LEVEL II ENERGY AUDIT

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT
5735 47th Avenue
Sacramento, California 95824

DLR GROUP
1050 20th Street, Suite 250
Sacramento, California 95967

PREPARED BY:
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EMG PROJECT #:

136988.19R0000-067.268

DATE OF REPORT:

October 28, 2019

ONSITE DATE:

August 5, 2019

ZERO NET ENERGY ASHRAE LEVEL II AUDIT

WEST CAMPUS HIGH SCHOOL

5022 58th Street

Sacramento, California 95820

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Certification

EMG has completed an Energy Audit of West Campus High School located at 5022 58th street in Sacramento, California 95820. EMG visited the site on osd1.

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 95820. 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:

Bhaskar Ale, CEM

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 West Campus High School 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.

Bldg #	Structures Assessed	Building Type	EMG Calculated Area (SF)	Estimated Occupancy
1	00A Classrooms 1-3	School Building	4,784	30-50
2	00B Admin	School Building	4,672	30-50
3	00C Cafeteria and Kitchen	School Building	12,956	100-130
4	00D Classrooms 11-17	School Building	6,457	40-60
5	00E Classrooms 21-28	School Building	6,076	40-60
6	00F Classrooms 31-33, Library	School Building	6,076	40-60
7	00G Classrooms 41-47	School Building	6,076	40-60
8	00I Classrooms 52, 54, 56, 59	School Building	6,448	40-60
9	00J Classrooms 61-64	School Building	12,740	100-130
10	00K/00H Mechanical	School Building	2,814	15-30
11	00L Gym	School Building	25,213	200-230
12	PO1 Portable Classroom	Portable School Building	960	5-10
13	Science Wing	School Building	9,000	60-80

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 six 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)*	$222,789 *(In Current Dollars)*
Estimated Annual Cost Savings *(Current Dollars Only)*	$28,393 *(In Current Dollars)*
ECM Effective Payback	7.85 years
Estimated Annual Energy Savings	14.64%
Estimated Annual Energy Utility Cost Savings *(Excluding Water)*	14.64%
Estimated Annual Water Cost Saving	2.25%

Solar Photovoltaic (PV) Screening for WEST CAMPUS HIGH SCHOOL

SOLAR ROOFTOP PHOTOVOLTAIC ANALYSIS		
Estimated Number of Panels	1,103	
Estimated KW Rating	348	KW
Potential Annual kWh Produced	535,745	kWh
% of Current Electricity Uses	63.9%	
FINANCIAL SUMMARY		
Investment Cost	$1,216,250	
Estimated Energy Cost Savings	$82,773	
Payback without Incentives	14.7	Years
Incentive Payback but without SRECs	8.9	Years
Payback with All Incentives	8.9	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)	50 kBtu/ft^2
Post ECM Site Energy Use Intensity (EUI)	43 kBtu/ft^2
SOURCE ENERGY USE INTENSITY (EUI)	**RATING**
Current Source Energy Use Intensity (EUI)	116 kBtu/ft^2
Post ECM Source Energy Use Intensity (EUI)	99 kBtu/ft^2
BUILDING COST INTENSITY (BCI)	**RATING**
Current Building Cost Intensity	$1.52/ft^2
Post ECM Building Cost Intensity	$1.31/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	769 MMbtu
Total CO_2 Emissions Reduced	58.28 MtCO_2/Yr
Total Cars Off the Road (Equivalent)*	11
Total Acres of Pine Trees Planted (Equivalent)*	13

**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	5,253,400 kBtu
Total Annual Energy Savings for Non-Renewable Energy Measures	769,115 kBtu
Total Annual Energy Savings from Renewable Energy Measures	1,827,962 kBtu
Total Annual Energy Savings	2,597,077 kBtu
Net Energy Consumption from Grid Post Implementation	2,656,323 kBtu
% Energy Reduction (Annual Energy-Net Energy) / (Annual Energy)	49%

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 West Campus High 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	Electricity								
		$	Therms	kWh	kgal	$	$	$	Years		$	Years
No/Low Cost Recommendations												
1	Install Low Flow Faucet Aerators Location: Restrooms And Classrooms	$503	154	0	33	$445	$0	$445	1.13	7.55	$3,294	10.00
Totals for No/Low Cost Items		**$503**	**154**	**0**	**33**	**$445**	**$0**	**$445**	**1.13**			
Capital Cost Recommendations												
1	Install Low Flow Shower Heads Location: Restrooms And Locker Rooms	$1,300	333	0	60	$879	$0	$879	1.48	5.77	$6,199	10.00
2	Install On-Demand Ventilation on Air Handlers Location: 00C Cafeteria And Kitchen	$1,816	336	157	0	$436	$22	$458	3.96	2.15	$2,093	10.00
3	Upgrade Building Lighting to LED and Install Automatic Lighting Controls Location: Building Interior And Exterior	$117,218	0	98,809	0	$15,264	$5,338	$20,603	5.69	2.10	$128,735	15.00
4	Re-Commission The Building & Its Control Systems Location: Throughout	$46,690	1,800	25,030	0	$6,076	$0	$6,076	7.68	1.55	$25,840	15.00
5	Add Reflective Coating To Exterior Windows Location: 00J Classrooms, 00B Admin, 00F Classrooms (Windows Without Blinds/Curtains)	$26,203	1,431	7,667	0	$2,940	$147	$3,087	8.49	1.41	$10,649	15.00
Total For Capital Cost		**$193,227**	**3,899**	**131,663**	**60**	**$25,595**	**$5,507**	**$31,103**	**6.21**			
	Interactive Savings Discount @ 10%		-405	-13,166	-9	-$2,604	-$551	-$3,155				
	Total Contingency Expenses @ 15%	$29,059										
Total for Improvements		**$222,789**	**3,648**	**118,497**	**83**	**$23,436**	**$4,957**	**$28,393**	**7.85**			

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 West Campus High 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	Electricity	kgal	$	$	$	Years		$	Years
1	Install Low Flow Tankless Restroom Fixtures Location: Restrooms	$59,128	0	0	440	$3,454	$0	$3,454	17.12	0.70	-$17,891	15.00
2	Replace Rooftop Package Unit Location: 00L Gym	$42,350	-120	11,078	1	$1,564	$78	$1,642	25.79	0.58	-$17,917	20.00
3	Control External Air Leakage In Commercial Buildings Location: All Buildings Except P01 And Science Wing	$70,590	1,352	7,243	0	$2,778	$139	$2,917	24.20	0.49	-$35,772	15.00
Total for Improvements		**$59,128**	**0**	**0**	**440**	**$3,454**	**$0**	**$3,454**	**17.12**			

2. Introduction

The purpose of this Energy Audit is to provide West Campus High School 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	40
Operational Weeks / Year	37
Estimated Facility Occupancy	918
% of Male Occupants	50%

POINT OF CONTACT	
Point of Contact Name	Roy brooks
Point of Contact Title	Plant operations manager 2
Point of Contact – Contact Number	916.395.5170

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

Description:

Heating and cooling to permanent buildings 00A-00K and the science wing is primarily provided by central split systems with natural gas forced air furnaces. Building 00L and the science wing are also served by packaged rooftop units which utilize natural gas for heating. The cafeteria 00C is additionally served by 1x air handler unit, 3x ductless split systems provide supplementary heating and cooling. Building 00B also has supplementary heating by central heating boiler.

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

BUILDING CENTRAL HEATING SYSTEM	
Primary Heating System	Forced Air Furnace
Secondary Heating System	Packaged RTU, Boilers
Hydronic Distribution System	Two Pipe
Primary Heating Fuel	Natural Gas
Heating Mode Set-point	69
Heating Mode- Set-back Temperature	53

BUILDING COOLING SYSTEM	
Primary Cooling System	Split Systems
Secondary Cooling System	Packaged RTU
Hydronic Distribution System	Two Pipe
Cooling Mode Set-point	73
Cooling Mode- Set-back Temperature	93

AIR DISTRIBUTION SYSTEM	
Building Ventilation	Mixed: AHU & Rooftop Exhaust Fans
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.

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
$0.15 /kWh	$1.23 /therm	$ 7.85/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.

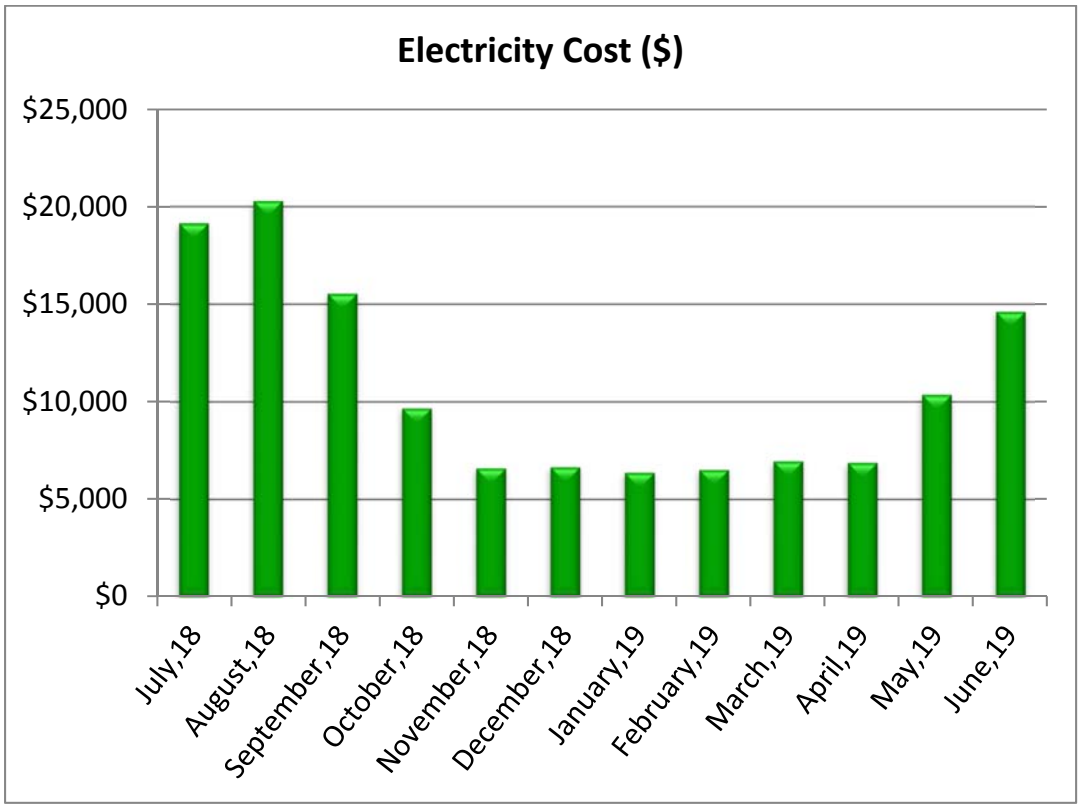
4.1. Electricity

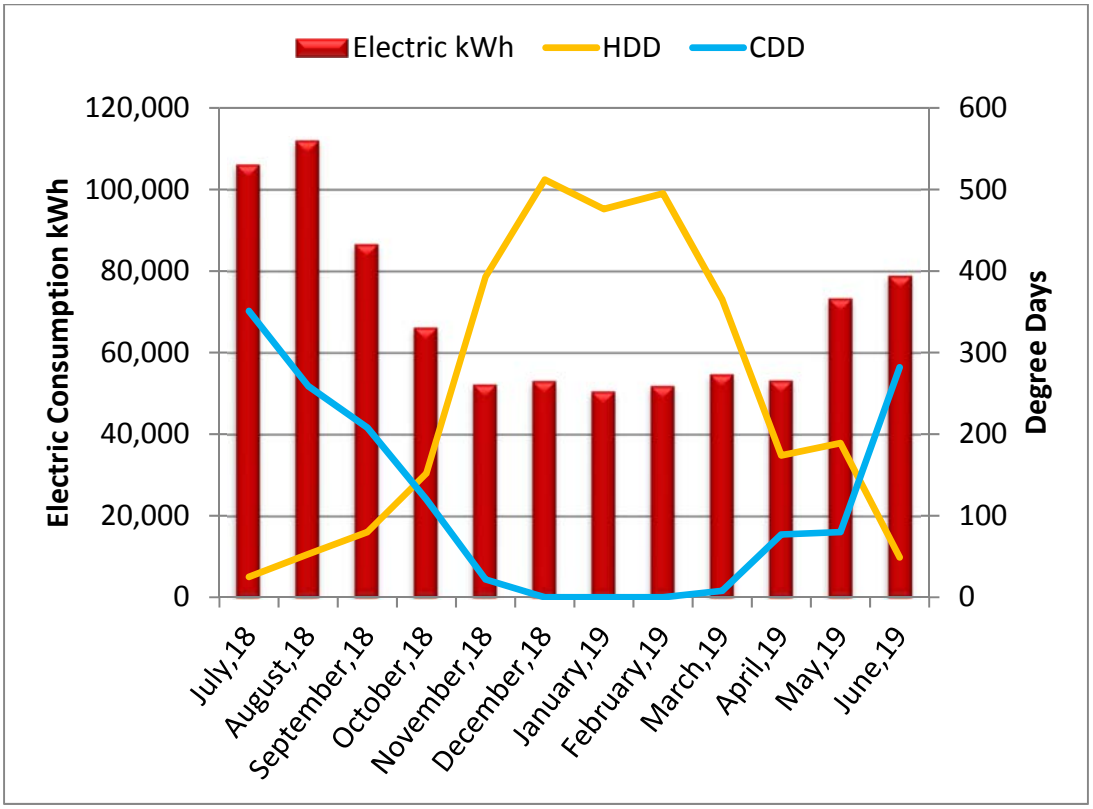
SMUD satisfies the electricity requirements for the facility. The primary end uses for electric utility compromises of lighting, cooling, office/school equipment, and appliances in the break room.

