



## Irvington Village Hall – Energy Audit

Village of Irvington

85 Main St, Irvington, NY

Mr. Larry Schopfer

Village of Irvington

85 Main Street

Irvington, NY 10533

Date: January 08, 2021

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Re:     Irvington Village Hall, Irvington, NY 105331  
       Energy Audit Report

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## Executive Summary

The purpose of this report is to provide a Level 2 Energy Audit per ASHRAE Guidelines. The energy audit will outline the existing systems currently in use in the building, analyze the building's energy usage, and indicate any recommendations that will improve the energy efficiency of the building, with order of magnitude budget pricing for implementing the recommended items. Energy usage data from the calendar years 2018 and 2019 were analyzed for this audit, due to the anomalous decreased occupancy of the building due to pandemic restrictions during 2020.

The building was originally constructed in 1900, and is 3 stories tall. The cellar level contains the village police department headquarters, the first floor primarily serves as local government (Village Hall) offices, and the second floor and mezzanine are a performing arts theater. The total square footage of the building is approximately 19,328 square feet. The police station operates 24/7, with the exception of police administrative offices which operate 9 AM to 5 PM Monday through Friday. The theater is typically used from October through May, with shows on the weekends and rehearsals on weekday evenings. The first floor Village Hall offices are typically occupied between 8:30 AM and 5 PM Monday through Friday. See **Appendix A** for a detailed description of the building specific information.

All costs shown in this report are order of magnitude estimates. Scope of work is estimated based on a building survey performed by EP Engineering on December 7, 2020. Energy cost savings are based on an average cost per energy unit based on the most recent utility bills available and best engineering practices. All payback analysis is based on a simple payback.

In the most recent calendar year with normal occupancy (2019), the building consumed 1,166 MBTU. Its Source EUI was 107.1 kBtu/SF, and its Site EUI was 60.3. According to Energy Star, this EUI is higher than the national median for mixed use properties (89.3 and 40.1, respectively), but close to the national median for offices (116.4 and 52.9) and Police Stations (124.9 and 63.5). The building does not have an Energy Star score because more than 25 percent of the property is a use type that is not eligible for a score (Police Station and Performing Arts).

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## Abbreviations

Abbreviation	Definition
AC	Air Conditioner
ACCU	Air Cooled Condensing Unit
B (i.e. B-1)	Boiler
BTU	British Thermal Unit
CHW	Chilled Water
CHWP	Chilled Water Pump
CT	Cooling Tower
CW	Condenser Water
CWP	Condenser Water Pump
DHW	Domestic Hot Water
DW	Dishwasher
EUI	Energy Utilization Index
FCU	Fan Coil Unit
GXF	Garage Exhaust Fan
HP	Horse Power
hr	Hour
HVAC	Heating, Ventilation and Air Conditioning
HW	Hot Water
HWP	Hot Water Pump
kBTU	Thousands of BTU's
kW	Kilowatt
kWh	Kilowatt-hour
KXF	Kitchen Exhaust Fan
MBTU	Millions of BTU's
N/A	Not Applicable
SF	Square Foot
TXF	Toilet Exhaust Fan



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## Existing Building Mechanical Systems

The building has a main heating plant that is both connected to the spaces they serve through a distribution network of piping and terminal devices throughout the building. Cooling is provided by split systems serving occupied spaces in the Village Hall and Police Department. The theater is only heated, not air conditioned. The items below are the main points for the building and more detailed information can be found in **Appendix B** Equipment Inventory log.

### Heating Systems

Heating for the Village Hall and Police Department is provided by a 298 kBTU/hr oil-fired hot water boiler, which is rated for an input of 3.00 GPH of oil (approx. 420 kBTU/hr). The hot water supply header branches into (7) zones consisting of hot water baseboard heaters and radiators, with each zone controlled by a circulator pump tied to a space thermostat. Thermostat types were a mix of programmable digital and simple dial thermostats. All visible piping serving this boiler was uninsulated.



Photo 1: Boiler serving Village Hall and Police Department

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**Photo 2: Uninsulated Hot Water Piping**

Heating for the Theater is provided by a 634 kBTU/hr oil-fired steam boiler, which is rated for an input of 5.50 GPH of oil (approx. 770 kBTU/hr). The theater is controlled as a single zone consisting of two-pipe vented radiators. The boiler is controlled by a single space thermostat located in the theater main seating area, but each radiator has a Vari-Valve adjustable vent that can be used to control the heat output of a given radiator. All visible piping serving this boiler was uninsulated. Equipment is currently serviced on an as-needed basis, and recommended thorough maintenance protocols are provided in **Appendix F**.

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Photo 3: Boiler Serving the Theater



Photo 4: Typical Steam Radiator in Theater



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## Cooling Systems

Cooling is provided to the Police Department and Village Hall offices by single and multi-split heat pump AC units, consisting of indoor wall-mounted evaporators and outdoor condensers. Most of the outdoor condensers were located in an alley on the side of the building. Most of the exterior piping insulation appeared to be severely damaged due to exposure to the elements. The layout of this condenser farm appeared to be problematic, as many of the condenser fans were either blocked or discharging air into the intake of another condenser. An inventory of these units can be found in **Appendix B**. Equipment is currently serviced on an as-needed basis, and recommended thorough maintenance protocols are provided in **Appendix F**.



Photo 5: Typical Indoor Evaporator



Photo 6: Outdoor Condenser Farm

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## Exhaust

The building does not have a central toilet exhaust system. Bathrooms without operable windows are provided with ceiling mounted exhaust fans discharging individually to the outside.

## Domestic Hot Water Systems

Domestic hot water for bathrooms is provided by a 4500-watt electric storage hot water heater. All visible piping serving this water heater was uninsulated.



Photo 7: Storage Hot Water Heater

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## Existing Building Envelope

### ENVELOPE EVALUATION

The evaluation of the exterior envelope of the building was based on visual observation and measurements, complemented by information provided by the building department and the manager of the facility. The inspection was performed on December 7th, 2020. The weather was fair and cold.

Irvington Town Hall was built in 1902 in a colonial revival style. It features a robust stone base with a brick wall above which features glazed terracotta and stone accent pieces. The building was built with structural clay tile, also known as hollow clay tile as a backup for what is assumed to be two wythes of common brick facing. Among the benefits of hollow clay tile construction is a robust substrate for masonry and fireproofing. Typically, the bricks are mounted onto the structure of the building with structural angles and the bricks are tied to the hollow clay wall with metal ties. It is not uncommon for there to be no gap between the inner face of brick and the outer face of the hollow clay tile, which can often be filled with mortar. The walls operate as mass walls, as opposed to veneered walls, with the expectation that water will shed off the face brick. The hollowness of the clay and the general conductivity of the mineral (stone, brick, clay tile, plaster) materials however do not provide an adequate thermal protection for the building as was the nature of construction over a hundred years ago. While robust, in such an assembly, air leakage is a feature. The scratch coat and interior finish plaster were very likely posed directly on the hollow clay tile. In many cases, electrical outlets were surface mounted to the wall. In most of the rooms visited the original baseboards, finished window casings, and radiators untouched, suggesting that subsequent modifications of were limited to a few local locations in the basement. The historic Tiffany reading room has the different window casing details but the rest of detailing is consistent with the 1<sup>st</sup> floor offices spaces confirming that no enhancements have been made to this floor's exterior envelope.

### WALLS

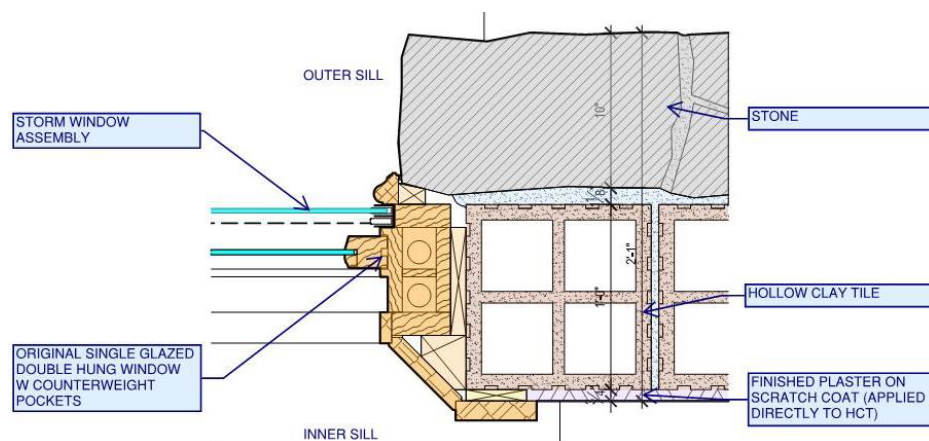


Figure 1: Plan Detail at Basement Jamb

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The basement wall is assumed to have 12" of hollow clay tile with finished rusticated stone of approximately 10" thickness. Certain assumptions were made in the recreation of this wall, notably that there is no insulation, the plaster finish is applied directly to the hollow clay tile, without wood furring strips which could benefit marginally the performance of this wall. The following is a calculation of the R value of this wall:

Assembly		Building Assembly Description					
2		TYPICAL EXISTING WALL-STONE HOLLOW CLAY BRICK (BASE)					
Surface Film Resistance, R		Interior:		0.74		(hr.ft <sup>2</sup> .F/BTU)	
		Exterior:		0.23			
Primary Material (Enter from interior to exterior)	Resistivity R per inch	Secondary Material (optional)	Resistivity R per inch	Tertiary Material (optional)	Resistivity R per inch	Thickness [in]	
1. PLASTER FINISH	0.345					0.750	
2. HOLLOW CLAY TILE	0.250					12.000	
3. MORTAR JOINT	0.720					0.375	
4. BRICK	0.250					3.625	
5. MORTAR JOINT	0.720					0.375	
6. GRANITE BASE STONE	0.070					10.000	
7.							
8.							
		Percentage of Mat'l 2		Percentage of Mat'l 3		Total Width	
						27.1 in	
R-Value:		6.4		(hr.ft <sup>2</sup> .F/BTU)			
U-Value:		0.1568		(BTU/hr.ft <sup>2</sup> .F)			

Figure 2: R-Value of Stone Base Wall

At the first floor, the wall comes slightly narrower, with what is assumed to be 2 wythes of brick. The same assumptions regarding the interior finishing were made. With un-insulated walls there is a consistent flow of heat in the winter outwards which has the beneficial effect of maintaining moisture control of the porous materials used in the wall assembly.



