Minneapolis Public Schools
Special School District #1

Air Conditioning
Cost Estimating Study
Pratt Community School

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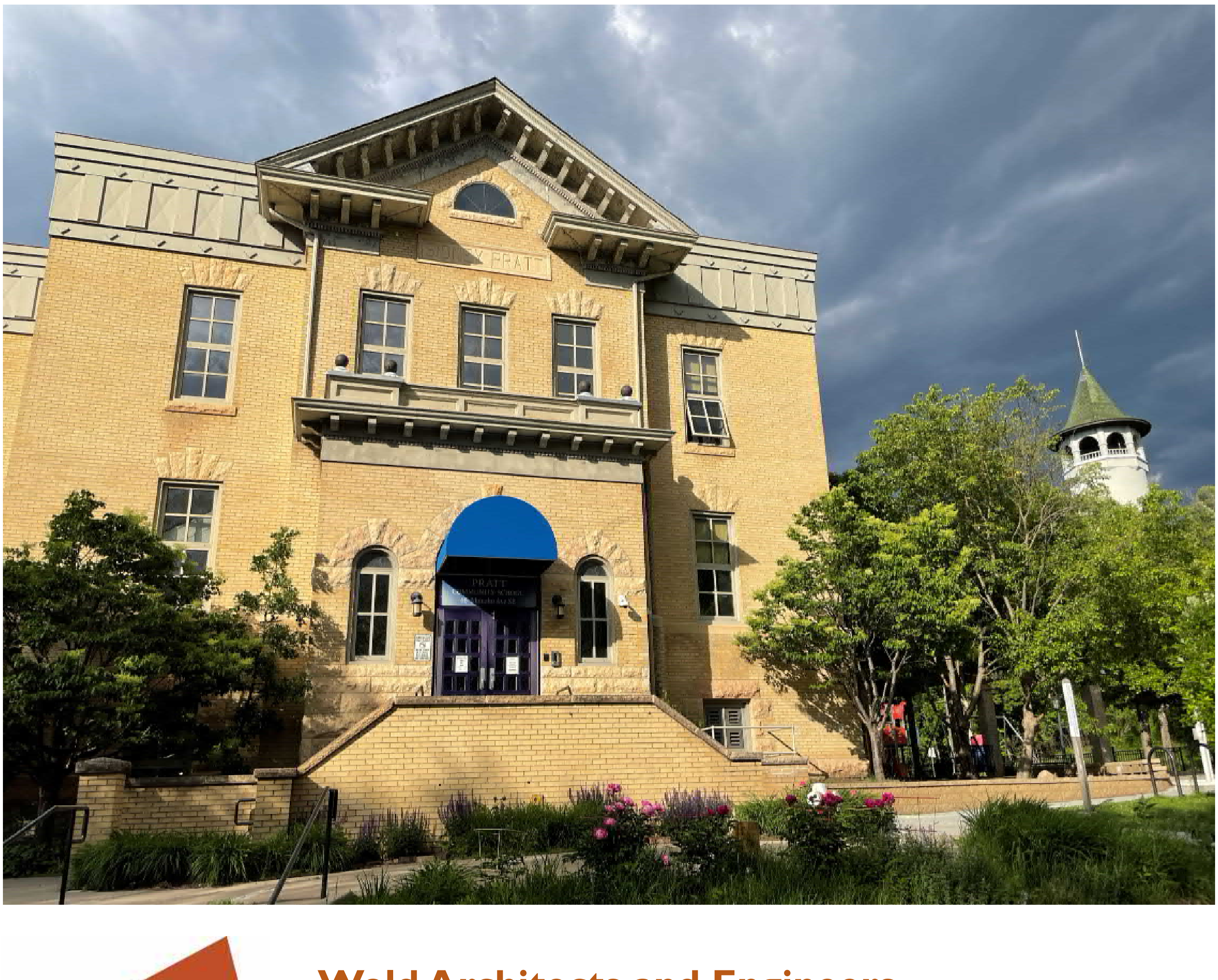

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DRAFT October 1, 2021

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INTRODUCTION / KEY INFORMATION:

Wold Architects and Engineers was hired May 2021 to develop options with a recommended approach and construction cost estimate to expand the air conditioned area at Pratt 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: **Pratt Community School**
  Minneapolis Public Schools
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  Minneapolis, MN 55410
  Phone: (612) 668-1122
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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 Pratt 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 Areas #1 and #2 (31,650 Sq Ft): Install a vertical unit ventilator with integral DX cooling in each classroom. Modify the existing steam distribution system to provide heating. The exterior louver will be installed through an existing window opening. The base project includes routing supply ductwork exposed along the exterior wall with registers for horizontal distribution. 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. Included with the ceilings and lights is overhead duct distribution to improve the sound performance and air distribution of the ventilation system.

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.
- Integrity and capacity of the existing steam and condensate systems. The basis for cost estimating assumes that necessary piping modifications will be made within each classroom.
- Historic preservation considerations related to modifying the exterior with a new louver installation.
- Route and termination of the cooling system condensate drain. An allowance is provided to route the condensate drain from each unit ventilator to a floor drain located in the lower level.
- Modification to perimeter casework and finishes are included only as necessary for the mechanical systems installation.

Construction Cost Estimate: $ 1,545,000
Add for Ceiling and Lights: $ 837,000

EXISTING BUILDING INFORMATION

The original building was constructed in 1898. 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.)
1898	13,830
1906	15,786
1926	12,416
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 is defined by the following approach to heating and cooling.

Low Cost Option: Integral DX, Modify existing Steam System

Medium Cost Option: Integral DX, Hot water heating from the 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

Vertical Unit Ventilators					
Building Area	**Serves**	**Area SF**	**Construction Budget**		
			Low	**Medium**	**High**
#1	Classrooms	22,890			
#2	Classrooms	8,760			
Total		**31,650**	**$1,545,000**	**$1,926,000**	**$3,718,000**

Central Variable Air Volume:

Install a variable central air handling system in each of the building areas. To serve building area #1, the most likely location in the boiler room and adjacent storage area. 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: 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	22,890			
#2	Classrooms	8,760			
Total		**31,650**	**$2,645,500**	**$3,074,000**	**$4,911,500**

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.

Dedicated Outside Air / Displacement					
Building Area	**Serves**	**Area SF**	**Construction Budget**		
			Low	**Medium**	**High**
#1	Classrooms	22,890	N/A	N/A	
#2	Classrooms	8,760	N/A	N/A	
Total		**31,650**	N/A	N/A	**$4,838,000**

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** **$ 837,000**

AIR CONDITIONING OPTIONS 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: 1898 / 1906 Classrooms (22,890 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 - 1898 / 1906 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 building construction included a large supply fan located on the ground floor in what is now the Minneapolis Kids Classroom. Supply and return air was distributed to each classroom vertically in shafts at what was a coatroom wall. Subsequent renovations have removed this walls and presumably in-filled the shaft openings to enlarge the classrooms. Horizontal unit ventilators installed in 1961 currently ventilate the Classrooms. The original outside air intake on the west side of the building currently serves as a path for the kitchen exhaust ductwork. The following outlines possible new air delivery methods:

Mini-split: There are multiple mini-split system currently installed in the building to serve spaces such as the office and data room. 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 steam finned tube radiation. Outside and relief would be available by replacing one of the windows adjacent to each unit ventilator. The remote

DX solution is not considered practical because of the challenge in locating the condensing units is an accessible location. The tight site and sloped roof restrict possible locations.

Central Variable Air Volume (VAV): The boiler room has space available to accommodate a new central variable air volume unit and is centrally located to the area it would serve. The ideal location and design of the space is dependent on the heating and cooling central plant options implemented. 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 de determined. It appears that the vertical paths in the original building construction have been mostly infilled. The building is wood frame construction limiting the flexibility in locating new large openings. It is anticipated that multiple vertical pathways will need to be identified to distribute form the ground floor to the upper floor. Louvers installed in the window openings in the boiler room can provide a relief air path. A new location for outside air needs to be determined. Ideally, the outside air louver location is above grade to minimize the risk of contaminants. Options include constructing a new intake louver structure adjacent to the building with a ducted path into the mechanical space below.

