MINNEAPOLIS PUBLIC SCHOOLS
Urban Education. Global Citizens.

Minneapolis Public Schools
Special School District #1

Air Conditioning Cost Estimating Study Longfellow High Five

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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 Longfellow High Five. 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: **Longfellow High Five**
  Minneapolis Public Schools
  3017 East 31st Street
  Minneapolis, MN 55410
  Phone: (612) 668-4700
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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 Longfellow High Five. 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 (32,800 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. Relocating the gymnasium unit identified as area #3 in this report would free up space in the mechanical room. 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 opration. 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. 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.
- Integrity and capacity of the existing steam and condensate systems. Modifications are necessary for the installation of the steam-to-hot water heat exchanger.
- 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.

Construction Cost Estimate:	**$ 3,588,000**
Add for Ceiling and Lights:	**$ 687,000**

Gymnasium Building Area #3 (4,300 Sq Ft): Install a new roof mounted constant volume unit with integral DX to serve the gymnasium. The preferred location for the proposed classroom ventilation system is to install it into the extent possible in the existing mechanical room. Relocating the gymnasium unit to the roof is a key component of this approach. Hot water for heating will be provided from the steam-to-hot water convertor provided in the recommended option to serve the classrooms. The base project includes routing supply ductwork exposed within the gymnasium. For consideration, added scope options are included to provide new LED lighting and controls and de-stratification fans.

- 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.
- 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.

Construction Cost Estimate:	**$ 362,000**
Add for De-stratification Fans	**$ 14,000**

Office Building Areas #4 (2,875 Sq Ft): Install a new roof mounted central variable air volume system with integral DX cooling to serve the office area. Hot water for heating will be provided from the steam-to-hot water convertor provided in the recommended option to serve the classrooms. The base project includes routing supply ductwork exposed within the office 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.
- 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.

Construction Cost Estimate:	**$ 267,000**
Add for Ceiling and Lights:	**$ 60,000**

EXISTING BUILDING INFORMATION

The original building was constructed in 1918. The ventilation system installed in the original 1916 project consisted of two large constant volume fans that distributed air through individual ducts located in the crawl space. Each temperature control zone is ducted separately with a pneumatic zone control damper. The gymnasium is served by a single zone constant volume fan. An HVAC rehabilitation project in 1955 added return/exhaust fans and new return ductwork in the attic space.

There is not a centralized cooling plant.

The building is heated with two large dual fuel fire tube steam boilers.

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

Building Area Summary:

Year	Area (sq. ft.)
1918	42,368
1955	365
1988 (Portables)	2,080
Total	**44,813**

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 is defined by the following approach to heating and cooling.

Low Cost Option: Integral DX, Modify existing steam system

Medium Cost Option: Air-cooled chiller, Modify existing steam system

High Cost Option: Air-cooled chiller, Convert existing boilers to HW

Vertical Unit Ventilators					
Building Area	**Serves**	**Area SF**	**Construction Budget**		
			Low	**Medium**	**High**
#1	Classrooms	15,375			
#2	Classrooms	17,425			
Total		**32,800**	**$1,529,300**	**$2,058,600**	**$3,827,000**

Central Variable Air Volume:

Install a variable central air handling system in each of the building areas. The units most likely will be field constructed in the existing mechanical rooms. The unit serving the gymnasium will most likely need to be relocated to the roof adjacent to the gym to create more space for the new air handling systems. New ductwork will be distributed in the existing crawl space. The budget do not include the relocation of the gymnasium unit. The construction budget includes an allowance as a placeholder for necessary structural work pending further investigation.

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

Medium Cost Option: Remote DX, HW Convertor

High Cost Option: Air-cooled chiller, Convert existing boilers to HW

Central Variable Air Volume					
Building Area	**Serves**	**Area SF**	**Construction Budget**		
			Low	**Medium**	**High**
#1	Classrooms	15,375			
#2	Classrooms	17,425			
Total		**32,800**	**$2,840,000**	**$3,460,000**	**$3,878,000**

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. To serve building area 2, the most likely location is in the storage room to the south of the gymnasium. There are considerable challenges to create new pathways for ductwork and piping because of the wood structure and because the existing vertical pathways in building are #1 have been removed. The construction budget includes an allowance as a placeholder for necessary structural work pending further investigation.

