

# CITY OF DOVER, NH



## YEAR 2 MEASUREMENT & VERIFICATION REPORT Annual Contract Savings

(November 1, 2012 – October 31, 2013)

July 2014



# CITY OF DOVER, NH

## PERFORMANCE CONTRACT

### Year 2 Annual M&V Report

Performance Period Dates Covered: November 1, 2012 to October 31, 2013

Contract #: 9236-0143

Contract Year #: 2

Annual Year 2 Guaranteed Energy Savings: \$280,169

Annual Year 2 Guaranteed O&M Savings: \$14,227

Annual Year 2 Guaranteed Capital Cost Avoidance: \$33,840

Annual Year 2 Total Guarantee: \$328,236

Contract Term: 10-Years

Term Guaranteed Savings: \$3,623,746

Utility Cost Avoidance Escalation Rate: 3.0%

Operations & Maintenance (O&M) Cost Avoidance Escalation Rate: 4.0%

Guarantee Start Date: 11/1/2011

Guarantee End Date: 10/31/2021



## TABLE OF CONTENTS

Executive Summary	
Cost Avoidance Summary.....	4
Monthly Comparison.....	5
Total Guarantee Year Savings.....	6
Savings per Facility.....	8
Aggregate Monthly FIM Savings.....	10
FIM Description.....	11
Environmental Benefits.....	24
Appendix A	
FIM 1 & 2: Lighting Fixture Retrofit & Controls.....	26
FIM 3: Weatherization.....	28
FIM 4: EMS Upgrades.....	29
FIM 6: Water Conservation.....	33
FIM 9: Vending Machine Controls.....	34
FIM 10: Pool Cover.....	35
FIM 11: Ice Arena Upgrades.....	36
FIM 12: Power Factor Correction.....	52
FIM 13: Transformers.....	54
FIM 14: Aeration Blower Upgrade.....	55
FIM 15: Boiler Replacement.....	56
Appendix B	
Performance Contract Project Progress.....	57
Weather Degree Days.....	58
Utility Rate Schedule.....	60
Glossary.....	61
Appendix C	
Savings Calculations.....	62

## EXECUTIVE SUMMARY

### Cost Avoidance Summary

The City of Dover, NH and Johnson Controls, Inc. entered into a performance contract in September in 2009. The purpose of this contract is to lessen the energy and energy related costs realized by the City of Dover moving forward through the implementation of specific Facility Improvement Measures (FIMs). The guaranteed savings portion of the contract (10 years) started on November 1 of 2011 and will end on October 31, 2021.

The original 1<sup>st</sup> year annual savings guarantee of \$304,510 includes \$256,990 in energy cost avoidance, \$13,680 in operations and maintenance (O&M) cost avoidance, and a future capital cost avoidance of \$33,840. This initial savings guarantee was increased from the original amount to \$319,463 due to Change Order (CO) # 9236-0142-CO2 which comprised of a lighting retrofit project at the McConnell Center. The annual guaranteed energy savings amount escalates by 3% and the O&M savings escalates by 4% each year to compensate for inflation. Total term benefits are \$3,623,746.

The following table summarizes the annual guaranteed savings by year vs. verified project savings:

City of Dover Annual Cost Savings Summary						
Guarantee Period	Guaranteed Energy Cost Avoidance	Guaranteed O&M Cost Avoidance	Guaranteed Future Capital Cost Avoidance	Total Guaranteed Cost Avoidance	Verified Annual Cost Avoidance	Variance
Year 1	\$271,943	\$13,680	\$33,840	\$319,463	\$317,642	(\$1,821) <sup>(1)</sup>
Year 2	\$280,169	\$14,227	\$33,840	\$328,236	\$321,420	(\$6,817)
Year 3	\$288,644	\$14,796	\$33,840	\$337,280		
Year 4	\$297,375	\$15,388	\$33,840	\$346,603		
Year 5	\$306,371	\$16,004	\$33,840	\$356,214		
Year 6	\$315,638	\$16,644	\$33,840	\$366,122		
Year 7	\$325,186	\$17,310	\$33,840	\$376,336		
Year 8	\$335,023	\$18,002	\$33,840	\$386,865		
Year 9	\$345,157	\$18,722	\$33,840	\$397,719		
Year 10	\$355,598	\$19,471	\$33,840	\$408,909		
<b>Total</b>	<b>\$3,121,103</b>	<b>\$164,244</b>	<b>\$338,400</b>	<b>\$3,623,746</b>	<b>\$639,062</b>	<b>N/A</b>

<sup>(1)</sup> Year 1 variance is due to non-installation of FIM 12- Power Factor Correction during Year 1 as explained in previous reports. The equipment was installed in the first quarter of Year 2 (January of 2013). The City of Dover has been compensated for the variance from guaranteed savings.

This report is designed to provide another tracking point for the City of Dover in understanding the energy savings of this project. The following report details the status of this project, including guaranteed and verified savings for all Facility Improvement Measures (FIMs) involved.

This report covers the second full contract (guarantee) year which runs from November 2012 through October 2013.

## EXECUTIVE SUMMARY

### Monthly Comparison

Cost savings are provided on a monthly basis for Contract Year 2 in the table below. The annual guaranteed savings per FIM represents the amount per FIM that adds up to the total annual guarantee. FIM savings are not guaranteed individually; the savings guarantee reflects the whole project. Therefore deficiencies from one FIM can be overcome by another FIM to result in overall project savings.

City of Dover, NH															
FIM #	FIM Description	Fiscal Year 2013								Fiscal Year 2014				Total Contract Yr 2 Savings	Annual Guaranteed Savings
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT		
1	Lighting - Fixture Retrofit	\$1,844	\$1,841	\$1,775	\$1,636	\$1,870	\$1,916	\$2,092	\$2,239	\$2,539	\$2,328	\$2,122	\$2,025	\$24,227	\$23,079
	Lighting Fixtures (McConnell Ctr)	\$819	\$802	\$769	\$745	\$817	\$855	\$932	\$1,047	\$1,221	\$1,077	\$973	\$895	\$10,953	\$11,008
2	Lighting - Fixture Control	\$527	\$544	\$544	\$492	\$544	\$527	\$544	\$527	\$544	\$544	\$527	\$544	\$6,411	\$6,159
	Lighting Controls (McConnell Ctr)	\$385	\$398	\$398	\$359	\$398	\$385	\$398	\$385	\$398	\$398	\$385	\$398	\$4,683	\$4,397
3	Building Envelope - Weatherization	\$1,771	\$2,142	\$2,483	\$2,132	\$1,994	\$1,394	\$956	\$142	\$544	\$516	\$752	\$1,200	\$16,026	\$14,899
4.1	EMS - Building Controls	\$1,048	\$1,332	\$1,603	\$1,360	\$1,214	\$749	\$390	\$120	\$78	\$46	\$243	\$583	\$8,766	\$8,653
4.2	EMS - Building Controls / Optimal Start	\$256	\$326	\$392	\$332	\$297	\$183	\$94	\$21	\$1	\$3	\$55	\$142	\$2,103	\$2,084
4.3	AHU Upgrade - VFD on Fan <sup>(2)</sup>	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$6,815
4.4	Pool Dehumidification - EMS & VFD's	\$978	\$1,011	\$1,011	\$913	\$1,011	\$978	\$1,011	\$978	\$1,011	\$1,011	\$978	\$1,011	\$11,899	\$11,542
4.5	Repair Snow Melt Sensor	\$276	\$571	\$571	\$515	\$571	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$2,504	\$2,428
6	Water Conservation	\$1,236	\$1,277	\$1,277	\$1,153	\$1,277	\$1,236	\$1,277	\$1,236	\$1,277	\$1,277	\$1,236	\$1,277	\$15,034	\$14,550
9	Vending Machine Controllers	\$82	\$85	\$85	\$77	\$85	\$82	\$85	\$82	\$85	\$85	\$82	\$85	\$997	\$964
10	Pool Covers	\$1,154	\$1,193	\$1,193	\$1,077	\$1,193	\$1,154	\$1,193	\$1,154	\$1,193	\$1,193	\$1,154	\$1,193	\$14,044	\$13,623
11	Ice Arena Upgrades <sup>(3)</sup>	\$4,365	\$1,769	\$4,934	\$2,486	\$4,521	\$3,232	\$6,764	\$17,747	\$16,891	\$13,541	\$12,788	\$8,454	\$97,491	\$97,890
12	Power Factor Correction	\$0	\$0	\$21	\$123	\$133	\$130	\$133	\$181	\$148	\$133	\$130	\$133	\$1,264	\$7,405
13	Energy Efficient Transformers	\$1,407	\$1,448	\$1,448	\$1,323	\$1,448	\$1,407	\$1,448	\$1,407	\$1,448	\$1,448	\$1,407	\$1,448	\$17,088	\$15,896
	E.E. Transformers (Ice Arena)	\$240	\$247	\$247	\$226	\$247	\$240	\$247	\$240	\$247	\$247	\$240	\$247	\$2,914	\$3,044
14	Aeration Blower Upgrade	\$2,936	\$3,019	\$3,019	\$2,769	\$3,019	\$2,936	\$3,019	\$2,936	\$3,019	\$3,019	\$2,936	\$3,019	\$35,648	\$34,444
15	Boiler Replacement	\$215	\$227	\$237	\$232	\$207	\$64	\$0	\$0	\$0	\$0	\$19	\$99	\$1,300	\$1,288
<b>ENERGY COST SAVINGS</b>		<b>\$19,538</b>	<b>\$18,231</b>	<b>\$22,005</b>	<b>\$17,951</b>	<b>\$20,844</b>	<b>\$17,468</b>	<b>\$20,582</b>	<b>\$30,441</b>	<b>\$30,644</b>	<b>\$26,867</b>	<b>\$26,027</b>	<b>\$22,754</b>	<b>\$273,353</b>	<b>\$280,169</b>
O&M Cost Avoidance		\$1,169	\$1,208	\$1,208	\$1,091	\$1,208	\$1,169	\$1,208	\$1,169	\$1,208	\$1,208	\$1,169	\$1,208	\$14,227	\$14,227
Future Capital Cost Avoidance		\$2,774	\$2,866	\$2,866	\$2,681	\$2,866	\$2,774	\$2,866	\$2,774	\$2,866	\$2,866	\$2,774	\$2,866	\$33,840	\$33,840
<b>TOTAL COST SAVINGS</b>		<b>\$23,481</b>	<b>\$22,305</b>	<b>\$26,079</b>	<b>\$21,724</b>	<b>\$24,919</b>	<b>\$21,411</b>	<b>\$24,657</b>	<b>\$34,384</b>	<b>\$34,719</b>	<b>\$30,942</b>	<b>\$29,970</b>	<b>\$26,829</b>	<b>\$321,420</b>	<b>\$328,237</b>

<sup>(2)</sup> The VFD as part of FIM 4.3 at the Public Works building was removed in September 2012 from the AHU due to continued system compatibility issues encountered over the life of the project.

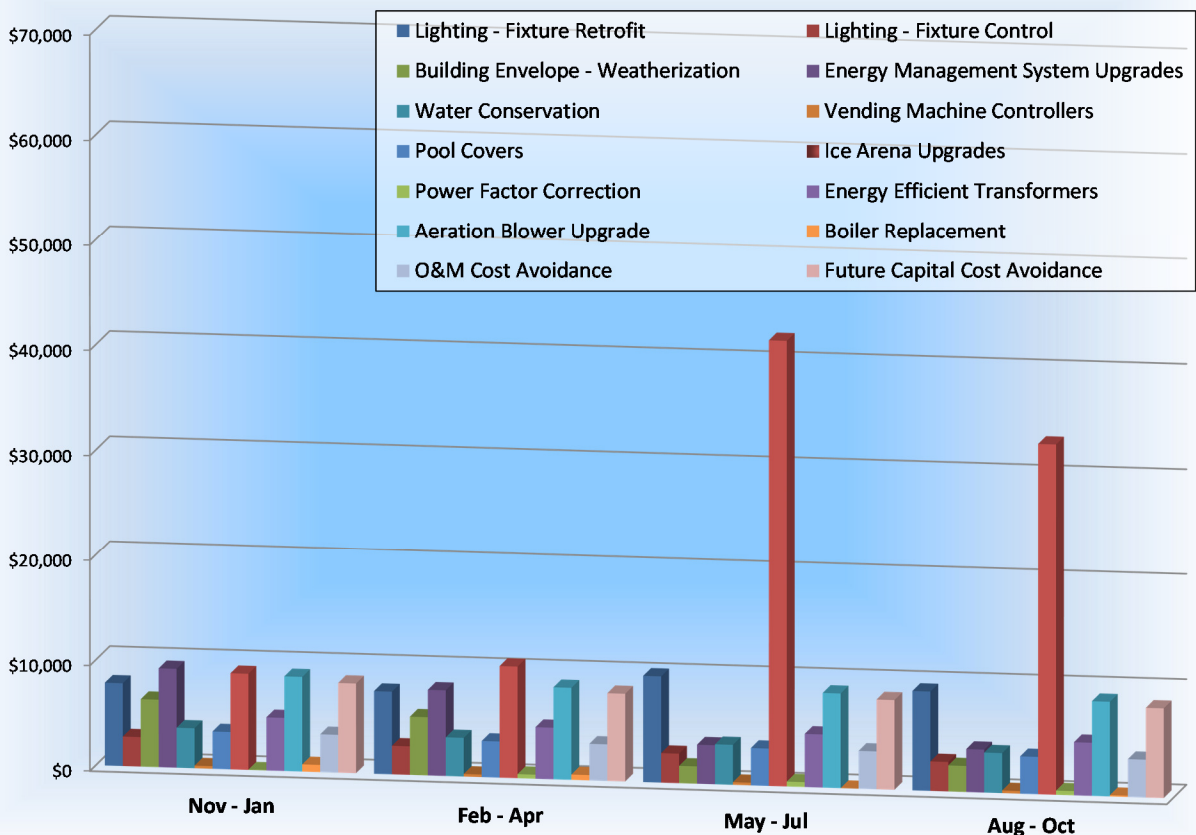
<sup>(3)</sup> FIM 11 Savings includes cost of IceMax in this chart. The City of Dover Ice Arena stopped using IceMax in January 2013. Savings and Cost have been adjusted to reflect the change.

## EXECUTIVE SUMMARY

### Total Guarantee Year Savings

Savings realized by the project during Guarantee Year 2 to Date totals 840,223 kWh & 1,809 kW (\$107,933), 11,443 MMBTU's (\$153,627) and 1,181 kGals of water/ sewer savings (\$13,437). Operation and maintenance (O&M) savings and capital cost avoidance stipulated in the performance contract totals \$48,067. FIM 11 Icemax costs are \$1,644 over this 12 month period where used.

**Guarantee Year 2 Cost Savings: City of Dover**

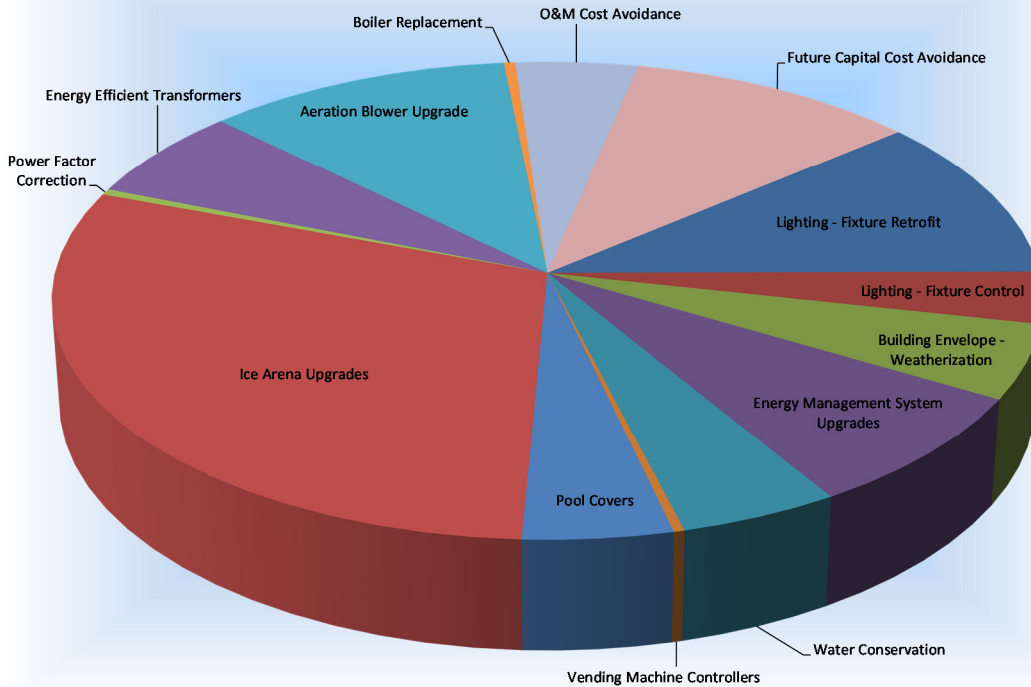


Thermal Savings consist of savings from Natural Gas (therms), Oil (gallons), and Propane (gallons). In order to provide a basis for comparison, these have all been reported in MMBtu. Conversion factors used in assembling this report are listed below:

- Natural Gas: 1 therm = 0.1 MMBtu
- Oil: 1 gallon = 0.139 MMBtu
- Propane: 1 gallon = 0.0916 MMBtu

## EXECUTIVE SUMMARY

### Guarantee Year 2 Cost Savings: City of Dover



City of Dover, NH - Guarantee Year 2 Savings									
FIM #	FIM Description	Electricity Savings			Thermal Savings		Water Savings		Total Y2 \$ Savings
		kW	kWh	\$	MMBtu	\$	kgal	\$	
1	Lighting - Fixture Retrofit	1,426	263,379	\$38,323	(228)	(\$3,143)	0	\$0	\$35,181
2	Lighting - Fixture Control	310	93,119	\$11,094	0	\$0	0	\$0	\$11,094
3	Bldg. Envelope - Weatherization	0	4,943	\$562	1,079	\$15,463	0	\$0	\$16,026
4	EMS -Upgrades	0	86,458	\$9,673	1,039	\$15,599	0	\$0	\$25,272
6	Water Conservation	0	0	\$0	164	\$2,329	1,117	\$12,705	\$15,034
9	Vending Machine Controllers	0	8,425	\$997	0	\$0	0	\$0	\$997
10	Pool Cover	0	46,656	\$5,023	560	\$8,290	64	\$732	\$14,044
11	Ice Arena - Upgrades	(1,010)	(70,313)	(\$14,653)	8,740	\$113,788	0	\$0	\$99,135
12	Power Factor Correction	40	8,917	\$1,264	0	\$0	0	\$0	\$1,264
13	Energy Efficient Transformers	318	150,628	\$20,002	0	\$0	0	\$0	\$20,002
14	Aeration Blower Upgrade	724	248,010	\$35,648	0	\$0	0	\$0	\$35,648
15	Boiler Replacement	0	0	\$0	89	\$1,300	0	\$0	\$1,300
<b>Energy Totals</b>		<b>1,809</b>	<b>840,223</b>	<b>\$107,933</b>	<b>11,443</b>	<b>\$153,627</b>	<b>1,181</b>	<b>\$13,437</b>	<b>\$274,997</b>
Ice Arena IceMax Cost <sup>(4)</sup>		-	-	-	-	-	-	-	(\$1,644)
O&M Cost Avoidance		-	-	-	-	-	-	-	\$14,227
Future Capital Cost Avoidance		-	-	-	-	-	-	-	\$33,840
<b>Totals</b>		<b>1,809</b>	<b>840,223</b>	<b>\$107,933</b>	<b>11,443</b>	<b>\$153,627</b>	<b>1,181</b>	<b>\$13,437</b>	<b>\$321,420</b>

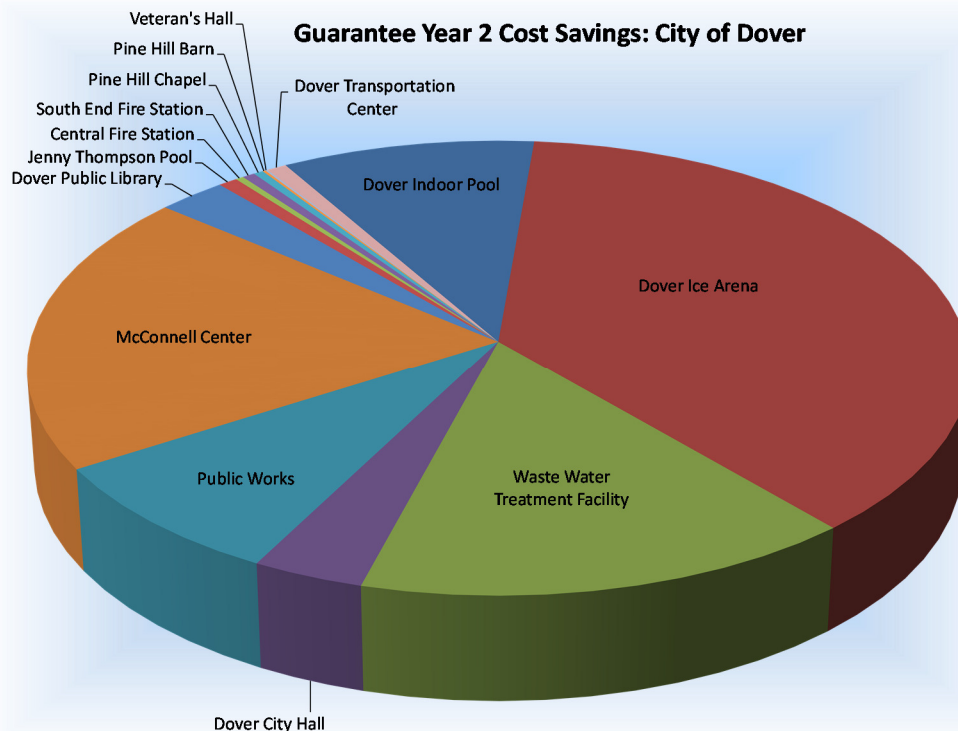
<sup>(4)</sup> Total IceMax Cost separated out from FIM 11 in this chart

## EXECUTIVE SUMMARY

### Savings per Facility

City of Dover, NH – Guarantee Year 2 Savings									
Facility Location	Electricity Savings			Thermal Savings		Water Savings		<sup>(5)</sup> O&M / Cap Cost Savings	Total \$ Savings
	kW	kWh	\$	MMBtu	\$	kgal	\$		
Central Fire Station	0	194	\$25	54	\$850	21	\$235		\$1,111
Dover City Hall	150	36,007	\$4,620	188	\$3,236	302	\$3,438	\$499	\$11,793
Dover Ice Arena	(711)	33,570	(\$1,554)	9,076	\$118,157	239	\$2,715	\$10,087	\$129,405
Dover Public Library	102	34,257	\$4,748	183	\$2,668	127	\$1,448	\$499	\$9,362
Dover Transportation Ctr.	0	19,905	\$2,504	0	\$0	0	\$0		\$2,504
Indoor Pool	37	123,672	\$13,645	1,016	\$15,037	280	\$3,182	\$34,339	\$66,203
Jenny Thompson Pool	0	0	\$0	25	\$351	141	\$1,601		\$1,952
McConnell Center	821	168,780	\$24,662	457	\$6,650	0	\$0	\$499	\$31,811
Pine Hill Barn	0	0	\$0	25	\$435	0	\$0		\$435
Pine Hill Chapel	0	23	\$4	45	\$766	7	\$74		\$844
Public Works	571	136,225	\$17,956	192	\$2,233	56	\$641	\$499	\$21,328
South End Fire Station	0	94	\$12	94	\$1,705	9	\$102		\$1,819
Veterans Hall	0	0	\$0	18	\$333	0	\$0		\$333
Waste Water Treatment Facility	838	287,496	\$41,312	70	\$1,208	0	\$0		\$42,519
<b>Totals</b>	<b>1,809</b>	<b>840,223</b>	<b>\$107,933</b>	<b>11,443</b>	<b>\$153,627</b>	<b>1,181</b>	<b>\$13,437</b>	<b>\$46,423</b>	<b>\$321,420</b>

<sup>(5)</sup>Total O&M / Capital Cost Savings contains \$1,644 cost of Icemax for FIM 11- Ice Arena Upgrades





## EXECUTIVE SUMMARY

Total project cost savings for Contract Year 2 are broken down by building and by FIM in the table below.

