Technical Energy Audit Report for
County of Fairfax, Virginia
Energy Savings Performance Contract

Submitted to: **Reston Community Center**
County of Fairfax, Virginia
2310 Colts Neck Road
Reston, VA 20191

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Tab 1
Executive Summary

To the Reston Community Center Staff and Board of Directors:
CMTA has evaluated the Reston Community Center (RCC) as a whole and audited every angle of energy consumption on site. We are excited to work alongside the RCC to ***develop and implement a project which leads not only to energy and cost savings but most importantly to carbon emissions reduction (CO_2e).*** We thus look forward in assisting RCC in achieving its strategic goal of being a responsible steward of the environment and to its community.

Project Scope – Technical Energy Audit

We've aimed for maximum carbon reduction through energy-efficient capital cost upgrades. By intelligently re-engineering the HVAC systems, energy can be saved while setting up the RCC Hunter Woods building for decades of high-performance operation. CMTA developed a comprehensive list of possible ECMs and grouped them into recommended project options as described below.

- ***Project Option #1:***

  98.55 kW (DC) Solar Photovoltaic System
  - Approximately 219 high-efficiency solar modules
  - Inverter to supply AC power to the existing 3Φ, 208V electrical system
  - Extended warranties included on the inverters
  - Construction, interconnection, startup, and commissioning performed and managed by CMTA
  - Optional annual service agreement with CMTA to maintain the system
- ***Project Option #2:***

  Project Option #2 provides RCC a new hot water plant alongside the solar array with significant energy savings, including a moderate reduction in onsite emissions, classified as scope 1 emissions. Highlights for the scope of work for this option:
  - Solar module system mentioned in Option #1
  - Comprehensive LED lighting upgrades, including redesigns and new fixtures in low lit areas
  - ***Hot water plant renovation, including new boilers and pumps***
  - ***A brand new IoT BAS system that will offer staff seamless accessibility and reliable energy savings***
  - Quick payback measures, such as cooling tower sewer credit
- ***Project Option #3:***

  Project Option #3 provides RCC with a larger electrification impact with heat recovery. This project option has the largest energy savings, with the largest reduction in onsite emissions. Highlights for the scope of work for this option:
  - Everything from Option #2 along with
  - ***A new Heat Recovery Chiller, to supplement the existing chiller including new chilled water pumps and a system conversion***

TEA Project Options Recommendations				
Project Options	Project Cost	Year 1 Energy Savings (MT, CO_2e)	Year 1 Cost Savings	Project Payback
Project #1: Solar Only	$363,949	77	$6,538	37 years
Project #2	$1,522,441	260	$37,095	26 years
Project #3	$2,200,535	297	$45,070	30 years

Ultimately, CMTA will work together with RCC to ***develop and customize*** a project with ECMs from the list that are within budget, meet facility needs, and drive RCC towards greater sustainability and energy-efficiency.

Sincerely,

Joel Sarmiento

Project Manager

TAB 2
BUILDING PROFILE

BUILDING PROFILES – AGE, OCCUPANCY SCHEDULES, SYSTEM DESCRIPTIONS

1 RESTON COMMUNITY CENTER

Location: 2310 Colts Neck Rd, Reston, VA 20191

Square Footage: 48,997

Age: 46 years (1977)

Major Renovations: 2007 – Heating Plant Rennovation
2008 – HVAC Rennovation
2011 – Cooling Plant Rennovation
2019 – Pool Rennovation

Total EUI (kBtu/ft²)	262.1
Elec EUI (kBtu/ft²)	120.3
Gas EUI (kBtu/ft²)	141.8
Metric Tons CO2 equivalent	1,590

Occupancy Schedule: Below is the regular occupancy schedule for the building.

Occupancy	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Natatorium	4:30a - 9:30p	4:30a - 9:30p	4:30a - 9:30p	4:30a - 9:30p	4:30a - 9:30p	6:00a - 9:30p	8:00a - 8:30p
Rest of the Facility	6:00a–11:00p	6:00a–11:00p	6:00a–11:00p	6:00a–11:00p	6:00a – 12:30p	6:00a – 12:30p	8:00a – 8:30p

System Descriptions

Air Distribution:

Two (2) single-zone 4-pipe air handling units (AHUs) serve the entrance/lobby and main community room. Each unit's supply fan is modulated with a VFD. Four (4) AHUs with terminal variable-air-volume (VAV) terminal units serve the main offices, meeting rooms, program offices, kitchen, dance areas, attic, and the downstairs. The VAV terminal units are fan-powered and have hot water reheat coils. A CHW/HW FCU serves the woodshop, and a CHW FCU provides cooling in the main mechanical room. A heat recovery DX/HW AHU serves the locker room areas on the lower level. The heat recovery AHU was installed in 2007. The other AHUs and the VAV boxes are from the 2008 HVAC renovation. **Appendix E** includes a HVAC zoning drawing which shows which areas are served by the existing units.

Two (2) Seresco 4-pipe pool dehumidification units (PDUs) are used to heat, cool, dehumidify, and ventilate the natoriums. PDU-1, located on the roof, serves the main natorium which contains the lap lane and therapy pools. PDU-2, located in an adjacent mechanical room serves the spa room and pool. By their nature, indoor-pool natatoriums are some of the most energy intensive spaces due to the high latent load caused by pool water evaporation.

From the drawings and sequences of operation, it was observed that the PDUs utilize energy recovery in two ways:

1. A plate-frame heat exchanger within the unit recovers latent heat from dehumidification into pool water piped into the unit.
2. The reheat coil in the PDU can also capture latent heat from dehumidification and provide air reheat.

Heating:

The hot water plant consists of four (4) Triad 750 MBH non-condensing boilers. A primary-secondary pumping system is used to circulate water from the boilers to the pool heat exchangers, pool dehumidification units, and all AHUs and VAV boxes. Each boiler has a pipe mounted two-fifths (2/5) HP pump for the HW supply and an external Powerflame burner. Two (2) base-mounted 15HP hot water pumps serve as primary pumps for the system. The 15HP pump serves the main loop of AHUs, VAVs, and FCU. There are three (3) sets of two (2) secondary hot water pumps each serving a different section of the building. Two (2) 3HP secondary hot water pumps serve the heat exchangers for the pool and domestic hot water tank. Two (2) 2HP secondary hot water pumps serve the main pool PDU. Two (2) 5HP secondary hot water pumps serve the spa PDU and ERU-A. All the hot water pumps are constant speed. The hydronic boilers and pumps were installed in the 2007 renovation. A 980-gallon domestic hot water tank and a compressed plate heat exchanger were added in 2019. The hydronic boilers serve the following equipment:

- Pool Dehumidification Units
- VAV Air Handling Units
- VAV Reheat
- Rooftop Energy Recovery Ventilation Unit
- Pool Water Heat Exchangers
- Domestic Hot Water Tank Heat Exchanger
- Fan Coil Unit A

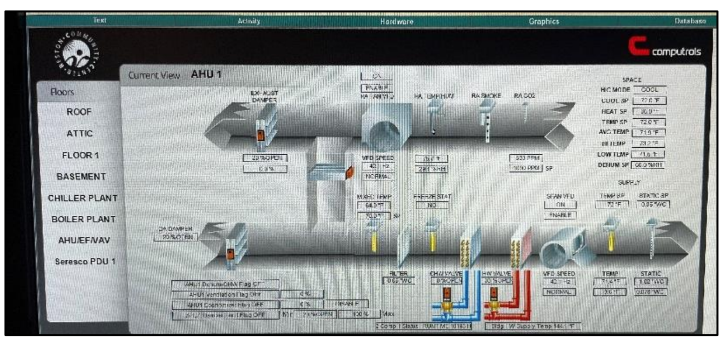
Cooling:

Chilled water is generated at Reston via a modular Artic Chill chiller and condenser water is circulated through one (1) EVAPCO closed loop induced draft cooling towers (i.e., fluid coolers) by one (1) 20HP condenser water pump. A constant-primary pumping system is used to circulate chilled water through the chiller's evaporators and to the building for conditioning and dehumidification. One (1) 20HP primary chilled water pump is used and one (1) 20 HP pump is on standby as redundancy for both the condenser water and chilled water pumps. The pumps for the chilled water system were replaced during the 2007 hot water plant renovation. The chiller and cooling tower were replaced in a 2011 cooling plant renovation. The chilled water serves the following equipment throughout the building:

- VAV Air Handling Units
- Fan Coil Units

Temperature Control:

Direct Digital Controls (DDC) are used to control and monitor equipment in the facility. The RCC has a Computrols® platform which was installed in the 2008 renovation and is nearing the end of it's useful life.



There are some HVAC equipment sequences already in place that are saving energy including

- Economizer
- Demand Control Ventilation
- Scheduling capabilities

Currently RCC has a standing maintenance contract with the company.

Pool Water Heating:

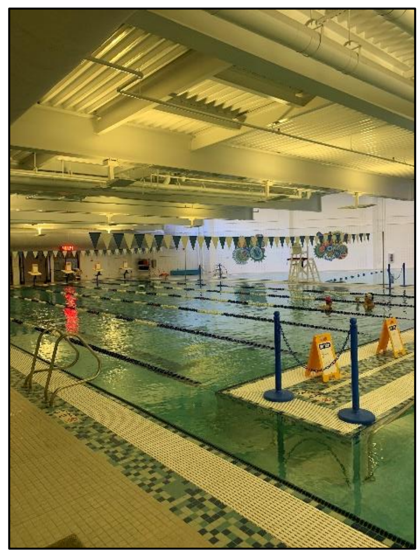
Reston Community Center contains a lap pool connected to a zero entry pool, and a therapy pool. The total volume is 216,961 gallons. Additionally, there is a small, heated spa whirlpool connected to the main natatorium. All of the pools are connected to their own pair of two (2) hot-water heat exchangers which are connected to the facility's main hydronic boiler plant. These heat exchangers were replaced in the 2019 pool renovations.

Domestic Hot Water Heating:

The current domestic hot water heating is supplied via a 980 gallon tank in the boiler room. The hot water tank is provided heater water through a plate and frame heat exchanger that is connected to the hydronic hot water system. This system was replaced in 2019 along with the pool renovation.

Lighting:

The lighting at Reston Community Center is a mix of fluorescent and LED fixtures. The natatorium received new LED fixtures in the 2019 renovation. The lobby, main community room, kitchen and other fixtures were upgraded to LED in other intermittent renovations.



Most fluorescent fixtures have 4' 30-watt T8 bulbs, 8' 71-watt T8 bulbs, and 2-ft 6" U-bend bulbs. CFL (Compact Fluorescent Light) bulbs are found in many downlight fixtures. There are a few remaining incandescent fixtures in the building.

4' and 8' Fluorescent bulbs in dance studio

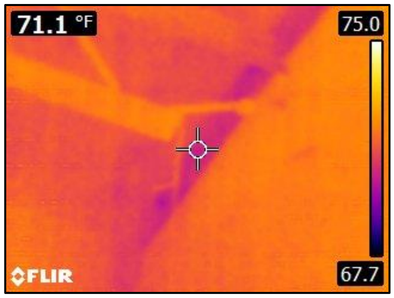
6" round CFL downlights in theatre lobby

Roof:

The roof at Reston Community Center has undergone two recent renovations. In 2022, the mechanical roof section was replaced with a Stressply IV roof type. In 2019, during the pool renovation, the back section of the roof was replaced. The front section of the roof was replaced in 2016 with a SealTite TPO roof. The map below shows the different roof sections.

Building Envelope:

Weather stripping around many doors was observed to be in poor condition. The above ceiling conditions had batt insulation and no substantial air leakage was discovered with thermal imaging.



2 Equipment Condition Summary

The table below summarizes our current assessment for the condition of all major equipment and systems at the facility. Each of our project options will not only save significant energy, but also address infrastructure improvements. **Tab 8 – Project Options** shows how proposed ECMs will improve equipment condition.

The table below is based of ASHRAE's median expected life for HVAC equipment. Numerous systems are at the end of their projected life including the circulation pumps, fluorescent lighting, and electronic controls. Reston's style of boilers are expected to last 24-25 years on average but they are listed as within 5 years of projected end of life because their burners and pipe mounted supply pumps are reaching the end of their life. The chilled water system is in good condition for the foreseeable future. All air handling equipment was installed in 2007 or 2008 renovations. This equipment could reasonably function for five more years before reaching end of life. Equipment installed in the 2019 pool renovation is still new and should function properly into the foreseeable future.

Fairfax Co. Govt. Ph 2 Equipment Age Summary	Reston CC	5 Year Projection
Boilers	16-18 years	21-23 years
Chiller	12 years	17 years
Cooling Tower	12 years	17 years
ERU-A	16 years	21 years
ACCU-A	16 years	21 years
AHUs	15 years	20 years
PDUs	4 years	9 years
Base Mounted Pumps	16 years	21 years
Pipe Mounted Pumps	16 years	21 years
Pool Pumps	4 years	9 years
Fan Coil Units	15-16 years	20-21 years
VAV Terminal Units	15 years	20 years
DWH Plate Heat Exchanger	4 years	9 years
Domestic Water Tank	4 years	9 years
Lighting	2-40 Years	7-45 years
Controls	16 Years	21 years
Pool Heat Exchangers	4 years	9 years

Legend
New or acceptable condition for the next 5 years
Within 5 years of the end of projected life
Equipment is past the end of projected life
Equipment is 5+ years past the end of projected life

Tab 3
Utility Baselines

Utility Baselines

1 Utility Account Information

The following utility account information was used to develop the baseline data for the Reston Community Center in the *Phase 3 – Technical Energy Audit*. The utility baselines described in *Sections 3, 4, & 5* represents the consumption data for Reston CC based on the facilities most recent years' worth of data. This information will be used as the basis of comparison for the determination of energy savings.

Electric Accounts

Utility - Power			
Location	Account #	Provider	Tariff
Reston CC	0706272507	Dominion	130

Gas Accounts

Utility - Fuel			
Site	Account #	Provider	Fuel
Reston CC	320005191004	Washington Gas	NG

Water/Sewer Account

Utility - Water		
Site	Account #	Utility
Reston CC	200058605	Fairfax Water

2 UTILITY RATE INFORMATION

The following utility rates were used as the basis of the energy cost savings calculations. These rates are based on the current tariff or rates identified on the utility invoices for each of the facilities.

Electric Rates

Dominion Schedule 130 – Secondary Service:

1. Distribution Charges

Basic Customer Charge	$ 91.41 / Billing Month
First 700 kW of Distribution	$ 3.068 / kW
Next 4300 kW of Distribution	$ 2.455 / kW
Additional kW of Distribution	$ 2.112 / kW
rkVA Demand Charge	$ 0.165 / rkVA

2. Electricity Supply Service

All kW of Electricity Supply	$ 7.931 / kW
Supply Adjustment first 700	($ 1.011) / kW
Supply Adjustment next 4300	($ 0.809) / kW
Any Additional	($ 0.697) / kW
First 24,000 kWh	1.763¢ /kWh
Next 186,000 kWh	1.007¢ /kWh
Additional kWh	0.667¢ /kWh
	+ All Applicable riders (varies)
	= Total Electric Charges

Gas Rates

Washington Gas Rate – Commercial Industrial Customer Rate Schedule No. 2A:

1. System Charge

System Charge	$ 22.50 / Billing Month

2. Distribution Charge
   a. Heating and/or Cooling Months

First 125 therms	54.89 ¢ /therm
Next 875 therms	44.79 ¢ /therm
Over 1,000 therms	34.15 ¢ /therm
Riders	(varies)

3. Commodity Charge – Fixed Rate

Purchased Gas	85.73¢ /therm
	=Total Natural Gas Charge

Water/Sewer Rates

The scheduled water and sewer rates effective June 2022 are included below.

Water– Fairfax Water Schedule #6

Water Service Charge	$ 128.75 (quarterly)
Water Service	$ 3.46 (per 1000 gal)
Additional Peak Use Charge	$ 3.85 (per 1000 gal)

Sewer – Fairfax County – Reston Community Center

Sewer Service Charge	$ 602.10 (quarterly)
Sewer Charge	$ 8.09 (per 1000 gal)
	= Total Water and Sewer Charges

3 Utility Benchmarking

The following tables and charts provide a detailed 1-year average energy summary of the electric, gas and water consumption for the Reston Community Center.

Facility Information

Name	Reston Community Center		**Area (ft²)**	48,997	**Occupants**	N/A
Location	2310 Colts Neck Rd, Reston, VA 20191					

Photo

Energy Summary

Electric Costs

Total ($/ft²)	$ 5.06
$/kWh Blend	$ 0.10
$/therm	$ 1.16
$/kgal	$ 13.16

Energy Use & Intensity

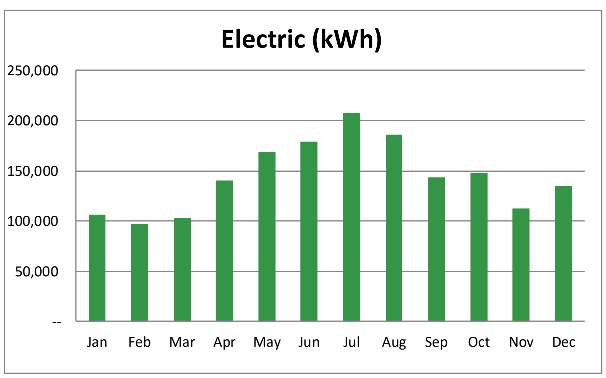
Total EUI (kBtu/ft²)	262.1
Elec EUI (kBtu/ft²)	120.3
Gas EUI (kBtu/ft²)	141.8
kgal/Occupant	N/A
W/ft²	8.31
Annual MTCO2e	1,590

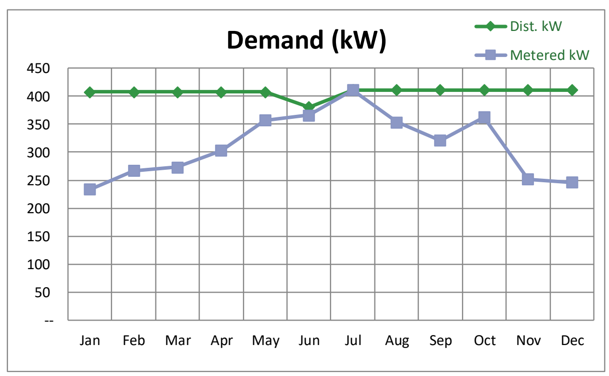
Comments

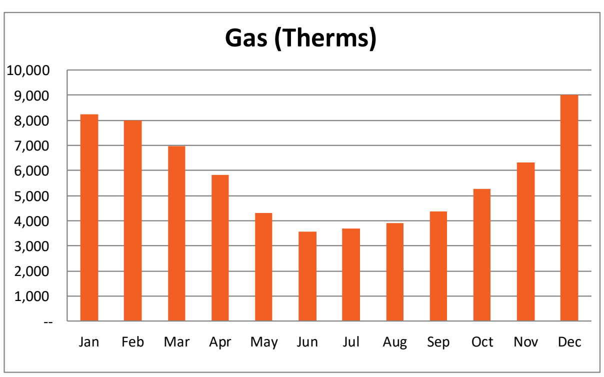
Average Energy Data

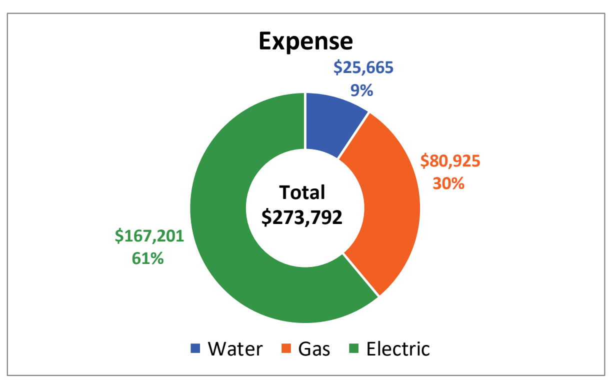
	Electric				Gas			Water		Totals	
	kWh	kW	mmBTU	Cost	Therms	mmBTU	Cost	kgal	Cost	mmBTU	Cost
Jan	106,200	408	362	$ 10,578	8,239	824	$ 7,702	--	$ -	1,186	***$ 18,280***
Feb	96,600	408	330	$ 9,596	8,008	801	$ 7,560	--	$ -	1,130	***$ 17,155***
Mar	103,200	408	352	$ 10,477	6,978	698	$ 7,730	434	$ 5,479	1,050	***$ 23,685***
Apr	140,700	408	480	$ 13,498	5,831	583	$ 7,112	--	$ -	1,063	***$ 20,610***
May	169,200	408	577	$ 14,195	4,319	432	$ 5,878	--	$ -	1,009	***$ 20,074***
Jun	178,800	381	610	$ 15,157	3,552	355	$ 4,769	373	$ 4,847	965	***$ 24,773***
Jul	207,600	411	708	$ 18,264	3,684	368	$ 5,161	--	$ -	1,077	***$ 23,425***
Aug	186,000	411	635	$ 16,271	3,910	391	$ 5,439	--	$ -	1,026	***$ 21,710***
Sep	143,700	411	490	$ 14,358	4,367	437	$ 6,161	836	$ 11,063	927	***$ 31,582***
Oct	148,200	411	506	$ 15,887	5,263	526	$ 5,532	--	$ -	1,032	***$ 21,418***
Nov	112,800	411	385	$ 13,359	6,320	632	$ 6,895	--	$ -	1,017	***$ 20,254***
Dec	134,700	411	460	$ 15,563	9,000	900	$ 10,987	307	$ 4,277	1,360	***$ 30,827***

	kWh	kW	mmBTU	Cost	Therms	mmBTU	Cost	kgal	Cost	mmBTU	Cost
Totals	1,727,700	4,887	5,895	*$ 167,201*	69,471	6,947	*$ 80,925*	1,950	*$ 25,665*	12,842	***$ 273,792***









4 Baseline Adjustments

To determine the most accurate baseline energy consumption data as the basis of savings for this project, an average of utility data from 2020-2022 was used.

The most recent rennovation to Reston Community Center was the main natorium renovation in 2019. Work done on the building since this renovation has been minor and should have minimal effects on the overall energy efficiency of the building. These baseline values will be used as the basis for energy savings calculations in this report.

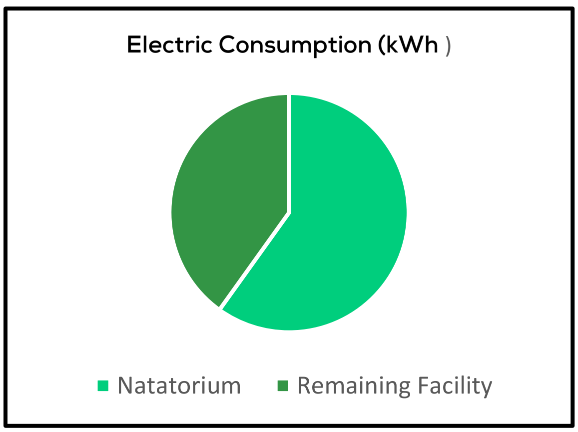
Facility Baseline Summary						
Facility Baseline Summary	Bldg sqft	Annual kWh	Annual Therm	Annual kW	Annual kGal	Baseline EUI
Reston Community Center	48,997	1,727,700	69,471	4,887	1,950	262

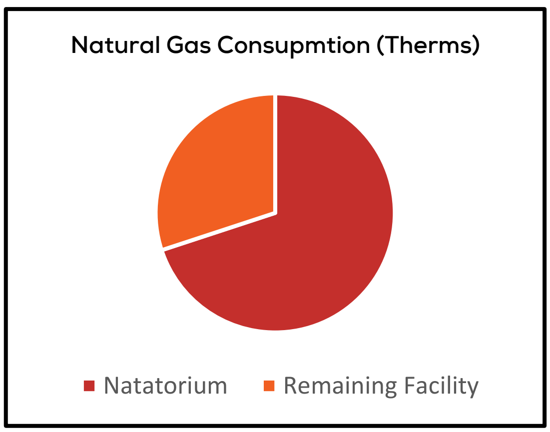
5 Facility EUI Breakdown

A natatorium energy study was completed to better understand how Reston's natatorium energy consumption is reflected in the total building energy profile. The summary table below indicates the modeled energy consumption of the natatorium, with the balance of energy usage allocated to the remainder of the facility. An eQuest building energy model was used in parallel with the natatorium energy study to confirm an accurate breakdown.

