nexus

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BIM Thesis | AEI Team 5 | Presentation #2 | 03 October 2012

Team Goals and Competition Goals

Goals

BIM Ex.

Architecture

Structural

Mechanical

Lighting / Electrical

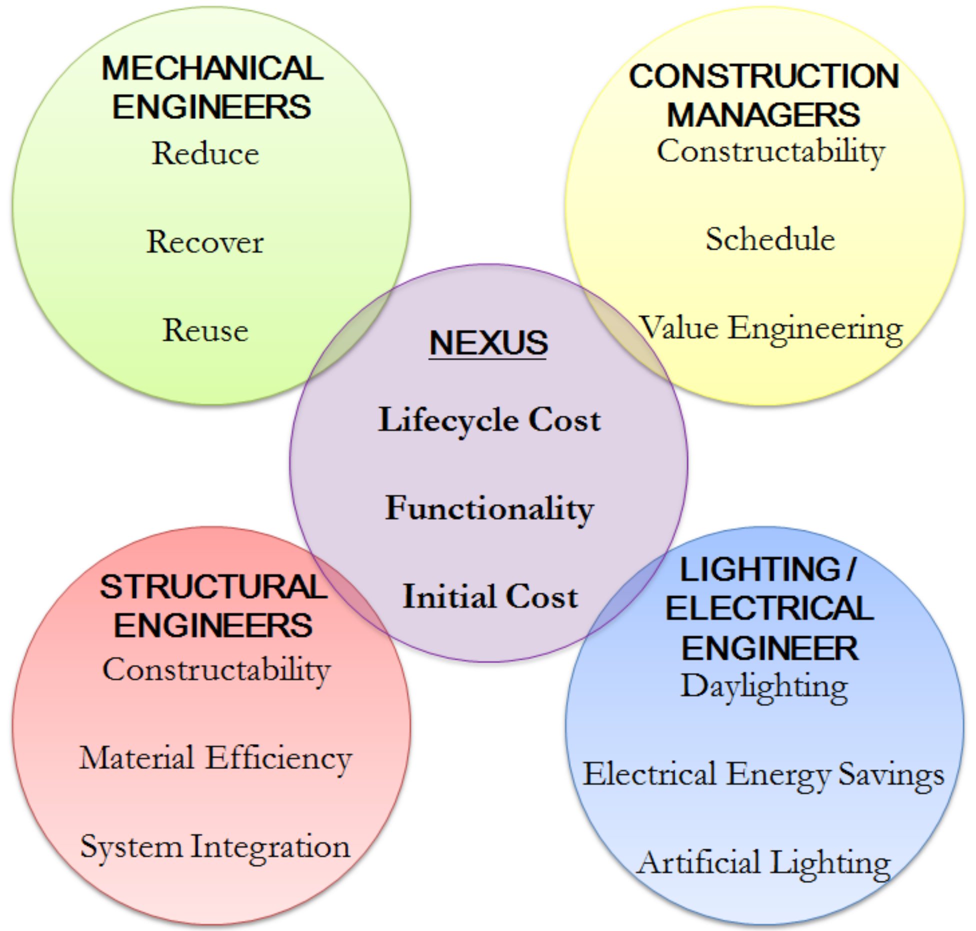
Construction

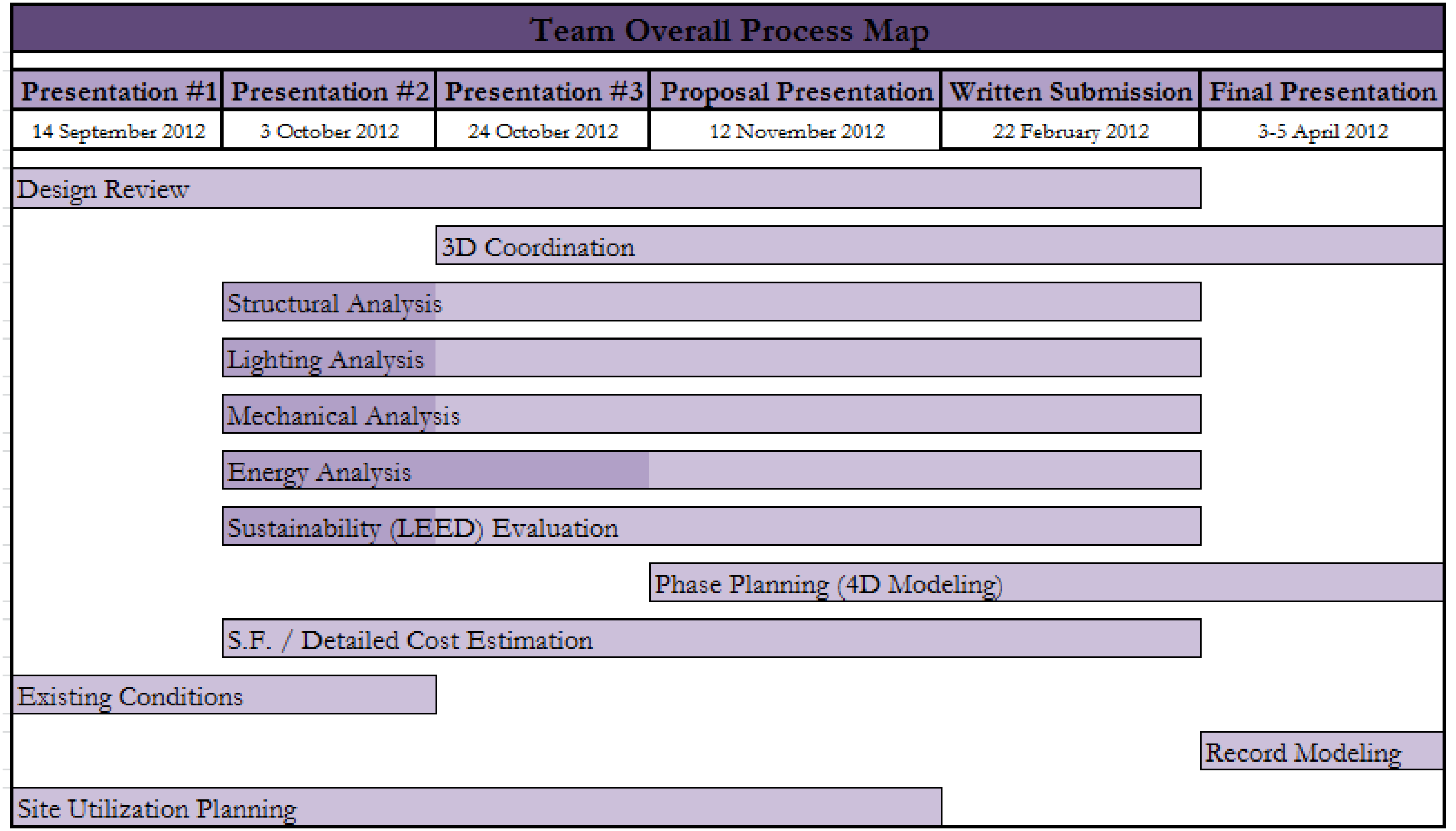
Conclusion

Team Goals

- Façade Integration
  - Structure
  - Exterior Cladding
  - Glazing
- Recreation
  - Swimming Pool
  - Gymnasium
  - Locker Rooms
- Classrooms
  - Layout
  - Flexibility
  - Learning Environment

Competition Goals



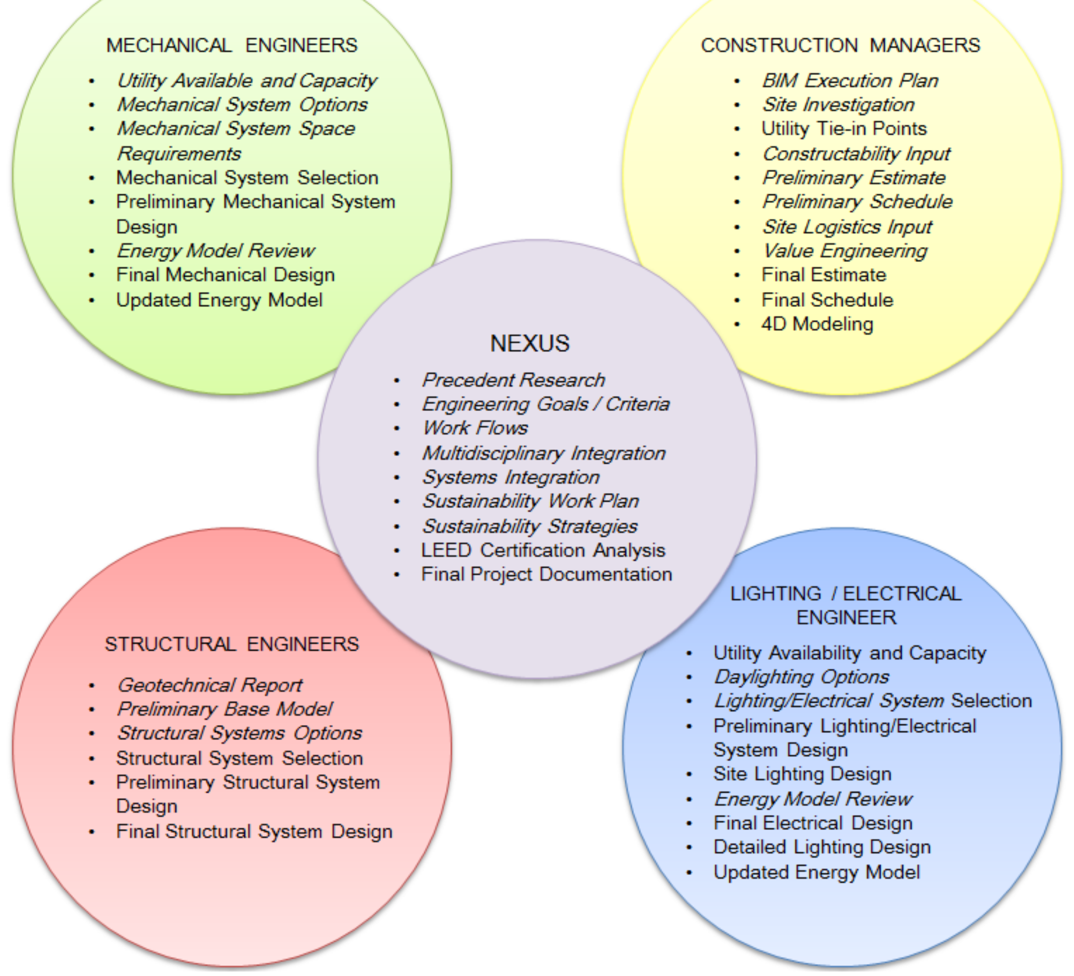


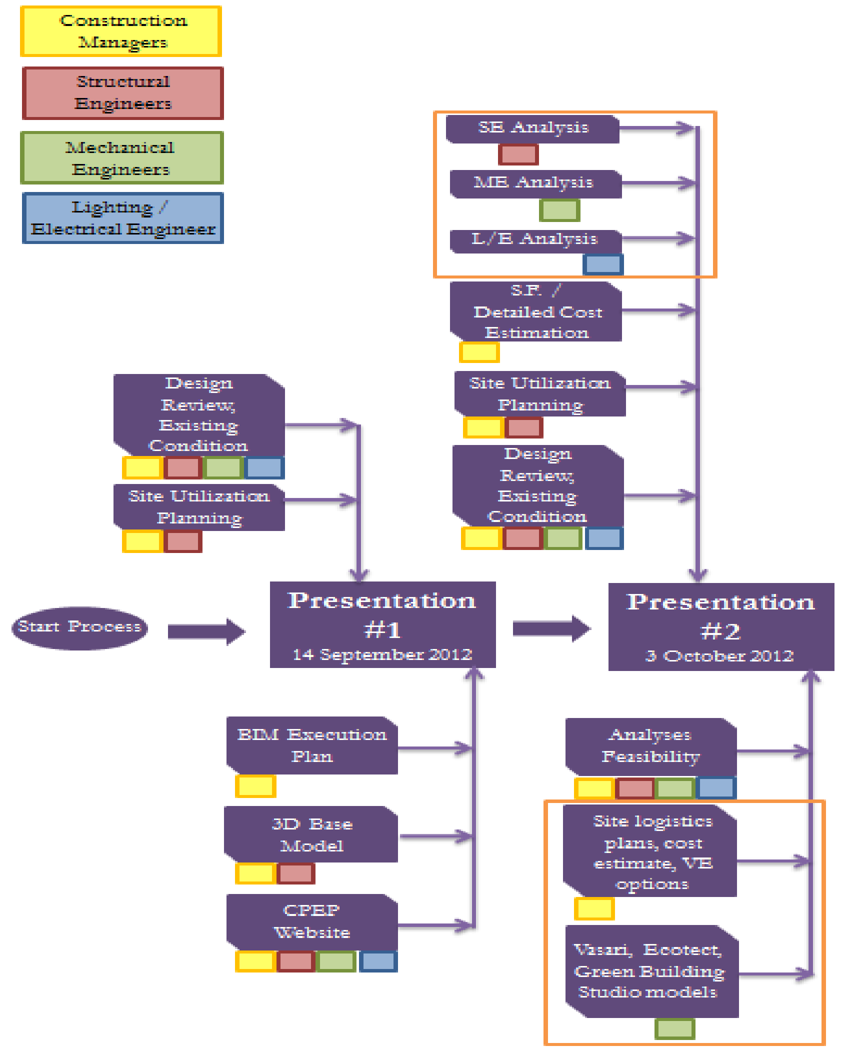
nexus

BIM Execution Plan Update

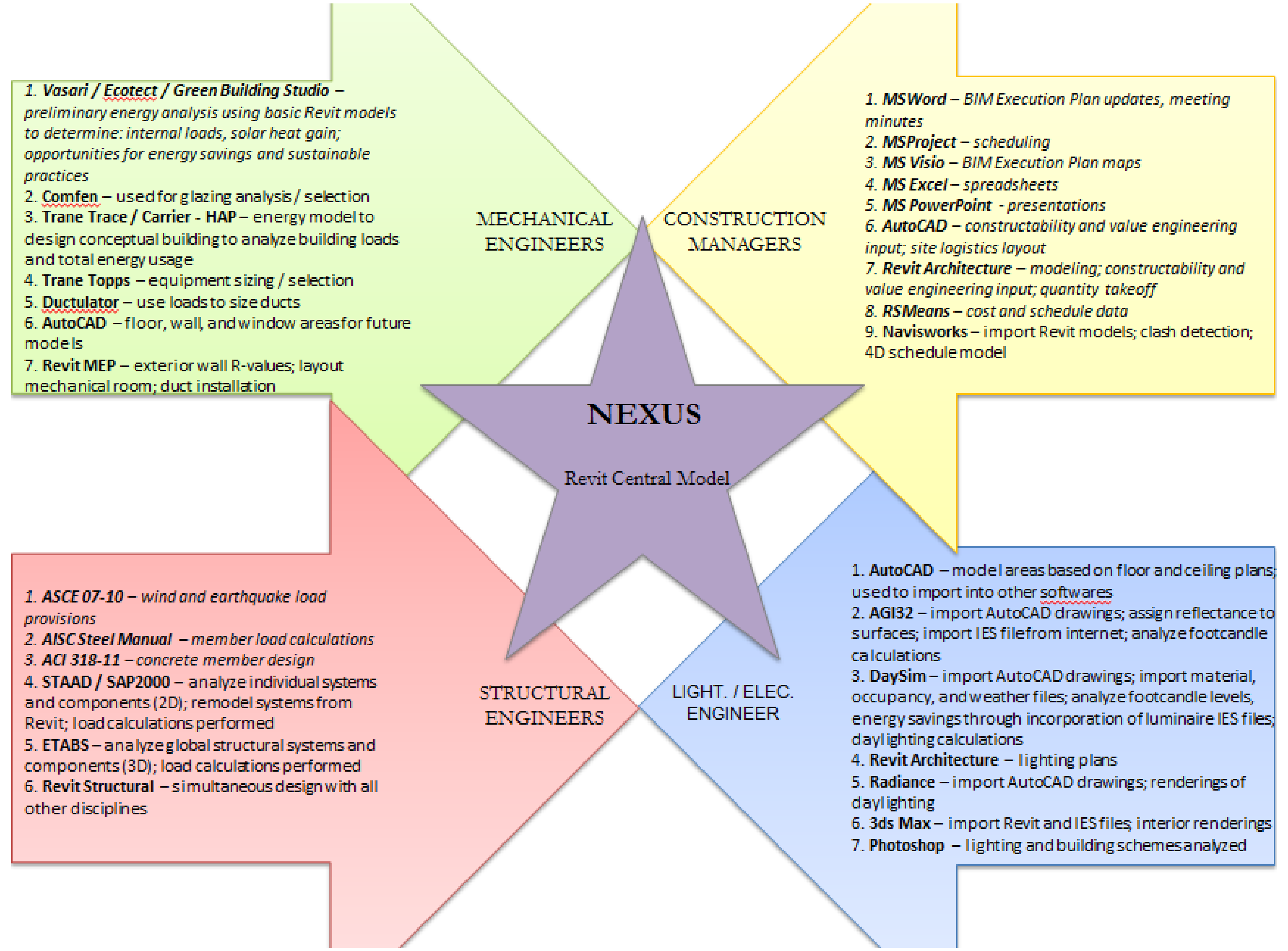
Goals
BIM Ex.
Architecture
Structural
Mechanical
Lighting / Electrical
Construction
Conclusion