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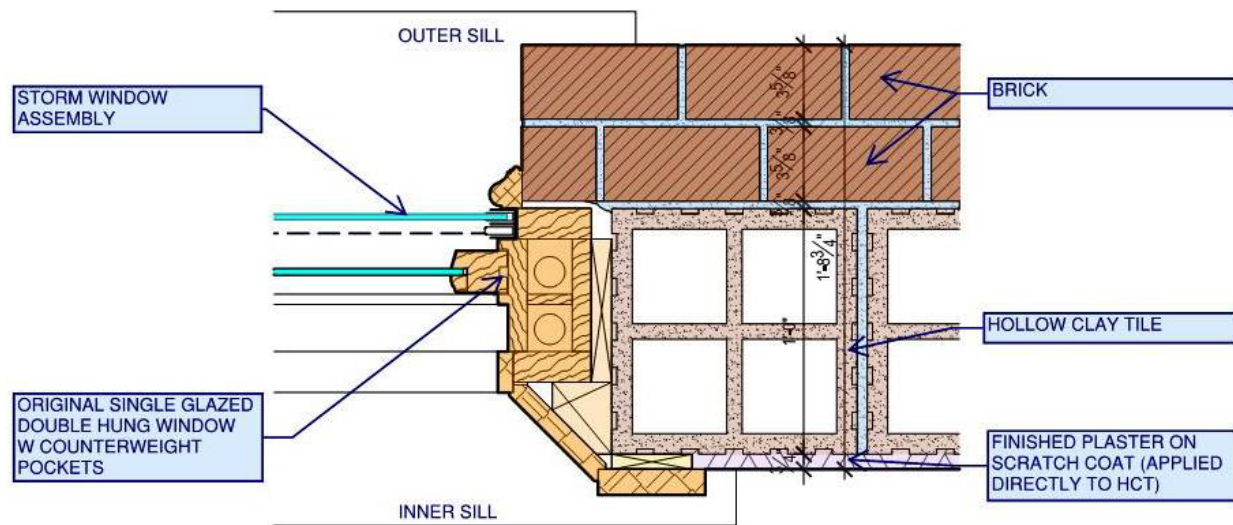


Figure 3: Plan Detail at 1<sup>st</sup>, 2<sup>nd</sup> Floor Jamb

The R value calculation for this modest change in material and thickness has no effect on the performance of the wall, and the R value for the entire building wall assembly is R 6.4.

Assembly	Building Assembly Description					
1	TYPICAL EXISTING WALL-BRICK HOLLOW CLAY BLOCK (1ST & 2ND FLOORS)					
Surface Film Resistance, R		Interior: 0.74 (hr.ft <sup>2</sup> .F/BTU)				
		Exterior: 0.23				
Primary Material (Enter from interior to exterior)	Resistivity R per inch	Secondary Material (optional)	Resistivity R per inch	Tertiary Material (optional)	Resistivity R per inch	Thickness [in]
1. PLASTER FINISH	0.345					0.750
2. HOLLOW CLAY TILE	0.231					12.000
3. MORTAR JOINT	0.720					0.375
4. BRICK	0.250					3.625
5. MORTAR JOINT	0.720					0.375
6. BRICK	0.250					3.625
7.						
8.						
Percentage of Mat'l 2		Percentage of Mat'l 3		Total Width		
				20.8 in		
R-Value:		6.4		(hr.ft <sup>2</sup> .F/BTU)		
U-Value:		0.1573		(BTU/hr.ft <sup>2</sup> .F)		

Figure 4: R-Value of Brick Wall (1<sup>st</sup> and 2<sup>nd</sup> Floors)



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## WINDOWS

The existing windows are historic wood sashes with single glazing configured as 1/1. The R-value of these windows shall be assumed to be R 1. Many of these windows are large format windows and all have counter-weights and chain pockets for ease of operation. The counter-weight pockets are uninsulated and generally are not sealed well, and thus contribute to heat loss in the winter and cooling loss in the summer. The addition of aluminum storm windows would typically increase the R value to R 1.79 of the entire glazing assembly. This will yield a U value of .59. At the date of the inspection it was noted that several of the storm windows were open even though it was late fall. It is safe to assume that the operation of the storm windows by occupants is uncommon, and therefore this contributes to the building's energy loss. The tripartite division of the glazing on the exterior of the storm windows is inconsistent in material and configuration with the historic 1/1 double hung sashes.



Photo 8: Typical Original Windows (Offices)



Photo 9: Typical Original Window with Storm Window

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Photo 10: View of Exterior Showing Storm Window. The 2<sup>nd</sup> Floor original sash appears to be open

## DOORS

The doors of the building are a mix of new and old. The original entry doors are 2 ¼" rail and stile hardwood panel doors, some with single glazing. They do not provide a good seal and no substantive weather stripping was noted. The entry door to the detective sergeant's office has single glazed lights, and no weather stripping. The entry doors to the village court room were non-thermally broken extruded entry storefront doors with glazing in anodized aluminum. No astragals were installed on the active door, and no substantive weather stripping was noted. This door was cold to the touch on the interior. The entry door to the police control center can be similarly described. The additional hollow metal door inside separating it from the lobby adds a physical barrier, but not a thermal barrier for the occupants working in the control room. Given the state of doors and their installation, R 1.79 is estimated and shall be used in calculations.

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Photo 11: View of Village Court Doors. Note daylight at lock, bottom and meeting of doors.



Photo 11: View of Entry to Police Control Center

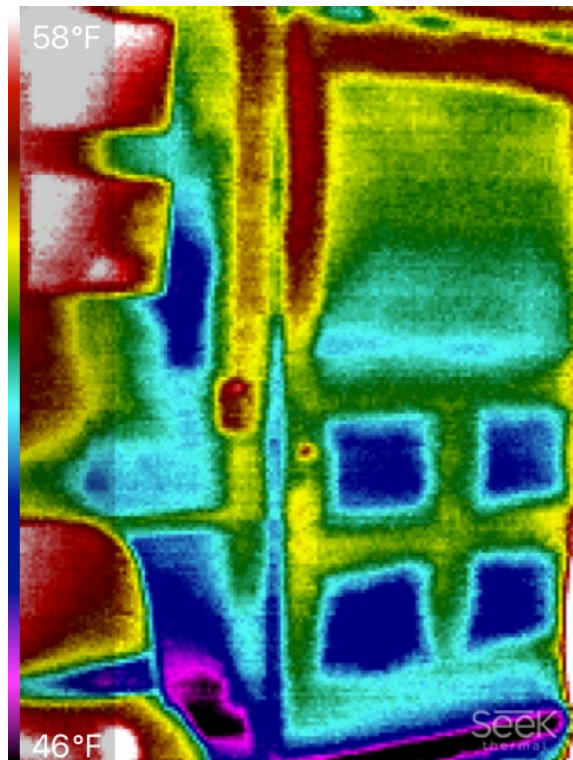


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Photo 12: View of Police Control Center. Note daylight from below door



Photos 13 & 14: View of Entry to Detective Sergeant's door, and a thermal image of the interior of this door. Significant heat loss is noted at perimeter, at the wood panels which are thinner, and at the single glazing.

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## ROOF

The typical roof section that was prepared by Watsky Associates in their set of drawings for renovation work implemented in 2004 indicates that the main roof assembly consists of 3" thick nail board insulation mounted directly on existing decking. A 3" nail board insulation typically has 2½" of EPS insulation with ½" OSB decking. For this evaluation, this assembly was considered the main configuration for evaluating the entire roof R value. Furthermore, the entire northern addition of the elevator and fire stairs was also discounted from this evaluation as these spaces are unconditioned, north facing, and therefore do not provide a critical additional barrier to energy loss through the northern wall. The footprint of the building is approximately 5515 square feet, but the slope of the roof will increase that area to approximately 5650 SF with a correction factor. The theater space is not commonly used due to the difficulties in conditioning the space. The existing steam radiator system provides heat but there is no cooling. The space is used only in the transitional months where heavily conditioned space is not required.

