Measurement & Verification Load Impact Study for NCPA SB5X Commercial and Industrial Lighting Programs

Study ID: NCP0001.02

FINAL REPORT

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1. Executive Summary

This study was conducted at the request of Northern California Power Agency (NCPA) and the California Energy Commission (CEC). The study was managed by NCPA. It was funded by Senate Bill 5X (SB5X) and is available online at www.calmac.org. This report provides Measurement and Verification (M&V) load impact results for the NCPA SB5X Commercial and Industrial (C&I) Lighting Programs implemented by Alameda, Gridley, Healdsburg, Lassen Municipal Utility District (LMUD), Lodi, Lompoc, Modesto Irrigation District (MID), Palo Alto, Roseville, Santa Clara (Silicon Valley Power), and Truckee Donner Public Utility District (TDPUD). The programs realized peak kW and kWh savings by paying incentives for the installation of high efficiency lighting systems, lamp removal (i.e., delamping), or controls. The lighting measures have an effective useful life of 16 years.[1] Approximately 626 projects and 125,966 lighting fixtures were installed from 2001 through 2003 by programs sponsored by 11 utilities with $2,100,482 of SB5X funds administered by NCPA.

The M&V results are summarized in **Table 1.1**. The total ex ante savings are 21,023,999 kWh/yr and 4,944 kW. The total M&V gross ex post program savings are 24,067,909 kWh/yr ± 255,650 kWh/yr and 5,203 kW ± 54 kW at the 90 percent confidence level. The total M&V net ex post program savings are 20,301,517 kWh/yr ± 213,512 kWh/yr and 4,414 kW ± 46 kW at the 90 percent confidence level. The total net ex post lifecycle savings are 324,824,278 ± 3,416,193 kWh based on a 16-year effective useful life. The net realization rates are 0.97 for kWh and 0.89 for kW savings.

Table 1.1 Summary of M&V Results for NCPA SB5X C&I Lighting

NCPA Utility	Measures	Ex Ante Savings kWh/yr	Ex Ante Savings kW	M&V Gross Ex Post Savings kWh/yr	M&V Gross Ex Post Savings kW	Net-to-Gross Ratio	M&V Net Ex Post Savings MWh/yr	M&V Net Ex Post Savings kW	Net Realization Rate Relative to Planning kWh/yr	Net Realization Rate Relative to Planning kW
Alameda	6,091	1,127,255	368.00	1,123,456	337.27	0.85	954,938	286.68	0.85	0.78
Gridley	74	38,468	16.99	37,940	16.74	0.84	31,870	14.06	0.83	0.83
Healdsburg	110	20,434	4.90	20,365	4.49	0.85	17,310	3.81	0.85	0.78
LMUD	994	183,964	80.44	183,344	73.72	0.85	155,842	62.67	0.85	0.78
Lodi	24	4,500	1.01	4,485	0.92	0.85	3,812	0.78	0.85	0.78
Lompoc	50	15,768	1.81	15,768	1.81	1.00	15,768	1.81	1.00	1.00
MID	11,230	847,226	207.20	844,371	189.89	0.84	709,272	159.51	0.84	0.77
Palo Alto	8,822	1,128,674	285.71	1,031,308	258.72	0.98	1,010,682	253.55	0.90	0.89
Roseville	6,718	1,651,041	384.96	1,294,766	423.13	0.88	1,139,394	372.36	0.69	0.97
SVP	87,913	15,612,124	3,436.29	19,089,720	3,742.14	0.83	15,844,468	3,105.98	1.01	0.90
TDPUD	3,940	394,545	156.40	422,386	154.40	0.99	418,162	152.86	1.06	0.98
Total	125,966	21,023,999	4,943.70	24,067,909	5,203.25	0.85	20,301,517	4,414.07	0.97	0.89

Note: Net-to-gross ratios for Alameda, Healdsburg, LMUD, and Lodi are weighted average values for all surveys.

The M&V savings are based on detailed on-site engineering analyses for a random sample of 44 sites where complete audits were performed. The on-site audits included verification of all installed measures that received incentives as well as true RMS power measurements of pre- and post-installation fixtures and light logger measurements or interviews to obtain hours of

[1] The SB5X lighting programs provided incentives for hard-wired fixtures with a 16 year lifetime. See *Energy Efficiency Policy Manual*, Chapter 4, page 21-22, prepared by the California Public Utilities Commission, 2001.

operation. The net-to-gross ratios are calculated based on decision maker surveys completed for 75 participants. The weighted average net-to-gross ratio is 85 percent indicating 15 percent of participants would have installed efficient lighting without the program.

Section 2 presents the detailed M&V analyses for the random sample of 44 sites. **Section 3** presents participant survey results and the methodology used to develop net-to-gross ratios. **Section 4** presents the M&V methodology used for the sample design, statistical analysis, database, baseline, and program evaluation savings estimates. **Appendix A** provides the Commercial and Industrial Lighting Decision-Maker Survey. **Appendices B-1** through **G-10** provide M&V reports for the 44 on-site audits in Gridley, Lompoc, Palo Alto, Roseville, Santa Clara, and Truckee Donner PUD.

2. M&V Approach and Results for C&I Lighting

The measurement and verification analysis for the study is based on the *International Performance Measurement & Verification Protocols* (IPMVP) defined **Table 2.1**.[2]

Table 2.1 IPMVP M&V Options

M&V Option	How Savings Are Calculated	Typical Applications
Option A. Partially Measured Retrofit Isolation Savings are determined by partial field measurement of energy use of system(s) to which a measure was applied, separate from facility energy use. Measurements may be either short-term or continuous. Partial measurement means that some but not all parameters may be stipulated, if total impact of possible stipulation errors is not significant to resultant savings. Careful review of measure design and installation will ensure that stipulated values fairly represent the probable actual value.	Engineering calculations using short term or continuous post-retrofit measurements or stipulations.	Pre- and post-retrofit values are measured with a kW meter and operating hours are based on interviews with occupants or stipulated values.
Option B. Retrofit Isolation Savings are determined by field measurement of the energy use of the systems to which the measure was applied, separate from the energy use of the rest of the facility. Short-term or continuous measurements are taken throughout the post-retrofit period.	Engineering calculations using short term or continuous measurements	Lighting system electricity use is measured with a kW meter. Hours of operation are measured with light loggers.
Option C. Whole Facility Savings are determined by measuring energy use (and production) at the whole facility level. Short-term or continuous measurements are taken throughout the post-retrofit period. Continuous measurements are based on whole-facility billing data.	Analysis of whole facility utility meter or sub-meter data using techniques from simple comparison to regression analysis or conditional demand analysis.	Energy management program affecting many systems in a building. Utility meters measure energy use for 12-month base year and throughout post-retrofit period.
Option D. Calibrated Simulation Savings are determined through simulation of the energy use of components or the whole facility. Simulation routines must be demonstrated to adequately model actual energy performance measured in the facility. This option usually requires considerable skill in calibrated simulation.	Energy use simulation, calibrated with hourly or monthly utility billing data and/or end-use metering.	Project affecting many systems in a building but where base year data are unavailable. Utility meters measure post-retrofit energy use. Base year energy use is determined by simulation using a model calibrated with post-retrofit utility data.

[2] See *International Performance Measurement & Verification Protocols*, DOE/GO-102000-1132, October 2000.

The M&V approach for the load impact evaluation involved performing on-site measurement and verification activities for a statistically significant random sample of participating customers. The ex post energy and peak demand savings were determined using IPMVP Option A (i.e., partially measured retrofit isolation) and IPMVP Option B (i.e., retrofit isolation).

2.1 M&V Methodology

The following M&V methodology was used at each site.

1. Randomly select M&V sites from the utility program tracking database.
2. Review rebate applications for selected sites to determine M&V plan for each site.
3. Perform site visits. For some sites pre- and post-retrofit site inspections were performed. Many sites were inspected with the lighting retrofit contractor to ensure a thorough understanding of the lighting retrofit project.
   - Verify pre-retrofit equipment power and hours of operation to develop the M&V baseline of energy and peak demand (i.e., kWh/yr and kW).
   - Verify post-retrofit equipment including proper installation of all lamps, ballasts, fixtures, and controls that received rebates including make, model, fixture counts, and power use.
   - Collect data for representative lighting fixtures using true RMS digital power meters, data loggers, light loggers, interviews, and telephone surveys (i.e., decision maker survey). Groups of like fixtures were measured at the light switch or electrical panel to determine true RMS wattage per fixture. Measured values were compared to reference values to ensure accurate engineering analysis of energy and peak demand savings.
4. Perform decision maker surveys to evaluate net-to-gross ratios at the site or via telephone.
5. Perform the M&V engineering analyses for each site based on information collected during the on-site surveys in order to evaluate energy and peak demand savings for each site consistent with IPMVP Option A (i.e., partially measured retrofit isolation) and IPMVP Option B (i.e., retrofit isolation).

M&V site work was performed at customer sites from September 2001 through December 2002 in the following utility areas: Gridley, Lompoc, Palo Alto, Roseville, Santa Clara, and TDPUD.

2.2 M&V Algorithms for Estimating kW and kWh Savings

M&V algorithms for estimating kW and kWh savings for each site in the random sample are based on the verified quantity of installed measures, pre- and post-installation fixture wattages and hours of operation (obtained from light loggers or maintenance personnel). Savings for each M&V site are summed and compared to the ex ante savings to develop M&V Average Gross Realization Rates (AGRR) for kW and kWh savings. The AGRR is combined with the Net-to-Gross Ratio (NTGR) to develop the Net Realization Rate (NRR) relative to planning (shown in **Table 1.1**). The methodology and equations used to calculate Net-To-Gross Ratios (NTGR) are discussed in **Section 3**. Equations used to calculate sample sizes and confidence intervals are discussed in **Section 4**.

The M&V kW and kWh savings for each site are calculated using **Equations 1** and **2**.

Eq. 1 $$\text{kW Savings}_k = \sum_{k=1}^{n} \text{Quantity} \times \left[\text{kW}_{pre} - \text{kW}_{post}\right]$$

Where,

kW Savings_k = kW savings for site "k" in the random sample.
Quantity = Quantity of fixtures.
kW_{pre} = Pre-installation kW use per fixture.
kW_{post} = Post-installation kW use per fixture.

Eq. 2 $$\text{kWh Savings}_k = \sum_{j=1}^{m} \text{Quantity} \times \left[\text{kW}_{pre} - \text{kW}_{post}\right] \times \text{hours/year}$$

Where,

kWh Savings_k = kWh savings for site "k" in the random sample.
hours/year = Hours of operation per year per fixture.

Savings for the M&V sites were summed and compared to ex ante savings to develop Average Gross Realization Rates (AGRR) for kW and kWh savings. The AGRR for kW and kWh savings were calculated using **Equation 3**.

Eq. 3 $$\text{AGRR}_h = \frac{\sum_{k=1}^{n} \text{M \& V Sample Savings}_k}{\sum_{k=1}^{n} \text{Ex Ante Sample Savings}_k}$$

Where,

AGRR_h = Average gross realization rate for program stratum "h." Defined as the sum of M&V savings for measures or sites in the random sample divided by ex ante savings for measures or sites in the random sample (kW or kWh).

The AGRR is combined with the Net-to-Gross Ratio (NTGR) to develop the Net Realization Rate (NRR) relative to planning. The net realization rates for kW and kWh savings were calculated using **Equation 4**.

Eq. 4 $$\text{NRR}_h = \text{NTGR}_h \times \text{AGRR}_h$$

Where,

NRR_h = Net Realization Rate for kW or kWh savings in program stratum "h"
NTGR_h = Net to Gross Ratio defined as the number of units that would not have been installed without the program divided by the total number of units installed through the program (kW or kWh).

2.3 Findings of the Random M&V On-Site Audits

Findings of the random M&V on-site audits are provided in the **Tables 2.2** through **2.7** for customer sites in the Gridley, Lompoc, Palo Alto, Roseville, Santa Clara, and TDPUD utility service areas. **Appendices B-1** through **G-10** provide M&V reports for the 44 on-site audits.

Table 2.2 Findings of Random M&V On-Site Audits in Gridley

Site	Ex Ante Savings kWh/yr	Ex Ante kW	M&V Savings kWh/yr	M&V Savings kW	Gross Realization Rate kWh	Gross Realization Rate kW	Fixture Qty.	Fixture Retrofit Type	Floor Area	Lighting Retrofit Cost	Incentive	M&V Measurement
#1	28,545	12.75	28,019	12.5	0.98	0.98	42	T5-6	n/a	$28,000	$10,000	True RMS Power
#2	9,923	4.24	9,922	4.24	1.00	1.00	32	T-8	7,200	$6,138	$4,876	True RMS Power
Total	**38,468**	**16.99**	**37,940**	**16.74**	**0.99**	**0.99**	**74**		**7,200**	**$34,138**	**$14,876**	

Table 2.3 Findings of Random M&V On-Site Audits in Lompoc

Site	Ex Ante Savings kWh/yr	Ex Ante kW	M&V Savings kWh/yr	M&V Savings kW	Gross Realization Rate kWh	Gross Realization Rate kW	Fixture Qty.	Fixture Retrofit Type	Floor Area	Lighting Retrofit Cost	Incentive	M&V Measurement
#1	**3,469**	**0.4**	**3,469**	**0.4**	**1.00**	**1.00**	**11**	**LED Exit**	**12,000**	**$550**	**$195**	True RMS Power

Table 2.4 Findings of Random M&V On-Site Audits in Palo Alto

Site	Ex Ante Savings kWh/yr	Ex Ante kW	M&V Savings kWh/yr	M&V Savings kW	Gross Realization Rate kWh	Gross Realization Rate kW	Fixture Qty.	Fixture Retrofit Type	Floor Area	Lighting Retrofit Cost	Incentive	M&V Measurement
#1	308,148	55.3	262,059	42.8	0.85	0.77	1,827	T-8, CFL, LED Exit	357,800	$88,252	$45,178	True RMS Power
#2	310,463	100.6	273,882	89.3	0.88	0.89	1,954	T-8, CFL, LED Exit	212,485	$124,621	$63,794	True RMS Power
#3	26,122	9.5	43,288	17.1	1.66	1.80	350	T-8, CFL, LED Exit	30,309	$16,663	$8,530	True RMS Power
#4	36,209	9.6	20,413	6.7	0.56	0.70	311	T-8, CFL, LED Exit	15,247	$14,408	$7,375	True RMS Power
#5	54,189	16.9	43,383	14.1	0.80	0.83	580	T-8, CFL, LED Exit	22,679	$27,642	$14,150	True RMS Power
#6	74,921	22.7	62,240	19.5	0.83	0.86	800	T-8, CFL, LED Exit	30,302	$32,689	$16,733	True RMS Power
#7	31,624	8	26,580	6.9	0.84	0.87	274	T-8, CFL, LED Exit	12,284	$19,234	$9,846	True RMS Power
#8	200,732	35.2	215,949	31.7	1.08	0.90	801	T-8, CFL, LED Exit	n/a	$59,908	$30,667	True RMS Power
#9	44,750	12.3	33,507	8.1	0.66	0.75	391	T-8, CFL, LED Exit	26,313	$26,120	$13,371	True RMS Power
#10	41,515	15.7	50,007	22.5	0.66	0.75	377	T-8, CFL, LED Exit	29,869	$19,983	$10,229	True RMS Power
Total	**1,128,674**	**285.8**	**1,031,308**	**258.8**	**0.91**	**0.91**	**7,665**		**737,288**	**$429,518**	**$219,870**	

Table 2.5 Findings of Random M&V On-Site Audits in Roseville

Site	Ex Ante Savings kWh/yr	Ex Ante kW	M&V Savings kWh/yr	M&V Savings kW	Gross Realization Rate kWh	Gross Realization Rate kW	Fixture Qty.	Fixture Retrofit Type	Floor Area	Lighting Retrofit Cost	Incentive	M&V Measurement
#1	6,479	1.5	3,450	1.2	0.53	0.80	69	T-8	9,300	$1,990	$1,820	True RMS Power
#2	5,714	1.3	4,239	1.3	0.74	1.00	54	T-8	8,900	$1,708	$1,608	True RMS Power
#3	3,936	1.0	6,163	1.3	1.57	1.30	34	T-8	4,000	$1,320	$1,230	True RMS Power
#4	6,123	1.4	4,083	1.4	0.67	1.00	43	T-8	3,000	$2,580	$1,720	True RMS Power
#5	43,866	9.8	28,094	11.71	0.64	1.19	266	T-8, CFL, LED Exit, Delamp	25,000	$7,025	$5,125	True RMS Power
#6	22,106	4.7	19,293	4.7	0.87	1.00	92	T-8, CFL, LED Exit	5,700	$2,976	$1,595	True RMS Power
#7	4,922	1.1	8,272	1.1	1.68	1.00	37	T-8	3,700	$1,420	$1,335	True RMS Power
#8	4,877	1.0	2,980	1.1	0.61	1.10	44	T-8	1,500	$1,539	$1,372	True RMS Power
#9	6,098	1.4	3,794	1.6	0.62	1.14	43	T-8, Delamp, Occ. Sensors	4,500	$3,502	$1,182	True RMS Power
#10	4,416	1.1	4,748	1.3	1.08	1.18	35	T-8	3,000	$1,730	$1,380	True RMS Power
Total	**108,537**	**24.3**	**85,116**	**26.71**	**0.78**	**1.10**	**717**		**68,600**	**$25,790**	**$18,367**	

Table 2.6 Findings of Random M&V On-Site Audits in Santa Clara

Site	Ex Ante Savings kWh/yr	Ex Ante kW	M&V Savings kWh/yr	M&V Savings kW	Gross Realization Rate kWh	Gross Realization Rate kW	Fixture Qty.	Fixture Retrofit Type	Floor Area	Lighting Retrofit Cost	Incentive	M&V Measurement
#1	90,696	23.5	106,012	28.0	1.17	1.19	730	T-8, CFL, LED Exit, Delamp	47,000	$57,836	$13,293	True RMS Power
#2	81,613	19.1	199,942	51.1	2.45	2.68	629	T-8	36,022	$10,141	$9,563	True RMS Power
#3	243,338	82.8	294,776	84.7	1.21	1.02	2,266	T-8, CFL, LED Exit, Occ. Sensors	31,600	$374,525	$62,535	Lite Loggers, True RMS Power
#4	41,678	16.0	57,729	19.0	1.39	1.19	254	T-8	25,125	$6,273	$6,273	True RMS Power
#5	196,560	22.5	273,403	23.1	1.39	1.03	331	T-8, Occ. Sensors	32,000	$48,350	$6,450	Lite Loggers, True RMS Power
#6	2,187,787	342.5	2,670,777	364.0	1.22	1.06	3,345	T-8, CFL, LED Exit, Delamp, Occ. Sensors	814,000	$381,728	$130,352	Lite Loggers, True RMS Power

Table 2.6 Findings of Random M&V On-Site Audits in Santa Clara (continued)

Site	Ex Ante Savings kWh/yr	Ex Ante kW	M&V Savings kWh/yr	M&V Savings kW	Gross Realization Rate kWh	Gross Realization Rate kW	Fixture Qty.	Fixture Retrofit Type	Floor Area	Lighting Retrofit Cost	Incentive	M&V Measurement
#7	141,523	32.4	159,909	37.3	1.13	1.15	401	T-8	30,000	$31,563	$8,708	True RMS Power
#8	194,401	43.8	205,310	44.1	1.06	1.01	372	T-8, CFL, LED Exit	32,150	$28,462	$7,699	True RMS Power
#9	225,228	58.9	321,743	70.9	1.43	1.20	1,871	T-8, CFL, Delamp, LED Exit, Occ. Sensors	125,482	$112,555	$34,997	True RMS Power
#10	69,568	29.7	120,763	35.9	1.74	1.21	454	T-8	80,210	$13,472	$7,939	True RMS Power
#11	341,687	78.2	253,300	58.0	0.74	0.74	1,595	T-8, CFL, Halogen	53,000	$18,386	$18,386	True RMS Power
Total	**3,814,079**	**749.4**	**4,663,664**	**816.1**	**1.22**	**1.09**	**12,248**		**1,306,589**	**$1,083,291**	**$306,195**	

Table 2.7 Findings of Random M&V On-Site Audits in Truckee Donner PUD

Site	Ex Ante Savings kWh/yr	Ex Ante kW	M&V Savings kWh/yr	M&V Savings kW	Gross Realization Rate kWh	Gross Realization Rate kW	Fixture Qty.	Fixture Retrofit Type	Floor Area	Lighting Retrofit Cost	Incentive	M&V Measurement
#1	66,171	34	72,827	37.2	1.10	1.10	66,171	T-8, CFL, MH, LED Exit	62,745	$65,036	$21,677	True RMS Power
#2	65,319	31	64,940	30.5	0.99	0.98	65,319	T-8, CFL, Delamp, Sensors	56,585	$60,787	$20,262	True RMS Power
#3	4,007	2	6,692	3.4	1.67	2.13	4,007	T-8, CFL, LED Exit	9,252	$3,948	$1,316	True RMS Power
#4	97,181	28	109,500	33	1.13	1.18	97,181	T-8, CFL, LED Exit, Halogen	n/a	$24,502	$15,000	True RMS Power
#5 - #9 5 sites	33,425	5.9	16,890	6.6	0.51	1.12	33,425	T-8, CFL, Halogen	n/a	$18,159	$6,053	True RMS Power
#10	55,802	18	106,824	28.7	1.91	1.59	55,802	T-8, CFL, LED Exit, Sensors	40,000	$52,308	$52,308	Lite Loggers, True RMS Power
Total	**321,905**	**118.5**	**377,673**	**139.4**	**1.17**	**1.18**	**3,170**		**168,582**	**$224,740**	**$116,616**	

Note: TDPUD Site #1 and #2 received additional measures after the M&V audit was completed.

3. Participant Survey Results

This study uses participant surveys to estimate the net-to-gross ratios for kWh and peak kW savings. Participant surveys were completed for 75 participants in seven NCPA utility service areas. The net-to-gross ratios for Alameda, Healdsburg, LMUD, and Lodi are the weighted average value.

3.1 Participant Survey Methodology

Participant surveys were used to develop net-to-gross ratios (NTGRs) for calculating net kW and kWh savings. The NTGR is used to estimate the fraction of free riders who would have otherwise implemented lighting improvements in the absence of the program. Ten participant survey questions are used to assess net-to-gross ratios as shown in **Table 3.1**. The NTGR score for each completed participant survey is the average score based on answers to questions 2 through 10. No score is assigned to responses of "don't know", "refused to answer," or "other."

Table 3.1 Net-to-Gross Ratio Participant Survey Questions and Scoring

#	Question	Answer	Score
2	Did you understand the value of the program BEFORE or AFTER you installed the efficiency upgrades?	Before	1
		After	0
3	Did you install the lighting efficiency upgrade BEFORE or AFTER you heard about the Rebate Program?	Before	0
		After	1
4	On a scale from 0 to 10, with 0 being no influence at all and 10 being very influential, how much influence did the Utility or Rebate have on your decision to install the efficiency upgrades?	0 to 10	0=0, 10=1
5	If the rebates had not been available, how likely is it you would have done exactly the *same* thing. Please use a scale from 0 to 10, with 0 being not at all likely and 10 being very likely.	0 to 10	0=1, 10=0
6	What role did the Utility Program play in your decision to install the upgrades?	1 = Reminded	0.25
		2 = Speeded Up (i.e., early replacement)	0.5
		3 = Showed Benefits Didn't Know Before	1
		4 = Clarified Benefits	0.75
		5 = No role	0
7	The Utility Program was nice but it was unnecessary to get the efficiency upgrades installed.	0 to 10	0=1, 10=0
8	The Utility Program was a critical factor in installing the efficiency upgrades.	0 to 10	0=0, 10=1
9	We would not have installed the efficiency upgrades without the Utility Program.	0 to 10	0=0, 10=1
10	If you had not received the [rebate or service] from the Utility, would you have installed upgrades?	Within 6 months	0
		< 1 year	0.125
		1 to 2 years	0.25
		2 to 3 years	0.5
		3 to 4 years	0.75
		4 or more years	1
		Never	1

3.2 Findings of the Participant Surveys

Findings of the participant surveys for each program are presented in **Table 3.2**. The weighted average net-to-gross ratio is 0.85 based on average participant survey results multiplied times savings for each program divided by total savings for all programs.[3]

Table 3.2 Findings of Participant Surveys

NCPA Utility	Projects	Completed Surveys	Gross Ex Post Savings kWh/yr	Gross Ex Post Savings kW	Weighting Factor kWh/yr	Weighting Factor kW	Net-to-Gross Ratio
Alameda	41	n/a	1,123,456	337.3	0.046679	0.064820	0.85
Gridley	4	1	37,940	16.7	0.001576	0.003217	0.84
Healdsburg	2	n/a	20,365	4.5	0.000846	0.000862	0.85
Lassen MUD	5	n/a	183,344	73.7	0.007618	0.014169	0.85
Lodi	3	n/a	4,485	0.9	0.000186	0.000177	0.85
Lompoc	2	1	15,768	1.8	0.000655	0.000349	1
MID	12	3	844,371	189.9	0.035083	0.036495	0.84
Palo Alto	10	39	1,031,308	258.7	0.042850	0.049723	0.98
Roseville	338	9	1,294,766	423.1	0.053796	0.081321	0.88
Santa Clara	201	7	19,089,720	3742.1	0.793161	0.719193	0.83
TDPUD	8	15	422,386	154.4	0.017550	0.029674	0.99
Total	626	75	24,067,909	5203.2	1	1	0.85

Note: Net-to-gross ratios for Alameda, Healdsburg, LMUD, and Lodi are weighted average values for all surveys.

4. M&V Methodology and Load Impacts

The M&V methodology for the on-site audit and participant survey tasks are discussed above in **Sections 2** and **3**. The M&V methodology for sample design, database tracking, baseline, and program evaluation savings estimates are discussed below.

4.1 Sampling Methods and Statistical Analysis

Statistical survey sampling methods were used to select a sample of customers or projects from each program population in order to evaluate load impacts.[4] Selecting participants for the sample was guided by the statistical sampling plan as well as input from NCPA utilities. Statistical analysis methods were used to analyze the data and extrapolate mean savings estimates from the sample sites to the population of all program participants and to evaluate the statistical precision of the results. The savings per site were normalized on a per unit basis in the statistical analyses (e.g., kW/fixture). Normalizing the savings on a per unit basis allows clearer interpretation of the savings data in the statistical analysis. Considering each utility program within a program category as a stratum, the sample mean within a program was calculated using **Equation 5**.

[3] Participant survey results for programs with lower savings are weighted lower in terms of the total weighted average NTGR for all sites.

[4] Cochran, William G. *Sampling Techniques*. New York: John Wiley & Sons, 1977, Kish, Leslie. *Survey Sampling*. New York: John Wiley & Sons, 1965. Thompson, Steven K. *Sampling*. New York: John Wiley & Sons, 1992.

Eq. 5 $$\text{Mean Savings} = \bar{y}_h = \frac{1}{N_h}\sum_{k=1}^{n} y_k$$

Where,

$\bar{y}_h$ = M&V mean kW or kWh savings for stratum "h."

N_h = Number of measures or sites in stratum "h."

y_k = M&V kW or kWh savings estimate for measure "k."

The mean savings for each program category is based on the sample mean savings estimate across NCPA utility programs strata in the program category. The program category sample mean savings were calculated using **Equation 6**.

Eq. 6 $$\text{Program Category Sample Mean} = \bar{y}_p = \sum_{h=1}^{L} W_h \bar{y}_h$$

Where,

$\bar{y}_p$ = Program category sample mean savings estimate.

$W_h = \frac{N_h}{N_p}$ = Weighting factor across all strata.

N_p = Total number of measures across all strata in program category.

The variance, s_h^2, of the sample mean for a utility program stratum within a program category was calculated using **Equation 7**.

Eq. 7 $$s_h^2 = \frac{\sum_{k=1}^{n}(y_k - \bar{y}_h)^2}{N_h - 1}$$

The coefficient of variation (Cv) provides a relative measure of the sample size required to satisfy the 90/10 criteria (or 80/20 criteria) for estimating the mean of the population. The sample Cv for the utility program stratum was calculated using **Equation 8**.

Eq. 8 $$\text{Sample Coefficient of Variation} = Cv_h = \frac{s_h}{\bar{y}_h}$$

Where,

$s_h = \sqrt{s_h^2}$ = Standard deviation of the sample mean savings in stratum "h."

The sample size necessary to obtain a desired level of relative precision for the utility program stratum mean savings estimate was calculated using **Equation 9**.

Eq. 9 $$\text{Utility Program Stratum Sample Size} = n_h = \frac{t_o Cv_h^2}{r_h^2}$$

Where,

n_h = Sample size of the utility program stratum.

r_h = Desired relative precision for the utility program stratum.

For small populations, the sample size was corrected using the finite population correction (FPC) equation as follows.[5]

Eq. 10 FPC Sample Size = $n_{FPCh} = \frac{n_h}{1+(n_h-1)/N_h}$

Where,

n_{FPCh} = Sample size for stratum with finite population correction.

The utility program stratum error bound of $\bar{y}_h$ as an estimator of the mean value at the 90% level of confidence was calculated using **Equation 11**.

Eq. 11 Stratum Error Bound $= Eb(\bar{y}_h) = t_o \frac{s_h}{\sqrt{n_h}}$

Where,

t_o = 1.645 at 90 percent level of confidence (1.28 at 80 percent confidence).

n_h = Number of units in sample in stratum h.

An unbiased estimate of the program category variance was calculated using **Equation 12**.

Eq. 12 $s_p^2 = \sum_{h=1}^{L} \frac{W_h^2 s_h^2}{n_h} - \sum_{h=1}^{L} \frac{W_h s_h^2}{N_p}$

Where,

s_p^2 = Variance of the program category mean savings estimate, $\bar{y}_p$.

The Cv for the program category was calculated using **Equation 13**.

Eq. 13 Program Category Coefficient of Variation = $Cv_p = \frac{s_p}{\bar{y}_p}$

Where,

$s_p = \sqrt{s_p^2}$ = Standard deviation of the mean savings in the program category.

Statistical analysis was used to extrapolate M&V ex post kW and kWh savings at the sample level for a utility program (stratum) to the program category level and finally for the NCPA SB5X portfolio. This step included an assessment of the error bounds and relative precision of program-level kW and kWh savings as discussed above. The gross M&V ex post program

[5] Cochran, William G. *Sampling Techniques*. New York: John Wiley & Sons, 1977, Kish, Leslie. *Survey Sampling*. New York: John Wiley & Sons, 1965. Thompson, Steven K. *Sampling*. New York: John Wiley & Sons, 1992.

category savings were calculated as the sum of the ex ante program stratum savings times the respective M&V average gross realization rate (AGRR) as shown in **Equation 14**.

Eq. 14 $$\hat{Y}_p = \text{M\&V Gross Ex Post Program Category Savings} = \sum_{h=1}^{L}\left[\hat{X}_h \times AGRR_h\right]$$

Where,

$\hat{Y}_p$ = M&V gross ex post program category savings (kW or kWh).

$\hat{X}_h$ = Ex ante program stratum "h" savings (kW or kWh).

$AGRR_h$ = M&V average gross realization rate for program stratum "h." Defined as the sum of M&V savings for measures or sites in the random sample divided by ex ante savings for measures or sites in the random sample (kW or kWh).

The error bound for the program category is the square root of the sum of the squared error bounds for each of the utility program stratums and was calculated using **Equation 15**.[6]

Eq. 15 $$\hat{E}b(\bar{y}_p) = \sqrt{\sum_{h=1}^{L}\left[Eb(\bar{y}_h)\right]^2}$$

Some statistics were calculated using other equations.[7]

The weighted M&V sample coefficient of variation (Cv) is 0.55 for kWh/fixture and 0.40 for kW/fixture based on the gross realization rates from the M&V results. The required sample size necessary to achieve the 90/10 confidence level is 80 for kWh and 44 for kW. The M&V on-site audit sample size included 23,885 fixtures at 44 participant sites. The participant survey coefficient of variation was 0.18, indicating a minimum 90/10 sample size of 10. The M&V participant survey sample size was 75.[8] These sample sizes exceed the 90/10 confidence level.

[6] This result is a consequence of (a) the fact that the standard deviation of the difference between two statistically independent random variables (e.g., the standard savings of each program) is the square root of the sum of the squares of the standard deviations of each of the random variables, and (b) the error bound at the 90 percent level of confidence is 1.645 times the standard deviation. See Hall, N., Barata, S., Chernick, P., Jacobs, P., Keating, K., Kushler, M., Migdal, L., Nadel, S., Prahl, R., Reed, J., Vine, E., Waterbury, S., Wright, R. 2004. *The California Evaluation Framework*, Chapter 12: Uncertainty, pp. 280-306. San Francisco, Calif.: California Public Utilities Commission.

[7] Hall, N., Barata, S., Chernick, P., Jacobs, P., Keating, K., Kushler, M., Migdal, L., Nadel, S., Prahl, R., Reed, J., Vine, E., Waterbury, S., Wright, R. 2004. *The California Evaluation Framework*, San Francisco, Calif.: California Public Utilities Commission. Cochran, William G. *Sampling Techniques*. New York: John Wiley & Sons, 1977, Kish, Leslie. *Survey Sampling*. New York: John Wiley & Sons, 1965. Thompson, Steven K. *Sampling*. New York: John Wiley & Sons, 1992.

[8] M&V audit sites were randomly selected in each utility service area based on a first come first served basis (i.e., available customer information from the utility program tracking databases and customers willing to participate).

4.2 Database

Data for the commercial and industrial lighting programs was tracked and archived in the NCPA Tracking Database. Data for all programs of this type are summarized within the database for M&V sampling and reporting purposes. The source of the tracking system data is based on reports provided by the respective utilities. The database includes general customer information, quantity and type of lighting fixtures, make and model number, and NCPA account number (if available). Tracking data was delivered electronically by utility program staff and entered into the database after the programs were completed.

4.3 Baseline

The baseline kWh and kW values are based on measured fixture Wattages or reference fixture Wattages. Measurements were made to verify pre-retrofit equipment power and hours of operation to develop the M&V baseline of energy and peak demand (i.e., kWh/yr and kW). Data were collected for representative lighting fixtures using true RMS digital power meters, data loggers, light loggers, interviews, and telephone surveys (i.e., decision maker survey). Groups of like fixtures were measured at the light switch or electrical panel to determine true RMS wattage per fixture. Measured values were compared to reference values to ensure accurate engineering analysis of energy and peak demand savings.

4.4 Program Evaluation Savings Estimates

Gross M&V program evaluation savings (i.e., kWh/yr and kW) are based on the Average Gross Realization Rates (AGRR) from the M&V on-site audits. Gross M&V savings for each site in the audit are based on the difference between pre- and post-retrofit equipment power and hours of operation. Gross savings for the sampled sites were used to develop gross realization rates for kW and kWh/yr, and these values were multiplied by the ex ante program savings to develop gross M&V program savings. Net program evaluation savings are based on the participant decision-maker survey results that were analyzed to develop net-to-gross ratios for kWh and kW savings. Methods used to develop net-to-gross ratios are described above in **Section 3**. The gross and net savings estimates obtained at the participant level are extrapolated to the population of program participants using the methods described above in **Section 4**. The weighted average gross realization rates for the 44 M&V sites are 1.145 for kWh and 1.053 for kW as shown in **Table 4.1**. Gross ex post savings and realization rates for all utilities in the C&I lighting program category are provided in **Table 4.2**.

Table 4.1 Average Gross Realization Rates for M&V Sites

NCPA Utility	Qty.	Ex Ante Savings kWh/yr	Ex Ante Savings kW	M&V Ex Post Savings kWh/yr	M&V Ex Post Savings kW	AGRR kWh/yr	AGRR kW
Gridley	74	38,468	16.99	37,942	16.74	0.986	0.985
Lompoc	11	3,469	0.40	3,469	0.40	1.000	1.000
Palo Alto	7,665	1,128,674	286	1,031,308	259	0.914	0.906
Roseville	717	108,537	24	85,116	27	0.784	1.099
SVP	12,248	3,814,079	749	4,663,664	816	1.223	1.089
TDPUD	3,170	321,905	119	377,673	139	1.173	1.176
M&V Total	23,885	5,415,132	1,195	6,199,172	1,258	1.145	1.053

Table 4.2 Gross Ex Post Savings and Realization Rates for C&I Lighting Programs

NCPA Utility	Qty.	Ex Ante Program Savings kWh/yr	Ex Ante Program Savings kW	M&V Gross Ex Post Savings kWh/yr	M&V Gross Ex Post Savings kW	AGRR kWh/yr	AGRR kW
Alameda	6,091	1,127,255	368.00	1,123,456	337.27	0.997	0.917
Gridley	74	38,468	16.99	37,942	16.74	0.986	0.985
Healdsburg	110	20,434	4.90	20,365	4.49	0.997	0.917
LMUD	994	183,964	80.44	183,344	73.72	0.997	0.917
Lodi	24	4,500	1.01	4,485	0.92	0.997	0.917
Lompoc	50	15,768	1.81	15,768	1.81	1.000	1.000
MID	11,230	847,226	207.20	844,371	189.89	0.997	0.917
Palo Alto	8,822	1,128,674	285.71	1,031,308	258.72	0.914	0.906
Roseville	6,718	1,651,041	384.96	1,294,766	423.13	0.784	1.099
SVP	87,913	15,612,124	3,436.29	19,089,720	3,742.14	1.223	1.089
TDPUD	3,940	394,545	156.40	422,386	154.40	1.173	1.176
Total	125,966	21,023,999	4,943.70	24,067,911	5,203.25	1.145	1.053

The M&V results are summarized in **Table 4.3**. The total ex ante savings are 21,023,999 kWh/yr and 4,944 kW. The total M&V gross ex post program savings are 24,067,909 kWh/yr ± 255,650 kWh/yr and 5,203 kW ± 54 kW at the 90 percent confidence level. The total M&V net ex post program savings are 20,301,517 kWh/yr ± 213,512 kWh/yr and 4,414 kW ± 46 kW at the 90 percent confidence level. The total M&V net ex post lifecycle savings are 324,824,278 ± 3,416,193 kWh based on a 16-year effective useful life. The total net realization rates are 0.97 for kWh and 0.89 for kW savings. The M&V savings are based on engineering analyses for a random sample of 23,885 fixtures at 44 participant sites where complete audits were performed. The on-site audits included verification of all installed measures that received incentives as well as true RMS power measurements of pre- and post-installation fixtures and light logger measurements or interviews to obtain hours of operation. The net-to-gross ratios are calculated based on decision maker surveys completed for 75 participants. The weighted average net-to-gross ratio is 85 percent meaning that roughly 15 percent of customers would have made the lighting improvements without the program.

Table 4.3 Summary of M&V Results for NCPA SB5X C&I Lighting

NCPA Utility	Measures	Ex Ante Savings kWh/yr	Ex Ante Savings kW	M&V Gross Ex Post Savings kWh/yr	M&V Gross Ex Post Savings kW	Net-to-Gross Ratio	M&V Net Ex Post Savings MWh/yr	M&V Net Ex Post Savings kW	Net Realization Rate Relative to Planning kWh/yr	Net Realization Rate Relative to Planning kW
Alameda	6,091	1,127,255	368.00	1,123,456	337.27	0.85	954,938	286.68	0.85	0.78
Gridley	74	38,468	16.99	37,940	16.74	0.84	31,870	14.06	0.83	0.83
Healdsburg	110	20,434	4.90	20,365	4.49	0.85	17,310	3.81	0.85	0.78
LMUD	994	183,964	80.44	183,344	73.72	0.85	155,842	62.67	0.85	0.78
Lodi	24	4,500	1.01	4,485	0.92	0.85	3,812	0.78	0.85	0.78
Lompoc	50	15,768	1.81	15,768	1.81	1.00	15,768	1.81	1.00	1.00
MID	11,230	847,226	207.20	844,371	189.89	0.84	709,272	159.51	0.84	0.77
Palo Alto	8,822	1,128,674	285.71	1,031,308	258.72	0.98	1,010,682	253.55	0.90	0.89
Roseville	6,718	1,651,041	384.96	1,294,766	423.13	0.88	1,139,394	372.36	0.69	0.97
SVP	87,913	15,612,124	3,436.29	19,089,720	3,742.14	0.83	15,844,468	3,105.98	1.01	0.90
TDPUD	3,940	394,545	156.40	422,386	154.40	0.99	418,162	152.86	1.06	0.98
Total	125,966	21,023,999	4,943.70	24,067,909	5,203.25	0.85	20,301,517	4,414.07	0.97	0.89

Note: Net-to-gross ratios for Alameda, Healdsburg, LMUD, and Lodi are weighted average values for all surveys.

Appendix A: NCPA Commercial and Industrial Lighting Decision-Maker Survey

Interview Instructions for Decision-Maker Survey

1. Purpose

The purpose of the Decision-Maker Survey is to obtain sufficient information to estimate the Net-to-Gross Ratio (NTGR).

2. Selection of Respondent

The **decision-maker** must be the person who decided to install or implement rebated measures.

3. Two Types of Sites

This survey will be used for two types of sites:

1. **On-Site M&V Only**. Sites that receive an on-site inspection for the M&V evaluation.
2. **Telephone Only**. Sites that only receive a telephone survey.

4. How to Start the Survey

Complete the following steps to start one of these surveys:

1. Review file information for the site (if available).
2. Make sure you understand what was installed prior to initiating the call or visit.
3. Contact the person and explain the purpose of the Survey. Tell them that the data provided by them will be kept strictly confidential and will not be shared with anyone.

C&I LIGHTING DECISION-MAKER SURVEY

Customer Name:_____ Date: _____

Business Name: _____ Contact: _____

Phone Number:_____ City: _____

Start Call Time: _____ End Call time:_____

Surveyor Initials: _____ Survey Completed: Y NA R WB BN

Y = yes, NA = no answer, R = refused, WB = wrong business, BN = bad number

The purpose of the decision-maker survey is to obtain information necessary to calculate a net-to-gross ratio. You will need to interview the customer who was responsible for the decision to implement measures at the site. If this person is not available attempt to locate someone who is at least familiar with how that decision was made.

Introduction

Say: "Hello. My name is [**Anne**] and I am conducting a survey regarding the your participating in the energy efficiency programs funded with SB5X funds. Would you mind spending 5 minutes to answer a few questions."

Begin Survey

1. When and how did you first learn about the Utility Program? [**Only ask this question <u>once,</u> for the first recommendation for each site.**]

   _____

   1 Didn't know there was a program (**Go to Q.3**)

2. Keeping that in mind, did you understand the value of the program BEFORE or AFTER you installed the efficiency upgrades? (**Circle One**)

   1 Before **2** After (**Go to Q.4**) **98** Don't Know **99** Refused to Answer

3. Did you install the lighting efficiency upgrade BEFORE or AFTER you heard about the Utility Rebate Program? (**Circle One**) (If Before, ask if their contractor informed them of the rebate.)

   1 Before **2** After **98** Don't Know **99** Refused to Answer

4. On a scale from 0 to 10, with 0 being no influence at all and 10 being very influential, how much influence did the Utility or Rebate have on your decision to install the efficiency upgrades?

   ___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

5. If the rebates had not been available, how likely is it you would have done exactly the *same* thing. Please use a scale from 0 to 10, with 0 being not at all likely and 10 being very likely.

   ___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

   Notes: _____

C&I LIGHTING DECISION-MAKER SURVEY (Continued)

Special Instruction for Contradictory Responses: If [**Q.4 is 0,1,2** *and* **Q.5 is 0,1,2**] *or* [**Q.4 is 8,9,10** *and* **Q.5 is 8,9,10**]. Probe for the reason. However, it is important not to communicate a challenging attitude when posing the question. For example, say,

> When you answered "8" for the question about the influence of the rebate or service, I interpreted that to mean that the Utility Program was important to your decision. Then, when you answered "8" for how likely you would be to take the same action *without* the rebate or service, it sounds like the Utility was *not* very important. I want to check to see if I understand your answers or if the questions may have been unclear.
>
> If they volunteer a helpful answer at this point, respond by changing the appropriate answer. If not, follow up with something like: "Would you explain in your own words, the role the Utility Program played in your decision to take this action?

If possible translate their answer into responses for **Questions 4** and **5** and check these responses with the respondent for accuracy. If the answer doesn't allow you to decide what answer should be changed, write the answer down and continue the interview.

Answer: _____

6. What role did the Utility Program play in your decision to install the upgrades [**describe implemented recommendation**]? [Prompt by reading list if the respondent has trouble answering.]

   1 Reminded us of something we already knew
   2 Speeded up process of what we would have done anyway (i.e., early replacement)
   3 Showed us the benefits of this action that we didn't know before
   4 Clarified benefits that we were *somewhat* aware of before
   5 Recommendation had no role
   6 Other _____
   98 Don't Know
   99 Refused to Answer

Say: Here are some statements that may be more or less applicable for your home or business about the Utility Program [**or recommendation**]. Please assign a number between 0 and 10 to register how applicable it is. A 10 indicates that you fully agree, and 0 indicates that you completely disagree.

7. The Utility Program was nice but it was unnecessary to get the efficiency upgrades installed.

   ___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

8. The Utility Program was a critical factor in installing the efficiency upgrades.

   ___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

C&I LIGHTING DECISION-MAKER SURVEY (Continued)

9. We would not have installed the efficiency upgrades without the Utility Program.

   ___ Response (**0**-**10**) **98** Don't Know **99** Refused to Answer

10. If you had not received the [rebate or service] from the Utility, would you have installed upgrades [**or other measures**]...

    1 ..within 6 months?

    2 ..6 months to 1 year?

    3 ..one to two years later?

    4 ..two to three years later?

    5 ..three to four years later?

    6 ..four or more years later?

    7 ..Never

    98 ..Don't Know - **Try less precise response, if still "don't know" use 98**

    8 ...less than one year?

    9 ...one year or more?

    99 ...Refused to Answer

    <u>Time relative to the installation date</u>. For customers with more than one measure ask if their response is the same. If not, obtain a response for each measure. Write answers in margins and enter answers on a new line in the Excel spreadsheet.

Repeat **Questions 2** through **10** for each installed measure or service.

Appendix B-1: Gridley C&I Lighting Rebate Site #1

M&V REPORT FOR C&I LIGHTING SITE #1

Prepared for the City of Gridley

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name:	**City of Gridley**	
Site Name:	**Site #1**	
Site Address:	**199 E. Hazel St., Gridley, CA 95948**	
Site Contact Name:	**Brad Wilke**	**Telephone: (530) 846-5695**
City Representative:	**Brad Wilkie, Finance Director**	**Telephone: (530) 846-5695**
Assigned Lead Engineer:	**Robert Mowris, P.E.**	**Telephone: (530) 583-1570**

Site: Gridley Site #1

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #1	BUT0062	Lighting	Gridley	SB5X Project	n/a	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #1	Lighting	12.75	28,545	n/a	10,000

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	
Site #1	Lighting	12.522	28,019	n/a	

Spillover

No evidence of spillover was found.

Impact Evaluation Report: City of Gridley **End Use: Lighting**

Measure Description

Efficiency Improvement: The efficiency improvement consisted of installing forty-two (42) T5 6-lamp fixtures with electronic ballasts at Site #1. The new T5 lighting system has measured illuminance of 36 footcandles at low power output and 50 footcandles at high power output. The two critical uses for the gymnasium are basketball and volleyball. The recommended illuminance for basketball is 30 for practice and 50 footcandles for tournaments, and the recommended illuminance for volleyball is 10 footcandles for recreational and 20 footcandles for tournaments.[9]

Pre- and Post-Installation Conditions: Site inspections were performed to verify the pre and post-installation conditions. Pre-installlation fixtures were verified on March 16, 2002 indicating sixteen (16) 250 nominal Watt HID fixtures, nine (9) 400 nominal Watt HID fixtures and four (4) 1,000 nominal Watt incandescent fixtures. Post-installation fixtures were verified on November 19, 2003 indicating forty-two (42) T5 6-lamp fixtures with low and high power output. The pre-retrofit lighting fixtures are shown in **Figure 1** and the post-retrofit lighting fixtures are shown in **Figure 2**.

Figure 1. Pre-Retrofit HID/Incand. Fixtures

Figure 2. Post-Retrofit T5 6-Lamp Fixtures

Measured power usage is shown in **Figure 3** for pre- and post-retrofit lighting systems (adjusted pre-installation power is extrapolated from the unadjusted pre-installation power). The pre-retrofit power usage was 12.66 kW. However, some lights were burned out, not all lighting fixtures were installed, and the pre-installation illuminance level was only 21 footcandles. The Gymnasium is used 10 months a year by the adjacent Gridley High School for gym classes, basketball and volleyball games. It also is the site for the Gridley Invitational Basketball Tournament, which attracts schools from all over the state and has been in existence for over 40 years. Due to the high use and high profile for fair exhibitions and tournament basketball, the required illuminance level for the gymnasium is 50 footcandles.[10] To achieve 50 footcandles, all 38 junction boxes would have required 400 Watt HID fixtures and corners would have required 1,000 Watt

[9] *Lighting Handbook*, Reference & Application, 8th Edition, Chapter 11, Illuminance Selection, Figure 11-1, V. Sports and Recreational Areas, p. 471-472, Illuminating Engineering Society of North America, 1995.

[10] The IESNA recommended illuminance is 50 footcandles for tournament basketball, see footnote 1.

incandescent fixtures.[11] Therefore, the adjusted pre-installation lighting power is 21.17 kW as shown in **Figure 3** and **Table 1**.