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: Air-cooled chiller, Convert existing boilers to HW

Dedicated Outside Air / Displacement					
Building Area	**Serves**	**Area SF**	**Construction Budget**		
			Low	**Medium**	**High**
#1	Classrooms	15,375	N/A	N/A	
#2	Classrooms	17,425	N/A	N/A	
Total		**32,800**	N/A	N/A	**$4,120,000**

Additional Scope:

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

New Ceilings and LED Lights: **Construction Budget** **$ 687,000**

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 - East Classrooms (15,375 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
1 - East Classrooms	A - Mini-Split	B - Remote DX	A - None
	B - Vertical Unit Vents	A - Integral DX	B - Steam
			C - Hot Water*
		B - Remote DX	B - Steam
			C - Hot Water*
		C - Chilled Water*	B - Steam
			C - Hot Water*
	C - Central VAV	B - Remote DX	B - Steam
			C - Hot Water*
		C - Chilled Water*	B - Steam
			C - Hot Water*
	D - DOAS	C - Chilled Water*	C - Hot Water*
	E - Add DDC	B - Remote DX	B - Steam
		C - Chilled Water*	B - Steam
	F - Reheat Coils	B - Remote DX	C - Hot Water*
		C - Chilled Water*	C - Hot Water*
	G - New VAV's	B - Remote DX	C - Hot Water*
		C - Chilled Water*	C - Hot Water*

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 1918 building construction included three large central supply fans located in the basement adjacent to the boiler room. Supply is distributed to each ventilation zone (typically each classroom) through a crawl space the extents the full area of the building. Supply S-1 serves the East side of the building and 13 independent duct zones with a pneumatic control damper located in the basement mechanical room. The return air system was modified in 1998 to provide a ducted return path and a return exhaust fan located in the attic space. 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. Modifications will be required to the perimeter steam finned tube radiation. The rooms typically do not have built in perimeter casework with a few rooms as exceptions.

Central Variable Air Volume (VAV): The basement fan room is a large area that will be utilized to the extent possible for new air handling equipment. A priority will be to keep the return exhaust fans and return duct modifications completed in 1998 in place to minimize the project cost. It is anticipated that the current MN Energy Code will require energy recovery for systems serving the classrooms. Most likely the outside air path will need to be modified to accommodate energy recovery systems. It may be necessary due to space constraints to install the energy recovery systems outside the building located on the loading dock. 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. Options to combine the existing system should be explored to save space. The Gymnasium may need to be combined with another system due to space constraints. New ductwork will be distributed through the crawlspace to each temperature control zone. The existing supply duct pathway to each space will be reused with variable air volume boxes located in each space. 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.

Modify Existing Systems (Options E – add DDC): The approach with this option is to reuse to the extent possible the existing air handling system and distribution ductwork. The existing unit S-1 has 13 individual ducted zones, each with a pneumatic control damper. The existing air-handling unit will be retrofit a new cooling coil. It appears that there is adequate space with modifications to the unit casing and possibly the existing steam heating coils. The supply damper for each zone will be controlled to minimize over cooling of each space. New DDC controls will coordinate the control of the heating terminal equipment in each space with the control damper. Consideration should be given to fully converting to electric actuation on the terminal heating devices. All existing distribution ductwork will insulated to prevent condensation to the extent possible**. Insulation of the existing ductwork will be extremely difficult due to the installation in the crawl space close proximity to each other – further investigation is necessary to determine the full extent of the risk in pursuing this option.**

Modify Existing Systems (Option F – Add Zone Reheat coils): The approach adds to the work outlined for Option E by retrofitting a reheat coil in the distribution duct for each zone. Current MN Energy Code requires multiple zone systems to be variable air volume as outline above. The addition of the reheat coil will allow the system to maintain minimum code required ventilation rates without over cooling the spaces. Year around availability of heat is necessary for this approach to work under all conditions.

