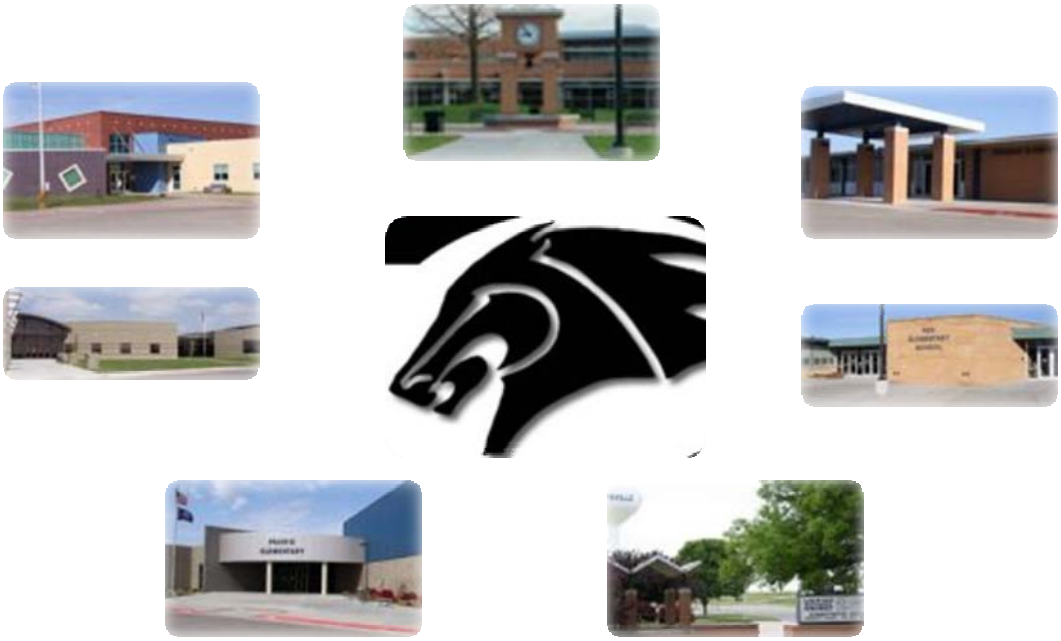
Conserve Resources
Reduce Operating Costs
Improve Occupant Comfort

Performance Contracting Report for Haysville USD 261



Presented By:
Johnson Controls, Inc.
February 6, 2013

Johnson Controls

1. HAYSVILLE USD#261 ESPC PROJECT SUMMARY

1.1 Executive Summary

Haysville USD #261 had the vision to modernize and update school facilities, resulting in improved appearance, function, resource efficiency, and comfort. These improvements were largely paid for by the reduction in utility and maintenance costs of new efficient and reliable equipment, as well as by other energy conservation upgrades in buildings throughout the district. Haysville USD#261 has demonstrated environmental stewardship while creating a better learning environment for their students.

Haysville USD#261 partnered with Johnson Controls, Inc. to execute an Energy Savings Performance Contract in year 2012. Facility Improvement Measures (FIMs) included lighting upgrades, water conserving low flow fixtures, building weatherization, HVAC upgrades, equipment controls, and architectural upgrades.

Measurement and Verification followed IPMVP (International Performance Measurement and Verification Protocol) Option A guidelines. The total guaranteed savings of $105,835 were exceeded by $1,325, to achieve a total annual savings of $107,160. Additional savings of $1,145 were accrued from the lighting upgrade when savings were re-calculated from as-builts with actual measured pre- and post fixture wattages. The plumbing fixture upgrade yielded an additional $222 from guaranteed savings.

		Energy Savings		
FIM	Annual Operational Savings	Measurable Savings	Non Measured Savings	Annual Savings
Lighting Upgrade	$628	$15,920		$16,548
Water Conserving Fixtures, Bathrooms	$2,917	$18,976		$21,893
Water Conserving Fixtures, Kitchens		$1,659		$1,659
Ice Machines			$327	$327
RTU Replacement	$5,000		$2,434	$7,434
Adjustment for RTU Scope Change, Oatville Elementary				($42)
Building Weatherization			$20,956	$20,956
Building Automation System		$4,370		$4,370
HVAC Improvements (Chiller, Boiler, Multizone AHU)	$14,413		$7,861	$22,274
Glass Replacement, Grand Lane			$2,652	$2,652
Pool Cover, High School			$3,837	$3,837
Radiant Heat, Service Center	$2,750		$2,503	$5,253
Totals	$25,708	$40,925	$40,569	$107,160

The following pages illustrate a few of the upgrades accomplished through the Energy Savings Performance Contract.

Grandlane



Before





Construction



- *Improved student learning environment*
- *Reduced energy consumption*
- *Sophisticated outside appearance*



After

Haysville Middle School

Before





Replaced aging equipment with new high efficiency, low maintenance equipment



Original cooling tower replaced with high efficiency BAC unit, with Variable Speed drives



Construction



- *Safe and healthy air quality*
- *Elimination of scale, leakage, and dangerous bacteria*
- *Reduced water loss*



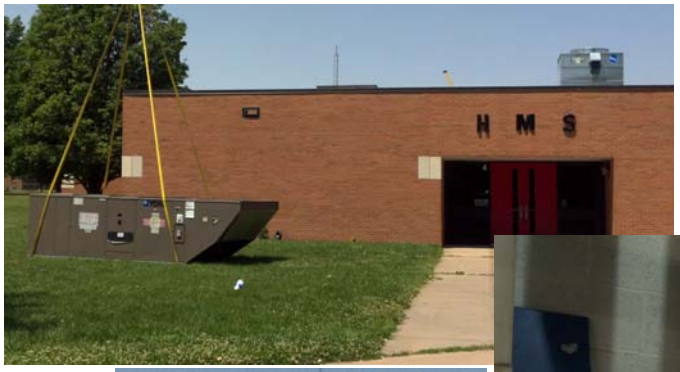
10 Rooftop Units Replaced

- *Reduced Maintenance*
- *Improved Efficiency*
- *Steady Comfort*

Before







Chiller Replacement

- *Increased Reliability*
- *Improved Efficiency*







After

Boiler Replacement

- *Modular condensing boilers cycle on to provide only the amount of hot water actually needed*
- *High part-load efficiency*
- *Low maintenance costs*

Before





Variable Speed Pumps

- *Low energy consumption*
- *Soft start for longer life*





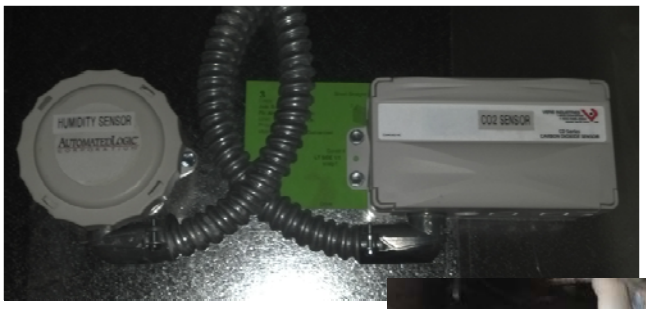
After

Multizone Air Handler Unit Replacement

- *Outside Air controlled by CO_2 sensors*
- *Variable Air Volume zone control*
- *Energy efficient*
- *Low maintenance*

Before





After



Service Center

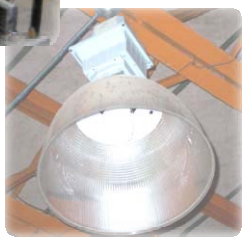
Radiant Heater Installation

- *Transfers heat directly to people and surfaces*
- *Heat remains in space when overhead doors are opened*









