Eastland Community Unit School District 308
Eastland Junior – Senior High School

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Facility Location: 500 School Drive, Lanark, Illinois 61046
Elara Job #: 15184
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I. EXECUTIVE SUMMARY

Elara Energy Services was enlisted by Richard L. Johnson Associates, Inc. to perform a Heating and Ventilation Evaluation Report for Eastland Junior – Senior High School in Eastland School District 308 in Lanark, Illinois. Elara’s findings, as well as recommendations to address occupant comfort concerns and increase the efficiency of the HVAC system, are included within this report.

This report presents the existing conditions and provides viable options that could be implemented to address the replacement of the existing steam boiler and related steam distribution and ventilation systems, as well as consideration for providing air conditioning to the spaces not currently conditioned. The following should be noted regarding this report:

- An engineering review and on-site inspection to evaluate the operation, condition, and layout of the existing HVAC system was performed.

- The equipment sizing selections indicated in this report are based on “Rule of Thumb” sizing criteria. Actual heating and cooling load calculations will be necessary to determine the actual equipment sizing once the project progresses into the design phase.

- This report will focus primarily on the original school construction as well as the 1958 addition. These spaces utilize original equipment and are still served by the steam boiler system. The HVAC system serving the 2010 building addition, that includes the physical education spaces, is only 4 years in service and is not considered for upgrade based on their observed condition. The HVAC systems serving the additions and interior renovations that took place in 1999 and 2005 also appear in fair condition and have minimal recommendations for improvement.

The original building was constructed as a low-pressure steam system with distribution of piping through an under floor crawl space to perimeter unit ventilators and corridor mounted convectors. Many of the systems installed are approaching 64 years old and have significantly exceeded their mean useful life and are in need of replacement. The main goal of this report is to evaluate alternatives for replacing this original equipment including converting to heating hot water and providing air conditioning.

The information indicated in this report is intended to provide the end user multiple options for consideration, each with their own benefits and limitations. This report is intended to serve as a guide to assist the end user in selecting the most attractive option considering first costs, operational costs, and the maintenance required for each system presented.
II. BUILDING DESCRIPTION

Eastland Junior – Senior High School is a two story building located at 500 School Drive in Lanark, Illinois 61046. The building was originally constructed in 1951 and included classroom spaces, a gymnasium, an industrial arts space, men’s and women’s toilet rooms, office areas, common areas and support spaces. In addition to a central mechanical room, the building incorporated an under-floor crawl space that serves as the pipe chase for all utilities serving the south classrooms. This crawlspace allowed for domestic water, waste, steam, and condensate piping to be routed to the classrooms without having to run piping above the ceilings. The crawlspace extends south from the boiler room and serves all south end classrooms.

In 1958 a four classroom addition was constructed on the south end of the original building. As part of this addition, the under-floor crawlspace was extended from the original building so that utilities could be routed to serve the HVAC equipment in this wing.

In 1999 an east wing was added to the building that housed classrooms and a media center. This portion of the building was constructed as slab on grade.

In 2004 a north addition was added that included a new main entry, kitchen and cafeteria spaces.

Finally, in 2010 a large physical education addition was added to the north end of the 2004 addition. This space included gymnasium, exercise rooms, locker rooms and mechanical spaces.

Based on the 10 year Health Life Safety drawings, the areas of the building this report will be based on are as indicated below (estimated):

- Original 1951 Building:  
  - First Floor: 14,876 SF  
  - Second Floor: 24,021 SF  
  - Total: 38,897 SF

- 1958 Building Addition:  
  - Second Floor: 4,781 SF

- 1999 Building Addition:  
  - Second Floor: 9,203 SF

- 2004 Building Addition:  
  - First Floor: 7,265 SF  
  - Second Floor: 778 SF  
  - Total: 8,043 SF

- 2010 Building Addition:  
  - First Floor: 33,507 SF  
  - Mezzanine: 3,158 SF  
  - Total: 36,665 SF

Total Building area in Square Feet = 97,589 SF
III. MECHANICAL SYSTEMS DESCRIPTION:

This study will focus on the original 1951 building as well as the 1958 addition. These portions of the building still utilize steam heat, lack air conditioning and are served by the original equipment installed at the time of construction. The remaining areas of the building (1999, 2004 and 2010 additions) will be discussed briefly below, although minimal recommendations exist for these spaces. In most case these areas are fully air conditioned, and the equipment range from 15 years to as recent at 4 years old. Below is a brief description of each construction phase.