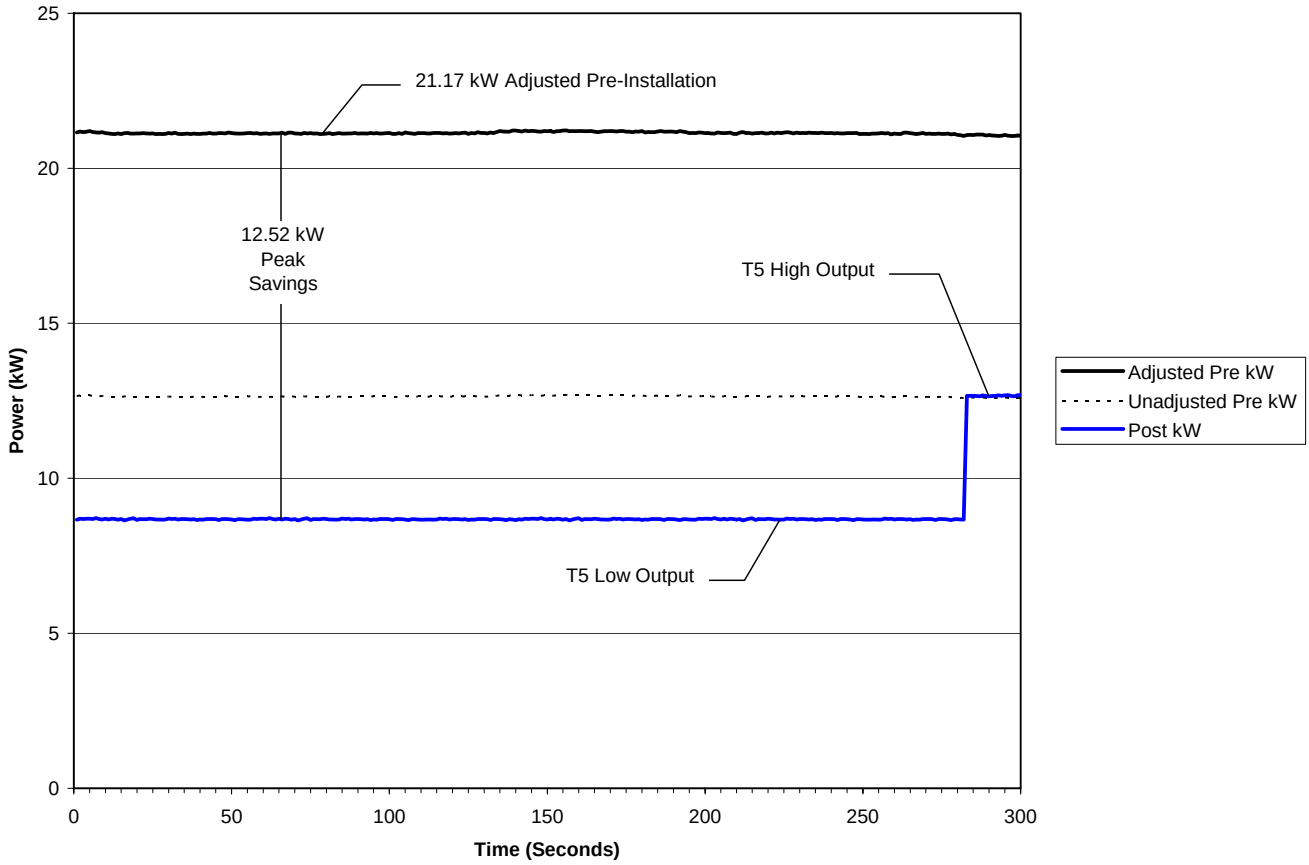

Figure 3. Site #1 Lighting Power

Primary Business Descriptions: Site #1 consists of the gymnasium, recreational meeting spaces, hallways, and restrooms. The gymnasium is the affected area.

Variability in Schedule and Production: Discussions were held with maintenance personnel at the gymnasium to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (\text{kW}_{\text{pre}} - \text{kW}_{\text{post}}) \times \text{Number}_{\text{fixtures}}$$

[11] The four incandescent fixtures are installed for emergency lighting.

$$\text{kWh Savings} = (\text{kW}_{\text{pre}} - \text{kW}_{\text{post}}) \times \text{hours/year} \times \text{Number}_{\text{fixtures}}$$

Table 1. M&V Savings for Gridley Site #1

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	HID Fixtures	38	2,286	454	17.252	39,438	T5-6 lamp-EB-Low	38	2,134	206	7.828	16,705	9.424	22,733
2	Incandescent Fixtures	4	2,286	981	3.922	8,966	T5-6 lamp-EB-Low	4	2,134	206	0.824	1,758	3.098	7,208
							T5-6 lamp-EB-High-Offpeak	38	152	301	11.438	1,739	n/a	-1,739
							T5-6 lamp-EB-High-Offpeak	4	152	301	1.204	183	n/a	-183
Total		**42**			**21.174**	**48,404**		**42**			**8.652**	**20,385**	**12.522**	**28,019**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 2**.

Table 2. Fixture Wattage Measurements From Site Visits

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Pre-Retrofit						
Site #1	Gymnasium	16	HID 250 Watt Nominal	4,656	291.0	295
Site #1	Gymnasium	9	HID 450 Watt Nominal	4,086	454.0	458
Site #1	Gymnasium	4	1,000 Watt Incandescent	3,922	980.5	1,000
Post-Retrofit						
Site #1	Gymnasium	7	T5-6 lamp-EB-Low	1,443	206.1	206
Site #1	Gymnasium	7	T5-6 lamp-EB-High	2,110	301.4	301

Customer Cost/Benefit Analysis

The installed cost for the new T5 lighting system is $28,000. Cost and Payback are based on 2003 Gridley Rates of 0.1204 $/kWh plus 5% over 2,675 kWh/month (effective 1-1-03).

- Site #1: (Retrofit Cost $28,000 - Rebate $10,000) / (Energy Savings $3,542.16) = Simple Payback 5.1 Years.

ATTACHMENTS

Utility Bills for 2002 and 2003

Utility billing data were used to check the unadjusted baseline. The billing data were not used to estimate project savings due to the need to adjust the pre-installation lighting power to comparable post-installation illuminance levels of 50 footcandles required for tournament basketball.

Appendix B-2: Gridley C&I Lighting Rebate Site #2

M&V REPORT FOR C&I LIGHTING SITE #2

Prepared for the City of Gridley

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name:	**City of Gridley**	
Site Name:	**Site #2**	
Site Address:	**685 Kentucky Street, Gridley, CA 95948**	
Site Contact Name:	**Brad Wilke**	**Telephone: (530) 846-5695**
City Representative:	**Brad Wilkie, Finance Director**	**Telephone: (530) 846-5695**
Assigned Lead Engineer:	**Robert Mowris, P.E.**	**Telephone: (530) 583-1570**

Site: Gridley Site #2

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #2	n/a	Lighting	Gridley	SB5X Project	7,200	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #2	Lighting	4.24	9,923	n/a	4,876.47

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	
Site #2	Lighting	4.24	9,922	n/a	

Spillover

No evidence of spillover was found.

Impact Evaluation Report: City of Gridley End Use: Lighting

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided, the following efficiency improvements were planned for Site #2.

Table 1. Planned Efficiency Improvements for Gridley Site #2

Measure	Description	Qty.	Location
1	8 ft. Tandem 4-lamp F32T8 w/Elec. Ballast and white reflector	24	Corp. Yard Bldg.
2	4 ft 2-lamp F32T8 w/Elec. Ballast-HLO (High Light Output) and white reflector	3	Corp. Yard Bldg.
3	4 ft 2-lamp F32T8 w/EB-HLO (High Light Output) in existing reflector or new fixture	5	Office
Total		**32**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #2.

Table 2. Verified Efficiency Improvements for Gridley Site #2

Measure	Description	Qty.	Location
1	8 ft. Tandem 4-lamp F32T8 w/Elec. Ballast and white reflector	24	Corp. Yard Bldg.
2	4 ft 2-lamp F32T8 w/Elec. Ballast-HLO (High Light Output) and white reflector	3	Corp. Yard Bldg.
3	4 ft 2-lamp F32T8 w/EB-HLO (High Light Output) in existing reflector or new fixture	5	Office
Total		**32**	

Pre-Installation Conditions: The pre-installation lighting system used approximately 7,248 W and 16,960 kWh per year based on 2,340 hours per year (9 hours/day and 260 days/year). This represents approximately 45 percent of the total annual electric use based on the previous year's metered consumption of 37,726 kWh. Based on site inspections and review of old fixtures, Site #2 had the following pre-installation configurations.

Table 3. Pre-Installation, Watts and Hours of Operation for Gridley Site #2

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	8 ft 4-lamp F96T12 w/Mag. Ballast and white reflector	24	2,340	256	Corp. Yard Bldg.
2	8 ft 2-lamp F96T12 w/Mag. Ballast and white reflector	3	2,340	128	Corp. Yard Bldg.
3	4 ft Wrap-Around F40T12 w/Mag. Ballast	5	2,340	144	Office
Total		**32**			

Pre-installation Lighting System at Site #2

Primary Business Descriptions:
Site #2 provides space for City maintenance office staff and City-owned maintenance vehicles.

Variability in Schedule and Production: Discussions were held with maintenance personnel at the site to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Gridley Site #2

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	8 ft 4-lamp F96T12 w/Mag. Ballast and white reflector	24	2,340	256	6.14	14,377	8 ft. Tandem 4-lamp F32T8 w/Elec. Ballast and white reflector	24	2,340	102	2.45	5,728	3.69	8,649
2	8 ft 2-lamp F96T12 w/Mag. Ballast and white reflector	3	2,340	128	.39	898	4 ft 2-lamp F32T8 w/Elec. Ballast-HLO (High Light Output) and white reflector	3	2,340	70	.21	491	.18	407
3	4 ft Wrap-Around F40T12 w/Mag. Ballast	5	2,340	144	.72	1,685	4 ft 2-lamp F32T8 w/EB-HLO (High Light Output) in existing reflector or new fixture	5	2,340	70	.35	819	.37	866
Total		**32**			**7.25**	**16,960**		**32**			**3.01**	**7,038**	**4.24**	**9,922**

Customer Cost/Benefit Analysis

Cost and Payback are based on 2003 Gridley Rates of 0.1204 $/kWh plus 5% over 2,675 kWh/month (effective 1-1-03).

- Site #2: (Retrofit Cost $6,137.69 - Rebate $4,876.47) / (Energy Savings $1,254.34) = Simple Payback 1 Year.

Appendix C-1: Lompoc C&I Lighting Rebate Site #1

M&V REPORT FOR C&I LIGHTING SITE #1

Prepared for the City of Lompoc

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Lompoc**

Site Name: **Site #1**

Site Address: **125 N. C Street, Lompoc, CA 93436**

Principal Site Contact Name: **Tricia Childs** **Telephone: (805) 736-2772**

Utility Representative Name: **Mary Kammer** **Telephone: (805) 736-1261**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM**

Site: Lompoc Site #1

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #1	5055001	Lighting	Lompoc	SB5X Project	12,000	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #1	Lighting	0.4	3,469	n/a	195

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #1	Lighting	0.4	3,469	n/a

Spillover

No evidence of spillover was found.

Impact Evaluation Report: Lompoc End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided, the following efficiency improvements were planned under this project at Site #1.

Table 1. Planned Efficiency Improvements at Lompoc Site #1

Measure	Description	Qty.	Location
1	LED Exit	11	Site #1
Total		**11**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #1.

Table 2. Verified Efficiency Improvements at Lompoc Site #1

Measure	Description	Qty.	Location
1	LED Exit	11	Site #1
Total		**11**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, Site #1 had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Lompoc Site #1

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	Incandescent Exit	11	8,760	40	Site #1
Total		**11**			

Primary Business Descriptions:
Site #1 consists of offices, storage, classrooms, restrooms, and a chapel.

Variability in Schedule and Production: Discussions were held with maintenance personnel at the church to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Lompoc Site #1

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	Incandescent	11	8,760	40	0.44	3,854	LED Exit	11	8,760	4	0.044	385	0.4	3,469
Total		**11**			**0.44**	**3,854**		**11**			**0.044**	**385**	**0.4**	**3,469**

Customer Cost/Benefit Analysis

Cost and Payback are based on Lompoc Rates of 0.10578 $/kWh (effective 7-1-01).

- Site #1: (Retrofit Cost $550 - Rebate $195) / (Energy Savings $366.95) = Simple Payback .97 Years.

Appendix D-1: Palo Alto C&I Lighting Rebate Site #1

M&V REPORT FOR C&I LIGHTING SITE #1

Prepared for the City of Palo Alto Utilities
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Palo Alto**

Site Name: **Site #1**

Site Address: **250 Hamilton Avenue, Palo Alto, CA 94303**

Principal Site Contact Name: **Virginia Waik** **Telephone: (650) 329-2168**

Utility Representative Name: **Virginia Waik** **Telephone: (650) 329-2168**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Palo Alto Site #1

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #1	100000-45566	Lighting	Palo Alto	SB5X Project	357,800	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #1	Lighting	55.27	308,148	n/a	45,178

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #1	Lighting	42.84	262,059	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: City of Palo Alto Utilities End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Planergy, Inc., the following efficiency improvements were plannned under this project at Site #1.

Table 1. Planned Efficiency Improvements at Palo Alto Site #1

Measure	Description	Qty.	Location
1	Exit40W	35	Exits
2	CFL15	2	Storage
3	CFL15	7	Office Areas
4	CFL15	32	Halls & Common RR
5	CFL42	6	Office Areas
6	Unknown	4	
7	Unknown	6	
8	2x15CFL	2	Halls & Common RR
9	Unknown	2	
10	Unknown	0	
11	Unknown	3	
12	T12F20 - 1 lamp MB	2	Office Areas
13	T8F17 - 3 lamp RLO	14	Halls & Common RR
14	T8F17 - 3 lamp RLO	3	Office Areas
15	T8F17 - 3 lamp RLO	7	Office Areas
16	T12F30 - 1 lamp MB	11	Office Areas
17a	T8F25 - 2 lamp RLO	4	Office Areas
17b	T8F25 - 2 lamp RLO	12	Halls & Common RR
18a	T8F32 - 1 lamp RLO	27	Halls & Common RR
18b	T8F32 - 1 lamp RLO	2	Storage
18c	T8F32 - 1 lamp RLO	44	Stairs & Garage
19	T8F32 - 2 lamp RLO	40	Office Areas
20a	T8F32 - 2 lamp RLO	63	Halls & Common RR
20b	T8F32 - 2 lamp RLO	84	Office Areas
21	T8F32 - 2 lamp RLO	10	Storage
22a	T8F32 - 2 lamp RLO	579	Stairs & Garage
22b	T8F32 - 2 lamp RLO	512	Office Areas
23a	T8F32 - 2 lamp RLO Tand	6	Halls & Common RR
23b	T8F32 - 2 lamp RLO Tand	58	Office Areas
23c	T8F32 - 2 lamp RLO Tand	40	Office Areas
24	T8F32 - 1 lamp NLO	6	Halls & Common RR
25	T8F32 - 3 lamp RLO	79	Office Areas
26a	T8F32 - 3 lamp RLO	19	Office Areas
26b	T8F32 - 3 lamp RLO	6	Storage
27	T8F95HO - 1 lamp	15	Halls & Common RR
28a	T8F32 - 4 lamp RLO	2	Halls & Common RR
28b	T8F32 - 4 lamp RLO	16	Office Areas
28c	T8F32 - 4 lamp RLO	10	Storage
28d	T8F32 - 4 lamp RLO	57	Stairs & Garage
Total		**1,827**	

Note: EB = Electronic Ballast

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #1.

Table 2. Verified Efficiency Improvements at Palo Alto Site #1

Measure	Description	Qty.	Location
1	Exit40W	35	Exits
2	CFL15	2	Storage
3	CFL15	7	Office Areas

Table 2. Verified Efficiency Improvements at Palo Alto Site #1

Measure	Description	Qty.	Location
4	CFL15	32	Halls & Common RR
5	CFL42	6	Office Areas
6	Unknown	4	
7	Unknown	6	
8	2x15CFL	2	Halls & Common RR
9	Unknown	2	
10	Unknown	0	
11	Unknown	3	
12	T12F20 - 1 lamp MB	2	Office Areas
13	T8F17 - 3 lamp RLO	14	Halls & Common RR
14	T8F17 - 3 lamp RLO	3	Office Areas
15	T8F17 - 3 lamp RLO	7	Office Areas
16	T12F30 - 1 lamp MB	11	Office Areas
17a	T8F25 - 2 lamp RLO	4	Office Areas
17b	T8F25 - 2 lamp RLO	12	Halls & Common RR
18a	T8F32 - 1 lamp RLO	27	Halls & Common RR
18b	T8F32 - 1 lamp RLO	2	Storage
18c	T8F32 - 1 lamp RLO	44	Stairs & Garage
19	T8F32 - 2 lamp RLO	40	Office Areas
20a	T8F32 - 2 lamp RLO	63	Halls & Common RR
20b	T8F32 - 2 lamp RLO	84	Office Areas
21	T8F32 - 2 lamp RLO	10	Storage
22a	T8F32 - 2 lamp RLO	579	Stairs & Garage
22b	T8F32 - 2 lamp RLO	512	Office Areas
23a	T8F32 - 2 lamp RLO Tand	6	Halls & Common RR
23b	T8F32 - 2 lamp RLO Tand	58	Office Areas
23c	T8F32 - 2 lamp RLO Tand	40	Office Areas
24	T8F32 - 1 lamp NLO	6	Halls & Common RR
25	T8F32 - 3 lamp RLO	79	Office Areas
26a	T8F32 - 3 lamp RLO	19	Office Areas
26b	T8F32 - 3 lamp RLO	6	Storage
27	T8F95HO - 1 lamp	15	Halls & Common RR
28a	T8F32 - 4 lamp RLO	2	Halls & Common RR
28b	T8F32 - 4 lamp RLO	16	Office Areas
28c	T8F32 - 4 lamp RLO	10	Storage
28d	T8F32 - 4 lamp RLO	57	Stairs & Garage
Total		**1,827**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #1

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	Exit40W	35	8760	40	Exits
2	75A	2	8760	75	Storage
3	75A	7	3570	75	Office Areas
4	75A	32	8760	75	Halls & Common RR
5	150A	6	3570	150	Office Areas
6	Unknown	4			
7	Unknown	6			
8	2x75A	2	8760	150	Halls & Common RR
9	Unknown	2			
10	Unknown	0			
11	Unknown	3			
12	T12F20 - 1 lamp MB	2	3570	28	Office Areas
13	T12F34 - 2 lamp U MB	14	8760	72	Halls & Common RR
14	T12F34 - 2 lamp U MB	3	3570	72	Office Areas
15	T12F34 - 2 lamp U MB	7	3570	72	Office Areas
16	T12F30 - 1 lamp MB	11	3570	46	Office Areas
17a	T12F30 - 2 lamp MB	4	3570	81	Office Areas
17b	T12F30 - 2 lamp MB	12	8760	81	Halls & Common RR

Table 3. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #1

Measure	Description	Qty.	Hours/yr	W/fixture	Location
18a	T12F34 - 1 lamp MB	27	8760	43	Halls & Common RR
18b	T12F34 - 1 lamp MB	2	800	43	Storage
18c	T12F34 - 1 lamp MB	44	8760	43	Stairs & Garage
19	T12F34 - 2 lamp MB	40	3570	72	Office Areas
20a	T12F34 - 2 lamp MB	63	8760	72	Halls & Common RR
20b	T12F34 - 2 lamp MB	84	3570	72	Office Areas
21	T12F34 - 2 lamp MB	10	800	72	Storage
22a	T12F34 - 2 lamp MB	579	8760	72	Stairs & Garage
22b	T12F34 - 2 lamp MB	512	3570	72	Office Areas
23a	T12F34 - 2 lamp MB	6	8760	72	Halls & Common RR
23b	T12F34 - 2 lamp MB	58	3570	72	Office Areas
23c	T12F34 - 2 lamp MB	40	3570	72	Office Areas
24	T12F34 - 1 lamp MB	6	8760	43	Halls & Common RR
25	T12F34 - 3 lamp MB	79	3570	115	Office Areas
26a	T12F34 - 3 lamp MB	19	3570	115	Office Areas
26b	T12F34 - 3 lamp MB	6	800	115	Storage
27	T12F96HO - 1 lamp MB	15	8760	112	Halls & Common RR
28a	T12F34 - 4 lamp MB	2	8760	144	Halls & Common RR
28b	T12F34 - 4 lamp MB	16	3570	144	Office Areas
28c	T12F34 - 4 lamp MB	10	800	144	Storage
28d	T12F34 - 4 lamp MB	57	8760	144	Stairs & Garage
Total		**1827**			

Primary Business Descriptions:
Site #1 consists of office areas, halls and common R&R, fitness areas, shops, storage, and stairs & garage.

Variability in Schedule and Production: Discussions were held with maintenance personnel to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Palo Alto Site #1

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	Exit40W	35	8760	40	1.40	12,264	Exit40W	35	8760	2.5	0.09	767	1.31	11,498
2	75A	2	8760	75	0.15	1,314	CFL15	2	800	15	0.03	24	0.12	1,290
3	75A	7	3570	75	0.53	1,874	CFL15	7	3570	15	0.11	375	0.42	1,499
4	75A	32	8760	75	2.40	21,024	CFL15	32	8760	15	0.48	4,205	1.92	16,819
5	150A	6	3570	150	0.90	3,213	CFL42	6	3570	42	0.25	900	0.65	2,313
6	Unknown	4					Unknown	4					0.00	0
7	Unknown	6					Unknown	6					0.00	0
8	2x75A	2	8760	150	0.30	2,628	2x15CFL	2	8760	30	0.06	526	0.24	2,102
9	Unknown	2					Unknown	2					0.00	0
10	Unknown	0					Unknown	0					0.00	0
11	Unknown	3					Unknown	3					0.00	0
12	T12F20 - 1 lamp MB	2	3570	28	0.06	200	T12F20 - 1 lamp MB	2	3570	28	0.06	200	0.00	0
13	T12F34 - 2 lamp U MB	14	8760	72	1.01	8,830	T8F17 - 3 lamp RLO	14	8760	47	0.66	5,764	0.35	3,066
14	T12F34 - 2 lamp U MB	3	3570	72	0.22	771	T8F17 - 3 lamp RLO	3	3570	47	0.14	503	0.08	268
15	T12F34 - 2 lamp U MB	7	3570	72	0.50	1,799	T8F17 - 3 lamp RLO	7	3570	47	0.33	1,175	0.18	625
16	T12F30 - 1 lamp MB	11	3570	46	0.51	1,806	T12F30 - 1 lamp MB	11	3570	46	0.51	1,806	0.00	0
17a	T12F30 - 2 lamp MB	4	3570	81	0.32	1,157	T8F25 - 2 lamp RLO	4	3570	50	0.20	714	0.12	443
17b	T12F30 - 2 lamp MB	12	8760	81	0.97	8,515	T8F25 - 2 lamp RLO	12	8760	50	0.60	5,256	0.37	3,259
18a	T12F34 - 1 lamp MB	27	8760	43	1.16	10,170	T8F32 - 1 lamp RLO	27	8760	27	0.73	6,386	0.43	3,784
18b	T12F34 - 1 lamp MB	2	800	43	0.09	69	T8F32 - 1 lamp RLO	2	800	27	0.05	43	0.03	26
18c	T12F34 - 1 lamp MB	44	8760	43	1.89	16,574	T8F32 - 1 lamp RLO	44	8760	27	1.19	10,407	0.70	6,167

Table 4. M&V Savings for Palo Alto Site #1

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
19	T12F34 - 2 lamp MB	40	3570	72	2.88	10,282	T8F32 - 2 lamp RLO	40	3570	52	2.08	7,426	0.80	2,856
20a	T12F34 - 2 lamp MB	63	8760	72	4.54	39,735	T8F32 - 2 lamp RLO	63	8760	52	3.28	28,698	1.26	11,038
20b	T12F34 - 2 lamp MB	84	3570	72	6.05	21,591	T8F32 - 2 lamp RLO	84	3570	52	4.37	15,594	1.68	5,998
21	T12F34 - 2 lamp MB	10	800	72	0.72	576	T8F32 - 2 lamp RLO	10	800	52	0.52	416	0.20	160
22a	T12F34 - 2 lamp MB	579	8760	72	41.7	365,187	T8F32 - 2 lamp RLO	579	8760	52	30.11	263,746	11.58	101,441
22b	T12F34 - 2 lamp MB	512	3570	72	36.9	131,604	T8F32 - 2 lamp RLO	512	3570	52	26.62	95,048	10.24	36,557
23a	T12F34 - 2 lamp MB	6	8760	72	0.43	3,784	T8F32 - 2 lamp RLO Tand	6	8760	51	0.31	2,681	0.13	1,104
23b	T12F34 - 2 lamp MB	58	3570	72	4.18	14,908	T8F32 - 2 lamp RLO Tand	58	3570	51	2.96	10,560	1.22	4,348
23c	T12F34 - 2 lamp MB	40	3570	72	2.88	10,282	T8F32 - 2 lamp RLO Tand	40	3570	51	2.04	7,283	0.84	2,999
24	T12F34 - 1 lamp MB	6	8760	43	0.26	2,260	T8F32 - 1 lamp NLO	6	8760	31	0.19	1,629	0.07	631
25	T12F34 - 3 lamp MB	79	3570	115	9.09	32,433	T8F32 - 3 lamp RLO	79	3570	78	6.16	21,998	2.92	10,435
26a	T12F34 - 3 lamp MB	19	3570	115	2.19	7,800	T8F32 - 3 lamp RLO	19	3570	78	1.48	5,291	0.70	2,510
26b	T12F34 - 3 lamp MB	6	800	115	0.69	552	T8F32 - 3 lamp RLO	6	800	78	0.47	374	0.22	178
27	T12F96HO - 1 lamp MB	15	8760	112	1.68	14,717	T8F95HO - 1 lamp	15	8760	80	1.20	10,512	0.48	4,205
28a	T12F34 - 4 lamp MB	2	8760	144	0.29	2,523	T8F32 - 4 lamp RLO	2	8760	102	0.20	1,787	0.08	736
28b	T12F34 - 4 lamp MB	16	3570	144	2.30	8,225	T8F32 - 4 lamp RLO	16	3570	102	1.63	5,826	0.67	2,399
28c	T12F34 - 4 lamp MB	10	800	144	1.44	1,152	T8F32 - 4 lamp RLO	10	800	102	1.02	816	0.42	336
28d	T12F34 - 4 lamp MB	57	8760	144	8.21	71,902	T8F32 - 4 lamp RLO	57	8760	102	5.81	50,931	2.39	20,971
Total		**1,827**			**138.8**	**831,724**		**1,827**			**95.9**	**569,665**	**42.8**	**262,059**

Customer Cost/Benefit Analysis

Cost and Payback are based on Palo Alto City Facility Rates of 0.0706 $/kWh (effective 1-1-05).

- Site #1: (Retrofit Cost $88,252 - Rebate $45,178) / (Energy Savings $18,501) = Simple Payback 2.3 Years

Appendix D-2: Palo Alto C&I Lighting Rebate Site #2

M&V REPORT FOR C&I LIGHTING SITE #2

Prepared for the City of Palo Alto Utilities
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Palo Alto**

Site Name: **Site #2**

Site Address: **4000 Middlefield Road, Palo Alto, CA 94303**

Principal Site Contact Name: **Bernie Sana** **Telephone: (650) 329-2418**

Utility Representative Name: **Virginia Waik** **Telephone: (650) 329-2168**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Palo Alto Site #2

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #2	n/a	Lighting	Palo Alto	SB5X Project	212,485	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #2	Lighting	100.6	310,463	n/a	63,794

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #2	Lighting	89.3	273,882	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: City of Palo Alto Utilities End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Planergy, Inc., the following efficiency improvements were plannned under this project at the Site #2.

Table 1. Planned Efficiency Improvements at Palo Alto Site #2

Measure	Description	Qty.	Location
1	CFL22	1	Building A
2	T8F32 - 2 lamp RLO Tandem	72	Building A
3	T8F32 - 2 lamp RLO	7	Building A
4	T8F32 - 2 lamp RLO Tandem	68	Building B
5	T8F32 - 2 lamp RLO	7	Building B
6	T8F32 - 2 lamp RLO Tandem	66	Building C
7	T8F32 - 2 lamp RLO	3	Building C
8	T8F32 - 4 lamp RLO	2	Building C
	CFL15	1	Building C
9	T8F32 - 2 lamp RLO Tandem	24	Building D
10	T8F32 - 2 lamp RLO	18	Building D
11	T8F32 - 4 lamp RLO	13	Building D
13	T8F32 - 2 lamp RLO	1	Building E
14	T8F32 - 2 lamp RLO	37	Building E
15a	T8F32 - 2 lamp NLO	12	Building E
15b	T8F32 - 4 lamp RLO	12	Building E
16	T8F32 - 8 lamp RLO	6	Building F
17	T8F32 - 2 lamp RLO	32	Building F
18	T8F32 - 4 lamp RLO	7	Building F
19	T8F32 - 4 lamp RLO	3	Building F
23	T8F32 - 2 lamp NLO	1	Building F
24	T8F32 - 4 lamp RLO	82	Building H
25	T8F32 - 4 lamp RLO	8	Building H
26	T8F32 - 2 lamp RLO	3	Building H
28	ExitLED	10	Building I
29	T8F17 - 1 lamp RLO	14	Building I
30	CFL22	1	Building I
31	T8F32 - 1 lamp RLO	75	Building I
32	T8F32 - 1 lamp RLO Tandem 4	131	Building I
33	T8F32 - 1 lamp RLO Tandem 4	251	Building I
34	T8F32 - 2 lamp RLO Tandem	72	Building I
35	T8F32 - 2 lamp RLO	21	Building I
36	T8F32 - 6 lamp RLO	20	Building I
37	T8F32 - 4 lamp RLO	52	Building J
38	T8F32 - 2 lamp RLO Tandem	42	Building J
39	T8F32 - 2 lamp RLO	1	Building J
40	T8F32 - 2 lamp RLO	4	Building J
41	T8F32 - 2 lamp RLO	2	Building J
42	T8F32 - 4 lamp RLO	15	Building K
43	T8F32 - 4 lamp RLO	31	Building K
44	CFL22	3	Building K
45	CFL 2x15	2	Building K
46	T8F32 - 2 lamp RLO	14	Building K
47	T8F32 - 4 lamp RLO	2	Building K
48	T8F32 - 6 lamp RLO	64	Building L
49	T8F25 - 6 lamp RLO	4	Building L
50	T8F32 - 4 lamp RLO	31	Building L
51	T8F32 - 4 lamp RLO	6	Building L
52	T8F32 - 4 lamp RLO	4	Building L
56	T8F32 - 4 lamp RLO	4	Building L
54	T8F32 - 2 lamp NLO	1	Building L

Table 1. Planned Efficiency Improvements at Palo Alto Site #2

Measure	Description	Qty.	Location
55	T8F32 - 2 lamp RLO Tandem	16	Building L
56	T8F32 - 2 lamp RLO	45	Building L
57	CFL 2x15	1	Building L
58	ExitLED	4	Building L
59	T8F59 - 2 lamp NLO	33	Building M
60	T8F32 - 4 lamp RLO	4	Building M
61	T8F32 - 2 lamp RLO	15	Building M
62	CFL 2x15	3	Building M
63	CFL23	4	Building M
64	CFL22	1	Building M
65	CFL15	1	Building M
66	ExitLED	2	Building M
67	T5F55 - 4 lamp RLO	36	Building MPR
68	T8F32 - 4 lamp RLO	13	Building MPR
69	T8F32 - 2 lamp RLO	6	Building MPR
70	T8F32 - 2 lamp RLO	1	Building MPR
71	T8F17 - 3 lamp RLO	6	Building MPR
72	CFL 3x15	2	Building MPR
73	CFL 3x15	1	Building MPR
74	CFL 2x15	2	Building MPR
75	CFL22	9	Building MPR
76	CFL15	2	Building MPR
77	ExitLED	4	Building MPR
78	T8F32 - 8 lamp RLO	20	Building P
79a	T8F32 - 4 lamp RLO	29	Building P
79b	T8F32 - 2 lamp NLO	4	Building P
80	T8F32 - 2 lamp RLO Tandem	4	Building P
81	T8F32 - 2 lamp RLO	2	Building P
82	T8F59 - 2 lamp NLO	30	Building S
83a	T8F32 - 1 lamp RLO	32	Building S
83b	T8F32 - 2 lamp RLO	9	Building S
83c	T8F32 - 2 lamp RLO	3	Building S
84	T8F59 - 2 lamp NLO	1	Building T
85	T8F32 - 4 lamp RLO	49	Building T
86	T8F32 - 2 lamp RLO Tandem	26	Building T
87a	CFL 2x22	1	Building T
87b	CFL22	1	Building T
87c	CFL 2x15	1	Building T
87d	CFL22	29	Building T
90b	T8F32 - 2 lamp RLO	1	Building T
89a	T8F32 - 4 lamp RLO	8	Building T
89b	T8F32 - 4 lamp RLO	11	Building T
86	T8F32 - 2 lamp NLO	6	Building U
88	T8F32 - 2 lamp NLO Tandem	58	Building U
90	T8F32 - 2 lamp RLO	12	Building U
91	CFL22	1	Building U
92	T8F32 - 8 lamp RLO	1	Building U
93a	T8F32 - 2 lamp NLO	15	Building V
93b	T8F32 - 2 lamp NLO Tandem	14	Building V
93c	T8F32 - 2 lamp RLO Tandem	4	Building V
94	T8F32 - 2 lamp RLO	24	Gym A
95	T8F32 - 2 lamp RLO	2	Gym A
96	T8F17 - 3 lamp RLO	1	Gym A
97	CFL 2x15	3	Gym A
98	CFL22	3	Gym A
99	ExitLED	4	Gym A
100	T5F55 - 4 lamp RLO	24	Gym B
101	T8F32 - 2 lamp RLO	22	Gym B
102	T8F32 - 2 lamp RLO	3	Gym B
103	ExitLED	4	Gym B
104	CFL 2x15	2	Gym B
105	T8F32 - 4 lamp RLO	3	Pavillion

Table 1. Planned Efficiency Improvements at Palo Alto Site #2

Measure	Description	Qty.	Location
106	T8F32 - 2 lamp RLO	18	Pavillion
107	T8F17 - 3 lamp RLO	12	Pavillion
108	CFL22	5	Pavillion
109	ExitLED	2	Pavillion
110a	T8F32 - 2 lamp NLO	5	Pavillion
110	T8F32 - 4 lamp RLO	8	Theatre
111	T8F32 - 2 lamp RLO Tandem	6	Theatre
112	CFL 2x15	2	Theatre
113	CFL22	8	Theatre
114	ExitLED	4	Theatre
Total		**2,111**	

Note: EB = Electronic Ballast

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #2.

Table 2. Verified Efficiency Improvements at Palo Alto Site #2

Measure	Description	Qty.	Location
2	T8F32 - 2 lamp RLO Tandem	72	Building A Classrooms
3a	T8F32 - 2 lamp RLO	2	Building A Bathrooms
3b	T8F32 - 2 lamp RLO	3	Building A Storage & Custodian
4	T8F32 - 2 lamp RLO Tandem	68	Building B Classrooms
5a	T8F32 - 2 lamp RLO	3	Building B Bathrooms
5b	T8F32 - 2 lamp RLO	3	Building B Storage
6	T8F32 - 2 lamp RLO Tandem	66	Building C Classrooms
7	T8F32 - 2 lamp RLO	3	Building C Classrooms
8	T8F32 - 4 lamp RLO	2	Building C Office
9	T8F32 - 2 lamp RLO Tandem	22	Building D Classrooms
10	T8F32 - 2 lamp RLO	28	Building D Classrooms
11	T8F32 - 4 lamp RLO	13	Building D Classrooms
12	CFL20	2	Building D Storage
13	T8F32 - 2 lamp RLO	1	Building E Closet
14	T8F32 - 2 lamp RLO	34	Building E Classrooms
15	T8F32 - 4 lamp RLO	24	Building E Classrooms
16	T8F32 - 8 lamp RLO	8	Building F Office
17	T8F32 - 2 lamp RLO	34	Building F Classrooms & Hall
18	T8F32 - 4 lamp RLO	8	Building F Classrooms
19	T8F32 - 4 lamp RLO	3	Building F Classrooms
20	T8F32 - 2 lamp RLO Tandem	4	Building F Classrooms
21	T8F32 - 4 lamp RLO	16	Building F Office
22	T8F32 - 2 lamp RLO	3	Building F Closet
24	T8F32 - 4 lamp RLO	116	Building H Classrooms
25	T8F32 - 4 lamp RLO	8	Building H Classrooms & Kitchen
26	T8F32 - 2 lamp RLO	3	Building H Classrooms & Kitchen
27	ExitLED	1	Building H Exit
28	ExitLED	6	Building I Exits
29	T8F17 - 1 lamp RLO	13	Building I Classrooms
30	CFL20	6	Building I Halls
31	T8F32 - 1 lamp RLO	38	Building I Classrooms
32	T8F32 - 2 lamp RLO Tandem	82	Building I Classrooms
33	T8F32 - 2 lamp RLO	159	Building I Classrooms
34	T8F32 - 2 lamp RLO Tandem	46	Building I Offices
35a	T8F32 - 2 lamp RLO	6	Building I Halls
35b	T8F32 - 4 lamp RLO	3	Building I Classrooms
36	T8F32 - 6 lamp RLO	20	Building I Lecture Hall
37	T8F32 - 4 lamp RLO	72	Building J Classrooms & Office
38	T8F32 - 2 lamp RLO Tandem	44	Building J Classrooms & Office
39	T8F32 - 2 lamp RLO	1	Building J Storage
40	T8F32 - 2 lamp RLO	3	Building J Bathrooms
42	T8F32 - 4 lamp RLO	36	Building K Classrooms
43	T8F32 - 4 lamp RLO	36	Building K Classrooms & Office
44	CFL20	2	Building K Office

Table 2. Verified Efficiency Improvements at Palo Alto Site #2

Measure	Description	Qty.	Location
45a	CFL 3x13	3	Building K Office
45b	CFL 3x13	3	Building K Storage
46	T8F32 - 2 lamp RLO	10	Building K Classrooms
47	T8F32 - 2 lamp RLO	2	Building K Bathrooms
48a	T8F32 - 6 lamp RLO	48	Building L Classrooms
48b	T8F32 - 6 lamp RLO	16	Building L Classrooms
49	T8F25 - 6 lamp RLO	4	Building L Classrooms
50	T8F32 - 4 lamp RLO	27	Building L Classrooms
51	T8F32 - 4 lamp RLO	6	Building L Classrooms
52	T8F32 - 4 lamp RLO	4	Building L Classrooms
53	T8F32 - 4 lamp RLO	4	Building L Storage
54	T8F32 - 4 lamp RLO	1	Building L Bathrooms
55a	T8F32 - 2 lamp RLO Tandem	18	Building L Office
55b	T8F32 - 2 lamp RLO	2	Building L Office
56a	T8F32 - 2 lamp RLO	3	Building L Bathrooms
56b	T8F32 - 2 lamp RLO	33	Building L Classrooms
56c	T8F32 - 2 lamp RLO Tandem	5	Building L Storage
57	CFL20	2	Building L Bathrooms
58	ExitLED	7	Building L Exits
59	T8F59 - 2 lamp NLO	39	Building M Classrooms
60	T8F32 - 4 lamp RLO	2	Building M Closet
61a	T8F32 - 2 lamp RLO	8	Building M Office & Hall
61b	T8F32 - 2 lamp RLO	5	Building M Storage
62	CFL 2x13	2	Building M Storage
63	CFL20	3	Building M Classrooms
64	CFL20	1	Building M Storage
65	CFL15	1	Building M Storage
66	ExitLED	2	Building M Exits
67	T5F55 - 4 lamp RLO	36	Building MPR
68a	T8F32 - 4 lamp RLO	2	Building MPR Storage
68b	T8F32 - 4 lamp RLO	13	Building MPR
69	T8F32 - 2 lamp RLO	6	Building MPR
70	T8F32 - 2 lamp RLO	1	Building MPR Storage
71	T8F17 - 3 lamp RLO	6	Building MPR
72	CFL 3x13	4	Building MPR Storage
73	CFL15	3	Building MPR Storage
74	CFL 2x13	1	Building MPR Storage
75a	CFL15	4	Building MPR Storage
75b	CFL15	5	Building MPR
76	CFL20	4	Building MPR
77	ExitLED	4	Building MPR Exits
78	T8F32 - 8 lamp RLO	24	Building P Classrooms
79	T8F32 - 4 lamp RLO	23	Building P Classrooms & Office
80	T8F32 - 2 lamp RLO Tandem	6	Building P Classrooms & Office
81	T8F32 - 2 lamp RLO	2	Building P Bathrooms
82	T8F59 - 2 lamp NLO	31	Building S Classrooms
83	T8F32 - 2 lamp RLO	27	Building S Classrooms
84	T8F59 - 2 lamp NLO	2	Building T1
85a	T8F32 - 4 lamp RLO	17	Building T2
85b	T8F32 - 4 lamp RLO	33	Building T1
86a	T8F32 - 2 lamp RLO	18	Building T2
86b	T8F32 - 2 lamp RLO	1	Building T2
86c	T8F32 - 2 lamp RLO	4	Building T1
87	CFL20	3	Building T2
88	T8F32 - 2 lamp RLO	58	Building U Classrooms
89a	T8F32 - 4 lamp RLO	4	Building U Classrooms
89b	T8F32 - 2 lamp RLO	2	Building U Classrooms
90	T8F32 - 2 lamp RLO	12	Building U Classrooms
91	CFL 3x13	1	Building U Storage
92	T8F32 - 2 lamp RLO	5	Building U Storage
93	T8F32 - 2 lamp NLO	34	Building V Classrooms
94a	T8F32 - 2 lamp RLO	20	Gym A Lockers

Table 2. Verified Efficiency Improvements at Palo Alto Site #2

Measure	Description	Qty.	Location
94b	T8F32 - 2 lamp RLO	4	Gym A Storage
95	T8F32 - 2 lamp RLO	2	Gym A Office
96	T8F17 - 2 lamp RLO	1	Gym A Lockers
97	CFL 2x13	3	Gym A Hall
98a	CFL15	3	Gym A Storage
98b	CFL20	4	Gym A Storage
99	ExitLED	4	Gym A Exits
100	T5F55 - 4 Lamp RLO	24	Gym B Gym
101a	T8F32 - 2 lamp RLO	16	Gym B Lockers
101b	T8F32 - 2 lamp RLO	12	Gym B Activity
102	T8F32 - 2 lamp RLO	3	Gym B Office
103	ExitLED	4	Gym B Exits
104	CFL 2x13	2	Gym B Lockers
105a	T8F32 - 4 lamp RLO	4	Pavilion Entrance
105b	T8F32 - 4 lamp RLO	2	Pavilion Lockers
105c	T8F32 - 4 lamp RLO	1	Pavilion Storage
106	T8F32 - 2 lamp RLO	12	Pavilion Lockers
107	T8F17 - 3 lamp RLO	12	Pavilion Lobby & Bathrooms
108	CFL20	4	Pavilion Hall & Lockers
109	ExitLED	10	Pavilion Exits
110	T8F32 - 4 lamp RLO	8	Theater
111a	T8F32 - 2 lamp RLO	6	Theater Control Rm
111b	T8F32 - 2 lamp RLO	1	Theater Storage
112	CFL20	2	Theater Office
113a	CFL20	4	Theater Stairwell
113b	CFL20	2	Theater Storage
113c	CFL28	2	Theater
114	ExitLED	2	Theater Exits
Total		**1,954**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #2

Measure	Description	Qty.	Hours/yr	W/fixture	Location
2	T12F34 - 2 lamp MB	72	3060	72	Building A Classrooms
3a	T12F34 - 2 lamp MB	2	3060	72	Building A Bathrooms
3b	T12F34 - 2 lamp MB	3	800	72	Building A Storage & Custodian
4	T12F34 - 2 lamp MB	68	3060	72	Building B Classrooms
5a	T12F34 - 2 lamp MB	3	3060	72	Building B Bathrooms
5b	T12F34 - 2 lamp MB	3	800	72	Building B Storage
6	T12F34 - 2 lamp MB	66	3060	72	Building C Classrooms
7	T12F34 - 2 lamp MB	3	3060	72	Building C Classrooms
8	T12F34 - 4 lamp MB	2	800	144	Building C Office
9	T12F34 - 2 lamp MB	22	3060	72	Building D Classrooms
10	T12F34 - 2 lamp MB	28	3060	72	Building D Classrooms
11	T12F34 - 4 lamp MB	13	3060	144	Building D Classrooms
12	100W	2	800	100	Building D Storage
13	T12F34 - 2 lamp MB	1	3060	72	Building E Closet
14	T12F34 - 2 lamp MB	34	3060	72	Building E Classrooms
15	T12F34 - 4 lamp MB	24	3060	144	Building E Classrooms
16	T12F96 - 4 lamp MB	8	3060	246	Building F Office
17	T12F34 - 2 lamp MB	34	3060	72	Building F Classrooms & Hall
18	T12F34 - 4 lamp MB	8	3060	144	Building F Classrooms
19	300W	3	3060	144	Building F Classrooms
20	T12F34 - 2 lamp MB	4	3060	72	Building F Classrooms
21	T12F34 - 4 lamp MB	16	3060	144	Building F Office
22	T12F34 - 2 lamp MB	3	800	72	Building F Closet
24	T12F96 - 2 lamp MB	116	3060	123	Building H Classrooms
25	T12F34 - 4 lamp MB	8	3060	144	Building H Classrooms & Kitchen
26	T12F34 - 4 lamp MB	3	3060	144	Building H Classrooms & Kitchen

Table 3. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #2

Measure	Description	Qty.	Hours/yr	W/fixture	Location
27	Exit40W	1	8760	40	Building H Exit
28	Exit40W	6	8760	40	Building I Exits
29	T12F20 - 1 lamp MB	13	3978	28	Building I Classrooms
30	75W	6	3978	75	Building I Halls
31	T12F34 - 1 lamp MB	38	3978	43	Building I Classrooms
32	T12F34 - 2 lamp MB	82	3978	72	Building I Classrooms
33	T12F34 - 2 lamp MB	159	3978	72	Building I Classrooms
34	T12F34 - 2 lamp MB	46	3366	72	Building I Offices
35a	T12F34 - 2 lamp MB	6	3978	72	Building I Halls
35b	T12F34 - 4 lamp MB	3	3978	144	Building I Classrooms
36	T12F34 - 6 lamp MB	20	3366	216	Building I Lecture Hall
37	T12F96 - 2 lamp MB	72	3060	123	Building J Classrooms & Office
38	T12F34 - 2 lamp MB	44	3060	72	Building J Classrooms & Office
39	T12F34 - 2 lamp MB	1	800	72	Building J Storage
40	T12F34 - 2 lamp MB	3	3060	72	Building J Bathrooms
42	T12F96 - 2 lamp MB	36	2805	123	Building K Classrooms
43	T12F34 - 4 lamp MB	36	2805	144	Building K Classrooms & Office
44	60W	2	2805	60	Building K Office
45a	100W	3	2805	100	Building K Office
45b	100W	3	800	100	Building K Storage
46	T12F34 - 2 lamp MB	10	2805	72	Building K Classrooms
47	T12F34 - 2 lamp MB	2	2805	72	Building K Bathrooms
48a	T12F96 - 4 lamp MB	48	2805	246	Building L Classrooms
48b	T12F96 - 3 lamp MB	16	2805	210	Building L Classrooms
49	T12F72 - 3 lamp MB	4	2805	122	Building L Classrooms
50	T12F96 - 2 lamp MB	27	2805	123	Building L Classrooms
51	T12F34 - 4 lamp MB	6	2805	144	Building L Classrooms
52	T12F34 - 4 lamp MB	4	2805	144	Building L Classrooms
53	T12F96 - 2 lamp MB	4	800	123	Building L Storage
54	T12F34 - 4 lamp MB	1	2805	144	Building L Bathrooms
55a	T12F34 - 2 lamp MB	18	2805	72	Building L Office
55b	T12F34 - 4 lamp MB	2	2805	144	Building L Office
56a	T12F34 - 2 lamp MB	3	2805	72	Building L Bathrooms
56b	T12F34 - 2 lamp MB	33	2805	72	Building L Classrooms
56c	T12F34 - 2 lamp MB	5	800	72	Building L Storage
57	60W	2	2805	60	Building L Bathrooms
58	Exit40W	7	8760	40	Building L Exits
59	T12F96 - 2 lamp MB	39	2805	123	Building M Classrooms
60	T12F34 - 4 lamp MB	2	800	144	Building M Closet
61a	T12F34 - 2 lamp MB	8	2805	72	Building M Office & Hall
61b	T12F34 - 2 lamp MB	5	800	72	Building M Storage
62	2x60W	2	2805	120	Building M Storage
63	60W	3	2805	60	Building M Classrooms
64	100W	1	800	100	Building M Storage
65	60W	1	800	60	Building M Storage
66	Exit40W	2	8760	40	Building M Exits
67	500W	36	3060	500	Building MPR
68a	T12F34 - 4 lamp MB	2	800	144	Building MPR Storage
68b	T12F34 - 4 lamp MB	13	3060	144	Building MPR
69	T12F34 - 2 lamp MB	6	3060	72	Building MPR
70	300W	1	800	300	Building MPR Storage
71	T12F34 - 2 lamp U MB	6	3060	72	Building MPR
72	60W	4	800	100	Building MPR Storage
73	60W	3	800	72	Building MPR Storage
74	60W	1	800	100	Building MPR Storage
75a	60W	4	800	100	Building MPR Storage
75b	60W	5	3060	72	Building MPR
76	100W	4	3060	72	Building MPR
77	Exit40W	4	8760	40	Building MPR Exits
78	T12F96 - 4 lamp MB	24	2805	246	Building P Classrooms
79	T12F34 - 4 lamp MB	23	2805	144	Building P Classrooms & Office
80	T12F34 - 2 lamp MB	6	2805	72	Building P Classrooms & Office

Table 3. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #2

Measure	Description	Qty.	Hours/yr	W/fixture	Location
81	T12F34 - 2 lamp MB	2	800	72	Building P Bathrooms
82	T12F96 - 2 lamp MB	31	3060	123	Building S Classrooms
83	T12F34 - 2 lamp MB	27	3060	72	Building S Classrooms
84	T12F96 - 2 lamp MB	2	2550	123	Building T1
85a	T12F34 - 4 lamp MB	17	3060	144	Building T2
85b	T12F34 - 4 lamp MB	33	2550	144	Building T1
86a	T12F34 - 2 lamp MB	18	3060	72	Building T2
86b	T12F34 - 2 lamp MB	1	3060	72	Building T2
86c	T12F34 - 2 lamp MB	4	2550	72	Building T1
87	60W	3	3060	60	Building T2
88	T12F34 - 4 lamp MB	58	2805	144	Building U Classrooms
89a	T12F34 - 4 lamp MB	4	2805	144	Building U Classrooms
89b	T12F34 - 4 lamp MB	2	2805	144	Building U Classrooms
90	T12F34 - 2 lamp MB	12	2805	72	Building U Classrooms
91	100W	1	800	100	Building U Storage
92	T12F34 - 4 lamp MB	5	800	144	Building U Storage
93	T12F34 - 4 lamp MB	34	4380	144	Building V Classrooms
94a	300W	20	2856	300	Gym A Lockers
94b	300W	4	800	300	Gym A Storage
95	T12F34 - 2 lamp MB	2	2856	72	Gym A Office
96	T12F20 - 2 lamp MB	1	2856	56	Gym A Lockers
97	60W	3	2856	60	Gym A Hall
98a	60W	3	800	60	Gym A Storage
98b	100W	4	800	100	Gym A Storage
99	Exit40W	4	2856	40	Gym A Exits
100	400WMH	24	2856	458	Gym B Gym
101a	100W	16	2856	100	Gym B Lockers
101b	300W	12	2856	300	Gym B Activity
102	T12F34 - 2 lamp MB	3	2856	72	Gym B Office
103	Exit40W	4	8760	40	Gym B Exits
104	60W	2	2856	60	Gym B Lockers
105a	T12F34 - 4 lamp MB	4	2856	144	Pavilion Entrance
105b	T12F34 - 4 lamp MB	2	2856	144	Pavilion Lockers
105c	T12F34 - 4 lamp MB	1	800	144	Pavilion Storage
106	300W	12	2856	300	Pavilion Lockers
107	T12F34 - 2 lamp U MB	12	2856	72	Pavilion Lobby & Bathrooms
108	100W	4	2856	100	Pavilion Hall & Lockers
109	Exit40W	10	2856	40	Pavilion Exits
110	T12F34 - 4 lamp MB	8	2805	144	Theater
111a	T12F34 - 2 lamp MB	6	2805	100	Theater Control Rm
111b	T12F34 - 2 lamp MB	1	800	100	Theater Storage
112	60W	2	2805	72	Theater Office
113a	60W	4	8760	72	Theater Stairwell
113b	100W	2	800	100	Theater Storage
113C	300W	2	2805	60	Theater
114	Exit40W	2	8760	123	Theater Exits
Total		**1,954**			

