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April 14, 2022

BY EMAIL AND FIRST-CLASS MAIL

Richard A. Lipof, Chairman
Land Use Committee
Newton City Council
1000 Commonwealth Avenue
Newton, MA 02459-1449

Re: Council Order #33-21(3)/Alexandria Real Estate Equities, Inc. ("ARE")
<u>275 Grove Street, Building 3/Heat Pump Feasibility Study</u>

Dear Chairman Lipof,

In December of last year, the City Council granted a Special Permit to ARE to allow laboratory, research, and development use throughout Building 3 of 275 Grove Street (the "Council Order"). Condition 47 of the Council Order states that prior to the issuance of a building permit, ARE must complete a study to determine the feasibility of installing water source modular heat pumps ("Heat Pumps") in Building 3 (the "Feasibility Study").

I am forwarding herewith the completed Feasibility Study, including exhibits. Based on the results of the Feasibility Study and ARE's return on investment analysis, ARE has determined that the installation of Heat Pumps in Building 3 is not feasible.

Pursuant to Condition 47 of the Council Order, we are prepared to present and discuss the results of the Feasibility Study at a meeting of the Land Use Committee to be held within 45 days.

Sincerely,

Stephen J. Buchbinder

SJB/mer
Enclosure
cc: (By Email and First-Class mail, w/enclosure)
Councilor Maria Scibelli Greenberg
Councilor Tarik J. Lucas
Councilor Andrea W. Kelley
Councilor Christopher J. Markiewicz
Councilor Andreae Downs
Councilor Alicia G. Bowman
Councilor Marc C. Laredo
Barney Heath, Director, Planning and Development Department
Ann F. Berwick, Co-Director, Climate and Sustainability Department
William Ferguson, Co-Director, Climate and Sustainability Department
(By Email, w/out enclosure)
Mr. Dante Angelucci
Ms. Rickie Golden

ALEXANDRIA®

Heat Pump Feasibility Study
275 Grove Street, Building 3

April 14, 2022

Pursuant to Condition 47 of Council Order #33-21(3), Alexandria Real Estate Equities, Inc. ("ARE") is required to complete a study to determine the feasibility of installing water source modular heat pumps in Building 3 of 275 Grove Street. This document sets forth ARE's analysis of the heat pump chiller system and the effects its incorporation would have on the redevelopment project at 275 Grove Street Building 3. ARE's analysis is based in part on the Enhanced Energy Recovery Study completed by Vanderweil Engineers and attached hereto as **Exhibit A** (the "Energy Recovery Study").

Description of Heat Pump Systems and Description of Construction Modifications

The "heat pump" study is based on a combination heat pump/chiller capable of simultaneously producing chilled water for cooling and hot water for heating while utilizing the exhaust air stream as the heat source/sink. The intent of the system is to eliminate the local use of fossil fuels (natural gas) during summer months as the energy source for heating the building. The system will have the added benefit of reducing the consumption of fossil fuels, for heating purposes, during the other seasons of the year as well.

To simplify the piping arrangement and control, the capacity of the machine was selected based on the full (i.e. winter) indoor heating requirement of the facility, assuming full occupancy of research tenants utilizing their full allotment of ventilation (100% outdoor air) flow density in a 60% laboratory and 40% office ratio in the occupied areas. Natural gas would still be needed to produce heating hot water in the winter, but the demand would be limited to use in the supply air handling units pre-heating coils.

As the indoor heat demand will fluctuate throughout the year, there will be times when the heat pump/chiller will not be required to operate at full heating capacity. During such times, the machine will be controlled to maintain adequate heating availability (as the priority) to the building hot water loop and any excess capacity will be directed to the cooling side of the machine to create chilled water for use in a "pre-cooling" coil in the supply air handling units.

To accomplish the intentions noted above, a 6-pipe heat pump/chiller was studied. The selected device will provide for the simultaneous heating and cooling desired without intermixing the fluids. One set of pipes will be dedicated to heating hot water, and as this loop will be confined within the building, it will be filled with clear water. The second set of pipes will serve the chilled water, as this loop will be routed outdoors to the supply air handling units and subject to freezing, they will be filled with a freeze protection solution of 35% glycol. The third set of pipes, also 35% glycol, are the source/sink lines and will be connected to recovery coils in the exhaust air handling units. Exhaust air flowing across the recovery coil will transfer heat to/from the source/sink lines which in turn will transfer heat from/to the heat pump/chiller. Each of the three sets of lines will be separated from the refrigerant loop, which is integral to the heat pump/chiller, by independent heat exchangers within the machine so there is no intermixing of the three fluids.

Two flow diagrams have been developed and are attached hereto as **Exhibit B.**

The machine selected for this study is designed to be installed indoors. A general arrangement drawing has been developed to show how the heat pump/chiller as well as the associated pumps and hydronic specialties (air/dirt separators, expansion tanks, glycol fill stations) could be installed in the penthouse. The drawing is attached hereto as **Exhibit C.** The results are that 19% of the available tenant penthouse mechanical space would need to be repurposed to accommodate the additional equipment. There is no effect to the overall height with the addition of the heat pump/chiller.

Energy Consumption and Green House Gas Emissions

The Energy Recovery Study concludes that the inclusion of a heat pump/chiller would reduce Building 3's annual energy consumption by 7,600 MMBTU (24.8%) and annual greenhouse gas emissions by 370 MTCO2 (19.9 %). Annual energy costs would increase by $21,000.

Physical Limitations of the Existing Structure and Envelope

The greatest difficulty posed by adding the heat/pump chiller system would be the reduction of available rooftop penthouse mechanical space, which is required for tenant equipment.

Additionally, on an operational level, an expanded penthouse within a space-constrained existing rooftop greatly impacts circulation space around the exterior rooftop equipment, making our operations less efficient and making preventive maintenance more complicated.

Based on the need to manage water around the extended penthouse footprint, there will be an additional roof drain required at both the main roof and the penthouse roof. Structurally, the new penthouse is supported by additional steel floor framing and additional roof and wall framing (girts) per the expanded penthouse footprint, with a reinforced concrete slab, and steel penthouse roof deck. The heat pump would require the penthouse floor and roof framing be extended approximately 10' x 40' in the northeast corner of the penthouse. See **Exhibit D** for sketches by our structural engineer. This framing is additional, not upsized from framing otherwise required.

These redesigns would add an estimated 2 months to our project schedule, which impacts both our revenue and market timing. Speed to market allowing us to offer lab space when other options are unavailable is critical to securing life science tenants in today's life science sector.

Estimated Cost/Financial Impact

The greatest potential financial impact of implementing a heat pump/chiller is the reduction in available tenant rooftop mechanical space. In this competitive market, a life science building cannot compete without providing the space needed to house equipment necessary for tenant operations. The amount of rooftop space available to tenants is already constrained at Building 3, a reduction of nearly 20% would mean certain potential tenants would be unable to occupy the space. We simply cannot risk developing a building that greatly impacts our ability to attract a tenant.

We cannot quantify the overall impact of offering a less competitive product to the market. However, we can list certain other major cost impacts as a result of the inclusion of a heat pump/chiller:

$2,000,000	upfront cost
$2,136,680	2 months full building lost revenue (estimate)
$ 892,999	2 months carry costs
$ 906,438	rental revenue attributable to lost leasable penthouse space over 20 years (estimate)
$5,936,116	**Total**

In summary, after analyzing the possibility of switching to the heat pump chiller system in extraordinary detail, we have identified the following impediments:

a. The critical loss of 19% of the leasable rooftop space needed for tenant equipment in an already-significantly constrained roof condition, which greatly impacts the marketability of the building by limiting future tenant requirements to operate. We are not able to estimate the financial impact of offering a less desirable building, but it would certainly impact lease rates and decrease the viability of this building as a life science building.
b. The operational, maintenance and logistical challenges that would be created by an enlarged penthouse on an already-tight existing rooftop.
c. Delay of the project in order to substantially redesign not only the building MEP system but the structure and overall design of the building.
d. An additional cost of $6 million to execute.
e. While this investment would decrease annual carbon generation from reduced fossil fuel usage, the heat pump chiller would use more electricity, and the additional electricity will increase overall electric and gas costs by $21,000 per year.

Conclusion

While we strive to incorporate as many sustainable features as possible in all of our assets, after thorough investigation by our architects, engineers, construction team, and financial team, we have determined that it would not be feasible to incorporate the heat pump chiller given the constraints outlined above.

On a positive note, we will be striving to obtain LEED Silver certification for this development, have added solar panels to the roof since our special permit application, and have doubled the quantity of EV stations on site.