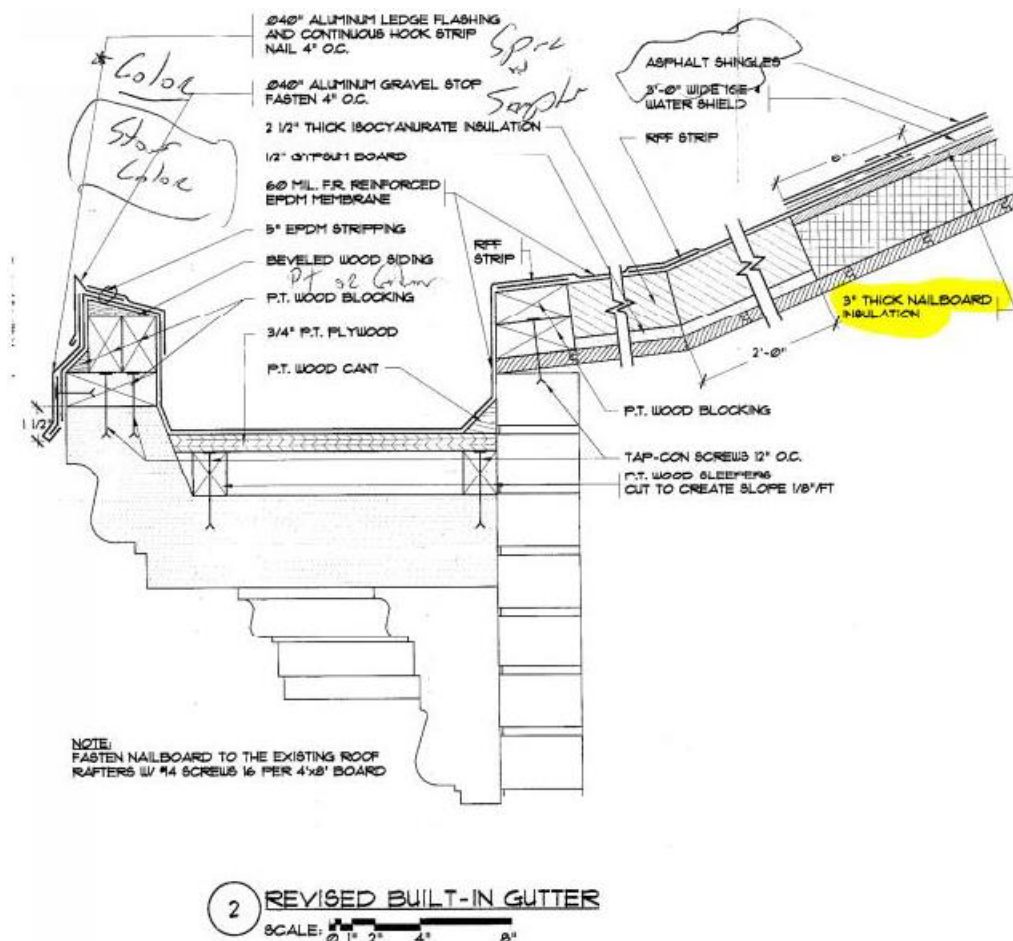


Figure 5: Section Detail Through Roof From 2004 Renovation

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The following assumptions were made regarding the R value calculation for the roof:

- There is no insulation between the roof decking and the ceiling which appeared to be original in our survey. The entire theater floor and the associated spaces at its perimeter and at the mezzanine did not appear touched by any renovations other than the installation of new seating.
- The R value derived for this assembly shall be used for the entirety of the roof although there are skylights and areas where additional insulation may or may not exist.

Assembly		Building Assembly Description					
3		ROOF ASSEMBLY					
		Surface Film Resistance, R		Interior: 0.57 (hr.ft <sup>2</sup> .F/BTU)			
				Exterior: 0.23			
	Primary Material (Enter from interior to exterior)	Resistivity R per inch	Secondary Material (optional)	Resistivity R per inch	Tertiary Material (optional)	Resistivity R per inch	Thickness [in]
1.	PLASTER ON LATH	0.345			LATH	1.280	0.750
2.	VOID						9.500
3.	DECKING (ORIGINAL)	1.280					0.625
4.	EPS (NAILBOARD)	4.125					2.500
5.	OSB (NAILBOARD)	1.390					0.500
6.	MEMBRANE	0.230					0.125
7.							
8.							
		Percentage of Mat'l 2		Percentage of Mat'l 3		Total Width	
				10.0%		14.0 in	
		R-Value:		12.9 (hr.ft <sup>2</sup> .F/BTU)			
		U-Value:		0.0773 (BTU/hr.ft <sup>2</sup> .F)			

Figure 6: R-Value of Roof



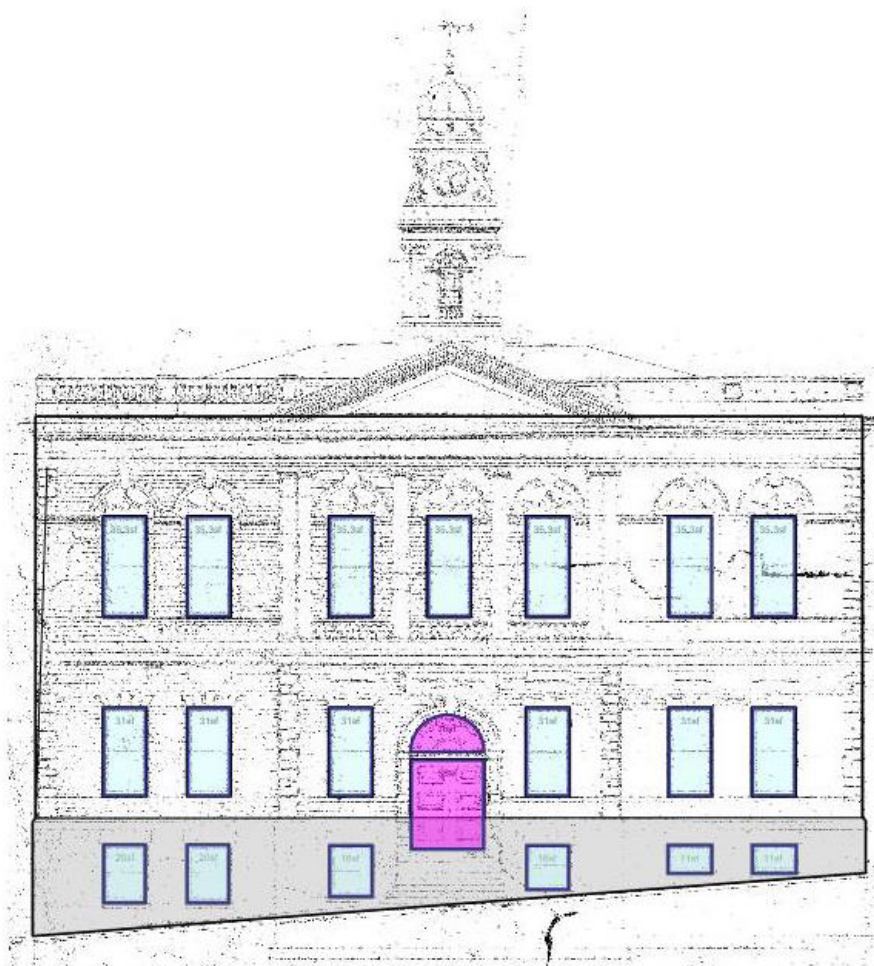
Photo 15: View of Theater & Roof with Skylight



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## COMPOSITION OF WALLS



AREA OF FACADE=3218SF  
PERCENTAGE OF WINDOWS=17%  
PERCENTAGE OF DOORS=2%  
PERCENTAGE OF MASONRY WALL=81%

ASSUMPTIONS MADE:  
DOORS AND WINDOWS SHALL HAVE SAME R VALUE  
WEATHERSTRIPPING NOT TAKEN INTO CONSIDERATION  
TWO SLIDING WINDOWS IN BREAKOUT ROOM NOT CONSIDERED DUE TO LIMITED  
SIZE AND IMPACT ON LOAD

Figure 7: South Elevation (Derived from Original Drawings by Architect)

Area of walls	3218 SF	R value=6.4
Area of windows	528 SF	R value=1.79

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AREA OF FACADE=3536SF  
PERCENTAGE OF WINDOWS=15.4%  
PERCENTAGE OF DOORS=3.2%  
PERCENTAGE OF MASONRY WALL=81.4%

ASSUMPTIONS MADE:  
DOORS AND WINDOWS SHALL HAVE SAME R VALUE  
WEATHERSTRIPPING NOT TAKEN INTO CONSIDERATION

Figure 8: West Elevation (Derived from Original Drawings by Architect)

Area of walls	3536 SF	R value=6.4
Area of windows/doors	543 SF	R value=1.79



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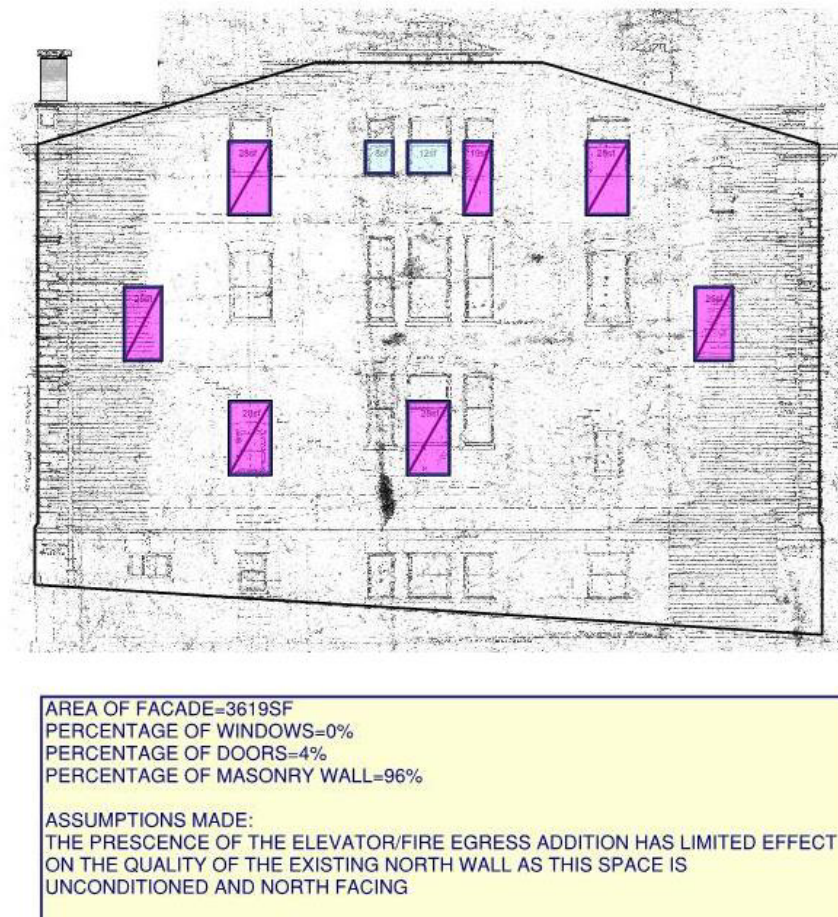


Figure 9: North Elevation (Derived from Original Drawings by Architect)

Area of walls	3619 SF	R value=6.4
Area of windows/doors	145 SF	R value=1.79

Note—as previously noted, the fire stair and elevator addition is not calculated as having a sizable effect on energy performance of building.