Primary Business Descriptions:
Site #2 consists of a theater, pavilion, gym, storage, offices, and classrooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Palo Alto Site #2

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
2	T12F34 - 2 lamp MB	72	3060	72	5.18	15,863	T8F32 - 2 lamp RLO Tandem	72	3060	51	3.67	11,236	1.51	4,627
3a	T12F34 - 2 lamp MB	2	3060	72	0.14	441	T8F32 - 2 lamp RLO	2	3060	52	0.10	318	0.04	122
3b	T12F34 - 2 lamp MB	3	800	72	0.22	173	T8F32 - 2 lamp RLO	3	800	52	0.16	125	0.06	48
4	T12F34 - 2 lamp MB	68	3060	72	4.90	14,982	T8F32 - 2 lamp RLO Tandem	68	3060	51	3.47	10,612	1.43	4,370
5a	T12F34 - 2 lamp MB	3	3060	72	0.22	661	T8F32 - 2 lamp RLO	3	3060	52	0.16	477	0.06	184
5b	T12F34 - 2 lamp MB	3	800	72	0.22	173	T8F32 - 2 lamp RLO	3	800	52	0.16	125	0.06	48
6	T12F34 - 2 lamp MB	66	3060	72	4.75	14,541	T8F32 - 2 lamp RLO Tandem	66	3060	51	3.37	10,300	1.39	4,241
7	T12F34 - 2 lamp MB	3	3060	72	0.22	661	T8F32 - 2 lamp RLO	3	3060	52	0.16	477	0.06	184
8	T12F34 - 4 lamp MB	2	800	144	0.29	230	T8F32 - 4 lamp RLO	2	800	102	0.20	163	0.08	67
9	T12F34 - 2 lamp MB	22	3060	72	1.58	4,847	T8F32 - 2 lamp RLO Tandem	22	3060	51	1.12	3,433	0.46	1,414
10	T12F34 - 2 lamp MB	28	3060	72	2.02	6,169	T8F32 - 2 lamp RLO	28	3060	52	1.46	4,455	0.56	1,714
11	T12F34 - 4 lamp MB	13	3060	144	1.87	5,728	T8F32 - 4 lamp RLO	13	3060	102	1.33	4,058	0.55	1,671
12	100W	2	800	100	0.20	160	CFL20	2	800	20	0.04	32	0.16	128
13	T12F34 - 2 lamp MB	1	3060	72	0.07	220	T8F32 - 2 lamp RLO	1	3060	52	0.05	159	0.02	61
14	T12F34 - 2 lamp MB	34	3060	72	2.45	7,491	T8F32 - 2 lamp RLO	34	3060	52	1.77	5,410	0.68	2,081
15	T12F34 - 4 lamp MB	24	3060	144	3.46	10,575	T8F32 - 4 lamp RLO	24	3060	102	2.45	7,491	1.01	3,084
16	T12F96 - 4 lamp MB	8	3060	246	1.97	6,022	T8F32 - 8 lamp RLO	8	3060	204	1.63	4,994	0.34	1,028
17	T12F34 - 2 lamp MB	34	3060	72	2.45	7,491	T8F32 - 2 lamp RLO	34	3060	52	1.77	5,410	0.68	2,081
18	T12F34 - 4 lamp MB	8	3060	144	1.15	3,525	T8F32 - 4 lamp RLO	8	3060	102	0.82	2,497	0.34	1,028
19	300W	3	3060	144	0.43	1,322	T8F32 - 4 lamp RLO	3	3060	102	0.31	936	0.13	386
20	T12F34 - 2 lamp MB	4	3060	72	0.29	881	T8F32 - 2 lamp RLO Tandem	4	3060	51	0.20	624	0.08	257

Table 4. M&V Savings for Palo Alto Site #2

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
21	T12F34 - 4 lamp MB	16	3060	144	2.30	7,050	T8F32 - 4 lamp RLO	16	3060	102	1.63	4,994	0.67	2,056
22	T12F34 - 2 lamp MB	3	800	72	0.22	173	T8F32 - 2 lamp RLO	3	800	52	0.16	125	0.06	48
24	T12F96 - 2 lamp MB	116	3060	123	14.27	43,660	T8F32 - 4 lamp RLO	116	3060	102	11.83	36,206	2.44	7,454
25	T12F34 - 4 lamp MB	8	3060	144	1.15	3,525	T8F32 - 4 lamp RLO	8	3060	102	0.82	2,497	0.34	1,028
26	T12F34 - 4 lamp MB	3	3060	144	0.43	1,322	T8F32 - 2 lamp RLO	3	3060	52	0.16	477	0.28	845
27	Exit40W	1	8760	40	0.04	350	ExitLED	1	8760	102	0.10	894	(0.06)	(543)
28	Exit40W	6	8760	40	0.24	2,102	ExitLED	6	8760	2	0.01	105	0.23	1,997
29	T12F20 - 1 lamp MB	13	3978	28	0.36	1,448	T8F17 - 1 lamp RLO	13	3978	15	0.20	776	0.17	672
30	75W	6	3978	75	0.45	1,790	CFL20	6	2856	20	0.12	343	0.33	1,447
31	T12F34 - 1 lamp MB	38	3978	43	1.63	6,500	T8F32 - 1 lamp RLO	38	3978	26	0.99	3,930	0.65	2,570
32	T12F34 - 2 lamp MB	82	3978	72	5.90	23,486	T8F32 - 2 lamp RLO Tandem	82	3978	51	4.18	16,636	1.72	6,850
33	T12F34 - 2 lamp MB	159	3978	72	11.45	45,540	T8F32 - 2 lamp RLO	159	3978	52	8.27	32,890	3.18	12,650
34	T12F34 - 2 lamp MB	46	3366	72	3.31	11,148	T8F32 - 2 lamp RLO Tandem	46	3366	51	2.35	7,897	0.97	3,252
35a	T12F34 - 2 lamp MB	6	3978	72	0.43	1,718	T8F32 - 2 lamp RLO	6	3978	52	0.31	1,241	0.12	477
35b	T12F34 - 4 lamp MB	3	3978	144	0.43	1,718	T8F32 - 4 lamp RLO	3	3978	102	0.31	1,217	0.13	501
36	T12F34 - 6 lamp MB	20	3366	216	4.32	14,541	T8F32 - 6 lamp RLO	20	3366	154	3.08	10,367	1.24	4,174
37	T12F96 - 2 lamp MB	72	3060	123	8.86	27,099	T8F32 - 4 lamp RLO	72	3060	52	3.74	11,457	5.11	15,643
38	T12F34 - 2 lamp MB	44	3060	72	3.17	9,694	T8F32 - 2 lamp RLO Tandem	44	3060	51	2.24	6,867	0.92	2,827
39	T12F34 - 2 lamp MB	1	800	72	0.07	58	T8F32 - 2 lamp RLO	1	800	52	0.05	42	0.02	16
40	T12F34 - 2 lamp MB	3	3060	72	0.22	661	T8F32 - 2 lamp RLO	3	3060	52	0.16	477	0.06	184
42	T12F96 - 2 lamp MB	36	2805	123	4.43	12,421	T8F32 - 4 lamp RLO	36	2805	102	3.67	10,300	0.76	2,121
43	T12F34 - 4 lamp MB	36	2805	144	5.18	14,541	T8F32 - 4 lamp RLO	36	2805	102	3.67	10,300	1.51	4,241
44	60W	2	2805	60	0.12	337	CFL20	2	2805	52	0.10	292	0.02	45
45a	100W	3	2805	100	0.30	842	CFL 3x13	3	2805	45	0.14	379	0.17	463
45b	100W	3	800	100	0.30	240	CFL 3x13	3	800	45	0.14	108	0.17	132
46	T12F34 - 2 lamp MB	10	2805	72	0.72	2,020	T8F32 - 2 lamp RLO	10	2805	52	0.52	1,459	0.20	561
47	T12F34 - 2 lamp MB	2	2805	72	0.14	404	T8F32 - 2 lamp RLO	2	2805	52	0.10	292	0.04	112
48a	T12F96 - 4 lamp MB	48	2805	246	11.81	33,121	T8F32 - 6 lamp RLO	48	2805	154	7.39	20,735	4.42	12,387
48b	T12F96 - 3 lamp MB	16	2805	210	3.36	9,425	T8F32 - 6 lamp RLO	16	2805	154	2.46	6,912	0.90	2,513
49	T12F72 - 3 lamp MB	4	2805	122	0.49	1,369	T8F25 - 6 lamp RLO	4	2805	134	0.54	1,503	(0.05)	(135)
50	T12F96 - 2 lamp MB	27	2805	123	3.32	9,315	T8F32 - 4 lamp RLO	27	2805	102	2.75	7,725	0.57	1,590
51	T12F34 - 4 lamp MB	6	2805	144	0.86	2,424	T8F32 - 4 lamp RLO	6	2805	102	0.61	1,717	0.25	707
52	T12F34 - 4 lamp MB	4	2805	144	0.58	1,616	T8F32 - 4 lamp RLO	4	2805	102	0.41	1,144	0.17	471
53	T12F96 - 2 lamp MB	4	800	123	0.49	394	T8F32 - 4 lamp RLO	4	800	102	0.41	326	0.08	67

Table 4. M&V Savings for Palo Alto Site #2

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
54	T12F34 - 4 lamp MB	1	2805	144	0.14	404	T8F32 - 4 lamp RLO	1	2805	102	0.10	286	0.04	118
55a	T12F34 - 2 lamp MB	18	2805	72	1.30	3,635	T8F32 - 2 lamp RLO Tandem	18	2805	51	0.92	2,575	0.38	1,060
55b	T12F34 - 4 lamp MB	2	2805	144	0.29	808	T8F32 - 2 lamp RLO	2	2805	52	0.10	292	0.18	516
56a	T12F34 - 2 lamp MB	3	2805	72	0.22	606	T8F32 - 2 lamp RLO	3	2805	52	0.16	438	0.06	168
56b	T12F34 - 2 lamp MB	33	2805	72	2.38	6,665	T8F32 - 2 lamp RLO	33	2805	52	1.72	4,813	0.66	1,851
56c	T12F34 - 2 lamp MB	5	800	72	0.36	288	T8F32 - 2 lamp RLO Tandem	5	800	51	0.26	204	0.11	84
57	60W	2	2805	60	0.12	337	CFL20	2	2805	20	0.04	112	0.08	224
58	Exit40W	7	8760	40	0.28	2,453	ExitLED	7	8760	2	0.01	123	0.27	2,330
59	T12F96 - 2 lamp MB	39	2805	123	4.80	13,456	T8F59 - 2 lamp NLO	39	2805	110	4.29	12,033	0.51	1,422
60	T12F34 - 4 lamp MB	2	800	144	0.29	230	T8F32 - 4 lamp RLO	2	800	102	0.20	163	0.08	67
61a	T12F34 - 2 lamp MB	8	2805	72	0.58	1,616	T8F32 - 2 lamp RLO	8	2805	52	0.42	1,167	0.16	449
61b	T12F34 - 2 lamp MB	5	800	72	0.36	288	T8F32 - 2 lamp RLO	5	800	52	0.26	208	0.10	80
62	2x60W	2	2805	120	0.24	673	CFL 2x13	2	2805	30	0.06	168	0.18	505
63	60W	3	2805	60	0.18	505	CFL20	3	2805	20	0.06	168	0.12	337
64	100W	1	800	100	0.10	80	CFL20	1	800	20	0.02	16	0.08	64
65	60W	1	800	60	0.06	48	CFL15	1	800	15	0.02	12	0.05	36
66	Exit40W	2	8760	40	0.08	701	ExitLED	2	8760	2	0.00	35	0.08	666
67	500W	36	3060	500	18.00	55,080	T5F55 - 4 lamp RLO	36	3060	240	8.64	26,438	9.36	28,642
68a	T12F34 - 4 lamp MB	2	800	144	0.29	230	T8F32 - 4 lamp RLO	2	800	102	0.20	163	0.08	67
68b	T12F34 - 4 lamp MB	13	3060	144	1.87	5,728	T8F32 - 4 lamp RLO	13	3060	102	1.33	4,058	0.55	1,671
69	T12F34 - 2 lamp MB	6	3060	72	0.43	1,322	T8F32 - 2 lamp RLO	6	3060	52	0.31	955	0.12	367
70	300W	1	800	300	0.30	240	T8F32 - 2 lamp RLO	1	800	52	0.05	42	0.25	198
71	T12F34 - 2 lamp U MB	6	3060	72	0.43	1,322	T8F17 - 3 lamp RLO	6	3060	47	0.28	863	0.15	459
72	60W	4	800	100	0.40	320	CFL 3x13	4	800	45	0.18	144	0.22	176
73	60W	3	800	72	0.22	173	CFL15	3	3060	15	0.05	138	0.17	35
74	60W	1	800	100	0.10	80	CFL 2x13	1	800	30	0.03	24	0.07	56
75a	60W	4	800	100	0.40	320	CFL15	4	800	15	0.06	48	0.34	272
75b	60W	5	3060	72	0.36	1,102	CFL15	5	3060	15	0.08	230	0.29	872
76	100W	4	3060	72	0.29	881	CFL20	4	3060	20	0.08	245	0.21	636
77	Exit40W	4	8760	40	0.16	1,402	ExitLED	4	8760	2	0.01	70	0.15	1,332
78	T12F96 - 4 lamp MB	24	2805	246	5.90	16,561	T8F32 - 8 lamp RLO	24	2805	204	4.90	13,733	1.01	2,827
79	T12F34 - 4 lamp MB	23	2805	144	3.31	9,290	T8F32 - 4 lamp RLO	23	2805	102	2.35	6,581	0.97	2,710
80	T12F34 - 2 lamp MB	6	2805	72	0.43	1,212	T8F32 - 2 lamp RLO Tandem	6	2805	52	0.31	875	0.12	337
81	T12F34 - 2 lamp MB	2	800	72	0.14	115	T8F32 - 2 lamp RLO	2	2805	52	0.10	292	0.04	(177)
82	T12F96 - 2 lamp MB	31	3060	123	3.81	11,668	T8F59 - 2 lamp NLO	31	3060	110	3.41	10,435	0.40	1,233
83	T12F34 - 2 lamp MB	27	3060	72	1.94	5,949	T8F32 - 2 lamp RLO	27	3060	52	1.40	4,296	0.54	1,652

Table 4. M&V Savings for Palo Alto Site #2

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
84	T12F96 - 2 lamp MB	2	2550	123	0.25	627	T8F59 - 2 lamp NLO	2	2550	110	0.22	561	0.03	66
85a	T12F34 - 4 lamp MB	17	3060	144	2.45	7,491	T8F32 - 4 lamp RLO	17	3060	102	1.73	5,306	0.71	2,185
85b	T12F34 - 4 lamp MB	33	2550	144	4.75	12,118	T8F32 - 4 lamp RLO	33	2550	102	3.37	8,583	1.39	3,534
86a	T12F34 - 2 lamp MB	18	3060	72	1.30	3,966	T8F32 - 2 lamp RLO	18	3060	52	0.94	2,864	0.36	1,102
86b	T12F34 - 2 lamp MB	1	3060	72	0.07	220	T8F32 - 2 lamp RLO	1	3060	52	0.05	159	0.02	61
86c	T12F34 - 2 lamp MB	4	2550	72	0.29	734	T8F32 - 2 lamp RLO	4	2550	52	0.21	530	0.08	204
87	60W	3	3060	60	0.18	551	CFL20	3	3060	20	0.06	184	0.12	367
88	T12F34 - 4 lamp MB	58	2805	144	8.35	23,427	T8F32 - 2 lamp RLO	58	2805	52	3.02	8,460	5.34	14,967
89a	T12F34 - 4 lamp MB	4	2805	144	0.58	1,616	T8F32 - 4 lamp RLO	4	2805	102	0.41	1,144	0.17	471
89b	T12F34 - 4 lamp MB	2	2805	144	0.29	808	T8F32 - 2 lamp RLO	2	2805	52	0.10	292	0.18	516
90	T12F34 - 2 lamp MB	12	2805	72	0.86	2,424	T8F32 - 2 lamp RLO	12	2805	52	0.62	1,750	0.24	673
91	100W	1	800	100	0.10	80	CFL 3x13	1	800	45	0.05	36	0.06	44
92	T12F34 - 4 lamp MB	5	800	144	0.72	576	T8F32 - 2 lamp RLO	5	800	52	0.26	208	0.46	368
93	T12F34 - 4 lamp MB	34	4380	144	4.90	21,444	T8F32 - 2 lamp NLO	34	2805	59	2.01	5,627	2.89	15,818
94a	300W	20	2856	300	6.00	17,136	T8F32 - 2 lamp RLO	20	2856	52	1.04	2,970	4.96	14,166
94b	300W	4	800	300	1.20	960	T8F32 - 2 lamp RLO	4	800	52	0.21	166	0.99	794
95	T12F34 - 2 lamp MB	2	2856	72	0.14	411	T8F32 - 2 lamp RLO	2	2856	52	0.10	297	0.04	114
96	T12F20 - 2 lamp MB	1	2856	56	0.06	160	T8F17 - 2 lamp RLO	1	2856	31	0.03	89	0.03	71
97	60W	3	2856	60	0.18	514	CFL 2x13	3	2856	30	0.09	257	0.09	257
98a	60W	3	800	60	0.18	144	CFL15	3	800	15	0.05	36	0.14	108
98b	100W	4	800	100	0.40	320	CFL20	4	800	20	0.08	64	0.32	256
99	Exit40W	4	2856	40	0.16	457	ExitLED	4	2856	2	0.01	23	0.15	434
100	400WMH	24	2856	458	10.99	31,393	T5F55 - 4 Lamp RLO	24	2856	240	5.76	16,451	5.23	14,943
101a	100W	16	2856	100	1.60	4,570	T8F32 - 2 lamp RLO	16	2856	52	0.83	2,376	0.77	2,193
101b	300W	12	2856	300	3.60	10,282	T8F32 - 2 lamp RLO	12	2856	52	0.62	1,782	2.98	8,499
102	T12F34 - 2 lamp MB	3	2856	72	0.22	617	T8F32 - 2 lamp RLO	3	2856	52	0.16	446	0.06	171
103	Exit40W	4	8760	40	0.16	1,402	ExitLED	4	8760	2	0.01	70	0.15	1,332
104	60W	2	2856	60	0.12	343	CFL 2x13	2	2856	30	0.06	171	0.06	171
105a	T12F34 - 4 lamp MB	4	2856	144	0.58	1,645	T8F32 - 4 lamp RLO	4	2856	102	0.41	1,165	0.17	480
105b	T12F34 - 4 lamp MB	2	2856	144	0.29	823	T8F32 - 4 lamp RLO	2	2856	102	0.20	583	0.08	240
105c	T12F34 - 4 lamp MB	1	800	144	0.14	115	T8F32 - 4 lamp RLO	1	800	102	0.10	82	0.04	34
106	300W	12	2856	300	3.60	10,282	T8F32 - 2 lamp RLO	12	2856	52	0.62	1,782	2.98	8,499
107	T12F34 - 2 lamp U MB	12	2856	72	0.86	2,468	T8F17 - 3 lamp RLO	12	2856	47	0.56	1,611	0.30	857
108	100W	4	2856	100	0.40	1,142	CFL20	4	2856	20	0.08	228	0.32	914
109	Exit40W	10	2856	40	0.40	1,142	ExitLED	10	2856	2	0.02	57	0.38	1,085

Table 4. M&V Savings for Palo Alto Site #2

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
110	T12F34 - 4 lamp MB	8	2805	144	1.15	3,231	T8F32 - 4 lamp RLO	8	2805	102	0.82	2,289	0.34	942
111a	T12F34 - 2 lamp MB	6	2805	100	0.60	1,683	T8F32 - 2 lamp RLO	6	2805	52	0.31	875	0.29	808
111b	T12F34 - 2 lamp MB	1	800	100	0.10	80	T8F32 - 2 lamp RLO	1	800	52	0.05	42	0.05	38
112	60W	2	2805	72	0.14	404	CFL20	2	2805	20	0.04	112	0.10	292
113a	60W	4	8760	72	0.29	2,523	CFL20	4	8760	20	0.08	701	0.21	1,822
113b	100W	2	800	100	0.20	160	CFL20	2	800	20	0.04	32	0.16	128
113C	300W	2	2805	60	0.12	337	CFL28	2	2805	28	0.06	157	0.06	180
114	Exit40W	2	8760	123	0.25	2,155	ExitLED	2	8760	4	0.01	70	0.24	2,085
Total		**1954**			**235.2**	**712,974**		**1954**			**145.9**	**439,092**	**89.31**	**273,882**

Customer Cost/Benefit Analysis

Cost and Payback are based on Palo Alto City Facility Rates of 0.0706 $/kWh (effective 1-1-05).

- Site #2: (Retrofit Cost $124,621 - Rebate $63,794) / (Energy Savings $19,336) = Simple Payback 3.1 Years

Appendix D-3: Palo Alto C&I Lighting Rebate Site #3

M&V REPORT FOR C&I LIGHTING SITE #3

Prepared for the City of Palo Alto

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Palo Alto**

Site Name: **Site #3**

Site Address: **1305 Middlefield Road, Palo Alto, CA 94301**

Principal Site Contact Name: **Minka Vanderzugacg** **Telephone: (650) 463-4900**

Utility Representative Name: **Virginia Waik** **Telephone: (650) 329-2168**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM**

Site: Palo Alto Site #3

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #3	n/a	Lighting	Palo Alto	SB5X Project	30,309	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #3	Lighting	9.5	26,122	n/a	8,530

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #3	Lighting	17.1	43,288	n/a

Spillover

No evidence of spillover was found.

Impact Evaluation Report: Palo Alto End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided, the following efficiency improvements were planned under this project at Site #3.

Table 1. Planned Efficiency Improvements at Palo Alto Site #3

Measure	Description	Qty.	Location
1	ExitLED	13	Luci Stern Community Center
2	CFL22	37	Luci Stern Community Center
3	CFL23	38	Luci Stern Community Center
4	T8F32 - 1 lamp RLO	51	Luci Stern Community Center
5	CFL 2x15	3	Luci Stern Community Center
6	T8F17 - 2 lamp RLO	6	Luci Stern Community Center
7	CFL 3x15	8	Luci Stern Community Center
8	CFL 6x23 Dimming	4	Luci Stern Community Center
9	T8F32 - 2 lamp RLO	131	Luci Stern Community Center
10	T8F32 - 2 lamp NLO	4	Luci Stern Community Center
11	CFL 4x15	6	Luci Stern Community Center
12	T8F32 - 4 lamp RLO	6	Luci Stern Community Center
13	T8F32 - 4 lamp RLO	28	Luci Stern Community Center
14a	T8F32 - 4 lamp RLO	6	Luci Stern Community Center
14b	T8F32 - 8 lamp RLO	6	Luci Stern Community Center
Total		**347**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #3.

Table 2. Verified Efficiency Improvements at Palo Alto Site #3

Measure	Description	Qty.	Location
1	ExitLED	21	Exit
2	CFL22	40	Theater
3a	CFL22	16	Office
3b	CFL22	15	Basement
4a	F32T8 - 1 lamp RLO	2	Theater
4b	F32T8 - 2 lamp RLO	28	Workshops
5	CFL 2x15	7	Theater
6a	F17T8 - 2 lamp RLO	1	Office
6b	F17T8 - 2 lamp RLO	4	Theater
7	CFL 3x15	3	Theater
8	CFL23 Dimming	24	Office
9a	F32T8 - 2 lamp RLO	83	Office
9b	F32T8 - 2 lamp RLO	41	Halls
9c	F32T8 - 2 lamp RLO	25	Theater
10	F32T8 - 2 lamp NLO	4	Office
12	F32T8 - 4 lamp RLO	6	Office
13	F32T8 - 4 lamp RLO	16	Theater
14	F32T8 - 8 lamp RLO	14	Office
Total		**350**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, Site #3 had the following pre-installation configurations and operating hours.

Table 4. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #3

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	Exit40W	21	8760	40	Exit
2	100W	40	1951	100	Theater
3a	100W	16	2550	100	Office
3b	100W	15	800	100	Basement
4a	F34T12 - 1 lamp MB	2	1951	43	Theater
4b	F34T12 - 1 lamp MB	49	1170	43	Workshops
5	3x60W	7	1951	180	Theater
6a	F20T12 - 2 lamp MB	1	2550	56	Office
6b	F20T12 - 2 lamp MB	4	1951	60	Theater
7	3x60W	3	1951	180	Theater
8	150W	24	2550	150	Office
9a	F34T12 - 2 lamp MB	83	2550	72	Office
9b	F34T12 - 2 lamp MB	41	4080	72	Halls
9b	F34T12 - 2 lamp MB	25	1951	72	Theater
10	F34T12 - 4 lamp MB	4	2550	144	Office
12	F34T12 - 4 lamp MB	6	2550	144	Office
13	F34T12 - 4 lamp MB	16	1951	144	Theater
14	F34T12 - 8 lamp MB	14	2550	288	Office
Total		**371**			

Primary Business Descriptions:
Site #3 consists of offices, a basement, and a theater.

Variability in Schedule and Production: Discussions were held with maintenance personnel at the site to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 5. M&V Savings for Palo Alto Site #3

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	Exit40W	21	8760	40	0.84	7,358	ExitLED	21	8760	2	0.04	368	0.8	6990
2	100W	40	1951	100	4.00	7,804	CFL22	40	1951	22	0.88	1,717	3.12	6087
3a	100W	16	2550	100	1.60	4,080	CFL22	16	2550	22	0.35	898	1.25	3182
3b	100W	15	800	100	1.50	1,200	CFL22	15	800	22	0.33	264	1.17	936
4a	F34T12 - 1 lamp MB	2	1951	43	0.09	168	F32T8 - 1 lamp RLO	2	1951	26	0.05	101	0.04	67
4b	F34T12 - 1 lamp MB	49	1170	43	2.11	2,465	F32T8 - 2 lamp RLO	28	1170	52	1.46	1,704	0.65	761
5	3x60W	7	1951	180	1.26	2,458	CFL 2x15	7	1951	31	0.22	423	1.04	2035

Table 5. M&V Savings for Palo Alto Site #3

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
6a	F20T12 - 2 lamp MB	1	2550	56	0.06	143	F17T8 - 2 lamp RLO	1	2550	29	0.03	74	0.03	69
6b	F20T12 - 2 lamp MB	4	1951	60	0.24	468	F17T8 - 2 lamp RLO	4	1951	29	0.12	226	0.12	242
7	3x60W	3	1951	180	0.54	1,054	CFL 3x15	3	1951	48	0.14	281	0.4	773
8	150W	24	2550	150	3.60	9,180	CFL23 Dimming	24	2550	23	0.55	1,408	3.05	7772
9a	F34T12 - 2 lamp MB	83	2550	72	5.98	15,239	F32T8 - 2 lamp RLO	83	2550	52	4.32	11,006	1.66	4233
9b	F34T12 - 2 lamp MB	41	4080	72	2.95	12,044	F32T8 - 2 lamp RLO	41	4080	52	2.13	8,699	0.82	3345
9b	F34T12 - 2 lamp MB	25	1951	72	1.80	3,512	F32T8 - 2 lamp RLO	25	1951	52	1.30	2,536	0.5	976
10	F34T12 - 4 lamp MB	4	2550	144	0.58	1,469	F32T8 - 2 lamp NLO	4	2550	59	0.24	602	0.34	867
12	F34T12 - 4 lamp MB	6	2550	144	0.86	2,203	F32T8 - 4 lamp RLO	6	2550	102	0.61	1,561	0.25	642
13	F34T12 - 4 lamp MB	16	1951	144	2.30	4,495	F32T8 - 4 lamp RLO	16	1951	102	1.63	3,184	0.67	1311
14	F34T12 - 8 lamp MB	14	2550	288	4.03	10,282	F32T8 - 8 lamp RLO	14	2550	204	2.86	7,283	1.17	2999
Total		**371**			**34.3**	**85,622**		**350**			**17.3**	**42,335**	**17.08**	**43,287**

Customer Cost/Benefit Analysis

Cost and Payback are based on Palo Alto City Facility Rates of 0.0706 $/kWh (effective 1-1-05).

- Site #3: (Retrofit Cost $16,663 - Rebate $8,530) / (Energy Savings $3,056) = Simple Payback 2.7 Years

Appendix D-4: Palo Alto C&I Lighting Rebate Site #4

M&V REPORT FOR C&I LIGHTING SITE #4

Prepared for the City of Palo Alto

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Palo Alto**

Site Name: **Site #4**

Site Address: **3201 East Bayshore Rd, Palo Alto, CA 94303**

Principal Site Contact Name: **Dennis Huebner** **Telephone: (650) 496-6970**

Utility Representative Name: **Virginia Waik** **Telephone: (650) 329-2168**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM**

Site: Palo Alto Site #4

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #4	n/a	Lighting	Palo Alto	SB5X Project	15,249	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #4	Lighting	9.6	36,209	n/a	7,357

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #4	Lighting	6.7	20,413	n/a

Spillover

No evidence of spillover was found.

Impact Evaluation Report: Palo Alto End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided, the following efficiency improvements were planned under this project at Site #4.

Table 1. Planned Efficiency Improvements at Palo Alto Site #4

Measure	Description	Qty.	Location
1	T8F32 - 2 lamp RLO Tandem	307	Municiple Services Center Building A
2	T8F32 - 2 lamp RLO	8	Municiple Services Center Building A
3	T8F32 - 2 lamp NLO	3	Municiple Services Center Building A
4	T8F32 - 4 lamp RLO	7	Municiple Services Center Building A
Total		**325**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #4.

Table 2. Verified Efficiency Improvements at Palo Alto Site #4

Measure	Description	Qty.	Location
1a	T8F32 - 2 lamp LP Tand	248	Shops & Offices
1b	T8F32 - 2 lamp LP Tand	46	Exterior
2a	T8F32 - 2 lamp LP	5	Shops & Offices
2b	T8F32 - 2 lamp LP	4	Exterior
4	T8F32 - 4 lamp LP	8	Shops & Offices
Total		**311**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, Site #4 had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #4

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1a	T12F34 - 2 lamp	248	2805	72	Shops & Offices
1b	T12F34 - 2 lamp	46	4380	72	Exterior
2a	T12F34 - 2 lamp	5	2805	72	Exterior
2b	T12F34 - 2 lamp	4	4380	72	Exterior
4	T12F34 - 4 lamp	8	2805	144	Shops & Offices
Total		**311**			

Primary Business Descriptions:
Site #4 A consists of shops and offices.

Variability in Schedule and Production: Discussions were held with maintenance personnel at the site to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Palo Alto Site #4

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1a	T12F34 - 2 lamp	248	2805	72	17.9	50,086	T8F32 - 2 lamp LP Tand	248	2805	51	12.7	35,478	5.21	14,608
1b	T12F34 - 2 lamp	46	4380	72	3.31	14,507	T8F32 - 2 lamp LP Tand	46	4380	51	2.35	10,275	0.97	4,231
2a	T12F34 - 2 lamp	5	2805	72	0.36	1,010	T8F32 - 2 lamp LP	5	2805	52	0.26	729	0.10	281
2b	T12F34 - 2 lamp	4	4380	72	0.29	1,261	T8F32 - 2 lamp LP	4	4380	52	0.21	911	0.08	350
4	T12F34 - 4 lamp	8	2805	144	1.15	3,231	T8F32 - 4 lamp LP	8	2805	102	0.82	2,289	0.34	942
Total		**311**			**23.0**	**70,095**		**311**			**16.3**	**49,682**	**6.7**	**20,413**

Customer Cost/Benefit Analysis

Cost and Payback are based on Palo Alto City Facility Rates of 0.0706 $/kWh (effective 1-1-05).

- Site #4: (Retrofit Cost $14,408 - Rebate $7,375) / (Energy Savings $1,441) = Simple Payback 4.9 Years

Appendix D-5: Palo Alto C&I Lighting Rebate Site #5

M&V REPORT FOR C&I LIGHTING SITE #5

Prepared for the City of Palo Alto

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Palo Alto**

Site Name: **Site #5**

Site Address: **3201 East Bayshore Rd, Palo Alto, CA 94303**

Principal Site Contact Name: **Dennis Huebner** **Telephone: (650) 496-6970**

Utility Representative Name: **Virginia Waik** **Telephone: (650) 329-2168**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM**

Site: Palo Alto Site #5

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Sie #5	n/a	Lighting	Palo Alto	SB5X Project	22,679	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #5	Lighting	16.9	54,189	n/a	14,150

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	
Site #5	Lighting	14.1	43,383	n/a	

Spillover

No evidence of spillover was found.

Impact Evaluation Report: Palo Alto End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided, the following efficiency improvements were planned under this project at Site #5.

Table 1. Planned Efficiency Improvements at Palo Alto Site #5

Measure	Description	Qty.	Location
1	T8F32 - 4 lamp RLO	6	Site #5
2	T8F32 - 4 lamp RLO	11	Site #5
3	T8F32 - 3 lamp RLO	3	Site #5
4	T8F32 - 2 lamp NLO	1	Site #5
5	T8F32 - 2 lamp NLO	12	Site #5
6	T8F32 - 2 lamp RLO	146	Site #5
7	T8F32 - 2 lamp RLO Tandem	438	Site #5
8	T8F17 - 3 lamp RLO	4	Site #5
9	T8F32 - 1 lamp RLO	10	Site #5
10	ExitLED	2	Site #5
Total		**633**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #5.

Table 2. Verified Efficiency Improvements at Palo Alto Site #5

Measure	Description	Qty.	Location
1	T8F32 - 4 lamp RLO	6	Shops & Offices
2	T8F32 - 4 lamp RLO	11	Shops & Offices
3	T8F32 - 3 lamp RLO	4	Shops & Offices
5	T8F32 - 2 lamp NLO	20	Shops & Offices
7	F32T8 - 2 lamp RLO Tand	454	Shops & Offices
8	F17T8 - 3 lamp RLO	4	Shops & Offices
6a	T8F32 - 2 lamp RLO	6	Shops & Offices
6b	T8F32 - 2 lamp RLO	63	Shops & Offices
6c	T8F32 - 2 lamp RLO	12	Exterior
Total		**580**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, Site #5 had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #5

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1a	T12F34 - 2 lamp	248	2805	72	Shops & Offices
1b	T12F34 - 2 lamp	46	4380	72	Exterior
2a	T12F34 - 2 lamp	5	2805	72	Exterior
2b	T12F34 - 2 lamp	4	4380	72	Exterior
4	T12F34 - 4 lamp	8	2805	144	Shops & Offices
Total		**311**			

Primary Business Descriptions:
Site #5 consists of shops and offices.

Variability in Schedule and Production: Discussions were held with maintenance personnel at the site to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Palo Alto Site #5

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	T12F34 - 4 lamp MB	6	3060	144	0.86	2,644	T8F32 - 4 lamp RLO	6	3060	102	0.61	1,873	0.25	771
2	T12F34 - 4 lamp MB	11	3060	144	1.58	4,847	T8F32 - 4 lamp RLO	11	3060	102	1.12	3,433	0.46	1,414
3	T12F34 - 3 lamp MB	4	3060	115	0.46	1,408	T8F32 - 3 lamp RLO	4	3060	78	0.31	955	0.15	453
5	T12F34 - 4 lamp MB	20	3060	144	2.88	8,813	T8F32 - 2 lamp NLO	20	3060	59	1.18	3,611	1.70	5,202
7	T12F34 - 2 lamp MB	454	3060	72	32.7	100,025	F32T8 - 2 lamp RLO Tand	454	3060	51	23.2	70,851	9.53	29,174
8	T12F34 - 2 lamp U MB	4	3060	72	0.29	881	F17T8 - 3 lamp RLO	4	3060	47	0.19	575	0.10	306
6a	T12F34 - 3 lamp MB	6	3060	115	0.69	2,111	T8F32 - 2 lamp RLO	6	3060	52	0.31	955	0.38	1,157
6b	T12F34 - 2 lamp MB	63	3060	72	4.54	13,880	T8F32 - 2 lamp RLO	63	3060	52	3.28	10,025	1.26	3,856
6c	T12F34 - 2 lamp MB	12	4380	72	0.86	3,784	T8F32 - 2 lamp RLO	12	4380	52	0.62	2,733	0.24	1,051
Total		**580**			**44.9**	**138,392**		**580**			**30.8**	**95,010**	**14.07**	**43,383**

Customer Cost/Benefit Analysis

Cost and Payback are based on Palo Alto City Facility Rates of 0.0706 $/kWh (effective 1-1-05).

- Site #5: (Retrofit Cost $27,642 - Rebate $14,150) / (Energy Savings $3,063) = Simple Payback 4.4 Years

Appendix D-6: Palo Alto C&I Lighting Rebate Site #6

M&V REPORT FOR C&I LIGHTING SITE #6

Prepared for the City of Palo Alto

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Palo Alto**

Site Name: **Site #6**

Site Address: **3201 East Bayshore Road, Palo Alto, CA 94303**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Virginia Waik** **Telephone: (650) 329-2436**

Assigned Lead Engineer: Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship

Site: Palo Alto Site #6

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #6	n/a	Lighting	Palo Alto	SB5X Project	30,302	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #6	Lighting	22.7	74,921	n/a	16,733

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #6	Lighting	19.5	62,240	n/a

Spillover

The following additional lighting improvements were found at the site (included in M&V savings).

Table 1. Site #6 Spillover Measures

Measure	Description	Qty.	Location
4	T8F32 – 2 lamp RLO	27	Shops, Offices, Hallways, and Restrooms
7	T8F32 - 3 lamp RLO	11	Shops, Offices, Hallways, and Restrooms
	T8F32 - 4 lamp RLO	10	Shops, Offices, Hallways, and Restrooms
Total		**48**	

Impact Evaluation Report: City of Palo Alto End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Site #6 and the city of Palo Alto, the following efficiency improvements were plannned under this project at Site #6.

Table 2. Planned Efficiency Improvements at Palo Alto Site #6

Measure	Description	Qty.	Location
1	ExitLED	9	Shops, Offices, Hallways, and Restrooms
2	T8F32 - 2 lamp RLO	25	Shops, Offices, Hallways, and Restrooms
3	F32T8 - 2 lamp RLO Tand	456	Shops, Offices, Hallways, and Restrooms
4	T8F32 - 2 lamp RLO	130	Shops, Offices, Hallways, and Restrooms
5	F32T8 - 2 lamp RLO Tand	8	Shops, Offices, Hallways, and Restrooms
6	T8F32 - 2 lamp NLO	4	Shops, Offices, Hallways, and Restrooms
7	T8F32 - 3 lamp RLO	119	Shops, Offices, Hallways, and Restrooms
Total		**751**	

Note: EB = Electronic Ballast

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #6.

Table 3. Verified Efficiency Improvements at Palo Alto Site #6

Measure	Description	Qty.	Location
1	ExitLED	9	Shops, Offices, Hallways, and Restrooms
2	T8F32 - 2 lamp RLO	25	Shops, Offices, Hallways, and Restrooms
3	F32T8 - 2 lamp RLO Tand	478	Shops, Offices, Hallways, and Restrooms
4	T8F32 - 2 lamp RLO	157	Shops, Offices, Hallways, and Restrooms
5	T8F32 - 2 lamp RLO	8	Shops, Offices, Hallways, and Restrooms
6	T8F32 - 2 lamp RLO	5	Shops, Offices, Hallways, and Restrooms
7	T8F32 - 3 lamp RLO	108	Shops, Offices, Hallways, and Restrooms
	T8F32 - 4 lamp RLO	10	Shops, Offices, Hallways, and Restrooms
Total		**800**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 4. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #6

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	Exit40W	9	8760	40	Shops, Offices, Hallways, and Restrooms
2	T12F34 - 2 lamp MB	25	4380	72	Shops, Offices, Hallways, and Restrooms
3	T12F34 - 2 lamp MB	478	3060	72	Shops, Offices, Hallways, and Restrooms
4	T12F34 - 2 lamp MB	157	3060	72	Shops, Offices, Hallways, and Restrooms
5	T12F34 - 4 lamp MB	8	3060	144	Shops, Offices, Hallways, and Restrooms
6	T12F34 - 3 lamp MB	5	3060	115	Shops, Offices, Hallways, and Restrooms
7	T12F34 - 3 lamp MB	108	3060	115	Shops, Offices, Hallways, and Restrooms
	T12F34 - 4 lamp MB	10	3060	144	Shops, Offices, Hallways, and Restrooms
Total		**800**			

Primary Business Descriptions:
Site #6 consists of shops, offices, hallways, and restrooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 5. M&V Savings for Palo Alto Site #6

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	Exit40W	9	8760	40	0.36	3,154	ExitLED	9	8760	2	0.02	158	0.34	2,996
2	T12F34 - 2 lamp MB	25	4380	72	1.80	7,884	T8F32 - 2 lamp RLO	25	4380	52	1.30	5,694	0.50	2,190
3	T12F34 - 2 lamp MB	478	3060	72	34.42	105,313	F32T8 - 2 lamp RLO Tand	478	3060	51	24.38	74,597	10.04	30,716
4	T12F34 - 2 lamp MB	157	3060	72	11.30	34,590	T8F32 - 2 lamp RLO	157	3060	52	8.16	24,982	3.14	9,608
5	T12F34 - 4 lamp MB	8	3060	144	1.15	3,525	T8F32 - 2 lamp RLO	8	3060	52	0.42	1,273	0.73	2,252
6	T12F34 - 3 lamp MB	5	3060	115	0.58	1,760	T8F32 - 2 lamp RLO	5	3060	52	0.26	796	0.32	964
7	T12F34 - 3 lamp MB	108	3060	115	12.42	38,005	T8F32 - 3 lamp RLO	108	3060	78	8.42	25,777	4.00	12,228
	T12F34 - 4 lamp MB	10	3060	144	1.44	4,406	T8F32 - 4 lamp RLO	10	3060	102	1.02	3,121	0.42	1,285
Total		**800**			**63.47**	**198,637**		**800**			**43.98**	**136,397**	**19.49**	**62,239**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 6**.

Table 6. Fixture Wattage Measurements From Palo Alto Site #6

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #6	Street Cleaning Shop	32	T8F32 - 2 lamp LP Tand	416	51.94	51
Site #6	Electric Operations/Gas Detector	8	T8F32 - 3 lamp LP	1,690	78.25	78
Site #6	Shop	16	T8F32 - 2 lamp LP	859	53.67	52

Customer Cost/Benefit Analysis

Cost and Payback are based on Palo Alto City Facility Rates of 0.0706 $/kWh (effective 1-1-05).

- Site #6: (Retrofit Cost $32,689 - Rebate $16,733) / (Energy Savings $4,394) = Simple Payback 3.6 Years

Appendix D-7: Palo Alto C&I Lighting Rebate Site #7

M&V REPORT FOR C&I LIGHTING SITE #7

Prepared for the City of Palo Alto

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Palo Alto**

Site Name: **Site #7**

Site Address: **2700 Middlefield Road, Palo Alto, CA 94303**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Virginia Waik** **Telephone: (650) 329-2436**

Assigned Lead Engineer: Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship

Site: Palo Alto Site #7

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #7	n/a	Lighting	Palo Alto	SB5X Project	12,484	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #7	Lighting	8.0	31,624	n/a	9,846

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #7	Lighting	6.93	26,580	n/a

Spillover

The following additional lighting improvements were found at the site (included in M&V savings).

Table 1. Site #7 Spillover Measures

Measure	Description	Qty.	Location
1	CFL22	15	
7	T8F32 - 3 lamp RLO	11	
	T8F32 - 4 lamp RLO	10	
Total		**48**	

Impact Evaluation Report: City of Palo Alto End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided, the following efficiency improvements were planned under this project at Site #7.

Table 2. Planned Efficiency Improvements at Palo Alto Site #7

Measure	Description	Qty.	Location
1	CFL22	15	Library and Crime Prevention Area
2	T8F32 - 1 lamp RLO Tandem 2	4	Library and Crime Prevention Area
3	T8F32 - 1 lamp RLO	3	Library and Crime Prevention Area
4	T8F32 - 2 lamp RLO Tandem	40	Library and Crime Prevention Area
5	T8F32 - 2 lamp RLO	23	Library and Crime Prevention Area
6	T8F17 - 3 lamp RLO	2	Library and Crime Prevention Area
7	T8F25 - 4 lamp RLO	80	Library and Crime Prevention Area
8	T8F32 - 4 lamp RLO	1	Library and Crime Prevention Area
9	T8F32 - 4 lamp RLO	120	Library and Crime Prevention Area
Total		**288**	

Note: EB = Electronic Ballast

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #7.

Table 3. Verified Efficiency Improvements at Palo Alto Site #7

Measure	Description	Qty.	Location
2a	T8F32 - 2 lamp LP	1	Library and Crime Prevention Area
2b	T8F32 - 1 lamp LP	1	Library and Crime Prevention Area
3	T8F32 - 1 lamp LP	3	Library and Crime Prevention Area
4a	T8F32 - 2 lamp LP Tand	16	Library and Crime Prevention Area
4b	T8F32 - 2 lamp LP	25	Library and Crime Prevention Area
5	T8F32 - 2 lamp LP	23	Library and Crime Prevention Area
6	T8F17 - 3 lamp	2	Library and Crime Prevention Area
7	T8F25 - 4 lamp LP	80	Library and Crime Prevention Area
8	T8F32 - 4 lamp LP	1	Library and Crime Prevention Area
9	T8F32 - 4 lamp LP	120	Library and Crime Prevention Area
	ExitLED	2	Library and Crime Prevention Area
Total		**274**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 4. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #7

Measure	Description	Qty.	Hours/yr	W/fixture	Location
2a	T12F34 - 2 lamp	1	3825	72	Library and Crime Prevention Area
2b	T12F34 - 1 lamp	1	3825	43	Library and Crime Prevention Area
3	T12F34 - 1 lamp	3	3825	43	Library and Crime Prevention Area
4a	T12F34 - 2 lamp	16	2550	72	Library and Crime Prevention Area
4b	T12F34 - 2 lamp	25	3825	72	Library and Crime Prevention Area
5	T12F34 - 2 lamp	23	3825	72	Library and Crime Prevention Area
6	T12F34 - 2 lamp U	2	3825	72	Library and Crime Prevention Area
7	T12F72 - 2 lamp	80	3825	122	Library and Crime Prevention Area
8	T12F34 - 4 lamp	1	3825	144	Library and Crime Prevention Area
9	T12F96 - 2 lamp	120	3825	123	Library and Crime Prevention Area
	Exit40W	2	8760	40	Library and Crime Prevention Area
Total		**274**			

Primary Business Descriptions:
Site #7 consists of a library and a crime prevention workroom.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 5. M&V Savings for Palo Alto Site #7

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
2a	T12F34 - 2 lamp	1	3825	72	0.07	275	T8F32 - 2 L LP	1	3825	52	0.05	199	0.02	76
2b	T12F34 - 1 lamp	1	3825	43	0.04	164	T8F32 - 1 L LP	1	3825	31	0.03	119	0.01	45
3	T12F34 - 1 lamp	3	3825	43	0.13	493	T8F32 - 1 L LP	3	2550	31	0.09	237	0.04	256
4a	T12F34 - 2 lamp	16	2550	72	1.15	2,938	T8F32 - 2 L LP Tand	16	2550	51	0.82	2,081	0.33	857
4b	T12F34 - 2 lamp	25	3825	72	1.80	6,885	T8F32 - 2 L LP	25	3825	52	1.30	4,973	0.50	1,912
5	T12F34 - 2 lamp	23	3825	72	1.66	6,334	T8F32 - 2 L LP	23	3825	52	1.20	4,575	0.46	1,759
6	T12F34 - 2 lamp U	2	3825	72	0.14	551	T8F17 - 3 L	2	3825	47	0.09	360	0.05	191
7	T12F72 - 2 lamp	80	3825	122	9.76	37,332	T8F25 - 4 L LP	80	3825	86	6.88	26,316	2.88	11,016
8	T12F34 - 4 lamp	1	3825	144	0.14	551	T8F32 - 4 L LP	1	3825	102	0.10	390	0.04	161
9	T12F96 - 2 lamp	120	3825	123	14.76	56,457	T8F32 - 4 L LP	120	3825	102	12.24	46,818	2.52	9,639
	Exit40W	2	8760	40	0.08	701	ExitLED	2	8760	2	0.00	35	0.08	666
Total		**274**			**29.74**	**112,682**		**274**			**22.81**	**86,101**	**6.93**	**26,578**

Customer Cost/Benefit Analysis

Cost and Payback are based on Palo Alto City Facility Rates of 0.0706 $/kWh (effective 1-1-05).

- Site #7: (Retrofit Cost $19,234 - Rebate $9,846) / (Energy Savings $1,876) = Simple Payback 5.0 Years

Appendix D-8: Palo Alto C&I Lighting Rebate Site #8

M&V REPORT FOR C&I LIGHTING SITE #8

Prepared for the City of Palo Alto

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Palo Alto**

Site Name: **Site #8**

Site Address: **2501 Embarcadero, Palo Alto, CA 94303**

Principal Site Contact Name: **Virginia Waik** **Telephone: (650) 329-2436**

Utility Representative Name: **Virginia Waik** **Telephone: (650) 329-2436**

Assigned Lead Engineer: Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship

Site: Palo Alto Site #8

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #8	n/a	Lighting	Palo Alto	SB5X Project	n/a	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #8	Lighting	35.2	200,732.9	n/a	30,667

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #8	Lighting	31.7	215,950	n/a

Spillover

No evidence of spillover was found.

Impact Evaluation Report: City of Palo Alto — End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications, the following efficiency improvements were plannned under this project at Site #8.