Currently the project is on track to consume approximately 28% less energy than the comparable LEED baseline building. This reduction is achieved by incorporating the following items into the design:

- Exhaust air energy recovery (approximately 40% effectiveness).
- High efficiency (approximately 92% efficient) gas-fired condensing boilers.
- Low lighting power density (1.2 W/sf in labs and 0.55 W/sf) in offices.
- High efficiency chiller water production (0.504 kW/ton).
- Roof level photovoltaic array sized to offset 0.5 W/SF of utility electrical consumption.

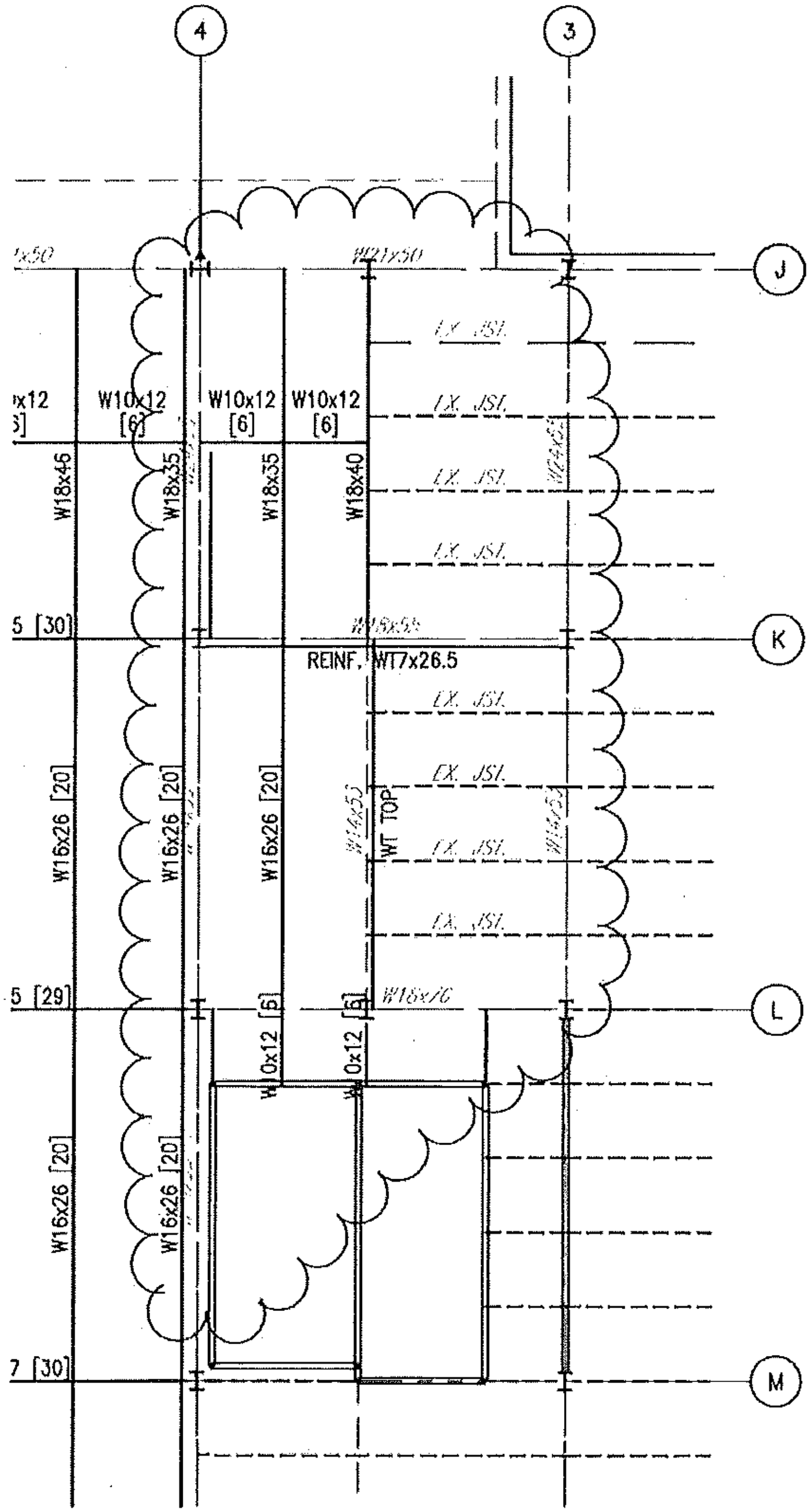
Non-energy sustainability measures will include:

- Reuse of existing building reduces embodied carbon over new builds.
- 40% potable water use reduction in plumbing fixtures.
- Use of low emitting and healthy products.
- Use of environmentally preferable products.
- Recycling of more than 50% of construction waste.

We thank the Land Use Committee, the Director of Planning and Development, and the Co-Directors of Climate and Sustainability for your commitment to sustainable development in Newton. We admire your focus on this and share your commitment. While we cannot justify pursuing electrification today for this project, ARE is committed to our goals of decarbonization by 2050 and is near completion of a strategic plan to accomplish this goal, including Building 3 at 275 Grove Street in Newton.

Thank you very much for your time and attention.

#33-21(3)



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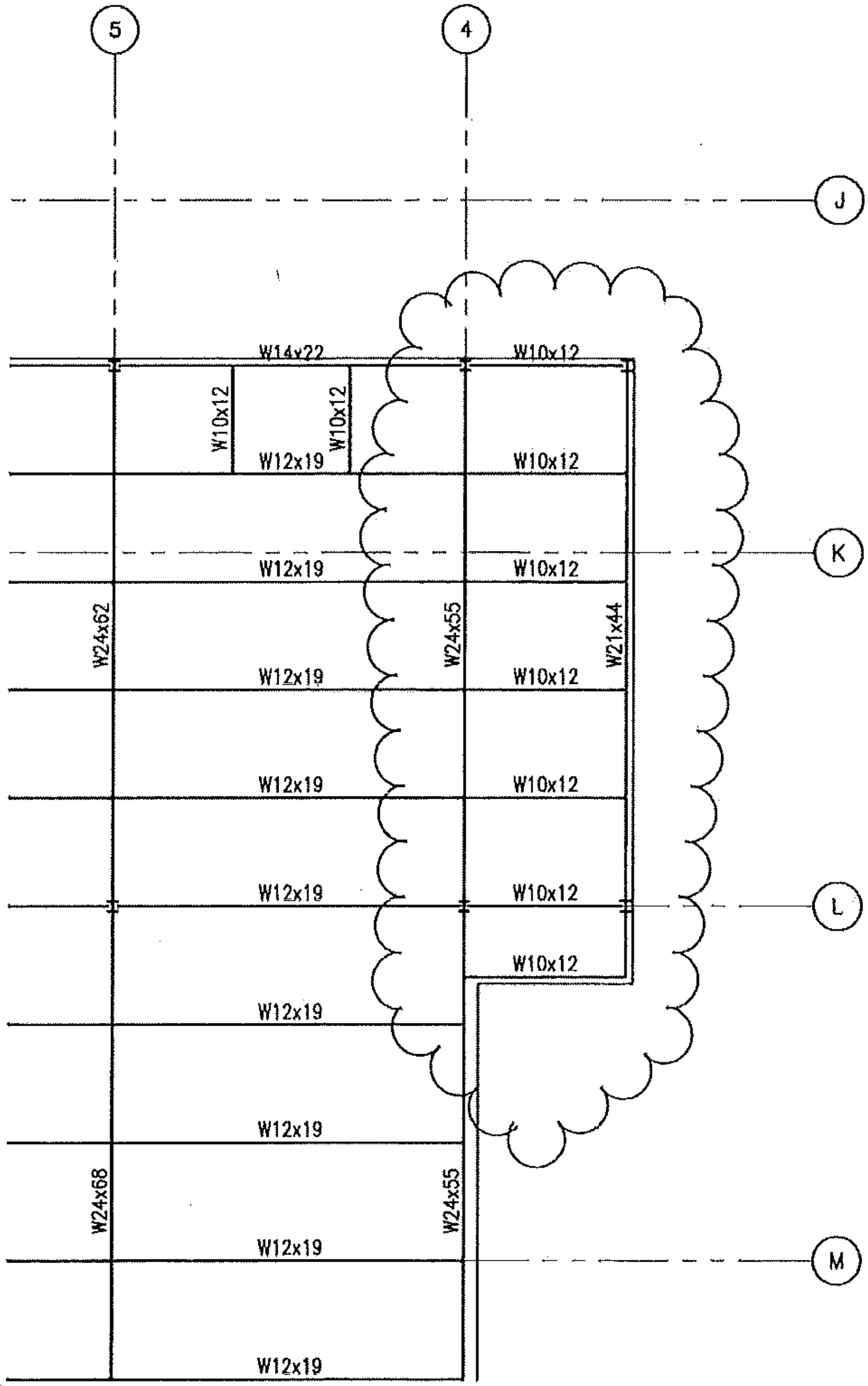
Dwg Name:	Part Penthouse Floor Plan	Date:	2021.12.09
Dwg No.:	Ssk.Alt.01	Scale:	AS NOTED
		By:	AS