1951 ORIGINAL BUILDING AND 1958 ADDITION

Most equipment in the original building and 1958 addition is original to the construction of the building. The spaces are heated by the steam plant and lack air conditioning in most areas.

Steam Distribution

The steam and condensate system serving the building is routed in the crawl space located under the original south classrooms and 1958 addition. It is also routed overhead in all areas north of the crawl space where the building becomes two stories. The steam heating system serves the following equipment:

- Ten (10) floor mounted unit ventilators
- One (1) ceiling mounted unit ventilators
- Eight (8) convectors
- Two (2) Gymnasium air handlers

Although black iron piping has been known to last 100 years or longer, the existing piping is approaching 64 years old and should be replaced in its entirety if the new heating system selected utilizes heating hot water or dual temperature chilled/hot water.

Corridor Heating

Steam convectors are located throughout the corridors and entry vestibules for space heating purposes. All convectors are original to the construction and are served by steam and condensate piping routed from the crawlspace.

Replacement with new heating hot water convectors or cabinet unit heaters are recommended for spaces such as corridors and toilet rooms.

Temperature control for the convectors is provided by local thermostats in the corridors and entryway vestibules. The thermostats are pneumatic and appear to be original to the building.

Unit Ventilators

Unit ventilators are installed to serve the classrooms throughout the original building and 1958 addition. The unit ventilators are steam heated and are served by the steam distribution piping located in the crawlspace. These unit ventilators are original to the construction of the building they serve. Each perimeter classroom is served by a vertical (floor mounted) unit ventilator and in some cases floor mounted convectors.
One (1) ceiling-mounted unit ventilator is located in the first floor original locker room. This ceiling-mounted unit ventilator operates very similarly to the floor mounted units, except that this unit lacks outside air and only operates in 100% re-circulation.

Controls for the unit ventilators utilize original pneumatic thermostats local to the equipment in which they serve.

**Air Conditioning**

Each classroom is equipped with air conditioning, provided via window mounted self-contained air conditioners. Each window air conditioning unit has its own thermostat that is internal to the equipment. In general, the units appear to be fairly old and are nearing the end of their life expectancy.

**Ventilation**

Ventilation for all of the classrooms spaces is provided by the unit ventilators. Every unit ventilator has an outside air intake through the wall that allows outside air into the room. This is very important in order to maintain proper indoor air quality. These louvers would be repurposed to serve any new unit ventilator installed as applicable. The louvers would be thoroughly cleaned and put back into service in this case.

**Exhaust**

Exhaust fans are installed to serve the toilet rooms, specialty rooms (i.e. home economics) and the gymnasium. These exhaust fans were observed to be in poor condition and are in need of replacement.

**Gymnasium**

The original gymnasium is served by two (2) indoor heating only air handlers located on mezzanines on either side of the stage. Both supply and return ductwork is extended to the face of the stage and inlet and discharge grilles are installed. Each air handler has return air and outside air connections. The heating coils associated with each unit are fed from the steam and condensate system located in the boiler room.

Pressurization control is provided by two (2) wall mounted propeller exhaust fans. These fans operate when space temperature in the summer rises above
setpoint and the air handlers are in full economizer (100% outside air mode)

**Temperature Controls**

The original building and 1958 addition use pneumatic control for the existing HVAC equipment. There is a pneumatic air compressor and compressed air dryer located in the mechanical room.

Under a majority of the options indicated within this report a new control system will be included that will be direct digital control with an open protocol to allow for any third party to operate. The School District has standardized to using Alpha Controls, and this provider will be expanded to serve any renovation to the building.

*Note:* The majority of existing mechanical equipment identified above is approximately 58 to 64 years old. Per American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), the mean useful service life for the installed equipment is as follows:

<table>
<thead>
<tr>
<th>Existing Equipment</th>
<th>Median Service Life (years)</th>
<th>Current Equipment Age</th>
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<tbody>
<tr>
<td>Cast Iron Boiler</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Steam Radiant Heater</td>
<td>25</td>
<td>64</td>
</tr>
<tr>
<td>Centrifugal Fans</td>
<td>25</td>
<td>64</td>
</tr>
<tr>
<td>Steam Coils</td>
<td>20</td>
<td>64</td>
</tr>
<tr>
<td>Pneumatic Controls</td>
<td>20</td>
<td>64</td>
</tr>
<tr>
<td>Window A/C Units</td>
<td>10</td>
<td>Unknown</td>
</tr>
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Mean useful life is defined as the point in which potential equipment failure exceeds 50% probability. From the table it is clear that the majority of the existing equipment has exceeded its expected life and is overdue for replacement.

