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Aurora Village

Energy Outreach Colorado Multifamily Audits

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TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

Group14 has completed an energy audit of Aurora Village, a site consisting of two apartment buildings built in 1982 which are each approximately 39,500 sq. ft. The three-story, wood frame apartment buildings consist of 100 total dwelling units, with a community room on the first floor of each building. Other common area spaces that are included in each building are a laundry room, meeting room, boiler room, and storage areas.

Aurora Village has hydronic baseboard heating controlled by in-unit, non-programmable thermostats with heating provided by a central boiler in each building. PTACs in each unit provide cooling utilizing integrated controls. In-unit ventilation is provided by bathroom exhaust fans, and operable windows.

Building and utility data were compiled and entered into DOE-2 modeling software.

Fuel	Annual Use	Annual Cost
Electric (kWh)		$
Gas (Therms)		$
	Total	**$**

Table 1 - Historical Energy Use Summary

Building envelope, HVAC, lighting, potable water, and control systems were analyzed for opportunities to improve efficiency and address health and safety issues. Specific details of savings calculations will be provided in subsequent reports.

The Energy Efficiency Measures (EEM) that were determined to meet Department of Energy (DOE) criteria for Weatherization Assistance Program (WAP) funding are presented in the table below:

Energy Efficiency Measure	1st Year Savings	SIR
In-Unit Lighting Improvements	TBD	TBD
Common Area Lighting Improvements	TBD	TBD
Exterior Lighting Improvements	TBD	TBD
Space Heating Boiler Upgrade	TBD	TBD
Domestic Hot Water Upgrade	TBD	TBD
Programmable Thermostats	TBD	TBD
Hot Water Pipe Insulation	TBD	TBD
High Efficiency Water Fixtures	TBD	TBD
Refrigerator Upgrade	TBD	TBD
Increase Attic Insulation	TBD	TBD
Install Solar PV	TBD	TBD
Package	**TBD**	**TBD**

Table 2 - EEM Summary

EEMs that were determined not to meet DOE WAP criteria are not recommended at this time:

Energy Efficiency Measure	1st Year Savings	SIR
Window Replacement	N/A	N/A

Table 3 - Measures Not Recommended

All energy efficiency measures are detailed in the DOE-2 model outputs (Appendix C) and Scope of Work Specifications (Appendix A).

In addition to the EEMs presented above, four health and safety measures were documented.

Existing Condition	Health and Safety Measure
Bathroom exhaust flow rates are below the code minimum.	Clean exhaust ducting and/or install new exhaust fans where necessary to meet ventilation requirements.
No Carbon Monoxide detectors are present in the units.	Install hardwired combination smoke and CO alarms in each unit.
The air handler in the community room of Building A is unable to provide ventilation during the winter months.	Repair the hot water heating coil of the air handling unit to provide ventilation to the community room throughout the year.

Table 4 - Health and Safety Measures

The existing building conditions of Aurora Village are documented in this report. Note that all existing equipment types, quantities, and costs listed in this report are for the purposes of this analysis and should not be used as a basis for contractor bids or construction estimates.

2 EXISTING BUILDING CONDITIONS

2.1 Building Description

Square Footage	39,500 ea.	**Lot Description**	Level suburban lot with two apartment buildings surrounded by other multi-family buildings. Parking in between the buildings.
Building(s)	2	**Unit Description**	**Building A (15972):** (49) 1-Bedroom units **Building B (15870):** (51) 1-Bedroom units
Stories	3	**Common Spaces**	Community room, common laundry, meeting room, storage, and boiler room in each building.

Table 5 - Building Description

The Google Earth image below provides an overhead view of the site.

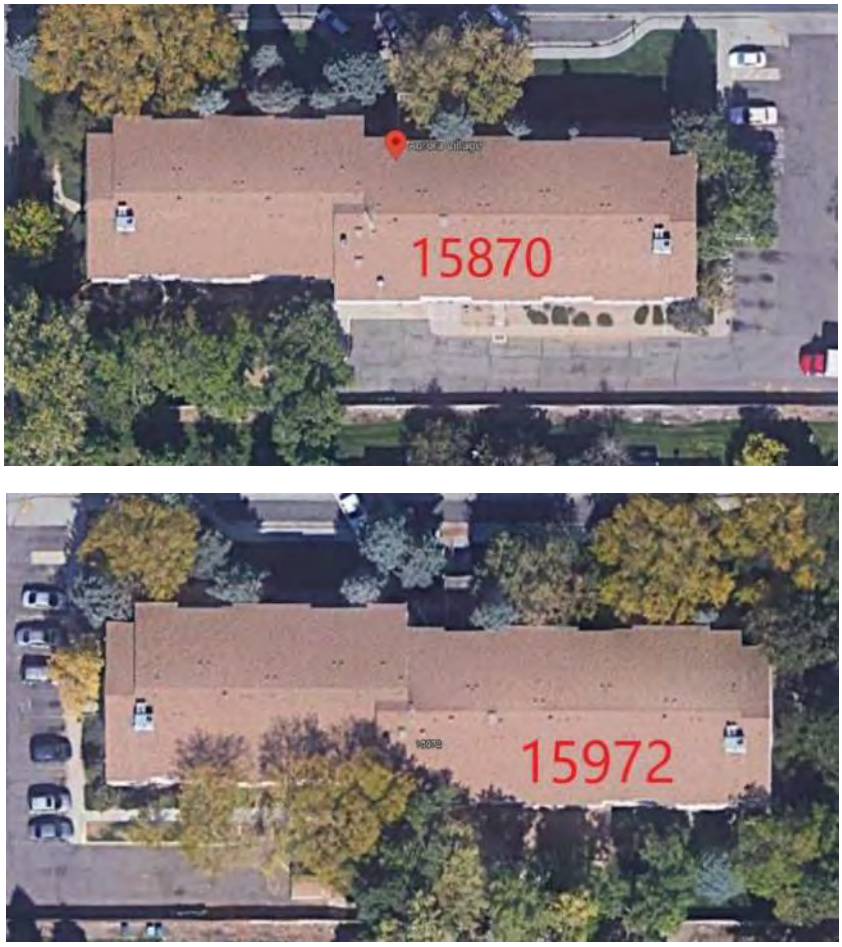


Figure 1 - Overhead view of Aurora Village in Aurora, CO. Buildings B (15870) and A (15972) were subject to this audit.

2.2 Building Envelope

The Aurora Village building consists of two low-rise style apartment buildings. The units are accessed through interior stairwells or elevators. The 15972 and 15870 buildings are almost identical with only minor differences in the number of units and size of the community rooms in each building.

The buildings are slab on grade with no crawl spaces. They have pitched asphalt shingle roofs that use soffit and ridge venting for the attic spaces. Blown cellulose insulation on top of batt fiberglass insulation was observed at the ceiling plane in the attic. The total value of the insulation in the attic was estimated to be R-23 based on average depth measurements. Each side of each building has an attic access hatch located in the center of the corridor on the upper level. Double pane vinyl frame windows with standard glazing were observed.

Images of the main east, north, south, and west facades of each building are presented below.

15972 E 13th Place (Building A)

Figure 2 - East Facade

Figure 3 - West Facade

Figure 4 - Partial South Facade

Figure 5 - Partial North Facade

15870 E 13th Place (Building B)	
 *Figure 6 - East Facade*	 *Figure 7 - West Facade*
 *Figure 8 - Partial South Facade*	 *Figure 9 - Partial North Facade*

2.2.1 Wall Insulation

Exterior walls consist of 2x4 wood framing with 3.5” of fiberglass insulation and 1” exterior rigid insulation. There is a plastic vapor barrier on the interior wall surface beneath the drywall. Exterior cladding is a mix of vinyl siding and brick depending on the floor. The first floor has brick, and the rest of the floors have vinyl siding.