Table 1. Planned Efficiency Improvements at Palo Alto Site #8

Measure	Description	Qty.	Location
1a	T8F32 - 2 lamp RLO	3	Aerator Tanks
1b	T8F32 - 2 lamp RLO	10	Air Compressor
2	T8F32 - 3 lamp RLO	8	Air Compressor
3	T8F32 - 2 lamp RLO	18	Chlorine Building
4	T8F32 - 3 lamp RLO	19	Chlorine Building
5	T8F17 - 3 lamp RLO	9	DMF Building
5b	T8F17 - 3 lamp RLO	8	Filter Building
6	T8F32 - 2 lamp RLO	43	DMF Building
6b	T8F32 - 2 lamp RLO	40	Filter Building
7	T8F32 - 2 lamp RLO	2	Electrical Shed
8	T8F32 - 8 lamp RLO	4	First Aid Station
9	T8F32 - 2 lamp RLO	6	Grit Dumping Bldg
10	ExitLED	3	Main Building
11	T8F17 - 3 lamp RLO	2	Main Building
12	T8F32 - 2 lamp RLO	42	Main Building
12b	T8F32 - 2 lamp RLO	23	Incinerator Bldg
13	T8F17 - 3 lamp RLO	2	Main Pump
14	T8F32 - 3 lamp RLO	6	Main Pump
15	T8F32 - 2 lamp RLO	38	Main Pump
16	T8F32 - 2 lamp RLO	30	N.S. Tower
17	T8F17 - 3 lamp RLO	216	Operations Building
18	T8F32 - 2 lamp RLO	5	Operations Building
19	T8F32 - 4 lamp RLO	2	Operations Building
20	T8F32 - 2 lamp RLO	9	Paint Storage
21	T8F32 - 2 lamp RLO	10	Power Elect Room
22	T8F17 - 3 lamp RLO	2	Primary Tanks Bldg
23	T8F32 - 3 lamp RLO	48	Primary Tanks Bldg
24	T8F32 - 2 lamp RLO	23	Primary Tanks Bldg
25	T8F32 - 2 lamp RLO	48	Primary Tanks Bldg
26	CFL22	4	Sludge Bldg
26b	CFL22	1	Old Pump Room
27	T8F32 - 2 lamp RLO	30	Sludge Bldg
28	T8F32 - 3 lamp RLO	3	Sludge Bldg
29	T8F32 - 4 lamp RLO	83	Warehouse
30	T8F17 - 2 lamp RLO	7	Warehouse
31	T8F17 - 3 lamp RLO	7	Warehouse
32	T8F32 - 2 lamp RLO Tandem	27	Warehouse
33	T8F32 - 2 lamp NLO	32	Warehouse
34	T8F32 - 2 lamp RLO	3	Warehouse
35	CFL22	2	Warehouse
36	T8F32 - 4 lamp RLO	1	Tool Shed
Total		**879**	

Note: EB = Electronic Ballast

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #8.

Table 2. Verified Efficiency Improvements at Palo Alto Site #8

Measure	Description	Qty.	Location
1	T8F32 - 2 lamp RLO	8	Air Compressor Building
2	T8F32 - 3 lamp RLO	8	Air Compressor Building
3	T8F32 - 2 lamp RLO	17	Chlorine Building
4	T8F32 - 3 lamp RLO	19	Chlorine Building
5	T8F17 - 3 lamp RLO	9	Dual Media Filters
6	T8F32 - 2 lamp RLO	46	Dual Media Filters
7	T8F32 - 2 lamp RLO	2	Electrical Shed
8	T8F32 - 2 lamp RLO	8	First Aid
9	T8F32 - 2 lamp RLO	6	Grit
10	ExitLED	3	Main Building
11	T8F17 - 3 lamp RLO	2	Main Building
12a	T8F25 - 2 lamp RLO	1	Main Building
12b	T8F32 - 2 lamp RLO	49	Main Building
15	T8F32 - 2 lamp RLO	39	Main Pump
16	T8F32 - 2 lamp RLO	28	N.S. Tower
17a	T8F17 - 3 lamp RLO	10	Operations
17b	T8F17 - 3 lamp RLO	74	Operations
17c	T8F17 - 3 lamp RLO	130	Operations
18	T8F32 - 2 lamp RLO	4	Operations
19	T8F32 - 4 lamp RLO	4	Operations
20	T8F32 - 2 lamp RLO	9	Paint Storage
21	T8F32 - 2 lamp RLO	10	Power Electric Room
23a	T8F32 - 3 lamp RLO	20	Primary Tanks
23b	T8F32 - 3 lamp RLO	40	Primary Tanks
24	T8F32 - 2 lamp RLO	40	Tunnels
25a	T8F32 - 2 lamp RLO	18	Primary Tanks
25b	T8F32 - 2 lamp RLO	1	Primary Tanks
27	T8F32 - 2 lamp RLO	28	Sludge
28	T8F32 - 2 lamp RLO	7	Sludge
29	T8F32 - 4 lamp RLO	81	Warehouse
30	T8F17 - 3 lamp RLO	7	Warehouse
31	T8F17 - 3 lamp RLO	8	Warehouse
32	T8F32 - 2 lamp RLO Tand	27	Warehouse
33	T8F32 - 2 lamp RLO	32	Warehouse
34	T8F32 - 2 lamp RLO	3	Warehouse
35	CFL15	2	Warehouse
36	T8F32 - 4 lamp RLO	1	Tool Shed
Total		**801**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #8

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	T12F40 - 2 lamp HO MB	8	8760	145	Air Compressor Building
2	T12F40 - 2 lamp HO MB	8	8760	145	Air Compressor Building
3	T12F34 - 2 lamp MB	17	8760	72	Chlorine Building
4	T12F40 - 2 lamp HO MB	19	8760	145	Chlorine Building
5	T12F34 - 2 lamp U MB	9	8760	72	Dual Media Filters
6	T12F40 - 2 lamp HO MB	46	8760	145	Dual Media Filters
7	T12F34 - 2 lamp MB	2	8760	72	Electrical Shed
8	T12F96 - 4 lamp MB	4	8760	246	First Aid
9	T12F34 - 2 lamp MB	6	8760	72	Grit
10	Exit40W	3	8760	40	Main Building
11	T12F34 - 2 lamp U MB	2	3060	72	Main Building
12a	T12F30 - 2 lamp MB	1	3060	81	Main Building
12b	T12F34 - 2 lamp MB	49	3060	72	Main Building
15	T12F40 - 2 lamp HO MB	39	5096	145	Main Pump
16	T12F40 - 2 lamp HO MB	28	8760	145	N.S. Tower
17a	T12F34 - 2 lamp U MB	10	800	72	Operations
17b	T12F34 - 2 lamp U MB	74	3570	72	Operations
17c	T12F34 - 2 lamp U MB	130	8760	72	Operations
18	T12F34 - 2 lamp MB	4	8760	72	Operations
19	T12F34 - 4 lamp MB	4	8760	144	Operations
20	T12F40 - 2 lamp HO MB	9	800	72	Paint Storage
21	T12F34 - 2 lamp MB	10	8760	72	Power Electric Room
23a	T12F34 - 2 lamp MB	20	8760	72	Primary Tanks
23b	T12F40 - 2 lamp HO MB	40	8760	145	Primary Tanks
24	T12F34 - 2 lamp MB	40	8760	72	Tunnels
25a	T12F34 - 2 lamp MB	18	8760	72	Primary Tanks
25b	T12F40 - 2 lamp HO MB	1	8760	145	Primary Tanks
27	T12F34 - 2 lamp MB	28	8760	72	Sludge
28	T12F40 - 2 lamp HO MB	7	8760	145	Sludge
29	T12F34 - 4 lamp MB	81	3060	144	Warehouse
30	T12F34 - 2 lamp U MB	7	3060	72	Warehouse
31	T12F34 - 2 lamp U MB	8	3060	72	Warehouse
32	T12F34 - 2 lamp MB	27	3060	72	Warehouse
33	T12F34 - 2 lamp MB	32	3060	72	Warehouse
34	T12F34 - 2 lamp MB	3	3060	72	Warehouse
35	60A	2	800	60	Warehouse
36	T12F34 - 4 lamp MB	1	3060	144	Warehouse
Total		**797**			

Primary Business Descriptions:
Site #8 consists of a toolshed, warehouse, sludge, tanks, tower, storage, tunnels, and numerous buildings.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Palo Alto Site #8

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	T12F40 - 2 lamp HO MB	8	8760	145	1.16	10,162	T8F32 - 2 lamp RLO	8	8760	52	0.42	3,644	0.74	6,517
2	T12F40 - 2 lamp HO MB	8	8760	145	1.16	10,162	T8F32 - 3 lamp RLO	8	8760	78	0.62	5,466	0.54	4,695
3	T12F34 - 2 lamp MB	17	8760	72	1.22	10,722	T8F32 - 2 lamp RLO	17	8760	52	0.88	7,744	0.34	2,978
4	T12F40 - 2 lamp HO MB	19	8760	145	2.76	24,134	T8F32 - 3 lamp RLO	19	8760	78	1.48	12,982	1.27	11,151
5	T12F34 - 2 lamp U MB	9	8760	72	0.65	5,676	T8F17 - 3 lamp RLO	9	8760	47	0.42	3,705	0.23	1,971
6	T12F40 - 2 lamp HO MB	46	8760	145	6.67	58,429	T8F32 - 2 lamp RLO	46	8760	52	2.39	20,954	4.28	37,475
7	T12F34 - 2 lamp MB	2	8760	72	0.14	1,261	T8F32 - 2 lamp RLO	2	8760	52	0.10	911	0.04	350
8	T12F96 - 4 lamp MB	4	8760	246	0.98	8,620	T8F32 - 2 lamp RLO	8	8760	52	0.42	3,644	0.57	4,976
9	T12F34 - 2 lamp MB	6	8760	72	0.43	3,784	T8F32 - 2 lamp RLO	6	8760	52	0.31	2,733	0.12	1,051
10	Exit40W	3	8760	40	0.12	1,051	ExitLED	3	8760	2	0.001	53	0.11	999
11	T12F34 - 2 lamp U MB	2	3060	72	0.14	441	T8F17 - 3 lamp RLO	2	3060	47	0.09	288	0.05	153
12a	T12F30 - 2 lamp MB	1	3060	81	0.08	248	T8F25 - 2 lamp RLO	1	3060	42	0.04	129	0.04	119
12b	T12F34 - 2 lamp MB	49	3060	72	3.53	10,796	T8F32 - 2 lamp RLO	49	3060	52	2.55	7,797	0.98	2,999
15	T12F40 - 2 lamp HO MB	39	5096	145	5.66	28,818	T8F32 - 2 lamp RLO	39	5096	52	2.03	10,335	3.63	18,483
16	T12F40 - 2 lamp HO MB	28	8760	145	4.06	35,566	T8F32 - 2 lamp RLO	28	8760	52	1.46	12,755	2.60	22,811
17a	T12F34 - 2 lamp U MB	10	800	72	0.72	576	T8F17 - 3 lamp RLO	10	800	47	0.47	376	0.25	200
17b	T12F34 - 2 lamp U MB	74	3570	72	5.33	19,021	T8F17 - 3 lamp RLO	74	3570	47	3.48	12,416	1.85	6,605
17c	T12F34 - 2 lamp U MB	130	8760	72	9.36	81,994	T8F17 - 3 lamp RLO	130	8760	47	6.11	53,524	3.25	28,470
18	T12F34 - 2 lamp MB	4	8760	72	0.29	2,523	T8F32 - 2 lamp RLO	4	8760	52	0.21	1,822	0.08	701
19	T12F34 - 4 lamp MB	4	8760	144	0.58	5,046	T8F32 - 4 lamp RLO	4	8760	102	0.41	3,574	0.17	1,472
20	T12F40 - 2 lamp HO MB	9	800	72	0.65	518	T8F32 - 2 lamp RLO	9	800	52	0.47	374	0.18	144
21	T12F34 - 2 lamp MB	10	8760	72	0.72	6,307	T8F32 - 2 lamp RLO	10	8760	52	0.52	4,555	0.20	1,752
23a	T12F34 - 2 lamp MB	20	8760	72	1.44	12,614	T8F32 - 3 lamp RLO	20	8760	78	1.56	13,666	-0.12	-1,051
23b	T12F40 - 2 lamp HO MB	40	8760	145	5.80	50,808	T8F32 - 3 lamp RLO	40	8760	78	3.12	27,331	2.68	23,477
24	T12F34 - 2 lamp MB	40	8760	72	2.88	25,229	T8F32 - 2 lamp RLO	40	8760	52	2.08	18,221	0.80	7,008
25a	T12F34 - 2 lamp MB	18	8760	72	1.30	11,353	T8F32 - 2 lamp RLO	18	8760	52	0.94	8,199	0.36	3,154
25b	T12F40 - 2 lamp HO MB	1	8760	145	0.15	1,270	T8F32 - 2 lamp RLO	1	8760	52	0.05	456	0.09	815
27	T12F34 - 2 lamp MB	28	8760	72	2.02	17,660	T8F32 - 2 lamp RLO	28	8760	52	1.46	12,755	0.56	4,906
28	T12F40 - 2 lamp HO MB	7	8760	145	1.02	8,891	T8F32 - 2 lamp RLO	7	8760	52	0.36	3,189	0.65	5,703
29	T12F34 - 4 lamp	81	3060	144		35,692	T8F32 - 4 lamp	81	3060	102		25,282	3.40	10,410

Table 4. M&V Savings for Palo Alto Site #8

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
	MB				11.66		RLO				8.26			
30	T12F34 - 2 lamp U MB	7	3060	72	0.50	1,542	T8F17 - 3 lamp RLO	7	3060	47	0.33	1,007	0.18	536
31	T12F34 - 2 lamp U MB	8	3060	72	0.58	1,763	T8F17 - 3 lamp RLO	8	3060	47	0.38	1,151	0.20	612
32	T12F34 - 2 lamp MB	27	3060	72	1.94	5,949	T8F32 - 2 lamp RLO Tand	27	3060	51	1.38	4,214	0.57	1,735
33	T12F34 - 2 lamp MB	32	3060	72	2.30	7,050	T8F32 - 2 lamp RLO	32	3060	52	1.66	5,092	0.64	1,958
34	T12F34 - 2 lamp MB	3	3060	72	0.22	661	T8F32 - 2 lamp RLO	3	3060	52	0.16	477	0.06	184
35	60A	2	800	60	0.12	96	CFL15	2	800	15	0.03	24	0.09	72
36	T12F34 - 4 lamp MB	1	3060	144	0.14	441	T8F32 - 4 lamp RLO	1	800	102	0.10	82	0.04	359
Total		**797**			**78.48**	**506,874**		**801**			**46.76**	**290927**	**31.72**	**215,950**

Customer Cost/Benefit Analysis

Cost and Payback are based on Palo Alto City Facility Rates of 0.0706 $/kWh (effective 1-1-05).

- Site #8: (Retrofit Cost $59,908 - Rebate $30,667) / (Energy Savings $15,246) = Simple Payback 1.9 Years.

Appendix D-9: Palo Alto C&I Lighting Rebate Site #9

M&V REPORT FOR C&I LIGHTING SITE #9

Prepared for the City of Palo Alto

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Palo Alto**

Site Name: **Site #9**

Site Address: **1213 Newell Road, Palo Alto, CA 94303**

Principal Site Contact Name: **Virginia Waik** **Telephone: (650) 329-2436**

Utility Representative Name: **Virginia Waik** **Telephone: (650) 329-2436**

Assigned Lead Engineer: Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship

Site: Palo Alto Site #9

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #9	n/a	Lighting	Palo Alto	SB5X Project	26,313	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #9	Lighting	12.3	44,750	n/a	13,371

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #9	Lighting	8.11	33,507	n/a

Spillover

No evidence of spillover was found.

Impact Evaluation Report: City of Palo Alto — End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications, the following efficiency improvements were plannned under this project at Site #9.

Table 1. Planned Efficiency Improvements at Palo Alto Site #9

Measure	Description	Qty.	Location
1	CFL22	17	Library
2	T8F32 - 2 lamp RLO	203	Library
3	T8F32 - 2 lamp NLO	35	Library
4	T8F32 - 2 lamp RLO	4	Library
5	T8F32 - 2 lamp Dimming NLO	8	Library
6	T8F32 - 4 lamp Dimming NLO	2	Library
7	T8F32 - 4 lamp RLO	3	Library
8	T12F96 - 2 lamp MB	1	Library
9	T8F32 - 2 lamp RLO	46	Library
10	T8F32 - 2 lamp RLO	72	Library
Total		**391**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #9.

Table 2. Verified Efficiency Improvements at Palo Alto Site #9

Measure	Description	Qty.	Location
1	CFL22	17	Library
2	T8F32 - 2 lamp RLO	203	Library
3	T8F32 - 2 lamp NLO	35	Library
4	T8F32 - 2 lamp RLO	4	Library
5	T8F32 - 2 lamp Dimming NLO	8	Library
6	T8F32 - 4 lamp Dimming NLO	2	Library
7	T8F32 - 4 lamp RLO	3	Library
8	T12F96 - 2 lamp MB	1	Library
9	T8F32 - 2 lamp RLO	46	Library
10	T8F32 - 2 lamp RLO	72	Library
Total		**391**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #9

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	60W	17	4131	60	Library
2	T12F34 - 2 lamp MB	203	4131	72	Library
3	T12F34 - 2 lamp MB	35	4131	72	Library
4	T12F34 - 2 lamp MB	4	4131	72	Library
5	T12F34 - 2 lamp MB Dimming	8	4131	78	Library
6	T12F34 - 4 lamp MB Dimming	2	4131	156	Library
7	T12F34 - 4 lamp MB	3	4131	144	Library
8	T12F96 - 2 lamp MB	1	4131	123	Library
9	T12F34 - 2 lamp MB	46	4131	72	Library
10	T12F96 - 1 lamp MB	72	4131	75	Library
Total		**391**			

Primary Business Descriptions: Site #9 consists of a library.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Palo Alto Site #9

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	60W	17	4131	60	1.02	4,214	CFL22	17	4131	22	0.37	1,545	0.65	2,669
2	T12F34 - 2 lamp MB	203	4131	72	14.62	60,379	T8F32 - 2 lamp RLO	203	4131	52	10.56	43,607	4.06	16,772
3	T12F34 - 2 lamp MB	35	4131	72	2.52	10,410	T8F32 - 2 lamp NLO	35	4131	59	2.07	8,531	0.46	1,880
4	T12F34 - 2 lamp MB	4	4131	72	0.29	1,190	T8F32 - 2 lamp RLO	4	4131	52	0.21	859	0.08	330
5	T12F34 - 2 lamp MB Dimming	8	4131	78	0.62	2,578	T8F32 - 2 lamp Dimming NLO	8	4131	64	0.51	2,115	0.11	463
6	T12F34 - 4 lamp MB Dimming	2	4131	156	0.31	1,289	T8F32 - 4 lamp Dimming NLO	2	4131	128	0.26	1,058	0.06	231
7	T12F34 - 4 lamp MB	3	4131	144	0.43	1,785	T8F32 - 4 lamp RLO	3	4131	102	0.31	1,264	0.13	521
8	T12F96 - 2 lamp MB	1	4131	123	0.12	508	T12F96 - 2 lamp MB	1	4131	123	0.12	508	0.00	0
9	T12F34 - 2 lamp MB	46	4131	72	3.31	13,682	T8F32 - 2 lamp RLO	46	4131	52	2.39	9,881	0.92	3,801
10	T12F96 - 1 lamp MB	72	4131	75	5.40	22,307	T8F32 - 2 lamp RLO	72	4131	52	3.74	15,466	1.66	6,841
Total		**391**			**28.65**	**118,341**		**391**			**16.79**	**69,368**	**8.11**	**33,507**

Customer Cost/Benefit Analysis

Cost and Payback are based on Palo Alto City Facility Rates of 0.0706 $/kWh (effective 1-1-05).

- Site #9: (Retrofit Cost $26,120 - Rebate $13,371) / (Energy Savings $2,366) = Simple Payback 5.4 Years.

Appendix D-10: Palo Alto C&I Lighting Rebate Site #10

M&V REPORT FOR C&I LIGHTING SITE #10

Prepared for the City of Palo Alto

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Palo Alto**

Site Name: **Site #10**

Site Address: **1313 Newell Road, Palo Alto, CA 94303**

Principal Site Contact Name: **Virginia Waik** **Telephone: (650) 329-2168**

Utility Representative Name: **Virginia Waik** **Telephone: (650) 329-2168**

Assigned Lead Engineer: Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship

Site: Palo Alto Site #10

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #10	n/a	Lighting	Palo Alto	SB5X Project	29,869	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #10	Lighting	15.7	41,515	n/a	10,229

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	
Site #10	Lighting	22.5	50,007	n/a	

Spillover

No evidence of spillover was found.

Impact Evaluation Report: City of Palo Alto — End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications, the following efficiency improvements were plannned under this project at Site #10 by Planergy.

Table 1. Planned Efficiency Improvements at Palo Alto Site #10

Measure	Description	Qty.	Location
1	ExitLED	10	Site #10
2	CFL15	1	Site #10
3	CFL22	18	Site #10
4	CFL23	28	Site #10
5	T8F32 - 1 lamp RLO	2	Site #10
6	CFL 2x22	15	Site #10
7	CFL 3x15	9	Site #10
8	CFL23 Dimming	32	Site #10
9	T8F17 - 3 lamp RLO	1	Site #10
10	T8F32 - 2 lamp RLO Tandem	36	Site #10
11	T8F32 - 2 lamp RLO	75	Site #10
12	T8F32 - 2 lamp RLO	10	Site #10
13	T8F32 - 2 lamp NLO	3	Site #10
14	T8F32 - 4 lamp RLO	93	Site #10
15	T8F25 - 6 lamp RLO	8	Site #10
16	T8F25 - 6 lamp RLO	15	Site #10
17	T8F32 - 6 lamp RLO	3	Site #10
18	T8F32 - 8 lamp RLO	10	Site #10
Total		**369**	

Note: EB = Electronic Ballast

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #10.

Table 2. Verified Efficiency Improvements at Palo Alto Site #10

Measure	Description	Qty.	Location
1	ExitLED	10	Cultural Center
2	CFL20	1	Cultural Center
3a	CFL20	7	Cultural Center
3b	CFL20	7	Storage
4	CFL20	28	Storage
5	T8F32 - 1 lamp RLO	2	Storage
6	CFL20	15	Cultural Center
7	3x15CFL	11	Cultural Center
8	CFL23Dim	32	Cultural Center
9	T8F17 - 3 lamp RLO	1	Cultural Center
10	T8F32 - 2 lamp RLO Tand	36	Cultural Center
11a	T8F32 - 2 lamp RLO Tand	22	Cultural Center
11b	T8F32 - 2 lamp RLO	3	Cultural Center
11c	T8F32 - 2 lamp RLO	20	Cultural Center
11d	Remove T12F34 - 2 lamp	19	Cultural Center
11e	T8F32 - 2 lamp RLO	20	Storage
12a	T8F32 - 2 lamp RLO	6	Cultural Center
12b	T8F32 - 2 lamp RLO	4	Cultural Center
13	T8F32 - 2 lamp NLO	3	Cultural Center
14a	T8F32 - 4 lamp RLO	87	Cultural Center
14b	T8F32 - 4 lamp RLO	2	Storage
15	T8F25 - 6 lamp RLO	8	Cultural Center
16	T8F25 - 6 lamp RLO	15	Cultural Center
17	T8F32 - 8 lamp RLO	3	Cultural Center
18a	T8F32 - 8 lamp RLO	11	Cultural Center
18b	T8F32 - 8 lamp RLO	4	Storage
Total		**377**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Palo Alto Site #10

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	Exit40W	10	2397	40	Cultural Center
2	100W	1	2397	100	Cultural Center
3a	60W	7	2397	60	Cultural Center
3b	100W	7	800	100	Storage
4	60W	28	800	60	Storage
5	T12F34 - 1 lamp	2	800	43	Storage
6	2x100W	15	2397	200	Cultural Center
7	2x100W	11	2397	200	Cultural Center
8	100W	32	2397	100	Cultural Center
9	T12F34 - 2 lamp U	1	2397	72	Cultural Center
10	T12F34 - 3 lamp	36	2397	115	Cultural Center
11a	T12F34 - 2 lamp	22	2397	72	Cultural Center
11b	T12F34 - 4 lamp	3	2397	144	Cultural Center
11c	T12F34 - 2 lamp	20	2397	72	Cultural Center
11d	T12F34 - 2 lamp	19	2397	72	Cultural Center
11e	T12F34 - 2 lamp	20	800	72	Storage
12a	T12F34 - 2 lamp U	6	2397	72	Cultural Center
12b	100W	4	2397	100	Cultural Center
13	T12F34 - 4 lamp	3	2397	144	Cultural Center
14a	T12F34 - 4 lamp	87	2397	144	Cultural Center
14b	T12F34 - 4 lamp	2	800	144	Storage
15	T12F72 - 3 lamp	8	2397	202	Cultural Center
16	T12F30 - 6 lamp	15	2397	243	Cultural Center
17	T12F34 - 8 lamp	3	2397	288	Cultural Center
18a	T12F34 - 8 lamp	11	2397	288	Cultural Center
18b	T12F34 - 8 lamp	4	800	288	Storage
Total		**377**			

Primary Business Descriptions:
Site #10 consists of a cultural center and storage.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Palo Alto Site #10

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	Exit40W	10	2397	40	0.40	959	ExitLED	10	2397	2	0.02	48	0.38	911
2	100W	1	2397	100	0.10	240	CFL20	1	2397	20	0.02	48	0.08	192
3a	60W	7	2397	60	0.42	1,007	CFL20	7	2397	20	0.14	336	0.28	671
3b	100W	7	800	100	0.70	560	CFL20	7	800	20	0.14	112	0.56	448

Table 4. M&V Savings for Palo Alto Site #10

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
4	60W	28	800	60	1.68	1,344	CFL20	28	800	20	0.56	448	1.12	896
5	T12F34 - 1 lamp	2	800	43	0.09	69	T8F32 - 1 lamp RLO	2	800	31	0.06	50	0.02	19
6	2x100W	15	2397	200	3.00	7,191	CFL20	15	2397	20	0.30	719	2.70	6,472
7	2x100W	11	2397	200	2.20	5,273	3x15CFL	11	2397	45	0.50	1,187	1.71	4,087
8	100W	32	2397	100	3.20	7,670	CFL23Dim	32	2397	23	0.74	1,764	2.46	5,906
9	T12F34 - 2 lamp U	1	2397	72	0.07	173	T8F17 - 3 lamp RLO	1	2397	47	0.05	113	0.03	60
10	T12F34 - 3 lamp	36	2397	115	4.14	9,924	T8F32 - 2 lamp RLO Tand	36	2397	51	1.84	4,401	2.30	5,523
11a	T12F34 - 2 lamp	22	2397	72	1.58	3,797	T8F32 - 2 lamp RLO Tand	22	2397	51	1.12	2,689	0.46	1,107
11b	T12F34 - 4 lamp	3	2397	144	0.43	1,036	T8F32 - 2 lamp RLO	3	2397	52	0.16	374	0.28	662
11c	T12F34 - 2 lamp	20	2397	72	1.44	3,452	T8F32 - 2 lamp RLO	20	2397	52	1.04	2,493	0.40	959
11d	T12F34 - 2 lamp	19	2397	72	1.37	3,279	Remove T12F34 - 2 lamp	19	2397	0	0.00	0	1.37	3,279
11e	T12F34 - 2 lamp	20	800	72	1.44	1,152	T8F32 - 2 lamp RLO	20	800	52	1.04	832	0.40	320
12a	T12F34 - 2 lamp U	6	2397	72	0.43	1,036	T8F32 - 2 lamp RLO	6	2397	52	0.31	748	0.12	288
12b	100W	4	2397	100	0.40	959	T8F32 - 2 lamp RLO	4	2397	52	0.21	499	0.19	460
13	T12F34 - 4 lamp	3	2397	144	0.43	1,036	T8F32 - 2 lamp NLO	3	2397	59	0.18	424	0.26	611
14a	T12F34 - 4 lamp	87	2397	144	12.53	30,030	T8F32 - 4 lamp RLO	87	2397	102	8.87	21,271	3.65	8,759
14b	T12F34 - 4 lamp	2	800	144	0.29	230	T8F32 - 4 lamp RLO	2	800	102	0.20	163	0.08	67
15	T12F72 - 3 lamp	8	2397	202	1.62	3,874	T8F25 - 6 lamp RLO	8	2397	134	1.07	2,570	0.54	1,304
16	T12F30 - 6 lamp	15	2397	243	3.65	8,737	T8F25 - 6 lamp RLO	15	2397	134	2.01	4,818	1.64	3,919
17	T12F34 - 8 lamp	3	2397	288	0.86	2,071	T8F32 - 8 lamp RLO	3	2397	204	0.61	1,467	0.25	604
18a	T12F34 - 8 lamp	11	2397	288	3.17	7,594	T8F32 - 8 lamp RLO	11	2397	204	2.24	5,379	0.92	2,215
18b	T12F34 - 8 lamp	4	800	288	1.15	922	T8F32 - 8 lamp RLO	4	800	204	0.82	653	0.34	269
Total		**377**			**46.79**	**103,611**		**377**			**24.24**	**53,604**	**22.54**	**50,007**

Customer Cost/Benefit Analysis

Cost and Payback are based on Palo Alto City Facility Rates of 0.0706 $/kWh (effective 1-1-05).

- Site #10: (Retrofit Cost $19,983 - Rebate $10,229) / (Energy Savings $3,530) = Simple Payback 2.8 Years.

Appendix E-1: Roseville C&I Lighting Rebate Site #1

M&V REPORT FOR C&I LIGHTING SITE #1

Prepared for the Roseville Electric Company
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **Site #1**

Site Name: **Site #1**

Site Address: **188 Cirby Way, Roseville, CA 95678**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Kris Blair** **Telephone: (916) 774-5581**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Roseville Site #1

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #1	138433-13881	Lighting	Roseville	SB5X Project	9,300	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #1	Lighting	1.46	6,479	n/a	1,820

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #1	Lighting	1.16	3,450	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Roseville Electric End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Roseville Electric, the following efficiency improvements were plannned under this project at Site #1. The Roseville Electric rebate was $10/lamp. For 182 reported lamps, the rebate was $1,820. Our M&V is based on installed fixtures including lamps and ballasts.

Table 1. Planned Efficiency Improvements at Roseville Site #1

Measure	Description	Qty.	Location
1	T8F32-2 lamps	182	Site #1
Total		**182**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at the Site #1. We verified that 138 lamps were installed at the site: 120 lamps in 49 fixtures with 3-lamps, and 18 lamps in 9 fixtures with 2-lamps.

Table 2. Verified Efficiency Improvements at Roseville Site #1

Measure	Description	Qty.	Location
1a	T8F32-3 lamp	40	Site #1
1b	T8F32-2 lamp	9	Site #1
1c	T12F34-2 lamp (no retrofit)	20	Site #1
Total		69	Total lamps are 178, but only 138 lamps were retrofitted

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Roseville Site #1

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1a	T12F34 - 3 lamp	40	2,984	89	Site #1
1b	T12F34 - 2 lamp	9	2,984	59	Site #1
1c	T12F34 - 2 lamp	20	2,984	59	Site #1
Total		**69**			

Primary Business Descriptions:
Site #1 consists of retail and storage space.

Variability in Schedule and Production: Discussions were held with personnel at the building to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Roseville Site #1

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1a	T12F34-3 lamp	40	2,984	115	4.60	13,724	T8F32-3 lamp	40	2,984	89	3.56	10,623	1.04	3,101
1b	T12F34-2 lamp	9	2,984	72	0.65	1,934	T8F32-2 lamp	9	2,984	59	0.53	1,585	0.12	349
1c	T12F34-2 lamp	20	2,984	72	1.44	4,297	T12F34-2 lamp	20	2,984	72	1.44	4,297	0	0
Total		69			6.69	19,955		69			6.69	16,505	1.16	3,450

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Roseville Electric Rates of 0.0784 $/kWh, effective 1-1-02).

- Site #1: (Retrofit Cost $1,990 - Rebate $1,820) / (Energy Savings $270.48) = Simple Payback 0.71 Years.

Appendix E-2: Roseville C&I Lighting Rebate Site #2

M&V REPORT FOR C&I LIGHTING SITE #2

Prepared for the Roseville Electric Company
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **Site #2**

Site Name: **Site #2**

Site Address: **1050 Melody Lane, Suite 10, Roseville, CA 95678**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Kris Blair** **Telephone: (916) 774-5581**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Roseville Site #2

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #2	106817-26507	Lighting	Roseville	SB5X Project	8,900	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #2	Lighting	1.28	5,714	n/a	1,608

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #2	Lighting	1.27	4,239	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Roseville Electric End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Roseville Electric, the following efficiency improvements were plannned under this project at Site #2. The Roseville Electric rebate for 4-foot lamps was $10/lamp. For 153 reported 4-foot lamps, the rebate was $1,530. The Roseville Electric Rebate for 8-foot lamps was $13/lamp. For 6 reported 8-foot lamps, the rebate was $78. Therefore the total rebate was $1,608. Our M&V is based on installed fixtures including lamps and ballasts.

Table 1. Planned Efficiency Improvements at Roseville Site #2

Measure	Description	Qty.	Location
1	T8F32-4 lamps	153	Site #2
1	T8F32-8 lamps	6	Site #2
Total		**159**	

Note: EB = Electronic Ballast

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #2.

Table 2. Verified Efficiency Improvements at Roseville Site #2

Measure	Description	Qty.	Location
1a	T8F32 - 3 lamp	47	Site #2
1b	T12F34 - 3 lamp	3	Site #2 (not retrofitted)
1c	T12F34 - 3 lamp	1	Site #2 (not retrofitted)
2	T8F59 - 2 lamp	3	Site #2
Total		54	

Pre-Installation Conditions: Based on site inspections and review of old fixtures we verified the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Roseville Site #2

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1a	T12F34 - 3 lamp	47	3,366	115	Site #2
1b	T12F34 - 3 lamp	3	0	72	Site #2 (not retrofitted)
1c	T12F34 - 3 lamp	1	3,366	72	Site #2 (not retrofitted)
2	T12F60 - 2 lamp-8’	3	3,009	123	Site #2
Total		**54**			

Primary Business Descriptions:
Site #2 consists of retail and storage space.

Variability in Schedule and Production: Discussions were conducted with personnel at the building to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Roseville Site #2

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1a	T12F34-3 lamp	47	3,366	115	5.41	18,193	T8F32-3 lamp	47	3,366	89	4.18	14,080	1.23	4,113
1b	T12F34-3 lamp	3	0	115	0.35	-	T12F34-3 lamp	3	0	115	0.35	-	-	-
1c	T12F34-3 lamp	1	3,366	115	0.12	387	T12F34-3 lamp	1	3,366	115	0.12	387	-	-
2	T12F60-2 lamp	3	3,009	123	0.37	1,110	T8F59-2 lamp	3	3,009	109	0.33	984	0.04	126
Total		54			6.25	19,690		54			4.97	15,451	1.27	4,239

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From Roseville Site #2

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Retail Area	Ceiling Fixture	4	T8F32 - 3 lamp	350	87.6	89.0
Retail Area	Ceiling Fixture	5	T8F32 - 3 lamp	447	89.4	89.0

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Roseville Electric Rates of 0.0784 $/kWh, effective 1-1-02)

- Site #2: (Retrofit Cost $1,708 - Rebate $1,608) / (Energy Savings $332.34) = Simple Payback 0.30 Years.

Appendix E-3: Roseville C&I Lighting Rebate Site #3

M&V REPORT FOR C&I LIGHTING SITE #3

Prepared for the Roseville Electric Company
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **Site #3**

Site Name: **Site #3**

Site Address: **199 Cirby Way #4, Roseville, CA 95678**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Kris Blair** **Telephone: (916) 774-5581**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Roseville Site #3

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #3	107969-13939	Lighting	Roseville	SB5X Project	4,000	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #3	Lighting	0.98	3,936	n/a	1,230

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #3	Lighting	1.28	6,163	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Roseville Electric — End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Roseville Electric, the following efficiency improvements were plannned under this project at Site #3. The Roseville Electric rebate was $10/lamp. For 123 reported lamps, the rebate was $1,230. Our M&V is based on installed fixtures including lamps and ballasts.

Table 1. Planned Efficiency Improvements at Roseville Site #3

Measure	Description	Qty.	Location
1	T8F32-2 lamps	123	Site #3
Total		**123**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #3.

Table 2. Verified Efficiency Improvements at Roseville Site #3

Measure	Description	Qty.	Location
1a	T8F32 - 4 lamp	22	Site #3
1b	T8F32 - 3 lamp	8	Site #3
1c	T8F32 - 2 lamp	4	Site #3
Total		34	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Roseville Site #3

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1a	T12F34 - 4 lamp	22	4845	144	Site #3
1b	T12F34 - 3 lamp	8	4845	115	Site #3
1c	T12F34 - 2 lamp	4	4845	72	Site #3
Total		**34**			

Primary Business Descriptions:
Site #3 consists of office space.

Variability in Schedule and Production: Discussions were held with personnel at the building to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Roseville Site #3

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1a	T12F34 - 4 lamp	22	4845	144	3.17	15,349	T8F32 - 4 lamp	22	4845	102	2.24	10,872	0.93	4477
1b	T12F34 - 3 lamp	8	4845	115	0.92	4,457	T8F32 - 3 lamp	8	4845	78	0.62	3,023	0.30	1434
1c	T12F34 - 2 lamp	4	4845	72	0.29	1,395	T8F32 - 2 lamp	4	4845	59	0.24	1,143	0.05	252
Total		34			4.38	21,201		34			3.10	15,038	1.28	6,163

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 4**.

Table 4. Fixture Wattage Measurements From Roseville Site #3

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Office Space	Ceiling Fixture	2	T8F32 - 4 lamp	209	104.40	102.0
Conference Room	Ceiling Fixture	4	T8F32 - 4 lamp	408	102.00	102.0
Office Space	Ceiling Fixture	2	T8F32 - 2 lamp	118	58.80	59.0

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Roseville Electric Rates of 0.0784 $/kWh, effective 1-1-02)

- Site #3: (Retrofit Cost $1,320 - Rebate $1,230) / (Energy Savings $483.18) = Simple Payback 0.19 Years.

Appendix E-4: Roseville C&I Lighting Rebate Site #4

M&V REPORT FOR C&I LIGHTING SITE #4

Prepared for the Roseville Electric Company
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **Site #4**

Site Name: **Site #4**

Site Address: **384 Roseville Square, Roseville, CA 95678**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Kris Blair** **Telephone: (916) 774-5581**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Roseville Site #4

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #4	135607-18813	Lighting	Roseville	SB5X Project	3,000	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #4	Lighting	1.38	6,123	n/a	1,720

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #4	Lighting	1.36	4,083	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Roseville Electric — End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Roseville Electric, the following efficiency improvements were plannned under this project at Site #4. The Roseville Electric rebate was $10/lamp. For 172 reported lamps, the rebate was $1,720. Our M&V is based on installed fixtures including lamps and ballasts.

Table 1. Planned Efficiency Improvements at Roseville Site #4

Measure	Description	Qty.	Location
1	T8F32-2 lamps	172	Site #4
Total		**172**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #4.

Table 2. Verified Efficiency Improvements at Roseville Site #4

Measure	Description	Qty.	Location
1	T8F32 - 4 lamp	42	Site #4
2	T8F32 - 2 lamp	1	Site #4
Total		**43**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Roseville Site #4

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	T8F32 - 4 lamp	42	3009	112	Site #4
2	T8F32 - 2 lamp	1	3009	59	Site #4
Total		**43**			

Primary Business Descriptions:
Site #4 consists of retail space.

Variability in Schedule and Production: Discussions were held with personnel at the building to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Roseville Site #4

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	T12F34 - 4 lamp	42	3009	144	6.05	18,198	T8F32 - 4 lamp	42	3009	112	4.70	14,154	1.35	4,044
2	T12F34 - 2 lamp	1	3009	72	0.07	217	T8F32 - 2 lamp	1	3009	59	0.06	178	0.01	39
Total		43			6.12	18, 415		43			4.76	14, 332	1.36	4,083

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Roseville Electric Rates of 0.0784 $/kWh, effective 1-1-02).

- Site #4: Retrofit Cost $2,580 - Rebate $1,720) / (Energy Savings $320.11) = Simple Payback 2.69 Years.

Appendix E-5: Roseville C&I Lighting Rebate Site #5

M&V REPORT FOR C&I LIGHTING SITE #5

Prepared for the Roseville Electric Company
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **Site #5**

Site Name: **Site #5**

Site Address: **889 Riverside Ave., Roseville, CA 95678**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Kris Blair** **Telephone: (916) 774-5581**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Roseville Site #5

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #5	140928-24588	Lighting	Roseville	SB5X Project	25,000	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #5	Lighting	9.75	43,866	n/a	5,125

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #5	Lighting	11.71	28,094	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Roseville Electric End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Roseville Electric, the following efficiency improvements were plannned under this project at Site #5. The Roseville Electric rebate for 5-13W compact fluorescent lamps was $10/lamp. For 113 reported 5-13W lamps, the rebate was $1,130. The Roseville Electric rebate for high efficiency exit signs was $35/sign. For 5 reported exit signs, the rebate was $175. The Roseville Electric rebate for the 4-foot lamps was $10/lamp. For 313 reported 4-foot lamps, the rebate was $3,130. The Roseville Electric Rebate for removing 4-foot lamps was $10/lamp. For 69 reported 4-foot lamp removals, the rebate was $690. Therefore the total rebate was $5,125. Our M&V is based on installed fixtures including lamps and ballasts.

Table 1. Planned Efficiency Improvements at Roseville Site #5

Measure	Description	Qty.	Location
1	CFL5-13W	113	Site #5
2	ExitLED2W	5	Site #5
3	T8F32	313	Site #5
4	T12F34-Removed	69	Site #5
Total		**500**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #5. Rebates were given for 5 LED Exit signs, but only 3 were found.

Table 2. Verified Efficiency Improvements at Roseville Site #5

Measure	Description	Qty.	Location
1	CFL15	103	Site #5
2	ExitLED2W	3	Site #5
3	T8F32 - 4 lamp	52	Site #5
3	T8F32 - 2 lamp	25	Site #5
3	T8F32 - 2 lamp	25	Site #5
3	T8F32 - 1 lamp	8	Site #5
4	T12F34-Removed	50	Site #5
Total		266	

Pre-Installation Conditions: Based on site inspections and review of old fixtures we verified the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Roseville Site #5

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	60W	103	2398.5	60	Site #5
2	Exit20W	3	2398.5	40	Site #5
3	T12F34 - 4 lamp	52	2398.5	144	Site #5
3	T12F34 - 4 lamp	25	2398.5	144	Site #5
3	T12F34 - 2 lamp	25	2398.5	72	Site #5
3	T12F34 - 1 lamp	8	2398.5	43	Site #5
4	T12F34-Removed				Site #5
Total		**216**			

Primary Business Descriptions:
Site #5 consists of a skating rink and storage space.

Variability in Schedule and Production: Discussions were conducted with personnel at the building to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Roseville Site #5

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	60W	103	2398.5	60	6.18	14,823	CFL15	103	2398.5	15	1.55	3,706	4.63	11,117
2	Exit20W	3	2398.5	40	0.12	288	ExitLED2W	3	2398.5	2	0.01	14	0.11	274
3	T12F34 - 4 lamp	52	2398.5	144	7.49	17,960	T8F32 - 4 lamp	52	2398.5	101	5.25	12,597	2.24	5,363
3	T12F34 - 4 lamp	25	2398.5	144	3.60	8,635	T8F32 - 2 lamp	25	2398.5	52	1.30	3,118	2.30	5,517
3	T12F34 - 2 lamp	25	2398.5	72	1.80	4,317	T8F32 - 2 lamp	25	2398.5	52	1.30	3,118	0.50	1,199
3	T12F34 - 1 lamp	8	2398.5	43	0.34	825	T8F32 - 1 lamp	8	2398.5	27	0.22	518	0.12	307
4	T12F34 (Removed)	50	2,399	36	1.80	4,317	T12F34-Removed						1.80	4,317
Total		**266**			**21.33**	**51,165**		**216**			**9.6**	**23,071**	**11.70**	**28,094**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From Roseville Site #5

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #5	Ceiling Fixture	14	T8F32 - 4 lamp	1,412	100.91	102.0
Site #5	Ceiling Fixture	14	T8F32 - 4 lamp	1,407	100.51	102.0
Site #5	Ceiling Fixture	12	CFL15	181	15.10	15.0

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Roseville Electric Rates of 0.0784 $/kWh, effective 1-1-02).

- Site #5: (Retrofit Cost $7,025 - Rebate $5,125) / (Energy Savings $2,202.68) = Simple Payback 0.86 Years.

Appendix E-6: Roseville C&I Lighting Rebate Site #6

M&V REPORT FOR C&I LIGHTING SITE #6

Prepared for the Roseville Electric Company
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **Site #6**

Site Name: **Site #6**

Site Address: **1850 Doulas Blvd., Roseville, CA 95661**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Kris Blair** **Telephone: (916) 774-5581**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Roseville Site #6

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #6	104115-38458	Lighting	Roseville	SB5X Project	5,700	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #6	Lighting	4.65	22,106	n/a	1,595

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #6	Lighting	4.68	19,293	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Roseville Electric End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Roseville Electric, the following efficiency improvements were plannned under this project at Site #6. The Roseville Electric rebate for compact flourescent lamps over 14 Watts was $15/lamp. For 73 reported lamps over 14 Watts, the rebate was $1,095. The Roseville Electric rebate for new exit signs was $35/sign. For 4 reported exit signs, the rebate was $140. The Roseville Electric rebate for 4-foot lamps was $10/lamp. For 18 reported 4-foot lamps, the rebate was $180. The Roseville Electric Rebate for 4-foot lamp removal was $10/lamp. For 18 reported 4-foot lamp removals, the rebate was $180. Therefore the total rebate was $1,595. Our M&V is based on installed fixtures including lamps and ballasts.

Table 1. Planned Efficiency Improvements at Roseville Site #6

Measure	Description	Qty.	Location
1	CFL>14W	73	Site #6
2	Exit20W	4	Site #6
3	T8F32	18	Site #6
4	T12F34 - Removed	18	Site #6
Total		**113**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at the Site #6.

Table 2. Verified Efficiency Improvements at Roseville Site #6

Measure	Description	Qty.	Location
1	CFL15	69	Site #6
2	Exit20W	4	Site #6
3	T8F32 - 4 lamp	8	Site #6
4	T8F32 - 2 lamp	11	Site #6
Total		**92**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures we verified the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Roseville Site #6

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	75R	69	3957	75	Site #6
2	Exit20W	4	8760	40	Site #6
3	T12F34 - 4 lamp	8	3957	144	Site #6
4	T12F34 - 2 lamp	11	3957	72	Site #6
Total		**92**			

Primary Business Descriptions:
Site #6 is a restaurant.

Variability in Schedule and Production: Discussions were conducted with personnel at the building to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Roseville Site #6

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	75R	69	3957	75	5.18	20,477	CFL15	69	3957	15	1.04	4,095	4.14	16,382
2	Exit20W	4	8760	40	0.16	1,402	Exit20W	4	8760	2	0.01	70	0.15	1,332
3	T12F34 – 4 lamp	8	3957	144	1.15	4,558	T8F32 - 4 lamp	8	3957	112	0.90	3,545	0.25	1,013
4	T12F34 – 2 lamp	11	3957	72	0.79	3,134	T8F32 - 2 lamp	11	3957	59	0.65	2,568	0.14	566
Total		**92**			**7.28**	**29,571**		**92**			**2.60**	**10,278**	**4.68**	**19,293**

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Roseville Electric Rates of 0.0784 $/kWh, effective 1-1-02).

- Site #6: (Retrofit Cost $2,976 - Rebate $1,595) / (Energy Savings $1,512.57) = Simple Payback 0.91Years.

Appendix E-7: Roseville C&I Lighting Rebate Site #7

M&V REPORT FOR C&I LIGHTING SITE #7

Prepared for the Roseville Electric Company
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **Site #7**

Site Name: **Site #7**

Site Address: **199 Cirby Way, Ste 19, Roseville, CA 95678**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Kris Blair** **Telephone: (916) 774-5581**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Roseville Site #7

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #7	146620-13936	Lighting	Roseville	SB5X Project	3,700	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #7	Lighting	1.11	4,922	n/a	1,335

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #7	Lighting	1.14	8,272	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Roseville Electric **End Use: LIGHTING**

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Roseville Electric, the following efficiency improvements were plannned under this project at the Site #7. The Roseville Electric rebate for 4-foot lamps was $10/lamp. For 132 reported 4-foot lamps, the rebate was $1,320. The Roseville Electric rebate for compact flourescent lamps over 14 Watts was $15/lamp. For 1 reported lamp over 14 Watts, the rebate was $15. Therefore the total rebate was $1,335. Our M&V is based on installed fixtures including lamps and ballasts.

Table 1. Planned Efficiency Improvements at Roseville Site #7

Measure	Description	Qty.	Location
1	T8F32	132	Site #7
3	CFL>14W	1	Site #7
Total		**133**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #7.

Table 2. Verified Efficiency Improvements at Roseville Site #7

Measure	Description	Qty.	Location
1	T8F32 - 4 lamp	30	Site #7
1a	T12F34 - 4 lamp (not retrofitted)	3	Site #7
2	T8F32 - 2 lamp	2	Site #7
2a	T12F34 - 2 lamp (not retrofitted)	1	Site #7
3	75W (not retrofitted)	1	Site #7
Total		37	

Pre-Installation Conditions: Based on site inspections and review of old fixtures we verified the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Roseville Site #7

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	T12F34 - 4 lamp	33	7300	144	Site #7
2	T12F34 - 2 lamp	3	7300	72	Site #7
3	75W	1	7300	75	Site #7
Total		**37**			

Primary Business Descriptions:
Site #7 consists of retail and storage space.

Variability in Schedule and Production: Discussions were conducted with personnel at the building to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following

spreadsheets provide ex-ante kW and kWh savings. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Roseville Site #7

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	T12F34 - 4 lamp	33	7300	144	4.75	34,690	T8F32 - 4 lamp	30	7300	112	3.36	24,528	1.39	10,162
2	T12F34 - 2 lamp	3	7300	72	0.22	1,577	T12F34 - 4 lamp (not retrofitted)	3	7300	144	0.43	3,154	(0.21)	(1,577)
3	75W	1	7300	75	0.08	548	T8F32 - 2 lamp	2	7300	59	0.12	861	(0.04)	(313)
							T12F34 - 2 lamp (not retrofitted)	1	7300	72	0.07	526	-	-
							75W (not retrofitted)	1	7300	75	0.08	548	-	-
Total		**37**			**5.05**	**36,815**		**37**			**4.06**	**29,617**	**1.14**	**8,272**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From Roseville Site #7

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Retail Area	Ceiling Fixture	4	T8F32 - 4 lamp	444	111	112.0
Retail Area	Ceiling Fixture	4	T8F32 - 4 lamp	438	109.5	112.0
Average	Ceiling Fixture	8	T8F32 – 4 lamp (NLO)	882	110.25	112.0

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Roseville Electric Rates of 0.0784 $/kWh, effective 1-1-02)

- Site #7: (Retrofit Cost $1,420 - Rebate $1,335) / (Energy Savings $648.52) = Simple Payback 0.13 Years.

