Minneapolis Public Schools
Special School District #1

Air Conditioning Cost Estimating Study Lake Harriet Community Upper Campus

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DRAFT October 1, 2021

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INTRODUCTION / KEY INFORMATION:

Wold Architects and Engineers was hired May 2021 to develop options with a recommended approach and construction cost estimate to expand the air conditioned area at Lake Harriet Community Upper Campus. The study also reviewed dehumidification capabilities and outlines additional work necessary to provide active dehumidification control. The study approach included a tour of the building site, review of available building construction documents, and a review of previous ventilation studies. Wold collaborated with the District's facility leadership team to establish criteria and guiding principles for developing options and to determine the recommended approach. Cost estimates are developed to reflect construction bids to be received on January 1, 2022 and includes a semi-annual cost inflation escalation to extend bids to January 1, 2025. .

Key Information:

- Building Address: **Lake Harriet Community Upper Campus**
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  Minneapolis, MN 55410
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EXECUTIVE SUMMARY:

Wold Architects and Engineers completed a study to determine the recommended approach and project budget to expand the air-conditioned area at the Lake Harriet Community Upper Campus. The options developed are organized around the priorities established by the District based on the use of each space and by grouping areas within each building geographically as served by common systems. In collaboration with the District, the recommendation was developed to serve the highest priority areas within the overall budget constraints. In addition, the building as a whole was evaluated to determine additional features and systems that are required to provide active dehumidification control.

Criteria / Guiding Principles:

Initial discussions provided a common understanding of the guiding principles to be used to develop options and a hierarchy of priorities based on the use of each space.

Guiding Principles:

- High quality proven system solutions preferred
- Systems shall be easy to operate and maintain
- A high level of temperature zone control required
- Centralized systems preferred
- Vertical unit ventilators may be an option depending on site factors
- DX or chilled water may be options depending on site factors
- Separate systems to serve administration areas should be considered
- COVID risk mitigation measures to focus on ventilation and filtration
- Window AC unit are not an option. Mini-splits may be is limited applications
- Heating for systems may be steam or hot water depending on site factors
- Systems shall be configured to allow for active dehumidification

Air-conditioning classrooms is the primary goal of this study. Additional spaces may be considered where possible within the overall budget constraints. Options were considered where space adjacencies allow opportunities to economically include additional areas. Gymnasiums are not typically air-conditioned but options were considered where they are central to a building and/or used as gathering spaces. It is not an intended outcome of the study to add ventilation and air conditioning to all spaces where it does not currently exist. The summary diagrams for each building identify the remaining unconditioned areas.

In addition, opportunities within each option were determined to provide added value scope where it is economically feasible to accomplish additional deferred maintenance needs within the scope of the air conditioning project i.e. ceilings, lights, and other room finishes.

Recommended Scope Summary:

Classrooms Building Areas #1 and #2 (50,285 Sq Ft): Install a new central variable air volume system with remote DX cooling to serve the classroom areas. Install the new central VAV classroom systems in the existing mechanical room to the extent possible. Install a new DX coil in the 2016 roof mounted air handling unit with a with a remote DX condensing unit. Provide a steam-to-hot water convertor located in the boiler room to provide hot water for the system heating needs and a high efficiency boiler for summer operation. The base project includes installing new ductwork exposed within the classrooms and similar areas. For consideration, an added scope option is included for providing a new lay-in ceiling and new LED lighting and controls. A perimeter soffit is included as may be required to accommodate the height of the exterior windows.

The cost estimate includes a design contingency to cover risks identified that require further investigation. Identified risks include the following:

- Space heating and cooling loads are estimated to determine preliminary equipment selections as a basis for cost estimating. Final heating and cooling loads need to be completed.
- The optimal air-handling unit configuration. A guiding principal is to locate as much of the new equipment inside the existing fan room as possible. Options to optimize the space include combining air-handling zone, determining and alternate outside airflow path, and maybe alternate locations for heat recovery equipment
- Integrity and capacity of the existing steam and condensate systems. Modifications are necessary for the installation of the steam-to-hot water heat exchanger.

Construction Cost Estimate: $ 5,426,000
Add for Ceiling and Lights: $ 1,053,000

Gymnasium Building Area #3 (10,080 Sq Ft): Install a new DX cooling coil in the existing gymnasium air-handling unit. Install a new DX condensing unit on the roof. Modify the existing variable air volume system that serves the adjacent media center to serve the areas adjacent to the gymnasium to improve temperature zone control. For consideration, added scope options are included to providing de-stratification fans in the gymnasium.

The cost estimate includes a design contingency to cover risks identified that require further investigation. Identified risks include the following:

- Adequacy of the existing structure to support the new rooftop unit. Resolution of this risk requires a specific air handling unit selection and an analysis by a structural engineer.

