Rough Calculation of the GS Wells requried for this site

Swampscott Hadley Elementary School

Heating & A/C:	GSHP		
Ventilation	ASHP		
Students:	900		
Building Size:	153,855	sf	
Well H/C	85	each	
Well Ventilation	+35-55	each	

Haverhill Consentino Middle School

Proposing to go to all GSHP

Heating & A/C:	GSHP		
Ventilation	GSHP		
Students:	1080		
Building Size:	183,128	sf	
Well H/C	110	each	Projected
Well Ventilation	66	each	Projected
Total Wells	176	each	Projected

GEOTHERMAL BORE FIELD SCHEDULE	
QTY CLOSED LOOP BORES	85
BORES CTR - CTR DISTANCE	30'
BORE FIELD AREA	115,000 SF

SITE UTILITY GENERAL NOTES

1. REFER TO DRAWING MSU5.1 AND MSU5.2 FOR ADDITIONAL GEOTHERMAL SYSTEM DETAILS AND NOTES.

SITE UTILITY KEY NOTES

1. GEOTHERMAL HEADER VAULT; 13'-10"L x 7'-10"W x 7'-11"Ht. PROVIDE 36" DIA MANHOLE & REINFORCED TRAFFIC PAD. ISCO INDUSTRIES, OR EQUIVALENT CUSTOM FABRICATED BURIED HDPE OR SEALED CONCRETE VAULT WITH FACTORY-INSTALLED PIPING MANIFOLD
2. EACH LINE REPRESENTS (1) 3" GWS & (1) 3" GWR IN REVERSE RETURN CONFIGURATION FOR HORIZONTAL PIPING FROM FIELD INTO GEOTHERMAL HEADER (TYPICAL OF 9 CIRCUITS); BOTTOM OF HORIZONTAL PIPING AT 4'-0" BELOW FINISH GRADE. PROVIDE WITH THERMAL BREAK BETWEEN SUPPLY AND RETURN. THERMAL BREAK TO BE 2" R-13 POLYISOCYANURATE BOARD.
3. 6" BORE WITH 1-1/4" BORE WATER SUPPLY & RETURN PIPES. 500' DEEP LOOP WITH THERMAL GROUT. TYPICAL 10 BORE LOOP PIPED IN REVERSE RETURN (TYPICAL FOR 84 BORES. 85 INCLUDING TEST BORE).
4. BURIED 8" GEOTHERMAL SUPPLY AND RETURN PIPING. PRE-ENGINEERED ROVANCO SCHEDULE 40 STEEL CARRIER PIPE (NON-POTABLE WATER) WITH FOAM INSULATION PIPE SYSTEM WITH HDPE OUTER JACKET. FURNISH AND INSTALL PIPE ANCHORS, FLEXIBLE EXPANSION PADDING AND 5'-0" X 10'-0" MINIMUM EXPANSION LOOPS AS REQUIRED BY MANUFACTURER'S RECOMMENDATIONS.
5. BURIED 8" GEOTHERMAL SUPPLY AND RETURN PIPING. PRE-ENGINEERED ROVANCO SCHEDULE 40 STEEL CARRIER PIPE PIPE ANCHORS AS REQUIRED BY MANUFACTURER'S RECOMMENDATIONS.
6. BURIED 8" GEOTHERMAL SUPPLY AND RETURN PIPING. PRE-ENGINEERED ROVANCO SCHEDULE 40 STEEL CARRIER PIPE FLEXIBLE EXPANSION PADDING AS REQUIRED BY MANUFACTURES RECOMMENDATIONS.
7. COORDINATE FINAL TOP OF WELL AND VERTICAL PIPING DEPTH WITH RETAINING WALL FOOTINGS (CIRCUIT 1). ADJUST TOP OF WELL HEIGHT AS REQUIRED TO ROUTE PIPING 3'-0" UNDER OBSTRUCTIONS.
8. PROVIDE (2) 4" SCH 80 PVC SLEEVES PER CIRCUIT UNDERNEATH ROADWAY TO VAULT.
9. SHADED REGIONS INDICATE SUGGESTED TRENCHING FOR CONSOLIDATION OF HORIZONTAL GEOTHERMAL MAINS TO VAULT. PROVIDE THERMAL BREAK BETWEEN SUPPLY AND RETURN. THERMAL BREAK TO BE 2" R-13 POLYISOCYANURATE BOARD. COORDINATE FINAL TRENCHING AND PIPE ROUTING WITH ALL TRADES.
10. GENERATOR EXHAUST STACK FURNISHED BY DIV 26, INSTALLED BY DIV 23. PROVIDE ALL SUPPORTS AND BRACING FOR WIND LOADS PER GENERATOR MANUFACTURER'S REQUIREMENTS.
11. CROSS HATCHED REGIONS INDICATE MATURE TREE ROOTS. NO GEOTHERMAL PIPING IS TO BE ROUTED THROUGH THESE AREAS.