The allocations shown are approximations, as these facilities do not have sub-metering of any kind. CMTA has concluded that the natatorium makes up a large portion of the building's gas usage on its own, exceeding ***48,596 therms***. This is a tremendously high amount of energy consumption, and a hot water plant renovation, along with retro-commissioning of the existing pool units, will drive energy savings in the indoor pool spaces. More details on the Natatorium Energy Study can be found in **Appendix A**.

Reston Community Center Energy Profile Breakdown						
Bldg Section	ft^2	kWh	therms	Elec EUI	Gas EUI	Total EUI
Total Bldg	**48,997**	**1,727,700**	**69,471**	**120.3**	**141.9**	**262.2**
Natatorium	12,530	1,034,957	48,596	281.8	388.2	670.0
Remaining Facility	36,467	692,743	20,875	64.8	57.3	122.1





Tab 4
Utility Rate Analysis

Utility Rate Analysis

1 Savings Rate Determination

The savings rates, used as the basis for guaranteed savings calculations, were determined by the published tariffs provided through Dominion Energy, Washington Gas, and Fairfax Water. The estabished savings rates are below:

Electric Rates:

Utility - Power			
Provider	Tariff	$/kW	$/kWh
Dominion	130	$18.21	$0.0603

Natural Gas Rates:

Utility - Fuel		
Provider	Fuel	$/Therm
Washington Gas	NG	$1.16

Water Rates:

Utility - Water	
Provider	$/kGal
Fairfax Water	$13.16

Schedule 130

CMTA identified that the billing rates for Schedule 130 vary, based on the individual account's annual load profile. The monthly $/kW charge is proportional to the ratio of the distribution kW (the annual peak load) divided by the monthly supplied kW (the peak load over any 30-minute interval in a billed month). The less deviation from the annual peak load to the average monthly load, the lower the $/kW charge. Reston Community Center operates at a ratio of 1.1 and **$18.21** per kW. The charge per kilowatt hour ($/kWh) is dependent on the monthly kWh used; as the monthly kWh increases, the $/kWh decreases. The facility operates at an average of **$0.0603.**

2 Utility Rate Savings Opportunities

Electric Rate Change

CMTA identified potential savings from an electric rate change on the Reston CC electric accounts. Schedule 130 is currently the most favorable rate for Reston's account, as it is the most favorable rate for very high kWh accounts. As the total kWh on these accounts is reduced, savings can be achieved by switching from Schedule 130 to Schedule 100. The chart below shows the threshold at which switching rates will generate additional savings. Negative values indicate no savings generated from a rate switch. Currently, CMTA doesn't expect a rate to save the RCC money, but if ECMs are implemented through CMTA, we will montior the usage in case the building profile changes enough to warrant a rate switch.

Rate Change Analysis

Annual kWh													
700,000	40	46	51	57	62	67	73	78	84	89	95	100	106
800,000	34	40	45	51	56	62	67	72	78	83	89	94	100
900,000	28	34	39	45	50	56	61	66	72	77	83	88	94
1,000,000	22	28	33	39	44	50	55	60	66	71	77	82	88
1,100,000	16	22	27	33	38	44	49	55	60	65	71	76	82
1,200,000	10	16	21	27	32	38	43	49	54	59	65	70	76
1,300,000	4	10	15	21	26	32	37	43	48	54	59	64	70
1,400,000	-2	4	9	15	20	26	31	37	42	48	53	58	64
1,500,000	-8	-2	3	9	14	20	25	31	36	42	47	53	58
1,600,000	-14	-8	-3	3	8	14	19	25	30	36	41	47	52
1,700,000	-20	***-14.1***	-9	-3	2	8	13	19	24	30	35	41	46
1,800,000	-25	-20	-15	-9	-4	2	7	13	18	24	29	35	40
1,900,000	-31	-26	-21	-15	-10	-4	1	7	12	18	23	29	34
2,000,000	-37	-32	-27	-21	-16	-10	-5	1	6	12	17	23	28
2,100,000	-43	-38	-32	-27	-22	-16	-11	-5	0	6	11	17	22
2,200,000	-49	-44	-38	-33	-28	-22	-17	-11	-6	0	5	11	16
2,300,000	-55	-50	-44	-39	-33	-28	-23	-17	-12	-6	-1	5	10
2,400,000	-61	-56	-50	-45	-39	-34	-29	-23	-18	-12	-7	-1	4
2,500,000	-67	-62	-56	-51	-45	-40	-35	-29	-24	-18	-13	-7	-2
2,600,000	-73	-68	-62	-57	-51	-46	-40	-35	-30	-24	-19	-13	-8
2,700,000	-79	-74	-68	-63	-57	-52	-46	-41	-36	-30	-25	-19	-14
2,800,000	-85	-80	-74	-69	-63	-58	-52	-47	-41	-36	-31	-25	-20
2,900,000	-91	-86	-80	-75	-69	-64	-58	-53	-47	-42	-37	-31	-26
3,000,000	-97	-92	-86	-81	-75	-70	-64	-59	-53	-48	-42	-37	-32
3,100,000	-103	-98	-92	-87	-81	-76	-70	-65	-59	-54	-48	-43	-38
3,200,000	-109	-104	-98	-93	-87	-82	-76	-71	-65	-60	-54	-49	-44
3,300,000	-115	-110	-104	-99	-93	-88	-82	-77	-71	-66	-60	-55	-49
3,400,000	-121	-116	-110	-105	-99	-94	-88	-83	-77	-72	-66	-61	-55
3,500,000	-127	-122	-116	-111	-105	-100	-94	-89	-83	-78	-72	-67	-61
3,600,000	-133	-127	-122	-117	-111	-106	-100	-95	-89	-84	-78	-73	-67
3,700,000	-139	-133	-128	-123	-117	-112	-106	-101	-95	-90	-84	-79	-73
Reston	4,500	4,800	5,100	5,400	5,700	6,000	6,300	6,600	6,900	7,200	7,500	7,800	8,100

Annual kW

PJM Power Rebates and Energy Generation Revenue

PJM is the regional transmission organization that coordinates the movement of wholesale electricity in the Virginia energy market. C-Power Energy Management facilitates rebates and opportunities for onsite energy revenue generation for PJM customers (separate from Dominion Energy's rebates). As part of this project, CMTA is exploring all applicable opportunities and is working with C-Power to maximize energy revenue generating options. The different program types are detailed below:

Energy Efficiency Program – PJM offers energy efficiency program rebates for new lighting construction and lighting renovations. The rebate value is determined on a per kW reduced basis and increases over 4 years. The total estimated rebate for the RCC is $3,293.

Year After Completion	Value ($/kW)
1	$5
2	$7
3	$12.5
4	$12.5

TAB 5
ECM DESCRIPTIONS

Energy Conservation Measure (ECM) Descriptions

E1 LED Lighting Upgrades

CMTA has developed a turnkey high efficiency lighting upgrade for Reston CC to replace all remaining fluorescent lighting fixtures with either LED retrofit applications, LED re-lamps, or new LED fixtures. General strategies and highlights of the lighting design are included below. **Appendix B** includes a preliminary lighting layout that shows the existing fixture locations and proposed solutions. If this ECM is selected, a detailed lighting drawing set will be created, and owner feedback will be solicited. As a part of any lighting scope, CMTA will ensure proper disposal of all mercury-containing lamps, including fluorescent tubes and compact fluorescent lights (CFLs). The solutions will provide light levels that match or improve existing light levels and will provide an ***upgraded and consistent aesthetic throughout the building.*** Currently, the building is a myriad of lighting technologies, making maintenance a challenge. Previous LED upgrades are intertwined throughout the spaces, yet there are still plenty of non-LED fixtures.

Retrofit Kits

The most common fluorescent fixture in the building are 2-lamp T8 U-tube 2'x2' fluorescent fixtures. The majority of these fixtures will be converted to LED by removing the existing ballast, lamps and internal hardware and installing an LED retrofit kit that will utilize the existing fixture frame. This solution will reduce the watts per fixture from 65 W to 31 W. Some areas that this fixture exist in are the administration office, meeting rooms 1-4, computer classroom, program office, and back offices.

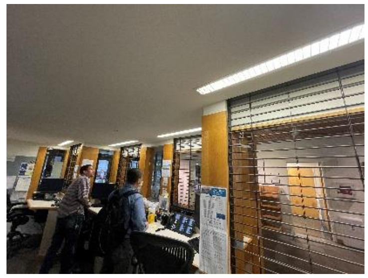


From left to right: (1) Main office, (2) Meeting Rooms 1-4, (3) Computer room

Another area receiving retrofit kits is the theatre lobby. The existing 28W, 6" round, 1-lamp CFL lamps will be replaced by a 15W LED retrofit kit.

Re-lamps

A common lamp style seen in the building are straight 2', 3', 4' and 8' fluorescent tubes. There are numerous styles of fixtures that contain these lamps. Some of these include industrial strip, pendant, and recessed fixtures.


From left to right: (1) Industrial Strip in Theatre Lobby Maintenance closet, (2) Recessed fixture in Main Office, (3) Pendant fixture in Program Office.

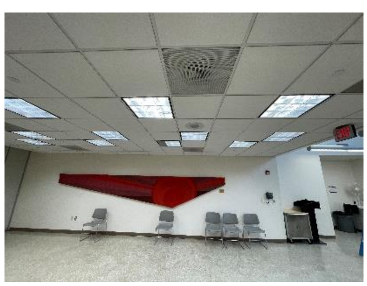
These fixtures will be re-lamped, their ballasts will be removed, and the tubes will be directly wired to line voltage. Below is a table of wattage reduction by bulb. Most fixtures will operate at half of their original wattage after the re-lamp and ballast bypass.

Bulb	Existing Wattage	New Wattage
2' T8 Fluorescent	18 W	9 W
3' T8 Fluorescent	25 W	12 W
4' T8 Fluorescent	30 W	12.5 W
8' T8 Fluorescent	71 W	25 W

This solution will be utilized for the front desk, maintenance closets, men's restroom, women's restroom, program office, and meeting room 6..

Removing Excess Fixtures

CMTA identified meeting room 6 as an area for fixture reduction. CMTA measured foot candles (FC) in the room and determined the room was over-lit in some spaces, but this over-lighting was not consistent. To provide optimal lighting while reducing energy use, four of the 2-lamp U-tube fluorescent fixtures will be removed. A detailed pre and post lighting study of the impact of this change is included in **Appendix B**. ***The remaining 12 fixtures will receive LED retrofit kits that will provide optimal consistent lighting at a reduced wattage.***




Meeting Room 6

New Fixtures

The dance studio is one area CMTA identified that needs new fixtures. Currently, the space is underlit, averaging between 24-32 foot candles, and the lumens are obstructed through old metal fins on the fixtures that make changing the lamps difficult and time consuming. New LED fixtures would provide improved lighting conditions and easier maintenance. The new light levels would be consistent, and the average is at the recommended level of 59 f.c. (see light level study in **Appendix B** on the dance studio area). Currently, the space is served by 19 8-foot T8 fluorescent lamps and 9 4-foot T8 fluorescent lamps. The new fixture plan would include 38 4-foot LED wrap fixtures to replace the 19 old 8-foot fixtures and 9 4foot LED wrap fixtures, as well as replacing the remaining 9 4-foot fixtures. Increasing the number of fixtures will provide optimal lighting for the space while still reducing overall wattage by 500 watts, due to the inefficiency of 8-foot T8 fluorescent bulbs.

E2 Solar Photovoltaic

CMTA has designed over 100 megawatts of photovoltaic systems on buildings across the country. We include photovoltaic systems on many of our designs to help achieve Net Zero Energy status. On staff, CMTA has five solar construction managers, four NABCEP certified PV installation professionals, and one NABCEP certified PV inspector. As such, CMTA is uniquely qualified to incorporate photovoltaic systems into a Guaranteed Energy Savings Contract.

Dominion Energy provides a distinctive opportunity to interconnect solar systems through a net metering agreement. Through this agreement, a building can use the electricity a PV system generates while receiving power service from Dominion. When the PV system produces more power than the building is consuming, the building's electric meter runs backward, generating credits. When the building needs more power than the PV system is producing, the meter runs forward. Net metering customers are charged only the "net" power that they consume from the utility grid. Any excess electricity produced from the PV system will be credited toward the next billing cycle. Details of the array are explained in the following sections, and the solar PV preliminary design drawing can be found in **Appendix C**.

Warranty & Maintenance

A small cost for an annual service agreement for CMTA to inspect and maintain the solar array can be included upon owner request and incorporated into project financial cash flows.

Any solar installation would also conform to ***preserve roof warranties***. The solar panels mentioned below utilize a ballasted system for mounting and will not affect or void the roof warranty. A written confirmation of warranty preservation post-solar will be obtained from the roof warranty-holder.

Lastly, any solar installation on a roof or other structure will be evaluated by a structural engineer as part of the final solar design. Each roof section will be analyzed to ensure it can bear the weight of the panels. The cost of a structural analysis is included in the costs shown.

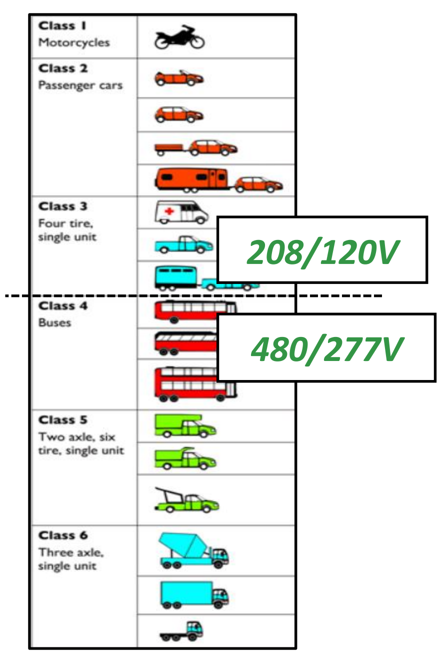
Solar Components

We have evaluated the installation of a solar PV array on two areas of the roof, the flat roof above the main lobby and the upper roof above the seating area for the stage. Our design will consist of 219 high-efficiency bi-facial commercial grade solar modules and two 50-kW inverters. The 98.55 kW solar system will allow Reston to offset a portion of the daily kWh usage.

E3 Electric Vehicle Charging Infrastructure

Reston Community Center has expressed interest in a "Community Center on Wheels," which would allow them to reach a larger portion of the community. Fairfax County policies make an electric vehicle (EV) the desired mode of transportation for new government vehicles. The current electrical infrastructure of the RCC consists of a 3,000 A main service with a 208-volt feed from Dominion. This knowledge has guided our budgeting for the design and installation of EV charging infrastructure. The current available EVs reach a threshold in vehicle size that requires a 480-volt charger, because of the larger battery size. For this reason, CMTA would recommend utilizing the current 208-volt service and installing 2-3 chargers in the back parking lot. The main benefits of choosing a vehicle from Class 1-3 are:

1. ***Short Towing Distances:*** The towing distance would be short for the Reston Community Center vehicle, and there have been many new light-duty EV trucks with increased towing capacity released to the market.
2. ***Flexibility and Added Patron Value:*** While installing infrastructure for the RCC vehicle additional chargers could be added to offer community members this option when visiting the center. This could initially be a free offering, or the charging stations could be an extra source of revenue.



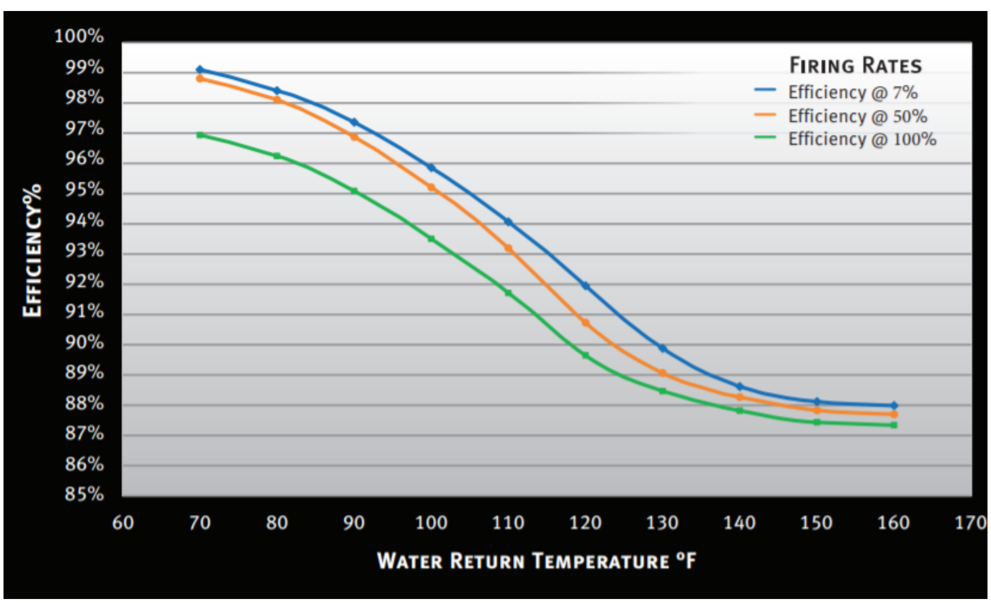
H1 Domestic Hot Water Air Source Heat Pump

The current hot water tank has a large heat storage capacity of 980 gallons. This is an ideal situation for a heat pump retrofit for the RCC's hot water needs. The new technology in air source heat pumps can provide reliable heating with ambient temperatures below 0º F. The current efficiency of the domestic hot water supply is ***less than 80%;*** however, by utilizing an electric heat pump, the coefficient of performance would range from 3-7. This means that for every kW consumed, ***the heat pump would deliver 3-7 kW for hot water heating.*** Not only would the retrofit be much more efficient, the overall heating load on the boilers would decrease allowing for potential boiler sizes when relacing the boilers.

The heat pump could be installed either outside or inside the mechanical room if paired with a hot water plant renovation. Ultimately, this ECM would reduce onsite emissions and make the hot water system more efficient.

H2A Hot Water Plant Renovation

When implementing and utilizing condensing boiler technology, *Turndown Ratio* and *Return Water Temperature* should be considered. Installing a condensing boiler does not guarantee the ultra-high efficiencies rated by the manufacturer unless the entire hot water system is designed and operated to achieve efficiency.



The chart above indicates the efficiency curves for a typical condensing boiler. Each line represents the boiler operating at a different load, i.e., 100% load would be on the coldest 0 °F day in January, while a 7% load might be a mild April afternoon. Note that the lower load lines always demonstrate more efficient operation than higher loads do. Therefore, a boiler with a better turndown ratio can not only modulate to a lower ignition level, it also burns fuel more efficiently at that lower level.

Most importantly, however, is the return water temperature that significantly drives high efficiency. At very high return water temperatures, most condensing boilers will still burn natural gas at efficiencies lower than 90% and often aren't much of an improvement over non-condensing units.

As part of our proposal to renovate the hot water system at the Reston CC, the boilers won't just be replaced. ***The system will be redesigned to achieve the highest efficiency while setting the building up for long-term reliability and cost effectiveness.***

The hot water plant serving Reston Community Center consists of four (4) Triad 750 MBH fire-tube boilers and a primary-secondary constant volume pumping system using 3-way valves. The existing boilers are non-condensing and were installed at the time of the facility's 2007 hot water plant renovation, making them 16 years old. Boiler 1 is listed as 2005 and probably was installed 2 years prior to the other boilers. While these boilers have an expected lifespan of 25 years, their parts, including the external pump and external burner, both have shorter lifespans, making replacement of the whole system a more desirable option.

With this ECM, CMTA would demolish the existing fire-tube boilers. In their place, a configuration of 2 or 3 new condensing boilers would be installed to achieve the greatest part-load fuel efficiencies. New modular boilers provide improved turndown ratios and easier maintenance. They also provide internal redundancy without requiring extra units by allowing modules to undergo maintenance while the rest of the boiler is still operational.

CMTA would also adjust the pumping operation. Currently, the system has a network of pumps that provide unnecessary redundancy and are nearing the end or past the end of their expected lifespans. Replacement of the current primary and circulation pumps with new base-mounted hot water pumps with variable frequency drives would provide greater turndown and energy savings. The 3-way valves serving the terminal hot water systems would then be replaced by 2-way valves to operate directly from the main pumps. Additionally, if this ECM is selected, CMTA will explore decoupling the pool units that require a larger heat capacity. This would allow the rest of the air handling equipment and pool heat exchangers to produce a lower hot water temperature and improve efficiency for the rest of the boilers.

Including this ECM in the project scope would provide long-term reduction in natural gas and electricity consumption ***and*** onsite emissions, while also taking care of needed upgrades to the hydronic heating plant. ***If this ECM were completed with ECM C2 – BAS Retro-Commissioning & Sequence Updates, the new hot water plant will be able to adapt to real-time changes in outside air temperature and system load to maximize energy and cost savings.***

H2B Central Plant Renovation & Electrification

This ECM would incorporate all of ECM H1A while also adding chilled water scope. A natatorium presents a unique load profile where there are consistent hot water loads year-round. In a non-natatorium the loads would trade off between chilled and hot water loads. However, at the Reston Community Center there are simultaneous loads, from April to October. ***This means that heat recovery,*** the heat we are removing from the building's air, can be transferred to the hot water system. The technology that CMTA is proposing to enable this is a dedicated water to water heat recovery chiller (HRC) that's piped into both hydronic systems (like the one pictured below).

This provides multiple levels of savings:

1. ***Increased Hot Water Plant Efficiency -*** The heat recovered from the building will decrease the natural gas usage of the boilers.
2. ***Increased Chilled Water Plant Efficiency -*** The existing chiller requires the cooling tower and condenser pump to operate to vent heat outside, but during lower load chilled water times, the new Heat Recovery Chiller (HRC) would reject heat to the hot water system and effectively reduce the annual usage of the cooling tower and condenser pump.

While adding this extra chiller, CMTA would also implement an upgrade of the entire chilled water system to maximize efficiency by converting it from constant volume to variable volume. This would require new unit valves at the air handlers and new system pumps, similar to the hot water system conversion in ECM H1A.

The proposed pool heat recovery system at Reston Community Center is similar to the system that was recently installed at Cub Run RECenter in Chantilly through a CMTA project. The Cub Run project was just completed in October 2022, but since the similar upgrade of high efficiency boilers combined with an HRC, the natural gas usage ***has decreased by ~44%.*** Also important to note is that the Cub Run pool units have their own chilled water system, providing more heat recovery. We are confident in ample savings from a similar system at Reston Community center.

CMTA has also implemented this technology for the Science Laboratory design at Bluegrass Community and Technical College (BCTC), which won a 2020 ASHRAE Technology Award. Although the BCTC design was for a new building, not a system redesign, the intent and basic functionality are very similar. This ECM is intended to utilize refrigerant heat recovery to drive the energy efficiency of an intrinsically energy intensive space with simultaneous cooling and heating loads as low as possible using a proven approach. CMTA has included a copy of the BCTC ASHRAE Technology Award Case Study in Appendix G for reference.

C1 Building Automation System Retro Commissioning & Sequence Updates

CMTA discovered opportunities for energy savings by adding and refining the existing controls sequences of operation. Evaluating the BAS would give us the opportunity to review and retro-commission certain aspects, such as scheduling, setpoints, and equipment operation. In some cases, CMTA may replace failed sensors or devices, or advise the RCC on equipment that is not functioning as intended.

To perform this scope, the RCC should ensure remote access to the BAS so that CMTA can continuously review schedules, setpoints, and trend data. Additionally, it's important that CMTA's engineers and controls technicians can remotely triage and troubleshoot any issues during the commissioning process.

The Reston Community Center currently uses a Computrols BAS system installed in 2008. There were multiple opportunities for energy savings with the existing controls system that were found via on site investigation; see Appendix D for a summary. Additionally, some schedules and setpoints need to be optimized. For example, the BAS indicates that the air handlers for the entire building are scheduled in parallel, although some spaces may not be used during events in the community room or early in the morning when just the natatorium is in use. By reconciling schedules and fine-tuning the system, energy savings can be realized for the RCC.

