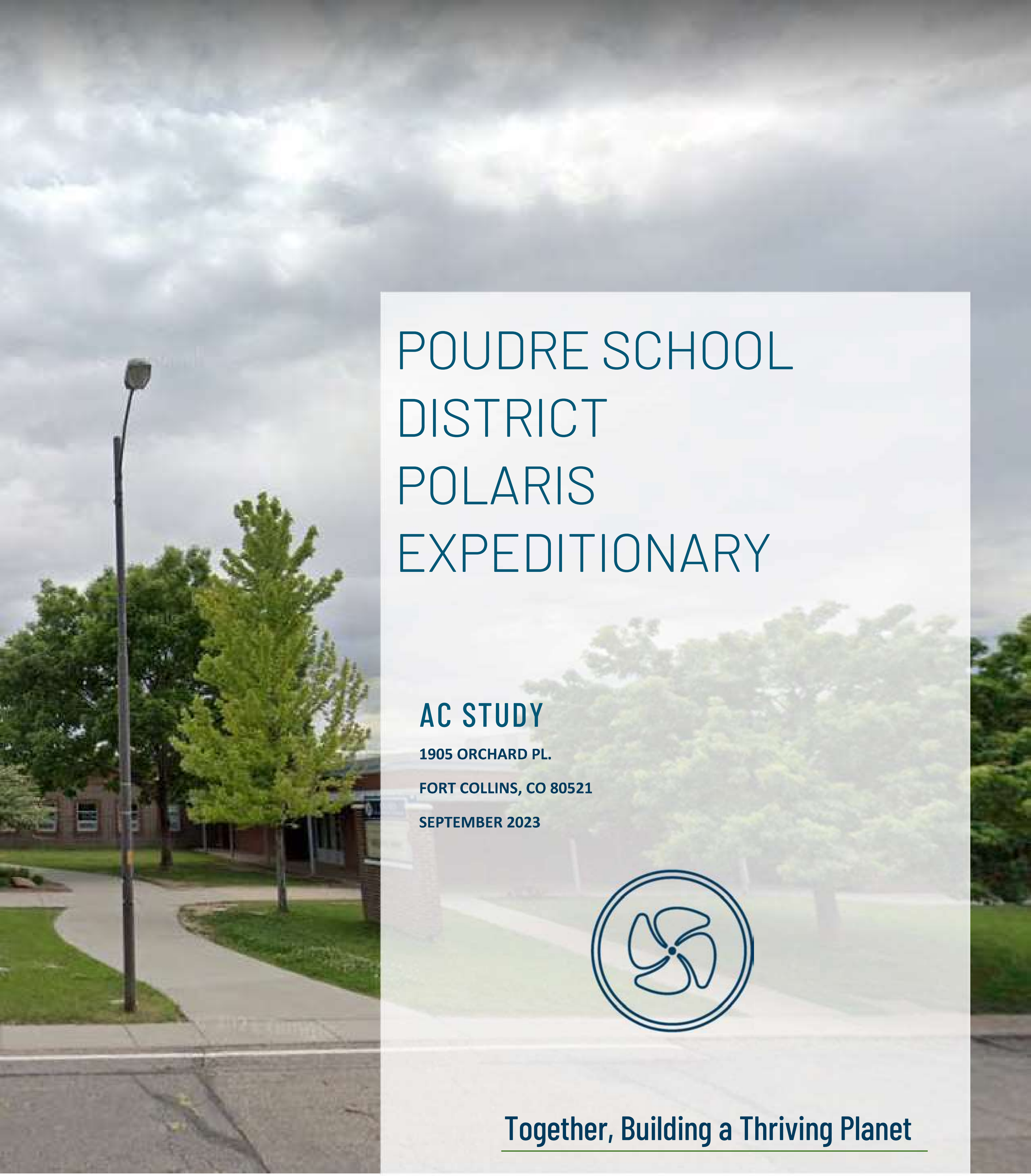

POUDRE SCHOOL DISTRICT POLARIS EXPEDITIONARY

AC STUDY

1905 ORCHARD PL.

FORT COLLINS, CO 80521

SEPTEMBER 2023

Together, Building a Thriving Planet

McKinstry
For The Life Of Your Building

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Polaris Expeditionary Learning K-12 AC Study

KEY CONTACT INFORMATION

McKinstry Contacts

John Runnels
Lead Mechanical Engineer
720.504.5097
johnrun@mckinstry.com

Lauren Bridgers
Project Director
720.583.5895
laurenb@mckinstry.com

Matt Wakulchik
Senior Program Manager
720.721.3960
matthewwa@mckinstry.com

Tracey Cousins
Account Manager
720.667.9091
traceyc@mckinstry.com

Client Contacts

Brett Larsen
Director of Special Projects and Initiatives
970.490.3215
blarsen@psdschools.org

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to “refresh” the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building’s construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry’s team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to “best case scenario” options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

Polaris Expeditionary Learning – AC Study

BUILDING SUMMARY

General:

Polaris Expeditionary Learning K-12 is a single-story, 51,670 square foot school located at 1905 Orchard Place, in Fort Collins, Colorado. Originally built in 1956, the building has seen multiple expansions and renovations in the last 50 years; these renovations are summarized in more detail in the history section below. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Existing Mechanical Systems:

Cooling: The building has no central cooling system. There are two existing pieces of cooling equipment; a DX Rooftop Unit (RTU-06) serving the Data room, and a split system DX coil at the furnace serving the computer room.

Heating: There are two separate heating systems for the Eastern and the Western sides of the building. Heating for the Eastern side of the building is served by two boilers in the basement mechanical room, with hot water piping routed throughout the building to RTUs, Air Handling Units (AHUs), and Vertical Unit Ventilators (VUVs). The Western side of the building has heating supplied by a single boiler to heating-only RTUs.

Ventilation: The building has multiple ventilation strategies. On the Eastern side of the building, the majority of the classrooms have ventilation served by VUVs. Other spaces on the Eastern side of the building are served by vertical furnace, AHU, and MAU. On the Western side of the building, ventilation is provided by RTU.

Existing Electrical Systems:

The building has an existing 1200 amp, 208Y/120V, 3-phase, 4-wire electrical service.

Existing Structural Systems:

The building consists of single-story CMU construction with interior bearing walls. The CMU is clad with brick wainscoting. The roof framing is configured with structural steel open web trusses at long span conditions along with wood frame joists spanning between bearing walls. Wood joists are supported by structural steel wide flange beams at girder locations. The foundation system consists of concrete pier with grade beams configured at bearing wall locations along with concrete strip footings constructed to support the 1966 Putnam / Moore School Additions.

BUILDING HISTORY

Building Updates since 2015 Study

In 2016 there was a major renovation of the mechanical systems of the Eastern side of the building. Previously, this section of the building was served by a multizone air handling unit located in the basement, providing heating and ventilation through underground ductwork to all spaces. In the 2016 remodel, this system was demolished and the underground ductwork blanked off. Heating-only VUVs were installed in each classroom, with hot water piping routed throughout the building to serve the VUVs. A heating-only AHU was installed to serve the cafeteria/gym.

Polaris Expeditionary Learning – AC Study

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below. McKinstry believes this summary to be accurate.