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	106,078	$0.18	$19,130
August,18	112,010	$0.18	$20,282
September,18	86,586	$0.18	$15,526
October,18	66,176	$0.15	$9,659
November,18	52,219	$0.13	$6,592
December,18	53,054	$0.13	$6,656
January,19	50,523	$0.13	$6,376
February,19	51,851	$0.13	$6,513
March,19	54,716	$0.13	$6,958
April,19	53,192	$0.13	$6,886
May,19	73,257	$0.14	$10,359
June,19	78,848	$0.19	$14,597
Total/average	**838,511**	**$0.15**	**$129,535**


Electricity Cost ($)
$25,000
$20,000
$15,000
$10,000
$5,000
$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


Electric kWh
HDD
CDD
Electric Consumption kWh
Degree Days
120,000
100,000
80,000
60,000
40,000
20,000
0
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

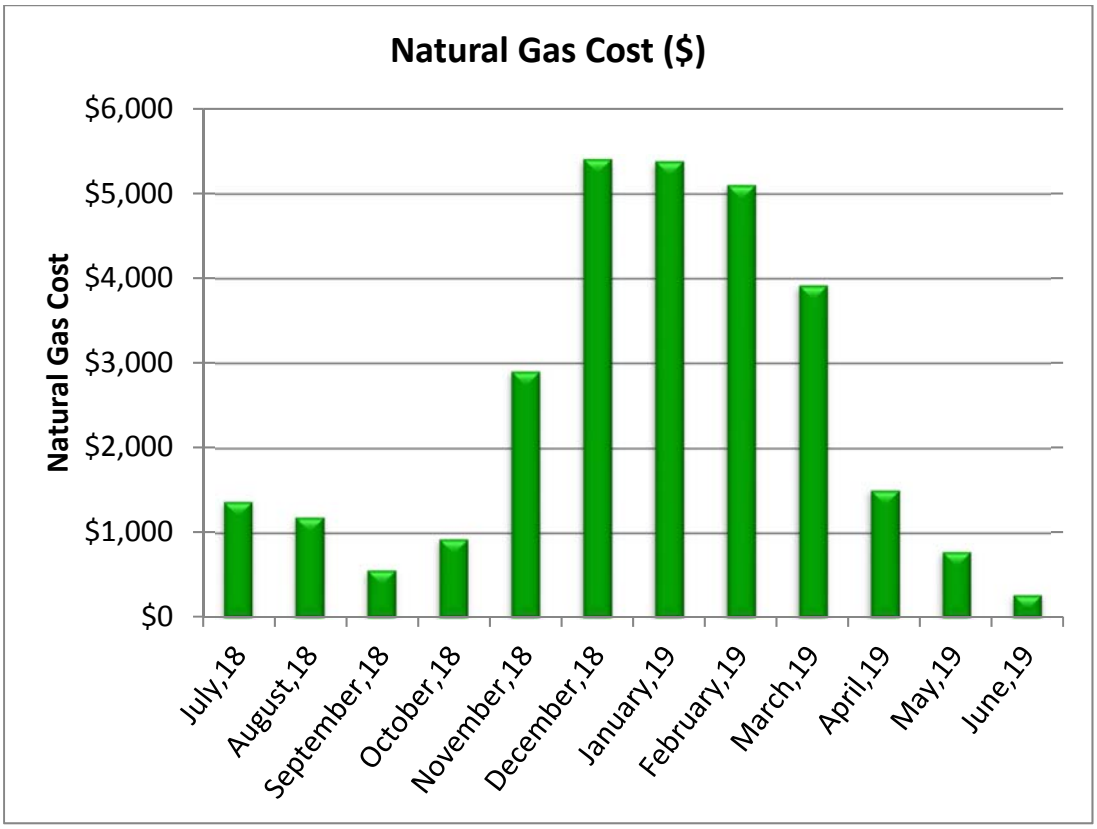
4.2. Natural Gas

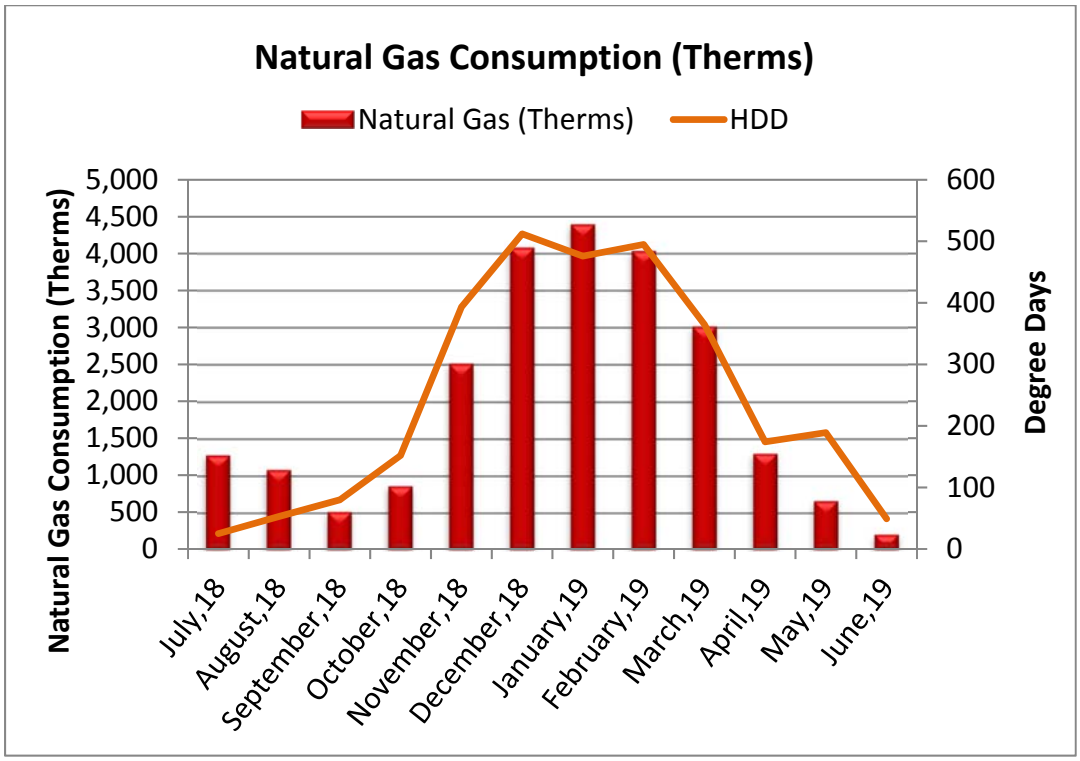
PGE satisfies the natural gas requirements of the facility. The primary end use of natural gas is for building heating, domestic water heating, and cooking in the cafeteria.

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	1,278	$1.08	$1,378
August,18	1,082	$1.10	$1,193
September,18	513	$1.10	$564
October,18	861	$1.08	$933
November,18	2,509	$1.16	$2,907
December,18	4,079	$1.33	$5,413
January,19	4,394	$1.23	$5,385
February,19	4,033	$1.27	$5,105
March,19	3,010	$1.30	$3,921
April,19	1,301	$1.16	$1,512
May,19	659	$1.19	$782
June,19	204	$1.31	$267
Total/average	**23,924**	**$1.23**	**$29,360**


Natural Gas Cost ($)
Natural Gas Cost
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$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

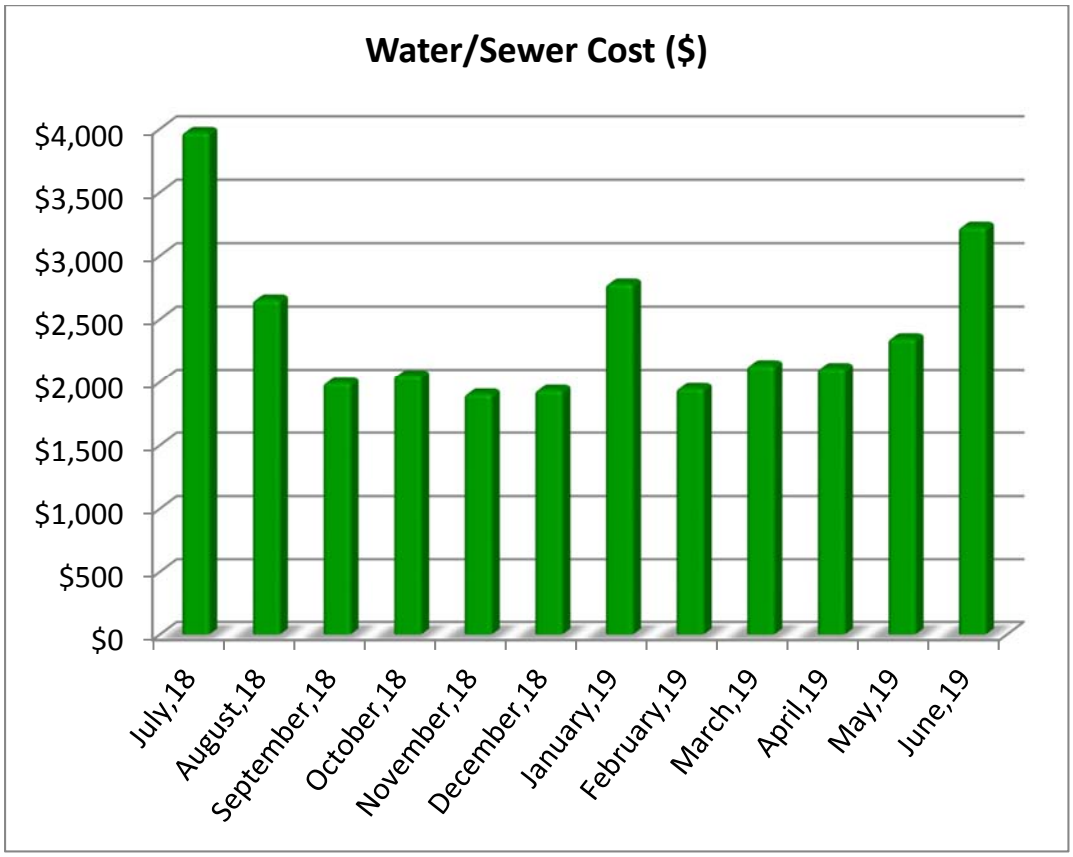

Natural Gas Consumption (Therms)
Natural Gas (Therms)
HDD
Natural Gas Consumption (Therms)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
600
500
400
300
200
100
0
Degree Days
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
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	1,128	$3.53	$3,979
August,18	495	$5.37	$2,658
September,18	170	$11.74	$1,998
October,18	155	$13.29	$2,057
November,18	107	$17.91	$1,911
December,18	79	$24.52	$1,941
January,19	88	$31.49	$2,784
February,19	92	$21.25	$1,954
March,19	123	$17.38	$2,139
April,19	114	$18.61	$2,117
May,19	244	$9.65	$2,353
June,19	914	$3.53	$3,232
Total/average	**3,710**	**$7.85**	**$29,122**


Water/Sewer Cost ($)
$4,000
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
July,18
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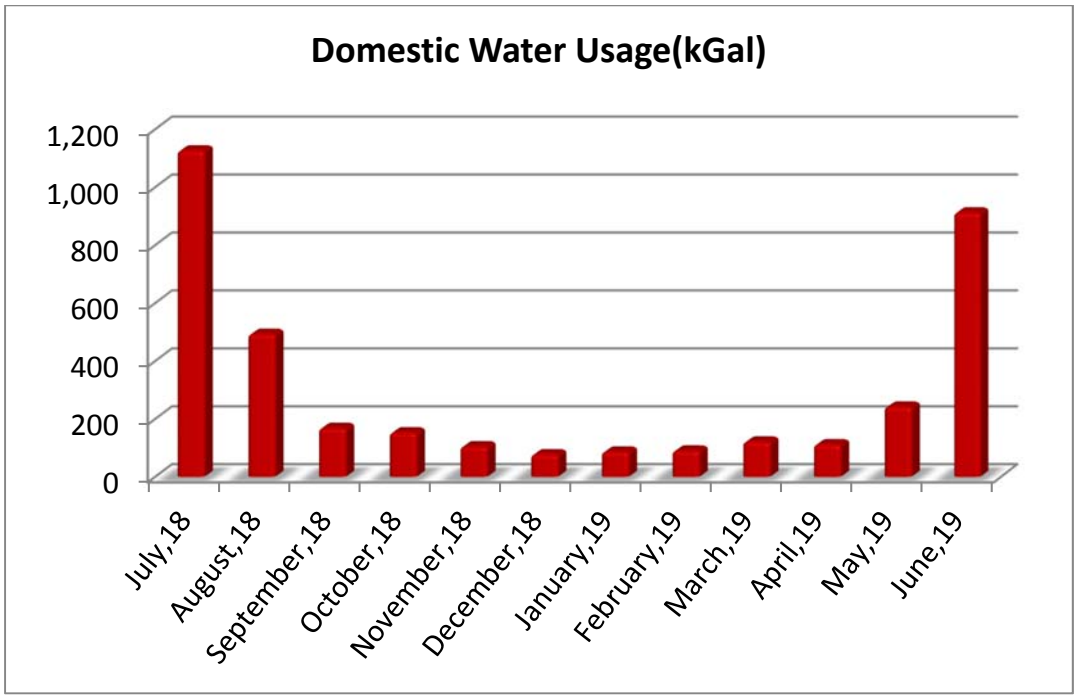
January,19
February,19
March,19
April,19
May,19
June,19


