Minneapolis Public Schools
Special School District #1

Air Conditioning Cost Estimating Study Anwatin Community Middle School

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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 the Anwatin Community Middle 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: **Anwatin Community Middle School**
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  Minneapolis, MN 55405
  Phone: (612) 668-2450
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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 Anwatin Community Middle 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 (90,235 Sq Ft): Install a vertical unit ventilator with integral DX cooling in each classroom. Remove the existing furnace rooms and reconstruct a wall to separate the classrooms. The intent is for the unit ventilator to be exposed in the classroom typically in the corner where the furnace room is currently located. Modify the exterior wall for a new louver penetration. Install a new high efficiency boiler plant to serve hot water to the building for heating needs. The plant will be sized to convert the entire building to hot water operation. Existing steam terminal devices will be replaced with hot water terminal heating. 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 to conceal ductwork along the classroom perimeter. The concealed ductwork will improve the sound performance of the systems. The existing structure is too low to allow for the ductwork to be distributed above the ceiling.

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 extent of reconstruction and restoration of room finishes requires further investigation.
- The loss of space in the smaller rooms in Building Area #2 and the main offices needs to be investigated. Consideration should be given to a hybrid approach to serve these areas with a rooftop unit.
- Modification to perimeter casework and finishes are included only as necessary for the mechanical systems installation.

Construction Cost Estimate: $ 9,808,000
Add for Ceiling and Lights: $ 2,180,000

Auditorium Building Areas #3 (15,885 Sq Ft): Install new constant volume air handling units in the same location as the existing in the mezzanine mechanical room. Insulate the existing supply ductwork above the ceiling in the auditorium. Provide remote DX condensing units for cooling. Connect to the new hot water heating plant included in the classroom option.

For consideration, an added scope option is included for providing a new lay-in ceiling and new LED lighting and controls. Replacement of the ceiling will mitigate risks associated with insulating the existing ductwork. 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.
- 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.
- Insulating the existing ductwork if the auditorium ceiling is not replaced. Access is very difficult.
- 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: $ 910,000

Gymnasium Building Areas #4 (8.400 Sq Ft): Install a new constant volume single zone roof mounted air handling unit with integral DX cooling. Install the unit on the adjacent lower roof and route new supply ductwork exposed within the gymnasium. Connect to the new hot water heating plant included in the classroom option.

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: $ 378,000
Add for De-stratification Fans $ 22,000

Cafeteria Building Areas #5 (7,490 Sq Ft): Install a new constant volume single zone roof mounted air handling unit with integral DX cooling. Install the unit on the roof above the

cafeteria and route new supply ductwork exposed. Connect to the new hot water heating plant included in the classroom option.
For consideration, an added scope option is included for providing a new lay-in ceiling and new LED lighting and controls. Soffits are included to conceal ductwork within the cafeteria. The concealed ductwork will improve the sound performance of the systems. The existing structure is too low to allow for the ductwork to be distributed above the ceiling.

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:	**$**	**442,000**
Add for Ceiling and Lights:	**$**	**152,000**

EXISTING BUILDING INFORMATION

The original building was constructed in 1959. The original project typically ventilated the classrooms with furnaces located in a mechanical space between classrooms. Spaces other than the classrooms are typically ventilated by central air handling systems installed in interior mechanical rooms.

There is not a centralized cooling plant. Window AC units or mini-split units serve a portion of the rest of the building.

The majority of the building is heated with individual residential style gas furnaces. A central plant with a dual fuel fire tube steam boiler serves some portions of the building including the gymnasium, cafeteria, and auditorium.

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

Building Area Summary:

Year	Area (sq. ft.)
1959	146,771
Total	**146,771**

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, New hot water plant

Medium Cost Option: Remote DX, Hot water plant

High Cost Option: Air-cooled chiller, Hot water plant

Vertical Unit Ventilators					
Building Area	**Serves**	**Area SF**	**Construction Budget**		
			Low	**Medium**	**High**
#1	Classrooms	74,350			
#2	Classrooms	15,885			
Total		**90,235**	**$5,496,000**	**$5,686,000**	**$7,520,000**

Central Variable Air Volume:

The most viable option to install a central variable air volume system is to locate the units on grade adjacent to the classrooms. Due to the low structure height it is likely the size of the ductwork will limit the number of classrooms that can be served by each unit. Further study is required.