TEST BORE

1 MECHANICAL SITE UTILITY
1" = 20'-0"

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Norwood MA 02062
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CES #2020029.00

COMMONWEALTH OF MASSACHUSETTS
MICHAEL B. WALSH
MECHANICAL
No. 52466
REGISTERED PROFESSIONAL ENGINEER

TOWN OF SWAMPSCOTT

SWAMPSCOTT ELEMENTARY SCHOOL

10 WHITMAN ROAD,
SWAMPSCOTT, MA 01907

NO.	DESCRIPTION	DATE

A B C

CONTENT:
MECHANICAL SITE UTILITY PLAN

DRAWN BY:	MC/CB
PROJECT NO:	19-097-00
DATE:	9/14/2022
REVISED:	
SCALE:	As indicated

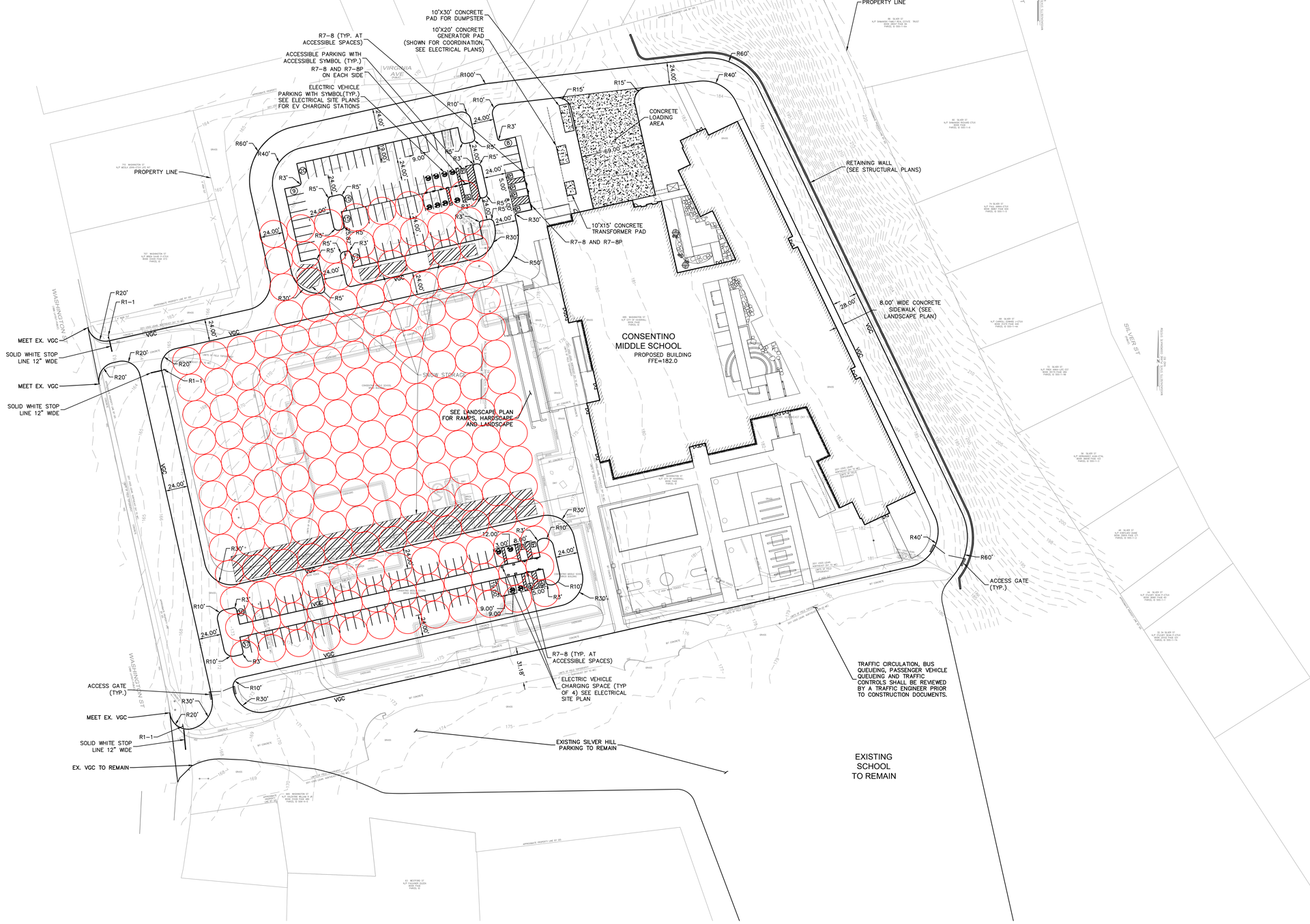
MSU1.0

Project Phase
CONSTRUCTION DOCUMENTS

FOR ADDITIONAL INFORMATION, REFER TO PROJECT MANUAL

Potential Geothermal Well Configuration

(Assuming 176 6" wells drilled 30' on center)



DORE + WHITTIER

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Nitsch Engineering

Haverhill Consentino MS

685 WASHINGTON STREET
HAVERHILL, MA

PROJECT NUMBER: 21-0818

SEAL AND SIGNATURE:

REVISIONS:

NO.	DATE	TITLE

ISSUE TITLE AND DATE:

DESIGN DEVELOPMENT
04.20.2023

KEY PLAN

A B C D

ORIENTATION AND SCALE:

SCALE: AS INDICATED

SHEET TITLE:
LAYOUT PLAN

SHEET NUMBER:
C4.01

Autodesk Docs://Haverhill Consentino MS/ARCH - 818 - HAVERHILL CONSENTINO_MS.rvt

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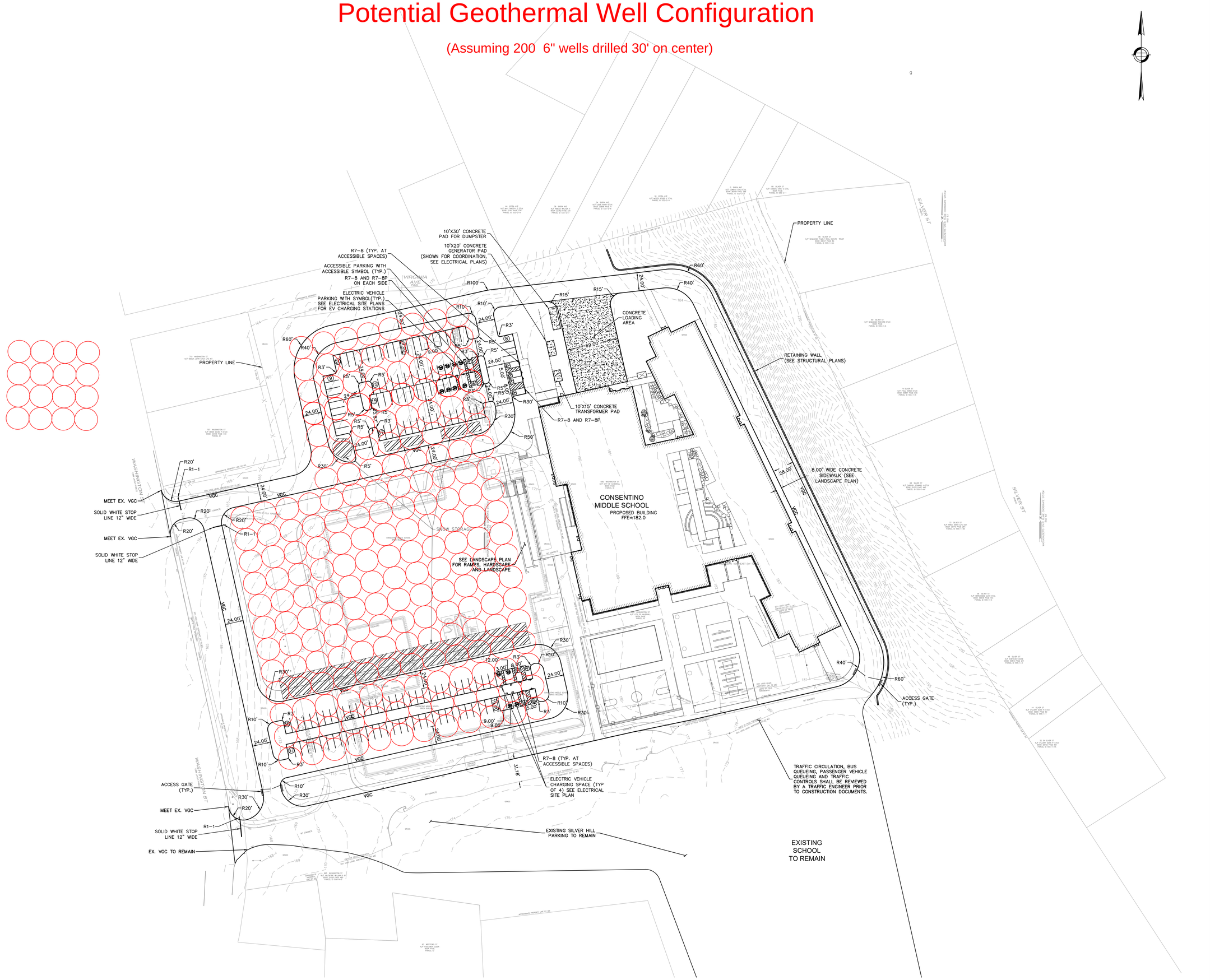
SCALE: AS INDICATED

Potential Geothermal Well Configuration

(Assuming 200 6" wells drilled 30' on center)



SCALE: 1" = 40'

40 20 0 40 80

SCALE: AS INDICATED

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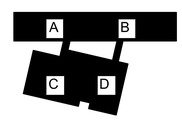

ORIENTATION AND SCALE:

SCALE: AS INDICATED

SHEET TITLE:
LAYOUT PLAN

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C4.01

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SCALE: AS INDICATED

Report Objective

- The objective of this report is to provide follow up to several questions related to the Energy Efficiency of the current Consentino MS Project.
- Ground Source Heat Pumps (GSHP) and several other options were considered throughout the design, but ultimately the direction received from the District was to move forward with the current design.
- We have been asked to review the previous information, which is all available in the previous submission to the MSBA, this has been done.
- We were also asked to provide a refreshed review of the HVAC options to see where we would stand today.
- Please note, as previously discussed, HVAC is a very important part of Sustainability, but it is not the only part.
- There are many other systems involved and this design is a very efficient design with a target EUI under 30.