- *In 2006 a gym addition was constructed. This area is served by a heating and ventilating only RTU.*
- *1996 a boiler was installed to convert the 1956 basement MZ from gas-fired to hot water heat.*
- *1994 consisted of multiple additions and in infill.*
    - *A portion of building was constructed to connect the original 1956 construction to the 1966 building. This infill area is served by a CV RTU with heating and ventilating only.*
    - *Two classrooms were added to the south end of the 1966 construction. This area is served by a CV RTU that is heating and ventilating only. Two classrooms were also added to the north end of the 1958 construction, these rooms are served by underground duct that was installed in the 1958 construction to allow for 2 more classrooms to be served from the basement MZ.*
- *In 1991 the 1966 construction on the east part of the building was converted to hot water heat. A boiler room was added on the north side of the 1966 construction. This heating system serves the infill area and classrooms on the south added in 1994.*
- *In 1987 a media center addition was constructed on the north side, this was infilled between the 1956 and 1958 wings. It is served by two gas fired furnaces. One of the furnaces provides air conditioning to the computer lab. Supply and return duct is overhead. The east side of the media center is 1958 construction and is served from the basement MZ.*
- *In 1966 an annex was built to the west of the building. It is served by two MZ RTUs.*
- *1958 the eastern half of the building was constructed. All these spaces are served from the basement MZ installed in 1956 with underground duct.*
- *1956 was the original construction of the building. A MZ unit was installed in the basement. Supply duct was all routed underground. Return air was transferred from the classrooms into the corridor. One large central return air opening in the corridor is connected to the MZ.*
- *Cafeteria is also served by the basement MZ via underground supply duct.*
- *Kitchen has no make-up air unit. It relies only on transfer air from the gym/cafeteria. There is a small duct from the basement MZ that provides heat to the eastern part of the kitchen.*
- *It appears as though the computer lab on the west end of the building does not currently have air conditioning.*

AIR CONDITIONING STRATEGIES

Contextual Narrative

During the site visit, it was noted by the PSD staff that one of the reasons cooling has not yet been implemented at Polaris is because of the concern of noise by nearby residents. It was suggested by the facilities team that because of this noise sensitivity, packaged RTUs may be preferable to a cooling tower or other central equipment. After some analysis, McKinstry does not suggest this approach; installing new RTUs on the roof to serve classrooms on the Eastern side of the building would likely require structural reinforcement. In addition, during the site visit, it appeared that routing centralized ductwork above the ceilings would be prohibitively difficult, requiring ductwork to be routed on the roof. Roof ductwork is not a preferred solution as it impedes access for maintenance, requires penetrations of the roof membrane to connect to structure, and has a shorter lifespan due to exposure to the elements. In addition, a packaged RTU solution would require demolition or abandonment of much of the existing equipment on the Eastern side of the building. McKinstry recommends a centralized system, but with a sound barrier wall to attenuate noise. During the design phase, equipment can be selected with special attention to a lower operating sound level, and an acoustic analysis can be performed to substantiate that sound levels will not exceed the levels outlined in the noise ordinance of Fort Collins at the edge of the property (55 dB(A) daytime, 50 dB(A) nighttime).

Sound Barrier Wall – Example

Polaris has two separate systems for the building – and Eastern and Western wing. Because of this, there is some flexibility to the implementation of mechanical system changes. For this report, we are assuming both sides of the building would be retrofitted at once.

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Polaris Expeditionary Learning K-12	51,670	Yes	$ 5,574,000	$ 7,524,900	$ 107.88	$ 145.63

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications

AC System Recommendation Descriptions

- **Heat Pump system**
  Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder seasons (Spring and Fall) when some spaces require cooling and others require heating, as the system allows that heat to be moved from one space to another. It is likely this system could utilize much of the existing piping, however it requires all the HVAC equipment to be replaced simultaneously to heat pump equipment to implement. This system also would also move towards the District goals of electrification, as it can be more easily converted to an electric-only solution via eventual implementation of ground-sourced heat pump or electric boilers.
    - Pros:
        - Highly efficient
        - Resilient, comfortable
        - Allows for central heat pump to provide heat most of the year, lowering carbon emissions and likely utility costs
        - Likely can re-use much of the existing heating water piping for condenser water
        - Condenser water lines do not require insulation
        - System can very effectively provide heating and cooling simultaneously
        - This system can also be used with a ground-sourced heat pump loop instead of an air-sourced heat pump for additional efficiency if there is opportunity or funding. The

system can also be converted to ground-source at the end of life of the air-sourced heat pump.

- Cons:
    - High capital cost for new mechanical system retrofit
    - Heat pump equipment have compressors, which can sometimes require additional maintenance and may be louder than typical HW/CW hydronic systems
    - Requires an upgrade to the building electrical service, details provided below
    - Will most likely trigger structural upgrades, details provided below.
- Implementation:
    - Install a new 100-ton air-to-water heat pump system and retrofit existing heating water piping as necessary. Route new piping and resize existing piping as necessary to connect both sides of the building for a new condenser water system. Provide new system circulation pumps and chiller circulation pumps. Reconfigure existing water treatment system. Provide new glycol feeder, air separator, and all other associated appurtenances for the modified water loop. Provide screening/sound barrier.
    - Utilize existing HW piping as possible for new condenser water system
    - Replace existing boiler plants and combine into a single plant using new high-efficiency boilers. Reconfigure piping as necessary for new CDW loop.
    - Replace all existing equipment with water-sourced heat pump equipment
        - Replace existing VUVs on the Eastern side of building with new heat pump VUVs in all classrooms
        - Replace existing HW RTUs on the Western side with new heat pump RTUs
            - Alternate: Provide new heat pump VUVs on the Western side of building in each classroom.
    - Install kitchen MAU with evaporative cooling coil.
    - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces).

- **Electrical Implications of AC Addition**
    - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 1200A service is 360 Amps. There is capacity to add cooling loads to the existing service but adding 100 tons of cooling would require a service upgrade to 1600 Amps.
    - Based on the configuration of the existing electrical service, a service upgrade may be required to add physical space for circuit breakers or fused switches to serve new chillers and Heat Pump RTU units.
    - When a heating only RTU is replaced with a Heat Pump unit, the existing electrical feeders and circuit breakers will need to be upsized to support the additional electrical load. There is also potential that exiting Panelboards serving the existing RTUs would require an upgrade, or additional panelboards would have to be added.
    - Costs for this upgrade is included
- **Structural Implications of AC Addition**
    - Replacement of RTU's with new HW/CW, HW/ASHP, or Heat Pump units at the 1966 (Moore Addition) section of the building
        - It is unlikely that the existing roof system will trigger additional structural reinforcing from the replacement mechanical units on the roof of the 1966 Moore Addition. The

