Minneapolis Public Schools
Special School District #1

Air Conditioning Cost Estimating Study
Kenwood Community School

Wold Architects and Engineers
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DRAFT October 1, 2021

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APPENDIX

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 of the Kenwood Community School. 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: **Kenwood Community School**
  Minneapolis Public Schools
  66 Malcolm Ave. SE
  Minneapolis, MN 55410
  Phone: (612) 668-2760
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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 Kenwood Community School. 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 Area #1 (27,420 Sq Ft): Install a new central variable air volume system in the location of the existing. Replace the existing ductwork with new insulated ductwork with VAV boxes and hot water reheat along the same pathways. Provide a new ground coupled geo-thermal systems to serve the building heating and cooling needs. Convert the remaining building steam systems to hot water operation. The geothermal system designed with capacity to provide cooling for the entire building; specifically for the future inclusion of areas currently served by DX outside of building area #1 and those areas currently not cooled. The base project includes connecting the new office system to the existing distribution ductwork. Replace the ductwork serving the commons area with new insulated supply ductwork. 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 new 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.
- The site geology and its specific characteristics to support a ground coupled geo-thermal systems have not been tested. Assumptions have been included for cost estimating.

Construction Cost Estimate: $ 3,742,000
Add for Ceiling and Lights: $ 479,000

Commons Building Area #2 (1,460 Sq Ft): Install a constant volume fan coil unit to serve the commons area. Because of the way the existing systems are installed in the mechanical room, replacement of the commons systems will require replacement of the system serving the office area. Connect each of these two systems to the new central geo-thermal chilled water and hot water plant. The base project includes routing supply 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.

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.

Construction Cost Estimate: $ 222,000

Gymnasium Building Area #3 (10,220 Sq Ft): Replace the existing constant volume air handling unit with a new constant volume unit. Connect to the new geo-thermal chilled water and hot water plant Connect to the exiting supply and return ductwork. For consideration, an added scope option is included adding de-stratification fans.

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.

Construction Cost Estimate: $ 298,000
Add for De-stratification Fans: $ 22,000

EXISTING BUILDING INFORMATION

The original building was constructed in 1908. Two major additions were added in 1906 and 1926. A project in 1961 replaced the original mechanical systems and installed horizontal steam unit ventilators throughout the building. A project in 2015 renovated the office area and added mini-split systems for cooling. The gymnasium air handling system was replaced in 2020 with steam heat and DX cooling.

There is not a centralized cooling plant. The Gymnasium is served by a constant volume system with DX cooling. Window AC units or mini-split units serve a portion of the rest of the building.

The building is heated with one large dual fuel fire tube steam boiler.

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

Building Area Summary:

Year	Area (sq. ft.)
1908	22,587
1923	13,553
1965	15,246
1981	9,914
Total	**42,032**

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.

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	27,420		N/A	
Total		**27,420**	**$1,057,500**		**$3,129,500**

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

Low Cost Option: Remote DX, Modify existing Steam System, Cooling only VAV's

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

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	27,420			
Total		**27,420**	**$1,826,500**	**$2,007,000**	**$3,742,000**

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. The classrooms have perimeter casework that will need

to be created elsewhere in the room. The budget provides a casework allowance for each of the classrooms.

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Dedicated Outside Air / Displacement					
Building Area	**Serves**	**Area SF**	**Construction Budget**		
			Low	**Medium**	**High**
#1	Classrooms	27,420	N/A	N/A	
Total		**27,420**	N/A	N/A	**$4,012,000**

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

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

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

Additional Scope:

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

New Ceilings and LED Lights: **Construction Budget** **$ 479,000**

AIR CONDITIONING SCOPE OPTIONS

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: 1908 / 1923 Classrooms (27,420 Sq. Ft.): 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 – 1908 / 1923 Classrooms	A - Mini-Split	B - Remote DX	A - None	1-ABA
	B - Vertical Unit Ventilators	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 1908 building construction included a large supply fan located in a mechanical room on the ground floor. Ductwork from the system installed in1908 was extended to serve the 1923 addition. The unit was replaced with a single zone constant volume heating only system in 1980. A single zone heating only unit installed in 1980 serves the multi-purpose room. 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 horizontal unit ventilators in approximately the same location. Modifications will be required to the casework and finned tube radiation. Outside and relief would be available by replacing one of the windows adjacent to each unit ventilator.

