Landis Run Intermediate School
Lancaster, PA

MATT STEVENSON

ADVISER: ROBERT LEICHT

CONSTRUCTION MANAGEMENT

Depth Topics:

Analysis #1: Feasibility and Impact of Geothermal Heat Pumps

Analysis #2: Feasibility and Impact of Modular Classrooms

Analysis #3: Analysis of Electrical Underground Rough-In Method

Analysis #4: Project Delivery Method Analysis

Breadth Topics:

Breadth Topic #1: Mechanical System Reduction (Tied into Analysis #1)

Breadth Topic #2: Acoustical Study of Modular Wall (Tied to Analysis #2)

I. Presentation Overview
II. **Project Background**
III. Analysis #1: Geothermal Heat Pumps
IV. Analysis #2: Modular Classroom Wings
V. Breadth #1: Noise Reduction of Modular Walls
VI. Analysis #3: Electrical Rough-In Method
VII. Analysis #4: Project Delivery Method
VIII. Summary and Conclusion
IX. Acknowledgements

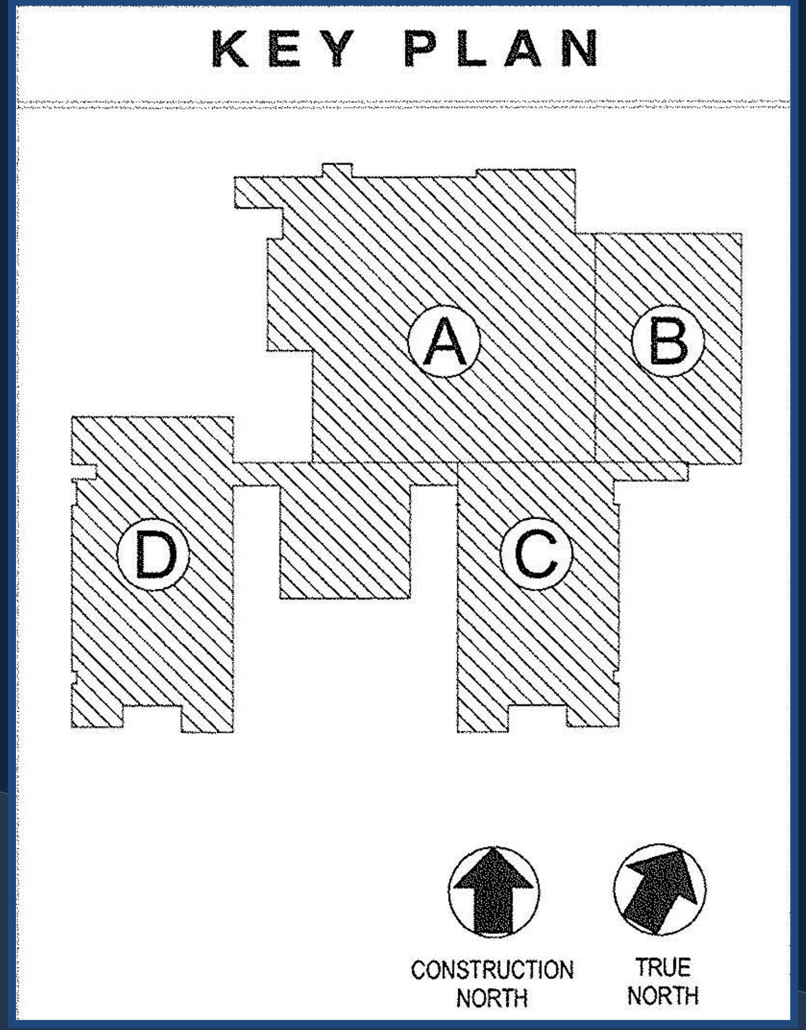
Project Background

General Project Information:

- 210, 000 SF Middle School (5th & 6th Grades)
- Total Building Cost $26.4 Million
- One Story in Areas A & B
- Three Stories in Areas C & D
- Striving for LEED Silver

Building Layout:

- Area A: Administrative Suite, Gymnasium, Cafeteria
- Area B: Mechanical Room, Music Classrooms
- Area C: Classrooms
- Area D: Classrooms and Library



Building Systems:

Facade

- Brick and Decorative CMU Veneer
- Glazing

Structural System

- Load Bearing Masonry
- Open Web K Joists
- CIP Concrete on Composite Deck

Mechanical System

- VAV System w/ Nine AHUs

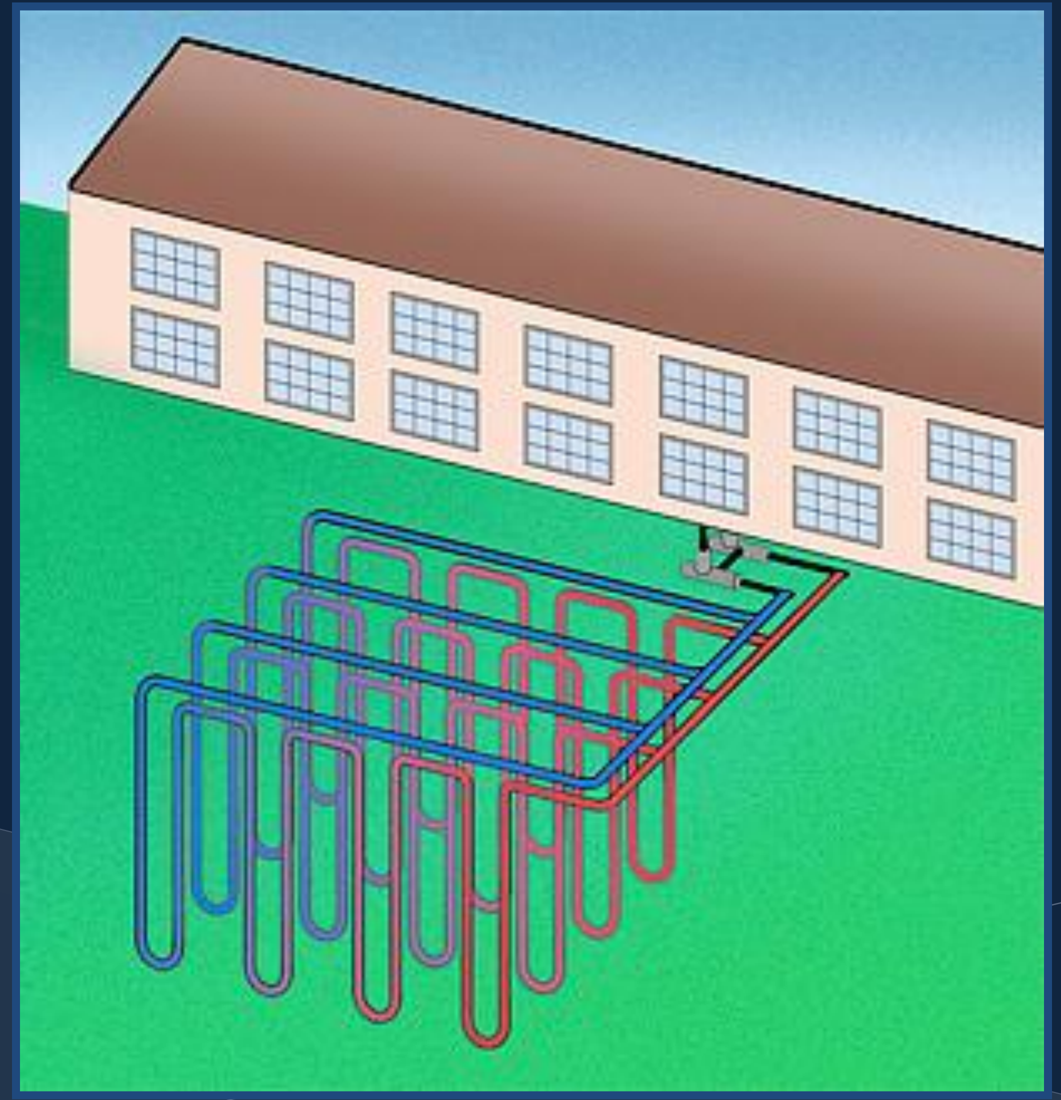
Geothermal Heat Pumps

Potential Problem/Opportunity

- LEED Silver Commendable
- Possibility of Achieving Higher
- Great Deal of Space on Site
- Long Life Span Can Sustain Longer Payback Periods for Renewable Energy

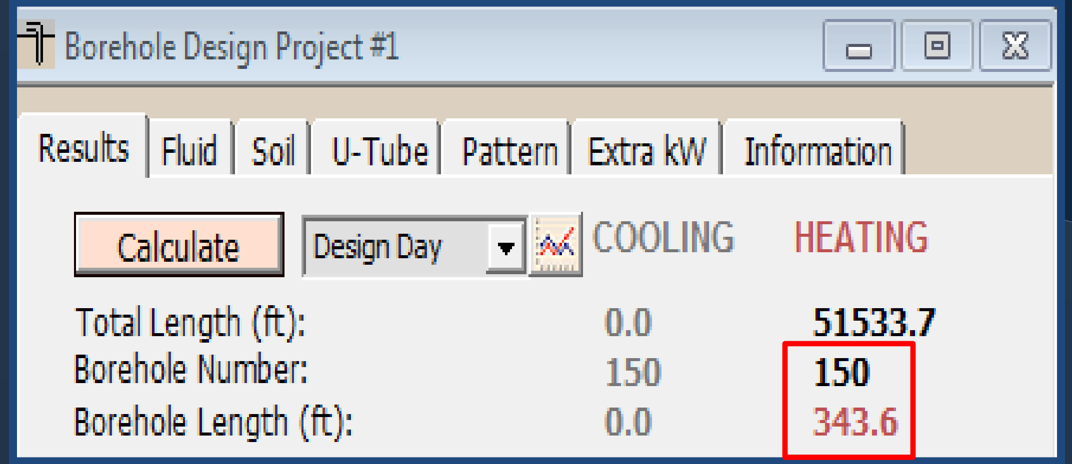
Goal Is To Determine:

