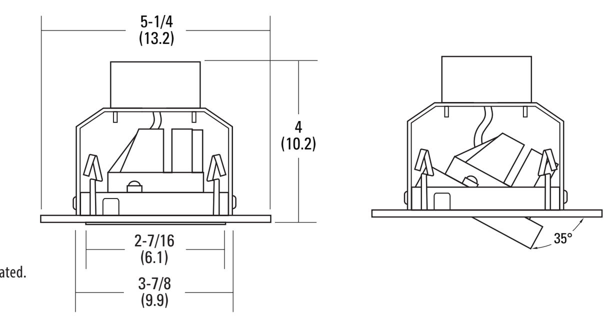
Matte Black
Brush Nickel
Oil Rubbed Bronze

DAMP LOCATION™

Specifications

Aperture:	2-7/16 (6.1)
Ceiling opening:	as rough-in
Length:	3-7/8 (9.9)
Height:	4 (10.2)
Overlap trim:	5-1/4 (13.2)

All dimensions are inches (centimeters) unless otherwise indicated.



E26 Adaptor (included)
Hardwire Kit (included)

ORDERING INFORMATION For shortest lead times, configure product using **standard options (shown in bold).**

Example: 4G1MW LED 27K 90CRI L3LED T24

4G1				LED						
Series/Finish				**Lamp**	**CCT/CRI/W/Lumens[2]**		**Voltage**		**Options**	
4G1	4" Gimbal module	**MW**	Matte white	**LED**	(blank)	3000K/83CRI/7.9W/435L	**(blank)**	120V	**L3LED T24**	IC/Non-IC rated, new construction rough-in LED base
		MB	Matte black[1]		27K 90CRI	2700K/91CRI/8.3W/480L			**L3RLED T24**	IC/Non-IC rated, remodel rough-in LED base
		BN	Brush nickel[1]		30K 90CRI	3000K/93CRI/7.7W/500L			**L3**	IC/Non-IC rated, new construction rough-in[3,4]
		ORB	Oil-rubbed bronze[1]		40K 90CRI	4000K/94CRI/8W/560L			**L3R**	IC/Non-IC rated, remodel rough-in[3,4]

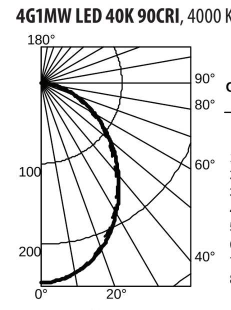
Notes
1 Available in 30K 83CRI only.
2 Total system delivered lumens.
3 Must be ordered on a separate line.
4 To install LED Gimbal, remove socket and assembly leaving socket wires. Install using hardwire kit provided.

4G1 4" LED Gimbal Module

PHOTOMETRICS

Distribution Curve | Distribution Data | Output Data | Coefficient of Utilization | Illuminance Data at 30" Above Floor for a Single Luminaire

4G1MW LED 40K 90CRI, 4000 K LEDs, input watts: 7.9, delivered lumens: 572, LM/W=72.4, test no. LTL28358, tested in accordance with IESNA LM 79-80.



CP Summary

	0°	90
0°	247	247
5°	245	245
15°	228	230
25°	199	203
35°	163	167
45°	124	130
55°	89	93
65°	55	60
75°	26	30
85°	5	7
90	0	0

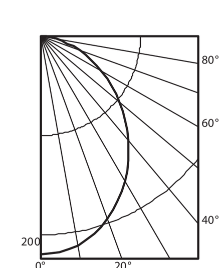
Coefficients of Utilization

pf	20%								
pc	80%			70%			50%		
pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
RCR 0	119	119	119	116	116	116	111	111	111
1	109	105	101	103	99	96	98	95	93
2	100	92	86	90	84	79	87	82	78
3	92	82	74	80	73	67	77	71	66
4	84	73	64	72	64	58	69	62	57
5	78	65	57	64	56	50	62	55	50
6	72	59	51	58	50	44	57	49	44
7	67	54	45	53	45	39	52	44	39
8	63	49	41	49	41	35	47	40	35
9	59	46	38	45	37	32	44	37	32
10	55	42	34	42	34	29	41	34	29

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	182	31.8	31.8
0° - 40°	287	50.2	50.2
0° - 60°	472	82.5	82.5
0° - 90°	572	100.0	100.0
90° - 180°	0	0.0	0.0
0° - 180°	572	100.0	100.0

4G1MW LED 30K 90CRI, 3000 K LEDs, input watts: 7.7, delivered lumens: 521, LM/W=68, test no. LTL28359, tested in accordance with IESNA LM 79-80.



	Ave	Lumens
0	220	
5	218	21
15	206	58
25	183	84
35	153	96
45	120	92
55	88	78
65	56	55
75	28	29
85	6	7
90	0	

Zone	Lumens	% Lamp
0° - 30°	162.7	31.2
0° - 40°	258.3	49.6
0° - 60°	428.8	82.3
0° - 90°	521.1	100.0
90° - 180°	0.0	0.0
0° - 180°	521.1	*100.0

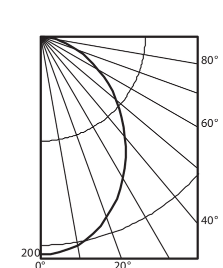
*Efficiency

Coefficients of Utilization

f p	% 0 2								
pc	80%			70%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
RCR 0	119	119	119	116	116	116	111	111	111
1	105	101	97	103	99	96	98	95	93
2	92	86	80	90	84	79	87	82	77
3	81	74	67	80	73	67	77	71	66
4	73	64	58	71	63	57	69	62	57
5	65	56	50	64	56	50	62	55	49
6	59	50	44	58	50	44	56	49	43
7	54	45	39	53	45	39	51	44	39
8	49	41	35	48	41	35	47	40	35
9	45	37	32	45	37	32	43	36	32
10	42	34	29	41	34	29	40	33	29

		50% beam - 59.8°		10% beam - 104.6°	
Mounting Height	Inital FC Center Beam	Diameter	FC	Diameter	FC
8.0	7.3	6.3	3.6	14.2	0.7
10.0	3.9	8.6	2.0	19.4	0.4
12.0	2.4	10.9	1.2	24.6	0.2
14.0	1.7	13.2	0.8	29.7	0.2
16.0	1.2	15.5	0.6	34.9	0.1

4G1MW LED 27K 90CRI, 27000 K LEDs, input watts: 8.3, delivered lumens: 480, LM/W = 59, test no. LTL28357, tested in accordance with IESNA LM 79-80.