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.

<u>Cooling Plant:</u> 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. There is precedent with the existing systems in the building. The existing condensing units are attached to the exterior wall approximately 6'-0" above grade. The proposed location for the new condensing units would be similar due to the sloped roof condition and the tight site constraints.

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 a single large dual fuel steam fire tube boiler. The steam option 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.

- Determining vertical pathways for new ductwork as necessary for the central air handling unit options. The existing structure is wood frame. It appears that the original vertical pathways in the building have been infilled.
- 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.

- Historic preservation considerations related to modifying the exterior with a new louver installation.
- Route and termination of the cooling system condensate drain. An allowance is provided to route the condensate drain from each unit ventilator to a floor drain located in the lower level.

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:

1898 / 1906 First Floor Hallway – Looking North

1898 / 1906 Typical Classroom – Rm 201

Building Area 2: 1926 Classrooms (8,760 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 - 1926 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

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 building construction included individual unit ventilators in each classroom. The original unit ventilators were replaced in 1961 with horizontal unit ventilators. The following outlines possible new air delivery methods:

Mini-split: There are multiple mini-split system currently installed in the building to serve spaces such as the office and data room. 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 steam 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): 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.

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.

<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 in an option for mini-split systems. There is precedent with the existing systems in the building. The 1926 addition was constructed with a flat roof allowing for remote condensing units to be installed 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 a single large dual fuel steam fire tube boiler. The steam option 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.

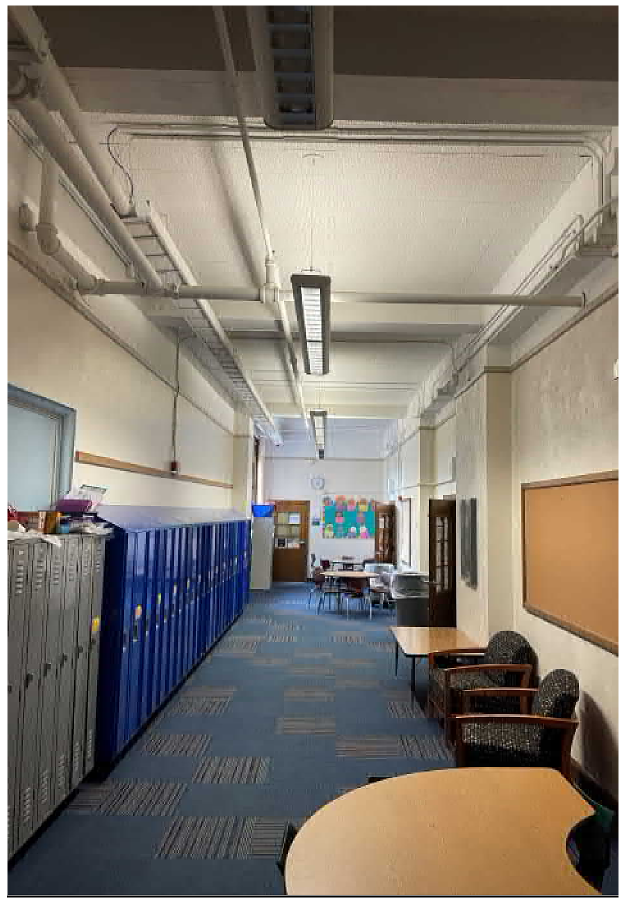
- Determining vertical pathways for new ductwork as necessary for the central air handling unit options. The existing structure poured concrete over clay tile. Options that require removing a concrete joist will require additional structural review.
- Determining a design solution for outside ventilation 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.
- Structural capacity for options that locate new equipment on the roof. If roof options are considered, further structural evaluation will be necessary.
- 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.
- Historic preservation considerations related to modifying the exterior with a new louver installation.
- Route and termination of the cooling system condensate drain. An allowance is provided to route the condensate drain from each unit ventilator to a floor drain located in the lower level.