Central Variable Air Volume (VAV): Replace the existing air handling unit with a new central variable air volume unit. It is anticipated that the current MN Energy code will

require heat recovery to be incorporated into the system. The existing supply and return duct pathways will be reused. The supply duct will need to be insulated to mitigate the risk of condensation. Install new variable air volume boxes in each control zone and extent supply ductwork to serve the space. Consideration should be given to provide new ceilings and soffits to control mechanical system sound levels and to provide better air distribution. The existing return and relief ductwork are tied together in the attic space. Replace the existing relief opening with a new variable speed propeller fan to control building pressure.

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 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 in an option for mini-split systems. Installing remote condensing units on the roof is an option for the vertical ventilator solution. It is anticipated that structural limitation will require a remote condensing unit for a central air handling solution be located on grade. Sound levels at the property line need to be consider due to the tight proximity to adjacent neighbors.

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: A single dual-fuel fire tube boiler heats the building. A hot water convertors installed in 1965 and 1980 deliver hot water to the majority of the building heating terminal equipment. Viable options include leaving the existing systems in place and installing a cooling only system, modifying the existing steam and hot water distribution systems, installing additional steam to hot water convertor capacity to serve all new systems with hot water, or installing a new high efficiency hot water plant. The following outlines possible heating plant options.

Modify Existing Heating Systems: The building is currently heated by a single large dual fuel steam fire tube boiler. Steam to hot water convertors installed in 1965 and 1980 deliver hot water to the majority of the building terminal heating systems.

Hot Water HX: Includes installing additional hot water heat exchanger capacity to serve all new system with hot water. Hot water distribution piping is more flexible to route to location as necessary than steam piping. The installation of a heat exchanger will 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.

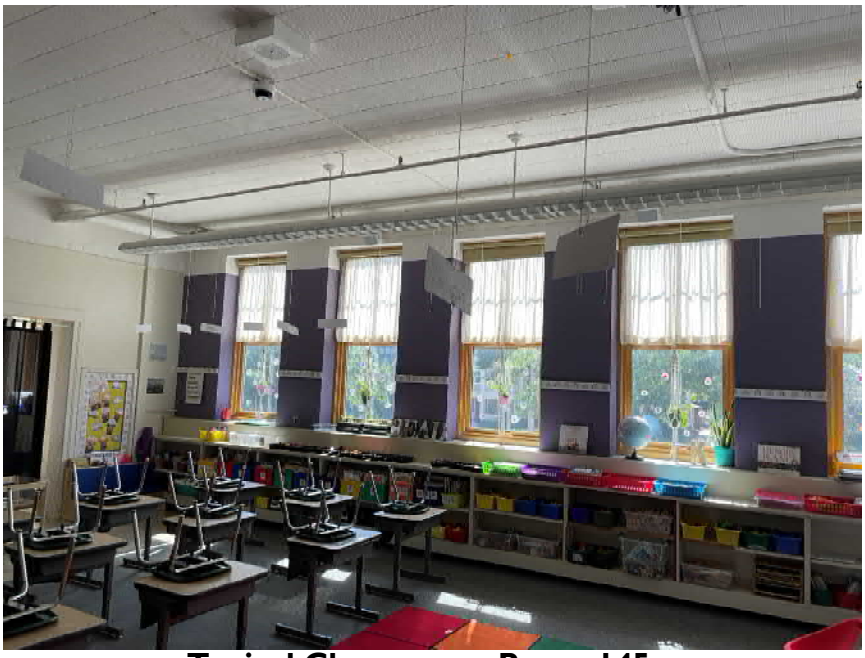
Project Risks: The following are design risks identified in implementing this project. The cost estimate includes a 15% design contingency to cover these risks. Further investigation into each of these could better define the solution and allow the design contingency to be reduced.

- Structural constraints for solutions that require new roof mounted equipment. The original vaulted roof constructed in 1908 was replaced with the current flat roof.
- Determining how new equipment will fit in the existing mechanical room for central air-handling solutions. It is anticipated that heat recovery will be required systems serving the classroom areas. Outside and return air are currently mixed in the attic space. A new outside air intake location may need to be determined.
- 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.
- Mitigating the risk of condensation for solutions that reuse the existing supply-air duct pathways. Full replacement of the supply ductwork should be considered.
- Replacement of casework storage space for a perimeter displacement solution.
- Site geology for options that include a ground coupled geothermal system.