Modify Existing Systems (Option G – New VAV Boxes): This approach eliminates the risk of reinsulating the existing ductwork by fully replacing the distribution system. The new supply ductwork will be routed similar to the existing in the crawl space and enter each ventilation zone in the same location as the existing. The existing supply duct pathway to each space will be reused with variable air volume boxes located in each space. Soffits and ceilings should be considered as part of the final design to minimize sound and improve air distribution.

<u>Cooling Plant:</u> 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 and vertical unit ventilators. 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.

<u>Heating Plant:</u> 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.

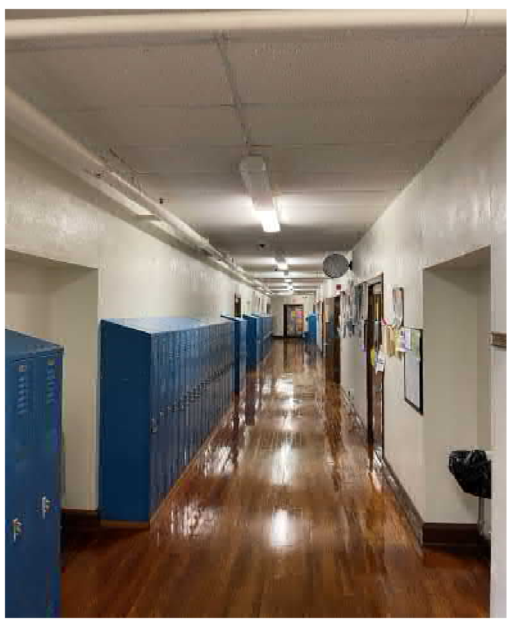
- Determine the optimal system configuration with the central air handling unit options. A guiding principal is to locate as much of the new equipment inside the existing fan room as possible. Options to optimize the space include combining air-handling zone, determining and alternate outside airflow path, and maybe alternate locations for heat recovery equipment.
- Accessibility of the crawl space. Preliminary investigation indicates that the space is accessible as needed but further investigation is required.
- 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 investigation is required.
- 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.

Typical Photos:

Room 124



East Corridor – Looking North from Rm 124

Building Area 2 - West Classrooms (17,425 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 - West Classrooms	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
	C - Central VAV	B - Remote DX	B - Steam	2-CBB
			C - Hot Water*	2-CBC
		C - Chilled Water*	B - Steam	2-CCB
			C - Hot Water*	2-CCC
	D - DOAS	C - Chilled Water*	C - Hot Water*	2-DCC
	E - Add DDC	B - Remote DX	B - Steam	1-EBB
		C - Chilled Water*	B - Steam	1-ECB
	F - Reheat Coils	B - Remote DX	C - Hot Water*	1-FBC
		C - Chilled Water*	C - Hot Water*	1-FCC
	G - New VAV's	B - Remote DX	C - Hot Water*	1-GBC
		C - Chilled Water*	C - Hot Water*	1-GCC

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 1918 building construction included three large central supply fans located in the basement adjacent to the boiler room. Supply is distributed to each ventilation zone (typically each classroom) through a crawl space the extents the full area of the building. Supply S-2 serves the West side of the building and 14 independent duct zones with a pneumatic control damper located in the basement mechanical room. The return air system was modified in 1998 to provide a ducted return path and a return exhaust fan located in the attic space. 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. Modifications will be required to the perimeter steam finned tube radiation. The rooms typically do not have built in perimeter casework with a few rooms as exceptions.

Central Variable Air Volume (VAV): The basement fan room is a large area that will be utilized to the extent possible for new air handling equipment. A priority will be to keep the return exhaust fans and return duct modifications completed in 1998 in place to minimize the project cost. It is anticipated that the current MN Energy Code will require energy recovery for systems serving the classrooms. Most likely the outside air path will need to be modified to accommodate energy recovery systems. It may be necessary due to space constraints to install the energy recovery systems outside the building located on the loading dock. 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. Options to combine the existing system should be explored to save space. The Gymnasium may need to be combined with another system due to space constraints. New ductwork will be distributed through the crawlspace to each temperature control zone. The existing supply duct pathway to each space will be reused with variable air volume boxes located in each space. 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.