- Cost Impacts
- Construction Impact
- LEED Impact



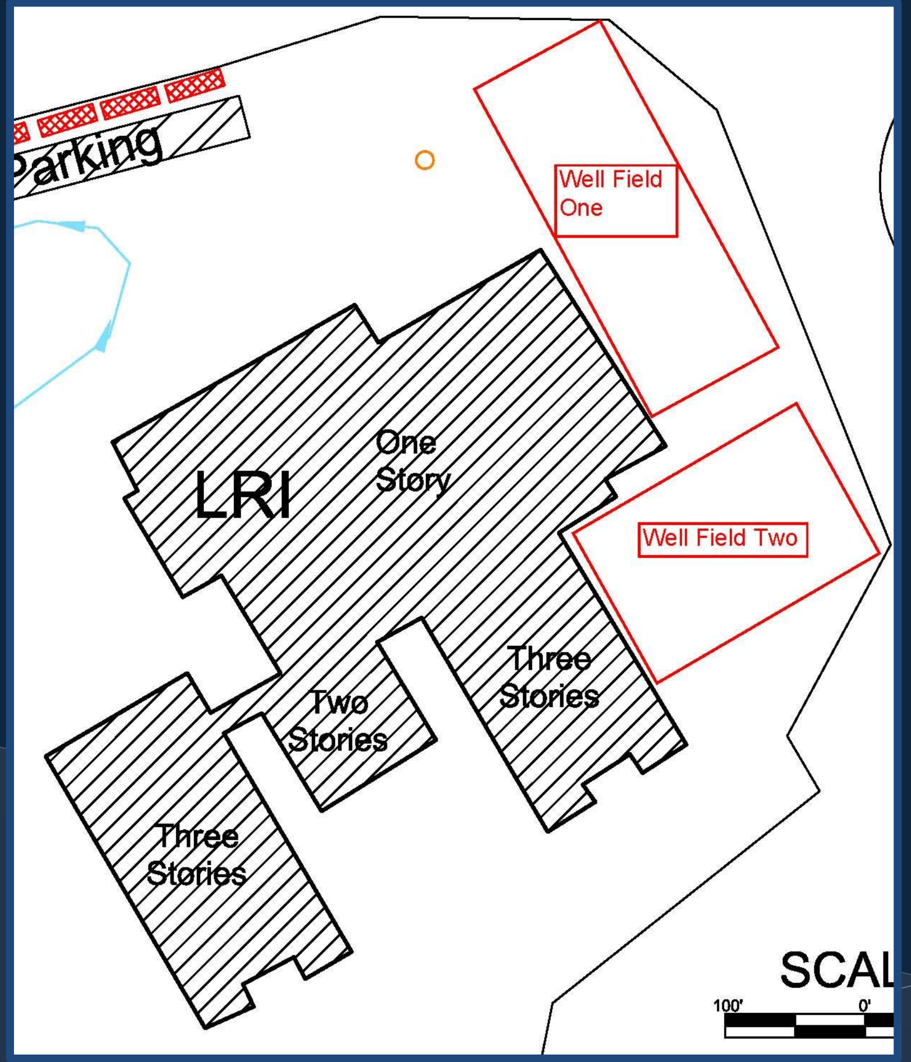
Quantity & Placement

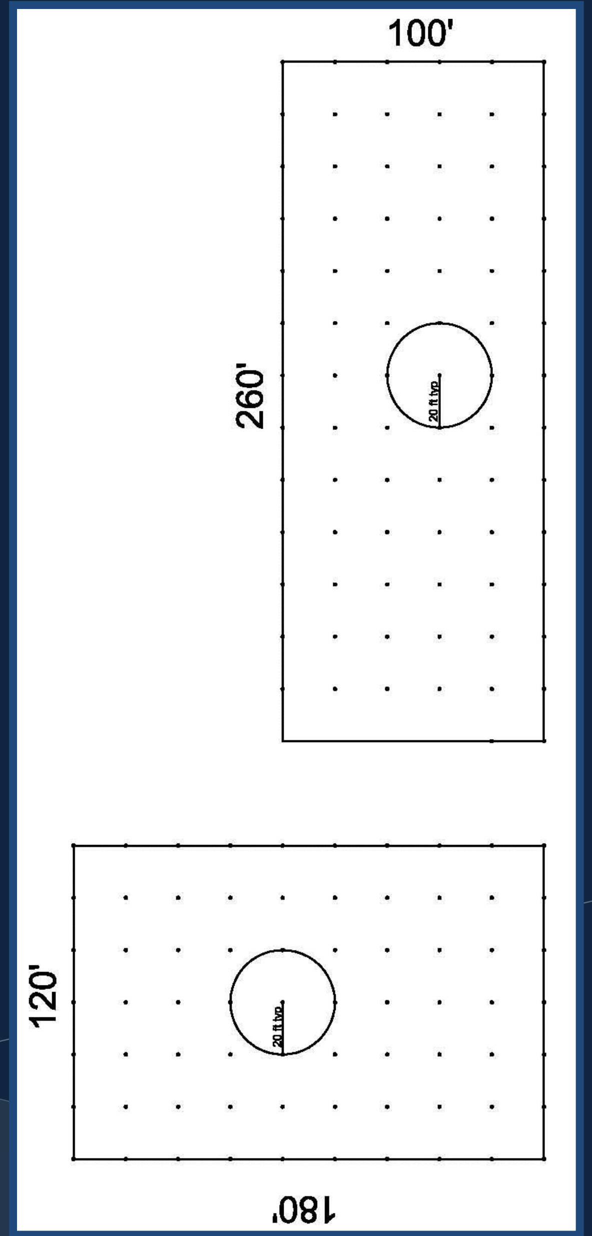
- GLD Software:150 Wells at 343'
- Two Well Fields to East of Building
- Minor Construction Traffic Interrupted



Schedule

- Assuming 2 Wells Per Day
- Drilling Would Start 5/25/11