Dedicated Outside Air/Displacement: The most viable option to install dedicated outside air systems is to locate the units on grade adjacent to the classrooms. Due to the low structure height it is likely the size of the ductwork will limit the number of classrooms that can be served by each unit. Further study is required.

Additional Scope:

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

New Ceilings and LED Lights: **Construction Budget** **$ 1,170,000**

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: North Classrooms (74,350 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 – 1921 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: Individual furnaces installed in mechanical spaces located between the classrooms typically serve the classrooms. There a total of 67 furnaces serving the building. 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 furnace serving each classroom. The existing furnace rooms are not large enough to accommodate the unit ventilators. It will be required to remove or modify the furnace rooms. The rooms typically have perimeter casework that will need to be modified. The science and FACS rooms have extensive perimeter casework.

Central Variable Air Volume (VAV): Provide a new central variable air volume system. Further investigation is required to determine the optimal location. It is likely that due to structural constraints that new units will need to be set on grade adjacent to the

building. It is anticipated that the current MN Energy code will require heat recovery to be incorporated into the system.

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

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

Integral Direct Expansion (DX): Integral DX is an option with the vertical unit ventilators and for package variable air volume units located outside. 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, vertical unit ventilators, and central variable air volume solutions. Condenser locations for remote DX locations need to be determined. Structural constraints of the roof need to be evaluated.

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 optimal equipment locations for central variable volume options.
- Determining a design solution for outside ventilation air with interior the central air handling unit options. Pathways for outside air and building relief air need to be determined.
- Determine structural capacity limitations with options that include roof mounted equipment.
- Space heating and cooling loads are estimated based on typical loads for this type of space. Final heating and cooling loads need to be completed.
- Integrity of the existing steam and condensate systems for options that include steam heating. Piping in poor condition may necessitate additional pipe removal. The best method to mitigate this risk is to pursue the hot water heating solution as outlined in the heating section above.

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

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

Typical Photos:

Typical Classroom

Media Center

Building Area 2 – South Classrooms (15,885 Sq. Ft.): The following is a summary of the range of possible options considered.

Options Cost Summary:

Building Area	Air Delivery Method	Cooling Plant	Heating Plant	Option
2 – South 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: Individual furnaces installed in mechanical spaces located between the classrooms typically serve the classrooms. There a total of 67 furnaces serving the building. 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 furnace serving each classroom. The existing furnace rooms are not large enough to accommodate the unit ventilators. It will be required to remove or modify the furnace rooms. The rooms typically have perimeter casework that will need to be modified. The science and FACS rooms have extensive perimeter casework.

Central Variable Air Volume (VAV): Provide a new central variable air volume system. Further investigation is required to determine the optimal location. It is likely that due to structural constraints that new units will need to be set on grade adjacent to the building. It is anticipated that the current MN Energy code will require heat recovery to be incorporated into the system.

Dedicated Outside Air (DOAS): Options for locating a new DOAS unit are similar to locating the VAV unit as describe above. The advantage of a DOAS unit is that the

volume of air it is moving is approximately 1/3 as compared to the VAV system. The equipment and associated ductwork are smaller and easier to retrofit.

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

Integral Direct Expansion (DX): Integral DX is an option with the vertical unit ventilators and for package variable air volume units located outside. 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, vertical unit ventilators, and central variable air volume solutions. Condenser locations for remote DX locations need to be determined. Structural constraints of the roof need to be evaluated.

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 optimal equipment locations for central variable volume options.
- Determining a design solution for outside ventilation air with interior the central air handling unit options. Pathways for outside air and building relief air need to be determined.
- Determine structural capacity limitations with options that include roof mounted equipment.
- Space heating and cooling loads are estimated based on typical loads for this type of space. Final heating and cooling loads need to be completed.
- Integrity of the existing steam and condensate systems for options that include steam heating. Piping in poor condition may necessitate additional pipe removal. The best method to mitigate this risk is to pursue the hot water heating solution as outlined in the heating section above.