Before

Replace Window Units with Central Air

- *Increased Efficiency and Reliability*
- *Quiet*





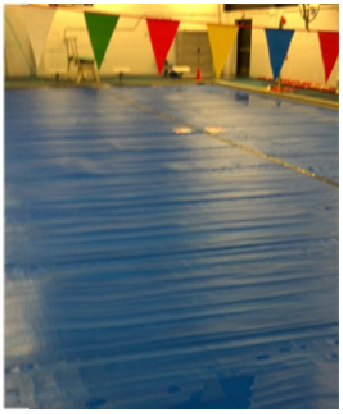
After

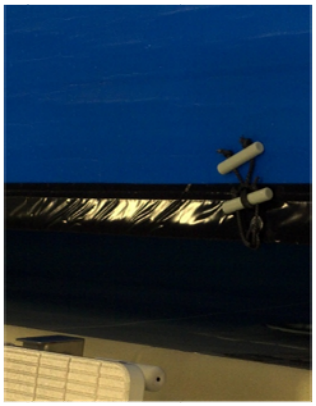
Campus High School

Pool Cover

- *Reduced heat loss*
- *Reduced evaporation rate*



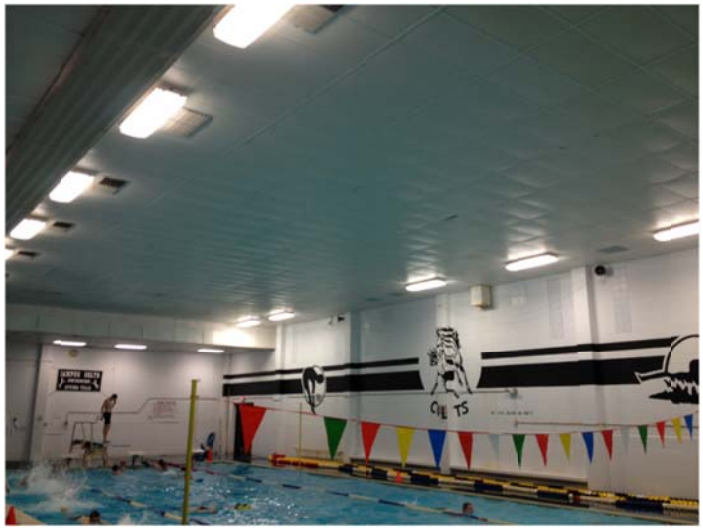




~~*Pool Cover*~~*Lighting Upgrade*

- *Low wattage, long life fluorescent tubes*
- *Brighter, more natural light*





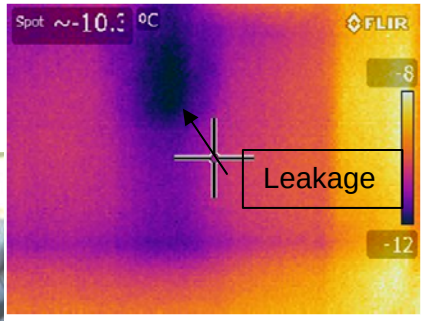
District-Wide

Caulking and Sealing

- *Windows and Roof-Wall joints*
- *360° Door seals*
- *Pipe penetrations*

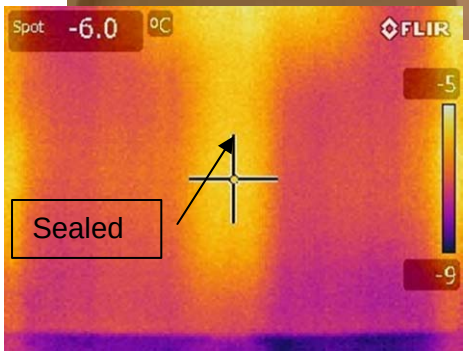


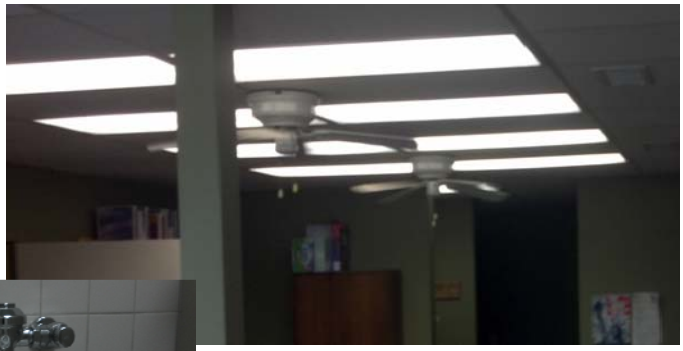






- *Increased comfort and productivity*
- *Less draftiness and summer humidity*
- *Lower utility costs*





Low Flow Water Retrofits for Plumbing Fixtures

- *Reduce rapidly rising water costs*
- *Significant Environmental Impact*



Energy Efficient, Long-Life Lighting

1.2 Project Timeline

September 1, 2011	Original Contract Signed Date
September 28, 2011	Change Order Signed Date
October 1, 2011	Project Start
September 30, 2012	Project Substantial Completion
October 1, 2012	Guarantee Start
Guarantee Term	17 Years

1.3 Project Overview

The Facility Improvement Measures (FIMs) chosen for implementation are summarized by building in Table 1.

Table 1: Facility Improvement Measures by Building

	Administration Building	Campus High School	Freeman Elementary	Grand Lane	Haysville Middle Sch	Haysville West Mid Sch	Learning Center	Nelson Elementary	Oatville Elementary	Prairie Elementary	Rex Elementary	Ruth Clark Elementary	Service Center	Tri-City Day School
Lighting Upgrade	X	X	X	X	X	X	X	X	X	X	X	X	X	
Low Flow Water Fixtures		X	X	X	X	X		X	X	X	X	X		X
Weatherization	X	X	X	X	X	X	X	X	X	X	X	X	X	
HVAC Upgrades	X			X	X				X					X
Building Automation System	X			X			X				X			X
Pool Blanket		X												
Glass Replacement				X										
Radiant Heat													X	

1.3.1 Scope of Work Summary

Table 2 summarizes the scope of work, M&V option, and guaranteed cost savings associated with each item.

Table 2: Scope of Work and Guaranteed Savings Summary

Building	FIM ID	Project	Change Order	Measured/ Non-Measured	Electric Savings	Gas Savings	Water Savings	O&M Savings	Total Savings
Admin Office	BAS	Install DDC Controls on 10 RTUs	x	Option A	$99	$1,205	$0	$0	$1,304
	BE	Weatherization	x	Non-measured	$7	$218	$0	$0	$225
	HVAC	Cooling for Server Room		Non-measured	$1	$0	$0	$0	$1
	Lighting	Lighting		Option A	$3	$0	$0	$0	$3
Campus High School	BE	Weatherization	x	Non-measured	$120	$3,746	$0	$0	$3,866
	Lighting	Lighting		Option A	$2,231	$0	$0	$127	$2,358
	Pool	Pool Cover		Non-measured	$0	$3,837	$0	$0	$3,837
	Water	Low Flow Water Fixture Retrofit		Option A	$0	$499	$6,092	$1,049	$7,640
	Ice	Ice Machines		Non-measured	$165	$0	$0	$0	$165
	Kitchen	Kitchen Water Fixture Retrofit	x	Option A	$0	$42	$211	$0	$253
Freeman Elementary	BE	Weatherization	x	Non-measured	$14	$427	$0	$0	$440
	Lighting	Lighting		Option A	$718	$0	$0	$28	$745
	Water	Low Flow Water Fixture Retrofit	x	Option A	$0	$76	$1,295	$238	$1,608
	Kitchen	Kitchen Water Fixture Retrofit	x	Option A	$0	$16	$72	$0	$88
Grand Lane	BAS	Install DDC Controls on 14 RTUs	x	Option A	$212	$758	$0	$0	$970
	BAS	Parking Lot Lights on BAS	x	Option A	$95	$0	$0	$0	$95
	BE	Weatherization	x	Non-measured	$16	$694	$0	$0	$710
	Glass	Replace store front glass	x	Non-measured	$298	$2,354	$0	$0	$2,651
	HVAC	Replace 1-3 ton split, 1-4 ton split, 2 RTUs		Non-measured	$270	$128	$0	$641	$1,039
	Lighting	Lighting		Option A	$1,245	$0	$0	$37	$1,282
	Water	Low Flow Water Fixture Retrofit		Option A	$0	$46	$460	$76	$583
Haysville Middle Sch	BE	Weatherization	x	Non-measured	$24	$885	$0	$0	$910

Building	FIM ID	Project	Change Order	Measured/ Non-Measured	Electric Savings	Gas Savings	Water Savings	O&M Savings	Total Savings
	HVAC	Replace 10 RTUs, natural gas boiler and circulation pumps, chiller, cooling tower, VFD chilled water pumps, 2 Multizone to VAV conversions with Demand Control Ventilation		Non-measured	$2,637	$4,176	$0	$13,039	$19,851
	Lighting	Lighting		Option A	$6,021	$0	$0	$201	$6,222
	Water	Low Flow Water Fixture Retrofit	x	Option A	$0	$39	$1,370	$371	$1,781
	Ice	Ice Machines		Non-measured	$162	$0	$0	$0	$162
	Kitchen	Kitchen Water Fixture Retrofit	x	Option A	$0	$40	$198	$0	$238
Haysville West Mid Sch	BE	Weatherization	x	Non-measured	$74	$2,235	$0	$0	$2,308
	Lighting	Lighting		Option A	$798	$0	$0	$52	$850
	Water	Low Flow Water Fixture Retrofit	x	Option A	$0	$151	$1,829	$100	$2,080
	Kitchen	Kitchen Water Fixture Retrofit	x	Option A	$0	$46	$198	$0	$244
Learning Center	BAS	Install DDC Controls on 8 RTUs	x	Option A	$83	$898	$0	$0	$981
	BE	Weatherization	x	Non-measured	$19	$847	$0	$0	$867
Nelson Elementary	BE	Weatherization	x	Non-measured	$93	$2,759	$0	$0	$2,852
	Lighting	Lighting		Option A	$149	$0	$0	$7	$155
	Water	Low Flow Water Fixture Retrofit		Option A	$0	$96	$2,815	$503	$3,414
	Kitchen	Kitchen Water Fixture Retrofit	x	Option A	$0	$40	$198	$0	$238
Oatville Elementary	BE	Weatherization	x	Non-measured	$29	$1,417	$0	$0	$1,446
	HVAC	Replace 4 RTUs		Non-measured	$295	$354	$0	$733	$1,382
	Lighting	Lighting		Option A	$659	$0	$0	$22	$681
	Water	Low Flow Water Fixture Retrofit		Option A	$0	$114	$1,122	$490	$1,726
	Kitchen	Kitchen Water Fixture Retrofit	x	Option A	$0	$40	$198	$0	$238
Prairie Elementary	BE	Weatherization	x	Non-measured	$52	$1,613	$0	$0	$1,666
	Lighting	Lighting		Option A	$693	$0	$0	$38	$731
	Water	Low Flow Water Fixture Retrofit	x	Option A	$0	$142	$836	$56	$1,034
	Kitchen	Kitchen Water Fixture Retrofit	x	Option A	$0	$15	$70	$0	$85
Rex Elementary	BAS	Install DDC Controls on 6 RTUs and 2 kitchen splits	x	Option A	$89	$390	$0	$0	$480