City of Dover, NH Building Location	FIM 1	FIM 2	FIM 3	FIM 4	FIM 6	FIM 9	FIM 10	FIM 11	FIM 12	FIM 13	FIM 14	FIM 15	<sup>(6)</sup> O&M Savings/ Capital Cost Avoidance	Totals / Building
	Lighting Fixtures	Lighting Controls	Building Envelope (Weatherization)	Energy Management System - Upgrades	Water Conservation	Vending Machine Controllers	Pool Cover	Ice Arena Upgrades	Power Factor Correction	Energy Efficient Transformers	Aeration Blower Upgrade	Boiler Replacement		
Central Fire Station			\$822		\$288									\$1,111
Dover City Hall	\$3,000	\$991	\$1,071	\$2,103	\$3,792	\$336							\$499	\$11,793
Dover Ice Arena	\$5,814	\$1,420	\$5,043		\$3,402	\$327		\$99,135	\$1,264	\$2,914			\$10,087	\$129,405
Dover Public Library	\$3,529	\$982	\$405	\$1,047	\$1,600							\$1,300	\$499	\$9,362
Dover Transportation Ctr.				\$2,504										\$2,504
Indoor Pool	\$1,237	\$28	\$1,288	\$12,111	\$2,994	\$161	\$14,044						\$34,339	\$66,203
Jenny Thompson Pool					\$1,952									\$1,952
McConnell Center	\$10,953	\$4,683	\$1,166	\$6,714						\$7,795			\$499	\$31,811
Pine Hill Barn				\$435										\$435
Pine Hill Chapel			\$533	\$230	\$81									\$844
Public Works	\$10,648	\$2,990	\$2,448	\$127	\$785	\$173				\$3,658			\$499	\$21,328
South End Fire Station			\$1,681		\$138									\$1,819
Veterans Hall			\$333											\$333
Waste Water Treatment Facility			\$1,236							\$5,635	\$35,648			\$42,519
<b>Totals / FIM</b>	<b>\$35,181</b>	<b>\$11,094</b>	<b>\$16,026</b>	<b>\$25,272</b>	<b>\$15,034</b>	<b>\$997</b>	<b>\$14,044</b>	<b>\$99,135</b>	<b>\$1,264</b>	<b>\$20,002</b>	<b>\$35,648</b>	<b>\$1,300</b>	<b>\$46,423</b>	<b>\$321,420</b>

<sup>(6)</sup> Ice Arena & FIM 11 Savings contains \$1,644 cost of Icemax as part of O&M Savings.

## EXECUTIVE SUMMARY

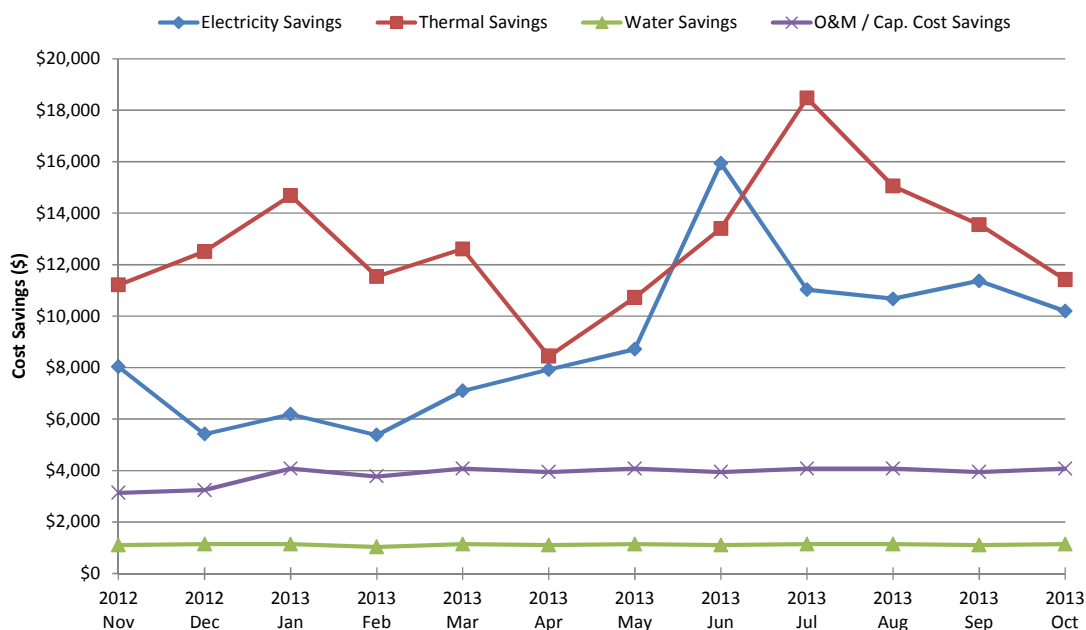
### Aggregate Monthly FIM Savings

Included below are the total monthly energy unit savings and associated dollar cost savings for all FIMs.

City of Dover- Performance Contract Savings										
Contract Year 2 Energy Cost Avoidance										
Month	Year	Electric Savings			Thermal Savings		Water Savings		O&M / Cap. Cost Savings <sup>(7)</sup>	Total Cost \$ Savings
		kW	kWh	Cost \$	MMBtu	Cost \$	kGal	Cost \$		
November	2012	154	61,057	\$8,034	823	\$11,208	97	\$1,104	\$3,134	\$23,481
December	2012	132	37,968	\$5,414	915	\$12,511	100	\$1,141	\$3,239	\$22,305
January	2013	90	48,052	\$6,182	1,075	\$14,681	100	\$1,141	\$4,075	\$26,079
February	2013	66	42,769	\$5,379	841	\$11,542	91	\$1,031	\$3,773	\$21,724
March	2013	105	55,148	\$7,093	926	\$12,610	100	\$1,141	\$4,075	\$24,919
April	2013	133	61,769	\$7,922	618	\$8,441	97	\$1,104	\$3,943	\$21,411
May	2013	198	64,446	\$8,715	803	\$10,726	100	\$1,141	\$4,075	\$24,657
June	2013	227	128,737	\$15,938	1,016	\$13,398	97	\$1,104	\$3,943	\$34,384
July	2013	152	88,386	\$11,029	1,407	\$18,475	100	\$1,141	\$4,075	\$34,719
August	2013	204	81,808	\$10,669	1,144	\$15,057	100	\$1,141	\$4,075	\$30,942
September	2013	177	90,292	\$11,366	1,024	\$13,556	97	\$1,104	\$3,943	\$29,970
October	2013	171	79,791	\$10,191	851	\$11,422	100	\$1,141	\$4,075	\$26,829
<b>Contract Yr 2</b>		<b>1,809</b>	<b>840,223</b>	<b>\$107,933</b>	<b>11,443</b>	<b>\$153,627</b>	<b>1,181</b>	<b>\$13,437</b>	<b>\$46,423</b>	<b>\$321,420</b>

<sup>(7)</sup> IceMax Cost from FIM 11 included in O&M column in this chart

### Monthly Project Savings



## FIM DESCRIPTION

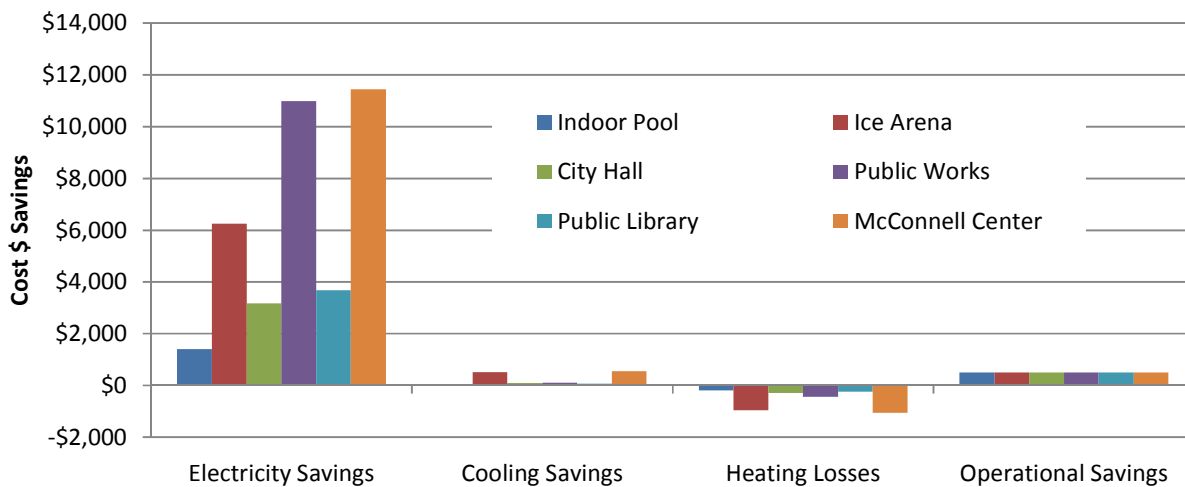
### FIM 1: Lighting – Fixture Retrofit

Lighting can be broken down into four savings parts: Electricity Savings from the replacement of higher power fixtures with more efficient ones, Cooling Savings from less fixture heat being introduced into a cooled space, Heating Losses from less fixture heat being introduced in a heated space, and Operational Savings from decreased lighting changes and uniform lighting stock. Annual guaranteed electric savings associated with FIM 1 are 262,508 kWh with a monthly reduction in demand of 118.8 kW. Annual guaranteed heating losses are calculated to be 233 MMBtu resulting in a total guaranteed energy cost savings for FIM 1 of \$34,087 in Contract Year 2. Operational Savings are stipulated at \$2,995 for Year 2 for this measure.

FIM 1: Lighting – Fixture Retrofit									
Contract Year 2 Energy Cost Avoidance									
Building	Electricity Savings			Cooling Savings		Heating Losses		O&M	Total Cost
	kW	kWh	Cost \$	kWh	Cost \$	MMBtu	Cost \$	\$ Savings	\$ Savings
Indoor Pool	36	10,084	\$1,416	84	\$9	(13)	(\$188)	\$499	\$1,736
Ice Arena	142	47,806	\$6,257	4,700	\$513	(73)	(\$956)	\$499	\$6,313
City Hall	88	24,717	\$3,172	809	\$104	(16)	(\$275)	\$499	\$3,499
Public Works	382	83,305	\$10,980	810	\$107	(38)	(\$439)	\$499	\$11,147
Public Library	102	26,608	\$3,688	530	\$73	(16)	(\$232)	\$499	\$4,028
McConnell Center <sup>(8)</sup>	675	58,936	\$11,453	4,992	\$552	(72)	(\$1,051)	\$499	\$11,453
<b>Totals</b>	<b>1,426</b>	<b>251,455</b>	<b>\$36,965</b>	<b>11,924</b>	<b>\$1,358</b>	<b>(228)</b>	<b>(\$3,143)</b>	<b>\$2,995</b>	<b>\$38,176</b>

<sup>(8)</sup> McConnell Center included into scope with FIM 1 due to CO # 9236-0142-CO2

### FIM 1: Contract Year 2 Savings



Verified savings are obtained from calculations and verified by measurements of circuit kW on a sample of lighting circuits before and after the retrofit was implemented. Calculation equations have been provided in Appendix C for reference. Hours of operation are stipulated for the contract term as per the contract.

## FIM DESCRIPTION

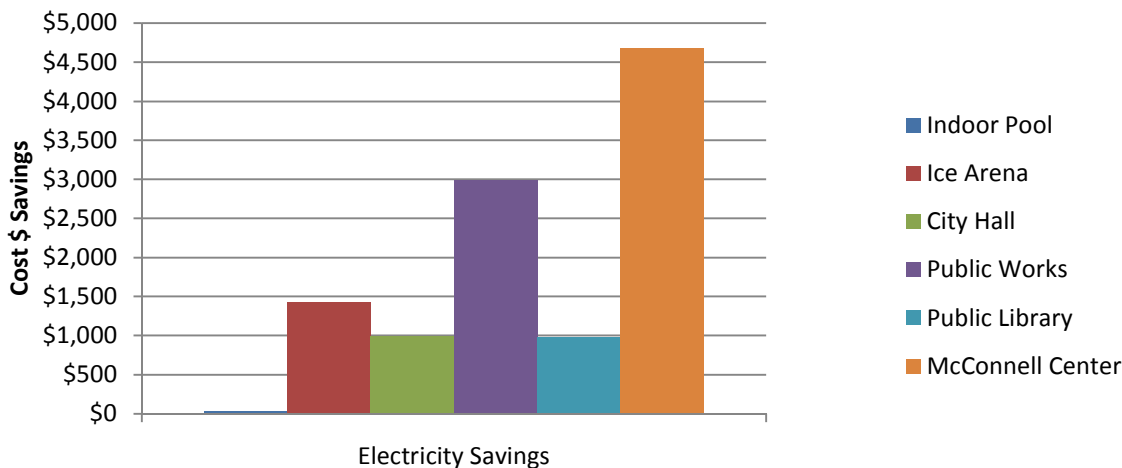
### FIM 2: Lighting – Fixture Controls

By using occupancy sensors and shutting off lights in unoccupied areas, Dover is guaranteed to save 88,559 kWh per year, with a reduction in demand of 24.8 kW. As per the Detailed Energy Audit (DEA) page 28, FIM 2 annual cost savings are not taken using demand savings. Cost savings are calculated from consumption savings only and are guaranteed to be \$10,556 for Year 2.

FIM 2: Lighting – Fixture Controls				
Contract Year 2 Energy Cost Avoidance				
Building	Electricity Savings			Total Cost \$ Savings
	kW	kWh	Cost \$	
Indoor Pool	1	260	\$28	\$28
Ice Arena	59	13,002	\$1,420	\$1,420
City Hall	61	7,726	\$991	\$991
Public Works	189	22,683	\$2,990	\$2,990
Public Library	0	7,084	\$982	\$982
McConnell Center <sup>(9)</sup>	0	42,364	\$4,683	\$4,683
<b>Totals</b>	<b>310</b>	<b>93,119</b>	<b>\$11,094</b>	<b>\$11,094</b>

<sup>(9)</sup> McConnell Center included with FIM 2 from CO # 9236-0142-CO2

### FIM 2: Contract Year 2 Savings



Verified savings are obtained from calculations which use collected data that tracked occupancy and lighting schedule in areas where equipment is installed. This data is used to verify lighting control savings. Calculation equations used have been provided in the appendix for reference. Fixture wattages under control of the sensors are stipulated as per the contract.

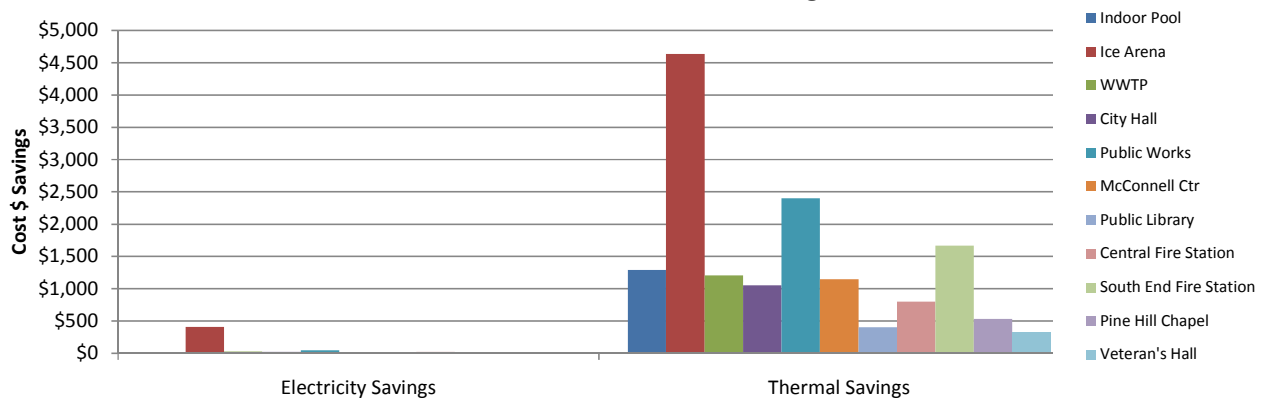
## FIM DESCRIPTION

### FIM 3: Building Envelope- Weatherization

Weatherization savings are determined by the losses of less conditioned air due to seals of gaps and openings in the building. The weatherization portion of the project is guaranteed to save 4,486 kWh of electrical energy and 1,019 MMBtu's in thermal energy, resulting in Year 2 savings of \$14,899.

FIM 3: Building Envelope- Weatherization						
Contract Year 2 Energy Cost Avoidance						
Building	Electricity Savings			Thermal Savings		Total Cost \$ Savings
	kW	kWh	Cost \$	MMBtu	Cost \$	
Indoor Pool	0	4	\$0	87	\$1,287	\$1,288
Ice Arena	0	3,708	\$405	356	\$4,638	\$5,043
WWTP	0	231	\$28	70	\$1,208	\$1,236
City Hall	0	134	\$17	61	\$1,054	\$1,071
Public Works	0	366	\$48	207	\$2,400	\$2,448
McConnell Center	0	154	\$17	79	\$1,149	\$1,166
Public Library	0	35	\$5	27	\$400	\$405
Central Fire Station	0	194	\$25	51	\$798	\$822
South End Fire Station	0	94	\$12	92	\$1,668	\$1,681
Pine Hill Chapel	0	23	\$4	31	\$529	\$533
Veteran's Hall	0	0	\$0	18	\$333	\$333
<b>Totals</b>	<b>0</b>	<b>4,943</b>	<b>\$562</b>	<b>1,079</b>	<b>\$15,463</b>	<b>\$16,026</b>

**FIM 3: Contract Year 2 Savings**



Weatherization savings are derived directly from engineering spreadsheet calculations. General formulas used are located in Appendix C. The scope of work has been verified to be complete.

## FIM DESCRIPTION

### FIM 4: Energy Management System (EMS) - Upgrades

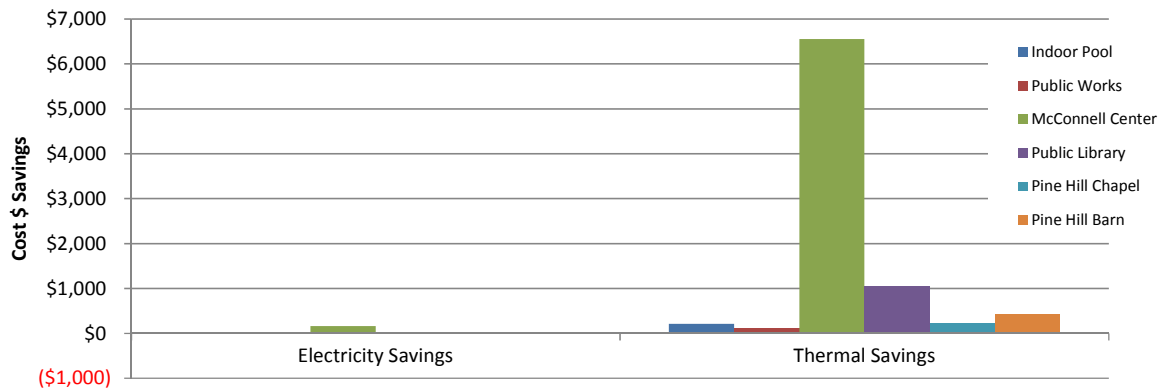
The EMS upgrade project is guaranteed to save 125,107 kWh of electrical energy and 1,138 MMBtu's of thermal energy. All sections of this FIM are further broken down as follows:

#### FIM 4.1: EMS- Building Controls

The building controls measure provides savings by providing a run-time schedule to provide a temperature setback when buildings are unoccupied, thus wasting less energy. The guaranteed annual energy savings for this FIM are calculated to be 1,092 kWh and 581 MMBtu's totaling \$8,653 over the Year 2 period.

FIM 4.1: Building Controls						
Contract Year 2 Energy Cost Avoidance						
Building	Electricity Savings			Thermal Savings		Total Cost \$ Savings
	kW	kWh	Cost \$	MMBtu	Cost \$	
Indoor Pool	0	(8)	(\$1)	14	\$213	\$212
Public Works	0	0	\$0	11	\$127	\$127
McConnell Center	0	1,466	\$162	450	\$6,552	\$6,714
Public Library	0	0	\$0	72	\$1,047	\$1,047
Pine Hill Chapel	0	0	\$0	13	\$230	\$230
Pine Hill Barn	0	0	\$0	25	\$435	\$435
<b>Totals</b>	<b>0</b>	<b>1,457</b>	<b>\$161</b>	<b>586</b>	<b>\$8,605</b>	<b>\$8,766</b>

**FIM 4.1: Contract Year 2 Savings**



Verified savings are derived from calculations and verified by trending and totalization with FMS. General formulas have been provided in the appendix for reference. Hours of operation, pre-installation control strategies, and pre & post retrofit equipment energy consumption are stipulated.

## FIM DESCRIPTION

### FIM 4.2: EMS- Building Controls / Optimal Start

Savings for Building Controls / Optimal Start are based off of improved starting and running of air systems at the Dover City Hall. By optimizing control, there are guaranteed savings of 121 MMBtu resulting in \$2,023 annually in Year 2.

FIM 4.2: Building Controls / Optimal Start			
Contract Year 2 Energy Cost Avoidance			
Building	Thermal Savings		Total Cost \$ Savings
	MMBtu	Cost \$	
City Hall	122	\$2,103	\$2,103

Verified savings are from calculations and tracked with FMS. Formulas have been provided in Appendix C for reference. Hours of operation, pre-installation control strategies, and pre & post retrofit equipment energy consumption are stipulated.

### FIM 4.3: Air Handling Unit Upgrade- VFD on Fan

The upgrade at the Dover Public Works building was installed for the AHU that serves the repair shop. With the VFD in place, the unit is able to slow down air flow based off occupancy. Thus savings are realized by using less energy on the AHU fan and having to condition less air. This measure has been guaranteed to save 41,564 kWh & 115 MMBtu's per year.

FIM 4.3: Air Handling Unit Upgrade - VFD on Fan								
Contract Year 2 Energy Cost Avoidance								
Building	Electricity Savings			Cooling Savings		Heating Savings		Total Cost \$ Savings
	kW	kWh	Cost \$	kWh	Cost \$	MMBtu	Cost \$	
Public Works	0	0	\$0	0	\$0	0	\$0	\$0

Verified savings were based off calculations and verified through measurement of fan kW, supply & space air temperatures. Calculations are spreadsheet based and general formulas have been provided in the appendix for reference. Hours of operation and motor power are stipulated.

\*\*\* This measure has been removed from the project (in September 2012) due to continued difficulty with parallel controls at the site. Any realized & verified savings realized from this measure have been discontinued as of mid-September and will continue to produce no savings for the remainder of the project, unless the measure is re-visited in the future. There are no current plans to re-install this savings measure.

## FIM DESCRIPTION

### FIM 4.4: Pool Dehumidification- EMS & VFDs

The replacement of the AHU with a new PoolPac™ unit in the Dover Indoor Pool will create savings through the implementation of a temperature setback and slowed fan speeds during unoccupied hours. Additionally, this FIM will eliminate simultaneous heating and cooling in the pool office. These upgrades are guaranteed to save Dover 63,143 kWh and 320 MMBtu's. Additionally, as stipulated in the contract, a capital cost avoidance savings with this measure is valued at \$338,400 over the 10 year term or an annual cost avoidance of \$33,840.

FIM 4.4: Pool Dehumidification - EMS & VFD's							
Contract Year 2 Energy Cost Avoidance							
Building	Electricity Savings			Thermal Savings		Capital Cost Avoidance \$	Total Cost \$ Savings
	kW	kWh	Cost \$	MMBtu	Cost \$		
Indoor Pool	0	65,096	\$7,008	330	\$4,891	\$33,840	\$45,739

Verified savings are from engineering spreadsheet calculations and verified through tracking and trending of pool humidity levels using the BAS and loggers. Hours of operation, equipment energy consumption pre & post retrofit, and pool operational temperatures are stipulated.

### FIM 4.5: Repair Snow Melt Sensor

The snow melt sensor system at the Dover Transportation Center is generally run from mid-November through the end of March; during the winter snow season. By repairing the system and adding sensors to control use, Dover is guaranteed to save 19,308 kWh per winter.