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

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

Typical Photos:

Typical Classroom - Room 512

Typical Furnace Installation

Building Area 3 – Auditorium (15,885 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 - Auditorium	C - Central CV	B - Remote DX	B - Steam	3-CBB
			C - Hot Water*	3-CBC
		C - Chilled Water*	B - Steam	3-CCB
			C - Hot Water*	3-CCC

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

Air Delivery: Two constant volume single zone air-handling units serve the north and south half of the auditorium. The air-handling units are located in a mechanical space on each side of the stage area. The following outlines possible new air delivery methods:

Central Constant Air Volume (CV): Replace the air-handling system with new constant volume air-handling units. Further investigation is necessary to determine the optimal configuration of the new mechanical systems and if the new unit will fit in the existing mechanical room. An option is to locate the new unit on the roof above. Pathways for vertical duct distribution need to be determined.

Cooling Plant: Viable options studied include integral packaged DX, remote DX, and construction of a new central chilled water plant. The location of the chiller plant needs to consider sound levels at the adjacent property line. There is a large space to the east of the building. The following outlines possible cooling plant options:

Remote Direct Expansion (DX): Remote DX in an option for the air-handling systems. The ideal location for a remote condensing unit is on the roof adjacent to the mechanical rooms. Further structural evaluation is necessary to determine the structural 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 one large dual fuel steam fire tube boilers. 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 a design solution for outside ventilation air with the central air handling unit options.
- Determine the optimal layout for air handling unit installation in the existing mechanical room. It would work best to reconfigure the other equipment in the room.
- 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 hot water convertor system and associated pumps and piping. 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.

Typical Photos:

Auditorium

Building Area 4 – Gymnasium (8,400 Sq. Ft.): The following is a summary of the range of possible options considered.

Options Cost Summary:

Building Area	Air Delivery Method	Cooling Plant	Heating Plant	Option
4 - Gymnasium	C - Central CV	B - Remote DX	B - Steam	4-CBB
			C - Hot Water*	4-CBC
		C - Chilled Water*	B - Steam	4-CCB
			C - Hot Water*	4-CCC

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

Air Delivery: A constant volume single zone air-handling units serve the gymnasium. The air-handling unit is located in an inside mechanical space. The following outlines possible new air delivery methods:

Central Constant Air Volume (CV): Replace the air-handling system with new constant volume air-handling units. Further investigation is necessary to determine the optimal configuration of the new mechanical systems and if the new unit will fit in the existing mechanical room. An option is to locate the new unit on the roof above. Pathways for vertical duct distribution need to be determined.

Cooling Plant: Viable options studied include integral packaged DX, remote DX, and construction of a new central chilled water plant. The location of the chiller plant needs to consider sound levels at the adjacent property line. There is a large space to the east of the building. The following outlines possible cooling plant options:

Remote Direct Expansion (DX): Remote DX in an option for the air-handling systems. The ideal location for a remote condensing unit is on the roof adjacent to the mechanical rooms. Further structural evaluation is necessary to determine the structural 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 one large dual fuel steam fire tube boilers. 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.