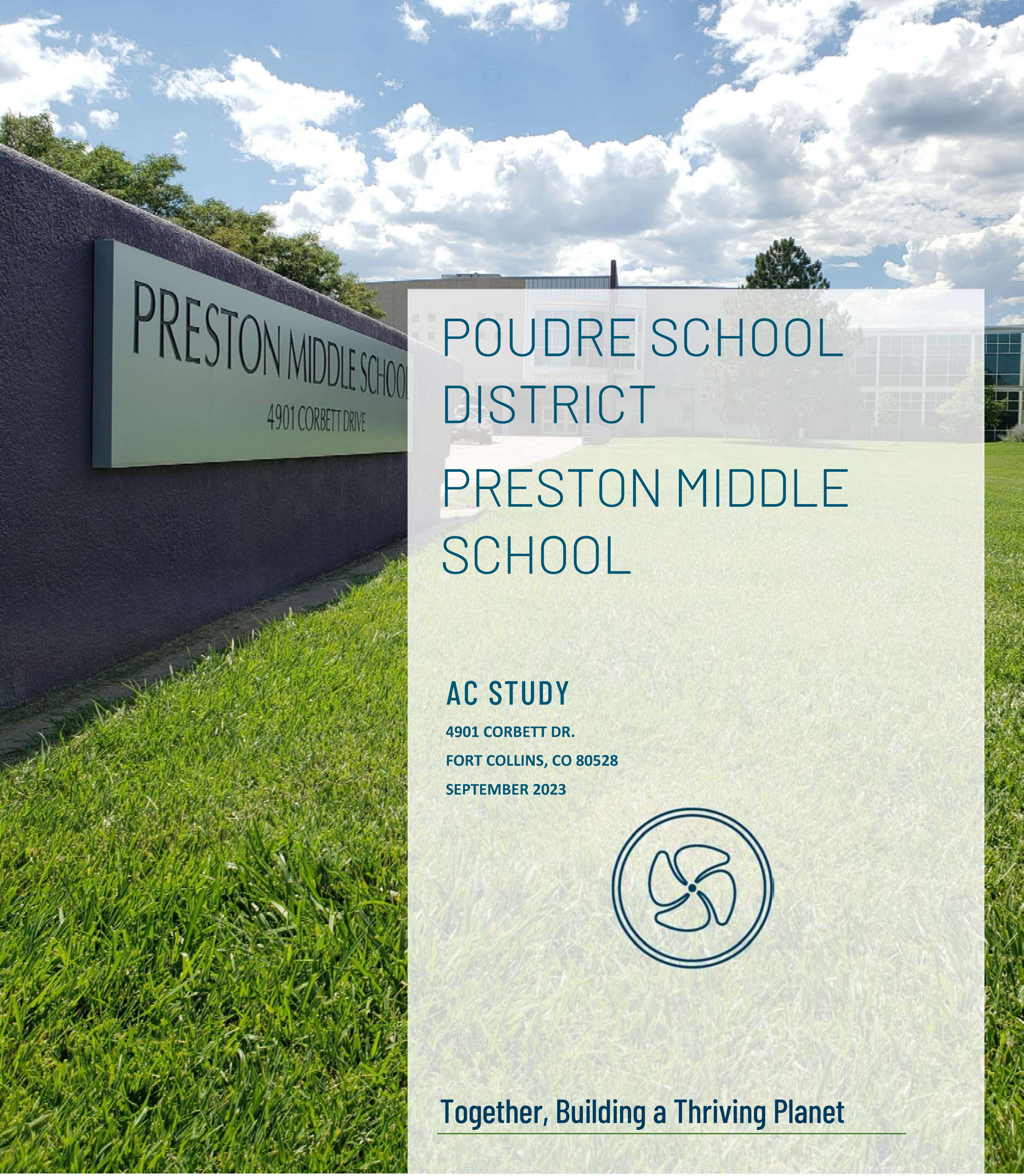
original construction drawings configured perimeter bearing walls in the area immediately under the rooftop mechanical units.
        - As long as the footprints remain relatively the same and existing supply and return openings can be maintained, we do not anticipate triggering a structural reinforcing upgrade.
        - If the openings need to be reconfigured, additional steel will be required to trim-out the new openings.
    - Pad-mounted air-cooled chiller or air-to-water heat pump
        - Provide reinforced concrete pad foundation on grade
    - Costs for these upgrades are included in the pricing above.
- **Architectural Implications of AC Addition**
    - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4'-0") with like material and installation techniques.
    - Where installation of new mechanical equipment is within 10' of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
    - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
    - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
    - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
    - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material
    - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer

Recommendations from 2015 Study

Below are excerpts of recommendations from the 2015 study. Recommendations that are no longer applicable, or that have already been implemented, have been removed. Recommendations related to the condition of existing equipment and systems are covered in the FCA report and have been removed.

- *Install VUVs for all areas on the western portion of the building (from the entry way west). Ceiling space available will make duct routing challenging for central VAV RTUs. Space for VUVs is limited due to extensive existing casework.*
    - McKinstry Comment: Included
- *Install chiller and route chilled water to new RTU and VUVs.*
    - McKinstry Comment: We have proposed a heat pump solution in lieu of CHW.
- *Install an RTU for the Media Center*
    - McKinstry Comment: This is a valid option, to be considered against installing a VUV
- *Reuse 1991 and 1996 boilers to route heating water to the new VUVs and RTU.*
    - McKinstry Comment: We suggest to demo existing boilers and combine into a single boiler plant.
- *Install a packaged DX RTU for the administration area.*
    - McKinstry Comment: ASHP included instead of DX

- *Install a make-up air unit with evaporative cooling for the kitchen.*
    - McKinstry Comment: Included
- *New control system for the whole school*
    - McKinstry Comment: Included



POUDRE SCHOOL DISTRICT

PRESTON MIDDLE SCHOOL

AC STUDY

4901 CORBETT DR.

FORT COLLINS, CO 80528

SEPTEMBER 2023

Together, Building a Thriving Planet

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AC Study: Preston Middle School

Preston Middle School AC Study

KEY CONTACT INFORMATION

McKinstry Contacts

John Runnels
Lead Mechanical Engineer
720.504.5097
johnrun@mckinstry.com

Lauren Bridgers
Project Director
720.583.5895
laurenb@mckinstry.com

Matt Wakulchik
Senior Program Manager
720.721.3960
matthewwa@mckinstry.com

Tracey Cousins
Account Manager
720.667.9091
traceyc@mckinstry.com

Client Contacts

Brett Larsen
Director of Special Projects and Initiatives
970.490.3215
blarsen@psdschools.org

AC Study: Preston Middle School

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to "refresh" the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building's construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry's team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to "best case scenario" options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

AC Study: Preston Middle School

BUILDING SUMMARY

General:

Preston junior high school is a two-story 127,966 square foot school located at 4901 Corbett Dr. in Fort Collins, Colorado. Originally built in 1993 with no major renovations since. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Existing Mechanical Systems:

Cooling: The building is served by a "tempered air" system, utilizing a cooling tower connected to the existing heating water piping in a 2-pipe changeover strategy to deliver cool water to all units in the building. All parts of the building connected to the heating water system are also able to use the tempered water; however, the entire system can only be operated in either heating or cooling mode. There are 7 Rooftop Units (RTUs) that have DX cooling, RTU-5, RTU-6, RTU-7, RTU-9, RTU-10, RTU-11, and RTU-12 all have DX cooling and serve the computer labs, administrators department and music department.

Heating: Heating is served by a central hot water plant with gas-fired boilers, piped throughout the building to all heating equipment.

Ventilation: The ventilation system consists primarily of Vertical Unit Ventilators (VUVs) serving the classrooms, with all other spaces served by RTUs.

Existing Electrical Systems:

The building has an existing 2500 amp, 480Y/277V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1993 with an addition in 2005 and a renovation completed in 2015. The building consists of HSS columns, concrete-masonry unit bearing and shear walls that are supported by mild reinforced concrete spread footing and strip footings. The main floor is supported by a nominal concrete slab-on-grade. The roof framing consists of open web steel trusses framing into wide flange beams supporting corrugated metal deck. The roof framing was originally designed for a nominal 30 psf snow load per the original structural drawings.

BUILDING HISTORY

Building Updates since 2015 Study

The 2015 work detailed below was completed.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *2015 HVAC updates will install a "tempered air" system utilizing a cooling tower and VUVs*
    - *This strategy is able to deliver 65 to 70 degree air into the classrooms during the hottest days of the year.*
    - *Air quantities are 1,200 to 2,000 CFM per classroom depending on number of exterior walls are orientation (east, west, north, south)*
    - *Air is delivered into the classrooms via ceiling diffusers. Air quantity varies between 50 and 100% based on how much heat or cooling the room requires.*
    - *Zoning per individual classrooms is provided.*

- *New pumps and piping to work with the 2-pipe system for heating and cooling were installed.*

- *2015 HVAC updates also included new packaged DX RTUs for the media center, admin area, and music department.*
- *1993 was the original construction of the building.*
    - *Cafeteria is provided with heating and ventilation by a RTU installed in 1993. This unit should be replaced in the next 10-15 years.*
    - *Heating and ventilating RTUs serve the gyms. These units should be replaced in the next 10-15 years.*
    - *The locker rooms are only exhausted and heated, no direct makeup air is provided. Makeup air is transferred from the gym.*
    - *An evaporative cooler serves the kitchen and should be replaced with a make-up air unit providing evaporative cooling in the next 3-5 years.*
    - *Packaged DX RTUs serve the computer labs and should be replaced in the next 0-5 years.*
    - *Boilers should be anticipated to be replaced in 15-20 years.*

AC Study: Preston Middle School

AIR CONDITIONING STRATEGIES

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
			Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
School Name	Square Footage	Electrical Service Upgrade	Low	High	Low	High
Preston MS	127,966	No	$ 8,050,300	$ 10,867,905	$ 62.91	$ 84.93

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

In the process of determining the system to propose, some of the explored options included: 2-pipe Changeover, 4-pipe HW/CW, VAV Reheat, DX Unit Ventilators, HW/DX RTUs, Variable Refrigerant Flow (VRF), and Chilled Beams.