Wall cavity and insulation depths were measured on site in each cardinal direction of Building A:

Building A			
Orientation	**Cavity**	**Insulation**	**Location**
South	3.5”	3.5” Batt + 1” EPS	Boiler Room
North	3.5”	3.5” Batt + 1” EPS	Managers Office
West	3.5”	3.5” Batt + 1” EPS	Mech Corridor
East	5”	5” Batt + 1” EPS	Community Room

Table 6 - Insulation Data

Figure 10 - 3.5" depth batt insulation in Managers Office

Figure 11 - 3.5” Batt insulation in Manager Office

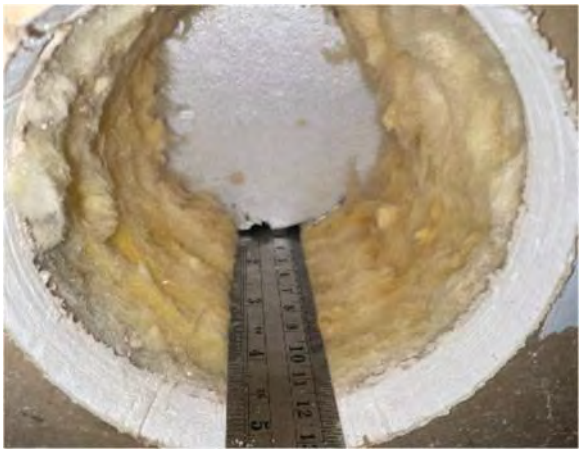


Figure 12 – 3.5” depth batt insulation and 1” expanded polystyrene in Boiler Room

Figure 13 – 3.5” Batt insulation in Boiler Room

2.2.2 Thermal Boundary

In the figures below, the redlines denote the boundaries of the conditioned space of the building. The stairwells are outside the thermal boundary. There are small bump-outs along the north and south faces of the buildings, but otherwise the thermal boundary is uniform.

Figure 14 – Typical End Thermal Boundary

Figure 15 – Typical North/South Side Thermal Boundary

2.2.3 Health and Safety Inspection

A visual inspection was conducted in 100% of the units at Aurora Village for health and safety concerns. A signed health and safety inspection form can be found in Appendix F. There were no issues to report.

2.3 Lighting

2.3.1 Common Area Lighting

Common area space in each building at Aurora Village consists of a community room, stairwells, common laundry, meeting room, storage spaces, and corridors. Many of the fixtures have been upgraded to LED fixtures, but there are still some incandescent and fluorescent bulbs in place.

2.3.2 Exterior Lighting

Exterior site lighting is provided mostly by LEDs with some incandescent fixtures. The exterior fixtures are controlled on dawn/dusk photosensors. A combination of pole-mounted lights, bollard lights, wall mounted fixtures, and canopy lights are used along the exterior.

2.3.3 In-Unit Lighting

Residential units have a mostly uniform lighting configuration, and many units have incandescent or CFL bulbs remaining, with about half of the fixtures upgraded to LED. A few units have ceiling fans installed in place of surface fixtures, which is reflected in the inventory below.

A full lighting inventory of the buildings is included below in **Table 8**.

Lighting Inventory							
Tag	**Fixture Type**	**Lamp / Ballast Type**	**Lamps per Fixture**	**Fixtures**	**Lamp Wattage**	**Area Served**	**Replace ?**
COMMON AREA LIGHTING (BUILDING A)							
T12-1	Wall Mount Strip	T12 / Electronic	1	1	40	Community Room	Y
T12-2	Ceiling Mount Strip	T12 / Electronic	2	1	40	Community Room	Y
T12-2	Strip Light	T12 / Electronic	2	2	40	Shed	Y
ISB	Surface Mount Screw Base	Screw-Base Incandescent	1	1	60	Storage Room	Y
LSB-1	Surface Mount Screw Base	LED	1	8	9	Storage / Garbage Rooms	N
LSB-C	Can Light	LED	1	28	8.5	Lobby / Elevator Lobbies	N
LSB-R	Surface Mount Round	LED	1	51	9	Hallways	N
LST	Strip Light	LED	1	16	40	Restrooms / Elevator / Stairs	N
LWR	Ceiling Mount Wrap	LED	1	25	50	Community Room / Laundry / Meeting Room	N
COMMON AREA LIGHTING (BUILDING B)							
T12-2	Ceiling Mount Strip	T12 / Electronic	2	2	40	Elevator / Maintenance Rooms	Y
FSB	Can Light	2 Pin CFL	1	1	18	Elevator Lobby – Floor 2	Y
ISB	Surface Mount Screw Base	Screw-Base Incandescent	1	3	60	Maintenance / Stroage Rooms	Y
LSB-1	Surface Mount Screw Base	LED	1	3	9	Garbage Rooms	N
LSB-2	Surface Mount Screw Base	LED	2	1	9	Boiler Room	N
LSB-C	Can Light	LED	1	24	8.5	Lobby	N
LSB-R	Surface Mount Round	LED	1	52	9	Hallways	N
LST	Strip Light	LED	1	14	40	Restrooms / Elevator / Stairs	N
LWR	Ceiling Mount Wrap	LED	1	12	50	Community Room / Laundry / Meeting Room	N
EXTERIOR LIGHTING (BUILDING A)							

Lighting Inventory							
IBL	Bollard Light	Incandescent	1	6	60	Exterior Walkway	Y
LSM-1	Surface Mount Round	LED	1	3	9	Front Canopy	N
LSM-1	Surface Mount Round	LED	1	2	9	Exterior Exits	N
LSM-2	Surface Mount Round	LED	1	4	9	Rear Canopy	N
LSM-3	Surface Mount Round	LED	1	1	9	Rear Canopy	N
LMWP	Mini Wall Pack	LED	1	6	20	Exterior Walls	N
LMWP	Mini Wall Pack	LED	1	1	20	Shed Exterior	N
LWP	Wall Pack	LED	1	2	120	Exterior Walls	N
LSB	Screw Base Mount	LED	1	1	9	Pavilion	N
LPL	Dual Head Pole Mount	LED	1	1	200	Parking Lot	N
LSC	Wall Mount Sconce	LED	1	1	9	Shed Exterior	N
EXTERIOR LIGHTING (BUILDING B)							
IBL	Bollard Light	Incandescent	1	3	60	Exterior Walkway	Y
LSM-1	Surface Mount Round	LED	1	3	9	Front Canopy	N
LSM-1	Surface Mount Round	LED	1	2	9	Exterior Exits	N
LMWP	Mini Wall Pack	LED	1	5	20	Exterior Walls	N
LWP	Wall Pack	LED	1	2	120	Exterior Walls	N
IN-UNIT LIGHTING (BUILDING A)							
BB	Range Hood	Screw-Base Incandescent	1	49	40	Kitchen	Y
CC	Vanity	Screw-Base Incandescent	1	12	60	Bathroom	Y
DD	Round Surface Mount	Screw-Base Incandescent	1	55	60	Kitchen / Hall	Y
EE	Round Surface Mount	Screw-Base Incandescent	2	28	60	Living Room / Kitchen	Y
FF	Ceiling Fan	Candelabra Incandescent	3	10	25	Living Room	Y
GG	Vanity	Screw-Base Incandescent	2	12	38	Bathroom	Y
HH	Round Surface Mount	Screw-Base Incandescent	1	20	38	Kitchen	Y