- Drilling Would End 9/7/11
- Earliest AHU Tie-In 10/7/11





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  a) Background Information
  b) Feasibility and Construction Impact
  c) **Cost Impact**
  d) LEED Impact
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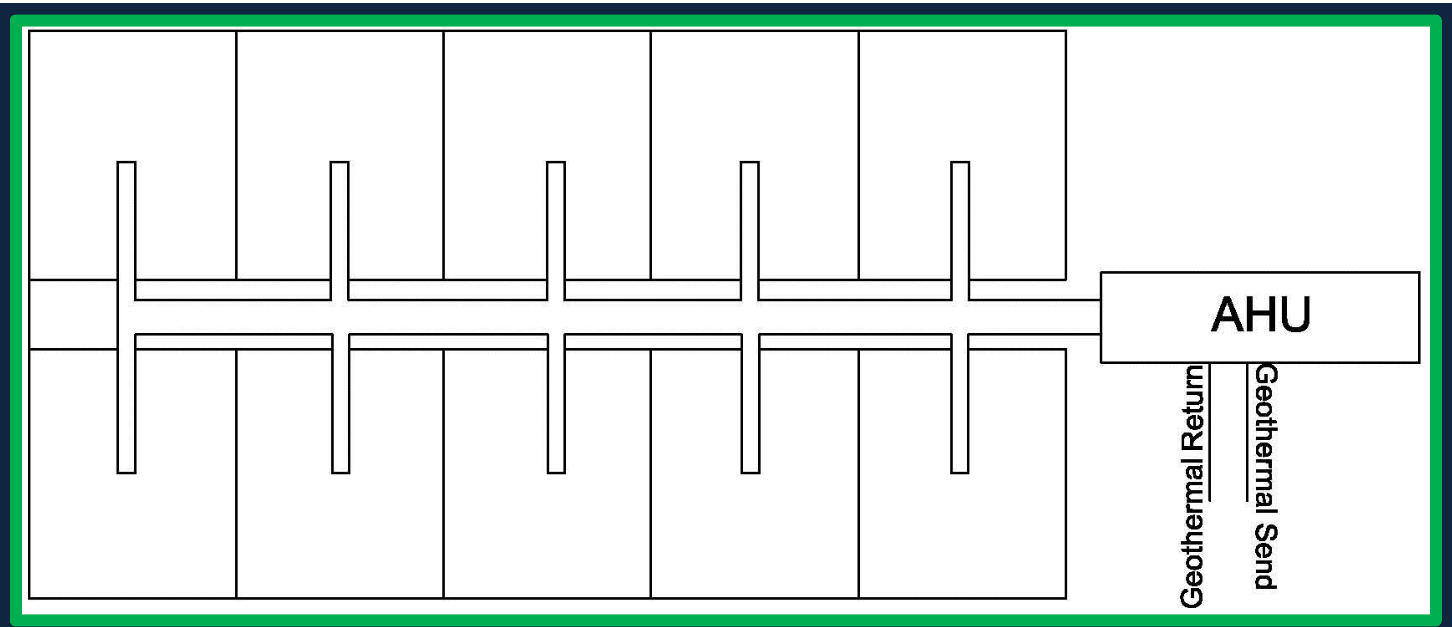
Initial Cost