BIM Roles and Responsibilities



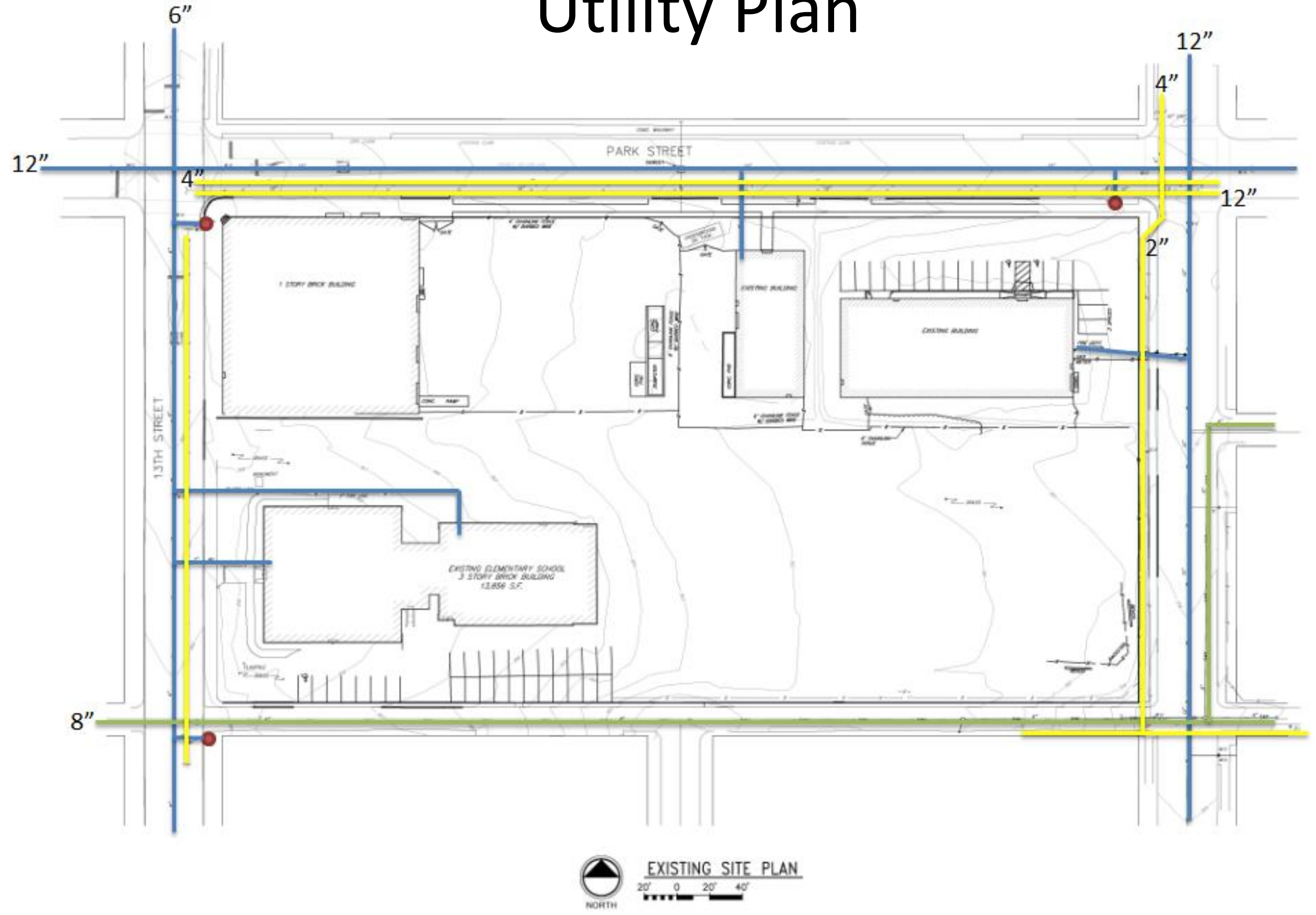


Software

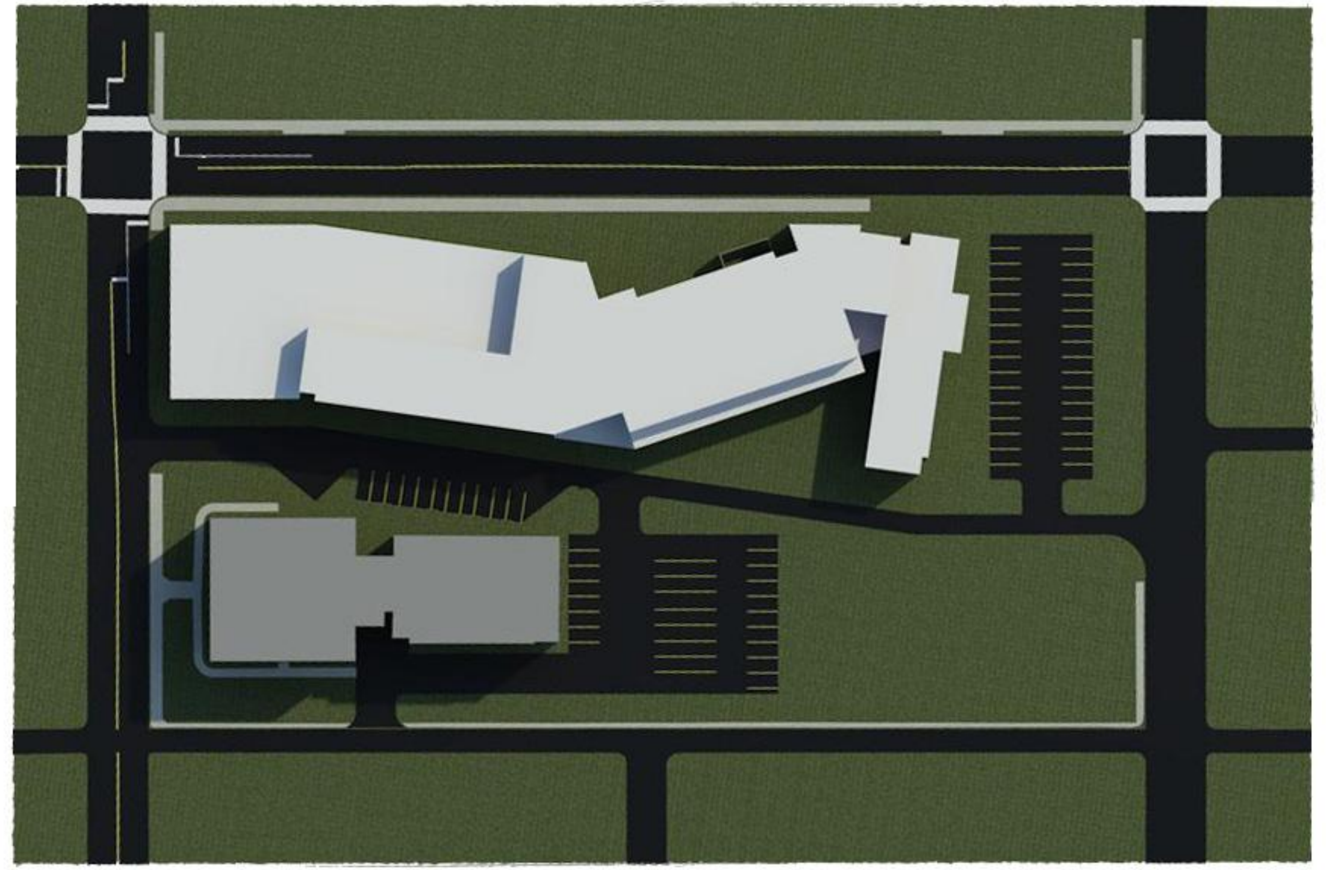


Site Conditions

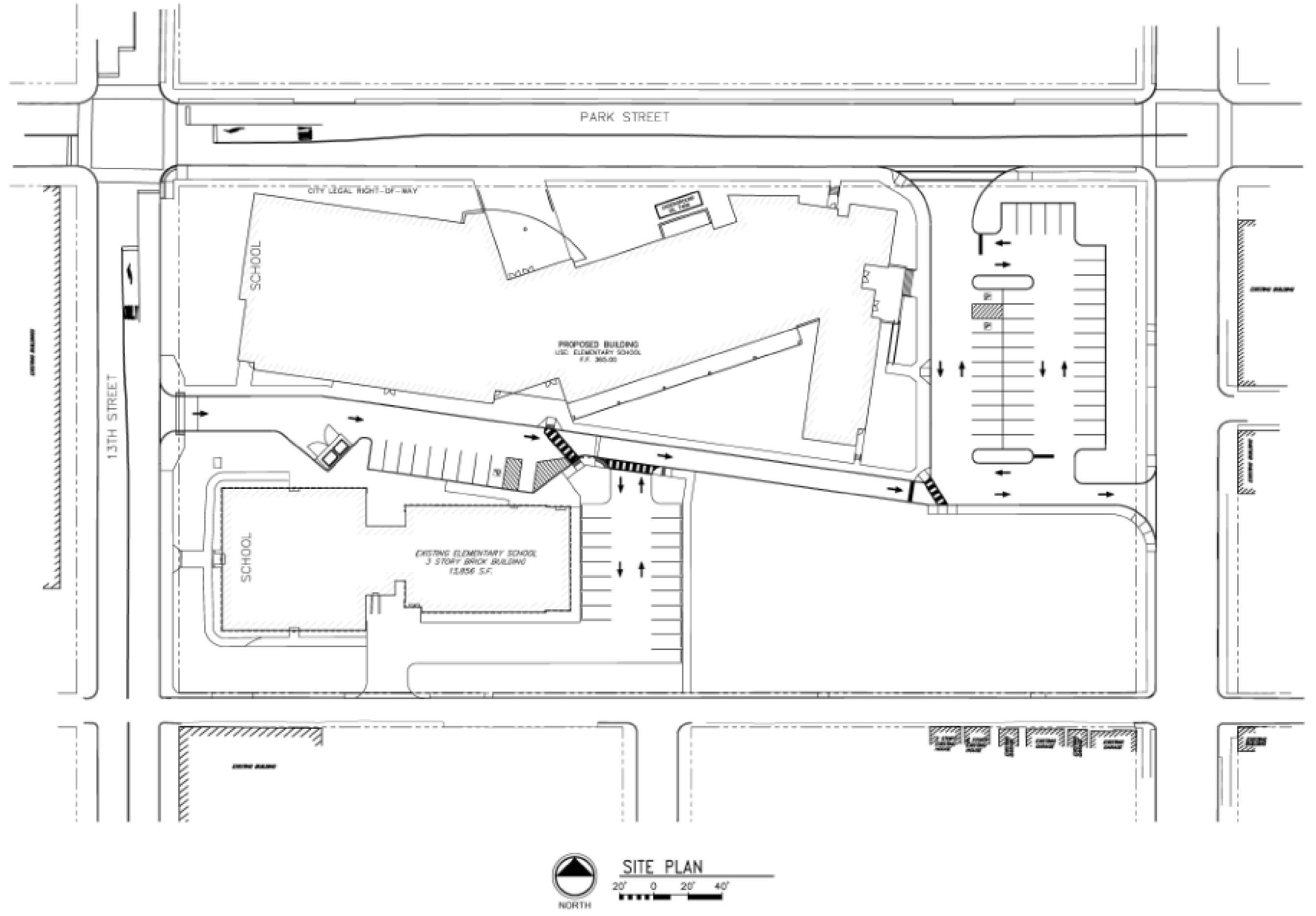
Utility Plan



New Site Layout

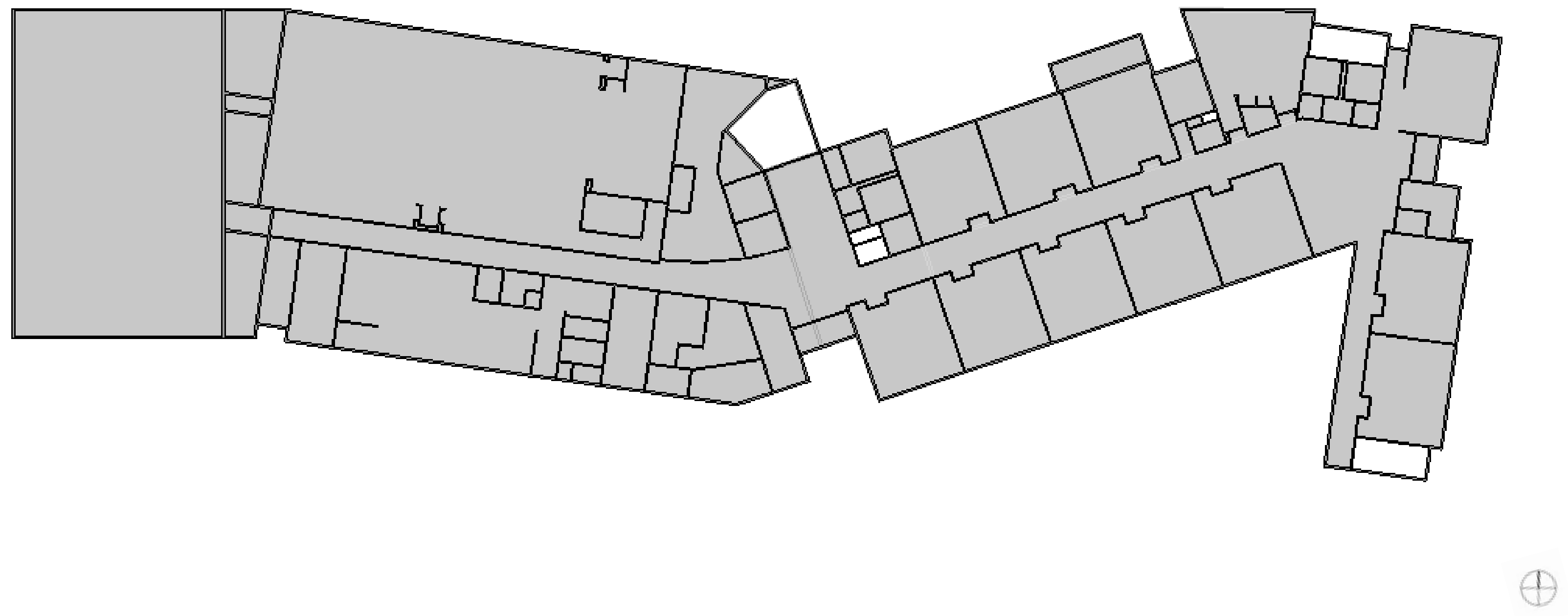


Old Site Layout

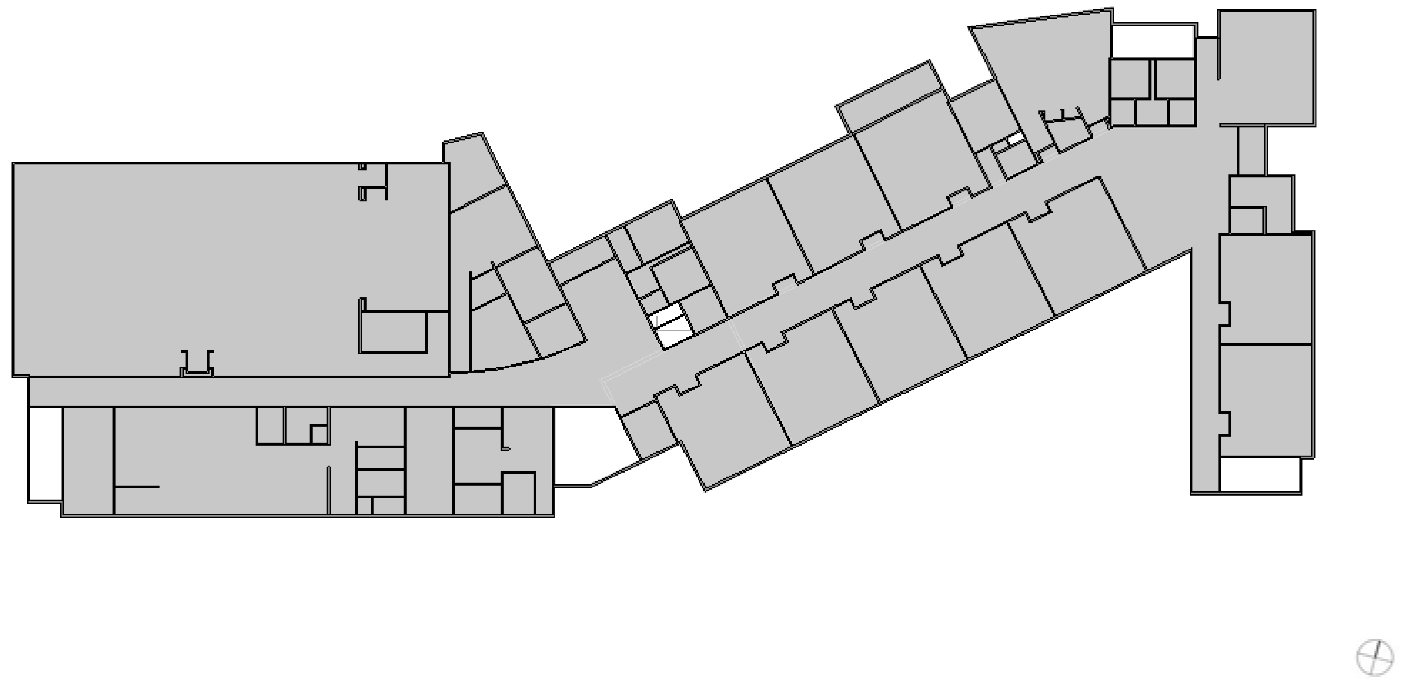


Architecture

New First Floor Plan



Old First Floor Plan

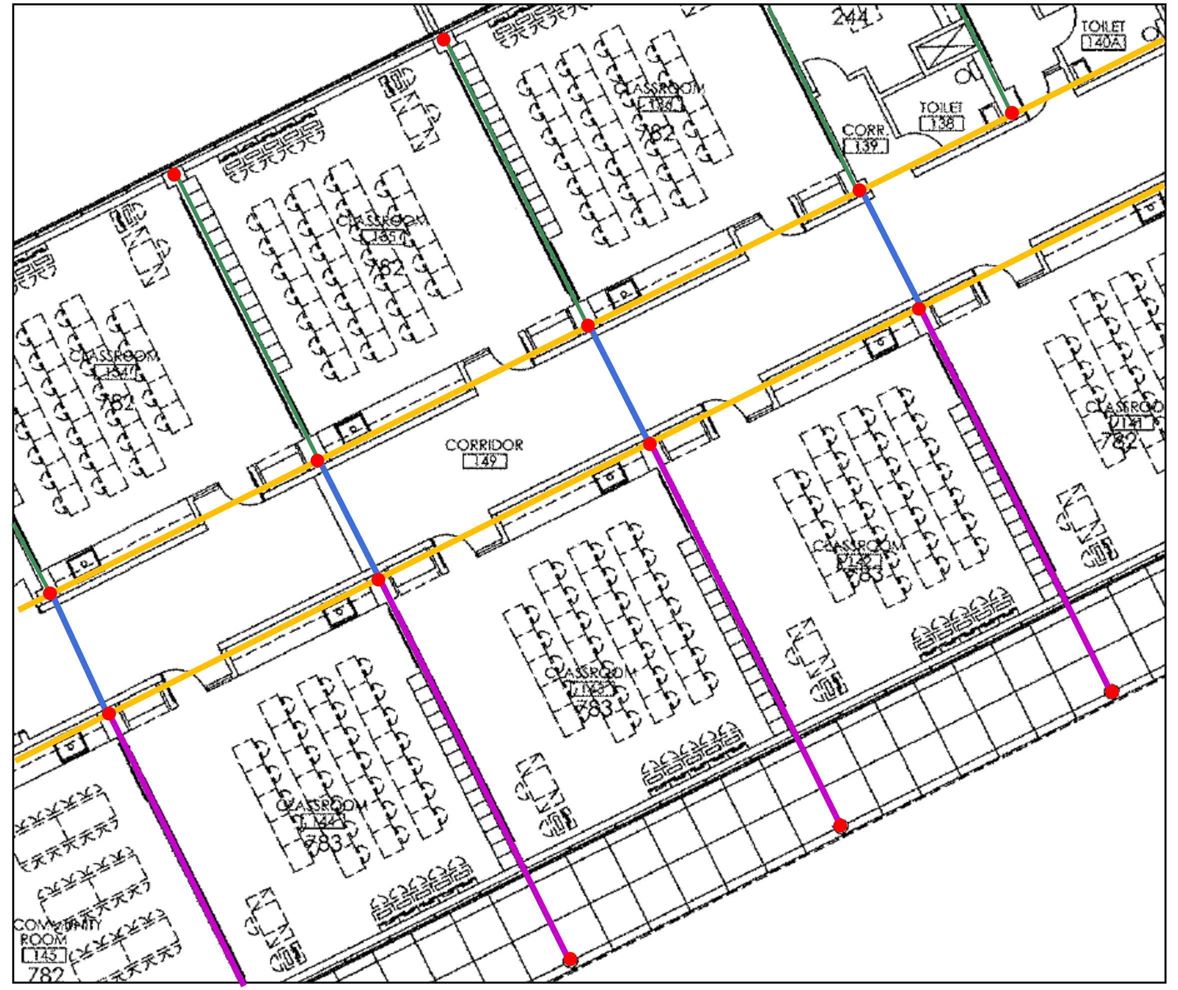


Structural Systems

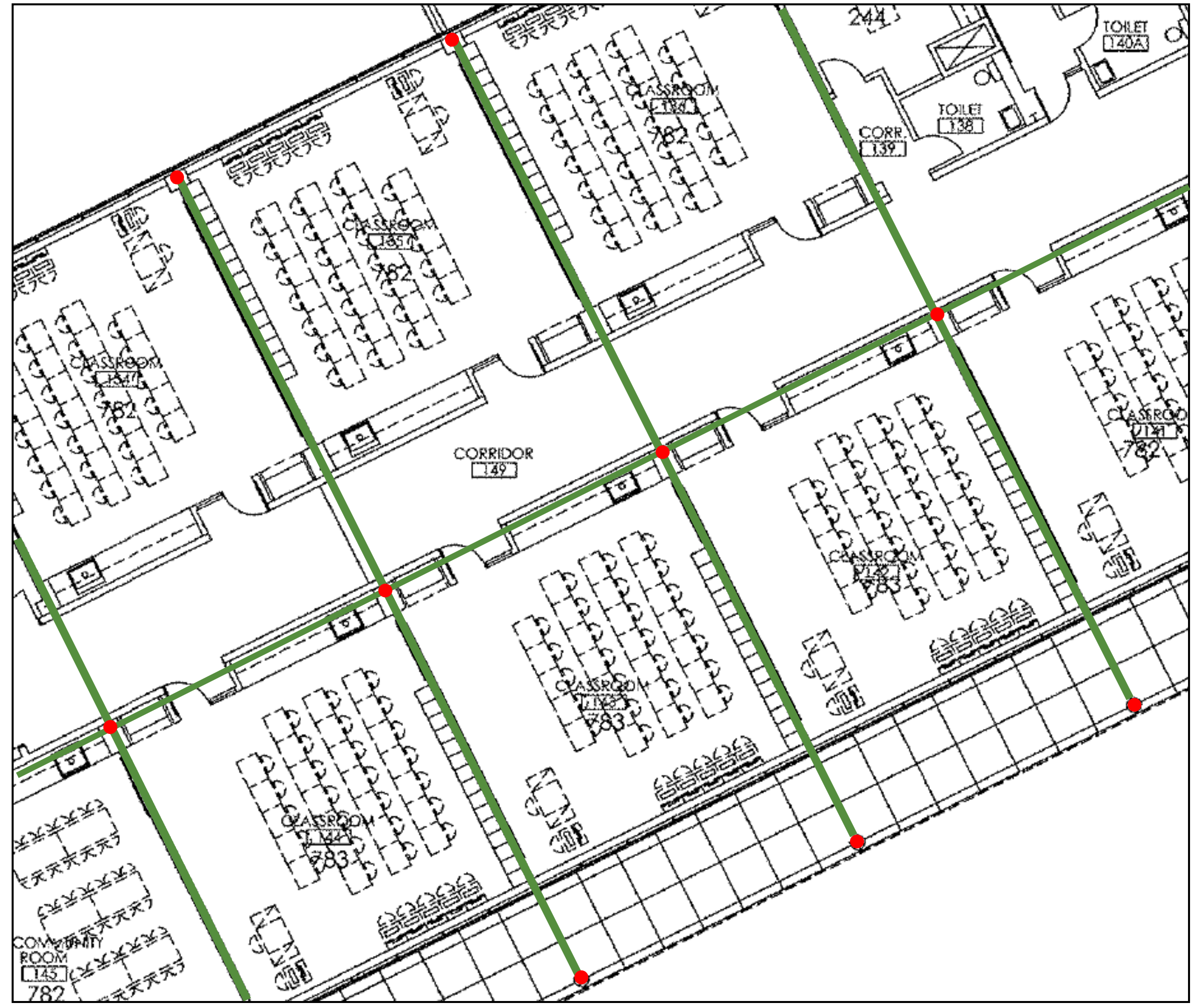
- Goals
- BIM Ex.
- Architecture
- **Structural**
- Mechanical
- Lighting / Electrical
- Construction
- Conclusion

Structural Goals

- Ease of Construction
- Low Cost
- Efficient Use of Material
- Limited Depth of Structure
- Interdisciplinary Input



Existing Structural Grid



Proposed Structural Grid

Structural Systems

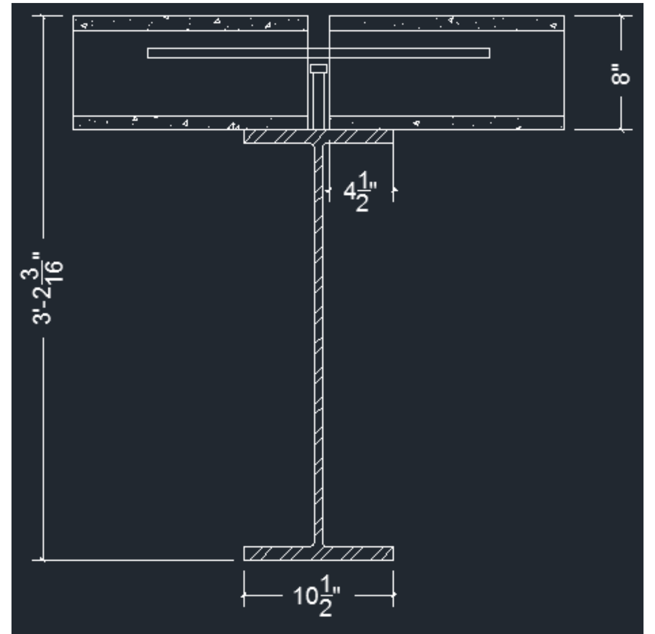
Steel Frame with Precast Hollow Core Concrete Planks

Pros

- Easy to construct
- Ability to cross long spans with no interior beams
- Efficient use of concrete material

Cons

- Larger depth than composite system
- Somewhat heavy floor system
- Potential acoustical concerns



HOLLOW CORE PLANK ON STEEL GIRDER

TOTAL DEPTH: 3'-2 3/16"

Conclusions

- Efficient use of building materials
- Very good constructability