Appendix E-8: Roseville C&I Lighting Rebate Site #8

M&V REPORT FOR C&I LIGHTING SITE #8

Prepared for the Roseville Electric Company
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **Site #8**

Site Name: **Site #8**

Site Address: **400 Sunrise Ave, Roseville, CA 95661**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Kris Blair** **Telephone: (916) 774-5581**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Roseville Site #8

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #8	147040-18968	Lighting	Roseville	SB5X Project	1,500	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #8	Lighting	1.01	4,877	n/a	1,372

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #8	Lighting	1.12	2,980	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Roseville Electric End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Roseville Electric, the following efficiency improvements were plannned under this project at Site #8. The Roseville Electric rebate for 4-foot lamps was $10/lamp. For 132 reported 4-foot lamps, the rebate was $1,320. The Roseville Electric Rebate for 8-foot lamps was $13/lamp. For 4 reported 8-foot lamps, the rebate was $52. Therefore the total rebate was $1,372. Our M&V is based on installed fixtures including lamps and ballasts.

Table 1. Planned Efficiency Improvements at Roseville Site #8

Measure	Description	Qty.	Location
1	T8F32-4 lamps	132	Site #8
1	T8F32-8 lamps	4	Site #8
Total		**136**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #8.

Table 2. Verified Efficiency Improvements at Roseville Site #8

Measure	Description	Qty.	Location
1a	T8F32 - 4 lamp (NLO)	29	Site #8
1b	T8F32 - 2 lamp (NLO)	12	Site #8
1c	T8F32 - 1 lamp (NLO)	1	Site #8
2	T8F59 - 2 lamp (NLO)	2	Site #8
Total		44	

Pre-Installation Conditions: Based on site inspections and review of old fixtures we verified the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Roseville Site #8

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1a	T12F34 - 4 lamp	29	2652	144	Site #8
1b	T12F34 - 2 lamp	12	2652	72	Site #8
1c	T12F34 - 1 lamp	1	2652	43	Site #8
2	T12F96 - 2 lamp	2	2652	123	Site #8
Total		**44**			

Primary Business Descriptions:
Site #8 consists of retail space.

Variability in Schedule and Production: Discussions were conducted with personnel at the building to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Roseville Site #8

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1a	T12F34 - 4 lamp	29	2652	144	4.18	11,075	T8F32 - 4 lamp	29	2652	112	3.25	8,614	0.93	2,461
1b	T12F34 - 2 lamp	12	2652	72	0.86	2,291	T8F32 - 2 lamp	12	2652	59	0.71	1,878	0.15	413
1c	T12F34 - 1 lamp	1	2652	43	0.04	114	T8F32 - 1 lamp	1	2652	31	0.03	82	0.01	32
2	T12F96 - 2 lamp	2	2652	123	0.25	652	T8F59 - 2 lamp	2	2652	109	0.22	578	0.03	74
Total		**44**			**5.33**	**14,132**		**44**			**4.21**	**11,152**	**1.12**	**2,980**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5.**

Table 5. Fixture Wattage Measurements From Roseville Site #8

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Back Area	Ceiling Fixture	2	T8F59 - 2 lamp	218	109.20	109.0

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Roseville Electric Rates of 0.0784 $/kWh, effective 1-1-02).

- Site #8: (Retrofit Cost $1,539 - Rebate $1,372) / (Energy Savings $233.63) = Simple Payback 0.71 Years.

Appendix E-9: Roseville C&I Lighting Rebate Site #9

M&V REPORT FOR C&I LIGHTING SITE #9

Prepared for the Roseville Electric Company
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **Site #9**

Site Name: **Site #9**

Site Address: **213 Kenroy Lane, Roseville, CA 95678**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Kris Blair** **Telephone: (916) 774-5581**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Roseville Site #9

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #9	147043-14972	Lighting	Roseville	SB5X Project	4,500	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #9	Lighting	1.36	6,098	n/a	1,182

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #9	Lighting	1.614	3,794	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Roseville Electric End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Roseville Electric, the following efficiency improvements were plannned under this project at Site #9. The Roseville Electric rebate for 4-foot lamps was $10/lamp. For 18 reported 4-foot lamps, the rebate was $180. The Roseville Electric rebate for 8-foot lamps was $13/lamp. For 68 reported 8-foot lamps, the rebate was $884. The Roseville Electric rebate for removal of 8-foot lamps was $13/lamp. For 6 reported 8-foot lamp removals, the rebate was $78. The Roseville Electric rebate for wallbox lighting sensors is $40/sensor. For 1 reported sensor, the rebate was $40. Therefore the total rebate was $1,182. Our M&V is based on installed fixtures including lamps and ballasts.

Table 1. Planned Efficiency Improvements at Roseville Site #9

Measure	Description	Qty.	Location
1	T8F32	18	Site #9
2	T8F59	68	Site #9
3	T12F96 Removed	6	Site #9
4	Occupancy Sensor	1	Site #9
Total		**93**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #9.

Table 2. Verified Efficiency Improvements at Roseville Site #9

Measure	Description	Qty.	Location
1	T8F32 - 2 lamp	6	Site #9
2	T8F32 - 4 lamp	29	Site #9
3	T12F96 Removed	6	Site #9
4a	Occupancy Sensor	1	Site #9
4b	Occupancy Sensor	1	Site #9
Total		43	

Pre-Installation Conditions: Based on site inspections and review of old fixtures we verified the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Roseville Site #9

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	T12F34 - 2 lamp	6	2805	72	Site #9
2	T12F96 - 2 lamp	29	2805	123	Site #9
3	T12F96 Removed				Site #9
4	Occupancy Sensor				Site #9
Total		**35**			

Primary Business Descriptions:
Site #9 consists of retail space.

Variability in Schedule and Production: Discussions were conducted with personnel at the building to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Roseville Site #9

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	T12F34 - 2 lamp	6	2805	72	0.43	1,212	T8F32 - 2 lamp	6	2805	59	0.35	993	0.08	219
2	T12F96 - 2 lamp	29	2805	123	3.57	10,005	T8F32 - 4 lamp	29	2805	111	3.22	9,029	0.35	976
3							T12F96 Removed	6	2805	(75)	(0.450)	(1,262)	0.450	1,262
4							Occupancy Sensor	1	(1,402)		(0.29)	(83)	0.029	83
							Occupancy Sensor	1	(1,402)		(0.444)	(1,254)	0.444	1,254
Total		**35**			**4.00**	**11,217**		**43**			**2.39**	**7,423**	**1.614**	**3,794**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5.**

Table 5. Fixture Wattage Measurements From Roseville Site #9

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Shop	Ceiling Fixture	6	T8F32 - 4 lamp	660	110.00	112.0
Shop	Ceiling Fixture	6	T8F32 - 4 lamp	672	112.00	112.0
Averages/Totals	**Ceiling Fixture**	**12**	**T8F32 - 4 lamp (RLO)**	**1332**	**111.00**	**112.0**

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Roseville Electric Rates of 0.0784 $/kWh, effective 1-1-02).

- Site #9: (Retrofit Cost $3,502 - Rebate $1,182) / (Energy Savings $93.69) = Simple Payback 24.76 Years.

Appendix E-10: Roseville C&I Lighting Rebate Site #10

M&V REPORT FOR C&I LIGHTING SITE #10

Prepared for the Roseville Electric Company
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **Site #10**

Site Name: **Site #10**

Site Address: **4012 Foothills Blvd., Roseville, CA 95747**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Kris Blair** **Telephone: (916) 774-5581**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Roseville Site #10

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #10	n/a	Lighting	Roseville	SB5X Project	3,000	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #10	Lighting	1.10	4,416	n/a	1,380

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #10	Lighting	1.33	4,748	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Roseville Electric — End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Roseville Electric, the following efficiency improvements were plannned under this project at Site #10. The Roseville Electric rebate was $10/lamp. For 138 reported lamps, the rebate was $1,380. Our M&V is based on installed fixtures including lamps and ballasts.

Table 1. Planned Efficiency Improvements at Roseville Site #10

Measure	Description	Qty.	Location
1	T8F32-2 lamps	138	Site #10
Total		**138**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #10.

Table 2. Verified Efficiency Improvements at Roseville Site #10

Measure	Description	Qty.	Location
1	T8F32 - 4 lamp	35	Site #10
Total		**35**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Roseville Site #10

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	T12F34 - 4 lamp	35	3570	144	Site #10
Total		**35**			

Primary Business Descriptions: Site #10 consists of office space.

Variability in Schedule and Production: Discussions were held with personnel at the building to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Roseville Site #10

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	T12F34 - 4 lamp	35	3570	144	5.04	17,993	T8F32 - 4 lamp	35	3570	106	3.71	13,245	1.33	4,748
Total		**35**			**5.04**	**17,993**		**35**			**3.71**	**13,245**	**1.33**	**4,748**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From Roseville Site #10

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Office	Ceiling Fixture	2	T8F32 - 4 lamp	211	105.60	105.0
Conference Room	Ceiling Fixture	2	T8F32 - 4 lamp	214	106.80	105.0
Office	Ceiling Fixture	4	T8F32 - 4 lamp	422	105.60	105.0
Average	Ceiling Fixture	8	T8F32 - 4 lamp	848	106.00	106.0

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Roseville Electric Rates of 0.0784 $/kWh, effective 1-1-02).

- Site #10: (Retrofit Cost $1,730 - Rebate $1,380) / (Energy Savings $372.24) = Simple Payback 0.94 Years.

Appendix F-1: Santa Clara C&I Lighting Rebate Site #1

M&V REPORT FOR C&I LIGHTING SITE #1

Prepared for the City of Santa Clara
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Santa Clara – Silicon Valley Power**

Site Name: **Site #1**

Site Address: **3550 Bassett St., Santa Clara, CA 95054**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Joyce Kinnear** **Telephone: (408) 615-5686**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Santa Clara Site #1

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #1	n/a	Lighting	Santa Clara	SB5X Project	47,000	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #1	Lighting	23.5	90,696	n/a	13,293

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #1	Lighting	27.97	106,012	n/a

Impact Evaluation Report: City of Santa Clara End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Site #1 and Silicon Valley Power, the following efficiency improvements were plannned under this project at Site #1.

Table 1. Planned Efficiency Improvements at Santa Clara Site #1

Measure	Description	Qty.	Location
1	Screw in CFL	2	Offices
2	Hardwired CFL	8	Offices
3	F17T8 Lamp	68	Offices
4	F32T8 Lamp	658	Offices
5	F32T8 Lamp	784	Offices
6	F40T12 Lamp Remove	267	Offices
7	Metal Halide 400 Remove	35	Offices
8	ExitLED2W	15	Offices
Total		**1,837**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #1.

Table 2. Verified Efficiency Improvements at Santa Clara Site #1

Measure	Description	Qty.	Location
1	CFL20W	2	Offices
2	CFL26W	8	Offices
3	T8F17 - 2 lamp	23	Offices
4a	T8F32 - 4 lamp	4	Offices
4b	T8F32 - 2 lamp	199	Offices
4c	T8F32 - 3 lamp	2	Offices
4d	T8F32 - 2 lamp	32	Offices
4e	T12F34 - 2 lamp Remove	10	Offices
4f	T8F32 - 1 lamp	8	Offices
5	T8F32 - 2 lamp HLO	392	Offices
6	Included in 4b, 4e		Offices
7	Metal Halide 400 Remove	35	Offices
8	ExitLED2W	15	Offices
Total		**730**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Santa Clara Site #1

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	100W	2	3060	100	Offices
2	100W	8	3672	100	Offices
3	T12F34 - 2 lamp U	23	3672	72	Offices
4a	T12F34 - 4 lamp	4	3672	144	Offices
4b	T12F34 - 3 lamp	199	3672	115	Offices
4c	T12F34 - 3 lamp	2	3672	115	Offices
4d	T12F34 - 2 lamp	32	3672	72	Offices
4e	T12F34 - 2 lamp	10	3672	72	Offices
4f	T12F34 - 1 lamp	8	3672	43	Offices
5	T12F34 - 2 lamp	392	3672	72	Offices
6	Included in 4b, 4e				Offices
7	Metal Halide 400	35	3672	458	Offices
8	ExitInc20W	15	8760	40	Offices
Total		**730**			

Primary Business Descriptions:
Site #1 consists of offices, hallways, restrooms, conference spaces, and computer rooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Santa Clara Site #1

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	100W	2	3,060	100	0.20	612	CFL20W	2	3,060	20	0.04	122	0.16	490
2	100W	8	3,672	100	0.80	2,938	CFL26W	8	3,672	26	0.21	764	0.59	2,174
3	T12F34 - 2 lamp U	23	3,672	72	1.66	6,081	T8F17 - 2 lamp	23	3,672	31	0.71	2,618	0.95	3,463
4a	T12F34 - 4 lamp	4	3,672	144	0.58	2,115	T8F32 - 4 lamp	4	3,672	112	0.45	1,645	0.13	470
4b	T12F34 - 3 lamp	199	3,672	115	22.90	84,034	T8F32 - 2 lamp	199	3,672	59	11.80	43,113	11.10	40,921
4c	T12F34 - 3 lamp	2	3,672	115	0.23	845	T8F32 - 3 lamp	2	3,672	89	0.18	654	0.05	191
4d	T12F34 - 2 lamp	32	3,672	72	2.30	8,460	T8F32 - 2 lamp	32	3,672	59	1.89	6,933	0.41	1,527
4e	T12F34 - 2 lamp	10	3,672	72	0.72	2,644	T12F34 - 2 lamp Remove	10	3,672	0	-	-	0.72	2,644
4f	T12F34 - 1 lamp	8	3,672	43	0.34	1,263	T8F32 - 1 lamp	8	3,672	31	0.25	911	0.09	352
5	T12F34 - 2 lamp	392	3,672	72	28.20	103,639	T8F32 - 2 lamp HLO	392	3,672	79	31.00	113,714	-2.80	-10,075
6					-	-	Included in 4b, 4e				-	-	-	-
7	Metal Halide 400	35	3,672	458	16.00	58,862	Metal Halide 400 Remove	35	3,672	0	-	-	16.00	58,862
8	ExitInc20W	15	8,760	40	0.60	5,256	ExitLED2W	15	8,760	2	0.03	263	0.57	4,993
Total		**730**			**74.53**	**276,749**		**730**			**46.56**	**170,737**	**27.97**	**106,012**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From Santa Clara Site #1

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #1	Manufacturing	38	T8F32 - 2 lampHLO	3,046.8	80.18	79
Site #1	Manufacturing	16	T8F32 - 2 lampHLO	1,249.3	78.08	79
Site #1	Manufacturing	14	T8F32 - 2 lampHLO	1,088.6	77.76	79
Site #1	Office	4	T8F32 - 2 lamp	238.2	59.56	59

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Santa Clara Electric Rate of 0.10358 $/kWh).

- Site #1: (Retrofit Cost $57,836 - Rebate $13,293) / (Energy Savings $10,981) = Simple Payback 4.06 Years.

Appendix F-2: Santa Clara C&I Lighting Rebate Site #2

M&V REPORT FOR C&I LIGHTING SITE #2

Prepared for the City of Santa Clara
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Santa Clara – Silicon Valley Power**

Site Name: **Site #2**

Site Address: **1450 Coleman, Santa Clara, CA**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Joyce Kinnear** **Telephone: (408) 615-5686**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Santa Clara Site #2

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #2	n/a	Lighting	Santa Clara	SB5X Project	36,022	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #2	Lighting	19.14	81,613	n/a	9,563

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #2	Lighting	51.11	199,942	n/a

Spillover

The following additional lighting improvements were found at the site (included in M&V savings).

Table 1. Santa Clara Site #2 Spillover Measures

Measure	Description	Qty.	Location
2b	Remove T12F40 - 2 lamp	12	Offices
Total		**25**	

Impact Evaluation Report: City of Santa Clara End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Site #2 and Silicon Valley Power, the following efficiency improvements were plannned under this project at Site #2.

Table 2. Planned Efficiency Improvements at Santa Clara Site #2

Measure	Description	Qty.	Location
1	T8F32 lamps	1276	Offices
Total		**1276**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #2.

Table 3. Verified Efficiency Improvements at Santa Clara Site #2

Measure	Description	Qty.	Location
1a	T8F32 - 2 lamp	521	Offices
1b	T8F32 - 2 lamp	55	Offices
1c	T8F32 - 2 lamp	33	Offices
2a	T8F32 - 2 lamp	8	Offices
2b	Remove T12F40 - 2 lamp	12	Offices
Total		**629**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 4. Pre-Installation, Watts and Hours of Operation for Santa Clara Site #2

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1a	T12F40 - 4 lamp	521	3417	144	Offices
1b	T12F40 - 4 lamp	55	8760	144	Offices
1c	T12F40 - 2 lamp	33	3417	72	Offices
1d	T12F40 - 4 lamp	8	3417	144	Offices
1e	T12F40 - 2 lamp	12	3417	72	Offices
Total		**629**			

Primary Business Descriptions:
Site #2 consists of offices, hallways, and restrooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 5. M&V Savings for Santa Clara Site #2

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1a	T12F40 - 4 lamp	521	3417	144	75.02	256,357	T8F32 - 2 lamp	521	3417	58	30.22	103,255	44.80	153,102
1b	T12F40 - 4 lamp	55	8760	144	7.92	69,379	T8F32 - 2 lamp	55	8760	58	3.19	27,944	4.73	41,435
1c	T12F40 - 2 lamp	33	3417	72	2.38	8,119	T8F32 - 2 lamp	33	3417	58	1.91	6,540	0.47	1,579
1d	T12F40 - 4 lamp	8	3417	144	1.15	3,936	T8F32 - 2 lamp	8	3417	112	0.90	3,062	0.25	874
1e	T12F40 - 2 lamp	12	3417	72	0.86	2,952	Remove T12F40 - 2 lamp	12	3417	0	-	-	0.86	2,952
Total		**629**			**87.33**	**340,743**		**629**			**36.22**	**140,801**	**51.11**	**199,942**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 6**.

Table 6. Fixture Wattage Measurements From Santa Clara Site #2

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #2	Office	10	F32T8 - 2 lamp LP	567.9	56.79	58
Site #2	Office	10	F32T8 - 2 lamp LP	603.9	60.39	58
Site #2	Office	8	F32T8 - 2 lamp LP	462.6	57.82	58
Site #2	Office	7	F32T8 - 2 lamp LP	396.1	56.59	58

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Santa Clara Electric Rate of 0.10358 $/kWh).

- Site #2: (Retrofit Cost $10,141 - Rebate $9,563) / (Energy Savings $20,710) = Simple Payback 0.03 Years.

Appendix F-3: Santa Clara C&I Lighting Rebate Site #3

M&V REPORT FOR C&I LIGHTING SITE #3

Prepared for the City of Santa Clara
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Santa Clara – Silicon Valley Power**

Site Name: **Site #3**

Site Address: **1655 Scott Boulevard, Santa Clara, CA 95050**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Joyce Kinnear** **Telephone: (408) 615-5686**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Santa Clara Site #3

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #3	n/a	Lighting	Santa Clara	SB5X Project	31,600	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #3	Lighting	82.8	243,338	n/a	62,535

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #3	Lighting	84.66	294,776	n/a

Spillover

The following additional lighting improvements were found at the site (included in M&V savings).

Table 1. Santa Clara Site #3 Spillover Measures

Measure	Description	Qty.	Location
1a	T8F32 - 4 lamp LP	384	Offices
1c	T8F32 - 2 lamp LP	110	Offices
2b	1 Occupancy Sensor	34	Office
3	New	123	New can CFL26 or Wall Sconce 26W
6	69 Occupancy Sensors	278	
6	69 Occupancy Sensors	16	
Total		**77**	

Impact Evaluation Report: City of Santa Clara End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Site #3 and Silicon Valley Power, the following efficiency improvements were plannned under this project at Site #3.

Table 2. Planned Efficiency Improvements at Santa Clara Site #3

Measure	Description	Qty.	Location
1	T8F32 - 3 lamp	605	Offices, Laboratories, Hallways, Restrooms
2	Occupancy Sensor	2	Offices, Laboratories, Hallways, Restrooms
3	75A to New Can CFL26	122	Offices, Laboratories, Hallways, Restrooms
4	New 2' T5 Up Light	1140	Offices, Laboratories, Hallways, Restrooms
5	ExitLED2W	37	Offices, Laboratories, Hallways, Restrooms
6	Occupancy Sensor	66	Offices, Laboratories, Hallways, Restrooms
Total		**1972**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #3.

Table 3. Verified Efficiency Improvements at Santa Clara Site #3

Measure	Description	Qty.	Location
1a	T8F32 - 4 lamp LP	384	Offices, Laboratories, Hallways, Restrooms
1b	T8F32 - 3 lamp LP	61	Offices, Laboratories, Hallways, Restrooms
1c	T8F32 - 2 lamp LP	110	Offices, Laboratories, Hallways, Restrooms
2a	1 Occupancy Sensor	16	Offices, Laboratories, Hallways, Restrooms
2b	1 Occupancy Sensor	34	Offices, Laboratories, Hallways, Restrooms
3	New Can CFL26 or Wall Sconce 26W	123	Offices, Laboratories, Hallways, Restrooms
4	New 2' T5 Up Light	1146	Offices, Laboratories, Hallways, Restrooms
5	ExitLED2W	32	Offices, Laboratories, Hallways, Restrooms
6	69 Occupancy Sensors	278	Offices, Laboratories, Hallways, Restrooms
6	69 Occupancy Sensors	36	Offices, Laboratories, Hallways, Restrooms
6	69 Occupancy Sensors	30	Offices, Laboratories, Hallways, Restrooms
6	69 Occupancy Sensors	16	Offices, Laboratories, Hallways, Restrooms
Total		**2266**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 4. Pre-Installation, Watts and Hours of Operation for Santa Clara Site #3

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1a	T12F40 - 4 lamp	384	3363	144	Offices, Laboratories, Hallways, Restrooms
1b	T12F40 - 3 lamp	61	3363	115	Offices, Laboratories, Hallways, Restrooms
1c	T12F40 - 2 lamp	110	3363	72	Offices, Laboratories, Hallways, Restrooms
2					Offices, Laboratories, Hallways, Restrooms
3	150R	39	3363	150	Offices, Laboratories, Hallways, Restrooms
4a	T12F40 - 4 lamp	657	3363	144	Offices, Laboratories, Hallways, Restrooms
4b	T12F40 - 3 lamp	600	3363	115	Offices, Laboratories, Hallways, Restrooms
4c	T12F40 - 2 lamp	20	3363	72	Offices, Laboratories, Hallways, Restrooms
5	Exit40W	14	8760	40	Offices, Laboratories, Hallways, Restrooms
6	No Occupancy Sensors	278	3363	74	Offices, Laboratories, Hallways, Restrooms
6	No Occupancy Sensors	36	3363	72	Offices, Laboratories, Hallways, Restrooms
6	No Occupancy Sensors	30	3363	26	Offices, Laboratories, Hallways, Restrooms
6	No Occupancy Sensors	16	3363	26	Offices, Laboratories, Hallways, Restrooms
Total		**2245**			

Primary Business Descriptions:
Site #3 consists of offices, laboratories, hallways, and restrooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 5. M&V Savings for Santa Clara Site #3

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1a	T12F40 - 4 lamp	384	3363	144	55.3	185,960	T8F32-2 lamp	324	4590	57	18.47	84,768	36.83	101,192
1b	T12F40 - 3 lamp	61	3363	115	7.02	23,591	T8F32 - 4 lamp LP	384	3363	102	39.17	131,722	-32.15	-108,131
1c	T12F40 - 2 lamp	110	3363	72	7.92	26,635	T8F32 - 3 lamp LP	61	3363	78	4.76	16,001	3.16	10,634
2					-	-	T8F32 - 2 lamp LP	110	3363	52	5.72	19,236	-5.72	-19,236
3	150R	39	3363	150	5.85	19,674	1 Occupancy Sensor	16		102		-	5.85	19,674
4a	T12F40 - 4 lamp	657	3363	144	94.61	318,167	1 Occupancy Sensor	34		52		-	94.61	318,167
4b	T12F40 - 3 lamp	600	3363	115	69	232,047	New Can CFL26 or Sconce 26W	123	3363	33	4.06	13,650	64.94	218,397
4c	T12F40 - 2 lamp	20	3363	72	1.44	4,843	New 2' T5 Up Light	1146	3363	74	84.8	285,196	-83.36	-280,353
5	Exit40W	14	8760	40	0.56	4,906	ExitLED2W	32	8736	2	0.06	559	0.5	4,347
6	No Occ. Sensors	278	3363	74	20.57	69,184	69 Occ. Sensors	278	2128	74	20.57	43,777	0	25,407
6	No Occ. Sensors	36	3363	72	2.59	8,717	69 Occ. Sensors	36	2128	72	2.59	5,516	0	3,201
6	No Occ. Sensors	30	3363	26	0.78	2,623	69 Occ. Sensors	30	2128	26	0.78	1,660	0	963

Table 5. M&V Savings for Santa Clara Site #3

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
6	No Occ. Sensors	16	3363	26	0.42	1,399	69 Occ. Sensors	16	2128	26	0.42	885	0	514
Total		**2245**			**266.06**	**897,746**		**2590**			**181.4**	**602,970**	**84.66**	**294,776**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 6**.

Table 6. Fixture Wattage Measurements From Santa Clara Site #3

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #3	Back Entrance Hallway	1	F32T8 - 2 lamp LP	52.63	52.63	52
Site #3	Boiler Room	3	F32T8 - 2 lamp LP	160.65	53.55	52
Site #3	Fixture Test Room	8	F32T8 - 4 lamp LP	778.40	97.30	102
Site #3	Fixture Test Room	6	F32T8 - 4 lamp LP	565.08	94.18	102
Site #3	Farrell Bldg. 1st Floor Zone 1 SW	40	FT40DL - 2 lamp	2,853.20	71.33	74
Site #3	Farrell Bldg. 1st Floor Zone 2 SE	45	FT40DL - 2 lamp	3,442.95	76.51	74
Site #3	Farrell Bldg. 2nd Floor Zone 3 NW	24	FT40DL - 2 lamp	1,767.36	73.64	74
Site #3	Farrell Bldg. 2nd Floor Zone 4 NE	32	FT40DL - 2 lamp	2,373.76	74.18	74

Occupancy Sensor Measurements

Occupancy sensor measurements were used for estimating hours of use. The non-occupancy sensor areas had 3,363 hrs/year and the occupancy sensor areas only had 2,128 hrs/year.

Table 7. Occupancy Sensor Measurements from Santa Clara Site #3

Light Logger Description	Logger #	Fixture Type	% On	Area Type	Ave. hours/yr
On/Off – 1st Flr Cubicles - No Sensors	1	278 Lamps	0.45	Cubicles	3,363 hrs/yr
On/Off – 1st Flr Cubicles - No Sensors	2	278 Lamps	0.32	Cubicles	3,363 hrs/yr
On/Off – 1st Flr Office Occ. Sensors	3	4 Lamp	0.32	Offices	2128 hrs/yr
On/Off – 2nd Flr N. Office Occ. Sensors	4	2 Lamp	0.20	Offices	2128 hrs/yr
On/Off – 2nd Flr S. Office Occ. Sensors	5	4 Lamp	0.21	Offices	2128 hrs/yr

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Santa Clara Electric Rate of 0.10358 $/kWh).

- Site #3: (Retrofit Cost $374,525.43 - Rebate $62,535) / (Energy Savings $30,533) = Simple Payback 10.2 Years.

Appendix F-4: Santa Clara C&I Lighting Rebate Site #4

M&V REPORT FOR C&I LIGHTING SITE #4

Prepared for the City of Santa Clara
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Santa Clara – Silicon Valley Power**

Site Name: **Site #4**

Site Address: **3600 Pruneridge Ave. #200, Santa Clara, CA 95051**

Principal Site Contact Name: **Anna Barlow** **Telephone: (408) 247-8446**

Utility Representative Name: **Joyce Kinnear** **Telephone: (408) 615-5686**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Santa Clara Site #4

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #4	n/a	Lighting	Santa Clara	SB5X Project	25,125	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #4	Lighting	16.03	41,678	n/a	6,273

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #4	Lighting	19.00	57,729	n/a

Spillover

The following additional lighting improvements were found at the site (included in M&V savings).

Table 1. Santa Clara Site #4 Spillover Measures

Measure	Description	Qty.	Location
1	T8F32 Lamp	25	Offices
Total		**25**	

Impact Evaluation Report: City of Santa Clara End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Site #4 and Silicon Valley Power, the following efficiency improvements were plannned under this project at Site #4 by Planergy.

Table 2. Planned Efficiency Improvements at Santa Clara Site #4

Measure	Description	Qty.	Location
1	T8F32 lamps	229	Offices
Total		**229**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #4.

Table 3. Verified Efficiency Improvements at Santa Clara Site #4- Building 1

Measure	Description	Qty.	Location
1c	T12F34 - 4 lamp	68	Offices
1d	T12F34 - 2 lamp	5	Offices
Total		**73**	

Table 4. Verified Efficiency Improvements at Santa Clara Site #4- Building 2

Measure	Description	Qty.	Location
1a	T8F32 - 4 lamp	29	Offices
1b	T8F32 - 2 lamp	3	Offices
1c	T8F32 - 4 lamp	13	Offices
1d	T8F32 - 4 lamp	92	Offices
1e	T8F32 - 2 lamp	2	Offices
1f	T8F32 - 4 lamp	9	Offices
1g	T8F32 - 4 lamp	33	Offices
Total		**181**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 5. Pre-Installation, Watts and Hours of Operation for Site #4- Building 1

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1c	T12F34 - 4 lamp	68	3315	189	Offices
1d	T12F34 - 2 lamp	5	3315	96	Offices
Total		**73**			

Table 6. Pre-Installation, Watts and Hours of Operation for Site #4- Building 2

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1a	T12F34 - 4 lamp	29	2754	189	Offices
1b	T12F34 - 2 lamp	3	2754	96	Offices
1c	T12F34 - 4 lamp	13	3060	189	Offices
1d	T12F34 - 4 lamp	92	2932.5	189	Offices
1e	T12F34 - 2 lamp	2	2932.5	96	Offices
1f	T12F34 - 4 lamp	9	3060	189	Offices
1g	T12F34 - 4 lamp	33	2805	189	Offices
Total		**181**			

Primary Business Descriptions: Site #4 consists of offices, hallways, and restrooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 7. M&V Savings for Santa Clara Site #4 Buildings 1 and 2

#	Pre-Retrofit	Qty	Hours	W/fix	Kw	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1c	T12F34 - 4 lamp	68	3315	189	12.7	42,604	T8F32 - 4 lamp	68	3315	112	7.62	25,247	5.08	17,357
1d	T12F34 - 2 lamp	5	3315	96	0.48	1,591	T8F32 - 2 lamp	5	3315	59	0.30	978	0.18	613
1a	T12F34 - 4 lamp	29	2754	189	5.48	15,095	T8F32 - 4 lamp	29	2754	112	3.25	8,945	2.23	6,150
1b	T12F34 - 2 lamp	3	2754	96	0.29	793	T8F32 - 2 lamp	3	2754	59	0.18	487	0.11	306
1c	T12F34 - 4 lamp	13	3060	189	2.46	7,518	T8F32 - 4 lamp	13	3060	112	1.46	4,455	1.00	3,063
1d	T12F34 - 4 lamp	92	2933	189	17.4	50,990	T8F32 - 4 lamp	92	2933	112	10.3	30,216	7.10	20,774
1e	T12F34 - 2 lamp	2	2933	96	0.19	563	T8F32 - 2 lamp	2	2933	59	0.12	346	0.07	217
1f	T12F34 - 4 lamp	9	3060	189	1.70	5,205	T8F32 - 4 lamp	9	3060	112	1.01	3,084	0.69	2,121
1g	T12F34 - 4 lamp	33	2805	189	6.24	17,495	T8F32 - 4 lamp	33	2805	112	3.70	10,367	2.54	7,128
Total		**254**			**46.94**	**141,854**		**254**			**27.94**	**84,125**	**19.00**	**57,729**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 8**.

Table 8. Fixture Wattage Measurements From Santa Clara Site #4

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #4, Building 1	Office 100	2	F32T8 - 4 lamp	230.4	115.20	112
Site #4, Building 1	Office 100	4	F32T8 - 4 lamp	457.2	114.30	112
Site #4, Building 1	Office 100	4	F32T8 - 4 lamp	452.4	113.10	112
Site #4, Building 2	Office 340	2	F32T8 - 4 lamp	223.2	111.60	112
Site #4, Building 2	Office 340	2	F32T8 - 4 lamp	224.4	112.20	112
Site #4, Building 2	Conference 380	2	F32T8 - 4 lamp	223.2	111.60	112
Site #4, Building 2	Office 380	2	F32T8 - 4 lamp	223.2	111.60	112
Site #4, Building 2	Office 300	2	F32T8 - 4 lamp	111.6	111.60	112
Site #4, Building 2	Office 300	2	F32T8 - 4 lamp	224.4	112.20	112

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Santa Clara Electric Rate of 0.10358 $/kWh).

- Site #4: (Retrofit Cost $6,273 - Rebate $6,273) / (Energy Savings $5,980) = Simple Payback 0.0 Years.

Appendix F-5: Santa Clara C&I Lighting Rebate Site #5

M&V REPORT FOR C&I LIGHTING SITE #5

Prepared for the City of Santa Clara
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Santa Clara – Silicon Valley Power**

Site Name: **Site #5**

Site Address: **2175 Mission College Blvd., Santa Clara, CA 95054**

Principal Site Contact Name: **Mack Tabei** **Telephone: (408) 565-0884**

Utility Representative Name: **Joyce Kinnear** **Telephone: (408) 615-5686**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Santa Clara Site #5

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #5	n/a	Lighting	Santa Clara	SB5X Project	32,000	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #5	Lighting	22.5	196,560	n/a	6,450

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #5	Lighting	23.12	273,403	n/a

Impact Evaluation Report: City of Santa Clara End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Site #5 and Silicon Valley Power, the following efficiency improvements were plannned under this project at Site #5 by Planergy.

Table 1. Planned Efficiency Improvements at Santa Clara Site #5

Measure	Description	Qty.	Location
1	T8F32 - 2 lamp	300	Offices, Hallways, and Bathrooms
2	Delamp	300	Offices, Hallways, and Bathrooms
3	Occupancy Sensor	30	Offices, Hallways, and Bathrooms
Total		**630**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #5.

Table 2. Verified Efficiency Improvements at Santa Clara Site #5

Measure	Description	Qty.	Location
1a	T8F32-EB-2 lamp	15	Office, copy
1b	T8F32-EB-2 lamp	51	Common, halls
1c	T8F32-EB-2 lamp	19	Cafeteria
1d	T8F32-EB-2 lamp	79	Cubicles
1e	T8F32-EB-2 lamp	54	Offices (central)
1f	T8F32-EB-2 lamp	45	Offices (south)
1g	T8F32-EB-2 lamp	30	Halls, offices
1h	T8F32-EB-2 lamp	8	Hall, offices
2a	Cafeteria - Occupancy Sensors (1)	1	1 sensor controlling 19 59W and 1 164W fixture
2b	Offices - Occupancy Sensors (24)	24	24 sensors controlling 72 136W fixtures
2c	Restrooms - Occ. Sensors (5)	5	5 sensors controlling 10 59W fixtures
Total		**331**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Santa Clara Site #5

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1a	T12F34-MB-3 lamp	15	8,760	136	Office, copy
1b	T12F34-MB-3 lamp	51	8,760	136	Common, halls
1c	T12F34-MB-3 lamp	19	8,760	136	Cafeteria
1d	T12F34-MB-3 lamp	79	8,760	136	Cubicles
1e	T12F34-MB-3 lamp	54	8,760	136	Offices (central)
1f	T12F34-MB-3 lamp	45	8,760	136	Offices (south)
1g	T12F34-MB-3 lamp	30	8,760	136	Halls, offices
1h	T12F34-MB-3 lamp	8	8,760	136	Hall, offices
2a	Cafeteria - No Occupancy Sensors (1)	1	8,760	1285	1 sensor controlling 19 59W and 1 164W fixture
2b	Offices - No Occupancy Sensors (24)	24	8,760	408	24 sensors controlling 72 136W fixtures
2c	Restrooms - No Occ. Sensors (5)	5	8,760	118	5 sensors controlling 10 59W fixtures
Total		**331**			

Primary Business Descriptions:
Site #5 consists of offices, hallways, and restrooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Santa Clara Site #5

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1a	T12F34-MB-3 L	15	8,760	136	2.04	17,870	T8F32-EB-2 L	15	8,760	59	0.89	7,753	1.15	10,117
1b	T12F34-MB-3 L	51	8,760	136	6.94	60,759	T8F32-EB-2 L	51	8,760	59	3.01	26,359	3.93	34,400
1c	T12F34-MB-3 L	19	8,760	136	2.58	22,636	T8F32-EB-2 L	19	8,760	59	1.12	9,820	1.46	12,816
1d	T12F34-MB-3 L	79	8,760	136	10.7	94,117	T8F32-EB-2 L	79	8,760	59	4.66	40,830	5.94	53,287
1e	T12F34-MB-3 L	54	8,760	136	7.34	64,333	T8F32-EB-2 L	54	8,760	59	3.19	27,909	4.15	36,424
1f	T12F34-MB-3 L	45	8,760	136	6.12	53,611	T8F32-EB-2 L	45	8,760	59	2.66	23,258	3.46	30,353
1g	T12F34-MB-3 L	30	8,760	136	4.08	35,741	T8F32-EB-2 L	30	8,760	59	1.77	15,505	2.31	20,236
1h	T12F34-MB-3 L	8	8,760	136	1.09	9,531	T8F32-EB-2 L	8	8,760	59	0.47	4,135	0.62	5,936
2a	Cafeteria - No Occupancy Sensors	1	8,760	1285	1.29	11,257	Cafeteria – Occ. Sensors	1	5,904	1285	1.29	7,587	-	3,670
2b	Offices - No Occupancy Sensors	24	8,760	408	9.79	85,778	Offices – Occ. Sensors	24	2,335	408	9.79	22,864	-	62,814
2c	Restrooms - No Occ. Sensors	5	8,760	118	0.59	5,168	Restrooms - Occ. Sensors	5	2,335	118	0.59	1,378	-	3,790
Total		**331**			**52.56**	**460,801**		**331**			**29.44**	**187,3978**	**23.12**	**273,403**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From Santa Clara Site #5

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #5	Office	3	T12F34-MB-3 Lamp	408.0	136.0	133
Site #5	Cafeteria	10	T8F32- 2 Lamp	593.5	59.3	59
Site #5	Cafeteria	1	T12F34-MB-4 Lamp	165.9	165.9	164

Occupancy Sensor Measurements

Occupancy sensor measurements are used for estimating hours of use for areas with and without occupancy sensors.

Table 6. Occupancy Sensor Measurements from Santa Clara Site #5

Light Logger Description	Logger #	Fixture Type	% On	Area Type	Ave. hours/yr
On/Off - Cafeteria - Occ. Sensors	1	10 Fixtures	0.67	Common	5,824 hrs/yr
On/Off - Cafeteria - Occ. Sensors	2	10 Fixtures	0.68	Common	5,824 hrs/yr
On/Off - Office - Occ. Sensors	3	3 Fixtures	0.21	Offices	2,335 hrs/yr
On/Off - Cubicles - No Sensors	4	54 Fixtures	1.00	Cubicles	8,760 hrs/yr
On/Off - Office - Occ. Sensors	5	3 Fixtures	0.32	Offices	2,335 hrs/yr

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Santa Clara Electric Rate of 0.10358 $/kWh).

- Site #5: (Retrofit Cost $48,350 - Rebate $6,450) / (Energy Savings $28,319) = Simple Payback 1.68 Years.

Appendix F-6: Santa Clara C&I Lighting Rebate Site #6

M&V REPORT FOR C&I LIGHTING SITE #6

Prepared for the City of Santa Clara
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Santa Clara – Silicon Valley Power**

Site Name: **Site #6**

Site Address: **960 Central Expressway, Santa Clara, CA 95050**

Principal Site Contact Name: **John Hostetler** **Telephone: (408) 235-1222**

Utility Representative Name: **Joyce Kinnear** **Telephone: (408) 615-5686**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Santa Clara Site #6

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #6	n/a	Lighting	Santa Clara	SB5X Project	814,000	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #6	Lighting	342.4	2,187,787	n/a	130,352

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #6	Lighting	364.0	2,670,777	n/a

Impact Evaluation Report: City of Santa Clara End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Site #6 and Silicon Valley Power, the following efficiency improvements were plannned under this project at Site #6 by Planergy.

Table 1. Planned Efficiency Improvements at Santa Clara Site #6

Measure	Description	Qty.	Location
1	CFL23	6	Offices, Warehouse Areas, and Restrooms
2	CFL23	58	Offices, Warehouse Areas, and Restrooms
3		182	Offices, Warehouse Areas, and Restrooms
4		173	Offices, Warehouse Areas, and Restrooms
5	T8F17-Lamp	75	Offices, Warehouse Areas, and Restrooms
6	T8F32-Lamp	7800	Offices, Warehouse Areas, and Restrooms
7	T12F34-Lamp Removed	1411	Offices, Warehouse Areas, and Restrooms
8	LEDExit	16	Offices, Warehouse Areas, and Restrooms
9	LEDExit	4	Offices, Warehouse Areas, and Restrooms
10	Wall Mounted Sensor		Offices, Warehouse Areas, and Restrooms
11	Ceiling Mounted Sensor		Offices, Warehouse Areas, and Restrooms
12	MH250W-Interior	583	Offices, Warehouse Areas, and Restrooms
13	MH125W-Exterior	6	Offices, Warehouse Areas, and Restrooms
14	MH250W-Exterior	15	Offices, Warehouse Areas, and Restrooms
Total		**10,329**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #6.

Table 2. Verified Efficiency Improvements at Santa Clara Site #6

Measure	Description	Qty.	Location
1	CFL23	0	No evidence of these fixtures
2	CFL23	4	Only 4 new vanity fixtures were installed on this job
3	200W	0	These fixtures were removed
4	300W	0	
5	T8F17 - 2 Lamp	3	Office areas
6a	T8F32 - 2 lamp	242	Plant & warehouse areas
6b	T8F32 - 2 lamp	1016	Office areas
6c	T8F32 - 4 lamp	817	Plant & warehouse areas
6d	T8F32 - 4 lamp	60	Office areas
	T8F32 - 5 lamp	106	Plant & warehouse areas
	T8F32 - 6 lamp	24	Plant & warehouse areas
7	T12F96SL - 2 lamp removed	0	Plant & warehouse areas
7	T12F96HO - 2 lamp removed	0	Plant & warehouse areas
8	Exit40W	16	
9	Exit40W	4	
10	Office Occupancy Sensor - Fluorescent	165	32 Sensors
11	Plant Sensor - High/Low Metal Halide	50	46 Sensors
11	Warehouse Sensor - Fluorescent	399	96 Sensors
12	MH250W-Interior	418	
13	MH125W-Exterior	6	
14	MH250W-Exterior	15	
Total		**3345**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Santa Clara Site #6

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	100A				No evidence of these fixtures
2	100A	4	5100	30	Only 4 new vanity fixtures were installed on this job
3	200W	125	8760	200	Best estimate from Tim Ocker & Shelly Coben
4	300W	125	8760	300	Best estimate from Tim Ocker & Shelly Coben
5	T12F20 - 2 lamp	15	5100	56	Office areas
6a	T12F34 - 2 lamp	199	8760	72	Plant & warehouse areas
6b	T12F34 - 2 lamp	329	5100	72	Office areas
6c	T12F34 - 4 lamp	43	8760	144	Plant & warehouse areas
6d	T12F34 - 4 lamp	747	5100	144	Office areas
7	T12F96SL - 2 lamp	456	8760	128	Plant & warehouse areas
7	T12F96HO - 2 lamp	319	8760	227	Plant & warehouse areas
8	Exit40W	16	8760	40	No exit signs were replaced
9	Exit40W	4	8760	40	No exit signs were replaced
10	Office Occupancy Sensor - Fluorescent				
11	Plant Sensor - High/Low Metal Halide				
11	Warehouse Sensor - Fluorescent				
12	MH400W-Interior	583	8760	458	
13	MH125W-Exterior	6	4380	295	
14	MH400W-Exterior	15	4380	458	
Total		**2986**			

Primary Business Descriptions:
Site #6 consists of offices, hallways, restrooms, conference spaces, and computer rooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Santa Clara Site #6

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	KW Savings	kWh Savings
1	100A				0	0	CFL23	0	0	0	0	0	0.00	0
2	100A	4	5,100	30	0	612	CFL23	4	5,100	30	0	612	0.00	0
3	200W	125	8,760	200	25	219,000	200W	0	0	0	0	0	25.00	219,000
4	300W	125	8,760	300	38	328,500	300W	0	0	0	0	0	38.00	328,500
5	T12F20 - 2 lamp	15	5,100	56	1	4,284	T8F17 - 2 L	3	5,100	33	0	505	1.00	3,779
6a	T12F34 - 2 lamp	199	8,760	72	14	125,513	T8F32 - 2 L	242	8,760	59	14	125,075	0.00	438
6b	T12F34 - 2 lamp	329	5,100	72	24	120,809	T8F32 - 2 L	1,016	5,100	59	60	305,714	-36.00	-184,905
6c	T12F34 - 4 lamp	43	8,760	144	6	54,242	T8F32 - 4 L	817	8,760	112	92	801,575	-86.00	-747,333

Table 4. M&V Savings for Santa Clara Site #6

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	KW Savings	kWh Savings
6d	T12F34 - 4 lamp	747	5,100	144	108	548,597	T8F32 - 4 L	60	5,100	112	7	34,272	101.00	514,325
							T8F32 - 5 L	106	8,760	142	15	131,856	-15.00	-131,856
							T8F32 - 6 L	24	8,760	171	4	35,951	-4.00	-35,951
7	T12F96SL - 2 lamp	456	8,760	128	58	511,304	T12F96SL - 2 L removed	0				0	58.00	511,304
7	T12F96HO - 2 lamp	319	8,760	227	72	634,338	T12F96HO - 2 L removed	0			0	0	72.00	634,338
8	Exit40W	16	8,760	40	1	5,606	Exit40W	16	8,760	40	1	5,606	0.00	0
9	Exit40W	4	8,760	40	0	1,402	Exit40W	4	8,760	40	0	1,402	0.00	0
10	Office Occ. Sensor - Fluorescent				0	0	Office Occ.Sensor - Fluorescent	165	1,493	-59	-10	-14,534	10.00	14,534
11	Plant Sensor - High/Low Metal Halide						Plant Sensor - High/Low Metal Halide	50	700	-145	-7	-5,075	7.00	5,075
11	Warehouse Sensor - Fluorescent				0	0	Warehouse Sensor - Fluorescent	399	5,956	-112	-45	-266,162	45.00	266,162
12	MH400W-Interior	583	8,760	458	267	2,339,043	MH250W-Interior	418	8,760	295	123	1,080,196	144.00	1,258,847
13	MH125W-Exterior	6	4,380	295	2	7,753	MH125W-Exterior	6	4,380	150	1	3,942	1.00	3,811
14	MH400W-Exterior	15	4,380	458	7	30,091	MH250W-Exterior	15	4,380	295	4	19,382	3.00	10,709
Total		2,986		2,664	623	4,931,094		3,345			259	2,260,317	364.00	2,670,777

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From Santa Clara Site #6

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #6, Warehouse Panel	DD-8 Breaker 3	3	T8F32 - 4 Lamp	342	114.00	112
Site #6, Warehouse Panel	DD-8 Breaker 4	3	T8F32 - 4 Lamp	345	115.60	112
Site #6, Warehouse Panel	DD-8 Breaker 5	3	T8F32 - 4 Lamp	343	114.40	112
Site #6, Warehouse Panel	DD-8 Breaker 6	3	T8F32 - 4 Lamp	337	112.40	112
Site #6, Warehouse	Warehouse	2	T8F32 - 6 Lamp	370	184.80	171
Site #6, Warehouse	Warehouse	3	T8F32 - 6 Lamp	524	174.80	171
Site #6, Warehouse	Warehouse	3	T8F32 - 6 Lamp	552	184.00	171
Site #6, Warehouse	Warehouse	2	T8F32 - 6 Lamp	338	169.20	171
Site #6	M-Line Bagage Pannel F Breaker 1	2	MH250	584	292.20	295
Site #6	M-Line Bagage Pannel F Breaker 7	2	MH250	583	291.60	295
Site #6	M-Line Bagage Pannel F Brkr 12	1	MH250	287	286.80	295
Site #6	M-Line Bagage Pannel F Breaker	2	MH250	587	293.40	295
Site #6	Office	6	T8F32 - 2 Lamp	348	58.00	59
Site #6	Office	8	T8F32 - 2 Lamp	481	60.15	59

Occupancy Sensor Measurements

Occupancy sensor measurements are used for estimating hours of use.

Table 6. Occupancy Sensor Measurements from Santa Clara Site #6

Light Logger Description	Logger #	Fixture Type	% On	Area Type
On/Off – Manufacturing	1	6 Lamp	66.70	Plant
On/Off - Engineering Office	2	2 Lamp	4.00	Office
On/Off – Warehouse	3	4 Lamp	17.00	Warehouse
On/Off – Gym	4	2 Lamp	19.50	Office
On/Off - Manufacturing Storage	5	4 Lamp	38.50	Warehouse
On/Off - Engineering Hall	6	2 Lamp	43.20	Office
On/Off – Warehouse	7	4 Lamp	21.10	Warehouse
On/Off – Warehouse	8	4 Lamp	32.60	Warehouse
High/Low – Manufacturing	9	250 W. MH	93.50	Plant
High/Low – Furnace	10	250 W. MH	91.60	Plant

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Santa Clara Electric Rate of 0.10358 $/kWh).

- Site #6: (Retrofit Cost $381,728 - Rebate $130,352) / (Energy Savings $276,639) = Simple Payback 0.91 Years.

Appendix F-7: Santa Clara C&I Lighting Rebate Site #7

M&V REPORT FOR C&I LIGHTING SITE #7

Prepared for the City of Santa Clara
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Santa Clara – Silicon Valley Power**

Site Name: **Site #7**

Site Address: **1601 Civic Center Drive, Santa Clara, CA 95050**

Principal Site Contact Name: **Jill Leon, Victor Owen** **Telephone: (408) 984-8934**

Utility Representative Name: **Joyce Kinnear** **Telephone: (408) 615-5686**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Santa Clara Site #7

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #7	n/a	Lighting	Santa Clara	SB5X Project	30,000	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #7	Lighting	32.4	141,523	n/a	8,708

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #7	Lighting	37.3	159,909	n/a

Spillover

The following additional lighting improvements were found at the site (included in M&V savings).

Table 1. Santa Clara Site #7 Spillover Measures

Measure	Description	Qty.	Location
1	T8F32-3 Lamp	44	Offices
2	T8F32-U-2 Lamp	32	Offices
3	T8F32-1 lamp	1	Office
Total		**77**	

Impact Evaluation Report: City of Santa Clara End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Site #7 and Silicon Valley Power, the following efficiency improvements were plannned under this project at Site #7 by Planergy.

Table 2. Planned Efficiency Improvements at Santa Clara Site #7

Measure	Description	Qty.	Location
1	T8F32-3 Lamp	324	Offices, Hallways, Restrooms
Total		**324**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #7.