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 – Room 145

Second Floor Corridor – Looking South

Building Area 2 – Atrium (1,460 Sq. Ft.): 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 - Atrium	A - Mini-Split	B - Remote DX	A - None	2-ABA
	C - Central CV	B - Remote DX	C - Hot Water	2-CBC
		C - Chilled Water	C - Hot Water	2-CCC

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

Air Delivery: A single zone heating only constant volume unit installed in 1980 serves the Atrium. The unit is served by hot water.

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.

Central Variable Air Volume (VAV): Locate a new central air handling unit in the storage room to the south of the gym. The new unit would be located adjacent to the air handling unit installed in 2020 to serve the gymnasium. Options may be considered to combine the gymnasium on the new system. It is anticipated that the current MN Energy code will require heat recovery to be incorporated into the system. Vertical paths for distribution need to be determined. The building is a poured pan joist concrete system limiting the flexibility in locating new large openings. It is anticipated that multiple vertical pathways will need to be identified to distribute from the ground floor to the upper floor. New openings will need to be located for outside and relief air connections to the outside.

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:

Remote Direct Expansion (DX): Remote DX in an option for mini-split systems and a central constant volume unit. The system serving the 1980 office addition is cooled with a remote condensing 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: A single dual-fuel fire tube boiler heats the building. A hot water convertors installed in 1965 and 1980 deliver hot water to the majority of the building heating terminal equipment. Viable options include leaving the existing systems in place and installing a cooling only system, modifying the existing steam and hot water distribution systems, installing additional steam to hot water convertor capacity to serve all new systems with hot water, or installing a new high efficiency hot water plant. The following outlines possible heating plant options.

Modify Existing Heating Systems: The building is currently heated by a single large dual fuel steam fire tube boiler. Steam to hot water convertors installed in 1965 and 1980 deliver hot water to the majority of the building terminal heating systems.

Hot Water HX: Includes installing additional hot water heat exchanger capacity to serve all new system with hot water. Hot water distribution piping is more flexible to route to location as necessary than steam piping. The installation of a heat exchanger will 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.

- Structural constraints for solutions that require new roof mounted equipment. The original vaulted roof constructed in 1908 was replaced with the current flat roof.
- Determining how new equipment will fit in the existing mechanical room for central air-handling solutions. It is anticipated that heat recovery will be required systems serving the classroom areas. Outside and return air are currently mixed in the attic space. A new outside air intake location may need to be determined.
- 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.

- Mitigating the risk of condensation for solutions that reuse the existing supply-air duct pathways. Full replacement of the supply ductwork should be considered.

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.

Added Construction Cost: $???????

Typical Photos:

H&V Unit 5 – Mechanical Room

Building Area 3: Gymnasium (10,220 Sq. Ft.): The following is a summary of the range of possible options considered.

Options Summary:

Building Area	Air Delivery Method	Cooling Plant	Heating Plant	Option
3 - Gymnasium	C - Central CV	B - Remote DX	B - Steam	3-CBB
			C - Hot Water	3-CBC
		C - Chilled Water	B - Steam	3-CCB
			C - Hot Water	3-CCC

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

Air Delivery: A single zone constant volume unit installed in the 1980 construction provides ventilation for the Gymnasium. The unit is served by steam for heating. The following outlines possible new air delivery methods:

Central Constant Volume (CV): Replace the existing heating and ventilation unit with a new constant volume unit in the same location..

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): A remote DX condensing unit would need to be located on grade adjacent to the boiler room. Options to limit the noise impact need to be studied.

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: A single dual-fuel fire tube boiler heats the building. A hot water convertors installed in 1965 and 1980 deliver hot water to the majority of the building heating terminal equipment. Viable options include leaving the existing systems in place and installing a cooling only system, modifying the existing steam and hot water distribution systems, installing additional steam to hot water convertor capacity to serve all new systems with hot water, or installing a new high efficiency hot water plant. The following outlines possible heating plant options.

Modify Existing Heating Systems: The building is currently heated by a single large dual fuel steam fire tube boiler. Steam to hot water convertors installed in 1965 and 1980 deliver hot water to the majority of the building terminal heating systems.

Hot Water HX: Includes installing additional hot water heat exchanger capacity to serve all new system with hot water. Hot water distribution piping is more flexible to route to location as necessary than steam piping. The installation of a heat exchanger will accommodate future conversion of the stem plant to hot water.

