HVAC Coil Restoration Project Report

Marcus Garvey Academy, Detroit, MI.

August 1 – August 6, 2010

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Executive Summary

- GreenAir Environmental was contracted by Macomb Mechanical to clean the coils in the Marcus Garvey Academy using GreenAir's patent pending HVAC coil restoration process, which returns HVAC coils to "like new" condition.
- As a measure of cleaning effectiveness, air velocity measurements through the coils were taken before and after the coil cleaning on each unit.
- After cleaning, the average air velocity through the coils increased by an overall average of 1264%. Every unit experienced an improvement in airflow, with airflow increasing by up to 7476% on the dirtiest units.

AHU	Pre-Clean Velocity Avg (ft/min)	Post-Clean Velocity Avg (ft/min)	% Increase
1	217	664	206
2	197	715	262
3	178	767	331
4	38	761	1926
5	77	748	876
6	231	884	282
7	4	331	7476
8	578	670	16
9	646	667	4

HVAC Unit Summary Table

Project Details

Background:

The Marcus Garvey Academy is undergoing a major renovation project. Macomb Mechanical was contracted to perform work on the school's mechanical systems which include the Air Handling Units (AHU's). Macomb Mechanical quickly saw that the coils were extremely impacted with contaminates and contracted with GreenAir to restore the coils. From Past experience at another school district they believed that the GreenAir Process could restore the original operating parameters of the AHU's in questions thus providing the greatest cost benefit to their client, Detroit Public Schools.

Traditional coil cleaning methods can be deceptively ineffective. These methods typically achieve a cosmetic cleaning of the coil surface, leaving the inner majority of the coil matrix untouched by the cleaning and unseen by both the technician and the consumer. After years of normal use, the inner majority of the coil matrix becomes caked with contaminates. As the buildup on the coils gradually increases over time, two undesirable effects occur:

- Air flow through the coil matrix decreases
- Thermal transfer (BTU's) through the coil matrix decreases

As these effects combine, the AHU delivers a decreasing quantity of warmer air. To compensate, the machinery must be run at full power for increased periods of time. When consistently operating under these conditions, the entire cooling system operates under increased stress which adversely affects the life cycle of these expensive mechanical systems.

HVAC Coil Cleaning Process:

The patent pending GreenAir process consists of a three pronged strategy to safely and thoroughly clean even the thickest and most contaminated coils.

1. Propane heated water generates wet steam at 250 deg and 1300 psi
    - Wet steam emulsifies the oils that act as a binding agent significantly faster than cold water.
    - At 1300 psi, the wet steam can fully penetrate the coil matrix while ensuring no harm to the delicate and expensive coil structure.

2. An EPA rated, environmentally save cleaning agent is injected into the wet steam, enhancing its cleaning ability. The majority of coil cleaning chemicals available on the market today are highly corrosive and can cause significant damage to the coil and the surrounding environment. Our cleaning agent is:
   - Non-corrosive
   - pH neutral
   - Emits no VOC's

3. We also apply an extensive set of proprietary cleaning techniques and tools developed during our many years of HVAC restoration work across the country. The results of our cleaning process meets standards measured in the parts per million

Cost Benefit Analysis:

The GreenAir process provides several hard and soft benefits with very attractive return on investment.

1. Hard Benefits
   - Direct energy savings: From the dramatic gains in airflow it is reasonable to expect remarkable increases in overall efficiency of the HVAC systems. It would not be surprising to see energy savings in the multiple tens of thousands of dollars.
   - Reduction of repair and maintenance expense: When fan drives are constantly pulling against the high pressure differentials created by these heavily soiled coils, they often burn out at a much accelerated rate. Replacement cost for one fan drive can easily run into thousands of dollars.
   - Extended lifecycle of expensive HVAC system equipment: Because the system is now functioning as designed the decision to upgrade to new HVAC systems can be reprioritized to alleviate budgetary concerns.