McNAMARA SALVIA
101 Federal Street, 11th Floor
Boston, MA 02110 USA



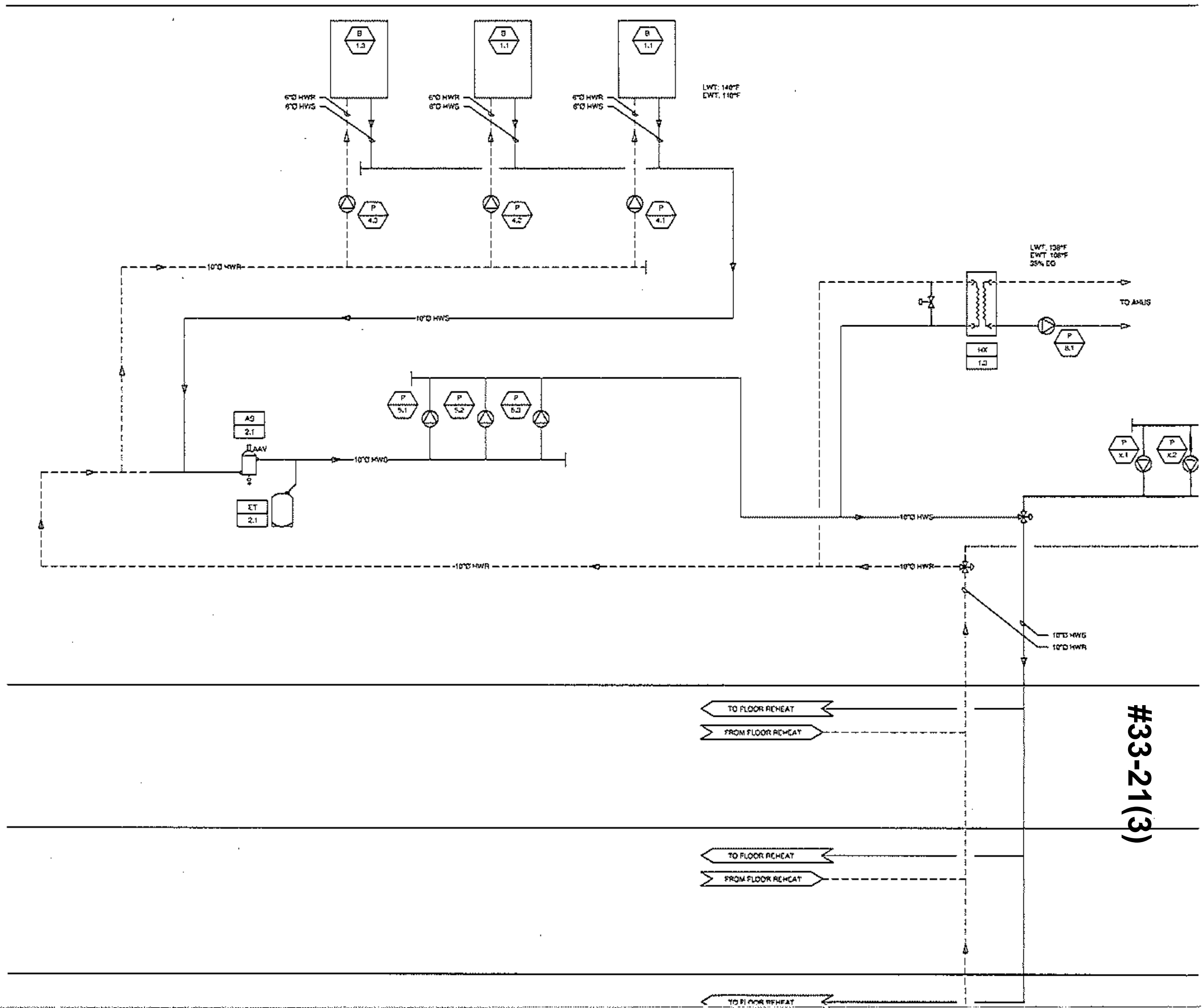
Project:	275 Grove Street	Project Number:	17117.003
Dwg Name:	Part Penthouse Roof Plan	Date:	2021.12.09
Dwg No.:	Ssk.Alt.02	Scale:	AS NOTED
		By:	AS

McNAMARA SALVIA
101 Federal Street, 11th Floor
Boston, MA 02110 USA
www.mcsal.com

#33-21(3)

NOTES:

① FOR CONTINUATION SEE MECHANICAL ENERGY RECOVERY FLOW DIAGRAM (SKM-704)



