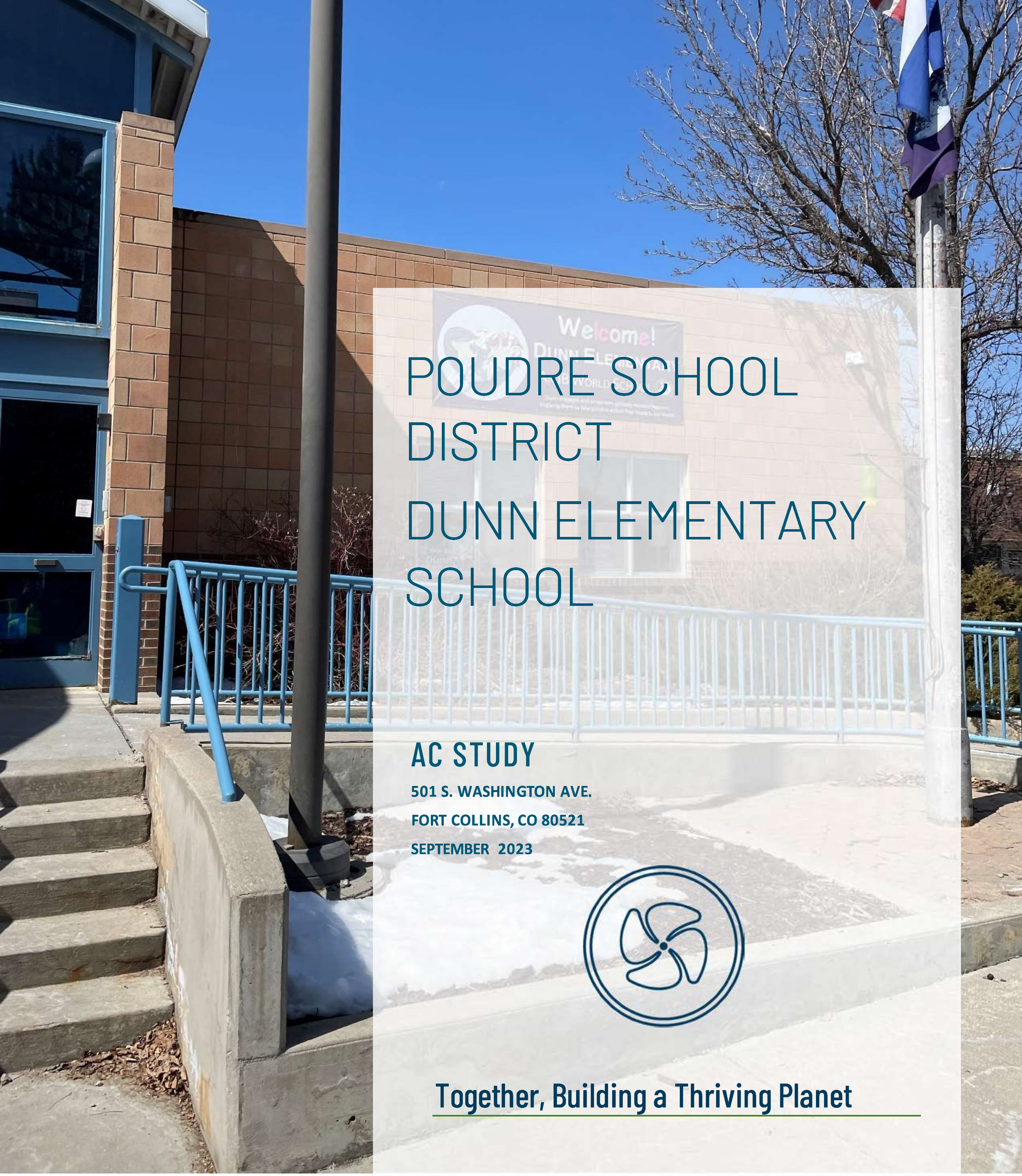

POUDRE SCHOOL DISTRICT
DUNN ELEMENTARY SCHOOL

AC STUDY

501 S. WASHINGTON AVE.
FORT COLLINS, CO 80521
SEPTEMBER 2023

Together, Building a Thriving Planet

McKinstry
For The Life Of Your Building

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AC Study: Dunn Elementary School

Dunn Elementary School AC Study

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AC Study: Dunn 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: Dunn Elementary School

BUILDING SUMMARY

General:

Dunn Elementary School is a single-story 45,957 square foot school located at 501 South Washington Avenue, in Fort Collins, Colorado. Originally built in 1948, 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 majority of the building has DX cooling, with most classrooms served by DX Vertical Unit Ventilators (VUVs), with a few spaces served by DX Rooftop Units (RTUs). The north classrooms and office area do not have cooling.

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 the rest of the spaces served by RTUs.

Existing Electrical Systems:

The building has an existing 1000 amp, 208Y/120V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1948. The existing roof plan consists of two types of systems: typical classroom and gymnasium. The classrooms have nominal 2x wood framing and sheathing that are supported by typical wood stud walls. The gymnasium has steel wide flange beams and columns. Both systems have a foundation consisting of nominal 2x wood framing crawl space spanning to exterior concrete wall footings and an interior steel wide flange girder that is supported by interior posts and typical spread footings.