Ground Source Heat Pump Project Costs

- This does not take into account any potential adjustments to the overall construction duration.
- Based on Experience the installation of Geothermal Wells requires a substantial amount of space. For this project it would have to be studied, but it is believed that we may need to encroach onto the Silver Hill ES site during the construction period.
- This will require the existing Consentino MS to be vacated at the start of Construction.
- We will have to relocate Staff and Student, and could require some SilverHill parking at a remote location
- The calculations below doe not account for any costs from the above

Current Building area 183,128 sf

				Current Design	Proposed Design	
Item	Unit		Unit Cost	Cost	Cost	Delta
HVAC System Costs						
Increased Building Size	1725	gsf	$473.17/sf	$0	$816,218	$816,218
Added cost on existing building	183,128	sf	$25.00/sf	$0	$4,578,200	$4,578,200
Current HVAC Cost	183,128	sf	$87.50/sf	$16,023,700	$16,023,700	$0
HVAC & Wellfield Costs	183,128	sf	$25.00/sf	$0	$4,578,200	$4,578,200
Cost for temporary System (1 year)	1	ls				EXCLUDED
				HVAC Premium to be paid		$9,972,618
Potential Additional Costs to change design at this time						
Designer Fees	1	ls	$50,000	$0	$50,000	$50,000
Drill Test well	1	Each	$50,000	$0	$50,000	$50,000
Project Start Delay Assume 3 months? Add 1% for escalation for the 3 months	$125,097,100		1.00%	$0	$1,250,971	$1,250,971
Design / OPM Fees for 3 months	3	Mnth	$50,000/mnth	$0	$150,000	$150,000
				Potential additional Costs		$1,500,971
				TOTAL COST TO ADJUST DESIGN		**$11,473,589**
POTENTIAL SAVINGS						
Mass Saves						
Current Path 2 Tier 1 ($1.25/sf)	183,128	sf	($1.25)/sf	($228,910)	($228,910)	$0
Potential HP savings (Heating load)	375	ton	($4,500)/ton	$0	($1,687,500)	($1,687,500)
Additional energy model? If we can even do it?					$29,990	$29,990
Federal Tax Savings						
Assume 30% of Geothermal System cost	$20,601,900		-30%	$0	($6,180,570)	($6,180,570)
				Potential Savings		($7,838,080)
				Project Net Cost		**$3,635,509**

	Construction Cost		
	Current Value	Potential Value	Delta
Construction Cost	$125,097,100	$136,570,689	$11,473,589
To stay on budget we would have to value engineer			$11,473,589

This does not take into consideration the long term operational cost, which would be less with a GSHP System.
This does not take into consideration life cycle analysis
This does not take into account the cost to relocate the existing school population during constructio

Ground Source Heat Pump Costs

Evaluation of Energy cost, annual Maintenance, & Life Cycle Analysis

Current System

1. Displacement Ventilation Diffusers with Radiant Cooling/Heating panels.
2. Gas-Fired Heating / Direct Expansion Cooling VAV Ventilating Unites with Energy Recovery with Terminal VAV Boxes with CO2 Controls
3. High-Efficiency Air Cooled Chiller Plant
4. High-Efficiency Gas-Fired Condensing Boiler Plant

Proposed System (Based on a similar project of 180,000sf adjusted)

1. Displacement Ventilation Diffusers with Radiant Cooling/Heating panels.
2. CHW/HHW DOAS RTUs ERV & Terminal VAV w/ DCV
3. High-Efficiency Ground Source Heat Pumps (GSHP) Chiller/Heater Plant w/ Geothermal Well Field.
4. Backup Side-Stream Electric Boiler Plant

	CURRENT SYSTEM			PROPOSED SYSTEM			Project Annual Savings
Item	Unit		Cost / Year	Unit		Cost / Year	
Energy Costs							
Gas	35,751	therms	$43,185	-	therms	$0	
Electric	770,928	kWh	$190,083	1118231	kWh	$241,507	
Total Cost of Energy			$233,268			$241,507	($8,239)
Annual Maintenance Costs	770,928						
Annual Maintenance Costs			$143,273			$106,400	$36,873
Expected Equipment Replacement Costs							
Existing Equipment Replacement (20 year)	$2,864,000		$143,200				$143,200
Proposed Equipment Replacement (30 year)				$3,116,250		$103,875	($103,875)
Annual projected costs (energy, maint & Replacement)			$519,741			$451,782	**$67,959**

