LEVEL II ENERGY AUDIT

A Bureau Veritas Group Company

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

5735 47th Avenue
Sacramento, California 95824

DLR GROUP

1050 20th Street, Suite 250
Sacramento, California 95953

PREPARED BY:
EMG / A Bureau Veritas Company
10461 Mill Run Circle, Suite 1100
Owings Mills, Maryland 21117
800.733.0660
www.emgcorp.com

EMG CONTACT:
Kaustubh Anil Chabukswar
Program Manager
800.733.0660 x7512
kachabukswar@emgcorp.com

EMG PROJECT #:

136988.19R000-053.268

DATE OF REPORT:

October 22, 2019

ONSITE DATE:

September 12, 2019

ZERO NET ENERGY ASHRAE LEVEL II AUDIT

WOODBINE ELEMENTARY

2500 52nd Avenue

Sacramento, California 95822

TABLE OF CONTENTS

Certification

EMG has completed an Energy Audit of Woodbine Elementary located at 2500 52nd Avenue in Sacramento, California. EMG visited the site on September 12, 2019.

The assessment was performed at the Client's request using methods and procedures consistent with ASHRAE Level II Energy Audit and using methods and procedures as outlined in EMG's Proposal.

This report has been prepared for and is exclusively for the use and benefit of the Client identified on the cover page of this report. The purpose for which this report shall be used shall be limited to the use as stated in the contract between the client and EMG.

This report, or any of the information contained therein, is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance written consent of EMG. Any reuse or distribution without such consent shall be at the client's or recipient's sole risk, without liability to EMG.

Estimated installation costs are based on EMG's experience on similar projects and industry standard cost estimating tools including *RS Means and Whitestone CostLab*. In developing the installed costs, EMG also considered the area correction factors for labor rates for Sacramento, California. Since actual installed costs may vary widely for particular installation based on labor & material rates at time of installation, EMG does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein. We strongly encourage the owner to confirm these cost estimates independently. EMG does not guarantee the costs savings estimated in this report. EMG shall in no event be liable should the actual energy savings vary from the savings estimated herein.

EMG certifies that EMG has no undisclosed interest in the subject property and that EMG's employment and compensation are not contingent upon the findings or estimated costs to remedy any deficiencies due to deferred maintenance and any noted component or system replacements.

Any questions regarding this report should be directed to Kaustubh Anil Chabukswar at 800.733.0660, ext. 7512.

Prepared by: Noah Strafford
Energy Auditor
Project Manager

Reviewed by:

Al Diefert
Technical Report Reviewer
For
Kaustubh Anil Chabukswar, CEM CRM
Program Manager

1. Executive Summary

The purpose of this Energy Audit is to provide Sacramento City Unified School District and Woodbine Elementary with a baseline of energy usage and the relative energy efficiency of the facility and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal & Utility grants towards energy conservation, support performance contracting, justify a municipal bond funded improvement program, or as a basis for replacement of equipment or systems.

BUILDING #	STRUCTURES ASSESSED	BUILDING TYPE	EMG CALCULATED AREA (SF)	ESTIMATED OCCUPANCY
1	001 MPR, Admin, Classrooms	School Building	3,146	45
2	002 Classrooms	School Building	2,080	25
3	003 Classroom 18	School Building	5,740	65
4	P01 Classrooms	School Building	983	15
5	P02, P06 Classrooms	Portable School Building	3,840	45
6	P03, P07, P09 Classrooms	Portable School Building	3,360	45
7	P04, P10, P11 Classrooms	Portable School Building	4,320	50
8	P05 Classrooms	Portable School Building	2,948	35
9	P08 Classrooms	Portable School Building	960	15

The study included a review of the building's construction features, historical energy and water consumption and costs, review of the building envelope, HVAC equipment, heat distribution systems, lighting, and the building's operational and maintenance practices.

1.1. Energy Conservation Measures

EMG has identified eight Energy Conservation Measures (ECMs) for this property. The savings for each measure is calculated using standard engineering methods followed in the industry, and detailed calculations for ECM are provided in Appendix for reference. A 10% discount in energy savings was applied to account for the interactive effects amongst the ECMs. In addition to the consideration of the interactive effects, EMG has applied a 15% contingency to the implementation costs to account for potential cost overruns during the implementation of the ECMs.

The following table summarizes the recommended ECMs in terms of description, investment cost, energy consumption reduction, and cost savings.

Summary of Financial Information for Recommended Non-Renewable Energy Conservation Measures

ITEM	ESTIMATE
Net Initial ECM Investment *(Current Dollars Only)*	$64,416 *(In Current Dollars)*
Estimated Annual Cost Savings *(Current Dollars Only)*	$7,843 *(In Current Dollars)*
ECM Effective Payback	8.2 years
Estimated Annual Energy Savings	23.4%
Estimated Annual Energy Utility Cost Savings *(Excluding Water)*	16.8%
Estimated Annual Water Cost Saving	7.4%

Solar Photovoltaic (PV) Screening for WOODBINE ELEMENTARY

SOLAR ROOFTOP PHOTOVOLTAIC ANALYSIS		
Estimated Number of Panels	426	
Estimated KW Rating	134	KW
Potential Annual kWh Produced	205,952	kWh
% of Current Electricity Uses	100.4%	
FINANCIAL SUMMARY		
Investment Cost	$470,050	
Estimated Energy Cost Savings	$32,952	
Payback without Incentives	14.3	Years
Incentive Payback but without SRECs	8.6	Years
Payback with All Incentives	8.6	Years

Key Metrics to Benchmark the Subject Property's Energy Usage Profile

- Building Site Energy Use Intensity - The sum of the total site energy use in thousands of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.

- Building Source Energy Use Intensity – The sum of the total source energy use in thousands of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.
- Building Cost Intensity - This metric is the sum of all energy use costs in dollars per unit of gross building area.
- Greenhouse Gas Emissions - Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions, the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).

SITE ENERGY USE INTENSITY (EUI)	RATING
Current Site Energy Use Intensity (EUI)	27 kBtu/ft^2
Post ECM Site Energy Use Intensity (EUI)	21 kBtu/ft^2
SOURCE ENERGY USE INTENSITY (EUI)	**RATING**
Current Source Energy Use Intensity (EUI)	75 kBtu/ft^2
Post ECM Source Energy Use Intensity (EUI)	62 kBtu/ft^2
BUILDING COST INTENSITY (BCI)	**RATING**
Current Building Cost Intensity	$1.07 /ft^2
Post ECM Building Cost Intensity	$0.89 /ft^2

Summary of the Greenhouse Gas Reductions from Recommended Non-Renewable Energy Conservation Measures

The following table provides a summary of the projected Greenhouse Gas Emissions reductions as a result of the recommended Energy Conservation Measures:

GREENHOUSE GAS EMISSIONS REDUCTION	
Estimated Annual Thermal Energy Reduction	216 MMbtu
Total CO_2 Emissions Reduced	15.6 MtCO_2/Yr
Total Cars Off the Road (Equivalent)*	3
Total Acres of Pine Trees Planted (Equivalent)*	4

**Equivalent reductions per DOE emissions calculation algorithms*

Zero Net Energy Analysis for Renewable and Non-Renewable Recommended Measures

ZERO NET ENERGY ANALYSIS	
Building Annual Net Energy Consumption	924,976 kBtu
Total Annual Energy Savings for Non-Renewable Energy Measures	216,096 kBtu
Total Annual Energy Savings from Renewable Energy Measures	702,708 kBtu
Total Annual Energy Savings	918,804 kBtu

ZERO NET ENERGY ANALYSIS	
Net Energy Consumption from Grid Post Implementation	6,172 kBtu
% Energy Reduction (Annual Energy-Net Energy) / (Annual Energy)	99%

Energy Conservation Measures Screening:

EMG screens ECMs using two financial methodologies. ECMs which are considered financially viable must meet both criteria.

1. Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates. ECMs with a payback period greater than the Expected Useful Life (EUL) of the project are not typically recommended, as the cost of the project will not be recovered during the lifespan of the equipment. These ECMs are recommended for implementation during future system replacement. At that time, replacement may be evaluated based on the premium cost of installing energy efficient equipment.

$$Simple\ Payback = \frac{Initial\ Cost}{Annual\ Savings}$$

2. Savings-to-Investment Ratio (SIR) – The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value over the estimated useful life (EUL) of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy efficiency recommendations should be based on a calculated SIR, with larger SIRs receiving a higher priority. A project is typically only recommended if SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

$$SIR = \frac{Present\ Value\ (Annual\ Savings, i\%, EUL)}{Initial\ Cost}$$

List of Recommended Energy Conservation Measures For Woodbine Elementary School

ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings					Estimated Annual Water Savings	Estimated Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Simple Payback	S.I.R.	Life Cycle Savings	Expected Useful Life (EUL)
			Natural Gas	Propane	No.2 Oil	Steam	Electricity								
		$	Therms	Gallons	Gallons	Mlbs	kWh	kgal	$	$	$	Years		$	Years
No/Low Cost Recommendations															
1	Install Low Flow Faucet Aerators Location: Restrooms And Classrooms	$244	343	0	0	0	0	44	$554	$0	$554	0.44	19.39	$4,482	10.00
2	Replace Exit Signs With LED Exit Signs Location: Throughout	$569	0	0	0	0	569	0	$93	$366	$459	1.24	5.03	$2,290	7.00
Totals for No/Low Cost Items		**$813**	**343**	**0**	**0**	**0**	**569**	**44**	**$647**	**$366**	**$1,013**	**0.80**			
Capital Cost Recommendations															
1	Upgrade Building Lighting to LED and Install Automatic Lighting Controls Location: Building Interior And Exterior	$23,046	0	0	0	0	19,637	0	$3,222	$528	$3,750	6.15	1.94	$21,724	15.00
2	Control External Air Leakage In Commercial Buildings Location: Building 001, 002, 003, P01, P05	$8,239	602	0	0	0	2,716	0	$1,245	$62	$1,307	6.30	1.89	$7,365	15.00
3	Install Low Flow Restroom Flush Tank Toilets Location: Restrooms And Locker Rooms	$2,846	0	0	0	0	0	174	$385	$0	$385	7.38	2.01	$2,888	20.00
4	Insulate Air Ducts Location: Rooftop Rtus	$5,675	407	0	0	0	773	0	$667	$0	$667	8.51	1.40	$2,287	15.00
5	Upgrade Electric Heating System To Heat Pumps Location: Portable Classroom P03, P09, P11	$10,443	0	0	0	0	7,071	0	$1,160	$0	$1,160	9.00	1.65	$6,816	20.00
6	Install Low Flow Tankless Restroom Fixtures Location: Restrooms	$4,952	0	0	0	0	0	195	$432	$0	$432	11.47	1.04	$201	15.00
Total For Capital Cost		**$55,201**	**1,008**	**0**	**0**	**0**	**30,197**	**369**	**$7,111**	**$591**	**$7,701**	**7.17**			
	Interactive Savings Discount @ 10%		-135	0	0	0	-3,077	-41	-$776	-$96	-$871				
	Total Contingency Expenses @ 15%	$8,402													
Total for Improvements		**$64,416**	**1,216**	**0**	**0**	**0**	**27,690**	**372**	**$6,982**	**$860**	**$7,843**	**8.21**			

In addition to the above measures, EMG has identified the following measure(s) but has not recommended as they fail to meet the above-mentioned financial criteria of SIR>1.0. Thus, EMG has classified the measure(s) as recommended for consideration.

List of Recommended For Consideration Energy Conservation Measures For Woodbine Elementary School

ECM #	Description of ECM	Initial Investment	Annual Energy Savings					Annual Water Savings	Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Payback	S.I.R.	Life Cycle Savings	Expected Useful Life (EUL)
		$	Natural Gas	Propane	No.2 Oil	Steam	Electricity	kgal	$	$	$	Years		$	Years
1	Replace External Windows Location: Building 001, 002, 003, P01, P05	$107,539	617	0	0	0	9,589	0	$2,393	$24	$2,417	44.50	0.39	-$65,460	25.00
1	Replace Existing Water Heater With New Energy Efficient Units Location: Building 003	$3,508	52	0	0	0	0	0	$69	$0	$69	50.67	0.27	-$2,555	18.00
Total for Improvements		**$107,539**	**617**	**0**	**0**	**0**	**9,589**	**0**	**$2,393**	**$24**	**$2,417**	**44.50**			

2. Introduction

The purpose of this Energy Audit is to provide Woodbine Elementary and Sacramento City Unified School District with a baseline of energy usage, the relative energy efficiency of the facility, and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal and Utility grants towards energy conservation, as well as support performance contracting, justify a municipal bond-funded improvement program, or as a basis for replacement of equipment or systems.