2. Soft Benefits: A recent report called "Greening Americas Schools" documents how improved indoor air quality produces many soft benefits for schools and students. Below are a couple excerpts, please see the referenced study for a complete description.
   - "Reduced teacher sick days, reduced operations and maintenance costs, reduced insured and uninsured risks, improved power quality and reliability, increased state competitiveness, reduced social inequality, and educational enrichment. "(Greening America's Schools, page 2)

2. Soft Benefits (continued)
   - The costs of poor indoor environmental and air quality in schools, including higher absenteeism and increased respiratory ailments, have generally been “hidden” in sick days, lower teacher and staff productivity, lower student motivation, slower learning, lower test scores, increased medical costs, and lowered lifelong achievement and earnings.” (Greening America’s Schools, page 8)
   - “The Carnegie Mellon building performance program identified 17 substantial studies that document the relationship between improved air quality and health. The health impacts include asthma, flu, sick building syndrome, respiratory problems, and headaches. These 17 separate studies all found positive health impacts (i.e. reduction in reported prevalence of symptoms) ranging from 13.5% up to 87% improvement, with average improvement of 41%.”(Greening America’s Schools, page 10)
   - ”Teachers believe that temperature comfort affects both teaching quality and student achievement. Research indicates that the best teachers emphasized that their ability to control temperature in classrooms is very important to student performance. ”(Greening America’s Schools, page 10

Air Velocity Measuring and Analysis Process:

GreenAir has developed a unique arsenal of measurement and analysis methods to define AHU performance and efficiency. These include the following:
Temperature drop

- Pressure differential
- Air velocity mapping
- Direct energy consumption
- Chiller water temperature differential
- Relative humidity differential
- Thermal imagery
- Compressor head pressure

During this project, weather conditions varied greatly in outdoor temperature and humidity. In order to maintain a consistent test environment for the duration of the project, it was decided by all parties to use air velocity mapping as the primary metric of coil performance for this project.

GreenAir Environmental has carefully developed an accurate and robust air velocity mapping method for collecting, storing and analyzing air velocity data for any given HVAC unit. GreenAir precisely scans the entire coil before and after cleaning. Air velocity mapping establishes an accurate understanding of the air flow characteristics of the coil being tested, and the before and after comparison provides a metric of coil cleaning effectiveness.

The mapping process is performed using a certified Dwyer AVU-3 air velocity transmitter. The transmitter operates by measuring heat loss from one of the two sensing elements in the air stream. This special design makes the transmitter accurate over a broad velocity range and gives excellent immunity to drift.

The velocity mapping is preformed by a two man team with one moving the probe from one coil section to the next, and the other using a stop watch to time the data collection in one minute increments. The velocity data is recorded by the data logging equipment and associated software. This data is then exported to Microsoft Excel for post-processing and graphing. Post-processing includes removing irrelevant probe start up and shut down data points, then an average velocity for each coil section is calculated. The raw data Excel files are available upon request.

The post-processed data for each coil section is displayed in two formats; 1) Line plot showing pre and post cleaning velocities for each section, 2) Section mapping grid which displays the section velocities in a grid representing the sections of the coils and is color coded by the section velocity. The section velocity color key is displayed below. Also attached are individual data sheets for each coil, with associated mapping grids, data summary, and plots.

(blue)	800 – 999 ft/min
(green)	600 – 799 ft/min
(yellow)	400 – 599 ft/min
(red)	0 – 399 ft/min