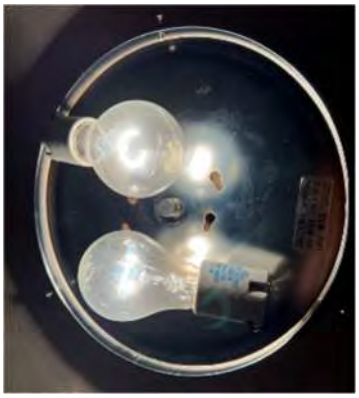
Lighting Inventory							
KK	Round Surface Mount	Screw-Base CFL	1	16	13	Hall	Y
LL	Vanity	LED	2	25	9	Bathroom	N
NN	Round Surface Mount	LED	2	10	9	Living Room	N
OO	Round Surface Mount	LED	1	30	9	Hall / Living Room / Kitchen	N
QQ	Ceiling Fan	LED	3	10	9	Living Room	N
RR	Pendent	LED	3	17	9	Hall	N
SS	Recessed Screw Mount	LED	1	49	9	Closet	N
IN-UNIT LIGHTING (BUILDING B)							
AA	Recessed Screw Mount	Screw-Base Incandescent	1	20	60	Closet	Y
BB	Range Hood	Screw-Base Incandescent	1	17	40	Kitchen	Y
CC	Vaity	Screw-Base Incandescent	1	10	60	Bathroom	Y
DD	Round Surface Mount	Screw-Base Incandescent	1	19	60	Kitchen / Hall	Y
EE	Round Surface Mount	Screw-Base Incandescent	2	9	60	Living Room / Kitchen	Y
II	Vaity	Screw-Base CFL	2	10	13	Bathroom	Y
JJ	Range Hood	Screw-Base CFL	1	17	13	Kitchen	Y
KK	Round Surface Mount	Screw-Base CFL	1	21	13	Hall	Y
LL	Vanity	LED	2	21	9	Bathroom	N
MM	Vanity	LED	1	10	9	Bathroom	N
NN	Round Surface Mount	LED	2	97	9	Hall / Living Room / Kitchen	N
OO	Round Surface Mount	LED	1	29	9	Hall / Living Room / Kitchen	N
PP	Round Surface Mount	LED	1	29	16	Living Room / Kitchen	N
SS	Recessed Screw Mount	LED	1	31	9	Closet	N
TT	Range Hood	LED	1	17	9	Kitchen	N

Table 7 – Lighting Inventory

A Sample of lighting photos for the building are presented below. Additional fixture photos may be found in Appendix E.

Common Area Lighting	
 *Figure 16 – Fluorescent Ceiling Mount Strip (T12-2)*	 *Figure 17 – LED Strip Light (LST)*
 *Figure 18 – LED Ceiling Mount Wrap (LWR)*	 *Figure 19 – Surface Mount Round Fixture (LSB-R)*

Exterior Lighting	
 *Figure 20 – Incandescent Bollard Light (IBL)*	 *Figure 21 – LED Parking Lot Light (LPL)*
 *Figure 22 – LED Surface Mount Canopy (LSM-1)*	 *Figure 23 – LED Mini Wall Pack (LMWP)*

In-Unit Lighting	
 *Figure 24 – Incandescent Surface Mount Round (EE)*	 *Figure 25 – LED Surface Mount Round (PP)*

In-Unit Lighting	
 *Figure 26 – Incandescent Vanity (CC)*	 *Figure 27 – LED Surface Mount Round (NN)*

2.4 Major Mechanical Systems & Controls

2.4.1 Central Heating Plant

Central Heating: Each building is heated by four natural draft boilers delivering hot water to baseboard registers in units. The four boilers are a part of a modular boiler plant with a total input capacity of 1,200 MBH. For further mechanical details, please see **Table 9** below and **Table 11** Mechanical Inventory on the following pages.

Space Heating Boiler Plant – Building A			
Boiler Information		Pump Information (x2)	
Manufacturer	HydroTherm	Manufacturer	Grundfos
Model	MR-1200B	Model	UPS 50-160F
Input Capacity (MBH):	1,200	Volume	Constant
Output Capacity (MBH):	960	HP	1.75
Fluid Type:	Water		
Operating Setpoint	180F		
Space Heating Boiler Plant – Building B			
Boiler Information		Pump Information (x2)	
Manufacturer	HydroTherm	Manufacturer	Grundfos
Model	MR-1200B	Model	UPS 50-160F
Input Capacity (MBH):	1,200	Volume	Constant
Output Capacity (MBH):	960	HP	1.75
Fluid Type:	Water		
Operating Setpoint	180F		

Table 8 - Space Heating Boiler and Pump Details

The boiler plant for each building operates in a constant primary configuration with analog controls that determine the system heating water temperature. Digital controls were present but not operational during the time of the audit. The boiler plants are each equipped with a warm weather shutdown which was set to 75F. Each system has two constant speed pumps plumbed in parallel supplying space heating water throughout the building.

Combustion analysis was performed in each building on the space heating boilers and the domestic hot water boiler in the mechanical room (see section 2.5).

2.4.2 In Unit Heating, Cooling, and Ventilation

In-Unit Heating and Cooling: Each unit at Aurora Village has hydronic baseboard heating controlled by an electronic, two-way zone valve and non-programmable analog thermostat. Each unit also has a packaged terminal air conditioner (PTAC) that is utilized for cooling and controlled by integrated controls.

In-Unit Ventilation: In addition to operable windows there are bath exhaust fans that provide ventilation and are ducted to the outside.

2.4.3 Common Area Heating, Cooling, and Ventilation

Common Area Heating: Common area heating in each building is primarily served by two roof top units (RTUs) providing gas-fried forced-air heating to the corridors. Heating in the corridors is supplemented by runs of hydronic baseboard that are near the stairwells. The community room and lobby of each building has heating provided by packaged terminal heat pumps (PTHPs) that have their outside air dampers open.

Common Area Cooling: Common area cooling in each building is primarily served by two roof top units (RTUs) providing DX forced-air cooling to the corridors. Cooling in both lobbies and the community room of Building B is provided by PTHPs. Cooling in the community room of Building A is provided by an air handler with DX cooling that is equipped with an outdoor air intake. The condensing unit serving the air handler has an 11 EER efficiency rating.

Common Area Ventilation: Common area ventilation is provided by two RTUs per building that are equipped with outdoor air intakes. Ventilation is also provided in the lobby and community rooms by the air handler and PTHPs that serve those spaces.

2.4.4 Domestic Hot Water

Domestic hot water for each building is provided by a single gas-fired boiler connected to two 115-gallon DHW storage tanks. The piping for the domestic hot water system is mostly uninsulated. The DHW boiler delivers water to the storage tanks using the boiler aquastat and it is set at 175F in Building A and 180F in Building B. A dedicated 1/2 HP pump supplies boiler water through the storage tanks to the boiler, and the pump is controlled by the tank aquastat which was set to 130F in Building A and 155F in Building B.

There is a thermostatic mixing valve in place on the outlet of the storage tanks. The DHW outlet was observed to be at 150F for Building A and 130F for Building B. There is a 1/8 HP circulation pump that was visible in each mechanical room.

For further mechanical details, please see **Table 10** below and **Table 11** Mechanical Inventory.