	Ave	Lumens
0	209	
5	207	20
15	195	55
25	172	79
35	141	88
45	109	84
55	79	70
65	50	50
75	25	27
85	6	7
90	0	

Zone	Lumens	% Lamp
0° - 30°	153.4	32.0
0° - 40°	241.8	50.4
0° - 60°	396.4	82.6
0° - 90°	479.8	100.0
90° - 180°	0.0	0.0
0° - 180°	479.8	*100.0

*Efficiency

Coefficients of Utilization

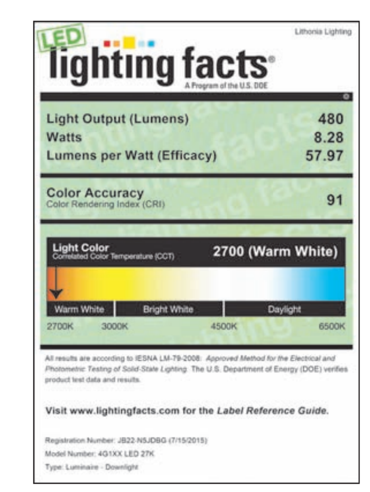
f p	% 0 2								
pc	80%			70%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
RCR 0	119	119	119	116	116	116	111	111	111
1	105	101	97	103	99	96	98	95	93
2	92	86	80	90	85	80	87	82	78
3	82	74	68	80	73	67	77	71	66
4	73	65	58	72	64	58	69	62	57
5	66	57	51	64	56	50	62	55	50
6	59	51	45	58	50	44	57	49	44
7	54	46	40	53	45	39	52	44	39
8	50	41	36	49	41	35	48	40	35
9	46	38	32	45	37	32	44	37	32
10	42	35	29	42	34	29	41	34	29

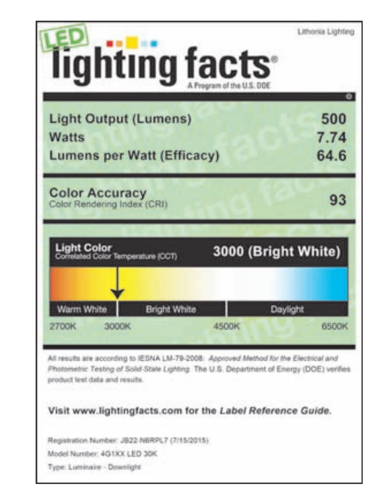
		50% beam - 59.1°		10% beam - 103.6°	
Mounting Height	Inital FC Center Beam	Diameter	FC	Diameter	FC
8.0	6.9	6.2	3.5	14.0	0.7
10.0	3.7	8.5	1.9	19.1	0.4
12.0	2.3	10.8	1.2	24.2	0.2
14.0	1.6	13.0	0.8	29.3	0.2
16.0	1.1	15.3	0.6	34.3	0.1

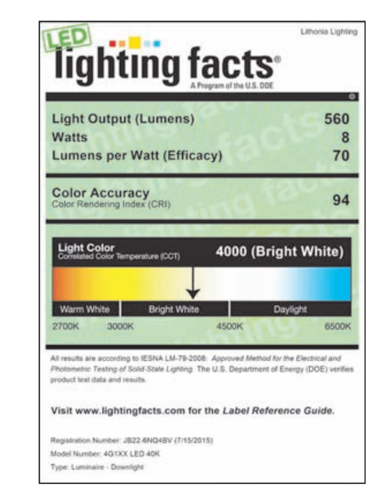
ENERGY DATA - 4G1			
Lumens	480	500	560
watts	8.28	7.74	8
LPW	58	65	70
CRI	91	93	94
Color Temp	2700	3000	4000
Minimum Starting Temp	0°F (-18°C)	0°F (-18°C)	0°F (-18°C)
EMI/RFI	FCC Title 47 CFR, Part 15, Class A	FCC Title 47 CFR, Part 15, Class A	FCC Title 47 CFR, Part 15, Class A
Min. Power Factor	0.80	0.80	0.80
Input current	0.07A	0.07A	0.07A

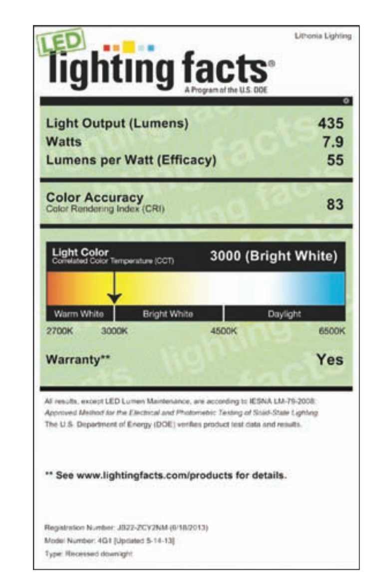
LITHONIA LIGHTING® An Acuity Brands Company

4G1 4" LED Gimbal Module









LITHONIA LIGHTING® An Acuity Brands Company

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Museum of Architecture

Final Project - Porto Portugal, Dennis Selke Spring 2016 AR833 John Dobyns, Instructor