**1999 ADDITIONS & RENOVATION**

An addition and renovation to the building took place in 1999. The addition consisted of 9,200 SF of new construction which included a new media center, classroom spaces and offices. The renovation portion of this project included new HVAC to serve the Science and Physics Lab and Music Department. The following describes the existing equipment serving each space:

**Renovations**

**Science, Physics Lab and Music Department**

Under the 1999 renovation these three classrooms had their original HVAC system replaced with new cooling only, constant volume rooftop units that included a dedicated energy recovery ventilator to recapture the energy from the exhaust air stream. Each of the three systems has hot water reheat coils to temper the discharge air. The three rooftop unit sizes are as follows:
Music Room
Carrier model 48TJE009 sized for 7.5 tons at 2,800 cubic feet per minute (CFM) of airflow with a Micromelt energy recovery ventilator.

Physics Lab
Carrier model 48TJE006 sized for 5 tons at 1,600 CFM with a Micromelt energy recovery ventilator.

Science Classroom
Carrier model 48TJE006 sized for 5 tons at 1,600 CFM with a Micromelt energy recovery ventilator.

Office, Practice Room, Technology (IT) Room
Under the 1999 renovation these spaces are served by a constant volume, cooling only rooftop unit manufactured by Carrier and sized for 1,200 CFM with a 3-ton capacity. Each supply duct branch that serves the individual rooms is equipped with a hot water reheat coil to temper supply air to meet the space temperature setpoint.

Note: All four rooftop units serving the 1999 renovated classrooms are currently 15 years old. Per ASHRAE, the mean useful service life of packaged rooftop equipment is 20 years. Therefore consideration of equipment replacement should be implemented within the next five years. This will be addressed in the recommendation phase of this report.

Addition
The majority of this addition is served by a cooling only packaged variable air volume rooftop unit (Carrier model 50EK028) sized for 23 tons of cooling at 8,750 CFM. The supply ductwork is extended to above ceiling mounted fan powered boxes that are equipped with hot water reheat coils that temper the air to meet the required space temperature in which it serves.

A smaller two ton constant volume rooftop unit was installed to serve the Storage, Science Prep and Science Office Area of the addition. The system has a hot water duct mounted reheat coil that tempers the mixed air to meet the space temperature setpoint.

Temperature Controls
The controls observed for the addition and renovated areas consist of a Siebe temperature control system that is a direct digital control system. The school district has standardized to using Alpha Controls, which is a later version of the original Siebe Control system. It is unclear if the 2010 system installed by Alpha is also controlling this portion of the building.
Note: Consideration should be given to add a reheat coil at the discharge of the rooftop unit that will allow the unit to temper the mixed air to a leaving air temperature of 60°F. Currently no reheat exists; therefore, the mixing dampers in the unit are modulating to maintain leaving air temperature. Under very cold temperatures the amount of outside air being provided may be less than required by code. This will be addressed in the recommendation phase of the report.

Additionally, both rooftop units serving the 1999 addition are currently 15 years old. As indicated above, ASHRAE defines the mean useful life of packaged rooftop equipment to be 20 years. Therefore consideration for the replacement of this equipment should be implemented within the next five years. This will be addressed in the recommendation phase of the report.

**Boiler Replacement**

Under the 1999 addition the building’s original heating boiler was replaced with two (2) new Burnham Model V114 cast iron steam boilers rated for 2,730 MBH output each. These boilers serve the entire facility with the exception of the 2010 P.E. addition that is equipped with its own boiler system as discussed further in this report.

The boilers serve an area of approximately 61,000 SF of floor area. At a total output capacity of 5,460 MBH, the BTU to SF ratio is 89.51 BTU / SF. This capacity indicates the boilers were installed to provide 100% redundancy. The boilers are currently 15 years old and have a life expectancy of approximately 30 to 35 years.

To provide heating hot water to the areas of renovation associated with the 1999 addition and renovation area, a shell and tube heat exchanger was installed in the boiler room that utilized steam from the main boilers to produce to heating hot water. The heating system is self contained with all required pumps, expansion tanks, air separator and temperature controls. Hot water was extended to serve the reheat coils and fan power box heating coils in the 1999 addition and renovated area. This heat exchanger was eventually replaced under the 2005 additions and renovation project.