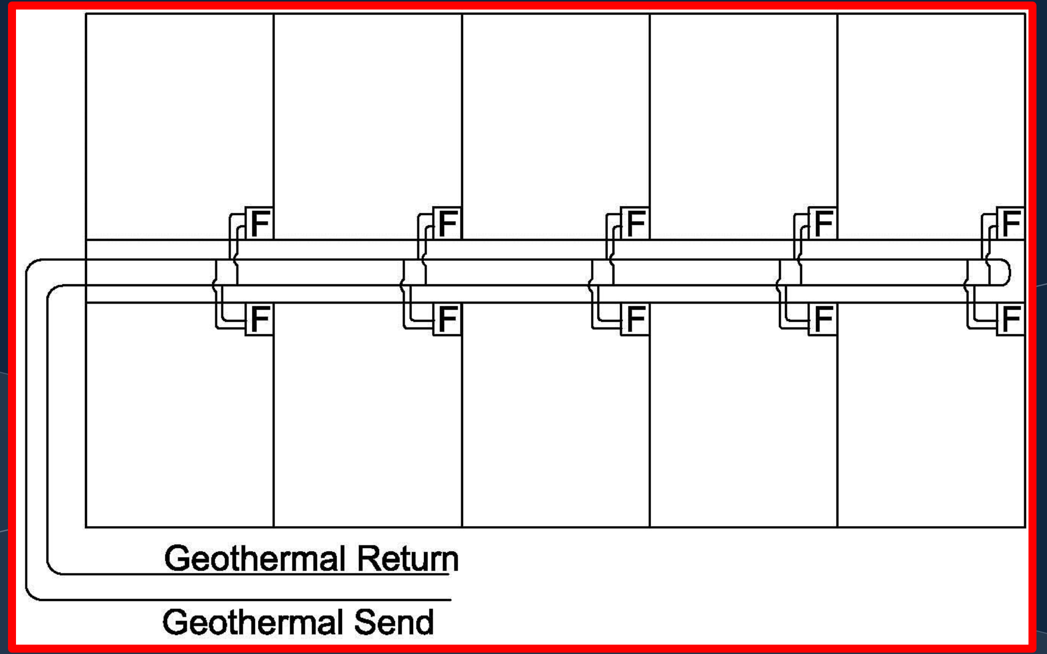
- Deduct $104,438
- Add $1,008,000 For Wells
- Mechanical Contract Will Increase By 18.4% to $5,803,562

Equipment	Quantity	Cost
Electric Boiler, 2616 MBH, 218 Ton	2	$61,292
Cooling Tower, 459 Ton	1	$43,146
	Total Cost	104,438

Long Term Cost

- Requires System Design, Building Loads, etc.
- Less Maintenance Required
- Longer Life Expectancy
- Efficiency Typically In the 300-450% As Compared With 80-90% of Typical Boilers





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Existing LEED Rating

- 44 Credits For 52 Points
- 2 Regional Priority Credits Missing For 2 Points
  - Public Transportation Access
  - Storm Water Design – Quality Control

Probable Additional Credits

- Optimize Energy Performance
  - Unknown Possible Point Value
- On-Site Renewable Energy
  - Probable 7 Points

Revised LEED Rating

- Obtain LEED Gold with 61 Points

% Renewable Energy	Points
1%	1
3%	2
5%	3
7%	4
9%	5
11%	6
13%	7

LEED Category	Number of Credits	Number of Points
Sustainable Sites	10	10
Water Efficiency	5	5
Energy & Atmosphere	4	11
Materials & Resources	8	8
Indoor Environmental Quality	14	15
Innovation & Design Process	3	3
Total	44	52

Potential Opportunity

- C & D Are Repetitive Both Horizontally & Vertically
- 70% of Building Square Footage
- Could Dramatically Impact Project Efficiency