Domestic Hot Water System - Bldg A		
	DHW Boiler	DHW Storage
Type:	Non-Condensing	Storage
Manuf.:	Raypak	Raypak
Model:	WH1-0724A	RSS115A-5
Eff.:	82%	-
Capacity:	726 MBH	115 Gal
Setpoint:	175F	130F
Pumps:		
Manuf:	Grundfos	Grundfos
Model:	UPS 43-100SF	UPS 15-55SFC
Controls:	Continuous	Continuous
Domestic Hot Water System - Bldg B		
	DHW Boiler	DHW Storage
Type:	Non-Condensing	Storage
Manuf.:	Raypak	Raypak
Model:	WH1-0724	RSS115A-5
Eff.:	82%	-
Capacity:	726 MBH	115 Gal
Setpoint:	180F	155F
Pumps:		
Manuf:	Grundfos	Grundfos
Model:	UPS 43-100SF	()
Controls:	Continuous	Continuous

Table 9 - DHW Equipment Details

2.4.5 Mechanical Inventory

Mechanical Inventory					
Tag	**Service**	**Make**	**Model #**	**Capacity / Setpoint**	**Age**
B-1	Space Heat - Bldg A	HydroTherm	MR-1200B	1,200 MBH / 180F	1982
B-2	Space Heat - Bldg B	HydroTherm	MR-1200B	1,200 MBH / 180F	1982
B-3	DHW - Bldg A	Raypak	WH1-0724A	726 MBH / 175F	2015
B-4	DHW - Bldg B	Raypak	WH1-0724	726 MBH / 180F	2011
ST-1, 2	DHW Storage - Bldg A	Raypak	RSS115A-5	115 Gal	2015

Mechanical Inventory					
ST-3, 4	DHW Storage - Bldg B	Raypak	RSS115A-5	115 Gal	2012 / 2016
P-1, 2	Space Heat (B-1) - Bldg A	Grundfos	UPS 50-160F	1.75 HP	
P-3, 4	Space Heat (B-2) - Bldg B	Grundfos	UPS 50-160F	1.75 HP	2006 / 2013
P-5	DHW (B-3) - Bldg A	Grundfos	UPS 43-100SF	1/2 HP	2023
P-6	DHW (B-4) - Bldg B	Grundfos	UPS 43-100SF	1/2 HP	2022
P-7	DHW Recirculation - Bldg A	Grundfos	UPS 15-55SFC	1/8 HP	2021
P-8	DHW Recirculation - Bldg B	Grundfos	UPS 20-80BYC	1/8 HP	
AHU-1	Community Room Cooling - Bldg A				2002
CU-1	Community Room - Bldg A	Carrier	38ARZ008---501CA	7 Ton / 11 EER	2002
MAU-1, 2	Ventilation - Bldg A				
MAU-3, 4	Ventilation - Bldg B				
UH-1	Boiler Room Heating - Bldg A	AAF	TAYU-1031		
PTHP-1	Lobby Conditioning	Amana	PTC123G35A		2017
PTHP-2	Lobby Conditioning	Remington	PTAC-12B-208		2017

Table 10 - Mechanical Equipment Inventory

Photos of the major mechanical equipment are shown below. Additional photos are included in Appendix E (separate file).

Building A - Space Heating

Figure 28 - Space Heating Boiler Plant (B-1)

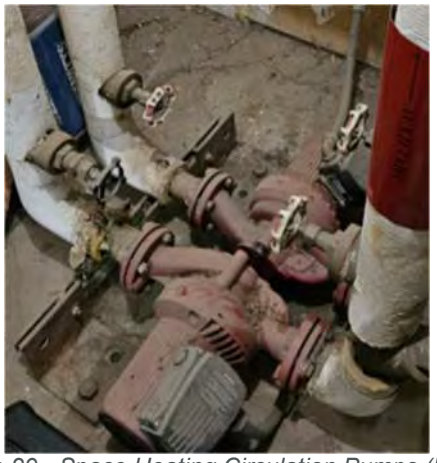


Figure 29 - Space Heating Circulation Pumps (P-1,2)

Building A – Domestic Hot Water

Figure 30 - DHW Boiler (B-3)

Figure 31 - DHW Circulation Pump (P-5)

Figure 32 - DHW Storage Tanks (ST-1,2)

Figure 33 - DHW Recirculation Pump (P-7)

Building B - Space Heating

Figure 34 - Space Heating Boiler Plant (B-2)

Figure 35 - Space Heating Circulation Pumps (P-3,4)

Building B – Domestic Hot Water

Figure 36 - DHW Boiler (B-4)

Figure 37 - DHW Circulation Pump (P-6)

Figure 38 - DHW Storage Tanks (ST-3,4)

Figure 39 - DHW Recirculation Pump (P-8)

Typical In-Unit Equipment (Building A & B)

Figure 40 - Original In-Unit PTAC

Figure 41 - Typical In-Unit PTAC Controls

Figure 42 - Updated In-Unit PTAC

Figure 43 - Updated In-Unit PTAC Controls

2.4.6 Equipment Testing and Records

Combustion gas analysis was completed on all gas appliances. Full results of the combustion analysis of all equipment are provided in Appendix D.

Service	Space	Equipment	Combustion Efficiency	Serial Number
Space Heating	Building A	B-1 (1)	84.6%	MNJ-2595
		B-1 (2)	85.2%	
		B-1 (3)	84.3%	
		B-1 (4)	84.0%	
	Building B	B-2 (1)	84.2%	MNJ-2594
		B-2 (2)	83.5%	
		B-2 (3)		
		B-2 (4)	83.0%	
DHW	Building A	B-3	86.6%	1506401375
	Building B	B-4	85.9%	1112332577

Table 11 - Mechanical System Combustion Testing Data

Combustion zone safety testing was completed on all gas appliances in the table above located in the mechanical room of each building. There were no issues to note.

Additionally, exhaust fan testing was performed in 100% of accessible units during the audit. Almost all of the exhaust fan terminals were drawing less than 50 cfm, the code minimum bathroom exhaust airflow for intermittent operation. A full listing of results can be found in Appendix D.

2.5 Building Energy Modeling

An energy model of the building was created using DOE approved DOE-2 software. Details of the energy model inputs and assumptions are summarized in this section.

2.5.1 Envelope Energy Modeling

The table below summarizes the previously discussed information that will be used in the energy modeling for each building at Aurora Village. Additional modeling details will be included in the final report.

Component	Description	R-Value / U-Value
Attic / Roof	3” Blown Cellulose and 4” Batt Fiberglass Insulation	R-23
Exterior Walls	3.5” Fiberglass Batt and 1” EPS	R-20
Double-Pane Windows	Vinyl Frame, Standard Glazing	U-0.40

Table 12 – Energy Modeling Information

2.5.2 Major HVAC Equipment Modeling

Boiler plant efficiency was based on combustion efficiency shown in Section 2.4.5 as well as total system performance adjusted to calibrate energy models to actual utility consumption. Building A was modeled at XX% plant efficiency and Building B was modeled at XX% plant efficiency.

Internal distribution piping is likely uninsulated, and continuous operation of the constant speed pumps likely increased system losses.

2.5.3 Thermostat Setpoints

Thermostat settings were not programmable and varied substantially from unit to unit. As a result, modeled space temperatures were set to typical temperatures with some minor adjustments made during calibration of the model to actual utility consumption.

3 RECOMMENDED ENERGY EFFICIENCY MEASURES

A short narrative of each EEM that meets DOE WAP funding criteria is provided below. More detailed guidance for measure implementation is included in the bid specifications (Appendix A).

3.1 In-Unit Lighting Retrofit

Existing Condition:

Most fixtures in dwelling units have a standard screw in base. About half of the fixtures use upgraded LED bulbs with the rest being incandescent or CFL.

Retrofit Incandescent and CFL Bulbs to LEDs:

The replacement of all hardwired screw-in incandescent and CFL fixtures with LED lamps has been evaluated. It is recommended to replace bulbs in all screw-in fixtures with incandescent and CFL bulbs with an LED.