There are also some sequences that could be upgraded in the existing system to reduce HVAC-related energy output. For example, a duct static pressure setpoint reset sequence may be implemented for the Variable Air Volume units. This would modulate the duct static pressure down during periods of mild-to-moderate loads for increased fan energy savings.

BAS RETRO CX AND SEQUENCE UPDATE		
Sequence of Operation	**Existing**	**Post-Project**
Remote Access without a dedicaed IP		
Optimize Building Schedules & Zone Setbacks		X
Occupied Standby Zone Setbacks		
Cooling/Heating System Lockouts	X	X
Optimal Start Warm-Up/Cool Down		
Central Plant Enable on Valve Requests		
Pumping System Optimizations		
Restore/Implement Economizer Controls	X	X
AHU Supply Temperature Reset		X
AHU Duct Static Pressure Reset		X
Chilled Water Supply Temperature Reset		
Hot Water Supply Temperature Reset		X
CO_2 Based Demand Controlled Ventilation	X	X

C2 New Building Automation System with Advanced Energy Sequences

One of the largest culprits of poor energy performance in commercial buildings is temperature controls. Some buildings utilize outdated control systems, or else the schedules, setpoints, and sequences have fallen into disarray. In our onsite investigation, it was discovered that parts of the control system aren't operating as intended, and valves aren't opening all the way as directed. The goal of this ECM is to integrate all new and existing equipment into a new IoT controls platform with advanced energy savings sequences.

CMTA recommends renovating as many systems and replacing as much equipment as possible while implementing a new BAS system for optimal reliability and maximum energy savings. In our experience, controlling old equipment with obsolete technology can often present maintenance and energy saving challenges. Whether equipment is replaced through the GESC or outside of our scope, CMTA encourages the RCC to make needed HVAC upgrades concurrent with, or soon after the installation of a new BAS.

The following sequences of operation would be implemented:

NEW BAS SYSTEM WITH ADVANCED ENERGY SEQUENCES		
Sequence of Operation	**Existing**	**Post-Project**
Remote Access without a dedicaed IP		X
Optimize Building Schedules & Zone Setbacks		X
Occupied Standby Zone Setbacks		X
Cooling/Heating System Lockouts	X	X
Optimal Start Warm-Up/Cool Down		X
Central Plant Enable on Valve Requests		X
Pumping System Optimizations		X
Restore/Implement Economizer Controls	X	X
AHU Supply Temperature Reset		X
AHU Duct Static Pressure Reset		X
Chilled Water Supply Temperature Reset		X
Hot Water Supply Temperature Reset		X
CO_2 Based Demand Controlled Ventilation	X	X

Optimize Building Schedules and Zone/Equipment Setbacks

This ECM implements zone, equipment, and ventilation schedules that set back based on the actual building occupancy schedule. By setting back the systems during unoccupied periods, significant reductions in building energy consumption will be achieved. Optimal Start with "intelligent learning" will be incorporated so that the BAS can learn over time when a unit should begin morning warm-up/cool-down so that the temperature reaches occupied setpoint precisely at the start of the occupied period. The BAS uses historical data, including distance from setpoint, outside air temperature, and time to reach setpoint, in order to predict and optimize future warm-up and cool-down procedures. A 3-5°F occupied setpoint dead band follows ASHRAE 90.1 requirements and will be discussed and applied with owner input if this ECM is selected.

Occupied Standby Zone Setbacks

A standby mode will be established to set back zones that are unoccupied during the building's scheduled occupied mode. When a zone becomes unoccupied during regular occupied hours, the HVAC system will be set back to the standby setpoints until the space either becomes occupied or until the space is scheduled to go into full setback mode. Occupancy will be detected by existing occupancy sensors or new thermostats with built-in occupancy sensors. This will only apply to multi-purpose fitness classrooms, and zones will setback 3 degrees from typical occupied setpoints in order to provide a quick temperature recovery upon detection of occupancy. Outside air dampers, where applicable, will be shut during occupied standby zone setbacks. If implemented on a VAV system, the VAV box damper will shut while a particular zone is in occupied standby setback.

Cooling/Heating System Lockouts

This is a controls strategy where the heating system and cooling system are locked out, based on zone or outside air conditions, to avoid heating and cooling simultaneously. Where airside economizers are present, the lockouts and dead bands will be coordinated with economizer operational ranges.

Pumping System Optimizations

Variable speed pumping system differential setpoints will be optimized and a differential pressure reset schedule will be implemented to further reduce energy consumption during low load periods. Lead/Lag pumping setpoints will be evaluated to minimize pumping energy.

Restore/Implement Economizer Controls

AHU Economizer functionality will be restored and proper enable/disable setpoints will be configured.

AHU Supply Air Temperature Reset

For VAV air handling units, the supply air temperature setpoint will be reset in response to outside air temperature within a limited control range in the heating and cooling modes. Discharge air temperature from the energy recovery ventilation units will also be reset in response to ambient temperature.

AHU Duct Static Pressure Reset

Where the VAV controllers report damper position back to the control system, duct static pressure reset will be implemented to reset the duct static pressure in response to the VAV box airflow demand.

Chilled Water Temperature Reset

In low load conditions, based on ambient air temperature, the chiller CHW supply temperature will be reset upward to reduce energy consumption.

Hot Water Temperature Reset

The hot water plant temperature setpoint will reset downward in low load conditions, based on ambient air temperature, to reduce boiler energy consumption. For condensing boilers, it is beneficial to reset as low as possible to achieve the greatest efficiencies while still satisfying coil demand.

CO_2-Based Demand Controlled Ventilation

Carbon dioxide sensors will be installed to sense changes in occupancy so the outside air intake can be reduced from design flow during periods of low occupancy.

This ECM involves installing controllers, valves, actuators, sensors, and other hardware needed to complete the new IoT BAS system for all equipment. This will be a IoT system using a tested product called 75F that offers unique capabilities, such as secure remote access and recurring remote software upgrades at a reduced price because of minimal wiring required.

It is highly recommended that a new BAS system be implemented in tandem with renovating the HVAC systems at the RCC. By combining a new BAS system with new boilers/or a heat recovery chiller, the RCC will be set up long-term for high-performance and reliable operation. The system is flexible and can also be easily retrofitted when it comes time to change out the air handling equipment.

P1 Cooling Tower Sewer Credit

CMTA investigated sewer cost reduction where some of the domestic water used does not end up in the sewer system. This is the case at Reston Community Center where some of the domestic water evaporates or drifts from the cooling tower system.

Typically, the sewer costs are based on the amount of water read through the water meter. By deducting the cooling tower makeup water from the volume of sewer, sewer charges are reduced. The amount of water that will qualify for sewer credit will be determined each month by installing a sub-meter on the cooling tower make-up water system and deducting the sub-meter’s water use from the main account water use every billing period.

This ECM has also been implemented at Cub Run RECenter with positive results, and CMTA has coordinated this work with Fairfax Water successfully.

The table below indicates the calculated savings from the sewer deduct meter, by month, for a total of 432.5 kGal deducted annually:

Cooling Tower Sewer Deduct - Estimated Savings					
Month	% of Max	Evaporation (kGal)	Drift (kGal)	Blowdown (kGal)	Net Sewer Deduct (kGal)
January	0	0.0	0.0	0.0	**0.0**
February	0	0.0	0.0	0.0	**0.0**
March	0	0.0	0.0	0.0	**0.0**
April	0.11	22.1	4.7	-5.0	**21.8**
May	0.317	63.7	4.7	-14.4	**54.0**
June	0.46	92.4	4.7	-20.9	**76.2**
July	0.55	110.5	4.7	-25.0	**90.2**
August	0.64	128.6	4.7	-29.1	**104.2**
September	0.36	72.3	4.7	-16.4	**60.7**
October	0.133	26.7	4.7	-6.1	**25.4**
November	0	0.0	0.0	0.0	**0.0**
December	0	0.0	0.0	0.0	**0.0**
TOTAL		**516.4**	**33.1**	**-116.9**	**432.5**

Tab 6
ECM Savings Summary

ECM Savings Summary

1 ECM List

Reston Community Center ECM List								
ECM No.	ECM Description	Year 1 Electric Savings (kWh)	Year 1 Fuel Savings (Therm)	Year 1 Total Energy Savings (MT, CO2e)	Year 1 Energy/Water Savings	Year 1 O&M Savings	ECM Cost	Simple Payback (Yrs.)
E1	LED Lighting Upgrades	30,997	-	21.9	$ 3,490.12	$ 340.00	$ 63,745.53	16.6
E2	Solar Photovoltaic	108,405	-	76.6	$ 6,537.91	$ -	$ 363,949.29	55.7
E3	EV Charging Infrastrucutre	-	-	-	$ -	$ -	$ 183,067.50	N/A
H1	DHW Air Source Heat Pump Retrofit	-91,809	9,922	-12.3	$ 3,655.97	$ -	$ 138,687.50	37.9
H2.a	Hot Water Plant Renovation	10,688	6,939	44.3	$ 8,693.80	$ 448.00	$ 885,880.28	96.9
H2.b	Central Plant Renovation and Electrification	10,688	13,814	80.8	$ 16,668.92	$ 448.00	$ 1,563,974.98	91.4
C1	BAS Enhanced Energy Sequences & Retro Cx	83,916	4,636	83.9	$ 10,438.73	$ -	$ 85,590.00	8.2
C2	New BAS System with Advanced Energy Strategies	114,540	6,885	117.5	$ 14,894.33	$ 5,492.96	$ 200,940.59	9.9
P1	Cooling Tower Sewer Credit	-	-	-	$ 3,478.70	$ -	$ 7,925.00	2.3
Facility Total (Project Option #1) Solar Only		108,405	0	77	$ 6,537.91	$ -	$363,949.29	
Facility Total (Project Option #2) Includes: E1, E2, H2.a, C2, P1		264,630	13,824	260	$ 37,094.86	$ 6,280.96	$1,522,440.68	
Facility Total (Project Option #3) Includes: E1, E2, H2.b, C2, P1		264,630	20,699	297	$ 45,069.98	$ 6,280.96	$2,200,535.38	

The project payback is calculated later in the report inside the project options and cash flows

2 Annual Solar Savings

The expected annual solar production amounts are shown in the table below. The descending values account for degradation of the efficiency of solar modules themselves and are calculated as: 2% degradation after the first year, followed by 0.55% every year thereafter. Additionally, CMTA has included the production amount and cost difference for a smaller solar PV system for the RCC when considering how it desires to structure the project options that fit needs and goals.

Year	Reston Community Center (98.55 kW)	
	Solar kWh Production	Solar Cost Savings (2.5% Esc.)
Year 1	108,405	$ 6,544
Year 2	106,237	$ 6,573
Year 3	105,653	$ 6,701
Year 4	105,072	$ 6,830
Year 5	104,494	$ 6,963
Year 6	103,919	$ 7,097
Year 7	103,347	$ 7,235
Year 8	102,779	$ 7,375
Year 9	102,214	$ 7,518
Year 10	101,651	$ 7,663
Year 11	101,092	$ 7,812
Year 12	100,536	$ 7,963
Year 13	99,983	$ 8,117
Year 14	99,434	$ 8,274
Year 15	98,887	$ 8,434
Year 16	98,343	$ 8,598
Year 17	97,802	$ 8,764
Year 18	97,264	$ 8,934
Year 19	96,729	$ 9,107
Year 20	96,197	$ 9,283
TOTAL	**2,030,037**	**$ 155,785**

Year	Reston Community Center (55 kW)	
	Solar kWh Production	Solar Cost Savings (2.5% Esc.)
Year 1	60,500	$ 3,649
Year 2	59,290	$ 3,665
Year 3	58,964	$ 3,736
Year 4	58,640	$ 3,808
Year 5	58,317	$ 3,882
Year 6	57,996	$ 3,957
Year 7	57,677	$ 4,034
Year 8	57,360	$ 4,112
Year 9	57,045	$ 4,192
Year 10	56,731	$ 4,273
Year 11	56,419	$ 4,356
Year 12	56,109	$ 4,440
Year 13	55,800	$ 4,526
Year 14	55,493	$ 4,614
Year 15	55,188	$ 4,703
Year 16	54,884	$ 4,794
Year 17	54,582	$ 4,887
Year 18	54,282	$ 4,981
Year 19	53,984	$ 5,078
Year 20	53,687	$ 5,176
TOTAL	**1,132,948**	**$ 86,863**

System Size (kW)	Cost of Solar	Federal Credit	Annual Cost Savings	Energy Saved 1st Year (MT, $CO2_e$)	Overall Payback (years)
98.55	$363,949.00	$92,807.00	$6,536.82	77	37
55	$244,090.00	$62,242.95	$3,648.15	43	44

The overall payback is smaller than simple payback because it assumes escalation of costs of utility rates and takes into account the federal credit in year, for more information see project option cash flows.

3 Savings Calculation Method

Each ECM was analyzed by the method indicated below in order to get the most accurate savings numbers. To reflect CMTA's real-world experience, savings calculations were compared and vetted against real-world facilities that CMTA has designed and renovated. The methodology indicated will also eventually be used as the contractual basis of the IPMVP energy savings guarantee, for those ECMs selected by the County.

ECM #	ECM Description	Savings Calculation Methodology
E1	LED Lighting Upgrades	Performance Model in MS Excel
E2	Solar Photovoltaic - Option A	Helioscope, SAM, Performance Model in MS Excel
E3	EV Charging Infrastrucutre	N/A
H1	DHW Air Source Heat Pump	Whole Building Energy Model & Benchmarking Comparison
H2.a	Hot Water Platn Renovation	Whole Building Energy Model & Benchmarking Comparison
H2.B	Central Plant Renovation and Electrification	Whole Building Energy Model & Benchmarking Comparison
C1	BAS Retro Commissioning and Sequences Updates	Whole Building Energy Model, Natatorium Energy Model, & Benchmarking Comparison
C2	New BAS with Advanced Energy Strategies	Whole Building Energy Model, Natatorium Energy Model, & Benchmarking Comparison
P1	Cooling Tower Sewer Credit	Performance Model in MS Excel

4 O&M Savings Summary

Operations & Maintenance (O&M) savings are actual or approximated cost savings that are justified by real expenditures of Fairfax County. Any positive O&M savings do not include on-staff Fairfax County maintenance personnel. Lighting savings from ballast and fluorescent lamp replacements were calculated based on median ballast and lamp life and approximate material costs. Annual O&M savings on HVAC equipment were justified through conservative estimates based on actual expenditures, except where actual O&M cost history was not available.

Operations and Maintenance (O&M) Savings Summary			
ECM No.	ECM Description	O&M Savings	Savings/Cost Justification
E1	LED Lighting Upgrades	$ 340.00	Estimated material savings for new fluorescent/LED lamp and ballast replacements
H2.a	Hot Water Plant Renovation	$ 448.00	Portion of actual maitenance costs of again Hot Water infrastrucure, boost pump seals and maintenaince on the boilers.
H2.b	Central Plant Renovation and Electricfication	$ 448.00	Portion of actual maitenance costs of again Hot Water infrastrucure, boost pump seals and maintenaince on the boilers.
C2	New BAS with Advanced Energy Strategies	$ 5,493.00	Current annual costs of service contract less new service contract with new controls vendor

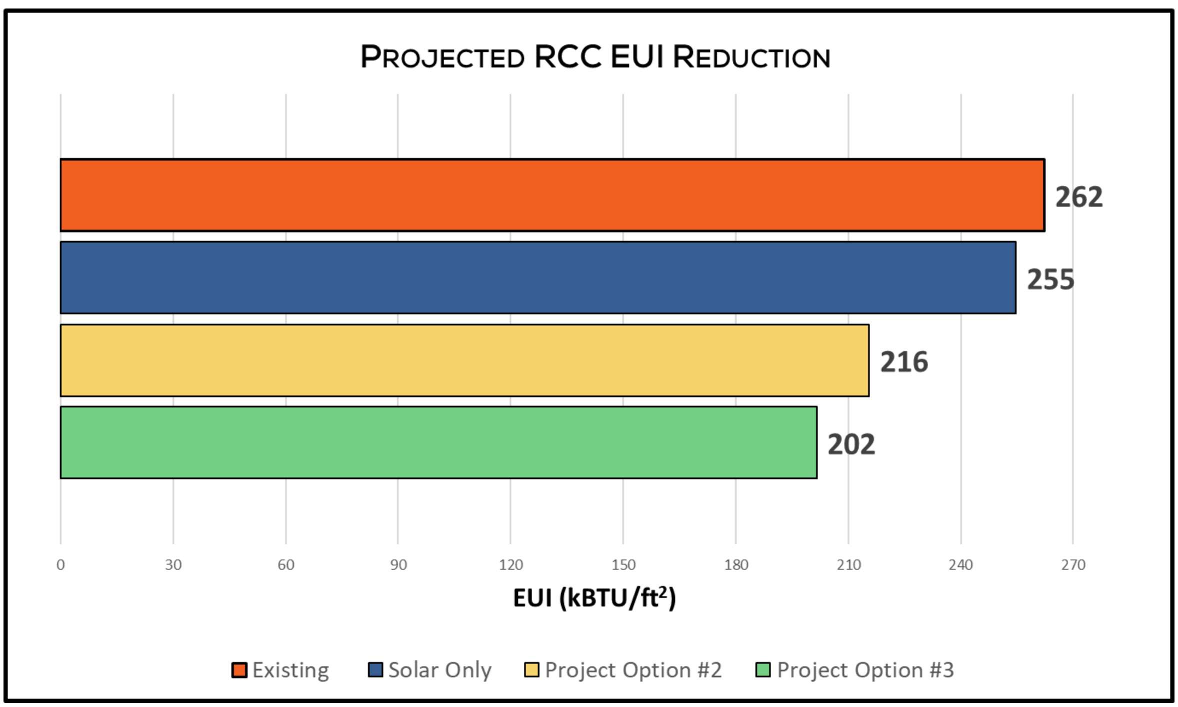
Tab 7
Project Options

Project Options

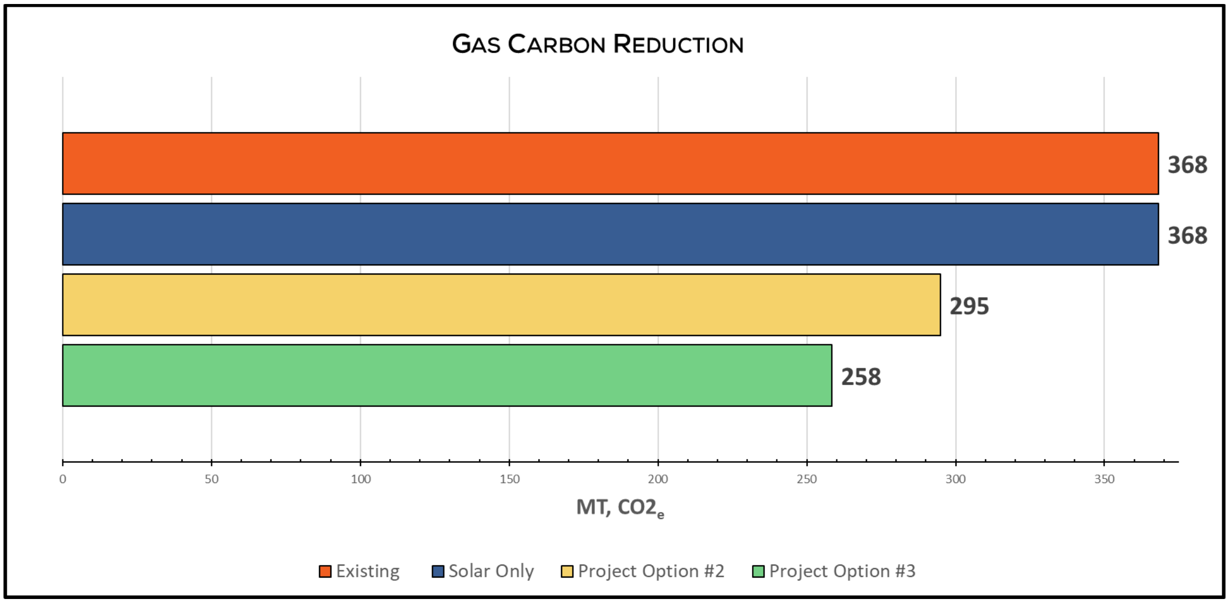
CMTA developed three project options with varying combinations of ECMs to reflect a project with 1) lowest cost/minimum scope, 2) balanced cost/moderate impact/moderate scope, and 3) highest cost/maximum impact/maximum scope. Those options are reviewed in more detail in this section, along with their effects on the condition of HVAC infrastructure. Finally, project cashflow 'Pro-Forma' statements are presented in the form of a direct-funded project. The effect of project financing is not shown here.

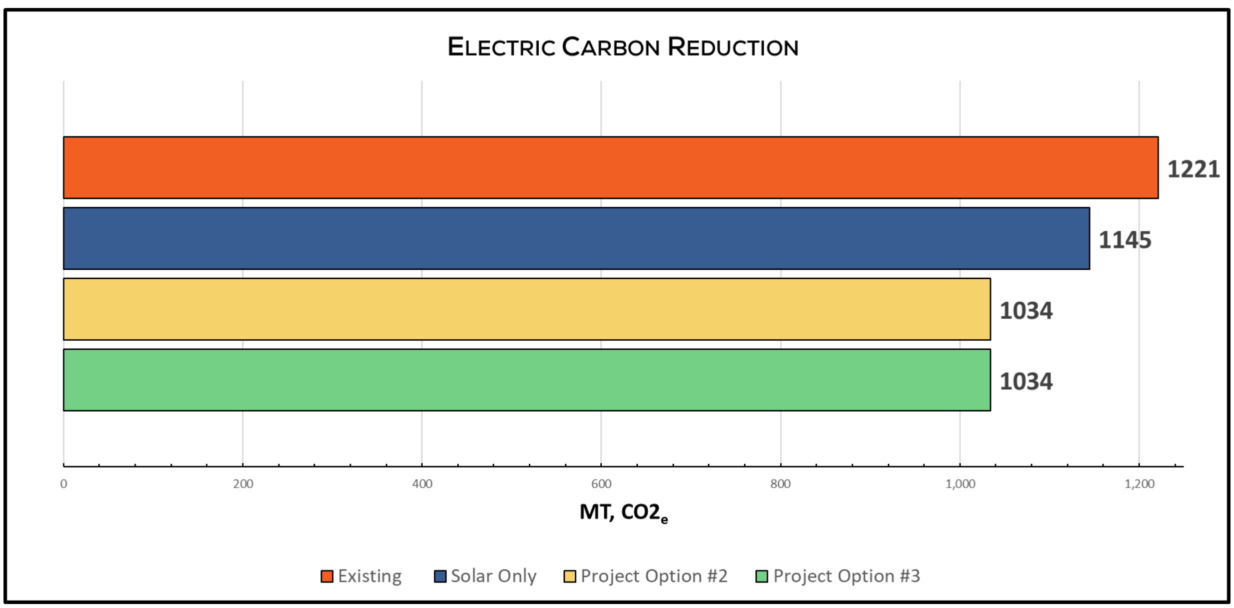
TEA Project Options Recommendations				
Project Options	Project Cost	Year 1 Energy Savings (MT, CO_2e)	Year 1 Cost Savings	Project Payback
Project #1: Solar Only	$363,949	77	$6,538	37 years
Project #2	$1,522,441	260	$37,095	26 years
Project #3	$2,200,535	297	$45,070	30 years

Each of the project options will increase the overall building efficiency. The solar only option will reduce scope 2 emissions, while both project options 2 and 3 will reduce both off site and onsite scope 1 emissions. The graph below illustrates the effect that each project scope would have on facility EUIs. On the next page are graphs showing the decrease in carbon emissions. It's important to remember that the actual savings and post-project EUI reductions may still exceed the modeled and guaranteed savings shown.



The first graph represents the scope 1, or on site, emission reductions. Here is where ***the RCC has the greater leverage and responsibility in carbon reduction***. ***Only the RCC can reduce these emissions*** through efficient redesign and responsible operation. However, the second graph represent emissions reductions that are produced from the utility provider and therefore ***RCC has shared responsibility***. Although the RCC can make the building as efficient as possible when it comes to electricity consumption it will ultimately rely on the utility to make the grid more renewable.





1 Option 1: Solar Only

CMTA submitted a Solar only report on February 2nd, 2023. Reston Community Center is an ideal candidate for a rooftop solar PV solution. An engineered drawing (preliminary design layout), a budgetary financial model, and a potential schedule are included in the Solar only report, along with preliminary specifications of the proposed solar system.

