POUDRE SCHOOL DISTRICT
AIR CONDITIONING STUDY

PHASE II

HORSETOOTH ENGINEERING, LLC

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GOALS

The goals of the Phase II study are as follows:

- Follow up on the concepts established in Phase I and provide an Opinion of Probable Cost for the work required to add air conditioning to all schools that currently do not have air conditioning.
- Establish an Opinion of Probable Costs for the items identified in Phase I as needing to be replaced either due to being beyond their useful service life or inadequate comfort performance.
- Establish Opinion of Probable Costs for the items identified in Phase I as feasible alternative options to air conditioning that could improve the comfort in the warmer times of the school year – but not incur the cost and energy use increase that industry standard air conditioning would require.

APPROACH

The scope to provide air conditioning, replace equipment beyond its useful service life or provide tempering has been defined in broad chunks; primarily consisting of demolition, new airside equipment, new central plant equipment and building controls. Areas such as administration areas, cafeterias, kitchens and gymnasiums have been identified individually since they tend to vary from a typical classroom in occupancy hours and usage duration.

The mechanical system requirements were then coordinate with architectural, structural, and electrical consultants to evaluate the mechanical system effects on the other building systems and their associated costs. A mechanical contractor was also consulted for assistance in establishing an Opinion of Probable Cost for the mechanical scope items.

The mechanical, architectural, structural and electrical scope items have been identified in Appendix 1 – Opinion of Probable Cost and Appendix 2 – Scope Definition Drawings. Each line item in Appendix 1 has a corresponding item that is further defined Appendix 2.

RESULTS

The cost to provide air conditioning to all schools in the district is $72.9 million dollars based on 2015 costs. Wellington, Rocky and Fullana have been included in this analysis even though they already have air conditioning because it has been determined that their systems have an eminent need to be replaced and perform better.

The cost to address life cycle needs or comfort issue concerns (i.e. 2012/2013 DOAS installations) at all schools evaluated for adding air conditioning is $50.9 million dollars based on 2015 costs. Note that other than the 2012/2013 DOAS installations, the only cooling included in this life cycle evaluation is for the administration area.

The cost to provide cooling tower tempering (similar to recently installed systems at Beattie/Irish/Riffenburgh/Traut/Laurel/Preston/Kruse/McGraw and existing systems at Rice/Bethke) to all schools in the district is $52.4 million dollars based on 2015 costs. This large reduction from providing typical air conditioning is primarily because the schools above already have tempering and because tempering was not evaluated at the high schools. Examining the individual schools will show that a cooling tower tempering system is typically only about 10% less costly from a first cost perspective than a traditional air cooled chiller when accounting for the other required mechanical system improvements.

The cost to address life cycle and/or comfort issue needs as well as add air conditioning at all schools evaluated is $83.8 million dollars based on 2015 costs.

Note that the air conditioning costs and life cycle costs cannot simply be added together. This is because in some schools, if air conditioning is to be added, some or all of the school's life cycle needs must be first addressed. Some schools also have life cycle needs that are not related to air conditioning; such as gymnasiums, which are not air conditioned.

For future planning purposes, the newer and already air conditioned schools of Bacon, Bethke, Rice, Zach, Fort Collins High School, Fossil Ridge High School, Kinard and the recently HVAC updated Poudre High School were looked at from a Cost per Square Foot basis and individual component basis. A replacement year was established for each school. Based on ASHRAE median service life of components, a whole building update of 30 years was established. A significant capital expenditure in the 2030-2040 time frame should be planned for these schools. Fort Collins High is a bit earlier at 2025. Cost and median service life have also been presented for individual components so preventive and predictive maintenance plans can be appropriately established. Individual component replacement costs are based on like for like replacement and no substantial change in mechanical capacity, weight or footprint.