An addition was constructed in 2006. This addition consists of a roof supported by open web steel trusses supporting corrugated metal deck. The trusses are supported by concrete-masonry unit bearing and shear walls supported by mild reinforced concrete spread footing, strip footings and grade beams.

BUILDING HISTORY

Building Updates since 2015 Study

In 2016 there was a major renovation which provided an overall controls update, installed new DX VUVs in most classrooms, installed new circulator pumps for the existing boilers, and installed a new RTU and ductwork for the gym.

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 2006 classroom addition was constructed on the northwest corner. These areas are served by a CV RTU providing heating and ventilation only. This RTU also serves the adjacent classroom that was added in 1992.*
- *1992 consisted of a major remodel and additions.*

  - *Three classrooms were added to the north end. These are served by unit ventilators, with the exception of one classroom which now borders the above mentioned 2006 addition.*
  - *The addition to the east side of the building consisted of classrooms and administration area. This area is served by a CV RTU. Zoning is via reheat coils in the ductwork. The adjacent area to the west of the addition is also served from this RTU.*
  - *1948 steam boilers and UVs were removed. New hot water boilers were installed.*
  - *New UVs, baseboard and convectors were installed throughout the original 1948 areas (including classrooms, gym/cafeteria and entry ways)*
  - *Tunnels along the exterior walls used in the 1948 construction for steam piping were reused for heating water pipe.*
  - *A packaged DX RTU was installed for the computer lab and resource room.*
- *In 1987 a media center addition was constructed on the north side. This area is served by a heating and ventilating AHU in the ceiling space.*
- *1948 was the original construction of the building. All HVAC systems were replaced in 1992.*
- *Kitchen has recently had new make-up air units and exhaust installed.*

AC Study: Dunn Elementary School

AIR CONDITIONING STRATEGIES

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
Dunn ES	45,957	No	$ 1,804,700	$ 2,436,345	$ 39.27	$ 53.01

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

- **Air-Sourced Heat Pump RTUs**
  Replacing the remaining RTU and AHU with no cooling will be the lowest first cost to implement cooling to the remaining parts of the building.
  - Pros:
    - Lowest first cost
    - Does not require replacing most equipment in the school; utilizes existing infrastructure.
    - Utilizes the existing hot water and hot water piping.
    - Cooling will be provided.
  - Cons:
    - Not as energy efficient has switching to a central plant or heat pump system.
    - Will most likely trigger structural upgrades, details provided below
  - Implementation:
    - Replace remaining heating-only RTUs with new ASHP/HW RTUs.
    - Install an evaporative cooler in the existing kitchen MAU
- **Electrical Implications of AC Addition:**
  - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 1000A service is 439 Amps. There is capacity to add an additional 35 tons of cooling loads to the existing service.

  - 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.
- **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.
  - 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.

- *Install a packaged DX RTU for the administration area.*
  - McKinstry Comment: Included, but with ASHP in lieu of DX
- *Install an evaporative cooling section in the recently installed make-up air unit for the kitchen.*
  - McKinstry Comment: Included

POUDRE SCHOOL DISTRICT

EYESTONE ELEMENTARY SCHOOL

AC STUDY

4000 WILSON AVE.

WELLINGTON, CO 80549

SEPTEMBER 2023

Together, Building a Thriving Planet

McKinstry
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AC Study: Eyestone Elementary School

Eyestone Elementary School AC Study

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AC Study: Eyestone 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: Eyestone Elementary School

BUILDING SUMMARY

General:

Eyestone Elementary School is a single-story 64,228 square foot school located at 4000 Wilson Ave, in Wellington, Colorado. Originally built in 1972, 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. This report will only concern the north building, as the south building already has AC. 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 evaporative cooling Dedicated Outdoor Air System (DOAS) Rooftop Unit (RTU) ducted to Variable Air Volume (VAV) boxes with HW Reheat for zone control. 2 existing RTUs have DX cooling, including the unit serving the Data Room.

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

Ventilation: The ventilation system consists primarily of DOAS serving the classrooms, with some spaces served by RTUs including the Data Room, Flex Room, and Media Center.

Existing Electrical Systems:

The building has an existing 1600 amp, 208Y/120V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1972 with additions in 1988, 1992 and 2002 and a renovation completed in 2012. The building consists of pipe columns and concrete shear walls that are supported by mild reinforced concrete spread and strip footings, respectively. 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 2012 HVAC updates installed a "tempered air" system utilizing indirect evaporative cooling Dedicated Outside Air Systems (DOAS) for portions of the building.*
  - *This strategy is to deliver outside air into the classrooms that is approximately 24 degrees cooler than the outside air temperature during the warmer parts of the year. For instance – at 95 degrees outside, the air delivered to the classroom is 71 degrees.*
  - *A future cooling coil could be installed in these units, downstream of the heating coil.*
  - *Exterior classrooms on the north and south side of the 1972/1988 construction and exterior classrooms in the 1992 addition are served by these units.*
  - *VAV boxes regulate air flow quantity into each zone/classroom. Maximum air quantity for each classroom is between 800 and 1,000 cfm.*
  - *Air is supplied via ceiling diffusers.*