Domestic Water Usage(kGal)
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

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?	**Additional Study Required**
Is the property located in a state eligible for net metering?	**Yes**

A solar feasibility analysis of the XXX 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	1,103	
Estimated KW Rating	348	KW
Potential Annual kWh Produced	535,745	kWh
% of Current Electricity Uses	63.9%	
FINANCIAL SUMMARY		
Investment Cost	$1,216,250	
Estimated Energy Cost Savings	$82,773	
Payback without Incentives	14.7	Years
Incentive Payback but without SRECs	8.9	Years
Payback with All Incentives	8.9	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) **I**nvestment 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	Room Number	Space Served	Quantity
Water Heater	Bradford White	EF60T125E3N2	SL42512588	60 GAL, 125 MBH	CUST 78	Science Wing	1
Water Heater	Rheem	G100UN	RRGUA291400990	100 GAL, 75 MBH	Mechanical room	00K /00H Mechanical	1
Water Heater	A. O. Smith	KEN 52	780T-J-77-16156	52 GAL, 4.5kW	Utility closet J00G	00G Classrooms 41-47	1
Wall Mounted Heat Pump	Bard	WH421-A10VX4XXX	1Z6L991387404-01	3.5 TON	Building exterior	P01 Portable Classroom	1
Split System Condensing Unit	American Standard Inc.	2A7C3036A4000AA	8214PHG3F	3 TON	Building exterior	00J Classrooms 61-64	1
Split System Condensing Unit	American Standard Inc.	2A7C3036A4000AA	83557FR3F	3 TON	Building exterior	00J Classrooms 61-64	1
Split System Condensing Unit	Trane	2TTA0048A4000AA	34422N73F	4 TON	Building exterior	00J Classrooms 61-64	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	3425K633F	5 TON	Building exterior	00J Classrooms 61-64	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	402582X3F	5 TON	Building exterior	00J Classrooms 61-64	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4031KA43F	5 TON	Building exterior	00B Admin	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	34148YS3F	5 TON	Building exterior	00C Cafeteria and Kitchen	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4034N0F3F	5 TON	Building exterior	00B Admin	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4023UGE3F	5 TON	Building exterior	00J Classrooms 61-64	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	40258T73F	5 TON	Building exterior	00F Classrooms 31-33, Library	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	40258TT3F	5 TON	Building exterior	00G Classrooms 41-47	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4034NXS3F	5 TON	Building exterior	00J Classrooms 61-64	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	402583A3F	5 TON	Building exterior	00B Admin	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	40258XD3F	5 TON	Building exterior	00G Classrooms 41-47	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4023UG83F	5 TON	Building exterior	00E Classrooms 21-28	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	40258WL3F	5 TON	Building exterior	00E Classrooms 21-28	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4034N203F	5 TON	Building exterior	00D Classrooms 11-17	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4023UM53F	5 TON	Building exterior	00D Classrooms 11-17	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4023UG33F	5 TON	Building exterior	00E Classrooms 21-28	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4023U8U3F	5 TON	Building exterior	00D Classrooms 11-17	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4034N243F	5 TON	Building exterior	00D Classrooms 11-17	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	3425KRH3F	5 TON	Building exterior	00D Classrooms 11-17	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4031KDY3F	5 TON	Building exterior	00D Classrooms 11-17	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	40258U53F	5 TON	Building exterior	00D Classrooms 11-17	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4031KEB3F	5 TON	Building exterior	00E Classrooms 21-28	1
Split System Condensing Unit	Trane	2TTA0060A4000AA	4023UHC3F	5 TON	Building exterior	00E Classrooms 21-28	1
Split System Condensing Unit	Trane	2TTA0072A4000AA	4132RPA2F	6 TON	Building exterior	00G Classrooms 41-47	1
Split System Condensing Unit	Trane	2TTA0072A4000AA	4132RWT2F	6 TON	Building exterior	00G Classrooms 41-47	1
Split System Condensing Unit	Trane	2TTA0072A4000AA	4132RPC2F	6 TON	Building exterior	00F Classrooms 31-33, Library	1
Split System Condensing Unit	Trane	2TTA0072A4000AA	4132R5G2F	6 TON	Building exterior	00F Classrooms 31-33, Library	1
Split System Condensing Unit	Trane	2TTA0072A4000AA	4132RWU2F	6 TON	Building exterior	00G Classrooms 41-47	1
Split System Condensing Unit	Trane	2TTA0072A4000AA	4132R8E2F	6 TON	Building exterior	00E Classrooms 21-28	1

Mechanical Inventory							
System	Make	Model	Serial Number	Input Capacity	Room Number	Space Served	Quantity
Split System Condensing Unit	Trane	2TTA2036A4000AB	411358S3F	3 TON	Building exterior	00B Admin	1
Split System Condensing Unit	Guardian	RAC17L60B21SA	W1L8253135	5 TON	Building exterior (science wing)	Science Wing	1
Split System Condensing Unit	Guardian	RAC17L60B21SA	W1L8253130	5 TON	Building exterior (science wing)	Science Wing	1
Split System Condensing Unit	Trane	TTA090A400FA	41441ERAD	7.5 TON	Building exterior	00A Classrooms 1-3	1
Split System Condensing Unit	Trane	TTA090A400FA	414514YAD	7.5 TON	Building exterior	00I Classrooms 52, 54, 56, 59	1
Split System Condensing Unit	Trane	TTA090A400FA	41446S5AD	7.5 TON	Building exterior	00I Classrooms 52, 54, 56, 59	1
Split System Condensing Unit	Trane	TTA090A400FA	4161S68AD	7.5 TON	Building exterior	00J Classrooms 61-64	1
Split System Condensing Unit	Trane	TTA090A400FA	41442T8AD	7.5 TON	Building exterior	00C Cafeteria and Kitchen	1
Split System Condensing Unit	Trane	TTA090A400FA	414503TAD	7.5 TON	Building exterior	00I Classrooms 52, 54, 56, 59	1
Split System Condensing Unit	Trane	TTA090A400FA	41445MKAD	7.5 TON	Building exterior	00F Classrooms 31-33, Library	1
Split System Condensing Unit	Trane	TTA090A400FA	414515CAD	7.5 TON	Building exterior	00I Classrooms 52, 54, 56, 59	1
Split System Condensing Unit	Trane	TTA090A400FA	4145KNRAD	7.5 TON	Building exterior	00F Classrooms 31-33, Library	1
Split System Condensing Unit	Trane	TTA120A400FA	4161246AD	10 TON	Building exterior	00A Classrooms 1-3	1
Split System Condensing Unit	Trane	TTA120A400FA	41610UJAD	10 TON	Building exterior	00A Classrooms 1-3	1
Packaged Unit (RTU)	Johnson Controls	J06ZJS12R4A1BCA6A2	N1F9990659	120 MBH	Roof	Science Wing	1
Packaged Unit (RTU)	Johnson Controls	J10ZJS18R4A1BCA3A1	N1L8272533	180 MBH	Roof	Science Wing	1
Packaged Unit (RTU)	Johnson Controls	J10ZS18R4A1BCA3A1	N1L8272532	180 MBH	Roof	Science Wing	1
Hot Water Boiler	Pennant	PNCH1000NACN2CXN	C04F04272	999 MBH	Roof	00B Admin	1
Furnace	Inaccessible	Inaccessible	Inaccessible	80 MBH	Throughout Building	00B Admin	1
Furnace	Inaccessible	Inaccessible	Inaccessible	80 MBH	Throughout Building	00B Admin	1
Furnace	Inaccessible	Inaccessible	Inaccessible	80 MBH	Throughout Building	00B Admin	1
Furnace	Inaccessible	Inaccessible	Inaccessible	80 MBH	Throughout building	00B Admin	1
Furnace	Guardian	RGF29120DE20MP11A	W1L8323534	120 MBH	MECH 76	Science Wing	1
Furnace	Trane	TUX060C936D3	41326CW7G	60 MBH	Mechanical room S64C	00J Classrooms 61-64	1
Furnace	Trane	TUX060C936D3	413256F7G	60 MBH	Classroom 0O31	00F Classrooms 31-33, Library	1
Furnace	Trane	TUX060C936D3	41325JR7G	60 MBH	Classroom 0O31	00F Classrooms 31-33, Library	1
Furnace	Trane	TUX060C936D3	41325YP7G	60 MBH	Classroom O023	00E Classrooms 21-28	1
Furnace	Trane	TUX060C936D3	4071KM47G	60 MBH	Mechanical room S64C	00J Classrooms 61-64	1
Furnace	Trane	TUX060C936D3	4071JYB7G	60 MBH	Classroom O059	00I Classrooms 52, 54, 56, 59	1
Furnace	Trane	TUX060C936D3	4071JU37G	60 MBH	Classroom O054	00I Classrooms 52, 54, 56, 59	1
Furnace	Trane	TUX060C936D3	4071JPN7G	60 MBH	Classroom NJ61	00J Classrooms 61-64	1
Furnace	Trane	TUX060C936D3	4071JU57G	60 MBH	Classroom O054	00I Classrooms 52, 54, 56, 59	1
Furnace	Trane	TUX060C936D3	4071JMK7G	60 MBH	Classroom NJ61	00J Classrooms 61-64	1
Furnace	Trane	TUX060C936D3	41326C07G	60 MBH	Classroom X038	00F Classrooms 31-33, Library	1
Furnace	Trane	TUX060C936D3	4071JU87G	60 MBH	Classroom O052	00I Classrooms 52, 54, 56, 59	1
Furnace	Trane	TUX060C936D3	4071KYM7G	60 MBH	Classroom O041	00G Classrooms 41-47	1
Furnace	Trane	TUX060C936D3	41325YW7G	60 MBH	Classroom O046	00G Classrooms 41-47	1
Furnace	Trane	TUX060C936D3	41326CU7G	60 MBH	Classroom O052	00I Classrooms 52, 54, 56, 59	1
Furnace	Trane	TUX060C936D3	4071JPM7G	60 MBH	Classroom O056	00I Classrooms 52, 54, 56, 59	1
Furnace	Trane	TUX060C936D3	4071JPL7G	60 MBH	Classroom O059	00I Classrooms 52, 54, 56, 59	1
Furnace	Trane	TUX060C936D3	4071JMJ7G	60 MBH	Classroom O047	00G Classrooms 41-47	1
Furnace	Trane	TUX060C936D3	41325YX7G	60 MBH	Classroom O046	00G Classrooms 41-47	1