Table 3. Verified Efficiency Improvements at Santa Clara Site #7

Measure	Description	Qty.	Location
1	T8F32-3 Lamp	324	Offices, Hallways, Restrooms
1a	T8F32-3 Lamp	44	Offices, Hallways, Restrooms
2	T8F32-U-2 Lamp	32	Offices, Hallways, Restrooms
3	T8F32-1 lamp	1	Offices, Hallways, Restrooms
Total		**401**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 4. Pre-Installation, Watts and Hours of Operation for Santa Clara Site #7

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	T12F40-MB-4 Lmp	324	4,368	189	Offices, Hallways, Restrooms
1a	T12F40-MB-4 Lmp	44	4,368	189	Offices, Hallways, Restrooms
2	T12F34U-MB-2 Lmp	32	4,368	72	Offices, Hallways, Restrooms
3	T12F34-MB-1 Lmp	1	4,368	43	Offices, Hallways, Restrooms
Total		**401**			

Primary Business Descriptions:
Site #7 consists of offices, hallways, restrooms, conference spaces, and computer rooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 5. M&V Savings for Santa Clara Site #7

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	T12F40-M-4L	324	4,368	189	61.2	262,335	T8F32-3L	324	4,368	89	28.8	123,533	32.4	138,802
1a	T12F40-M-4L	44	4,368	189	8.3	35,626	T8F32-3L	44	4,368	89	3.9	16,776	4.4	18,850
2	T12F34U-M-2L	32	4,368	72	2.3	9,870	T8F32U-2L	32	4,368	56	1.8	7,677	0.51	2,193
3	T12F34-MB-1L	1	4,368	43	0.04	184	T8F32-1L	1	4,368	28	0.03	120	0.02	64
Total		401			71.84	308,015		401			34.53	148,106	37.31	159,909

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 6**.

Table 6. Fixture Wattage Measurements From Santa Clara Site #7

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #7	Ceiling Fixture	1	Office T8F32 3- lamp	88.8	88.8	89
Site #7	Ceiling Fixture	3	Office T8F32 3- lamp	88.8	266.4	89
Site #7	Ceiling Fixture	2	Office T8F32 3- lamp	88.2	176.4	89
Similar SVP Building	Ceiling Fixture	6	Pre-existing T12F40	189.0	1134.0	190

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Santa Clara Electric Rate of 0.10358 $/kWh).

- Site #7: (Retrofit Cost $31,563 - Rebate $8,708) / (Energy Savings $16,563) = Simple Payback 1.4 Years.

Appendix F-8: Santa Clara C&I Lighting Rebate Site #8

M&V REPORT FOR C&I LIGHTING SITE #8

Prepared for the City of Santa Clara
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Santa Clara – Silicon Valley Power**

Site Name: **Site #8**

Site Address: **1333 Lawrence Expressway, Building 200, Santa Clara, CA 95051**

Principal Site Contact Name: **Amber Brocht** **Telephone: (650) 344-1500**

Utility Representative Name: **Joyce Kinnear** **Telephone: (408) 615-5686**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Santa Clara Site #8

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #8	n/a	Lighting	Santa Clara	SB5X Project	32,150	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #8	Lighting	43.8	194,401	n/a	7,699

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #8	Lighting	44.1	205,310	n/a

Impact Evaluation Report: City of Santa Clara End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Site #8 and Silicon Valley Power, the following efficiency improvements were plannned under this project at Site #8 by Planergy.

Table 1. Planned Efficiency Improvements at Santa Clara Site #8

Measure	Description	Qty.	Location
1	T8F32-2 lamp	324	Offices
3	ExitLED	40	Offices
4	CFL 23W Recessed Exterior	8	Offices
Total		**372**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #8.

Table 2. Verified Efficiency Improvements at Santa Clara Site #8

Measure	Description	Qty.	Location
1	T8F32-2 lamp	324	Offices
2	ExitLED	40	Offices
3	CFL 23W Recessed Exterior	8	Offices
Total		**372**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Santa Clara Site #8

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	T12F34-MB-4 Lamp	324	4590	189	Offices
2	Exit 20W	40	8760	20	Offices
3	100W Incandescent Reflector	8	4380	100	Offices
Total		**372**			

Primary Business Descriptions:
Site #8 consists of offices, hallways, restrooms, conference spaces, and computer rooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Santa Clara Site #8

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	T12F34-MB-4 Lamp	324	4590	189	61.24	281,073	T8F32-2 lamp	324	4590	57	18.47	84,768	42.77	196,305
2	Exit 20W	40	8760	20	0.80	7,008	ExitLED	40	8760	2	0.08	701	0.72	6,307
3	100W Incandescent Reflector	8	4380	100	0.80	3,504	CFL 23W Recessed Exterior	8	4380	23	0.18	806	0.62	2,698
Total		372			62.8	291,585		372			18.7	86,275	44.11	205,310

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From Santa Clara Site #8

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #8	Office	4	T12F40-MB-4 Lamp	756.2	189.1	190
Site #8	Office	11	T8F32 - 3 Lamp	630.2	57.3	59

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Santa Clara Electric Rate of 0.10358 $/kWh).

- Site #8: (Retrofit Cost $28,462 - Rebate $7,699) / (Energy Savings $21,266) = Simple Payback 0.98 Years.

Appendix F-9: Santa Clara C&I Lighting Rebate Site #9

M&V REPORT FOR C&I LIGHTING SITE #9

Prepared for the City of Santa Clara
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Santa Clara – Silicon Valley Power**

Site Name: **Site #9**

Site Address: **3560 Bassett St., Santa Clara, CA 95054**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Joyce Kinnear** **Telephone: (408) 615-5686**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Santa Clara Site #9

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #9	n/a	Lighting	Santa Clara	SB5X Project	125,482	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #9	Lighting	58.87	225,228	n/a	34,997

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #9	Lighting	70.94	321,743	n/a

Spillover

The following additional lighting improvements were found at the site (included in M&V savings).

Table 1. Site #9 Spillover Measures

Measure	Description	Qty.	Location
1	CFL27W	10	Offices, Hallways, and Restrooms
3	T8F25 - 2 lamp	3	Offices, Hallways, and Restrooms
Total		**13**	

Impact Evaluation Report: City of Santa Clara End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Site #9 and Silicon Valley Power, the following efficiency improvements were plannned under this project at Site #9 by Planergy.

Table 2. Planned Efficiency Improvements at Santa Clara Site #9

Measure	Description	Qty.	Location
1	Screw in compact fluorescent lamp	18	Offices, Hallways, and Restrooms
2	F17T8 Lamp	8	Offices, Hallways, and Restrooms
3	F25T8 Lamp	5	Offices, Hallways, and Restrooms
4	F32T8 Lamp	3130	Offices, Hallways, and Restrooms
5	F32T8 Lamp	620	Offices, Hallways, and Restrooms
6	F59T8 Lamp	8	Offices, Hallways, and Restrooms
7	F40T12 Lamp Remove	648	Offices, Hallways, and Restrooms
8	Metal Halide 400 Remove	51	Offices, Hallways, and Restrooms
9	ExitLED2W	59	Offices, Hallways, and Restrooms
10	Wall Mount Sensor	16	Offices, Hallways, and Restrooms
11	Ceiling Mount Sensor	15	Offices, Hallways, and Restrooms
Total		**4578**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #9.

Table 3. Verified Efficiency Improvements at Santa Clara Site #9

Measure	Description	Qty.	Location
1	CFL27W	26	Offices, Hallways, and Restrooms
1b	CFL27W	2	Offices, Hallways, and Restrooms
2	T8F17 - 2 lamp	8	Offices, Hallways, and Restrooms
3	T8F25 - 2 lamp	8	Offices, Hallways, and Restrooms
4a	T8F32 - 4 lamp	12	Offices, Hallways, and Restrooms
4b	T8F32 - 2 lamp	132	Offices, Hallways, and Restrooms
4c	T8F32 - 4 lamp	41	Offices, Hallways, and Restrooms
4d	Remove T8F32 - 4 lamp	18	Offices, Hallways, and Restrooms
4e	T8F32 - 3 lamp	105	Offices, Hallways, and Restrooms
4f	T8F32 - 3 lamp	62	Offices, Hallways, and Restrooms
4g	T8F32 - 2 lamp	212	Offices, Hallways, and Restrooms
4h	T8F32 - 2 lamp	131	Offices, Hallways, and Restrooms
4i	T8F32 - 2 lamp T	443	Offices, Hallways, and Restrooms
4j	T8F32 - 2 lamp	137	Offices, Hallways, and Restrooms
4k	T8F32 - 2 lamp U	6	Offices, Hallways, and Restrooms
4l	T8F32 - 2 lamp U	20	Offices, Hallways, and Restrooms
4m	T8F32 - 2 lamp	10	Offices, Hallways, and Restrooms
4n	T8F32 - 2 lamp U	40	Offices, Hallways, and Restrooms
4o	T8F32 - 3 lamp	6	Offices, Hallways, and Restrooms
4p	T8F32 - 2 lamp	6	Offices, Hallways, and Restrooms
5	T8F32 - 2 lamp HLO	310	Offices, Hallways, and Restrooms
6	T8F59 - 2 lamp	0	Offices, Hallways, and Restrooms
7	Included in 4b, 4d, 4f, 4g, 4o		Offices, Hallways, and Restrooms
8	Metal Halide 400 Remove	51	Offices, Hallways, and Restrooms
9	ExitLED2W	54	Offices, Hallways, and Restrooms
10	Wall Mount Sensor included in 4f	16	Offices, Hallways, and Restrooms
11	Ceiling Mount Sensor included in 4f	15	Offices, Hallways, and Restrooms
Total		**1871**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 4. Pre-Installation, Watts and Hours of Operation for Santa Clara Site #9

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	100W	26	2907	100	Offices, Hallways, and Restrooms
1b	300W	2	5508	300	Offices, Hallways, and Restrooms
2	F20T12 - 2 lamp	8	5508	56	Offices, Hallways, and Restrooms
3	T12F30 - 2 lamp	8	5508	73	Offices, Hallways, and Restrooms
4a	T12F34 - 4 lamp	12	5508	144	Offices, Hallways, and Restrooms
4b	T12F34 - 4 lamp	132	5508	144	Offices, Hallways, and Restrooms
4c	T12F34 - 4 lamp	41	5508	144	Offices, Hallways, and Restrooms
4d	T12F34 - 4 lamp	18	5508	144	Offices, Hallways, and Restrooms
4e	T12F34 - 3 lamp	105	5508	115	Offices, Hallways, and Restrooms
4f	T12F34 - 3 lamp	62	5508	115	Offices, Hallways, and Restrooms
4g	T12F34 - 3 lamp	212	3672	115	Offices, Hallways, and Restrooms
4h	T12F34 - 3 lamp	131	3672	115	Offices, Hallways, and Restrooms
4i	T12F34 - 2 lamp	443	5508	72	Offices, Hallways, and Restrooms
4j	T12F34 - 2 lamp	137	5508	72	Offices, Hallways, and Restrooms
4k	T12F34 - 2 lamp U	6	5508	72	Offices, Hallways, and Restrooms
4l	T12F34 - 2 lamp U	20	3672	72	Offices, Hallways, and Restrooms
4m	T12F34 - 2 lamp	10	8760	72	Offices, Hallways, and Restrooms
4n	T12F34 - 2 lamp U	40	2907	72	Offices, Hallways, and Restrooms
4o	T12F34 - 3 lamp	6	2907	115	Offices, Hallways, and Restrooms
4p	T12F34 - 4 lamp	6	2907	144	Offices, Hallways, and Restrooms
5	T12F34 - 2 lamp	310	5508	72	Offices, Hallways, and Restrooms
6	T12F96 - 2 lamp	0			Offices, Hallways, and Restrooms
7					Offices, Hallways, and Restrooms
8	Metal Halide 400	51	3672	458	Offices, Hallways, and Restrooms
9	ExitInc20W	54	8760	40	Offices, Hallways, and Restrooms
10	Wall Mount Sensor				Offices, Hallways, and Restrooms
11	Ceiling Mount Sensor				Offices, Hallways, and Restrooms
Total		**1840**			

Primary Business Descriptions:
Site #9 consists of offices, hallways, and restrooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 5. M&V Savings for Santa Clara Site #9

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	100W	26	2907	100	2.60	7,558	CFL27W	26	2907	27	0.70	2,041	1.9	5,517
1b	300W	2	5508	300	0.60	3,305	CFL27W	2	5508	27	0.05	297	0.55	3,008
2	F20T12 - 2 lamp	8	5508	56	0.45	2,468	T8F17 - 2 lamp	8	5508	33	0.26	1,454	0.19	1,014
3	T12F30 - 2 lamp	8	5508	73	0.58	3,217	T8F25 - 2 lamp	8	5508	46	0.37	2,027	0.21	1,190

Table 5. M&V Savings for Santa Clara Site #9

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
4a	T12F34 - 4 lamp	12	5508	144	1.73	9,518	T8F32 - 4 lamp	12	5508	112	1.34	7,403	0.39	2,115
4b	T12F34 - 4 lamp	132	5508	144	19.01	104,696	T8F32 - 2 lamp	132	5508	59	7.79	42,896	11.22	61,800
4c	T12F34 - 4 lamp	41	5508	144	5.90	32,519	T8F32 - 4 lamp	41	5508	112	4.59	25,293	1.31	7,226
4d	T12F34 - 4 lamp	18	5508	144	2.59	14,277	Remove T8F32 - 4 lamp	18	0	0	-	-	2.59	14,277
4e	T12F34 - 3 lamp	105	5508	115	12.08	66,509	T8F32 - 3 lamp	105	5508	89	9.35	51,472	2.73	15,037
4f	T12F34 - 3 lamp	62	5508	115	7.13	39,272	T8F32 - 3 lamp	62	3580	89	5.52	19,754	1.61	19,518
4g	T12F34 - 3 lamp	212	3672	115	24.38	89,523	T8F32 - 2 lamp	212	3672	59	12.51	45,929	11.87	43,594
4h	T12F34 - 3 lamp	131	3672	115	15.07	55,319	T8F32 - 2 lamp	131	3672	59	7.73	28,381	7.34	26,938
4i	T12F34 - 2 lamp	443	5508	72	31.90	175,683	T8F32 - 2 lamp T	443	5508	66	29.24	161,043	2.66	14,640
4j	T12F34 - 2 lamp	137	5508	72	9.86	54,331	T8F32 - 2 lamp	137	5508	59	8.08	44,521	1.78	9,810
4k	T12F34 - 2 lamp U	6	5508	72	0.43	2,379	T8F32 - 2 lamp U	6	5508	59	0.35	1,950	0.08	429
4l	T12F34 - 2 lamp U	20	3672	72	1.44	5,288	T8F32 - 2 lamp U	20	3672	59	1.18	4,333	0.26	955
4m	T12F34 - 2 lamp	10	8760	72	0.72	6,307	T8F32 - 2 lamp	10	8760	59	0.59	5,168	0.13	1,139
4n	T12F34 - 2 lamp U	40	2907	72	2.88	8,372	T8F32 - 2 lamp U	40	2907	59	2.36	6,861	0.52	1,511
4o	T12F34 - 3 lamp	6	2907	115	0.69	2,006	T8F32 - 3 lamp	6	2907	89	0.53	1,552	0.16	454
4p	T12F34 - 4 lamp	6	2907	144	0.86	2,512	T8F32 - 2 lamp	6	2907	59	0.35	1,029	0.51	1,483
5	T12F34 - 2 lamp	310	5508	72	22.32	122,939	T8F32 - 2 lamp HLO	310	5508	80	24.80	136,598	-2.48	-13,659
6	T12F96 - 2 lamp	0			-	-	T8F59 - 2 lamp	0			-	-	-	-
7					-	-	Included in 4b, 4d, 4f, 4g, 4o				-	-	-	-
8	Metal Halide 400	51	3672	458	23.36	85,771	Metal Halide 400 Remove	51	3672	0	-	-	23.36	85,771
9	ExitInc20W	54	8760	40	2.16	18,922	ExitLED2W	54	8760	2	0.11	946	2.05	17,976
10	Wall Mount Sensor						Wall Mount Sensor included in 4f	16			-	-	-	-
11	Ceiling Mount Sensor						Ceiling Mount Sensor incl. in 4f	15			-	-	-	-
Total		**1740**			**188.74**	**912,691**		**1,871**			**117.80**	**590,948**	**70.94**	**321,743**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 6**.

Table 6. Fixture Wattage Measurements From Santa Clara Site #9

Building	Location	Qty	Fixture Type	Watts/Fixt	Measured W/Fixture	Reference W/Fixture
Site #9	Manufacturing	67	T8F32 - 2 lampHLO	5,321	79.42	80
Site #9	Manufacturing	14	T8F32 - 2 lampHLO	1,132	80.92	80
Site #9	Manufacturing	22	T8F32 - 2 lampHLO	1,759	79.95	80
Site #9	Manufacturing	19	T8F32 - 2 lamp T	2,161	66.33	66
Site #9	Office	16	T8F32 - 2 lamp	969	60.59	59

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Santa Clara Electric Rate of 0.10358 $/kWh).

- Site #9: (Retrofit Cost $112,555 - Rebate $34,997) / (Energy Savings $33,326) = Simple Payback 2.33 Years.

Appendix F-10: Santa Clara C&I Lighting Rebate Site #10

M&V REPORT FOR C&I LIGHTING SITE #10

Prepared for the City of Santa Clara
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Santa Clara – Silicon Valley Power**

Site Name: **Site #10**

Site Address: **2062 Walsh Avenue, Suite B-1, Santa Clara, CA 95050**

Principal Site Contact Name: **Gabe Lucero** **Telephone: (408) 727-2299**

Utility Representative Name: **Joyce Kinnear** **Telephone: (408) 615-5686**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Santa Clara Site #10

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #10	n/a	Lighting	Santa Clara	SB5X Project	80,210	Rebate

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #10	Lighting	29.73	69,568	n/a	7,939

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #10	Lighting	35.85	120,763	n/a

Impact Evaluation Report: City of Santa Clara End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Site #10 and Silicon Valley Power, the following efficiency improvements were plannned under this project at Site #10 by Planergy.

Table 1. Planned Efficiency Improvements at Santa Clara Site #10

Measure	Description	Qty.	Location
1	T8F32 lamps	860	Offices, Hallways, Restrooms
2	T12F40 delamp	374	Offices, Hallways, Restrooms
Total		**1234**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #10.

Table 2. Verified Efficiency Improvements at Santa Clara Site #10

Measure	Description	Qty.	Location
1	T8F32-EB-2 lamp	187	Offices, Hallways, Restrooms
2	T8F32U-EB-2 lamp	11	Offices, Hallways, Restrooms
2a-S	T8F32U-EB-2 lamp	5	Offices, Hallways, Restrooms
3	T8F32-EB-2 lamp	184	Offices, Hallways, Restrooms
4-S	T8F32-EB-3 lamp	43	Offices, Hallways, Restrooms
5	T8F32-EB-4 lamp	17	Offices, Hallways, Restrooms
6	T8F32-EB-4 lamp	7	Offices, Hallways, Restrooms
Total		**454**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for Santa Clara Site #10

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	T12F40-MB-4 lamp	187	3366	189	Offices, Hallways, Restrooms
2	T12F34U-MB-2 lamp	11	3366	72	Offices, Hallways, Restrooms
2a	T12F34U-MB-2 lamp	5	3366	72	Offices, Hallways, Restrooms
3	T12F40-MB-2 lamp	184	3366	103	Offices, Hallways, Restrooms
4	T12F34-MB-3 lamp	43	3366	133	Offices, Hallways, Restrooms
5	T12F40-MB-4 lamp	17	3366	189	Offices, Hallways, Restrooms
6	T12F96-MB-2 lamp	7	3366	123	Offices, Hallways, Restrooms
Total		**454**			

Primary Business Descriptions:
Site #10 consists of offices, hallways, and restrooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for Santa Clara Site #10

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	T12F40-MB-4 lamp	187	3366	189	35.34	118,965	T8F32-EB-2 lamp	187	3366	59	11.03	37,137	24.31	81,828
2	T12F34U-MB-2 lamp	11	3366	72	0.79	2,666	T8F32U-EB-2 lamp	11	3366	59	0.65	2,185	0.14	481
2a	T12F34U-MB-2 lamp	5	3366	72	0.36	1,212	T8F32U-EB-2 lamp	5	3366	59	0.30	993	0.06	219
3	T12F40-MB-2 lamp	184	3366	103	18.95	63,792	T8F32-EB-2 lamp	184	3366	59	10.86	36,541	8.09	27,251
4	T12F34-MB-3 lamp	43	3366	133	5.72	19,250	T8F32-EB-3 lamp	43	3366	86	3.70	12,447	2.02	6,803
5	T12F40-MB-4 lamp	17	3366	189	3.21	10,815	T8F32-EB-4 lamp	17	3366	118	2.01	6,752	1.20	4,063
6	T12F96-MB-2 lamp	7	3366	123	0.86	2,898	T8F32-EB-4 lamp	7	3366	118	0.83	2,780	0.03	118
Total		**454**			**65.23**	**219,598**		**454**			**29.38**	**98,835**	**35.85**	**120,763**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From Santa Clara Site #10

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #10	Office	6	F32T8 - 2 lamp LP	352.1	58.7	59
Site #10	Office	1	F32T8 - 3 lamp LP	86.5	86.5	89
Site #10	Office	1	F32T8 - 4 lamp LP	118.5	118.5	118

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Santa Clara Electric Rate of 0.10358 $/kWh).

- Site #10: (Retrofit Cost $13,472- Rebate $7,939) / (Energy Savings $12,509) = Simple Payback 0.44 Years.

Appendix F-11: Santa Clara C&I Lighting Rebate Site #11

M&V REPORT FOR C&I LIGHTING SITE #11

Prepared for the City of Santa Clara
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name: **City of Santa Clara – Silicon Valley Power**

Site Name: **Site #11**

Site Address: **3051 Stevens Creek Blvd. Santa Clara, CA 95050**

Principal Site Contact Name: **N/A** **Telephone: N/A**

Utility Representative Name: **Joyce Kinnear** **Telephone: (408) 615-5686**

Assigned Lead Engineer: **Robert Mowris, P.E., Shelly Coben, CEM, Anne Blankenship**

Site: Santa Clara Site #11

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #11	n/a	Lighting	Santa Clara	SB5X Project	53,000	Custom

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #11	Lighting	78.2	341,687	n/a	18,386.37

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #11	Lighting	58.0	253,300	n/a

Spillover

The following additional lighting improvements were found at the site (included in M&V savings).

Table 1. Santa Clara Site #11 Spillover Measures

Measure	Description	Qty.	Location
2c	F40T5 - 2 Lamp	31	Retail Space and Offices
3	R60W	919	Retail Space and Offices
4	2x26CFL	426	Retail Space and Offices
Total		**1376**	

Impact Evaluation Report: City of Santa Clara End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Site #11 and Silicon Valley Power, the following efficiency improvements were plannned under this project at Site #11.

Table 2. Planned Efficiency Improvements at Santa Clara Site #11

Measure	Description	Qty.	Location
1	F17T8 Lamp	90	Retail Space and Offices
2	F32T8 Lamp	2400	Retail Space and Offices
3	R50W	1407	Retail Space and Offices
Total		**3897**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #11.

Table 3. Verified Efficiency Improvements at Santa Clara Site #11

Measure	Description	Qty.	Location
1	F17T8 - 2 Lamp	6	Offices, Hallways, Restrooms
2a	F32T8 - 1 Lamp	97	Offices, Hallways, Restrooms
2b	F32T8 - 2 Lamp	116	Offices, Hallways, Restrooms
2c	F40T5 - 2 Lamp	31	Offices, Hallways, Restrooms
3	R60W	919	Offices, Hallways, Restrooms
4	2x26CFL	426	Offices, Hallways, Restrooms
Total		**1595**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 4. Pre-Installation, Watts and Hours of Operation for Santa Clara Site #11

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	F20T12 - 2 Lamp	6	4368	56	Retail Space and Offices
2a	F24T12 - 1 Lamp	97	4368	43	Retail Space and Offices
2b	F34T12 - 2 Lamp	116	4368	72	Retail Space and Offices
2c	F34T12 - 2 Lamp U	31	4368	72	Retail Space and Offices
3	R75W	919	4368	75	Retail Space and Offices
4	R150W	426	4368	150	Retail Space and Offices
Total		**1595**			

Primary Business Descriptions:
Site #11 consists of retail space and offices.

Variability in Schedule and Production: Discussions were held with maintenance personnel and personnel occupying the office spaces to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 5. M&V Savings for Santa Clara Site #11

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	F20T12 - 2 Lamp	6	4368	56	0.34	1,468	F17T8 - 2 Lamp	6	4368	33	0.20	865	0.14	603
2a	F24T12 - 1 Lamp	97	4368	43	4.17	18,219	F32T8 - 1 Lamp	97	4368	30	2.91	12,711	1.26	5,508
2b	F34T12 - 2 Lamp	116	4368	72	8.35	36,482	F32T8 - 2 Lamp	116	4368	59	6.84	29,895	1.51	6,587
2c	F34T12 - 2 Lamp U	31	4368	72	2.23	9,749	F40T5 - 2 Lamp	31	4368	72	2.23	9,749	-	-
3	R75W	919	4368	75	68.93	301,064	R60W	919	4368	54	49.63	216,766	19.3	84,298
4	R150W	426	4368	150	63.90	279,115	2x26CFL	426	4368	66	28.12	122,811	35.78	156,304
Total		**1595**			**147.92**	**646,097**		**1595**			**89.93**	**392,797**	**57.99**	**253,300**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 6**.

Table 6. Fixture Wattage Measurements From Santa Clara Site #11

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #11	Retail Breaker 25	6	60/par30/halogen	332.80	53.80	54
Site #11	Retail Breaker 27	7	60/par30/halogen	379.19	54.17	54
Site #11	Retail Breaker 29	8	60/par30/halogen	438.00	54.75	54
Site #11	Storage Breaker 3	11	T8F32 - 1 lamp	426.03	38.73	30
Site #11	Retail Breaker 38	10	T5F40 - 2 lamp	801.60	80.16	72

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 Santa Clara Electric Rate of 0.10358 $/kWh).

- Site #11: (Retrofit Cost $18,386.37 - $18,386.37) / (Energy Savings $26,236.81) = Simple Payback 0.0 Years.

Appendix G-1: TDPUD C&I Lighting Rebate Site #1

M&V REPORT FOR C&I LIGHTING SITE #1

Prepared for the Truckee Donner Public Utility District

and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name:	**Tahoe Truckee Unified School District**	
Site Name:	**Site #1**	
Site Address:	**11839 Donner Pass Road, Truckee, CA 96161**	
Principal Site Contact Name:	**Rob Koster**	**Telephone: (530) 582-2542**
Utility Representative Name:	**Scott Terrell**	**Telephone: (530) 582-3931**
Assigned Lead Engineer:	**Robert Mowris, P.E., Shelly Coben, CEM**	

Site: Tahoe Truckee Unified School District

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #1	4700962024	Lighting	TDPUD	SB5X Project	62,745	Custom

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #1	Lighting	33.7	66,171	n/a	21,677

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	
Site #1	Lighting	37.2	72,827	n/a	

Spillover

No evidence of spillover was found.

Impact Evaluation Report: Truckee Donner PUD End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Planergy, Inc., the following efficiency improvements were plannned under this project at Site #1.

Table 1. Planned Efficiency Improvements at TDPUD Site #1

Measure	Description	Qty.	Location
1	CFL22W	11	Site #1
2	T8F32-2 lamp-EB	552	Site #1
2a	Remove 2 lamp	75	Site #1
3	T8F32-3 lamp-EB	98	Site #1
4	T8F32-4 lamp-EB	33	Site #1
5	T8F17-2 lamp-EB	37	Site #1
6	HID320W	6	Site #1 Multipurpose Room
7	ExitLED2W	14	Site #1
Total		**826**	

Note: EB = Electronic Ballast

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #1.

Table 2. Verified Efficiency Improvements at TDPUD Site #1

Measure	Description	Qty.	Location
1	CFL20W	11	Site #1
2	T32-2 lamp-EB	267	Site #1
2a	Remove 2 lamp	75	Site #1
3	T32-3 lamp-EB	100	Site #1
3a	T32-2 lamp-EB-Ref	212	Site #1
4	T32-4 lamp-EB	21	Site #1
4a	T32-4 lamp-EB	12	Site #1
4b	T32-2 lamp-EB-Ref	71	Site #1
5	T17-2 lamp Ref-w/3 lamp EB	37	Site #1
6	Metal Halide-320W	6	Site #1 Multipurpose Room
7	ExitLED2W	15	Site #1
Total		827	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, Site #1 had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for TDPUD Site #1

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	A60W	11	1,260	60	Site #1
2	T12F34-2 lamp	267	1,800	72	Site #1
2a	T12F34-2 lamp	75	1,800	72	Site #1
3	T12F34-3 lamp	100	1,800	115	Site #1
3a	T12F34-3 lamp	212	1,800	115	Site #1
4	T12F34-4 lamp	21	1,800	144	Site #1
4a	T12F34-4 lamp	12	2,610	144	Site #1
4b	T12F34-4 lamp	71	1,800	144	Site #1
5	T12F34-U-2 lamp	37	2,610	72	Site #1
6	Metal Halide-400W	6	2,160	458	Site #1
7	Exit 2x20W	15	8,760	40	Site #1
Total		**827**			

Primary Business Descriptions: Site #1 consists of classrooms, hallways, restrooms, offices, gymnasiums and cafeterias.

Variability in Schedule and Production: Discussions were held with maintenance personnel at the school to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for TDPUD Site #1

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	A60W	11	1,260	60	0.7	832	CFL20W	11	1,260	20.0	0.2	277	0.50	555
2	T12F34-2 lamp	267	1,800	72	19.2	34,603	T32-2 lamp-EB	267	1,800	52.0	13.9	24,991	5.30	9,612
2a	T12F34-2 lamp	75	1,800	72	5.4	9,720	Remove 2 lamp	75	0	0.0	0.0	0	5.40	9,720
3	T12F34-3 lamp	100	1,800	115	11.5	20,700	T32-3 lamp-EB	100	1,800	79.0	7.9	14,220	3.60	6,480
3a	T12F34-3 lamp	212	1,800	115	24.4	43,884	T32-2 lamp-EB-Ref	212	1,800	102.0	12.5	22,514	11.90	21,370
4	T12F34-4 lamp	21	1,800	144	3.0	5,443	T32-4 lamp-EB	21	1,800	35.0	2.1	3,856	0.90	1,587
4a	T12F34-4 lamp	12	2,610	144	1.7	4,510	T32-4 lamp-EB	12	2,610	366.0	0.6	1,629	1.10	2,881
4b	T12F34-4 lamp	71	1,800	144	10.2	18,403	T32-2 lamp-EB-Ref	71	1,800	2.0	4.2	7,540	6.00	10,863
5	T12F34U-2 lamp	37	2,610	72	2.7	6,953	T17-2L Refl.-w/3 lamp EB	37	2,610	35.0	1.3	3,380	1.40	3,573
6	Metal Halide-400W	6	2,160	458	2.7	5,936	Metal Halide-320W	6	2,160	366.0	2.2	4,743	0.50	1,193
7	Exit 2x20W	15	8,760	40	0.6	5,256	ExitLED2W	15	8,760	2.0	0.0	263	0.60	4,993
Total		**827**			**82.1**	**156,240**		**827**			**44.9**	**83,413**	**37.2**	**72,827**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From TDPUD Site #1

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Pre-Retrofit						
Site #1	Boiler Room	3	T12F34-4 lamp - MB	411.00	137.0	133.0
Site #1	Gymnasium	6	Metal Halide HID-250W	1,778	296.0	295.0
Post-Retrofit						
Site #1	Classroom #10	6	T8F32-3 lamp-EB RLO	480	80.0	78.0
Site #1	Classroom M18	7	T8F32-3 lamp-EB RLO	560.40	80.1	78.0
Site #1	Classroom M18	8	T8F32-3 lamp-EB RLO	608.40	76.0	78.0

RLO = reduced light output

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 TDPUD Rates effective 1-1-02).

- Site #1: (Retrofit Cost $65,036 - Rebate $21,677) / (Energy Savings $8,857 + O&M $2,128) = Simple Payback 3.95 Years.

Appendix G-2: TDPUD C&I Lighting Rebate Site #2

M&V REPORT FOR C&I LIGHTING SITE #2

Prepared for the Truckee Donner Public Utility District
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name:	**Tahoe Truckee Unified School District**	
Site Name:	**Site #2**	
Site Address:	**11839 Donner Pass Road, Truckee, CA 96161**	
Principal Site Contact Name:	**Rob Koster**	**Telephone: (530) 582-2542**
Utility Representative Name:	**Scott Terrell**	**Telephone: (530) 582-3931**
Assigned Lead Engineer:	**Robert Mowris, P.E., Shelly Coben, CEM**	

Site: Tahoe Truckee Unified School District

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Sierra Mountain Middle	4700771024	Lighting	TDPUD	SB5X Project	56,585	Custom

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Sierra Mountain Middle	Lighting	31.2	65,319	n/a	20,262

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Sierra Mountain Middle	Lighting	30.5	64,940	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Truckee Donner PUD End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Planergy, Inc., the following efficiency improvements were plannned under this project at Site #2.

Table 1. Planned Efficiency Improvements at TDPUD Site #2

Measure	Description	Qty.	Location
1	CFL23W	1	Site #2
2	CFL20W	5	Site #2
3a	T8F32-2 lamp-EB	15	Site #2
3b	T8F32-2 lamp-EB	75	Site #2
3c	T8F32-2 lamp-EB	3	Site #2
3d	T8F32-2 lamp-EB	19	Site #2
3dd	T8F32-2 lamp-EB-T	22	Site #2
3e	T8F32-2 lamp-EB-T	32	Site #2
3e	T8F32-2 lamp-EB	18	Site #2
4a	T8F32-2 lamp-EB-T	4	Site #2
4b	T8F32-3 lamp-EB	2	Site #2
4c	T8F32-2 lamp-EB	4	Site #2
5a	T8F32-2 lamp-EB	16	Site #2
5b	T8F32-2 lamp-EB	2	Site #2
6	T8F32-2 lamp-EB	26	Site #2
7a	T8F32-4 lamp-EB	12	Site #2
7b	T8F32-2 lamp-EB	10	Site #2
7c	T8F32-4 lamp-EB	6	Site #2
7d	T8F32-3 lamp-EB	30	Site #2
7dd	T8F32-2 lamp-EB-T	62	Site #2
8	T8F32-4 lamp-EB	0	Site #2
9a	T8F32-2 lamp-EB	292	Site #2
9b	Remove	65	Site #2
10	T8F32-3 lamp-EB	6	Site #2
11a	T8F17-2 lamp-w/Ref-3 lamp-EB	9	Site #2
11b	T8F17-2 lamp-w/Ref-3 lamp-EB	2	Site #2
11c	T8F17-2 lamp-w/Ref-3 lamp-EB	1	Site #2
11d	T8F17-2 lamp-w/Ref-3 lamp-EB	6	Site #2
12	Metal Halide-320W	10	Site #2 Gym
13	ExitLED2W	20	Site #2
14a	*T8F32-2 lamp-EB*		*Site #2 (not replaced)*
14b	*T8F32-2 lamp-EB*		*Site #2 (not replaced)*
14c	*T8F32-3 lamp-EB*		*Site #2 (not replaced)*
15	Controls	26	Site #2
Total		**801**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #2.

Table 2. Verified Efficiency Improvements at TDPUD Site #2

Measure	Description	Qty.	Location
1	CFL23W	1	Site #2
2	CFL20W	5	Site #2
3a	T8F32-2 lamp-EB	15	Site #2
3b	T8F32-2 lamp-EB	75	Site #2
3c	T8F32-2 lamp-EB	3	Site #2
3d	T8F32-2 lamp-EB	19	Site #2
3dd	T8F32-2 lamp-EB-T	22	Site #2
3e	T8F32-2 lamp-EB-T	32	Site #2
3ee	T8F32-2 lamp-EB	18	Site #2
4a	T8F32-2 lamp-EB	4	Site #2
4b	T8F32-3 lamp-EB	2	Site #2
4bb	T8F32-2 lamp-EB-T	4	Site #2
5a	T8F32-2 lamp-EB	16	Site #2
5b	T8F32-2 lamp-EB	2	Site #2
6	T8F32-2 lamp-EB	26	Site #2
7a	T8F32-4 lamp-EB	12	Site #2
7b	T8F32-2 lamp-EB	10	Site #2
7c	T8F32-4 lamp-EB	6	Site #2
7d	T8F32-3 lamp-EB	30	Site #2
7dd	T8F32-2 lamp-EB-T	62	Site #2
8	T8F32-4 lamp-EB	0	Site #2
9a	T8F32-2 lamp-EB	292	Site #2
9b	Remove	65	Site #2
10	T8F32-3 lamp-EB	6	Site #2
11a	T8F17-2 lamp-w/Ref-3 lamp-EB	9	Site #2
11b	T8F17-2 lamp-w/Ref-3 lamp-EB	2	Site #2
11c	T8F17-2 lamp-w/Ref-3 lamp-EB	1	Site #2
11d	T8F17-2 lamp-w/Ref-3 lamp-EB	6	Site #2
12	Metal Halide-320W	10	Site #2 Gym
13	ExitLED2W	20	Site #2
14a	T8F32-2 lamp-EB		*Site #2 (not replaced)*
14b	T8F32-2 lamp-EB		*Site #2 (not replaced)*
14c	T8F32-3 lamp-EB		*Site #2 (not replaced)*
15	Controls	26	Site #2
Total		801	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, Site #2 had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for TDPUD Site #2

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	100W(A)	1	180	100	Site #2
2	100W(A)	5	2,500	100	Site #2
3a	T12F34-2 lamp-MB	15	180	72	Site #2
3b	T12F34-2 lamp-MB	75	2,970	72	Site #2
3c	T12F34-2 lamp-MB	3	2,500	72	Site #2
3d	T12F34-2 lamp-MB	19	1,800	72	Site #2
3dd	T12F34-2 lamp-MB	22	4,302	72	Site #2
3e	T12F34-2 lamp-MB	32	1,800	72	Site #2
3ee	T12F34-2 lamp-MB	18	2,500	72	Site #2
4a	T12F34-3 lamp-MB	4	1,800	115	Site #2
4b	T12F34-3 lamp-MB	2	180	115	Site #2
4bb	T12F34-3 lamp-MB	4	2,500	115	Site #2
5a	T12F34-4 lamp-MB	16	2,970	144	Site #2
5b	T12F34-4 lamp-MB	2	2,970	144	Site #2
6	T12F34-4 lamp-MB	26	1,530	144	Site #2
7a	T12F34-4 lamp-MB	12	1,530	144	Site #2
7b	T12F34-4 lamp-MB	10	0	144	Site #2
7c	T12F34-4 lamp-MB	6	1,530	144	Site #2
7d	T12F34-4 lamp-MB	30	2,970	144	Site #2
7dd	T12F34-4 lamp-MB	62	1,530	144	Site #2
8	T12F34-6 lamp-MB	0	1,800	178	Site #2
9a	T12F34-2 lamp-MB	292	2,500	72	Site #2
9b	T12F34-2 lamp-MB	65	2,970	72	Site #2
10	T12F34-3 lamp-MB	6	2,970	89	Site #2
11a	T12F34-2 lamp U-MB	9	8,760	72	Site #2
11b	T12F34-2 lamp U-MB	2	1,530	72	Site #2
11c	T12F34-2 lamp U-MB	1	2,970	72	Site #2
11d	T12F34-2 lamp U-MB	6	2,970	72	Site #2
12	Metal Halide 400	10		458	Site #2
13	ExitInc20W	20	8,760	40	Site #2
14a	T8F32-2 lamp-EB		1,530		Site #2
14b	T8F32-2 lamp-EB		2,970		Site #2
14c	T8F32-3 lamp-EB		2,970		Site #2
15	Controls	26			Site #2
Total		**801**			

Primary Business Descriptions: Site #2 consists of classrooms, hallways, restrooms, offices, gymnasiums and cafeterias.

Variability in Schedule and Production: Discussions were held with maintenance personnel at the school to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for TDPUD Site #2

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	100W(A)	1	180	100	0.1	18	CFL23W	1	180	23	0.0	4	0.10	14
2	100W(A)	5	2,500	100	0.5	1,250	CFL20W	5	2,500	20	0.1	250	0.40	1,000
3a	T12F34-2 lamp	15	180	72	1.1	194	T8F32-2 lamp-EB	15	180	52	0.8	140	0.30	54
3b	T12F34-2 lamp	75	2,970	72	5.4	16,038	T8F32-2 lamp-EB	75	2,970	52	3.9	11,583	1.50	4,455
3c	T12F34-2 lamp	3	2,500	72	0.2	540	T8F32-2 lamp-EB	3	2,500	52	0.2	390	0.00	150
3d	T12F34-2 lamp	19	1,800	72	1.4	2,462	T8F32-2 lamp-EB	19	1,800	52	1.0	1,778	0.40	684
3dd	T12F34-2 lamp	22	1,800	72	1.6	2,851	T8F32-2 lamp-EB-T	22	1,800	51	1.1	2,020	0.50	832
3e	T12F34-2 lamp	32	4,302	72	2.3	9,911	T8F32-2 lamp-EB-T	32	4,302	51	1.6	7,020	0.70	2,891
3ee	T12F34-2 lamp	18	4,302	72	1.3	5,575	T8F32-2 lamp-EB	18	4,302	51	0.9	3,949	0.40	1,626
4a	T12F34-3 lamp	4	1,800	115	0.5	828	T8F32-2 lamp-EB	4	2,500	52	0.2	520	0.30	308
4b	T12F34-3 lamp	2	2,500	115	0.2	575	T8F32-3 lamp-EB	2	2,500	78	0.2	390	0.00	185
4bb	T12F34-3 lamp	4	2,500	115	0.5	1,150	T8F32-2 lamp-EB-T	4	1,800	51	0.2	367	0.30	783
5a	T12F34-4 lamp	16	1,800	144	2.3	4,147	T8F32-2 lamp-EB	16	1,800	59	0.9	1,699	1.40	2,448
5b	T12F34-4 lamp	2	180	144	0.3	52	T8F32-2 lamp-EB	2	180	59	0.1	21	0.20	31
6	T12F34-4 lamp	26	2,500	144	3.7	9,360	T8F32-2 lamp-EB	26	2,500	59	1.5	3,835	2.20	5,525
7a	T12F34-4 lamp	12	2,970	144	1.7	5,132	T8F32-4 lamp-EB	12	2,970	102	1.2	3,635	0.50	1,497
7b	T12F34-4 lamp	10	2,970	144	1.4	4,277	T8F32-2 lamp-EB	10	2,970	52	0.5	1,544	0.90	2,732
7c	T12F34-4 lamp	6	1,530	144	0.9	1,322	T8F32-4 lamp-EB	6	1,530	102	0.6	936	0.30	386
7d	T12F34-4 lamp	30	1,530	144	4.3	6,610	T8F32-3 lamp-EB	30	1,530	89	2.7	4,085	1.60	2,525
7dd	T12F34-4 lamp	62	1,530	144	8.9	13,660	T8F32-2 lamp-EB-T	62	1,530	51	3.2	4,838	5.70	8,822
8	T12F34-6 lamp	0	0	178	0.0	0	T8F32-4 lamp-EB	0	0	102	0.0	0	0.00	0
9a	T12F34-2 lamp	292	1,530	72	21.0	32,167	T8F32-2 lamp-EB	292	1,530	52	15.2	23,232	5.80	8,935
9b	T12F34-2 lamp	65	1,530	72	4.7	7,160	Remove	65	1,530	0	0.0	0	4.70	7,160
10	T12F34-3 lamp	6	2,970	89	0.5	1,586	T8F32-3 lamp-EB	6	2,970	78	0.5	1,390	0.00	196
11a	T12F34-2 lamp U	9	1,530	72	0.6	991	T8F17-2 lamp-w/Ref-3 lamp-EB	9	1,530	35	0.3	482	0.30	509
11b	T12F34-2 lamp U	2	1,800	72	0.1	259	T8F17-2 lamp-w/Ref-3 lamp-EB	2	1,800	35	0.1	126	0.00	133
11c	T12F34-2 lamp U	1	2,500	72	0.1	180	T8F17-2 lamp-w/Ref-3 lamp-EB	1	2,500	35	0.0	88	0.10	93
11d	T12F34-2 lamp U	6	2,970	72	0.4	1,283	T8F17-2 lamp-w/Ref-3 lamp-EB	6	2,970	35	0.2	624	0.20	659
12	Metal Halide 400	10	2,970	458	4.6	13,603	Metal Halide-320W	10	2,970	365	3.7	10,841	0.90	2,762
13	ExitInc20W	20	8,760	40	0.8	7,008	ExitLED2W	20	8,760	2	0.0	350	0.80	6,658
14a	T8F32-2 lamp-EB		1,530		0	0	T8F32-2 lamp-EB		1,530		0.0	0	0.00	0
14b	T8F32-2 lamp-EB		2,970		0	0	T8F32-2 lamp-EB		2,970		0.0	0	0.00	0
14c	T8F32-3 lamp-EB		2,970		0	0	T8F32-3 lamp-EB		2,970		0.0	0	0.00	0
15	Controls	26			0	4,373	Controls	26		0	0.0	3,485	0.00	888
Total		**801**			**71.4**	**154,562**		**801**			**40.9**	**89,622**	**30.5**	**64,940**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From TDPUD Site #2

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #2	Weight Room	7	T8F32-2 lamp-EB	425.60	60.8	59.0
Site #2	Weight Room	7	T8F32-2 lamp-EB	428.40	61.2	59.0

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 TDPUD Rates effective 1-1-02).

- Site #2: (Retrofit Cost $60,787 – Rebate $20,262) / (Energy Savings $7,648 + O&M $1,943) = Simple Payback 4.2 Years

Appendix G-3: TDPUD C&I Lighting Rebate Site #3

M&V REPORT FOR C&I LIGHTING SITE #3

Prepared for the Truckee Donner Public Utility District
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name:	**Tahoe Truckee Unified School District**	
Site Name:	**Site #3**	
Site Address:	**11839 Donner Pass Road, Truckee, CA 96161**	
Principal Site Contact Name:	**Rob Koster**	**Telephone: (530) 582-2542**
Utility Representative Name:	**Scott Terrell**	**Telephone: (530) 582-3931**
Assigned Lead Engineer:	**Robert Mowris, P.E., Shelly Coben, CEM**	

Site: Tahoe Truckee Unified School District

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #3	GHB1560101-9	Lighting	TDPUD	SB5X Project	9,252	Custom

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #3	Lighting	1.6	4.007	n/a	1,316

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #3	Lighting	3.4	6,692	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Truckee Donner PUD End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Planergy, Inc., the following efficiency improvements were plannned under this project at Site #3.

Table 1. Planned Efficiency Improvements at TDPUD Site #3

Measure	Description	Qty.	Location
1	CFL23W	1	Site #3
2	CFL22W-2 lamp	2	Site #3
3	T8F32-4 lamp	5	Site #3
4	T8F32-8 lamp	12	Site #3 Gym
5	ExitLED2W	5	Site #3
Total		**25**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #3.

Table 2. Verified Efficiency Improvements at TDPUD Site #3

Measure	Description	Qty.	Location
1	CFL23W	1	Site #3
2	CFL22W-2 lamp (installed 1 lamp)	2	Site #3
3	T8F32-4 lamp	4	Site #3
3a	T8F32-4 lamp	1	Site #3
4	T8F32-8 lamp (installed 6 lamp)	12	Site #3 Gym
5	ExitLED2W	5	Site #3
Total		**25**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, Site #3 had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for TDPUD Site #3

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	60W	1	2,125	60	Site #3
2	60W-2	2	1,620	22	Site #3
3	T12F34-4 lamp	4	1,620	144	Site #3
3a	T12F34-4 lamp	1	2,125	144	Site #3
4	T12F95-4 lamp	12	1,620	414	Site #3
5	Exit20W	5	8,760	40	Site #3
Total		**25**			

Primary Business Descriptions: Site #3 consists of classrooms, hallways, restrooms, offices, gymnasiums and cafeterias.

Variability in Schedule and Production: Discussions were held with maintenance personnel at the schools and community centers to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following

spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for TDPUD Site #3

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	60W	1	2,125	60	0.1	128	CFL23W	1	2,125	23	0.0	49	0.0	79
2	60W-2	2	1,620	22	0.0	71	CFL22W-2 lamp (installed 1 lamp)	2	1,620	22	0.0	71	0.0	0
3	T12F34-4 lamp	4	1,620	144	0.6	933	T8F32-4 lamp	4	1,620	102	0.4	661	0.2	272
3a	T12F34-4 lamp	1	2,125	144	0.1	306	T8F32-4 lamp	1	2,125	102	0.1	217	0.0	89
4	T12F95-4 lamp	12	1,620	414	5.0	8,048	T8F32-8 lamp (installed 6 lamp)	12	1,620	178	2.1	3,460	2.9	4,588
5	Exit20W	5	8,760	40	0.2	1,752	ExitLED2W	5	8,760	2	0.0	88	0.2	1,664
Total		25			6.0	11,238		25			2.6	4,546	3.4	6,692

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 TDPUD Rates effective 1-1-02).

- Site #3: (Retrofit Cost $3,948- Rebate $1,316) / (Energy Savings $800 + O&M $261) = Simple Payback 2.9 Years.

Appendix G-4: TDPUD C&I Lighting Rebate Site #4

M&V REPORT FOR C&I LIGHTING SITE #4

Prepared for the Truckee Donner Public Utility District
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name:	**Tahoe Truckee Unified School District**	
Site Name:	**Site #4**	
Site Address:	**11509 Northwoods Blvd, Truckee, CA 96160**	
Principal Site Contact Name:	**Tim Burke**	**Telephone: (530) 587-9400**
Utility Representative Name:	**Scott Terrell**	**Telephone: (530) 582-3931**
Assigned Lead Engineer:	**Robert Mowris, P.E., Shelly Coben, CEM**	

Site: TDPUD Site #4

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #4	n/a	Lighting	TDPUD	SB5X Project	n/a	Custom

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #4	Lighting	28.0	97,181	n/a	15,000

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Site #4	Lighting	33.0	109,500	n/a

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Truckee Donner PUD End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications provided by Planergy, Inc., the following efficiency improvements were plannned under this project at Site #4 (from Planergy).