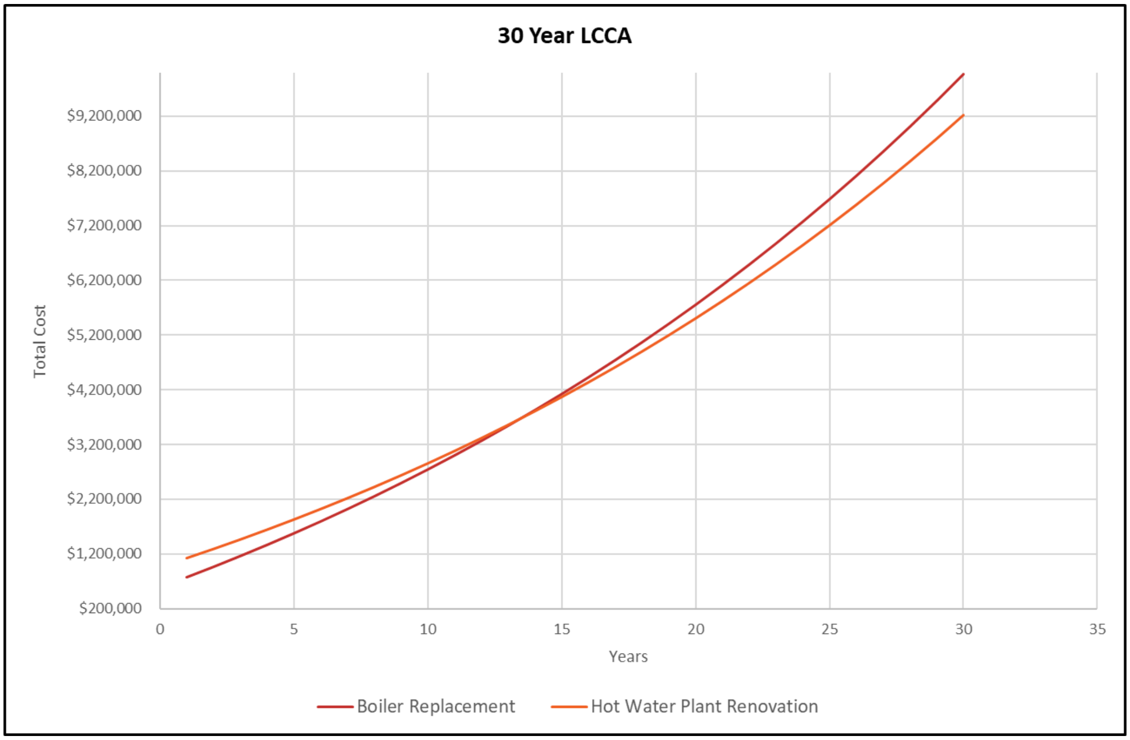
2 Option 2: Hot Water Plant Renovation

Reston Community Center has expressed interest in replacing their existing boilers with new gas-fired high-efficiency condensing boilers. To maximize the energy efficiency of condensing boilers, a full hot water plant renovation is required. The benefits of a full hot water plant renovation over a boiler replacement are described in ECM H2.a. This option combines a holistic hot water plant renovation with easy-to-implement ECMs. These ECMs will save energy while reducing the building's maintenance burden. The ECMs associated with this option are listed below:

E1	**LED Lighting Upgrades**
H2.a	**Hot Water Plant Renovation**
E2	**Solar Photovoltaic**
C1	**New BAS System with Advanced Energy Strategies**
P4	**Cooling Tower Sewer Credit**

CMTA has performed a life cycle cost analysis that compares on the one hand relacing the boiler in kind through a different procurement method with minimal energy savings, since the system is hamstrung via the constant pumping and three-way valves, versus renovating the hot water plant through CMTA. The budgeted costs and savings for boiler replacement in kind reflect today's labor and materials prices, and we combined both H2.a and C2 to ensure the system saves what we guarantee on its own to attempt a best "apples to apples" comparison.

HVAC Option	System	Cost	Annual On Site Emissions (MT, CO2e)	Annual Energy Cost	30 Year On Site Emissions (MT, CO2e)	30 Years Total Energy Cost
In Kind	Boiler Replacement	$ 586,500	368	$ 184,475	11,027	$ 9,379,261
Project #2	Hot Water Plant Renovation	$ 971,470	308	$ 165,740	9,240	$ 8,454,918
Δ		$ (384,970)	60	$ 18,735	1,787	$ 924,343



This calculation shows that after ***year 15*** the total costs (annual energy and first costs) of replacing the boilers in kind would surpass that of the hot water plant renovation, with a ***30-year total difference in energy cost of $924,343!*** One other note to explain is the emissions onsite. **Each year the hot water plant renovation project, at minimum, would produce *60 metric tons of carbon dioxide less*** than a boiler replacement in kind. Equivalent amounts would be:

6,751 gallons of gasoline consumed

7.6 homes' energy use for one year

This is equivalent to carbon sequestered by:

992 tree seedlings grown for 10 years

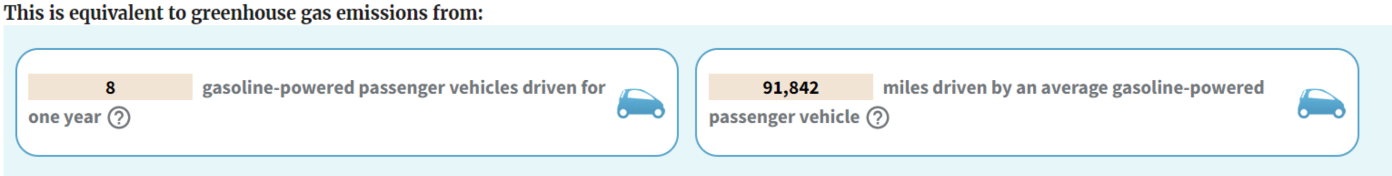
3 Option 3: Heat Recovery Central Plant and Electrification

The third project option uses many of the previous ECMs of project option 2, while also including some key upgrades. Along with replacing the hot water system, the entire central plant would be upgraded through additional chiller capacity that would recover heat rejection into the hydronic hot water system. This method of saving natural gas and reducing on site emission has been tested and proven at effective at other local CMTA projects.

E1	**LED Lighting Upgrades**
H2.b	**Central Plant Renovation and Electrification**
E2	**Solar Photovoltaic**
C1	**New BAS System with Advanced Energy Strategies**
P4	**Cooling Tower Sewer Credit**

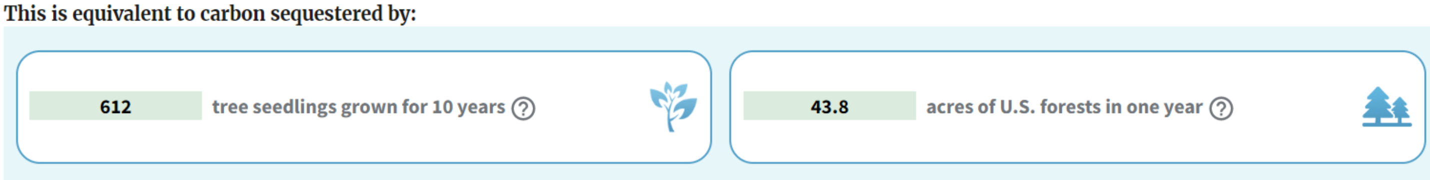
The difference in the reduction of gas emissions from Project Option #2 to Project Option #3 is 37 MT,CO_2e . That means the equivalents below would no longer be contributed to local environment and air quality.

This is equivalent to greenhouse gas emissions from:



Or as if the RCC had planted 612 trees and allowed them to grow for 10 years.

This is equivalent to carbon sequestered by:



4 HVAC Infrastructure Improvement Summary

Each of the project options aims not only to reduce energy consumption and greenhouse gas emissions, but also to make needed HVAC upgrades while setting up the facilities for improved long-term performance and reliability. The following tables illustrate how each of the project options would incorporate necessary capital improvements to the buildings in this project phase. Refer to the color-coded legend for equipment condition and expected remaining lifespan, which is based on data compiled by ASHRAE.

Legend
New or acceptable condition for the next 5 years
Within 5 years of the end of projected life
Equipment is past the end of projected life
Equipment is 5+ years past the end of projected life

Reston Community Center Equipment Age Summary	Current	Solar Only (Project Option #1)	Hot Water Plant Renovation (Project Option# 2)	Central Plant Renovation (Project Option# 3)
Boilers	16-18 years	16-18 years	NEW	NEW
Solar PV System	N/A	NEW	NEW	NEW
Chiller	12 years	12 years	12 years	12 years
Cooling Tower	12 years	12 years	12 years	12 years
ERU-A	16 years	16 years	16 years	16 years
ACCU-A	16 years	16 years	16 years	16 years
AHUs	15 years	15 years	15 years	15 years
PDUs	4 years	4 years	4 years	4 years
Base Mounted Pumps	16 years	16 years	New-16 years	NEW
Pipe Mounted Pumps	16 years	16 years	New-16 years	NEW
Pool Pumps	4 years	4 years	4 years	4 years
Fan Coil Units	15-16 years	15-16 years	15-16 years	15-16 years
VAV Terminal Units	15 years	15 years	15 years	15 years
DWH Plate Heat Exchanger	4 years	4 years	4 years	4 years
Domestic Water Tank	4 years	4 years	4 years	4 years
Lighting	2-40 Years	2-40 Years	LED	LED
Controls	Computrols (15 yrs)	Computrols (15 yrs)	NEW	NEW
Pool Heat Exchangers	4 years	4 years	4 years	4 years

5 Total Project Cashflows

The total project cashflow 'Pro-Forma' statements are included for each option. At this time, it's assumed that all ECMs will be funded directly by the RCC and no financing will be utilized. An annual energy escalation rate of 2.5% is used, based on historical trends of the local utility tariffs. An annual 2.5% escalation rate for O&M costs and savings is also incorporated to account for inflation affecting the cost of goods and services. Annual degradation of the annual solar panel production is accounted for as part of these financial models. Also, please note that the financial models take into account two one-time positive cash flows. The first one during year two is a $9,000 rebate from Washington Gas for high-efficiency boilers, and the second is the Inflation Reduction Act investment tax credit for the solar PV installation cost. This is estimated to be 25.5% of the total solar cost; the 30% of IRA guidelines less any tax consultant fees results in $92,807.07. More information on the IRA is included in **Appendix F**.

PROJECT OPTION #1

PROPOSED PROJECT FINANCIAL PRO-FORMA COUNTY OF FAIRFAX RESTON COMMUNITY CENTER - SOLAR PV SYSTEM w/ IRA ITC								
COST INPUTS				SAVINGS INPUTS				
Project Cost			**$363,949**	Year 1 Energy & Water Savings				$6,538
Fairfax County Direct Funding			$363,949	Year 1 O&M Savings				$0
Financed Amount			$0					
Municipal Advisor & Bond Attorney Fees			$0	Annual Energy Escalation Rate				2.50%
Lease Purchase			$0	Annual O&M/M&V Escalation Rate				2.50%
Interest Rate			0.00%	Project Payback Term				37 years
Financing Term (Years)			0	% of Project Directly Funded				100%
Savings Term (Years)			20					
YEAR	LEASE PAYMENT	M&V	TOTAL COST	ENERGY & WATER SAVINGS	O&M SAVINGS	TOTAL COST SAVINGS	ANNUAL CASHFLOW	CUMULATIVE CASHFLOW
Year 1	$0	$0	$0	$6,538	$0	$6,538	$6,538	$6,538
Year 2	$0	$3,000	$3,000	$6,567	$0	$6,567	$3,567	$10,105
Year 3	$0	$3,075	$3,075	$6,694	$0	$99,501	$96,426	$106,532
Year 4	$0	$3,167	$3,167	$6,824	$0	$6,824	$3,657	$110,189
Year 5	$0	$3,262	$3,262	$6,956	$0	$6,956	$3,694	$113,883
Year 6	$0	$3,360	$3,360	$7,091	$0	$7,091	$3,731	$117,613
Year 7	$0	$3,461	$3,461	$7,228	$0	$7,228	$3,767	$121,381
Year 8	$0	$3,565	$3,565	$7,368	$0	$7,368	$3,803	$125,184
Year 9	$0	$3,672	$3,672	$7,511	$0	$7,511	$3,839	$129,023
Year 10	$0	$3,782	$3,782	$7,656	$0	$7,656	$3,874	$132,898
Year 11	$0	$3,895	$3,895	$7,805	$0	$7,805	$3,909	$136,807
Year 12	$0	$4,012	$4,012	$7,956	$0	$7,956	$3,943	$140,750
Year 13	$0	$4,133	$4,133	$8,110	$0	$8,110	$3,977	$144,727
Year 14	$0	$4,257	$4,257	$8,267	$0	$8,267	$4,010	$148,738
Year 15	$0	$4,384	$4,384	$8,427	$0	$8,427	$4,043	$152,780
Year 16	$0	$4,516	$4,516	$8,590	$0	$8,590	$4,074	$156,854
Year 17	$0	$4,651	$4,651	$8,756	$0	$8,756	$4,105	$160,959
Year 18	$0	$4,791	$4,791	$8,926	$0	$8,926	$4,135	$165,094
Year 19	$0	$4,934	$4,934	$9,099	$0	$9,099	$4,164	$169,259
Year 20	$0	$5,083	$5,083	$9,275	$0	$9,275	$4,192	$173,451
TOTAL	**$0**	**$74,999**	**$74,999**	**$155,643**	**$0**	**$248,450**	**$173,451**	

Project Option #2

PROPOSED PROJECT FINANCIAL PRO-FORMA COUNTY OF FAIRFAX RESTON COMMUNITY CENTER - Project Option #2			
COST INPUTS		SAVINGS INPUTS	
Project Cost	**$1,522,440**	Year 1 Energy & Water Savings	$37,094
Fairfax County Direct Funding	$1,522,440	Year 1 O&M Savings	$6,281
Financed Amount	$0		
Municipal Advisor & Bond Attorney Fees	$0	Annual Energy Escalation Rate	2.50%
Lease Purchase	$0	Annual O&M/M&V Escalation Rate	2.50%
Interest Rate	0.00%	Project Payback Term	26 years
Financing Term (Years)	0	% of Project Directly Funded	100%
Savings Term (Years)	20		

YEAR	LEASE PAYMENT	M&V / SERVICE AGREEMENT	TOTAL COST	ENERGY & WATER SAVINGS	O&M SAVINGS	TOTAL COST SAVINGS	ANNUAL CASHFLOW	CUMULATIVE CASHFLOW
Year 1	$0	$0	$0	$37,094	$6,281	$43,375	$43,375	$43,375
Year 2	$0	$3,000	$3,000	$37,887	$6,438	$53,325	$50,325	$93,700
Year 3	$0	$3,075	$3,075	$38,797	$6,599	$138,203	$135,128	$228,828
Year 4	$0	$3,167	$3,167	$39,730	$6,764	$46,493	$43,326	$272,155
Year 5	$0	$3,262	$3,262	$40,684	$6,933	$47,617	$44,355	$316,510
Year 6	$0	$3,360	$3,360	$41,662	$7,106	$48,769	$45,408	$361,918
Year 7	$0	$3,461	$3,461	$42,664	$7,284	$49,948	$46,487	$408,405
Year 8	$0	$3,565	$3,565	$43,690	$7,466	$51,156	$47,591	$455,996
Year 9	$0	$3,672	$3,672	$44,740	$7,653	$52,393	$48,721	$504,717
Year 10	$0	$3,782	$3,782	$45,817	$7,844	$53,661	$49,879	$554,596
Year 11	$0	$3,895	$3,895	$46,919	$8,040	$54,959	$51,064	$605,660
Year 12	$0	$4,012	$4,012	$48,048	$8,241	$56,289	$52,277	$657,937
Year 13	$0	$4,133	$4,133	$49,204	$8,447	$57,651	$53,519	$711,455
Year 14	$0	$4,257	$4,257	$50,388	$8,658	$59,047	$54,790	$766,246
Year 15	$0	$4,384	$4,384	$51,602	$8,875	$60,476	$56,092	$822,338
Year 16	$0	$4,516	$4,516	$52,844	$9,097	$61,941	$57,425	$879,763
Year 17	$0	$4,651	$4,651	$54,117	$9,324	$63,441	$58,790	$938,553
Year 18	$0	$4,791	$4,791	$55,420	$9,557	$64,978	$60,187	$998,740
Year 19	$0	$4,934	$4,934	$56,756	$9,796	$66,552	$61,617	$1,060,357
Year 20	$0	$5,083	$5,083	$58,123	$10,041	$68,164	$63,082	$1,123,438
TOTAL	**$0**	**$74,999**	**$74,999**	**$936,186**	**$160,445**	**$1,198,438**	**$1,123,438**	

Project Option #3

PROPOSED PROJECT FINANCIAL PRO-FORMA COUNTY OF FAIRFAX RESTON COMMUNITY CENTER - Project Option #3								
COST INPUTS				SAVINGS INPUTS				
Project Cost			**$2,200,535**	Year 1 Energy & Water Savings				$45,070
Fairfax County Direct Funding			$2,200,535	Year 1 O&M Savings				$6,281
Financed Amount			$0					
Municipal Advisor & Bond Attorney Fees			$0	Annual Energy Escalation Rate				2.50%
Lease Purchase			$0	Annual O&M/M&V Escalation Rate				2.50%
Interest Rate			0.00%	Project Payback Term				30 years
Financing Term (Years)			0	% of Project Directly Funded				100%
Savings Term (Years)			20					
YEAR	LEASE PAYMENT	M&V / SERVICE AGREEMENT	TOTAL COST	ENERGY & WATER SAVINGS	O&M SAVINGS	TOTAL COST SAVINGS	ANNUAL CASHFLOW	CUMULATIVE CASHFLOW
Year 1	$0	$0	$0	$45,070	$6,281	$51,351	$51,351	$51,351
Year 2	$0	$3,000	$3,000	$46,063	$6,438	$61,501	$58,501	$109,851
Year 3	$0	$3,075	$3,075	$47,177	$6,599	$146,583	$143,508	$253,360
Year 4	$0	$3,167	$3,167	$48,319	$6,764	$55,083	$51,916	$305,275
Year 5	$0	$3,262	$3,262	$49,488	$6,933	$56,421	$53,159	$358,434
Year 6	$0	$3,360	$3,360	$50,686	$7,106	$57,793	$54,433	$412,867
Year 7	$0	$3,461	$3,461	$51,914	$7,284	$59,198	$55,737	$468,603
Year 8	$0	$3,565	$3,565	$53,171	$7,466	$60,637	$57,072	$525,675
Year 9	$0	$3,672	$3,672	$54,458	$7,653	$62,111	$58,439	$584,115
Year 10	$0	$3,782	$3,782	$55,777	$7,844	$63,622	$59,840	$643,954
Year 11	$0	$3,895	$3,895	$57,129	$8,040	$65,169	$61,274	$705,228
Year 12	$0	$4,012	$4,012	$58,513	$8,241	$66,754	$62,742	$767,970
Year 13	$0	$4,133	$4,133	$59,931	$8,447	$68,378	$64,246	$832,215
Year 14	$0	$4,257	$4,257	$61,383	$8,658	$70,042	$65,785	$898,001
Year 15	$0	$4,384	$4,384	$62,871	$8,875	$71,746	$67,362	$965,363
Year 16	$0	$4,516	$4,516	$64,396	$9,097	$73,492	$68,977	$1,034,340
Year 17	$0	$4,651	$4,651	$65,957	$9,324	$75,281	$70,630	$1,104,970
Year 18	$0	$4,791	$4,791	$67,557	$9,557	$77,114	$72,323	$1,177,293
Year 19	$0	$4,934	$4,934	$69,195	$9,796	$78,992	$74,057	$1,251,350
Year 20	$0	$5,083	$5,083	$70,874	$10,041	$80,915	$75,833	$1,327,183
TOTAL	**$0**	**$74,999**	**$74,999**	**$1,139,930**	**$160,445**	**$1,402,182**	**$1,327,183**	

Appendix A – Natatorium Energy Study

Facility Data

Name: Reston Community Center

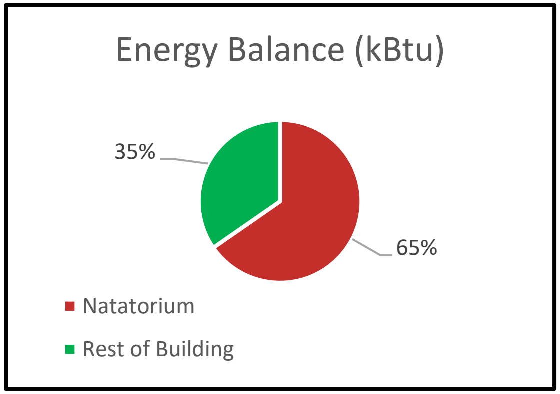
Address: 2310 Colts Neck Rd, Reston VA 20191

Building Square Footage: 48,997

Natatorium Square Footage: 12,530

During development of the utility benchmarking efforts of this Technical Energy Audit, the Reston Community Center was identified as having a slightly higher EUI (Energy Use Index) than expected. It is common for natatoriums to have a larger EUI compared to other types of facilities, but the RCC has been the largest EUI per Natatorium square feet compared to all other Fairfax FCPA Natatoriums. CMTA has performed an in-depth review of the energy use of the natatoriums at Fairfax County to help identify existing defiencies in equipment and find opportunities that may exist to decrease the EUI at the facilities and used this previous data to influence the current RCC model.