Velocity Color Key

Air Velocity Summary Sheets

AHU 1

Velocity Color Key

0 – 399	600 – 799
400 – 599	800 – 999

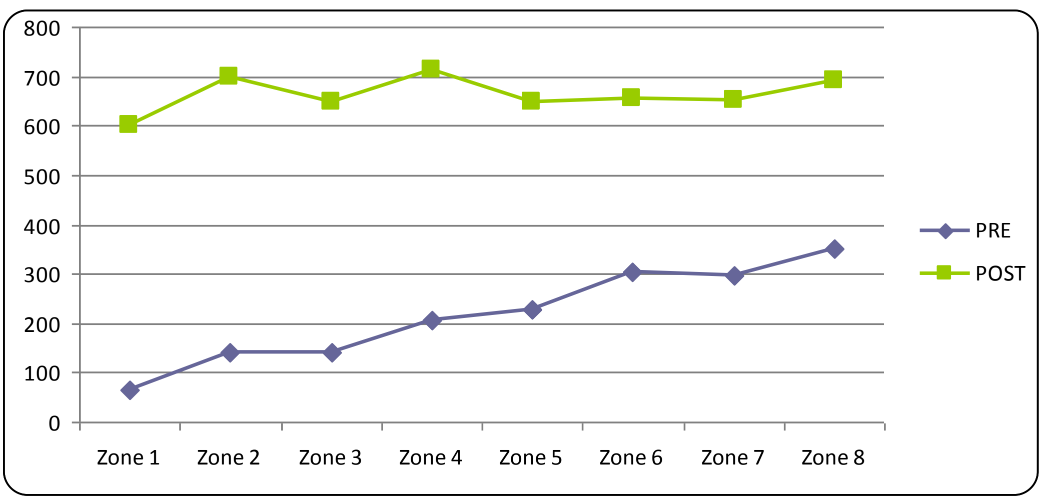
Pre Clean Velocity (ft/min)

303	229	141	64
297	352	141	205

Post Clean Velocity (ft/min)

655	648	700	602
651	693	647	715

Velocity Comparison by Coil Section



Velocity % Change by Coil Section

Bin #	1	2	3	4	5	6	7	8	AVG
Pre	64	141	141	205	229	303	297	352	217
Post	602	700	647	715	648	655	651	693	664
% Chg	834	395	359	249	182	116	119	97	**206**

Air Velocity Summary Sheets

AHU 2

Velocity Color Key

0 – 399	600 – 799
400 – 599	800 – 999

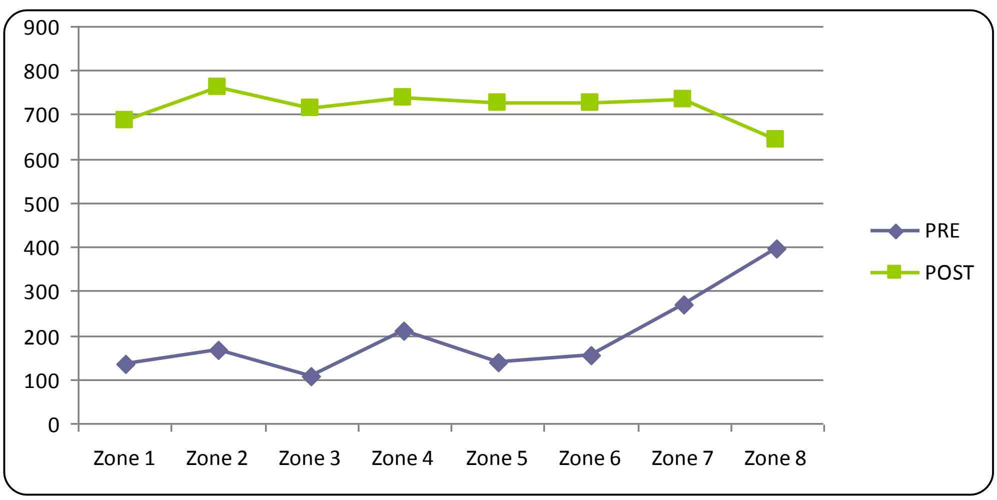
Pre Clean Velocity (ft/min)

154	138	167	136
271	396	105	212

Post Clean Velocity (ft/min)