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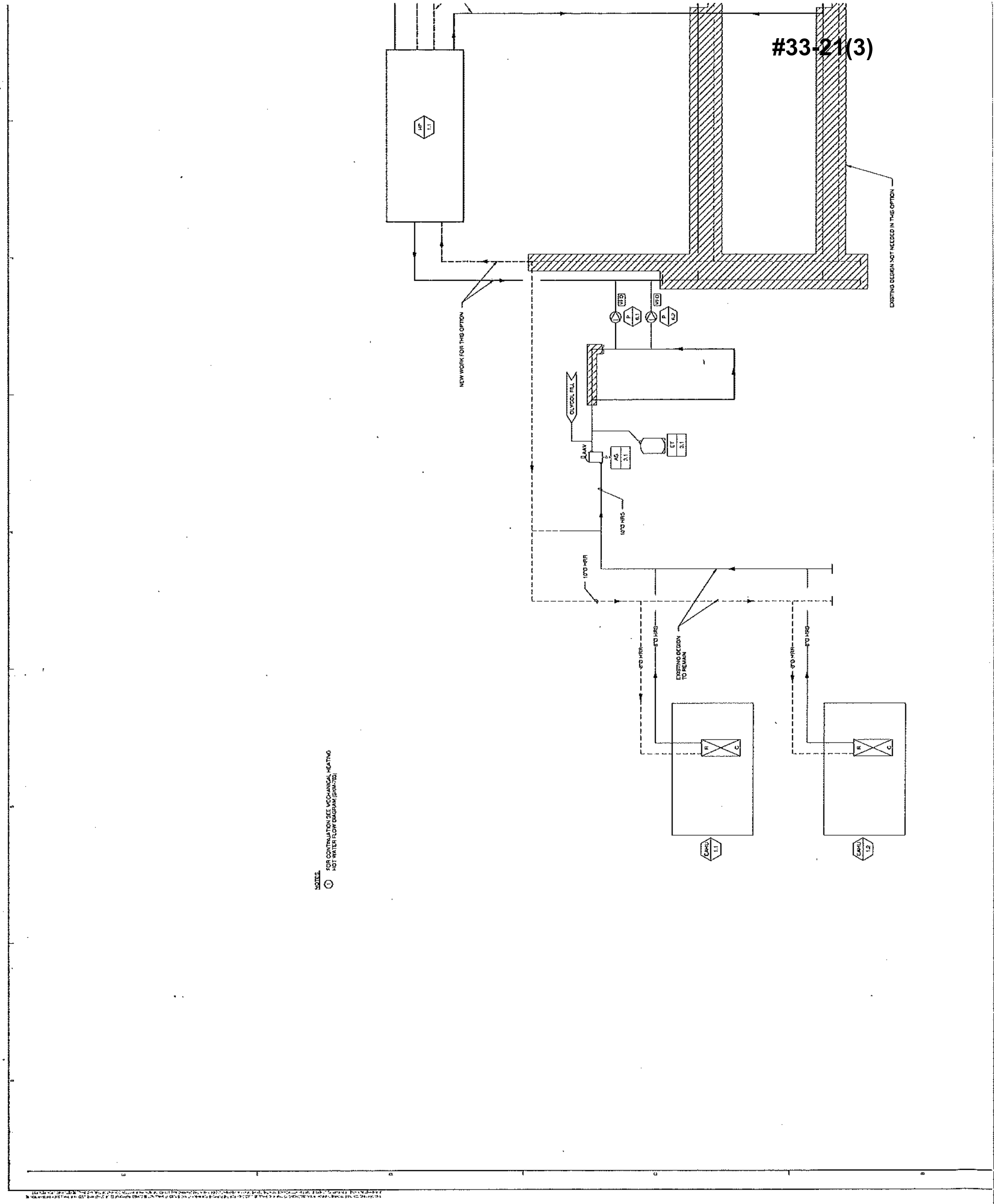
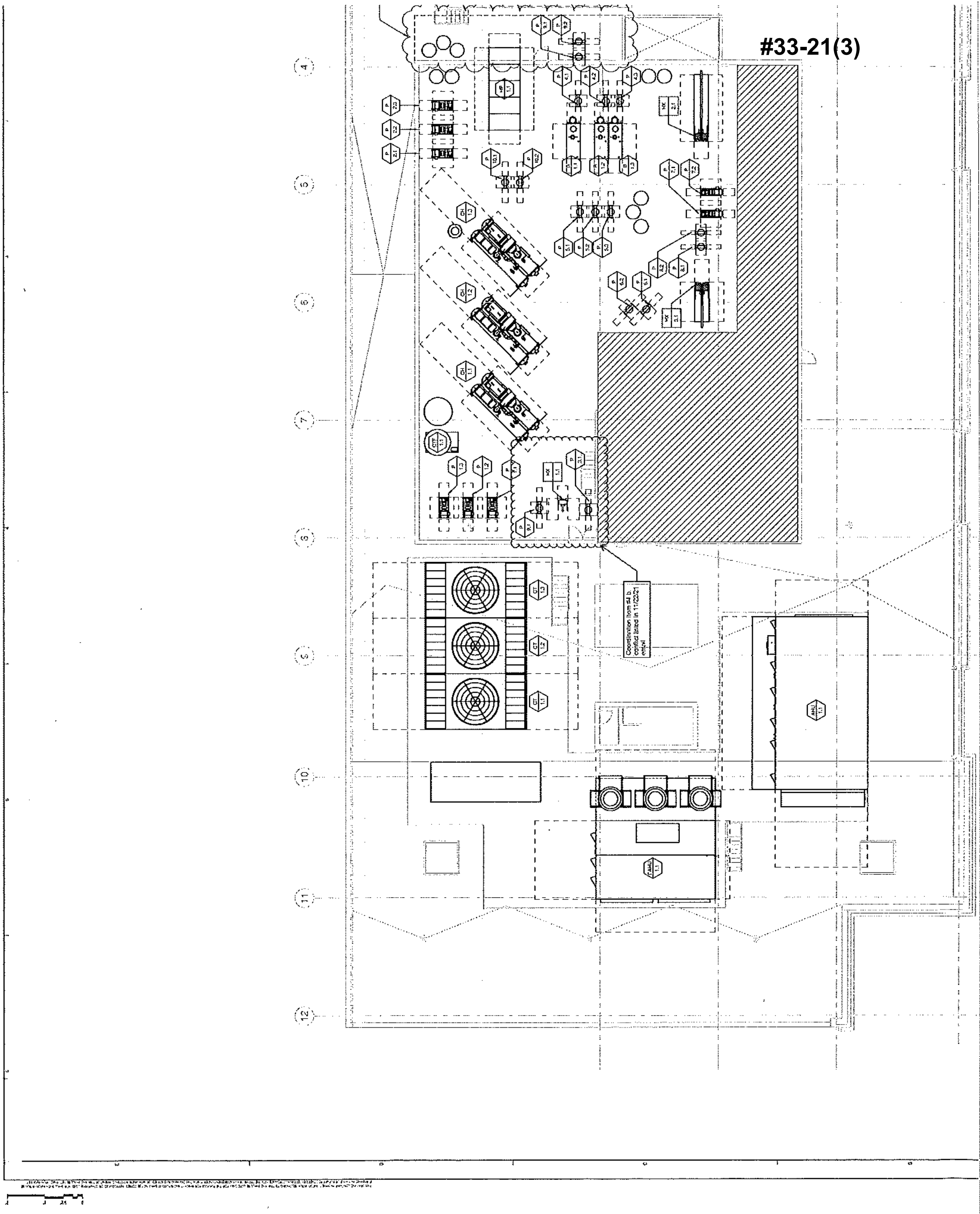


NEW WORK FOR THIS OPTION
EXISTING DESIGN NOT NEEDED IN THIS OPTION
GLYCOL FILL
EXISTING DESIGN TO REMAIN
EAHU 1.1
EAHU 1.2

#33-21(3)



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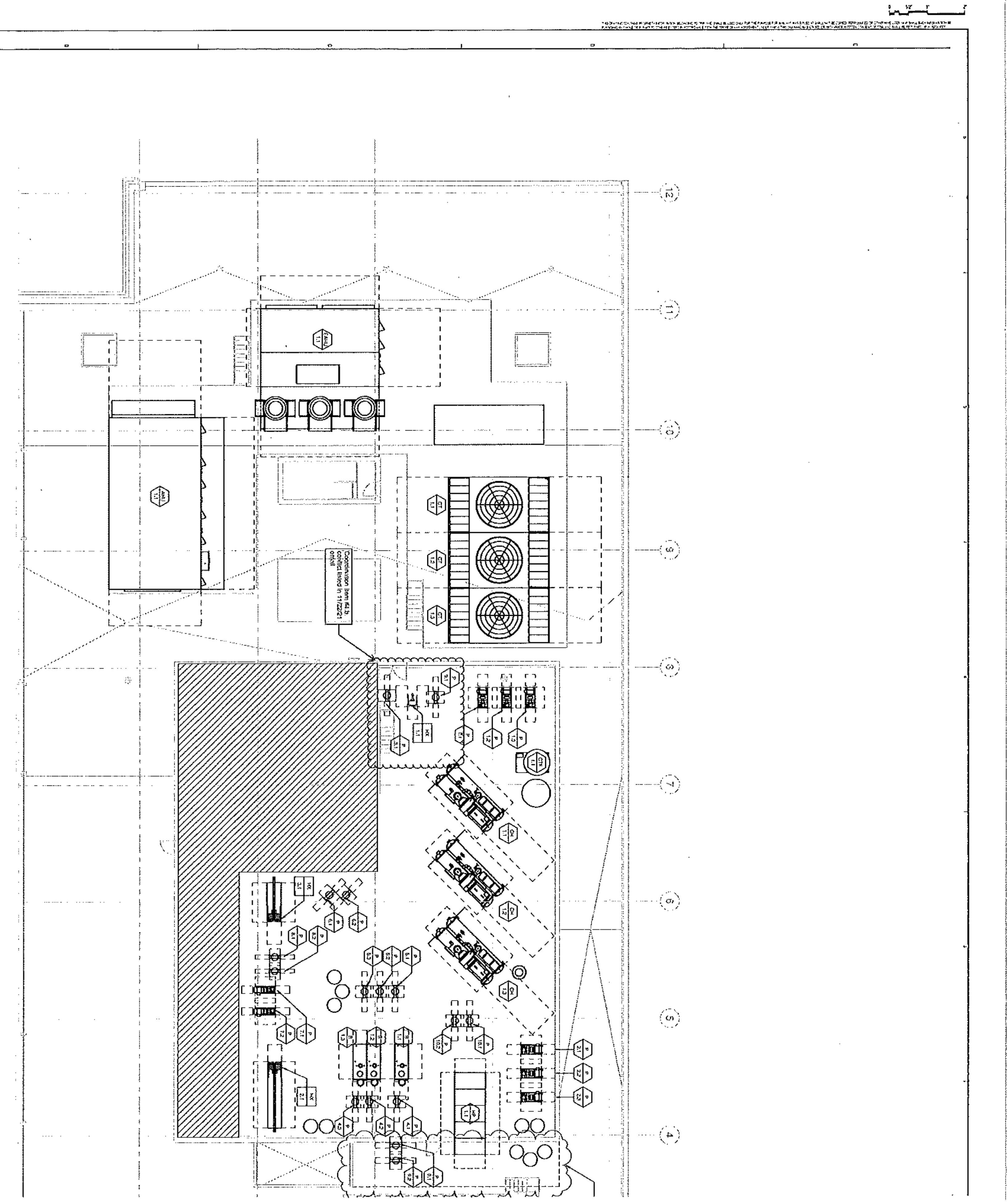


ENHANCED ENERGY RECOVERY STUDY

Riverside Center Building 3 | Newton, MA

An Energy Evaluation by Vanderweil's Building Performance Group

Rev. 03/17/2022
12/13/2021

VANDERWEIL

EXECUTIVE SUMMARY

Alexandria Real Estate Equities (ARE) is currently planning a renovation of Building #3 at the Riverside Center in Newton, Massachusetts, into a core/shell life-science facility. As part of the permitting and planning process for the City of Newton, the project team has performed a study examining the fossil-fuel-reducing impacts of a water-to-water heat pump to recover heat for use elsewhere in the project. Vanderweil's report describes the energy consumption, energy cost, and greenhouse gas impacts of the water-to-water heat pump option compared to the basis of design building.