The energy audit consisted of an onsite visual assessment to determine current conditions, itemize the energy consuming equipment (i.e. Boilers, Make-Up Air Units, DWH equipment); review lighting systems both exterior and interior; and review efficiency of all such equipment. The study also included interviews and consultation with operational and maintenance personnel. The following is a summary of the tasks and reporting that make up the Energy Audit portion of the report.

The following is a summary of the tasks and reporting that make up the Energy Audit portion of the report.

ENERGY AND WATER USING EQUIPMENT

- EMG has surveyed the common areas, office areas, rooms, maintenance facilities and mechanical rooms to document utility-related equipment, including heating systems, cooling systems, air handling systems and lighting systems.

BUILDING ENVELOPE

- EMG has reviewed the characteristics and conditions of the building envelope, checking insulation values and conditions. This review also includes an inspection of the condition of walls, windows, doors, roof areas, insulation and special use areas

RECOMMENDATIONS FOR ENERGY SAVINGS OPPORTUNITIES

- Based on the information gathered during the on-site assessment, the utility rates, as well as recent consumption data and engineering analysis, EMG has identified opportunities to save energy and provide probable construction costs, projected energy/utility savings and provide a simple payback analysis.

ANALYSIS OF ENERGY CONSUMPTION

- Based on the information gathered during the on-site assessment, EMG has conducted an analysis of the energy usage of all equipment, and identified which equipment is using the most energy and what equipment upgrades may be necessary. As a result, equipment upgrades, or replacements are identified that may provide a reasonable return on the investment and improve maintenance reliability.

ENERGY AUDIT PROCESS

- Interviewing staff and review plans and past upgrades
- Performing an energy audit for each use type
- Performing a preliminary evaluation of the utility system
- Analyzing findings, utilizing ECM cost-benefit worksheets
- Making preliminary recommendations for system energy improvements and measures
- Estimating initial cost and changes in operating and maintenance costs based on implementation of energy efficiency measures
- Ranking recommended cost measures, based on the criticality of the project and the largest payback

REPORTING

The EMG Energy Audit Report includes:

- A comprehensive study identifying all applicable Energy Conservation Measures (ECMs) and priorities, based on initial cost and payback
- A narrative discussion of building systems/components considered and a discussion of energy improvement options;
- A summary of ECMs including initial costs and simple paybacks, based on current utility rates and expected annual savings.

3. Facility Overview and Existing Conditions

3.1. Building Occupancy and Point of Contact

FACILITY SCHEDULE	
Hours of Operations / Week	35 Hours
Operational Weeks / Year	36 Weeks
Estimated Facility Occupancy	305
% of Male Occupants	50%

POINT OF CONTACT	
Point of Contact Name	Maria
Point of Contact Title	Plant Manager
Point of Contact – Contact Number	(916) 433-5358

3.2. Building Heating, Ventilating and Air-Conditioning (HVAC)

Description:

Heating and cooling to buildings 002, 003, P01 and P05 is provided primarily by central split AC systems with natural gas furnaces. Building 001 and 003 are served by rooftop package units utilizing natural gas for heat. Wall mounted heat pumps serve the portable classroom for heating and cooling.

The Mechanical Equipment Schedule in Appendix E contains a summary of the HVAC Equipment at the property.

BUILDING CENTRAL HEATING SYSTEM	
Primary Heating System	Forced Air Furnace
Secondary Heating System	Heat Pump System
Hydronic Distribution System	Not Applicable
Primary Heating Fuel	Natural Gas
Heating Mode Set-point	68 °F
Heating Mode- Set-back Temperature	65 °F

BUILDING COOLING SYSTEM	
Primary Cooling System	Split Systems

BUILDING COOLING SYSTEM	
Secondary Cooling System	Air Cooled Heat pumps
Hydronic Distribution System	Not Applicable
Cooling Mode Set-point	68 °F
Cooling Mode- Set-back Temperature	74 °F

AIR DISTRIBUTION SYSTEM	
Building Ventilation	Roof Top Exhaust Fans, Central AHU
On-Demand Ventilation System in Use?	No
Energy Recovery Wheel / Enthalpy Wheel Exhaust Fans	No

DOMESTIC HOT WATER SYSTEM	
Primary Domestic Water Fuel	Natural Gas

3.3. Lighting

Description:

The lighting in the school building primarily consists of T8 linear fluorescent lamp fixtures in classrooms and hallways. The fixtures were observed to be operating on bi-level mode in the classrooms. The exterior lights were primarily High Intensity Discharge (HID) fixtures.

The detailed lighting schedule and the proposed LED alternative is provided in Appendix D.

4. Utility Analysis

Establishing the energy baseline begins with an analysis of the utility cost and consumption of the building. Utilizing the historical energy data and local weather information, we evaluate the existing utility consumption and assign it to the various end-uses throughout the buildings. The Historical Data Analysis breaks down utilities by consumption, cost and annual profile.

This data is analyzed, using standard engineering assumptions and practices. The analysis serves the following functions:

- Allows our engineers to benchmark the energy and water consumption of the facilities against consumption of efficient buildings of similar construction, use and occupancy.
- Generates the historical and current unit costs for energy and water
- Provides an indication of how well changes in energy consumption correlate to changes in weather.
- Reveals potential opportunities for energy consumption and/or cost reduction. For example, the analysis may indicate that there is excessive, simultaneous heating and cooling, which may mean that there is an opportunity to improve the control of the heating and cooling systems.

By performing this analysis and leveraging our experience, our engineers prioritize buildings and pinpoint systems for additional investigation during the site visit, thereby maximizing the benefit of their time spent on-site and minimizing time and effort by the customer's personnel.

Based upon the utility information provided about the Sacramento City Unified School District, the following energy rates are utilized in determining existing and proposed energy costs.

Utility Rates used for Cost Analysis

ELECTRICITY (BLENDED RATE)	NATURAL GAS	WATER / SEWER
$0.16 /kWh	$1.33 /therm	$2.22 /kGal

The data analyzed provides the following information: 1) breakdown of utilities by consumption, 2) cost and annual profile, 3) baseline consumption in terms of energy/utility at the facility, 4) the Energy Use Index, or Btu/sq ft, and cost/sq ft. For multiple water meters, the utility data is combined to illustrate annual consumption for each utility type.

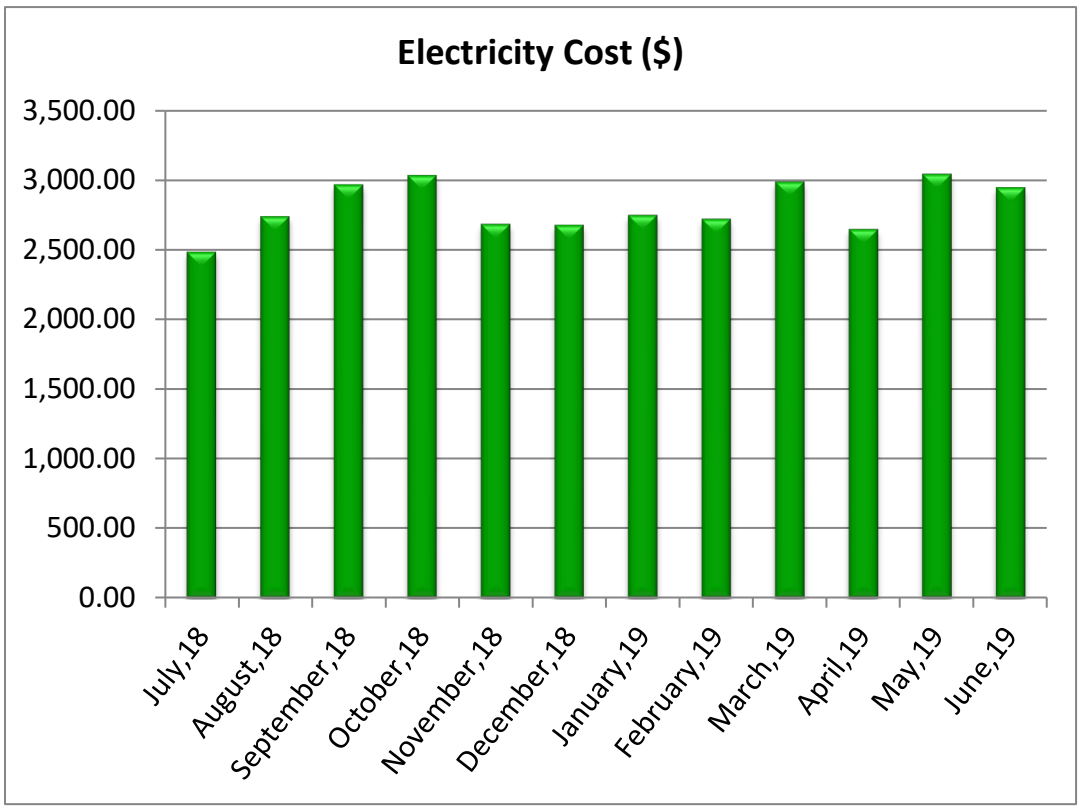
4.1. Electricity

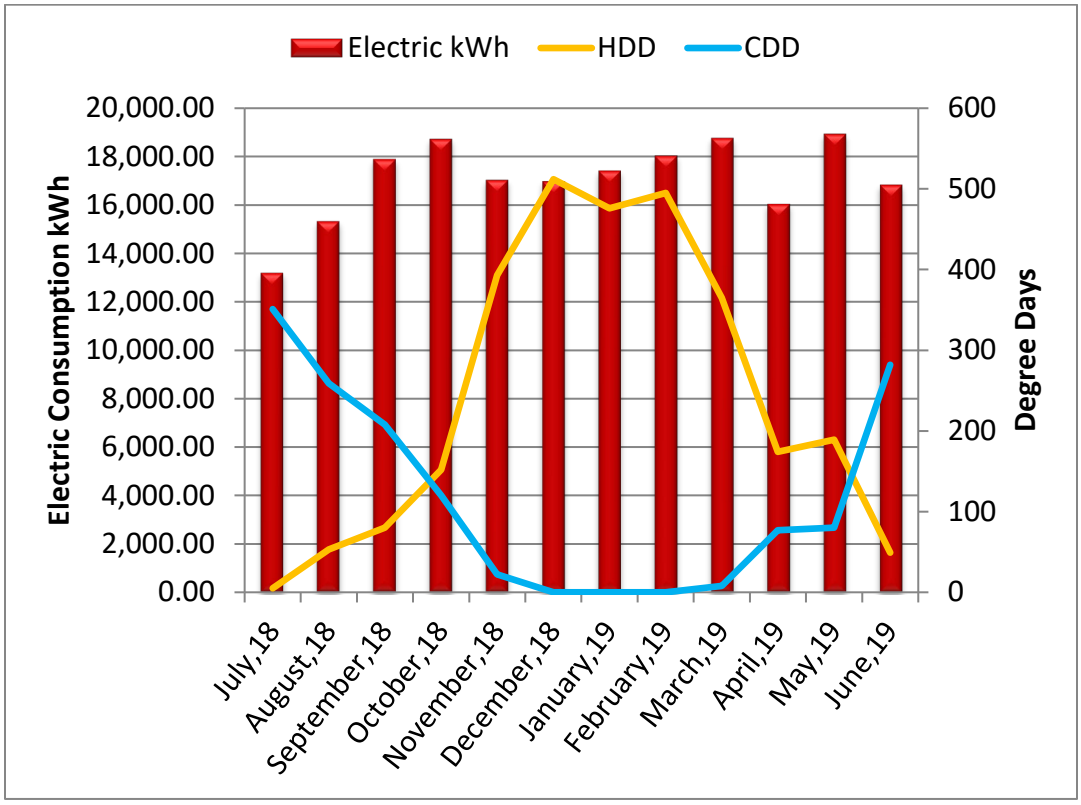
PGE satisfies the electricity requirements for the facility. The primary end uses for electric utility compromises of lighting, cooling, office/school equipment, and appliances in the break room.

The table below provides the electric use for the period of twelve continuous months.