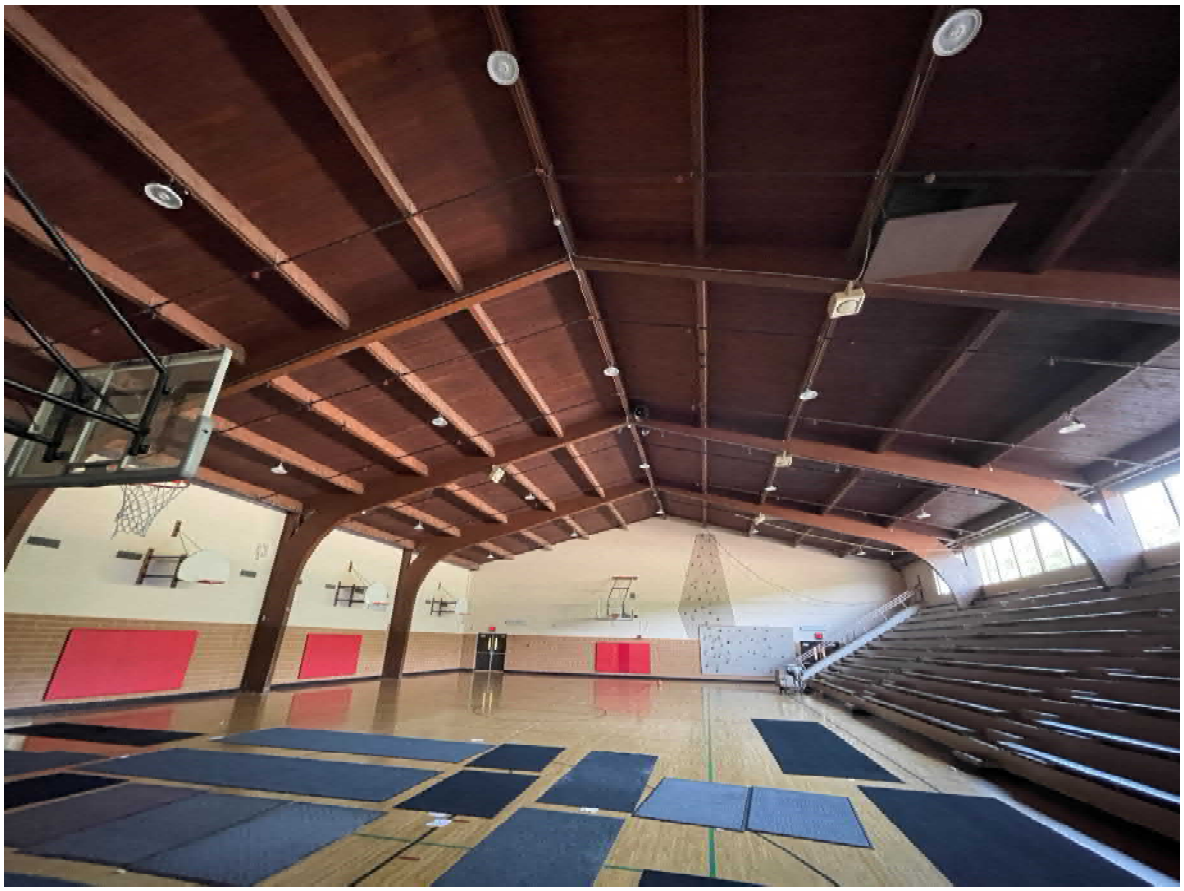
Hot Water Plant: There are multiple options to generate hot water to meet the heating needs of the building. Refer to the central plant options in this report for a discussion of each.

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 a design solution for outside ventilation air with the central air handling unit options.
- Determine the optimal layout for air handling unit installation in the existing mechanical room. It would work best to reconfigure the other equipment in the room.
- 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 hot water convertor system and associated pumps and piping. 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.

Typical Photos:



Gymnasium

Building Area 5 – Cafeteria (7,490 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
5 - Cafeteria	C - Central CV	B - Remote DX	B - Steam	5-CBB
			C - Hot Water*	5-CBC
		C - Chilled Water*	B - Steam	5-CCB
			C - Hot Water*	5-CCC

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

Air Delivery: A constant volume single zone air-handling units serve the Cafeteria. The air-handling unit is located in an inside mechanical space. The following outlines possible new air delivery methods:

Central Constant Air Volume (CV): Replace the air-handling system with new constant volume air-handling units. Further investigation is necessary to determine the optimal configuration of the new mechanical systems and if the new unit will fit in the existing mechanical room. An option is to locate the new unit on the roof above. Pathways for vertical duct distribution need to be determined.

Cooling Plant: Viable options studied include integral packaged DX, remote DX, and construction of a new central chilled water plant. The location of the chiller plant needs to consider sound levels at the adjacent property line. There is a large space to the east of the building. The following outlines possible cooling plant options:

Remote Direct Expansion (DX): Remote DX in an option for the air-handling systems. The ideal location for a remote condensing unit is on the roof adjacent to the mechanical rooms. Further structural evaluation is necessary to determine the structural 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 one large dual fuel steam fire tube boilers. 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 a design solution for outside ventilation air with the central air handling unit options.
- Determine the optimal layout for air handling unit installation in the existing mechanical room. It would work best to reconfigure the other equipment in the room.
- 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 hot water convertor system and associated pumps and piping. 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.