Museum of Architecture

Heating and Cooling Systems for Large Buildings: Summary Chart †

Give Special Consideration to the Systems Indicted if You Want to:	Variable air Volume (VAV) [page 168]	Variable air Volume (VAV) Reheat [page 169]	Variable air Volume (VAV) Induction [page 169]	Dual-duct Variable air Volume (VAV) [page 169]	Single Duct Constant air Volume (CAV) [page 170]	Constant air Volume (Cave) Reheat [page 171]	Multi-zone with Reheat [page 171]	Air Water Induction [page 172]	Fan-Coil Terminals or Unit Ventilators [page 174]	Closed-Loop Heat Pumps [page 175]	Hydronic Convectors (heating only) [page 176]	Packaged Terminal Units or Through-the-Wall Units [page 178]	Passive Systems: Passive Solar Heating [page 222]	Passive Systems: Natural Ventilation cooling [page 225]	Passive Systems: Thermal Mass Cooling [page 228]	Passive Systems: Evaporative Cooling [page 231]
Chiller Location	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	No Chiller	No Chiller-- Heating Only	No Chiller	No Chiller	No Chiller	No Chiller	No Chiller
Boiler Location	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	Central Mechanical Room	No boiler	No Boiler	No Boiler	No Boiler	Not Applicable
Fan Room Required?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No Central Fan	No Central Fan	No Central Fan	No Central Fan
Cooling Tower Required?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No Cooling Tower	No Cooling Tower	No Cooling Tower	No Cooling Tower
Distribution Type	Ducts	Ducts	Ducts	Ducts	Ducts	Ducts	Ducts	Pipes and Ducts	Pipes	Pipes	Pipes	None	Not applicable	Not applicable	Not applicable	No boiler
Return air	Return Ducts to Fan Room	Return Ducts to Fan Room	Return Ducts to Fan Room	Return Ducts to Fan Room	Return Ducts to Fan Room	Return Ducts to Fan Room	Return Ducts to Fan Room	Exhaust Fan to Outdoors	Return Grill on FCU	Return Ducts or Plenum	Part of Unit	Part of Unit	Not applicable	Not applicable	Not applicable	Not applicable
Delivery System	Ducts to VAV box to Diffusers	Ducts to VAV box to Diffusers	Ducts to VAV box to Diffusers	Ducts to VAV box to Diffusers	Ducts to Diffusers	Ducts to Diffusers	Ducts to Diffusers	Ducts to Induction Unit	Ducts to Diffusers	Part of Unit, or Ducts to Diffusers	Part of Unit	Part of Unit	Not applicable	Not applicable	Not applicable	Not applicable
Location of Delivery Unit	VAV Box above Dropped Ceiling	VAV Box above Dropped Ceiling	VAV Box above Dropped Ceiling	VAV Box above Dropped Ceiling	Diffusers in Ceiling, Wall, or Floor	Diffusers in Ceiling, Wall, or Floor	Diffusers in Ceiling, Wall, or Floor	Usually above Ceiling, but Wall & Closets also	Usually above Ceiling, but Wall & Closets also	Usually above Ceiling, but Wall & Closets also	Floor	Through the Wall or Window	Not applicable	Not applicable	Not applicable	Not applicable
Minimize First Cost					●							●				
Minimize Operating Cost and Energy Consumption	●				●					●	●		●	●	●	●
Maximize Control of air Velocity and Energy consumption	●	●	○	○	●	○	○									
Maximize Individual Control over Temperature	●	●	○	○		○	○	○	●			●				
Minimize System Noise	●	●		○	●	○	○				●		●	●	●	●
Minimize Visual Obtrusiveness	●	●	○	○	●	○	○					●	●	●	●	●
Maximize Flexibility of Rental Space	●	●	○				○		●			●				
Minimize Floor Space Used for the Heating and Cooling Systems			○					○			●		●	●	●	●
Minimize Floor-to-Floor Height								○			●	●	●	●	●	●
Minimize System Maintenance	●				●						●		●	●	●	●
Avoid Having a Chimney[a]	●[b]	●[b]	○[b]	○[b]	●[b]	○[b]	○[b]	○[b]	●[b]	●[b]	●[b]	●	●			
Maximize the Speed of Construction												●				

† Based on the *Architect's Studio Companion, Rules of Thumb for Preliminary Design*, by Edward Allen and Joseph Iano. Page numbers in [brackets] reference the 4th Edition

● Frequently Used

○ Less Frequently Used

a Condensing Boilers do not require traditional chimneys

Chiller Selection and system selection

Lighting Calculations

	Step	Calculation
1	Examine the Architectural Objectives	Space is an Auditorium and needs lower lighting levels
	Classroom is 60 x 50 ft., with 16 ft ceilings; Wall and ceiling reflectivity is 70%	
2	Explore the Opportunities for Daylighting	Auditorium generally needs darkness from any openings
3	Determine the Task Lighting Levels	1 foot-candles 30 inches above floor
4	Select and Appropriate Lighting Source	LED fixtures
5	Choose Lighting Type	Downlights, because ceiling and walls are non-reflective
6	Select Fixtures	Lithonia LED adjustable led gimbal, Model 4g1, 480 lumens, 58 watt input
7	Determine the Number of Fixtures Required	round up to16
7a	Calculate Room Cavity Ratio (RCR)	RCR = 2.5 * Cavity Height * Perimeter / Floor Area
	Room area (ft^2) =	3000
	Room perimeter (ft) =	220
	Cavity Height (ft) =	16
	RCR =	2.93
7b	Look up CU on Lithonia Website for 70% reflectivity, and RCR of 3.86	64%
!"	Estimate Maintenance Factor	#$%
	Number of Required Fixtures	12.21
7d	Round-off Number of Fixturres	&'
8	Calculate Lighting Output (Lumens)	7,680
9	Calculate Energy Consumption (kWh)	0.93
&$	Calulcate Efficacy (Lumens / Watt)	8.28