- Access to the gymnasium unit cooling coil section. A preliminary site investigation identified space constraints that may necessitate removing a portion of the exterior wall to accommodate the new coil installation.
- Temperature zone control of areas adjacent to the gymnasium. These areas are currently served by the gymnasium unit and will not have cooling zone control after the new cooling systems is installed. The option included in the cost estimate is to remove them from the gymnasium unit and serve them from the adjacent variable air volume system serving the media center to serve these area and

Construction Cost Estimate:	**$**	**188,000**
Add for De-stratification Fans	**$**	**14,000**

EXISTING BUILDING INFORMATION

The original building was constructed in 1916. A major addition was added in 1922. The classroom addition in 1966 was subsequently converted to the Media Center, Art, and Computer Lab when the Gymnasium was added in 2000. The ventilation system installed in the original 1916 project consisted of a large constant volume fan that distributed air through individual ducts served vertically through the building. The classroom addition in 1922 extended the ductwork from this system to the new areas. The project in 2000 included a constant volume heating only AHU to serve the Gymnasium and a variable air volume system with DX cooling to serve the media center.

There is not a centralized cooling plant. Window AC units or mini-split units serve a portion some areas of the building including the office area and data room.

The building is heated with two large dual fuel fire tube steam boilers. A steam to hot water convertor was installed in 2016 to serve the cafeteria renovation area.

A complete summary of the existing building systems is shown graphically in Appendix A.

Building Area Summary:

Year	Area (sq. ft.)
1915	28,554
1922	23,075
1966	6,494
2000	15,000
Total	**73,123**

AIR CONDITIONING OPTIONS SUMMARY

The Primary driver of the overall project scope and budget is the decision about the air delivery method. The size of the equipment and the configuration within the building affects the work scope of multiple trades to provide pathways for ductwork and piping and to restore building finishes. With each air delivery method, there are multiple options to provide cooling and multiple options to provide heating which typically are part of the overall building central heating and cooling plant strategy. There are long-term benefits to the overall maintenance and operation of the facility to consider the heating and cooling approach for each air delivery option within the overall plan for the central heating and cooling plants that serve the building.

The range of air delivery options presented in this summary are narrowed to those that fit the District's criteria that includes centralizing systems to the extent possible to minimize regular and periodic maintenance. These options typically include vertical unit ventilators, variable air volume central air handling, and dedicated outside air displacement systems. The full range of options are discussed in more detail in the "Air Conditioning Options Detail" section of this report.

In addition to the first cost, the attributes of each system also have an effect on the quality of the learning environment and the on-going operational costs related to energy efficiency and the requirements for regular and periodic maintenance. As an aid for discussion, each of the air delivery options presented are rated relative to each other in terms of good, better, best in each of these performance categories as follows.

Attribute	Vertical Unit Vents	Central VAV	DOAS / Displacement
Environment Quality	Good	Better	Best
Energy Efficiency	Good	Better	Best
Maintenance	Good	Better	Best

A summary of the cost range for viable options for each of the air delivery methods is as follows. The options prioritize adding cooling to the classrooms and are summarized in total to cover all of the currently unconditioned classrooms in the building. Other areas that may include gymnasiums, auditoriums or other common areas are listed separately. All cost are presented as construction costs.

Vertical Unit Ventilators:

Install a vertical unit ventilator along the perimeter of each classroom. The work will include installing a new exterior louver through either a window or cutting a louver through the exterior wall. The range of costs includes is defined by the following approach to heating and cooling.

Low Cost Option: Integral DX, Modify existing hot water system

Medium Cost Option: N/A, The proximity to adjacent neighbors presents risks in meeting the noise ordinance that will require further study.

High Cost Option: Geo-thermal chilled water and hot water plant

Vertical Unit Ventilators					
Building Area	**Serves**	**Area SF**	**Construction Budget**		
			Low	**Medium**	**High**
#1	Classrooms	48,305			
Total		**48,305**	**$1,554,000**	**$2,340,000**	**$3,690,500**

Central Variable Air Volume:

Install a variable central air handling system in each of the building areas. Install a new air-handling unit in the location of the existing. Replace the existing ductwork with new insulated ductwork along the same pathways. Building Are #2 is served by a rooftop unit installed in 1999 that was planned for the addition of a future cooling coil.

Low Cost Option: Remote DX, Modify existing Steam System, Cooling only VAV's. The proximity to adjacent neighbor's presents risks in meeting the noise ordinance and will require further study.

Medium Cost Option: Remote DX, Steam service to AHU's, Hot water service to VAV's from a steam convertor. The proximity to adjacent neighbor's presents risks in meeting the noise ordinance and will require further study.