Building	FIM ID	Project	Change Order	Measured/ Non-Measured	Electric Savings	Gas Savings	Water Savings	O&M Savings	Total Savings
	BE	Weatherization	x	Non-measured	$84	$2,316	$0	$0	$2,400
	Lighting	Lighting		Option A	$1,148	$0	$0	$62	$1,210
	Water	Low Flow Water Fixture Retrofit	x	Option A	$0	$53	$991	$113	$1,157
	Kitchen	Kitchen Water Fixture Retrofit	x	Option A	$0	$40	$198	$0	$238
Ruth Clark Elementary	BE	Weatherization	x	Non-measured	$49	$1,812	$0	$0	$1,862
	Lighting	Lighting		Option A	$751	$0	$0	$44	$795
	Water	Low Flow Water Fixture Retrofit	x	Option A	$0	$11	$122	$66	$199
	Kitchen	Kitchen Water Fixture Retrofit	x	Option A	$0	$19	$60	$0	$79
Service Center	BE	Weatherization	x	Non-measured	$49	$1,357	$0	$0	$1,406
	Lighting	Lighting		Option A	$360	$0	$0	$10	$370
	Radiant	Radiant Heater Installation	x	Non-measured	$749	$1,753	$0	$2,750	$5,253
	RTU	Install 3 RTUs with DDC Controls		Non-measured	$0	$0	$0	$0	$0
Tri-City Day School	BAS	Install DDC Controls on 1 split system and new RTUs		Option A	$540	$0	$0	$0	$540
	RTU	Remove existing PTAC units and replace with 8-3 ton Rooftop units	x	Non-measured	$2,434	$0	$0	$5,000	$7,434
	Water	Low Flow Water Fixture Retrofit		Option A	$0	$9	$350	$49	$407
Total					$23,535	$37,713	$18,685	$25,902	$105,835

1.4 Performance Guarantee

Project benefits consist of measured and non-measured utility cost avoidance, and operations and maintenance cost avoidance. Utility cost avoidance is based on anticipated unit reduction and the cost of energy or water. Table 1 lists the annual guaranteed savings, costs, and cash flow for the term of the contract. This table includes both the original contract and the change order.

Table 3: Energy Savings Guarantee

Year	Utility Cost Avoidance	Operations & Maintenance Cost Avoidance	Annual Project Benefits
Installation*	$21,236	$3,238	$24,474
1	$79,933	$25,902	$105,835
2	$82,777	$26,680	$109,457
3	$85,723	$27,480	$113,203
4	$88,774	$28,304	$117,078
5	$91,933	$29,153	$121,086
6	$95,204	$30,028	$125,232
7	$98,592	$30,929	$129,521
8	$102,101	$31,857	$133,957
9	$105,734	$32,812	$138,547
10	$109,497	$33,797	$143,294
11	$113,393	$845	$114,238
12	$117,429	$870	$118,298
13	$121,607	$896	$122,503
14	$125,935	$923	$126,858
15	$130,417	$951	$131,367
16	$135,058		$135,058
17	$139,864		$139,864
Total	$1,845,206	$304,664	$2,149,870

* Installation savings are expected, but not guaranteed. In event of a shortfall, Johnson Controls reserves the right to apply Installation Savings to Year 1.

1.5 Changes Between Final Proposal and As-Built Conditions

Changes to the project between Contract descriptions and As-Built installation are described and documented below.

Lighting

The As-Built Lighting summary is included in the O&M documentation submitted by the JCI Project Manager. There is always some variation from the audit due to lighting counts and unexpected existing fixture types.

Twenty-four lamps in the High School Library could not be retrofit without replacing entire fixtures, causing an annual savings deficit of $289. This was offset by executing additional scope at Haysville Middle School, where eighty-three lamps were replaced in the hallways for an annual savings of $1,523.

Lighting was upgraded in the Haysville Middle School boiler room to assist mechanics with the boiler installation. Three fixtures were upgraded with higher wattage lamps for additional light, and two retrofit with higher efficiency lamps for a positive annual savings difference of $18.

RTU Replacement

At Oatville Elementary, the 4 RTU replacements were originally planned to be 3-phase, but needed to be single phase. Single phase motors are inherently less efficient than 3-phase motors, and the EER of the new units was 11.2 instead of the planned 12.2. The calculated annual savings dropped from $763 to $721.

The 3 RTU replacements at the Service Center were changed from 208V units to 480V units, but the efficiency on the replacements did not change.

Additional heat strips are to be installed in the 8 RTUs at Tri-City. The units were not heating sufficiently due to installation issues; these have been corrected, but additional heat strips will provide further assurance of adequate heating on cold days.

Plumbing

Changes in fixture retrofits scoped versus installed are summarized by fixture type and building below. Savings calculations have been updated to account for these changes.

Table 4: Water Conserving Fixture Retrofit

Water Closets			
Building	Scope	Installed	Comments
Campus High School	85	86	1 extra Tank Toilet missed on audit
Freeman/Service/Admin	14	2	Audit counts off
Haysville Middle School	8	9	Toilet missed on audit
Totals	107	97	10 Short
Urinals			
Building	Scope	Installed	Comments
Freeman/Service/Admin	15	11	Audit counts off
Haysville Middle School/ Colt	37	27	Double counts on audit
Totals	52	38	14 Short
Lavatory Aerators			
Building	Scope	Installed	Comments
Campus High School	72	71	
Haysville Middle School + Colt	5	21	
West Middle School	49	45	
Freeman/Services/Admin/Ecc	29	17	
Grand Lane Learning Center	5	5	
Nelson Elementary	29	29	
Oatville Elementary	33	33	
Prarie Elementary	26	11	
Rex Elementary	9	1	
Ruth Clark Elementary	4	20	
Tri-City Day School	4	5	
Totals	265	258	7 Short
Showerheads			
Building	Scope	Installed	Comments
Campus High School	63	62	
Haysville Middle School + Colt	12	30	
West Middle School	21	20	
Ruth Clark Elementary	2	0	
Totals	98	112	14 Additional
Kitchen Pre-Rinse Sprayers			
Building	Scope	Installed	Comments
Campus High School	2	2	
Haysville Middle School	2	2	

Haysville West Middle	3	3	
Nelson Elementary	1	1	
Oatville Elementary	1	0	Sprayer on a steam pot
Rex Elementary	2	2	
Prairie Elementary	2	2	
Ruth Clark Elementary	1	1	
Freeman/Service/Admin	1	1	
Tri-City Day School	0	0	
Totals	15	14	1 Short

Kitchen Pedal Valves			
Building	Scope	Installed	Comments
Campus High School	1	1	
Haysville Middle School/ Colt	2	1	
Haysville West Middle	1	1	
Nelson Elementary	1	1	
Oatville Elementary	1	1	
Rex Elementary	1	0	No prep sink
Prairie Elementary	1	1	
Ruth Clark Elementary	0	1	
Freeman/Service/Admin	1	0	No prep sink
Tri-City Day School	0	0	
Totals	9	7	2 Short

Kitchen Hand Sink			
Building	Scope	Installed	Comments
Learning Center	0	1	
Totals	0	1	No kitchen hand sink in scope

1.6 Energy Rates

Energy rates used for savings calculations are summarized in Table 5 from the Contract Schedule 2. Rates include all fees including tariffs, taxes, and transport fees. Seasonal rates are averaged by month.

Table 5: Utility Rates Used for Calculations, from Contract Schedule 2

Building	Average $/kWh	Average $/MCF	Water & Sewer $/kgal
Campus High School	$0.076	$7.32	$7.500
Haysville Middle School	$0.076	$6.94	$7.500
Haysville West Middle School	$0.076	$6.90	$3.030

Building	Average $/kWh	Average $/MCF	Water & Sewer $/kgal
Freeman/Service/Admin/ECC	$0.076	$7.13	$7.500
Grandlane Facilities	$0.076	$10.24	$7.500
Nelson Elementary	$0.076	$7.22	$7.500
Oatville Elementary	$0.076	$8.75	$7.500
Prairie Elementary	$0.076	$7.06	$7.500
Rex Elementary	$0.076	$7.21	$7.500
Ruth Clark Elementary	$0.076	$8.41	$6.430
Tri-City Day School	$0.076		$7.500

Utility Rate Adjustment Factors

Utility rates are escalated each year by the escalation factors listed in Table 6. These are repeated from Contract Schedule 2, and derived from the Bureau of Labor Statistics. Installation Period (Year 0) and Year 1 savings are calculated with rates directly from Table 5. Years 2-15 are escalated annually by the factors in Table 6.

Table 6: Escalation Rates, from Contract Schedule 2

Year	Electric	Natural Gas	Water/Sewer	Operational Savings
All	3.3%	4.22%	3.03%	3.0%

1.7 Guaranteed Annual Cost Savings by FIM, from Contract

Annual Guaranteed cost savings are listed by FIM in Table 7, repeated from the Contract.

Table 7: Annual Guaranteed Energy Savings by FIM

FIM	Annual Operational Savings	Energy Savings		Annual Savings
		Measurable Savings	Non Measured Savings	
Lighting Upgrade	$628	$14,776		$15,403
Water Conserving Fixtures (Bathroom)	$3,111	$18,518		$21,629
Water Conserving Fixtures (Kitchen)		$1,701		$1,701
Ice Machines			$327	$327
RTU Replacement	$5,000		$2,434	$7,434
Building Weatherization			$20,956	$20,956
Building Automation System		$4,370		$4,370
HVAC Improvements (Chiller, Boiler, Multizone AHU)	$14,413		$7,861	$22,274
Glass Replacement, Grand Lane			$2,652	$2,652
Pool Cover, High School			$3,837	$3,837
Radiant Heat, Service Center	$2,750		$2,503	$5,253
Totals	$25,902	$39,365	$40,569	$105,835

1.8 Measured Energy Savings

Three FIMs were measured through Option A, Retrofit Isolation Partial Measurement. Table 8 shows the guaranteed cost savings and Table 9 the verified cost savings through Option A measurements.