ARE will utilize the annual energy cost savings figure with their own incremental first cost analysis to understand the economic feasibility of the heat pump. Note that in order to accommodate the heat pump, the penthouse would require enlargement (as shown on Vanderweil's sketch SKM-205 issued Nov 23, 2021), and the structural consultant would need to confirm the adequacy of the existing structure to support the unit.

Our analysis finds that the heat pump option would increase the annual energy cost by $21,000 (a 2.1% of total energy cost) and reduce its greenhouse gas emissions by 370 metric tons per year compared to the basis of design building. Additionally, the heat pump would offset 100% of the project's reheat natural gas usage from June through September. Some modest gas use would remain during that period in order to satisfy base building domestic hot water loads and minimal peak reheat loads.

Table 1 below summarizes the results of our study.

ANNUAL ENERGY COST INCREASE ($)	**$21,000**
ANNUAL ENERGY CONSUMPTION SAVINGS	**7,600 MMBTU**
ANNUAL GREENHOUSE GAS EMISSIONS SAVINGS (METRIC TONS CO2 EQUIVALENT)	**370 MTCO2e**
% OF JUNE THROUGH AUGUST NATURAL GAS USAGE OFFSET	**100%**

Table 1. *Summary of Enhanced Energy Recovery Study's Results*

STUDY OVERVIEW AND CONTEXT

Building #3 is a 148,000 GSF existing building forming part of the Riverside Center in Newton, MA. The building formerly housed office space but will undergo a conversion into core/shell laboratory space to accommodate life science program. As part of the planning and permitting process, the design team has performed a study to evaluate the impacts of a water-to-water heat pump which would recover excess heat for use elsewhere in the building.

Within this study, we compare the basis of design building (as modeled for the Design Development effort) against the alternative developed by the project team utilizing a water-to-water heat pump for heat recovery. Our study has specifically examined four key metrics by which to evaluate the heat pump option:

- Site energy consumption: The heat pump's coefficient of performance (COP) and use of pre-existing waste heat in the building would allow it to utilize fewer site-measured Btus than the gas boiler plant operating similarly. The condensing gas boiler plant operates at an efficiency of around 90% depending on various conditions; the water-to-water heat pump would operate at 400% efficiency or greater, also depending on various conditions.

- Energy (utility) costs: Although we expect the building's total energy use to decrease under the heat pump option (as noted above), the higher cost per Btu of electricity than natural gas means that the cost savings are lesser than the energy savings. Costs have been calculated using the latest historical commercial energy rates for Massachusetts.

- Greenhouse gas (GHG) emissions: To understand the carbon impact of the heat pump, we have calculated the carbon dioxide equivalent (CO_2e) emissions saved. Emissions factors are the latest from the United States Environmental Protection Agency (EPA).

- Summertime fossil fuel usage: We understand that the City of Newton is particularly interested in the heat pump's ability to offset or eliminate natural gas usage during the summertime months of operation. We have therefore evaluated the total quantity and percentage of natural gas usage which would be offset by the heat pump from the months of June, July, and August.

OPTIONS ANALYZED

Our analysis compares the basis of design building against an alternative which adds a water-to-water heat pump and associated infrastructure for its operation. The basis of design is modeled according to the 10/04/2021 Design Development drawings, while the heat pump option is modeled based on sketches developed and selections made by Vanderweil in late November 2021.

Basis of Design Option

The building has been modeled according to the 10/04/2021 Design Development drawings. Please refer to Vanderweil's 10/04/2021 energy model report for detailed results associated with that energy model. Key performance inputs governing this option are provided in this report's appendix within the input tables.

The basis of design building is conditioned by 2 (105,000) CFM air handling units (AHUs) located in the building's penthouse and fed by the building's chilled water loop for cooling and hot water loop for heating. Chilled water is provided by an electric water-cooled chiller plant located in the mechanical penthouse, while hot water is provided by a gas-fired condensing boiler plant also located in the mechanical penthouse. Exhaust for the building is provided by 2 (105,000) CFM exhaust air handling units (EAHUs) located on the building's roof.

The basis of design utilizes a pumped glycol run-around system to exchange heat between the outgoing exhaust air (via coils located in the EAHUs) and the incoming outside air (via coils located in the AHUs).

Water-to-Water Heat Pump Option

Under this option, a six-pipe water-to-water heat pump and associated infrastructure would be installed in the building's penthouse to enhance the basis of design heat recovery loop. Changes to the basis of design include:

- Addition of a 292 ton / 3,800 MBH six-pipe water-to-water heat pump unit to the building penthouse
- As an initial assumption, an addition of two (2) 7.5 HP pumps to provide circulation to the hot water loop side of the heat pump
- As an initial assumption, an addition of two (2) 7.5 HP pumps to provide circulation to the air-handling side of the heat pump
- Addition of two (2) sets of hydronic loop specialties (expansion tank, air separator, etc.), one for the air-handling side of the heat pump, one for the hot water loop side of the heat pump
- Enlargement of the building penthouse to provide the additional area needed for this equipment
- Potential structural work to the building roof to support the additional weight of the heat pump, pumps, and loop specialties (to be determined by the structural consultant)

RESULTS

The results of our study are summarized in the table below:

ANNUAL ENERGY COST INCREASE ($)	**$21,000**
ANNUAL ENERGY CONSUMPTION SAVING	**7,600 MMBTU**
ANNUAL GREENHOUSE GAS EMISSIONS SAVINGS (METRIC TONS CO2 EQUIV)	**370 MTCO2**
% OF JUNE THROUGH AUGUST NATURAL GAS USAGE OFFSET	**100%**

Our analysis indicates that the heat pump reduces site energy use; increases energy costs; and reduces emissions. Specifically, compared to the basis of design:

- The heat pump option decreases site annual energy use (i.e. kWh and therms measured at the site utility meters) by 24.8% thanks to the 400%+ efficiency of the heat pump compared to the 90%+ efficiency of the basis of design boiler plant.
- The heat pump option increases annual utility costs by 2.1% due to the high price per Btu of electricity compared to the low price per Btu of natural gas.
- The heat pump option decreases annual greenhouse gas emissions by 19.9% due to the site energy reduction discussed above.
- The heat pump option produces sufficient heat from June through September to avoid firing the natural gas boilers for space heating during those months; given the operational airflows assumed for our analysis, all reheat loads during those months can be served by the heat pump.

Figures 1 through 4 on the following pages show the performance of the heat pump option against the BOD in greater detail.

Site Energy Consumption

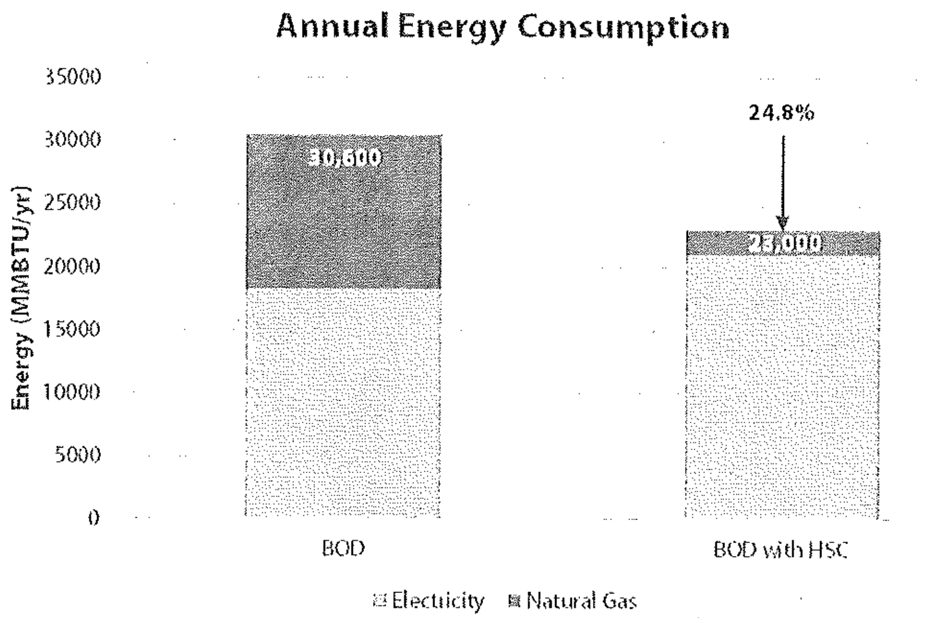


Figure 1. *Annual Energy Consumption Comparison: BOD vs BOD with Heat Shift Chiller*