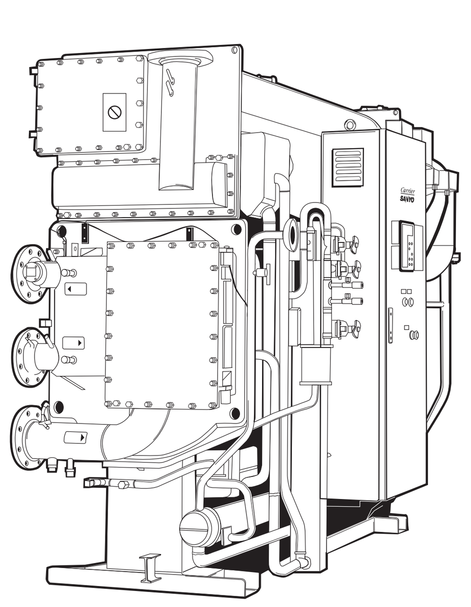
Lighting calculation

Carrier

Product Data

16TJ Single-Effect, Steam Hermetic Absorption Liquid Chiller

100 to 700 Nominal Tons



Carrier-Sanyo's 16TJ single-effect hermetic absorption liquid chiller is an efficient and functional alternative to traditional electric driven chillers. The 16TJ absorption chiller uses low-pressure steam as its energy source; as it eliminates the need for high cost electricity, it may qualify for financial incentives as a gas cooling product. The 16TJ absorption chiller offers functional flexibility in a variety of installations:

- no CFCs; environmentally sound
- single stage design for simple, dependable operation
- high reliability with few moving parts
- nominal full-load steam rate of 17.2 lb/hr-ton
- quiet, vibration-free operation
- Direct Digital Controls (DDC) for optimum chiller performance

Features/Benefits

Single-effect absorption cycle provides efficient, economical water chilling with minimal use of electricity.

Cost-effective cooling

Alternative-energy chiller — The 16TJ chiller is a so lution for building owners who want to avoid high operating costs associated with electric driven chillers. Powered by low-pressure steam, the Carrier-Sanyo 16TJ absorption chiller reduces or eliminates electric demand and/or ratchet charges while allowing the owner to take advantage of gas cooling incentives when offered by local utility companies.

Form 16TJ-1PD

Site plan 1/32"=1'

Physical data

Carrier

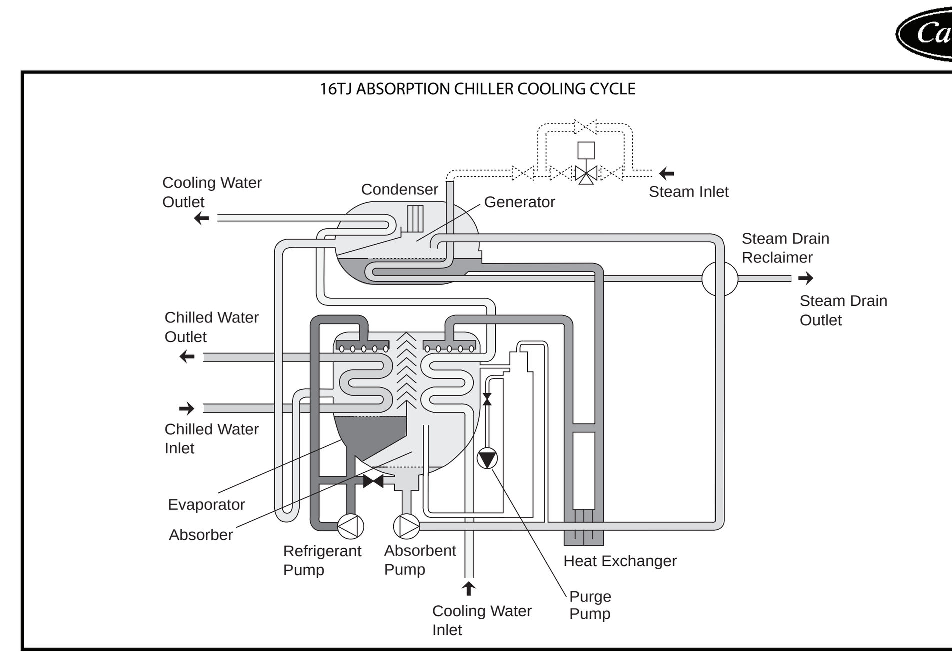
UNIT 16TJ	11	12	13	14	21
NOMINAL COOLING CAPACITY (ton)	100	120	150	180	210
→ RIGGING WEIGHT (lb)	7,500	8,000	9,800	10,200	12,400
OPERATING WEIGHT (lb)	8,600	9,100	11,100	11,500	14,200
LITHIUM BROMIDE SOLUTION CHARGE (lb)	800	900	1,200	1,300	1,600
REFRIGERANT (WATER) CHARGE (lb)	110	90	150	150	180
CHILLED WATER Pipe Connection Size (in.)	4	4	4	4	5
No. of Passes	4	4	3	3	3
COOLING WATER Pipe Connection Size (in.)	5	5	5	5	6
No. of Passes Absorber	3	3	2	2	2
Condenser	2	2	1	1	1
STEAM Pipe Connection Size (in.)					
Steam Inlet	5	5	5	5	6
Drain Outlet	1.5	1.5	1.5	1.5	1.5