Modify Existing Systems (Options E – add DDC): The approach with this option is to reuse to the extent possible the existing air handling system and distribution ductwork. The existing unit S-1 has 13 individual ducted zones, each with a pneumatic control damper. The existing air-handling unit will be retrofit a new cooling coil. It appears that there is adequate space with modifications to the unit casing and possibly the existing steam heating coils. The supply damper for each zone will be controlled to minimize over cooling of each space. New DDC controls will coordinate the control of the heating terminal equipment in each space with the control damper. Consideration should be given to fully converting to electric actuation on the terminal heating devices. All existing distribution ductwork will insulated to prevent condensation to the extent possible**. Insulation of the existing ductwork will be extremely difficult due to the installation in the crawl space close proximity to each other – further investigation is necessary to determine the full extent of the risk in pursuing this option.**

Modify Existing Systems (Option F – Add Zone Reheat coils): The approach adds to the work outlined for Option E by retrofitting a reheat coil in the distribution duct for each zone. Current MN Energy Code requires multiple zone systems to be variable air volume as outline above. The addition of the reheat coil will allow the system to maintain minimum code required ventilation rates without over cooling the spaces. Year around availability of heat is necessary for this approach to work under all conditions.

Modify Existing Systems (Option G – New VAV Boxes): This approach eliminates the risk of reinsulating the existing ductwork by fully replacing the distribution system. The new supply ductwork will be routed similar to the existing in the crawl space and enter each ventilation zone in the same location as the existing. The existing supply duct pathway to each space will be reused with variable air volume boxes located in each space. Soffits and ceilings should be considered as part of the final design to minimize sound and improve air distribution.

<u>Cooling Plant:</u> 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 and vertical unit ventilators. 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.

<u>Heating Plant:</u> 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.

<u>Dehumidification:</u> 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.
- Accessibility of the crawl space. Preliminary investigation indicates that the space is accessible as needed but further investigation is required.
- 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:

Media Center

Building Area 3 – Gymnasium (4,300 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	A - Integral DX	A - No Heat	3-CAA
			B - Steam	3-CAB
			C - Hot Water*	3-CAC
		B - Remote DX	A - No Heat	3-CBA
			B - Steam	3-CBB
			C - Hot Water*	3-CBC
		C - Chilled Water*	B - Steam	3-CCB
			C - Hot Water*	3-CCC
	E - Add Cooling Coil	B - Remote DX	B - Steam	3-EBB
			C - Hot Water*	3-EBC
		C - Chilled Water*	B - Steam	3-ECB
			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 original 1918 building construction included three large central supply fans located in the basement adjacent to the boiler room. A constant volume unit S-3 serves the gymnasium. Supply ductwork is routed to the gymnasium through the crawl space that extends under the entire building. The following outlines possible new air delivery methods:

Central Variable Air Volume (CV): Install a new constant volume fan system on the roof adjacent to the gymnasium and route ductwork exposed in the space. The basement fan room is currently configured with the three central fan systems serving the building. The fan room is a large space, but would benefit by relocating the gymnasium to a location closer to the space it serves. The structural capacity of the roof and the necessary structural modifications needs to be investigated.

Modify Existing Systems (Options E – add DDC): The approach with this option is to reuse to the extent possible the existing air handling system and distribution ductwork. The existing unit S-3 is a single zone with distribution ductwork routed through the crawl space. The existing return air path is not ducted and independent from the other systems in the building. Retrofitting the existing system for cooling should only be considered if the other building systems are also retrofitted for cooling. All existing distribution ductwork will be insulated to prevent condensation to the extent possible. **Insulation of the existing ductwork will be extremely difficult due to the installation in the crawl space close proximity to each other – further investigation is necessary to determine the full extent of the risk in pursuing this option.**

<u>Cooling Plant:</u> 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:

> *Integral Direct Expansion (DX): Install a package DX cooling unit with integral compressors and condensing systems.*
>
> *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.

<u>Heating Plant:</u> 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.

