



Housing Authority of the City of Asheville

Energy Guarantee Report

Post-Construction Report

May 2010 – November 2010

Submitted by:

Siemens Industry, Inc.

April 2011



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Executive Summary

Siemens Industry, Inc (SIEMENS) is submitting this Post-Construction Period Measurement and Verification (M&V) Report for the construction period May 2010 through November 2010 in compliance with the Performance Contracting Agreement (PCA) of January 2010 between the Housing Authority of the City of Asheville (HACA) and SIEMENS. This report details the savings in energy units and dollars associated with the Facility Improvement Measures (FIMs) implemented during the construction period, during which time, SIEMENS installed and commissioned FIMs in the developments as defined in the PCA. SIEMENS will continue to issue an annual M&V report to document and confirm that SIEMENS has met the energy savings guarantees for the preceding 12 month period, as defined in the PCA. This Post Construction Period M&V Report is intended to satisfy the requirements of the FIMs that utilized M&V Option A, as specified in the PCA.

The following FIMs were implemented at HACA:

- Attic Insulation
- Door Insulation
- Wall Insulation
- Water Conservation
- Weatherization
- Window Replacement

The total savings achieved utilizing M&V Option A are summarized in the following table:

Table 1: Post-Construction Period Savings

FIM Name	Electricity		Natural Gas		Water/Sewer	
	Guaranteed \$ Savings	Achieved \$ Savings	Guaranteed \$ Savings	Achieved \$ Savings	Guaranteed \$ Savings	Achieved \$ Savings
#1 Water Conservation					\$ 1,995	\$ 5,647
#2 Weatherization	\$ 11,242	\$13,235	\$ 70,202	\$ 81,884		
*#6 Insulation: Door	\$ 43	\$ 54	\$ 1,388	\$ 2,256		
#3 Insulation: Attic	\$ 364	\$ 435	\$ 15,766	\$ 18,451		
#4 Insulation: Wall	\$1,379	\$ 2,189	\$ 45,227	\$ 73,905		
#5 Window Replacement	\$ 211	\$ 267	\$ 6,392	\$ 7,701		
Totals:	\$13,239	\$ 16,179	\$138,975	\$184,198	\$ 1,995	\$ 5,647

FIM #6 uses blower door testing to verify reduced ACH. FIM #2 uses the same testing. Combined FIMs 2 & 6 for M&V purposes.

The total Option A savings are \$206,106 compared to a guaranteed Option A Savings of \$154,209. This results in an excess of \$50,000 or 34% more savings than guaranteed.





Facility Improvement Measures (FIM)

FIM #1: Water Conservation – Livingston only

SIEMENS has retrofitted the existing water fixtures to increase efficiency. Those fixtures included toilets, faucet aerators and showerheads. The water conservation measure for Livingston only is an M&V Option A. Other water conservation measures utilize an Option C guarantee, which will be addressed in the next annual report.

- The existing 1.6 gallon per flush (gpf) toilets tanks were retrofitted with 1.28 gpf pressure assisted vessels.
- The existing 2.25 gallons per minute (gpm) showerheads were replaced with 1.75 gpm showerheads.
- The existing bathroom sink aerators of 1.25 gpm were replaced with 1.0 gpm aerators.
- The existing kitchen sink aerators of 2.0 gpm were replaced with 1.5 gpm aerators.

The following table is the actual savings compared to the guaranteed savings.

Table 2: Guaranteed and Actual Savings for Water Conservation Measures

Development	Guarantee (gallons)	Achieved (gallons)	Guarantee Savings (\$)	Achieved Savings (\$)
Livingston	221,409	610,368	\$ 1,995	\$ 5,647

Standard Usage per Person

- | | <u>Range</u> | <u>Average</u> |
|---|-----------------|----------------|
| • Toilet Usage - Flushes per Person per Day: | 5 to 8 Flushes | 6.5 Flushes |
| • Shower Usage – Minutes per Person per Day: | 5 to 8 Minutes | 6.5 Minutes |
| • Bathroom Sink Usage – Minutes per Person per Day: | 2 to 4 Minutes | 3 Minutes |
| • Kitchen Sink Usage – Minutes per Person per Day: | 8 to 10 Minutes | 9 Minutes |

Formulas for Water/Sewer Energy Savings (gallons)

Annual Toilet Water Cons./Person = Toilet Consumption Rate * Flushes/Day *365

Annual Water Cons. Savings per Site = (Pre-Project Cons./person – Post-Project Cons./person) * Site Population

Formulas for Cost Savings

Annual Cost Savings per Site = Water Consumption Savings * Water/Sewer Blended Rate

The pre and post average measurements are listed below.

Table 3: Pre and Post Project Measurements

Fixture	Pre-Project Measurement	Post-Project Measurement
Toilet	1.6 gpf	1.28 gpf
Bathroom Sink	1.25 gpm	1.0 gpm
Kitchen Sink	2.0 gpm	1.5 gpm
Showerhead	2.25 gpm	1.75 gpm



The following tables are used to calculate the pre-project water consumptions on a per person basis.

Table 4: Pre-Project Consumption

Type	Gallons	X	Usage	
Toilet Flush	1.6	x	6.5	Flushes per person per day (1.6 gpf tank)
Shower	14.625	x	1	Showers per person per day (2.25 gpm X 6.5 minutes)
Dish load	3	x	0.5	Dish loads per person per day
Laundry	8	x	0.2	Clothes loads per person per day
Meal	0.1	x	3	Meals per person per day
Hand washing	0.1	x	10	Hand washings per person per day
Other	5	x	1	per person per day

The gallons listed in table 4 are on a per person basis. Applying that per person basis in Table 4 to the number of bedrooms per unit multiplied by a potential of 1.5 people per bedroom, gives the total consumption per month per bedroom type. The table below shows the water distribution for each water consuming activity on a per bedroom type basis.

Table 5: Pre-Project Water Consumption Totals

# Bdrm	# People	Toilet	Shower	Dishes	Clothes	Cooking	Hand Wash	Other	Gallons /Day	Gallons /Month	Ccf/ Month
1	1.5	15.60	21.94	2.25	2.40	0.45	1.50	7.50	51.64	1,570.64	2.10
2	3	31.20	43.88	4.50	4.80	0.90	3.00	15.00	103.28	3,141.28	4.20
3	4.5	46.80	78.98	6.75	7.20	1.35	4.50	22.50	168.08	5,112.28	6.83
4	6	62.40	105.30	9.00	9.60	1.80	6.00	30.00	224.10	6,816.38	9.11

After the water fixtures were retrofitted, the post-project consumption had to be verified. The following table was used to calculate the post-project water consumptions on a per person basis.

Table 6: Post-Project Consumption

Type	Gallons	X	Usage	
Toilet Flush	1.28	x	6.5	Flushes per person per day (1.6 gpf tank)
Shower	11.375	x	1	Showers per person per day (1.75 gpm X 6.5 minutes)
Dish load	3	x	0.5	Dish loads per person per day
Laundry	8	x	0.2	Clothes loads per person per day
Meal	0.1	x	3	Meals per person per day
Hand washing	0.1	x	10	Hand washings per person per day
Other	5	x	1	per person per day

By taking the per person water consumptions in Table 6 and applying it to the number of bedrooms per unit, multiplied by a potential of 1.5 people per bedroom, gives the total



consumption per month per bedroom type. The table below shows the water distribution for each water consuming activity on a per bedroom type basis.

Table 7: Post-Project Water Consumption Totals

# Bdrm	# People	Toilet	Shower	Dishes	Clothes	Cooking	Hand Wash	Other	Gallons /Day	Gallons /Month	Ccf/ Month
1	1.5	12.48	21.94	2.25	2.4	0.45	1.5	7.5	48.52	1,475.74	1.97
2	3	24.96	43.88	4.5	4.8	0.9	3	15	97.04	2,951.48	3.95
3	4.5	37.44	65.81	6.75	7.2	1.35	4.5	22.5	145.55	4,427.22	5.92
4	6	49.92	87.75	9	9.6	1.80	6	30	194.07	5,902.96	7.89

Tables 5 and 7 show the total monthly consumptions pre and post-project in units of gallons and ccf. The water company bills in units of ccf. The savings below are determined using units of ccf to remain consist with the water company's blended rates for water and sewer.