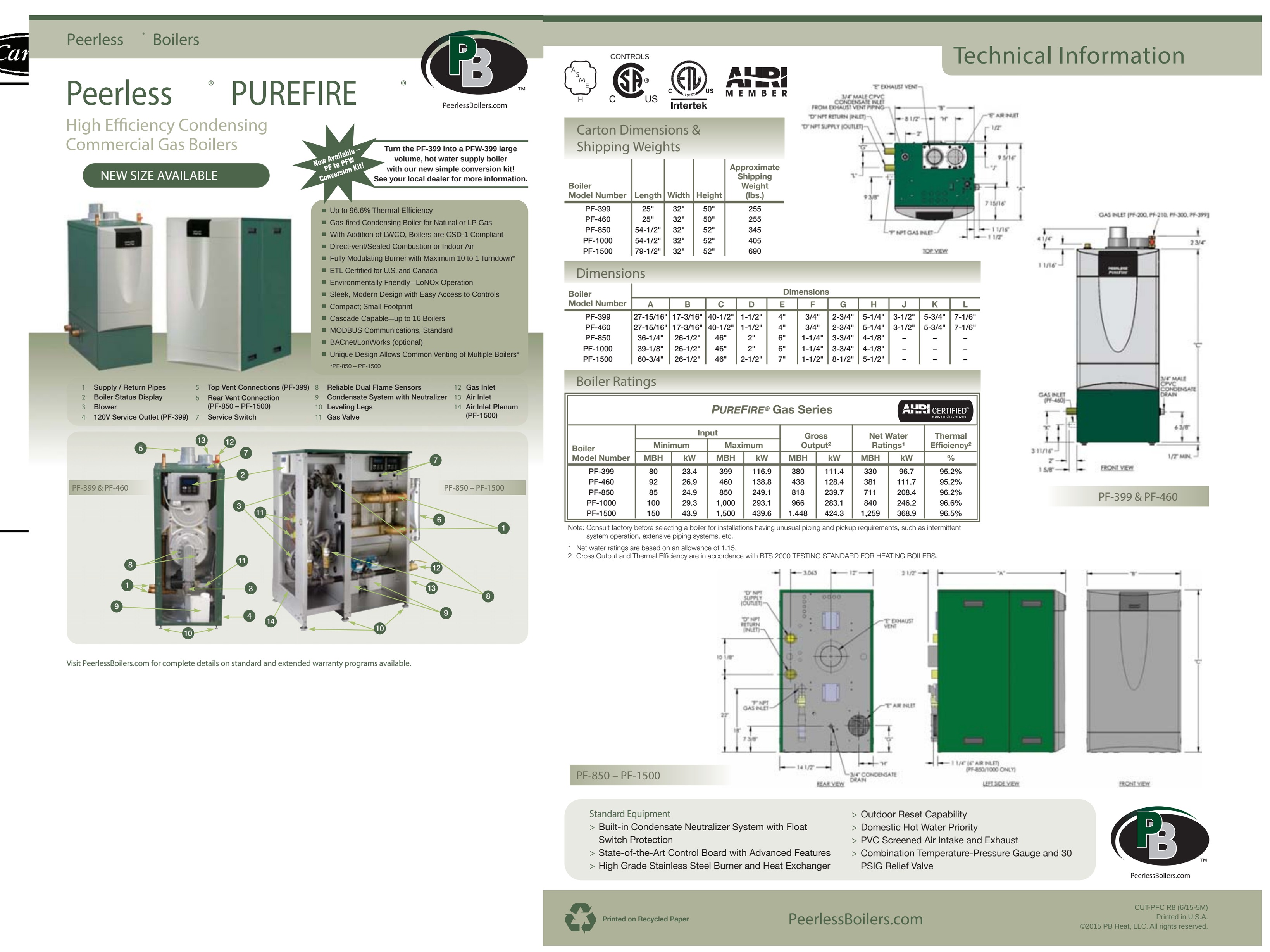
UNIT 16TJ	22	23	24	31	32
NOMINAL COOLING CAPACITY (ton)	240	280	320	360	400
RIGGING WEIGHT (lb)	12,800	15,000	15,700	19,500	20,100
OPERATING WEIGHT (lb)	14,800	17,200	18,100	22,300	23,200
LITHIUM BROMIDE SOLUTION CHARGE (lb)	1,900	2,100	2,400	2,800	2,800
REFRIGERANT (WATER) CHARGE (lb)	150	240	200	240	240
CHILLED WATER Pipe Connection Size (in.)	5	6	6	6	6
No. of Passes	3	2	2	2	2
COOLING WATER Pipe Connection Size (in.)	6	8	8	8	8
No. of Passes Absorber	2	2	2	2	2
Condenser	1	1	1	1	1
STEAM Pipe Connection Size (in.)					
Steam Inlet	6	8	8	8	8
Drain Outlet	1.5	1.5	1.5	2	2

UNIT 16TJ	41	42	51	52	53
NOMINAL COOLING CAPACITY (ton)	450	500	560	630	700
RIGGING WEIGHT (lb)	23,200	23,900	32,500	35,100	37,500
OPERATING WEIGHT (lb)	27,000	28,100	38,400	41,500	44,400
LITHIUM BROMIDE SOLUTION CHARGE (lb)	3,600	3,600	4,200	4,700	5,200
REFRIGERANT (WATER) CHARGE (lb)	330	330	370	420	490
CHILLED WATER Pipe Connection Size (in.)	8	8	8	8	8
No. of Passes	2	2	2	2	2
COOLING WATER Pipe Connection Size (in.)	10	10	12	12	12
No. of Passes Absorber	2	2	2	2	2
Condenser	1	1	1	1	1
STEAM Pipe Connection Size (in.)					
Steam Inlet	8	8	10	10	10
Drain Outlet	2.5	2.5	2.5	2.5	2.5