<u>Dehumidification:</u> 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.
- Accessibility of the crawl space. Preliminary investigation indicates that the space is accessible as needed but further investigation is required.
- 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 equipment 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.

- *Install De-stratification Fans:* Current design practice has been to install de-stratification fans in high volume spaces to improve air circulation and reduce thermal stratification. As an energy conservation strategy, the fans can be controlled as the first stage of heating.

Typical Photos:

Gymnasium

Building Area 4 – Office (2,875 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
4 - Office	C - Central VAV	A - Integral DX	A - No Heat	3-CAA
			B - Steam	3-CAB
			C - Hot Water*	3-CAC
		B - Remote DX	A - No Heat	3-CBA
			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: The original 1918 building construction included three large central supply fans located in the basement adjacent to the boiler room. The office is currently served by both S-1 and S-2. Supply ductwork is routed to the gymnasium through the crawl space that extends under the entire building. Installing an independent system for the office would allow for flexibility with time of day operation. The following outlines possible new air delivery methods:

Central Variable Air Volume (VAV): Install a new variable air volume system on the roof above the office area. Route new supply ductwork over head and provide variable air volume boxes for independent temperature zone control.

Cooling Plant: Viable options studied include integral DX, remote DX, and construction of a new central chilled water plant. The following outlines possible cooling plant options:

Integral Direct Expansion (DX): Install a package DX cooling unit with integral compressors and condensing systems.

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.

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.

- 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 equipment will need to be reviewed for structural limitations.

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 they have added value.

- *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.

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

Typical Photo:

Office

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 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: T*he most likely option for locating the chiller is in the parking lot to the South of the boiler room between the East and West classroom wings. West. The impact to the outdoor storage building, trash pick-up, and parking needs to be further analyzed. A study of the chiller sound output at the school property line needs to be completed. 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 adjacent parking lot and park area to the south appears to have adequate area for a well field. Approximately 27,000 sq. ft. is required based on an assumption of 1 ton of cooling per well at a 15'-0" x 15'-0". 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: 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 Cooling Plant Equipment / Geo Thermal Well Field Location

Appendix A:

Existing Systems Diagram

Redacted

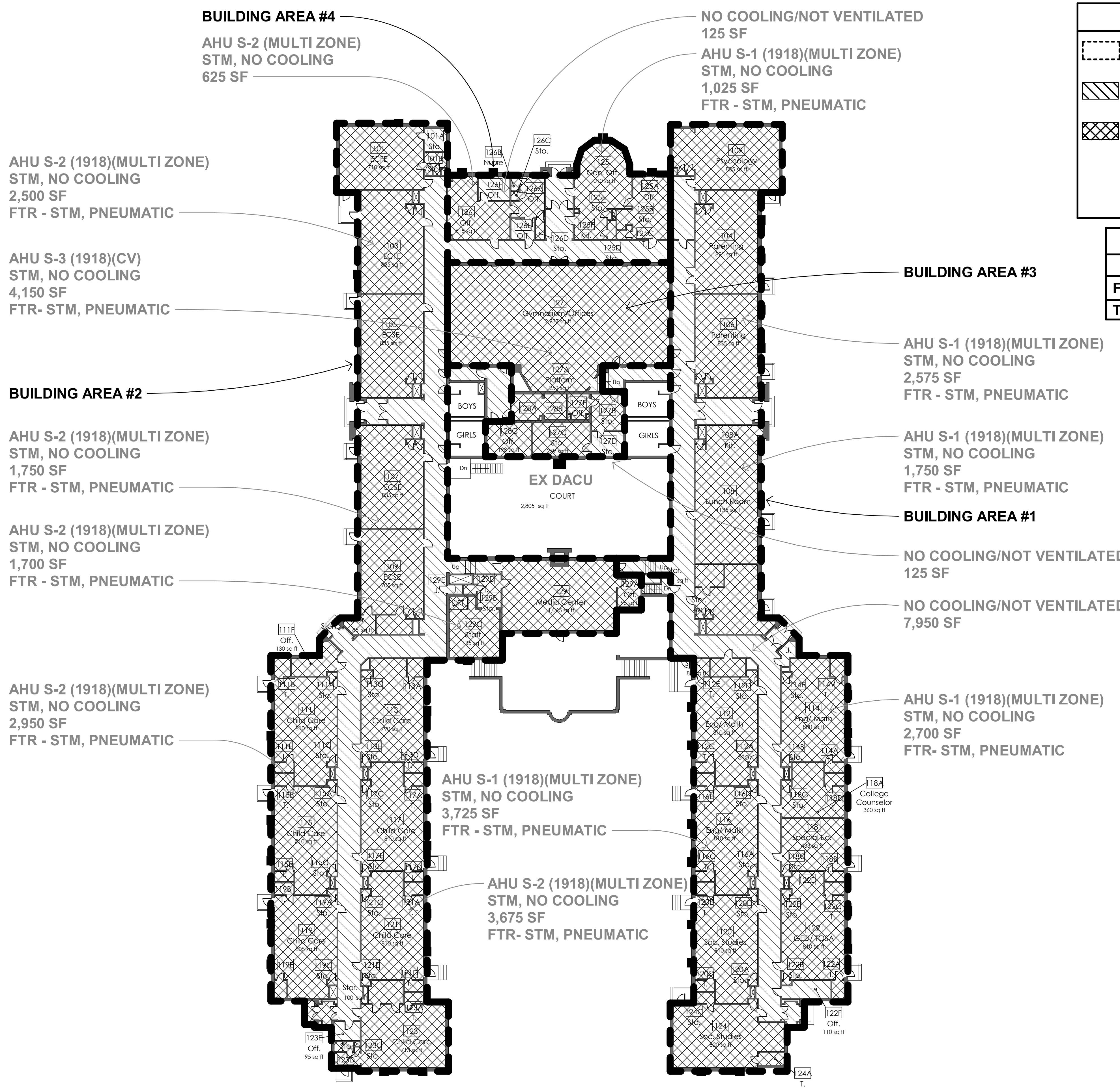
Appendix A:

Existing Systems Diagram

Redacted

Appendix B:

Proposed Systems Diagrams



SYMBOL KEY	ABBREVIATION KEY
VENTILATION ZONE	VAV - VARIABLE AIR VOLUME
NO COOLING/NOT VENTILATED	CV - CONSTANT VOLUME
NO COOLING	STM - STEAM
	HW - HOT WATER
	DX - DIRECT EXPANSION
	CHW - CHILLED WATER
	UV - UNIT VENTILATOR
	FTR - FINNED TUBE RADIATOR
	SS - SPLIT DX SYSTEMS
	- WINDOW AIR CONDITIONER

PROPOSED BUILDING AREA SUMMARY

LEVEL	AREA #1	AREA #2	AREA #3	AREA #4
FIRST	15,375 SQ FT	17,425 SQ FT	4,300 SQ FT	2,875 SQ FT
TOTAL	15,375 SQ FT	17,425 SQ FT	4,300 SQ FT	2,875 SQ FT

1 LONGFELLOW HIGH SCHOOL PROPOSED SYSTEMS PLAN - FIRST FLOOR

1" = 40'-0"

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 renovation scope 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 - East Classrooms	15,375		
BUILDING AREA 2 - West Classrooms	17,425		
Area - SQ FT	**32,800**	**32,800**	**44,873**