726	725	763	686
733	642	712	738

Velocity Comparison by Coil Section



Velocity % Change by Coil Section

Bin #	1	2	3	4	5	6	7	8	AVG
Pre	136	167	105	212	138	154	271	396	197
Post	686	763	712	738	725	726	733	642	715
% Chg	404	356	577	248	424	371	171	62	**262**

Air Velocity Summary Sheets

AHU 3

Velocity Color Key

0 – 399	600 – 799
400 – 599	800 – 999

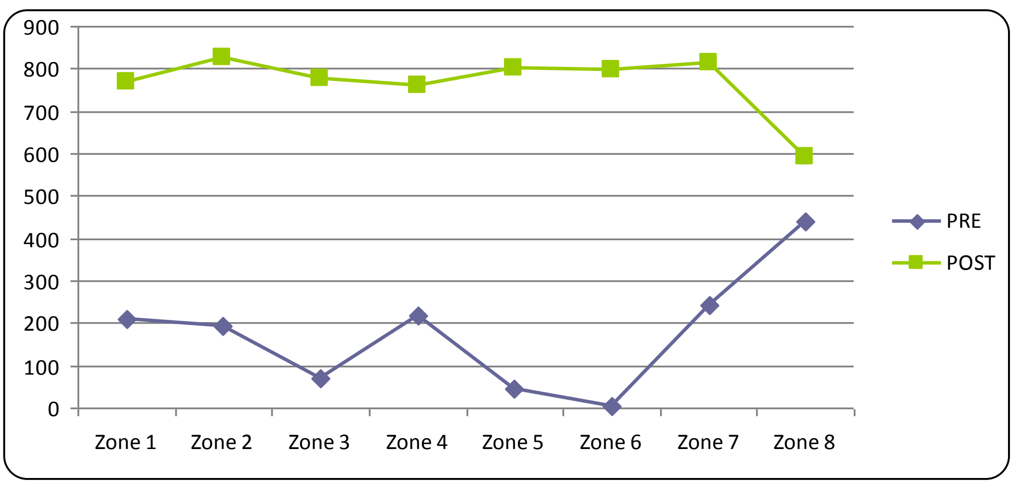
Pre Clean Velocity (ft/min)

5	47	193	208
244	439	69	219

Post Clean Velocity (ft/min)

797	802	826	770
814	591	777	761

Velocity Comparison by Coil Section



Velocity % Change by Coil Section

Bin #	1	2	3	4	5	6	7	8	AVG
Pre	208	193	69	219	47	5	244	439	178
Post	770	826	777	761	802	797	814	591	767
% Chg	271	328	999	247	999	999	233	35	**331**

Air Velocity Summary Sheets

AHU 4

Velocity Color Key

0 – 399	600 – 799
400 – 599	800 – 999

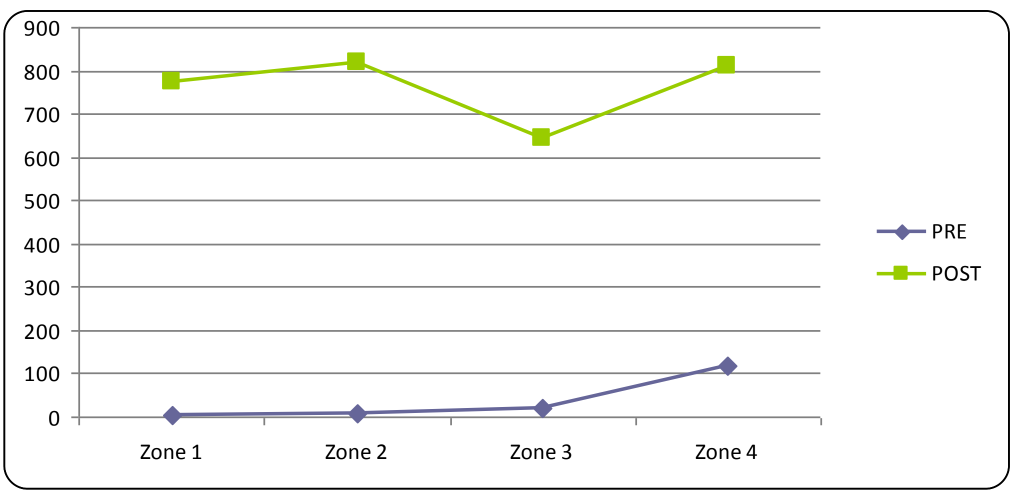
Pre Clean Velocity (ft/min)