Table 8: Water Consumption Total Savings

Bdrm Type	# Units	Water Pre-Proj Gallons	Water Pre-Project CCF	Water Post-Proj Gallons	Water Post-Project CCF	Savings (ccf/unit /month)	Savings (ccf/unit /year)	Savings (ccf/ year)	Savings (gallons /year)
1	24	1,571	2	1,476	2	0	0	0	0
2	74	3,141	4	2,951	4	0	0	0	0
3	36	5,112	7	4,427	6	1	12	432	323,136
4	32	6,816	9	5,903	8	1	12	384	284,232
Total:	166							816	610,368

Apply the total water savings to the water and sewer rates in effect in 2008.

Table 9: Water Dollar Total Savings

Bedroom Type	# Units	Savings (ccf/ year)	Water Savings (\$3.41/ccf) Per Year	Sewer savings (\$3.51/ccf) Per Year
1	24	0	0	0
2	74	0	0	0
3	36	432	\$ 1,473	\$ 1,516
4	32	384	\$ 1,309	\$ 1,348
Total:	166	816	\$ 2,783	\$ 2,864





FIM #2: Weatherization (including change order for Door Insulation)

SIEMENS installed weather stripping on the door and window seals at each development listed in Table 10. Included in the weatherization was caulking the exterior of the window frames to prevent air infiltration and seal any other leaks found during blower door testing. A change order was issued to address the FIM titled: Door Replacement. The change order removed the Door Replacement and replaced it with Door Insulation at Livingston. Since the method of M&V utilizes the blower door test results, this section combines the savings of weatherization and door insulation. The weatherization measures are an M&V Option A.

The following table is the actual savings compared to the guaranteed savings.

Table 10: Guaranteed and Actual Savings for Weatherization

Development	Electricity (kWh)		Electricity (\$)		Natural Gas (ccf)		Natural Gas (\$)	
	Guarantee	Achieved	Guarantee	Achieved	Guarantee	Achieved	Guarantee	Achieved
Bartlett Arms	76,570	102,093	\$ 5,092	\$ 6,789	-	-	-	-
Pisgah View	3,874	4,231	\$ 497	\$ 543	8,903	9,464	\$ 14,326	\$ 16,494
Hillcrest	3,545	4,193	\$ 425	\$ 503	8,546	10,114	\$ 15,356	\$ 17,629
Erskin - Walton	1,966	2,109	\$ 167	\$ 180	6,444	7,898	\$ 10,824	\$ 12,198
Aston Park Towers	43,648	44,568	\$ 3,872	\$ 3,953	-	-	-	-
Livingston	2,543	2,543	\$ 351	\$ 351	6,122	6,122	\$ 10,642	\$ 10,643
Deaverview	5,729	6,821	\$ 838	\$ 998	11,163	14,600	\$ 19,054	\$ 24,921
Livingston Door	314	388	\$43	\$53	798	1,298	\$ 1,388	\$ 2,256
Total Savings	138,189	166,947	\$ 11,285	\$ 13,370	41,976	48,306	\$ 71,590	\$ 84,140

Savings Calculation Methodology

Variables per Unit Data and Operation Data:

ACH_c: Pre-Project Air Changes per Hour (see Table 11)
 ACH_p: Post-Project Air Changes per Hour (see Table 11)
 ρ: Air Density
 C: Specific Heat of Air
 V_{UNIT}: Total Unit Volume (see Table 11)
 HDD: Annual Heating Degree Days
 DTD: Design Temperature Difference
 CD: Correction Factor
 E_{HP}: Heating System Efficiency
 C_{GAS}: Blended Natural Gas Rate
 C_{ELEC}: Blended Electric Rate

Values:

1.0
 Varies Per Unit
 0.075 lb/ft³
 0.24 BTU/lb
 Varies Per Unit
 4,203 °D
 54 °F
 0.77
 65 – 90% (Furnace)
 Varies per site
 Varies per site

Formulas for Energy Savings (kWh or ccf)

$$\text{Infiltration Heat Loss} = \text{ACH} * V_{\text{UNIT}} * \rho * C * \text{DTD}$$

$$\text{Annual Heating System Consumption} = \frac{\text{Heat Loss} * \text{HDD} * 24 \text{ hours/day} * \text{CD}}{E_{\text{HP}} * \text{DTD}}$$

$$\text{Annual Consumption Savings} = \text{Pre-Project System Consumption} - \text{Post-Project System Consumption}$$

Formulas for Cost Savings (\$)

$$\text{Annual Cost Savings} = (\text{Annual Electric Consumption Savings} * C_{\text{ELEC}}) + (\text{Annual Natural Gas Consumption Savings} * C_{\text{Gas}})$$



The pre and post average measurements are listed below.

Table 11: Pre and Post Project Measurements

Development	Bedroom Types	Pre-Project ACH	Post-Project ACH	Total Unit Volume
Bartlett Arms	0	1	0.25	3,250
	1	1	0.25	4,112
	2	1	0.19	8,160
	3	1	0.38	4,704
Pisgah View	1	1	0.38	4,704
	2	1	0.37	6,944
	3	1	0.37	8,736
	4	1	0.34	9,992
Hillcrest	1	1	0.5	4,152
	2	1	0.27	6,032
	3	1	0.22	8,264
	4	1	0.19	9,624
	5	1	0.57	11,368
Erskin - Walton	1	1	0.52	5,440
	2	1	0.27	7,760
	3	1	0.26	9,424
	4	1	0.38	10,496
	5	1	0.38	11,952
Aston Park Towers	0	1	0.31	2,824
	1	1	0.24	3,840
Livingston	1	1	0.39	5,144
	2	1	0.29	6,912
	3	1	0.21	9,424
	4	1	0.38	10,960
Deaverview	1	1	0.52	4,408
	2	1	0.30	7,312
	3	1	0.22	7,656
	4	1	0.38	9,248



The following table is an example calculation for the heat load calculation to determine pre and post-project consumption savings for both electricity and natural gas.

Table 12: Pre and Post Project Consumption Calculations

PROJECT NAME:	Hillcrest		
PROJECT NUMBER:	NC 07-04		
UNIT TYPE:	2 Bedroom		
APARTMENT DATA:			
	Pre-Project	Unit of Measure	Post-Project
Number of Stories:	2		2
Perimeter Linear Footage:	110	ft.	110
Perimeter HTM:	8	Btuh/lf	8
Perimeter Heat Loss:	849	Btu/h	849
Roof Square Footage:	377	ft ²	377
Roof U-Value:	0.067	Btu/(h °F ft ²)	0.067
Roof Heat Loss:	1357	Btu/h	1357
Exterior Wall Area:	1627	ft ²	1627
Wall U-Value:	0.091	Btu/(h °F ft ²)	0.091
Wall Heat Loss	7986	Btu/h	7986
Window Area:	94	ft ²	94
Window U-Value:	0.667	Btu/(h °F ft ²)	0.667
Window Heat Loss:	3391	Btu/h	3391
Door Area:	39	ft ²	39
Door U-Value:	0.333	Btu/(h °F ft ²)	0.333
Door Heat Loss:	702	Btu/h	702
Air Changes Per Hour	1	AC/H	0.27
Apt Volume	6032.00	cubic feet	6032.00
Infiltration Loss:	4631.85216	cubic feet/min	1583.03808
Total Apartment Heat Loss Rate:	18,917	Btu/h	15,868
Estimated Heating System Overall Efficiency:	90%		90%
Standing Pilot?	Yes		Yes
Pilot BTU/hr.:	500	Btu/h	500
Pilot Operating Hours:	8760	hrs/yr	8760
Pilot Consumption:	4380	kBTU/yr	4380
Heating Fuel? (Natural Gas, Electric, Propane)	Natural Gas		Natural Gas
Estimated Heating System Consumption:	336	CCF	289
Heating System Fan?	Yes		Yes
Heating Output:	54,000	Btu/h	54,000
Fan Size:	250	Watts	250
Fan Operating Hours:	560	hours	470
Fan Energy:	140	kWh	118



Annual Consumption Savings = Pre-Project System Consumption – Post-Project System Consumption
Electricity Consumption Savings for 2 Bedroom Unit at Hillcrest = 140 kWh – 118 kWh = 22 kWh Annually
(closer to 20 kWh annually without rounding)

20 kWh Annual Savings X 110 2-Bedroom Units = 2,160 kWh Annual Savings

2,160 kWh X \$0.12/kWh = \$259 Annual Savings

The following table reflects all sites within this FIM's electricity consumption savings.