- Excessive structural depth along girders
- Still worth consideration, but not the probable choice

Structural Systems

Concrete Frame Using a One-Way Slab

Pros

- Does not require additional fireproofing
- Concrete is cheap and generally available
- Good choice for the bay sizes of this building

Cons

- Typically deeper floor system than steel
- Much heavier than steel frame
- Shrinkage and creep may be concerns later in the life of the structure

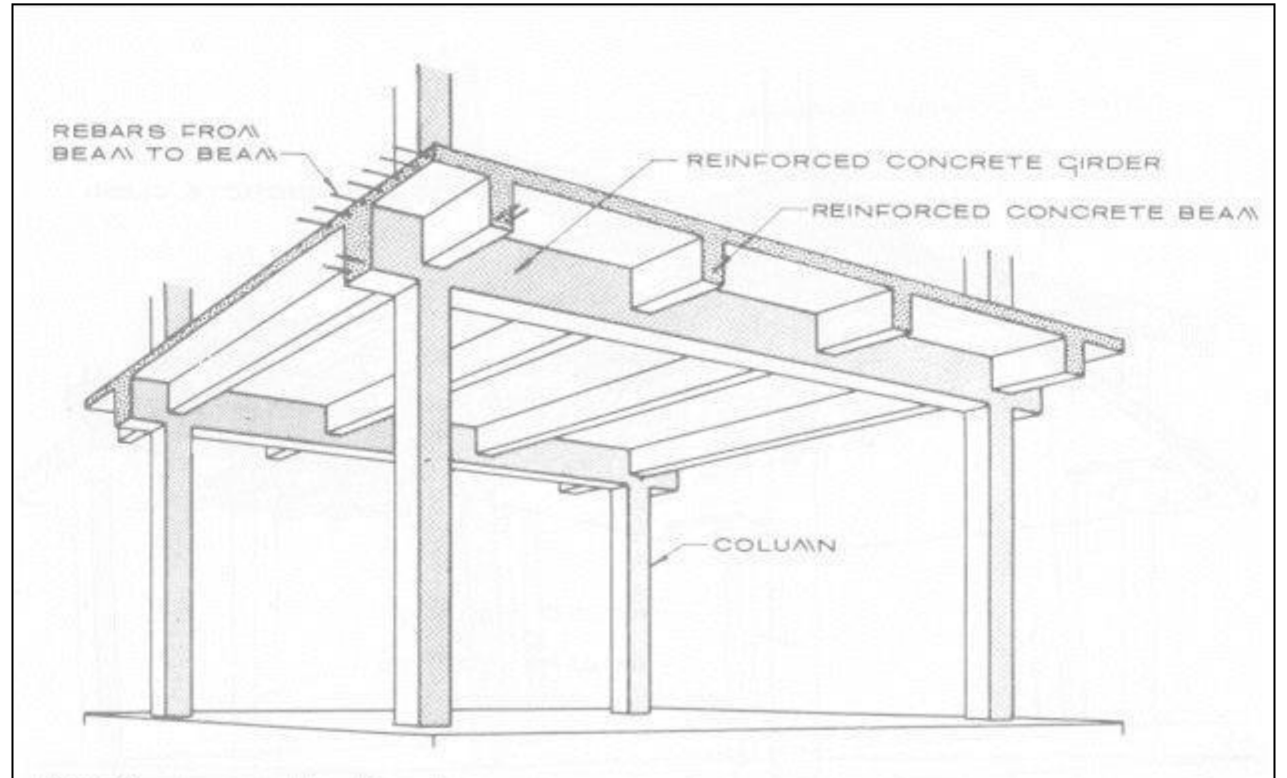
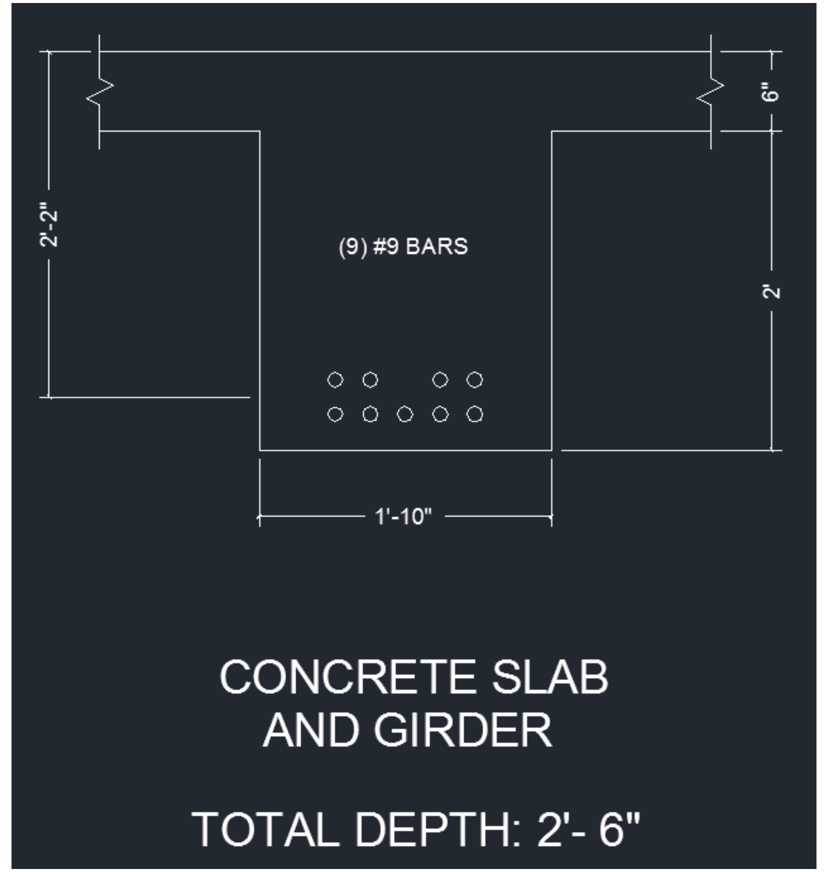


Figure 14. A one-way slab-and-beam floor.



Conclusions

- Acceptable structural depth
- Generally average in terms of constructability and efficiency
- May work well with proposed ICF wall system
- Another option worth continued consideration

Structural Systems

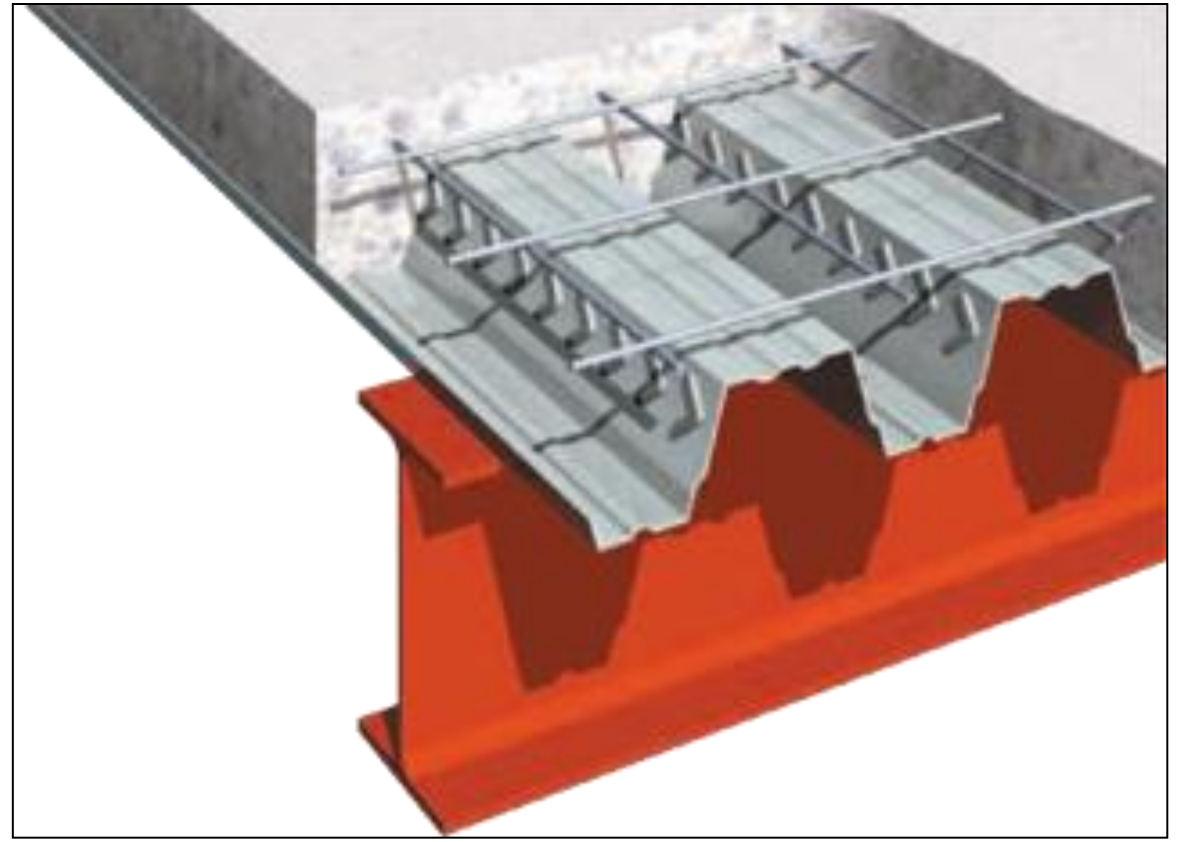
Non-Composite Deck on Steel Frame

Pros

- Lightweight
- Can span long distances
- Easy to construct
- Opportunity for open floor plan

Cons

- Potential for large deflections
- Greater depth than composite system
- Inefficient use of concrete material



Conclusions

- Very easy to construct
- Very inefficient use of concrete material
- Excessively deep structure
- Probably not a feasible system for achieving team goals