Mechanical Inventory							
System	Make	Model	Serial Number	Input Capacity	Room Number	Space Served	Quantity
Furnace	Trane	TUX060C936D3	41325557G	60 MBH	Classroom O047	00G Classrooms 41-47	1
Furnace	Trane	TUX060C936D3	4071JML7G	60 MBH	Classroom X038	00F Classrooms 31-33, Library	1
Furnace	Trane	TUX060C936D3	41326CS7G	60 MBH	Classroom O032	00F Classrooms 31-33, Library	1
Furnace	Trane	TUX060C936D3	41326G87G	60 MBH	Classroom O056	00I Classrooms 52, 54, 56, 59	1
Furnace	Trane	TUX060C936D3	4071JMG7G	60 MBH	Classroom O041	00G Classrooms 41-47	1
Furnace	Trane	TUX060C936D3	413256D7G	60 MBH	Classroom O032	00F Classrooms 31-33, Library	1
Furnace	Trane	TUX060C936D3	4071JMA7G	60 MBH	Classroom O002	00A Classrooms 1-3	1
Furnace	Trane	TUX060C936D3	41325Y17G	60 MBH	Classroom O009	00C Cafeteria and Kitchen	1
Furnace	Trane	TUX120C960D3	4103S567G	120 MBH	Classroom O026	00E Classrooms 21-28	1
Furnace	Trane	TUX120C960D3	4103RCY7G	120 MBH	Classroom O011	00D Classrooms 11-17	1
Furnace	Trane	TUX120C960D3	4093WNY7G	120 MBH	Classroom O034	00F Classrooms 31-33, Library	1
Furnace	Trane	TUX120C960D3	4124LDM7G	120 MBH	Classroom O014	00D Classrooms 11-17	1
Furnace	Trane	TUX120C960D3	4124LDL7G	120 MBH	Classroom O012	00D Classrooms 11-17	1
Furnace	Trane	TUX120C960D3	4124LDF7G	120 MBH	Classroom O013	00D Classrooms 11-17	1
Furnace	Trane	TUX120C960D3	4103RBG7G	120 MBH	Classroom O017	00D Classrooms 11-17	1
Furnace	Trane	TUX120C960D3	4103RCM7G	120 MBH	Classroom O042	00G Classrooms 41-47	1
Furnace	Trane	TUX120C960D3	4124LDN7G	120 MBH	Classroom O027	00E Classrooms 21-28	1
Furnace	Trane	TUX120C960D3	4124LDG7G	120 MBH	Classroom O043	00G Classrooms 41-47	1
Furnace	Trane	TUX120C960D3	4124K587G	120 MBH	Classroom O015	00D Classrooms 11-17	1
Furnace	Trane	TUX120C960D3	4103S577G	120 MBH	Classroom O028	00E Classrooms 21-28	1
Furnace	Trane	TUX120C96G3	4104CMT7G	120 MBH	Mechanical room S64C	00J Classrooms 61-64	1
Exhaust Fan	Westinghouse	Air-Over	309P485-A	600 CFM	Classroom NJ61	00J Classrooms 61-64	1
Exhaust Fan	No tag/plate found	No tag/plate found	No tag/plate found	600 CFM	Classroom NJ61	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	FHI-20X20-G-BS	04F04100	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04124	2,000 CFM	Roof	00D Classrooms 11-17	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04148	2,000 CFM	Roof	00C Cafeteria and Kitchen	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04145	2,000 CFM	Roof	00I Classrooms 52, 54, 56, 59	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04117	2,000 CFM	Roof	00B Admin	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04114	2,000 CFM	Roof	00D Classrooms 11-17	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04147	2,000 CFM	Roof	00I Classrooms 52, 54, 56, 59	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04136	2,000 CFM	Roof	00F Classrooms 31-33, Library	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04111	2,000 CFM	Roof	00D Classrooms 11-17	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04143	2,000 CFM	Roof	00I Classrooms 52, 54, 56, 59	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04129	2,000 CFM	Roof	00E Classrooms 21-28	1
Exhaust Fan	Greenheck	CUE-095-D-X	15618099	1,000 CFM	Roof	Science Wing	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04118	2,000 CFM	Roof	00D Classrooms 11-17	1
Exhaust Fan	Dayton	4HX80A	No tag/plate found	2,000 CFM	Roof	00D Classrooms 11-17	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04125	2,000 CFM	Roof	00D Classrooms 11-17	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04142	2,000 CFM	Roof	00I Classrooms 52, 54, 56, 59	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04123	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	FHI-20-X20-G-BS	04F04605	2,000 CFM	Roof	00B Admin	1
Exhaust Fan	Greenheck	FHI-20X20-G-BS	04F04096	2,000 CFM	Roof	00B Admin	1

Mechanical Inventory							
System	Make	Model	Serial Number	Input Capacity	Room Number	Space Served	Quantity
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04137	2,000 CFM	Roof	00E Classrooms 21-28	1
Exhaust Fan	Greenheck	FHR-36X36-G-BS	04F04151	2,000	Roof	00A Classrooms 1-3	1
Exhaust Fan	CaptiveAire	Illegible	Illegible	3,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04126	2,000 CFM	Roof	00D Classrooms 11-17	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04146	2,000 CFM	Roof	00G Classrooms 41-47	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04120	2,000 CFM	Roof	00E Classrooms 21-28	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04122	2,000 CFM	Roof	00B Admin	1
Exhaust Fan	Greenheck	FHI-16X20-G-BS	04F04100	2,000 CFM	Roof	00C Cafeteria and Kitchen	1
Exhaust Fan	Greenheck	FHI-20X20-G-BS	04F04097	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04139	2,000 CFM	Roof	00F Classrooms 31-33, Library	1
Exhaust Fan	Greenheck	FHI-20X20-G-BS	04F04105	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Inaccessible	Inaccessible	Inaccessible	15,000 CFM	Mechanical room	00C Cafeteria and Kitchen	1
Exhaust Fan	Dayton	4HX80A	No tag/plate found	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04130	2,000 CFM	Roof	00G Classrooms 41-47	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04115	2,000 CFM	Roof	00E Classrooms 21-28	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04113	2,000 CFM	Roof	00E Classrooms 21-28	1
Exhaust Fan	Dayton	4HX80A	No tag/plate found	2,000 CFM	Roof	00G Classrooms 41-47	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04127	2,000 CFM	Roof	00D Classrooms 11-17	1
Exhaust Fan	Greenheck	FHI-16X20-G-BS	04F04104	2,000 CFM	Roof	00B Admin	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04138	2,000 CFM	Roof	00A Classrooms 1-3	1
Exhaust Fan	Greenheck	6-080-6-X	04F06884	500 CFM	Roof	00G Classrooms 41-47	1
Exhaust Fan	Greenheck	FHR-20X20-G-BS	04F04133	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Power Ventilator	4HX80A	No tag/plate found	2,000 CFM	Roof	00C Cafeteria and Kitchen	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04110	2,000 CFM	Roof	00B Admin	1
Exhaust Fan	Greenheck	FHR-20X24-G-BS	04F4135	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04109	2,000 CFM	Roof	00B Admin	1
Exhaust Fan	Greenheck	FHI-16X20-G-BS	04F04102	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	CUE-095-D-X	15618102	1,000 CFM	Roof	Science Wing	1
Exhaust Fan	Greenheck	FHR-20X20-G-BS	04F04134	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	FHI-20X30-G-BS	04F04108	2,000 CFM	Roof	00F Classrooms 31-33, Library	1
Exhaust Fan	Inaccessible	Inaccessible	Inaccessible	1,000 CFM	Building exterior	Science Wing	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04112	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	FHI-20X20-G-BS	04F04604	2,000 CFM	Roof	00B Admin	1
Exhaust Fan	Greenheck	BSQ-240-20-X	04F06557	20,000 CFM	Mechanical room	00C Cafeteria and Kitchen	1
Exhaust Fan	Greenheck	FHI-20X30-G-BS	04F04106	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04144	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	FHI-20X20-G-BS	04F04099	2,000 CFM	Roof	00B Admin	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04150	2,000 CFM	Roof	00G Classrooms 41-47	1
Exhaust Fan	Greenheck	VK-H-9-A15-X	15619000	2,000 CFM	Roof	Science Wing	1
Exhaust Fan	Greenheck	FHI-20X30-G-BS	04F04107	2,000 CFM	Roof	00I Classrooms 52, 54, 56, 59	1
Exhaust Fan	Dayton	4HX80A	No tag/plate found	2,000 CFM	Roof	00E Classrooms 21-28	1
Exhaust Fan	Greenheck	CUE-095-D-X	15618101	2,000 CFM	Roof	Science Wing	1
Exhaust Fan	Dayton	4HX80A	No tag/plate found	2,000 CFM	Roof	00E Classrooms 21-28	1
Exhaust Fan	Penn Ventilation	DX06B	No tag/plate found	1,000 CFM	Roof	00C Cafeteria and Kitchen	1
Exhaust Fan	Inaccessible	Inaccessible	Inaccessible	1,000 CFM	Building exterior	Science Wing	1
Exhaust Fan	Greenheck	FHR-20X20-G-BS	04F04132	2,000 CFM	Roof	00C Cafeteria and Kitchen	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04140	2,000 CFM	Roof	00G Classrooms 41-47	1
Exhaust Fan	Dayton	4HX80A	No tag/plate found	2,000 CFM	Roof	00D Classrooms 11-17	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04131	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	CUE-095-D-X	15618100	2,000 CFM	Roof	Science Wing	1
Exhaust Fan	Greenheck	FHR-36X36	04F04152	2,000 CFM	Roof	00A Classrooms 1-3	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04116	2,000 CFM	Roof	00F Classrooms 31-33, Library	1

Mechanical Inventory							
System	Make	Model	Serial Number	Input Capacity	Room Number	Space Served	Quantity
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04149	2,000 CFM	Roof	00F Classrooms 31-33, Library	1
Exhaust Fan	Dayton	4YC86G	11636254 0901	500 CFM	Roof	00I Classrooms 52, 54, 56, 59	1
Exhaust Fan	Greenheck	FHR-20X42-G-BS	04F04141	2,000 CFM	Roof	00F Classrooms 31-33, Library	1
Exhaust Fan	Greenheck	FHI-20X20-G-BS	04F04098	2,000 CFM	Roof	00B Admin	1
Exhaust Fan	Dayton	4HX80A	No tag/plate found	2,000 CFM	Roof	00G Classrooms 41-47	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04119	2,000 CFM	Roof	00E Classrooms 21-28	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04128	2,000 CFM	Roof	00G Classrooms 41-47	1
Exhaust Fan	Greenheck	VK-H-9-STACK	90235417-0001	2,000 CFM	Roof	Science Wing	1
Exhaust Fan	Greenheck	FHI-20X20-G-BS	04F04101	2,000 CFM	Roof	00J Classrooms 61-64	1
Exhaust Fan	Greenheck	FHR-20X30-G-BS	04F04121	2,000 CFM	Roof	00A Classrooms 1-3	1
Ductless Split System	EMI	SHC18DF0000AA0A	1-04-A-1602-05	1.5 TON	Building exterior	00J Classrooms 61-64	1
Ductless Split System	Johnson Controls	DHR24CSB21S	D0E1800686	2 Ton	Roof	Science Wing	1
Ductless Split System	Johnson Controls	DCX24CSB21S	D0G1801190	2 Ton	Roof	Science Wing	1
Air-Cooled Scroll Condensing Unit	McQuay	ACZ025AC27-ER11	STNU040600194	25 TON	Building exterior	00C Cafeteria and Kitchen	1
Air-Cooled Scroll Condensing Unit	McQuay	ACZ025AC27-ER11	STNU040600193	25 TON	Building exterior	00C Cafeteria and Kitchen	1
Air Handler (AHU)	McQuay	CAH032FDAM	FBOU040601417	50,000 CFM	Mechanical room	00C Cafeteria and Kitchen	1