- **Heat Pump system**
  Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder seasons (Spring and Fall) when some spaces require cooling and others require heating, as the system allows that heat to be moved from one space to another. It is likely this system could utilize much of the existing piping, however it requires all the HVAC equipment to be replaced simultaneously to heat pump equipment to implement. This system also would also move towards the District goals of electrification, as it can be more easily converted to an electric-only solution via eventual implementation of ground-sourced heat pump or electric boilers.
  - Pros:
    - Highly efficient
    - Resilient, comfortable
    - Allows for central heat pump to provide heat most of the year, lowering carbon emissions and providing fuel flexibility to react to changing utility costs

- Likely can re-use some of the existing heating water piping for condenser water
- Condenser water lines do not require insulation
- System can very effectively provide heating and cooling simultaneously
- This system can also be used with a ground-sourced heat pump loop instead of an air-sourced heat pump for additional efficiency if there is opportunity or funding. The system can also be converted to ground-source at the end of life of the air-sourced heat pump.

- Cons:
  - High capital cost for new mechanical system retrofit
  - Heat pump equipment have compressors, which can sometimes require additional maintenance
  - Heat pump units may be louder than other HW/CW hydronic systems
  - Will most likely trigger structural upgrades, details provided below.
- Implementation:
  - Install a new 150-ton air-to-water heat pump system and connect to existing heating water piping. Provide new circulation pumps. Provide screening/sound barrier.
  - Provide new condenser water piping system loop. Utilize/reconfigure existing HW/tempered water piping as possible for new condenser water system
  - Replace existing boiler plant with new high-efficiency boilers. Reconfigure piping as necessary for new CDW loop.
  - Replace all existing equipment with water-sourced heat pump equipment
    - Replace existing RTUs, AHUs, VUVs, and VAVs with new heat pump equipment
  - Install a Kitchen MAU with evaporative cooling coil
  - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces).

- **Electrical Implications of AC Addition:**
  - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 2500A service is 526 Amps. There is capacity to add 150 tons of cooling load to the existing service.
  - When a heating only RTU is replaced with a Heat Pump unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load. There is also potential that Panelboards N2M, S2M, C1H and W1M serving the existing RTUs would have to be upgraded as well, or additional panels served by the existing service switchboard.
- **Structural Implications:**
  - Rooftop equipment: The existing bar joist, K truss support framing will likely trigger reinforcing.
    - Truss reinforcing to consist of welded compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord and web reinforcing will also be required.
    - Deck reinforcing will be required if new openings are larger than 16” x 16” square.
  - Air-Source Heat Pump Pad
    - The new ground mounted equipment will be supported by a down-turned thickened lip concrete footing.
      - Thickened lip = 12” tall x 10” deep perimeter footing with minimum size equal to the footprint of the equipment + 6” all-around.
      - Reinforcing = (2) #4’s top and bottom.

        - 6” slab-on-grade to span between thickened lip and configured with #4 at 16” OC each way centered.
    - Costs for this upgrade is included in the pricing above.
- **Architectural Implications:**
    - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4’-0”) with like material and installation techniques.
    - Where installation of new mechanical equipment is within 10’ of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
    - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
    - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
    - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
    - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
    - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

Below are excerpts of recommendations from the 2015 study. Recommendations that are no longer applicable, or that have already been implemented, have been removed. Recommendations related to the condition of existing equipment and systems are covered in the FCA report and have been removed.

- *Install a chiller and connect to existing piping.*
    - McKinstry Comment: We have proposed a heat pump solution in lieu of CHW.
- *Install new RTUs with a cooling coil for the cafeteria and route chilled water piping to these RTUs.*
    - McKinstry Comment: We have proposed a heat pump solution in lieu of CHW.
- *Install a new make-up air unit for kitchen with evaporative cooling. The locker rooms should have an ERV installed to serve them for exhaust and makeup air.*
    - McKinstry Comment: Included

POUDRE SCHOOL DISTRICT

PUTNAM ELEMENTARY SCHOOL

AC STUDY

1400 MAPLE STREET

FORT COLLINS, CO 80521

SEPTEMBER 2023

Together, Building a Thriving Planet

McKinstry
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AC Study: Putnam Elementary School

Putnam Elementary School AC Study

KEY CONTACT INFORMATION

McKinstry Contacts

John Runnels
Lead Mechanical Engineer
720.504.5097
johnrun@mckinstry.com

Lauren Bridgers
Project Director
720.583.5895
laurenb@mckinstry.com

Matt Wakulchik
Senior Program Manager
720.721.3960
matthewwa@mckinstry.com

Tracey Cousins
Account Manager
720.667.9091
traceyc@mckinstry.com

Client Contacts

Brett Larsen
Director of Special Projects and Initiatives
970.490.3215
blarsen@psdschools.org

AC Study: Putnam Elementary School

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to “refresh” the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building’s construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry’s team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to “best case scenario” options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

AC Study: Putnam Elementary School

BUILDING SUMMARY

General:

Putnam Elementary School is a single-story 59,101 square-foot school located at 1400 Maple Street in Fort Collins, Colorado. Originally built in 1955, the building has seen multiple expansions and renovations in the last 50 years; these renovations are summarized in more detail in the history section below. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Existing Mechanical Systems:

Cooling: The building is served by a mixture of RTUs, Multi-Zone (MZ) units, and AHUs. Of the 10 existing RTUs, 7 have DX cooling, with the unit serving the IT Room having cooling only.

Heating: Heating is served by two central hot water plants with gas-fired boilers, piped throughout the building to all heating equipment, including RTUs, MZ units, and AHUs.

Ventilation: Ventilation for the building is provided by the RTUs, MZ units, and AHUs.

Existing Electrical Systems:

The building has an existing 1800 amp, 208Y/120V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1955 with additions in 1966 and 1997 and major renovations in 2014. The building consists of pumice block bearing and shear walls supported by mild reinforced concrete grade beams supported by concrete piers. The main floor is supported by a nominal concrete slab on grade spare the main floor over the basement. The main floor over the basement is supported by mild reinforced concrete panned joists that frame into concrete girders. The roof framing consists of steel trusses spanning each of the main rooms and wood joists spanning the width of the hallways of the building all supporting a pitch and gravel built up roof.

BUILDING HISTORY

Building Updates since the 2015 Study

There have been no major additions or renovations since the 2015 study was conducted.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *The 2014 project related to the 2010 Bond consisted mainly of adding variable frequency drives to the existing AHU fan motors to improve energy efficiency. Budget constraints limited the work for this school.*
- *1997 consisted of multiple additions and in infill.*
    - *A portion of building was constructed to connect the original 1955 construction to the 1966 building. This infill area is served by CV packaged DX RTUs.*
    - *The original 1955 entry way was removed and an addition was constructed to the south. This area and the rooms adjacent to it are served by CV packaged DX RTUs.*
    - *The classrooms in between the infill and the entry way are also served by CV packaged DX RTUs.*

- *A gym and cafeteria addition was installed on the north side. Each area is served by a dedicated indoor heating and ventilating only AHU.*
- *The media center is served by an indoor AHU installed in the same mechanical mezzanine as the gym AHU. This unit provides heating and ventilation only. A cooling coil is installed in the unit and could be connected to a condensing unit in the future.*
- *New boilers were installed in the 1955 basement mechanical room. These serve the 1955 MZ and the zone reheat coils installed in 1999.*

- *In 1991 the 1966 construction on the west part of the building was converted to hot water heat. A boiler room was added on the south side of the 1966 construction. This heating system still serves the west end MZs.*
- *In 1986 a media center addition was constructed on the west side. This was removed in the 1997 remodel and addition.*
- *In 1966 an annex was built to the west of the building. It is served by three MZ RTUs. 1955 was the original construction of the building. A MZ unit was installed in the basement. Supply duct was all routed underground. Return air was transferred from the classrooms into the corridor. One large central return air opening in the corridor is connected to the MZ.*
- *Kitchen has no make-up air unit. It relies only on transfer air from the gym/cafeteria. There is a small duct from the basement MZ that provides heat to the eastern part of the kitchen, from below.*

AC Study: Putnam Elementary School

AIR CONDITIONING STRATEGIES

Contextual Narrative

During interviews with the facility management team, it was suggested to replace the existing underground duct work. This has been included in all options. It was also mentioned that the existing 1955 MZU should be abandoned. We suggest replacing all existing equipment for both of our options below.