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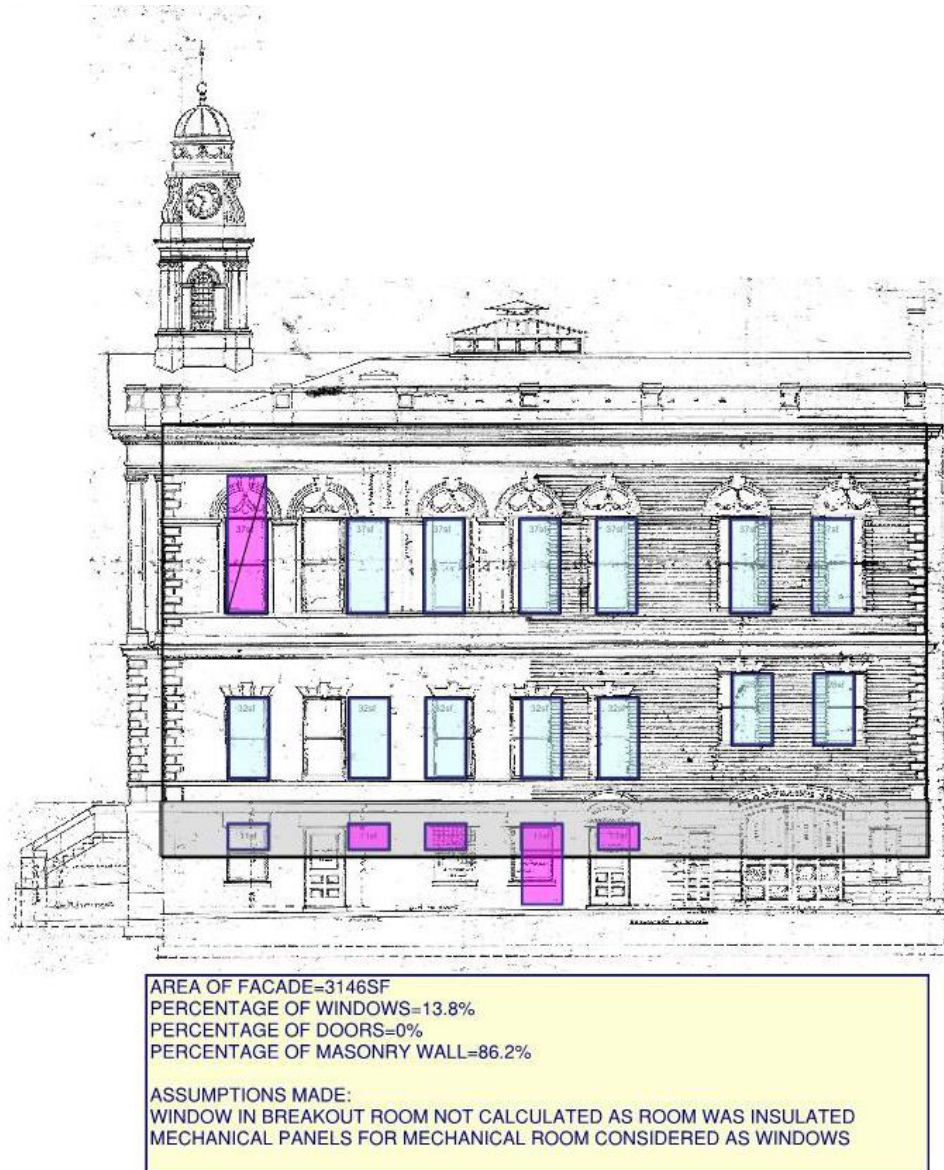


Figure 10: East Elevation (Derived from Original Drawings by Architect)

Area of walls	3146 SF	R value=6.4
Area of windows/doors	436 SF	R value=1.79

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## ENERGY LOSS THROUGH BUILDING COMPONENTS

For the purposes of this evaluation, the correction of the heat loss in specific areas below grade was not considered due to the limited areas themselves, and that many of them were in service areas on the west east side of the building. It was noted that some of the spaces had been renovated, with insulation and drywall added to the original structure to provide for greater thermal comfort, though this was considered negligible.

The following values are determined through an average of 5 years of temperature readings at Westchester County airport for Heating Degree Days (HDD) and Cooling Degree Days (CDD):

HDD for interior temperature at 68F	6150
CDD for interior temperature at 77F	159
Total area of walls @ R 6.4 (U=.156)	11,866 SF
Total area of windows @ R 1.79 (U=.59)	1653 SF
Total area of roof @ R 12.9 (U=.077)	5650 SF

Annual heat loss through building components:

$$\begin{aligned}
 AHD_{WALL} &= U \cdot A \cdot HDD \cdot 24 \\
 &= 0.156 \cdot 11,866 \cdot 6150 \cdot 24 \\
 &= 273,221,770 \text{ BTU/YR} \\
 &= \mathbf{273,222 \text{ KBTU/YR}}
 \end{aligned}$$

$$\begin{aligned}
 AHD_{WINDOW} &= 0.59 \cdot 1653 \cdot 6150 \cdot 24 \\
 &= 143,949,852 \text{ BTU/YR} \\
 &= \mathbf{143,950 \text{ KBTU/YR}}
 \end{aligned}$$

$$\begin{aligned}
 AHD_{ROOF} &= 0.077 \cdot 5650 \cdot 6150 \cdot 24 \\
 &= 64,213,380 \text{ BTU/YR} \\
 &= \mathbf{64,213 \text{ KBTU/YR}}
 \end{aligned}$$

For the purposes of calculating cooling load losses, note that heat pumps are used solely in the basement and the 1<sup>st</sup> floor. The theatre has no cooling, therefore for this calculation, ½ of the overall wall area is used. The area of windows is corrected to reflect the actual areas of windows on these two floors. The roof does not figure in this calculation.

Total area of walls @ R 6.4 (U=.156)	5933 SF
Total area of windows @ R 1.79 (U=.59)	1116 SF

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Annual cooling loss through building components:

$$\begin{aligned} ACD_{WALL} &= U \cdot A \cdot CDD \cdot 24 \\ &= 0.156 \cdot 5933 \cdot 159 \cdot 24 \\ &= 3,531,891 \text{ BTU/YR} \\ &= \mathbf{3,532 \text{ KBTU/YR}} \end{aligned}$$

$$\begin{aligned} ACD_{WINDOW} &= 0.59 \cdot 1116 \cdot 159 \cdot 24 \\ &= 2,512,607 \text{ BTU/YR} \\ &= \mathbf{2,513 \text{ KBTU/YR}} \end{aligned}$$

## LIMITED COST IMPROVEMENTS

The following is a list of improvements that can enhance the thermal comfort of the occupants and can save a modest amount of energy. Refer to figure 9 for the basement plan locations.

1. Provide weather stripping for HM fire door in village court room.
2. Insulate and provide air sealing in closet at all three sides & at ceiling to prevent heat loss through the masonry wall. The probability of a thin brick wall exposed to north fire stair elevator addition is high.
3. Replace entry doors to village court with thermally broken wood doors with insulated glass lights. Assure that proper weather stripping is installed at head, jambs, strike, and saddle. In lieu of this, build an air lock for these doors, but provide robust weather stripping and gasketed saddle, and gasketed astragal at active door. For window at western façade, provide weather stripping at window, or consider a new thermally broken window properly air sealed at opening.
4. Weatherstrip the entry door to the detective sergeant's office. Provide a gasketed saddle to prevent air penetration from outside. At the window use expandable foam and non-mold silicone to enclose and seal the service penetrations for the heat pump in the jamb of the window.
5. At the police control room, the existing 2x4 stud wall that separates the lobby from the booking room should be insulated with R 13 insulation. The lobby side is perhaps best for this installation and air sealing should be executed as well. The entry door should have a gasketed saddle, and weatherstripping should be installed at the perimeter of the door. Due to the constant use of these doors, coordinate with mechanical contractor and relocate the thermostat for proper functioning of the building's steam heat system.
6. The storage room under the stoop of the main entry at the south has a 2 x 3 wood stud wall with a modest amount of insulation. The adjacent room for booking is particularly cold although a baseboard heater is noted on the north partition by the door. The entirety of the storage room should be insulated including the ceiling with R 20 insulation, and air sealing on the storage side should be installed. A hollow core wood door should be replaced with a thicker insulated fully gasketed door.

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7. It was noted in these windows that were condemned for mechanical purposes. It is not clear if insulation was installed, and these rooms were on the cold side due to a lack of heating. The lounge has an independent heat pump which was actively heating the space and contributing somewhat to the adjacent locker. The service penetrations for the heat pumps could be better coordinated and sealed.
8. Install insulation and air sealing in furring wall. This may prove to be difficult due to the locations of the doors.