  - *Return air is pulled from down low. An exposed spiral duct is installed in each classroom that goes to the floor. A return grille is installed near floor level in the spiral duct. Many of these were observed to be blocked, by furniture, etc.*
  - *A packaged DX RTU was installed for the Comm Data room.*
  - *A boiler was installed to supplement the boiler from 1972. The 1972 boiler still remains in service.*
- *An addition was installed in 2002. No drawings were available.6 classrooms were added to the east end. Two RTUs serve this area. Both provide heating and ventilation only. One contains an energy recovery heat wheel.*
  - *Also a gym was added to the northwest corner. The RTU serving this space provides heating and ventilation only. Supply duct is distributed via a DuctSox. Air movement is noticeably better in this gym than in many other gyms in PSD.*
- *1992 classrooms were added to the east of the 1988 construction. This is still served by the RTU installed in 1992.*
- *1988 classrooms were added to the east and south of the 1972 construction. This area is now served by the HVAC update installed in 2012.*
- *1972 was the original construction of the building. 3 MZ RTUs from this construction remain in place.*
  - *1 MZ serves the interior spaces such as the media center and surrounding rooms. These spaces are adjacent to the exterior classrooms served by the 2012 DOAS system.*
  - *Another MZ RTU serves the kitchen and office areas.*
  - *The 3rd MZ serves the cafeteria.*
- *Kitchen does not have a dedicated make-up air unit.*
- *A packaged DX RTU serves the computer lab.*

AC Study: Eyestone Elementary School

AIR CONDITIONING STRATEGIES

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
Eyestone ES (North and South)	64,228	Yes	$ 6,006,400	$ 8,108,640	$ 93.52	$ 126.25

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 115-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.
        - Demo existing base board heaters
        - Replace all existing equipment with water-sourced heat pump equipment
        - All VUVs, 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 new 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 1600A service is 586 Amps. There is capacity to add cooling loads to the existing service but adding 115 tons of cooling would require a service upgrade to 2000 Amps or 2500 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.
    - Cost for these upgrades are included.
- **Structural Implications:**
    - Rooftop equipment: The existing bar joist, LH and H truss support framing will likely trigger reinforcing.
        - Truss reinforcing to consist of bolted compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord 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.

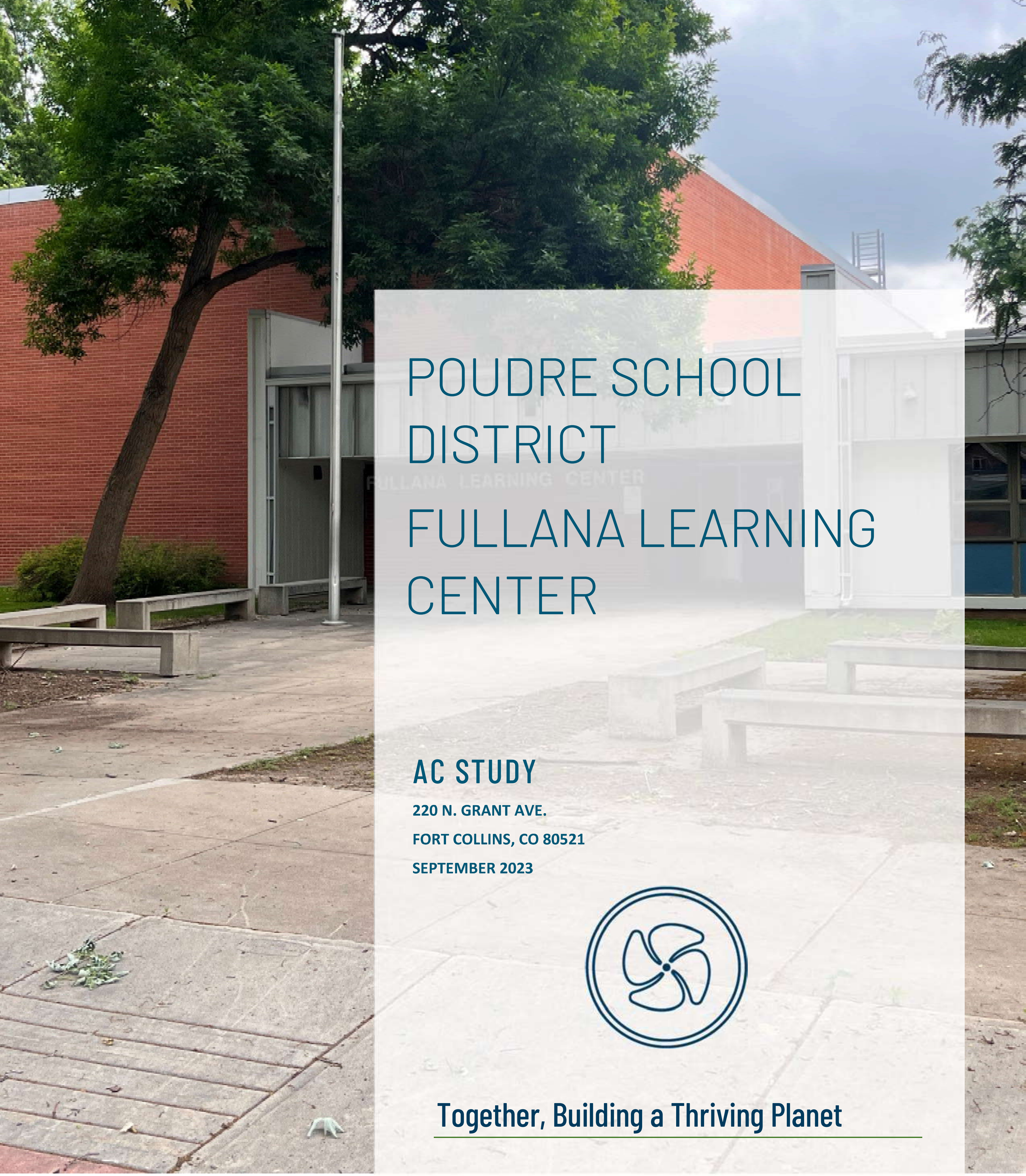
        - Thickened lip = 12"tall x 10" deep perimeter footing with minimum size equal to the footprint of the equipment + 6" all-around.
        - Reinforcing = (2) #4's top and bottom.
        - 6" slab-on-grade to span between thickened lip and configured with #4 at 16" OC each way centered.
    - Costs for 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.