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:

1926 Typical Classroom – Room 106



1926 1st Floor Corridor Looking West

Building Area 3: Office (1,990 Sq. Ft.): Split DX systems installed in 2015 currently cool the office area. As an alternative, central ventilation solutions were evaluated. These options will allow for the Office to be operated independently of the systems serving the classrooms.

Options Summary:

Building Area	Air Delivery Method	Cooling Plant	Heating Plant	Option
3 - Office	C - Central VAV	B - Remote DX	B - Steam	3-CBB
			C - Hot Water*	3-CBC
		C - Chilled Water*	B - Steam	3-CCB
			C - Hot Water*	3-CCC
	D - DOAS	C - Chilled Water*	C - Hot Water*	3-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 building construction included a large supply fan located on the ground floor. Supply and return air was distributed vertically in shafts at what was a coatroom wall between classrooms. Horizontal unit ventilators installed in 1961 currently ventilate the office area. The following outlines possible new air delivery methods:

Central Variable Air Volume (VAV): The boiler room has space available to accommodate a new central variable air volume unit and is centrally located to the area it would serve. The ideal location and design of the space is dependent on the heating and cooling central plant options implemented. Vertical paths for distribution need to be determined. The building is wood frame construction limiting the flexibility in locating new large openings. Louvers installed in the window openings in the boiler room can provide a relief air path. A new location for outside air needs to be determined. Ideally, the outside air louver location is above grade to minimize the risk of contaminants. Options include constructing a new intake louver structure adjacent to the building with a ducted path into the mechanical space below.

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 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: 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 a single large dual fuel steam fire tube boiler. The steam option 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.

- 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.

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:

Main Office – Rm 109

Storage Room 109A

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 in the parking lot to the West. An abandoned air tunnel under the gymnasium that may provide a route for chilled water distribution throughout the building from the chiller. Locating the chiller close to the building will minimize the associated piping costs. A likely candidate for the chiller location is between the building and the hard play surface. 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. 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. The refrigerant piping could be installed in the abandoned air tunnel beneath the gymnasium to locate the chiller compressors in the mechanical space on the east end of the gymnasium. The distance from the air-cooled condenser to the possible compressor location is approximately 130 feet. The distance exceeds the maximum length recommendations of a typical chiller. The remote chiller option would work best if the building were to be converted to hot water such that the condensate receiver in the tunnel could be eliminating to allow for more space for the remote compressors and other chilled water equipment.

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 to the west is approximately 27,000 sq. ft. and would be a possible location for the well field. Assuming a well cooling capacity of 1 ton per well with a 15'-0" x 15'-0" spacing the parking lot would have an area adequate for a 120 ton cooling system. 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.

<u>Heating Plant:</u> 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:

Possible Cooling Plant Equipment / Geo Thermal Well Field Location

Appendix A:

Existing Systems Diagram

Redacted

Appendix B:

Proposed Systems Diagrams

Redacted

Appendix C:

Dehumidification Capabilities

The building is heated with a single steam boiler. De-humidification is coincident with cooling. There is no option for active de-humidification as the building is currently configured.

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		
BUILDING AREA 2 - 1926 Classrooms	8,760		
Area - SQ FT	**31,650**	**31,650**	**42,032**