FIM 4.5: Repair Snow Melt Sensor				
Contract Year 2 Energy Cost Avoidance				
Building	Electricity Savings			Total Cost \$ Savings
	kW	kWh	Cost \$	
Dover Transportation Center	0	19,905	\$2,504	\$2,504

Verified savings are derived from calculations involving power draw of the snow melt system and time-of-use of the system while operated manually. Savings are verified through inspection of post installation hours of operation. Calculations are from spreadsheets located in the DEA. Pre-installation hours of operation are a stipulated variable. A consideration is that savings are a function of the severity of the winter.



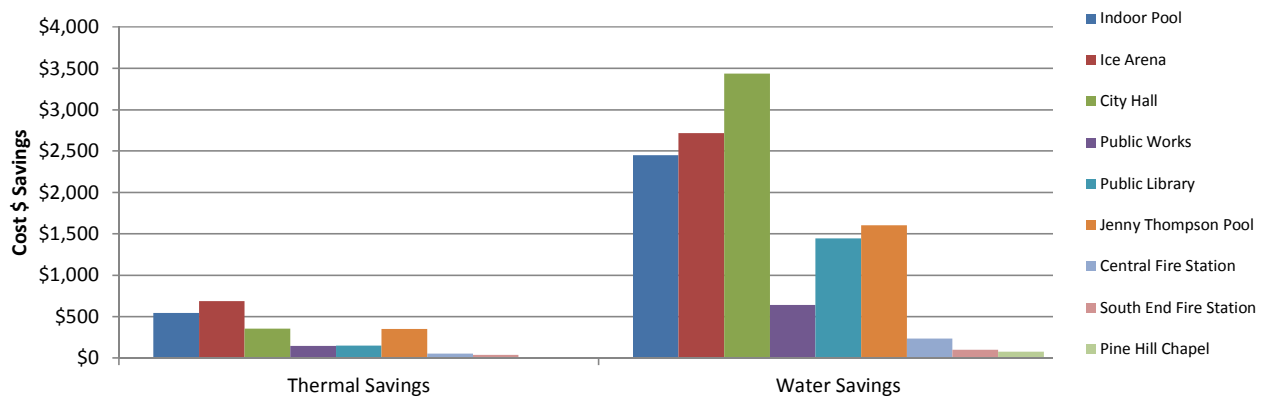
## FIM DESCRIPTION

### FIM 6: Water Conservation

The change in fixtures to more efficient ones is guaranteed to save 1,083 kgal of water annually and 159 MMBtu's in costs associated with heating that water. Total guaranteed savings are \$14,550.

FIM 6: Water Conservation					
Contract Year 2 Energy Cost Avoidance					
Building	Thermal Savings		Water Savings		Total Cost \$ Savings
	MMBtu	Cost \$	kGal	Cost \$	
Indoor Pool	37	\$544	215	\$2,451	\$2,994
Ice Arena	53	\$687	239	\$2,715	\$3,402
City Hall	21	\$354	302	\$3,438	\$3,792
Public Works	12	\$144	56	\$641	\$785
Public Library	10	\$152	127	\$1,448	\$1,600
Jenny Thompson Pool	25	\$351	141	\$1,601	\$1,952
Central Fire Station	3	\$53	21	\$235	\$288
South End Fire Station	2	\$37	9	\$102	\$138
Pine Hill Chapel	0	\$7	7	\$74	\$81
<b>Totals</b>	<b>164</b>	<b>\$2,329</b>	<b>1,117</b>	<b>\$12,705</b>	<b>\$15,034</b>

**FIM 6: Contract Year 2 Savings**



Verified savings are obtained from calculations and verified through flow measurements of fixtures before and after retrofit. Calculations have been provided in the appendix for reference. Pre-installation operation and occupancy are stipulated variables.

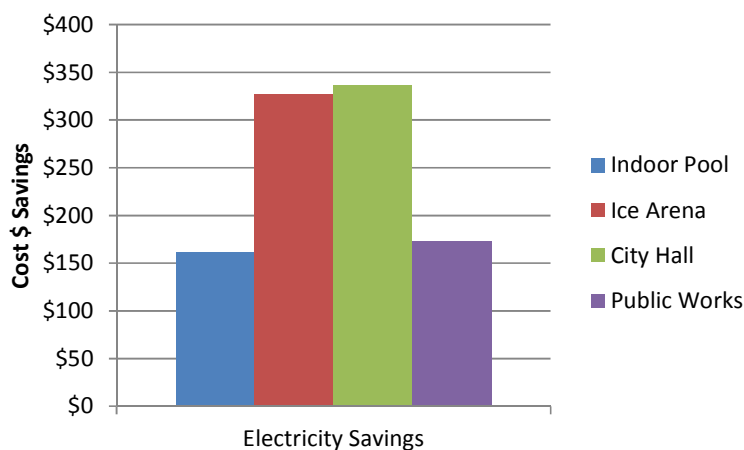
## FIM DESCRIPTION

### FIM 9: Vending Machine Controls

Savings from this FIM are derived from motion sensors which shut off the lights to the vending machine when nobody is around. The annual savings are guaranteed to be 8,146 kWh.

FIM 9: Vending Machine Controls				
Contract Year 2 Energy Cost Avoidance				
Building	Electricity Savings			Total Cost \$ Savings
	kW	kWh	Cost \$	
Indoor Pool	0	1,498	\$161	\$161
Ice Arena	0	2,995	\$327	\$327
City Hall	0	2,621	\$336	\$336
Public Works	0	1,311	\$173	\$173
<b>Totals</b>	<b>0</b>	<b>8,425</b>	<b>\$997</b>	<b>\$997</b>

**FIM 9: Contract Year 2 Savings**



Verified savings for vending machine controls are directly from engineering calculations. Equations used have been provided in the appendix. The scope of work has been verified to be fully implemented.

## FIM DESCRIPTION

### FIM 10: Pool Covers

Covering the pool when it is not in use eliminates heating need and water losses during unoccupied times. The annual savings that Dover can expect to see by using the pool cover is 45,256 kWh, 543 MMBtu's & 62.4 kgals of water, resulting in a cost savings over Year 2 of \$13,623.

FIM 10: Pool Covers								
Contract Year 2 Energy Cost Avoidance								
Building	Electricity Savings			Thermal Savings		Water Savings		Total Cost \$ Savings
	kW	kWh	Cost \$	MMBtu	Cost \$	kGal	Cost \$	
Indoor Pool	0	46,656	\$5,023	560	\$8,290	64	\$732	\$14,044

Verified savings for the pool covers are directly from engineering calculations. The installation has been inspected for completeness. Operational hours are a stipulated variable.

## FIM DESCRIPTION

### FIM 11: Ice Arena Updates

The Dover Ice Arena updates have been designed to produce an extra 32,649 kWh per year and create 61.8 kW more electrical demand per month (742 kW annually) in order to save 9,370 MMBtu's of natural gas annually. Additionally, from the work performed, there is an Operational Savings of \$11,232 for Year 2 that is realized at the Ice Arena. This is a result of moving the dashers and a decreased cost in overall maintenance costs due to the new electric chiller.

FIM 11: Ice Arena Upgrades								
Contract Year 2 Energy Cost Avoidance								
Building	Electricity Savings			Thermal Savings		Icemax	O&M	Total Cost
	kW	kWh	Cost \$	MMBtu	Cost \$	Cost \$	\$ Savings	\$ Savings
Ice Arena	(1,010)	(70,313)	(\$14,653)	8,740	\$113,788	(\$1,644)	\$11,232	\$108,723

This FIM is measured using IPMVP option C which measures performance through the use of utility bill analysis. Monthly utility invoices have been analyzed and accounted for to determine FIM 11 savings. Calculations and supporting documentation can in the FIM 11 section of Appendix A.

FIM 11: Ice Arena Updates consists of the following measures which contribute to arena savings

- FIM 11.1: Low Emissivity Ceiling
- FIM 11.2: Ice Temperature Control Optimization
- FIM 11.3: Dehumidification Controls
- FIM 11.4: Icemax System \*\*\*\* (Arena discontinued use in December 2012)
- FIM 11.5: Move the Dashers Inboard
- FIM 11.6: Installation of New Chiller
- FIM 11.7: Pumping System – VFD on Pump
- FIM 11.8: Controls Update

Since the implementation of these measures, savings realized over the summer at the Ice Arena are more significant than winter period. This is due to several of the measures providing more savings during warmer weather. For example, the low-e ceiling provides more of a difference in transfer of heat onto the ice surface over the summertime when weather is warmer and the sun's path is higher and longer.

## FIM DESCRIPTION

### **FIM 12: Power Factor Correction**

The power factor correction measure was designed to be applied at the Dover Ice Arena to correct and prevent low power factor. Other ancillary benefits to be gained by power factor correction include lower energy losses and better voltage regulation. It is guaranteed that by using the KVAR Energy Savings System the rink will save 67,810 kWh annually.

Expected completion of this measure took substantially longer than expected due to inability to have the chiller company provide documentation that the warranty on their equipment would not be affected by the implementation of the capacitors. The scope of work has varied slightly from the original scope but the equipment was installed at the ice arena in January 2013. Savings below (in this report) reflect operation of the measure for a period of time representative of 9 months of the contract year.

FIM 12: Power Factor Correction				
Contract Year 2 Energy Cost Avoidance				
Building	Electricity Savings			Total Cost \$ Savings
	kW	kWh	Cost \$	
Ice Arena	40	8,917	\$1,264	\$1,264

Verified savings are obtained from calculations and verified through electric measurements before and after the installation. Additional details are provided in the appendix on the installation of this measure.

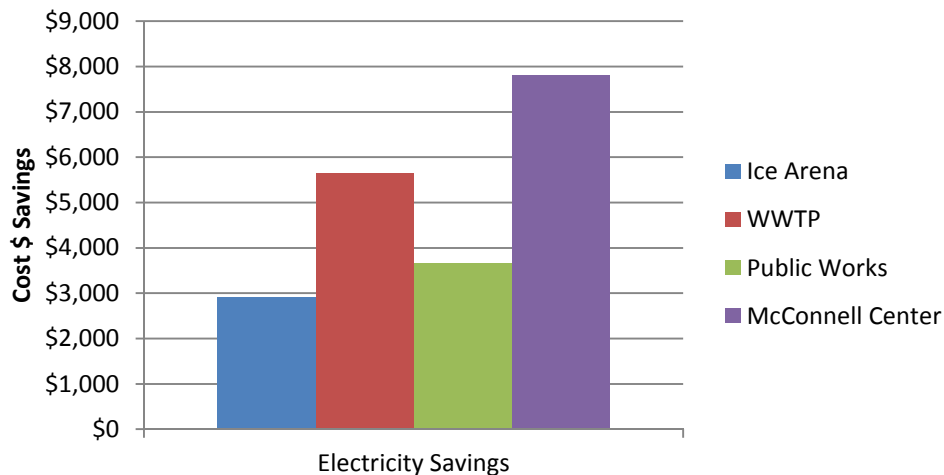
## FIM DESCRIPTION

### FIM 13: Energy Efficient Transformers

Savings associated with FIM 13 are from the replacement of transformers with more efficient ones, thus saving 145,554 kWh annually, with a monthly 25.7 kW reduction in demand (306 kW annually). Contract Year 2 cost savings are guaranteed to be \$18,941.

FIM 13: Transformers				
Contract Year 2 Energy Cost Avoidance				
Building	Electricity Savings			Total Cost \$ Savings
	kW	kWh	Cost \$	
WWTP	114	39,255	\$5,635	\$5,635
Public Works	0	27,750	\$3,658	\$3,658
McConnell Center	146	60,869	\$7,795	\$7,795
Ice Arena	59	22,754	\$2,914	\$2,914
<b>Totals</b>	<b>318</b>	<b>150,628</b>	<b>\$20,002</b>	<b>\$20,002</b>

### FIM 13: Contract Year 2 Savings



Verified savings for transformers are based off calculations and verified through field measurements of power, harmonics, and efficiency. Calculation equations have been provided in the appendix for reference. Operational hours and input power are stipulated variables.

## FIM DESCRIPTION

### FIM 14: Aeration Blowers – Retrofit

This measure was guaranteed to save \$34,444 over Year 2 through the replacement of three older positive displacement blowers with new high efficiency turbine blowers. Guaranteed annual energy savings for this FIM are obtained by reducing the electricity consumption by 272,264 kWh and monthly demand by 62.2 kW. In March of 2012, the odor control unit and silencer which provides ability to run the unit 24-7 were installed and scheduled to run full time to prevent odiferous concentration in the tanks. The energy usage of this blower has been subtracted from the verified overall blower savings but does not modify the guarantee.

FIM 14: Aeration Blowers Retrofit				
Contract Year 2 Energy Cost Avoidance				
Building	Electricity Savings			Total Cost \$ Savings
	kW	kWh	Cost \$	
WWTP	724	248,010	\$35,648	\$35,648

Additional controls work has been provided since full installation by both Dover and JCI to allow for further control of the units. This will assist the WWTP in control of the units and provide unrealized additional energy and operations savings based.

Verified savings are obtained from calculations and verified using measurements of power draw on the previous and new system. Methods of calculation have been provided in Appendix C for reference. Pre- installation loading and hours of operation are stipulated variables.

### FIM 15: Boiler Replacement

Savings for this measure are based on an increase in boiler efficiency from the old boiler to the high efficiency gas-fired boiler by approximately 7%. It is assumed that the boiler runs roughly from the middle of September through the middle of April. The annual savings associated with FIM 15 are calculated to be 88 MMBtu's annually or an estimated \$1,288 in Year 2.

FIM 15: Boiler Replacement			
Contract Year 2 Energy Cost Avoidance			
Building	Thermal Savings		Total Cost \$ Savings
	MMBtu	Cost \$	
Public Library	89	\$1,300	\$1,300

Verified savings are obtained from calculations and verified by testing the improved efficiency of the new boiler after emergency replacement of the old one. Calculations have been provided in the appendix for reference. Pre- installation boiler efficiency is a stipulated variable.

## ENVIRONMENTAL BENEFITS

### Greenhouse Gas Emissions

Total estimated emissions reductions are as follows:







Estimated Emissions Reductions: Contract Year 2- Tons of CO <sub>2</sub> -e						
FIM #	Facility Improvement Measure	Electricity	Natural Gas	#2 Fuel Oil	Propane	Total
FIM 1	Lighting Fixtures	99.9	(11.3)	(1.2)	0.0	87.5
FIM 2	Lighting Controls	35.3	0.0	0.0	0.0	35.3
FIM 3	Weatherization	1.9	43.8	11.9	5.8	63.4
FIM 4	EMS Upgrades	32.8	46.6	11.8	0.0	91.3
<i>FIM 4.1</i>	<i>Building Controls</i>	0.6	29.1	2.8	0.0	32.5
<i>FIM 4.2</i>	<i>Building Controls / Optimal Start</i>	0.0	0.0	9.0	0.0	9.0
<i>FIM 4.3</i>	<i>AHU Upgrade – VFD on Fan</i>	0.0	0.0	0.0	0.0	0.0
<i>FIM 4.4</i>	<i>Pool Dehumidification</i>	24.7	17.5	0.0	0.0	42.2
<i>FIM 4.5</i>	<i>Snow Melt Sensor</i>	7.6	0.0	0.0	0.0	7.6
FIM 6	Water Conservation	0.0	7.5	1.5	0.1	9.2
FIM 9	Vending Machine Controls	3.2	0.0	0.0	0.0	3.2
FIM 10	Pool Cover	17.7	29.7	0.0	0.0	47.4
FIM 11	Ice Rink Upgrades	(26.7)	464.2	0.0	0.0	437.5
FIM 12	Power Factor Correction	3.4	0.0	0.0	0.0	3.4
FIM 13	Energy Efficient Transformers	57.2	0.0	0.0	0.0	57.2
FIM 14	Aeration Blower Upgrade	94.1	0.0	0.0	0.0	94.1
FIM 15	Boiler Replacement	0.0	4.7	0.0	0.0	4.7
<b>Totals</b>		<b>318.8</b>	<b>585.3</b>	<b>24.1</b>	<b>6.0</b>	<b>934.2</b>



## ENVIRONMENTAL BENEFITS

**Dover Contract Year 2 Equivalency Savings**

The project's reduced emissions would be equivalent to:

CO <sub>2</sub> sequestered by	<b>23,955</b>	tree seedlings grown for 10 years in an urban scenario	
CO <sub>2</sub> sequestered by	<b>212</b>	acres of pine or fir forests	
CO <sub>2</sub> emissions from	<b>171</b>	passenger vehicles	
CO <sub>2</sub> emissions from	<b>2,173</b>	barrels of oil consumed	
CO <sub>2</sub> emissions from the <i>energy</i> use of	<b>82</b>	homes for one year	
CO <sub>2</sub> emissions from burning	<b>5</b>	coal railcars	

Source:  
All carbon equivalencies extracted directly from the EPA website.  
"Greenhouse Gas Equivalencies Calculator." Clean Energy. U.S. Environmental Protection Agency. <www.epa.gov/cleanenergy/energy-resources/calculator.html> (Aug. 6, 2008).

*Version:*  
Energy Project GHG Calculator. USA Version 3.0. January 7, 2009.

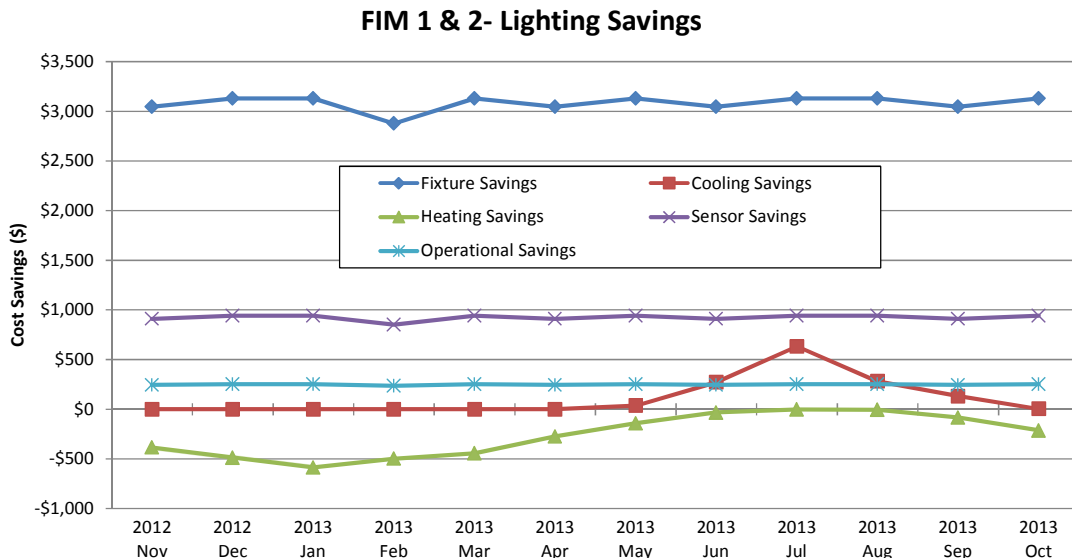
## APPENDIX A

### FIM 1 & 2: Lighting Fixture Retrofit & Controls

In the FIM 1 table below, energy savings are calculated using a combination of weather and days in order to provide a seasonal weighting towards cooling savings and heating losses. McConnell Center savings are included in this chart.

FIM 1: Lighting – Fixture Retrofit										
Contract Year 2 Energy Cost Avoidance										
Month	Year	Electricity Savings			Cooling Savings		Heating Savings		O&M	Total Cost
		kW	kWh	Cost \$	kWh	Cost \$	MMBtu	Cost \$	\$ Savings	\$ Savings
November	2012	119	20,668	\$3,045	0	\$0	(28)	(\$383)	\$246	\$2,908
December	2012	119	21,356	\$3,129	0	\$0	(35)	(\$486)	\$254	\$2,897
January	2013	119	21,356	\$3,129	0	\$0	(43)	(\$585)	\$254	\$2,798
February	2013	119	19,290	\$2,877	0	\$0	(36)	(\$497)	\$237	\$2,618
March	2013	119	21,356	\$3,129	0	\$0	(32)	(\$443)	\$254	\$2,940
April	2013	119	20,668	\$3,045	0	\$0	(20)	(\$274)	\$246	\$3,017
May	2013	119	21,356	\$3,129	313	\$36	(10)	(\$141)	\$254	\$3,278
June	2013	119	20,668	\$3,045	2,393	\$273	(2)	(\$32)	\$246	\$3,532
July	2013	119	21,356	\$3,129	5,552	\$632	(0)	(\$1)	\$254	\$4,014
August	2013	119	21,356	\$3,129	2,469	\$281	(0)	(\$5)	\$254	\$3,660
September	2013	119	20,668	\$3,045	1,164	\$133	(6)	(\$83)	\$246	\$3,341
October	2013	119	21,356	\$3,129	32	\$4	(15)	(\$213)	\$254	\$3,174
<b>Contract Year 2</b>		<b>1,426</b>	<b>251,455</b>	<b>\$36,965</b>	<b>11,924</b>	<b>\$1,358</b>	<b>(228)</b>	<b>(\$3,143)</b>	<b>\$2,995</b>	<b>\$38,176</b>

FIM 1&2 savings are shown monthly below for the Contract Year:



## APPENDIX A

### FIM 1 & 2: Lighting Fixture Retrofit & Controls

The FIM 2 table breaks down the measure by month over the year. McConnell Center savings are included in this chart.

FIM 2: Lighting – Fixture Controls					
Contract Year 2 Energy Cost Avoidance					
Month	Year	Electricity Savings			Total Cost \$ Savings
		kW	kWh	Cost \$	
November	2012	26	7,654	\$912	\$912
December	2012	26	7,909	\$942	\$942
January	2013	26	7,909	\$942	\$942
February	2013	26	7,143	\$851	\$851
March	2013	26	7,909	\$942	\$942
April	2013	26	7,654	\$912	\$912
May	2013	26	7,909	\$942	\$942
June	2013	26	7,654	\$912	\$912
July	2013	26	7,909	\$942	\$942
August	2013	26	7,909	\$942	\$942
September	2013	26	7,654	\$912	\$912
October	2013	26	7,909	\$942	\$942
Contract Year 2		310	93,119	\$11,094	\$11,094

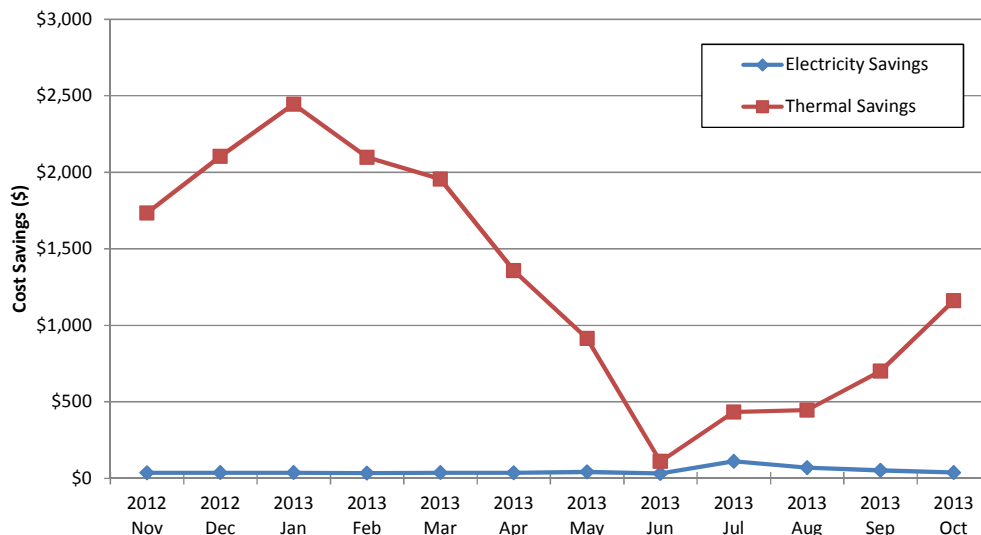
## APPENDIX A

### FIM 3: Weatherization

In the FIM 3 table below, energy savings are calculated using a combination of weather and days in order to provide a seasonal weighting towards cooling and heating savings. As such, cooling savings are more concentrated during warmer weather and heating savings are larger during colder weather when more heating is necessary.