Electric Consumption and Cost Data

BILLING MONTH	CONSUMPTION (KWH)	UNIT COST/KWH	TOTAL COST
July,18	13,191.00	0.19	2,481.00
August,18	15,326.00	0.18	2,737.00
September,18	17,882.00	0.17	2,966.00
October,18	18,722.00	0.16	3,032.00
November,18	17,024.00	0.16	2,682.00
December,18	16,980.00	0.16	2,674.00
January,19	17,406.00	0.16	2,746.00
February,19	18,036.00	0.15	2,720.00
March,19	18,756.00	0.16	2,985.00
April,19	16,033.00	0.17	2,646.00
May,19	18,936.00	0.16	3,042.00
June,19	16,830.00	0.17	2,944.00
Total/average	**205,122.00**	**0.16**	**33,655.00**


Electricity Cost ($)
3,500.00
3,000.00
2,500.00
2,000.00
1,500.00
1,000.00
500.00
0.00
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19


Electric kWh
HDD
CDD
Electric Consumption kWh
20,000.00
18,000.00
16,000.00
14,000.00
12,000.00
10,000.00
8,000.00
6,000.00
4,000.00
2,000.00
0.00
Degree Days
600
500
400
300
200
100
0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

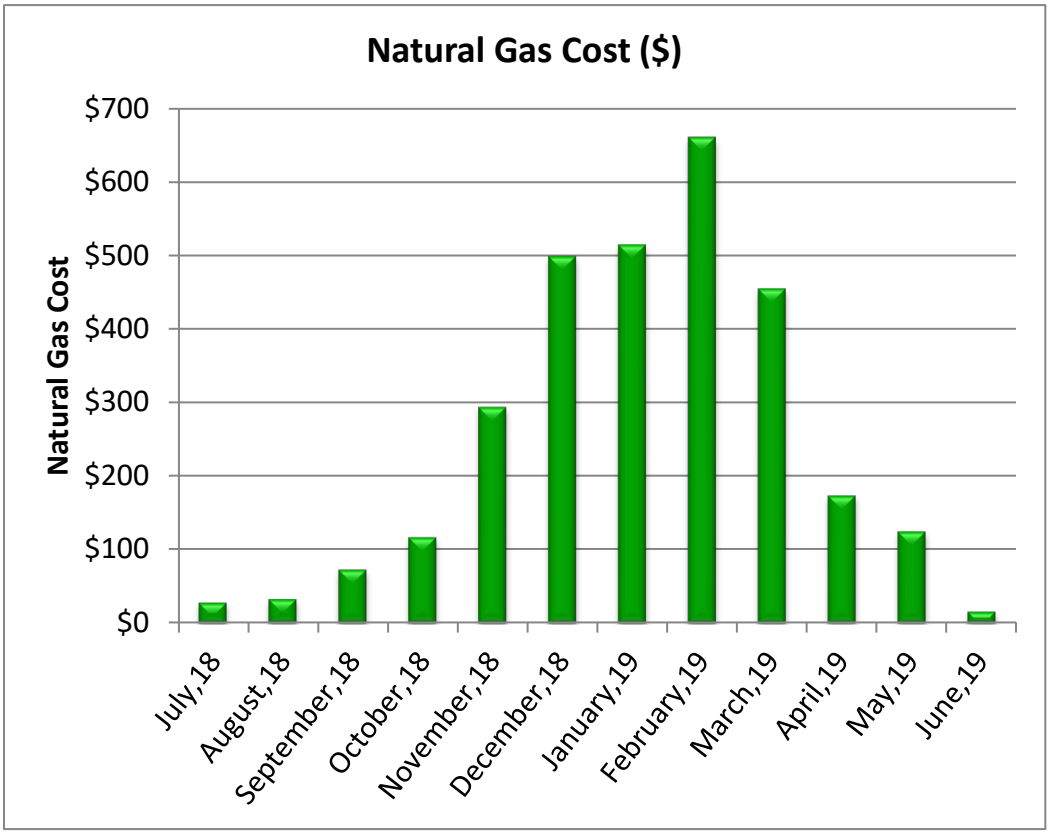
4.2. Natural Gas

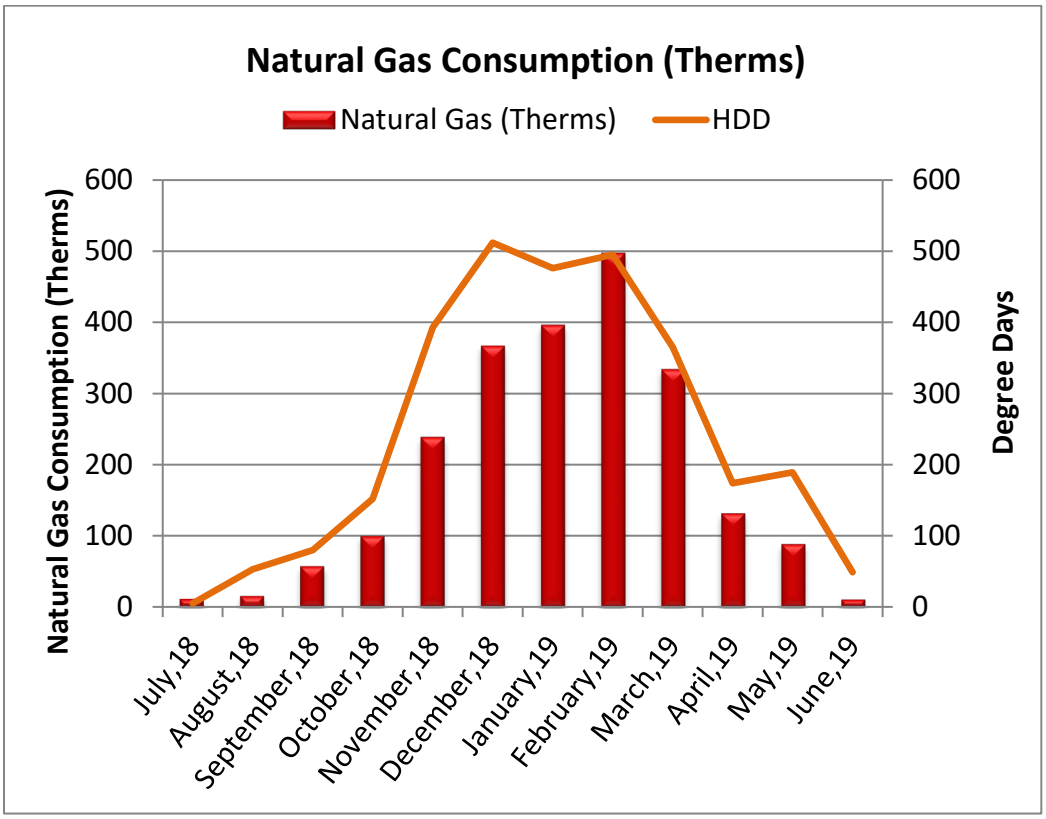
SPURR Gas satisfies the natural gas requirements of the facility. The primary end use of natural gas is for building heating, domestic water heating, and cooking in the cafeteria.

The analysis of the 12 months of consumption is provided below.

Natural Gas Consumption and Cost Data

BILLING MONTH	CONSUMPTION (THERMS)	UNIT COST/THERM	TOTAL COST
July,18	12	$2.33	$28
August,18	16	$2.06	$33
September,18	58	$1.26	$73
October,18	100	$1.17	$117
November,18	239	$1.23	$294
December,18	367	$1.36	$499
January,19	396	$1.30	$515
February,19	497	$1.33	$661
March,19	334	$1.36	$455
April,19	132	$1.32	$174
May,19	89	$1.40	$125
June,19	11	$1.45	$16
Total/average	**2,251**	**$1.33**	**$2,990**


Natural Gas Cost ($)
Natural Gas Cost
$700
$600
$500
$400
$300
$200
$100
$0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

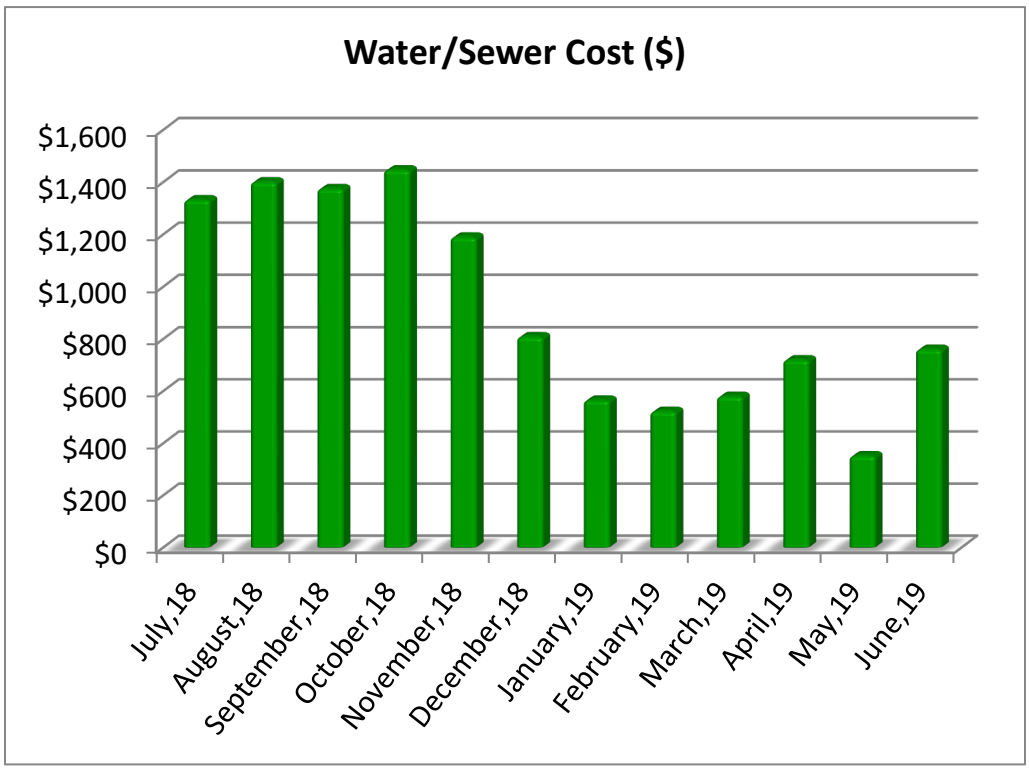

Natural Gas Consumption (Therms)
Natural Gas (Therms)
HDD
Natural Gas Consumption (Therms)
Degree Days
600
500
400
300
200
100
0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

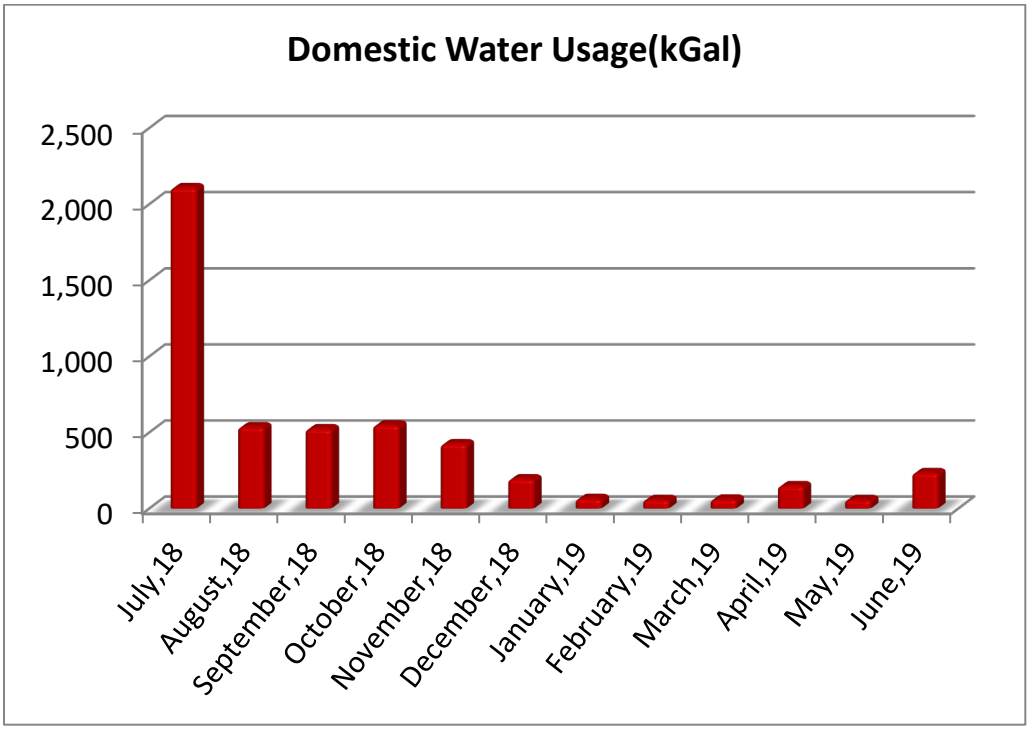
4.3. Water and Sewer

The City of Sacramento satisfies the water requirements for the facility. The primary end use of water is the plumbing fixtures such as staff showers, water closets, and lavatories. The table below provides the twelve continuous months' worth of consumption and cost for water in kGal for the facility.