Typical Photos:

Cafeteria

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. Any centralized solution that has outside equipment will need to be evaluated for the sound levels at the adjacent property line. There is lots of flexibility to locate a chiller on site. Final load calculations are necessary to determine the final chiller size.

Air Cooled Chiller: A possible location for a chiller is on grade to the west of the boiler room. 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.

Ground Coupled Geo-thermal: A ground coupled geothermal solution has the advantage in eliminating the risk of a sound impact to the adjacent residential neighbors. There is ample site to locate a well field. Further study and a test well is necessary to determine the site specific well conditions to optimize the depth, capacity, and cost. Alternate geothermal technologies including Darcy Solutions closed loop systems should be considered to further reduce the cost and size of the well field.

Heating Plant: A single dual fuel steam fire-tube boiler currently serves the 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 geothermal or chiller Location - West Side of Building

Appendix A:

Existing Systems Diagram

Redacted

Appendix B:

Proposed Systems Diagrams

Redacted

Appendix C:

Dehumidification Capabilities

The recommended solution to provide air conditioning to the classrooms includes providing a high efficiency boiler for summer operation. Areas included in the scope of renovation 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

VUV Qty = 52

		Ventilation Area	Bldg Total
BUILDING AREA 1 - North Classrooms	74,350		
BUILDING AREA 2 - South Classrooms	15,885		
Area - SQ FT	**90,235**	**90,235**	**156,771**