Table 8: Annual Guaranteed Energy Savings of Measured FIMs

FIM	Annual Operational Savings	Guaranteed Energy Savings	Total Annual Savings
Lighting Upgrade	$628	$14,776	$15,403
Water Conserving Fixtures, Bathrooms	$3,111	$18,518	$21,629
Water Conserving Fixtures, Kitchens		$1,701	$1,701
Building Automation System		$4,370	$4,370
Totals	$3,739	$39,365	$43,103

Table 9: Verified Annual Savings of Measured FIMs

FIM	Annual Operational Savings	Verified Energy Savings	Annual Savings
Lighting Upgrade	$628	$15,920	$16,549
Water Conserving Fixtures, Bathrooms	$2,917	$18,976	$21,893
Water Conserving Fixtures, Kitchens		$1,659	$1,659
Building Automation System		$4,370	$4,370
Totals	$3,545	$40,925	$44,470

An excess annual savings of $44,470 - $43,103 = $1,367 was achieved from the *measured* FIMs.

1.9 Total Project Savings, Measured and Non-Measured

Table 10 combines the Measured cost savings with all of the Non-Measured items, and adds any adjustments for scope changes. This represents the final verified cost savings for the project.

Table 10: Total Project Verified Savings

FIM	Annual Operational Savings	Energy Savings		Annual Savings
		Measurable Savings	Non Measured Savings	
Lighting Upgrade	$628	$15,920		$16,548
Water Conserving Fixtures, Bathrooms	$2,917	$18,976		$21,893
Water Conserving Fixtures, Kitchens		$1,659		$1,659
Ice Machines			$327	$327
RTU Replacement	$5,000		$2,434	$7,434
Adjustment for RTU Scope Change, Oatville Elementary				($42)
Building Weatherization			$20,956	$20,956
Building Automation System		$4,370		$4,370
HVAC Improvements (Chiller, Boiler, Multizone AHU)	$14,413		$7,861	$22,274
Glass Replacement, Grand Lane			$2,652	$2,652
Pool Cover, High School			$3,837	$3,837
Radiant Heat, Service Center	$2,750		$2,503	$5,253
Totals	$25,708	$40,925	$40,569	$107,160

The final verified savings for the project is $107,160, an excess of $1,325 from the guaranteed amount.

2. SAVINGS VERIFICATION BY FIM

2.1.1 Lighting and Lighting Controls

2.1.2 Summary

A lighting audit was first completed for the school district in June 2011 to identify fixtures and spaces that would experience an energy savings cost benefit from lamp and ballast upgrade and lighting control installation.

The following steps were completed to verify the operation and savings potential of the lighting retrofit.

1. Pre-and post-retrofit wattage measurements were performed on a sample of each fixture type to verify estimated wattages. The sample size was estimated to achieve a statistical 80% Confidence/20% Precision. Statistical confidence represents the probability that the Sample Mean represents the True Population Mean within the stated Precision. Precision is stated as a percentage of the sample mean value. Most measurement groups actually achieved a higher certainty of 90% Confidence/10% Precision. Light levels were also recorded on a sampling of fixtures. All measurements were completed with an approved power meter having a current calibration certificate (calibration within 1 year of measurements).
2. After the retrofit, an As-Built detailed list of the actual replacements was compiled by the lighting installers. It is normal that some of the actual lamps and ballasts will vary from the audit, during which large numbers of fixtures must be catalogued and counted quickly. The lighting installation technicians record all variations from the original lighting scope. The Lighting As-Built is included in the attached CD.
3. The Project Manager walked the site with the installer and verified that all proposed retrofits were completed and the lamps operating as intended, and that the site had been returned to original condition.
4. Savings are calculated by applying the measured wattages to the final As-Built record. If no fixture measurements are available, an estimated wattage based on manufacturer specifications for the lamp and ballast combination is applied. Lighting Operating Hours are agreed upon in the contract.

2.1.3 Measurements

Tables 11-12 summarize the fixtures measured and the statistical data evaluation. Raw measurement data is listed in Appendix A. According to FEMP (Federal Energy Management Protocol) M&V Guidelines, power consumption of light fixtures comprising the top 75% of savings should be measured. In this project, the FEMP guideline was exceeded by measuring 90% of total fixture replacement power consumption. All fixture groups achieved a 90% Confidence/10% Precision accuracy level, exceeding the 80% Confidence/20% precision goal.

Table 11: Pre-Retrofit Fixture Measurement Summary

Fixture Type	Fixture Code	Qty Installed	% of Savings Represented	Number of Measure-ments	Sample Mean Watts	Standard Deviation	Relative Precision at 90% Confidence	Population Mean Watts	Predicted Watts
4-Lamp 4' T12	AAR2W	595	46%	11	147	1.6	0.60%	147 +/- 0.88	145
400W Metal Halide, Gyms (120V)	HBMH400/ HB1632	37	10%	4	517	1	0.23%	517+/- 1.2	458
400W Metal Halide (277V-480V circuit)	HBMH400/ HB1632	68	23%	7	440	13	2.17%	440 +/- 9.5	458
250W Metal Halide	DECOCMM H250/ RLMP-205	27	0.2%	7	284	11.6	3.00%	284 +/- 8.5	290
4-Lamp 4' T12, Middle School Hallways	A2LO	86	11%	6	167	3.7	1.84%	167 +/- 3.1	
Totals		823	90.2%	35					

Table 12: Post-Retrofit Fixture Measurement Summary

Fixture Type	Fixture Code	Qty Installed	% of Savings	Number of Measure-ments	Sample Mean Watts	Standard Deviation	Relative Precision at 90% Confidence	Population Mean Watts	Predicted Watts
2-Lamp T8 Normal Pwr Ballast	A4R2W	552	46%	7	58	1.2	1.50%	58 +/- 0.85	55
6-Lamp T8, High Bay	HBMH400/ HBI632	105	18%	7	220	8.3	2.75%	220 +/- 6.1	220
320W Metal Halide, Exterior	POLE-MH400/ RL/RB-320PS	70	14%	7	359	8.3	1.70%	359 +/- 6.1	365
2-Lamp T8 Low Power Ballast	A2LO	86	11%	7	40	0.7	1.31%	40 +/- 0.52	48
205W Metal Halide	DECOCMM H250/ RLMP-205	27	2%	6	230	5	1.79%	230 +/- 4.1	232
Totals		840	91%	34					

2.1.4 As-Builts

Lighting and Lighting Controls As-Builts are included in the CD included with the report.

2.1.5 Savings Calculation

Lighting retrofit savings consist of several components, as detailed below.

Consumption (kilowatt-hour: kWh) savings:

→ Monthly electric kWh consumption is reduced by reducing the kW power draw of the fixtures.

*[Sum of Pre-Retrofit (Watts * Hours of Operation) – Sum of Post-Retrofit (Watts * Hours of Operation)]/(1000 kW/W)*

Operations and Maintenance (O&M) Savings:

→ Replacement of all lamps at once will reduce future re-lamping costs. The longer life of newer lamps further reduces the cost of maintenance. O&M Savings are calculated based on pre- and post-retrofit lamp and ballast life (hours).

2.1.6 Lighting Savings

Lighting Savings are summarized in Table 13 below.

Table 13: Lighting Savings Summary

Item	Value
Upgraded Quantity of Luminaires	1,004
Total kWh Used (Existing System)	482,585
Total kWh Used (Upgraded System)	271,143
Total kWh Saved	211,442
Total Savings (Energy)	$15,456
HVAC Penalty or Savings	$464
Total Maintenance Savings (Material only)	$628
Total Savings (Maint, HVAC, Energy)	$16,548

2.2 Water Saving Retrofit

2.2.1 Summary

The Federal government established the Energy Policy Act of 1992 (EPAct), a national policy that set 1997 maximum water usage for all new water closets at 1.6 gallons of water per flush and urinals at 1.0 gallon per flush. Since that time, water closet manufacturers have redesigned their china to exceed these water use efficiencies. A plumbing fixture audit of the school district was conducted in April 2011 to identify fixtures for which significant water savings could be achieved. At that time, water consumption was measured on a sample of lavatory sinks, kitchen sinks, toilets, and urinals. A scope of work and savings potential was identified. Potential savings are calculated based on ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) water usage standards, and are based on facility demographics, building schedules, and billed water consumption.

1. Water consumption was measured before and after the retrofit on a sample of fixtures. Sample sizes were designed to achieve a statistical 80% confidence/20% precision. Statistical confidence represents the probability that the Sample Mean represents the True Population Mean within the stated Precision. Precision is stated as a percentage of the sample mean value.

2. An As-Built detailed list of the fixture retrofit was compiled by Professional Energy Services, Inc.

3. The Project Manager verified that all proposed retrofits were completed and operating as intended, and that the site had been returned to original condition.

4. Savings were calculated by applying the measured water consumption averages by fixture type to the As-Built list of retrofits. Facility demographics and building operating schedules remain as listed in the Contract.

2.2.2 Savings Calculations

A short summary of the savings calculation is listed below.

- Pre-Retrofit Water Consumption = Number of Fixtures * Existing flow per fixture (GPM or GPF) * [Number of people (male/female staff and male/female visitors) * Usage per day per person (by type)] * # days of building operation per year
- Pre-Retrofit Water Consumption = Number of Fixtures * Existing flow per fixture (GPM or GPF) * [Number of people (male/female staff and male/female visitors) * Usage per day per person (by type)] * # days of building operation per year
- Water Savings = Existing Water Consumption - Proposed Water Consumption
- $ Savings = Water Savings * Water Rate ($/kgal)

2.2.3 Measurements

Raw measurements obtained on the fixtures are listed in Appendix A. Table 14 and Table 15 present statistical summaries for Pre- and Post-Retrofit measurements. The sample size achieved a statistical 80% Confidence/20% Precision. Table 16 summarizes the water retrofit savings. As-Built files are included in the attached CD.