Water and Sewer Consumption and Cost Data

BILLING MONTH	CONSUMPTION (KGAL)	UNIT COST/KGAL	TOTAL COST
July,18	2,111	$0.63	$1,334
August,18	539	$2.60	$1,403
September,18	527	$2.61	$1,377
October,18	552	$2.62	$1,449
November,18	428	$2.78	$1,192
December,18	197	$4.11	$810
January,19	68	$8.33	$567
February,19	61	$8.54	$524
March,19	64	$9.06	$582
April,19	152	$4.74	$722
May,19	61	$5.82	$354
June,19	238	$3.20	$762
Total/average	**4,999**	**2.22**	**$11,077**


Water/Sewer Cost ($)
$1,600
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19


Domestic Water Usage(kGal)
2,500
2,000
1,500
1,000
500
0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

5. Renewable Energy Discussions

5.1. Rooftop Solar Photovoltaic Feasibility

Solar Energy Feasibility

A photovoltaic array is a linked collection of photovoltaic modules, which are in turn made of multiple interconnected solar cells. The cells convert solar energy into direct current electricity via the photovoltaic effect. The power that one module can produce is seldom enough to meet requirements of a home or a business, so the modules are linked together to form an array. Most PV arrays use an inverter to convert the DC power produced by the modules into alternating current that can plug into the existing infrastructure to power lights, motors, and other loads. The modules in a PV array are usually first connected in series to obtain the desired voltage; the individual strings are then connected in parallel to allow the system to produce more current. Solar arrays are typically measured by the peak electrical power they produce, in watts, kilowatts, or even megawatts.

When determining if a site is suitable for a solar application, two basic considerations must be evaluated:

- At minimum, the sun should shine upon the solar collectors from 9 AM to 3 PM. If less, the application may still be worthwhile, but the benefit will be less.
- The array should face south and be free of any shading from buildings, trees, rooftop equipment, etc. If the array is not facing directly south, there will be a penalty in transfer efficiency, reducing the overall efficiency of the system.

SOLAR PV QUESTIONNAIRE	RESPONSE
Does the property have a south, east, or west facing roof or available land of more than 250 square feet per required Solar Array Panel?	Yes
Is the area free from any shading such as trees, buildings, equipment etc throughout the whole day?	Yes
Can the panels be mounted at an incline of roughly 25-45 degrees? (equal to latitude of property)	Yes
Is the property in an area with acceptable average monthly sunlight levels?	Yes
Has the roofing been replaced within the past 3-5 years?	No
Is the roof structure sufficient to hold solar panels?	Must Evaluate
Is the property located in a state eligible for net metering?	Yes

A solar feasibility analysis of the Woodbine Elementary School site has resulted in the building containing more than sufficient amount of roof area for solar electricity generation. The analysis through the use of National Renewable Energy Laboratory's solar photovoltaic software assisted in calculating the potential electricity generated from the allocated land and roof area set for solar photovoltaic installment. The allocated roof area was through looking at the roof and surrounding areas at a bird's eye view. Also detailed in the report are incentives and rebates that can potentially bring down the installation cost of the ECMs and result in a higher return on investment and quicker payback period.

The approach taken in the solar photovoltaic (PV) roof analysis begins with surveying the roof and determine areas on the roof where solar PV panels can potentially be installed.

1) Conducting a preliminary sizing of solar PV panels on the roofs and on the ground and its potential electricity production for its first year of installment using the National Renewable Energy Laboratory (NREL) PV WATTS Version 2 Software.

2) Calculate energy and cost savings for the site as a sole proprietor of the system capable of collecting state, local, and federal tax credits and incentives and interconnecting and selling the renewable energy electrical production to the building.

SOLAR ROOFTOP PHOTOVOLTAIC ANALYSIS		
Estimated Number of Panels	426	
Estimated KW Rating	134	KW
Potential Annual kWh Produced	205,952	kWh
% of Current Electricity Uses	100.4%	
FINANCIAL SUMMARY		
Investment Cost	$470,050	
Estimated Energy Cost Savings	$32,952	
Payback without Incentives	14.3	Years
Incentive Payback but without SRECs	8.6	Years
Payback with All Incentives	8.6	Years

A photovoltaic array is a linked collection of photovoltaic modules, which are in turn made of multiple interconnected solar cells. The cells convert solar energy into direct current. Modules of cells are linked together to form an array. Most PV arrays use an inverter to convert the DC power produced by the modules into alternating current that can connect to existing AC infrastructure to power lights, motors, and other loads.

Cost of production has fallen years with increasing demand and through production and technological advances. The cost dropped from $8–10/watt in 1996 to $4–7/watt in 2006. The market is diversifying with new types of panels suited to unique installation methods including stick on sheets and PV spray coating. The solar PV cost used in the analysis was set at $7.0/Watt which includes design, construction, administration, and installation and maintenance cost throughout the life of the solar panels.

One breakthrough for PV is “Net Metering”. When more PV electric power is generated than is consumed on site, the electric service meter reverses to “sell” the excess power directly back onto the power grid. The economics of PV for commercial industrial installations become attractive when coupled with incentives from Federal and state agencies, as well utility companies.

A kilowatt-hour costing $0.15 might be valued at $0.30 when produced by PV and sent to the grid. The economics of PV for commercial industrial installations become attractive when coupled with incentives from Federal and state agencies, as well utility companies.

The low payback period is highly dependent on the marketing potential of selling Solar Renewable Certificates to electricity generated providers who are under state regulations to contain a certain percentage of their electricity generation derived from renewable energy such as wind and solar.

Solar facilities are encouraged to sell their SRECs on the market (either spot market or through long-term contracts). Utilities may use SRECs for compliance under the state RPS for the year in which they are generated. Utilities may purchase up to 10% more SRECs than they require for compliance and "bank" those surplus SRECs for compliance during the following two years. Any SRECs pricing can range from $300 - $450/MWh and can be sold across state borders to other utility providers looking to purchase SRECs. EMG has selected to use the market value of $300/MWh minus 5% administrative fee in the analysis.

A number of states and corresponding electrical utility supplier are required under regulation to have a certain percentage of its electricity be produced by solar energy. To offset that they allow other utility companies to buy Renewable Energy Credits (REC) credit off their customers and facilities that produce their own solar energy. Typically, the national market, the utility market is $400 per MWh to Utility Suppliers for not meeting this standard percentage so these REC credits are sold for $350 per MWH. (1 REC credit = 1 MWH).

State charges these utility companies to meet their state compliance of 0.2% of the entire electricity consumption from solar energy by 2022 (from.005% in 2008 aggregated up to 0.2% by 2022). The REC credits correspond to these percentages as they aggregate each year.

6. Operations and Maintenance Plan

The quality of the maintenance and the operation of the facility's energy systems have a direct effect on its overall energy efficiency. Energy-efficiency needs to be a consideration when implementing facility modifications, equipment replacements, and general corrective actions. The following is a list of activities that should be performed as part of the routine maintenance program for the property.

Building Envelope

- ✓ Ensure that the building envelope has proper caulking and weather stripping.
- ✓ Patch holes in the building envelope with foam insulation and fire rated caulk around combustion vents
- ✓ Inspect building vents semiannually for bird infestation
- ✓ Inspect windows monthly for damaged panes and failed thermal seals
- ✓ Repair and adjust automatic door closing mechanisms as needed.

Heating and Cooling

- ✗ Pilots lights on furnaces and boilers be turned off in summer
- ✓ All preventive maintenance should be performed on all furnaces and boilers, which would include cleaning of burners and heat exchanger tubes.
- ✓ Ensure that the combustion vents exhaust outside the conditioned space and the vent dampers are functional
- ✓ Ensure that the control valves are functioning properly before start of every season
- ✗ Ensure steam traps are functional before start of each heating season
- ✗ Ensure use of chemical treatment for boiler make up water
- ✗ Ensure boiler outside temperature re-set is set to 55F
- ✗ Ensure use of chemical treatment for Colling tower water to prevent corrosion
- ✓ Ensure the duct work in unconditioned space is un-compromised and well insulated
- ✓ Duct cleaning is recommended every 10 years. This should include sealing of ducts using products similar to 'aero-seal'
- ✗ Ensure use of economizer mode is functional and used
- ✗ Ensure that the outside air dampers actuators are operating correctly
- ✗ Ensure air coils in the AHU and FCA's are pressure washed annually
- ✓ Return vents should remain un-obstructed and be located centrally
- ✓ Temperature settings reduced in unoccupied areas and set points seasonally adjusted.
- ✓ Evaporator coils and condenser coils should be regularly cleaned to improve heat transfer
- ✓ Refrigerant pipes should be insulated with a minimum of ¾" thick Elastomeric Rubber Pipe Insulation
- ✓ Ensure refrigerant pressure is maintained in the condensers
- ✓ Change air filters on return vents seasonally. Use only filters with 'Minimum Efficiency Rating Value'(MERV) of 8

Central Domestic Hot Water Heater

- ✓ Never place gas fired water heaters adjacent to return vents so as to prevent flame roll outs
- ✓ Ensure the circulation system is on timer to reduce the losses through re-circulation
- ✓ Ensure all hot water pipes are insulated with fiberglass insulation at all times
- ✗ Replacement water heater should have Energy Factor (EF)>0.9
- ✗ Tank-type water heaters flushed monthly

Lighting Improvements

- ✓ Utilize bi-level lighting controls in stairwells and hallways.
- ✓ Use LED replacement lamps
- ✓ Clean lighting fixture reflective surfaces and translucent covers.
- ✓ Ensure that timers and/or photocells are operating correctly on exterior lighting
- ✓ Use occupancy sensors for offices and other rooms with infrequent occupancy

Existing Equipment and Replacements

- ✓ Ensure that refrigerator and freezer doors close and seal correctly
- ✓ Ensure kitchen and bathroom exhaust outside the building and the internal damper operates properly
- ✓ Ensure that bathroom vents exhaust out
- ✓ Office/ computer equipment either in the “sleep” or “off” mode when not used

7. Appendices

APPENDIX A: GLOSSARY OF TERMS

APPENDIX B: MECHANICAL EQUIPMENT INVENTORY

APPENDIX C: LIGHTING SYSTEM SCHEDULE

APPENDIX D: ECM CHECKLIST

APPENDIX E: ECM CALCULATIONS

APPENDIX F: SOLAR PV

APPENDIX A:
Glossary of Terms

Glossary of Terms and Acronyms

ECM – Energy Conservation Measures are projects recommended to reduce energy consumption. These can be No/Low cost items implemented as part of routine maintenance or Capital Cost items to be implemented as a capital improvement project.

Initial Investment – The estimated cost of implementing an ECM project. Estimates typically are based on R.S. Means Construction cost data and Industry Standards.

Annual Energy Savings – The reduction in energy consumption attributable to the implementation of a particular ECM. These savings values do not include the interactive effects of other ECMs.

Cost Savings – The expected reduction in utility or energy costs achieved through the corresponding reduction in energy consumption by implementation of an ECM.

Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates.

EUL – Expected Useful Life is the estimated lifespan of a typical piece of equipment based on industry accepted standards.

RUL – Remaining Useful Life is the EUL minus the effective age of the equipment and reflects the estimated number of operating years remaining for the item.

SIR - The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy-efficiency recommendations be based on a calculated SIR, with larger SIRs receiving a higher priority. A project typically is recommended only if the SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

Life Cycle Cost - The sum of the present values of (a) Investment costs, less salvage values at the end of the study period; (b) Non-fuel operation and maintenance costs: (c) Replacement costs less salvage costs of replaced building systems; and (d) Energy and/or water costs.

Life Cycle Savings – The sum of the estimated annual cost savings over the EUL of the recommended ECM, expressed in present value dollars.

Building Site Energy Use Intensity - The sum of the total site energy use in thousands of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.