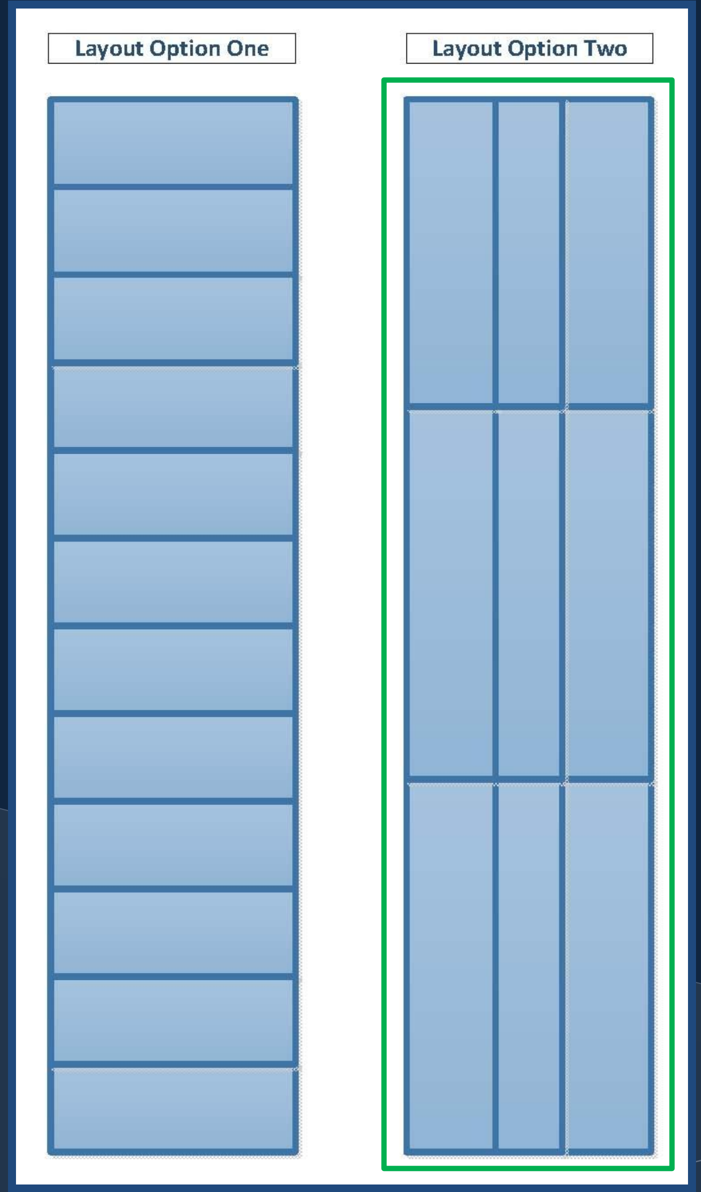
Goal Is To Determine

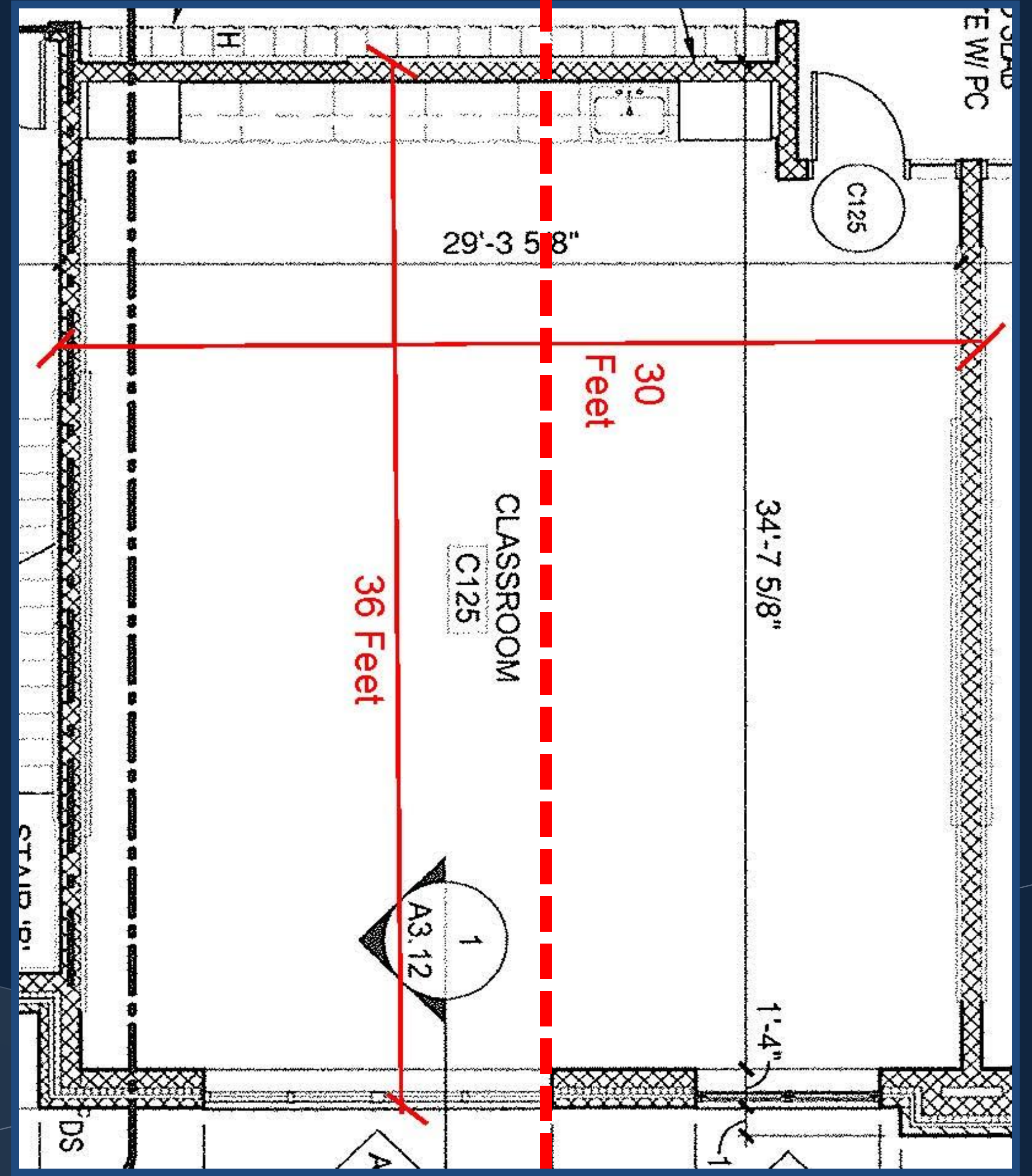
- Cost Impact
- Schedule Impact

Modular Classrooms

Module Assumptions

- All Systems (MEP),Finishes, & Casework Preinstalled
- Each Classroom Comprised of Two Modules
- Interior Module Layout Two
- Cost Savings of 20%
- Four Modules Can Be Set per Day





Schedule Impact

- 186 Modules / 4 (mod/day) = 46.5 Working Days
- Area C Accelerated 347
- Area D Accelerated 363 Days

Cost Impact

- Overall Project Savings of $3.72 Million
- Results in Cost Savings of 14.1%

Area	FRP Slab Completion Date	Stick-Built Completion Date	Modular Substantial Completion Date	Completion Date Acceleration
C	7/1/11	8/21/12	8/3/11	347 Days
D	7/28/11	8/28/12	8/30/11	363 Days

	Stick-Built Construction Method	Modular Construction Method
Cost per SF	$125.71	$100.56
Total Cost	$18,622,679.	$14,902,166

Noise Reduction of Modular Wall

Goal

- Determine Difference in Noise Reduction of Existing & Modular Wall
- Ensure Modules Still Meet Acoustical Prerequisite

Results

- Significantly Differ At 2k and 4k
- Modular Wall Still Performs Adequately
- Prerequisite Only Based on Area and NR Rating of Ceiling Materials
- Classrooms Still Meet Acoustical Prerequisite

		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Modular Assembly	10log(a/S)	6.17	5.00	4.58	5.72	6.64	6.60
	TL (dB)	28.00	37.00	46.00	52.00	38.00	43.00
	Noise Reduction (dB)	34.17	42.00	50.58	57.72	44.64	49.60
Existing Assembly	10log(a/S)	3.95	4.52	4.47	5.85	6.54	6.50
	TL (dB)	33.00	37.00	47.00	54.00	63.00	72.00