Table 14: Pre-Retrofit Measurement Statistical Summary

Fixture Type	# Measurements	Mean Flow	Std Dev	Std Error	Relative Precision at 80% Confidence	Population Mean, 80% Confidence
Toilets	9	1.6 GPF	0.1	0	4.2%	1.6 +/- 0.1
Urinals	3	1.0 GPF	0	0	0%	1.0
Restroom Faucets	8	2.1 GPM	0.1	0.04	2.5%	2.1 +/- 0.1

Table 15: Post-Retrofit Measurement Statistical Summary

Fixture Type	# Measurements	Mean Flow	Std Dev	Std Error	Relative Precision at 80% Confidence	Population Mean, 80% Confidence
Toilets	8	1.3 GPF	0.0	0	0%	1.3
Urinals	3	0.5 GPF	0.0	0	0%	0.5
Restroom Faucets w/ Aerators	7	0.5 GPM	0.0	0	0%	0.5

Table 16: Water Savings Retrofit Summary

	Campus High School	Haysville Middle/ Colt Stadium	Haysville West Middle School	Freeman/ Service/ Admin/ECC	Grandlane/ Learning Center	Nelson Elementary	Oatville Elementary	Prairie Elementary	Rex Elementary	Ruth Clark Elementary	Tri-City Day School	TOTALS
Water Baseline (gals)	3,188,000	767,000	417,000	307,000	511,000	416,000	487,000	250,000	369,000	205,000	72,000	6,989,000
Allocated Domestic Water Consumption (gals)	2,072,200	682,630	354,450	282,440	153,300	349,440	418,820	220,000	313,650	174,250	70,560	5,091,740
% Water Usage Reduction Domestic	42%	31%	30%	27%	49%	56%	39%	19%	22%	8%	70%	36%
% Water Usage Reduction Baseline	27%	28%	61%	29%	13%	95%	32%	47%	29%	15%	68%	40%
Water Savings	$6,547	$1,613	$1,922	$659	$505	$2,960	$1,181	$873	$816	$223	$368	$17,668
Gas Savings	$529	$65	$158	$80	$55	$100	$120	$148	$10	$34	$9	$1,308
Operational Savings	$1,053	$336	$96	$86	$76	$503	$489	$47	$109	$72	$49	$2,917
Total Plumbing Savings	$8,129	$2,014	$2,177	$825	$636	$3,563	$1,790	$1,069	$935	$329	$426	$21,893
Ice Machine Heat Exchangers	$164	$163										$327
Kitchen Equipment	$266	$251	$257	$43	$0	$251	$168	$89	$83	$251		$1,659

2.3 Building Automation System Upgrades

Controls were installed, as summarized below, to both existing equipment and newly installed equipment. All Rooftop units were supplied with, at minimum, fan status, discharge air, zone temperature, and set point adjust visible from the existing Building Automation System (BAS) workstation. Control strategies included Optimal Start, Scheduling, and Economizer control if the equipment is so equipped. Demand Control Ventilation was included on the Oatville Rooftop Units (existing) and the Middle School Air Handler Units (replaced). Table 17 lists equipment details for all equipment added to the BAS.

Administration Building	Install controls on 10 existing Rooftop Units (RTUs).
Grand Lane Alternative High School	Install controls on 14 RTUs and two split systems. RTU-5, RTU-12, and the split systems are new equipment.
Haysville Middle School	Replace two Multizone Air Handling Units (AHUs) with Variable Air Volume units. Replace 10 RTUs on south addition.
Learning Center	Install controls on 8 existing RTUs.
Oatville Elementary School	Install controls on 4 new RTUs
Rex Elementary School	Install controls on 4 existing RTUs (RTU-41, -42, -43, -44) and 2 existing split systems.
Tri-City Day School	Install controls on 8 new RTUs and 1 new split system
Service Center	Install controls on 3 new RTUs

Table 17: Controlled Equipment Details

Count	Building	Equipment	New/ Existing	Economizer (Yes/No)	Demand Control Ventilation
1	Administration	RTU-1	Existing	Yes	No
2	Administration	RTU-2	Existing	Yes	No
3	Administration	RTU-3	Existing	Yes	No
4	Administration	RTU-4	Existing	Yes	No
5	Administration	RTU-5	Existing	Yes	No
6	Administration	RTU-6	Existing	Yes	No
7	Administration	RTU-7	Existing	Yes	No
8	Administration	RTU-8	Existing	Yes	No
9	Administration	RTU-9	Existing	Yes	No
10	Administration	RTU-10	Existing	Yes	No
11	Grand Lane	RTU-1	Existing	No	No
12	Grand Lane	RTU-2	Existing	No	No
13	Grand Lane	RTU-3	Existing	No	No
14	Grand Lane	RTU-4	Existing	Yes	No

Count	Building	Equipment	New/ Existing	Economizer (Yes/No)	Demand Control Ventilation
15	Grand Lane	RTU-5	New	Yes	No
16	Grand Lane	RTU-6	Existing	Yes	No
17	Grand Lane	RTU-7	Existing	Yes	No
18	Grand Lane	RTU-8	Existing	Yes	No
19	Grand Lane	RTU-9	Existing	Yes	No
20	Grand Lane	RTU-10	Existing	Yes	No
21	Grand Lane	RTU-11	Existing	No	No
22	Grand Lane	RTU-12	New	Yes	No
23	Grand Lane	RTU-13	Existing	No	No
24	Grand Lane	RTU-14	Existing	No	No
25	Grand Lane	AC-1	Existing	No	No
26	Grand Lane	AC-2	Existing	No	No
27	Middle School	AHU-1	New	Yes	Yes
28	Middle School	AHU-2	New	Yes	Yes
29	Middle School	RTU-1	New	Yes	No
30	Middle School	RTU-2	New	Yes	No
31	Middle School	RTU-3	New	Yes	No
32	Middle School	RTU-4	New	Yes	No
33	Middle School	RTU-5	New	Yes	No
34	Middle School	RTU-6	New	Yes	No
35	Middle School	RTU-7	New	Yes	No
36	Middle School	RTU-8	New	Yes	No
36	Middle School	RTU-10	New	Yes	No
37	Middle School	RTU-11	New	Yes	No
38	Learning Center	RTU-1	Existing	Yes	No
39	Learning Center	RTU-2	Existing	Yes	No
40	Learning Center	RTU-3	Existing	Yes	No
41	Learning Center	RTU-4	Existing	Yes	No
42	Learning Center	RTU-5	Existing	Yes	No
43	Learning Center	RTU-6	Existing	Yes	No
44	Learning Center	RTU-7	Existing	Yes	No
45	Learning Center	RTU-8	Existing	Yes	No
46	Oatville Elementary	RTU-35	New	Yes	Yes
47	Oatville Elementary	RTU-36	New	Yes	Yes
48	Oatville Elementary	RTU-37	New	Yes	Yes
49	Oatville Elementary	RTU-44	New	Yes	Yes
50	Rex Elementary	RTU-41	Existing	Yes	No
51	Rex Elementary	RTU-42	Existing	Yes	No
52	Rex Elementary	RTU-43	Existing	No	No
53	Rex Elementary	RTU-44	Existing	No	No
54	Rex Elementary	AC-1	Existing	No	No
55	Rex Elementary	AC-2	Existing	No	No

Count	Building	Equipment	New/ Existing	Economizer (Yes/No)	Demand Control Ventilation
56	Tri-City	RTU-1	New	Yes	No
57	Tri-City	RTU-2	New	Yes	No
58	Tri-City	RTU-3	New	Yes	No
59	Tri-City	RTU-4	New	Yes	No
60	Tri-City	RTU-5	New	Yes	No
61	Tri-City	RTU-6	New	Yes	No
62	Tri-City	RTU-7	New	Yes	No
63	Tri-City	RTU-8	New	Yes	No
64	Tri-City	AC-1	New	No	No
65	Service Center	RTU-1	New	Yes	No
66	Service Center	RTU-2	New	Yes	No
67	Service Center	RTU-3	New	Yes	No

Central plant equipment at Haysville Middle School was commissioned by Piland Engineering in May 2012. The commissioning report is included in Appendix B.

After installation, control strategies were again reviewed and commissioned by JCI Measurement and Verification to verify that energy savings control strategies were in place and operating as intended. This was done through trend data on several different days to confirm that schedules, occupied and unoccupied set points, optimal start, economizer (where installed), and demand control ventilation (where installed) were operating in a manner that would achieve the calculated energy savings. A commissioning summary is included in Appendix B, and screen prints in the included CD.

Table 18 summarizes issues that were observed.

Table 18: Measurement and Verification Commissioning

Facility	Equipment	Existing/ New	Observation	Resolution
Administration	RTU-3	Existing	No minimum outdoor air damper setting	Ok, 2/1/2013
Administration	RTU-5	Existing	No minimum outdoor air damper setting	Ok, 2/1/2013
Administration	RTU-8	Existing	Recovered late, check economizer damper	Ok, 2/1/2013
Grand Lane	RTU-6	Existing	Cooling setpoint 69°, No minimum outdoor air damper setting	Ok, 2/1/2013
Grand Lane	RTU-8	Existing	Drawings show economizer enabled, not economizing	JCI Tech 12/2012
Middle School	AHU-1	New	Check economizer operation, not clear if economizing	Ok, 2/1/2013
Middle School	AHU-2	New	Check economizer operation, not clear if economizing	Ok, 2/1/2013
Middle School	RTU-7	New	Check economizer damper operation, MA-T not dropping	JCI Tech 12/2012
Learning Center	RTU-8	Existing	Drawings show economizer enabled, not economizing	JCI Tech 12/2012

Facility	Equipment	Existing/ New	Observation	Resolution
Oatville Elementary	RTU-35	New	Check CO_2 sensor	Ok, 2/1/2013
Rex Elementary	RTU-42	Existing	Discharge Air Temp and Setpoint, Mixed Air Temp, look reversed	Ok, 2/1/2013
Tri-City Day	All	New	Check all economizers	JCI Tech 12/2012

It was noted that supply fans on most RTUs were allowed to cycle off during occupied periods. Johnson Controls strongly recommends that supply fans remain on during building occupied periods to maintain Indoor Air Quality. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) have issued standards (ASHRAE 62.1-2010) for acceptable indoor air quality. Minimum ventilation air can be calculated according to population size in the building or controlled by a measurement of CO_2 or air contaminants.