High Cost Option: Geo-thermal chilled water and hot water plant

Central Variable Air Volume					
Building Area	**Serves**	**Area SF**	**Construction Budget**		
			Low	**Medium**	**High**
#1	Classrooms	48,305	$4,006,000	$4,842,000	$5,665,000
#2	Classrooms	1,980	$66,000	$66,000	$66,000
Total		**50,285**	**$4,072,000**	**$5,426,000**	**$6,231,000**

Dedicated Outside Air/Displacement:

Install a central dedicated outside air system to serve all classroom areas. The dedicated outside air unit would be located in the boiler room. Install a new air-handling unit in the location of the existing. Replace the existing ductwork with new insulated ductwork along the

same pathways. There are considerable challenges to create new pathways for ductwork and piping because of the wood structure.

Low Cost Option: Displacement requires both chilled and hot water. Work is necessarily required on the central heating plant.

Medium Cost Option: Air-cooled chiller, Steam to HW convertor. The proximity to adjacent neighbor's presents risks in meeting the noise ordinance and will require further study.

High Cost Option: Geo-thermal chilled water and hot water plant

Dedicated Outside Air / Displacement					
Building Area	**Serves**	**Area SF**	**Construction Budget**		
			Low	**Medium**	**High**
#1	Classrooms	48,305	N/A		
Total		**48,305**	N/A	**$5,253,500**	**$5,887,500**

Additional Scope:

Additional work that may be considered with each of these options includes the following:

New Ceilings and LED Lights: **Construction Budget** **$ 1,053,000**

AIR CONDITIONING SCOPE DETAIL

The following options to expand air conditioning are noted as "Building Area #'s". The area to be air-conditioned is annotated on the Proposed Systems Diagrams in Appendix B.

Building Area 1 – 1916 Building (48,305 SF): The following is a summary of the range of possible options considered.

Options Summary:

Building Area	Air Delivery Method	Cooling Plant	Heating Plant	Option
1 – 1916 Building	A - Mini-Split	B - Remote DX	A - None	1-ABA
	B - Vertical Unit Vents	A - Integral DX	B - Steam	1-BAB
			C - Hot Water*	1-BAC
		B - Remote DX	B - Steam	1-BBB
			C - Hot Water*	1-BBC
		C - Chilled Water*	B - Steam	1-BCB
			C - Hot Water*	1-BCC
	C - Central VAV	B - Remote DX	B - Steam	1-CBB
			C - Hot Water*	1-CBC
		C - Chilled Water*	B - Steam	1-CCB
			C - Hot Water*	1-CCC
	D - DOAS	C – Chilled Water*	C – Hot Water*	1-DCC

Notes: * There are multiple central plant options for chilled and hot water. Refer to the Central Plant section of this report.

Air Delivery: The original 1916 building construction included a large constant volume single zone heating only air handling unit located on the ground floor of the building adjacent to the boiler room. Ventilation air is ducted to each ventilation zone from the ground floor vertically to each classroom. It appears that air is supplied to the 1922 addition by a pressurized ceiling plenum on the ground floor. The following outlines possible new air delivery methods:

Mini-split: The systems would be installed while leaving the existing heating and ventilation systems in place. Because unconditioned ventilation air is delivered to the space by the central system, there is a risk of creating high humidity conditions.

Vertical Unit Ventilators: Install new vertical unit ventilators to replace the existing central air handling system. An outside and relief air will be though a new louver installed in one of the existing windows. Modifications will be required to the perimeter steam finned tube radiation. The classrooms typically do not have perimeter casework.

Central Variable Air Volume (VAV): The ground floor mechanical room is a large area that will be utilized to the extent possible for new air handling equipment. It is anticipated that the current MN Energy Code will require energy recovery for systems serving the classrooms. It is possible that new heat recovery equipment will need to be located

outside the building on grade to the east. It is anticipated that the new air handling systems will need to be field constructed in place due to limited access to the mechanical room. The existing supply ductwork will be replaced to allow for the ductwork to be insulated. A new return air path will need to be determined. Variable air volume boxes for each zone will be located typically within the classrooms. Soffits and ceilings should be considered as part of the final design to minimize sound and improve air distribution.

Dedicated Outside Air (DOAS): Options for locating a new DOAS unit are similar to locating the VAV unit as describe above. The advantage of a DOAS unit is that the volume of air it is moving is approximately 1/3 as compared to the VAV system. The equipment and associated ductwork are smaller and easier to retrofit.

Cooling Plant: Viable options studied include integral packaged DX, remote DX, and construction of a new central chilled water plant. The tight site and proximity to the neighboring residential areas to the north, east, and west presents challenges in designing new equipment to meet the noise criteria at the property line. It may be possible to locate the chiller to the south in the hard pay surface area. The following outlines possible cooling plant options:

Integral Direct Expansion (DX): Integral DX is an option with the vertical unit ventilators and there is precedent with this type of system in the District. Design considerations need to include meeting the classroom ambient sound levels. Integral cooling systems have an impact on future maintenance by distributing possible failure points of the system.

Remote Direct Expansion (DX): Remote DX is an option for mini-split systems and vertical unit ventilators. The condensing units can be located above each space on the roof.