In addition, it was mentioned that it would be ideal to upgrade the heating plant. The existing heating scheme consists of 2 separate heating plants – we have included combining the two systems into a single one. This will require significant repiping.

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Putnam ES	59,101	Yes	$ 5,867,000	$ 7,920,450	$ 99.27	$ 134.02

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

In the process of determining the system to propose, some of the explored options included: 2-pipe Changeover, 4-pipe HW/CW, VAV Reheat, DX Unit Ventilators, HW/DX RTUs, Variable Refrigerant Flow (VRF), and Chilled Beams

- **Heat Pump system**
  Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder seasons (Spring and Fall) when some spaces require cooling and others require heating, as the system allows that heat to be moved from one space to another. It is likely this system could utilize much of the existing piping, however it requires all the HVAC equipment to be replaced simultaneously to heat pump equipment to

implement. This system also would also move towards the District goals of electrification, as it can be more easily converted to an electric-only solution via eventual implementation of ground-sourced heat pump or electric boilers.

- Pros:
    - Highly efficient
    - Resilient, comfortable
    - Allows for central heat pump to provide heat most of the year, lowering carbon emissions and providing fuel flexibility to react to changing utility costs
    - Likely can re-use some of the existing heating water piping for condenser water
    - Condenser water lines do not require insulation
    - System can very effectively provide heating and cooling simultaneously
    - This system can also be used with a ground-sourced heat pump loop instead of an air-sourced heat pump for additional efficiency if there is opportunity or funding. The system can also be converted to ground-source at the end of life of the air-sourced heat pump
- Cons:
    - High capital cost for new mechanical system retrofit
    - Heat pump equipment have compressors, which can sometimes require additional maintenance
    - Heat pump units may be louder than other HW/CW hydronic systems
    - Requires an upgrade to the building electrical service, details provided below.
    - Will most likely trigger structural upgrades, details provided below.
- Implementation:
    - Install a new 150-ton air-to-water heat pump system and connect to existing heating water piping. Provide new circulation pumps. Provide screening/sound barrier.
    - Demolish existing baseboard heaters, cabinet unit heaters, and other radiant heaters
    - Provide new condenser water piping system loop. Utilize/reconfigure existing HW piping as possible for new condenser water system
    - Replace existing boiler plants with a single new high-efficiency boiler plant. Reconfigure piping as necessary to combine the two heating systems, and to connect to new CDW loop.
    - Replace all existing equipment with water-sourced heat pump equipment
        - Replace existing RTUs with new heat pump RTUs
        - Remove existing MZ units and replace with heat pump VUVs
        - Replace existing heating-only AHUs with new heat pump AHUs
    - Abandon all underground ductwork and either re-route in the ceiling, on the roof, or provide VUVs and eliminate the need for ductwork.
    - Install kitchen MAU with evaporative cooling
    - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces)

- **Electrical Implications of AC Addition:**
    - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 1800A service is 1205 Amps. There is capacity to add cooling loads to the existing service but adding 150 tons of cooling would require a service upgrade to 4000 Amps.

  - When a heating only RTU is replaced with a Heat Pump unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load.
  - Costs for these upgrades are included in the pricing above.
- **Structural Implications:**
  - Rooftop equipment: The existing bar joist, SJ truss support framing will likely trigger reinforcing.
    - Truss reinforcing to consist of welded compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord and web reinforcing will also be required.
    - Deck reinforcing will be required if new openings are larger than 16" x 16" square.
  - Air-Source Heat Pump Pad
    - The new ground mounted equipment will be supported by a down-turned thickened lip concrete footing.
      - Thickened lip = 12" tall x 10" deep perimeter footing with minimum size equal to the footprint of the equipment + 6" all-around.
      - Reinforcing = (2) #4's top and bottom.
      - 6" slab-on-grade to span between thickened lip and configured with #4 at 16" OC each way centered.
  - Costs for these upgrades are included in the pricing above.
- **Architectural Implications:**
  - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4'-0") with like material and installation techniques.
  - Where installation of new mechanical equipment is within 10' of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
  - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
  - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
  - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
  - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
  - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

Below are excerpts of recommendations from the 2015 study. Recommendations that are no longer applicable, or that have already been implemented, have been removed. Recommendations related to the condition of existing equipment and systems are covered in the FCA report and have been removed.

- *Cap all underground ductwork. Seal all transfer air into the corridor from the classrooms. Remove the basement MZ unit, this will require cutting up and disassembling the unit to get it out of the basement.*
  - McKinstry Comment: Removing MZ unit is included

AC Study: Putnam Elementary School

- *Install VUVs per classroom on the east half of the building (from the entry way east). Wood structure and little space to route duct does not allow for a central AHU or RTU solution.*
    - McKinstry Comment: Installing new VUVs for the classrooms is included.
- *Install a cooling coil in AHU supply main for the cafeteria.*
    - McKinstry Comment: Included
- *Remove the media center DX cooling coil and install a chilled water coil.*
    - McKinstry Comment: Installing new AHU for the Media Center is included.
- *Remove the DX RTUs on the infill and install VUVs in place.*
    - McKinstry Comment: Included.
- *Install VUVs for on the western portion of the building (1966 and 1994 classrooms.*
    - McKinstry Comment: Installing new VUVs for the classrooms is included
- *Install chiller and route chilled water to existing AHUs and new VUVs.*
    - McKinstry Comment: We have proposed a heat pump system in lieu of chilled water.
- *Replace all ductwork in the 1966 construction area.*
    - McKinstry Comment: Included.
- *Reuse 1991 and 1999 boilers to route heating water to the new VUVs.*
    - McKinstry Comment: We have proposed replacing the existing heating plants with a single plant.
- *Install a make-up air unit with evaporative cooling for the kitchen.*
    - McKinstry Comment: Included.
- *Packaged DX administration RTU to remain.*
    - McKinstry Comment: New RTU included.
- *New control system for whole school.*
    - McKinstry Comment: Included.

POUDRE SCHOOL DISTRICT

RED FEATHER ELEMENTARY SCHOOL

AC STUDY

505 NORTH COUNTY RD 73C

RED FEATHER, CO 80545

SEPTEMBER 2023

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Red Feather Elementary School AC Study

KEY CONTACT INFORMATION

McKinstry Contacts

John Runnels
Lead Mechanical Engineer
720.504.5097
johnrun@mckinstry.com

Lauren Bridgers
Project Director
720.583.5895
laurenb@mckinstry.com

Matt Wakulchik
Senior Program Manager
720.721.3960
matthewwa@mckinstry.com

Tracey Cousins
Account Manager
720.667.9091
traceyc@mckinstry.com

Client Contacts

Brett Larsen
Director of Special Projects and Initiatives
970.490.3215
blarsen@psdschools.org

AC Study: Red Feather Elementary School

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to "refresh" the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building's construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry's team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to "best case scenario" options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

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AC Study: Red Feather Elementary School

BUILDING SUMMARY

General:

Red Feather Elementary School is a single-story 9,416 square foot school located at 505 North County Road 73C, in Red Feather, Colorado. Originally built in 1984, the building has seen one expansion. The renovation is summarized in more detail in the history section below. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Existing Mechanical Systems:

Cooling: There is currently no cooling system installed.

Heating: Heating is provided by (4) Trane vertical gas-fired furnaces.

Ventilation: Ventilation is provided by the furnaces listed above.

Existing Electrical Systems:

The building has an existing 400 amp, 240/120V 1-phase, 3-wire electrical service.