BUILDING SYSTEMS

SIZING AND QUANTITY

It must be noted that all equipment and conceptual sizing noted in the Scope Definition Drawings and the architectural/structural/electrical item cost evaluation is based on rules of thumb and past experience with PSD projects. The sizing of all

equipment and supporting systems must be taken through a construction document process. What is presented here is only a conceptual representation to establish potential costs for PSD to consider in its planning process.

MECHANICAL

Systems analysis per school can be further understood by review of the Phase I report and the Scope Definition Drawings. In general terms, the following concepts were evaluated.

- Air delivery systems were chosen to be either VUVs or VAV RTUs with the exception of the small schools where furnace type systems are already in place.
- Air cooled chillers were the primary option for almost all schools except small schools such as the mountain schools, Mountain View, and Fullana.
- Packaged VAV RTUs was an additional option explored in schools where the primary air delivery system was to be via VAV RTUs in lieu of VUVs.
- Providing cooling tower tempering in lieu of a traditional mechanical cooling system was evaluated for all schools where an air cooled chiller was evaluated.

ARCHITECTURAL

- Architectural building effects were evaluated based on the mechanical system concepts impact to the existing walls, roofs and ceilings.
- Costs based on size of wall opening, size of roof patching, amount of ceiling removal, and floor patching were established on a square foot basis.
- A cost has been added to most projects to account for the likelihood that some asbestos abatement will be required should extensive HVAC retrofits be installed. Although the actual abatement scope is unknown at this time, the opinion of cost for abatement correlates with the most recent AHERA-Facility Information provided by PSD.

STRUCTURAL

- The effects that the different mechanical system concepts would have on the existing structural walls, columns, and roof framing members were evaluated.
- Existing building documents were reviewed, as well as site observation visits, to evaluate the structure and help determine the extent of structural modifications necessary to support the mechanical concepts.
- Strategies to support the mechanical concepts vary widely due to existing framing type, existing loads, equipment location, and construction approach.

- Costs were established based on the extent of structural modifications, reinforcing material, and design approach. Some schools required minimal to no structural work to support the mechanical concepts.

ELECTRICAL

- Electrical building effects were evaluated based on the mechanical system concepts impact to the existing power distribution components, lighting, fire alarm and low voltage systems installed in the ceilings such as wireless access points (WAP), intercom, security cameras, etc.
- Existing drawings were reviewed and site visits conducted to evaluate the extent of the work required to install and power the new mechanical equipment.
- Strategies to power the mechanical concepts vary widely due to existing building electrical components, existing service voltage and age. For example, a school with 480 volt service incurs less cost to power a chiller than does a school with 208 volt service with an equally sized chiller. In addition, the following schools require a larger electrical service to be provided to the building to power the air conditioning equipment: Dunn, Irish, Johnson, Kruse, Laurel, McGraw, Olander, Riffenburgh, Stove Prairie, Timnath, Traut, and Werner.
- LED lighting was established as a line item cost for consideration by PSD because this retrofit is most cost effectively completed while the mechanical work above the ceilings is being installed. LED lighting can result in an energy savings of 25%-40% over traditional fluorescent lighting. LEDs also reduce the heat gain to the space and will reduce the load of the air conditioning systems. LED lighting also reduces maintenance costs due to the bulb life being 70,000 hours as opposed to fluorescent bulb life at 50,000 hours. LED bulbs contain no mercury so they also offer a disposable advantage over fluorescent bulbs. LEDs are also inherently dimmable, which offers more control flexibility and increased potential for energy savings.

MAINTENANCE

System maintenance must be accounted for in determining if PSD desires to add air conditioning to schools which are not currently air conditioned. Data which quantifies the expense of maintenance is not widely published. The best available resources that quantified this expense were ASHRAE and the State of North Carolina.

- Air cooled chillers can be estimated to require 7% of their first cost in yearly maintenance. So for example, an air cooled chiller for an elementary at $74,000 would require approximately $5,000 in yearly maintenance costs. Middle Schools and High School needs should be scaled up accordingly.