Baseline Utility	Building	Natatorium	Natatorium as % of Bldg	Rest of Building
Square Feet	48,997	12,530	26%	36,467
kWh	1,727,700	1,034,957	60%	692,743
kW	4,887	1,828	37%	3,059
Therms	69,471	48,596	70%	20,875
Gallons	1,950,000	237,019	12%	1,712,981
Cost	$241,985	$154,814	64%	$87,171
EUI	**262**	**670**		**122**
Utility $/SF	**$4.94**	**$12.36**		**$2.39**



Key Inputs and Formulas for Energy Study

Pool Information	Competition Pool + Therapy Pool
Pool Surface Area	5799
Pool Capacity (Gallons)	216,961
Pool Water Heater Efficiency %	85%
Pool Turnover Rate (hours)	6
Pool Circulation Pump GPM	603
Pump Motor HP	40
Pump Motor Efficiency %	83%
Pump Motor Load %	100%
Pump Run Hours per Day	24
Quantity of PRUs	1
PRU Exhaust Fan CFM	10,000
PRU Exhaust Fan HP	15
PRU Supply Fan CFM	22,500
PRU Supply Fan HP	37.5
PRU OA CFM	5,000
Air Conditioning System COP	3.2
Space Heating System Efficiency %	86%
Occupied Start Time, 7 days/Wk	5 am
Occupied End Time, 7 days/Wk	10 pm
Equipment Run Hours/Day	19
Wall Area (ft^2)	1,593
Roof Area (ft^2)	10,200
North Window Area (ft^2)	885
South Window Area (ft^2)	0
East Window Area (ft^2)	0
West Window Area (ft^2)	0

Assumptions and Formulas	
IBC 2006 Max Occ (person/SF)	50
Evaporative Loss Equations per ASHRAE 2019 Applications Chapter 6.	$w_p = \frac{A}{Y}(p_w - p_a)(95+0.425V)$
	$w_p = 0.1A(p_W - p_a)F_a$
Activity Factor (F_a) Public Pool	1.0
Activity Factor (F_a) Unoccupied Pool	0.5
Room Temp degrees F	84
Room Humidity %	52%
Deh % of Latent Heat Recovery	60%
Room Air Dew Point at 86°F, 55% RH	63.6
P_a (Saturation pressure @ DP)	0.59
P_w (Saturation vapor pressure)	1.4
Lbs per Gallon of Water conversion	8.34
Pool Water Temp °F	84
People Sensible Load (Btu/hr)	510
People Latent Load (Btu/hr)	940
Lighting and Plug Load, Watt/SF	1.4
Wall U-Value (Btu/h x °F x SF)	0.0400
Roof U-Value (Btu/h x °F x SF)	0.0500
Window U-Value (Btu/h x °F x SF)	0.50
Electric $/kWh rate	$0.0603
Electric $/kW rate	$18.21
Heating Fuel Cost (Per Therm)	$1.16
Water/Sewer cost per $/1000 gal	$11.55

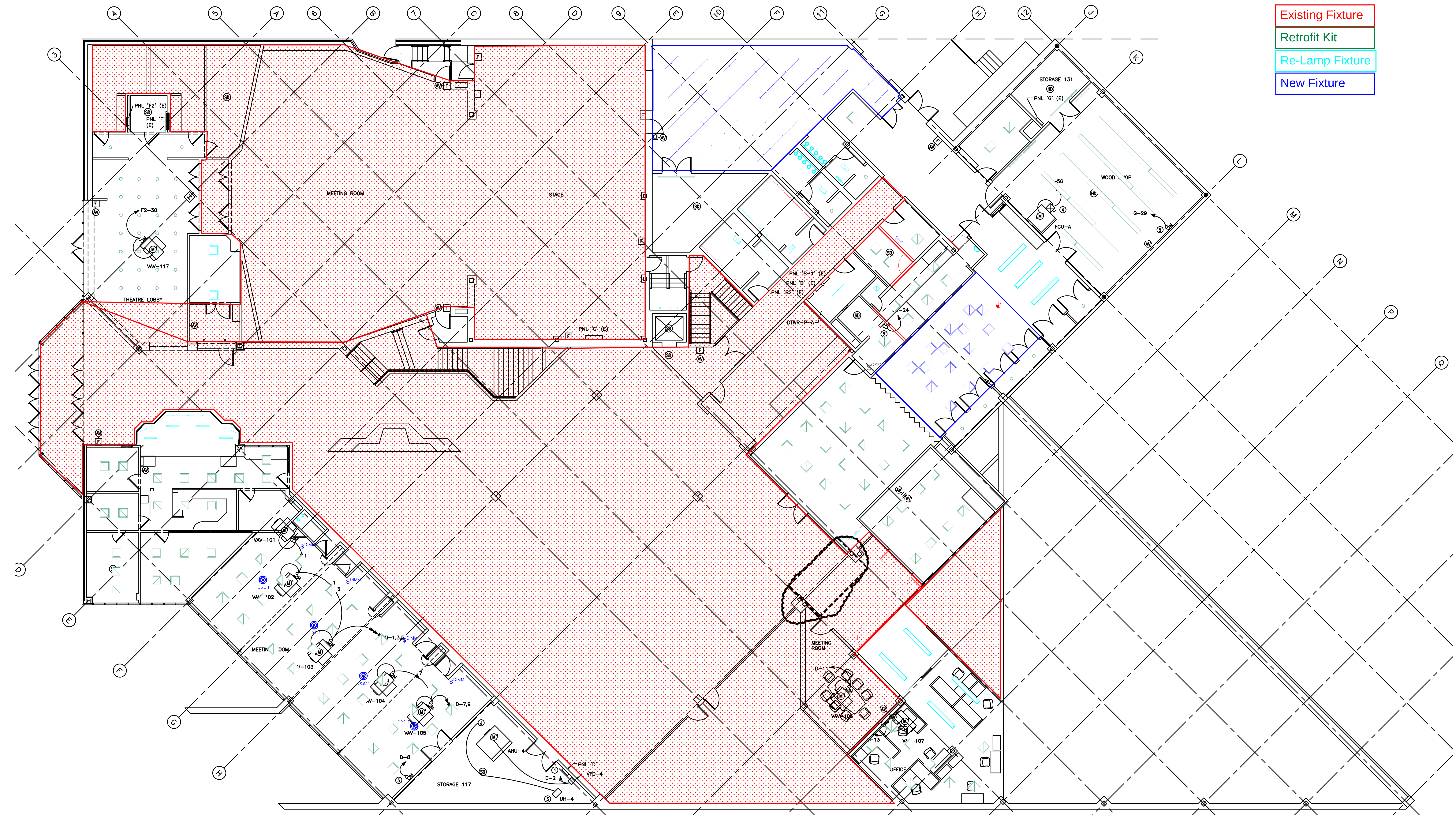
ENERGY BALANCE MODEL RESULTS

Pool Evaporation	Lbs/Hr	Btu/Hr	Btu/Day/SF	Gallons/yr
Peak Evaporative Loss	325.4	340339.1	--	--
Average Evaporative Loss	225.7	235975.4	--	--
Btu Loss per Day per SF of Pool	--	--	1958.0	--
Annual Evaporative Loss	--	--	--	237,019

Pool Energy Use	kWh/Yr	kW/Yr	Therms/Yr
Exhaust Fans	98,024	134	--
Supply Fans	258,131	336	--
Dehumidification/Cooling	391,565	916	--
Pool Circulation Pumps	177,186	233	--
Lighting & Plug Loads	110,051	209	--
Space Heating	--	--	26,229
Pool Heating	--	--	22,367
Total Natatorium	1,034,957	1,828	48,596

Appendix B – Lighting Audit Information

Preliminary Lighting Layout
Main Floor



1/E5 FIRST FLOOR PLAN
SCALE: 1/8"=1'-0"

GENERAL DRAWING NOTES

A. FOR SYMBOLS, ABBREVIATIONS, AND ELECTRICAL NOTES SEE DRAWING E1.

B. CONTRACTOR MAY REUSE CONDUIT AT HIS OPTION. ALL REUSED CONDUIT MUST MEET THE SPECIFICATION FOR TYPE, USE AND INSTALLATION AND BE WARRANTED AS NEW BY THE CONTRACTOR. TYPICAL FOR ALL REFERENCES MADE TO REUSING EXISTING CONDUIT THROUGHOUT THE PROJECT.

C. MAINTAIN CONTINUITY OF EXISTING CIRCUITS TO REMAIN.

D. PROTECT ALL EXISTING DEVICES TO REMAIN FROM DAMAGE DURING CONSTRUCTION.

E. PROVIDE DISCONNECT SWITCHES FOR NEW MECHANICAL EQUIPMENT AND CONNECT TO THE CIRCUIT AS SHOWN. COORDINATE LOCATION IN THE FIELD WITH MECHANICAL CONTRACTOR AND OWNER'S REPRESENTATIVE PRIOR TO ROUGH IN. REFER TO MECHANICAL EQUIPMENT, RELATED ELECTRICAL EQUIPMENT LIST, AND PANEL SCHEDULES DRAWINGS E1 AND E7 RESPECTIVELY.

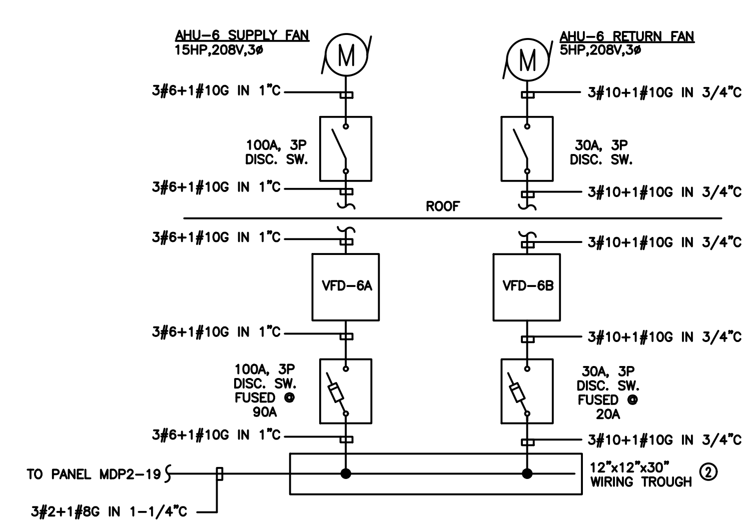
F. ALL OUTSIDE ELECTRICAL EQUIPMENT SHALL BE FURNISHED IN NEMA 3R RATED ENCLOSURES.

G. COORDINATE FINAL LOCATION FOR ALL CONNECTIONS TO EQUIPMENT WITH THE MECHANICAL CONTRACTOR PRIOR TO ROUGH-IN.

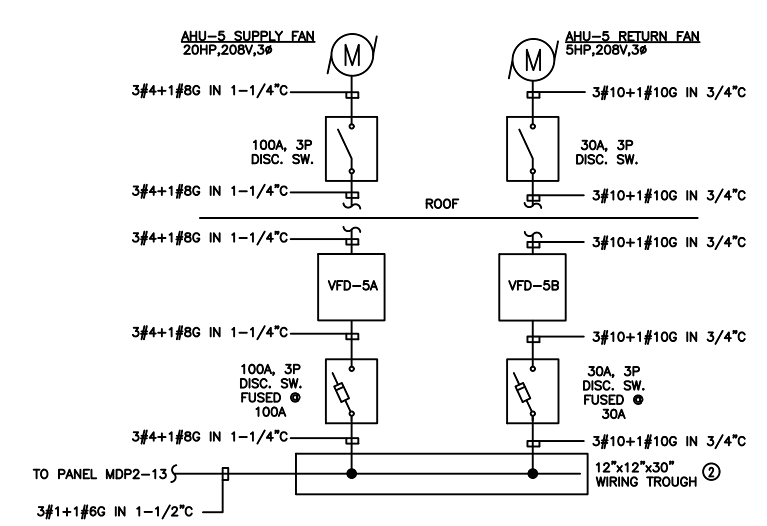
H. PROVIDE REVISED TYPE WRITTEN PANELBOARD DIRECTORY CARDS REFLECTING ALL REMOVED AND ADDED CIRCUITS.

DRAWING NOTES

1. PROVIDE 225A MCB, 3ø, 4 WIRE, 24 POLE PANELBOARD AS SHOWN. REFER TO PANEL SCHEDULES DRAWING E7 AND RISER DIAGRAM DRAWING E1.
2. VERIFY LOCATION IN THE FIELD WITH MECHANICAL CONTRACTOR.
3. RELOCATED EXISTING HYDRONIC UNIT HEATER (UH-4). EXTENDED EXISTING CIRCUIT TO NEW LOCATION. SEE NOTE 'D' ON DRAWING E3.
4. PROVIDE COMBINATION MOTOR STARTER/DISCONNECT AS SHOWN. REFER TO MECHANICAL EQUIPMENT LIST ON DRAWING E1.
5. PROVIDE MOTOR RATED SWITCH TO CONNECT LOW VOLTAGE TRANSFORMER FOR ELECTRONICS DAMPERS AND INSTALL TO THE CIRCUIT AS SHOWN. COORDINATE WITH MECHANICAL CONTRACTOR FOR LOCATION.
6. PROVIDE TIME CLOCK FOR DOMESTIC WATER RETURN PUMP DTWR-P-A. COORDINATE EXACT LOCATION IN THE FIELD WITH OWNER'S REPRESENTATIVE.



2/E5 WIRE DIAGRAM VFD 6A/6B
SCALE: NTS



3/E5 WIRE DIAGRAM VFD 5A/5B
SCALE: NTS

SWSG
SHAFFER WILSON SARVER & GRAY
A PROFESSIONAL CORPORATION

COUNTY OF FAIRFAX
FACILITIES MANAGEMENT DEPARTMENT

FIRST FLOOR PLAN
NEW WORK

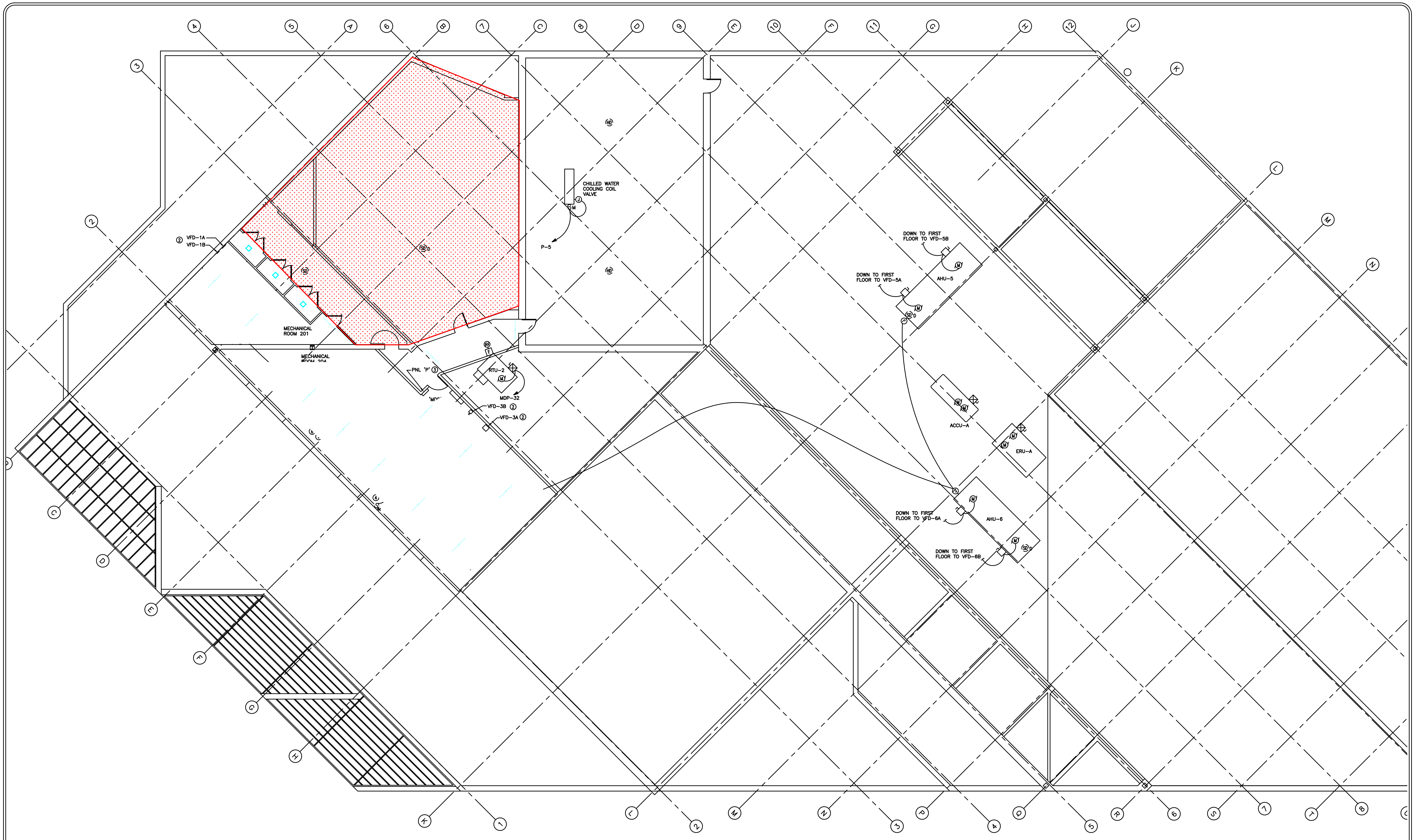
RESTON COMMUNITY CENTER HVAC SYSTEM UPGRADE
2310 COLTS NECK ROAD
RESTON, VA 22191

JOB# 05-102

E5

5 OF 7

Preliminary Lighting Layout
Attic



1 / E6 ATTIC/LOWER ROOF – NEW WORK
SCALE: 1/8"=1'-0"

GENERAL DRAWING NOTES

A. FOR SYMBOLS, ABBREVIATIONS, AND ELECTRICAL NOTES SEE DRAWING E1.

B. CONTRACTOR MAY REUSE CONDUIT AT HIS OPTION. ALL REUSED CONDUIT MUST MEET THE SPECIFICATION FOR TYPE, USE AND INSTALLATION AND BE WARRANTED AS NEW BY THE CONTRACTOR. TYPICAL FOR ALL REFERENCES MADE TO REUSING EXISTING CONDUIT THROUGHOUT THE PROJECT.

C. MAINTAIN CONTINUITY OF EXISTING CIRCUITS TO REMAIN.

D. PROTECT ALL EXISTING DEVICES TO REMAIN FROM DAMAGE DURING CONSTRUCTION.

E. PROVIDE DISCONNECT SWITCHES FOR NEW MECHANICAL EQUIPMENT AND CONNECT TO THE CIRCUIT AS SHOWN. COORDINATE DISCONNECT SWITCH LOCATION IN THE FIELD WITH MECHANICAL CONTRACTOR AND OWNER'S REPRESENTATIVE PRIOR TO ROUGH–IN. REFER TO MECHANICAL EQUIPMENT RELATED ELECTRICAL EQUIPMENT LIST AND PANEL SCHEDULES DRAWINGS E1 AND E7 RESPECTIVELY.

F. ALL OUTSIDE ELECTRICAL EQUIPMENT SHALL BE FURNISHED IN NEMA 3R RATED ENCLOSURES.

G. COORDINATE FINAL LOCATION FOR ALL CONNECTIONS TO EQUIPMENT WITH THE MECHANICAL CONTRACTOR PRIOR TO ROUGH–IN.

H. FOLLOW MECHANICAL PIPING FOR ROOF PENETRATIONS.

I. PROVIDE REVISED TYPE WRITTEN PANELBOARD DIRECTORY CARDS REFLECTING ALL REMOVED AND ADDED CIRCUITS.

DRAWING NOTES

1. PROVIDE CIRCUIT FOR AHU'S FACTORY FURNISHED LIGHT AND SWITCH AS SHOWN. REFER TO PANEL SCHEDULES DRAWING E7.
2. VARIABLE FREQUENCY DRIVE PROVIDED BY MECHANICAL CONTRACTOR. COORDINATE INSTALLATION WITH MECHANICAL CONTRACTOR.
3. PROVIDE PANELBOARD 60A, 120/208, 3ø, 4W, 18 POLE. REFER TO PANEL SCHEDULES FOR CIRCUIT DIRECTORY.
4. PROVIDE MOTOR RATED SWITCH TO CONNECT LOW VOLTAGE TRANSFORMER FOR ELECTRONICS DAMPERS AND INSTALL TO THE CIRCUIT AS SHOWN. COORDINATE WITH MECHANICAL CONTRACTOR FOR LOCATION.
5. CONNECT NEW EXHAUST FANS TO EXISTING CIRCUIT. CONTRACTOR MAY REUSE EXISTING DISCONNECT SWITCH IF WARRANTEE AS NEW.
6. PROVIDE CIRCUIT FOR ELECTRONIC VALVES TRANSFORMER. COORDINATE LOCATION WITH MECHANICAL CONTRACTOR.

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COUNTY OF FAIRFAX
FACILITIES MANAGEMENT DEPARTMENT

ATTIC/LOWER ROOF PLAN
NEW WORK

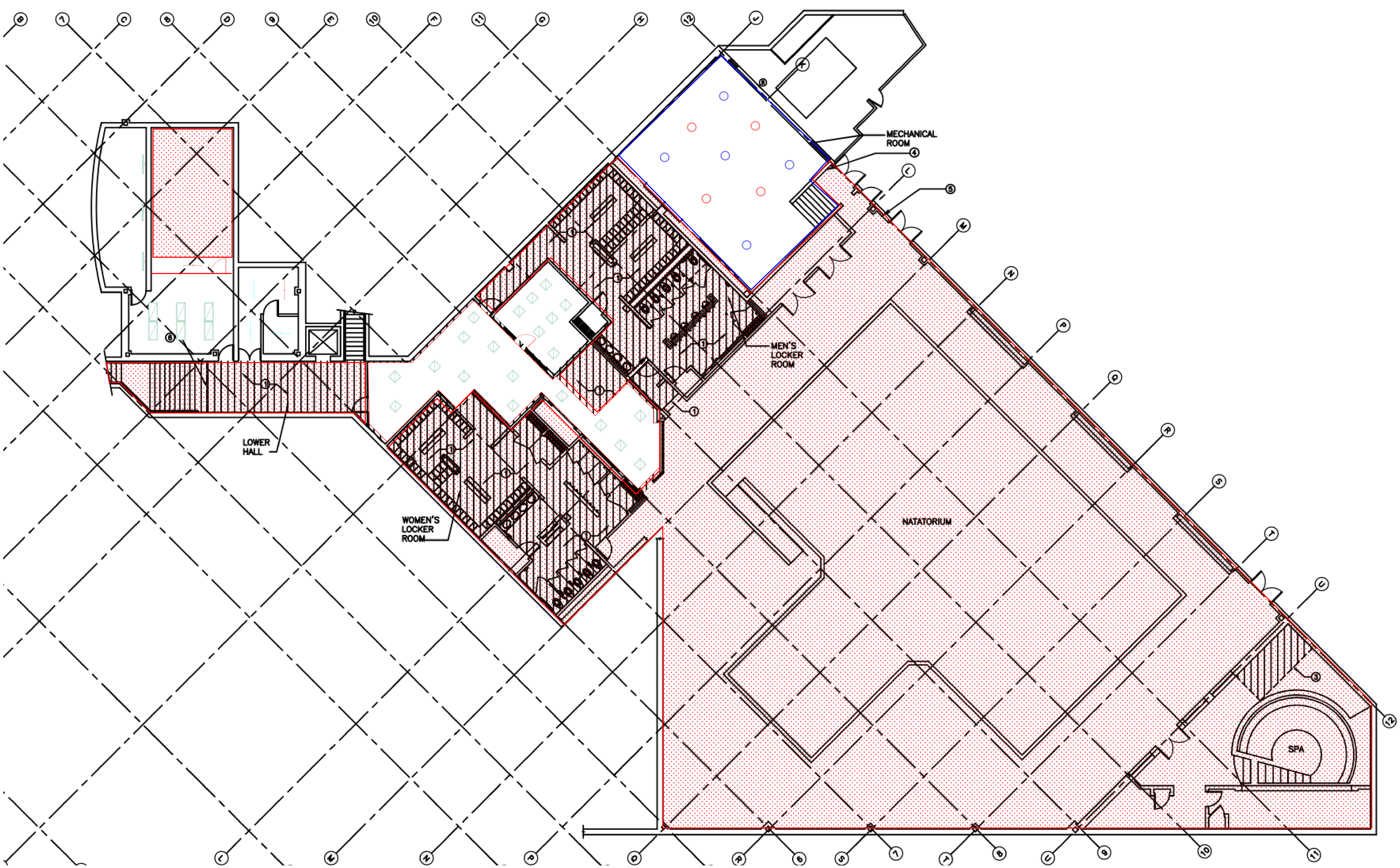
RESTON COMMUNITY CENTER HVAC SYSTEM UPGRADE
2310 COLTS NECK ROAD
RESTON, VA 22191

JOB# 05-102

E6

6 OF 7

Preliminary Lighting Layout
Lower Level



Photometric Study
Meeting Room 6 - Fixture Reduction

MEETING ROOM 6 (EXISTING)

Area = 504.00 Sq.ft
Total Watts = 896
LPD = 1.778 Watts/Sq.ft

25	28	30	32	32	32	29	23	15
38	39	42	48	49	50	46	34	21
47	49	52	60	64	68	61	43	27
54	57	62	72	78	82	74	51	32
56	60	66	77	84	89	80	56	34
56	59	64	76	83	89	79	55	34
58	61	67	78	85	90	81	56	35
58	62	68	80	87	92	83	58	36
56	59	65	76	84	90	80	56	35
57	60	66	77	85	89	80	56	35
55	59	64	76	84	89	80	55	34
48	51	56	66	74	80	72	49	30
39	41	45	55	62	68	60	41	25
26	30	33	40	48	52	45	31	20

MEETING ROOM 6 (PROPOSED)

Area = 504.00 Sq.ft
Total Watts = 255.6
LPD = 0.507 Watts/Sq.ft

31	37	40	41	42	41	40	37	31
44	54	55	57	60	57	55	54	44
55	68	69	71	76	71	68	67	55
58	71	73	75	79	75	72	70	57
61	74	76	79	83	79	76	73	60
64	79	81	83	88	83	80	78	63
63	76	79	81	85	81	78	76	62
63	77	79	81	85	81	78	76	62
64	79	81	83	88	83	80	78	63
61	74	76	79	83	79	76	73	60
58	71	73	75	79	75	72	70	58
55	68	69	71	76	71	68	67	55
44	54	55	57	60	57	55	54	44
31	38	40	41	42	41	40	37	31