Estimated bulb replacements per building are shown in the table below:

Space	Lighting Inventory Tag	Fixture Type	Replacement Fixture	Replacement Fixture Code	Estimated Replacements
Building A	BB, CC, DD, EE, GG & HH	Screw-Base Incandescent	9.5W LED Bulb	L1-b	216
Building A	KK	Screw-Base CFL	9.5W LED Bulb	L1-b	16
Building A	FF	Candelabra Incandescent	5 W LED Bulb	L5-a	30
Building B	AA, BB, CC, DD & EE	Screw-Base Incandescent	9.5W LED Bulb	L1-b	84
Building B	II, JJ & KK	Screw-Base CFL	9.5W LED Bulb	L1-b	58

Table 13 - In Unit Lighting Replacements

Predicted Savings - Building A:	**$TBD**	**SIR:**	**TBD**
Predicted Savings - Building B:	**$TBD**	**SIR:**	**TBD**

3.2 Common Area Lighting Improvements

Existing Condition:

Most fixtures in common areas have been upgraded to LED bulbs or fixtures. There are still a few incandescent and fluorescent fixtures that remain in the spaces.

3.2.1 Replace Linear Fluorescent Fixtures

The replacement of all hardwired linear fluorescent fixtures with LED fixtures has been evaluated. It is recommended to replace all fixtures with linear fluorescent tubes with LED fixtures.

Estimated fixture replacements are shown in the table below:

Space	Lighting Inventory Tag	Fixture Type	Replacement Fixture	Replacement Fixture Code	Estimated Replacements
Building A	T12-1	Ceiling Mount Strip	4' 22W LED Strip Light	RS3	1
Building A	T12-2	Ceiling Mount Strip	4' 32W LED Strip Light	RS4	1
Bldg B Shed	T12-2	Ceiling Mount Strip	4' 32W LED Strip Light	RS4	2
Building B	T12-2	Ceiling Mount Strip	4' 32W LED Strip Light	RS4	2

Table 14 - Common Area Lighting Replacements

Predicted Savings - Building A:	**$TBD**	**SIR:**	**TBD**
Predicted Savings - Building B:	**$TBD**	**SIR:**	**TBD**

3.2.2 Retrofit Incandescent and CFL Bulbs to LEDs

The replacement of all hardwired screw-in incandescent and CFL fixtures with LED lamps has been evaluated. It is recommended to replace bulbs in all screw-in fixtures with incandescent and CFL bulbs with LED bulbs.

Estimated bulb replacements are shown in the table below:

Space	Lighting Inventory Tag	Fixture Type	Replacement Fixture	Replacement Fixture Code	Estimated Replacements
Building A	ISB	Surface Mount	9.5W LED Bulb	L1-b	1
Building B	ISB	Surface Mount	9.5W LED Bulb	L1-b	3
Building B	FSB	Can Light	5.5 W LED Bulb	L3	1

Table 15 - Common Area Lighting Replacements

Predicted Savings - Building A:	**$TBD**	**SIR:**	**TBD**
Predicted Savings - Building B:	**$TBD**	**SIR:**	**TBD**

3.3 Exterior Lighting Improvements

Existing Condition:

Most of the exterior lighting fixtures have been upgraded to LEDs. There are some incandescent fixtures that remain around the walkways.

Replace Bollard Light Fixtures to LEDs:

The replacement of all bollard light fixtures with LED fixtures has been evaluated. It is recommended to replace all bollard light fixtures with LED fixtures.

Estimated fixture replacements are shown in the table below:

Space	Lighting Inventory Tag	Fixture Type	Replacement Fixture	Replacement Fixture Code	Estimated Replacements
Building A	IBL	Bollard Light	15 W LED Bollard Light	LB1	6
Building B	IBL	Bollard Light	15 W LED Bollard Light	LB1	3

Table 16 - Exterior Lighting Replacements

Predicted Savings - Building A:	**$TBD**	**SIR:**	**TBD**
Predicted Savings - Building B:	**$TBD**	**SIR:**	**TBD**

3.4 Replace Central Heating Boiler with Modulating Condensing Boiler

Existing Condition:

Aurora Village has a central boiler plant in each building. The plants are comprised of four natural draft gas-fired boilers that provide heating to hydronic baseboard registers in the dwelling units and common area. The boilers were manufactured in 1982 and each plant has a nominal input capacity of 1,200 MBH. The boilers were measured operating around nameplate efficiency of 80%. For a detailed mechanical inventory, please see **Table 11**.

System piping is a constant primary system, with two pumps circulating water through each building. There are two-way zone valves in each dwelling unit at the baseboard register in the living room which is controlled by a non-programmable wall mounted thermostat.

The system is operated with the following setpoints:

- Heating water supply temperature setpoint of 180°F
- Warm Weather Shut Down set at 75°F
- No outside air reset temperatures

The boiler flues for each building terminate at the roof. Piping for space heating in the mechanical rooms was observed to be copper with insulation.

The existing combustion air intake in each building is provided by one opening in the exterior mechanical room wall. The intake is approximately 1,500 square inches.

Efficiency Measure:

The space heating boilers in each building have reached the end of their useful life expectancy. It is recommended to replace the existing boilers with 2 or 3 modulating condensing boilers with a minimum 5:1 turn down ratio.

New heat loss calculations shall be performed to determine the necessary capacity of the new boilers without oversizing. The new boilers shall be designed and specified so that they can handle 2/3 of peak heating load for a 2-boiler system or 1/2 of peak heating load for a 3-boiler system.

The new boilers should be plumbed in primary secondary configuration, with a dedicated boiler pump for each boiler.

New parallel high efficiency pumps shall have ECM motors or be installed with variable frequency drives (VFDs) to allow variable speed operation. The new pumps shall be engineered to meet the system flow and pressure requirements. The new pumps shall be controlled to maintain minimum system flows either by utilizing a differential pressure sensor located on the top floor of the building or by utilizing a minimum flow controller. These flows shall be verified by an independent balancer for both part load and full load conditions.

A new boiler control system with an outdoor air sensor shall be installed in each building to operate the boilers and pumps with the following sequence of control:

> *Enable boilers when the outside air temperature falls below 68 F (adj.). Disable boilers when outside air temperature rises above 72 F (adj.). Stage and modulate boilers using manufacturer's controls to meet the HWST setpoint. System pumps and primary boiler pumps to be controlled by boiler plant controls.*
>
> *The HWST setpoint shall be reset according to a linear outdoor air reset schedule in which the design hot water temperature, 160 F (Adj.), is delivered at 5 F (Adj.) outside air temperature and lower, and 130 F (Adj.) HWS is delivered at the high outdoor air temperature of 65 F (Adj.). This reset shall be optimized to deliver 130F water at the furthest radiator on the coldest day.*

Combustion air intakes and flues shall be installed for the new condensing boilers and terminated per the manufacturer's recommended installation guidelines and/or mechanical design drawings.

The new condensing boilers shall have ducted combustion air as well. Existing combustion air openings can be reduced to meet the requirements of any remaining gas fired appliances in the mechanical room such as the DHW boiler. If the DHW boilers are replaced as part of the recommended efficiency measures, the combustion air openings can be covered.

General Requirements:

Please consider the following while pricing:

1. The Contractor shall be responsible for construction of the installation in its entirety and shall secure the services of qualified professionals as required to complete this scope of work.
2. The capacity of the boilers shall be engineered to match the anticipated space heating loads. A load calculation, piping layout and drawings are part of the design scope of work. The Design/Build installer shall submit all engineering calculations for Owner review and acceptance prior to ordering equipment.
3. The contractor shall provide a fully operational hot water system including but not limited to the electrical work, flues, combustion air, natural gas piping, equipment and piping supports, anchors, pumps, boilers, acid neutralization for condensing equipment drainage, and associated controls. Follow manufacturer's guidelines for proper installation and venting.
4. The HW boiler controls shall be able to perform the following:
    a. Incorporate a warm weather shut down (WWSD) based upon the owner's preference.
    b. Incorporate a HWS reset based upon outside air temperature and owner's preference. Careful consideration shall be given to the location of the outdoor temperature sensor so that it is sensing true ambient conditions. Reset shall be tuned during cold and warm conditions to provide maximum comfort and efficiency.
    c. Contractor shall document all installed setpoints, provide documentation to the Owner, and fully train the Owner on setpoint adjustment.