7	3
21	120

Post Clean Velocity (ft/min)

821	772
642	810

Velocity Comparison by Coil Section



Velocity % Change by Coil Section

Bin #	1	2	3	4	AVG
Pre	3	7	21	120	38
Post	772	821	642	810	767617
% Chg	25,333	11,956	3013	576	**1926**

Air Velocity Summary Sheets

AHU 5

Velocity Color Key

0 – 399	600 – 799
400 – 599	800 – 999

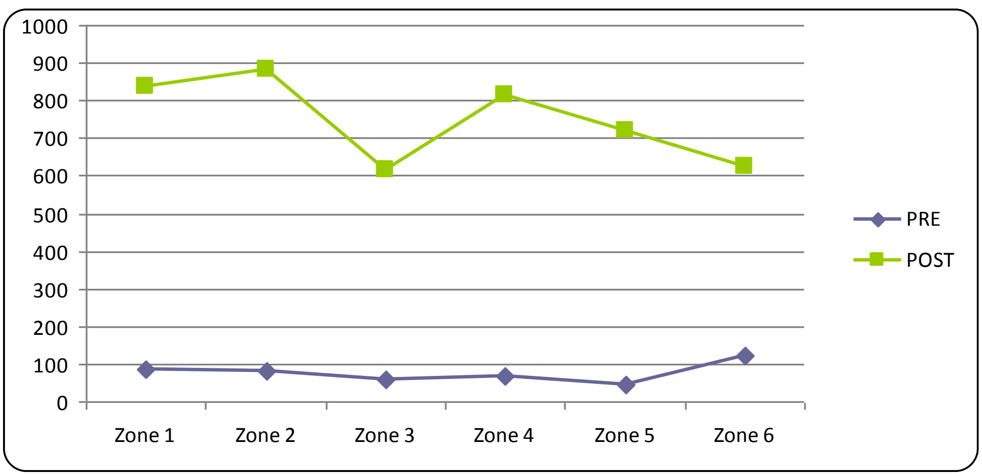
Pre Clean Velocity (ft/min)

59	79	87
70	44	121

Post Clean Velocity (ft/min)

614	881	836
813	721	622

Velocity Comparison by Coil Section



Velocity % Change by Coil Section

Bin #	1	2	3	4	5	6	AVG
Pre	87	79	59	70	44	121	77
Post	836	881	614	813	721	622	748
% Chg	858	1008	949	1063	1540	416	**876**

Air Velocity Summary Sheets

AHU 6

Velocity Color Key

0 – 399	600 – 799
400 – 599	800 – 999

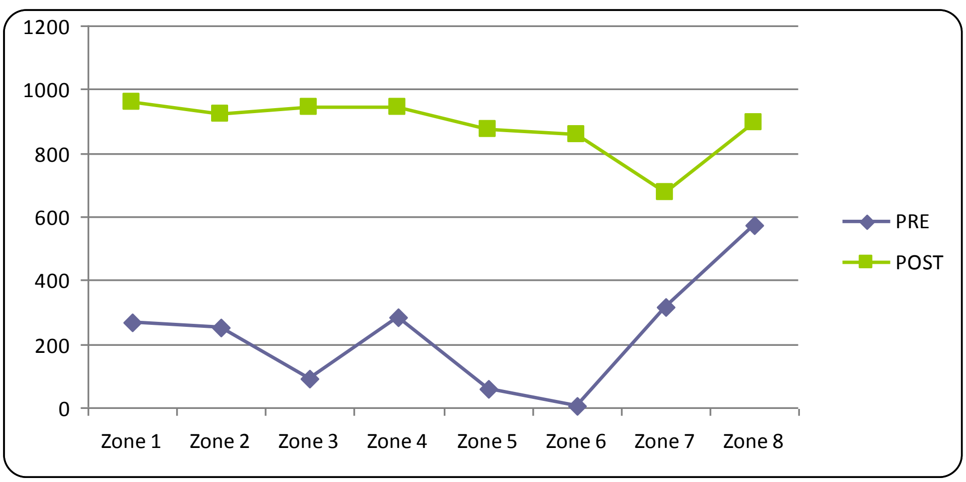
Pre Clean Velocity (ft/min)