FIM 3: Weatherization							
Contract Year 2 Energy Cost Avoidance							
Month	Year	Electricity Savings			Thermal Savings		Total Cost \$ Savings
		kW	kWh	Cost \$	MMBtu	Cost \$	
November	2012	0	332	\$36	120	\$1,734	\$1,771
December	2012	0	343	\$37	145	\$2,105	\$2,142
January	2013	0	343	\$37	168	\$2,445	\$2,483
February	2013	0	310	\$34	144	\$2,099	\$2,132
March	2013	0	343	\$37	135	\$1,956	\$1,994
April	2013	0	332	\$36	95	\$1,358	\$1,394
May	2013	0	376	\$42	65	\$914	\$956
June	2013	0	248	\$32	7	\$110	\$142
July	2013	0	918	\$111	33	\$433	\$544
August	2013	0	599	\$70	34	\$446	\$516
September	2013	0	453	\$52	51	\$701	\$752
October	2013	0	346	\$38	82	\$1,162	\$1,200
<b>Contract Year 2</b>		<b>0</b>	<b>4,943</b>	<b>\$562</b>	<b>1,079</b>	<b>\$15,463</b>	<b>\$16,026</b>

**FIM 3- Weatherization Savings**



## APPENDIX A

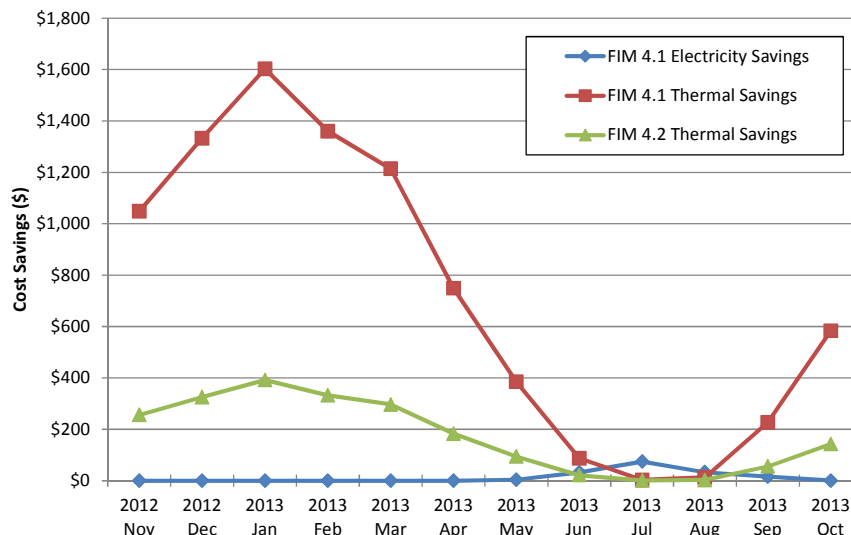
### FIM 4: Energy Management System Upgrades

FIM 4.1: EMS – Building Controls & FIM 4.2: EMS – Building Controls / Optimal Start

In the FIM 4.1 & 4.2 table below, weather is used to provide a seasonal weighting towards cooling and heating savings. As such, cooling savings are more concentrated during warmer weather and heating savings are concentrated during colder weather when more heating is necessary.

City of Dover		FIM 4.1: EMS - Building Controls						FIM 4.2: Building Controls / Optimal Start		
		Contract Year 2 Energy Cost Avoidance						Contract Year 2 Energy Cost Avoidance		
		Electricity Savings			Thermal Savings		Total Cost \$ Savings	Thermal Savings		Total Cost \$ Savings
Month	Year	kW	kWh	Cost \$	MMBtu	Cost \$		MMBtu	Cost \$	
November	2012	0	0	\$0	71	\$1,048	\$1,048	15	\$256	\$256
December	2012	0	0	\$0	91	\$1,332	\$1,332	19	\$326	\$326
January	2013	0	0	\$0	109	\$1,603	\$1,603	23	\$392	\$392
February	2013	0	0	\$0	93	\$1,360	\$1,360	19	\$332	\$332
March	2013	0	0	\$0	83	\$1,214	\$1,214	17	\$297	\$297
April	2013	0	0	\$0	51	\$749	\$749	11	\$183	\$183
May	2013	0	38	\$4	26	\$385	\$390	5	\$94	\$94
June	2013	0	293	\$32	6	\$87	\$120	1	\$21	\$21
July	2013	0	679	\$75	0	\$3	\$78	0	\$1	\$1
August	2013	0	302	\$33	1	\$13	\$46	0	\$3	\$3
September	2013	0	142	\$16	15	\$227	\$243	3	\$55	\$55
October	2013	0	4	\$0	40	\$583	\$583	8	\$142	\$142
<b>Contract Year 2</b>		<b>0</b>	<b>1,457</b>	<b>\$161</b>	<b>586</b>	<b>\$8,605</b>	<b>\$8,766</b>	<b>122</b>	<b>\$2,103</b>	<b>\$2,103</b>

**FIM 4.1/4.2- EMS Building Controls**



## APPENDIX A

### FIM 4: Energy Management System Upgrades

FIM 4.3: AHU Upgrade – VFD on Fan

Savings for fan electricity are based off fan run-time while conditioning savings are weighted based off monthly weather and temperature profiles. This VFD installed as part of this unit was removed in September of 2012 due to difficulty of operation and multiple ongoing problems. JCI has paid to restore the system to previous operation capability. There is no current plan to re-install the VFD on this unit

FIM 4.3: AHU Upgrade - VFD on Fan									
Contract Year 2 Energy Cost Avoidance									
Month	Year	Fan Electricity Savings			Cooling Savings		Thermal Savings		Total Cost \$ Savings
		kW	kWh	Cost \$	kWh	Cost \$	MMBtu	Cost \$	
November	2012	0	0	\$0	0	\$0	0	\$0	\$0
December	2012	0	0	\$0	0	\$0	0	\$0	\$0
January	2013	0	0	\$0	0	\$0	0	\$0	\$0
February	2013	0	0	\$0	0	\$0	0	\$0	\$0
March	2013	0	0	\$0	0	\$0	0	\$0	\$0
April	2013	0	0	\$0	0	\$0	0	\$0	\$0
May	2013	0	0	\$0	0	\$0	0	\$0	\$0
June	2013	0	0	\$0	0	\$0	0	\$0	\$0
July	2013	0	0	\$0	0	\$0	0	\$0	\$0
August	2013	0	0	\$0	0	\$0	0	\$0	\$0
September	2013	0	0	\$0	0	\$0	0	\$0	\$0
October	2013	0	0	\$0	0	\$0	0	\$0	\$0
<b>Contract Year 2</b>		<b>0</b>	<b>0</b>	<b>\$0</b>	<b>0</b>	<b>\$0</b>	<b>0</b>	<b>\$0</b>	<b>\$0</b>

## APPENDIX A

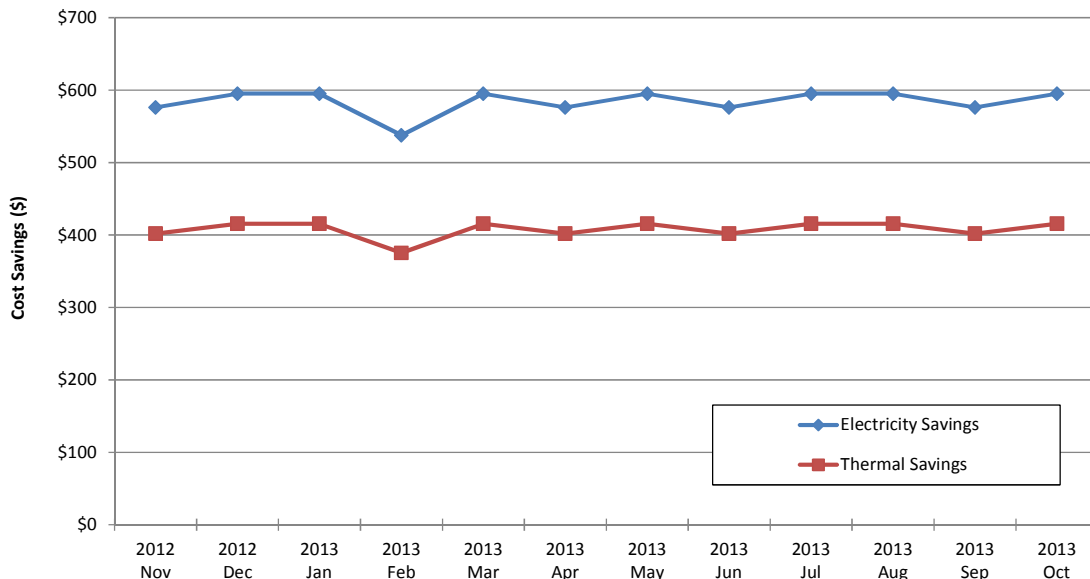
### FIM 4: Energy Management System Upgrades

#### FIM 4.4: Pool Dehumidification – EMS & VFD's

In the FIM 4.4 table below, electricity and thermal savings are realized by the Indoor Pool as follows:

FIM 4.4: Pool Dehumidification - EMS & VFD's								
Contract Year 2 Energy Cost Avoidance								
Month	Year	Electricity Savings			Thermal Savings		Capital Cost	Total Cost
		kW	kWh	Cost \$	MMBtu	Cost \$	\$ Avoidance	
November	2012	0	5,350	\$576	27	\$402	\$2,774	\$3,752
December	2012	0	5,529	\$595	28	\$415	\$2,866	\$3,877
January	2013	0	5,529	\$595	28	\$415	\$2,866	\$3,877
February	2013	0	4,994	\$538	25	\$375	\$2,681	\$3,594
March	2013	0	5,529	\$595	28	\$415	\$2,866	\$3,877
April	2013	0	5,350	\$576	27	\$402	\$2,774	\$3,752
May	2013	0	5,529	\$595	28	\$415	\$2,866	\$3,877
June	2013	0	5,350	\$576	27	\$402	\$2,774	\$3,752
July	2013	0	5,529	\$595	28	\$415	\$2,866	\$3,877
August	2013	0	5,529	\$595	28	\$415	\$2,866	\$3,877
September	2013	0	5,350	\$576	27	\$402	\$2,774	\$3,752
October	2013	0	5,529	\$595	28	\$415	\$2,866	\$3,877
Contract Year 2		0	65,096	\$7,008	330	\$4,891	\$33,840	\$45,739

**FIM 4.4- Pool Dehumidification Savings**



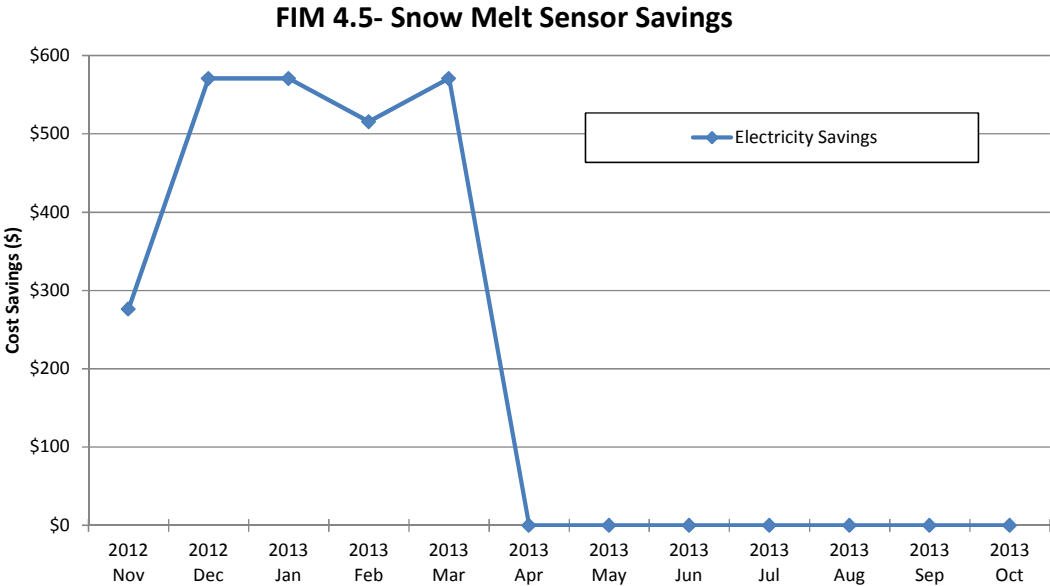
## APPENDIX A

### FIM 4: Energy Management System Upgrades

FIM 4.5: Repair Snow Melt Sensor

The snow melt sensor is assumed to be operational from mid November through March during the snow season. Savings are concentrated over that period.

FIM 4.5: Repair Snow Melt Sensor					
Contract Year 2 Energy Cost Avoidance					
Month	Year	Electricity Savings			Total Cost \$ Savings
		kW	kWh	Cost \$	
November	2012	0	2,195	\$276	\$276
December	2012	0	4,537	\$571	\$571
January	2013	0	4,537	\$571	\$571
February	2013	0	4,098	\$515	\$515
March	2013	0	4,537	\$571	\$571
April	2013	0	0	\$0	\$0
May	2013	0	0	\$0	\$0
June	2013	0	0	\$0	\$0
July	2013	0	0	\$0	\$0
August	2013	0	0	\$0	\$0
September	2013	0	0	\$0	\$0
October	2013	0	0	\$0	\$0
<b>Contract Year 2</b>		<b>0</b>	<b>19,905</b>	<b>\$2,504</b>	<b>\$2,504</b>



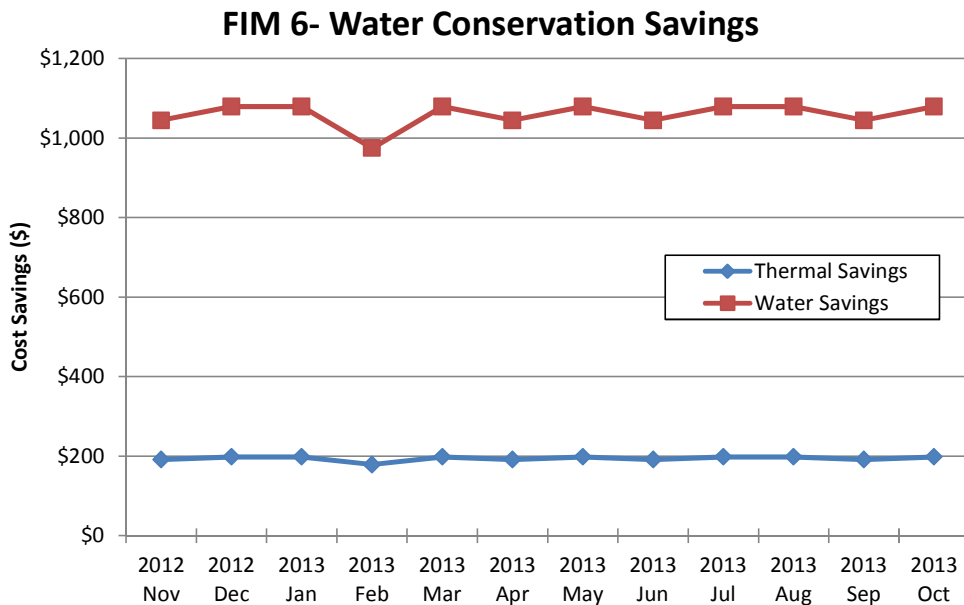


## APPENDIX A

### FIM 6: Water Conservation

The FIM 6 table and chart breaks down the monthly savings by month over Contract Year:

FIM 6: Water Conservation						
Contract Year 2 Energy Cost Avoidance						
Month	Year	Thermal Savings		Water Savings		Total Cost \$ Savings
		MMBtu	Cost \$	kGal	Cost \$	
November	2012	13	\$191	92	\$1,044	\$1,236
December	2012	14	\$198	95	\$1,079	\$1,277
January	2013	14	\$198	95	\$1,079	\$1,277
February	2013	13	\$179	86	\$975	\$1,153
March	2013	14	\$198	95	\$1,079	\$1,277
April	2013	13	\$191	92	\$1,044	\$1,236
May	2013	14	\$198	95	\$1,079	\$1,277
June	2013	13	\$191	92	\$1,044	\$1,236
July	2013	14	\$198	95	\$1,079	\$1,277
August	2013	14	\$198	95	\$1,079	\$1,277
September	2013	13	\$191	92	\$1,044	\$1,236
October	2013	14	\$198	95	\$1,079	\$1,277
Contract Year 2		164	\$2,329	1,117	\$12,705	\$15,034

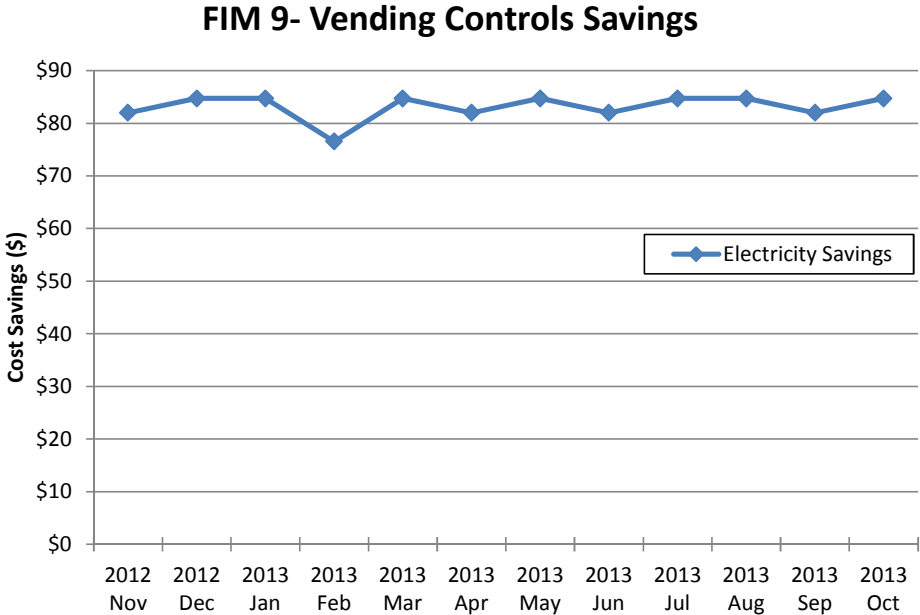


## APPENDIX A

### FIM 9: Vending Machine Controls

The FIM 9 table breaks down the measure by month over Year 2.

FIM 9: Vending Machine Controls					
Contract Year 2 Energy Cost Avoidance					
Month	Year	Electricity Savings			Total Cost \$ Savings
		kW	kWh	Cost \$	
November	2012	0	692	\$82	\$82
December	2012	0	716	\$85	\$85
January	2013	0	716	\$85	\$85
February	2013	0	646	\$77	\$77
March	2013	0	716	\$85	\$85
April	2013	0	692	\$82	\$82
May	2013	0	716	\$85	\$85
June	2013	0	692	\$82	\$82
July	2013	0	716	\$85	\$85
August	2013	0	716	\$85	\$85
September	2013		692	\$82	\$82
October	2013		716	\$85	\$85
<b>Contract Year 2</b>		<b>0</b>	<b>8,425</b>	<b>\$997</b>	<b>\$997</b>



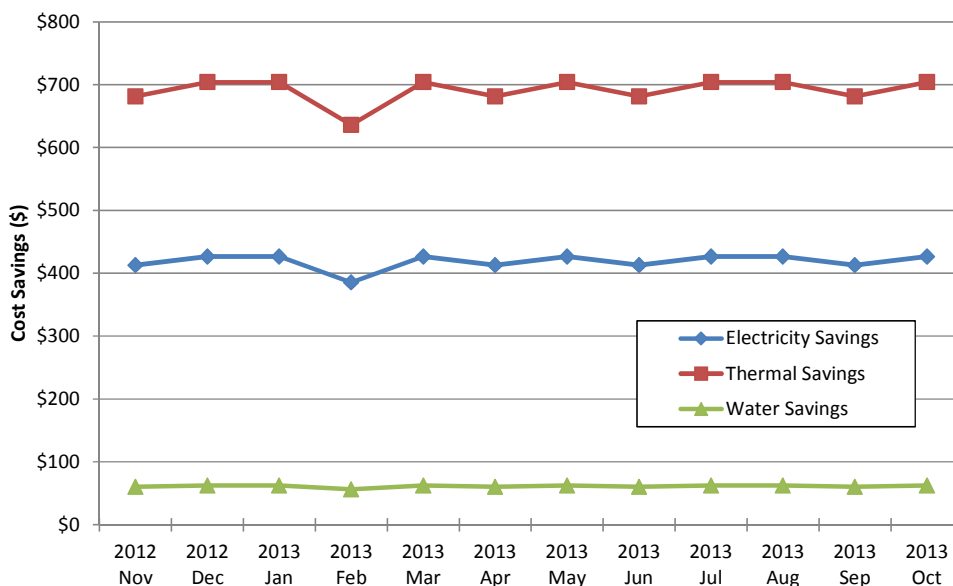
## APPENDIX A

### FIM 10: Pool Cover

The following FIM 10 table and chart break down the measure by month over the year.

FIM 10: Pool Cover									
Contract Year 2 Energy Cost Avoidance									
Month	Year	Electricity Savings			Thermal Savings		Water Savings		Total Cost \$ Savings
		kW	kWh	Cost \$	MMBtu	Cost \$	kGal	Cost \$	
November	2012	0	3,835	\$413	46	\$681	5.3	\$60	\$1,154
December	2012	0	3,963	\$427	48	\$704	5.5	\$62	\$1,193
January	2013	0	3,963	\$427	48	\$704	5.5	\$62	\$1,193
February	2013	0	3,579	\$385	43	\$636	4.9	\$56	\$1,077
March	2013	0	3,963	\$427	48	\$704	5.5	\$62	\$1,193
April	2013	0	3,835	\$413	46	\$681	5.3	\$60	\$1,154
May	2013	0	3,963	\$427	48	\$704	5.5	\$62	\$1,193
June	2013	0	3,835	\$413	46	\$681	5.3	\$60	\$1,154
July	2013	0	3,963	\$427	48	\$704	5.5	\$62	\$1,193
August	2013	0	3,963	\$427	48	\$704	5.5	\$62	\$1,193
September	2013		3,835	\$413	46	\$681	5.3	\$60	\$1,154
October	2013		3,963	\$427	48	\$704	5.5	\$62	\$1,193
<b>Contract Year 2</b>		<b>0</b>	<b>46,656</b>	<b>\$5,023</b>	<b>560</b>	<b>\$8,290</b>	<b>64</b>	<b>\$732</b>	<b>\$14,044</b>

**FIM 10- Pool Cover Savings**



## APPENDIX A

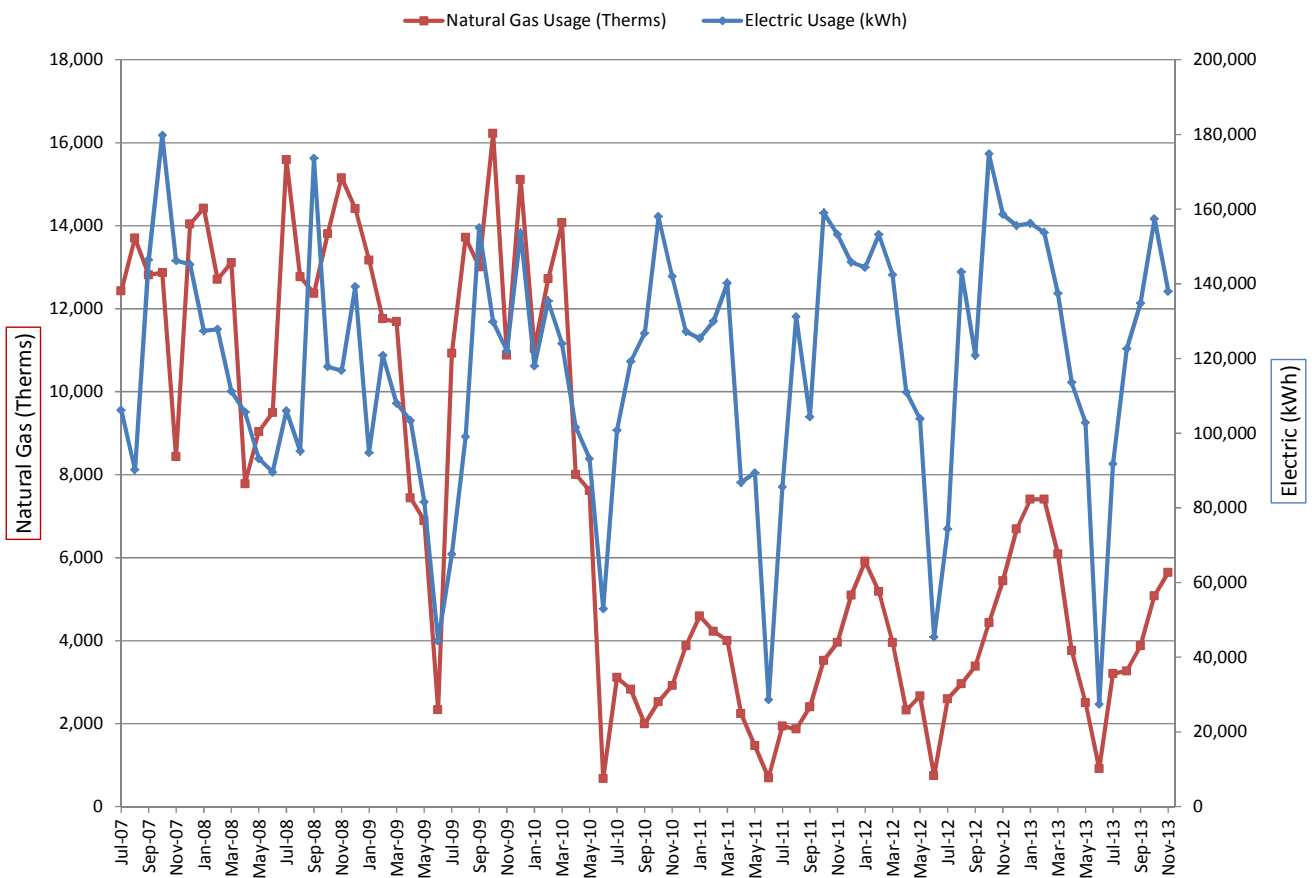
### FIM 11: Ice Arena Upgrades

#### Overall Utility Comparison

The Ice Arena part of this project consists of many items that together will achieve savings. The measurement method of FIM 11 is done via entire building utility comparison analysis. This analysis compares the usage of electricity and natural gas before and after the changes occurred. It applies the change in utilities use to track the effectiveness and calculate the savings of the work done.