Chilled Water: There are multiple options to generate chilled water to meet the cooling needs of the building. Refer to the central plant options in this report for a discussion of each.

Heating Plant: Viable options include leaving the existing steam systems in place and installing a cooling only system, connecting to the existing steam plant, installing a steam to hot water convertor, or installing a new high efficiency hot water plant. The following outlines possible heating plant options.

Steam: The building is currently heated by two large dual fuel steam fire tube boilers. The steam options includes modifying steam and condensate distribution piping to accommodate the new systems.

Hot Water HX: Includes the installation of a new steam-to-hot water heat exchanger, pumps and distribution system to deliver hot water to the new systems. Hot water distribution piping is more flexible to route to location as necessary than steam piping.

The installation of a heat exchanger will easily accommodate future conversion of the stem plant to hot water.

Hot Water Plant: There are multiple options to generate hot water to meet the heating needs of the building. Refer to the central plant options in this report for a discussion of each.

Dehumidification: Active dehumidification requires a heating source that is currently not available with the existing steam plant during the summer months. Options for active dehumidification will depend on the extent of hot water that is installed with the new systems. If hot water distribution is included as the heating source, the heating coils will be located in the reheat position downstream of the cooling coils. If hot water is generated through a steam-to-hot water convertor, then reheat will only be possible when the steam boiler is in operation. An option to extend the time that hot water is available is to add a small high efficiency gas boiler. If the project include replacing the steam plant, the boiler capacity would be selected to provide adequate turn down during low load periods.

Project Risks: The following are design risks identified in implementing this project. The cost estimate includes a 15% design contingency to cover these risks. Further investigation into each of these could better define the solution and allow the design contingency to be reduced.

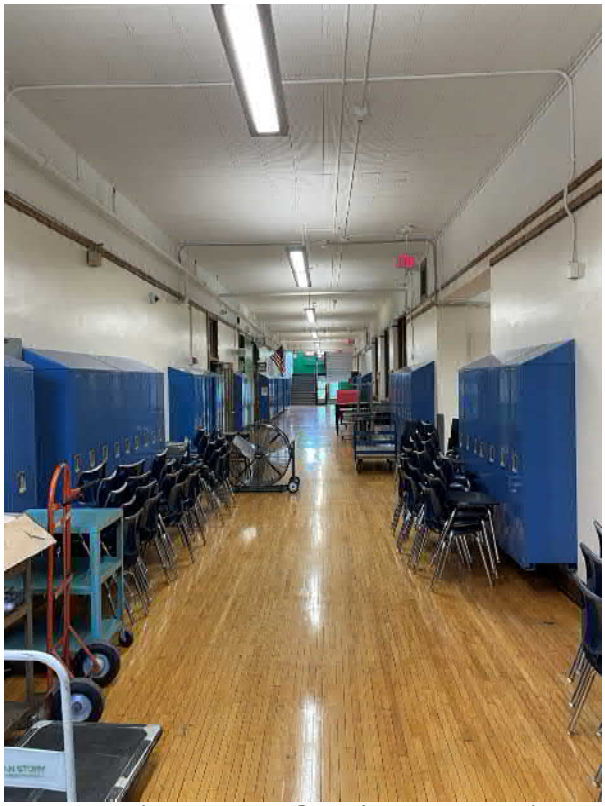
- Determine the optimal system configuration with the central air handling unit options. A guiding principal is to locate as much of the new equipment inside the existing fan room as possible. Options to optimize the space include combining air-handling zone, determining and alternate outside airflow path, and maybe alternate locations for heat recovery equipment.
- Space heating and cooling loads are estimated based on typical loads for this type of space. Final heating and cooling loads need to be completed.
- Integrity of the existing steam and condensate systems for options that include steam heating. Piping in poor condition may necessitate additional pipe removal. The best method to mitigate this risk is to pursue the hot water heating solution as outlined in the heating section above.
- Determine structural constraints. Roof mounted remote condensing units will need to be reviewed for structural limitations. Further structural investigation is required.

Additional Scope Considerations: The following items could be considered for inclusion in the project work scope. These items are not directly related to adding air conditioning but there would be cost efficiency by including them in the project scope and the have added value as noted.

- *Provide new ceilings and lights:* Provide new lay-in ceilings typically throughout with new LED lighting and controls. With the vertical unit ventilator options, new ceilings would allow for the air distribution above the ceiling to reduce the system noise. The ceiling condition likely will require a soffit along the exterior walls to accommodate the existing windows elevations.

Typical Photos:

Typical Classroom



First Floor Corridor – Looking East

Building Area 2 – 1966 Second Flr Addition (1,980 SF): The following is a summary of the range of possible options considered.