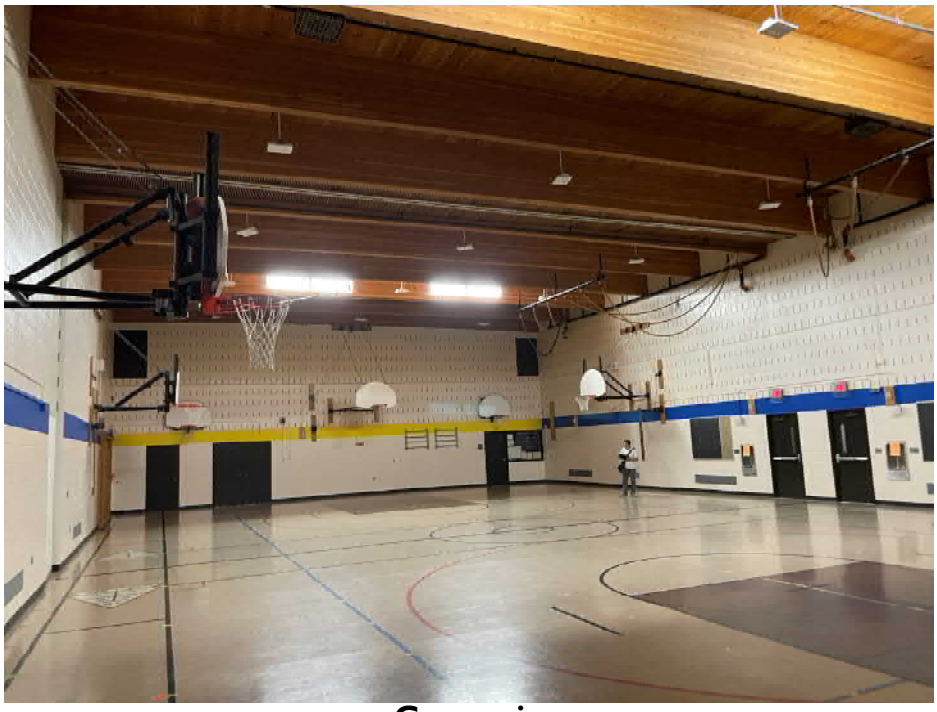
Hot Water Plant: There are multiple options to generate hot water to meet the heating needs of the building. Refer to the central plant options in this report for a discussion of each.

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.

- Determining vertical pathways for new ductwork as necessary for the central air handling unit options. The existing structure is wood frame construction, which will limit the options for new marge openings.
- Determining a design solution for outside ventilation air with the central air handling unit options. The proposed location for new air handling equipment is on the ground floor adjacent to the boiler room. It is desirable to provide for the outside air intake point above grade to minimize the introduction of contaminants.
- 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.
- Space constraints for options that include locating new central air handling units in the storage room. Final load calculations and air handling unit selections are necessary to determine the final design to fit the new equipment.

Typical Photos:



Gymnasium

Gymnasium Air Handling Unit

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
	B - Split Chiller	A - STM Distribution	9-BA
		B - STM w/ HW HX	9-BB
		C - HW Plant	9-BC
	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: Because of site constraints and the proximity to the neighbors, the most likely option for locating the chiller is the playground to the west. Chilled water piping would need to be routed below grade south of the building to the boiler room on the east side of the building. 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. It is possible that this option will not be viable due to excessive noise concerns.

Air Cooled Condenser with Remote Compressors: An alternative to minimize the sound output of the cooling plant equipment is to provide split chiller system with a remote air-cooled condensing unit. Due to restriction on length of refrigerant piping the air cooled condenser would need to be located on the east side of the building adjacent to the property line. The sound output levels at the property line needs further study. It is likely that this option is not viable.

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. W well field area of approximately 27,000 sq. ft. and is required assuming a well cooling capacity of 1 ton per well with a 15'-0" x 15'-0". The parking lot to the north and the playground to the west are possible locations. Further study and a test well is necessary to determine the site specific well conditions to optimize the depth, capacity, and cost. Alternate geothermal technologies including Darcy Solutions closed loop systems should be considered to further reduce the cost and size of the well field.