Energy Cost

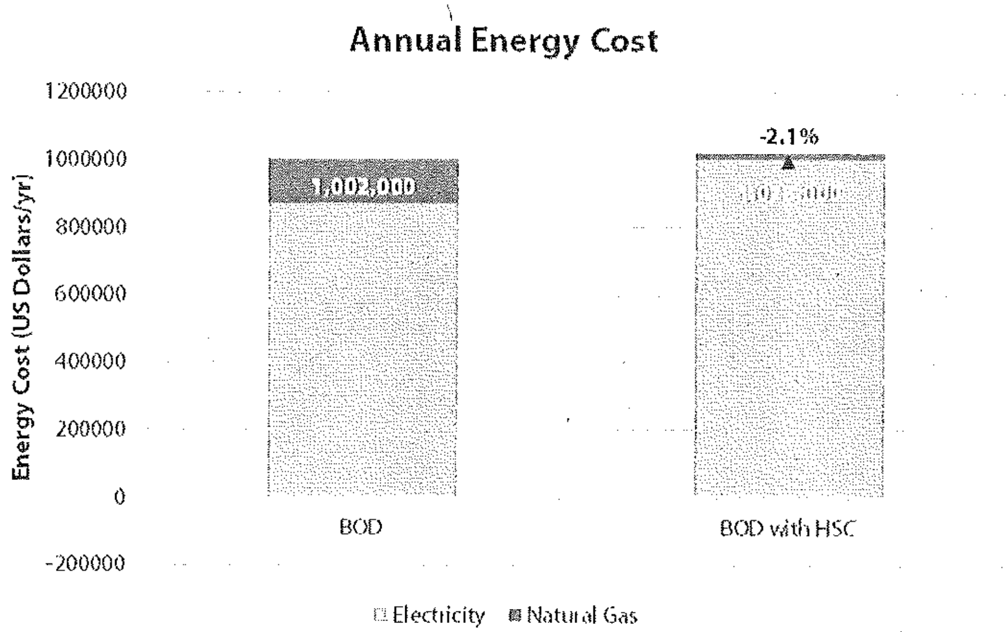


Figure 2. *Annual Energy Cost Comparison: BOD vs BOD with Heat Shift Chiller*

Greenhouse Gas Emissions

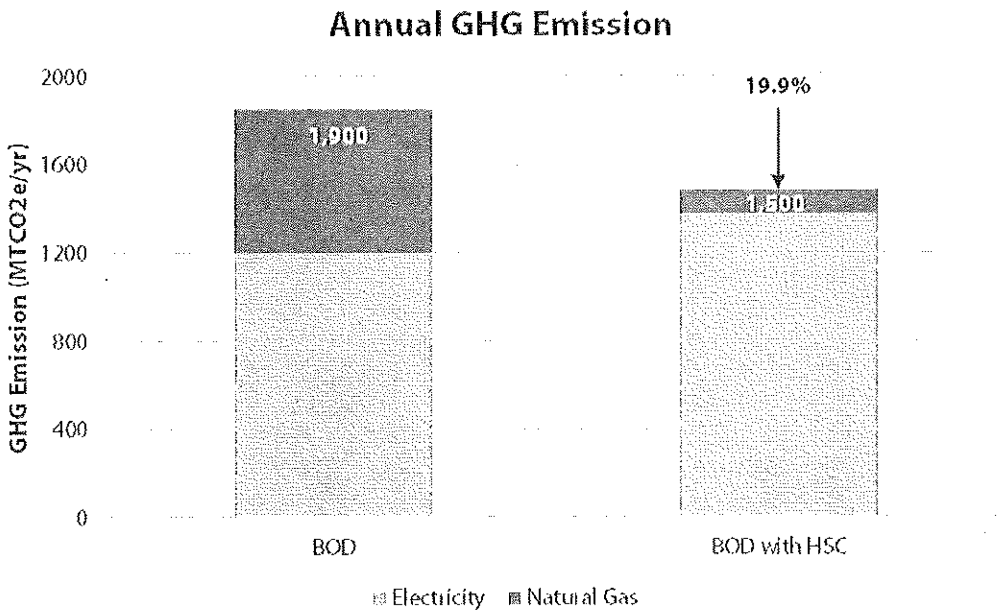


Figure 3. *Annual GHG emission comparison: BOD vs BOD with Heat Shift Chiller*

Reheat Load (MMBtu/hr) Met By Natural Gas Boilers

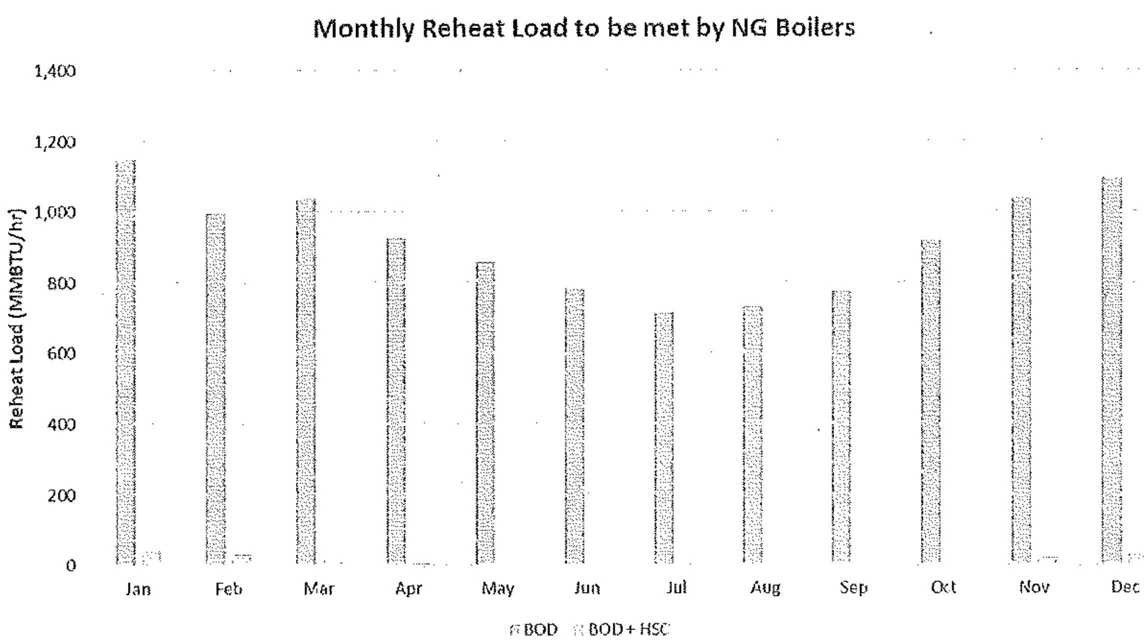


Figure 4. *Monthly reheat loads to be met by Natural Gas Boilers*

APPENDIX

ENERGY PERFORMANCE SUMMARY

100% DD Proposed Design						
End Use	ELEC (kWh)	NAT GAS (therms)	STEAM (MBTU)	CHW (MBTU)	Total Energy (kBTU)	% of Total
Lights	421,815				1,439,655	5%
Exterior Lights						0%
Misc. Equipment	2,229,192				7,608,232	25%
Space Heating		119,374			11,937,400	39%
Space Cooling	636,694				2,173,037	7%
Heat Rejection	4,990				17,031	0%
Pumps & Aux	535,722				1,828,419	6%
Ventilation & Fans	1,534,257				5,236,419	17%
Onsite Rewnables						0%
Domestic Hot Water		3,476			347,600	1%
Total Energy by Type	5,362,670	122,850	-	-	30,587,793	100%
Total Cost by Type	$ 872,506	$ 129,607	$ -	$ -		
Total Energy Cost	$					1,002,113
Site EUI (kBTU/SF)						206.7
Site Emissions (MTCO2e)						1,853.68

100% DD Proposed Design with Heat Shift Chiller						
End Use	ELEC (kWh)	NAT GAS (therms)	STEAM (MBTU)	CHW (MBTU)	Total Energy (kBTU)	% of Total
Lights	421,815				1,439,655	6%
Exterior Lights						0%
Misc. Equipment	2,229,192				7,608,232	33%
Space Heating		16,193			1,619,293	7%
Space Cooling	1,239,774				4,231,349	18%
Heat Rejection	4,990				17,031	0%
Pumps & Aux	732,663				2,500,579	11%
Ventilation & Fans	1,534,257				5,236,419	23%
Onsite Renewables						0%
Domestic Hot Water		3,476			347,600	2%
Total Energy by Type	6,162,691	19,669	-	-	23,000,157	100%
Total Cost by Type	$ 1,002,670	$ 20,751	$ -	$ -		
Total Energy Cost	$					1,023,421
Site EUI (kBTU/SF)						155.4
Site Emissions (MTCO2e)						1,484.89