Options Summary:

Building Area	Air Delivery Method	Cooling Plant	Heating Plant	Option
2 – 1966 Second Flr Addition	A - Mini-Split	B - Remote DX	A - None	2-ABA
	B - Vertical Unit Ventilators	A - Integral DX	B - Steam	2-BAB
			C - Hot Water*	2-BAC
		B - Remote DX	B - Steam	2-BBB
			C - Hot Water*	2-BBC
		C - Chilled Water*	B - Steam	2-BCB
			C - Hot Water*	2-BCC
	D - DOAS	C – Chilled Water*	C – Hot Water	2-DCC
	E - Add Cooling to Existing AHU	B - Remote DX	C - Steam	2-EBC
		C - Chilled Water*	C - Steam	2-ECC
	F - Add a CC and Convert to VAV	B - Remote DX	B - Steam	2-FBB
			C - Hot Water*	2-FBC
		C - Chilled Water*	B - Steam	2-FCB
			C - Hot Water*	2-FCC

Notes: * There are multiple central plant options for chilled and hot water. Refer to the Central Plant section of this report.

Air Delivery: The 1966 addition infilled an area on the second floor of the building on the east side. The project in 2000 added a rooftop air handling unit to serve the space as a single zone constant volume system. Air is distributed to each temperature control zone through supply and return located above the ceiling. The rooftop unit was provided with space to accommodate a future cooling coil. The following outlines possible new air delivery methods:

Mini-split: The systems would be installed while leaving the existing heating and ventilation systems in place. Because unconditioned ventilation air is delivered to the space through the existing unit ventilator, there is a risk of creating high humidity conditions.

Vertical Unit Ventilators: Install new vertical unit ventilators to replace the existing central air handling system. An outside and relief air will be though a new louver installed in one of the existing windows. Modifications will be required to the perimeter steam finned tube radiation.

Central Variable Air Volume (VAV): The existing variable air volume rooftop unit installed in 2000 was provided with space for a future cooling coil. Retrofit the existing AHU with a cooling coil. Further investigation is needed to determine if the supply duct is fully insulated. The existing systems is single zone constant volume. It is also an option to convert the system to variable air volume and provide a VAV box with terminal reheat for each zone.

Dedicated Outside Air (DOAS): The best option for providing a dedicated outside air system would be to include this area with the solution for Building Area 1.

Cooling Plant: Viable options studied include integral packaged DX, remote DX, and construction of a new central chilled water plant. The tight site and proximity to the neighboring residential areas presents challenges in designing new equipment to meet the noise criteria at the property line. The following outlines possible cooling plant options:

Integral Direct Expansion (DX): Integral DX is an option with the vertical unit ventilators and there is precedent with this type of system in the District. Design considerations need to include meeting the classroom ambient sound levels. Integral cooling systems have an impact on future maintenance by distributing possible failure points of the system.

Remote Direct Expansion (DX): Remote DX is an option for mini-split systems, vertical unit ventilators, and retrofitting the existing rooftop air-handling unit. The condensing units can be located directly above each space on the roof.

Chilled Water: There are multiple options to generate chilled water to meet the cooling needs of the building. Refer to the central plant options in this report for a discussion of each.

Heating Plant: Viable options include leaving the existing steam systems in place and installing a cooling only system, connecting to the existing steam plant, installing a steam to hot water convertor, or installing a new high efficiency hot water plant. The following outlines possible heating plant options.

Steam: The building is currently heated by two large dual fuel steam fire tube boilers. The steam options includes modifying steam and condensate distribution piping to accommodate the new systems.

Hot Water HX: The area is currently served by with hot water from a steam to hot water heat exchanger installed in the 1999 construction. The heat exchanger is sized to accommodate the variable air volume system installed at that time. Includes the installation of a new steam-to-hot water heat exchanger, pumps and distribution system to deliver hot water to the new systems. Hot water distribution piping is more flexible to route to location as necessary than steam piping. The installation of a heat exchanger will easily accommodate future conversion of the stem plant to hot water.

Hot Water Plant: There are multiple options to generate hot water to meet the heating needs of the building. Refer to the central plant options in this report for a discussion of each.

Dehumidification: Active dehumidification requires a heating source that is currently not available with the existing steam plant during the summer months. Options for active dehumidification will depend on the extent of hot water that is installed with the new systems.

If hot water distribution is included as the heating source, the heating coils will be located in the reheat position downstream of the cooling coils. If hot water is generated through a steam-to-hot water convertor, then reheat will only be possible when the steam boiler is in operation. An option to extend the time that hot water is available is to add a small high efficiency gas boiler. If the project include replacing the steam plant, the boiler capacity would be selected to provide adequate turn down during low load periods.

Project Risks: The following are design risks identified in implementing this project. The cost estimate includes a 15% design contingency to cover these risks. Further investigation into each of these could better define the solution and allow the design contingency to be reduced.