The natural gas and electric usage are affected by the measures implemented at the Ice Arena. There is major mechanical equipment at the site that runs on both gas and electric. As part of this project, an electric chiller was installed as the lead unit which was previously gas, so there is a relationship between the two energy usages. Below is a graph showing the history of both since July 2007. As a note, most FIM 11 work was completed between June and September 2010.

**Dover Ice Arena- Monthly Electric & Gas Usage**



## APPENDIX A

### FIM 11: Ice Arena Upgrades

As part of the utility bill comparison, normalization of utility data is done through the use of Metrix software. This takes weather history and other entered variables into account in order to provide bills in different years and scenarios on an equal playing field. Weather degree days have been provided in Appendix B.

The one entered variable needed in this case is shown below. In order to properly take into account the load seen by the chillers and rink scheduling, this 'Chiller- Ice Hours' variable was created and used in the regression analysis performed. Below is the simple calculation table and equations used to create the variable.

Dover Ice Arena Chiller- Ice Hours Variable Calculation						
Month	Avail Hours	Arena 1	Arena 2	Ice Hours	2nd Rink Startup	Chiller- Ice Hours
August	744	100%	0%	744	0	744
September	720	100%	23%	888	540	1,428
October	744	100%	100%	1,488	186	1,674
November	720	100%	100%	1,440	0	1,440
December	744	100%	100%	1,488	0	1,488
January	744	100%	100%	1,488	0	1,488
February	696	100%	100%	1,392	0	1,392
March	744	100%	100%	1,488	0	1,488
April	720	100%	0%	720	0	720
May	744	100%	0%	744	0	744
June	720	0%	0%	0	0	0
July	744	100%	0%	744	0	744

$$\text{Ice Hours} = \text{Available Hours} \times (\text{Arena 1} + \text{Arena 2})$$

$$\text{Chiller-Ice Hours} = \text{Ice Hours} + \text{2nd Rink Startup}$$

$$\text{2nd Rink Startup}_{\text{Sept.}} = \frac{168 \frac{\text{Hours}}{\text{Week}} \times 30 \frac{\text{Days}}{\text{Month}} \times \frac{3}{4} \text{ Months Run Time}}{7 \frac{\text{Days}}{\text{Week}}}$$

$$\text{2nd Rink Startup}_{\text{Oct.}} = \frac{168 \frac{\text{Hours}}{\text{Week}} \times 31 \frac{\text{Days}}{\text{Month}} \times \frac{1}{4} \text{ Months Run Time}}{7 \frac{\text{Days}}{\text{Week}}}$$

## APPENDIX A

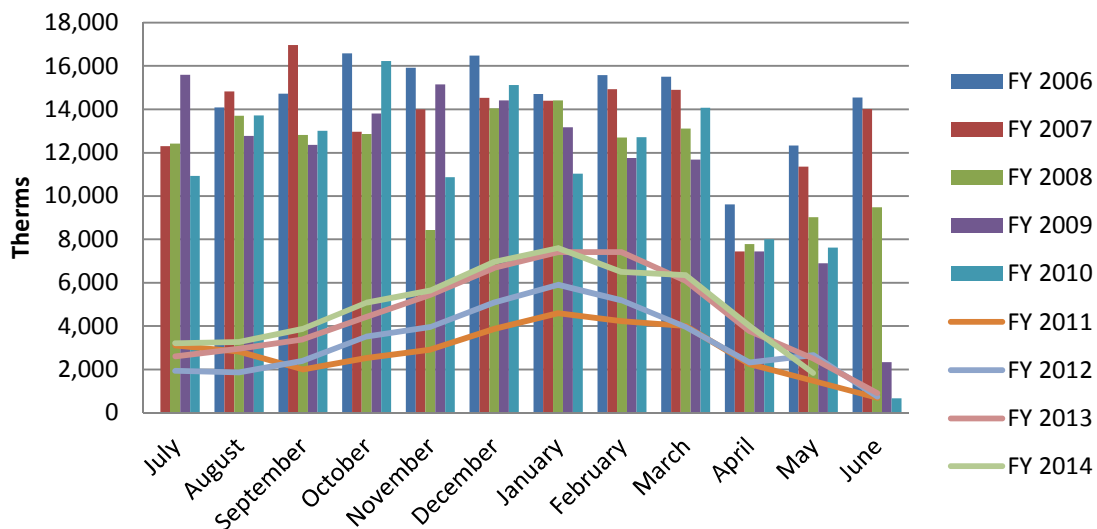
### FIM 11: Ice Arena Upgrades- Natural Gas

#### Natural Gas

Savings from FIM 11 are realized through comparison of utility bills. Below is the natural gas usage per month obtained from bills since August 2007. Baseline data in the chart below is in green, year 1 contract data is in yellow, and year 2 contract period in blue. Future year 3 contract period is in pink.

Dover Ice Arena Natural Gas Billable Usage (Therms)							
Month	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13	2013 - 14
August	13,703	12,769	13,718	2,828	1,869	2,959	3,271
September	12,817	12,369	13,008	1,995	2,403	3,384	3,877
October	12,869	13,804	16,225	2,527	3,522	4,433	5,084
November	8,430	15,155	10,880	2,917	3,956	5,443	5,643
December	14,039	14,410	15,114	3,875	5,092	6,689	6,970
January	14,419	13,171	11,041	4,593	5,911	7,404	7,598
February	12,708	11,754	12,717	4,225	5,183	7,410	6,489
March	13,110	11,687	14,072	4,003	3,955	6,090	6,343
April	7,784	7,441	8,006	2,246	2,323	3,762	4,001
May	9,038	6,892	7,616	1,470	2,665	2,500	1,838
June	9,495	2,336	675	688	742	915	-
July	15,589	10,925	3,110	1,943	2,599	3,210	-

### Dover Ice Arena- Monthly Natural Gas Usage



## APPENDIX A

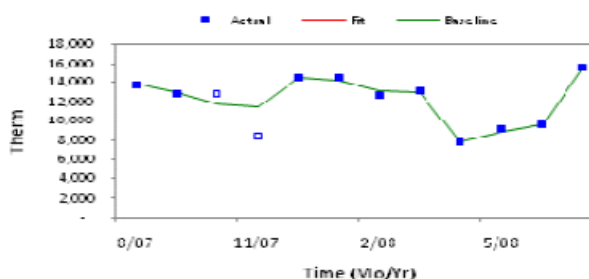
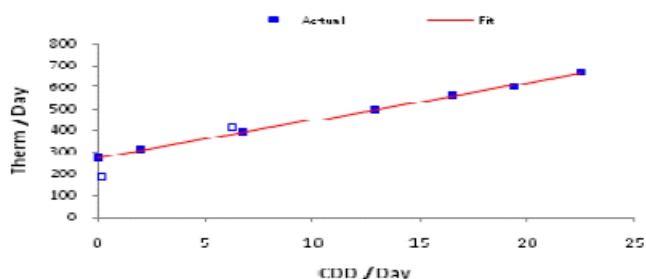
### FIM 11: Ice Arena Upgrades- Natural Gas

Using Metrix regression analysis software, a natural gas usage baseline was developed for the Ice Arena to be used in comparing bills with different weather and arena usage. The meter tuning contract for natural gas is included below. This provides the calculation of how the FIM 11 baseline for natural gas was developed.

#### Meter Tuning Contract

Project: Dover, NH  
 Area: Dover Ice Arena  
 Account: 4170121-4061358

Site: Dover, NH  
 Meter: Natural Gas  
 Unit: Therm(Qty OnPk)



From	To	# Days	Reading	Incl?	HDD	CDD	Chiller-Ice Hours	Offset	Baseline	Deviation
08/01/07	08/31/07	31	13,703	<input checked="" type="checkbox"/>	29.5	601.0	744	-	13,869	1.2%
09/01/07	09/30/07	30	12,817	<input checked="" type="checkbox"/>	109.0	386.0	1,428	-	12,980	1.3%
10/01/07	10/31/07	31	12,869	<input type="checkbox"/>	293.0	192.5	1,674	-	11,844	-8.0%
11/01/07	11/30/07	30	8,430	<input type="checkbox"/>	782.5	4.5	1,440	-	11,437	35.7%
12/01/07	12/31/07	31	14,439	<input checked="" type="checkbox"/>	1162.5	0.0	1,488	-	14,368	-0.5%
01/01/08	01/31/08	31	14,419	<input checked="" type="checkbox"/>	1134.5	0.5	1,488	-	14,168	-1.7%
02/01/08	02/29/08	29	12,708	<input checked="" type="checkbox"/>	1051.5	0.0	1,392	-	13,173	3.7%
03/01/08	03/31/08	31	13,110	<input checked="" type="checkbox"/>	970.5	0.0	1,488	-	12,941	-1.3%
04/01/08	04/30/08	30	7,784	<input checked="" type="checkbox"/>	491.5	58.5	720	-	7,829	0.6%
05/01/08	05/31/08	31	9,038	<input checked="" type="checkbox"/>	258.0	210.0	744	-	8,815	-2.5%
06/01/08	06/30/08	30	9,495	<input checked="" type="checkbox"/>	38.0	496.5	-	-	9,644	1.6%
07/01/08	07/31/08	31	15,589	<input checked="" type="checkbox"/>	0.0	697.5	744	-	15,316	-1.8%
<b>Sum/Average/Max</b>		<b>366</b>	<b>144,401</b>		<b>6320.5</b>	<b>2647.0</b>	<b>13,350</b>	<b>-</b>	<b>146,383</b>	<b>0% +/- 1.9%</b>

**Natural Gas (Account # 4170121-4061358): Tuning Period is 366 days from 8/1/2007 until 7/31/2008.**  
 Below is the equation used to calculate the Baseline values for the tuning period and all future periods:  

$$\text{Baseline (Therm)} = 26.26 \times \# \text{Days} + 7.43 \times \text{HDD} + 17.27 \times \text{CDD} + 3.3 \times \text{Chiller-Ice Hours}$$
  
 The Baseline Equation has a Net Mean Bias of 0% and a Monthly Mean Error of +/-1.9%. The underlying regression has a  $R^2=0.991$   
 Baseline Costs are calculated using Average Total Cost/Consumption, but no less than \$1.242132/ Therm.  
**Explanations and Assumptions:**  
 (empty checkbox) under 'Incl?' indicates that the bill is excluded from the regression. However the Baseline Equation is always applied for all billing periods, even those excluded from the regression.  
 HDD = Heating Degree-Days calculated for ROCHESTERNH for a 63.0 F° balance point.  
 CDD = Cooling Degree-Days calculated for ROCHESTERNH for a 49.0 F° balance point.  
 Multiplier is derived from Modification(s) in effect during the tuning period and is replicated annually for all future periods.

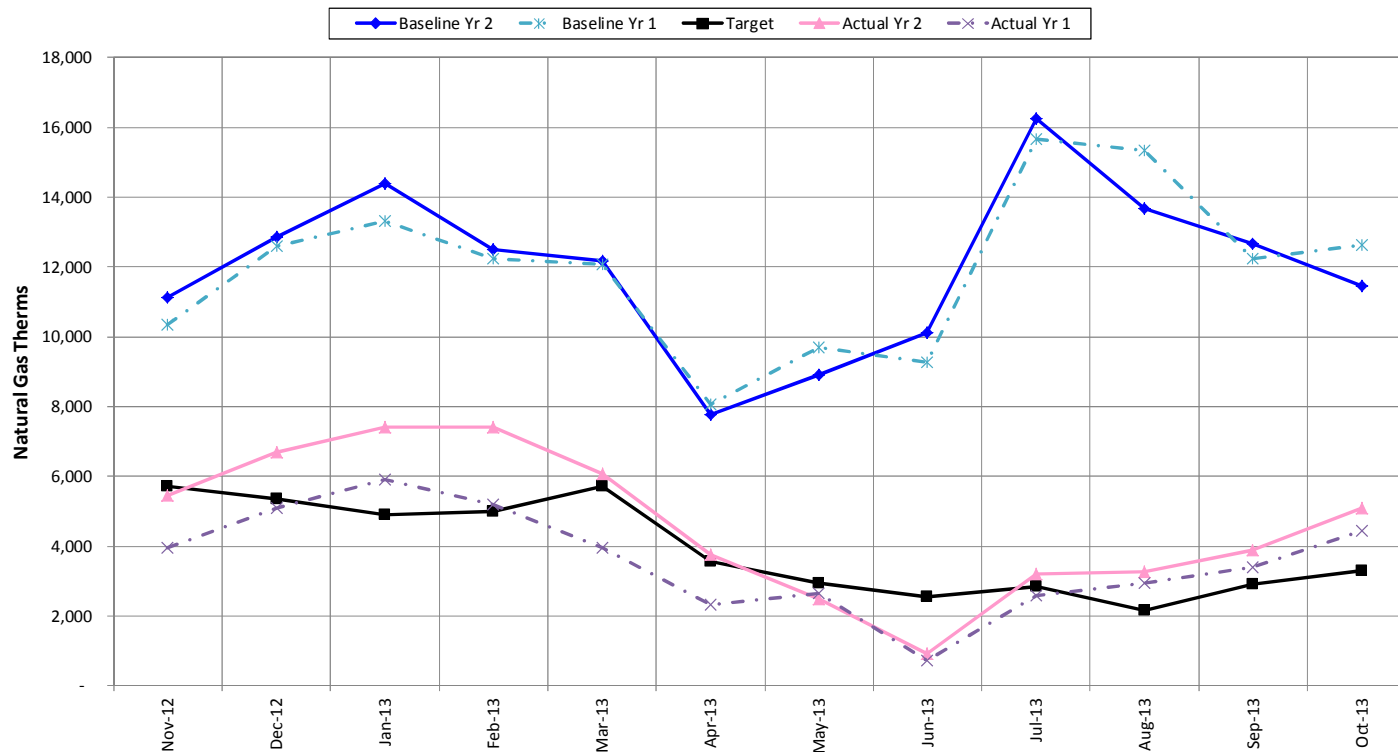
The regression has a  $R^2$  value of 0.991 excluding two of the twelve baseline points, which is exceptionally better than required. As per the contract, the natural gas baseline is within 1.4% of the actual utility data complying with the necessary 2% mark.

## APPENDIX A

### FIM 11: Ice Arena Upgrades- Natural Gas

This regression analysis graph was run for **natural gas therm usage**. The three solid lines shown represent the calculated Year 2 baseline (blue), target utility use based off calculations and guarantees (black), and actual Year 2 ice arena utility use from utility invoices (pink). Year 1 data baseline (teal) and actual (purple) have been superimposed using dotted lines for reference as shown below:

Baseline/Target/Actual Natural Gas Therm for Dover Ice Arena Natural Gas Meter



Scenario	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Total
Baseline Yr 2	11,142	12,859	14,401	12,509	12,187	7,784	8,923	10,119	16,244	13,663	12,672	11,441	143,944
Target	5,700	5,348	4,898	4,992	5,714	3,571	2,949	2,551	2,859	2,162	2,918	3,302	46,964
Actual Yr 2	5,443	6,689	7,404	7,410	6,090	3,762	2,500	915	3,210	3,271	3,877	5,084	55,655
Savings	5,699	6,170	6,997	5,099	6,097	4,022	6,423	9,204	13,034	10,392	8,795	6,357	88,289

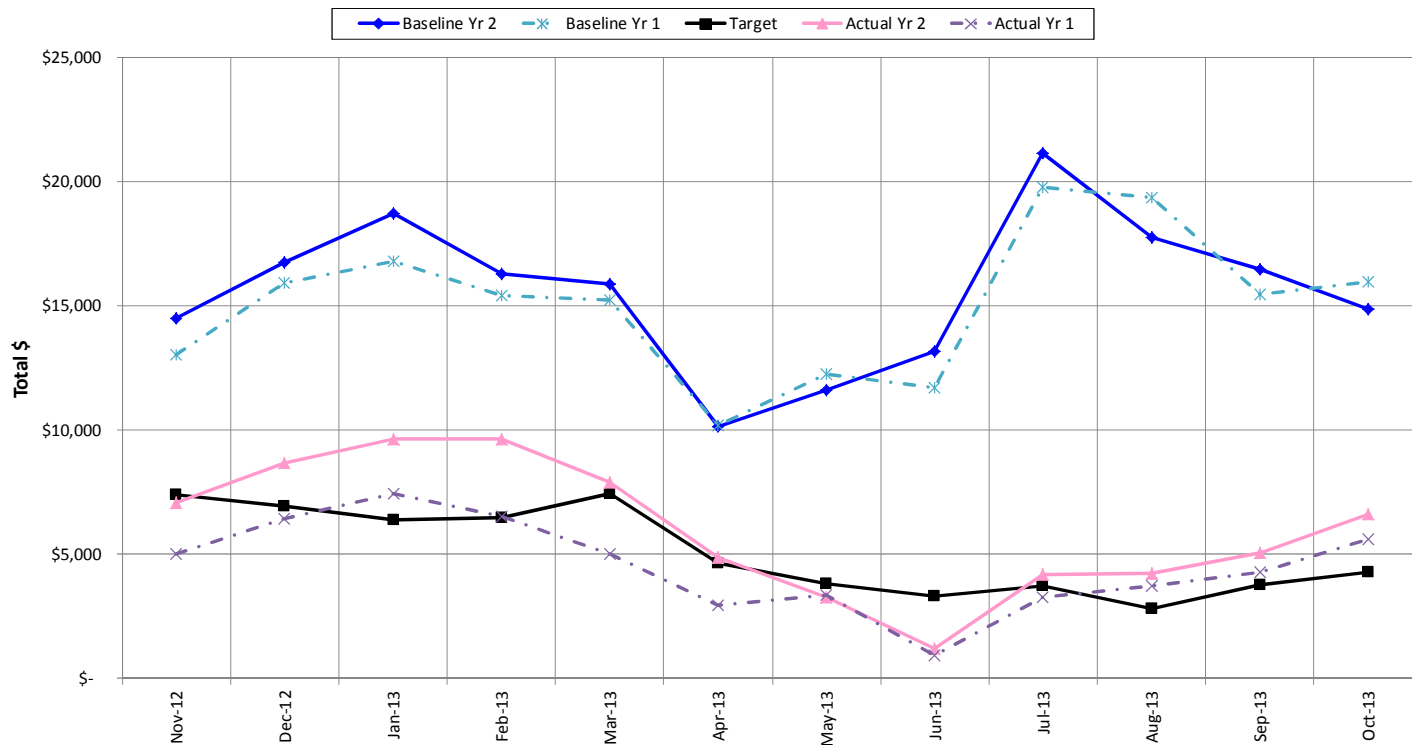


## APPENDIX A

### FIM 11: Ice Arena Upgrades- Natural Gas

This regression analysis graph was run for **natural gas cost**. The three solid lines shown represent the calculated Yr 2 baseline (blue), target utility cost based off calculations and guarantees (black), and actual Yr 2 contractual ice arena utility cost from utility use & contractual rates (pink). Year 1 cost baseline (teal) and actual (purple) have been superimposed using dotted lines for reference as shown below:

Baseline/Target/Actual Total \$ for Dover Ice Arena Natural Gas Meter



Scenario	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Total
Baseline Yr 2	\$ 14,507	\$ 16,742	\$ 18,750	\$ 16,287	\$ 15,867	\$ 10,135	\$ 11,618	\$ 13,175	\$ 21,150	\$ 17,789	\$ 16,499	\$ 14,896	\$ 187,415
Target	\$ 7,421	\$ 6,963	\$ 6,377	\$ 6,500	\$ 7,440	\$ 4,649	\$ 3,840	\$ 3,321	\$ 3,722	\$ 2,815	\$ 3,799	\$ 4,299	\$ 61,147
Actual Yr 2	\$ 7,087	\$ 8,709	\$ 9,640	\$ 9,648	\$ 7,929	\$ 4,898	\$ 3,255	\$ 1,191	\$ 4,179	\$ 4,259	\$ 5,048	\$ 6,619	\$ 72,463
Savings	\$ 7,420	\$ 8,033	\$ 9,110	\$ 6,639	\$ 7,938	\$ 5,237	\$ 8,363	\$ 11,984	\$ 16,970	\$ 13,530	\$ 11,451	\$ 8,277	\$ 114,952

## APPENDIX A

### FIM 11: Ice Arena Upgrades- Natural Gas

Since there are measures included at the Ice Arena that are not to be measured by utility bill analysis, they must be subtracted from the overall savings as to not be counted twice. Below is a table of Year 2 natural gas savings from all other measures at the Ice Arena:

FIM 11: Ice Arena Upgrades			
Year 2 Savings from Other FIMs			
FIM #	FIM Description	Thermal Savings	
		MMBtu	Cost \$
1	Lighting Fixtures	(73)	(\$956)
2	Lighting Controls	0	\$0
3	Weatherization	356	\$4,638
6	Water Conservation	53	\$687
9	Vending Controls	0	\$0
12	Power Factor	0	\$0
13	Transformers	0	\$0
Total		336	\$4,369

FIM 11: Ice Arena Upgrades			
Year 2 Savings Adjustments			
FIM #	FIM Description	Thermal Savings	
		MMBtu	Cost \$
11.4	Ice Max	246	\$3,204

Natural Gas consumption savings from the analysis are 88,289 therms for Yr 2. Of those, as seen in the first table above, 336 MMBtu = 3,355 therms are from different measures within this project. In the second table, an adjustment of 246 MMBtu = 2,461 therms are taken due to the discontinued use of IceMax. So the total reported savings from FIM 11 in Year 2 is 87,395 therms.

The natural gas cost savings from the analysis are \$114,952 with \$4,369 in savings coming from other FIMs and \$3,204 attributed to IceMax. By isolating and removing savings from the other measures (including IceMax), the total FIM 11 natural gas utility analysis cost savings is \$113,788.