Calculation Summary

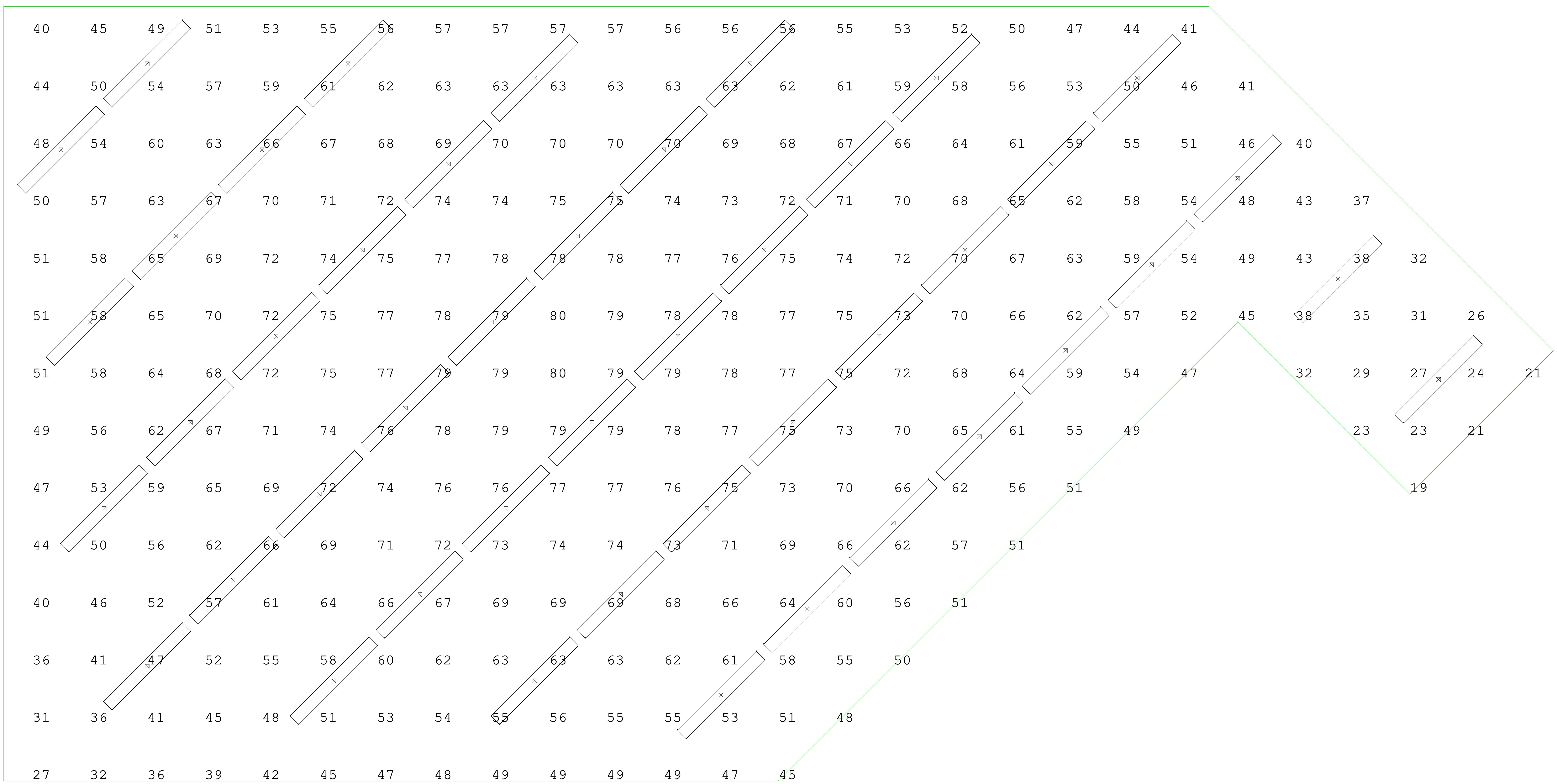
Label	Avg	Max	Min	Avg/Min	Max/Min
MEETING ROOM 6 (EXISTING)_Workplane	56.88	92	15	3.79	6.13
MEETING ROOM 6_1_Workplane	64.96	88	31	2.10	2.84

Photometric Study
Dance Studio - New Fixture Plan

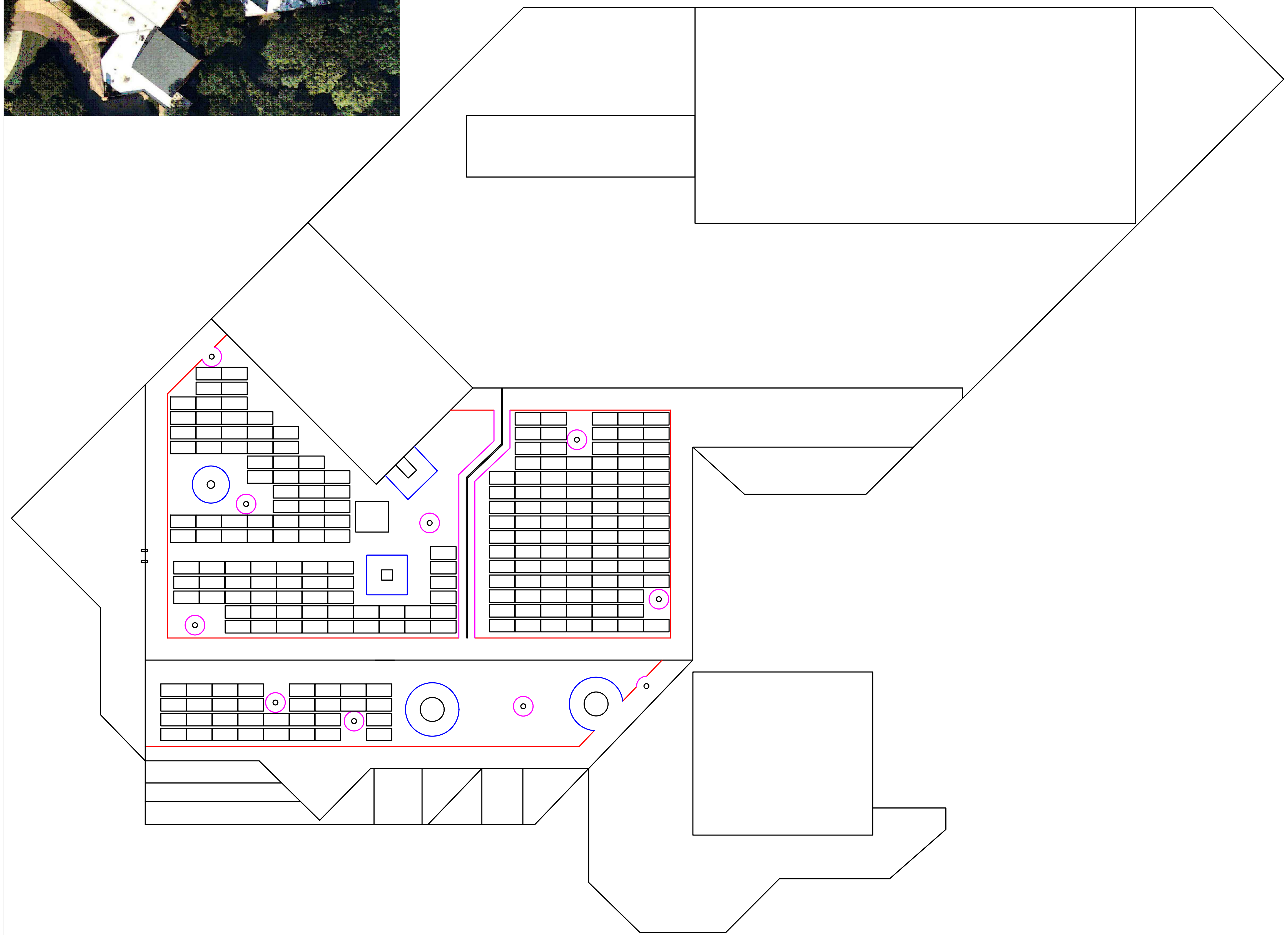
DANCE STUDIO (PROPOSED)_LPD

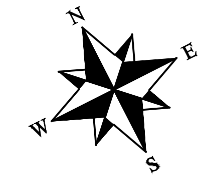
Area = 1118 Sq.ft
Total Watts = 706.05
LPD = 0.632 Watts/Sq.ft

Calculation Summary					
Label	Avg	Max	Min	Avg/Min	Max/Min
DANCE STUDIO_Floor	59.66	80	19	3.14	4.21



Appendix C – Solar PV Drawings





System Summary

Electrical Equipment:

219 – 450W Talesun Commercial Solar Module(s)
2 – SolarEdge 50kW 208V Commercial Inverter(s)

98.55kW DC System Size
100kW AC System Size

Annual Production Estimate (Year 1):

108,405 kWhrs

Roof Details:

Roof Type: TPO

Racking Unirac 5° Ballast

Module Tilt: 5°

Azimuth: 217°

Key:

Solar Module

Roof Drain or Roof Vent

6 ft Roof Edge Setback

2 ft Minor Vent/Drain Setback

4 ft Obstruction Setback

CMTA
A LEGENCE Company

Preliminary layout

Reston Community Center
2310 Colts Neck Rd,
Reston, VA 20191

Site Plan

Client/CMTA Job #:	ZFA22-XX
DATE	x/x/xx
DRAWN	CG
CHECKED	KK

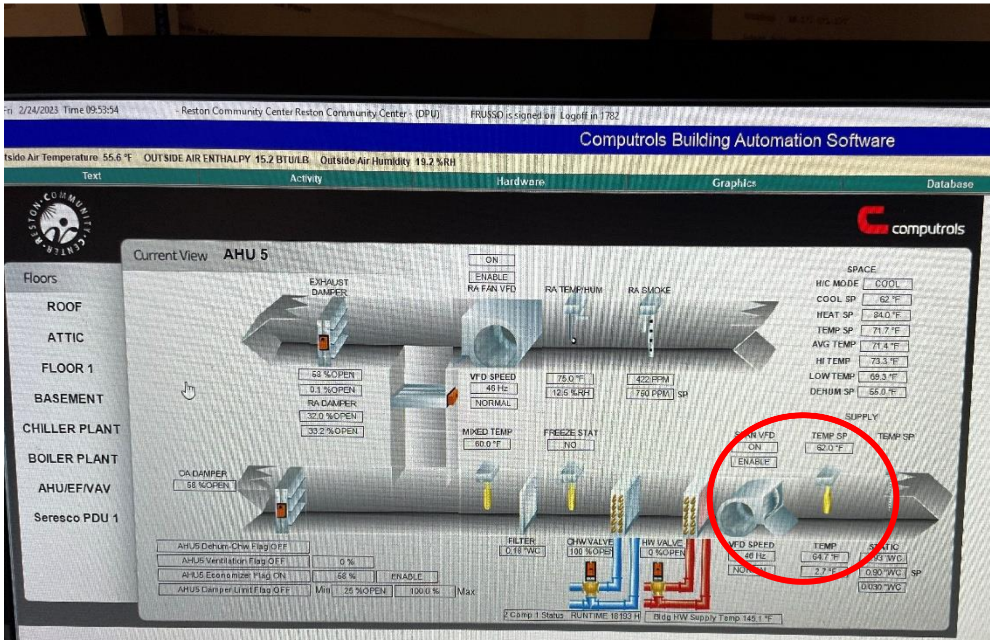
REVISIONS

PV xxx

Appendix D – BAS Analysis

Left: is a graph of the Chilled Water Supply Temperature and Chilled Water Return. The temperature difference is minimal all day of between 2-3 degrees. This a result of the 3 way vales mixing the CHWS with the CHWR and reduces overall plant efficiency and is a waste of pump energy.

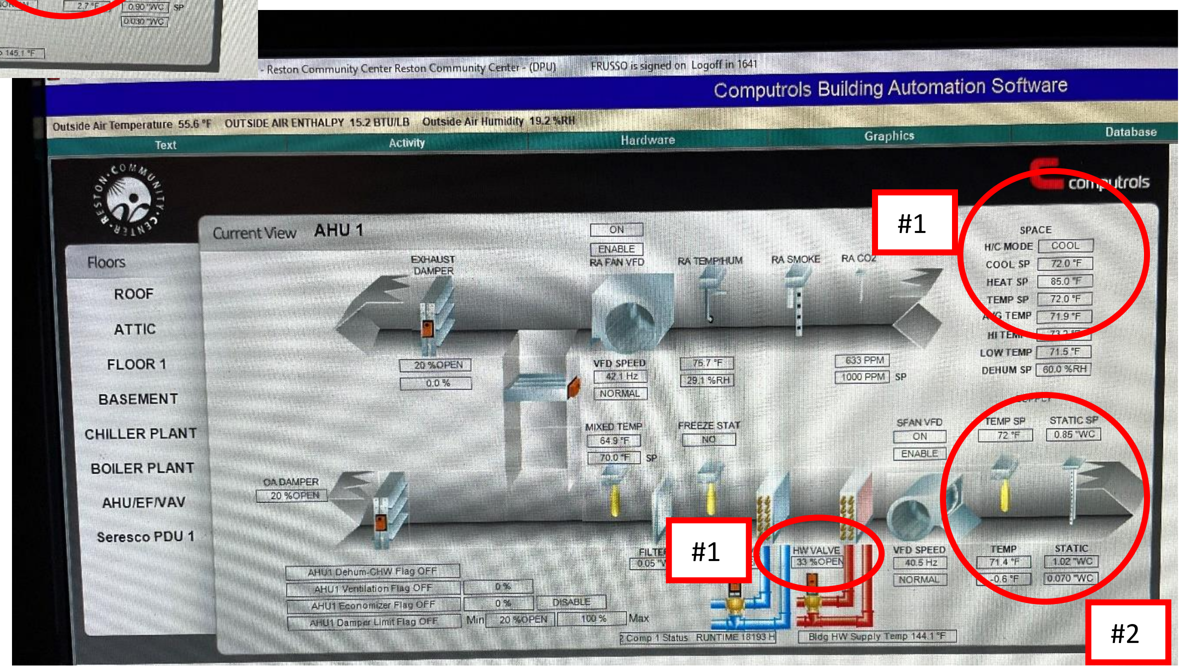
Right: is a graph of the Hot Water Supply (HWS) Temperature and Hot Water Return (HWR). The temperature difference is minimal all day of between 2-3 degrees similar to the Chilled water system. This a result of the 3 way vales mixing which once again reduces overall plant efficiency and is a waste of pump energy. Unless this is improved boiler replacements in kind will minimal impact on efficiency.

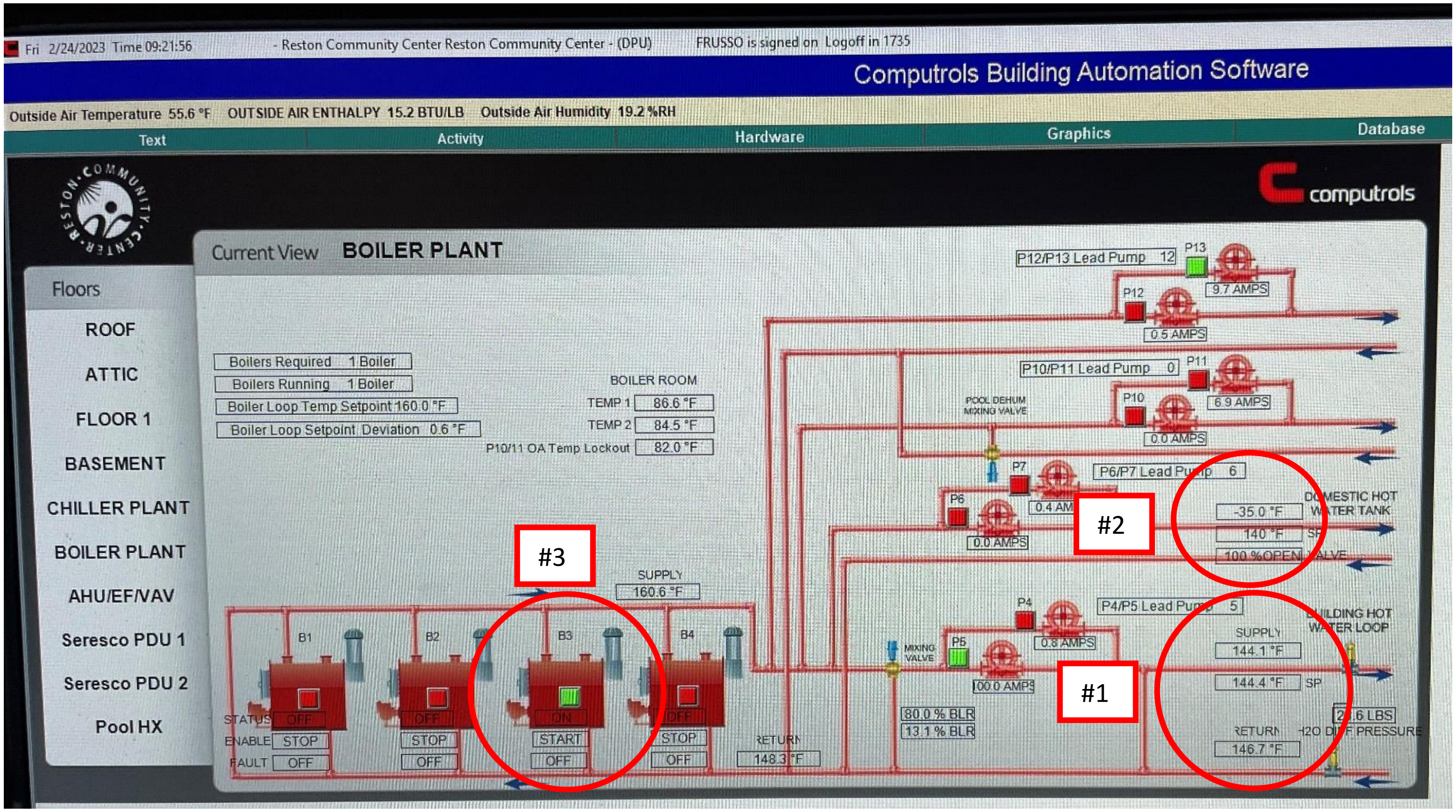


Left: is a graphic of AHU 5. The temperature difference is minimal all day of between 2-3 degrees. This a result of the 3 way vales mixing the CHWS with the CHWR and reduces overall plant efficiency and is a waste of pump energy.

Right: is a graphic of AHU 1. First to highlight is the unit should be in cooling mode however the HW valve is being commanded to open up 33%,

Secondly, the Static SP is .85" WC however the current static is 1.05" WC which means the fan speeds should be able to decrease and save energy but they aren't

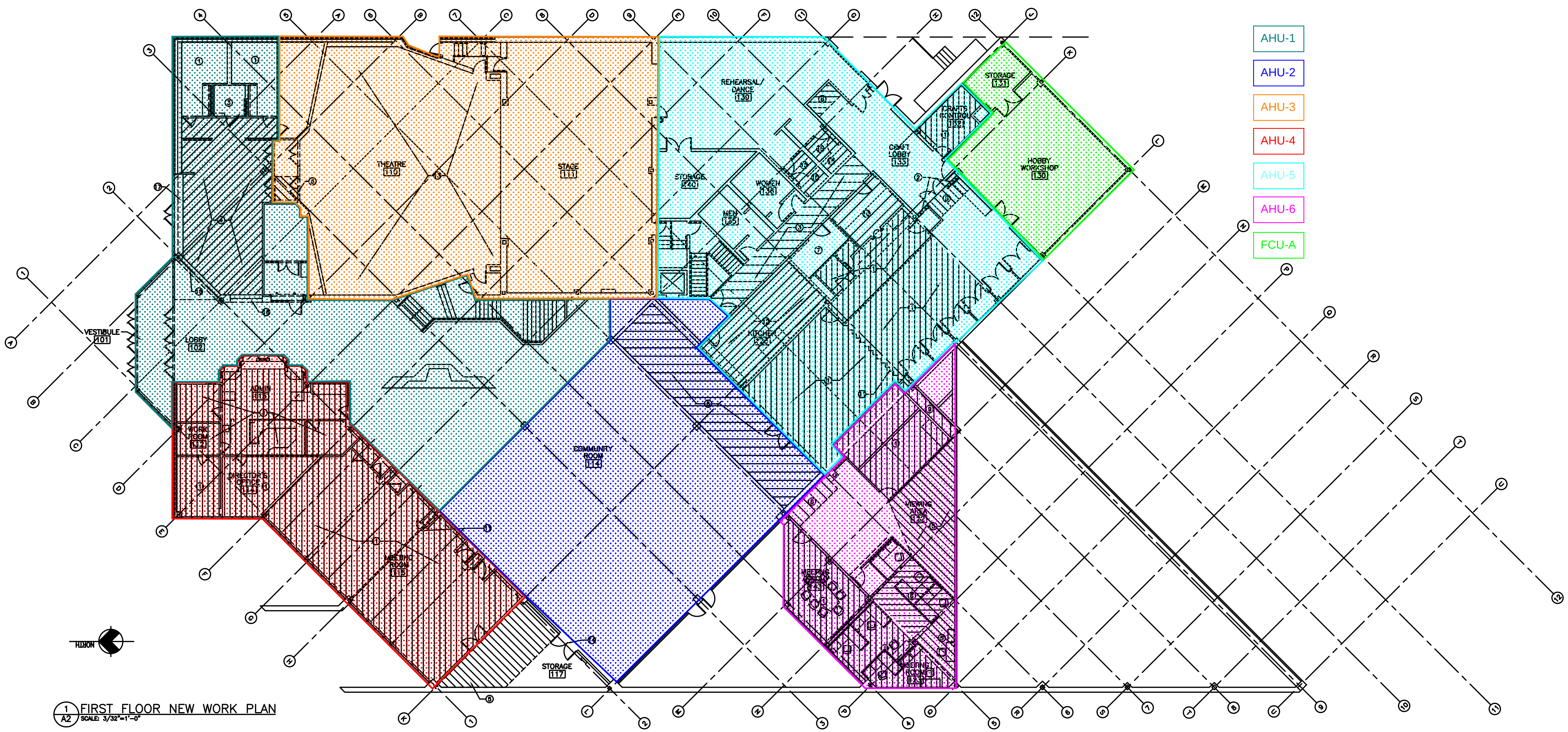




Above: This is the graphic of the Hot Water plant. A couple of items to note are:

1. The Hot Water Building Return loop is actually greater than the Supply, which could be cause of sensor failure or faulty valves in the system of combination.
2. The Domestic Hot Water Tank reading is – 35^{0} F so it’s calling for the Hot Water Valve to be open at 100% which if that sensor has failed then the valve on the heat exchanger would always be open wasting thermal energy
3. It’s clear that there are many days with smaller loads based only one boiler needing to run which calls attention the opprotuntity of renovating the Hot Water Plant to maximize that part load efficiency or AFUE

Appendix E – HVAC Zoning Map



1/A2 FIRST FLOOR NEW WORK PLAN
SCALE: 3/32"=1'-0"

DEMOLITION GENERAL NOTES

1. DEMOLITION SCHEDULES/PROCEDURES: THE GENERAL CONTRACTOR SHALL FORWARD SCHEDULE AND SAFETY PROCEDURES TO THE ARCHITECT AND SHALL NOT PROCEED WITH DEMOLITION UNTIL THESE ARE APPROVED. SLAB CUTTING, SLAB REMOVAL AND OTHER NOISY/HEAVY DEMOLITION SHALL HAVE OWNER'S PERMISSION BEFORE WORK PROCEEDS.

2. THE GENERAL CONTRACTOR SHALL RETURN ALL SALVAGEABLE MATERIALS AND / OR EQUIPMENT REMOVED TO THE OWNER TO BE STORED AT THEIR DISCRETION. THE GENERAL CONTRACTOR SHALL DISPOSE OF ALL NON-SALVAGABLE MATERIALS IN ACCORDANCE WITH OWNER'S RECOMMENDATION AND LOCAL ZONING CODES.

3. THE CONTRACTOR SHALL CONSULT WITH THE ARCHITECT ON ANY CONCEALED CONDITIONS UNCOVERED DURING DEMOLITION THAT IMPEDES THE EXECUTION OF THE DESIGN AS INDICATED ON THE DRAWINGS.