- *Install chiller and chilled water piping and route to new RTUs*
    - McKinstry Comment: Existing HW piping to be repurposed as possible as CDW piping for Heat Pump System
- *Replace all existing RTUs in the building, except RTUs installed in 2012.*
    - McKinstry Comment: All RTUs to be replaced with heat pump equipment
- *Reuse RTUs, ductwork, and VAVs installed in 2012. Install chilled water coils in the existing RTUs.*
    - McKinstry Comment: All RTUs to be replaced with heat pump equipment. Existing ductwork to be used as possible.
- *Reuse ductwork installed in the east addition, and add VAV zone control for each classroom.*
    - McKinstry Comment: Included
- *Remove all ductwork and piping in the 1972 area that remain from original construction. Install new VAV zoning for each classroom.*
    - McKinstry Comment: Included
- *Install a new RTU for the cafeteria and route chilled water to it.*
    - McKinstry Comment: Included, but with heat pump RTU
- *Install a dedicated make-up air unit for the kitchen with evaporative cooling.*

    - McKinstry Comment: Included
- *Packaged DX RTU for admin*
    - McKinstry Comment: Our solutions suggest installing new Heat Pump systems rather than DX.



POUDRE SCHOOL DISTRICT
FULLANA LEARNING CENTER

AC STUDY

220 N. GRANT AVE.

FORT COLLINS, CO 80521

SEPTEMBER 2023

Together, Building a Thriving Planet

McKinstry
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AC Study: Fullana Learning Center

Fullana Learning Center AC Study

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AC Study: Fullana Learning Center

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: Fullana Learning Center

BUILDING SUMMARY

General:

Fullana Learning Center is a single-story 24,109 square foot school located at 220 North Grant Avenue, in Fort Collins, Colorado. Originally built in 1974, this building has experienced some renovations and upgrades since its construction. 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 almost complete AC implementation. DX split systems were recently added to the furnaces in the main building. The annex also has AC, and the kitchen is served by a makeup air unit with direct evaporative cooling. The only space left requiring AC is the gym.

Heating: Part of the building is served by an air handling unit with 2 gas fired duct furnaces. The classrooms are heated with gas fired furnaces.

Ventilation: The ventilation system consists primarily of gas furnaces serving the classrooms, with some spaces served by an AHU. The kitchen is served by an make up air unit with direct evaporative cooling.

Existing Electrical Systems:

The building has an existing 1600 amp, 208Y/120V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1974 with a remodel completed in 2000. The building consists of metal columns and metal load bearing walls that are supported by mild reinforced concrete spread and strip footings, respectively. The main floor is supported by a nominal concrete slab-on-grade. The roof framing consists of mostly open web steel trusses supporting steelox roof. The main building system is a pre-engineered metal building.

BUILDING HISTORY

Building Updates since 2015 Study

Recently, split system condensing units were installed on many of the furnaces serving the main building. The only building left without AC is the annex.

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 2006 a residential style evaporative cooler was installed for the kitchen. The kitchen and storage rooms on the east end have no heat if the indoor AHU is not running. Doors to the gym and storage areas must be left open to ensure no pipes freeze during cold spells.*
- *1974 Building installed furnaces with DX condensing units – residential type installation. Total of eight furnaces was installed in the early education classroom and office area. Furnaces appear to have been replaced in 1996. Condensing units are replaced as they fail.*
    - *Return air path in some areas appears to have been comprised in various floor plan remodels that have happened through the years. Future HVAC projects should examine and rectify these issues.*
    - *Return duct is underground in some places.*

    - *Ductwork is 40 years in service, replacement should be done in the next 0-5 years.*
- *1974 an indoor AHU with gas-fired duct furnace was installed for the Gym/Cafeteria.*
    - *Ductwork and AHU is 40 years in service, replacement should be done in the next 0-5 years.*
- *Annex has hot water heat from a small boiler that just serves the Annex. Heat is via UVs. Cooling is via ceiling mounted fan coils with condensing units on the east end at grade. Relief air for economizer mode is via barometric dampers under the high windows on the west side.*

AC Study: Fullana Learning Center

AIR CONDITIONING STRATEGIES

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
Fullana Learning Center-Headstart	24,109	No	$ 533,900	$ 720,765	$ 22.15	$ 29.90

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

- **Heat Pump Cooling**
  Heat pump systems are one of the most efficient systems available. Each individual heat pump can either reject or absorb heat from the atmosphere. As the gym is the only part of the building without cooling, and it is currently served by an AHU, a new central cooling system would not be very cost effective. Replacing the existing AHU with a new ASHP AHU is the best option for this school.
    - Pros:
        - Highly efficient
        - Resilient, comfortable
        - Allows for heat pumps to provide heat most of the year, lowering carbon emissions and providing fuel flexibility to react to changing utility costs
        - VUVs can either have electric backup heat or hydronic backup heat
        - Cooling will be provided
    - Cons:
        - Heat pump equipment has compressors, which can sometimes require additional maintenance
        - Heat pump units may be louder than other HW/CW hydronic systems
    - Implementation:
        - Replace existing gym AHU with new air-sourced heat pump AHU with remote condensing unit.