Building Source Energy Use Intensity – The sum of the total source energy use in thousands of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.

Building Cost Intensity - This metric is the sum of all energy use costs in dollars per unit of gross building area.

Greenhouse Gas Emissions - Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions, the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).

APPENDIX B:
Mechanical Equipment Inventory

Mechanical Inventory								
System	Make	Model	Serial Number	Input Capacity	Output Capacity	Room Number	Space Served	Quantity
Central Split System Condensing Unit	Ruud	UAMB-048CAZ	6268F289917473	4 Ton	-	Roof classroom 7	002 Classroom 7,	1
Central Split System Condensing Unit	Ruud	UAMB-048CAZ	6268F289917474	4 TON	-	P05 Classrooms 15-17	P05 Classrooms 15-17	1
Central Split System Condensing Unit	Ruud	UAMB-048CAZ	6268F289917481	4 TON	-	003 Classrooms 1-5, Admin/Principal	003 Classrooms 1-5, Admin/Principal	1
Central Split System Condensing Unit	Ruud	UAMB-048CAZ	6268F289917482	4 TON	-	003 Classrooms 1-5, Admin/Principal	003 Classrooms 1-5, Admin/Principal	1
Central Split System Condensing Unit	Ruud	UAMB-048CAZ	6268F289917479	4 TON	-	003 Classrooms 1-5, Admin/Principal	003 Classrooms 1-5, Admin/Principal	1
Central Split System Gas Furnace	Ruud	UGRA-07NYBGS	EJ5D707F279804072	75 MBH	70 MBH	Classroom 15	P05 Classrooms 15-17	1
Central Split System Gas Furnace	Ruud	UGRA-07NYBGS	Inaccessible	75 MBH	70 MBH	Classrooms 7	002 Classroom 7, Toilets	1
Central Split System Gas Furnace	Ruud	UGRA-07NYBGS	EJ5D707F229902380	75 MBH	70 MBH	Classroom 16	P05 Classrooms 15-17	1
Central Split System Gas Furnace	Ruud	UGRA-07NYBGS	EJ5D707F069903731	75 MBH	70 MBH	Classrooms 1	003 Classrooms 1-5, Admin/Principal	1
Central Split System Condensing Unit	Ruud	UAMB-048CAZ	6268F289917480	4 TON	-	003 Classrooms 1-5, Admin/Principal	003 Classrooms 1-5, Admin/Principal	1
Domestic Booster Pump Station	-	-	-	7.5 HP	-	Site	Site	1
Exhaust Fan	Penn Ventilator Company	WFX13R	No tag/plate found	No tag/plate found	-	Roof	001 MPR	1
Packaged Unit (RTU)	Carrier	48GX-024040381AD	2501G13269	40 MBH	32 MBH	Roof-admin	003 Classrooms 1-5, Admin/Principal	1
Packaged Unit (RTU)	Rheem	RKKB-A180CM25E	2D6606ADAAF110030806	250 MBH	203 MBH	Roof	001 MPR	1
Wall Mounted Heat Pump	Bard	WH431-A10CX4XXX	176D991339796-02	3.5 TON	-	Classrooms 11	P03, P07 & P09 Classrooms 11, 12, 22 and toilets	1
Wall Mounted Heat Pump	Bard	WH361-A05XX4XXX	125F971106671-02	3 TON	-	Classrooms 8	P02 & P06 Classrooms 8-10, 18-20	1
Wall Mounted Heat Pump	Bard	WH421-A10VX4XXX	126L991387210-01	3.5 TON	-	Classrooms 24	P04, P10 & P11 Classrooms 13-14, 23, 24	1
Water Heater	Rheem / Ruud	G75-75N-2	RRLN0609101481	75 GAL, 75 MBH, 80%	-	Utility closet	001 MPR	1
Wall Mounted Heat Pump	Bard	WH361-A05XX4XXX	L25B981201247-02	3 TON	-	Classrooms 18	P02 & P06 Classrooms 8-10, 18-20	1
Wall Mounted Heat Pump	Bard	H431-A02CX4XXX	176L981277067-02	3.5 TON	-	Classrooms 14	P04, P10 & P11 Classrooms 13-14, 23, 24	1
Wall Mounted Heat Pump	No tag/plate found	No tag/plate found	No tag/plate found	3 TON	-	Classrooms 21	P08 Classroom 21	1
Central Split System Gas Furnace	Ruud	UGRA-07NYBGS	EJ5D707F399807913	75 MBH	70 MBH	Classrooms 4	003 Classrooms 1-5, Admin/Principal	1
Wall Mounted Heat Pump	Bard	WH421LA08VX4XXX	126J99 1366702-02	3.5 TON	-	Classrooms 22	P03, P07 & P09 Classrooms 11, 12, 22 and toilets	1
Central Split System Condensing Unit	Ruud	UAMB-048CAZ	6268F289917475	4 Ton	-	Roof	P01 Kindergarten	1
Central Split System Condensing Unit	Ruud	UAMB 048CAZ	6268F289917477	4 TON	-	P05 Classrooms 15-17	P05 Classrooms 15-17	1
Packaged Unit (RTU)	Carrier	48GX-024040301AD	2901G11124	40 MBH	32 MBH	Roof-admin	003 Classrooms 1-5, Admin/Principal	1
Central Split System Condensing Unit	Ruud	UAMB-048CAZ	6268F289917476	4 TON	-	003 Classrooms 1-5, Admin/Principal	003 Classrooms 1-5, Admin/Principal	1
Central Split System Gas Furnace	Ruud	UGRA-07NYBGS	EJ5D707F399807922	75 MBH	70 MBH	Classrooms 5	003 Classrooms 1-5, Admin/Principal	1
Central Split System Condensing Unit	Ruud	UAMB-048CAZ	6268F289917478	4 TON	-	P05 Classrooms 15-17	P05 Classrooms 15-17	1
Central Split System Gas Furnace	Ruud	UGRA-07NYBGS	EJ5D707F399807920	75 MBH	70 MBH	Library	003 Classrooms 1-5, Admin/Principal	1
Central Split System Gas Furnace	Ruud	UGRA-07NYBGS	EJ5D707F399807918	75 MBH	70 MBH	Classrooms 17	P05 Classrooms 15-17	1
Central Split System Gas Furnace	Ruud	UGRA-07NYBGS	EJ5D707F289805687	75 MBH	70 MBH	Classrooms 3	003 Classrooms 1-5, Admin/Principal	1
Water Heater	A. O. Smith	FGR 40 242	GH99-5064851-R99	40 GAL, 38 MBH	-	002 Classroom 7, Toilets	002 Classroom 7, Toilets	1
Ductless Split System	Carrier	38MAQB12 1	1715V36826	1 TON	-	Roof	001 MPR	1
Wall Mounted Heat Pump	Bard	WH43-AOZCX4XXB	176L981277070-02	3.5 TON	-	Classrooms 13	P04, P10 & P11 Classrooms 13-14, 23, 24	1

Wall Mounted Heat Pump	Bard	WH361-A05XX4XXX	125B981201263-02	3 TON	-	Classrooms 19	P02 & P06 Classrooms 8-10, 18-20	1
Wall Mounted Heat Pump	Bard	WH361-A05XX4XXX	125B981201234-02	3 TON	-	Classrooms 20	P02 & P06 Classrooms 8-10, 18-20	1
Wall Mounted Heat Pump	Bard	WH361-A05XX4XXX	125F971106674-02	3 TON	-	Classrooms 9	P02 & P06 Classrooms 8-10, 18-20	1
Wall Mounted Heat Pump	Marvair	AVP60HPA10NB	AL35035	5 TON	-	P10 Classrooms 23	P04, P10 & P11 Classrooms 13-14, 23, 24	1
Wall Mounted Heat Pump	Bard	WH361-A05XX4XXX	125F971106673-02	3 TON	-	Classrooms 10	P02 & P06 Classrooms 8-10, 18-20	1
Central Split System Gas Furnace	Ruud	UGRA-07NYBGS	EJ5D707F229902379	75 MBH	70 MBH	Classroom 6	P01 Kindergarten	1
Wall Mounted Heat Pump	Bard	WH431-A10CX4XXX	176D9913394O5-02	3.5 TON	-	Classrooms 12	P03, P07 & P09 Classrooms 11, 12, 22 and toilets	1

APPENDIX C:
Lighting System Schedule

										Lamp Details				Fixture Details				Existing Consumption	
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	Additional Area Description	LUX	Control Quantity	Existing Control	Technology	Sub-Technology	Lamp Type	Total Lamps	Fixture Type	Fixture Quantity	24x7 Fixture Count	Fixture Height	Annual Hours	Existing Annual kWh
1	003	Interior	1	CLASSROOM	O001	LLS 2fixtures 2sin	285	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	Industrial	2	0	11	1,260	645
2	003	Interior	1	OFFICE	C004		266	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	8	1,260	161
3	003	Interior	1	OFFICE	C003		280	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	2x4 Prism Troffer	1	0	8	1,260	81
4	003	Interior	1	LIBRARY	X002		461	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	Industrial	2	0	12	1,260	323
5	003	Interior	1	LIBRARY	X002		461	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	3	0	8	1,260	242
6	003	Interior	1	LIBRARY	O003	1LS 2fixtures	338	3	Light Switch	Linear Fluorescent	T8	8' 50W T8	8	Industrial	2	0	12	1,260	504
7	003	Interior	1	LIBRARY	O003	1LS 2fixtures	338	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	3	0	8	1,260	242
8	003	Interior	1	CLASSROOM	O004		277	9	Light Switch	Linear Fluorescent	T8	8' 50W T8	24	Industrial	6	0	12	1,260	1,512
9	003	Interior	1	CLASSROOM	O004		277	9	Light Switch	Linear Fluorescent	T8	4' 32W T8	18	2x4 Prism Troffer	9	0	8	1,260	726
10	003	Interior	1	CLASSROOM	O006		331	3	Light Switch	Linear Fluorescent	T8	8' 50W T8	12	Industrial	6	0	12	1,260	756
11	P04	Interior	1	CLASSROOM	O014	LS 16Fixtures 1sir	724	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	96	2x4 Prism Troffer	32	0	9	1,260	3,871
12	P03	Interior	1	CLASSROOM	O012	LS 16Fixtures 1sir	724	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	96	2x4 Prism Troffer	32	0	9	1,260	3,871
13	P02	Interior	1	CLASSROOM	O010	LS 12Fixtures 1sir	775	6	Light Switch	Linear Fluorescent	T8	4' 32W T8	108	2x4 Prism Troffer	36	0	9	1,260	4,355
14	P05	Interior	1	CLASSROOM	O015		540	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	36	2x4 Prism Troffer	6	0	9	1,260	1,452
15	P05	Interior	1	CLASSROOM	O016		254	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	6	0	9	1,260	484
16	P06	Interior	1	CLASSROOM	O018		782	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	108	2x4 Prism Troffer	36	0	9	1,260	4,355
17	P08	Interior	1	CLASSROOM	O022		537	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	36	2x4 Prism Troffer	12	0	9	1,260	1,452
18	P08	Interior	1	CLASSROOM	O021		635	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	45	2x4 Prism Troffer	15	0	9	1,260	1,814
19	P07	Interior	1	RESTROOM	T003		463	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	6	0	9	1,260	484
20	Room 24	Interior	1	CLASSROOM	O024		668	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	36	2x4 Prism Troffer	12	0	9	1,260	1,452
21	002	Interior	1	CLASSROOM	O007		318	3	Light Switch	Linear Fluorescent	T8	8' 50W T8	8	2x4 Prism Troffer	2	0	12	1,260	504
22	002	Interior	1	CLASSROOM	O007		318	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	3	0	8	1,260	242
23	003	Interior	1	OPEN OFFICE	C001	Admin	315	1	Light Switch	Linear Fluorescent	T8	8' 50W T8	2	Industrial	1	0	8	1,260	126
24	003	Interior	1	OPEN OFFICE	Z002		163	1	Light Switch	Linear Fluorescent	T8	8' 50W T8	2	Industrial	1	0	7	1,260	126
25	003	Interior	1	OPEN OFFICE	Z001		463	2	Light Switch	Linear Fluorescent	T8	8' 50W T8	4	Industrial	2	0	7	1,260	252
26	001	Interior	1	CAFETERIA	U001		506	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	84	2x4 Prism Troffer	28	0	16	1,260	3,387
27	001	Interior	1	OFFICE	D001	Plant Manger	274	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	10	1,260	323
28	001	Interior	1	KITCHEN	Kitchen		254	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	10	2x4 Prism Troffer	5	0	10	1,260	403
29	001	Interior	1	CAFETERIA	U001		506	2	Timer	LED	-	-	4	Flood Light	2	0	11	1,260	-
30	Exterior	Interior	1	CLASSROOM	Exterior		-		Timer	HID	MH	MH450	1	Wallpack-Horizontal	1	0	13	1,260	567
31	Exterior	Interior	1	CLASSROOM	Exterior		-		Timer	HID	MH	MH350	1	Wallpack-Horizontal	1	0	9	1,260	441
32	Exterior	Interior	1	CLASSROOM	Exterior		-		Timer	CFL	CFL - 2 Pin	CFL28	5	Surface Mount Can	5	0	8	1,260	176
33	Exterior	Interior	1	CLASSROOM	Exterior		-		Timer	HID	MH	MH400	3	Wallpack-Horizontal	3	0	11	1,260	1,512
34	Exterior	Interior	1	CLASSROOM	Exterior		-		Timer	HID	MH	MH350	4	Wallpack-Horizontal	4	0	10	1,260	1,764
35	Exterior	Interior	1	CLASSROOM	Exterior		-		Timer	HID	MH	MH450	4	Wallpack-Horizontal	4	0	12	1,260	2,268
36	Exterior	Interior	1	CLASSROOM	Exterior		-		Timer	CFL	CFL - 2 Pin	CFL28	7	Surface Mount Can	7	0	7	1,260	247
37	Exterior	Interior	1	CLASSROOM	Exterior		-		Timer	CFL	CFL - 2 Pin	CFL28	18	Surface Mount Can	18	0	8	1,260	635
	Totals												860		320			46,620	41,751