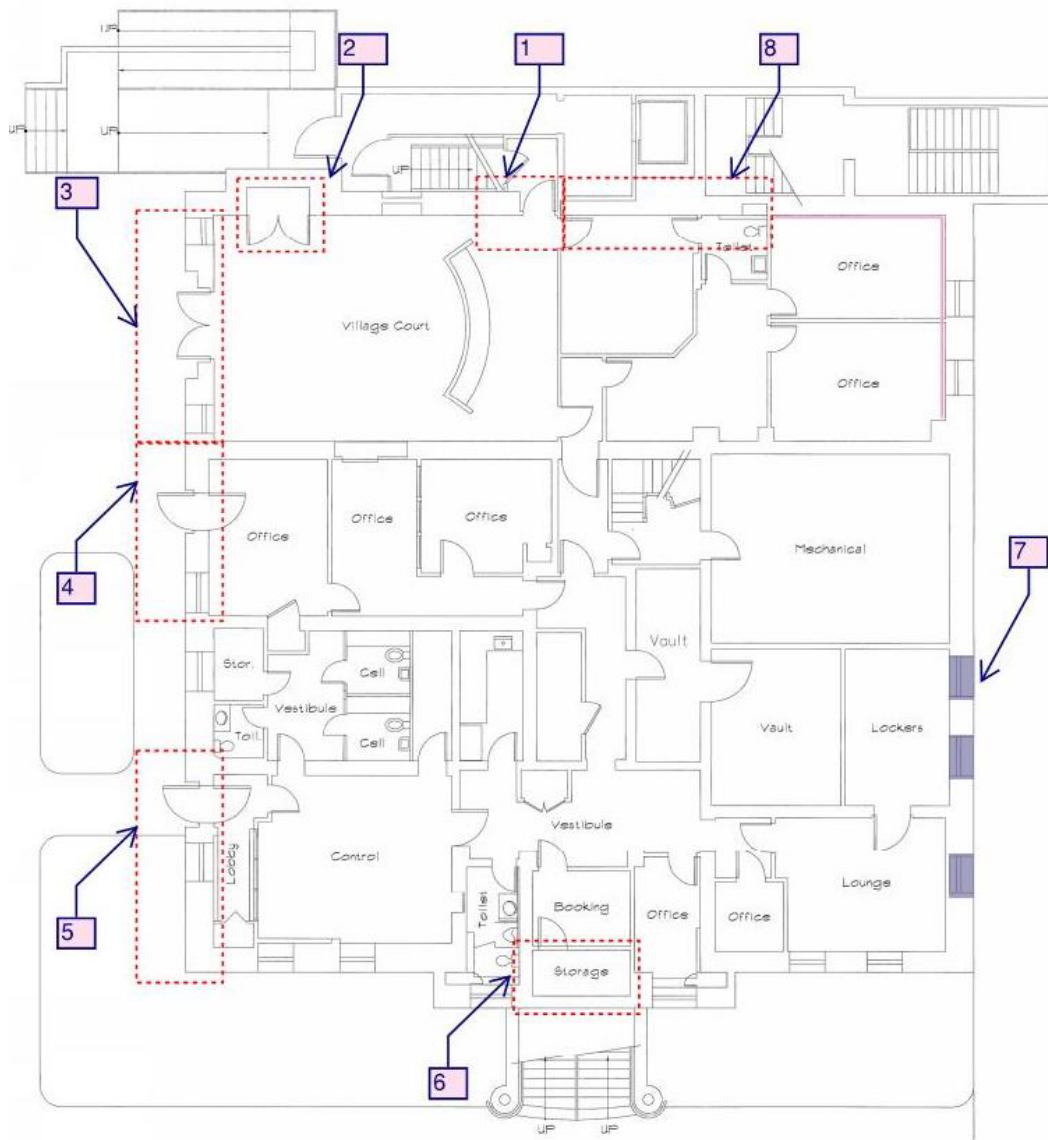


Figure 11: Basement Plan



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## Existing Building Lighting

The existing building lighting fixtures were retrofit to be all LED in 2016. Lighting in each space is controlled by on/off switches. An inventory of existing fixtures, including make and model, quantities and power usage is shown in **Appendix C**.



Photo 16: Typical T8 LED Fixtures

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## Current Building Energy Usage

The building is provided with electricity and fuel oil #2 from the local utility companies. Based on the utility bills provided and benchmarking through the Energy Star Portfolio Manager, the building consumed an average of 1221 MBTU annually in 2018 & 2019. In the most recent calendar year (2019), the building consumed 1,166 MBTU, its Source EUI was 107.1 kBTU/SF, and its Site EUI was 60.3.

Energy Use Compared to Similar Buildings			
Metric	Median Property	In-Use Property	Target
Source EUI	116.4	107.1	100
Site EUI	65.5	60.3	50
Source Energy Use	2249205.8	2069986.9	1716407.0
Site Energy Use	1266864	1165919	966765.3
Energy Cost	33423.12	30759.93	25505.7
Total Emissions (CO2)	96.9	89.1	73.9

Figure 11: Table Comparing the Energy Use to Median Mixed-Use Properties & Target

As indicated in Figure 11, the building's energy usage is slightly better than the median mixed-use property. This is likely due to the fact that only regularly occupied areas are currently conditioned in the summer, during which time the theater does not typically operate.

## Electricity

The buildings average electricity consumption is 12,410 kWh per month. This electricity is used for general power and lighting, heat pump systems and domestic hot water. The maximum electrical consumption occurred in November 2019 and was approximately 15,040 kWh. See **Appendix D** for a detailed breakdown of the electrical utility information mentioned above. The building does not separately meter any power, so an accurate breakdown of electricity consumption by end use cannot be performed. The average cost per KWH these years was approximately \$0.15/KWH. Through the Westchester Smart Power Program, this rate could be reduced to nearly half. Standard small commercial rates are currently advertised as \$0.0645/KWH on the programs website. This reduction in cost could help fund additional energy efficiency measures.

## Fuel Oil

The buildings quarterly average fuel oil consumption is 1,334 gallons per quarter. This fuel oil usage is solely used for space heating. The maximum fuel oil consumption occurred in January-March 2019 and

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was approximately 2,402 gallons. See **Appendix E** for a detailed breakdown of the fuel oil utility information mentioned above.

## Suggested Building System improvements and Benefits

The below items are the major low cost and capital improvement measures that should be addressed by the building. Detailed benefits can be found in the **Appendix G**.

### Low Cost Measures

1. Insulate steam and hot water piping.
2. Repair damaged insulation on exterior refrigerant piping and provide weatherproof jacketing.
3. Reconfigure condenser farm to allow for proper airflow.
4. Install light switches with vacancy sensors in occupied spaces.
5. Replace dial thermostats with programmable thermostats.
6. Implement maintenance protocols listed in Appendix F.
7. Provide weatherstripping for fire door in Court Room, entry door in Detective's Office, Police Control Room.

### Capital Improvement Measures

1. Replace existing boilers with gas-fired condensing boilers.
2. Insulate Storage Room, Police Control Room, furring wall.
3. Replace entry doors to Court Room.

Very truly yours,



EP ENGINEERING

Evan Parganos, P.E.



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## Appendix

### Appendix A – Building Specific Information

Building		
Owner/Operator Name	Village of Irvington	
Building Name	Irvington Village Hall	
Site Address	85 Main Street	
City	New York	
State	New York, 10533	
Building Uses	Offices/Police Station/Performing Arts	
Building Area (gross)	19,328 SF	
Year Built	1900	
Use		
Cellar		Police Station: Admin, Dispatch, Court House
1 <sup>st</sup> Floor		Offices: Building Dept, Clerk’s Office, Admin
2nd Floor		Performing Arts: Theater, Dressing Rooms
Occupancy		
<u>Hours of Operation</u>		
Police Station	24/7	
Village Hall	8:30 AM – 5:00 PM M-F	
Theater	5:00 PM – 9:00 PM All Week, October-May	

### Space Function Analysis

#	Space Function Type	Gross Floor Area	Weekly Operating Hours	Weeks/Year	# Occupants	# PCs	Principal Lighting Type	Principal HVAC Type	% of Spaces Heated	% of Spaces Cooled
1	Courthouse	900	40	52	40	2	LED	Split AC & Hot Water Radiator	100%	100%
2	Office	3552	168	52	15	12	LED	Split AC & Hot Water Radiator	100%	50%
3	Office	5761	40	52	25	16	LED	Split AC & Hot Water Radiator	100%	60%
4	Other	7963	28	35	250	0	LED	Steam Radiators, No AC	100%	0%
<b>Total</b>		<b>18176</b>			<b>330</b>	<b>30</b>				

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## Appendix B – Equipment Inventory Log

Existing Heating & Cooling Equipment Inventory						
TAG	LOCATION	SERVICE	MANUFACTURER	MODEL	CAPACITY	NOTES
AC-1	Alley	Court House	Mitsubishi	PUZ-A36NHA6	36,000 BTUH	Single-Split Heat Pump AC Unit. Approx 5 years old.
AC-2	Alley	Cellar	Mitsubishi	MXZ-3B30NA	30,000 BTUH	Multi-Split Heat Pump AC Unit. Approx 7 years old.
AC-3	Alley	Cellar	Mitsubishi	MXZ-2B20NA	20,000 BTUH	Multi-Split Heat Pump AC Unit. Approx 6 years old.
AC-4	Alley	Court House	Mitsubishi	MUZ-GL15NA	15,000 BTUH	Single Split Heat Pump AC Unit. Approx 3 years old.
AC-5	Alley	Court House	Mitsubishi	MUZ-GL15NA	15,000 BTUH	Single Split Heat Pump AC Unit. Approx 3 years old.
AC-6	Alley	Court House	Mitsubishi	MXZ-3C24NA2	24,000 BTUH	Single Split Heat Pump AC Unit. Approx 1 year old.
AC-7	Alley	Court House	Mitsubishi	MUZ-GL12NA	12,000 BTUH	Single Split Heat Pump AC Unit. Approx 4 years old.
AC-8	Alley	Court House	Mitsubishi	MUZ-GE12NA	12,000 BTUH	Single Split Heat Pump AC Unit. Approx 6 years old.