      - Route new condensate lines to nearest sink branch tailpiece or floor drain

- **Electrical Implications of AC Addition:**
    - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 1600A service is 214 Amps. There is capacity to add 10 tons of cooling load to the existing service.
    - 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.
- **Structural Implications:**
    - It is unlikely that replacing the AHU will trigger structural modifications.

Recommendations from 2015 Study

- *Install hot water heat, DX cooling indoor AHU in ceiling of Annex. VAV with 3 zones for each room. Create platform and access for unit. Patch UV outside air louvers and barometric relief damper openings in exterior wall.*
    - McKinstry Comment: After consulting with the facilities team, the only space requiring the addition of cooling is the Gymnasium. The annex is to be left as-is.

POUDRE SCHOOL DISTRICT

HARRIS BILINGUAL ELEMENTARY SCHOOL

AC STUDY

501 EAST ELIZABETH ST.

FORT COLLINS, CO 80524

JUNE 2023

Together, Building a Thriving Planet

McKinstry
For The Life Of Your Building

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AC Study: Harris Bilingual Elementary School

Harris Bilingual Elementary School AC Study

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AC Study: Harris Bilingual 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: Harris Bilingual Elementary School

BUILDING SUMMARY

General:

Harris Bilingual Elementary School is a two-story 38,599 square foot school located at 501 East Elizabeth Street, in Fort Collins, Colorado. Originally built in 1919, the building saw a major expansion in 2002; this 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: The building has no central cooling system. There are two RTUs with DX cooling that serve the Learning Lab, Kindergarten, and Admin. The computer lab is served by a residential furnace with a DX coil.

Heating: Heating is served by a central hot water plant with gas-fired boilers, piped throughout the building to baseboard heaters, cabinet unit heaters, AHUs and RTUs.

Ventilation: The ventilation system consists primarily of two AHUs, with some spaces served by RTUs including the Learning Lab, Kindergarten, and Admin.

Existing Electrical Systems:

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

Existing Structural Systems:

The initial building was constructed in 1919 with renovations completed in 1976 and 2001. The building consists of pipe columns and concrete shear walls that are supported by mild reinforced concrete spread and strip footings, respectively. The main floor is supported by a nominal concrete slab-on-grade. The roof framing consists of mostly open web steel trusses supporting 2" tongue and groove decking.

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 2002 a significant building addition was done. Areas of the original construction were also remodeled.*
    - *A packaged DX RTU provides cooling to the office lobby and the Learning Lab.*
    - *The ductwork from an existing packaged DX RTU installed in 1998 was reworked to serve Early Childhood, Principal and conference room.*
    - *A DX fan coil with a condensing unit was installed to serve the computer lab on the northeast corner of the lower level.*
    - *The addition is served by two air handlers. One is an ERV serving the classrooms, the other is a heating and ventilating only RTU serving the gym/cafeteria.*
    - *A make-up air unit and exhaust fan serves the kitchen.*
- *Drawing sets go back as far as 1962. Based on construction of the building, it is estimated that this building is much older. Data available from PSD indicates that 1919 is the original construction and additions were done in 1958, 1987 and the above noted 2002. 1919, 1958 and 1987 drawings are not available.*

- *Original construction part of the building on both levels is heated via baseboard radiation and ventilated via operable windows.*
- *A whole house fan type of fan is in the corridor of the main level for exhaust of hot air during warmer months and induction of fresh air through open windows*
- *The flex room on the interior of the original part of the building on the main level has no ventilation air.*
- *As mentioned above, a few spaces in this original construction part of the building, did receive AC units in 1998 and 2002.*

AC Study: Harris Bilingual Elementary School

AIR CONDITIONING STRATEGIES

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
Harris Billingual ES	38,599	No	$ 3,423,600	$ 4,621,860	$ 88.70	$ 119.74

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.