									Fixture Details						Existing Consumption					Proposed- Post Retrofit			
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	Additional Area Description	Existing Control	Control Quantity	Technology	Sub-Technology	Lamp- Fixture	Fixture Quantity	Total Lamps	Fixture Height	Annual Hours	Existing Annual kWh	ECM	ECM Type	Recommended Sensor	LED Lamp Retrofit	Annual Hours of Operation	Proposed Annual kWh	Annual Savings From LED Retrofit
																							kWh
1	003	Interior	1	CLASSROOM	O001	1LS 2fixtures 2sink	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; Industrial	2	16	11	1,260	645	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	343	302
2	003	Interior	1	OFFICE	C004		Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	8	1,260	161	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	86	76
3	003	Interior	1	OFFICE	C003		Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	2	8	1,260	81	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	43	38
4	003	Interior	1	LIBRARY	X002		Light Switch	3	Linear Fluorescent	T8	4' 32W T8; Industrial	2	8	12	1,260	323	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	171	151
5	003	Interior	1	LIBRARY	X002		Light Switch	3	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	3	6	8	1,260	242	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	129	113
6	003	Interior	1	LIBRARY	O003	1LS 2fixtures	Light Switch	3	Linear Fluorescent	T8	8' 50W T8; Industrial	2	8	12	1,260	504		RB - Replace Bulb	Wall Mounted				
7	003	Interior	1	LIBRARY	O003	1LS 2fixtures	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	3	6	8	1,260	242	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	129	113
8	003	Interior	1	CLASSROOM	O004		Light Switch	9	Linear Fluorescent	T8	8' 50W T8; Industrial	6	24	12	1,260	1,512		RB - Replace Bulb	Wall Mounted				
9	003	Interior	1	CLASSROOM	O004		Light Switch	9	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	9	18	8	1,260	726	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	386	340
10	003	Interior	1	CLASSROOM	O006		Light Switch	3	Linear Fluorescent	T8	8' 50W T8; Industrial	6	12	12	1,260	756		RB - Replace Bulb	Wall Mounted				
11	P04	Interior	1	CLASSROOM	O014	1LS 16Fixtures 1sink	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	32	96	9	1,260	3,871	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	2,056	1,814
12	P03	Interior	1	CLASSROOM	O012	1LS 16Fixtures 1sink	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	32	96	9	1,260	3,871	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	2,056	1,814
13	P02	Interior	1	CLASSROOM	O010	1LS 12Fixtures 1sink	Light Switch	6	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	36	108	9	1,260	4,355	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	2,313	2,041
14	P05	Interior	1	CLASSROOM	O015		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	6	36	9	1,260	1,452	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	771	680
15	P05	Interior	1	CLASSROOM	O016		Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	6	12	9	1,260	484	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	257	227
16	P06	Interior	1	CLASSROOM	O018		Light Switch	3	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	36	108	9	1,260	4,355	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	2,313	2,041
17	P08	Interior	1	CLASSROOM	O022		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	12	36	9	1,260	1,452	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	771	680
18	P08	Interior	1	CLASSROOM	O021		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	15	45	9	1,260	1,814	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	964	851
19	P07	Interior	1	RESTROOM	T003		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	6	12	9	1,260	484	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	257	227
20	Room 24	Interior	1	CLASSROOM	O024		Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	12	36	9	1,260	1,452	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	771	680
21	002	Interior	1	CLASSROOM	O007		Light Switch	3	Linear Fluorescent	T8	8' 50W T8; 2x4 Prism Troffer	2	8	12	1,260	504		RB - Replace Bulb	Wall Mounted				
22	002	Interior	1	CLASSROOM	O007		Light Switch	3	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	3	6	8	1,260	242	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	129	113
23	003	Interior	1	OPEN OFFICE	C001	Admin	Light Switch	1	Linear Fluorescent	T8	8' 50W T8; Industrial	1	2	8	1,260	126		RB - Replace Bulb	Wall Mounted				
24	003	Interior	1	OPEN OFFICE	Z002		Light Switch	1	Linear Fluorescent	T8	8' 50W T8; Industrial	1	2	7	1,260	126		RB - Replace Bulb	Wall Mounted				
25	003	Interior	1	OPEN OFFICE	Z001		Light Switch	2	Linear Fluorescent	T8	8' 50W T8; Industrial	2	4	7	1,260	252		RB - Replace Bulb	Wall Mounted				
26	001	Interior	1	CAFETERIA	U001		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	28	84	16	1,260	3,387	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	1,799	1,588
27	001	Interior	1	OFFICE	D001	Plant Manger	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	10	1,260	323	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	171	151
28	001	Interior	1	KITCHEN	Kitchen		Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	5	10	10	1,260	403	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,260	214	189
29	001	Interior	1	CAFETERIA	U001		Timer	2	LED	-		2	4	11	1,260		No ECM		Wall Mounted				
30	Exterior	Interior	1	CLASSROOM	Exterior		Timer		HID	MH	MH450; Wallpack-Horizontal	1	1	13	1,260	567	ECM	RB - Replace Bulb	Retain Existing Controls	70W LED Wallpack	1,260	88	479
31	Exterior	Interior	1	CLASSROOM	Exterior		Timer		HID	MH	MH350; Wallpack-Horizontal	1	1	9	1,260	441	ECM	RB - Replace Bulb	Retain Existing Controls	70W LED Wallpack	1,260	88	353
32	Exterior	Interior	1	CLASSROOM	Exterior		Timer		CFL	CFL - 2 Pin	CFL28; Surface Mount Can	5	5	8	1,260	176			Retain Existing Controls				
33	Exterior	Interior	1	CLASSROOM	Exterior		Timer		HID	MH	MH400; Wallpack-Horizontal	3	3	11	1,260	1,512	ECM	RB - Replace Bulb	Retain Existing Controls	70W LED Wallpack	1,260	265	1,247
34	Exterior	Interior	1	CLASSROOM	Exterior		Timer		HID	MH	MH350; Wallpack-Horizontal	4	4	10	1,260	1,764	ECM	RB - Replace Bulb	Retain Existing Controls	70W LED Wallpack	1,260	353	1,411
35	Exterior	Interior	1	CLASSROOM	Exterior		Timer		HID	MH	MH450; Wallpack-Horizontal	4	4	12	1,260	2,268	ECM	RB - Replace Bulb	Retain Existing Controls	70W LED Wallpack	1,260	353	1,915
36	Exterior	Interior	1	CLASSROOM	Exterior		Timer		CFL	CFL - 2 Pin	CFL28; Surface Mount Can	7	7	7	1,260	247			Retain Existing Controls				
37	Exterior	Interior	1	CLASSROOM	Exterior		Timer		CFL	CFL - 2 Pin	CFL28; Surface Mount Can	18	18	8	1,260	635			Retain Existing Controls				
Totals													860									17,276	19,637

APPENDIX D:
ECM Checklist

NA	In Place	Evaluate	ECM Description
✓			Add Reflective Coating To Exterior Windows
		✓	Replace External Windows
✓			Upgrade Insulation
		✓	Control External Air Leakage In Commercial Buildings
✓			Install Reflective Insulation Between Radiators And External Wall
✓			Replace Existing Motors With High Efficiency Motors
✓			Install On-Demand Ventilation on Air Handlers
✓			Reduce HVAC Hours of Operation
✓			Install Variable Frequency Drives (VFD)
✓			Install Outside Air Temperature Reset Controls For Hot Water Boilers
✓			Install Chilled Water Reset Control
✓			Install Timers On Exhaust Fans
✓			Install Energy Savers on Vending, Snack Machines
	✓		Install Building Energy Management System and Replace Terminal Units
✓			Re-Commission The Building & Its Control Systems
✓			Replace Inefficient Heating Plant
✓			Replace Inefficient Cooling Plant
✓			Replace Existing Air Conditioners with Energy Star Air Conditioners
✓			Replace Unit Electric Heaters with Natural Gas Fired Unit Heaters
✓			Convert From Gas Pilot to Electronic Ignition for Boilers
✓			Insulate Hot Water Pipes
	✓		Insulate Refrigerant Lines
✓			Insulate Hot Surfaces And Tanks
		✓	Insulate Air Ducts
✓			Replace Defective Steam Traps
		✓	Upgrade Electric Heating System To Heat Pumps
	✓		Replace Inefficient Furnace System
✓			Replace Rooftop Package Unit
✓			Install Energy Recovery Wheel on Air Handling Unit
		✓	Replace Existing Water Heater With New Energy Efficient Units
✓			Replace Incandescent/Halogen Lamps With Energy Efficient Lamps
		✓	Upgrade Inefficient Linear Fluorescent Lamps And Fixtures
		✓	Upgrade EXIT SIGNS With LED EXIT Signs
	✓		Bilevel and Tandem Linear Fluorescent Lighting ECM
		✓	Replace High Intensity Discharge (HID) Lamps With Energy Efficienct Lamps
		✓	Replace Existing Refrigerator(s) With Energy Star Certified Refrigerator(s)
✓			Replace Existing Freezers With High Efficiency Freezers
✓			Install Low Flow Shower Heads
		✓	Install Low Flow Faucet Aerators
		✓	Install Low Flow Restroom Flush Tank Toilets
		✓	Install Low Flow Tankless Restroom Fixtures

APPENDIX E:
ECM Calculations

UIC	Install Low Flow Faucet Aerators
EAP2-b	**Location**: Restrooms and Classrooms

Property Type:	Commercial	Estimated No. of Operational Weeks	36
		Number of Occupied Days/Week (Max 7)	5

KITCHEN FAUCETS			BATHROOM FAUCETS		
Number of Occupants Affected By Retrofit	302		Number of Occupants Affected by Retrofit	302	
Do You Want To Replace Kitchen Faucets Aerators	Yes	*(Select)*	Do You Want To Replace Bathroom Faucets Aerators	Yes	*(Select)*
Total Number of Faucet Aerators To Be Replaced	10		Total Number of Faucet Aerators To Be Replaced	6	
Total Number of Faucets To Be Replaced:	0		Total Number of Faucets To Be Replaced:	0	
GPM of Existing Faucet Aerators	2.2	GPM	GPM of Existing Faucet Aerators	2.2	GPM
GPM of Proposed Faucet Aerator	0.5	GPM	GPM of Proposed Faucet Aerator	0.5	GPM
Estimated Number of Uses Per Day	1		Estimated Number of Uses Per Day	4	

Annual Water Savings From Installing Low Flow Aerators: 44.36 kGal

WATER & ENERGY SAVING CALCULATION			COST SAVING CALCULATION		
Select Type of Water Heater Fuel:	Natural Gas	(Select)	Property Location in United States	North Central Localities	
Energy Factor of Domestic Hot Water Heater:	0.55	EF	Heating Fuel Tariff	$1.33	$/Therm
Hot Water Discharge Temperature at Faucet	110.00	°F	Water Tariff ($/1000 Gal)	$2.22	$/kGal
Equivalent Heating Fuel Savings: *Savings Discounted by 15% to Account For Cold Water Use*	343	Therms	Annual Cost Savings In Form of Water	$98	$
Annual Water Savings	44.36	kGal	Annual Energy Savings From Water Heater	$456	$

COST BENEFIT ANALYSIS					
Estimated Total Annual Cost Savings	$554	$$	Estimated Total Installation Cost	$244	$$
Simple Payback Period	0.44	Years	*Type of Recommendation*	No/Low Cost ECM Recommendation	

ECM EXPLANATION:

By reducing the flow of water coming from the restroom faucets, aerators can generate energy savings at low cost and with easy installation. The savings generated would be in the form of reduced water and sewer costs and at the same time aerators would save energy by reducing the demand for hot water. The average faucet has a flow rate of about 2 to 4 GPM. Adding a screw-in faucet aerator reduces the flow to 0.5 to 1.5 GPM in the bathroom and 2.2 GPM in the kitchen. In addition to saving energy and water, the "foamier" water that comes from faucet aerators wets objects better than water from a faucet with no aerator, which tends to bounce off the object rather than thoroughly wetting it.