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AC-9	Alley	1st Floor	Fujitsu	AOU9C1	9,000 BTUH	Single Split Heat Pump AC Unit. Approx 6 years old.
AC-10	Outside Detective's Office	1st Floor	Mitsubishi	MUZ-GL12NA	12,000 BTUH	Single Split Heat Pump AC Unit. Approx 4 years old.
B-1	Cellar Mechanical Room	Cellar & 1st Floor	Weil McLain	76 Series Model 576	343,000 BTUH	Oil-fired hot water boiler. Over 15 years old.
B-2	Cellar Mechanical Room	Theater	Weil McLain	80 Series Model 680	634,000 BTUH	Oil-fired steam boiler. Approx 5 years old.
WH-1	Cellar Mechanical Room	1st Floor & Cellar	Bradford White	RE350S6	4.5 kW	50 Gallon Electric water heater. Approx 5 years old.

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### Appendix C – Lighting Level Information

#### Police Department Lighting Inventory

LOCATION	MANUFACTURER	FIXTURE MODEL	WATTAGE	QUANTITY	TOTAL WATTAGE	NOTES
Police Department	Maxlite	12A19DLED30	12	8	96	LED 12W "A19" Lamp
Police Department	Maxlite	10A19DLED39	10	1	10	LED 10W "A19" Lamp
Police Department	Maxlite	6PLGX23LED27	6	3	18	2 Pin 6W Bypass Ballast Lamp
Police Department	Maxlite	L15T8SE440-G	15	3	45	LED T8 4' - 2 Lamp
Police Department	Maxlite	L15T8SE440-G	15	59	885	LED T8 4' - 4 Lamp
Police Department	Maxlite	17A19DLED39	17	1	17	LED 17W "A19" Lamp
Police Department	Maxlite	U16T8DF240	16	7	112	LED U - 2 Lamp

#### Theater Lighting Inventory

LOCATION	MANUFACTURER	FIXTURE MODEL	WATTAGE	QUANTITY	TOTAL WATTAGE	NOTES
Theater	Maxlite	7A19DLED27	7	40	280	LED 7W "A19" Lamp
Theater	Maxlite	12A19DLED30	12	13	156	LED 12W "A19" Lamp
Theater	Maxlite	10A19DLED39	10	3	30	LED 10W "A19" Lamp
Theater	Maxlite	FLS40U50BPC	40	8	320	LED 40W Flood Fixture
Theater	Maxlite	U16T8DF240	16	1	16	LED U - 2 Lamp
Theater	Maxlite	L15T8SE440-G	15	3	45	LED T8 4' - 2 Lamp
Theater	Maxlite	L15T8SE440-G	15	8	120	LED T8 4' - 4 Lamp
Theater	Maxlite	8PLGX23LED27	8	2	16	2 Pin 8W Bypass Ballast Lamp



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### **Village Hall Lighting Inventory**

LOCATION	MANUFACTURER	FIXTURE MODEL	WATTAGE	QUANTITY	TOTAL WATTAGE	NOTES
Village Hall	Maxlite	12A19DLED30	12	4	48	LED 12W "A19" Lamp
Village Hall	Maxlite	10A19DLED39	10	3	30	LED 10W "A19" Lamp
Village Hall	Maxlite	6PLGX23LED27	6	1	6	2 Pin 6W Bypass Ballast Lamp
Village Hall	Maxlite	L10T8SE241	10	5	50	LED T8 4' - 2 Lamp
Village Hall	Maxlite	L15T8SE440-G	15	36	540	LED T8 4' - 4 Lamp
Village Hall	Maxlite	L10T8SE241	12	2	24	LED T8 2' - 2 Lamp
Village Hall	Maxlite	L10T8SE341	12	2	24	LED T8 3' - 2 Lamp
Village Hall	Maxlite	17A19DLED39	17	5	85	LED 17W "A19" Lamp
Village Hall	Maxlite	U16T8DF240	16	6	96	LED U - 2 Lamp
Village Hall	Maxlite	SKMR1607DLED27FL	7	6	42	LED 7W MR16 Lamp
Village Hall	Maxlite	17P38DLED30FL	17	1	17	LED 17W Par38 Lamp

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## Appendix D - Electrical Utility Information

### Electricity Usage By Month (2018-2019)

Month	Usage (kWh)	Cost
Jan 2018	14080	2217.8
Feb 2018	12720	2670.95
Mar 2018	11600	1485.75
Apr 2018	12400	1764.8
May 2018	12000	1796.03
Jun 2018	12720	1699.09
Jul 2018	11920	1722.09
Aug 2018	12480	1886.31
Sep 2018	12160	2249.84
Oct 2018	12320	1810.56
Nov 2018	13760	2649.72
Dec 2018	13520	1740.61
Jan 2019	13520	1644.81
Feb 2019	14480	2010.08
Mar 2019	11600	1490.6
Apr 2019	12400	1817.69
May 2019	12560	1327.87
Jun 2019	12000	1563.04
Jul 2019	11920	1351.2
Aug 2019	13280	1744.03
Sep 2019	11040	1754.13
Oct 2019	4640	1128.46
Nov 2019	15040	2447.13
Dec 2019	13680	1696.05



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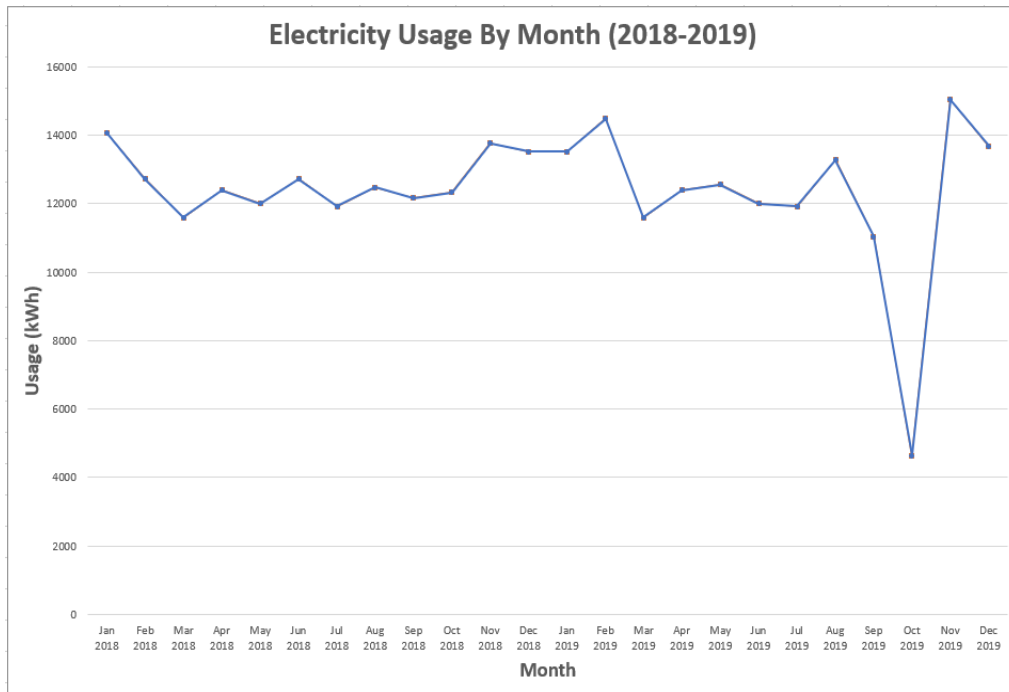


Figure 2: Chart showing the electricity usage for the building in 2018-2019

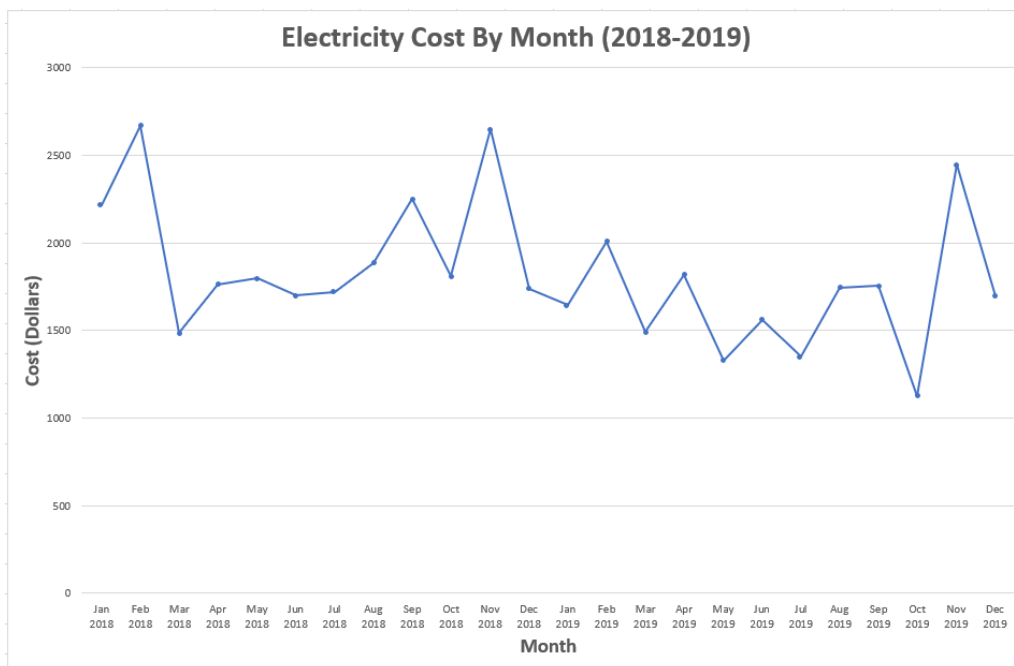


Figure 3: Chart showing the cost of electricity for the building in 2018-2019

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### **Combined Fuel End-Use Breakdown (2019)**