Heating Plant: A single 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:

Boiler Room Proximity to Neighbors

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 full conversion of the building to year around hot water operation. All areas included in the scope for new air conditioning systems 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 - 1898 / 1906 Classrooms	22,890																	
						Commons					Gymnasium							
Area - SQ FT	**22,890**	**22,890**	**42,032**			**Building Area #2**	**1,460 SQ FT**				**Building Area #3**	**10,220 SQ FT**						
Specification Division		**Building Area #1 - Central VAV, Geothermal**				**Building Area #2 - Central CV, Geothermal**					**Building Area #3 - Central CV, Geothermal**					**Area #1 - Add for Ceilings and Lights**		
		Sq. Ft. / Qty	**Unit Cost**		**Cost**	**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)				**$**	**22,890**			**$**	**1,460**				**$**	**10,220**				**$**	**11,445**
Miscellaneous		22,890	$ 1.00	$	22,890	1,460	$ 1.00	$	1,460		10,220	$ 1.00	$	10,220		22,890	$ 0.50	$	11,445
Division 03 - Concrete				**$**	**17,445**			**$**	**-**				**$**	**8,500**				**$**	**-**
Floor Patch and Repair		22,890	$ 0.50	$	11,445			$	-		1	$ 5,000	$	5,000				$	-
Cast-in-place / Misc		1	$ 6,000	$	6,000			$	-		1	$ 3,500	$	3,500				$	-
Division4 - Masonary				**$**	**5,000**			**$**	**-**				**$**	**-**				**$**	**-**
Non-bearing Infill		1	$ 5,000	$	5,000			$	-				$	-				$	-
Load bearing - new wall construction				$	-			$	-				$	-				$	-
Division 5 - Metals				**$**	**22,890**			**$**	**7,500**				**$**	**-**				**$**	**-**
Structural Steel / Misc. Fabrications Allowance		22,890	$ 1.00		22,890	1	$ 7,500		7,500					-					-
Division 6 - Carpentry				**$**	**-**			**$**	**-**				**$**	**-**				**$**	**-**
Rough Carpentry				$	-			$	-				$	-				$	-
Casework Modifications																		$	-
Division 7 - Thermal / Moisture Protection				**$**	**-**			**$**	**-**				**$**	**-**				**$**	**-**
Roof Patch and Repair				$	-			$	-				$	-				$	-
Roof New Construction				$	-			$	-				$	-				$	-
Fire Stopping / Miscellaneous				$	-			$	-				$	-				$	-
Division 8 - Openings				**$**	**7,000**			**$**	**-**				**$**	**7,000**				**$**	**-**
Access Panels					-				-					-					-
Doors / Hardware					-				-					-					-
Windows					-				-					-					-
Louvers		2	$ 3,500		7,000				-		2	$ 3,500		7,000					-
Division - 9 Finishes				**$**	**148,785**			**$**	**11,920**				**$**	**20,330**				**$**	**148,785**
Soffits / Chases		22,890	$ 3.50	$	80,115	1	$ 5,000	$	5,000		1	$ 5,000	$	5,000		22,890	$ 2.00	$	45,780
Floor Patch and Repair		22,890	$ 2.00	$	45,780	1	$ 2,500	$	2,500				$	-				$	-
Acoustic Ceilings				$	-	1,460	$ 2.00	$	2,920				$	-		22,890	$ 3.50	$	80,115
Painting		22,890	$ 1.00	$	22,890	1	$ 1,500	$	1,500		10,220	$ 1.50	$	15,330		22,890	$ 1.00	$	22,890
Division 10 - Specialties				**$**	**-**			**$**	**-**				**$**	**-**				**$**	**-**
Miscellaneous					-				-					-					-
Division 11 - Equipment				**$**	**-**			**$**	**-**				**$**	**-**				**$**	**-**
Miscellaneous				$	-			$	-				$	-				$	-
Division 12 - Furnishings				**$**	**-**			**$**	**-**				**$**	**-**				**$**	**-**
Casework				$	-			$	-				$	-				$	-
Miscellaneous				$	-			$	-				$	-				$	-