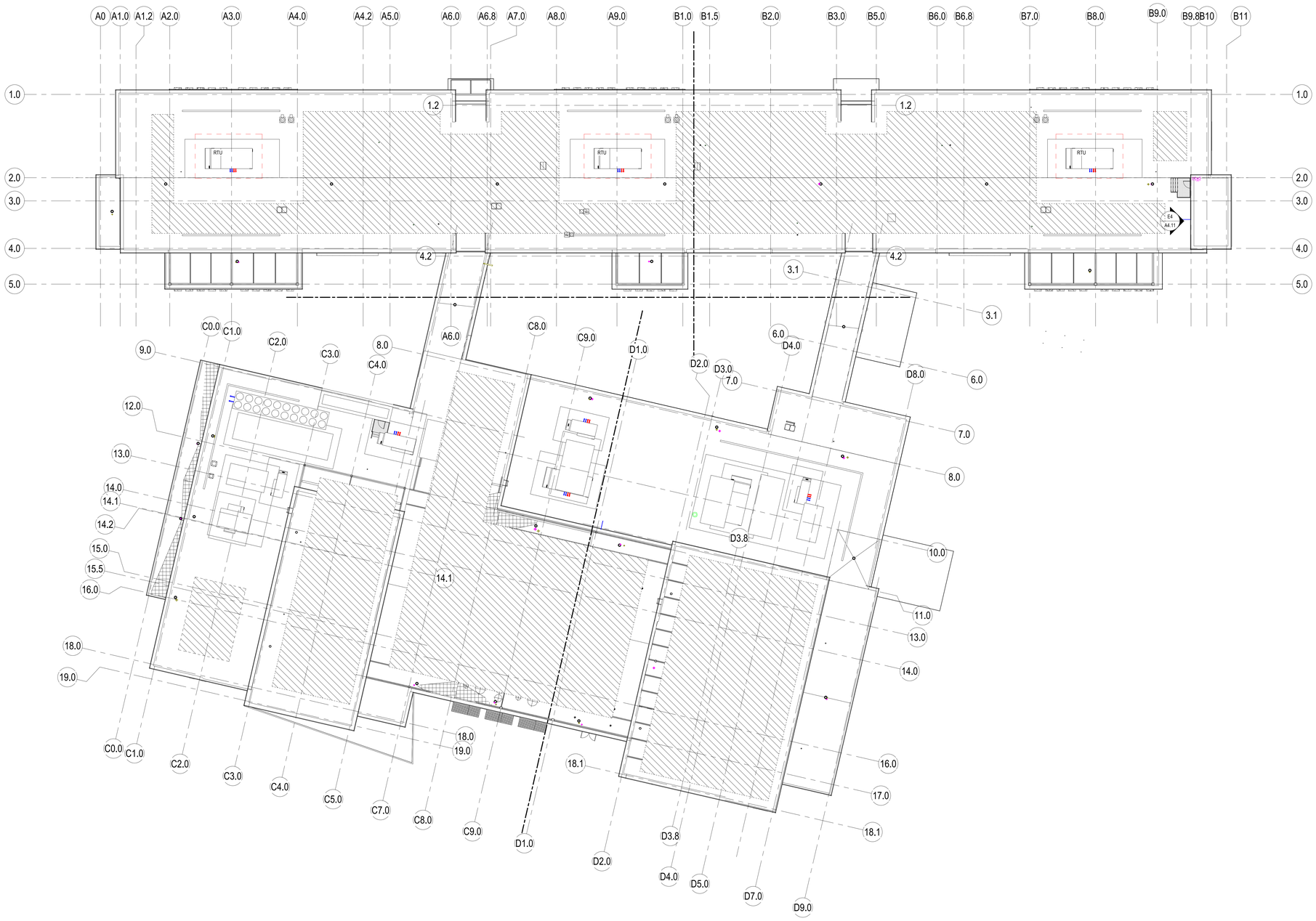
Potential Savings / year**	$67,959
Payback on investment **	53.50 Years