Specification Division		**VUV - Intrgral DX, Modify Steam**			**Add for Ceilings and Lights**		
		Sq. Ft. / Qty	**Unit Cost**	**Cost**	**Sq. Ft. / Qty**	**Unit Cost**	**Cost**
Division 02 - Demolition (excludes Div 21, 22, 23, and 26)				**$ 24,000**			**$ 15,825**
Miscellaneous		20	$ 1,200	$ 24,000	31,650	$ 0.50	$ 15,825
Division 03 - Concrete				**$ -**			**$ -**
Floor Patch and Repair				$ -			$ -
Cast-in-place / Misc				$ -			$ -
Division4 - Masonary				**$ -**			**$ -**
Non-bearing Infill				$ -			$ -
Load bearing - new wall construction				$ -			$ -
Division 5 - Metals				**$ -**			**$ -**
Structural Steel / Misc. Fabrications Allowance				-			-
Division 6 - Carpentry				**$ 50,000**			**$ -**
Rough Carpentry				$ -			$ -
Casework Modifications		20	$ 2,500	$ 50,000			$ -
Division 7 - Thermal / Moisture Protection				**$ -**			**$ -**
Roof Patch and Repair				$ -			$ -
Roof New Construction				$ -			$ -
Fire Stopping / Miscellaneous				$ -			$ -
Division 8 - Openings				**$ 50,000**			**$ -**
Access Panels				-			-
Doors / Hardware				-			-
Windows				-			-
Louvers		20	$ 2,500	50,000			-
Division - 9 Finishes				**$ 48,000**			**$ 234,775**
Soffits / Chases				$ -	20	$ 5,000	$ 100,000
Floor Patch and Repair		20	$ 1,200	$ 24,000			$ -
Acoustic Ceilings				$ -	31,650	$ 3.5	$ 110,775
Painting		20	$ 1,200	$ 24,000	20	$ 1,200	$ 24,000
Division 10 - Specialties				**$ -**			**$ -**
Miscellaneous				-			-
Division 11 - Equipment				**$ -**			**$ -**
Miscellaneous				$ -			$ -
Division 12 - Furnishings				**$ -**			**$ -**
Casework				$ -			$ -
Miscellaneous				$ -			$ -
Division 21 - Fire Protection				**$ 15,825**			**$ 79,125**
Demolition				$ -			$ -
New / Modify Existing		31,650	$ 0.50	$ 15,825	31,650	$ 2.50	$ 79,125
Division 22 - Plumbing				**$ -**			**$ -**
Demolition				$ -			$ -
Plumbing Fixtures				$ -			$ -
Micellaneous				$ -			$ -
Division 23 - HVAC				**$ 832,000**			**$ 100,000**
Air Handling Equipment (VUV's / AHU's / RTU's)		20	$ 18,500	$ 370,000			$ -
Cooling Plant Equipment (Chiller / DX / Heat Pump)				$ -			$ -
Heating Plant Equipment (Boiler)				$ -			$ -
Demolition		20	$ 800	$ 16,000			$ -
AHU Equipment Installation / Start-up		20	$ 2,500	$ 50,000			$ -
Cooling Plant Equipment Installation				$ -			$ -
Heating Plant Installation				$ -			$ -
Chilled Water Distribution				$ -			$ -
Steam / Condensate Distribution		20	$ 2,500	$ 50,000			$ -
Hot Water Distribution				$ -			$ -
Ductwork Distribution Misc. (VAV's / Exhaust)		20	$ 10,000	$ 200,000	20	$ 5,000	$ 100,000
Controls		20	$ 6,500	$ 130,000			$ -
Test and Balance		20	$ 800	$ 16,000			$ -
Division 26 - Electrical				**$ 124,000**			**$ 189,900**
Demolition		20	$ 1,200	$ 24,000	31,650	$ 1	$ 15,825
Electrical Service		1	$ 50,000	$ 50,000			$ -
Power Connections		20	$ 2,500	$ 50,000			$ -
Lighting and Controls				$ -	31,650	$ 5.50	$ 174,075
Division 27 - Technology				**$ -**			**$ -**
Demolition Allowance				$ -			$ -
Fire / Sound / Data Allowance				$ -			$ -
DIVISION SUB-TOTAL				**$ 1,143,825**			**$ 619,625**
Division 1 - General Conditions				**$ 200,169**			**$ 108,434**
OH & P	10%			$ 114,383			$ 61,963
Liability Insurance	1%			$ 11,438			$ 6,196
Performance Bond	2%			$ 17,157			$ 9,294
General Contractor Misc.	5%			$ 57,191			$ 30,981
CONSTRUCTION SUB-TOTAL				**$ 1,343,994**			**$ 728,059**
CONTINGENCY	15%			**$ 201,599**			**$ 109,209**
CONSTRUCTION GRAND-TOTAL				**$ 1,545,594**			**$ 837,268**
COST per SQ FT				**$ 36.77**			**$ 19.92**