**2004 ADDITION AND RENOVATION**

An addition and renovation project to the existing building took place in 2005 which provided a new main entrance lobby, toilet rooms, a cafeteria, and kitchen. Renovations to the original building under this project included the first floor art room and 2nd floor main office. Under this addition and renovation, new HVAC equipment was installed to serve the affected spaces. The following describes the existing equipment serving each space:
First Floor Art Classroom
The first floor art classroom is served by a constant volume fan coil unit (Trane model TWE 060) which is sized for 5-tons of cooling with a remote air cooled condenser. Two duct mounted hot water reheat coils serve the Art Room and Art Multi Purpose room respectively.

Second Floor Main Office
The second floor main office is served by a cooling only, constant volume packaged rooftop unit (Trane model THC048) which is sized for a 4-ton capacity. Two duct mounted hot water reheat coils serve the interior and exterior portion of the office.

Lobby & Toilet Rooms
The lobby is served by a constant volume, cooling only packaged rooftop unit (Trane model THC048) which is sized for a 4-ton capacity. Heating is provided by a duct mounted hot water coil. The toilet rooms have a dedicated exhaust fan and the Girls Toilet Room located on the exterior wall is equipped with hot water fin tube radiation mounted on the exterior wall.

Kitchen and Cafeteria
The kitchen and cafeteria are served by a constant volume, cooling only packaged rooftop unit installed on the roof of the Kitchen. The rooftop unit is Trane model TCH301 and is sized for a 25-ton capacity. Heating is provided by three (3) duct mounted hot water coils: one that serves the cafeteria and two to serve the kitchen.

Wood Shop
A gas fired make up air rooftop unit is installed on the roof of the kitchen and provides tempered fresh air to the Wood Shop Classroom.

Heating Source
To provide space heating for the 2004 additions and renovations, a shell and tube heat exchanger was installed in the boiler room that utilized steam from the main boilers to produce heating hot water. The heating system is self contained with all required pumps, expansion tanks, air separator and temperature controls. This existing heat exchanger replaced the one installed in 1999 and serves the 1999 and 2004 additions and renovated areas.

The heat exchanger has a capacity of 142.1 MBH while pumping 142 GPM to both the 1999 and 2004 areas. The area the heat exchanger serves is
approximately 21,600 SF. At a total output capacity of 142.1 MBH the BTU to SF ratio is 6.58 BTU / SF. This capacity indicates the heat exchanger is grossly undersized for the area it serves.

*Note:* All equipment installed as part of the 2004 addition and renovations project is approximately 10 years old. Most equipment installed has an ASHRAE mean useful life of 20 years. Therefore the equipment is approximately half way through its anticipated life span. No recommendations to this area are considered with the exception of the heat exchanger that will be addressed under the renovations to the original building and 1958 addition.

**Temperature Controls**

The controls observed for the addition and renovated areas consist of an Alpha temperature control system that is a direct digital control system. The school district has standardized to using Alpha Controls, and this is expandable to serve any future renovation to the building.

### 2010 ADDITION AND RENOVATIONS

In 2010 a major addition was added to the High School. The north addition consists of new PE facilities to serve the school’s needs. As it relates to the HVAC systems, the addition was constructed as a stand-alone facility meaning that all utilities and heat sources were constructed as part of the building. The facility has its own boiler plant that utilizes high efficiency condensing boilers as well as indoor air handlers with hot water heating and direct expansion cooling. Natural gas was extended from the original service located outside the music department and routed across the roof to provide natural gas to gas fired appliances within the new addition.

As part of the 2010 renovation a portion of the original building was renovated. This work took place within the first floor industrial arts area of the building. Work consisted of the installation of new heating only unit ventilators and fan coil units. Hot water to serve these units was extended from the new condensing boiler plant in the 2010 addition. The 2010 addition and renovation systems have only been in service for four years and all equipment appears in good condition. Therefore, the 2010 addition will not be addressed in the recommendation section of this report.

**Temperature Controls**

The controls observed for the addition and renovated areas consist of an Alpha temperature control system that is a direct digital control system. The school district has standardized to using Alpha Controls, and this is expandable to serve any future renovation to the building.
IV. CONCEPTUAL OPTIONS

The following list is broken down into two building levels (classroom and central plant heating/cooling). These are system options that Elara has identified as opportunities to increase system efficiency, reduce utility costs, and/or improve occupant comfort. In addition, these recommendations also assist Eastland School District in planning and budgeting for the replacement of systems that are out-of-date and inefficient so that unexpected equipment failure does not necessitate an emergency installation of a system that is not properly designed. The recommendations presented below are not intended to be inclusive of every possible option.