Structural Systems

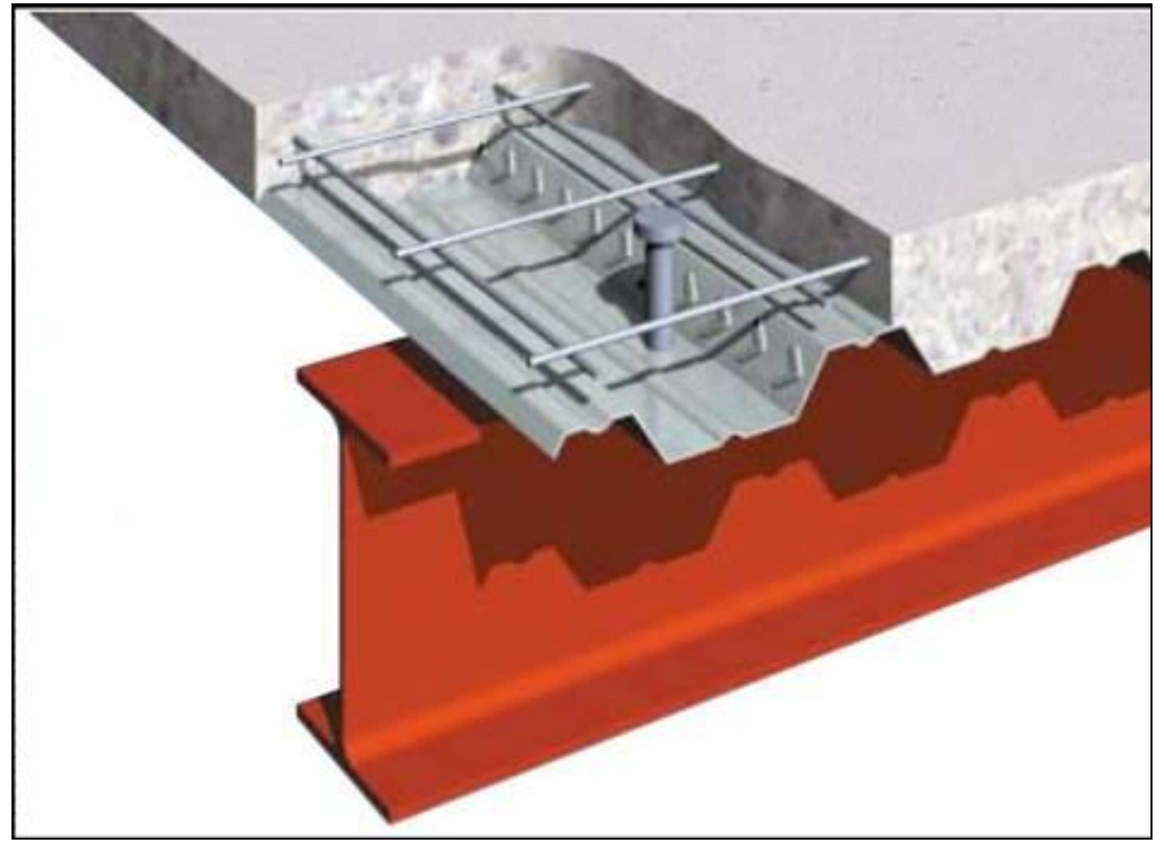
Composite Deck on Steel Frame

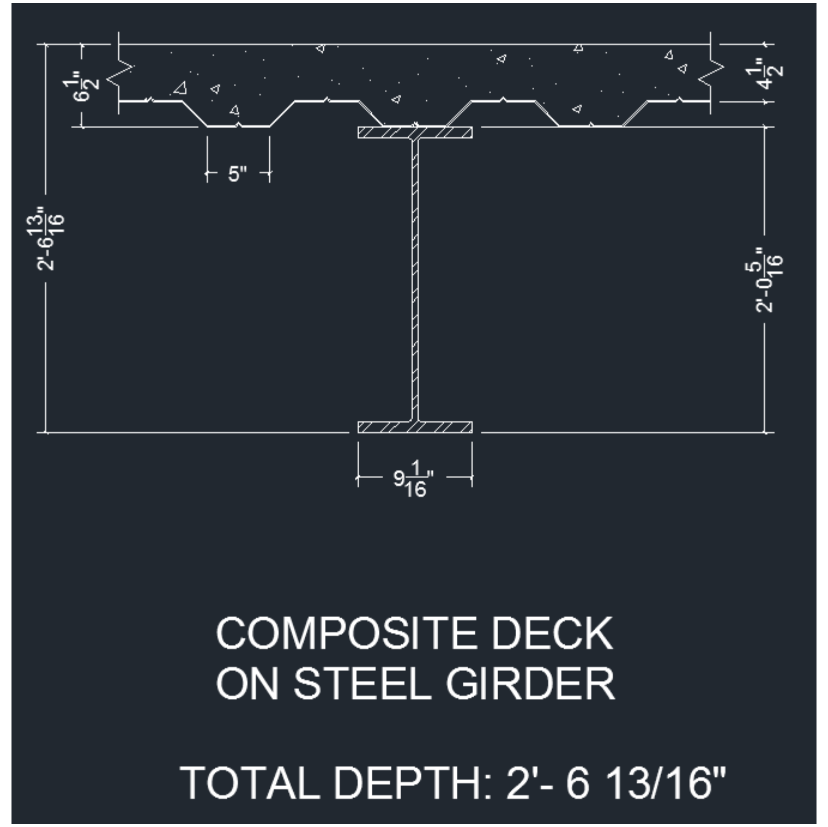
Pros

- Lightest-weight system
- More efficient use of materials than non-composite
- Relatively quick construction
- Opportunity for open floor plan

Cons

- More labor-intensive than non-composite
- Added cost because of shear studs (welding)
- Requires fireproofing of steel members

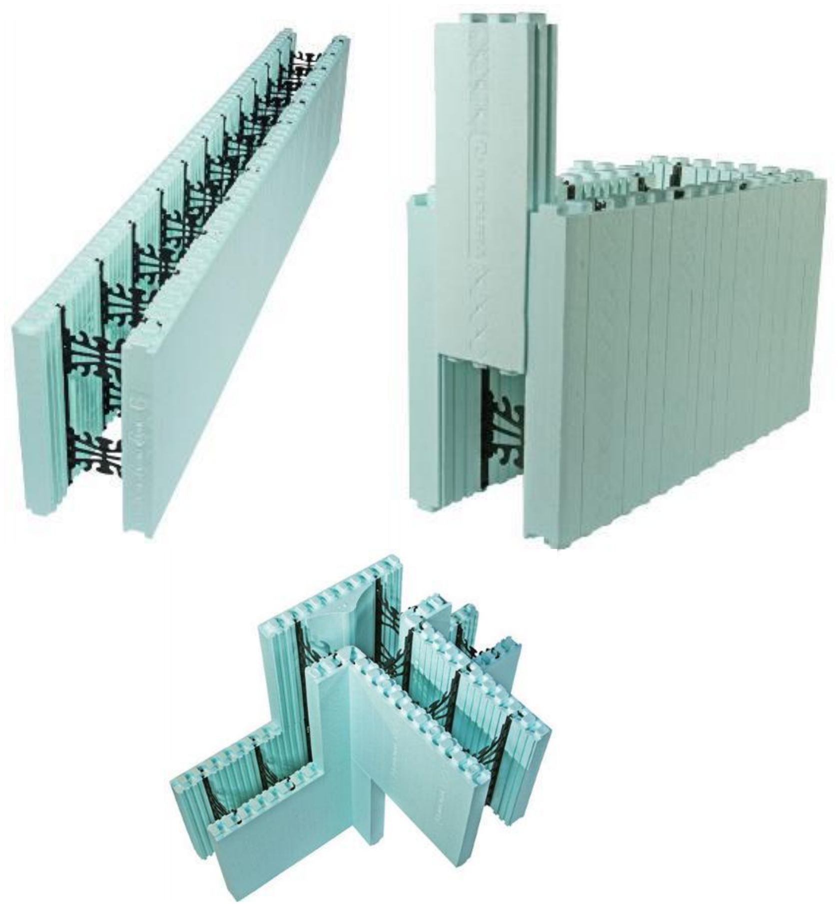


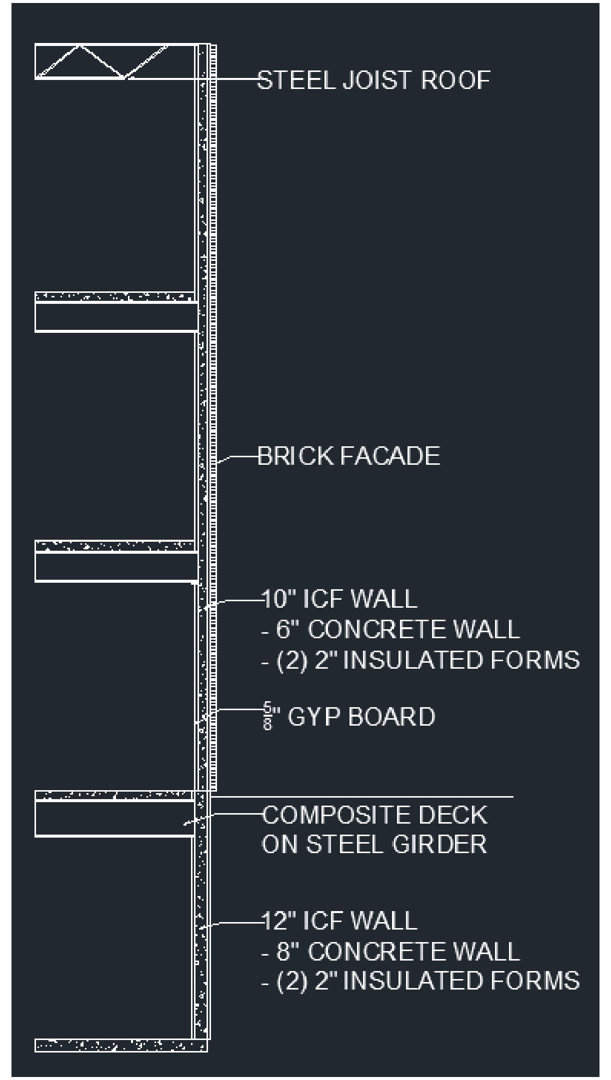


Conclusions

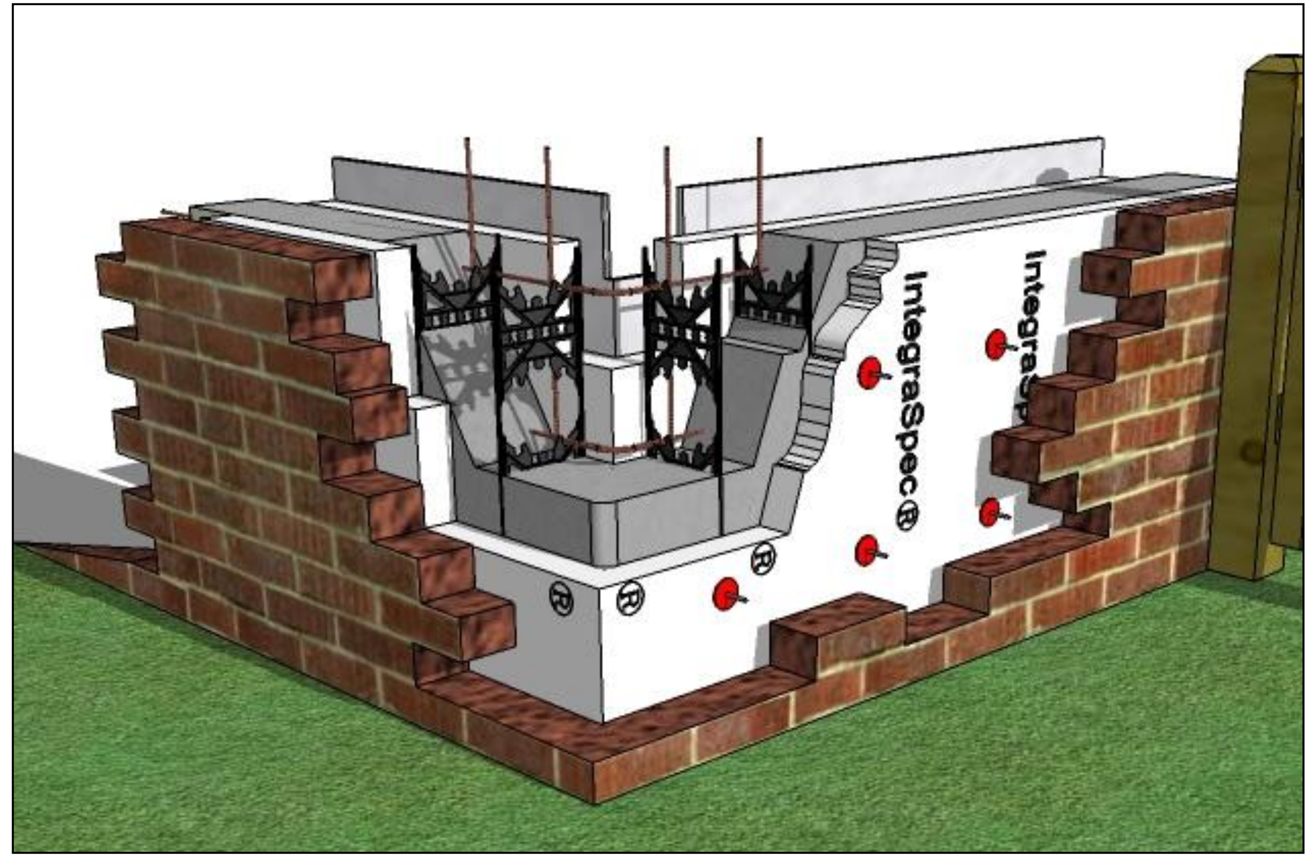
- Much more efficient use of building materials
- Acceptable structural depth
- Provides flexibility for MEP systems
- Viable option for continued exploration

Structural Systems





Insulated Concrete Forms (ICFs)



Advantages

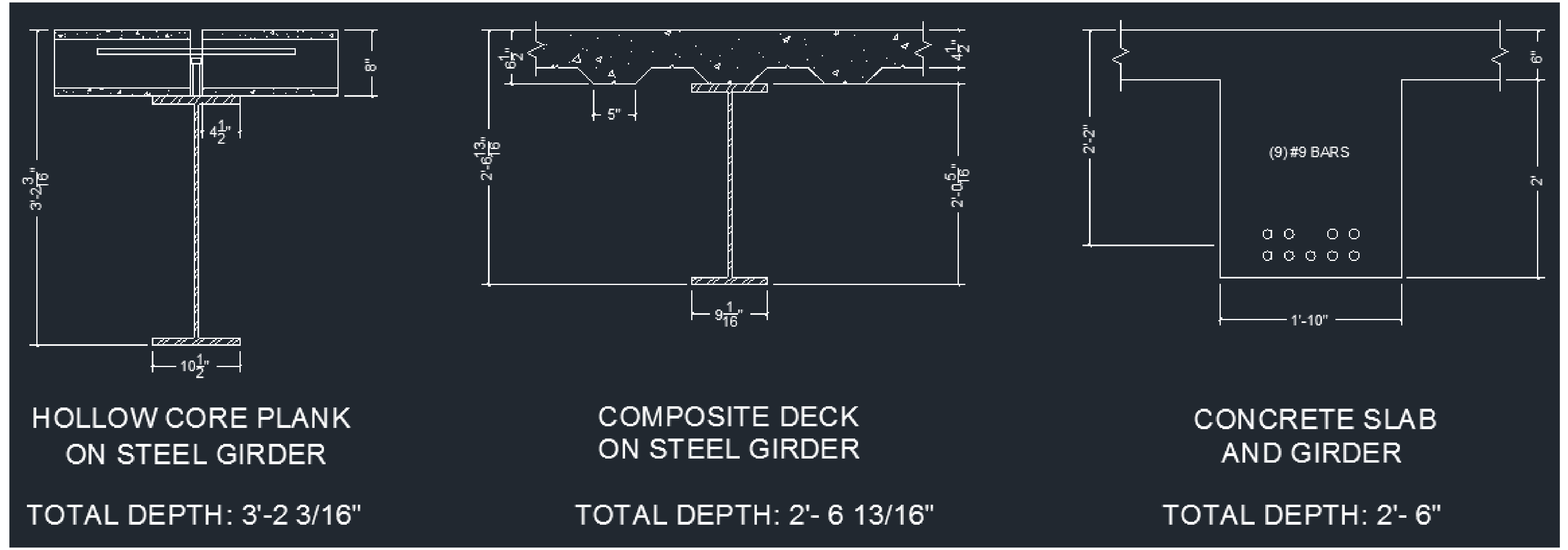
- Thermally efficient
- Structurally useful as:
  - Exterior bearing walls
  - Shear walls
- Easy and quick to construct
- Reduced cost
- Adaptable

Structural Systems Analyses

	Material Efficiency	Ease of Construction	Structural Depth	Overall
Non-composite	Poor	Good	Poor	**Poor**
Composite	Good	Fair	Fair	**Good**
Hollow core concrete	Good	Good	Poor	**Fair**
One-way slab and beams	Fair	Fair	Fair	**Fair**

Structural Systems		Lifecycle Cost	Functionality	Upfront Cost	Total
Floor Systems	Hollow Core Concrete Planks	4	4	3	**11**
	Composite Slab on Metal Deck	4	4	2	**10**
	Non-composite Slab on Metal Deck	3	2	3	**8**
Framing Systems	Steel Frame	4	3	2	**9**
	Concrete Frame (One Way Slab and Supporting Beams)	3	3	3	**9**
Wall Types	ICF (Insulated Concrete Form) Exterior Wall System	5	5	4	**14**
	Metal Stud Partitions and Drywall	2	4	4	**10**
	Masonry Partitions	4	2	3	**9**

Depth Comparison



(Deep) → (Shallow)