4. PROVIDE ALL DEMOLITION REQUIRED FOR NEW LAYOUT AS SHOWN TO INCLUDE CEILINGS, LIGHTS, POWER, DATA, SPRINKLER HEADS, WALLS, DOORS, FRAMES, HARDWARE, FINISHES AND CONCRETE SLABS. ADDITIONAL DEMOLITION MAY BE REQUIRED AND SHALL BE THE RESPONSIBILITY OF THE GENERAL CONTRACTOR. GENERAL CONTRACTOR SHALL BE RESPONSIBLE FOR RESTORING ALL FINISHES DAMAGED BY HIS WORK.

5. REFER TO MECHANICAL DWGS. FOR DEMOLITION INFORMATION AND REQUIREMENTS.

6. REFER TO ELECTRICAL DWGS. FOR DEMOLITION INFORMATION AND REQUIREMENTS.

NEW CONSTRUCTION GENERAL NOTES

1. FIGURED DIMENSIONS SHALL TAKE PRECEDENCE OVER MEASUREMENTS BY SCALE. IN THE EVENT OF DIMENSIONAL DISCREPANCIES, NOTIFY THE ARCHITECT IMMEDIATELY FOR CLARIFICATION.

2. ALL DIMENSIONS GIVEN ARE FROM CENTER LINE OF COLUMN OR BEAM TO FACE OF STUD OR FURRING OR FROM FACE OF STUD TO FACE OF STUD OR FURRING, UNLESS NOTED OTHERWISE. DIMENSIONS GIVEN FROM EXISTING CONSTRUCTION ARE FROM FINISHED SURFACES, UNLESS NOTED OTHERWISE.

3. DIMENSIONS NOTED "CLR" (CLEAR) ARE NOT ADJUSTABLE WITHOUT APPROVAL FROM THE ARCHITECT.

4. IF CONFLICTS OCCUR BETWEEN DRAWING AND EXISTING FIELD CONDITIONS, THE GENERAL CONTRACTOR SHALL IMMEDIATELY CONTACT THE ARCHITECT FOR DIRECTION.

5. PROVIDE AND INSTALL NON-COMBUSTIBLE WOOD BLOCKING AND / OR STEEL SUPPORTS AS REQUIRED IN PARTITIONS BEHIND WALL MOUNTED EQUIPMENT, COUNTERTOPS, AND OTHER MILLWORK ITEMS TO PROVIDE SUFFICIENT SUPPORT AS TO PREVENT SAGGING. GENERAL CONTRACTOR SHALL COORDINATE WITH THE ARCHITECT ON LOADING IF BLOCKING OR STEEL SUPPORTS ARE NOT NOTED IN THE PLANS OR DETAILS.

6. ALL WOOD INDICATED ON PLANS WHICH IS NOT INTERIOR EXPOSED TRIM SHALL BE FIRE RETARDANT TREATED, INCLUDING ANY PLYWOOD PANELS AND CONCEALED WOOD BLOCKING FOR WALL MOUNTED ITEMS.

7. ALL PIPE AND CONDUIT PENETRATIONS THROUGH ANY FIRE RATED ASSEMBLIES SHALL BE FIRESTOPPED WITH TESTED UL RATED THROUGH PENETRATION FIRESTOP SYSTEMS BEARING THE REQUIRED RATINGS.

8. SEAL ALL PENETRATIONS OF PIPING, DUCTWORK, ETC. THROUGH EXISTING PERIMETER DEMISING WALLS TO MAINTAIN ENVIRONMENTAL CONTROL. GENERAL CONTRACTOR TO VERIFY THE INTEGRITY OF THE PERIMETER ENCLOSURE OF THESE AREAS UPON COMPLETION OF PARTITIONING.

9. FLASH PATCH ALL HOLES AND PENETRATIONS IN CONCRETE SLAB TO ENSURE ACCEPTABLE SUBSTRATES FOR FLOOR FINISHES.

10. PROVIDE AND INSTALL ACCESS PANELS THROUGH ALL CEILINGS AS REQUIRED TO ACCESS MECHANICAL, ELECTRICAL AND PLUMBING SYSTEMS.

NEW CONSTRUCTION GENERAL NOTES– cont.

11. INSTALL PVC SLEEVES OF SIZES AND QUANTITIES DICTATED BY THE DESIGN PARAMETERS INDICATED ON THE MECHANICAL AND ELECTRICAL DOCUMENTS AT ANY CONDITION THAT NECESSITATES PENETRATION OF EXISTING EXTERIOR WALLS. MAINTAIN THE STRUCTURAL INTEGRITY OF THE AFFECTED WALL AND GROUT SOLID AROUND SLEEVES. UPON COMPLETION OF THE INSTALLATION OF ALL PIPING, LINES AND CONDUITS, SEAL ALL OPENINGS AROUND SAME WITH JOINT SEALANT AS REQUIRED TO MAKE WATERTIGHT. FINISH INTERIOR SURFACES OF WALL TO MATCH EXISTING ADJACENT SURFACES.

12. APPLY JOINT SEALANT BEAD TO ALL TRANSITIONS OF DISSIMILAR MATERIALS.

13. EQUIPMENT LOCATIONS INDICATED ARE FOR INFORMATION ONLY. CONTRACTOR IS RESPONSIBLE TO COORDINATE APPLICABLE INTERACTING TRADES TO FACILITATE FULL OPERATION WHEN EQUIPMENT IS INSTALLED.

14. SEAL ALL PENETRATIONS OF EXISTING AND NEW CONDUIT, PIPING, DUCTWORK, ETC. THRU NEW AND EXISTING WALL. SEE MECHANICAL DRAWINGS FOR ADDITIONAL INFORMATION.

15. GENERAL CONTRACTOR SHALL REMOVE ALL OFFICE FURNITURE SYSTEMS AS REQUIRED TO FACILITATE THE EXECUTION OF ALL WORK WITHIN THE SCOPE OF THIS PROJECT, INCLUSIVE OF ELECTRIC, PHONE AND DATA SERVICE CONNECTIONS. UPON COMPLETION OF SCHEDULED WORK, ALL FURNITURE SYSTEM COMPONENTS ARE TO BE RESTORED TO THEIR PREVIOUS LOCATIONS AND ALL ELECTRIC, PHONE AND DATA CONNECTIONS ARE TO BE RESTORED.

NEW CONSTRUCTION KEY NOTES:

1. REMOVE AND DISPOSE OF EXISTING SUSPENDED ACOUSTIC CEILING SYSTEM THROUGHOUT AS DESIGNATED TO FACILITATE MODIFICATION OF THE HVAC SYSTEM– SEE MECH DWGS. UPON COMPLETION OF SCHEDULED WORK, INSTALL NEW SUSPENDED CEILING SYSTEM WITH $\frac{11}{16}$" CEILING GRID AND #1911A CEILING TILE AS MANUFACTURED BY ARMSTRONG IN THE SAME LAYOUT AND AT THE SAME HEIGHT AS THE REMOVED CEILING SYSTEM. PROVIDE AN ADDITIONAL QUANTITY OF ACOUSTIC TILES EQUAL TO 5% OF TOTAL DISTURBED AREA FOR FUTURE REPLACEMENT. COORDINATE LOCATION OF CEILING DIFFUSERS, RETURN AIR GRILLES, LIGHTS AND SPRINKLER HEADS, MAINTAINING THE PREVIOUS COMPONENT LAYOUT.

2. UPON COMPLETION OF THE EXISTING CEILING REMOVAL, DEMOLISH EXISTING ABANDONED FIRE SHUTTER, INCLUSIVE OF ALL TRACK, HARDWARE AND CONTROL SYSTEM COMPONENTS. UPON COMPLETION, INSTALL NEW SUSPENDED CEILING SYSTEM– SEE KEYNOTE #5. PATCH AND REPAIR ANY DISRUPTED SURFACES AS REQUIRED TO MATCH EXISTING ADJACENT FINISHES.

3. REMOVE AND DISPOSE OF EXISTING GWB CEILING TO EXTENT REQUIRED AND INDICATED TO FACILITATE MODIFICATION OF THE HVAC SYSTEM– SEE MECH DWGS. UPON COMPLETION OF SCHEDULED WORK, INSTALL NEW SUSPENDED CEILING SYSTEM WITH $\frac{11}{16}$" CEILING GRID AND #1911A CEILING TILE AS MANUFACTURED BY ARMSTRONG AT THE SAME HEIGHT AS THE REMOVED CEILING SYSTEM. COORDINATE LOCATION OF CEILING DIFFUSERS, RETURN AIR GRILLES, LIGHTS AND SPRINKLER HEADS, MAINTAINING THE PREVIOUS COMPONENT LOCATIONS.

4. REMOVE AND DISPOSE OF THE EXISTING PLASTER LATHE CEILING SYSTEM THROUGHOUT THE THEATRE LOBBY IN ITS ENTIRETY TO FACILITATE MODIFICATION OF THE HVAC SYSTEM – SEE MECHANICAL DRAWINGS. UPON COMPLETION OF SCHEDULED WORK, INSTALL NEW WHITE SUSPENDED MONOLITHIC CEILING SYSTEM WITH VECTOR $\frac{15}{16}$" CEILING GRID AND ULTIMA VECTOR– #1920 24"X24" CEILING TILE AS MANUFACTURED BY ARMSTRONG AT THE SAME HEIGHT AS THE REMOVED CEILING SYSTEM. RESTORE SALVAGED RECESSED LIGHTING FIXTURES TO PREVIOUS LOCATIONS AND COORDINATE LOCATION OF SPRINKLER HEADS, RETURN AIR GRILLES, ETC. WITH MECHANICAL DWGS. PROVIDE COORDINATION DWGS OF CEILING LAYOUT TO ARCHITECT FOR APPROVAL AS PART OF THE SHOP DWG. REVIEW PROCESS.

5. REMOVE EXISTING GWB CEILING SYSTEM TO EXTENT REQUIRED AND INDICATED TO FACILITATE SCHEDULED NEW WORK – SEE MECHANICAL DRAWINGS. UPON COMPLETION OF SCHEDULED WORK, PATCH AND REPAIR GWB CEILING SYSTEM AS REQUIRED TO MATCH EXISTING ADJACENT FINISHES.

6. REMOVE EXISTING SLOPED GWB CEILING SYSTEM IN ITS ENTIRETY TO FACILITATE SCHEDULED NEW WORK– SEE MECHANICAL DRAWINGS. UPON COMPLETION OF SCHEDULED WORK, INSTALL NEW GWB CEILING ASSEMBLY, TAPING AND SANDING ALL JOINTS PER INDUSTRY STANDARDS AND PRIME NEW GWB SURFACES AS REQUIRED TO RECEIVE TWO FINISH COATS OF PAINT TO MATCH EXISTING ADJACENT AREAS.

NEW CONSTRUCTION KEY NOTES– cont.:

7. REMOVE EXISTING GWB CEILING THROUGHOUT ROOM TO FACILITATE NEW SCHEDULED WORK– SEE MECHANICAL DRAWINGS. UPON COMPLETION OF SCHEDULED WORK, INSTALL NEW SUSPENDED CEILING SYSTEM WITH $\frac{11}{16}$" CEILING GRID AND #1911A CEILING TILE AS MANUFACTURED BY ARMSTRONG AT SAME HEIGHT AS REMOVED CEILING SYSTEM.

8. EXPAND BOUNDARY OF GWB BULKHEAD/CEILING AS REQUIRED TO ENCOMPASS NEW SCHEDULED WORK– SEE MECHANICAL DRAWINGS. PATCH AND REPAIR GWB CEILING SYSTEM AS REQUIRED TO MATCH ADJACENT FINISHES.

9. REMOVE REAR WALL SECTION OF GWB CHASE ENCLOSURE NECESSARY TO FACILITATE NEW SCHEDULED WORK – SEE MECHANICAL DRAWINGS. UPON COMPLETION OF NEW SCHEDULED WORK, PATCH AND REPAIR GWB WALL AS REQUIRED TO MATCH EXISTING ADJACENT FINISHES.

10. REMOVE EXISTING SUSPENDED ACOUSTIC CEILING SYSTEM THROUGHOUT ROOM TO FACILITATE NEW SCHEDULED WORK– SEE MECHANICAL DRAWINGS. INSTALL NEW SUSPENDED CEILING SYSTEM WITH $\frac{11}{16}$" CEILING GRID AND #1911A CEILING TILE AS MANUFACTURED BY ARMSTRONG TIGHT TO UNDERSIDE OF NEW WORK, ALLOWING FOR REQUIRED OPERATIONAL CLEARANCES.

11. MODIFY EXISTING MOVABLE PARTITION SUPPORT ABOVE CEILING TO FACILITATE DUCTWORK INSTALLATION PER MECH. DWG. SEE DETAILS 2/A2, AND 3/A2. UPON COMPLETION OF MODIFICATION, CONTRACTOR SHALL ENSURE PROPER OPERATION OF MOVABLE PARTITION.

12. REMOVE EXISTING METAL PANELIZED CEILING SYSTEM THROUGHOUT ROOM IN ITS ENTIRETY TO FACILITATE MODIFICATION OF THE HVAC SYSTEM – SEE MECHANICAL DRAWINGS. UPON COMPLETION OF SCHEDULED WORK, INSTALL NEW SUSPENDED CEILING SYSTEM WITH MOISTURE RESISTANT CEILING PANELS AS MANUFACTURED BY ARMSTRONG AT SAME HEIGHT AS REMOVED CEILING SYSTEM.

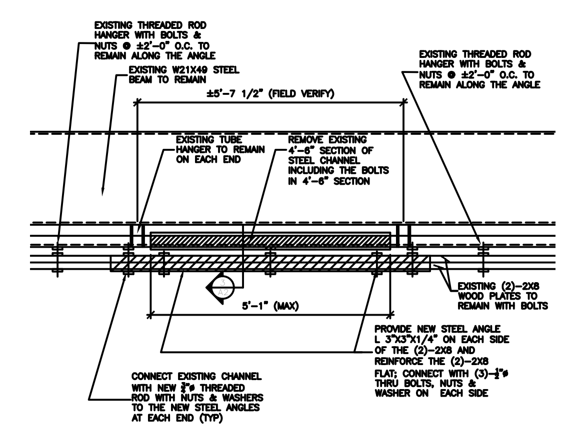
13. PATCH AND REPAIR EXISTING GWB CEILING AT OPENING AROUND EACH SPRINKLER HEAD. CONTRACTOR SHALL ASSUME 20 HEADS APPROXIMATELY 20'-0" ABOVE THE FINISH FLOOR. PROVIDE ALL MATERIALS AND EQUIPMENT, INCLUDING SCAFFOLDING NECESSARY TO FACILITATE COMPLETION OF THIS WORK. PAINT ENTIRE CEILING UPON COMPLETION OF REPAIR. GENERAL CONTRACTOR SHALL PROVIDE A UNIT PRICE PER SPRINKLER HEAD AS A SEPARATE LINE ITEM.

14. PROVIDE AND INSTALL DOOR CLOSERS ON EACH DOOR LEAF TO CONTROL MAXIMUM SWING OF DOOR.

15. REMOVE EXISTING GWB CEILING THROUGHOUT ROOM IN ITS ENTIRETY TO FACILITATE MODIFICATION OF THE HVAC SYSTEM– SEE MECHANICAL DWGS. NEW CEILING IS TO BE INSTALLED BY OTHERS UNDER SEPARATE CONTRACT.

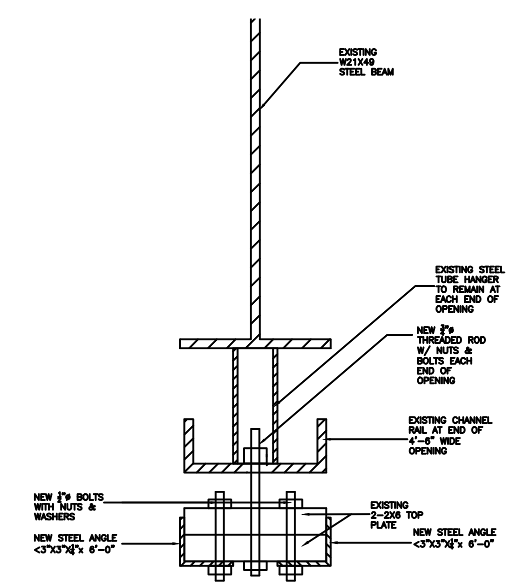
16. UPON COMPLETION OF THE EXISTING CEILING REMOVAL, DEMOLISH EXISTING ABANDONED FIRE SHUTTER, INCLUSIVE OF ALL TRACK, HARDWARE AND CONTROL SYSTEM COMPONENTS. UPON COMPLETION, REFRAME BULKHEAD BETWEEN COLUMNS WITH $\frac{5}{8}$" GWB ON 2 $\frac{5}{8}$" – 20 GA. METAL STUDS @ 16" O.C., SETTING THE BOTTOM ELEVATION OF THE BULKHEAD 2" BELOW THE SCHEDULED HEIGHT OF THE THEATRE LOBBY CEILING. TAPE AND SAND ALL JOINTS PER INDUSTRY STANDARDS AND PRIME ALL NEW GWB SURFACES AS REQUIRED TO RECEIVE TWO FINISH COATS OF PAINT TO MATCH EXISTING ADJACENT FINISHES. PATCH AND REPAIR ANY DISRUPTED ADJACENT SURFACES AS REQUIRED TO MATCH EXISTING ADJACENT FINISHES.

17. AFTER DEMOLITION OF EXISTING CEILING SYSTEM, REFRAME BULKHEAD PARALLEL TO WINDOW WALL WITH $\frac{5}{8}$" GWB ON 2 $\frac{5}{8}$" – 20 GA. METAL STUDS @ 16" O.C., SETTING THE BOTTOM ELEVATION OF THE BULKHEAD 2" BELOW THE SCHEDULED HEIGHT OF THE THEATRE LOBBY CEILING. TAPE AND SAND ALL JOINTS PER INDUSTRY STANDARDS AND PRIME ALL NEW GWB SURFACES AS REQUIRED TO RECEIVE TWO FINISH COATS OF PAINT TO MATCH EXISTING ADJACENT FINISHES. PATCH AND REPAIR ANY DISRUPTED ADJACENT SURFACES AS REQUIRED TO MATCH EXISTING ADJACENT FINISHES.



2/A2 ELEVATION ALONG CHANNEL RAIL
SCALE: 3/4"=1'-0"

1) STRUCTURAL STEEL ANGLES SHALL CONFORM TO ASTM A-36 MATERIAL.
2) PROVIDE NECESSARY SHORING ON EACH SIDE OF THE RAIL ANGLE, PRIOR TO THE REMOVAL OF SECTION OF THE STEEL RAIL ANGLE. THE SHORING SHALL NOT BE REMOVED UNTIL THE NEW STEEL ANGLES ARE BOLTED TO THE EXISTING CHANNELS AT EACH END.
3) PROPER CARE SHALL BE TAKEN DURING CUTTING OF THE EXISTING STEEL CHANNEL SECTION, NOT TO BURN ANY WOOD MATERIAL OR ANY COMBUSTIBLE MATERIAL IN THE VICINITY.



3/A2 SECTION THROUGH RAIL CHANNEL
SCALE: 3"=1'-0"

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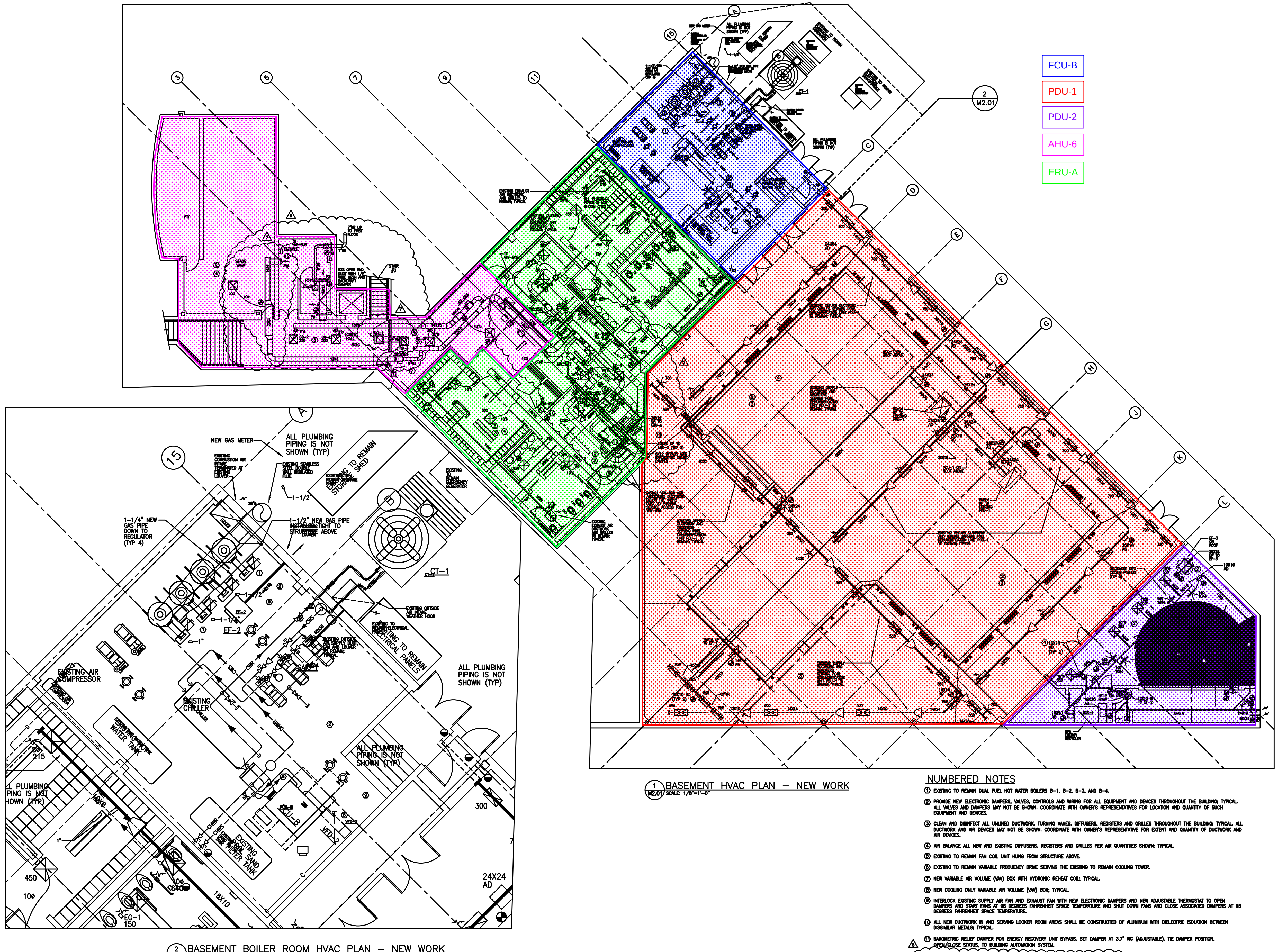
COUNTY OF FAIRFAX
FACILITIES MANAGEMENT DEPARTMENT
12000 Government Center Parkway, Suite 424
Fairfax, Virginia 22035-0011

NO.	DATE	SUBMISSION	NO.	DATE	SUBMISSION
	11/28/2006	FINAL SUBMISSION		08/22/2007	PHASE 3 CONSTRUCTION SUBMISSION
	02/07/2007	BID AND PERMIT		02/15/2008	REVISION
	04/19/2008	COORDINATION DRAWING SK1		03/20/2008	PERMIT REVIEW COMMENTS
	05/05/2008	COORDINATION DRAWING SK2		07/2/2008	DUCTWORK FIELD CHANGES
	10/16/2008	DUCTWORK REVISIONS		08/1/2008	DUCTWORK FIELD CHANGES
	10/22/2008	DUCTWORK FIELD MODIFICATIONS		10/03/2008	LIGHT FIXTURE RELOCATION

FIRST FLOOR DEMOLITION AND NEW WORK PLAN, AND NOTES
RESTON COMMUNITY CENTER HVAC SYSTEM UPGRADE
2310 COLTS NECK ROAD
RESTON, VA 22191

JOB# 05-102
A2
OF 4



1 BASEMENT HVAC PLAN – NEW WORK
M2.01 SCALE: 1/8"=1'-0"

2 BASEMENT BOILER ROOM HVAC PLAN – NEW WORK
M2.01 SCALE: 1/4"=1'-0"

NUMBERED NOTES

1. EXISTING TO REMAIN DUAL FUEL HOT WATER BOILERS B-1, B-2, B-3, AND B-4.
2. PROVIDE NEW ELECTRONIC DAMPERS, VALVES, CONTROLS AND WIRING FOR ALL EQUIPMENT AND DEVICES THROUGHOUT THE BUILDING; TYPICAL. ALL VALVES AND DAMPERS MAY NOT BE SHOWN. COORDINATE WITH OWNER'S REPRESENTATIVES FOR LOCATION AND QUANTITY OF SUCH EQUIPMENT AND DEVICES.
3. CLEAN AND DISINFECT ALL UNLINED DUCTWORK, TURNING VANES, DIFFUSERS, REGISTERS AND GRILLES THROUGHOUT THE BUILDING; TYPICAL. ALL DUCTWORK AND AIR DEVICES MAY NOT BE SHOWN. COORDINATE WITH OWNER'S REPRESENTATIVE FOR EXTENT AND QUANTITY OF DUCTWORK AND AIR DEVICES.
4. AIR BALANCE ALL NEW AND EXISTING DIFFUSERS, REGISTERS AND GRILLES PER AIR QUANTITIES SHOWN; TYPICAL.
5. EXISTING TO REMAIN FAN COIL UNIT HUNG FROM STRUCTURE ABOVE.
6. EXISTING TO REMAIN VARIABLE FREQUENCY DRIVE SERVING THE EXISTING TO REMAIN COOLING TOWER.
7. NEW VARIABLE AIR VOLUME (VAV) BOX WITH HYDRONIC REHEAT COIL; TYPICAL.
8. NEW COOLING ONLY VARIABLE AIR VOLUME (VAV) BOX; TYPICAL.
9. INTERLOCK EXISTING SUPPLY AIR FAN AND EXHAUST FAN WITH NEW ELECTRONIC DAMPERS AND NEW ADJUSTABLE THERMOSTAT TO OPEN DAMPERS AND START FANS AT 98 DEGREES FAHRENHEIT SPACE TEMPERATURE AND SHUT DOWN FANS AND CLOSE ASSOCIATED DAMPERS AT 95 DEGREES FAHRENHEIT SPACE TEMPERATURE.
10. ALL NEW DUCTWORK IN AND SERVING LOCKER ROOM AREAS SHALL BE CONSTRUCTED OF ALUMINUM WITH DIELECTRIC ISOLATION BETWEEN DISSIMILAR METALS; TYPICAL.
11. BAROMETRIC RELIEF DAMPER FOR ENERGY RECOVERY UNIT BYPASS. SET DAMPER AT 3.7" WG (ADJUSTABLE). TIE DAMPER POSITION, OPEN/CLOSE STATUS, TO BUILDING AUTOMATION SYSTEM.
12. PROVIDE 14X6 NAILOR MODEL 300RS OR APPROVED EQUAL SIDEWALL SUPPLY GRILLE.