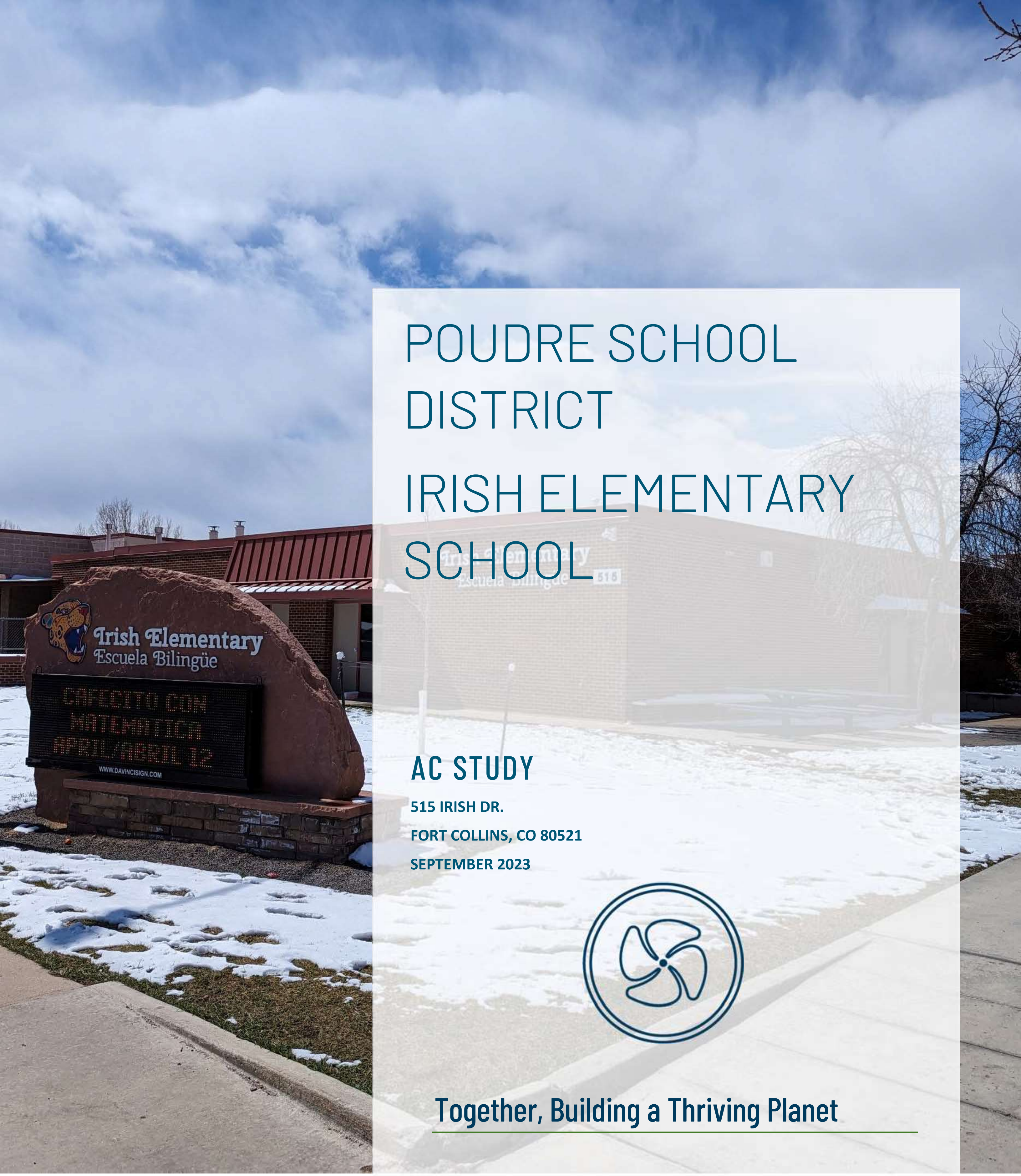
- **Heat Pump system**
  Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder 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 50-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
        - Existing boiler is slated for replacement this year
        - Replace all existing equipment with water-sourced heat pump equipment.
        - Install new heat pump VUVs in classrooms.
        - 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 new 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 1200A service is 316 Amps. There is capacity to add 50 tons of cooling load to the existing service.
    - 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.
- **Structural Implications:**
    - Rooftop equipment: The existing metal building joist 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

- *Remove RTUs installed in 2002 for addition and replace with chilled water VUVs for classrooms and RTU for cafeteria/gymnasium.*
    - McKinstry Comment: VUVs for classrooms are included.
- *Install VUVs in each room in the original construction part of the building.*
    - McKinstry Comment: Included.
- *Install a chiller and route chilled water to the new VUVs and RTUs.*
    - McKinstry Comment: Included, but as ASHP in lieu of CW.
- *Add an evaporative cooling section on to the intake of the make-up air/exhaust RTU installed for the kitchen in 2002.*
    - McKinstry Comment: New KMAU Included.
- *New controls system for the whole school.*
    - McKinstry Comment: Included.



POUDRE SCHOOL DISTRICT

IRISH ELEMENTARY SCHOOL

AC STUDY

515 IRISH DR.

FORT COLLINS, CO 80521

SEPTEMBER 2023

Together, Building a Thriving Planet

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AC Study: Irish Elementary School

Irish Elementary School AC Study

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AC Study: Irish 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: Irish Elementary School

BUILDING SUMMARY

General:

Irish Elementary School is a single-story 52,291 square foot school located at 515 Irish Drive, 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. 3 existing RTUs have DX cooling.

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 2004 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:

- *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.*
    - *A new RTU serving the 2006 southeast addition is air conditioning ready.*
    - *Heating water piping and boilers were installed in 1993 and were all reused in the 2014 HVAC updates.*
    - *A new RTU serves the media center area that was added in 1989. 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 gym 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.*
- *The RTU serving the gym is original from 1967. The gym is also used as the cafeteria. 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 gym/cafeteria*

AC Study: Irish Elementary School

AIR CONDITIONING STRATEGIES

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
Irish ES	52,291	Yes	$ 5,418,800	$ 7,315,380	$ 103.63	$ 139.90

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

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 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 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 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 1200A service is 455 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 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 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.