EMG recommends replacing the proposed faucet aerators with new low flow aerators as mentioned above. The proposed ECM shall also result in an annual energy saving in form of reduction in water heating bills.

Summary:

Initial Investment: $244 Estimated Annual Cost Savings: $554 Simple Payback Period (Yrs): 0.44

UIC	Replace Exit Signs With LED Exit Signs
EAL7-S	Location: Throughout

Total Existing Fixtures:	5	
Current Watts/ Fixture:	15	Watts
Annual Hours of Operation *(24hrsx365 days):*	8,760	Hrs
Total Annual Energy Consumption:	657	kWh
Electric Rate:	$0.16	$$
EMG Recommends:	**Replace Entire EXIT Fixture**	
Number of Fixtures To Be Replaced:	5	(Qty)
(2W/Fixture)		
Total Material Cost of Replacing Entire Fixture $35/Fix.:	$175	$$
Source www.1000bulbs.com		
Estimated Annual Energy Consumption By Replacing Entire EXIT Fixture:	88	kWh
Total Cost Savings:	$14	$$
Total Labor Costs For Retrofit:	$206	$$
Estimated Total Investment:	$568.85	$$
Estimated Annual Energy Savings From EXIT Sign Retrofits :	569	kWh
Estimated O&M Savings From The Proposed Retrofit:	$366	$$
(Average Life of Incandescent Lamps in Exit Fixtures is 2000 hrs)		
Estimated Total Cost Savings:	$459	$$
Simple Pay Back Period:	**1.24**	
Type of Recommendation	No/Low Cost ECM Recommendation	

ECM DESCRIPTION:

Life safety of the occupants holds the primary importance for any facility; hence the EXIT signs need to be illuminated all the times irrespective of the occupancy in the building. This means that these signs remain ON 24/7. In most cases the EXIT sign fixtures are powered by either a 40W incandescent lamp or an 11/13 Watt CFL lamp. EMG strongly recommends replacing the existing fixtures with LED fixtures powered by 2 or 4 watt LED lamps. At the same time the existing EXIT light fixture can be retrofitted with an LED lamp in place of an incandescent lamp. The later turns out to be a more cost effective procedure but might not apply to all the existing EXIT fixtures.

SUMMARY:

Initial Investment:	$569	Simple Payback Period:	1.24
Annual Cost Savings:	$459		

UIC	**Upgrade Building Lighting to LED and Install Automatic Lighting Controls**
EAL10	**Location: Building Interior and Exterior**

	No. of ECMs	No. of Fixtures	No. of Lamps	KWh Saved	Energy Cost Saving	O & M Savings
Upgrade Lighting to LED	26	268	766	19,637	$3,141.94	$528.30

Existing Technology	**Sub-Technology**	No. of ECMs	No. of Fixtures	No. of Lamps	KWh Saved	Energy Cost Saving	O & M Savings
CFL	CFL - 2 Pin	0	0	0	0	$0	$0
CFL	CFL - 4 Pin	0	0	0	0	$0	$0
CFL	CFL - Screw-in	0	0	0	0	$0	$0
Circiline	T9	0	0	0	0	$0	$0
Incan/H/MR	H	0	0	0	0	$0	$0
Incan/H/MR	Incan	0	0	0	0	$0	$0
Incan/H/MR	MR	0	0	0	0	$0	$0
HID	HPS	0	0	0	0	$0	$0
HID	MH	5	13	13	5,405	$865	$47
HID	MV	0	0	0	0	$0	$0
HID	QL	0	0	0	0	$0	$0
Linear Fluorescent	T8	21	255	255	14,232	$2,277	$481
Linear Fluorescent	T12	0	0	0	0	$0	$0
Linear Fluorescent	T8 U	0	0	0	0	$0	$0
Linear Fluorescent	T12 U	0	0	0	0	$0	$0
Linear Fluorescent	T5	0	0	0	0	$0	$0
Linear Fluorescent	T6	0	0	0	0	$0	$0
Linear Fluorescent	T10	0	0	0	0	$0	$0

Proposed Controls	**No. of Controls**		**No. of Controls**
Photo Sensor	0	Ceiling Mounted	0
Wall Mounted	57		

Initial Investment			**Equipment Rentals**	
Material Cost	$11,210.89		Scissor Lift 26' - Interior Spaces	$370.00
Labor Cost	$11,464.67		Bucket Truck - Exterior Spaces	$0.00
Local Electric Rate:	$0.17	$/kWh	Estimated Annual Energy Savings:	19,637
Hourly Labor Rate For Electrician:	$72.40		Estimated Annual Energy Cost Savings:	$3,142
Budgeted Initial Investment:	$23,046		Estimated Annual O&M Cost Savings:	$528
Estimated Return on Investment: *(Including O&M Savings)*	6.28	Years	Estimated Annual Cost Savings:	$3,670

UIC	Control External Air Leakage In Commercial Buildings
EAE4A	Location: Building 001, 002, 003, P01, P05

ENTER EXISTING CONDITION

Insert Existing Estimated Air Change Rate/Hr (ACH 1): *(Existing Air Changes Per Hour, 3 is very leaky and 0.35 ideal)*	1.00	Cubic Feet/Min (CFM 1):	2,235
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.70	Cubic Feet/Min (CFM 2):	1,564
Estimated Space Volume Under Consideration	134,073.00 Cu.Ft		

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas (Select)		Is The Building Cooled?	Yes	
Estimated Annual Heating Plant Efficiency	85.00	%	Estimated Annual Cooling Plant Efficiency	9.00	EER
Annual Heating Degree Days(HDD):	2,943		Annual Cooling Degree Days(CDD):	1,407	
Estimated Total Annual Input Heating Energy Savings	602	Therms	Estimated Total Annual Input Cooling Energy Savings	2,716	kWh
Cost/Unit of Heating Fuel:	$1.33	$/Therm	Cost/Unit For Electricity	$0.16	$$
Estimated Annual Heating Cost Savings	$799	$$	Estimated Annual Cooling Cost Savings	$446	$$

Cost Analysis

Install Flush Mounted, Vinyl Door Sweeps ?	No	Total Length of Door Sweeps to Be Installed: *(3.5' Standard Width Door)*	0 LF
Install Window Air Conditioner Covers For Winter:	No	Number of Air Conditioner Covers To Be Installed: *(Covers would meet HUD Chapter-12 Energ Conservation Compliance Section 329C)*	0
Estimated Annual O&M Savings	$62	Estimated Length of Joints To Be Re-Caulked: *(Includes Demolition and Re-Caulking)*	2000 LF
Total Estimated Annual Cost Savings	$1,307	Total Cost For Controlling Air Leakage	$8,239
Simple Pay Back Period	6.30 Yrs	*Type of Recommendation*	Capital Cost ECM Recommendation

ECM DESCRIPTION:

One of the most commonly used methods for reducing air leakage through building structures is caulking and weather stripping.

Particularly effective measures include caulking cracks around windows and door frames and weather stripping around windows and doors. Weather-stripping and caulking of doors and windows, helps in thermally isolating of the building with the outside atmosphere. This prevents the infiltration of external un-conditioned air along with moisture and humidity into the conditioned space at the same time, prevents the conditioned air from escaping out. A precisely thermally isolated building directly affects the cooling and heating load on the facilities HVAC system as it has to put in less effort in maintaining the desired temperature inside the facility. As per ASHRAE a well insulated and ventilated building should have an air change rate not more than 0.35 per hour.

In order to ensure proper thermal isolation of the property, EMG recommends ensuring that the weather-stripping and caulking of all external doors and windows remains intact. Its also recommended that door sweeps be installed under all the doors opening into conditioned space. Any visible cracks between the window frame and wall should be plugged by caulking.

In case of building with window airconditioners, EMG recommends use of interior/exterior window airconditioner covers so as to prevent cold air drafts into the conditioned space during the winter so as to save on heating costs.

SUMMARY:

Initial Investment: $8,239 Simple Pay Back Period: 6.30 Yrs

Annual Energy Cost Savings: $1,307

UIC	Install Low Flow Restroom Flush Tank Toilets
EAP3	Location: Restrooms and Locker Rooms

EXISTING CONDITION

Total Occupants:	302	
Number of Water Closets To Be Replaced	3	
Number of Occupied Days Per Week (Max 7)	5	
Number of Occupied Weeks/Year (Max 52)	36	
Estimated Restroom Usage/Individual/Day *5.05 flushes/person/day@American Water Works Association (AWWA)*	4	(Select)

PROPOSED RETROFIT/REPLACEMENT

Existing Gallons Per Flush Ratings For Water Closet Flushes	1.60	GPF
Replace or Retrofit Toilets With Dual Flush Toilets	Replace	
Replace		
Proposed Toilet	0.8GPF -Floor Mount, 10" Rough-In	
GPF of Proposed New Low Flow Water Closet Fixture*	0.80	GPF
Retrofit		
Dual Flush - Retrofit Setup Valve for Flush Tank Toilet	*Solid Waste(20%)* 0.80	GPF
**(Federal Law Requires All Flushes Not To Exceed 1.6 GPF)*	*Liquid Waste(80%)* 0.80	GPF

Water & Cost Saving Calculations

Water Savings By The Use of Low Flow Water Closet Flush Valves/Day	966.40	gal
Total Annual Water Savings in gallons	173.95	kgal
Cost Savings Calculations		
Enter Water Tariff Rate ($/1000Gal)	$2.22	$$
Estimated Cost Savings From Water	$385	$$
Estimated Cost of Retrofit		
Estimated Total Cost For Retrofit	$2,846	$$
Simple Pay Back Period	7.38	Yrs
Type of Recommendation	Capital Cost ECM Recommendation	

ECM EXPLANATION:

The highest water utilization at any home/office occurs in the restrooms. It is estimated that on an average a normal human being uses the restroom at least four times a day. Keeping with the global water conservation objectives, federal law prohibits use of any new water closet flushes over 1.6 GPF.

Existing toilets can be retrofitted with pressure-assisted flush technology to reduce the flush rate to 1.0 GPF or less. Though water efficient these toilets make considerable amount of noise as this involves release of pressurized air during the course of flushing. Thus making them unpopular among residential properties.

Thus EMG recommends replacing the existing high flow toilets with new low flow 1.28GPF rated flush tank toilets, which are comparatively more water efficient at the same time considerably quiter as compared to the pressure assisted technology retrofitted toilets.