Sufficient ventilation air must be provided at all occupied times, but outside ventilation air can only be pulled into the building by the supply fans. When outside air temperatures are very hot or very cold, the heating/cooling equipment must run often to satisfy space temperatures and indoor air quality is not likely to be a problem. However, during mild weather the units seldom need to cycle on, which means that outside air may never be pulled into the spaces. The air in the classrooms will become still, stuffy, and contaminated.

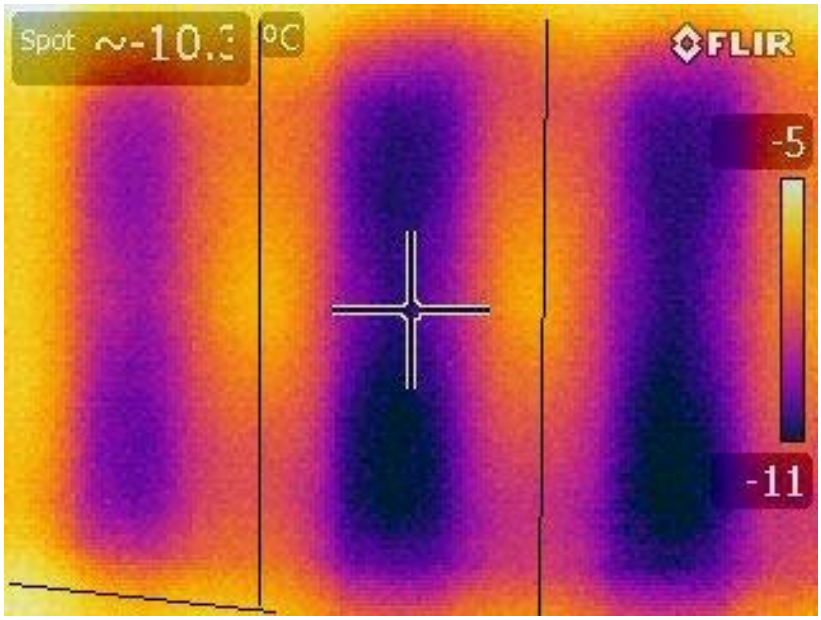
ASHRAE 62.1-2012 includes two standards for maintaining Indoor Air Quality: 1) setting the minimum outside air damper settings to bring in sufficient outside air as calculated according to the occupied population and activity level, and 2) operating the outside air damper according to CO_2 or bio-contaminant measurements. According to ASHRAE 62.1, CO_2 concentrations in outdoor air typically range from 300-500 parts per million (ppm). The maximum steady state indoor concentration is 700 ppm over outdoor levels; therefore the maximum total concentration should be no more than 1000-1200 ppm.

2.4 Building Weatherization

Building weatherization was performed on all of the district's buildings in late summer 2011. This included installing perimeter weather stripping on 228 exterior doors and 12 overhead doors, installing sweeps on 40 exterior doors, running 2,720 lineal feet of caulk around windows, and foaming 13,585 lineal feet of cracks at roof-wall joints.

During the walk-through with the weatherization supervisor in January 2012, a number of positive comments were received regarding the absence of drafts. The crews used over twice the amount of foam they had estimated for the job.

Infrared (FLIR) pictures were obtained for the post-weatherization condition. Infrared photography requires a substantial temperature delta between inside and outside, and requires that there be no sunlight reflected or impinging on the surfaces. The best time to take infrared pictures is at night when it is very cold, which was accomplished well before sunrise on a 30°F January morning.

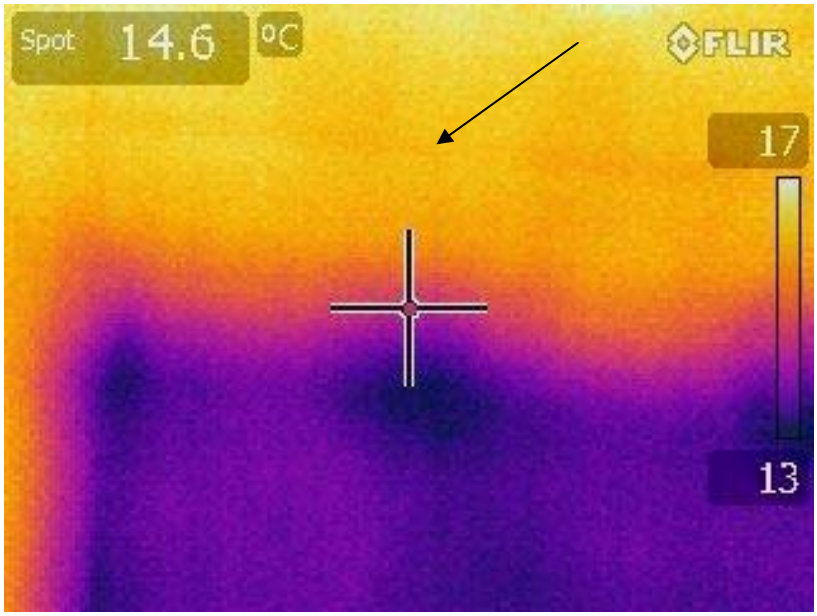


Campus High School

Doors

30° morning, looking inside to outside.

Note very little cold air leakage between the doors. Cold material is the glass.

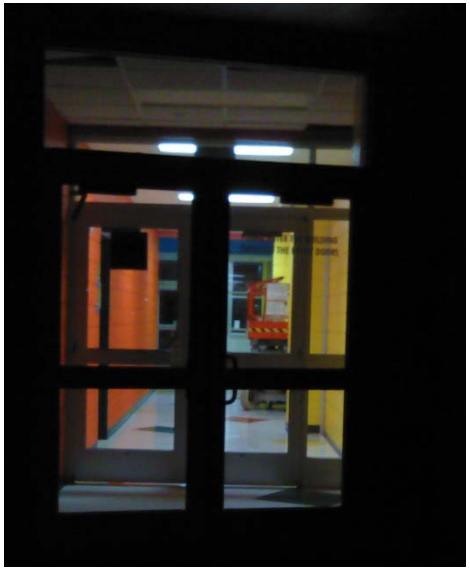
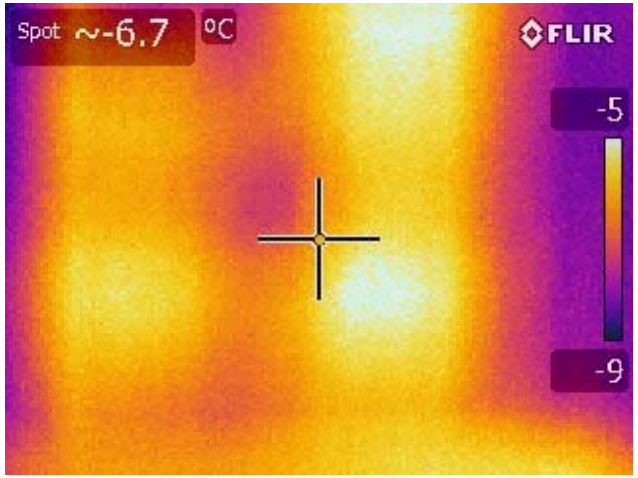
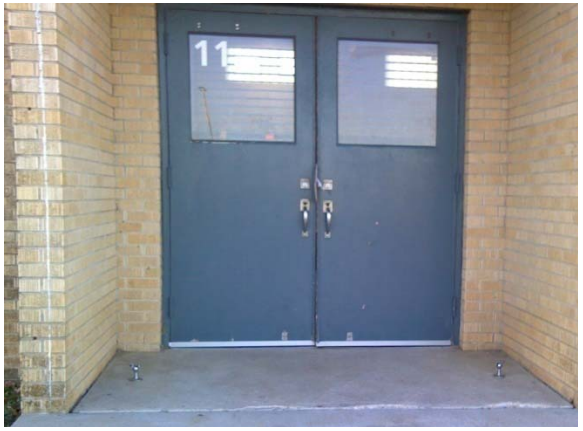
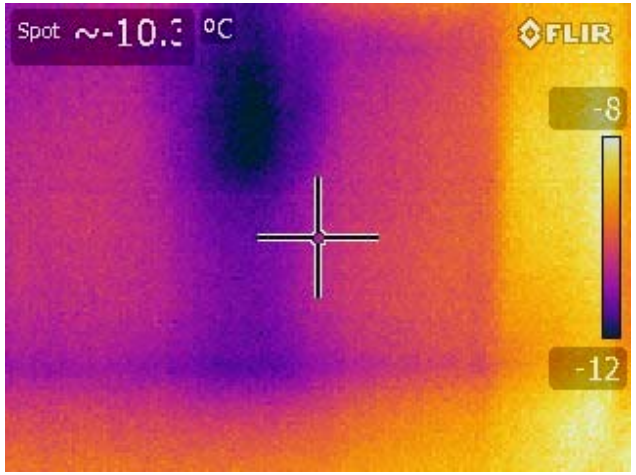