Additionally, not all recommendations presented below are driven solely by energy savings, but rather, a combination of energy savings, increased occupant comfort, building construction, and the replacement of equipment deemed beyond its useful life. It is important to note, once again, that the recommendations presented in this report are conceptual in nature and should not be used in place of a properly designed system.

ORIGINAL BUILDING AND 1958 ADDITION ROOM LEVEL

Option 1A: Two Pipe Chilled / Hot Water Unit Ventilators

Under this option, each classroom would be equipped with a two pipe chilled/hot water unit ventilator in the same location as the existing unit. The existing exterior wall intake louver would be cleaned and reutilized to serve the new unit ventilator. If requested, unit ventilator shelving would be installed to match the unit ventilator color and size. New hot/chilled water piping would be routed in the crawl space to serve each unit. Condensate piping could exit the exterior wall or penetrate the floor and be routed in the crawl space. New temperature controls would be included to control each unit.

Option 2A: Four Pipe Chilled & Hot Water Unit Ventilators

Under this option, each classroom would be equipped with a four pipe chilled and hot water unit ventilator in the same location as the existing unit. Similar to the two-pipe unit ventilation option, the existing exterior wall intake louver would be cleaned and reutilized to serve the new unit ventilator. If requested, unit ventilator shelving would be installed to match the unit ventilator color and size. New hot and chilled water piping would be routed in the crawl space to serve each unit. Condensate piping could exit the exterior wall or penetrate the floor and be routed in the crawl space. New temperature controls would be included to control each unit.

Option 3A: Hot Water / Direct Expansion Unit Ventilators

Under Option 3A, each classroom would be equipped with a hot water / direct expansion unit ventilator in the same location as the existing unit. As above, the existing exterior wall intake louver would be cleaned and reutilized to serve the new unit ventilator. If requested, unit ventilator shelving would be installed to match the unit ventilator color and size. New hot water piping would be routed in the crawl space to serve each unit. Condensate piping could exit the exterior wall or penetrate the floor and be routed in the crawl space. An air cooled condenser would be installed at grade or on the roof to accommodate each unit ventilator. New temperature controls would be included to control each unit.

Option 4A: Geothermal Heat Pumps

Under Option 4A, each classroom would be equipped with a vertical cabinet geothermal heat pump unit in the same location as the existing unit ventilator. As above, the existing exterior wall intake
louver could be cleaned and reutilized to serve the vertical heat pump. New piping from the geothermal field would be routed in the tunnel space to serve each unit. Condensate piping would exit the exterior wall or penetrate the floor and be routed in the tunnel space. All associated temperature controls will be purchased as part of the cabinet heat pump and will operate as a stand-alone system.

The cabinet heat pump will be equipped with an outside air and return air damper assembly, internal pump, supply and return grille and outside air connection. Ductwork from the fresh air intake to the existing unit ventilator louver will be required.

For spaces internal to the building or small spaces such as offices, a floor mounted console or horizontal heat pump will be utilized with the same features as the cabinet heat pump units. Outside ventilation air will be introduced via a duct connection to the return air of the heat pump.

**ORIGINAL BUILDING AND 1958 ADDITION CENTRAL PLANT HEATING SYSTEM LEVEL**

**Option 1B: Condensing Hot Water Boiler (Applicable to Room Level 1A, 2A & 3A)**

Install two (2) 2,000,000 BTU/hr gas fired condensing boilers to provide sufficient capacity to serve the space heating needs and provide redundancy. The new boilers would produce a maximum water temperature of 140°F to allow the boiler flue gases to condense. This low water temperature and condensing technology is capable of providing operating efficiencies of 95% or greater. The new boilers would be piped in a variable/primary arrangement to allow for the boiler to reset water temperature based on outside air temperature.

*Note:* The existing steam boilers are 80% efficient, cast iron and are approaching 16 years old. The boilers are approximately half way through their useful life expectancy and could remain in operation depending on the options selected to be implemented. In addition, utilizing a shell and tube heat exchanger decreases the overall efficiency of the system even lower.

**Option 2B: Shell and Tube Heat Exchanger (Applicable to Room Level 1A, 2A & 3A)**

Install a shell and tube heat exchanger that would be of sufficient size to not only serve the original building and the 1958 addition, but also to include the 1999 and 2004 additions and renovated areas. The heat exchanger could convert the entire boiler capacity to hot water or, if for some reason an area of the building wanted to defer equipment replacement due to budget constraints such as the gymnasium, than that portion could remain on the steam system.