8

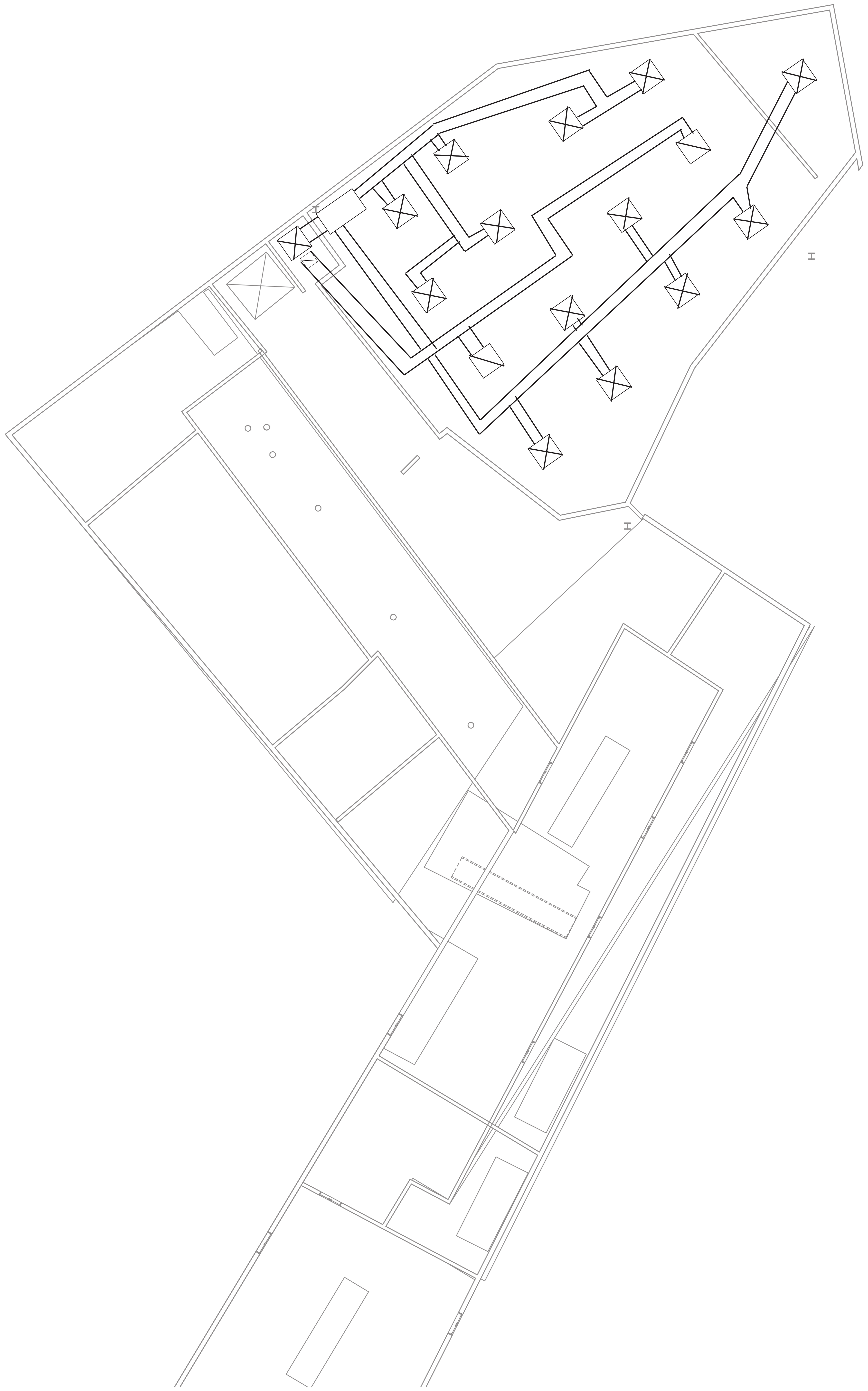
805

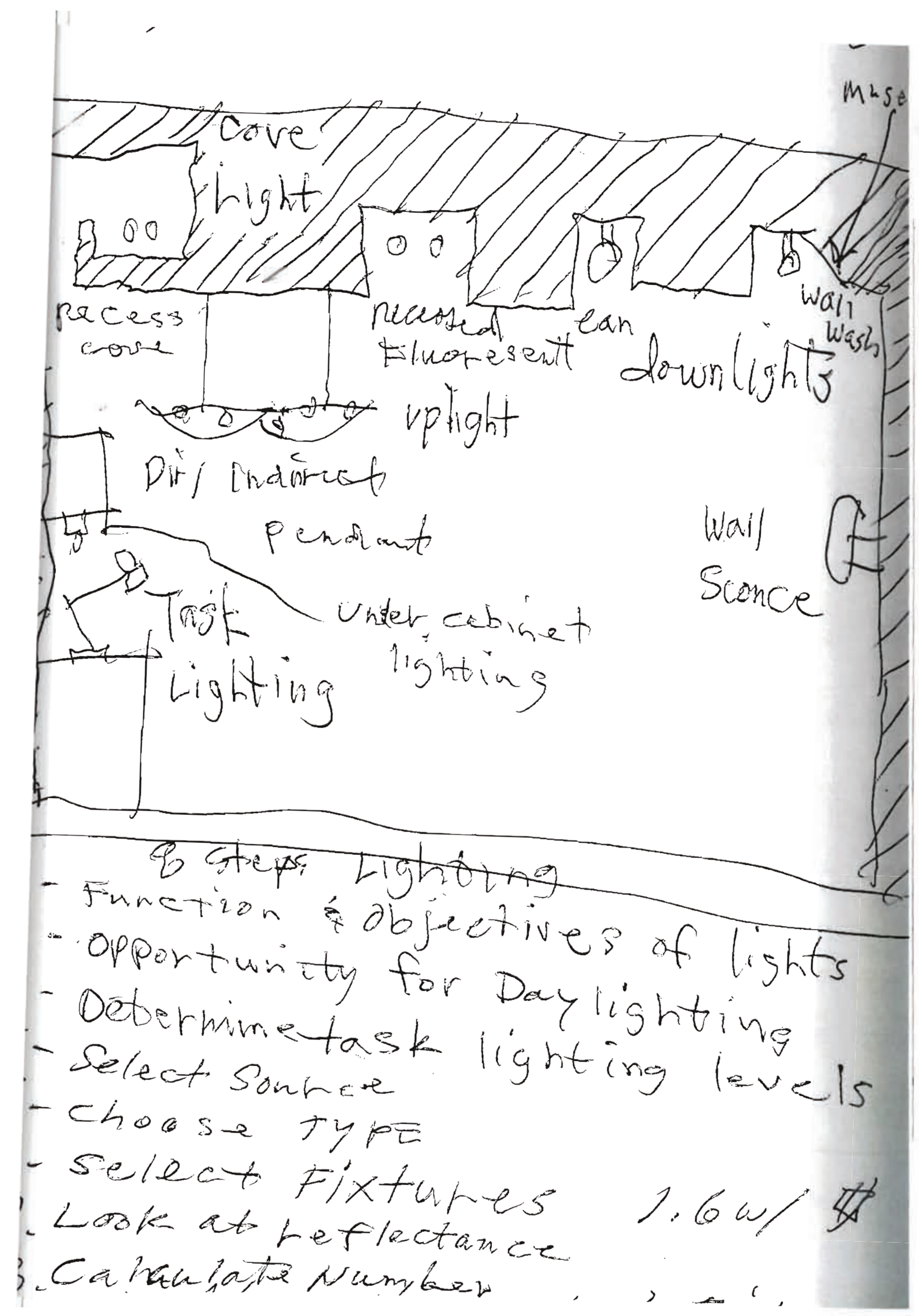


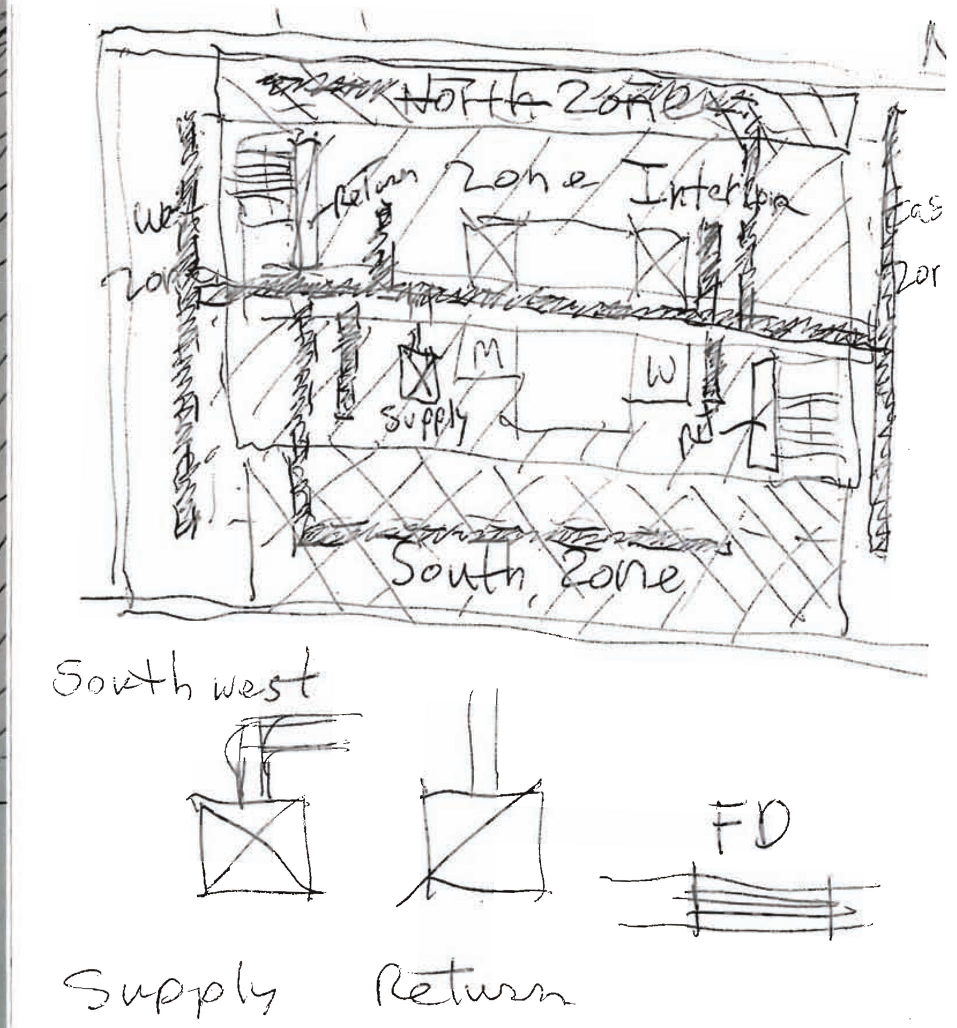


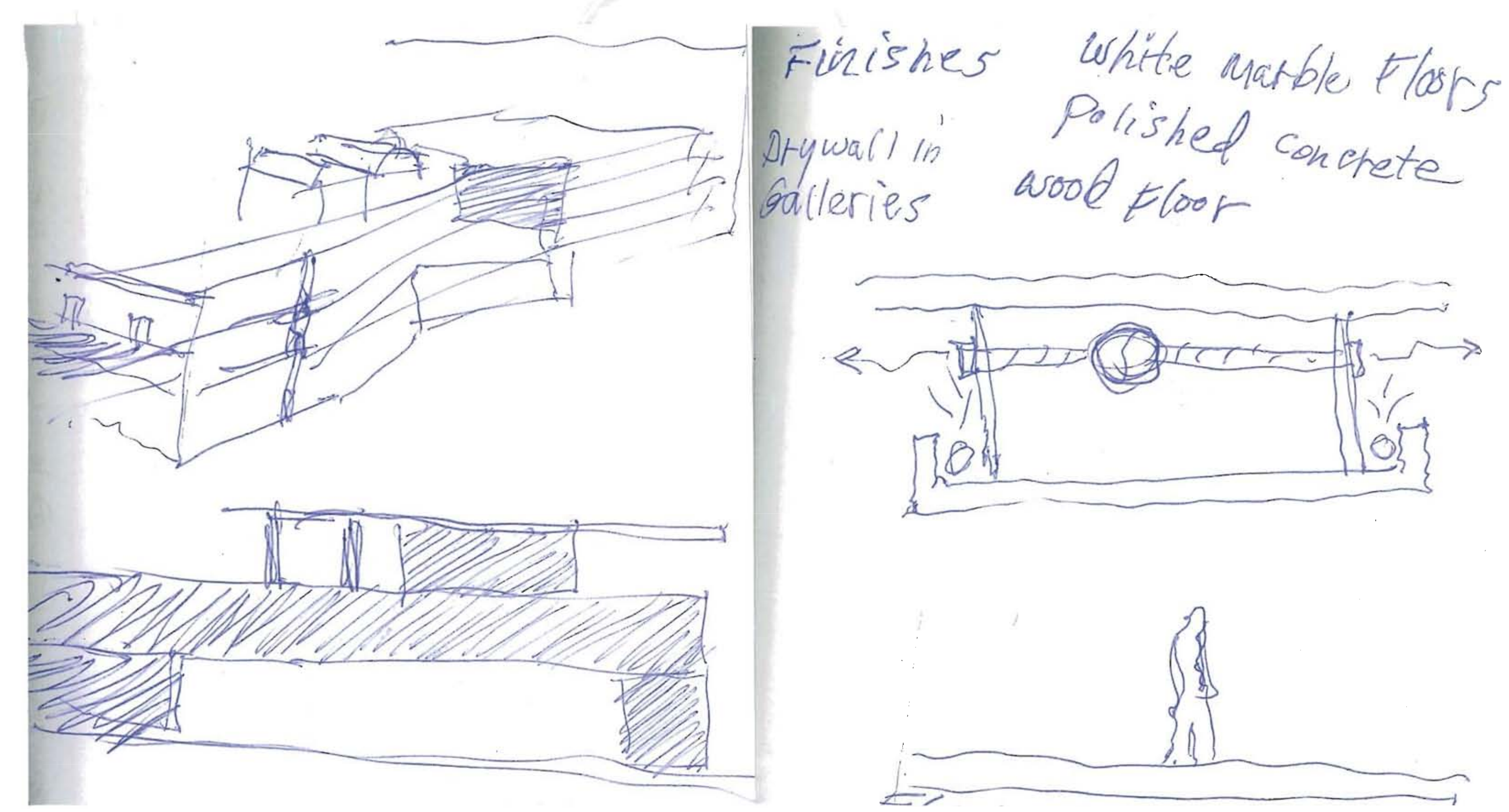
Boiler Selection

Final Project - Porto Portugal, Dennis Selke Spring 2016 AR833 John Dobyns, Instructor