Specification Division	**Areas #1 and #2 - VUV, Integral DX, HW**			**Auditorium** **Building Area #3** **15,887 SQ FT** **Area #3 - Central CV, Remote DX, HW**			**Gymnasium** **Building Area #4** **8,400 SQ FT** **Area #4 - RTU CV, Interal DX, HW**			**Cafeteria** **Building Area #5** **7,490 SQ FT** **Area #5 - RTU CV, Interal DX, HW**			**Building Area** **90,235 SQ FT** **Area #1 and #2 - Add for Ceilings and Lights**			**Building Area** **7,490 SQ FT** **Area #5- 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**	**Sq. Ft. / Qty**	**Unit Cost**	**Cost**
Division 02 - Demolition (excludes Div 21, 22, 23, and 26)			**$ 180,000**			**$ 7,944**			**$ 4,200**			**$ 7,490**			**$ 45,118**			**$ 3,745**
Miscellaneous	36	$ 5,000	$ 180,000	15,887	$ 0.50	$ 7,944	8,400	$ 1	$ 4,200	7,490	$ 1.00	$ 7,490	90,235	$ 0.50	$ 45,118	7,490	$ 0.50	$ 3,745
Division 03 - Concrete			**$ -**			**$ 7,000**			**$ -**			**$ -**			**$ -**			**$ -**
Floor Patch and Repair			$ -			$ -			$ -			$ -			$ -			$ -
Cast-in-place / Misc			$ -	2	$ 3,500	$ 7,000			$ -			$ -			$ -			$ -
Division4 - Masonary			**$ 306,000**			**$ -**			**$ -**			**$ -**			**$ -**			**$ -**
Non-bearing Infill	36	$ 8,500	$ 306,000			$ -			$ -			$ -			$ -			$ -
Load bearing - new wall construction			$ -			$ -			$ -			$ -			$ -			$ -
Division 5 - Metals			**$ 20,000**			**$ 17,000**			**$ 20,000**			**$ 20,000**			**$ -**			**$ -**
Structural Steel / Misc. Fabrications Allowance	1	$ 20,000	20,000	2	$ 8,500	17,000	1	$ 20,000	20,000	1	$ 20,000	20,000			-			-
Division 6 - Carpentry			**$ 57,600**			**$ -**			**$ -**			**$ -**			**$ -**			**$ -**
Rough Carpentry			$ -			$ -			$ -			$ -			$ -			$ -
Casework Modifications	24	$ 2,400	$ 57,600						$ -						$ -			$ -
Division 7 - Thermal / Moisture Protection			**$ 80,400**			**$ 2,500**			**$ -**			**$ 5,000**			**$ -**			**$ -**
Roof Patch and Repair	67	$ 1,200	$ 80,400	1	$ 2,500	$ 2,500			$ -	1	$ 5,000	$ 5,000			$ -			$ -
Roof New Construction			$ -			$ -			$ -			$ -			$ -			$ -
Fire Stopping / Miscellaneous			$ -			$ -			$ -			$ -			$ -			$ -
Division 8 - Openings			**$ 301,500**			**$ -**			**$ -**			**$ -**			**$ -**			**$ -**
Access Panels			-			-			-			-			-			-
Doors / Hardware			-			-			-			-			-			-
Windows			-			-			-			-			-			-
Louvers	67	$ 4,500	301,500			-			-			-			-			-
Division - 9 Finishes			**$ 627,084**			**$ 95,322**			**$ -**			**$ 29,960**			**$ 541,410**			**$ 44,940**
Soffits / Chases	156,771	$ 2.00	$ 313,542	15,887	$ 4.50	$ 71,492			$ -	7,490	$ 2.50	$ 18,725	90,235	$ 2.00	$ 180,470	7,490	$ 2.00	$ 14,980
Floor Patch and Repair	156,771	$ 1.00	$ 156,771			$ -			$ -			$ -			$ -			$ -
Acoustic Ceilings	156,771	$ 0.50	$ 78,386			$ -			$ -			$ -	90,235	$ 3.50	$ 315,823	7,490	$ 3.50	$ 26,215
Painting	156,771	$ 0.50	$ 78,386	15,887	$ 1.50	$ 23,831			$ -	7,490	$ 1.50	$ 11,235	90,235	$ 0.50	$ 45,118	7,490	$ 0.50	$ 3,745
Division 10 - Specialties			**$ -**			**$ -**			**$ -**			**$ -**			**$ -**			**$ -**
Miscellaneous			-			-			-			-			-			-
Division 11 - Equipment			**$ -**			**$ -**			**$ -**			**$ -**			**$ -**			**$ -**
Miscellaneous			$ -			$ -			$ -			$ -			$ -			$ -
Division 12 - Furnishings			**$ -**			**$ -**			**$ -**			**$ -**			**$ -**			**$ -**
Casework			$ -			$ -			$ -			$ -			$ -			$ -
Miscellaneous			$ -			$ -			$ -			$ -			$ -			$ -
Division 21 - Fire Protection			**$ 90,235**			**$ 15,887**			**$ -**			**$ 14,980**			**$ 225,588**			**$ 18,725**
Demolition			$ -	-		$ -			$ -	-		$ -			$ -			$ -
New / Modify Existing	90,235	$ 1.00	$ 90,235	15,887	$ 1.00	$ 15,887			$ -	7,490	$ 2.00	$ 14,980	90,235	$ 2.50	$ 225,588	7,490	$ 2.50	$ 18,725