Savings by Enduse						
	Energy			Energy Cost		
End Use	kBTU	Enduse Savings %	Enduse Energy Savings %	$	Enduse Savings %	Enduse Cost Savings %
Lights		0%	0.0%	$ -	0%	0.0%
Exterior Lights			0.0%	$ -		0.0%
Misc. Equipment		0%	0.0%	$ -	0%	0.0%
Space Heating	10,318,107	86%	33.7%	$ 108,856	86%	10.9%
Space Cooling	(2,058,312)	-95%	-6.7%	$ (98,121)	-95%	-9.8%
Heat Rejection		0%	0.0%	$ -	0%	0.0%
Pumps & Aux	(672,160)	-37%	-2.2%	$ (32,042)	-37%	-3.2%
Ventilation & Fans		0%	0.0%	$ -	0%	0.0%
Onsite Renewables			0.0%	$ -		0.0%
Domestic Hot Water		0%	0.0%	$ -	0%	0.0%
Total	7,587,636		24.8%	$ (21,307)		-2.1%
			Total Site Energy Savings 24.8%			Total Site Cost Savings -2.1%
						Greenhouse Gas Reduction 19.9%

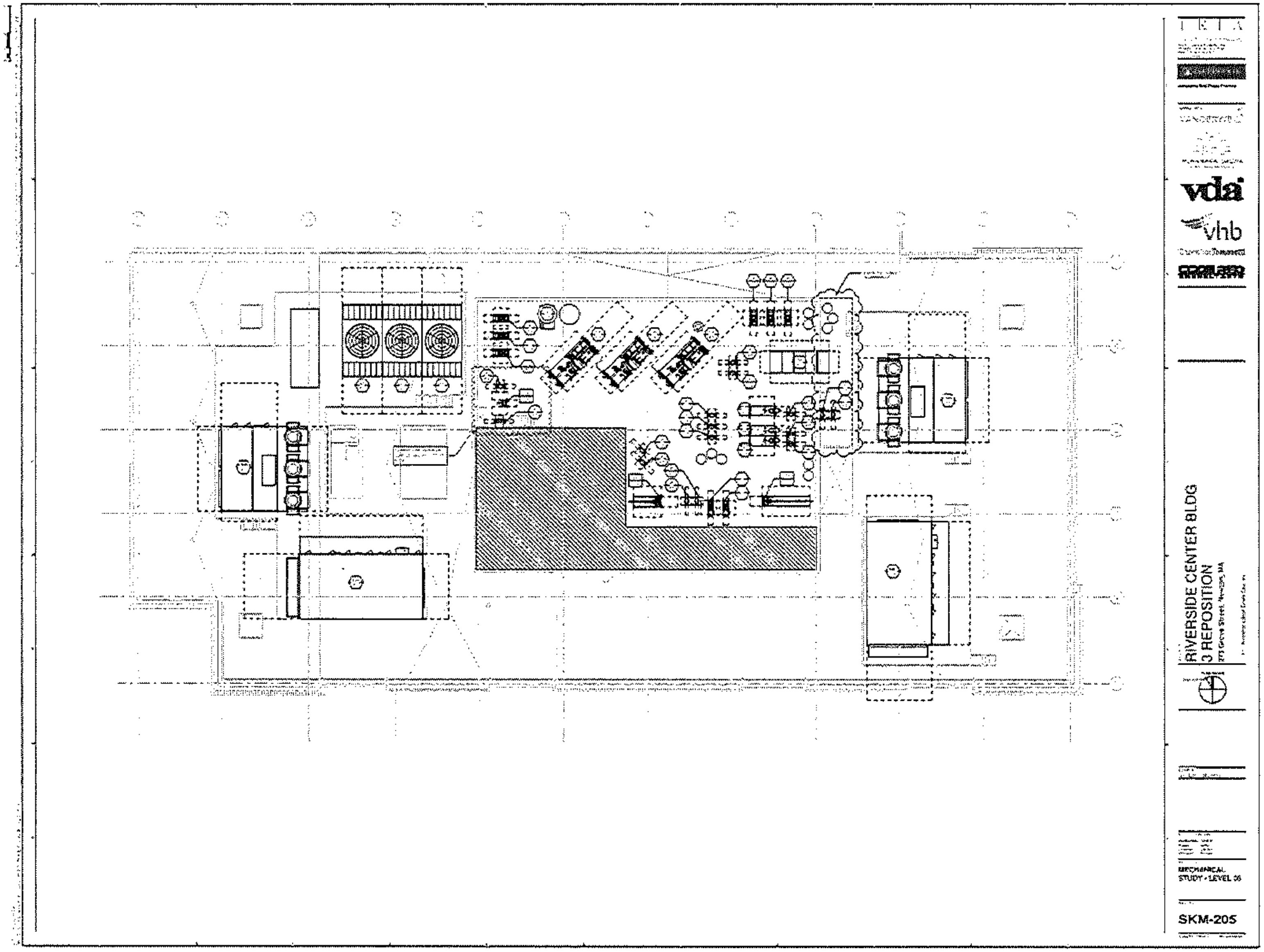
* Positive values indicate energy savings. Negative values indicate an energy penalty.

INPUT TABLES

Performance inputs associated with the heat pump study are provided below. For a comprehensive list of inputs associated with the basis of design building, please refer to the 10/01/2021 Design Development energy model report.

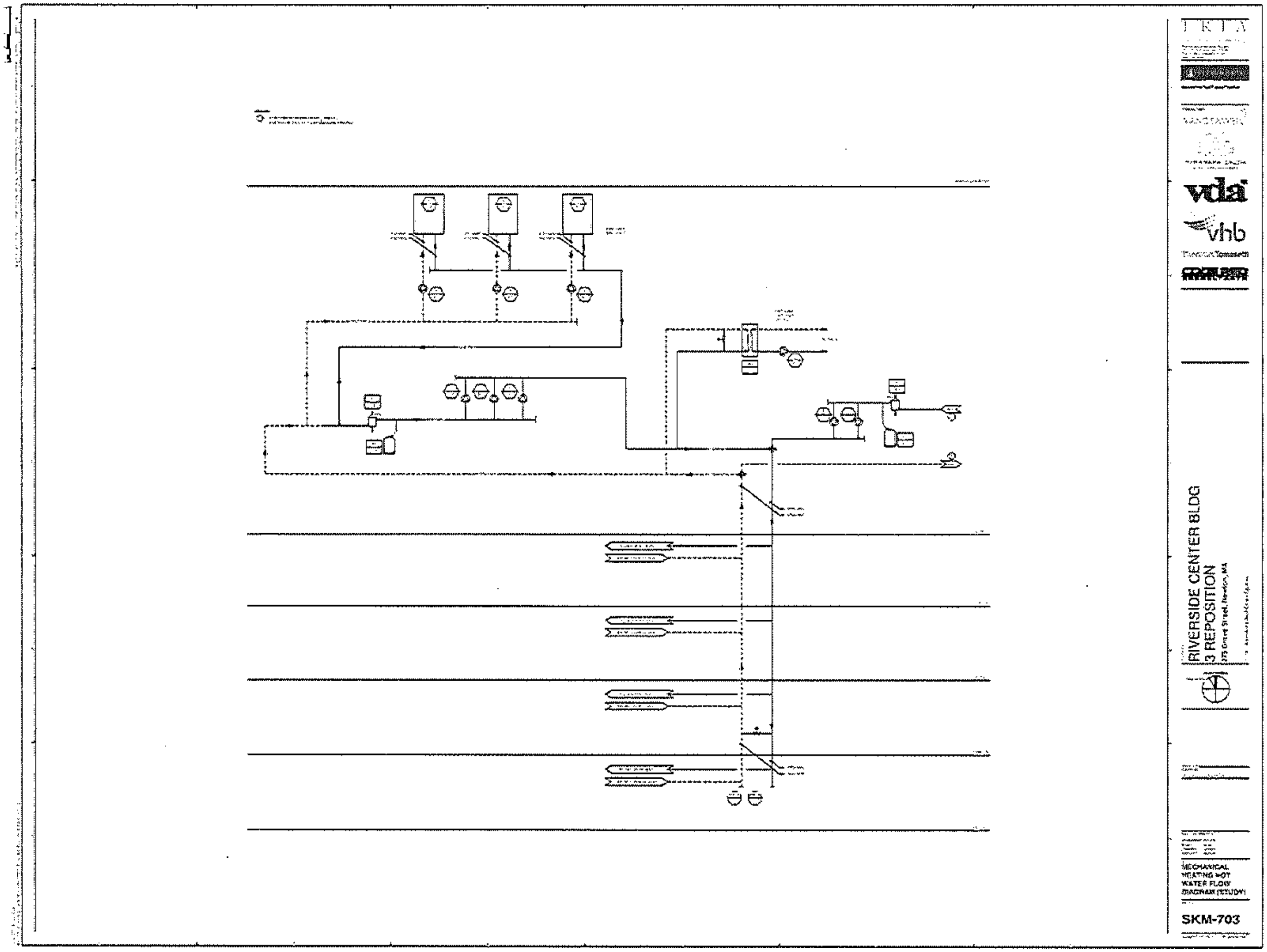
INPUT PARAMETER	BASIS OF DESIGN	HEAT PUMP OPTION	INFORMATION SOURCES
GENERAL INFORMATION			
COOLING PLANT AND EFFICIENCY	Water-cooled Centrifugal Chiller 0.504 kW/ton		10/04/2021 100% DD Design
HEATING PLANT AND EFFICIENCY	Natural Gas Boilers 88% efficiency		
OUTSIDE AIR AND EXHAUST QUANTITIES	140,000 OA total 150,000 cfm peak exhaust		
UTILITY RATES	Electricity: $0.1627/kWh Natural Gas: $1.055/therm		EIA MA 2021 Average
GREENHOUSE GAS (GHG) EMISSIONS FACTORS	Electricity (NEWE Grid): 0.000223997 MTCO2e/kWh Natural Gas: 0.005311 MTCO2e/therm		eGrid2019 LEED guideline
TYPICAL OPERATING SCHEDULE	AHUs are always on to maintain space temperature and building pressure		Initial assumptions 10/04/2021 100% DD Design