APPENDIX C:
Lighting System Schedule

									Lamp Details				Fixture Details				Existing Consumption	
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	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	West Campus high school	Interior	1	CLASSROOM	JN564	151	12	Light Switch	Linear Fluorescent	T8	4' 32W T8	144	Troffer 20"x4'	12	0	8	2,220	10,230
2	West Campus high school	Interior	1	OFFICE	JS64A	355	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	8	2,220	568
3	West Campus high school	Interior	1	OFFICE	JS61A	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	8	2,220	284
4	West Campus high school	Interior	1	CLASSROOM	J063A	248	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	60	Industrial	5	0	8	2,220	4,262
5	West Campus high school	Interior	1	OFFICE	J063B	327	1	Light Switch	Linear Fluorescent	T5	4' 28W T5	8	1x4 Prism Troffer	2	0	8	2,220	497
6	West Campus high school	Interior	1	ESTROOM - PRIVAT	JTJ01	303	1	Light Switch	Linear Fluorescent	T5	4' 28W T5	2	2x4 Prism Troffer	1	0	8	925	52
7	West Campus high school	Interior	1	GYMNASIUM	CU001	706	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	138	Industrial	2	0	8	2,220	9,804
8	West Campus high school	Interior	1	JANITORIAL	JJJ01	193	1	Light Switch	Linear Fluorescent	T5	4' 28W T5	2	2x4 Prism Troffer	1	0	8	703	39
9	West Campus high school	Interior	1	GYMNASIUM	CU001	706	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	120	Industrial	2	0	8	2,220	8,525
10	West Campus high school	Interior	1	GYMNASIUM	CU001	706	4	Wall-Mounted Sensor	LED	-	-	10	Round Head	5	0	8	2,220	-
11	West Campus high school	Interior	1	HALLWAY	CH00U	100	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	3	0	8	2,220	426
12	West Campus high school	Interior	1	GYMNASIUM	CU001	706	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	20	2x4 Prism Troffer	10	0	8	2,220	1,421
13	West Campus high school	Interior	1	RESTROOM	JTJ02	583	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	14	2x4 Prism Troffer	7	0	8	2,220	995
14	West Campus high school	Interior	1	RESTROOM	JTJ02	583	1	Light Switch	Linear Fluorescent	T5	4' 28W T5	22	2x4 Prism Troffer	11	0	8	2,220	1,368
15	West Campus high school	Interior	1	OFFICE	JS0J1	168	2	Light Switch	Linear Fluorescent	T5	4' 28W T5	8	2x4 Prism Troffer	4	0	8	2,220	497
16	West Campus high school	Interior	1	RESTROOM	SRestroom	629	12	Wall-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	20	Surface Mount w Lense	20	0	8	2,220	1,421
17	West Campus high school	Exterior	1	CLASSROOM	Science Building	-	1	Timer	LED	-	-	132	Flood Light	11	0	8	2,220	-
18	West Campus high school	Exterior	1	CLASSROOM	Science Building	-	1	Timer	Linear Fluorescent	T8	18" 15W T8	12	Surface Mount w Lense	6	0	8	2,220	400
19	West Campus high school	Interior	1	CLASSROOM	S75	505	2	Wall-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	12	Strip Fixture	4	0	8	2,220	852
20	West Campus high school	Interior	1	CLASSROOM	S75	505	2	Wall-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	4	Strip Fixture	2	0	8	2,220	284
21	West Campus high school	Interior	1	CLASSROOM	S74	505	3	Wall-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	144	Industrial	12	0	8	2,220	10,230
22	West Campus high school	Interior	1	CLASSROOM	S74	505	3	Building Management System	LED	-	-	12	Exit Sign	6	0	8	2,220	-
23	West Campus high school	Interior		MECHANICAL	S72	103	2	Wall-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	2	Surface Mount w Lense	2	0	8	1,554	99
24	West Campus high school	Exterior	1	CLASSROOM	Science Building	-	1	Timer	LED	-	-	8	Recessed Can-hor8"	8	0	8	1,480	-
25	West Campus high school	Interior		MECHANICAL	SCUST78	551	1	Wall-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	1	Surface Mount w Lense	1	0	8	1,554	50
26	West Campus high school	Interior	1	MECHANICAL	SFireControl	203	1	Wall-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	1	Surface Mount w Lense	1	0	8	1,554	50
27	West Campus high school	Exterior	1	MECHANICAL	L	-	1	Light Switch	Linear Fluorescent	T5	2' 24W T5	2	2x4 Prism Troffer	1	0	8	1,554	75
28	West Campus high school	Interior	2	MECHANICAL	KB002	819	1	Light Switch	Linear Fluorescent	T5	2' 24W T5	8	2x4 Prism Troffer	4	0	8	1,554	298
29	West Campus high school	Interior	1	CLASSROOM	CO009	217	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	90	Industrial	3	0	8	1,480	4,262
30	West Campus high school	Interior	1	GYMNASIUM	LHG01	212	14	Light Switch	Linear Fluorescent	T8	4' 32W T8	18	2x4 Prism Troffer	9	0	8	2,220	1,279
31	West Campus high school	Interior	1	GYMNASIUM	LHG01	212	14	Light Switch	Linear Fluorescent	T8	4' 32W T8	208	Industrial	52	0	8	2,220	14,776
32	West Campus high school	Interior	1	GYMNASIUM	LHG01	212	14	Light Switch	Linear Fluorescent	T8	4' 32W T8	24	1x4 Prism Troffer	12	0	8	2,220	1,705
33	West Campus high school	Interior	1	GYMNASIUM	LHG01	212	14	Light Switch	Linear Fluorescent	T8	4' 32W T8	92	Industrial	23	0	8	2,220	6,536
34	West Campus high school	Interior	1	GYMNASIUM	LHG01	212	14	Light Switch	Linear Fluorescent	T8	4' 32W T8	50	Troffer 2'x4'	25	0	8	2,220	3,552
35	West Campus high school	Interior	1	GYMNASIUM	LHG01	212	14	Timer	LED	-	-	4	Flood Light	2	0	8	2,220	-
36	West Campus high school	Interior	1	GYMNASIUM	LHG01	212	14	Light Switch	Linear Fluorescent	T5	4' 28W T5	4	2x4 Prism Troffer	2	0	8	2,220	249
37	West Campus high school	Interior	1	GYMNASIUM	LHG01	212	14	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	Strip Fixture	2	0	8	2,220	142
38	West Campus high school	Interior	2	CLASSROOM	JH66D	270	2	Light Switch	Incan/H/MR	Incan	I60-Globe	9	Bollard	3	0	8	1,480	799
39	West Campus high school	Interior	2	CLASSROOM	JH66D	270	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	60	2x4 Prism Troffer	15	0	8	1,480	2,842
40	West Campus high school	Interior	1	CLASSROOM	NJ61	583	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	48	Industrial	4	0	8	1,480	2,273
41	West Campus high school	Interior	1	CLASSROOM	JO62A	281	7	Light Switch	Linear Fluorescent	T8	4' 32W T8	60	Industrial	5	0	8	1,480	2,842
42	West Campus high school	Interior	1	CLASSROOM	JO62A	281	7	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	8	1,480	379
43	West Campus high school	Interior	1	CLASSROOM	JN564	151	12	Light Switch	Linear Fluorescent	T5	4' 28W T5	16	2x4 Prism Troffer	8	0	8	1,480	663
44	West Campus high school	Interior	1	CLASSROOM	HO059	246	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	48	Industrial	3	0	8	1,480	2,273
45	West Campus high school	Interior	1	CLASSROOM	HO059	246	4	Light Switch	Linear Fluorescent	T5	4' 28W T5	2	2x4 Indirect Troffer	1	0	8	1,480	83
46	West Campus high school	Interior	1	CLASSROOM	HO056	166	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	48	Industrial	3	0	8	1,480	2,273
47	West Campus high school	Interior	1	CLASSROOM	HO056	166	3	Light Switch	Linear Fluorescent	T5	4' 28W T5	2	2x4 Prism Troffer	1	0	8	1,480	83
48	West Campus high school	Interior	1	CLASSROOM	HO54	245	5	Light Switch	Linear Fluorescent	T8	4' 32W T8	48	Industrial	3	0	8	1,480	2,273
49	West Campus high school	Interior	1	CLASSROOM	HO54	245	5	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	2x2 Parabolic Troffer	4	0	8	1,480	758
50	West Campus high school	Interior	1	CLASSROOM	HO54	245	5	Light Switch	Linear Fluorescent	T5	4' 28W T5	16	2x4 Prism Troffer	4	0	8	1,480	663
51	West Campus high school	Interior	1	CLASSROOM	HO52	249	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	48	Industrial	3	0	8	1,480	2,273
52	West Campus high school	Interior	1	STORAGE	HS00J	178	1	Light Switch	Linear Fluorescent	T5	4' 28W T5	1	2x4 Prism Troffer	1	0	8	703	20
53	West Campus high school	Interior	1	RESTROOM	SRestroom	629	12	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	8	2,220	568
54	West Campus high school	Interior	1	STORAGE	GJ00G	-	1	Light Switch	Linear Fluorescent	T5	4' 28W T5	2	2x4 Prism Troffer	1	0	8	703	39
55	West Campus high school	Interior	1	CLASSROOM	GO043	377	20	Wall-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	180	Industrial	15	0	8	1,480	8,525
56	West Campus high school	Interior	1	CLASSROOM	GO42	377	9	Light Switch	Linear Fluorescent	T8	4' 32W T8	108	Industrial	9	0	8	1,480	5,115
57	West Campus high school	Interior	1	LIBRARY	FX038	236	6	Light Switch	Linear Fluorescent	T8	4' 32W T8	84	Industrial	3	0	8	2,220	5,967
58	West Campus high school	Interior	1	LIBRARY	FX038	236	6	Light Switch	Linear Fluorescent	T5	4' 28W T5	20	2x4 Prism Troffer	10	0	8	2,220	1,243
59	West Campus high school	Interior	1	LIBRARY	FX038	236	6	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x2 Prism Troffer	2	0	8	2,220	568
60	West Campus high school	Interior	1	STORAGE	FS032	241	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	2x4 Prism Troffer	1	0	8	703	45
61	West Campus high school	Interior	1	CLASSROOM	FO031	296	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	36	Industrial	3	0	8	1,480	1,705
62	West Campus high school	Interior	1	CLASSROOM	EO026	223	12	Light Switch	Linear Fluorescent	T8	4' 32W T8	120	Industrial	12	0	8	1,480	5,683
63	West Campus high school	Interior	1	CIASSROOM	EO023	275	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	36	Industrial	3	0	8	1,480	1,705
64	West Campus high school	Interior	1	CIASSROOM	EO023	275	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	8	1,480	379
65	West Campus high school	Interior	1	CLASSROOM	EO021	187	32	Wall-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	240	Industrial	24	0	8	1,480	11,366
66	West Campus high school	Interior	1	CLASSROOM	PO1	625	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	48	Troffer 2'x4'	12	0	8	1,480	2,273
67	West Campus high school	Interior	1	CLASSROOM	AO01	325	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	81	Industrial	3	0	8	1,480	3,836
68	West Campus high school	Interior	1	CLASSROOM	AO01	325	3	Light Switch	Incan/H/MR	Incan	I60-Globe	1	Ceiling Fan Light Combo	1	0	8	1,480	89
69	West Campus high school	Interior	1	CLASSROOM	AO02	-	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	72	Industrial	3	0	8	1,480	3,410
70	West Campus high school	Interior	1	CLASSROOM	AO03	218	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	72	Industrial	3	0	8	1,480	3,410
71	West Campus high school	Interior	1	CLASSROOM	AO03	218	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	8	1,480	379
72	West Campus high school	Interior	1	STORAGE	ES003	59	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	Strip Fixture	2	0	8	703	45
73	West Campus high school	Interior	1	OPEN OFFICE	BC019	304	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	63	Industrial	3	0	8	2,220	4,476

74	West Campus high school	Interior	1	OPEN OFFICE	BC019	304	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	18	Industrial	2	0	8	2,220	1,279
75	West Campus high school	Interior	1	MECHANICAL	BS013	67	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	8	1,554	199
76	West Campus high school	Interior	1	MECHANICAL	BS014	129	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	1	2x4 Prism Troffer	1	0	8	1,554	50
77	West Campus high school	Interior	1	ESTROOM - PRIVAT	BT012	171	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	2x4 Prism Troffer	1	0	8	925	59
78	West Campus high school	Interior	1	STORAGE	BC008	105	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	8	703	180
79	West Campus high school	Interior	1	OFFICE	BZ011	286	7	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	Troffer 2'x4'	4	0	8	2,220	1,137
80	West Campus high school	Interior	1	OFFICE	BC015	274	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	18	Industrial	2	0	8	2,220	1,279
81	West Campus high school	Interior	1	OFFICE	BC015	274	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	2x4 Prism Troffer	1	0	8	2,220	142
82	West Campus high school	Interior	1	HALLWAY	BHallway	140	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	2x4 Prism Troffer	8	0	8	2,220	1,137
83	West Campus high school	Interior	1	OFFICE	BZ011	286	7	Light Switch	Linear Fluorescent	T8	4' 32W T8	15	2x4 Prism Troffer	5	0	8	2,220	1,066
84	West Campus high school	Interior	1	CLASSROOM	BC001	-	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	Industrial	1	0	8	1,480	284
85	West Campus high school	Interior	1	CLASSROOM	BC001	-	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	30	Industrial	2	0	8	1,480	1,421
86	West Campus high school	Interior	1	KITCHEN	BKitchen	317	25	Light Switch	Linear Fluorescent	T8	4' 32W T8	20	2x4 Prism Troffer	10	0	8	1,850	1,184
87	West Campus high school	Interior	1	KITCHEN	BKitchen	317	25	Light Switch	Linear Fluorescent	T8	4' 32W T8	120	2x4 Prism Troffer	30	0	8	1,850	7,104
88	West Campus high school	Interior	1	KITCHEN	BKitchen	317	25	Light Switch	Linear Fluorescent	T8	4' 32W T8	24	Industrial	4	0	8	1,850	1,421
89	West Campus high school	Interior	1	KITCHEN	BKitchen	317	25	Light Switch	Linear Fluorescent	T5	4' 28W T5	16	1x4 Prism Troffer	8	0	8	1,850	829
90	West Campus high school	Interior	1	KITCHEN	BKitchen	317	25	Light Switch	LED	-	-	1	Socket-hor	1	0	8	1,850	-
91	West Campus high school	Exterior	1	Building	Exterior	-	1	Timer	HID	MH	MH400	19	Pole Square Yoke-Mount	19	0	8	1,850	14,060
92	West Campus high school	Exterior	1	Building	Exterior	-	1	Timer	Incan/H/MR	Incan	I60-Globe	3	Wallpack-Horizontal	3	0	8	1,850	333
93	West Campus high school	Exterior	1	Building	Exterior	-	1	Timer	CFL	CFL - 2 Pin	CFL28	35	Wallpack-Horizontal	35	0	8	1,850	1,813
94	West Campus high school	Exterior	1	Building	Exterior	-	1	Timer	CFL	CFL - 4 Pin	CFL26	2	Wallpack-Horizontal	2	0	8	1,850	96
95	West Campus high school	Exterior	1	Building	Exterior	-	1	Timer	CFL	CFL - 4 Pin	CFL32	65	Wallpack-Horizontal	65	0	8	1,850	3,848
96	West Campus high school	Exterior	1	Building	Exterior	-	1	Timer	HID	MH	MH100	1	Wallpack-Horizontal	1	0	8	1,850	185
97	West Campus high school	Exterior	1	Building	Exterior	-	1	Timer	HID	HPS	HPS150	1	Wallpack-Horizontal	1	0	8	1,850	278
98	West Campus high school	Exterior	1	Building	Exterior	-	1	Timer	HID	HPS	HPS400	4	Wallpack-Horizontal	4	0	8	1,850	2,960
99	West Campus high school	Exterior	1	Building	Exterior	-	1	Timer	HID	MH	MH70	15	Wallpack-Horizontal	15	0	8	1,850	1,943
100	West Campus high school	Exterior	1	Building	Exterior	-	1	Timer	CFL	CFL - 4 Pin	CFL26	4	Wallpack-Horizontal	4	0	8	1,850	192
101	West Campus high school	Exterior	1	Building	Exterior	-	1	Timer	HID	MH	MH100	1	Wallpack-Vertical	1	0	8	1,850	185
	Totals											3,512		699			179,006	211,213