FIM 11: Ice Arena Upgrades		
Contract Year 2 Energy Cost Avoidance		
Building	Thermal Savings	
	MMBtu	Cost \$
Ice Arena	8,740	\$113,788

## APPENDIX A

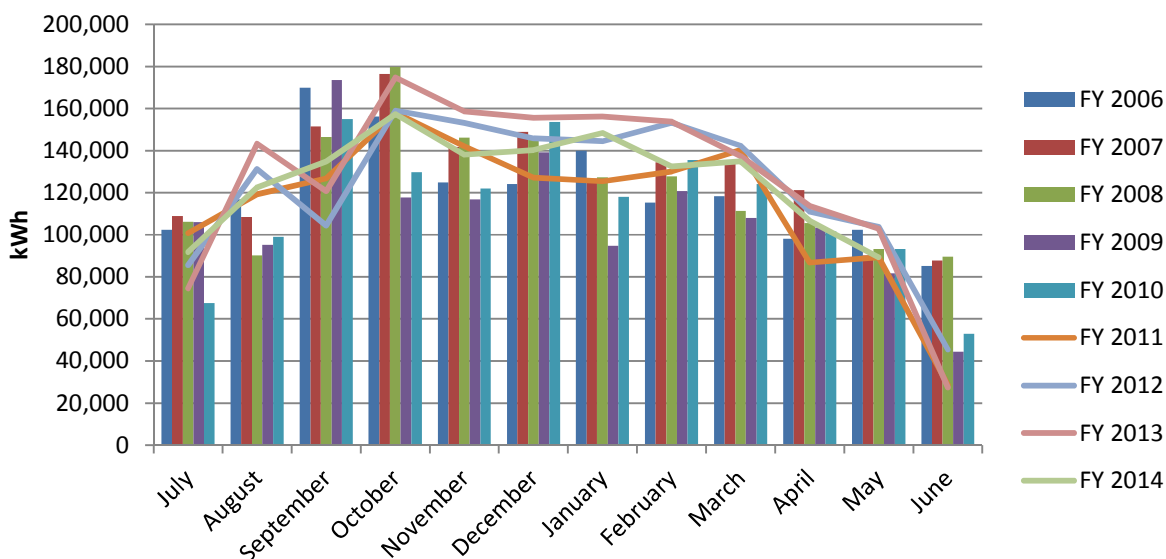
### FIM 11: Ice Arena Upgrades- Electric

#### Electric

Savings from FIM 11 were obtained through utility bill analysis. Below is the electric consumption per month obtained from bills for the baseline year through the installation period. Baseline data is in green, year 1 contract data is in yellow, and year 2 contract period in blue. Future year 3 contract period is in pink.

Dover Ice Arena Electric Consumption (kWh)							
Month	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13	2013 - 14
September	146,400	173,600	155,000	126,800	104,400	120,800	134,800
October	179,800	117,800	129,800	158,000	159,000	174,800	157,400
November	146,200	116,800	122,000	142,000	153,200	158,600	138,000
December	145,200	139,200	153,600	127,200	145,800	155,600	140,200
January	127,400	94,800	118,000	125,400	144,400	156,200	148,400
February	127,800	120,800	135,400	130,000	153,200	153,800	132,400
March	111,200	108,000	124,000	140,200	142,400	137,400	134,800
April	105,600	103,400	101,600	86,800	111,000	113,600	106,600
May	93,200	81,600	93,200	89,400	103,800	102,800	89,400
June	89,600	44,400	53,000	28,600	45,400	27,400	-
July	106,000	67,600	100,800	85,600	74,400	91,800	-
August	95,200	99,000	119,200	131,200	143,200	122,600	-

### Dover Ice Arena- Monthly Electricity Usage



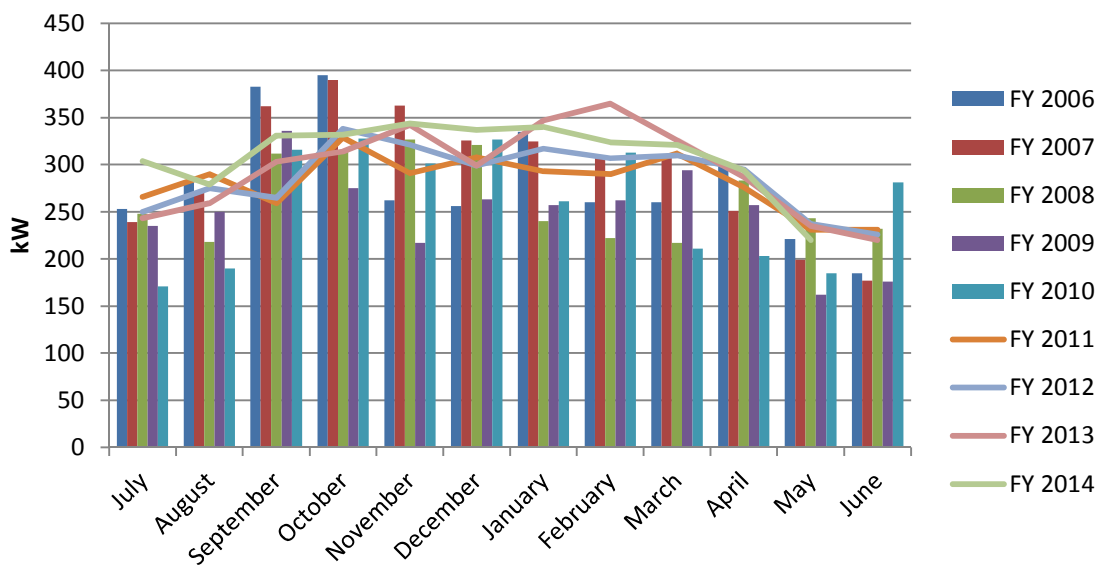
## APPENDIX A

### FIM 11: Ice Arena Upgrades- Electric

Below is the electric demand per month obtained from bills from the baseline year through the installation period. Baseline data is in green, year 1 contract data is in yellow, and year 2 contract period in blue. Future year 3 contract period is in pink.

Dover Ice Arena Electric Demand (kW)							
Month	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13	2013 - 14
September	312	336	316	259	265	303	331
October	315	275	328	329	338	314	332
November	327	217	301	291	321	342	344
December	321	263	327	308	299	299	337
January	240	257	261	293	317	347	340
February	222	262	313	290	307	365	324
March	217	294	211	312	310	326	321
April	283	257	203	276	295	287	294
May	243	162	185	231	237	235	220
June	232	176	281	231	226	220	-
July	235	171	266	250	243	304	-
August	250	190	290	275	259	279	-

### Dover Ice Arena- Monthly Electricity Demand



## APPENDIX A

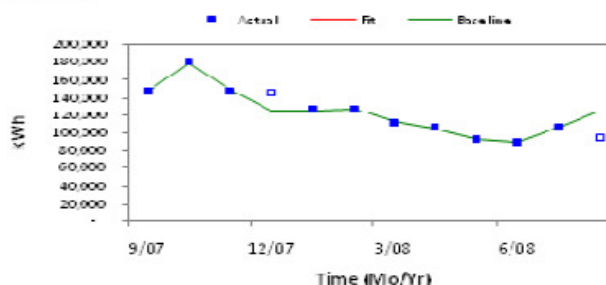
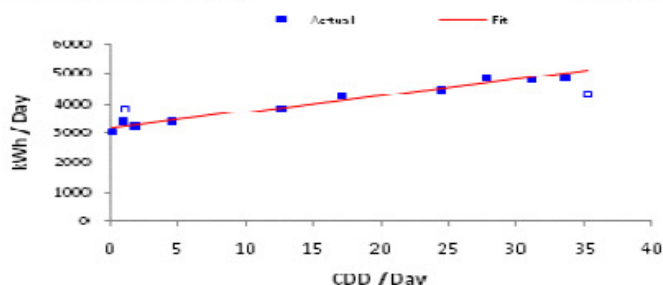
### FIM 11: Ice Arena Upgrades- Electric

Using Metrix regression analysis software, a electric consumption baseline was developed for the Ice Arena to be used in comparing bills with different weather and arena usage. The meter tuning contract for electric kWh is included below. This provides the calculation of how the baseline for electric consumption was developed.

#### Meter Tuning Contract

Project: Dover, NH  
Area: Dover Ice Arena  
Account: 8000626-01-6-2

Site: Dover, NH  
Meter: Electric  
Unit: kWh(Qty OnPk)



From	To	# Days	Reading	Incl?	HDD	CDD	Chiller-Ice Hours	Offset	Baseline	Deviation
08/14/07	09/13/07	31	146,400	<input checked="" type="checkbox"/>	0.0	964.5	1,065	-	147,571	0.8%
09/14/07	10/15/07	32	179,800	<input checked="" type="checkbox"/>	0.0	782.5	1,619	-	177,848	-1.1%
10/16/07	11/14/07	30	146,200	<input checked="" type="checkbox"/>	0.0	381.5	1,536	-	147,868	1.1%
11/15/07	12/15/07	31	145,200	<input type="checkbox"/>	0.0	36.5	1,488	-	125,102	-13.8%
12/16/07	01/15/08	31	127,400	<input checked="" type="checkbox"/>	0.0	57.0	1,488	-	126,276	-0.9%
01/16/08	02/16/08	32	127,800	<input checked="" type="checkbox"/>	0.0	6.0	1,536	-	127,322	-0.4%
02/17/08	03/15/08	28	111,200	<input checked="" type="checkbox"/>	0.0	27.5	1,344	-	112,682	1.3%
03/16/08	04/15/08	31	105,600	<input checked="" type="checkbox"/>	0.0	143.5	1,128	-	105,096	-0.5%
04/16/08	05/14/08	29	93,200	<input checked="" type="checkbox"/>	0.0	495.0	696	-	92,904	-0.3%
05/15/08	06/12/08	29	89,600	<input checked="" type="checkbox"/>	0.0	805.5	408	-	89,784	0.2%
06/13/08	07/15/08	33	106,000	<input checked="" type="checkbox"/>	0.0	1113.0	360	-	105,849	-0.1%
07/16/08	08/13/08	29	95,200	<input type="checkbox"/>	0.0	1024.5	696	-	123,239	29.5%
<b>Sum/Average/Max</b>		<b>366</b>	<b>1,473,600</b>		<b>0.0</b>	<b>5837.0</b>	<b>13,364</b>	<b>-</b>	<b>1,481,540</b>	<b>0% +/- 0.9%</b>

**Electric (Account # 8000626-01-6-2): Tuning Period is 366 days from 8/14/2007 until 8/13/2008.**  
Below is the equation used to calculate the Baseline values for the tuning period and all future periods:  

$$\text{Baseline (kWh)} = 483.36 \times \# \text{Days} + 57.29 \times \text{CDD} + 72.6 \times \text{Chiller-Ice Hours}$$

The Baseline Equation has a Net Mean Bias of 0% and a Monthly Mean Error of +/-0.9%. The underlying regression has a  $R^2=0.998$   
Baseline Costs are calculated using Average Cost/Consumption, but no less than \$0.106/ kWh.

**Explanations and Assumptions:**

(empty checkbox) under 'Incl?' indicates that the bill is excluded from the regression. However the Baseline Equation is always applied for all billing periods, even those excluded from the regression.

CDD = Cooling Degree-Days calculated for ROCHESTERNH for a 34.0 F° balance point.

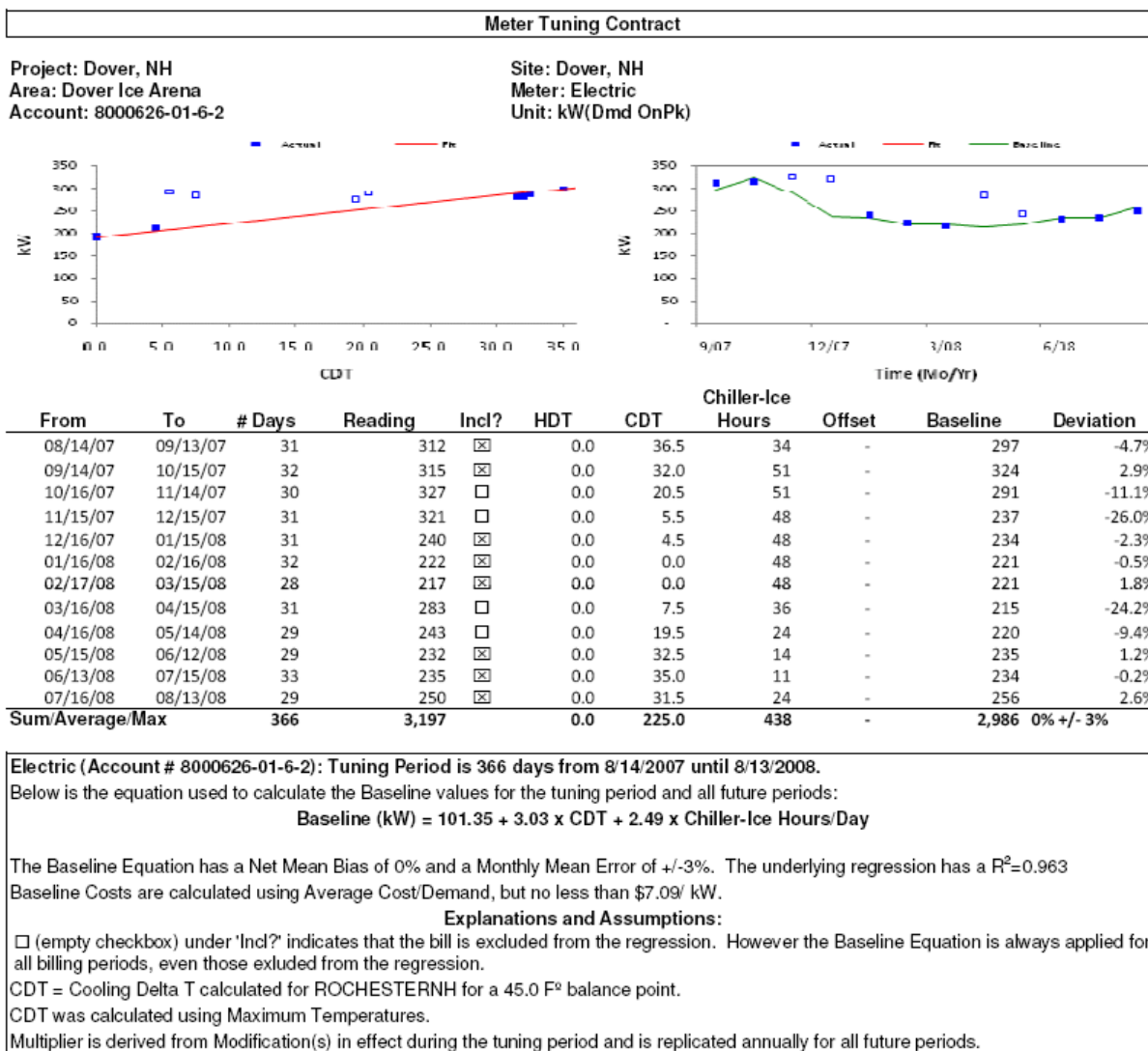
Multiplier is derived from Modification(s) in effect during the tuning period and is replicated annually for all future periods.

The regression has a  $R^2$  value of 0.998 excluding two of the twelve baseline points, which is exceptionally better than required. As per the contract, the electric consumption baseline is within 0.5% of the actual utility data complying with the necessary 2% mark.

## APPENDIX A

### FIM 11: Ice Arena Upgrades- Electric

Using Metrix regression analysis software, a electric demand baseline was developed for the Ice Arena to be used in comparing bills with different weather and arena usage. The meter tuning contract for electric kW is included below. This provides the calculation of how the baseline for electric demand was developed.

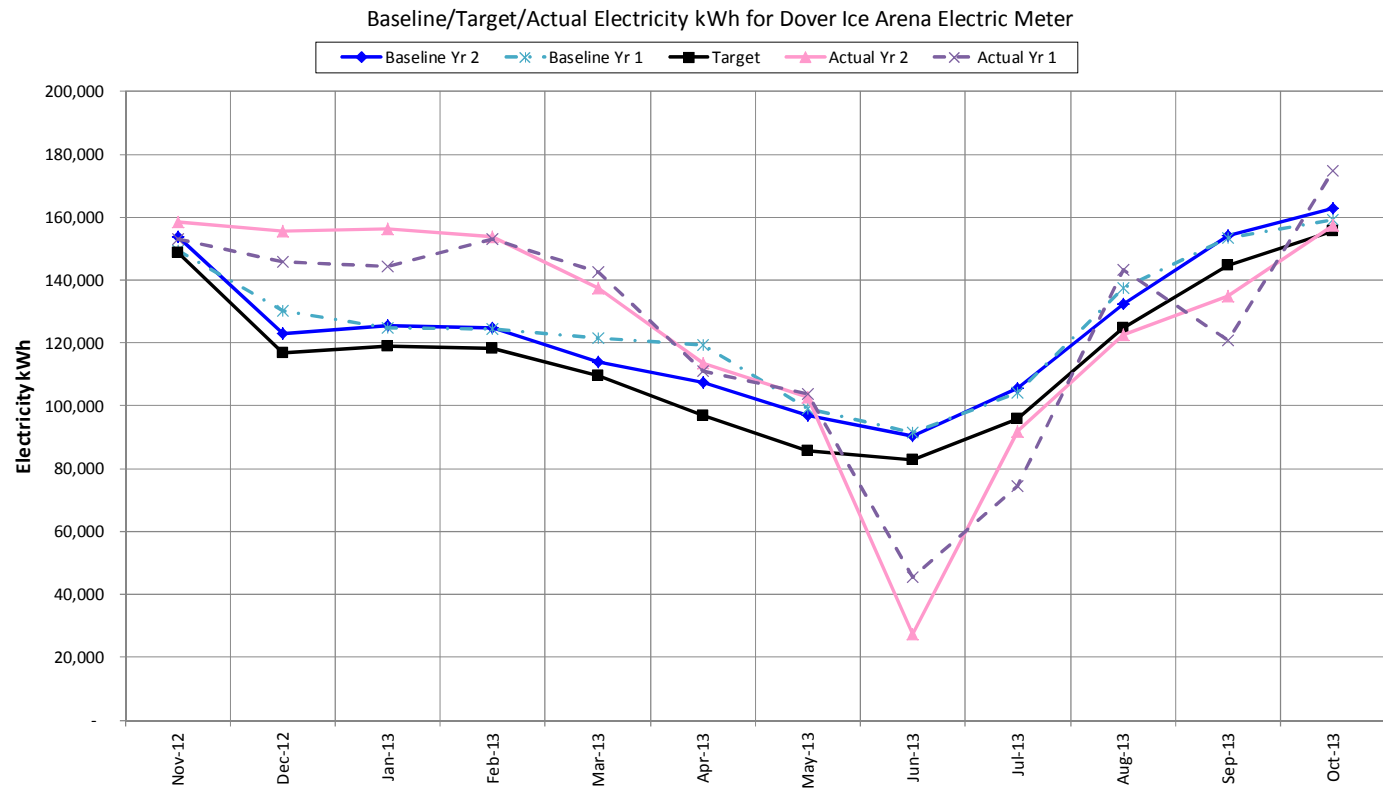


The regression has a  $R^2$  value of 0.963 excluding four of the twelve baseline points, which is better than required. The electric consumption baseline is within 6.6% of the actual utility data. Since demand is not as cut and dry as other measures, it is difficult to determine a solution that would fall within the 2% difference. The difference of 4.6% is on the lower end of the baseline which in the end benefits the City of Dover. Johnson Controls accepts this difference and believes it is the best and most sensible option moving forward.

## APPENDIX A

### FIM 11: Ice Arena Upgrades- Electric

This regression analysis graph was run for **electric kWh consumption**. The three solid lines shown represent the calculated Year 2 baseline (blue), target utility use based off calculations and guarantees (black), and actual Year 2 ice arena utility use from utility invoices (pink). Year 1 data baseline (teal) and actual (purple) have been superimposed using dotted lines for reference as shown below:

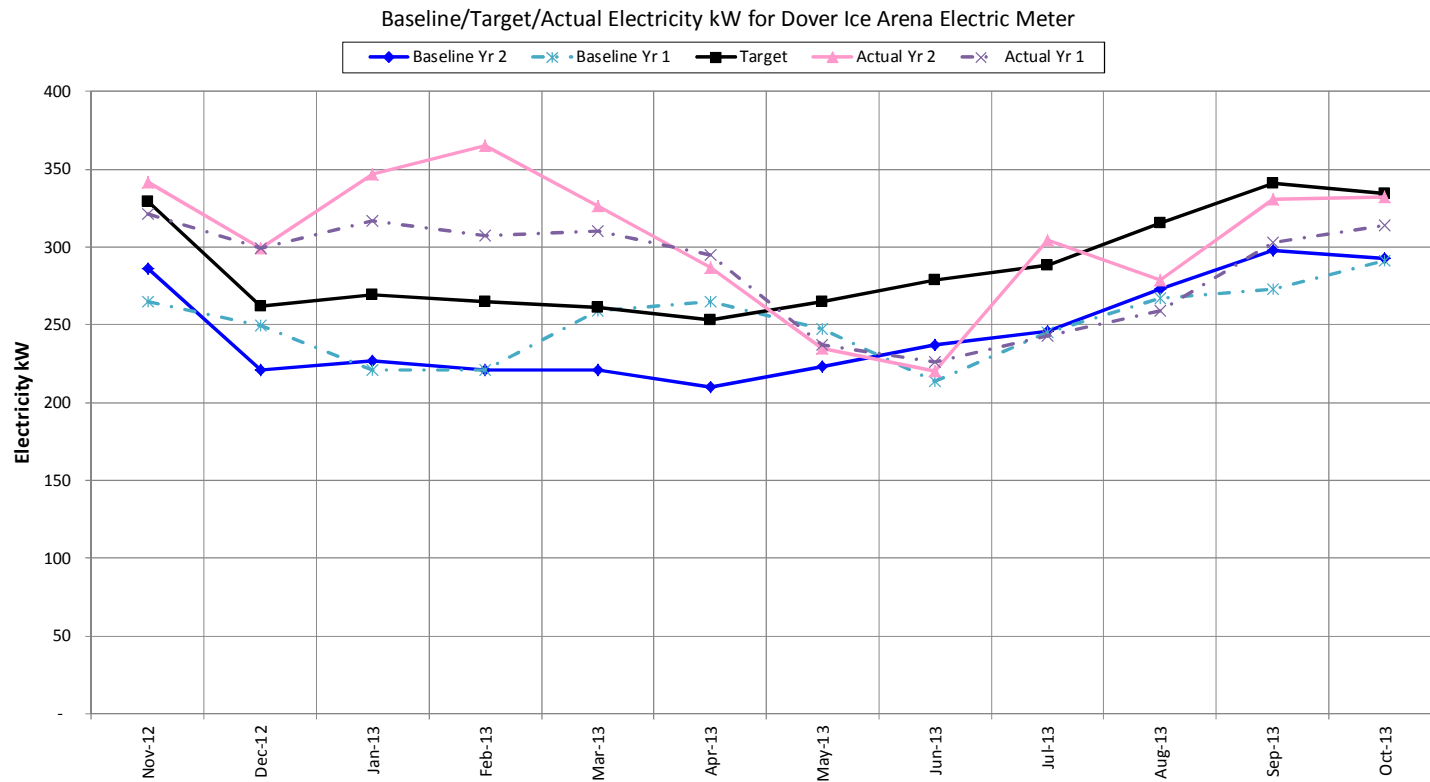


Scenario	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Total
Baseline Yr 2	153,612	123,053	125,474	124,615	113,770	107,388	96,877	90,297	105,459	132,245	154,077	162,923	1,489,790
Target	148,852	116,721	118,955	118,171	109,598	96,900	85,855	82,617	95,959	124,620	144,792	155,627	1,398,667
Actual Yr 2	158,600	155,600	156,200	153,800	137,400	113,600	102,800	27,400	91,800	122,600	134,800	157,400	1,512,000
Savings	(4,988)	(32,547)	(30,726)	(29,185)	(23,630)	(6,212)	(5,923)	62,897	13,659	9,645	19,277	5,523	(22,210)

## APPENDIX A

### FIM 11: Ice Arena Upgrades- Electric

This regression analysis was run for **electric kW demand**. The three lines shown represent the calculated Year 2 baseline (blue), target utility use based off calculations and guarantees (black), and actual Year 2 ice arena utility use from utility invoices (pink). Year 1 data baseline (teal) and actual (purple) have been superimposed using dotted lines for reference as shown below:



Scenario	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Total
Baseline Yr 2	286	221	227	221	221	210	223	237	246	273	298	293	2,956
Target	329	262	269	265	261	253	265	279	288	315	341	334	3,461
Actual Yr 2	342	299	347	365	326	287	235	220	304	279	331	332	3,667
Savings	(56)	(78)	(120)	(144)	(105)	(77)	(12)	17	(58)	(6)	(33)	(39)	(711)

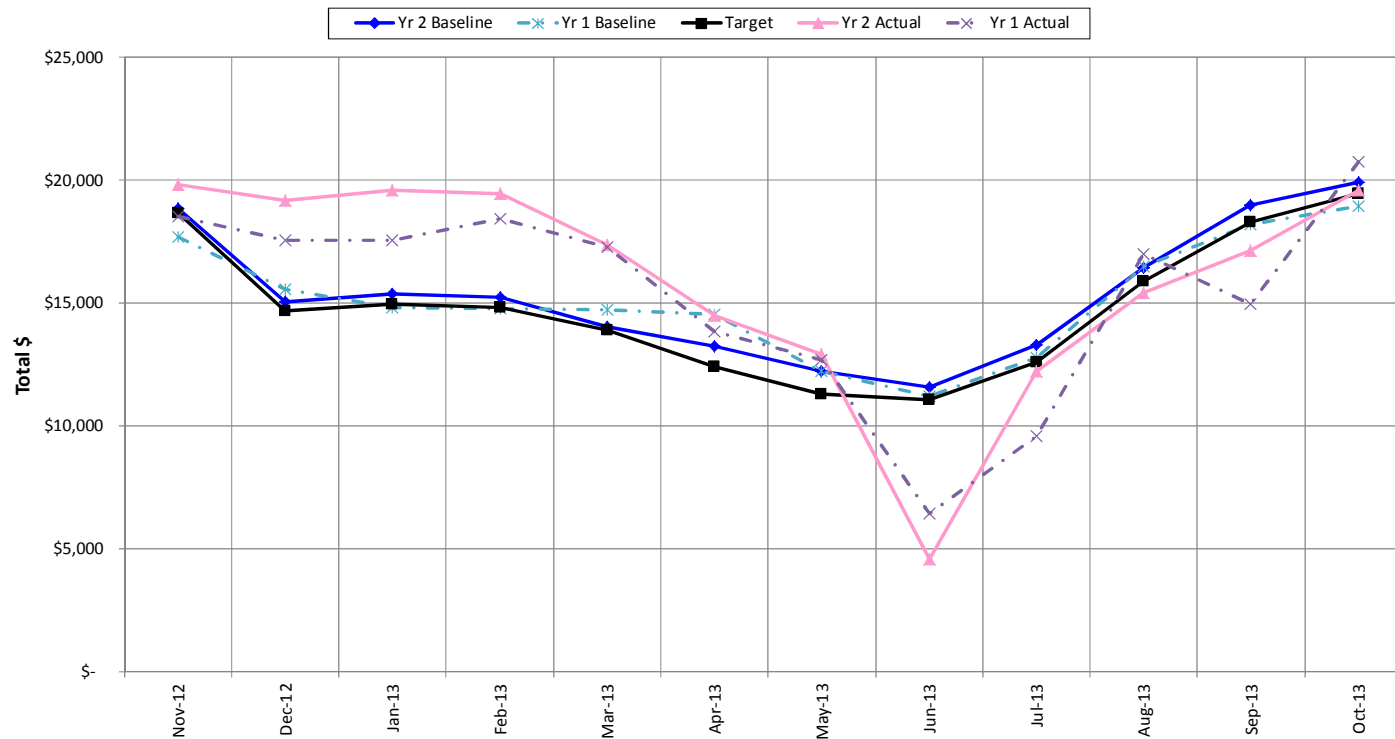


## APPENDIX A

### FIM 11: Ice Arena Upgrades- Electric

This regression analysis was run for **electric cost** which includes both demand and consumption. The three solid lines shown represent the calculated Year 2 baseline (blue), target utility use based off calculations and guarantees (black), and actual Year 2 cost from utility invoices and contractual rates (pink). Year 1 cost baseline (teal) and actual (purple) have been superimposed using dotted lines for reference as shown below:

Baseline/Target/Actual Total \$ for Dover Ice Arena Electric Meter



Scenario	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Total
Yr 2 Baseline	\$ 18,865	\$ 15,052	\$ 15,361	\$ 15,223	\$ 14,039	\$ 13,261	\$ 12,208	\$ 11,592	\$ 13,314	\$ 16,436	\$ 19,003	\$ 19,932	\$ 184,287
Target	\$ 18,659	\$ 14,660	\$ 14,956	\$ 14,841	\$ 13,875	\$ 12,430	\$ 11,312	\$ 11,060	\$ 12,583	\$ 15,910	\$ 18,303	\$ 19,435	\$ 178,024
Yr 2 Actual	\$ 19,818	\$ 19,177	\$ 19,593	\$ 19,462	\$ 17,386	\$ 14,502	\$ 12,943	\$ 4,599	\$ 12,246	\$ 15,427	\$ 17,139	\$ 19,614	\$ 191,906
Savings	\$ (954)	\$ (4,124)	\$ (4,232)	\$ (4,239)	\$ (3,348)	\$ (1,241)	\$ (734)	\$ 6,993	\$ 1,068	\$ 1,009	\$ 1,864	\$ 318	\$ (7,619)

## APPENDIX A

### FIM 11: Ice Arena Upgrades- Electric

Again, since there are measures included at the Ice Arena that are not to be measured by utility bill analysis, they need to be subtracted from the overall savings as to not be counted twice. Below is a table of electric contract year savings from all other FIMs at the Ice Arena:

FIM 11: Ice Arena Upgrades				
Year 2 Savings from Other FIMs				
FIM #	FIM Description	Electricity Savings		
		kW	kWh	Cost \$
1	Lighting Fixtures	142	52,506	\$6,770
2	Lighting Controls	59	13,002	\$1,420
3	Weatherization	0	3,708	\$405
6	Water Conservation	0	0	\$0
9	Vending Controls	0	2,995	\$327
12	Power Factor	40	8,917	\$1,264
13	Transformers	59	22,754	\$2,914
Total		299	103,883	\$13,099

FIM 11: Ice Arena Upgrades				
Year 2 Savings Adjustments				
FIM #	FIM Description	Electricity Savings		
		kW	kWh	Cost \$
11.4	Ice Max	0	55,780	\$6,092

Electric consumption savings from the analysis are an additional 22,210 kWh. On top of that, 103,883 kWh are from different measures within this project. In the second table, an adjustment of 55,780 kWh are taken due to the discontinued use of IceMax. So the total reported additional usage from FIM 11 is 70,313 kWh.

Similarly, the electric demand savings from the graphical analysis are a 711 kW increase. 299 kW were saved from other measures not to be included in the FIM 11 utility bill analysis. IceMax does not affect the kW Demand. This leaves a demand increase of 1,010 kW over the reporting period.

Lastly, electric cost savings from the regression analysis are an increase of \$7,619. Savings from other measures total electric savings of \$13,099 and \$6,092 attributed to IceMax. By isolating and removing the other FIM cost savings (including IceMax), the total FIM 11 electric utility additional cost usage is \$14,653.

FIM 11: Ice Arena Upgrades			
Contract Year 2 Energy Cost Avoidance			
Building	Electricity Savings		
	kW	kWh	Cost \$
Ice Arena	(1,010)	(70,313)	(\$14,653)

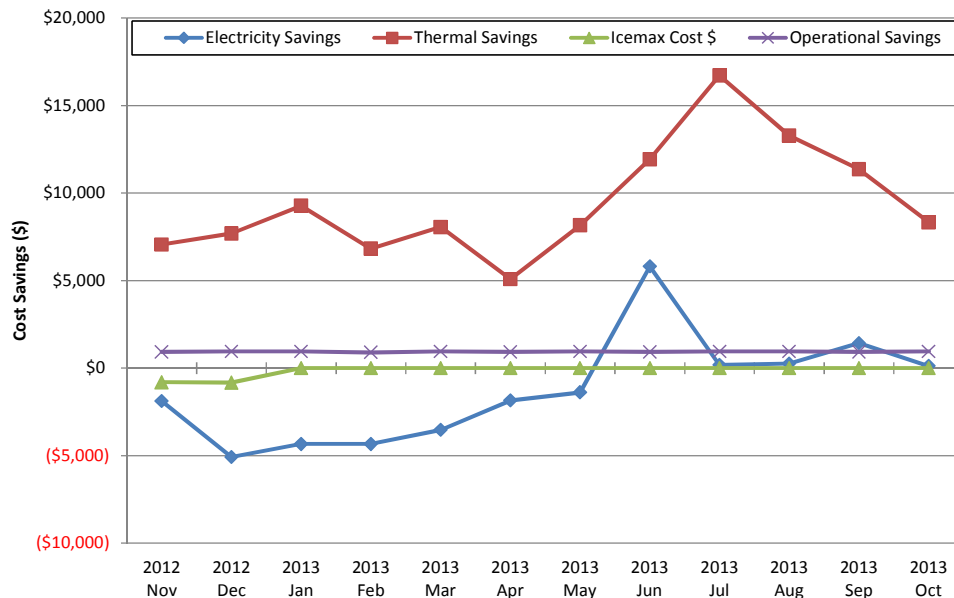
## APPENDIX A

### FIM 11: Ice Arena Upgrades

Breaking out the energy savings on a monthly basis and combining all previous figures, the total FIM 11 savings for Year 2 are listed below:

FIM 11: Ice Arena Upgrades									
Contract Year 2 Energy Cost Avoidance									
Month	Year	Electricity Savings			Thermal Savings		Icemax	O&M	Total Cost
		kW	kWh	Cost \$	MMBtu	Cost \$	Cost \$	\$ Savings	\$ Savings
November	2012	(78)	(12,434)	(\$1,889)	542	\$7,062	(\$809)	\$921	\$5,285
December	2012	(100)	(40,242)	(\$5,086)	591	\$7,691	(\$836)	\$951	\$2,720
January	2013	(142)	(30,349)	(\$4,339)	712	\$9,273	\$0	\$951	\$5,885
February	2013	(169)	(28,766)	(\$4,340)	524	\$6,826	\$0	\$890	\$3,376
March	2013	(130)	(24,052)	(\$3,541)	619	\$8,062	\$0	\$951	\$5,473
April	2013	(102)	(10,485)	(\$1,854)	391	\$5,086	\$0	\$921	\$4,152
May	2013	(37)	(10,600)	(\$1,392)	626	\$8,156	\$0	\$951	\$7,715
June	2013	(15)	53,880	\$5,810	917	\$11,937	\$0	\$921	\$18,668
July	2013	(85)	6,917	\$170	1,284	\$16,721	\$0	\$951	\$17,843
August	2013	(31)	4,118	\$259	1,020	\$13,282	\$0	\$951	\$14,493
September	2013	(58)	16,611	\$1,426	873	\$11,362	\$0	\$921	\$13,708
October	2013	(64)	5,089	\$124	640	\$8,330	\$0	\$951	\$9,405
<b>Contract Year 2</b>		<b>(1,010)</b>	<b>(70,313)</b>	<b>(\$14,653)</b>	<b>8,739.5</b>	<b>\$113,788</b>	<b>(\$1,644)</b>	<b>\$11,232</b>	<b>\$108,723</b>

**FIM 11- Ice Arena Savings**



## APPENDIX A

### FIM 12: Power Factor Correction

This measure was fully installed on January 26, 2013 on the following devices:

- A1 63kw Compressor
- B1 63kw Compressor
- A2 45kw Compressor
- 15 HP Electric Chiller Pump
- 30 HP Backup Pump

Power measurements taken on the following equipment yields the following savings from the installation of the equipment:

Equipment	INITIAL AMPS	INITIAL P.F.	OPTIMIZED AMPS	OPTIMIZED P.F.	KW BEFORE	KW AFTER
A1 63 kW Compressor	63	0.73	47	0.95	39	37
B1 63 kW Compressor	62	0.74	46	0.95	38	37
A2 45 kW Compressor	55	0.78	43	0.96	36	35
15 HP Electric Chiller Pump	13	0.81	11	0.98	9	9
30 HP Back Up Pump	39	0.81	33	0.98	27	27

Run Hours for the equipment is as follows:

Equipment	MOTOR RUNTIME YEARLY HRS
A1 63 kW Compressor	3,600
B1 63 kW Compressor	3,600
A2 45 kW Compressor	3,600
15 HP Electric Chiller Pump	8,640
30 HP Back Up Pump	2,880

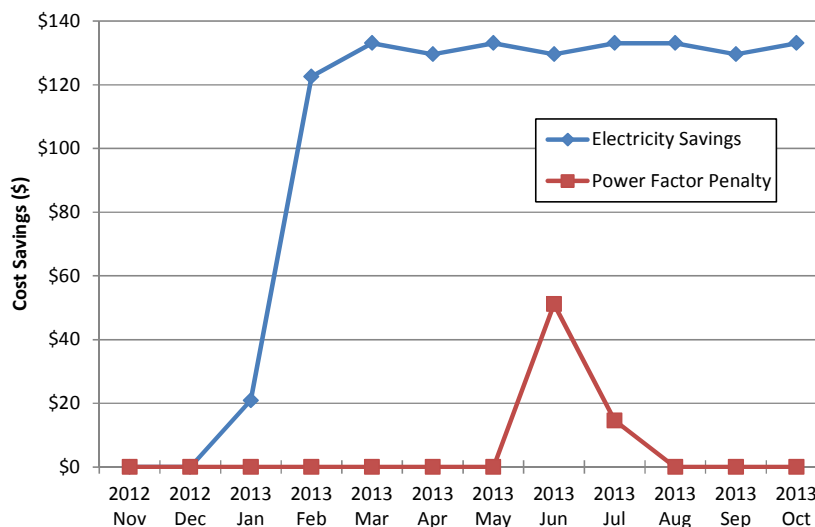
## APPENDIX A

### FIM 12: Power Factor Correction

Savings for FIM 12 will be obtained from the date of installation going forward.

FIM 12: Power Factor Correction							
Contract Year 2 Energy Cost Avoidance							
Month	Year	Electricity Savings			Power Factor Penalty Savings		Total Cost \$ Savings
		kW	kWh	Cost \$	kW	Cost Savings \$	
November	2012	0	0	\$0	0	\$0	\$0
December	2012	0	0	\$0	0	\$0	\$0
January	2013	0	192	\$21	0	\$0	\$21
February	2013	3	895	\$123	0	\$0	\$123
March	2013	3	991	\$133	0	\$0	\$133
April	2013	3	959	\$130	0	\$51	\$130
May	2013	3	991	\$133	0	\$15	\$133
June	2013	3	959	\$130	7	\$0	\$181
July	2013	3	991	\$133	2	\$0	\$148
August	2013	3	991	\$133	0	\$0	\$133
September	2013	3	959	\$130	0	\$0	\$130
October	2013	3	991	\$133	0	\$0	\$133
Contract Year 2		31	8,917	\$1,198	9	\$66	\$1,264

**FIM 12- Power Factor Correction Savings**



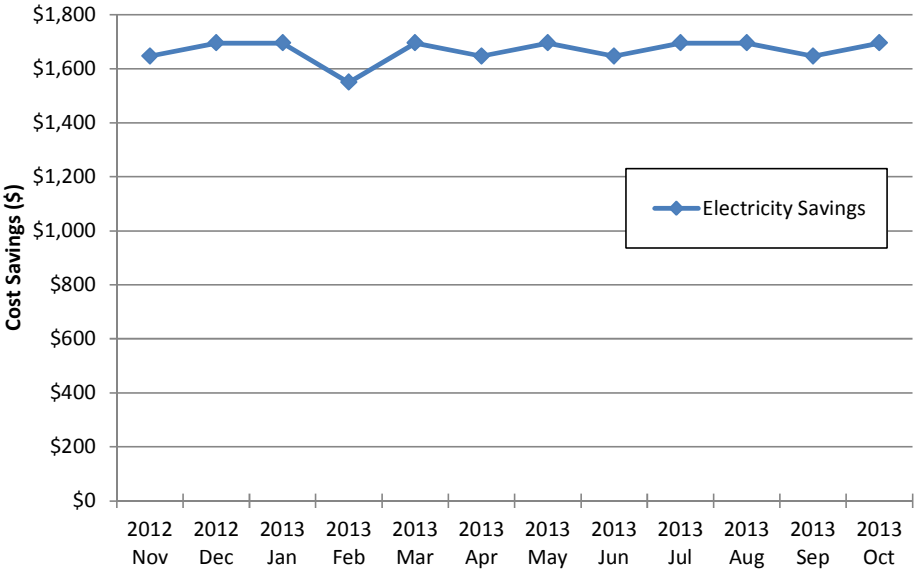
## APPENDIX A

### FIM 13: Transformers

The FIM 13 table breaks down the measure by month over the contract year. Savings for the replacement of transformers come from the Ice Arena, Waste Water Treatment Plant, Public Works, and McConnell Center.

FIM 13: Transformers					
Contract Year 2 Energy Cost Avoidance					
Month	Year	Electricity Savings			Total Cost \$ Savings
		kW	kWh	Cost \$	
November	2012	27	12,380	\$1,647	\$1,647
December	2012	27	12,793	\$1,695	\$1,695
January	2013	27	12,793	\$1,695	\$1,695
February	2013	27	11,555	\$1,550	\$1,550
March	2013	27	12,793	\$1,695	\$1,695
April	2013	27	12,380	\$1,647	\$1,647
May	2013	27	12,793	\$1,695	\$1,695
June	2013	27	12,380	\$1,647	\$1,647
July	2013	27	12,793	\$1,695	\$1,695
August	2013	27	12,793	\$1,695	\$1,695
September	2013	27	12,380	\$1,647	\$1,647
October	2013	27	12,793	\$1,695	\$1,695
<b>Contract Year 2</b>		<b>318</b>	<b>150,628</b>	<b>\$20,002</b>	<b>\$20,002</b>

**FIM 13- Transformers Savings**



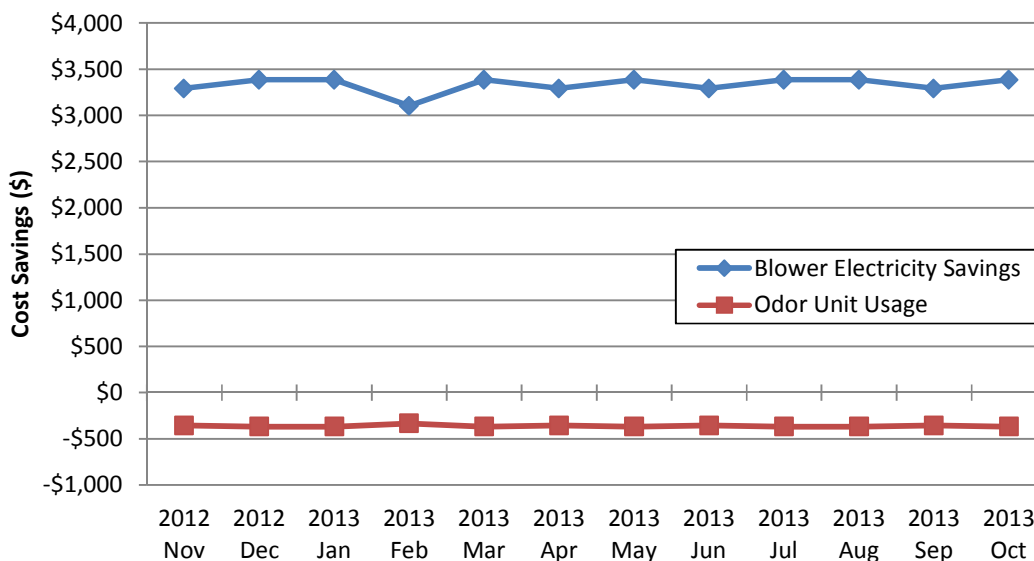
## APPENDIX A

### FIM 14: Aeration Blower Upgrade

The FIM 14 table breaks down the measure over the contract year. A silencer was added to the unit in March 2012 allowing for the recommended 24-7 run time to control odors. This has been included in the savings below.

FIM 14: Aeration Blower Upgrade					
Contract Year 2 Energy Cost Avoidance					
Month	Year	Electricity Savings			Total Cost \$ Savings
		kW	kWh	Cost \$	
November	2012	60	20,384	\$2,936	\$2,936
December	2012	60	21,064	\$3,019	\$3,019
January	2013	60	21,064	\$3,019	\$3,019
February	2013	60	19,025	\$2,769	\$2,769
March	2013	60	21,064	\$3,019	\$3,019
April	2013	60	20,384	\$2,936	\$2,936
May	2013	60	21,064	\$3,019	\$3,019
June	2013	60	20,384	\$2,936	\$2,936
July	2013	60	21,064	\$3,019	\$3,019
August	2013	60	21,064	\$3,019	\$3,019
September	2013	60	20,384	\$2,936	\$2,936
October	2013	60	21,064	\$3,019	\$3,019
<b>Contract Year 2</b>		<b>724</b>	<b>248,010</b>	<b>\$35,648</b>	<b>\$35,648</b>

### FIM 14- Aeration Blower Savings



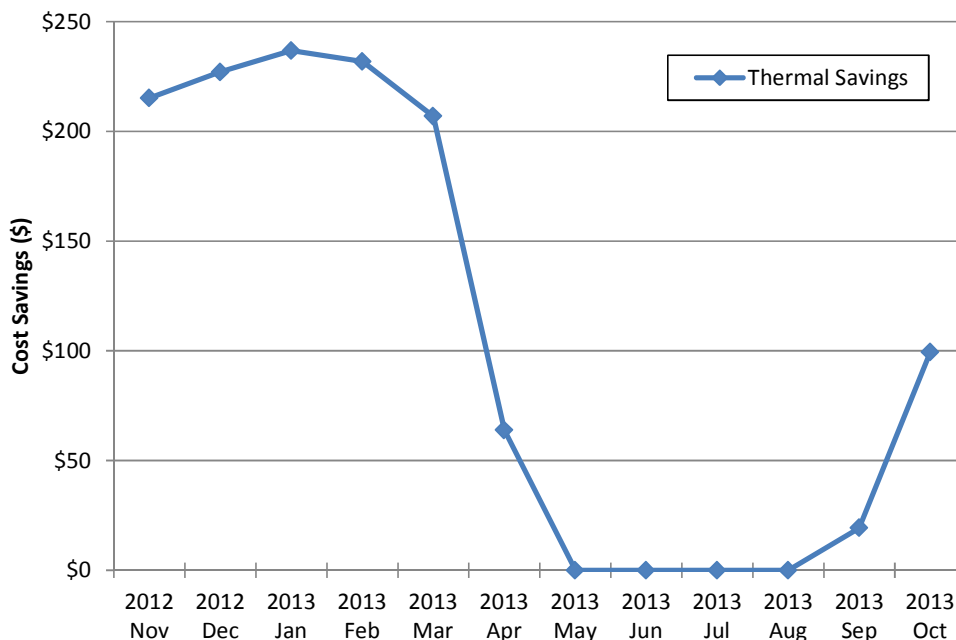
## APPENDIX A

### FIM 15: Boiler Replacement

Annual savings are concentrated over the winter months from mid-September through mid-April with a partial weighting for weather over that time.

FIM 15: Boiler Replacement				
Contract Year 2 Energy Cost Avoidance				
Month	Year	Thermal Savings		Total Cost \$ Savings
		MMBTU	Cost \$	
November	2012	15	\$215	\$215
December	2012	16	\$227	\$227
January	2013	16	\$237	\$237
February	2013	16	\$232	\$232
March	2013	14	\$207	\$207
April	2013	4	\$64	\$64
May	2013	0	\$0	\$0
June	2013	0	\$0	\$0
July	2013	0	\$0	\$0
August	2013	0	\$0	\$0
September	2013	1	\$19	\$19
October	2013	7	\$99	\$99
<b>Contract Year 2</b>		<b>89</b>	<b>\$1,300</b>	<b>\$1,300</b>

**FIM 15- Boiler Replacement Savings**





## APPENDIX B

### Performance Contract Project Progress

City of Dover- Year 2 Performance Contracting Tracking			
Quarter	<sup>(10)</sup> Annual Guaranteed Savings	Total Reported Savings	% Savings of Guarantee
1 (Nov,Dec,Jan)	-	\$71,856	21.9%
2 (Feb,Mar,Apr)	-	\$68,083	20.7%
3 (May,Jun)	-	\$59,034	18.0%
4 (Jul,Aug,Sep,Oct)	-	\$122,447	37.3%
Total	\$328,237	\$321,420	97.9%

<sup>(10)</sup>Annual guaranteed savings are guaranteed on an annual basis

Year 2 total reported savings to date include November 2012 through October 2013 as per the November 1<sup>st</sup> start date of the performance period.