Net Cost from Previ	$3,635,509
Equipment Expected life	30 years

**Does not include Solar Considerations

ROOF LEGEND

	SOLAR READY ZONE
REFER TO A3.XX SERIES FOR ROOF AREA PLANS	



A25 OVERALL ROOF
1/16" = 1'-0"

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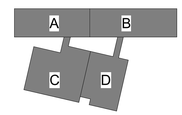

ORIENTATION AND SCALE:

TRUE NORTH
N
0 8' 16' 32'
SCALE: 1/16"=1'-0" GRAPHIC SCALE

PROJECT NORTH

SHEET TITLE:
ROOF KEY PLAN

SHEET NUMBER:
A3.10

Solar Power Considerations

- Early on this was reviewed and at the time the district directed the design team to provide a building which would be solar ready, but that we would not install panels at this time.

The Current design provides

- 2 conduits run from the Electric room up to the roof, and a 600A breaker for Future PV Connection.
- We have not included any additional items such as separate PV Metering.
- During the PSR phase we did evaluate multiple building options for PV.
- We will be using this information to supply the initial thoughts on our reconsideration.
- Reviewing the PSR options the building which is closes to our current building is option N.1080.A-3.
- This building was 188,903 sf with a roof area of approx 83,523 sf and available PV area of 41,762 sf.

If you are to proceed with Solar, there are 2 main options to consider

1. Having the contractor purchase and install the panels. This would provide higher up front costs, but you receive the benefits of the energy generation as well as the $ savings for that generation.

2. Having a 3rd party come in after the contractor and they install their solar on your building. This would provide a lower up front cost and while you receive the benefit of the energy being generated locally, the cost of that energy would still be the City's responsibility.

Item	Unit		Unit Cost	Current Cost	Potential Cost	Delta
Approximate Building Size	183,128	sf				
Potential area for Solar	35,000	sf	$37.00/sf	$0	$1,295,000	$1,295,000
(A Full Solar Study would be required to confirm exact area)						
Designer Fees	1	ls				TBD
Project Start Delay Assume 3 months? Add 1% for escalation for the 3 months	$125,097,100		1.00%			TBD
Design / OPM Fees for 3 months?						TBD

Premium to be paid	$1,295,000

	Current Cost	Potential Cost	Delta
Construction Cost	$125,097,100	$126,392,100	$1,295,000
To stay on budget we would have to value engineer			$1,295,000

Item	Unit		Potential AC Output	% of Electric Power
Approximate Building Size	183,128	sf		
Potential area for Solar	35,000	sf	769,991 kWh	
(A Full Solar Study would be required to confirm exact area)				
Anticipated Building Electric requirement			770,925 kWh	99.88%
Potential Building Electric requirements (GSHP)			1,118,231 kWh	68.86%
Additional area required (Parking lot?)	16,000.00	sf	351,996 kWh	

NOTES:

- Current design, if solar was added could be close to electric neutral, but would still have gas for heating.
- Proposed Design with GSHP, would require additional solar to be net zero energy.
- Net zero energy is not net zero cost. To determine cost a Study would need to be done.
- If you were to go all electric with Heat pumps the solar on the roof would not provide sufficient power to the building.
- To provide power you would need to expand to the parking lot area. Providing approximately 16,000 sf of additional panels.
- The addition of solar to The parking lots would have substantial cost for structures to support The panels in addition to The solar cost.
- The addition of solar to the parking lots would negatively impact the number of available parking spaces.