								Fixture Details						Existing Consumption				Proposed- Post Retrofit				
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	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	West Campus high school	Interior	1	CLASSROOM	JN564	Light Switch	12	Linear Fluorescent	T8	4' 32W T8; Troffer 20"x4'	12	144	8	2,220	10,230	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	5,435	4,795
2	West Campus high school	Interior	1	OFFICE	JS64A	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	8	2,220	568	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	302	266
3	West Campus high school	Interior	1	OFFICE	JS61A	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	8	2,220	284	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	151	133
4	West Campus high school	Interior	1	CLASSROOM	JO63A	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; Industrial	5	60	8	2,220	4,262	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	2,264	1,998
5	West Campus high school	Interior	1	OFFICE	JO63B	Light Switch	1	Linear Fluorescent	T5	4' 28W T5; 1x4 Prism Troffer	2	8	8	2,220	497	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	2,220	266	231
6	West Campus high school	Interior	1	RESTROOM - PRIVATE	JTJ01	Light Switch	1	Linear Fluorescent	T5	4' 28W T5; 2x4 Prism Troffer	1	2	8	925	52	ECM	RB - Replace Bulb	Wall Mounted	4' 15W LED T5	925	28	24
7	West Campus high school	Interior	1	GYMNASIUM	CU001	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Industrial	2	138	8	2,220	9,804	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	5,208	4,595
8	West Campus high school	Interior	1	JANITORIAL	JJJ01	Light Switch	1	Linear Fluorescent	T5	4' 28W T5; 2x4 Prism Troffer	1	2	8	703	39	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	703	21	18
9	West Campus high school	Interior	1	GYMNASIUM	CU001	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Industrial	2	120	8	2,220	8,525	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	4,529	3,996
10	West Campus high school	Interior	1	GYMNASIUM	CU001	Wall-Mounted Sensor	4	LED	-		5	10	8	2,220		ECM	RB - Replace Bulb	Ceiling Mounted				
11	West Campus high school	Interior	1	HALLWAY	CH00U	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	3	6	8	2,220	426	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	226	200
12	West Campus high school	Interior	1	GYMNASIUM	CU001	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	10	20	8	2,220	1,421	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	755	666
13	West Campus high school	Interior	1	RESTROOM	JTJ02	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	7	14	8	2,220	995	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	528	466
14	West Campus high school	Interior	1	RESTROOM	JTJ02	Light Switch	1	Linear Fluorescent	T5	4' 28W T5; 2x4 Prism Troffer	11	22	8	2,220	1,368	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	2,220	733	635
15	West Campus high school	Interior	1	OFFICE	JS0J1	Light Switch	2	Linear Fluorescent	T5	4' 28W T5; 2x4 Prism Troffer	4	8	8	2,220	497	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	2,220	266	231
16	West Campus high school	Interior	1	RESTROOM	SRestroom	Wall-Mounted Sensor	12	Linear Fluorescent	T8	4' 32W T8; Surface Mount w Lense	20	20	8	2,220	1,421	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	755	666
17	West Campus high school	Exterior	1	CLASSROOM	Science Building	Timer	1	LED	-		11	132	8	2,220				Retain Existing Controls				
18	West Campus high school	Exterior	1	CLASSROOM	Science Building	Timer	1	Linear Fluorescent	T8	18" 15W T8; Surface Mount w Lense	6	12	8	2,220	400	ECM	RB - Replace Bulb	Retain Existing Controls	2' 8W LED T8	2,220	213	186
19	West Campus high school	Interior	1	CLASSROOM	S75	Wall-Mounted Sensor	2	Linear Fluorescent	T8	4' 32W T8; Strip Fixture	4	12	8	2,220	852	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	453	400
20	West Campus high school	Interior	1	CLASSROOM	S75	Wall-Mounted Sensor	2	Linear Fluorescent	T8	4' 32W T8; Strip Fixture	2	4	8	2,220	284	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	151	133
21	West Campus high school	Interior	1	CLASSROOM	S74	Wall-Mounted Sensor	3	Linear Fluorescent	T8	4' 32W T8; Industrial	12	144	8	2,220	10,230	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	5,435	4,795
22	West Campus high school	Interior	1	CLASSROOM	S74	Building Management System	3	LED	-		6	12	8	2,220				Retain Existing Controls				
23	West Campus high school	Interior		MECHANICAL	S72	Wall-Mounted Sensor	2	Linear Fluorescent	T8	4' 32W T8; Surface Mount w Lense	2	2	8	1,554	99	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,554	53	47
24	West Campus high school	Exterior	1	CLASSROOM	Science Building	Timer	1	LED	-		8	8	8	1,480				Retain Existing Controls				
25	West Campus high school	Interior		MECHANICAL	SCUST78	Wall-Mounted Sensor	1	Linear Fluorescent	T8	4' 32W T8; Surface Mount w Lense	1	1	8	1,554	50	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,554	26	23
26	West Campus high school	Interior	1	MECHANICAL	SFireControl	Wall-Mounted Sensor	1	Linear Fluorescent	T8	4' 32W T8; Surface Mount w Lense	1	1	8	1,554	50	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,554	26	23
27	West Campus high school	Exterior	1	MECHANICAL	L	Light Switch	1	Linear Fluorescent	T5	2' 24W T5; 2x4 Prism Troffer	1	2	8	1,554	75	ECM	RB - Replace Bulb	Retain Existing Controls	2' 8W LED T5	1,554	25	50
28	West Campus high school	Interior	2	MECHANICAL	KB002	Light Switch	1	Linear Fluorescent	T5	2' 24W T5; 2x4 Prism Troffer	4	8	8	1,554	298	ECM	RB - Replace Bulb	Ceiling Mounted	2' 8W LED T5	1,554	99	199
29	West Campus high school	Interior	1	CLASSROOM	CO009	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Industrial	3	90	8	1,480	4,262	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,480	2,264	1,998
30	West Campus high school	Interior	1	GYMNASIUM	LHG01	Light Switch	14	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	9	18	8	2,220	1,279	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	679	599
31	West Campus high school	Interior	1	GYMNASIUM	LHG01	Light Switch	14	Linear Fluorescent	T8	4' 32W T8; Industrial	52	208	8	2,220	14,776	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	7,850	6,926
32	West Campus high school	Interior	1	GYMNASIUM	LHG01	Light Switch	14	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	12	24	8	2,220	1,705	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	906	799
33	West Campus high school	Interior	1	GYMNASIUM	LHG01	Light Switch	14	Linear Fluorescent	T8	4' 32W T8; Industrial	23	92	8	2,220	6,536	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	3,472	3,064
34	West Campus high school	Interior	1	GYMNASIUM	LHG01	Light Switch	14	Linear Fluorescent	T8	4' 32W T8; Troffer 2'x4'	25	50	8	2,220	3,552	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	1,887	1,665
35	West Campus high school	Interior	1	GYMNASIUM	LHG01	Timer	14	LED	-		2	4	8	2,220				Wall Mounted				
36	West Campus high school	Interior	1	GYMNASIUM	LHG01	Light Switch	14	Linear Fluorescent	T5	4' 28W T5; 2x4 Prism Troffer	2	4	8	2,220	249	ECM	RB - Replace Bulb	Wall Mounted	4' 15W LED T5	2,220	133	115
37	West Campus high school	Interior	1	GYMNASIUM	LHG01	Light Switch	14	Linear Fluorescent	T8	4' 32W T8; Strip Fixture	2	2	8	2,220	142	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	75	67
38	West Campus high school	Exterior	2	CLASSROOM	JH66D	Light Switch	2	Incan/H/MR	Incan	I60-Globe; Bollard	3	9	8	1,480	799	ECM	RB - Replace Bulb	Wall Mounted	11W LED A19	1,480	147	653
39	West Campus high school	Interior	2	CLASSROOM	JH66D	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	15	60	8	1,480	2,842	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	1,510	1,332
40	West Campus high school	Interior	1	CLASSROOM	NJ61	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; Industrial	4	48	8	1,480	2,273	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	1,208	1,066
41	West Campus high school	Interior	1	CLASSROOM	JO62A	Light Switch	7	Linear Fluorescent	T8	4' 32W T8; Industrial	5	60	8	1,480	2,842	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	1,510	1,332
42	West Campus high school	Interior	1	CLASSROOM	JO62A	Light Switch	7	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	8	1,480	379	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	201	178
43	West Campus high school	Interior	1	CLASSROOM	JN564	Light Switch	12	Linear Fluorescent	T5	4' 28W T5; 2x4 Prism Troffer	8	16	8	1,480	663	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	1,480	355	308
44	West Campus high school	Interior	1	CLASSROOM	HO059	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Industrial	3	48	8	1,480	2,273	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,480	1,208	1,066
45	West Campus high school	Interior	1	CLASSROOM	HO059	Light Switch	4	Linear Fluorescent	T5	4' 28W T5; 2x4 Indirect Troffer	1	2	8	1,480	83	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	1,480	44	38
46	West Campus high school	Interior	1	CLASSROOM	HO056	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; Industrial	3	48	8	1,480	2,273	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	1,208	1,066
47	West Campus high school	Interior	1	CLASSROOM	HO056	Light Switch	3	Linear Fluorescent	T5	4' 28W T5; 2x4 Prism Troffer	1	2	8	1,480	83	ECM	RB - Replace Bulb	Wall Mounted	4' 15W LED T5	1,480	44	38
48	West Campus high school	Interior	1	CLASSROOM	HO54	Light Switch	5	Linear Fluorescent	T8	4' 32W T8; Industrial	3	48	8	1,480	2,273	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	1,208	1,066
49	West Campus high school	Interior	1	CLASSROOM	HO54	Light Switch	5	Linear Fluorescent	T8	4' 32W T8; 2x2 Parabolic Troffer	4	16	8	1,480	758	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	403	355
50	West Campus high school	Interior	1	CLASSROOM	HO54	Light Switch	5	Linear Fluorescent	T5	4' 28W T5; 2x4 Prism Troffer	4	16	8	1,480	663	ECM	RB - Replace Bulb	Wall Mounted	4' 15W LED T5	1,480	355	308
51	West Campus high school	Interior	1	CLASSROOM	HO52	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; Industrial	3	48	8	1,480	2,273	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	1,208	1,066
52	West Campus high school	Interior	1	STORAGE	HS00J	Light Switch	1	Linear Fluorescent	T5	4' 28W T5; 2x4 Prism Troffer	1	1	8	703	20	ECM	RB - Replace Bulb	Wall Mounted	4' 15W LED T5	703	11	9
53	West Campus high school	Interior	1	RESTROOM	SRestroom	Light Switch	12	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	8	2,220	568	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	302	266
54	West Campus high school	Interior	1	STORAGE	GJ00G	Light Switch	1	Linear Fluorescent	T5	4' 28W T5; 2x4 Prism Troffer	1	2	8	703	39	ECM	RB - Replace Bulb	Wall Mounted	4' 15W LED T5	703	21	18
55	West Campus high school	Interior	1	CLASSROOM	GO043	Wall-Mounted Sensor	20	Linear Fluorescent	T8	4' 32W T8; Industrial	15	180	8	1,480	8,525	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,480	4,529	3,996
56	West Campus high school	Interior	1	CLASSROOM	GO42	Light Switch	9	Linear Fluorescent	T8	4' 32W T8; Industrial	9	108	8	1,480	5,115	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	2,717	2,398
57	West Campus high school	Interior	1	LIBRARY	FX038	Light Switch	6	Linear Fluorescent	T8	4' 32W T8; Industrial	3	84	8	2,220	5,967	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	3,170	2,797
58	West Campus high school	Interior	1	LIBRARY	FX038	Light Switch	6	Linear Fluorescent	T5	4' 28W T5; 2x4 Prism Troffer	10	20	8	2,220	1,243	ECM	RB - Replace Bulb	Retain Existing Controls	4' 15W LED T5	2,220	666	577
59	West Campus high school	Interior	1	LIBRARY	FX038	Light Switch	6	Linear Fluorescent	T8	4' 32W T8; 2x2 Prism Troffer	2	8	8	2,220	568	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	302	266
60	West Campus high school	Interior	1	STORAGE	FS032	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	2	8	703	45	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	24	21
61	West Campus high school	Interior	1	CLASSROOM	FO031	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; Industrial	3	36	8	1,480	1,705	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	906	799
62	West Campus high school	Interior	1	CLASSROOM	EO026	Light Switch	12	Linear Fluorescent	T8	4' 32W T8; Industrial	12	120	8	1,480	5,683	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	3,019	2,664
63	West Campus high school	Interior	1	CIASSROOM	EO023	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Industrial	3	36	8	1,480	1,705	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	906	799
64	West Campus high school	Interior	1	CIASSROOM	EO023	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	8	1,480	379	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	201	178
65	West Campus high school	Interior	1	CLASSROOM	EO021	Wall-Mounted Sensor	32	Linear Fluorescent	T8	4' 32W T8; Industrial	24	240	8	1,480	11,366	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,480	6,038	5,328
66	West Campus high school	Interior	1	CLASSROOM	PO1	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Troffer 2'x4'	12	48	8	1,480	2,273	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,480	1,208	1,066
67	West Campus high school	Interior	1	CLASSROOM	AO01	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; Industrial	3	81	8	1,480	3,836	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	2,038	1,798
68	West Campus high school	Interior	1	CLASSROOM	AO01	Light Switch	3	Incan/H/MR	Incan	I60-Globe; Ceiling Fan Light Combo	1	1	8	1,480	89	ECM	RB - Replace Bulb	Wall Mounted	11W LED A19	1,480	16	73
69	West Campus high school	Interior	1	CLASSROOM	AO02	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; Industrial	3	72	8	1,480	3,410	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	1,812	1,598
70	West Campus high school	Interior	1	CLASSROOM	AO03	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Industrial	3	72	8	1,480	3,410	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	1,812	1,598
71	West Campus high school	Interior	1	CLASSROOM	AO03	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	8	1,480	379	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	201	178
72	West Campus high school	Interior	1	STORAGE	ES003	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; Strip Fixture	2	2	8	703	45	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	24	21
73	West Campus high school	Interior	1	OPEN OFFICE	BC019	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Industrial	3	63	8	2,220	4,476	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	2,378	2,098
74	West Campus high school	Interior	1	OPEN OFFICE	BC019	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Industrial	2	18	8	2,220	1,279	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	679	599
75	West Campus high school	Interior	1	MECHANICAL	BS013	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	8	1,554	199	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,554	106	93
76	West Campus high school	Interior	1	MECHANICAL	BS014	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	1	8	1,554	50	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,554	26	23
77	West Campus high school	Interior	1	RESTROOM - PRIVATE	BT012	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	2	8	925	59	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	925	31	28
78	West Campus high school	Interior	1	STORAGE	BC008	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	8	703	180	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	96	84
79	West Campus high school	Interior	1	OFFICE	BZ011	Light Switch	7	Linear Fluorescent	T8	4' 32W T8; Troffer 2'x4'	4	16	8	2,220	1,137	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	604	533
80	West Campus high school	Interior	1	OFFICE	BC015	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Industrial	2	18	8	2,220	1,279	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	679	599
81	West Campus high school	Interior	1	OFFICE	BC015	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	2	8	2,220	142	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	75	67
82	West Campus high school	Interior	1	HALLWAY	BHallway	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	8	16	8	2,220	1,137	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	604	533
83	West Campus high school	Interior	1	OFFICE	BZ011	Light Switch	7	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	5	15	8	2,220	1,066	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	566	500
84	West Campus high school	Interior	1	CLASSROOM	BC001	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Industrial	1	6	8	1,480	284	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	151	133
85	West Campus high school	Interior	1	CLASSROOM	BC001	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Industrial	2	30	8	1,480	1,421	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	755	666
86	West Campus high school	Interior	1	KITCHEN	BKitchen	Light Switch	25	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	10	20	8	1,850	1,184	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,850	629	555
87	West Campus high school	Interior	1	KITCHEN	BKitchen	Light Switch	25	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	30	120	8	1,850	7,104	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,850	3,774	3,330
88	West Campus high school	Interior	1	KITCHEN	BKitchen	Light Switch	25	Linear Fluorescent	T8	4' 32W T8; Industrial	4	24	8	1,850	1,421	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,850	755	666
89	West Campus high school	Interior	1	KITCHEN	BKitchen	Light Switch	25	Linear Fluorescent	T5	4' 28W T5; 1x4 Prism Troffer	8	16	8	1,850	829	ECM	RB - Replace Bulb	Wall Mounted	4' 15W LED T5	1,850	444	385
90	West Campus high school	Interior	1	KITCHEN	BKitchen	Light Switch	25	LED	-		1	1	8	1,850				Wall Mounted				
91	West Campus high school	Exterior	1	Building	Exterior	Timer	1	HID	MH	MH400; Pole Square Yoke-Mount	19	19	8	1,850	14,060	ECM	RF - Replace Entire Fixture	Retain Existing Controls	200W LED Post	1,850	7,030	7,030
92	West Campus high school	Exterior	1	Building	Exterior	Timer	1	Incan/H/MR	Incan	I60-Globe; Wallpack-Horizontal	3	3	8	1,850	333	ECM	RF - Replace Entire Fixture	Retain Existing Controls	11W LED A19	1,850	61	272
93	West Campus high school	Exterior	1	Building	Exterior	Timer	1	CFL	CFL - 2 Pin	CFL28; Wallpack-Horizontal	35	35	8	1,850	1,813			Retain Existing Controls				
94	West Campus high school	Exterior	1	Building	Exterior	Timer	1	CFL	CFL - 4 Pin	CFL26; Wallpack-Horizontal	2	2	8	1,850	96			Retain Existing Controls				
95	West Campus high school	Exterior	1	Building	Exterior	Timer	1	CFL	CFL - 4 Pin	CFL32; Wallpack-Horizontal	65	65	8	1,850	3,848			Retain Existing Controls				
96	West Campus high school	Exterior	1	Building	Exterior	Timer	1	HID	MH	MH100; Wallpack-Horizontal	1	1	8	1,850	185	ECM	RF - Replace Entire Fixture	Retain Existing Controls	37W LED Wall Pack	1,850	68	117
97	West Campus high school	Exterior	1	Building	Exterior	Timer	1	HID	HPS	HPS150; Wallpack-Horizontal	1	1	8	1,850	278	ECM	RF - Replace Entire Fixture	Retain Existing Controls	30W LED Wall Pack	1,850	56	222
98	West Campus high school	Exterior	1	Building	Exterior	Timer	1	HID	HPS	HPS400; Wallpack-Horizontal	4	4	8	1,850	2,960	ECM	RF - Replace Entire Fixture	Retain Existing Controls	70W LED Wallpack	1,850	518	2,442
99	West Campus high school	Exterior	1	Building	Exterior	Timer	1	HID	MH	MH70; Wallpack-Horizontal	15	15	8	1,850	1,943	ECM	RF - Replace Entire Fixture	Retain Existing Controls	20W LED Wall Pack	1,850	555	1,388
100	West Campus high school	Exterior	1	Building	Exterior	Timer	1	CFL	CFL - 4 Pin	CFL26; Wallpack-Horizontal	4	4	8	1,850	192			Retain Existing Controls				