- Space heating and cooling loads are estimated based on typical loads for this type of space. Final heating and cooling loads need to be completed.
- Integrity of the existing steam and condensate systems for options that include steam heating. Piping in poor condition may necessitate additional pipe removal. The best method to mitigate this risk is to pursue the hot water heating solution as outlined in the heating section above.
- Determine structural constraints. Roof mounted remote condensing units will need to be reviewed for structural limitations.
- Fully insulating the existing ductwork for options that reuse the existing distribution system will be extremely difficult. Uninsulated portions of the duct are at risk of sweating and being a source of microbial growth.

Additional Scope Considerations: The following items could be considered for inclusion in the project work scope. These items are not directly related to adding air conditioning but there would be cost efficiency by including them in the project scope and the have added value as noted.

- *Provide new ceilings and lights:* Provide new lay-in ceilings typically throughout with new LED lighting and controls. With the vertical unit ventilator options, new ceilings would allow for the air distribution above the ceiling to reduce the system noise. The ceiling condition likely will require a soffit along the exterior walls to accommodate the existing windows elevations.

Typical Photo:

Room 207

Building Area 3 – Gymnasium (10,000): The following is a summary of the range of possible options considered.

Options Cost Summary:

Building Area	Air Delivery Method	Cooling Plant	Heating Plant	Option
3-Gymansium	E – Add CC to Ex. AHU	B-Remote DX	C - Hot Water*	3-EBC
		C - Chilled Water*	C - Hot Water*	3-ECC

Notes: * There are multiple central plant options for chilled and hot water. Refer to the Central Plant section of this report.

Air Delivery: The gymnasium is ventilated by a single zone constant volume system installed in 2000 located on a mezzanine adjacent to the gymnasium. The unit is installed with a section for a cooling coil; however, the width of the mechanical room may necessitate removing a section of an adjacent wall to install the coil. The gymnasium unit also serves the adjacent corridor on the ground level. Options to improve temperature zone control need to be further investigated including adding the corridor to the adjacent variable air volume system that serves the Media Center. The following outlines possible new air delivery methods:

Central Constant Air Volume (CV): Retrofit the existing single zone constant volume system with a new cooling coil.

Cooling Plant: Viable options studied include remote DX and construction of a new central chilled water plant. The tight site and proximity to the neighboring residential areas presents challenges in designing new equipment to meet the noise criteria at the property line. The following outlines possible cooling plant options:

Remote Direct Expansion (DX): Install a remote DX condensing unit on the roof adjacent to the roof mounted air-handling unit.

Chilled Water: There are multiple options to generate chilled water to meet the cooling needs of the building. Refer to the central plant options in this report for a discussion of each.

Heating Plant: Viable options include leaving the existing steam systems in place and installing a cooling only system, connecting to the existing steam plant, installing a steam to hot water convertor, or installing a new high efficiency hot water plant. The following outlines possible heating plant options.

Hot Water HX: The existing system is served by a steam to hot water heat exchanger.
Hot Water Plant: There are multiple options to generate hot water to meet the heating needs of the building. Refer to the central plant options in this report for a discussion of each.

Dehumidification: Active dehumidification requires a heating source that is currently not available with the existing steam plant during the summer months. Hot water is generated through a steam-to-hot water convertor and will only be possible when the steam boiler is in operation. An option to extend the time that hot water is available is to add a small high efficiency gas boiler. If the project include replacing the steam plant, the boiler capacity would be selected to provide adequate turn down during low load periods.

Project Risks: The following are design risks identified in implementing this project. The cost estimate includes a 15% design contingency to cover these risks. Further investigation into each of these could better define the solution and allow the design contingency to be reduced.

- Space heating and cooling loads are estimated based on typical loads for this type of space. Final heating and cooling loads need to be completed.
- Space constraints related to adding a cooling coil to the existing unit needs to be investigated to ensure there is still appropriate access.
- Determine structural constraints. Roof mounted equipment will need to be reviewed for structural limitations.

Typical Photos:

Gymnasium

9 - Central Plant Options: Centralizing the heating and cooling plants has benefits of replacing aged infrastructure, improving the overall operating efficiency of the building and reducing on-going maintenance cost by reducing the number of failures points in the building systems. The building currently has a centralized steam plant. The building does not have a centralized cooling systems approach. The following options have been considered.

Options Cost Summary:

Building Area	Cooling Approach	Heating Approach	Option
9 - Central Plant	A - Air Cooled Chiller	A - STM Distribution	9-AA
		B - STM w/ HW HX	9-AB
		C - HW Plant	9-AC
	C - Geo Thermal	A - STM Hybrid	9-CA
		B - HW Hybrid	9-CB
		C - Full Size Heat	9-CC

Cooling Plant: Centralizing the building cooling plant will improve the overall building operating efficiency and reduce the on-going maintenance requirements. The tight urban location and proximity to residential neighbors presents a risk of noise from centralized systems having a negative impact. Any centralized solution that has outside equipment will need to be evaluated for the sound levels at the adjacent property line. A 120-ton chiller capacity is assumed for cost estimation purposes based on a square foot estimate. Final load calculations are necessary to determine the final chiller size.