BUILDING HISTORY

Building Updates since 2015 Study

There have been no major additions or renovations since the 2015 study was conducted.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *1997 modular was built as an addition to the west of the original 1986 construction. The furnace serving this area was recently replaced in 2013. This unit does not have an economizer. Supply and return air are overhead.*
- *1984 was the original construction of the school. Three residential furnaces serve this area. One furnace serves the classrooms on the north and east. Another furnace serves the 2 south facing classrooms. The third furnace serves the gym/cafeteria. All areas received new furnaces in 2013.*
- *Gym supply and return air is delivered via sidewall, from the same wall.*
- *Kitchen currently has no exhaust and has supply and return air from the furnace serving the gym/cafeteria.*

AC Study: Red Feather Elementary School

AIR CONDITIONING STRATEGIES

Contextual Narrative

During interviews with the facility management staff, it was noted that there are concerns about radon in this school. Radon mitigation is best accomplished through a dedicated system, ideally in a crawlspace below the floor and above the soil. Once radon is in the breathing zone, there is not much that can be accomplished other than dilution (increasing the amount of outside air) during occupied hours, and flushing (through economizers or other high outside air/exhaust methods) before occupancy. McKinstry has suggested incorporating full economizers on the existing furnaces for this reason, but during the design phase a more robust radon mitigation strategy can be developed.

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Red Feather ES	9,416	Yes	$ 662,800	$ 894,780	$ 70.39	$ 95.03

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications

AC Recommendations

- **Heat Pump Cooling**
  Due to the small size of the building, it is unlikely to be cost effective to demolish the existing system entirely and replace it with a new central system. Central systems require additional mechanical room space. On a floorplan of this size, it is difficult to reallocate enough square footage without significant alternations. For this reason, a full system replacement to a 4-pipe or heat pump system has not been suggested.
  - Pros:
    - Fully-functional, reliable AC system
    - Common solution with relatively inexpensive equipment
    - Low first cost

  - Cons:
    - The existing service is small and any additional load will likely trigger an electrical service upgrade
  - Implementation
    - Provide (4) new 5-ton ASHP coils and condensing units, one for each furnace. Route condensate lines to the nearest floor drain or sink branch tailpiece. Provide condensate drain pumps if required.
    - Reconfigure existing furnaces to provide full economizers. Resize existing outside air ductwork for full outside air flow.
    - Install condensing units on ground outdoors.
      - The existing furnaces can be retrofitted to include heat pump coils, but will require ductwork modifications.
    - Install kitchen exhaust and MAU with evaporative cooling. Remove return air from kitchen
- **Electrical Implications of AC Addition:**
  - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 400A service is 366 Amps. Adding 20 tons of cooling load to the existing low voltage single-phase service would require a service upgrade to 1,000 Amps.
  - Costs for these upgrades are included in the pricing above.
- **Structural Implications:**
  - The addition of condensing units on grade will not require structural modifications.
- **Architectural Implications:**
  - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4'-0") with like material and installation techniques.
  - Where installation of new mechanical equipment is within 10' of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
  - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
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  - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

- *Add a DX cooling coil to the furnaces installed in 2013. Ductwork revisions would be required to install a new cooling coil.*
  - McKinstry Comment: We agree with this recommendation but suggest heat pump units to allow for heat pump heating when advantageous.
- *Exhaust fans should be installed for the kitchen and return air removed.*

  - McKinstry Comment: We agree with this recommendation; included in option 1
- *Exposed spiral duct or DuctSox should be installed for the gym/cafeteria to better distribute the supply air.*
  - McKinstry Comment: This solution would improve gym airflow but is not necessary for AC implementation.
- *Due to the elevation and cooler climate of this school, consideration should be given to installing economizers on all furnaces to bring in more fresh air during warmer times of the year. If this were to be implemented, it is unlikely that AC is necessary unless year round school schedule was adopted.*
  - McKinstry Comment: Economizers are required for all system 5 tons and larger – thus, this would be required to be implemented as part of our solution. With warmer summers and changes in school schedule, we suggest installing AC if possible.

POUDRE SCHOOL DISTRICT

RICE ELEMENTARY SCHOOL

AC STUDY

7000 THIRD ST.

WELLINGTON, CO 80549

SEPTEMBER 2023

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AC Study: Rice Elementary School

Rice Elementary School AC Study

KEY CONTACT INFORMATION

McKinstry Contacts

John Runnels
Lead Mechanical Engineer
720.504.5097
johnrun@mckinstry.com

Lauren Bridgers
Project Director
720.583.5895
laurenb@mckinstry.com

Matt Wakulchik
Senior Program Manager
720.721.3960
matthewwa@mckinstry.com

Tracey Cousins
Account Manager
720.667.9091
traceyc@mckinstry.com

Client Contacts

Brett Larsen
Director of Special Projects and Initiatives
970.490.3215
blarsen@psdschools.org

AC Study: Rice Elementary School

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AC Study: Rice Elementary School

BUILDING SUMMARY

General:

Rice Elementary School is a single-story 63,092 square foot school located at 5100 School House Road, in Timnath, Colorado. This school was built in 2007 and has not undergone any major renovations since. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Mechanical Systems:

Cooling: The building is served by a "tempered air" system, utilizing a cooling tower connected to the heating water piping in a 2-pipe changeover strategy to deliver cool water to all units in the building. All parts of the building connected to the heating water system are also able to use the tempered water; however, the entire system can only be operated in either heating or cooling mode. There are 5 RTUs connected to the tempering system. One rooftop unit has DX cooling serving the admin and computer lab.

Heating: Heating is served by a central hot water plant with gas-fired boilers, piped throughout the building to all heating equipment.

Ventilation: The ventilation system consists primarily of RTUs and an AHU.

Electrical Systems:

The building has an existing 600 amp, 480Y/277V 3-phase, 4-wire electrical service.

Structural Systems:

The initial building was constructed in 2007. The building consists of HSS columns supported by spread footings, concrete-masonry unit bearing and shear walls that are supported by mild reinforced concrete strip footings. The main floor is supported by a nominal concrete slab-on-grade. The roof framing consists of mostly open web steel trusses framing into wide flange beams supporting corrugated metal deck, there are a few locations where joists frame into CMU bearing walls.

BUILDING HISTORY

Building Updates since 2015 Study

There have been no major additions or renovations since the 2015 study was conducted.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *This school was built in 2007. It is not "air conditioned" in the traditional sense. However, with the sustainable building construction and system installed – it has, according to PSD personnel, consistently provided adequate comfort in the warmer times of the year.*
- *The 2007 system consists of the following*
    - *VAV RTUs*
    - *VAV reheat zoning at each classroom, office area, etc*
    - *Cooling tower to create cool water coupled with a flat plate heat exchanger.*
    - *Chilled water piping routed to all RTUs except the gym and administration area.*
    - *The administration area is served by DX cooling*
    - *The gym is provided with heating and ventilation only.*

- *High efficiency boilers were installed in 2007 as well.*
- *Kitchen does not have any dedicated make-up air unit. Make-up air is via transfer air from the adjacent cafeteria RTU.*

AC Study: Rice Elementary School

AIR CONDITIONING STRATEGIES

Contextual Narrative

During interviews with the building management team, it was noted that the tempered system for Rice is more effective than many of the others. As such, this school should be less prioritized than many other buildings. This building has still been shown with a central heat pump mechanical system for comparison with other schools, but implementation of air conditioning could alternatively be accomplished by replacing existing rooftop units with new ASHP or DX units.

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Rice ES	63,092	Yes	$ 3,753,362	$ 5,067,039	$ 59.49	$ 80.31

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

In the process of determining the system to propose, some of the explored options included: 2-pipe Changeover, 4-pipe HW/CW, VAV Reheat, DX Unit Ventilators, HW/DX RTUs, Variable Refrigerant Flow (VRF), and Chilled Beams.