Mechanical Analysis

Goals
BIM Ex.
Architecture
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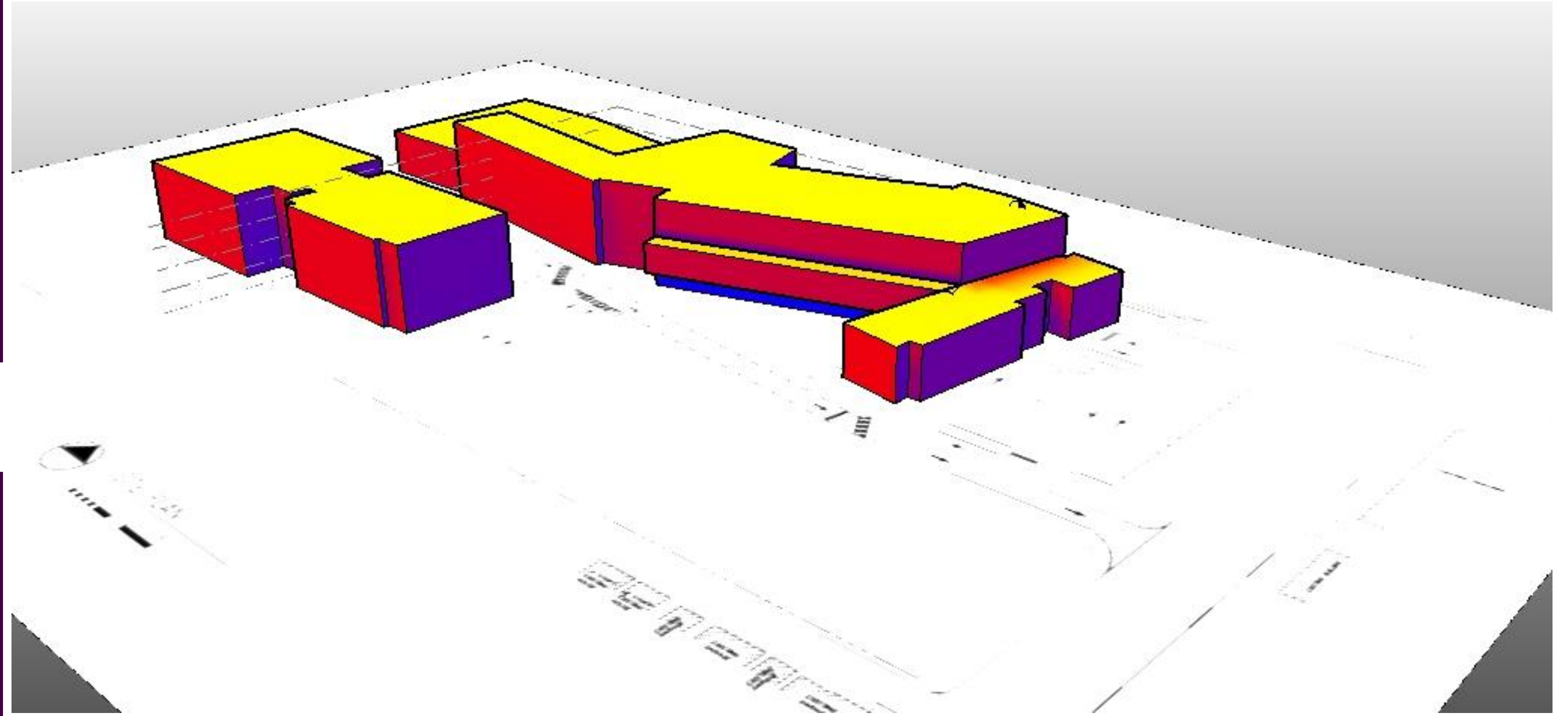
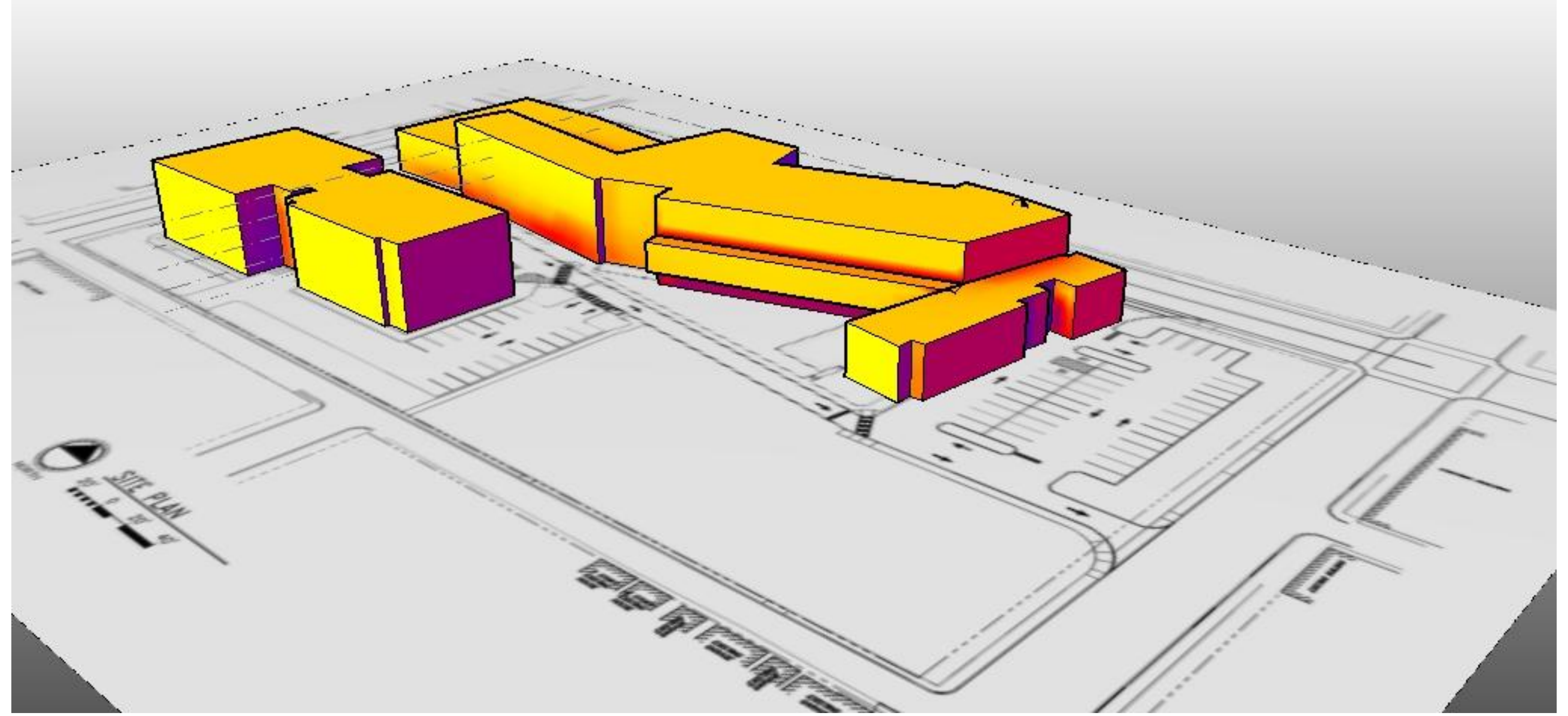
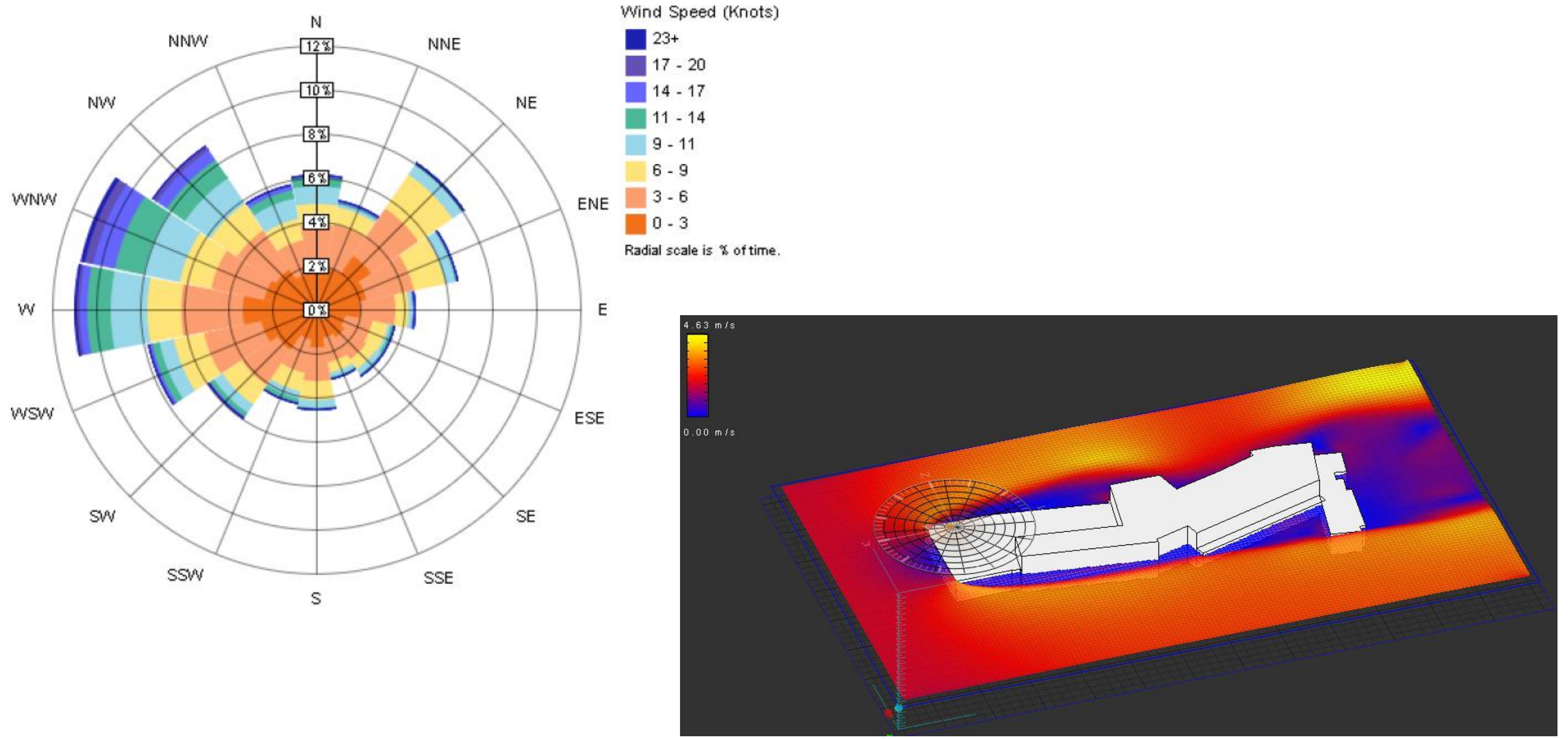


Summer Solar Radiation

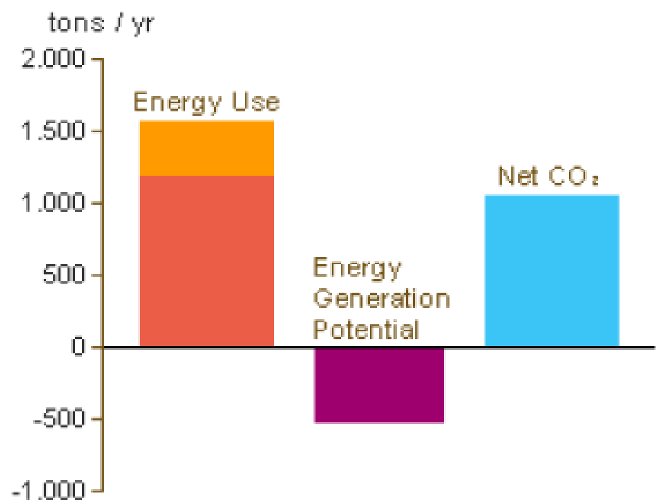


Winter Solar Radiation



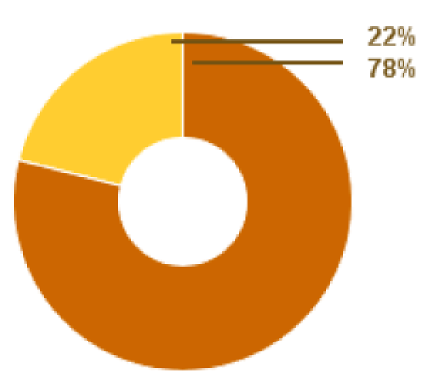
Annual Wind Analysis and Wind Rose

Preliminary Vasari Energy Model



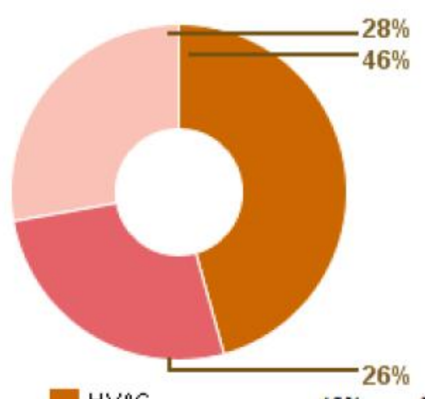
	(tons / yr)
Electricity Consumption	1,193
Fuel Consumption	377
Roof PV Potential (High Efficiency)	-523
Single 15' Wind Turbine Potential	0
Net CO_2	1,047

Energy Use: Fuel



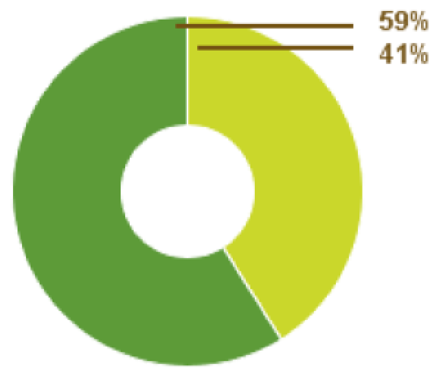
			(Therms)
HVAC	78%	$52,186	51,384
Domestic Hot Water	22%	$13,917	13,703
		$66,103	65,087

Energy Use: Electricity



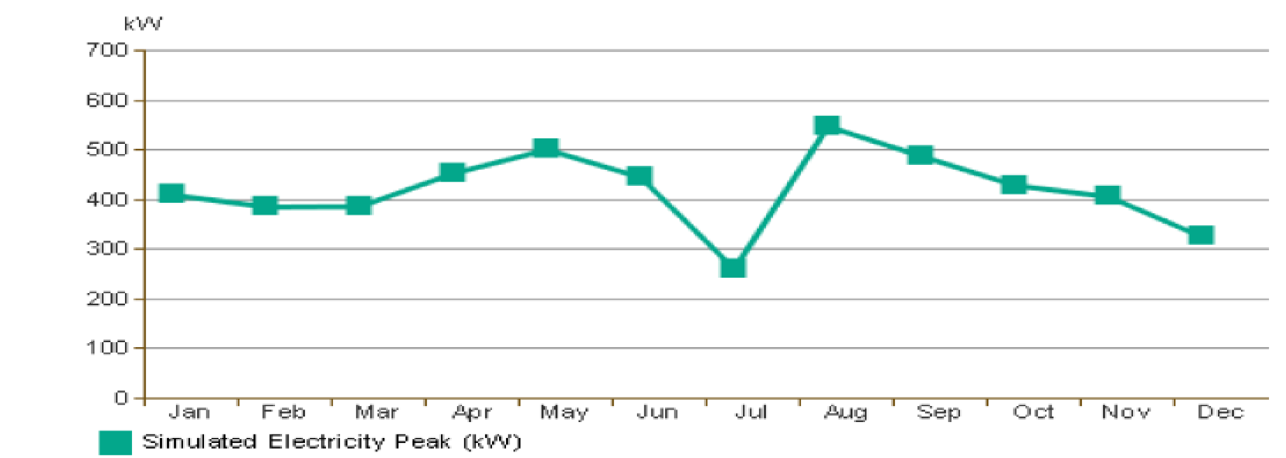
			(kWh)
HVAC	46%	$58,241	604,160
Lighting	26%	$33,861	351,261
Misc Equipment	28%	$35,420	367,429
		$127,522	1,322,850