Table 13: Pre and Post Project Electricity Consumption Savings

Project Name	# Bdrms	# of Units	Pre-Proj Avg Monthly Elec Load	Post-Proj Avg Monthly Elec Load	One Unit's Savings kWh/ Month	One Unit's Savings kWh/ Year	All Units Annual Savings kWh/Year	Site Specific \$/kWh	All Units Annual Savings
Bartlett Arms	0	87	544	473	72	858	74,654	\$0.0665 /kWh	\$ 4,964
	1	26	630	547	84	1,003	26,066		\$ 1,733
	2	1	873	759	114	1,373	1,373		\$ 91
									102,093
Pisgah View	1	32	235	234	1	16	510	\$0.1283 /kWh	\$ 65
	2	124	278	277	2	18	2,245		\$ 288
	3	68	317	316	1	15	1,053		\$ 135
	4	38	358	358	1	11	423		\$ 54
									4,231
Hillcrest	1	16	450	450	1	8	122	\$0.12 /kWh	\$ 15
	2	110	614	612	2	20	2,160		\$ 259
	3	80	860	858	2	18	1,449		\$ 174
	4	20	1,115	1,113	2	23	463		\$ 56
	5	8	1,378	1,378	0	0	0		\$ 0
									4,193
Erskin - Walton	1	12	228	227	1	10	126	\$0.0852 /kWh	\$ 11
	2	48	221	219	2	22	1,058		\$ 90
	3	46	340	338	1	16	723		\$ 62
	4	16	307	306	1	12	194		\$ 17
	5	2	328	328	0	5	10		\$ 1
									2,109
Aston Park Towers	0	93	430	404	25	306	29,376	\$0.0887 /kWh	\$ 2,606
	1	65	486	467	19	233	15,149		\$ 1,344
	2	1	640	636	4	43	43		\$ 4
									44,568
Livingston	1	24	203	202	1	13	309	\$0.1379 /kWh	\$ 43
	2	74	238	236	2	22	1,615		\$ 223
	3	36	275	273	2	21	770		\$ 106
	4	16	308	307	1	15	237		\$ 33
									2,931
Deaverview	1	20	213	211	2	20	398	\$0.1463 /kWh	\$ 58
	2	70	248	245	3	40	2,783		\$ 407
	3	58	287	282	5	58	3,374		\$ 494
	4	14	320	318	2	19	266		\$ 39
									6,821
Total Savings:							166,947		\$13,370



Annual Consumption Savings = Pre-Project System Consumption – Post-Project System Consumption
 Natural Gas Consumption Savings for 2 Bedroom Unit at Hillcrest = 336 ccf – 289 ccf = 47 ccf Annually
 47 ccf Annual Savings X 110 2-Bedroom Units = 5,170 ccf Annual Savings

5,170 ccf X \$1.797/ccf = \$9,550 Annual Savings

The following table reflects all sites within this FIM's natural gas consumption savings.

Table 14: Pre and Post Project Natural Gas Consumption Savings

Project Name	# Bdrm	# of Units	Pre-Proj Avg Monthly Gas Load	Post-Proj Avg Monthly Gas Load	One Unit's Savings ccf/ Month	One Unit's Savings ccf/ Year	All Units Annual Savings ccf/Year	Site Specific \$/kccf	All Units Annual Savings
Pisgah View	1	32	36	33	2	29	928	\$1.7428 /ccf	\$ 1,617
	2	124	79	45	4	43	5,332		\$ 9,293
	3	68	65	63	2	27	1,836		\$ 3,200
	4	38	81	78	3	36	1,368		\$ 2,384
									9,464
Hillcrest	1	16	24	22	2	19	304	\$1.797 /ccf	\$ 546
	2	110	35	31	4	47	5,170		\$ 9,290
	3	80	40	36	4	44	3,520		\$ 6,325
	4	20	44	40	5	56	1,120		\$ 2,013
	5	8	49	49	0	0	0		\$0
							10,114	\$ 17,629	
Erskin - Walton	1	12	39	34	4	53	636	\$1.6797 /ccf	\$ 1,068
	2	48	52	46	6	74	3,552		\$ 5,966
	3	46	69	65	4	52	2,392		\$ 4,018
	4	16	84	78	6	72	1,152		\$ 1,935
	5	2	98	91	7	83	166		\$ 279
							7,898	\$ 12,198	
Livingston	1	24	35	32	3	31	744	\$1.7384 /ccf	\$ 1,293
	2	74	46	41	4	52	3,848		\$ 6,689
	3	36	63	59	4	51	1,836		\$ 3,192
	4	16	79	73	5	62	992		\$ 1,724
							7,420	\$ 12,899	
Deaverview	1	20	40	35	5	58	1,160	\$1.7069 /ccf	\$ 1,980
	2	70	57	50	7	88	6,160		\$ 10,515
	3	58	72	63	9	105	6,090		\$ 10,395
	4	14	82	75	7	85	1,190		\$ 2,031
							14,600	\$ 24,921	
Total Savings:							49,496		\$ 84,140





FIM #3: Attic Insulation

SIEMENS added blown in insulation in the attic space to bring the insulation R value up to R-38 at each development listed in Table 15. The attic insulation measures are an M&V Option A.

The following table is the actual savings compared to the guaranteed savings.

Table 15: Guaranteed and Actual Savings for Attic Insulation

Development	Electricity (kWh)		Electricity (\$)		Natural Gas (ccf)		Natural Gas (\$)	
	Guarantee	Achieved	Guarantee	Achieved	Guarantee	Achieved	Guarantee	Achieved
Pisgah View	910	1,137	\$ 117	\$ 146	2,488	3,110	\$ 4,336	\$ 5,420
Hillcrest	1,342	1,513	\$ 161	\$ 182	3,302	3,737	\$ 5,934	\$ 6,716
Erskin - Walton	1,012	1,265	\$ 86	\$ 108	3,272	3,760	\$ 5,496	\$ 6,316
Total Savings	3,264	3,915	\$ 364	\$ 435	9,062	10,607	\$ 15,766	\$ 18,451

Savings Calculation Methodology

Variables per Unit Data and Operation Data:

- R_C: Pre-Project Attic Insulation Value (see Table 15)
- R_P: Post-Project Attic Insulation Value (see Table 15)
- A_{ROOF}: Area of Attic per Unit
- HDD: Annual Heating Degree Days
- DTD: Design Temperature Difference
- CD: Correction Factor
- E_{HP}: Heating System Efficiency
- C_{GAS}: Blended Natural Gas Rate
- C_{ELEC}: Blended Electric Rate

Values:

- 15 ft² · °F · hr / BTU
- 38 ft² · °F · hr / BTU
- Varies per Unit
- 4,203 °D
- 54 °F
- 0.77
- 65 – 90% (Furnace)
- Varies per site
- Varies per site

Formulas for Energy Savings (kWh or ccf)

$$\text{Attic Heat Loss} = \text{DTD} * R_{\text{ROOF}} * 1/R$$

$$\text{Annual Heating System Consumption} = \frac{\text{Attic Heat Loss} * \text{HDD} * 24 \text{ hours/day} * \text{CD}}{E_{\text{HP}} * \text{DTD}}$$

$$\text{Annual Consumption Savings} = \text{Pre-Project System Consumption} - \text{Post-Project System Consumption}$$

Formulas for Cost Savings (\$)

$$\text{Annual Cost Savings} = (\text{Annual Electric Consumption Savings} * C_{\text{ELEC}}) + (\text{Annual Natural Gas Consumption Savings} * C_{\text{Gas}})$$



The pre and post average measurements are listed below.

Table 16: Pre and Post Project Measurements

Development	Bedroom Types	Pre-Project Attic R-Value	Post-Project Attic R-Value	Roof Square Footage
Pisgah View	1	15	38	530
	2	15	38	377
	3	15	38	454
	4	15	38	522
Hillcrest	1	15	38	519
	2	15	38	377
	3	15	38	517
	4	15	38	602
	5	15	38	711
Erskin - Walton	1	15	38	680
	2	15	38	970
	3	15	38	642
	4	15	38	452
	5	15	38	634



The following table is an example calculation for the heat load calculation to determine pre and post-project consumption savings.