City of Dover Performance Contracting Tracking				
Period	Date Range	<sup>(11)</sup> Total Guaranteed Savings	Reported Savings	Variance
Installation	Sep '09 – Oct '11	\$0	\$400,730	N/A
Year 1	Nov '11 – Oct '12	\$319,463	\$317,642	<sup>(12)</sup> (\$1,821)
Year 2	Nov '12 – Oct '13	\$328,236	\$321,420	(\$6,817)
Year 3	Nov '13 – Oct '14	\$337,280		
Year 4	Nov '14 – Oct '15	\$346,603		
Year 5	Nov '15 – Oct '16	\$356,214		
Year 6	Nov '16 – Oct '17	\$366,122		
Year 7	Nov '17 – Oct '18	\$376,336		
Year 8	Nov '18 – Oct '19	\$386,865		
Year 9	Nov '19 – Oct '20	\$397,719		
Year 10	Nov '20 – Oct '21	\$408,909		
<b>Total Contract</b>	<b>N/A</b>	<b>\$3,623,746</b>	<b>N/A</b>	<b>N/A</b>

<sup>(11)</sup> Guaranteed Savings baseline has been adjusted from original contract to reflect CO # 9236-0142-CO2 associated with the McConnell Center (added lighting and lighting controls)

<sup>(12)</sup> Variance is due in part to non-installation of FIM 12- Power Factor Correction through Year 1

## APPENDIX B

Weather Degree Days

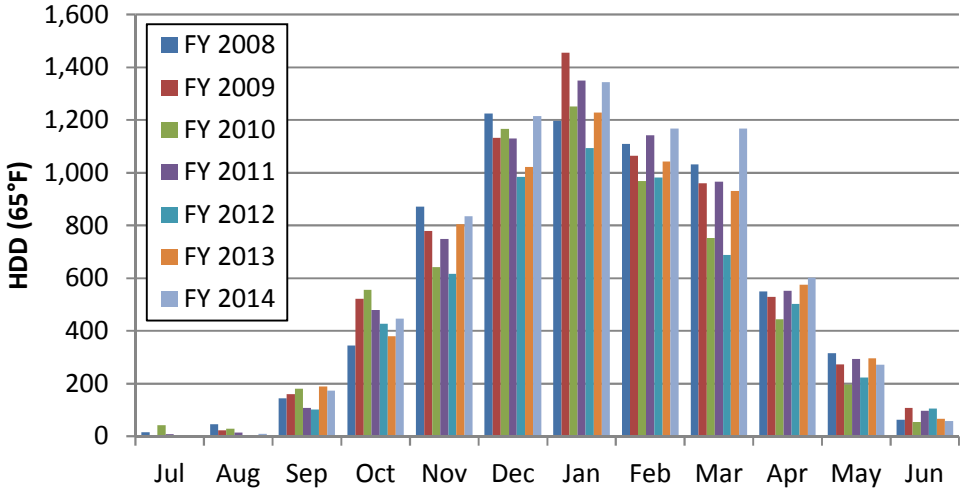
Weather data obtained from Skyhaven Airport Weather Station, Rochester, NH for Base 65°F.

Rochester, NH Weather Heating Degree Days (Base 65°F)

Report Period	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
July	16.5	0.0	41.5	8.5	0.0	0.0	2.5
August	46.0	23.0	29.0	14.0	3.5	2.5	10.0
September	145.5	160.5	181.0	109.0	102.0	189.0	174.0
October	344.0	521.5	555.0	480.0	427.5	380.0	447.0
November	872.5	780.0	643.0	749.0	616.0	804.0	836.0
December	1,224.5	1,133.0	1,166.0	1,130.5	983.5	1,021.5	1,215.0
January	1,196.5	1,456.0	1,251.5	1,350.5	1,094.0	1,229.0	1,343.0
February	1,109.5	1,064.5	968.5	1,141.5	981.5	1,043.0	1,168.0
March	1,032.5	960.5	752.5	965.5	688.0	931.0	1,167.5
April	550.5	529.0	445.0	552.5	502.0	574.5	602.0
May	315.0	272.5	197.5	294.0	223.5	295.5	271.0
June	63.0	108.5	55.5	97.0	106.0	67.0	57.0

The baseline period is highlighted in green, year 1 contract period is yellow, and year 2 contract period in blue. Future year 3 contract period is in pink.

### Monthly Heating Degree Days



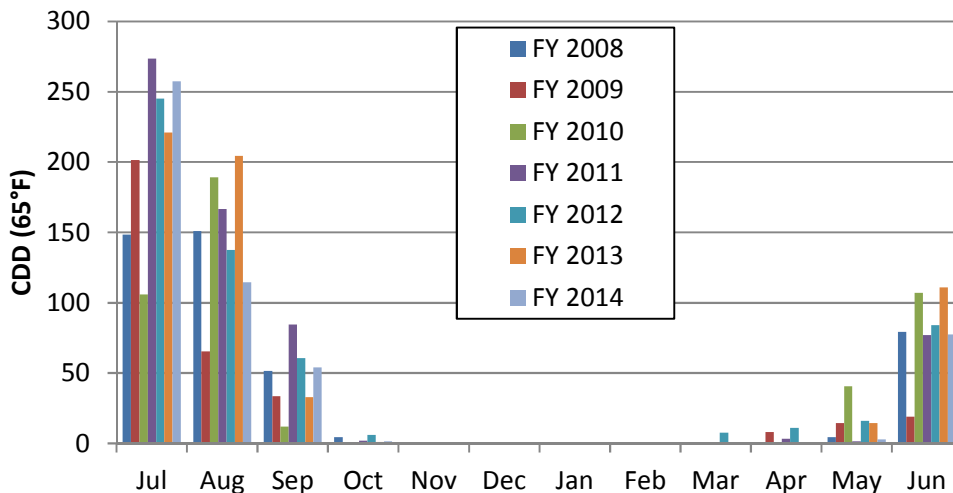
## APPENDIX B

Rochester, NH Weather Cooling Degree Days (Base 65°F)

Report Period	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
July	148.5	201.5	106.0	273.5	245.0	221.0	257.5
August	151.0	65.5	189.0	166.5	137.5	204.5	114.5
September	51.5	33.5	12.0	84.5	60.5	33.0	54.0
October	4.5	0.0	0.0	2.0	6.0	1.0	1.5
November	0.0	0.0	0.0	0.0	0.0	0.0	0.0
December	0.0	0.0	0.0	0.0	0.0	0.0	0.0
January	0.0	0.0	0.0	0.0	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0	0.0	0.0	0.0
March	0.0	0.0	0.0	0.0	7.5	0.0	0.0
April	0.0	8.0	0.0	3.5	11.0	0.0	0.0
May	4.5	14.5	40.5	1.5	16.0	14.5	3.0
June	79.5	19.0	107.0	77.0	84.0	111.0	77.5

The baseline period is highlighted in green, year 1 contract period is yellow, and year 2 contract period in blue. Future year 3 contract period is in pink.

## Monthly Cooling Degree Days



## APPENDIX B

### Utility Rate Schedule

Below are the contractual utility rates obtained from Schedule C: Part III of the contract. The rates below are the contractual rate escalated by the contractual 3% per year.

The above rates have been escalated by 3% for the second guarantee year as per the contract.

Rate Summary Table							
Contract Year 2 Rates							
City of Dover, NH Building Location	Electric		Natural Gas	Oil	Propane	Water	Sewer
	\$/kW	\$/kWh	\$/Therm	\$/Therm	\$/Therm	\$/HCF	\$/HCF
Indoor Pool	\$9.08	\$0.108	\$1.481	-	-	\$3.86	\$4.65
Dover Ice Arena	\$7.30	\$0.109	\$1.302	-	-		
Waste Water Treatment Facility	\$7.24	\$0.123	-	\$1.717	-		
Dover City Hall	-	\$0.128	-	\$1.717	-		
Public Works	-	\$0.132	\$1.162	-	-		
McConnell Center	\$7.31	\$0.111	\$1.454	-	-		
Dover Public Library	-	\$0.139	\$1.457	-	-		
Jenny Thompson Pool	-	\$0.130	\$1.390	-	-		
Central Fire Station	-	\$0.129	\$1.575	-	-		
South End Fire Station	-	\$0.132	-	-	\$1.821		
Pine Hill Chapel	-	\$0.174	-	\$1.717	-		
Pine Hill Barn	-	\$0.206	-	\$1.717	-		
Veterans Hall	-	\$1.700	\$1.857	-	-		
Dover Train Station	-	\$0.126	\$1.971	-	-		

Note: Unblended cost if demand charges are available, if not blended cost

**\*\*\*\*\*These rates are used to cover all months between November 2012 – October 2013\*\*\*\*\***

The above contract rates for Oil and Propane are listed in \$/Therm. The below conversions are provided for both to give the rates in \$/Gallon:

Oil rate at \$1.717 per Therm = \$2.387 per Gallon

Propane rate at \$1.821 per Therm = \$1.668 per Gallon

## APPENDIX B

### Glossary

Actual Utility Usage (FIM 11)- Amount of electricity or natural gas used; Obtained from invoices received through utility companies

Baseline- The adjusted pre-retrofit bills (usually one year) used to compare to the post-retrofit energy usage in order to provide a basis for calculating savings; can be adjusted for variables such as weather, hours, etc.

Construction Period- The period between the commencement date and the first day of the month following the date of Substantial Completion

Contract Savings- Savings obtained over the course of the contract, in this case from the start of Year 1

Contract (Guarantee) Year Savings- Savings occurring over the course of a contract year; this contract's year runs from November through October

Cost Avoidance- Dollars that would have been spent if the energy conservation measures had not been installed.

Degree Day- A unit of measurement equal to a difference of one degree between the mean outdoor temperature on a certain day and a reference temperature (can be summed monthly or yearly). For example, a daily outdoor average temperature of 30°F would be 35 Heating Degree Days with a base temperature of 65°F.

FIM- Facility improvement measure, sometimes referred to as energy conservation measure (ECM)

Fiscal Year Savings- Savings occurring over the course of a fiscal year; Dover's runs from July through June

Guarantee Period- The period of time typically after the date of Substantial Completion. This period starts the reporting and monitoring of the performance contract.

Guaranteed Savings- The amount of savings guaranteed to be achieved.

Installation Savings- FIMs installed during the construction period and being of beneficial use prior to the date of Substantial Completion are monitored to determine savings.

Savings to Date- Savings obtained through a portion of a period

Substantial Completion- Sufficient materials and services have been provided to permit the intended benefit from the work. This term can apply to individual measures and the overall project.

Target Savings- Savings figures estimated to be achieved, determined by calculations and measurements

## APPENDIX C

### **FIM 1- Lighting: Formulas & Calculations Used**

$$\text{Lighting kW Savings} = \sum (\text{Fixture Wattage}_{\text{Pre}} - \text{Retrofit Fixture Wattage}_{\text{Post}})$$

$$\text{Lighting kWh Savings} = \sum (\text{Lighting kW Savings} \times \text{Hours of Operation})$$

$$\text{kWh Cooling Savings}_{\text{Period}} = \frac{\text{CDD}_{\text{Period}}}{\text{CDD}_{\text{Annual}}} \times \text{kWh Cooling Savings}_{\text{Annual}}$$

$$\text{MMBtu Heating Losses}_{\text{Period}} = \frac{\text{HDD}_{\text{Period}}}{\text{HDD}_{\text{Annual}}} \times \text{MMBtu Heating Losses}_{\text{Annual}}$$

### **FIM 2- Lighting Controls: Formulas & Calculations Used**

$$\text{Lighting Controls kWh Savings} = \sum \text{Retrofit Fixture Wattage}_{\text{Post}} \times (\text{Lighting Runtime}_{\text{Pre}} - \text{Hours of Occupancy})$$

### **FIM 3- Weatherization: Formulas & Calculations Used**

Spreadsheet based- General Formulas used include:

$$\text{CFM}_{\text{Infiltration}} [\text{Winter}] = \text{Wind Speed} \times \text{Area of Cracks} \times \% \text{ Area Heated} \times \% \text{ Windward Diversity}$$

$$\text{CFM}_{\text{Infiltration}} [\text{Summer}] = \text{Wind Speed} \times \text{Area of Cracks} \times \% \text{ Area with AC} \times \% \text{ Windward Diversity}$$

$$\text{Existing Btu Saved}_{\text{Occupied}} = 1.08 \times \text{CFM}_{\text{Infiltration}} \times \Delta T \times \text{Bin Hours}_{\text{Occupied}}$$

$$\text{Existing Btu Saved}_{\text{Unoccupied}} = 1.08 \times \text{CFM}_{\text{Infiltration}} \times \Delta T \times \text{Bin Hours}_{\text{Unoccupied}}$$

$$\text{kWh Saved} = \frac{\text{Cooling Btu Saved} \times 12}{12,000 \frac{\text{Btu}}{\text{Ton}} \times \text{EER}}$$

$$\text{MMBtu Saved} = \frac{\text{Heating Btu Saved}}{1 \times 10^6 \frac{\text{Btu}}{\text{MMBtu}} \times \text{Boiler Efficiency} (\%)}$$

## APPENDIX C

### **FIM 4.1- EMS Building Controls: Formulas & Calculations Used**

Spreadsheet based- General Formulas used include:

$$\text{Cooling kWh} = \frac{(\text{Envelope Load} + \text{Infiltration Load}) \times \frac{1 \times 10^6 \text{ Btu}}{\text{MMBtu}} \times \text{Cooling} \frac{\text{kW}}{\text{Ton}}}{12,000 \frac{\text{Tons}}{\frac{\text{Btu}}{\text{Hr}}}}$$

$$\text{Heating MMBtu} = \frac{(\text{Envelope Load} + \text{Infiltration Load})}{\text{Boiler Efficiency (\%)}}$$

$$\begin{aligned} \text{Envelope Load} = & \frac{1}{\text{Rvalue}} \times \text{Exposed Area} \times \left[ \sum (\text{Air Temp}_{\text{Outdoor}} - \text{Setpoint}_{\text{Occupied}}) \times \text{Occupied Hours} \right. \\ & \left. + \sum (\text{Air Temp}_{\text{Outdoor}} - \text{Setpoint}_{\text{Unoccupied}}) \times \text{Unoccupied Hours} \right] \end{aligned}$$

$$\begin{aligned} \text{Infiltration Load} = & \frac{1.08 \times \text{Infiltration CFM}}{1 \times 10^6} \times \left[ \sum (\text{Air Temp}_{\text{Outdoor}} - \text{Setpoint}_{\text{Occupied}}) \times \text{Occupied Hours} \right. \\ & \left. + \sum (\text{Air Temp}_{\text{Outdoor}} - \text{Setpoint}_{\text{Unoccupied}}) \times \text{Unoccupied Hours} \right] \end{aligned}$$

### **FIM 4.2- EMS Building Controls/ Optimal Start: Formulas & Calculations Used**

Spreadsheet based- General Formulas used include:

$$\text{Baseline MMBtu} = 1.08 \times \text{CFM} \times \% \text{ Speed at Warmup} \times (\text{Air Temp}_{\text{Outdoor}} - \text{Air Temp}_{\text{Room}}) \times \text{Warmup Hours}$$

$$\text{Proposed MMBtu} = \frac{\frac{\text{Envelope Load} + \text{Infiltration Load}}{1 \times 10^6} \times \text{Warmup Hours}}{\text{Morning Run Hours}}$$

$$\text{Warmup Hours} = \text{Hours before Occupancy Unit Ventilators Turned to Occupied Mode}$$

$$\text{MMBtu Savings} = \frac{\text{Baseline MMBtu} - \text{Propose MMBtu}}{\text{Boiler Efficiency (\%)}}$$

## APPENDIX C

### **FIM 4.3-AHU Upgrade / VFD on Fan: Formulas & Calculations Used**

Spreadsheet based- General Formulas used include:

$$\text{Cooling kWh} = \frac{\left( \text{Sensible Cooling} \left( \frac{\text{Btu}}{\text{Hr}} \right) + \text{Latent Cooling} \left( \frac{\text{Btu}}{\text{Hr}} \right) \right) \times \text{Cooling} \frac{\text{kW}}{\text{Ton}} \times \text{Bin Hours}}{12,000 \frac{\text{Tons}}{\frac{\text{Btu}}{\text{Hr}}}}$$

$$\text{Sensible Cooling} \left( \frac{\text{Btu}}{\text{Hr}} \right) = 1.08 \times \text{CFM}_{\text{Mixed Air}} \times (\text{Temp}_{\text{Mixed Air}} - \text{Temp}_{\text{Cooling Coil}})$$

$$\text{Latent Cooling} \left( \frac{\text{Btu}}{\text{Hr}} \right) = 0.68 \times \text{CFM}_{\text{Mixed Air}} \times (\text{Relative Humidity}_{\text{Mixed Air}} - \text{RH Setpoint}_{\text{Discharge Air}})$$

$$\text{Heating MMBtu} = \frac{\text{Preheat} \left( \frac{\text{Btu}}{\text{Hr}} \right) + \text{Reheat} \left( \frac{\text{Btu}}{\text{Hr}} \right)}{1 \times 10^6 \text{ Boiler Efficiency (\%)}} \times \text{Bin Hours}$$

$$\text{Preheat} \left( \frac{\text{Btu}}{\text{Hr}} \right) = 1.08 \times \text{CFM}_{\text{Mixed Air}} \times (\text{Temp}_{\text{Preheat Coil}} - \text{Temp}_{\text{Mixed Air}})$$

$$\text{Reheat} \left( \frac{\text{Btu}}{\text{Hr}} \right) [\text{Cooling Season}] = 1.08 \times \text{CFM}_{\text{Mixed Air}} \times (\text{Temp}_{\text{Discharge Air; Summer}} - \text{Temp}_{\text{Cooling Coil}})$$

$$\begin{aligned} \text{Reheat} \left( \frac{\text{Btu}}{\text{Hr}} \right) [\text{Heating Season}] \\ = 1.08 \times \text{CFM}_{\text{Mixed Air}} \times [\text{Temp}_{\text{Discharge Air; Winter}} - \text{Max}(\text{Temp}_{\text{Preheat Coil}}, \text{Temp}_{\text{Mixed Air}})] \end{aligned}$$

$$\text{CFM}_{\text{Mixed Air}} = \text{CFM}_{\text{Total Supply}} \times \% \text{ Fan Speed}$$

$$\text{Temp}_{\text{Mixed Air}} = \frac{\text{CFM}_{\text{Outside Air}}}{\text{CFM}_{\text{Mixed Air}}} \times \text{Temp}_{\text{Outside Air}} + \frac{\text{CFM}_{\text{Return Air}}}{\text{CFM}_{\text{Mixed Air}}} \times \text{Temp}_{\text{Return Air}}$$

$$\text{Relative Humidity}_{\text{Mixed Air}} = \frac{\text{CFM}_{\text{Outside Air}}}{\text{CFM}_{\text{Mixed Air}}} \times \text{RH}_{\text{Outside Air}} + \frac{\text{CFM}_{\text{Return Air}}}{\text{CFM}_{\text{Mixed Air}}} \times \text{RH}_{\text{Return Air}}$$



## APPENDIX C

### **FIM 4.4- Pool Dehumidification: Formulas & Calculations Used**

Spreadsheet based-

See DEA Appendix for Calculations

### **FIM 4.5- Snow Melt Sensor: Formulas & Calculations Used**

Spreadsheet based-

See DEA Appendix for Calculations

### **FIM 6- Water Conservation: Formulas & Calculations Used**

$$\text{Water Savings} = \sum (\text{Fixture Water Flow}_{\text{Pre}} - \text{Retrofit Fixture Water Flow}_{\text{Post}})$$

$$\text{Water Cost Savings} = \sum (\text{Water Savings}) \times \text{Fixture Usage}$$

## APPENDIX C

### **FIM 9- Vending Controls: Formulas & Calculations Used**

$$\text{Electric Savings} = \sum (\text{Energy Usage}_{\text{Pre}} - \text{Energy Usage}_{\text{Post}})$$

$$\text{Energy Usage} = \sum (\text{Lighting kWh} + \text{Compressor kWh})$$

$$\text{Lighting}_{\text{Pre}} \text{ kWh} = \sum (\text{Lighting kW} \times \text{Hours per Day} \times \text{Days per Year})$$

$$\text{Lighting}_{\text{Post}} \text{ kWh} = \sum \text{Lighting kW} \times (\text{Hours}_{\text{Occupied}} + (\text{Hours}_{\text{Unoccupied}} \times \text{Night Duty Cycle}))$$

$$\text{Compressor Hours}_{\text{Post}} = \sum (\text{Hours}_{\text{Occupied}} \times \text{Existing Duty Cycle}) + (\text{Hours}_{\text{Unoccupied}} \times \text{Night Duty Cycle})$$

$$\text{Compressor}_{\text{Pre}} \text{ kWh} = \sum \left( \frac{\text{Volts} \times \text{Amps} \times 80\% \text{ P. F.}}{\frac{1,000 \text{ W}}{1 \text{ kW}}} - \text{Lighting kW} \right) \times \frac{\text{Hours}_{\text{Pre}}}{\text{Year}} \times \text{Duty Cycle}$$

$$\text{Compressor}_{\text{Post}} \text{ kWh} = \sum \left( \frac{\text{Volts} \times \text{Amps} \times 80\% \text{ P. F.}}{\frac{1,000 \text{ W}}{1 \text{ kW}}} - \text{Lighting kW} \right) \times \frac{\text{Compressor Hours}_{\text{Post}}}{\text{Year}}$$

### **FIM 10- Pool Cover: Formulas & Calculations Used**

Spreadsheet based-

See DEA Appendix for Calculations

### **FIM 11- Ice Arena Upgrades: Formulas & Calculations Used**

Savings based on Utility Invoices & Metrix Meter Tuning Contracts contained in previous sections of this report.

## APPENDIX C

### **FIM 12- Power Factor: Formulas & Calculations Used**

$$\text{Electric kWh Savings} = \sum (\text{kW}_{\text{Pre}} - \text{kW}_{\text{Post}}) \times \text{Runtime Hrs}$$

$$\text{kW} = \frac{\sqrt{PHase} \times \text{Volts} \times \text{Amps} \times \text{Power Factor}}{1,000 \frac{\text{Watts}}{\text{kW}}}$$

$$\text{Power Factor Penalty kW}_{\text{Savings}} = \text{kW}_{\text{CHarged}} - \text{kW}_{\text{Used}}$$

### **FIM 13- Transformers: Formulas & Calculations Used**

$$\text{Electric Savings} = \sum (\text{Transformer Losses}_{\text{Pre}} - \text{Transformer Losses}_{\text{Post}})$$

$$\text{Transformer Losses} = \sum [\text{kVA} \times \text{Load} \times \text{Load Factor} \times (\frac{1}{\% \text{ Efficiency}} - 1)]$$

### **FIM 14- Aeration Blowers: Formulas & Calculations Used**

$$\text{Electric Savings} = \text{kWh Use}_{\text{Pre}} - \text{kWh Use}_{\text{Post}}$$

$$\text{kWh Use} = \frac{\text{Voltage} \times \text{Amperage} \times \text{PF} \times \sqrt{3}}{\frac{1,000 \text{ W}}{\text{kW}}} \times \text{Hours}$$

### **FIM 15- Boiler Replacement: Formulas & Calculations Used**

$$\text{Fuel Savings} = \text{Fuel Usage} \times \frac{\text{Fuel to Heat Efficiency}_{\text{Pre}}}{\text{Fuel to Heat Efficiency}_{\text{Post}}}$$

$$\text{Fuel to Heat Efficiency (\%)} = \text{Combustion Efficiency} \times (1 - \text{Radiant Jacket Losses}) \times (1 - \text{Distribution Losses})$$