Air Cooled Chiller: The boiler room is on the east side of the building. Locating the chiller in the adjacent parking lot will minimize the cost of installation, however, the close proximity of neighbors on the east side of the building will make it a challenge to install the chiller and meet sound criteria at the property line. The best option to reduce the sound risk is to locate the chiller to the south adjacent to the hard play surface. For the purposes of estimating, it is assumed that the chiller will have all of the available factory sound attenuation features and will be installed in a masonry enclosure with sound attenuating panels.

Ground Coupled Geo-thermal: A ground coupled geothermal solution has considerable advantages in eliminating the risk of a sound impact to the adjacent residential neighbors. The hard play surface to the south has ample room for a well field. Alternate geothermal technologies including Darcy Solutions closed loop systems should be considered to reduce the cost and size of the well field.

Heating Plant: Two dual fuel steam fire-tube boiler currently serves the entire building for heating. Converting the building to hot water for heating will reduce the overall operating cost of the building, reduce the regular maintenance requirements, and allow greater flexibility in routing piping to terminal heating systems throughout the building.

Hot Water Boilers: Includes replacing the existing steam systems with a new high efficiency hot water dual fuel boiler plant. The plant will consist of multiple boilers to provide redundancy in the event of equipment failure. The existing steam and condensate piping will be removed. A variable primary hot water supply and return with multiple supply pumps will be distribute hot water throughout the building.

Ground Coupled Geo-thermal: If the ground coupled geo-thermal option is selected for cooling, the plant would also provide heating capacity for the building. Options for geo-thermal would be to increase the size of the well field and deliver all of the building heating needs from the central plant or provide a hybrid plant that includes high efficiency boiler capacity for peak heating loads. Because of the limited site available for the well field, increasing to size to match the building heating loads may not be possible. Further evaluation and a test well is necessary to determine the maximum heating capacity potential.

Typical Photo:

Possible Geo Thermal Well Field – South of Building

Appendix A:

Existing Systems Diagram

Redacted

Appendix B:

Proposed Systems Diagrams

Redacted

Appendix C:

Dehumidification Capabilities

The recommended solution to provide air conditioning to the classrooms includes providing a high efficiency boiler for summer operation. Areas included in the scope for a new variable air volume system will be capable of active de-humidification.

Appendix D:

Cost Estimate Detail

SSD#1 Minneapolis Public Schools
Air Conditioning Cost Estimating

Cost Basis - June 2021

		Ventilation Area	Bldg Total			
BUILDING AREA 1 - 1916 Classrooms	48,305					
BUILDING AREA 2 - 1966 Classrooms	1,980			**Gymnasium**		
Area - SQ FT	**50,285**	**50,285**	**73,123**	**Building Area #3**	**10,080 SQ FT**	