Annual Energy Use/Cost

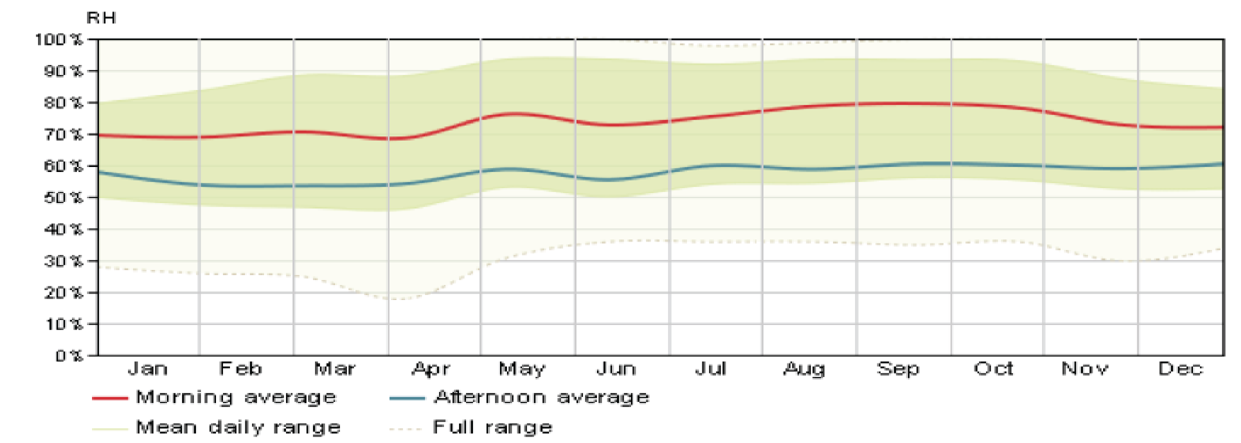


Electricity	41%	$127,934	1,327,118	kWh
Fuel	59%	$66,105	65,088	Therms
		$194,039		

Monthly Peak Demand

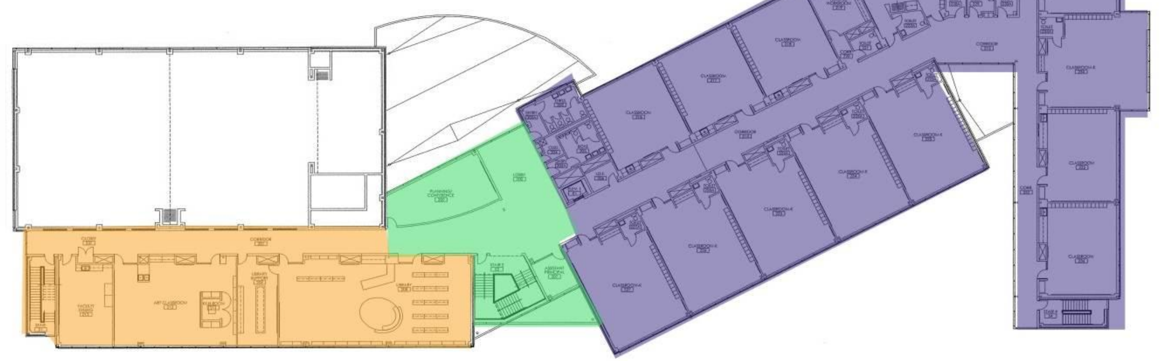


Humidity

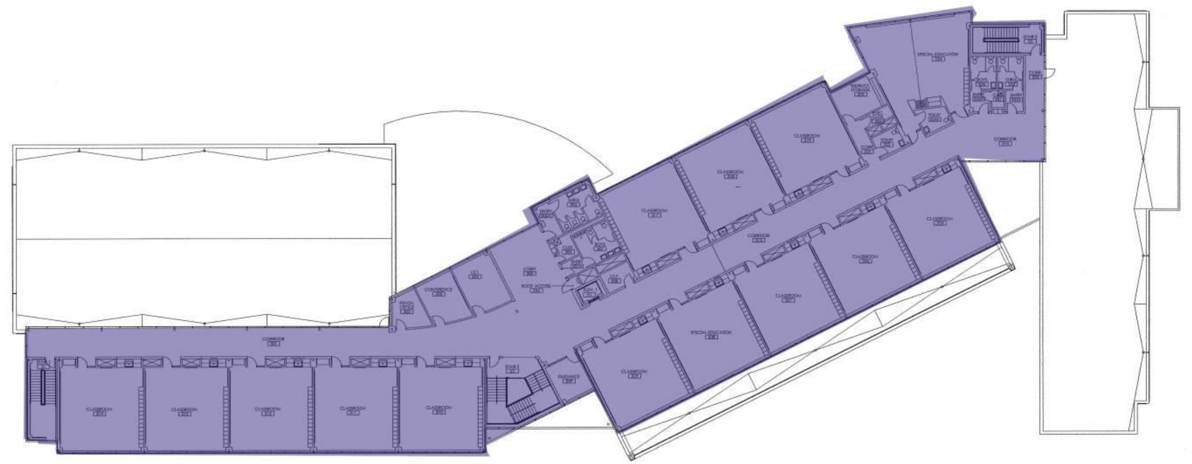


Mechanical Zone Diagrams

FIRST FLOOR PLAN



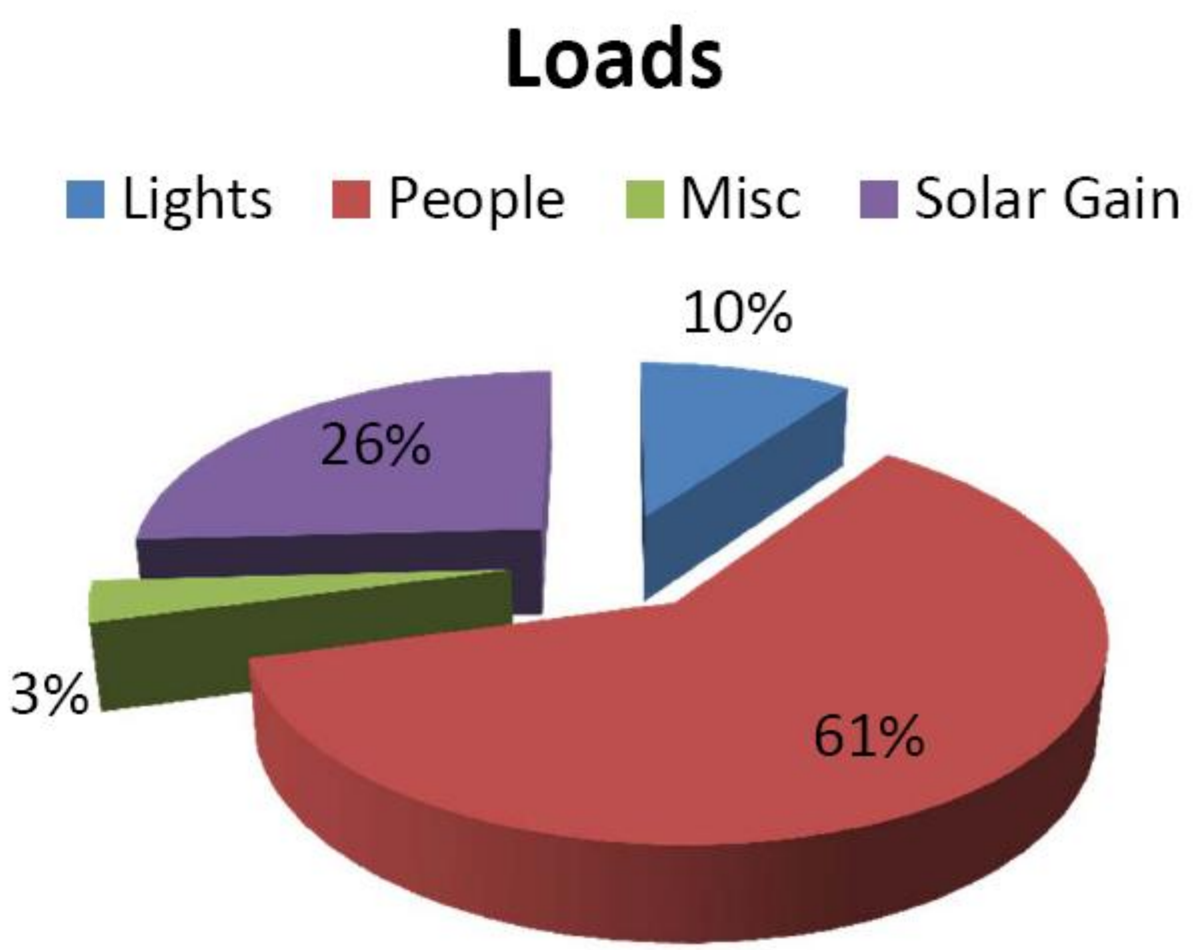
SECOND FLOOR PLAN



THIRD FLOOR PLAN

Preliminary Trane Trace Model

Zone	Total Capacity Tons	Total Capacity MBh	Peak CFM	Primary Occupancy Type
1	22.4	269.2	8,753	Classroom
2	41.8	501.4	12,458	Classroom
3	14.6	175.7	7,422	Lobby
4	29.1	348.8	8,403	Kitchen
5	16.1	193.0	4,102	Gymnasium
6	13.6	162.9	2,634	Natatorium
7	60.9	730.8	18,269	Classroom
8	9.1	108.8	3,810	Lobby
9	28.3	340.1	9,412	Classroom
10	80.3	964.5	26,067	Classroom
Total	**306.3**	**3675.1**	**110,969**	



ENGINEERING CKS

	Cooling	Heating
% OA	52.7	0.0
cfm/ft²	1.27	0.38
cfm/ton	362.34	
ft²/ton	286.04	
Btu/hr·ft²	41.95	-4.89
No. People	3,896	

HEATING COIL SELECTION

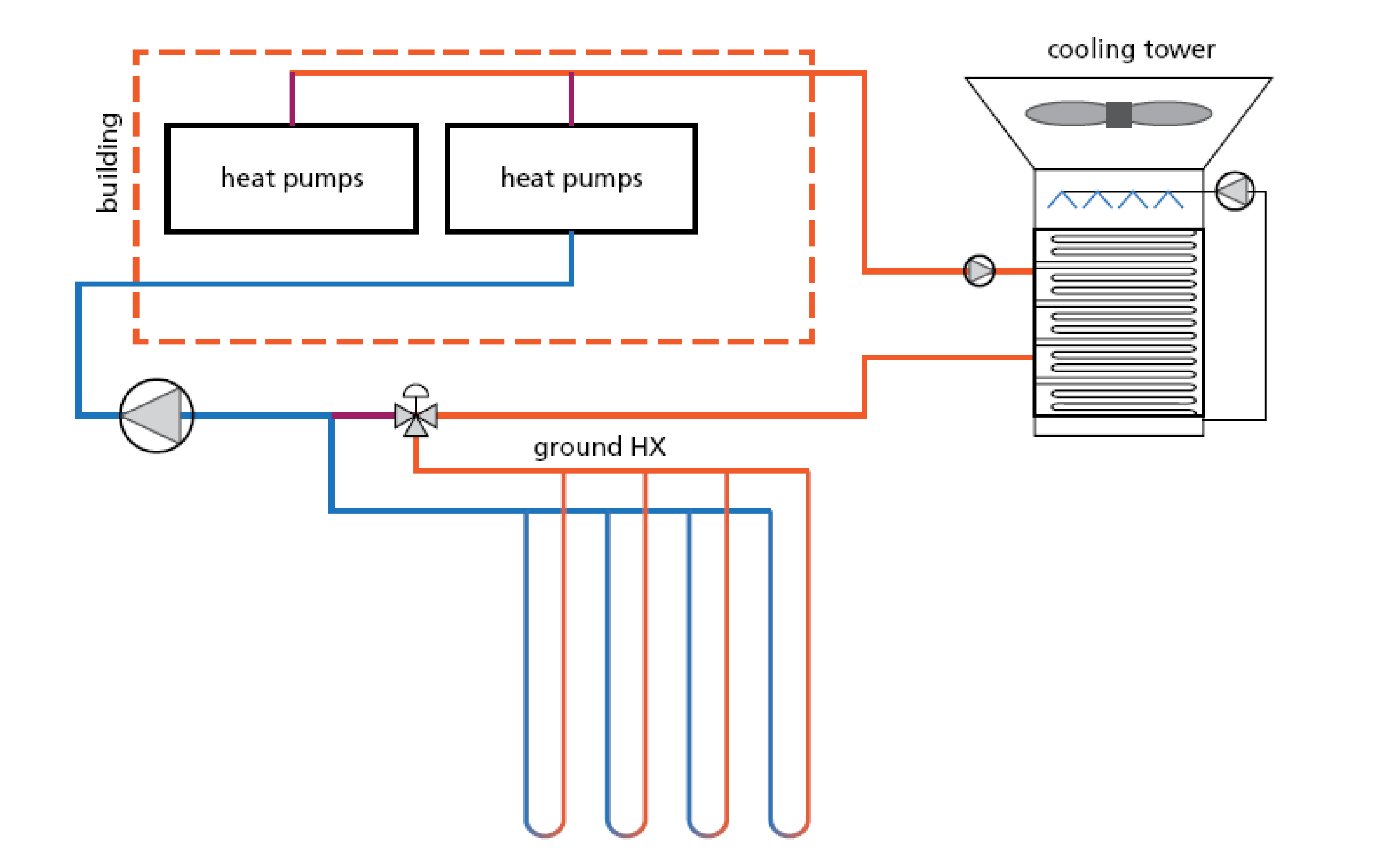
	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-428.2	33,291	68.2	79.9
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-428.2			

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR °F	Enter °F	Enter gr/lb	Leave DB/WB/HR °F	Leave °F	Leave gr/lb
Main Clg	306.3	3,675.1	2,766.5	101,331	79.9	63.8	64.2	55.0	51.4	51.4
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	306.3	3,675.1								

Hybrid Geothermal

Figure 1—A TYPICAL HYBRID SYSTEM



FIRST COSTS

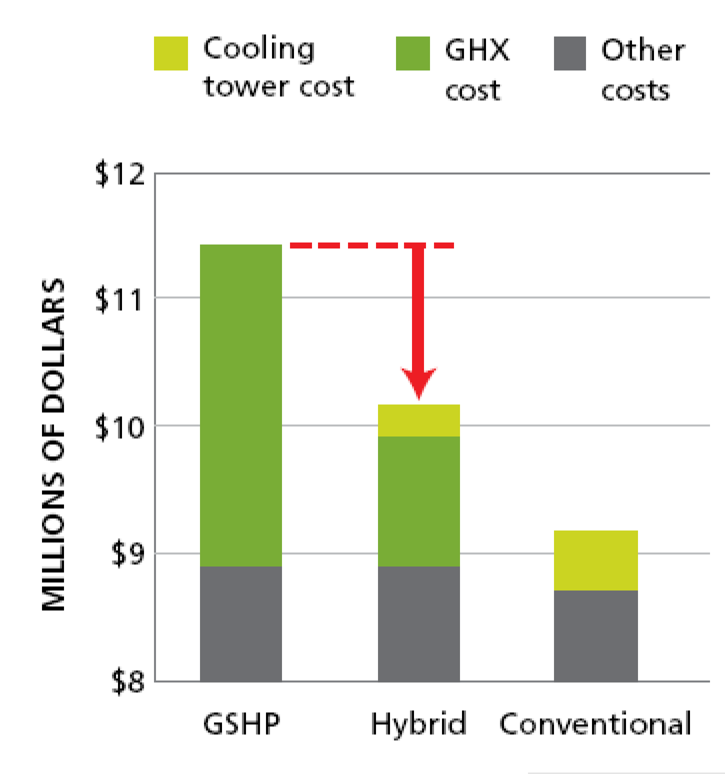
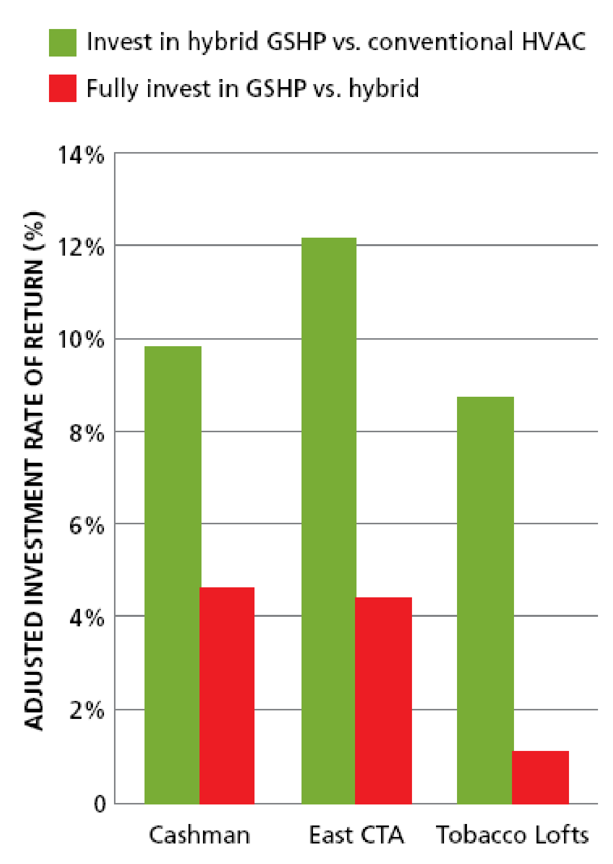
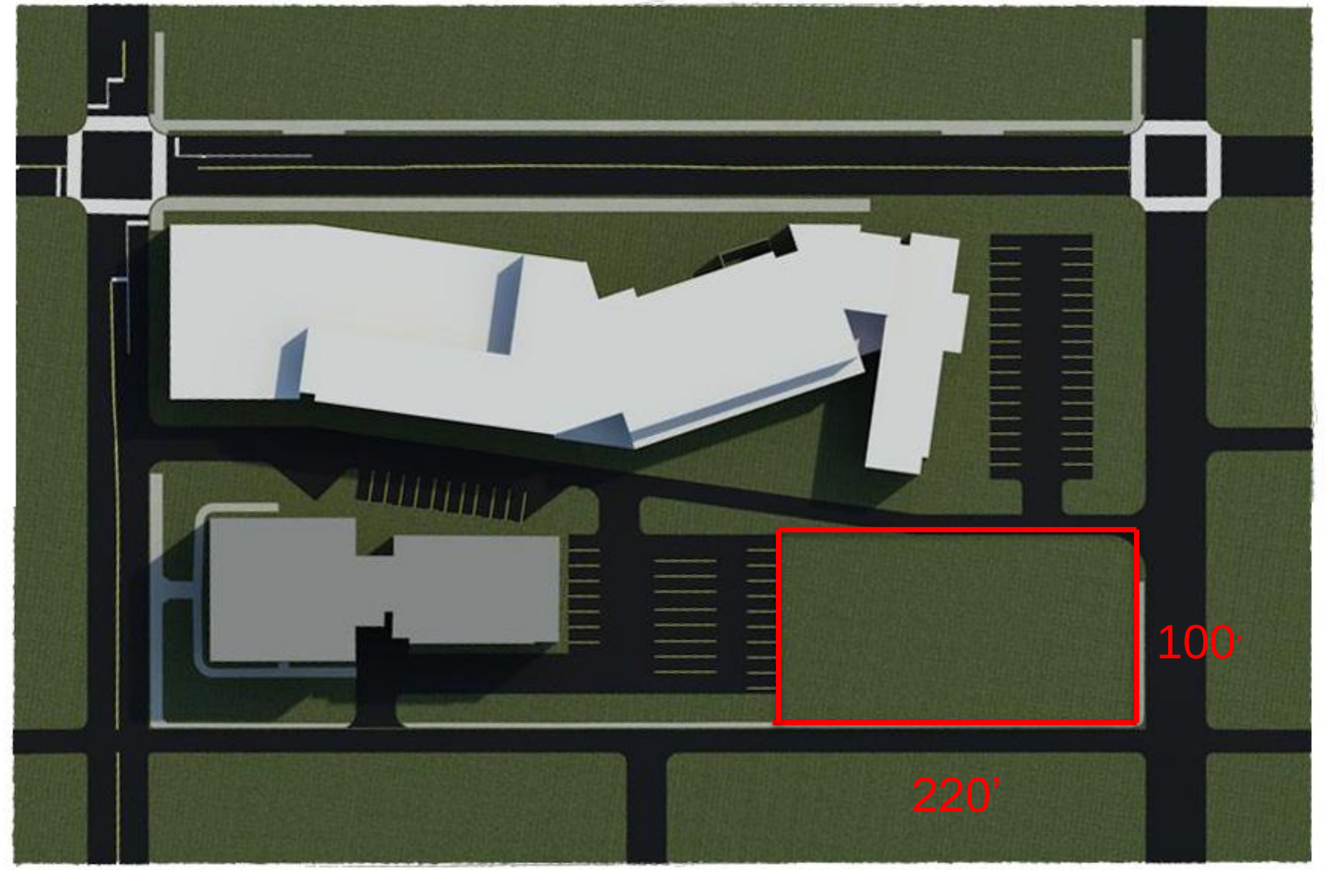


Figure 2—THE ECONOMICS OF HYBRID SYSTEMS





Swimming Pool

Goals
BIM Ex.
Architecture
Structural
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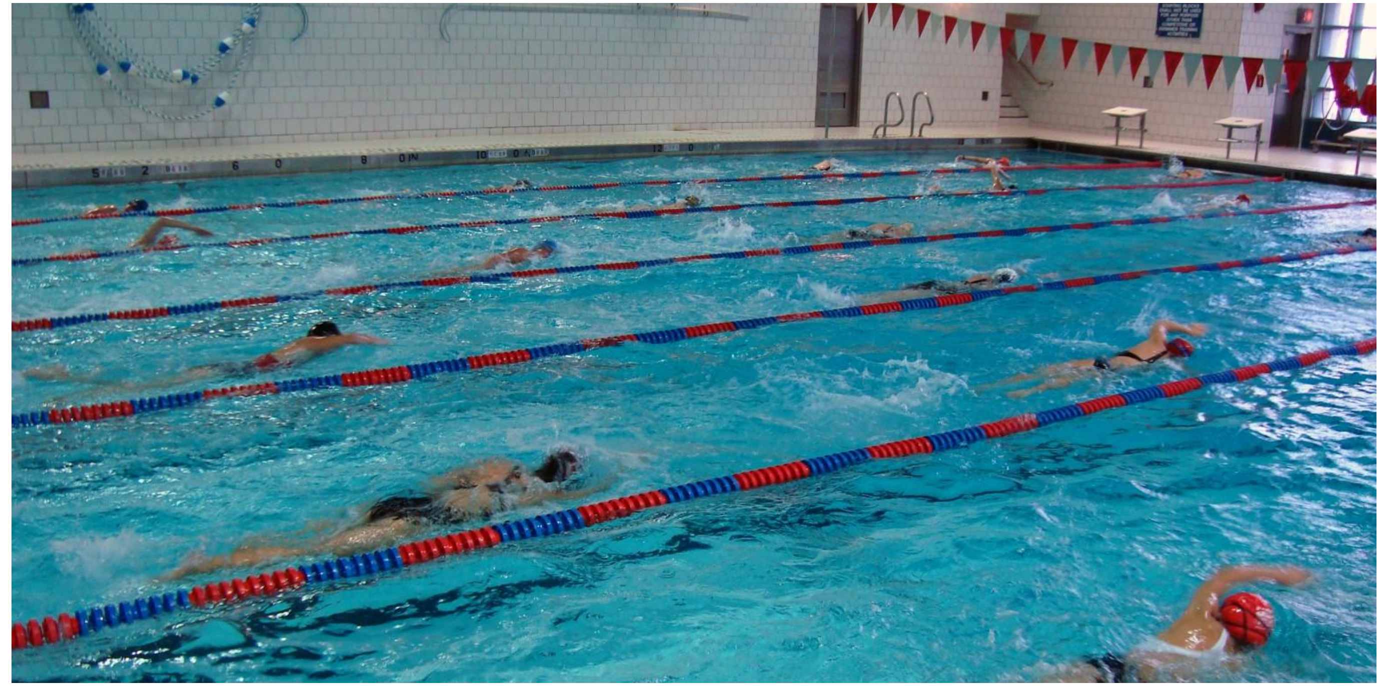
Design Criteria:

- The water temperature is set between 80° F and 84° F.
- The air temperature is set at two degrees above the pool water temperature.
- The relative humidity is maintained between 50% and 60%.