Building Area #3 4,300 SQ FT **Building Area #4** 2,875 SQ FT

Specification Division		**Area #1 and #2 - Central VAV, Remote DX, HW VAV's**			**Area #3 - RTU CV, Integral DX, HW**			**Area #4 - RTU VAV, Integral DX, HW VAV's**			**Area #1 and #2 - Add for Ceilings and Lights**			**Area #4 - 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**	**Sq. Ft. / Qty**	**Unit Cost**	**Cost**
Division 02 - Demolition (excludes Div 21, 22, 23, and 26)				**$ 32,800**			**$ 4,300**			**$ 2,875**			**$ 16,400**			**$ 1,438**
Miscellaneous		32,800	$ 1.00	$ 32,800	4,300	$ 1.00	$ 4,300	2,875	$ 1.00	$ 2,875	32,800	$ 0.50	$ 16,400	2,875	$ 0.50	$ 1,438
Division 03 - Concrete				**$ 22,400**			**$ -**			**$ -**			**$ -**			**$ -**
Floor Patch and Repair		32,800	$ 0.50	$ 16,400			$ -			$ -			$ -			$ -
Cast-in-place / Misc		2	$ 3,000	$ 6,000			$ -			$ -			$ -			$ -
Division4 - Masonary				**$ 20,000**			**$ 5,000**			**$ -**			**$ -**			**$ -**
Non-bearing Infill		1	$ 20,000	$ 20,000	1	$ 5,000	$ 5,000			$ -			$ -			$ -
Load bearing - new wall construction				$ -			$ -			$ -			$ -			$ -
Division 5 - Metals				**$ 16,400**			**$ 15,000**			**$ 15,000**			**$ -**			**$ -**
Structural Steel / Misc. Fabrications Allowance		32,800	$ 0.50	16,400	1	$ 15,000	15,000	1	$ 15,000	15,000			-			-
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				**$ 18,000**			**$ -**			**$ -**			**$ -**			**$ -**
Access Panels				-			-			-			-			-
Doors / Hardware				-			-			-			-			-
Windows				-			-			-			-			-
Louvers		4	$ 4,500	18,000			-			-			-			-
Division - 9 Finishes				**$ 213,200**			**$ 4,300**			**$ 2,875**			**$ 213,200**			**$ 18,688**
Soffits / Chases		32,800	$ 3.50	$ 114,800			$ -			$ -	32,800	$ 2.00	$ 65,600	2,875	$ 2.00	$ 5,750
Floor Patch and Repair		32,800	$ 2.00	$ 65,600			$ -			$ -			$ -			$ -
Acoustic Ceilings				$ -			$ -			$ -	32,800	$ 3.50	$ 114,800	2,875	$ 3.50	$ 10,063
Painting		32,800	$ 1.00	$ 32,800	4,300	$ 1.00	$ 4,300	2,875	$ 1.00	$ 2,875	32,800	$ 1.00	$ 32,800	2,875	$ 1.00	$ 2,875
Division 10 - Specialties				**$ -**			**$ -**			**$ -**			**$ -**			**$ -**
Miscellaneous				-			-			-			-			-
Division 11 - Equipment				**$ -**			**$ -**			**$ -**			**$ -**			**$ -**
Miscellaneous				$ -			$ -			$ -			$ -			$ -
Division 12 - Furnishings				**$ -**			**$ -**			**$ -**			**$ -**			**$ -**
Casework				$ -			$ -			$ -			$ -			$ -
Miscellaneous				$ -			$ -			$ -			$ -			$ -
Division 21 - Fire Protection				**$ 65,600**			**$ 4,300**			**$ 2,875**			**$ 82,000**			**$ 7,188**
Demolition		-		$ -			$ -	-		$ -			$ -			$ -
New / Modify Existing		32,800	$ 2.00	$ 65,600	4,300	$ 1.00	$ 4,300	2,875	$ 1.00	$ 2,875	32,800	$ 2.50	$ 82,000	2,875	$ 2.50	$ 7,188
Division 22 - Plumbing				**$ -**			**$ -**			**$ -**			**$ -**			**$ -**
Demolition				$ -			$ -			$ -			$ -			$ -
Plumbing Fixtures				$ -			$ -			$ -			$ -			$ -
Micellaneous				$ -			$ -			$ -			$ -			$ -