- *Install chiller and reuse chilled water piping installed in 2014 that is currently connected to the cooling tower.*
    - McKinstry Comment: Heat pump system suggested in lieu of CHW.
- *Rebalance chilled water flows at new RTUs installed in 2014.*
    - McKinstry Comment: TAB recommended at all pieces of equipment for a renovation of this magnitude.

AC Study: Irish Elementary School

- *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 gym/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: Included to replace with a new unit.
- *Packaged DX RTU for admin*
    - McKinstry Comment: Included, with ASHP in lieu of DX.
- *Kitchen makeup air unit with evaporative cooling.*
    - McKinstry Comment: Included.

board

POUDRE SCHOOL DISTRICT

JOHNSON ELEMENTARY

AC STUDY

4101 SENECA STREET

FORT COLLINS, CO 80526

SEPTEMBER 2023

Together, Building a Thriving Planet

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Johnson Elementary School AC Study

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AC Study: Johnson Elementary

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: Johnson Elementary

BUILDING SUMMARY

General:

Johnson Elementary is a single-story 56,396 square foot school located at 4101 Seneca Street, in Fort Collins, Colorado. Originally built in 1988, an addition to the building was constructed in 1994. In 2012, a Dedicated Outdoor Air System (DOAS) was installed to provide "tempered air" and 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: The building is served by a "tempered air" system, utilizing DOAS units on the roof with indirect evaporative cooling and energy wheels delivering 100% outside air to all classrooms. This system is not a formal cooling system. Two Rooftop Units (RTUs) serving the IT spaces have DX cooling.

Heating: Heating is served by a central hot water plant with gas-fired boilers, piped throughout the building to all heating equipment, including perimeter baseboard heating, Fan Coil Units (FCUs), AHUs, and DOAS units.

Ventilation: Ventilation for the building is provided by the DOAS units serving the classrooms via displacement ventilation diffusers and other interior spaces by FCUs, and AHUs serving the Gymnasium and Media Center.

Existing Electrical Systems:

The building has an existing 600 amp, 208Y/120V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1988 with a renovation completed in 1994 and 2012. The building consists of 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 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:

- *2012 HVAC improvements installed a "tempered air" system utilizing indirect evaporative cooling Dedicated Outside Air Systems (DOAS)*
    - *This strategy is to deliver outside air into the classrooms that is approximately 14 degrees cooler than the outside air temperature during the warmer parts of the year. For instance – at 85 degrees outside, the air delivered to the classroom is 71 degrees.*
    - *Air quantities and fan speed are varied depending on the mode that the air handler is in.*
        - *In heating mode the goal is to deliver 300 cfm per classroom, slightly over Code required ventilation air*
        - *In tempering mode the goal is to deliver 600 cfm per classroom*
    - *Air is delivered into the classrooms via floor displacement ventilation diffusers. The strategy is to deliver the air down in the occupant zone in lieu of overhead at the ceiling*

  - *No zoning for individual classrooms is provided. They all receive the same quantity and temperature of air.*
  - *Return grilles were not observed in the classrooms. Most likely the space between the ceiling and exposed roof joists was determined to be enough free area for return air to get back to the RTU.*
  - *Fan coil units that provide heating and ventilation only were installed in corridor, work areas and office areas. PSD staff has added economizers to the fan coils in the administration area to increase outside air quantities for warmer times of the year.*
- *Four classrooms were added to the west part of the building in 1994. These are now served by the 2012 DOAS system.*
- *Heating water piping and boilers were installed in 1988 and were all reused in the 2012 HVAC updates. Heat is provided by baseboard radiation at the exterior walls, which was installed in 2012.*
- *A packaged DX RTU installed by PSD serves the computer lab. Replacement should be anticipated in the next 5-7 years.*
- *The cafeteria is heated and ventilated via 4 ceiling mounted unit ventilators installed in 1988.*
- *Media Center is provided with heating and ventilation by an indoor AHU installed in 1988.*
- *The AHU serving the gym is original from 1988. This unit should be replaced in the next 10-15 years.*
- *Kitchen make-up air unit and evaporative cooler was replaced in 2012.*

AC Study: Johnson Elementary

AIR CONDITIONING STRATEGIES

Contextual Narrative

The existing DOAS "tempered air" system is unfortunately not compatible with a simple solution for implementing AC. The existing DOAS units have space for future cooling coils, but they are not sized adequately to provide full cooling to the building – only lowering the supply air to approximately 65 degrees. The DOAS displacement ventilation strategy is incompatible with discharge air temperatures lower than 65 degrees, which creates a further barrier to AC implementation using primarily the DOAS system. While the additional cooling would not be enough to fully cool the spaces, it would make the spaces more comfortable – however, an electric upgrade would be required to install the additional cooling coils, which would be a significant cost. Because this upgrade would be expensive, and would not achieve full air conditioning, this option has not been recommended.

The original 2015 study recommended a VAV reheat system as a possible strategy. We do not agree with this recommendation. VAV reheat systems, while popular in the past, are not particularly efficient when compared to newer systems. Energy is spent both in cooling down the main supply air, and then spent again to reheat the air in zones that are not in cooling mode. Our proposed option is a more efficient system, as each zone is able to condition independently without reheating.

In our recommended system, a new DOAS system is still utilized, with new VUV equipment replacing the displacement ventilators. Tonnage estimation was done using industry best practices, but it is likely that tonnage will decrease during the design phase when full load calculations are performed.