	Noise Reduction (dB)	36.95	41.52	51.47	59.85	69.54	78.50
	Difference	2.78	-0.48	0.89	2.13	24.90	28.89

Noise Reduction = TL + 10log(a/S), where S = Area of Common Wall and a = Room Absorption

Material	Area (Ft²)		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Carpet, heavy	890	α	0.02	0.06	0.14	0.37	0.6	0.65
		a (sabins)	17.8	53.4	124.6	329.3	534	578.5
Drywall, 1 layer 5/8" thick	1250	α	0.55	0.14	0.08	0.04	0.12	0.11
		a (sabins)	687.5	175	100	50	150	137.5
ACT, 3/4" thick	890	α	0.76	0.93	0.83	0.99	0.99	0.94
		a (sabins)	676.4	827.7	738.7	881.1	881.1	836.6
Window	72	α	0.35	0.25	0.18	0.12	0.07	0.04
		a (sabins)	25.2	18	12.96	8.64	5.04	2.88
		Total Absorption (sabins)	1406.9	1074.1	976.26	1269.04	1570.14	1555.48

α = sound absorption coefficient a = sound absorption per specified octave

Material	Area (Ft²)		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Carpet	890	α	0.02	0.06	0.14	0.37	0.6	0.65
		a (sabins)	17.8	53.4	124.6	329.3	534	578.5
Concrete Block, Painted	1250	α	0.1	0.05	0.06	0.07	0.09	0.08
		a (sabins)	125	62.5	75	87.5	112.5	100
ACT	890	α	0.76	0.93	0.83	0.99	0.99	0.94
		a (sabins)	676.4	827.7	738.7	881.1	881.1	836.6
Window	72	α	0.35	0.25	0.18	0.12	0.07	0.04
		a (sabins)	25.2	18	12.96	8.64	5.04	2.88
		Total Absorption (sabins)	844.4	961.6	951.26	1306.54	1532.64	1517.98

α = sound absorption coefficient a = sound absorption per specified octave

Electrical Rough-In Method

Potential Problem

- Underground Rough-In Used for All Ground Floors
- Activity Part of Critical Path, & Delays Dry-In
- Possibly More Expensive, Longer