- Cooling towers can be estimated to require 5.5% of their first cost in yearly maintenance. So for example, a cooling tower and a heat exchanger for an elementary at $42,000 would require approximately $2,300 in yearly maintenance costs. Middle School needs should be scaled up accordingly.
- Although cooling tower tempering first cost is not significantly less than traditional air conditioning it does result in a yearly maintenance savings of more than 50%.

ENERGY

The installation of air conditioning will increase the annual utility costs for the schools. An evaluation of Preston Middle School was used for analysis.

- Air cooled chillers can be estimated to increase utility costs by approximately $7,000 per year based on an August through May operation. If school was to be changed to be year round, the utility costs would increase by approximately $16,000. Most of these costs are from electric demand (KW) charges. Only a small portion is electric consumption charges (kWh). Energy modeling software does not allow for months to be split in half so the costs for August through May operation may be slightly overestimated. However, due to electric demand charges being based on the peak usage at any one period in the month, it can be assumed that these same peak usage numbers would be experienced while school is in session in late August. Fort Collins Utilities most expensive electric demand rates are in June, July and August.
- Cooling tower tempering systems will result in an approximately 50% decrease in utility costs over an air cooled chiller. Again, electric demand is responsible for the majority of the utility cost increase and the cooling tower fan and associated pump has a peak usage demand of a approximately 60% less than an air cooled chiller.

COST SUMMARY

Based on the categorization established in Phase I, the following summarization of requirements can be made.

NO TEMPERING OR AC

No Tempering or AC schools are still to have HVAC improvements installed under the 2010 Bond Project, or will remain Non-Tempered after the 2010 Bond Projects are complete.

- Barton, Bennett, Dunn, Lab/Polaris, O'Dea, Putnam. These schools are some of the oldest in the district with original building construction dates ranging

from 1947 to 1962. Most of the air conditioning costs are very similar to their life cycle cost needs. Air conditioning only slightly increases the budget needs of these schools. Extensive architectural, electrical and structural impacts are experienced to properly update the HVAC system.

- Harris and Timnath have similar costs for air conditioning, however the life cycle needs are much different due to recent HVAC updates at Harris.
- Livermore, Stove Prairie and Red Feather have very similar costs to add air conditioning. However, Livermore has much higher life cycle budget needs due to its most recent HVAC update being less extensive than Stove Prairie and Red Feather being a relatively newer school.
- CLP Elementary falls on the lower end for both AC and life cycle needs due to its recent installation in 2015 that has installed equipment that is relatively adaptable to AC.
- Blevins is one of the lower cost schools from a $$ per square foot basis for air conditioning due to the equipment installed in 2012 being AC ready. However, its needs for life cycle is more than twice its needs for AC due to aged equipment that was left in place in 2012 due to budget constraints.
- Lincoln and CLP Middle Schools have some of the highest need from a life cycle perspective. Both these schools require a complete HVAC tear out. Adding air conditioning is a relatively small cost increase from life cycle needs.
- Lesher has a high cost increase to add air conditioning, but a relatively modest life cycle budget requirement. This is primarily because it had quite a few HVAC updates in 2007, however this equipment is not air conditioning ready and would be replaced if AC was installed.
- Webber equipment installed in 2012 was made to be AC ready, however it has a higher cost than most AC ready schools due to the shape of the building and the chiller needing to be installed at the far north end. Life cycle needs are small due to it being a relatively new school in terms of original construction date and then receiving HVAC updates in 2012.
- Centennial High School life cycle needs are driven by the 1906 portion of the building. Although an addition was recently constructed in this building, none of the equipment installed is AC ready so this newer equipment must also be removed to add AC to this school.
- Mountain View air conditioning and life cycle costs are primarily driven by the needs to install equipment in the southwest corner of the building that currently has baseboard heat and operable windows only.

TEMPERED – MORE THAN 30 YEARS OLD – RELATIVELY ADAPTABLE

Tempered schools that are more than 30 years old and relatively adaptable to adding air conditioning.