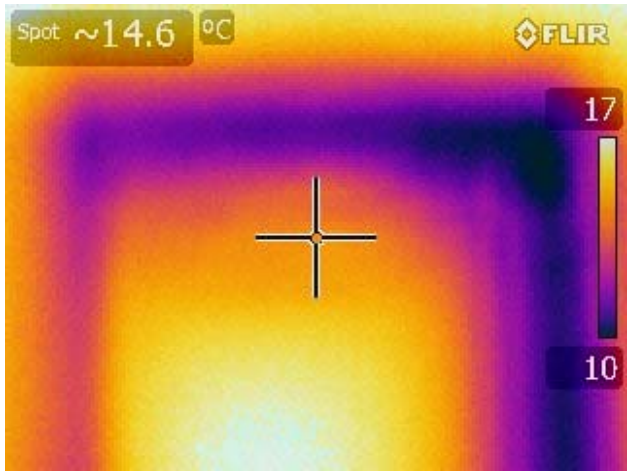
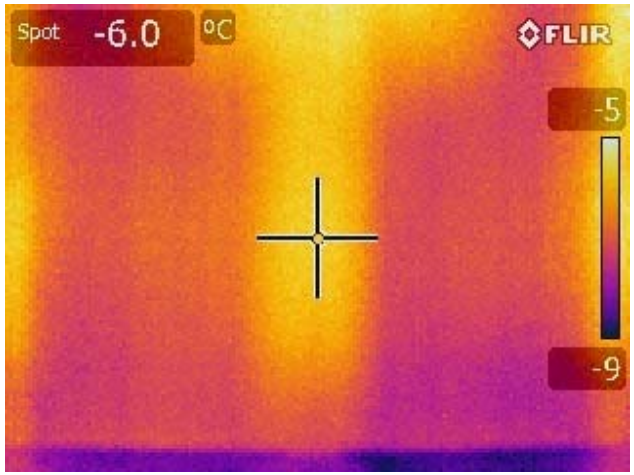
Campus High School

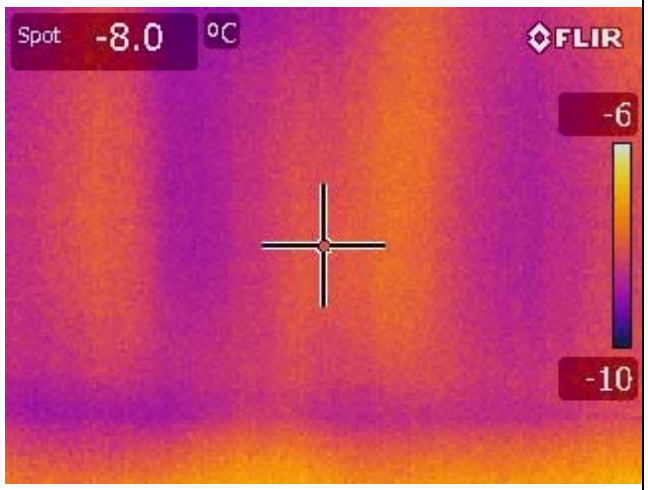
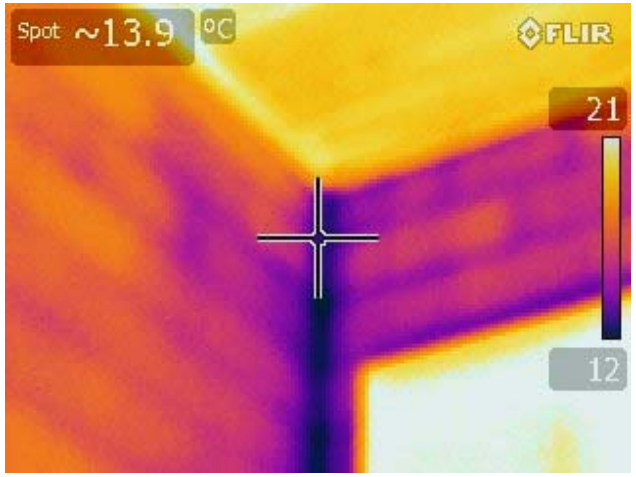
Gym Roof-Wall Seal

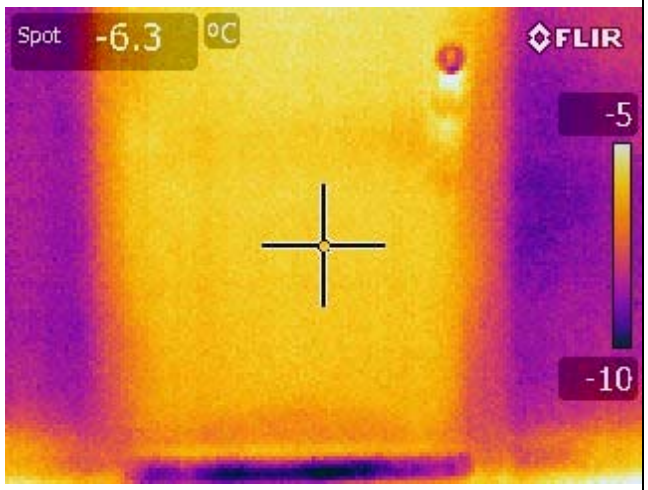
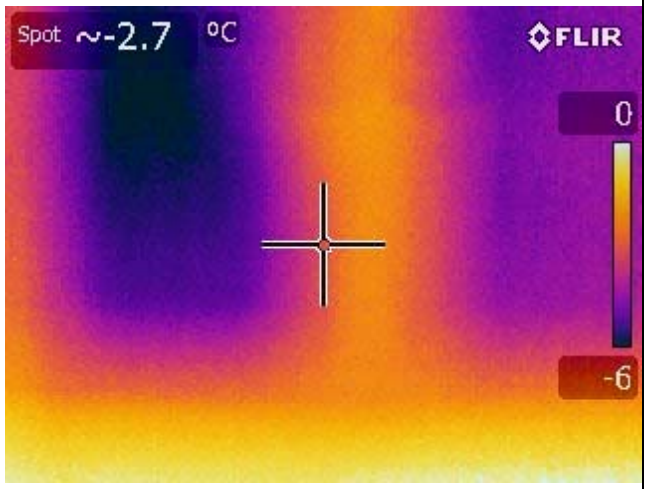
30° morning, looking inside to outside.

Note lack of leakage through joint above doors. Cold material is the metal door closers.

		**Campus High School** **Doors** 30° morning, looking outside in Note lack of leakage between and below doors. Cold spot between doors is metal latch.
		**Rex back door, gym** **Example of leakage: Door Propped Open slightly**

		**Prairie Music Room** **Elementary School** This door seal had been removed and replaced incorrectly. Note severe leakage.
		Prairie Gym Note lack of leakage in comparison. Cold material is metal threshold.

		Probably Nelson but might be Rex Very little leakage between doors. Cold areas are glass.
		**Nelson Elementary** **Roof-Wall Joint Sealing** Note lack of leakage at roof-wall joint

		**Nelson Elementary** **Exterior Door Sealing** Coldest spot is metal threshold. Bricks have high specific heat and warm slowly, so they are still cold. There is very little leakage around doorframe.
		**West Middle School** Glass doors, note lack of heat loss between and below metal frames.

2.5 Other Non-Measured FIMs

Pool Cover

The pool cover at Campus High School was completed on March 23, 2012. The cost savings of $3,387 in gas are from a reduction in surface heat loss.

Ice Machines

Maximicer™ counter-flow heat exchangers recover energy from purged ice water exiting the machine. These were installed at Campus High and Colt Stadium, for a total annual savings of $327.

Glass Storefront Replacement at Grand Lane

Replacing the glass storefront was an architectural improvement that also saved energy. The resulting cost savings are $298 in electricity and $2,354 in heating gas.

Radiant Heat at Service Center

Radiant heat is much more efficient than forced air heat. Radiant heat requires no fan power, and does not heat up the air surrounding occupants; instead, infrared radiation is transferred directly to the skin of the occupants and any exposed surface. If an overhead door is opened with forced air heat, a great deal of heated air is lost as well as the energy that went into heating it. With radiant heat, there is very little energy loss since the air is not the primary heating medium. The savings associated with the radiant heat is $749 in electricity (fan savings), $1,753 in heating natural gas, and $2,750 in boiler Operation and Maintenance avoided.