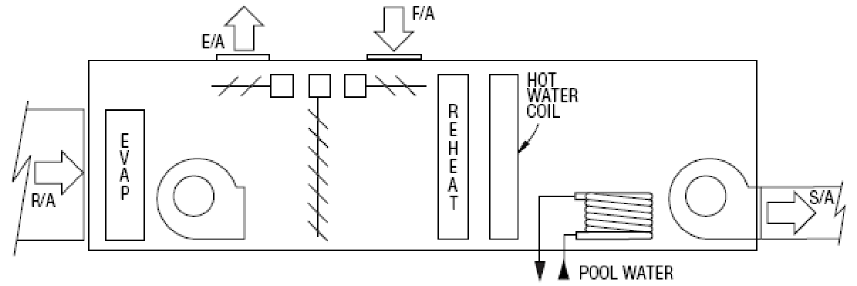


Figure 7 - Economizer Schematic

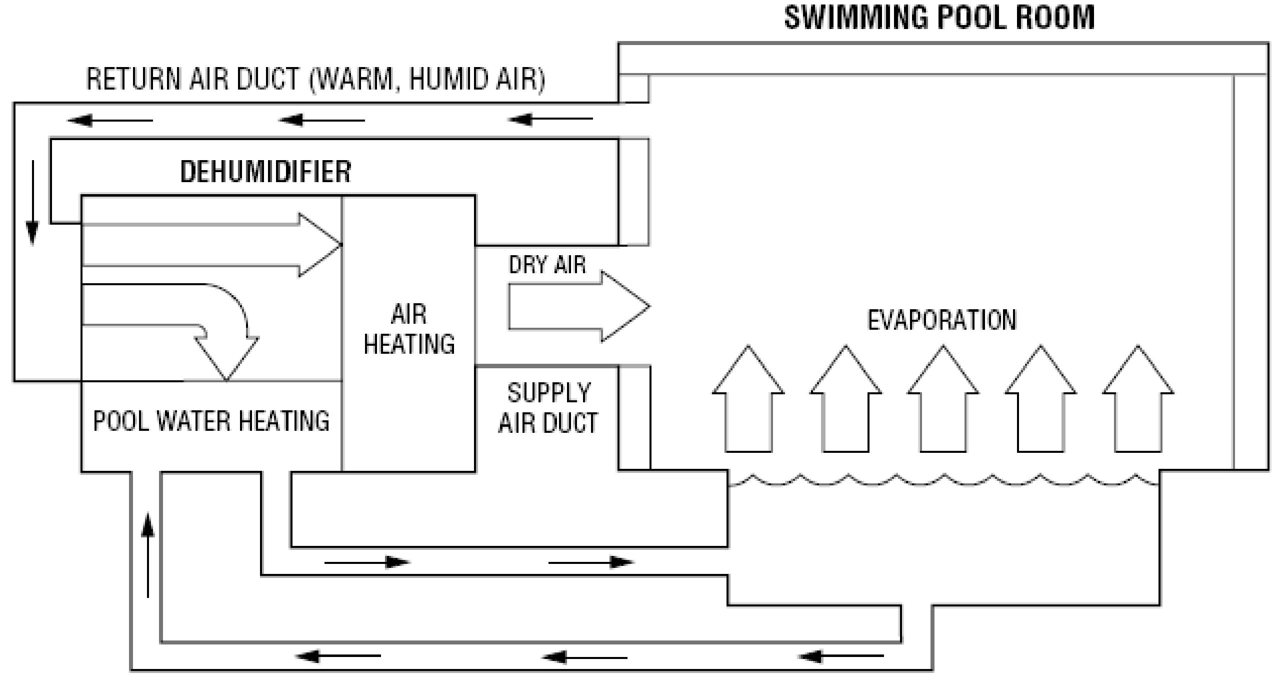
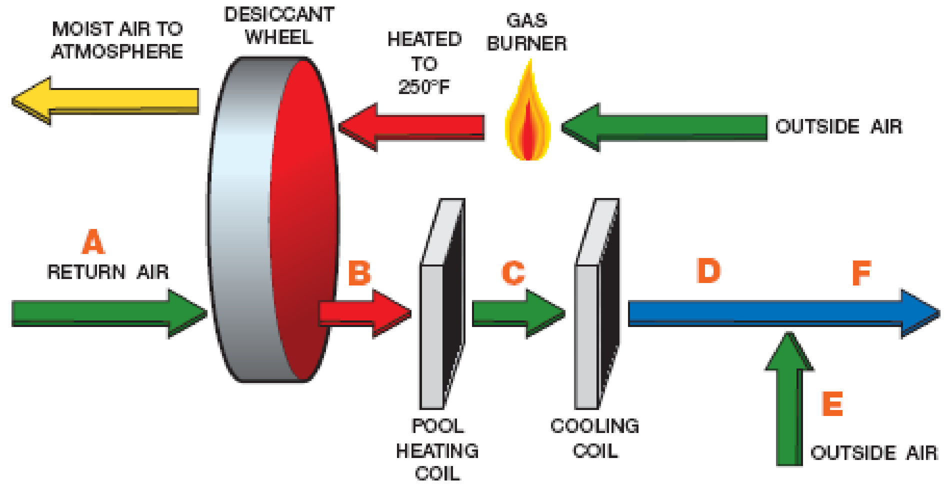


Figure 5 - Standard Dehumidifier Schematic

Desiccant Wheel



Trichloramine Capture and Exhaust

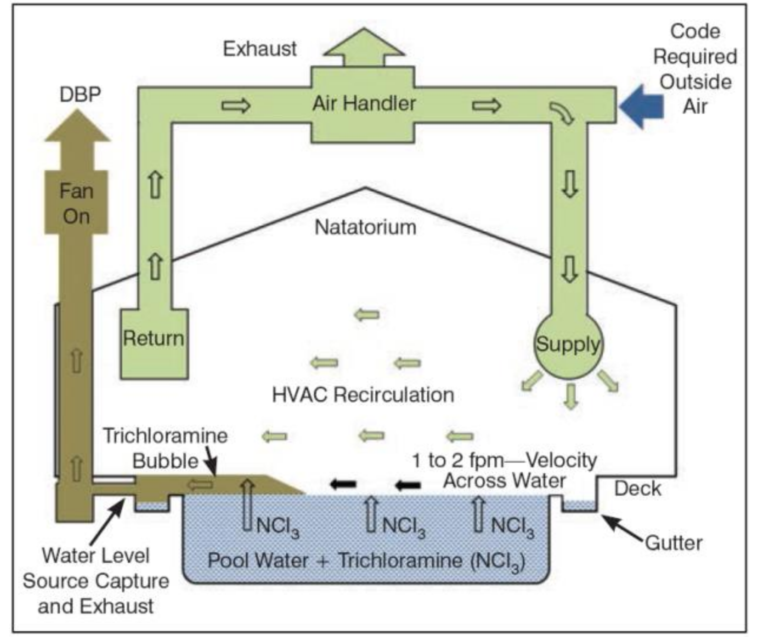


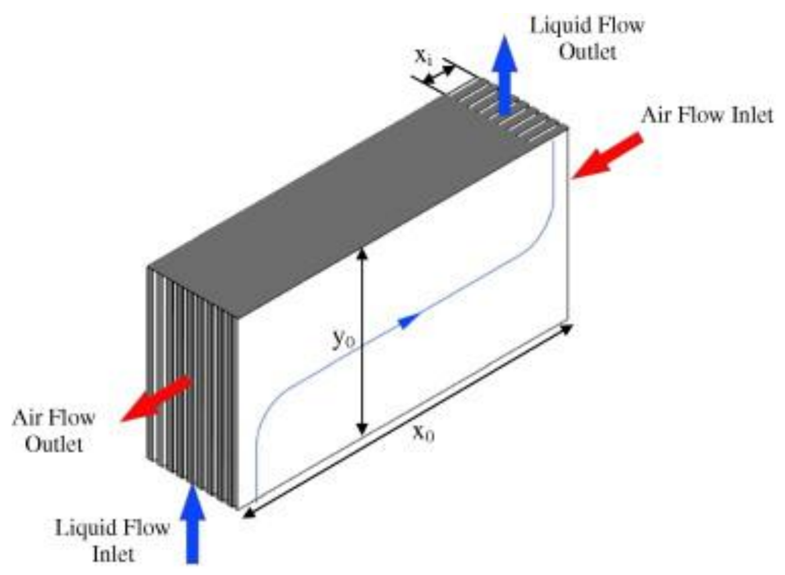
Figure 1: Source capture and exhaust strategy.

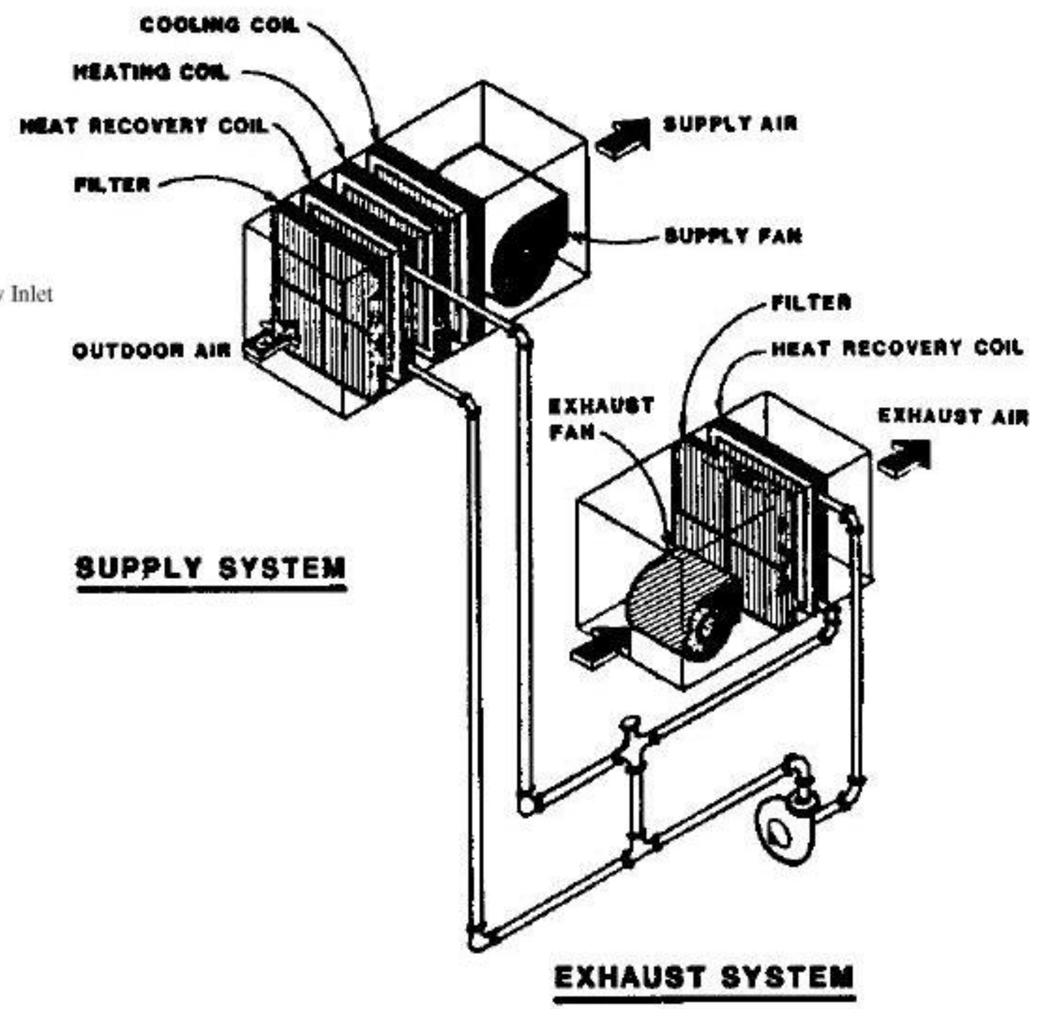
Heat Recovery Analyses

Flat Plates

Pros
- 50-80% Recovery
- Very compact system
- Latent recovery

Cons
- Exhaust/OA inlet locations not as flexible

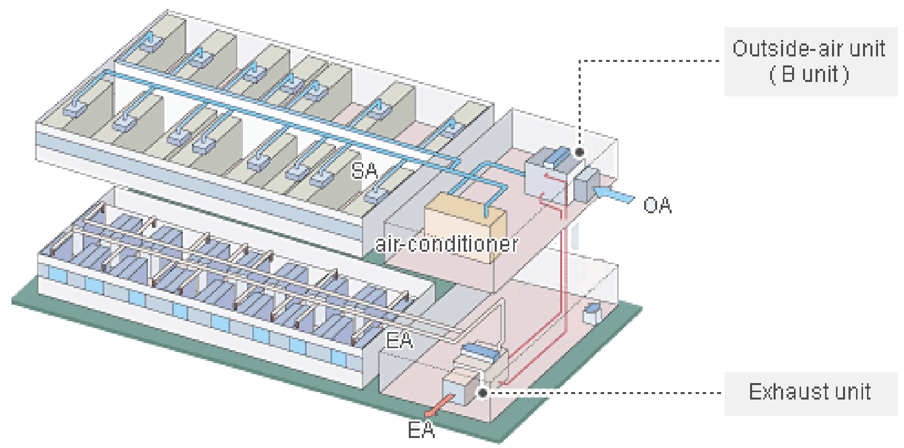




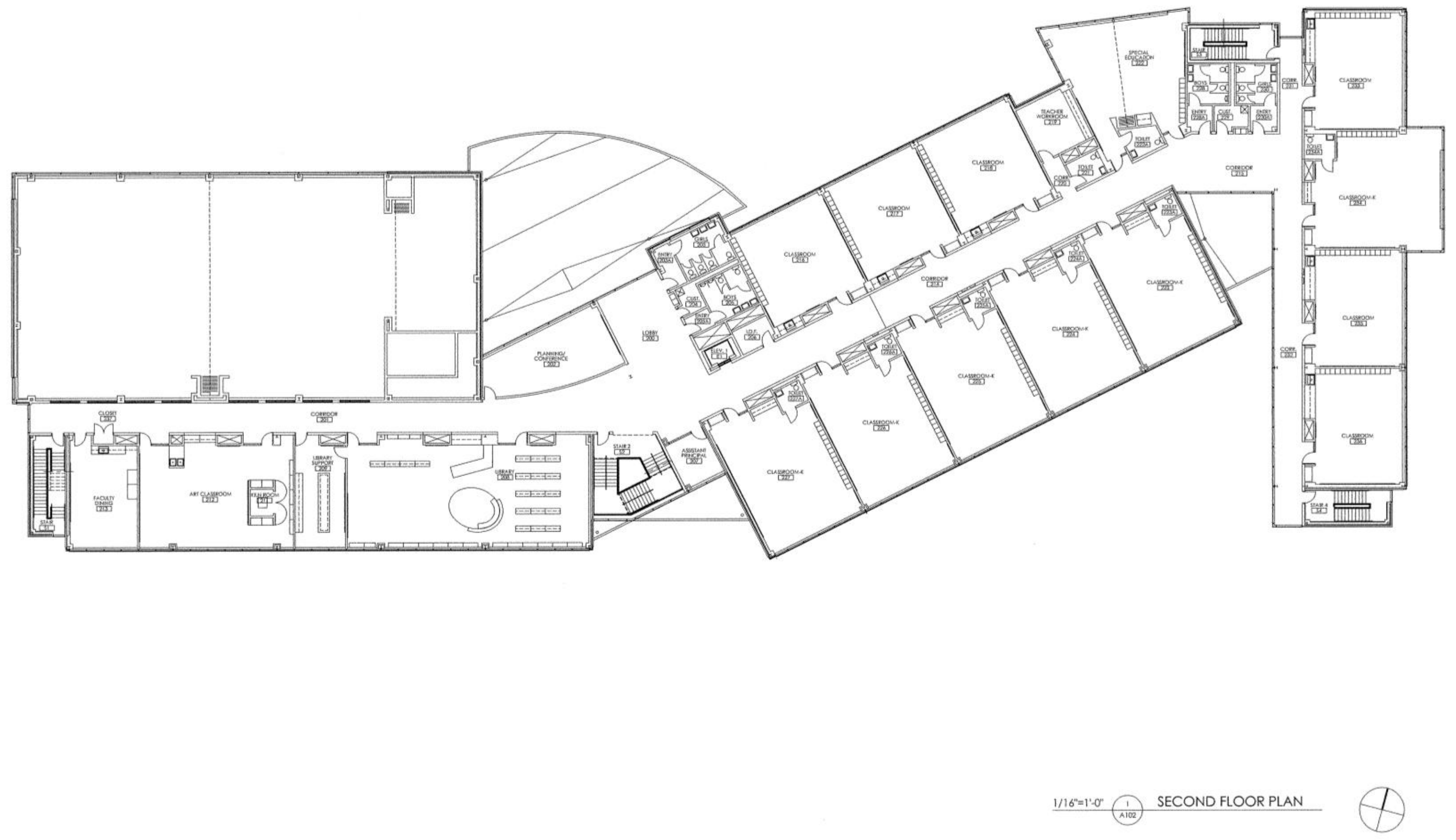
Ethylene Glycol Run Round

Pros
- 55-70% Recovery
- Exhaust/OA inlet locations can vary
- Thermal storage potential