285	90	251	270
61	6	318	571

Post Clean Velocity (ft/min)

945	945	921	958
874	858	677	895

Velocity Comparison by Coil Section



Velocity % Change by Coil Section

Bin #	1	2	3	4	5	6	7	8	AVG
Pre	270	251	90	285	61	6	318	571	231
Post	958	921	945	945	874	858	677	895	884
% Chg	255	267	947	231	1328	14397	113	57	**282**

Air Velocity Summary Sheets

AHU 7

Velocity Color Key

0 – 399	600 – 799
400 – 599	800 – 999

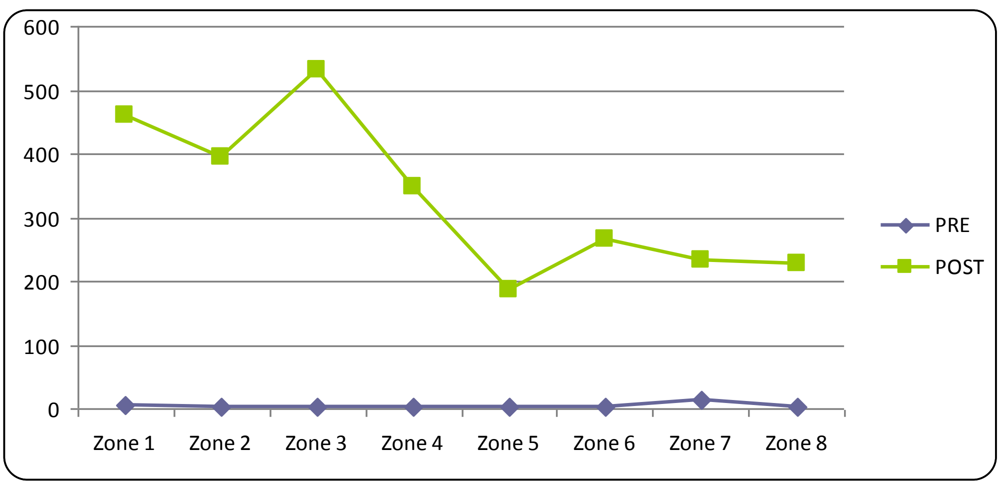
Pre Clean Velocity (ft/min)

3	2	3	5
2	2	15	3

Post Clean Velocity (ft/min)

349	530	395	459
187	266	233	226

Velocity Comparison by Coil Section



Velocity % Change by Coil Section

Bin #	1	2	3	4	5	6	7	8	AVG
Pre	5	3	2	3	2	62	15	3	4
Post	459	395	530	349	187	266	233	226	326
% Chg	8348	14260	22819	13605	9224	12281	1458	8105	**7476**