- **Heat Pump system**
  Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder seasons (Spring and Fall) when some spaces require cooling and others require heating, as the system allows that heat to be moved from one space to another. It is likely this system could utilize much of the existing piping, however it requires all the HVAC equipment to be replaced simultaneously to heat pump equipment to implement. This system also would also move towards the District goals of electrification, as it can be

more easily converted to an electric-only solution via eventual implementation of ground-sourced heat pump or electric boilers.

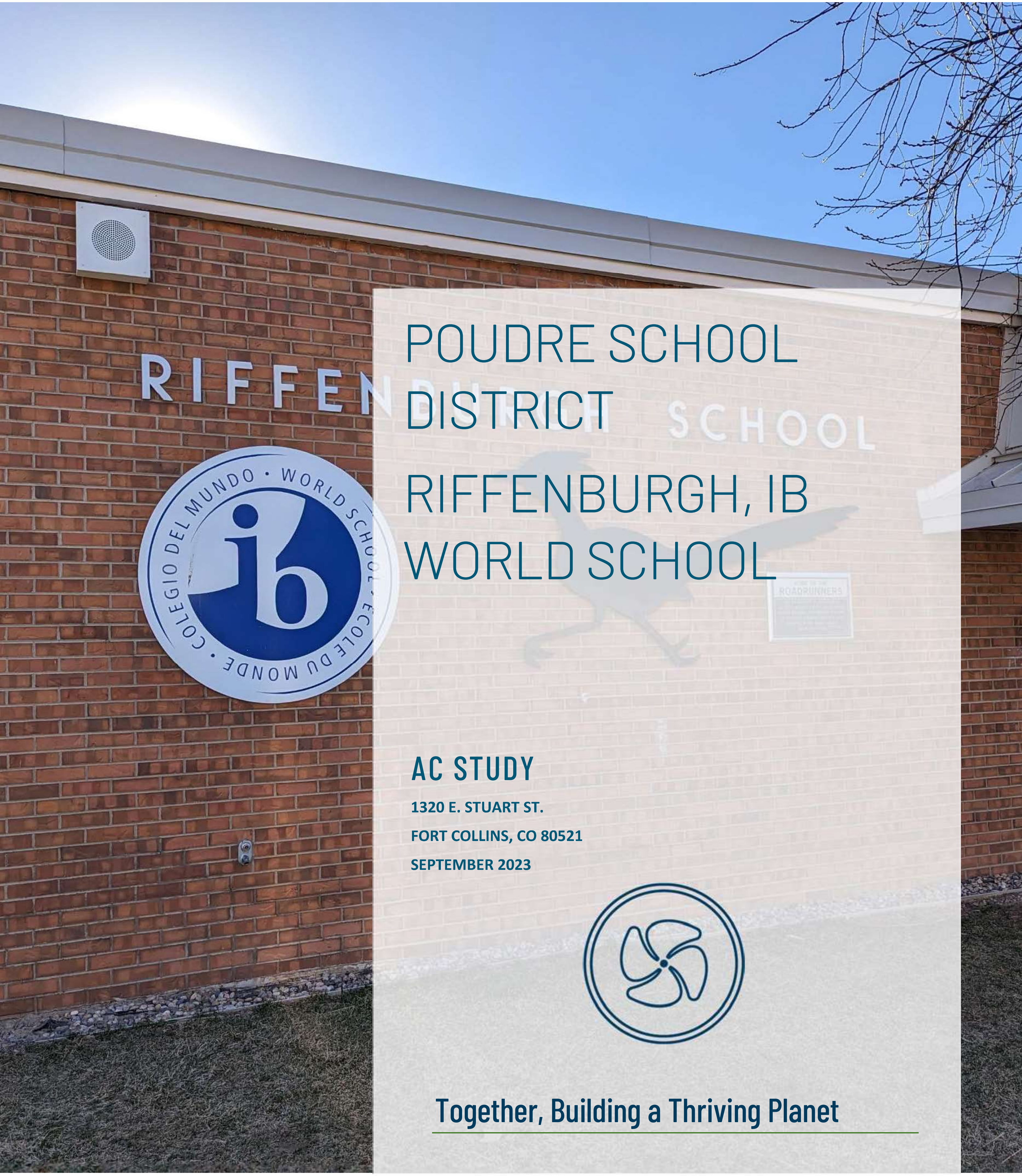
- Pros:
  - Highly efficient
  - Resilient, comfortable
  - Allows for central heat pump to provide heat most of the year, lowering carbon emissions and providing fuel flexibility to react to changing utility costs
  - Likely can re-use some of the existing heating water piping for condenser water
  - Condenser water lines do not require insulation
  - System can very effectively provide heating and cooling simultaneously
  - This system can also be used with a ground-sourced heat pump loop instead of an air-sourced heat pump for additional efficiency if there is opportunity or funding. The system can also be converted to ground-source at the end of life of the air-sourced heat pump.
- Cons:
  - High capital cost for new mechanical system retrofit
  - Heat pump equipment has compressors, which can sometimes require additional maintenance
  - Heat pump units may be louder than other HW/CW hydronic systems
  - Requires an upgrade to the building electrical service, details provided below.
  - Will most likely trigger structural upgrades, details provided below.
- Implementation:
  - Install a new 125-ton air-to-water heat pump system and connect to existing heating water piping. Provide new circulation pumps. Provide screening/sound barrier.
  - Demolish existing baseboard heaters, cabinet unit heaters, and other radiant heaters
  - Provide new condenser water piping system loop. Utilize/reconfigure existing HW piping as possible for new condenser water system
  - Demo or abandon in place existing cooling tower
  - Replace all existing equipment with water-sourced heat pump equipment
    - All RTUs and FCUs in the building would require replacement with new heat pump equipment. All CUHs will require replacement with electrical unit heaters.
  - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces).
  - Install a kitchen MAU with evaporative cooling.

- **Electrical Implications of AC Addition:**
  - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 600A service is 226 Amps. There is capacity to add cooling loads to the existing service but adding 125 tons of cooling would require a service upgrade to 1,000 Amps.
  - When a heating only RTU is replaced with a DX unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load.
  - Costs for this upgrade is included in all options
- **Structural Implications:**
  - Rooftop equipment: The existing bar joist, LH, K and H truss support framing will likely trigger reinforcing.

    - Truss reinforcing to consist of welded compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord and web reinforcing will also be required.
    - Deck reinforcing will be required if new openings are larger than 16” x 16” square.
  - Air-Source Heat Pump Pad
    - The new ground mounted equipment will be supported by a down-turned thickened lip concrete footing.
      - Thickened lip = 12”tall x 10” deep perimeter footing with minimum size equal to the footprint of the equipment + 6” all-around.
      - Reinforcing = (2) #4’s top and bottom.
      - 6” slab-on-grade to span between thickened lip and configured with #4 at 16” OC each way centered.
  - Costs for this upgrade is included in above pricing.
- **Architectural Implications:**
  - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4’-0”) with like material and installation techniques.
  - Where installation of new mechanical equipment is within 10’ of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
  - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
  - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
  - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
  - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
  - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

- *Install a dedicated make-up air unit with evaporative cooling for the kitchen.*
  - McKinstry Comment: Included



POUDRE SCHOOL DISTRICT

RIFFENBURGH, IB WORLD SCHOOL

AC STUDY

1320 E. STUART ST.

FORT COLLINS, CO 80521

SEPTEMBER 2023

Together, Building a Thriving Planet

McKinstry
For The Life Of Your Building

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AC Study: Riffenburgh, IB World School

Riffenburgh, IB World School AC Study

KEY CONTACT INFORMATION

McKinstry Contacts

John Runnels
Lead Mechanical Engineer
720.504.5097
johnrun@mckinstry.com

Lauren Bridgers
Project Director
720.583.5895
laurenb@mckinstry.com

Matt Wakulchik
Senior Program Manager
720.721.3960
matthewwa@mckinstry.com

Tracey Cousins
Account Manager
720.667.9091
traceyc@mckinstry.com

Client Contacts

Brett Larsen
Director of Special Projects and Initiatives
970.490.3215
blarsen@psdschools.org

AC Study: Riffenburgh, IB World School

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to “refresh” the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building’s construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry’s team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to “best case scenario” options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

AC Study: Riffenburgh, IB World School

BUILDING SUMMARY

General:

Riffenburgh, IB World School is a single-story 48,433 square foot school located at 1320 E. Stuart Street, in Fort Collins, Colorado. Originally built in 1967, the building has seen with multiple expansions and renovations in the last 50 years; these renovations are summarized in more detail in the history section below. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Existing Mechanical Systems:

Cooling: The building has no central cooling system. It has a "tempered air" system provided by a cooling tower with tempered water routed to cooling coils in rooftop air handling units. One RTU has DX Cooling and no heating serving the IT room.