Table 17: Pre and Post Project Consumption Calculations

PROJECT NAME:	Hillcrest		
PROJECT NUMBER:	NC 07-04		
UNIT TYPE:	2 Bedroom		
APARTMENT DATA:			
	Pre-Project	Unit of Measure	Post-Project
Number of Stories:	2		2
Perimeter Linear Footage:	110	ft.	110
Perimeter HTM:	8	Btuh/lf	8
Perimeter Heat Loss:	849	Btu/h	849
Roof Square Footage:	377	ft ²	377
Roof U-Value:	0.067	Btu/(h °F ft²)	0.0263
Roof Heat Loss:	1357	Btu/h	536
Exterior Wall Area:	1627	ft ²	1627
Wall U-Value:	0.091	Btu/(h °F ft ²)	0.091
Wall Heat Loss	7986	Btu/h	7986
Window Area:	94	ft ²	94
Window U-Value:	0.667	Btu/(h °F ft ²)	0.667
Window Heat Loss:	3391	Btu/h	3391
Door Area:	39	ft ²	39
Door U-Value:	0.333	Btu/(h °F ft ²)	0.333
Door Heat Loss:	702	Btu/h	702
Air Changes Per Hour	1	AC/H	1
Apt Volume	6032.00	cubic feet	6032.00
Infiltration Loss:	4631.85216	cubic feet/min	4631.85216
Total Apartment Heat Loss Rate:	18,917	Btu/h	18,095
Estimated Heating System Overall Efficiency:	90%		90%
Standing Pilot?	Yes		Yes
Pilot BTU/hr.:	500	Btu/h	500
Pilot Operating Hours:	8760	hrs/yr	8760
Pilot Consumption:	4380	kBTU/yr	4380
Heating Fuel? (Natural Gas, Electric, Propane)	Natural Gas		Natural Gas
Estimated Heating System Consumption:	336	ccf	323.3
Heating System Fan?	Yes		Yes
Heating Output:	54,000	Btu/h	54,000
Fan Size:	250	Watts	250
Fan Operating Hours:	560	hours	536
Fan Energy:	140	kWh	134



Annual Consumption Savings = Pre-Project System Consumption – Post-Project System Consumption
Electricity Consumption Savings for 2 Bedroom Unit at Hillcrest = 140 kWh – 134 kWh = 6 kWh Annually
(closer to 5.24 kWh annually without rounding)

5.24 kWh Annual Savings X 110 2-Bedroom Units = 576 kWh Annual Savings

576 kWh X \$0.12/kWh = \$69 Annual Savings

The following table reflects all sites within this FIM's electricity consumption savings.

Table 18: Pre and Post Project Electricity Consumption Savings

Project Name	# Bdrm	# of Units	Pre-Proj Avg Monthly Elec Load	Post-Proj Avg Monthly Elec Load	One Unit's Savings kWh/ Month	One Unit's Savings kWh/ Year	All Units kWh/ Year	Site Specific \$/kWh	All Units Annual Savings
Pisgah View	1	32	235	234.92	0.47	6	182	\$0.1283 /kWh	\$ 23
	2	124	278	277.67	0.35	4	514		\$ 66
	3	68	317	316.86	0.33	4	267		\$ 34
	4	38	358	358.05	0.38	5	174		\$ 22
									3,137
Hillcrest	1	16	450	449.69	0.60	7	115	\$0.12 /kWh	\$ 14
	2	110	614	613.35	0.44	5	576		\$ 69
	3	80	860	859.15	0.60	7	576		\$ 69
	4	20	1,115	1,114.17	0.69	8	166		\$ 20
	5	8	1,378	1,377.08	0.84	10	80		\$ 10
									1,513
Erskin - Walton	1	12	228	226.88	1.00	12	144	\$0.0852 /kWh	\$ 12
	2	48	221	219.93	1.07	13	618		\$ 53
	3	46	340	338.85	0.71	9	391		\$ 33
	4	16	307	306.50	0.51	6	98		\$ 8
	5	2	328	327.83	0.56	7	14		\$ 1
									1,265
Total Savings:							3,915	\$ 435	



Annual Consumption Savings = Pre-Project System Consumption – Post-Project System Consumption
 Natural Gas Consumption Savings for 2 Bedroom Unit at Hillcrest = 336 ccf – 323 ccf = 13 ccf Annually
 (without rounding it is actually 12.7 ccf annually)

12.7 ccf Annual Savings X 110 2-Bedroom Units = 1,397 ccf Annual Savings

1,397 ccf X \$1.797/ccf = \$ 2,511 Annual Savings

The following table reflects all sites within this FIM's natural gas consumption savings.

Table 19: Pre and Post Project Natural Gas Consumption Savings

Project Name	# Bdrm	# of Units	Pre-Proj Avg Monthly Gas Load	Post-Proj Avg Monthly Gas Load	One Unit's Savings ccf/ Month	One Unit's Savings ccf/ Year	All Units Annual Savings ccf/Year	Site Specific \$/kccf	All Units Annual Savings
Pisgah View	1	32	35.75	34.7	1.08	13	416	\$1.7428 /ccf	\$ 725
	2	124	48.5	47.7	0.83	10	1,240		\$ 2,161
	3	68	65.00	63.9	1.08	13	884		\$ 1,541
	4	38	80.67	79.4	1.25	15	570		\$ 993
							3,110		\$ 3,110
Hillcrest	1	16	24.00	22.5	1.50	18	288	\$1.797 /ccf	\$ 288
	2	110	34.50	33.4	1.06	13	1,397		\$ 2,511
	3	80	39.67	38.2	1.50	18	1,440		\$ 2,588
	4	20	44.33	42.6	1.75	21	420		\$ 755
	5	8	48.92	46.9	2.00	24	192		\$ 345
							3,737		\$ 6,716
Erskin - Walton	1	12	38.75	36.4	2.33	28	336	\$1.6797 /ccf	\$ 564
	2	48	51.75	48.5	3.25	39	1,872		\$ 3,144
	3	46	68.92	66.8	2.17	26	1,196		\$ 2,009
	4	16	84.17	82.6	1.58	19	304		\$ 511
	5	2	97.83	95.7	2.17	26	52		\$ 87
							3,760		\$ 6,316
Total Savings:							10,607		\$ 18,451





FIM #4: Wall Insulation

SIEMENS filled the exterior wall cavities in between each wall stud with cellulose insulation to bring the insulation R value up to R-19 at each development listed in Table 20. The wall insulation measures are an M&V Option A.

The following table is the actual savings compared to the guaranteed savings.

Table 20: Guaranteed and Actual Savings for Wall Insulation

Development	Electricity (kWh)		Electricity (\$)		Natural Gas (ccf)		Natural Gas (\$)	
	Guarantee	Achieved	Guarantee	Achieved	Guarantee	Achieved	Guarantee	Achieved
Pisgah View	3,530	5,146	\$ 453	\$ 660	9,560	16,362	\$ 16,661	\$ 28,516
Erskin - Walton	2,118	3,093	\$ 181	\$ 264	6,950	9,798	\$ 11,675	\$ 16,458
Deaverview	5,090	8,645	\$ 745	\$ 1,265	9,896	16,950	\$ 16,891	\$ 28,932
Total Savings	10,738	16,884	\$ 1,379	\$ 2,189	26,406	43,110	\$ 45,227	\$ 73,905

Savings Calculation Methodology

Variables per Unit Data and Operation Data:

R_C: Pre-Project Wall Insulation Value (see Table 21)
 R_P: Post-Project Wall Insulation Value (see Table 21)
 A_{WALL}: Area of Exposed Wall per Unit
 HDD: Annual Heating Degree Days
 DTD: Design Temperature Difference
 CD: Correction Factor
 E_{HP}: Heating System Efficiency
 C_{GAS}: Blended Natural Gas Rate
 C_{ELEC}: Blended Electric Rate

Values:

7 ft².°F.hr/BTU
 19 ft².°F.hr/BTU
 Varies per Unit
 4,203 °D
 54 °F
 0.77
 65 – 90% (Furnace)
 Varies per site
 Varies per site

Formulas for Energy Savings (kWh or ccf)

Exposed Wall Heat Loss = DTD * R_{Wall} * 1/R

$$\text{Annual Heating System Consumption} = \frac{\text{WallHeat Loss} * \text{HDD} * 24 \text{ hours/day} * \text{CD}}{E_{HP} * \text{DTD}}$$

Annual Consumption Savings = Pre-Project System Consumption – Post-Project System Consumption

Formulas for Cost Savings (\$)

Annual Cost Savings = (Annual Electric Consumption Savings * C_{ELEC}) + (Annual Natural Gas Consumption Savings * C_{GAS})



The pre and post average measurements are listed below.