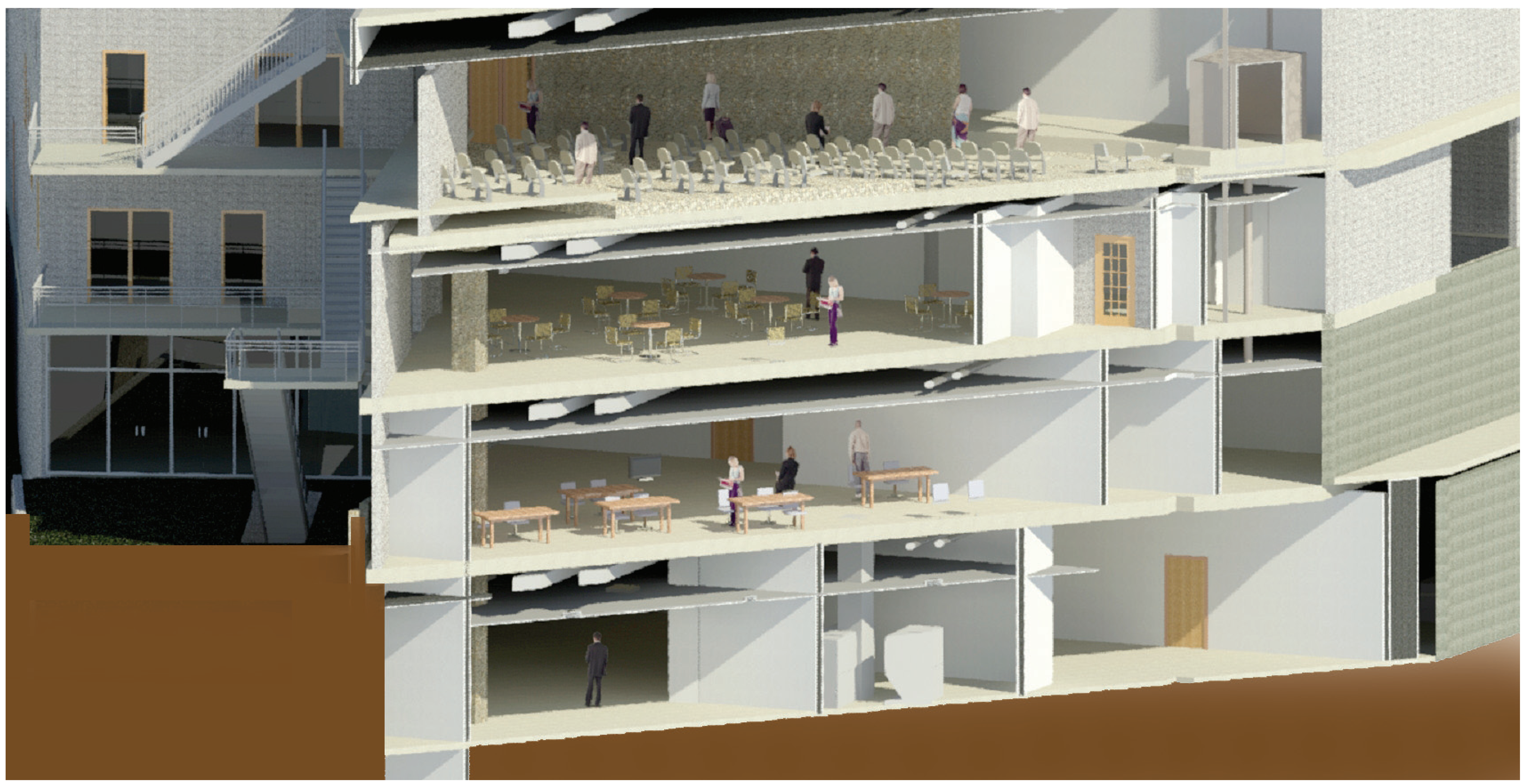

Cove light
recess cove
recessed Fluorescent
can downlights
wall wash
uplight
Dir/Indirect Pendant
Wall Sconce
Task Lighting
Under cabinet lighting
8 Steps Lighting
- Function & objectives of lights
- Opportunity for Daylighting
- Determine task lighting levels
- Select Source
- Choose Type
- Select Fixtures 1.6w/ft
- Look at reflectance
- Calculate Number


North Zone
Return
Zone Interior
Supply
M
W
South Zone
South west
FD
Supply
Return


Finishes
White marble Floors
Polished concrete
wood Floor
Drywall in Galleries

HVAC plan

Museum of Architecture



Sectional perspectives