**Option 1C: Air Cooled Chiller (Applicable to Room Level 1A & 2A)**

Based on observations in the field, a new air-cooled central chilled water plant can be installed near the lower level boiler room on grade with a pumping station located within the lower level boiler room. We anticipate that to support the infrastructure work under this potential project a total capacity of 200 to 250 tons is required. A central chilled water loop would be routed to each of the new systems requiring chilled water. Additional electrical capacity could be required to handle to power requirements of the new chiller.

*Note:* The fluctuation in the chiller sizing is based on whether or not the gymnasium is served by chilled water or packaged rooftop equipment.
Option 1D – Geothermal (Applicable to Room Level 4A)

This option incorporates vertical geothermal wells drilled in the open field area adjacent to the school on the south side building. Based on “Rule of Thumb” sizing the wells would be roughly 300 feet deep with a total capacity of two (2) tons of capacity per well. The actual length of the well depth required will be based on the square footage of the area in which it serves times a multiplier of .42 linear feet of well per square foot of building area served. For Eastland Junior-Senior High School this area will include the original 1951 building as well as the 1958 addition less the gymnasium area which would be served by gas fired packaged rooftop equipment. This area is approximately 34,242 square foot multiplied by .42 which equals 14,382 linear feet of well, divided by 300 linear feet per well for a total of 48 wells at 300 feet deep at 2 tons per well or 96 tons of total capacity. This equates 357 square feet per ton of cooling.

GYMNASIUM SYSTEM

Option 1D: Gas Fired Packaged Rooftop Units

Under this option, the gymnasium would be provided with a new gas fired packaged rooftop unit. Natural gas piping would be routed on the roof to accommodate the new rooftop unit. The unit would be sized to meet ventilation requirements and transmission losses of the space.

Option 2D: Indoor Chilled Water / Hot Water Air Handlers (Applicable to Central Heating 1C)

Under this option, indoor air handlers located on the equipment mezzanines on one or both sides of the stage will be provided with both chilled and hot water to control space temperature. Fresh air and exhaust air will be included to allow for code required ventilation air as well as an economizer feature.
V. ESTIMATED COSTS

CLASSROOM OPTIONS

The following are the options available from the individual systems indicated above. The gymnasium options have been isolated and removed from each of these options to be discussed separately.

Note: The cost for upgrading the controls for the area of the building defined in each option is included in each project’s estimated cost.

Option 1

(1A) Room Level: 2 pipe chilled/hot water unit ventilators
(1B) Central Plant Heating: Condensing hot water boilers
(1C) Central Plant Cooling: Air Cooled Chiller

The estimated square foot associated with this system is 34,242 SF. An estimated construction cost including DDC temperature controls and associated electrical power is in the range of approximately $36.00 to $38.00 / SF. Therefore, the estimated construction cost range for Option 1 is $1,250,000.00 to $1,300,000.00 exclusive of design fees and associated general construction cost.

It should be noted that this option utilizes condensing boilers with low temperature water (140°F maximum) and provide the additional benefit for increased energy efficiency and energy savings associated with the heating hot water system.

Option 2

(2A) Room Level: 4 pipe chilled and hot water unit ventilators
(1B) Central Plant Heating: Condensing hot water boilers
(1C) Central Plant Cooling: Air Cooled Chiller

The estimated square foot associated with this system is 34,242 SF. An estimated construction cost including DDC temperature controls and associated electrical power is in the range of $40.00 to $42.00 / SF. Therefore, the estimated construction cost range for Option 2 is $1,375,000.00 to $1,450,000.00 exclusive of design fees and associated general construction cost.

As with Option 1, it should be noted that this option utilizes condensing boilers with low temperature water (140°F maximum) and provide the additional benefit for increased energy efficiency and energy savings associated with the heating hot water system.

Option 3

(3A) Classroom Level: Hot Water / Direct Expansion (DX) unit ventilators
(1B) Central Plant Heating: Condensing hot water boilers

The estimated square foot associated with this system is 34,242 SF. An estimated construction cost including DDC temperature controls and associated electrical power is in the range of $32.00 to $34.00 / SF. Therefore, the estimated construction cost range for Option 3 is $1,100,000.00 to $1,175,000.00 exclusive of design fees and associated general construction cost.
As with Options 1 and 2, it should be noted that this option utilizes condensing boilers with low temperature water (140°F maximum) and provide the additional benefit for increased energy efficiency and energy savings associated with the heating hot water system.