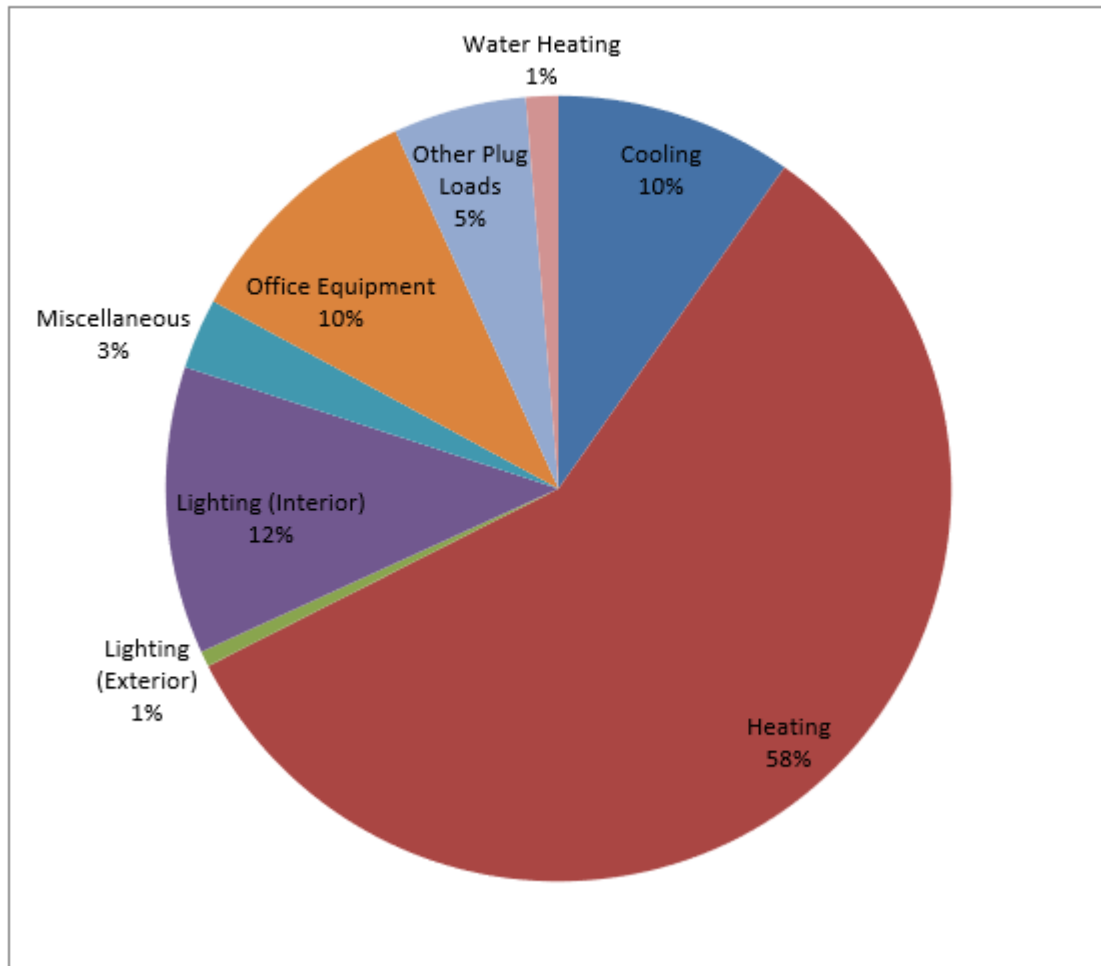


Figure 4: Chart Showing the Estimated End Use Breakdown of the Building in 2019



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## Appendix E – Fuel Oil Utility Information

### **Fuel Oil Usage By Quarter (2018-2019)**

<b>Quarter</b>	<b>Usage (Gallons)</b>	<b>Cost (Dollars)</b>
Jan-Mar 2018	2181.4	4871.99
Apr-Jun 2018	1232.9	1861.39
Jul-Sep 2018	322.4	795.31
Oct-Dec 2018	1695.9	3892.95
Jan-Mar 2019	2401.7	5343.08
Apr-Jun 2019	1014.5	2195.42
Jul-Sep 2019	195.6	437.62
Oct-Dec 2019	1625.4	3726.37

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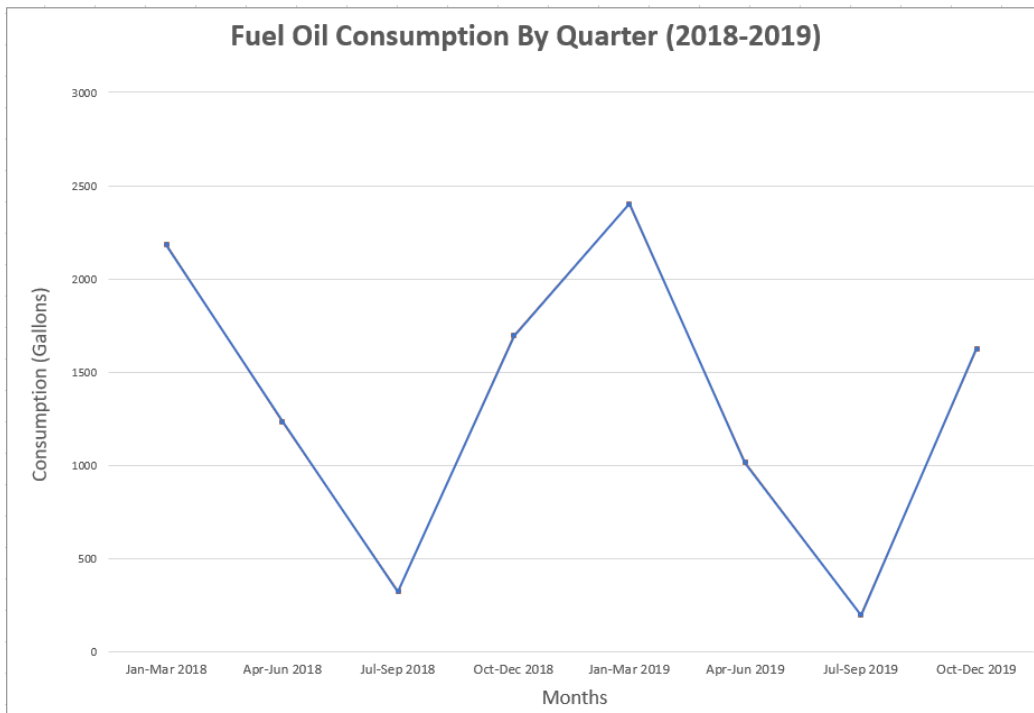


Figure 4: Chart showing the fuel oil consumption for the building in 2018-19

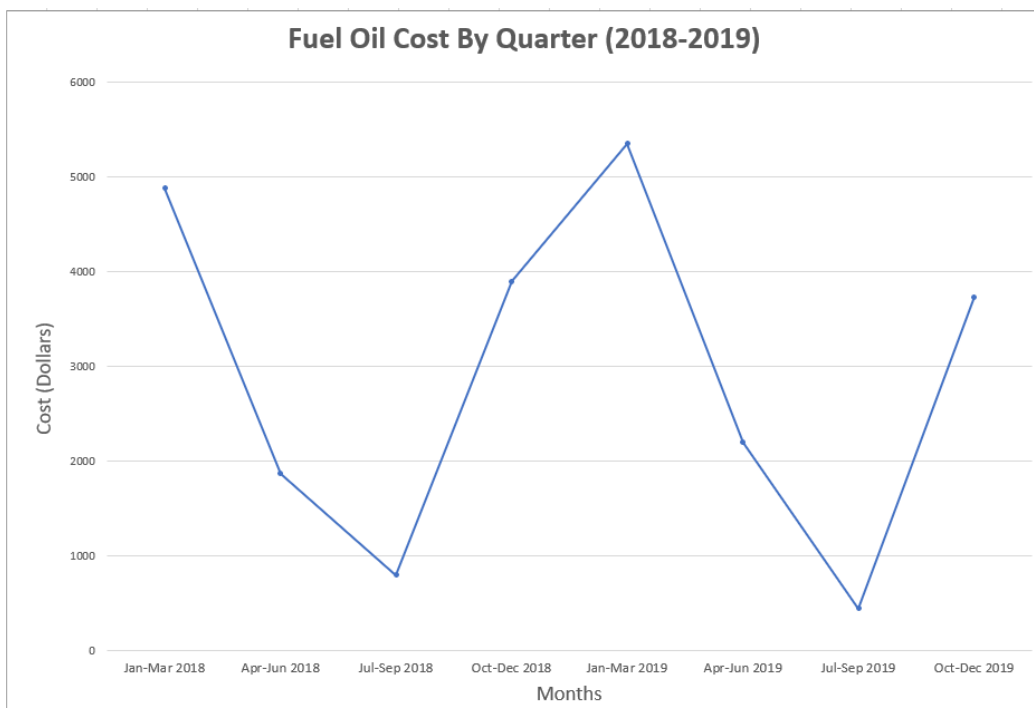


Figure 5: Chart showing the cost of fuel oil for the building in 2018-19

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## Appendix F – Recommended Maintenance Protocol