Division 21 - Fire Protection				**$**	**45,780**			**$**	**2,920**				**$**	**10,220**				**$**	**57,225**
Demolition		-		$	-	-		$	-		-		$	-				$	-
New / Modify Existing		22,890	$ 2.00	$	45,780	1,460	$ 2.00	$	2,920		10,220	$ 1.00	$	10,220		22,890	$ 2.50	$	57,225
Division 22 - Plumbing				**$**	**-**			**$**	**-**				**$**	**-**				**$**	**-**
Demolition				$	-			$	-				$	-				$	-
Plumbing Fixtures				$	-			$	-				$	-				$	-
Micellaneous				$	-			$	-				$	-				$	-
Division 23 - HVAC				**$**	**2,380,945**			**$**	**132,740**				**$**	**154,700**				**$**	**-**
Air Handling Equipment (VUV's / AHU's / RTU's)		1	$ 65,000	$	65,000	2	$ 8,500	$	17,000		1	$ 30,000	$	30,000				$	-
Cooling Plant Equipment (Chiller / DX / Heat Pump)		1	$ 180,000	$	180,000			$	-				$	-				$	-
Heating Plant Equipment (Boiler)		1	$ 35,000	$	35,000			$	-				$	-				$	-
Demolition		22,890	$ 1.00	$	22,890	1	$ 3,500	$	3,500		1	$ 7,500	$	7,500				$	-
AHU Equipment Installation / Start-up		1	$ 30,000	$	30,000	2	$ 7,500	$	15,000		1	$ 15,000	$	15,000				$	-
Cooling Plant Equipment Installation		1	$ 775,000	$	775,000		$ 5,000	$	-				$	-				$	-
Heating Plant Installation		1	$ 140,000	$	140,000			$	-				$	-				$	-
Chilled Water Distribution		22,890	$ 2.50	$	57,225	1	$ 28,000	$	28,000		1	$ 24,000	$	24,000				$	-
Steam / Condensate Distribution				$	-			$	-				$	-				$	-
Hot Water Distribution		22,890	$ 6.50	$	148,785	1	$ 12,000	$	12,000		1	$ 24,000	$	24,000				$	-
Ductwork Distribution Misc. (VAV's / Exhaust)		22,890	$ 32.00	$	732,480	1,460	$ 24.00	$	35,040		1	$ 30,000	$	30,000				$	-
Controls		22,890	$ 7.50	$	171,675	2	$ 10,000	$	20,000		1	$ 22,000	$	22,000				$	-
Test and Balance		22,890	$ 1.00	$	22,890	1	$ 2,200	$	2,200		1	$ 2,200	$	2,200				$	-
Division 26 - Electrical				**$**	**107,225**			**$**	**7,500**				**$**	**7,000**				**$**	**137,340**
Demolition		22,890	$ 0.50	$	11,445	1	$ 1,500	$	1,500		1	$ 2,000	$	2,000		22,890	$ 1	$	11,445
Electrical Service		1	$ 50,000	$	50,000			$	-				$	-				$	-
Power Connections		22,890	$ 1.00	$	22,890	2	$ 3,000	$	6,000		1	$ 5,000	$	5,000				$	-
Lighting and Controls		22,890	$ 1.00	$	22,890			$	-				$	-		22,890	$ 5.50	$	125,895
Division 27 - Technology				**$**	**11,445**			**$**	**-**				**$**	**2,500**				**$**	**-**
Demolition Allowance				$	-			$	-				$	-				$	-
Fire / Sound / Data Allowance		22,890	$ 0.50	$	11,445			$	-		1	$ 2,500	$	2,500				$	-
DIVISION SUB-TOTAL				**$**	**2,769,405**			**$**	**164,040**				**$**	**220,470**				**$**	**354,795**
Division 1 - General Conditions				**$**	**484,646**			**$**	**28,707**				**$**	**38,582**				**$**	**62,089**
OH & P	10%			$	276,941			$	16,404				$	22,047				$	35,480
Liability Insurance	1%			$	27,694			$	1,640				$	2,205				$	3,548
Performance Bond	2%			$	41,541			$	2,461				$	3,307				$	5,322
General Contractor Misc.	5%			$	138,470			$	8,202				$	11,024				$	17,740
CONSTRUCTION SUB-TOTAL				**$**	**3,254,051**			**$**	**192,747**				**$**	**259,052**				**$**	**416,884**
CONTINGENCY	15%			**$**	**488,108**			**$**	**28,912**				**$**	**38,858**				**$**	**62,533**
CONSTRUCTION GRAND-TOTAL				**$**	**3,742,159**			**$**	**221,659**				**$**	**297,910**				**$**	**479,417**
COST per SQ FT				**$**	**89.03**			**$**	**151.82**				**$**	**7.09**				**$**	**11.41**