Table 21: Pre and Post Project Measurements

Development	Bedroom Types	Pre-Project Wall R-Value	Post-Project Wall R-Value	Exposed Wall Square Footage
Pisgah View	1	7	19	481
	2	7	19	838
	3	7	19	904
	4	7	19	962
Erskin - Walton	1	7	19	530
	2	7	19	650
	3	7	19	1058
	4	7	19	1231
	5	7	19	1001
Deaverview	1	7	19	472
	2	7	19	918
	3	7	19	920
	4	7	19	930



The following table is an example calculation for the heat load calculation to determine pre and post-project consumption savings.

Table 22: Pre and Post Project Consumption Calculations

PROJECT NAME:	Erskin-Walton		
PROJECT NUMBER:	NC 07-05		
UNIT TYPE:	2 Bedroom		
APARTMENT DATA:			
	Pre-Project	Unit of Measure	Post-Project
Number of Stories:	1		1
Perimeter Linear Footage:	94	ft.	94
Perimeter HTM:	8	Btuh/lf	8
Perimeter Heat Loss:	725	Btu/h	725
Roof Square Footage:	970	ft ²	970
Roof U-Value:	0.067	Btu/(h °F ft ²)	0.067
Roof Heat Loss:	3492	Btu/h	3492
Exterior Wall Area:	650	ft ²	650
Wall U-Value:	0.143	Btu/(h °F ft²)	0.091
Wall Heat Loss	5014	Btu/h	1847
Window Area:	63	ft ²	63
Window U-Value:	0.667	Btu/(h °F ft ²)	0.667
Window Heat Loss:	2268	Btu/h	2268
Door Area:	39	ft ²	39
Door U-Value:	0.333	Btu/(h °F ft ²)	0.333
Door Heat Loss:	702	Btu/h	702
Air Changes Per Hour	1	AC/H	1
Apt Volume	7760.00	cubic feet	7760.00
Infiltration Loss:	5958.7488	cubic feet/min	5958.7488
Total Apartment Heat Loss Rate:	18160	Btu/h	14,993
Estimated Heating System Overall Efficiency:	75%		75%
Standing Pilot?	No		No
Pilot BTU/hr.:	500	Btu/h	500
Pilot Operating Hours:	0	hrs/yr	0
Pilot Consumption:	0	kBTU/yr	0
Heating Fuel? (Natural Gas, Electric, Propane)	Natural Gas		Natural Gas
Estimated Heating System Consumption:	338	ccf	279
Heating System Fan?	Yes		Yes
Heating Output:	75000	Btu/h	75,000
Fan Size:	250	Watts	250
Fan Operating Hours:	464	hours	383
Fan Energy:	116	kWh	96



Annual Consumption Savings = Pre-Project System Consumption – Post-Project System Consumption
Electricity Consumption Savings for 2 Bedroom Unit at Erskin-Walton = 116 kWh – 96 kWh = 20 kWh
Annually (closer to 18 kWh annually without rounding)

17.67 kWh Annual Savings X 48 2-Bedroom Units = 848 kWh Annual Savings

848 kWh X \$0.12/kWh = \$72 Annual Savings

The following table reflects all sites within this FIM's consumption savings.

Table 23: Pre and Post Project Electricity Consumption Savings

Project Name	# Bdrm	# of Units	Pre-Proj Avg Monthly Elec Load	Post-Proj Avg Monthly Elec Load	One Unit's Savings kWh/ Month	One Unit's Savings kWh/ Year	All Units kWh/ Year	Site Specific \$/kWh	All Units Annual Savings
Pisgah View	1	32	235.39	234.48	0.91	11	349	\$0.1283 /kWh	\$ 45
	2	124	278.02	276.42	1.60	19	2,381		\$ 305
	3	68	317.19	315.00	2.19	26	1,786		\$ 229
	4	38	358.43	357.05	1.38	17	630		\$ 81
							5,146		\$660
Erskin - Walton	1	12	227.88	226.35	1.53	18	220	\$0.0852 /kWh	\$ 19
	2	48	221.00	219.53	1.47	18	848		\$ 72
	3	46	339.56	337.00	2.56	31	1,411		\$ 120
	4	16	307.01	304.00	3.01	36	578		\$ 49
	5	2	328.40	326.87	1.53	18	37		\$ 3
							3,093		\$ 264
Deaverview	1	20	212.66	209.00	3.66	44	878	\$0.1463 /kWh	\$ 128
	2	70	248.31	244.00	4.31	52	3,623		\$ 530
	3	58	286.85	282.0	4.85	58	3,374		\$ 494
	4	14	319.58	315.0	4.58	55	770		\$ 113
							8,645		\$1,265
Total Savings:							16,884		\$ 2,189



Annual Consumption Savings = Pre-Project System Consumption – Post-Project System Consumption
 Natural Gas Consumption Savings for 2 Bedroom Unit at Hillcrest = 338 ccf – 279 ccf = 59 ccf Annually
 (without rounding it is actually 12.7 ccf annually)

12.7 ccf Annual Savings X 110 2-Bedroom Units = 1,397 ccf Annual Savings

1,397 ccf X \$1.797/ccf = \$ 2,511 Annual Savings

The following table reflects all sites within this FIM's natural gas consumption savings.

Table 24: Pre and Post Project Natural Gas Consumption Savings

Project Name	# Bdrm	# of Units	Pre-Proj Avg Monthly Gas Load	Post-Proj Avg Monthly Gas Load	One Unit's Savings ccf/ Month	One Unit's Savings ccf/ Year	All Units Annual Savings ccf/Year	Site Specific \$/kccf	All Units Annual Savings
Pisgah View	1	32	35.75	33.00	3.00	36	1,152	\$1.7428 /ccf	\$ 2,008
	2	124	48.5	43.00	5.25	63	7,812		\$ 13,615
	3	68	65.00	59.00	5.67	68	4,624		\$ 8,059
	4	38	80.67	75.00	6.08	73	2,774		\$ 4,835
							16,362		\$ 28,516
Erskin - Walton	1	12	38.75	34.75	4.00	48	576	\$1.6797 /ccf	\$ 968
	2	48	51.75	46.83	4.92	59	2,832		\$ 4,757
	3	46	68.92	60.92	8.00	96	4,416		\$ 7,418
	4	16	84.17	74.83	9.33	112	1,792		\$ 3,010
	5	2	97.83	90.25	7.58	91	182		\$ 306
							9,798		\$ 9,798
Deaverview	1	12	40.00	35.17	4.83	58	1,160	\$1.7069 /ccf	\$ 1,980
	2	48	57.17	47.92	9.25	111	7,770		\$ 13,263
	3	46	72.00	62.75	9.25	111	6,438		\$ 10,989
	4	16	81.58	72.17	9.42	113	1,582		\$ 2,700
							16,950		\$ 28,932
Total Savings:							43,110		\$ 73,905





FIM #5: Window Replacements – Livingston Heights Only

SIEMENS replaced the existing windows and aluminum frames with double-pane windows with vinyl frames. The window replacement measures are an M&V Option A.

The following table is the actual savings compared to the guaranteed savings.