Equipment Type	Maintenance Task	Frequency
Boiler	Visually inspect fuel filter. Clean, repair, or replace as needed to ensure proper operation	Monthly
	Perform chemical testing of system water. Treat as needed to ensure proper water chemistry.	Monthly
	Check fuel pump for proper operation. Repair or replace as needed to ensure proper operation.	Quarterly
	Inspect blowdown or drain valve. Clear all debris to ensure proper operation. Repair or replace if needed.	Quarterly
	Check for evidence of leakage of fuel supply, heat transfer fluid, and flue gas. Repair as needed to ensure proper operation.	Quarterly
	Check control system and devices for evidence of improper operation. Clean, lubricate, repair, replace, or adjust components as needed to ensure proper operation.	Semiannually
	Check control box for dirt, debris, and/or loose terminations. Clean and tighten as needed.	Annually
	Check motor contactor for pitting or other signs of damage. Repair or replace as needed.	Annually
	Check for evidence of buildup or fouling, corrosion, or degradation on heat exchange surfaces. Restore as needed to ensure proper operation.	Annually
	Check for proper damper operation. Clean, lubricate, repair, replace, or adjust as needed to ensure proper operation.	Annually
	Check combustion chamber, burner, and flue for deterioration, moisture problems, condensation, and combustion products. Clean, test, and adjust combustion process for	Annually
	Inspect refractory for damage or wear. Repair or replace as necessary to ensure proper operation. Clean upper and lower drums.	Annually
	Observe burner flame at high load for correct clearance from refractory.	Annually
	Verify proper operation of safety devices per manufacturer's recommendations. Repair or replace as needed.	Annually

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Equipment Type	Maintenance Task	Frequency
Condensing Units	Check control system and devices for evidence of improper operation. Clean, lubricate, components as needed to ensure proper operation. repair, adjust, or replace	Semiannually
	Check fan belt tension. Check for belt wear and replace if necessary to ensure proper operation. Check sheaves for evidence of improper alignment or evidence of wear and correct as needed.	Semiannually
	Check variable-frequency drive for proper operation. Correct as needed.	Semiannually
	Check control box for dirt, debris, and/or loose terminations. Clean and tighten as needed.	Annually
	Check motor contactor for pitting or other signs of damage. Repair or replace as needed.	Annually
	Check fan blades and fan housing. Clean, repair, or replace as needed to ensure proper operation.	Annually
	Check motor contactor for pitting or other signs of damage. Repair or replace as needed.	Annually
	Check refrigerant system pressures or temperatures. If outside of recommended levels, find cause, repair, and adjust refrigerant to achieve optimal operating levels.	Annually
	Check for evidence of buildup or fouling on heat exchange surfaces. Restore as needed to ensure proper operation.	Annually
	Check open drive couplings, bearings, and seals for evidence of wear or alignment problems. Lubricate and repair or replace as needed.	Annually
	Inspect air-cooled condenser surfaces for damage or evidence of leaks. Repair or clean as needed.	Annually
	Check low ambient head pressure control sequence for evidence of improper operation. Repair or replace components or modify software/algorithm to ensure proper operation.	Annually
	Check refrigerant oil levels for refrigerant systems with oil pressure/level controls. Repair, replace, or adjust as needed to ensure proper operation.	Annually

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Equipment Type	Maintenance Task	Frequency
<b>Indoor Section Duct-Free Splits</b>	Check for particulate accumulation on filters. Clean or replace as necessary to ensure proper operation.	Quarterly
	Check control system and devices for evidence of improper operation. Clean, lubricate, repair, adjust, or replace components as needed to ensure proper operation.	Semiannually
	Check P-trap drain. Clean if necessary.	Semiannually
	Check air filter fit and housing seal integrity. Correct as needed.	Annually
	Check for proper operation of cooling or heating coil and for damage or evidence of leaks. Clean, restore, or replace as required.	Annually
	Check fan blades and fan housing. Clean, repair, or replace as needed to ensure proper operation.	Annually
	Check refrigerant system temperatures. If outside of recommended levels, find cause, repair, and adjust refrigerant charge to achieve optimal operating levels.	Annually
	Check integrity of all panels on equipment. Replace fasteners as needed to ensure proper integrity and fit/finish of equipment.	Annually
	Assess field-serviceable bearings. Lubricate if necessary.	Annually
	Check for proper fluid flow. Clean, adjust, and repair as needed to restore proper flow.	Annually
	Check drain pan, drain line, and coil for biological growth. Clean as needed.	Annually
	Check coil fins. Restore if possible. Replace coil if necessary to return to proper functioning.	Annually
	Visually inspect areas of moisture accumulation for biological growth. If present, clean	Annually
	Check condensate pump. Clean or replace as necessary.	Annually
	Check variable-frequency drive for proper operation. Correct as needed.	Annually

Equipment Type	Maintenance Task	Frequency
<b>Pumps</b>	Check variable-frequency drive for proper operation. Correct as needed.	Semiannually
	Visually inspect pumps and associated electrical components. Repair or replace as needed to ensure proper operation.	Annually
	Check control system and devices for evidence of improper operation. Clean, lubricate, repair, adjust, or replace components as needed to ensure proper operation.	Annually
	Check motor contactor for pitting or other signs of damage. Repair or replace as needed.	Annually
	Check pump drive for wear or problems due to poor alignment or poor bearing seating. Repair or replace as needed.	Annually
	Check for proper fluid flow. Clean, adjust, and repair as needed to restore proper flow.	Annually
	Check pump, piping, and seals for fluid leaks. Repair as needed.	Annually
	Assess field-serviceable bearings. Lubricate if necessary.	Annually
	Check insulation, vibration isolators, and flexible connectors for integrity. Repair as needed.	Annually

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## Appendix G – System Improvements and Benefits

Low Cost and Capital Improvements:

Low Cost Measures						
Item	Estimated Cost to Implement	Current Energy Consumption in Dollars	Percent Cost Savings [%]	Annual Energy Savings in Dollars	Payback Period	Notes
LCM #1 – Insulate Steam and Hot Water Piping	\$550	\$1006	80%	\$804.9	0.7 yrs	Approximately 50 feet of piping is accessible in each system to insulate. Assumes \$5.50 per linear foot for materials and installation. Utility rate was obtained using an average rate over the course of the past 2 years.
LCM #2 – Repair damaged insulation on exterior refrigerant piping and provide weatherproof jacketing	\$330	\$202	80%	\$161.6	2.0 yrs	Approximately 60 feet of piping is accessible to insulate. Assumes \$5.50 per linear foot for materials and installation. Utility rate was obtained using an average rate over the course of the past 2 years.
LCM #3 – Reconfigure condenser farm to allow for proper airflow	\$1,500	\$3548	20%	\$709.6	2.1 yrs	Utility rate was obtained using an average rate over the course of the past 2 years.
LCM #4 - Install light switches with occupancy sensors in occupied spaces.	\$1,700	\$2,772	30.0%	\$831	2.0 yrs	This analysis is based on occupancy sensors reducing lighting usage by 30 percent. Utility rate was obtained using an average rate over the course of the past 2 years.



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LCM #5 – Replace dial thermostats with programmable thermostats.	\$1,060	\$6,904	5.0%	\$345.2	3.1 yrs	Utility rate was obtained using an average rate over the course of the past 2 years.
LCM #6 – Implement maintenance protocols listed in Appendix F.	\$0	\$12,383	1.0%	\$124	0 yrs	Based on total cost of energy usage for cooling and heating systems.
LCM #7 - Provide weather stripping for fire door in Court Room, entry door in Detective's Office, Police Control Room.	\$800	\$3,709	5.0%	\$185	4.3 yrs	Based on estimated heating losses through existing doors.
<b>Totals</b>	<b>\$5,940</b>			<b>\$3161.3</b>	<b>1.88 yrs</b>	
<b>Capital Improvements</b>						
Item	Estimated Cost to Implement	Current Energy Consumption in Dollars	Percent Cost Savings [%]	Annual Energy Savings in Dollars	Payback Period	Notes
CI #1 – Replace Boilers with Gas-fired Condensing Boilers	\$50,000	\$11,562	18%	\$2,081	24.0 yrs	Based on a new efficiency of 98% compared to an old efficiency of 80%. Not factoring in cost of installing new gas service.
LCM #2 - Replace entry doors and window in Court Room.	\$12,000	\$2,157	20.0%	\$431	27.8 yrs	Based on estimated heating losses through existing doors and windows
LCM #3 – Insulate and air seal Storage Room, Police Control Room, furring wall.	\$15,500	\$4,681	20.0%	\$936	16.5 yrs	Based on estimated heating losses through exiting walls.
<b>Totals</b>	<b>\$77,500</b>			<b>\$3448</b>	<b>22.48 yrs</b>	



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Potential Larger-Scale Projects for Future Consideration:

1. Remove boilers and convert building heating and cooling to heat pump VRF systems. Currently cost-prohibitive and difficult to implement due to extent of interior renovation required.
2. Install solar panels on roof as renewable energy source for building. Not currently desirable due to historic exterior and limited space available on roof, but could potentially be installed at another site such as the adjacent building, which has a large flat roof surface:



Photo 17: Potential Location for Future Solar Array