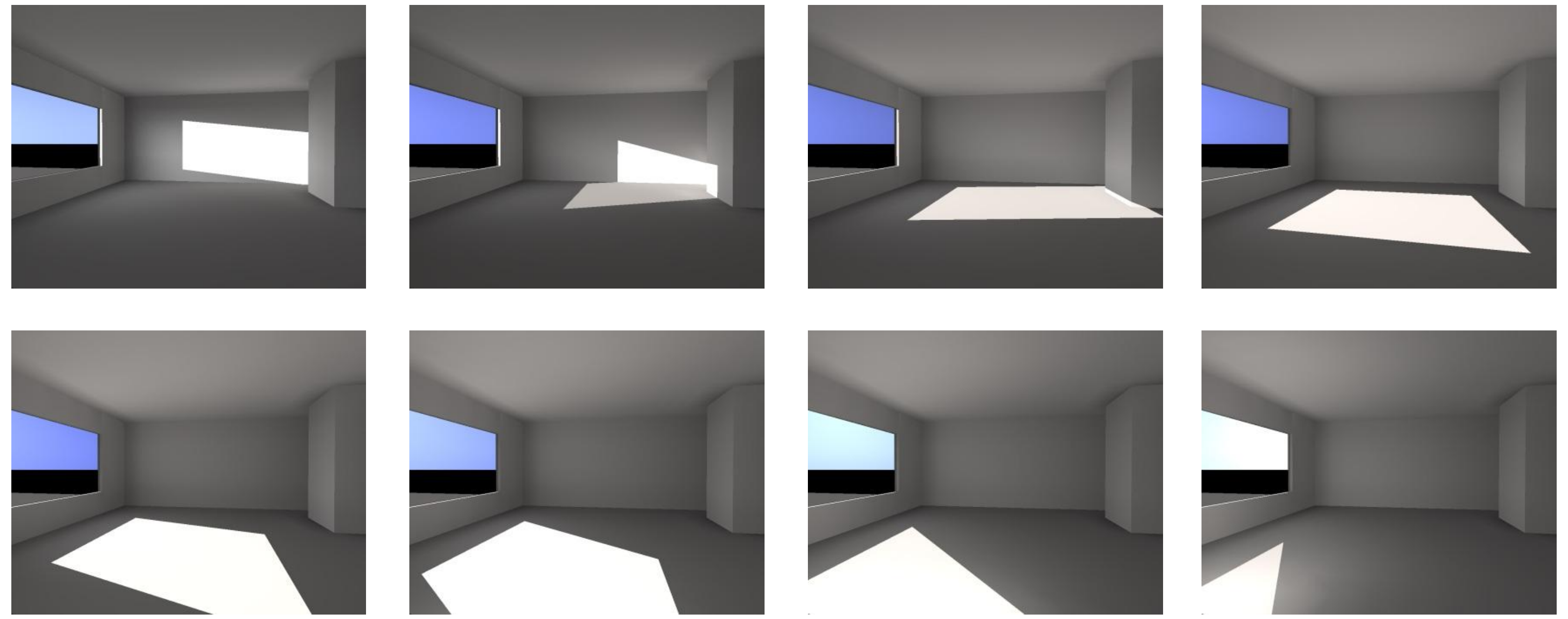
Cons
- Piping cost
- Pump energy use
- No latent recovery



Daylighting



Daylighting Study – South Façade Base Case



Design Considerations

- Clerestories/ Light wells
- Overhangs
- Light shelves
- Shades

Lighting / Electrical Systems

http://www.solaripedia.com/images/large/2597.jpg

http://www.edcsystems.com.au/uploads/images/Ipswich_SSP_Pool_View_2.JPG

Design Considerations

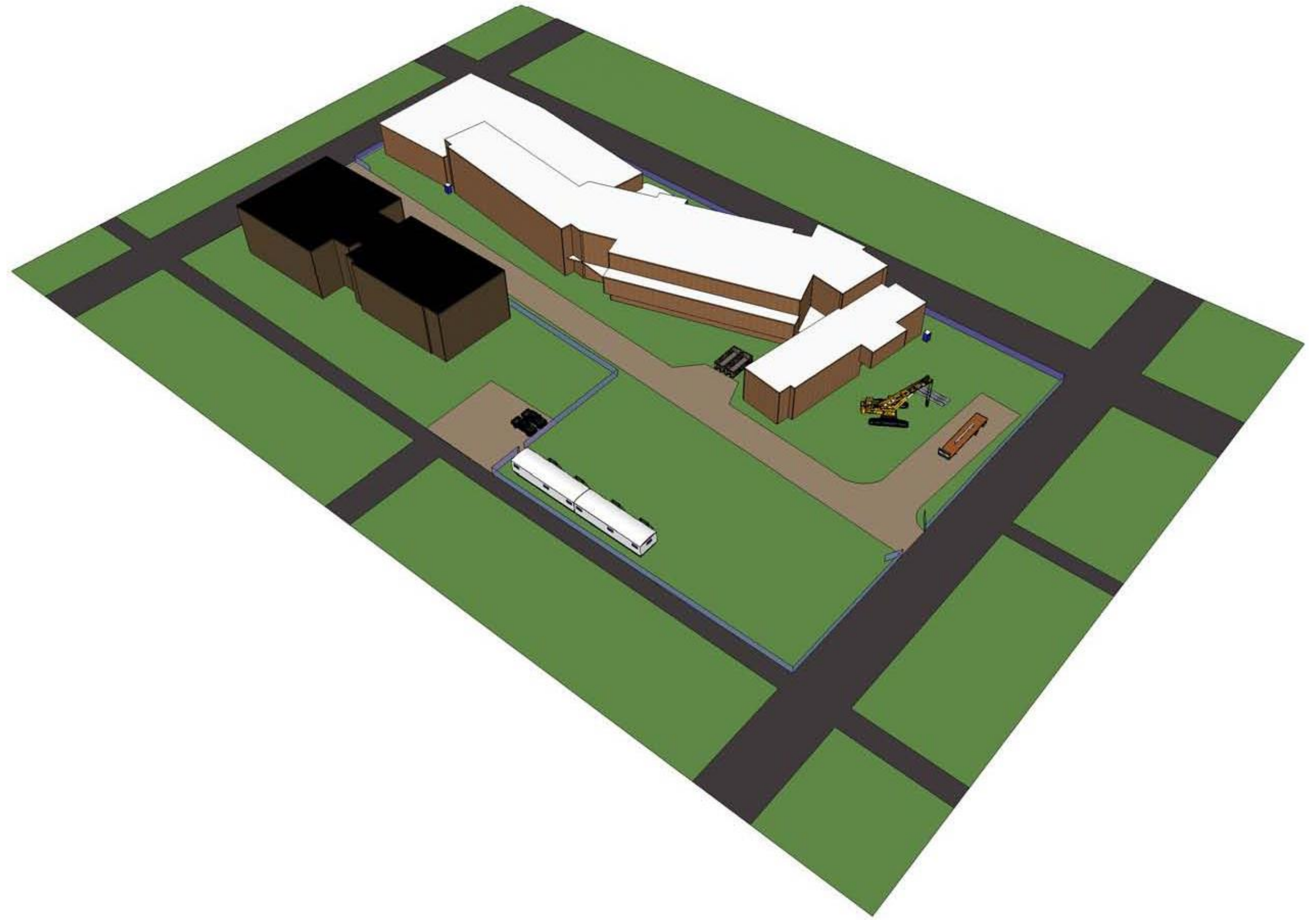
- Occupancy/vacancy sensor
- Daylight sensor
- Direct/indirect for classroom
- Indirect for pool

Site Plan

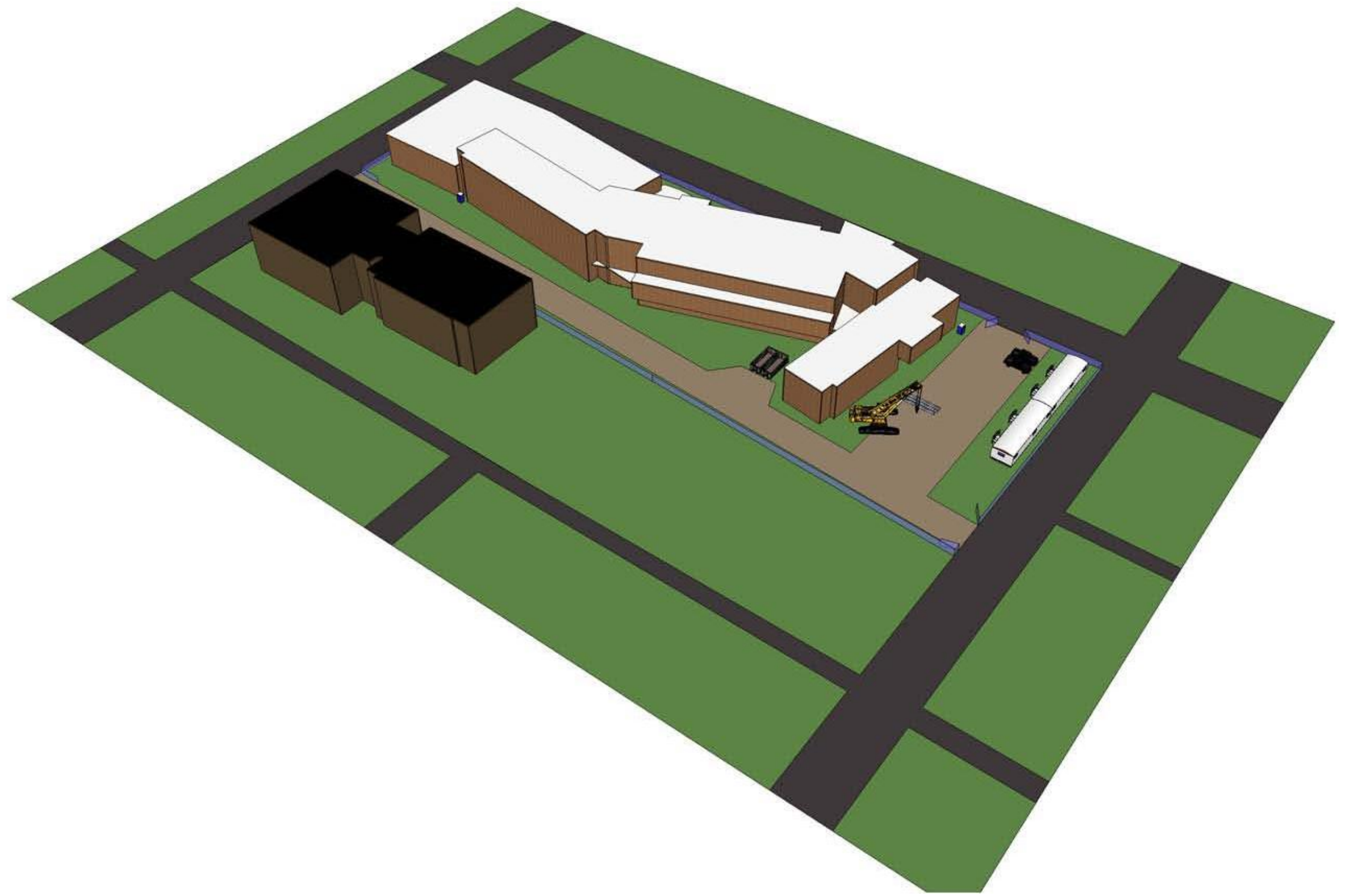
Site Considerations

- Contaminated Soil
- Available Utilities
- Community Garden
- Parking
- Bus Lane
- Entrances/Exits
- Field
- Occupant Safety
- Site and Building Security

Option 1



Option 2



Estimate and Delivery Method

Square Foot Cost Estimate

LOW:
Entire Elementary School - $180/SF
Total Cost - $17,460,000

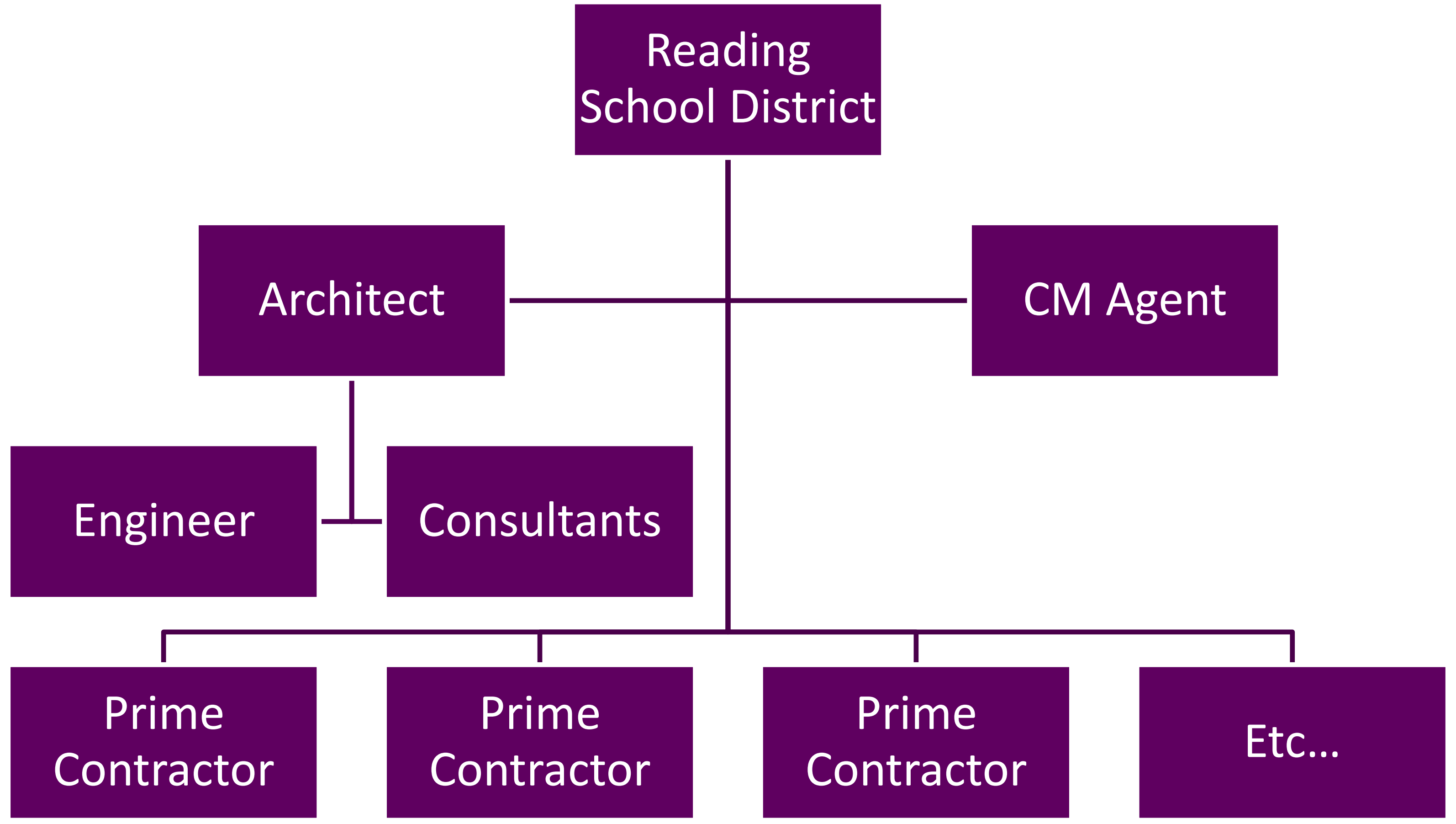
HIGH:
Entire Elementary School - $220/SF
Total Cost - $21,340,000

Gymnasium - $180/SF * 7900 SF ≈ $1,422,000
Swimming Pool - $260/SF * 6700 SF ≈ $1,742,000

Building Square Footage – 97,000 SF

Interior Materials		Lifecycle Cost	Functionality	Upfront Cost	Total
Floor Finishes	Polished Concrete Corridor Floors	5	5	4	**14**
	VCT Corridor Floors	3	4	3	**10**
	Linoleum in Classrooms	3	4	3	**10**
	Carpet Tile in Classrooms	3	3	3	**9**
Ceiling Finishes	Exposed Ceiling	5	5	5	**15**
	Drop Ceiling	2	3	3	**8**
Roof Finishes	White TPO Roof	5	5	3	**13**
	Green Roof	3	3	2	**8**
Exterior Cladding	Brick Exterior	4	4	2	**10**
	Metal Panel Exterior	2	3	2	**7**
Casework	Movable Casework	2	5	2	**9**
	Built-in Casework	3	1	3	**7**
Metal Decking	Regular Composite Metal Decking	2	5	4	**11**
	Acoustical Metal Decking	4	3	2	**9**

Delivery Method



Construction Schedule

	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Notice to Proceed														
	Excavation														
		Foundation													
			Exterior Walls	Exterior Walls											
					Interior Walls	Interior Walls									
					Roof	Roof									
							Rough-ins	Rough-ins	Rough-ins	Rough-ins	Rough-ins	Rough-ins			
									Finishes	Finishes	Finishes	Finishes	Finishes	Finishes	
															FFE
															Certificate of Occupancy

nexus