Table 25: Guaranteed and Actual Savings for Window Replacements

Development	Electricity (kWh)		Electricity (\$)		Natural Gas (ccf)		Natural Gas (\$)	
	Guarantee	Achieved	Guarantee	Achieved	Guarantee	Achieved	Guarantee	Achieved
Livingston	1527	1,937	\$ 211	\$ 267	3,677	4,430	\$ 6,392	\$ 7,701

Savings Calculation Methodology

Variables per Unit Data and Operation Data:

R_C: Pre-Project Window R-Value (see Table 26)

R_P: Post-Project Window R-Value (see Table 26)

A_{WINDOW}: Total Window Area per Unit

HDD: Annual Heating Degree Days

DTD: Design Temperature Difference

CD: Correction Factor

E_{HP}: Heating System Efficiency

C_{GAS}: Blended Natural Gas Rate

C_{ELEC}: Blended Electric Rate

Values:

1.5 ft².°F.hr/BTU

3.33 ft².°F.hr/BTU

Varies per Unit

4,203 °D

54 °F

0.77

90% (Furnace)

\$0.1379/kWh

\$1.7384/ccf

Formulas for Energy Savings (kWh or ccf)

$$\text{Window Heat Loss} = \text{DTD} * R_{\text{WINDOW}} * 1/R$$

$$\text{Annual Heating System Consumption} = \frac{\text{Window Heat Loss} * \text{HDD} * 24 \text{ hours/day} * \text{CD}}{E_{\text{HP}} * \text{DTD}}$$

$$\text{Annual Consumption Savings} = \text{Pre-Project System Consumption} - \text{Post-Project System Consumption}$$

Formulas for Cost Savings (\$)

$$\text{Annual Cost Savings} = (\text{Annual Electric Consumption Savings} * C_{\text{ELEC}}) + (\text{Annual Natural Gas Consumption Savings} * C_{\text{Gas}})$$

The pre and post average measurements are listed below.

Table 26: Pre and Post Project Measurements

Development	Bedroom Types	Pre-Project Window R-Value	Post-Project Window R-Value	Window Square Footage
Livingston	1	1.5	3.33	48.6
	2	1.5	3.33	67.4
	3	1.5	3.33	145.3
	4	1.5	3.33	183



The following table is an example calculation for the heat load calculation to determine pre and post-project consumption savings.

Table 27: Pre and Post Project Consumption Calculations

PROJECT NAME:	Livingston Heights		
PROJECT NUMBER:	NC 07-08		
UNIT TYPE:	3 Bedroom		
APARTMENT DATA:			
	Pre-Project	Unit of Measure	Post-Project
Number of Stories:	2		2
Perimeter Linear Footage:	73	ft.	73
Perimeter HTM:	8	Btuh/lf	8
Perimeter Heat Loss:	563	Btu/h	563
Roof Square Footage:	589	ft ²	589
Roof U-Value:	0.050	Btu/(h °F ft ²)	0.050
Roof Heat Loss:	1590	Btu/h	1590
Exterior Wall Area:	984	ft ²	984
Wall U-Value:	0.091	Btu/(h °F ft ²)	0.091
Wall Heat Loss	4829	Btu/h	4829
Window Area:	145	ft ²	145
Window U-Value:	0.667	Btu/(h °F ft²)	0.300
Window Heat Loss:	5231	Btu/h	2356
Door Area:	39	ft ²	39
Door U-Value:	0.333	Btu/(h °F ft ²)	0.333
Door Heat Loss:	702	Btu/h	702
Air Changes Per Hour	1	AC/H	1
Apt Volume	9,424.00	cubic feet	9,424.00
Infiltration Loss:	5221.27296	cubic feet/min	5221.27296
Total Apartment Heat Loss Rate:	18,137	Btu/h	15,262
Estimated Heating System Overall Efficiency:	90%		90%
Standing Pilot?	Yes		Yes
Pilot BTU/hr.:	500	Btu/h	500
Pilot Operating Hours:	8760	hrs/yr	8760
Pilot Consumption:	4380	kBTU/yr	4380
Heating Fuel? (Natural Gas, Electric, Propane)	Natural Gas		Natural Gas
Estimated Heating System Consumption:	324	ccf	279
Heating System Fan?	Yes		Yes
Heating Output:	54,000	Btu/h	54,000
Fan Size:	250	Watts	250
Fan Operating Hours:	537	hours	452
Fan Energy:	134	kWh	113



Annual Consumption Savings = Pre-Project System Consumption – Post-Project System Consumption
Electricity Consumption Savings for 3 Bedroom Unit = 134 kWh – 113 kWh = 21 kWh Annually (closer to 19.6 kWh annually with rounding)

19.6 kWh Annual Savings X 36 3-Bedroom Units = 707 kWh Annual Savings

707 kWh X \$0.12/kWh = \$97 Annual Savings

The following table reflects all sites within this FIM's electricity consumption savings.

Table 28: Pre and Post Project Electricity Consumption Savings

Project Name	# Bdrm	# of Units	Pre-Proj Avg Monthly Elec Load	Post-Proj Avg Monthly Elec Load	One Unit's Savings kWh/ Month	One Unit's Savings kWh/ Year	All Units kWh/ Year	Site Specific \$/kWh	All Units Annual Savings
Livingston Heights	1	24	202.73	202.19	0.5	6.5	157	\$0.1379 /kWh	\$ 22
	2	74	237.77	237.00	0.8	9.2	678		\$ 94
	3	36	274.88	273.25	1.6	19.6	707		\$ 97
	4	16	308.24	306.18	2.1	24.7	394		\$ 54
Total Savings:							1,937		\$ 267

Annual Consumption Savings = Pre-Project System Consumption – Post-Project System Consumption

Natural Gas Consumption Savings for 3 Bedroom Unit = 324 ccf – 279 ccf = 45 ccf Annually

45 ccf Annual Savings X 36 3-Bedroom Units = 1,620 ccf Annual Savings

1,620 ccf X \$1.7069/ccf = \$ 2,816 Annual Savings

The following table reflects all sites within this FIM's natural gas consumption savings.

Table 29: Pre and Post Project Natural Gas Consumption Savings

Project Name	# Bdrm	# of Units	Pre-Proj Avg Monthly Gas Load	Post-Proj Avg Monthly Gas Load	One Unit's Savings ccf/ Month	One Unit's Savings ccf/ Year	All Units Annual Savings ccf/Year	Site Specific \$/kccf	All Units Annual Savings
Livingston Heights	1	24	35.00	33.75	1.25	15	360	\$1.7069 /ccf	\$ 626
	2	74	45.75	44.00	1.75	21	1,554		\$ 2,701
	3	36	62.92	59.17	3.75	45	1,620		\$ 2,816
	4	16	78.58	73.92	4.67	56	896		\$ 1,558
Total Savings:							4,430		\$ 7,701





Greenhouse Gas Emissions

This section demonstrates the impact of the energy efficiency improvements at HACA using the SIEMENS Greenhouse Gas Emissions Reductions calculator. By converting energy savings into emissions reductions for electricity and natural gas and comparing these reductions to acres of forest, railcars of coal or cars removed from the road.

As a result of this project, HACA has reduced the total electricity consumption by 189,682 kWh and natural gas consumption by 106,453 ccf. The graphics below show the impact of that reduction.

Table 30: Pre and Post Project Carbon Emissions Reduction

	Pre-Project Carbon Footprint	Achieved Annual Carbon Footprint Reduction	Total Achieved Reduction over Project Term
CO_{2e} Emissions			
Electricity	7,252,788	339,652	4,755,126
Natural Gas	7,721,485	1,246,352	17,448,924
Total	14,974,273	1,586,004	22,204,050
Other Pollutants			
NO_x	20,092	2,069	28,962
SO₂	37,436	1,776	24,869
The equivalent number of acres of deforestation	<p>47.9 The equivalent number of acres of deforestation</p>	<p>5.0 Acres of forest preserved from deforestation</p>	<p>71.0 Acres of forest preserved from deforestation</p>
The number railcars of coal not used	<p>35.9 Railcars of coal</p>	<p>3.8 Railcars of coal</p>	<p>53.2 Railcars of coal</p>
Number of cars not driven	<p>1,244.4 Cars driven for a year</p>	<p>131.8 Cars driven for a year</p>	<p>1,845.2 Cars driven for a year</p>





Option C FIM: Water Conservation

SIEMENS retrofitted the existing water fixtures to increase efficiency. Those fixtures included toilets, faucet aerators and showerheads. The water conservation measures addressed in this section utilize an Option C guarantee. A full year's of guaranteed savings will be addressed in the next annual report.

- The existing 1.6 gallon per flush (gpf) toilets tanks were retrofitted with 1.28 gpf pressure assisted vessels.
- The existing 2.25 gallons per minute (gpm) showerheads were replaced with 1.75 gpm showerheads.
- The existing bathroom sink aerators of 1.25 gpm were replaced with 1.0 gpm aerators.
- The existing kitchen sink aerators of 2.0 gpm were replaced with 1.5 gpm aerators.

The following developments received water conservation retrofits as part of Phase II.