Appendix A

Raw Measurements

Haysville Public Schools USD 261 Lighting Data Sheet

Pre-Retrofit Fixture Measurement

Lighting Code: 4X34T12MB2
Quantity Installed: 597
Total Measurements: 11

Meas#	Fixture Type	Predicted Watts	Measured Watts	Measured Volts	Measured Amps	Power Factor	Building	Room
1	4-Lamp 4' T12 MB2	145	147	122	1.35	0.89	Middle school	B4
2	4-Lamp 4' T12 MB2	145	150	120	1.4	0.89	Middle school	B3
3	4-Lamp 4' T12 MB2	145	147	122	1.35	0.91	Middle school	B2
4	4-Lamp 4' T12 MB2	145	144	122	1.36	0.88	Middle school	C5
5	4-Lamp 4' T12 MB2	145	145	122	1.4	0.91	Oatville	133
6	4-Lamp 4' T12 MB2	145	147	121	1.37	0.91	Grand Lane	1
7	4-Lamp 4' T12 MB2	145	147	121.7	1.39	0.91	Grand Lane	3
8	4-Lamp 4' T12 MB2	145	148	121	1.37	0.91	Grand Lane	7
9	4-Lamp 4' T12 MB2	145	148	121	1.38	0.9	Middle school	C3
10	4-Lamp 4' T12 MB2	145	146	121.6	1.37	0.9	Oatville	130
11	4-Lamp 4' T12 MB2	145	146	122	1.39	0.89	Oatville	132

Pre-Retrofit Fixture Measurement

Lighting Code: 1X400MH
Quantity Installed: 216
Total Measurements: 11

Meas#	Fixture Type	Predicted Watts	Measured Watts	Measured Volts	Measured Amps	Power Factor	Building	Room
1	HBMH400/HBI632	458	515	120	4.58	0.95	Middle school	gym
2	HBMH400/HBI632	458	517	119.7	4.55	0.94	Middle school	gym
3	HBMH400/HBI632	458	517	120	4.48	0.96	Rex	gym
4	HBMH400/HBI632	458	517	120.4	4.5	0.96	Rex	gym
5	HBMH400/HBI632	458	448	283	1.69	0.94	Ruth Clark	gym
6	HBMH400/HBI632	458	451	283	1.7	0.94	Ruth Clark	gym
7	HBMH400/HBI632	458	448	279	1.7	0.94	High school	gym
8	POLE-MH400/RL/RB-320PS	458	451	485	1.1	0.85	West Middle exterior	ext
9	POLE-MH400/RL/RB-320PS	458	419	486	1	0.86	West Middle exterior	ext
10*	POLE-MH400/RL/RB-320PS	458	429	485	1.04	0.85	West Middle exterior	ext
11*	POLE-MH400/RL/RB-320PS	458	431	485	1.1	0.85	West Middle exterior	ext

*Only do if measurements vary widely

Pre-Retrofit Fixture Measurement

Lighting Code: 1X250MH
Quantity Installed: 27

Total Measurements: 8

Meas#	Fixture Type	Predicted Watts	Measured Watts	Measured Volts	Measured Amps	Power Factor	Building	Room
1	DECOCMMH250/RLMP-205	290	289	277	1.1	0.95	Ruth Clark	hall
2	DECOCMMH250/RLMP-206	290	288	279	1.1	0.94	Ruth Clark	hall
3	DECOCMMH250/RLMP-207	290	270	283	1	0.94	Ruth Clark	hall
4	DECOCMMH250/RLMP-208	290	290	279	1.1	0.94	Prairie	cafeteria
5	DECOCMMH250/RLMP-209	290	298	280	1.11	0.96	Prairie	cafateria
6	DECOCMMH250/RLMP-210	290	266	280	1	0.95	Prairie	library
7	DECOCMMH250/RLMP-211	290	288	279	1.1	0.94	Prairie	library
8	DECOCMMH250/RLMP-212	290						
9*	DECOCMMH250/RLMP-213	290						
10*	DECOCMMH250/RLMP-214	290						

*Only do if measurements vary widely

Additional Measurements for 4-Lamp T12 as Middle School

	Voltage (V)	Amperage (A)	Wattage (W)	Power Factor
Pre	118.3	1.184	122	0.88
Pre	117.5	1.546	163	0.9
Pre	119.7	1.578	168	0.9
Pre	120.2	1.611	172	0.9
Pre	119.5	1.559	166	0.89
Pre	118.7	1.513	168	0.9
Pre	117.7	1.544	161	0.9
Pre	119.1	1.602	169	0.89

Outlier test for first measurement

122

161 Q 0.78

163

166 Can be rejected with 99% confidence
168
168
169
172

Haysville Public Schools USD 261 Lighting Data Sheet

Post-Retrofit Fixture Measurement

Lighting Code: 2x32T8EBN
Quantity Installed: 619
Total Measurements: 7

Meas#	Fixture Type	Predicted Watts	Measured Watts	Measured Volts	Measured Amps	Power Factor	Building	Room
1	2 Lamp T8 EB	55	59	122	0.54	0.89	middle school	B4
2	2 Lamp T8 EB	55	58	120	0.54	0.89	middle school	B3
3	2 Lamp T8 EB	55	59	122	0.49	0.91	middle school	B2
4	2 Lamp T8 EB	55	59	122	0.53	0.88	middle school	C5
5	2 Lamp T8 EB	55	58	122	0.53	0.91	Oatville	133
6	2 Lamp T8 EB	55	57	121	0.53	0.91	Grand lane	1
7	2 Lamp T8 EB	55	56	121	0.54	0.91	Grand lane	3

Post-Retrofit Fixture Measurement

Lighting Code: 1X320MH
Quantity Installed: 80
Total Measurements: 7

Meas#	Fixture Type	Predicted Watts	Measured Watts	Measured Volts	Measured Amps	Power Factor	Building	Room
1	320MH	365	350	486	0.81	0.88	west middle	exterior
2	320MH	365	348	487	0.86	0.83	west middle	exterior
3	320MH	365	355	486	0.91	0.8	west middle	exterior
4	320MH	365	370	486	0.88	0.87	west middle	exterior
5	320MH	365	367	485	0.9	0.84	west middle	exterior
6	320MH	365	361	485	0.9	0.83	west middle	exterior
7	320MH	365	362	485	0.89	0.84	west middle	exterior

Post-Retrofit Fixture Measurement

Lighting Code: 6X32T8EBN

Quantity Installed: 105
Total Measurements: 7

Meas#	Fixture Type	Predicted Watts	Measured Watts	Measured Volts	Measured Amps	Power Factor	Building	Room
1	High Bay 6 Lamp T8	220	228	120	1.9	0.98	Middle school	gym
2	High Bay 6 Lamp T8	220	228	119.8	1.9	0.99	Middle school	gym
3	High Bay 6 Lamp T8	220	227	120	1.9	0.99	Rex	gym
4	High Bay 6 Lamp T8	220	225	120	1.93	0.98	Rex	gym
5	High Bay 6 Lamp T8	220	211	283	0.78	0.92	Ruth Clark	gym
6	High Bay 6 Lamp T8	220	212	279	0.78	0.92	High school	gym
7	High Bay 6 Lamp T8	220	212	278	0.78	0.92	High school	gym

Post-Retrofit Fixture Measurement

Lighting Code: 1X330MH
Quantity Installed: 31
Total Measurements: 6

Meas#	Fixture Type	Predicted Watts	Measured Watts	Measured Volts	Measured Amps	Power Factor	Building	Room
1	330MH	374	0	0	0	0	Ruth Clark	hall
2	330MH	374	0	0	0	0	Ruth Clark	hall
3	330MH	374	0	0	0	0	Ruth Clark	hall
4	330MH	374	0	0	0	0	Ruth Clark	hall
5	330MH	374	0	0	0	0	Ruth Clark	hall
6	330MH	374	0	0	0	0	Ruth Clark	hall

Post-Retrofit Fixture Measurement

Lighting Code: 1X205MH
Quantity Installed: 27
Total Measurements: 6

Meas#	Fixture Type	Predicted Watts	Measured Watts	Measured Volts	Measured Amps	Power Factor	Building	Room
1	205MH	232	223	279	0.85	0.94	Ruth Clark	hall
2	205MH	232	237	283	0.89	0.94	Ruth Clark	hall
3	205MH	232	228	279	0.87	0.94	Prairie	cafeteria
4	205MH	232	234	280	0.87	0.96	Prairie	cafeteria
5	205MH	232	228	280	0.86	0.95	Prairie	library
6	205MH	232	228	279	0.87	0.94	Prairie	library

Additional Scope at Middle School:

2-Lamp 25W T8

Qty 61

Voltage (V)	Amperage (A)	Wattage (W)	Power Factor
119.4	0.591	40	0.57
119.1	0.596	40	0.57
121.1	0.564	38	0.55
121.3	0.586	40	0.56
121.4	0.578	40	0.58
120.4	0.593	40	0.57
119.3	0.581	40	0.56
121.6	0.591	40	0.57

Water Fixture Measurements

Measurement	Building	Location	Toilet (GPF)	Urinal (GPF)	Shower (GPM)	Faucet (GPM)
Pre-Retrofit	Campus-Gym	1st Floor Boys	1.6	1.0		
Pre-Retrofit	Campus-Gym	1st Floor Girls	1.6			2.0
Pre-Retrofit	Campus-N/T Café	1st Floor Boys	1.8	1.0		2.0
Pre-Retrofit	Campus-N/T Café	1st Floor Boys	1.6	1.0		2.2
Pre-Retrofit	Campus-N/T Café	1st Floor Girls	1.6			2.0
Pre-Retrofit	Campus-N/T Café	1st Floor Girls	1.6			2.2
Pre-Retrofit	Campus Kitchen	Unisex RR	1.8			2.2
Pre-Retrofit	Campus-B Hall	1st Floor Women	1.6			
Pre-Retrofit	Campus-B Hall	1st Floor Women	1.3			
Pre-Retrofit	Campus-B Hall	1st Floor Men				2.0
Pre-Retrofit	Campus-B Hall	1st Floor Men				2.2
Post-Retrofit	Campus-Gym	1st Floor Boys	1.3	0.5		
Post-Retrofit	Campus-Gym	1st Floor Girls	1.3			0.5
Post-Retrofit	Campus-N/T Café	1st Floor Boys		0.5		0.5
Post-Retrofit	Campus-N/T Café	1st Floor Boys	1.3	0.5		
Post-Retrofit	Campus-N/T Café	1st Floor Girls	1.3			0.5
Post-Retrofit	Campus-N/T Café	1st Floor Girls	1.3			0.5
Post-Retrofit	Campus Kitchen	Unisex RR	1.3			0.5
Post-Retrofit	Campus-B Hall	1st Floor Women	1.3			
Post-Retrofit	Campus-B Hall	1st Floor Women	1.3			
Post-Retrofit	Campus-B Hall	1st Floor Men				0.5
Post-Retrofit	Campus-B Hall	1st Floor Men				0.5

GPM = Gallons per Minute, GPF = Gallons per Flush

Appendix B

Commissioning Reports