5. The Contractor shall be responsible for the demolition, removal and proper disposal of all of the existing equipment to be replaced. This includes but is not limited to any regulated materials such as asbestos, lead, etc. Regulated materials shall be disposed of in accordance with local and federal regulations.
6. Existing natural gas supply pressure and capacity should be evaluated to ensure adequate service for new equipment.
7. The Contractor shall secure all permits and inspections required for demolition and installation.
8. The new boilers shall include a factory start-up. This factory start-up shall include at least one return trip for the purposes of tuning and optimizing boiler plant operation.
9. Piping and pumping shall meet the following requirements:
    a. The new condensing boiler shall have a primary pump with an EC motors capable of varying flow based on delta T. The pump shall start when the associated boiler is called to activate.
    b. The building circulation pumps shall have EC motors or VFD control capable of varying flow based system pressure to adapt to variations in heating demand.
    c. One line piping diagram shall be provided to owner prior to ordering any equipment.
    d. TAB shall be performed on all pumps to verify flow rates meet the design requirements.
    e. Insulate all exposed piping.
10. Provide proper venting for condensing boilers. Flue paths should be approved by the owner prior to installation.
    a. It is noted that there is unlikely to be sufficient clearance for boiler venting through the mechanical room walls, likely necessitating a flue run through to the roof.
11. If applicable, the Contractor shall work with and assist the Owner's Commissioning Agent to commission the plant operation.
12. Install a means of water treatment and hire a qualified firm to flush and treat the both the newly installed components and hydronic heat piping. The means of water treatment installed shall be based on the results of a water quality test conducted by the contractor or it's sub and be provided to the Owner and CxA for approval. Consider including a side stream filter or other means of maintaining water quality.
13. One full hard copy of O&M's shall be present at the site and electronic O&M's presented to the owner upon completion of the project.
14. Please refer to relevant specifications in the appendices.

Improvements to Operations and Maintenance:

New boilers will extend the lifecycle of the plant and will reduce the number of maintenance and repair work orders.

Pricing and Site-Specific Installation Notes to Contractor:

Before final equipment selection, the contractor shall be responsible for load calculation and equipment sizing per specifications. It should be noted that the contractor is ultimately responsible for verifying site conditions. The contractor will be responsible for issuing a deduction if plant has been reduced significantly in size.

Predicted Savings - Building A:	**$TBD**	**SIR:**	**TBD**
Predicted Savings - Building B:	**$TBD**	**SIR:**	**TBD**

3.5 Domestic Hot Water Upgrade

Existing Condition:

Domestic hot water in each building is provided by a single atmospheric gas-fired boiler supplying heating water to a pair of 115-gallon DHW storage tanks. The DHW boilers are set to circulate 180F water to the storage tanks on a call for heat. A dedicated 1/2 HP pump in each system supplies boiler water to the storage tanks. The storage tanks maintain a setpoint of 130F in Building A and 155F in Building B. There is a thermostatic mixing valve connected to the outlet of the storage tanks. Domestic hot water is provided at 150F for Building A and 130F for Building B. A 1/8 HP recirculation pump is utilized in each system.

Efficiency Measure:

Replace the existing equipment with a high efficiency condensing boiler. If the existing storage tanks are in good condition, they should be incorporated into the new DHW plant.

Calculations shall be performed to determine the necessary domestic hot water capacity for the current connected hot water loads. Loads may be reduced from existing as new low flow water fixtures are installed.

The combustion air intake and flues for the boiler will depend on the manufacturer selected. Ducted combustion air (direct vent) is required unless an alternative design is approved by EOC and the owner. Some condensing boilers have a concentric vent/flue option that may allow both the combustion air and flue to go to the roof where the existing flue terminates.

The Contractor shall install, test, and balance the thermostatic mixing valve to temper the domestic hot water to 120°F. The domestic hot water storage tanks should be maintained at a minimum of 140°F to prevent the risk of Legionella.

Replacement of the DHW recirculation pumps should be included in the scope of the upgrade. The new pump shall have an ECM motor and automatically adapt setpoint to adjust to actual system characteristics and sized to meet the calculated pressure loss of the longest piping run.

General Requirements:

Please consider the following while pricing:

1. The Contractor shall be responsible for the design and construction of the installation in its entirety and shall secure the services of qualified professionals as required to complete this scope of work.
2. The capacity of the domestic water heating plant shall be engineered to match the anticipated domestic hot water loads, considering that all conventional flow fixtures will be replaced with low-flow fixtures. A load calculation, piping layout and drawings are part of the design scope of work. The Design/Build installer shall submit all engineering calculations for Owner review and acceptance prior to ordering equipment.
3. Existing natural gas supply pressure and capacity should be evaluated to ensure adequate service for new equipment.

4. The contractor shall provide a fully operational hot water system including but not limited to the electrical work, flues, combustion air, natural gas piping, equipment and piping supports, anchors, pumps, boilers, acid neutralization for condensing equipment drainage, and associated controls. Follow manufacturer's guidelines for proper installation and venting.
5. The Contractor shall be responsible for the demolition, removal, and proper disposal of all of the existing equipment to be replaced. This includes but is not limited to any regulated materials such as asbestos, lead, etc. Regulated materials shall be disposed of in accordance with local and federal regulations.
6. The Contractor shall secure all permits and inspections required for demolition and installation.
7. Piping and pumping shall meet the following requirements:
    a. One line piping diagram shall be provided to owner prior to ordering any equipment.
    b. Insulate all exposed piping.
8. Provide proper venting for boiler. The combustion air and flue shall be engineered to meet the manufacturer's requirements and code. Flue paths should be approved by the owner prior to installation.
9. If applicable, the Contractor shall work with and assist the Owner's Commissioning Agent to commission the plant operation.
10. One full hard copy of O&M's shall be present at the site and electronic O&M's presented to the owner upon completion of the project.
11. Please refer to relevant specifications in the appendices.

Improvements to Operations and Maintenance:

A new condensing boiler will extend the lifecycle of the plant and will reduce the number of maintenance and repair work orders.

Pricing and Site-Specific Installation Notes to Contractor:

Before final equipment selection, the contractor shall be responsible for load calculation and equipment sizing per specifications for domestic hot water plant. It should be noted that the contractor is ultimately responsible for verifying site conditions. The contractor will be responsible for issuing a deduction if plant has been reduced significantly in size.

Predicted Savings - Building A:	**$TBD**	**SIR:**	**TBD**
Predicted Savings - Building B:	**$TBD**	**SIR:**	**TBD**

3.6 Programmable Wall Mounted Thermostats

Existing Condition:

Hydronic baseboard radiators throughout the building are controlled by non-programmable analog thermostats.

Efficiency Measure:

Replace an estimated 105 wall-mounted, non-programmable thermostats with programmable thermostats. This

includes dwelling units, boiler rooms, meeting rooms, and common laundry rooms. The contractor should verify thermostat counts prior to ordering any equipment.

The contractor shall provide simplified training materials to teach management and residents how to operate and program their new thermostat.

Predicted Savings - Building A:	**$TBD**	**SIR:**	**TBD**
Predicted Savings - Building B:	**$TBD**	**SIR:**	**TBD**

3.7 Hot Water Pipe Insulation

Existing Condition:

Copper domestic hot water piping in the boiler rooms is uninsulated. The tables below show the approximate lengths and diameters of domestic hot water piping in the mechanical room of each building.