101	West Campus high school	Exterior	1	Building	Exterior	Timer	1	HID	MH	MH100; Wallpack-Vertical	1	1	8	1,850	185	ECM	RF - Replace Entire Fixture	Retain Existing Controls	37W LED Wall Pack	1,850	68	117
	Totals											3,512									106,454	98,809

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	Add Reflective Coating To Exterior Windows
EAE1	Location: 00J Classrooms, 00B Admin, 00F Classrooms (windows without blinds/curtains)

ENTER EXISTING CONDITIONS

Total Sq.Ft window area:	1,848	sq.ft	Select The Existing Window Type:	Metal Frame & Single Glazing	(Select)
Approximate number of windows:	154		Existing U-value of window: (1/R)	1.31	Btu/ ft².°F·h
ASHRAE Climatic Zone	Zone-3		New U-value with Double pane Low E window: (1/R)	0.45	Btu/ ft².°F·h
Select Type of Heating Fuel	Natural Gas	(Select)	Is the Property Cooled ?	Yes	(Select)

WINTER			SUMMER		
Net heating plant & distribution system efficiency:	79.00	%	Cooling Plant Efficiency (EER):	7.00	EER
Annual Heating Degree Days (HDD):	2,963		Annual Cooling Degree Days (CDD):	1,407	
Heat loss through Existing Window/ Yr :	172,154	kBtu/Yr	Energy Loss Through Existing Single Pane Window/Yr	81,748	kBtu/Yr
Estimated Heat Loss With New Windows:	59,137	kBtu/Yr	Estimated Energy Loss With New Windows:	28,081	kBtu/Yr
Annual Heat Loss Reduction:	113,017	kBtu/Yr	Annual Energy Loss Reduction:	53,667	kBtu/Yr
Estimated Total Annual Input Heating Energy Savings	1,431	Therms	Annual Cooling Fuel Savings During Summer Season	7,667	Kwh

ENERGY & COST ANALYSIS

Insert Cost of Heating Fuel:	$1.23	$/Therm	Annual Heating Cost Savings:	$1,755.65	$
Insert Cost of Cooling Fuel:	$0.15	$/kWh	Annual Cooling Cost Savings:	$1,184.36	$
Estimated Annual O&M Savings	$147	$	Total Annual Cost Savings From Heating & Cooling:	$2,940	$
Total Annual cost savings:	**$3,087**	**$**			
Cost of window upgrade:	$26,203		Cost For Up-grading Windows	$17,556	
			Total project cost:	$17,556	
Simple payback:	8.49	**years**	*Type of Recommendation*	Capital Cost ECM Recommendation	

ECM DESCRIPTION:

When the existing windows are not justified for complete replacement retrofit due to financial, functional, historical building restrictions or aesthetic reasons, higher performance low-emissivity (low-E) and reflective coating films can improve the performance of the windows for a lower cost and reduce the desired heating or cooling load. Low-emissivity (Low-E) coatings on glazing or glass control the heat transfer through a double paned or higher glazing window. A Low-E coating is a microscopically thin, virtually invisible, metallic oxide layer deposited directly on one or more panes of glass. Different types of Low-E coatings have been designed to allow for high solar gain, moderate solar gain, or low solar gain. A high solar gain coating is applied to reduce heat conduction and intended for cold climates. To keep the heat inside, the Low-E coating should be applied to the inside pane of glass. A low solar gain coating is used for hot climates and designed to reduce solar heat gain by blocking admission of the infrared portion of the sunlight spectrum. To keep the sun's heat out, the Low-E coating should be applied to the outside pane of glass. Tinted and reflective films can also be used on single paned and multi-paned windows to reduce solar heat gain to reduce the cooling load for hotter climates.

Summary:

Initial Investment:	$26,203	Simple Payback Period:	8.49 Yrs
Annual Energy Cost Savings:	$3,087		

UIC	Control External Air Leakage In Commercial Buildings
EAE4A	Location: All Buildings Except P01 and Science Wing

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):	3,476
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.60	Cubic Feet/Min (CFM 2):	2,085
Estimated Space Volume Under Consideration	208,544.00 Cu.Ft		

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas (Select)		Is The Building Cooled?	Yes	
Estimated Annual Heating Plant Efficiency	79.00	%	Estimated Annual Cooling Plant Efficiency	7.00	EER
Annual Heating Degree Days(HDD):	2,963		Annual Cooling Degree Days(CDD):	1,407	
Estimated Total Annual Input Heating Energy Savings	1,352	Therms	Estimated Total Annual Input Cooling Energy Savings	7,243	kWh
Cost/Unit of Heating Fuel:	$1.23	$/Therm	Cost/Unit For Electricity	$0.15	$$
Estimated Annual Heating Cost Savings	$1,659	$$	Estimated Annual Cooling Cost Savings	$1,119	$$

Cost Analysis

Install Flush Mounted, Vinyl Door Sweeps ?	Yes	Total Length of Door Sweeps to Be Installed: *(3.5' Standard Width Door)*	88 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	$139	Estimated Length of Joints To Be Re-Caulked: *(Includes Demolition and Re-Caulking)*	16746 LF
Total Estimated Annual Cost Savings	$2,917	Total Cost For Controlling Air Leakage	$70,590
Simple Pay Back Period	24.20 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: $70,590 Simple Pay Back Perio 24.20 Yrs

Annual Energy Cost Savings $2,917

UIC	Install On-Demand Ventilation on Air Handlers
EAC1	Location: 00C Cafeteria and Kitchen

ENTER EXISTING CONDITION

Estimated Facility Sq.Ft Under Consideration:	12956	Sq.ft	No. of Sensors To Be Installed (One/AHU)	1	Qty
Outside Air Intake CFM (Cubic Feet/Min):	2332.08	CFM	Estimated Savings From On-Demand Ventilation	15%	CFM

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas	(Select)	Is The Building Cooled?	Yes	(Select)
Estimated Annual Heating Plant Efficiency *(COP in Case of Heat Pumps Only Max 4.5)*	80.00	%	Estimated Annual Cooling Plant Efficiency (EER)	9.00	EER
Annual Heating Degree Days(HDD):	2,963		Annual Cooling Degree Days(CDD):	1,407	
Estimated Annual Energy Consumed For Heating Outside Air During Winter	179,106	kbtu/Yr	Estimated Annual Energy Consumed For Cooling Outside Air During Summer	85,050	kbtu/Yr
Estimated Annual Input Heating Energy Savings By Use of On-Demand Ventilation System	33,582	kbtu/Yr	Estimated Annual Input Cooling Energy Savings By Use of On-Demand Ventilation System	1,417	kbtu/Yr
Estimated Intake Annual Heating Fuel Savings:	336	Therms	Estimated Annual Intake Cooling Fuel Savings:	157	kWh
Cost/Unit of Heating Fuel:	$1.23	$/Therm	Cost/Unit For Electricity	$0.15	$$
Estimated Annual Heating Cost Savings	$412	$$	Estimated Annual Cooling Cost Savings	$24	$$

COST ANALYSIS

Estimated Annual O&M Savings	$21.82	$$	Estimated Installation Cost (Including Labor)	$1,816	$$
Total Estimated Annual Cost Savings	$458	$$	Total Estimated Installation Cost	$1,816	$$
Simple Pay Back Period	3.96	Yrs	*Type of Recommendation*	Capital Cost ECM Recommendation	

ECM DESCRIPTION:

Some buildings are ventilated at a rate in excess of the recommended values. To reduce the energy consumed by the ventilation system, the ventilation rates should be lowered, unless typically high levels of pollutants are being generated. (If human carcinogens or other harmful contaminants are suspected to be present in the occupied space, other relevant standards or guidelines, such as OSHA or NIH, must supersede the listed values.) For spaces with transient or variable occupancy, the quantity of outdoor air should be adjusted by use of dampers, multi-speed ventilation fans, or by duty cycling the system. When contaminants independent of the occupants are generated in the space, the supply of outdoor air should lead occupancy so that acceptable conditions are attained before occupants return. On the other hand, if contaminants are generated solely by the occupants, the supply of outdoor air may lag occupancy. Such control over the ventilation rate can be achieved by installing on demand ventilation system on air-handling units that senses the amount of carbon di-oxide in the return air and modulates the external air flow based on it. In case the CO_2 levels are low, which means the occupancy level in the facility is below normal, hence there doesn't exist, a need to bring in fresh air. This indirectly reduces the load on the air handling unit as it decreases the amount of energy required to condition the outside air. Conversely on detecting a high level of pollutants and carbon di-oxide residue in the return air, the sensor shall modulate to increase the intake of outside air, for compensating the impure air.