- Beattie, Irish and Riffenburgh. These schools received a cooling tower tempering system in 2014. The original construction dates range from 1967 to 1971. The life cycle cost needs and the cost to add air conditioning are almost identical. This is due to the old equipment and duct from the late 1960s/early 1970s that had to be left in place due to budgetary constraints in 2014. It does not make sense to install air conditioning equipment in these schools when you already have cooling tower tempering unless PSD intends to address the equipment that is far beyond its useful service life at 45-50 years old.

TEMPERED – LESS THAN 30 YEARS OLD – RELATIVELY ADAPTABLE

Tempered schools that are less than 30 years old and relatively adaptable to adding air conditioning

- Kruse, McGraw, Laurel, Traut andPreston. These schools received a cooling tower tempering system connected to new VUVs in 2014 or 2015. They have the lowest cost requirement to add industry standard air conditioning. Due to their relative newer construction – the early 1990s – they also have small life cycle budget needs compared to many other schools.

TEMPERED – 2012/2013 DOAS INSTALLATIONS

2012/2013 DOAS installations have air handling units consisting of some type of air-air heat exchanger to precool and preheat outside air in concert with an evaporative media section on the exhaust stream providing indirect evaporative cooling. Air distribution to the space in terms of concept and quantity varies widely. Refer to Phase I for more information on the individual schools installed equipment.

- Johnson, Linton, Olander, Werner (Dulaney model). These schools distribute ventilation air via floor mounted displacement ventilation diffusers. Conventional industry standard air conditioning of providing 55 degree air into the space is not recommended with these type of diffusers. Due to the air quantities currently being supplied and the diffuser strategy, most of the 2012/2013 installation for these schools must be removed to provide industry standard air conditioning. This is why the budget for these schools is close to some of the older schools that have had no recent updates. The life cycle needs of these schools is very similar to Kruse/McGraw/Linton/Olander, however PSD management asked for costs to leave in place the 2012/2013 installation but improve its performance, so that is what the budget numbers for these schools reflect.
- Lopez, Shepardson, Tavelli. These schools all have a similar footprint and are alike to Bauder/Beattie/Irish/Riffenburgh. The costs to add air conditioning are all very similar and had similar installations to

Johson/Linton/Olander/Werner. Tavelli has had some more recent updates than Shepardson and Lopez and has about half the life cycle budget needs.

- Bauder. The air handling equipment at Bauder is similar to the schools above, but the air distribution into the spaces is much different. The air quantity is on average more than twice the schools above, the air is distributed with conventional ceiling diffusers and each room is zoned with a VAV box for air quantity control. Adding air conditioning at this school is much less than the schools above because the air handling equipment and air distribution can remain in place and be supplemented with cooling coils in the existing air handlers. This schools life cycle needs exceed the costs to provide air conditioning, because like Beattie/Irish/Riffenburgh, duct from 1967 and some units in non-classroom spaces were left in place in 2013 due to budgetary constraints.
- Eyestone. The air handling equipment at Eyestone is similar to the schools above, but the air distribution into the spaces is much different. The air quantity is 30% more than the Dulaney model schools, the air is distributed with conventional ceiling diffusers and each room is zoned with a VAV box for air quantity control. However, adding air conditioning at this school is very similar in cost to the Dulaney model schools. This is primarily due to some of the air handlers that had to remain in place in 2012 due to budgetary constraints. The 2012 units can have cooling coils added and be used as part of an air conditioning strategy at this school. This schools life cycle needs are similar to the costs to provide air conditioning, because like Beattie/Irish/Riffenburgh, duct from1972 and some air handling units were left in place in 2012 due to budgetary constraints.
- Boltz. This school has the highest cost per square foot of any school in the study. The 2012 air handling units are not capable of having a cooling coil added and must be removed if air conditioning is to be installed. Much of the pipe, duct and some of the air handling units from 1971 and later additions were left in place due to budgetary constraints in 2012. Most concerning are the common space indoor air handlers, that as mentioned in Phase I, are a maintenance nightmare. The only way to replace these is to remove the roof. They cannot be removed any other way. They cannot remain in place because the space is needed for new duct routing from new RTUs. Due to the age of this school and the large amount of non-air conditioned space such as gyms and locker rooms, this school's life cycle cost needs exceeds its air conditioning budget needs.