Heating: Heating is served by boilers, with hot water piping routed to RTUs.

Ventilation: Ventilation is provided through ducting and supply grilles that are connected to the rooftop units. One Rooftop unit that is serving the 1970 area of the building was replaced in 2014 has VAV boxes connected to it.

Existing Electrical Systems:

The building has an existing 1200 amp, 208Y/120V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1967 with an addition in 1970 and a renovation completed in 2014. The building consists of HSS columns supported by concrete piers or spread footings, concrete-masonry unit bearing and shear walls that are supported by mild reinforced concrete spread footing, strip footings and grade beams. The main floor is supported by a nominal concrete slab-on-grade. The roof framing consists of mostly open web steel trusses supporting corrugated metal deck.

BUILDING HISTORY

Building Updates since 2015 Study

There have been no major additions or renovations since the 2015 study was conducted.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *In 2014 HVAC updates installed a "tempered air" system utilizing a cooling tower to create cool water that was routed via roof mounted piping to a number of rooftop units.*
    - *This strategy is able to deliver 65 to 70 degree air into the classrooms during the hottest days of the year.*
    - *Heating water piping and boilers were installed in 1994 and were all reused in the 2014 HVAC updates.*
    - *A new RTU serves the media center area that was added in 1988. This unit is air conditioning ready.*
    - *The existing RTU serving the 1970 area of the building was replaced with a new RTU because it was not able to be retrofitted with a cooling coil. The area served by this unit now has VAV*

zoning and some new ductwork. Existing ductwork downstream of the new VAVs was reused. Sections of duct in this area that remain from 1970 should be replaced. The RTU and zoning scheme is air conditioning ready.

- *The two classrooms north of the cafeteria are served by a new RTU installed in 2014 and is air conditioning ready.*
- *Existing MZ RTUs from 1967 were retrofitted with cooling coils and all ductwork was reused. These units and the associated ductwork should be replaced. Budget constraints and prioritization of improved comfort resulted in these RTUs remaining in place during the 2014 HVAC updates project.*

- *In 2002 a gym addition was constructed. Equipment is relatively new and gyms are not to be air conditioned. Air handling equipment should be replaced in 15-20years.*
- *The RTU serving the cafeteria is original from 1967. This unit should be replaced and piping extended to this area to provide air conditioning.*
- *Kitchen has no makeup air. It relies only on transfer air from the cafeteria.*

AC Study: Riffenburgh, IB World School

AIR CONDITIONING STRATEGIES

Contextual Narrative

During interviews with the facility management team, it was discussed that the RTU serving the IT Room is overcooling the space as it has no reheat capability. This is likely due to a lack of turndown on the unit and a mismatch of cooling load to equipment size. In our solutions, we suggest replacing this unit with an ASHP RTU, which would allow the system to either heat or cool. The replacement unit should also be multi-stage, reducing the likelihood of overcooling.

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Riffenburgh, IB World School ES	48,433	Yes	$ 5,131,000	$ 6,926,850	$ 105.94	$ 143.02

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

In the process of determining the system to propose, some of the explored options included: 2-pipe Changeover, 4-pipe HW/CW, VAV Reheat, DX Unit Ventilators, HW/DX RTUs, Variable Refrigerant Flow (VRF), and Chilled Beams.

- **Heat Pump system**
- Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder seasons (Spring and Fall) when some spaces require cooling and others require heating, as the system allows that heat to be moved from one space to another. It is likely this system could utilize much of the existing piping, however it requires all the HVAC equipment to be replaced simultaneously to heat pump equipment to implement. This system also would also move towards the District goals of electrification, as it can be

more easily converted to an electric-only solution via eventual implementation of ground-sourced heat pump or electric boilers.

- Pros:
  - Highly efficient
  - Resilient, comfortable
  - Allows for central heat pump to provide heat most of the year, lowering carbon emissions and providing fuel flexibility to react to changing utility costs
  - Likely can re-use some of the existing heating water piping for condenser water
  - Condenser water lines do not require insulation
  - System can very effectively provide heating and cooling simultaneously
  - This system can also be used with a ground-sourced heat pump loop instead of an air-sourced heat pump for additional efficiency if there is opportunity or funding. The system can also be converted to ground-source at the end of life of the air-sourced heat pump
- Cons:
  - High capital cost for new mechanical system retrofit
  - Heat pump equipment have compressors, which can sometimes require additional maintenance
  - Heat pump units may be louder than other HW/CW hydronic systems
  - Will most likely trigger structural upgrades, details provided below.
- Implementation:
  - Install a new 125-ton air-to-water heat pump system and connect to existing heating water piping. Provide new circulation pumps. Provide screening/sound barrier
  - Provide new condenser water piping system loop. Utilize/reconfigure existing HW piping as possible for new condenser water system.
  - Replace existing boiler plant with new high-efficiency boilers. Reconfigure piping as necessary for new CDW loop.
  - Replace all existing equipment with water-sourced heat pump equipment
    - Replace existing RTUs with new heat pump RTUs
    - Replace existing AHUs with new heat pump AHUs
  - Install evaporative cooling on Kitchen MAU
  - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces).

- **Electrical Implications:**
  - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 1200A service is 511 Amps. There is capacity to add cooling loads to the existing service but adding 125 tons of cooling would require a service upgrade to 2000 or 2500 Amps.
  - When a heating only RTU is replaced with a heat pump unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load.
  - Costs for this upgrade is included in the pricing above.
- **Structural Implications:**
  - Rooftop equipment: The existing bar joist, LH and H truss support framing will likely trigger reinforcing.

        - Truss reinforcing to consist of welded compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord and web reinforcing will also be required.
        - Deck reinforcing will be required if new openings are larger than 16" x 16" square.
    - Air-Source Heat Pump Pad
        - The new ground mounted equipment will be supported by a down-turned thickened lip concrete footing.
            - Thickened lip = 12"tall x 10" deep perimeter footing with minimum size equal to the footprint of the equipment + 6" all-around.
            - Reinforcing = (2) #4's top and bottom.
            - 6" slab-on-grade to span between thickened lip and configured with #4 at 16" OC each way centered.
    - Costs for these upgrades are included in the pricing above.
- **Architectural Implications:**
    - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4'-0") with like material and installation techniques.
    - Where installation of new mechanical equipment is within 10' of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
    - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
    - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
    - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
    - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
    - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

Below are excerpts of recommendations from the 2015 study. Recommendations that are no longer applicable, or that have already been implemented, have been removed. Recommendations related to the condition of existing equipment and systems are covered in the FCA report and have been removed.

- *Rebalance chilled water flows at new RTU installed in 2014.*
    - McKinstry Comment: TAB recommended at all RTUs.
- *Install new RTUs for the 3 RTUs serving the 1967 area. Energy Code and best practice will require zoning control in these areas to be revised to VAV. All ductwork in these areas to be removed and replaced.*
    - McKinstry Comment: Included.
- *Install new RTU on cafeteria and install a new branch from the existing roof mounted chilled water piping to the gym roof. Remove and replace existing duct in gym/cafeteria.*
    - Mckinstry Comment: We have proposed a heat pump solution in lieu of CHW
- *Packaged DX RTU for admin*

    - McKinstry Comment: Included, with ASHP RTUs in lieu of DX
- *Install evaporative cooling on kitchen MAU installed in 2014.*
    - McKinstry Comment: Included.