Table 1. Planned Efficiency Improvements at TDPUD Site #4

Measure	Description	Qty.	Location
1	T8F17-2 lamp EB	3	Corporation Building
2	T8F32-4 lamp EB	4	Corporation Building
3	T8F32-2 lamp EB	1	Corporation Building
4	CFL20	1	Corporation Building
5	T8F32-2 lamp EB	6	Corporation Building
6	T8F32-4 lamp EB	3	Corporation Building
7	T8F32-4 lamp EB	8	Corporation Building
8	T8F32-4 lamp EB	5	Corporation Building
9	T8F32-4 lamp EB	1	Corporation Building
10	T8F32-2 lamp EB	4	Corporation Building
11	CFL20	0	Corporation Building
16	T8F32-4 lamp EB	1	Forestry Building
17	T8F32-4 lamp EB	2	Forestry Building
18	T8F32-4 lamp EB	5	Forestry Building
19	T8F32-2 lamp EB	1	Forestry Building
21	T8F32-4 lamp EB	5	Golf Maintenance Building
22	ExitLED2W	1	Golf Maintenance Building
23	T8F32-2 lamp EB	1	Golf Maintenance Building
25	T8F32-2 lamp EB	1	Golf Course Clubhouse
26	T8F32-2 lamp EB	1	Golf Course Clubhouse
27	CFL20	1	Golf Course Clubhouse
28	T8F32-4 lamp EB	2	Golf Course Clubhouse
29	T8F32-2 lamp EB	6	Golf Course Clubhouse
30	CFL20	1	Golf Course Clubhouse
31	ExitLED2W	8	Golf Course Clubhouse
32	R45W	3	Golf Course Clubhouse
33	CFL20	6	Golf Course Clubhouse
34	CFL15	24	Golf Course Clubhouse
35	T8F32-4 lamp EB	15	Golf Course Clubhouse
36	R45W	11	Golf Course Clubhouse
37	T8F32-4 lamp EB	2	Golf Course Clubhouse
38	T8F32-2 lamp EB	1	Golf Course Clubhouse
39	CFL20	1	Golf Course Clubhouse
40	T8F32-2 lamp EB	1	Golf Course Clubhouse
41	T8F32-4 lamp EB	4	Golf Course Clubhouse
42	CFL15	3	Golf Course Clubhouse
43	T8F32-4 lamp EB	1	Golf Cart Building
44	50W	11	Tennis Clubhouse
45	CFL20	1	Tennis Clubhouse
46	CFL15	12	Tennis Clubhouse
47	50W	8	Tennis Clubhouse
48	T8F32-4 lamp EB	8	Tennis Clubhouse
49	T8F32-4 lamp EB	25	Golf Cart Building
50	T8F32-2 lamp EB	14	Golf Cart Building
51	T8F32-3 lamp EB	12	Golf Cart Building
52	42W	6	Ski Lodge - First Floor
53	New T8F32-4 lamp EB	6	Ski Lodge - First Floor
54	ExitLED2W	8	Ski Lodge - First Floor
55	T8F32-2 lamp EB	8	Ski Lodge - First Floor
56	T8F32-4 lamp EB	7	Ski Lodge - First Floor
57	T8F17-2 lamp EB	3	Ski Lodge - First Floor

Table 1. Planned Efficiency Improvements at TDPUD Site #4

Measure	Description	Qty.	Location
58	T8F32-4 lamp EB	10	Ski Lodge - First Floor
59	T8F32-2 lamp EB-T	0	Ski Lodge - First Floor
60	T8F32-2 lamp EB	1	Ski Lodge - First Floor
61	T8F17-2 lamp EB	2	Ski Lodge - First Floor
62	R45W	17	Ski Lodge - First Floor
63	CFL23	2	Ski Lodge - First Floor
64	T8F32-4 lamp EB	13	Ski Lodge - First Floor
65	T8F17-2 lamp EB	2	Ski Lodge - First Floor
66	T8F32-1 lamp EB	2	Ski Lodge - First Floor
67	T8F17-2 lamp EB	4	Ski Lodge - First Floor
68	T8F32-1 lamp EB	3	Ski Lodge - First Floor
69	T8F32-2 lamp EB	6	Ski Lodge - First Floor
70	T8F17-2 lamp EB	1	Ski Lodge - First Floor
71	T8F32-4 lamp EB	4	Ski Lodge - First Floor
72	T8F32-2 lamp EB	3	Ski Lodge - First Floor
73	T8F32-4 lamp EB	4	Ski Lodge - First Floor
74	T8F32-2 lamp EB	10	Ski Lodge - First Floor
75	CFL20	1	Ski Lodge - First Floor
76	T8F32-4 lamp EB	1	Ski Lodge - First Floor
77	T8F32-4 lamp EB	1	Ski Lodge - First Floor
78	CFL20	1	Ski Lodge - First Floor
79	T8F17-2 lamp EB	1	Ski Lodge - First Floor
80	CFL20	1	Ski Lodge - First Floor
81	T8F32-4 lamp EB	8	Ski Lodge - First Floor
82	T8F32-1 lamp EB	3	Ski Lodge - First Floor
83	T8F32-4 lamp EB	7	Ski Lodge - First Floor
84	T8F17-2 lamp EB	1	Ski Lodge - First Floor
85	T8F32-4 lamp EB	8	Ski Lodge - First Floor
86	T8F17-2 lamp EB	6	Ski Lodge - First Floor
87	ExitLED2W	3	Ski Lodge - Second Floor
88	T8F32-4 lamp EB	2	Ski Lodge - Second Floor
89	T8F17-1 lamp EB	2	Ski Lodge - Second Floor
90	CFL18	1	Ski Lodge - Second Floor
91	T8F32-4 lamp EB	7	Ski Lodge - Second Floor
92	T8F32-4 lamp EB	2	Ski Lodge - Second Floor
93	CFL23	8	Ski Lodge - Second Floor
94	CFL15	8	Ski Lodge - Second Floor
95	R45W	31	Ski Lodge - Second Floor
96	42W	37	Cross Country Lodge
97	T8F32-4 lamp EB	3	Cross Country Lodge
98	T8F32-4 lamp EB	6	Cross Country Lodge
99	CFL20	18	Cross Country Lodge
100	T8F32-2 lamp EB	38	Cross Country Lodge
101	R45W	21	Cross Country Lodge
102	T8F32-2 lamp EB	5	Cross Country Lodge
103	T8F32-2 lamp EB	0	Cross Country Lodge
112	T8F32-2 lamp EB	6	Clubhouse
113	CFL20	6	Clubhouse
114	50W	4	Clubhouse
115	R45W	23	Clubhouse
116	T8F32-4 lamp EB	6	Clubhouse
117	CFL23	8	Clubhouse
118	ExitLED2W	9	Clubhouse
119	T8F32-4 lamp EB	8	Clubhouse
120	T8F32-2 lamp EB	4	Clubhouse
121	T8F32-4 lamp EB	3	Clubhouse
122	T8F32-2 lamp EB	2	Clubhouse
123	CFL20	7	Clubhouse
124	T8F32-4 lamp EB	2	Clubhouse
125	R35W	20	Clubhouse
126	T8F32-2 lamp EB	5	Clubhouse
127	R45W	2	Clubhouse

Table 1. Planned Efficiency Improvements at TDPUD Site #4

Measure	Description	Qty.	Location
128	CFL20	3	Clubhouse
129	R45W	4	Clubhouse
130	T8F32-4 lamp EB	22	Clubhouse
131	CFL23	1	Clubhouse
132	T8F32-2 lamp EB	20	Clubhouse
133	T8F32-4 lamp EB	0	Clubhouse
134	CFL20	1	Clubhouse
135	T8F32-2 lamp EB	2	Clubhouse
136	T8F32-4 lamp EB	1	Clubhouse
137	T8F32-2 lamp EB	1	Clubhouse
138	T8F32-4 lamp EB	2	Clubhouse
139	CFL15	1	Clubhouse
Total		**761**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #4.

Table 2. Verified Efficiency Improvements at TDPUD Site #4

Measure	Description	Qty.	Location
1	T8F17-2 lamp EB	3	T.D. Corporation Building
2	T8F32-4 lamp EB	4	T.D. Corporation Building
3	T8F32-2 lamp EB	1	T.D. Corporation Building
4	CFL20	1	T.D. Corporation Building
5	T8F32-2 lamp EB	6	T.D. Corporation Building
6	T8F32-4 lamp EB	3	T.D. Corporation Building
7	T8F32-4 lamp EB	8	T.D. Corporation Building
8	T8F32-4 lamp EB	5	T.D. Corporation Building
9	T8F32-4 lamp EB	1	T.D. Corporation Building
10	T8F32-2 lamp EB	4	T.D. Corporation Building
11	CFL20	0	T.D. Corporation Building
16	T8F32-4 lamp EB	1	Forestry Building
17	T8F32-4 lamp EB	2	Forestry Building
18	T8F32-4 lamp EB	5	Forestry Building
19	T8F32-2 lamp EB	1	Forestry Building
21	T8F32-4 lamp EB	5	Golf Maintenance Building
22	ExitLED2W	1	Golf Maintenance Building
23	T8F32-2 lamp EB	1	Golf Maintenance Building
25	T8F32-2 lamp EB	1	Golf Course Clubhouse
26	T8F32-2 lamp EB	1	Golf Course Clubhouse
27	CFL20	1	Golf Course Clubhouse
28	T8F32-4 lamp EB	2	Golf Course Clubhouse
29	T8F32-2 lamp EB	6	Golf Course Clubhouse
30	CFL20	1	Golf Course Clubhouse
31	ExitLED2W	8	Golf Course Clubhouse
32	R45W	3	Golf Course Clubhouse
33	CFL20	6	Golf Course Clubhouse
34	CFL15	24	Golf Course Clubhouse
35	T8F32-4 lamp EB	15	Golf Course Clubhouse
36	R45W	11	Golf Course Clubhouse
37	T8F32-4 lamp EB	2	Golf Course Clubhouse
38	T8F32-2 lamp EB	1	Golf Course Clubhouse
39	CFL20	1	Golf Course Clubhouse
40	T8F32-2 lamp EB	1	Golf Course Clubhouse
41	T8F32-4 lamp EB	4	Golf Course Clubhouse
42	CFL15	3	Golf Course Clubhouse
43	T8F32-4 lamp EB	1	Golf Cart Building
44	50W	11	Tennis Clubhouse
45	CFL20	1	Tennis Clubhouse
46	CFL15	12	Tennis Clubhouse
47	50W	8	Tennis Clubhouse
48	T8F32-4 lamp EB	8	Tennis Clubhouse

Table 2. Verified Efficiency Improvements at TDPUD Site #4

Measure	Description	Qty.	Location
49	T8F32-4 lamp EB	25	Golf Cart Building
50	T8F32-2 lamp EB	14	Golf Cart Building
51	T8F32-3 lamp EB	12	Golf Cart Building
52	42W	6	Ski Lodge - First Floor
53	New T8F32-4 lamp EB	6	Ski Lodge - First Floor
54	ExitLED2W	8	Ski Lodge - First Floor
55	T8F32-2 lamp EB	8	Ski Lodge - First Floor
56	T8F32-4 lamp EB	7	Ski Lodge - First Floor
57	T8F17-2 lamp EB	3	Ski Lodge - First Floor
58	T8F32-4 lamp EB	10	Ski Lodge - First Floor
59	T8F32-2 lamp EB-T	0	Ski Lodge - First Floor
60	T8F32-2 lamp EB	1	Ski Lodge - First Floor
61	T8F17-2 lamp EB	2	Ski Lodge - First Floor
62	R45W	17	Ski Lodge - First Floor
63	CFL23	2	Ski Lodge - First Floor
64	T8F32-4 lamp EB	13	Ski Lodge - First Floor
65	T8F17-2 lamp EB	2	Ski Lodge - First Floor
66	T8F32-1 lamp EB	2	Ski Lodge - First Floor
67	T8F17-2 lamp EB	4	Ski Lodge - First Floor
68	T8F32-1 lamp EB	3	Ski Lodge - First Floor
69	T8F32-2 lamp EB	6	Ski Lodge - First Floor
70	T8F17-2 lamp EB	1	Ski Lodge - First Floor
71	T8F32-4 lamp EB	4	Ski Lodge - First Floor
72	T8F32-2 lamp EB	3	Ski Lodge - First Floor
73	T8F32-4 lamp EB	4	Ski Lodge - First Floor
74	T8F32-2 lamp EB	10	Ski Lodge - First Floor
75	CFL20	1	Ski Lodge - First Floor
76	T8F32-4 lamp EB	1	Ski Lodge - First Floor
77	T8F32-4 lamp EB	1	Ski Lodge - First Floor
78	CFL20	1	Ski Lodge - First Floor
79	T8F17-2 lamp EB	1	Ski Lodge - First Floor
80	CFL20	1	Ski Lodge - First Floor
81	T8F32-4 lamp EB	8	Ski Lodge - First Floor
82	T8F32-1 lamp EB	3	Ski Lodge - First Floor
83	T8F32-4 lamp EB	7	Ski Lodge - First Floor
84	T8F17-2 lamp EB	1	Ski Lodge - First Floor
85	T8F32-4 lamp EB	8	Ski Lodge - First Floor
86	T8F17-2 lamp EB	6	Ski Lodge - First Floor
87	ExitLED2W	3	Ski Lodge - Second Floor
88	T8F32-4 lamp EB	2	Ski Lodge - Second Floor
89	T8F17-1 lamp EB	2	Ski Lodge - Second Floor
90	CFL18	1	Ski Lodge - Second Floor
91	T8F32-4 lamp EB	7	Ski Lodge - Second Floor
92	T8F32-4 lamp EB	2	Ski Lodge - Second Floor
93	CFL23	8	Ski Lodge - Second Floor
94	CFL15	8	Ski Lodge - Second Floor
95	R45W	31	Ski Lodge - Second Floor
96	42W	37	Cross Country Lodge
97	T8F32-4 lamp EB	3	Cross Country Lodge
98	T8F32-4 lamp EB	6	Cross Country Lodge
99	CFL20	18	Cross Country Lodge
100	T8F32-2 lamp EB	38	Cross Country Lodge
101	R45W	21	Cross Country Lodge
102	T8F32-2 lamp EB	5	Cross Country Lodge
103	T8F32-2 lamp EB	0	Cross Country Lodge
112	T8F32-2 lamp EB	6	Clubhouse
113	CFL20	6	Clubhouse
114	50W	4	Clubhouse
115	R45W	23	Clubhouse
116	T8F32-4 lamp EB	6	Clubhouse
117	CFL23	8	Clubhouse
118	ExitLED2W	9	Clubhouse

Table 2. Verified Efficiency Improvements at TDPUD Site #4

Measure	Description	Qty.	Location
119	T8F32-4 lamp EB	8	Clubhouse
120	T8F32-2 lamp EB	4	Clubhouse
121	T8F32-4 lamp EB	3	Clubhouse
122	T8F32-2 lamp EB	2	Clubhouse
123	CFL20	7	Clubhouse
124	T8F32-4 lamp EB	2	Clubhouse
125	R35W	20	Clubhouse
126	T8F32-2 lamp EB	5	Clubhouse
127	R45W	2	Clubhouse
128	CFL20	3	Clubhouse
129	R45W	4	Clubhouse
130	T8F32-4 lamp EB	22	Clubhouse
131	CFL23	1	Clubhouse
132	T8F32-2 lamp EB	20	Clubhouse
133	T8F32-4 lamp EB	0	Clubhouse
134	CFL20	1	Clubhouse
135	T8F32-2 lamp EB	2	Clubhouse
136	T8F32-4 lamp EB	1	Clubhouse
137	T8F32-2 lamp EB	1	Clubhouse
138	T8F32-4 lamp EB	2	Clubhouse
139	CFL15	1	Clubhouse
Total		**761**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, Site #4 had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation Watts and Hours for TDPUD Site #4

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	T12F34-2 lamp U	3	2750	72	Corporation Building
2	T12F34-4 lamp	4	2750	144	Corporation Building
3	T12F34-2 lamp	1	2750	72	Corporation Building
4	60W	1	2750	60	Corporation Building
5	T12F34-2 lamp	6	2750	72	Corporation Building
6	T12F60-2 lamp	3	2750	123	Corporation Building
7	T12F110-2 lamp	8	2750	242	Corporation Building
8	T12F110-2 lamp	5	2750	242	Corporation Building
9	T12F34-4 lamp	1	2750	144	Corporation Building
10	T12F34-2 lamp	4	2750	72	Corporation Building
11	60W	0	2750	60	Corporation Building
16	T12F34-4 lamp	1	2750	144	Forestry Building
17	T12F60-2 lamp	2	2750	123	Forestry Building
18	T12F60-2 lamp	5	2750	123	Forestry Building
19	T12F34-2 lamp	1	2750	72	Forestry Building
21	T12F110-2 lamp	5	2744	242	Golf Maintenance Building
22	Exit20W	1	8759.52	80	Golf Maintenance Building
23	T12F34-2 lamp	1	2744	72	Golf Maintenance Building
25	T12F34-2 lamp	1	2744	72	Golf Course Clubhouse
26	T12F34-2 lamp	1	2744	72	Golf Course Clubhouse
27	60W	1	2744	60	Golf Course Clubhouse
28	T12F34-4 lamp	2	2744	144	Golf Course Clubhouse
29	T12F34-2 lamp	6	2744	72	Golf Course Clubhouse
30	60W	1	2744	60	Golf Course Clubhouse
31	Exit20W	8	8759.52	80	Golf Course Clubhouse
32	R75W	3	2744	75	Golf Course Clubhouse
33	60W	6	2744	180	Golf Course Clubhouse
34	60W	24	2744	60	Golf Course Clubhouse
35	T12F34-4 lamp	15	2744	144	Golf Course Clubhouse
36	R75W	11	2744	75	Golf Course Clubhouse
37	T12F34-4 lamp	2	2744	144	Golf Course Clubhouse
38	T12F34-2 lamp	1	2744	72	Golf Course Clubhouse
39	60W	1	2744	180	Golf Course Clubhouse

Table 3. Pre-Installation Watts and Hours for TDPUD Site #4

Measure	Description	Qty.	Hours/yr	W/fixture	Location
40	T12F34-2 lamp	1	2744	72	Golf Course Clubhouse
41	T12F34-4 lamp	4	2744	144	Golf Course Clubhouse
42	60W	3	2744	60	Golf Course Clubhouse
43	T12F34-4 lamp	1	2744	144	Golf Cart Building
44	75W	11	2184	75	Tennis Clubhouse
45	60W	1	2184	60	Tennis Clubhouse
46	60W	12	2184	60	Tennis Clubhouse
47	75W	8	3832.29	75	Tennis Clubhouse
48	T12F34-4 lamp	8	2184	144	Tennis Clubhouse
49	T12F110-2 lamp	25	2744	242	Golf Cart Building
50	T12F34-2 lamp	14	2744	72	Golf Cart Building
51	T12F34-3 lamp	12	2744	114.99	Golf Cart Building
52	60W	6	3832.29	60	Ski Lodge - First Floor
53	60W	48	2184	60	Ski Lodge - First Floor
54	Exit20W	8	8759.52	80	Ski Lodge - First Floor
55	T12F34-2 lamp	8	2184	72	Ski Lodge - First Floor
56	T12F34-4 lamp	7	2184	144	Ski Lodge - First Floor
57	T12F34-2 lamp U	3	2184	72	Ski Lodge - First Floor
58	T12F34-4 lamp	10	2184	144	Ski Lodge - First Floor
59	T12F34-4 lamp	0	2184	144	Ski Lodge - First Floor
60	T12F34-2 lamp	1	2184	72	Ski Lodge - First Floor
61	T12F34-2 lamp U	2	2184	72	Ski Lodge - First Floor
62	R75W	17	2184	75	Ski Lodge - First Floor
63	60W	2	2184	60	Ski Lodge - First Floor
64	T12F34-4 lamp	13	2184	144	Ski Lodge - First Floor
65	T12F34-2 lamp U	2	2184	72	Ski Lodge - First Floor
66	T12F34-1 lamp	2	2184	43	Ski Lodge - First Floor
67	T12F34-2 lamp U	4	2184	72	Ski Lodge - First Floor
68	T12F34-1 lamp	3	2184	43	Ski Lodge - First Floor
69	T12F34-2 lamp	6	2184	72	Ski Lodge - First Floor
70	T12F34-2 lamp U	1	2184	72	Ski Lodge - First Floor
71	T12F34-4 lamp	4	2184	144	Ski Lodge - First Floor
72	T12F34-2 lamp	3	2184	72	Ski Lodge - First Floor
73	T12F34-4 lamp	4	2184	144	Ski Lodge - First Floor
74	T12F34-2 lamp	10	2184	72	Ski Lodge - First Floor
75	60W	1	2184	60	Ski Lodge - First Floor
76	T12F34-4 lamp	1	2184	144	Ski Lodge - First Floor
77	T12F34-4 lamp	1	2184	144	Ski Lodge - First Floor
78	60W	1	2184	60	Ski Lodge - First Floor
79	T12F34-2 lamp U	1	2184	72	Ski Lodge - First Floor
80	60W	1	2184	60	Ski Lodge - First Floor
81	T12F34-4 lamp	8	2184	144	Ski Lodge - First Floor
82	T12F34-1 lamp	3	2184	43	Ski Lodge - First Floor
83	T12F34-4 lamp	7	2184	144	Ski Lodge - First Floor
84	T12F34-2 lamp U	1	2184	72	Ski Lodge - First Floor
85	T12F34-4 lamp	8	2184	144	Ski Lodge - First Floor
86	T12F34-2 lamp U	6	2184	72	Ski Lodge - First Floor
87	Exit20W	3	8759.52	80	Ski Lodge - Second Floor
88	T12F34-4 lamp	2	2184	144	Ski Lodge - Second Floor
89	T12F20-1 lamp	2	2184	28	Ski Lodge - Second Floor
90	60W	1	2184	60	Ski Lodge - Second Floor
91	T12F34-4 lamp	7	2184	144	Ski Lodge - Second Floor
92	T12F34-4 lamp	2	2184	144	Ski Lodge - Second Floor
93	100W	8	2184	100	Ski Lodge - Second Floor
94	60W	8	2184	60	Ski Lodge - Second Floor
95	R75W	31	2184	75	Ski Lodge - Second Floor
96	60W	37	3832.29	60	Cross Country Lodge
97	T12F60-2 lamp	3	2352	123	Cross Country Lodge
98	T12F34-4 lamp	6	2352	144	Cross Country Lodge
99	60W	18	2352	180	Cross Country Lodge
100	T12F34-2 lamp	38	2352	72	Cross Country Lodge
101	R75W	21	2352	75	Cross Country Lodge

Table 3. Pre-Installation Watts and Hours for TDPUD Site #4

Measure	Description	Qty.	Hours/yr	W/fixture	Location
102	T12F34-2 lamp	5	2352	72	Cross Country Lodge
103	T12F34-2 lamp	0	2352	72	Cross Country Lodge
112	T12F34-2 lamp	6	4732	72	Clubhouse
113	60W	6	4732	180	Clubhouse
114	75W	4	4732	75	Clubhouse
115	R75W	23	4732	75	Clubhouse
116	T12F60-2 lamp	6	4732	123	Clubhouse
117	100W	8	4732	100	Clubhouse
118	Exit20W	9	8759.52	80	Clubhouse
119	T12F34-4 lamp	8	4732	144	Clubhouse
120	T12F34-2 lamp	4	4732	72	Clubhouse
121	T12F34-4 lamp	3	4732	144	Clubhouse
122	T12F34-2 lamp	2	4732	72	Clubhouse
123	60W	7	4732	60	Clubhouse
124	T12F34-4 lamp	2	4732	144	Clubhouse
125	60W	20	4732	60	Clubhouse
126	T12F34-2 lamp	5	4732	72	Clubhouse
127	R75W	2	4732	75	Clubhouse
128	60W	3	4732	60	Clubhouse
129	R75W	4	4732	75	Clubhouse
130	T12F34-4 lamp	22	4732	144	Clubhouse
131	100W	1	4732	200	Clubhouse
132	T12F34-2 lamp	20	4732	72	Clubhouse
133	T12F34-4 lamp	0	4732	144	Clubhouse
134	60W	1	4732	60	Clubhouse
135	T12F34-2 lamp	2	4732	72	Clubhouse
136	T12F34-4 lamp	1	4732	144	Clubhouse
137	T12F34-2 lamp	1	4732	72	Clubhouse
138	T12F34-4 lamp	2	4732	144	Clubhouse
139	60W	1	4732	60	Clubhouse
Total		**803**			

Primary Business Descriptions: Site #4 consist of a clubhouse, cross country lodge, ski lodge, golf cart building, tennis clubhoues, golf course clubhouse, golf maintenance building, forestry building, and a corporation building.

Variability in Schedule and Production: Discussions were held with maintenance personnel at the schools and community centers to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for TDPUD Site #4

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	T12F34-2 lamp U	3	2750	72	0.22	594	T8F17-2 L EB	3	2750	37	0.11	305	0.11	289
2	T12F34-4 lamp	4	2750	144	0.58	1,584	T8F32-4 L EB	4	2750	110	0.44	1,210	0.14	374
3	T12F34-2 lamp	1	2750	72	0.07	198	T8F32-2 L EB	1	2750	55	0.06	151	0.02	47
4	60W	1	2750	60	0.06	165	CFL20	1	2750	22	0.02	61	0.04	105

Table 4. M&V Savings for TDPUD Site #4

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
5	T12F34-2 lamp	6	2750	72	0.43	1,188	T8F32-2 L EB	6	2750	55	0.33	908	0.10	281
6	T12F60-2 lamp	3	2750	123	0.37	1,015	T8F32-4 L EB	3	2750	110	0.33	908	0.04	107
7	T12F110-2 lamp	8	2750	242	1.94	5,324	T8F32-4 L EB	8	2750	112	0.90	2,464	1.04	2,860
8	T12F110-2 lamp	5	2750	242	1.21	3,328	T8F32-4 L EB	5	2750	112	0.56	1,540	0.65	1,788
9	T12F34-4 lamp	1	2750	144	0.14	396	T8F32-4 L EB	1	2750	110	0.11	303	0.03	94
10	T12F34-2 lamp	4	2750	72	0.29	792	T8F32-2 L EB	4	2750	55	0.22	605	0.07	187
11	60W	0	2750	60	0.00	0	CFL20	0	2750	22	0.00	0	0.00	0
16	T12F34-4 lamp	1	2750	144	0.14	396	T8F32-4 L EB	1	2750	102	0.10	281	0.04	116
17	T12F60-2 lamp	2	2750	123	0.25	677	T8F32-4 L EB	2	2750	110	0.22	605	0.03	72
18	T12F60-2 lamp	5	2750	123	0.62	1,691	T8F32-4 L EB	5	2750	110	0.55	1,513	0.06	179
19	T12F34-2 lamp	1	2750	72	0.07	198	T8F32-2 L EB	1	2750	52	0.05	143	0.02	55
21	T12F110-2 lamp	5	2744	242	1.21	3,320	T8F32-4 L EB	5	2744	158	0.79	2,168	0.42	1,152
22	Exit20W	1	8759.52	80	0.08	701	ExitLED2W	1	8759.52	2	0.00	18	0.08	683
23	T12F34-2 lamp	1	2744	72	0.07	198	T8F32-2 L EB	1	2744	52	0.05	143	0.02	55
25	T12F34-2 lamp	1	2744	72	0.07	198	T8F32-2 L EB	1	2744	55	0.06	151	0.02	47
26	T12F34-2 lamp	1	2744	72	0.07	198	T8F32-2 L EB	1	2744	55	0.06	151	0.02	47
27	60W	1	2744	60	0.06	165	CFL20	1	2744	22	0.02	60	0.04	104
28	T12F34-4 lamp	2	2744	144	0.29	790	T8F32-4 L EB	2	2744	112	0.22	615	0.06	176
29	T12F34-2 lamp	6	2744	72	0.43	1,185	T8F32-2 L EB	6	2744	52	0.31	856	0.12	329
30	60W	1	2744	60	0.06	165	CFL20	1	2744	20	0.02	55	0.04	110
31	Exit20W	8	8759.52	80	0.64	5,606	ExitLED2W	8	8759.52	2	0.02	140	0.62	5,466
32	R75W	3	2744	75	0.23	617	R45W	3	2744	45	0.14	370	0.09	247
33	60W	6	2744	180	1.08	2,964	CFL20	6	2744	66	0.40	1,087	0.68	1,877
34	60W	24	2744	60	1.44	3,951	CFL15	24	2744	17	0.41	1,120	1.03	2,832
35	T12F34-4 lamp	15	2744	144	2.16	5,927	T8F32-4 L EB	15	2744	112	1.68	4,610	0.48	1,317
36	R75W	11	2744	75	0.83	2,264	R45W	11	2744	45	0.50	1,358	0.33	906
37	T12F34-4 lamp	2	2744	144	0.29	790	T8F32-4 L EB	2	2744	112	0.22	615	0.06	176
38	T12F34-2 lamp	1	2744	72	0.07	198	T8F32-2 L EB	1	2744	52	0.05	143	0.02	55
39	60W	1	2744	180	0.18	494	CFL20	1	2744	66	0.07	181	0.11	313
40	T12F34-2 lamp	1	2744	72	0.07	198	T8F32-2 LEB	1	2744	55	0.06	151	0.02	47
41	T12F34-4 lamp	4	2744	144	0.58	1,581	T8F32-4 L EB	4	2744	112	0.45	1,229	0.13	351
42	60W	3	2744	60	0.18	494	CFL15	3	2744	17	0.05	140	0.13	354
43	T12F34-4 lamp	1	2744	144	0.14	395	T8F32-4 L EB	1	2744	112	0.11	307	0.03	88
44	75W	11	2184	75	0.83	1,802	50W	11	2184	50	0.55	1,201	0.28	601
45	60W	1	2184	60	0.06	131	CFL20	1	2184	22	0.02	48	0.04	83
46	60W	12	2184	60	0.72	1,572	CFL15	12	2184	15	0.18	393	0.54	1,179
47	75W	8	3832.29	75	0.60	2,299	50W	8	3832.29	50	0.40	1,533	0.20	766
48	T12F34-4 lamp	8	2184	144	1.15	2,516	T8F32-4 L EB	8	2184	99	0.79	1,730	0.36	786
49	T12F110-2 lamp	25	2744	242	6.05	16,601	T8F32-4 L EB	25	2744	158	3.95	10,839	2.10	5,762
50	T12F34-2 lamp	14	2744	72	1.01	2,766	T8F32-2 L EB	14	2744	52	0.73	1,998	0.28	768
51	T12F34-3 lamp	12	2744	114.99	1.38	3,786	T8F32-3 L EB	12	2744	78	0.94	2,568	0.44	1,218
52	60W	6	3832.29	60	0.36	1,380	42W	6	3832.29	42	0.25	966	0.11	414
53	60W	48	2184	60	2.88	6,290	New T8F32-4 lamp EB	6	2184	56	0.34	734	2.54	5,556
54	Exit20W	8	8759.52	80	0.64	5,606	ExitLED2W	8	8759.52	2	0.02	140	0.62	5,466
55	T12F34-2 lamp	8	2184	72	0.58	1,258	T8F32-2 L EB	8	2184	55	0.44	961	0.14	297
56	T12F34-4 lamp	7	2184	144	1.01	2,201	T8F32-4 L EB	7	2184	99	0.69	1,514	0.32	688
57	T12F34-2 lamp U	3	2184	72	0.22	472	T8F17-2 L EB	3	2184	37	0.11	242	0.11	229
58	T12F34-4 lamp	10	2184	144	1.44	3,145	T8F32-4 L EB	10	2184	99	0.99	2,162	0.45	983
59	T12F34-4 lamp	0	2184	144	0.00	0	T8F32-2 L EB-T	0	2184	49.5	0.00	0	0.00	0
60	T12F34-2 lamp	1	2184	72	0.07	157	T8F32-2 L EB	1	2184	55	0.06	120	0.02	37
61	T12F34-2 lamp U	2	2184	72	0.14	314	T8F17-2 L EB	2	2184	37	0.07	162	0.07	153
62	R75W	17	2184	75	1.28	2,785	R45W	17	2184	45	0.77	1,671	0.51	1,114
63	60W	2	2184	60	0.12	262	CFL23	2	2184	23	0.05	100	0.07	162
64	T12F34-4 lamp	13	2184	144	1.87	4,088	T8F32-4 L EB	13	2184	99	1.29	2,811	0.59	1,278
65	T12F34-2 lamp U	2	2184	72	0.14	314	T8F17-2 L EB	2	2184	37	0.07	162	0.07	153
66	T12F34-1 lamp	2	2184	43	0.09	188	T8F32-1 L EB	2	2184	31	0.06	135	0.02	52
67	T12F34-2 lamp U	4	2184	72	0.29	629	T8F17-2 L EB	4	2184	37	0.15	323	0.14	306
68	T12F34-1 lamp	3	2184	43	0.13	282	T8F32-1 L EB	3	2184	31	0.09	203	0.04	79
69	T12F34-2 lamp	6	2184	72	0.43	943	T8F32-2 L EB	6	2184	55	0.33	721	0.10	223
70	T12F34-2 lamp U	1	2184	72	0.07	157	T8F17-2 L EB	1	2184	37	0.04	81	0.04	76
71	T12F34-4 lamp	4	2184	144	0.58	1,258	T8F32-4 L EB	4	2184	99	0.40	865	0.18	393

Table 4. M&V Savings for TDPUD Site #4

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
72	T12F34-2 lamp	3	2184	72	0.22	472	T8F32-2 L EB	3	2184	55	0.17	360	0.05	111
73	T12F34-4 lamp	4	2184	144	0.58	1,258	T8F32-4 L EB	4	2184	99	0.40	865	0.18	393
74	T12F34-2 lamp	10	2184	72	0.72	1,572	T8F32-2 L EB	10	2184	55	0.55	1,201	0.17	371
75	60W	1	2184	60	0.06	131	CFL20	1	2184	22	0.02	48	0.04	83
76	T12F34-4 lamp	1	2184	144	0.14	314	T8F32-4 L EB	1	2184	99	0.10	216	0.05	98
77	T12F34-4 lamp	1	2184	144	0.14	314	T8F32-4 L EB	1	2184	99	0.10	216	0.05	98
78	60W	1	2184	60	0.06	131	CFL20	1	2184	22	0.02	48	0.04	83
79	T12F34-2 lamp U	1	2184	72	0.07	157	T8F17-2 L EB	1	2184	37	0.04	81	0.04	76
80	60W	1	2184	60	0.06	131	CFL20	1	2184	22	0.02	48	0.04	83
81	T12F34-4 lamp	8	2184	144	1.15	2,516	T8F32-4 L EB	8	2184	99	0.79	1,730	0.36	786
82	T12F34-1 lamp	3	2184	43	0.13	282	T8F32-1 L EB	3	2184	31	0.09	203	0.04	79
83	T12F34-4 lamp	7	2184	144	1.01	2,201	T8F32-4 L EB	7	2184	99	0.69	1,514	0.32	688
84	T12F34-2 lamp U	1	2184	72	0.07	157	T8F17-2 L EB	1	2184	37	0.04	81	0.04	76
85	T12F34-4 lamp	8	2184	144	1.15	2,516	T8F32-4 L EB	8	2184	99	0.79	1,730	0.36	786
86	T12F34-2 lamp U	6	2184	72	0.43	943	T8F17-2 L EB	6	2184	37	0.22	485	0.21	459
87	Exit20W	3	8759.52	80	0.24	2,102	ExitLED2W	3	8759.52	2	0.01	53	0.23	2,050
88	T12F34-4 lamp	2	2184	144	0.29	629	T8F32-4 L EB	2	2184	99	0.20	432	0.09	197
89	T12F20-1 lamp	2	2184	28	0.06	122	T8F17-1 L EB	2	2184	16	0.03	70	0.02	52
90	60W	1	2184	60	0.06	131	CFL18	1	2184	18	0.02	39	0.04	92
91	T12F34-4 lamp	7	2184	144	1.01	2,201	T8F32-4 L EB	7	2184	99	0.69	1,514	0.32	688
92	T12F34-4 lamp	2	2184	144	0.29	629	T8F32-4 L EB	2	2184	99	0.20	432	0.09	197
93	100W	8	2184	100	0.80	1,747	CFL23	8	2184	25	0.20	437	0.60	1,310
94	60W	8	2184	60	0.48	1,048	CFL15	8	2184	17	0.14	297	0.34	751
95	R75W	31	2184	75	2.33	5,078	R45W	31	2184	45	1.40	3,047	0.93	2,031
96	60W	37	3832.29	60	2.22	8,508	42W	37	3832.29	42	1.55	5,955	0.67	2,552
97	T12F60-2 lamp	3	2352	123	0.37	868	T8F32-4 L EB	3	2352	102	0.31	720	0.06	148
98	T12F34-4 lamp	6	2352	144	0.86	2,032	T8F32-4 L EB	6	2352	99	0.59	1,397	0.27	635
99	60W	18	2352	180	3.24	7,620	CFL20	18	2352	66	1.19	2,794	2.05	4,826
100	T12F34-2 lamp	38	2352	72	2.74	6,435	T8F32-2 L EB	38	2352	55	2.09	4,916	0.65	1,519
101	R75W	21	2352	75	1.58	3,704	R45W	21	2352	45	0.95	2,223	0.63	1,482
102	T12F34-2 lamp	5	2352	72	0.36	847	T8F32-2 L EB	5	2352	55	0.28	647	0.09	200
103	T12F34-2 lamp	0	2352	72	0.00	0	T8F32-2 L EB	0	2352	55	0.00	0	0.00	0
112	T12F34-2 lamp	6	4732	72	0.43	2,044	T8F32-2 L EB	6	4732	52	0.31	1,476	0.12	568
113	60W	6	4732	180	1.08	5,111	CFL20	6	4732	66	0.40	1,874	0.68	3,237
114	75W	4	4732	75	0.30	1,420	50W	4	4732	50	0.20	946	0.10	473
115	R75W	23	4732	75	1.73	8,163	R45W	23	4732	45	1.04	4,898	0.69	3,265
116	T12F60-2 lamp	6	4732	123	0.74	3,492	T8F32-4 L EB	6	4732	102	0.61	2,896	0.13	596
117	100W	8	4732	100	0.80	3,786	CFL23	8	4732	25	0.20	946	0.60	2,839
118	Exit20W	9	8759.52	80	0.72	6,307	ExitLED2W	9	8759.52	2	0.02	158	0.70	6,149
119	T12F34-4 lamp	8	4732	144	1.15	5,451	T8F32-4 L EB	8	4732	99	0.79	3,748	0.36	1,704
120	T12F34-2 lamp	4	4732	72	0.29	1,363	T8F32-2 L EB	4	4732	52	0.21	984	0.08	379
121	T12F34-4 lamp	3	4732	144	0.43	2,044	T8F32-4 L EB	3	4732	102	0.31	1,448	0.13	596
122	T12F34-2 lamp	2	4732	72	0.14	681	T8F32-2 L EB	2	4732	55	0.11	521	0.03	161
123	60W	7	4732	60	0.42	1,987	CFL20	7	4732	22	0.15	729	0.27	1,259
124	T12F34-4 lamp	2	4732	144	0.29	1,363	T8F32-4 L EB	2	4732	99	0.20	937	0.09	426
125	60W	20	4732	60	1.20	5,678	R35W	20	4732	35	0.70	3,312	0.50	2,366
126	T12F34-2 lamp	5	4732	72	0.36	1,704	T8F32-2 L EB	5	4732	55	0.28	1,301	0.09	402
127	R75W	2	4732	75	0.15	710	R45W	2	4732	45	0.09	426	0.06	284
128	60W	3	4732	60	0.18	852	CFL20	3	4732	20	0.06	284	0.12	568
129	R75W	4	4732	75	0.30	1,420	R45W	4	4732	45	0.18	852	0.12	568
130	T12F34-4 lamp	22	4732	144	3.17	14,991	T8F32-4 L EB	22	4732	99	2.18	10,306	0.99	4,685
131	100W	1	4732	200	0.20	946	CFL23	1	4732	46	0.05	218	0.15	729
132	T12F34-2 lamp	20	4732	72	1.44	6,814	T8F32-2 L EB	20	4732	52	1.04	4,921	0.40	1,893
133	T12F34-4 lamp	0	4732	144	0.00	0	T8F32-4 L EB	0	4732	99	0.00	0	0.00	0
134	60W	1	4732	60	0.06	284	CFL20	1	4732	22	0.02	104	0.04	180
135	T12F34-2 lamp	2	4732	72	0.14	681	T8F32-2 L EB	2	4732	55	0.11	521	0.03	161
136	T12F34-4 lamp	1	4732	144	0.14	681	T8F32-4 L EB	1	4732	102	0.10	483	0.04	199
137	T12F34-2 lamp	1	4732	72	0.07	341	T8F32-2 L EB	1	4732	52	0.05	246	0.02	95
138	T12F34-4 lamp	2	4732	144	0.29	1,363	T8F32-4 L EB	2	4732	102	0.20	965	0.08	397
139	60W	1	4732	60	0.06	284	CFL15	1	4732	15	0.02	71	0.05	213
Total		**803**			**79.96**	**249,904**		**761**			**46.99**	**140,418**	**33.06**	**109,500**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From TDPUD Site #4

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Clubhouse	First Floor	6	T8F32-4 lamp NLO	681.60	113.60	110
Clubhouse	First Floor	7	CFL23W Dimmable	162.00	23.14	23
Clubhouse	Second Floor	6	T8F32-4 lamp RLO	610.80	101.80	99
Cross Country Lodge	Rental & Dinning	5	T8F32-2 lamp NLO	284.13	56.83	55
Cross Country Lodge	Rental & Dinning	6	T8F32-2 lamp RLO	308.73	51.46	55
Cross Country Lodge	Tack Room	2	T8F32-4 lamp RLO	204.96	102.48	99
Golf Cart Building	Cart Building	12	T8F32-3 lamp RLO	968.82	80.73	78
Golf Course Clubhouse	Pro Shop	5	T8F32-4 lamp NLO	559.32	111.86	110
Golf Course Clubhouse	Pro Shop	3	T8F32-4 lamp NLO	338.66	112.89	110
Golf Course Clubhouse	Pro Shop	7	R50W	331.58	47.37	50
Ski Lodge	Kids Rental	7	T8F32-4 lamp RLO	689.70	98.53	99
Ski Lodge	Kids Rental	6	T8F32-4 lamp RLO	584.43	97.41	99
Ski Lodge	Locker Room	1	T8F32-2 lamp NLO	61.71	61.71	55
Ski Lodge	Locker Room	5	T8F32-2 lamp NLO	302.50	60.50	55
Ski Lodge	Hallway	1	T8F17-2 lamp w/3 lamp ballast	35.09	35.09	37
Maintenance Shop	Lunch Room	3	T8F32-2 lamp RLO	150.04	50.01	55
Maintenance Shop	Shop Area	4	T8F32-4 lamp NLO	447.70	111.93	110
Maintenance Shop	Shop Area	4	T8F32-4 lamp NLO	447.70	111.93	110

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 TDPUD Rates effective 1-1-02).

- Site #4 (Retrofit Cost $24,502 - Rebate $6,053) / (Energy Savings $12,989) = Simple Payback 1.4 Years.

Appendix G-5: TDPUD C&I Lighting Rebate Site #5 - #9

M&V REPORT FOR C&I LIGHTING SITE #5 - #9

Prepared for the Truckee Donner Public Utility District
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name:	**Truckee Donner Public Utility District**	
Site Name:	**Sites #5 - #9**	
Site Address:	**10049 Donner Pass Road, Truckee, CA 96161**	
Principal Site Contact Name:	**Mike Twilliger**	**Telephone: (530) 582-7850**
Utility Representative Name:	**Scott Terrell**	**Telephone: (530) 582-3931**
Assigned Lead Engineer:	**Robert Mowris, P.E., Shelly Coben, CEM**	

Site: TDPUD Site #4

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Sites #5 - #9	GHB1560101-9	Lighting	TDPUD	SB5X Project	n/a	Custom

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Sites #5 - #9	Lighting	5.9	33,425	n/a	9,935

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings		
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)
Sites #5 - #9	Lighting	6.6	16,890	n/a

Spillover

No evidence of spillover was found.

Impact Evaluation Report: Truckee Donner PUD End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Based on information from the as-built specifications, the following efficiency improvements were plannned under this project at Site #5 - #9.

Table 1. Planned Efficiency Improvements at TDPUD Sites #5 - #9

Measure	Description	Qty.	Location
1	T8F32-2 lamp-EB	9	Site #5
2	T8F32-4 lamp-EB	16	Site #5
3	T8F32-2 lamp-EB	2	Site #5
4	T8F32-4 lamp-EB	8	Site #5
5	T8F32-2 lamp-EB	12	Site #6
6	T8F32-4 lamp-EB	34	Site #6
7	A45	12	Site #6
8	R45W	4	Site #6
9	CFL15W	12	Site #6
10	T8F32-2 lamp-EB	9	Site #6
11	HPS35W	0	Site #6
12	T8F32-4 lamp-EB	15	Site #6
13	T8F32-4 lamp-EB	1	Site #7
14	T8F17-1 lamp-EB	1	Site #7
15	CFL15W	10	Site #7
16	T8F17-2 lamp-EB	2	Site #7
17	T8F32-2 lamp-EB-T	26	Site #7
18	CFL15W	14	Site #8
19	T8F32-4 lamp-EB	4	Site #8
20	T8F32-2 lamp-EB	3	Site #9
Total		**194**	

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Sites #5 - #9.

Table 2. Verified Efficiency Improvements at TDPUD Sites #5 - #9

Measure	Description	Qty.	Location
1	T8F32-2 lamp-EB	9	Site #5
2	T8F32-4 lamp-EB	16	Site #5
3	T8F32-2 lamp-EB	2	Site #5
4	T8F32-4 lamp-EB	8	Site #5
5	T8F32-2 lamp-EB	12	Site #6
6	T8F32-4 lamp-EB	34	Site #6
7	A45	12	Site #6
8	R45W	4	Site #6
9	CFL15W	12	Site #6
10	T8F32-2 lamp-EB	9	Site #6
11	HPS35W	0	Site #6
12	T8F32-4 lamp-EB	15	Site #6
13	T8F32-4 lamp-EB	1	Site #7
14	T8F17-1 lamp-EB	1	Site #7
15	CFL15W	10	Site #7
16	T8F17-2 lamp-EB	2	Site #7
17	T8F32-2 lamp-EB-T	26	Site #7
18	CFL15W	14	Site #8
19	T8F32-2 lamp-EB	3	Site #8
20	T8F32-4 lamp-EB	4	Site #8
21	T8F32-2 lamp-EB	3	Site #9
22	CFL15W	12	Site #9
23	T8F32-4 lamp-EB	4	Site #9
Total		**213**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, Sites #5 - #9 had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for TDPUD Sites #5 - #9

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	T12F34-2 lamp	9	2346.3	73	Site #5
2	T12F60-2 lamp	16	2346.3	123	Site #5
3	T12F34-2 lamp	2	2346.3	73	Site #5
4	T12F60-2 lamp	8	2346.3	123	Site #5
5	T12F34-2 lamp	12	4380	73	Site #6
6	T12F60-2 lamp	34	4380	123	Site #6
7	A75	12	4380	75	Site #6
8	R150W	4	4380	150	Site #6
9	A75W	12	4380	75	Site #6
10	T12F34-2 lamp	9	4380	73	Site #6
11	A75W-2 lamp	0	4380	0	Site #6
12	T12F34-4 lamp	15	4380	146	Site #6
13	T12F40-4 lamp	1	782.1	146	Site #7
14	T12F20-1 lamp	1	782.1	28	Site #7
15	A60W	10	782.1	60	Site #7
16	T12F20-2 lamp	2	782.1	56	Site #7
17	T12F34-2 lamp	26	782.1	73	Site #7
18	A60W	14	782.1	60	Site #8
19	T12F34-2 lamp	3	782.1	73	Site #8
20	T12F60-4 lamp	4	782.1	246	Site #8
21	T12F34-2 lamp	3	782.1	73	Site #9
22	A60W	12	782.1	60	Site #9
23	T12F34-4 lamp	4	782.1	146	Site #9
Total		**213**			

Primary Business Descriptions: Sites #5 - #9 consist of offices, storage, garage, kitchen, restrooms, and sleep rooms.

Variability in Schedule and Production: Discussions were held with maintenance personnel at the schools and community centers to determine lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions for each building.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for TDPUD Sites #5 - #9

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
1	T12F34-2 lamp	9	2346.3	73	0.66	1,542	T8F32-2 lamp-EB	9	2346.3	60	0.54	1,267	0.12	275
2	T12F60-2 lamp	16	2346.3	123	1.97	4,618	T8F32-4 lamp-EB	16	2346.3	105	1.68	3,942	0.29	676
3	T12F34-2 lamp	2	2346.3	73	0.15	343	T8F32-2 lamp-EB	2	2346.3	60	0.12	282	0.03	61
4	T12F60-2 lamp	8	2346.3	123	0.98	2,309	T8F32-4 lamp-EB	8	2346.3	105	0.84	1,971	0.14	338
5	T12F34-2 lamp	12	4380	73	0.88	3,837	T8F32-2 lamp-EB	12	4380	60	0.72	3,154	0.16	683
6	T12F60-2 lamp	34	4380	123	4.18	18,317	T8F32-4 lamp-EB	34	4380	105	3.57	15,637	0.61	2,680
7	A75	12	4380	75	0.90	3,942	A45	12	4380	45	0.54	2,365	0.36	1,577

Table 4. M&V Savings for TDPUD Sites #5 - #9

#	Pre-Retrofit	Qty	Hours	W/fix	kW	kWh	Post-Retrofit	Qty	Hours	W/fix	kW	kWh	kW Savings	kWh Savings
8	R150W	4	4380	150	0.60	2,628	R45W	4	4380	45	0.18	788	0.42	1,840
9	A75W	12	4380	75	0.90	3,942	CFL15W	12	4380	15	0.18	788	0.72	3,154
10	T12F34-2 lamp	9	4380	73	0.66	2,878	T8F32-2 lamp-EB	9	4380	60	0.54	2,365	0.12	513
11	A75W-2 lamp	0	4380	0	0.00	0	HPS35W	0	4380	0	0.00	0	0.00	0
12	T12F34-4 lamp	15	4380	146	2.19	9,592	T8F32-4 lamp-EB	15	4380	105	1.58	6,899	0.61	2,693
13	T12F40-4 lamp	1	782.1	146	0.15	114	T8F32-4 lamp-EB	1	782.1	105	0.11	82	0.04	32
14	T12F20-1 lamp	1	782.1	28	0.03	22	T8F17-1 lamp-EB	1	782.1	16	0.02	13	0.01	9
15	A60W	10	782.1	60	0.60	469	CFL15W	10	782.1	15	0.15	117	0.45	352
16	T12F20-2 lamp	2	782.1	56	0.11	88	T8F17-2 lamp-EB	2	782.1	33	0.07	52	0.04	36
17	T12F34-2 lamp	26	782.1	73	1.90	1,484	T8F32-2 lamp-EB-T	26	782.1	52.5	1.37	1,068	0.53	416
18	A60W	14	782.1	60	0.84	657	CFL15W	14	782.1	15	0.21	164	0.63	493
19	T12F34-2 lamp	3	782.1	73	0.22	171	T8F32-2 lamp-EB	3	782.1	60	0.18	141	0.04	30
20	T12F60-4 lamp	4	782.1	246	0.98	770	T8F32-4 lamp-EB	4	782.1	105	0.42	328	0.56	442
21	T12F34-2 lamp	3	782.1	73	0.22	171	T8F32-2 lamp-EB	3	782.1	60	0.18	141	0.04	30
22	A60W	12	782.1	60	0.72	563	CFL15W	12	782.1	15	0.18	141	0.54	422
23	T12F34-4 lamp	4	782.1	146	0.58	457	T8F32-4 lamp-EB	4	782.1	102	0.41	319	0.17	138
Total		**213**			**20.42**	**58,914**		**213**			**13.79**	**42,024**	**6.63**	**16,890**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From TDPUD Sites #5 - 9

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Site #7	Interior	3	CFL15W	39.78	13.26	15
Site #6	Office	2	T8F32-2 lamp NLO	114.46	57.23	60
Site #6	Break Room	2	T8F32-2 lamp NLO	113.28	56.64	60
Site #6	Weight Room	4	T8F32-4 lamp RLO	395.08	98.77	105
Site #6	Weight Room	3	T8F32-4 lamp RLO	301.07	100.36	105
Site #6	Sleeping Room	3	CFL15W	40.12	13.37	15
Site #8	Garage	4	T8F32-4 lamp RLO	402.72	100.68	105

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 TDPUD Rates effective 1-1-02).