Summary:

Initial Investment:	$2,846			
		Simple Payback:	7.38	Years
Annual Cost Savings:	$385			

UIC	Insulate Air Ducts
EAH8	Location: Rooftop RTUs

ENTER EXISTING CONDITION

Existing Net Effective R-Value of The Duct Insulation	1.00	Sq.Ft deg F.hr/btu	Estimated Annual Cooling Plant Efficiency (EER):	9.00	EER
Proposed Net Effective R-Value of The Duct Insulation	6.00	Sq.Ft deg F.hr/btu	Estimated Annual Heating Plant Efficiency : %	81.00	%
Enter Estimated Length of Duct	75	Ft	Enter Estimated Average Height of Duct	1.50	Ft
Total Estimated Exposed Surface Area	450.00	Sq.ft	Enter Estimated Average Width of Duct	1.50	Ft
Annual Heating Hours (Hrs):	1,464		Annual Cooling Hours (Hrs):	976	

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas	(Select)	Is the Building Cooled?	Yes	(Default)
Insert Temperature of Air in The Duct	125.00	◦F	Insert Temperature of Air in The Duct	55.00	◦F
Insert Average Ambient Temperature Around Air Ducts	65.00	◦F	Insert Average Ambient Temperature Around Air Ducts	74.00	◦F
Annual Conduction Losses From Existing Insulation	39,528	Kbtu	Annual Conduction Losses From Existing Insulation	8,345	kBtu
Annual Conduction Losses From Proposed Insulation	6,588	kBtu	Annual Conduction Losses From Proposed Insulation	1,391	kBtu
Savings In Conduction Losses After Adding Insulation	32,940	kBtu	Savings In Conduction Losses After Adding Insulation	6,954	kBtu
Estimated Total Annual Input Heating Energy Savings	407	Therms	Estimated Total Annual Input Cooling Energy Savings	773	kWh
Heating Fuel Rate:	$1.33	$/Therm	Cost of Electricity/Unit	$0.16	$$
Annual Heating Cost Savings	$540	$$	Annual Cooling Cost Savings	$127	$$

COST ANALYSIS

Select Location of Duct Work: **Ducts Located outdoor, eg connecting the RTU**

Total Estimated Annual Cost Savings	$667	$$	Estimated Cost To Add Insulation/Sqft	$8.45	
Simple Pay Back Period	8.51	Years	Estimated Cost To Add Insulation	$5,675	$$

Type of Recommendation — Capital Cost ECM Recommendation

ECM DESCRIPTION:

Ducts provide air distribution. A complete duct system may include supply and return ducts, as well as outdoor air ducts for ventilation. Ducts may be located in conditioned spaces; in areas exposed to outdoor conditions (such as ventilated crawl spaces or ventilated attics); in areas of inter-mediate conditions, such as basements or garages; or embedded in floor slabs. Local circumstances determine the need for insulation on ducts within the conditioned space, but all ducts exposed to the outdoors or unconditioned spaces should be insulated. In addition to energy savings, insulating ductwork permits the supply of adequately conditioned air at distant outlets by reducing heat loss en route. Sometimes, reduced distribution losses permit reductions in the size of equipment such as fan motors.

Duct insulation includes semi rigid boards and flexible-blanket types, composed of organic and inorganic materials in fibrous, cellular or bonded particle forms. Insulation used for cooling ducts requires vapor barriers to prevent condensation. Joints and laps in the vapor barriers should be sealed. Vapor barriers are not required for exterior insulation of heating-only ducts. To satisfy most building codes, the duct insulation must meet the fire hazard requirements of the National Fire Protection Association (ASHRAE 1985).

SUMMARY:

Initial Investment:	$5,675	Simple Payback period:	8.51
Energy Cost Savings:	$667		

UIC	Upgrade Electric Heating System To Heat Pumps
EAH11-A	Location: Portable Classroom P03, P09, P11

ASHRAE Climatic Zone: Zone-3

P03, P09, P11

Select Existing Heating System Type	Heat Pump - Split System	Heat Pump - Split System	Heat Pump - Split System	PTAC
Number of Existing Systems:	Qty	3 Qty	Qty	Qty
Output Capacity of Heating System/Unit:	btuh	34,000.00 btuh	btuh	kW
Output Capacity of Heating System:	0 Btuh	34,000 Btuh	0 Btuh	0 Btuh
Existing COP of Heating System:	COP	3.00 COP	COP	COP
Estimated Annual Heating Hours:	Hrs	950 Hrs	Hrs	Hrs
Auxiliary Heating In Heatpumps:	kW	10 kW	kW	kW
Cooling Capacity of Each System:	Btuh	43,000 Btuh	Btuh	Btuh
Existing EER of Cooling System:	EER	8.70 EER	EER	EER
Estimated Annual Cooling Hours:	Hrs	680 Hrs	Hrs	Hrs
Install Programmable Thermostats With Heatpumps:	No	No	No	Yes
Current Energy Consumption From Cooling:	0 kWh	10,083 kWh	0 kWh	0 kWh
Current Energy Consumption From Heating:	0 kWh	13,273 kWh	0 kWh	0 kWh
Total Existing Electric Consumption:	0 kWh	23,356 kWh	0 kWh	0 kWh

Proposed System

Heat pump Type	Air-Source Split Heat Pump System	Air-Source Split Heat Pump System	Air-Source Split Heat Pump System	Water-Source System
Proposed Number of Systems:	Qty	3 Qty	Qty	Qty
Proposed Heat pump Capacity:	- Btuh	42,000 Btuh	- Btuh	- Btuh
Proposed COP:	- COP	3.72 COP	- COP	- COP
Proposed Emergency Heat Rating:	0.00 kW	12.31 kW	0.00 kW	0.00 kW
Proposed Energy Consumption From Cooling:	0 kWh	6,753 kWh	0 kWh	0 kWh
Proposed Energy Consumption From Heating:	0 kWh	9,532 kWh	0 kWh	0 kWh
Total Proposed Electric Consumption:	0 kWh	16,285 kWh	0 kWh	0 kWh
Total Electric Savings:	0 kWh	7,071 kWh	0 kWh	0 kWh
Total Cost For Replacement:	$0.00	$10,442.98	$0.00	$0.00
Annual Energy Cost Savings:	$0	$1,160	$0	$0
Individual Simple Payback	- Yrs	9.00 Yrs	- Yrs	- Yrs

Total Initial Investment:	$10,442.98	Total Annual Electric Savings	7,071 kWh
Total Annual Cost Savings	$1,160.10	Overall Simple Payback Period:	9.00 Yrs

UIC	Install Low Flow Tankless Restroom Fixtures
EAP4	Location: Restrooms

ECM FOR DETERMINING WATER SAVINGS IN COMMERCIAL PROPERTIES

Number of Males	151	
Number of Females	151	
Number of Occupied Days Per Week (Max 7)	5	
Number of Occupied Weeks/Year (Max 52)	36	
Number of Urinals To Be Retrofitted	6	
Number of Water Closets To Be Retrofitted	8	
No. of Water Closets With Separate Flush Tank (Typical Residential Type)	3	
Estimated Restroom Usage/Individual/Day (Default is 4 Uses/Day For Residential/Office)	4	(Select)

Urinal Water Savings

Do you Want To Make Any Changes To The Urinals?	No	
Estimated Existing Use of Urinal/Day/Man	80%	
Existing Gallons Per Flush Ratings For Urinal Flushes	1.00	GPF
Proposed Urinal	0.125 GPF -Wall Mount	
GPF of Proposed Urinal Flush Valve** (**(1992 EpACT Energy Act Mandates 1.0GPF Max on Urinals)	0.125	GPF
Estimated Annual Water Savings From Urinal	0.00	kGal

Water Closet Water Savings

Tankless Water Closets

Do The Water Closet Need To Be Retrofitted?	(Select) Yes	
Existing Gallons Per Flush Ratings For Water Closet Flushes	1.60	GPF
Are The Existing Water Closet Being Replaced? (if No; Then Only The Flush Valve Would Be Replaced With Dual Flush Retrofit Kit)	(Select) No	
No. of Tankless Water Closets	5	
GPF of Proposed Dual Flush- Water Closet Valve* (*Federal Law Requires All Flushes Not To Exceed 1.6 GPF)	Solid Waste(20%) 1.60	GPF
	Liquid Waste(80%) 0.48	GPF
Estimated Annual Water Savings From Male Users	97.41	kGal
Estimated Annual Water Savings From Female Users	97.41	kGal
Total Water Savings From Water Closets	194.83	kGal

Water & Cost Saving Calculations

Water Savings Calculation

Water Savings By The Use of Low Flow Water Closet Flush Valves/Yr	194.83	kgal
Water Savings By The Use of Low Flow Urinal Flush Valves/ Yr	0.00	kgal
Total Annual Water Savings in kgal	194.83	kgal

Cost Savings Calculations

Enter Water Tariff Rate ($/1000Gal)	$2.22	$$
Estimated Cost Savings From Water	$433	$$

Estimated Cost of Retrofit

Cost For Replacing Existing Urinal Fixture With A Low Flow Fixture	$0 (Includes Labor)	$$
Cost For Replacing Existing Flush Valves With Low Flow - Dual Flush Valves ($80 Per Unit) (Up For Liquid Waste And Down For Solid Waste)	$4,952 (Includes Labor)	$$
Estimated Total Cost For Retrofit	$4,952	$$
Simple Pay Back Period	11.45	Yrs
Type of Recommendation	Capital Cost ECM Recommendation	

ECM EXPLANATION:

The highest water utilization at any home/office occurs in the restrooms. It is estimated that on an average a normal human being uses the restroom at least four times a day. Keeping with the global water conservation objectives, federal law prohibits use of any new water closet flushes over 1.6 GPF. At the same time the '1992 EpACT' mandates all new Urinals to have a maximum 1.0 GPF flush valves on urinals.

EMG recommends replacing all urinals above 1.0 GPF with a new 0.5 GPF or lesser urinals. At the same time EMG also recommends replacing all the water closets having a GPF rating of 1.6 and over with low flow water closet fixtures equipped with dual flush valves.

In case the property doesn't wish to replace the entire water closet fixtures, EMG recommends retrofitting all the tankless water closet flush fixtures with new dual flush fixtures that would result in a 30% water savings per flush for liquid wastes, while retaining the same flush rate for solid wastes.

SUMMARY:

Initial Investment:	$4,952	Simple Payback Period:	11.45 Yrs
Annual Cost Savings:	$433		

APPENDIX F:
Solar PV

UIC	Install Fixed Tilt Solar Photovoltaic System
EAR-2	Install Solar PV on All Roofs

Select State: Northern California **Electric Rate:** **$0.16** $/KWH Annual Electric Consumption: 205,122 KWh

Roof No.	Description	Number of Roofs	DC System Size Per Roof	PV System Sizing For All Roofs	Estimated Number of 315 Watt PV Panels:	Total Estimated Annual Electricity Generated/ Roof	Total Estimated Electricity Generated (All Roofs)	Total Cost Savings	Installation Cost: ($3.5/Watt)	Simple Pay Back Period without Incentives	One Time Potential Utility or State Incentives	One Time Potential Federal Incentives	Annual Potential Incentives and Rebates		Simple Pay Back Period with All Incentives
			kW	kW		kWh	kWh			Yrs		Dept. of Treasury Renewable Grant (30%)	Federal REPI Incentive	Solar Renewable Certificates (SRECS)-(~$0/MWH)	Years
												30%	$0.02	$0	
1	Building 1	1	35.30	35	112	54,133	54,133	$8,661	$123,550	14.3	$0	$37,065	$1,191	$0	8.6
2	Building 2	1	22	22	69	33,431	33,431	$5,349	$76,300	14.3	$0	$22,890	$735	$0	8.6
3	Building 3	1	22	22	69	33,431	33,431	$5,349	$76,300	14.3	$0	$22,890	$735	$0	8.6
4	Building 4	1	16	16	50	24,076	24,076	$3,852	$54,950	14.3	$0	$16,485	$530	$0	8.6
5	Building 5	1	21	21	66	32,051	32,051	$5,128	$73,150	14.3	$0	$21,945	$705	$0	8.6
6	Building 6	1	19	19	60	28,830	28,830	$4,613	$65,800	14.3	$0	$19,740	$634	$0	8.6
7				0	0		0	$0	$0		$0	$0	$0	$0	
8				0	0		0	$0	$0		$0	$0	$0	$0	
9				0	0		0	$0	$0		$0	$0	$0	$0	
10				0	0		0	$0	$0		$0	$0	$0	$0	
		6		**134**	**426**	**205,952.0**	**205,952**	**$32,952**	**$470,050**	**14.26**	**$0**	**$141,015**	**$4,531**	**$0**	**8.61**

Solar Rooftop Photovoltaic Analysis		
Total Number of Roofs	6	
Estimated Number of Panels	426	
Estimated KW Rating	134	KW
Potential Annual KWh Produced	205,952	KWh
% of Current Electricity Load	100.4%	

Financial Analysis		
Investment Cost	$470,050	
Estimated Energy Cost Savings	$32,952	
Potential Rebates	$141,015	
Potential Annual Incentives	$4,531	
Payback without Incentives	14.3	years
Incentive Payback but without SRECS	8.6	years
Payback with All Incentives	8.6	years