Table 31: Completion Dates for Water Conservation

Development	Completion Date
Bartlett Arms	6/8/2010
Pisgah View Apartments	6/24/2010
Hillcrest Apartments	7/6/2010
Erskin-Walton Apartments	5/12/2010
Aston Park Towers	6/1/2010
Deaverview Apartments	5/25/2010
Altamont Tower	6/8/2010



The following table is the guaranteed savings from Phase I and Phase II for all developments utilizing Option C as the M&V Guarantee.

Table 32: Guaranteed Savings for Option C Water Conservation Measures

Development	Phase	Guarantee (k gals)	Guarantee (ccf)	Guarantee (\$)
NC 7-01 Bartlett Arms	Phase I	1,997	2,670	\$ 13,570
	Phase I Extra	449	600	\$ 8,606
	Phase II	74	98	\$ 646
	Total:	2,519	3,368	\$ 22,822
NC 7-6 Aston Park Tower	Phase I	2,877	3,846	\$ 19,552
	Phase I Extra	1,450	1,939	\$ 20,842
	Phase II	104	140	\$ 918
	Total:	4,431	5,924	\$ 41,312
NC7-10 Altamont Tower	Phase I	1,432	1,914	\$ 9,729
	Phase I Extra	409	546	\$ 6,998
	Phase II	35	47	\$ 306
	Total:	1,875	2,507	\$ 17,033
AMP-1 Total:	Phase I	6,306	8,430	\$ 42,851
	Phase I Extra	2,307	3,085	\$ 36,446
	Phase II	213	285	\$ 1,870
	Total:	8,826	11,800	\$81,167
NC 7-02 Lee-Walker Homes	Phase I	2,545	3,402	\$ 17,294
	Phase I Extra	1,019	1,362	\$ 14,107
	Phase II			
	Total:	3,564	4,764	\$ 31,401
NC 7-05 Erskin-Walton Apts	Phase I	-	-	
	Phase I Extra	3,663	4,897	\$ 35,704
	Phase II	1,178	1,575	\$ 10,272
	Total:	4,841	6,472	\$ 45,976
NC 7-8 Livingston Heights	Phase I	-	-	-
	Phase I Extra	-	-	-
	Phase II	-	-	-
	Total:	-	-	-
AMP-2 Total:	Phase I	2,545	3,402	\$ 17,294
	Phase I Extra	4,681	6,259	\$ 49,811
	Phase II	1,178	1,575	\$ 10,272
	Total:	8,404	11,236	\$ 77,377
NC 7-03 Pisgah View	Phase I	5,014	6,703	\$ 35,392
	Phase I Extra	4,164	5,566	\$ 55,329
	Phase II	377	504	\$ 4,327
	Total:	9,555	12,774	\$ 95,048
NC 7-9 Deaverview Apts	Phase I	(42)	(56)	\$ (281)
	Phase I Extra	-	-	-
	Phase II	1,567	2,095	\$ 8,704
	Total:	1,525	2,038	\$ 8,423



AMP-3 Total:	Phase I	4,972	6,647	\$ 35,111
	Phase I Extra	4,164	5,566	\$ 55,329
	Phase II	1,944	2,599	\$13,031
	Total:	11,079	14,812	\$ 103,471
NC 7-04 Hillcrest Apts	Phase I	5,282	7,061	\$ 35,893
	Phase I Extra	2,384	3,188	\$ 32,874
	Phase II	323	431	\$ 3,062
	Total:	7,989	10,680	\$ 71,829
NC7-12 Klondyke	Phase I	3145	4,205	\$ 21,373
	Phase I Extra	1739	2,325	\$ 22,741
	Phase II	0		
	Total:	4,884	6,529	\$ 44,114
AMP-4 Total:	Phase I	8,427	11,266	\$ 57,266
	Phase I Extra	4,123	5,513	\$ 55,615
	Phase II	323	431	\$ 3,062
	Total:	12,873	17,210	\$ 115,943
All AMPs Total:	Phase I	22,250	29,746	\$ 152,522
	Phase I Extra	15,276	20,422	\$ 197,201
	Phase II	3,657	4,889	\$ 28,235
	Total:	41,183	55,058	\$ 377,958

Standard Usage per Person

	<u>Range</u>	<u>Average</u>
• Toilet Usage - Flushes per Person per Day:	5 to 8 Flushes	6.5 Flushes
• Shower Usage – Minutes per Person per Day:	5 to 8 Minutes	6.5 Minutes
• Bathroom Sink Usage – Minutes per Person per Day:	2 to 4 Minutes	3 Minutes
• Kitchen Sink Usage – Minutes per Person per Day:	8 to 10 Minutes	9 Minutes

Formulas for Water/Sewer Energy Savings (ccf)

Annual Water Cons. Savings per Site = (Pre-Project Consumption – Post-Project Consumption)

Formulas for Cost Savings

Annual Cost Savings per Site = Water Consumption Savings * Water/Sewer Blended Rate



Bartlett Arms completed water conservation retrofits in June 2010.

The following table is a monthly breakdown of water consumption since the beginning of Phase I. As displayed in the table below, after retrofitting water consumption devices in Phase II the monthly consumption dropped.

Table 33: Bartlett Arms Monthly Water Consumption

	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	Monthly Average
Nov	637	447	537	517	678	648	480	577
Jan	700	505	555	571	769	643	469	624
Mar	700	466	540	625	518	639		581
May	657	560	537	637	620	605		603
Jul	511	510	506	686	676	524		569
Sep	483	510	569	703	650	471		583
Annual Total ccf	3,688	2,998	3,244	3,739	3,911	3,530		3,537

Table 34: Bartlett Arms Water Consumption Savings Estimate

Description	Water (ccf)
Frozen Baseline	7,370
Total Guaranteed Reduction	3,368
Monthly Average since July 2010	473
Estimated Annual Average	2,840
Expected Annual Savings	4,530



Lee-Walker Homes did not receive Phase II water retrofits. The following table is a monthly breakdown of water consumption since the beginning of Phase I.

Table 35: Lee-Walker Homes Monthly Water Consumption

	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	Monthly Average
Oct	457	494	480	427				
Nov	410	495	529	502	885	813	972	923
Dec	523	504	476	503				
Jan	425	492	479	433	1037	874	1,142	984
Feb	432	373	443					
Mar	465	507	522	693	840	827		850
Apr	537	431	410					
May	461	474	490	921	851	871		908
Jun	504	515	444					
Jul	435	455	408	1,018	957	990		954
Aug	596	503	479					
Sep	591	441	435	887	798	1,002		955
Annual Total ccf	5,836	5,684	5,595	5,384	5,368	5,377		5,575

Table 36: Lee-Walker Homes Water Consumption Savings Estimate

Description	Water (ccf)
Frozen Baseline	11,273
Total Guaranteed Reduction	4,764
Monthly Average	929
Estimated Annual Average	5,575
Expected Annual Savings	5,698



Pisgah View Apartments completed water conservation retrofits in June 2010.

The following table is a monthly breakdown of water consumption since the beginning of Phase I. As displayed in the table below, after retrofitting water consumption devices in Phase II the monthly consumption did not drop.

Table 37: Pisgah View Apartments Monthly Water Consumption

	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	Monthly Average
Oct	2,076	1,819	1,808	1,850	1,990	1,811	2,110	1,892
Nov								
Dec	1,666	1,769	1,702	1,811	2,264	1,919	2,136	1,855
Jan								
Feb	1,791	1,954	1,972	2,252	2,160	2,455	2,363	2,097
Mar								
Apr	1,942	2,039	1,963	1,747	1,877	2,378		1,991
May								
Jun	1,868	1,721	1,977	2,166	1,997	2,838		2,095
Jul								
Aug	1,714	1,813	2,028	2,174	2,356	2,216		2,017
Sep								
Annual Total ccf	11,169	11,112	11,450	12,000	12,644	13,617		11,947

Table 38: Pisgah View Water Consumption Savings Estimate

Description	Water (ccf)
Frozen Baseline	28,865
Total Guaranteed Reduction	12,774
Monthly Average since July 2010	2,206
Estimated Annual Average	13,238
Expected Annual Savings	15,628



Hillcrest Apartments completed water conservation retrofits in July 2010.

The following table is a monthly breakdown of water consumption since the beginning of Phase I. As displayed in the table below, after retrofitting water consumption devices in Phase II the monthly consumption did not drop.