- Sites #5 - #9: (Retrofit Cost $18,159 - Rebate $9,935) / (Energy Savings $2,001) = Simple Payback 4.1 Years.

Appendix G-10: TDPUD C&I Lighting Rebate Site #10

M&V REPORT FOR C&I LIGHTING SITE #10

Prepared for the Truckee Donner Public Utility District
and the Northern California Power Agency

Prepared by Robert Mowris & Associates

SITE SUMMARY INFORMATION

Company Name:	**Truckee Donner Public Utility District**	
Site Name:	**Site #10**	
Site Address:	**11570 Donner Pass Road, Truckee, CA 96161**	
Principal Site Contact Name:	**Scott Terrell**	**Telephone: (530) 582-3931**
Utility Representative Name:	**Scott Terrell**	**Telephone: (530) 582-3931**
Assigned Lead Engineer:	**Robert Mowris, P.E.**	

Site: TDPUD Site #10

PROJECTS PAID BY SB5X FUNDS

Project	Account Number	End Use	Utility	Program	Sq. Ft.	Project Type
Site #10	4700962024	Lighting	TDPUD	SB5X Project	40,000	Custom

MEASURES FOR EACH PROJECT

		Ex Ante Savings Estimate			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	Rebate ($)
Site #10 (Ameresco)	Lighting	31.5	126,602	n/a	
Site #10 (Planergy)	Lighting	18.1	55,802	n/a	

PROGRAM MEASUREMENT AND VERIFICATION SAVINGS ESTIMATE

		M&V Evaluation Savings			
Item No.	Efficiency Measure	(kW)	(kWh/yr)	(therms)	
Site #10	Lighting	28.7	106,824	n/a	

Spillover
No evidence of spillover was found.

Impact Evaluation Report: Truckee Donner PUD End Use: LIGHTING

Measure Description

Planned Efficiency Improvement: Ameresco and Planergy provided proposals for lighting efficiency improvements at Site #10. **Table 1** presensts the proposed retrofits by both energy service companies (ESCOs). The following combined improvements were recommended.

Table 1. Planned Efficiency Improvements at TDPUD Site #10

Measure	Description	Qty.	Location
1	2-4'T8,RW	3	Entry
2	2-4'T8,RW	1	Entry (24 hrs)
3	2-'4'T8,RW,RFL	7	Lobby
4	2-'4'T8,RW,RFL	3	Lobby (24 hrs)
5	Rec. Cans 2-13W CFL-EB	2	Lobby CFLs
6	2-'4'T8,RW	20	Town of Truckee Offices
7	2-'4'T8,RW	1	Town of Truckee Offices
8	2-2'UT8,RW	1	Town of Truckee Offices
9	2-'4'T8,RW	2	Town of Truckee Offices (24 hrs)
10	2-'4'T8,RW,RFL	1	Lobby
11	2-2'UT8,RW	1	Lobby
12	2-4'T8,RW,(1)WMS	4	Town of Truckee Offices (2)
13	2-4'T8,RW	8	Computer Room
14	2-4'T8,RW,(1)WMS	1	Closet
15	2-4'T8,STD	3	Telephone Equip. Rm.
16	2-4'T8,RW,(2)WMS	4	Rest Rooms
17	1-4'T8,RW	2	Rest Rooms
18	2-4'T8,STD,RFL(1)WMS	5	Conference Rooms
19	2-4'T8,STD,RFL(1)WMS	1	Conference Rooms (24 hrs)
20	2-4'T8,STD,RFL	19	Customer Service Room
21	2-4'T8,STD,RFL	5	Customer Service Room (24 hrs)
22	Rec. Cans 2-13W CFL-EB	3	Customer Service Room CFLs
23	2-4'T8,RW,(1)WMS	1	Copy Room
24	2-4'T8,RW	5	Computer Work Area
25	2-4'T8,RW	1	Computer Work Area (24 hrs)
26	2-4'T8,STD,RFL,(1)WMS	5	West Conference Room
27	2-4'T8,STD,RFL,(1)WMS	1	West Conference Room (24 hrs)
28	2-4'T8,RW,(1)WMS	8	Mail/Copy Room
29	2-4'T8,RW,(1)WMS	1	Mail/Copy Room (24 hrs)
30	2-4'T8,RW	3	Hall to Boardroom
31	2-4'T8,RW	2	Hall to Boardroom (24 hrs)
32	2-4'T8,STD,RFL,(2)WMS	8	Kitchen/Lunch Room
33	2-4'T8,STD,RFL,(2)WMS	2	Kitchen/Lunch Room (24 hrs)
34	NO ACCESS	0	Vault
35	2-4'T8,RW,(1)WMS	2	Mens Room
36	2-4'T8,RW,(1)WMS	1	Mens Room (24 hrs)
37	1-4'T8,RW	1	Mens Room
38	Rec. Cans 2-13W CFL-EB	1	Mens Room CFLs
39	2-4'T8,RW,(1)WMS	2	Locker Room
40	2-4'T8,RW,(1)WMS	3	Exercise Room
41	2-4'T8,RW,(2)WMS	2	Womens Rest Room
42	2-4'T8,RW,(2)WMS	1	Womens Rest Room (24 hrs)
43	1-4'T8,RW	1	Womens Rest Room
44	Rec. Cans 2-13W CFL-EB	1	Womens Rest Room CFLs
45	2-4'T8,RW,(1)WMS	5	Board Conf. Room
46	2-4'T8,RW,(1)WMS	1	Board Conf. Room (24 hrs)
47	2-4'T8,STD,RFL	4	Board Room
48	2-4'T8,STD,RFL	1	Board Room (24 hrs)
49	Rec. Cans 2-13W CFL-EB	22	Board Room CFLs
50	2-4'T8,RW,(1)WMS	2	Board Room Closet
51	1-4'T8,RW	17	Board Room Soffet
52	1-2'T8,RW	2	Board Room Soffet

Table 1. Planned Efficiency Improvements at TDPUD Site #10

Measure	Description	Qty.	Location
53	1-4'T8,RW	2	Elevator Equip. Room
54	1-4'T8,RW	3	Elec. Room Closets
			2nd Floor
55	2-4'T8,RW	1	Stair Well (24 hrs)
56	2-4'T8,RW	2	Back Stair Well (24 hrs)
57	4-4'T8,RW	1	Back Stair Well (24 hrs)
58	2-4'T8,STD,RFL	5	Elect. Dept. Office #1
59	2-4'T8,STD,RFL	1	Elect. Dept. Office #1 (24 hrs)
60	2-4'T8,STD,RFL	6	Elect. Dept. Office #2
61	CFL 26W PAR	2	Elect. Dept. Office #2
62	2-4'T8,RW,(2)WMS	4	Rest Rooms
63	1-4'T8,RW	2	Rest Rooms
64	2-4'T8,RW, NO RFL	2	Hall
65	2-4'T8,RW, NO RFL	1	Hall (24 hrs)
66	2-4'T8,RW	1	Hall
67	2-4'T8,RW	1	Hall (24 hrs)
68	2-4'T8,RW	2	Boiler Room
69	1-4'T8,RW, Kit	4	Hall
70	1-4'T8,RW, Kit	3	Hall (24 hrs)
71	2-4'T8,STD,RFL	27	Town Offices
72	2-4'T8,STD,RFL	3	Town Offices (24 hrs)
73	2-4'T8,STD,RFL	52	Common Area
74	2-4'T8,STD,RFL	10	Common Area (24 hrs)
75	2-2'UT8,RW	1	Common Area
76	2-4'T8,RW	1	Elevator (24 hrs)
			Warehouse, Vehicle, Maintenance Offices
77	Sportlite GX 400 (4-42W CFLs)	5	Hall Between Bldgs.
78	Sportlite GX 400 (4-42W CFLs)	3	Hall Between Bldgs. (24 hrs)
79	Sportlite GX 400	7	Electric Vehicle Gar.
80	Sportlite GX 400	1	Electric Vehicle Gar. (24 hrs)
81	4-4'T8,RW, Tandem Kit	1	Work Bench
82	2-4'T8,STD,(2)CMS	8	Sub Station Office
83	2-4;T8,RW	1	Office
84	2-4'T8,RW	2	Office
85	2-4'T8,STD,(1)WMS	2	Electric Panel Room
86	2-4'T8,STD,(1)WMS	1	Electric Panel Room (24 hrs)
87	2-4'T8,STD,(1)CMS	4	Electric Foreman Office
88	2-4'T8,RW,(1)WMS	1	Build & Ground Office
89	2-4'T8,STD	7	Purchasing & Receiving Office
90	Downlight 26W CFL RF1	4	Purchasing & Receiving Office
91	2-4'T8,STD	6	Water Service Foreman
92	2-4'T8,STD,(1)WMS	2	Crew Lounge
93	Sportlite GX 400 (4-42W CFLs)	5	Water Vehicle Garage
94	Sportlite GX 400 (4-42W CFLs)	2	Water Vehicle Garage (24 hrs)
95	4-4'T8,STD, Tandem Kit	8	Vehicle Maint. Shop
96	2-4'T8,RW	7	Vehicle Maint. Shop
97	2-4'T8,RW	2	Vehicle Maint. Shop (24 hrs)
98	2-4'T8,STD,(1)WMS	1	Rest Rooms
99	4-4'T8,STD, Tandem Kit	2	Generator Room
100	2-4'T8,RW	7	Generator Room
101	4-'4'T8'STD, Tandem Kit	49	Warehouse
102	4-'4'T8'STD, Tandem Kit	8	Warehouse (24 hrs)
103	1-3W LED Kit	29	Exist Signs (24 hrs)
			Exterior (Ameresco measures)
104	Photo cell	6	Entrance & Front Eve
105	Photo cell, Elec. Blst. For 2-13W	7	Entrance & Front Eve
106	Photo cell	5	E. Side Par Polese
107	Photo cell	2	Wall Pack
108	Photo cell	3	North Side Wall Shoe
109	Photo cell	2	West Side Par Poles
110	Photo cell	3	Wall Pack
Total		**543**	

Note: EB = Electronic Ballast

Verified Efficiency Improvement: Based on site inspections, the following energy efficiency improvements were made under this project at Site #10.

Table 2. Verified Efficiency Improvements at TDPUD Site #10

Measure	Description	Qty.	Location
1	2-4'T8,RW	3	Entry
2	2-4'T8,RW	1	Entry (24 hrs)
3	2-'4'T8,RW,RFL	7	Lobby
4	2-'4'T8,RW,RFL	3	Lobby (24 hrs)
5	Rec. Cans 2-13W CFL-EB	2	Lobby CFLs
6	2-'4'T8,RW	20	Town of Truckee Offices
7	2-'4'T8,RW	1	Town of Truckee Offices
8	2-2'UT8,RW	1	Town of Truckee Offices
9	2-'4'T8,RW	2	Town of Truckee Offices (24 hrs)
10	2-'4'T8,RW,RFL	1	Lobby
11	2-2'UT8,RW	1	Lobby
12	2-4'T8,RW,(1)WMS	4	Town of Truckee Offices (2)
13	2-4'T8,RW	8	Computer Room
14	2-4'T8,RW,(1)WMS	1	Closet
15	2-4'T8,STD	3	Telephone Equip. Rm.
16	2-4'T8,RW,(2)WMS	4	Rest Rooms
17	1-4'T8,RW	2	Rest Rooms
18	2-4'T8,STD,RFL(1)WMS	5	Conference Rooms
19	2-4'T8,STD,RFL(1)WMS	1	Conference Rooms (24 hrs)
20	2-4'T8,STD,RFL	19	Customer Service Room
21	2-4'T8,STD,RFL	5	Customer Service Room (24 hrs)
22	Rec. Cans 2-13W CFL-EB	3	Customer Service Room CFLs
23	2-4'T8,RW,(1)WMS	1	Copy Room
24	2-4'T8,RW	5	Computer Work Area
25	2-4'T8,RW	1	Computer Work Area (24 hrs)
26	2-4'T8,STD,RFL,(1)WMS	5	West Conference Room
27	2-4'T8,STD,RFL,(1)WMS	1	West Conference Room (24 hrs)
28	2-4'T8,RW,(1)WMS	8	Mail/Copy Room
29	2-4'T8,RW,(1)WMS	1	Mail/Copy Room (24 hrs)
30	2-4'T8,RW	3	Hall to Boardroom
31	2-4'T8,RW	2	Hall to Boardroom (24 hrs)
32	2-4'T8,STD,RFL,(2)WMS	8	Kitchen/Lunch Room
33	2-4'T8,STD,RFL,(2)WMS	2	Kitchen/Lunch Room (24 hrs)
34	NO ACCESS	0	Vault
35	2-4'T8,RW,(1)WMS	2	Mens Room
36	2-4'T8,RW,(1)WMS	1	Mens Room (24 hrs)
37	1-4'T8,RW	1	Mens Room
38	Rec. Cans 2-13W CFL-EB	1	Mens Room CFLs
39	2-4'T8,RW,(1)WMS	2	Locker Room
40	2-4'T8,RW,(1)WMS	3	Exercise Room
41	2-4'T8,RW,(2)WMS	2	Womens Rest Room
42	2-4'T8,RW,(2)WMS	1	Womens Rest Room (24 hrs)
43	1-4'T8,RW	1	Womens Rest Room
44	Rec. Cans 2-13W CFL-EB	1	Womens Rest Room CFLs
45	2-4'T8,RW,(1)WMS	5	Board Conf. Room
46	2-4'T8,RW,(1)WMS	1	Board Conf. Room (24 hrs)
47	2-4'T8,STD,RFL	4	Board Room
48	2-4'T8,STD,RFL	1	Board Room (24 hrs)
49	Rec. Cans 2-13W CFL-EB	22	Board Room CFLs
50	2-4'T8,RW,(1)WMS	2	Board Room Closet
51	1-4'T8,RW	17	Board Room Soffet
52	1-2'T8,RW	2	Board Room Soffet
53	1-4'T8,RW	2	Elevator Equip. Room
54	1-4'T8,RW	3	Elec. Room Closets
			2nd Floor
55	2-4'T8,RW	1	Stair Well (24 hrs)
56	2-4'T8,RW	2	Back Stair Well (24 hrs)

Table 2. Verified Efficiency Improvements at TDPUD Site #10

Measure	Description	Qty.	Location
57	4-4'T8,RW	1	Back Stair Well (24 hrs)
58	2-4'T8,STD,RFL	5	Elect. Dept. Office #1
59	2-4'T8,STD,RFL	1	Elect. Dept. Office #1 (24 hrs)
60	2-4'T8,STD,RFL	6	Elect. Dept. Office #2
61	CFL 26W PAR	2	Elect. Dept. Office #2
62	2-4'T8,RW,(2)WMS	4	Rest Rooms
63	1-4'T8,RW	2	Rest Rooms
64	2-4'T8,RW, NO RFL	2	Hall
65	2-4'T8,RW, NO RFL	1	Hall (24 hrs)
66	2-4'T8,RW	1	Hall
67	2-4'T8,RW	1	Hall (24 hrs)
68	2-4'T8,RW	2	Boiler Room
69	1-4'T8,RW,Kit	4	Hall
70	1-4'T8,RW,Kit	3	Hall (24 hrs)
71	2-4'T8,STD,RFL	27	Town Offices
72	2-4'T8,STD,RFL	3	Town Offices (24 hrs)
73	2-4'T8,STD,RFL	52	Common Area
74	2-4'T8,STD,RFL	10	Common Area (24 hrs)
75	2-2'UT8,RW	1	Common Area
76	2-4'T8,RW	1	Elevator (24 hrs)
77	Sportlite GX400 (4-42W CFLs)	5	Hall Between Bldgs.
78	Sportlite GX400 (4-42W CFLs)	3	Hall Between Bldgs. (24 hrs)
79	Sportlite GX400 (4-42W CFLs)	7	Electric Vehicle Gar.
80	Sportlite GX400 (4-42W CFLs)	1	Electric Vehicle Gar. (24 hrs)
81	4-4'T8,RW, Tandem	1	Work Bench
82	2-4'T8,STD,(2)CMS	8	Sub Station Office
83	2-4;T8,RW	1	Office
84	2-4'T8,RW	2	Office
85	2-4'T8,STD,(1)WMS	2	Electric Panel Room
86	2-4'T8,STD,(1)WMS	1	Electric Panel Room (24 hrs)
87	2-4'T8,STD,(1)CMS	4	Electric Foreman Office
88	2-4'T8,RW,(1)WMS	1	Build & Ground Office
89	2-4'T8,STD	7	Purchasing & Receiving Office
90	Downlight 26W CFL RF1	4	Purchasing & Receiving Office
91	2-4'T8,STD	6	Water Service Foreman
92	2-4'T8,STD,(1)WMS	2	Crew Lounge
93	Sportlite GX400 (4-42W CFLs)	5	Water Vehicle Garage
94	Sportlite GX400 (4-42W CFLs)	2	Water Vehicle Garage (24 hrs)
95	4-4'T8,STD, Tandem Kit	8	Vehicle Maint. Shop
96	2-4'T8,RW	7	Vehicle Maint. Shop
97	2-4'T8,RW	2	Vehicle Maint. Shop (24 hrs)
98	2-4'T8,STD,(1)WMS	1	Rest Rooms
99	4-4'T8,STD, Tandem Kit	2	Generator Room
100	2-4'T8,RW	7	Generator Room
101	4-'4'T8'STD,Tandem Kit	49	Warehouse
102	4-'4'T8'STD,Tandem Kit	8	Warehouse (24 hrs)
103	1-3W LED KIT	29	Exist Signs (24 hrs)
			Exterior
104	Photo cell	6	Entrance & Front Eve
105	Photo cell and Elec. Ballasts	7	Entrance & Front Eve
106	Photo cell	5	E. Side Par Polese
107	Photo cell	2	Wall Pack
108	Photo cell	3	North Side Wall Shoe
109	Photo cell	2	West Side Par Poles
110	Photo cell	3	Wall Pack
Total		**543**	

Pre-Installation Conditions: Based on site inspections and review of old fixtures, each site had the following pre-installation configurations and operating hours.

Table 3. Pre-Installation, Watts and Hours of Operation for TDPUD Site #10

Measure	Description	Qty.	Hours/yr	W/fixture	Location
1	2-4'T12,SL,ESB	3	2,935	72	Entry
2	2-4'T12,SL,ESB	1	8,760	72	Entry (24 hrs)
3	3-4'T12,SL,ESB	7	2,935	115	Lobby
4	3-4'T12,SL,ESB	3	8,760	115	Lobby (24 hrs)
5	Rec. 2-13W CFL MB	2	2,935	36	Lobby CFLs
6	2-4'T12,SL,ESB	20	1,761	72	Town of Truckee Offices
7	3-4'T12,SL,ESB	1	1,761	115	Town of Truckee Offices
8	Trfr,2-2'UT12,SL,ESB	1	1,761	72	Town of Truckee Offices
9	2-4'T12,SL,ESB	2	8,760	72	Town of Truckee Offices (24 hrs)
10	3-4'T12,SL,ESB	1	2,935	115	Lobby
11	Trfr,2-2'UT12,SL,ESB	1	2,935	72	Lobby
12	2-4'T12,SL,ESB	4	2,935	72	Town of Truckee Offices (2)
13	2-4'T12,SL,ESB	8	2,935	72	Computer Room
14	Wrp,2-4'T12,SL,ESB	1	981	72	Closet
15	Wrp,4-4'T12,SL,ESB	3	2,155	144	Telephone Equip. Rm.
16	Wrp,2-4'T12,SL,ESB	4	2,935	72	Rest Rooms
17	Vanity,1-4'T12,SL,ESB	2	2,935	72	Rest Rooms
18	3-4'T12,SL,ESB	5	981	115	Conference Rooms
19	3-4'T12,SL,ESB	1	8,760	115	Conference Rooms (24 hrs)
20	3-4'T12,SL,ESB	19	2,935	115	Customer Service Room
21	3-4'T12,SL,ESB	5	8,760	115	Customer Service Room (24 hrs)
22	Rec. 2-13W CFL MB	3	2,935	36	Customer Service Room CFLs
23	Strp,2-4'T12,SL,ESB	1	2,935	72	Copy Room
24	2-4'T12,SL,ESB	5	2,935	72	Computer Work Area
25	2-4'T12,SL,ESB	1	8,760	72	Computer Work Area (24 hrs)
26	3-4'T12,SL,ESB	5	2,935	115	West Conference Room
27	3-4'T12,SL,ESB	1	8,760	115	West Conference Room (24 hrs)
28	2-4'T12,SL,ESB	8	2,935	72	Mail/Copy Room
29	2-4'T12,SL,ESB	1	8,760	72	Mail/Copy Room (24 hrs)
30	2-4'T12,SL,ESB	3	2,935	72	Hall to Boardroom
31	2-4'T12,SL,ESB	2	8,760	72	Hall to Boardroom (24 hrs)
32	Board Room	8	2,935	144	Kitchen/Lunch Room
33	Trfr,4-4'T12,SL,ESB	2	8,760	144	Kitchen/Lunch Room (24 hrs)
34	NO ACCESS	0	2,935	0	Vault
35	Wrp,2-4'T12,SL,ESB	2	2,935	72	Mens Room
36	Wrp,2-4'T12,SL,ESB	1	8,760	72	Mens Room (24 hrs)
37	Vanity,1-4'T12,SL,ESB	1	2,935	43	Mens Room
38	Rec. 2-13W CFL MB	1	2,935	36	Mens Room CFLs
39	Wrp,2-4'T12,SL,ESB	2	2,935	72	Locker Room
40	Strp,2-4'T12,SL,ESB	3	1,761	72	Exercise Room
41	Wrp,2-4'T12,SL,ESB	2	2,935	72	Womens Rest Room
42	Wrp,2-4'T12,SL,ESB	1	8,760	72	Womens Rest Room (24 hrs)
43	Vanity,1-4'T12,SL,ESB	1	2,935	43	Womens Rest Room
44	Rec. 2-13W CFL MB	1	2,935	36	Womens Rest Room CFLs
45	2-4'T12,SL,ESB	5	981	73	Board Conf. Room
46	2-4'T12,SL,ESB	1	8,760	73	Board Conf. Room (24 hrs)
47	3-4'T12,SL,ESB	4	981	115	Board Room
48	3-4'T12,SL,ESB	1	8,760	115	Board Room (24 hrs)
49	Rec. 2-13W CFL MB	22	981	36	Board Room CFLs
50	Wrp,2-4'T12,SL,ESB	2	981	73	Board Room Closet
51	Strp,1-4'T12,SL,ESB	17	981	43	Board Room Soffet
52	Strp,1-2'T12,SL,SB	2	981	28	Board Room Soffet
53	Strp,2-4'T12,SL,ESB	2	250	72	Elevator Equip. Room
54	Strp,2-4'T12,SL,ESB	3	250	72	Elec. Room Closets
			0		2nd Floor
55	Wrp,2-4'T12,SL,ESB	1	8,760	72	Stair Well (24 hrs)
56	Wrp,2-4'T12,SL,ESB	2	8,760	72	Back Stair Well (24 hrs)
57	Wrp,4-4'T12,SL,ESB	1	8,760	144	Back Stair Well (24 hrs)
58	Trfr,4-4'T12,SL,ESB	5	2,948	144	Elect. Dept. Office #1
59	Trfr,4-4'T12,SL,ESB	1	8,760	144	Elect. Dept. Office #1 (24 hrs)
60	Trfr,4-4'T12,SL,ESB	6	2,948	144	Elect. Dept. Office #2
61	Rec. Can 65W PAR	2	2,948	65	Elect. Dept. Office #2
62	Wrp,2-4'T12,SL,ESB	4	2,948	72	Rest Rooms

Table 3. Pre-Installation, Watts and Hours of Operation for TDPUD Site #10

Measure	Description	Qty.	Hours/yr	W/fixture	Location
63	Vanity,1-4'T12,SL,ESB	2	2,948	72	Rest Rooms
64	Trfr,4-4'T12,SL,ESB	2	2,948	144	Hall
65	Trfr,4-4'T12,SL,ESB	1	8,760	144	Hall (24 hrs)
66	Wrp,2-4'T12,SL,ESB	1	2,948	144	Hall
67	Wrp,2-4'T12,SL,ESB	1	8,760	144	Hall (24 hrs)
68	Strp,2-4'T12,SL,ESB	2	250	72	Boiler Room
69	Strp,2-4'T12,SL,ESB	4	2,948	72	Hall
70	Strp,2-4'T12,SL,ESB	3	8,760	72	Hall (24 hrs)
71	Trfr,4-4'T12,SL,ESB	27	2,948	144	Town Offices
72	Trfr,4-4'T12,SL,ESB	3	8,760	144	Town Offices (24 hrs)
73	Trfr,4-4'T12,SL,ESB	52	2,948	144	Common Area
74	Trfr,4-4'T12,SL,ESB	10	8,760	144	Common Area (24 hrs)
75	Trfr,2-2'UT12,SL,ESB	1	2,948	72	Common Area
76	Strp,2-4'T12,SL,ESB	1	8,760	72	Elevator (24 hrs)
					Warehouse, Vehicle, Offices
77	Downlt MH295W	5	2,155	295	Hall Between Bldgs.
78	Downlt MH295W	3	8,760	295	Hall Between Bldgs. (24 hrs)
79	M.H. 1-400	7	1,927	295	Electric Vehicle Gar.
80	M.H. 1-400	1	8,760	295	Electric Vehicle Gar. (24 hrs)
81	Strip,2-8'ESL,ESB	1	1,927	215	Work Bench
82	Wrp,4-4'T12,SL,ESB	8	2,155	144	Sub Station Office
83	Wrp,4-4'T12,SL,ESB	1	2,155	144	Office
84	Wrp,2-4'T12,SL,ESB	2	2,155	72	Office
85	Wrp,2-4'T12,SL,ESB	2	2,155	72	Electric Panel Room
86	Wrp,2-4'T12,SL,ESB	1	8,760	72	Electric Panel Room (24 hrs)
87	Wrp,4-4'T12,SL,ESB	4	2,155	115	Electric Foreman Office
88	Strp,2-4'T12,SL,ESB	1	2,155	72	Build & Ground Office
89	Wrp,3-4'T12,SL,ESB	7	2,155	115	Purchasing & Receiving Office
90	Rec. 85W PAR	4	2,155	85	Purchasing & Receiving Office
91	Wrp,3-4'T12,SL,ESB	6	2,155	115	Water Service Foreman
92	Wrp,3-4'T12,SL,ESB	2	8,760	115	Crew Lounge
93	M.H. 1-400	5	2,155	295	Water Vehicle Garage
94	M.H. 1-400	2	8,760	295	Water Vehicle Garage (24 hrs)
95	Strip,2-8'HO	8	2,155	123	Vehicle Maint. Shop
96	Strp,2-4'T12,SL,ESB	7	2,155	72	Vehicle Maint. Shop
97	Strp,2-4'T12,SL,ESB	2	8,760	72	Vehicle Maint. Shop (24 hrs)
98	Wrp,3-4'T12,SL,ESB	1	2,155	115	Rest Rooms
99	Strp,2-8'HO	2	2,155	207	Generator Room
100	Strp,2-4'T12,SL,ESB	7	2,155	73	Generator Room
101	Strip,2-8'HO	49	2,155	215	Warehouse
102	Strip,2-8'HO	8	8,760	215	Warehouse (24 hrs)
103	2-20 INC	29	8,760	20	Exist Signs (24 hrs)
					Exterior
104	Rec. 1-70W MH	6	4,732	85	Entrance & Front Eve
105	Rec. 2-13W CFL MB	7	4,732	36	Entrance & Front Eve
106	1-400W HPS	5	4,732	465	E. Side Par Polese
107	1-250 HPS	2	4,732	265	Wall Pack
108	1-400 HPS	3	4,732	465	North Side Wall Shoe
109	1-400 HPS	2	4,732	465	West Side Par Poles
110	1-400 HPS	3	4,732	465	Wall Pack
Total		**543**			

Primary Business Descriptions: Site #10 consists of office space, conference rooms, boardroom, hallways, restrooms, locker room, kitchen/cafeteria, warehouse storage, and vehicle maintenance areas.

Variability in Schedule and Production: Discussions were held with maintenance personnel at the building and ten lighting loggers were installed to evaluate and measure lighting hours of use. These hours are reflected in the lighting surveys for the pre-installation and as-built conditions.

Algorithms for Estimating Energy Savings for Paid Measure

Algorithms for estimating kW and kWh savings for each measure are based on pre-installation fixture wattages and hours of operation (obtained from maintenance personnel). The following spreadsheets provide ex-ante kW and kWh savings for each building. The general equations for calculating kW and kWh savings are as follows.

$$\text{kW Savings} = (kW_{pre} - kW_{post}) \times Number_{fixtures}$$

$$\text{kWh Savings} = (kW_{pre} - kW_{post}) \times hours/year \times Number_{fixtures}$$

Table 4. M&V Savings for TDPUD Site #10

#	Pre-retrofit	Qty	Hrs	W/Fix	kW	kWh	Post-retrofit	Qty	Hrs	W/Fix	kW	kWh	kW Savings	kWh Savings
1	2-4'T12,SL,ESB	3	2,935	72	0.22	634	2-4'T8,RW	3	2,935	59	0.18	519	0.04	115
2	2-4'T12,SL,ESB	1	8,760	72	0.07	631	2-4'T8,RW	1	8,760	59	0.06	517	0.01	114
3	3-4'T12,SL,ESB	7	2,935	115	0.81	2,363	2-'4'T8,RW,RFL	7	2,935	59	0.41	1,212	0.40	1,151
4	3-4'T12,SL,ESB	3	8,760	115	0.35	3,022	2-'4'T8,RW,RFL	3	8,760	59	0.18	1,551	0.17	1,471
5	Rec. 2-13W CFL MB	2	2,935	36	0.07	211	Rec. Cans 2-13W CFL-EB	2	2,935	26	0.05	153	0.02	58
6	2-4'T12,SL,ESB	20	1,761	72	1.44	2,536	2-'4'T8,RW	20	1,761	59	1.18	2,078	0.26	458
7	3-4'T12,SL,ESB	1	1,761	115	0.12	203	2-'4'T8,RW	1	1,761	59	0.06	104	0.06	99
8	Trfr,2-2'UT12,SL,ESB	1	1,761	72	0.07	127	2-2'UT8,RW	1	1,761	59	0.06	104	0.01	23
9	2-4'T12,SL,ESB	2	8,760	72	0.14	1,261	2-'4'T8,RW	2	8,760	59	0.12	1,034	0.02	227
10	3-4'T12,SL,ESB	1	2,935	115	0.12	338	2-'4'T8,RW,RFL	1	2,935	59	0.06	173	0.06	165
11	Trfr,2-2'UT12,SL,ESB	1	2,935	72	0.07	211	2-2'UT8,RW	1	2,935	59	0.06	173	0.01	38
12	2-4'T12,SL,ESB	4	2,935	72	0.29	845	2-4'T8,RW,(1)WMS	4	2,935	59	0.24	693	0.05	152
13	2-4'T12,SL,ESB	8	2,935	72	0.58	1,691	2-4'T8,RW	8	2,935	59	0.47	1,385	0.11	306
14	Wrp,2-4'T12,SL,ESB	1	981	72	0.07	71	2-4'T8,RW,(1)WMS	1	981	59	0.06	58	0.01	13
15	Wrp,4-4'T12,SL,ESB	3	2,155	144	0.43	931	2-4'T8,STD	3	2,155	59	0.18	381	0.25	550
16	Wrp,2-4'T12,SL,ESB	4	2,935	72	0.29	845	2-4'T8,RW,(2)WMS	4	2,935	59	0.24	693	0.05	152
17	Vanity,1-4'T12,SL,ESB	2	2,935	72	0.14	423	1-4'T8,RW	2	2,935	31	0.06	182	0.08	241
18	3-4'T12,SL,ESB	5	981	115	0.58	564	2-4'T8,STD,RFL(1)WMS	5	981	59	0.3	289	0.28	275
19	3-4'T12,SL,ESB	1	8,760	115	0.12	1,007	2-4'T8,STD,RFL(1)WMS	1	8,760	59	0.06	517	0.06	490
20	3-4'T12,SL,ESB	19	2,935	115	2.19	6,413	2-4'T8,STD,RFL	19	2,935	59	1.12	3,290	1.07	3,123
21	3-4'T12,SL,ESB	5	8,760	115	0.58	5,037	2-4'T8,STD,RFL	5	8,760	59	0.3	2,584	0.28	2,453
22	Rec. 2-13W CFL MB	3	2,935	36	0.11	317	Rec. Cans 2-13W CFL-EB	3	2,935	26	0.08	229	0.03	88
23	Strp,2-4'T12,SL,ESB	1	2,935	72	0.07	211	2-4'T8,RW,(1)WMS	1	2,935	59	0.06	173	0.01	38
24	2-4'T12,SL,ESB	5	2,935	72	0.36	1,057	2-4'T8,RW	5	2,935	59	0.3	866	0.06	191
25	2-4'T12,SL,ESB	1	8,760	72	0.07	631	2-4'T8,RW	1	8,760	59	0.06	517	0.01	114
26	3-4'T12,SL,ESB	5	2,935	115	0.58	1,688	2-	5	2,935	59	0.3	866	0.28	822

Table 4. M&V Savings for TDPUD Site #10

#	Pre-retrofit	Qty	Hrs	W/Fix	kW	kWh	Post-retrofit	Qty	Hrs	W/Fix	kW	kWh	kW Savings	kWh Savings
							4'T8,STD,RFL,(1)WMS							
27	3-4'T12,SL,ESB	1	8,760	115	0.12	1,007	2-4'T8,STD,RFL,(1)WMS	1	8,760	59	0.06	517	0.06	490
28	2-4'T12,SL,ESB	8	2,935	72	0.58	1,691	2-4'T8,RW,(1)WMS	8	2,935	59	0.47	1,385	0.11	306
29	2-4'T12,SL,ESB	1	8,760	72	0.07	631	2-4'T8,RW,(1)WMS	1	8,760	59	0.06	517	0.01	114
30	2-4'T12,SL,ESB	3	2,935	72	0.22	634	2-4'T8,RW	3	2,935	59	0.18	519	0.04	115
31	2-4'T12,SL,ESB	2	8,760	72	0.14	1,261	2-4'T8,RW	2	8,760	59	0.12	1,034	0.02	227
32	Board Room	8	2,935	144	1.15	3,381	2-4'T8,STD,RFL,(2)WMS	8	2,935	59	0.47	1,385	0.68	1,996
33	Trfr,4-4'T12,SL,ESB	2	8,760	144	0.29	2,523	2-4'T8,STD,RFL,(2)WMS	2	8,760	59	0.12	1,034	0.17	1,489
34	NO ACCESS												0.00	0
35	Wrp,2-4'T12,SL,ESB	2	2,935	72	0.14	423	2-4'T8,RW,(1)WMS	2	2,935	59	0.12	346	0.02	77
36	Wrp,2-4'T12,SL,ESB	1	8,760	72	0.07	631	2-4'T8,RW,(1)WMS	1	8,760	59	0.06	517	0.01	114
37	Vanity,1-4'T12,SL,ESB	1	2,935	43	0.04	126	1-4'T8,RW	1	2,935	31	0.03	91	0.01	35
38	Rec. 2-13W CFL MB	1	2,935	36	0.04	106	Rec. Cans 2-13W CFL-EB	1	2,935	26	0.03	76	0.01	30
39	Wrp,2-4'T12,SL,ESB	2	2,935	72	0.14	423	2-4'T8,RW,(1)WMS	2	2,935	59	0.12	346	0.02	77
40	Strp,2-4'T12,SL,ESB	3	1,761	72	0.22	380	2-4'T8,RW,(1)WMS	3	1,761	28	0.08	148	0.14	232
41	Wrp,2-4'T12,SL,ESB	2	2,935	72	0.14	423	2-4'T8,RW,(2)WMS	2	2,935	59	0.12	346	0.02	77
42	Wrp,2-4'T12,SL,ESB	1	8,760	72	0.07	631	2-4'T8,RW,(2)WMS	1	8,760	59	0.06	517	0.01	114
43	Vanity,1-4'T12,SL,ESB	1	2,935	43	0.04	126	1-4'T8,RW	1	2,935	31	0.03	91	0.01	35
44	Rec. 2-13W CFL MB	1	2,935	36	0.04	106	Rec. Cans 2-13W CFL-EB	1	2,935	26	0.03	76	0.01	30
45	2-4'T12,SL,ESB	5	981	73	0.37	358	2-4'T8,RW,(1)WMS	5	981	59	0.3	289	0.07	69
46	2-4'T12,SL,ESB	1	8,760	73	0.07	639	2-4'T8,RW,(1)WMS	1	8,760	59	0.06	517	0.01	122
47	3-4'T12,SL,ESB	4	981	115	0.46	451	2-4'T8,STD,RFL	4	981	59	0.24	232	0.22	219
48	3-4'T12,SL,ESB	1	8,760	115	0.12	1,007	2-4'T8,STD,RFL	1	8,760	59	0.06	517	0.06	490
49	Rec. 2-13W CFL MB	22	981	36	0.79	777	Rec. Cans 2-13W CFL-EB	22	981	26	0.57	561	0.22	216
50	Wrp,2-4'T12,SL,ESB	2	981	73	0.15	143	2-4'T8,RW,(1)WMS	2	981	59	0.12	116	0.03	27
51	Strp,1-4'T12,SL,ESB	17	981	43	0.73	717	1-4'T8,RW	17	981	31	0.53	517	0.20	200
52	Strp,1-2'T12,SL,SB	2	981	28	0.06	55	1-2'T8,RW	2	981	17	0.03	33	0.03	22
53	Strp,2-4'T12,SL,ESB	2	250	72	0.14	36	1-4'T8,RW	2	250	31	0.06	16	0.08	20
54	Strp,2-4'T12,SL,ESB	3	250	72	0.22	54	1-4'T8,RW	3	250	31	0.09	23	0.13	31
	2nd Floor												0.00	0
55	Wrp,2-4'T12,SL,ESB	1	8,760	72	0.07	631	2-4'T8,RW	1	8,760	59	0.06	517	0.01	114
56	Wrp,2-4'T12,SL,ESB	2	8,760	72	0.14	1,261	2-4'T8,RW	2	8,760	59	0.12	1,034	0.02	227

Table 4. M&V Savings for TDPUD Site #10

#	Pre-retrofit	Qty	Hrs	W/Fix	kW	kWh	Post-retrofit	Qty	Hrs	W/Fix	kW	kWh	kW Savings	kWh Savings
57	Wrp,4-4'T12,SL,ESB	1	8,760	144	0.14	1,261	4-4'T8,RW	1	8,760	112	0.11	981	0.03	280
58	Trfr,4-4'T12,SL,ESB	5	2,948	144	0.72	2,123	2-4'T8,STD,RFL	5	2,948	59	0.3	870	0.42	1,253
59	Trfr,4-4'T12,SL,ESB	1	8,760	144	0.14	1,261	2-4'T8,STD,RFL	1	8,760	59	0.06	517	0.08	744
60	Trfr,4-4'T12,SL,ESB	6	2,948	144	0.86	2,547	2-4'T8,STD,RFL	6	2,948	59	0.35	1,044	0.51	1,503
61	Rec. Can 65W PAR	2	2,948	65	0.13	383	CFL 26W PAR	2	2,948	26	0.05	153	0.08	230
62	Wrp,2-4'T12,SL,ESB	4	2,948	72	0.29	849	2-4'T8,RW,(2)WMS	4	2,948	59	0.24	696	0.05	153
63	Vanity,1-4'T12,SL,ESB	2	2,948	72	0.14	425	1-4'T8,RW	2	2,948	31	0.06	183	0.08	242
64	Trfr,4-4'T12,SL,ESB	2	2,948	144	0.29	849	2-4'T8,RW, NO RFL	2	2,948	59	0.12	348	0.17	501
65	Trfr,4-4'T12,SL,ESB	1	8,760	144	0.14	1,261	2-4'T8,RW, NO RFL	1	8,760	59	0.06	517	0.08	744
66	Wrp,2-4'T12,SL,ESB	1	2,948	144	0.14	425	2-4'T8,RW	1	2,948	59	0.06	174	0.08	251
67	Wrp,2-4'T12,SL,ESB	1	8,760	144	0.14	1,261	2-4'T8,RW	1	8,760	59	0.06	517	0.08	744
68	Strp,2-4'T12,SL,ESB	2	250	72	0.14	36	2-4'T8,RW	2	250	59	0.12	30	0.02	6
69	Strp,2-4'T12,SL,ESB	4	2,948	72	0.29	849	1-4'T8,RW,Kit	4	2,948	31	0.12	366	0.17	483
70	Strp,2-4'T12,SL,ESB	3	8,760	72	0.22	1,892	1-4'T8,RW,Kit	3	8,760	31	0.09	815	0.13	1,077
71	Trfr,4-4'T12,SL,ESB	27	2,948	144	3.89	11,462	2-4'T8,STD,RFL	27	2,948	59	1.59	4,696	2.30	6,766
72	Trfr,4-4'T12,SL,ESB	3	8,760	144	0.43	3,784	2-4'T8,STD,RFL	3	8,760	59	0.18	1,551	0.25	2,233
73	Trfr,4-4'T12,SL,ESB	52	2,948	144	7.49	22,075	2-4'T8,STD,RFL	52	2,948	59	3.07	9,044	4.42	13,031
74	Trfr,4-4'T12,SL,ESB	10	8,760	144	1.44	12,614	2-4'T8,STD,RFL	10	8,760	59	0.59	5,168	0.85	7,446
75	Trfr,2-2'UT12,SL,ESB	1	2,948	72	0.07	212	2-2'UT8,RW	1	2,948	59	0.06	174	0.01	38
76	Strp,2-4'T12,SL,ESB	1	8,760	72	0.07	631	2-4'T8,RW	1	8,760	59	0.06	517	0.01	114
	Warehouse												0.00	0
77	Downlt MH295W	5	2,155	295	1.48	3,179	Sportlite GX400 (4-42W CFLs)	5	2,860	150	0.75	2,145	0.73	1,034
78	Downlt MH295W	3	8,760	295	0.89	7,753	Sportlite GX400 (4-42W CFLs)	3	2,860	150	0.45	1,287	0.44	6,466
79	M.H. 1-400	7	1,927	295	2.07	3,979	Sportlite GX400 (4-42W CFLs)	7	1,927	150	1.05	2,023	1.02	1,956
80	M.H. 1-400	1	8,760	295	0.3	2,584	Sportlite GX400 (4-42W CFLs)	1	8,760	150	0.15	1,314	0.15	1,270
81	Strp,2-8'ESL,ESB	1	1,927	215	0.22	414	4-4'T8,RW, Tandem	1	1,927	112	0.11	216	0.11	198
82	Wrp,4-4'T12,SL,ESB	8	2,155	144	1.15	2,483	2-4'T8,STD,(2)CMS	8	2,155	59	0.47	1,017	0.68	1,466
83	Wrp,4-4'T12,SL,ESB	1	2,155	144	0.14	310	2-4;T8,RW	1	2,155	59	0.06	127	0.08	183
84	Wrp,2-4'T12,SL,ESB	2	2,155	72	0.14	310	2-4'T8,RW	2	2,155	59	0.12	254	0.02	56
85	Wrp,2-4'T12,SL,ESB	2	2,155	72	0.14	310	2-4'T8,STD,(1)WMS	2	2,155	59	0.12	254	0.02	56
86	Wrp,2-4'T12,SL,ESB	1	8,760	72	0.07	631	2-4'T8,STD,(1)WMS	1	8,760	59	0.06	517	0.01	114
87	Wrp,4-4'T12,SL,ESB	4	2,155	115	0.46	991	2-4'T8,STD,(1)CMS	4	2,155	59	0.24	509	0.22	482
88	Strp,2-4'T12,SL,ESB	1	2,155	72	0.07	155	2-4'T8,RW,(1)WMS	1	2,155	59	0.06	127	0.01	28
89	Wrp,3-	7	2,155	115	0.81	1,735	2-4'T8,STD	7	2,155	59	0.41	890	0.40	845

Table 4. M&V Savings for TDPUD Site #10

#	Pre-retrofit	Qty	Hrs	W/Fix	kW	kWh	Post-retrofit	Qty	Hrs	W/Fix	kW	kWh	kW Savings	kWh Savings
	4'T12,SL,ESB													
90	Rec. 85W PAR	4	2,155	85	0.34	733	Downlight 26W CFL RF1	4	2,155	26	0.1	224	0.24	509
91	Wrp,3-4'T12,SL,ESB	6	2,155	115	0.69	1,487	2-4'T8,STD	6	2,155	32	0.19	414	0.50	1,073
92	Wrp,3-4'T12,SL,ESB	2	8,760	115	0.23	2,015	2-4'T8,STD,(1)WMS	2	8,760	59	0.12	1,034	0.11	981
93	M.H. 1-400	5	2,155	295	1.48	3,179	Sportlite GX400 (4-42W CFLs)	5	2,155	150	0.75	1,616	0.73	1,563
94	M.H. 1-400	2	8,760	295	0.59	5,168	Sportlite GX400 (4-42W CFLs)	2	8,760	150	0.3	2,628	0.29	2,540
95	Strp,2-8'HO	8	2,155	123	0.98	2,121	4-4'T8,STD, Tandem Kit	8	2,155	112	0.9	1,931	0.08	190
96	Strp,2-4'T12,SL,ESB	7	2,155	72	0.5	1,086	2-4'T8,RW	7	2,155	59	0.41	890	0.09	196
97	Strp,2-4'T12,SL,ESB	2	8,760	72	0.14	1,261	2-4'T8,RW	2	8,760	59	0.12	1,034	0.02	227
98	Wrp,3-4'T12,SL,ESB	1	2,155	115	0.12	248	2-4'T8,STD,(1)WMS	1	2,155	59	0.06	127	0.06	121
99	Strp,2-8'HO	2	2,155	207	0.41	892	4-4'T8,STD, Tandem Kit	2	2,155	112	0.22	483	0.19	409
100	Strp,2-4'T12,SL,ESB	7	2,155	73	0.51	1,101	2-4'T8,RW	7	2,155	59	0.41	890	0.10	211
101	Strp,2-8'HO	49	2,155	215	10.5	22,703	4-'4'T8'STD,Tandem Kit	49	2,155	112	5.49	11,827	5.01	10,876
102	Strp,2-8'HO	8	8,760	215	1.72	15,067	4-'4'T8'STD,Tandem Kit	8	8,760	112	0.9	7,849	0.82	7,218
103	2-20 INC	29	8,760	20	0.58	5,081	1-3W LED KIT	29	8,760	3	0.09	762	0.49	4,319
	Exterior												0.00	0
104	Rec. 1-70W MH	6	4,732	85	0.51	2,413	Photo cell	6	4,259	85	0.51	2,172	0.00	241
105	Rec. 2-13W CFL MB	7	4,732	36	0.25	1,192	Photo cell and Elec. Ballasts	7	4,259	26	0.09	388	0.16	804
106	1-400W HPS	5	4,732	465	2.33	11,002	Photo cell	5	4,259	465	2.33	9,902	0.00	1,100
107	1-250 HPS	2	4,732	265	0.53	2,508	Photo cell	2	4,259	265	0.53	2,257	0.00	251
108	1-400 HPS	3	4,732	465	1.4	6,601	Photo cell	3	4,259	465	1.4	5,941	0.00	660
109	1-400 HPS	2	4,732	465	0.93	4,401	Photo cell	2	4,259	465	0.93	3,961	0.00	440
110	1-400 HPS	3	4,732	465	1.4	6,601	Photo cell	3	4,259	465	1.4	5,941	0.00	660
Total		**543**			**68.02**	**241,794**		**543**			**39.30**	**134,970**	**28.72**	**106,824**

Data Collection

Representative lighting fixtures were measured using true RMS digital power and amperage meters. Measured and reference fixture wattages are provided in **Table 5**.

Table 5. Fixture Wattage Measurements From Pre-Retrofit TDPUD Site #10

Building	Location	Qty	Fixture Type	Watts	Measured W/Fixture	Reference W/Fixture
Town of Truckee Offices	Ceiling Fixture	1	2 Lamp –4'T12,SL,ESB	73.0	73.0	72.0
Town of Truckee Offices	Ceiling Fixture	1	3 Lamp –4'T12,SL,ESB	115.0	115.0	115.0
Board Room	Soffet Area	2	3 Lamp –4'T12,SL,ESB	200.0	100.0	115.0
Board Room	Soffet Area	5	3 Lamp-4'T12,SL,ESB	515.0	115.0	115.0
Board Room	Soffet Area	1	2 Lamp-2'T12,SL,ESB	56.0	56.0	56.0
Board Room	Perimeter	22	Rec. Can,2-13W CFL,MB	792.0	36.0	31.0
Warehouse	Ceiling	9	2 Lamp-8'T12,HO,MSB	1,936.0	215.0	215.0

Light Loggers were installed to measure hours of operation over a 3-week period (see **Table 6**).

Table 6. Lighting Fixture % On Time (Hours/Year) Based on Lite Logger Data

Building	Location	Qty	Fixture Type	% On	Hours/Year
Town of Truckee Offices	Ceiling Fixture	23	2 Lamp –4'T12,SL,ESB	20.1	1,761
Customer Service	Ceiling Fixture	24	3 Lamp –4'T12,SL,ESB	33.5	2,935
Entry at Stairs	Ceiling Fixture	1	2 Lamp –4'T12,SL,ESB	100.0	8,760
Board Room	Soffet Area	3	3 Lamp –4'T12,SL,ESB	11.2	981
Conference	Ceiling Fixture	5	3 Lamp-4'T12,SL,ESB	11.2	981
2nd Floor Common Area	Ceiling Fixture	62	3 Lamp-4'T12,SL,ESB	30.6	2,681
Warehouse	Ceiling Area	49	2 Lamp-8'T12,ESB	24.6	2,155
Electric Garage	Ceiling	8	MH 400W	22.0	1,927
Water Garage	Ceiling	7	MH 400W	25.0	2,190

Customer Cost/Benefit Analysis

Cost and Payback (based on 2002 TDPUD Rates effective 1-1-02).

- Site #10: (Retrofit Cost $52,308 - Rebate $52,308) / (Energy Savings $12,613) = Simple Payback 0 Years.