AIR CONDITIONED

Air conditioned or partially air conditioned schools that have upcoming work planned, or need improvement were examined as part of the study to add air conditioning to all schools.

- Fullana. This school is primarily air conditioned via residential furnaces and condensing units. The duct systems are 40 years old and should be replaced. An entire mechanical replacement is appropriate for this building.
- Wellington Middle School. This school was mostly air conditioned in 1992 and has received some additions and renovations so that most of the school is air conditioned now. Some parts of the original construction have life cycle needs and is why the life cycle needs are approximately half of the air conditioning budget. This school will be reaching its life cycle in 2022 and complete replacement to a more energy efficient VAV based system should be installed.
- Rocky Mountain High School. This school is a mix between 1971, 1994, and 2012 installations. 1971 has no AC, 1994 has AC and 2012 is DOAS tempering. All 1994 and 1971 equipment should be removed. 1971 pipe and duct should be removed. All new RTUs and VAVs should be installed throughout these areas. The 2012 DOAS RTUs should have cooling coils installed to provide air conditioning. The life cycle needs are much less than the air conditioning budget needs, however still amount to almost $2 million due to the gym and locker room spaces still being served by 1971 equipment.

CONSTRUCTION SCHEDULING

The extensive work required to install air conditioning and/or the life cycle needs at most schools is beyond what can be accomplished in a typical summer break.

- Elementary school construction schedule should allow 4 months.
- Middle School construction schedule should allow 8-9 months.
- High School construction schedule should allow 12 months.
- Schools such as Kruse/McGraw/Laurel/Traut/Preston which mainly require only the addition of a chiller can be completed over summer break.

CONCLUSION

The need to air condition schools in a Colorado climate and in a district where school is not year round may be debatable, however, based on industry standards there are a lot of life cycle needs at most schools in Poudre School District. Addressing these life cycle needs should, at a minimum, incorporate design that allows adding air conditioning at a future date in a budget friendly manner; such as has been recently done at Kruse/Laurel/McGraw//Traut/Preston/Bauder. As future additions and renovations are done to existing schools, the budget should be established with the whole facility in mind and the life cycle cost of its mechanical systems. As a major driver of comfort and energy, mechanical systems maintenance and/or replacement should not be deferred until the equipment has fallen apart or reaches emergency status. Doing so can often result in increased costs to repair or life safety concerns.

Additionally, renovations and additions should aim to install systems which are consistent with the existing building, this will facilitate improved maintenance and give students and staff a comparable comfort and noise experience throughout the school.

Due to its reduced first cost, reduced maintenance costs, reduced energy costs, and successful comfort improvement; Horsetooth Engineering suggests that PSD consider implementing cooling tower tempering similar to what has been installed at Beattie/Irish/Riffenburgh or Kruse/McGraw. Over a 30 year life cycle, not adjusting for inflation, maintenance and energy savings for a typical middle school would be $186,000. Given the limited number of hours that cooling is required with the current school calendar, this strategy can satisfy comfort, maintenance and energy goals, while allowing for relatively easy addition of industry standard air conditioning should a year round school calendar be implemented.

An air cooled chiller solution's advantage would be the ability to provide industry standard air conditioning during all times of the year and avoidance of "thrown away" costs should PSD feel that a year round calendar is a near future reality.

Due to the significant energy cost, heat gain, and maintenance reduction it is highly recommended that any mechanical system replacement also incorporate the replacement of the existing fluorescent lighting to LED lighting.