Division 22 - Plumbing			**$ -**			**$ -**			**$ -**			**$ -**			**$ -**			**$ -**
Demolition			$ -			$ -			$ -			$ -			$ -			$ -
Plumbing Fixtures			$ -			$ -			$ -			$ -			$ -			$ -
Micellaneous			$ -			$ -			$ -			$ -			$ -			$ -
Division 23 - HVAC			**$ 5,029,778**			**$ 486,927**			**$ 240,600**			**$ 227,055**			**$ 260,000**			**$ -**
Air Handling Equipment (VUV's / AHU's / RTU's)	67	$ 18,500	$ 1,239,500	2	$ 45,000	$ 90,000	1	$ 35,000	$ 35,000	1	$ 35,000	$ 35,000			$ -			$ -
Cooling Plant Equipment (Chiller / DX / Heat Pump)			$ -	2	$ 24,000	$ 48,000			$ -			$ -			$ -			$ -
Heating Plant Equipment (Boiler)	3	$ 55,000	$ 165,000			$ -			$ -			$ -			$ -			$ -
Demolition	67	$ 1,200	$ 80,400	15,887	$ 1.00	$ 15,887	8,400	$ 0.50	$ 4,200	7,490	$ 0.50	$ 3,745			$ -			$ -
AHU Equipment Installation / Start-up	67	$ 2,500	$ 167,500	2	$ 50,000	$ 100,000	1	$ 10,000	$ 10,000	1	$ 10,000	$ 10,000			$ -			$ -
Cooling Plant Equipment Installation			$ -	2	$ 15,000	$ 30,000			$ -			$ -			$ -			$ -
Heating Plant Installation	3	$ 40,000	$ 120,000			$ -			$ -			$ -			$ -			$ -
Chilled Water Distribution			$ -			$ -			$ -			$ -			$ -			$ -
Steam / Condensate Distribution			$ -			$ -			$ -			$ -			$ -			$ -
Hot Water Distribution	156,771	$ 12.50	$ 1,959,638	1	$ 20,000	$ 20,000	1	$ 20,000	$ 20,000	1	$ 20,000	$ 20,000			$ -			$ -
Ductwork Distribution Misc. (VAV's / Exhaust)	67	$ 6,500	$ 435,500	15,887	$ 8.00	$ 127,096	8,400	$ 18.00	$ 151,200	7,490	$ 18.00	$ 134,820	52	$ 5,000	$ 260,000			$ -
Controls	156,771	$ 5.00	$ 783,855	2	$ 24,000	$ 48,000	1	$ 16,000	$ 16,000	1	$ 16,000	$ 16,000			$ -			$ -
Test and Balance	156,771	$ 0.50	$ 78,386	15,887	$ 0.50	$ 7,944	8,400	$ 0.50	$ 4,200	7,490	$ 1.00	$ 7,490			$ -			$ -
Division 26 - Electrical			**$ 565,557**			**$ 32,831**			**$ 11,700**			**$ 18,735**			**$ 541,410**			**$ 44,940**
Demolition	67	$ 1,200	$ 80,400	15,887	$ 0.50	$ 7,944	8,400	$ 0.50	$ 4,200	7,490	$ 0.50	$ 3,745	90,235	$ 0.50	$ 45,118	7,490	$ 0.50	$ 3,745
Electrical Service	1	$ 250,000	$ 250,000			$ -			$ -			$ -			$ -			$ -
Power Connections	156,771	$ 1.50	$ 235,157	2	$ 4,500	$ 9,000	1	$ 7,500	$ 7,500	1	$ 7,500.00	$ 7,500			$ -			$ -
Lighting and Controls			$ -	15,887	$ 1.00	$ 15,887			$ -	7,490	$ 1.00	$ 7,490	90,235	$ 5.50	$ 496,293	7,490	$ 5.50	$ 41,195
Division 27 - Technology			**$ -**			**$ 7,944**			**$ 3,745**			**$ 3,745**			**$ -**			**$ -**
Demolition Allowance			$ -			$ -			$ -			$ -			$ -			$ -
Fire / Sound / Data Allowance			$ -	15,887	$ 0.50	$ 7,944	7,490	$ 0.50	$ 3,745	7,490	$ 0.50	$ 3,745			$ -			$ -
DIVISION SUB-TOTAL			**$ 7,258,154**			**$ 673,353**			**$ 280,245**			**$ 326,965**			**$ 1,613,525**			**$ 112,350**
Division 1 - General Conditions			**$ 1,270,177**			**$ 117,837**			**$ 49,043**			**$ 57,219**			**$ 282,367**			**$ 19,661**
OH & P	10%		$ 725,815			$ 67,335			$ 28,025			$ 32,697			$ 161,353			$ 11,235
Liability Insurance	1%		$ 72,582			$ 6,734			$ 2,802			$ 3,270			$ 16,135			$ 1,124
Performance Bond	2%		$ 108,872			$ 10,100			$ 4,204			$ 4,904			$ 24,203			$ 1,685
General Contractor Misc.	5%		$ 362,908			$ 33,668			$ 14,012			$ 16,348			$ 80,676			$ 5,618
CONSTRUCTION SUB-TOTAL			**$ 8,528,330**			**$ 791,190**			**$ 329,288**			**$ 384,184**			**$ 1,895,892**			**$ 132,011**
CONTINGENCY	15%		**$ 1,279,250**			**$ 118,678**			**$ 49,393**			**$ 57,628**			**$ 284,384**			**$ 19,802**
CONSTRUCTION GRAND-TOTAL			**$ 9,807,580**			**$ 909,868**			**$ 378,681**			**$ 441,811**			**$ 2,180,276**			**$ 151,813**
COST per SQ FT			**$ 62.56**			**$ 57.27**			**$ 45.08**			**$ 58.99**			**$ 24.16**			**$ 20.27**