Option 4
(1A) Classroom Level: 2 pipe chilled/hot water unit ventilators
(2B) Central Plant Heating: Shell & Tube Heat Exchanger
(1C) Central Plant Cooling: Air Cooled Chiller

The estimated square foot associated with this system is 34,242 SF. An estimated construction cost including DDC temperature controls and associated electrical power is in the range of $32.00 to $34.00 / SF. Therefore, the estimated construction cost range for Option 4 is $1,100,000.00 to $1,175,000.00 exclusive of design fees and associated general construction cost.

Option 5
(2A) Classroom Level: 4 pipe chilled and hot water unit ventilators
(2B) Central Plant Heating: Shell & Tube Heat Exchanger
(1C) Central Plant Cooling: Air Cooled Chiller

The estimated square foot associated with this system is 34,242 SF. An estimated construction cost including DDC temperature controls and associated electrical power is in the range of $36.00 to $38.00 / SF. Therefore, the estimated construction cost range for Option 5 is $1,250,000.00 to $1,300,000.00 exclusive of design fees and associated general construction cost.

Option 6
(3A) Classroom Level: Hot Water / Direct Expansion (DX) unit ventilators
(2B) Central Plant Heating: Shell & Tube Heat Exchanger

The estimated square foot associated with this system is 34,242 SF. An estimated construction cost including DDC temperature controls and associated electrical power is in the range of $30.00 to $32.00 / SF. Therefore, the estimated construction cost range for Option 6 is $1,000,000.00 to $1,175,000.00 exclusive of design fees and associated general construction cost.

Option 7
(4A) Classroom Level: Geothermal Heat Pumps
(1D) Central Plant Heating: Geothermal
(1D) Central Plant Cooling: Geothermal

The estimated square foot associated with this system is 34,242 SF. An estimated construction cost including standalone unit mounted temperature controls and associated electrical power is in the range of $34.00 to $38.00 / SF. Therefore, the estimated construction cost range for Option 7 is $1,165,000.00 to $1,300,000.00 exclusive of design fees and associated general construction cost.
GYMNASIUM OPTIONS

Option 1

(1D) Air Handling Level: Gas Fired Packaged Rooftop Unit
Central Plant Heating: Not Required
Central Plant Cooling: Not Required

The estimated square foot associated with this system is 9,436 SF. An estimated construction cost including DDC temperature controls and associated electrical power is in the range of $24.00 to $26.00 / SF. Therefore, the estimated construction cost range for Gymnasium Option 1 is $225,000.00 to $250,000.00 exclusive of design fees and associated general construction cost.

General construction cost would include structural steel modifications and roof/wall cutting and patching associated with the RTU Unit.

Option 2

(2D) Air Handling Level: Indoor Chilled / Hot Water Air Handler
(1B or 2B) Central Plant Heating: Condensing or Shell & Tube Heat Exchanger
(1C) Central Plant Cooling: Air Cooled Chiller

The central plant cost is not included in the estimate for this option. The assumption is made that the chiller plant and boiler plant is covered in the cost of the Classroom level system above.

The estimated square foot associated with this system is 9,436 SF. An estimated construction cost including DDC temperature controls and associated electrical power is in the range of $40.00 to $42.00 / SF. Therefore, the estimated construction cost range for Gymnasium Option 2 is $375,000.00 to $400,000.00 exclusive of design fees and associated general construction cost. If air conditioning is not pursued, the anticipated construction cost will be reduced by $50,000.

1999 & 2004 ADDITIONS OPTIONS

1999 Renovation Area

The four (4) rooftop units installed to serve the Music room, Physics lab, science lab and practice area are 15 years old. Consideration for equipment replacement would be warranted within the next 5 years.

The estimated cost associated with this replacement of this equipment falls within the range of $12,000.00 to $15,000.00 per rooftop unit and includes removal of the old unit, installation of the new rooftop unit in the same location, all associated electrical, ductwork and temperature control modifications.

1999 Addition

Provide a duct mounted hot water reheat coil to serve the large VAV rooftop unit serving the 1999 addition. Currently no reheat exists; therefore, the mixing dampers in the unit are modulating to maintain leaving air temperature. Under very cold temperatures the amount of outside air being provided may be less than required by code.
The estimated cost associated with this modification falls within the range of $15,000.00 to $20,000.00 and includes a new coil, duct modifications and temperature control modifications.