AC Study: Johnson Elementary

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
Johnson ES	56,396	Yes	$ 4,779,700	$ 6,452,595	$ 84.75	$ 114.42

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 110-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 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 displacement ventilators with new heat pump VUVs.
            - Replace existing DOAS units with heat pump units. Connect existing outside air from DOAS to the new VUVs
            - Replace existing RTUs with new heat pump RTUs
            - Replace existing FCUs with new horizontal heat pumps
            - Replace existing heating-only AHUs with new heat pump AHUs
        - 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 600A service is 353 Amps. There is capacity to add cooling loads to the existing service but adding 110 tons of cooling would require a service upgrade to 1600 or 2000 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, 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 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.

- *Remove RTUs installed in 2012.*
    - McKinstry Comment: We have recommended a solution to replace the existing DOAS units in order to minimize changes to the existing system where possible. Our solution utilizes the existing ductwork to provide outside air to the classrooms, but relies on a different system for space conditioning.
- *Install new RTUs capable of delivering 1,000 to 1,500 cfm per classroom.*
    - McKinstry Comment: Refer to previous comment.
- *Reuse supply duct installed in 2012 to the greatest extent possible and install VAV boxes to provide airflow zone control at each classroom, corridor and work areas.*
    - McKinstry Comment: Refer to previous comment.
- *Install new return air duct main to new RTUs. Utilize plenum return from each classroom*
    - McKinstry Comment: Refer to previous comment.
- *Install chiller and route chilled water piping to new RTUs.*
    - McKinstry Comment: We have proposed a heat pump solution in lieu of CHW.
- *Install chilled water coil in existing duct main serving the media center.*

  - McKinstry Comment: We suggest replacing the main system rather than installing a cooling coil in the existing ductwork, as there are other spaces attached to the main system that would benefit from cooling.
- *Install new RTUs for the cafeteria and route chilled water to the new RTU.*
  - McKinstry Comment: We have proposed a heat pump solution in lieu of CHW
- *Install new packaged DX RTUs for the administration areas.*
  - McKinstry Comment: Included, with ASHP RTUs in lieu of DX.

POUDRE SCHOOL DISTRICT

KRUSE ELEMENTARY SCHOOL

AC STUDY

4400 MCMURRAY AVE.

FORT COLLINS, CO 80525

SEPTEMBER 2023

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Kruse Elementary School AC Study

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AC Study: Kruse 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: Kruse Elementary School

BUILDING SUMMARY

General:

Kruse Elementary School is a single-story 51,384 square foot school located at 4400 McMurray Ave. in Fort Collins, Colorado. Originally built in 1992, it had a major renovation in 2014 to implement a "tempered air" system. Building history 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: 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. Two Rooftop Units (RTUs) have DX cooling – RTU-1 serving the IT room and RTU-2 serving the 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 Vertical Unit Ventilators (VUVs) serving the classrooms, with some spaces served by RTUs including the Data Room, Flex Room, and Media Center.

Existing Electrical Systems:

The building has an existing 600 amp, 208Y/120V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1992 with a renovation completed in 2016. The building consists of 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 open web steel trusses supporting corrugated metal deck. Per the original structural drawings, the roof framing was originally designed for nominal 15 psf dead load.

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 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.

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 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 and orientation (east, west, north, south)*
  - *Air is delivered into the classrooms via exposed spiral ductwork up high with sidewall diffusers. Air quantity varies between 50 and 100% based on how much heat or cooling the room requires.*
  - *Zoning per individual classrooms is provided.*
  - *Fan coil units that also receive cool water from the tower were installed in corridor, work areas, cafeteria and office areas.*
  - *New pumps and piping to work with the 2-pipe system for heating and cooling were installed.*
- *2014 HVAC updates also included new packaged DX RTUs for the computer lab and Comm Data rooms.*
- *A new kitchen make-up air unit with evaporative cooling was also installed in 2014.*
- *1992 was the original construction of the building.*
  - *Media Center is provided with heating and ventilation by an indoor AHU installed in 1992. This unit should be replaced in the next 10-15 years.*
  - *The AHU serving the gym is original from 1992. This unit should be replaced in the next 10-15 years.*
  - *Boilers should be anticipated to be replaced in 15-20 years.*

AC Study: Kruse Elementary School

AIR CONDITIONING STRATEGIES

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
Kruse ES	51,384	Yes	$ 5,113,900	$ 6,903,765	$ 99.52	$ 134.36

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. It was noted during interviews with District facilities staff that the boilers are at the end of their useful life. With the heat pump system, the boiler would only need to run as emergency backup, most likely less than 1% of the year.
    - 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 100-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.
        - Demo existing cooling tower.
        - Replace all existing equipment with water-sourced heat pump equipment
            - All VUVs, 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).
- **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 369 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 or 2000 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.
- **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 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

- *Install a chiller and connect to existing piping.*
  - McKinstry Comment: Heat pump system suggested in lieu of chilled water
- *Install a cooling coil in the supply duct main for the Media Center.*
  - McKinstry Comment: We suggest replacing the main system rather than installing a cooling coil in the existing ductwork, as there are other spaces attached to the main system that would benefit from cooling.
- *Packaged DX RTU for admin.*
  - McKinstry Comment: Included but with an ASHP RTU instead of DX to allow for heat pump heating.