Goal Is To Determine

- Cost Impact
- Schedule Impact

Electrical Rough-In Method

Schedule Impact

- Overhead Performed After Dry-In
- Underground Performed Prior To Slab Pouring
- OH Finishes on Average 23 Days Sooner

Duration Impact

- Electricians: 2.6 Hours Less per Classroom with OH
- Equals Saving 34.5 Working Days By Using Overhead RI

Area	UG Dry-In Date	OH Dry-In Date	Dry-In Date Acceleration
A	10/6/11	9/6/11	30 Days
B	9/22/11	8/22/11	31 Days
C	2/14/12	2/2/12	12 Days
D	2/29/12	2/10/12	19 Days

2.6 Hours = 156 Min / 975 Ft^2 = .16 Min/Ft^2 * 60 Secs / 1 Min = 9.6 Secs / Ft^2

9.6 Secs/Ft^2*103, 018 Ft^2 = 988,973 Secs*1 Min/60 Secs = 16, 483 Min

16, 483 Min*1 Hrs/60 Min = 275 Hrs*1 Working Day/8 Hrs = 34.5 Working Days

Cost Impact

- Estimate Yields OH is $.49 *Cheaper*
- Differing Items Include Conduit, Wire, Hangers, & Trench Digging
- Results In A Savings of $50,086.71
- 1.7% of Electrical Contract
- 0.18% of Overall Building Cost

Electrical Rough-In Method Cost Difference Estimate

Underground Method	Cost	Per Unit	Quanity	Unit	Waste Factor	Total Cost
Trench Digging, Backfilling Stone	$28.87	Hr	1.5	Hr	0	$43.31
PVC Conduit	$5.90	L.F.	208	L.F.	10%	$1,349.92
Conduit Hanger, Strap 3/4" dia.	$3.71	Ea.	18	Ea.	0%	$66.78
Wires	$71.50	C.L.F.	208	L.F.	5%	$148.72
					Total	$1,608.73
Overhead method	Cost	Per Unit	Quanity	Unit	Waste Factor	Total Cost
MC Cable, #12, 2 wire	$330.00	C.L.F.	240	L.F.	5%	$831.60
Cable Support, Clip 3/4" dia.	$2.60	Ea.	100	Ea.	0%	$260.00
Cable Hanger, Strap 3/4" dia.	$1.77	Ea.	2	Ea.	0%	$3.54
					Total	$1,095.14
Cost Difference Total per Classroom						$513.59
Location Factor						0.923
Adjusted Cost Difference Total per Classroom						$474.04
Adjusted Cost Difference Total per SF						$0.49
Total Cost Difference For Building						$50,086.71

Project Delivery Method

Potential Problem

- Using Multiple Prime;
  - Increases Coordination & Communication
  - Increases Owner Paperwork & Organization Load
  - Multiples Costs
  - Increases the Litigation Potential Against Owner
  - Increases Chances of Miscommunication & Mistakes

Goal

- Determine How Government Projects Can Gain Exemption To The Pennsylvania Separations Act of 1913

The Pennsylvania Separations Act of 1913

- Requires Government Entities To Seek & Hold Separate Contracts For Electrical, Heating, Ventilation, and Plumbing In Excess of $4,000
- Only Three Other States Have Similar Laws (ND, IL, NY)
- Present In Both State Law & School Code

Project Delivery Method

Department of General Services

- Places Requirements on DB Contractor
- Contractor Must Identify Major Subs Before Hand
- At Discretion of DGS

Department of Education

- Waiver Program As Part of EEA
- Could Apply To Be Waived From Separations Act
- Challenged In Court But Ultimately Upheld
- Expired in 2010, No Similar Programs or Plans To Renew

Exemptions

- The Act Has Long Since Been Repealed For:
  - Boroughs
  - Townships
  - Second-Class Townships
  - Third Class Cities
  - Counties

Summary & Conclusion

Geothermal Heat Pumps - Implement

- Initial Cost Increased By 18.4%
- Lower Utility & Maintenance Cost
- Reduces Emissions
- No Significant Construction Impact
- Pushes Project To LEED Gold

Modular Classrooms - Implement

- Substantial Completion Date of Areas C & D Accelerated
- Savings of $3.72 Million or 14.1% of Project Cost

Electrical Rough-In Method - Implement

- OH RI Saves $50,000
- Dry-In Dates Accelerated 23 Days on Average
- Activity Duration Reduced By 35 Working Days

Alternative Project Delivery Method – Not Possible

- Design Build May Be Used For DGS Projects At Their Discretion
- Previously Used To Be Able To Use Single Prime For DOE But No Longer Can
- Multiple Prime Not Required For Boroughs, Townships, Second-Class Townships, Third-Class Cities, and Counties

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