Specification Division	**Area #1 and #2 - Central VAV, Remote DX, HW VAV's**			**Building Area #3 - Retrofit Existing, Remote DX**			**Area #1 and #2 - Add for Ceilings and Lights**		
	Sq. Ft. / Qty	**Unit Cost**	**Cost**	**Sq. Ft. / Qty**	**Unit Cost**	**Cost**	**Sq. Ft. / Qty**	**Unit Cost**	**Cost**
Division 02 - Demolition (excludes Div 21, 22, 23, and 26)			**$ 50,285**			**$ 1,200**			**$ 25,143**
Miscellaneous	50,285	$ 1.00	$ 50,285	1	$ 1,200	$ 1,200	50,285	$ 0.50	$ 25,143
Division 03 - Concrete			**$ 31,143**			**$ -**			**$ -**
Floor Patch and Repair	50,285	$ 0.50	$ 25,143			$ -			$ -
Cast-in-place / Misc	2	$ 3,000	$ 6,000			$ -			$ -
Division4 - Masonary			**$ 80,000**			**$ 12,000**			**$ -**
Non-bearing Infill	1	$ 80,000	$ 80,000	1	$ 12,000	$ 12,000			$ -
Load bearing - new wall construction			$ -			$ -			$ -
Division 5 - Metals			**$ 25,143**			**$ 6,000**			**$ -**
Structural Steel / Misc. Fabrications Allowance	50,285	$ 0.50	25,143	1	$ 6,000	6,000			-
Division 6 - Carpentry			**$ -**			**$ -**			**$ -**
Rough Carpentry			$ -			$ -			$ -
Casework Modifications						$ -			$ -
Division 7 - Thermal / Moisture Protection			**$ -**			**$ 3,500**			**$ -**
Roof Patch and Repair			$ -	1	$ 3,500	$ 3,500			$ -
Roof New Construction			$ -			$ -			$ -
Fire Stopping / Miscellaneous			$ -			$ -			$ -
Division 8 - Openings			**$ 18,000**			**$ -**			**$ -**
Access Panels			-			-			-
Doors / Hardware			-			-			-
Windows			-			-			-
Louvers	4	$ 4,500	18,000			-			-
Division - 9 Finishes			**$ 356,603**			**$ 4,000**			**$ 326,853**
Soffits / Chases	50,285	$ 3.50	$ 175,998			$ -	50,285	$ 2.00	$ 100,570
Floor Patch and Repair	50,285	$ 2.00	$ 100,570	1	$ 4,000	$ 4,000			$ -
Acoustic Ceilings	8,500	$ 3.50	$ 29,750			$ -	50,285	$ 3.50	$ 175,998
Painting	50,285	$ 1.00	$ 50,285			$ -	50,285	$ 1.00	$ 50,285
Division 10 - Specialties			**$ -**			**$ -**			**$ -**
Miscellaneous			-			-			-
Division 11 - Equipment			**$ -**			**$ -**			**$ -**
Miscellaneous			$ -			$ -			$ -
Division 12 - Furnishings			**$ -**			**$ -**			**$ -**
Casework			$ -			$ -			$ -
Miscellaneous			$ -			$ -			$ -
Division 21 - Fire Protection			**$ 100,570**			**$ -**			**$ 125,713**
Demolition	-		$ -			$ -			$ -
New / Modify Existing	50,285	$ 2.00	$ 100,570			$ -	50,285	$ 2.50	$ 125,713
Division 22 - Plumbing			**$ -**			**$ -**			**$ -**
Demolition			$ -			$ -			$ -
Plumbing Fixtures			$ -			$ -			$ -
Micellaneous			$ -			$ -			$ -
Division 23 - HVAC			**$ 3,146,679**			**$ 104,900**			**$ -**
Air Handling Equipment (VUV's / AHU's / RTU's)	1	$ 180,000	$ 180,000			$ -			$ -
Cooling Plant Equipment (Chiller / DX / Heat Pump)	1	$ 160,000	$ 160,000	1	$ 14,000	$ 14,000			$ -
Heating Plant Equipment (Boiler)	1	$ 45,000	$ 45,000			$ -			$ -
Demolition	50,285	$ 0.75	$ 37,714	1	$ 2,400	$ 2,400			$ -
AHU Equipment Installation / Start-up	1	$ 40,000	$ 40,000	0	$ 1,800	$ -			$ -
Cooling Plant Equipment Installation			$ -	1	$ 28,000	$ 28,000			$ -
Heating Plant Installation	1	$ 180,000	$ 180,000			$ -			$ -
Chilled Water Distribution			$ -			$ -			$ -
Steam / Condensate Distribution	2	$ 20,000	$ 40,000			$ -			$ -
Hot Water Distribution	50,285	$ 10.00	$ 502,850	1	$ 10,000	$ 10,000			$ -
Ductwork Distribution Misc. (VAV's / Exhaust)	50,285	$ 32.00	$ 1,609,120	1	$ 30,000	$ 30,000			$ -
Controls	50,285	$ 6.50	$ 326,853	1	$ 14,000	$ 14,000			$ -
Test and Balance	50,285	$ 0.50	$ 25,143	1	$ 6,500	$ 6,500			$ -
Division 26 - Electrical			**$ 181,893**			**$ 7,500**			**$ 301,710**
Demolition	50,285	$ 0.50	$ 25,143			$ -	50,285	$ 1	$ 25,143
Electrical Service	1	$ 50,000	$ 50,000			$ -			$ -
Power Connections	4	$ 15,000	$ 60,000	1	$ 7,500.00	$ 7,500			$ -
Lighting and Controls	8,500	$ 5.50	$ 46,750			$ -	50,285	$ 5.50	$ 276,568
Division 27 - Technology			**$ 25,143**			**$ -**			**$ -**
Demolition Allowance			$ -			$ -			$ -
Fire / Sound / Data Allowance	50,285	$ 0.50	$ 25,143			$ -			$ -
DIVISION SUB-TOTAL			**$ 4,015,456**			**$ 139,100**			**$ 779,418**
Division 1 - General Conditions			**$ 702,705**			**$ 24,343**			**$ 136,398**
OH & P	10%		$ 401,546			$ 13,910			$ 77,942
Liability Insurance	1%		$ 40,155			$ 1,391			$ 7,794
Performance Bond	2%		$ 60,232			$ 2,087			$ 11,691
General Contractor Misc.	5%		$ 200,773			$ 6,955			$ 38,971
CONSTRUCTION SUB-TOTAL			**$ 4,718,161**			**$ 163,443**			**$ 915,816**
CONTINGENCY	15%		**$ 707,724**			**$ 24,516**			**$ 137,372**
CONSTRUCTION GRAND-TOTAL			**$ 5,425,885**			**$ 187,959**			**$ 1,053,188**
COST per SQ FT			**$ 107.90**			**$ 18.65**			**$ 14.40**