SKM-205: MECHANICAL STUDY - LEVEL 05

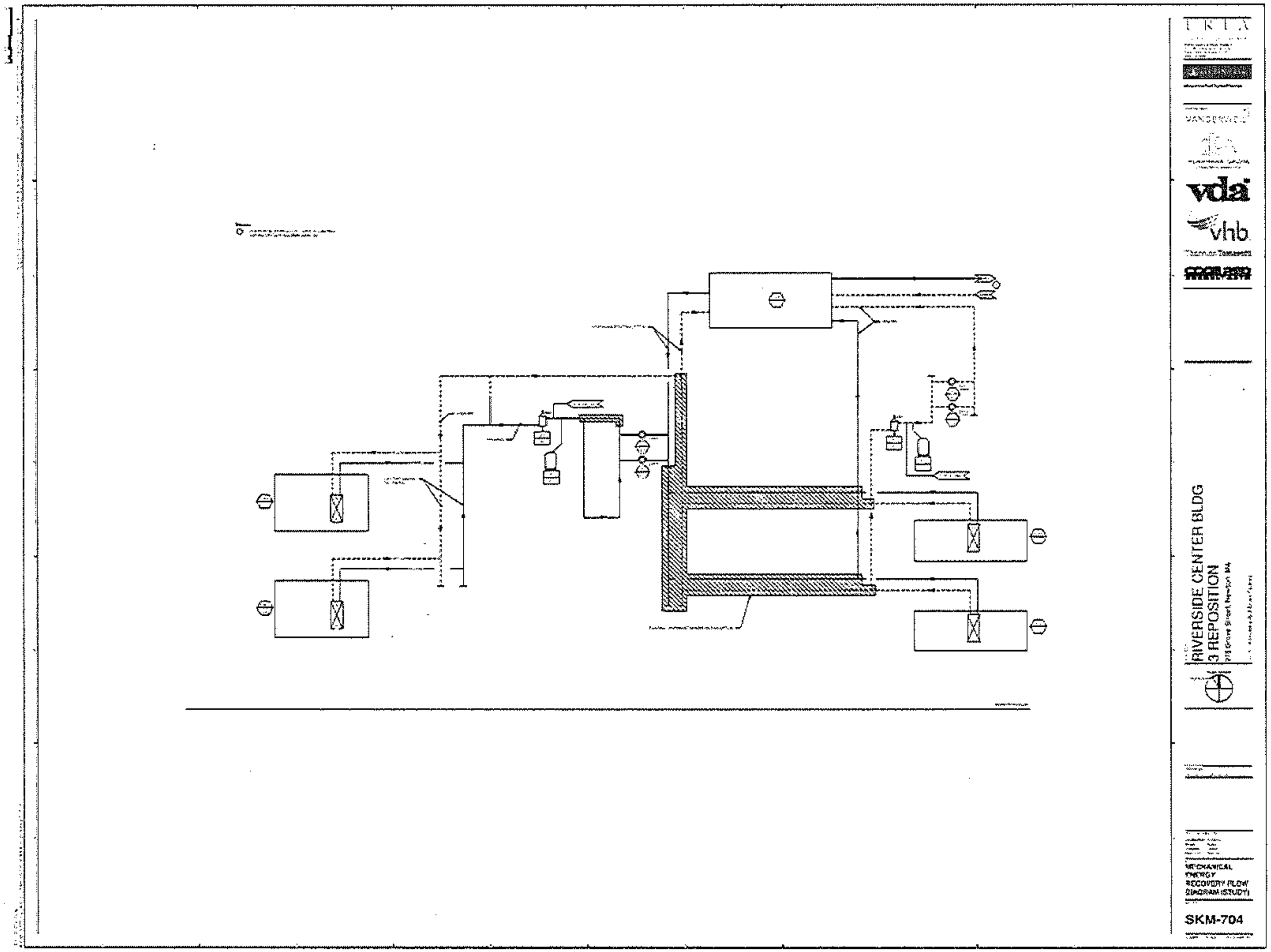


#33-21(3)

SKM-703: MECHANICAL HEATING HOT WATER FLOW DIAGRAM



SKM-704: MECHANICAL ENERGY RECOVERY FLOW DIAGRAM



MODELING HISTORY

DATE	MODEL REPORT	SUMMARY OF CHANGES	DESIGN EUI (KBTU/FT²-YR)	ENERGY CONSUMPTION SAVINGS*	ENERGY COST SAVINGS**	LEED POINTS	MODELER	CHECK
10/01/2021	DD	Original run	152	20.9%* 28.6%**	5.7%* 10.0%**	4	CK	CK/CS
12/13/2021	Heat Pump Study	Evaluation of heat pump option	BOD: 206.7 HSC: 155.4 (heat pump option)	24.8% (heat pump against BOD)	-2.1 (heat pump against BOD)	N/A	CK/NH	CK/CS
03/17/2022	Heat Pump Study - Revision	Revised narratives; no changes to results	BOD: 206.7 HSC: 155.4 (heat pump option)	24.8% (heat pump against BOD)	-2.1 (heat pump against BOD)	N/A	NH	CS

* Compared to the Energy Code Baseline (ASHRAE 90.1-2016 Section 11 ECB Method)

** Compared to the LEEDv4 Baseline (ASHRAE 90.1-2010 Appendix G)

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METHODOLOGY

Vanderweil models energy performance using eQUEST 3.64, a software program that utilizes DOE-2.2 to simulate the hourly energy consumption and demand load shapes for a given building. To develop a model, a graphic representation of the building is created using floor plans, floor heights, and window configurations. Mechanical systems and building envelope are defined, and operating parameters such as lighting power density, airflow rates, and occupancy schedules are included. The simulation uses 30-year average hourly weather data to estimate the energy consumption of the building for each hour of the year.

LIMITATIONS

In order to estimate energy consumption profiles, Vanderweil utilizes traditional computer-based simulation programs such as Trane Trace®, DOE-2, and/or our own in-house calculations and/or programs based on industry standard methods. Vanderweil neither has control of nor assumes control of the actual building, occupant behavior, equipment operation/maintenance, or climatic conditions. Accordingly, Vanderweil does not expressly or implicitly warrant or represent that Vanderweil's energy and associated cost estimates of the building or equipment operation will be the actual operation energy and cost. Rather, the purpose of this energy model is only to compare design options against a baseline to inform design decisions.

CODES & INDUSTRY STANDARDS

U.S. Green Building Council LEED for Interior Design and Construction LEEDv4 ID+C

ASHRAE Standard 90.1-2016 Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE Standard 90.1-2010 Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE Standard 62.1-2016 Ventilation for Acceptable Indoor Air Quality