Building A - Domestic Hot Water (155F)		
Total Piping (ft):	10	1" dia
	30	2” dia
Uninsulated Piping (ft):	10	1" dia
	25	2” dia
Building B – Domestic Hot Water (130F)		
Total Piping (ft):	5	1" dia
	40	2” dia
Uninsulated Piping (ft):	5	1" dia
	30	2” dia

Table 17 - Hot Water Pipe Insulation

Efficiency Measure:

All hot water piping accessible in the boiler room should be insulated with faced fiberglass pipe insulation per local code requirements or 2018 IECC requirements, whichever is greater:

- Space Heating Piping:
  Conductivity - 0.25-0.29 btu•in/h•ft2•ºF (Rated at 125ºF)
  <1-1/2”ø – 1.5” of insulation
  ≥1-1/2”ø – 2” of insulation

- DHW Piping:
  Conductivity – 0.21-0.28 btu•in/h•ft2•ºF (Rated at 120ºF)
  <1-1/2”ø – 1” of insulation
  ≥1-1/2”ø – 1-1/2” of insulation

Improvements to Operations and Maintenance:

Insulation of piping will reduce energy waste and increase comfort in mechanical spaces for maintenance teams working on equipment.

Pricing and Site-Specific Installation Notes to Contractor:

The Contractor shall be responsible for the design and construction of the installation in its entirety and shall secure the services of qualified professionals as required to complete this scope of work.

Predicted Savings - Building A:	**$TBD**	**SIR:**	**TBD**
Predicted Savings - Building B:	**$TBD**	**SIR:**	**TBD**

3.8 Install High-Efficiency (Low-Flow) Water Fixtures

Many kitchen faucets, bathroom faucets, and showerheads had conventional flow fixtures. Fixtures should be replaced as needed to meet the Recommended Minimum Performance indicated in the table below.

Please note that the number of replacement fixtures are to be verified in the field by installing contractor due to significant variability in flow rates among units.

Fixture	EPA Requirements (GPM)	Recommended Minimum Performance (GPM)	Anticipated Number to Be Replaced per Building
Bathroom Faucet	2.0	1.0	100
Shower	2.5	1.5	100
Kitchen Faucet	2.2	1.5	100

Table 18 - Water Fixture information

Predicted Savings - Building A:	**$TBD**	**SIR:**	**TBD**
Predicted Savings - Building B:	**$TBD**	**SIR:**	**TBD**

3.9 Replace Inefficient Refrigerators

Existing Condition:

Current refrigerators range in age, some are energy efficient models with estimated annual electric consumption of approximately 350 kWh/yr each. Some are past their expected lifespan and not as energy efficient as the newer models.

Efficiency Measure:

Replace older, inefficient refrigerators with an energy consumption of 650 kWh/year or greater with ENERGY STAR-qualified refrigerators rated at an annual energy consumption of 330 kWh or less.

Predicted Savings - Building A:	**$TBD**	**SIR:**	**TBD**
Predicted Savings - Building B:	**$TBD**	**SIR:**	**TBD**

3.10 Increase Attic Insulation

Existing Condition:

4” of batt fiberglass insulation and 3” of blown cellulose insulation was observed in the each of the attic areas, for a nominal R-value of approximately R-23. The insulation appeared to be even and uniformly installed to a high quality.

Efficiency Measure:

Seal any gaps or cracks in the ceiling plane drywall from the attic side to reduce air infiltration from conditioned space into the attic. Additionally, increase existing attic insulation to at least R-49 by blowing loose-fill cellulose insulation in addition to existing batts.

General Requirements:

A completed and signed “Certificate of Insulation” must be posted if insulation is installed. Certificate must include insulation type, coverage area, R-value, and installed thickness. Insulation must be installed in such a manner that ensures complete coverage at the thermal boundary and a consistent R-value, except where physical constraints may exist. Installation must be within 10% of the estimate. Lesser or greater amounts must be documented and must be reasonable.

Predicted Savings - Building A:	**$TBD**	**SIR:**	**TBD**
Predicted Savings - Building B:	**$TBD**	**SIR:**	**TBD**

3.11 Install Solar Photovoltaics

Existing Condition:

Aurora Village does not have any solar photovoltaics (PV) or other renewable energy generation on site for either building. There are pieces of mechanical equipment as well as plumbing vent penetrations scattered throughout the roof area of each building.

Efficiency Measure:

Aurora Village has a shallow pitched asphalt shingle roof for both buildings. Excluding roof penetrations and mechanical equipment, approximately 20% of the total roof area is available for PV (~2,000 sf) on Building A and approximately 40% of the total roof area is available for PV on Building B (~4,000 sf). The potential area can be seen in the photos below as shaded green areas.

Figure 44 - Potential Solar Voltaic Area

The total area for Building A was multiplied by 15 W/ft^2 to come to an estimated system size of 38kW. Typical parameters were applied in PVWatts to determine a potential energy production of nearly 50,000 kWh per year.

The total area for Building B was multiplied by 15 W/ft^2 to come to an estimated system size of 64kW. Typical parameters were applied in PVWatts to determine a potential energy production of nearly 90,000 kWh per year.

General Requirements:

Please consider the following while pricing:

1. This project is considered a design build project, and the contractor is responsible for all necessary design responsibilities to meet the expectations outlined in this scope of work.
2. Equipment locations and electrical connections should be coordinated with any other mechanical or electrical upgrades being performed on site.

Predicted Savings - Building A:	**$TBD**	**SIR:**	**TBD**
Predicted Savings - Building B:	**$TBD**	**SIR:**	**TBD**

4 EFFICIENCY MEASURES NOT RECOMMENDED

4.1 Replace Windows

Existing Condition:

Double-pane, vinyl frame windows with standard coating were observed in all dwelling units.

Efficiency Measure:

Replace windows with new ENERGY STAR rated double pane vinyl frame windows with Low-E coating.

Reason Not Recommended:

The windows are currently double pane installed with vinyl framing, and there wouldn't be any significant savings from replacement compared to the high cost of the measure.

5 RECOMMENDED HEALTH & SAFETY MEASURES

5.1 Replace Non-Functional or Low Flow Bathroom Exhaust Fans

Bathroom exhaust in the units are provided by individually ducted exhaust fans. As part of the audit, all the exhaust intakes at the units were tested for exhaust air flow. The majority (96%) of the exhaust fan terminals were drawing less than 50 cfm, the code minimum bathroom exhaust airflow for intermittent operation. Poor exhaust in wet rooms can create an environment for mold and other air quality health and safety issues.

It is recommended that all exhaust ducting be cleaned, and all exhaust fans should be replaced with ENERGY STAR labeled fans. Fan flow rates should be measured to verify adequate flow.

Please reference Appendix D for a listing of the measured exhaust rates in each unit bathroom.

The new equipment should include the following:

- ENERGY STAR® rated exhaust fans
- Contractor should perform calculations to ensure fan specifications comply with minimum ventilation rates defined in ASHRAE 62.2.
- To ensure adequate flow, in general fans should be rated at 80 CFM if operating intermittently (switched). 30-50 CFM rating may be adequate if fans are operating continuously (hardwired).
- Properly seal the fan to drywall with caulk or other similar material to inhibit air leakage to the exterior of the thermal envelope of the building.
- Always reuse existing duct work. If instances are found where existing duct infrastructure is not code compliant, bring to the attention of the owner.
- All new ductwork routing shall be approved by the Owner for locations and enclosure finishes.

Replacing the exhaust fans with ENERGY STAR qualified fans can save $2-5/fan each year. While this measure would only have an SIR of 0.1, it would produce some energy savings.

5.2 Install Hardwired Combination Smoke/Carbon Monoxide Alarms

Existing Condition:

No inspected units at the Aurora Village has a carbon monoxide alarm. Most units had battery powered smoke detectors.

Health & Safety Measure:

Install a hardwired combination smoke and carbon monoxide detector in each unit. The contractor should verify the operation of existing equipment and replace existing smoke detectors that are missing, inoperable or beyond recommended useful life.