Division 23 - HVAC				**$ 2,110,800**			**$ 215,925**			**$ 155,781**			**$ -**			**$ -**
Air Handling Equipment (VUV's / AHU's / RTU's)		2	$ 45,000	$ 90,000	1	$ 15,000	$ 15,000	1	$ 6,500	$ 6,500			$ -			$ -
Cooling Plant Equipment (Chiller / DX / Heat Pump)		2	$ 32,000	$ 64,000			$ -			$ -			$ -			$ -
Heating Plant Equipment (Boiler)		1	$ 45,000	$ 45,000			$ -			$ -			$ -			$ -
Demolition		32,800	$ 0.75	$ 24,600	4,300	$ 0.75	$ 3,225	2,875	$ 0.75	$ 2,156			$ -			$ -
AHU Equipment Installation / Start-up		2	$ 20,000	$ 40,000	1	$ 10,000	$ 10,000	1	$ 10,000	$ 10,000			$ -			$ -
Cooling Plant Equipment Installation				$ -			$ -			$ -			$ -			$ -
Heating Plant Installation		1	$ 200,000	$ 200,000			$ -			$ -			$ -			$ -
Chilled Water Distribution				$ -			$ -			$ -			$ -			$ -
Steam / Condensate Distribution		2	$ 20,000	$ 40,000			$ -			$ -			$ -			$ -
Hot Water Distribution		32,800	$ 10.00	$ 328,000	1	$ 20,000	$ 20,000	1	$ 25,000	$ 25,000			$ -			$ -
Ductwork Distribution Misc. (VAV's / Exhaust)		32,800	$ 32.00	$ 1,049,600	4,300	$ 32.00	$ 137,600	2,875	$ 32.00	$ 92,000			$ -			$ -
Controls		32,800	$ 6.50	$ 213,200	4,300	$ 6.50	$ 27,950	2,875	$ 6.50	$ 18,688			$ -			$ -
Test and Balance		32,800	$ 0.50	$ 16,400	4,300	$ 0.50	$ 2,150	2,875	$ 0.50	$ 1,438			$ -			$ -
Division 26 - Electrical				**$ 140,150**			**$ 17,150**			**$ 16,438**			**$ 196,800**			**$ 17,250**
Demolition		32,800	$ 0.50	$ 16,400	4,300	$ 0.50	$ 2,150	2,875	$ 0.50	$ 1,438	32,800	$ 1	$ 16,400	2,875	$ 1	$ 1,438
Electrical Service		1	$ 50,000	$ 50,000			$ -			$ -			$ -			$ -
Power Connections		4	$ 15,000	$ 60,000	1	$ 15,000	$ 15,000	1	$ 15,000	$ 15,000			$ -			$ -
Lighting and Controls		2,500	$ 5.50	$ 13,750			$ -			$ -	32,800	$ 5.50	$ 180,400	2,875	$ 5.50	$ 15,813
Division 27 - Technology				**$ 16,400**			**$ 2,150**			**$ 1,438**			**$ -**			**$ -**
Demolition Allowance				$ -			$ -			$ -			$ -			$ -
Fire / Sound / Data Allowance		32,800	$ 0.50	$ 16,400	4,300	$ 0.50	$ 2,150	2,875	$ 0.50	$ 1,438			$ -			$ -
DIVISION SUB-TOTAL				**$ 2,655,750**			**$ 268,125**			**$ 197,281**			**$ 508,400**			**$ 44,563**
Division 1 - General Conditions				**$ 464,756**			**$ 46,922**			**$ 34,524**			**$ 88,970**			**$ 7,798**
OH & P	10%			$ 265,575			$ 26,813			$ 19,728			$ 50,840			$ 4,456
Liability Insurance	1%			$ 26,558			$ 2,681			$ 1,973			$ 5,084			$ 446
Performance Bond	2%			$ 39,836			$ 4,022			$ 2,959			$ 7,626			$ 668
General Contractor Misc.	5%			$ 132,788			$ 13,406			$ 9,864			$ 25,420			$ 2,228
CONSTRUCTION SUB-TOTAL				**$ 3,120,506**			**$ 315,047**			**$ 231,805**			**$ 597,370**			**$ 52,361**
CONTINGENCY	15%			**$ 468,076**			**$ 47,257**			**$ 34,771**			**$ 89,606**			**$ 7,854**
CONSTRUCTION GRAND-TOTAL				**$ 3,588,582**			**$ 362,304**			**$ 266,576**			**$ 686,976**			**$ 60,215**
COST per SQ FT				**$ 79.97**			**$ 84.26**			**$ 92.72**			**$ 15.31**			**$ 20.94**