Air Velocity Summary Sheets

AHU 8

Velocity Color Key

0 – 399	600 – 799
400 – 599	800 – 999

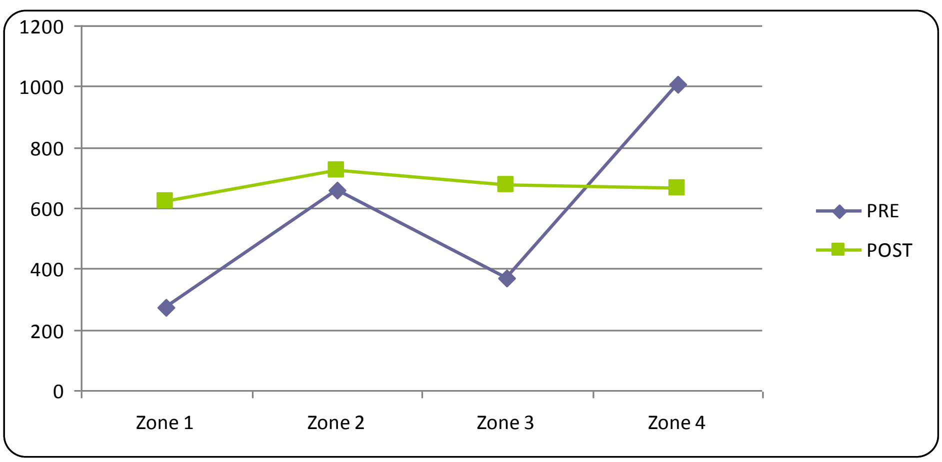
Pre Clean Velocity (ft/min)

660	276
367	1008

Post Clean Velocity (ft/min)

722	620
673	666

Velocity Comparison by Coil Section



Velocity % Change by Coil Section

Bin #	1	2	3	4	AVG
Pre	276	660	367	1008	578
Post	620	722	673	666	670
% Chg	125	9	83	-34	**16**

Air Velocity Summary Sheets

AHU 9

Velocity Color Key

(red)	0 – 399	(green)	600 – 799
(yellow)	400 – 599	(blue)	800 – 999

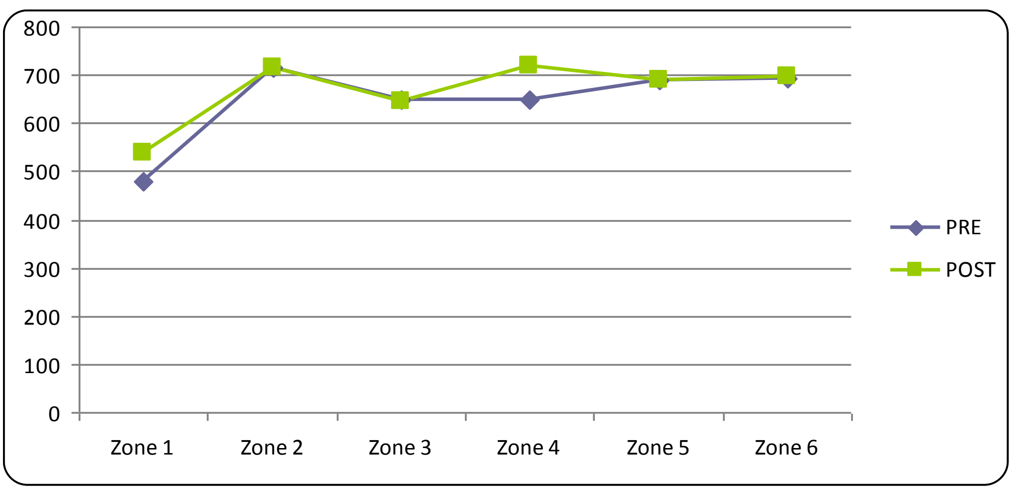
Pre Clean Velocity (ft/min)

647	716	481
650	688	694

Post Clean Velocity (ft/min)

645	714	539
718	688	695

Velocity Comparison by Coil Section



Velocity % Change by Coil Section

Bin #	1	2	3	4	5	6	AVG
Pre	481	716	647	650	688	694	646
Post	539	714	645	718	688	695	667
% Chg	12	0	0	11	0	0	**4**

References

Kats, Greg. “Greening American’s Schools: costs and benefits”, p. 2-14. October 2006. <www.cap-e.com>