*Note:* The above estimates include all mechanical and electrical cost associated with the project. What is not included is the architectural, structural, asbestos abatement cost, and fees that each project may require. These additional costs would need to evaluated and provided by Richard L Johnson & Associates and added to the M/E cost indicated.
VI. RECOMMENDATIONS

CLASSROOMS
Although the systems listed above all provide the end user with a new HVAC system to serve the classrooms, not all systems are the same. The following are our recommendations for the classroom, boiler plant and cooling plant options:

We recommend implementing the chilled / hot water two-pipe system, the four-pipe chilled and hot water system or the geothermal system, each with their own benefits and drawbacks. The most significant differences among the recommended systems are found to be in implementation cost and operating flexibility. While the two-pipe system is the most cost effective of the three systems recommended, this type of system requires a time of year changeover between heating and cooling and can never provide both heating and cooling simultaneously. During the swing months (October, November, March and April) ambient temperatures can range from requiring either cooling or heating and building conditioning is limited by the changeover requirements of a two-pipe system.

For a small incremental implementation cost increase, a geothermal system can be implemented and provide the flexibility of simultaneous heating and cooling. However, geothermal systems are non-conventional in the sense that they are a newer technology (putting potential limitations on qualified contractors and maintenance providers) and require outdoor space for the installation of a geothermal well-field. While highly energy efficient, the School District will need to determine whether a non-conventional system is a desirable alternative. Finally, the installation of a four-pipe system represents the greatest cost impact of the recommended alternatives, but provides a conventional system that provides the flexibility of both heating and cooling year round.

The air cooled condensers option for providing cooling is a viable option if budget requires a less expensive alternative, although the drawbacks associated with this option are the number of condensers either on the roof or at grade level as well as the lack of energy efficiency when compared to an air cooled chiller.

HEATING PLANT
The existing cast iron boilers, although only 80% efficient, have 15 to 20 years of service remaining. In addition, by utilizing a shell and tube heat exchanger to produce heating hot water an additional reduction in efficiency is obtained. By installing high efficiency condensing boilers the overall heating efficiency will increase by approximately 20%. The School District will need to determine if the increased cost of replacing boilers that having useful life outweighs the increased energy consumption over the remaining life of the existing boilers.

Alternately, if a geothermal heating and cooling system is selected (above); a central heating plant will be replaced with the geothermal well field and its associated equipment.

COOLING PLANT
The only viable option presented for the cooling plant was the addition of an air cooled chiller. The other options for cooling were indicated at the classroom and gymnasium level by utilizing direct expansion (DX) cooling. The chiller provides increased efficiencies over a packaged or split system DX. The only other decision is whether to utilize the chiller in a four pipe or two pipe configuration.
Alternately, if a geothermal heating and cooling system is selected (above); a central cooling plant will be replaced with the geothermal well field and its associated equipment.

**GYMNASIUM**

**Option 1**
The gymnasium is a large, open volume space that functions, at times, when the remainder of the school is closed. Therefore, providing an independent system such as a gas fired packaged rooftop unit to serve the space is desirable. The rooftop unit option provides a cost effective solution for independently providing heating and cooling to the space. Therefore we recommend that Gymnasium Option 1 be considered as the preferred option to serve the gymnasium.

**Option 2**
The indoor chilled/hot water air handler solution for the gymnasium will provide the most efficient system, but the increased cost and lack of available space for this system makes it the less favorable of the two options listed.
VII. GRANTS

Through grant programs provided by the Illinois Department of Commerce and Economic Opportunity (DCEO) and the Illinois Board of Education IWAS program, the School District can recapture a portion of the cost of the potential projects selected based on their energy efficiency. The DCEO grants are based on energy savings and can be submitted as a prescriptive method or custom method. Elara is well versed in the DCEO process and is available assistance for all grant applications.
VIII. ATTACHMENTS

Hand written field notes from our site visit are enclosed and include the following:

- Floor plan of existing HVAC equipment and systems currently installed
- Roof plan of existing equipment locations
- Floor plan indicating the construction timeframe of the original building and each addition.
EASTLAND SCHOOL DISTRICT - HVAC STUDY

PROJECT NO.: 15184
PROJECT NAME: EASTLAND SCHOOL DISTRICT - HVAC STUDY
DRAWING TITLE: HIGH SCHOOL BUILDING ADDITIONS CONTINUED
DATE: 10/06/15
SCALE: N.T.S.

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