Table 39: Hillcrest Apartments Monthly Water Consumption

	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	Monthly Average
Oct	936	903	80	1,115	2,334	2,223	2,253	1,764
Nov	922	887	55	1,131	0			
Dec	829	1,029	60	1,138	2,542	2,430	2,396	1,893
Jan	1016	928	215	1,175	0			
Feb	881	577	1,031	1,014	1,937	2,330		1,774
Mar	822	50	957	1,047	0			
Apr	1,019	85	1,153	1,042	2,447	2,520		1,709
May	982	55	948	0	0			
Jun	917	80	1,166	2,882	2,555	2,420		2,054
Jul	1,079	95	1,129	0		0		
Aug	868	45	1,034	2,247	2,166	2,237		2,021
Sep	1,102	75	2,353	0	0	0		
Annual Total ccf	11,373	4,809	10,181	12,791	13,981	14,160		11,216

Table 40: Hillcrest Apartments Water Consumption Savings Estimate

Description	Water (ccf)
Frozen Baseline	25,672
Total Guaranteed Reduction	10,680
Monthly Average since July 2010	2,325
Estimated Annual Average	13,947
Expected Annual Savings	11,725



Erskin-Walton Apartments completed water conservation retrofits in May 2010.

The following table is a monthly breakdown of water consumption since the beginning of Phase I. As displayed in the table below, after retrofitting water consumption devices in Phase II the monthly consumption did drop.

Table 41: Erskin-Walton Apartments Monthly Water Consumption

	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	Monthly Average
Oct	1,646	1,302	553	0	0	0	0	
Nov	987	973	1,076	1,891	1,505	1,503	905	1,906
Dec	809	648	638	0	0	0	0	
Jan	1,073	969	990	1,704	1,745	1,649	1,020	1,704
Feb	669	823	550	0	0	0		
Mar	1,114	973	1,106	1,495	1,390	1,642		1,627
Apr	766	1,325	552	0	0	0		
May	1,156	825	1,185	1,415	1,601	1,428		1,709
Jun	791	922	633	0	0	0		
Jul	1,310	1,432	1,005	1,698	1,716	1,096		1,948
Aug	845	830	722	0	0	0		
Sep	1,504	1,095	1,053	1,652	1,882	1,017		1,925
Annual Total ccf	12,670	12,117	10,063	9,855	9,839	8,335		10,819

Table 42: Erskin-Walton Apartments Water Consumption Savings Estimate

Description	Water (ccf)
Frozen Baseline	11,905
Total Guaranteed Reduction	6,472
Monthly Average since July 2010	1,010
Estimated Annual Average	6,057
Expected Annual Savings	5,848



Aston Park Towers completed water conservation retrofits in June 2010.

The following table is a monthly breakdown of water consumption since the beginning of Phase I. As displayed in the table below, after retrofitting water consumption devices in Phase II the monthly consumption did not drop.

Table 43: Aston Park Towers Monthly Water Consumption

	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	Monthly Average
Oct	205	187	221	0	0	0	0	
Nov	202	189	245	653	657	633	638	532
Dec	181	217	249	0	0	0	0	
Jan	210	179	208	729	692	675	650	557
Feb	186	217	198	0	0	0		
Mar	185	178	191	614	561	673		501
Apr	189	219	217	0	0	0		
May	217	167	178	632	654	625		516
Jun	224	185	210	0	0	0		
Jul	224	225	163	625	669	597		505
Aug	192	203	208	0	0	0		
Sep	218	243	536	559	603	673		552
Annual Total ccf	2,433	2,409	2,824	3,812	3,836	3,876		3,163

Table 44: Aston Park Towers Water Consumption Savings Estimate

Description	Water (ccf)
Frozen Baseline	10,544
Total Guaranteed Reduction	5,942
Monthly Average since July 2010	654
Estimated Annual Average	3,922
Expected Annual Savings	6,622



Deaverview Apartments completed water conservation retrofits in May 2010.

The following table is a monthly breakdown of water consumption since the beginning of Phase I. As displayed in the table below, after retrofitting water consumption devices in Phase II the monthly consumption did drop.

Table 45: Deaverview Apartments Monthly Water Consumption

	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	Monthly Average
Oct								
Nov	1,562	1,284	1,152	2,429	1,429	1,854	1,080	1,618
Dec								
Jan	1,523	1,663	1,505	1,589	1,683	2,181	1,236	1,691
Feb	115							
Mar	1,566	1,388	1,855	1,685	1,115	1,632		1,540
Apr								
May	1,501	1,624	1,962	1,576	1,399	1,723		1,661
Jun								
Jul	1,667	1,491	2,144	1,580	1,869	1,168		1,750
Aug								
Sep	1,409	1,106	2,375	1,144	1,978	1,304		1,602
Annual Total ccf	9,343	8,556	10,993	10,003	9,473	9,862		9,863

Table 46: Deaverview Apartments Water Consumption Savings Estimate

Description	Water (ccf)
Frozen Baseline	8,987
Total Guaranteed Reduction	2,038
Monthly Average since July 2010	1,197
Estimated Annual Average	7,182
Expected Annual Savings	1,805



Altamont Tower completed water conservation retrofits in June 2010.

The following table is a monthly breakdown of water consumption since the beginning of Phase I. As displayed in the table below, after retrofitting water consumption devices in Phase II the monthly consumption did drop.

Table 47: Altamont Tower Monthly Water Consumption

	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	Monthly Average
Oct	155	120	150	145				
Nov	110	130	160	185	417	353	257	321
Dec	1415	130	130					
Jan	140	150	135	270	557	407	269	339
Feb	120	140	115					
Mar	110	160	140	293	503	396		330
Apr	125	115	125					
May	140	130	165	278	402	430		318
Jun	135		200					
Jul	130	110	130	336	391	269		286
Aug	160	130	170					
Sep	140	150	160	301	397	268		322
Annual Total ccf	1,580	1,465	1,780	1,808	2,667	2,123		1,916

Table 48: Altamont Tower Water Consumption Savings Estimate

Description	Water (ccf)
Frozen Baseline	4,418
Total Guaranteed Reduction	2,507
Monthly Average since July 2010	266
Estimated Annual Average	1,595
Expected Annual Savings	2,824



Klondyke Apartments were not part water conservation retrofits for Phase II.

The following table is a monthly breakdown of water consumption since the beginning of Phase I.

Table 49: Klondyke Apartments Monthly Water Consumption

	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	Monthly Average
Oct	14	296		3		12		
Nov	340	46	445	433	558	540	257	467
Dec	383	800	17	1		19		
Jan	22	51	313	475	641	665	269	596
Feb	375	614	19			11		
Mar	17	43	338	485	477	632		534
Apr	421	0	324			16		
May	19	788	380	605	579	639		666
Jun	389	56	390			13		
Jul	28	339	17	552	572	617		511
Aug	329	21	427	1		15		
Sep	113	375	355	557	538	524		563
Annual Total ccf	2,450	3,429	3,025	3,112	3,365	3,703		3,327

Table 50: Klondyke Apartments Water Consumption Savings Estimate

Description	Water (ccf)
Frozen Baseline	11,310
Total Guaranteed Reduction	6,529
Monthly Average	555
Estimated Annual Average	3,327
Expected Annual Savings	7,983



The water conservation measures and consumptions illustrated in the previous tables are summarized below:

Table 51: Total Water Consumption Savings Estimate

Development	Frozen Consumption (ccf)	Guaranteed Annual Consumption Reduction (ccf)	Average Post-Project Monthly Consumption (ccf)	Estimated Annual Consumption (ccf)	Estimated Annual Consumption Savings (ccf)
Bartlett Arms	7,370	3,368	473	2,838	4,532
Lee-Walker	11,273	4,764	929	5,574	5,699
Pisgah View	28,865	12,774	2,206	13,236	15,629
Hillcrest	25,672	10,680	2,325	13,950	11,722
Erskin-Walton	11,905	6,472	1,010	6,060	5,845
Aston Park	10,544	5,942	654	3,924	6,620
Livingston	1,180				
Deaverview	8,987	2,038	1,197	7,182	1,805
Altamont	4,418	2,507	266	1,596	2,822
Klondyke	11,310	6,259	555	3,330	7,980
Total:	121,525	54,804	9,615	57,690	62,654

The preliminary monthly water consumptions show that the water conservation measures for the Option C M&V Guarantee are on track to meet savings.