SUMMARY:

Initial Investment:	$1,816	Simple Payback (Yrs)	3.96
Energy Cost Savings:	$458		

UIC	Re-Commission The Building & Its Control Systems
EAC10	Location: Throughout

Enter the Total Area of The Facility	104,272	SqFt
Select the Type of Heating Fuel:	Natural Gas	*(Select)*
Estimated Annual Heating Fuel Consumption:	12,000	Therms
Is the Property Cooled?	Yes	*(Select)*
Estimated Annual Electrical Energy Consumed For Cooling:	166,864	kWh
Estimated Energy Savings From Re-Commissioning on Building Systems:	15%	*(Select)*
Estimated Heating Energy Saving Post Re-Commissioning:	1,800	Therms
Estimated Cooling Energy Saving Post Re-Commissioning:	25,030	kWh
Average Heating Fuel Rate Paid By The Property:	$1.23	$/Therm
Average Electrical Rate Paid By The Property:	$0.15	$/kWh
Annual Energy Cost Savings:	$6,076	$
Estimated Cost For Re-Commissioning The Facility: *(LBNL 2009 Report on Building Commissioning)*	$46,690	$
Simple Payback Period:	7.68	Yrs

Type of Recommendation — Capital Cost ECM Recommendation

ECM DESCRIPTION

The goal of commissioning of a facility is to ensure that the equipments in the facility are performing as per the desired standards or as per design standards. The role of commissioning in existing buildings is to identify the almost inevitable "drift" from where things should be and puts the things back on track. Based on the LBNL 2009 Report on Building Commissioning the average re-commissioning of existing buildings yielded atleast 16% of energy savings across the facility. This average has been developed based on over 643 buildings that were commissioned across United States in different climatic zones.

Thus EMG strongly recommends re-commissioning of all existing buildings in order to ensure that all the sensors, equipments and control systems are working as per the design conditions.

SUMMARY:

Initial Investment: $46,690 Simple Payback: 7.68 Years

Energy Cost Savings: $6,076

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

Property Type:	Commercial	Estimated No. of Operational Weeks	37
		Number of Occupied Days/Week (Max 7)	5

KITCHEN FAUCETS			BATHROOM FAUCETS		
Number of Occupants Affected By Retrofit	918		Number of Occupants Affected by Retrofit	918	
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	11		Total Number of Faucet Aerators To Be Replaced	22	
Total Number of Faucets To Be Replaced:	0		Total Number of Faucets To Be Replaced:	0	
GPM of Existing Faucet Aerators	2	GPM	GPM of Existing Faucet Aerators	2	GPM
GPM of Proposed Faucet Aerator	1.5	GPM	GPM of Proposed Faucet Aerator	0.5	GPM
Estimated Number of Uses Per Day	1		Estimated Number of Uses Per Day	1	

Annual Water Savings From Installing Low Flow Aerators: 32.61 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:	0.90	EF	Heating Fuel Tariff	$1.23	$/Therm
Hot Water Discharge Temperature at Faucet	110.00	°F	Water Tariff ($/1000 Gal)	$7.85	$/kGal
Equivalent Heating Fuel Savings: *Savings Discounted by 15% to Account For Cold Water Use*	154	Therms	Annual Cost Savings In Form of Water	$256	$
Annual Water Savings	32.61	kGal	Annual Energy Savings From Water Heater	$189	$

COST BENEFIT ANALYSIS				
Estimated Total Annual Cost Savings	$445	$$	Estimated Total Installation Cost	$503 $$
Simple Payback Period	1.13	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: $503 Estimated Annual Cost Savings: $445 Simple Payback Period (Yrs): 1.13

UIC	Replace Rooftop Package Unit
EAH12-B	Location: 00L Gym

Estimated Annual Cooling Hours:	680	Hrs	Estimated Annual Heating Hours:	140	Hrs
Units to Replace	Air Conditioning: Yes	Heating System: Yes	Existing Type of Heating Fuel:	Natural Gas	

Existing Package System

	Cooling	Heating	Total Combined Units
Number of Package Units to be Replaced:	2	2	2

Capacity of the air conditioner:	16	Tons	EER of the Existing Air Conditioner:	7.50	
Capacity of Existing Heating System:	270	MBH	Input Existing AFUE for the Furnace:	79%	
Estimated Annual Cooling Consumption: *(For All Units)*	34,816	kWh	Estimated Annual Heating Consumption : *(For All Units)*	957	Therms

Proposed Package System

Capacity of the Proposed Air Conditioner:	16	Tons	EER of the Proposed Air Conditioner:	11.00	EER
Capacity of Proposed Heating System:	Gas Fired -300MBH	MBH	AFUE of Proposed Heating System:	78%	%
Estimated Annual Energy Consumption With New Package Units					
Annual Electric Fuel Consumption:	23,738	kWh	Annual Heating Fuel Consumption:	1,077	Therms

Energy and Cost Analysis

Average Electric Rate:	$0.15	$/kWh	Average Heating Rate:	$1.23	$/Therm
Estimated Annual Electric Savings : *From All New Package Systems*	11,078	kWh	Estimated Annual Heating Savings : *From All New Package Systems*	-11,996	kBtus
Annual Electric Cost Savings: *From All New Package Systems*	$1,711		Annual Electric Cost Savings: *From All New Package Systems*	-$147	$

Proposed Type of System to be installed:	Package Heating and Cooling System		
Estimated Material and Labor Cost Including Overheads and Profits For All Units:		$42,350.00	$
Estimated Total Energy Cost Savings From New HVAC System:		$1,564	$
Estimated O&M Savings:		$78	
Estimated Simple Pay Back Period:	25.7868978 Yrs		

Capital Cost ECM Recommendation

UIC	Install Low Flow Shower Heads
EAP1	Location: Restrooms and Locker Rooms

Total Number of Shower Heads To Be Replaced		41	
No. of Shower Days/Year		37	
No. of Residents		200	
Estimated Time Per Shower		8.10	Mins
GPM of Existing Shower Head		2.5	GPM
GPM of Proposed Shower Head *	*(Select)*	1.50	GPM

**(Federal Law Requires all new shower heads to have a max flow rate of 2.5 GPM)*

Water & Energy Savings Calculations

Property Location in United States		North Central Localities	
Select Type of Water Heater Fuel	*(Select)*	Natural Gas	
Average Hot Water Discharge Temperature		110.00	°F
Annual Water Savings		60	kGal
Energy Factor of Domesitc Hot Water Heater:		0.90	EF
Equivalent Heating Fuel Energy savings:		33,287	kBtu

Cost Savings Calculations

Equivalent Heating Fuel Savings	Natural Gas	333	Therms
Water Tariff ($/1000 Gal)	$7.85	$/kGal	
Annual Cost Savings In Form of Water		$471	$$
Annual Energy Savings From Water Heater		$408	$$
Estimated Total Annual Cost Savings		$879	$$

Estimated Installation Costs

Estimated Total Installation Cost	$1,300	$$
Simple Payback Period	1.48	Years
Type of Recommendation	Capital Cost ECM Recommendation	

ECM EXPLANATION:

By reducing the flow of water coming off the shower heads, savings can be generated in the form of reduced water and sewer costs. Additional savings can be realized via reduction in the demand for hot water. Currently Federal law requires all new shower heads to have a maximum flow rate of 2.5 GPM.

EMG recommends replacing the existing shower heads with new low flow shower heads 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:	$1,300	Simple Payback:	1.48
Annual Cost Savings:	$879		

UIC	Install Low Flow Tankless Restroom Fixtures
EAP4	Location: Restrooms

ECM FOR DETERMINING WATER SAVINGS IN COMMERCIAL PROPERTIES

Number of Males	459	
Number of Females	459	
Number of Occupied Days Per Week (Max 7)	5	
Number of Occupied Weeks/Year (Max 52)	36	
Number of Urinals To Be Retrofitted	25	
Number of Water Closets To Be Retrofitted	43	
No. of Water Closets With Separate Flush Tank *(Typical Residential Type)*	0	
Estimated Restroom Usage/Individual/Day *Default is 4 Uses/Day For Residential/Office*	3	(Select)

Urinal Water Savings

Do you Want To Make Any Changes To The Urinals?	Yes	
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	173.50	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		43	
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		44.42	kGal
Estimated Annual Water Savings From Female Users		222.08	kGal
Total Water Savings From Water Closets		266.50	kGal

Water & Cost Saving Calculations

Water Savings Calculation

Water Savings By The Use of Low Flow Water Closet Flush Valves/Yr	266.50	kgal
Water Savings By The Use of Low Flow Urinal Flush Valves/ Yr	173.50	kgal
Total Annual Water Savings in kgal	440.00	kgal

Cost Savings Calculations

Enter Water Tariff Rate ($/1000Gal)	$7.85	$$
Estimated Cost Savings From Water	$3,454	$$

Estimated Cost of Retrofit

Cost For Replacing Existing Urinal Fixture With A Low Flow Fixture	$32,509 *(Includes Labor)*	$$
Cost For Replacing Existing Flush Valves With Low Flow - Dual Flush Valves ($80 Per Unit) *(Up For Liquid Waste And Down For Solid Waste)*	$26,619 *(Includes Labor)*	$$
Estimated Total Cost For Retrofit	$59,128	$$
Simple Pay Back Period	17.12	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:	$59,128	Simple Payback Period:	17.12 Yrs
Annual Cost Savings:	$3,454		

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	91	565	3,249	98,809	$15,266.00	$5,338.48

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	3	7	7	997	$154	$297
Incan/H/MR	MR	0	0	0	0	$0	$0
HID	HPS	2	5	5	2,664	$412	$79
HID	MH	4	36	36	8,651	$1,337	$572
HID	MV	0	0	0	0	$0	$0
HID	QL	0	0	0	0	$0	$0
Linear Fluorescent	T8	66	452	452	83,312	$12,872	$3,631
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	16	60	60	3,185	$492	$759
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	65
Wall Mounted	343		

Initial Investment			**Equipment Rentals**	
Material Cost	$47,599.50		Scissor Lift 26' - Interior Spaces	$0.00
Labor Cost	$69,618.72		Bucket Truck - Exterior Spaces	$0.00
Local Electric Rate:	$0.15	$/kWh	Estimated Annual Energy Savings:	98,809
Hourly Labor Rate For Electrician:	$82.45		Estimated Annual Energy Cost Savings:	$15,266
Budgeted Initial Investment:	$117,218		Estimated Annual O&M Cost Savings:	$5,338
Estimated Return on Investment: *(Including O&M Savings)*	5.69	Years	Estimated Annual Cost Savings:	$20,604

APPENDIX F:
Solar PV

UIC	Install Fixed Tilt Solar Photovoltaic System
EAR-2	Details: West Campus High School

Select State: Northern California **Electric Rate:** $0.15 $/KWH Annual Electric Consumption: 838,511 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	53.50	54	170	82,482	82,482	$12,743	$187,250	14.7	$0	$56,175	$1,815	$0	8.9
2	Building 2	1	32	32	102	49,489	49,489	$7,646	$112,350	14.7	$0	$33,705	$1,089	$0	8.9
3	Building 3	1	36	36	115	55,964	55,964	$8,646	$127,050	14.7	$0	$38,115	$1,231	$0	8.9
4	Building 4	1	38	38	120	58,277	58,277	$9,004	$132,300	14.7	$0	$39,690	$1,282	$0	8.9
5	Building 5	1	43	43	138	66,910	66,910	$10,338	$151,900	14.7	$0	$45,570	$1,472	$0	8.9
6	Building 6	1	44	44	139	67,681	67,681	$10,457	$153,650	14.7	$0	$46,095	$1,489	$0	8.9
7	Building 7	1	32	32	103	49,797	49,797	$7,694	$113,050	14.7	$0	$33,915	$1,096	$0	8.9
8	Building 8	1	18	18	56	27,288	27,288	$4,216	$61,950	14.7	$0	$18,585	$600	$0	8.9
9	Building 9	1	51	51	160	77,857	77,857	$12,029	$176,750	14.7	$0	$53,025	$1,713	$0	8.9
		9		**348**	**1,103**	**535,745.0**	**535,745**	**$82,773**	**$1,216,250**	**14.69**	**$0**	**$364,875**	**$11,786**	**$0**	**8.86**

Solar Rooftop Photovoltaic Analysis		
Total Number of Roofs	9	
Estimated Number of Panels	1,103	
Estimated KW Rating	348	KW
Potential Annual KWh Produced	535,745	KWh
% of Current Electricity Load	63.9%	

Financial Analysis		
Investment Cost	$1,216,250	
Estimated Energy Cost Savings	$82,773	
Potential Rebates	$364,875	
Potential Annual Incentives	$11,786	
Payback without Incentives	14.7	years
Incentive Payback but without SRECS	8.9	years
Payback with All Incentives	8.9	years