5.3 Repair Hot Water Coil for Air Handling Unit

Existing Condition:

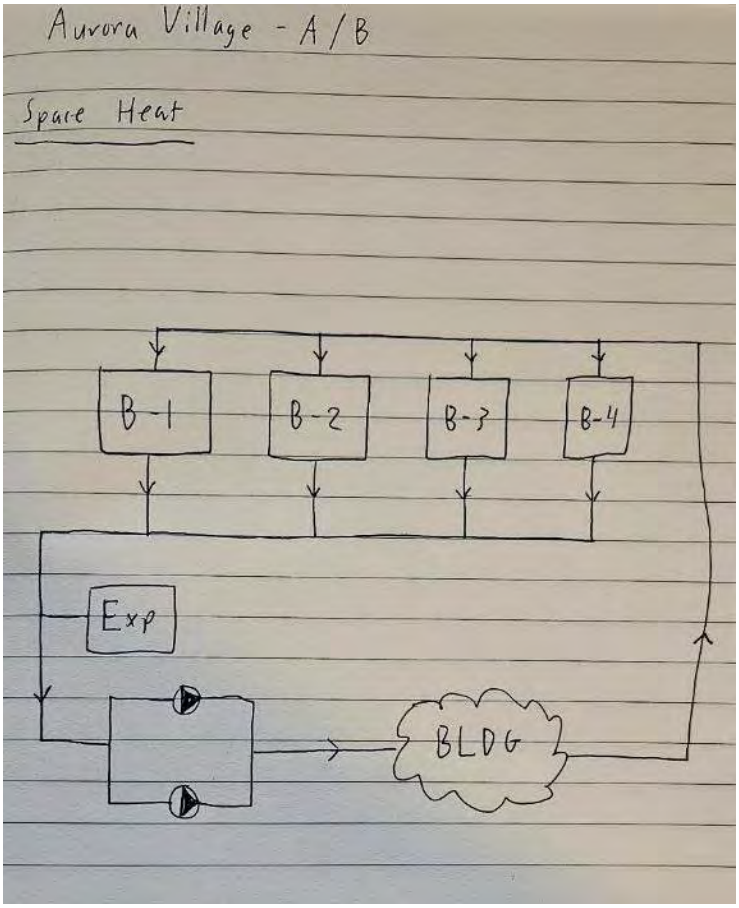
The air handling unit in the community room of Building A is only providing cooling to the space. The cooling is provided by DX cooling and a ground mounted condensing unit. Heating from the hot water coil is not operational. The system is controlled by a programmable thermostat. Since the heating is not operational the community room is not being ventilated during the winter months of the year.

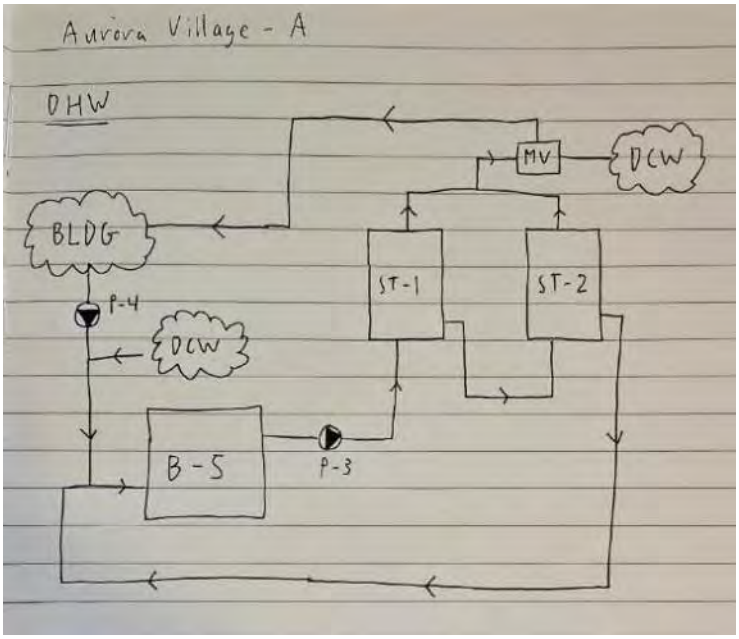
Health & Safety Measure:

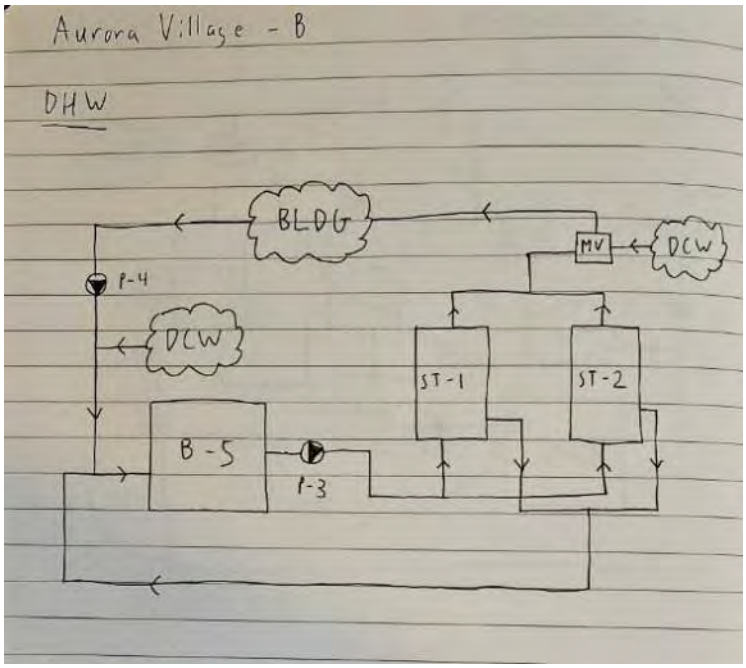
To ensure proper ventilation of the community room year-round the air handling unit should have the hot water coil repaired or replacement if needed. This will allow for proper ventilation and conditioning of the space throughout the year.

APPENDIX A – SPECIFICATIONS (PROVIDED SEPARATELY)

APPENDIX B – ONE-LINE DIAGRAMS






Aurora Village - B
DHW
BLDG
MV
DCW
P-4
DCW
ST-1
ST-2
B-5
P-3

APPENDIX C – DOE-2 DOCUMENTATION (PROVIDED SEPARATELY)

APPENDIX D – AUDITOR NOTES

Major Equipment Combustion Gas Analysis Results

Equipment Tag	Fuel	%O2	ppm CO	ppm CO(O2)	%Efficiency	%CO2	%EA	TStk	TAir	Temp Units
B-1 (1)	Nat Gas	10.1	22	42	84.6	6.1	83.6	222	60.1	°F
B-1 (2)	Nat Gas	8.7	37	63	85.2	6.9	63.7	224	60.9	°F
B-1 (3)	Nat Gas	9.2	45	80	84.3	6.6	70.5	243	62	°F
B-1 (4)	Nat Gas	10.7	20	42	84	5.8	93.5	231	63	°F
B-2 (1)	Nat Gas	8.3	21	35	84.2	7.1	58.3	252	55.9	°F
B-2 (2)	Nat Gas	10.5	42	84	83.5	5.8	90.6	240	56.5	°F
B-2 (3)	Nat Gas									°F
B-2 (4)	Nat Gas	7.5	91	142	83	7.5	50.2	293	50.9	°F
B-3	Nat Gas	11.3	11	25	86.6	5.4	105.1	165	64	°F
B-4	Nat Gas	13.7	11	31	85.9	4.1	168.8	153	61.4	°F

APPENDIX E – SITE AUDIT PHOTOS (PROVIDED SEPARATELY)

APPENDIX F – HEALTH AND SAFETY CHECKLIST