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COUNTY OF FAIRFAX
FACILITIES MANAGEMENT DEPARTMENT

NO.	DATE	SUBMISSION	NO.	DATE	SUBMISSION
7	10/22/2008	DUCTWORK FIELD MODIFICATIONS	5	10/03/2008	LIGHT FIXTURE RELOCATION
6	10/16/2008	DUCTWORK REVISIONS	4	08/1/2008	DUCTWORK FIELD CHANGES
	08/08/2008	COORDINATION DRAWING SK2	3	07/2/2008	DUCTWORK FIELD CHANGES
	06/19/2008	COORDINATION DRAWING SK1	2	03/20/2008	PERMIT REVIEW COMMENTS
	02/07/2007	BID AND PERMIT	1	02/15/2008	REVISION
	11/28/2006	FINAL SUBMISSION		08/22/2007	PHASE 3 CONSTRUCTION

BASEMENT HVAC PLAN – NEW WORK

RESTON COMMUNITY CENTER HVAC SYSTEM UPGRADE
2310 COLTS NECK ROAD
RESTON, VA 22191

JOB# 05-102

M2.01

Appendix F – Potential IRA Funding

CMTA

A LEGENCE Company

Inflation Reduction Act

The Inflation Reduction Act has the potential to be the single most influential legislation for energy efficiency and carbon reduction in our lifetime. The provisions detailed in the law will have significant impacts to upcoming new building and renovation projects across the country. At nearly $370B in direct funding, the Inflation Reduction Act represents the single largest investment in climate and clean energy solutions in American history. A major provision in the Inflation Reduction Act is the extension and expansion of tax credits for renewable and energy efficient technologies.

Investment Tax Credit

The Investment Tax Credit (ITC) will apply to the following technologies: solar energy, wind energy, geothermal energy, ground-source heat pumps, fiber-optic solar, fuel cell, microturbine, combined heat and power, energy storage, biogas, microgrid, and dynamic glass.

30% Base Tax Credit

ITC has a 30% initial base tax credit based on the efficiency or generation measure's installed cost. To achieve this tax credit, prevailing wages and an apprenticeship program must be met. If these requirements are not met, the credit is reduced to 6%. These requirements have some exceptions, most notably, systems smaller than 1MW are exempt.

Direct-Payment for Private & Public Owners

Private owners and for-profit healthcare continue to qualify for the ITC. Public K-12 school systems, Universities, state and local governments that are tax exempt will qualify for the direct payment option in the ITC.

Tax Exempt Bonds

If a project is funded by tax exempt bonds, the ITC is fractionally reduced by up to 15% (eg. A 30% incentive is reduced to 25.5%). If only partially funded by tax exempt bonds, the reduction can be decreased.

Domestic Manufacturing Incentive

The ITC base rate can be increased by 10% if certain domestic content thresholds are achieved. Those thresholds include at least 40% of the projects components and 100% of the steel and iron must be manufactured in the US.

Energy Community Incentive

There is a potential for the ITC rate to be increased by 10% if the project is located in an "energy community." External agencies and the US treasury are working to publish maps of these energy communities soon.

CMTA is the national leader in maximizing the impact of the IRA for facilities:

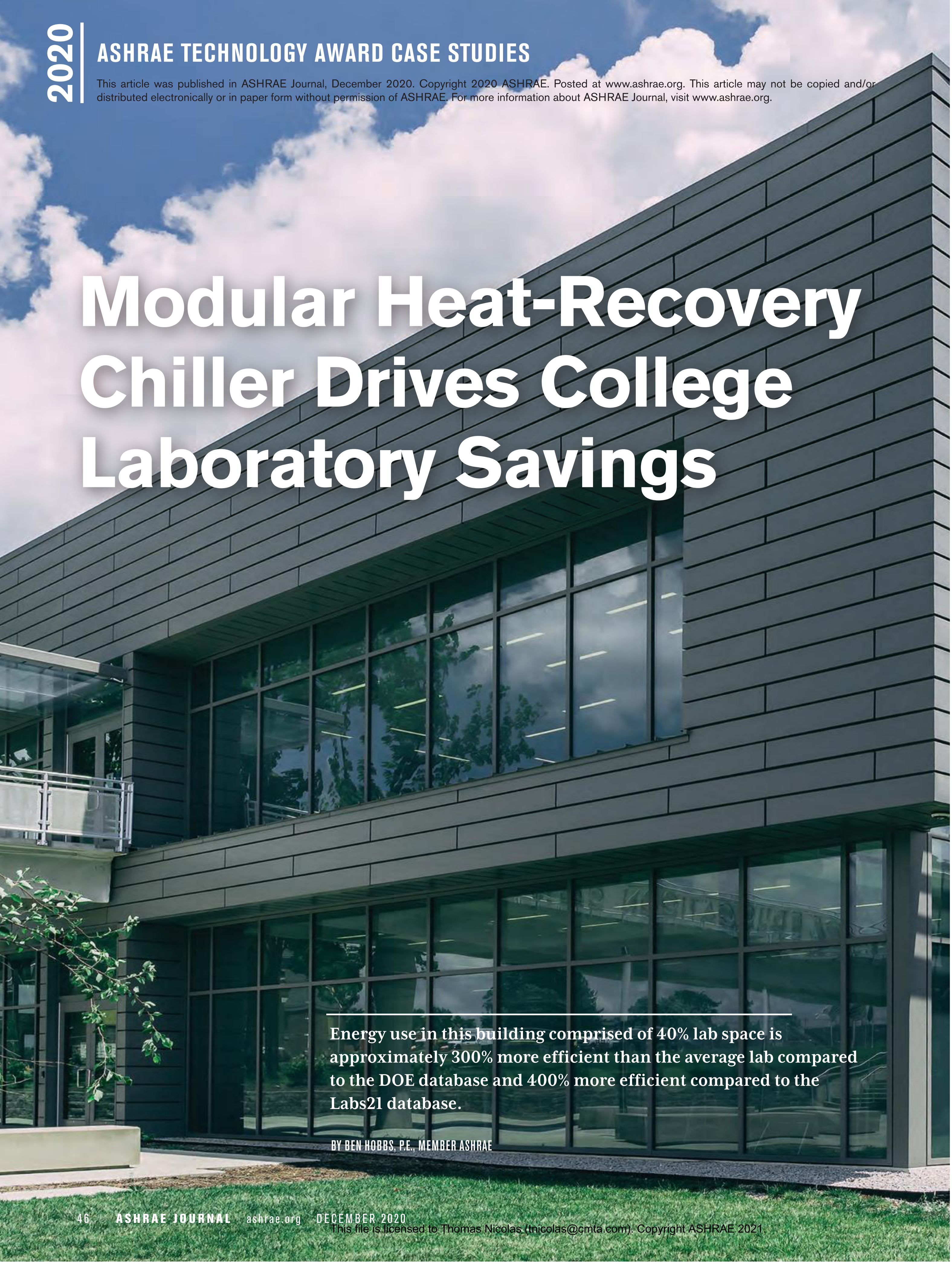
5,500 Miles
of geothermal HVAC
**Most in U.S.*

9,500,000 SF
of Zero Carbon facility design
**Most in U.S.*

140 MW
of renewable energy designed/installed

24 M SF
of Zero Carbon Ready
**Most in U.S.*

Appendix G – CMTA ASHRAE Technology Award



Modular Heat-Recovery Chiller Drives College Laboratory Savings

Energy use in this building comprised of 40% lab space is approximately 300% more efficient than the average lab compared to the DOE database and 400% more efficient compared to the Labs21 database.

BY BEN HOBBS, P.E., MEMBER ASHRAE

Located in Lexington, Kentucky, the Bluegrass Community and Technical College (BCTC) Newtown Campus Science Building was constructed as a 63,938 ft^2 (5940 m^2), three-story building with administrative spaces, lecture classrooms, laboratory classrooms, and student commons areas. The building is designed to accommodate approximately 850 students and staff, with approximately 40% used as lab space and the remaining area used as classroom and office space. The building was designed to achieve LEED Silver in accordance with the U.S. Green Building Council standard. The building is also designed to showcase how sustainable design can be safely applied to typical energy-intensive environments that require 24/7 operation and uncompromising indoor-environmental design approaches to maintain safe learning spaces.

Energy Efficiency

Laboratory buildings are some of the most energy-intensive buildings due to their ventilation requirements and simultaneous heating and cooling needs. The ASHRAE/IES Standard 90.1-2010, Appendix G baseline energy model generated for the Newtown Campus Science Building operated at an EUI of 127.9 kBtu/ft^2·yr (403.5 kWh/m^2). However, most labs seem to operate significantly higher than the baseline. Therefore, in addition to using the baseline energy model, the design team used the International Institute of Sustainable Labs (I2SL) and Department of Energy (DOE) databases of actual energy used by laboratory buildings to help lead the energy discussion as it relates to building systems.

These databases allow the design team to compare lab buildings in similar climate zones with similar fume hood densities and operational characteristics. The I2SL database indicated an energy usage of 381 kBtu/ft^2·yr (1201.9 kWh/m^2), while the DOE database showed an energy usage of 290 kBtu/ft^2·yr (914.8 kWh/m^2). These databases use actual energy performance in lieu of modeled data. The Newtown

Ben Hobbs, P.E., is a mechanical engineer at CMTA in Lexington, Ky.

Building at a Glance

BCTC Newtown Campus Science Building

Location: Newtown, Ky

Owner: Bluegrass Community and Technical College

Principal Use: Laboratories, classrooms, offices

Gross Square Feet: 63,938

Conditioned Square Feet: 63,938

Substantial Completion/Occupancy: January 2018

Campus Science Building was modeled and predicted to use 83.2 kBtu/ft^2·yr (262.5 kWh/m^2), and is currently operating at an EUI of 79.63 kBtu/ft^2·yr (251.2 kWh/m^2), which is one of the most energy-efficient community college buildings in the academic system.

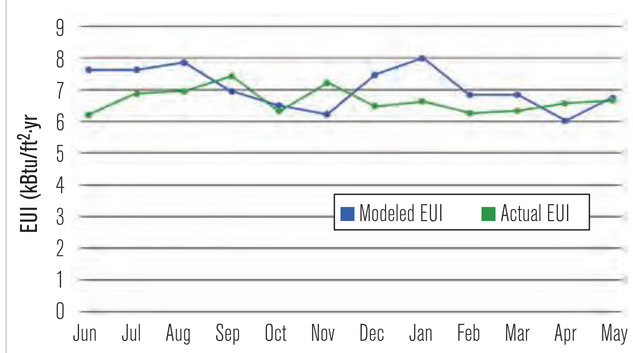
Since laboratory buildings use simultaneous heating and cooling, a modular heat-recovery chiller was used in place of the traditional chiller and boiler cooling and heating plants. This system has the ability, when producing 45°F (7.2°C) chilled water, to simultaneously produce 120°F (48.9°C) water by capturing the heat rather than rejecting it. The HVAC design used two air-handling units to handle the heating and the cooling of the building and the required ventilation air. The laboratory spaces required one-pass-through air due to the high amount of exhaust with the fume hood, and, thus, a 100% outdoor air system was provided with a run-around heat recovery coil in the exhaust airstream.

The classroom and office spaces do not have this same requirement; therefore, a traditional VAV air-handling unit with heating and cooling coils was used to heat and cool these spaces. However, this unit did not provide the ventilation air to these spaces. The ventilation air was provided through the laboratory unit. The advantage of providing ventilation air via the 100% outside air lab unit to non-lab spaces in lieu of the traditional air-handler VAV system was the ability to use demand control ventilation via occupancy sensors and the energy recovery of the run-around loop.

To generate additional energy reduction, dual-contact occupancy sensors were provided to control the lights in the building and to reset the temperature set point during occupied times. In addition, the occupancy sensors were also able to be used to shut off ventilation air in the classroom and lab spaces during occupied hours because sensors were monitoring occupancy at all times. Venturi valves were used in all lab spaces that were designed to precisely control air at 8 ach, but also allowed for a demand response to occupancy and hood use.

When labs were unoccupied, or during unoccupied hours, airflow reduced in labs from 8 ach to 2 ach, allowing for a reduction of 27,000 cfm (45 873.29 m^3/h) of conditioned 100% outside air. The design team additionally carefully coordinated the user group's hood sash height requirements, where a reduced sash height from 18 in. (457 mm) in height to 12 in. (305 mm) was deemed

FIGURE 1 Modeled EUI vs actual EUI.



appropriate for student use. The sash height reduction allowed for an exhaust air reduction while operating hoods of 7525 cfm (12,785 m^3/h), compared to a working sash height of 18 in. (457 mm) and a lab air-handler coil-size reduction of approximately 21 tons (74 kW).

Indoor Air Quality and Thermal Comfort

ASHRAE Standard 62.1-2010 air quality calculations were performed for the science building. The building has a 100% outside air-handling unit that delivers ventilation air to the entirety of the building. The air handler uses a UV light system to treat for entering airborne pathogens and microorganisms. Ventilation air is designed to be closely monitored, measured, and delivered with a combination of VAV boxes and venturi valves that display cfm airflow values to a controls system graphical front end. To maintain safe and comfortable lab working spaces for students and staff, all lab spaces in the building were designed to exceed ASHRAE Standard 62.1-2010.

Venturi valves were implemented in the design to accurately monitor airflows and pressurizations, and to provide an immediate response to the lab hood operation in all labs on two floors of the building. Safety of lab spaces is paramount and, as such, outside air and exhaust air is provided 24/7 to lab spaces where users have implemented occupancy schedules.

The system achieves 8 ach in occupied lab spaces, and responds to an unoccupied schedule where lab spaces are maintained at 2 ach or an airflow rate to maintain minimum hood velocities. Venturi valves allow the system to remain active, so if a hood is operated during any occupancy schedule, it will be successfully and safely maintained at a minimum sash velocity. Administration spaces and classrooms are provided with ventilation air directly from the 100% outside air lab unit. The outside air delivery remaining separate of the space-conditioning air in administration spaces and classrooms allows for effective delivery of outside air to the breathing zone and precise temperature delivery. If outdoor air was delivered through a traditional air-handler VAV system, the air volume would fluctuate and impact the effectiveness of outside air delivery to the breathing zone during occupancy.

ASHRAE Standard 55-2010 recommended thermal comfort is maintained with separate thermostatic zoning of all occupied spaces and careful monitoring of humidity levels. Humidity sensors are provided on all three floors, in the return duct of the space-conditioning air handler and in the exhaust duct of the 100% outside air lab unit. Humidity sensors are provided on all three floors, in the return duct of the space-conditioning air handler and in the exhaust duct of the 100% outside air lab unit. These are used to monitor the humidity in the space and to work in concert with optimized supply air temperature resets and extended unoccupied setpoints to maintain acceptable indoor environmental conditions.

Airflow measuring stations, controls points totalizing airflows from venturi valves, variable-air-volume boxes, and building pressurization sensors were employed to allow the user, commissioning agent, and engineer to fine-tune building pressures and ensure the air distribution design was executed as intended. Air devices were selected, examined, and located to provide appropriate air velocities for optimal occupant comfort and to address areas with high thermal losses or gains, such as curtain walls, large glazing, and dense occupation.

Morning warm-up and morning cool-down modes, in conjunction with optimal start logic in the controls system, are used to bring the building temperature back to occupied thermostatic set points. Activity levels and clothing were reviewed with the user group to inform indoor temperature design conditions and establish allowable temperature ranges in spaces. As an example, laboratory occupants wear lab coats on a regular basis, so lower temperatures are allowed in lab spaces.

Innovation

A modular heat-recovery chiller serves the science building's chilled- and hot-water needs for the heating and cooling of spaces. The modular heat-recovery chiller consists of five modules. Three of the five modules can operate in cooling mode, heating mode, or heat recovery mode, while two modules are heating and cooling only. These modules can all work independently of each other, and the equipment is automated to decide how best to assign module operation modes based on chilled- and hot-water loads. When implementing this design, it is essential to understand the simultaneous heating and cooling requirements to maximize this operation. The benefit is in the heating aspect, as this approach equates to a COP of 6.6 instead of traditional, high-efficiency boilers, which are 93% efficient and operate with a COP of 0.93. To maximize the use of heat recovery operation, a "load dump coil" was implemented to generate a chilled-water load in the heating-dominant season.

As the science building has very minimal interior HVAC zones, the design needed to take on the challenge of how to generate chilled-water loads in the winter, when most or all spaces are in heating mode. In order to address this issue, a coil was located in the lab air-handling unit exhaust airstream, where room temperature air would be taken across a chilled-water coil. The heat-recovery chiller also serves the domestic hot-water heating needs by transferring heat through a domestic hot-water tank with a built-in heat exchanger. These innovative approaches allow the chiller to operate longer in the heating season, maximizing the system's efficiency.

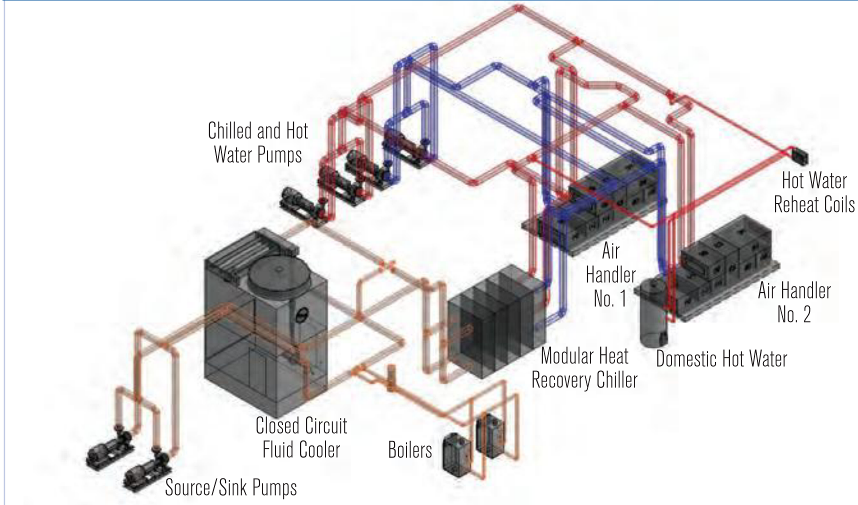
Operation and Maintenance

The design team considered four different options for the HVAC systems to serve the building: a geothermal central plant, using a modular heat-recovery chiller serving air-handler VAV systems in conjunction with water-source heat pumps for admin spaces; a geothermal central plant, using a modular heat-recovery chiller serving air-handler VAV systems; a packaged air-source chiller and boiler system, providing hot and chilled water to air-handler VAVs; and a modular heat recovery chiller, using a boiler for heat absorption and a closed-circuit fluid cooler for heat rejection with air-handler VAVs.

The design team, owner, and user group decided the fourth option was the best fit for the project. While it did not achieve the best life-cycle cost, it did fit within the budget and was a system the owner was accustomed to maintaining, as major equipment was similar to a neighboring large classroom building. The building has a total of three mechanical rooms for ease of maintenance. The mechanical rooms are divided up to house the central plant providing hot and chilled water to the building, the 100% outdoor air lab air-handling unit, and the recirculation space-conditioning air handler. Equipment clearances, owner walkways, work areas, and equipment grouping were all designed to provide the user with an easily maintainable system. Building commissioning was completed on this project and played an essential role in reviewing the envelope, testing the emergency generator and interaction with lab HVAC, and reviewing building pressurization. A blower door test was performed on the building to test the envelope and building's ability to maintain pressurization; the building passed this test, according to criteria established by the commissioning agent. While the system did pass the building pressure testing, the building experienced higher humidity than initially anticipated.

Thermography was used to identify an infiltration issue around a louver on the third floor of the building that was generating humidity issues in lab spaces. The engineering design team optimized the facility during post-commissioning and reduced the energy usage by an additional 12.5%, from an average monthly EUI of 7.57 down to 6.63—a savings of $17,712 annually.

FIGURE 2 HVAC system schematic.



Cost-Effectiveness

The system selection was based upon life-cycle costing and the owner's ability to maintain the system. While the final selection did not appear to be the most efficient, it was the most efficient within project budget. A geothermal well field was also analyzed, but it was proven to not be feasible due to budget constraints. The use of dual occupancy sensors to control ventilation air in place of a more complex CO_2 system was a cost-effective approach to provide demand-controlled ventilation.

The most recent annual review of utility bills shows a yearly electrical cost of $122,108.20, which accounts for 82% of the building's energy usage. The remaining 18% is gas usage, with a cost of $3,711, resulting in a total utility cost of $125,819.20. Compared to the I2SL database, this building saves approximately $480,926 in annual utility costs, compared to a similar laboratory building.

Environmental Impact

The building energy usage is approximately 300% more efficient than the average lab, compared to the Department of Energy database, and 400% more efficient than the Labs21 database. The BCTC Newtown Campus Science Building generates approximately 865 metric tons of CO_2, compared to an ASHRAE/IES Standard 90.1-2010 baseline building, which produces 1390 metric tons of CO_2, and 3275 metric tons according to the I2SL database.

An exhaust dispersion and re-entrainment study was performed for this building to assist in proper placement of exhaust and intakes for the 100% lab air-handling unit and recirculation air-handling unit. The position of the intakes for outside air was reviewed for appropriate relationships to laboratory exhaust, flues, and surrounding building air discharges based upon the actual chemicals that would be used. A computational fluid dynamics model was created to model these conditions, and a list of recommendations was provided. The design team reviewed this and provided modifications to the design to reduce the environmental impact and improve the indoor air quality, while maintaining a safe indoor environment. ■

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